WATER RESOURCES DEVELOPMENT PROJECT

PARK RIVER
LOCAL PROTECTION

CONNECTICUT RIVER BASIN

HARTFORD, CONNECTICUT

DESIGN MEMORANDUM NO. 2

PHASE II

PROJECT DESIGN

PART II - AUXILIARY CONDUIT

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

JANUARY 1975

17

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

REPLY TO
ATTENTION OF:

NEDED-E

24 January 1975

SUBJECT: Park River Local Protection, Connecticut River Basin, Hartford, Connecticut, Design Memorandum No. 2, Phase II-Project Design: Part II-Auxiliary Conduit

HQDA (DAEN-CWE-B)
WASH DC 20314

In accordance with ER 1110-2-1150, there is submitted herewith for review and approval Design Memorandum No. 2, Phase II-Project Design: Part II-Auxiliary Conduit, for the Park River Local Protection, Connecticut River Basin, Hartford, Connecticut.

FOR THE DIVISION ENGINEER:

George T. Sarandis

for JOHN WM. LESLIE
Chief, Engineering Division

Incl (14 cys)
as

WATER RESOURCES DEVELOPMENT PROJECT

PARK RIVER LOCAL PROTECTION
CONNECTICUT RIVER BASIN
HARTFORD, CONNECTICUT

DESIGN MEMORANDA INDEX

Number	Title	Anticipated Submission Date	Date Submitted	Date Approved
1	Hydrology		16 Feb 73	12 Apr 73
2	GDM - Phase I - Plan Formulation		30 Mar 73	16 Jul 73
2	GDM - Phase II - Project Design, Site Geology & Interior Drainage Part I - Box Conduit		30 Aug 74	18 Oct 74
2	GDM - Phase II - Project Design Part II - Auxiliary Conduit		24 Jan 75	
3	Hydraulic Analysis	Feb 75		
4	Concrete Materials	Apr 75		
5	Embankment & Foundations			
	Part I - Box Conduit	Feb 75		
	Part II - Auxiliary Conduit	Aug 75		
6	Pumping Stations		29 Nov 74	
7	Detailed Design of Structures			
	Part I - Box Conduit		25 Oct 74	4 Dec 74
	Part II - Auxiliary Conduit	Dec 75		
8	Site Geology			
	Part II - Auxiliary Conduit	Apr 76		

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WATER RESOURCES DEVELOPMENT PROJECT

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CONNECTICUT RIVER BASIN
HARTFORD, CONNECTICUT

DESIGN MEMORANDUM NO. 2
PHASE II - PROJECT DESIGN - PART II - AUXILIARY CONDUIT

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C	Consultant's Report
D	Project Cost and Estimates

FOREWORD

PURPOSE. This memorandum is a functional design document concerned primarily with the technical design of the structures necessary to achieve the objectives previously approved in Design Memorandum No. 2-Phase I-Plan Formulation and Design Memorandum No. 2-Phase II-Project Design, Site Geology & Interior Drainage: Part I-Box Conduit.

SCOPE. In accordance with ER 1110-2-1150 duplication of data submitted in previously approved design memoranda has been minimized. This document includes the Phase II-Project Design: Part II for the Auxiliary Conduit.

For purposes of estimating the total cost of the project and computing the Benefit to Cost Ratio, revised total Project Cost Estimates and Benefits based on all of the design accomplished to date also have been included in this Design Memorandum.

FIELD CONFERENCE. In accordance with ER 1110-2-1150, Change 5, 21 Sep 73, paragraph 14.b., a Phase II general design conference between OCE and NED personnel was held on 21 and 22 October 1974. The first day was spent at NED Headquarters in Waltham, Massachusetts and the second day was spent at the project site in Hartford, Connecticut.

WATER RESOURCES DEVELOPMENT PROJECT

PARK RIVER LOCAL PROTECTION
CONNECTICUT RIVER BASIN
HARTFORD, CONNECTICUT

A. PERTINENT DATA

NOTE: The pertinent data submitted herein applies to the Auxiliary Conduit. For additional pertinent data relating to the project in its entirety as well as other project features refer to Design Memorandum No. 2, Phase II-Project Design, Site Geology & Interior Drainage: Part I-Box Conduit which was submitted 30 August 1974 and approved 18 October 1974.

AUXILIARY CONDUIT

Length, feet	9,200
Size, Inside Diameter	22'-0"
Material	Reinforced Concrete

CONDUIT CAPACITY

Auxiliary Conduit (22 ft. dia.)	5,400 CFS

LANDS AND DAMAGES (Entire Project)

Lands Previously Acquired in Fee	9.50 acres
Permanent Easements	10.15 acres
Temporary Easements	41.24 acres
Building	Brick Garage

PRINCIPAL QUANTITIES (Auxiliary Conduit Only)

Excavation	
Earth, common	11,000 c.y.
Rock, structure	11,000 c.y.
Rock, tunnel	200,000 c.y.
Tunnel, mine ties	240,000 lbs.
Rock bolts	18,000 ea.
Soldier beams, lagging, bracing	15,000 s.f.
Concrete, mass	4,000 c.y.
Concrete, reinforced	
Tunnel in rock	4,000 c.y.
Concrete, tunnel lining	74,000 c.y.
Grout, tunnel rock	5,000 c.f.
Water stops	29,000 l.f.
Misc. metals	40,000 lbs.
Seeded topsoil	20,000 s.y.

ESTIMATED PROJECT COSTS (Entire Project-Nov 1974 Price Level)

Lands and Damages	1,000,000
Relocations	400,000
Pumping Stations	1,300,000
Conduit Extension	26,100,000
Auxiliary Conduit	33,500,000
Engineering and Design	4,800,000
Supervision and Administration	4,000,000
TOTAL FIRST COST	71,100,000

COST APPORTIONMENT

Federal	69,700,000
Non-Federal	1,400,000

ECONOMIC ANALYSIS

Annual Benefits	3,349,500
Annual Costs	2,620,000
Benefit-Cost Ratio	1.3 to 1

CONSTRUCTION PERIODS

Box Conduit	3.5 Years
Auxiliary Conduit	3.0 Years

B. LOCAL COOPERATION

1. VIEWS OF LOCAL INTERESTS. Meetings have been held with local officials to keep them advised as to the progress of the preliminary design of the project, to exchange ideas, and to keep them informed of the total estimated project cost and non-Federal costs.

The following question was approved by the voters at the November 5, 1974, State and Special City Election of the City of Hartford, Connecticut.

"For ordinance authorizing $3,000,000 Bonds to provide funds for City's share toward total cost for completion of Park River Flood Control Project."

The votes for this referendum were as follows: 13,384 Yes and 5,350 No. A letter dated November 8, 1974 confirming this vote and attested to by Robert J. Gallivan, Town and City Clerk is included in Appendix B as Exhibit 1.

2. LOCAL AGREEMENTS. The formal Agreements were prepared in accordance with the conditions submitted in Design Memorandum No. 2 - Phase II - Part I which was approved 18 October 1974. The formal Agreements were requested of the local interests on 29 October 1974.

On 25 November 1974 copies of the Agreement for Local Cooperation were received from the State of Connecticut. The Agreement was executed by the Commissioner of the Department of Environmental Protection, Douglas M. Costle.

On 21 November 1974 the Greater Hartford Flood Commission unanimously passed a Resolution, with all seven members of the Commission present, to authorize the Chairman of the Greater Hartford Flood Commission to sign the Agreement for Local Cooperation. The executed agreement was returned to the New England Division by letter dated 24 December 1974, from the Greater Hartford Flood Commission.

C. LOCATION OF PROJECT AND TRIBUTARY AREA

3. REFERENCE. See DM No. 2 - Phase II - Part I, page 7.

D. HYDRAULIC ANALYSIS

4. HYDRAULIC ANALYSIS. The function of the Auxiliary Conduit is to supplement the capacity of the main Park River Conduit to convey peak runoff rates during large flood events. Under design flood conditions the conduit will discharge at the peak rate of 5,400 cfs. This discharge rate, coupled with the requirement of maintaining the headwater pools on the North and South Branches of the Park River at or below elevation 52.0± feet, m.s.l. formed the basis for selection of the size and shape of the Auxiliary Conduit cross-sections for all the alternative schemes presented in this design memorandum.

In the development of hydraulic and energy gradelines a Manning "n" value of 0.013 was used to compute energy losses due to frictional resistance while bend losses were computed using coefficients of velocity head determined from WES Hydraulic Design Chart 228-1. Losses due to gradual contraction or expansion of area were determined using 0.2 and 0.3, respectively, times the change in velocity head across the transition. Energy losses occurring in the Auxiliary Conduit entrance at the Junction Structure were determined by hydraulic studies performed on a physical model of the conduit system at the Alden Research Laboratories of the Worcester Polytechnic Institute, Holden, Massachusetts. An exit loss of one full velocity head was assumed to occur at the exit.

Although the model study indicated no adverse hydraulic conditions occurring at the Auxiliary Conduit entrance with or without an air vent, it has been decided to provide one as a conservative measure.

A detailed report of the hydraulic analysis of the Park River Conduit System will be presented in Design Memorandum No. 3, Hydraulic Analysis.

E. GEOLOGY AND SOILS

5. GENERAL GEOLOGY. The project is located within the Connecticut Valley, a broad lowland underlain by Triassic bedrock consisting of conglomerate, sandstone and shale with included sheets of basalt. The bedrock of the region is blanketed by glacial till which generally mantles the bedrock surface and is exposed at the surface in the higher parts of the lowland. In the low lying areas, the till is buried beneath extensive lacustrine deposits of stratified sands and varved silts and clays. The varved, fine grained deposits grade upward to silts and sands and become integral with the terraces of sands and gravels.

The subsurface water surface is generally controlled by local stream gradients with the upper clay layer creating an impervious boundary which may control subsurface discharge.

A complete discussion of the geology will be covered in DM No. 8, Site Geology - Part II - Auxiliary Conduit.

6. SUBSURFACE INVESTIGATIONS. Explorations and seismic profiles have been made along the tunnel alinement. Seismic lines have been confined to the area between Stations 44+00 and 98+00 where the tunnel alinement parallels Park Street. Twenty-two borings have been completed for the Elevation -14 invert studies for Alinement "A". Additional borings are in progress along Alinement "D" with approximately 50% of the existing borings previously completed being deepened to the revised conduit grade. Additional borings are planned along the revised alinement between Stations 7+25 and 29+00.

7. ALINEMENT A.

a. Geology. A profile of the assumed rock surface along the Auxiliary Conduit alinement is shown on Plates 2B-2 thru 2B-15. The bedrock on the tunnel portion of the project between Stations 27+75 and 98+25 consists of interbedded sandstone and shales with a basalt intrusion between Stations 86+00 and 89+00. The sandstones and shales are generally thin-bedded, soft to moderately hard and variable in color from red to gray. The bedding trends approximately normal to the tunnel alinement and dips eastward at 15° to 20°. Widely spaced relatively tight, steeply dipping strike and dip joints provide a dominant control in the rock structure. The basalt, emplaced as a series of volcanic flows, is dark gray to black, very hard, and fine grained. Pressure tests indicate the bedrock to be relatively tight except for isolated areas and a fault zone encountered at Station 57+50. A high water surface exists in the tunnel section with artesian flows being encountered at the till-rock interface throughout the tunnel alinement at the higher elevations.

Overburden overlying the tunnel section generally consists of a till mantle overlain by silt and soft varved clay deposits which thicken to depths of 60 feet at the intake portal.

Tunneling conditions will be highly variable ranging from all earth to mixed face and rock alternating in sections throughout the tunnel alinement. Typical sections shown on Plates 2B-2 thru 2B-11 indicate the range of tunnel support systems which will be required. Tunneling in the soft varved clay sections, based on previous tunnel experience in the immediate vicinity will require the use of compressed air.

In the open cut portion of the project between the Connecticut River floodwall and Station 27+75 the bedrock is an interbedded sandstone and shale, generally sound, unweathered and moderately hard. The overburden is highly variable consisting of a thin till mantle overlying the rock which is blanketed by thicker deposits of silts, clays and soft varved clays. Recent fills in thicknesses ranging from 5 to 40 feet are prevelant throughout the open-cut portion of the work. Subsurface water levels generally profile the ground surface at the depth of less than 10 feet.

b. Soils.

(1) General. The construction of Alternate "A" will involve the use of "cut and cover" methods for the 1800-foot reach between Station 27+75 and the Connecticut River. The foundation soils within and below excavation grades consist of silts, clays, and soft varved clays overlain in places by 5 to 40 feet of man-made fill and alluvium and underlain by a thin glacial till mantle and bedrock. The silts and clays are 20 to 60 feet thick with the thickness increasing toward the Connecticut River. The construction methods investigated are based on causing the least foundation disturbance in order to minimize damage to buildings, utilities and pavements. The major controlling design considerations included means to prevent consolidation of the foundation soil by maintaining the water table at its present level outside the excavation, and means of minimizing lateral movement of the soil towards excavated areas. Construction methods satisfying these considerations were developed to the extent necessary to provide preliminary construction cost estimates for the purposes of cost comparison and evaluation.

(2) Reinforced Concrete Wall Built by Slurry Trench Method. Reinforced concrete walls, constructed in slurry filled trenches, will extend to rock or to a depth below required excavation equal to two-thirds the maximum differential head of water to prevent uplift at the bottom of the excavation. These concrete walls will act as sheeting and also serve as construction forms for a rectangular shaped conduit. The walls would remain in-place permanently as a seepage barrier. There are several potential disadvantages to this type of construction related to the design, control and disposal of the slurry mix, and the potential of lateral movement towards the excavated area within the active pressure zone on either side of the slurry wall.

(3) Ground Freezing Method. The soil on both sides of the excavation would be frozen prior to excavation. Principal disadvantages of this type of construction are cost and potential damages from frost action in the soils.

(4) Underwater Construction with Precast Sections. The excavation would be done by dredging between sheet pile walls without unwatering. Precast conduit sections would be lowered through the water to a prepared bed and joined tight by divers. Principal disadvantages of this type of construction are those typical of any underwater construction operation.

8. ALINEMENT D.

a. Geology. Overburden conditions as discussed under Alinement "A" are assumed to be generally applicable to Alinement "D". The lowering of the tunnel to an invert grade which, based on all available geologic information will place the entire tunnel in rock, has reduced the amount of temporary support and eliminated any tunnel sections in earth. The selected invert grade was based on obtaining a minimum of two diameters of rock cover above the tunnel crown. The assumed elevation of rock at the discharge portal is based on subsurface data available from borings made during the design of the Hartford Dike by the Corps of Engineers in 1942. It is presently assumed, that rock conditions for the deep tunnel will not be dissimilar from conditions assumed in the deeper sections of Alinement "A".

b. Soils. The principal geotechnical aspect of Alinement "D" involves the design and construction of the outlet shaft through overburden. Approximately 90 feet of the shaft will be through soil consisting of 30 feet of man-made fill and alluvium underlain by 50 feet of varved clay and 10 feet of glacial till. Several methods of construction are being considered. At this stage of design, it is considered that one of the most economical and efficient methods of construction would be the "open-pit," caisson method with materials dredged out within the advancing caisson and the caisson sunk under its own weight with the aid of jetting along its perimeter and materials removed by clamshell bucket. Once the caisson reaches the till and rock, special provisions will be made for reaming, seating and plugging at the rock surface. The shaft would be located on the river bank at a safe distance from any structure in the event that shaft construction induced ground subsidence.

F. OTHER PLANS INVESTIGATED

9. BOX CONDUIT. The Box Conduit portion of the project consists of the design of the remaining sections necessary to complete the existing box conduit plan for Park River (Plate 2B-1). This part of the project was presented in Design Memorandum No. 2, Phase II, Part I - Box Conduit submitted 30 August 1974 and approved 18 October 1974.

10. AUXILIARY CONDUIT.

a. Concept. Major consideration was given to the selection of the alinement for the Auxiliary Conduit. The number of alternatives available was greatly influenced by the manner in which the conduit could be built. Two basic approaches were considered in the investigation. The first approach considered construction of about 80 percent of the conduit by the tunneling method and 20 percent by the cut-and-cover method (two-phase construction). Tunneling was contemplated for the segment originating at the Junction Structure in Pope Park and terminating at Union Street. The remainder of the Auxiliary Conduit from Union Street to the Connecticut River would be constructed by the cut-and cover method. The second basic approach considered was a single phase through tunnel (single phase construction) from the Junction Structure to the Connecticut River.

b. Two-Phase Construction:Part Tunnel-Part Cut-and-Cover.

(1) Considerations. The terrain appeared to favor the plan of tunneling in the high cover area which extends from Pope Park to Governor Street and cut-and-cover from Governor Street to the end of the project. This logic stemmed from past experiences which indicated that open excavation is normally considerably cheaper than tunneling. The feasibility of open excavation in the lower segment was influenced by the large segments of land to be made available by the Hartford Redevelopment Agency. The alinement for the tunnel segment was fixed by the Junction Structure at its origin and by the availibility of land at the tunnel's terminus. Running the tunnel underneath Park Street would minimize the cost of permanent subsurface easements. The alinement for the open excavation segment from Governor Street to the Connecticut River was flexible and required an in-depth study. The study revealed that four possible routes were available which are indicated on Plate 2B-36 as "Original Scheme" and as Schemes "A", "B", and "C". Major problems encountered in evaluating the four schemes included: utilities, traffic, business disruptions, ground water, Interstate Route 91 bridge foundations, a railroad line and the existing pumping station and flood walls. The utilities encountered were found to be critical and very expensive items to accomodate since they involved buried main trunk lines. Electrical services for half the City enters the sub-station from the east (Plate 2B-36) and departs from the sub-station along Van Dyke Ave. then branches out along Sheldon Street and Charter Oak Ave. The closeness of the bent supports for Interstate Route 91 and the depth of the bearing piles greatly influenced the alinement and costs. Only two bays were determined to be sufficiently wide

enough to permit the conduit to pass through and these would provide but a minimum amount of clearance. The foundation material and the ground water were considered to be a very serious problem in the areas of open excavation. The area already shows signs of ground settlement in the vicinity of the sub-station and the church. The church steeple is tilting and is presently under investigation by the owner. Any change in the ground water table could seriously affect existing structures, consequently it was determined that any open cut construction technique must utilize a system of support which would not alter the water table. This requirement eliminated the more conventional and cheaper methods of steel sheeting or soldier beams and lagging. The most practical and positive method of support and water cutoff was found to be the costly system of reinforced concrete walls built by the slurry trench method and with required bracing.

(2) Cost Comparison. A cost comparison was made for each of the four schemes cited above. The comparison dealt with the segment from Station 27+75 (Union Street) to the flood walls at the Connecticut River. A summary of costs is included in Tables 1 and 2. Scheme "A" was determined to be the least costly overall and the second lowest in cost for the City.

(3) Scheme A. Since "A" was determined to be least expensive of the two-phase construction alternatives, the scheme was studied in greater detail. The plans, profile and sections for Scheme "A" are shown on Plates 2B-2 thru 2B-17. The plan includes a tie in at the Junction Structure, an intake at Station 98+71, a transition from a 22 ft. square to a 22 ft. circular section, a tunnel with invert at Elevation -14.0 m.s.l. would begin at Station 97+61 and would end at Station 27+75. At Station 27+75 the conduit would revert to an open-cut cast-in-place rectangular conduit 18.5 feet by 22 feet which would extend to the outlet structure located at the Connecticut River. The portal for construction of the tunnel would be reached by means of a ramp in the vicinity of Union Street. The tunnel segment would be located in an area slated for urban renewal which will provide sufficient room for the tunneling operation. The site of the portal was governed by the depth of the overburden, the availability of land and also by the need of a positive cutoff for the reinforced concrete slurry wall. To obtain a positive cutoff for ground water Union Street was considered to be a less expensive site than the previously considered Governor Street site for locating the tunnel portal.

(4) Cost. A detailed cost estimate was made for Scheme A and is included in Appendix "D". Major factors which influenced the cost included: extensive amount of mixed face tunneling, utilization of a costly system of reinforced concrete slurry wells, massive buried utilities, Interstate Route 91, a railroad and buried foundations. The total cost for Scheme "A" including lands and damages, relocations, contingencies, E & D and S & A is estimated to be $53,900,000. See Table 1.

c. Single Phase Construction: Through-Tunnel.

(1) Development. The excessive costs encountered in the two-phase construction, particularly the mixed face tunneling and the reinforced

concrete "slurry" walls, dictated that further consideration should be given to alternatives which would avoid or minimize the amount of the costly items. For the Auxiliary Conduit it became obvious that the normally cheaper open excavation type construction had serious drawbacks and that a deeper through-tunnel should be considered. A study of the rock profile and an investigation of field conditions revealed that a deeper through-tunnel was worthy of consideration.

(2) Scheme D. An in depth study was undertaken for a deep through-tunnel and the selected alinement is shown on Plate 2B-1 and also on Plate 2B-36 as Scheme D. The Scheme D alinement terminated at the Connecticut River at a site which was determined to be highly favorable since it contained an excellent work site, easy access and river docking facilities. Other alinements for the deep tunnel were considered particularly those that would have a shorter length. The shorter alinements were ruled out due to the cost of developing a reasonable work site at the river, and the desire to avoid tunneling underneath high-rise buildings. The detailed plans, profiles and sections for Scheme D are shown on Plates 2B-18 thru 2B-34. A more detailed description of the features contained in Scheme D is included in Section G, Description of Proposed Structures and Improvement.

