
RECONNAISSANCE REPORT

Shetucket River

Sprague (Baltic), Connecticut

LOCAL ICE JAM FLOOD PROTECTION



MAY 1995



US Army Corps
of Engineers
New England Division

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LOCAL ICE JAM FLOOD PROTECTION

**VILLAGE OF BALTIC
SPRAGUE, CONNECTICUT**

**RECONNAISSANCE REPORT
MAY 1995**

**NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149**

**VILLAGE OF BALTIC
SPRAGUE, CONNECTICUT
LOCAL ICE JAM FLOOD PROTECTION
RECONNAISSANCE REPORT**

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**VILLAGE OF BALTIC
SPRAGUE, CONNECTICUT
LOCAL ICE JAM FLOOD PROTECTION
RECONNAISSANCE REPORT**

EXECUTIVE SUMMARY

This reconnaissance scope study was conducted under the special continuing authority contained in Section 205 of the 1948 Flood Control Act, as amended. It investigated alternative measures to eliminate recurring ice jam flood damages to the Village of Baltic in Sprague, Connecticut.

The Town of Sprague is located along the Shetucket River in east-central Connecticut. The town is approximately 6 miles north of Norwich, Connecticut and 18 miles north of New London, Connecticut. The Shetucket River, with a total drainage area of approximately 1,264 square miles flows south to Norwich, where the river meets with the Yantic River to form the Thames River.

This report describes the plan formulation process that resulted in the selection of a plan for ice jam flood control. The selected plan involves construction of 13 concrete monoliths across the Shetucket River, located about 500 feet upstream from the Main Street bridge (Route 97). In addition to the monoliths, a 21 inch thick rock blanket would be placed at the base of the monolith structures. Stone protection would also be placed at the entrance of the overflow channel as part of this proposed plan.

The estimated first cost of this plan is \$360,000 with an annual cost of \$29,600. Total annual benefits associated with the monolith structures are estimated at \$51,200. The project is therefore economically justified with a benefit to cost ratio of 1.7 to 1.

On April 12, 1995, the Corps met with officials of the State of Connecticut Department of Environmental Protection and the Town of Sprague to discuss the study findings. State and local officials indicated that they will not support further Corps study of the proposed ice control structure due to high non-Federal cost for the feasibility study. Instead implementation will be carried out by a partnership of state and local resources. Consequently, since a Federal project lacks a non-Federal sponsor, all further Federal

involvement has been terminated. However, the town may work with the State of Connecticut to continue with the proposed project.

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**VILLAGE OF BALTIC
SPRAGUE, CONNECTICUT
LOCAL ICE JAM FLOOD PROTECTION
RECONNAISSANCE REPORT**

INTRODUCTION

On January 29, 1994, an ice jam occurred on the Shetucket River downstream of the Route 97 bridge in the Village of Baltic, Town of Sprague, Connecticut. The 1994 flood event damaged 31 houses and 4 commercial buildings. One house was severely damaged when the ice broke through the masonry block foundation wall. Because of the severe ice jam flood, this study was initiated at the request of State of Connecticut and Town of Sprague officials.

This report presents the results of reconnaissance scope investigations of recurring ice jam flooding in the Village of Baltic, Town of Sprague, Connecticut. It documents the plan formulation process that has resulted in positive findings for providing ice jam flood control along a portion of the Shetucket River.

This reconnaissance study phase is the first of a two-phase planning process and provides the basis for continuing into the feasibility phase. Detailed engineering, economics and environmental coordination during the feasibility phase will result in a viable, cost efficient and acceptable plan of improvements for local ice jam flood protection.

STUDY AUTHORITY

This report was prepared under the special continuing authority contained in Section 205 of the 1948 Flood Control Act, as amended. This authority specifies that, not more than \$5,000,000 shall be allowed for Federal participation in a project at any single locality. The work shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation. Items of local cooperation, including cost sharing, shall be provided by a legally empowered and financially responsible local sponsor.

Cost sharing responsibilities are 50% Federal and 50% non-Federal for preparation of the feasibility phase detailed project report (DPR). Additionally, 75% Federal and 25% non-Federal are required for the cost shared construction cost which include engineering, design and construction management.

DESCRIPTION OF STUDY AREA

The Town of Sprague is located in east-central Connecticut about 6 miles north of Norwich, Connecticut. The Town of Sprague is bordered by the Town of Scotland to the north, the Town of Canterbury to the northeast, the Town of Lisbon to the east, the City of Norwich to the south, the Town of Franklin to the west and the Town of Windham to the northwest.

The Shetucket River is formed by the confluence of the Willimantic and Natchang Rivers below Willimantic, Connecticut. The river flows south to Norwich, where its confluence with the Yantic River forms the Thames River. The Shetucket River has a total drainage area of approximately 1,264 square miles and is approximately 18 miles long.

The Village of Baltic is a section of Sprague located about 9 miles upstream from the Thames River confluence. The total drainage area at Baltic is 460 square miles. There are two hydro-electric dams which affect river discharge through Baltic. The Scotland Dam is located about 4 miles upstream and the Occum Dam is located about 2.2 miles downstream from the Main Street bridge (Route 97) in Baltic.

Since 1956, the town has experienced several ice jams during mid- to late winter, usually in January and February. Prior to 1956, no ice-related flooding was recorded in the village, probably because Baltic Dam, which breached in 1955, controlled the ice upstream of the populated area of the village.

These breakup jams form when solid ice cover on the Shetucket River breaks up and moves downstream. It appears as though most of the ice, causing problems in Baltic, comes from the 2-mile river reach between Scotland Dam upstream on the Shetucket River and the Village of Baltic. The slope of the river through this reach is very flat and the channel meanders, causing ice floes to lose momentum and slow down. In addition, Occum Dam is located about two miles downstream of the village, and its backwater causes a thick and

stable floes. The ice jams tend to remain intact until significant pressure is built up behind them to dislodge the jam and move it downstream.

In the mid-1950s, the Corps was requested by the town to provide assistance during non-ice related flooding. As a result, a PL99 earth berm was built along the low lying residential area. This berm has a top elevation of about 77.5 feet NGVD, and top width of about 8 feet. Although the berm does not tie into high ground, it does provide protection against an approximate 10-year flood event.

On 29 January 1994, ice jammed in the Village of Baltic. The ice jam, about three-fourths of a mile in length, was grounded in numerous locations. Based on average ice thickness of 18 to 20 inches, the jam appeared to be about 8 feet thick in several locations. Floodwaters behind the jam overtopped the PL99 berm, inundating several homes and businesses. Eventually, a channel opened under the ice to allow some discharge to pass the jam and the flood area drained, but the jam remained in place.

The principal ice jam flood problem area is located adjacent to Route 97. It extends a distance of about 2200 linear feet from a drainage culvert under Route 97 that drains a low area to the south of the State Highway to an area upstream of the Blanchette Field at River Drive (see Plate 1).

It is estimated that there are 84 structures in the 500 year flood plain, 77 of which are residential structures, 4 are commercial structures and 3 are public buildings. The January 1994 ice jam, estimated to be a 12 year return interval ice affected event, flooded 31 residential structures and 4 commercial properties, located on River Drive and Route 97 in areas upstream and downstream of Blanchette Field.

EXISTING CONDITIONS

PHYSICAL SETTING

The study area lies within the Eastern Connecticut Highland region. Local relief of up to 200 feet is typical. Drainage is generally to the south. Elevation of the river bed at the proposed project location ranges from 67 feet NGVD at its deepest point, to about 75 feet NGVD at its banks. Topography in the study area has been influenced by four factors: presence of bedrock, the effects of glaciation, river processes, construction and alteration by man.

Upstream of the proposed project location, the Shetucket River flow is bounded by its floodplain, (elevation 80 feet NGVD). On the west side of the river, the floodplain is long and crescent shaped, and between 150 feet and 500 feet wide. On the east side of the river, the floodplain is wedge shaped, and shorter and narrower than the west side. The long, flat area on the west side of the river is the proposed overflow channel. Beyond this area on the west side, there is a steep-faced rock outcrop, reaching a maximum elevation 200 feet higher than the floodplain. Beyond the floodplain on the east side of the river, the land rises another 50 feet above the elevation of the floodplain.

The bedrock geology of New England is the result of a complicated history of orogeny, intrusion, and metamorphism. Bedrock in the study area consists of pre-Pennsylvanian aged metamorphic rock types. Large bedrock outcrops occur along the west side of the floodplain. Depth to bedrock in the river channel is not known, however, it is expected to occur at sufficient depth not to impact construction of the proposed project.

Glacial deposits occur along either side of the Shetucket River floodplain. Along the west side, glacial till is mapped as a thin mantle over the underlying bedrock (amid bedrock outcrops). Along the east side, stratified drift deposits are mapped along the terrace above the floodplain, at an elevation of 130 feet NGVD. It is believed that the major drainage patterns in the study area were not significantly altered by glaciation, and that the Shetucket River is probably flowing in a valley that was carved out prior to glaciation. The former bedrock valley has since been filled with an unknown thickness of glacial stratified drift and/or till materials and alluvium, over which the present river flows.

In January 1994, two borings were taken in the general vicinity of the proposed ice control structures by Lenard Engineering, Inc. Materials encountered in the borings consisted mainly of dense well-graded, medium to coarse gravelly sand and sand with gravel. A few of the samples contained silt and were slightly plastic. Both borings were greater than 70 feet deep, and bedrock was not encountered in either of them. Detailed geotechnical evaluation of the study area is presented in Appendix B - Geotechnical Assessment.

ENVIRONMENTAL SETTING AND RESOURCES

The proposed project is located in Baltic, Connecticut along the Shetucket River. Baltic is the largest of three villages that make up the Town of Sprague, which is located in New London County in eastern Connecticut. The Shetucket River flows through Baltic along a nearly north-south orientation, while nearby Beaver Brook winds through the center of the village and empties into the Shetucket River near the Town Hall. The Providence and Worcester Railroad (Willimantic Branch) passes through the town from east to west.

The Shetucket River adjacent to the project area is known to support a variety of freshwater finfish. The area between the Scotland Dam in Scotland and the Route 97 bridge in Baltic has been evaluated for its potential to support holdover brown trout. This area is also known for its abundant smallmouth bass population. Besides smallmouth bass and trout, other species such as blacknose dace, fallfish, tessellated darter, spottail shiner, American eel and white sucker are found in this area. A warmwater fish community such as largemouth bass, rockbass, chain pickerel, various sunfish species, yellow perch, white sucker, golden shiner, spottail shiner and brown bullhead are expected in the impounded areas of the Shetucket River.

The area selected to be utilized as an overflow currently exists in agricultural production along the Shetucket River floodplain. The size of the floodplain field which will be utilized as an overflow area roughly measured approximately 40-50 acres and was used last season in corn production. Riparian vegetation bordered the river bank within the proposed project area. The western edge of the floodplain contained a freshwater wetland which also served as an outer drainage ditch, catching water runoff from the field as well as the hillside. Fishing, hunting and off-road vehicle tracks were noted in the project area.

Species of wildlife identified in the area included Red-tailed hawk, blue jays, cardinal, song sparrows, tree sparrows, American robin, blackbirds, red-winged blackbirds and cowbirds. Whitetailed deer tracks and beaver activity dominated the project area. Species of vegetation noted include hemlock, black walnut, sycamore, silver maple, black cherry, pussy willow, birch, aspen (poplar), oaks, ash, sumacs, cedars, bittersweet, raspberry, rose, poison ivy and phragmites sp.

Except for the occasional transient bald eagles or peregrine falcons, no other federally listed or proposed threatened and endangered species under jurisdiction of the U.S. Fish and Wildlife Service occur in the study area. The State of Connecticut Natural Diversity Data Base has indicated no endangered, threatened or special concern species are present in the subject area. The Environmental Resource Reconnaissance Report for this study is contained in Appendix C.

PROBLEM DESCRIPTION

During a thaw period in late January 1994 floating river ice jammed in an area below the Route 97 Bridge which is in the backwater area of the Occum Dam pool. Sheet ice in the pool basically kept the floating ice from moving further downstream. Because the floating ice jammed the river, the river discharge went "out of bank" in a low land area located about 2,000 feet downstream from the Route 97 bridge and inundated residential areas along River Drive and State Highway 97 and a large recreation field (Blanchette Field). The force of the water caused structural damage to several house foundations along Route 97. About 16 acres were under water before the flood receded (see following flood photos). A total of 31 houses and 4 commercial structures including a general store and a gas station experienced flood damages in a 2,200 foot long reach of the Shetucket River.

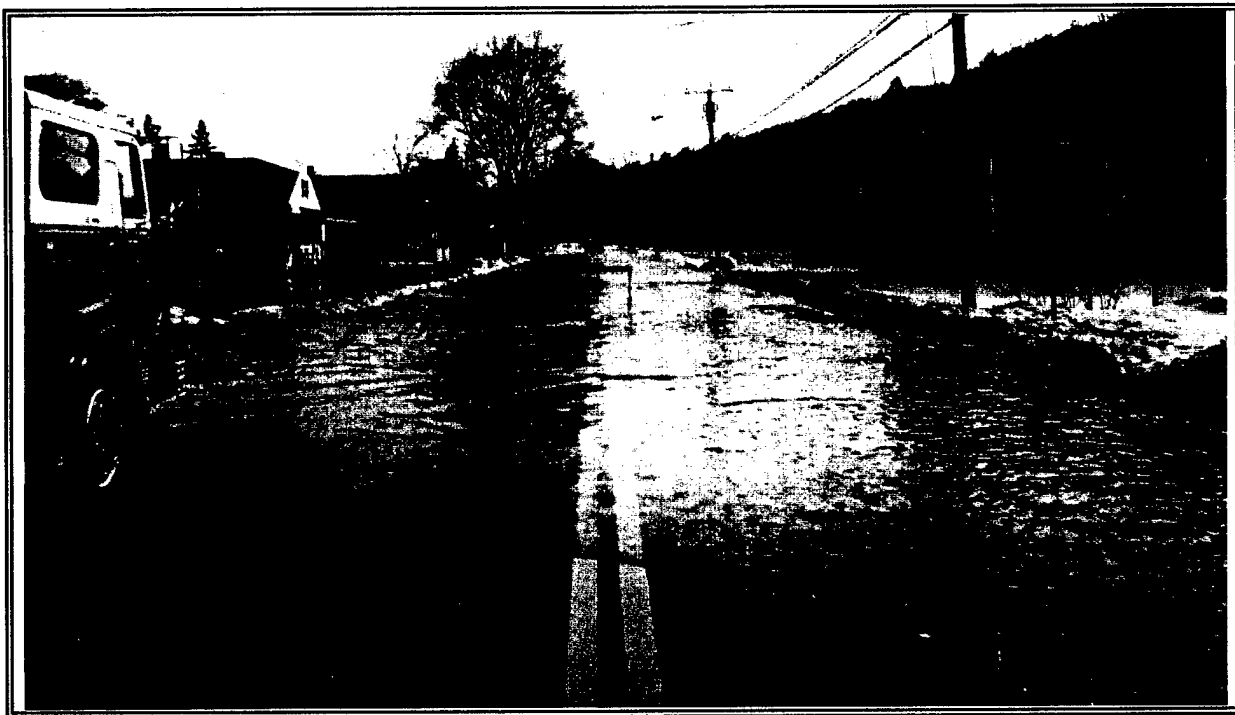


PHOTO 1: MAIN STREET LOOKING DOWNSTREAM

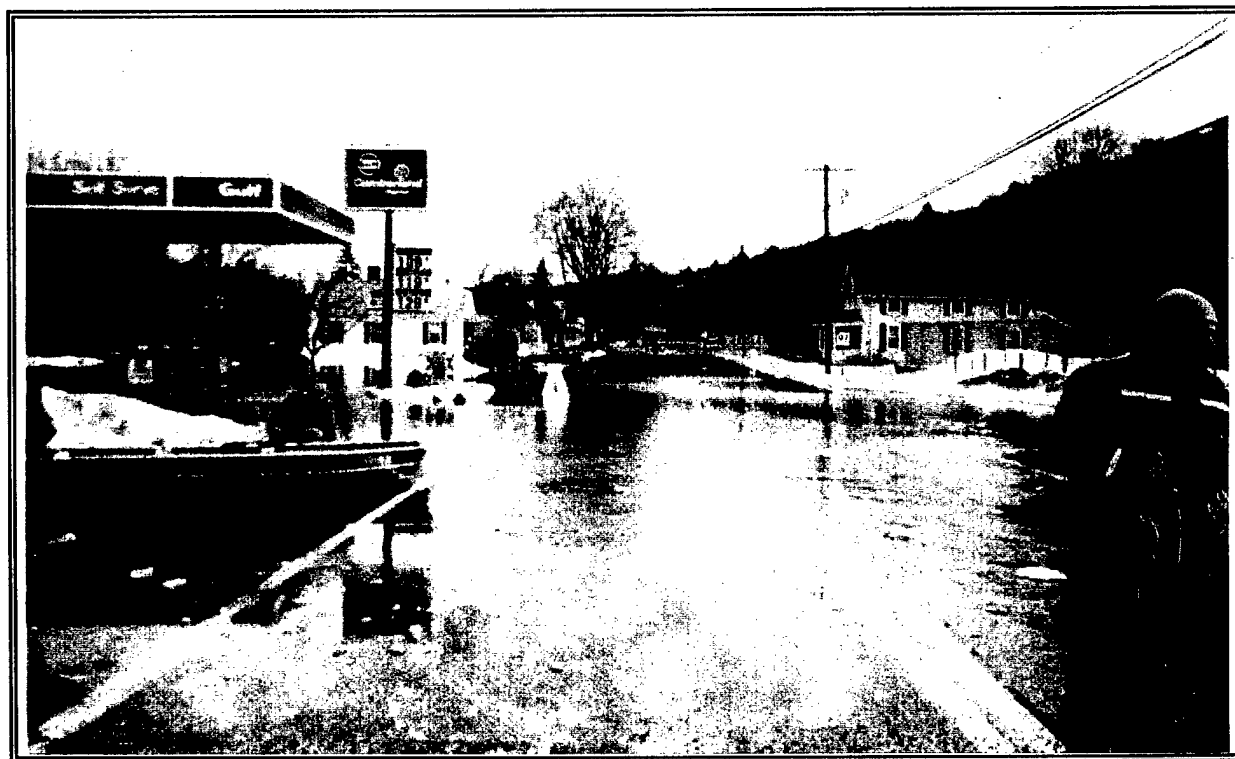


PHOTO 2: MAIN STREET LOOKING DOWNSTREAM



PHOTO 3: RIVER STREET LOOKING DOWNSTREAM

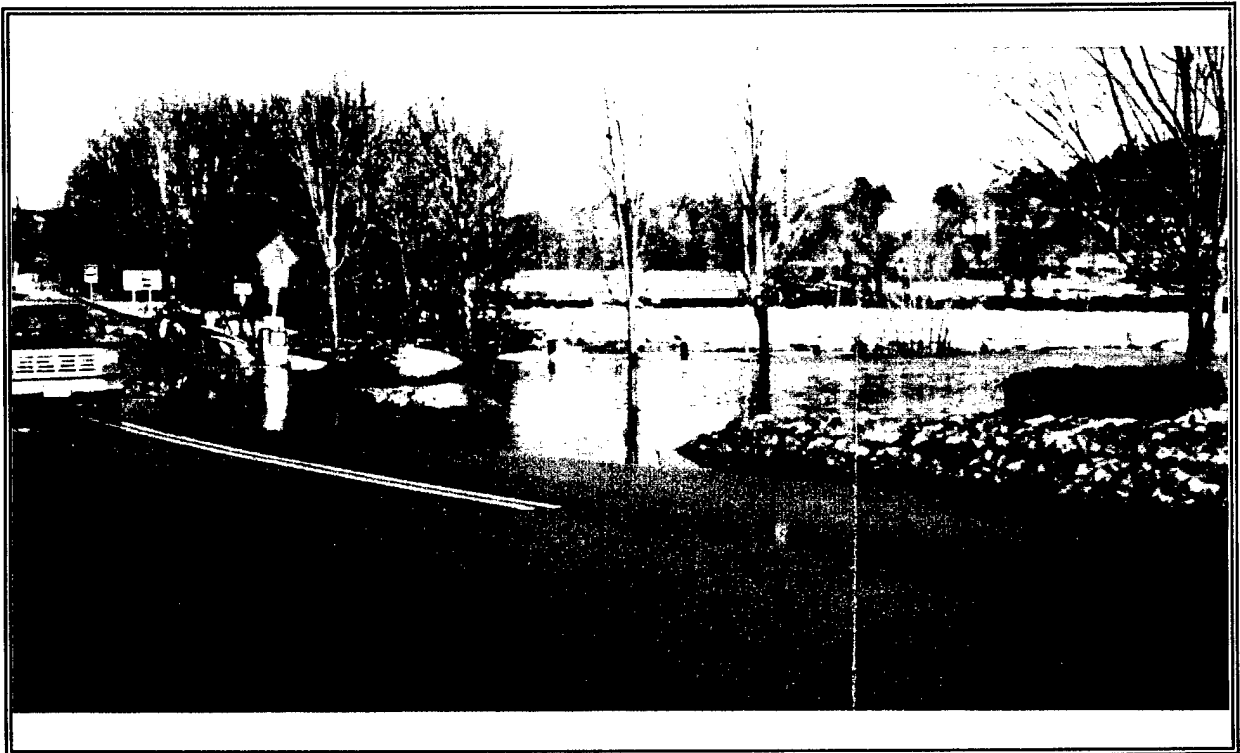


PHOTO 4: RT. 97 BRIDGE LOOKING ACROSS FROM MAIN STREET

PLAN FORMULATION

Prior to formulating plans for providing ice jam flood protection in the Village of Baltic, an assessment of "without project" conditions was accomplished to determine impacts to the area and the community if an ice jam flood control project was not implemented. This evaluation disclosed that recurring ice jam floods would continue to negatively impact on flood prone properties damaged in the January 1994 flood and also to other nearby property if higher river discharges and flood elevations occur in the future. Damages to structures and contents will require further payment of subsidized flood insurance to owners after each flood event and would also negatively impact on the tax base of the community.

DESCRIPTION OF ALTERNATIVE PLANS

Five separate plans for ice jam and non-ice flood control were initially investigated to determine their feasibility and acceptability to local officials and citizens and cost efficiency. These plans included:

- (1) Dikes and Walls
- (2) Diversion
- (3) River Dredging
- (4) House Raising
- (5) Ice Retention Structures

Dikes and Walls: A 3,500 foot long earth dike, with a top elevation of about 85.5 feet NGVD (approximately 15 feet high), would prevent flooding associated with an ice-affected event having frequencies of up to once in 100 years (1% chance flood). This earth dike would be constructed of impervious earth materials with a layer of stone slope protection and gravel bedding on the riverside face. An existing 1,000 foot long earth berm; constructed by the Corps of Engineers as an emergency measure, was not considered to be a permanent structure, and would be removed and replaced as part of this new dike construction. A pumping station and interior drainage facilities would also be required to prevent ponding of interior storm runoff. With regard to concrete walls it was determined that this alternative would be more expensive than the earth dike option. The concrete structure is estimated to cost about \$4.8 million as compared to \$3.7 million for the earth dike option. Both of these

options are not cost efficient and, as such are not recommended for further study.

Diversion: There is an existing abandoned canal along the east bank of the river that extends from upstream of the Route 97 bridge to an area opposite the upstream end of River Drive. This canal was utilized as a mill race prior to 1955, when the mill dam was breached. Diverting flows through the mill canal during ice jams is not a feasible option, due to the fact the ice jams occur just downstream of the Blanchette Field and the mill canal reenters the river upstream of this area. Therefore, an extension approximately 1,000 feet would have to be constructed for the canal, so that flood flows can be passed around the damage area effectively. However, the steep topography in the area of the mill race outlet precluded an extension of the mill canal due to excessive costs. Consequently, this plan was not investigated further.

River Dredging: The slope of the Shetucket River is very flat and the channel meanders between the former Baltic Dam and Occum Dam. Even with no flow in the river, backwater from Occum Dam would extend upstream to the problem area. Therefore, removing sediment deposits from the river channel is not expected to improve the ice jam situation in Baltic and would not be environmentally acceptable. Since Occum Dam is a major control in the river's hydraulics and has limited outlet capacity (900 cfs turbine capacity), dredging the river channel to increase the river bed slope would not significantly change the hydraulic gradient through this reach. This alternative was not considered for further study.

House Raising: A plan for house raising would include elevating the first floor of impacted structures within the 100 year flood plain above the 100 year flood level. To meet this criteria, the first floor of the 36 houses in Baltic would have to be raised approximately 10 feet higher than the existing first floor elevation. The process for raising houses includes separating the wood frame structure from the building foundation and jacking the carrying beams to the desired elevation. The existing foundation is rebuilt or extended to the raised beams and the building is set onto the raised foundation. Utilities such as water and sewer lines are extended and heating systems are raised to the first floor so that they are not damaged during flood periods. The new cellar space cannot be utilized as it must be allowed to flood so that hydrostatic pressure does not destroy the foundation. It is estimated that it would cost about \$1.4 million to raise 36 structures. Due to the high costs for raising, this alternative was not considered further.

Ice Retention Structures: Ice retention structures are constructed upstream from flood problem areas. They function independently or in conjunction with overflow weir construction by holding floating ice or cover ice in place, while passing river discharges under or around the resulting ice jam. Any overflow discharge is returned to the river channel downstream from the retention structures and river overflow into the flood damage areas is prevented.

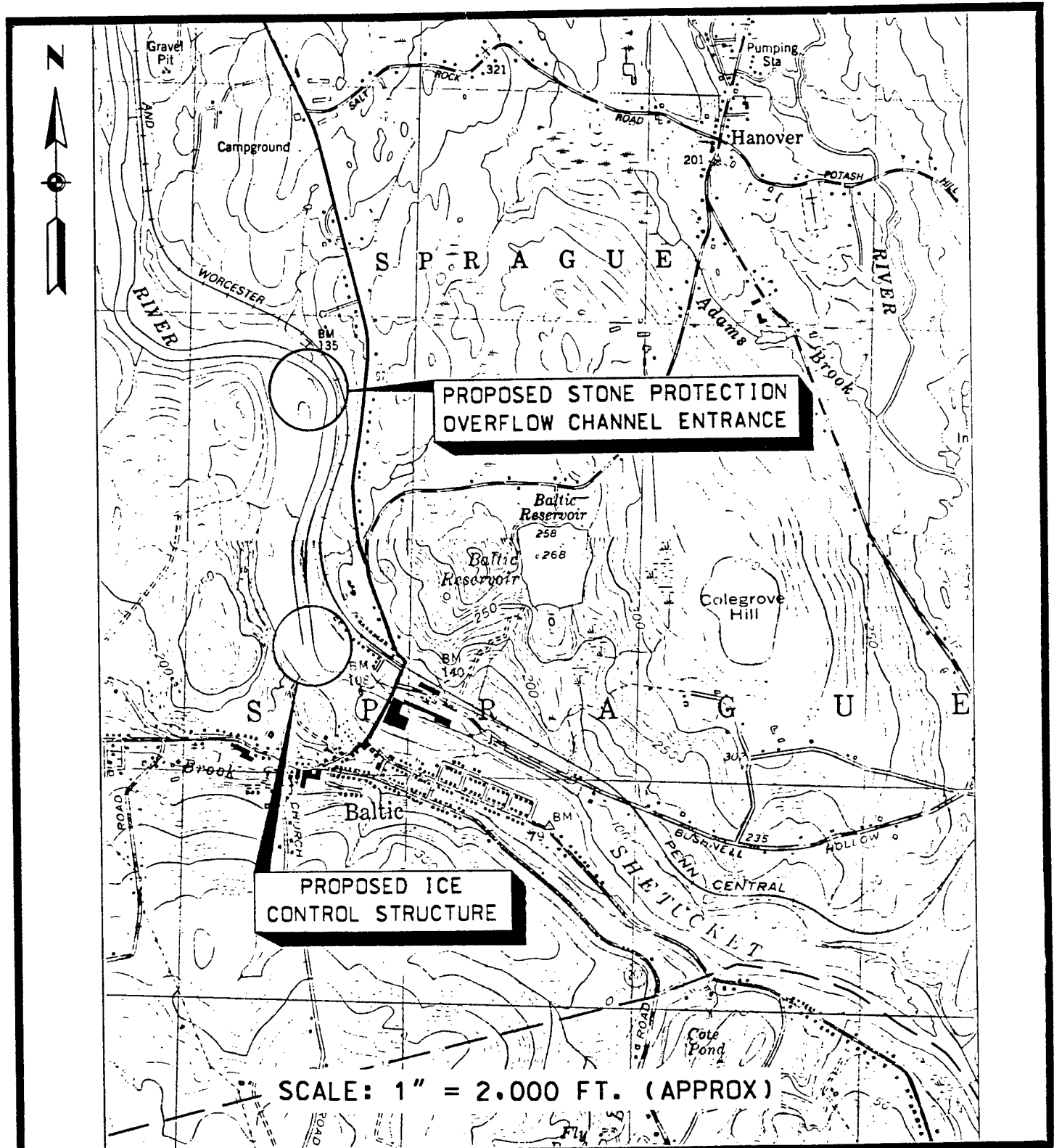
Ice retention structures include those that are tied to the river bottom such as rock filled timber cribs, large precast concrete blocks or granite blocks or floating barriers such as log booms or steel cable nets. Because the channel upstream from Route 97 bridge has a slight gradient it is anticipated that river velocities would cause floating river ice to overtop any floating structures. Therefore those were not considered further.

Initial studies conducted in this reconnaissance level study determined that the construction of concrete monoliths would be the most cost efficient plan for preventing future ice jam flooding of residential and commercial structures in Baltic.

SELECTED PLAN

The proposed plan of improvements includes the construction of concrete monoliths across a 165 foot wide section of the Shetucket River, located about 500 feet upstream from the former Baltic Dam. Thirteen monoliths, spaced 12 feet on centers, would be placed in a straight line across the river (see Plates 2 & 3). Each monolith would be 4 feet wide by 12 feet long and an average of 8 feet high above the river bottom (see Plates 4 & 5). The downstream face of the monoliths would be vertical while the upstream face would have a 2 vertical to 1 horizontal slope. The monoliths would be held in place below the river bed to prevent undermining by scour.

A 21-inch thick rock blanket on a one-foot-thick gravel bedding layer would be placed in dry conditions, or a 30-inch thick rock blanket on a one-foot-thick gravel bedding would be placed under water, across the river width at the crib site to prevent scour caused by the increased river velocities that would occur due to the instream restrictions. The blanket would be about 165 feet long, extending about 75 feet downstream of the monoliths. The rock blanket extends up the river banks and approximately 5 feet into the overflow channel.

