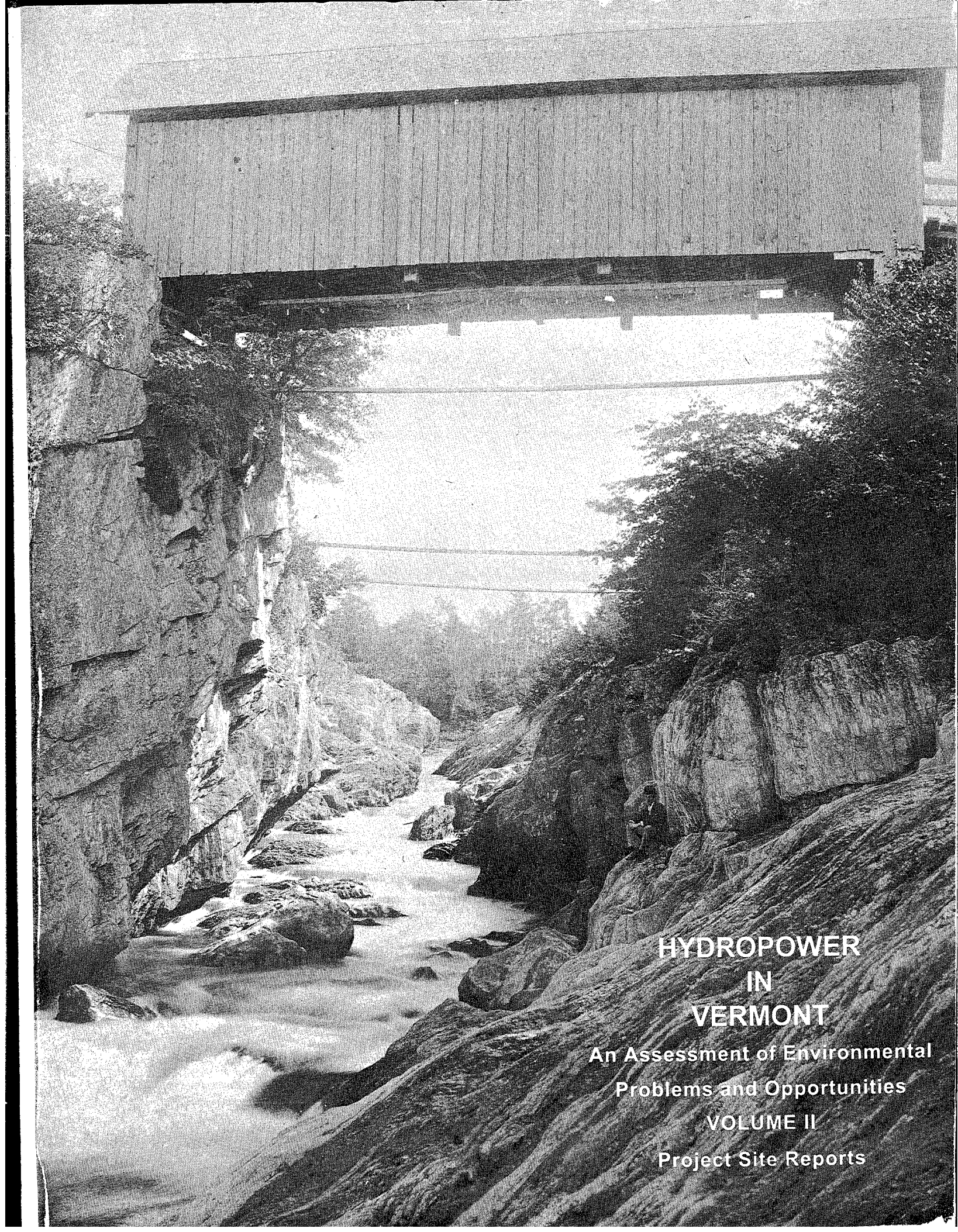

HYDROPOWER IN VERMONT

An Assessment of Environmental Problems and Opportunities

VOLUME II

Project Site Reports

HYDROPOWER IN VERMONT

AN ASSESSMENT OF ENVIRONMENTAL PROBLEMS AND OPPORTUNITIES

VOLUME II

PROJECT SITE REPORTS

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BY

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Cover Photo - Middlesex Gorge, Winooski River, Circa 1890.
Looking upstream before flooding by 1895
construction of dam for Middlesex #2 Project.
(Photo from the collection of Jeffrey R. Cueto.)

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GLOSSARY

assimilative capacity (ASCAP): a measure of the capacity of the receiving waters to assimilate wastes without lowering their quality below the applicable water quality criteria.

bypass: a section of stream bypassed by a hydroelectric project. These sections are usually located between a project's dam and the end of a project's tailrace. This section may vary in length from simply the width of a dam to a few miles. These stream sections are either completely or partially dewatered.

dissolved oxygen (D.O.): oxygen dissolved in water, measured in terms of mg/l or percent saturation. The concentration of dissolved oxygen present in a stream is an indicator of water quality.

flashboard: boards installed along the crest of a dam. These boards increase the available head for a given project and increase the size of an impoundment which in turn increases a project's storage capacity. These boards are frequently designed to fail under high stream flows.

impoundment: an impounded body of water located upstream of a dam.

invertebrates: refers to aquatic larval stages of insects which contribute to the aquatic biota of a stream and are indicators of water quality. Many invertebrates serve as fish food organisms (may also be referred to as macroinvertebrates or benthos).

leakage flow: that flow which leaks through a hydroelectric project. The source of this flow is usually leakage through or around a project's dam, flashboards, gates, bedrock or powerhouse. This flow is frequently less than the 7Q10 value for the stream on which the project is located.

lentic: of, relating to, or living in slow moving water.

lotic: of, relating to, or living in actively moving water.

peaking project: a project which operates to maximize power generation during periods of peak power demand. Natural stream flows below the project's powerhouse are artificially regulated as a result.

penstock: a conduit or pipe for conducting water from an impoundment to a project's powerhouse.

periphyton: organisms (such as algae or mosses) which live attached to the submerged substrate of a streambed. It is an important food source for some fish and many invertebrates.

reoxygenation: the process of oxygen entering and mixing with water.

rheophilic: preferring or living in flowing water.

riffle: a shallow section of stream characterized by a broken, turbulent water surface.

run: a deep, fast-moving section of stream where the water surface is non-turbulent.

run-of-the-river project:

a. true run-of-the-river: a project which does not operate out of storage and, therefore, does not artificially regulate natural stream flows below the project's powerhouse. Outflow from the project is equal to inflow to the project's impoundment on an instantaneous basis.

b. essentially run-of-the-river project: a project which does not utilize substantial storage, does not significantly fluctuate flows, and at all times releases adequate minimum flows. Project outflow is substantially equal to project inflow.

storage reservoir or storage natural lake: a manmade reservoir or natural lake used to augment natural stream flows for downstream generating facilities.

stratification: the distinct layering of reservoir water during the summer season. The warmer upper layer of the water is prevented from mixing with the cooler lower layer because of the large difference in their densities due to temperature differentials. Oxygen isolated in the lower water at the beginning of the stratification period, if used up, cannot be replenished. An oxygen deficit occurs in the deeper sections as a result.

tailrace: a canal located at the powerhouse discharge to divert flows back into the river channel.

useable area: the area of a section of stream having suitable depths, velocity and substrate for a specific fish species at a particular life stage or for invertebrates.

ABBREVIATIONS

ACOE: Army Corps of Engineers

cfs: cubic feet per second

csm: cubic feet per square mile of drainage area

D.O.: dissolved oxygen

FERC: Federal Energy Regulatory Commission

FFNA methodology: Fishery Flow Needs Assessment methodology

IFIM: Instream Flow Incremental Methodology

PSD: Vermont Public Service Department

7Q10: a statistical flow value representing the consecutive seven-day mean low flow with a recurrence interval of ten years.

STP: Sewage Treatment Plant

TNC: The Nature Conservancy

USFWS: U.S. Fish and Wildlife Service

VINS: Vermont Institute of Natural Science

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Introduction

"Hydropower in Vermont: An Assessment of Environmental Problems and Opportunities" is the first comprehensive environmental study of existing hydroelectric projects in Vermont. The primary focus of the study, initiated by the Department of Environmental Conservation in 1982, was the identification of water quality and quantity problems which may occur at these projects as a result of the artificial regulation of natural stream flows. By design, the study includes only those 62 projects which predate the recent period of renewed interest in hydroelectric power development.

The study is presented in two volumes. "Volume I: Summary of Study and Results" includes an executive summary; introduction; background; study procedure; results and discussion; and finally, conclusions and recommendations. This particular volume--"Volume II: Project Site Reports"--includes individual site reports for the projects studied. These reports discuss major findings for each project and support the information presented in Volume I. The basic report format and content is described on pages 4-1 through 4-3 of Volume I.

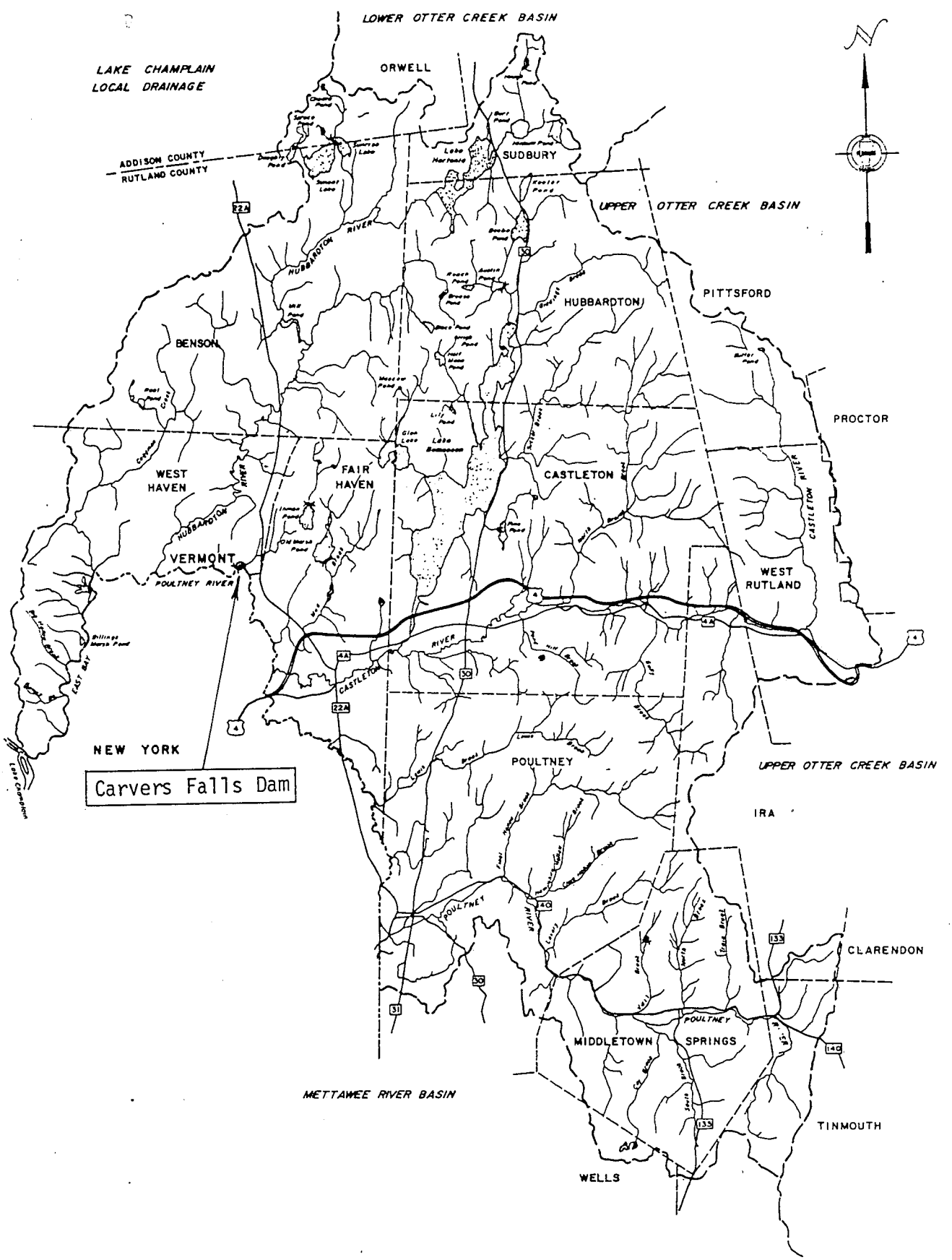

FIGURE 1

POULTNEY RIVER
DRAINAGE BASIN

SCALE OF MILES
0 1 2 3

APRIL, 1980

BASIN 2

STREAM: Poultney River

PROJECT: Carvers Falls

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed; Water Quality Certification issued May 7, 1981

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Warm water

IMPACT: Significant

Project Features

The Carvers Falls project is located on the Poultney River in the Town of West Haven (Figure 1). The project has a drainage area of 187 square miles. Project features include a concrete dam 34 feet high and 450 feet long with a total spillway length of 340 feet. The Vermont side of the dam is fitted with 5.5 foot flashboards, with 1.5 foot flashboards on the New York side. The main section of the project's penstock is 200 feet long with each header being 132 feet long. The project bypasses about 600 feet of streambed. The powerhouse contains two turbines with capacities of 600 kW and 1200 kW under an operating head of 112 feet. The impoundment extends upstream about three-eights mile and has a surface area of 10 acres. Department records do not indicate if these impoundment features are with or without flashboards.

Operating Mode

Carvers Falls is reported by the utility to be a run-of-the-river project, however, the operator has stated that the facility often stops generating at 4:00 p.m. and ponds until the next morning and that whether the project generates or not depends on system load. During a site visit by the Department on August 4, 1982, the facility was not generating and the pond level was drawn down 2 to 3 feet. On this same date the Department measured a leakage flow of 6.7 cfs at a point just below the tailrace. The source of this flow was leakage through the dam and a small amount of flow which runs through the powerhouse to keep the turbines wet.

In 1983 the Department found that the 6.7 cfs measured in 1982 was not the actual leakage flow but instead the natural low flow in the river the day the measurement was taken. The Department made this finding when reviewing CVPSC's compliance

with Condition D of a Water Quality Certification issued May 7, 1981, for dam repair and desilting work which required an Army Corps of Engineers (ACOE) 404 permit. Condition D of this certification is as follows:

"D. The amount of reduction in leakage resulting from this project shall be restored by alternate means by CVPSC. CVPSC shall submit a proposal to the Department of Water Resources and Environmental Engineering for maintaining flows equivalent to those previously experienced through leakage at full pool. Included shall be the previous leakage rate and the release method used to supplement future leakage. The leakage flows shall be determined using USGS gage 42800. The proposal shall be submitted prior to June 30, 1981, implementation to be completed as soon as possible."

In reference to this condition, the Department contacted CVPSC by letter dated June 1, 1983. To summarize this letter, the Department reviewed flow records from USGS gage 04280000 on the Poultney River in Fair Haven and found that average leakage flows for the period August to November, 1980, ranged from 15 to 17 cfs. Records from July, 1982, indicated leakage was on the order of 29 cfs. This higher flow bore out the utility's conclusion that leakage rates at the site are increasing as erosion between the dam and the adjacent bedrock continues. Based on this analysis, the Department concluded that the 6.7 cfs measurement on August 4, 1982, was probably the natural low flow in the Poultney and could not be attributed to the dam. The Department also stated in this letter that they realized CVPSC may wish to make further repairs at the dam and required, therefore, "that no repairs be undertaken such that they would result in the leakage flow downstream of the dam being reduced below 16 cfs."

The Department finds that the 16 cfs leakage flow may not be maintained as required. Reviewing flow records from the USGS gage for summer 1985, the Department found that during cycling operations in September, the flow releases were commonly depressed to 8.3 cfs, about half of the 16 cfs requirement. This flow is less than the 7Q10 (9.0 cfs) for the river.

On three separate occasions, the Department has requested that CVPSC provide us with a proposal for a fail-safe measure to pass the required 16 cfs at the dam. To date, the Department has received no response.

Environmental Review

a. Water Quality

The Poultney STP is located eight miles upstream and has a permitted total discharge of .350 mgd. Also, the Fair Haven STP and the Castleton STP are located on the Castleton River whose

confluence with the Poultney River is 2.8 miles upstream of the dam. The design flows for these two projects are .750 mgd for the Fair Haven plant and .360 mgd for the Castleton plant.

Water quality conditions of the Poultney River are described in the Department's 1984 Water Quality Assessment 305(b) Report. The Poultney River from Poultney to the confluence with the Castleton River is a water quality limited segment for D.O. concentrations because of municipal wastes. The actual miles of water quality standards violated is unknown pending an assimilative capacity study by the Department. From the Castleton River downstream to Lake Champlain, the Poultney is an effluent limited segment which is presently meeting water quality standards.

In August, 1982, the Department collected temperature and D.O. data from two stations, one just below the project's tailrace and the other further downstream beyond an island. The data was collected during the daylight hours when flow was 6.7 cfs which is 74% of the estimated 7Q10 flow of 9 cfs. Supersaturated conditions were found, which is evidence of algal activity. Violations of D.O. standards may occur during the early morning, pre-dawn hours, particularly if the project is ponding overnight.

b. Fisheries

The Poultney River upstream of the Carvers Falls Dam supports a cold water fishery, the principal species being brown trout. Below the dam is a warm water fishery which is influenced by Lake Champlain. Spawning, nursery and adult habitat is present above the project's impoundment. The tailrace provides spawning habitat for walleyes. Nursery and adult habitat is found downstream of the tailrace. There is no information on the project's bypass.

Vermont Fish & Wildlife reports that the project could impair fisheries, in particular spawning walleyes, if during periods of low flows in the spring, downstream flows were interrupted by the project.

The Vermont Field Office of The Nature Conservancy (TNC) has also reported to the Department by letter dated April 11, 1985, that the Poultney River from Coggman Bridge (three miles downstream of Carvers Falls) to a point about .8 mile downstream has been found to support populations of three species of fish uncommon to rare in Vermont. These species are the Eastern Sand Darter, Black Chin Shiner, and the Channel Darter. According to the information provided, "it is not apparent at this time that this dam poses a threat to these species."

Increased turbidity and siltation have been identified as threats to these uncommon to rare species by limiting visibility for feeding and siltation of feeding areas and spawning grounds.

TNC plans to contact CVPSC regarding these fish and their sensitivity to silt. Any desilting of the Carvers Falls impoundment should, therefore, be done with the utmost caution to prevent the discharge of excessive silt levels downstream.

c. Recreation/Aesthetics

Department representatives report that the Carvers Falls impoundment may be used for swimming but the water is quite turbid and water levels fluctuate. The Poultney River upstream of the dam is used for flat water boating. Downstream recreational use includes flat water canoeing.

Access to the impoundment is via a public road. There is a canoe launch to the impoundment as well as a primitive scenic overlook to the falls. Downstream access is via a private road to the project's powerhouse, and a trail from the powerhouse to the river. This trail is quite steep, however.

The lack of adequate flow releases both at the dam and downstream of the powerhouse impair the recreational and aesthetic value of the stream.

d. Natural Area/Wildlife Habitat

The Agency's Waterfalls, Cascades and Gorges Study identifies Carvers Falls as being of high statewide importance. The falls are the largest and highest in the state and discharge into a limestone gorge which is one of the best examples of this kind of gorge in Vermont. One rare plant species was also found in the gorge and others are expected. The study recommends that the Carvers Falls site "be restored" by removing an abandoned penstock which crosses the falls just below the dam and providing adequate summer flows.

e. Erosion/Siltation

As previously stated, the Department issued a Water Quality Certification to CVPSC in 1981 to perform some desilting and dam repair work. In June/July of 1982 while CVPSC was doing some repairs to the dam, there was a substantial silt release from the project. This release silted in the control section for the USGS gage in Fair Haven. USGS reports that a new rating had to be established for the gage and that it took at least a year for the silt to wash out of the control section.

Silt releases from the project pose a threat to the uncommon to rare fish species found downstream in the Poultney River.

Recommendations for Further Study

a. A water quality sampling program should be conducted to determine the project's impact on water quality, particularly on D.O. concentrations. The critical time to collect this data would be during the early morning hours and periods when the project is impounding in the warmer, low flow months. This study could possibly be incorporated into the assimilative capacity study the Department has scheduled for the Poultney River.

b. The project's bypass should be evaluated for potential fish habitat.

c. The site should be reviewed for recommendations regarding recreational development.

Recommendations

a. Minimum flow should be required at the site for water quality, fisheries, aesthetics and recreation. Flow should be released both over the dam and below the powerhouse.

b. The old penstock at the top of the falls should be removed.

c. Silt releases should be avoided, in particular, to protect the uncommon to rare fish species identified below the project.

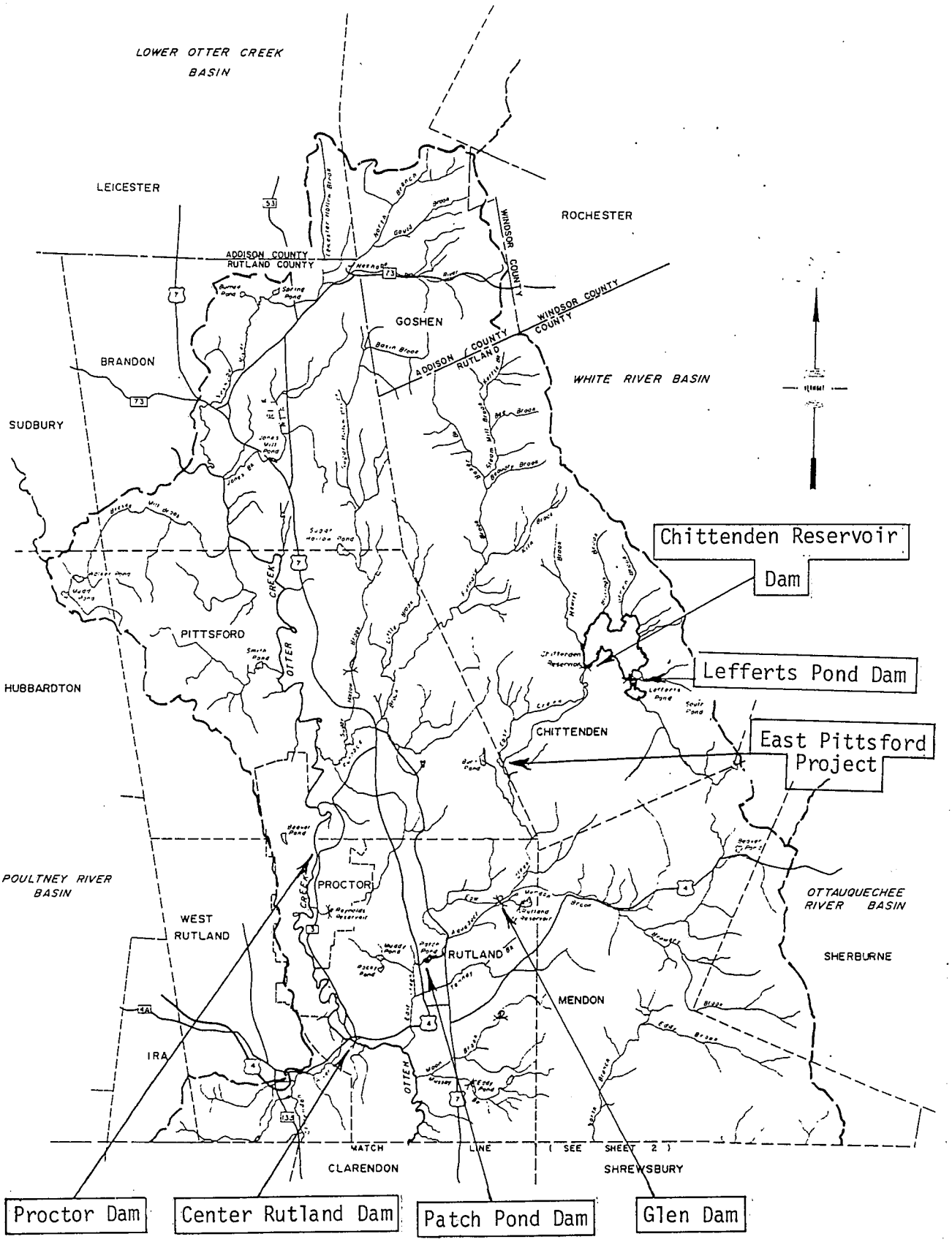

FIGURE 2

UPPER OTTER CREEK
DRAINAGE BASIN

SCALE OF MILES

APRIL, 1980

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

BASIN 3

STREAM: East Creek

PROJECT: Lefferts Pond

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Minor

Project Features

Lefferts Pond is located on East Creek in the Town of Chittenden immediately upstream of Chittenden Reservoir (Figure 2). The pond has a drainage area of 6 square miles (CVPSC uses a drainage area of 7 square miles) and a surface area of 55 acres. Project works include two dams referred to as Lefferts Pond East (back spillway) and Lefferts Pond West (front spillway).

Operating Mode

Lefferts Pond, in conjunction with Chittenden Reservoir, was operated as a storage reservoir for the East Pittsford Project downstream. CVPSC reports by letter dated July 17, 1987, to the Department that they do "not utilize Lefferts Pond in a pond-release mode... The pond is maintained mainly for recreational purposes (fishery, waterfowl)." Department personnel reported considerable leakage through the Lefferts East dam. On July 19, 1982, a leakage flow of 1.8 cfs was measured 20 feet below this dam.

Environmental Review

a. Fisheries

Vermont Fish and Wildlife reports that there is spawning and nursery habitat upstream of Lefferts Pond for salmon which have been stocked in Chittenden Reservoir. This stocking has been temporarily discontinued. The upstream migration of salmon to these areas was prevented in 1981 when the back spillway was repaired. CVPSC reports by letter dated July 17, 1987, that they are currently working with Vermont Fish and Wildlife to rebuild the back (east) spillway to facilitate fish movement. Vermont

Fish and Wildlife reports that although the pond is no longer used as a storage facility, the pond provides important fish and waterfowl habitat and should be maintained.[1]

Recommendations

Vermont Fish and Wildlife should continue working with CVPSC to rebuild the back (east) spillway to facilitate fish movement.

[1] Personal communication with David Callum, District Fisheries Manager, Vermont Fish and Wildlife, January 21, 1988.

BASIN 3

STREAM: East Creek

PROJECT: Chittenden Reservoir/East Pittsford Project

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Chittenden Reservoir is located in the Town of Chittenden on East Creek (Figure 2) upstream of the Glen Dam and Patch Dam projects. The reservoir has a drainage area of 17 square miles and extends upstream 1.6 miles with a surface area of 760 acres at elevation 1492' USGS. (Spillway crest elevation is 1495' USGS.) The usable storage of the impoundment with a 16-foot drawdown from elevation 1492' USGS is 8400 acre feet. A penstock about three miles long diverts stream flows from the project downstream to the East Pittsford Power Project (actually located in Chittenden), which is a peaking facility owned by CVPSC. This penstock bypasses a total of about four miles of East Creek. The East Pittsford Project operates with 480 feet of head and has an installed capacity of 2300 kW. The maximum discharge from the station is 130 cfs.

Operating Mode

"The Chittenden Reservoir Dam is used primarily for the storage of water for the production of power by the Central Vermont Public Service Corporation. Water stored at Chittenden Reservoir is also used as a water source to Vermont Marble, as well as being used for recreation during the summer months. Under normal operation, the penstock gates are continually open and the wastegates closed. Water level is allowed to reach no higher than three (3) feet below the spillway crest elevation. Water is released from the reservoir as needed for power generation. During the fall and winter the reservoir is drawn down 19 feet below the spillway crest for storage of snowmelt and spring runoff. Water for power generation is fed through a long (greater than one-half mile) 42 inch diameter penstock."[1]

[1] Chittenden Dam. Phase 1 Inspection Report. National Dam Inspection Program. Army Corp of Engineers. January, 1979.

Available information indicates there is no flow maintained below the reservoir in the four mile bypassed section of East Creek, other than that which flows in from intervening tributaries. In addition, the Department observed no leakage flow below the East Pittsford powerhouse on August 4, 1982. CVPSC reports to the Department by letter dated July 17, 1987, that there is leakage through the dam's wastegate. There is no additional information on the operation of the East Pittsford station other than it is a peaking project.

Environmental Review

a. Water Quality

The Department collected water quality data from the site in 1982. A preliminary review of the data indicates that Chittenden Reservoir stratifies and a D.O. depletion occurs with increases in depth, approaching anoxic conditions at the greatest depths with D.O. concentrations as low as 1% of saturation near the dam. The project operates with a bottom withdrawal structure; therefore, these low D.O. concentrations could be carried downstream.

During periods of impounding, there may be water quality problems below the East Pittsford Project. No water quality data was collected by the Department below the project's powerhouse. Water quality problems may also develop in the bypassed section of stream due to insufficient flows.

A minimum flow requirement of at least 7Q10 is necessary below all projects on East Creek for assimilative capacity purposes on the Otter Creek below Rutland.

b. Fisheries

Chittenden Reservoir supports a cold water fishery, the principal species being brook trout and brown trout. Salmon stocking has been discontinued, although further studies may call for restocking. Yellow perch and smelt are also found in the impoundment. The tributaries upstream of the project support brook trout and rainbow trout. A brook, brown, and rainbow trout fishery is also found in East Creek below the East Pittsford powerhouse. Nursery and adult habitat for all species is found in the impoundment and upstream. Spawning areas for all species are found above the impoundment. There is no information on the quality or type of fishery, if any, in the bypass.

Vermont Fish and Wildlife reports that the reservoir drawdown in the winter and early spring impairs fisheries. No comments were provided on the impact the project may have on fisheries in East Creek below the East Pittsford powerhouse.

c. Recreation/Aesthetics

The reservoir level is maintained for boating and swimming in the summer months. CVPSC maintains a fishing access area on the reservoir. The dewatering of the streambed below the reservoir impairs the recreational and aesthetic use of the area. This should be of particular concern as the project is within the Green Mtn. National Forest; the impoundment appears to receive heavy recreational use; and a town highway follows East Creek below the project, making the creek quite visible. There is no recreational development below the project.

Recommendations for Further Study

a. Assess project impact on water quality and fisheries in the bypass and downstream of the powerhouse. D.O. and temperature data should be collected below the powerhouse during periods of generation and nongeneration.

b. Existing and recommended flows in the bypass should be determined and more information should be obtained on the operation of the East Pittsford Project.

c. A more detailed analysis of the water quality data collected from the reservoir should be conducted.

d. Based on a further assessment of project impact on fisheries and water quality, a minimum flow requirement may be established both in the bypass and downstream of the East Pittsford powerhouse. This flow would also improve downstream recreation and aesthetics. It may also be necessary to install a reaeration structure at the discharge from the East Pittsford powerhouse if D.O. concentrations below the powerhouse are substandard due to the hypolimnetic withdrawal from the reservoir.

e. Determine if there are any problems as a result of impoundment drawdown.

Recommendations

Minimum flow requirements should be maintained in the project's bypass and downstream of the East Pittsford powerhouse. The flow below the powerhouse should be coordinated with Glen and Patch dams downstream as the projects should be managed as a unit.

BASIN 3

STREAM: East Creek

PROJECT: Glen Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Glen Dam is located on East Creek in the Town of Rutland about eight miles downstream of Chittenden Reservoir and four miles upstream of Patch Dam (Figure 2). The project has a drainage area of 44 square miles and an impoundment with a surface area of about 6.3 acres extending upstream 500 feet. The dam is fitted with 6 feet of flashboards. It is not known if the impoundment size is with or without project flashboards in place.

A penstock 6000 feet long and bypassing 3 miles of East Creek diverts stream flows to the project's powerhouse which contains two generators having an installed capacity of 1000 kW each under an operating head of 173 feet. The maximum discharge from the project is 187 cfs. The tailrace discharges into the upstream end of the Patch Dam impoundment.

Operating Mode

Department personnel report from discussions with the utility that this is a daily peaking project with a maximum drawdown of 2 to 3 feet. The project generates or ponds based on system needs. Water levels in the impoundment are influenced by Chittenden Reservoir and Mendon Brook, whose confluence with East Creek is about 1000 feet upstream. An employee for the project reported to the Department August 4, 1982, that the plant usually shuts down at night but that some flow is maintained through the powerhouse to keep the turbines wet. Department records do not indicate what this flow is. The Department measured a leakage flow at a point 150 feet below the dam of 1.3 cfs on August 4, 1982. The source of this flow was through the flashboards and the seal around the project's waste gate. This flow is 11% of the estimated 7Q10 for the project of 12 cfs. During periods when only leakage flow is maintained below the dam, the only flow in East Creek is that which is contributed by tributaries.

Environmental Review

a. Water Quality

The Department collected temperature and D.O. data from the project site. D.O. concentrations approaching saturation were measured in the late afternoon in the bypass and tailrace. These measurements may be an indication of algal activity.

Water quality problems may develop in Patch Pond during periods when both the Patch Dam and Glen Dam projects are impounding, particularly during the warmer low flow months.

A minimum flow of at least 7Q10 is necessary below all projects on East Creek for assimilative capacity purposes on the Otter Creek below Rutland.

b. Fisheries

East Creek supports a cold water fishery above and below Glen Dam (including the bypass) consisting of brook trout, brown trout and rainbow trout. Nursery and adult habitat is present for these species above and below the dam and spawning habitat is available above the project's impoundment and below the dam.

Vermont Fish and Wildlife reports that the hydropower operation impairs fisheries as there are times when there is no flow in sections of East Creek both in the bypass and downstream. Fisheries in this watershed could be improved if there was a low flow requirement.

c. Erosion/Siltation

Mild erosion was observed in the project's impoundment. This is probably from unstable water levels.

d. Recreation/Aesthetics

A private road access to the impoundment is the only recreation development above or below Glen Dam. Department personnel report that higher stream flows in the bypass would improve the stream section for whitewater boating.

The lack of a minimum flow requirement at the dam and through the bypassed section of stream and downstream impairs the aesthetics and recreational use of the area.

Recommendations for Further Study

a. Early morning temperature and D.O. samples should be collected in the project's bypass to check for D.O. violations

under leakage flow conditions. Water quality impacts below the project's powerhouse, particularly during periods of nongeneration, should also be determined.

b. Determine the need for additional recreational development at the project site.

Recommendations

A minimum flow requirement should be established through the bypass and below the project during periods of nongeneration for fisheries and water quality. This would improve the aesthetics and recreational use of the bypass and downstream as well. Minimum flow requirements should be coordinated with those at Patch Dam and Chittenden Reservoir as these projects should be managed as a unit.

BASIN 3

STREAM: East Creek

PROJECT: Patch Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Patch Dam is located on East Creek in the Town of Rutland downstream of Glen Dam and Chittenden Reservoir, and 2.4 miles upstream of the confluence with Otter Creek (Figure 2). The project has a drainage area of 51 square miles and an impoundment with a surface area of 22 acres extending about 4000 feet upstream. No flashboards are used. The powerhouse is an integral part of the dam and has an installed capacity of 300 kw. Maximum discharge from the project is 174 cfs. There is no bypassed section of stream.

Operating Mode

CVPSC reported to the Department in a 1982 interview that the project is operated as a run-of-the-river facility; however, Vermont Fish and Wildlife says that the project does pond. Maximum drawdown is reportedly one foot. Inflow to the project depends on the operation of the Glen Dam and Chittenden Reservoir projects upstream.

The Department has also reviewed flow records from a USGS gaging station (04281500) which was located just downstream of the project from 1941 to 1977. These records indicate the project is not operated in a run-of-the-river mode and that ponding does occur, resulting in extremely low flows below the project. For example, during water year 1976, there were 25 days when flows were less than the 7Q10 flow of 14 cfs. (In water year 1977, flows less than 7Q10 were recorded 76 days). The majority of these low flows were recorded in November and September. They occurred for as long as eight hours at a time, primarily in the early morning. The lowest flow recorded, which probably could be considered leakage through the project, was 4.5 cfs on November 11, 1975. This flow is only 32% of 7Q10.

The Department also noted when reviewing these records that this ponding operation did not necessarily occur in days of

particularly low flows. For example, on the date the 4.5 cfs was recorded, the mean flow recorded at the gage was 117 cfs, eight times higher than 7Q10.

Environmental Review

a. Water Quality

There is no recent water quality data from the project area to indicate whether there are any water quality problems. No data was collected during the summer of 1982.

It is possible there could be water quality problems below the project during periods of impounding.

A minimum flow requirement of at least 7Q10 is necessary below all projects on the East Creek for assimilative capacity purposes on the Otter Creek below Rutland.

b. Fisheries

East Creek above and below Patch Dam supports a cold water fishery. Brook trout, brown trout, and rainbow trout are found above the dam. Brown trout and some smallmouth bass are found below. The project's impoundment provides nursery and adult habitat for salmonids.

The tailrace provides nursery and adult habitat for salmonids and smallmouth bass. Adult habitat for smallmouth bass and salmonids is also present downstream of the tailrace.

Vermont Fish and Wildlife reports that the hydropower operation impairs fisheries below the dam by creating extreme low flow conditions. A minimum stream flow would mitigate this problem.

c. Recreation/Aesthetics

The impoundment and project tailrace are used for fishing. The impoundment is posted against trespassing. Department records indicate there is no recreational development above or below the site.

The lack of a minimum flow over the dam and downstream would impair the aesthetics and recreational use of the site.

d. Erosion/Siltation

Patch Dam has had a history of desilting problems. According to a Vermont Fish and Wildlife memo dated December 5, 1979: "A few years ago, a project was undertaken to desilt this impoundment. The problem caused by the silt downstream can be

found even today". In September of 1980, another silt release occurred below the project while CVPSC dewatered the pond to facilitate making some repairs to the dam. This silt release resulted in a violation of Vermont Water Quality Standards in East Creek and Otter Creek, as well as fish mortality and sedimentation of the streambed.

The Department's Otter Creek Basin Water Quality Management Plan (April, 1975) states that the impoundment fills in with silt rapidly and problems have occurred in the past with efforts to desilt behind the dam.

Recommendations for Further Study

a. Temperature and D.O. data should be collected below the project during periods of impounding, particularly in the early morning hours, to assess water quality impacts. Leakage flows during these periods should also be measured.

b. The site should be reviewed to determine the need for recreational development.

Recommendations

a. A minimum flow requirement should be established below the project during periods of impounding for fisheries and water quality. Passage of part of this flow at the dam would improve project aesthetics as well. The minimum flow requirement should be coordinated with Glen Dam and Chittenden Reservoir as these projects should be managed as a unit. Minimum flows would also improve downstream recreational use.

b. Any proposed desilting or dam repair work should be carefully reviewed by the Department to prevent silt releases from recurring below the project.

c. Public access to the creek and pond should be allowed within the limits of public safety.

BASIN 3

STREAM: Upper Otter Creek

PROJECT: Center Rutland

UTILITY: Vermont Marble Company (VMARCO)

LICENSE STATUS: FERC license expires December 31, 1993

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Center Rutland is located on the Otter Creek in Rutland about seven miles upstream of Proctor Dam and 6000 feet downstream of the confluence with East Creek (Figure 2). The confluence of the Clarendon River with the Otter Creek is about 1000 feet below the project. The project has a drainage area of 308 square miles. The dam is founded on ledge. The spillway is 175 feet long and topped with 18-inch flashboards which create an impoundment with a surface area of nine acres extending 2500 feet upstream to Ripley Bridge. Usable storage is estimated by VMARCO to be 18 acre-feet with a two foot drawdown from the top of the flashboards. A 75 foot long penstock directs flows to a power-house containing a horizontal Francis type turbine with a hydraulic capacity of 160 cfs. The project has an installed capacity of 300 kW, under a gross head of 26.5 feet. One hundred feet of stream are bypassed by the project.

Operating Mode

VMARCO reports that under low flow conditions, the project generates seven days a week, 24 hours a day, with an average drawdown of 1.5 feet. During extreme low flows, it is uneconomical to run on weekends; therefore, spillage occurs. In the winter months, the project generates seven days a week under low flows to prevent freeze-ups.

Under moderate flows, the utility states that the project generates seven days a week, 24 hours a day, with an average drawdown of one foot. The project generates seven days a week, 24 hours a day, under high flows with no drawdown.

Dam repairs are made during low flow periods when flows are discharged through the wastegate.

There is no information available as to the flow that is maintained below the project during periods of refilling the

impoundment. Presumably, all that is maintained below the project downstream to the confluence with the Clarendon River is that which leaks through the project. No leakage flows have been measured at the site; however, there is a USGS stream gage (04282000) 200 feet below the project.

Reviewing the records from the USGS gage for the period June 6, 1985, through September 25, 1985, flows less that 80 cfs (7Q10) were measured on 29 separate days out of the 112 day period. In most cases, these low flows occurred either in the early morning at about 0700 hours or late afternoon at about 1600 hours and were maintained one to two hours at a time. The average low flow measured was 40 cfs, or 50% of 7Q10. The lowest flows measured were 8.1 cfs on August 19 and 8.4 cfs on August 13. These flows represent only about 10% of 7Q10 and may represent project leakage flows. "From July 11 to August 1, 1985, the period of near record low stream flow on Otter Creek, the Center Rutland Station was shut down and all water was passed over the dam."[1]

Environmental Review

a. Water Quality

Center Rutland Dam is located in a water quality limited segment which extends from Moon Brook in Rutland downstream to Furnace Brook in Pittsford. The quantity of wastes currently discharged to this segment exceeds the stream's assimilative capacity. The Rutland City STP is located upstream of the dam. Downstream discharges include the West Rutland, Rutland Town, Proctor and Pittsford STPs.

The Department conducted a wasteload allocation study on the Otter Creek in 1978, the results of which are presented in two parts. Otter Creek Wasteload Allocation Study, Part A: Report of Data, January, 1979; and Otter Creek Wasteload Allocation Study, Part B: Mathematical Modeling Report, May, 1979. Reference should be made to these reports for a detailed description of the water quality in the project area.

The Center Rutland Dam may have an impact on the Assimilative capacity of the stream, particularly during those periods when no flow is maintained below the project. The stream's assimilative capacity could also be affected if there is no spillage over the dam for reaeration. This needs to be evaluated further.

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[1]Personal communication with David Ferris, VMARCO, June 1987.

b. Fisheries

The Otter Creek above and below the project supports a mixed fishery, the principal species upstream being rainbow trout and brown trout, northern pike and smallmouth bass. The project's tailrace and the river downstream support brown trout, northern pike, and smallmouth bass. There is no information on the bypass fishery.

Vermont Fish and Wildlife reports that the hydropower operation impairs fisheries in the project's tailrace and river downstream by "holding back" stream flow during low flow periods. The project's tailrace provides spawning habitat for smallmouth bass; nursery habitat for trout and smallmouth bass; and adult habitat for all species. Downstream of the project's tailrace there is trout spawning habitat; nursery habitat for trout and northern pike; and adult habitat for all species.

c. Recreation/Aesthetics

Center Rutland Dam is located on a set of falls which, when water is spilling over the dam, are very pretty. Under certain flow conditions, these falls may be dewatered. The project is in an industrial setting and is quite visible.

No conflicts with recreation were noted by Department personnel. The impoundment is used for fishing. Downstream is used for fishing, picnicking, and flatwater boating. The only access downstream is via a public road.

Recommendations for Further Study

a. The project impact on the water quality of the Otter Creek should be determined.

b. The bypassed section of stream should be assessed for its significance for fisheries.

c. The need for recreational development should be determined.

Recommendations

A minimum flow requirement should be established below the project for fisheries and water quality concerns. Passage of part or all of this flow at the dam would improve project aesthetics and may enhance the bypass for fisheries.

BASIN 3

STREAM: Upper Otter Creek

PROJECT: Proctor Dam

UTILITY: Vermont Marble Company (VMARCO)

LICENSE STATUS: FERC License issued February 23, 1976 and amended October 15, 1981; Water Quality Certification issued July 21, 1981

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Some

Project Features

Proctor Dam is located on the Upper Otter Creek in the Town of Proctor (Figure 2). It is part of the Proctor-Beldens-Huntington Falls Project (the project), owned and operated by VMARCO. FERC licensed the project February 23, 1976. The license was then amended October 15, 1981, to authorize redevelopment of the Proctor station. A prerequisite to this amendment was the issuance of a Water Quality Certification by the Department dated July 21, 1981. This certification includes conditions which are intended to insure maintenance of Vermont Water Quality Standards at the project site during project construction and operation. Reference should be made to the Water Quality Certification and the FERC license for a complete description of the project.

Environmental Review

a. Recreation/Aesthetics

The lack of a minimum flow requirement through the project's bypass impairs the aesthetics and recreational use of the area.

b. Natural Area/Wildlife Habitat

The Proctor Dam site was included in the Agency's Waterfalls, Cascades, and Gorges Study. The dam is constructed above a gorge which includes a set of falls referred to as Sunderland Falls. The gorge itself is one of the three largest limestone gorges in the state. The falls are about 60 feet high and 50 yards long. The study identifies reduction of flows over the falls and through the gorge as impacting the area. No minimum flow requirement at the dam was included in the Department's certification for this project, the certification having been

issued several years before the Waterfalls, Cascades, and Gorges Study was undertaken.

Recommendation For Further Study

An aesthetics study involving observation of several measured flow releases at the dam should be conducted to determine a minimum flow requirement through the bypass.

Recommendation

a. Follow up on the conditions of the Water Quality Certification by contacting VMARCO to see if they have had any problems operating as certified which is essentially run-of-the-river with releases approximating instantaneous inflows to the reservoir. Project redevelopment is believed to have been completed in 1985.

b. Arrange for the flow demonstration for the aesthetics study.

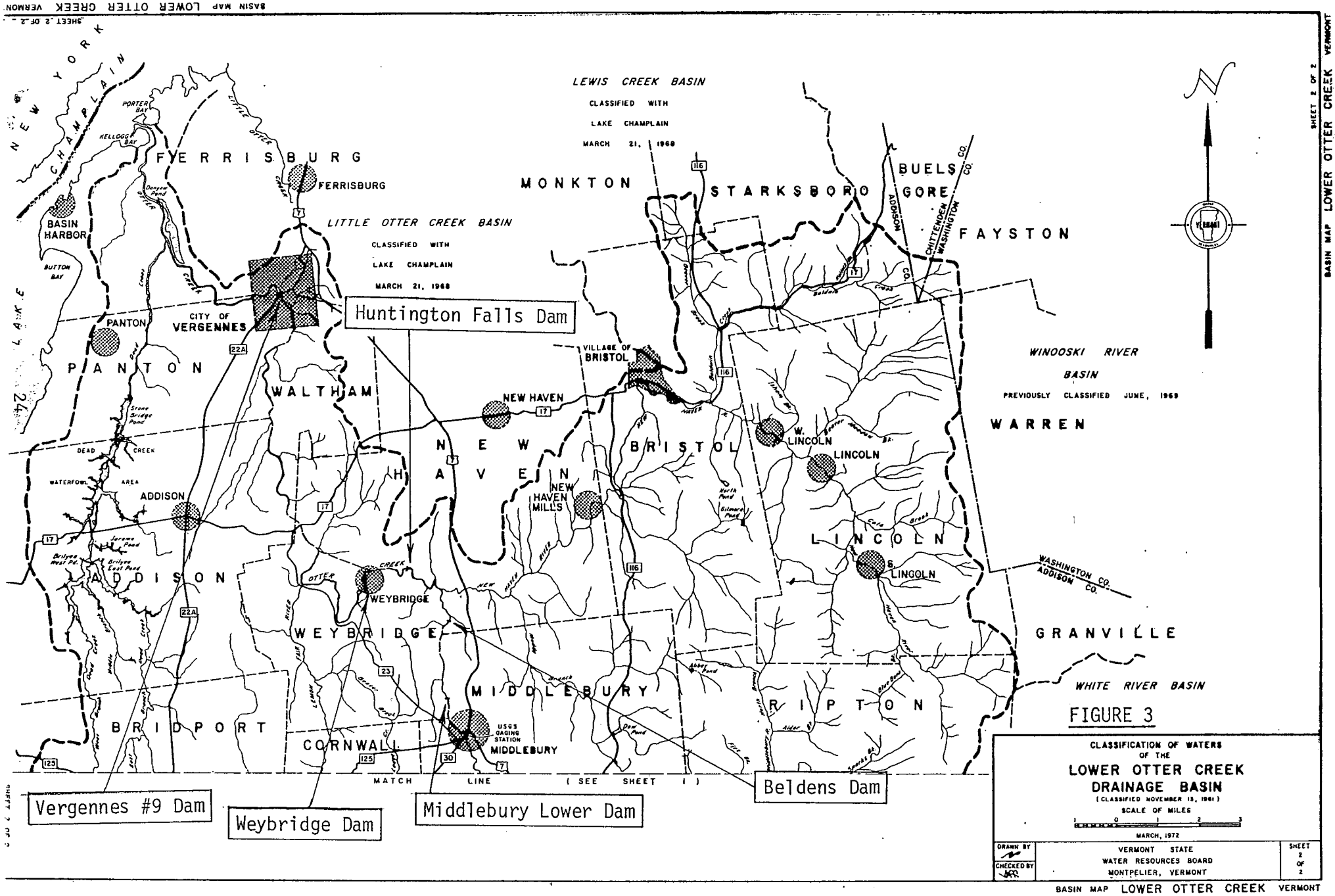


FIGURE 3

CLASSIFICATION OF WATERS
OF THE
LOWER OTTER CREEK
DRAINAGE BASIN
(CLASSIFIED NOVEMBER 19, 1968)

SCALE OF MILES
1 0 1 2 3

MARCH, 1972

DRAWN BY	VERMONT STATE WATER RESOURCES BOARD MONTPELIER, VERMONT	SHEET 2 OF 2
CHECKED BY		

BASIN MAP LOWER OTTER CREEK VERMONT

BASIN MAP LOWER OTTER CREEK VERMONT
SHEET 2 OF 2

BASIN 3

STREAM: Lower Otter Creek

PROJECT: Middlebury Lower

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC License issued July 8, 1980; Water Quality Certification issued December 31, 1974.

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Warm water

IMPACT: Some

Project Features

Middlebury Lower is located on Lower Otter Creek in the Town of Middlebury (Figure 3). The project has a drainage area of 630 square miles and is located two miles upstream of the Beldens facility. The dam is constructed in two sections - one being 80 feet long and the other 270 feet. A small island separates these two sections. There are no flashboards. Reservoir storage is extremely limited since the dam is essentially designed only for streamflow diversion. The reservoir area is approximately 16 acres, impounds approximately 45 acre-feet, and extends one mile upstream to just downstream of the falls located below the Battell bridge in Middlebury.

The powerhouse contains three generating units with designed net heads of 28 feet. The generators are rated at 750 kW each. The project bypasses about 400 feet of stream. The tailrace discharges almost directly into the upstream end of the Beldens impoundment.

Operating Mode

CVPSC describes the operating mode of the project in their FERC license application (1975) as follows:

"Middlebury Lower plant is operated in the most economical manner of the load of the system. Storage is extremely limited to hourly pondage at times of low flow. The usual rules for seasonal storage are not required at the time of normal flow. The operation is 'run-of-the-river'. At times of flood flows, the plant is operated to the maximum practical extent. No minimum flow, to be released during periods of low water, is proposed." The maximum discharge from the facility is 1000 cfs.

The Department issued CVPSC a Water Quality Certification December 31, 1974, stating that the project is not considered to be a discharge of pollutants subject to the requirements of the amended Federal Water Pollution Control Act and that operation of the facility does not violate applicable water quality standards. This certification is based on the Department's understanding that the project is a run-of-the-river facility which does not impound the flow in the river when not operating and therefore does not affect downstream water quality as a result of imposed low flow conditions.

It is unclear why the project was certified as a run-of-the-river facility which does not impound water when the FERC license application clearly states that it does impound during low flow periods.

Department personnel visiting the site in 1982 state that they strongly suspect pooling does occur at this project site in the low flow periods. During a water quality study at the site, water level fluctuations of one to two feet were observed in the impoundment. Vermont Fish and Wildlife also commented that the project may impair fisheries downstream during periods of low water, implying the project impounds.

Environmental Review

a. Water Quality

The Middlebury STP is located one mile upstream of the project and has a permitted total discharge of 1.5 mgd. If the project does impound during periods of low flow, this may impair the assimilative capacity of the stream both above and below the project.

The Department conducted a water quality study at the site in 1982. A preliminary review of the data indicates water quality problems do exist at the site. Near saturated D.O. concentrations were measured during daylight hours both above and below the dam. The Department also noted substantial algal and weed growth in the impoundment.

b. Fisheries

The Lower Otter Creek above and below the project supports a warm water fishery of northern pike and smallmouth bass. Trout (species not identified) have also been taken from this section of the river.

Spawning sites are available for all warm water species and small numbers of trout. Nursery and adult habitat are located above and below the project (presumably for warm water species though not specified). No information was provided on the bypassed section of stream.

Vermont Fish and Wildlife reports that the project probably presents no problems upstream, but may impair fisheries downstream during periods of low water.

c. Recreation/Aesthetics

There is no recreational development in the immediate project area other than a private road access to the impoundment owned by the utility and a private road access and boat launch downstream owned by private landowners.

According to the project's FERC license, the recreational needs for the project area consist of improved access to fishing areas and additional boat launching facilities. CVPSC had proposed in the license application to develop an access road, boat launch and parking area and install four picnic tables at suitable sites. They had also proposed to place a sign to warn boaters of dangerous fast currents and shallow waters upstream. CVPSC reported to the Department in a 1982 interview that they had an agreement with FERC regarding the proposed recreation plan and were not going to act on it at that time.

Lack of a minimum flow requirement at the dam and downstream impairs aesthetic and recreational values of the project and downstream.

d. Erosion/Siltation

Some mild erosion in the impoundment and downstream was reported by Department representatives during a site visit in 1982; however, it was not known if this was natural or caused by the hydro operation.

Recommendations for Further Study

a. Determine whether the project is a true run-of-the-river project. If the project is found not to operate as a true run-of-the-river facility, CVPSC should be required to apply for an amended Water Quality Certification or change the project operation such that instantaneous inflows to the project equal instantaneous outflows.

b. Survey the bypass to determine its significance for fisheries. Leakage flows through this area should be measured. If the bypass is found to be significant for fisheries and the flows through this section are found to be inadequate, a minimum flow at the dam should be required to protect and enhance the stream section for fisheries. This would improve the aesthetics and recreational values of the project as well as water quality.

c. Determine the status of the recreational plan referred to in the project's FERC license.

d. Complete the analysis of the water quality data collected in 1982. Identify any problems and additional studies which should be conducted. This may include an assimilative capacity study of the Lower Otter Creek. Appropriate recommendation for mitigation with respect to water quality will be made once problems are clearly identified.

Recommendations

In developing recommendations for mitigation for this site, reference should be made to Article 36 of the project's FERC license:

"Article 36. The Licensee shall continue to consult and cooperate with the U.S. Department of the Interior and the Oregon* State Department of Fish and Wildlife for the protection and development of the natural resources of the project area."

*This is apparently a typographical error in the project's license.

BASIN 3

STREAM: Lower Otter Creek

PROJECT: Beldens/Huntington Falls Project

UTILITY: Vermont Marble Company (VMARCO)

LICENSE STATUS: FERC license issued February 23, 1976 and amended October 15, 1981; Water Quality Certification issued June 7, 1972. The projects were recently issued a FERC license amendment. (October 15, 1986) and a Water Quality Certification (May 27, 1986) for proposed expansion.

CLASSIFICATION: Beldens-C
Huntington Falls-B

FISH HABITAT DESIGNATION: Beldens-Upstream: Cold water
-Downstream: Warm water
Huntington Falls-Upstream: Warm water
-Downstream: Cold water

IMPACT: Some

Beldens and Huntington Falls are part of the Proctor-Beldens-Huntington Falls Project (the project) owned and operated by VMARCO. Beldens and Huntington Falls are located on Otter Creek in the Towns of New Haven and Weybridge (Figure 3). The project was issued a FERC license February 23, 1976. This license was amended October 15, 1981, to authorize further development of the Proctor Station. Article 42 of this amended license is as follows:

"Article 42. The Licensee shall, within one year from the issuance date of this order, file with the Commission a detailed study of the feasibility of installing additional hydroelectric capacity at the Beldens and Huntington Falls power plants. If economically feasible, Licensee shall submit plans and a schedule for installing additional capacity at that time."

By condition of the Water Quality Certification, the two facilities are to operate run-of-the-river with minimum flow releases at the dams to assure combined spillage and leakage flows of 5.0 cfs at Beldens and 15.0 cfs at Huntington Falls. These minimum flow requirements are equivalent to the existing leakage flows at each site.

Reference should be made to the project's FERC license amendment application and Water Quality Certification for additional information on these plants.

Environmental Review

a. Recreation/Aesthetics

The minimum flow requirements at both plants are not adequate to preserve the aesthetic and recreational values of either site.

b. Natural Area/Wildlife Habitat

The Agency's Waterfalls, Cascades, and Gorges study includes the falls on which the Beldens Dam is constructed. The dam at Huntington Falls is also constructed on a set of falls, but this site was not included in the study.

No recommendations were made in the study regarding the impact on aesthetics of the Beldens generating facility. The site was noted for its interesting rocks and possible geological importance.

Recommendations

Follow up on the conditions of the Water Quality Certification and the articles of the license amendment for compliance.

BASIN 3

STREAM: Lower Otter Creek

PROJECT: Weybridge Project

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC license issued May 12, 1980; Water Quality Certification issued March 20, 1975

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Warm water

IMPACT: Significant

The Weybridge Project is located on the Lower Otter Creek in the Town of Weybridge (Figure 3). Project features and operating mode are described in a report prepared by Vermont Fish and Wildlife entitled "Assessment of Fishery Flow Needs in Otter Creek at Weybridge, Vermont" (July, 1983). This report is available by contacting the Department.

Environmental Review

a. Water Quality

The Department issued a Water Quality Certification for the project dated March 20, 1975. The certification was issued with an understanding that the project is a run-of-the-river facility which does not impound the flow in the river when not operating and therefore does not affect downstream water quality as a result of imposed low flow conditions. It was later revealed that the project is not operated in a true run-of-the-river manner, but normally peaks on a daily basis with no minimum flow release except for a very small amount of leakage. The leakage has been estimated by CVPSC to be 10 cfs or 0.013 cfs/sq. mi. Realizing that operation in this manner may violate State Water Quality Standards, the Department requested by letter dated April 8, 1982, that the utility apply for an amendment to their existing certification. To date, no such amendment application has been submitted to the Department.

The Department conducted a water quality study at the project site in 1982. A preliminary review of the data indicates supersaturated D.O. concentrations above and below the project, evidence of algal activity. One early morning (0638) D.O. sample collected from a station just below the project measured only 60% saturation. The data collected must be analyzed further to better assess water quality problems at the project site. Additional data may need to be collected, particularly early morning D.O. and temperature data.

b. Fisheries

To summarize the project status with respect to fisheries, the Agency is presently negotiating with CVPSC, USFWS and FERC regarding a minimum flow requirement below the project as stipulated in Article 31 of the project's FERC license. Article 31 is as follows:

"Article 31. The Licensee shall, within 18 months from the date of issuance of this license, in consultation with the Vermont Department of Fish and Game and the U.S. Fish and Wildlife Service, have conducted a study to determine the need, if any, for a minimum flow release from the project, for the purpose of protecting and enhancing fish and wildlife resources. The Licensee shall, within six months from the date of completion of the study, file with the Commission, with copies to the agencies consulted, a report of its findings and recommendations, if any, for a minimum flow release from the project."

Relative to Article 31, the Department conducted a FFNA study below the project in 1982. Benthic data were also collected. The study sections for the FFNA study are located in Figure 4 and the useable area curves generated from the data gathered are presented in Figures 4a thru 4d. The previously referenced report prepared by Vermont Fish and Wildlife discusses the results of the FFNA and benthic studies. An interim minimum flow requirement of 200 cfs was recommended by Vermont Fish and Wildlife based on an analysis of the data collected.

