DEFINITE PROJECT REPORT
CONNECTICUT RIVER
MIDDLETOWN, CONNECTICUT



# EMERGENCY STREAMBANK PROTECTION

OCTOBER 1987

U.S. Army Corps
of Engineers
New England Division

# DEFINITE PROJECT REPORT

## EMERGENCY STREAMBANK PROTECTION

## CONNECTICUT RIVER

## MIDDLETOWN, CONNECTICUT

OCTOBER 1987

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# DEFINITE PROJECT REPORT
# CONNECTICUT RIVER
# MIDDLETOWN, CONNECTICUT
OCTOBER 1987

## 1. AUTHORIZATION

The following investigations have been accomplished under the special continuing authority contained in Section 14 of the 1946 Flood Control Act, as amended, to determine the need and feasibility of constructing emergency streambank protection along River Road in Middletown, Connecticut. Federal assistance in preventing further erosion in the River Road area was requested by Middletown's Municipal Development Director, William M. Kuehn, Jr. in a letter dated 20 November 1986 (see Inclosure 1).

Under the provisions of Section 14 authority, Federal construction funding is available for the protection of highways, bridges, public works and public use facilities from streambank erosion. Such work must be economically justified and advisable in the opinion of the Chief of Engineers.

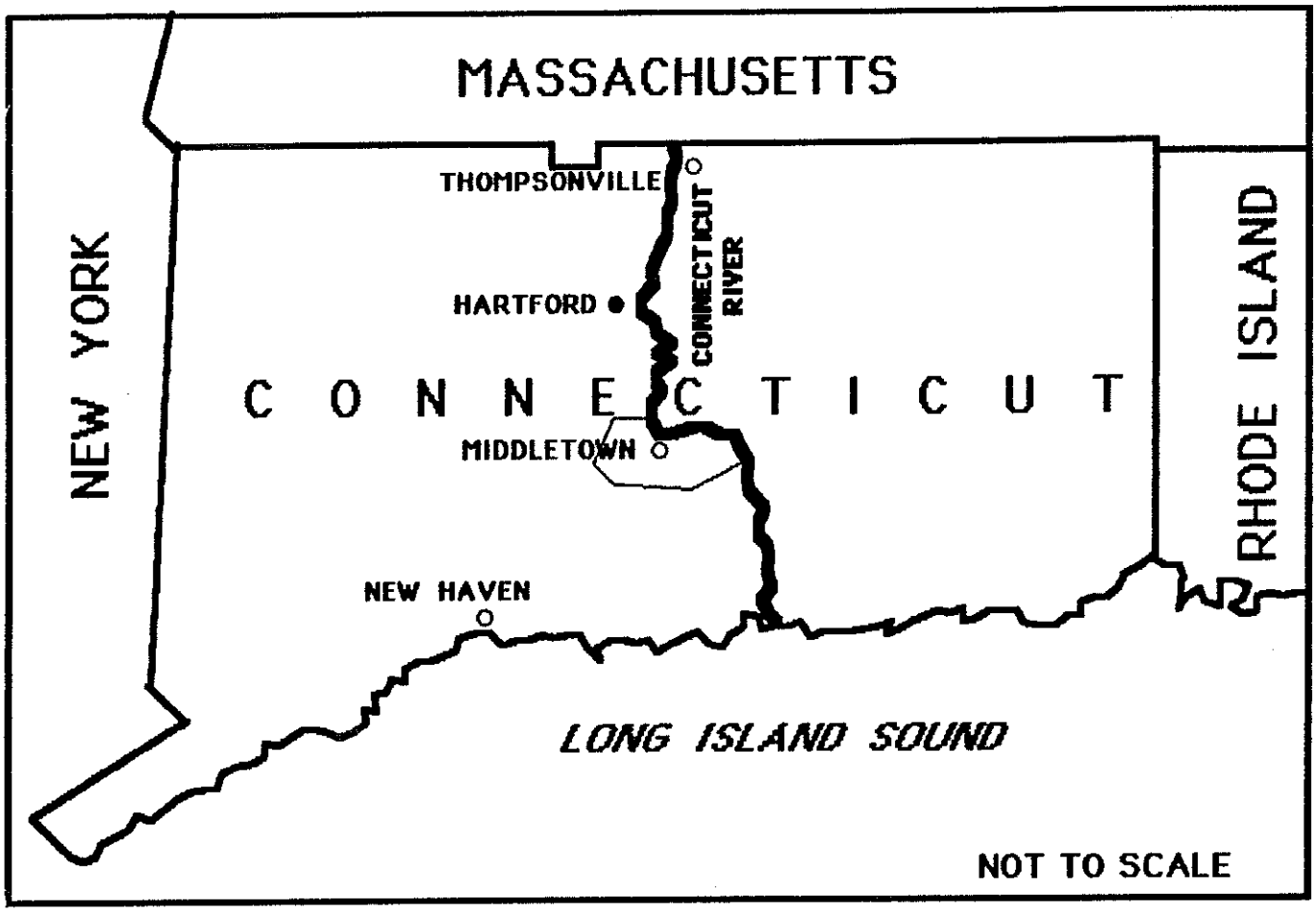
## 2. DESCRIPTION OF AREA

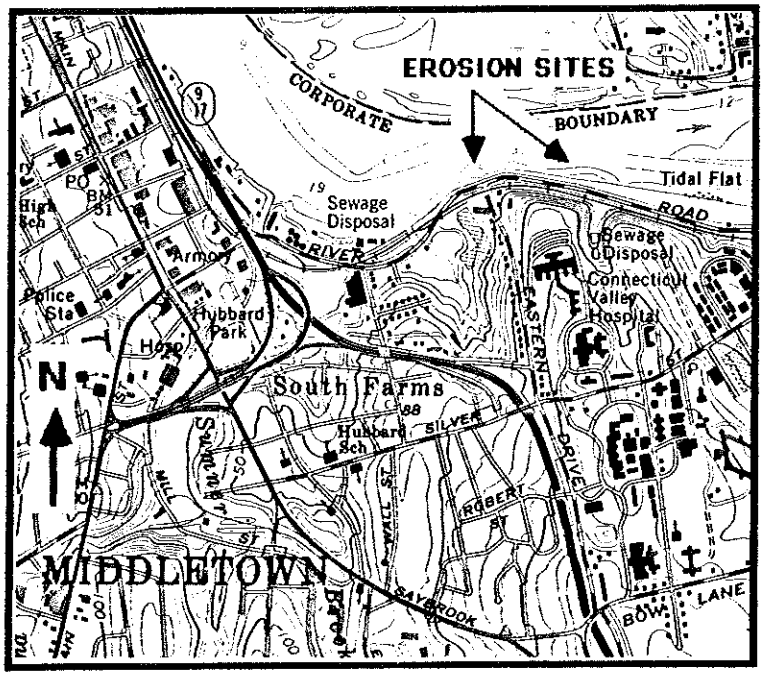
The city of Middletown is located in Middlesex County, in the lower Connecticut River Valley, in south-central Connecticut. Middletown is approximately 15 miles south of Hartford and 20 miles northeast of New Haven. Middletown is bordered to the north by Cromwell, to the south by Durham and Higganum, to the west by Meriden and Middlefield, and to the east by the Connecticut River (see Plate 1).