(3) Cost. A detailed cost estimate of Scheme D was prepared and is included in Appendix D. The cost of the deep tunnel was determined to be $38,530,000, including lands and damages, relocations, contingencies, E & D and S & A.

d. Selected Plan. The deep tunnel, Scheme D, was selected as the best plan since it provides for substantial savings $15,370,000 less cost than the second best scheme Scheme A. See Table 1. In addition to the substantial savings, Scheme D would require no disruption of streets, utilities, traffic or businesses, and is also less costly to the City of Hartford.

G. DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

11. GENERAL. The selected plan for the Auxiliary Conduit contains four basic structural elements which include the intake structure, the tunnel, the outlet structure and an inspection and clean out shaft. The overall length of the Auxiliary Conduit is 9,200 feet which extends from the Junction Structure at Pope Park to the outfall structure at the Connecticut River. The layout and details of the proposed structures are shown on Plate 2B-18 thru 2B-34.

12. INTAKE STRUCTURE COMPLEX. The intake complex abuts the Junction Structure and provides for a smooth transition of flows from EL 16.4 to EL-95.22 msl. The intake structure is to be of concrete and also serves as an air vent for conduit flows. The structure contains provisions for the installation of stop logs to permit dewatering of

the tunnel. The stop logs for the intake structure as well as for the outlet structure are to be stored in compartments as shown on Plate 2B-18 and 2B-33. The lower end of the intake complex contains the transition from a 22 foot square conduit to a 22 foot round tunnel.

13. TUNNEL. The tunnel is to be constructed in rock with an inside diameter of 22 feet and lined with 2 foot thick concrete walls. The concrete liner will contain a minimum amount of reinforcing and the major portion of the rock will be secured by means of mine ties, rock bolts and shotcrete. The tunnel is approximately 9000 feet long and has an invert slope of approximately 0.5778%. The assumed invert of the tunnel at its lowest point (Sta 7+91) is EL-147.0 msl and may be modified slightly when additional borings have been completed.

14. OUTLET STRUCTURE COMPLEX. The complex begins at Sta 7+91.48 and is shown on Plates 2B-32 and 2B-34. The transition from the tunnel to the vertical shaft will contain a bend with radius of 3D (66 ft) to provide for a smooth transition of flow. The vertical segment will be 22 feet inside diameter constructed partly in rock and partly in earth. The vertical shaft in rock will contain a concrete liner; in earth the shaft will consist of the concrete caisson used to construct the shaft. The outfall structure located at the top of the shaft will be approximately 72 feet by 65 feet with a sill elevation of 0.0. The outfall structure will contain piers with stoplog recesses which are to be used as part of the tunnel dewatering process. The segment from the outfall structure to the river will be paved with rock.

15. CLEAN OUT AND INSPECTION SHAFT. An intermediate shaft has been located at Sta 37+00 to serve several functions (Plates 2B-27 and 2B-32). The shaft will provide access to the tunnel for inspection and clean out. Neither the intake structure or the outlet structure could be used as clean outs due to the steep slopes of the bends. The structures could not be easily modified to accommodate cleaning equipment. The clean out shaft will contain an opening in the roof of the tunnel approximately 12 feet by 20 feet by which standard equipment can be lowered vertically into the tunnel and debris can be lifted out. A working platform will be provided at the bottom of the shaft. The shaft will be excavated mostly in rock and will be circular and contain a concrete liner. The intermediate shaft will also benefit the construction of the tunnel. Once the Contractor has driven his tunnel from the river's edge to the intermediate shaft the risk of a shut-down of tunneling operations due to flood stages in the Connecticut River is eliminated. The Contractor can readily seal the shaft at the river's edge and continue to work through the intermediate shaft. The flood stage protection at the river during construction can be reduced to an economical level. Utilizing the inspection shaft to remove tunneling material during constructions will also cut down substantially on the distance the material must be hauled. The intermediate shaft may be of benefit if a tunneling machine is used to

construct the tunnel. This shaft will permit the tunneling machine to be backed up past the shaft (without having to be dismantled and removed from the tunnel) so that conventional drilling and blasting techniques can be used to excavate through the basalt dike that is upstream of the shaft.

H. CONSTRUCTION PROCEDURE AND DIVERSION PLAN

16. GENERAL. The major construction feature of the proposed Auxiliary Conduit, Scheme "D", is the 9000 foot tunnel. To minimize the impact of the water control on the tunneling operation, it is logical to assume that the Contractor will commence tunneling at the lowest elevation (Connecticut River end) and tunnel upward to the Pope Park end. By tunneling in this direction, the water drainage is away from the tunneling face; and is readily controlled and the risk of flooding equipment is greatly reduced. In order to begin the tunneling operation, the Contractor must obtain access at the proper elevation; consequently the Contractor's first major priority will be to construct the shaft at the Connecticut River's edge. Simultaneous with the construction of the river shaft it is expected that he will initiate the construction of the clean out shaft located at Sta 37+00. The intake structure is not as critical, and it is contemplated that construction will be delayed a year in order to permit the completion of the Junction Structure by a separate contract.

17. CONSULTANT. During the preliminary planning for the proposed scheme the services of a consultant were obtained. Particular features of the proposed plan were discussed with the consultant by members of NED representing the various design disciplines. The consultant, Dr. Ronald C. Hirschfeld of Geotechnical Engineers Inc., prepared a summary of his observations which are included in Appendix C. Many of his recommendations have been incorporated in the proposed plan.

18. OUTLET STRUCTURE. The most difficult feature to construct of the Auxiliary Conduit is expected to be the river shaft. The depth to bed rock, and the 30-40 feet of sand and 40 feet of varved clay are considered to be problem areas. The shaft is planned so as to be constructed by means of a 22 foot inside diameter cast in place open caisson. The sinking of the caisson will be controlled by a combination of excavation, jetting and weight application. Obtaining a water-tight joint between the bottom edge of the caisson and the bed rock will require special consideration in the design. The shaft is expected to be constructed vertically to EL-147 msl to facilitate construction. The curvature required for the bend at the bottom of the shaft between the tunnel and the shaft will be constructed after the need for the shaft for tunneling purposes has been completed. The top of the caisson during construction has been selected at EL-25.0 msl. This elevation will provide flood protection for a flood frequency of

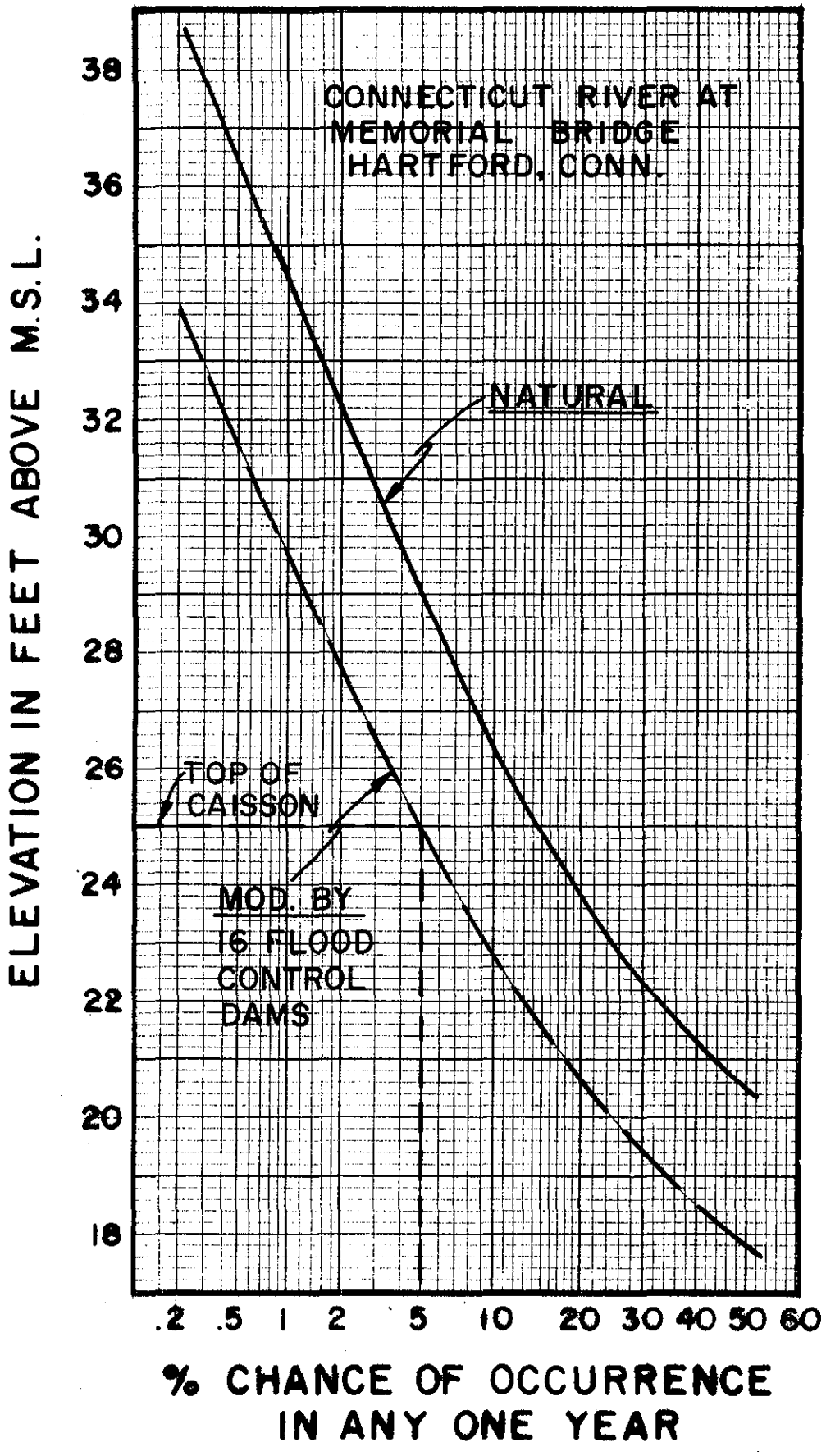

CONNECTICUT RIVER AT
MEMORIAL BRIDGE
HARTFORD, CONN.
NATURAL
TOP OF
CAISSON
MOD. BY
16 FLOOD
CONTROL
DAMS
ELEVATION IN FEET ABOVE M.S.L.
38
36
34
32
30
28
26
24
22
20
18
.2
.5
1
2
5
10
20
30
40
50
60
% CHANCE OF OCCURRENCE
IN ANY ONE YEAR

FIGURE 1

1 in 20 years. See Figure 1. The men and equipment can be protected from greater floods by means of sealing the shaft and by working out of the shaft at Sta 37+00 once the tunneling has progressed to Sta 37+00. Upon completion of the tunneling, the upper level of the outlet structure will be modified and the outfall structure will be built. Construction will be accomplished by means of a single-wall braced steel sheet cofferdam.

19. TUNNEL. The tunnel is expected to be excavated by the conventional drill, blast and muck method. The relatively short length of the tunnel, 9000 feet and the basalt dike make it improbable that a machine tunneling method would be employed since it requires a large initial investment. The contract would permit the Contractor to use a tunneling machine if he so elected. By the conventional method the rock excavation is expected to be to 26 feet in diameter and would permit 6" overbreak at the face. The rock is primarily a sound shale and sandstone having good strength and moderate hardness. Following the excavation, the rock face is to be secured by means of rock bolts and longitudinal mine ties. As the excavation and bolting progresses, the tunnel lining will be installed. This will be accomplished by means of constructing the inner liner and by placing concrete between the form and the rock surface.

20. INTAKE STRUCTURE. No particular problems are expected to be encountered in construction of this structure. Support for excavation in earth is expected to be accomplished by means of soldier beams and lagging and rock anchors. The final connection to the Junction Structure will not be made until the tunneling operation is complete.

21. CLEAN OUT SHAFT. The majority of the excavation is in rock with only a thin layer, 30 feet, of overburden. The support of the overburden during construction will be by means of soldier beams and lagging. The rock excavation is not expected to present any significant problems.

I. ENVIRONMENTAL ANALYSIS

22. ENVIRONMENTAL SETTING. The Auxiliary Conduit will pass from Pope Park in an easterly direction to the Connecticut River. The proposed alinement will pass under the residential area along Park Street, and then under lands owned by the Hartford Redevelopment Agency and the Hartford Electric Light Company.

23. SCHEME A. The Auxiliary Conduit will be tunneled from Pope Park to the Connecticut River. Subsurface easements will be obtained for this section of the conduit. It will come out from underground in the vicinity of Union Street, where it will then proceed in a trench to the river. The trench, upon completion of the conduit, will be backfilled and then regraded. There will be no enhancement measures taken in this area.

The outfall at the river will have an invert of -14 feet msl with the bottom of the river being approximately -17 feet msl. Because of this, the conduit will be filled with water to varying depths depending on the stage of the river.

24. SCHEME D. This scheme will essentially follow the same alinement as Scheme A except that instead of coming out from underground it will remain in a deep rock tunnel to a point on the bank of the Connecticut River. The tunnel will reach a low point elevation of -147 feet msl and then proceed in a vertical shaft to the riverbank above. This shaft will be topped with a "morninglory" which will allow water to flow from the conduit smoothly. With this scheme, the tunnel will be filled with water.

Subsurface easements will also be obtained for this scheme except that it will not come out from underground as does Scheme A. This has an advantage in that there will be no need for trenching, utility relocation, shoring and sheeting, and slurry trenching.

The Auxiliary Conduit although filled with water will be flushed out by heavy rainfall on the average of three times per year. Ventilation for the tunnel will be provided at three locations (Pope Park, Governor Street, and the Connecticut River).

Since the conduit will be constructed nearly all underground (except for a portion in Scheme A) no esthetic impairment for the area above it is foreseen. In all cases preventative measures will be taken to minimize any adverse impact on the local environment. During construction; noise, increased siltation and dust resulting from moving equipment and traffic congestion will be minimized and controlled as much as possible. Traffic controls will be in cooperation with local officials.

J. CORROSION MITIGATION

25. REFERENCE. See DM No. 2-Phase II-Part 1, page 31.

K. ACCESS ROADS

26. REFERENCE. See DM No. 2-Phase II-Part I, page 31.

L. CONSTRUCTION MATERIALS

27. REFERENCE. See DM No. 2-Phase II-Part I, page 31.

M. RESERVOIR CLEARING

28. REFERENCE. See DM No. 2-Phase II-Part I, page 32.

N. ENVIRONMENTAL QUALITY ENHANCEMENT MEASURES

29. ARCHITECTURAL ENHANCEMENT. In Scheme D the above ground elements of the intake structure consists of an air vent shaft, covers at stop log storage crypts, and curb and covers at stop log slots. These features will be consolidated to provide a visitors rest area in Pope Park. Because of the infrequent need to have maintenance or other access to the conduit at this point the public will be allowed pedestrian use of the area. The curb and cover at the stop log slots will provide a large seat. An air vent will extend vertically to exhaust conduit odors approximately 10 feet above ground level. Exposed surfaces of the remaining elements will be flush and form part of a slightly elevated platform. All construction will be concrete with smooth finish and surface sealed to facilitate graffiti removal. Corrosion resistant anchors will be provided for easy handling of covers by mobile equipment.

30. LANDSCAPE ARCHITECTURAL ENHANCEMENT.

a. Scheme A. The Auxiliary Conduit will be tunneled from Pope Park in an easterly direction under Park Street toward the Connecticut River. The conduit will come out from underground in the vicinity of Union Street, where it will then proceed in a trench to the river. The trench will be backfilled, and then regraded. The alignment will pass through lands owned by the Hartford Electric Light Company and the Hartford Redevelopment Agency. Because of this, there will be no formal site planning or design work implemented in this area. The Hartford Redevelopment Agency will develop new streets, utilities, open space, and land use patterns.

b. Scheme D. In this scheme there will be no need for landscape architectural environmental enhancement since the conduit will be in a deep-rock tunnel.

O. REAL ESTATE REQUIREMENTS

31. SPOIL AREA. The Spoil Area as depicted on Plate No. 2B-35 contains about 15.35 acres. About 13.50 acres of the proposed area available for spoil distribution is located in the inactive Underwood Urban Renewal Project, and about 1.85 acres in the city-owned Pope Park.

It is relatively low land adjacent to both sides of the Park River. The area required for spoil is subject to flooding, flood erosion, and flood plain zoning. Although a portion of the Underwood land is currently privately-owned by approved developers, there are no imminent plans for its development. It is noted that new construction restrictions require extraordinarily high cost flood proof design of buildings in this flood plain area.

Upon completion of construction of the Box Conduit the majority of the subject land areas would be subject to pondage from rains and natural surface runoff conditions. Therefore by raising of the present grade by deposits of spoils material, accumulation of pondage will be eliminated and the future use of the now flood prone area will revert to developable land. It is assumed that due to the direct benefit afforded to the subject area that no other costs will be involved and use of the land will be accomplished by agreement.

32. BOX CONDUIT. A review of the real estate costs for the box conduit extensions indicates that these costs will remain about the same as reported in the previous preliminary estimate submitted in Design Memorandum No. 2-PhaseII-Part I-Box Conduit.

33. AUXILIARY CONDUIT-SCHEME D. The Auxiliary Conduit Scheme D alinement consists of a deep-rock 22-foot interior diameter tunnel. It will commence at a point on the southeasterly elevation of the proposed Junction Structure in the bed of the Park River near the confluence of its North and South Branches. At this point, the tunnel will have an invert of minus 95 feet below mean sea level and will slope to elevation minus 147 feet below mean sea level at the Connecticut River discharge. The center line of the Scheme D alinement is a straight line projection.

It will be constructed beneath street rights-of-way of public streets and private lands. Where the subsurface conduit passes under 40 private ownerships, real estate interests in the nature of 40-foot wide permanent subsurface easements will be required. From its point of beginning at the Junction Structure in the bed of the Park River, it will run in a southeasterly direction about 230 feet to Park Street, then in a straight line under the rights-of-way in Park Street in an easterly direction about 3,440 feet to the junction of Park Street and Washington Street, then again easterly about 5,600 feet under the 40 private and 4 public ownerships. The lower end of the tunnel would pass under Interstate Highway No. 91, the track of the Penn-Central Transportation Company and the Central Dike at the Connecticut River. The overall length of the tunnel alinement is about 9,270 feet or 1.76 miles.

A preliminary legal opinion prepared by the Hartford Corporation Counsel indicates that the city has the authority to permit construction of the conduit under the affected streets, and it is their further opinion that should there be any doubt of the city's ownership of the land in question, the city has full authority under the General Statutes and under Special Act No. 72, 1955 Special Acts, to acquire any land necessary for this project, therefore, the value of the subsurface easements in the public rights-of-way are considered to be nominal.

P. RELOCATIONS

34. BOX CONDUIT. The relocations for the Box Conduit were submitted in Design Memorandum No. 2-PhaseII-Part I.

35. AUXILIARY CONDUIT-SCHEME A. Construction of Scheme A would require the removal of portions of Taylor Street, Van Block Avenue, Charter Oak Avenue and Sheldon Street. Upon completion of the conduit, the street pavement, sidewalks, drains and other appurtenances will be replaced in the same general locations with the grades adjusted to meet the changed conditions. On Van Block Avenue a 78" Sewer and a 78" Storm Drain will be relocated outside the area required for construction of the conduits.

36. AUXILIARY CONDUIT-SCHEME D. Construction of Scheme D will require no disruption of streets, utilities, traffic or businesses.

37. ATTORNEY'S REPORT. An Attorney's Report of compensable interests for utilities and roads is included in this Design Memoranda as Appendix A. This report covers all aspects of the project including items for which the local interests are financially responsible as well as those items which are a Federal financial responsibility.

Q. COST ESTIMATES

38. FIRST COSTS. Unit prices used in estimating construction and relocation costs are based on average bid prices for similar work in the same general area, estimated at the November 1974 price level. Valuations of real estate are based on appraisals of properties at the site made during the period June 1974 through November 1974 and includes the additional costs for resettlement and acquisition as required under Public Law 91-646. The construction costs of the Pumping Plants and the Conduit Extension include an allowance of 15% for contingencies. The construction cost of the Auxiliary Conduit includes an allowance of 20% for contingencies. Costs of engineering and design and of supervision and administration, are estimated lump sums based on experience, knowledge and evaluation of the site and project, and comparison with similar projects in the area. The total first cost of the project is estimated at $71,100,000. A summary of costs for project features and a detailed breakdown of quantities and unit prices is included in Appendix D.

There has been no significant change in the scope of the project. The changes that have occurred are the result of more detailed design.

An analysis and comparison of estimates for the period June 1966 through July 1974 was submitted 30 August 1974 in Design Memorandum No. 2, Phase II-Project Design, Site Geology & Interior Drainage: Part I-Box Conduit which was approved 18 October 1974.

The current estimates presented in this Design Memorandum No. 2, Phase II-Project Design: Part II-Auxiliary Conduit are compared in relation to the estimates previously approved in the Phase II-Part I Design Memoranda.

39. FEDERAL COSTS. The current Federal cost estimate of $69,700,000 has decreased by $1,300,000 from the previous estimate of $71,000,000 and the Non-Federal cost estimate of $1,400,000 has decreased by $900,000 from the previous estimate of $2,300,000.

