CONNECTICUT RIVER TRANSMISSION CROSSINGS IN THE MIDDLETOWN - HADDAM AREA

Northeast Utilities Service Company

Berlin, Connecticut

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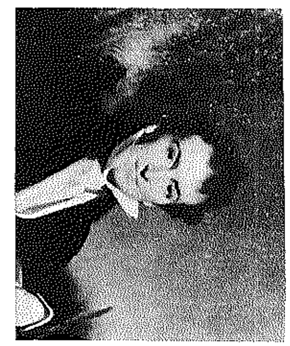
ERRATA

"Connecticut River Crossings In The Middletown-Haddam Area"

Page	Line	Change
8	Last	Add: East before Haddam town dump.
Following 11	Figure 3	Delete the word proposed on "PLAN" before 345 KV Transmission Line Conn. Yankee - Manchester and 345 KV transmission line Black Pond - Conn. Yankee.
		Delete word proposed in title figure second line "Tower line crossings over the Connecticut River."
Following 13	Figure 5	Delete the word proposed on "PLAN" before 345 KV transmission line Conn. Yankee - Manchester.
		Delete word proposed in the title of Figure 5 second line--"Tower line...."
	Photo 8	Caption should read as follows: The north tower of the Bodkin Rock crossing. (The river......)
16	3	Change Haddam to Hampton.



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FOREWORD

Within the next few weeks, the Connecticut Department of Environmental Protection will be asked to consider the issue of overhead versus underground or relocation for three high-voltage transmission crossings of the Connecticut River in the Middletown-Haddam area.

Two of these crossings have been overhead for about six years near Middletown. The third involves a new transmission line for a crossing which has been in existence between Haddam and East Haddam since 1928.

In January of this year, a decision by the Connecticut Supreme Court affirmed the jurisdiction of the Department over electric transmission line crossings of navigable waterways and thus its authority to review the future of the crossings in question.

Because this regulatory proceeding will involve a substantial issue of public policy, a careful study of the facilities in question has been conducted by the Northeast Utilities system. The findings of that study and the conclusions drawn therefrom are presented here for public consideration and discussion.

As a result of this study, the Northeast Utilities system will ask the Department to permit continued overhead crossings as having the least adverse environmental and economic impact upon the state when compared to alternatives.

The Company hopes that this report of the study will aid citizens as they make up their own minds as to whether additional land and capital should be committed to place these transmission crossings underground or to relocate them. As is emphasized in the final section, the study suggests that the economic costs and environmental penalties of all alternatives to the present crossings make them less satisfactory than the present situation.

The issue is important and the subject complex. There are no easy answers--for the Department, for Northeast Utilities, and, most importantly, for the people of Connecticut. Therefore, we trust this report will receive the thoughtful attention of all concerned citizens.

Because of the complicated nature of defining and assessing this problem, much of this report will not be easy reading. Considerable detail is required in order to discuss electrical transmission systems, the topography of the river lands near Middletown and Haddam, construction techniques, and the technicalities and costs of underground technology. To include relevant matters, a lengthy presentation is unavoidable.

I. INTRODUCTION

As a result of rather unusual circumstances, three major links in the Northeast Utilities system transmission grid will be under regulatory review at the same time. As a result, the Company conducted a systematic study of the present crossings and alternatives to them in order to reach its own conclusions as to a proper course of action. The study examined need, specific choice of crossing locations, visual impact, underground cable technology, future crossing needs, and the environmental impact of the present crossings and alternatives to them.

The issue of these crossings, which must be decided by the Department of Environmental Protection, stems back to a 1966 decision by the then Connecticut Water Resources Commission (WRC) that two of the crossings should be relocated or placed underground. In that same year (1966), the Connecticut Public Utilities Commission (PUC) had issued a separate opinion that the lines should be overhead.

In the years between 1967 and 1971, the matter of conflicting jurisdictions between the WRC and the PUC was under review by the Connecticut Supreme Court. While the Court was deliberating the evidence, the Department of Environmental Protection came into being by an act of the State Legislature and absorbed the functions of the former Water Resources Commission.

In January of this year, the Court decided that jurisdiction over electric transmission line crossings of navigable waterways lay with the Water Resources Commission and, thus, today with the Department of Environmental Protection (DEP).

The third crossing in question is a proposed rebuilt crossing for a higher voltage line which is necessary to bring electric power from the Millstone Nuclear Power Station in Waterford to the population centers of central and western Connecticut. Application to the DEP for an overhead crossing in the same location as one presently in existence to accommodate the new Millstone line was submitted by the Northeast Utilities system in January of this year. Thus, three crossings are at issue before the DEP.

II. HISTORIC DEVELOPMENT OF CONNECTICUT RIVER TRANSMISSION CROSSINGS

A. Function of High-Voltage Transmission

Before describing and locating the three transmission crossings in question, it is essential to understand the basic function of high-voltage transmission in a modern power supply system.

In Connecticut, as elsewhere in the New England region, most electric power is transported from generating stations to the centers of heaviest consumer use by 115,000-volt or 345,000-volt transmission lines. The higher the voltage, the greater the quantity of electric power that can be moved. For example, a 345-kV line can transport about six times as much electricity as a 115-kV circuit. From these high-voltage arteries, the electric energy is "stepped down" to relatively low voltages for distribution along neighborhood streets.

In 1971, about 62 percent of Connecticut's electric power output was produced east of the Connecticut River (or otherwise had to cross the river) to reach the major consumption centers west of the river. With much of the source of electricity east of the river and the major use west of the river, a number of transmission crossings are absolutely essential to a reliable power supply system. The question thus becomes where should these crossings be located and should they be overhead or underground.

These high-voltage lines are also essential links in the interconnected New England transmission grid which serves three vital functions: (1) the interchange of the most economical power from generating sources within the region at times of low or moderate use, (2) the emergency "backup" of a regional power supply when local generators are out-of-service; and, (3) greater assurance of uninterrupted electric service should an area transmission line fail or be "out" for maintenance.

Not too many years ago, the highest operating voltage level interconnections were at the 115-kV level, but as larger generating units were built in New England to reduce the overall price of electricity, voltages were raised to 345 kV to move larger and larger blocks of power. This development reflected a national policy which encouraged low-cost electric energy through the economies associated with large-scale generation and transmission.

For New England, the advent of large-scale generation has meant increased reliance upon nuclear fuel for both economic and environmental reasons. Because U. S. Atomic Energy Commission criteria require nuclear plant location in low-density population areas, Connecticut's nuclear units have been sited in the eastern part of the state. Much of this power must then cross the river to reach the urban load centers to the west. Where to place these crossings and whether to build them overhead or underground has involved difficult choices reflecting an evaluation of engineering, economic and environmental factors.

B. The Middletown-Haddam Crossings

Haddam

The first transmission line to cross the river here was a 69-kV tie between Haddam and East Haddam built in 1928 on two towers, one on each bank of the river. In this report, the site is referred to as the Haddam crossing. The construction of this early east-west line served to connect generation at Montville with load centers around Meriden. This line was converted to the higher 115-kV voltage in 1946 and a second 115-kV circuit was added in 1954 when generating capacity was increased at Montville. To serve local electric needs a lower voltage 28-kV subtransmission line also crosses overhead on the same towers. The original line improved reliability of service in major portions of the state by providing the first alternate power artery south of Hartford.

In January of 1972, the Northeast Utilities system made application to the DEP to rebuild this crossing with higher towers to accommodate a 345-kV line for the power output of a second nuclear generating unit at Millstone Point in Waterford (scheduled for operation in early 1974).

Scovill Rock

When the Connecticut Yankee Atomic Power plant was being built at Haddam Neck in 1965, it became necessary to cross the river with a 115-kV line at Scovill Rock about six miles below Middletown and about 3.5 miles above the Connecticut Yankee plant, in order to satisfy Atomic Energy Commission criteria.

In 1966, The Hartford Electric Light Company applied to the Public Utilities Commission and to the Water Resources Commission for permission to construct four additional towers at Scovill Rock to accommodate two 345-kV circuits needed to bring Connecticut Yankee power to the load centers west of the river. One of these circuits was also in anticipation of a similar need which would occur in 1968 when the first nuclear unit came into service at Millstone Point in Waterford.

Bodkin Rock

Located about four miles below the Middletown Bridge, a crossing at Bodkin Rock was also part of the 1966 HELCO application to the PUC and WRC. It was needed to complete the loop for Connecticut Yankee and Millstone power to reach the Manchester-Hartford area. A single tower on each bank at Bodkin Rock was erected in accordance with PUC authorization.

The Crossings in Question

As a result of the Supreme Court decision upholding the 1966 order of the Water Resources Commission, the single crossing at Bodkin Rock and the two 345-kV crossings at Scovill Rock must either be relocated or placed underground as matters stand today. As a result of the Northeast Utilities study of these crossings and the proposed rebuilt crossing at Haddam, the Department of Environmental Protection is being asked to review the matter of the removal of these crossings in the light of present-day technology and environmental concerns.

Although not a part of the DEP proceeding, a major crossing at Paper Rock opposite the Middletown generating station provides an essential 115-kV link in the east-west transmission lines which serve the state. By virtue of its location, this crossing became an integral part of the study.

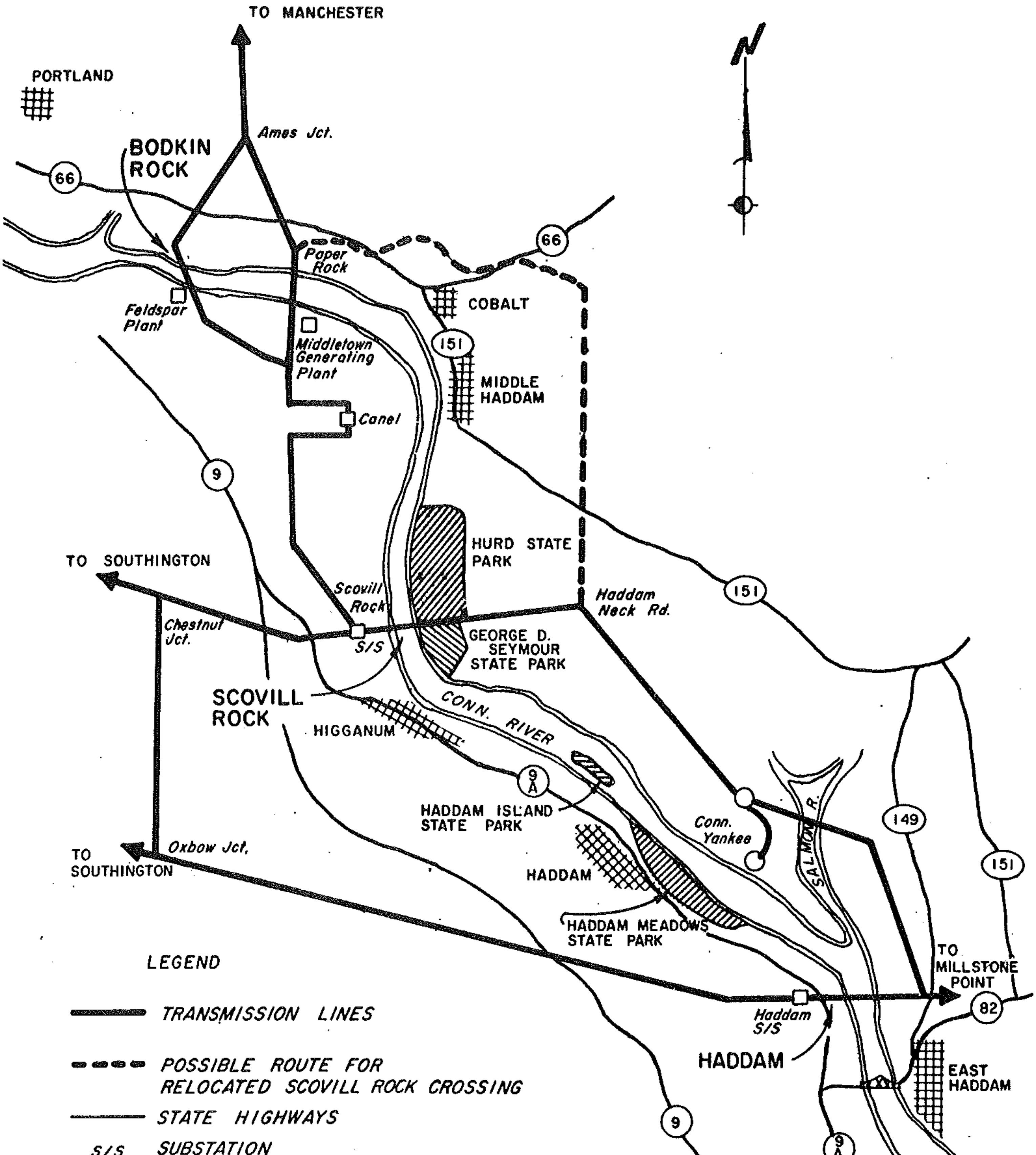
The locations of the crossings are mapped on the next page (Figure 1).

III. APPLICATIONS TO THE DEPARTMENT OF ENVIRONMENTAL PROTECTION

WHY A HEARING ON THREE TRANSMISSION CROSSINGS AT ONE TIME?

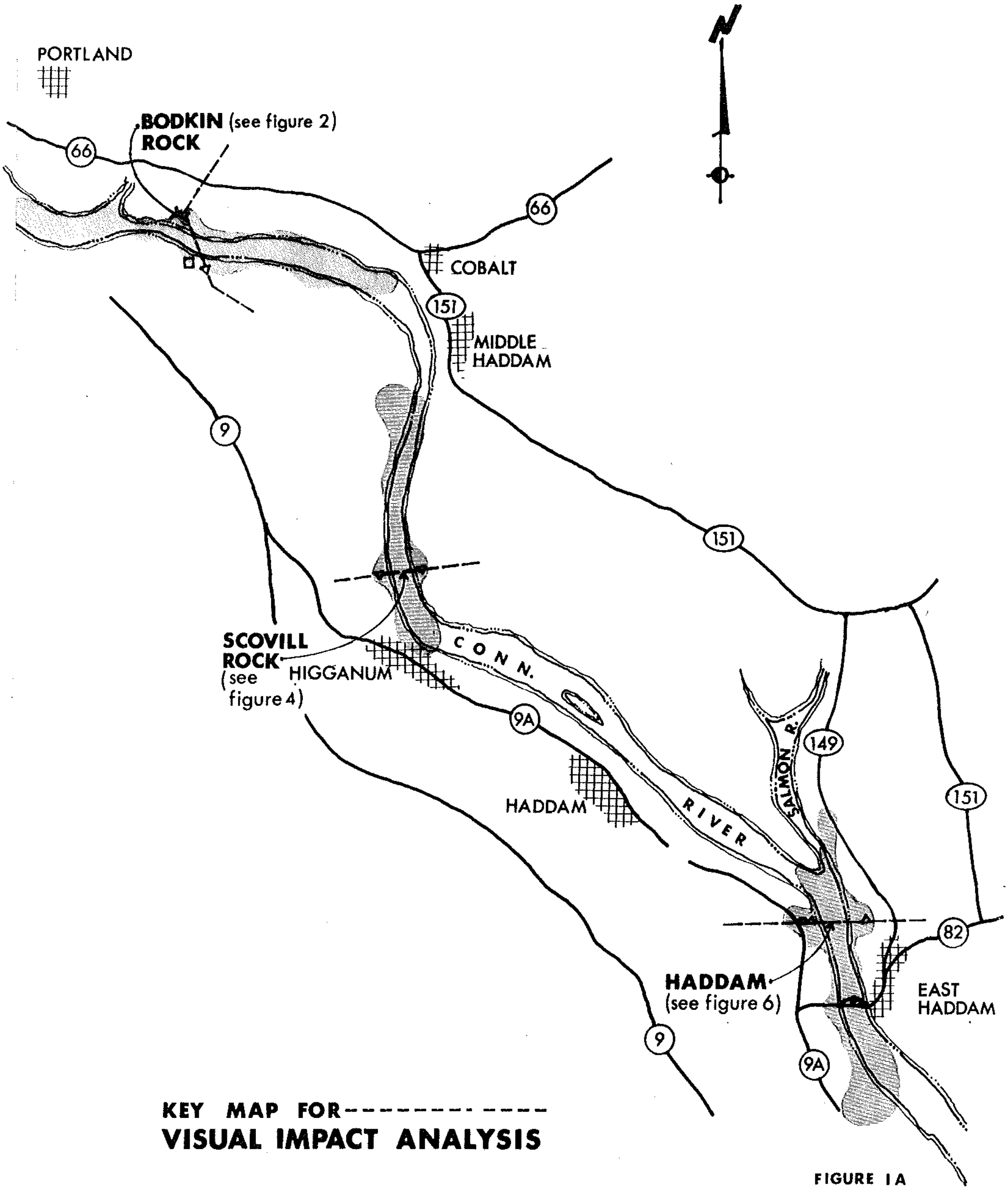
A. Haddam

The proposed 345-kV crossing at Haddam is an integral part of the 345-kV transmission line needed to bring power from the Millstone generating plant to the load centers in the western part of the state following the commencement of commercial operation of Millstone No. 2 nuclear power plant in early 1974. It is the first 345-kV transmission crossing of the river below Middletown that



SKETCH OF CONN. RIVER
SHOWING TRANSMISSION CROSSINGS IN THE
MIDDLETOWN – HADDAM AREA

FIGURE I



KEY MAP FOR

VISUAL IMPACT ANALYSIS

FIGURE 1A

has been needed since 1967. The Company submitted its application for this entire line to the PUC in January of 1972. A public hearing was held in February and the PUC certificate of approval was issued in March 1972. In its decision, the PUC found that it was necessary to complete the line, including the overhead crossing, before early 1974.

Also in January, an application was submitted to the DEP for a permit to construct an overhead transmission crossing of the river between Haddam and East Haddam, which crossing represents an essential link in the transmission line now approved by the PUC. A parallel application had been filed with the U. S. Army Corps of Engineers a few weeks earlier.* Both the state and federal agencies have jurisdication over encroachments on navigable waterways.

In March, the Corps of Engineers referred the application it had received to the DEP for comment and enclosed letters from several Haddam and East Haddam residents criticizing the Company's plans for a rebuilt overhead crossing. The Corps indicated that it would not act on this application until the DEP has made its decision.