The Connecticut River traverses a length of more than 400 miles from beyond the Canadian border and flows south through four New England states before emptying into the tidal waters of Long Island Sound. The Connecticut River Basin encompasses a drainage area of about 11,265 square miles. Vermont has the largest basin area percentage of the four states with 35 percent. New Hampshire, Massachusetts and Connecticut have basin area percentages of 28, 24 and 13 percent, respectively. The Corps of Engineers has 16 flood control reservoirs in the Connecticut River Basin which provide about 530,000 acre-feet of storage. Middletown is located approximately 30 miles upstream of the mouth of the Connecticut River and is subjected to tidal influences. At Middletown, the Connecticut River Basin has a drainage area of about 10,775 square miles.

## 3. PROBLEM DESCRIPTION

Two primary streambank erosion areas are located along the Connecticut River in the vicinity of River Road and Middletown's Well Fields. Area 1 is located along River Road at the intersection with Eastern Drive,




SECTION 14

MIDDLETOWN, CONNECTICUT
CONNECTICUT RIVER

LOCATION MAP

JULY 1987

PLATE 1

approximately 6,500 feet downstream of the Arrigoni (Route 66) Bridge. The erosion area consists of approximately 420 linear feet of riverbank (see Plate 2). The road surface ranges from 10 to 18 feet above the riverbed. The slope of the riverbank varies from a 1 vertical on 3 horizontal along the lower sections to a 1 vertical on 1 horizontal at higher sections. Along certain areas of River Road, erosion has undermined the shoulder causing sections of the guardrail to fail.

Area 2 is located along the riverbank adjacent to Middletown's Well Field, approximately 3000 feet downstream from Area 1. The erosion area consists of about 150 linear feet of eroding riverbank (see Plate 3). The top of the existing bank is 10 to 12 feet above the riverbed and slopes to a 1 vertical on 1.5 horizontal. One of the municipal wells is located within 35 feet of the eroding riverbank.

## 4. RECENT FLOODING

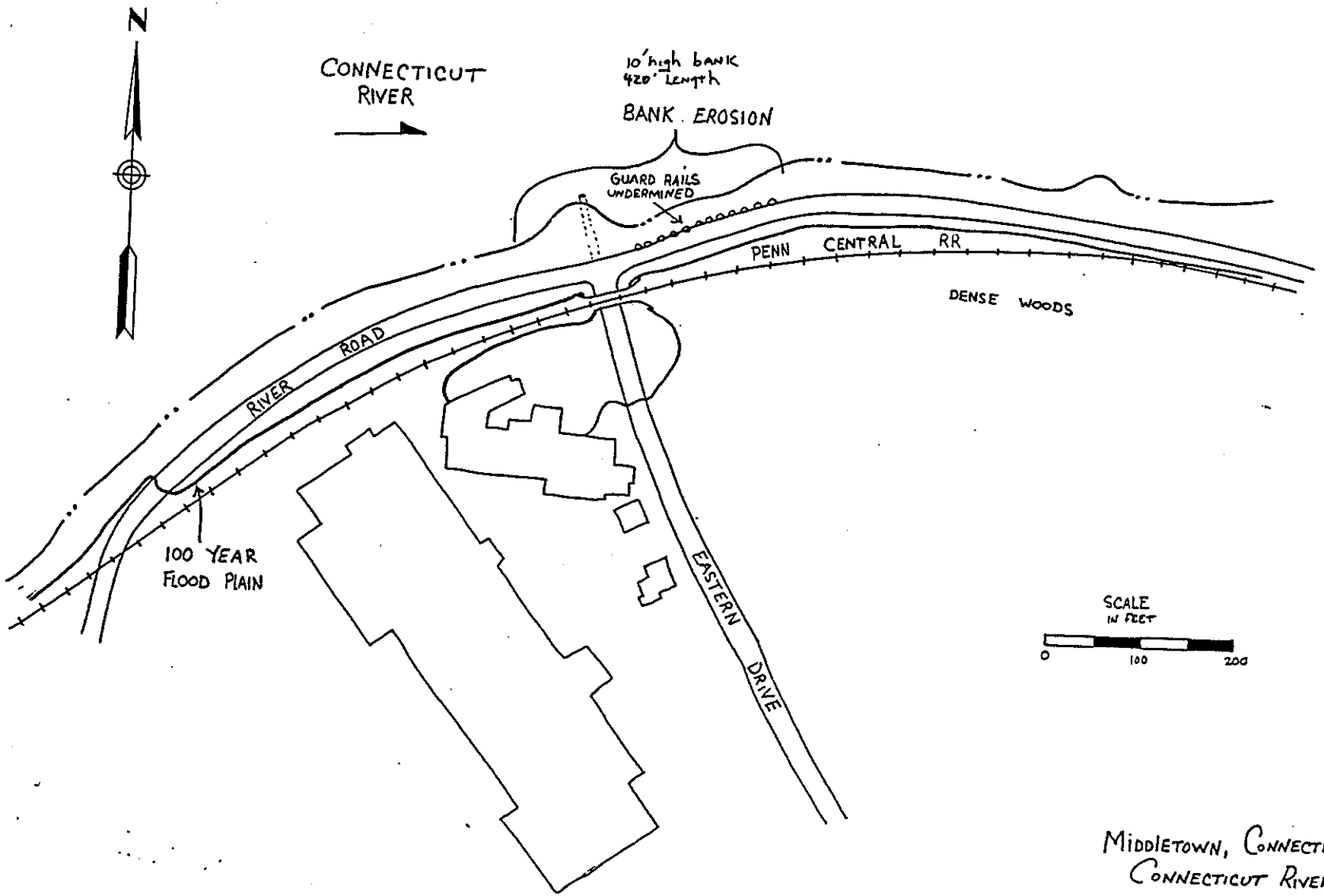
The most recent flooding event occurred during the period of March 31-April 8, 1987 in which a pair of intense rainstorms hit most of New England. These two storms, augmented by snowmelt in the mountains and northern areas, resulted in the most widespread flooding in about 50 years. The storms created two separate and significant flood peaks, especially in southern and central regions.

