

**BLACKSTONE RIVER FLOOD CONTROL**

# **BLACKSTONE**

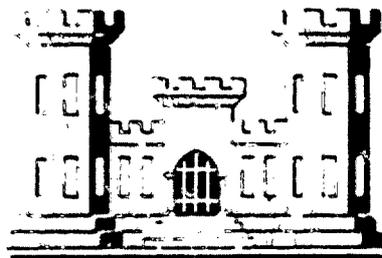
**RESTORATION OF FLOOD CONTROL PROJECT**

**BLACKSTONE RIVER**

**MASSACHUSETTS**

**LETTER DESIGN REPORT**

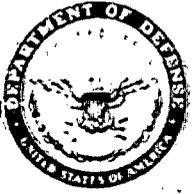
**( ADVANCE DRAFT )**



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

**DECEMBER 1969**

*28*



DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
424 TRAPELO ROAD  
WALTHAM, MASSACHUSETTS 02154

NEDED-B

19 December 1969

SUBJECT: Letter Design Report for Restoration of Flood Control  
Project, Public Law 99, Blackstone, Massachusetts

Chief of Engineers  
ATTN: ENGCW-OE

1. Pursuant to authority contained in 1st Indorsement, OCE, dated 15 November 1968 to letter dated 8 November 1968 from the Division Engineer, New England Division, subject: "Blackstone River, Blackstone, Massachusetts, Request for P. L. 99 Funds", there are submitted for review and approval six copies of Letter Design Report for the Restoration of Flood Control Project along the Blackstone River in Blackstone, Massachusetts. The location and general plan of recommended improvements are designated in this report.
2. Attachment A contains a letter from the Town of Blackstone which indicates an intention of local interests to meet the requirements of local cooperation. Formal assurances of local participation will be obtained pending approval and authorization of final designs for the project.
3. Plans and specifications will be prepared substantially in accordance with this report as approved. Funds in the amount of \$9,000 for preparation of contract plans and specifications, and \$128,000 for construction will be required. It is anticipated that actual construction work on this project could be started by the spring of 1970 and be completed within six months. Funds for construction will be requested upon the evaluation of bids received.

Sincerely yours,

FRANK P. BANE  
Colonel, Corps of Engineers  
Division Engineer

Incl  
as (6 cys)

BLACKSTONE RIVER FLOOD CONTROL

BLACKSTONE

RESTORATION OF FLOOD CONTROL PROJECT

BLACKSTONE RIVER

BLACKSTONE, MASSACHUSETTS

LETTER DESIGN REPORT

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

December 1969

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## ATTACHMENTS

A	Letter of Intent from Town of Blackstone
B	Real Estate

## PLATES

1	Basin Map
2	Plan and Profile
3	Sections
4	Soil Profile

BLACKSTONE

RESTORATION OF FLOOD CONTROL PROJECT

BLACKSTONE RIVER BASIN-BLACKSTONE RIVER

BLACKSTONE, MASSACHUSETTS

DECEMBER 1969

A. PERTINENT DATA

1. Purpose Overbank flood control of the Blackstone River.
2. Location Along right bank of the Blackstone River from St. Paul Street bridge downstream to the railroad embankment, Town of Blackstone, Worcester County, Mass.
3. Type of Improvement Earth dike, stone slope protection and appurtenant work.
4. Length of Improvement 1,100 L.F.
5. Hydrology

Project Design Flood (Aug 1955 Flood)	26,000 cfs
Standard Project Flood	30,000 cfs
6. Dike

Type	Earth-filled with stone slope protection to elev. 160 (msl) and topsoiled and seeded on river side, top and land side.
Length	863 feet
Top elevation	Varies
Top width	12 feet
Side slopes	1 vertical on 2 horizontal
Maximum height	7 feet
Thickness of protective stone	18 inches

7. Principal Quantities

Excavation	9,100 c. y.
Compacted earth fill	3,500 c. y.
Compacted gravel fill	2,200 c. y.
Dumped gravel fill	600 c. y.
Gravel bedding	1,700 c. y.
Protection stone	3,300 c. y.
Topsoil and Seeding	3,600 s. y.
Drainage Facilities	1 job

8. Cost Estimates

First Cost:

Federal	\$137,000
Non-Federal	9,000
	<hr/>
Total	\$146,000

9. Benefits

Flood losses (recurring 1955 record flood)	\$160,000
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## B. PROJECT AUTHORITY

This Letter Design Report is submitted pursuant to authority contained in 1st Indorsement dated 15 November 1968 from the Chief of Engineers to a letter dated 8 November 1968 from the Division Engineer, New England Division, subject: "Blackstone River, Blackstone, Massachusetts, Request for P. L. 99 Funds."

## C. SCOPE OF LETTER DESIGN REPORT

### 1. SCOPE

The report reviews the general overbank flood problem along the right bank of the Blackstone River in Blackstone, Massachusetts and submits a solution for the restoration of existing flood control works under the provisions of Public Law 99, 84th Congress. A flood control wall, constructed under the Emergency Relief Act (ERA) in 1936, provided protection for the town hall, courthouse building, residential homes and the town's recreational park and athletic field. During the March 1968 flood, the stone masonry floodwall fractured and fell into the river.

### 2. TOPOGRAPHIC SURVEY

A topographic survey of the project site on a scale of 1" = 40', and a contour interval of 2', was made in December 1968.

### 3. SUBSURFACE EXPLORATIONS

Geological reconnaissance of the project area and subsurface explorations were made during June 1969. The location and description of four test borings are shown on Plates No. 2 and 4.

### 4. ECONOMIC INVESTIGATIONS

Damage surveys were made following the March 1968 flood. Economic investigations developed losses which would result if a flood of greater magnitude or similar to the record flood of August 1955 was to occur under present conditions.

### 5. REAL ESTATE STUDIES

Real estate studies were made during September 1969. Local interests will procure all rights required in land. Present indications are that permanent easements for structures will be adequate.

Real estate costs have been estimated to be \$7,500. Details of the studies are set forth in Attachment B.

## 6. CONTACTS WITH LOCAL OFFICIALS

Close liaison has been maintained with town officials and other interested parties. A strong desire for construction and completion of the proposed project has been expressed. A letter indicating the town's willingness and ability to participate in the proposed improvement has been made available. (See Attachment A).

## 7. FIELD RECONNAISSANCE AND OFFICE STUDIES

Field reconnaissances have been made of the problem area and site of the proposed improvements. Office studies consisted of hydrologic and hydraulic analyses, design of improvement, and estimate of quantities and costs of proposed construction.

### D. PRIOR REPORTS

There are no prior reports for a local protection project along the Blackstone River in Blackstone, Massachusetts.

### E. DESCRIPTION OF AREA

## 8. GEOGRAPHY

The Town of Blackstone is located in southern Massachusetts along the Blackstone River in the lower half of the Blackstone River Basin. It is situated in Worcester County on the border of Massachusetts-Rhode Island state boundary just north of the City of Woonsocket, Rhode Island. The town has a population of about 6,000 based on the 1965 state census and a land area of approximately 11 square miles.