40. NON-FEDERAL COSTS. The cost estimate of Lands and Damages of $1,000,000 has decreased by $350,000 from the previous estimate of $1,350,000 and the estimate of relocations cost of $400,000 has decreased $550,000 from the previous estimate of $950,000. Both of these decreases are the result of the revision of the alinement of the Auxiliary Conduit.

41. PUMPING PLANTS COST. The cost estimate for the Pumping Plants of $1,300,000 has increased $500,000 from the previous estimate of $800,000. The increase is based on the more detailed design accomplished in the preparation of Design Memorandum No. 6-Pumping Stations which was submitted 29 November 1974. The bulk of the increase was in the mechanical equipment.

42. CONDUIT EXTENSION COSTS. The cost estimate for the Conduit Extension of $26,100,000 has increased $1,400,000 from the previous estimate of $24,700,000. The increase is based on the more detailed design accomplished in the preparation of Design Memorandum No. 7-Detailed Design of Structures-Part I-Box Conduit which was submitted 25 October 1974 and approved 4 December 1974. The bulk of the increase was in the steel reinforcing which increased from 10,748,100 pounds to 13,000,000 pounds. A new item of water stops was added. The unit prices of the four following items were revised upward: Excavation, Rock, Structure; Borrow and Place-Stone Protection, Gravel Fill and Pervious Fill.

43. AUXILIARY CONDUIT COSTS. The cost estimate for the Auxiliary Conduit of $33,500,000 has decreased $3,000,000 from the previous estimate of $36,500,000. The decrease is based on the more detailed design accomplished in the preparation of this Design Memorandum No. 2, Phase II-Project Design: Part II-Auxiliary Conduit.

The five alinements investigated are indicated on Plate No. 2B-36: "Auxiliary Conduit, Location of Alternate Schemes," and described in Section F, "Other Plans Investigated" of this design memorandum.

44. ORIGINAL SCHEME COST. The estimate for the Auxiliary Conduit submitted in the Phase II-Part I-Design Memorandum was a planning type of estimate for the purpose of estimating the total cost of the project and computing the Benefit to Cost Ratio. This was the first alinement investigated and is referred to herein as the "Original Alinement." After investigation it was determined that the new estimated cost of the original alinement was $57,170,000 which is an increase of $14,303,000 over the estimate of $42,867,000 submitted in Phase II-Part I.

45. SCHEMES A, B AND C COST. Three additional alinements, all of two-phase construction: Part Tunnel-Part Cut-and-Cover were investigated. These were designated as Schemes A, B and C and their costs were determined as $53,900,000, $54,990,000 and $55,100,000 respectively. Scheme A was determined to be the least costly overall of the four schemes of two-phase construction investigated.

46. SCHEME D COST. The fifth alinement investigated consisted of a single-phase-construction deep through-tunnel. This was designated as Scheme D. This is the least costly of the five schemes investigated with an estimated cost of $38,530,000 it is $18,640,000 less than the Original Scheme and $15,370,000 less than Scheme A. A comparison of the five schemes investigated for the Auxiliary Conduit is presented in Table 1.

47. TOTAL PROJECT COSTS. The total project cost of $71,100,000 is $18,640,000 less than the total cost of $89,740,000 including the Original Scheme and $15,370,000 less than the total project cost of $86,470,000 including Scheme A. The total project costs for the five schemes investigated is presented in Table 2.

48. COMPARISON OF ESTIMATES. A comparison of previous estimates is presented in Table 3. Reference is also made to Section Q of DM-2-Phase II-Part I approved 18 October 1974.

R. SCHEDULES FOR DESIGN AND CONSTRUCTION

49. SCHEDULE FOR DESIGN. The schedule for design is predicated upon two construction contracts; the first for the Pumping Plants and Conduit Extension with a construction start in the spring of 1976 contingent upon future appropriations. A separate contract for the construction of the Auxiliary Conduit could then be awarded approximately one year later.

TABLE 1

AUXILIARY CONDUIT
COMPARISON OF SCHEMES
(Amounts in Thousands of Dollars)

Project Feature	Orig. Scheme*	Scheme "A"	Scheme "B"	Scheme "C"	Scheme "D"
01. Lands & Damages	350	400	560	530	140
02. Relocations	1090	210	220	220	0
Total Non-Federal	1440	610	780	750	140
15.2 Auxiliary Conduit					
98+31 to 27+75	33300	33300	33300	33300	25960
27+75 to Conn. River	13238	12563	13313	13688	7540
Electrical Util.	1677	500	500	255	0
Railroad Track	100	50	100	100	0
Cooling Water Pipes	0	1	0	0	0
Other Utilities	315	86	97	87	0
Total Aux. Cond.	48630	46500	47310	47430	33500
30. Engineering & Design	3890	3720	3780	3790	2680
31. Supervision & Admin.	3210	3070	3120	3130	2210
Total Federal	55730	53290	54210	54350	38390
TOTAL COSTS	57170	53900	54990	55100	38530
Deduct SCHEME "D"	38530	38530	38530	38530	38530
Net Savings	18640	15370	16460	16570	0

* Original Scheme refers to alinement submitted in GDM-Phase II-Part 1 submitted 30 Aug 74 and approved 18 Oct 74.

TABLE 2

TOTAL PROJECT
COMPARISON OF SCHEMES
(Amounts in Thousands of Dollars)

Project Feature		Orig. Scheme*	Scheme "A"	Scheme "B"	Scheme "C"	Scheme "D"
01.	Lands & Damages	1210	1260	1420	1390	1000
02.	Relocations	1490	610	620	620	400
	Total Non-Federal	2700	1870	2040	2010	1400
13.	Pumping Plants	1300	1300	1300	1300	1300
15.1	Conduit Extension	26100	26100	26100	26100	26100
15.2	Auxiliary Conduit	48630	46500	47310	47430	33500
30.	Engineering & Design	6030	5860	5920	5930	4800
31.	Supervision & Administration	4980	4840	4890	4900	4000
	Total Federal	87040	84600	85520	85660	69700
	TOTAL COSTS	89740	86470	87560	87670	71100
	Deduct SCHEME "D"	71100	71100	71100	71100	71100
	Net Savings	18640	15370	16460	16570	0

*Original Scheme refers to alinement submitted in GDM-Phase II-Part 1 submitted 30 Aug 74 and approved 18 Oct 74.

TABLE 3

COMPARISON OF ESTIMATES
(Amounts in Thousands of Dollars)

Project Feature		Proj. Doc. (Jun 66)	1st Bud. Req. (Jun 70)	Phase I (Jan 73)	Phase II-1 (31 Jul 74)	PB-3 (1 Sep 74)	Current (30 Nov 74)	Change
01.	Lands & Damages	630	880	1100	1350	1350	1000	- 350
02.	Relocations	170	220	500	950	950	400	- 550
13.	Pumping Plants	480	650	1400	800	800	1300	+ 500
15.1	Conduit Extension	9400	12900	17500	24700	24700	26100	+ 1400
15.2	Auxiliary Conduit	16360	22200	25300	36500	36500	33500	- 3000
30.	Engineering & Design	2090	2750	3900	4900	4900	4800	- 100
31.	Supervision & Admin.	1970	2500	3300	4100	4100	4000	- 100
	TOTAL COST	31100	42100	53000	73300	73300	71100	- 2200

(1) Based on revised real estate appraisals.
(2) Based on more detailed design accomplished in preparation of GDM-Phase II-Part 2.
(3) Based on more detailed design accomplished in preparation of DM 6-Pumping Stations.
(4) Based on more detailed design accomplished in preparation of DM 7 Detailed Design of Structures-Part I-Box Conduit
(5) Based on more detailed design accomplished in preparation of GDM-Phase II-Part 2.
(6) Re-analysis of requirements; Federal pay increases.
(7) Re-analysis of requirements; Federal pay increases.
(8) See Section "Q. COST ESTIMATES".
See also GDM-Phase II-Part 1 submitted 30 AUG 74 and approved 18 OCT 74.

50. DESIGN MEMORANDA COMMON TO BOTH CONTRACTS.

Number	Title	Anticipated Submission Date	Date Submitted	Date Approved
1	Hydrology		16 Feb 73	12 Apr 73
2	GDM-Phase I- Plan Formulation		30 Mar 73	16 Jul 73
3	Hydraulic Analysis	Feb 75		
4	Concrete Materials	Apr 75		

51. DESIGN SCHEDULE PUMPING PLANTS AND CONDUIT EXTENSION.

Number	Title	Anticipated Submission Date	Date Submitted	Date Approved
2	GDM-PHASE II- Project Design, Site Geology & Interior Drainage Part I - Box Conduit		30 Aug 74	18 Oct 74
5	Embankment & Foundations Part I - Box Conduit	Feb 75		
6	Pumping Stations		29 Nov 74	
7	Detailed Design of Structures Part I - Box Conduit		25 Oct 74	4 Dec 74
	PLANS & SPECIFICATIONS*	Jun 75		

*It is estimated that with funds available in FY 75 the plans and specifications will be complete on 30 June 1975.

52. DESIGN SCHEDULE AUXILIARY CONDUIT.

Number	Title	Anticipated Submission Date	Date Submitted	Date Approved
2	GDM- Phase II-Project Design Part II-Auxiliary Conduit		24 Jan 75	
5	Embankment & Foundations Part II-Auxiliary Conduit	Aug 75		
7	Detailed Design of Structures Part II-Auxiliary	Dec 75		
8	Site Geology Part II-Auxiliary Conduit	Apr 76		
	PLANS & SPECIFICATIONS	Oct 76		

53. CONSTRUCTION SCHEDULE GENERAL. The Box Conduit feature and the Auxiliary Conduit feature are sufficiently different and independent such that construction could be initiated concurrently. The Box Conduit aspect in itself is fragmented such that the Contractor could initiate construction in 3 sections simultaneously. It is assumed that the Box Conduit will be initiated first and will run for a period of 4 construction seasons (3-1/2 years). The Auxiliary Conduit would commence approximately 1 year later than the box conduit construction start and would run for a period of 3 years. The schedule as set forth herein is considered reasonable and one that takes into account economics. The construction schedule for the Box Conduit feature was presented in Design Memorandum No. 2, Phase II-Part I - Box Conduit submitted in August 1974. It was assumed that the Box Conduit contract would be awarded in early spring of 1976, the 1st construction season.

54. AUXILIARY CONDUIT. It is assumed that the contract will be awarded in early spring of 1977, the 2nd construction season. The phases of construction are briefly outlined below, whereas the details of construction are more clearly discussed in Section H, "Construction Procedure and Diversion Plan."

a. Second Construction Season (First Year Auxiliary Conduit Construction).

(1) River Shaft. The Contractor is expected to concentrate on the construction of the river shaft. It will take the Contractor

approximately 6 months to prepare the site, construct and lower the caisson into place, grout-seal the interface between caisson and bedrock and complete the mucking out of the caisson. An additional 2 months will be required to continue the vertical shaft through rock down to EL-147 msl and an additional month will be required to set up his horizontal tunneling equipment which is expected to be the drill, blast and muck system. The Contractor will then proceed with his tunneling operation from the river shaft driving upward to the Pope Park end. The tunneling operation is expected to proceed uninterrupted throughout the winter. The tunneling heading should advance at a rate of approximately 750 ft./month based upon round-the-clock operations, 6 days a week. As the rock excavation progresses, the rock anchors are installed followed by the installation of the concrete liner. By the 13th month (4th month of tunneling) the Contractor is expected to be at the clean out shaft.

(2) Clean Out Shaft. Simultaneous with the construction of the river shaft, the Contractor is expected to initiate the construction of the shaft at Sta 37+00. The Contractor will require approximately 1 month for mobilizing and preparing the site, 2 months to install the system of soldier beams - lagging and rock anchors and approximately 1 month to excavate the 30 feet of overburden. The vertical shaft rock excavation is expected to require 2 months work. Once the clean out shaft is driven to the bottom, the Contractor has the flexibility to initiate a 2nd tunneling operation from the clean out shaft to the Pope Park end.

b. Third Construction Season (Second Year Auxiliary Conduit Construction).

(1) Tunneling. Upon reaching the clean out shaft on the 1st month of the 2nd year, the Contractor is expected to continue tunneling from the clean out shaft to the intake shaft at Pope Park. However, the excavated rock from the tunnel is expected to be removed from the clean out shaft rather than the river shaft since the distance to the spoil area is considerably shorter. By the end of the second year the tunneling operation is expected to be complete.

(2) River Shaft. Once the river shaft is no longer needed for rock removal the Contractor is expected to proceed to modify the river shaft. At the junction between the tunnel and the river shaft, rock will have to be carefully removed to provide the necessary curvature for the bend; this is to be followed by the installation of the concrete lining both in the tunnel and in the shaft. At the same time the Contractor is expected to construct the single-wall braced steel sheet cofferdam around the outfall structure (top of river shaft).

(3) Intake Shaft. Towards the middle of the 2nd construction season, the Contractor is expected to initiate construction at the intake structure. He will initiate the installation of the steel sheeting, the soldier beams and lagging, and the rock anchors. During the winter months he will remove the overburden and excavate the necessary rock down to the tunnel invert and initiate the installation of the concrete liner in the segment of the tunnel between the clean out shaft and Pope Park.

c. 4th Construction Season (Third Year Auxiliary Conduit Construction).

(1) Intake Shaft. The Contractor will form and place the concrete, backfill, remove the cofferdam and perform final grading, landscaping and cleanup.

(2) River Shaft. The Contractor is expected to excavate to grade, remove the segment of the caisson above EL-11.0 msl, form and place the necessary concrete, remove the cofferdam and excavate and place the rock paving. The necessary grading and cleanup would complete the river phase of the project.

S. OPERATION AND MAINTENANCE

55. REFERENCE. See DM No. 2-Phase II-Part I, page 45.

T. RESERVOIR REGULATION

56. REFERENCE. See DM No. 2-Phase II-Part I, page 45.

U. BENEFITS

57. GENERAL. All benefits except the Redevelopment Benefits are considered to remain unchanged from those submitted in Design Memorandum No. 2, Phase II-Project Design, Site Geology & Interior Drainage: Part I - Box Conduit. For this reason the revised derivation of the Redevelopment Benefits is submitted herein. The total estimated construction cost of the project has decreased $1,650,000 from $62,950,000 to $61,300,000. The Auxiliary Conduit has been revised from a two phase construction to a single phase construction. The "Summary of Benefits" includes the previously submitted benefits as well as the revised Redevelopment Benefits. As a result the Redevelopment Benefits have decreased $42,900 from $286,300 to $243,400 and the Total Average Annual Benefits have decreased $42,900 from $3,392,400 to $3,349,500.

58. REDEVELOPMENT BENEFITS. Senate Document No. 97 of the 87th Congress directs that where areas have been designated as Redevelopment Areas by the Redevelopment Administration, the project benefits shall be considered as increased by the value of the labor and other resources required for project construction and expected to be used in project operations, project maintenance and added area employment during the life of the project to the extent that such labor and resources would - in the absence of the project- be unutilized or underutilized.

The City of Hartford has been designated as a Title IV Redevelopment Area under P.L. 89-136 by the Economic Development Administration of the U.S. Department of Commerce. A sizeable proportion of the construction industry's work force is unemployed and the project will draw its workers from this pool.

The records of this office indicate that on the average civil works project, the labor cost approximates 27 percent of total construction cost. It is noted that a large part of this project consists of a tunnel which normally requires a special work crew so the total cost is not to be used. The construction cost involved will therefore be $27,800,000 of normal construction and three tenths of the $33,500,000 tunnel cost or a total of $37,900,000. The estimated labor component is 27 percent of $37,900,000 or $10,233,000.

It is regular practice for a Contractor to bring a skeleton crew of his own men on to a job and fill the rest of his requirements from the local labor pool. It is estimated that 75 percent of the laborers will be locally hired for this project. While not all of the labor put to work will come from the rolls of the unemployed, the jobs that they leave will be filled by people from the unemployed or underemployed rolls so that the entire 75 percent is used. It is estimated that the work will take three years to complete. With interest at 3-1/4 percent the derivation of the annual redevelopment benefit is as follows:

$10,233,000 x .75 = $7,674,750
1st yr. $2,174,750 x PW_1 (.9685) = $2,106,250
2nd yr. $2,750,000 x PW_2 (.9380) = $2,579,500
3rd yr. $2,750,000 x PW_3 (.9085) = $2,498,400

Total P.W. $7,184,150

Annual Benefit = $7,184,150 x (CRF - 3-1/4% - 100 yrs.) .033883 = $ 243,400

A benefit for unemployed labor put to work for maintenance and operation of the completed project is not claimed as the city will do this with their own regular force.

59. SUMMARY OF BENEFITS. A summary of the total average annual benefits creditable to the project for flood control based on completing the conduit extensions, a 22-foot diameter auxiliary conduit and appurtenant works, are set forth below:

Benefit Category	Amount
Flood Damages Prevented	$ 2,746,500
Business Activity	201,800
Parking Facilities	184,000
Total average annual benefits providing a 25-foot dia. auxiliary conduit	$ 3,132,300
Negative benefits based on estimated additional losses in headpool areas	-56,100
Adjusted total average annual benefits providing a 22-foot dia. auxiliary conduit	$ 3,076,200
Advanced Replacement of Bridges	29,900
Redevelopment Benefits	243,400
TOTAL AVERAGE ANNUAL BENEFITS	$ 3,349,500

V. COST ALLOCATION

60. SUMMARY OF FIRST COSTS.

Federal	$69,700,000
Non-Federal	1,400,000
	$71,100,000

The details of cost allocation are presented in Appendix D, "Project Cost and Estimates."

W. STATEMENT OF FINDINGS

61. REFERENCE. See DM No. 2- Phase II-Part I, page 52.

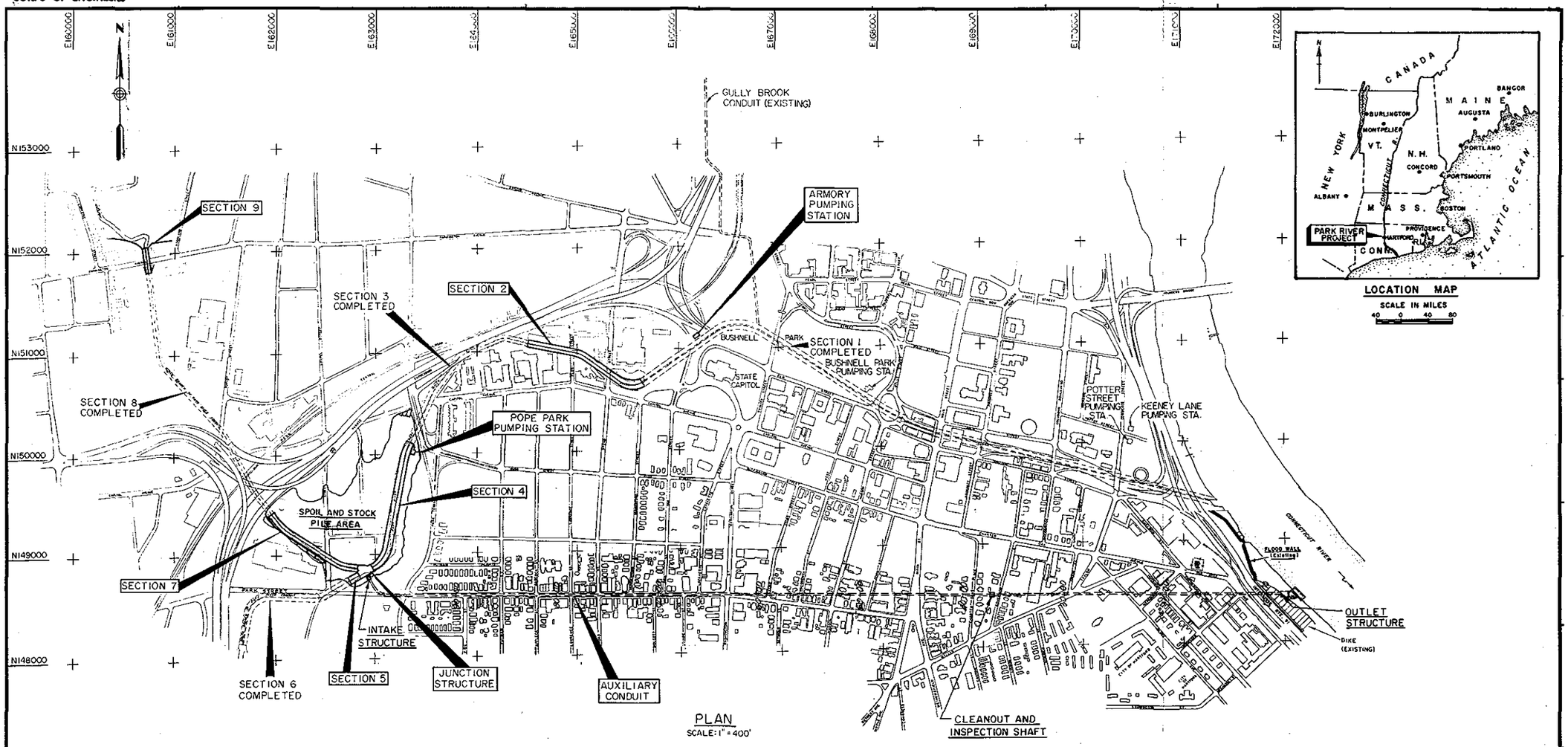
X. DELETED

62. DELETED. This section is deleted in accordance with ER 1110-2-1150, Change 7, 22 July 1974.

Y. RECOMMENDATIONS

63. TREATMENT RECOMMENDED. It is recommended that the project plan for the Auxiliary Conduit, designated as Scheme D, which consists of a single-phase deep through-tunnel with three shafts and appurtenances; submitted in this memorandum, be approved as the basis for preparation of Detailed Feature Design Memoranda and contract plans for this, the Auxiliary Conduit portion of the Park River Local Protection Project, Hartford, Connecticut.