A U.S. Geological Survey gage situated at Bodkin Rock (drainage area = 10,880 square miles) is located 6,300 feet downstream from the problem site. The maximum peak discharge of the two storms at Bodkin Rock gage was reported as 140,500 cubic feet per second (cfs) on April 8, 1987.

The massive rain storm of May 28 - June 3, 1984 caused large scale flooding on the Connecticut River. The frequency of the 1984 storm on the Connecticut River ranged from a 50-year event at Thompsonville to a 75-year event at Middletown. The maximum recorded discharge at Bodkin Rock gage was reported as 186,000 cfs (cubic feet per second) on June 2, 1984.

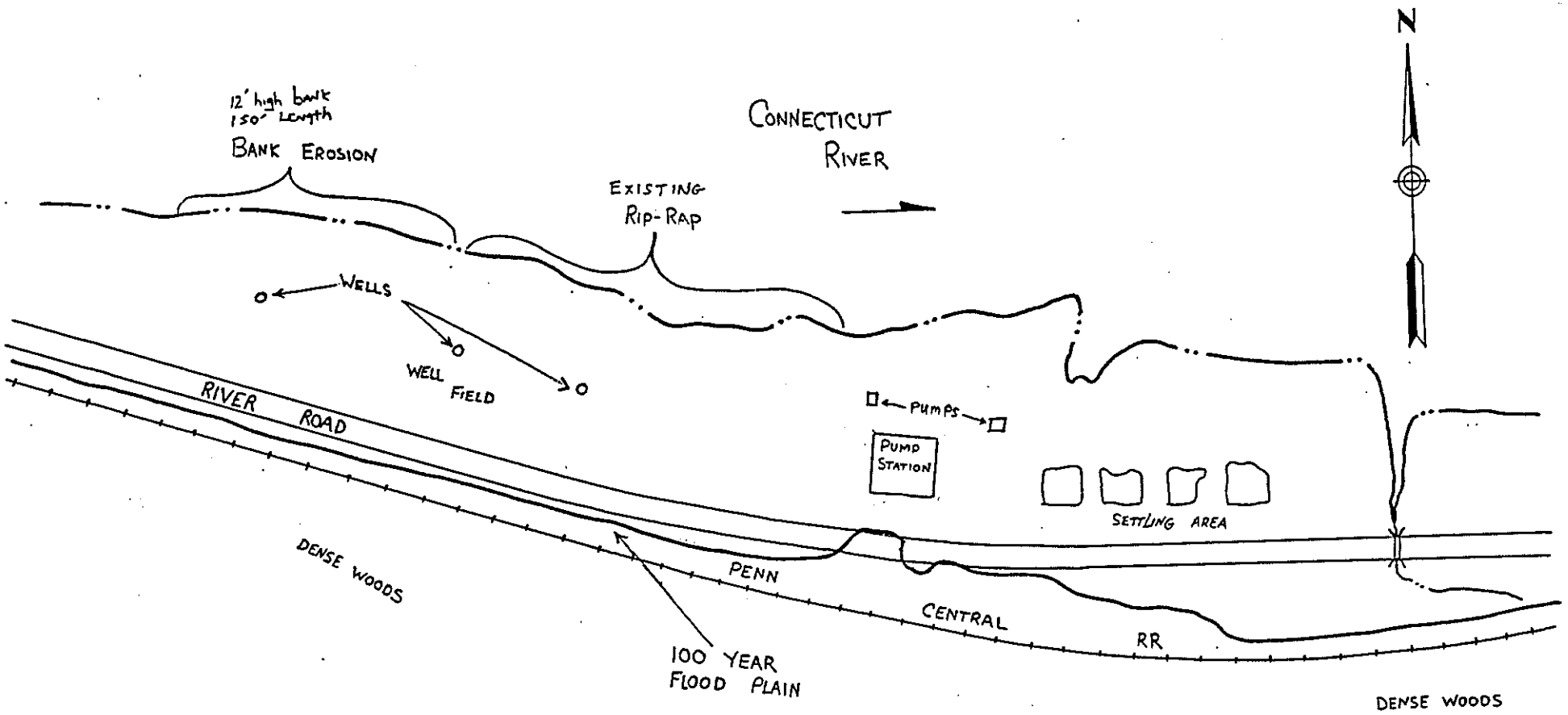
## 5. PLAN FORMULATION

Without Project Condition - If no action is taken to protect the riverbank in the two areas, erosion will continue, causing the eventual failure of the roadway and the water line situated in Area 1, and the loss of one of the municipal wells in Area 2. If the erosion was allowed to continue at Area 1, the eventual failure of both the roadway and the water main system would require the city of Middletown to administer emergency measures in maintaining the water supply for the area. Losses and disruption would include fire protection for the city, the transfer of potable water to the city, and disruption to many of the city's businesses. At Area 2, the loss of a municipal well would force the city of Middletown to seek an alternate reserve wellfield.




Middletown, Connecticut
Connecticut River
Erosion Area

Plate 2




SCALE

0 100 200

IN FEET

MIDDLETOWN, CONNECTICUT
CONNECTICUT RIVER
EROSION AREAS

Plate 3

During the reconnaissance study, two alternative courses of action were investigated to determine the best solution to the erosion problem. The alternatives are as follows:

(1) Relocate River Road

(2) Construct Streambank Protection

The feasibility and advisability of each alternative was evaluated as follows:

(1) Relocate River Road - The existing road runs parallel to the Connecticut River and is situated between the riverbank and the Conrail tracks. It currently provides an access road to several businesses located on Eastern Drive and River Road. River Road also provides access to the wellfield facility. Due to the limited area between the Conrail tracks and the steep incline immediately south of the tracks (see Plate 4), and the high cost of excavating such a steep slope, it was determined unfeasible to relocate River Road.