## 9. TOPOGRAPHY AND GEOLOGY

The valley of the Blackstone River at the project site is relatively wide and flat. In this reach the river flows along the northeast border of a broad, flat flood plain which is underlain by glacial outwash consisting of stratified and lensed sands and gravels with variable amounts of silt. The outwash deposits are generally

covered throughout the area by a thin blanket of recent alluvium composed mainly of silty sands. Locally along the river bank and elsewhere on the flood plain which has been developed, artificial, man-made fills occur overlying the natural alluvium and outwash deposits. Above the wide plain, the sides of the Blackstone valley rise from the edge of the channel on the northeast side of the river and the steep slopes are underlain by till and bedrock. Except locally adjacent to the main valley walls, bedrock is generally deeply buried under the wide flood plain.

## 10. STREAM CHARACTERISTICS

The Blackstone River Basin is located in south-central Massachusetts and northern Rhode Island and is generally elongated in shape with a length of about 49 miles, average width of 12 miles, and a total drainage area of about 540 square miles as shown on Plate No. 1. The Blackstone River originates northwest of Worcester, Massachusetts and flows in a southeasterly and southerly direction to the mouth of the estuary in Providence Harbor. In the reach from Millville, Massachusetts, the Blackstone River flows through the southwestern corner of Blackstone to the town of North Smithfield, Rhode Island. Flowing in a southerly direction and then turning sharply to a northeasterly direction, the river again enters Blackstone. It continues flowing northeasterly to Saranac Dam and St. Paul Street bridge. Just upstream of the bridge the river channel turns sharply to a southeasterly direction and continues through the proposed project site and enters Woonsocket, Rhode Island. The Blackstone River channel is about 100 feet wide through the proposed site of improvement.

## 11. PROJECT AREA

The project area is located in the Town of Blackstone on the right bank of the Blackstone River between St. Paul Street and the New York, New Haven, and Hartford Railroad. In general, the site parallels the recreational park and athletic field.

## 12. MAPS

The reach of the Blackstone River in the town of Blackstone is shown on U. S. Geological Survey Map indexed as Blackstone, Massachusetts-Rhode Island quadrangle, at a scale of 1:24,000.

## F. CLIMATOLOGY

### 13. GENERAL

The Blackstone River Basin, a humid region with an average annual precipitation of 41 inches, has a variable climate characterized by frequent but generally short periods of heavy precipitation. It lies in the path of the "prevailing westerlies" and cyclonic storms that move across the country from the west or southwest. The area is also exposed to coastal storms, locally known as "northeasters," that travel up the Atlantic seaboard. In addition, tropical hurricanes constitute an infrequent but very important potential for flood-producing precipitation, particularly from July to October. Thunderstorms may occur over the basin at any time of the year and may be of local origin or associated with a stationary front.

### 14. TEMPERATURE

The average annual temperature of the Blackstone River Basin is about 49° Fahrenheit. Recorded temperature extremes have varied from occasional highs slightly in excess of 100° Fahrenheit to infrequent lows below minus 20° Fahrenheit.

### 15. PRECIPITATION

The mean annual precipitation over the basin is about 41 inches distributed rather uniformly throughout the year.

### 16. SNOWFALL

Annual snowfall for the Blackstone River Basin averages from 35 to 40 inches with extremes ranging from 30 inches in the southern portions to about 60 inches in the northern portions. The mean annual water content of snow cover over the basin seldom exceeds three inches. Melting of the snow results in heavy spring runoff, but this source alone seldom produces a damaging flood.

### 17. STORMS

Continental storms that originate over the United States and southwestern Canada move in a general easterly and northeasterly direction and produce frequent periods of unsettled but not severe weather. The basin is also exposed to occasional coastal storms,

some of tropical origin, that travel up the Atlantic coast and move inland over New England. In addition, local thunderstorms can cause serious flash floods along the smaller streams.

## G. RUNOFF AND STREAMFLOW DATA

### 18. DISCHARGE RECORDS

The U. S. Geological Survey publishes records of six stream gaging stations in the Blackstone River Basin, four of which are on tributaries and two on the main stream. Pertinent data on the existing gages are summarized on Table 1.

### 19. RUNOFF

Flow data applicable to the area of the proposed project were determined by drainage area relationship, with the records of the USGS gaging station at Woonsocket, Rhode Island. The mean annual runoff for 26 years of record for the Woonsocket gage is 22.5 inches which represents approximately 50 percent of the mean annual precipitation.

## H. FLOODS OF RECORD

### 20. NOTABLE FLOODS

Outstanding floods on the Blackstone River may occur during any season of the year. Early spring rains combined with melting snow resulted in the flood of March 1936, 1968 and 1969. Heavy rains during summer and fall months caused the floods of November 1927, July 1938, September 1954, August 1955 and October 1955.

The flood of August 1955, the largest flood of record on the Blackstone River, was nearly two times the magnitude of the previous maximum discharge. The August flood resulted from record rainfall accompanying hurricane "Diane" falling on ground previously saturated by the precipitation of hurricane "Connie" which occurred only a few days earlier. This flood resulted in a peak discharge at Woonsocket Falls Dam of 26,000 cfs. The second largest flood of record with comparable discharge of 15,000 cfs

TABLE 1

BLACKSTONE RIVER BASIN  
STREAM FLOW RECORDS THROUGH WATER YEAR 1962

<u>Location of Gaging Station</u>	<u>Drainage Area</u> (sq. mi.)	<u>Period of Record</u>	<u>Mean</u> (cfs)	<u>Instantaneous Maximum</u> (cfs)	<u>Daily Minimum</u> (cfs)
Kettle Brook at Worcester, Mass.	31.3	1923 -	54.0	3,970 <sup>(1)</sup>	0.2
Quinsigamond River at North Grafton, Mass.	25.5	1939 -	42.9	820 <sup>(1)</sup>	0.3
Blackstone River at Northbridge, Mass.	139.0	1939 -	246.0	16,900 <sup>(1)</sup>	2.0
∞ West River below West Hill Dam near Uxbridge, Mass.	27.9	1962 - Records too short for discharge statistics			
Branch River at Forestdale, R.I.	93.3	1940 -	166.0	5,800 <sup>(2)</sup>	5.2
Blackstone River at Woonsocket, R.I.	416.0	1929 -	731.0	32,900 <sup>(1)</sup>	21.0

(1) Occurred in August 1955 (observed)

(2) Occurred in March 1936 (estimated)

occurred in March 1968 and July 1938. Table 2 is a summary of the seven highest floods recorded at the USGS gaging station on the Blackstone River at Woonsocket, Rhode Island.

TABLE 2

SUMMARY OF HIGHEST EXPERIENCED FLOODS  
BLACKSTONE RIVER AT WOONSOCKET, R. I.  
 (Discharge in Cubic Feet Per Second)

<u>Date</u>	<u>USGS Gage</u> (416 sq. mi.)	<u>Woonsocket</u> <u>Falls Dam</u> (369 sq. mi.)
Aug. 1955	32,900*	26,000 (est)
Mar. 1968	15,400	15,000 "
July 1938	15,100	15,000 "
Mar. 1936	15,000	13,200 "
Nov. 1927	15,000	13,200 "
Sept. 1954	9,400	8,300 "
Oct. 1955	8,700	7,700 "

\* Abnormal peak resulting from failure of Harris Pond Dam on Mill River. Natural peak discharge is estimated to be 29,600 cfs.