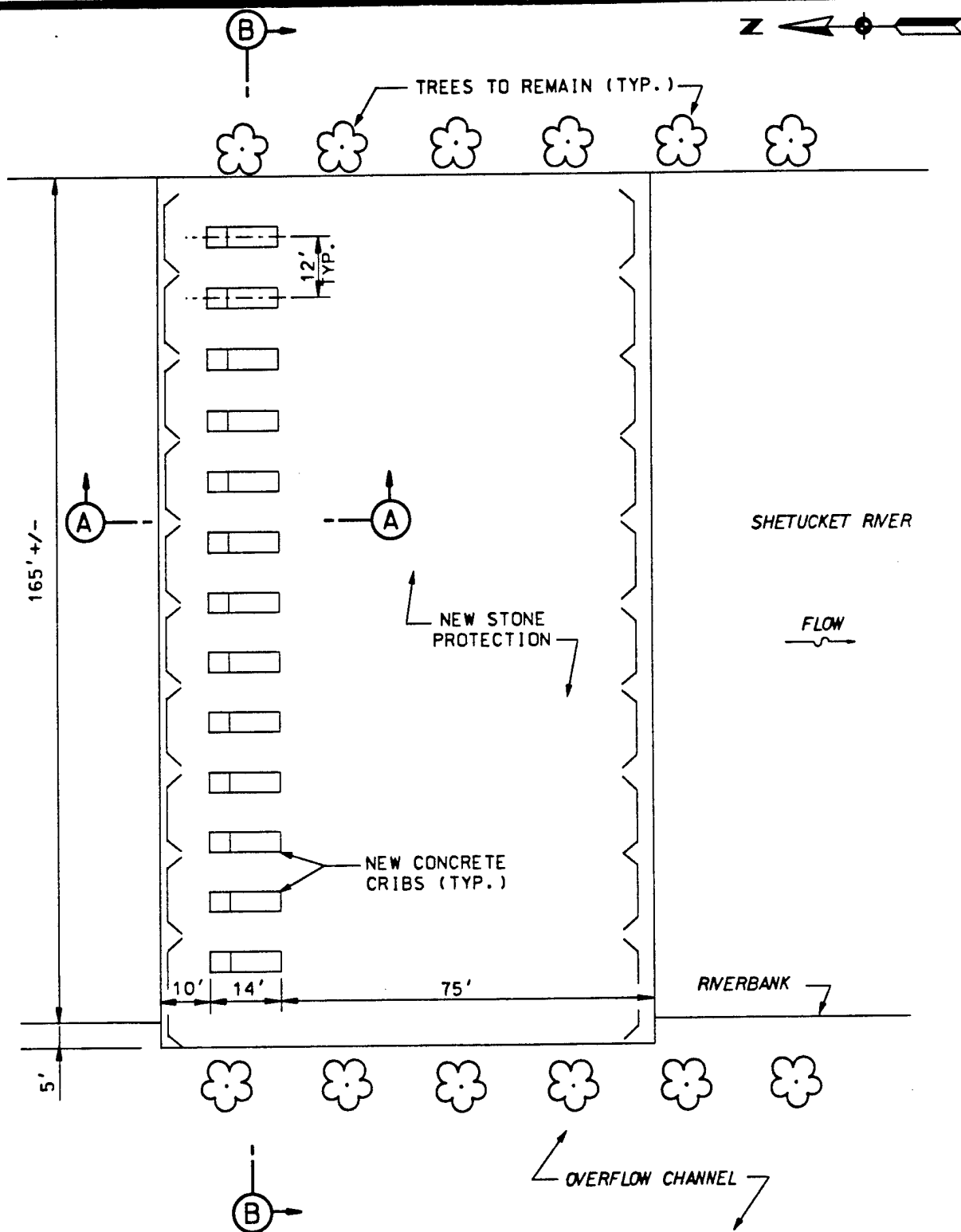


**LOCAL ICE JAM FLOOD PROTECTION
SHETUCKET RIVER
SPRAGUE (BAL TIC), CONNECTICUT**

SITE PLAN

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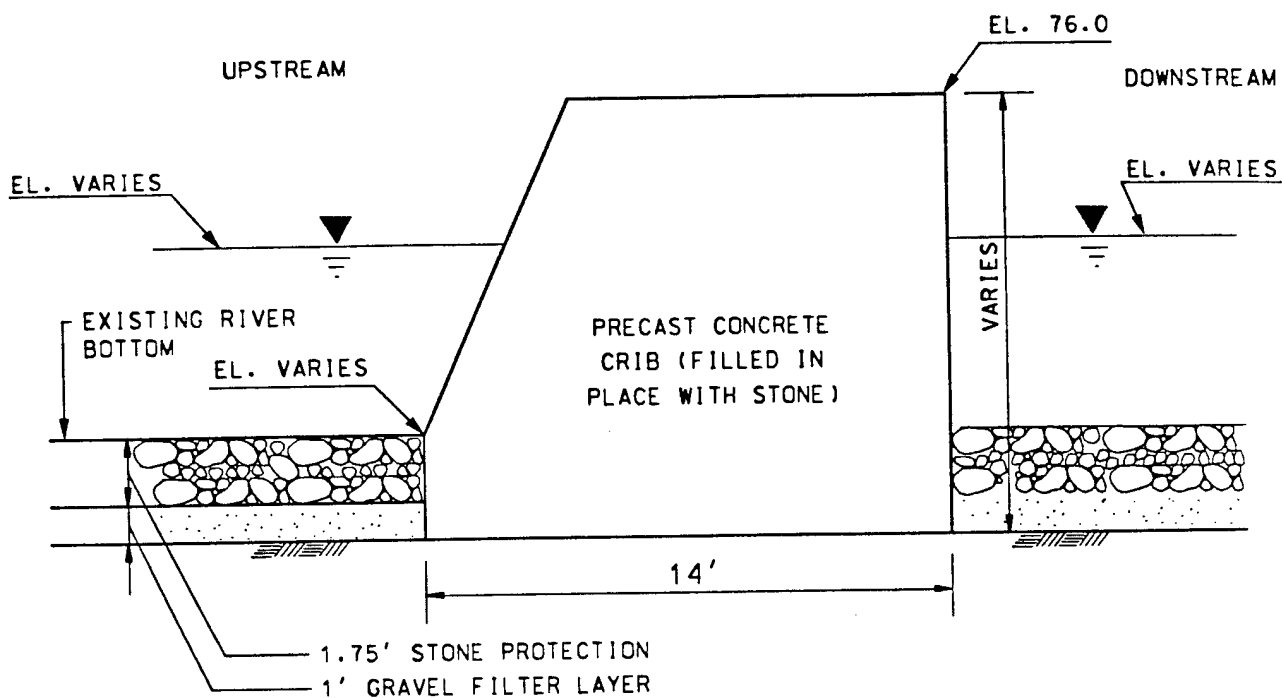


**LOCAL ICE JAM FLOOD PROTECTION
SHETUCKET RIVER
SPRAGUE (BAL TIC), CONNECTICUT**

GENERAL PROJECT PLAN

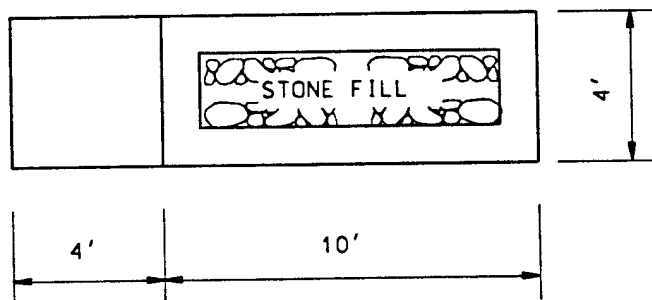
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SECTION A - A

SCALE: 1" = 5'



PLAN - PRECAST CONCRETE CRIB

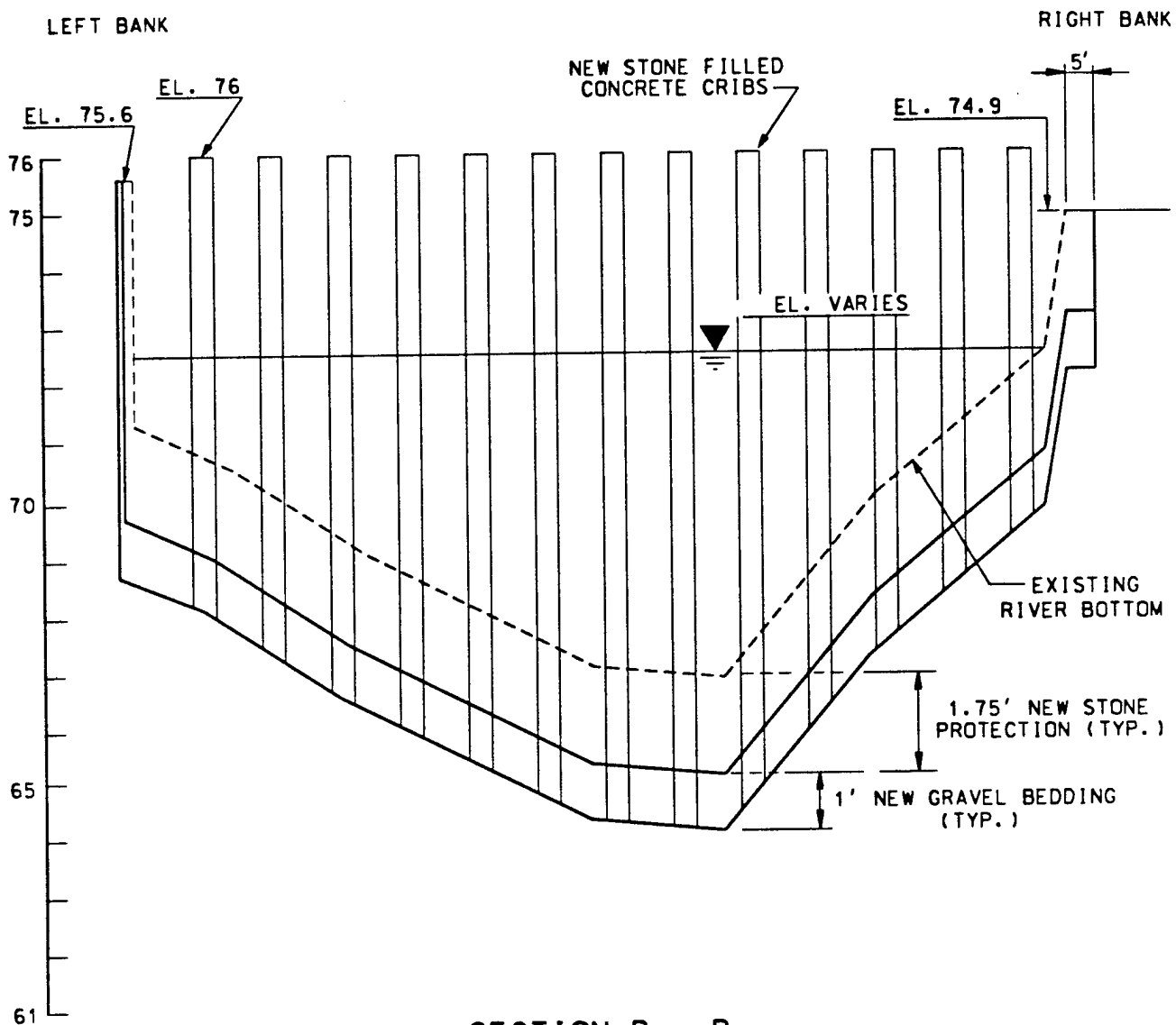
SCALE: 1" = 5'

**LOCAL ICE JAM FLOOD PROTECTION
SHETUCKET RIVER
SPRAGUE (BAL TIC), CONNECTICUT**

PRECAST CONCRETE CRIBS - SECTION A-A

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SECTION B - B

SCALE: HOR. 1" = 30'
VER. 1" = 3'

LOCAL ICE JAM FLOOD PROTECTION
SHETUCKET RIVER
SPRAGUE (BAL TIC), CONNECTICUT

PRECAST CONCRETE CRIBS - SECTION B-B

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In addition to the rock blanket, stone protection would be constructed in the area where river flows enter the designated overflow area during ice jam flood periods. The exact location of the rock berm will be determined during the Feasibility phase (see Plate 6).

CONSTRUCTION CONSIDERATIONS

Site Access: To construct the concrete monoliths, access to the proposed project site may be required from both river banks as well as access along the right bank to the proposed new stone protection at the entrance to the overflow channel. Along the right bank of Shetucket River from the Route 97 bridge, an existing unpaved road will provide access to the two proposed sites of the concrete monoliths and the overflow channel stone protection. Along the left bank of the river, an existing road and parking lot extends only halfway (700± feet) northward from the Route 97 bridge to the proposed monoliths location. An additional 800 feet of access road from the end of the existing road to the proposed monolith structures may be required.

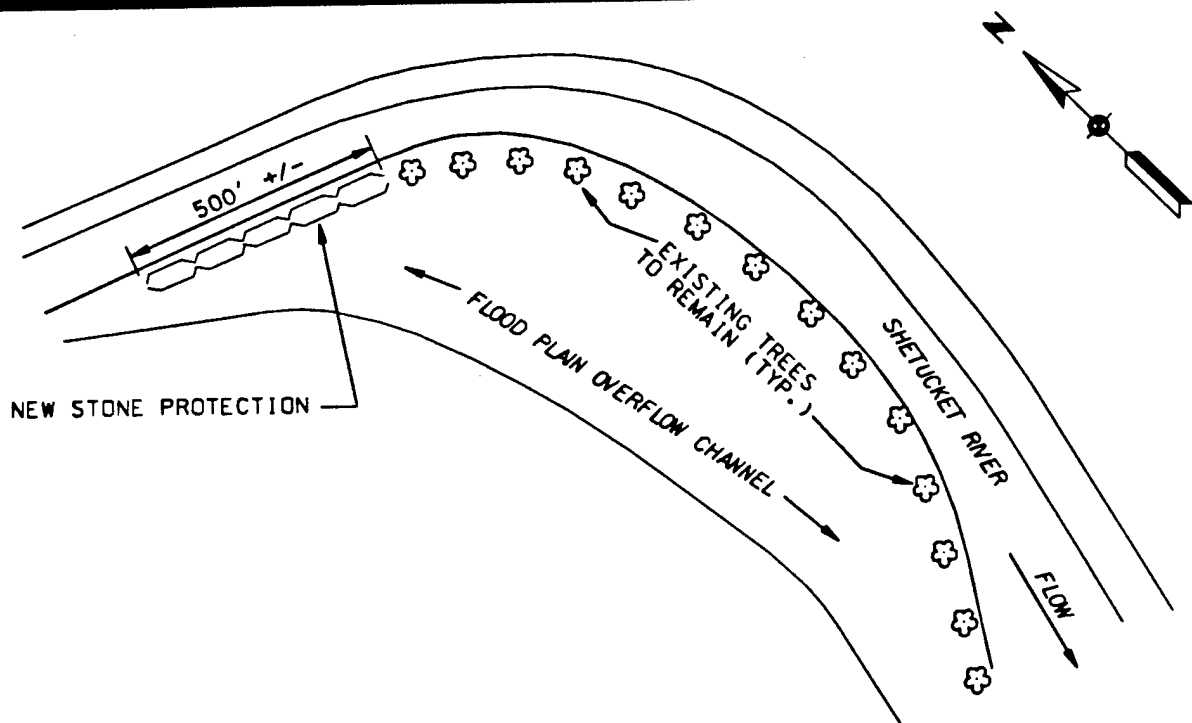
A method of flow diversion will also be necessary for access to the center of the river during construction. Stone protection shall be 21 inches thick if placed in the dry within the cofferdam. The thickness should be increased by 50% if the riprap is placed underwater to provide for uncertainties associated with this type of placement.

ECONOMIC ANALYSIS

The estimated first cost for the proposed project, includes a 25% contingency factor, as well as costs for engineering, design and construction management. The total estimated first cost, as shown on Table 1, is \$360,000.

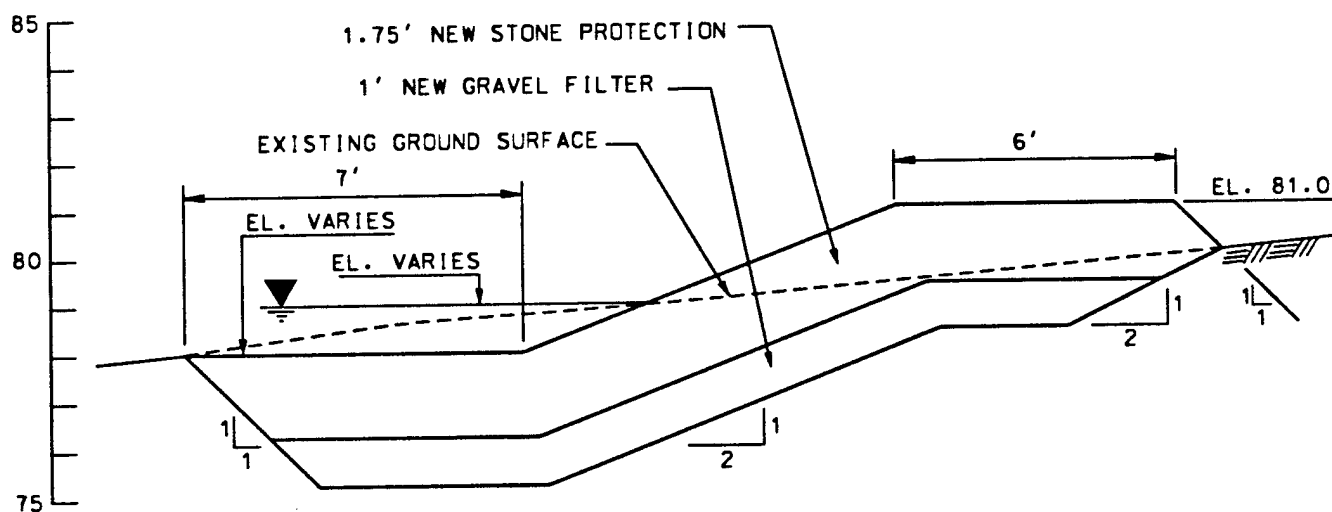
Annual costs of \$29,600 are taken over a 50 year amortization period at the current interest rate of 7 3/4% and includes a \$1,000 annual cost for maintenance which includes debris removal from the monolith structures.

With the construction of an ice retention structure, future ice jam flooding in a 2,200 foot long reach along River Drive and Route 97 will be eliminated. During the most recent ice jam flood of January 1994, the Corps of Engineers estimated that flood damages for the thirty one residential structures and four commercial properties amounted to \$526,000.



**PLAN - OVERFLOW CHANNEL
STONE PROTECTION**

N.T.S.



TYPICAL SECTION

SCALE: 1" = 4'

**LOCAL ICE JAM FLOOD PROTECTION
SHETUCKET RIVER
SPRAGUE (BAL TIC), CONNECTICUT**

OVERFLOW CHANNEL STONE PROTECTION

**US ARMY CORPS
OF ENGINEERS**

New England Division
Waltham, MA

TABLE 1

SUMMARY OF PROJECT COSTS

Construction Cost (1995 Price Level)

Ice Control Structure	<u>\$280,000</u>
Total Construction Cost	\$280,000

Project First Cost

Planning, Engineering & Design (PED)	\$ 60,000
Construction Management	<u>\$ 20,000</u>
Total Project First Cost	\$360,000

Project Cost Share

Total Federal Cost (75% of Total Project First Cost):	\$270,000
Total Non-Federal Cost (25% of Total Project First Cost):	\$ 90,000

Economic Data (7 3/4%, 50 Year Life)

Annual Benefit:	\$ 51,200
Annual Cost (including annual maintenance cost):	\$ 29,600
Benefit-Cost Ratio:	1.7

Based on ice jam affected flood stages experienced during the January 1994 flood it is estimated that this event could occur at a recurring interval of once in 12 years for ice affected flow.

The construction of ice holding cribs will prevent estimated annual losses of \$51,200 which is taken as the annual benefit for project construction of the ice control structure. Based on an estimated annual cost of \$360,000 the benefit to cost ratio is 1.7 with a net benefit of \$21,600.

For details of the economic analysis refer to Appendix D.

ENVIRONMENTAL CONSIDERATIONS

The State of Connecticut Department of Environmental Protection (CTDEP) has promulgated extensive regulations to protect the environmental resources of the state. Riverine regulations are particularly stringent and require that fishery resources, water quality, wetlands, river discharges etc. are not adversely impacted by any in-river construction.

A letter dated January 12, 1995 (see Appendix E - Pertinent Correspondence), CTDEP has expressed their concerns of potential project impacts to riparian vegetation, fishery resources, impacts to existing floodplain, instream alterations and potential for increased erosion and sedimentation. Detailed description of these potential impacts can be found in Appendix C - Environmental Resource Reconnaissance Report.

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

FINDINGS

Results of the reconnaissance level study indicated that construction of the concrete monoliths would significantly reduce ice jam flood damages and the threat to life and health in the Village of Baltic. Although there is sufficient economic justification for construction of ice holding blocks in the river upstream from the flood area, there are some drawbacks to this type of solution such as the environmental impacts with construction in a waterway, potential impacts upon archaeological resources in the Shetucket River flood plain and the lack of protection against non-ice induced flooding. It is expected that the proposed monolith structures would somewhat restrict the natural flow capacity of the river and increase the river stage in the vicinity of the monoliths during flood periods. Debris removal would have to be performed at regular intervals to maintain the openings of the monolith structures free of flow. These problem areas would require further more detailed investigations during subsequent study periods.

CONCLUSIONS

It is concluded that, subject to concurrence by a legally empowered non-Federal sponsor, the proposed local ice jam flood protection project could be advanced to the feasibility phase.

At an April 12, 1995 meeting with Connecticut Department of Environmental Protection (CTDEP) personnel and the First Selectman of Sprague, it was determined that a commitment of non-Federal funding to cost share in the preparation of a Detailed Project Report (DPR) would not be forthcoming. Instead implementation will be carried out by a partnership of state and local resources. Therefore, due to lack of a non-Federal sponsor the Corps of Engineers will not be involved in any further investigation of the ice jam flood control project in the Town of Sprague.

ACKNOWLEDGMENT

This report was prepared under the supervision and management of the following New England Division personnel:

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APPENDIX A

SHETUCKET RIVER
BALTIC, CONNECTICUT
SECTION 205 LOCAL FLOOD PROTECTION
HYDROLOGIC/HYDRAULIC ANALYSES

BY
HYDROLOGIC ENGINEERING BRANCH
WATER CONTROL DIVISION
ENGINEERING DIRECTORATE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS 02254-9149

MARCH 1995

SHETUCKET RIVER
BALTIC, CONNECTICUT
SECTION 205 LOCAL FLOOD PROTECTION

HYDROLOGIC ANALYSES

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SHETUCKET RIVER
BALTIC, CONNECTICUT
SECTION 205 LOCAL FLOOD PROTECTION
HYDROLOGIC ANALYSES

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SHETUCKET RIVER
BALTIC, CONNECTICUT
SECTION 205 LOCAL FLOOD PROTECTION

HYDROLOGIC ANALYSES

1. PURPOSE

Authority for this study is derived from Section 205 of the 1948 Flood Control Act. Hydrologic analyses have been performed for both free-flow and ice-affected conditions at the study location to determine whether further investigation of an ice control structure is warranted. These analyses include examination of data concerning the January 1994 ice jam, which flooded several homes and businesses in the village of Baltic. Reconnaissance level screening of the feasibility of several ice control and flood damage control alternatives was performed. In addition, preliminary hydraulic design of the most feasible alternative was completed due to the innovative nature of the chosen alternative.

2. BACKGROUND

The village of Baltic is located in the town of Sprague, Connecticut, along the Shetucket River (a tributary of the Thames River) as shown on plate 1. Since 1956, the town has experienced several ice jams during mid- to late winter, usually in January and February. Prior to 1956, no ice-related flooding was recorded in the village, probably because Baltic Dam, which breached in 1955, controlled the ice upstream of the populated area of the village.

These breakup jams form when solid ice cover on the Shetucket River breaks up and moves downstream. It appears as though most of the ice causing problems in Baltic, comes from the 2-mile river reach between Scotland Dam upstream on the Shetucket River and the village of Baltic¹. The slope of the river through this reach is very flat and the channel meanders, causing ice floes to lose momentum and slow down. In addition, Occum Dam is located about two miles downstream of the village, and its backwater causes a thick and stable ice cover which tends to stay in place and stop the ice floes (see plate 2). The ice jams tend to remain intact until significant pressure is built up behind them to dislodge the jam and move it downstream.

¹ Personal observations made during the January 1994 event and anecdotal information from town officials.

In the mid-1950s, the Corps was requested by the town to provide technical assistance during non-ice related flooding². As a result, a PL99 earth berm was built along the low lying residential area (see plate 3). This berm has a top elevation of about 77.5 feet NGVD, and top width of about 8 feet. Although the berm does not tie into high ground, it does provide protection against an approximate 10-year flood event.

On 29 January 1994, ice jammed in the village of Baltic. The ice jam, about three-fourths of a mile in length, was grounded in numerous locations. Based on average ice thickness of 18 to 20 inches, the jam appeared to be about 8 feet thick in several locations. Floodwaters behind the jam overtopped the PL99 berm, inundating several homes and businesses. Eventually, a channel opened under the ice to allow some discharge to pass the jam and the flood area drained, but the jam remained in place.

Technical assistance was requested by the Connecticut Department of Environment Protection, and Corps personnel (from NED and CRREL) responded on 2 February. During the time the jam was in place, very cold temperatures dominated the weather pattern for the area. Frazil ice was observed to be adding to the jam at the upstream end, and also, in several observation holes drilled in the solid ice cover downstream of the jam. Frazil ice is comprised of tiny ice crystals formed in supercooled water, which tend to flocculate and adhere to almost any solid surface which is contacted. In this case, the frazil ice might adhere to ice blocks in the jam and further restrict discharges through the jam, causing higher water levels upstream. As a result of the site visit and field observations, NED and CRREL personnel suggested a channel be opened through the ice jam to allow discharges to pass.

During the first two weeks in February, a discharge channel, one-third the width of the river, was being excavated in the jam by the town, as advised by NED and CRREL personnel. About a week into the ice removal process, higher than normal winter discharges (2,000 to 2,500 cfs) were experienced, dislodging the ice jam, and moving it downstream; thereby, eliminating further threat of flooding.

3. WATERSHED DESCRIPTION

The Shetucket River is formed by the confluence of the Willimantic and Natchaug Rivers in Willimantic, Connecticut,

² Information obtained from Baltic First Selectman, USACE plans for the emergency berm are located in town hall.

where it flows southeasterly and southerly to Norwich, a total distance of 18 miles. The river has a drainage area of 460 square miles at Baltic, Connecticut and drains 1,264 square miles at its mouth. The valley is generally narrow, with a fall of 145 feet. The mouth of the Shetucket River is navigable and tidal for one-half mile, beyond which there is a rise of about 6 feet to Greenville Dam, located about two miles from the mouth. This dam and others above Norwich, at Taftville, Occum, and Scotland Station, have no locks and form a succession of ponds as far upstream as South Windham. Main tributaries of the Shetucket are the Quinebaug, Natchaug, and Willimantic Rivers.

Mansfield Hollow Lake is a Corps of Engineers flood control reservoir located on the Natchaug River in Mansfield Hollow, Connecticut, about 5.3 miles upstream of the confluence with the Shetucket River. This project, completed in 1952, with a drainage area of 159 square miles and total flood control storage of 49,200 acre-feet (5.8 inches), is operated to reduce flood stages on the Natchaug, Shetucket, and Thames Rivers.

4. HYDROLOGIC ANALYSIS

a. General. The study area in Baltic is ungaged; however, there are three USGS stream gaging stations in the general vicinity of Baltic: Shetucket River upstream at Willimantic, downstream at Taftville, and Little River at Hanover. The gage location used as a long term index station for this analysis is Shetucket River at Willimantic, CT, (drainage area 404 square miles). The other gage locations were used to verify the adopted relationship between the study location (drainage area 460 square miles) and the index station. Both free flow and ice-affected conditions were analyzed for the Baltic site.

b. Breakup Conditions. An assessment of average flows during the breakup period of December through March was performed for the study area. Average monthly flows at the USGS stream gaging station on the Shetucket River at Willimantic, Connecticut, were studied and related by drainage area ratio to Baltic. Results of this analyses are listed in table 1.

Average discharges on the Shetucket River at Baltic are influenced by operation of the hydropower plant at Scotland Dam, located about 3.5 miles upstream of the study area. This plant cycles its discharges to maximize power generation, allowing the pool to fill overnight to the top of the flashboards, then generating power at a constant discharge of 1,260 cfs until the pool falls below the spillway (about

TABLE 1

AVERAGE MONTHLY FLOWS
BREAKUP SEASON
SHETUCKET RIVER

Month	Flow at Willimantic (DA=404 sq. mi.)	Flow at Baltic (DA=460 sq. mi.)
December	1,580	1,730
January	1,300	1,420
February	630	690
March	1,550	1,700

2 feet). Therefore, during periods when the flow in the river falls below 1,260 cfs, the flows experienced at Baltic will cycle about 80 cfs (minimum discharge at Scotland Dam) and 1,300 cfs. We note that since no major tributaries flow into the Shetucket River between Scotland Dam and Baltic, discharges at these two locations are essentially equal.

Average flows during the breakup season are about 1,500 cfs at Baltic. Analysis of daily flows on the dates of some of the known ice jam events revealed that ice jams typically occur at a breakup discharge between 3,000 and 6,000 cfs. The damaging January 1994 event had an associated discharge of about 6,000 cfs; however, the ice above Scotland Dam remained intact even though significant flow was passing over the flashboards at the project.

c. Upstream Flow Control. Flows on the Shetucket River are regulated by mills and flood detention reservoirs, hydropower projects, pumping for municipal water supply, and by the Corps flood control reservoir Mansfield Hollow Lake.

The mills, flood detention reservoirs, and municipal water supply pumping have a negligible impact on peak breakup discharges at Baltic. In general, these regulations have the greatest effect on very low flows.

As previously discussed, Scotland Dam is a daily cycling hydropower plant owned and operated by Northeast Utilities. The plant currently cycles the turbines, drawing the pool down about 2 feet per cycle. This operating scheme tends to keep ice cover above the dam intact for a longer period of time, than by making large drawdowns or allowing spillway

discharge. Keeping the ice cover above Scotland Dam intact as long as possible is important, because it allows the downstream ice to pass through Baltic without the added volume of the ice above Scotland Station. If the ice above the dam were to move downstream prior to ice-out at Baltic, ice jam potential and possible flooding could be exacerbated.

Mansfield Hollow Lake is operated by the Corps of Engineers to reduce flood stages downstream on the Shetucket River, and in conjunction with five other projects, to reduce flood damages on the Thames River. The drainage area of the Natchaug River at Mansfield Hollow Lake is 159 square miles, about one-third of the total drainage area at Baltic. During major flood events, Mansfield Hollow Lake delays flood peaks and stores floodwaters, considerably reducing downstream flood stages.

Operation of Mansfield Hollow Lake does not usually begin until a threat of downstream flooding exists, as determined by several climatologic and hydrologic parameters set forth in the Thames River Basin Master Water Control Manual. One of these parameters is a river stage of 7.5 feet (4,010 cfs) and rising on the Shetucket River at Willimantic. At this point, discharges on the Shetucket River in Baltic are about 4,600 cfs, sufficient flow to cause breakup of the solid ice cover on the river and potentially cause ice jams. As a result, Mansfield Hollow Lake provides little relief from the threat of ice jams in Baltic. Even if the gates at Mansfield Hollow were to be closed prior to breakup, the project controls such a limited amount of drainage area, reduction of flows from 5,000 to 3,300 cfs is probably not significant enough to prevent potential jamming of the ice floes.

Peak outflow from Mansfield Hollow Lake during the 29 January 1994 ice jam flood in Baltic was only 880 cfs. Peak flow at Baltic is estimated at 6,000 cfs. After the jam formed and Mansfield Hollow project personnel were notified of the situation, the gates at the project were closed and outflow was limited to about 20 cfs. Even if the gates at Mansfield Hollow Lake were closed prior to the event at Baltic, peak flood stages in the village would most likely have been unaffected due to the extremely localized flooding associated with ice jam floods.

d. Free-Flow Discharge Frequency. A peak discharge frequency relationship was developed for the Shetucket River at Willimantic using a Log Pearson Type III analysis. The period of record at this gage is from 1904 to present; however, the period for analysis was 1936, 1938, and 1952 to

1992. The Corps flood control project, Mansfield Hollow Lake, became operational in 1952 and, therefore, recorded discharges since that time were modified by flood control operations. The 1936 and 1938 discharges were adjusted for expected operational impacts due to Mansfield Hollow Lake's flood regulations, and were included in the analysis. This analysis resulted in a mean log of 3.7842, standard deviation of 0.2193, and adopted skew of 0.7000, and the resulting curve is shown on plate 4. The frequency curve at Willimantic was transferred to Baltic, using the drainage area ratio to the 0.7 power and is shown on plate 5. This curve compares well to discharges reported by the Federal Emergency Management Agency in the Flood Insurance Study, Town of Sprague, Connecticut (July 1984) which were developed at the confluence of the Shetucket and Little Rivers (drainage area 465 square miles) and also shown on plate 5.

e. Free-Flow Stage Frequency. Limited information was available concerning the stage-discharge relationship at Baltic. Flood profiles for the Shetucket River, published by the Federal Emergency Management Agency in the 1984 Flood Insurance Study (FIS), were used to develop the rating curve at the study location in Baltic. In addition, high watermarks from the 1936 and 1938 flood events, and observed river stages and estimated flows were used to further refine the relationship. High watermarks for the 1936 flood were not available specifically at the study area; therefore, a straight line profile, between upstream and downstream high watermarks, was used to estimate the peak flood stage in the study area from this event. This discharge rating curve is shown on plate 6. Both high watermarks fit well with the stage-discharge curve developed from the 1984 FIS.

The discharge rating curve was used, together with the discharge-frequency curve, to develop the free flow stage-frequency curve shown on plate 7. Stages associated with the discharges at each of the various frequencies were taken from the discharge rating curve. These stages were plotted at the respective frequencies to develop the stage frequency relationship.

f. Ice Affected Stage Frequencies. Estimated ice affected stage-frequency curves were developed at Baltic as described in Draft ETL 1110-2-XXX (released February 1990). Peak stages for all years (either free flow or ice affected) were ranked and assigned Weibull plotting positions. According to town records, five damaging ice jams have occurred since 1956 (the first year after the Baltic Dam breached): January 1956, February 1970, February 1982, January 1984, and January 1994. Sufficient information to

approximate peak flood stages was only available for three of these ice events. Based on newspaper accounts and photos, stages were approximated for the 1970, 1984, and 1994 events. The February 1970 ice jam was described as being 7 to 10 feet over the riverbanks, which would put the peak stage about 2 feet above top of the berm at 79.5 feet NGVD. The January 1984 event appeared to flood to top of the PL99 earth berm, about 77.5 feet NGVD. The January 1994 high watermark was surveyed at 78.8 feet NGVD by the Connecticut DEP. Insufficient information was found to justify approximate elevations for the other events. Therefore, a stage frequency curve was developed, based on a mixed population of both peak ice jam and free flow stages.

Discharges were estimated for the 1936 and 1938 floods as modified by regulation of Mansfield Hollow Lake. Stages for these events were developed, based on the adopted stage-discharge rating curve at Baltic. Several other high ranking discharges recorded at Willimantic, after Mansfield Hollow Lake became operational in 1952, were transferred to Baltic. Associated stages for these events were also estimated from the adopted discharge rating curve for the site.

Table 2 lists the three peak ice jam stages at Baltic as estimated, based on high watermarks as well as several of the peak free flow stages. Due to limited data available at the site, both the peak free flow and ice jam stages were ranked based on the period from 1936 to 1994 and plotted.

The adopted ice-affected stage frequency curve is shown on plate 7. Ice effects in a river are expected to cause higher water stages than free flow floods occurring at similar discharges. It is estimated that due to increased friction with an ice cover (either broken or solid) on the river, annual peak ice-affected stages will approach bankfull conditions (about elevation 70 feet NGVD).

5. REMEDIAL MEASURES

a. General. Two types of structural remedial measures can be used to reduce or eliminate damage associated with ice jam flooding. Standard flood damage reduction measures include using dikes, walls, floodproofing, and other methods to either stop all flooding of affected properties or reduce property damage. Other methods involve eliminating the ice, which reduces peak stages by eliminating the threat of ice jams. The major drawback to this is that the threat of free flow (high discharge events) flooding still exists. These measures include utilizing ice booms, ice retention structures, and diversions to control ice or divert excess flows.

TABLE 2

PEAK FREE-FLOW AND ICE JAM STAGES
SHETUCKET RIVER AT BALTIC, CT
(1936 to 1994)

Year	Peak Flow* (cfs)	Peak Stage** (ft NGVD)
1938	26,200	83.8
1955	21,300	81.0
1970	Ice Jam	79.5
1994	Ice Jam	78.8
1982	15,400	78.3
1936	14,900	78.2
1984	Ice Jam	77.5
1979	11,500	76.3
1956	9,580	75.7
1984	9,370	75.6
1980	9,210	75.4

* Flows measured at Willimantic and transferred by drainage area ratio to Baltic. Flows during ice jam floods were not estimated since flood levels are not dependent on discharges during these events. Discharges for 1936 and 1938 are as modified by Mansfield Hollow Lake if it were in operation.

** Stages estimated from high watermarks or read from discharge rating curve shown on plate 6.

b. Dikes and Walls. Dikes and walls could be used to protect the damage area as shown on plate 8. The dike should roughly follow the existing PL99 earth berm and could tie into high ground in the vicinity of Beaver Brook and Town Offices. This dike would be about 4,000 feet long, and would need a top elevation of about 85.5 feet NGVD (approximately 15 feet high, or 8 feet above the existing berm) to protect against the 100-year ice-affected event. A pumping station would probably be needed with this dike to allow interior runoff, which normally drains through a box culvert under Route 97, to be discharged to the river during high river stages. If the existing berm were tied into high ground on the upstream end between Second and Third Streets, it would protect against the 7-year event (about a 13 percent chance of exceedance). This second alternative would provide much less protection than the dike discussed earlier in this paragraph, but might be considered by locals to maximize protection of the existing berm. There appears to be sufficient storage area to allow interior drainage to pond without causing additional flooding problems due to the smaller interior drainage area. Based on cursory economic analyses, both of these options were ruled out due to the high costs associated with them.

c. Floodproofing. Since floodproofing of the existing structures in the flood plain is probably not feasible, buildings are woodframe.

d. Raising. Elevating structures to reduce the risk of flood damage would be a costly option since the homes are mostly two-story, two-family structures. The 100-year flood elevation with ice effects is 83.2 feet NGVD. Raising first floor elevations to this height would require lifting the structures about 10 feet.

e. Dredging. Removing sediment deposits from the river is not expected to improve the ice jam situation in Baltic. The Shetucket River drops less than 10 feet in 2.8 miles between the sites of the former Baltic and Occum Dams. Spillway crest at Occum Dam is about 72 feet NGVD. Even with no flow in the river, backwater from Occum Dam would reach the village of Baltic. Since the dam is a major control in the river's hydraulics and has limited outlet capacity (900 cfs turbine capacity), dredging to increase the riverbed slope would not change the hydraulic gradient through the reach. Dredging small gravel deposits, which create visible rapids in portions of the river is not recommended either. The gravel deposits are indications of river reaches with flat slopes where flow velocities slow and sediment drops out. Ice floes stop in these areas due to the flat river slope, deposition of frazil under the ice

cover which thickens the ice and causes increased resistance to movement downstream, and intact downstream ice cover.

f. Diversion. Diverting flows through the abandoned mill canal (see plate 8) during ice jams, as suggested by the Connecticut DEP, does not appear to be feasible at this time. Ice generally jams just downstream of the baseball fields; however, the mill canal reenters the river upstream of the fields. The canal would have to be extended about 1,000 feet downstream. Based on the topography and location of the road on the east bank of the river, extending the canal does not appear to be a feasible low cost option. Using the existing canal, water cannot be carried far enough downstream to bypass the jam; therefore, this option is not recommended.

g. Ice Control. Utilization of flood plain storage, upstream of the Route 97 bridge, to hold ice during breakup is probably the most feasible option for eliminating the increased flood stages associated with ice jams. Since the river is relatively wide (about 200 feet) and shallow (less than 4 feet deep in many locations during normal flows), and because problems are caused by breakup ice, concrete monoliths or timber cribs are most likely to be the least costly option to be used to retain the ice. These monoliths would probably be installed across the river, about 500 feet upstream of the former Baltic Dam as shown in plate 8. The monoliths are expected to have a footprint 12 feet by 4 feet, about 8 feet high above streambed, and placed at 12 feet on-center across the river, see plate 9. Two major drawbacks to this type of solution are the environmental concerns with construction in a waterway, and the fact that no protection is provided against free flow flooding. In addition, since the structure would restrict the natural flow capacity of the river, an increase in stage in the vicinity of the monoliths would be expected. Accumulated debris would have to be removed from the structure by locals at regular intervals (every spring and fall, or after significant flood events) to ensure the openings do not become completely blocked.