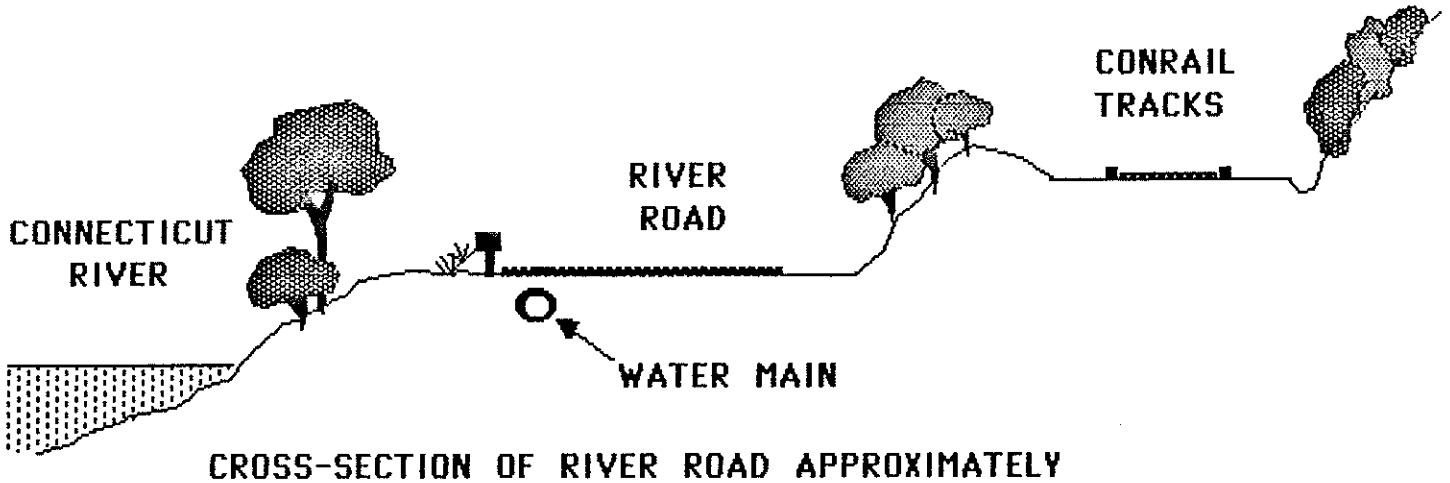
(2) Provide Riverbank Protection - Several possible methods of protecting the roadway and the wellfield were investigated. A timber crib, a wood or steel sheet piling wall, precast modular retaining wall and stone revetment were all potential structural solutions which were considered for protection of the two areas.

A rock-filled timber crib wall was considered to provide protection to the roadway and the wellfield. Although such a plan would provide protection to the two areas, the cost of the timber crib alternative was extremely high and thus not considered appropriate.

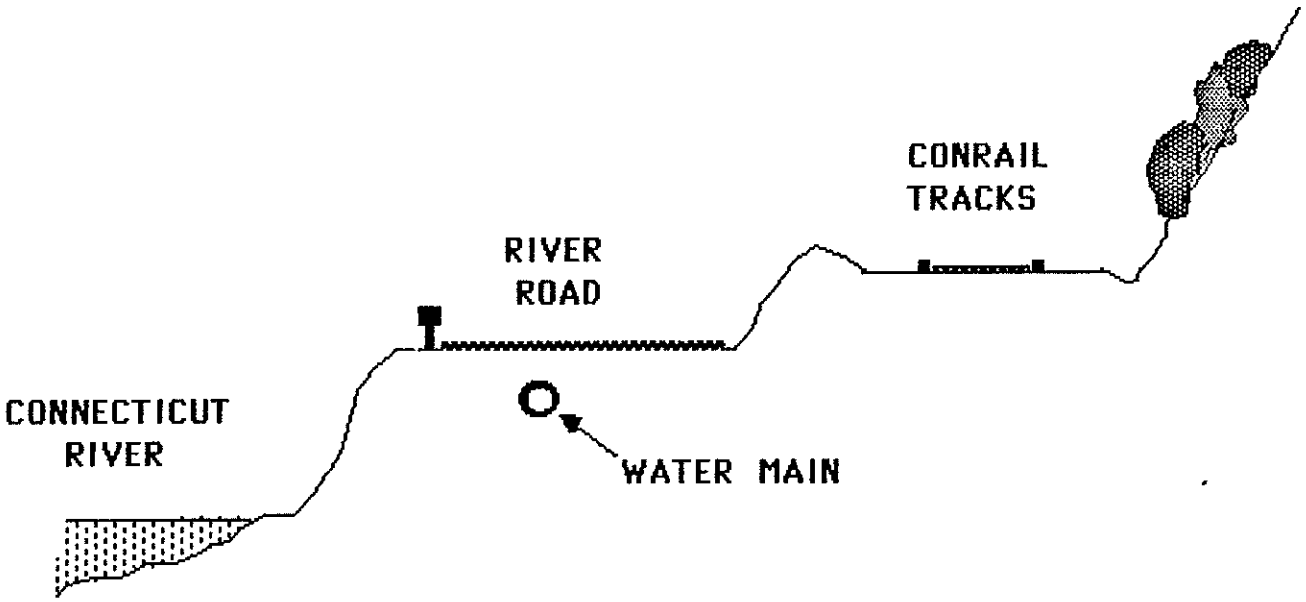
Due to the height of the wall (12-15 feet) required along area 1, a wood or steel sheet piling wall would need to be driven down to a depth of 20 feet in order to provide sufficient stability. Without detailed geologic information, it is not possible to determine if the subsurface material is suitable to drive piles to a depth of 20 feet.

A precast modular concrete retaining wall with stone toe protection would provide the essential protection to the two erosion areas. This alternative would also require minimum maintenance. However, due to the high cost of constructing a modular concrete retaining wall along these areas, this alternative was eliminated from further study.

Stone revetment, when designed to provide adequate protection to the roadway and wellfield from erosion, would require a 3.9-foot thick layer of rock. The rock revetment alternative would be aesthetically sound and require minimum maintenance throughout its project life. The cost of this solution was the lowest of all potential structural solutions as seen in Table 1, and is the selected plan for both erosion areas.




CROSS-SECTION OF RIVER ROAD APPROXIMATELY
50 FEET UPSTREAM OF THE INTERSECTION
WITH EASTERN DRIVE.




CROSS-SECTION OF RIVER ROAD APPROXIMATELY
200 FEET DOWNSTREAM OF THE INTERSECTION
WITH EASTERN DRIVE.