The Company has requested that the DEP hold a hearing on the subject of the overhead crossings jointly with the request to modify the 1966 WRC order which required that within five years the Scovill and Bodkin Rock 345-kV crossings must be removed.

B. Scovill Rock and Bodkin Rock Crossings

In 1966, when HELCO applied for a permit for the 345-kV transmission crossings of the river at Scovill Rock and Bodkin Rock, there was opposition at the public hearings before the PUC and the WRC. The PUC approved the crossings, but the 1966 WRC order approving the crossings contained the following condition:

> The overhead transmission lines constructed under this certificate shall be removed and placed under water at the present location or constructed at some other alternative location within five years from the date of issuance of this certificate ...

Following the 1966 ruling, HELCO challenged the jurisdiction of the Water Resources Commission over these overhead transmission crossings in the courts. In January 1972, the Supreme Court of the State of Connecticut ruled that the condition that the WRC had attached to its permit of 1966 was valid, and that the WRC (now the DEP) had jurisdiction over all encroachments on navigable waterways, including electric transmission line crossings. While the Court did not itself order the overhead crossings at Scovill and Bodkin to be placed underground or removed, it did find jurisdiction for the WRC (and thus the DEP) over such crossings. Therefore, the validity of the 1966 condition was upheld, and since five years has elapsed, the order to remove the crossings now pertains.

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*A 27.6-kV circuit now on the Haddam towers is planned to be installed beneath the river when the crossing is reconstructed for an overhead 345-kV circuit. As this is a low-voltage line, installation can be by direct burial and presents minimal economic and environmental problems. A separate application will be made for a DEP permit for this low-voltage line.

C. The Company Request to the DEP

As a result of the combination of circumstances--the need to apply for a 345-kV crossing at Haddam and the recent Supreme Court decision--Northeast Utilities was faced with the necessity for regulatory decisions on the three major extra-high-voltage transmission line crossings at the same time. This led to the study of all its crossings in the area, and to a finding, after weighing all alternatives, that these overhead crossings remain the preferable solution to the problem of crossing the river.

Accordingly, Northeast Utilities has informed the DEP that it wishes to proceed with an overhead crossing of the river at Haddam, and that it wishes to secure a modification of the 1966 WRC order. Because of the complexity of the problem and because these crossings are all part of an integrated system, the Company has requested the DEP to treat them together in one proceeding.

The Company's decision to continue to apply for an overhead crossing at Haddam and to ask the DEP to modify the WRC order of 1966 is based on its own study of the issues involved which shows that the WRC order of 1966 was based in part on assumptions which no longer seem to be relevant.

For example, the findings of the WRC in 1966 suggested that the transmission line crossings would affect the use and development of adjacent lands or would depreciate the value of adjacent land. In the six years since the construction of the lines at Scovill Rock, there is no available evidence that real estate has depreciated in the town of Haddam. The reverse seems to have occurred as land values have risen in that town, including those in the vicinity of the transmission line crossing.

The WRC finding that the proposed towers on the east bank would be located in Hurd State Park did not note that most of the land on which they were to stand had been given to the State of Connecticut by HELCO as part of right-of-way acquisition.

The WRC acknowledged that the Scovill and Bodkin sites "offer advantages for overhead construction" but added "other sites along the river would offer certain advantages and possible economies for underwater crossings." The recent study by the Company shows, however, that there are no other crossing points in the vicinity that would be preferred to those at Haddam or Scovill for overhead or underground installation, as will be fully described in the discussion of the alternatives to those crossings.

The WRC findings assumed that costs of underground transmission would go down compared to overhead, and suggested in 1966 that there would soon be important technological developments in underground transmission. However, neither of these expectations have come true in the intervening six years: the cost of underground transmission at 345 kV remains as high proportionate to overhead construction as it was in 1966, and there have been no technological breakthroughs which either diminish this cost or make underground installation significantly easier.

transmission crossings in 1966, and those of the proposed rebuilt Haddam crossing in 1972, to oppose the crossings primarily on aesthetic grounds. In 1966, the WRC findings took note that "preservation of natural beauty and aesthetics are of concern to many persons ... and therefore should be recognized as public interest."

The Company does not suggest that the river crossings are aesthetically attractive to viewers. Aesthetic judgments differ and some clearly find these structures an intrusion, others accept them, and a few may find them interesting in the landscape. Although it is fruitless to seek agreement on the aesthetic quality of the structures, it is pertinent to bear in mind what the English architect Brenda Colvin suggests--that in some cases observers are conditioned in their response by the memory of transmission lines at more crowded places.*

The question of the aesthetic impact of the river crossings themselves cannot be judged in isolation from consideration of the aesthetic impact of the alternate transmission routes on the river. The Company study shows that good environmental reasons exist why the particular sites for the Scovill and Bodkin crossings and the proposed 345-kV crossing at Haddam were chosen as they were, and why they are at the locations on the river where their visual impact is the least, compared to alternatives in the Middletown-Haddam area. As will be explored more fully in discussion of the individual crossings, alternative routings themselves have adverse aesthetic implications, as well as being undesirable for electrical reasons and on economic grounds.

The question of aesthetics also cannot be divorced entirely from economic costs. Although it is impossible to fix a dollar value to the aesthetic benefits gained for the public from a major capital investment, it is clear that some benefits do not measure up to the cost when the expense involved grows beyond a certain point. To define that point is a matter of judgment that the Northeast Utilities system, the DEP and the citizens of the state all must make.

Finally, in terms of the aesthetic appearance of the river for future generations, it is worth noting that overhead is the simplest and least permanent type of transmission construction. When the day comes that new techniques of transmission and generation may make overhead lines obsolete, overhead lines can be dismantled readily and the land will return to a natural state within a few years. By contrast, underground construction at the present technology represents a far larger commitment of resources and leaves a more permanent scar on the landscape. It is thus a structural solution to a present-day problem which leaves a larger commitment to future generations.

The Company study examined afresh the reasons that guided the choice of crossing locations as follows:

B. Theoretical System Alternatives

In theory, of course, there are innumerable permutations that can be made in an electrical transmission system to convey energy from one point to another. Alternatives which did not appear to warrant detailed consideration by the Company could have included the development of a large new right-of-way along the shoreline to cross the river at Baldwin Bridge, pass through the shoreline

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*Land and Landscape, London, John Murray, 1970, p. 352.

towns to the west of the river, and connect with the Coke Works Substation in New Haven, with a spur that would go northward to Southington. Similarly, an entirely new right-of-way could have been created to take additional 345-kV circuits overland to Manchester and then cross the river south of Hartford, passing through heavily built-up areas to reach the Southington Substation.

Again, in theory, there are any number of alternatives to avoid the Middletown-Haddam area, even given the system as it is today, with major generation in the east and load centers in the west. However, even a superficial glance at a map of the state will reveal that such alternatives would involve construction of new rights-of-way across the countryside and would involve river crossings at other locations. In addition to the staggering cost, such extensive system redesign would create undesirable environmental impacts, in terms of visibility, disturbance of rural and urban areas, and considerable dislocation of dwellings and businesses.

C. Haddam

The location of the crossing. The Haddam crossing point was selected initially in 1928 because it lay on a direct east-west path to connect facilities in Montville with the system just south of Meriden. For engineering and aesthetic reasons, it was also a suitable location because at this point the river is comparatively narrow with fairly high banks on either side, and the height of the towers and the length of the span could be made as short as the topography would permit. The Company's 1972 decision to propose to cross the river at Haddam with a 345-kV line (from Millstone Point to Chestnut Junction in Middletown--the Millstone-Chestnut Junction line) was taken because of the recognition of the generally accepted desirability of using an existing right-of-way as a route to and from the river, which was possible here because this route had been used for many years for transmission circuits at lower voltages. What was required along most of the route to accommodate the 345-kV line was the widening of the right-of-way. At the river itself an overhead crossing could be made with structures that would be only slightly different in appearance than the existing structures.

Present crossing. The present transmission line crossing of the Connecticut River between Haddam and East Haddam, which has been in existence for nearly 45 years, consists of two 115-kV circuits and one 27.6-kV circuit supported by two lattice-type steel structures. The towers are 231 feet tall with a base 45 feet square.

Visibility. The present structures can be seen from Route 9A for a few seconds at right angles looking east over the Haddam Substation and by northbound motorists from 9A south of Haddam again for a few seconds (Photo 1). They can be seen from Route 82 at the western approach to the Haddam Bridge (Photo 2) and from the bridge itself (Photo 3), though the most prominent landmark in the vicinity is the Goodspeed Opera House which attracts most viewers' interest in this area.

The towers cannot be seen from the center of East Haddam, but the west tower can be seen at right angles at a few points on Route 149 (Photo 4). The base of the east tower is almost completely screened by vegetation from this highway. Viewers in cars heading south on Route 149 can see the structures for 20-40 seconds north of the East Haddam town dump (Photo 5).

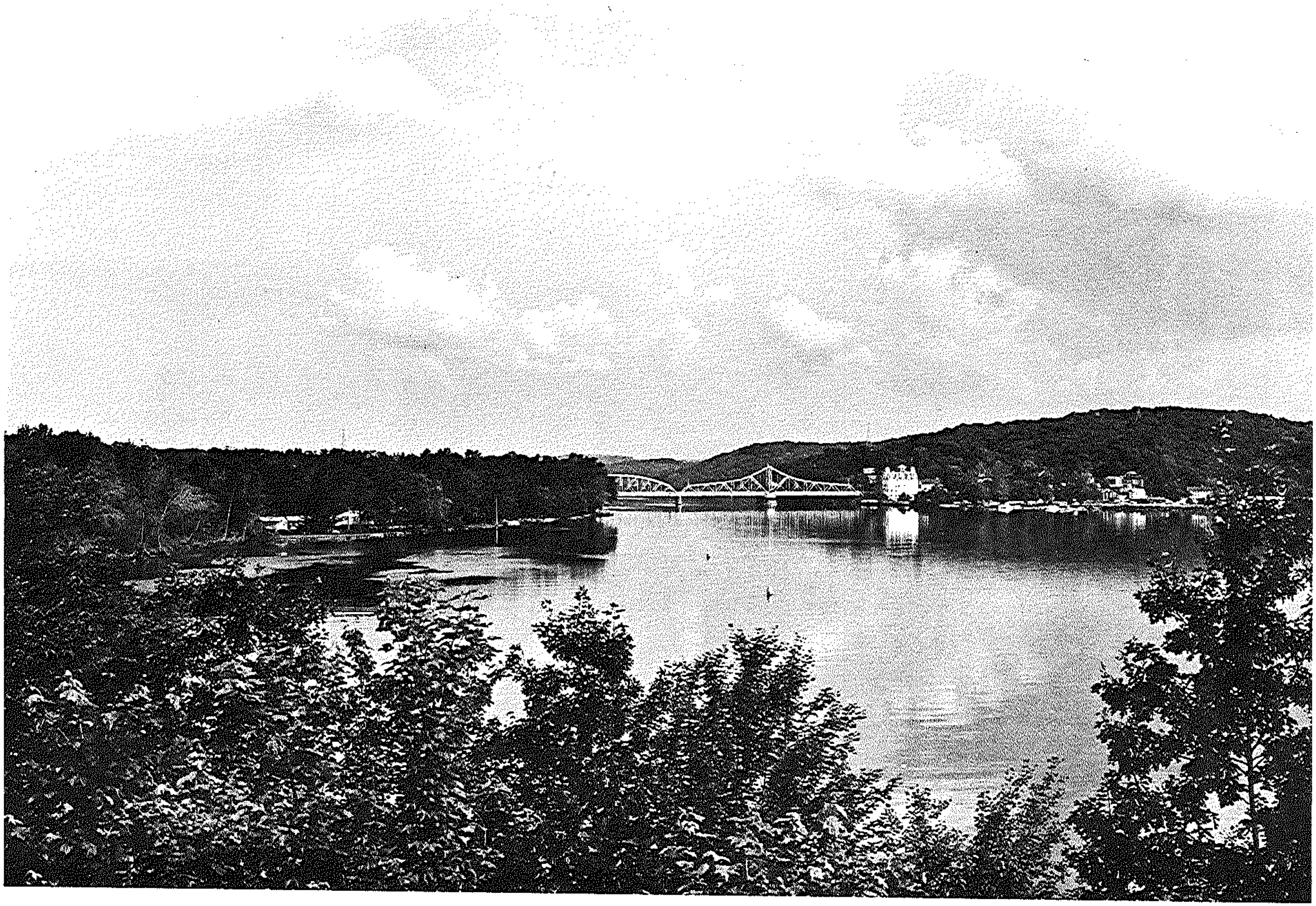


PHOTO 1. View from Route 9A, looking north. The tops of the towers of the Haddam transmission crossing can be seen in the background. In the foreground is the Haddam-East Haddam Bridge (Route 82) and the Goodspeed Opera House.

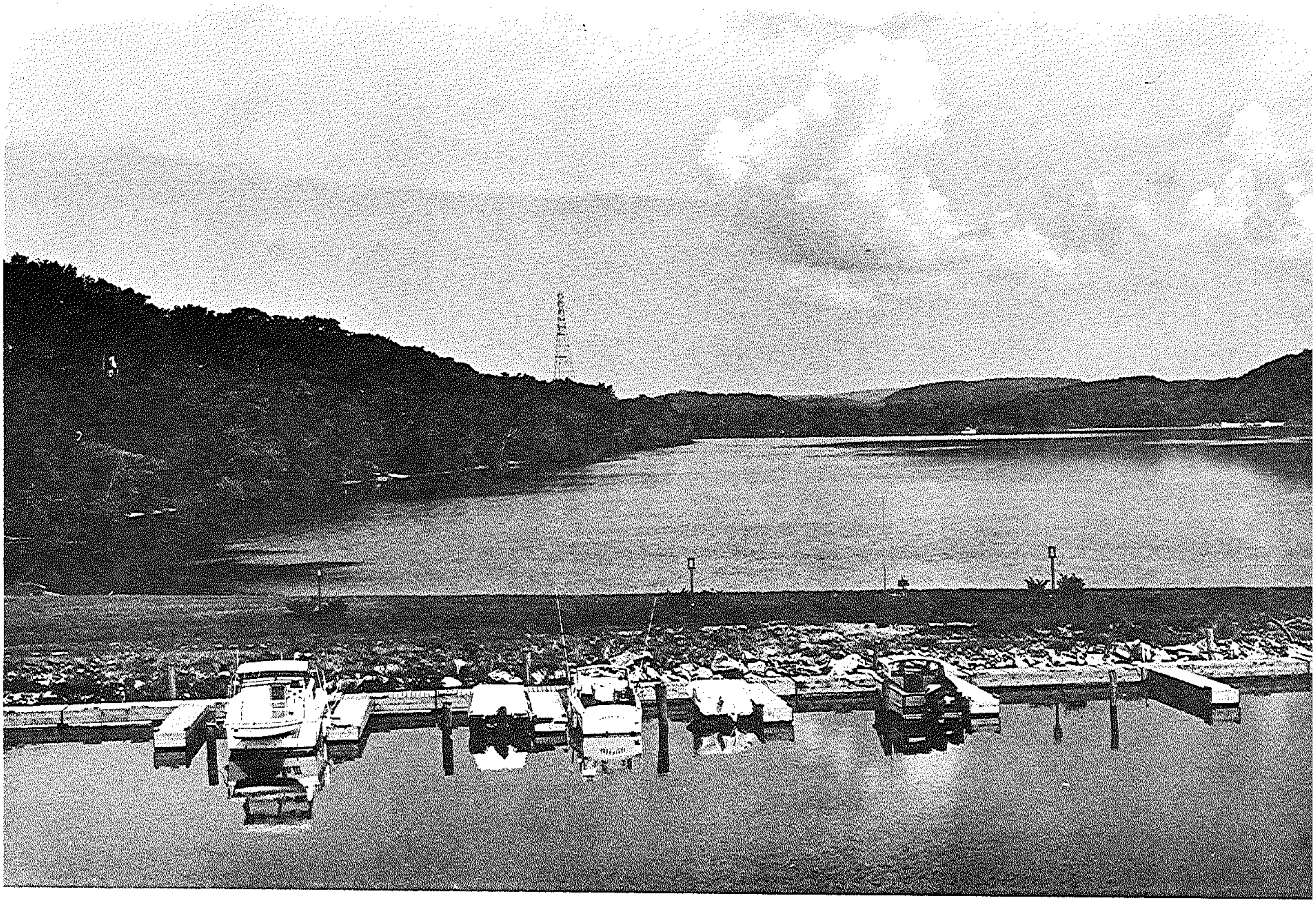


PHOTO 2. The west tower of the Haddam transmission line crossing as seen from the approach to the Haddam-East Haddam Bridge.