CVPSC conducted another flow study in the fall of 1986 and concluded a minimum flow of 100 cfs was adequate to protect downstream fisheries. The utility has been maintaining this flow, which is roughly half of the stream's 7Q10 value, as a minimum flow since June, 1987. The Agency does not believe this flow provides sufficient resource protection. The Agency has recommended to FERC that CVPSC conduct an expanded study and in the interim, provided a minimum flow of 375 cfs (USFWS flow).

c. Recreation/Aesthetics

Article 30 of the project's FERC license addresses recreational facilities at the site. This article is as follows:

"Article 30. Within one year from the date of issuance of this license, the licensee shall: (1) complete construction of the recreational facilities proposed in Exhibit R; (2) file a revised Exhibit F and, for approval, revised Exhibits K and R drawings which include within the project boundary all recreational lands developed or proposed for development; and (3) study, in consultation with the Vermont Agency of Environmental Conservation (AEC), the recreational need for a canoe portage

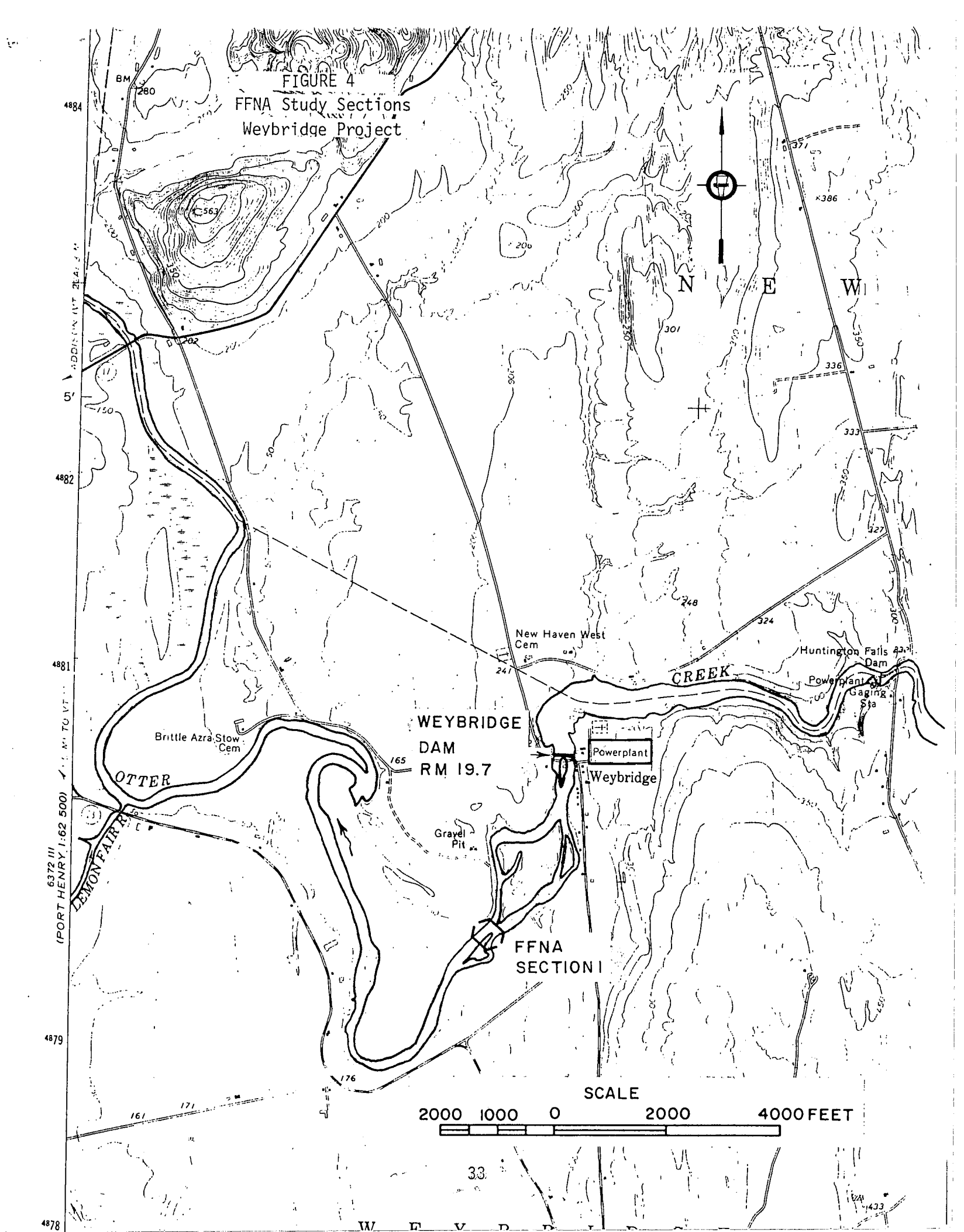


FIGURE 4
FFNA Study Sections
Weybridge Project
N
E
W
WEYBRIDGE
DAM
RM 19.7
Powerplant
Weybridge
FFNA
SECTION I
New Haven West
Cem
Huntington Falls
Dam
Powerplant
Gaging
Sta
CREEK
Brittle Azra Stow
Cem
OTTER
LEMON FAIR R
Gravel
Pit
SCALE
2000 1000 0 2000 4000 FEET
33

FIGURE 4a

FFNA Useable Area Curve - Weybridge Project

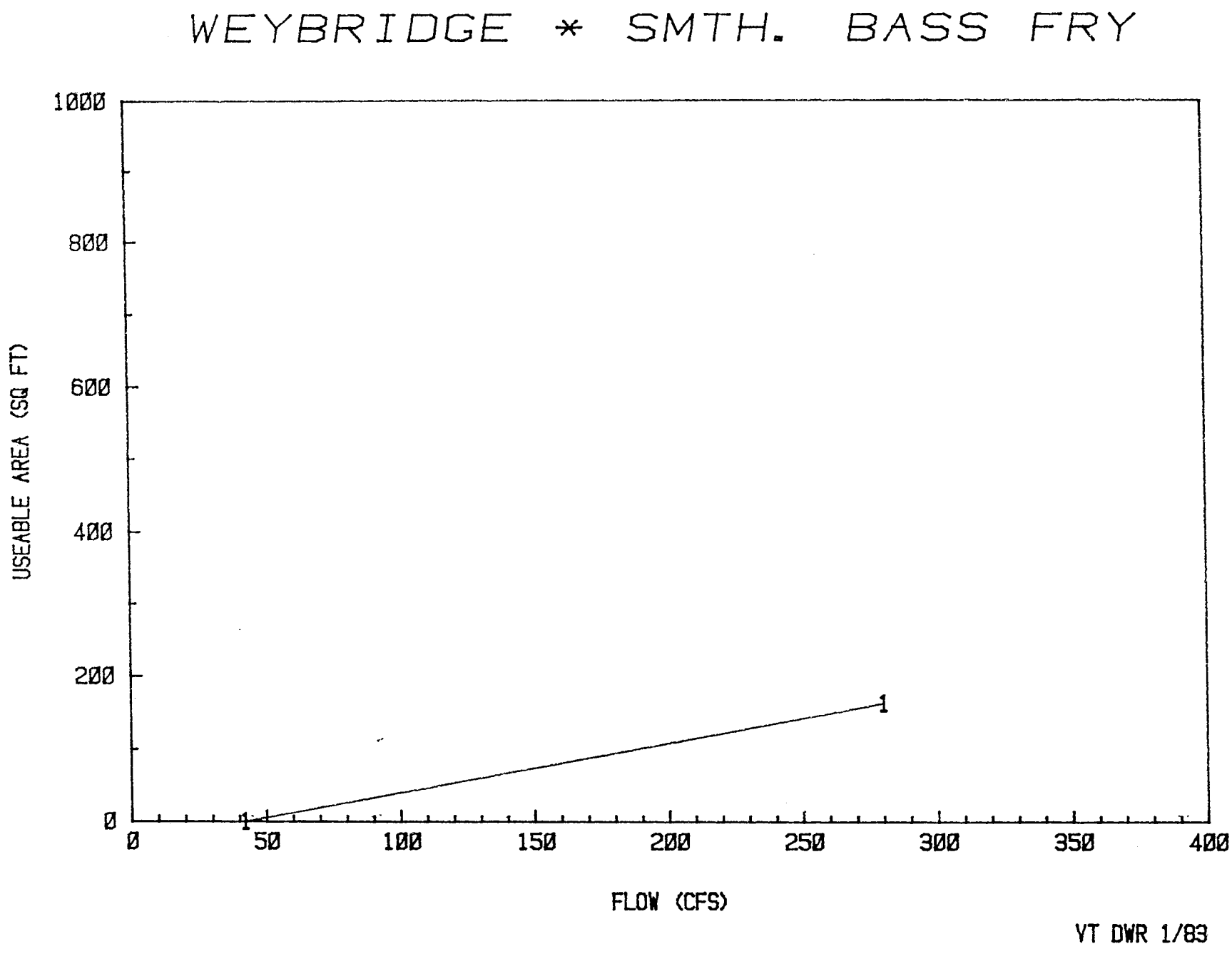


FIGURE 4b
FFNA Useable Area Curve - Weybridge Project

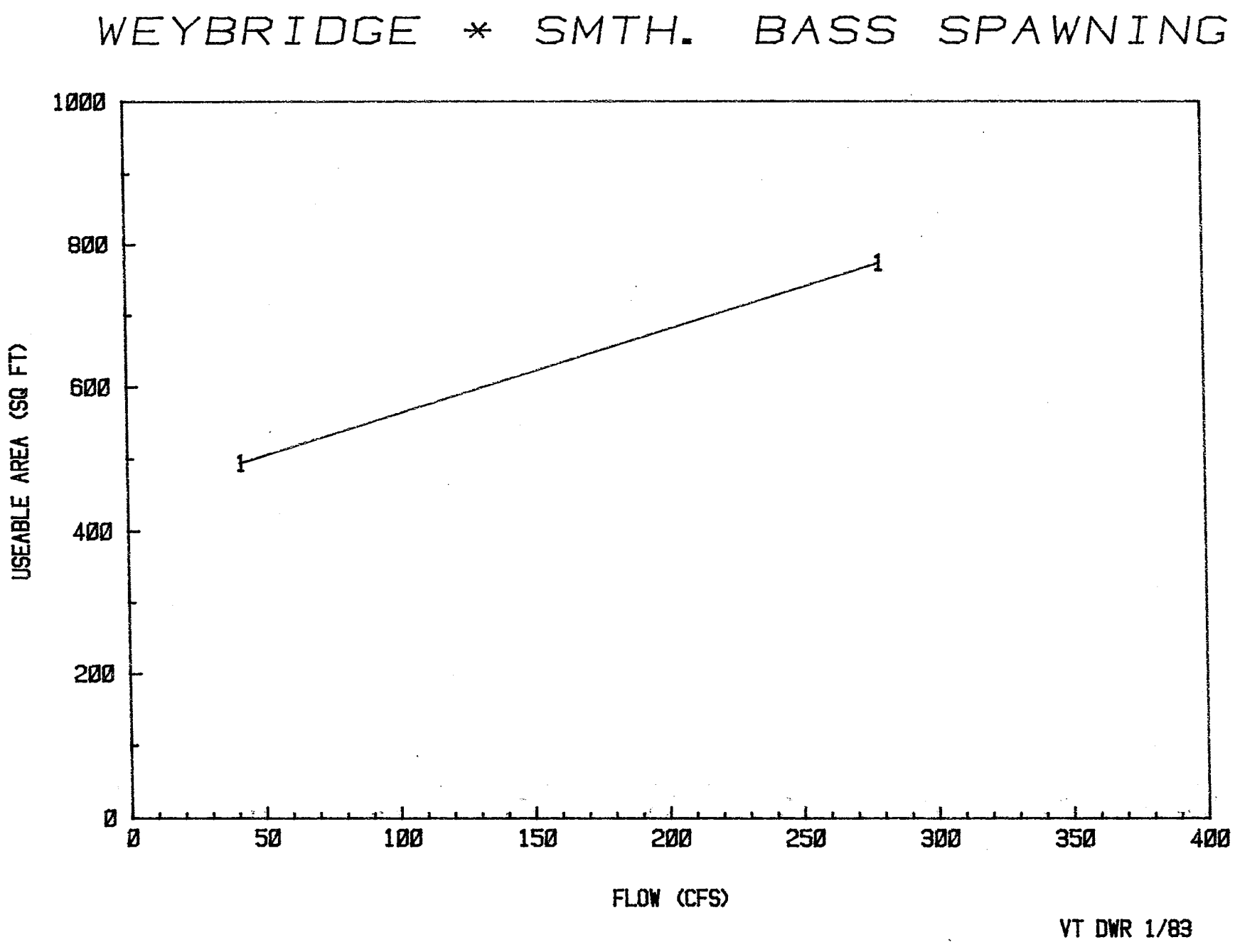


FIGURE 4c
FFNA Useable Area Curve - Weybridge Project

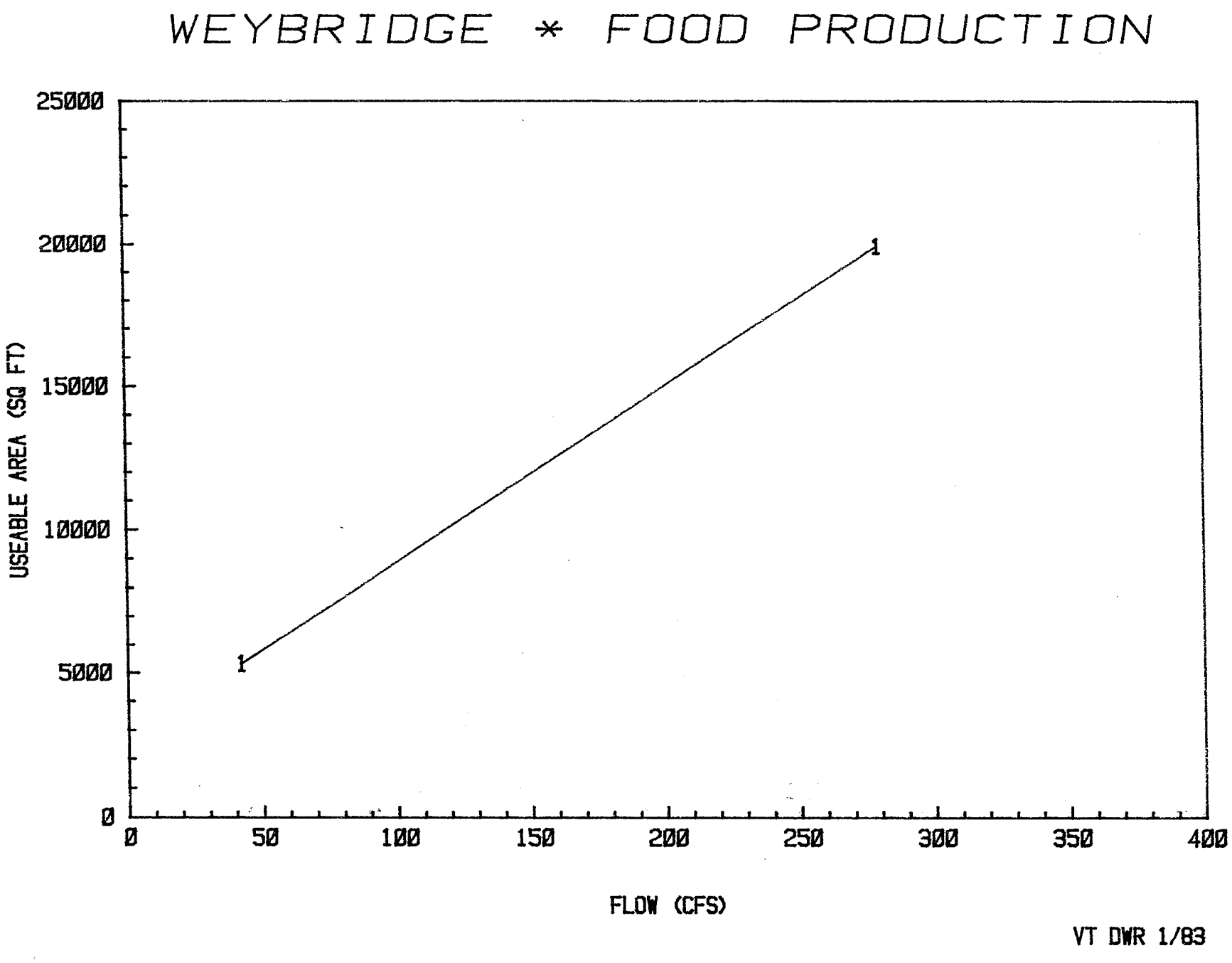
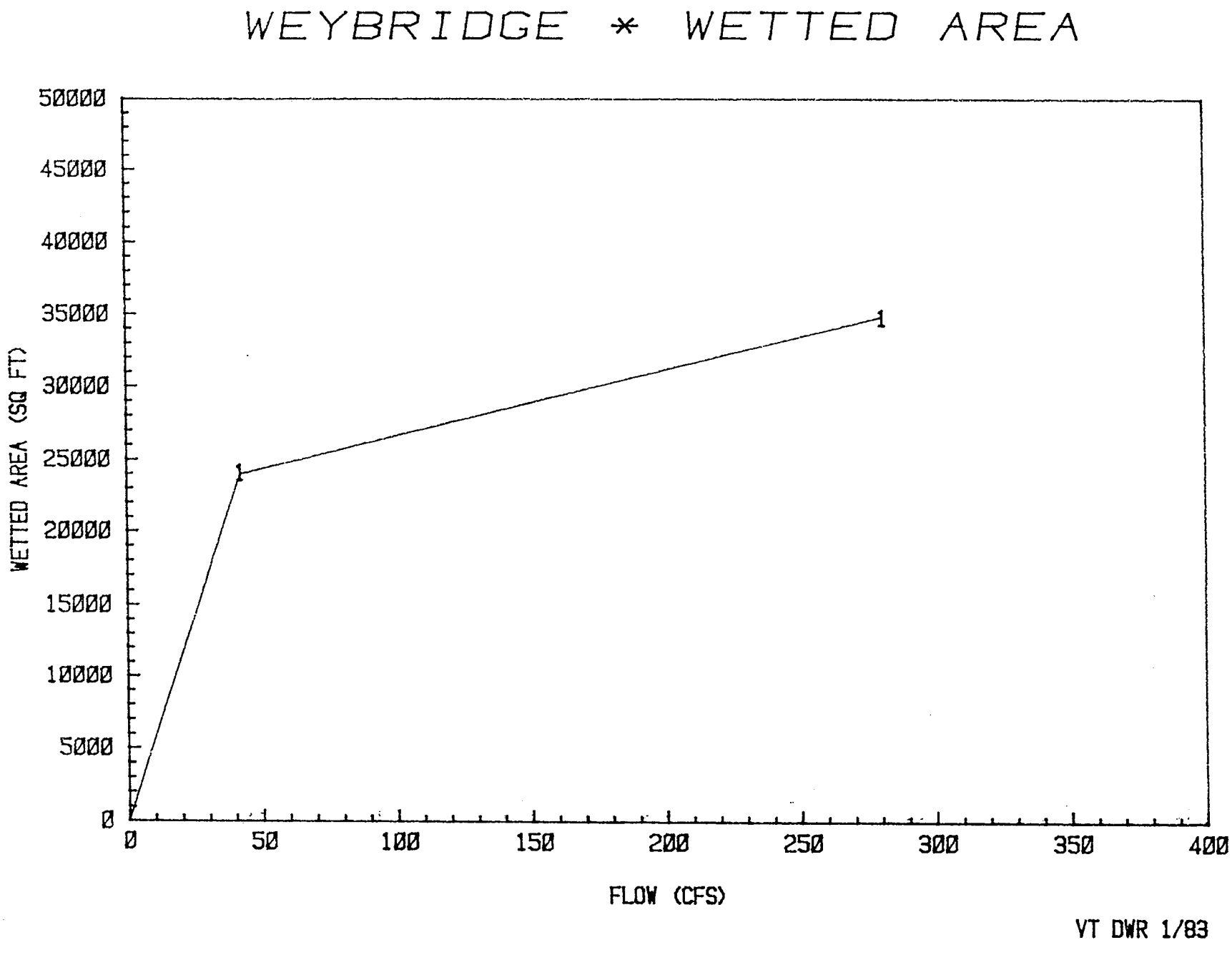


FIGURE 4d

FFNA Useable Area Curve - Weybridge Project



around the project dam and file a report on the results of that study, with a copy to AEC, together with any revisions to the approved Exhibit R to reflect the canoe portage development, if needed."

The status of this article is not known.

The lack of a minimum flow at the dam and downstream impairs the aesthetic and recreational values of the stream.

d. Erosion/Siltation

The Department observed heavy siltation in the Weybridge impoundment in 1982. Records indicate the impoundment was desilted in August of that year. Serious erosion of agricultural land along the Lower Otter Creek in the Weybridge area was also observed. It is not clear from Department records if the erosion is attributed in part to the operation of the Weybridge project.

Recommendations for Further Study

a. The water quality data collected in 1982 must be analyzed further and problems identified. Additional data may need to be collected.

b. Determine the status of Article 30 of the project's FERC license regarding recreation. Recommendations regarding recreation will be made accordingly.

c. Assess the reported agricultural land erosion problem and determine if operation of the Weybridge Plant aggravates this problem. If it is found that the plant contributes to erosion problems, appropriate recommendations for mitigation should be made.

Recommendations

a. Continue negotiations with CVPSC, USFWS, and FERC regarding a minimum flow requirement below the project pursuant to Article 31 of the FERC license. Passage of some of this flow at the dam would improve project aesthetics.

b. Require CVPSC to amend the Weybridge Water Quality Certification.

BASIN 3

STREAM: Lower Otter Creek

PROJECT: Vergennes #9

UTILITY: Green Mountain Power Corporation (GMP)

LICENSE STATUS: FERC License issued June 29, 1979

CLASSIFICATION: Upstream - B
Downstream - C

FISH HABITAT DESIGNATION: Warm water

IMPACT: Some

Project Features

The Vergennes #9 site is located on the Lower Otter Creek in the Town of Vergennes, 12.1 miles downstream from the Weybridge Project and 7.6 miles upstream of Lake Champlain (Figure 3). The project has a drainage area of 866 square miles and includes three concrete overflow dams and one concrete non-overflow dam connecting the banks and two midstream islands. The dam is topped with 1.5 feet of flashboards which create an impoundment with a surface area of 70 acres. Usable storage of the impoundment is 350 acre-feet with a drawdown of 1.5 feet from the top of the flashboards. The impoundment extends upstream 6 to 8 miles.

There are powerhouses located on the north and south dam abutments. The north powerhouse has a single generator having an installed capacity of 1000 kW and a turbine with a hydraulic range of up to 500 cfs. The south powerhouse contains two generating units having a total installed capacity of 1400 kW and two turbines with a combined hydraulic range of up to 700 cfs. The project operates under a gross head of 38 feet. The bypassed section of stream is about 75 feet long.

Operating Mode

Under low flow conditions, the utility reports that the project generates from 0700 to 1200, seven days a week. Due to the lack of storage capability and equipment constraints, one of the turbines on the south side of the river is often maintained on line during low flow conditions, responding to the river automatically via a float arrangement. Under moderate and high flow conditions the project generates 24 hours a day, seven days a week, with no average drawdown.

The typical drawdown at low flows is reported by the utility to be 1.5 feet from the top of the flashboards.

According to the FERC license issued for this project, June 29, 1979, "power from the project is derived from run-of-the-river operation, except for daily peaking. Under median flows the plants discharge 300 to 1000 cfs from six to eighteen hours a day. Under flood conditions the project is operated 24 hours a day, discharging 1200 cfs through the turbine. Before anticipated floods, the 1.5 foot flashboards are removed."

The only flow maintained below the project during periods of ponding is leakage flow which has not been measured. The tail-water of the project is essentially the backwater of Lake Champlain, and there may be no dewatered section of stream. This should be confirmed with a site visit.

Environmental Review

a. Water Quality

The Vergennes STP is located less than one mile downstream and has a permitted total discharge of .660 mgd. It is possible that water quality problems may occur below the discharge of the STP during periods of impounding.

Water quality data was collected by the Department in 1982, from above and below the project. A preliminary analysis of this data indicates supersaturated conditions during daylight hours both in the project's impoundment and downstream.

b. Fisheries

Vermont Fish and Wildlife reports that the project does not, to their knowledge, impair fisheries at the site either upstream or downstream.

In commenting to GMP by letter dated February 16, 1968, the Department of Fish and Game (now Fish and Wildlife) stated that "there is no demonstrated need, at this time at least, for either fish passage facilities or minimum flows" at the Vergennes site.

c. Erosion/Siltation

Department personnel report that siltation is a problem, especially because of daily water level fluctuations.

d. Recreation/Aesthetics

The dam is constructed at the top of a 500 foot wide set of natural falls. These falls are probably frequently dewatered as there is no indication that a minimum stream flow is maintained over them. This would impair the aesthetics and recreational use of the site.

In GMP's Exhibit R approved by FERC September 12, 1980, GMP proposed to install canoe portage signs and warning signs and to reserve one acre of land for possible future recreational development when necessary. The status of this proposal is not known.

Recommendations for Further Study

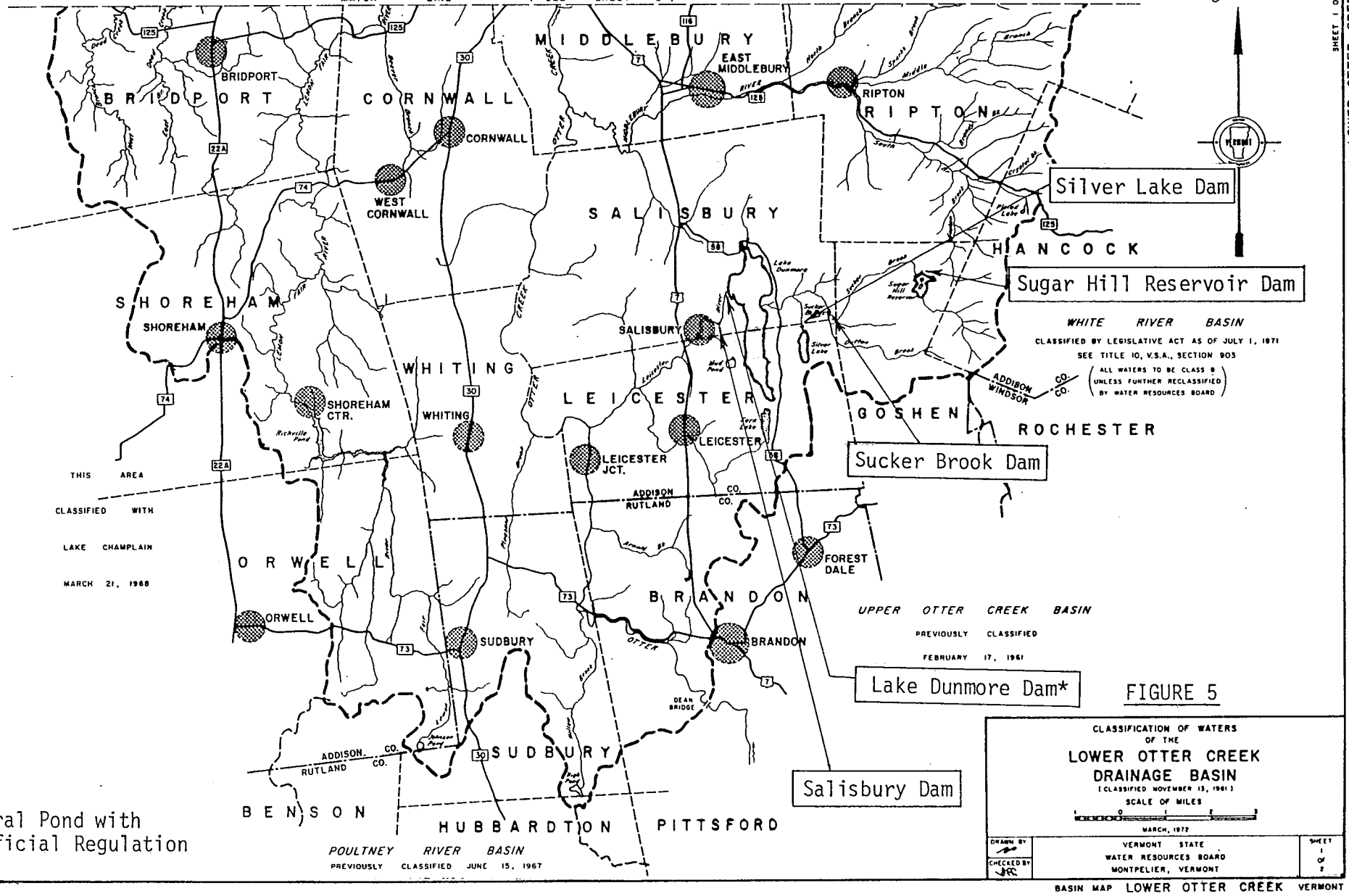
a. Determine the impact the project has on the water quality of Lower Otter Creek, in particular, determine if project operation impacts the assimilative capacity of the stream below the Vergennes STP. Complete the analysis of the water quality data collected in 1982. If water quality problems are found, appropriate mitigation measures will be recommended. This may include passage of a minimum flow requirement at the dam and/or downstream.

b. Determine if there are any dewatered sections of stream below the project during periods of low lake levels when the project is impounding.

c. Determine the extent and cause of the siltation problem in the project impoundment.

d. Determine the status of recreation development at the site.

e. An aesthetic study should be done at the site to determine the need for a minimum spillage requirement at the dam.



*Natural Pond with Artificial Regulation

FIGURE 5

CLASSIFICATION OF WATERS OF THE
LOWER OTTER CREEK DRAINAGE BASIN
(CLASSIFIED NOVEMBER 15, 1961)
SCALE OF MILES
MARCH, 1972
DRAWN BY
CHECKED BY
VERMONT STATE WATER RESOURCES BOARD MONTPELIER, VERMONT
SHEET 1 OF 2

BASIN 3

STREAM: Sucker Brook

PROJECT: Sugar Hill Reservoir

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Sugar Hill Reservoir is located on Sucker Brook in the Town of Goshen, 2.5 miles upstream of the Sucker Brook Diversion Dam (Figure 5). The project has a drainage area of 2.5 square miles. The dam is an earthen structure 63 feet high and about 855 feet long. At the normal pool elevation, the reservoir has a surface area of 75 acres and extends upstream 2000 feet. Water levels in the reservoir are maintained by a regulating outlet conduit under the dam controlled at its downstream end.

Operating Mode

Sugar Hill provides water storage for hydroelectric power generation as part of the Silver Lake Hydroelectric Development. The water level in the reservoir has reportedly been maintained well below the spillway crest in the recent past. The Army Corps of Engineers (ACOE) state in a Phase 1 inspection report (February, 1980) that at the time of their inspection of Sugar Hill the water level was 12 feet below the spillway crest. The ACOE also state that several of the valves in the outlet structure are open and they allow for continuous outflow from the dam into Sucker Brook. CVPSC confirmed this in an interview with the Department August 3, 1982. At the time of this interview, the Department estimated a flow of 5 cfs through a set of five valves which control the outlet flow. CVPSC says that the valves are always opened to allow at least this much water downstream. This conflicts with reports from Vermont Fish and Wildlife that there are times when there is no release below the dam. The discharge from Sugar Hill enters Sucker Brook and flows downstream to the Sucker Brook Dam. Vermont Fish and Wildlife states that severe drawdowns of the reservoir occur in the winter. Maximum drawdown is reportedly 40 feet.

Environmental Review

a. Water Quality

There is no water quality data from the reservoir or the brook downstream to indicate if any water quality problems exist at the site, in particular whether the reservoir stratifies and whether a D.O. depletion occurs in the greater depths of the reservoir. The maximum depth of the reservoir is estimated to be 40 feet (based on maximum drawdown level) and the project operates with a bottom withdrawal structure. If the impoundment does stratify and a D.O. depletion occurs, this would impact downstream water quality because of the bottom withdrawal. This potential problem should be investigated.

Water quality problems may also exist downstream if flow releases from the project are interrupted.

b. Fisheries

The project's impoundment and downstream supports a cold water fishery, the principal species being rainbow trout, brown trout, and brook trout. Spawning, nursery, and adult habitat is present downstream of the project. The impoundment provides adult habitat.

Vermont Fish and Wildlife states that operation of the reservoir impairs fisheries in the impoundment because of severe drawdowns during the winter months. The downstream fishery is also impaired during periods when no flows are released below the project. A minimum flow below the project is recommended at all times.

c. Recreation/Aesthetics

The reservoir is used for swimming, fishing, flatwater boating, and picnicking. Recreational development includes a private beach area and a private road access maintained by the utility. Conflicts with recreation may occur with premature or significant reservoir drawdowns.

There is no recreational use or development downstream other than fishing. Lack of adequate flow releases below the project may impair downstream aesthetics and recreation.

d. Erosion/Siltation

The Department observed some siltation at the beach area on August 3, 1982. It was thought this may be from erosion problems on the access road. No other erosion problems were noted.

Recommendations for Further Study

a. The potential of the reservoir to stratify and for a D.O. depletion to occur in the greater depths should be determined. This should include a water quality study if deemed necessary. If water quality problems are found below the project because of reservoir stratification, appropriate mitigation measures should be employed.

b. The access road should be inspected for erosion problems. Erosion control measures should be recommended on the access road if found to be necessary.

c. Determine if additional recreational development is needed.

d. Collect more information on project operation, in particular, how downstream flows are regulated.

Recommendations

a. A minimum flow requirement should be established below the project for fisheries. This would also improve downstream aesthetics, recreation and water quality.

b. A restriction on reservoir drawdowns would be beneficial to the fisheries in the impoundment and enhance recreational use.

BASIN 3

STREAM: Sucker Brook, Dutton Brook

PROJECT: Sucker Brook Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Sucker Brook Dam is located at the confluence of Sucker Brook and Dutton Brook in the Town of Salisbury, 2.5 miles downstream of Sugar Hill Reservoir (Figure 5). The drainage area at the dam is 10.2 square miles. (CVPSC uses a drainage area of 8.7 square miles.) The dam is a rolled earth embankment about 36 feet high and 660 feet long. Stream flows are diverted into a penstock which discharges into an open channel approximately 450 feet in length. This channel then discharges into Silver Lake, which is a daily peaking project also operated by CVPSC. The penstock discharges into a 75 foot long tailrace before entering the lake. The total length of Sucker Brook bypassed by Sucker Brook Dam and the Silver Lake Project is 1.5 miles. Two small streams flow into the bypass 3000 feet and 6000 feet downstream of the dam.

At the time of the Department's site inspection, there was no impoundment, only a small wetland area.

Operating Mode

According to an Army Corps of Engineers inspection report (February, 1980), "Sucker Brook Reservoir was originally used as a diversion and storage reservoir as part of the Silver Lake Hydroelectric Development. Presently, the reservoir is used only to divert water with the normal water level reportedly being maintained well below the spillway crest. Apparently, the slide gate is left fully open so that as much water as possible is diverted to Silver Lake. Except for heavy flows in the spring, it appears that all the normal flow of Sucker and Dutton Brooks is directed to Silver Lake".

Environmental Review

a. Water Quality

There are no known water quality problems as a result of project operation other than that flows in Sucker Brook are severely reduced.

The Department took one temperature and D.O. measurement at the site on August 5, 1982 (12:30 p.m.), just upstream of the intake structure. D.O. was 9 mg/l at 19.0°C, or 96% saturation.

b. Fisheries

Sucker Brook above and below the project supports brook trout, brown trout, and rainbow trout. Spawning, nursery, and adult habitat is present above the project and in the project's tailrace and downstream. The bypassed section of stream probably provides spawning habitat for salmonids.

Vermont Fish and Wildlife states that the fisheries above the project and downstream in the project's tailrace are impaired by low flows. A minimum flow requirement would provide better fisheries habitat. No comments were provided on the need for a minimum flow requirement below the dam.

c. Recreation/Aesthetics

The project is located in the Green Mountain National Forest. The only access is a public road which requires a permit from the U.S. Forest Service to use. The surrounding shoreline is heavily forested as well. A lack of water in the impoundment and downstream of the dam impairs the aesthetic value and recreational use of the area which has a high recreational value as a natural area for bird and wildlife watching.

Recommendations for Further Study

Determine the extent to which the bypassing of Sucker Brook impairs fisheries. A minimum flow requirement should be established below the dam if a problem is identified. This would improve downstream recreation and aesthetics.

Recommendations

a. Since the slide gate to the project's penstock is reportedly always open, the project itself should not reduce flows at the tailrace. Instead, low flow problems probably develop in the tailrace when the discharge from Sugar Hill Reservoir is reduced. Therefore, a minimum flow requirement at Sugar Hill may resolve the low flow problem reported by Vermont Fish and Wildlife in the Sucker Brook tailrace.

b. A minimum flow requirement in the bypassed section of Sucker Brook is recommended for recreational enhancement and possibly fisheries.

BASIN 3

STREAM: Tributary of Sucker Brook

PROJECT: Silver Lake Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Silver Lake Dam is located on a tributary of Sucker Brook in the Town of Leicester and within the Green Mountain National Forest (Figure 5). The project has a drainage area of one square mile. (CVPSC uses a drainage area of one half mile.) The impoundment extends upstream 4800 feet and has a surface area of 117 acres at the spillway crest. The dam is 31 feet high and approximately 280 feet long. No flashboards are used. The project's penstock is a mile in length, bypassing 3800 feet of the tributary and one half mile of Sucker Brook. The powerhouse contains one generating unit with an installed capacity of 2400 kW under an operating head of 677 feet. The project's powerhouse discharges into Sucker Brook about 2000 feet upstream of Lake Dunmore.

Operating Mode

Silver Lake is a storage reservoir as part of the Silver Lake Hydroelectric Development which includes Sucker Brook Diversion Dam and Sugar Hill Reservoir upstream. The water level of the reservoir is reportedly maintained below the spillway crest. According to an Army Corps of Engineers inspection report (March, 1980), the water level never rises more than a few feet above a point 4.8 feet below the spillway crest.

The Silver Lake project generates in a daily peaking mode. At the time of the Department's site visit on August 5, 1982, the project was not generating and had reportedly not generated since August 2 of that year because water levels were too low. According to the dam operator, after May 15, CVPSC cuts back on generation. This is to maintain a summer recreation pool which, based on an informal agreement with the U.S. Forest Service, is no greater than 4.5 feet below the spillway crest. After Labor Day, the project then generates more frequently.

The Department measured a leakage flow of 2.1 cfs on August 5, 1982, below the project's gate house. The source of this flow was from the dam and the wastegate which was opened. This gate is usually closed (no reference).

Vermont Fish and Wildlife in commenting on Lake Dunmore stated that the flow and surface area of Sucker Brook decrease drastically when the Silver Lake powerhouse is not generating as there is no flow maintained through the Silver Lake powerhouse during periods of nongeneration.

Environmental Review

a. Water Quality

The Department collected temperature and D.O. data from the project's impoundment on August 5, 1982, during a period of non-generation. Unfortunately the time at which the measurements were taken was not recorded. D.O. concentrations were at or near saturation.

b. Fisheries

Silver Lake supports a cold water fishery, the principal species being rainbow trout. Brown trout, brook trout, and rainbow trout are found below the project. Salmon are restricted to below the Falls of Lana. Spawning areas for trout and smelt (from Lake Dunmore) are found below the project as well as nursery and adult habitat for trout. Vermont Fish and Wildlife reports that the operation of the project impairs fisheries downstream by "shutting off water flow".

Smelt from Lake Dunmore spawn in Sucker Brook, usually in March. Vermont Fish and Wildlife reports that since the late 1960's, CVPSC has voluntarily agreed to modify the project's operating mode during this period to protect smelt spawning habitat in the brook.

c. Recreation/Aesthetics

One potential conflict with recreation is that the agreement between CVPSC and U.S.Forest Service regarding summer drawdowns no greater that 4.5 feet is only an informal one. It is possible, therefore, that drawdowns greater than this could occur.

d. Natural Area/Wildlife Habitat

Fluctuating water levels below the Falls of Lana as discussed by Vermont Fish and Wildlife may impair the aesthetics of the area below the Falls. These Falls were included in the Waterfalls, Cascades and Gorges Study. They are identified as being of high importance because they are moderately wild and

frequently visited by hikers. The project's penstock is located about 1000 feet south of the Falls but is not visible from the Falls. Also, this project may reduce flows at the Falls of Lana.

Recommendations for Further Study

Determine the project's impact on fisheries and water quality of Sucker Brook both in the bypass and downstream. The project's impact on the Falls of Lana should be included in this determination. Based on the information gathered, appropriate minimum flow requirements should be recommended. The Agency may want to formalize the agreement between CVPSC and Vermont Fish and Wildlife concerning protection of smelt spawning habitat in Sucker Brook.

Recommendations

a. The agreement between CVPSC and the U.S. Forest Service regarding summer drawdowns should be formalized. The Agency should be included as a party in this agreement.

b. A minimum flow should be maintained below the Silver Lake powerhouse for fisheries and aesthetics.

BASIN 3

STREAM: Leicester River

PROJECT: Lake Dunmore

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Lake Dunmore is a natural lake located on the Leicester River in the Towns of Leicester and Salisbury (Figure 5). It has a drainage area of 20.3 square miles and a surface area of 985 acres. The Salisbury Hydroelectric Project is located about a mile downstream and the Silver Lake Hydroelectric Development is located upstream. The outlet structure for Lake Dunmore is located on the west shore and is a deep gate outlet framed by concrete wall sections. Discharge from this outlet structure is directly into the Leicester River.

Operating Mode

CVPSC utilizes Lake Dunmore for the regulation of streamflow in connection with hydroelectric plants downstream. Operation of the dam on the lake is coincident with water demands downstream but with some regard to maintaining a lake level for summer residence. CVPSC has an agreement with the Lake Dunmore Association (dated 1973) to try to maintain a level of 48 to 52 inches from June 1 through September 5 and above 46 inches September 5 through October 15. From October 15 through the end of May the lake is seldom drawn down much below the 14 inch level. The top of the outlet structure is at elevation 60 inches as a reference.

No additional information was obtained on flow releases from Lake Dunmore other than comments from Vermont Fish and Wildlife that flows below the project are shut off at times.

Environmental Review

a. Water Quality

Water quality problems may exist below the project if releases from the dam are reduced significantly. There is no data to document water quality conditions below the project during these periods.

b. Fisheries

Lake Dunmore supports a mixed fishery of salmon, rainbow trout, brook trout, lake trout, northern pike, large and smallmouth bass, yellow perch, and smelt. The lake provides spawning, adult and nursery habitat for lake trout; nursery habitat for the other trout species; and adult habitat for all other species.

The project's tailrace provides adult habitat for rainbow trout and brook trout. The river downstream of the tailrace also provides adult habitat for these species as well as bullhead and yellow perch.

Vermont Fish and Wildlife states that the hydropower operation impairs fisheries in the tailrace and downstream by shutting off downstream flows. Impoundment drawdowns can also impair fisheries. A minimum flow requirement at the outlet of Lake Dunmore is recommended.

c. Recreation/Aesthetics

The aesthetic and recreational values of the Leicester River downstream of Lake Dunmore Dam may be impaired during periods of no flow releases. There is no recreational development below the project. Premature drawdowns could impair the recreational use of the impoundment.

Recommendations for Further Study

A temperature and D.O. study should be conducted below the project when no flow (or leakage) is being maintained to check for water quality violations.

Recommendations

A minimum flow should be maintained below Lake Dunmore for fisheries. This would also improve water quality if found to be a problem, as well as aesthetics and recreation.

BASIN 3

STREAM: Leicester River

PROJECT: Salisbury Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC).

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Salisbury Dam is located about one mile downstream of Lake Dunmore on the Leicester River in the Town of Salisbury (Figure 5). The dam has a drainage area of approximately 22 square miles. The dam creates an impoundment which extends upstream about 100 feet with a surface area of less than one acre. It is fitted with 6-inch flashboards. A 1550-foot long pipe carries flows from the dam to a surge tank. From the surge tank, a penstock 1250 feet long bypasses 2800 feet of stream and extends to the project's powerhouse where a static head of 190 feet is obtained. The powerhouse contains one turbine and a generator with an installed capacity of 1350 kW. Normal discharge is 104 cfs.

Operating Mode

Department files indicate the Salisbury Project is operated as a daily peaking facility (no reference). There is no additional information available on the project's operating mode. Vermont Fish and Wildlife, however, comments that stream flows are reduced below the project. No leakage flow measurements were made.

Environmental Review

a. Water Quality

There may be water quality problems below Salisbury Dam if the facility reduces flows downstream significantly during periods of impounding, particularly during the warmer low flow months. This should be investigated.

b. Fisheries

The Leicester River above the impoundment supports a cold water fishery, the principal species being brook trout and

rainbow trout. The project's impoundment supports a warm water fishery of bullhead and yellow perch. Brown trout are found in the project's tailrace and downstream, along with northern pike and bass. There is no information on fisheries in the bypass.

The project's tailrace provides spawning habitat for brown trout as well as nursery and adult habitat (species not identified). Adult habitat is found in the impoundment and upstream, and downstream of the project's tailrace (species not identified).

Vermont Fish and Wildlife reports that fisheries are impaired upstream and downstream because of reduced stream flows and recommends that a minimum flow be maintained both above (from Lake Dunmore) and below the project.

c. Recreation/Aesthetics

The lack of a minimum flow requirement over the dam and through the bypassas well as downstream, impair both the aesthetic and recreational values of the stream.

Recreational use in the impoundment may include swimming and fishing. There is no information on downstream use. Access to the impoundment is via a public road.

Recommendations for Further Study

a. More information must be gathered on project operation to better assess the potential problems at the site. Leakage flows should be measured.

b. The project's bypass should be evaluated to determine its significance for fisheries.

c. Determine the need for additional recreational development at the site.

Recommendations

Maintain a minimum flow below the project to protect stream uses and values.

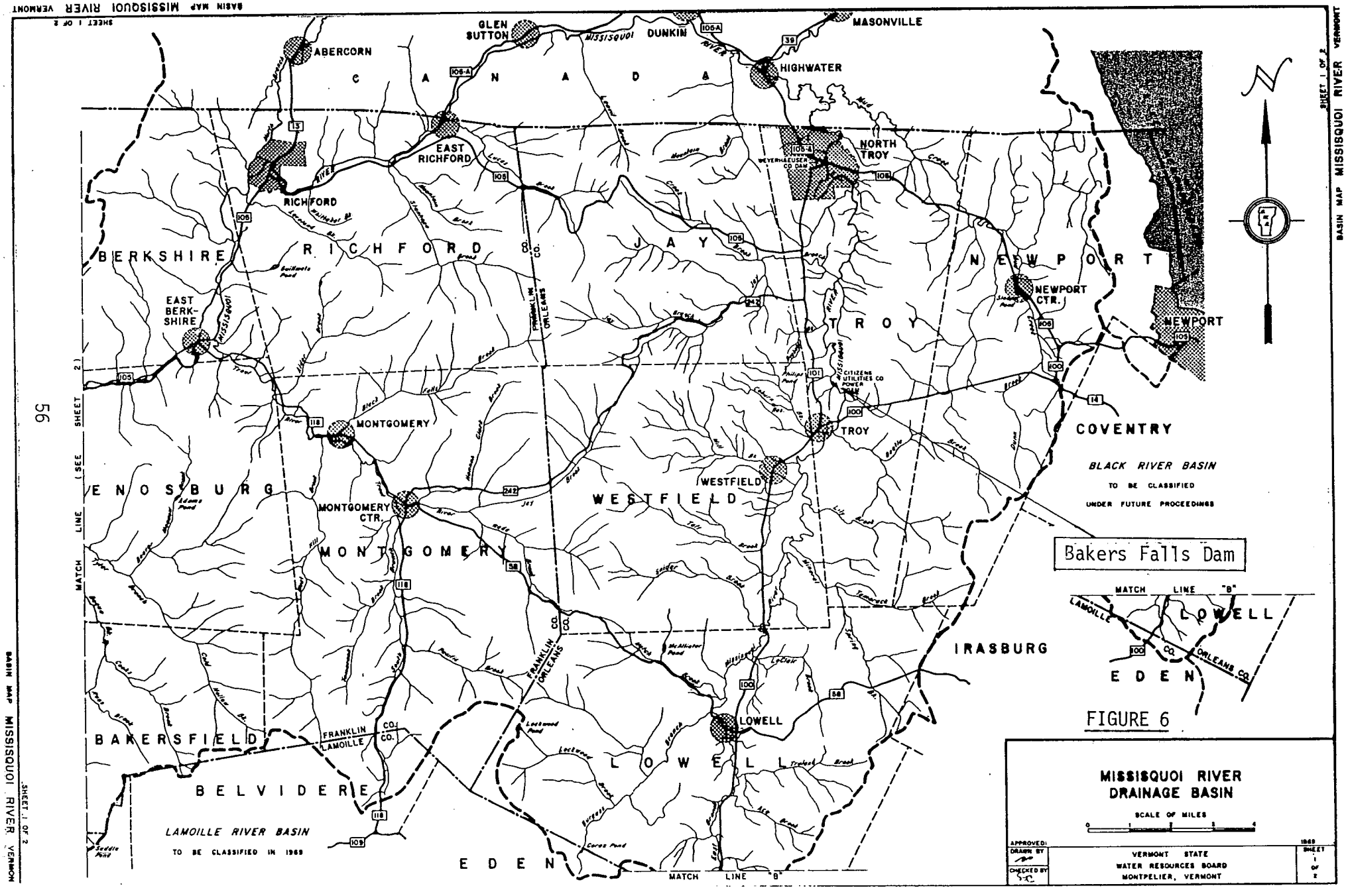

BASIN MAP MISSISQUOI RIVER VERMONT
SHEET 1 OF 2
GLEN SUTTON
DUNKIN
MASONVILLE
ABERCORN
HIGHWATER
C A N A D A
EAST RICHFORD
NORTH TROY
RICHFORD
BERKSHIRE
R I C H F O R D
J A Y
N E W P O R T
EAST BERK-SHIRE
NEWPORT CTR.
NEWPORT
T R O Y
MONTGOMERY
COVENTRY
TROY
WESTFIELD
E N O S B U R G
MONTGOMERY CTR.
W E S T F I E L D
M O N T G O M E R Y
IRASBURG
LOWELL
BAKERSFIELD
FRANKLIN CO.
LAMOILLE CO.
ORLEANS CO.
B E L V I D E R E
L O W E L L
EDEN
MATCH LINE (SEE SHEET 2)
MATCH LINE "B"
LAMOILLE RIVER BASIN
TO BE CLASSIFIED IN 1969
BLACK RIVER BASIN
TO BE CLASSIFIED UNDER FUTURE PROCEEDINGS
Bakers Falls Dam
MISSISQUOI RIVER DRAINAGE BASIN
SCALE OF MILES
APPROVED:
DRAWN BY
CHECKED BY
VERMONT STATE WATER RESOURCES BOARD MONTPELIER, VERMONT
1969
SHEET 1 OF 2
BASIN MAP MISSISQUOI RIVER VERMONT
SHEET 1 OF 2

FIGURE 6

BASIN 6

STREAM: Missisquoi River

PROJECT: Bakers Falls

UTILITY: Citizens Utilities Company (CUC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Bakers Falls is located on the Missisquoi River in the Town of Troy (Figure 6). The project has a drainage area of approximately 97 square miles. An impoundment extends one mile upstream with a surface area of about 12 acres and a usable storage of about 50 acre-feet with a drawdown of three feet from the dam crest.

The project utilizes a concrete-type dam constructed in 1925, with modifications and repairs in 1951. Located at the top of a cascade, the dam extends 180 feet with a spillway of 134 feet. A 3.33-foot by 4-foot wastegate is located beneath the spillway section of the dam, some 6 feet 10 inches east of the intake area. The bottom of the gate is located 9 feet below the spillway crest. The intake structure contains two 3.33-foot by 4-foot headgates that open to a forebay area. A 2-foot by 2-foot wastegate is located in the forebay. Eighteen inch flashboards extend the length of the spillway. A 6.5-foot diameter steel penstock extends from the forebay 250 feet to the Troy Plant. There is a gross head, as measured from the crest of the spillway, of 55.7 feet. The project bypasses 250 feet of stream. An island (Sand Island), immediately downstream of the dam, separates the bypass into two sections.

Troy Plant's generation is regulated by the opening of the turbine gate. The hydraulic operating range is from 0 to 200 cfs. The turbine is a horizontal, 25-inch twin runner rated 815 hp and is connected to a 600 kW generator.

Operating Mode

The utility reports that, under daily operating conditions, the drawdown is limited to 3 feet from the crest of the dam. During maintenance of the intake areas and the dam, maximum drawdown capability is 9 feet 10 inches. The project operates

continuously under low, moderate, and high flows. Under low and extremely low flows, the project must pool. During extremely low flow periods, the project may not generate for several days. There are no minimum flow requirements.

The Department measured a leakage flow of 0.1 cfs on July 14, 1982 in the right channel of the bypass. The source of this flow was the wastegate in the headrace and leakage through the sluice gate in the dam. No flow could be measured in the left channel on the same date. A leakage flow of 0.1 cfs is only .5% of the estimated 7Q10 value at the site of 16 cfs. When the project is pooling, this may be the only flow maintained below the site.

Environmental Review

a. Water Quality

The North Troy STP is located about five and one half miles downstream of the Bakers Falls Project and has a permitted total discharge of .110 mgd. A plant owned by Kraft and H.P. Hood and Sons is located in Troy and has a permitted total discharge of 50,000 gallons per day of dairy waste. The plant is to eventually be hooked up with the proposed Troy STP, the construction of which is scheduled sometime before July 1, 1988. Department records also state that heavy agricultural runoff is a problem in this reach of the Missisquoi.

The Missisquoi River from Troy downstream to the Canadian border has been designated an effluent limited segment (presently not meeting water quality standards) because of violations of coliform levels from dairy and municipal wastes, as stated in the Department's 1984 Water Quality Assessment 305(b) Report.

The Department collected temperature and D.O. data during daylight hours from six stations both above and below the Bakers Falls site on July 27, 1982. At the time this data was collected, the impoundment level was four and one half feet below the dam crest. The water was described as stagnant, turbid, and green. Red algae and sphagnum was observed in the bypass. Water levels below the powerhouse were described as being very low with an abundance of algae, sphagnum, grasses, and potomogeton present. The water was also a murky green with a brown foam on the surface. An abundance of algae was also observed on the rocks downstream of the project. The discharge from the project at the time this data was collected was not noted.

A review of the data indicates violations of D.O. standards in the impoundment. There may also be violations below the project during the early-morning, pre-dawn hours from algal activity. No early-morning data was collected to document this. It is not known if any data was collected during periods of impounding.

b. Fisheries

Information on the Bakers Falls Project is limited, especially in the area downstream of the dam and powerhouse.

The Missisquoi River above Bakers Falls has populations of brown trout and brook trout. Yellow perch, minnows, brown bullheads, and brown trout are found in the impoundment. The fish population immediately below the project powerhouse has not been assessed but is presumed to be similar in species composition to that above the dam. Brown trout and brook trout are probably found in the bypass on a seasonal basis. Brown trout is the principal species downstream of the project.

Spawning and nursery habitat for brook trout and brown trout is found above the project's impoundment. The impoundment probably provides spawning, nursery, and adult habitat for yellow perch and bullhead. Spawning, nursery, and adult habitat for brown trout is found downstream of the tailrace.

Vermont Fish and Wildlife reports that the Bakers Falls Project impacts the fishery to some degree by changing the river from a free-flowing stream to an impoundment. Some warming of the water results from the impoundment. Sediment build-up and fluctuating water levels are not beneficial to the spawning success of cold water species. The discharge from the Kraft/H.P. Hood and Sons plant also adversely impacts fish as it has resulted in low D.O. levels in the stream. The existence of the project impoundment, curtailment of downstream flows, and elimination of reaeration by the cascade are expected to exacerbate this condition. Vermont Fish and Wildlife recommends that the water levels above and below the facility be stabilized to improve fish habitat.

c. Erosion/Siltation

Available information indicates that siltation is a problem at the Bakers Falls site. CUC reports that the impoundment is dredged or the sluice gates opened once every two years for desilting purposes. Also, CUC reports that the wicket gates are opened 15 minutes a day when the facility is not operating to flush silt out of the system. During the Department's July 7, 1982, sampling program at the site, a build up of silt was observed on the left shore and in front of the trashracks.

d. Recreation/Aesthetics

The Department reports no recreational development above or below the site. The only recreational use is fishing.

The dam is constructed at the top of a cascade which is frequently dewatered. The site would be quite scenic if a minimum flow was spilled at the dam.

The Department also observed that the Missisquoi River within the project area had a bad odor reportedly due to the discharge of dairy wastes, and that the "character of the upper Missisquoi watershed is drastically changed by the dam."

e. Natural Area/Wildlife Habitat

The Agency's Waterfalls, Cascades and Gorges Study identifies Bakers Falls as a "dried up cascade below a dam." Two uncommon plants were found at the edge of a channel near the bottom of the cascades.

The study recommends that there be a minimum flow release to protect the rare plants and to improve water quality and aesthetics.

Recommendations for Further Study

a. Additional water quality data should be collected from the site, particularly temperature and D.O. data, to better document project impact. The critical time to sample would be in the early-morning, pre-dawn hours and during periods of impounding. As part of this study, additional information should be collected on project operation to better determine its impact on stream flows and impoundment levels.

b. A fisheries survey should be conducted below the project to better assess project impact on species composition and abundance and fish habitat. Fish habitat in the bypass should also be evaluated.

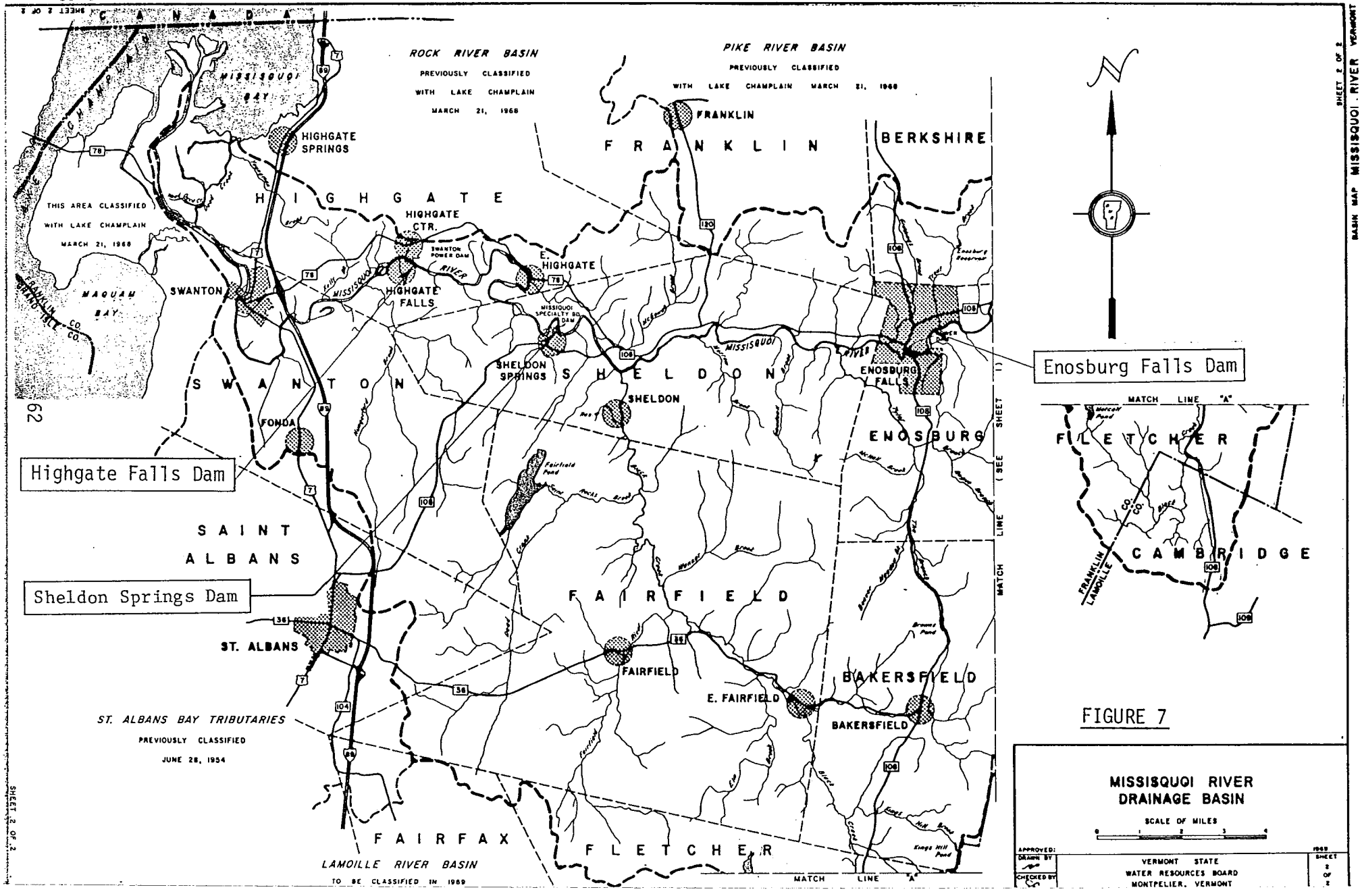
c. The need for recreational development at the site should be determined.

d. Appropriate recommendations should be made with respect to water quality and fisheries once the above mentioned studies are completed. Recommendations will include the maintenance of a minimum flow at the dam and possibly below the project's powerhouse if project operation is found to regulate flows downstream of the project. Recommendations should take into consideration the impact of the discharge from the Kraft/H.P. Hood and Sons plant and the fact that water quality problems and resultant fisheries problems will be reduced once the plant is connected to the Troy STP scheduled for construction within the next few years.

e. Desilting operations at the project should be reviewed to determine their acceptability and conformance with the Agency Desilting Policy. Based on this review, appropriate recommendations will be made.

Recommendation

A minimum flow requirement should be established at the dam to improve project aesthetics, protect the two rare plants identified on the cascade below the dam, and to improve water quality and to protect fish habitat, especially for all life stages of brown trout.


BASIN MAP MISSISQUOI RIVER VERMONT
SHEET 2 OF 2
C A N A D A
ROCK RIVER BASIN
PREVIOUSLY CLASSIFIED WITH LAKE CHAMPLAIN MARCH 21, 1968
PIKE RIVER BASIN
PREVIOUSLY CLASSIFIED WITH LAKE CHAMPLAIN MARCH 21, 1968
MISSISQUOI BAY
HIGHGATE SPRINGS
FRANKLIN
BERKSHIRE
THIS AREA CLASSIFIED WITH LAKE CHAMPLAIN MARCH 21, 1968
HIGHGATE
HIGHGATE CTR.
SWANTON POWER DAM
E. HIGHGATE
MAQUAM BAY
SWANTON
HIGHGATE FALLS
MISSISQUOI SPECIALTY BD. DAM
SHELDON SPRINGS
SHELDON
ENOSBURG FALLS
ENOSBURG
FONDA
Highgate Falls Dam
Sheldon Springs Dam
SAINT ALBANS
ST. ALBANS
FAIRFIELD
E. FAIRFIELD
BAKERSFIELD
ST. ALBANS BAY TRIBUTARIES
PREVIOUSLY CLASSIFIED
JUNE 28, 1954
FAIRFAX
FLETCHER
LAMOILLE RIVER BASIN
TO BE CLASSIFIED IN 1969
MATCH LINE "A"
MATCH LINE (SEE SHEET 1)
Enosburg Falls Dam
FLETCHER
CAMBRIDGE
FRANKLIN
LAMOILLE
FIGURE 7
MISSISQUOI RIVER
DRAINAGE BASIN
SCALE OF MILES
APPROVED:
DRAWN BY
CHECKED BY
VERMONT STATE
WATER RESOURCES BOARD
MONTPELIER, VERMONT
1968
SHEET 2 OF 2
SHEET 2 OF 2
BASIN MAP MISSISQUOI RIVER VERMONT

BASIN 6

STREAM: Missisquoi River

PROJECT: Enosburg Falls

UTILITY: Vermont Public Power Supply Authority (VPPSA)

LICENSE STATUS: FERC license issued July 12, 1983; Water Quality Certification issued June 10, 1982. FERC license amendment application March 19, 1986; Water Quality Certification issued February 26,1986.