I. FLOOD FREQUENCY

Discharge frequency data for the Blackstone River at Woonsocket, Rhode Island, drainage area of 416 square miles, were developed using procedures described in Civil Works Engineering Bulletins 51-1 and 51-14 and are shown in Table 3.

TABLE 3

BLACKSTONE RIVER BASIN  
NATURAL PEAK DISCHARGE FREQUENCY DATA  
(discharge in CFS)

<u>Expected Probability Percent Chance</u>	<u>Years</u>	<u>Blackstone River at Woonsocket, R. I.</u>
.5	200	30,600
1.0	100	23,900
2.0	50	18,700
4.0	25	14,900
5.0	20	13,500
10.0	10	10,400
20.0	5	7,800
50.0	2	5,200

## J. HYDROLOGIC AND HYDRAULIC CONSIDERATIONS

### 21. FLOOD PROFILES

Flood profiles were determined by backwater computations, using computer program 22-J-L212 furnished by the Hydrologic Engineering Center. Computations were made using a Manning's "n" of 0.035 and expansion and contraction loss coefficients of 0.7 and 0.3 respectively. Flood profile elevations for three different floods are shown in Table 4.

### 22. VELOCITIES

The design flood flow of 26,000 cfs produces velocities in the subject reach area of about 9 feet per second. This represents approximately a 50 percent increase in velocities as a result of construction of the downstream Woonsocket Local Protection Project. Computed velocities are shown in Table 4.

### 23. CHANNEL SECTION

The project will be designed to provide a channel section having an approximate bottom width of 100 feet and a side slope along the right bank of 2 horizontal to 1 vertical.

TABLE 4

BLACKSTONE RIVER BASIN  
FLOOD ELEVATIONS AND VELOCITIES

Flood	Upstream End of Woonsocket LPP Station 34+50		New Haven Railroad Bridge Station 26+00		St. Paul Street Bridge Station 14+15		Saranac Dam Tailwater Station 0+50	
	Stage (msl)	Velocity (ft/sec)	Stage (msl)	Velocity (ft/sec)	Stage (msl)	Velocity (ft/sec)	Stage (msl)	Velocity (ft/sec)
<u>August 1955</u> (26,000 cfs)								
Experienced	171.0	5.7	171.4	6.3	171.6	18.4*	179.0	5.8
II Recurring with Woonsocket LPP	161.8	9.3	163.7	8.8	166.9	9.3	170.7	8.8
** <u>Standard Project</u> (30,000 cfs)	163.5	9.6	165.4	9.2	168.7	9.9	172.3	9.3
** <u>15,000 cfs Flood</u>	156.7	8.2	158.6	6.8	161.4	7.6	165.6	7.5

\*Velocity with original triple arch bridge - bridge replaced following 1955 flood

\*\* With Woonsocket LPP

## 24. STONE SLOPE PROTECTION

The design of stone slope protection was based on the "Tractive force" theory described in the draft report titled, "Criteria for Graded Stone Riprap Channel Protection," dated 20 April 1966. A D-50 minimum of 0.75 foot was used for design based on the maximum boundary shear in the section which occurs at the toe of the side slope. Depths of flow and friction slopes used in the analyses were the maximum derived from the backwater studies. Slope protection requirements are shown on Plate No. 3.

## 25. HEIGHT OF PROTECTION

The dike will be constructed to the elevation of the original flood-wall, as shown on Plate No. 2. Protection to this elevation will provide approximately 2 feet of freeboard above the profile of the August 1955 flood of record, the adopted project design flood.

## K. STANDARD PROJECT FLOOD

### 26. STANDARD PROJECT FLOOD

The standard project flood at the project site, developed in 1956 for the contiguous Woonsocket Local Protection Project, has a peak discharge of 30,000 cfs. The SPF was derived by applying the SPS 12-hour rainfall excess of 8.0 inches to the adopted unit hydrograph plus an assumed base flow of 500 cfs.

### 27. PROJECT DESIGN FLOOD

The August 1955 maximum flood of record, flow of 26,000 cfs, was adopted as the project design flood. The dike will provide 2 feet of freeboard above the design flood stage. This height is approximately equal to the SPF flood level after reduction resulting from the downstream Woonsocket project. Consideration was given to providing 3 feet of freeboard for the stages of the SPF but the scope of the project and extent of damages did not justify the additional cost.

## L. FLOOD DAMAGE AND ECONOMIC DEVELOPMENT

### 28. EXTENT AND CHARACTER OF FLOODED AREA

The town of Blackstone is basically a bedroom community in the Providence-Pawtucket Standard Metropolitan-Statistical Area with many

of its residents employed in adjoining Woonsocket, Rhode Island. The economy of the Blackstone area has completely recovered from the flood of August 1955 and the town's population is increasing at a current rate of over 3% annually. Of the 19.9% population increase between 1955 and 1965, 17.4% took place between 1960 and 1965. Located only a short distance from recently completed Interstate Route I-495 and with Interstate Route I-295 currently under construction just to the south of Blackstone, the area will continue to increase in population as the expansion outward from the growing SMSA's of Providence-Pawtucket and Boston place an increasing demand for space in the entire area between these two major urban centers.

## 29. FLOOD DAMAGES

In a recurrence of the 1955 flood levels, under today's conditions, losses in the immediate vicinity of the project area would amount to over \$160,000. The major losses would be incurred by public properties including the Town Hall, of which the basement is used as the Town Library, the District Courthouse and a park and playground of 8.5 acres. Some residential property would also be damaged. The estimated value of the properties involved exceeds \$1,000,000.

## M. EXISTING CORPS OF ENGINEERS FLOOD CONTROL PROJECTS

### 30. GENERAL

There are three existing Corps of Engineers flood control projects in the Blackstone River Basin; the West Hill Dam and Reservoir, the Worcester Diversion and the Woonsocket Local Protection.

a. The West Hill Dam and Reservoir, located on the West River in the Town of Uxbridge, Massachusetts was completed in 1961 at a cost of \$2,300,000 including recreational facilities. The earth dam is 2,400 feet long, has a maximum height of 48 feet, and retains 12,350 acre-feet of floodwater.

b. The Worcester Local Protection project, located in the towns of Auburn and Millbury, Massachusetts was completed in 1960 at a Federal cost of \$4,940,000 and a non-Federal cost of approximately \$1,021,000. The project consists of an earth-fill dam that diverts floodwaters from Kettle Brook into a 16-foot diameter, 4,200-foot long concrete tunnel and an open channel, 11,300 feet long. The diverted floodwaters by-pass

the industrial and residential areas of Worcester and flow into the Blackstone River below the city.

c. The Woonsocket Local Protection project, located in Woonsocket, Rhode Island was constructed in two stages under two separate authorizations. The Upper Woonsocket project was completed in 1960 at a Federal cost of \$4,000,000 and a local cost of \$224,000. The project, located immediately downstream of the proposed restoration works, consists of an improved channel 8,300 feet long, replacement of an existing dam with a new 266-foot long dam having four 50-foot tainter gates, four earth dikes totaling 1,310 feet in length, a concrete floodwall 310 feet long, a pumping station, modification of two railroad bridges, replacement of a highway bridge, and three new highway bridges. The Lower Woonsocket project was completed in 1966 at a Federal cost of about \$6,850,000 and a local cost of \$2,300,000. The project consists of 4,950 feet of channel improvement along the Blackstone, Mill, and Peters Rivers, 2,300 feet of pressure conduits, alterations of utilities, and modification of the Bernon Street Bridge.