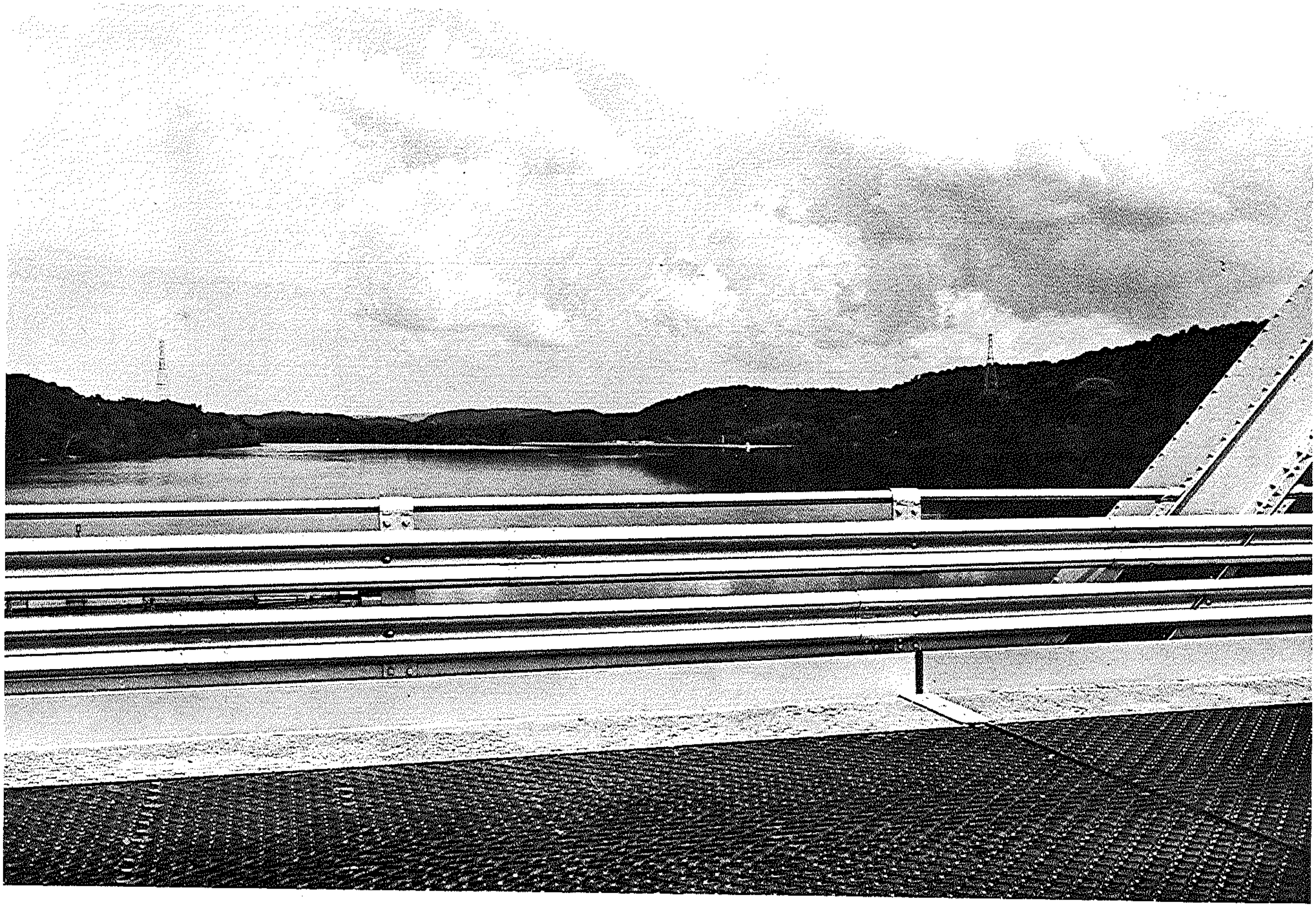


PHOTO 3. The Haddam transmission line crossing as seen from the Haddam-East Haddam Bridge.

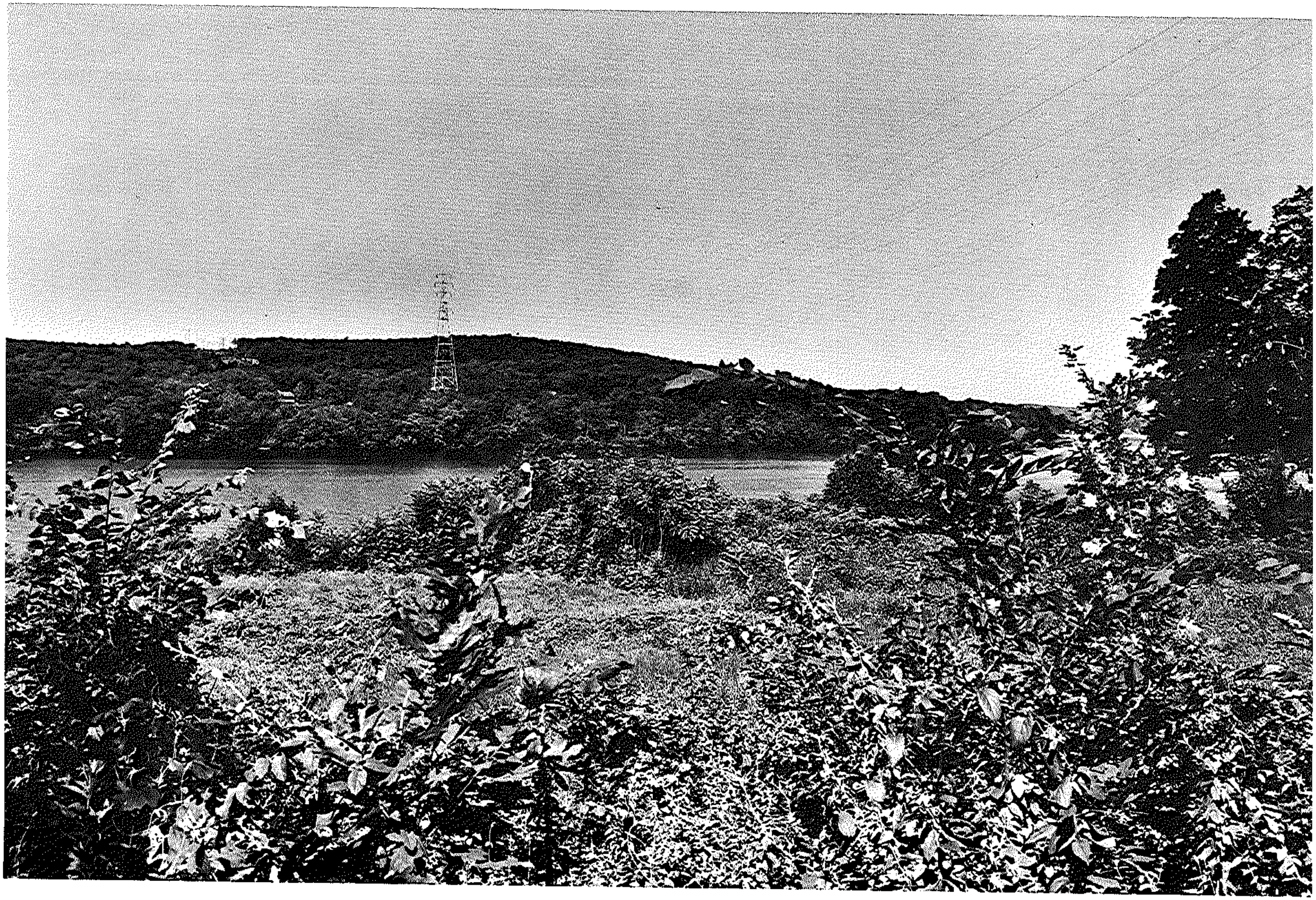


PHOTO 4. The west tower of the Haddam crossing as seen from Route 149 in East Haddam. The transmission right-of-way may be seen in the background.

PHOTO 5. The Haddam transmission crossing towers as seen from Route 149, to the north. The East Haddam refuse disposal area is in the foreground.

The towers are also visible from the Salmon River boat landing area, and are prominently visible from the river itself for a distance of about 1.7 miles in each direction, though their bases are heavily screened.

The towers can be seen from a portion of the East Haddam cemetery and from approximately 25 residences in Haddam and East Haddam. The majority of the views are screened in the summer or are distant views.

Depending upon light conditions, the conductors (wires) at all the crossings cannot be distinguished from beyond 7,000 feet, and they are only faintly visible from 2,500 feet. They are primarily visible to those in the immediate vicinity and to boaters on the river nearby. Figure 2 indicates the zone of visibility of the Haddam crossing.

Proposed rebuilt crossing. The Company proposes to remove the existing lines and structures and to construct new lattice-type crossing structures in approximately the same location as the existing structures. The new crossing will consist of two 345-kV circuits with one initially energized at 115 kV.

The new structures, designed to maintain the existing 111-foot clearance over the river, will be about 30 feet taller and have a base dimension of about 70 feet by 70 feet. If the 111-foot clearance requirement of the Corps of Engineers were applied only to the channel area as opposed to the entire river, the new structures would be only about 20 feet taller than the existing ones. However, this would require special arrangements with the Corps.

Environmental impact. The proposed towers can be erected with a minimum of impact on the natural environment because they would be assembled incrementally. Although the towers would occupy a base area about twice as large as now exists, their construction would involve a small amount of vegetation clearing and soil removal.

The zone of visibility of the towers will not be increased over the present. Because of the topography and the placement of houses in the area, the slightly taller towers should not significantly increase the number of private viewing points on land, and the views from public roads will remain substantially the same as they are now.

Evaluation. Less than ten residences in Haddam and East Haddam have a view of this overhead transmission crossing in which the structures and conductors become major features of the landscape from the living area. Most residences in the two towns concerned, and all within and nearby the zone of visibility, are well maintained and in some cases have recently been improved. Two new homes have been built in recent years adjacent to the line on the east side of the river. There is no evidence, therefore, that the existing overhead crossing has caused a deterioration in its neighborhood.

From public viewing points the towers can be only faintly and fleetingly seen on Route 9A. They are .6 of a mile north of the Haddam-East Haddam Bridge and while the upper portions of the structures are clearly visible, they are not as prominent features in the landscape to passing motorists as the bridge itself or the Goodspeed Opera House to the south.

The most prominent view of this crossing, and all of the others in question, is from the water. The U.S. Bureau of Outdoor Recreation did a census of boating

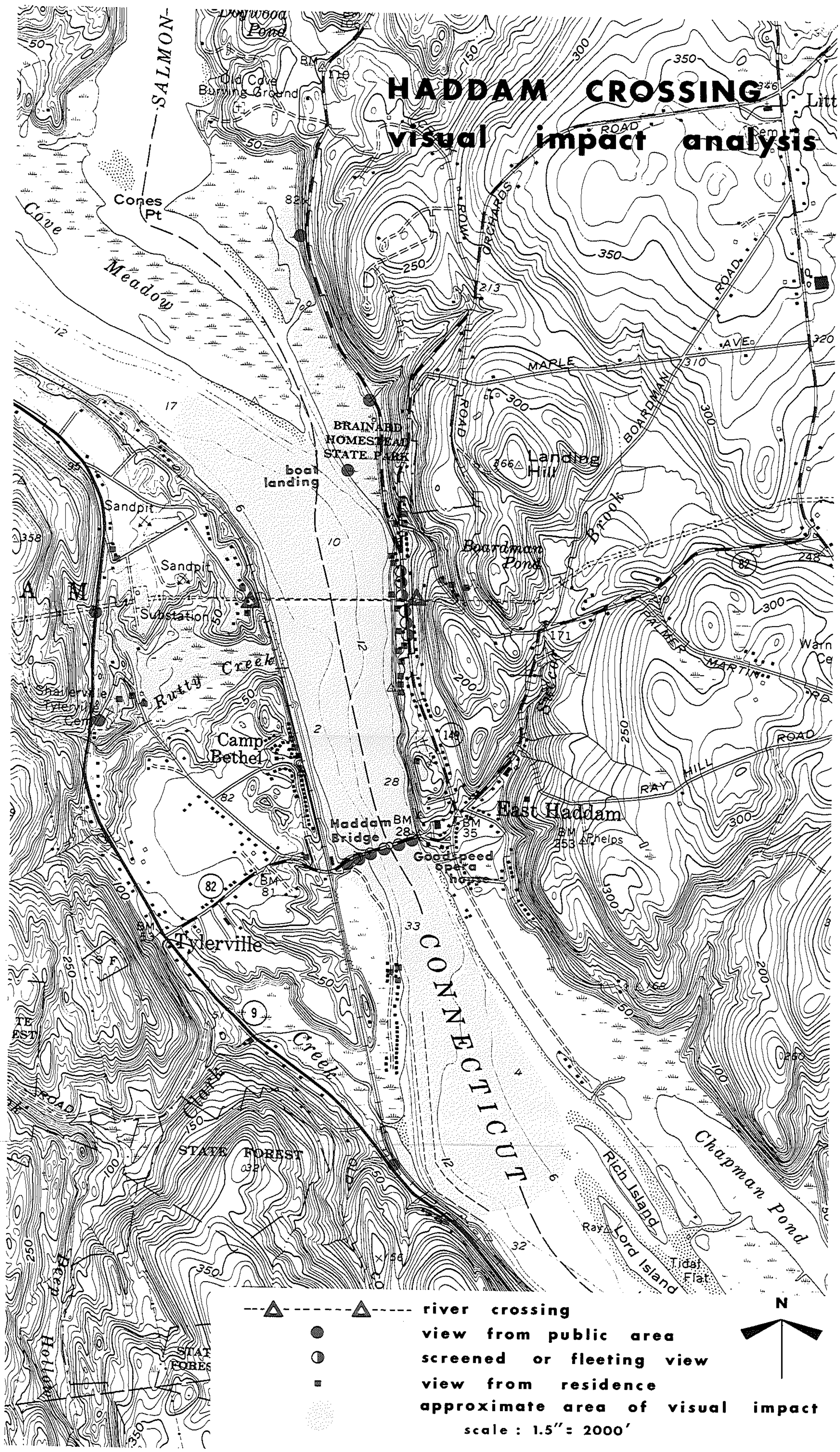

HADDAM CROSSING
visual impact analysis
river crossing
view from public area
screened or fleeting view
view from residence
approximate area of visual impact
scale : 1.5" = 2000'
N
CONNECTICUT
East Haddam
Haddam Bridge
Goodspeed opera house
BRAINARD HOMESTEAD STATE PARK
boat landing
Tylerville
Camp Bethel
Cones Pt
Cove Meadow
SALMON
Rich Island
Lord Island
Chapman Pond
Tidal Flat
Landing Hill
Boardman Pond
Substation
Sandpit
Rutty Creek
Clark Creek
STATE FOREST
Deep Hollow
Old Cove Burying Ground

FIGURE 2

traffic on the river in 1970 and found that on the average July or August weekday there were 3,500 pleasure boats on the water between Hartford and Long Island Sound. The peak weekend count was 5,000. Most of these presumably were to be found nearer the Sound than in the stretch of the river between Middletown and Haddam; nonetheless, it is possible that several hundred boaters pass by the transmission crossings in this area every week during the 8 to 10 weeks of the prime boating season.

The transmission structures at Haddam are heavily screened at their bases by deciduous trees and shrubs which grow naturally along the banks. They are placed about 60 feet above water level on both banks which means that the view from the river is not one of an exposed structure, standing in a clear-cut area, but the view is partially screened by topography and vegetation. Therefore, the visual impact on viewers from the water is somewhat softened.

Cost. The cost of the proposed rebuilt overhead crossing at Haddam is an estimated $345,000.

D. Scovill Rock

The crossing location. The crossing at Scovill Rock was chosen after the examination of a number of alternatives.

One that was rejected was to cross the river in the immediate vicinity of the Connecticut Yankee plant. Purely for economic reasons it would have been preferable to take the 345-kV transmission line leading from the plant along the bank of the river, heading south or north along the bank, and cross the river so that on the Haddam side a transmission tower would be placed either through or just north or south of the Haddam Meadows State Park. Because of aesthetic considerations, the transmission line from Connecticut Yankee was constructed so that it disappears from view from the river behind a hill to the east after only a short stretch of visibility. As a result, the Connecticut Yankee plant presents a far more clean and less intrusive appearance than it would have with a transmission line paralleling the shore or crossing the river in the immediate vicinity.

The river crossing could also have been made south of Scovill Rock where the banks of the river are low and the river is wider, but this would have involved taller towers, would have considerably increased the visibility of the crossing from the river, and made it far more visible in Higganum.

Another alternative might have been to place the crossing north of Hurd Park where on the western side it would pass just south of the CANEL plant of United Aircraft. While the east bank is high and thus suitable for a crossing, the west bank is comparatively low and flat. Therefore, a crossing at this point would again have involved taller towers (at least on one side) which would have considerably increased its visibility from the river and made it highly visible from the Middle Haddam area.

Still another possibility, and one which would have temporarily eliminated the Bodkin crossing in addition to one of those 345-kV circuits at Scovill Rock, would have been to route the 345-kV line from Connecticut Yankee to Manchester northward from the point where the present lines cross Haddam Neck Road to a point on Route 16 east of Cobalt and then westerly along what was the Airline

Railroad to Paper Rock Junction (see Figure 7, following Page 16). This alternative was examined and rejected in the mid-1960s because it would have required the acquisition of a completely new right-of-way through the Cobalt area, east of the river, which was more highly developed than the west side of the river. This right-of-way appears to be the only plausible alternative to one of the Scovill circuit crossings and the Bodkin Rock crossing. It will be discussed in detail in relation to the relocation alternative of the Scovill Rock crossing, Section VII, but given present system needs, the Bodkin crossing could not, in 1972, be eliminated in this way.

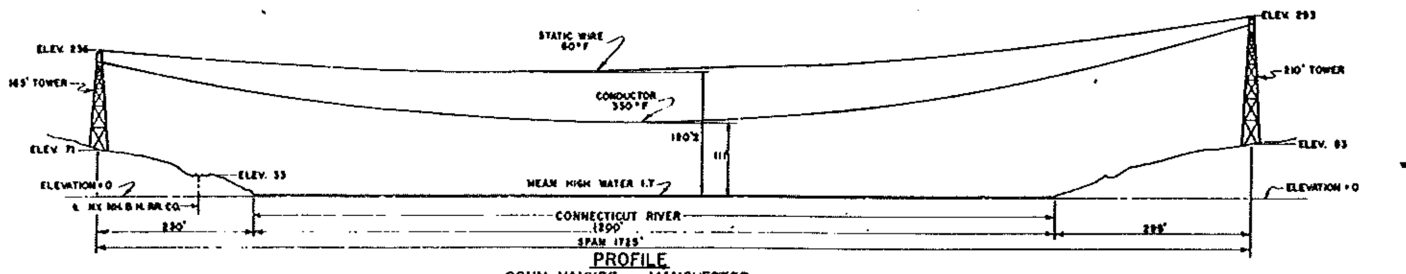
The specific Scovill Rock crossing site was chosen in 1966 because it permitted a relatively short span and shorter towers than at any other location. In addition, at Scovill Rock only the transmission structures are visible from the river, and no related structures can be seen. The transmission crossing is also visible from only a very few residences.

The route for the 345-kV transmission line to this crossing utilized rights-of-way which had been acquired and to a great extent already occupied by the 115-kV transmission system associated with the development of HELCO's Middletown Station: from the CANEL Plant of United Aircraft north to Manchester, and from a transmission junction point in Middletown (Chestnut Junction) to another junction in Meriden (Black Pond Junction). New rights-of-way were developed east of the river to serve Connecticut Yankee.