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Warm water

IMPACT: Minor

The Enosburg Falls Project is located on the Missisquoi River in the Village of Enosburg Falls about 11 miles upstream of the Sheldon Springs Project (Figure 7). Project features include a concrete overflow dam, a maintenance and control building, switchyard, two powerhouse structures and the associated headrace and tailrace channels and conduits. The Village Plant contains a single 600 kw turbine/generator unit and bypasses 1200 feet of stream via a headrace and tailrace channel. The Kendall Plant contains a single 150 kw turbine/generator unit and utilities a short penstock which discharges into the main stream channel 120 feet downstream of the dam. The project's impoundment extends 4.3 miles upstream of the dam.

VPPSA had proposed to modify the existing project and was issued a FERC license in 1983 and a Water Quality Certification in 1982 for these modifications; however, VPPSA is no longer proposing modifications. They have, therefore, applied for a FERC license amendment to cover the existing project. They have also been issued a Water Quality Certification for the existing facility. The certification requires the project to be operated as essentially run-of-the-river.

No spillage flows have been required at the dam for aesthetics.

Recommendations

a. A minimum spillage flow at the dam should be required for aesthetics.

b. Follow up on the conditions of the Water Quality Certification for compliance.

BASIN 6

STREAM: Missisquoi River

PROJECT: Sheldon Springs

UTILITY: Missisquoi Associates

LICENSE STATUS: FERC License issued November 2, 1984, 401 Water Quality Certification issued March 19, 1984 and amended October 18,1984 and February 13, 1986.

CLASSIFICATION: Upstream of mill treatment plant - B
Downstream of mill treatment plant - C

FISH HABITAT DESIGNATION: Warm water

IMPACT: Significant

Missisquoi Associates is redeveloping the existing hydroelectric facility at the former Saxon Industries Paper Mill located on the Missisquoi River at Sheldon Springs eight miles upstream of the Highgate Falls project and 11 miles downstream of the Enosburg Falls facility (Figure 7).

Project redevelopment includes the use of the existing features plus the construction of a new intake structure, installation of a penstock 1900 feet long, and a new powerhouse and tailrace. The existing project presently operates out of storage with no minimum stream flow constraint and the project's bypass is about 2800 feet long and frequently dewatered.

Missisquoi Associates applied to the Department for a Water Quality Certification on March 25, 1983, for the expanded project. They also applied to FERC for an operating license in 1983. The license was issued November 2, 1984. The certification was issued March 30, 1984 and subsequently amended October 18, 1984. It was amended once again on February 13, 1986. The project is certified as a peaking project with minimum flow requirements in the bypass and downstream of the powerhouse.

The site was included in the Agency's Waterfalls, Cascades and Gorges Study. The study identifies the dam as having been constructed on what was once known as Sheldon Falls. The falls are completely obliterated by the dam. Below the dam is a short gorge followed by a river section of ledges, carved rocks, and chutes. A rare plant has been identified just below the dam.

It should be noted that the bypassed section, which includes the gorge and river below, has been almost completely dewatered in years past due to no bypass minimum flow requirement. This 2800 foot bypass has not been used for fishing or whitewater

boating because of a lack of water and limited access. The site has been identified as having excellent potential for whitewater boating and providing smallmouth bass habitat.

As a result of the licensing and certification of the project, minimum flow requirements have been established for the project's bypass to benefit fisheries and whitewater boating. Minimum flow requirements have also been established for below the project to benefit downstream fisheries, including walleye. It should be noted that Missisquoi Associates has conducted a flow study which is presently (spring, 1988) under review by the Agency. The purpose of this study is to determine a minimum flow requirement to be released below the project for walleye spawning in the spring. The Department has already established a minimum flow requirement for walleye spawning; however, Missisquoi Associates would like to reduce this flow if the results of their study demonstrate a lesser flow would be also adequate. Project construction commenced in the summer of 1986.

Recommendations

Follow up on the articles of the FERC license and conditions of the Water Quality Certification for compliance.

BASIN 6

STREAM: Missisquoi River

PROJECT: Highgate Falls

UTILITY: Village of Swanton

LICENSE STATUS: FERC License issued May 24, 1984; Water Quality Certification issued November 25, 1983.

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Warm water

IMPACT: Significant

The Village of Swanton proposes to redevelop the Highgate Falls Hydroelectric Project on the Missisquoi River in the Town of Highgate (Figure 7). The facility is located about seven miles upstream of the Swanton Village Dam and about eight miles downstream of the Sheldon Springs project.

Project redevelopment would increase the normal pool elevation from 170.8' NGVD to 200' NGVD. The impoundment would increase from one mile to four miles in length. The hydraulic capacity of the project would also be increased with the installation of a new unit and the replacement of two existing ones.

The existing project operates in a peaking mode with a maximum drawdown of 2.5 feet. The proposed project would continue to operate in this manner. Presently, the only flow maintained below the project during periods of impounding is that which leaks through the project. On July 1, 1982, the Department measured a leakage flow of 35 cfs at a point 15 feet downstream of the dam. This flow is only 35% of the 7Q10 value at the site of 100 cfs.

The Village of Swanton applied to the Department for a Water Quality Certification on April 6, 1983, for the revised project. The certification was issued November 25, 1983. As certified, the project will operate as a peaking facility with minimum flow requirements in the bypass and downstream. The Village also applied to FERC for an operating license which was issued May 24, 1984.

Highgate Falls was included in the Agency's Waterfalls, Cascades and Gorges Study. Below the dam there is a falls about 15 feet high and a cascade about the same height on either side of the falls. Below the falls is a gorge about one third of a mile long with walls 20 to 30 feet high. Almost all of this

gorge is bypassed by the project. The study comments that the "site must have been spectacular before the dam was built... The rocks are remarkable and with more flow the gorge would be a beautiful site."

The 35 cfs minimum flow requirement through the bypass is not adequate to enhance the recreation and aesthetic values of this stream section. Project construction commenced the summer of 1986.

Recommendations

Follow up on the articles of the license and conditions of the Water Quality Certification for compliance. These include stocking of the reservoir for walleye and providing spawning habitat for walleye downstream of the project.

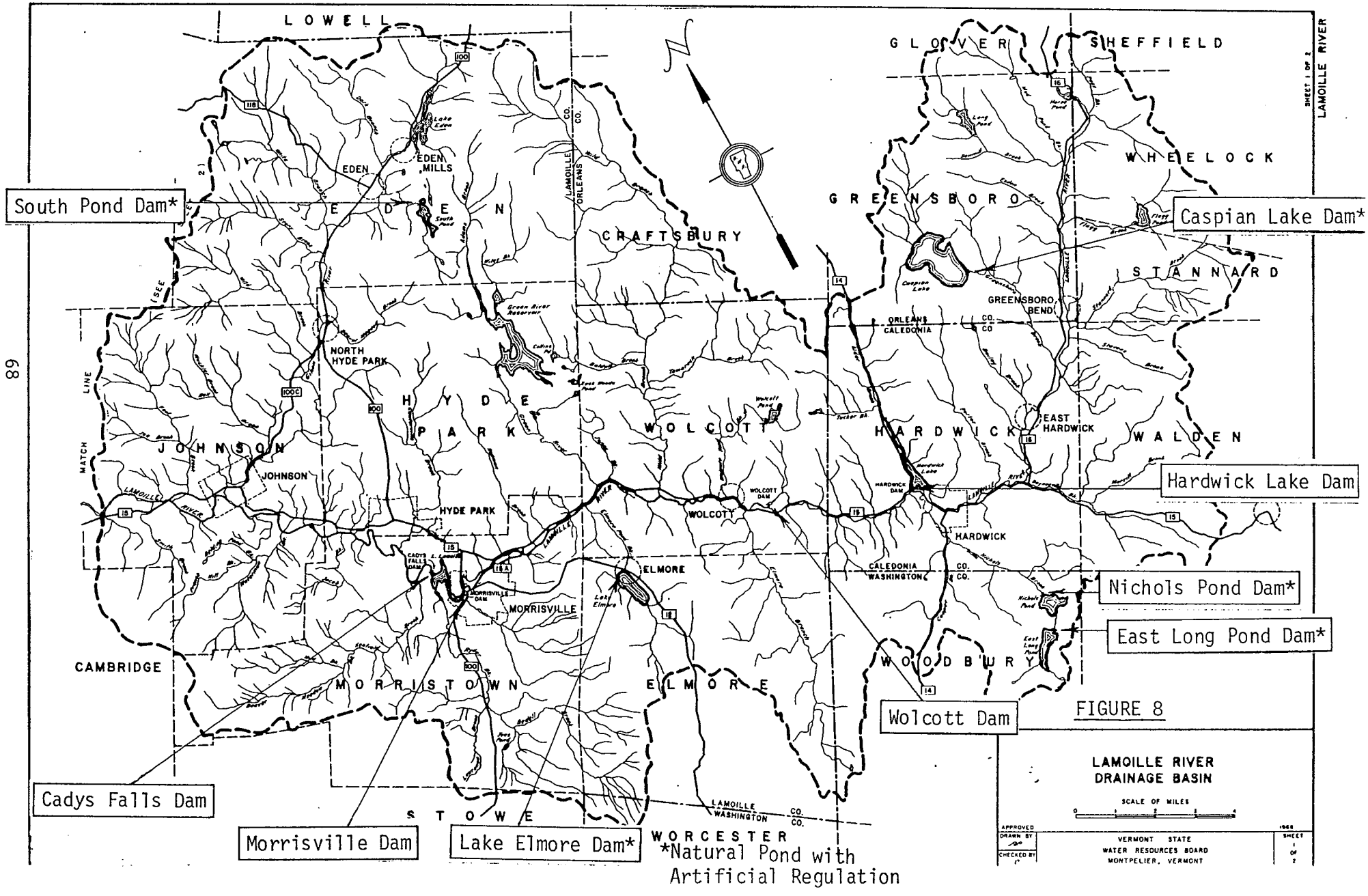

South Pond Dam*
Caspian Lake Dam*
Hardwick Lake Dam
Nichols Pond Dam*
East Long Pond Dam*
Wolcott Dam
Cadys Falls Dam
Morrisville Dam
Lake Elmore Dam*
*Natural Pond with Artificial Regulation
LOWELL
GLOVER
SHEFFIELD
WHEELOCK
GREENSBORO
CRAFTSBURY
STANNARD
EDEN
EDEN MILLS
NORTH HYDE PARK
HYDE PARK
JOHNSON
WOLCOTT
HARDWICK
EAST HARDWICK
WALDEN
ELMORE
MORRISVILLE
CAMBRIDGE
MORRISTOWN
STOWE
WORCESTER
WOODBURY
LAMOILLE RIVER
LAMOILLE RIVER DRAINAGE BASIN
SCALE OF MILES
VERMONT STATE WATER RESOURCES BOARD MONTPELIER, VERMONT

FIGURE 8

BASIN 7

STREAM: Greensboro Brook

PROJECT: Caspian Lake

UTILITY: Village of Hardwick Electric Light Department

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Minor

Project Features:

Caspian Lake is the source of Greensboro Brook in the Town of Greensboro 3.9 miles upstream of the brook's confluence with the Lamoille River (Figure 8). The lake has a drainage area of eight square miles and a surface area of 789 acres. Useable storage is 1600 acre-feet with a drawdown of 2.2 feet from the top of the flashboards, which the Village of Hardwick Electric Light Department (the Village) reports are 8 inches in height.

Operating Mode

Caspian Lake is a natural lake with a manmade outlet structure used by the Village to augment flows on the Lamoille River. The normal operating procedures of the lake are described by the Army Corps of Engineers (ACOE) in their 1979 dam inspection report:

"The normal operational procedure for this dam is to maintain the water level at a depth of less than four inches above the spillway crest. There is reportedly a court order which indicates the owner may not store water at an elevation greater than eight inches above the spillway crest. This was established for the protection of shoreline properties, not for downstream flow control. In November of each year, the lake is lowered to channel level by opening the sluice gate. The available storage is used to control snow melt and heavy runoff during the winter and spring months. In late spring of each year, the sluice gate is closed, thus returning the reservoir level to its summertime elevation."

The Village reports the maximum drawdown is 26 inches "by agreement". This seems to conflict with the description provided by the ACOE report which indicates the lake is drained in November of each year.

The Department measured a leakage flow below the project of 7.9 cfs on June 15, 1982. The source of this flow was through the dam and the bottom of a gate.

Environmental Review

a. Water Quality

Caspian Lake is an oligotrophic water body. D.O. was collected by the Department downstream of the dam mid-afternoon June 15, 1982. This data indicates no apparent water quality problems though one sample was supersaturated.

b. Fisheries

The major fishery in Caspian Lake is lake trout, with brown trout and rainbow trout being secondary. The lake also supports a smelt and yellow perch populations. Tributaries upstream of the lake support a cold water fishery of brook trout, brown trout, and rainbow trout. Greensboro Brook below the lake supports a brook, brown, and rainbow trout fishery.

The tributaries upstream of the lake provide spawning and nursery habitat for rainbow trout and brown trout and spawning habitat for smelt. The lake provides spawning, nursery, and adult habitat for lake trout. It also provides adult habitat for smelt, brown trout, and rainbow trout. Spawning, nursery, and adult habitat for brook, rainbow, and brown trout are located in Greensboro Brook below the dam.

Vermont Fish and Wildlife reports that the present management of the lake level appears adequate toward maintenance of the existing salmonid populations. Problems could develop, however, if extreme drawdowns were to occur during the smelt spawning period in the spring and during lake trout spawning in the fall. No comments were provided on project impact on downstream fisheries.

Recommendations for Further Study

a. Determine more specifically the nature and content of existing agreements regarding lake level management. If agreements are informal, a formal agreement should be established with the Village of Hardwick to limit excessive water level fluctuations during the spring and fall to protect smelt and lake trout spawning habitat.

b. Determine if downstream flows are ever interrupted as a result of lake level management. If flows are regulated, the Department should seek to establish a minimum flow requirement to protect habitat for all life stages of brook, brown, and rainbow trout.

BASIN 7

STREAM: Nichols Brook

PROJECT: East Long Pond

UTILITY: Village of Hardwick Electric Light Department

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

East Long Pond is the source of Nichols Brook in the Town of Woodbury (Figure 8). It is 4 miles upstream of the brook's confluence with Cooper Brook which flows into the Lamoille River. It is also one mile upstream of Nichols Pond. The pond has a drainage area of 3 square miles and a surface area of 181 acres. Usable storage of the pond is 2715 acre feet with a drawdown of 10 feet. There is no bypassed section of stream below the dam.

Operating Mode

East Long Pond is a natural lake with a manmade outlet structure used by the Village of Hardwick Electric Light Department (the Village) to augment flows for the Wolcott generating facility downstream on the Lamoille River. The Village reports a maximum drawdown of ten feet. No other specifics about the project's operating mode were provided by the utility. A dam inspection report prepared by the Army Corps of Engineers in 1980 describes the management of the pond as follows:

"Operational procedures consist primarily of opening the gates in the summertime in order to augment flows to the power dam downstream on the Lamoille River..... The gates are reportedly opened in mid-summer and the pond level is maintained at approximately one foot below spillway level. The gates are then closed in the spring to raise the pool level and normal flows exit via the emergency spillway." The Department finds that closing the gates in the spring may result in an interruption of downstream flows.

Department records indicate the pond is drawn down 13 to 15 feet each October. The source of this information was not recorded.

Leakage flow measurements were taken below the dam on June 16, 1982, by the Department. A flow of 3.1 cfs was measured below the emergency spillway (which was spilling). A flow of .13 cfs was measured below the gate in the dam.

Environmental Review

a. Water Quality

Water quality data collected by the Department in 1973 indicates the pond stratifies in the deeper sections (90 to 100 feet) with some depression in D.O. with depth. The outlet gates for the pond, however, are located in a section of pond where depths are only 10 to 20 feet; therefore, the discharge from the project should not be substandard in D.O.

The Department collected temperature and D.O. data from the brook below the dam on June 16, 1982. The data indicates there are no apparent water quality problems resulting from the pond discharge.

b. Fisheries

Self-sustaining brook trout populations exist in tributaries flowing into East Long Pond. A good lake trout fishery, supported by annual stocking of juvenile fish and possibly by natural reproduction, exists in the lake. Brook trout, originating in the tributaries, are also expected to occur in the lake. Rainbow trout migrate upstream in the spring to spawn in the short segment of Nichols Brook between the East Long Pond outlet and Nichols Pond.

Existence and location of lake trout spawning habitat has not yet been determined. Extreme (10 to 15 feet) water level drawdown may make potential lake trout spawning sites unavailable. Drawdown following lake trout spawning (between mid-October and mid-November) and prior to fry emergence (March to May) could catastrophically eliminate natural reproduction.

Likewise, curtailment of flow below the outlet during rainbow trout spawning, egg incubation, and fry rearing (April to July) could preclude rainbow trout reproductive success.

c. Recreation/Aesthetics

The lake is used for swimming, fishing, picnicking, and boating. There is limited public access. There is a private road access and boat launch. Downstream recreation and aesthetics may be impaired if insufficient flow releases occur.

d. Natural Area/Wildlife Habitat

The Vermont Institute of Natural Science (VINS) reported to the Department by letter dated May 17, 1985, that the common loon, listed as endangered in Vermont, breeds on East Long Pond. In 1984, only six pairs of loons were known to have successfully reared young in the state. One factor identified by VINS as a cause of loon nest failure is drastic water level changes. VINS reports that there have been no known conflicts with nesting loons on the pond as a result of water level fluctuations. However, VINS states that artificial water levels must be monitored and limited during the loon nesting season which begins in mid-May and generally ends in mid-July. VINS recommends that water levels remain stable from May 1 through the beginning of August to allow for loon nest building in early May, egg laying, incubation, and late renesting.

Recommendations for Further Study

a. Determine if downstream flows are interrupted during reservoir filling in the spring and how the pond is drained in the fall.

b. Determine the need for additional recreational development.

c. Identify active and potential lake trout spawning habitat in East Long Pond and determine the extent of impact due to water level fluctuation.

Recommendations

a. An agreement should be established with the Village, prior to completion of the lake trout spawning habitat assessment, that fall drawdowns be completed prior to October 15 to prevent the dewatering of possible lake trout spawning sites and fertilized eggs.

b. The Vermont Field Office of The Nature Conservancy (TNC) is presently (1987-1988) negotiating with the Village of Hardwick Electric Light Department to control water levels of the pond during the loon nesting season. These negotiations should continue.

BASIN 7

STREAM: Nichols Brook

PROJECT: Nichols Pond

UTILITY: Village of Hardwick Electric Light Department (the Village)

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Nichols Pond is a natural lake located in the Town of Woodbury on Nichols Brook, 2.8 miles upstream of the brook's confluence with Cooper Brook which flows into the Lamoille River (Figure 8). East Long Pond is located about one-third of a mile upstream of Nichols Pond. The pond has a drainage area of 4 square miles and a surface area of 167 acres. Usable storage with an 8.5-foot drawdown is 1000 acre-feet. There is no bypassed section of stream.

Operating Mode

Nichols Pond is used to augment flows for the Village's Wolcott generating facility on the Lamoille River. The Village reports that the maximum drawdown of the pond is 8.5 feet. A leakage flow of 0.1 cfs was measured by the Department below the dam on June 16, 1982. The source of this flow was through the dam.

A dam inspection report prepared by the Army Corp of Engineers (ACOE) in 1980 states the following:

"Operational procedures consist primarily of opening the gates in the summer time in order to augment flows to the power dam downstream on the Lamoille River."

There is no additional information regarding project operation other than what is provided in the ACOE report. The Village did not provide any additional information in their questionnaire.

Environmental Review

a. Water Quality

Water quality data was collected by the Department during daylight hours on June 16, 1982, just downstream of the dam.

Lower D.O. concentrations of 74% and 81% were measured below the project. Department records indicate that these D.O. measurements are probably a result of beaver activity in the area. The low leakage flow measured on June 16 may also be contributing to the low D.O. concentrations.

b. Fisheries

Nichols Ponds contains populations of lake trout and rainbow trout supported by stocking and possibly by natural reproduction. Smelt are thought to serve as a forage for these species. Rainbow trout and smelt migrate upstream into Nichols Brook to spawn in springtime. Downstream of the Nichols Pond dam, self-sustaining populations of brook trout and rainbow trout are believed to exist.

Existence and location of lake trout spawning habitat has not yet been determined. Extreme water level drawdown (8.5') prior to spawning may make potential spawning sites unavailable. Drawdown following lake trout spawning (mid-October to mid-November) and prior to fry emergence (March to May) could catastrophically eliminate natural reproduction.

Curtailment of flows in the inlet brook due to gate closure at East Long Pond during rainbow trout and smelt spawning, egg incubation, and fry rearing (April to July) could preclude reproductive success. Extreme low flows below the Nichols Pond Dam have been documented (June 16, 1982) and may be limiting trout production downstream.

c. Recreation/Aesthetics

A two foot high "bathtub ring" was observed at the time the Department inspected the pond in the summer of 1982. The pond is used for swimming, fishing and picnicking. There is no recreational development other than a public road access.

Recommendations for Further Study

a. Determine if recreational development is needed.

b. Identify active and potential lake trout spawning habitat in the pond and determine the extent of impact due to water level fluctuations.

c. Additional information on project operation should be collected to determine the extent of stream flow regulation below the project as a result of project operation.

Recommendations

a. Seek to establish a minimum flow requirement in the inlet to Nichols Pond (at East Long Pond Dam) to protect habitat for spawning smelt and all life stages of rainbow trout.

b. Seek to establish minimum flow requirement below Nichols Pond to protect habitat for all life stages of brook trout and rainbow trout.

c. Prior to completion of lake trout spawning habitat assessment, drawdown each fall should be completed prior to October 15 to prevent dewatering of lake trout spawning sites and fertilized eggs.

BASIN 7

STREAM: Lamoille River

PROJECT: Hardwick Lake

UTILITY: Village of Hardwick Electric Light Department

LICENSE STATUS: Unlicensed

CLASSIFICATION: Upstream - B
Downstream - C

FISH HABITAT DESIGNATION: Impoundment - Warm water
Downstream - Cold water

IMPACT: Significant

Project Features

Hardwick Lake is located in the Town of Hardwick on the Lamoille River 4.4 miles upstream of the Wolcott Dam (Figure 8). The dam is 22.4 feet high with a crest 523 feet long fitted with 30 inch flashboards. The lake has a drainage area of 118 square miles and a surface area of 180 acres with the water level at the dam crest. It extends north up the Alder Brook valley about 10,000 feet. The useable storage area of the pond is reported by the utility to be 730 acre-feet (drawdown not specified).

Operating Mode

Hardwick Lake is a storage reservoir used to augment flows on the Lamoille River for the Wolcott Project downstream. The flashboards are removed from the dam crest November 1 of each year and replaced the following spring.

The utility reports an average drawdown of one foot under low flow conditions and 2 feet under moderate flows. This conflicts with another report by the utility that the impoundment is drawn down about six feet daily. During high flows there is no drawdown. Maximum drawdown is 10.5 feet with the flashboards in place. The gate to the outlet of the dam is opened from 6:00 a.m. to 10:00 p.m. daily to coincide with operations at the Wolcott Dam. This gate is reportedly never closed completely.

Severe ice jamming problems occur upstream in the Village of Hardwick (the Village) during the winter and spring. In order to alleviate these problems, normal operating procedures at the dam are changed during these periods in an effort to surge any ice packs which may have formed upstream. The gate to the dam is closed long enough for water to back upstream to float the ice. The gate is then opened and the flow of water transports the ice downstream from the Village where it collects behind the dam.

This operational procedure occurs one to two times a year, for periods lasting from three days to two weeks.

According to a 1980 Army Corps of Engineers dam inspection report, the "dam is used during the summer to maintain the level of Hardwick Lake and to some extent during periods of low flow to augment flow to the power generating dam about 3.8 miles downstream. The low level outlet is opened in the fall and the lake remains drained until late spring."

Individuals in the area have observed changes in water level fluctuations since the early to mid-1970's. Prior to that time, lake levels were reportedly higher and more stable than what they are now. Conversations with the utility in 1984 indicate that the only change in operations over the past 10 to 15 years is that in the last three to four years the gate for the outlet of the dam has been opened and closed on a daily basis. Prior to this time, the operators "never touched the gate at Hardwick Lake"; it was "open all the time."

According to the Department's 1976 Water Quality Management Plan, there is an informal agreement between the Hardwick Electric Department and the Department that, in the event Hardwick Lake impoundment is drained, it will be refilled allowing half of the river flow through the dam during the impounding process.

Environmental Review

a. Water Quality

The outfall for the Hardwick STP is located just downstream of the dam. This plant went on line in May, 1979, and has a design flow of .371 mgd. Prior to the construction of this facility, the Village of Hardwick upstream of Hardwick Lake was discharging raw sewage in the Lamoille River. Nitrogen and phosphorous loading from these discharges contributed to the accelerated eutrophication in Hardwick Lake.[1] The lake has also exhibited high water temperatures.

The lake is operated with no minimum flow requirement. It is possible that flows in the Lamoille below the dam can be reduced to less than the 7Q10 flow of 27 cfs. Violations of Vermont Water Quality Standards may occur during these periods.

[1] Lamoille River Basin Water Quality Management Plan. May 1976. Vermont Department of Water Resources.

The assimilative capacity of the stream may also be significantly reduced. A minimum flow requirement below Hardwick Lake should be recommended to encourage mixing and moving of the sewage effluent downstream.[1]

Temperature and D.O. data was collected from above and below the project in 1982. Supersaturated D.O. concentrations were measured in the impoundment and downstream. No early morning data was collected to determine the influence of algal activity.

b. Fisheries

The Lamoille River and other tributary streams upstream of and flowing into Hardwick Lake support good brook trout and rainbow trout populations. The lake itself supports warm water populations, the principal species being yellow perch. Common warm water species, and rainbow and brook trout, are present below the dam.

Tributaries upstream and downstream of the impoundment provide spawning, nursery, and adult habitat for trout species. The impoundment provides spawning, nursery, and adult habitat for warm water species, although frequent and large pond level fluctuations may preclude development and maintenance of balanced, healthy, warm water fish populations. These fluctuations also interfere with shore and boat angling. Spawning, nursery, and adult habitat for cold water species and adult habitat for warm water species are located downstream of the dam.

Hardwick Lake is a good example of how the impounding of water and resultant rise in water temperatures can cause a drastic shift in species composition, as is evidenced by predominance of such species as yellow perch, pickerel, and suckers in the impoundment. Vermont Fish and Wildlife reports that fluctuating water levels in the impoundment and downstream and sediment releases from the lake have impaired the salmonid population downstream of the dam.

A fish kill occurred below the dam on July 12, 1981. According to a report prepared by a Department Investigator, this kill was due in part to the reduction in stream flows below the project when flashboards were installed to hold back stream flows while some work was being done at the Wolcott facility.

The FFNA methodology was conducted at this site. One additional flow measurement must be taken before usable area curves can be plotted and a minimum flow requirement determined. The results of this study will be presented in the discussion of the FFNA study conducted at the Wolcott Dam project (page 81).

[1] Lamoille River Basin Water Quality Management Plan. May 1976. Vermont Department of Water Resources.

c. Erosion/Siltation

There is a serious shoreline erosion problem both upstream of Hardwick Lake and in the lake itself. The erosion problem in the impoundment is due to the daily impoundment level fluctuations which are not conducive to the establishment of vegetation on the shoreline. Erosion problems upstream are most likely due to poor land management practices such as clear cutting all vegetation to the streambank.[1]

The impoundment contains a substantial amount of silt. The utility states that since a large flood which occurred in 1973, the amount of silt in the impoundment has increased considerably. They report that the impoundment has never been desilted as it is too difficult to obtain a permit and is also too costly.

d. Recreation/Aesthetics

Fluctuating water levels in the impoundment have created an unsightly "bathtub ring" around the perimeter of the lake. Department representatives reported the impoundment had a bad odor when it was drawn down during their site visit in the summer of 1982. Extensive mudflats were also visible during this drawdown. The lack of a minimum spillage requirement at the dam also impairs project aesthetics.

The impoundment receives no recreational use other than possibly boating which is probably limited because of the drawdown. There is no recreational development at the impoundment or downstream other than a public road access.

e. Natural Area/Wildlife Habitat

Wetlands along the perimeter of the impoundment are exposed during the daily drawdown.

Recommendations for Further Study

a. The FFNA study should be completed. Depth and velocity measurements must be taken in Section 1 within a flow range of 25 to 30 cfs. Once these measurements are taken, useable area curves must be plotted. The minimum flow requirement below the project should be coordinated with a Wolcott Project flow requirement downstream.

b. An assessment of the project's impact on the assimilative capacity of the Lamoille River below the Hardwick

[1] Lamoille River Basin Water Quality Management Plan. May 1976. Vermont Department of Water Resources

STP must be made. Early morning temperature and D.O. data should be collected from Hardwick Lake downstream to below Wolcott Dam under low flow conditions to determine if D.O. violations occur.

c. An assessment of project impact on streambank erosion and downstream siltation should be made.

d. The impact of water level fluctuations on the wetlands in the impoundment should be determined.

e. The need for recreational development at the site should be determined.

Recommendations

a. A minimum flow requirement should be established below the project for the protection of fisheries and water quality. This flow requirement should be coordinated with the Wolcott Project downstream. Passage of part of this flow over the dam would improve project aesthetics.

b. Pond level fluctuations should be minimized to encourage development of stable, healthy, warm water fish populations and associated fishing opportunities in Hardwick Lake. Aesthetic qualities and recreational opportunities would also benefit by pond level stabilization.

BASIN 7

STREAM: Lamoille River

PROJECT: Wolcott Dam

UTILITY: Village of Hardwick Electric Light Department

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

The Wolcott Dam project is located on the Lamoille River about four miles downstream of Hardwick Lake (Figure 8). The project has a drainage area of 144 square miles. The dam is 52 feet high with a crest length of 384 feet creating an impoundment with a surface area of 12 acres. The impoundment extends upstream from the dam about one mile to the Route 15 bridge. With 3-foot flashboards in place, the impoundment has a usable storage capacity of 60 acre-feet with a 6-foot drawdown (maximum drawdown). The project operates with a gross head of 50 feet and has an installed capacity of 800 kW. The Department has estimated the project's hydraulic capacity to be 62 to 250 cfs. The project bypasses about 100 feet of streambed.

Operating Mode

The Wolcott Dam project is operated as a daily peaking operation. The Village of Hardwick Electric Light Department (the Village) reports that under low to moderate flow conditions, the project generates from 6:00 a.m. to 10:00 p.m., seven days a week, while storing at night. The average drawdown is 3 to 5 feet with the flashboards in place. Under high flows the project will operate run-of-the-river 24 hours a day with no drawdown.

During periods of refilling the impoundment, only leakage flows are maintained below the project. The Department measured a leakage flow of 0.4 cfs on July 6, 1982, 100 feet downstream of the dam in the bypassed section of stream. The source of this flow was through the dam and flashboards. A leakage flow of 7.4 cfs was measured below the project tailrace. This measurement included flows from Elmore Brook. A flow of 7.4 cfs is about 25% of the estimated 7Q10 flow of 30 cfs at the dam.

Based on an informal agreement between the Department and the Village confirmed in a Department letter dated January 30,

1970, the gate controlling a 6-foot diameter conduit is to be raised 4 inches to allow for a continuous release of water downstream. Under 50 feet of head, this results in a minimum flow of 18 to 25 cfs. This flow was determined to be essential to the recreational usage and aesthetic quality of the Lamoille River below Hardwick. The streamflow measurement of 7.4 cfs below the project indicates this flow release may not be maintained as agreed.

Project operation is described in the 1980 Army Corps of Engineers (ACOE) Phase 1 inspection report on Wolcott Dam as follows:

"Flashboards are installed to a level of 2.5 feet above the spillway crest when ice conditions are unlikely. Pond level is regulated as necessary to coordinate power generation with available flow. At times of low flow, power generation is curtailed in the evening to restore the pond level."

Environmental Review

a. Water Quality

The Hardwick STP is located 3 to 4 miles upstream of the Wolcott impoundment. The design flow for this plant is .371 mgd.

The Department collected temperature and D.O. data at stations above and below the Wolcott Dam on July 6, 26, and 29, 1982. Supersaturated conditions were recorded above and below the project, an indication of algal activity. Substantial algal growth was observed below the project.

No early morning D.O. data were collected from the site to check for possible violations. Worst case conditions would be expected during the early morning hours of the low flow months when the project is impounding.

b. Fisheries

The Lamoille River upstream and downstream of the impoundment at Wolcott Dam contains populations of rainbow trout, brook trout, yellow perch, pickerel, bullhead, suckers ,and minnow species. The impoundment itself supports yellow perch and pickerel populations primarily.

The Wolcott Dam impoundment provides habitat for warm water species in all life stages. Trout nursery and adult habitat is also available. Downstream of the dam there is nursery and adult habitat for both cold and warm water species. The primary spawning areas for the trout species are in the tributaries flowing into the Lamoille.

Vermont Fish and Wildlife reports that the project impairs fisheries above and below the project. The primary impact results from variable flows. In addition, the impoundment provides habitat for warm water species which in turn compete with cold water species in the impoundment. Poor desilting practices and streambank erosion problems have also impacted fisheries according to Vermont Fish and Wildlife.

Vermont Fish and Wildlife reports that salmonid habitat and populations could be improved if adequate flows were maintained downstream of the dam. Improved desilting procedures and implementation of a streambank stabilization program would reduce the sediment loading throughout the watershed. Should these recommendations be pursued, the stream has the potential of becoming a high priority site for fisheries both above and below the project.

There is no information on the potential fish habitat of the project's bypass.

FFNA

Section 1
Drainage Area: 118 mi^2
7Q10: 27 cfs
USFWS Flow: 59 cfs
Recommended Flow: survey not completed

Section 2
Drainage Area: 162 mi^2
7Q10: 30 cfs
USFWS Flow: 80 cfs
Recommended Flow: 90 cfs (at Section 2), 80 cfs (at Wolcott Dam)

A FFNA study was conducted at two sections. One was below Hardwick Lake and the other was downstream of Wolcott Dam (Figure 9). One additional flow measurement must be taken at Section 1 before usable area curves are generated for Section 1. The usable area curves for Section 2 below Wolcott Dam are presented in Figures 9a-9g.

Based on a review by Vermont Fish and Wildlife of usable area curves generated at Section 2, a minimum flow of 90 cfs (0.56 cfsm) would satisfy criteria for target fish species at the FFNA site. Since FFNA Section 2 is located just downstream of Elmore Branch and encompasses 18 mi^2 more drainage area than Wolcott Dam, the flow requirement for Wolcott Dam can be pro-rated downward to 80 cfs (i.e., 144 mi^2 of drainage area x 0.56 cfsm), allowing for the remainder of the necessary flow to be contributed by the Elmore Branch watershed.

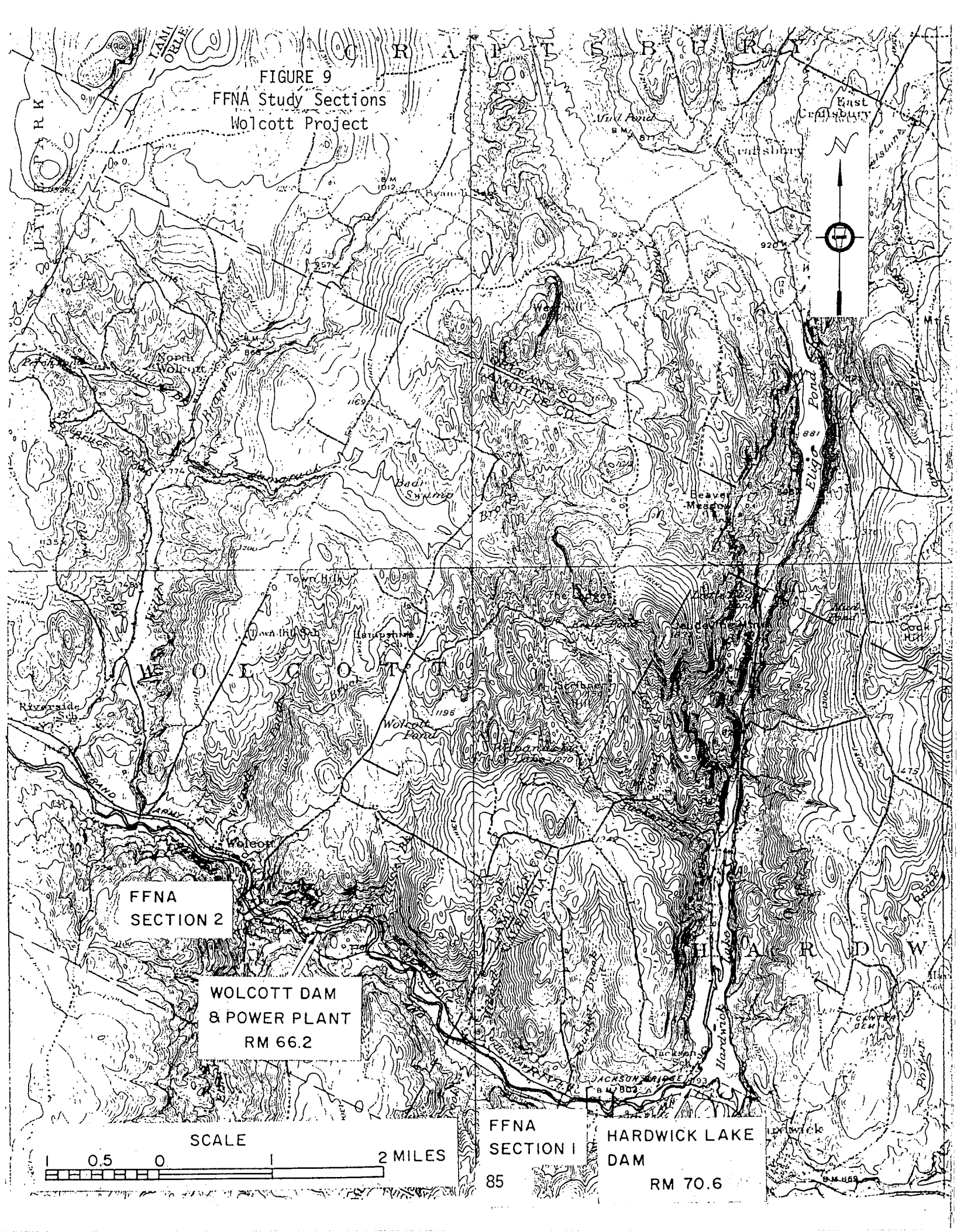


FIGURE 9
FFNA Study Sections
Wolcott Project
FFNA
SECTION 2
WOLCOTT DAM
& POWER PLANT
RM 66.2
FFNA
SECTION 1
HARDWICK LAKE
DAM
RM 70.6
SCALE
1 0.5 0 1 2 MILES
85

FIGURE 9a

FFNA Useable Area Curve - Wolcott Project

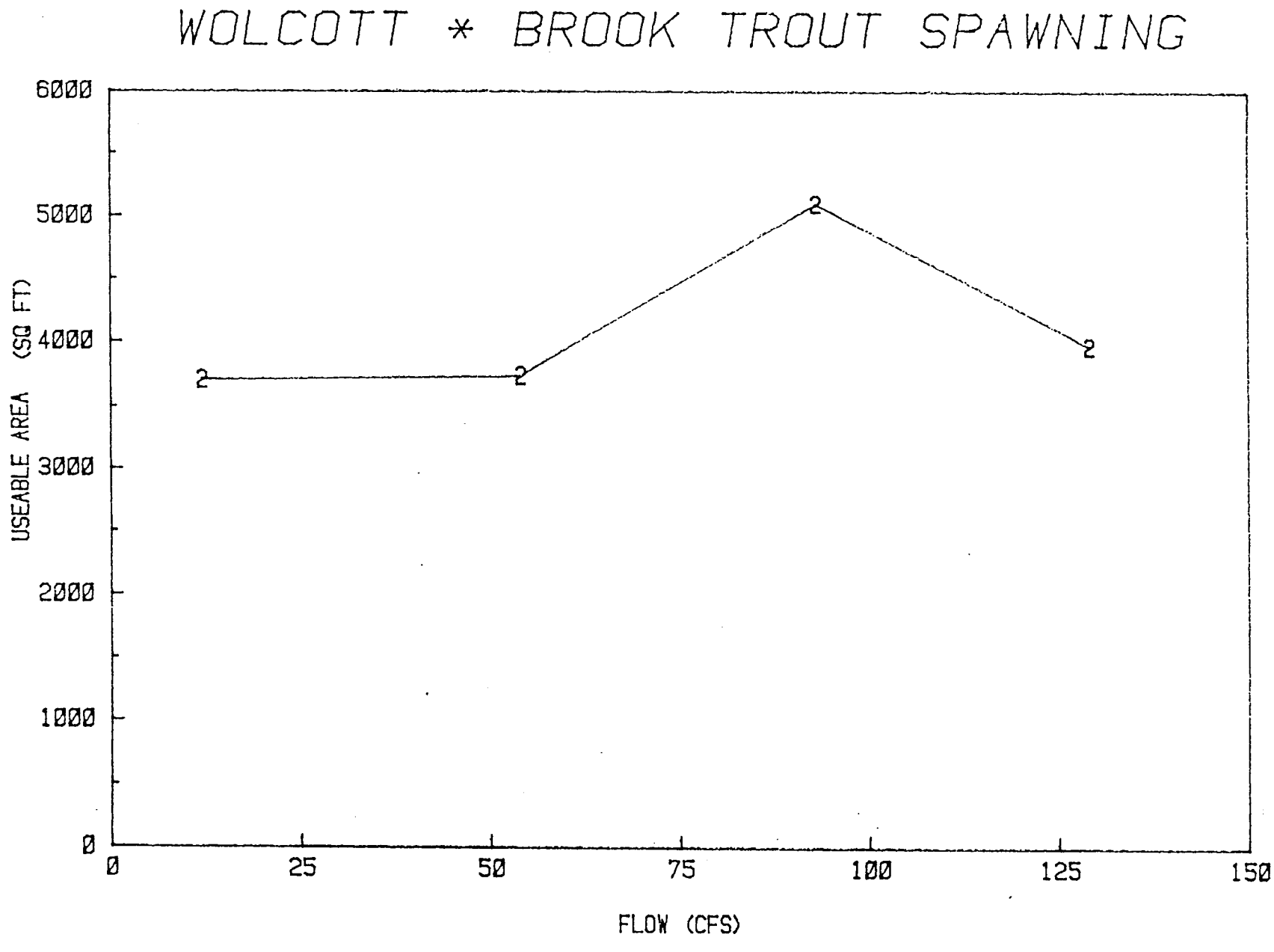


FIGURE 9b

FFNA Useable Area Curve - Wolcott Project

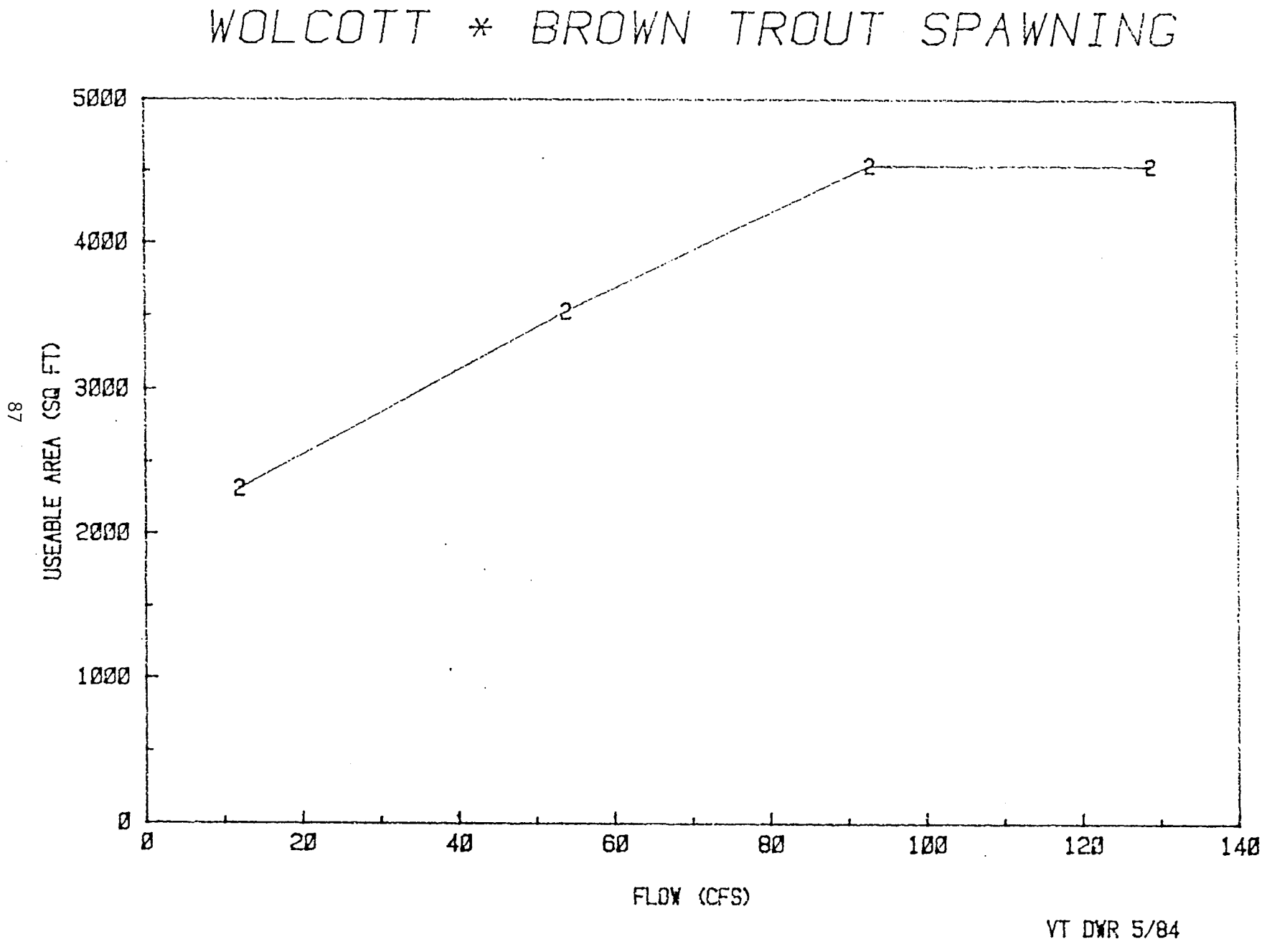


FIGURE 9c

FFNA Useable Area Curve - Wolcott Project

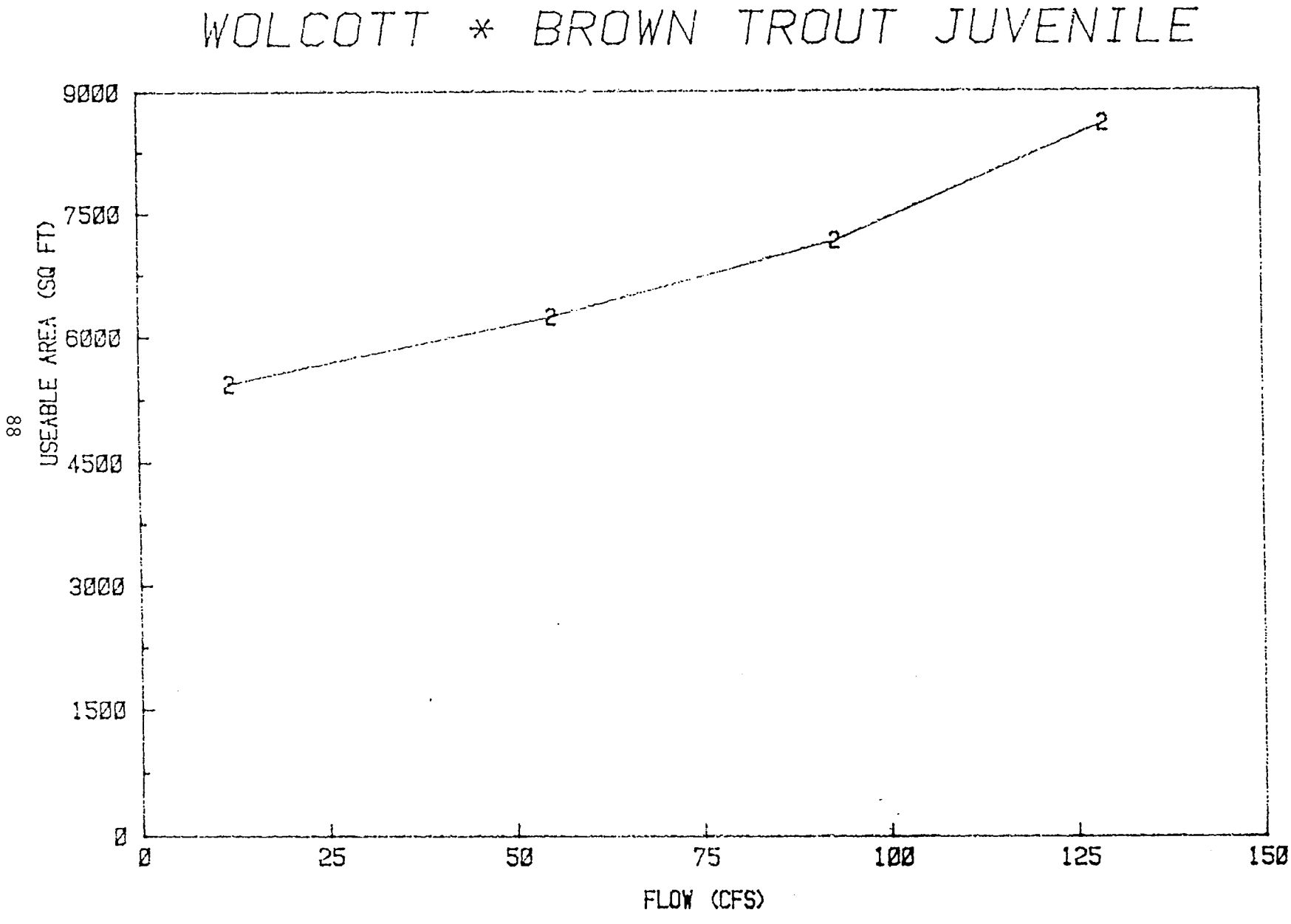


FIGURE 9d

FFNA Useable Area Curve - Wolcott Project

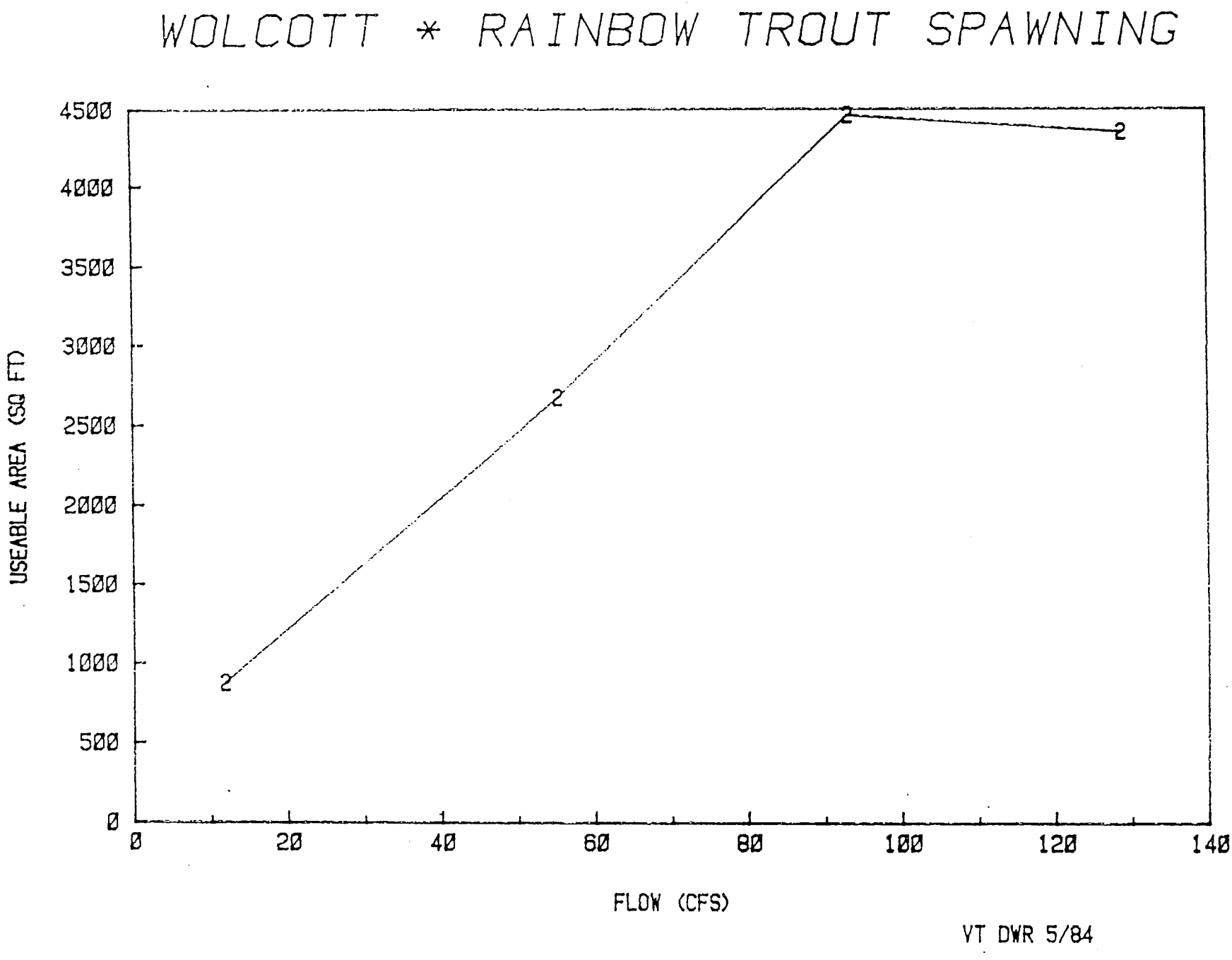


FIGURE 9e

FFNA Useable Area Curve - Wolcott Project

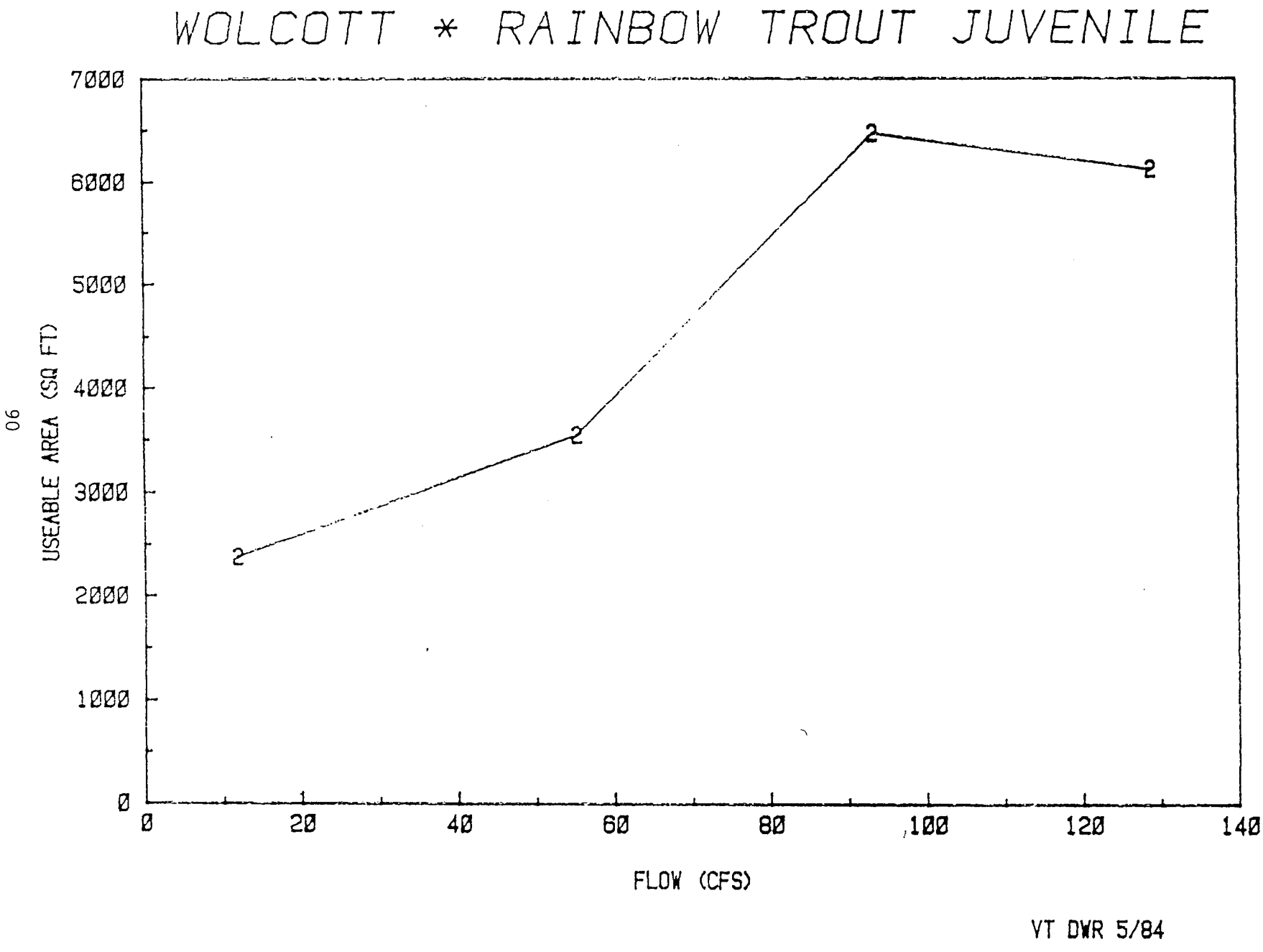


FIGURE 9f

FFNA Useable Area Curve -- Wolcott Project

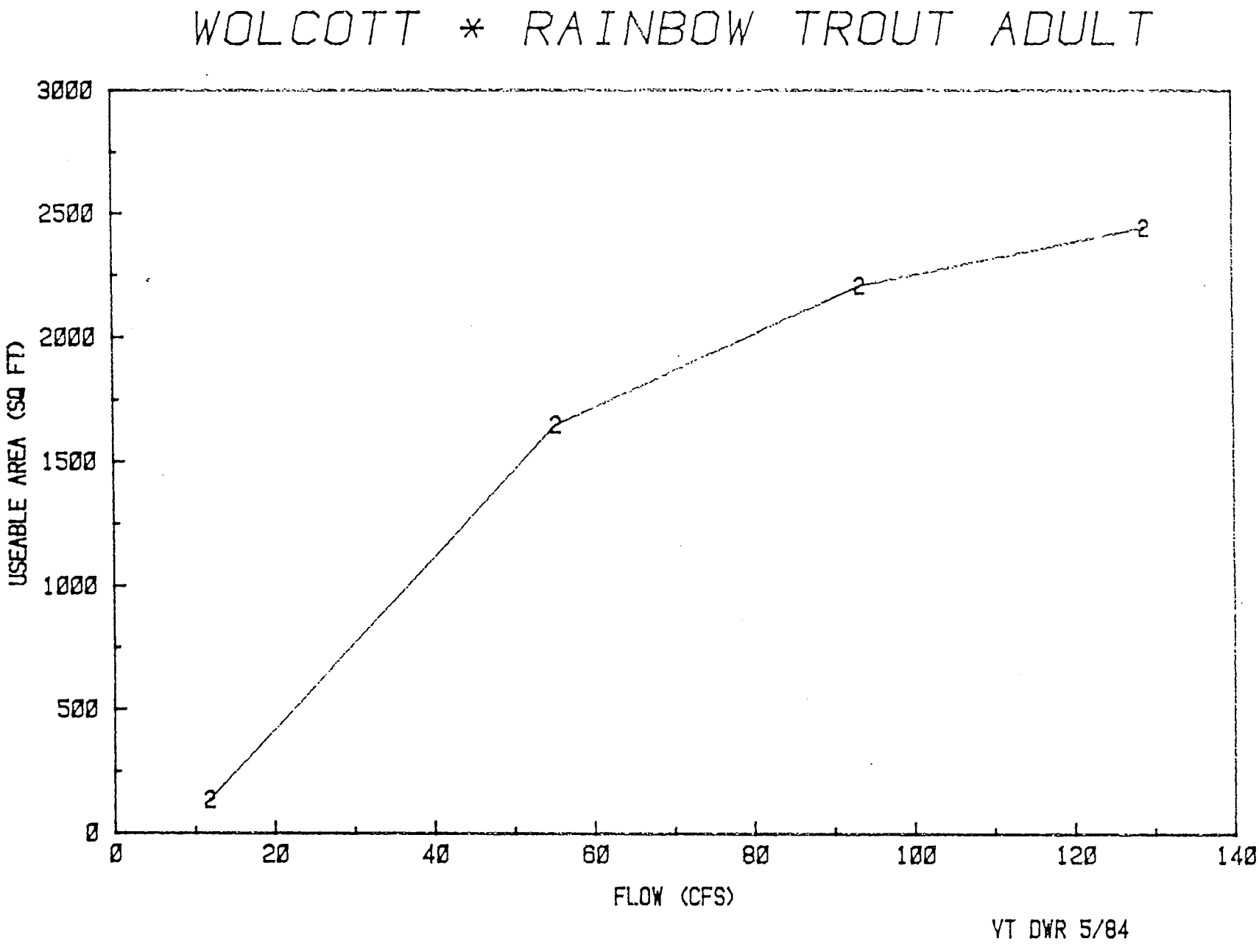
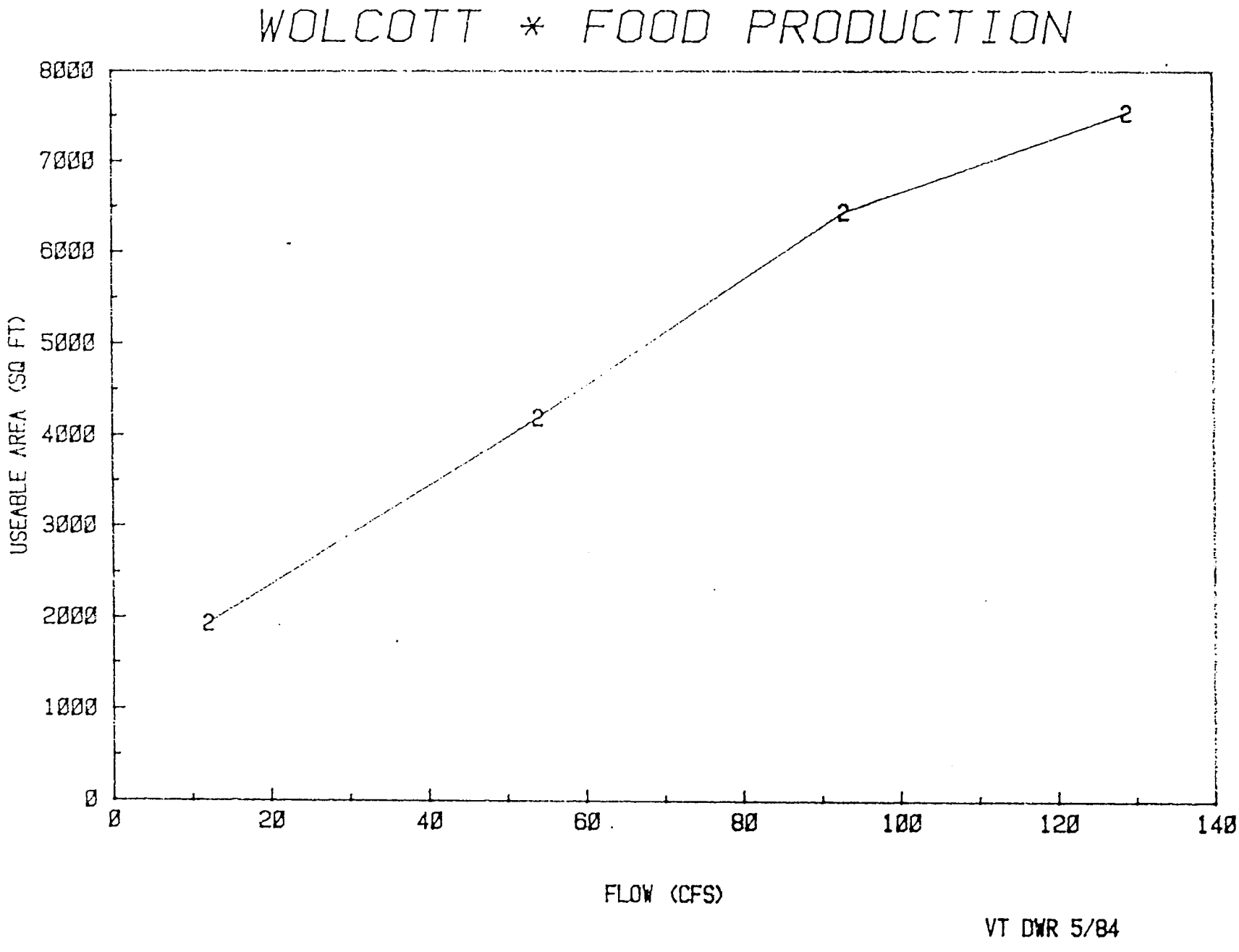


FIGURE 9g

FFNA Useable Area Curve - Wolcott Project



Using this same drainage area pro-rata figure (0.56 cfsm), the proportional minimum flow requirement at Hardwick Lake Dam is 66 cfs. Following completion of data collection and analysis at FFNA Section 1, flow needs for fish habitat protection below Hardwick Dam will be compared to this figure to determine whether the Hardwick Lake release must be greater than 66 cfs in order to satisfy habitat requirements in the Section 1 area as well as to furnish enough water to Wolcott Dam to meet the minimum flow requirement at Section 2.

c. Erosion/Siltation

There are significant streambank erosion problems both upstream and downstream of the Wolcott Dam, primarily due to poor land management practices of clearing vegetation up to the stream's edge. Poor logging practices have been reported in the watershed as well, contributing to a heavy silt load in the stream. Fluctuating water levels in the impoundment and downstream may also be contributing to streambank erosion problems. The combination of these factors has resulted in substantial amounts of silt accumulating in the impoundment. The silt level in the impoundment was estimated to be about 15 feet in 1982.