SECTION 14.
MIDDLETOWN, CONNECTICUT
CONNECTICUT RIVER
RIVER ROAD AREA 1
CROSS-SECTION

SEPTEMBER 1987 NOT TO SCALE

PLATE 4

TABLE 1

ALTERNATIVE SLOPE PROTECTION MEASURES
MIDDLETOWN, CONNECTICUT

| Alternatives | Area 1 Total cost | Area 2 Total cost |
|---|---|---|
| Timber Crib | $372,000 | $241,000 |
| Sheet Pile | $247,000 | $175,000 |
| Concrete Wall | $412,000 | $291,000 |
| Stone Revetment | $169,000 | $100,000 |

## 6. THE SELECTED PLAN

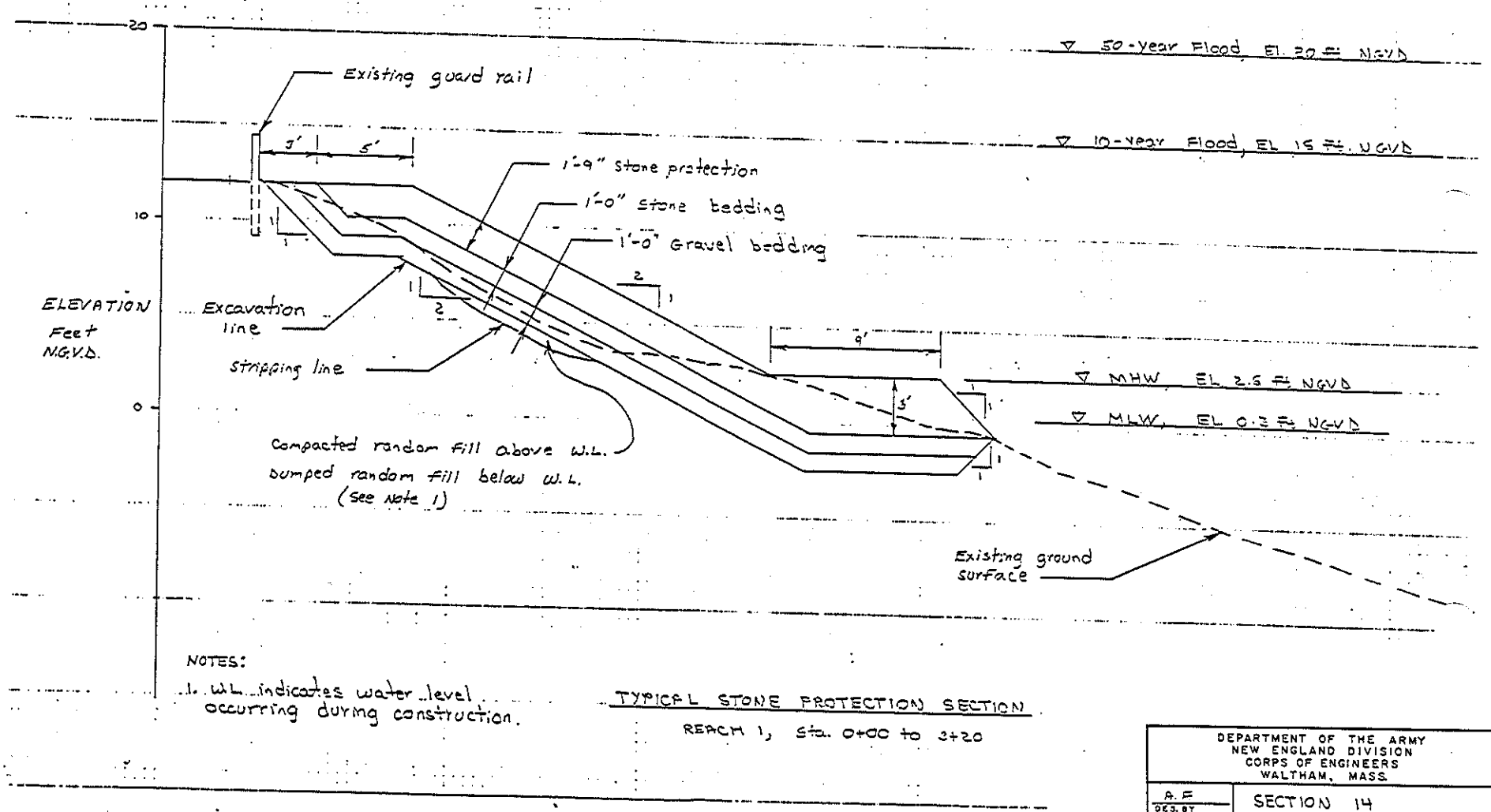
Studies indicate that the placement of a graded system of stone slope protection at both areas 1 and 2 is the most cost effective and viable erosion control method to prevent future streambank erosion at the proposed sites.

The selected plan at Area 1 calls for construction of a stone revetment consisting of a 1.9-foot layer of stone protection underlain by 1-foot layers of stone bedding and gravel bedding placed on a 1 vertical on 2 horizontal slope (see Plates 5 & 6 - Typical Section of Reach 1). The stone revetment would be approximately 420 feet in length beginning at a point 70 feet upstream of Eastern Drive. The height of the stone protection would range from 10 to 18 feet above the mean low water level of the Connecticut River.

The selected plan at Area 2 calls for construction of a stone revetment consisting of a 1.9-foot thick layer of stone protection underlain by 1-foot layers of stone bedding and gravel bedding placed on a 1 vertical on 2 horizontal slope (see Plate 7 - Typical Section of Reach 2). The stone revetment would be approximately 150 feet in length beginning 75 feet upstream of the western most well pump. The height of the stone protection would range from 10 to 12 feet above the mean low water level of the Connecticut River.

Stone size requirements for both areas were determined utilizing a design discharge of 236,000 cfs for the estimated 100-year flood event. For this event, at an estimated water depth of 33 feet and an estimated energy gradient of 7.4 ft/mile, a minimum D-50 of 1.4 foot was chosen for both sites. It was determined that the riverbank could be stabilized with a 2.0-foot layer of stone protection, based on this design criteria.

The recommended plan would provide a 50-year level of protection for the Connecticut River streambank along both sites, the adjacent River Road, and associated utilities.




NOTES:

1. W.L. indicates water level occurring during construction.

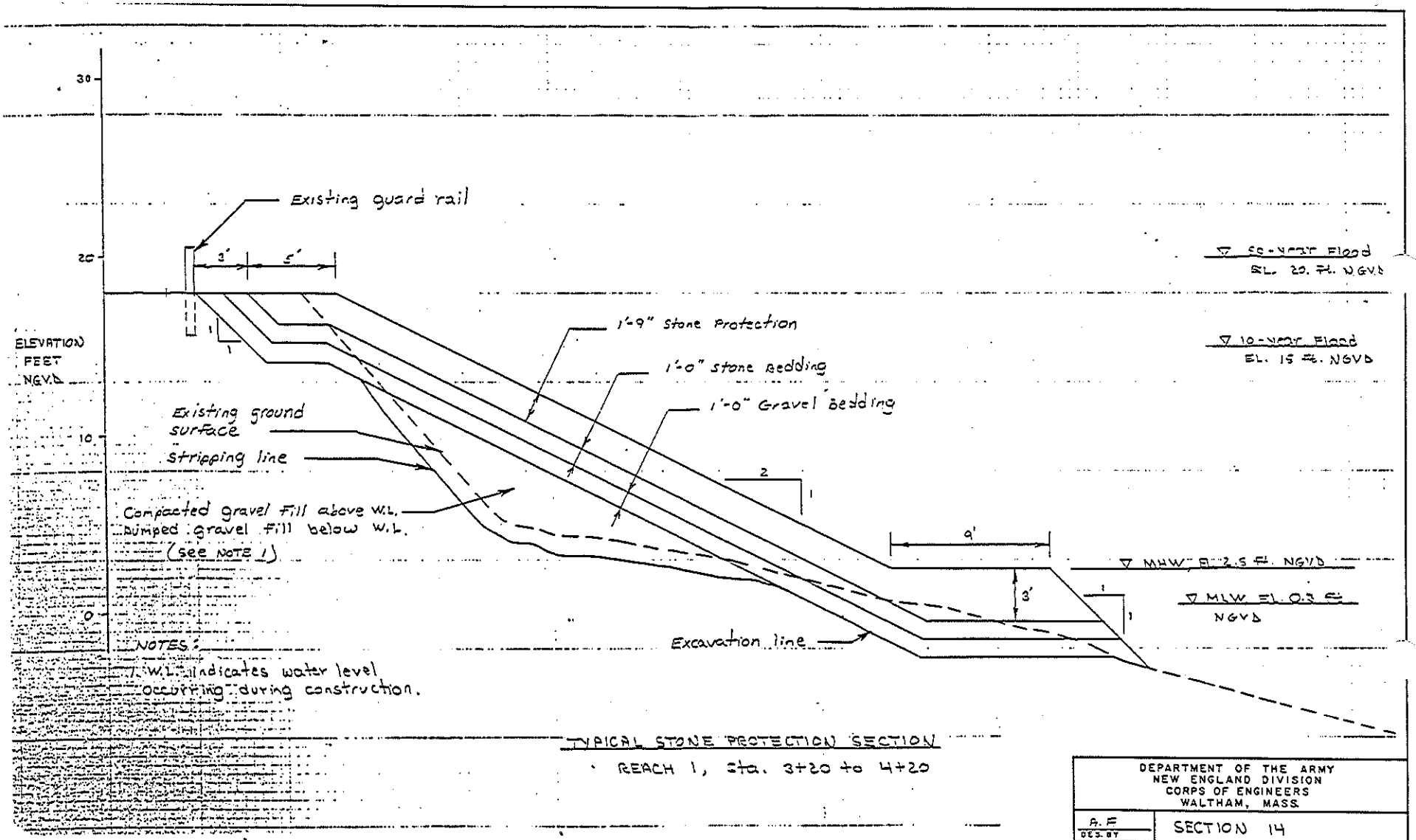
TYPICAL STONE PROTECTION SECTION

REACH 1, Sta. 0+00 to 3+20

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

| | |
|---|---|
| A.F. DES. BY | SECTION 14 |
| A.F. DR. BY | EROSION CONTROL |
| CK. BY | AREA 1 |
| | MIDDLETOWN, CT |
| GEOTECH. ENG. BR. | SCALE: 1" = 5' |
| SK. NO. 2 | DATE: JUNE 87 |

PLATE 5



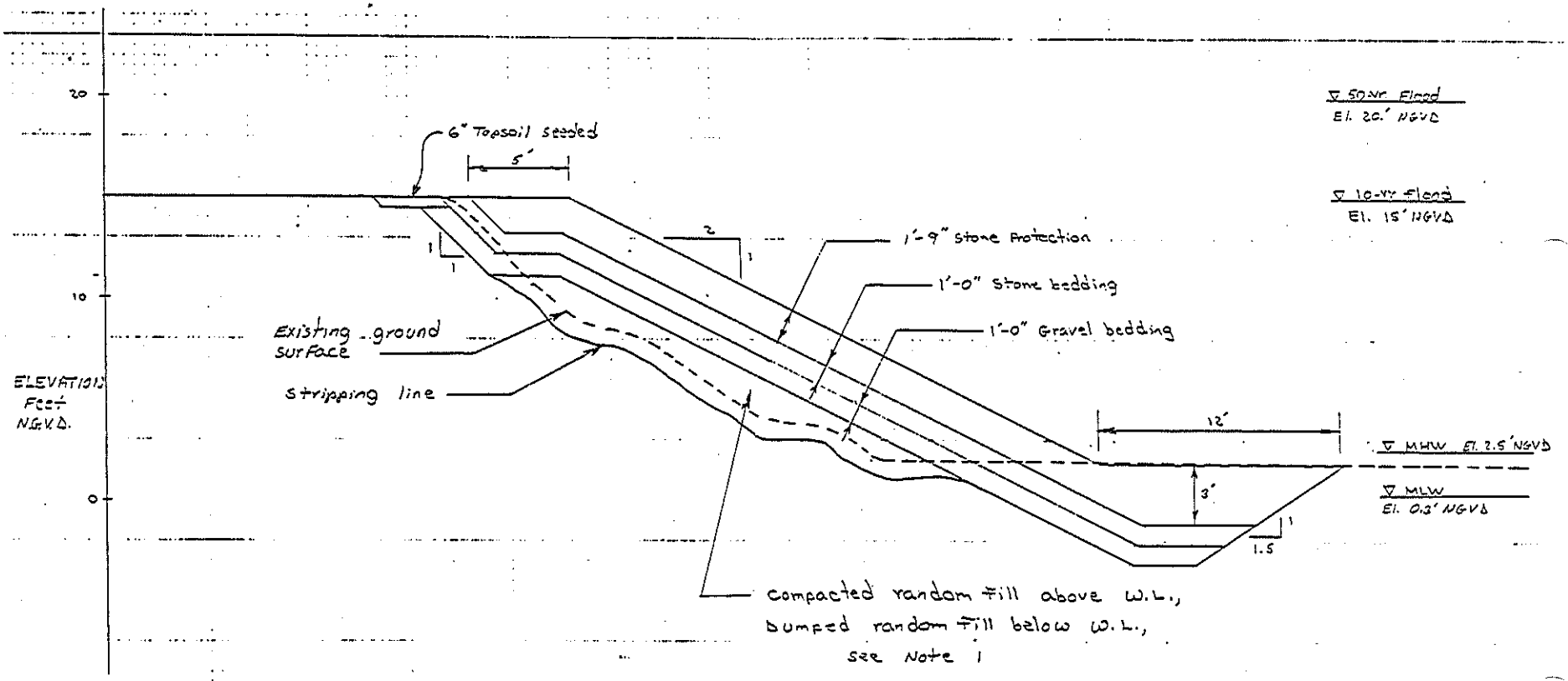

TYPICAL STONE PROTECTION SECTION

REACH 1, Sta. 3+20 to 4+20

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

| | |
|---|---|
| A. F. DES. BY | SECTION 14 |
| A. F. DR. BY | EROSION CONTROL AREA 1 |
| CK. BY | MIDDLETOWN, CT |
| GEOTECH. ENG. BR. | SCALE: 1"=5' |
| SK. NO. 3 | DATE: JUNE 87 |