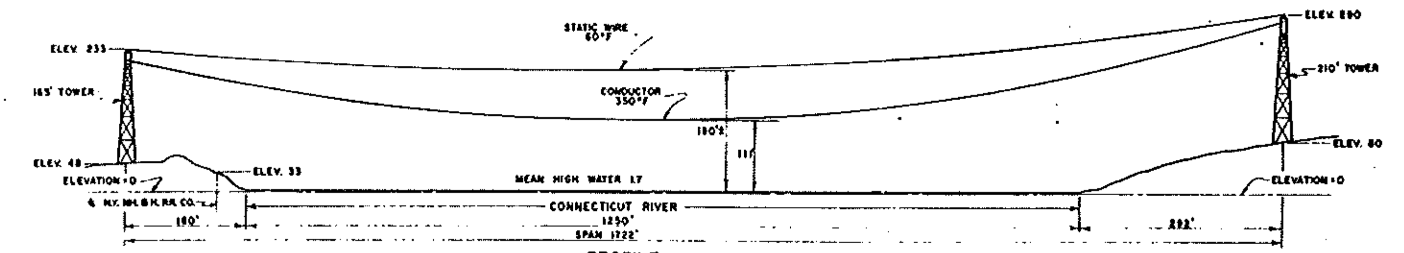
There was an added public benefit from the 1966 choice of the Scovill Rock location. On the east side of the river, there was a relatively narrow strip of privately owned land which separated the state-owned Hurd Park from George Dudley Seymour State Park. The state had been anxious to acquire this 74.4-acre property to link the two parks. Since it would provide an adequate right-of-way for the transmission line, the Company purchased it and donated it to the state in exchange for the right to pass through 23.6 acres of state land. On the western side of the river, the crossing point consisted of an old gravel pit, and the land near it was owned by the Company and zoned industrial by the town of Middletown. The Company did not feel, therefore, that the transmission line would interfere with any existing or proposed land uses at this location.

<u>The present crossing</u>. There are presently two 345-kV and one 115-kV transmission circuits which cross the Connecticut River at Scovill Rock. The two 345-kV circuits are subject to the WRC order of 1966 requiring them to be moved to another location or placed underground within five years.

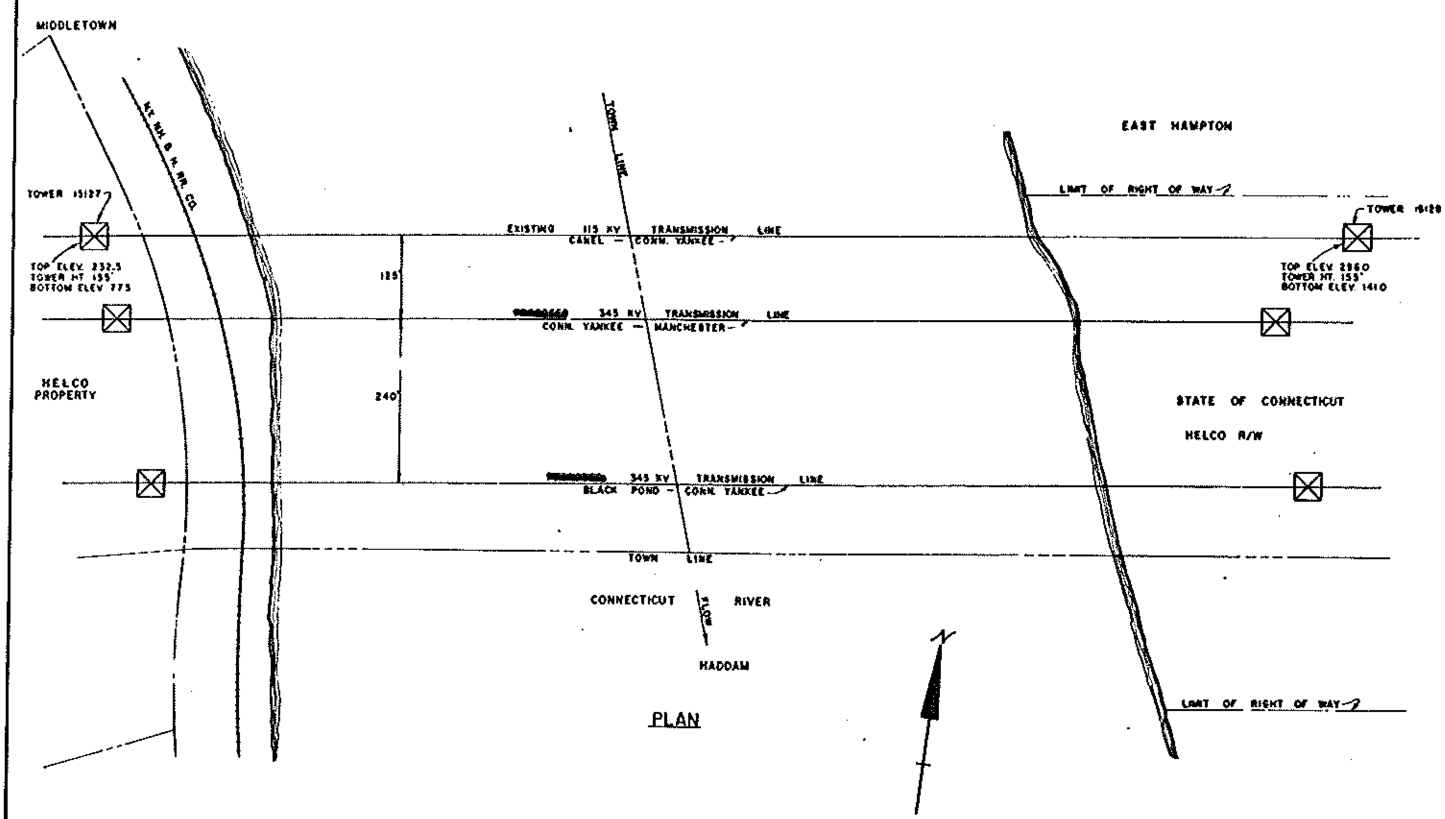
The physical characteristics of the Scovill Rock crossing are shown in Figure 3 and in Photo 6. The circuits are supported by three similar lattice-type towers on each bank of the river. The banks of the river on the west side rise sharply about 30 feet to a railroad embankment and then sharply again to a point near the base of the towers which are located in a gravel pit. On the east side, the bank rises slightly less steeply and the bases of the towers are almost 300 feet from the river's edge. Both banks are covered with deciduous trees and hemlocks, which conceal the lower base of the towers from viewing from the river or from any distant landward points. The towers are painted in orange and white stripes to increase their visibility for aircraft. The towers carry a total of 21 conductors, 15 of which are for the transmission of electricity and 6 are static wires.



PROFILE
CONN. YANKEE - MANCHESTER



PROFILE
BLACK POND - CONN. YANKEE



PLAN

THE HARTFORD ELECTRIC LIGHT CO.

[redacted] TOWER LINE CROSSINGS OVER THE CONNECTICUT RIVER

MIDDLETOWN - EAST HAMPTON, CONN.

SCALE: 1"=100' HORIZONTAL AND VERTICAL
ELEVATIONS REFERRED TO MEAN SEA LEVEL - (USC & GS DATUM)

SCOVILL ROCK
CROSSING

Figure 3

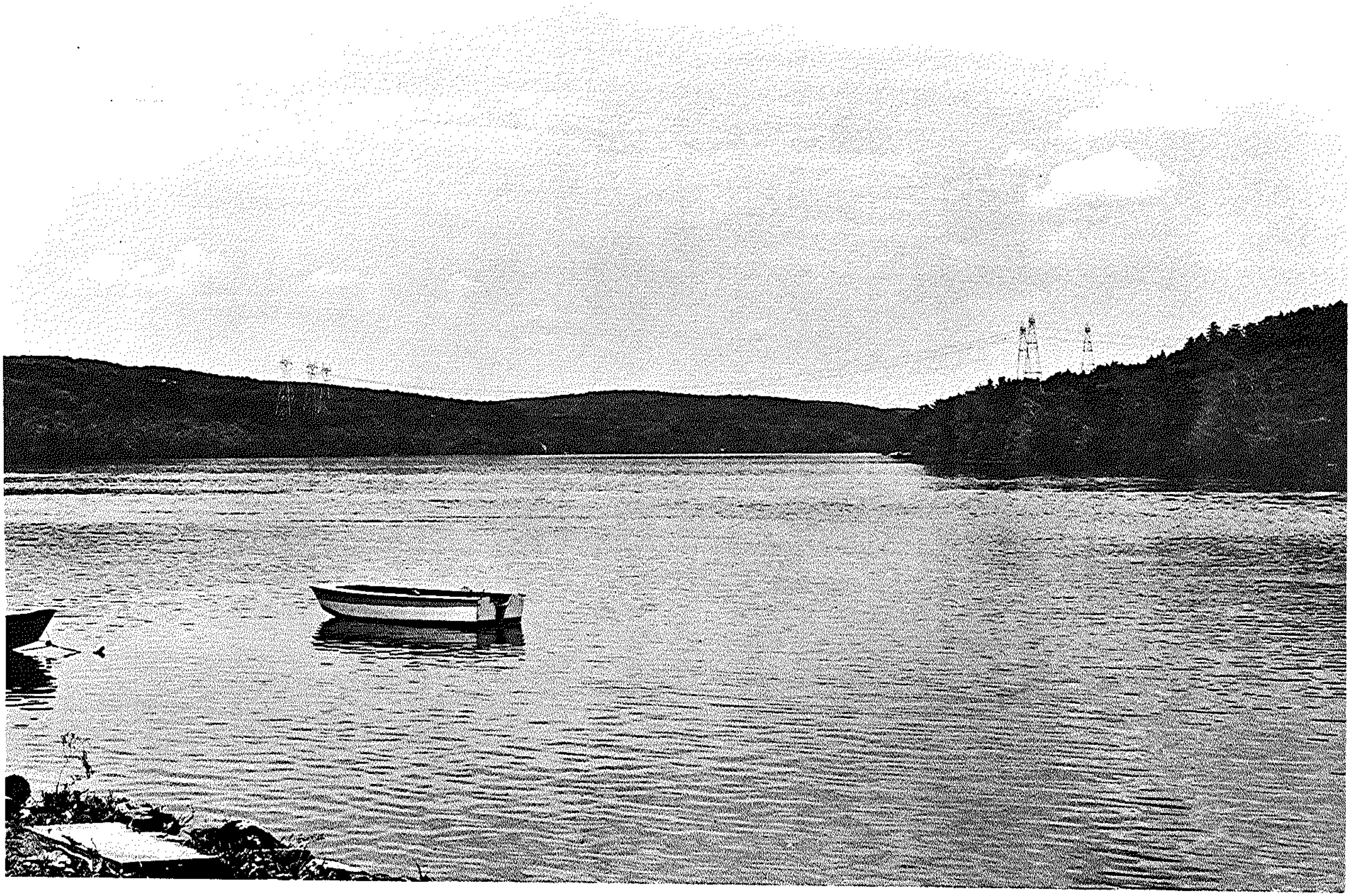


PHOTO 6. The Scovill Rock transmission crossing as seen from the riverbank in the Landing Road area of Higganum.

Visibility. The towers on both sides of the river are visible to residents from 8 to 10 houses in Higganum in the Landing Road area, about .8 miles distant (Photo 6 shows this view), from 2 to 4 houses on Route 9A, about 1 mile distant, from the back of the CANEL plant, about 1.5 miles away, and they can be seen from a few points by walkers in Hurd State Park (Photo 7). The upper portions of the east towers can be seen about 1 mile distant from northbound cars on Route 9A for a period of a few seconds. They can also be seen nearly 3 miles away at right angles for a few seconds by those in northbound cars on Route 9 just north of the Route 81 exit. From the river, the upper portion of the towers can be seen from boats over a stretch of approximately 2.5 miles from the vicinity of the CANEL plant heading south and for about 1 mile from Higganum heading north. But the lower portions of the towers are heavily screened by trees along the river's edge, and the structures are placed high on the banks.

The zone of the visual impact of this crossing is shown in Figure 4.

Evaluation. Only a small number of the 8 to 10 residences in the zone of visibility of this crossing have views in which the structures are prominent features; the rest have screened views or views from the sides or backs of the houses. Under most light conditions the conductors are only faintly visible or invisible from these residences.

The views of the crossings from public roads are of very short duration and are either heavily screened, as at 9A, or distant, as from Route 9. It is probable that many travelers do not notice this crossing at all from the roads.

The towers are prominent parts of the landscape from the river's edge and from Split Rock, a walkers' outlook in Hurd Park. The latter point is one of the few public viewing points from which the Scovill Rock 345-kV substation can also be seen.

As with the other crossings, the major visual impact is on boaters in the river. In this case, the Scovill crossing can be seen from southbound boats from the turn of the river at Maromas Point, near the oil intake pier of the United Aircraft CANEL plant, and from northbound boats as they approach the vicinity of Higganum, about 1 mile to the south of the crossing. As in the other locations, however, the base of the towers is heavily screened by vegetation and the towers are high on the banks. The natural vegetation at this crossing contains conifers whose dark green provides contrast and screening that is particularly important during the winter months.

The repainting of the six towers to a neutral shade to eliminate the highly visible orange and white stripes would considerably decrease their visibility. Lattice towers of the sort at this crossing tend to become "transparent" at a distance if painted a light color. In this case, a slightly darker shade at the base would help the tower to blend in with screening vegetation, and lighter color at the top would help diminish the silhouette against the sky. Such repainting can be done without violation of the FAA regulations, and the Company proposes to do it in the near future.

Cost. From 1964 through 1967 when the crossings were built, their capital cost was:

1 circuit at 115 kV (1964-5)	$140,000
2 circuits at 345 kV (1966-7)	585,000
Total	$725,000

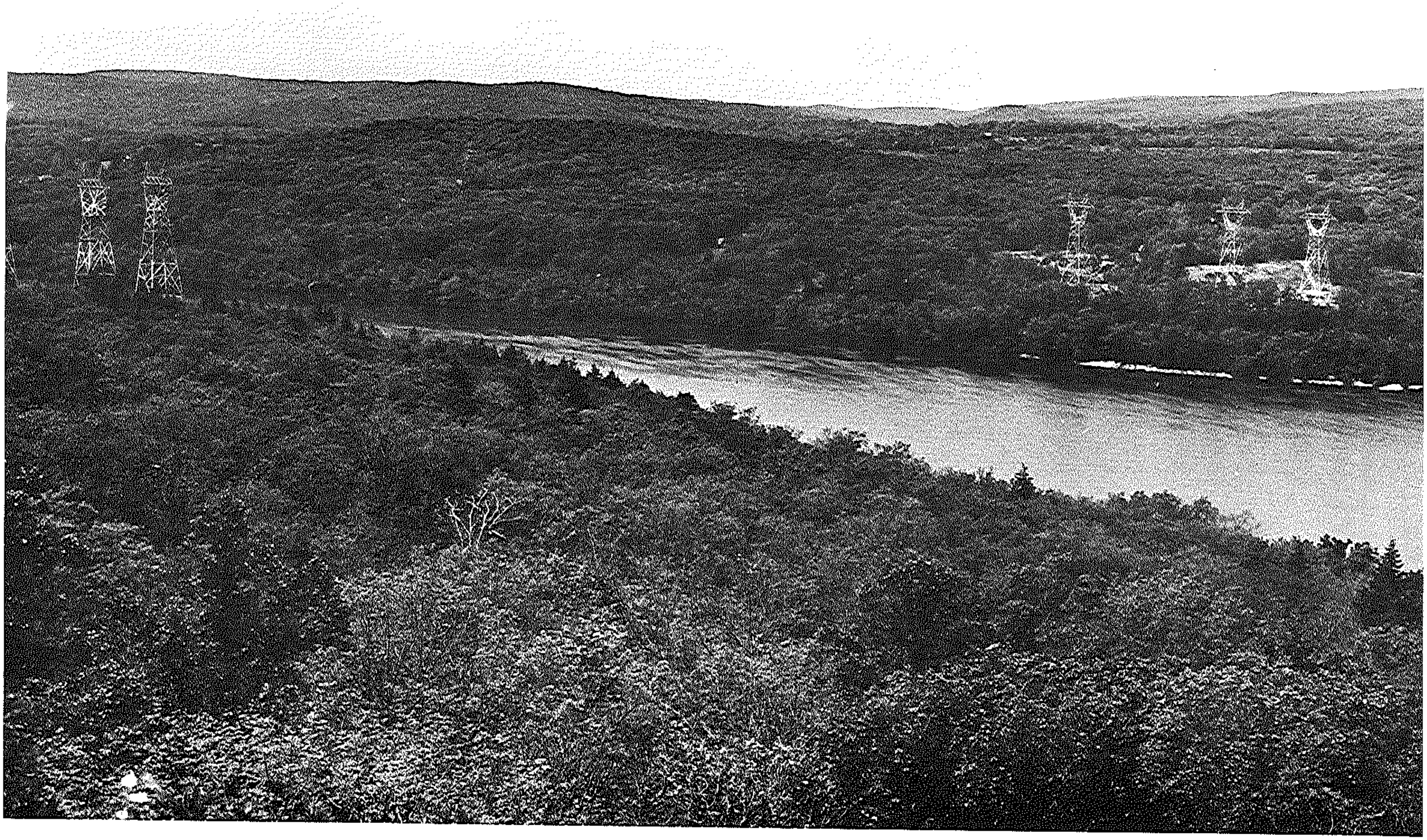


PHOTO 7. The Scovill Rock transmission crossing as seen from Split Rock, a walker's overlook in Hurd State Park.