6. HYDRAULIC DESIGN OF ICE CONTROL STRUCTURE

a. General. At present, there are very little data about the hydrologic/hydraulic design criteria of structures to hold ice during breakup. The only other structure of this type in the United States was installed during the fall of 1994 on the Lamoille River in Hardwick, Vermont; therefore, performance data about this structure are unavailable. Similar structures have been constructed in Canada and

Czechoslovakia and appear to be effective in holding back breakup ice³.

b. River Modelling

(1) Free-Flow. The Shetucket River was modelled using the Corps water surface profile model HEC-2. Cross sections from the confluence of Cold Brook upstream to the Route 97 bridge were taken from existing Flood Insurance Study (FIS) surveys performed in 1978. Cross sections upstream of the bridge were obtained by Corps surveyors in December 1994. Starting water surface elevations for the model were taken from a rating curve based on the 1984 FIS.

The HEC-2 model was calibrated to the existing FIS profiles in the reach from the most downstream section to 300 feet upstream of the Route 97 bridge (see plate 10). As noted earlier, these profiles are in general agreement with recorded high watermarks for the 1936 and 1938 flood events. Flood profiles were not developed further upstream for the FIS; therefore, calibration of the HEC-2 model was not possible.

Water surface profiles for the study reach were computed for the 10, 50, and 100-year free flow floods under existing conditions and with the proposed structure in place. As shown on plate 11, water surface elevations for free flow conditions are expected to increase in the immediate vicinity of the structure and a short distance upstream, due to the restriction that the monoliths cause. The 10-year water surface profile is increased by about one foot at the structure and is affected for about 1.5 miles upstream. The 100-year water surface elevation is about 0.6 foot higher at the structure and is increased for about two miles upstream.

Profiles representing free flow conditions at typical break up discharges of 1,500, 3,000, and 6,000 cfs were also developed for existing and proposed cases. Results of the HEC-2 analysis are shown on plate 12. The increase in water surface elevation is generally less than one foot within 2,000 feet of the structure. Effects of the structure are observed for approximately 1.5 miles upstream of the monoliths.

(2) Ice Affected. After the HEC-2 model was calibrated for free flow conditions, the ICETHK module was run with HEC-2 to compute equilibrium ice jam thickness, ice affected water surface elevations, and hydraulic

³ Information supplied by the Cold Regions Research and Engineering Laboratory.

characteristics at the structure (velocity, Froude number, depth of flow). ICETHK was developed by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) to interactively compute equilibrium jam ice thicknesses and resulting water surface elevations through an iterative process. Equilibrium jam ice thickness is, by definition, the thickest stable ice accumulation (based on a force balance) which can form at a given section and discharge. This results in the highest computed water surface elevations for this type of jam. Input parameters used in ICETHK are listed in table 3.

TABLE 3
ICETHK INPUT PARAMETERS

Parameter	Value
Jam type	Breakup
Width smoothing option	No
Slope smoothing option	Yes
Initial ice thickness	1.5 feet
Initial ice roughness (Manning's "n")	0.020
Computed ice roughness method	ICETHK computes by Nezhikhovskiy's method
Coefficient related to internal friction of jam	1.2
Ice accumulation porosity	0.5
Cohesion factor of ice	0 (since break-up jam)
Specific gravity of ice	0.916
Maximum non-eroding velocity	5 ft/sec
Maximum ice thickness increase allowed in a single iteration	3 feet
Overbank ice method	ICETHK computes
Water depth above flood-plain for overbank ice	2 X ice thickness
Ice smoothing option	Yes
Ice smoothing threshold	2 feet

Breakup ice jam formation in a dynamic, highly unsteady process. In the study area, where jams are said to form and remain in place for a period of time before progressing downstream and reforming, this is especially true. Using the ICETHK module with HEC-2 may not provide an accurate model of the physical processes involved in breakup

ice jam formation and evolution, however, the model can be used to predict estimated river stages resulting from an equilibrium ice jam.

Computations were made for ice thickness at typical breakup discharges of 1,500, 3,000, and 6,000 cfs, as shown on plate 13. As can be seen, the thickest ice deposits form between stations 9 and 11, which is the river reach between Third Avenue and Elm Street, one of the locations where ice was reported to momentarily slow or stop during the January 1994 ice jam. This modelling shows that during breakup, the ice floes will tend to thicken through the entire study reach. Since a thickened ice accumulation at any point provides increased resistance to moving ice from upstream, jams can potentially occur at any point along the river through town.

The preferred method to reduce the possibility of damaging ice jams for this location is to delay the downstream migration of ice from above the village. By holding upstream ice until downstream ice has disappeared or its strength has deteriorated, the potential for ice jams in the village is lessened. In addition, if the ice does temporarily stop or jam, the volume of ice is limited so that likelihood of a major ice jam is significantly reduced.

c. Ice Control Structure

(1) Description. The purpose of the proposed structure on the Shetucket River is to cause breakup ice jams to form upstream of the village of Baltic, in an area where no damages will occur. The monoliths are designed to allow the ice pieces to arch between them during ice runs. The ice will then thicken, forming a jam. Flow relief is provided by the wide flood plain in this area. Ice will be stored in the river channel, held there by existing trees along both banks of the river. Due to the natural topography of the selected site, flow will reenter the river channel about 100 feet downstream of the structure along the right river bank.

The proposed ice control structure (conceptually shown on plate 16) is made up of concrete monoliths; however, timber cribs filled with stone may be more economical and will be investigated during feasibility studies. These monoliths have a footprint of 4 feet wide by 12 feet long. The top of the concrete monoliths is set at elevation 76.0 feet NGVD, one foot above the flood plain elevation. Average height of the monoliths is about 8 feet above streambed, and the upstream face has a slope of 1 horizontal to 2 vertical to allow the ice to ride up the monoliths and thicken the jam at the toe. The monoliths should be

embedded in the riverbed to prevent undermining by scour (unless on bedrock), and must be designed against tipping and sliding forces of water and ice.

(2) Design Criteria. The monoliths will be spaced at 12 feet on center, or an 8-foot clear opening between monoliths. Originally, a 12-foot clear opening was considered; however, the only working structures of this type with some record of performance have clear spacings of about 7 feet (2 meters). Therefore, the more conservative 8-foot opening was adopted. Future performance of the structure on the Lamoille River at Hardwick, Vermont, (clear opening of 14 feet) may allow for a wider spacing to be considered during feasibility design though. Design of the Lamoille River structure was based on physical model results, not hydraulic design. After discussion of design parameters with members of the Ice Engineering Research Branch at CRREL, we chose to base the design of this structure on hydraulic criteria of other similar structures, with a record of performance.

TABLE 4

COMPARISON OF HYDRAULIC CHARACTERISTICS
FOR ICE CONTROL STRUCTURES
AT BREAKUP

Parameter	Credit River	Shetucket River
F	0.051	0.074
v , feet/second	1	2
d , feet	12	17
Q , cfs	6,000+	6,000

where: F is the Froude number ($v/\sqrt{gd}$) upstream of structure
 v is the average velocity upstream of structure
 d is the hydraulic depth upstream of structure
 Q is the average design flow through structure

Most hydraulic design of this concrete structure is based on design of ice control structures on the Credit River, Mississauga, Ontario, Canada (completed in 1988), and on the Hnilec River near Jaklovce, Czechoslovakia (completed in 1970). It has been reported that both structures have been effective in forming ice jams upstream of the damage areas, alleviating downstream flooding. Table 4 shows a comparison between hydraulic characteristics for the .

proposed structure on the Shetucket River at Baltic, and the structure on the Credit River. Detailed hydraulic design information was not available for the Hnilec River structure; however, design drawings of the structure were considered in our analysis.

The ICETHK module was used to compute river velocities and Froude numbers at the adopted design discharge of 6,000 cfs, with the proposed structure in place and an equilibrium ice jam formed behind it (see plate 14). In addition, a profile of computed ice thickness, resulting from the structure trapping of all ice below Scotland Dam, is shown on plate 15. As can be seen, the modified water surface elevations above the structure with a full equilibrium jam in place at a flow of 6,000 cfs, approach the 100-year water surface elevations. As a result, flowage easements will be required due to the increased frequency of inundation of areas upstream of the structure. We note that these areas are presently heavily wooded or cleared for agriculture. There are no habitable structures which would be impacted upstream of the ice control structure and since ice accumulations would only increase stages during the winter months, agricultural use of the land should not be affected.

(3) Design Limitations. An important component of the design of this structure is that the ice above Scotland Dam remains intact until after the ice below the concrete monoliths is released. The ice control structure is designed to hold about 5.5×10^6 cubic feet of ice. This is the volume of ice produced between the structure and Scotland Dam, when the river has an initial thick ice cover of 18 inches (the average thickness measured in February 1994). It may be advisable for the town of Sprague or the Connecticut Department of Environmental Protection (CTDEP) to continue installing an ice motion detector in the ice cover at Scotland Dam, as used during the winters of 1994 and 1995. This will provide sufficient warning time (about 2 hours) for someone to assess the ice cover and river condition, both upstream and downstream of the village of Baltic.

Due to the lack of design criteria for this type of structure, much of the design was guided by comments and review provided by CRREL researchers. We recommend that members of the Ice Engineering Research Branch of CRREL be included as team members during feasibility design, to ensure a thorough review, and that all state-of-the-art knowledge concerning this type of structure is incorporated into the design effort. If a Corps ice control structure is

to be constructed, CRREL must have input during final design.

d. Stone Protection. Stone protection was sized based on velocities at the structure and in the flood plain, assuming a full equilibrium ice jam in place at the design flow of 6,000 cfs. Velocities of 8 feet per second were computed at the structure, using the HEC-2 model. At flows above 6,000 cfs, the ice behind the structure becomes unstable, and is expected to release downstream prior to higher velocities being achieved. A check of these velocities using the Federal Highway Administration WSPRO model may be necessary during feasibility studies. The advantage of this water surface profile model is that velocities can be requested at any station, rather than just the average velocity in the channel, which is computed by HEC-2.

Based on a channel velocity of 8 feet per second, a D_{50} stone size of 1.0 foot was adopted for protection of the bed and banks at the structure and for the inlet area to the flood plain (see plates 16 and 17). This is slightly larger than the 0.8-foot D_{50} size which is required, based on the Waterways Experiment Station Hydraulic Design Criteria (Chart 712-1). The increase in size was based on potential ice action and use of average velocity for design. However, we note that ice forces on riprap are poorly understood. We recommend using a conservative gradation and blanket thickness to protect against potential ice forces. Continued coordination with Geotechnical Engineering Division will take place during feasibility studies.

Average velocities over the flood plain were computed to be less than 2 feet per second at the design discharge. These velocities are low enough so that protection of the flood plain against scour should not be required. If some small deposits of very fine material exist, crushed stone may have to be placed to prevent washout, or to fill any small holes which may form after an event.

e. Interim Measures. Due to the nature of the design of this structure, it may take several years before construction of the proposed structure is complete. At present, the threat of ice jams continues to exist in Baltic. Several relatively easy measures can be implemented to help the town be more prepared should an event occur prior to completion of this project.

(1) An ice monitoring program should be established by the town and Northeast Utilities. This informal program should consist of regular observations of river ice during

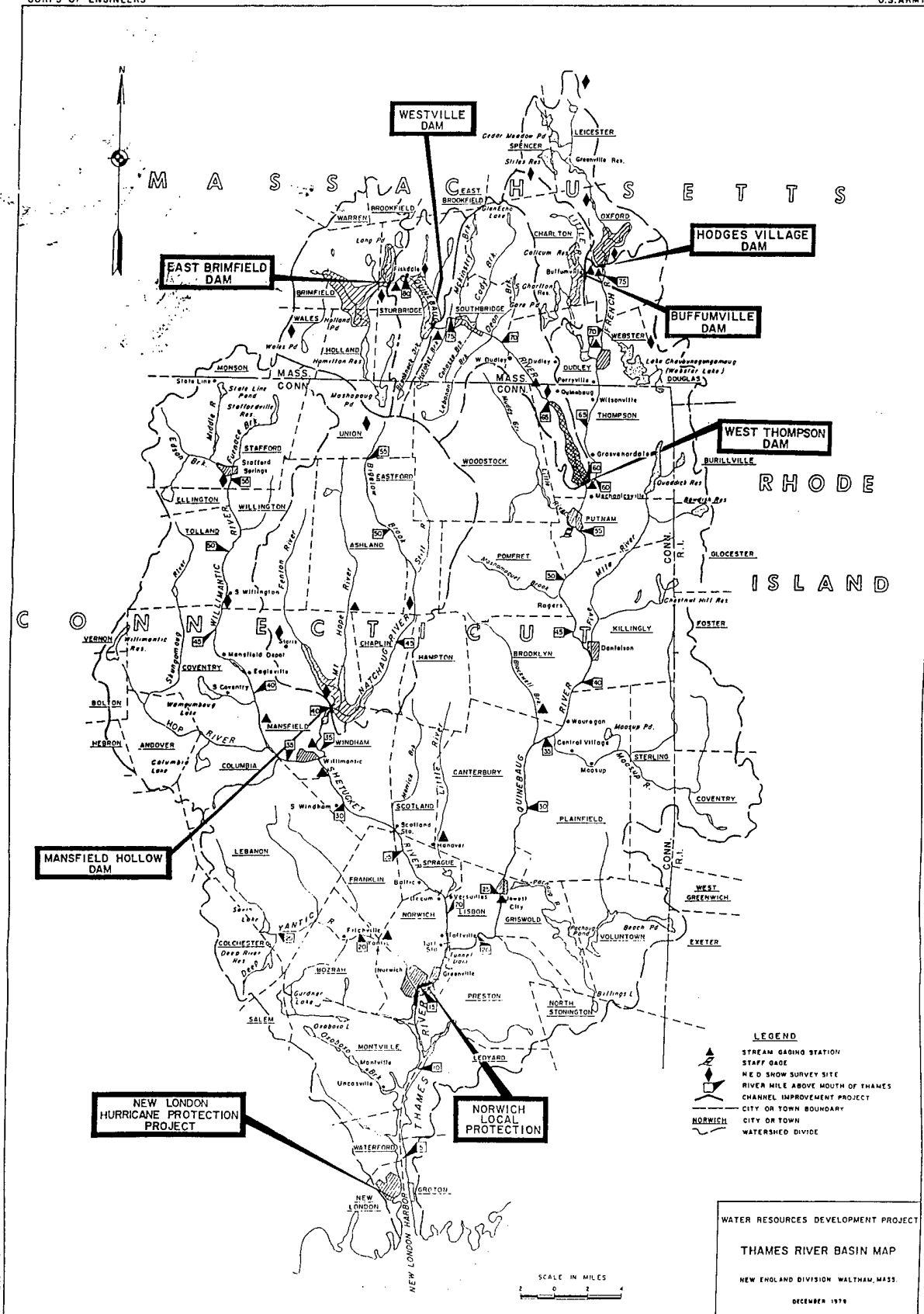
formation through the winter, and especially during breakup. Typically, this type of monitoring program can help in providing information and insight into the progression of ice growth and ice regime, throughout the entire winter season. It is also important to monitor breakup to determine how much ice is available for a potential jam, condition of ice prior to breakup, and where ice is originating. Examples of generic ice monitoring forms are shown on plate 18.

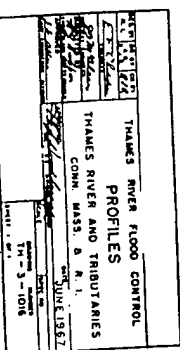
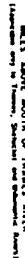
(2) The town or the CTDEP may want to install ice motion detectors in ice covers above Scotland Dam and above the town, similar to what was performed in February 1994. These detectors will provide warning to appropriate personnel that the ice has moved, possibly indicating start of breakup. The detector above Scotland Dam will provide at least two hours advance notice that the ice has moved, before ice floes from above the dam reach Baltic. Someone should observe and verify ice movement and the condition of the river (ice covered or open water), after the detector has alerted authorities.

(3) In the event an ice jam forms at Baltic, local officials should contact the CTDEP, who will determine if New England Division's Emergency Operations Center should be notified.

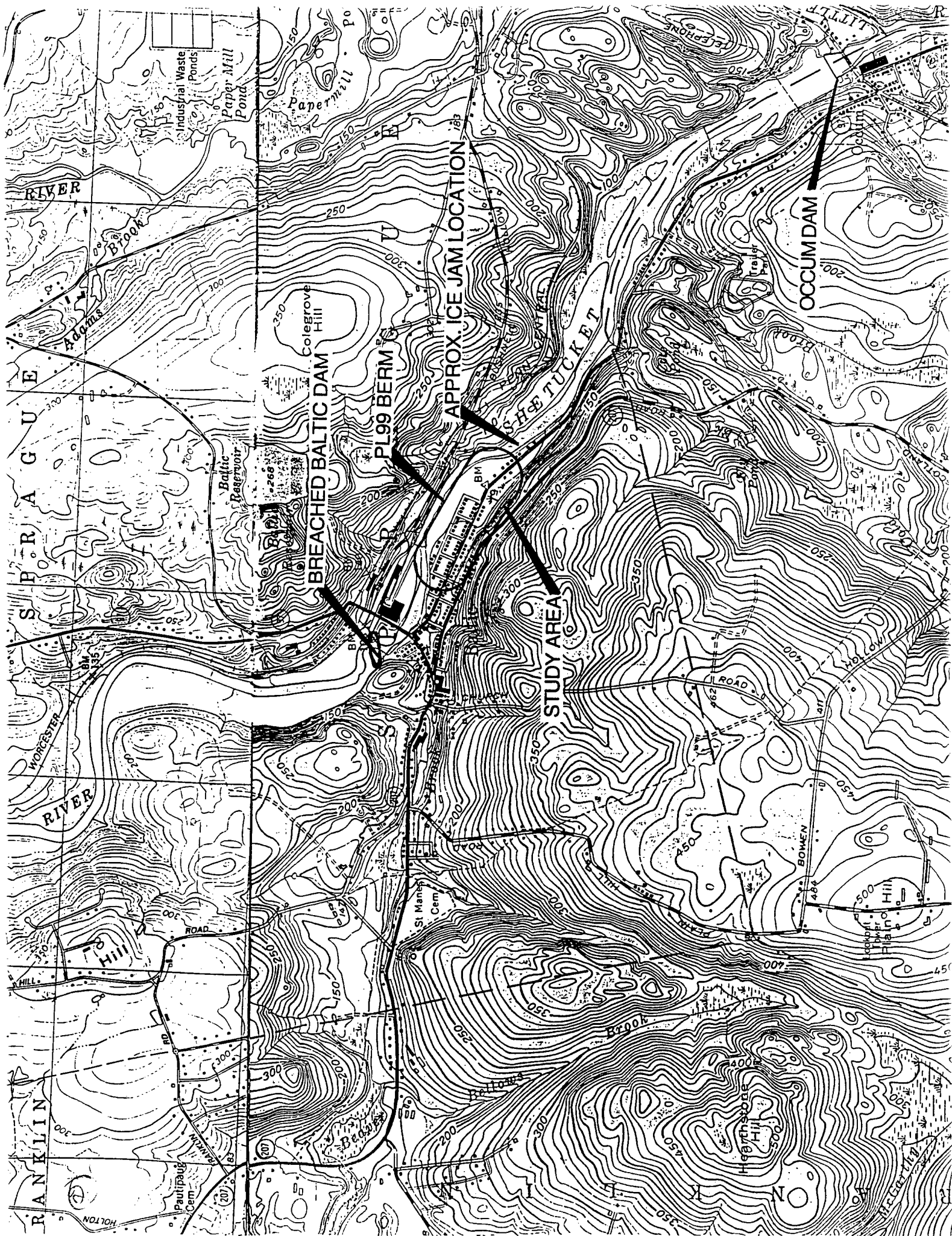
7. REFERENCES

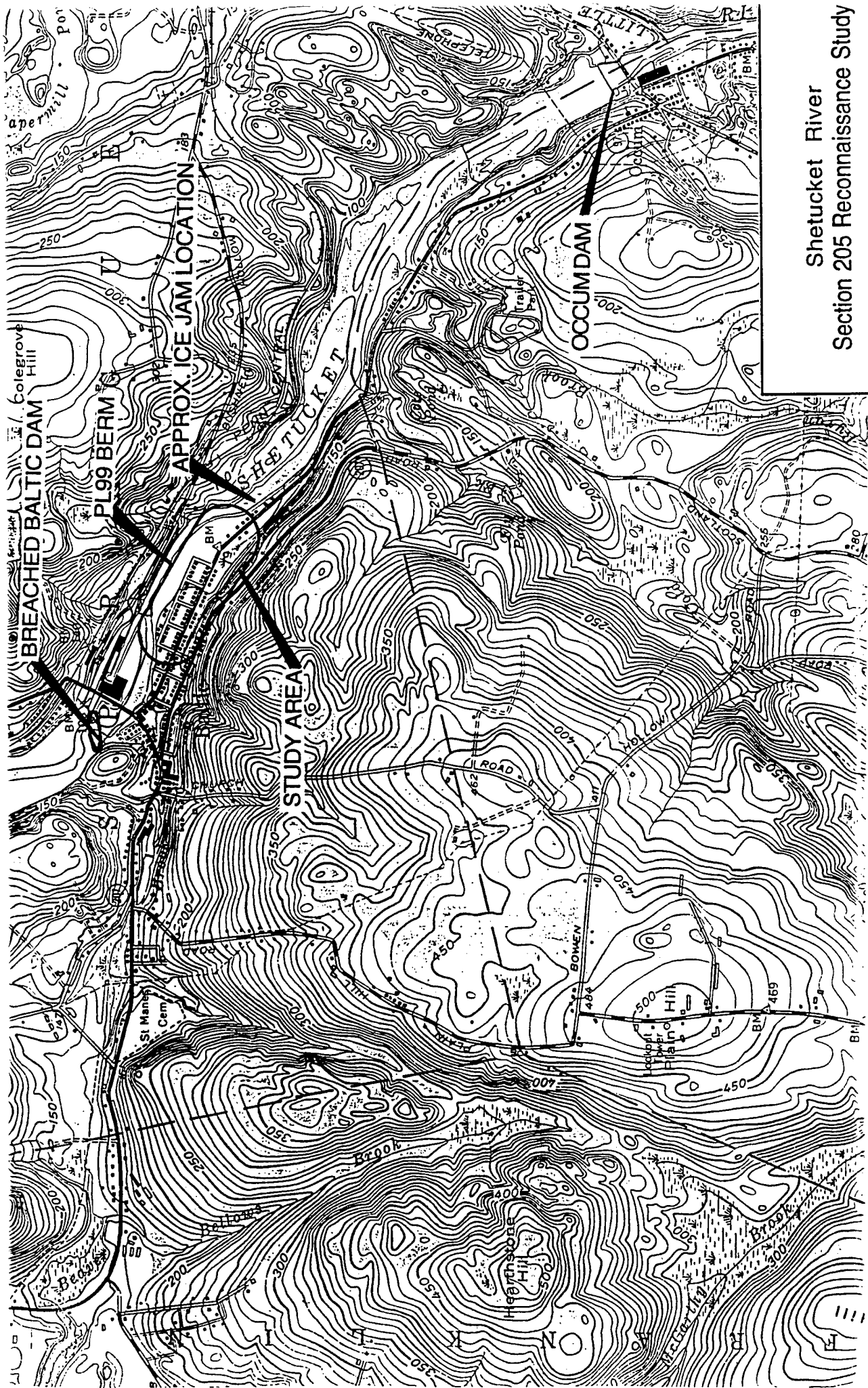
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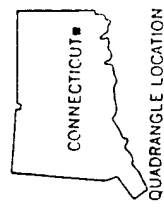




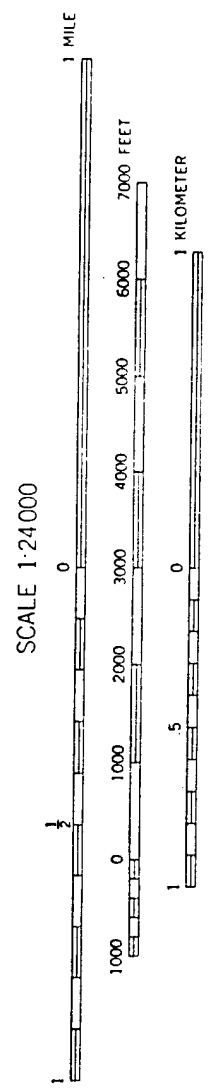


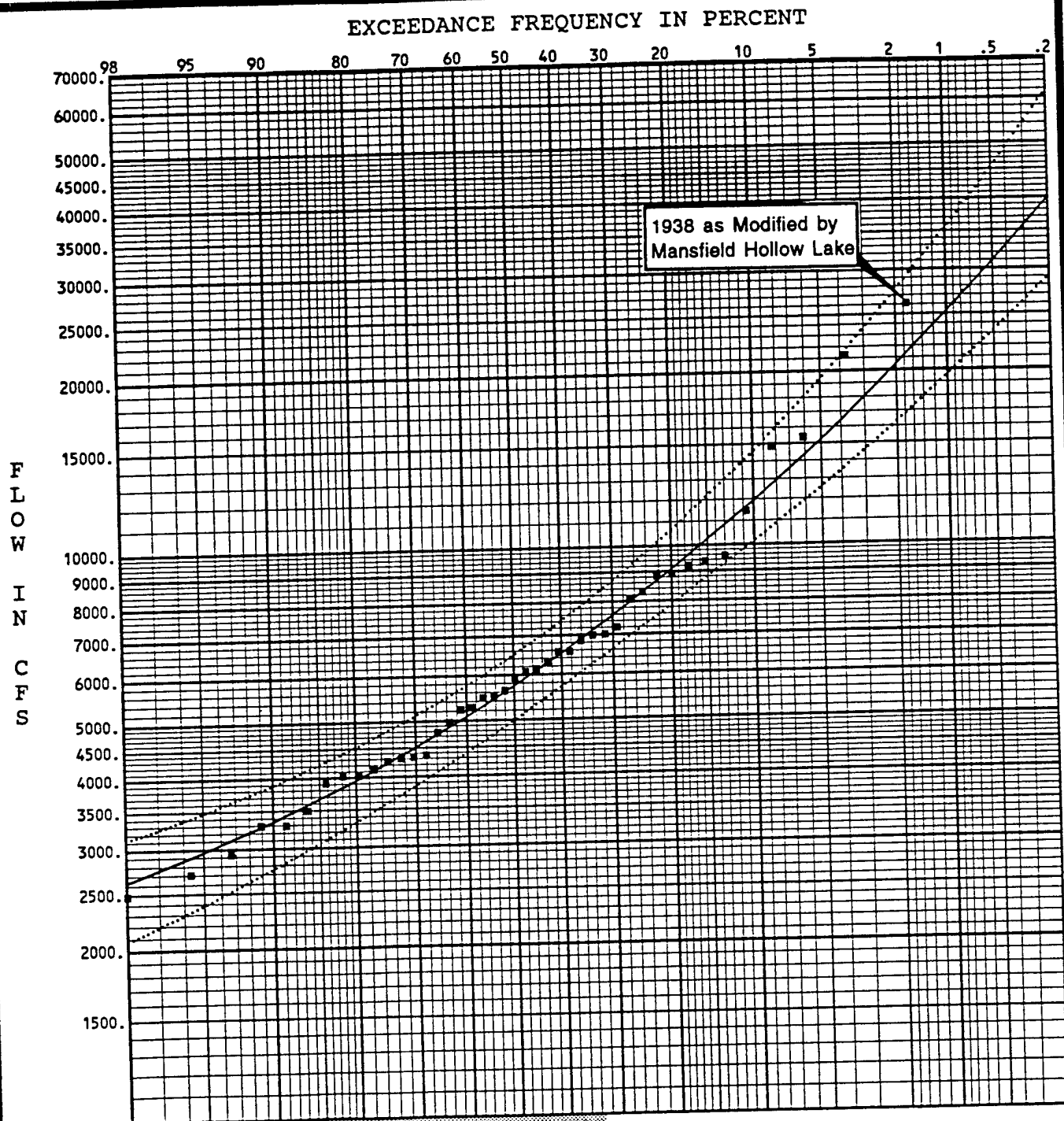
Shetucket River
Section 205 Reconnaissance Study
Study Area
Baltic, CT

H.E.B. May 19



QUADRANGLE LOCATION





— Flow Frequency (without Exp. Prob.)

■ Weibull Plotting Positions

..... 5% and 95% Confidence Limits

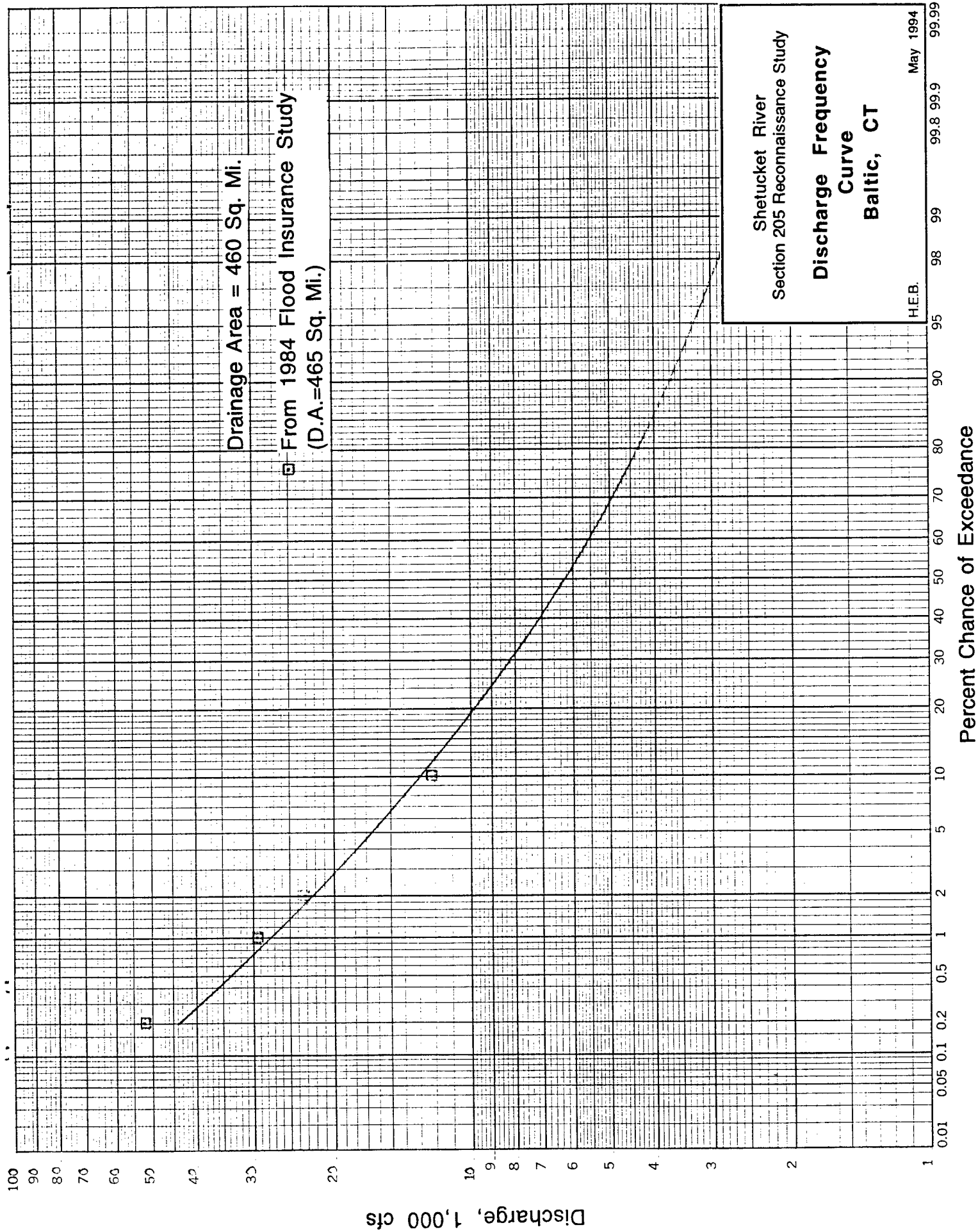
FREQUENCY STATISTICS

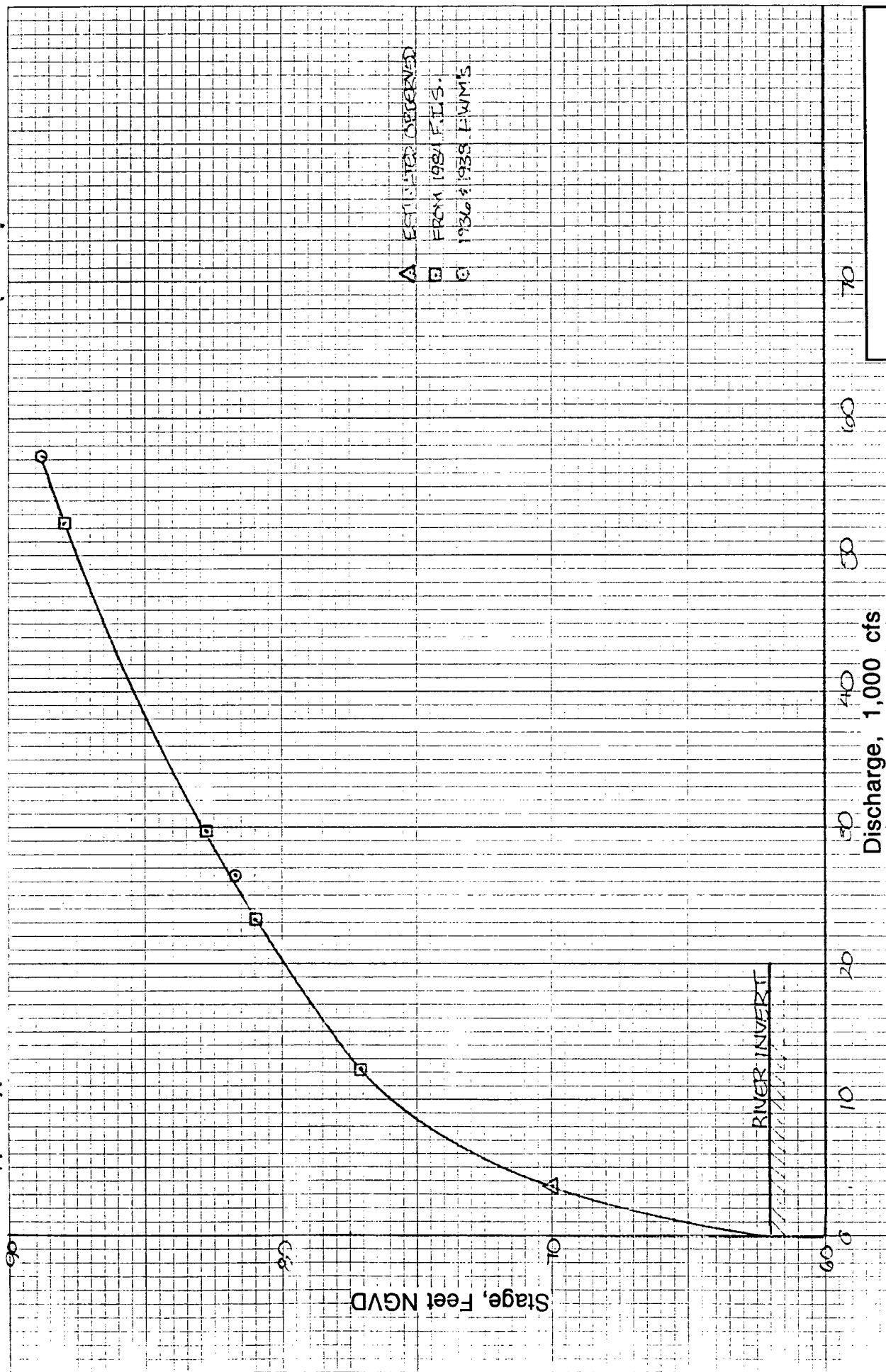
LOG TRANSFORM OF FLOW, CFS

NUMBER OF EVENTS

MEAN	3.7842	HISTORIC EVENTS	1
STANDARD DEV	.2193	HIGH OUTLIERS	0
SKEW	.7238	LOW OUTLIERS	0
REGIONAL SKEW	.7000	ZERO OR MISSING	0
ADOPTED SKEW	.7000	SYSTEMATIC EVENTS	42
		HISTORIC PERIOD(1936-1992)	57