PLATE 6




NOTES:

1. W.L. indicates water level occurring during construction

TYPICAL SECTION

REACH 2, 150-Feet

| | |
|---|---|
| DEPARTMENT OF THE ARMY<br>NEW ENGLAND DIVISION<br>CORPS OF ENGINEERS<br>WALTHAM, MASS. | |
| A. F. DES. BY | SECTION 14 |
| A. F. DR. BY | EROSION CONTROL<br>AREA 2 |
| CK. BY | MIDDLETOWN, CT |
| GEOTECH. ENG. BR.<br>SK. NO. 6 | SCALE: 1"=5'<br>DATE: JUNE 87 |

PLATE 7

## 7. ESTIMATES OF FIRST COSTS AND ANNUAL CHARGES

Estimates of first costs and annual charges for the proposed project at Area 1 and Area 2 are reported in Table 2 and Table 3, respectively. An estimate of $1,000 for each site is included as a non-Federal responsibility for obtaining lands and easements for project construction. Unit prices are based on similar work performed in this area. Cost sharing requirements include a 25 percent contribution of project costs by non-Federal interests, including necessary lands, easements and rights-of-way. With the total project first cost estimated at $163,000 for Area 1 and $93,000 for Area 2, the non-Federal share of the first cost is currently estimated at $40,750 and $23,250 respectively, subject to change depending on the actual construction bid price for the project. Total annual costs of $17,000 at Area 1 and $10,000 at Area 2 were computed using a project life of 25 years and an interest rate of 8-7/8 percent.

## 8. ESTIMATES OF BENEFITS AND BENEFIT-COST RATIO

Benefits due to project construction are based on comparison of the "with" and "without" project condition. Should the embankment be left as is, erosion will continue, leading to undermining and failure of the roadway and wellfield.

A benefit evaluation has been prepared for Area 1. Benefits as derived for the selected project are those recurring costs for temporary embankment repair, road repairs, utility repairs and traffic detours which would be avoided by preventing eventual road damage with construction of permanent erosion protection. Using unit prices similar to these of the recommended plan, temporary repairs and associated costs were estimated to be $79,600 as shown in Table 4. Benefit estimates consist of temporary repair to stabilize the eroded bank with dumped angular rock protection, as well as repair of the roadway to a usable and passable condition in the event of road failure.

Repair work to the embankment and road at Area 1 represents emergency type construction and would only be a temporary fix. Construction repair is done on an emergency need basis and only where a direct threat to the roadway exists. Temporary repair does not provide a permanent solution to the erosion problem.

The emergency level construction done on the River Road embankment at Area 1 is expected to last about 3 years before erosive action of the Connecticut River undermines the emergency protection and further erodes unprotected banks, requiring more extensive emergency repairs. Under these circumstances and during the 25-year life of the recommended plan, erosion repair would have to be done 8 times under a without project condition. Amortized over a 3-year life at the applicable interest rate of 8-7/8, annual benefits resulting from construction of an erosion control project, equated to the cost of avoiding recurring damages associated with the without project condition, are estimated at $31,400. Compared to estimated annual costs of $17,000 for the proposed project, the ratio of benefits-to-costs is 1.85 to 1.

TABLE 2

PRELIMINARY TOTAL COSTS AND ANNUAL CHARGES
EMERGENCY STREAMBANK PROTECTION - AREA 1
RIVER ROAD, MIDDLETOWN, CONNECTICUT
(March 1987 Price Level)

TOTAL COST

| ITEM | QUANTITY | UNIT | UNIT PRICE | COST |
|---|---|---|---|---|
| SITE PREPARATION | 1 | JOB | L.S. | $ 5,000 |
| EXCAVATION | 1,075 | C.Y. | $ 7 | 7,525 |
| STRIPPING | 155 | C.Y. | 10 | 1,550 |
| COMPACTED RANDOM FILL | 280 | C.Y. | 7 | 1,960 |
| GRAVEL BEDDING | 645 | C.Y. | 18 | 11,610 |
| STONE BEDDING | 610 | C.Y. | 30 | 18,300 |
| STONE PROTECTION | 1,170 | C.Y. | 45 | 52,650 |
| | | | SUBTOTAL | $ 98,595 |
| | | | Contingencies | 24,405 |
| | | | TOTAL CONSTRUCTION COST | $ 123,000 |
| | | | Engineering & Design | 18,000 |
| | | | Supervision & Administration | 21,000 |
| | | | Lands, Easements & Rights-of-Way | 1,000 |
| | | | TOTAL PROJECT FIRST COST | $ 163,000* |

* Does not include pre-authorization costs of $7,500

ANNUAL COST

| | |
|---|---|
| STREAMBANK PROTECTION PROJECT AMORTIZATION (25-year @ 8-7/8%) | $ 16,500 |
| OPERATION & MAINTENANCE | 500 |
| TOTAL ANNUAL COST | $ 17,000 |

NON-FEDERAL COSTS

| | |
|---|---|
| Cash - 5% of Total Project Cost | $ 8,000 |
| Lands, Easements & Rights-of-Way | 1,000 |
| Additional Cash Required | 31,750 |
| TOTAL NON-FEDERAL COST (25%) | $ 40,750 |

TABLE 3

PRELIMINARY TOTAL COSTS AND ANNUAL CHARGES
EMERGENCY STREAMBANK PROTECTION - AREA 2
WELLFIELDS, MIDDLETOWN, CONNECTICUT
(March 1987 Price Level)

TOTAL COST

| ITEM | QUANTITY | UNIT | UNIT PRICE | COST |
|---|---|---|---|---|
| SITE PREPARATION | 1 | JOB | L.S. | $ 5,000 |
| EXCAVATION (GEN.) | 380 | C.Y. | $ 7 | 2,660 |
| STRIPPING | 110 | C.Y. | 10 | 1,100 |
| COMPACTED RANDOM FILL | 245 | C.Y. | 7 | 1,715 |
| GRAVEL BEDDING | 235 | C.Y. | 18 | 4,230 |
| STONE BEDDING | 240 | C.Y. | 30 | 7,200 |
| STONE PROTECTION | 460 | C.Y. | 45 | 20,700 |
| TOPSOIL/SEED | 60 | C.Y. | 10 | 600 |
| | | | SUBTOTAL | $ 43,205 |
| | | | Contingencies | 10,795 |
| | | | TOTAL CONSTRUCTION COST | $ 54,000 |
| | | | Engineering & Design | 18,000 |
| | | | Supervision & Administration | 20,000 |
| | | | Lands, Easements & Rights-of-Way | 1,000 |
| | | | TOTAL PROJECT FIRST COST | $ 93,000* |