The project has had a history of desilting problems. In 1977, the impoundment was drawn down for repairs. Reports from a Department investigator and a Vermont Fish and Wildlife warden indicate that considerable sediment and high turbidity was released downstream during this drawdown. The utility also undertook a desilting project at the site in 1982 resulting in substantial silt releases downstream.

d. Recreation/Aesthetics

The lack of adequate minimum flows below the project degrade the aesthetics of the site and the quality of fishing as well. As previously stated, an informal agreement had been made in 1970 between the Department and the Village regarding a minimum flow release of 18 to 25 cfs for downstream recreation and aesthetics. Flow measurements by the Department in 1982 indicate the flow release is not being maintained.

The lack of a minimum flow over the dam impairs project aesthetics. There is also no recreational development above or below the project.

Recommendations for Further Study

a. The FFNA study must be completed and a minimum flow requirement finalized for below Hardwick Lake. The flow requirement should be coordinated with the requirement established at Hardwick Lake upstream.

b. An assessment of the project's impact on streambank erosion should be made.

c. Early morning D.O. and temperature data should be collected from Hardwick Lake downstream to below Wolcott Dam under low flow conditions to determine if D.O. violations occur. The impact of the two projects on the stream's assimilative capacity should also be determined.

d. The need for recreational development at the site should be determined.

Recommendations

a. A minimum flow requirement must be established below the project based on the results of the FFNA study. This flow requirement would reduce flow and water level fluctuations both upstream and downstream of the project, thereby reducing any streambank erosion problems which may be identified due to project operation. It would also improve downstream aesthetics and water quality. Passage of part of this flow at the dam would improve aesthetics as well.

b. Any proposed desilting projects should be regulated in accordance with the Agency Desilting Policy and carefully reviewed to prevent the discharge of sediment downstream.

BASIN 7

STREAM: Lamoille River

PROJECT: Morrisville Dam, Cadys Falls Project

UTILITY: Morrisville Water and Light Department

LICENSE STATUS: FERC license issued August 28, 1981; Water Quality Certification issued May 7, 1981

CLASSIFICATION: Morrisville Dam - Upstream - B
- Downstream - C
Cadys Falls - Impoundment - C
Downstream - B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Some - Morrisville
Significant - Cadys Falls

Project Features

The Morrisville Water and Light Department was issued a Water Quality Certification dated May 7, 1981, for the Morrisville and Cadys Falls projects located on the Lamoille River in the Town of Morrisville (Figure 8). The projects are part of the Morrisville Project which includes Cadys Falls, Morrisville Dam, Green River Dam, and Lake Elmore. The Morrisville Project was issued a FERC license August 28, 1981.

A description of project features and operating mode is available in the FERC license application and Water Quality Certification.

The Water Quality Certification requires minimum flows below both projects based on a FFNA study conducted by the Department. Both projects have bypassed sections of stream through which no minimum flow has been required. Cadys Falls bypasses 1800 feet and Morrisville Dam Project bypasses 300 feet of stream. A leakage flow of 0.4 cfs was measured by the Department 46 feet downstream of Cadys Falls Dam on July 7, 1982. The source of this flow was through the dam and bedrock. The impoundment level during measurement of this leakage flow was 5 inches below the dam crest. No leakage flow was measured in the bypass at Morrisville Dam.

Environmental Review

a. Erosion/Siltation

Both impoundments have substantial amounts of silt accumulation. At Cadys Falls the silt level was estimated to be about 15 feet.

b. Recreation/Aesthetics

The lack of a minimum flow at the dam and through the bypass at both projects impairs project aesthetics and recreation.

Recommendation

Follow up on the conditions of the FERC license and Water Quality Certification for compliance. Department representatives observed while inspecting the Cadys Falls Project on July 7, 1982, that the impoundment was drawn down 5 inches below the dam crest with 4-foot flashboards installed. Drawdown was, therefore, 4 feet 5 inches. According to the FERC license application and findings of the 401 for the project, Cadys Falls operates with a maximum daily drawdown of 2 feet. It was not specified in either document whether this drawdown was from the top of the flashboards, which in the FERC license application are only 3.5 feet high, or from the dam crest. During this drawdown, wetlands upstream of the impoundment were exposed, as well as extensive mudflats, resulting in an unpleasant odor.

BASIN 7

STREAM: Elmore Pond Brook

PROJECT: Lake Elmore

UTILITY: Morrisville Water and Light Department

LICENSE STATUS: FERC license issued August 28, 1981

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Impoundment - Warm water
Downstream - Cold water

IMPACT: Significant

Project Features

Lake Elmore is a natural lake with a manmade outlet structure located on Elmore Pond Brook in the Town of Elmore (Figure 8). It is part of the Morrisville Project which includes the Morrisville Dam, Cadys Falls Dam, and the Green River Dam. The brook flows into the Lamoille River 2 miles downstream. Lake Elmore has a drainage area of 7.5 square miles and a surface area of 224 acres. The dam has raised the natural level of the lake 4 feet. Available storage is 1000 acre-feet.

Operating Mode

No utility questionnaire was sent to the Village of Morrisville. The FERC license application for the Morrisville Project (submitted to FERC June 6, 1980) states that Lake Elmore is "utilized to firm up the low water conditions in the Lamoille River. Usage of this water is made during the fall and winter times of subnormal water levels in the Lamoille River. However, since the drainage area is small, the lake is not used extensively for water use. In addition, the lake is used intensively for recreation during the summer months and the water level, therefore, is not drawn down during this time period" as a result of an agreement with the Town of Elmore Selectmen.

Residents from the area report that beginning around October 1, the lake may be drawn down to a maximum of 40 inches (reference point unknown) and that the gates to the lake are opened and closed throughout the winter. The utility superintendent reported to the Department during a site visit in 1982 that, from September 1 to May 1, the lake can be drawn down 2 feet. Drawdown usually takes place from September 1 through the middle of November. Residents around the lake are usually informed when drawdowns will take place.

Available information, in particular that the gates are reportedly opened and closed all winter, indicates that downstream flows in Elmore Pond Brook may be interrupted during certain times of the year.

Environmental Review

a. Water Quality

The Department collected temperature and D.O. data from Elmore Pond Brook below the dam in 1982. This D.O. data indicates no problems. Releases from the pond are from the surface.

Water quality problems may occur in the stream below the lake if there are periods when no flows are released from the dam.

b. Fisheries

Lake Elmore supports a warm water fishery, the principal species being yellow perch, northern pike, and smallmouth bass. Brook trout are found upstream of the lake. No survey has been conducted downstream of the lake. It is expected to support a cold water fishery.

The lake provides spawning, nursery, and adult habitat for northern pike and nursery and adult habitat for the other warm water species. Vermont Fish and Wildlife states that fluctuating water levels in the spring conflict with northern pike spawning. Stabilizing the spring pool would negate this problem.

Elmore Pond Brook is thought to serve as a spawning and nursery stream for brook, brown, and rainbow trout from the Lamoille River. Extreme low flows possibly caused by gate closure at Elmore Lake have been observed at the mouth of the brook. Although the extent of the problem has not been fully assessed by Vermont Fish and Wildlife, fluctuating flows below the project are believed to impair trout populations and habitat in Elmore Pond Brook as well as in the Lamoille River.

c. Erosion/Siltation

During a Department site inspection in 1982, there appeared to be a silt problem. Silt could be seen just upstream of the spillway.

d. Recreation/Aesthetics

There is no information on whether the project impacts downstream recreation and aesthetics.

Recommendations for Further Study

a. A fisheries survey below the lake in Elmore Pond Brook should be conducted to confirm species composition and habitat potential and to assess the extent of impact of flow curtailment on trout in the brook and the Lamoille River.

b. An assessment of stream flow fluctuations should be made to determine their impact on recreation, aesthetics, and water quality.

Recommendations

a. Water levels in the lake should be stabilized to enhance fisheries, particularly during the spring spawning period.

b. A minimum flow requirement should be established for the Elmore Pond Dam to protect trout populations resident in Elmore Pond Brook and that migrate into the brook from the Lamoille River to spawn.

c. Petition should be made to FERC to reopen the governing license in order to establish flows and water levels as license conditions.

BASIN 7

STREAM: Tributary of Gihon River

PROJECT: South Pond Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

South Pond Dam is a natural lake with a manmade outlet structure located in the Town of Eden on a tributary on the Gihon River (Figure 8). The pond has a drainage area of 6 square miles. With the water level at the dam crest, the pond has a surface area of 109 acres. A 17.5 foot drawdown from the dam crest provides a usable storage of 1835 acre-feet.

Operating Mode

According to a 1959 dam inspection report made by CVPSC, "Since the spillway of this dam is not considered adequate to safely discharge a major flood, it has been the practice to maintain the pond 14 feet below the top of the dam and it is reported to have filled only to within about seven feet of the top in 1927, the highest since it was built".

According to a 1979 Public Service Commission report, South Pond is operated as a storage dam in connection with the water needs of the company's power plants further downstream.

Vermont Fish and Wildlife reports that downstream flows are curtailed as a result of project operation. At the time the Department inspected the site on June 15, 1982, no flow was being maintained below the dam. The next tributary below South Pond Dam is 0.9 mile downstream. This 0.9 mile section of stream may be dewatered certain times of the year.

Environmental Review

a. Water Quality

There is no information on water quality either upstream or downstream of the dam. The lack of adequate flows below the project could impair water quality.

b. Fisheries

South Pond supports a warm water fishery, the principal species being smallmouth bass, yellow perch, and brown bullheads. Brook trout is the principal fishery below the project. Vermont Fish and Wildlife reports that fisheries are impaired due to pond level fluctuations and curtailment of downstream flows. Maintenance of a minimum flow at the pond's outlet and stabilizing pond levels would improve fisheries at this site. The Gihon River is a very important local resource; therefore, flow protection is a high priority.

Vermont Fish and Wildlife also reports that public access to the impoundment is extremely limited so their interest in this pond is presently low. Their interest in limiting pond level fluctuations would be great if access was improved.

c. Shoreline Development

A few camps are located around the pond. If the water level was raised to the dam crest, these camps would be flooded.

d. Recreation/Aesthetics

Vermont Fish and Wildlife reports that access to the pond is quite limited.

Recommendation for Further Study

a. Additional information on project operation should be collected to determine its impact on the uses and values of the tributary and necessary mitigative measures. Mitigative measures will most likely include reduced water level fluctuations in the pond and an improved downstream flow regime.

b. Determine how access to the site could be improved.

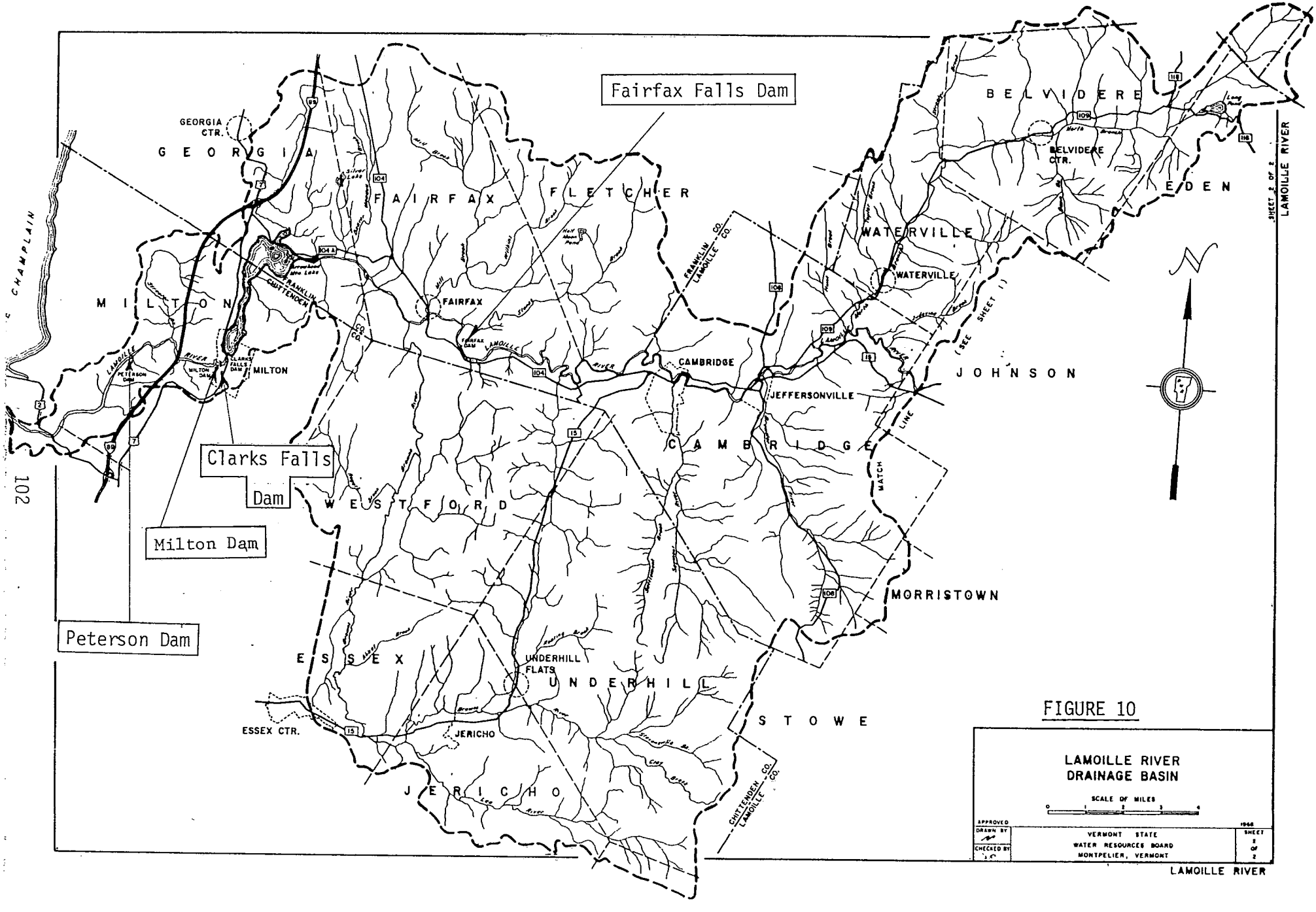


FIGURE 10

LAMOILLE RIVER
DRAINAGE BASIN

SCALE OF MILES

APPROVED		1968
DRAWN BY	VERMONT STATE WATER RESOURCES BOARD MONTPELIER, VERMONT	SHEET 1 OF 2
CHECKED BY		

BASIN 7

STREAM: Lamoille River

PROJECT: Lamoille River Project - Fairfax Falls, Clarks Falls, Milton, Peterson

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Issued February 4, 1969; expired December, 1987. CVPSC applied for a FERC license and a Water Quality Certification prior to the license's expiration date. However, due to various licensing circumstances, neither a license or certification has been issued to date.

CLASSIFICATION: Fairfax Falls - B
Clarks Falls - B upstream, C downstream
Milton - C
Peterson - C upstream, B downstream

FISH HABITAT DESIGNATION: Cold water, except for Arrowhead Mountain Lake, which is warm water, and the section from Peterson Dam downstream, which is warm water, for the period June 1 to September 1 only

IMPACT: Significant

The Lamoille River Project includes the Fairfax Falls, Clarks Falls, Milton, and Peterson facilities from upstream to downstream, respectively (Figure 10). CVPSC's license application is for existing facilities at Clarks Falls, Milton, and Peterson. Project expansion is proposed for Fairfax Falls. Project features and operating modes are briefly summarized below. Reference should be made to the license and certification when issued for a detailed description of the project.

PROJECT: Fairfax Falls

Project Features

Fairfax Falls is located in the Town of Fairfax. The project has a drainage area of 529 square miles. The dam is constructed at the top of a set of falls known as Fairfax Falls which are bypassed by the project. These falls were included in the Agency's Waterfalls, Cascades, and Gorges study. The project's penstock, powerhouse, tailrace, and appurtenant facilities are located on the left streambank. The project operates with two turbines, each having a rated discharge of 272 cfs and a rated capacity of 1440 kW.

Proposed project expansion involves the installation of generating facilities on the opposite side of the river, the site of a former station which was made inoperable by a 1927 flood. A 3.5 mw Francis turbine would be installed with a design flow of 520 cfs. The operating flow range would be 200 to 606 cfs, increasing maximum plant capacity from 545 cfs to 1150 cfs. The design change will increase the plant's operating range and allow for more flexibility in individual turbine operation. Installation of the proposed turbine would reduce the amount of time that spillage occurs by roughly 10% to 40% on a monthly basis.

Operating Mode

The utility describes the operating mode of the project in a letter to the Agency dated September 10, 1984. This description is as follows:

"Because the pool does not impound a substantial amount of water and is confined to the river channel, the station operates in a daily run-of-the-river mode, i.e., water flowing into the pool, flows out of the pool and through the station on a daily basis. The lack of storage ability allows high flows to bypass the station".

During periods of refilling the impoundment, no minimum flow is maintained below the project. The Department measured a leakage flow 200 feet below the project of 0.8 cfs on July 12, 1982. The impoundment level was 6 to 8 inches below the top of the flashboards. The source of this flow was between the flashboards and the dam and through the skim gate. This leakage flow is less than 1% of the 7Q10 flow of 122 cfs.

PROJECT: Clarks Falls

Project Features

Clarks Falls is located in the Town of Milton and has a drainage area of 690 square miles. Project features consist of a dam, 360 foot penstock, and a powerhouse which discharges into the upstream end of the Milton impoundment. The Clarks Falls impoundment is referred to as Arrowhead Mountain Lake. The project's powerhouse contains a turbine with a rated discharge of 997 cfs and rate capacity of 3000 kW.

Operating Mode

Clarks Falls impounds water, primarily during the summer over the weekend period, and then utilizes the impounded water to generate during the following work week. CVPSC states that the drawdown during the summer is 2 to 3 feet a week. Maximum operational drawdown is 5 feet.

The project operates with no minimum low flow. During periods of impounding, the only flow maintained below the project is leakage. The Department measured a leakage flow on June 22, 1982, of 16 cfs which is only 10% of the 7Q10 flow of 160 cfs. The source of this flow was through the dam, flashboards, bedrock, and tainter gates.

PROJECT: Milton

Project Features

Milton is located in the Town of Milton one quarter mile downstream of Clarks Falls and about 2.5 miles upstream of the Peterson dam. The project has a drainage area of 690 square miles. Project features include a dam, penstock, powerhouse, and tailrace. The powerhouse contains two turbines, one with a rated discharge of 495 cfs and the other with a rated discharge of 465 cfs. The generator rating for each turbine is 3000 kW. The dam is constructed at the top of a set of falls known as Milton Falls which are bypassed by the project. (These falls were included in the Agency's Waterfalls, Cascades, and Gorges study.) The tailrace discharge is directly into the upstream end of the Peterson impoundment.

Operating Mode

Operation of the Milton project is controlled by the Clarks Falls facility upstream. The impoundment is usually drawn down 2.5 feet below the top of the flashboards. Daily discharge releases vary depending on the load demand but after Clarks Falls has drawn down 2 to 3 feet during the week, the Milton discharges are substantially reduced.

No minimum flow is maintained below the project during periods of impounding other than leakage. The Department measured a leakage flow 200 feet below the dam of about 3.6 cfs on June 22, 1982. The source of this flow was through the dam, flashboards, bedrock, wastegate and skim gate. This flow is only 2% of the 7Q10 flow of 160 cfs.

PROJECT: Peterson

Project Features

Peterson is located on the Lamoille River in the Town of Milton 2.5 miles downstream of the Milton Project and 6 miles upstream of Lake Champlain. The project has a drainage area of 700 square miles. Project features include a dam, penstock, and powerhouse. The project's tailrace discharges into the lower end of the dam's plunge pool. The project's powerhouse contains a

turbine with a rated discharge of 1700 cfs and generator rating of 5000 kW.

Operating Mode

Operation of the Peterson project is influenced by the Milton and Clarks Falls facilities which operate as daily peaking facilities. Water is drawn from storage to augment releases from Clarks Falls, which has a smaller turbine capacity. Maximum operational drawdown is 6 feet.

No minimum stream flow is maintained below the project during periods of impounding other than leakage through the flashboards and bascule gate. This flow has not been measured by the Department as a deep pool is located directly below the dam making it difficult to take such measurements.

Environmental Review

The Agency's position on this project with respect to water quality, fisheries, recreation, aesthetics/natural areas, and pond level stabilization is discussed in a letter dated January 5, 1987, from the Agency to CVPSC. This letter is summarized as follows:

a. Water Quality

Loss of spillage, flow regulation, impoundment fluctuation, and penstock withdrawal level all have an important impact on river water quality. To evaluate plant operations with respect to river water quality, CVPSC undertook a water quality sampling effort in both 1979-80 and 1983.

The Department has reviewed these water quality studies and finds that, based on this data and data collected by the Department in 1982, it cannot justify CVPSC's conclusion that no minimum flow releases are needed.

The Department recommends that CVPSC spill a flow of 7Q10 (160 cfs) at the three lower facilities as an interim condition until a more vigorous study is completed. The results of this study could be used to adjust this spillage requirement to insure that D.O. standards would be met.

b. Fisheries

- Walleye Spawning. The period of April 1 through June 1 adequately brackets the walleye spawning period and would guarantee reasonable spawning success with a favorable flow regime. The Department recommends that the projects operate in true run-of-the-river modes during this period. CVPSC has agreed to operate the projects accordingly.

- Sturgeon Spawning. Lake sturgeon spawning closely follows walleye spawning. The Department recommends that run-of-the-river conditions be maintained below each project through June 15, which is the approximate end of their incubation period. CVPSC has agreed to operate the projects accordingly.

- Lake Champlain Salmonid Restoration Program. Spring instream movements of steelhead rainbow trout will be satisfactorily accommodated by the walleye/sturgeon flow regime.

Natural reproduction of landlocked Atlantic salmon will only be emphasized after a determination is made that stocking has successfully established a lake population. The Lamoille River is a targeted tributary for introduction of the species. When and if program success has been demonstrated, the Department will, upon its own motion, require CVPSC to maintain flows necessary for the fall salmon run. Upstream and downstream passage will also be a topic at that time. Until special flows are set under the Water Quality Certification process, required fall flows will be in accordance with the next section.

- Year-round Flows for Fisheries. Below the Fairfax Falls Plant, CVPSC has proposed the release of 296 cfs (0.561 csm) as a minimum continuous flow throughout the year. The Department accepts this flow below the plant.

Spillage flows required for water quality and aesthetics will be sufficient to maintain limited habitat conditions in the bypassed section at Fairfax Falls.

CVPSC proposes to continuously spill 100 cfs at the three downstream projects. This flow is acceptable at the Milton and Clarks Falls site. However, a flow demonstration will have to be conducted at the Peterson site before a determination can be made whether this flow is acceptable.

- Fish Movement. The Department will require Vermont Fish and Wildlife approval of methods to both minimize or prevent fish impingement on trashracks and turbine mortality and to safely convey fish downstream.

c. Recreation

With improvements to the river flow regime and fisheries enhancement, including the progression of the Lake Champlain Salmonid Fisheries Development Program, it is expected that recreational pressure will increase substantially. CVPSC has proposed recreational improvements to various projects including boat access, parking, and canoe portage facilities. The Agency has asked that additional improvements be made, such as scenic overlooks and additional access for swimmers and fishermen.

Also, Trout Unlimited has negotiated scheduled fall releases of 200 to 300 cfs from Peterson to enable people to fish for salmon during the fall run. This informal agreement will continue until such time as permanent flows are set after the salmon restoration program is considered successful.

d. Aesthetics/Natural Areas

Fairfax Falls is one of Vermont's major cascades. The aesthetic value of the falls has been compromised by the existing hydro facility both by the civil works and seasonal diversion of flow away from the falls. The additional unit proposed for Fairfax would substantially reduce the frequency and volume of spillage which the site now experiences.

The Agency believes it is important for an adequate minimum spillage to be released at the dam. In order to determine spillage requirements at this site, CVPSC must arrange a variable flow demonstration.

Spillage of 7Q10 flows at the lower sites as the minimum spillage requirement for water quality, in the Department's opinion, would serve to restore the visual qualities of Clarks Falls and Milton Falls.

e. Pond Level Stabilization

New limitations on pond level drawdowns are being sought by the Agency for both Peterson and Clarks Falls. Those sites have operational drawdowns of up to 6 feet (daily) and 5 feet (weekly), respectively, at this time.

The Agency believes that maximum limits of two feet for both Peterson and Clarks Falls would significantly reduce environmental impacts and improve public use. With the required spring spawning run-of-the-river flow regime set for the projects, no pond level fluctuation would be possible during April 1 to June 15. At the beginning of the period, the Agency would want the impoundments at their normal maximum operating level.

Expected benefits would include establishment of aquatic vegetation; improved habitat for invertebrates; spawning, nursery, and cover for adult and juvenile fish; enhanced recreational use; and better aesthetics.

Fairfax Falls has been operated with a maximum drawdown of three feet historically. The Department wishes to limit this drawdown to two feet maximum; however, a strict run-of-the-river operation would be preferred. A 2-foot cycle is more typical of most older hydroelectric stations with which we deal. We believe that cycles greater than two feet are limiting with regard to macroinvertebrate food production and would be disruptive to fish life.

Recommendations

a. Continue negotiations with CVPSC regarding those issues addressed in the Agency's January 5, 1987, letter.

b. Upon issuance of the FERC license and Water Quality Certification, follow up on the conditions and articles of these documents for compliance.

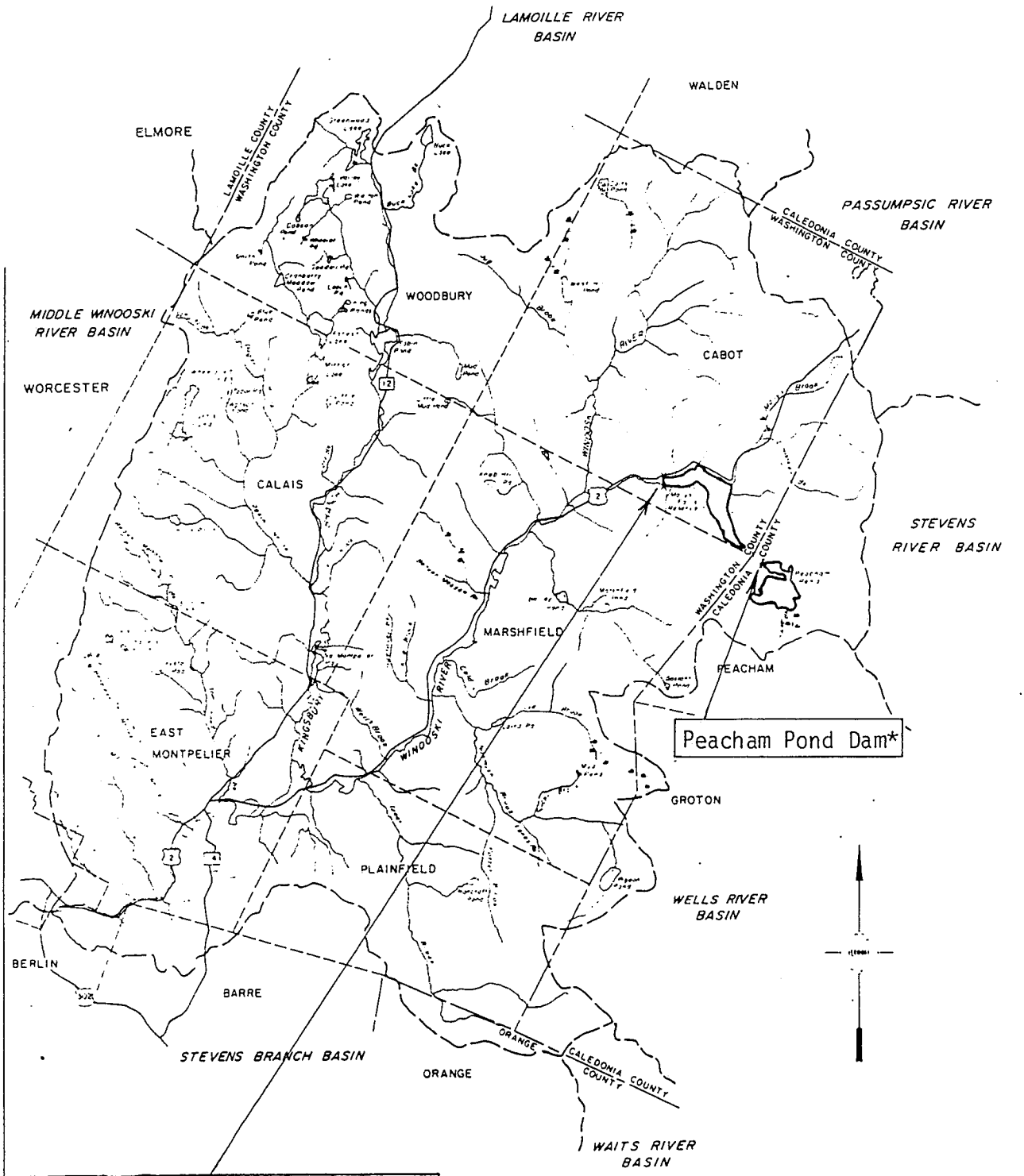


FIGURE 11

UPPER WINOOSKI RIVER
DRAINAGE BASIN

SCALE OF MILES

APRIL 1980

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

*Natural Pond with
Artificial Regulation

BASIN MAP- UPPER WINOOSKI RIVER VERMONT

BASIN MAP- UPPER WINOOSKI RIVER VERMONT

BASIN 8

STREAM: Sucker Brook

PROJECT: Peacham Pond

UTILITY: Green Mountain Power Corporation (GMP)

LICENSE STATUS FERC issued an order August 24,1979 dismissing license application for Mollys Falls Project which includes Peacham Pond.

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Peacham Pond is a natural lake located on Sucker Brook in the Town of Peacham and is operated as a storage reservoir for the Mollys Falls project one mile downstream (Figure 11). The pond has a drainage area of 7 square miles and a surface area of 370 acres. Useable storage is 2867 acre-feet with a drawdown of 14 feet. The discharge from the pond is at the base of the dam.

Operating Mode

GMP reports that the pond is maintained at a high level during the summer months for the benefit of privately owned camps and summer residences around the pond. During periods of low flow there is no fluctuation. Under moderate to high flows the pond is drawn down about 0.5 feet. In the early winter months the pond is drawn down up to 14 feet and then refilled in the spring, moderating the heavy water flows during that period.

Fluctuation and curtailment of downstream flows are suspected based on Vermont Fish and Wildlife reports.

Environmental Review

a. Water Quality

Water quality sampling conducted by the Department in 1970 and 1983 indicates that Peacham Pond stratifies and a slight D.O. depletion occurs in the bottom waters during the summer. The maximum depth of the pond is 60 feet. The withdrawal structure for the pond, however, is located in a section of pond which is relatively shallow. D.O. deficits in this section of pond are unlikely.

Water quality data was also collected by the Department in 1982 from Sucker Brook below Peacham Pond. The data did not reveal a D.O. problem. Water quality problems may exist if downstream flows are interrupted.

b. Fisheries

Peacham Pond provides spawning, nursery, and adult habitat for yellow perch and adult habitat for brook and brown trout. Inlet streams upstream of the pond provide spawning habitat for smelt, brown trout, and brook trout and nursery and adult habitat for brown trout and brook trout. Sucker Brook below the pond provides spawning, nursery and adult habitat for brook and brown trout.

The effect of winter drawdown on fish in the impoundment has not been determined. Flow fluctuations and interruptions downstream of the dam may be adversely affecting salmonid populations resident in the stream or migrating into it from Marshfield Reservoir to spawn.

c. Natural Area/Wildlife Habitat

The Vermont Institute of Natural Science (VINS) reported to the Department by letter dated May 17, 1985, that Peacham Pond generally has a pair of breeding loons which nest each year. The common loon is endangered in Vermont. VINS reports that drastic water level fluctuations have been identified as one cause of loon nest failure on various lakes in Vermont. VINS states that artificial water levels must be monitored and controlled during the loon nesting season which begins in mid-May and generally ends in mid-July. Water levels should be restored by May 1 and held stable through the beginning of August to allow for loon nest building in early May, egg laying, incubation, and late renesting.

A pair of common loons nested in Peacham Pond in 1983 but the nest failed when the water level was raised and the nest flooded.[1] It is not clear if this increase in the water level was a natural occurrence or a result of artificial controls by GMP. Camp owners around the pond reported to the Department in 1982 that GMP is cooperative in maintaining a stable pond level to benefit the loons.

Recommendations for Further Study

a. Determine how downstream flows are regulated by the project and the impact this has on water quality, fisheries, and other stream values.

[1] 1983 Vermont Lay Monitoring Report Volume II. Department of Water Resources.

b. Determine the effects of winter drawdown on populations of various fish species in the impoundment.

Recommendations

a. The winter drawdown should be reduced and pond levels stabilized throughout the rest of the year to benefit the fishery.

b. The Vermont Field Office of The Nature Conservancy (TNC) registered Peacham Pond in 1986 under their registry program. As a registered site, GMP has voluntarily agreed with TNC to maintain the water levels of Peacham Pond to protect nesting loons. This is only a voluntary, nonbinding agreement, however. A more formal agreement, or a water level restriction under the project's FERC license, would offer even more protection.

c. Stabilized flows downstream of the dam should be established to protect the downstream fish populations and habitat. This would also serve to improve downstream water quality if there are D.O. problems.

BASIN 8

STREAM: Mollys Brook and Winooski River

PROJECT: Mollys Falls

UTILITY: Green Mountain Power Corporation

LICENSE STATUS: FERC issued order August 24, 1979, dismissing license application.

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Mollys Falls is a storage reservoir and hydroelectric development located on Mollys Brook and the Winooski River in the Town of Marshfield (Figure 11). It consists of Peacham Pond, which is a storage reservoir; Mollys Falls Pond; an 8293 foot long penstock bypassing the lower two miles of Mollys Brook; and a powerhouse on the Winooski River. Mollys Falls Pond has a drainage area of 23 square miles. The dam at Mollys Falls has a spillway crest elevation of 1223.85' NGVD. Timber stoplogs set in stanchions and flashboards provide a normal full pool elevation of 1230.05'. The reservoir at this elevation has an area of about 411 acres and usable storage of 8078 acre-feet. The installed capacity of the development is 5000 kW under a design head of 350 feet (gross head of 378 feet). The hydraulic operating range of the project's turbine is up to 208 cfs.

Operating Mode

The project operates as a daily peaking facility. GMP reports in its questionnaire that, when possible, the project generates Monday through Friday during low flows, from 1000 to 1200 hours with no drawdown. The project generates from 0800 to 1300 hours with an average drawdown of 0.5 feet under moderate flows and from 0600 to 2300 hours with an average drawdown of 1.0 foot under high flows. The reservoir is maintained near full pool during the summer months and drawn down from December through early spring. Maximum drawdown is reported by the utility to be 39 feet, with a normal drawdown before spring runoff to about 1209 feet.

Under normal conditions, the only flow maintained in the 2-mile bypassed section of stream is leakage through the stoplog structure across the spillway. There is also leakage through the project's penstock. GMP has installed a v-notch weir to monitor the leakage from the penstock.

On June 21, 1982, the Department measured a leakage flow of 0.7 cfs 1000 feet below the dam in the bypassed section of stream. The source of this flow was through the dam, flash-boards, and bedrock. It is not clear from the Department's record if this included leakage from the penstock.

The project operates with no minimum flow requirement. As GMP stated in their October 9, 1972, draft environmental statement (Exhibit W) to the Federal Power Commission, "The flow from the reservoir enters the Winooski River at the generating station located on its banks. To date, no flow requirements have been deemed necessary. However, should such a requirement become necessary, Green Mountain Power Corporation will comply."

Environmental Review

a. Water Quality

Water quality data collected from the project area in summer, 1982, indicates that the reservoir is stably stratified and that severe oxygen depletion can occur. The lowest recorded oxygen level (0.90 mg/l, 10% saturation) in the reservoir was observed at a depth of 7.5 meters. At a station just upstream of the dam, a D.O. measurement of 5.35 mg/l (58% saturation) was measured at a depth of 7.2 meters.

The project operates with a bottom withdrawal structure. It is possible that the release from the project could lower D.O. concentrations in the Winooski River below the powerhouse. The water quality data from stations downstream of the powerhouse discharge was collected during periods of nongeneration so this potential impact of a release of oxygen-deficient water from the project was not identified.

There are no point sources on the Winooski upstream of the project. Two point sources are located downstream of the project powerhouse on the Winooski River. The Marshfield STP has a permitted discharge of .045 mgd and is located 2 miles downstream of the project's powerhouse. The Plainfield STP is located 11 miles downstream and has a permitted discharge of 0.100 mgd.

It is not known whether project reduction of flows during periods of nongeneration impairs the assimilative capacity of the Winooski River below the Marshfield STP. The project controls 36% of the drainage area at the treatment facility; therefore, when the project is not generating during periods of low stream flows, it is possible flows in the Winooski at the discharge from the treatment plant could be reduced to below the 7Q10 flow.

b. Fisheries

Mollys Falls reservoir supports a mixed warm water/cold water fishery, the primary species being yellow perch and stocked brown trout. Other species include rainbow trout, smallmouth bass, brown bullheads, and northern pike. The reservoir provides spawning and nursery habitat for yellow perch and pickerel and significant adult habitat for all but the trout species.

Sucker Brook and Mollys Brook are the two main tributaries which enter the upstream end of the reservoir. These provide viable spawning and nursery habitat for salmonids.

The Winooski River below the project's powerhouse supports populations of brown trout and brook trout. It is believed to contain spawning and nursery habitat for brown trout, brook trout, and rainbow trout.

During the summer of 1982, Department personnel observed brook trout in the bypassed section of stream just below the dam. Vermont Fish and Wildlife believes that a self sustaining population of brook trout, limited by minimal summer leakage flows, exists in the bypass.

Vermont Fish and Wildlife reports that project operation may be impairing the fishery above and below the project. Water level fluctuations impact pickerel and northern pike spawning. Fluctuating stream flows below the project may also impact fish production in the Winooski River.

c. Erosion/Siltation

The Department observed severe erosion at the outlet from the powerhouse on the Winooski River in 1982.

d. Recreation/Aesthetics

The impoundment is heavily used for recreation with a public road access and a boat launch and picnic area leased and maintained by Vermont Fish and Wildlife. The impoundment is maintained at full pool during the summer months.

Vermont Fish and Wildlife states that under present conditions, the winter drawdown creates hazardous ice conditions. If the water levels were stabilized during the winter months, there could be a long ice-fishing season on the reservoir.

No comments were provided on project impact on downstream recreation and aesthetic values. Significant fluctuation of flows would most certainly impair these values.

e. Natural Area/Wildlife Habitat

Mollys Falls, located about one half mile downstream of the dam on Mollys Brook, was included in the Agency's Waterfalls, Cascades and Gorges Study. The falls are about 150 feet long and 25 feet wide. They are identified as being one of the two or three highest woodland falls in Vermont and are probably the tallest continuous falls of any kind in the State. The site has reportedly lost much of its scenic and biological character as the falls are dewatered for most of the year. The study reports "that before the reservoir was built you could hear [the falls] a mile away. They must be spectacular in the spring."

Recommendation for Further Study

a. A study should be conducted to determine if the project impairs the water quality and/or fishery of the Winooski River below the project's powerhouse. This should include a summer water quality study to determine how the release from the project impacts D.O. and temperatures of the Winooski River. An evaluation of project impact on the assimilative capacity of the Winooski below the Marshfield STP should be made. An assessment of project operation and its impact on stream flow fluctuations on the Winooski should also be conducted.

b. A fisheries survey and habitat analysis of Mollys Brook should be conducted.

c. The reported erosion problem at the outlet of the powerhouse should be investigated to determine its source and severity. Mitigation measures should be implemented at the powerhouse if the reported erosion problem is found to be significant.

d. A study should be conducted to determine the feasibility of and public interest in maintaining a stable winter pool for recreational purposes.

Recommendations

a. Following the study of project impact on water quality and fisheries of the Winooski River, appropriate mitigation measures should be identified and implemented. If it is found that reduced stream flows below the project during periods of nongeneration are impacting the fishery and water quality, a minimum flow requirement should be established.

As previously stated, GMP reported in a draft environmental statement dated October 9, 1972, and prepared as part of their FERC license application that "The flow from the reservoir enters the Winooski River at the generating station located on its

banks. To date, no flow requirements have been deemed necessary. However, should such a requirement become necessary, Green Mountain Power Corporation will comply".

b. A stable winter pool should be maintained for recreational purposes if it is found to be feasible and if there is sufficient public interest. Changes to reservoir level management may also be warranted to protect spring spawning fish (chain pickerel, northern pike).

c. A minimum flow requirement should be established in the bypassed section of stream for aesthetics at Mollys Falls. Flows may also be needed to restore brook trout populations.

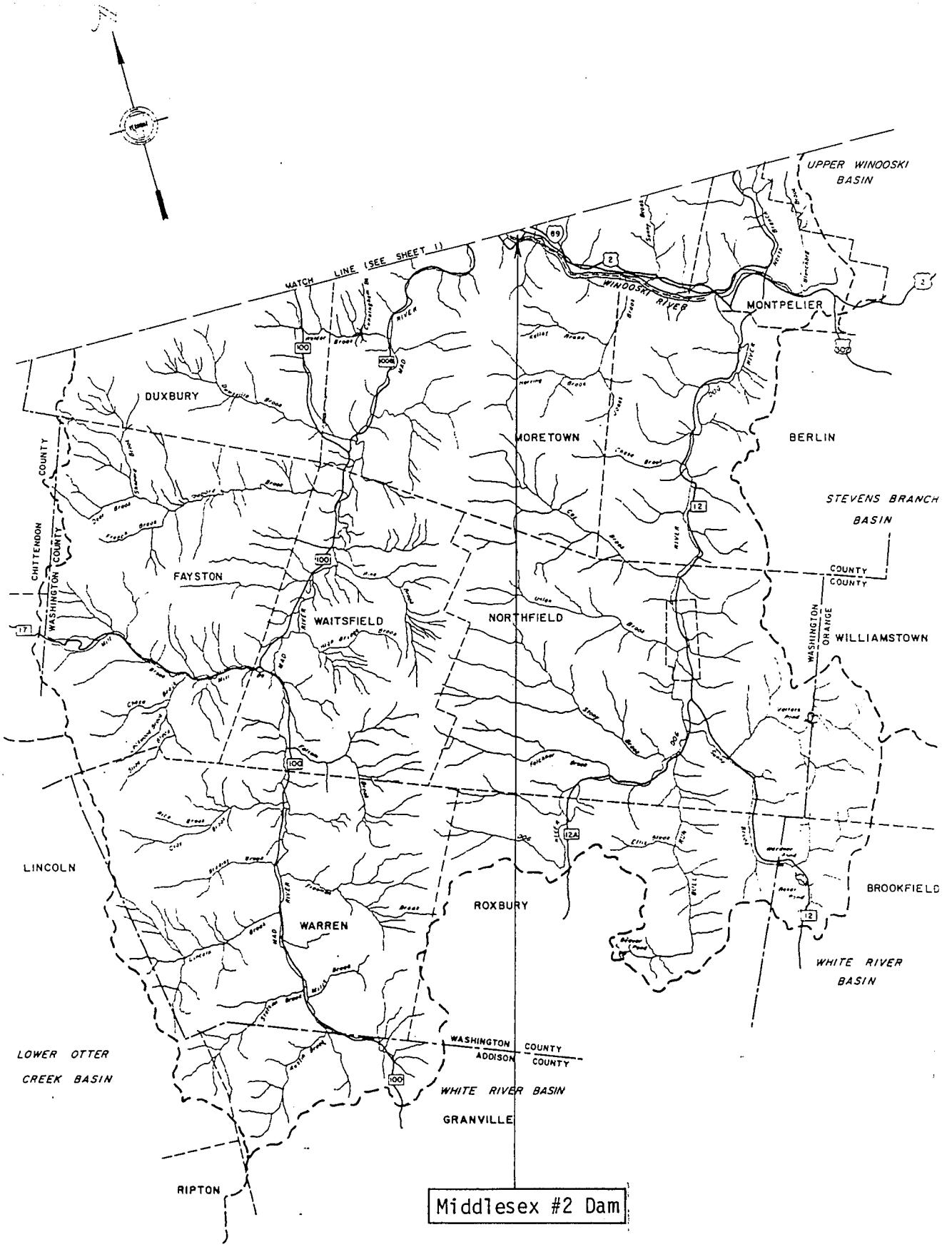


FIGURE 12

MIDDLE WINOOSKI RIVER
DRAINAGE BASIN

SCALE OF MILES
0 1 2 3

APRIL, 1960

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

BASIN 8

STREAM: Winooski River

PROJECT: Middlesex #2

UTILITY: Green Mountain Power Corporation (GMP)

LICENSE STATUS: FERC issued an order August 24, 1979 dismissing the license application (project on non-navigable water way and constructed prior to 1935).

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Some

Project Features

Middlesex #2 is located on the Winooski River in Middlesex at river mile 49.5 just upstream of the confluence with the Mad River (Figure 12). The drainage area at the site is 539 square miles. (GMP uses a drainage area of 531 square miles.) Project features include a dam 283 feet long and 50 feet high, fitted with 30-inch flashboards, creating an impoundment with a surface area of 33 acres extending upstream about two miles. The impoundment has a useable storage of 69 acre-feet with a 3.5 foot drawdown from the top of the boards. Two 80 foot long penstocks carry stream flows to the project's powerhouse containing two generating units with a total installed capacity of 3200 kW. The project operates with two Francis turbines, each having a hydraulic capacity of up to 515 cfs under a gross head of 52 feet.

Operating Mode

Middlesex #2 is operated as a daily peaking project. The utility reports two different levels of drawdown. In a discussion with Department personnel in 1982, GMP reported that the pond fluctuates within the limits of the flashboards and is not drawn down below the dam crest; however, in the questionnaire it reports an average drawdown of 3 feet which indicates that the pond is drawn several inches below the dam crest.

GMP reports that during low flows the project generates from 0700 to 1200 and 1700 to 2000 daily, seven days a week, with an average drawdown of 3 feet (0.75 feet during the winter months). Under moderate flow conditions the project operates 24 hours a day, seven days a week, with an average drawdown of 3 feet (0.75

feet during the winter months). During high flows, the project generates 24 hours a day, seven days a week, with no drawdown.

The Department measured a leakage flow at the site on July 29, 1980, of 7.6 cfs (9% of 7Q10). The record does not indicate the source of this flow. If it is through the flashboards and the pond is drawn down below the dam crest, the leakage would be even less at times.

Since the 1982 inventory when this data on project operation was collected, the Agency and GMP have established an agreement regarding the maintenance of a minimum flow of 228 cfs, or instantaneous inflow if less, below the Middlesex #2 Project. This agreement, dated April 16, 1985, was established as mitigation for construction impacts GMP's recently developed Bolton Falls Project was to have on the fisheries resource. The Bolton Falls Project is located 10 miles downstream on the Winooski River. Pursuant to this agreement, GMP was to begin maintaining this flow when the Bolton Falls Project went on line. That project has been on line since November, 1986. GMP began maintaining the 228 cfs at Middlesex #2 in November/December, 1986, and is presently making appropriate adjustments to the project's operating mode to ensure compliance with this agreement.

The majority of comments presented in the environmental review of this project are based on project impact prior to the minimum flow agreement.

Environmental Review

a. Water Quality

Point source discharges include the Montpelier STP 5 miles upstream with a permitted total discharge of 2.2 mgd and the Waterbury STP about five miles downstream with a permitted total discharge of 0.51 mgd.

The Department collected water quality data below the project in the summer of 1982. The data indicates that there are high levels of nutrients in the water which can contribute to algal growth. Supersaturated D.O. concentrations indicate that this algal growth is occurring. During the early morning hours, it is possible that D.O. violations may occur, particularly if the project is ponding the previous night. Violations could be even more severe in the stream section between the dam and the confluence with the Mad River as this area is subjected to lower flows. No early morning D.O. samples were collected.

The minimum flow requirement of 228 cfs should improve downstream water quality. Passage of some of this flow over the dam for aeration may be necessary.

b. Fisheries

The fishery below the project is heavily impacted by flow fluctuations and the lack of an adequate minimum flow requirement. As previously stated, the leakage flow from the dam during periods of impounding is 7.6 cfs which is only 9% of the 7Q10 value of 82 cfs at the dam. Approximately 4500 feet of stream from the dam to the confluence with the Mad River is subjected to this low flow. Downstream of this section, this flow is supplemented by natural flows from the Mad River, somewhat reducing the impact.

Vermont Fish and Wildlife reports that the only known significant fisheries in this area are upstream at the mouth of the Dog River and downstream at the mouth of the Mad River and in the vicinity of a picnic area located below FFNA Section 2 (Figure 13) where 20-inch rainbow and brown trout have been caught. Low flows and high water temperatures have had an adverse impact on salmonid populations; however, the newly required minimum flow may improve temperature and the salmonid potential of the stream. The river above and below the dam is stocked with rainbow trout. There is limited spawning, nursery, and adult habitat in the project's impoundment. There is adequate nursery and adult habitat below the project, particularly with the 228 cfs minimum flow requirement. Passage of the 228 cfs minimum flow requirement should also provide good juvenile habitat for brown trout and rainbow trout below the project.

FFNA

Drainage Area: Section 1: 540 mi^2
Section 2: 706 mi^2

7Q10 Flow: Section 1: 82 cfs
Section 2: 107 cfs

USFWS Flow: Section 1: 270 cfs
Section 2: 353 cfs

Recommended Flow: 300-350 cfs

The Department conducted a FFNA study below the project at two stream sections (Figure 13). Important habitat criteria at this site are food production, rainbow trout adults and juveniles, and brown trout juveniles (Figures 13a to 13d). The recommended flow for food production is 385 cfs. Optimum ranges for rainbow trout juveniles and brown trout juveniles are 250 to 400 cfs and 130 to 250 cfs respectively. Based on an analysis of the usable area curves generated from the study, a minimum flow of 300 to 350 cfs is recommended.