FLOOD FLOW FREQUENCY
Shetucket River
near Willimantic, CT
BASIN AREA = 404 SQ MI
WATER YEARS IN RECORD
1936, 1938, 1952-1992

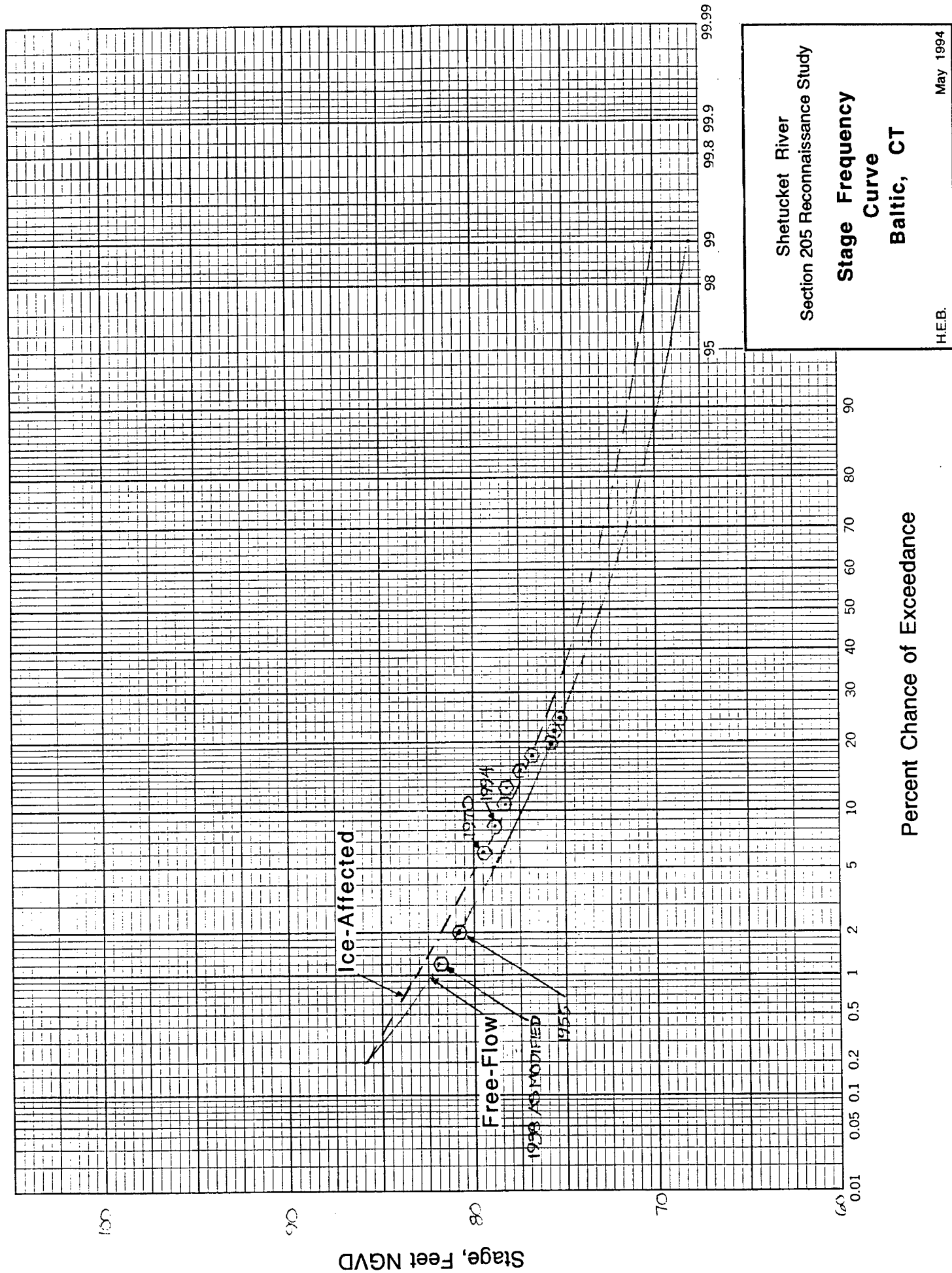


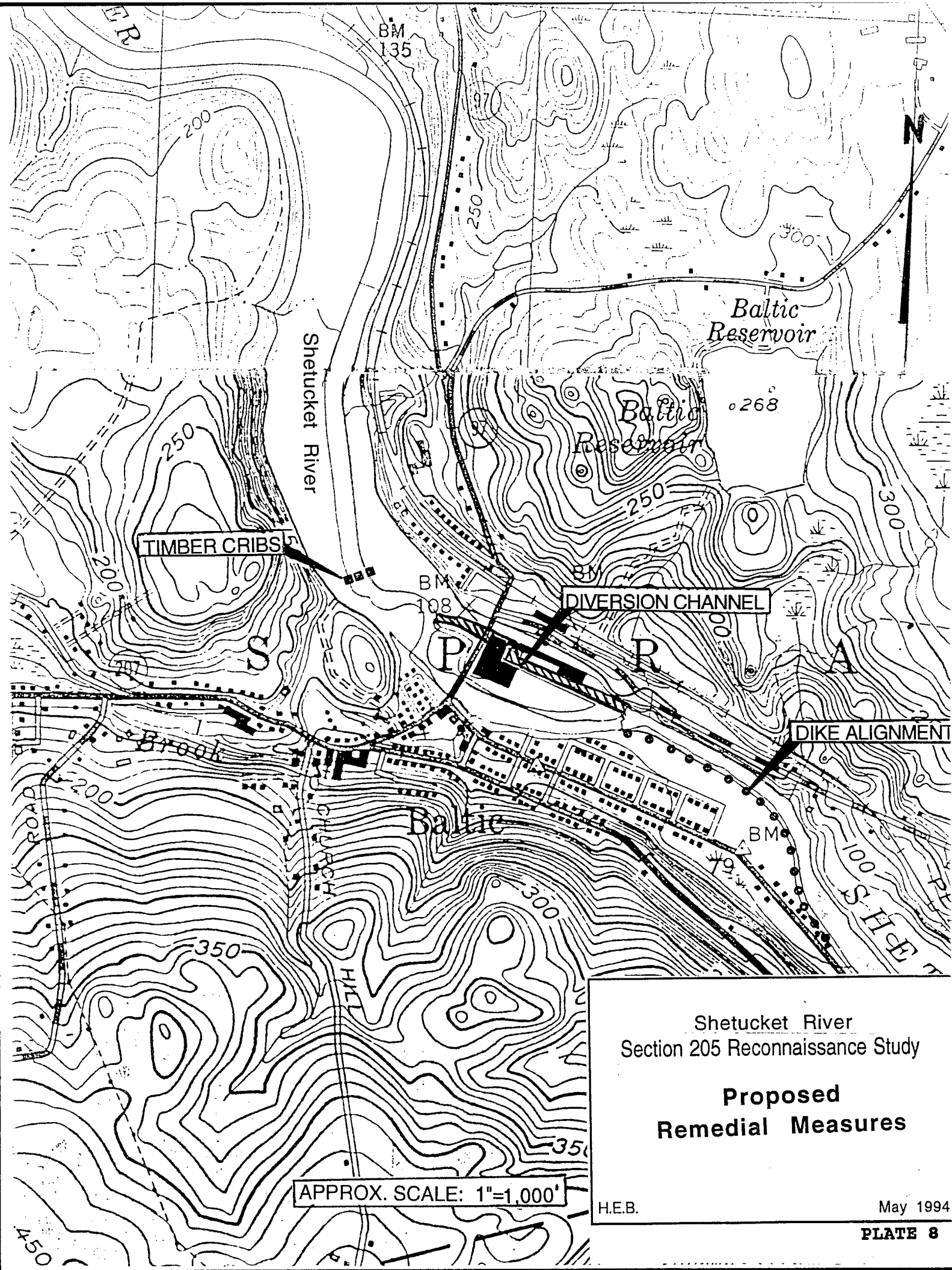


Shetucket River
 Section 205 Reconnaissance Study
**Stage-Discharge
 Rating Curve**
 Baltic, CT

H.E.B.

May 1994





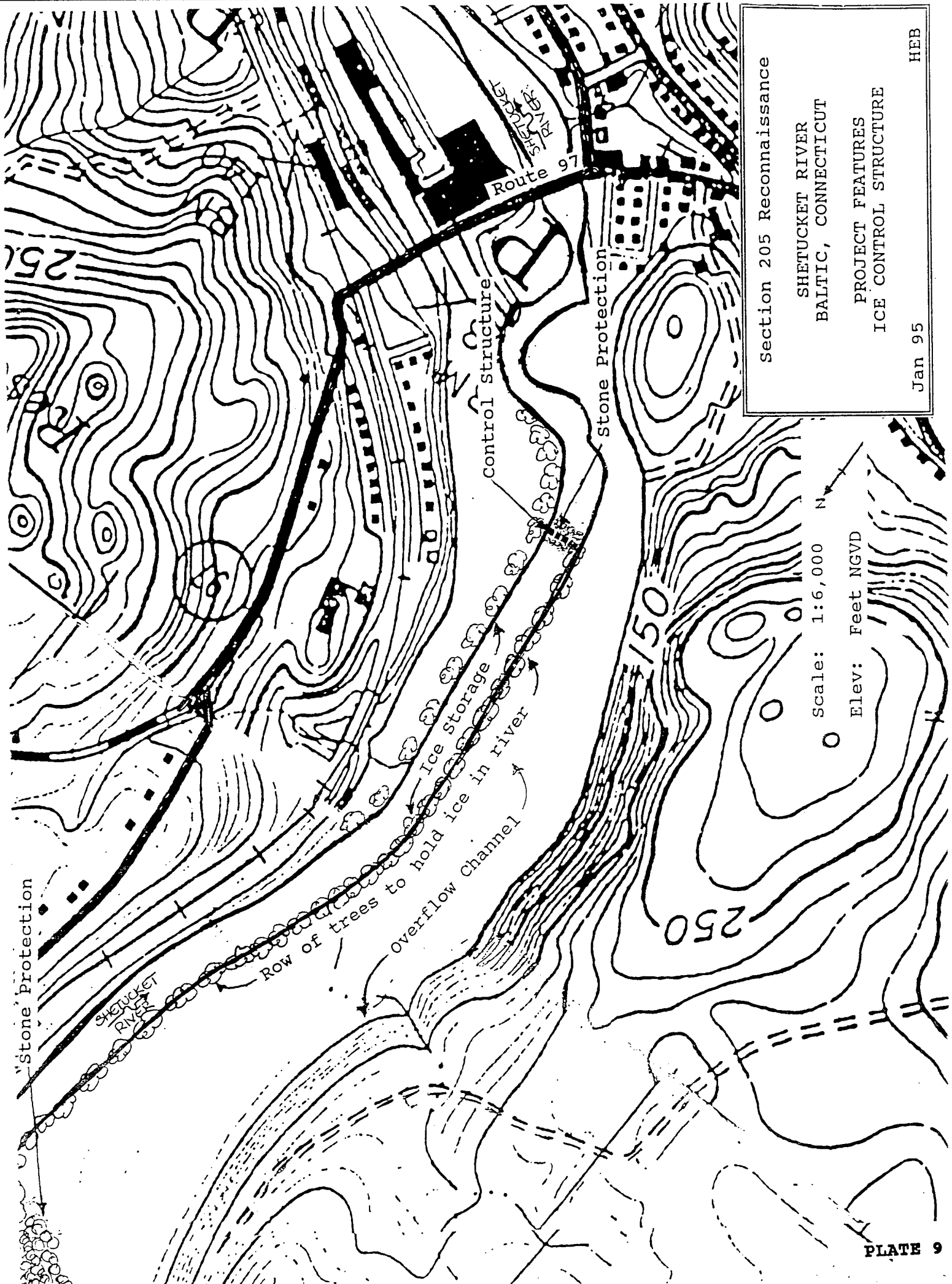
Shetucket River
Section 205 Reconnaissance Study

**Proposed
Remedial Measures**

H.E.B.

May 1994

PLATE 8



Section 205 Reconnaissance

SHETUCKET RIVER
BALTIMORE, CONNECTICUT

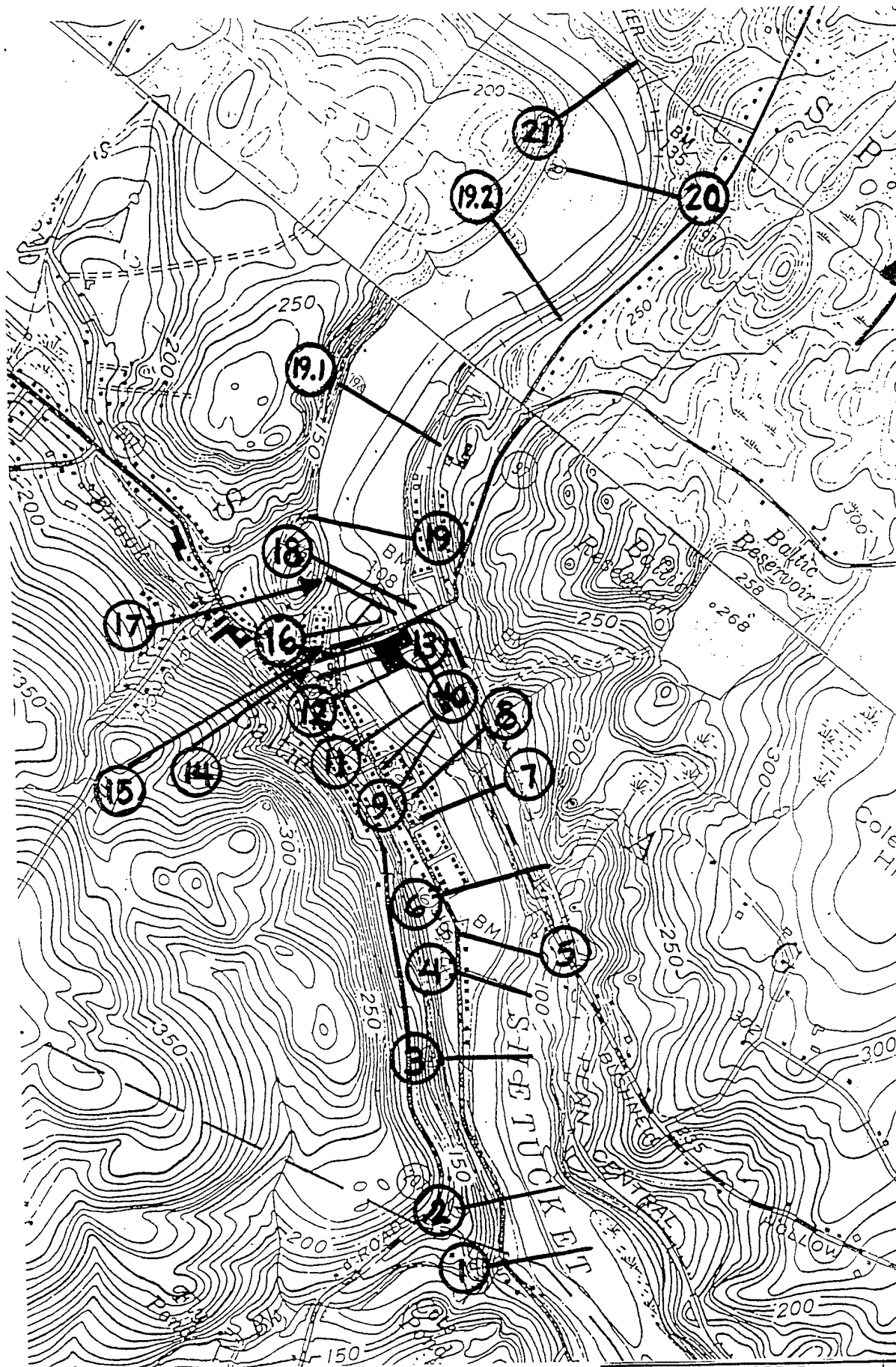
PROJECT FEATURES
ICE CONTROL STRUCTURE

Jan 95

HEB

Scale: 1:6,000 N

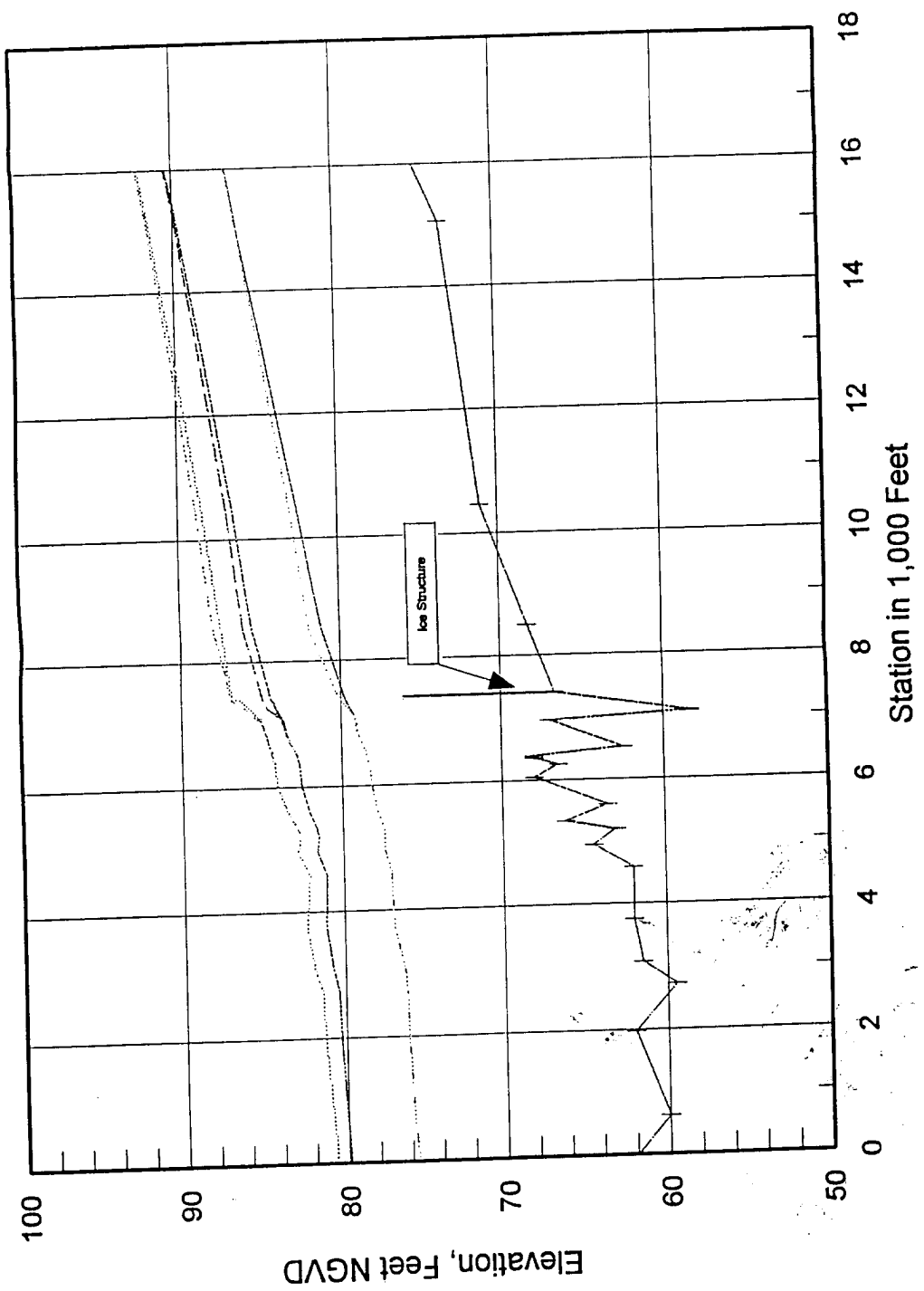
Elev: Feet NGVD



SCALE 1:16,000

Section 205 Reconnaissance
Shetucket River at Baltic, CT
Location of River Sections

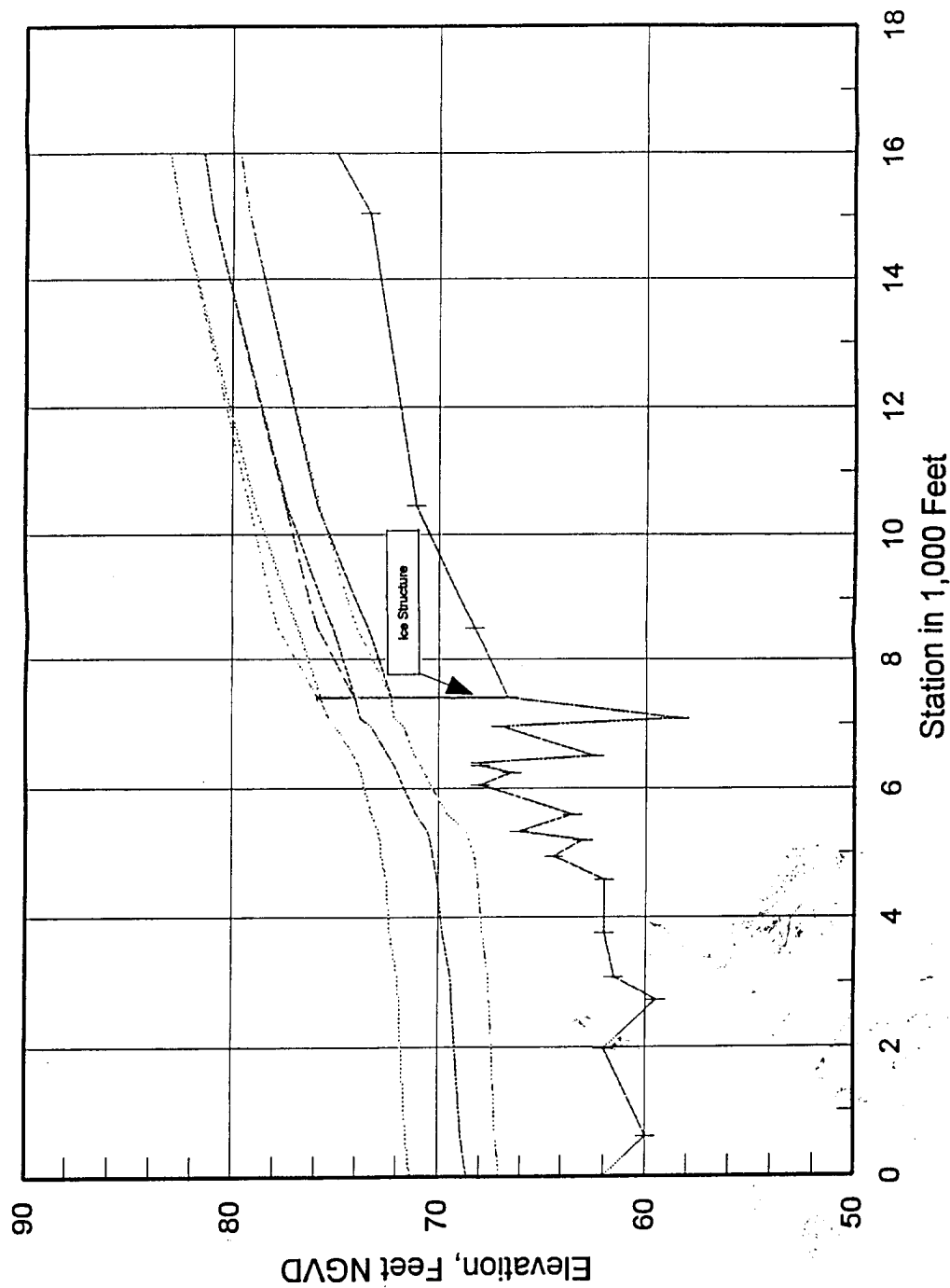
Water Surface Profiles Shetucket River at Baltic, CT



- 10-Yr Existing
- - - 50-Yr Existing
- ... 100-Yr Existing
- - - 10-Yr Proposed
- - - 50-Yr Proposed
- . - 100-Yr Proposed
- + River Invert

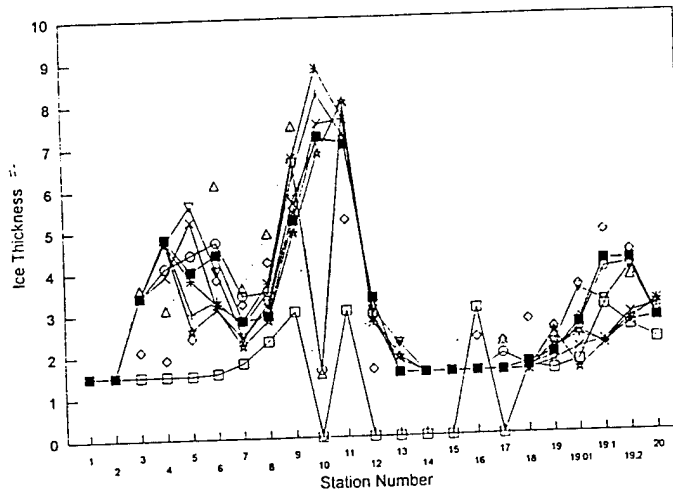
Comparison of existing and proposed conditions
Crib at 12 ft OC Free-flow conditions (no ice).

Water Surface Profiles Shetucket River at Baltic, CT

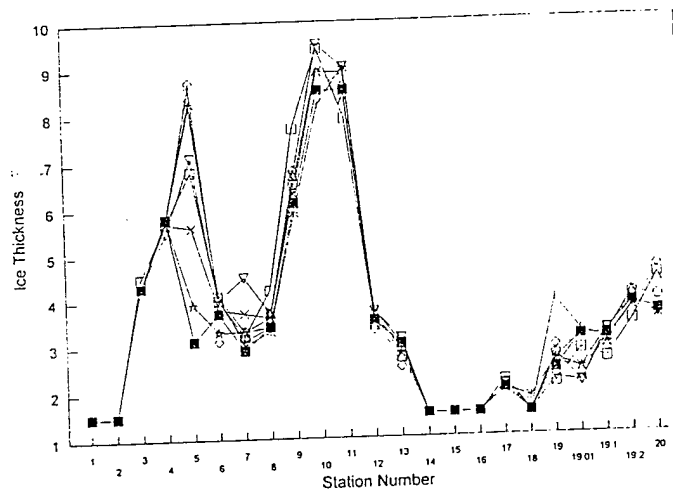


Comparison of existing and proposed conditions
Cribbs at 12 ft OC Free-flow conditions (no ice).

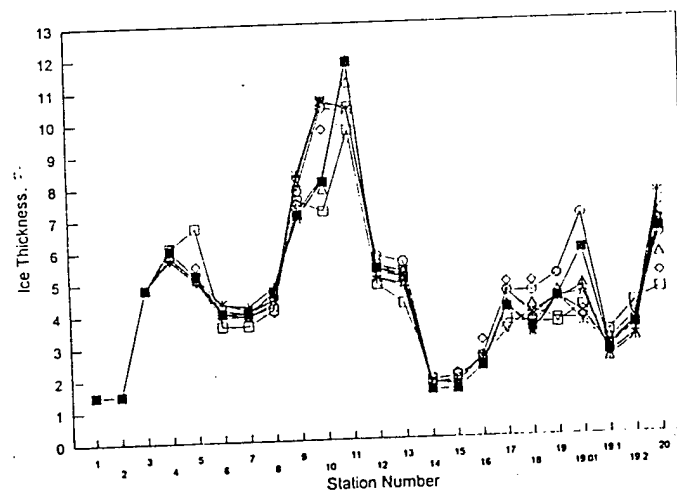
Break Up Ice Thickness Shetucket River at Baltic, CT



- Run 1
- ◇ Run 2
- △ Run 3
- ⊖ Run 4
- Run 5
- ▽ Run 6
- ☆ Run 7
- × Run 8
- + Run 9
- ※ Run 10

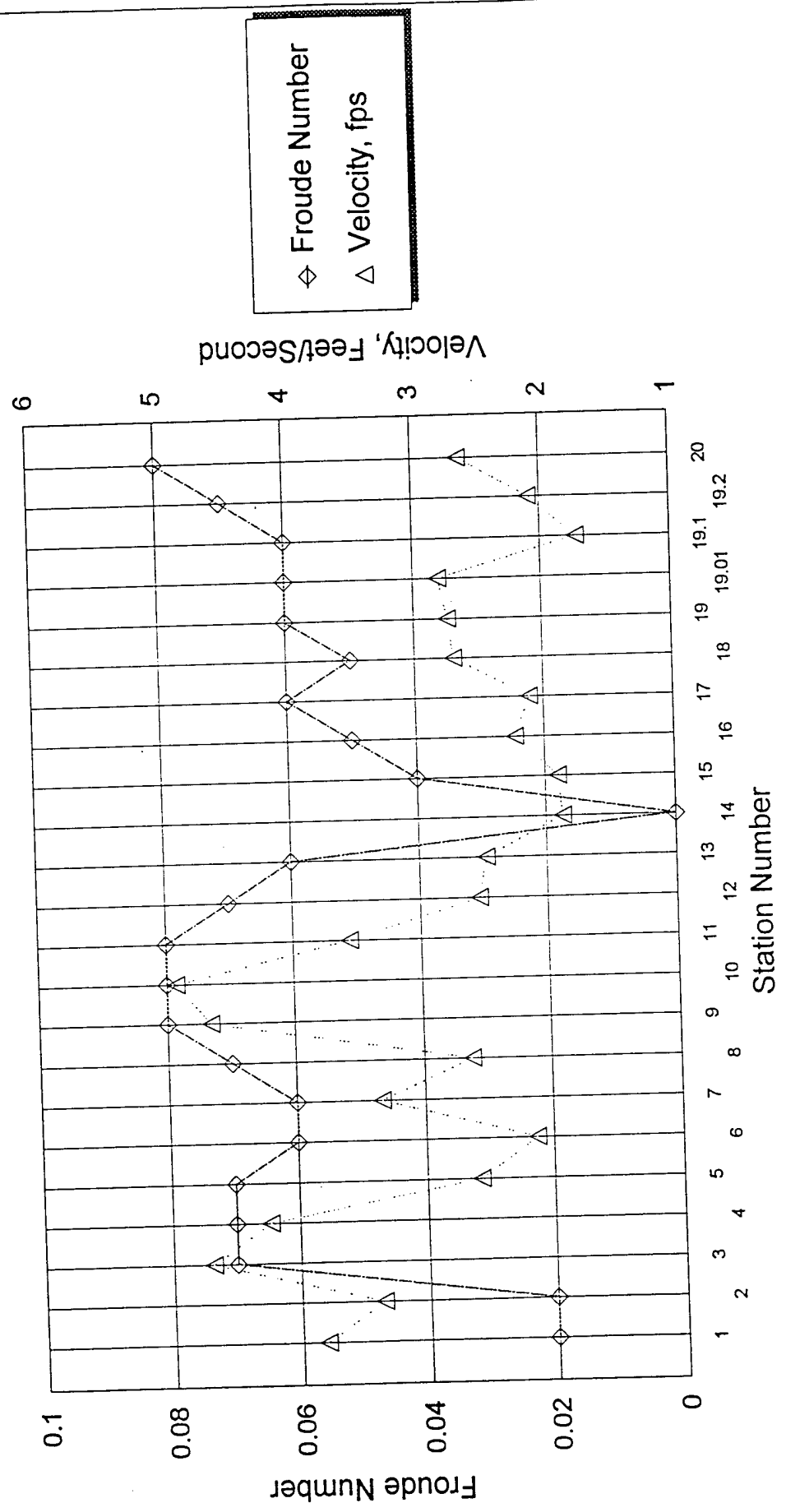


Flow = 3,000 cfs
Cribs spaced at 12 ft OC.



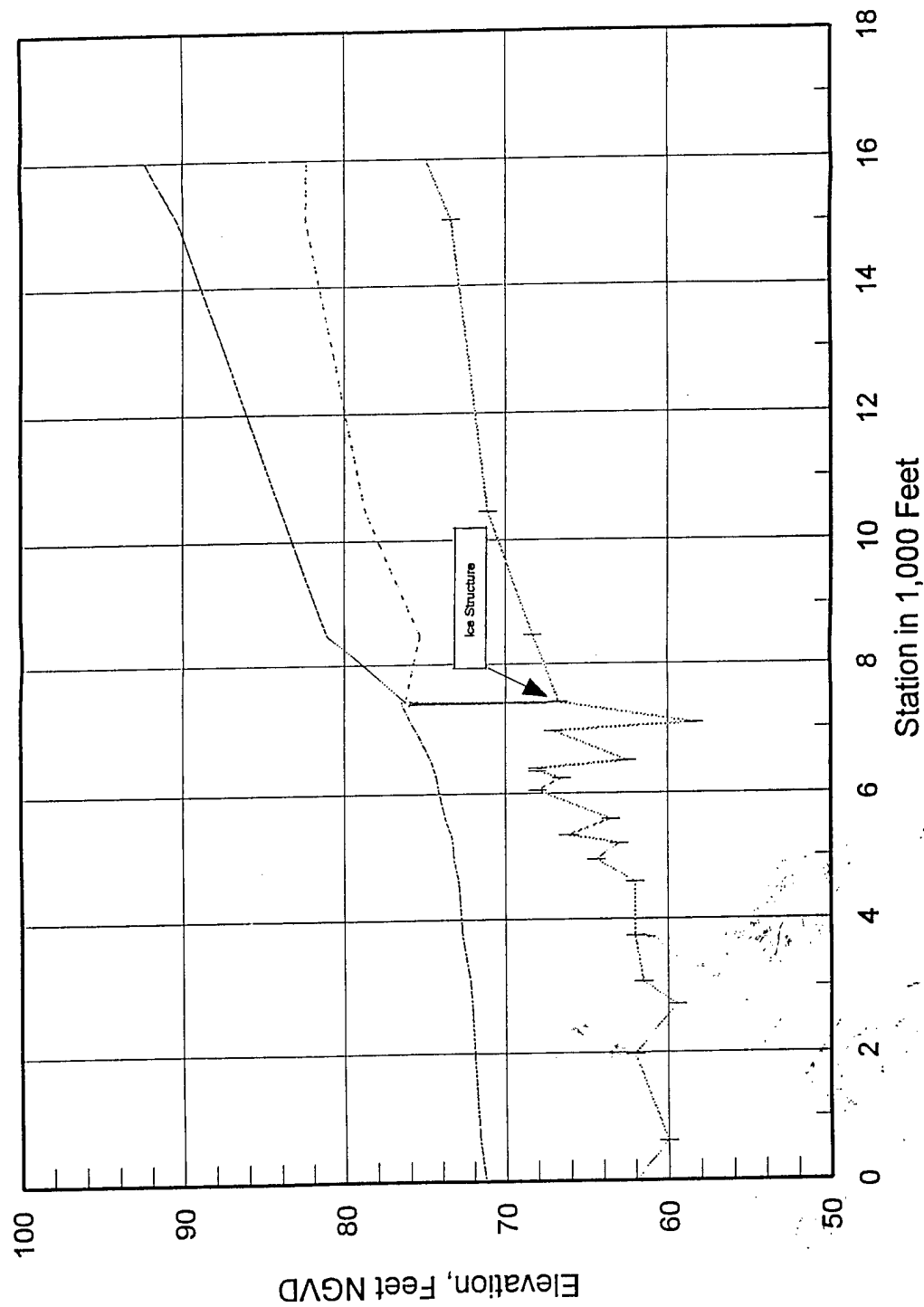
Flow = 6,000 cfs
Cribs spaced at 12 ft OC.