CORPS OF ENGINEERS



PLAN
SCALE: 1" = 400'

● FD IOT U.S. ARMY CORPS OF ENGINEERS BORING

GENERAL NOTES:

1. Elevations refer to Mean Sea Level Datum.
2. All elevations are plus except as noted otherwise.
3. Plane coordinates refer to Connecticut Lambert Grid System.

GRAPHIC SCALES
1" = 400' 400' 0 400' 800'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

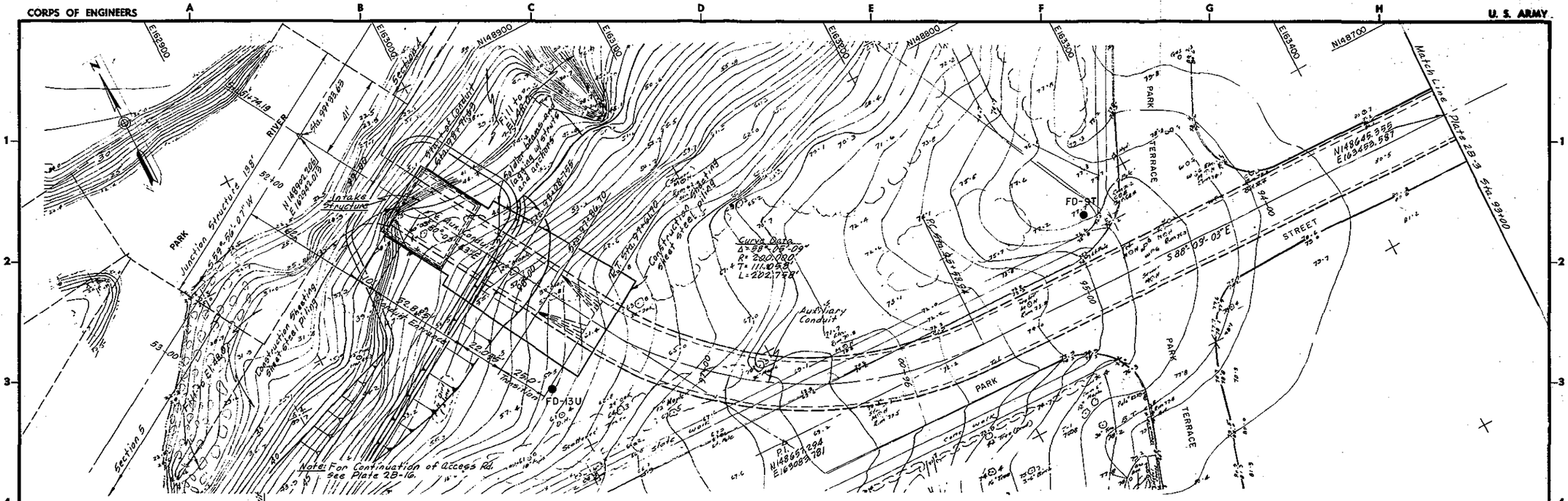
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

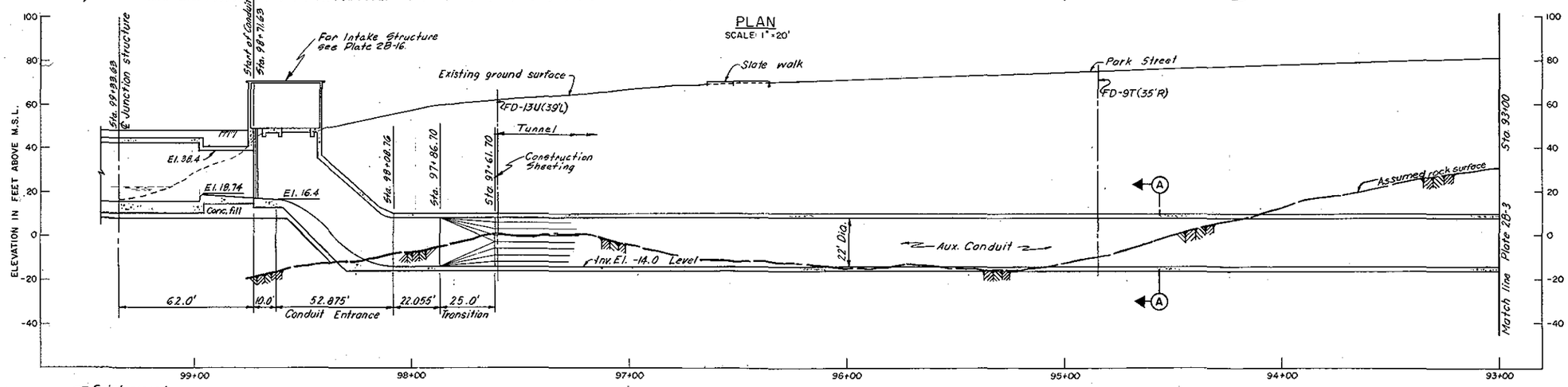
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

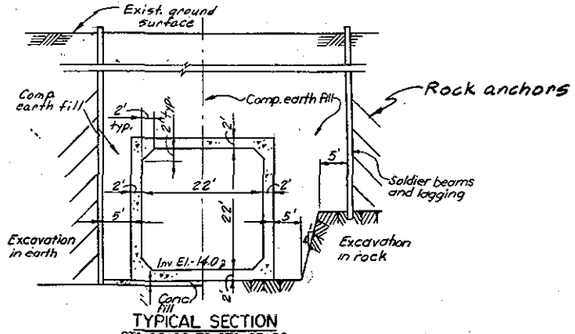
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
GENERAL PLAN
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-1

CORPS OF ENGINEERS U. S. ARMY

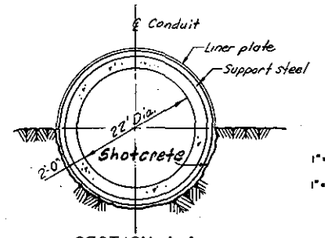






TYPICAL SECTION
STA. 98+08 TO STA. 97+86
SCALE 1"=10'

℄ PROFILE
SCALE: 1"=20'



SECTION A-A
SCALE: 1"=10'

GRAPHIC SCALES
1"=20' 20' 0 20' 40'
1"=10' 10' 0 10' 20'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 1
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-2

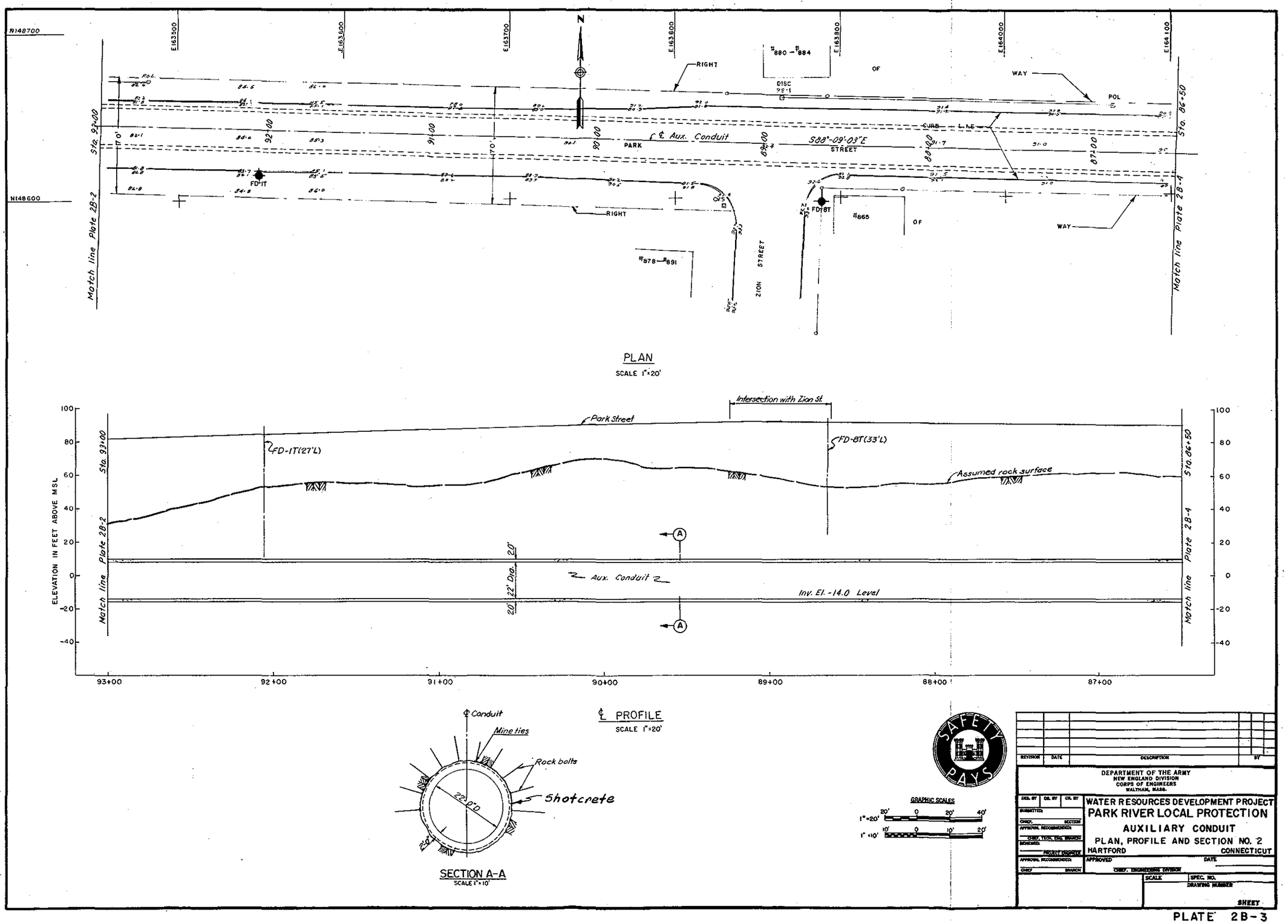
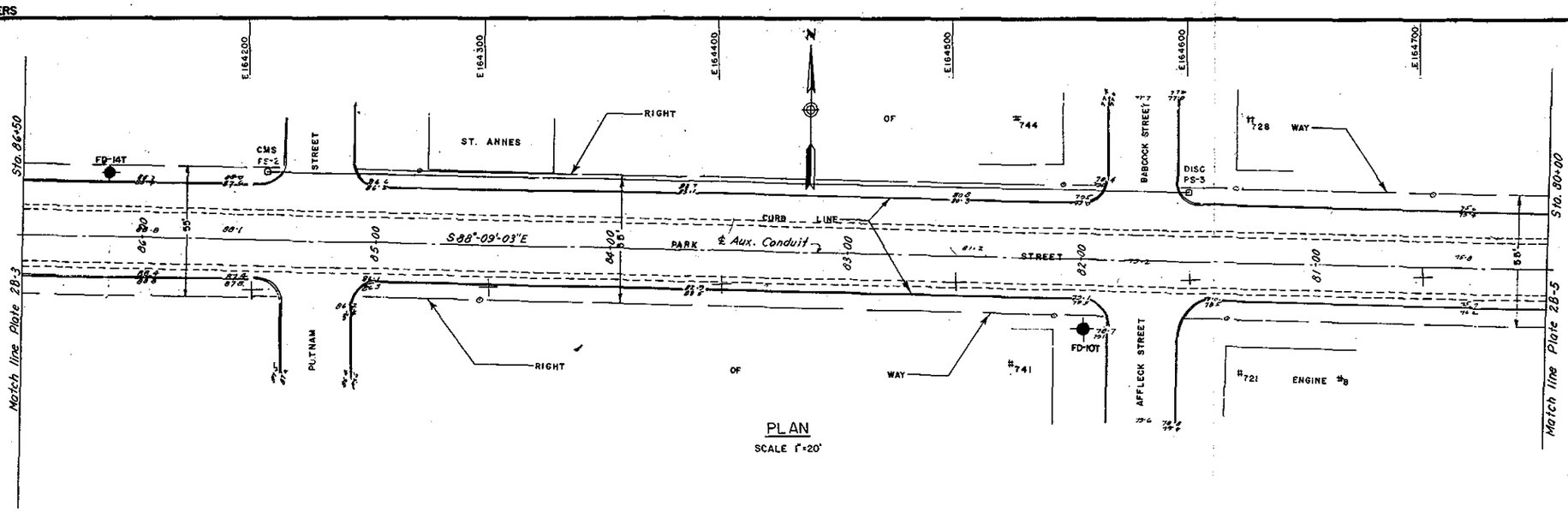
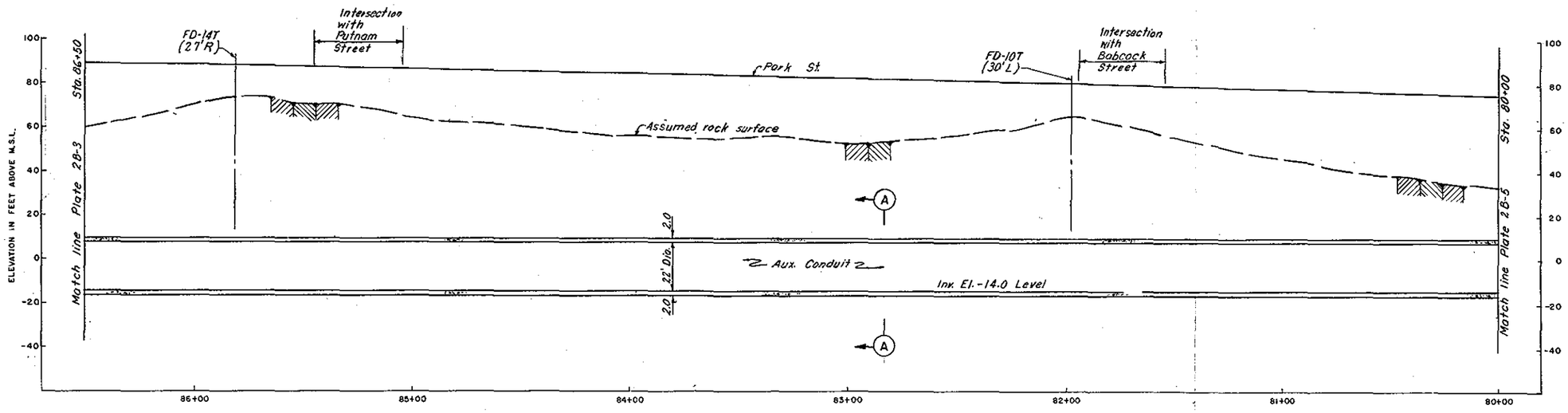

N148700
N148600
E163500
E163600
E163700
E163800
E163900
E164000
E164100
N
RIGHT
#880 – #884
DISC
OF
WAY
POL
CURB LINE
℄ Aux. Conduit
S88°-09'-03"E
PARK
STREET
FD-1T
FD-8T
#865
#878 – #891
ZION STREET
Sta. 92+00
Sta. 86+50
Match line Plate 2B-2
Match line Plate 2B-4
PLAN
SCALE 1"=20'
Intersection with Zion St.
Park Street
FD-1T(27'L)
FD-8T(33'L)
Assumed rock surface
Sta. 93+00
Sta. 86+50
Aux. Conduit
Inv. El. -14.0 Level
20' 22' Dia. 20'
ELEVATION IN FEET ABOVE MSL
100
80
60
40
20
0
-20
-40
93+00
92+00
91+00
90+00
89+00
88+00
87+00
℄ PROFILE
SCALE 1"=20'
℄ Conduit
Mine ties
Rock bolts
Shotcrete
22' O.D.
20'
SECTION A-A
SCALE 1"=10'
GRAPHIC SCALES
1"=20'
1"=10'
SAFETY PAYS
REVISION
DATE
DESCRIPTION
BY
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 2
HARTFORD
CONNECTICUT
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED
CHIEF, TECH. ENG. BRANCH
REVIEWED
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF BRANCH
APPROVED
DATE
CHIEF, ENGINEERING DIVISION
SCALE
SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-3



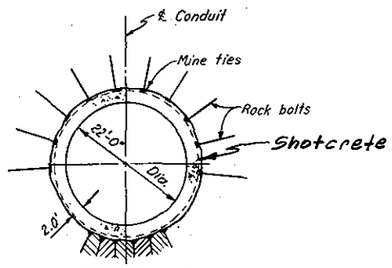
PLAN

SCALE 1"=20'



℄ PROFILE

SCALE 1"=20'



SECTION A-A

SCALE: 1"=10'

GRAPHIC SCALES

1"=20' 20' 0 20' 40'

1"=10' 10' 0 10' 20'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

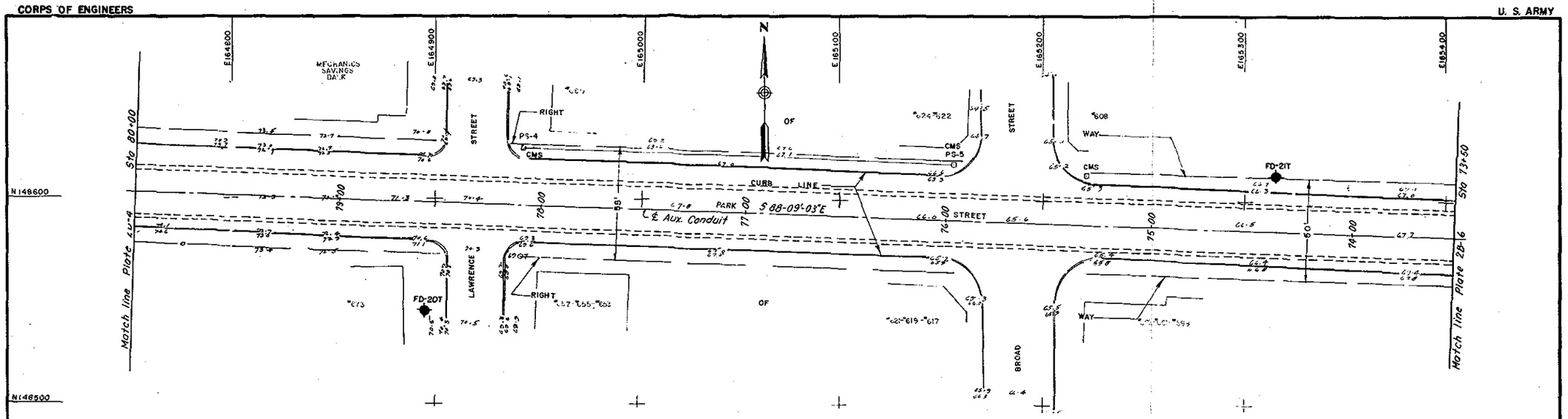
DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED
CHIEF, REAL ENG. BRANCH
REVIEWED
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 3
HARTFORD CONNECTICUT

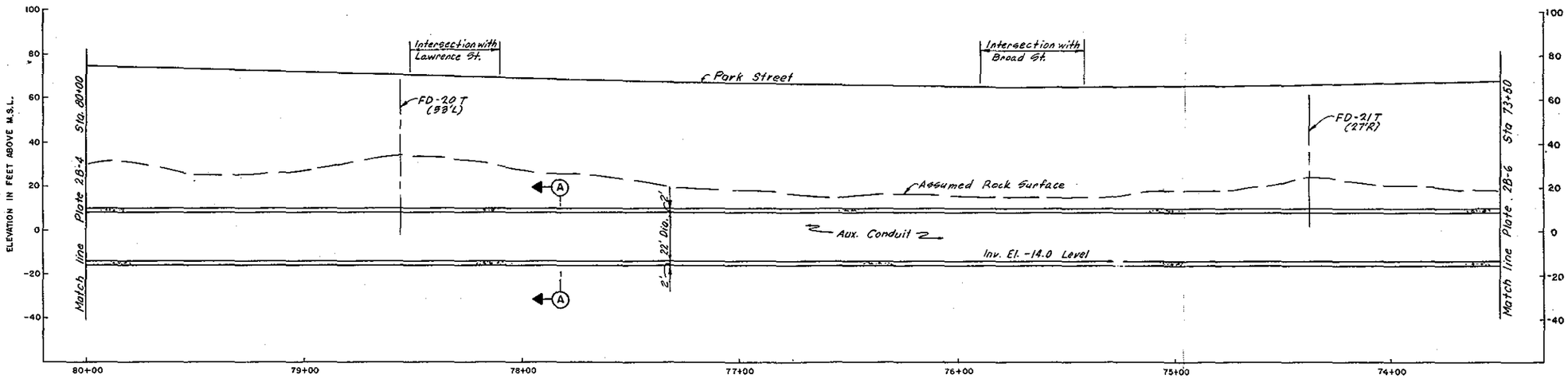
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE SPEC. NO.
DRAWING NUMBER
SHEET