The minimum flow requirement of 228 cfs for fisheries, as established in the April 16, 1985, agreement between the Agency

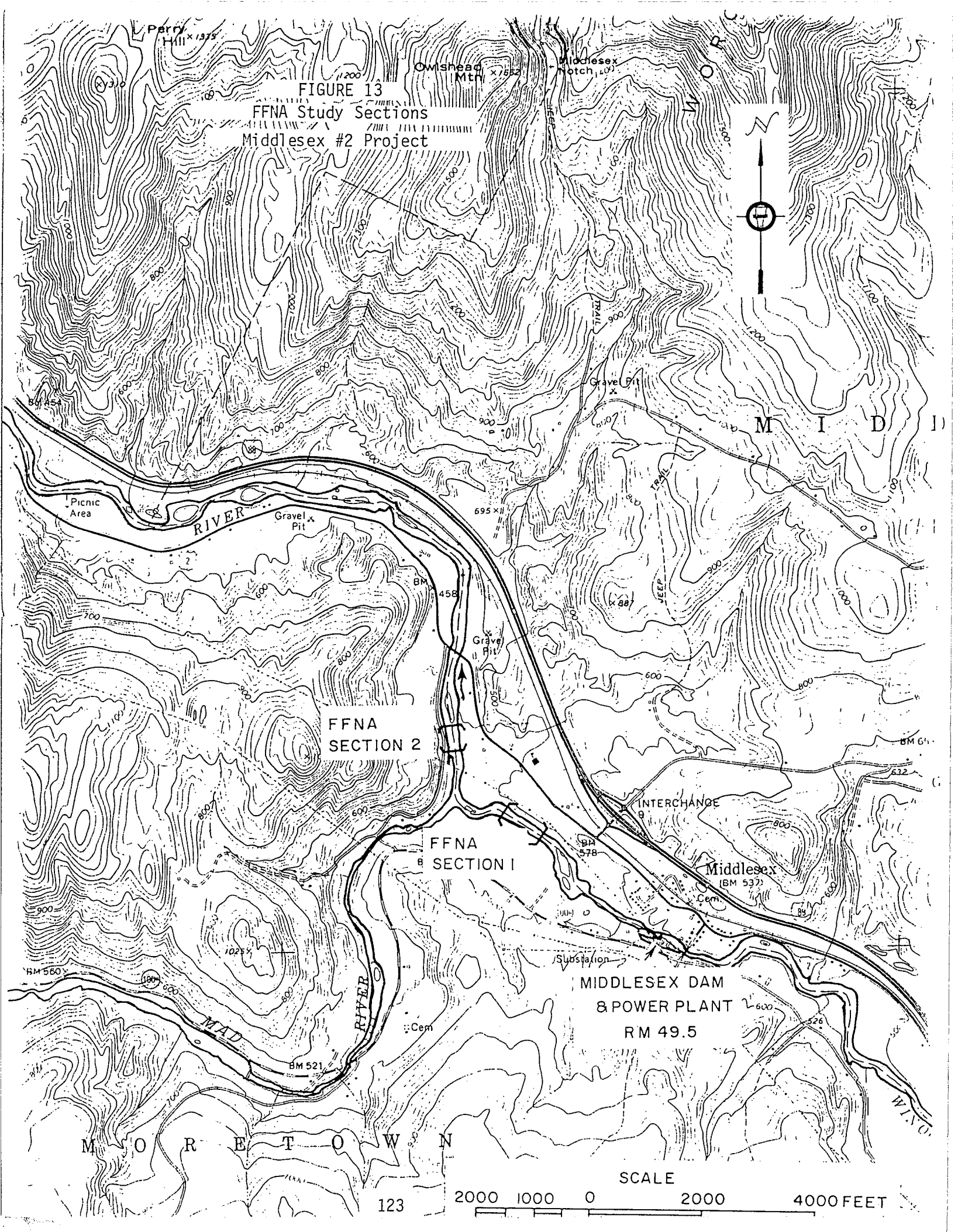


FIGURE 13
FFNA Study Sections
Middlesex #2 Project
Perry Hill
Owlshead Mtn
Middlesex Notch
FFNA SECTION 2
FFNA SECTION I
INTERCHANGE 9
MIDDLESEX DAM & POWER PLANT RM 49.5
Middlesex
Gravel Pit
Picnic Area
RIVER
MAD
MORETOWN
WINOOSKI
Substation
Cem
TRAIL
JEEP
BM 454
BM 458
BM 578
BM 560
BM 521
SCALE
2000 1000 0 2000 4000 FEET

FIGURE 13a

FFNA Useable Area Curve - Middlesex #22 Project

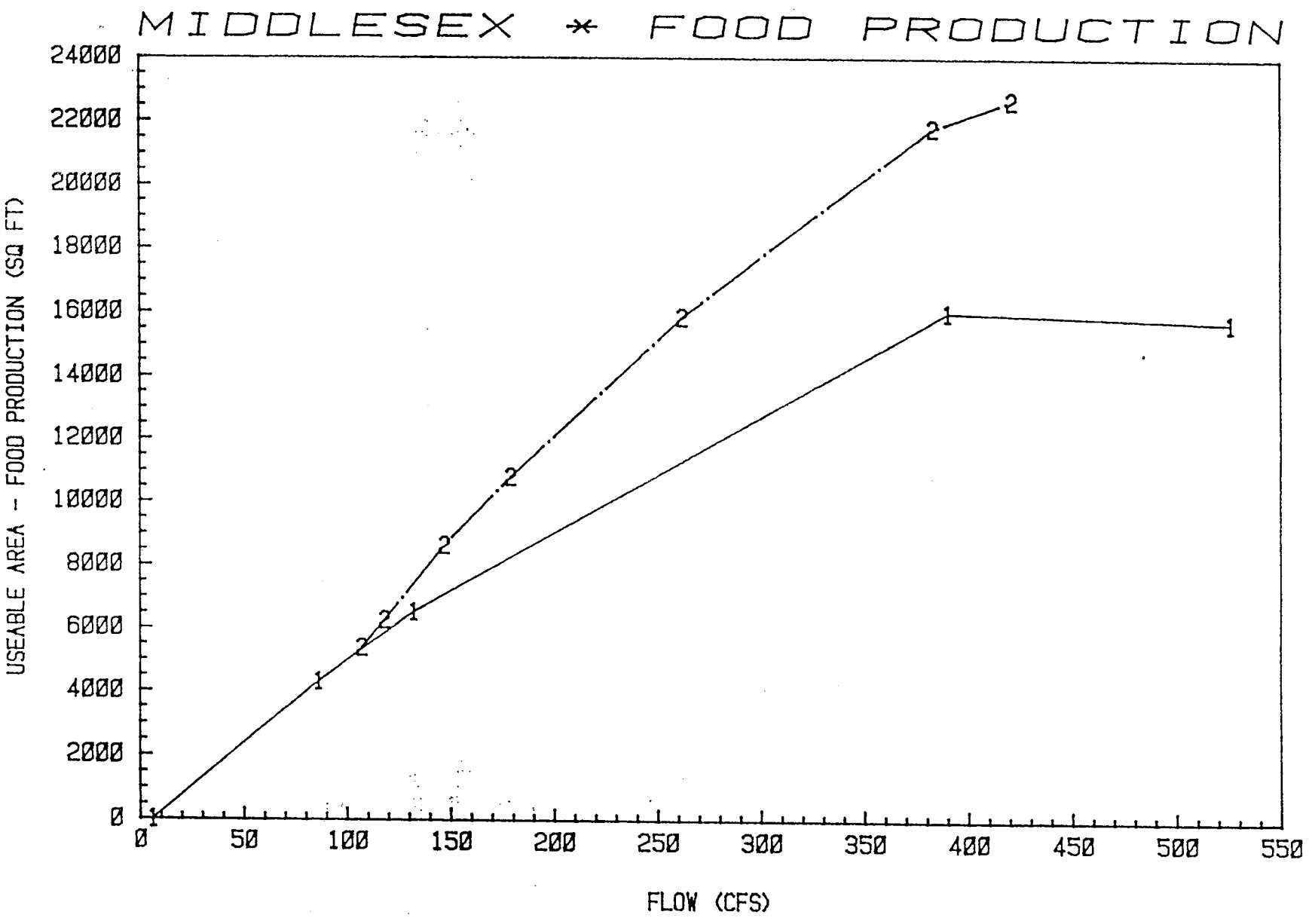


FIGURE 13b

FFNA Useable Area Curve - Middlesex #22 Project

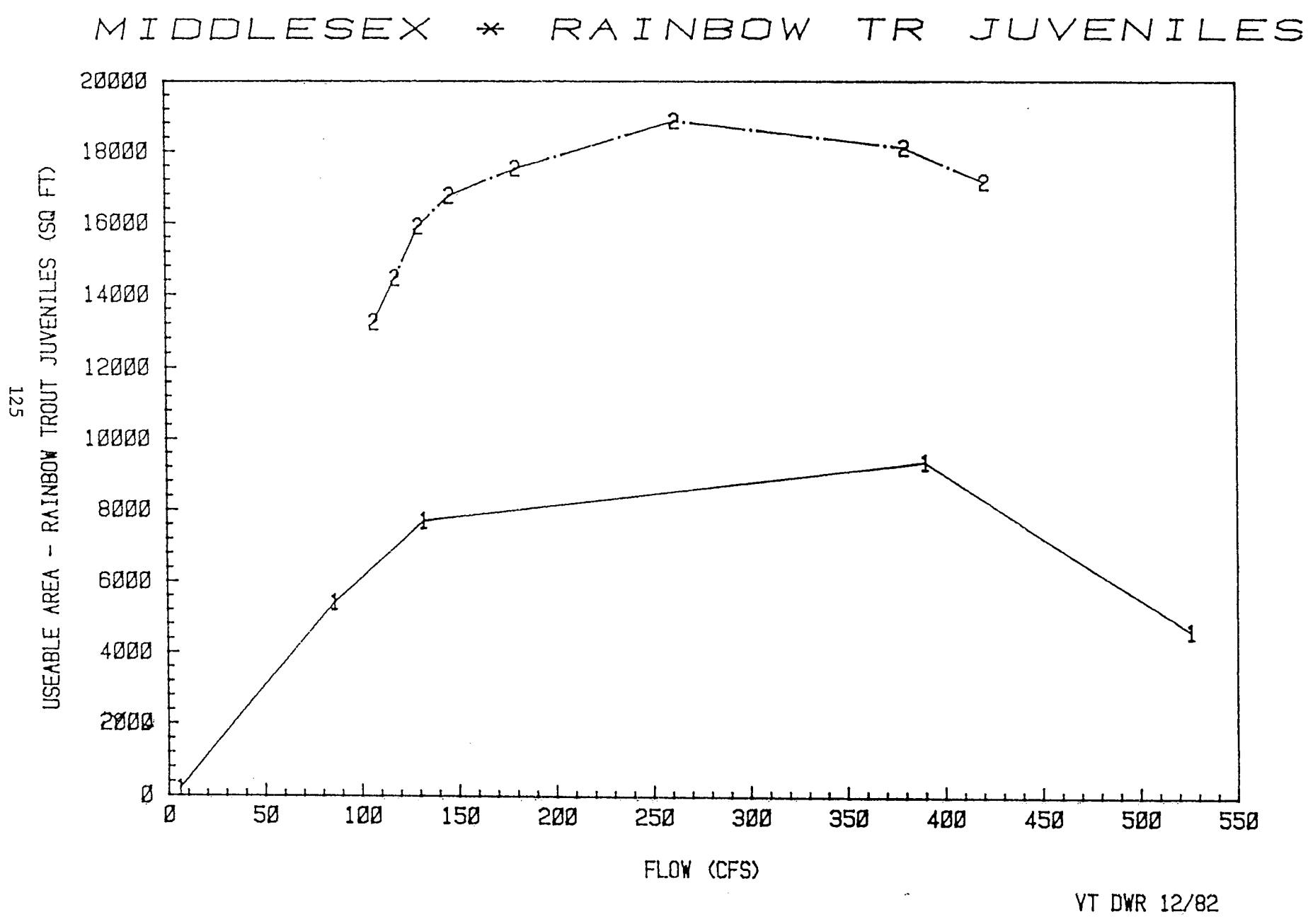


FIGURE 13c

FFNA Useable Area Curve - Middlesex #22 Project

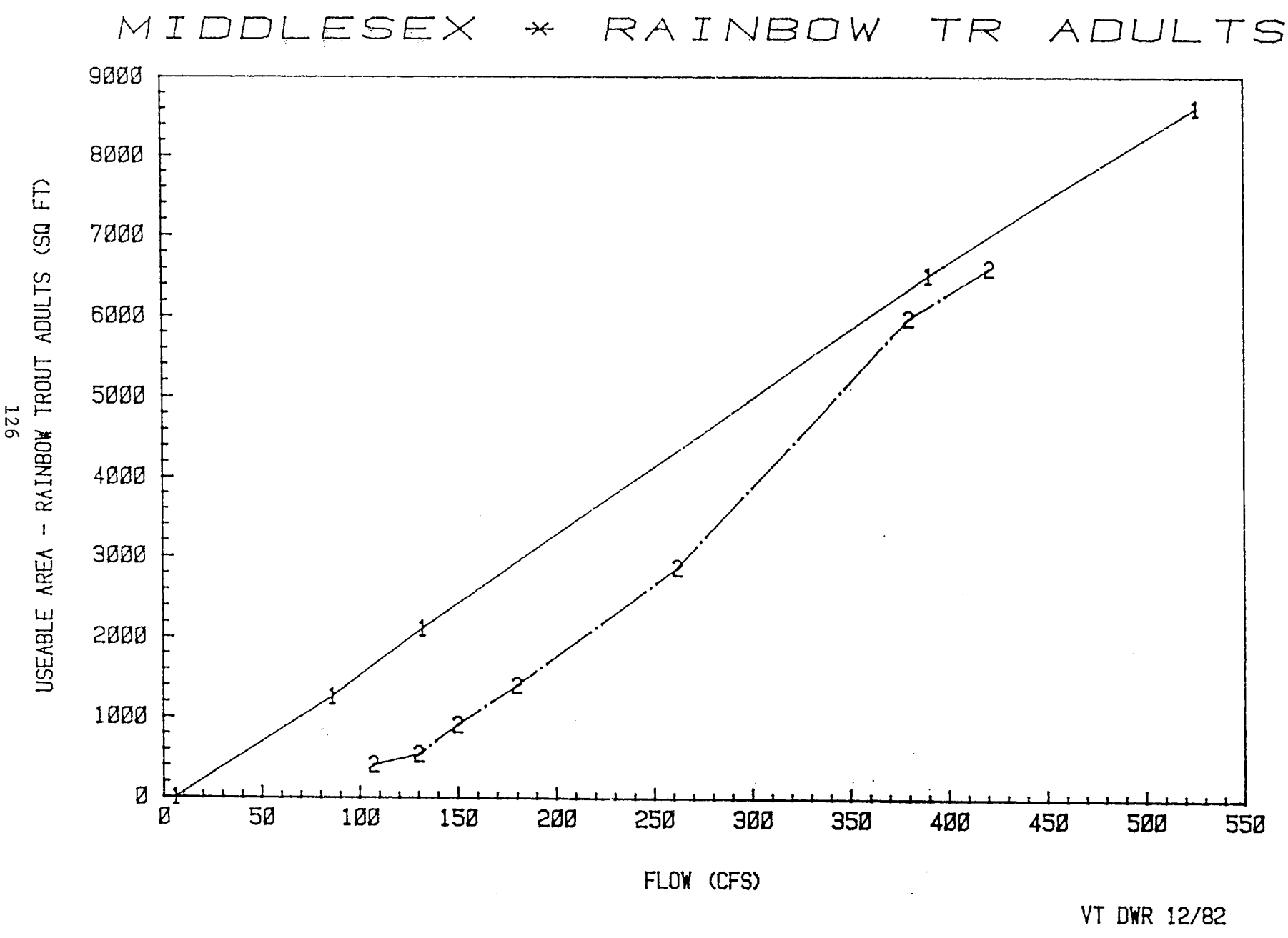
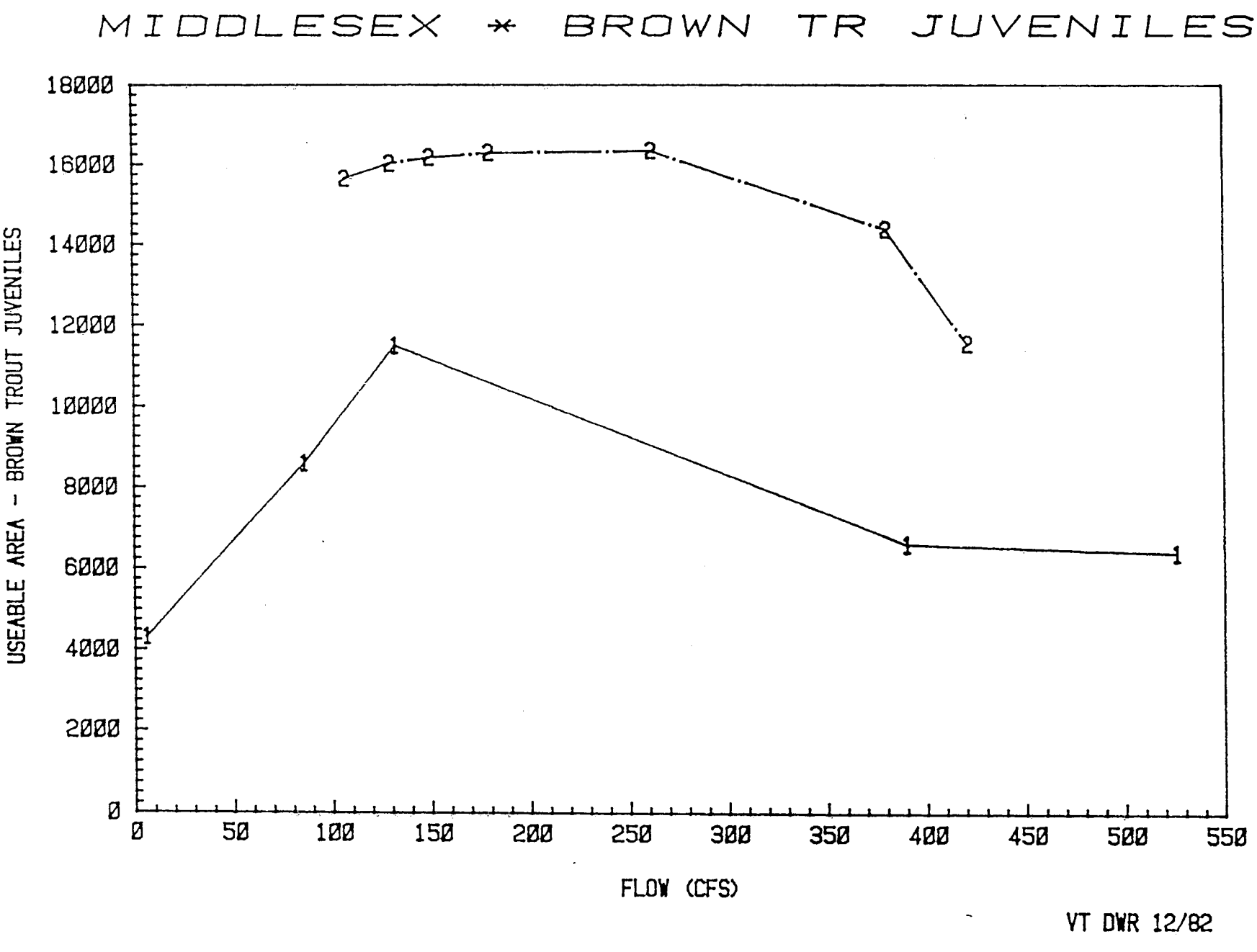


FIGURE 13d

FFNA Useable Area Curve - Middlesex #22 Project



and GMP, is the total flow resulting from a flow of 0.35 cfsm of drainage area at both Middlesex (89 cfs) and Little River (39 cfs) projects. The flow requirement at Bolton Falls is equal to 0.35 cfsm. This flow of 228 cfs is less than the optimum flow of 300 to 350 cfs based on the FFNA study at Middlesex; however, Vermont Fish and Wildlife found it to be adequate mitigation. Figures 13a to 13d demonstrate the increase in useable area below the project at this flow. Passage of the 228 cfs from the project commenced in November, 1986.

A flow requirement of 228 cfs should also be adequate for recreation and water quality.

c. Recreation/Aesthetics

Prior to the 228 cfs minimum flow agreement, rapid downstream flow fluctuations were identified as creating hazardous conditions for swimmers and anglers. The lack of a minimum flow requirement over the dam impacts the aesthetics of the gorge immediately below the dam and reduces the recreation potential of the stream.

Recreational development includes a canoe portage. There is also a public road access upstream and downstream of the dam.

d. Natural Area/Wildlife Habitat

Middlesex #2 is located at the site of the Middlesex Gorge which was included in the Agency's Waterfalls, Cascades and Gorges Study. The gorge is about 1000 feet long with high-angle rock walls from 20 to 60 feet high. The upper two-thirds of the gorge are flooded by the project's impoundment. The site is noteworthy for four scarce plants. The study recommends "that the state attempt to assure a minimum flow between the dam and the power station to protect the plants."

e. Erosion/Siltation

Project operation may be causing streambank erosion and sedimentation upstream and downstream of the project. The impoundment has a substantial amount of silt. Some of these silt deposits have resulted in the formation of islands. The Department has had problems with maintenance drawdowns and desilting operations in the past. In 1981 and 1983 the impoundment was drained without Department approval. Turbidity levels were violated above and below the project during the 1981 event. No turbidity measurements were taken during the 1983 drawdown.

Recommendations for Further Study

a. The site should be reviewed to determine the need for additional recreational development such as a picnic area and scenic overlook.

b. D.O. and water temperature data should be collected in the early-morning, pre-dawn hours to check for substandard conditions due to algal activity.

Recommendations

The minimum flow requirement of 228 cfs for fisheries, as established in the April 16, 1985, agreement between the Agency and GMP, should also be adequate for water quality. It should also improve the downstream area for recreation as the severity of flow fluctuations would be reduced. It may also help to reduce any erosion problems which may exist at the site because of water level fluctuations in the impoundment and flow fluctuations downstream as these fluctuations would be reduced.

Passage of part of this flow, preferably 82 cfs which is 7Q10, should be maintained over the dam for aesthetics. This would also improve the bypass area for fisheries and water quality, be beneficial to the rare and scarce plant species found on the rock walls of the gorge, and improve downstream water quality if D.O. violations are found to occur.

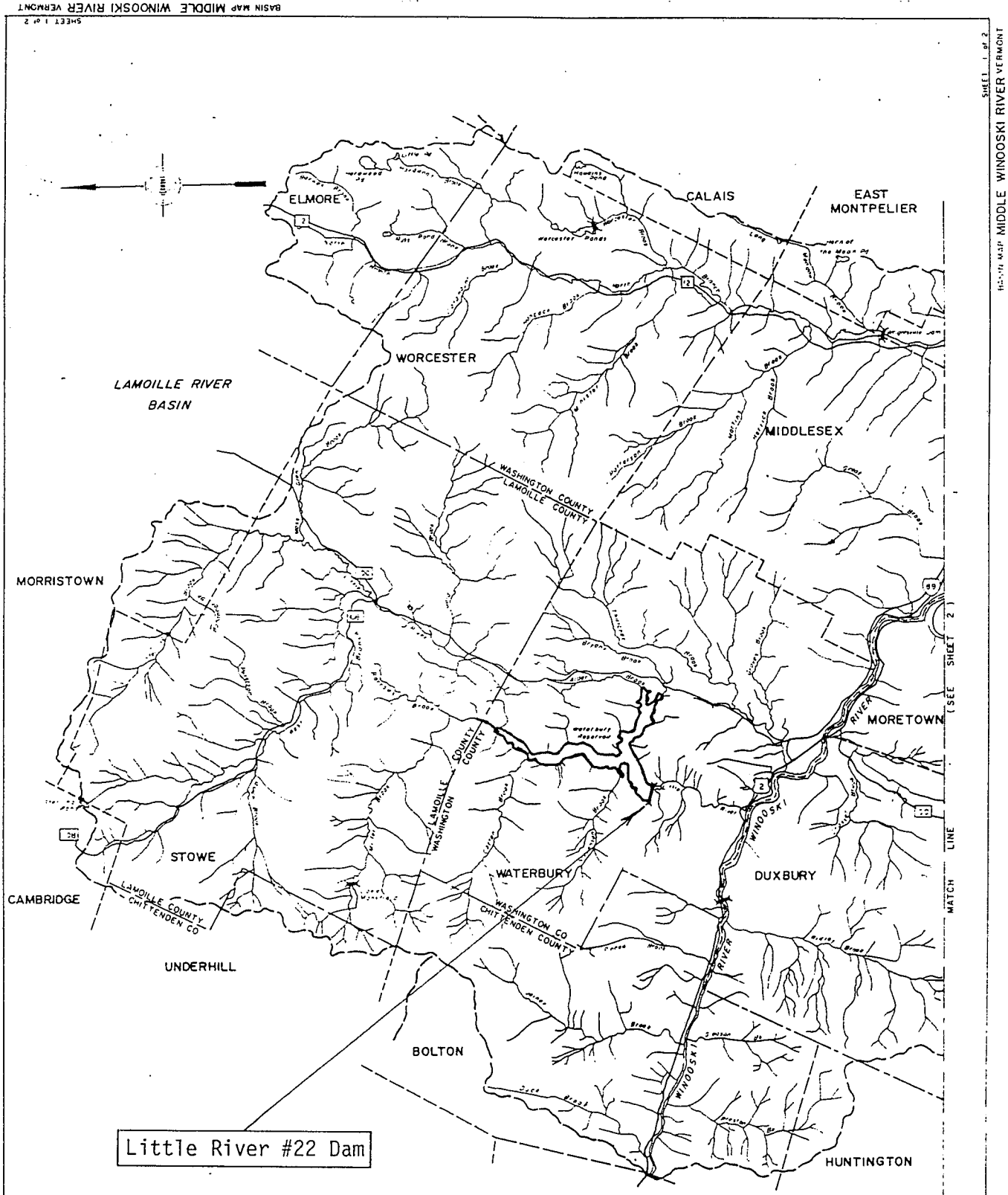


FIGURE 14

MIDDLE WINOOSKI RIVER
DRAINAGE BASIN

SCALE OF MILES

APRIL, 1980

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

SHEET 1 of 2

BASIN MAP MIDDLE WINOOSKI RIVER VERMONT

BASIN MAP MIDDLE WINOOSKI RIVER VERMONT
SHEET 1 of 2

BASIN 8

STREAM: Little River

PROJECT: Little River #22

UTILITY: Green Mountain Power Corporation (GMP)

LICENSE STATUS: FERC License issued July 20, 1954, expires September 1, 2001

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Little River #22 is located at the site of the Waterbury Flood Control Dam (Figure 14). It has a drainage area of 110 square miles. The project has an installed capacity of 5500 kW and a gross head of 146 feet. The powerhouse contains one Francis turbine with a hydraulic operating range of up to 510 cfs. The reservoir extends upstream six miles and has a surface area of 885 acres at a pool elevation of 592' NGVD. The storage capacity below elevation 592' is reported by the utility to be about 36,330 acre-feet with a drawdown of 92 feet. The reservoir capacity above elevation 592' is reserved for flood control purposes only.

Operating Mode

The project operates as a daily peaking project. GMP reports that under low flow conditions, the project operates Monday through Friday from 1000-1200 hours with an average drawdown of 0.2 feet per day. Generation during the summer usually ceases whenever necessary to preserve the pool level at 590' for recreational purposes. Under moderate flows, the project generates Monday through Friday from 0800 to 1200 hours with an average drawdown of 0.2 feet per day. The project operates seven days a week, 24 hours a day, during high flows with no drawdown.

A review by the Department of reservoir elevations recorded for the period 1939 to 1979 indicates that the impoundment is usually drawn down to an elevation of about 540' to 550' beginning in early January. In late March and early April, it is then refilled to a stage of approximately 592'. This drawdown occurs so that the utility can take advantage of high spring flows for power generation and to moderate the impact of heavy spring runoff on downstream areas.

Exhibit H of GMP's FERC license application (date unknown) for this project states that "The Waterbury plant, due to its limited storage capacity, will be normally operated as a run-of-the-river development serving, in general, the peakload requirements. Consequently, during low flow conditions, the discharge from Waterbury will be shut down during off peak periods of the day and during weekends. When flows exceed the capacity of the plant the operation of the plant would produce negligible effect upon the natural flow of the river."

Article 18 of the project's FERC license requires the utility to maintain a minimum flow requirement below the project of 3 cfs. Article 18 reads:

"A minimum of three cubic feet per second shall be maintained in Waterbury (Little) River below the Waterbury flood control dam at all times. This minimum flow shall be increased during the spring of the year when directed by the Commission upon the recommendation of the Director of Vermont Fish and Game Service. Such increase is required for successful spawning of rainbow trout."

This minimum flow requirement is maintained by passing water through the turbines and by project leakage. The Department measured a flow of 11.2 cfs below the project on May 30, 1980. This flow measurement may be higher than 3 cfs as a result of flow contributed from intervening tributaries.

Environmental Review

a. Water Quality

Temperature and D.O. profiles of the reservoir in 1959, 1968, and 1972 indicate that the reservoir stratifies thermally and some depression of D.O. occurs with depth. A D.O. of 3.2 mg/l (31% saturation) was measured at a depth of 39 feet in 1968.

The project operates with a bottom withdrawal structure. The discharge from the project, therefore, reduces downstream D.O. concentrations. Low D.O. concentrations have been measured in the pool just below the project. Vermont Fish and Wildlife reports that low D.O. concentrations from just below the project downstream to the USGS gaging station have resulted in virtually no fish in this section in some years.

The discharge from the project has also resulted in fluctuating water temperatures below the project, particularly during the warmer months of the year. During periods of generation, the outlet water temperature remains below 60° F all year.[1]

[1] Lakes & Ponds Fisheries Report, District IV, Waterbury Reservoir, Jon Anderson, April 11, 1969

Water quality sampling was conducted by the Department at two stations below the project during the summer of 1982. High stream temperatures were recorded at both stations. At the time these samples were taken, the flow in the stream was 50 to 60 cfs and the reservoir was at a pool stage of 529.52'. D.O. concentrations were lowest at the upstream station. Because the reservoir was about 63 feet lower than its normal stage during the summer months, the data collected below the project is probably not representative of typical stream conditions during the summer months.

Fluctuating water levels in the reservoir have resulted in unstable banks in the reservoir, contributing to the suspension of clay particles which reduce light penetration and inhibit primary productivity.[1]

b. Fisheries

The Little River supports a brown trout and rainbow trout fishery above the Waterbury Reservoir. The reservoir contains brown trout and rainbow trout, walleyes and smallmouth bass. A brown trout fishery and a limited brook trout fishery is located below the project.

Spawning, nursery, and adult habitat for brown trout and rainbow trout is located above the impoundment. Spawning, nursery, and adult habitat for walleye and smallmouth bass is present in the impoundment. The impoundment also provides adult habitat for brown trout and rainbow trout. Downstream of the project there is spawning, nursery, and adult habitat for brown trout.

Fisheries below the project has been impacted in several ways. Vermont Fish and Wildlife reports that the cold water release benefits the salmonid population. At the same time, however, low D.O. concentration from the project discharge have reduced the salmonid population and spawning success downstream to the USGS gage. If the project were operated as a base load facility, downstream salmonid potential to the Winooski River would be enhanced substantially.

Vermont Fish and Wildlife reports that Waterbury Reservoir historically supported an excellent rainbow trout fishery and that this fishery has declined significantly over the years. This decline coincides with the introduction and establishment of yellow perch. Prior to draining the reservoir in 1980, Vermont

[1] Lakes & Ponds Fisheries Report, District IV, Waterbury Reservoir, Jon Anderson, April 11, 1969

Fish and Wildlife was attempting to establish a salmonid fishery in the impoundment. The two most significant factors which limit the salmonid potential of the reservoir are competition from yellow perch and the winter drawdown which annihilates littoral food organisms.

The fact that the reservoir and upstream tributaries had historically supported an excellent rainbow trout fishery may explain, in part, why a minimum flow requirement (even though inadequate) below the project for rainbow spawning was included in the FERC license.

FFNA

Drainage Area: 110 mi^2
7Q10: Section 1: 1.9 cfs (5-15 unregulated)
Section 2: 11 cfs

USFWS Flow: 55 cfs
Recommended Flow: 55 cfs

The Department conducted a FFNA study below the Little River Project at two stream sections (Figure 15). The usable area curves generated from this study are presented in Figures 15a15c. Vermont Fish and Wildlife considers habitat criteria for food production and brown trout spawning and juveniles to be important in the river reach below the project. No useable area curves were generated for brown trout adults as these fish inhabit pool areas which are abundant below the project and not severely impacted by normal flow fluctuations.

Based on an analysis of the useable area curves and consultation with Vermont Fish and Wildlife, a minimum flow requirement of 55 cfs is recommended. This flow is equal to the USFWS flow of 0.5 cfsm.

c. Recreation/Aesthetics

Fluctuating water levels in the impoundment and downstream conflict with the recreational use of the area, primarily fishing.

Waterbury Reservoir is heavily used for summer recreation and includes a campground and beach at Little River State Park. The water level in the reservoir is stabilized during the summer months for recreation purposes.

d. Erosion/Siltation

There is evidence of streambank erosion downstream of the project. Fluctuating water levels in the impoundment have also

FIGURE 15
FFNA Study Sections
Little River #22

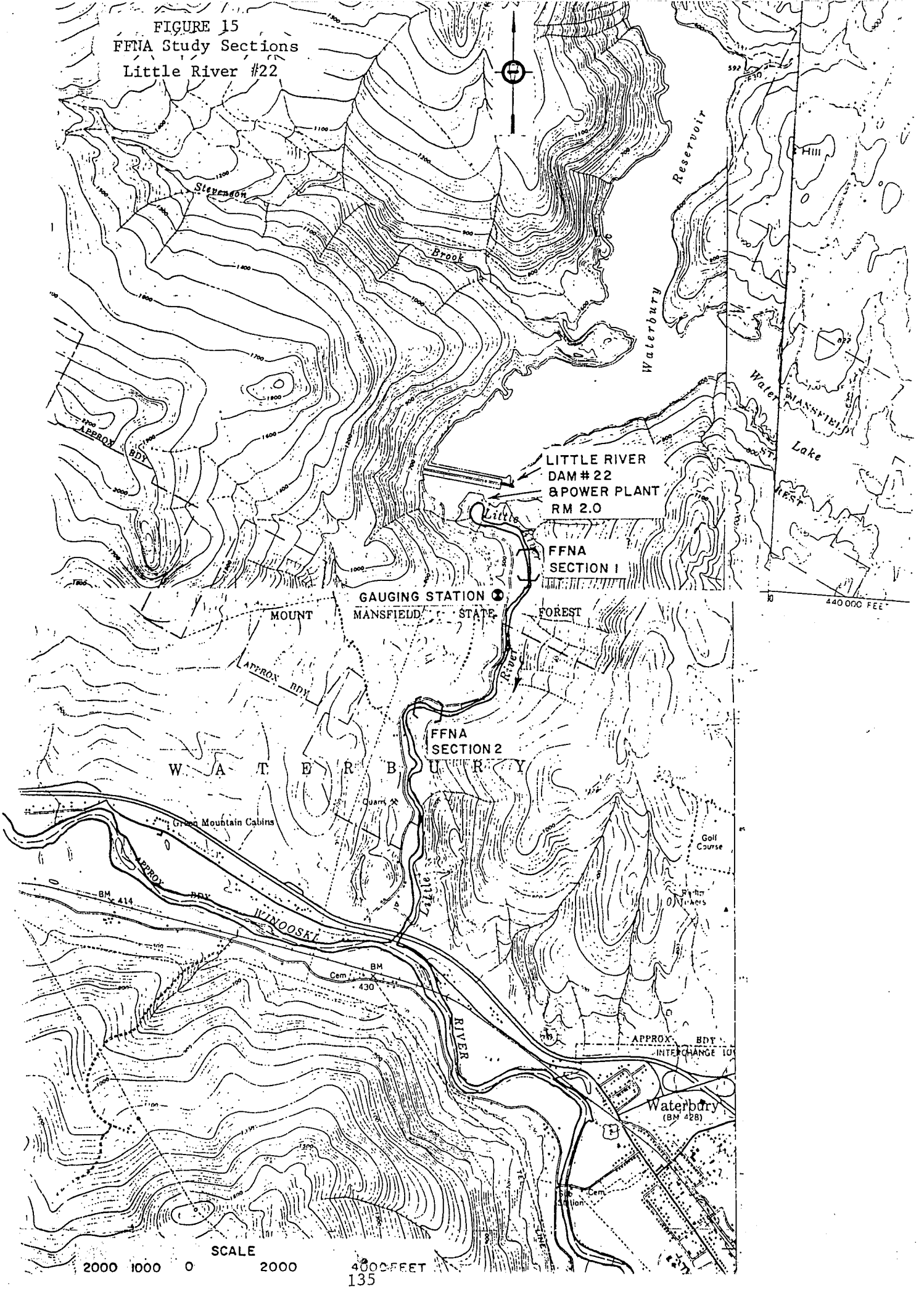


FIGURE 15a

FFNA Useable Area Curve - Little River #22 Project

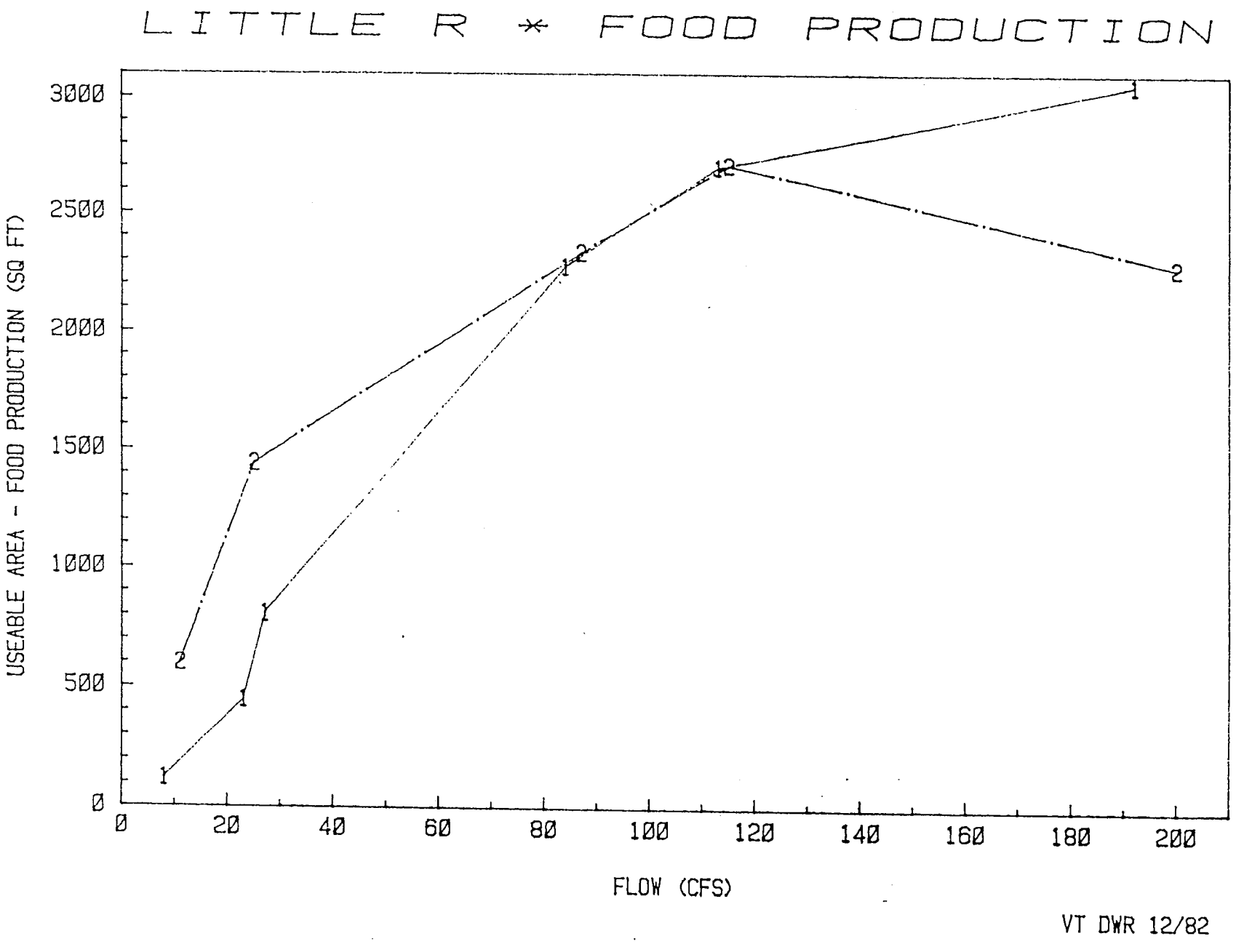


FIGURE 15b

FFNA Useable Area Curve - Little River #22 Project

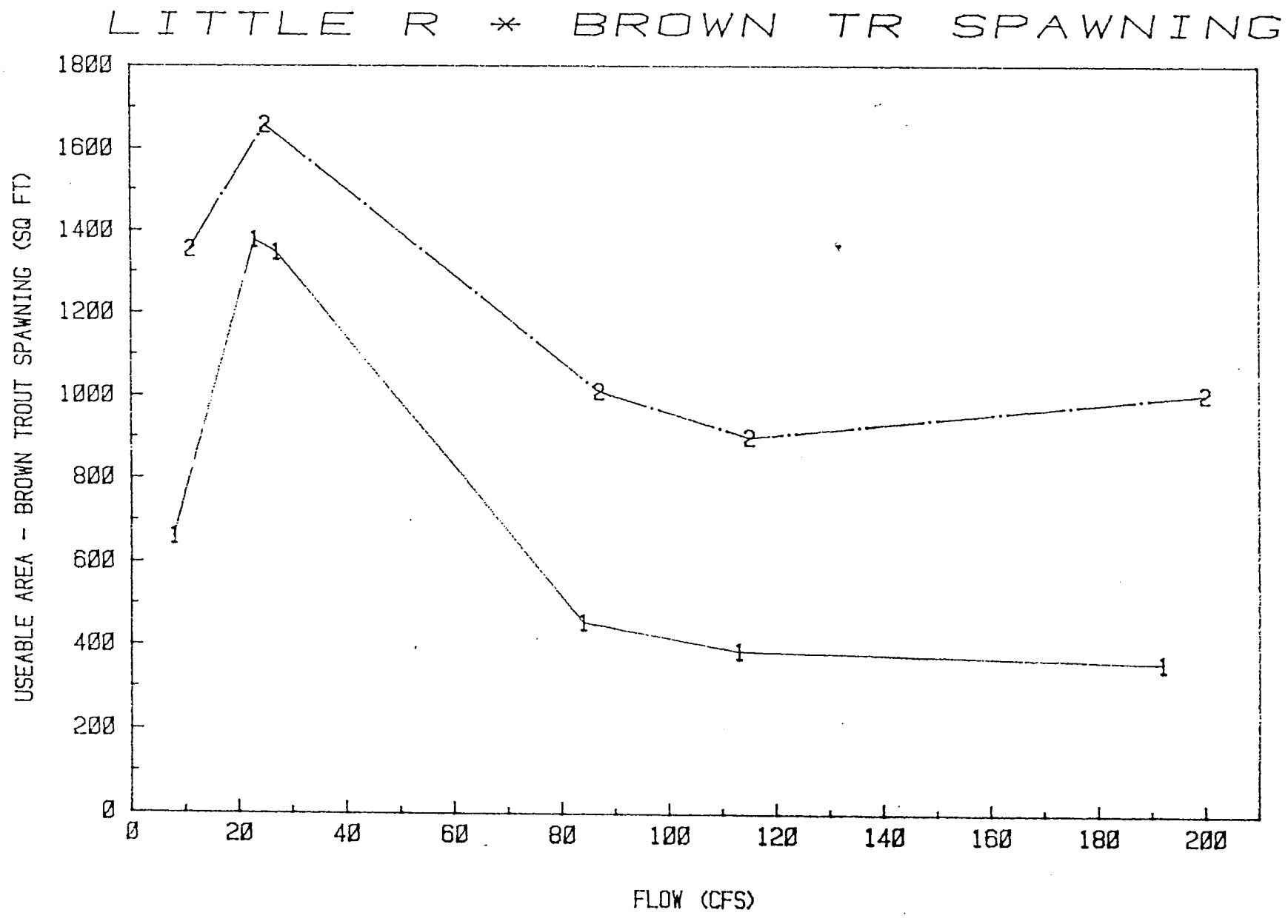
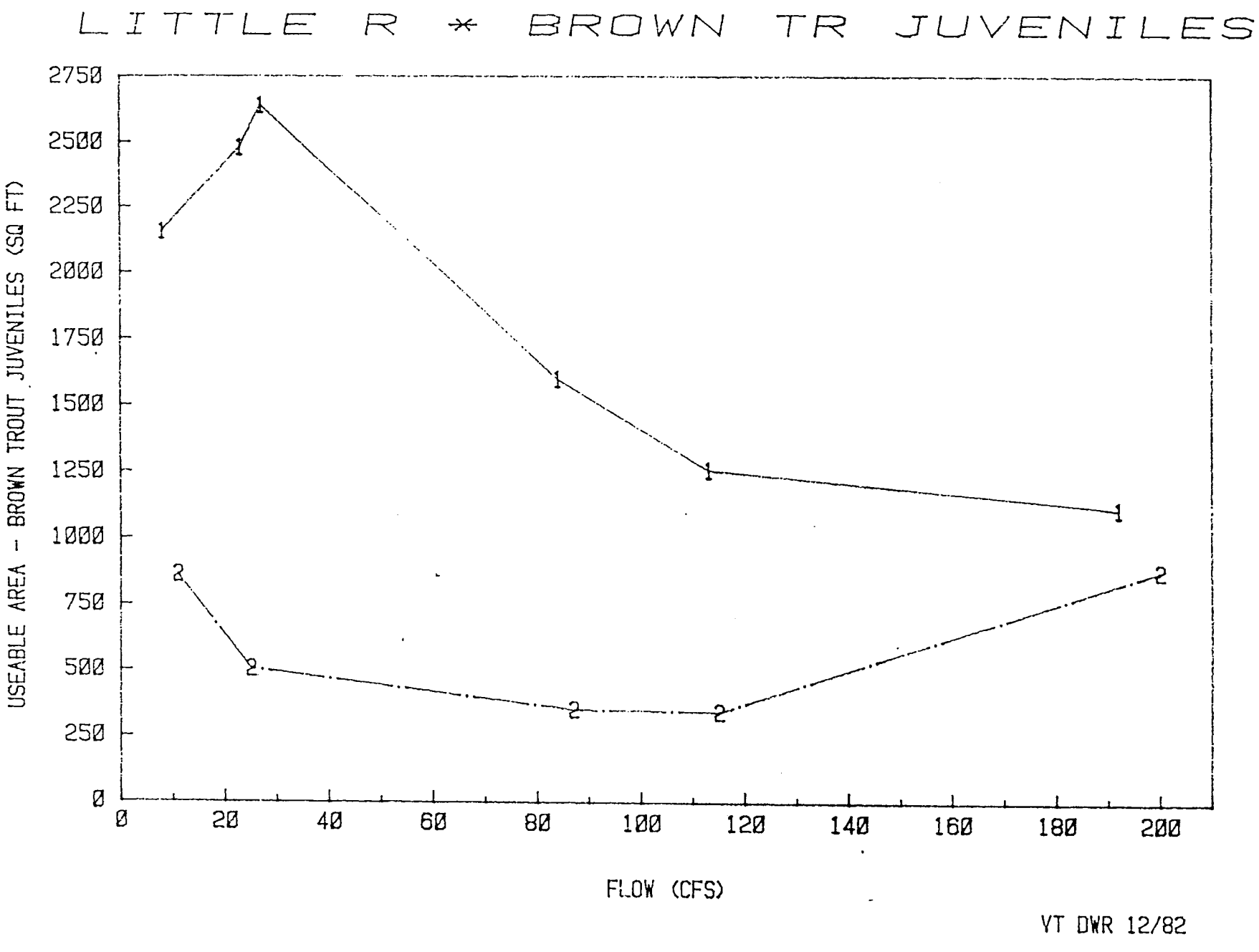


FIGURE 15c

FFNA Useable Area Curve - Little River #22 Project



resulted in severe shoreline erosion. The lake has considerable boating activity, and this, plus the wind action, prevent the banks from stabilizing. It is not uncommon to watch an entire bank slide into the reservoir.[1]

Recommendations for Further Study

A summer study of D.O. and temperature below the project is recommended to determine the extent and severity of the water quality problem. Measurements should be taken during periods of generation and nongeneration to determine D.O. concentrations and temperature fluctuations. The study should consider the recreation potential of the Little River below the project also. The minimum flow of 55 cfs recommended for fisheries should be evaluated in this study to determine if it is adequate for water quality as well.

Recommendations

a. A minimum flow requirement should be established to improve the downstream fishery and water quality. Depending on the results of the water quality study, additional mitigation measures to improve downstream D.O. concentrations may be required. These may entail the installation of a reaeration structure just below the powerhouse discharge.

b. The banks of the reservoir should be stabilized. This could be accomplished in part by reducing the extent of reservoir fluctuations.

[1] Lakes and Ponds Fisheries Report, District IV, Waterbury Reservoir, Jon Anderson, April 11, 1969

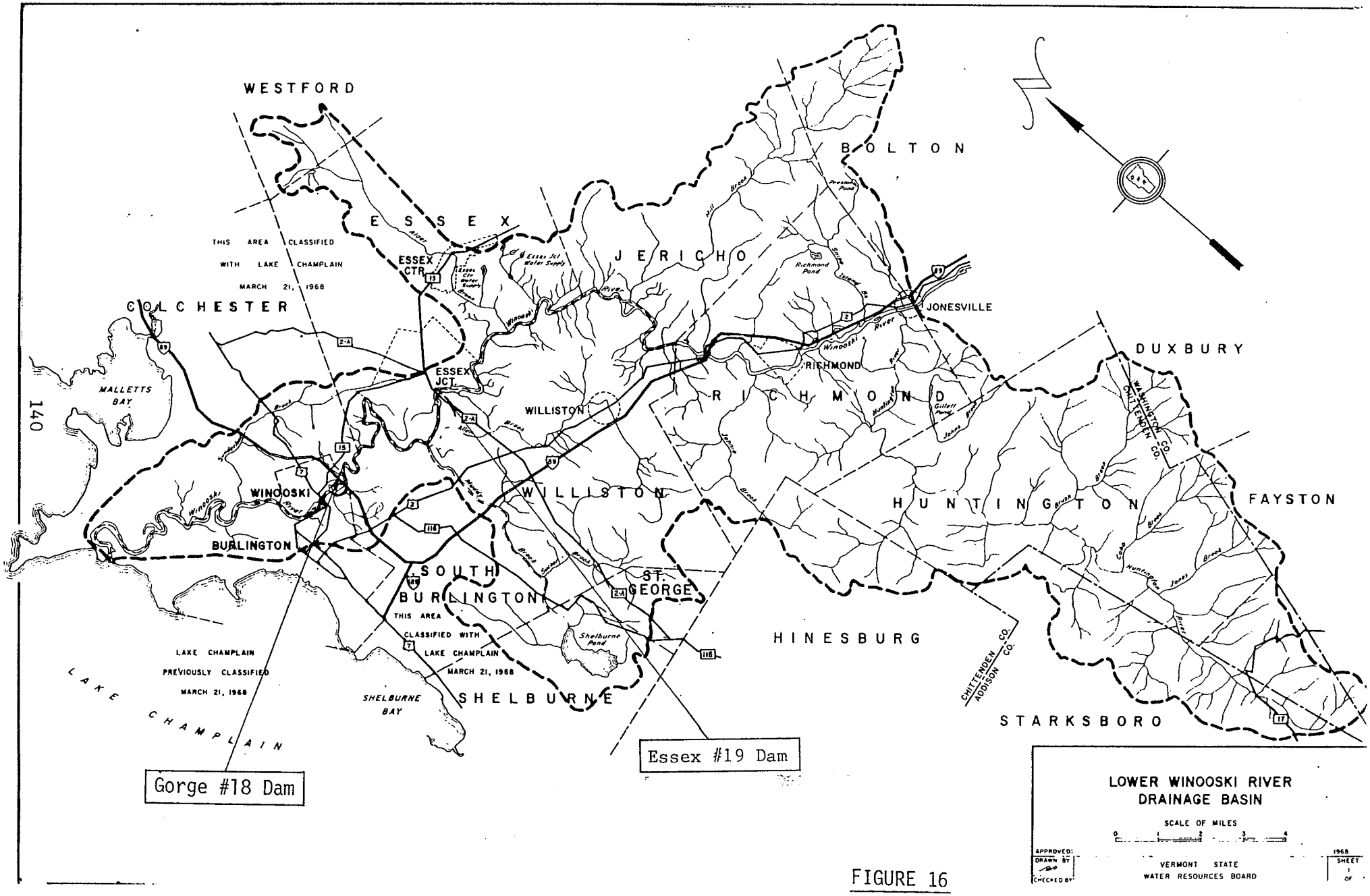

WESTFORD
BOLTON
ESSEX
ESSEX CTR
JERICHO
THIS AREA CLASSIFIED WITH LAKE CHAMPLAIN MARCH 21, 1968
COLCHESTER
JONESVILLE
DUXBURY
ESSEX JCT.
RICHMOND
MALLETTS BAY
WILLISTON
WINOOSKI
BURLINGTON
SOUTH BURLINGTON
ST. GEORGE
HUNTINGTON
FAYSTON
HINESBURG
LAKE CHAMPLAIN PREVIOUSLY CLASSIFIED MARCH 21, 1968
THIS AREA CLASSIFIED WITH LAKE CHAMPLAIN MARCH 21, 1968
SHELBURNE BAY
SHELBURNE
LAKE CHAMPLAIN
CHITTENDEN CO.
ADDISON CO.
STARKSBORO
140
Gorge #18 Dam
Essex #19 Dam
LOWER WINOOSKI RIVER
DRAINAGE BASIN
SCALE OF MILES
0 1 2 3 4
APPROVED:
DRAWN BY
CHECKED BY
VERMONT STATE
WATER RESOURCES BOARD
1968
SHEET 1 OF

FIGURE 16

BASIN 8

STREAM: Winooski River

PROJECT: Essex #19

UTILITY: Green Mountain Power Corporation (GMP)

LICENSE STATUS: FERC License issued January 21, 1969; expires December 31, 1993

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Upstream - Cold water
Downstream - Cold water, except for June 1 to September 30 only, when it is warm water

IMPACT: Significant

Project Features

Essex #19 is located on the Winooski River at river mile 16.9 in the Town of Essex (Figure 16) and has a drainage area of 1044 square miles. The project operates with an installed capacity of 7200 KW and a gross head of 65 feet. The powerhouse contains four Francis horizontal turbines, each having a hydraulic operating range of up to 525 cfs. The dam is 494 feet long and an average of 46 feet high with a 345 feet long crest at an elevation of 270' USGS. The crest is fitted with 5-foot flashboards except for an 84 foot section fitted with 6.5-foot flashboards. The impoundment at elevation 275' has a surface area of 352 acres and extends upstream seven miles. The penstock-bypassed section of stream is 400 feet long.

Operating Mode

Essex #19 is a daily peaking plant except under high flows when it operates as a base load facility. It operates in coordination with Gorge #18 located 6.4 miles downstream. Generation at the #18 facility generally begins and ends about one hour after #19 operations.

GMP reports that under low-flow conditions, the project operates Monday through Friday from 0800 to 1200 with an average drawdown of 2 feet. Under moderate flows, the project operates Monday through Friday from 0700 to 1600 with an average drawdown of 4 feet. The project generates 24 hours a day, 7 days a week, with no drawdown under high flows.

Exhibit H of the project's April 6, 1965, FERC license application states that the project is a run-of-the-river project which is partially regulated by the Mollys Falls and Waterbury

(Little River #22) projects upstream. "Under median flows, the plant will discharge from 530 C.F.S. (one unit) and 2120 C.F.S. (four units) eight (8) to sixteen (16) hours a day between normal full pond elevation 275 feet U.S.G.S. Datum and 274 feet."

Prior to August 1, 1987, the only flow maintained downstream of the project during periods of refilling the impoundment was that which leaked through the dam and/or flashboards. When there was no power generation at Essex #19 during periods of low flow and when the pond was low, the river flow was reduced to about 55 cfs. This represents the average leakage through the dam.[1] GMP reports that leakage at full pond (275' USGS) is approximately 140 cfs with all generators shut down. The operation of Essex #19 can result in drastic flow fluctuations below the project as graphically illustrated in Figure 17.

Effective August 1, 1987, GMP began operating one turbine at approximately half load during off-peak periods to provide at least 167 cfs (7Q10) at all times that sufficient water is available. The environmental review of this project is based on project operation prior to passage of this minimum flow.

Environmental Review

a. Water Quality

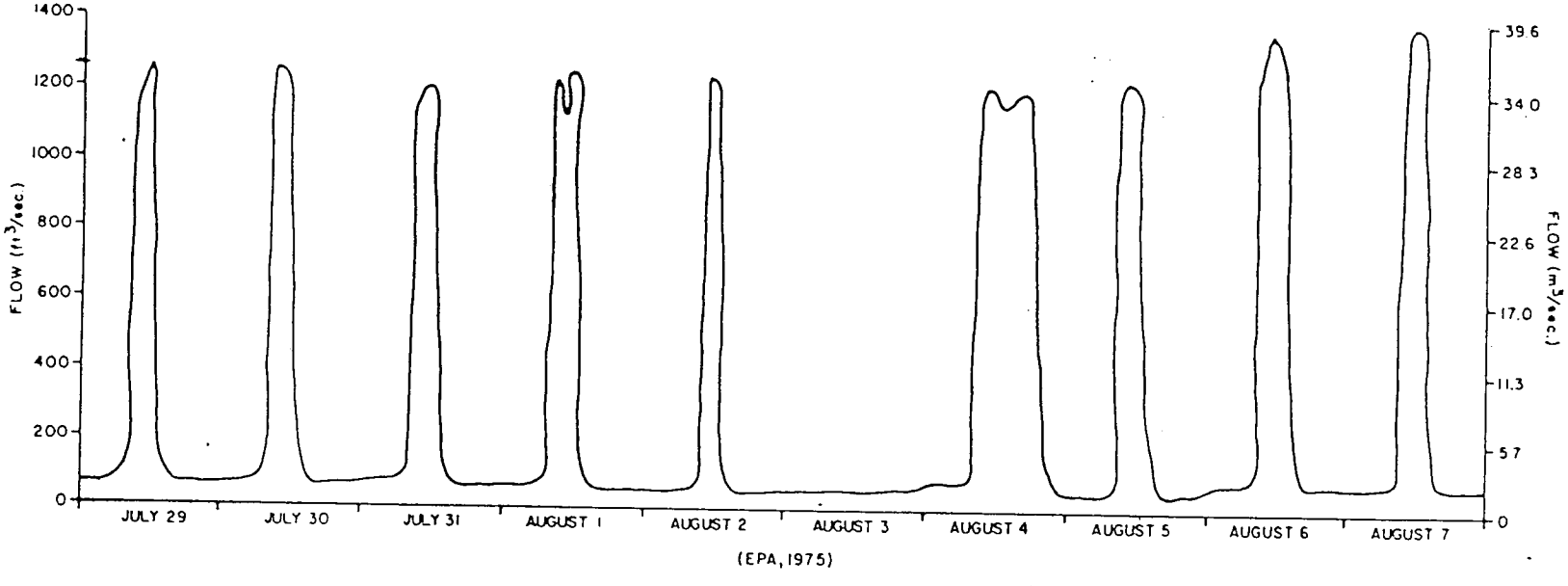
Natural stream flows on the Lower Winooski are influenced greatly by operation of Essex #19 and Gorge #18. The average leakage flows below these projects are 55 cfs for Essex #19 and 63 cfs for #18. These flows are significantly less than the estimated 7Q10 flow through this river reach of 167 cfs.

The Lower Winooski from its confluence with Alder Brook, 3.3 miles upstream of Essex #19, downstream to Lake Champlain receives waste discharges from six municipal water pollution control facilities and one industrial discharge, International Business Machines. The six municipal facilities are listed in Table 1. This 20.9 mile section of river has been designated a water quality segment for D.O. by the Department.

The Department conducted a wasteload allocation study of the Lower Winooski to quantify the impact of future dischargers on water quality as well as to define what treatment beyond secondary may be necessary to attain Water Quality Standards. A sensitivity analysis of the mathematical model used in this study was conducted at flows of 70 cfs and 200 cfs to determine how sensitive D.O. concentrations are to changes in

[1] Low Flow Augmentation Study. Lower Winooski River Vermont. Dubois and King, Vermont. February, 1981.

Figure 17: Winooski River Flow at USGS Gage, Essex Junction
July 29 to August 7 1975*



*From Lower Winooski River Wasteload Allocation Study. Part A: Report of Data. Vermont Department of Water Resources. December, 1980.

Table 1

Municipal Wastewater Pollution Control Facilities
Lower Winooski River

Essex Tri-Town

Colchester #1

South Burlington

Burlington - Riverside

Winooski

Burlington - North End

flows. Flow sensitivity results are indicated in Figure 18. It is evident from this analysis that at a flow of 70 cfs (42% of 7Q10) and the treatment facilities at design loads, a substantial degradation of water quality below cold water fisheries standards results. It should be pointed out that the analysis assumes that all flow is spilled at the two dams, providing maximum reaeration.

b. Fisheries

Vermont Fish and Wildlife conducted some limited sampling between Essex #19 and Gorge #18 in 1978. Smallmouth bass and fall fish were quite abundant. Juvenile steelhead and landlocked salmon have been stocked in the Winooski and pass through this section of stream as they migrate to Lake Champlain. Adult brown trout and rainbow trout are expected in the riffle area below #19. Anglers have reported catching these fish between #19 and the "Salmon Hole" located approximately eight miles downstream. There is no information regarding the potential fish habitat in the penstock-bypassed section of stream. Vermont Fish and Wildlife is also not familiar with fisheries above #19.

Vermont Fish and Wildlife reports that the stream section between #19 and #18 contains adult salmonid habitat which is impacted by extremely low flows during periods of impoundment. Drastic flow fluctuations may impair downstream fisheries as well, along with the poor water quality in this river reach.

Historical records show that the major tributaries of Lake Champlain at one time supported migratory salmonids. In conjunction with the Lake Champlain strategic plan for fisheries restoration, Vermont Fish and Wildlife is currently evaluating the potential trout and salmon spawning and nursery habitat in the tributary systems of Lake Champlain, including the Winooski River. This plan calls for the development of a trap and truck operation to be located in the Lower Winooski River to move upstream migrants around impassable dams.

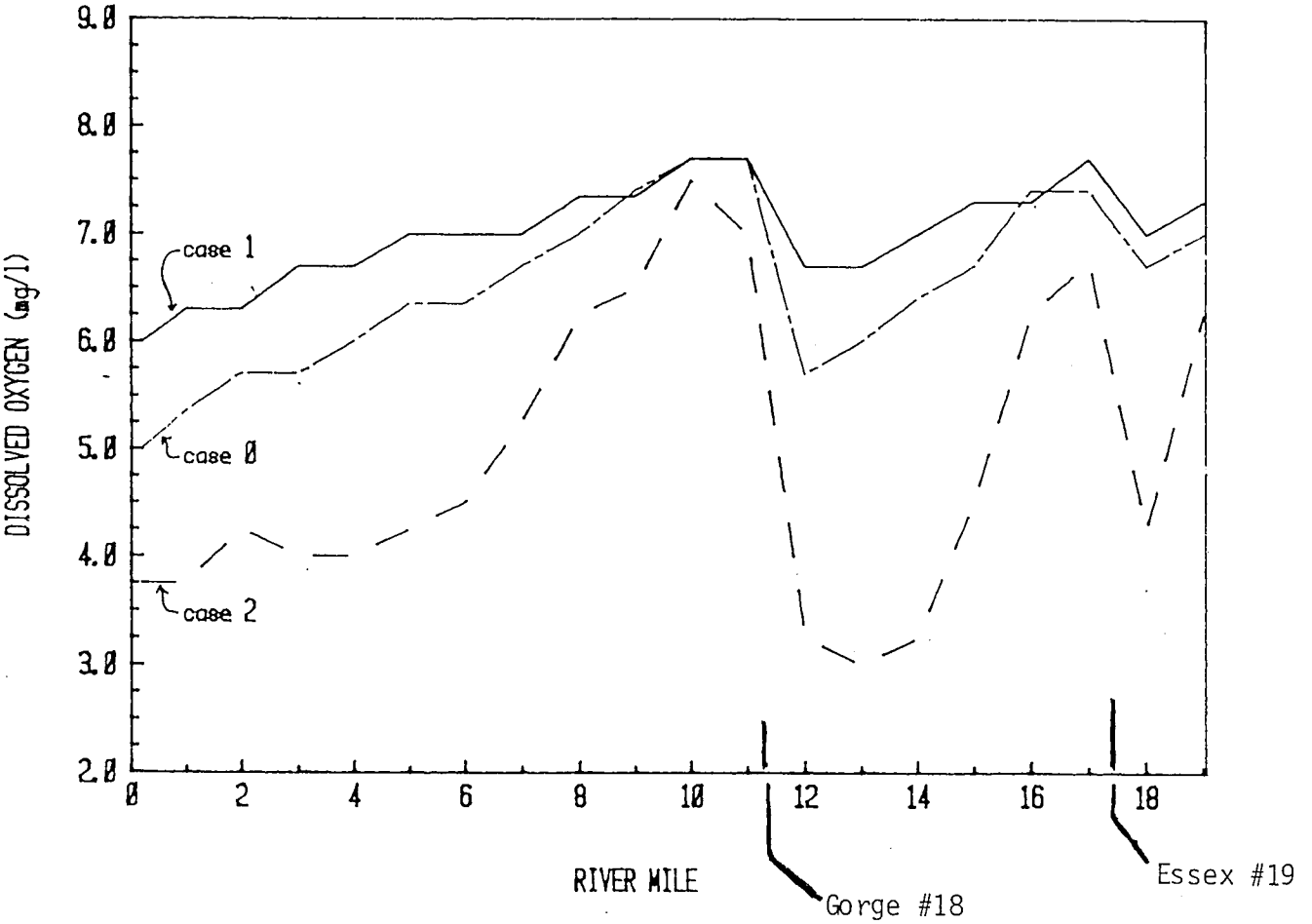
FFNA

Drainage Area: 1044 mi^2
7Q10: 167 cfs
USFWS Flow: 522 cfs
Recommended Flow: 340cfs (June - March)
1000 cfs (April 1 - May 31)

A FFNA study was conducted by the Department below Essex #19 at two study sections (Figure 19). The useable area curves generated from this study are presented in Figures 19a-19f.

Vermont Fish and Wildlife has identified habitat criteria for food production, rainbow trout adults, and smallmouth bass spawning, juveniles, fry, and adults as being most important in

Figure 18: Flow Sensitivity Results*



Case	Headwater Flow (cfs)
0	142
1	200
2	70

For all cases: CBOD = +
NBOD = +
Benthic = +
Algal R = +
Algal P = -

(+ = process included, - = process excluded)

*From Lower Winooski River Wasteload Allocation Study. Part B: Mathematical Modeling Report. Vermont Department of Water Resources. December, 1982.