#### N. IMPROVEMENT DESIRED

Several meetings have been held between representatives of the Corps of Engineers and local interests. According to local interests, the flood of March 1968 was not as severe as some in the past. However, it caused serious erosion and the collapse of the existing flood protection wall. Local officials of Blackstone are most desirous that the restoration of the flood protection works be undertaken to insure the security of public and private properties. A letter of comment from local interests is included in Attachment A of this report.

#### O. FLOOD PROBLEM AND SOLUTIONS CONSIDERED

##### 31. FLOOD PROBLEM

The damage to the floodwall along the right bank of the Blackstone River was caused by high water and high velocities. The undermining of the wall by floodwaters caused portions of the wall to collapse and fracture. Major erosion occurred intermittently along both banks of the channel in this section.

##### 32. SOLUTIONS CONSIDERED

Consideration was given to three alternatives for solving the flood

problem at Blackstone.

The first alternative consisted of widening the channel and removing the solid ledge outcrops along the river bottom. This proposal involved the taking of several acres of town property, placing slope protection along both banks, and constructing an earth dike along the right bank. Total cost of improvements was estimated at about \$250,000. This solution was not considered feasible since a dike was also required to prevent overbank flooding.

The second alternative consisted of excavating the river channel and deepening the river bed to provide a greater waterway. This plan, however, produced insufficient hydraulic benefits owing to the fact that the water surface elevation is controlled by tainter gates at the Upper Woonsocket Local Protection Dam located about two miles downstream of the proposed project site.

The third alternative consisted of constructing a concrete type T-wall but because of the excessive cost the method was altered to a cantilever concrete I-wall with steel sheet piling embedded below river bottom. The upper 6 feet of the concrete cap would extend above the original ground elevation. The cost of this plan was estimated at \$325,000 and was dropped in favor of the less costly recommended improvement.

## P. PROPOSED IMPROVEMENT

### 33. GENERAL DESCRIPTION

Plate No. 2 shows the general plan and profile of the recommended plan of restoration which consists principally of an earth dike with stone slope protection. It would include topsoiling and seeding from an approximate elevation 160 msl on the river side, across the top, and down the land side of the dike. Stone slope protection would extend upstream to cover a portion of the existing floodwall that has been undercut by the stream erosion. The dike with stone slope protection would tie into the existing floodwall about 45 feet upstream of the town highway garage and blend into the railroad embankment at the downstream end. A new drain inlet and pipe outlet to the river with a flapgate closure would be constructed for the control of interior drainage. The town highway garage would be removed and the basketball court with drainage facilities would be relocated. Plate No. 3 shows cross sections of the recommended earth dike.

### 34. EARTH DIKE

The proposed improvement would consist of removing the damaged portion of the floodwall and constructing an earth dike that would begin about 180 feet downstream of St. Paul Street, follow parallel to the river and connect to the railroad embankment. The dike would have a 12-foot top width and 1 vertical on 2 horizontal side slopes. The embankment would be a compacted earthfill section. Seepage control features include a landside toe drain which extends through the less pervious upper deposits of silty sand and tops the more pervious sandy gravel. The top of the dike averages about 6 feet above the landside ground surface.

### 35. FOUNDATION AND EMBANKMENT MATERIALS

#### a. Foundation Conditions

(1) Overburden. Man-made fill and flood plain deposits containing loose, silty, medium to fine sand extend generally to a depth of about 7 to 10 feet below the ground surface along the dike foundation area. Underlying these deposits there is a stratum about 5 feet thick of moderately compact sandy gravel underlain by loose to moderately compact silty sand. A soil profile is shown on Plate No. 4.

(2) Bedrock. Although very dark, schistose bedrock occurs in bold outcrops along the river bed and the left bank opposite the upstream end of the proposed dike, bedrock is believed to be buried below excavation grades in the dike foundation. Bedrock was not encountered within the explored depths.

#### b. Embankment Material

Preliminary studies indicate that the construction materials for the dike, earth and gravel fill, gravel bedding, and stone are available at sources located within 20 to 30 miles of the project site.

### Q. ESTIMATES OF FIRST COST

Estimates of Federal and non-Federal first cost for the project are given in Table 5. These estimates have been prepared on the basis that local interests would bear the entire cost of relocation and alterations of buildings and the paved recreational area, furnish all lands and

rights-of-way necessary for construction and operation of the project including disposal areas for excavated material not used in the dike.

Unit prices used in estimating costs are based on average bid prices for similar work in the same general area and are adjusted to the 1969 price level.

TABLE 5  
BLACKSTONE RIVER  
COST ESTIMATE FOR FLOOD CONTROL DIKE

FIRST COST  
(1969 Base)

FEDERAL

<u>Item</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
Site Preparation	1	Job	LS	\$ 1,300
Stream Control	1	Job	LS	1,000
Removal Existing Wall	1	Job	LS	4,000
Excavation	9,100	CY	\$2.00	18,200
Compacted Earth Fill	3,500	CY	3.00	10,500
Compacted Gravel Fill	2,200	CY	3.00	6,600
Dumped Gravel Fill	600	CY	3.00	1,800
Gravel Bedding	1,700	CY	4.00	6,800
Protection Stone	3,300	CY	12.00	39,600
Topsoiling & Seeding	3,600	SY	1.50	5,400
Drainage Facilities	1	Job	LS	1,800
Subtotal				<u>\$ 97,000</u>
Contingencies, 20%				19,400
				<u>116,400</u>
Engineering & Design				9,000 <sup>(1)</sup>
Supervision & Administration				11,600
<b>TOTAL ESTIMATED FEDERAL FIRST COST</b>				<u><b>\$137,000</b></u>

(1) Does not include \$16,000 allotted to perform engineering and design work including preparation of this letter-design report.

TABLE 5 (cont'd.)

NON-FEDERAL

<u>Item</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
Lands & Damages	1	LS	\$7,500	\$ 7,500
Relocation of Existing Utilities	1	LS	500	500
Building Removal	1	LS	1,000	<u>1,000</u>
TOTAL ESTIMATED NON-FEDERAL FIRST COST				\$ 9,000
TOTAL ESTIMATED PROJECT FIRST COST				\$146,000

## R. PROJECT RESULTS

Restoration of the existing project as proposed in this report will provide protection to public properties essential to the welfare of the Town of Blackstone. In an event of the magnitude of the design flood the basement of the Town Hall would be flooded to a depth of six feet without protection thus destroying the Town Library and a meeting room housed in this area. The basement of the District Court House would be flooded to a depth of five feet. Housed in this area are the repair facilities of the town's Water Department including spare meters, tools, equipment for meter repairs, and test equipment. Adjoining residential properties would also have basement flooding to full depth of the basement. A park and playground of 8.5 acres are also susceptible to heavy damage. Without the protection, a flood of greater magnitude than the March 1968 flood would overflow the bank and inundate the adjacent properties. The construction of the dike would eliminate damages from floods in this frequency range. In a recurrence of the 1955 flood levels, under today's condition, losses in the immediate vicinity of the project area would amount to over \$160,000.