PLAN

SCALE 1" = 20'



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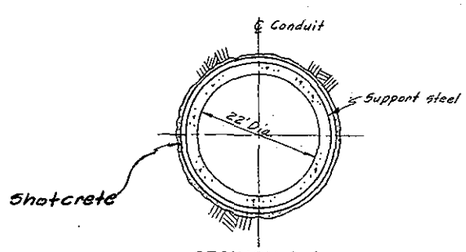


SECTION A-A

SCALE: 1" = 10'

GRAPHIC SCALES

1" = 20' 20' 0 20' 40'

1" = 10' 10' 0 10' 20'

REVISION	DATE	DESCRIPTION	BY

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

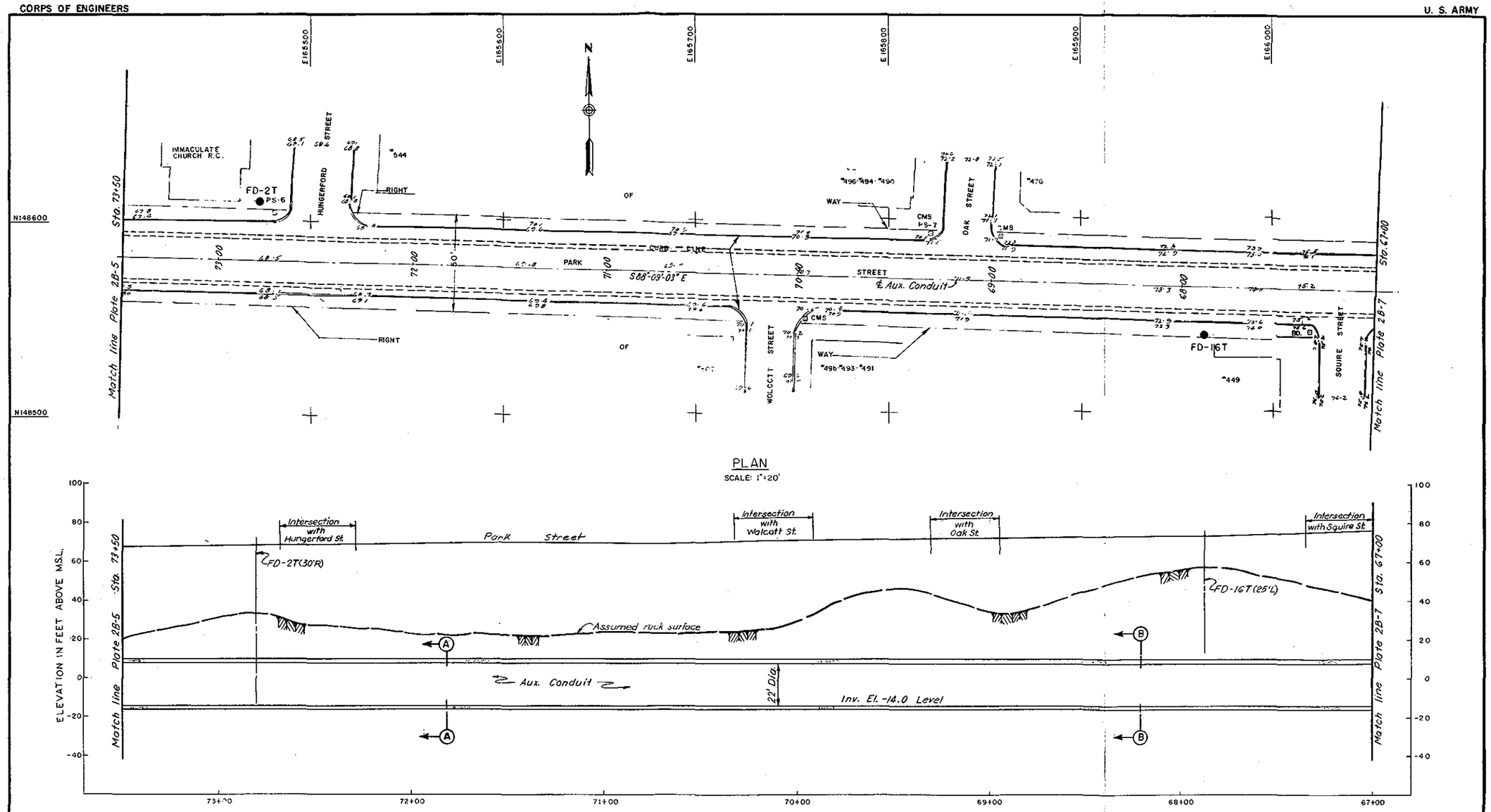
DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 4
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

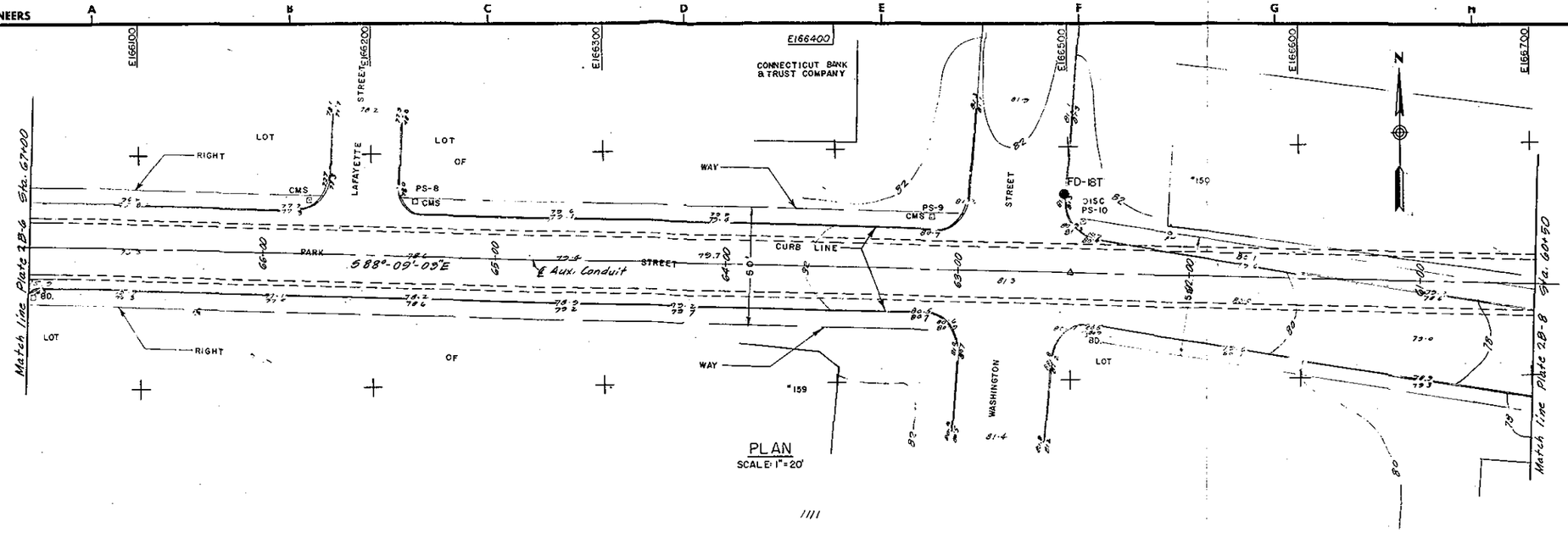
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 5
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS — U. S. ARMY



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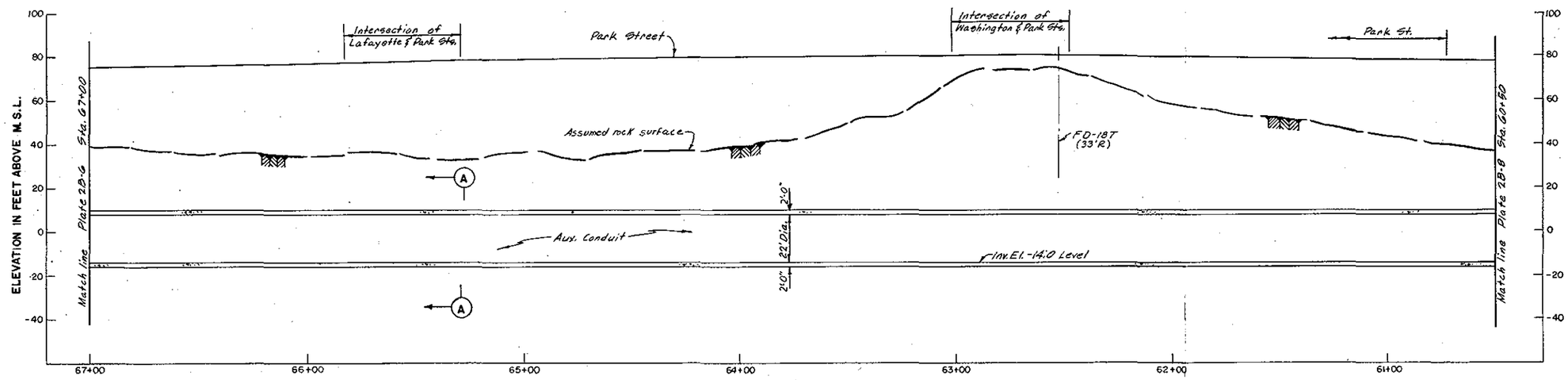
SCALE: 1" = 20'



℄ PROFILE
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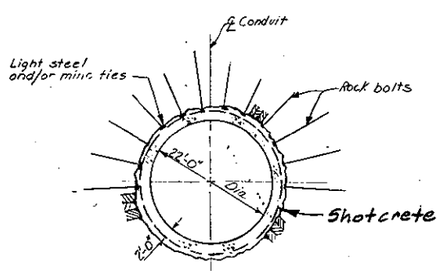


SECTION A-A
SCALE 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

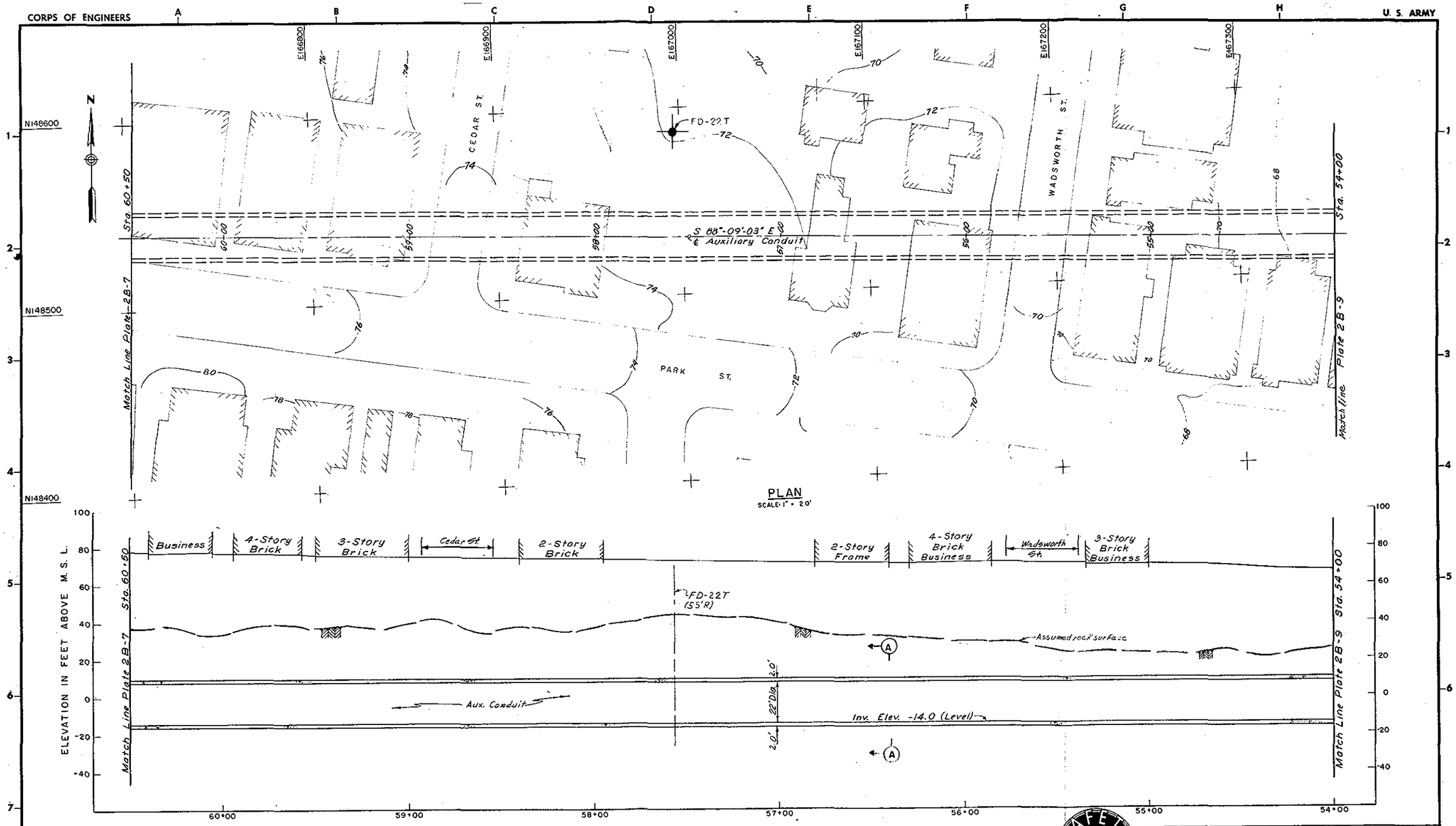
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 6
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-7

CORPS OF ENGINEERS — U. S. ARMY



SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

SUBMITTED: CHIEF, SECTION

APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH

REVIEWED: PROJECT ENGINEER

APPROVAL RECOMMENDED: CHIEF BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION

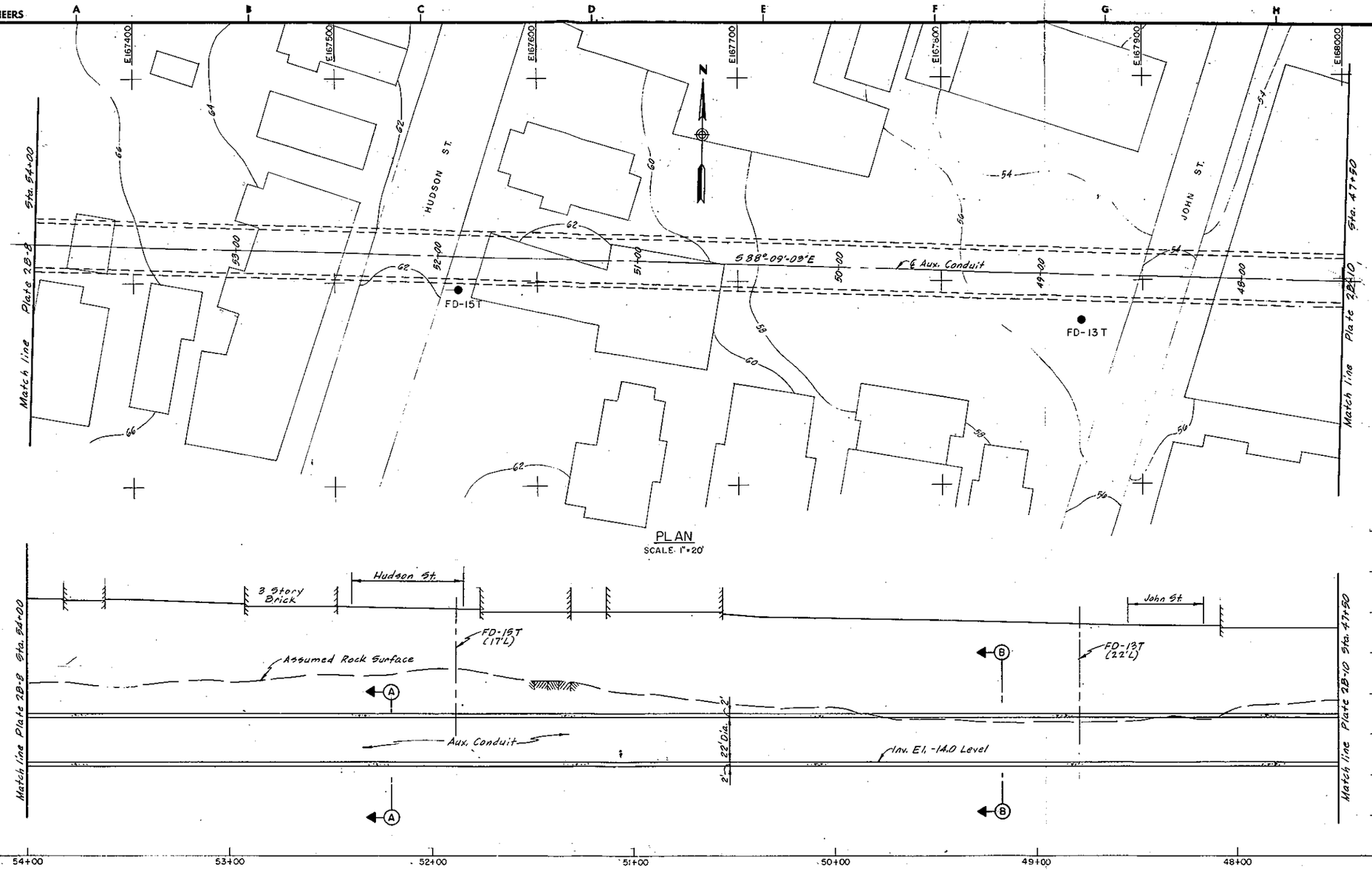
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 7
HARTFORD CONNECTICUT

DATE

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-8

CORPS OF ENGINEERS — U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF, BRANCH

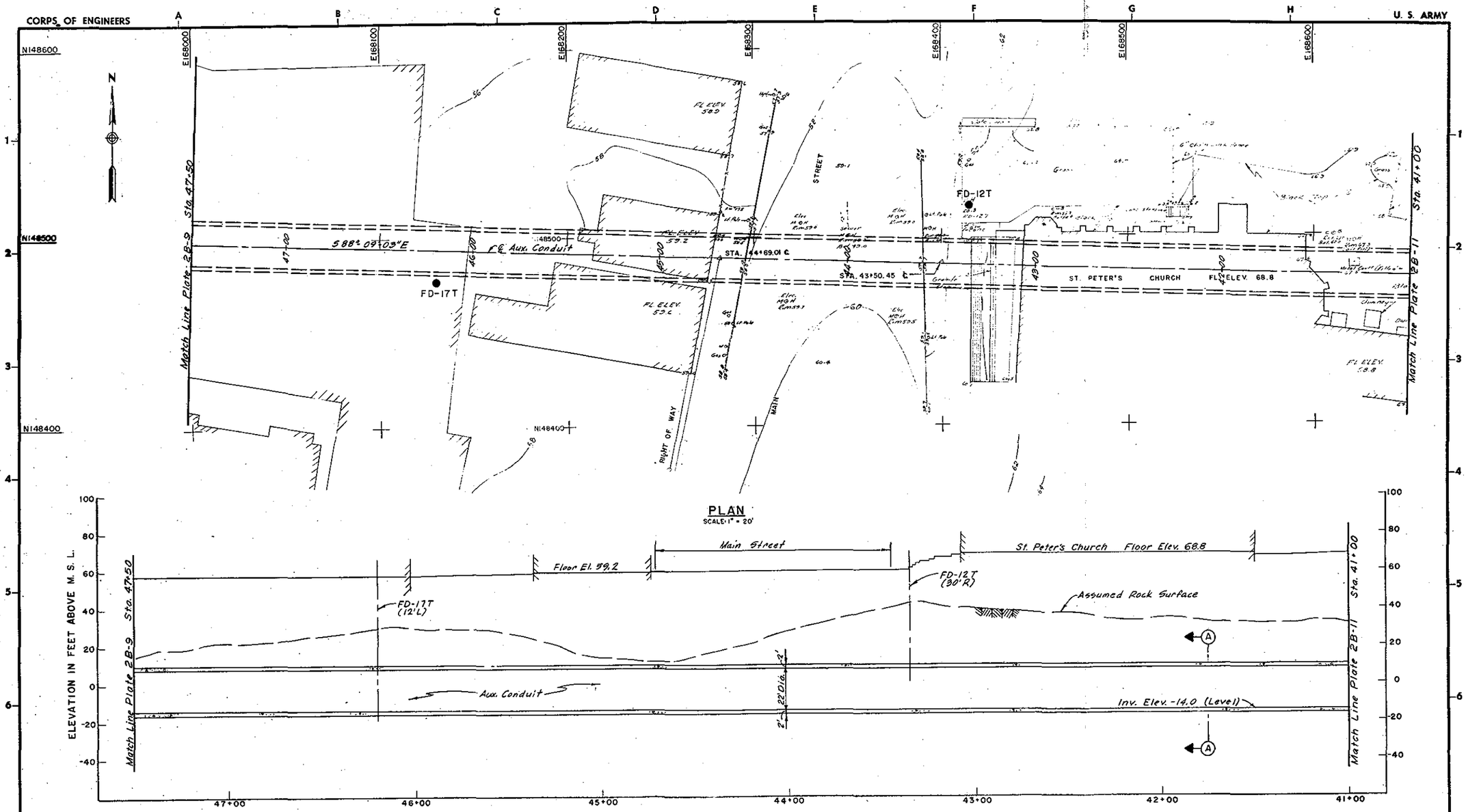
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 8
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-9