Break Up Froude Number Shetucket River at Baltic, CT

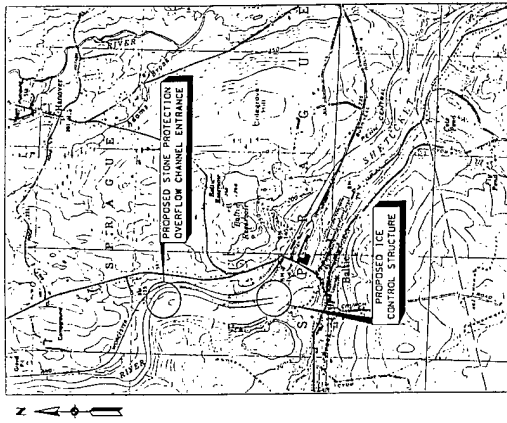


Flow = 6,000 cfs
Cribs spaced at 12 ft OC.

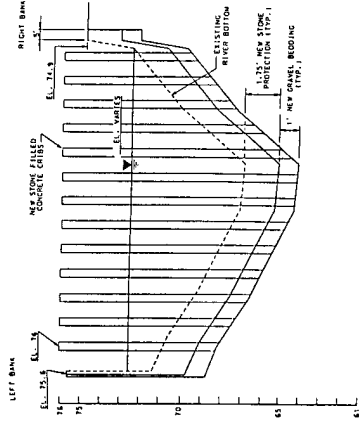
Water Surface and Ice Profile Shetucket River at Baltic, CT



Flow = 6,000 cfs Initial ice thickness = 1.5 feet
Cribs at 12 ft OC All ice trapped at structure

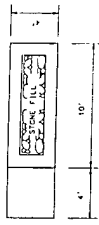


SCALE: 1" = 2,000' (APPROX)



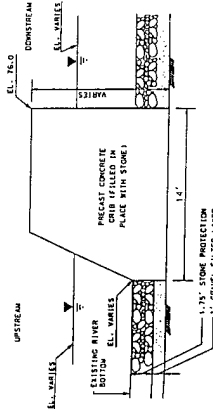
SECTION B - B

SCALE: HOR. 1" = 60'
VER. 1" = 6'



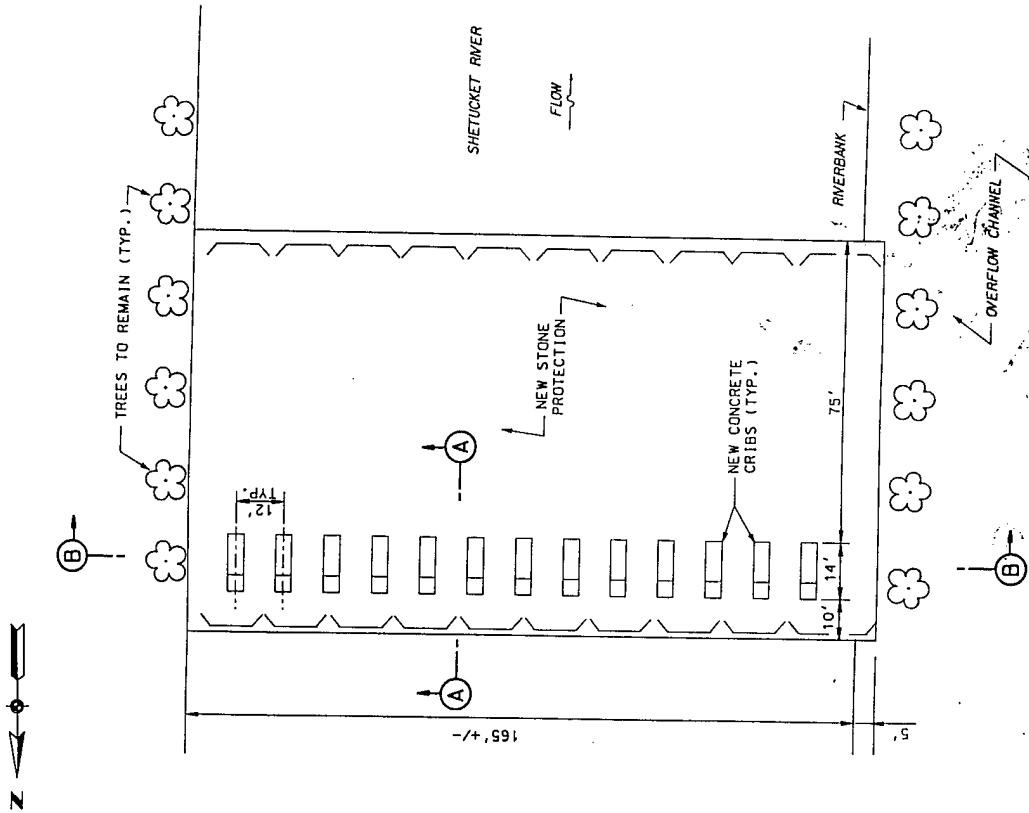
PLAN - PRECAST CONCRETE CRIB

SCALE: 1" = 10'



SECTION A - A

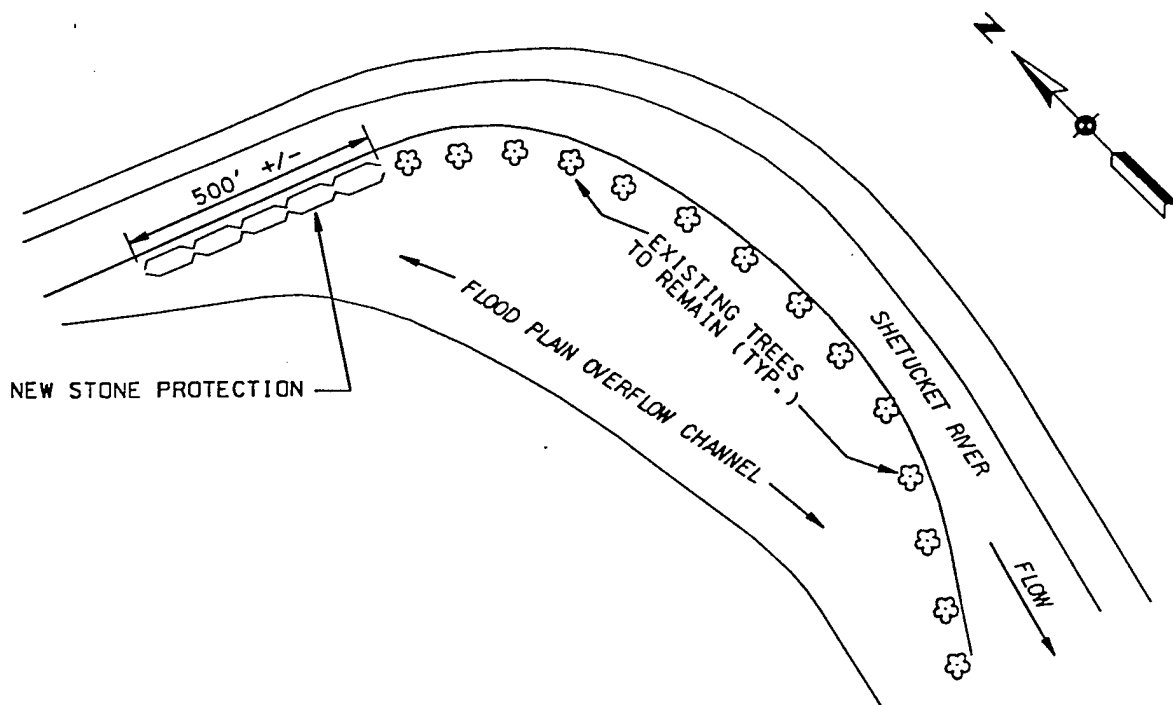
SCALE: 1" = 10'



PLAN

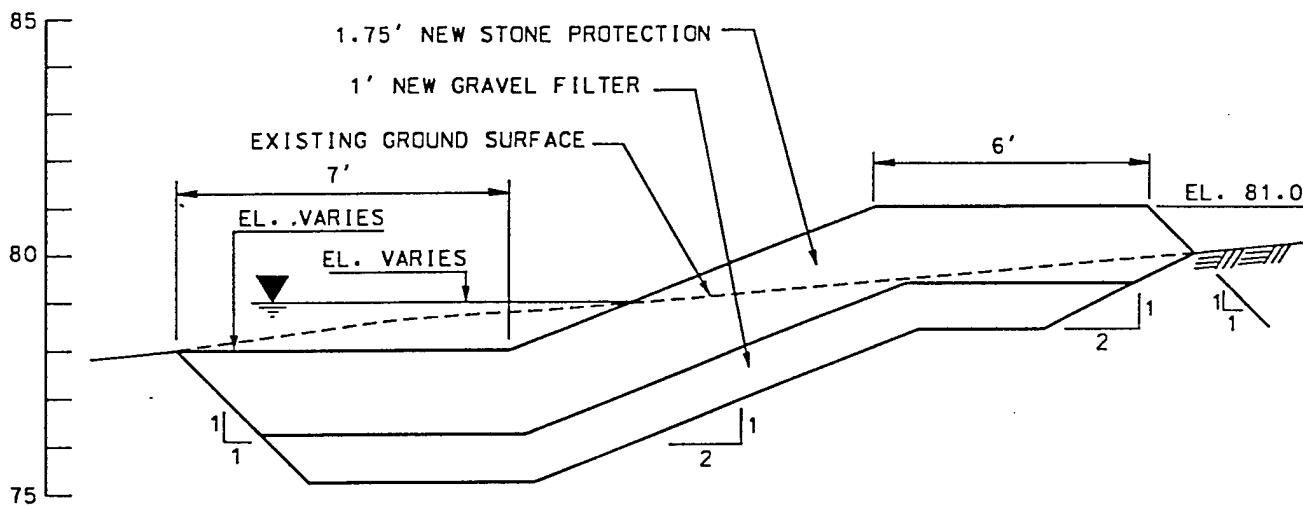
SCALE: 1" = 30'

Section 205 Reconnaissance
Shetucket River at Baltic, CT
PLAN AND SECTION
ICE CONTROL STRUCTURE
(Conceptual)



PLAN - OVERFLOW CHANNEL
STONE PROTECTION

N.T.S.



TYPICAL SECTION

SCALE: 1" = 4'

Section 205 Reconnaissance
Shetucket River at Baltic, CT

PLAN AND SECTION
ICE CONTROL STRUCTURE OVERFLOW
(Conceptual)

Section A

DATE: _____ mm/dd/yy TIME: _____ AM/PM

OBSERVER'S NAME: _____

RIVER STATION: _____

Is this a changed condition? ☐ Yes ☐ No

Photographs: ☐ Yes ☐ No

LOCAL WEATHER

Temperature: _____ °F ☐ Snow: _____

Precipitation: ☐ Rain: _____ in.

Snow on the ground: _____ in.

RIVER CONDITION

☐ Bank full _____ ft ☐ Estimate less than bank full _____ ft

Section B

☐ FREEZEUP

Border ice: Growth from shore _____ ft _____ % of channel remaining open

Moving ice: Types ☐ Frazil slush ☐ Frazil pans

(Check all that apply) ☐ Fragmented sheet ice ☐ Large sheets

☐ Other: _____

Percentage of open channel surface occupied by moving ice: _____ %

Ice cover complete _____ (mm/dd/yy)

☐ CHARACTER OF INTACT ICE COVER

Location of downstream end of ice cover (River Station): _____

Location of upstream end of ice cover (River Station): _____

Surface roughness (check one):

☐ Smooth ☐ < 1.0 ft ☐ < 1.5 ft ☐ > 1.5 ft

☐ No ☐ Snow covered

Evidence of decay: ☐ Yes ☐ Melting ice ☐ Candelled ice

If yes, check: ☐ Melting snow ☐ No

Cracks in ice cover: ☐ Yes ☐ No

If yes, check: ☐ Parallel to shore ☐ Distance from shore: _____ ft ☐ Estimate ☐ Measured

☐ Perpendicular to shore

Evidence of fracturing along banks ☐ Yes ☐ No

If yes, check: ☐ (a) Ice thickness when fracture occurred: _____ ft ☐ Estimate ☐ Measured

☐ (b) Displacement: _____ ft ☐ Estimate ☐ Measured

☐ (c) Distance from shore: _____ ft ☐ Estimate ☐ Measured

☐ BREAKUP

Cracks (check one):

☐ Parallel to shore ☐ Distance from shore: _____ ft ☐ Estimate ☐ Measured

☐ Perpendicular to shore

Average distance between cracks: _____ ft

Water on top of ice: ☐ Pooled ☐ Flowing ☐ None

Time ice started to move: _____ AM/PM ☐ mm/dd/yy

Time water was clear of ice: _____ AM/PM ☐ mm/dd/yy

☐ ICE JANIS

Cause (check one):

☐ Freezeup ☐ Breakup

Condition at ice jam initiation point (check all that apply):

☐ Solid ice sheet ☐ Bend ☐ Bridge ☐ Island

☐ Reduction in water slope ☐ Other: _____

Jam length: _____ mi (approx)

Location of ice jam toe (River Station of downstream end), if known: _____

Location of ice jam head (River Station of upstream end), if known: _____

Height of sheer walls along bank after jam release: _____ ft

Shoetucket River Ice Report: Additional Information

Page 2

Section C

Observer: _____

Date: _____

Time: _____

Location: _____

Sketches: Include approximate scale.

Illustrate character of ice cover, ice coverage, water level, etc.

1. River cross section:

Left bank

Looking downstream

Right bank

2. River reach (use copy of map if available; show flow direction).

Comments on any aspect of ice quantity, quality, freezeup, breakup, jamming, weather, etc.:

CONTACT #1:

Local Emergency Mgr.

CONTACT #2:

Connecticut DEP

Inland Water Resources

CONTACT #3:

Corps of Engineers

New England Division

Emergency Operations

APPENDIX B

**SHETUCKET RIVER
BAL TIC, CONNECTICUT
ICE JAM REDUCTION STUDY**

**APPENDIX B
GEOTECHNICAL ASSESSMENT**

Prepared by:

**Design & Facilities Evaluation Branch
and
Geology and Chemistry Branch
Geotechnical Engineering Division
Engineering Directorate**

**New England Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254-9149**

**SECTION 205 RECONNAISSANCE STUDY
ICE JAM REDUCTION STUDY
SHETUCKET RIVER, BALTIC, CT
GEOTECHNICAL ASSESSMENT**

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LIST OF PLATES

FIGURE 1
FIGURE 2
PLATE 3

SECTION 205 RECONNAISSANCE STUDY
ICE JAM REDUCTION STUDY
SHETUCKET RIVER, BALTIC, CT

GEOTECHNICAL ASSESSMENT

1. SUMMARY. A Section 205 Reconnaissance Study for ice jam reduction measures for the Shetucket River in Baltic, CT is being conducted by the U.S. Army Corps of Engineers, New England Division. The study originated after an ice jam had inundated several homes and businesses on 29 January 1994. The proposed solution to alleviate this problem is construction of an ice-holding crib transversing a 160-foot-wide section of the Shetucket River, approximately 1,300 feet upstream of the Route 97 bridge in the town of Sprague, CT. This ice retention structure would consist of 13 cribs, 12 feet apart on center. Each crib would be 8 feet long at the top, 4 feet wide, and built to elevation 76.0 feet National Geodetic Vertical Datum (NGVD), 1 foot above the top of the bank. The cribs would be constructed of either a concrete shell or 8-inch by 8-inch timber, and filled with stone or concrete, depending on the shell.

2. TOPOGRAPHY. The study area is located in the Norwich, Connecticut Quadrangle. The area lies within the Eastern Connecticut Highland region. Local relief of up to 200 feet is typical. Drainage is generally to the south. While the drainage patterns of the major rivers, such as the Shetucket, are not strongly controlled by bedrock structure, the smaller tributaries are clearly influenced by the north-northeast trend of the underlying bedrock. Elevation of the river bed at the proposed crib location ranges from 67 feet NGVD at its deepest point, to 75 feet NGVD at its banks. Topography in the study area has been influenced by four factors: presence of bedrock, the effects of glaciation, river processes, construction and alteration by man.

Upstream of the proposed ice crib location, the Shetucket River flows within its floodplain, which is at elevation 80 feet NGVD. The floodplain west of the river is long and crescent shaped, and between 150 feet and 500 feet wide. The floodplain on the east side of the river is wedge shaped, and shorter and narrower than the west side. The long, flat area on the west side of the river is the proposed overflow channel. Beyond this area on the west side, there is a steep-faced rock outcrop, reaching a maximum elevation 200 feet higher than the floodplain. Beyond the floodplain on the east side of the river, the land rises another 50 feet above the elevation of the floodplain.

3. GEOLOGY.

3.1 General. The geology of New England is the result of a complicated history of orogeny, intrusion, and metamorphism. There are mixed rock types in very complex associations. Although numerous faults have been mapped or otherwise suspected, none are presently known to be active. The area has been glaciated several times and the modern landscape is largely one of remnant surficial deposits of glacial origin overlying bedrock.

3.2 Bedrock Geology. Bedrock in the study area consists of pre-Pennsylvanian aged metamorphic rock types. In this locality, the Putnam gneiss occurs in its biotite-muscovite schist phase, and is described as a medium-grained, quartz-calcic oligoclase-biotite-muscovite schist, with minor garnet and potassium feldspar (Snyder, 1961). Large bedrock outcrops occur along the west side of the flood plain. Depth to bedrock in the river channel is not known, but is expected to occur at sufficient depth not to impact construction of the proposed cribs.

3.3 Surficial Geology. Glacial deposits occur along either side of the Shetucket River floodplain. Along the west side, glacial till is mapped as a thin mantle over the underlying bedrock (amid bedrock outcrops). This deposit is described as chiefly compact clayey till, including some compact sandy till (Hanshaw and Snyder, 1962). Along the east side, stratified drift deposits are mapped along the terrace above the floodplain, at an elevation of 130 feet NGVD. Such deposits typically consist of well sorted layers of materials, ranging from boulders to gravel, sand, and silt sized particles.

The flood plain may consist of recent alluvium (gravel, sand, and silt) overlying or intermixed with reworked till or stratified drift deposits. It is believed that the major drainage patterns in this area were not significantly altered by glaciation, and that the Shetucket River is probably flowing in a valley that was carved out prior to glaciation. The former bedrock valley has since been filled with an unknown thickness of glacial stratified drift and/or till materials, over which the present river flows. Two borings were made in the general vicinity of the proposed ice crib by Lenard Engineering, Inc. in January 1994. The borings were taken east of the Shetucket River, between the old Baltic Dam and the Route 97 bridge. The exact location and elevation of the borings are unknown. Materials encountered in the borings consisted mainly of dense well-graded, medium to coarse gravelly sand and sand with gravel. A few of the samples contained silt and were slightly plastic. Both borings were greater than 70 feet deep, and bedrock was not encountered in either of them.

4. GENERAL SUBSURFACE CONDITIONS AND DESIGN PARAMETERS.

Soil explorations and laboratory testing were not performed as they are not within the scope of this reconnaissance study. The only subsurface information available is from the two borings mentioned in the above paragraph and from the surficial and bedrock geology maps.

Most of the samples from the borings consisted mainly of dense sands with gravel and silt. However, there were samples which were loose and medium dense. The exact location and elevations of the borings are unknown. Therefore, for the purpose of this study, the more conservative design assumes loose sand as the foundation material on the bottom of the river. From the Naval Facilities DM 7.02, Table 1 (1 September 1986), the allowable bearing pressure for loose coarse to medium sand with little gravel is 2 tsf. A conservative angle of internal friction, ϕ , is 28° . Bedrock was not encountered and is assumed for the purpose of this study to be at a sufficient depth that it will not be encountered during construction of the ice cribs.

5. DESIGN CRITERIA.

5.1 General. The geotechnical materials required for the construction of the ice-holding cribs consist of stone for the interior of the ice holding crib, stone for the apron and stone protection area, and a gravel filter between the stone and the existing material. The grain size distribution graph for the stone and gravel filter is shown on Figures 1 and 2. The apron extends from 20 feet upstream to 65 feet downstream of the ice crib retention structure. A typical cross section of the crib and apron are shown in Figure 3.

5.2 Stone. The same stone used in the apron and stone protection area can be used in the ice holding crib structure. The analysis determined that a minimum D_{50} for the apron is 1 foot. With this information, the grain size distribution curve was created in accordance with EM 1110-2-1601 (July 1991) and shown in Figure 1. The minimum design thickness required for the apron is 21 inches, the maximum stone size, provided that the stone is placed in the dry. The quantity of stone required is 1330 cubic yards for the apron and additional protection, and 250 cubic yards for inside the cribs. Parameters for the stone are as follows: $\phi = 40^\circ$, $Y_{sat} = 135$ p.c.f., $Y_{moist} = 120$ p.c.f., $Y_{dry} = 115$ p.c.f., and $Y_{sub} = 73$ p.c.f.

5.3 Crushed Stone Filter. A 12-inch crushed stone layer is required between the rock apron and existing river bottom material to act as a filter between the stone and underlying material. The grain size distribution curve for this crushed stone is shown on Figure 2. It conforms to M.12.02 Type 4 - Special Riprap, of the State of Connecticut Department of Transportation State Specifications for Roads, Bridges, and Incidental Construction (1985). Approximately 750 cubic yards of filter material is required. Parameters for the crushed stone are as follows: $\phi = 40^\circ$, $Y_{sat} = 128$ p.c.f., $Y_{moist} = 110$ p.c.f., $Y_{dry} = 105$ p.c.f., and $Y_{sub} = 65$ p.c.f.

6. MATERIAL AVAILABILITY.

6.1 General. The geotechnical materials required for this project are stone and crushed stone filter material. A material survey was conducted of sources within a radius of approximately 50 miles of the study area. Several stone quarries with crushing and processing operations exist in the eastern portion of the state. A total of eleven sources were contacted for this study.

6.2 Stone. The material required is a quarried stone, having a D_{50} of 12 inches to 14 inches and a maximum diameter of 15 inches to 21 inches. The gradation for this material falls between the Intermediate Riprap and the Standard Riprap gradations cited in M.12.02 of the CTDOT State Specifications. The quantity of stone material required is approximately 1,600 cubic yards, or approximately 2,200 tons. Five sources indicated they are capable of producing the required quantity of stone. Two are located within a radius of 15 miles of the study area, and three are located at distances of 40 to 50 miles from the study area. The remaining six sources contacted either indicated they were unable to make the required gradation, or considered the study area too far away.

Since the required gradation does not conform to a CTDOT specification, some special efforts to produce the required stone may be required, depending on the source. One source indicated that its Intermediate Riprap would meet the required specification. The other four sources indicated that the specified material could be produced, if given sufficient advance notice, and if additional coordination was provided at the quarry, in identifying which materials meet the specifications.

6.3 Crushed Stone. The material required is a processed crushed stone, 100% passing the 3-inch sieve, and meeting the gradation cited for "Special Riprap" in M.12.02 of the Connecticut Department of Transportation (CTDOT) Specifications. The quantity of filter material required is approximately 750 cubic yards, or approximately 1,100 tons. Only two sources indicated they are capable of producing the required quantity of filter material. Both are located within a radius of approximately 15 miles of the study area. The remaining nine sources contacted either indicated they are unable to make the required gradation, or considered the study area too far away.

7. CONSTRUCTION CONSIDERATIONS. There is an existing access road which runs parallel to the west side of the river. On the east side of the river there is an existing access road, approximately 700 feet long, extending northward from the Route 97 bridge. An additional 800 feet must be constructed for access to the proposed crib location. This access road must be constructed in compliance with the state specifications.

A method of flow diversion will also be necessary for access to the center of the river during construction. Stone protection shall be 21 inches thick if placed in the dry within the cofferdam. The thickness should be increased by 50% if the riprap is placed underwater to provide for uncertainties associated with this type of placement.

8. RECOMMENDED FUTURE STUDIES. Subsurface explorations should be conducted as part of the feasibility study. This should be done to determine the type of material present along the river bottom. This will result in a more precise bearing capacity calculation, filter design, and determination of any shallow bedrock. At least three borings should be taken across the river channel in the location of the proposed cribs, at a depth no less than 15 feet. Standard Penetration Testing, along with continuous sampling should be conducted.

REFERENCES

Hanshaw, P.M., and Snyder, G.L., 1962, "Geologic Map of the Norwich Quadrangle, Connecticut, Surficial Geology."

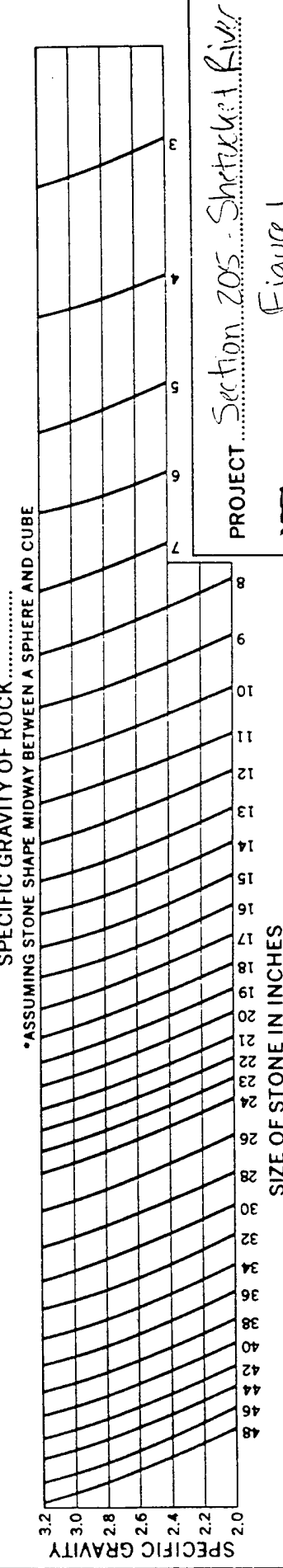
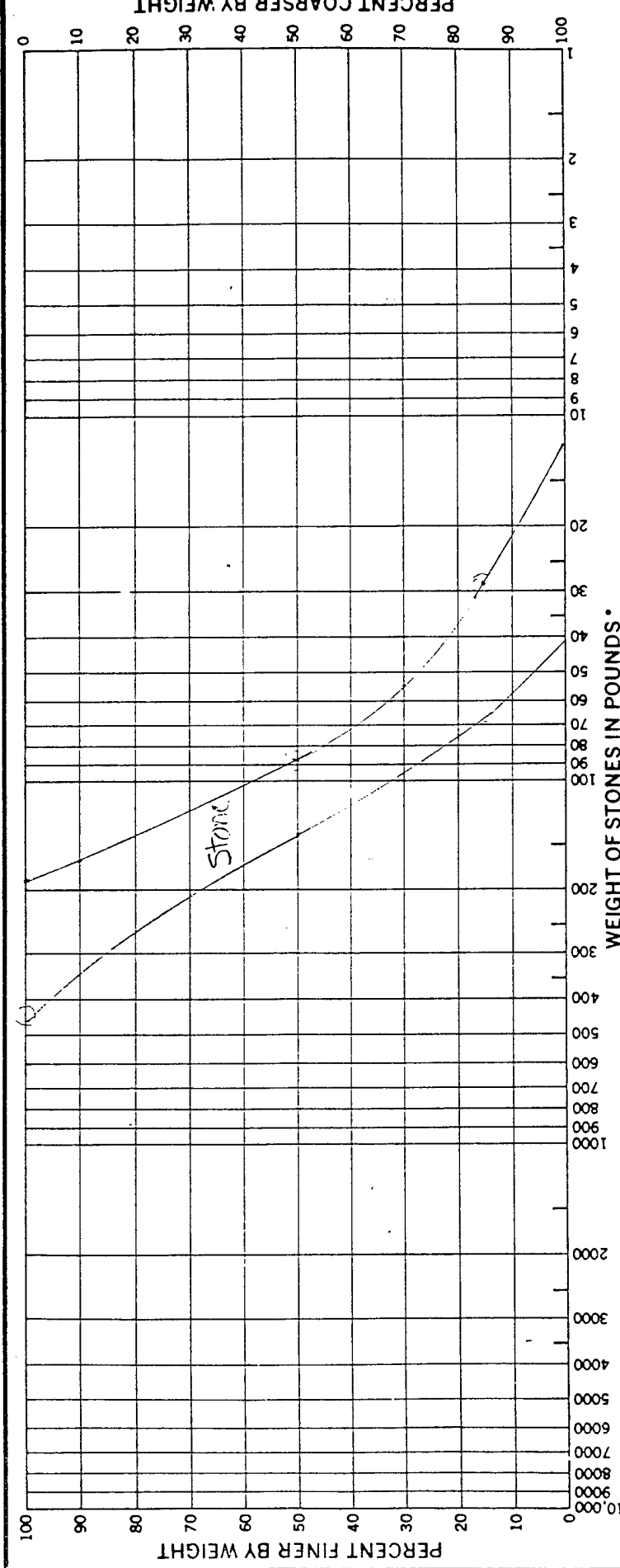
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Snyder, G.L., 1961, "Bedrock Geology Map of the Norwich Quadrangle, Connecticut."

State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges and Incidental Construction, Form 813, 1985.

U.S. Army Corps of Engineers, Engineering Manual 1110-2-1601, Hydraulic Design of Flood Control Channels, 1 July 1991.

U.S. Army Corps of Engineers, Engineering Manual 1110-2-1901, Change 1, Seepage Analysis and Control for Dams, 30 April 1993.



PROJECT Section 205 - Shetucket River

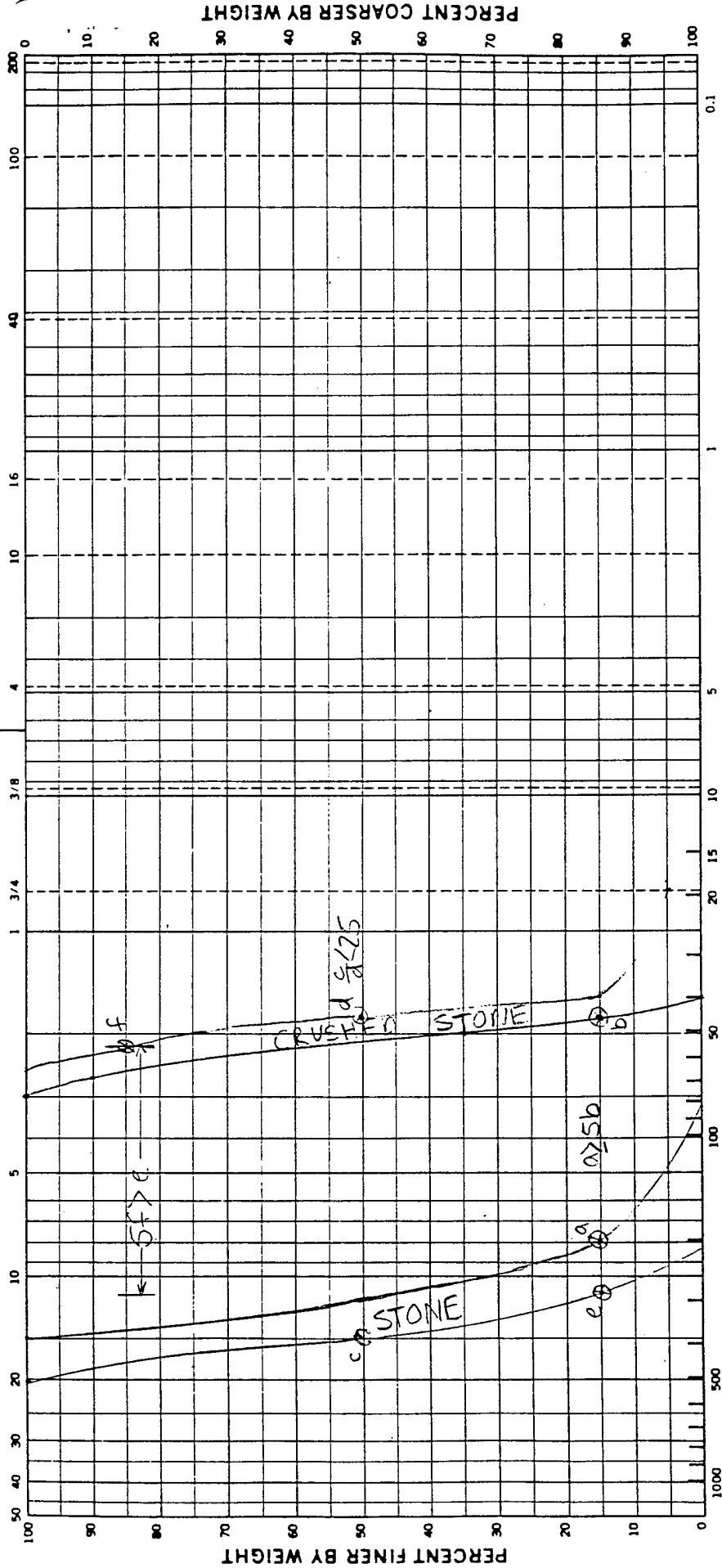
AREA Figure 1

DATE Feb 1995

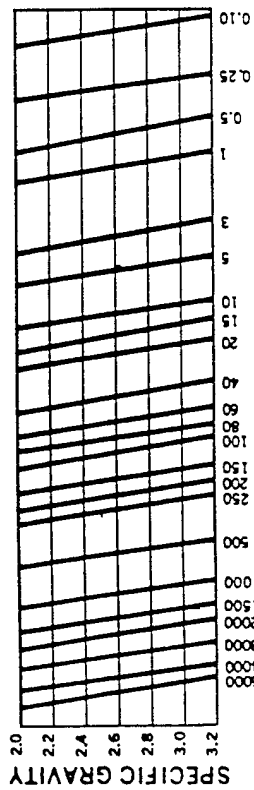
RIPRAP GRADATION CURVES

U. S. STANDARD SIEVE NUMBERS

STONE SIZE IN INCHES



SPECIFIC GRAVITY OF STONES.....