## S. SCHEDULES FOR DESIGN AND CONSTRUCTION

It is estimated that preparation of contract plans and specifications for the project will cost \$9,000 and can be completed in 4 months after approval of this report. Construction of the project can be accomplished under a single contract during a 6-month period. Funds for construction of the project would be requested upon evaluation of bids received.

## T. MAINTENANCE

Maintenance of the project will be the responsibility of local interests. Periodic inspections will be made to assure that adequate maintenance is performed in accordance with regulations prescribed by the Secretary of the Army. The estimated maintenance cost to be borne by local interests is \$300 annually.

## U. LOCAL COOPERATION

Plans for local protective works in Blackstone have been reviewed by officials of the Town of Blackstone. The project has no effect on hydro-electric power generation, recreation, pollution abatement, or other collateral water resource uses.

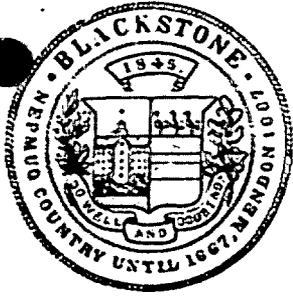
Under the delegated authority of Public Law 99, local interests are required to provide without cost to the United States, all lands, easements, rights-of-way, utility and basketball court relocation, removal of the town highway garage, and alterations necessary for project construction, including disposal areas; hold and save the United States free from damages due to the construction works; maintain and operate the project after completion without cost to the United States in accordance with regulations prescribed by the Secretary of the Army; and prevent future encroachment which might interfere with proper functioning of the project for flood control.

## V. CONCLUSION

The restoration of the existing flood control works along the right bank of the Blackstone River in Blackstone, Massachusetts, essentially as described in this report, is needed. The proposed project would provide a high degree of protection and meets the desires of local interests.

## W. RECOMMENDATIONS

It is recommended that the restoration of the floodwall at Blackstone, Massachusetts, as submitted in this report, be authorized under the provisions of Public Law 99, 84th Congress and additional funds of \$9,000 be allotted for the completion of contract plans and specifications. Funds for construction will be requested upon receipt and analysis of bids for construction.



# Town of Blackstone

Office of Selectmen

Blackstone, Massachusetts

JULES R. C. GADOURY  
RICHARD A. RYAN  
RAYMOND E. TROTTIER

October 9, 1969

Mr. Frank P. Bane  
Colonel, Corps of Engineers  
424 Travelo Road  
Waltham, Massachusetts

Dear Mr. Bane:

In reference to your communication of October 1, 1969, relative to the restoration of Flood Control Works along the Blackstone River, in the Town of Blackstone, please be advised that the Board of Selectmen, on behalf of the Town, has so voted, and hereby indicates its willingness to cooperate under the delegated authority of Public Law 99.

If there is anything further we can do to expedite the start of this restoration project, do not hesitate to call on us.

Very truly yours,

*Jules R. C. Gadoury*  
Jules R. C. Gadoury, (alt)  
Chairman  
Board of Selectmen

cc: Honorable Harold D. Donahue, Congressman

JRCG/dlb

NEDED-B

1 October 1969

Mr. Jules R. C. Gadoury, Chairman  
Board of Selectmen  
Town of Blackstone  
Blackstone, Massachusetts 01504

Dear Mr. Gadoury:

Detailed studies for the restoration of flood control works along the Blackstone River in the Town of Blackstone are nearing completion. We are currently preparing a report to the Chief of Engineers requesting additional funding and authorization under the 1941 Flood Control Act, as amended by Public Law 99, 84th Congress, to proceed with contract plans and specifications.

The project would be located along the right bank of the Blackstone River adjacent to the town park in the area between St. Paul Street and the New Haven Railroad. Flood control improvements consist of replacing the damaged stone masonry floodwall with an earth dike and stone protection along the river side slope extending down to the river edge. The dike would have a length of about 850 feet and an average height of about six feet above the existing ground. Top width of the dike would be about twelve feet and the top, landside slope, and riverside slope above the stone protection would be topsoiled and seeded. The north end of the dike would tie into the existing floodwall at a point about 45 feet upstream of the town highway garage and the south end would tie into the railroad embankment.

In addition, stone protection along the river edge would extend upstream to the concrete retaining wall by the St. Paul Street bridge and downstream to the railroad bridge abutment. A new drain inlet and pipe outlet to the river with a flap gate closure would be constructed for the control of interior drainage. The town highway garage would be removed and the basketball court with drainage facilities would be relocated.

NEDED-B

1 Oct 69

Mr. Jules R. C. Gadoury

The proposed project, which would require the taking of about two acres of town-owned land, has a preliminary estimated cost of \$148,000 of which \$9,000 would be chargeable to local interests to provide lands and pay for removal of the town highway garage and relocation of the basketball court and existing utilities. Inclosed, for your retention, are two sets of preliminary plans outlining the proposed improvements.

To indicate the views and desires of local interests in our report to the Chief of Engineers, it is requested that a letter be furnished this office outlining the willingness of the Town of Blackstone to cooperate in items of local cooperation required under the delegated authority of Public Law 99. The requirements of local cooperation are as follows:

- a. Provide, without cost to the United States, all lands, easements and rights-of-way, utility and basketball court relocations and alterations necessary for project construction which includes removal of the town highway garage;
- b. Hold and save the United States free from damages due to the construction works;
- c. Maintain and operate the project after completion without cost to the United States in accordance with regulations prescribed by the Secretary of the Army, currently estimated at \$300 per year; and
- d. Prevent future encroachment which might interfere with proper functioning of the project for flood control.

A breakdown of estimated non-Federal costs is as follows:

Lands and damages	\$6,000
Removal of town highway garage	1,000
Relocation of basketball court and existing utilities	2,000
	<hr/>
Total non-Federal cost	\$9,000

NEDED-B

1 Oct 69

Mr. Jules R. C. Cadoury

The letter of intent should be general in nature and will not be binding upon the town at this time. Prior to the issuance of contract plans and specifications, formal assurances of local cooperation will be required. We have scheduled submission of our report to the Chief of Engineers upon receipt of your letter of intent, including project approval and preliminary assurances of local cooperation.

Please advise this office if you have any questions pertaining to the proposed restoration project or the items of local cooperation.

Sincerely yours,

FRANK P. BANE  
Colonel, Corps of Engineers  
Division Engineer

2 Incl

1. Plate 1 (dupe)
2. Plate 2 (dupe)

## ATTACHMENT B

### REAL ESTATE

#### 1. LOCATION AND DESCRIPTION

The project is located easterly of and between the St. Paul Bridge and the existing railroad bridge abutment adjoining the southerly side of the Blackstone River in the Town of Blackstone, Massachusetts.