CORPS OF ENGINEERS — U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

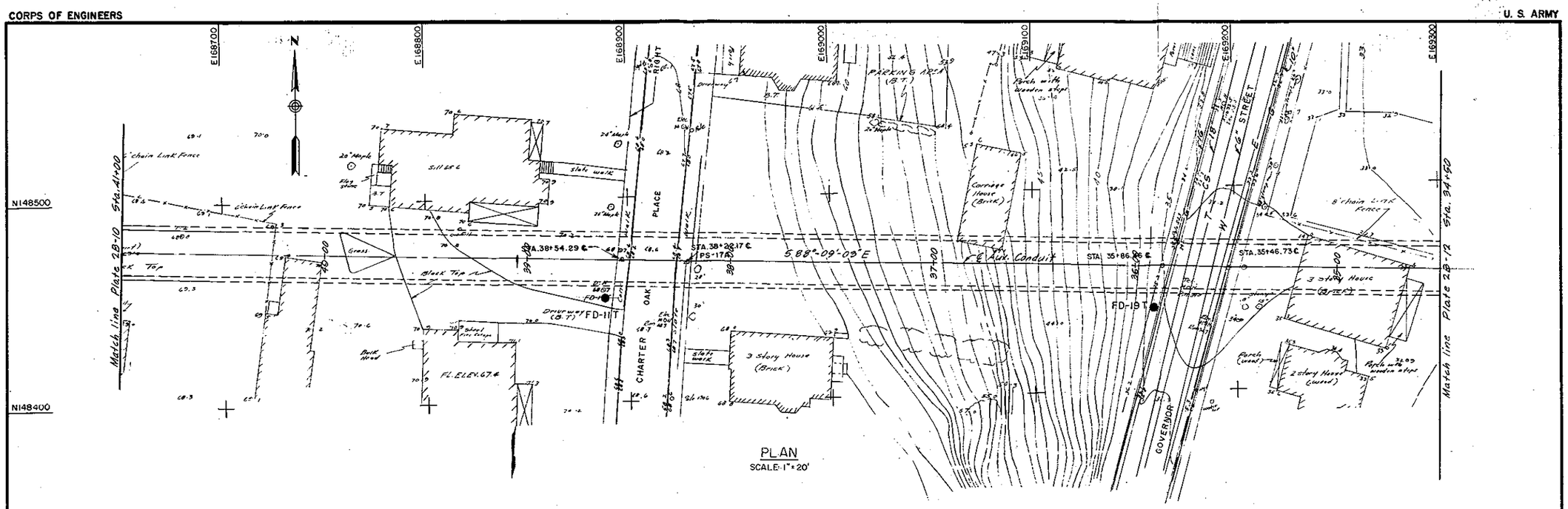
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 9
HARTFORD CONNECTICUT

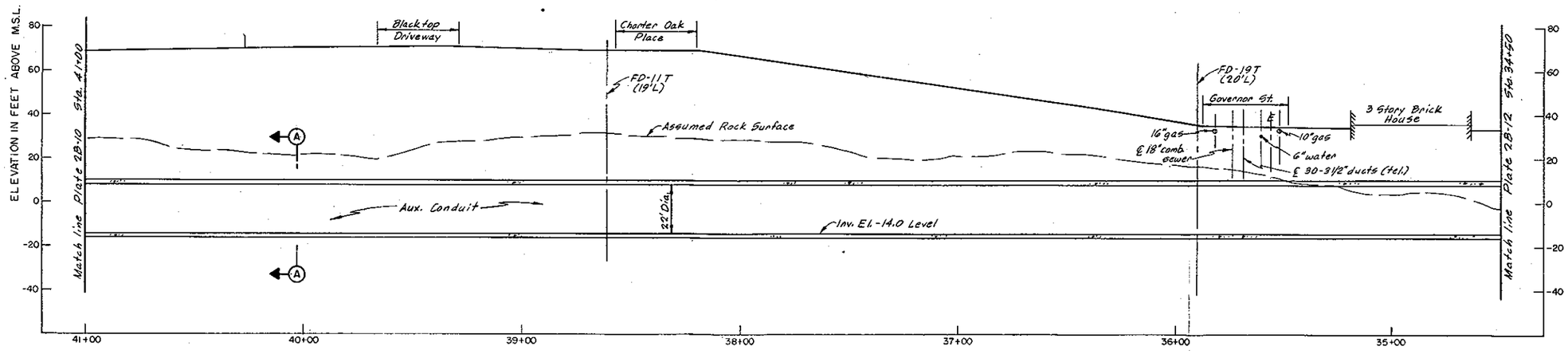
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

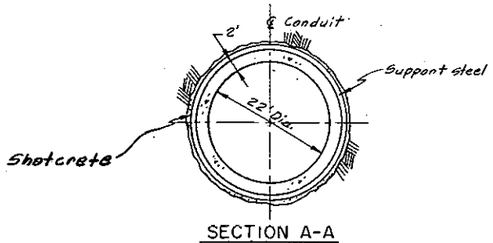
PLATE 2B-10



PLAN
SCALE: 1" = 20'



℄ PROFILE
SCALE: 1" = 20'



SECTION A-A
SCALE: 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'

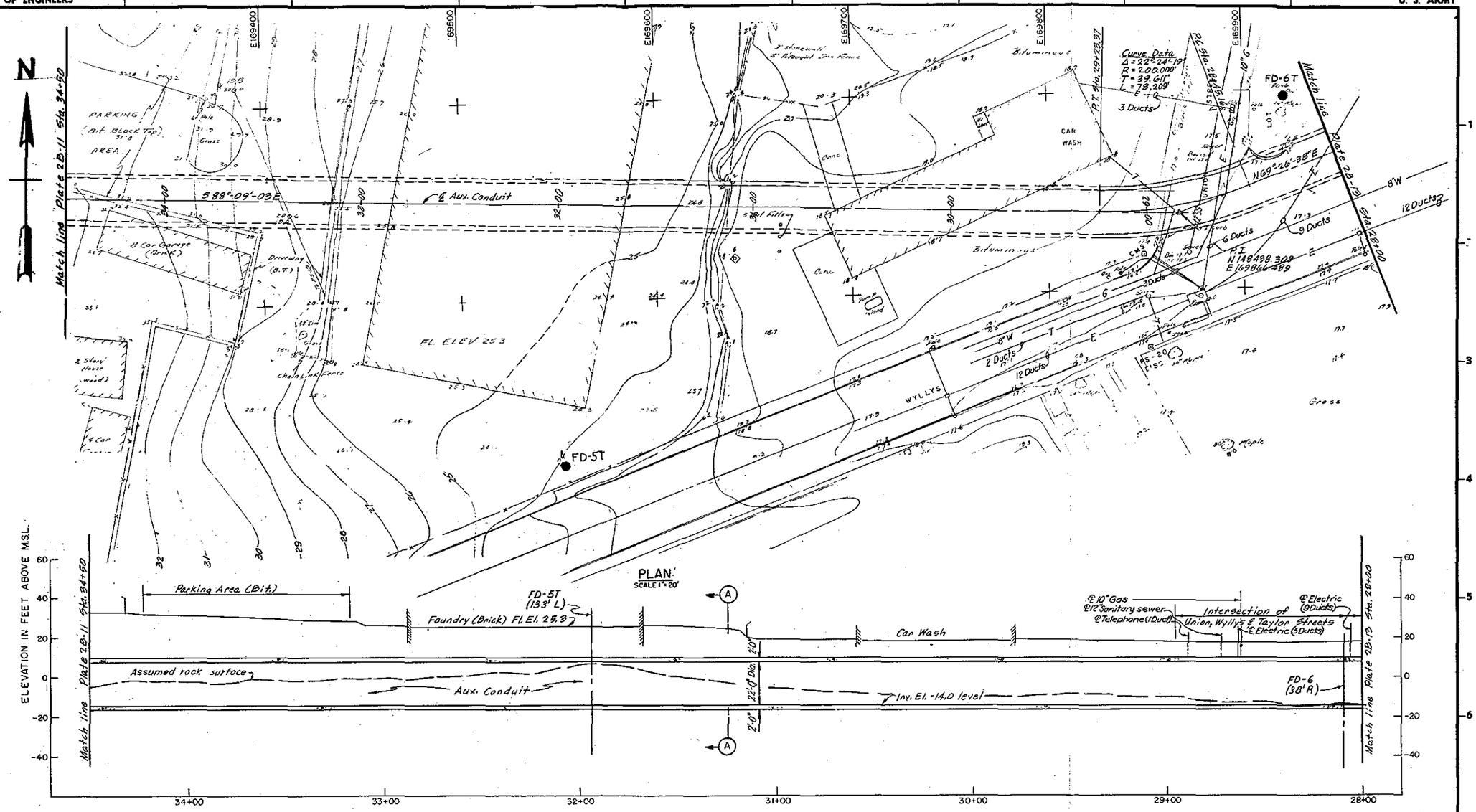
REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, FOUN. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 10
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

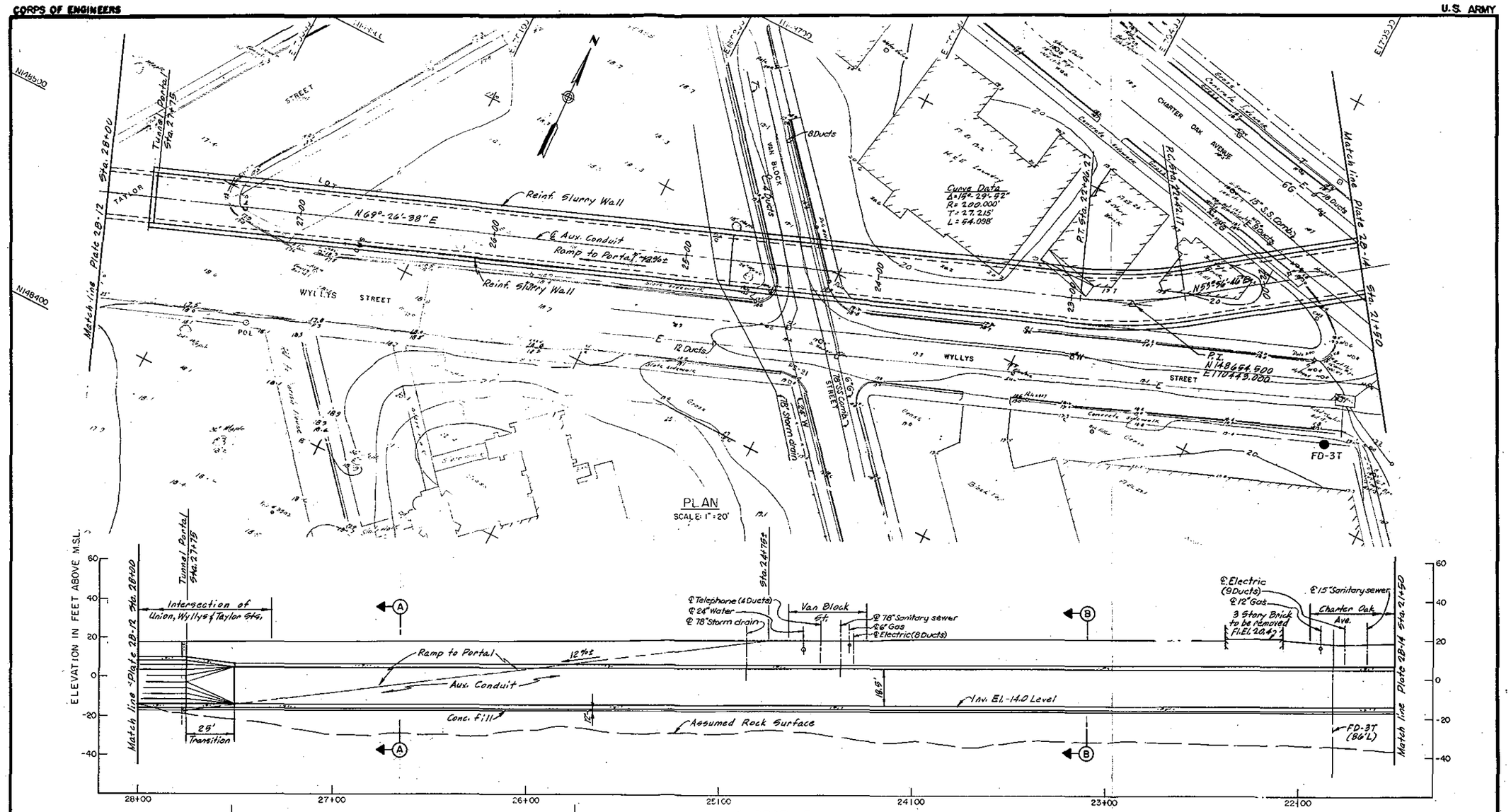
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. II
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

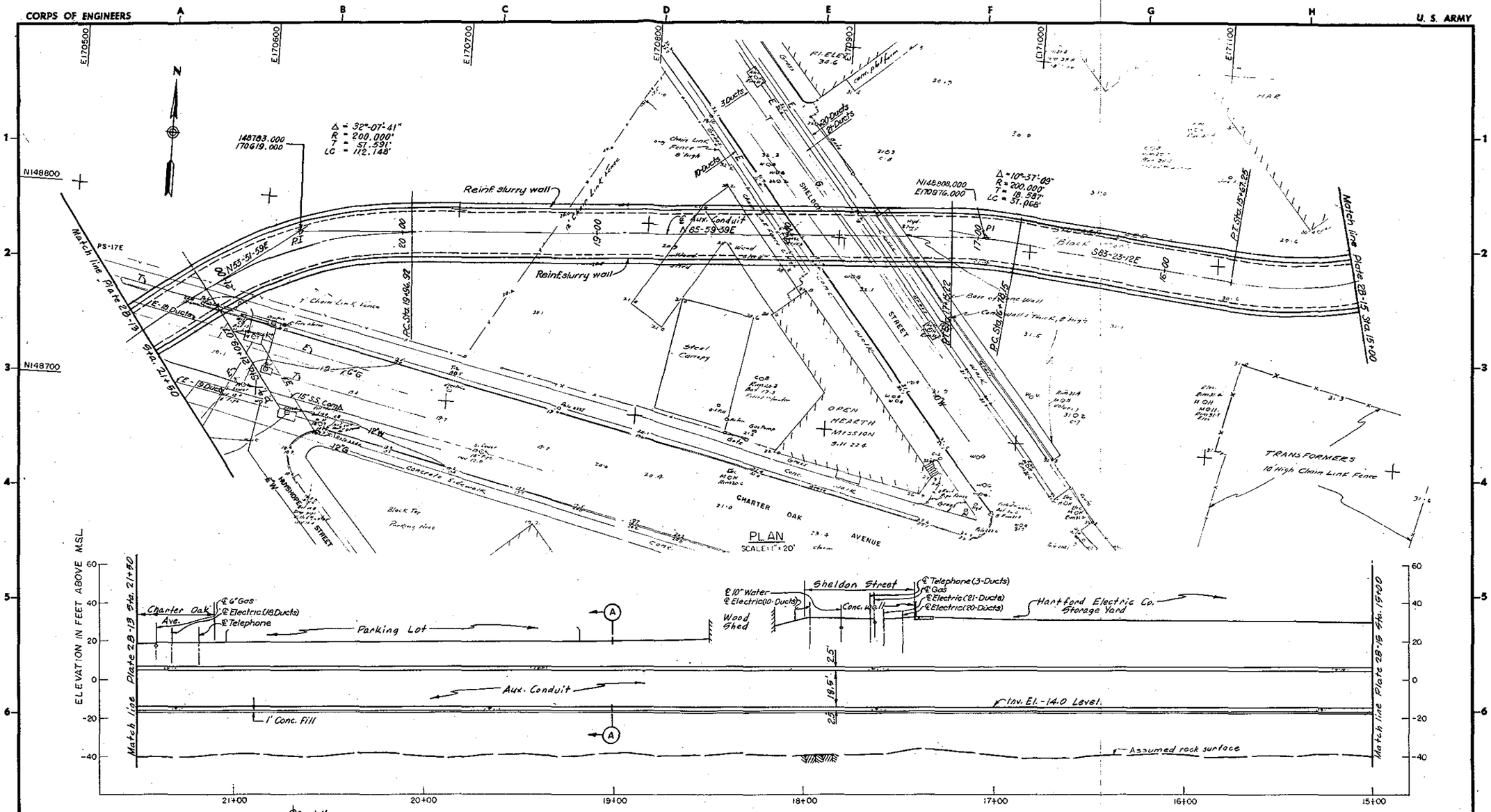
PLATE 2B-12



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

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 12
HARTFORD CONNECTICUT

CORPS OF ENGINEERS — U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

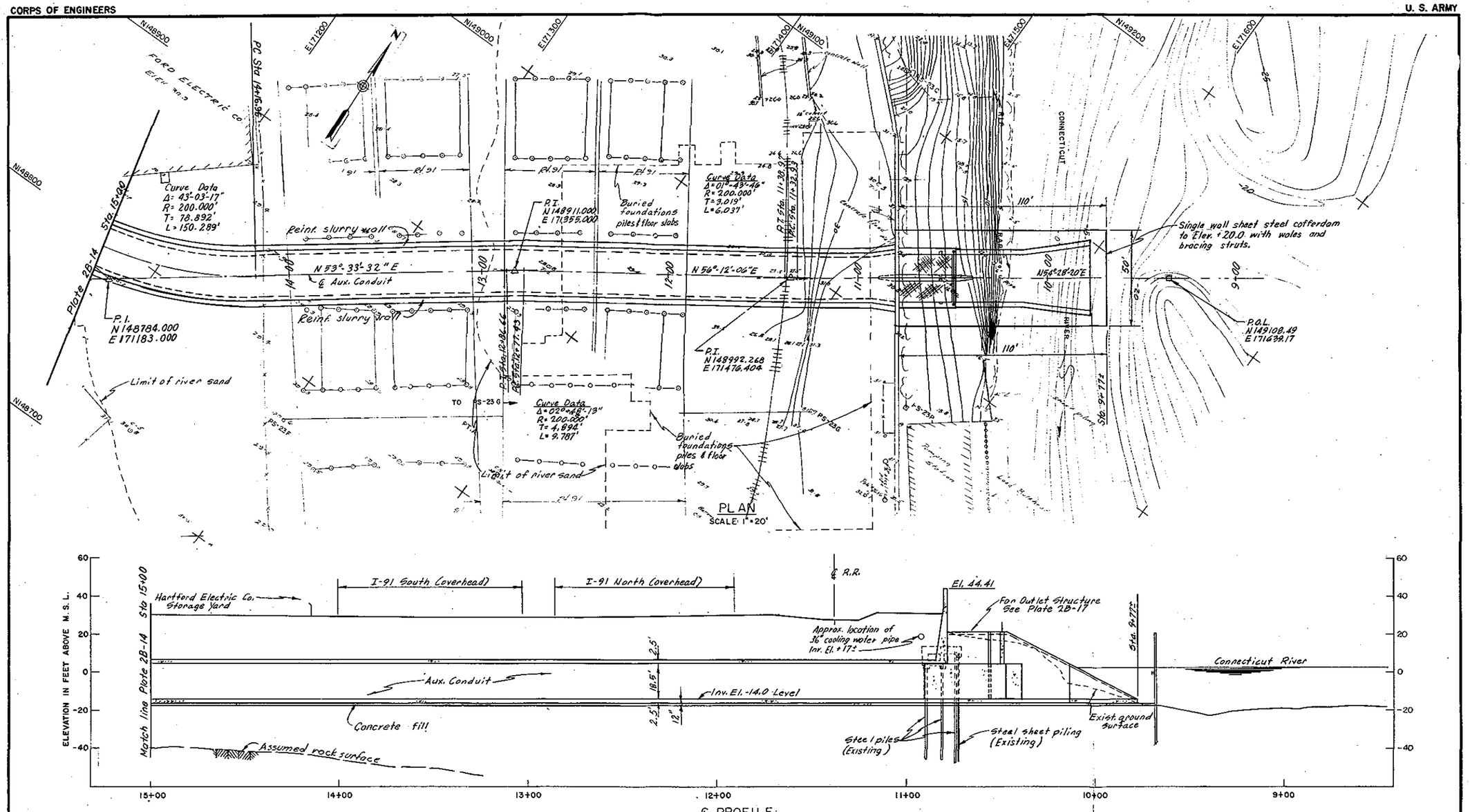
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 13
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-14