* Does not include pre-authorization costs of $7,500

ANNUAL COST

| | |
|---|---|
| STREAMBANK PROTECTION PROJECT AMORTIZATION (25-year @ 8-7/8%) | $ 9,500 |
| OPERATION & MAINTENANCE | 500 |
| TOTAL ANNUAL COST | $ 10,000 |

NON-FEDERAL COST

| | |
|---|---|
| Cash - 5% of Total Project Cost | $ 4,650 |
| Lands, Easements & Rights-of-Way | 1,000 |
| Additional Cash Required | 17,600 |
| TOTAL NON-FEDERAL COST (25%) | $ 23,250 |

TABLE 4

DERIVATION OF BENEFITS
RIVER ROAD-AREA 1
MIDDLETOWN, CONNECTICUT

PREVENTABLE DAMAGES

| ITEM | ESTIMATED TEMPORARY REPAIR COST |
|---|---|
| A. BANK STABILIZATION | $57,100 |
| B. ROAD REPAIR | 3,550 |
| C. UTILITY REPAIRS | 14,550 |
| D. DETOUR COSTS | 200 |
| E. EMERGENCY CREWS COSTS | 4,200 |
| TOTAL PREVENTABLE DAMAGES | $79,600 |

ANNUAL BENEFITS

TEMPORARY BANK STABILIZATION AND ASSOCIATED COSTS
(3-year recurrence interval)

TOTAL ANNUAL BENEFIT $31,400

A benefit evaluation has been prepared for Area 2. Benefits are derived from the acquisition of Middletown's reserve wellfield before its projected utilization. As indicated in the 1984 CDM Report, the need for putting the reserve wellfield on-line was projected for the year 2010 at a cost of $7,100,000 as shown in Table 5. However, if the existing wellfield fails before the year 2010, Middletown will be required to utilize the reserve wellfield sooner.

TABLE 5

COST OF THE RESERVE
WELLFIELD-AREA 2
MIDDLETOWN, CONNECTICUT

| ITEM | ESTIMATED COST |
|---|---|
| A. NEW 4 MGD WATER TREATMENT PLANT | $ 3,125,000 |
| B. 4 NEW WELL PUMPS | 325,000 |
| C. TRANSMISSION LINES | 3,140,000 |
| D. PUMP STATION | 510,000 |
| TOTAL COST (1984 PRICES) | $ 7,100,000 |
| TOTAL COST (1987 PRICES) | $ 7,500,000 |

If the erosion were allowed to continue, at least one well would be forced out of use by the year 2000. The city of Middletown would be required to bring the new wellfield on-line 10 years sooner than projected.

If the wellfield were protected from erosion, the new wellfield would be brought on-line in the year 2010 as planned. The benefit to providing streambank protection is derived from delaying the $7,500,000 expenditure for 10 years.

The benefit is determined by computing the present worth of $7,500,000 in the year 2000 versus the present worth of $7,500,000 in the year 2010. The present worth of $7,500,000 in the year 2000 is $2,485,000, whereas the present worth in the year 2010 is $1,060,000.

The present worth is the amount of money needed to be put in a bank in 1987 at 8-7/8 percent to compound interest to be worth $7,500,000 at some future date. For example, if $2,485,000 were set aside in 1987, it would be worth $7,500,000 in 13 years in the year 2000. If $1,060,000 were set aside in 1987, and had 23 years to compound, it would also be worth $7,500,000 in the year 2010.

If erosion protection were provided at the wellfield, the new wellfield would be delayed for 10 years, therefore, saving $1,425,000 ($2,485,000 - $1,060,000), which is the total benefit.

The total benefit, $1,425,000, annualized over the 25-year life of the project at a rate of 8-7/8 percent yields an annual benefit of $143,600. The annual cost to protect area 2 from further streambank erosion is $10,000, therefore, the benefit-cost ratio is 14.4 to 1.

## 9. ENVIRONMENTAL CONSIDERATIONS

No significant environmental impacts are expected to occur during or after construction of the erosion protection project. Construction activities will probably cause increased turbidity in the Connecticut River for a short period, but should have no permanent effect on water quality. Efforts will be made to minimize sediment inputs into the Connecticut River caused by construction activities by use of erosion control measures such as hay bales. Pending coordination with relevant state and federal agencies, no significant impact on fish and wildlife habitat is expected due to project construction. Approximately 170 trees will be removed from the areas on and around the failing riverbanks. However, most of these trees are already leaning and will fall into the river in the near future. Construction activities will result in loss of some bird nesting habitat.

## 10. REQUIREMENTS OF LOCAL COOPERATION

The City of Middletown is the non-Federal sponsor for the proposed project. The non-Federal sponsor's requirements of local cooperation are outlined in the draft Local Cooperation Agreement (LCA).

## 11. RECOMMENDATIONS

I recommend that this report be approved as the basis for preparation of plans and specifications and construction of the selected plan described herein (Area 1 and Area 2) under authority contained in Section 14 of the 1946 Flood Control Act, as amended. It is further requested that the New England Division Engineer be designated the authority to approve construction plans and specifications.

Thomas A. Rhen
Colonel, Corps of Engineers
Division Engineer

Enclosure

- rung -
- 19 - DE

# City of Middletown

MUNICIPAL DEVELOPMENT OFFICE
deKOVEN DRIVE, MIDDLETOWN, CONNECTICUT 06457
(203) 344-3419

November 20, 1986

Col. Thomas A. Rhen
Division Engineer
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Re: City of Middletown Request for Assistance

Dear Col. Rhen:

Pursuant to a telephone conversation between my staff member, Linda A. Ozga and Robert Martin, Chief of Special Program Section, I am writing on behalf of the City of Middletown to formally request assistance from the Corps of Engineers.

The reason for this request is to address the severe erosion of the river banks along sections of the Connecticut River which over time has caused trees to topple into the river and now even threatens to undermine a public road.

Your prompt attention to this matter will be appreciated.

Very truly yours,

William M. Kuehn, Jr.
Municipal Development Director

WMK/bds

cc: Sebastian J. Garafalo, Mayor
Samuel Gejdenson, U.S. Congressman (Middletown Office)
Edward J. Dzialo, Chairman, Harbor Improvement Agency

INCLOSURE 1