Land within the confines of the proposed project are in a single ownership, and extend to underlying high water line of the Blackstone River. A portion of a 10.5-acre recreational field required for the project is utilized as a ball park, basketball courts, winter ice skating, etc., and is owned by the Town of Blackstone.

Improvements within the proposed project include a 2-bay, garage type building of concrete block construction. The main portion of this building is presently in hazardous condition, resulting from the 1968 flood. The rear foundation and wall collapsed and the building is presently temporarily supported. Interior equipment including furnace and doors have been removed. No value is assigned to the remainder of this structure since the building is to be removed by others prior to construction of project.

Approximately 8,000 s.f. of a black-topped basketball court is located within the proposed project area necessitating removal and thereby causing severance damage to an additional 6,000 s.f. of the remaining court.

#### 2. EVALUATION

Land values are estimated on the basis of adjustments in correlating market data in the area. Permanent easement values are considered tantamount to fee values. Temporary easement values are predicated on a fair return of invested capital and real estate tax expense for a one year duration, and are estimated at 10% of fair market value. Improvement values are estimated on the basis of their contributions to in-place use.

3. VALUATION

a. Land (Permanent Easement 1.9 acres)

1.0 acre @ \$2500 per acre \$2500

(upland - Tantamount to Fee)

0.9 acres -0-

(Land underlying high water line)

0.3 acre @ \$2500 per acre x 10% 75

Total Estimated Land Value \$2575

b. Improvements

Town Garage -0-

(Hazardous condition)

8000 s.f. black-top in-place \$1500

(Portion of basketball court removed)

Total Estimated Improvement Value \$1500

c. Severance Damage

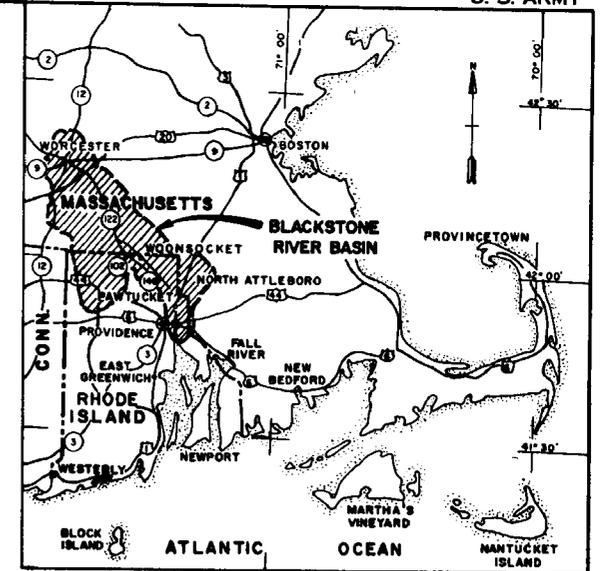
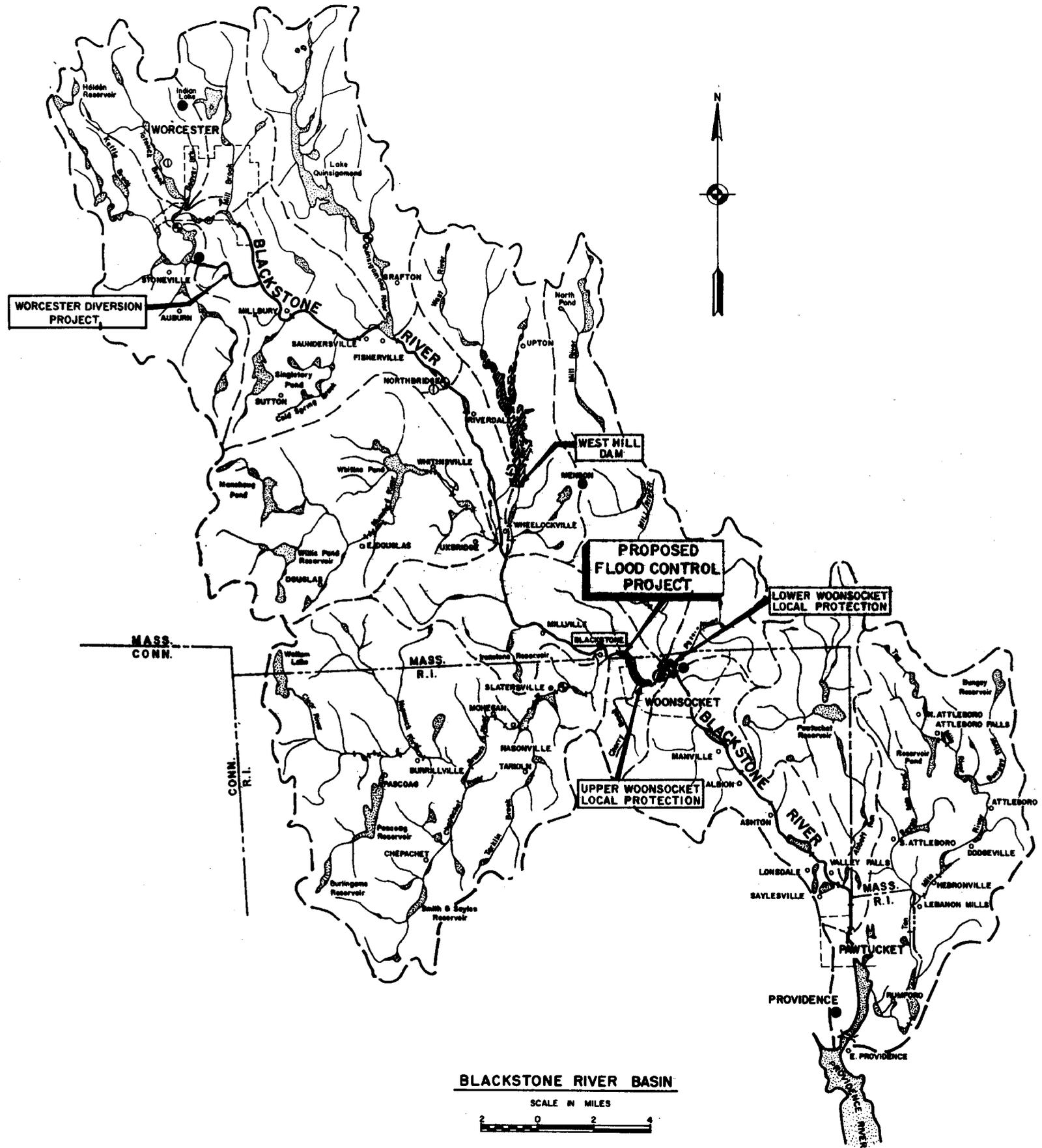
6000 s.f. black-top in-place \$1000

(residue of basketball court)

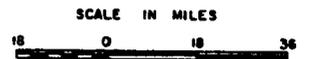
Total Estimated Severance Damages \$1000

4. COST SUMMARY

Land	\$2575
Improvements	1500
Severance Damages	1000
Acquisition Costs	1200
Contingencies (20% of \$6275)	<u>1255</u>
Total Real Estate Costs	\$7530
Rounded to:	\$7500