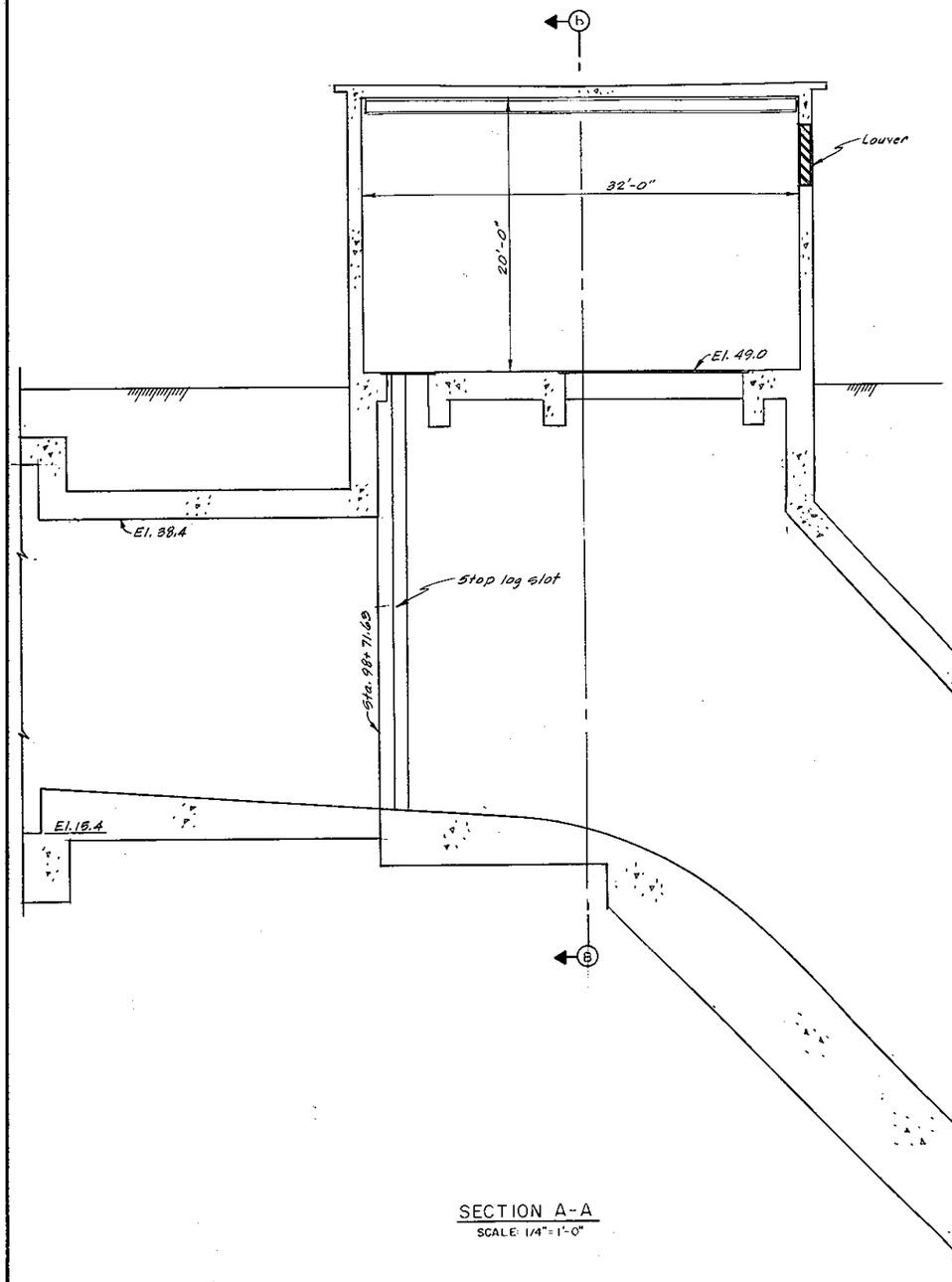
NOTE
For typical section see section A-A Plate 2B-14.

REVISION	DATE	DESCRIPTION	BY

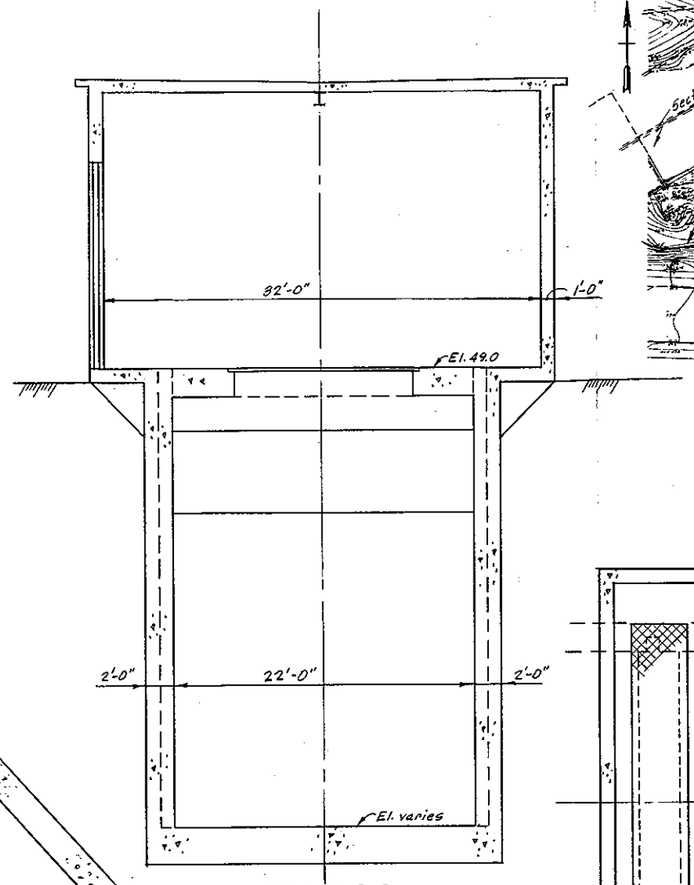
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

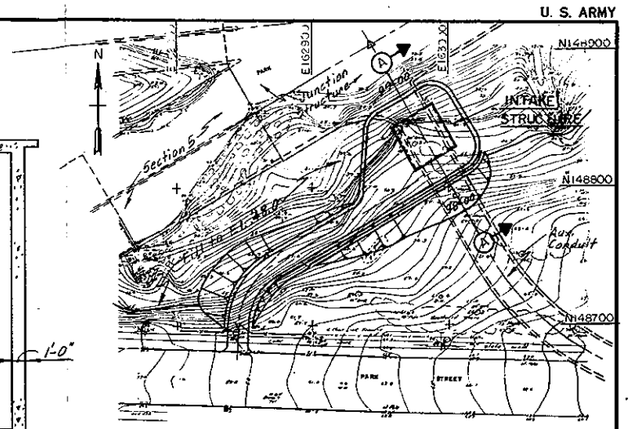
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
PLAN, PROFILE AND SECTION NO. 14
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET



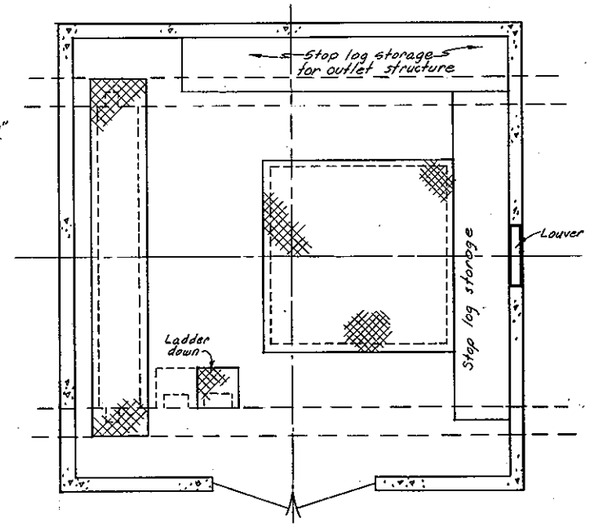
SECTION A-A
SCALE: 1/4" = 1'-0"



SECTION B-B
SCALE: 1/4" = 1'-0"



PLAN
SCALE: 1" = 40'



FLOOR PLAN
SCALE: 1/4" = 1'-0"

GRAPHIC SCALES
1" = 40' 40' 0 40' 80'
1/4" = 1'-0" 4' 0 4' 8'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

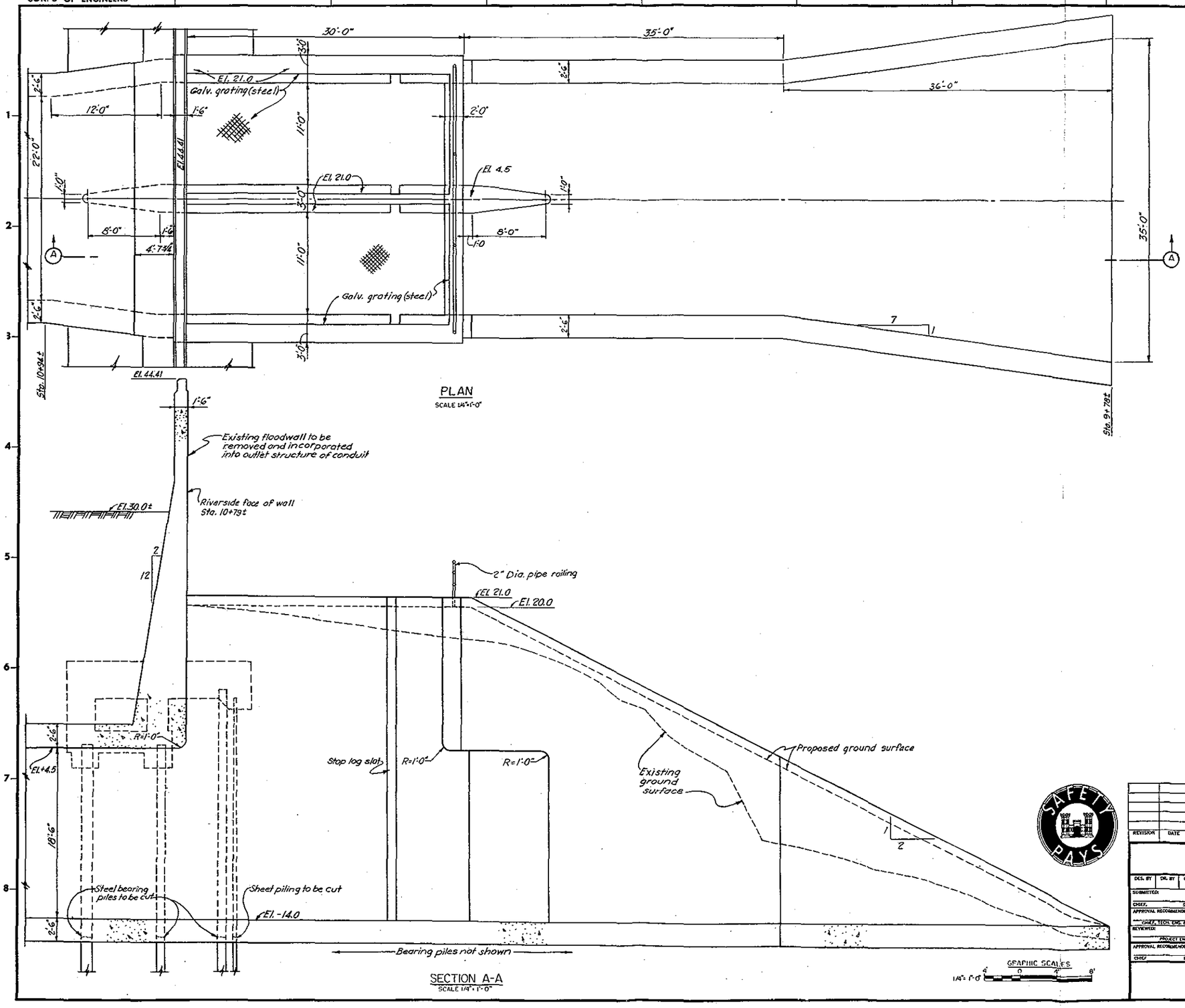
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
INTAKE STRUCTURE
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-16

CORPS OF ENGINEERS U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

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

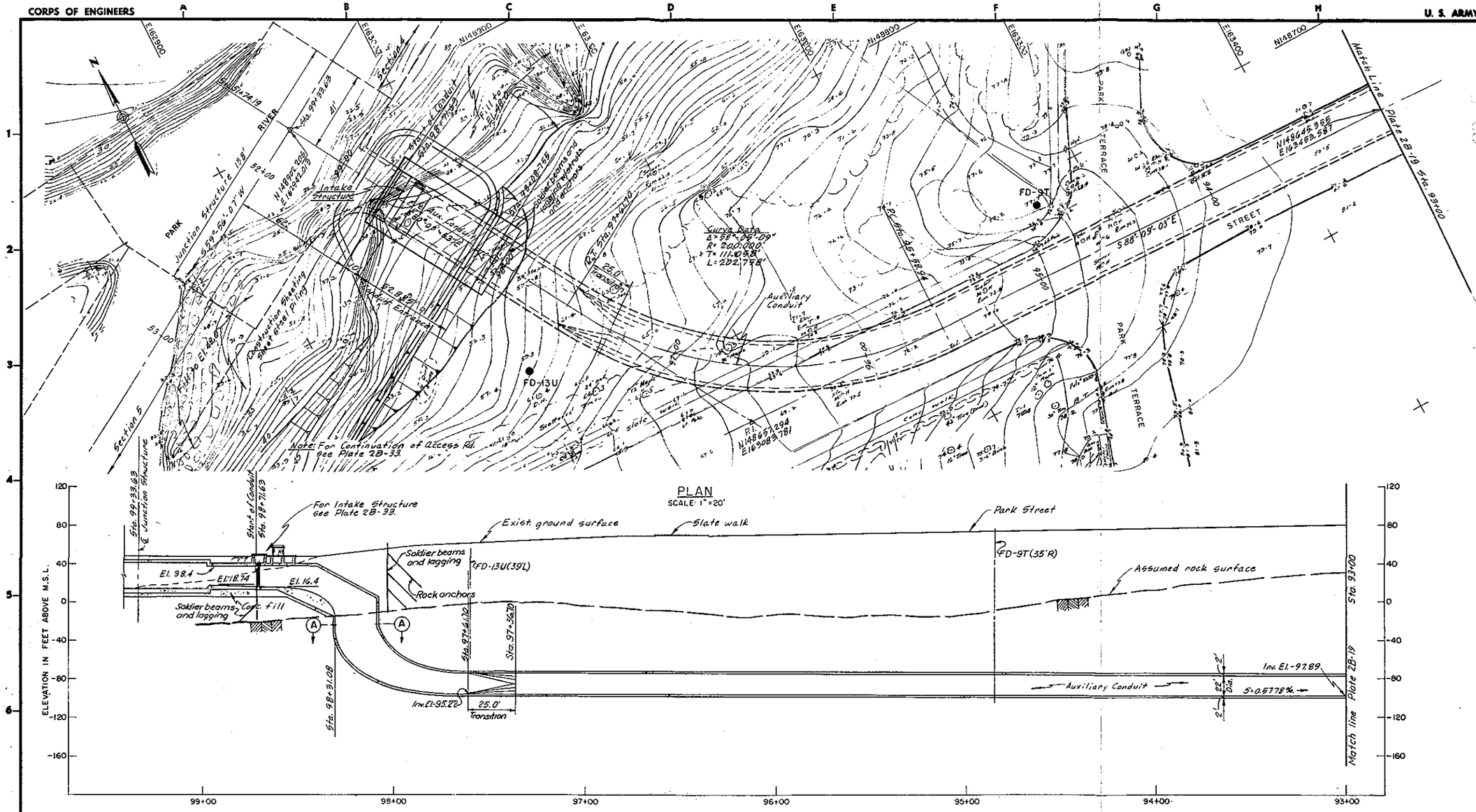
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
OUTLET STRUCTURE
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION

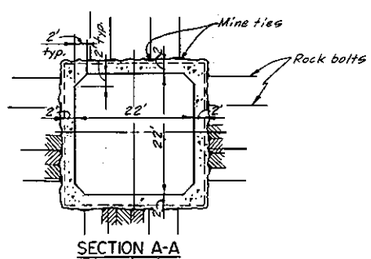
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 28-17

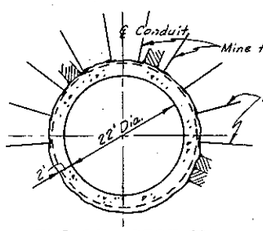
CORPS OF ENGINEERS U. S. ARMY



℄ PROFILE
SCALE: HORIZ. 1" = 20'
VERT. 1" = 40'



SECTION A-A
SCALE 1" = 10'



TYPICAL SECTION
STA. 97+36 TO STA. 93+00
SCALE: 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'
1" = 40' 40' 0 40' 80'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
RECOMMEND:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME "D"
PLAN, PROFILE AND SECTION NO. 1
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-18

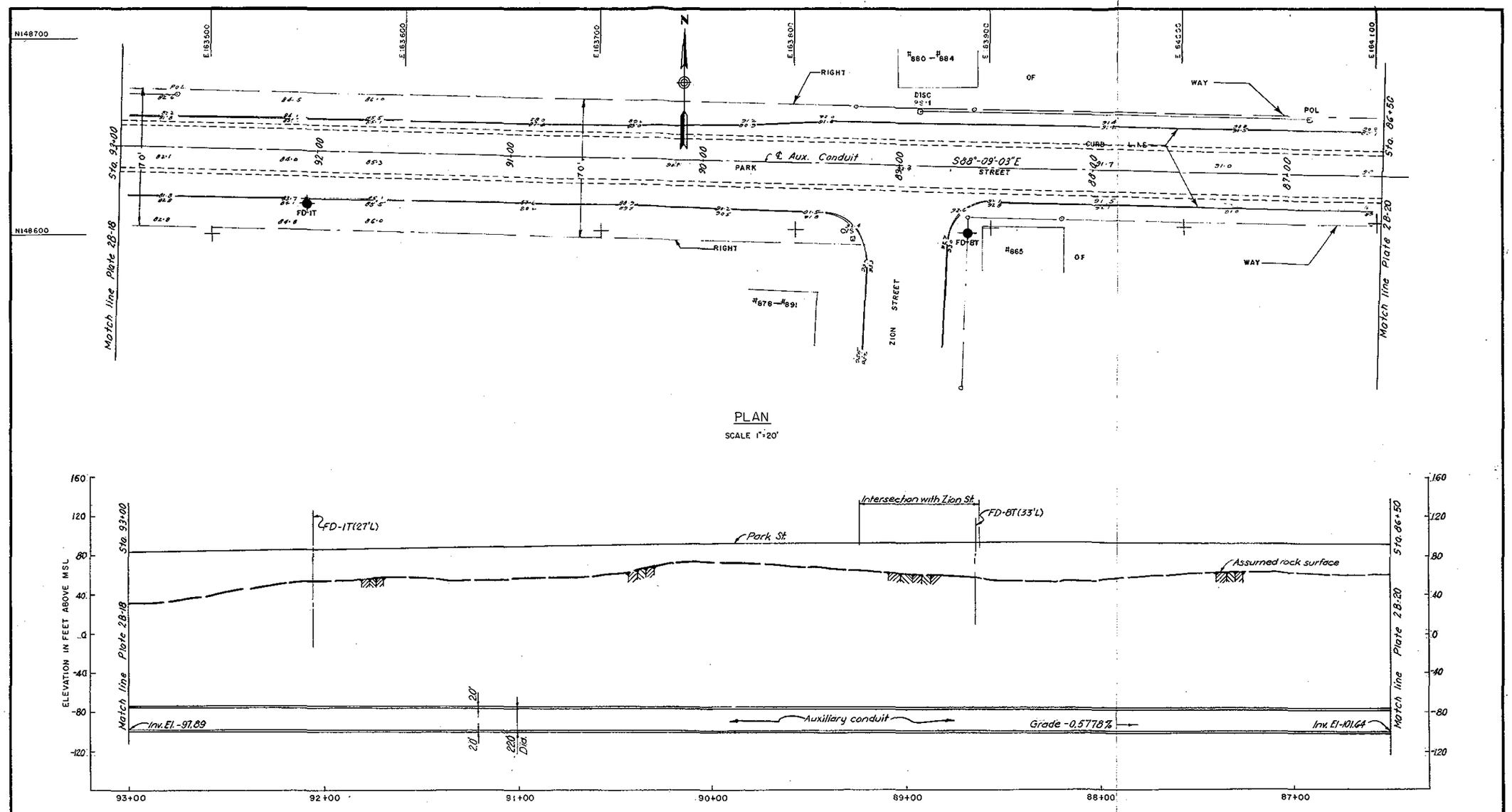
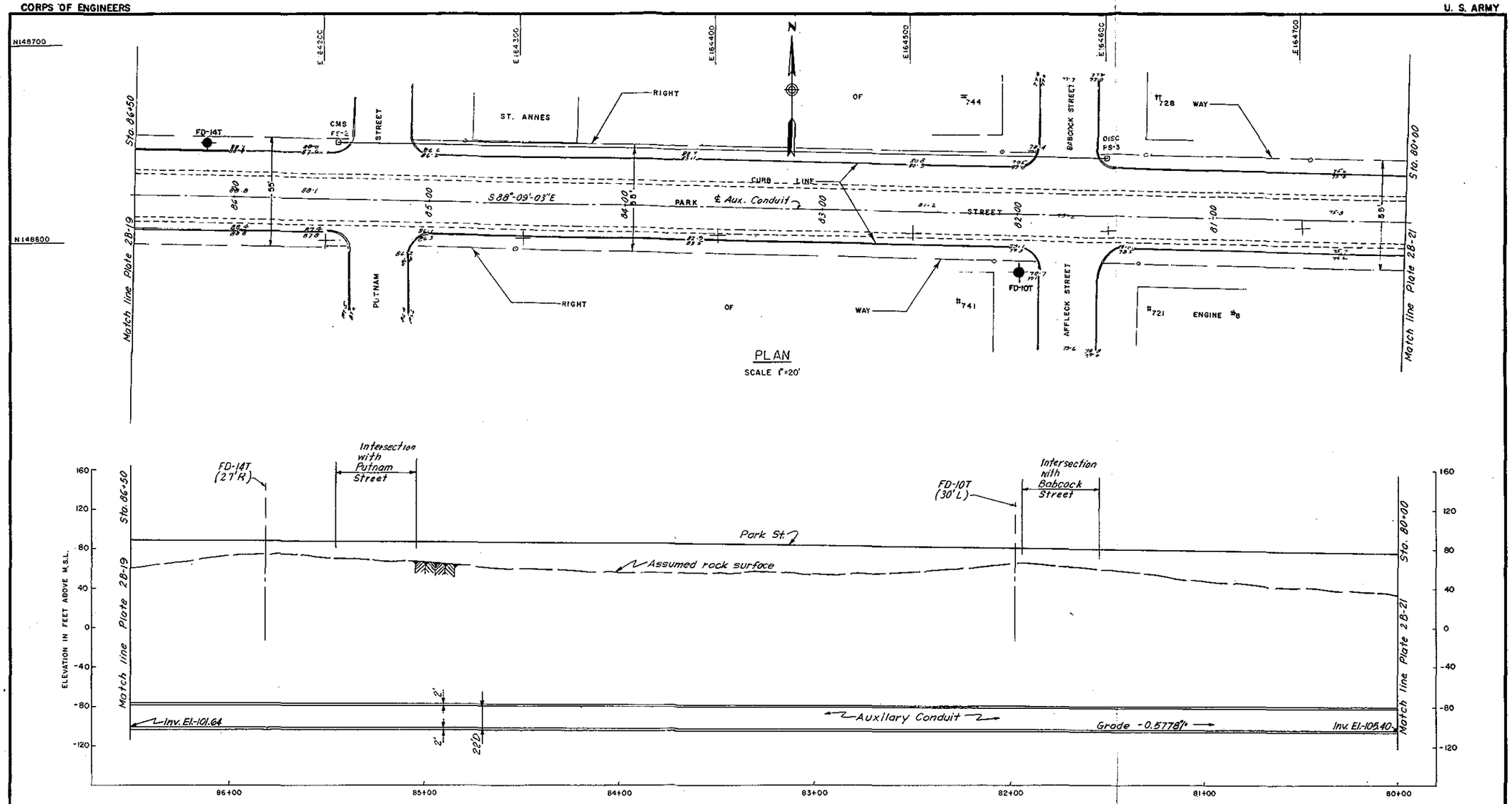
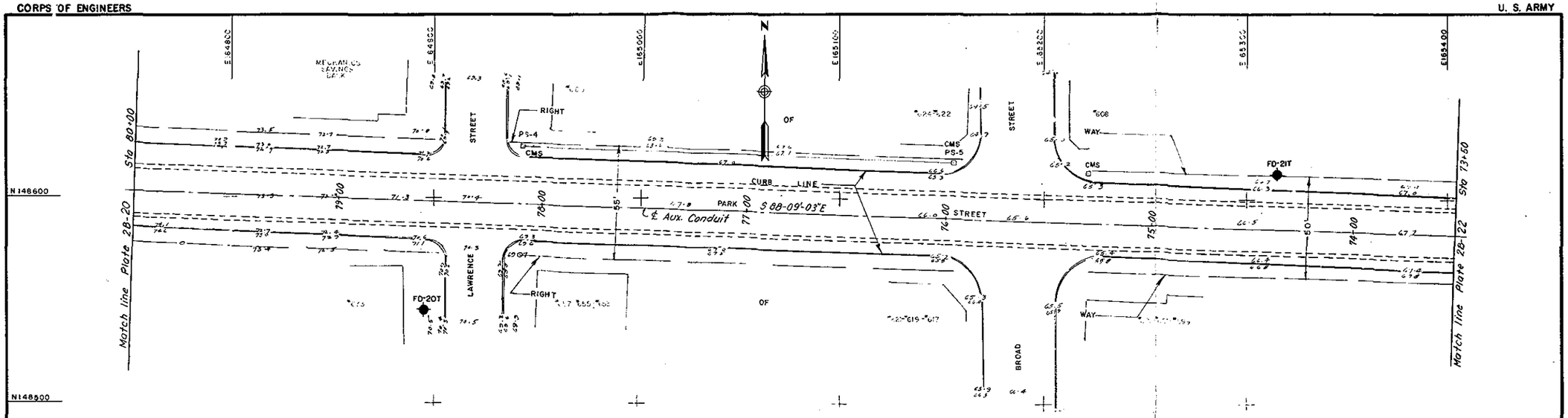