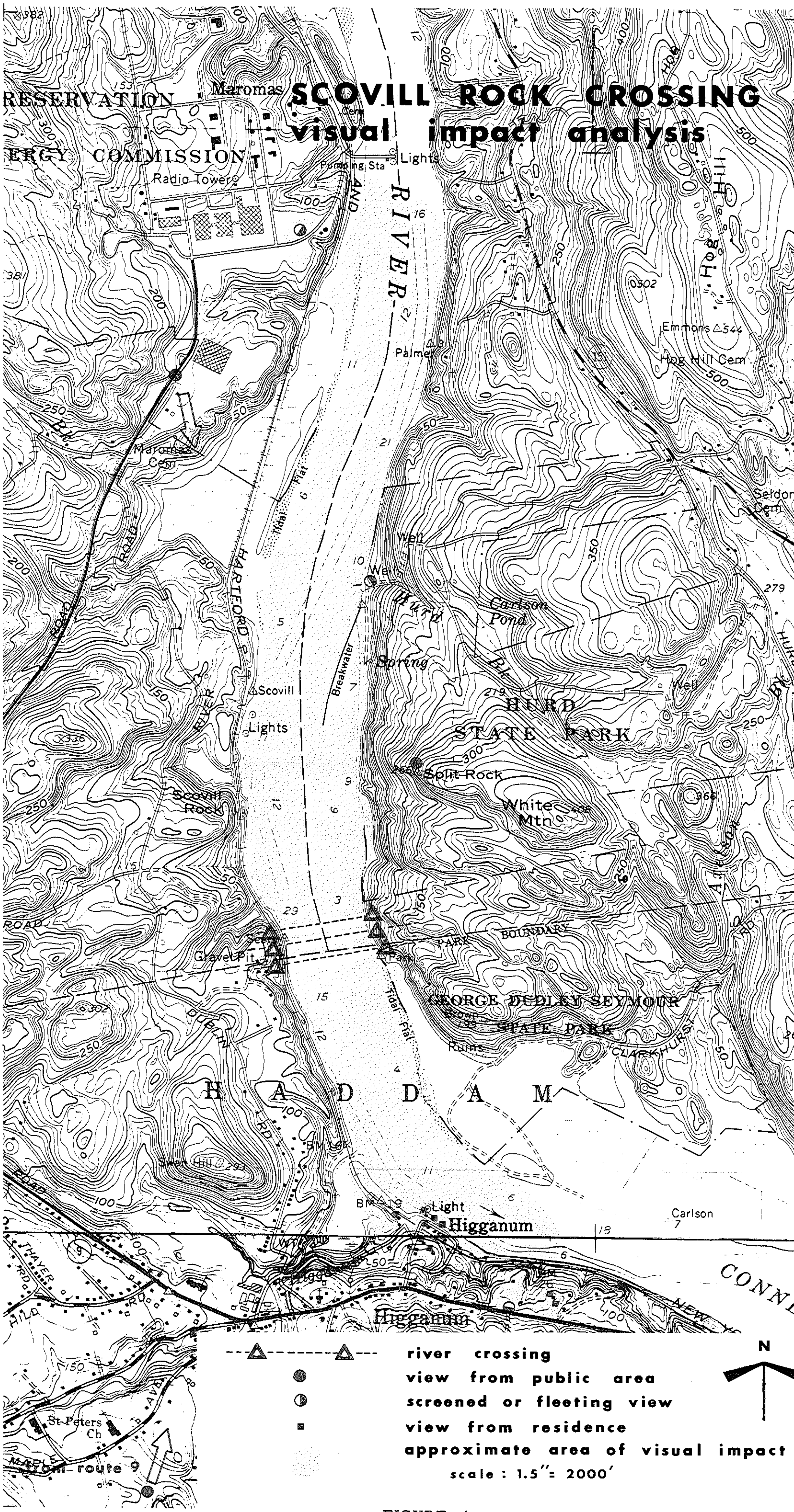

SCOVILL ROCK CROSSING
visual impact analysis
Maromas
RESERVATION
COMMISSION
Radio Tower
Pumping Sta
Lights
RIVER
Palmer
Maromas Cem
HARTFORD
ROAD
Scovill
Lights
Scovill Rock
Gravel Pit
DUBLIN
Swan Hill
HADDAM
Well
Hurd
Carlson Pond
Spring
Breakwater
Split Rock
White Mtn
HURD STATE PARK
PARK BOUNDARY
GEORGE DUDLEY SEYMOUR STATE PARK
Ruins
Tidal Flat
Emmons
Hog Hill Cem
Seldom Cem
Light
Higganum
Carlson
CONNE
St Peters Ch
THAYER RD
route 9
river crossing
view from public area
screened or fleeting view
view from residence
approximate area of visual impact
scale : 1.5" = 2000'
N

FIGURE 4

E. Bodkin Rock

The crossing location. The location of the Bodkin Rock crossing was chosen because at that point the banks were high and crossing structures could be kept comparatively low and could be placed back far enough to be well screened from most viewing points. A feldspar processing operation on the south bank gave (and still gives) an industrial appearance to the river at this point.

An alternative to this crossing would have involved adding a 345-kV circuit at Paper Rock. This would have caused a concentration of facilities that would have involved the construction of another river crossing tower on the north shore of the river which would be far more visible from a number of viewpoints than the existing crossing.

The present crossing. A single 345-kV transmission line crosses the Connecticut River at Bodkin Rock. The transmission structures on both sides are of the lattice-type construction about 100 feet tall. (Physical details of this crossing are shown in Figure 5.)

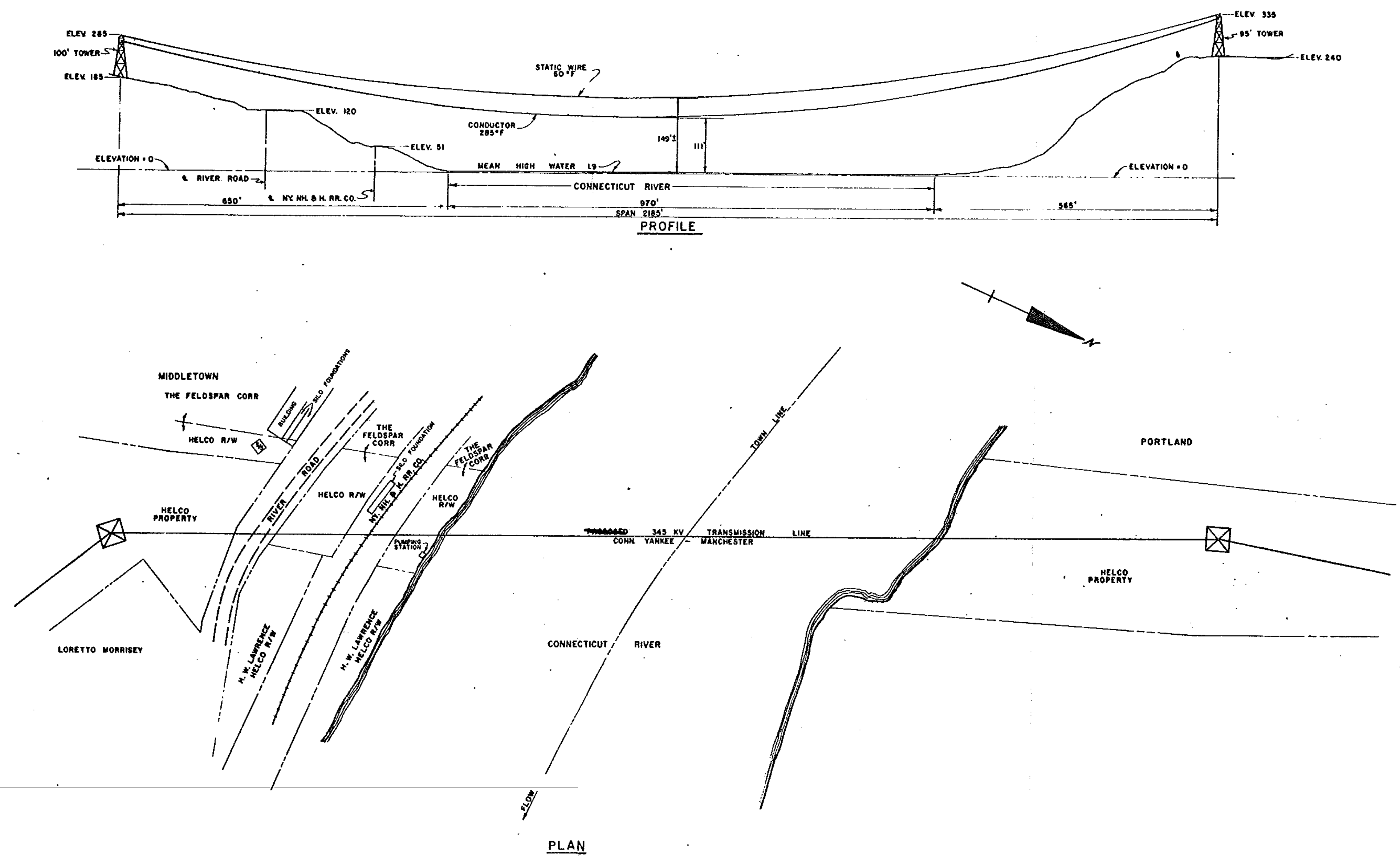
The tower on the north bank is set high above the river on a bluff and is screened at its base by vegetation. The south bank at the crossing is considerably marred by an extensive feldspar quarrying operation, spoil pile and processing plant, which along with Middletown generating plant, give an industrial appearance to this part of the river. The south tower is also well screened by vegetation.

Visibility. The Bodkin Rock north tower can be seen from no nearby public viewing points on land except from the road to the HELCO Middletown plant (Photo 8). It can be faintly seen from the Middletown-Portland Bridge nearly 3 miles away and for a few seconds for southbound drivers on Route 9 in Middletown (about 2.5 miles distant) and on Route 66 in Portland about 1.5 miles away, but it is barely distinguishable from either the bridge or Middletown. The south tower is adjacent to the feldspar plant and is only visible on land from the road next to the feldspar plant. From the river, one or both towers are visible for approximately 2 miles from boats heading east and west. Because of the height of Bodkin Rock and natural cover which was left largely undisturbed, the north tower has little visual impact on boaters, and the south tower is well screened from boaters in the vicinity by trees along the riverbank.

As at Scovill Rock, the visibility of the towers is increased by the orange and white aircraft warning paint on the towers. Again, the zone of visual impact can be seen most fully on a map (Figure 6).

Cost. The estimated capital cost of this crossing from bank-to-bank in 1966 was $55,000.

Evaluation. As the Bodkin Rock crossing can be seen from no residences and there are distant or screened views except from the public road used primarily for access to the feldspar plant and Middletown Station, its impact on landward points is negligible. From the water, the south tower is obscured by the feldspar plant, and the north tower is heavily screened and high on the bank. The crossing would thus seem to have a minimal visual impact on all who come near it.



THE HARTFORD ELECTRIC LIGHT CO.

[redacted] TOWER LINE CROSSING OVER THE CONNECTICUT RIVER

MIDDLETOWN – PORTLAND, CONN.

SCALE: 1" = 100' HORIZONTAL AND VERTICAL
ELEVATIONS REFERRED TO MEAN SEA LEVEL - (USC & GS DATUM)

BODKIN ROCK
CROSSING

Figure 5

PHOTO 8. The north tower of the Bodkin Park crossing. (The river runs west to east at this point).

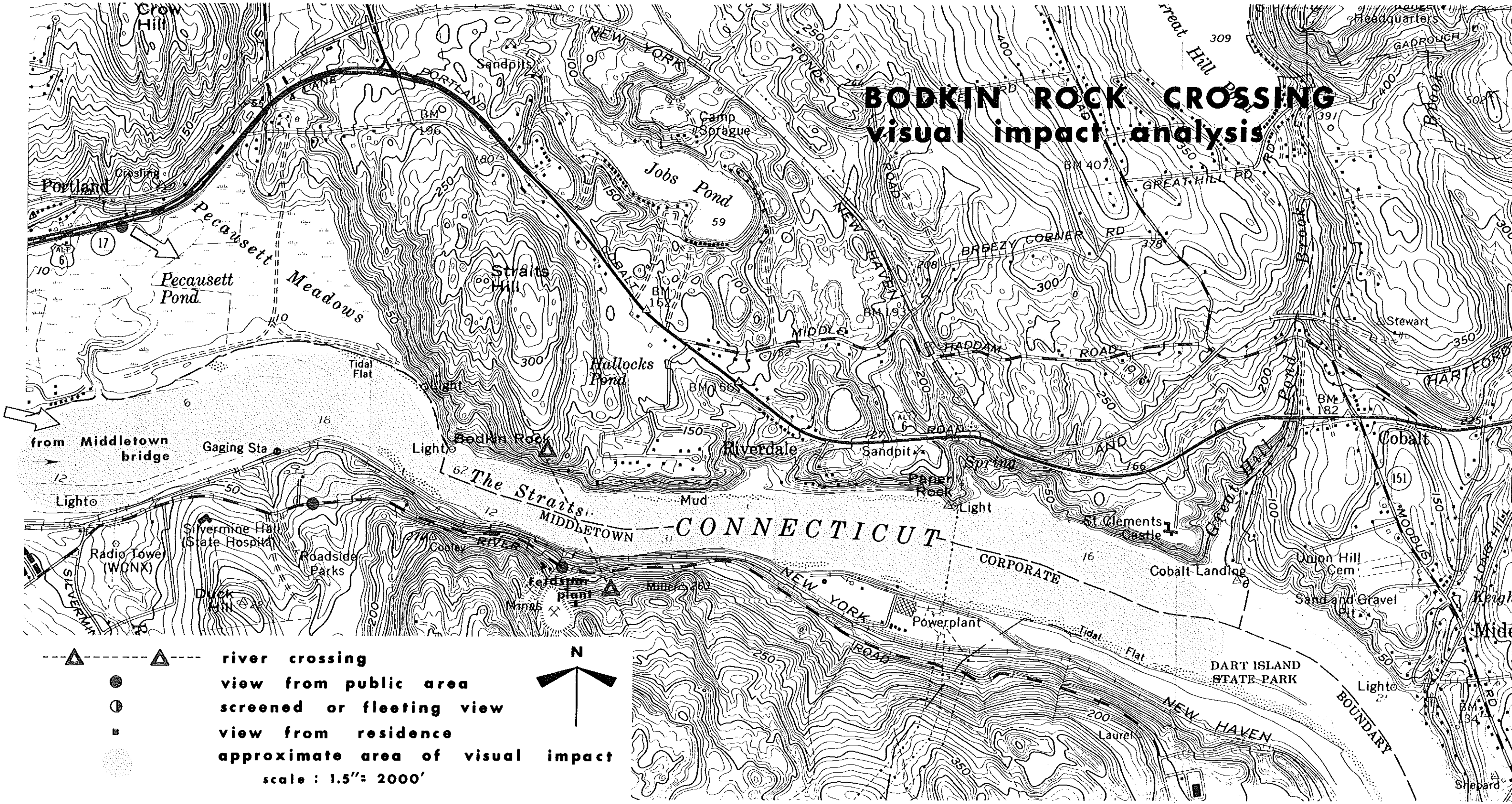

BODKIN ROCK CROSSING
visual impact analysis
river crossing
view from public area
screened or fleeting view
view from residence
approximate area of visual impact
scale : 1.5"= 2000'
N
from Middletown bridge
Portland
Crow Hill
Pecausett Pond
Pecausett Meadows
Straits Hill
Hallocks Pond
Jobs Pond
Camp Sprague
Sandpits
Tidal Flat
Light
Bodkin Rock
The Straits
Riverdale
Sandpit
Paper Rock
Spring
Gaging Sta
Silvermine Hall (State Hospital)
Radio Tower (WCNX)
Roadside Parks
Duck Hill
Cooley
Feldspar plant
Mines
CONNECTICUT
RIVER
MIDDLETOWN
CORPORATE
BOUNDARY
St Clements Castle
Cobalt Landing
Cobalt
Union Hill Cem
Sand and Gravel Pit
Powerplant
DART ISLAND STATE PARK
Laurel
Shepard
Stewart
Headquarters
NEW YORK
NEW HAVEN
PORTLAND
COBALT
MIDDLE HADDAM ROAD
BREEZY CORNER RD
GREAT HILL RD
HARTFORD
MOODUS
Great Hill Pond
Brook

FIGURE 6

The visibility of the north tower could be even further reduced by repainting it a neutral shade, as suggested for the Scovill Rock crossing. The Company proposes to do this in the near future.

V. IMPACT OF THE OVERHEAD CROSSINGS ON SOILS AND VEGETATION

During the construction of the Scovill and Bodkin Rock crossings in 1967 it was necessary to clear trees and some low-growing vegetation along the right-of-way and to provide access routes for equipment. It was also necessary to excavate for the footings for each of the structures. Since that time, the only disturbance of the soils and vegetation has been connected with right-of-way maintenance: tree suckers are cleared periodically, but low-growing vegetation such as laurel, dogwood, sumac and berry bushes is retained.

The construction of the proposed lattice-type towers for the Haddam crossing would involve the clearing of an area adjacent to the bases of the present structures for foundations for new structures. There would also be a minimal amount of clearing, including some trees, in order to allow access of construction equipment.

Apart from the above, the overhead crossings have negligible impact on soils and vegetation.

VI. IMPACT OF THE OVERHEAD CROSSINGS ON LAND VALUES

It is occasionally alleged that the presence of transmission lines causes land values in the vicinity to deteriorate and opponents of the Scovill Rock crossing at the WRC hearing in 1966 argued that its construction would lower the value of adjacent land by 50 percent. Company studies of the Higganum, Haddam and East Haddam areas indicate, however, that land values have increased considerably in the years since 1966, including the value of parcels within sight of the transmission lines.

Although there can be no definitive agreement as to aesthetic matters, particularly those concerning transmission line crossings, one indicator that has some bearing is the value of nearby land, which in a scenic and sparsely populated area like the lower Connecticut Valley has a considerable relationship to the aesthetic quality of the landscape. There is a clear indication that the price of this land has risen in recent years, despite the transmission line crossings, which suggests the continued attractiveness of the area.

VII. ALTERNATIVES: RELOCATION OF THE CROSSINGS

During the course of its recent review of the overhead crossings on the river in the Haddam-Middletown area, the Company examined numerous alternatives. These included: (1) relocating the crossings, (2) placing them underground by either a trenching or tunneling method, and (3) replacing the present structures with those of a different design. Each of these alternatives involves additional economic costs--in the case of relocation and underground alternatives running into several millions of dollars--and each of them involves environmental penalties as well as benefits.

It will be remembered that the 1966 WRC permit had a condition which provided that the 345-kV circuits at Scovill and Bodkin Rock "shall be removed and placed underwater at the present location or constructed at some other alternative location within five years from the date of issuance of this certificate ..." Therefore, in its present study the Company examined the feasibility of relocating the Scovill and Bodkin crossings and the costs and environmental impacts involved with such alternatives.