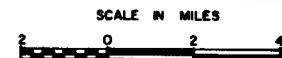
LOCATION MAP



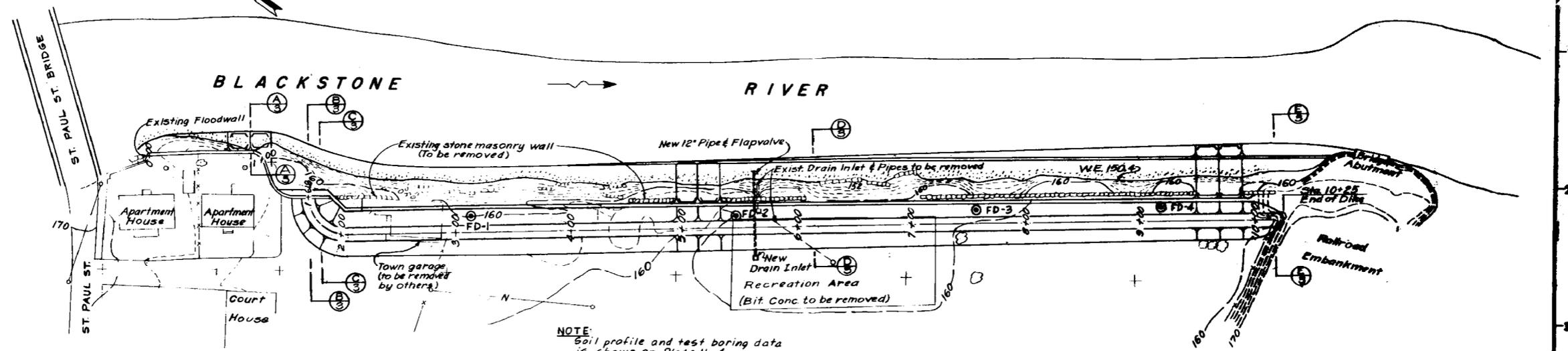
LEGEND

- ① NON RECORDING PRECIPITATION STATION
- RECORDING PRECIPITATION STATION
- ⊙ STREAM FLOW GAGING STATION
- BLACKSTONE RIVER BASIN
- EXISTING DAMS
- U.S. HIGHWAY
- STATE HIGHWAY
- STATE BOUNDARIES
- SUB-BASIN BOUNDARIES

BLACKSTONE RIVER BASIN

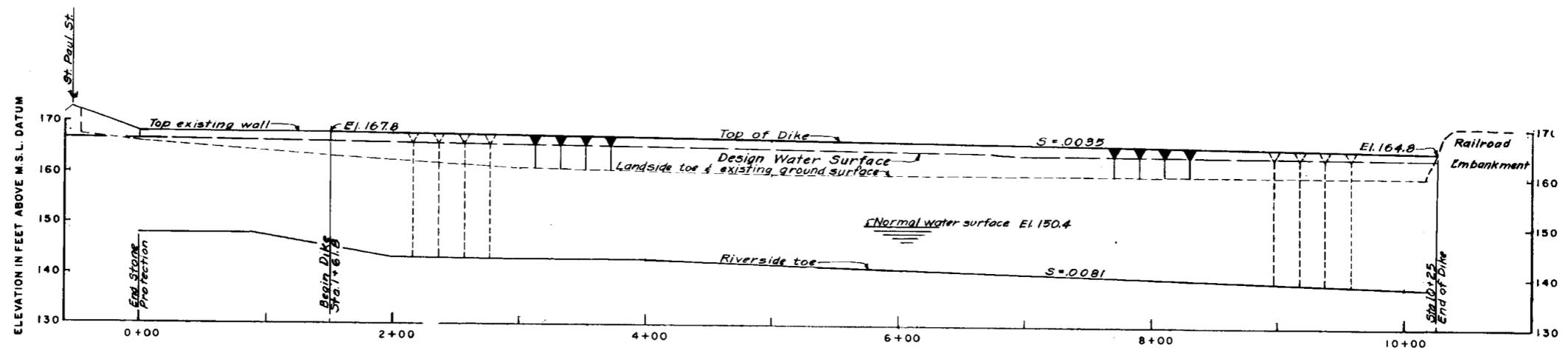


REVISION	DATE	DESCRIPTION	BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
<b>BLACKSTONE RIVER FLOOD CONTROL</b> <b>BLACKSTONE RIVER</b> <b>BASIN MAP</b>			
DESIGNED BY DRAWN BY CHECKED BY PROJECT ENGINEER	BLACKSTONE RIVER MASS. & R.I.		
APPROVAL RECOMMENDED DATE	APPROVED DATE	SCALE GRAPHIC DRAWING NUMBER	
TO ACCOMPANY REPORT DATED:		SHEET	



NOTE:  
Soil profile and test boring data  
is shown on Plate No. 4.