FIGURE 19
FFNA Study Sections
Essex #19 Project

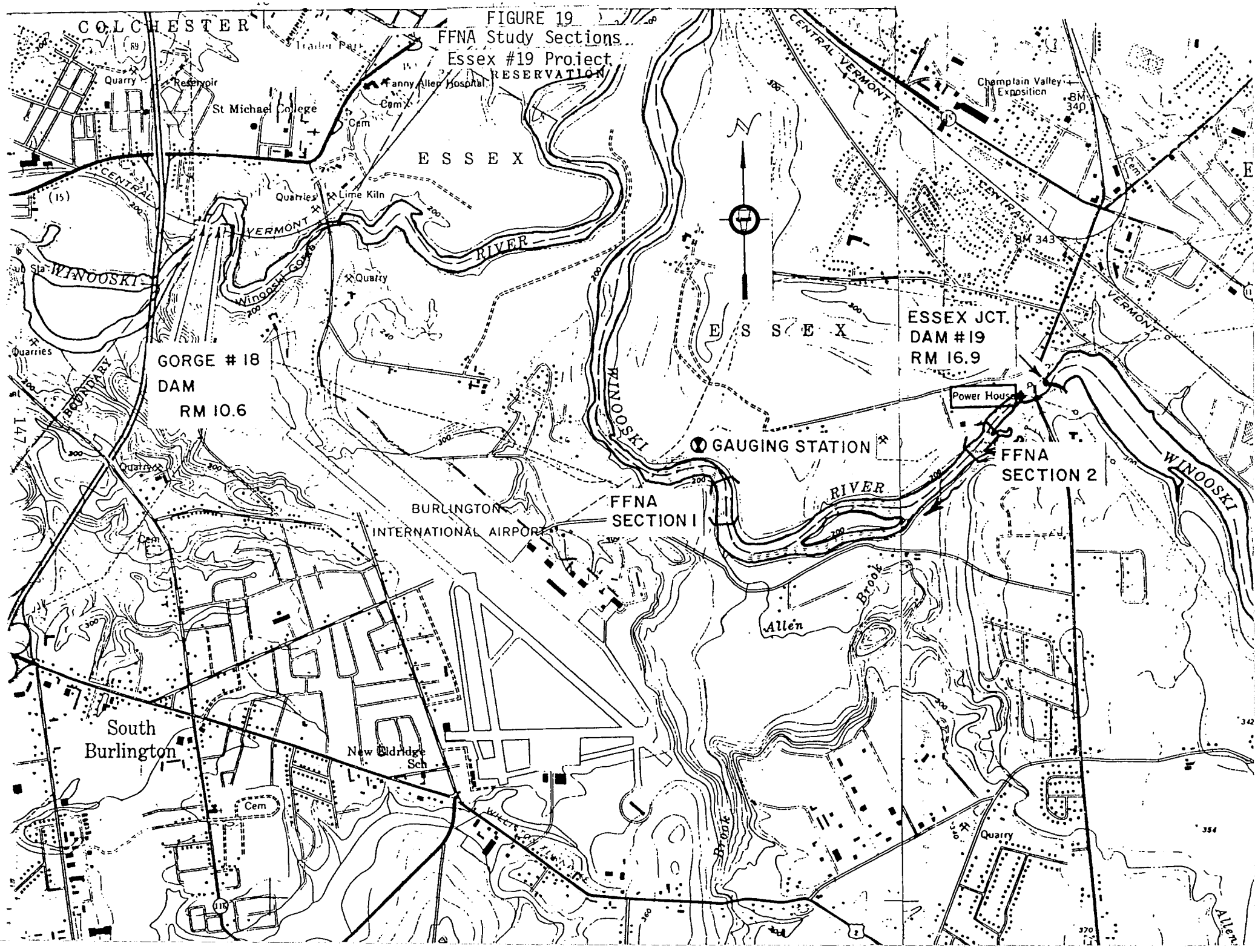


FIGURE 19a

FFNA Useable Area Curve - Essex #19 Project

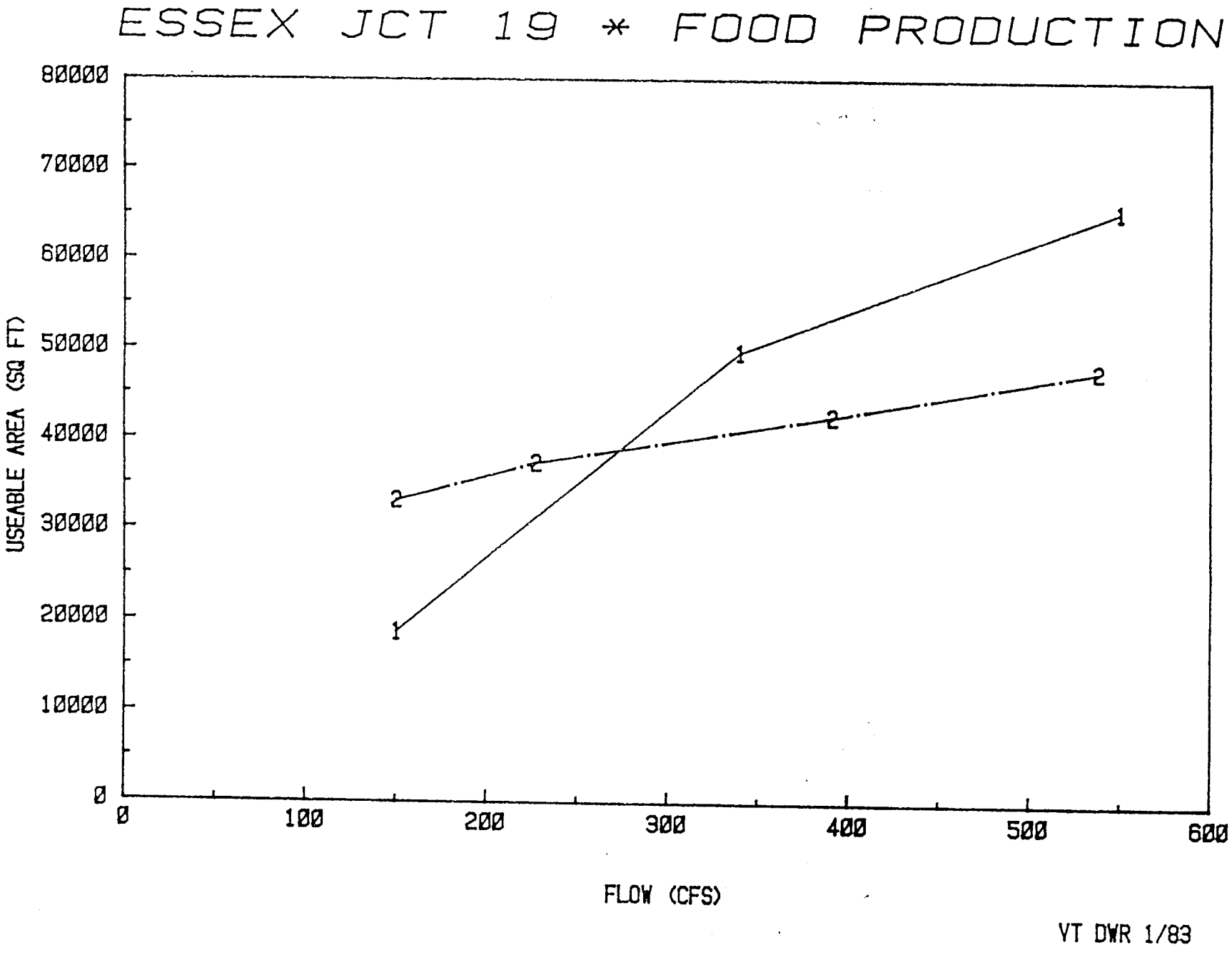


FIGURE 19b

FFNA Useable Area Curve - Essex #19 Project

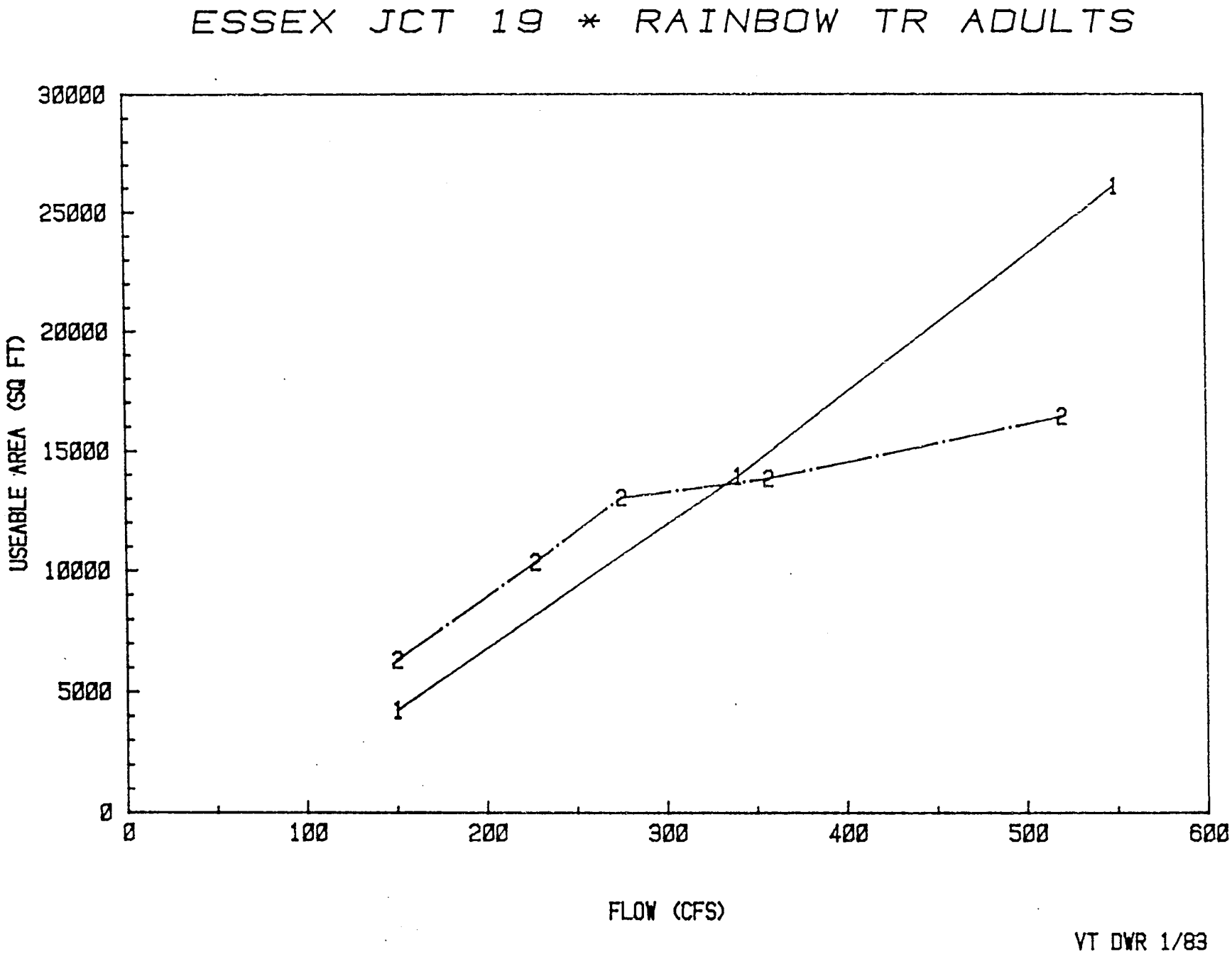


FIGURE 19c

FFNA Useable Area Curve - Essex #19 Project

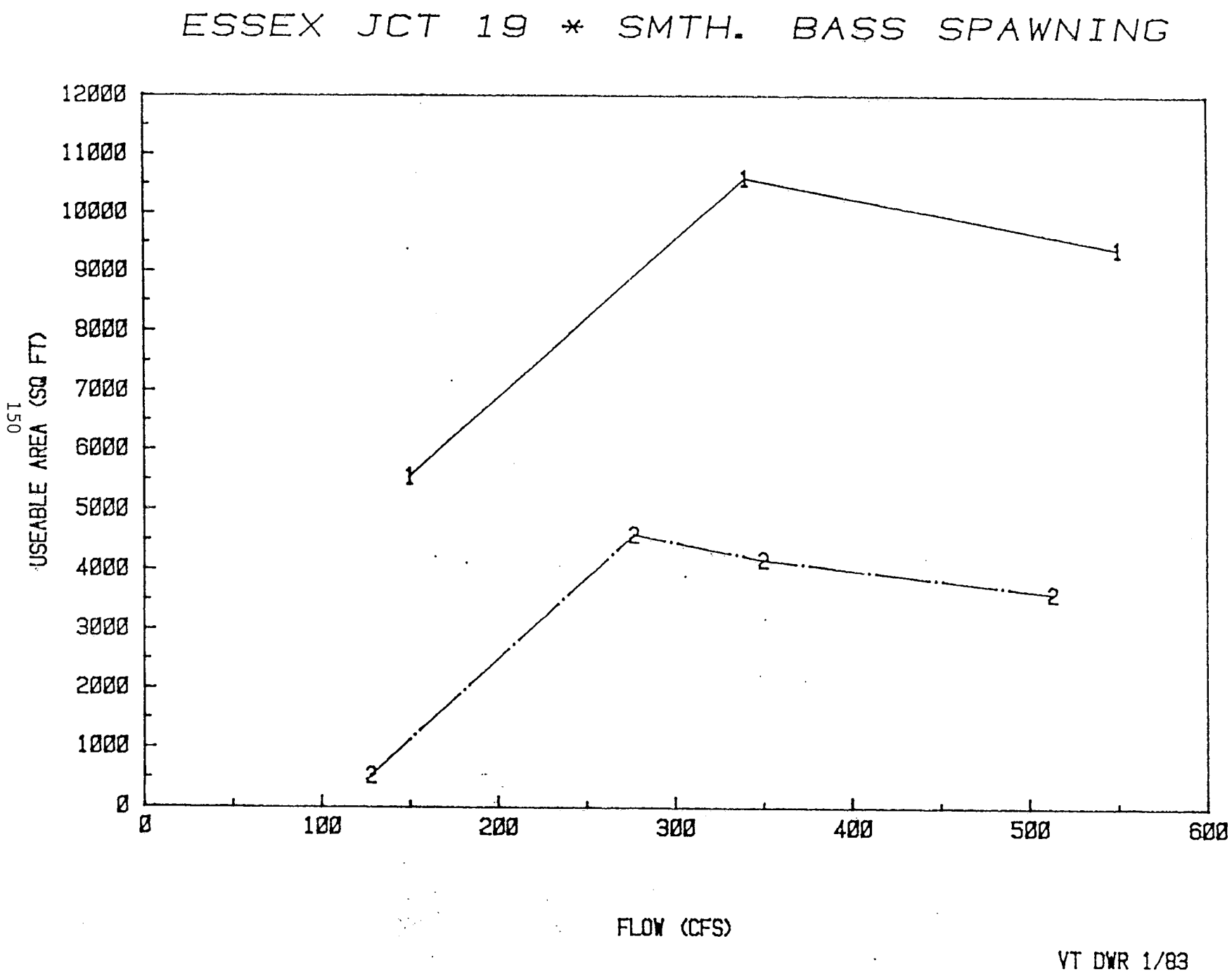


FIGURE 19d

FFNA Useable Area Curve - Essex #19 Project

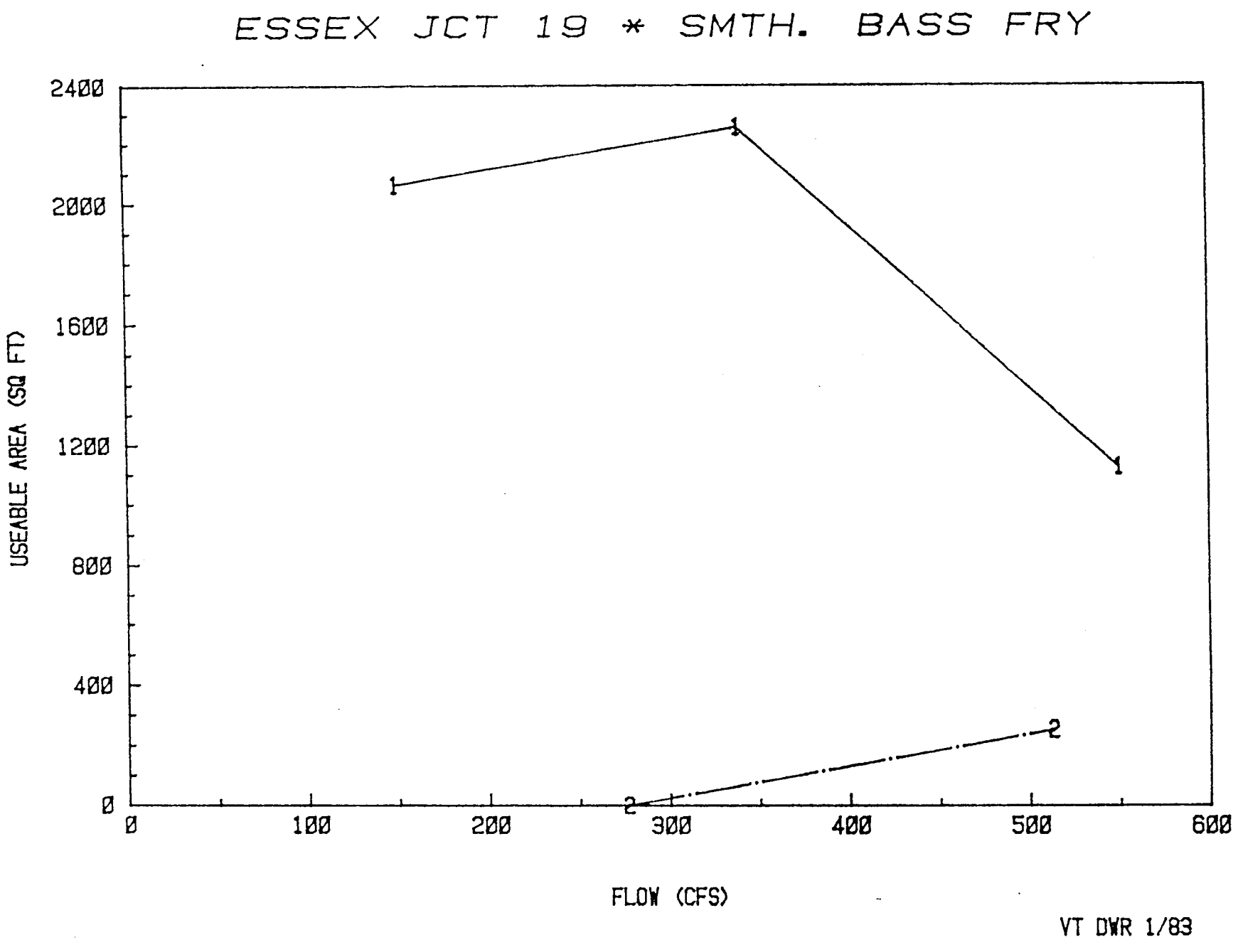


FIGURE 19e

FFNA Useable Area Curve - Essex #19 Project

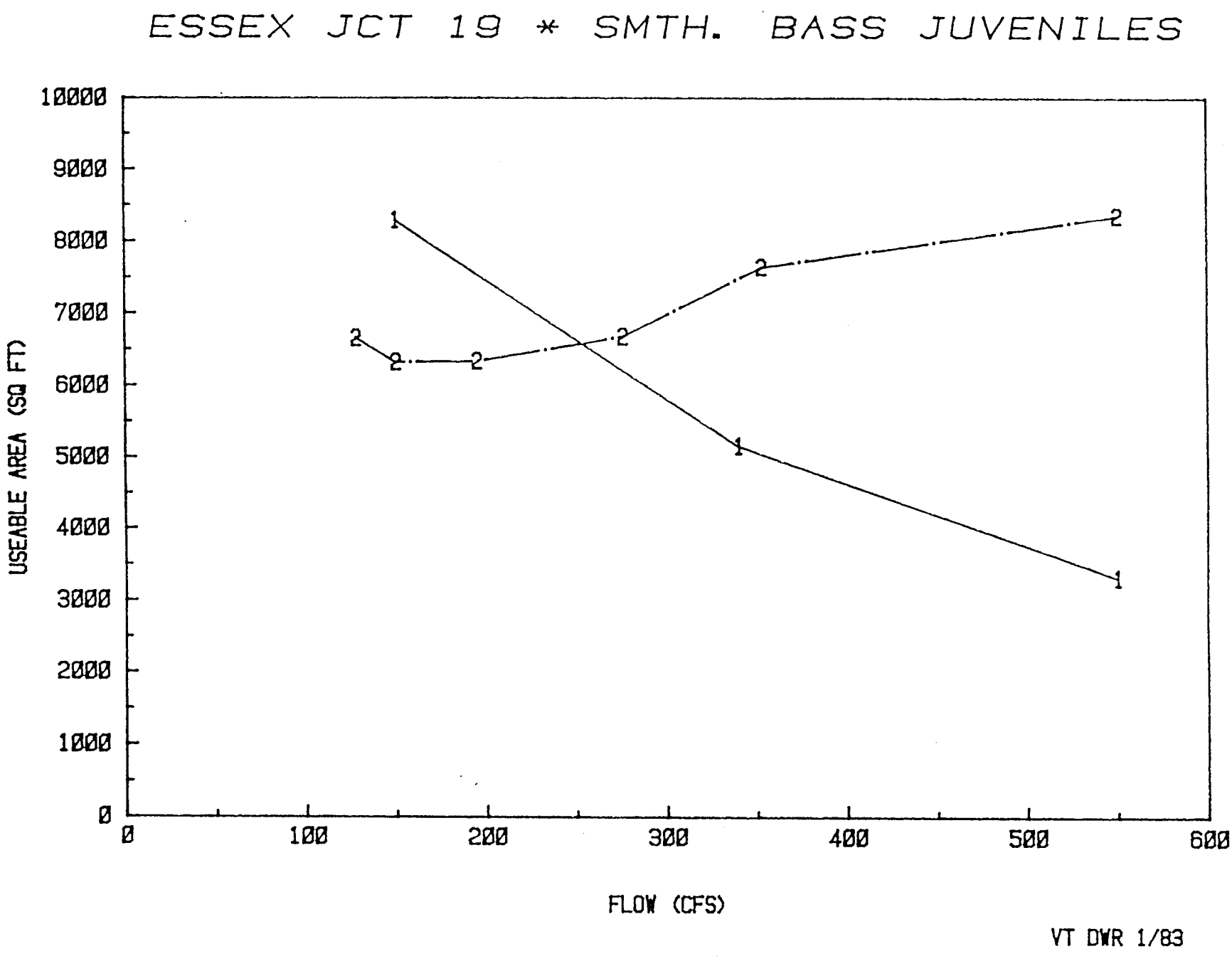
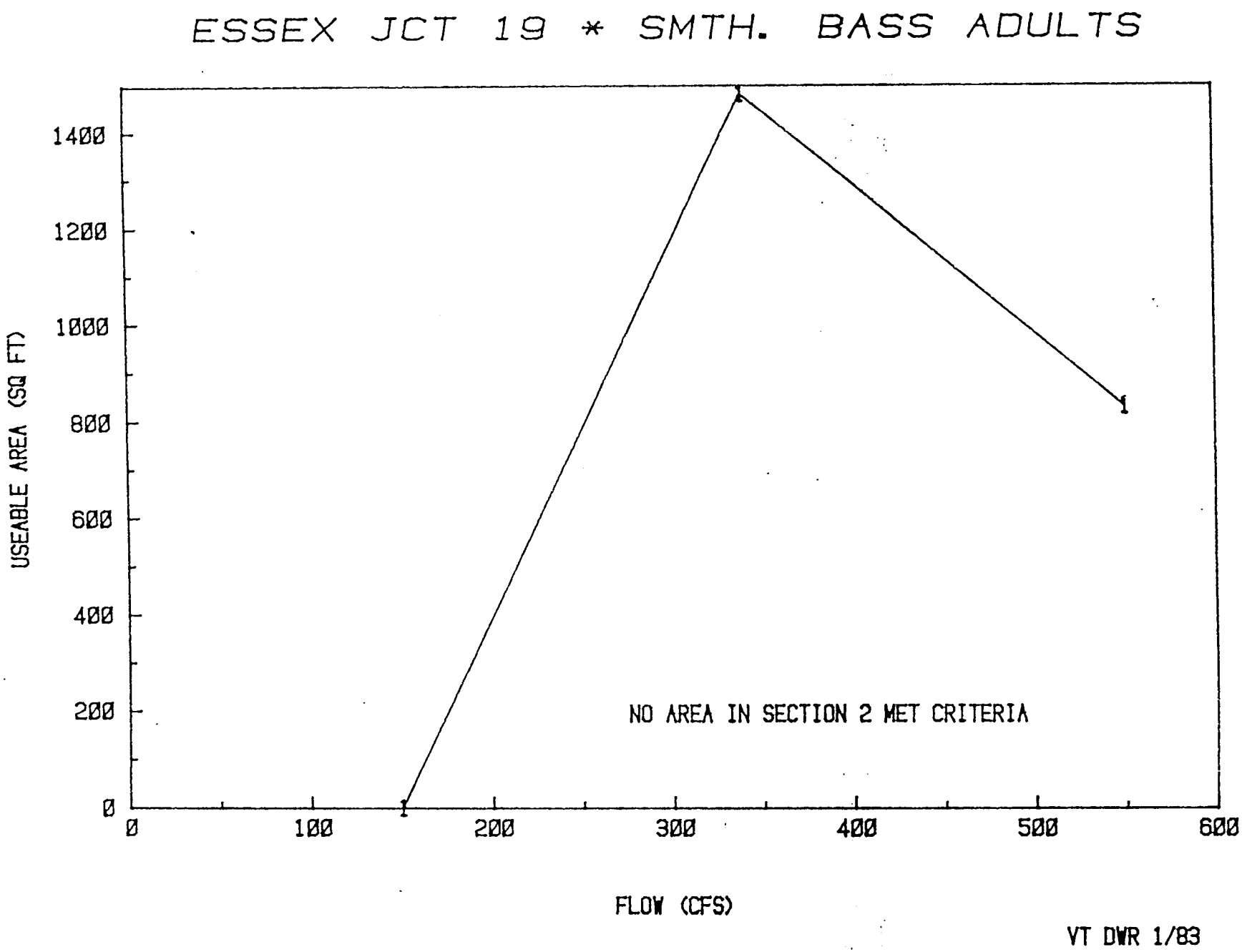


FIGURE 19f

FFNA Useable Area Curve - Essex #19 Project



analyzing the FFNA data. Figures 19a and 19b demonstrate a flow of 550 cfs would be optimum for food production and rainbow trout adults. Considering the fish passage plan for the Winooski River and the fact that the potential for this plan to be successful is very high in this river reach, this flow is preferred with a flow of 340 cfs being the absolute minimum. A flow of 340 cfs would also be adequate for all life stages of smallmouth bass.

Walleye spawn below Gorge #18 in the spring (April 1 to May 31). The recommended flow at Gorge #18 for walleye spawning is 1000 cfs. In order for this spawning flow to be maintained, a flow of 1000 cfs would also be necessary at #19 during the same spring period.

The Department finds that access to the section between Essex #19 and Gorge #18 is quite good. The social value is very high as a result, as is the demand for a quality fishery, particularly since it is so near to Burlington. The passage of minimum flows for the protection and enhancement of fisheries is, therefore, all that much more important.

A minimum flow requirement of 340 cfs would also improve water quality in the Winooski. A 7Q10 flow of 167 cfs as spillage is necessary to meet minimum water quality standards for dissolved oxygen.

c. Recreation/Aesthetics

Unstable impoundment elevations and downstream flow fluctuations may impact the recreational use of the stream above and below the project, particularly fishing and canoeing.

The stream section below the project is quite scenic with a steep ledge wall on the left side of the stream and a forested shoreline on the right. A roadside park day-use area is located below the powerhouse and overlooks the project. The development of this area was required under Article 28 of the project's FERC license. This article was included in the license following recommendations made by the Vermont Recreation Department on the need for recreational development at the site. Article 28 is as follows:

"Article 28. Licensee shall conduct studies on the feasibility of establishing a roadside park day-use area below the powerhouse overlooking the Winooski River Falls in cooperation with the Vermont State Highway Department, and shall cooperate with State and local agencies and organizations in the development and maintenance of access areas, roads and roadside parks, and such other facilities necessary for optimum recreational utiliztion by the public of project lands and water, consistent with the terms of this license and the operation of the project. Licensee shall, within one year from the date of

issuance of this license, submit for Commission approval revised Exhibit R for this project which conforms to Section 4.41 R of the Commission's Regulations under the Federal Power Act."

The lack of a minimum flow requirement below the project and in the 400 foot bypassed section of stream significantly degrades the aesthetics of area. The Department has photographs documenting this impact.

d. Natural Area/Wildlife Habitat

The Essex #19 project is located at the upstream end of a low limestone gorge known as Williston Gorge. The gorge was included in the Agency's Waterfalls, Cascades and Gorges Study. The rock-walled section of the gorge below the dam is about 150 feet to 200 yards long and from 15 to 35 feet high. The study reports that at "night the dam is lighted and looks quite pretty when water is flowing over it. In the summer the river is usually low and there is little flow over the dam and through the gorge." The study also identified four noteworthy interesting plants in the gorge, one of which is a threatened species in Vermont.

Recommendations for Further Study

a. Benthological data should be collected from above and below the project. This data could be used to support the Department's recommended minimum flow requirement and to document the project's impact on water quality.

b. An economic analysis should be done to determine the impact a minimum flow requirement would have on the utility. The Department has calculated that a minimum flow of 7Q10 at the project site would result in an economic loss to GMP of approximately $22,000/year.

c. An analysis of the bypassed section of stream should be done to assess the potential value of this reach for fisheries.

d. The need for additional recreational development should be assessed. A canoe portage may be recommended as available information indicates one has not been developed. A copy of the revised Exhibit R referenced in Article 28 should be located and reviewed.

Recommendations

A minimum flow requirement of 7Q10 should be required to be spilled over the dam to improve downstream water quality. This spillage flow would also improve project aesthetics and the quality of the bypass for fisheries. Minimum flow requirements

of 340 cfs from June 1 through March 31, and 1000 cfs from April 1 through May 31, should also be established below the project to improve downstream fisheries. A minimum flow requirement will reduce the severity of downstream flow fluctuations as well as improve the river for recreational use.

BASIN 8

STREAM: Winooski River

PROJECT: Gorge #18

UTILITY: Green Mountain Power Corporation (GMP)

LICENSE STATUS: FERC issued an order dismissing the license application for Gorge #18 on August 24, 1979.

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Cold water, except from June 1 to September 30, when it is warm water

IMPACT: Significant

Project Features

Gorge #18 is located at river mile 10.6 on the Winooski River in the Towns of Colchester and South Burlington (Figure 16) and has a drainage area of 1047 square miles. It is about one mile upstream of the proposed Chace Mill project. It consists of two dams separated by an island. The southern dam is fitted with 5 feet of flashboards resulting in a normal full pond elevation of 190.55' NGVD. The impoundment at this elevation has a surface area of 87 acres and extends upstream 3 miles. With a drawdown of 5 feet from the top of the flashboards, the useable storage of the impoundment is 400 acre-feet.

The project has a gross head of 34 feet. The powerhouse contains one vertical fixed propeller turbine with a hydraulic operating range of up to 1710 cfs and has an installed capacity is 3000 kW. A 50 foot penstock bypasses about 150 feet of stream; however, the backwater from the tailrace extends upstream to the dam.

Operating Mode

Gorge #18 operates as a unit with Essex #19 located 6.4 miles upstream. The two projects are partially regulated by the Mollys Falls and Waterbury (Little River #22) projects upstream.

Gorge #18 operates as a daily peaking plant except under high flow conditions when it operates as a baseload facility. GMP reports that under low-flow conditions the project operates Monday through Friday from 0800 to 1200 with an average drawdown of 3 feet. Under moderate flows, the project operates seven days a week from 0700 to 1300 with an average drawdown of 4 feet. The project operates 24 hours a day, seven days a week, during high flows.

Exhibit H of the FERC license application for the project states that under median flows the plant will discharge from 1300 to 1600 cfs from 5 to 20 hours a day between normal full pond elevation 190.35 NGVD and 188 feet.

Prior to August 1, 1987, the only flow maintained below the project during periods of refilling the impoundment was leakage from the dam. When there was no power generation at Gorge #18 during low-flow periods the river flow below the dam was reduced to 63 cfs; this discharge represents the average leakage through the dam.[1] Leakage at full pond is estimated by GMP to be 92 cfs with all generators shut down.

Effective August 1, 1987, GMP began spilling water to provide at least 7Q10 flow (167 cfs) at all times that sufficient water is available. The environmental review of this project is based on operations prior to passage of this minimum flow.

Environmental Review

a. Water Quality

Refer to the discussion of water quality for Essex #19 (page 142).

b. Fisheries

No fisheries survey has been conducted at this site by Vermont Fish and Wildlife. Walleyes spawn in the river reach below the project in the spring. Reference should be made to the discussion on the FFNA study conducted at Essex #19 (page 145).

c. Recreation/Aesthetics

In a letter dated November 20, 1967, to the Department, the Town of South Burlington Planning Commission, in commenting on the FERC license application for this project, stated that the Conservation Services of the U.S. Dept. of Agriculture, the Vermont Department of Forest, Parks, and Recreation, and the Extension Service of UVM had recently completed a natural resource survey for the Town. The report that they issued for Gorge #18 recommends that a trail system, scenic overlooks, and boardwalks be considered as an improvement for this area. Details of these recommendations are in Department files. The Planning Commission was going to recommend implementation of this recreational project and requested that the Town be given easements or rights of way in the project area to permit the

[1] Low Flow Augmentation Study. Lower Winooski River, Vermont. Dubois and King, Vermont. February, 1981.

establishing of trails, boardwalks, and overlooks. In this same letter, they request that the flow of water continue at the same rate as in the past.

It is not known whether these recommendations regarding recreational development were ever implemented. Available information indicates they were not.

Throughout much of the year, the dam face is dewatered with the exception of leakage through the flashboards. A beautiful gorge is located immediately below the dam. The project area is highly visible from I-89 which crosses the Winooski a short distance downstream. Passage of a minimum flow at the dam would improve project aesthetics substantially.

d. Natural Area/Wildlife Habitat

Gorge #18 is located at the site of the Winooski Gorge which was included in the Agency's Waterfalls, Cascades, and Gorges Study. The study notes that "the gorge was formerly one of Vermont's most notable natural features. It has now been dammed...." The gorge is located both above and below the dam. It is a long and deep gorge, one of Vermont's largest, and is important botanically from a historical and contemporary standpoint.

e. Erosion/Siltation

The headrace for the project is desilted every one or two years.

Recommendations for Further Study

a. A fisheries survey should be conducted at the site and an assessment of project impact on fisheries should be made.

b. The status of the recreational development plan should be determined.

c. How the headrace is desilted and if there are any problems with this method should be determined.

Recommendations

A minimum flow requirement must be established at the site for water quality and fisheries. A flow of 340 cfs year round for fisheries and water quality, and a flow of 1000 cfs from April 1 through May 31 for walleye spawning, is recommended based on the FFNA study conducted at Essex #19. Passage of part of this flow (7Q10) at the dam would improve project aesthetics and may be necessary for water quality.

It is clear that the need for a minimum flow requirement was an issue when the FERC license was issued in 1969. The Department of the Interior's Federal Water Pollution Control Administration (FWPCA), in reporting on the license application, had advised FERC that the "license should provide for a minimum flow to be derived from further study by the appropriate State agency or the Federal Water Pollution Control Administration."

Reference should also be made to a letter dated July 29, 1967, from the Department to the Federal Power Commission stating the extent of cooperation between the Vermont Water Resources Board and GMP relating to stream flow during critical periods in the Winooski River. The last paragraph of this letter is as follows:

> "At our last meeting on June 13, 1967, it was mutually agreed that the State would install a gage station downstream of the Middlesex Plant below the mouth of the Mad River. This gage would record flows through the plant combined with flows from the Mad River to give us a better understanding of flows in the river below the Middlesex Plant. After we have obtained these flow measurements, the Green Mountain Power Corporation officials have indicated to us that they will cooperate with us further in an effort to operate the Middlesex Plant and the Essex Junction Plant to provide recommended minimum flow releases required during critical streamflow periods."

There is no record of any negotiations based on the Middlesex gaging.

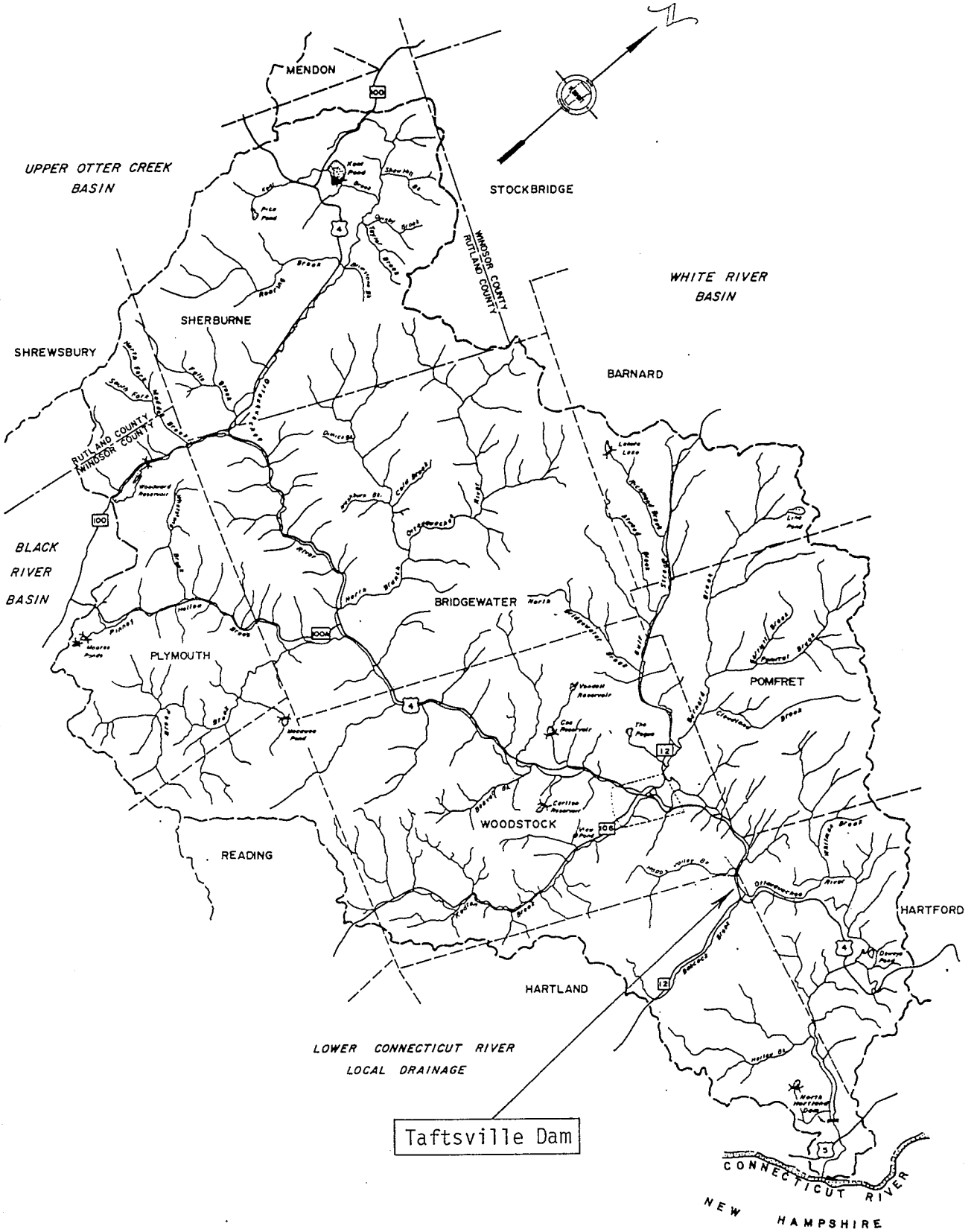


FIGURE 20

OTTAUQUECHEE RIVER
DRAINAGE BASIN

SCALE OF MILES

APRIL, 1980

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

BASIN 10

STREAM: Ottauquechee River

PROJECT: Taftsville

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC license issued June 6, 1966, expires December 31, 1993

CLASSIFICATION: Upstream - B
Downstream - C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

The Taftsville Project is located on the Ottauquechee River in the Town of Woodstock (Figure 20) and has a drainage area of 200 square miles. Project features include a concrete dam approximately 220 feet long and 16 feet high containing a spillway section 194 feet long topped with 18-inch wood flashboards. The project's reservoir extends upstream 500 to 600 feet and is about 16.6 acres in size with about 30 acre-feet useable storage (presumably these figures are with the flashboards in place). An intake structure diverts flows from the reservoir to the powerhouse which is immediately below the dam. The powerhouse contains one vertical turbine with a capacity of 675 hp. connected to a 500 kW generator. The project has an estimated operating head of 20 feet and bypasses 50 to 100 feet of streambed.

Operating Mode

There is limited and conflicting information on the operation of the Taftsville Project. During an interview with CVPSC personnel at the project site in the summer of 1982, the utility described Taftsville as a run-of-the-river plant with no storage and no drawdowns. At the same time, however, CVPSC reported a maximum drawdown of two feet and that sporadic ponding and some winter peaking occurs.

Observations made by the Department during the summers of 1982 and 1985 indicate that during low flows, ponding occurs almost on a daily basis. During periods of impounding, which may last for 12 to 16 hours at a time, a leakage flow of less than 8 cfs (measured by the Deparment August 31, 1982) is maintained below the dam. This flow is less than 40% of the estimated 7Q10 value of 20 cfs for the Ottauquechee at this site. Downstream

flow fluctuations were observed to occur frequently, sometimes two to three times an hour. Flows would sometimes fluctuate from 8 cfs in the early morning to 100 to 180 cfs by late morning.

On June 26, 1985, while the Department was performing some field work at the Taftsville site, the leakage through the dam was substantially reduced from the past norm. According to one of the maintenance people at the site, during the dam project in 1984, a channel was placed in the dam crest. Plywood flashboards are now inserted into the channel and coal ash used to seal the leakage. It is very effective. In the past, vertical rough cut flashboards were used and, with no channel, they leaked a fair amount. The dam was observed with about 0.7 feet of head on the crest on June 26 and the leakage was very low.

Environmental Review

a. Water Quality

The Woodstock STP is located 3.3 miles upstream of the Taftsville Project and has a permitted total discharge of .350 mgd. The Taftsville STP and Quechee STP are located downstream of the dam about 150 feet and 5.5 miles respectively. The permitted total discharge for Taftsville is 0.01 mgd and 0.300 mgd for Quechee. The periodic interruption of downstream flows to less than 7Q10 during periods of impounding at Taftsville may result in violations of Water Quality Standards for D.O. concentrations downstream of the dam and impact the stream's assimilative capacity. Prolonged periods of impounding and the release of extreme low flows warmed in the downstream channel may also result in high water temperatures.

The Department collected water quality data from various stations above and below the Taftsville site during daylight hours. This data reveals high temperatures. Supersatured D.O. conditions, an indication of algal activity, were also recorded. Evidence of algae was recorded by the Department during the data collection effort.

Unfortunately, no early morning D.O. samples were taken at the project site to measure the effect of respiration on D.O. levels.

b. Fisheries

The Ottauquechee River, supports a cold water fishery above and below the dam, the principal species being brown and rainbow trout. Salmonid spawning habitat is spotty above and

below the dam. Rainbow trout spawning occurs primarily in the tributaries. The presence of spawning habitat is limited below the dam. Adult habitat and nursery habitat for brown trout and

rainbow trout is present above and below the dam but is restricted by summer water temperatures.

Vermont Fish and Wildlife reports that the Taftsville project impairs fisheries downstream of the project's tailrace. Anglers complain of severely reduced flows and that occassionally flows are quite turbid because of desilting activities. High stream temperatures, caused in part by the operation of the hydroelectric project, are also impacting the fishery. Vermont Fish and Wildlife recommends that a minimum flow requirement be established at the site to improve the salmonid potential of the Ottauquechee. A minimum flow should also improve stream temperatures as well.

FFNA

Drainage area: 200 mi^2
7Q10: 20 cfs
USFWS Flow: 100 cfs
Recommended Flow: 110 cfs

The Department conducted a FFNA study at two study sections below the project in 1982 (Figure 21). Vermont Fish and Wildlife identified these sections as being important for rainbow trout and brown trout juveniles.

Based on an analysis of the useable area curves generated from this study and presented in Figures 21a-21e, a minimum flow of 110 cfs is recommended to protect these fish species.

A minimum spillage flow of 7Q10 (20 cfs) would most likely only satisfy aesthetic concerns, as evidenced in Figure 21e where there is a significant increase in wetted area at this flow, and meet the design standards for the treatment plants downstream. It would provide little useable area for food production and rainbow trout adults as evidenced in Figures 21c and 21d.

The Department conducted an intensive study at the site in the summer of 1985. The study, entitled "The Effects of the Taftsville Hydroelectric Facility on Downstream Fish and Macroinvertebrate Populations" (1986) is available by contacting the Department.

The study concludes that peaking operations at the Taftsville facility during the summer months has adversely impacted both the fish and macroinvertebrate populations downstream of the facility. Fish populations above and below the project were dominated by long nose and black nose dace and not by trout. High stream temperatures during the summer months are believed to seriously limit the trout population in the Ottauquechee River.

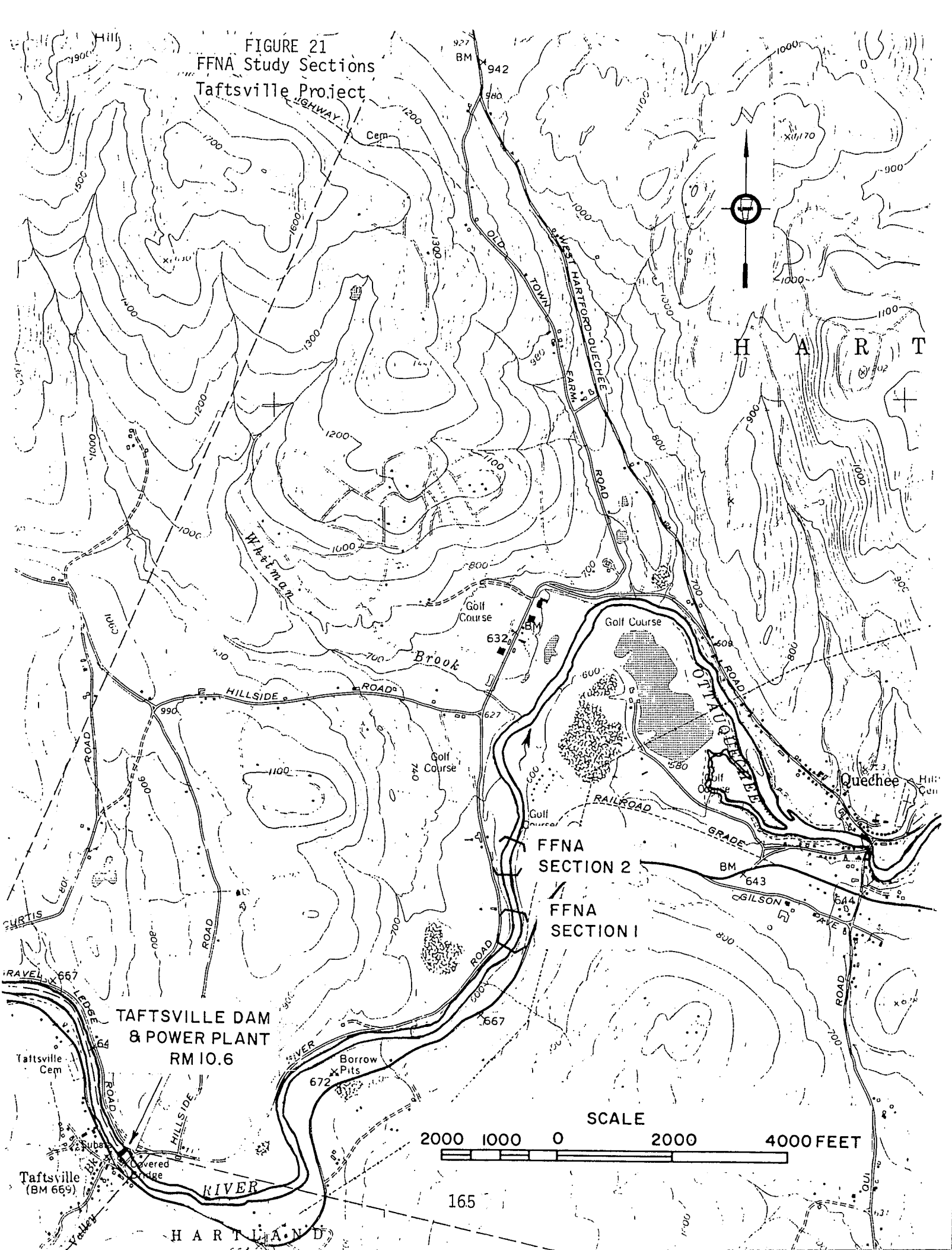


FIGURE 21
FFNA Study Sections
Taftsville Project
FFNA SECTION 2
FFNA SECTION I
TAFTSVILLE DAM & POWER PLANT RM 10.6
SCALE
2000 1000 0 2000 4000 FEET
HARTLAND
Taftsville (BM 669)
Taftsville Cem
Covered Bridge
Borrow Pits
Golf Course
Quechee
HILLSIDE ROAD
WEST HARTFORD-QUECHEE ROAD
OLD TOWN FARM ROAD
RAILROAD GRADE
GILSON AVE
OTTAUQUECHEE RIVER
Whitman Brook
RIVER
H A R T

FIGURE 21a

FFNA Useable Area Curve - Taftsville Project

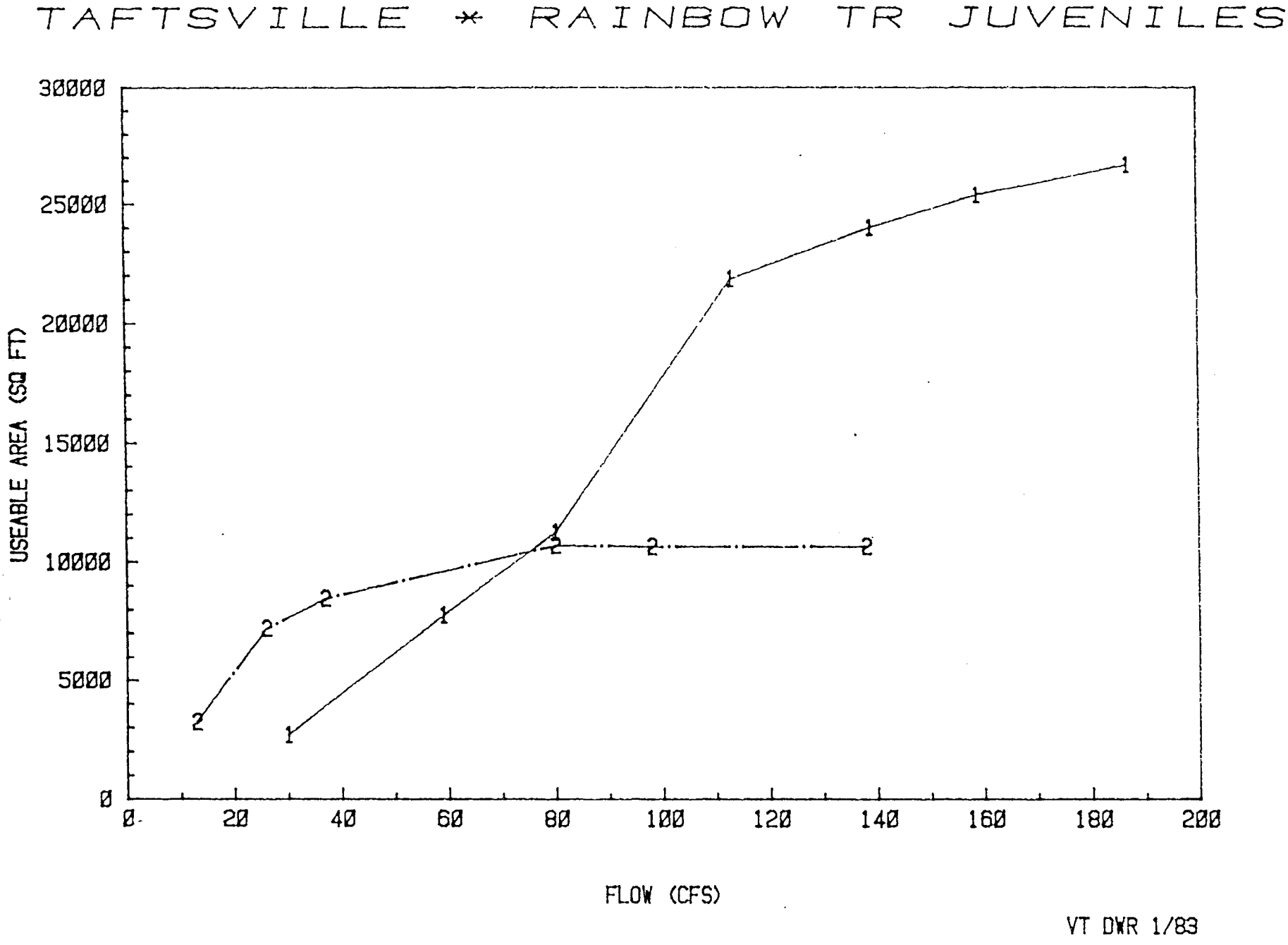


FIGURE 21b

FFNA Useable Area Curve - Taftsville Project

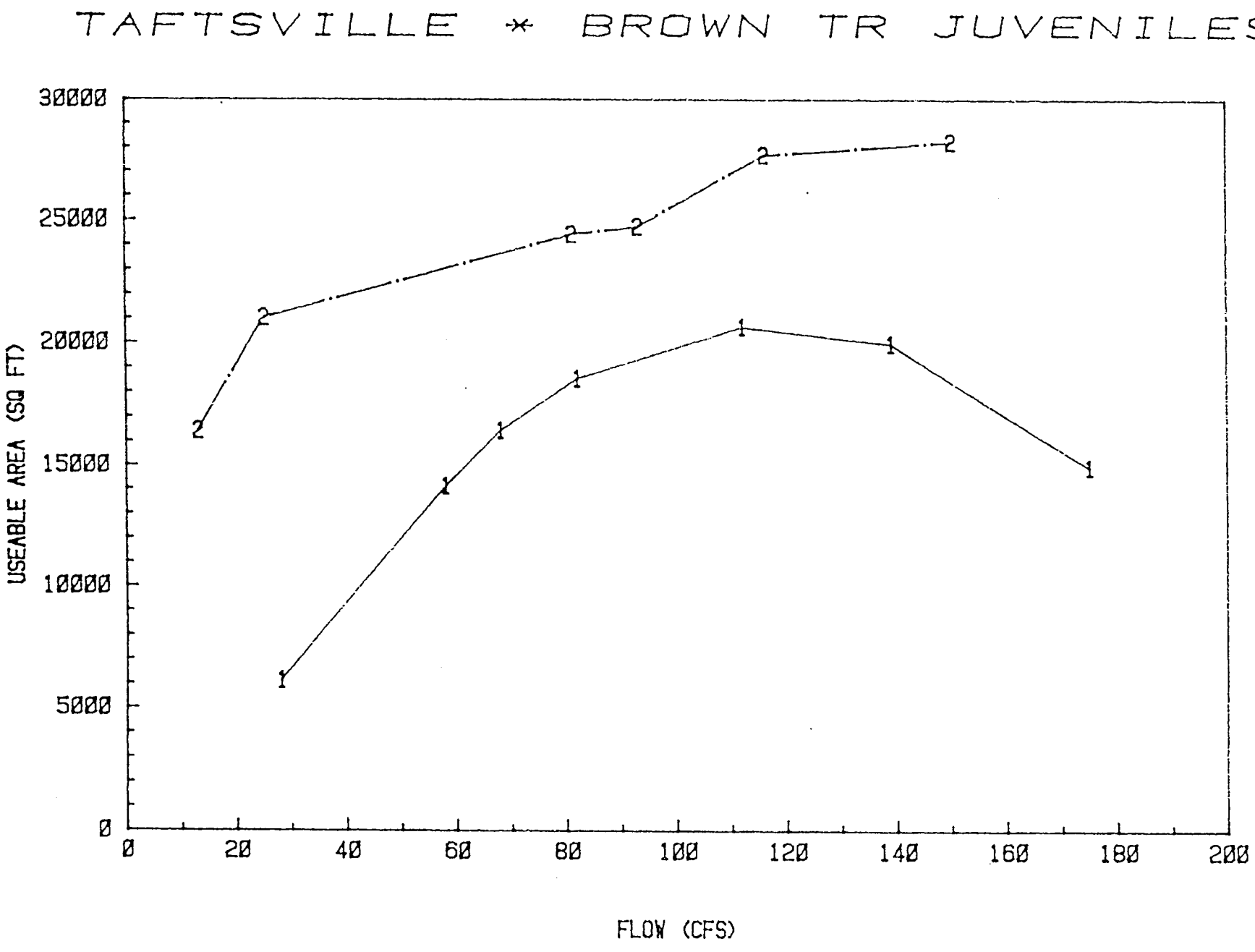


FIGURE 21c

FFNA Useable Area Curve - Taftsville Project

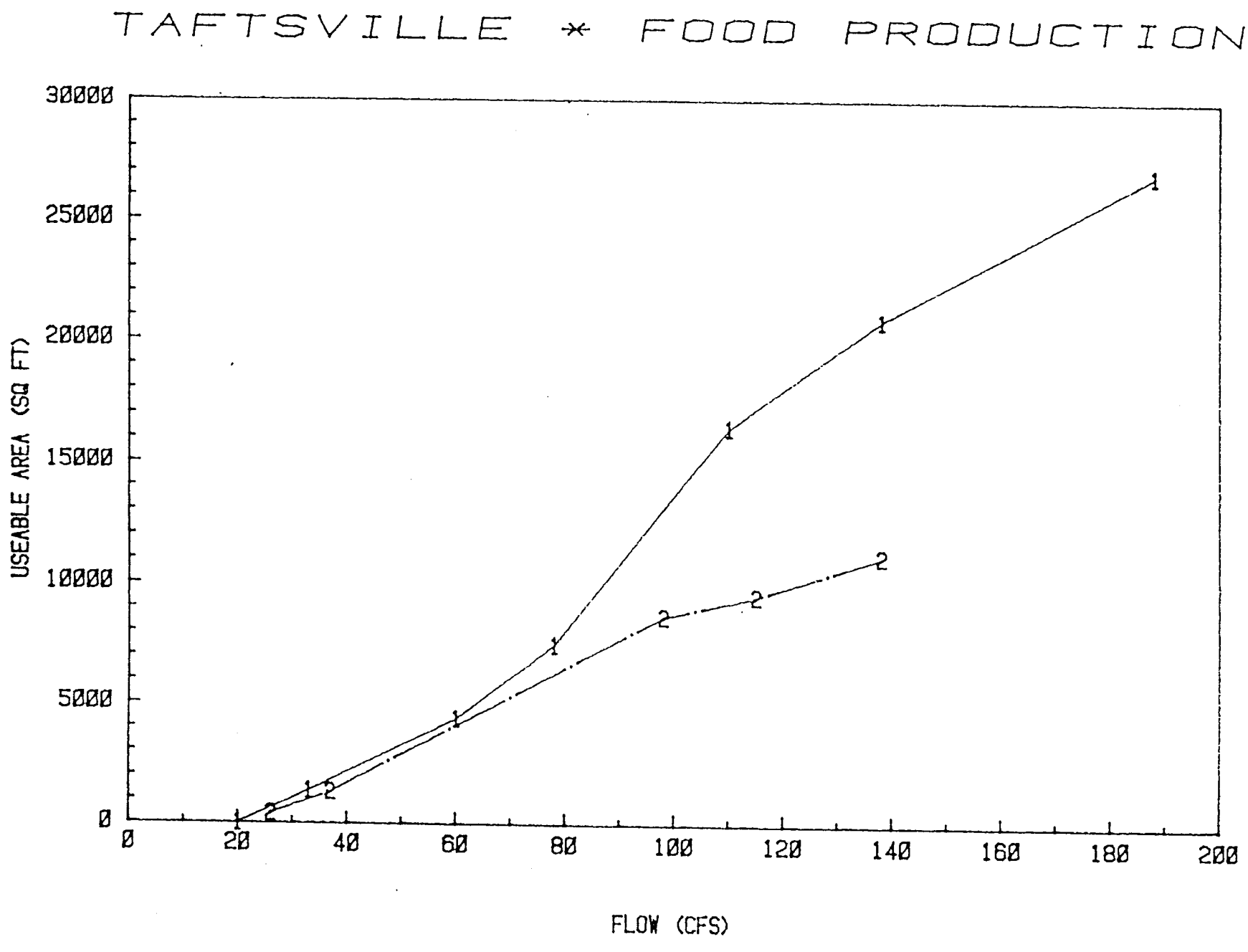


FIGURE 21d

FFNA Useable Area Curve - Taftsville Project

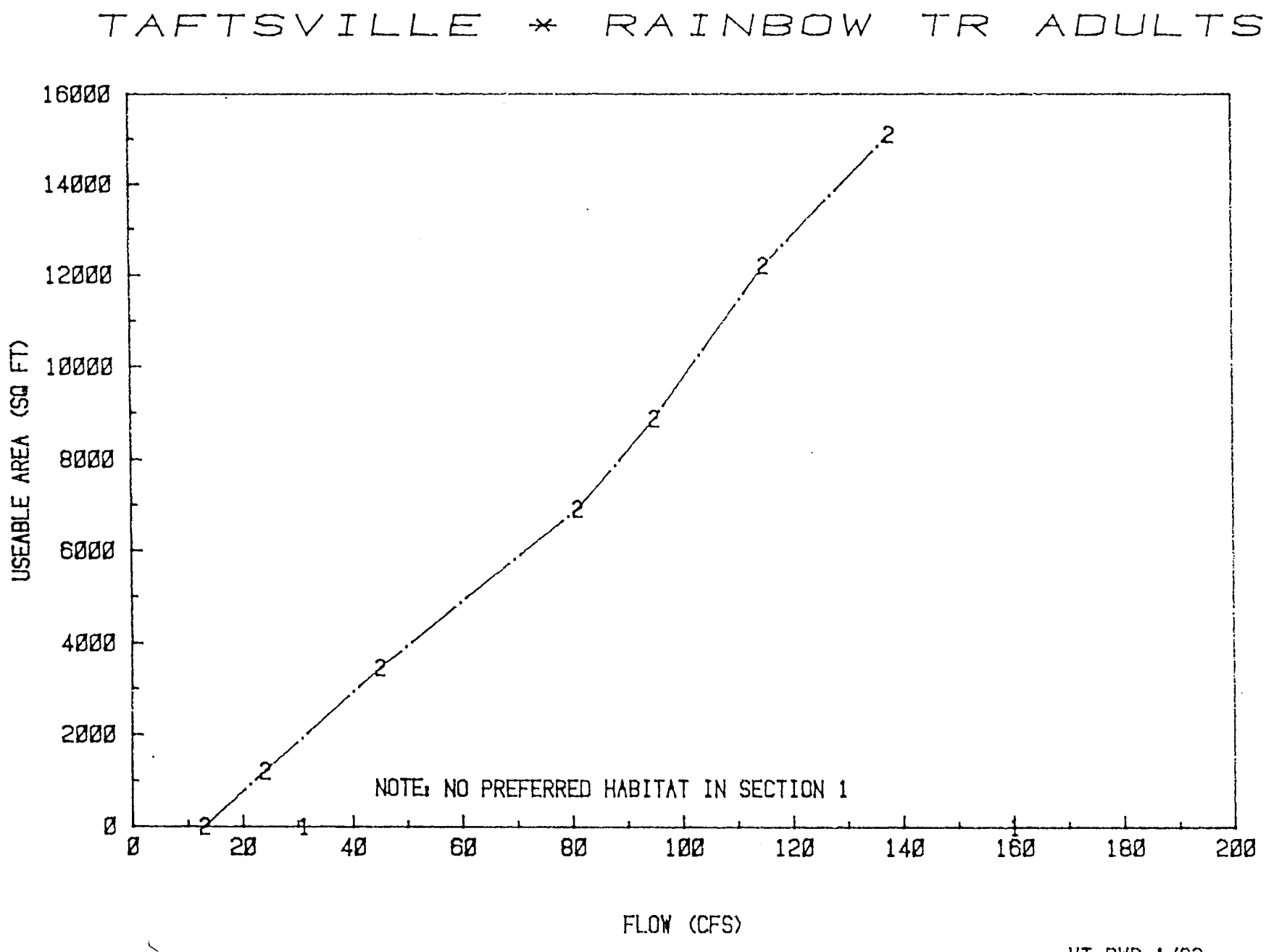
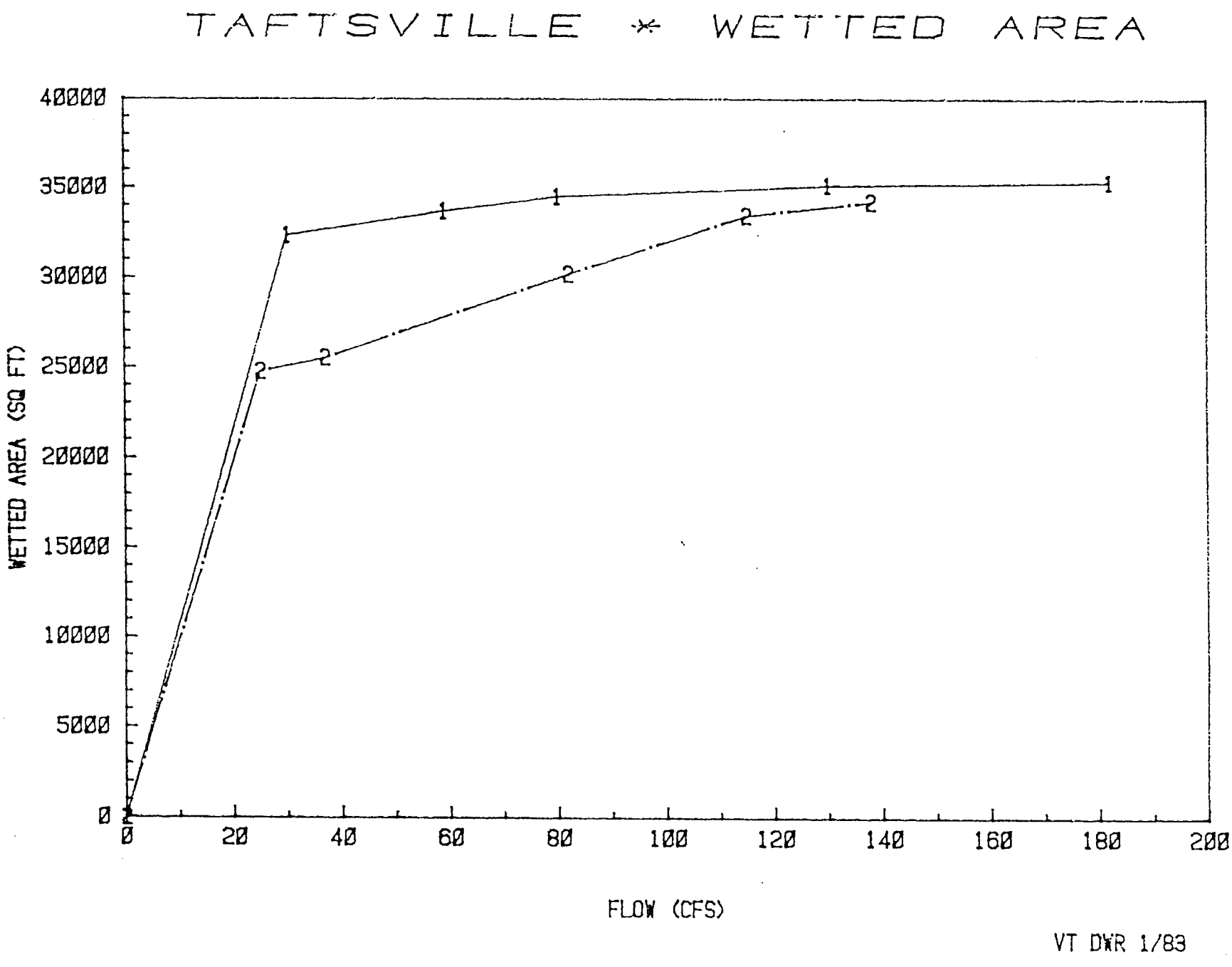


FIGURE 21e

FFNA Wetted Area Curve - Taftsville Project



An additional FFNA study was conducted as part of the 1985 study to determine a minimum flow requirement to protect the downstream black nose dace population since this species was more adversely impacted than the long nose dace. A minimum flow requirement of 80 cfs was established based on this study.