* ASSUMING STONE SHAPE MIDWAY BETWEEN A SPHERE & CUBE

PROJECT..... Section 205 - Sheteket River

AREA..... Figure 2

DATE..... Feb 1995

GRADATION CURVES
FOR RIPRAP FILTER AND BEDDING

APPENDIX C

ENVIRONMENTAL RECONNAISSANCE REPORT

SECTION 205
LOCAL FLOOD PROTECTION-ICE JAM STUDY
SHETUCKET RIVER
BALTIMORE, CONNECTICUT

Prepared by:

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April 1995

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**SECTION 205, LOCAL FLOOD PROTECTION-ICE JAM STUDY
SHETUCKET RIVER, BALTIMORE, CONNECTICUT
Environmental Resources Reconnaissance Report**

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**SECTION 205, LOCAL FLOOD PROTECTION-ICE JAM STUDY
SHETUCKET RIVER, BAL TIC, CONNECTICUT**

Environmental Resources Reconnaissance Report

I. Project Description and Problem Identification

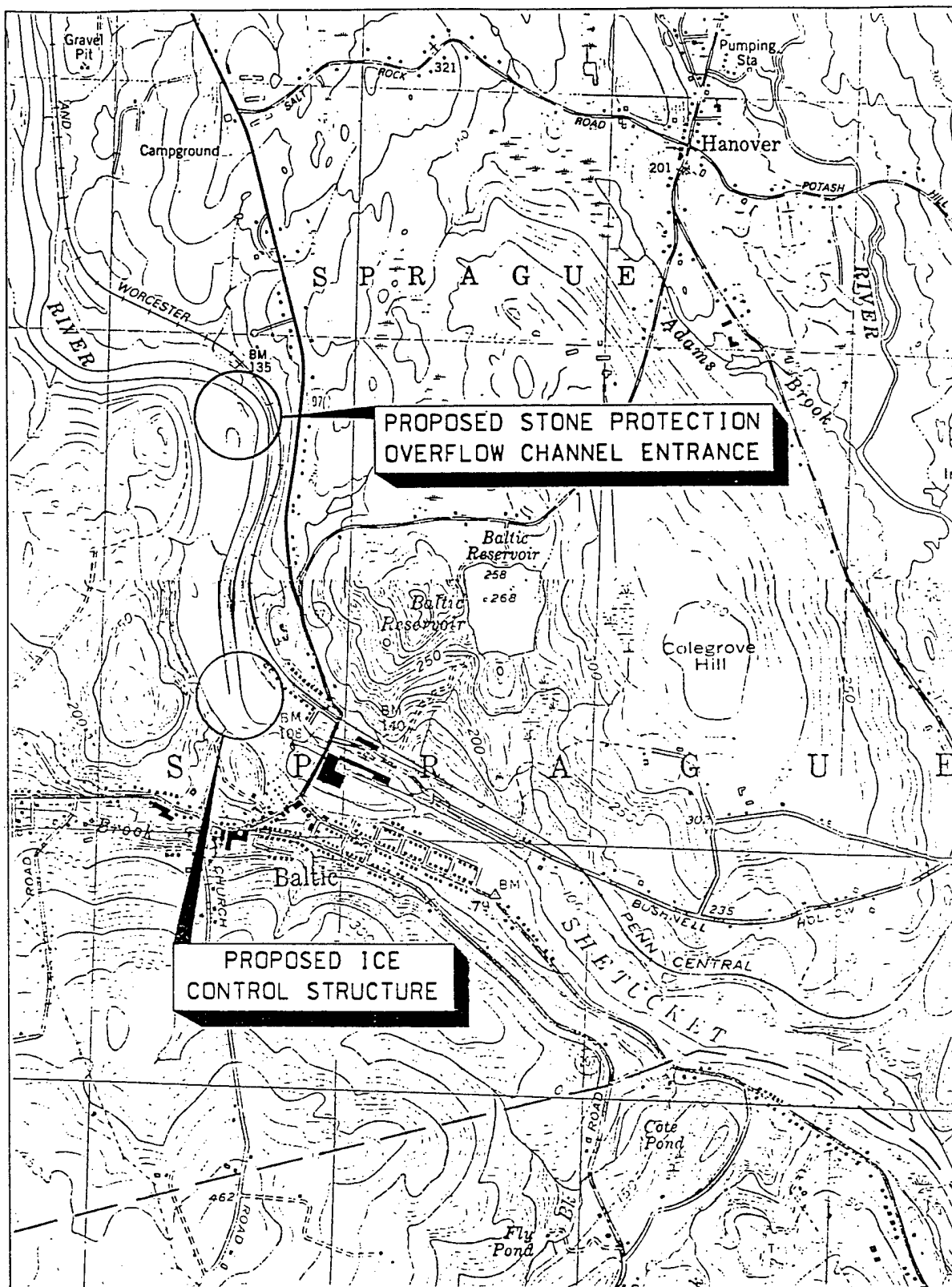
This project is being evaluated under the special continuing authority contained in Section 205 of the 1948 Flood Control Act, as amended. The purpose of the study is to examine the potential for constructing ice jam holding structures, cribs or blocks, upstream from the Main Street Bridge (Route 97) in order to provide flood protection for the Village of Baltic, Town of Sprague, Connecticut (see Plate 1). In January 1994, an ice jam occurred upstream of the Route 97 bridge. Floodwaters behind the ice jam overtopped a berm constructed by the Corps of Engineers resulting in the damage to several homes and commercial buildings.

The potential construction of 13 timer cribs across the Shetucket River, approximately 300 feet upstream from the Route 97 bridge, is being evaluated for the purpose of eliminating peak water stages associated with ice jams. The Shetucket River in this reach is estimated to be 200 feet wide and with normal flows averaging approximately three feet depth. The proposed timber cribs would have a footprint of 16 feet by 8 feet, about six to ten feet above the streambed and placed in a straight line perpendicular to stream flow direction at 16 feet on-center. A two feet deep stone protection apron extending ten feet upstream and ten feet downstream of the timber crib structures would also be required.

By holding the cover ice and spring ice flows, ice jams will occur behind the timber cribs and prevent river overflow into downstream properties. In addition to the timber crib structures, the right bank flood plain will serve as an overflow channel allowing river waters to pass around the jam site. Dimensions of a stone inlet and outlet of the overflow channel, which would be situated approximately 6,000 feet upstream of the crib structures, would be 500 feet wide, 60 feet in length and two feet deep.

1. Revised Project Plans

A more detailed proposed project was delivered at the end of this environmental study period which slightly altered the proposed plan for local flood protection which was the basis for this report. The revised plan, differs from the original by



SCALE: 1" = 2,000 FT. (APPROX)

Plate 1

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

ICE JAM FLOOD CONTROL
SECTION 205
SPRAGUE (BAL TIC), CT
SHETUCKET RIVER
LOCATION MAP

utilizing concrete monoliths which have a footprint 4 feet wide by 12 feet long and are embedded in the river bottom to prevent undermining by scour. These monoliths are to be spaced 12 feet on-center with an eight foot clear opening between monoliths. The specific parameters associated with these structures would be established in the feasibility study. Stone protection at the base would be required and present plans involve laying a rock foundation across the entire river bed. The estimated size is 165±' by 75 feet, an area equal to 12,375 square feet (0.28 acres). Removal of riparian vegetation, approximately 500' X 60' will also be required to accomodate the construction of an overflow inlet channel upstream.

II. Initial Coordination

Project information letters requesting comments and information on natural resources were mailed to the following individuals and agencies prior to the preparation of this reconnaissance report:

1. Mr. Gordon E. Beckett, U.S. Fish and Wildlife Service
3. Mr. Douglas A. Thompson, U.S. Environmental Protection Agency
4. Mr. Timothy Keeney, Connecticut (CT) Department of Environmental Protection
5. Mr. John Spencer, CT Department of Natural Resources, Bureau of Natural Resources
6. Mr. Tom Morrissey, Director, Water Resources Unit, CT Department of Environmental Protection
7. Ms. Nancy Murray, CT Natural Diversity Data Base

Comments and letters which have provided information regarding this reconnaissance level report have been received from:

1. Mr. Brian J. Emerick, Connecticut Department of Environmental Protection, Office of Environmental Review, 12 January 1995. (Coordinated regulatory and resource management disciplines reply).
2. Ms. Stacey Kingsbury, Connecticut Department of Environmental Protection, Natural Resources Center, Natural Diversity Data Base, 29 November 1994.
3. Mr. Gordon E. Beckett, U.S. Department of the Interior, Fish and Wildlife Service, Fish and Wildlife Coordination Act Section 7(c) consultation, 23 December 1994.
4. Mr. Greg Monesto of the U.S. Fish and Wildlife Service, Rhode Island Office (indicated he wants to receive a copy of the Reconnaissance report when it is available for review).

III. Environmental Setting

1. General

The proposed project is located in Baltic, Connecticut along the Shetucket River. Baltic is the largest of three villages that make up the Town of Sprague, which is located in New London County in eastern Connecticut. The Shetucket River runs through Baltic along a nearly north-south orientation, while nearby Beaver Brook winds through the center of the village and empties into the Shetucket River near the Town Hall.

2. Water Quality

The Connecticut Water Quality Classifications Map (1987) in this reach of the Shetucket River, near the Village of Baltic, indicates the proposed stone protection overflow channel to be located near an area rated as GA/GA/GC, while the water classification near the proposed ice control structures are Bc.

GA/GA/GC is in a category known as Class GC. Designated uses involve the assimilation of treated discharges which have been permitted by the Commissioner pursuant to Section 22a-430 of the Connecticut General Statutes. GA/GA/GC are areas not presently used for waste disposal and where existing water quality is presumed to be suitable for direct human consumption. The immediate goal is to maintain existing water quality. The potential use of the ground waters for purposes other than drinking water, based on a preliminary evaluation of hydrogeological conditions, is indicated by a Class GC designation. A municipality or person may submit permit applications for certain wastewater discharges and a request to change to Class GC.

Class B waters are waters which have designated uses for recreation, fish and wildlife habitat, agricultural and industrial supply, and other legitimate uses including navigation. The subclass Bc are waters which are known or presumed to meet water quality criteria which supports designated uses, where Bc designates uses by cold water fisheries.

3. Aquatic Resources

The Connecticut Department of Environmental Protection provided a comment letter in support of the proposed Corps of Engineers plan. The letter provided extensive information regarding the environmental resources present in this area of the Shetucket River and has been summarized or incorporated into the remaining sections of this report.

a. **Fisheries Resources:** The Shetucket River adjacent to the project area is known to support a variety of freshwater finfish. It is annually stocked by the Connecticut DEP's Fisheries Division (FD) with approximately 5,000 adult (9"-12") hatchery brown, brook and rainbow trout (Salmo trutta, Salvelinus fontinalis and Salmo gairdneri). The area between the Scotland Dam in Scotland and the Route 97 bridge in Baltic has been evaluated by the Fisheries Division for its potential to support holdover brown trout. This same area is also known for its abundant smallmouth bass (Micropterus dolomieu) population. Since 1992, this section of the Shetucket River has been stocked with surplus Atlantic salmon brood stock every fall, which has resulted in the development of a popular recreational fishery.

In addition to trout (Salmo spp.) and smallmouth bass, other resident species include: blacknose dace (Rhinichthys atratulus), fallfish (Semotilus corporalis), tessellated darter (), spottail shiner (Notropis hudsonius), American eel (Anguilla rostrata) and white sucker (Catostomus commersoni).

Impounded areas of the river are expected to contain a warmwater fish community represented by species such as largemouth bass (Micropterus salmoides), rockbass (Ambloplites rupestris), chain pickerel (Esox niger), various sunfish species (Lepomis spp.), yellow perch (Perca flavescens), white sucker, golden shiner (Notropis sp.), spottail shiner and brown bullhead (Ictalurus nebulosus).

The Shetucket River is in the early stage of an anadromous fish restoration program, with the initial focus being on American shad (Alosa sapidissima) and river herrings (Alosa sp.). Anadromous fish passage will soon be achieved past the Greenville Dam in Norwich with the installation of a fish lift, with passage at two dams downstream of the project still to be provided.

4. Terrestrial Resources: Riparian Habitat

Riparian vegetation occurs along the banks within the proposed project area. The area selected to be utilized as an overflow currently exists in agricultural production along the Shetucket River floodplain. Rivers are often bordered by vegetative communities which are dominated by hydric species. Their presence increases habitat diversity for a variety of wildlife species as well as provide bufferzones to control sedimentation runoff and aid in flood reduction.

Leaves, branches and twigs fall from the trees and shrubs into the streams and rivers, decompose, and provide an important energy source for the river food chain. Insects by the thousands spend their lives near in the stream, providing an important food source for birds and other woodland animals (Kricher 1988).

The size of the floodplain field which will be utilized as an overflow area roughly measured approximately 40-50 acres and was used last season in corn production. It was bordered on the west by steeply sloped rocky outcrops. At the base of the slopes, the western edge of the entire field contained a freshwater wetland which also served as an outer drainage ditch, catching water drainage from the field as well as runoff from the hillside. The width of this area varied between 15 feet in some areas to as much as 40-50 feet. Phragmites sp. and woody wetland vegetation occupied a large portion along this area, with three large distinct patches of Phragmites sp. present with the entire acreage.

5. Endangered, Threatened and Rare Species

The U.S. Fish and Wildlife Service (letter dated 23 December 1994) reported the base on the information provided in the coordination letter, no federally listed or proposed threatened and endangered species under jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area, with the exception of occasional transient bald eagles (Haliaeetus leucocephalus) or peregrine falcons (Falco peregrinus anatum).

In the initial coordination phase with the State of Connecticut Natural Diversity Data Base, letter dated 29 November 1994, a preliminary review of the project area has indicated no known extant populations of Federal or State Endangered, Threatened or Special Concern Species occur in the delineated project area provide by NED. This is only a preliminary review and not a final determination. A more detailed review will be required at during the Detailed Project Report.

6. Historical and Archaeological Resources

Baltic is the largest of three villages that comprise the town of Sprague, Connecticut which is located within New London County in the eastern portion of the state. It is also the seat of government for the town. The Shetucket River flows through the village, as does Beaver Brook which winds through the center of Baltic and empties into the Shetucket near the town hall. The Providence and Worcester Railroad (Willimantic Branch) passes east to west through Baltic providing freight service.

The town of Norwich, Connecticut was founded on June 6, 1659 from lands purchased from Uncas and other sachems of the Mohegans totalling approximately nine square miles. The town of Sprague would eventually be located within the far north central portion of the tract and comprised from parts of Franklin and Lisbon.

About 1763, John Elderlein II built a sawmill and grist mill near where the present bridge crosses the Shetucket River on Route 97 in Baltic. The tiny hamlet established there was known as Elderkins Bridge and is located on Beaver Brook, behind where the post office and town hall are located on Main Street today.

In 1798, this cluster of buildings was purchased by the Lords family which had settled here since the early 1700's and the village became known as Lord's Bridge, a name which was retained until 1867 when the post office was renamed Baltic after the European nation with which the town conducted trade.

In the mid-nineteenth century, Lord's Bridge was transformed from a peaceful hamlet into a bustling mill village. In July of 1856, William Sprague, a former Rhode Island Governor and Senator and New England textile tycoon, bought over 300 acres in the area along with water rights on the Shetucket River from Lord's Bridge to Windham. Sprague found this location to be an ideal spot for a cotton mill with good facilities for harnessing water power. In addition, the Hartford, Providence and Fishkill Railroad was established at Lord's Bridge in 1854 and was largely built by Irish immigrants who settled in nearby Willimantic and vicinity. Sprague found at his command sufficient water power, good railway transportation and a supply of labor. The emerging Sprague cotton mill and village was later known as the Baltic Mills.

The mill complex was leased to a Providence firm in 1874, as the Sprague family lost their empire in Baltic, and was operated as such until the original mill burned in 1887. Frederick Sayles of Pawtucket, Rhode Island built the present mill on the Shetucket River in 1901 on the site of the former Sprague Mill. The Baltic Mills prospered over the years, particularly during World Wars I and II as clothing for the war effort was produced here. Supervisor and worker housing was established, with gable-roofed, double-entry frame houses constructed northeast of the mill for supervisors and southwest of the mill in a similar design for the workers.

In 1967, operations at the Baltic Mills ceased under the ownership of a New York group. Since then, a mail order business has operated out of the premises before going out of business. Most of the present buildings are vacant, however several have been leased as warehouse space by an occasional business.

IV. Alternatives and Options

No action by the Federal government would ultimately leave the responsibility for protection of the residential structures to local property owners, the town of Sprague and the State of Connecticut. The homes and commercial businesses will be subject to recurring ice jams floods that would negatively impact on flood prone properties and other nearby properties if higher river discharges and flood elevations occur in the future.

Flood Control Alternatives: Several options are being investigated in order to determine the least environmentally damaging and economical solution to the problem. Current options include construction of both structural and non-structural solutions. These presently include: concrete walls; earth dikes; dredging; streamflow diversion; ice retention structures; and house raising.

Based on the initial analysis, the focus for flood protection has initially been selected to be construction of ice retention structures in the form of concrete or rock-filled timber cribs.

During the DPR phase all alternatives that would fulfill the project purpose will need to be evaluated to determine the least environmentally damaging practicable alternative. Additionally, any potential for adding an incremental environmental feature, for example wetland improvements, would be evaluated.

V. Potential Impacts

Habitat types found within the potential project area include instream riverain habitats, riparian habitats and riverain floodplain. The anticipated environmental impacts to the Shetucket River include the permanent loss of land under water displaced by the physical presence of timber cribs and scour aprons, impacts to riparian vegetation and impacts to existing floodplain and potential for increased erosion and stabilization of streambanks. Other impacts may include impacts to fisheries resources and impedance to anadromous fisheries restoration.

1. Riparian Environment

During the 1993-94 winter season, DEP staff reviewed ice jams at numerous locations in Connecticut. They reported that at locations where rivers jumped their banks and overflowed into the floodplain, materials were scoured from these areas and transported back into the river system. In addition to adding to the sedimentation load, these events caused elevated instream sedimentation.

The construction of an overflow channel inlet and outlet will result in the loss of at least 400 linear feet of riparian vegetation. The primary functions of on-site riparian zones and their alteration should be reviewed.

Collection of ice behind the timber cribs may cause erosion of the streambanks and damage existing vegetation and potentially may effect the stability of the river streambanks.

2. Instream Alterations

The total footprint of the project involves 13 individual structures consisting of a 16' X 4' timber crib and associated 16' X 10' rock apron which would extend both upstream and downstream. This would represent a direct instream loss of habitat for the resident fisheries population. Hydraulic considerations could include a broader range of stream alterations beyond direct habitat loss.

Construction of timber cribs and stone aprons may increase instream disturbances and water velocities. Timber cribs also have the potential to accumulate large, woody debris that can eventually develop into involuntary dams. CT DEP indicates that any accumulation of debris that impounds water may pose a threat to property, although this would defeat the purpose of the structures, the potential for such an indirect impact exists. CT DEP also has indicated that an accumulation of debris which may seem insignificant could pose a threat to shad migration. American shad are not strong migrants and may turn back by partial barriers or turbulent flow conditions. Thus debris accumulation may be detrimental to anadromous fisheries restoration in the Shetucket River.

3. Endangered, Threatened, and Rare Species

At this stage in the planning process, it is not anticipated that the construction of the proposed project will have any impacts to Federally listed or proposed threatened and endangered species under jurisdiction of the U.S. Fish and Wildlife Service nor any State Endangered, Threatened, and Special Concern Species.

4. Historical and Archaeological Impacts

Congress has recently passed legislation establishing the Quinebaug and Shetucket Rivers Valley National Heritage Corridor whose boundaries include the subject project area. Under this legislation, the Governor of Connecticut is encouraged to develop a management plan for the Corridor that would focus in part on historical preservation. The subject project would need to be carefully coordinated at the Federal, State, and local levels in order to maintain the integrity, setting, and historic qualities

of this area. The National Park Service as the Federal agency most responsible for safeguarding the historic integrity of the Corridor must also be included in the coordination process.

There are no documented archaeological sites located within the proposed project area, according to state files. However, the potential for undiscovered resources may exist, particularly along portions of the right bank flood plain which is to be utilized as an overflow channel. The Baltic Historic District, a National Register of Historic Places District, encompasses portions of the project area, and consists of residential, commercial, institutional and industrial structures and buildings associated with the establishment of a mill village complex during the nineteenth century. Further coordination with the National Park Service, the State of Connecticut and the local community would be required prior to any new construction.

VI. Related Environmental Recommendations/Concerns

This is a preliminary investigation. If this project proceeds to the next phase in the planning process, an Environmental Assessment and a Clean Water Act Section 404 (b) (1) evaluation will be required. The EA will require additional special studies to determine the exact loss of habitat types, both instream and riparian, and potential mitigation measures to be incorporated into project plans. The Department of Environmental Protection in their letter of 12 January 1995 has indicated their support of the Corps efforts to provide protection of Baltic, Connecticut from flooding due to ice jams. To that end, they have indicated if appropriate evaluations are made during the DPR phase, then the Inland Water Resources Division (IWRD) would be willing to act as the non-federal sponsor for the proposed project.

Instream Impacts: During the next phase, an evaluation of the specific aquatic habitats which will be directly lost will need to be evaluated. The loss of this instream habitat would likely require mitigation measures. Compensatory mitigation measures might involve a project design to enhance fisheries habitats, both upstream and downstream, by placement of rock and gravel around the timbercrib structures and digging of pools to duplicate or enhance lost habitat types. A construction window will likely be required for the proposed activity to minimize impacts to anadromous fisheries migration.

Construction activities surrounding the timber cribs and stone aprons may increase instream disturbances. Plans to minimize potential disturbances will need to be incorporated into the project design, examples may include construction during the

seasonal low flow and installation of temporary roadways or instream coffer dams. CT DEP questions whether stone aprons are necessary to reduce potential scour, both upstream and downstream of each structure.

An evaluation into the long-term impacts associated with construction of the both the cribs and aprons will need to be incorporated into the report. This evaluation should include information such as the potential alterations of river depth and slope, velocity and changes in bottom slope. Evaluation of impacts on fish passages through these reaches as well as the newly created diversion channel upstream will need to be determined, especially during seasonal low flow periods. Increases on downstream sedimentation loads and potential locations for their deposition should be determined.

Potential impacts to anadromous fisheries restoration efforts can be avoided by having the operational and maintenance plan that is developed for this project include the periodic removal of trash as required. This option is anticipated to be the responsibility of the local sponsor once the project is completed and turned over for future operations and maintenance activities.

Riparian/Floodplain Impacts: The effects of the construction of the cribs and aprons relative to the potential increases of scour material from the Shetucket River riparian habitat and floodplain as well as the overflow channel should be evaluated as well as the downstream deposition of this material.

An exact location of the inlet and outlet for the proposed overflow channel will need to be determined. Any wetland impacts would also have to be determined and as such may require compensatory mitigation to replace any lost habitat function. Riparian zones affected by the project should be evaluated as well as any potential erosion and streambank stability from either the accumulation of debris or by alterations in riverflow because of the structures.

During the DPR, the proposed plan will need to be evaluated for its impacts upon cultural resources and formal coordination will be initiated with the Connecticut State Historic Preservation Officer (CT SHPO), amongst others, in order to comply with Section 106 of the National Historic Preservation Act of 1966, as amended and accompanying regulations 36 CFR 800. The CT SHPO, in a letter dated February 3, 1995 has concurred with these determinations.

Additional Considerations: In their comment letter, CT DEP indicates the IWRD administers a floodplain protection program throughout the state. Stream Channel Encroachment Lines (SCEL) exists in the Shetucket River that extend approximately 300 feet

upstream of the Route 97 bridge. Under this program there is a requirement that an analysis be performed of the existing and proposed hydraulic conditions for the SCEL design discharge of 21,000 cubic feet per second (cfs).

Temporary hydraulic facilities and diversions would have to be designed to at least the minimum standards of Chapter 18 of the Connecticut DOT drainage manual. The project would have to be consistent with the floodway standards established by the Federal Emergency Management Agency and the CT DEP. A sedimentation and erosion control plan, a construction water handling plan and a flood contingency plan will have to be developed for the project. The project would have to be consistent with Federal laws, regulations and Executive Orders.

VII. References

Delaney, Dennis. 1986. History of the Town of Sprague, Connecticut. Published by the Town of Sprague, Connecticut.

Kricher, John C. 1988. A Field Guide to Eastern Forests. Houghton Mifflin Company, Boston.

Roth, Michael, Bruce Clouette and Victor Darnell. 1981. Connecticut: An Inventory of Historic Engineering and Industrial Sites. Published by the Society for Industrial Archaeology, Washington, D.C.

Connecticut Department of Environmental Protection. January 12, 1995. Planning Aid Letter.

Murphy, James E. 1987. Water Quality Standards Map of Connecticut. Connecticut Department of Environmental Protection, Water Compliance Unit.

APPENDIX A: CORRESPONDENCE



STATE OF CONNECTICUT
CONNECTICUT HISTORICAL COMMISSION

February 3, 1995

Mr. Joseph L. Ignazio
Impact Analysis Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

Subject: Ice Jam Holding Structures
Baltic, CT

Dear Mr. Ignazio:

The State Historic Preservation Office understands that the Corps of Engineers is undertaking a reconnaissance report for a proposed Section 205 (Local Flood Protection) study concerning the above-named project. This office notes that the village of Baltic is listed on the National Register of Historic Places. All proposed new construction would need to be evaluated vis-a-vis the historic and architectural ambiance of this important 19th-century mill community.

Although the state archaeological inventory does not indicate any known sites as having been identified within the general project area, the State Historic Preservation Office believes that the Shetucket River flood plain possesses moderate archaeological sensitivity. Depending upon the specifics of the proposed improvements, an archaeological reconnaissance survey may be warranted in order to definitively evaluate potential impacts upon archaeological resources.

This office looks forward to working with the Corps of Engineers regarding the expeditious furtherance of the proposed preliminary investigation.

For further information please contact Dr. David A. Poirier,
Staff Archaeologist.

Sincerely,

A handwritten signature in cursive script that reads "Dawn Maddox".

Dawn Maddox
Deputy State Historic
Preservation Officer

DAP

cc: Dr. Nicholas Bellantoni/OSA



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF ENVIRONMENTAL REVIEW
79 ELM STREET, HARTFORD, CT 06106
Tel. - 424-4114 Fax - 566-5426



January 12, 1995

Joseph L. Ignazio
Director of Planning
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254-9149

RE: Section 205 Ice Jam Study - Baltic

Dear Mr. Ignazio:

Your letter dated December 2, 1994 to Commissioner Keeney that was received on December 12, 1994 was referred to this office for Departmental review. As a part of this effort, various regulatory and resource management disciplines within the Department have reviewed the information furnished and inspected the project site. This a coordinated reply.

The Department supports the efforts of the Corps to provide protection to the Village of Baltic from flooding due to ice jams on the Shetucket River. If the questions raised by these comments can be addressed by the Corps during either the proposed Section 205 Study or some other required project analysis phase, the Department, through our Inland Water Resources Division (IWRD), is prepared to act as the non-federal sponsor for this project. Also, addressing these comments will provide some of the essential information required by the Department to issue a 401 water quality certificate for the project.

The following are specific comments regarding existing Shetucket River resources and conditions that you should be aware of and issues that should be evaluated as part of your study efforts.

Fisheries Resources of the Shetucket River

The Shetucket River adjacent to the project area is known to support a variety of freshwater finfish. It is annually stocked by the Fisheries Division (FD) of the Department with approximately 5,000 adult (9"-12") hatchery brown, brook and rainbow trout. The area between the Scotland Dam in Scotland and the Route 97 bridge in Baltic has been evaluated by the FD for its potential to support holdover brown trout. This same area is also known for its abundant smallmouth bass population. Since 1992, this section of the Shetucket River has been stocked with surplus Atlantic salmon brood stock each fall, which has resulted in the development of a popular recreational fishery.

In addition to trout and smallmouth bass, other resident species include: blacknose dace, fallfish, tessellated darter, spottail shiner, American eel and white sucker.

Impounded areas of the river are expected to contain a warmwater fish community that is represented by species such as largemouth bass, rock bass, chain pickerel, various sunfish species, yellow perch, white sucker, golden shiner, spottail shiner and brown bullhead.

The Shetucket River is in the early stage of an anadromous fish restoration program, with the initial focus being on American shad and river herrings. Anadromous fish passage will soon be achieved past the Greenville Dam in Norwich with the installation of a fish lift, with passage at two dams downstream of the project still to be provided.

Natural Diversity Data Base

As stated in a recent letter from the Natural Diversity Data Base to you, there are no known extant populations of Federal or State Endangered, Threatened or Special Concern Species that occur at the subject project site.

National Heritage Corridor

As you may know, Congress recently passed legislation establishing the "Quinebaug and Shetucket Rivers Valley National Heritage Corridor." The boundaries of the Corridor include the project site. Under the legislation, the Governor of Connecticut is encouraged to develop a management plan for the Corridor that focuses on comprehensive historic preservation, interpretation and recreational activities. Given the timing of the proposed project and the planning efforts envisioned by this legislation, I would suggest, at a minimum, that you evaluate the relationship of the proposed project with the purpose of this legislation.

Instream Impact Concerns

1.) The total footprint of the project, which includes the 12 (estimated) individual structures consisting of a 16'x 4' timber crib and associated 16'x 10' rock apron that would extend upstream and downstream, represents a loss of physical instream habitat for resident finfish. Mapping information that was provided was not accurate enough to field verify the exact location of the proposed structures. Thus, FD staff was not able to evaluate which microhabitat type(s) will be impacted. A map drawn to scale that shows the specific location of the timber cribs is requested. It is possible that the loss of instream habitat could require mitigation measures.

2.) Will the timber cribs and stone aprons be installed below stream grade? If so, what construction techniques will be utilized to minimize instream disturbances? Are stone aprons necessary to reduce potential scour both upstream and downstream

of each structure?

3.) What are the possible long-term effects of the timber cribs on the geometry of the stream channel in project area? Will the structures cause the river to widen or change its slope? Will fish passage through the project area under low flow conditions be impeded? Will the timber cribs alter the existing downstream transport of bedload materials and cause material to aggregate upstream?

4.) The timber cribs have the potential to accumulate large, woody debris that develops into a dam. It is assumed that maintenance of the project would prevent the development of a dam that impounds water and poses a threat to property. However, the accumulation of debris that would be deemed insignificant to other concerns could pose a threat to shad migration. American shad are not strong migrants and can be easily turned back by partial barriers or turbulent flow conditions. Debris dams at this site could pose a problem for our program to restore American shad (and other anadromous clupeids) to the Shetucket River. This potential problem can be avoided by having the operational and maintenance plan that is developed for this project include the periodic removal of trash, as required.

Riparian Impact Concerns

1.) During the 1993-94 winter season, staff reviewed ice jams at numerous locations in Connecticut. At locations where rivers jumped their banks and overflowed floodplains, materials, e.g. nutrient enriched sediments, were scoured from these areas and transported back into the river system. Besides adding to the sediment load, these events caused elevated instream sedimentation. The effects of this proposal relative to the scour of materials from the Shetucket River floodplain (overflow channel), which is presently utilized for corn production, should be evaluated, as well as, the possible deposition of this material in downstream areas.

2.) A map drawn to scale showing the specific locations of the inlet and outlet for the proposed overflow channel is necessary. The presence of and impact on inland wetlands within the project areas should be documented.

3.) The construction of the overflow channel inlet and outlet will result in the loss of at least 400 linear feet of riparian vegetation. The primary functions of on-site riparian zones and their alteration should be evaluated.

4.) Will the collection of ice behind the timber cribs cause erosion of the streambanks and damage to the riparian vegetation? Will the stability of the streambanks be altered?

Hydraulic Considerations

1.) The IWRD administers a floodplain protection program (Stream Channel Encroachment Line Program) on selected rivers throughout the state. There are Stream Channel Encroachment Lines (SCEL) on the Shetucket River that extend approximately 300 feet upstream of the Route 97 bridge. Under this program there is a requirement that an analysis be performed of the existing and proposed hydraulic conditions for the SCEL design discharge of 21,000 cfs.

2.) Any temporary hydraulic facilities and diversions would have to be designed to at least meet the standards of Chapter 18 of the Connecticut DOT Drainage Manual. Pertinent pages of this Manual are enclosed.

3.) The project would have to be consistent with the floodway standards established by the Federal Emergency Management Agency and the Department. These standards prohibit an increase of the elevation of the base flood or ten year flood profile.

4.) A sediment and erosion control plan, a construction water handling plan, and a flood contingency plan will have to be developed for the project.

I hope these comments are helpful in your efforts to advance the planning and design of this project. If I can be of further assistance or can answer any questions about these comments, please give me a call. Thank you.

Sincerely,



Brian J. Emerick
Supervising Environmental Analyst

Encl.

cc: T. Morrissey, DEP/IWRD
C. Berger, DEP/IWRD
B. Murphy, DEP/FD
S. Gephard, DEP/FD
M. Sullivan,, DEP/OCER

18.00 - TEMPORARY HYDRAULIC FACILITIES

18.01 - Introduction

Temporary hydraulic facilities include all channels, culverts or bridges which are required for haul roads, channel relocations, culvert installations, bridge construction, temporary roads, or detours. They are to be designed with the same care which is used for the primary facility.

These designs are to be included in the plans for the project. Hydraulic approval is required from the Connecticut Department of Environmental Protection for those designs which they regulate.

18.02 - Detours and Temporary Roadways

Drainage systems for these are to be designed for a two-year frequency if the roadway is required for a year or less and a five-year frequency if required for longer than a year. All other temporary hydraulic facilities connected with these roads are to be designed for frequencies as determined by using Section 18.04.

18.03 - Haul Roads

Hydraulic facilities for haul roads which cross or encroach into a watercourse are to be designed for a frequency as determined by using a Design Risk of 50% which is found on F22. As a general rule, to avoid excess upstream flooding, the profile of the road should connect the tops of the channel embankments and the road designed to be overtopped by those events which exceed the design discharge. Sufficient cover must be provided over the temporary conduit to insure structural integrity. The structural analysis of the conduit is to be included with the design.

The plan is to include a warning to the Contractor that this road is expected to be under water during certain rainfall events for undetermined lengths of time.

18.04 - Design Procedure

The selection of a design flood frequency for the remaining temporary hydraulic facilities involves consideration of several factors. These factors are rated considering their severity as 1, 2, or 3 for low, medium or high conditions.

FACTORS

Potential Loss of Life - If inhabited structures, permanent or temporary, can be inundated or are in the path of a flood wave caused by an embankment failure, then this item will have a multiple of fifteen applied. If no possibility of the above exists, then loss of life will be the same as the severity used for the A.D.T.

Property Damages - Private and public structures (houses, commercial, or manufacturing); appurtenances such as sewerage treatment and water supply; utility structures either above or below ground, are to have a multiple of ten applied. Active cropland, parking lots, recreational areas are to have multiple of five applied. All other areas shall use the severity determined by site conditions.

Traffic Interruption - Includes consideration for emergency supplies and rescue; delays; alternate routes; busses; etc. Short duration flooding of a low volume roadway might be acceptable. If the duration of flooding is long (more than a day), and there is nearby good quality alternate route, then the flooding of a higher volume highway might also be acceptable. The severity of this component is determined by the detour length multiplied by the average daily traffic projected for bi-directional travel.

Detour Length - The length in miles of an emergency detour by other roads should the temporary facility fail.

Height Above Streambed - The difference in elevation in feet between the traveled roadway and the bed of the waterway.

Drainage Area - The total area contributing runoff to the temporary facility, in square miles.

Average Daily Traffic - The average amount of vehicles passing through the area both ways in a twenty-four hour period.

The attached example (F23) illustrates the method of determining the design discharge. The severity and rating of each component is determined and entered in the Impact Rating Table. The total impact rating determines the % Design Risk, and the construction time is then considered to find the design frequency. A ratio corresponding to the frequency is used with the 100-year storm to determine the design discharge.

NOTE: If sufficient discharges have been developed either by the designer or the Flood Insurance Study then a frequency curve should be plotted to determine the Design Discharge instead of the final formula using the ratio.