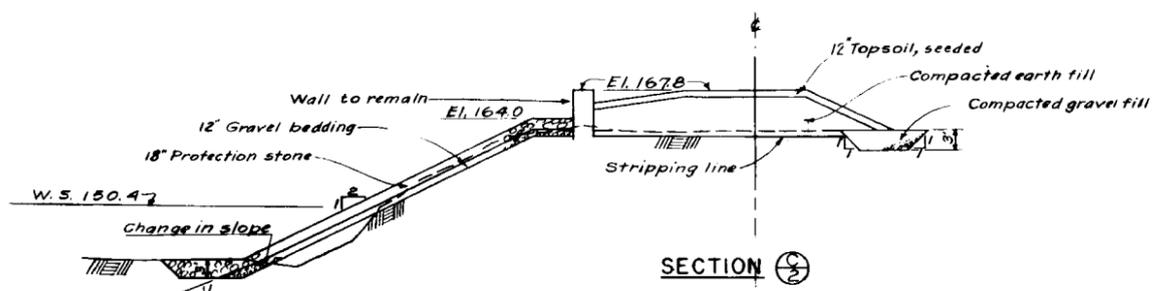
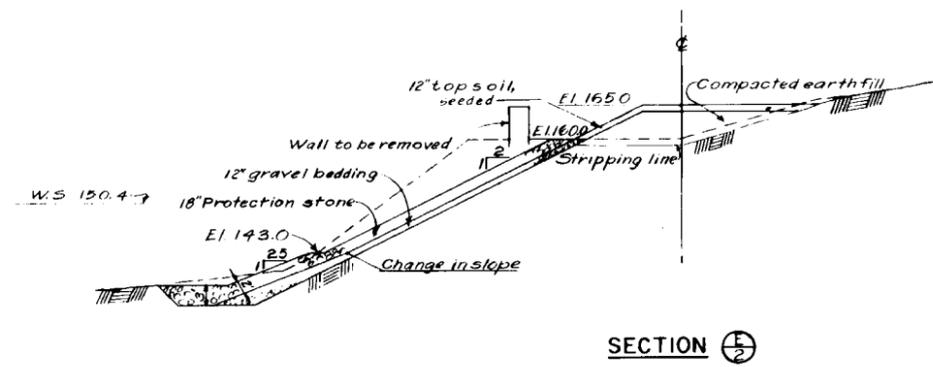
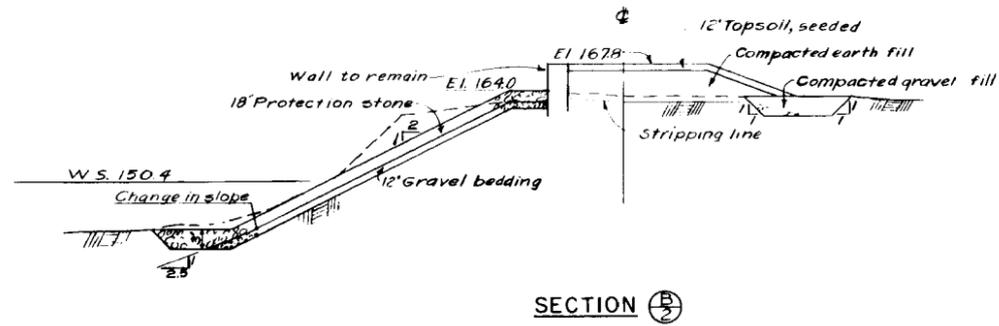
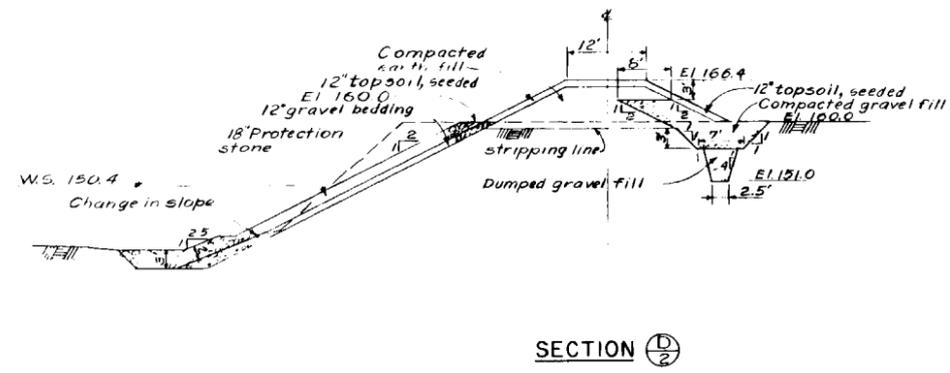
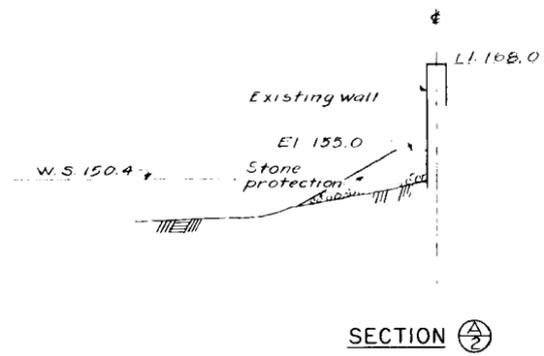
PLAN  
SCALE 1" = 40'



PROFILE ALONG C OF DIKE  
SCALE: HOR. 1" = 40'  
VERT. 1" = 10'



REVISION	DATE	DESCRIPTION	BY
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.			
<b>BLACKSTONE RIVER FLOOD CONTROL BLACKSTONE, MASS. RESTORATION OF FLOOD CONTROL PROJECT PLAN AND PROFILE</b>			
DES. BY F.T.B.	CHK. BY J.B.M.	DATE	
SUBMITTED: _____			
APPROVAL RECOMMENDED: _____			
REVIEWED: _____			
APPROVED: _____ DATE _____			
SCALE AS SHOWN SPEC. NO. _____			
DRAWING NUMBER			
SHEET			



NOTE:  
Elevations are in feet and refer to Mean Sea Level Datum.



REVISION	DATE	DESCRIPTION	BY

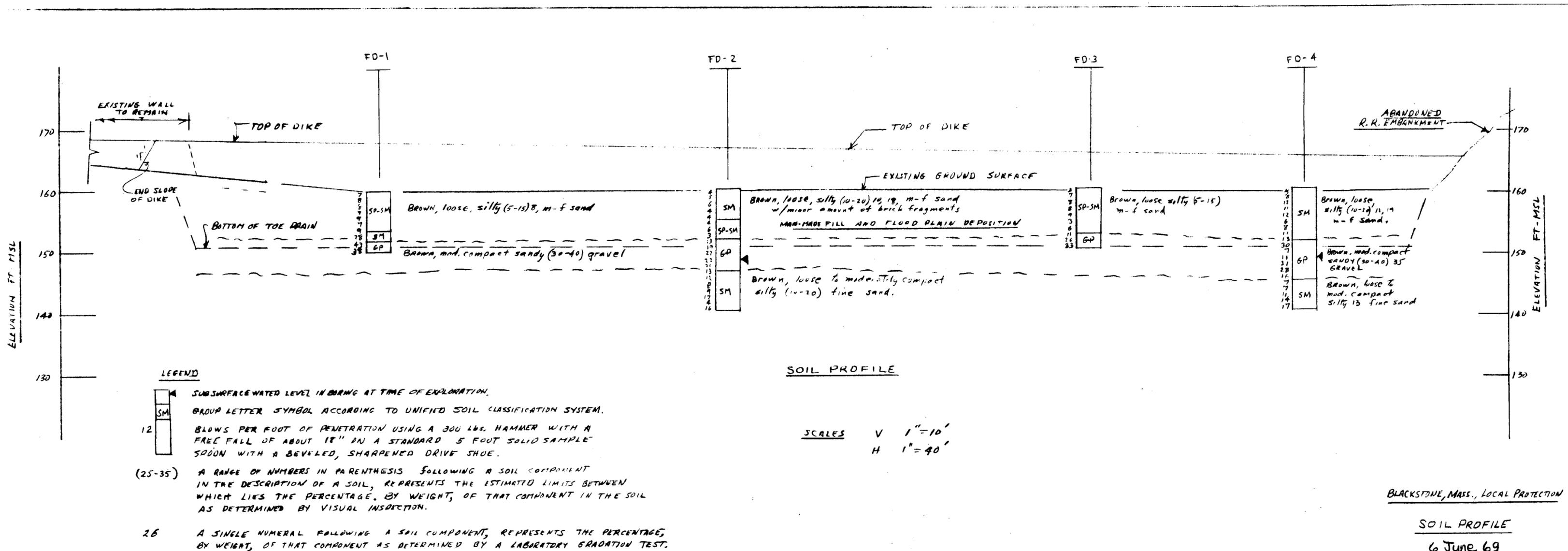
DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION  
CORPS OF ENGINEERS  
WALTHAM, MASS.

BLACKSTONE RIVER FLOOD CONTROL  
BLACKSTONE, MASS.  
RESTORATION OF FLOOD CONTROL  
PROJECT  
SECTIONS  
BLACKSTONE RIVER MASS.

APPROVED: \_\_\_\_\_ DATE: \_\_\_\_\_  
CHIEF ENGINEERING DIVISION

SCALE AS SHOWN SPEC. NO. \_\_\_\_\_  
SHEET NUMBER: \_\_\_\_\_

SHEET



ELEVATION FT. MSL

ELEVATION FT. MSL

SOIL PROFILE

BLACKSTONE, MASS., LOCAL PROTECTION

SOIL PROFILE

6 June 69

Plate No 4