The flow recommendation of 110 cfs for brown and rainbow trout would appear then to also protect the black nose dace. Since the river section is managed for trout, and the minimum flow for trout is more restrictive, it would seem appropriate to apply the trout-based minimum flow requirement of 110 cfs to provide protection of the total fish community.

c. Recreation/Aesthetics

The project is located in the resort town of Woodstock, one of Vermont's more popular tourist areas. The covered bridge immediately below the project and the surrounding rural landscape add to the aesthetic appeal of the area. In addition, the Ottauquechee flows through the resort village of Quechee* (in the Town of Hartford), which is located less than two miles downstream of the dam. Finally, the project is quite visible as U.S. Route 4, which is a heavily-travelled road, follows the south side of the river.

The lack of a minimum flow requirement over the dam crest and the dewatering of the streambed below the project significantly impair the aesthetics of the area. Fishing, as previously discussed, is also impacted. Finally, there are no recreational developments below the project such as picnic areas. There is also no canoe portage or landscaping around the project's transformer pad.

d. Erosion/Siltation

There is extensive siltation behind the dam. According to Vermont Fish and Wildlife, anglers report that flows below the project are occassionally quite turbid and that this may be attributed to maintenance drawdowns or desilting at the dam.

Recommendations

a. A minimum flow requirement must be established at this site to improve the downstream fishery, water quality,

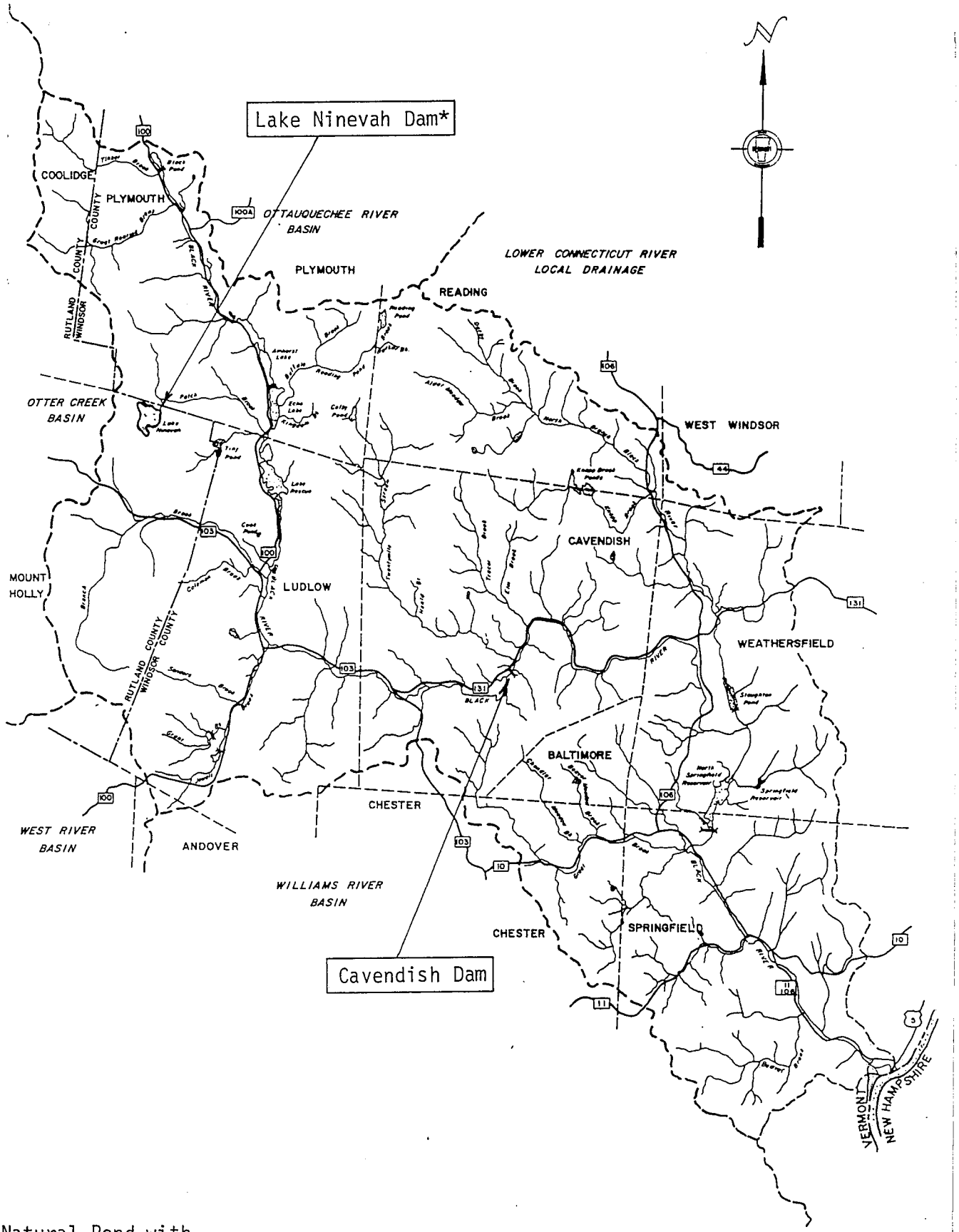
*Quechee is the site of an additional hydroelectric project recently developed by Simon Pearce.

aesthetics, and recreation. The effect a minimum flow would have on Simon Pearce's hydroelectric facility in Quechee should be investigated.

b. A public picnic/parking area should be established below the project. A canoe portage should also be established.

c. The transformer pad should be landscaped.

There has been a substantial amount of public interest in this project regarding its impact on fisheries. The Department has received letters from representatives of Trout Unlimited and the John Wheelock Titcomb Ottauquechee River Trust urging the Department to institute a minimum flow requirement at this site.



*Natural Pond with
Artificial Regulation

FIGURE 22

BLACK RIVER
DRAINAGE BASIN

SCALE OF MILES
0 1 2 3
APRIL, 1980

BASIN 10

STREAM: Patch Brook

PROJECT: Lake Ninevah

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Impoundment - Warm water
Downstream - Cold water

IMPACT: Minor

Project Features

Lake Ninevah is a natural lake located on Patch Brook in the Town of Mt. Holly (Figure 22). The project has a drainage area of 2 square miles. Project features include a dam 13 feet high with a crest length of 176 feet. The dam is fitted with one foot of flashboards. A wastegate is located at the base of the dam. The lake has a surface area of 237 acres. Figures on usable storage are not available.

Operating Mode

Lake Ninevah is used for augmenting flows at CVPSC's Cavendish Hydroelectric Project downstream on the Black River. Department records indicate that the 12 inch flashboards are installed after spring runoff (end of April) and that they are then taken out in September. The lake can be drawn down 3 to 4 feet but these drawdowns occur rarely and are only for maintenance purposes.

Wilderness Camp is located on the lakeshore. Department records state that a "Mr. Webb" of this camp apparently "takes the lake level into his own hands and controls the lake level." If camp owners around the lake "do not like what CV is doing with it", they "will sometimes regulate the level" themselves.

The Department measured a leakage flow below the dam of 0.7 cfs on August 10, 1982. The source of this flow was through the flashboards and possibly the dam and bedrock.

Environmental Review

a. Water Quality

Lake Ninevah is a warm water, mesotrophic lake. There are no known water quality problems.

b. Fisheries

Lake Ninevah supports a warm water fishery with early put and take trout. Species consist of largemouth and smallmouth bass, pickerel, and yellow perch. The lake provides nursery and spawning habitat for bass and pickerel.

Vermont Fish and Wildlife reports no impairment of fisheries either in the lake or downstream as a result of project operation.

Recommendations for Further Study

Collect more information on project operation, in particular, whether downstream flows are regulated.

Note: Information on this site is based on data gathered during the 1982 inventory. CVPSC sold the dam to the Wilderness Corporation in 1984. Mr. Paul Nebin of Mount Holly is a member of the corporation and responsible for managing the lake. The Department contacted Mr. Nebin in Feburary, 1988. Mr. Nebin says that the pond is drained every fall (usually in October) in an effort to freeze weeds which have become a nuisance in one section of the pond shoreline where there are a number of camps. The pond is drained through a "sluiceway". The pond takes about two weeks to drain. The sluiceway remains open another two weeks and is then closed to allow the pond to refill. Then, usually around Memorial Day, a 10-inch board is placed across the spillway to maintain the water level during the summer months. This board is removed in September.

BASIN 10

STREAM: Black River

PROJECT: Cavendish

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC license issued June 11, 1969; expires December 31, 1993

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

The Cavendish Project is located on the Black River in the Town of Cavendish (Figure 22). The project has a drainage area of about 83 square miles. Project features include a concrete dam 130 feet long and 33 feet high containing a spillway section 105 feet long, 90 feet of which is topped with 6 feet of flashboards and the remaining 15 feet with flashboards 2.5 feet high; a reservoir 10 acres in size, extending 500 to 600 feet upstream with storage limited to hourly pondage; a 180 foot tunnel extending from the intake structure to a steel penstock 1050 feet long; a powerhouse equipped with three generating units having an installed capacity of 1440 kW (the projects FERC license states 1440 kW; CVPSC states 1500 kW) under an operating head of 120 feet. A bubbler system is installed to keep the flashboards free of ice.

The project bypasses about 1050 feet of stream.

Operating Mode

It is difficult to determine exactly how this project operates. The project's FERC license states that storage is limited to hourly pondage. Department records state that the pond fluctuates within the range of the flashboards and that during low flows, the impoundment is sometimes pulled down to the crest. Records also state that the project does not usually peak but may during the winter months. If flows are low enough in the winter, the project will not operate. The source of this information was not noted in Department files but is presumably from conversations with CVPSC employees. Maximum drawdown is 6 feet.

No leakage flows were measured by the Department because, at the time of inspection, the dam was being resurfaced. Leakage flows are estimated by the Department to be less than 3 cfs.

Environmental Review

a. Water Quality

The Cavendish Project is located in a section of the Black River which has been designated by the Department as an effluent limited segment presently meeting water quality standards. The Ludlow STP is located about five miles upstream and has a design flow of 0.600 mgd. Downstream plants include Cavendish, which discharges into the Black River immediately below the project; Springfield; and Springfield Town. These projects have design flows of 0.100 mgd, 0.101 mgd, and 1.900 mgd respectively. Operation of the Cavendish Project may impact the water quality of the Black River, in particular the stream's assimilative capacity, depending on the project operation and amount of leakage during periods of impoundment.

b. Fisheries

No recent surveys have been conducted at this site. Vermont Fish and Wildlife reports, however, that this section of the Black River presently supports a limited salmonid fishery, primarily because of high water temperatures. With the State's ongoing pollution abatement program and the reduction of artificial flow regulation as the Cavendish Project, habitat conditions are and will continue to improve for cold water species. The Black River, especially the reach from Cavendish to the Tolles Hill Dam 9.5 miles downstream, would be used as nursery habitat for non-natal smolt production. There is no information on the potential quality of the bypass for fisheries.

Beginning in 1986, catchable-size rainbow trout were stocked into a section of the Black River between the hamlet of Whitesville in Cavendish and Downers Covered Bridge in Weathersfield. This reach has good potential for being developed into a highly desirable sport fishery, especially if improvements can be made on the artificial regulation of flows below the subject project.

Structural aquatic habitat in this section of river is diverse. Pools, riffles, and rapids are numerous, and fish cover as provided by large boulders and pools is good. However, the river is negatively affected by the absence of an environmentally sound minimum flow release below the project as well as rapid changes in flow and wetted perimeter in response to alteration of generation mode. Both of these effects can be observed over a long length of the river (i.e., Cavendish downstream to the confluence of the river with the North Branch). Furthermore, the

long history of high summer water temperatures in this reach of the Black River probably has been exacerbated by these flow conditions.

From the perspective of recreational fishing, the river is easily accessed along most of its length by Route 131. Vehicle turnouts are frequent, thereby permitting problem free parking for river users. Lands adjacent to the river are undeveloped, aesthetically appealing particularly when there is reasonable flow in the channel, and free of land posting.

The decision to stock this section of river was in part a response to public interest as well as biological considerations. In July, 1985, representatives of Vermont Fish and Wildlife were invited to participate in an informational meeting organized by the Black River Rod and Gun Club and State Representative John Murphy. Several citizens requested the Department to investigate the potential of stocking trout into this reach. On the basis of available habitat, public need, access, and the hope of improving river flows in the near future, the decision to test a stocking program was undertaken in 1986. Most recently (winter, 1987) another informational meeting was held. Vermont Fish and Wildlife Warden Patch reported that public comment was most favorable for this management action.

c. Recreation/Aesthetics

The 1050 foot section of stream bypassed by the project is a beautiful gorge which is essentially dewatered most of the summer. The area is quite scenic with a number of hiking trails. Downstream recreation potential is considered to be high. Recreational development is limited. There is a private road to access the impoundment and some well-worn paths along the gorge. There is no recreational development downstream of the project. Access is via Route 131 which follows the Black River. (Reference should also be made to Fisheries for a discussion of Recreation/Aesthetics.)

d. Natural Area/Wildlife Habitat

The Cavendish Project is located at the site of Cavendish Gorge which was identified in the Agency's Waterfalls, Cascades and Gorges Study as a site of high statewide importance. The project's dam is located near the head of the gorge and the powerhouse at the other end. The gorge is identified as a large, beautifully-sculptured gorge with pools and cascades. The dam, powerhouse, and penstock are not visible from most of the gorge and much of the gorge is undisturbed and private. It is a popular local swimming area. The study says that current "summer flow from leaks around the dam appears adequate for swimming and to preserve the plant communities..... Lower flows would dry the gorge out, raise the water temperature, and possibly damage the plants, which require considerable humidity. This would cost

the state one of its best lowland sites for mosses and liverworts." The study recommends that "arrangements be made to guarantee flows".

The Department inspected the site during the summer of 1986 and found leakage flows through the dam to be negligible. It is doubtful that the flow is adequate to maintain pools in the gorge for fish and swimming. The Department speculates that perhaps flows observed during the Waterfalls, Cascades, and Gorges Study were higher than normal leakage flows.

Recommendations for Further Study

The Department initiated a study in 1986 similar to the one conducted at Taftsville to evaluate project impact on downstream fish and macroinvertebrates. Due to high stream flows that summer, the Department was unable to finish the study. The Department anticipates completing the study during the summer of 1988.

The study is to include an assessment of project impact on water quality, in particular the assimilative capacity of the stream. It will also assess project leakage flows and their impact on fisheries, aesthetics, and recreational values in the project's bypass. Additional information on project operation will also be collected. Appropriate recommendations for mitigation will be developed following study completion. Minimum flow requirements through the bypass and downstream will be recommended as a result of the study.

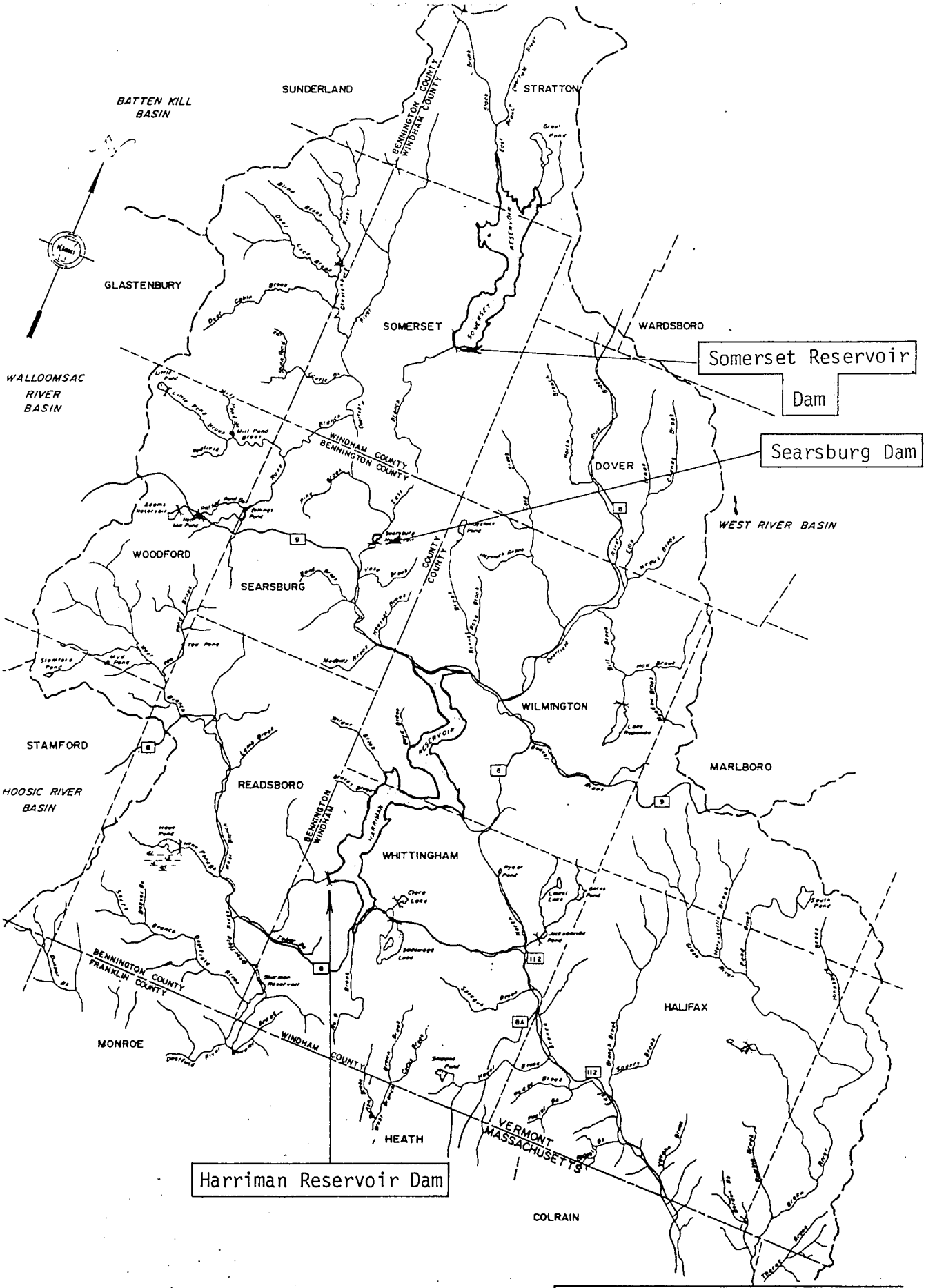

SUNDERLAND
STRATTON
BATTEN KILL BASIN
BENNINGTON COUNTY
WINDHAM COUNTY
GLASTENBURY
SOMERSET
WARDSBORO
Somerset Reservoir Dam
WALLOOMSAC RIVER BASIN
WINDHAM COUNTY
BENNINGTON COUNTY
Searsburg Dam
DOVER
WEST RIVER BASIN
WOODFORD
SEARSBURG
WILMINGTON
STAMFORD
MARLBORO
HOOSIC RIVER BASIN
READSBORO
WHITTINGHAM
BENNINGTON COUNTY
FRANKLIN COUNTY
HALIFAX
MONROE
WINDHAM COUNTY
HEATH
VERMONT
MASSACHUSETTS
Harriman Reservoir Dam
COLRAIN
DEERFIELD RIVER
DRAINAGE BASIN
SCALE OF MILES
APRIL, 1960
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

FIGURE 23

BASIN 12

STREAM: Deerfield River, East Branch of the Deerfield River

PROJECTS: Somerset Reservoir, Searsburg Dam, Harriman Reservoir

UTILITY: New England Power Company (NEPC)

LICENSE STATUS: FERC license issued October 29, 1963; expires December 31, 1993.

CLASSIFICATION: B, except for a section of Deerfield River from Wilmington to upstream end of Harriman Reservoir, which is C.

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

The Federal Power Commission (FPC) issued NEPC a license dated October 29, 1963, for the Deerfield River Project. The license for this project expires December 31, 1993. The project includes facilities in both Vermont and Massachusetts. Vermont facilities include Somerset Reservoir on the East Branch of the Deerfield River, and Searsburg Dam and Harriman Reservoir on the Deerfield River (Figure 23). Massachusetts facilities are Deerfield Plants 2, 3, 4 and 5, and the Sherman Plant. The total installed capacity of the project is 74,200 kW.

PROJECT: Somerset Reservoir

Project Features

Somerset Reservoir has a 30 square mile drainage area and is located on the East Branch of the Deerfield River about 6.2 miles upstream from Searsburg Dam. Project features include an earth-fill dam about 104 feet high and 2101 feet long with a concrete gravity spillway with provisions for 3 feet of flashboards; a spillway channel 800 feet long, 45 feet wide and 6 to 30 feet deep; and a regulating reservoir about 5.6 miles long providing 57,340 acre-feet of storage with a usable draw-down of 81.7 feet from the spillway crest (2135.58' NGVD). A concrete outlet tunnel about 425 feet long and 12 feet in diameter is located in the south end. At its entrance is a concrete intake tower. Two discharge pipes 48 inches in diameter are set on concrete cradles in the bore of the tunnel. Discharge is controlled by hand-operated 48-inch gate valves at the head end and by power-driven, 42-inch gate valves at the discharge end. The center line of the discharge pipes is at 2051.8' NGVD.

Operating Mode

Somerset Reservoir is used to store water for downstream generating stations. The utility reports that the pool level fluctuates as a result of downstream augmentation of flows for fish life and hydroelectric generating purposes. (The Department notes that hydroelectric generation should have a far greater influence on pool level fluctuations than would downstream augmentation of flows for fish life.) Water levels are controlled during the recreation season. Reviewing a graph of reservoir elevations submitted by the utility and covering the period July 1940 to July 1979, water levels are more or less stabilized from late May through July at an average elevation of 2128' USGS. From August through October the levels are then gradually lowered about five feet and maintained at that level through the end of December. Beginning in about early January, the reservoir is drawn down to an elevation of about 2112.6' by the end of March at which time the reservoir begins to refill to the 2128' level.

Article 28 of the project's license states that "The licensee (NEPC) shall not operate the Somerset Reservoir above the level of the concrete crest of the spillway El. 2135.58 feet USGS until the low level outlet conduits are operating at full capacity. The outlets shall remain fully open until the level of the reservoir has receded to concrete crest".

Department records indicate that in May of 1963 a continuous flow pipe was installed to provide a continuous discharge for downstream fisheries. Vermont Fish and Wildlife reports this discharge to be 3.9 to 4.6 cfs.

Environmental Review

a. Water Quality

The Department collected temperature and D.O. data from Somerset Reservoir on August 5, 1982. The data indicates that Somerset Reservoir stratifies thermally with the thermocline at a depth of about 30 feet. D.O. concentrations decreased from 92% saturation at the surface to as low as 35% saturation at a depth of about 43 feet.

Water quality data was also collected by Vermont Fish and Wildlife in July, 1970. This data also indicated that the reservoir stratifies thermally with the thermocline existing between 30 and 50 feet. Sufficient D.O. extended down to 40 feet. D.O. concentrations below that point were as low as 9% saturation.

This data indicates water quality problems may exist below the dam as the discharge may be oxygen deficient due to the project's bottom withdrawal structure.

b. Fisheries

Somerset Reservoir and upstream areas support a mixed fishery with a cold water fishery located below the project. Brook trout is the principal fishery above and below the reservoir. Fisheries in the reservoir include brook trout, yellow perch, brown bullhead, brown trout, and rock bass. The reservoir had been stocked with rainbow trout and landlocked Atlantic salmon. The stocking of salmon discontinued in the late 1970's and the stocking of rainbows ceased in 1982. Natural reproduction for both species is unknown but unlikely.

Spawning, nursery, and adult habitat is located upstream and downstream of the impoundment for brook trout. The reservoir provides spawning, nursery, and adult habitat for chain pickerel, smallmouth bass, and yellow perch. It also provides adult habitat for brown trout, rainbow trout, and brook trout.

Vermont Fish and Wildlife states that the winter drawdown does not favor the establishment of a productive littoral zone beneficial for food production and spawning and nursery habitat. Also, fluctuating flows and the lack of an adequate minimum stream flow have had an adverse impact on downstream habitat. Fisheries could be potentially improved if pool levels were stabilized and an acceptable minimum stream flow imposed below the dam.

c. Recreation/Aesthetics

As previously mentioned, the water levels of Somerset Reservoir are stabilized during the summer recreation season. The utility has also developed an excellent recreation area according to Department records.

When the impoundment is drawn down, a "bathtub ring" is visible around the reservoir shoreline.

d. Natural Areas/Wildlife Habitat

The Vermont Institute of Natural Science (VINS), Woodstock, Vermont reports in a letter to the Department dated May 17, 1985, that Somerset Reservoir generally has breeding loon pairs each year. Loons are listed as endangered in Vermont. In 1984 only six pairs were known to have successfully reared young in the state. VINS states that one factor identified as a cause of loon nest failure is drastic water level change. Artificial water levels must be monitored and limited during the loon nesting season which begins in mid-May and generally ends in mid-July.

VINS recommends that water levels of Somerset Reservoir remain stable from May 1 through early August to allow for loon nest building in early May, egg laying, incubation, and late renesting.

Recommendations for Further Study

Project impact on downstream water quality and other stream values should be determined. This may include a minimum flow study.

Recommendations

a. Pool levels should be stabilized for the protection and enhancement of fisheries.

b. Pool levels should be stabilized from May 1 through early August to protect nesting loons. Negotiations are presently (1988) underway between the Vermont Field Office of The Nature Conservancy (TNC) and NEPC to establish an agreement to stabilize water levels. These negotations should continue.

c. Somerset, Searsburg, and Harriman should be reviewed as a unit as the operation of each project influences the operation of the others.

d. A minimum flow requirement should be established below the project for fisheries.

PROJECT: Searsburg Dam

Project Features

Searsburg Dam is located on the Deerfield River about 4.5 miles upstream of the upstream end of Harriman Reservoir. The project has a drainage area of 98 square miles. Project features include an earth-fill dam about 50 feet high and 612 feet long with a concrete gravity spillway fitted with five foot flashboards; a reservoir about 0.9 mile long with a maximum operating elevation of 1755.66' NGVD, a surface area of 25 acres (30 acres with flashboards in place), and usable storage of 258 acre-feet with a drawdown of 10.5 feet from the top of the flashboards; a woodstave conduit 8 feet in diameter and 18,412 feet long; one surge tank; a steel penstock 6.5 feet in diameter and 495 feet long; and a powerhouse (known as Searsburg Station) containing a generator with an installed capacity of 5000 kW and a Francis-type turbine with a hydraulic capacity of 330 cfs (presumably maximum capacity though not specifically stated as such). The project has operating head of 230 feet and bypasses approximately 18,900 feet of streambed. The discharge from the powerhouse enters the stream about a mile upstream of Harriman Reservoir.

Operating Mode

NEPC reports that the Searsburg Project is a run-of-the-river facility with limited storage, the discharges from the

project being dependent on the need for power generation and available water from upstream storage. Normal pond elevations vary from 1754.66' to 1751.66' during the summer period and 1746.66' to 1749.66' during the winter period.

Department records state, however, that the project cycles on a daily basis with a daily fluctuation of approximately three feet and a maximum drawdown of 10.5 feet. In the summer the project usually operates from 7:30 a.m. to 5 or 6 p.m., and in the winter, it runs 24 hours a day to prevent ice buildup which can damage the penstock. Vermont Fish and Wildlife reports that there is no minimum stream flow below the dam. NEPC reports that flow between the dam and powerhouse is controlled by numerous intermittent small streams.

NEPC reports that, during periods of nongeneraiton, flow below the powerhouse is controlled by intermittent streams between the project's dam and Harriman Reservoir.

Environmental Review

a. Water Quality

Water quality problems may exist below the project during periods of nongeneration. With respect to the bypass, water quality problems may exist as no minimum flow is maintained. Five brooks flow into the bypass, preventing it from being dewatered.

The project's impoundment is about 50 feet deep. The invert elevation of the project's intake gate is at a depth of about 23 feet. There is no water quality data on the project reservoir. If the reservoir stratifies, it is possible low D.O. concentrations could be discharged downstream.

b. Fisheries

A cold water fishery is found upstream of the project reservoir and downstream in the bypassed section, the principal species being brook trout. The bypassed section also supports some brown trout. The reservoir supports a mixed fishery with the principal species being brook trout. Yellow perch is also very common. During their spring spawning runs, smelt have been observed migrating out of Harriman Reservoir and up the Deerfield River at least as far as in the vicinity of Harriman Station. The smelt population is an important forage species for game fish populations, especially salmonids, in Harriman Reservoir.

Spawning, nursery, and adult habitat for brook trout is located above the Searsburg Reservoir. The reservior provides spawning and nursery habitat for yellow perch and adult habitat for brook trout. The presence of fish habitat in the bypass is unknown.

Vermont Fish and Wildlife reports that the operation of the Searsburg Project impairs fisheries in the reservoir and downstream. The lack of a minimum stream flow below the dam limits fisheries in all respects. The bypassed reach could be returned to productive fish habitat in time with the establishment of a biologically acceptable minimum flow below Searsburg Dam. Spawning habitat would improve significantly with implementation of a minimum stream flow following a fisheries flow needs study. Adequate minimum flows below Searsburg Dam are recommended. Stabilization of pool levels would favor the establishment of a littoral community, contributing to overall productivity.

c. Recreation/Aesthetics

In the summer months higher reservoir levels are maintained for recreational purposes whenever possible according to NEPC. The impoundment is used for fishing and some flat water boating. There are no recreation facilities. Access to the reservoir is via a public road access.

The Department finds that fluctuating water levels in the reservoir and the lack of adequate flows in the bypass impact the recreational use of the area.

Article 25 of the project's license refers to a recreational use plan which was to have been submitted to the FPC within a year from the issuance date of the license. The plan was to be prepared after consultation with Federal, state, and local agencies. This plan should be located.

d. Erosion/Siltation

The shoreline of the reservoir is eroded in the zone of fluctuation.

Department records state that "the gates" are opened once a year by order of FERC and a sizeable amount of silt is most likely lost at that time. This practice is usually done in the spring. There is no reference to the source of this information. It may have been obtained during a conversation with a NEPC employee. The "FERC order" may have been pursuant to Article 30 of the project's license. Article 30 is as follows:

"Article 30. The Licensee shall be responsible for and shall minimize soil erosion and siltation on lands adjacent to the stream resulting from construction and operation of the project. The Commission upon request, or upon its own motion, may order the licensee to construct and maintain such preventive works to accomplish this purpose and to revegetate exposed soil surface as the Commission may find to be necessary after notice and opportunity for hearing."

Recommendations for Further Study

a. A survey of the bypass should be conducted to determine its existing and potential significance for fisheries.

b. The impact of the reservoir on downstream water quality should be assessed. This should include either a water quality study or modelling of the impoundment to determine its potential for stratifying.

c. The impact of project operation on downstream flows, both in the bypass and downstream of the powerhouse, should be determined. Appropriate recommendations regarding minimum flow requirements should be made as necessary. Other recommendations for water quality such as installation of a reaeration structure at the powerhouse discharge should also be made as necessary.

d. The recreational use plan referred to in Article 25 of the project's license should be located and reviewed.

e. The desilting method employed by NEPC should be reviewed for potential problems.

Recommendations

a. A minimum flow requirement should be established for the bypassed section of stream to protect and enhance fisheries. This would also enhance the recreational use and aesthetics of the stream.

b. Water levels in the reservoir should be stabilized.

c. Somerset, Searsburg, and Harriman should be reviewed together as a unit as the operation of each facility influences the operation of the others.

PROJECT: Harriman Reservoir

Project Features

Harriman Reservoir is located on the Deerfield River. The upstream end of the reservoir is about 4.5 miles downstream of Searsburg Dam and about one mile downstream of the Searsburg Station. The reservoir has a drainage area of 184 square miles. Project features include an earth fill dam 206 feet high (9.5 feet added in 1963) and 1250 feet long; a morning- glory type spillway fitted with six feet of stanchion boards; a reservoir about nine miles long with a surface area of 2184 acres (with flashboards) and 116,070 acre-feet of seasonal storage with a usable drawdown of 92 feet from a maximum operating elevation of 1497.66' NGVD; a concrete-lined tunnel 12,812 feet long; a surge tank; three steel penstocks 9 feet in diameter and 620 feet long;

a powerhouse containing three generators with a capacity of 11,200 kW each under an operating head of 375 feet and three Francis-type turbines. The maximum discharge from the project is 1800 to 1830 cfs. The length of river reach bypassed by the penstock is approximately 4.5 miles. At a point 3.5 miles downstream in the bypass is the confluence of the Deerfield with the West Branch. The discharge from the powerhouse enters the upstream end of the Sherman Reservoir.

Operating Mode

Department records indicate that Harriman Reservoir is a daily peaking project (no reference). Vermont Fish and Wildlife states that extreme water level fluctuations result from the reservoir's use for power production and that yearly variations between high and low lake levels amount to about 80 feet. NEPC reports that, because of the large volume of water in the reservoir, daily fluctuations are minimal.

NEPC reports that water levels of the reservoir fluctuate as a result of seasonal augmentation of river flow. NEPC provided the Department with a graph of average reservoir elevations for the period July 1940 to July 1979. Water levels of the reservoir are more or less stabilized at an average elevation of 1489.66' from the end of May to mid-July. From mid-July through early October, the reservoir is gradually lowered eleven feet to an elevation of 1478.66'. It is then maintained at this elevation through early December at which time the winter drawdown begins. By mid-March the reservoir is at an elevation of 1448.66'. From mid-March to mid-May the reservoir is then refilled to about the 1489.66' elevation.

Available information indicates no flow is released below the project's dam into the four miles of the Deerfield River bypassed by the project. During a Department site visit in the summer of 1985, there was no flow in the bypass directly below the project. The only flow in this section of stream above the confluence with the West Branch is that which is provided by a small stream less than half a mile downstream of the dam, and Tobey Brook which flows in at a point about 2.5 miles below the dam.

Flow releases below the project during periods of non-generation are controlled by flow in the West Branch of the Deerfield River.

Environmental Review

a. Water Quality

The Wilmington STP is located on the North Branch of the Deerfield River which flows into the upstream end of Harriman

Reservoir. The stream section from the treatment plant downstream to Readsboro, a total of 12 miles, has been designated by the Department as a water quality limited segment (presently not meeting water quality standards) according to the Department's 1984 Water Quality Assessment 305(b) Report. Standards for coliform levels are violated because of municipal wastes/ combined sewers. Violations occur during periods of high flows.

Temperature and D.O. data were collected by the Department at six different sampling stations in the project area on August 4, 1982. A review of this data indicates that the impoundment may have been setting up for stratification. A D.O. reduction of 23% occurs between the reservoir's surface and its greater depths. Also, a comparison of stations in the bypass and below the powerhouse discharge indicates the discharge from the powerhouse influences temperatures and D.O. concentrations of the Deerfield (Sherman Reservoir) because of the project's bottom withdrawal structure.

According to an EPA National Eutrophication Survey on Harriman Reservoir (September 1974), the reservoir is mesotrophic, as evidenced by low chlorophyll values; relatively good secchi disc transparency; minimal occurrences of algal blooms and rooted aquatic vegetation; and some depression but no depletion of D.O. in the hypolimnion. The survey also states that thermal stratification develops in the summer and that the minimal occurrence of algal blooms and the fact that aquatic macrophyte growths do not occur to a great extent in the littoral zone is possibly due to water level fluctuations.

Water quality collected by Vermont Fish and Wildlife July 16, 1970, and August 18, 1960, indicates that the reservoir stratifies thermally with the thermocline existing between 30 and 60 feet. There was sufficient D.O. to support salmonids at all levels, however.

b. Fisheries

A mixed fishery is found in Harriman Reservoir as well as upstream. Vermont Fish and Wildlife reports that no fish population surveys have been conducted in the bypass and tailrace, perhaps due to its long standing minimum flow problems. As a result, there is no information on the fishery in these sections.

Brook trout, brown trout, and smallmouth bass are the principal species above the reservoir, with yellow perch, brown trout, rainbow smelt, brown bullhead, smallmouth bass, rock bass, rainbow trout, brook trout, and chain pickerel being the principal species in the reservoir. A stocking program for landlocked Atlantic salmon has been conducted in the reservoir since 1975. This program has not been successful and stocking was suspended in the spring of 1986. Emphasis will be placed on brown trout management instead.

Spawning and adult habitat (species not indicated) is located upstream of the reservoir as well as nursery habitat for landlocked Atlantic salmon, brook trout, brown trout, and yellow perch. The impoundment provides spawning and nursery habitat for rainbow smelt, chain pickerel, smallmouth bass, and yellow perch. It also provides nursery habitat for landlocked salmon and brown trout, and adult habitat for all species.

Vermont Fish and Wildlife reports that the project impairs fisheries in the reservoir and below the dam due to unstable pool levels and the lack of adequate flows in the bypass. Fluctuating pool levels prevent the establishment of littoral plant and animal communities which would contribute to fish production and overall lake productivity. For example, Vermont Fish and Wildlife reports that in March, 1987, the reservoir was drawn down to such a degree that flow in the upper two miles of the impoundment was confined to the original river channel. The littoral zone throughout the reservoir was completely dewatered.

Drawdowns have also prevented the establishment of a lake trout fishery in the reservoir. Lake trout were introduced to the reservoir from 1971 to 1978. The stabilization of pool levels year around would improve spawning, nursery, and adult habitat for these fish. Stable pool levels from early fall through late spring is particularly important for the protection of spawning habitat. Also, the ability of smelt to ascend the small feeder streams to the impoundment to spawn is dependent on whether or not the reservoir has refilled enough in the spring to coincide with their spawning season.

Another negative effect of the annual drawdown which should not be overlooked is that it represents an export of productivity and fish biomass from the impoundment. Many fish are entrained into the penstock, passed downstream to the powerhouse where fish are subjected to turbine mortality as well as pressurization in the penstock. How significant the loss of nutrients, productivity, and fish from the impoundment each year has not been studied but should be.

Vermont Fish and Wildlife also states that access to the North Branch of the Deerfield River from Harriman Reservoir must be provided for the landlocked salmon program.

c. Recreation/Aesthetics

NEPC reports that Harriman Reservoir is used for fishing, boating, and swimming and that pool levels are stabilized during the summer recreation period to enhance boating activities. Recreational development includes a public road access, boat launch, and picnic area. Department representatives state that the recreation potential of the reservoir appears to be used to its maximum as provided by NEPC.

Harriman Reservoir provides a popular ice fishing resource. An annual ice fishing derby has been held here during the winters of 1985, 1986, and 1987. Vermont Fish and Wildlife reports that parking facilities at this time of year are inadequate, and this problem is a concern to town emergency services and other road users. Improvements are needed to accommodate year round parking.

Reservoir drawdown has created a prominent "bathtub ring" along the reservoir's shoreline.

d. Erosion/Siltation

The erosion potential along the reservoir's shoreline is high due to annual fluctuations of up to 80 feet, although severe erosion is not evident and no reports of erosion problems have been noted.

Recommendation for Further Study

a. A fisheries survey should be conducted in the project's bypass.

b. A study of the biomass export problem resulting from the annual drawdown and as discussed in the fisheries section of this site report should be conducted.

c. Determine the operation of Sherman Reservoir and whether dewatering problems occur at the upstream end of the reservoir as a result of operation of the Harriman facility.

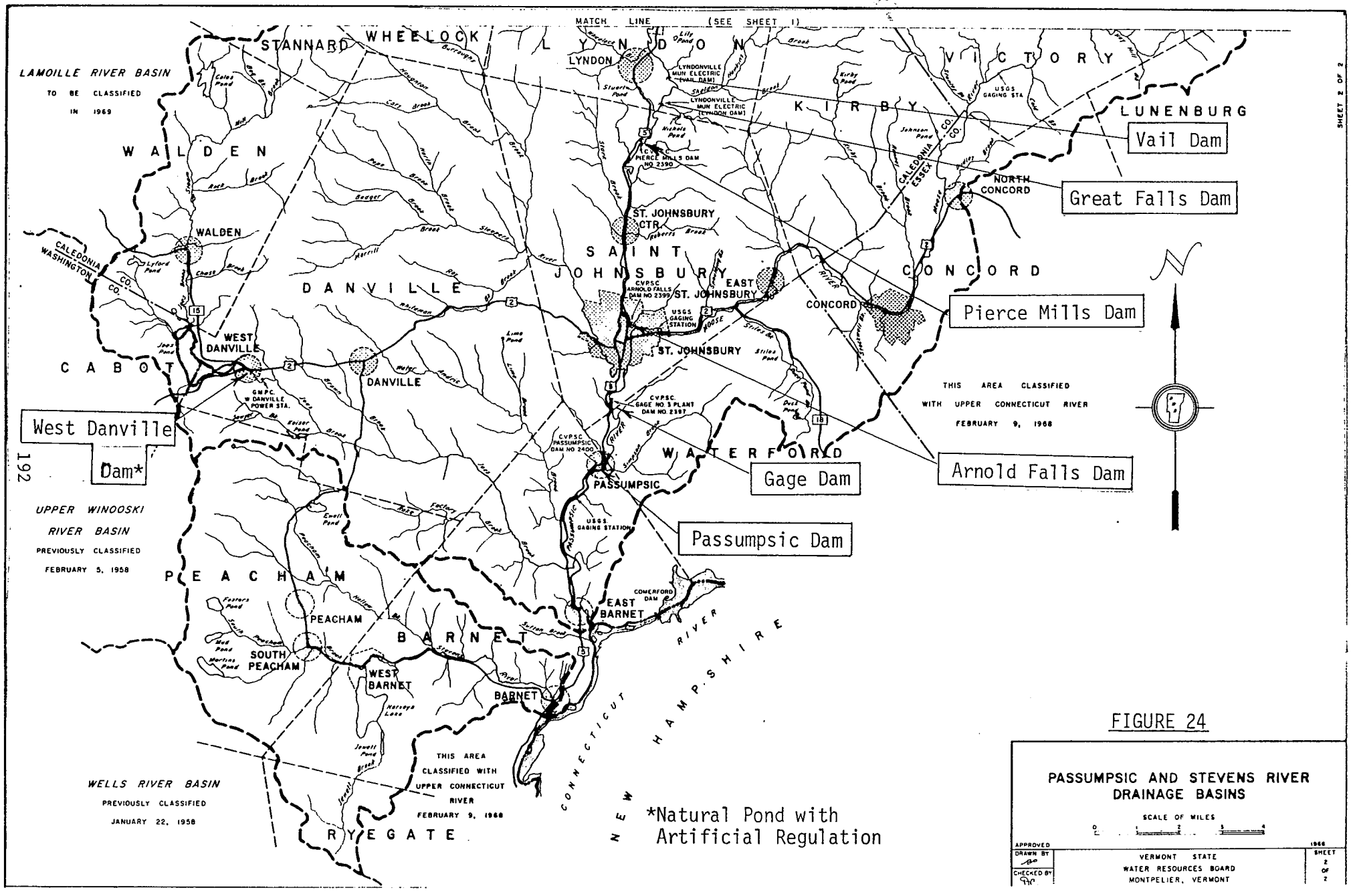
d. The water quality data from the reservoir should be reviewed further and the need for additional data collection determined.

Recommendations

a. Water level fluctuations in the impoundment should be stabilized, particularly from early fall through late spring, to protect and enhance the reservoir's fishery. This would also improve recreation, aesthetics, and reduce the erosion potential.

b. A minimum flow requirement should be established below the dam once the bypass has been surveyed for fisheries.

c. Improvements are needed to accomodate year round parking at the reservoir.



*Natural Pond with Artificial Regulation

FIGURE 24

PASSUMPSIC AND STEVENS RIVER DRAINAGE BASINS

SCALE OF MILES 0 1 2 3 4

APPROVED 1968

DRAWN BY

CHECKED BY

VERMONT STATE WATER RESOURCES BOARD MONTPELIER, VERMONT

SHEET 2 OF 2

BASIN 15

STREAM: Passumpsic River

PROJECT: Vail Station

UTILITY: Village of Lyndonville

LICENSE STATUS: FERC license issued January 23, 1981; Water Quality Certification issued March 5, 1980

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Minor

Vail Station is located on the Passumpsic River in the Town of Lyndon, one mile upstream of the Great Falls Project (Figure 24). The project was licensed by FERC in 1981 and certified by the Department in 1980 as a run-of-the-river project. There is no minimum flow requirement through the project's 30 to 40 foot bypass.

CVPSC reported to the Department in 1982 and during an assimilative capacity study on the Passumpsic River July 29 thru 31, 1985, that this project does regulate flows. The Village also stated in 1982 that they operate run-of-the-river except during periods of low flow when they pond overnight. At the time of the Department's site inspection in 1982, the project was impounding. Flow releases below the project during times of ponding are not known. It is likely they are just leakage flows.

Environmental Review

a. Erosion/Siltation

The facility has to desilt three to four times in the spring and two times in the fall. The silt level in the impoundment was estimated by the Department in 1982 to be within three to four feet of the water surface.

b. Recreation/Asethetics

The impoundment and downstream are used for swimming, fishing, and boating. The only recreational development above and below the project is a private road access to the impoundment.

Recommendations for Further Study

Determine the need for recreational development at the site. Recommendations will be made as necessary.

Recommendations

a. The Department should follow up on the terms of the license and certification for compliance, in particular, whether the project is being operated run-of-the-river.

b. The Department should contact the Village regarding the Agency's desilting policy.

BASIN 15

STREAM: Passumpsic River

PROJECT: Great Falls

UTILITY: Village of Lyndonville

LICENSE STATUS: FERC license issued June 29, 1979, amended March 8, 1985; 401 Water Quality Certification issued February 26, 1984

CLASSIFICATION: Upstream - C
Downstream - B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Some

Great Falls is located on the Passumpsic River in the Town of Lyndon, one mile downstream of the Vail Station Project and two miles upstream of Pierce Mills (Figure 24). The project was licensed by FERC in 1985 and certified by the Department in 1984 as a run-of-the-river facility. The Water Quality Certification and FERC license describe project features and operation and are available by contacting the Department.

The Department conducted an assimilative capacity study on the Passumpsic River July 29 thru 31, 1985. During this study it became apparent to the Department that this project may not be operating as certified. CVPSC employees reported that the Lyndonville projects (Vail and the Great Falls) do regulate flows in the stream. The operator of the Great Falls station also said that a week or two before our visit, the impoundment had been drawn down six inches.

Environmental Review

a. Erosion/Siltation

The utility reported in 1982 that the impoundment is desilted once a year after July 4 by opening the forebay at the end of the headrace. No special conditions regarding desilting were included in the Water Quality Certification.

Recommendations

a. The Department should follow up on the conditions of the certification and articles of the license to ensure compliance.

b. The Department should contact the Village regarding the Agency's desilting policy.

BASIN 15

STREAM: Passumpsic River

PROJECT: Pierce Mills

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC license issued June 11, 1969, expires December 31, 1993

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Pierce Mills is located on the Passumpsic River in the Town of St. Johnsbury (Figure 24). The project has a drainage area of 237 square miles. Project features consist of a concrete dam about 130 feet long topped with 18-inch flashboards; a 25-acre reservoir extending about 200 feet upstream (it is not known if this is with or without flashboards); a penstock 246 feet long; and a powerhouse with a vertical shaft turbine connected to a 250 kW generator. Operating head is 18 feet. The maximum hydraulic capacity is estimated by the Department to be 185 cfs. The total bypassed section of stream is approximately 300 feet.

Operating Mode

CVPSC reported in an interview with the Department on July 16, 1982, that the project is run-of-the-river although it may peak at times. The utility states that they like to keep the pool full for use in "emergencies" and that the project has two hours of storage under low flow periods, which is when they pool. They also report that they try to keep the bottom edge of the flashboards and dam wet to maintain a silt layer which seals a crack between the crest and flashboards. This is presumably to reduce leakage. Maximum drawdown is 18 inches (no reference); however, during a Department site visit August 3, 1982, the impoundment was drawn down two feet below the flashboards.

According to a Department interview with CVPSC employees in 1982, the operation of Pierce Mills is influenced by Great Falls upstream. Great Falls reportedly pools, usually overnight. During these periods, Pierce Mills has "no water". As discussed in the report for Great Falls, Great Falls was certified as a run-of-the-river project by the Department February 26, 1984; however, the project apparently does not operate as certified. If it did operate as certified, it is possible pooling would not occur at Pierce Mills.

During periods of impounding at Pierce Mills, the only flow maintained below the project is presumably that which leaks through the project. No leakage flows have been measured.

Environmental Review

a. Water Quality

The Lyndonville STP is located about four miles upstream of the Pierce Mills project and has a total permitted discharge of 0.750 mgd. Downstream discharges include EHV Weidmann with a total average daily flow of 0.200 mgd and the St. Johnsbury STP with a total permitted discharge of 1.9 mgd. These discharges are located about two and five miles downstream respectively.

The Passumpsic River from St. Johnsbury Center to the Connecticut River is designated by the Department as an effluent limited segment which is presently not meeting water quality standards. This segment includes discharges from EHV Weidmann and the St. Johnsbury STP, as well as the Arnold Falls, Gage and Passumpsic dams. This designation is due to discharges from the St. Johnsbury STP. Water quality problems are attributed to combined sewer overflows, as well as impacts from hydroelectric facilities on the river.[1] Water quality problems may also occur below the EHV Weidmann discharge during periods of impounding at Pierce Mills.

The Department conducted an assimilative capacity study on the Passumpsic River from St. Johnsbury Center to the Connecticut River July 29 thru 31, 1985. The data from this study has not yet been analyzed. This data should identify water quality problems and mitigation measures, including the impact of each hydro project.

Temperature and D.O. data were collected by the Department at Pierce Mills, Arnold Falls and the Gage Project in 1982. The D.O. data indicates evidence of algal activity throughout the river reaches sampled. Unfortunately, no early morning D.O. and temperature data were collected.

b. Fisheries

The Passumpsic River in the Pierce Mills reach principally supports populations of brown trout, brook trout, and to a

[1] State of Vermont, 1986 Water Quality Assessment 305(b) Report, Department of Water Resources and Environmental Engineering

lesser extent, rainbow trout. Sucker and minnow species also occur. Yellow perch may be present in the impoundment. Natural reproduction of brown trout and brook trout occurs in the project area. Brown trout and rainbow trout are stocked throughout the Lyndon to Barnet reach of the river.

The Pierce Mills hydro operation is known to interrupt stream flows downstream for significant lengths of time and to draw down the impoundment at least two feet. The bypass, which contains potential spawning, nursery, and adult habitat for salmonids, receives only leakage flows. These conditions all affect trout production adversely.

A FFNA was undertaken downstream of Pierce Mills in 1982. The study has not yet been completed. The FFNA is intended to identify a minimum flow to prevent significant impact to fish populations and habitat. Minimum impact to fishery resources can be assured at Pierce Mills by requirement of strict run-of-the-river operation (inflow equals outflow, instantaneously; no impoundment drawdown) and passage of no less than a 7Q10 flow in the bypass.

c. Recreation/Aesthetics

The Department reports that there is very little recreational use of this area. The impoundment is used for fishing and swimming and there is no recreational development above or below the project.

The lack of a minimum flow over the dam and downstream impairs project aesthetics and the recreational use of the stream. Boating is also impeded on the Passumpsic because of the number of dams in close proximity to one another.

d. Erosion/Siltation

The impoundment contains a substantial amount of silt. The silt level in 1982 was reported by the Department to be within two feet from the dam crest.

Recommendations for Further Study

a. Complete the FFNA study which was started in 1982. Leakage flows during periods of impounding should be measured during this study.

b. Collect more information on project operation and determine how or if operation of the Lyndonville projects in run-of-the-river modes would cause CVPSC to modify operations at the Pierce Mills Project.

c. Determine the need for additional recreational development.

d. Upon completion of the analysis of the data collected during the assimilative capacity study, appropriate recommendations will be made.

Recommendations

a. A minimum flow requirement should be established in the bypass and below the project for fisheries, water quality, recreation and aesthetics.

b. Impoundment water level should be stabilized to protect fishery resources.

c. Recommendations for Pierce Mills should be pursued in conjunction with those for other CVPSC facilities on the Passumpsic included in this study (Arnold Falls, Gage, Passumpsic).

BASIN 15

STREAM: Passumpsic River

PROJECT: Arnold Falls

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC License issued June 11, 1969, expires December 31, 1993

CLASSIFICATION: Upstream - B
Downstream - C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

The Arnold Falls Project is located on the Passumpsic River in the Town of St. Johnsbury (Figure 24). It is 5.4 miles downstream of the Pierce Mills Project and 4.0 miles upstream of the Gage Station. The project has a drainage area of 245 square miles. Project works consist of a timber crib, rock-filled dam about 18 feet high and 255 feet long consisting of two spillway sections both topped with 12 inches of flashboards and separated by an island. The impoundment is about 7.2 acres in area with about 11 acre-feet of usable storage (presumably with the flashboards in place). There is no available information on impoundment length. The project's powerhouse is integral with the dam and contains a 350 kW generator. Operating head is about 22 feet. Maximum hydraulic capacity is 262 cfs. The length of the project's bypass is not indicated in Department records but was estimated by the Department during a site visit in 1985 to be about 100 feet long.

Operating Mode

CVPSC reported to the Department in 1982 that the project generates constantly with no pooling. Maximum drawdown, however, is one foot from the top of the flashboards according to Department records (no reference) and during a Department site visit August 3, 1982, the impoundment was drawn down three feet below the flashboards.

A Department memo dated December 13, 1963, in which comments were made on the Federal Power Commission (FPC) Licenses for Pierce Mills, Arnold Falls, Gage and Passumpsic, states that "Flow in the receiving water at the point of discharge of the St. Johnsbury [treatment] plant is regulated by the Arnold Falls plant. Partial non-regulation occurs as a result of the Moose River input to the Passumpsic downstream of this plant. Hence,

to maintain 62.3 cfs at the treatment plant at least 95% of the time . . . a request for at least 0.2 cfs per square mile at all times through the Arnold Falls plant should be submitted to the FPC to ensure sufficient dilution below St. Johnsbury." This statement indicates that the project does not operate in a true run-of-the-river mode. It is not known if this request for a 0.2 cfsm flow requirement was ever formally made to FERC. There is no reference to this flow in the project's license.

CVPSC informed the Department in 1982 and during an assimilative capacity study conducted by the Department July 29 thru 31, 1985 that their plants on the Passumpsic are operated as a unit and that pooling at the Lyndonville projects (Vail and Great Falls) affects the water supply at their facilities. Both Great Falls and Vail are certified by the Department as run-of-the-river projects. As discussed in the individual reports for these two facilities, they may not be operated as certified. If they were operated as strictly run-of-the-river, operation of the CVPSC plants on the Passumpsic River could be modified accordingly.

Finally, CVPSC gave the Department a tour of their projects on the Passumpsic during the 1985 assimilative capacity study. Level sensors have been installed at all the stations to regulate impoundment fluctuations. At Arnold Falls the level sensor is adjusted to allow only a one to two inch fluctuation. This sensor was installed about two years ago. According to a CVPSC employee, when impoundment levels go below the one to two inch level, the wicket gates begin to close incrementally every two minutes until they are either closed completely or until the water level in the impoundment begins to rise. When the gates are closed, the only flow below the project is that which leaks at the dam and through the wicket gates. Leakage flows have not been measured.

Environmental Review

a. Water Quality

Reference should be made to the water quality section of the Pierce Mills report (page 197) for a description of water quality concerns at this site.

b. Fisheries

The Passumpsic River in the Arnold Falls reach principally supports populations of brown, brook, and rainbow trout. Sucker and minnow species also occur. Yellow perch may be present in the impoundment. Natural reproduction of brown trout and brook trout between the impoundment and Pierce Mills has been confirmed. Brown trout and rainbow trout are stocked throughout the Lyndon to Barnet reach of the river.