As noted earlier, in theory there are numerous alternatives to the Scovill and Bodkin Rock crossings that would involve the development of new rights-of-way in other parts of the state and would cross the Connecticut River at other locations. The Company examined a number of these alternatives and concluded that they would involve unreasonable costs and would create new adverse environmental impacts on a large scale. Therefore, only those alternatives that appear feasible, given the topography of the land and the concentration of developed areas in the Middletown-Haddam area, are discussed here.

A. Haddam

The principal justification for the proposed 345-kV circuit on rebuilt structures at Haddam is, as discussed earlier, to provide an added link between generating sources at Millstone Point and the principal loads in the central and western portions of the state.

The Company did consider an alternative routing for the new 345-kV line which would take it north across the Salmon River and cross the Connecticut River at Scovill Rock (with the existing two 345-kV circuits and 115-kV circuit), and then go southward to join the existing east-west right-of-way in Haddam along a completely new right-of-way through that town. Because this alternative would involve three major east-west 345-kV circuits on one right-of-way for several miles and at one river crossing point this alternative was unacceptable from the reliability of service point of view. An outage to all three circuits on that crossing would mean serious disruption of east-west service, which could mean major load shedding in Connecticut. It is just such a contingency that the Company is trying to avoid by planning for an additional 345-kV circuit on a separate right-of-way.

An additional circuit at Scovill Rock would also increase the visibility of that crossing and would be less desirable on aesthetic grounds than the alteration to the Haddam crossing.

Therefore, the Company concluded that the Haddam crossing was preferable on economic, reliability or environmental grounds.

B. Scovill Rock

Inspection in the field or reference to a topographic map will show that it is difficult to find a route for a 345-kV north-south transmission line on the east side of the river north of Haddam Neck that would join the right-of-way to Manchester at Paper Rock Junction. There are no unusual technical problems in construction, but there are numerous difficulties involved in selecting a right-of-way which would avoid both ridgetops and settled areas. In theory, it would be possible to build a line further to the east of Great Hill in East Hampton ~~Haddam~~ and join the north-south transmission line from Scovill Rock to Manchester in Glastonbury, but this route would pass through many acres of the Meshomasic State Forest. Placing this on a high ridge back of the summit of Great Hill would thus make it highly visible.

The most practical route--but one which does not avoid built-up areas--for the relocation of the two 345-kV circuits at this crossing would be to remove one circuit to the proposed rebuilt overhead crossing at Haddam, and the other to a new right-of-way, beginning at Haddam Neck Road, extending north through Pine Brook Valley in East Hampton, crossing Routes 16 and 66 to join the abandoned Airline Railroad right-of-way through Cobalt and continuing on this westward into Portland through to the point where the 115-kV line from the Middletown Station joins the railroad right-of-way. The line would then cross the river southward at the present Paper Rock crossing and be tied to the Scovill Rock Substation. (This line is called the Haddam Neck Road-Cobalt-Paper Rock Junction-Middletown Station line. Figure 7 shows this relocation alternative and its probable visual impact.)

The 115-kV circuits, one crossing at Scovill Rock and the other at Haddam, are essential to provide station service for Connecticut Yankee and an alternate supply to the Haddam Substation and they would have to be maintained on separate rights-of-way. In this case, the 115-kV circuit at Haddam which is to be strung on the proposed rebuilt structure in conjunction with the proposed single-circuit 345-kV crossing, would be forced underground unless a higher and more complex structure were to be built.

The existing 115-kV crossing at Scovill Rock would be placed as a second circuit on the line that would carry the 345-kV circuit on the Haddam Neck Road-Cobalt-Paper Rock Junction-Middletown Station line.

Eliminating the 115-kV circuit at Scovill Rock would also require a replacement circuit of 115-kV to maintain the two 115-kV circuits that are necessary to provide reliable energy to the United Aircraft CANEL plant. This circuit would require a new line from the Middletown Station overland to CANEL.

Total relocation of the lines at the Scovill Rock crossing thus requires a new river crossing at Paper Rock (one 115-kV circuit and one 345-kV circuit), a 115-kV underground crossing at Haddam, and a new 345-kV crossing of the Salmon River.*

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*This is what would be required to relocate the Scovill Rock crossing in 1972. In 1966 it might have been possible to eliminate both the Scovill and Bodkin Rock crossings this way, because at that time the 345-kV circuit that passes over the river at Scovill and then northward to cross the river again at Bodkin heading towards Manchester was primarily used as a north-south circuit. But, as has been noted, this relocation alternative was not explored then because it would have required the acquisition of a completely new right-of-way through well-developed portions of Cobalt, on the east side of the river.

System needs and the capacity on the lines have changed since 1966: the circuit over Bodkin Rock must now be used for both north-south and east-west service, and a new 345-kV circuit is required at Haddam to serve the Millstone No. 2 plant.

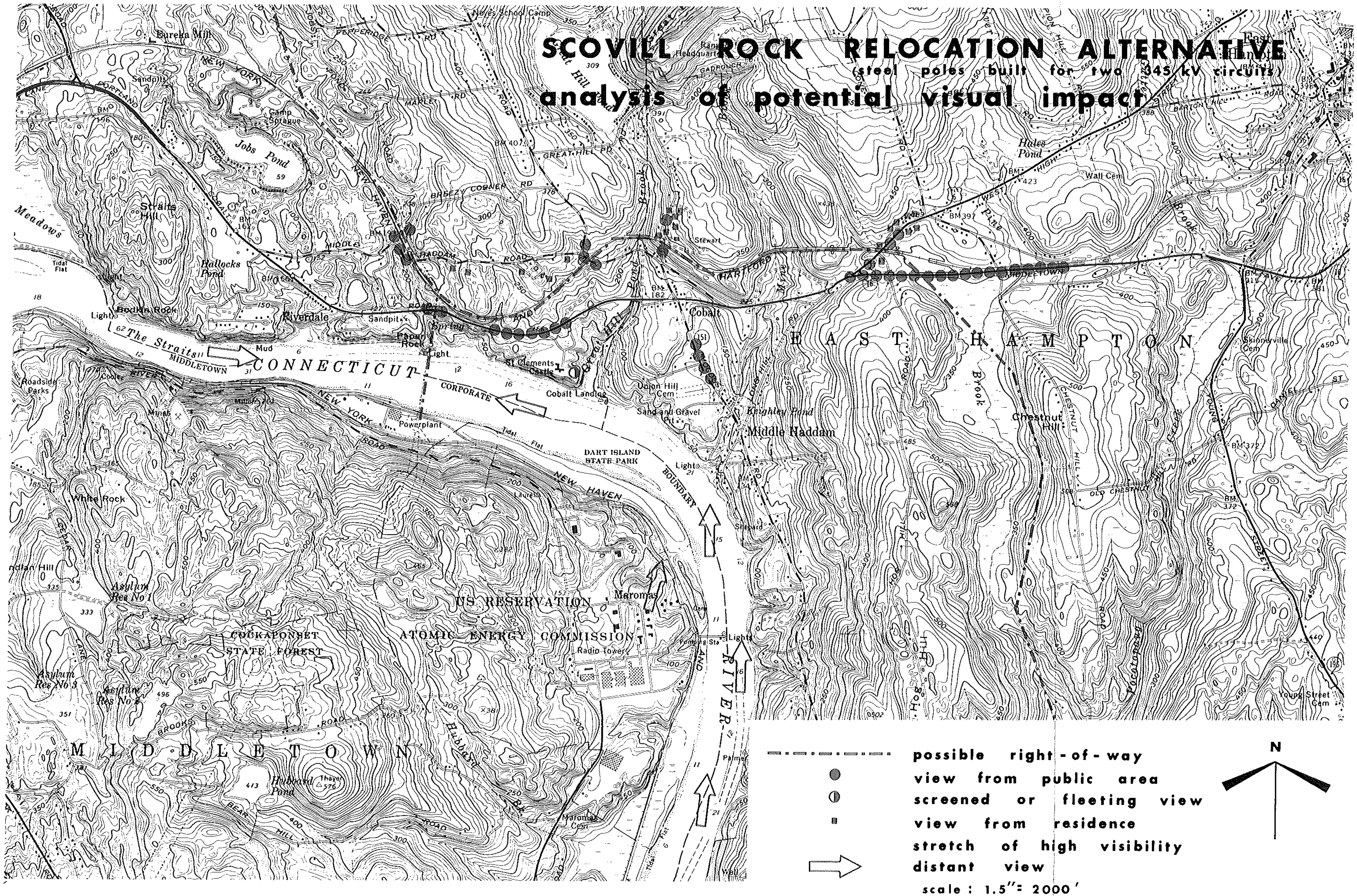
SCOVILL ROCK RELOCATION ALTERNATIVE
(steel poles built for two 345 kV circuits)
analysis of potential visual impact
possible right-of-way
view from public area
screened or fleeting view
view from residence
stretch of high visibility
distant view
scale : 1.5"= 2000'
N
CONNECTICUT
RIVER
EAST HAMPTON
MIDDLETOWN
US RESERVATION
ATOMIC ENERGY COMMISSION
COCKAPONSET STATE FOREST
DART ISLAND STATE PARK
Middle Haddam
Cobalt
Riverdale
Maromas

FIGURE 7

<u>Construction</u>. This alternative would involve the following construction:

1. Build a Haddam Neck Road-Cobalt-Paper Rock Junction-Middletown Station-Scovill Rock 345-kV line (10.25 miles) nearly all on new or widened right-of-way.

2. Build the Haddam Neck Substation-East Haddam Junction-Oxbow Junction 345-kV line (12.4 miles) on existing, widened right-of-way.

3. Construct a 115-kV circuit from Haddam Neck Road to CANEL (about 8.4 miles).

4. Underground the Haddam-East Haddam 115-kV line (approximately 1 mile).

The construction outlined in items 1 and 3 above would provide one 345-kV circuit from Scovill Rock Substation to Haddam Neck Substation via Cobalt and one 115-kV circuit (nearly all built for eventual 345-kV operation) from CANEL to Connecticut Yankee also via Cobalt. Scovill Rock Substation would be recommended as the terminus of the 345-kV line on the basis of economics. If an alternate location, Middletown Station, were chosen, 345-kV switching would have to be installed. The cost for the latter would run to about $4,200,000 compared to just over $300,000 to extend the line south to Scovill Rock Substation. For similar reasons, the 115-kV line would terminate at CANEL.

It would not be necessary to build new lines from Haddam Neck Road south to the Haddam Neck Substation since the existing facilities could be employed.

Construction of a second 345-kV circuit between Haddam and Oxbow Junction (Item 2) would require widening of the existing occupied right-of-way to about 300 feet, 100 feet more than is now owned in most cases. For nearly half of the distance, the line passes through the Cockaponsett State Forest. Constructing a 345-kV circuit from Haddam Neck Substation to East Haddam Junction (Item 2 also) also involves another crossing of the Salmon River.

Undergrounding the 115-kV lines crossing the Connecticut River at Haddam (Item 4) would be done by trenching. This line is required to provide reliable station service for the Connecticut Yankee plant and an alternate supply to the Haddam Substation. If it cannot cross the river overhead, it must be placed underground. No other alternate appears feasible. Building the second 345-kV circuit across the river at Haddam preempts the river crossing structure from use by the 115 kV and so forces it to be placed underground.

<u>Environmental Impact</u>: The removal of the Scovill Rock towers and anchor structures could be accomplished with a minimum of disturbance and this would eliminate any visual impact of transmission structures on viewers from the river.

The impact of the separate construction projects involved would be as follows:

1. The Haddam Neck Road-Cobalt-Paper Rock-Middletown lines could affect two wetlands in the Pine Brook area of East Hampton south of Route 16, but the impact would be mitigated by careful siting and construction. The other portions of the line that go through woodland would have a minor impact.

   The visual impact of the line would be generally minor between Haddam Neck Road and Route 16, and it could not be seen from any significant public viewing points.

A significant visual impact would occur as the line crosses Route 16 and Route 66 where it joins the abandoned railroad right-of-way and along the railroad right-of-way from a point one-quarter of a mile from Route 66 to the junction with the Paper Rock line. When the sides of the railroad embankment are cleared, the resulting naked ridge and structures would be visible to observers from Route 66 and from the river. Widening and straightening of the railroad right-of-way might also be necessary with possible impact on residences between Cobalt and Paper Rock.

The two circuits would require new towers at Paper Rock and at the Middletown Plant and would add to the present industrial appearance of that area.

Construction of the line from Middletown Station south about 3.4 miles to Scovill Rock Substation would parallel existing facilities. It would require some additional right-of-way and clearing. The only portions of the line which would be visible would be where it ascends the hill behind Middletown Station and at the crossing of the CANEL access road.

2. The widening of the right-of-way from Haddam Substation westward to Oxbow Junction would require clearance of land in Cockaponsett State Forest. This is not extensively visible except at the junction of Route 9 and Route 81. Between Haddam Neck Substation and East Haddam Junction the line would also require a new crossing of the Salmon River.

3. There is no significant adverse effect from constructing the 115-kV line from Middletown Station to CANEL. Except where it climbs the hill behind the Middletown Station it would not be visible from roads or from the river.

4. The trenching of the 115-kV line would cause some disturbance of soils and rocks and the river bottom. At Haddam, the trenching would generally follow on the existing right-of-way (assuming underground rights can be obtained) and would require clearing areas which are now undisturbed to a width of about 50 feet. The severe grade change on the east bank of the river would cause considerable cut and fill work to be necessary.

<u>Estimated Cost:</u>

1	New widened right-of-way (240 acres approximately)	$ 750,000
2	Build Haddam Neck Road-Cobalt-Paper Rock Junction-Middletown-Scovill Rock 345-kV line	2,400,000
3	Build Haddam Neck Substation-East Haddam Junction-Oxbow Junction 345-kV line	1,000,000
4	Construct 115-kV circuit Haddam Neck Road-Cobalt-Paper Rock Junction-Middletown-CANEL	400,000
5	Underground Haddam-East Haddam 115-kV line	1,150,000
		$5,700,000

Not included in the above figures is the value of the 115-kV and 345-kV facilities which would be abandoned. In aggregate this amounts to about 10 miles of line with a depreciated value of about $1,300,000.

The total cost of relocating the Scovill Rock crossing is, therefore, an estimated $7,000,000.

C. Bodkin Rock

It would be possible to relocate this 345-kV circuit to cross overhead at Paper Rock near the Middletown Station. This would require the building of new structures at Paper Rock, expanding the right-of-way from Paper Rock Junction to Ames Junction (about 1.5 miles north, in Portland), and abandoning about 3 miles of existing 345-kV facilities and rights-of-way from the base of the hill just south of Middletown Station to Bodkin Rock and to Ames Junction.

Environmental Impact: The environmental effect would be to eliminate two towers having low visibility from the river at Bodkin Rock. However, the appearance of the south bank of the river would not be significantly improved because the feldspar plant presently dominates the landscape at that point. The addition of a 345-kV circuit at Middletown Station (and perhaps two if the Scovill Rock 345-kV circuit were relocated there) would add to the visual clutter at that point on the river.

Cost: The cost of relocation would be an estimated $860,000, which includes the cost of removal (but not writing off the present investment in the Bodkin Rock crossing) and of reconstructing the crossing at Paper Rock to accommodate a 345-kV circuit.

VIII. ALTERNATIVES: UNDERGROUND INSTALLATION

In 1966, opponents of the Company's plans to build the Scovill Rock and Bodkin Rock 345-kV crossings (the 115-kV crossing was already in place at Scovill Rock) urged that these crossings be placed underground. This opposition was reflected in the final WRC order, that the Company relocate the structures elsewhere or place them underground and underwater.

In 1972, the Company thoroughly examined the underground alternatives at the two above crossings and at Haddam in light of currently available technology and present-day costs.

A. The State of the Art

In the years since 1966 there have been major advances in the state of the art of providing underground facilities for certain parts of the electrical system. The most dramatic advance has been a reduction in the relative cost of placing distribution systems underground. These are the systems which serve the individual homeowner, and some commercial and industrial buildings. The cost of placing them underground is now roughly twice as much for underground as for overhead (apart from special excavation problems). Both HELCO and CL&P now have policies which encourage developers and builders to place new electrical distribution systems in developments underground.

However, cost multiples rise rapidly with the voltage rating of line. The Northeast Utilities system includes transmission consisting of 69 kV, 115 kV and 345 kV. It is technically possible to place lines at all these voltages underground, but only at rapidly increasing costs and difficulties of construction and maintenance.

One of the major problems involved with placing EHV lines (EHV--extra-high voltage) underground is that of dissipating the heat created by energy flowing in the insulated conductors. With overhead construction this heat is released from the conductors directly to the air; with underground it is contained by the insulation system and therefore auxiliary cooling is required to attain capacities equivalent to overhead lines. An additional problem is caused by "charging current" accentuated by underground installation, which causes some energy loss, and, especially over distances of more than about 10 miles, a significant reduction in current carrying capacity. For this reason, underground lines at higher voltages have reactor stations placed at a specified number of miles along the route to offset the effects of this charging current. These reactor stations resemble substations of a similar voltage.

Lines at 138 kV and below can be manufactured in self-contained cable form. That is, the conductors are encased in insulation and "armor" at the factory, and the cables can be buried directly without a pipe. The 138-kV line which connects the Northeast Utilities system to that of the Long Island Lighting Company underwater from Norwalk to Northport, Long Island, is 12 miles long. It was prepared at the factory in one piece and laid on the bottom of the Sound with special cable-laying barges and equipment. It was necessary to provide the longest possible unspliced length for this crossing because a splice is a point of weakness in any underground installation. Seven separate cables were laid, each about 900 feet apart. In depths of up to 35 feet, they were laid in a trench, but directly onto the bottom of the Sound at greater depths. This was a pioneering effort, because there was no feasible alternative but to go underwater and underground in a trench near shore. It is thus difficult to make a direct comparison to a situation on land.

There are 22.0 miles of underground 115-kV circuits on the Northeast Utilities system, all in urban areas, primarily Stamford, Norwalk and Springfield. There are also numerous underground circuits at subtransmission voltages, below 69 kV, in both Massachusetts and Connecticut.