DESIGN DISCHARGE FOR TEMPORARY CROSSING

Project No. _____ Town _____ Road or Route No. _____
 Station _____ Stream _____ Drainage Area _____ (Sq.Mi)
 Height Above Streambed _____ Ft. Anticipated Time of Use _____ Months
 ADT _____ (X) Detour Length _____ (Miles) = _____ Traffic Interruption:
 Q50 = _____ Q100 = _____

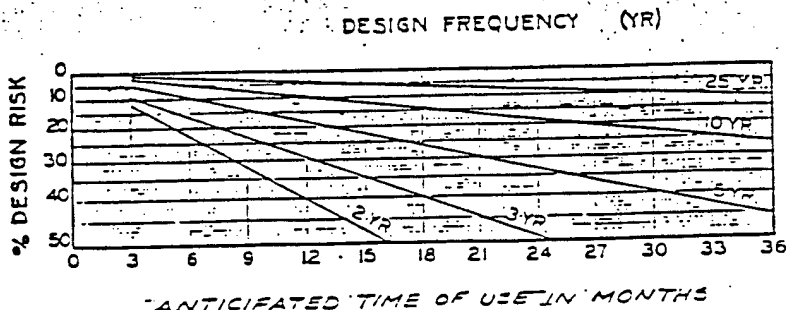
Prepared By _____ Date _____ Checked By _____ Date _____ Unit/
 Firm _____

RATING SELECTION

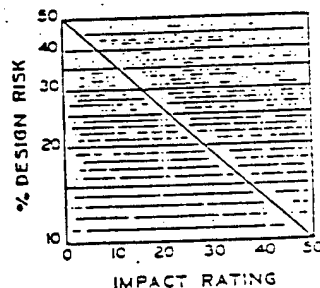
FACTOR	RATING		
	1	2	3
LOSS OF LIFE	SEE INSTRUCTIONS		
PROPERTY DAMAGE	SEE INSTRUCTIONS		
TRAFFIC INTERRUPTIONS	0-2000	2001-4000	4001-6000
DETOUR LENGTH (ML)	< 5	5-10	>10
HEIGHT ABOVE STREAMBED	< 10	11-20	>20
DRAINAGE AREA SQ. MI.	< 1	1-10	> 10
RURAL ADT	0-400	401-1500	>1500
SUBURBAN ADT	0-750	751-1500	>1500
URBAN ADT	0-1500	1501-3000	>3000

IMPACT RATING TABLE

LOSS OF LIFE X 1/5	PROPERTY DAMAGE X 1/5	TRAFFIC INTERRUPTION X 1/5	DETOUR LENGTH	HEIGHT ABOVE STREAMBED	DRAINAGE AREA	AVERAGE DAILY TRAFFIC	TOTAL IMPACT RATING



DESIGN RISK VS. IMPACT RATING



DESIGN FREQ. = _____ YRS.

YEAR	RATIO
2.0	.9
2.33	1.0
3.0	1.2
4.0	1.3
5.0	1.4
10.0	1.9
25.0	2.7
50.0	3.7
100.0	5.0

RATIO _____ $\times$ 0.27 (Q₅₀ _____) = _____ CFS.

RATIO _____ $\times$ 0.20 (Q₁₀₀ _____) = _____ CFS.

DESIGN DISCHARGE FOR TEMPORARY CROSSING

Project No. 60-151 Town HINDHAM Road or Route No. 8
 Station Stream SALT PETER BK. Drainage Area 6.75 (Sq.Mi)
 Height Above Streambed 8 Ft. Anticipated Time of Use 5 Months
 ADT 860 (X) Detour Length 7 (Miles) = 6020 Traffic Interruption
 Q50 = Q100 = 350

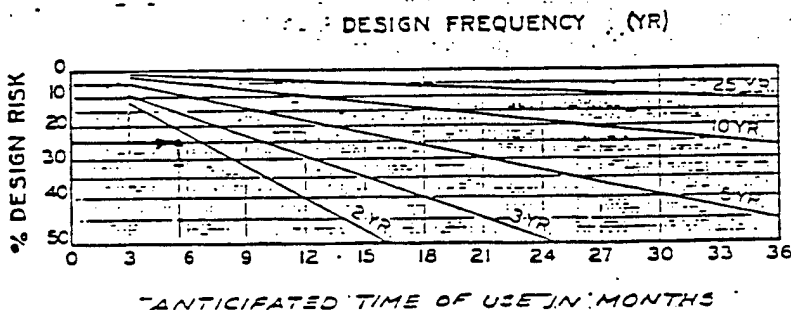
Prepared By R.L.H. Date 2/30/82 Checked By H.I. Date 3/4/82 Unit/
 Firm 2115

RATING SELECTION

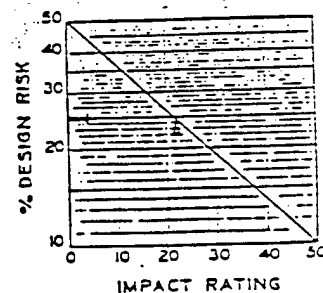
FACTOR	RATING		
	1	2	3
LOSS OF LIFE	SEE INSTRUCTIONS		
PROPERTY DAMAGE	SEE INSTRUCTIONS		
TRAFFIC INTERRUPTIONS	0-2000	2001-4000	4001-6000
DETOUR LENGTH (MI)	< 5	5-10	> 10
HEIGHT ABOVE STREAMBED	< 10	11-20	> 20
DRAINAGE AREA SQ. MI.	< 1	1-10	> 10
RURAL ADT	0-400	401-1500	> 1500
SUBURBAN ADT	0-750	751-1500	> 1500
URBAN ADT	0-1500	1501-3000	> 3000

IMPACT RATING TABLE

LOSS OF LIFE	PROPERTY DAMAGE TO OR FROM TRAFFIC	TRAFFIC INTERRUPTION	DETOUR LENGTH	HEIGHT ABOVE STREAMBED	DRAINAGE AREA	AVERAGE DAILY TRAFFIC	TOTAL IMPACT RATING
2	10	3	2	1	1	2	21



DESIGN RISK VS. IMPACT RATING



DESIGN FREQ. = 2 YRS.

YEAR	RATIO
2.0	.9
2.33	1.0
3.0	1.2
4.0	1.3
5.0	1.4
10.0	1.9
25.0	2.7
50.0	3.7
100.0	5.0

RATIO 1.4 x 0.27 (Q₅₀) = CFS.

RATIO 1.4 x 0.20 (Q₁₀₀ 350) = CFS.



United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Offices
22 Bridge Street, Unit #1
Concord, New Hampshire 03301-4986

December 23, 1994

Joseph L. Ignazio
Planning Directorate
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254-9149

Dear Mr. Ignazio:

This responds to your letter dated November 18, 1994 requesting information on the presence of federally listed and proposed endangered or threatened species in relation to the proposed Section 205 Ice Jam Study in Baltic, Connecticut.

Based on information currently available to us, no federally listed or proposed threatened and endangered species under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area, with the exception of occasional transient endangered bald eagles (*Haliaeetus leucocephalus*) or peregrine falcons (*Falco peregrinus anatum*). However, we suggest that you contact Nancy Murray, Connecticut Natural Diversity Data Base, 79 Elm St., Store Level, Hartford, CT 06106, 203-566-3540 for information on state listed species that may be present.

Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required. Should project plans change, or additional information on listed or proposed species becomes available, this determination may be reconsidered. This response relates only to endangered species under our jurisdiction. It does not address other legislation or our responsibilities under the Fish and Wildlife Coordination Act and the Federal Power Act.

Thank you for your cooperation and please contact Susi von Oettingen of this office at (603) 225-1411 if we can be of further assistance.

Sincerely yours,

Gordon E. Beckett
Supervisor
New England Field Offices



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION



NATURAL RESOURCES CENTER
79 Elm Street, Store Level
Hartford, CT 06106
Natural Diversity Data Base

November 29, 1994

Joseph Ignazio
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

Re: Section 205 Ice Jam Study, Baltic

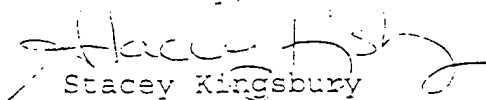
Dear Mr. Ignazio:

I have reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map you provided and listed above. According to our information, there are no known extant populations of Federal or State Endangered, Threatened or Special Concern Species that occur at the site in question.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Natural Resources Center's Geological and Natural History Survey and cooperating units of DEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

Please contact me if you have further questions at 424-3584. Thank you for consulting the Natural Diversity Data Base. Also be advised that this is a preliminary review and not a final determination. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to DEP for the proposed site.

Sincerely,


Stacey Kingsbury
Environmental Analyst

(Printed on Recycled Paper)
79 Elm Street • Hartford, CT 06106 • 5127
An Equal Opportunity Employer

Bargerhuff

November 17, 1994

Planning Directorate
Impact Analysis Division

Mr. Gordon E. Beckett, Supervisor
U.S. Department of the Interior
Fish and Wildlife Service
Ecological Services
22 Bridge Street
Ralph Pill Bldg., 4th Floor
Concord, New Hampshire 03301

Dear Mr. Beckett:

We are proposing to conduct a Section 205 Ice Jam Study in Baltic, Connecticut. The purpose of this letter is to request a list of endangered and threatened species for the project area pursuant to Section 7(c) of the Endangered Species Act of 1973, as amended. Enclosed please find a location map for the area to aid you in your work. The proposed project description is also attached.

This project is responding to a State request for Corps of Engineers assistance. We respectfully request your office provide comments to us within 30 days to facilitate our response.

If you require any further information about the proposed project or the affected area, please contact Mr. Kirk E. Bargerhuff, of the Environmental Resources Branch at (617) 647-8114.

Sincerely,

Joseph L. Ignazio
Director of Planning

Enclosure

cc:

Bargerhuff ✓

Chu

Hubbard

Rubin

Read File

Plng File

IAD File

November 17, 1994

Planning Directorate
Impact Analysis Division

Ms. Nancy Murray
Connecticut Natural Diversity Data Base
79 Elm Street, Store Level
Hartford, Connecticut 06106-5127

Dear Ms. Murray:

We are proposing to conduct a Section 205 Ice Jam Study, in Baltic, Connecticut. The purpose of this letter is to obtain your comments on the project, as well as to request a state list of endangered or threatened species for the project area. Enclosed, please find a location map of the area to aid you in your work. The proposed project description is also attached.

This project is responding to a State request for Corps of Engineers assistance. We respectfully request your office provide comments to us within 30 days to facilitate our response.

If you require any further information about the proposed project or the affected area, please contact Mr. Kirk E. Bargerhuff, of the Environmental Resources Branch at (617) 647-8114.

Sincerely,

Joseph L. Ignazio
Director of Planning

Enclosure

cc:
Bargerhuff ✓
Chu
Hubbard
Rubin
Read File
Plng File
IAD File

Bargerhuff

December 2, 1994

Planning Directorate
Impact Analysis Division

1~
2~
3~
4~

Dear 5~:

We are proposing to conduct a Section 205 Ice Jam Study on the Shetucket River in Baltic, Connecticut. The purpose of this letter is to obtain your comments on the proposed project. Enclosed please find a location map of the area to aid you in your work.

The proposed project involves the construction of 12 timber cribs across the river, about 300 feet upstream from the route 97 bridge. This appears to be the most feasible option for eliminating peak stages associated with ice jams. The river in this reach is about 200 feet wide and normal flows only average about three feet in depth. The proposed timber cribs would have a footprint of 16 feet by 8 feet, about 6 to 10 feet high above streambed, and placed in straight line perpendicular to flow direction at 16 feet on-center. A 2 foot deep stone protection apron extending 10 feet upstream and 10 feet downstream of the timber crib structures would also be required.

By holding the cover ice and spring ice floes, ice jams will occur behind the timber cribs and prevent river overflow into downstream properties. In addition to the timber crib structures, the right bank flood plain will serve as an overflow channel allowing riverflow to pass around the jam site. Dimensions of the stone inlet and outlet of the overflow channel would be 200 feet wide, 20 feet in length and 2 feet deep.

If you require any further information about the proposed project or the effected area, please contact Mr. Kirk Bargerhuff, of the Environmental Resources Branch at (617) 647-8114.

Sincerely,

Joseph L. Ignazio
Director of Planning

Enclosure

cc: Bargerhuff, Chu, Hubbard, Rubin, Plng. Ofc., IAD File

Same ltr sent to SHS

SAME LETTER SENT TO:

Mr. Douglas Thompson
Chief, Wetlands Protection Section
U.S. Environmental Protection Agency - Region I
J.F.K. Federal Building
Boston, Massachusetts 02203-2211

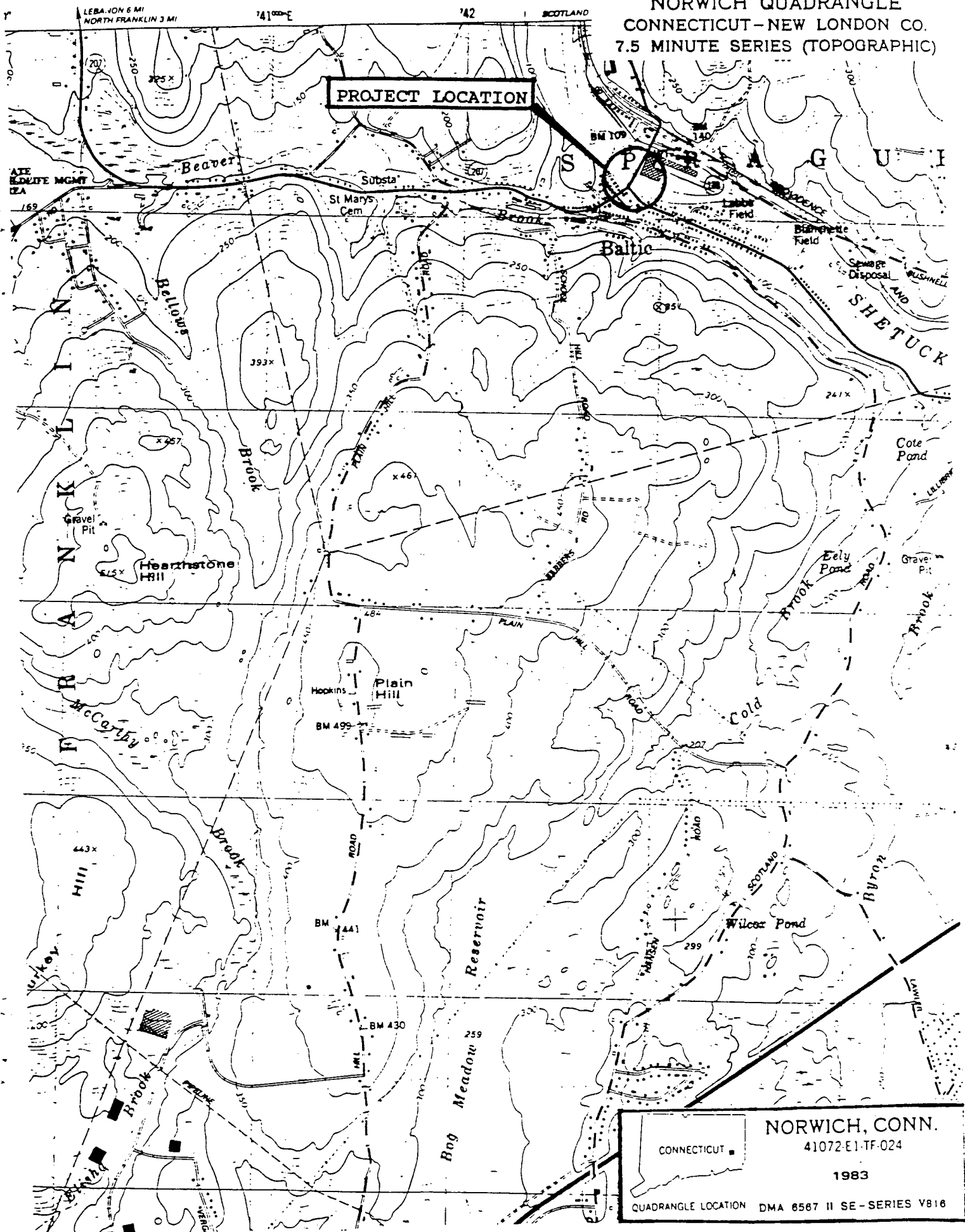
Mr. Gordon E. Beckett, Supervisor
U.S. Department of the Interior
Fish and Wildlife Service
Ecological Services
22 Bridge Street
Ralph Pill Bldg., 4th Floor
Concord, New Hampshire 03301

Mr. Timothy Keeney, Commissioner
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Mr. John Spencer, Chief
CT Department of Environmental Protection
Bureau of Natural Resources
79 Elm Street, 6th Floor
Hartford, Connecticut 06106-5127

Mr. Tom Morrissey
Water Resources Unit
Department of Environmental Protection
79 Elm Street
Hartford, Connecticut 06106-5127

PROJECT LOCATION



Sept 49

CORPS OF ENGINEERS, U.S. ARMY

PAGE

SUBJECT

BALTIC

COMPUTATION

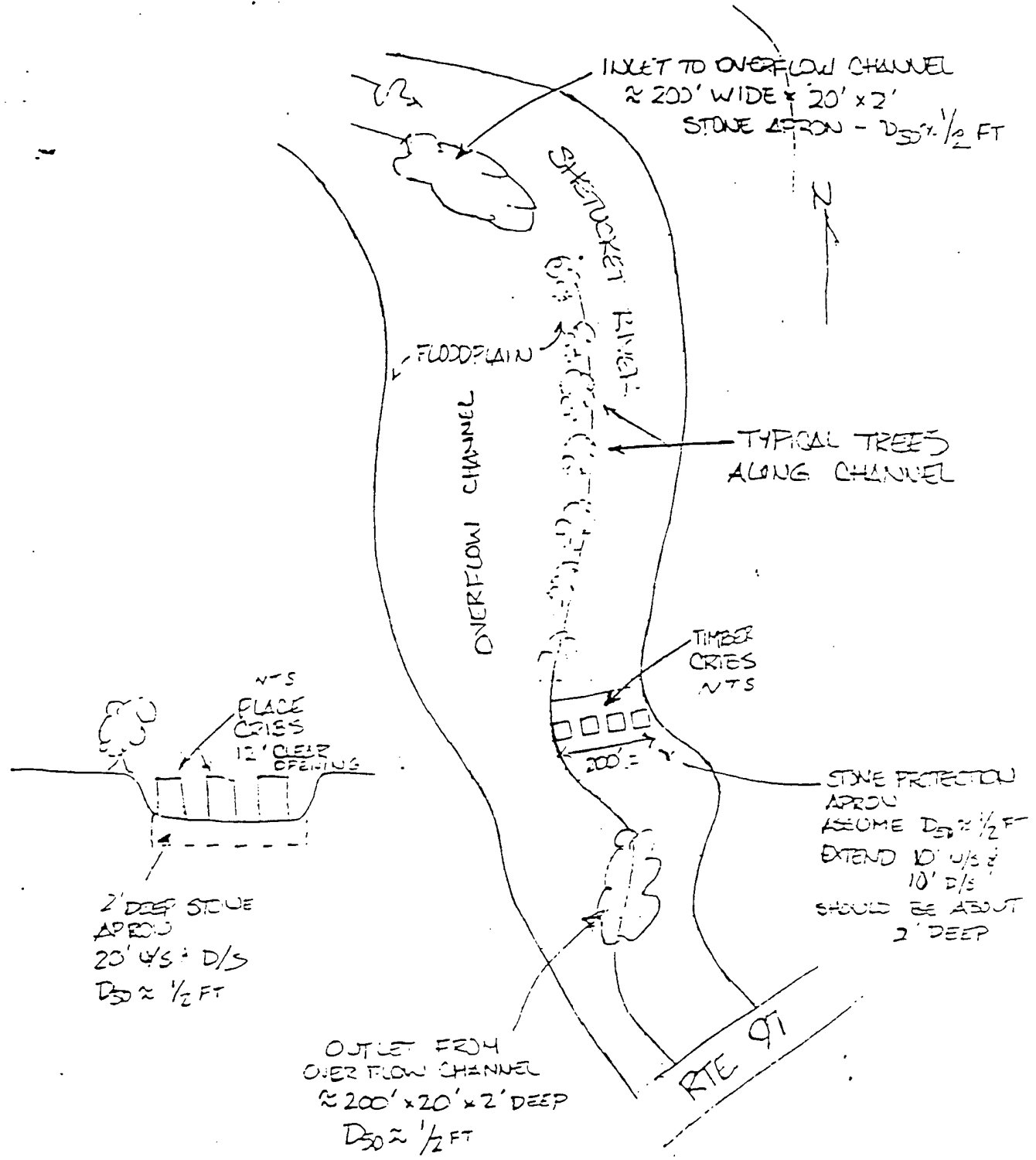
RAISED ICE - HYDRAULIC TIMBER CRIBS

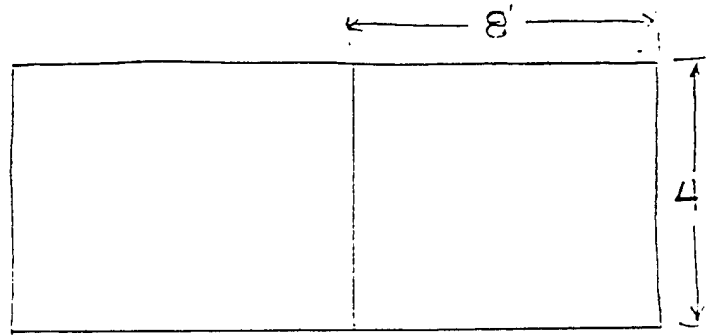
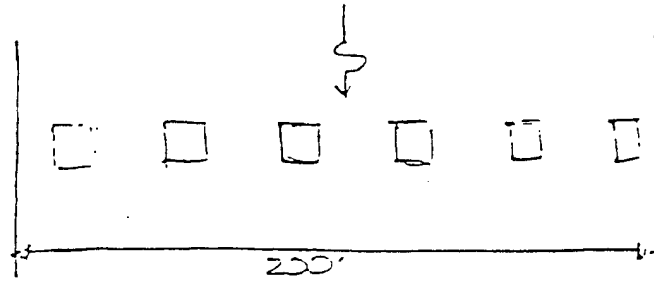
COMPUTED BY

SEA

CHECKED BY

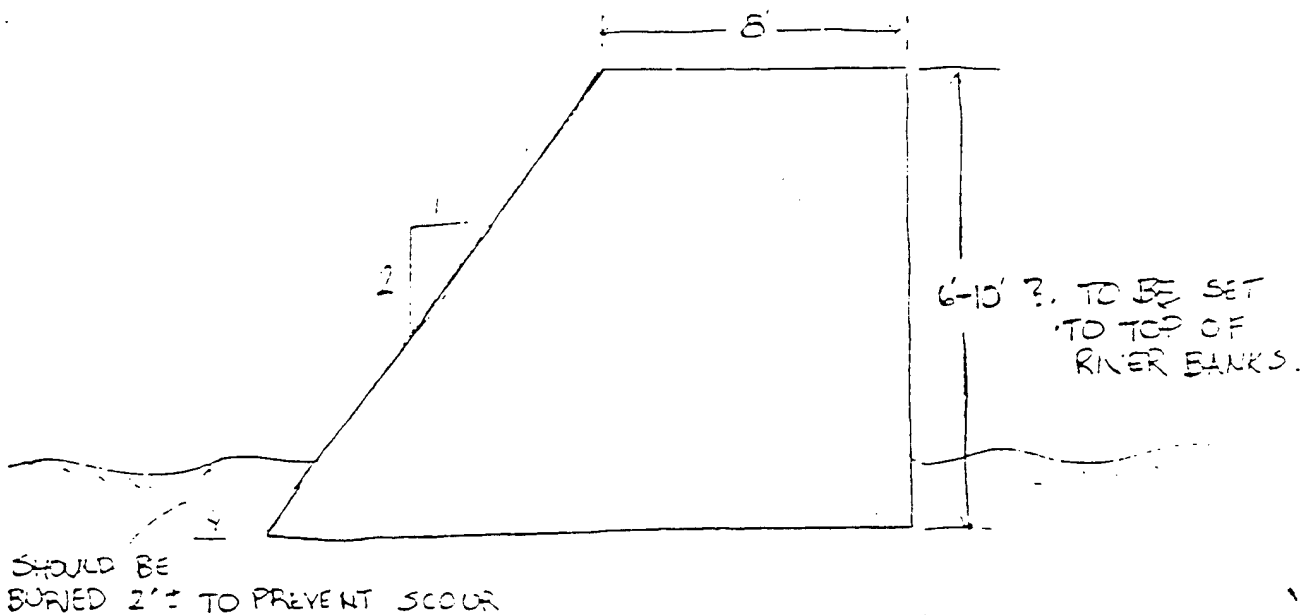
DATE 19 AUG 94





ROCK PROTECTION ~ 2' DEEP MUST BE PROVIDED
 AS AN APPROX 10 US $\pm$ 1/2 OF STRUCTURES
 ASSUME $\bar{R}_s \approx 1/2$ FT.

PLACE IN STRAIGHT LINE PERPENDICULAR TO FLOW
 DIRECTION



APPENDIX D

WATER RESOURCE IMPROVEMENT STUDY

SHETUCKET RIVER

BALTIC, CONNECTICUT

FLOOD DAMAGE REDUCTION PROJECT
RECONNAISSANCE REPORT

APPENDIX D

DECEMBER, 1994

PREPARED BY:

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

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2	Project Benefits and Residual Damages, Shetucket River Baltic, CT	4

INTRODUCTION

The purpose of this report is to provide an economic analysis of flood damage reduction benefits along the Shetucket River in the village of Baltic, town of Sprague, Connecticut. Plans that reduce flood damages are evaluated. For each plan annual benefits are divided by annual costs to determine a benefit/cost ratio. This ratio must be equal to or greater than one for Federal participation in water resource improvement projects.

METHODOLOGY

Benefits and costs are made comparable by conversion to average annual equivalents. An interest rate of 7 3/4% as specified in the Federal Register is to be used by Federal agencies in the formulation and evaluation of water and land resource plans for the period 1 October 1994 to 30 September 1995. All costs and benefits are stated at the 1994 price level. The project economic life is considered to be 50 years. The analysis of costs and benefits follows standard U.S. Army Corps of Engineers procedures described in ER 1105-2-100, Section III, Chapter 4, Flood Damage Reduction.

STUDY AREA

The village of Baltic is located in the town of Sprague, Connecticut, along the Shetucket River (a tributary of the Thames River).

WITHOUT PROJECT CONDITION

Since 1956, the town has experienced several ice jams. Prior to 1956, no ice-related flooding was recorded in the village, probably because the Baltic Dam, which breached in 1955, controlled the ice up stream of the village. Ice floes jam in the 2 mile reach between the Scotland Dam upstream and the village of Baltic. The slope of the river through this reach is very flat and the channel meanders, causing ice floes to lose momentum and slow down. In addition, backwater from Occum Dam located two miles downstream, causes a thick and stable ice cover that offers resistance to the ice floe. The most recent ice jam occurred in January 1994. Floodwaters inundated several homes and businesses.

In the mid-1950's, the Corps was requested by the town to provide technical assistance with their flooding problem. As a result, a PL99 earth berm was built along the low lying residential area. This berm has a top elevation of about 77.5 feet NGVD and a top width of 8 feet. Although the berm does not tie-in to high ground, it does provide protection against an approximate 10-year flood event.

Recurring Damages

On July 12, 1994 a damage survey was conducted in the village of Baltic in the Town of Sprague, Connecticut. There are 84 structures in the 500 year flood plain. Of these 77 are residential structures, 4 are commercial structures and 3 are public buildings. Inundation damages were developed for each property using a typical stage damage function for residential, commercial and institutional structures. Stage damage functions were developed for each structure using typicals developed for previous studies and updated to current price level. The stage or elevation at which flood damage begins was determined to be at the ground elevation for each property. Estimates of potential damages were then made from this point, in one foot increments of stage, to a level 3 feet above the first floor. Dollar value estimates were made for physical damages to site, structure, contents and utilities. Seepage through the bottom of the foundation was not assumed as the start of damage. First floor elevations and start of damage elevations were estimated based on flood elevations at these structures for the 1994 event and the 1955 event.

Flood damages were developed using a program developed by the New England Division (NED). Stage damage information for each of the residential housing units was input. The elevation of the first floor and the elevation at which damage starts, the ground elevation, were also input for each structure. Stage frequency data were then input. The computer model combined stage-frequency data and stage-damage information to compute damage frequency and expected annual damage. Recurring damages are associated with different return intervals, or frequencies. Recurring damages are shown in Table 1.

Table 1
Ice Affected
Recurring Damages,
Shetucket River
Baltic, CT

<u>Recurrence Interval</u>	<u>Stages</u>	<u>Damages</u>
Years	Feet NGVD	
500	86	\$5,662,700
200	84.5	\$3,256,500
100	83.3	\$2,594,400
50	82	\$1,963,200
20	80	\$ 867,500
10	78.5	\$ 380,800

Annual Damages

As mentioned previously, recurring losses relate the dollar value of flood damage to specific flood depths. For the purpose of determining the severity of potential flooding in each damage reach, the statistical concept of "expected value" is employed. Annual losses for Baltic are simply the integration of two sets of data: (i) recurring losses displayed in one-foot increments of flood depth from the start of damage to the elevation 3 feet above the first floor and (ii) the estimated annual percent chance that flood levels will exceed each elevation for which recurring losses were estimated. Simply, the probability of exceeding a specific flood stage during any given year is multiplied by the corresponding dollar value of damage. The summation of these expected values results in potential annual losses. The effectiveness of a flood reduction plan is measured by the extent to which it reduces annual losses. The stage frequency information found in Table 1 was used to estimate expected annual damages. Expected annual damage for the ice affected stage frequency curve is estimated to be \$148,300.

WITH PROJECT CONDITION

Improvement Plans

Project benefits are developed for three plans of improvement. The first plan would tie the existing PL99 earth berm into high ground between Second and Third Streets. This would provide protection against the 7-year event (13 percent chance of exceedance). Raising the dike by approximately 5 feet would provide protection against the 33-year ice affected event. A second plan would provide for a dike following the existing earth berm and tying in to high ground in the vicinity of Beaver Brook and the Town Office Building. This plan would provide protection against the 100-year event. A third plan would provide for ice retention structures (cribs) upstream from the damage area. This plan would eliminate the increased river stages associated with ice jams.

Annual Benefit

Project benefit is the difference in expected annual damages between the with and without project conditions. Expected damages with the project in place are referred to as residual damages. Benefits and residual damages are shown in Table 2.

Table 2
Project Benefits and
Residual Damages
Shetucket River
Baltic, CT

<u>Project</u>	<u>Without Project Damages</u>	<u>With Project Damages</u>	<u>Annual Benefit</u>
7-Year Protection	\$148,300	\$133,300	\$ 15,000
33-Year Protection	\$148,300	\$ 77,400	\$ 70,900
100-Year Protection	\$148,300	\$ 39,900	\$108,400
Ice Cribs	\$148,300	\$ 97,100	\$ 51,200

The plan that provides protection against the 7-year event as high residual damages and consequently the lowest benefit. Benefit for the ice cribs plan is the difference between expected annual damages between the ice affected flow and the natural flow.

APPENDIX E

CENED-PL-P (1105-2-100)

29 June 1995
Chu/sdp/78549

MEMORANDUM FOR Commander, HQ, USACE (CECW-P), 20 Massachusetts
Avenue, N.W., Washington, D.C. 20314-1000

SUBJECT: Reconnaissance Report, Sprague (Baltic), CT (2nd
Congressional District), CWIS# 94380

1. Under authority contained in Section 205 of the 1948 Flood Control Act, as amended, a reconnaissance level study of ice jam flood control for the Village of Baltic in Sprague, CT has been completed. We have concluded that a plan utilizing ice retention structures has sufficient economic justification to continue into a feasibility study.

2. State and town officials were informed of the study results and recommendations. However, the State of Connecticut Department of Environmental Protection and town of Sprague have agreed to undertake the design and construction of the ice jam control structure on the Shetucket River without further Corps assistance. Therefore, Corps of Engineers involvement was terminated.

3. A letter of our decision was forwarded to the non-federal sponsor on 6 June 1995. Enclosed is a copy of the letter for your information.

Encl

EARLE C. RICHARDSON
COL, EN
Commanding

CF:

CECW-PE

cc:

Ms. Chu, 114S (baltic.oce)
Mr. Pronovost, 114N
Ignazio/reading
Reading
Prog. Office, 113S
FD Files, 114S

June 6, 1995

Planning Directorate
Plan Formulation Division

Mr. Alphonse Letendre, Director
Bureau of Water Management
Inland Water Resource Division
Connecticut Department of Environmental Protection
79 Elm Street, 3rd Floor
Hartford, Connecticut 06106

Dear Mr. Letendre:

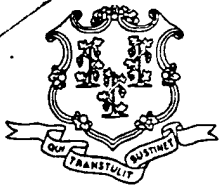
I am writing in regard to the results of our April 12, 1995 meeting with you and Mr. Thomas McAvoy that was held at the Sprague Town Hall. We concluded that there will be no further involvement by the Corps of Engineers to provide ice jam flood control on the Shetucket River in Baltic due to decisions by the non-Federal sponsor. It is our understanding that the town of Sprague will work with the State of Connecticut DEP to undertake the design and construction of the ice jam flood protection project as stated in the Town's May 23, 1995 letter (see attached).

The Reconnaissance Report of the ice jam study will be made available to the State and Town as soon as reproduction is completed. If you have further questions, please contact me at (617) 647-8508 or the study manager, Ms. Phoebe Chu, at (617) 647-8549.

Sincerely,

Joseph L. Ignazio
Director of Planning

Attachment



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER MANAGEMENT



May 26, 1995

Joseph L. Ignazio, Planning Director
U S Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA. 02254-9149

Re: Baltic Ice Control Structure Sprague, Connecticut

Dear Mr. Ignazio:

The State of Connecticut, through the Department of Environmental Protection, is informing you that the State and Town of Baltic have agreed to undertake the design and construction of the ice jam control structure on the Shetucket River. As such, we will not need further assistance from the Corps beyond the completion of the reconnaissance study. Please be advised that the Town and State will complete a design and later construct the improvement using non-federal funds.

We understand that the Corps is planning to undertake only projects that have a significant national interest. We thank your staff for the efforts made to date and hope to receive the final reconnaissance study as soon as it is complete.

Sincerely yours,

Robert Smith
Bureau Chief
Water Resource Bureau

CEB:AJL flood\alphonse\baltice.ltr

cc
Thomas McAvoy, Jr. First Selectman, Town of Sprague
E. Hemstreet - DEP
File



TOWN OF SPRAGUE

MAIN STREET
P.O. BOX 677
BALTIMORE, CONNECTICUT 06330

THOMAS N. McAVOY, JR.
First Selectman

PHONE (203) 822-3000
FAX (203) 822-3013

May 23, 1995

Robert Smith
Bureau Chief
Bureau of Water Management
79 Elm Street
Hartford, CT 06106-5127

Dear Mr. Smith:

I am pleased to inform you that the Town of Sprague will participate with the State of Connecticut DEP to undertake the design and construction of the ice jam control structure on the Shetucket River. It is my understanding that the Army Corps of Engineers will not be participating in this project and the Town of Sprague and State of Connecticut will determine project cost and sharing of expenses at a later date.

I will be working with Mr. Al Letendre to establish a flood and erosion control board as part of the mitigation program.

I look forward to working with you and the DEP on this important project. Please call if you have any questions.