The Arnold Falls hydro operation is known to interrupt stream flows downstream for significant lengths of time and to draw down the impoundment at least three feet. The bypass, which contains potential spawning, nursery, and adult habitat for salmonids, recieves only leakage flows. These conditions all affect trout production adversely.

Minimum impact to fishery resources can be assured at Arnold Falls by requirement of strict run-of-the-river operation (inflow equals outflow, instantaneously; no impoundment drawdown) and passage of a minimum flow in the bypass.

c. Recreation/Aesthetics

Department personnel reported no conflicts with recreation. The impoundment is used for fishing. Downstream is used for boating and fishing. There is no recreational development at this site.

The lack of a minimum flow requirement at the dam impairs project aesthetics.

Recommendations for Further Study

a. More information should be collected on the project's operating mode. Determine how or if the operation of the Lyndonville projects as run-of-the-river facilities would modify operations at the downstream CVPSC projects, including Arnold Falls.

b. Determine the need for recreational development at the site.

c. Upon completion of the analysis of the data collected during the assimilative capacity study, appropriate recommendations will be made.

Recommendations

a. A minimum flow requirement should be established in the bypass and below the project for fisheries, water quality, and aesthetics.

b. Impoundment water level should be stabilized to protect fishery resources.

c. Recommendations for Arnold Falls should be pursued in conjunction with those for other CVPSC operations on the Passumpsic River (Pierce Mills, Gage, Passumpsic) and included in this study.

BASIN 15

STREAM: Passumpsic River

PROJECT: Gage Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC License issued June 11, 1969, expires December 31, 1993

CLASSIFICATION: C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

The Gage Project (also known as Gage Station) is located on the Passumpsic River in the Town of St. Johnsbury (Figure 24). It is about four miles downstream of the Arnold Falls station and 1.7 miles upstream of the Passumpsic Station. The drainage area at the dam site is 418 square miles. Project works include a concrete dam in two sections, one of which is topped with 6-foot flashboards, and the other topped with 1-foot boards, and a reservoir area of 15 acres with about 16 acre-feet usable storage (presumably with the flashboards in place). Department records indicate the impoundment extends upstream to the St. Johnsbury STP; however, it is not indicated if this is with or without flashboards. The project has a 90-foot long intake canal which diverts stream flows to a powerhouse containing two generating units, rated 300 kW and 400 kW, respectively. With an operating head of 18 feet, the Department has estimated that the project has a maximum hydraulic capacity of 655 cfs. The project bypasses a minimum of 90 feet of streambed.

Operating Mode

CVPSC reported during an interview with the Department in 1982 that the project is never shut down and operates continuously, generating down to 50 kW. They also reported that the pool level is usually maintained at the top of the flashboards. Department personnel commented, however, that during their interview with CVPSC, the interview was rushed and contradicting statements were made regarding pool management. The project is suspected to actually be operated in a daily peaking mode during some periods.

CVPSC also reported to the Department in a 1982 interview that operation of the Gage Project is influenced by Pierce Mills which is in turn influenced by Great Falls. Great Falls would pool, usually overnight. As discussed in the Great Falls report,

Great Falls was certified as a run-of-the-river project in 1984 but may not be operating as certified. If the project was operated run-of-the-river, operations at the downstream CVPSC projects, including Gage, could change accordingly.

The Department conducted an assimilative capacity study on the Passumpsic River July 29 thru 31, 1985. During this study, CVPSC employees gave the Department a tour of their facilities on the Passumpsic and explained project operations. They said a level sensor was installed at the Gage Project within the past year to control impoundment fluctuations and the opening of the wicket gates. The project operates with a 3-inch fluctuation. As soon as the impoundment level drops below the 3-inch level, the wicket gates close incrementally every two minutes until they are closed or until the impoundment level rises above the 3-inch mark at which time the project starts to generate again. When the gates are closed and the impoundment is refilling, the only flow maintained below the project is that which leaks at the dam, through the wicket gates, and recently installed gate used for emptying the intake canal. The Department estimated the leakage flow through this mud gate to be about 10 cfs.

Environmental Review

a. Water Quality

Reference should be made to the water quality section of the Pierce Mills report (page 197) for a description of water quality problems.

b. Fisheries

The Passumpsic River in the Gage Dam reach supports populations of brown and rainbow trout. Sucker and minnow species, as well as yellow perch, rock bass, and brown bullheads, also occur. Major tributaries (Moose River, Sleepers River) enter the Passumpsic just upstream of the Gage impoundment. Significant spawning and nursery habitat for salmonids is present upstream of the impoundment and in the tributaries. Downstream of Gage there is a limited stretch of low gradient river before reaching the Passumpsic Dam impoundment. There is no known salmonid spawning habitat in this reach, although a couple small tributaries are available to river trout. Brown trout and rainbow trout are stocked throughout the Lyndon to Barnet reach.

The Gage Dam hydro station is thought to operate in a cycling mode, although it is equipped (like Arnold Falls) to operate nearly in a strict run-of-the-river mode. Interruption of downstream flow and significant drawdown of the impoundment associated with cycling, as well as limitation of flow in the bypass, all affect production of trout species adversely. The

discharge of treated and untreated sewage by the Town of St. Johnsbury to the Gage impoundment and associated dissolved oxygen depression may aggravate the stressful conditions created by cycling.

Minimum impact to fishery resources can be assured at Gage Dam by requirement of strict run-of-the-river operation (inflow equals outflow, instantaneously; no impoundment drawdown) and passage of a minimum flow in the bypass.

c. Recreation/Aesthetics

There is no known recreational use or development other than possible fishing in the impoundment and downstream. No conflicts with recreation were noted by Department personnel during their site visit other than possibly fishing in the impoundment.

The lack of a minimum flow requirement at the dam impairs aesthetics.

Recommendations for Further Study

a. Collect more information on project operation and determine how or if operation of the Lyndonville projects upstream as run-of-the-river would modify the operation of the CVPSC projects downstream, including Gage Dam.

b. Determine the need for recreational development at the project site.

c. Upon completion of the analysis of the data collected during the assimilative capacity study, appropriate recommendations will be made.

Recommendations

a. A minimum flow requirement should be established in the bypass and below the project for fisheries, water quality, and aesthetics.

b. Impoundment water level should be stabilized to protect fishery resources.

c. Recommendations for Gage should be pursued in conjunction with those for other CVPSC operations on the Passumpsic River (Pierce Mills, Arnold Falls, Passumpsic) included in this study.

BASIN 15

STREAM: Passumpsic

PROJECT: Passumpsic Dam

UTILITY: Central Vermont Public Service Corporation (CVPSC)

LICENSE STATUS: FERC license issued February 11, 1970; expires December 31, 1993

CLASSIFICATION: Upstream - C
Downstream - B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

The Passumpsic Dam is located on the Passumpsic River in the Town of Barnet 1.7 miles downstream of the Gage Project (Figure 24). The dam has a drainage area of 428 square miles. Project features include a concrete gravity type dam 258 feet long, two to ten feet high, consisting of two spillway sections topped with one foot of flashboards, and a 10-foot stoplog section. The project's reservoir is 18.3 acres in area with about 18 acre-feet of usable storage. With the water level at the dam crest, the impoundment extends upstream 100 feet. An 87-foot long canal diverts flows from the reservoir to the project's powerhouse which contains a 700 kw generating unit. The project bypasses about 500 feet of stream. The project has an operating head of 22 feet and a maximum hydraulic capacity of 458 cfs according to CVPSC.

Operating Mode

CVPSC gave the Department conflicting information regarding project operation at a site visit in 1982. The utility stated that project shutdown is very rare and that the project generates constantly with no pooling. At the same time, however, they reported that the project shuts down at 10:00 p.m. and starts up at 8:00 a.m. with pooling overnight. The impoundment is drawn down 18 inches and the project then shuts down.

CVPSC also said during the 1982 site visit that the operation of the Gage, Arnold Falls, Pierce Mills, and Lyndonville projects (Great Falls and Vail) influence the operation of the Passumpsic Station. The Lyndonville projects would reportedly pool and stop flows. As discussed in the individual reports for the Lyndonville projects, both facilities

have been issued Water Quality Certifications for run-of-the-river operations and may not be operating as certified. If they were, operations at the four CVPSC projects, including Passumpsic, could change accordingly.

The Department conducted an assimilative capacity study on the Passumpsic River July 29 to 31, 1985. During this study CVPSC employees gave the Department a tour of their facilities on the Passumpsic and explained project operations. Operations continue to be influenced by the Lyndonville projects. During the tour, CVPSC said that in the past year a level sensor had been installed at the Passumpsic Project. The sensor controls impoundment fluctuations and the opening of the wicket gates. The project operates with a 3-inch fluctuation. As soon as the impoundment goes below this 3-inch level, the wicket gates begin to close incrementally every two minutes until they close completely or until the impoundment level rises above the three-inch mark at which time the project starts to generate again. When the gates close completely, the only flow below the project is leakage through the gates and at the dam. No leakage flow measurements have been made at the project.

The Department reviewed flow records from the USGS surface water gaging station (01135500) on the Passumpsic River. The gage is located about a mile below the dam. For water year 1985, the Department found the stream flows were less than 7Q10 (86 cfs) for 72 days. In most instances flows were significantly less than 86 cfs, the lowest being 14 cfs (16% of 7Q10) on August 19 and September 30, and the average being 40 cfs (46% of 7Q10). The duration of these low-flow conditions ranged from an hour to nine hours a day. They occurred during the months of October, November, December, January, June, July, August, and September, being most frequent in the low-flow months of July through September.

The Department also finds that even on days when flows were not particularly low, some flow regulation occurs. For example, on November 29, the mean discharge for the day was 492 cfs. The minimum discharge recorded at the gage that day was 112 cfs and the maximum was 810 cfs. This flow regulation may be attributed to operation of the Passumpsic Project and/or other CVPSC projects and Village of Lyndonville projects upstream.

Environmental Review

a. Water Quality

Reference should be made to the water quality section of the Pierce Mills report (page 197) for a description of water quality problems.

b. Fisheries

The Passumpsic River in the Passumpsic Dam reach supports populations of brown trout and rainbow trout. Sucker and minnow species, as well as yellow perch, rock bass, and brown bullheads, also occur. The 1.7 mile upstream stretch between the Passumpsic and Gage Dams contains no known salmonid spawning habitat, although a couple of small tributaries are available to river trout. Downstream, between Passumpsic Dam and the East Barnet Hydro impoundment, limited, scattered trout spawning habitat may exist. Two significant tributaries (Water Andric, Joes Brook) enter the Passumpsic River in this reach and make extensive salmonid spawning and nursery habitat available to trout resident in the main stem. Brown trout and rainbow trout are stocked throughout the Lyndon to Barnet reach, including in Joes Brook.

The Passumpsic Dam hydro station is thought to operate in a cycling mode despite its being equipped (like Gage and Arnold Falls) to operate nearly in a strict run-of-the-river mode. The Passumpsic Dam operation, alone or in conjunction with Gage, is responsible for interruption of stream flows for significant lengths of time (as evidenced by USGS gaging records), and it is known to draw down the impoundment at least 18 inches. The bypass, which may contain some limited salmonid spawning and nursery habitat, receives only leakage flows. These conditions all affect production of trout species adversely. The discharge of treated and untreated sewage by the Town of St. Johnsbury less than four miles upstream and associated D.O. depression may aggravate the stressful conditions created by the existing operational mode.

Minimum impact to fishery resources can be assured at Passumpsic Dam by requirement of strict run-of-the-river operation (inflow equals outflow, instantaneously; no impoundment drawdown) and passage of a minimum flow in the bypass.

c. Recreation/Aesthetics

The lack of a minimum flow over the dam impairs the aesthetics of the project area.

Department personnel report that the impoundment is used for fishing, flat water boating, and possible whitewater boating. No recreational use is reported downstream nor is there any recreational development in the project's impoundment or downstream.

d. Erosion/Siltation

Department personnel observed a moderate amount of silt in the impoundment during a 1982 site visit.

Recommendation for Further Study

a. More information should be collected on the project's operating mode. Determine if or how operation of the Great Falls project as a run-of-the-river project would modify operations at Passumpsic.

b. Determine the need for recreational development.

c. Upon completion of the analysis from the data collected during the assimilative capacity study, appropriate recommendations will be made.

Recommendations

a. A minimum spillage requirement should be established in the bypass and below the project for fisheries, water quality, and aesthetics.

b. Impoundment water levels should be stabilized to protect fishery resources.

c. Recommendations for Passumpsic should be pursued in conjunction with those for other CVPSC operations on the Passumpsic included in this study (Pierce Mills, Arnold Falls, Gage).

BASIN 15

STREAM: Joes Brook

PROJECT: West Danville

UTILITY: Green Mountain Power Corporation (GMP)

LICENSE STATUS: License application dismissed by FERC May 23, 1979

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

The West Danville Project is a storage and hydroelectric development located at the outlet of Joes Pond, which is on Joes Brook in the Town of Danville (Figure 24). Joes Brook is a tributary of the Passumpsic. The project has a drainage area of 31 square miles. Project features include a dam with an overall length of 50 feet and a 33-foot long spillway. The crest is fitted with 2 feet of flashboards which create an impoundment with a surface area of 419 acres and a usable storage of 1200 acre-feet with a 3-foot drawdown from the top of the boards. A 2022-foot long penstock extends from the intake to the power plant which contains a horizontal Francis-type turbine with a hydraulic capacity of up to 103 cfs. The project's generator has an installed capacity of 1000 kw under a gross head of 180 feet. The penstock bypasses over 2000 feet of Joes Brook.

Operating Mode

According to GMP's August 17, 1965, FERC license application, "The operation of the project is restricted by virtue of an agreement dated October 9, 1926, between Eastern Vermont Public Utilities Corporation and Joes Pond Association, a voluntary association of camp owners on the shores of Joes Pond. This restriction limits the use of water for hydroelectric purposes between elevations two feet above crest of dam and one foot below crest of dam."

GMP reports that under low-flow conditions, the project generates Monday through Friday from 0800 to 1200 with an average drawdown of 0.1 foot per day. Generation usually ceases in the summer under low and moderate flows if necessary to preserve the pond level about one half foot below the top of the flashboards. Under moderate flows, the project generates Monday through Friday

from 0700 to 1500 with an average daily drawdown of 0.1 foot per day. Under high flows the project generates seven days a week, 24 hours a day with no drawdown.

No leakage flows were measured in the project's bypassed section of stream. It is also not known what flows, if any, are maintained below the project's powerhouse during periods of nongeneration.

Environmental Review

a. Water Quality

According to a fisheries report prepared by Vermont Fish and Wildlife in 1973, the maximum depth of Joes Pond is 98 feet with thermal stratification occurring at a depth of 15 to 20 feet, and D.O. becomes critical for trout at the 74-foot level. Water quality data collected by the Department in 1977 indicates that significant D.O. depletions occur at depths beginning at about 28 feet. Just upstream of the West Danville dam, the pond is only zero to ten feet deep according to a contour map prepared by Fish and Wildlife; therefore, this D.O. problem is not likely to be transferred downstream via the plant's discharge.

The Department has no water quality data from the project's bypass or downstream of the powerhouse. It is possible water quality problems could exist in these areas during periods of low flows.

b. Fisheries

Joes Pond supports a mixed fishery of yellow perch, smallmouth bass, chain pickerel, rainbow trout, brown trout, and lake trout. The tailrace and downstream supports brook trout and brown trout. The impoundment provides spawning, nursery, and adult habitat for lake trout, smallmouth bass, chain pickerel, and yellow perch. The project's tailrace and downstream provides significant spawning, nursery, and adult habitat for brook trout and brown trout. Significant habitat potential for stream salmonids exists in the bypass and is limited only by diversional flow.

Vermont Fish and Wildlife states that fluctuating flows below the project, fluctuating water levels in the impoundment, and limitation of flows in the bypass impair the fishery resource and impact management.

c. Recreation/Aesthetics

The lack of a minimum flow at the dam and through the project's bypass impairs project aesthetics and downstream recreational use.

Recommendations for Further Study

a. Determine what flows are maintained below the project during periods of impounding and nongeneration.

b. The extent of impact on fish populations and habitat due to the curtailment of flow in the bypassed section of stream should be evaluated. Existing leakage flows through this stream section should also be determined.

c. Temperature and D.O. data should be collected from below the project during nongeneration, and possibly in the bypass, to evaluate potential water quality problems.

Recommendations

a. Water level fluctuations in Joes Pond should be stabilized to protect and enhance fisheries.

b. Minimum flow requirements should be established in the bypass and below the project for fisheries and possibly water quality. This would also improve project aesthetics.

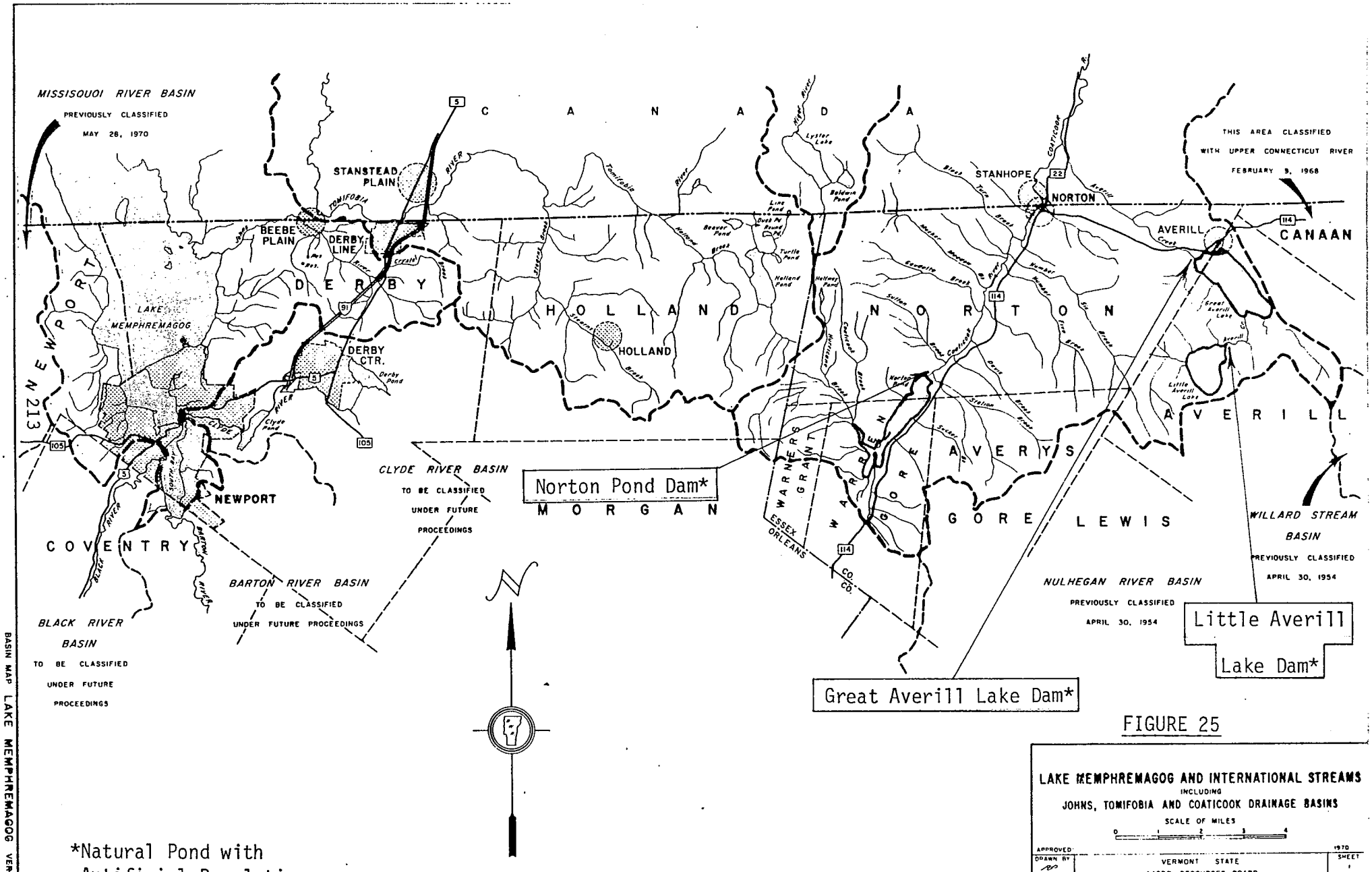


FIGURE 25

LAKE MEMPHREMAGOG AND INTERNATIONAL STREAMS
INCLUDING
JOHNS, TOMIFOBIA AND COATICOOK DRAINAGE BASINS
SCALE OF MILES
0 1 2 3 4

APPROVED
DRAWN BY
CHECKED BY
1970
VERMONT STATE
WATER RESOURCES BOARD
MONTPELIER, VERMONT
SHEET 1 OF 1

BASIN MAP LAKE MEMPHREMAGOG VERMONT

BASIN MAP LAKE MEMPHREMAGOG VERMONT

BASIN 17

STREAM: Averill Creek

PROJECTS: Little Averill Lake, Great Averill Lake

UTILITY: Coaticook River Water Power Company (CRWPC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Little Averill Lake and Great Averill Lake are natural lakes with manmade outlet structures located on Averill Creek in the towns of Averill and Norton (Figure 25). Little Averill is about one mile upstream of Great Averill which is about 4.4 miles upstream of the creek's confluence with the Coaticook River.

Little Averill has a drainage area of five square miles with a surface area of 483 acres and useable storage of 5630 acre-feet with a 4-foot drawdown. The dam is about 14 feet high with a crest length of 100 feet. Flow releases from the dam are over the spillway and through a sluiceway located about 10 feet below the spillway crest.

Great Averill Lake has a drainage area of 12 square miles (this includes Little Averill), a surface area of 847 acres, and a useable storage of 4480 acre-feet with a 5-foot drawdown from the crest. The dam is about 10 feet high and 40 feet long, topped with 18-inch flashboards. Flows are controlled by a wooden wastegate and two inner spillway gates.

Operating Mode

Little Averill and Great Averill are natural lakes used for storage by the CRWPC for a generating station downstream on the Coaticook River in Coaticook, Quebec.

The utility only provided the Department with information on normal operations of both lakes under low-flow conditions. It is, therefore, not known how the levels are regulated under moderate and high flows. Under low-flow conditions, both lakes are drawn down Monday through Friday. At Little Averill, the average drawdown is 4 to 5 feet. At Great Averill, the average drawdown is 2.5 feet.

Leakage flows were measured below both lakes by the Department. On July 23, 1982, a flow of 7.6 cfs was measured at a point 50 feet downstream of the Little Averill dam. The source of this flow was through the dam and penstock. On the same day a leakage flow of 13.4 cfs was measured 75 feet downstream of the dam at Great Averill. The source of this flow was through the flashboards and gates. There is limited information on flow releases below the two lakes other than these leakage flows. Vermont Fish and Wildlife reported in 1970 that the flow in Averill Creek below Little Averill is fairly steady and slow. At a public hearing held by the former State Water Conservation Board (date unknown), an individual testified that the gates to the dams of both lakes are sometimes completely shut so that the stream below the lakes is practically dry.

The water levels of both lakes are regulated as a result of a certification issued September 15, 1953, by the Vermont Public Service Commission (PSC). At Great Averill, the maximum water level is at a point 16 inches above the crest of the spillway sections. The minimum level is at a point which is four feet lower than the crest of the spillway sections, or at a point that is five feet, four inches below the maximum water level. Permanent identifying markers have been placed near the lake's outlet to identify these levels. According to the PSC's findings in establishing these levels, the high level is reached at about the time the ice goes out in the spring and the low water level occurs about the first of September.

With respect to Little Averill, the PSC certified the maximum water level at the pond's outlet as being a point that is 6 inches above the spillway crest and the minimum water level as being the bottom of the penstock as it now exists at the outlet of the pond. (This calculates to a drawdown of about 10 feet.) Permanent markers have been established to identify these maximum and minimum water levels. According to the PSC's findings in establishing these levels, the waters of Little Averill Pond empty into Great Averill and the draw-off of waters in Little Averill help to maintain the water levels in Great Averill.

Environmental Review

a. Water Quality

Water quality problems could develop below both lakes if inadequate flows are released. The lakes are oligotrophic with suitable water temperatures and oxygen levels at all depths for the management of salmonids.

b. Fisheries

Little Averill and Great Averill, as well as Averill Creek and other inlets to both lakes, support a cold water fishery. The principal species are brook trout above Little Averill, brook trout, and rainbow trout between the two lakes, and brook trout and salmon downstream of Great Averill.

The water quality and rocky shorelines of the lakes lend themselves to the management of lake trout on which Vermont Fish and Wildlife has placed primary emphasis. Salmon are present in Great Averill and rainbow trout in Little Averill. Rainbow smelt is the principal forage fish in both lakes. Vermont Fish and Wildlife reports that both of the lakes are high quality fishing lakes. Great Averill is one of the four lakes in Vermont that is presently managed for landlocked salmon.

Spawning, nursery, and adult habitat is located in the lakes and inlet and outlet streams for the fish species mentioned.

Vermont Fish and Wildlife reports various impairments of fisheries due to the management of lake levels and resultant flow releases. Extreme drawdown of both lakes from the first part of October to late April impair the lake trout spawning habitat. These drawdowns result in the loss of lake trout production. The magnitude of such losses would be dependent upon the extent of the drawdown and the severity of the winter weather. If a drawdown took place before October and extended into the winter months, much of the spawning rubble would be above water and this would result in the reduction of lake trout reproduction. Drawdowns between the time the eggs hatch and the resulting fry are ready to migrate to deeper water may result in high losses by forcing the fry into deeper water before they attain desirable growth to successfully survive predation from other fish. Vermont Fish and Wildlife states that in order to protect the lake trout population in Little Averill and Great Averill, it is imperative that no drawdowns occur from the first of October to the last of April and that extreme caution be exercised when sanctioning drawdowns outside of this period.

Vermont Fish and Wildlife also reports that drawdowns of the lakes impair other fisheries as well by reducing the amount of available habitat. Drawdowns of Little Averill prevent the migration of fish to upstream areas. Variable flow releases below each project may impair fisheries as well.

c. Recreation/Aesthetics

Department records state that there are seasonal changes in management of water levels in both lakes for recreational purposes. Water levels are "kept up" at Little Averill in the summer and are lowered on Great Averill "to give shoreline land

owners a beach area in the summer months". Land owners along the shores of Little Averill reportedly complain of water level fluctuations. Both lakes are highly scenic. Variable flow releases from the projects may conflict with fishing downstream of the lakes.

Department records also indicate that water level fluctuations in both lakes impair aesthetics.

d. Natural Area/Wildlife Habitat

The Vermont Institute of Natural Science (VINS) reported to the Department by letter dated May 17, 1985, that the common loon, listed as endangered in Vermont, breeds on Little Averill. In 1984, only six pairs of loons were known to have successfully reared young in the state. One factor identified by VINS as a cause of loon nest failure is drastic water level changes. VINS states that artificial water levels must be monitored and limited during the loon nesting season which begins in mid-May and generally ends in mid-July. VINS recommends that water levels remain stable from May 1 through early August to allow for loon nest building in early May, egg laying, incubation, and late renesting.

Recommendations for Further Study

a. The extent of impact on spawning smelt due to winter drawdown in Little Averill Lake should be investigated. Maximum drawdown compatible with smelt spawning should be determined.

b. Recommendations regarding water level fluctuations in the lakes with respect to recreation must be made.

Recommendations

a. Minimum flow requirements should be established for dams at Great and Little Averill lakes to protect resident trout populations in Averill Creek upstream and downstream of Great Averill Lake.

b. Agreements should be sought to minimize lake level fluctuations on both lakes, to limit maximum drawdown on Little Averill Lake, and to assure that drawdown is complete prior to October 15 to prevent dewatering of lake trout spawning sites and fertilized eggs.

c. Water levels should be stabilized on Little Averill from May 1 through early August to protect loon nesting areas. The lake was registered in 1986 under the registry program of the Vermont Field Office of The Nature Conservancy (TNC). As a registered site, the CRWPC has voluntarily agreed to maintain water levels of the pond to protect nesting loons. This is only

a voluntary, nonbinding agreement, however. A more formal agreement should be established or CRWPC should be required, under appropriate state regulations, to stabilize water levels during the loon nesting season.

BASIN 17

STREAM: Coaticook River

PROJECT: Norton Pond

UTILITY: Coaticook River Water Power Company (CRWPC)

LICENSE STATUS: Unlicensed

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant

Project Features

Norton Pond is a natural lake with a manmade outlet structure located on the Coaticook River in the Town of Norton and in Warren Gore at river mile 39.2 (Figure 25). A hydroelectric project known as the Swanson-Eames facility is located about three miles downstream of the pond. The pond has a drainage area of about 17 square miles, a surface area of 583 acres, and a useable storage of 4400 acre-feet with a 4-foot drawdown. Project features include an earthen dam which is 10 feet high with a crest length of 1200 feet. Lake levels are controlled by two sluice ways and two stoplog sections separated by a 2-foot pier.

Operating Mode

Norton Pond is operated as a storage reservoir for hydroelectric power generation in the town of Coaticook, Quebec. Stored water is released as necessary. Normal operating procedures are described as follows in a dam inspection report (January, 1979), prepared by the Army Corps of Engineering (ACOE):

"Stoplogs are usually left in place in the spillway channel to within one foot of the top of structure to form a weir outlet. One of the two sluiceway gates is left open several inches to maintain minimum flows in the downstream channel. The pond level is maintained at the top of the stoplogs as long as runoff will provide."

CRWPC reports a maximum drawdown of 5.5 feet. Under low and moderate flow conditions, the pond is normally drawn down an average of 4 to 5 feet. Under low flows, this drawdown occurs Monday through Friday. No information was provided by the utility on the duration of this drawdown during moderate flows or on normal operating procedures under high flows.

Water levels of Norton Pond are regulated by a certification issued by the Vermont Public Service Commission (PSC) on September 15, 1953. This certification established the maximum water level at the outlet as being at a point which is 6 inches below the top of the middle pier at the spillway, and the minimum water level as being at a point which is vertically 5.5 feet below the maximum water level. Permanent identifying markers have been established to identify these levels. These levels were determined based on a finding that since 1947, the CRWPC has maintained these levels in accordance with an agreement with individuals representing the fishing, camping, and recreational interests around the lake and in the vicinity thereof.

No leakage flows have been measured by the Department below the dam. There may be times when flows below the project are reduced significantly.

Environmental Review

a. Water Quality

Water quality problems may develop below Norton Pond if flows are sufficiently reduced.

Vermont Fish and Wildlife states that because half the pond is only about 10 feet deep, drawdowns in the summer reduce these depths even further to the point where temperatures increase to the critical point for a cold water fishery. D.O. concentrations also become critical.

b. Fisheries

Brook trout is the primary species found in the feeder streams of Norton Pond. A mixed fishery of northern pike, large-mouth bass, smallmouth bass, brook trout, rainbow trout, suckers, minnow species, and bullhead are found in the impoundment. The fishery below the dam is mixed with a cold water fishery further downstream. Brook trout and brown trout predominate downstream of Norton Pond. Spawning, nursery, and adult habitat for brook trout is found in the feeder streams to Norton Pond. The impoundment provides spawning, nursery, and adult habitat for northern pike and bass species. Spawning, nursery, and adult habitat for trout species is found in the stream below the dam.

As previously stated, the temperature and D.O. conditions of Norton Pond make it borderline habitat for trout. Vermont Fish and Wildlife states that the extreme drawdowns which occur in the pond have a significant impact on the fishery resource when one considers approximately half of the lake has a depth of 10 feet. During the summer months, additional drawdowns decrease the depths to the point where temperatures may increase to the critical point for salmonids. The lack of adequate flows below

the project also impairs fisheries. Fish and Wildlife says that easy access to the pond and the unusual species composition for this area results in a top quality fishery. The potential for fisheries downstream of the dam is high if adequate flows were maintained.

c. Recreation/Aesthetics

An extensive "bathtub ring" is located along the pond's shoreline. The only access to the pond is via a privately owned road, the gate to which the Department says is locked at all times.

As previously stated, the minimum and maximum water levels of the pond were established based on concerns of individuals representing fishing, camping, and recreational interests.

d. Natural Area/Wildlife Habitat

The Vermont Institute of Natural Science (VINS) reported to the Department by letter dated May 17, 1985, that the common loon, listed as endangered in Vermont, breeds on Norton Pond. In 1984, only six pairs of loons were known to have successfully reared young in the state. One factor identified by VINS as a cause of loon nest failure is drastic water level changes. VINS states that artificial water levels must be monitored and limited during the loon nesting season which begins in mid-May and generally ends in mid-July. VINS recommends that water levels remain stable from May 1 through early August to allow for loon nest building in early May, egg laying, incubation, and late renesting.

Recommendations for Further Study

a. Determine the need for additional recreational development at the site.

b. Determine to what degree downstream flows are regulated.

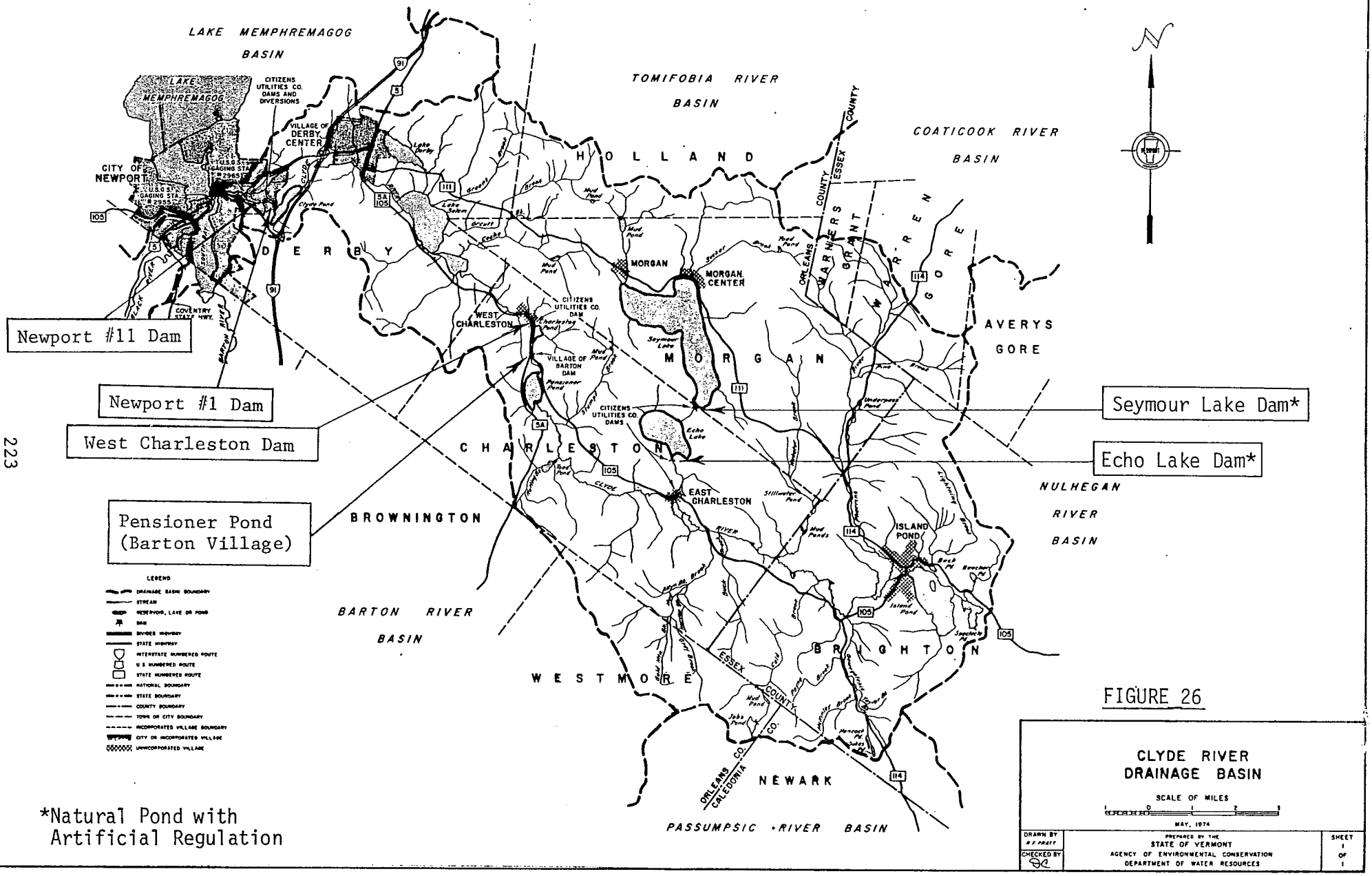
Recommendations

a. Water levels in the pond should be stabilized for fisheries, especially during low-flow periods to try to reduce high temperatures, improve D.O. concentrations in the pond, preserve physical habitat, and to protect northern pike spawning in the spring and bass spawning in early summer. Stabilizing water levels would also eliminate the "bathtub ring".

b. Water levels should be stabilized from May 1 through early August to protect nesting loons. The pond was registered under the registry program of The Nature Conservancy (TNC) in 1986. As a registered site, CRWPC has voluntarily agreed to stabilize water levels during the loon nesting period. This is

only a voluntary, nonbinding agreement, however. To provide even better protection, a more formal agreement should be established, or CRWPC should be required, under state regulations, to maintain stable water levels during the loon nesting season.

c. An adequate minimum flow for fisheries should be maintained below the dam.



*Natural Pond with Artificial Regulation

FIGURE 26

CLYDE RIVER
DRAINAGE BASIN

SCALE OF MILES

MAY, 1974

DRAWN BY R.F. PRATT
CHECKED BY

PREPARED BY THE
STATE OF VERMONT
AGENCY OF ENVIRONMENTAL CONSERVATION
DEPARTMENT OF WATER RESOURCES

SHEET 1 OF 1

BASIN MAP CLYDE RIVER VERMONT

BASIN MAP CLYDE RIVER VERMONT

BASIN 17

STREAM: Clyde River

PROJECT: Pensioner Pond Dam

UTILITY: Village of Barton

LICENSE STATUS: FERC license issued October 11, 1984; 401 Water Quality Certification issued June 4, 1984.

CLASSIFICATION: B

FISH HABITAT DESIGNATION: Cold water

IMPACT: Some

Pensioner Pond Dam, also known as the Barton Village Dam, is a peaking project located on the Clyde River in the Town of Barton 0.7 miles upstream of West Charleston Dam (Figure 26). The project was issued a Water Quality Certification and FERC license in 1984. Reference should be made to these documents for a complete description of the project.

It should be noted that the dam is constructed at the top of a set of falls known as the Great Falls of the Clyde. These falls were included in the Agency's Waterfalls, Cascades and Gorges Study. The study describes the site as a large vertical-walled gorge in limestone with several waterfalls, damaged by a dam and powerplant. The gorge is most notable for its plant population. It is also described as "an attractive place...but suffers from low summer flows which dry it out and the clearing and blasting of the east side to install the penstock...it must of been a very striking place before it was developed."

The project's certification requires a minimum flow through the bypass of 21 cfs (7Q10) from June 15 to September 15 and 10 cfs from September 16 to June 14. These flow requirements may not be adequate to preserve the aesthetic qualities of the falls.

Recommendations

a. The only recommendation for this project is to follow up on the articles of the FERC license and conditions of the Department's certification to see if they are being complied with.

BASIN 17

STREAM: Clyde River, Tributary of the Clyde River

PROJECTS: Seymour Lake, Echo Lake, West Charleston, Newport, Newport #11

UTILITY: Citizens Utilities Company (CUC)

LICENSE STATUS: FERC license issued November 6, 1963, expires December 31, 1993.

CLASSIFICATION: B, except for section below Newport #11, which is C

FISH HABITAT DESIGNATION: Cold water

IMPACT: Significant - West Charleston, Newport, Newport #11
Some - Echo Lake, Seymour Lake

The Federal Power Commission (now FERC) issued CUC an operating license November 6, 1963, for hydroelectric project works on the Clyde River and a tributary thereof. The projects include Seymour Lake and Echo Lake on the tributary and the West Charleston, Newport and Newport #11 dams on the Clyde. The license for these projects expires December 31, 1993.

Echo Lake and Seymour Lake will be discussed as a unit, as will the West Charleston, Newport, and Newport #11 facilities. The description of project features and operating modes for each project is as described in an August 28, 1987, letter from CUC to the Department.

PROJECTS: Seymour Lake and Echo Lake

a. Seymour Lake

Project Features

Seymour Lake is a natural lake with a manmade outlet structure located on a tributary to the Clyde River in the Town of Morgan (Figure 26). Seymour Lake is approximately 1350 feet upstream of Echo Pond. The project has a drainage area of approximately 21 square miles. An impoundment area extends approximately 3.5 miles upstream with a surface area of approximately 1750 acres and a usable storage of approximately 2040 acre-feet.

The project utilizes a rock-filled timber crib-type dam constructed in 1928. The dam was filled with concrete in 1954, and a concrete facing was added, along with other repairs, in 1984. Located beyond a natural obstruction, the dam extends 43 feet with a spillway of 28 feet (crest elevation 1279 USGS

datum). A 5-foot by 4.5-foot sluicegate regulates flow. The bottom of the gate is located some three feet below the crest of the spillway (elevation 1276 feet). Six-inch flashboards extend the length of the spillway.

Operating Mode

Seymour Lake is a natural lake utilized to store water for CUC's projects downstream on the Clyde River. The operation of the dam is regulated by the following Articles in the FERC license.

> "Article 22. The Licensee shall at no time cause or permit the elevation of the water surface of the Seymour Lake to be raised more than six inches higher or to be lowered more than eight inches below the crest of Licensee's present dam, said crest of dam being at elevation 1279 feet USGS datum. Maximum lake elevation shall be not higher than 1279.5 feet USGS datum and minimum lake elevation to be no lower than 1278.33 feet USGS datum.
>
> Article 24. The Licensee shall make water releases in the interest of fish and wildlife in accordance with the following schedule:
>
> (i) At Seymour Dam - Keep the gate continuously open at least one inch from the sill for the continuous discharge of water.
>
> Article 25. The Licensee shall raise and lower the gates at Seymour and Echo dams gradually in order to prevent scouring of the streambed."

Under daily operating conditions, the drawdown is limited to 8 inches (elevation 1278.33 feet) from the crest of the dam.

During extremely low flow periods, the drawdown has been known to be lower than 1278.33 feet (USGS datum), established under Article 22, in order to maintain a minimum flow as called for under Article 24(i). In addition, prior to the severe runoff season, the pond is allowed to drop below elevation of 1278.33 feet, as established in Article 22, in order to minimize flooding and to try to limit the runoff from forcing the pond elevation from exceeding the maximum elevation (1279.5 feet) established in that same Article.

b. Echo Lake

Project Features

Echo Lake is a natural lake with a manmade outlet structure on a tributary to the Clyde River in the Town of Charleston

(Figure 26). Echo Lake is approximately 6300 feet upstream of the tributary's confluence with the Clyde River. The project has a drainage area of approximately 24 square miles. An impoundment area extends approximately one mile upstream, with a surface area of impoundment of approximately 530 acres and a usable storage of approximately 3180 acre-feet.

The project utilizes a concrete-type dam constructed in 1922, with modifications and repairs in 1949 and 1984. The dam extends 120 feet with a spillway of 70 feet 5 inches. A 2.5-foot by 4.5-foot sluicegate regulates flow. The bottom of the gate is located some 12 feet below the crest of the spillway (elevation 1249 feet).

Operating Mode

Echo Lake is a natural lake utilized to store water for CUC's projects downstream on the Clyde River. The operation of the dam is regulated by the following Articles in the FERC license.

> "Article 23. The Licensee shall at no time cause or permit the elevation of the surface of Echo Lake to rise above the crest of the present dam at elevation 1249 feet USGS datum.
>
> Article 24. The Licensee shall make water releases in the interest of fish and wildlife in accordance with the following schedule:
>
> (ii) At Echo Lake - Keep the gate continuously open at least one inch from the sill for the continuous discharge of water.
>
> Article 25. The Licensee shall raise and lower the gates at Seymour and Echo dams gradually in order to prevent scouring of the streambed."

Under daily operating conditions, the drawdown is limited to 6 feet (elevation 1243 feet) from the crest of the dam.

During extremely low flow periods, the drawdown has been known to be lower than 1243 feet in order to maintain a minimum flow as called for under Article 24(ii). In addition, prior to the severe runoff season, the pond is allowed to drop below the elevation of 1243 feet in order to minimize flooding and to try to limit the runoff from forcing the pond elevation from exceeding the maximum elevation (1249 feet) established in Article 23.

Environmental Review

a. Water Quality

Echo Lake and Seymour Lake are oligotrophic. The only water quality problems which may exist as a result of operation of these lakes as storage reservoirs would be in the one half mile stream section between the two lakes and in the stream section below Echo Lake if flows released from the two dams are significantly reduced.

b. Fisheries

Seymour Lake supports a mixed fishery of primarily cold water species, the principal ones being lake and brown trout, salmon, smallmouth bass, and yellow perch. Habitat is present in the lake for lake trout spawning and adults and for salmon and brown trout adults. The tributaries above the lake provide habitat for salmon, smelt, brook trout, and brown trout spawning. They also provide nursery and adult habitat for salmon, brook trout, and brown trout. The lake's tailrace provides spawning, nursery, and adult habitat for rainbow trout and salmon and nursery and adult habitat for brook trout.

Echo Lake supports a mixed fishery with lake trout, rainbow trout, brook trout, smelt, and perch being the principal species. Rainbow trout and brown trout are found above the lake and rainbow trout, brown trout, and brook trout are found below. The lake provides spawning, nursery, and adult habitat for lake trout. Spawning habitat for smelt is located above the project, as well as spawning, nursery, and adult habitat for brook and rainbow trout. Downstream of Echo Lake the brook provides spawning, nursery, and adult habitat for rainbow trout, brown trout, and brook trout.

Vermont Fish and Wildlife reports that operations of Echo Lake and Seymour Lake impair fisheries. If flow releases as required by FERC were maintained below each project, Vermont Fish and Wildlife reports these flows would be adequate for fisheries. Also, if water levels at Seymour were maintained as required by FERC, this would also be adequate for fisheries. However, the flow releases below both lakes and the water levels at Seymour are not always maintained as required.

Early spring drawdowns of Seymour Lake impair smelt movement to spawning areas upstream. This is especially evident in what is referred to as the "twin culvert area" where such drawdowns prevent fish passage over the culvert's invert. Lake drawdowns in the fall during the lake trout spawning and incubation period subjects eggs to ice damage and desiccation. This particular

problem also occurs at Echo Lake. Extreme drawdowns of Echo Lake during spring spawning runs could impact fisheries below the lake because of the resultant variable flows.

Vermont Fish and Wildlife recommends that no drawdowns of either Seymour or Echo occur from the fall through the first part of May to protect the lake trout fishery. These fish spawn in the shallow rubble areas along the shoreline from approximately mid-October to mid-November and sometimes later. The fry then hatch out 140-166 days later and generally stay in the shallows until water temperatures reach the mid-forties, usually around the first part of May, before moving out to deeper water. Fall drawdowns would impair the spawning, and spring drawdowns could result in high mortalities to the eggs by stranding them out of the water. Excessive fry mortality may also be experienced by forcing them into deeper water before they have attained desirable growth to survive predation from other fish in adequate numbers to contribute to the fishery.

c. Recreation/Aesthetics

Water level fluctuations in Seymour Lake may conflict with the recreational use of the area which is quite high. The lake itself is well developed for recreational use.

The Echo Lake Association filed a petition with the PSB on July 21, 1972, concerning water levels of Echo Lake. The petition alleged that CUC's use of the dam has caused the level of water in Echo to fluctuate beyond its natural maximum and minimum levels and has on one occasion permitted the water to be drawn down by as much as 57 inches. The association complained that this manipulation of water levels damages natural wildlife habitat, creates unsightly and unhealthy conditions, diminishes property values, and destroys Echo Lake's recreational value. The petition requested that a minimum water level be set for the lake. On November 15, 1972, the PSB dismissed the petition due to their lack of jurisdiction over the matter.

Echo Lake is used for swimming, fishing, boating, and picnicking. Recreational development includes a public boat launch. Access is provided by a public and private road.

Recommendations for Further Study

The management of water levels of Seymour Lake and Echo Lake, as well as flow releases from the two dams, should be discussed further with Vermont Fish and Wildlife to determine appropriate actions to assure compliance by CUC. The lakes should be reviewed together as the flow releases from Seymour dictate, in part, the flow releases and water levels of Echo Lake.

Based on a December 16, 1986, conversation with Vermont Fish and Wildlife, the Department understands that the Lake Seymour Association is in the process of working out a voluntary agreement with CUC. This agreement would allow the association to control the release of flow (which would in turn control lake level fluctuations) from both Echo and Seymour in an attempt to stabilize these releases. The Department should follow up to determine the results of this agreement and whether it is adequate to maintain the beneficial values and uses for which the lakes and streams are managed.

PROJECTS: West Charleston, Newport, Newport #11

a. West Charleston

Project Features

Lubber Lake is a manmade lake located on the lower part of the Clyde River in Charleston (Figure 26). West Charleston Dam is approximately 0.7 miles downstream of the Village of Barton's hydroelectric project on Pensioner Pond and approximately 2.2 miles upstream of Salem Pond. The project has a drainage area of approximately 107 square miles. An impoundment area extends approximately one-half mile upstream, with a surface area of approximately 40 acres and a usable storage of approximately 220 acre-feet.

The project utilizes a rock-fill and masonry dam with concrete facing, constructed around 1900, with modifications in 1927, 1955 and 1961. The dam extends 196.5 feet with a spillway of 106 feet (elevation 1059 feet). A single 19-foot square forebay extends to a 6-foot and an 8-foot diameter headgate. The bottom of the gate is located 16.33 feet below the crest of the dam. On the west end of the dam there was a 6-foot diameter sluicegate. The gate has been plugged with concrete and capped. Eighteen inch flashboards extend the length of the spillway. A 6-foot diameter steel penstock extends 1622 feet from the dam to the Charleston Plant. There is a gross head, as measured from the crest of the spillway, of 63.5 feet. The project bypasses approximately 1600 feet of stream.

West Charleston Plant's generation is regulated, to a large extent, by the discharge of water from the Village of Barton's hydroplant located upstream from Lubber Lake. Barton's discharge at full capacity greatly exceeds the discharge of the West Charleston Plant at full capacity.

In anticipation of Barton's generation, the Charleston generator is loaded prior to Barton's generation and allowed to continue generating after Barton has ceased generating. Thus, the reserve capacity of impoundment area is used as a buffer between Barton's Plant and the Charleston Plant.

The turbine is a horizontal twin runner rated at 1000 hp and is connected to an 800 kW generator.

Operating Mode

Under daily operating conditions, the drawdown is limited to 5.5 feet from the crest of the spillway (elevation 1053.5 feet). During maintenance of the intake areas and the dam, maximum drawdown capability is 16.33 feet. The project operates as a peaking facility under low and moderate flows. During low flow conditions, the project generates between 0 to 8 hours daily. During moderate flow conditions, the project generates approximately 16 to 18 hours daily. During high flow conditons, the project generates 24 hours daily. There are no minimum flow requirements.

The Department measured a leakage flow of 2.8 cfs on July 14, 1982, at a point 150 feet downstream of the West Charleston dam. The source of this flow was leakage from the penstock and wastegate. It can be assumed that this is the only flow maintained through the bypass during periods when no spillage is occurring at the dam. This flow is also probably the only flow maintained downstream of the project's powerhouse during periods of refilling the impoundment. This leakage flow is only 14% of the estimated 7Q10 value of 19.8 cfs at the dam.

b. Newport Dam

Project Features

Clyde Pond is a manmade lake located on the lower part of the Clyde River in Derby (Figure 26). Newport Dam is approximately 9.5 miles downstream of West Charleston Dam and approximately 2600 feet upstream of the Newport Diversion Dam. The project has a drainage area of approximately 140 square miles. An impoundment area extends approximately 4500 feet upstream, with a surface area of approximately 200 acres and a usable storage of approximately 2400 acre-feet.

The project utilizes a masonry dam with concrete buttress, concrete facing, and earthen section. It was constructed in 1918, with modifications and repairs in 1930, 1955, 1985, and 1986. The dam extends 713 feet, with a spillway of 324 feet (elevation 878 feet) and an earthen section of 347.5 feet.

The intake structure is located on the north end of the spillway. A 21-foot by 12-foot forebay extends to a 6-foot diameter headgate. The bottom of the gate is located some 17.2 feet (elevation 860.8 feet) below the spillway. Two 6-foot by 4-foot sluicegates are located on either side of the spillway. Fifteen-inch flasboards extend the length of the spillway. A 6-foot diameter steel penstock extends 50 feet from the dam, at

which point it bifurcates into a 6-foot and a 5-foot diameter penstock. The 6-foot penstock extends 2175 feet, and the 5-foot extends 1800 feet to the Newport Plant. A 4.5-foot diameter pipe connects the two penstocks together at the Newport Plant. There is a gross head, as measured from the crest of the spillway, of 140 feet. The project bypasses approximately 1600 feet of stream.

Newport Plant is comprised of three units. Units 1 and 2 are the primary hydro units, and unit 3 is utilized primarily during high water conditions. Units 1 and 2 are vertical Francis-type turbines, rated at 2400 hp each and connected to two 1700 kW generators. Unit 3 is a horizontal-type turbine, rated at 1000 hp, and is connected to a 600 kW generator.

Operating Mode

Under daily operating conditions, the drawdown is limited to 12 feet from the crest of the spillway (elevation 866 feet). During maintenance of the intake areas and the dam, maximum drawdown capability is 17.2 feet. The project operates as a peaking facility under low and moderate flows. During low flow conditions the project generates between zero and eight hours daily. During moderate flow conditions, the project generates 24 hours daily.

There are no minimum flow requirements at the dam. During the times that the project is pooling, in order to satisfy minimum flow requirements below the Newport Diversion Dam (FERC License 2306A), water is allowed to pass through Unit 1 or 2.

The Department measured a leakage flow of 2.0 cfs at a point 114 feet downstream from the dam on July 13, 1982. This flow is 8 percent of the estimated 7Q10 value of 28 cfs at the dam. The source of this flow was through the dam and bedrock.

c. Newport #11 Dam

Project Features

Newport #11 Dam (Newport Diversion Dam) is located on the lower part of the Clyde River in the City of Newport (Figure 26). Newport #11 Dam is approximately 2600 feet downstream of Newport Dam and approximately 7500 feet upstream of Lake Memphremagog. The project has a drainage area of 141 square miles. A diversion canal approximately 2170 feet long extends from the dam to the intake structure. The usable storage area is approximately 3.5 acre-feet.

The project utilizes a concrete gravity dam constructed in 1956 with modifications and repairs in 1981. The dam extends 114 feet with a spillway of 90 feet (elevation 741 feet). A 4-foot by 4-foot sluicegate is located in the west abutment of

the dam. The bottom of the gate is 12 feet below the crest of the dam (elevation 729 feet). The intake structure is located at the end of the 2170-foot canal and contains a 10-foot headgate. A 10-foot diameter steel penstock extends 80 feet to the powerhouse. There is a gross head of 57.5 feet. The project bypasses 2600 feet of stream.

Newport #11 Plant's generation is regulated by the output of the Newport Plant. The turbine is a vertical leffel-type rated at 2400 hp and is connected to a 1920 kW generator.

Operating Mode

Under daily operating conditions, the drawdown is limited to 3.5 feet from the crest of the dam (elevation 737.5 feet). During maintenance of the intake areas and the dam, maximum drawdown capability is 12 feet. The project operates in conjunction with the output of the Newport Project 2306B. The operation of the dam is further regulated by the following article in the FERC license.

"Article 24. The Licensee shall make water releases in the interest of fish and wildlife in accordance with the following schedule:

(iii) At Unit No. 11 Dam

(a) Discharge at least five cubic feet per second of water continuously through the sluice gate in the dam.

(b) For the period April 15 to June 15 of every year discharge continuously at least ten cubic feet per second of water through the sluice gate in the dam.

(c) For the period September 15 to November 15 of every year discharge continuously at least ten cubic feet per second of water through the sluice gate in the dam."

A Department review of flow data for water years 1971 to 1977 recorded at the USGS gage (04296500) located a mile downstream of the Newport #11 dam indicated violations of these minimum flow requirements for a total of 155 days. On a site visit to the project in 1980, the Department observed violations of the minimum flow requirement on August 27 and 28 as well.

The Department measured a leakage flow of 12.2 cfs 75 feet downstream of the dam in July 13, 1982. This flow is 47% of the estimated 7Q10 value of 28 cfs at the dam. The source of this flow was through the sluice gate.

Environmental Review

a. Water Quality

Point source discharges on the Clyde River include the Island Pond STP 10 miles upstream of West Charleston Dam with a total permitted discharge of 0.150 mgd and the City of Newport STP located one mile downstream of the Newport #11 dam with a total permitted discharge of 0.975 mgd.

The Clyde River in the stream section from Island Pond to Lake Memphremagog was designated by the Department in 1982 as a water quality limited segment. From Island Pond to Derby Center water quality problems are due to phosphorous and nonpoint agricultural sources. From Derby Center to Lake Memphremagog, water quality problems are due to municipal wastes and phosphorus. The lack of adequate flows below the West Charleston and Newport projects during periods of impounding and the lack of adequate flows over these dams for reaeration may contribute to the water quality problems through this river reach.

The Department collected temperature and D.O. data from stations at the West Charleston, Newport, and Newport #11 facilities in 1982. The data indicates supersaturated D.O. concentrations at points above and below each project with some D.O. depletion occurring at Lubber Lake. No early morning data was collected to measure the impact of algal respiration on D.O. In addition, the Department's 1974 Water Quality Management Plan for the Lake Memphremagog Basin states that Clyde Pond, the impoundment for the Newport project, is typed mesotrophic to eutrophic. The trophic type varies due to the pond's short mean hydraulic residence time of 3.6 days. Salem Pond is located upstream and is also typed mesotrophic to eutrophic. The trophic type of Salem Pond probably dictates the trophic type of Clyde Pond.

b. Fisheries

The Clyde River is important not only for resident fish species such as smallmouth bass, largemouth bass, rainbow trout, and brown trout, but also for spawning of walleye and for spring feeding runs and fall spawning runs of the famous Memphremagog strain of landlocked salmon.

The construction and operation of the West Charleston, Newport, and Newport #11 projects have significantly impaired fisheries, particularly the salmon. This impact is well documented in a report prepared by the Department of Fish and Game (now Fish and Wildlife) entitled "Clyde River Job Performance Report" and dated June 15, 1979. Reference should be made to this report for a complete description of this impact. To briefly summarize, substantial fall salmon spawning runs exited within the river until the 1940's when facilities began operating as peaking projects. Extreme water fluctuations resulted in the loss of natural production, decreasing the number of salmon entering the river to successfully spawn. In addition, further encroachment and the loss of salmon habitat occurred with the construction of the Newport #11 diversion dam which

eliminated the spawning areas as well as creating reduced flows in a substantial portion of the normal river course. Vermont Fish and Wildlife states that the required flows from the Newport #11 project pursuant to Article 24 of the Federal Energy Regulatory Commission license are inadequate for restoration and maintenance of a significant, naturally reproducing landlocked salmon population in the lower Clyde River.

Article 20 of the Federal Energy Regulatory Commission license for these projects requires the utility to "arrange for construction, maintenance and operation of ... protective devices and shall comply with such reasonable modification of the project structures and operation in the interest of fish and wildlife resources...." In accordance with this provision, the Department began a detailed study of the flow and fish passage problems on the Clyde River in 1978. The Agency petitioned the U.S. Department of the Interior in 1978 regarding the State of Vermont's desire to direct and to observe the provisions and mandate of Article 20. The Department conducted a FFNA study below the Newport #11 project in 1980 and initiated another study below West Charleston Dam in 1983. The Department anticipates the completion of the study below West Charleston Dam in 1987.

Article 21 of the FERC license also makes reference to fish handling facilities at these projects.

c. Recreation/Aesthetics

The lack of minimum flows at all project dams and "bathtub rings" at Clyde Pond and Lubber Lake impair the aesthetics of these projects. Drawdowns at both Clyde Pond and Lubber Lake, and fluctuating flows below all three projects, conflict with the recreational use of the Clyde River. Department records indicate that recreational development at all three projects is quite limited. The only access is via private roads to the impoundments. No recreational development was reported below each project; however, state highways follow the Clyde from West Charleston Dam downstream to Lake Memphremagog. The Department finds that recreation potential is moderate to high at Clyde Pond and moderate at Lubber Lake. Recreational potential below these projects is high for fishing.

d. Erosion/Sedimentation

Bank erosion was observed at both Clyde Pond and Lubber Lake due to the daily drawdowns. Some erosion was observed below the tailrace at the Newport #11 project.

Recommendations for Further Study

a. A water quality sampling program should be conducted on the Clyde to assess the impact of the West Charleston, Newport and #11 projects. Early morning temperature and D.O. data should be collected as part of this study.

b. The study of flow and fish passage problems on the Clyde River should be completed, and recommendations thereof should be made.

c. The need for recreational development at the projects should be determined. Article 30 of the FERC license required the utility to file a recreational use plan for the Clyde River Projects. This plan should be located and reviewed as part of this determination.

Recommendations

a. Minimum flow requirements should be established in the bypass and downstream of the West Charleston station following completion of the FFNA study.

b. Minimum flow requirements should be amended for the Newport #11 station bypass and expanded to encompass the river reach below the powerhouse. Further, a minimum flow requirement should be established for the Newport station and bypass to assure provision of adequate flows to meet the Newport #11 requirements for protection of fishery resources, water quality, and aesthetics as applicable.