Underground transmission. Transmission line cable for underground installation at 345 kV and 115 kV in the United States is normally laid in pipes, and is called pipe-type cable. The conductors are wrapped in oil-impregnated paper in numerous layers to provide adequate electrical insulation, and, for physical protection, contained in rigid and impervious pipe. The pipe is then filled usually with oil or sometimes inert gas such as nitrogen and pressurized. The large amount of heat generated by this system is dissipated by the oil or gas to its surroundings, usually the earth. The lengths of the cable are determined in part by the nature of the installation, but also by the ability of the length to be manufactured and shipped. Every installation must be designed separately--there is no such thing as "off the shelf" pipe-type cable, as there is for cable used at distribution levels. Further, only a few cable companies have the costly facilities to manufacture such specialized cable. As a result, there is now about a one-year period between order and delivery for underground cable.

Each pipe in such an installation contains three cables, one for each of the three electrical phases. Two pipes containing three cables each are usually required to obtain equivalent capacity underground for each circuit of overhead installation.

Because the lengths are limited, it is usually necessary to provide for splices at intervals of about one-half mile or less in the course of an underground installation. At the Haddam river crossings, for example, three sections of cable would have to be used, each involving a splice. These splices take several days for skilled workers to perform and must be done in completely dry, dust-free surroundings--which require an air-conditioned chamber. Each splice requires access by a manhole for maintenance after installation is completed.

At the terminals of underground high-voltage lines potheads with associated switching equipment are required to connect the lines to an overhead system. These together take up about the same space as a substation of the same voltage, and have a similar appearance.

Forced-oil cooling designs have been improved since 1966. By providing a pumping station with necessary accessories at either terminal, oil can be continually circulated through heat exchangers to more rapidly dissipate the heat. The advantage is that the cable can thus carry more energy than it would with the system under static pressure. It is the pipe-type cable technology with forced-oil cooling that the Company has examined in detail for the underground cable discussed in this paper.

Reliability: As is generally known, the Consolidated Edison system in New York City has installed 345-kV underground systems for nearly 10 years in Manhattan, the Bronx, Brooklyn, and Queens. There is also a 345-kV underwater crossing in a dry walk-through tunnel between Staten Island and Brooklyn in the Narrows, which was too long to be readily spanned by overhead, and Con Edison proposes to build crossings under the Hudson from its proposed Storm King pumped-storage project in Cornwall, if and when that project is allowed to proceed. Several other systems in the country have or are planning underground 345-kV installations, almost entirely in the built-up urban areas, or across bodies of water where the span is so great that towers to support them would be of considerable height and expense.

The Northeast Utilities system has 345-kV pipe-type cable installed at its Northfield Mountain pumped-storage plant in Massachusetts. There the pipe containing the cable is installed against the wall of the access tunnel and connects the turbines in a chamber excavated in the mountain to a switchyard on the surface.

The experience of underground 345-kV pipe-type cable has been excellent on the Con Edison system: no outages have been attributed to cable failures. However, in underground systems there and elsewhere problems occasionally develop in the splices. If these must be repaired it takes several days or even weeks because of the need for careful and painstaking handling of the splice in completely controlled atmospheric conditions.

Environmental Impacts: The cost and environmental damage done by the installation of underground cable depends on the condition of the soils, the nature and extent of the rock and the contour of the land. In all cases, a right-of-way must be completely cleared of vegetation for a width of at least 20 feet on each side of the installation. Each cable must be at least three feet from another. For underground systems in general, a trench must be dug to the depth of five feet. Rock must be blasted and considerable cut and fill is involved if the contour of the land requires it--as it almost invariably does in New England. A characteristic of pipe-type cable is that it must be pulled through pipes between manholes where it is spliced. In order to maintain long lengths (thus keeping splices at a minimum), it is necessary to maintain a smooth contour of the pipe with as few bends as possible. Deep cutting and extensive fill is needed to accomplish this over terrain with sharp relief. Thus, it is unlike a gas pipeline which generally is constructed to conform to the contours of the land. The trench must be back-filled to about three feet with thermal sand (special sand with high heat conductivity) to improve heat dissipation.

Photos 9 and 10 show the installation of a 138-kV underground cable in Long Island. These indicate the need for cut and fill and for a right-of-way which resembles an unpaved road. Whereas installation on Long Island is aided by the presence of sand and gravel of glacial origin at almost all points below the surface, in Connecticut there would be in most cases problems with bedrock and frequent changes in grade.

After construction, the right-of-way over an underground installation must be kept completely free of all woody plants. This is in part to ensure access for vehicles and in part to keep the soil from being dried out by the roots of trees and shrubs which might reduce the heat dissipating capability of the system. Photo 11 shows the Long Island underground line 6 years after installation.

The environmental impact of placing transmission lines underground must be judged in each case. In some cases a hoped-for visual improvement through the elimination of overhead structures will not occur because of the need to maintain an unnatural cleared swath through the landscape. In other cases, particularly in built-up areas where the addition of further overhead facilities would be visually oppressive, the installation of an underground line may constitute a considerable visual improvement. However, in all areas where natural values are important, overhead is probably less detrimental to the natural environment, providing that good maintenance practices are observed. The selective clearing of a right-of-way for overhead construction in many cases encourages the growth of berry-bearing shrubs and small trees like dogwood which attract certain animal and bird species. The "edge" effect of a transmission line which serves to attract game species has been well established. In certain cases, particularly in areas which are forested, the clearing of the right-of-way also encourages botanical variety. Finally, if due care is taken during construction and maintenance, overhead lines have a minimal or negligible impact on small watercourses and wetlands.

The Northeast Utilities system has recently issued improved right-of-way construction and maintenance specifications to minimize the effect of these activities on soils, vegetation and drainage. In addition, management procedures have been instituted to see that these specifications are in fact carried out in the field.

Costs. The costs of EHV undergrounding vary with the type of terrain, the costs of construction and the design specifications for both overhead and underground. Generally, the ratios for 115-kV underground versus overhead are in the range of 5 or 10 to 1 and the ratios for 345 kV are in the range of 15 or 30 to 1.

B. New Technology

A variety of efforts are being made to develop new technologies for the underground installation of transmission cables. Northeast Utilities is spearheading one such research and development project in connection with compressed gas

PHOTO 9. Preparation of the right-of-way for the underground installation of 138-kV cable on Long Island.

PHOTO 10. Completed right-of-way for 138-kV undergound cable on Long Island.

PHOTO 11. Right-of-way for 138-kV underground cable installation six years after construction.

insulated cables (CGI) and has made a commitment to invest a total of $821,400 in this project up to the end of 1972.

In the opinion of the Company's engineers who are in closest touch with the problem, none of the current research efforts will serve to reduce the cost of underground EHV transmission by as much as a single order of magnitude. There may be some reduction in cost relative to overhead construction, primarily because some new technologies (like CGI and the more remote cryogenically cooled transmission) will permit underground cables to carry much larger capacity than is possible with today's technology. These new technologies may also make it possible to carry current underground at higher voltages than the 345 kV which is the practical limit today. This is particularly important when many larger systems in the United States are beginning to install transmission circuits with voltage capacities from 500 to 765 kV.

Most of these new technologies are important for special applications. The successful development of CGI cable, for example, will make it more feasible to bring energy underwater from offshore generating plants and thus make possible a whole new range of siting possibilities. This could be done only with the greatest difficulty using present technology.

Although these new technologies may improve certain aspects of underground installations (i.e.; greater capacity, higher voltages, special applications), it seems likely that the cost in relation to overhead in most situations will remain as high as it is today. Although there may be improvements in installation, particularly in relation to splicing, the environmental objections to underground transmission installations on the basis of disturbance to soils, watercourses and wetlands will continue to be true.

On the basis of presently available information, this situation will continue for the foreseeable future and possibly until the end of the century. It may be that considerable changes will be in store after 2000. It could be, for example, that changes in the nature and methods of generation and transmission might then be possible and that a gaseous fuel, possibly hydrogen, could be transmitted by pipeline to decentralized generating sources, thus doing away altogether with higher voltage overhead transmission lines. Other changes may make it possible, as Brenda Colvin observed in the book cited before, that the overhead transmission lines of today will become "curios of the past like the telegraph poles of yesterday." It is important, however, to realize that it will take at least a generation and perhaps more to realize this under any feasible program of technological development and construction.

C. Underground Alternatives at the Haddam and Scovill Rock Crossings

The Company has examined two methods of placing these crossings underground.

The first is by the trenching method, which involves excavating a trench in which to lay the pipe-type cable along the river bottom and up each of the banks.

The second is by tunneling beneath the river from points on each bank, involving no disturbance of the riverbed or of the banks immediately adjacent to the river.

In both cases, extensive terminal facilities would be required. Such facilities would need access roads, would cover two to three acres and would contain oil-pumping equipment for the cable, potheads and facilities to connect the conductors to overhead structures. The following examination assumes that the length of the trench would be such that no terminal facilities would be visible from the river.

D. Haddam

1. Trenching

To place the proposed 345-kV and 115-kV circuits at Haddam underground, a single trench would be provided for four pipes (two 345 kV, one 115 kV, one spare) on the river bottom and upon the banks with a total length of 4,950 feet. The trench would be about 15 feet wide and a minimum of 5 feet deep. The trenches on the banks would be on steep slopes, an abrupt climb to approximately 65 feet in altitude on the west bank, and a longer climb to approximately 300 feet on the east bank. To limit the grades it would be necessary either to extensively cut and fill the riverbanks or to provide acceptable grades by deeper than normal trenching at certain locations.

In the river, no unusual construction problems are anticipated in the shallow water from the west shore to a point where the channel begins near the east bank. Crossing beneath the channel is more complex. First, the pipes must be placed 10-15 feet below the channel bottom (which varies in depth up to about 35 feet) to minimize any possible damage due to dredging or a marine accident. Second, the east bank rises very sharply from the 30± foot deep channel to about 15 feet above the water. Portions of this bank are evidently mostly ledge. The abrupt grade change on both banks and their composition would thus require more costly construction and considerable disturbance in excavating. The topography on the east side of the river is very irregular with numerous outcroppings of ledge. Construction of a trench under these conditions would inevitably leave a considerable scar.

As an alternate to trenching on the east side of the river up to the point where the line could no longer be seen from the river, it would be possible to excavate a tunnel from just east of Route 149 to a point beyond the ridge east of Creek Row Road and to install the pipes and cables in the tunnel.

The type of equipment to be utilized in the trenching would be: treaded equipment (bulldozers), welding trucks, barge-mounted crane, cable trailers, splicing trailers, dump trucks, crane trucks, delivery trucks of various sizes.

The entire job would take about one year and the river channel would be closed for short periods of time over about two weeks.

<u>Cost</u>. Undergrounding using trenching method alone:	$4,000,000
Undergrounding using trenching method under the river and tunneling on east bank	$4,175,000

It must be emphasized that the estimated cost of tunneling is made without detailed knowledge of actual subsurface conditions on the route. If adverse conditions exist, the cost would be significantly higher.

Easements. The Company presently has limited rights in its easements approaching the river crossing and underground facilities are only permitted in a few more recently acquired easements. Therefore, additional easement rights would have to be obtained before the undergrounding alternatives could be effected. The cost of these new easement rights is estimated to be about $50,000, and they may be difficult to obtain. Condemnation might be necessary.

Environmental Impact. Trenching would cause soils disturbance on the west bank, involve disturbance of the river sediment, and on the east bank involve blasting of rock as well as soils displacement. On the east bank it would also involve extensive clearing of vegetation along about a 60-foot right-of-way to the top of the ridge over the river. Such damage could, however, be minimized by the tunneling technique over the east ridge.

The environmental effects would also include the use of nonrenewable resources in construction, construction noise and disturbance, and spoil disposal. The amount of materials and fuels consumed in construction would be considerable.

After installation, a right-of-way free of trees would have to be maintained over the underground line. The potheads and oil-pumping station for the terminals on the line on the west bank could be placed at the existing Haddam Substation. A new terminal facility would be constructed beyond the east ridge at a point where it would not be visible from the river, but would be visible from neighboring residences.

The visual impact of the line placed underground by the trenching method would be confined to viewers on the river and to those in the immediate vicinity of the line. The maintenance of a cleared swath at the river's edge because of the need for access to the right-of-way and to prevent drying out of the earth, would make a sharp contrast to the tree-covered banks at present. With the tunneling of the east ridge the underground installation would only be visible where the transition from trench to tunnel would take place near Route 149.

2. Tunneling

A tunnel could possibly be constructed from the Haddam Substation easterly under the river to a point east of the ridge on the opposite side of the river, a total distance of approximately 5000 feet. The principal difference between tunneling and trenching lies in the method and impact of construction. The terminal facilities would be essentially identical.

For purposes of cost estimating, the following assumptions were made: the work would consist of a 125-foot deep shaft at Haddam Substation and a 280-foot deep shaft at the east terminus, both about 14 feet in diameter. From the bottom of these shafts, a tunnel about 9 feet high and 10 feet wide would cross beneath the river at a depth of about 170 feet below mean water, hopefully well down into solid rock. The cables would be placed in pipes mounted on the tunnel walls. Oil would be circulated through the pipes and air circulated in the tunnel to dissipate heat.

Construction by this method would take approximately 18 months.

Equipment to be used would include those typical of a large quarrying operation, drilling rigs, numerous types of tanks for removal of spoil and delivery of materials, grading equipment and equipment to provide access to the shafts.

Cost. The economics of tunneling are significantly different from either the overhead or trenching alternatives. The estimate for tunneling the Haddam crossing is $6,550,000, including the necessary land and right-of-way costs. These costs are minimum amounts. Should tunneling encounter unsound rock, severe fissures or major problems with water, the costs could increase substantially.

Available geologic information indicates reasonable uniformity and soundness of rock in the area of the Haddam crossing, but this can only be confirmed by further subsurface exploration such as borings.

Environmental Impact. The impact on the natural environment of the tunneling method would include the consumption of nonrenewable resources (fuels and materials) in the construction process. About 17,000 cubic yards of spoil from tunnel excavation would require disposal.

Noise and disturbance in the towns of Haddam and East Haddam would be caused by the movement of trucks and construction equipment on state and town roads in the vicinity. The disposal of spoil would require around 1,700 trucking hours, assuming a load of approximately 10 cubic yards per truck, and a disposal point within 2 miles of the terminals on either side. The location of such a disposal area may itself be a problem.

With the exception of the terminals, after construction there would be no visual impact of a transmission crossing using a tunneling method. The terminals would cover approximately one acre each with some additional land for suitable screening. In both cases they would be hidden from public viewing points.

E. Scovill Rock

1. Trenching

It would require an underground line about 10,000 feet long, from Scovill Rock Substation to a point west of Hurd Park Road about 4,500 feet east of the river to ensure that the terminal structures would not be visible from the river. If the transmission crossing were to be provided bank-to-bank on the river, there would be no significant improvement in visual impact because the terminal structures, although not as tall as the present towers, would give a cluttered and industrial appearance to the riverbank. For this reason the Company does not consider in 1972 the bank-to-bank alternative as viable as it had in 1966.

The trenching method would involve the excavation of a trench at least 5 feet deep with a bottom width of 24 feet for both the 345-kV and the 115-kV cables, which would be laid in seven (four 345 kV, two 115 kV, and one spare) pipes. The width of the top of the trench could be much greater than 24 feet, depending upon the depth of the cut required, particularly on the steep banks.

In the river, the pipes must be embedded 10-15 feet below the channel bottom to avoid being damaged by dredging. Thus, in the relatively short distance from the railroad track to the channel on the west bank, the elevation of the pipes would change by nearly 60 feet. Therefore, on the west bank, the outcropping of ledge adjacent to the channel would require considerable cutting to maintain an acceptable grade for the pipe cable system. An alternative would be to adopt a zigzag or diagonal pattern up the sharp slope of the bank. Either method would require extensive disturbance of soils and rock.

From the channel eastward up the riverbank, the pipes would be placed in a trench which would have to be a minimum of 24 feet wide at the bottom. As the east bank rises irregularly to about 200 feet above the river within about 500 feet of the water's edge, considerable cutting may be required on this bank as well. As rock outcroppings are common at this point blasting would be required to obtain necessary depths and grades.

In would take an estimated one year to complete the excavation and installation.

Cost. The cost of placing the 345-kV lines alone underground by the trenching method would be an estimated $8,100,000. (This would assume that the 115-kV circuit crossing would remain overhead.) If the 115 kV were to be also placed underground the total cost would be an estimated $9,650,000. (This compares to a cost of the present overhead construction of about $725,000 in 1965 and 1967.)

Environmental Impact. The excavation for the trenches would cause extensive destruction to vegetation along the right-of-way and would involve large-scale movement of soils and blasting particularly on the bank near the river surface. The trenching in the river bottom would disturb aquatic life and interfere with navigation during the time of construction. The completed right-of-way would again have to be kept clear of deep-rooted vegetation to avoid drying out the ground adjacent to the pipes and thereby impairing heat dissipation. Its appearance would be similar to that of a gas pipeline right-of-way except that it would be wider and would require more extensive grading.

Although trenching to this extent would mean that the terminal structures would be concealed from most public viewing spots, they still would be large installations, each covering about 2 acres. Terminal construction would also involve disturbance of vegetation and soils. The terminal structure on the east side of the river would be an intrusion into Hurd State Park.

2. Tunneling

As an alternative to trenching, it could be possible to construct a tunnel that could completely conceal the line from view from the river and which would not interfere with any vegetation or soils visible from the river. If the terminal structures were to be kept out of sight from the river, the tunnel would have to be approximately 10,000 feet long.

The design of this tunnel would be based upon two pipes for each of the two 345-kV circuits and two pipes for the 115-kV circuit plus one spare pipe. Beginning at the bottom of a 130-foot deep shaft 13 feet in diameter at Scovill Rock Substation, the tunnel, with a "horseshoe" cross-section 10 feet wide and 17 feet high, would cross beneath the river at a depth of about 170 feet below mean water, presumably well into bedrock. Passing beneath the east bank of the river, the tunnel would rise gradually to another vertical shaft at the Hurd Park terminal station. This shaft, also 13 feet in diameter, would be about 115 feet deep. A third vertical shaft about 16 feet in diameter and 328 feet deep would be required and would be located on the east side of the river about at the center of the tunnel. This would be required as part of the air ventilation and cooling system. Oil would be circulated through the pipes and air circulated in the tunnel to dissipate heat.