Very truly yours,

Thomas N. McAvoy, Jr.
First Selectman

TNM:lm

cc: Al Letendre, DEP
Bill Swain, Army Corps of Engineers



STATE OF CONNECTICUT
CONNECTICUT HISTORICAL COMMISSION

February 3, 1995

Mr. Joseph L. Ignazio
Impact Analysis Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

Subject: Ice Jam Holding Structures
Baltic, CT

Dear Mr. Ignazio:

The State Historic Preservation Office understands that the Corps of Engineers is undertaking a reconnaissance report for a proposed Section 205 (Local Flood Protection) study concerning the above-named project. This office notes that the village of Baltic is listed on the National Register of Historic Places. All proposed new construction would need to be evaluated vis-a-vis the historic and architectural ambiance of this important 19th-century mill community.

Although the state archaeological inventory does not indicate any known sites as having been identified within the general project area, the State Historic Preservation Office believes that the Shetucket River flood plain possesses moderate archaeological sensitivity. Depending upon the specifics of the proposed improvements, an archaeological reconnaissance survey may be warranted in order to definitively evaluate potential impacts upon archaeological resources.

This office looks forward to working with the Corps of Engineers regarding the expeditious furtherance of the proposed preliminary investigation.

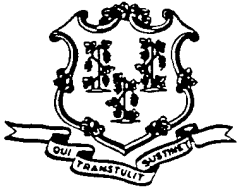
For further information please contact Dr. David A. Poirier,
Staff Archaeologist.

Sincerely,

Dawn Maddox
Deputy State Historic
Preservation Officer

DAP

cc: Dr. Nicholas Bellantoni/OSA



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF ENVIRONMENTAL REVIEW
79 ELM STREET, HARTFORD, CT 06106
Tel. - 424-4114 Fax - 566-5426



January 12, 1995

Joseph L. Ignazio
Director of Planning
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254-9149

RE: Section 205 Ice Jam Study - Baltic

Dear Mr. Ignazio:

Your letter dated December 2, 1994 to Commissioner Keeney that was received on December 12, 1994 was referred to this office for Departmental review. As a part of this effort, various regulatory and resource management disciplines within the Department have reviewed the information furnished and inspected the project site. This a coordinated reply.

The Department supports the efforts of the Corps to provide protection to the Village of Baltic from flooding due to ice jams on the Shetucket River. If the questions raised by these comments can be addressed by the Corps during either the proposed Section 205 Study or some other required project analysis phase, the Department, through our Inland Water Resources Division (IWRD), is prepared to act as the non-federal sponsor for this project. Also, addressing these comments will provide some of the essential information required by the Department to issue a 401 water quality certificate for the project.

The following are specific comments regarding existing Shetucket River resources and conditions that you should be aware of and issues that should be evaluated as part of your study efforts.

Fisheries Resources of the Shetucket River

The Shetucket River adjacent to the project area is known to support a variety of freshwater finfish. It is annually stocked by the Fisheries Division (FD) of the Department with approximately 5,000 adult (9"-12") hatchery brown, brook and rainbow trout. The area between the Scotland Dam in Scotland and the Route 97 bridge in Baltic has been evaluated by the FD for its potential to support holdover brown trout. This same area is also known for its abundant smallmouth bass population. Since 1992, this section of the Shetucket River has been stocked with surplus Atlantic salmon brood stock each fall, which has resulted in the development of a popular recreational fishery.

In addition to trout and smallmouth bass, other resident species include: blacknose dace, fallfish, tessellated darter, spottail shiner, American eel and white sucker.

Impounded areas of the river are expected to contain a warmwater fish community that is represented by species such as largemouth bass, rock bass, chain pickerel, various sunfish species, yellow perch, white sucker, golden shiner, spottail shiner and brown bullhead.

The Shetucket River is in the early stage of an anadromous fish restoration program, with the initial focus being on American shad and river herrings. Anadromous fish passage will soon be achieved past the Greenville Dam in Norwich with the installation of a fish lift, with passage at two dams downstream of the project still to be provided.

Natural Diversity Data Base

As stated in a recent letter from the Natural Diversity Data Base to you, there are no known extant populations of Federal or State Endangered, Threatened or Special Concern Species that occur at the subject project site.

National Heritage Corridor

As you may know, Congress recently passed legislation establishing the "Quinebaug and Shetucket Rivers Valley National Heritage Corridor." The boundaries of the Corridor include the project site. Under the legislation, the Governor of Connecticut is encouraged to develop a management plan for the Corridor that focuses on comprehensive historic preservation, interpretation and recreational activities. Given the timing of the proposed project and the planning efforts envisioned by this legislation, I would suggest, at a minimum, that you evaluate the relationship of the proposed project with the purpose of this legislation.

Instream Impact Concerns

1.) The total footprint of the project, which includes the 12 (estimated) individual structures consisting of a 16'x 4' timber crib and associated 16'x 10' rock apron that would extend upstream and downstream, represents a loss of physical instream habitat for resident finfish. Mapping information that was provided was not accurate enough to field verify the exact location of the proposed structures. Thus, FD staff was not able to evaluate which microhabitat type(s) will be impacted. A map drawn to scale that shows the specific location of the timber cribs is requested. It is possible that the loss of instream habitat could require mitigation measures.

2.) Will the timber cribs and stone aprons be installed below stream grade? If so, what construction techniques will be utilized to minimize instream disturbances? Are stone aprons necessary to reduce potential scour both upstream and downstream

of each structure?

3.) What are the possible long-term effects of the timber cribs on the geometry of the stream channel in project area? Will the structures cause the river to widen or change its slope? Will fish passage through the project area under low flow conditions be impeded? Will the timber cribs alter the existing downstream transport of bedload materials and cause material to aggregate upstream?

4.) The timber cribs have the potential to accumulate large, woody debris that develops into a dam. It is assumed that maintenance of the project would prevent the development of a dam that impounds water and poses a threat to property. However, the accumulation of debris that would be deemed insignificant to other concerns could pose a threat to shad migration. American shad are not strong migrants and can be easily turned back by partial barriers or turbulent flow conditions. Debris dams at this site could pose a problem for our program to restore American shad (and other anadromous clupeids) to the Shetucket River. This potential problem can be avoided by having the operational and maintenance plan that is developed for this project include the periodic removal of trash, as required.

Riparian Impact Concerns

1.) During the 1993-94 winter season, staff reviewed ice jams at numerous locations in Connecticut. At locations where rivers jumped their banks and overflowed floodplains, materials, e.g. nutrient enriched sediments, were scoured from these areas and transported back into the river system. Besides adding to the sediment load, these events caused elevated instream sedimentation. The effects of this proposal relative to the scour of materials from the Shetucket River floodplain (overflow channel), which is presently utilized for corn production, should be evaluated, as well as, the possible deposition of this material in downstream areas.

2.) A map drawn to scale showing the specific locations of the inlet and outlet for the proposed overflow channel is necessary. The presence of and impact on inland wetlands within the project areas should be documented.

3.) The construction of the overflow channel inlet and outlet will result in the loss of at least 400 linear feet of riparian vegetation. The primary functions of on-site riparian zones and their alteration should be evaluated.

4.) Will the collection of ice behind the timber cribs cause erosion of the streambanks and damage to the riparian vegetation? Will the stability of the streambanks be altered?

January 12, 1995

Hydraulic Considerations

1.) The IWRD administers a floodplain protection program (Stream Channel Encroachment Line Program) on selected rivers throughout the state. There are Stream Channel Encroachment Lines (SCEL) on the Shetucket River that extend approximately 300 feet upstream of the Route 97 bridge. Under this program there is a requirement that an analysis be performed of the existing and proposed hydraulic conditions for the SCEL design discharge of 21,000 cfs.

2.) Any temporary hydraulic facilities and diversions would have to be designed to at least meet the standards of Chapter 18 of the Connecticut DOT Drainage Manual. Pertinent pages of this Manual are enclosed.

3.) The project would have to be consistent with the floodway standards established by the Federal Emergency Management Agency and the Department. These standards prohibit an increase of the elevation of the base flood or ten year flood profile.

4.) A sediment and erosion control plan, a construction water handling plan, and a flood contingency plan will have to be developed for the project.

I hope these comments are helpful in your efforts to advance the planning and design of this project. If I can be of further assistance or can answer any questions about these comments, please give me a call. Thank you.

Sincerely,



Brian J. Emerick
Supervising Environmental Analyst

Encl.

cc: T. Morrissey, DEP/IWRD
C. Berger, DEP/IWRD
B. Murphy, DEP/FD
S. Gephard, DEP/FD
M. Sullivan,, DEP/OCER

18.00 - TEMPORAR. HYDRAULIC FACILITIES

18.01 - Introduction

Temporary hydraulic facilities include all channels, culverts or bridges which are required for haul roads, channel relocations, culvert installations, bridge construction, temporary roads, or detours. They are to be designed with the same care which is used for the primary facility.

These designs are to be included in the plans for the project. Hydraulic approval is required from the Connecticut Department of Environmental Protection for those designs which they regulate.

18.02 - Detours and Temporary Roadways

Drainage systems for these are to be designed for a two-year frequency if the roadway is required for a year or less and a five-year frequency if required for longer than a year. All other temporary hydraulic facilities connected with these roads are to be designed for frequencies as determined by using Section 18.04.

18.03 - Haul Roads

Hydraulic facilities for haul roads which cross or encroach into a watercourse are to be designed for a frequency as determined by using a Design Risk of 50% which is found on F22. As a general rule, to avoid excess upstream flooding, the profile of the road should connect the tops of the channel embankments and the road designed to be overtopped by those events which exceed the design discharge. Sufficient cover must be provided over the temporary conduit to insure structural integrity. The structural analysis of the conduit is to be included with the design.

The plan is to include a warning to the Contractor that this road is expected to be under water during certain rainfall events for undetermined lengths of time.

18.04 - Design Procedure

The selection of a design flood frequency for the remaining temporary hydraulic facilities involves consideration of several factors. These factors are rated considering their severity as 1, 2, or 3 for low, medium or high conditions.

FACTORS

Potential Loss of Life - If inhabited structures, permanent or temporary, can be inundated or are in the path of a flood wave caused by an embankment failure, then this item will have a multiple of fifteen applied. If no possibility of the above exists, then loss of life will be the same as the severity used for the A.D.T.

Property Damages - Private and public structures (houses, commercial, or manufacturing); appurtenances such as sewerage treatment and water supply; utility structures either above or below ground, are to have a multiple of ten applied. Active cropland, parking lots, recreational areas are to have multiple of five applied. All other areas shall use the severity determined by site conditions.

Traffic Interruption - Includes consideration for emergency supplies and rescue; delays; alternate routes; busses; etc. Short duration flooding of a low volume roadway might be acceptable. If the duration of flooding is long (more than a day), and there is nearby good quality alternate route, then the flooding of a higher volume highway might also be acceptable. The severity of this component is determined by the detour length multiplied by the average daily traffic projected for bi-directional travel.

Detour Length - The length in miles of an emergency detour by other roads should the temporary facility fail.

Height Above Streambed - The difference in elevation in feet between the traveled roadway and the bed of the waterway.

Drainage Area - The total area contributing runoff to the temporary facility, in square miles.

Average Daily Traffic - The average amount of vehicles passing through the area both ways in a twenty-four hour period.

The attached example (F23) illustrates the method of determining the design discharge. The severity and rating of each component is determined and entered in the Impact Rating Table. The total impact rating determines the % Design Risk, and the construction time is then considered to find the design frequency. A ratio corresponding to the frequency is used with the 100-year storm to determine the design discharge.

NOTE: If sufficient discharges have been developed either by the designer or the Flood Insurance Study then a frequency curve should be plotted to determine the Design Discharge instead of the final formula using the ratio.

DESIGN DISCHARGE FOR TEMPORARY CROSSING

Project No. _____ Town _____ Road or Route No. _____
 Station _____ Stream _____ Drainage Area _____ (Sq.Mi)
 Height Above Streambed _____ Ft. Anticipated Time of Use _____ Months
 ADT _____ (X) Detour Length _____ (Miles) = _____ Traffic Interruption
 Q50 = _____ Q100 = _____

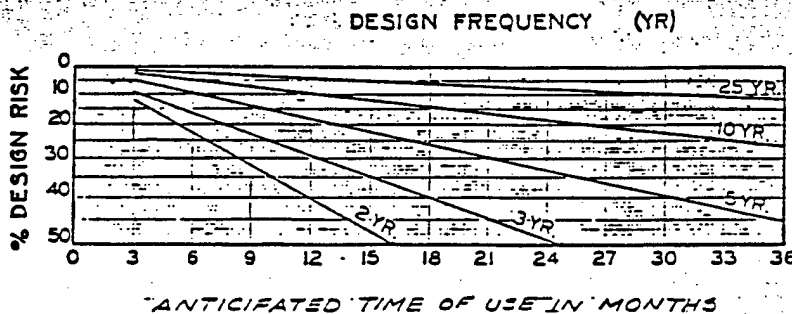
Prepared By _____ Date _____ Checked By _____ Date _____ Unit/Firm _____

RATING SELECTION

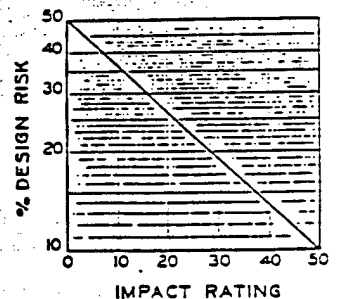
FACTOR	RATING		
	1	2	3
LOSS OF LIFE	SEE INSTRUCTIONS		
PROPERTY DAMAGE	SEE INSTRUCTIONS		
TRAFFIC INTERRUPTIONS	0-2000	2001-4000	4001-6000
DETOUR LENGTH (ML)	< 5	5-10	> 10
HEIGHT ABOVE STREAMBED	≤ 10	11-20	> 20
DRAINAGE AREA SQ. MI.	< 1	1-10	> 10
RURAL ADT	0-400	401-1500	> 1500
SUBURBAN ADT	0-750	751-1500	> 1500
URBAN ADT	0-1500	1500-3000	> 3000

IMPACT RATING TABLE

LOSS OF LIFE X 15	PROPERTY DAMAGE X 10 OR X 5	TRAFFIC INTERRUPTION	DETOUR LENGTH	HEIGHT ABOVE STREAMBED	DRAINAGE AREA	AVERAGE DAILY TRAFFIC	TOTAL IMPACT RATING



DESIGN RISK VS. IMPACT RATING



DESIGN FREQ. = _____ YRS.

YEAR	RATIO
2.0	.9
2.33	1.0
3.0	1.2
4.0	1.3
5.0	1.4
10.0	1.9
25.0	2.7
50.0	3.7
100.0	5.0

RATIO _____ × 0.27 (Q₅₀ _____) = _____ C.F.S.

RATIO _____ × 0.20 (Q₁₀₀ _____) = _____ C.F.S.

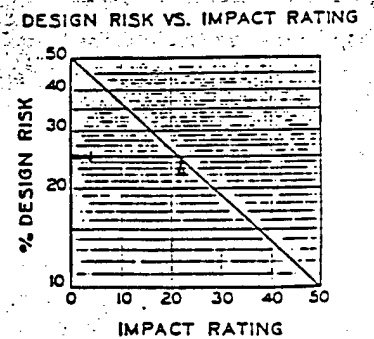
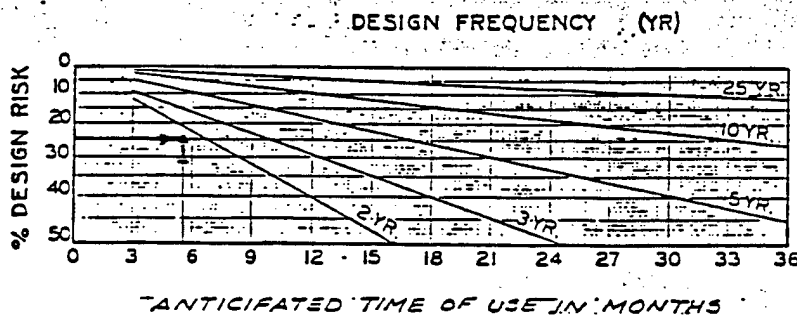
DESIGN DISCHARGE FOR TEMP RY CROSSING

Project No. 60-151 Town HINDHAM Road or Route No. 4
 Station Stream SALT PETER BK. Drainage Area 0.75 (Sq.Mi)
 Height Above Streambed 8 Ft. Anticipated Time of Use 5 Months
 ADT 860 (X) Detour Length 7 (Miles) = 6020 Traffic Interruption
 Q50 = Q100 = 350

Prepared By R.L.H. Date 2/30/82 Checked By H.I. Date 3/4/82 Unit/
 Firm 2110

RATING SELECTION			
FACTOR	RATING		
	1	2	3
LOSS OF LIFE	SEE INSTRUCTIONS		
PROPERTY DAMAGE	SEE INSTRUCTIONS		
TRAFFIC INTERRUPTIONS	0-2000	2001-4000	4001-6000
DETOUR LENGTH (MI.)	< 5	5-10	> 10
HEIGHT ABOVE STREAMBED	< 10	11-20	> 20
DRAINAGE AREA SM.	< 1	1-10	> 10
RURAL ADT	0-400	401-1500	> 1500
SUBURBAN ADT	0-750	751-1500	> 1500
URBAN ADT	0-1500	1500-3000	> 3000

IMPACT RATING TABLE							
LOSS OF LIFE X/5	PROPERTY DAMAGE X/10	TRAFFIC INTERRUPTION X/3	DETOUR LENGTH X/3	HEIGHT ABOVE STREAMBED X/3	DRAINAGE AREA X/3	AVERAGE DAILY TRAFFIC X/3	TOTAL IMPACT RATING
2	10	3	2	1	1	3	3



DESIGN FREQ. = 2 YRS.

YEAR	RATIO
2.0	.9
2.33	1.0
3.0	1.2
4.0	1.3
5.0	1.4
10.0	1.9
25.0	2.7
50.0	3.7
100.0	5.0

RATIO $\times$ 0.27 (Q₅₀) = C.F.S.

RATIO 2.7 $\times$ 0.20 (Q₁₀₀ 350) = 190 C.F.S.

54912

December 28, 1994

Planning Directorate
Plan Formulation Division

Honorable Sam Gejdenson
House of Representatives
Washington, DC 20515

Dear Mr. Gejdenson:

This responds to your letters of October 28 and October 31, 1994 regarding drainage and flooding problems along the Shetucket River in the Baltic section of Sprague, Connecticut. Coordination with Mr. Dennis Riley of your staff resulted in a November 29, 1994 meeting with town and State of Connecticut officials to discuss the status of our current Section 205 ice jam flood control study and other issues described in your letters.

Our evaluation for providing permanent ice jam flood control in the form of ice holding cribs in the river reach upstream from the flood prone area is ongoing by the Planning Directorate. As noted in my October 21, 1994 letter, we expect the reconnaissance phase of our studies to be completed in March 1995. Topographic surveys have been completed. Hydraulic and foundation investigations will determine if a viable plan for ice jam flood control can be implemented.

In response to your Oct 28 letters' concern, for short term actions, we have discussed with the town that monitoring of the river ice conditions and close coordination between town and State officials is needed to permit timely use of equipment should an ice jam occur. We also suggested to the town officials that ice motion detectors be installed to assist in monitoring conditions.

With regard to the drainage problem discussed in the Oct 31 letter, being experienced by Mr. Al Cote of 190 Main Street, the Sprague First Selectman, Mr. Thomas McAvoy, stated that he was aware of the drainage conditions and would utilize town resources to resolve the problem since operation and maintenance is a local responsibility.

-2-

As the reconnaissance study progresses, we will maintain close contact with town and State officials as well as your office. If you have further questions, please contact me at (617) 647-8220, or the study manager, Ms. Phoebe Chu, at (617) 647-8549.

Sincerely,

Earle C. Richardson
Colonel, Corps of Engineers
Division Engineer

Copy Furnished:

Honorable Sam Gejdenson
Representative in Congress
74 West Main Street
Norwich, Connecticut 06360

cc:
Mr. Swaine
Reading File
Mr. Pronovost
Operations Dir
Executive Office
PDB Files/114S(gejspr)
EOC, 115S



United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Offices
22 Bridge Street, Unit #1
Concord, New Hampshire 03301-4986

December 23, 1994

Joseph L. Ignazio
Planning Directorate
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254-9149

Dear Mr. Ignazio:

This responds to your letter dated November 18, 1994 requesting information on the presence of federally listed and proposed endangered or threatened species in relation to the proposed Section 205 Ice Jam Study in Baltic, Connecticut.

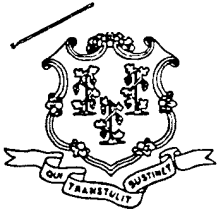
Based on information currently available to us, no federally listed or proposed threatened and endangered species under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area, with the exception of occasional transient endangered bald eagles (*Haliaeetus leucocephalus*) or peregrine falcons (*Falco peregrinus anatum*). However, we suggest that you contact Nancy Murray, Connecticut Natural Diversity Data Base, 79 Elm St., Store Level, Hartford, CT 06106, 203-566-3540 for information on state listed species that may be present.

Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required. Should project plans change, or additional information on listed or proposed species becomes available, this determination may be reconsidered. This response relates only to endangered species under our jurisdiction. It does not address other legislation or our responsibilities under the Fish and Wildlife Coordination Act and the Federal Power Act.

Thank you for your cooperation and please contact Susi von Oettingen of this office at (603) 225-1411 if we can be of further assistance.

Sincerely yours,

Gordon E. Beckett
Supervisor
New England Field Offices



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION



NATURAL RESOURCES CENTER
79 Elm Street, Store Level
Hartford, CT 06106
Natural Diversity Data Base

November 29, 1994

Joseph Ignazio
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

Re: Section 205 Ice Jam Study, Baltic

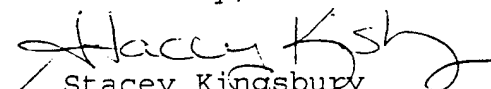
Dear Mr. Ignazio:

I have reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map you provided and listed above. According to our information, there are no known extant populations of Federal or State Endangered, Threatened or Special Concern Species that occur at the site in question.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Natural Resources Center's Geological and Natural History Survey and cooperating units of DEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

Please contact me if you have further questions at 424-3584. Thank you for consulting the Natural Diversity Data Base. Also be advised that this is a preliminary review and not a final determination. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to DEP for the proposed site.

Sincerely,


Stacey Kingsbury
Environmental Analyst

(Printed on Recycled Paper)
79 Elm Street • Hartford, CT 06106 • 5127
An Equal Opportunity Employer

October 21, 1994

Planning Directorate
Plan Formulation Division

Honorable Samuel Gejdenson
House of Representatives
Washington, DC 20515-0702

Dear Mr. Gejdenson:

As requested by Mr. Dennis Riley, of your staff, I am providing this status update of our investigation for providing ice jam flood protection along the Shetucket River in the village of Baltic (Sprague), Connecticut for your information. The area is being studied under the special continuing authority contained in Section 205 of the 1948 Flood Control Act, as amended.

Our preliminary evaluation has considered ice jam holding structures (cribs or blocks) upstream from the Main Street (Route 97) bridge. Our first estimates indicate that the project could be constructed for about \$250,000 and may have sufficient economic justification for Corps of Engineers participation.

A recent report from the Corps' Cold Regions Research Laboratory (CRREL) at Hanover, New Hampshire indicates that a proposed upstream site and structure appear feasible for ice storage and the right bank flood plain is suitable for passing relief overflow. However, because there is no longer a dam in the area, the river current velocity will be higher, making it more difficult to retain ice behind the structure. In addition, scour of the river bed may occur at the cribs due to increased ice thickness. Therefore, our further studies will have to investigate energy slope and water current velocity for the expected range of breakup river flows to determine if the proposed ice retention structure will perform adequately.

We recently provided an update of our activities to the Sprague First Selectman, Mr. Thomas McAvoy, and representatives of the Connecticut Department of Environmental Protection. They have indicated that they are interested in protection from a recurrence of the ice jam flooding and may cost share in the construction cost as required by Corps of Engineers authorities. We have also notified Mr. McAvoy that a flowage easement on the riverbank property located upstream from the proposed crib site, would have to be acquired by the Town of Sprague before any project could proceed.

Current schedules call for the reconnaissance study to be completed during March 1995. At that time, we will determine whether additional, more detailed study is needed. I will notify you of our findings at that time.

I trust this information adequately explains our study requirements and the status of our current investigations for providing ice jam flood control in Baltic, Connecticut. If you have any questions regarding this study or this response, please contact me at (617) 647-8220 or the study manager, Ms. Phoebe Chu, at (617) 647-8549.

Sincerely,

Earle C. Richardson
Colonel, Corps of Engineers
Division Engineer

Copies Furnished:

Honorable Samuel Gejdenson
Representative in Congress
P.O. Box 2000
Norwich, Connecticut 06360-2000

Mr. Charles Berger, Assistant Director
Bureau of Water Management
Inland Water Resource Division
Connecticut Department of Environmental Protection
79 Elm Street, 3rd Floor
Hartford, Connecticut 06106

Mr. Thomas McAvoy, First Selectman
Town of Sprague
P.O. Box 677
Baltic, Connecticut 06330

cc:

Mr. Swaine, 114S
Ms. Chu, 114S
Mr. Pronovost, 114N
Plng. Dir. Files, 114N
Reading
PDB Files, 114S (GEJDENSO)



DEPARTMENT OF THE ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY, CORPS OF ENGINEERS
HANOVER, NEW HAMPSHIRE 03755-1290

September 6, 1994

Mr. F. William Swaine
U.S. Army Engineer Division, New England
Frederick C. Murphy Federal Building
424 Trapelo Road
Waltham, MA 02254-9149

Dear Bill:

Thank you for sending us information on the proposed ice control structure for the Shetucket River at Baltic, CT for review and comment. Andrew M. Tuthill, Jon E. Zufelt, and Kathleen D. White reviewed and discussed the proposed structure. We also discussed our comments with Scott Acone while he was at CRREL attending the short course on HEC DSS. Our comments follow.

The proposed rock filled cribs are similar to those constructed by NED on the Narragausus River upstream of Cherryfield, Maine. On the Narragausus River, the three cribs, spaced 60 ft apart, were designed to prevent sheet ice from passing the spillway of the timber crib dam. Pool depth at low water is about 10 ft. No ice passed the Narragausus structure during the severe breakup event of February 1968. The three cribs on the Narragausus are designed to work in conjunction with the dam. More important than the rock filled cribs themselves, the pool behind the dam helps preserve an intact sheet ice cover during an ice run. The destabilizing effects of high water current velocity and rapid stage rise are dampened by the pool.

The concept of the proposed ice retention structure constructed from rock filled timber cribs is sound. The reach upstream of the proposed structure is ideal for ice storage and the right floodplain suitable for passing relief flow. Furthermore, the proposed location in the former pool of a removed dam is undeveloped.

Unlike the Cherryfield structure, there will be no dam downstream of the proposed cribs at Baltic. Without the impoundment, water current velocity at the cribs will be higher and stage rise more rapid. As a result, the ice cover behind the cribs may breakup and form a grounded ice jam at the structure. If formation of a grounded jam at the cribs is anticipated, near bed water current velocities will likely be high enough to cause scour and bed protection will be needed. The arching capacity of broken ice pieces between the cribs should therefore be considered in the design. The proposed gap width of 12 ft appears to be reasonable, but more information on energy slope and water current velocity for the expected range of breakup flows is needed before reaching definite conclusions on crib spacing.

The alternative of laying out the cribs in a straight line perpendicular to the flow should also be considered. The upstream vee shape is optimum for frazil ice cover formation using an ice boom but may create flow patterns that are less conducive to arching of broken ice pieces than a linear configuration. In addition, the linear configuration may also reduce construction costs.

The height of the cribs affects flow depth and hence ice conveyance capacity on the floodplain. Since the right bank is tree-lined, a good approach may be to store ice in the main channel while passing flood flow on the right floodplain. This has been achieved at other locations by setting the top of structure at, or slightly above, the right bank elevation. This scheme will decrease the required height of the proposed cribs from 16 ft to roughly 6 ft, reducing construction costs and minimizing water level rise upstream of the structure.

Other considerations include the ice volume to be retained, the available ice storage capacity, and the water surface profile that results from an equilibrium ice jam behind the structure. Bank protection will likely be needed where relief flow exits and reenters the main channel. The conveyance capacity of the right overbank also needs to be examined for the expected range of breakup flows. In addition, the potential for upstream flooding resulting from an ice jam behind the cribs should be assessed.

The cribs on the Naragaus River are designed to retain an intact sheet ice cover. Force levels and abrasion resulting from moving ice may be much greater in the grounded ice jam situation. The design and performance of existing rock filled timber cribs on rivers with severe breakup ice runs should therefore be examined.

A timber crib ice retention structure could be an effective, low cost solution to the ice jam flood problem at Baltic, CT. However, we feel that the issues and questions raised in this letter should be addressed before the start of construction. After speaking with Scott Acone, we feel that NED is capable of performing the necessary analyses. We would be happy to assist if requested. Please contact Andy Tuthill 603-646-4225 or Kate White 603-646-4187, if you have questions or comments.

Sincerely,

Andrew M. Tuthill

Andrew M. Tuthill, P.E.
Research Hydraulic Engineer
Ice Engineering Research Branch

Kathleen D. White

Kathleen D. White, P.E.
Research Hydraulic Engineer
Ice Engineering Research Branch



TOWN OF SPRAGUE

MAIN STREET
P.O. BOX 677
BAL TIC, CONNECTICUT 06330

March 9, 1994

THOMAS N. McAVOY, JR.
First Selectman

PHONE (203) 822-3000
FAX (203) 822-3013

Mr. Bill Swaine
Department of Corps
of Army Engineers
New England Division
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Bill:

It was a pleasure meeting with you on Thursday, February 3rd, where we discussed the process of a reconnaissance survey.

Please accept this letter as a formal request of the Town of Sprague for the Army Corps of Engineers to undertake a reconnaissance survey of the village of Baltic in the Town of Sprague. This study is needed, not only because of the threat of flooding in Baltic, but because of the threat of flooding downstream in the villages of Occum and Taftville.

I am grateful for your speedy response to our recent disaster.

Very truly yours,

Thomas N. McAvoy, Jr.
First Selectman

TNM:lm



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149
February 23, 1994

REPLY TO
ATTENTION OF

Planning Directorate
Plan Formulation Division

Honorable Samuel Gejdenson
House of Representatives
Washington, DC 20515-0702

Dear Mr. Gejdenson:

In the temporary absence of Colonel Miller, I am responding to your letters of February 2 and 3, 1994 concerning the ice jam flood conditions along the Shetucket River in Sprague, Connecticut. As you noted, personnel of my staff met with city and state officials, as well as Dennis Riley of your Norwich office, on February 3, 1994.

As discussed at the meeting we have initiated a reconnaissance scope investigation to determine if there is sufficient economic justification for Corps of Engineers participation in the construction of a permanent local flood protection project that will prevent future flood losses in the Baltic neighborhood. The investigation will be performed under the special continuing authority contained in Section 205 of the 1948 Flood Control Act.

I am sure that Colonel Miller will accord this important investigation a high priority, as requested, and will keep state and city officials, as well as Mr. Riley informed of developments as they occur. A complete report of our findings will be forwarded to you as soon as we possibly can.

If you have any questions regarding our study, please do not hesitate to contact me at 617-647-8222 or the Project Manager William Swaine at 617-647-8532.

Sincerely,

Dwight S. Durham
Lieutenant Colonel, Corps of Engineers
Acting Division Engineer

Copy Furnished:
Honorable Samuel Gejdenson
Representative in Congress
P.O. Box 2000
Norwich, Connecticut 06360-2000

WASHINGTON OFFICE:
2416 RAYBURN BUILDING
WASHINGTON, DC 20515
(202) 225-2076

HOME OFFICE:
P.O. Box 2000
NORWICH, CT 06360
(203) 886-0139

84 COURT STREET
MIDDLETOWN, CT 06457
(203) 346-1123



Congress of the United States
House of Representatives
Washington, DC 20515

SAM GEJDENSON
2D DISTRICT
CONNECTICUT
COMMITTEE ON
FOREIGN AFFAIRS
CHAIRMAN,
SUBCOMMITTEE ON INTERNATIONAL
ECONOMIC POLICY AND TRADE
COMMITTEE ON INTERIOR
AND INSULAR AFFAIRS
COMMITTEE ON HOUSE
ADMINISTRATION
DEMOCRATIC STEERING AND
POLICY COMMITTEE
MAJORITY WHIP AT-LARGE

February 3, 1994

Colonel Brink P. Miller
Division Engineer
Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254-9149

flm
Dear Colonel Miller:

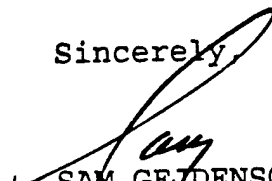
I am grateful for your speedy response to the Town of Sprague's request for a reconnaissance survey in the wake of the recent flooding in the Baltic section.

A member of my staff attended this morning's session at the Town Hall with Bill Swaine and Rich Ring from your office and he reports they were extremely helpful to First Selectman Tom McAvoy with data on this type of project and possibilities thereafter.

I know there is a sizeable workload on the Corps in its planning and other divisions but I ask you to accord the Sprague project a high priority because of the damages the recent flooding brought to the community and the importance of pursuing a long-term project to lessen flooding threats for Sprague and the downstream villages of Occum and Taftville.

I have assigned Dennis Riley at my Norwich office and Scott Kovarovics in the Washington office to act as liaisons on this situation.

Sincerely,


SAM GEJDENSON
Member of Congress

SG/dr

WASHINGTON OFFICE:
2416 RAYBURN BUILDING
WASHINGTON, DC 20515
(202) 225-2076

HOME OFFICE:
P.O. Box 2000
NORWICH, CT 06360
(203) 886-0139

84 COURT STREET
MIDDLETOWN, CT 06457
(203) 346-1123



Congress of the United States
House of Representatives
Washington, DC 20515
February 2, 1994

SAM GEJDENSON
2D DISTRICT
CONNECTICUT
COMMITTEE ON
FOREIGN AFFAIRS
CHAIRMAN
SUBCOMMITTEE ON INTERNATIONAL
ECONOMIC POLICY AND TRADE
COMMITTEE ON INTERIOR
AND INSULAR AFFAIRS
COMMITTEE ON HOUSE
ADMINISTRATION
DEMOCRATIC STEERING AND
POLICY COMMITTEE
MAJORITY WHIP AT-LARGE

Colonel Brink P. Miller
Division Engineer
Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254-9149
Dear Colonel Miller:

A section of the Baltic region in the Town of Sprague has been horribly affected again by flooding which has damaged several dozen homes and businesses.

From my visits Sunday and Monday to the area, it is evident that a plan must be developed to provide long-term approaches designed to eliminate this type of troubling situation.

I therefore request that the Army Corps of Engineers--as speedily as possible--undertake a reconnaissance survey (as provided in Section 205 of pertinent Federal regulations) that would consider two elements in keeping with a request I received this morning from First Selectman Tom McAvoy.

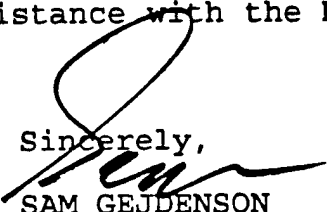
One is the reconstruction of an earthen dike which extends along the Shetucket River in the village of Baltic and the other is the feasibility of a bypass through a canal-area near that river. Naturally, the scope should also include aspects that the Corps deems pertinent.

The study is needed not only because of the flooding problems in Baltic but because of the threat of flooding downstream in the villages of Baltic and Taftville and in other sections of Norwich.

I ask that you accord this request a high priority in view of the dangers that exist for residents of the regions.

I am grateful for the speedy response from the Corps with its ice experts and for the Corps assistance with the Mansfield Dam flow revisions.

Sincerely,


SAM GEJDENSON
Member of Congress