A tunnel approximately 2 miles long would be a major undertaking and construction could be complicated by the geological conditions encountered. Borings would have to be undertaken to make firm estimates. If the tunnel were in tight, good quality rock, construction would be more or less conventional. If the rock were badly faulted, or if other adverse conditions were encountered, tunneling would involve working within a steel caisson, possibly under pressure, and the tunnel would be lined as excavation progressed.

There is some evidence in the available information from the state Geological and Natural History Survey that the configuration of rock in the area of Scovill Rock might cause some tunneling difficulties.

However, it has been assumed here that conditions would be satisfactory and, therefore, the estimated cost is a minimum figure. This construction and installation job would be expected to take approximately two years.

Cost. The estimated cost of a cable system installed in a tunnel, given favorable condition of rock, is $19,800,000.

Environmental Impact. Construction of the tunnel would consume large quantities of nonrenewable resources in the form of materials and fuels used in construction. Included in these categories would be such items as the commitment of manufacturing facilities, large amounts of construction labor, vehicles and construction equipment of all types and the resources in addition to these more obvious items.

During construction there would be considerable acreage used for equipment and vehicles, laydown space and spoil disposal. Some of this might intrude into Hurd State Park.

The spoil itself would create a major disposal problem. It would amount to about 63,000 cubic yards, equivalent to a pile 20 feet high, 150 feet wide and 560 feet long. This would require trucking to other sites for disposal. The availability of such disposal sites has not been determined.

Tunneling would eliminate any visual impact of the transmission crossing from the river. The vent shaft enclosing the terminal facilities and an access road would be visible in Hurd Park.

F. Bodkin Rock Alternatives

The Company estimates that it would cost $3,200,000 to place the Bodkin Rock crossing underground using the trenching method. Tunneling would cost an estimated $6,750,000. Rather than incur these costs and to avoid the environmental impacts of either of these two techniques of placing the crossing underground, if the Company were forced to remove this crossing, it would be preferable to relocate the 345-kV circuit to cross overhead at Paper Rock near the Middletown Station.

As noted earlier in the discussion of relocation alternatives, this would require the building of new structures at Paper Rock, expanding the right-of-way from Paper Rock Junction to Ames Junction (about 1.5 north in Portland), and abandoning about 3 miles of existing 345-kV facilities and right-of-way from the base of the hill just south of Middletown Station to Bodkin Rock and to Ames Junction.

Also, as noted earlier, the cost of relocation would be an estimated $860,000.

G. Combining All Crossings in a Single Tunnel

The Company study estimated that the cost of placing all crossings in the Middletown-Haddam area (Bodkin Rock, Paper Rock, Scovill Rock and Haddam) underground in a single tunnel would be approximately $43,500,000. The extensive amount of new construction of new rights-of-way to bring lines to the single-point crossing and the construction of a large tunnel itself would have major adverse environmental empacts. This solution thus appears to be unreasonable from an economic point of view and is highly undesirable from a reliability point of view.

IX. ALTERNATIVES: MODIFIED STRUCTURE DESIGN

It will be remembered that the WRC order permit of 1966 had a condition which provided that the 345-kV circuits at Scovill and Bodkin Rock "shall be removed and placed underwater at the present location or constructed at some other alternative location within five years from the date of issuance of this certificate..." Therefore, in its present study, the Company examined the feasibility of relocating the Scovill and Bodkin crossings and the costs and environmental impacts involved with such alternatives.

Following examination of relocation and underground alternatives, the Company examined the alternatives of changed structure design, to improve the appearance of the crossing.

A. Haddam

In the studies for rebuilding this crossing, serious consideration was given to the use of tubular steel pole structures similar to the type used at the Suffield-Enfield river crossing although with a vertical rather than a horizontal configuration of conductors.

Construction of a structure of this type would present no problems on the west bank. However, there would be difficulties on the east bank. A tubular structure would require a crane with about a 300-foot long boom to aid in its erection, but a crane of this size could not be assembled at the location of the present structures. Because of the proximity of several houses, the use of a large helicopter for raising the structure would be precluded. For these reasons, a tubular steel pole structure could not be placed approximately where the present crossing structure is located, 100 feet to the east of Route 149, but rather would have to be located in the approximately 200-foot strip deep between Route 149 and the riverbank.

Environment Impact: Construction of the east structure in the location close to the riverbank would disturb about the same amount of vegetation and soils as the construction of a lattice-type structure near the existing tower. But, because of its location, the disturbance would be more visible and more permanent due to the removal of large trees near Route 149.

A tubular-style structure placed close to the bank would be more visible from the water's edge and from Route 149. Its base would not be as well screened by vegetation as would be that of the proposed east structure higher up on the slope.

The extent of the visual impact of the tubular poles on land and water would be approximately the same as that of the present towers. However, the clean and modern design of the tubular structures, attractive to some viewers, might to others contrast unfavorably with the design of the East Haddam Bridge which is the most significant river structure close by. Tubular structures would also tend to present a sharper profile than the lattice type. As noted, the latter tend to become somewhat "transparent" when viewed from a distance because of the relative slenderness of each individual component.

Cost: Tubular structures in the location described would cost nearly $300,000 more than the proposed lattice structures, or a total of $632,000.

B. Scovill Rock

The four present 345-kV structures and the two 115-kV Scovill Rock structures could be replaced with a single structure on either bank. It is possible for a tubular steel pole structure with two poles about 20 feet apart to accommodate the two 345-kV circuits and one 115-kV circuit. These would be similar to the tubular structures used at Haddam except that the spacing between the poles would be increased from 5-6 feet to about 20 feet.

Environmental Impact: Constructing the foundations for such a tubular steel structure would involve considerable disturbance on both banks, particularly on the less accessible east bank where the vegetation has not been disturbed by the existing facilities.

There would be about 50 feet of added height to this structure which would make it a more prominent feature of the landscape than the present crossing and more clearly visible from Route 9 and from further points in the river than is the present crossing. However, the clean, modern appearance might to many observers compare favorably with the present lattice-type towers.

Cost: Based on preliminary estimates the cost of this alteration would be approximately $475,000.

C. Bodkin Rock

The replacement of the present lattice-type structures by tubular structures could be done, but the present crossing is not prominently visible from the river and is not visible from residences or any well-traveled roads. Therefore, the Company did not consider this alternative worth pursuing.

X. REGULATORY REVIEWS

As indicated at the beginning, the Company has applied for permits from the Corps of Engineers and the Department of Environmental Protection for the Haddam crossing. A permit has already been granted by the PUC for that crossing, and, in order to maintain overhead crossings at Bodkin and Scovill Rock, the Company is requesting the Department of Environmental Protection to modify the 1966 WRC order to permit continued overhead crossings at these locations.

It is probable that most of these permits will require public hearings which would take several months to prepare and complete. Administrative reviews for relocation and underground alternatives might be completed within two years.

All the relocation and underground alternatives discussed would require applications for permits from a variety of regulatory agencies. The State Department of Environmental Protection would be asked to approve all overhead and underground river crossings, and would be asked for permission to widen rights-of-way in state forest lands, for permission to use Hurd State Park land for terminal facilities, and for construction laydown space.

The state Power Facility Evaluation Council would have to be asked to issue a certificate for any new transmission construction of over one mile in length whether underground or overhead.

The U. S. Army Corps of Engineers would be asked to give a permit for underground and overhead transmission crossings of navigable rivers. It is probable that a full National Environmental Policy Act statement would be required for underground construction using the trenching method. Judging by recent experience elsewhere, this statement might be referred to the federal Environmental Protection Agency for its review because of the potential for oil spillage from the underground pipe-type cable with its pressurized oil-cooling system.

The State Public Utilities Commission would be requested to give a permit for any proposed alternate facilities.

XI. SUMMARY OF COST ESTIMATES
(Given in 1972 Dollars)

A. Scovill Rock

1.	Underground with trenching	$ 9,650,000
2.	Underground with tunneling	19,800,000
3.	Actual overhead cost (1967)	725,000
4.	Consolidate all lines into a single overhead crossing structure	475,000
5.	Relocation overhead via Cobalt and Haddam	5,700,000
6.	Combining all crossings into a single tunnel	43,500,000

B. Bodkin Rock

1.	Relocation overhead via Paper Rock	860,000
2.	Underground with trenching	3,200,000
3.	Underground with tunneling	6,750,000

C. Haddam

1.	Overhead as applied for	345,000
2.	Overhead with tubular steel towers	632,000
3.	Underground with trenching	4,000,000
4.	Underground with trenching and tunneling	4,175,000
5.	Underground with tunneling	6,550,000

If Northeast Utilities were forced to place both the Scovill Rock and Haddam crossings underground and to relocate Bodkin Rock to Paper Rock instead of undergrounding, the annual carrying charges on the required investment (assuming trenching would be permitted) would be $2,010,925, calculated as follows:

> Annual carrying charges of 13.85 percent for underground and 13.99 percent for overhead depreciation charges, annual cost of invested capital, costs of operation and maintenance expressed as a level annual charge, and local property taxes.
>
> Useful life of underground and overhead facilities are, on a composite basis, assumed to be 50 years and 45 years respectively.

The figure of $2,010,925 represents 0.66 percent of Northeast Utilities' total annual electric revenues in Connecticut as of April 30, 1972. Assuming all classes of customers were to support these costs of undergrounding, the average cost to each residential customer in CL&P and HELCO would be approximately $1.41 annually (including gross revenues tax).

One other way of evaluating the costs of facilities is to consider the cumulative costs over their expected life.

	Haddam Crossing	Scovill Crossing
	Underground by Trenching	Underground by Trenching
Construction Costs	$ 4.0 Million	$ 9.65 Million
Annual Costs	$554,000	$1,336,525
Present Value of Annual Costs	$ 5.7 Million	$13.8 Million
Total Annual Costs over a 50-year period	$27.7 Million	$66.8 Million

XII. THE FUTURE

A. Transmission Implications of the 1978 Unit

In the "Ten- and Twenty-Year Forecast of Loads and Resources" prepared by Northeast Utilities Service Company and submitted to the Power Facility Evaluation

Council on January 1, 1972, the Company announced that it is considering three possible sites for its proposed 1978 base-load generating unit: Millstone Point (Waterford), Connecticut Yankee (Haddam Neck) and Maromas (Middletown). In late 1972, the Company will submit an application with these three alternative sites to the Connecticut Power Facility Evaluation Council and the U. S. Atomic Energy Commission.

The development of any one of these sites would mean an alternative expansion pattern of the 345-kV transmission system. Depending on the decision concerning the 1978 generating site by state and federal agencies, the Company would then apply to the Power Facility Evaluation Council for the certification of transmission facilities as follows (crossings, if any, of the Connecticut River are noted):

1. Millstone Point--A unit in 1978 at Millstone Point would require the construction of only one additional 345-kV circuit from the plant site northerly to Village Hill Road Junction (near Willimantic) and then westerly to Manchester. No additional river crossing would be required.

2. Connecticut Yankee--Were a second unit to be added at this site in 1978, one of two likely transmission alternatives would be required. The first would be a single 345-kV circuit from Haddam Neck northward to Cobalt and then westerly to Paper Rock Junction and again northward to Manchester. (The environmental and technological characteristics of this route were discussed above in connection with the potential relocation of the Scovill Rock crossing.) The other alternative is to build an additional circuit paralleling existing facilities from Haddam Neck across the river at Scovill Rock then northerly to Middletown, Paper Rock or Bodkin Rock and Manchester. This latter alternative involves two additional river crossings.

3. Maromas--Were this site to be developed, it would be possible to construct a single 345-kV circuit from Scovill Rock northerly to Middletown to cross the Connecticut River at Bodkin or Paper Rock, and thence to Manchester. This would involve a single additional river crossing.

B. Future River Crossings

As listed in the same 1972 forecast report, one additional 345-kV circuit crossing of the Connecticut River between Middletown and Haddam is contemplated in the next decade as follows:

In 1978, a 345-kV line from the Middletown Station is planned to cross the river at Paper Rock (where there is presently a 115-kV crossing) and run northward about 4 1/2 miles to Portland Junction newly created. From Portland Junction it would be tied into the Portland-Berlin line.

This line would be required regardless of the location of the 1978 operating unit and is needed to serve the growing loads in central Connecticut and the metropolitan Hartford area.

The Power Facility Evaluation Council must issue a certificate of environmental compatability and public need before this new transmission facility can be built.

XIII. COST-BENEFIT CONSIDERATIONS

The Company study of the river crossings in the Middletown-Haddam area has involved an assessment of the relationship of the costs of the relocation or underground alternatives with the benefits to be derived from them.

The problem posed by the river crossings can be stated thus in terms of economic theory:

The two trading parties in this instance are a government agency and an electric utility. These are trustees of economic and environmental resources owned by a third party, society. Neither of these trading parties acting individually or in concert has the authority to decide one way or another solely on the basis of its own sense of right. As trustees of the public interest the parties must weigh the decision of committing additional resources to the project on the basis of a cost-benefit analysis. If the parties fail to use this decision-making approach, it could find itself using scarce resources in a manner in which the benefits might not be commensurate with the economic and environmental costs incurred.

Consideration of all possible benefits of undergrounding indicates that the benefits to human life, animal life, air quality, water quality and to the productivity of land are zero in monetary terms. However, the benefits of undergrounding relative to aesthetic values are real. Quantifying such benefits is most difficult because individual values differ widely relative to such effects, e.g.; some persons view overhead crossings as ugly infringements on the natural beauty of the area, a few persons may view overhead lines favorably as examples of applied technology, and many persons would be quite indifferent to their presence.

Regardless of the wide range of values relative to aesthetics, it is obvious that such effects cannot be ignored in assessing the benefits of undergrounding. The aesthetic effect is limited to the values of individuals who come in visual contact with overhead facilities and they can be classified into two broad groups:

1. People who reside or own property within sight of the facilities.

2. People who are transient to the area, such as motorists, boaters and park visitors.

The Company study has found no evidence of depreciation of real estate values in proximity to the river crossings. In fact, it has found evidence that land values have been rising near the crossings and in the towns concerned. Because land prices have been rising it can be assumed that the crossings have not unduly discouraged buyers from paying rising prices for these properties. Therefore, the added benefits to residents and property owners of placing the crossings underground are probably not calculable in monetary terms.

Concerning transients who may be affected by the facilities, the U. S. Bureau of Outdoor Recreation census in 1970 concluded that 3,500 boats are to be found between Old Saybrook and Hartford on a weekday in summer and 5,000 on a peak summer weekend. The state DEP estimates that there were 78,000 visitors to Hurd State Park in 1971, but there are no figures available for traffic on the

Haddam-East Haddam Bridge or on Route 149 and Route 9A, points where the Haddam crossing can be seen.

The annual carrying costs of placing the Haddam and Scovill Rock crossings underground by the trenching method and of relocating the Bodkin Rock crossing is $2,011,000. It is reasonable to assume that the cost of removing these crossings would exceed what the motorists, boaters and park visitors who would benefit might be expected to be willing to pay. In any event, the benefits would be enjoyed by only a relatively small number of people but would be paid for in the form of higher electric rates by a large number of people who would probably never experience them.

XIV. THE COMPANY POSITION

The Scovill Rock crossing can be seen from 10 to 15 residences and fleetingly from roads or other public viewing points on land. It can be seen most fully by recreational river traffic in the summer and by Hurd Park visitors.

At this crossing, underground installation by the trenching method would cost $9,500,000 and result in questionable aesthetic improvement because of the clearing required to be maintained from the river to the terminal stations. Pipe-type cable used for underground installation cannot be laid to follow the land contours as closely as can pipe for gas transmission. The result at Scovill (and Haddam) would be a considerable alteration of the contours on the banks along a clearing which would be a minimum of about 65 feet and possibly more. Underground installation by the tunneling method would eliminate visual impact for viewers from the river, but it would consume large quantities of fuels and materials, create a major problem with spoil disposal and cost at least $19.8 million at Scovill alone. Relocation of the overhead crossings would require the development of a new right-of-way, possible underground installation of the 115-kV line, and would cost about $5.7 million. Finally, even the reconstruction of the Scovill Rock crossing to replace the present six towers with two tubular frame towers would cost roughly $475,000 and in the Company's judgment is of questionable aesthetic improvement compared to the capital cost.

Regarding Bodkin Rock, the Company believes that if it were ever required to remove this crossing, relocation to the overhead Paper Rock crossing at a total of $860,000 would be the preferable alternative to undergrounding. The Company believes that the aesthetic improvement of such a relocation would not be commensurate with the cost because the portion of the river in the vicinity of Bodkin Rock already has an industrial appearance by virtue of the feldspar plant and Middletown generating plant and because the crossing is not visible to residences in the vicinity and has a minimal impact on boaters.

Regarding Haddam, the Company study indicates that the visual impact of the present structures affects some 25 to 30 residences and recreational river traffic in the summer, and that the visual impact of the taller structures proposed will not be appreciably greater than that of the present structures. It does not believe that the $4.0 to $6.5 million required for underground installation can be justified in terms of aesthetic benefits gained and the number of people benefited.

If the Company were directed to place both the Scovill Rock and Haddam crossings underground and to relocate Bodkin Rock to Paper Rock (instead of undergrounding), the implications for each residential ratepayer would be about $1.41 per year. However, the true financial impact can be better evaluated when expressed in terms of the total cost to the citizens of the state over the useful life of the facilities. Based on the annual carrying charge of $2,011,000, the total cost in 1972 dollars for the estimated 50 years of useful life of the facilities would be $20,733,000 (the "present value," to use the terminology of engineering economics). This might be compared to the $23,000,000 which is the total amount of federal financing requested for the Connecticut National Riverway proposal in the latest Senate bill.

The Company questions whether the sum of $20,733,000 is a worthwhile investment for the people of the state, when the benefits would accrue to so few and where these expensive alternatives have their own environmental penalties.

Thus the Company concludes that, at the present time:

(a) overhead crossings represent the most appropriate use of economic resources,

(b) the aesthetic effect of underground alternatives is at the best disproportionate to the amount of money spent,

(c) underground and relocation alternatives have environmental effects which negate all or most of the presumed aesthetic advantage,

(d) there have been no measurable adverse effects on the values of nearby land because of overhead crossings, and

(e) overhead crossings presently represent the most reliable method of transmission of electric power.