N148700
N148600
E163500
E163600
E163700
E163800
E163900
E164000
E164100
Sta. 93+00
Sta. 86+50
Match line Plate 2B-18
Match line Plate 2B-20
RIGHT
#880 – #884
DISC
OF
WAY
POL
CURB
L.S.
℄ Aux. Conduit
S88°-09'-03"E
PARK
STREET
FD-1T
FD-8T
#865
#878 – #891
ZION STREET
PLAN
SCALE 1"=20'
Intersection with Zion St.
FD-1T(27'L)
FD-8T(33'L)
Park St.
Assumed rock surface
Inv. El. -97.89
Auxiliary conduit
Grade -0.5778%
Inv. El.-101.64
20'
2.0'
22.0' Dia.
ELEVATION IN FEET ABOVE MSL
160
120
80
40
0
-40
-80
-120
93+00
92+00
91+00
90+00
89+00
88+00
87+00
℄ Conduit
Mine ties
Rock bolts
22.0' O.D.
2.0'
TYPICAL SECTION
SCALE 1"=10'
℄ PROFILE
SCALE: HORIZ 1"=20' VERT 1"=40'
SAFETY PAYS
GRAPHIC SCALES
1"=20'
1"=10'
1"=40'
REVISION
DATE
DESCRIPTION
BY
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT - SCHEME D
PLAN, PROFILE AND SECTION NO. 2
HARTFORD
CONNECTICUT
APPROVED
DATE
CHIEF, ENGINEERING DIVISION
SCALE
SPEC. NO.
DRAWING NUMBER
SHEET

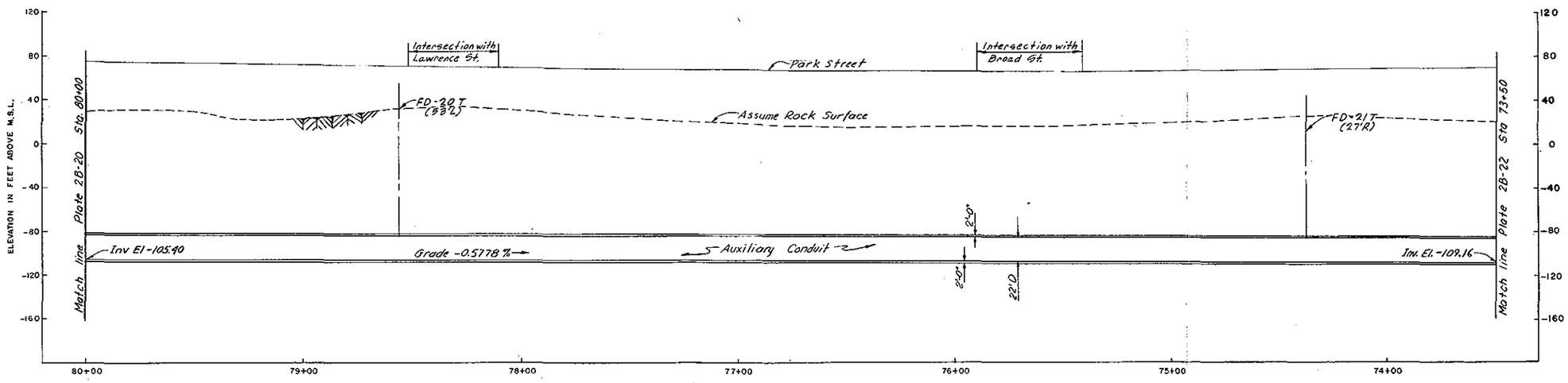
PLATE 2B-19


N148700
N148600
E164200
E164300
E164400
E164500
E164600
E164700
N
Sta. 86+50
Match line Plate 2B-19
Sta. 80+00
Match line Plate 2B-21
FD-14T
CMS FS-2
STREET
ST. ANNES
RIGHT
OF
#744
BABCOCK STREET
DISC FS-3
#728
WAY
CURB LINE
S88°-09'-03"E
PARK & Aux. Conduit
STREET
PUTNAM
RIGHT
OF
WAY
#741
FD-10T
AFFLECK STREET
#721
ENGINE #8
PLAN
SCALE 1"=20'
Intersection with Putnam Street
FD-14T (27'R)
FD-10T (30'L)
Intersection with Babcock Street
Park St.
Assumed rock surface
Inv. El.-101.64
Auxiliary Conduit
Grade -0.5778'
Inv. El.-105.40
22'D
ELEVATION IN FEET ABOVE M.S.L.
160
120
80
40
0
-40
-80
-120
86+00
85+00
84+00
83+00
82+00
81+00
80+00
℄ PROFILE
SCALE HORZ 1"=20' VERT. 1"=40'
℄ Conduit
Mine ties
Rock bolts
22'-0" Dia.
2.0'
TYPICAL SECTION
SCALE 1"=10'
SAFETY PAYS
GRAPHIC SCALES
1"=20' 20' 0 20' 40'
1"=10' 10' 0 10' 20'
1"=40' 40' 0 40' 80'
REVISION DATE DESCRIPTION BY
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME D
PLAN, PROFILE AND SECTION NO. 3
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE
SPEC. NO.
DRAWING NUMBER
SHEET



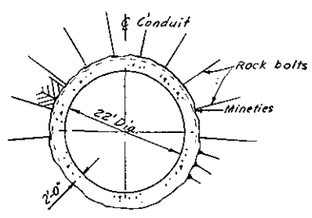
PLAN

SCALE 1" = 20'



℄ PROFILE

SCALE HORIZ. 1" = 20' VERT. 1" = 40'



TYPICAL SECTION

SCALE: 1" = 10'

GRAPHIC SCALES

1" = 20' 20' 0 20' 40'

1" = 10' 10' 0 10' 20'

1" = 40' 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT

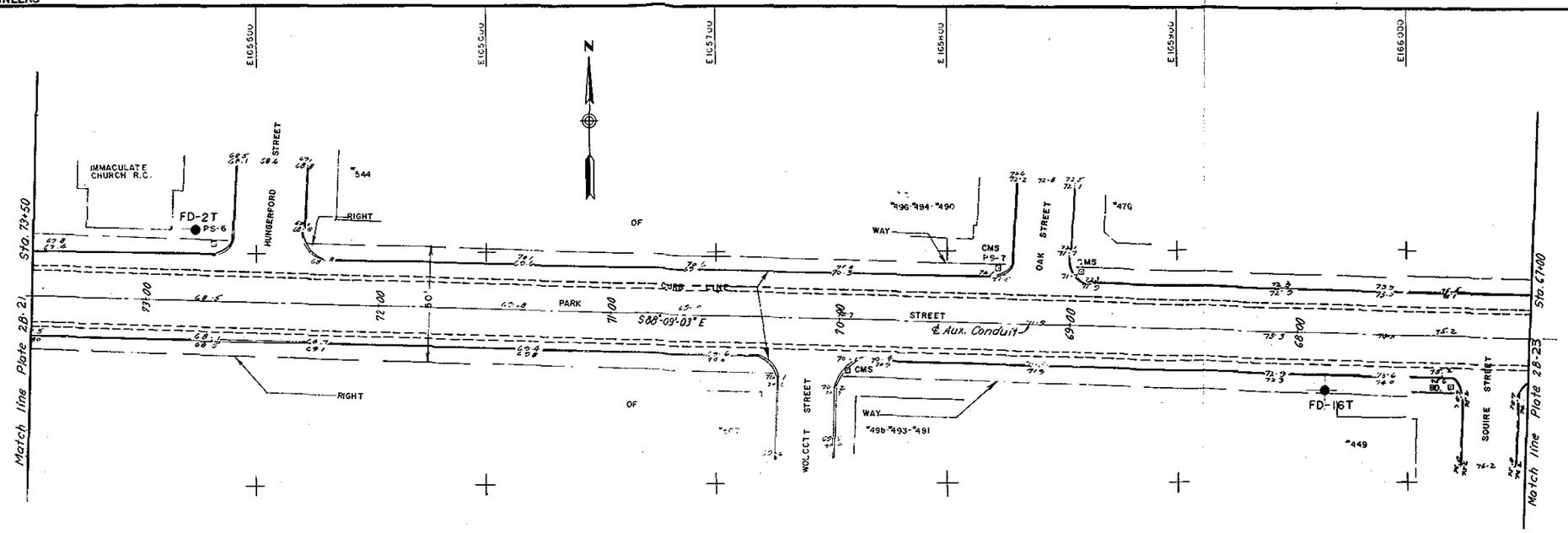
PARK RIVER LOCAL PROTECTION

AUXILIARY CONDUIT
SCHEME D
PLAN, PROFILE AND SECTION NO. 4

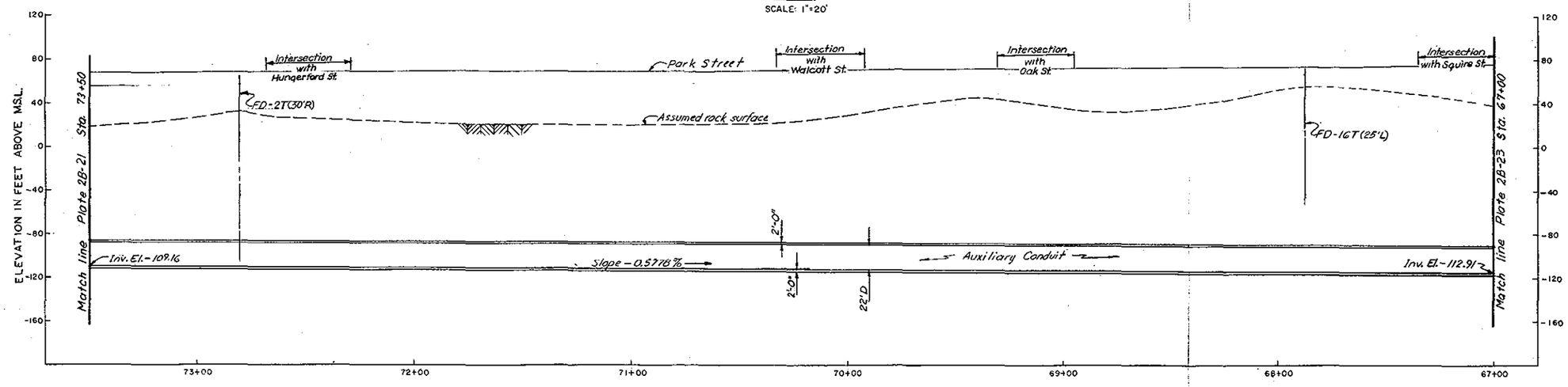
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

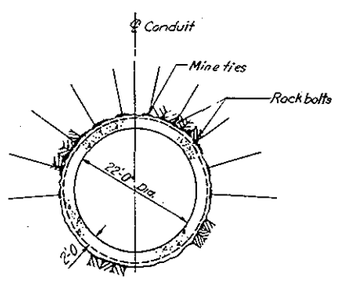
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET



PLAN
SCALE: 1"=20'



℄ PROFILE
SCALE: HORIZ. 1" = 20'
VERT. 1" = 40'



TYPICAL SECTION
SCALE 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10 0 10 20
1" = 40' 40' 0 40' 80'

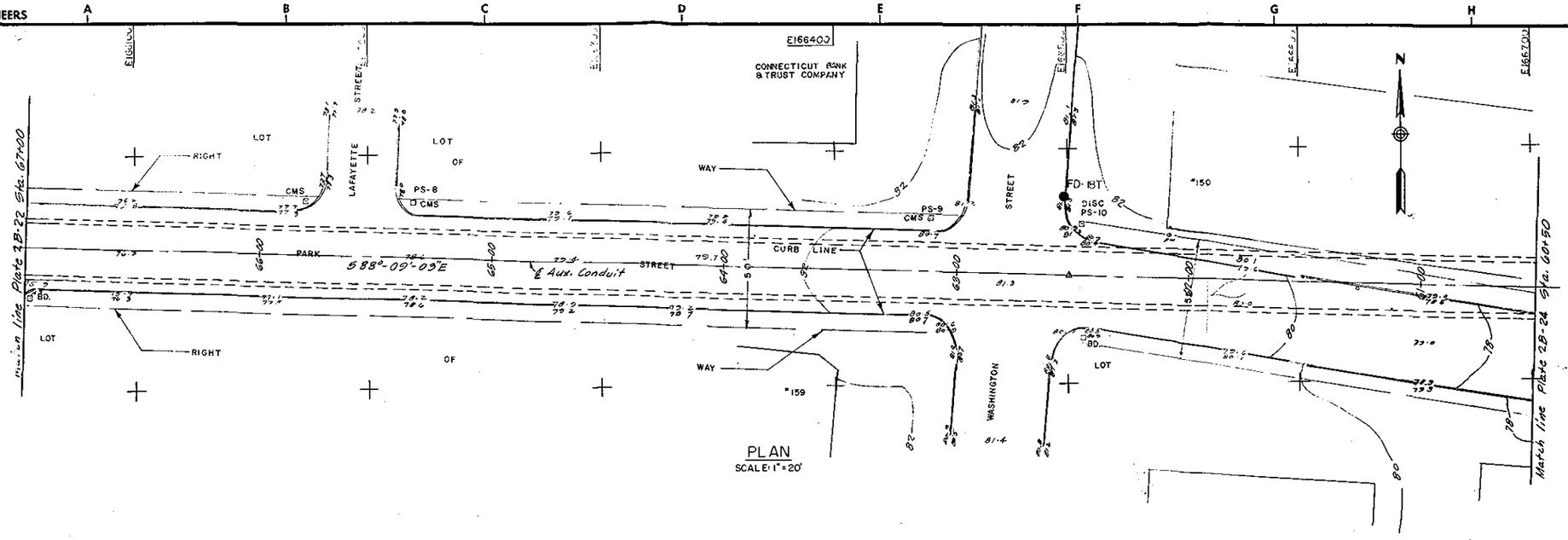
REVISION	DATE	DESCRIPTION	BY

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

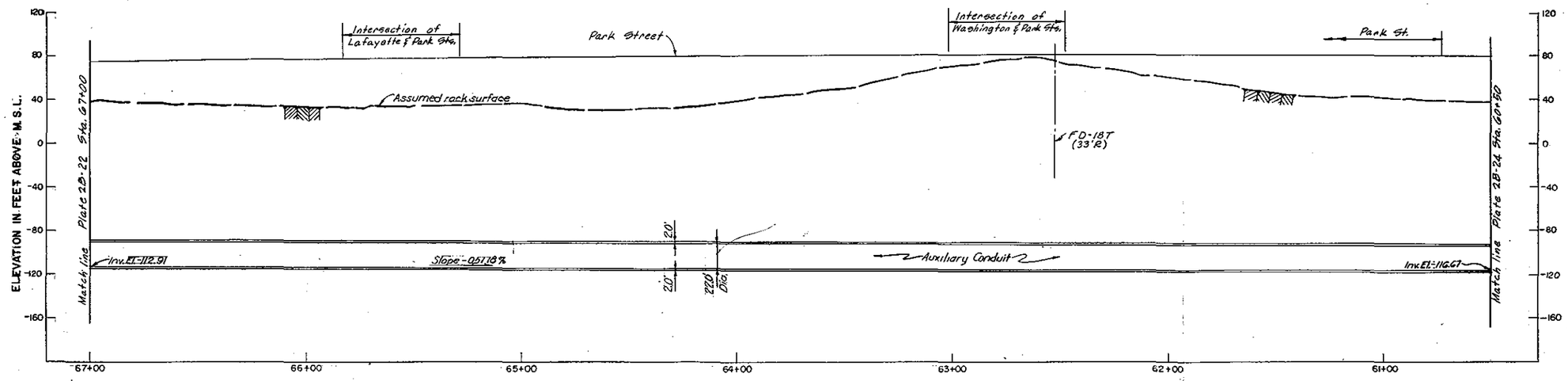
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME D
PLAN, PROFILE AND SECTION NO. 5
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE SPEC. NO.
DRAWING NUMBER
SHEET

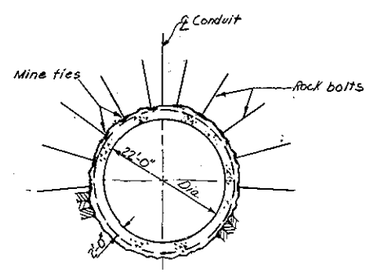
CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE: 1" = 20'



PROFILE
SCALE: HORIZ. 1" = 20'
VERT. 1" = 40'



TYPICAL SECTION
SCALE 1" = 10'

GRAPHIC SCALES
1" = 20' — 20' 0 20' 40'
1" = 10' — 10' 0 10' 20'
1" = 40' — 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

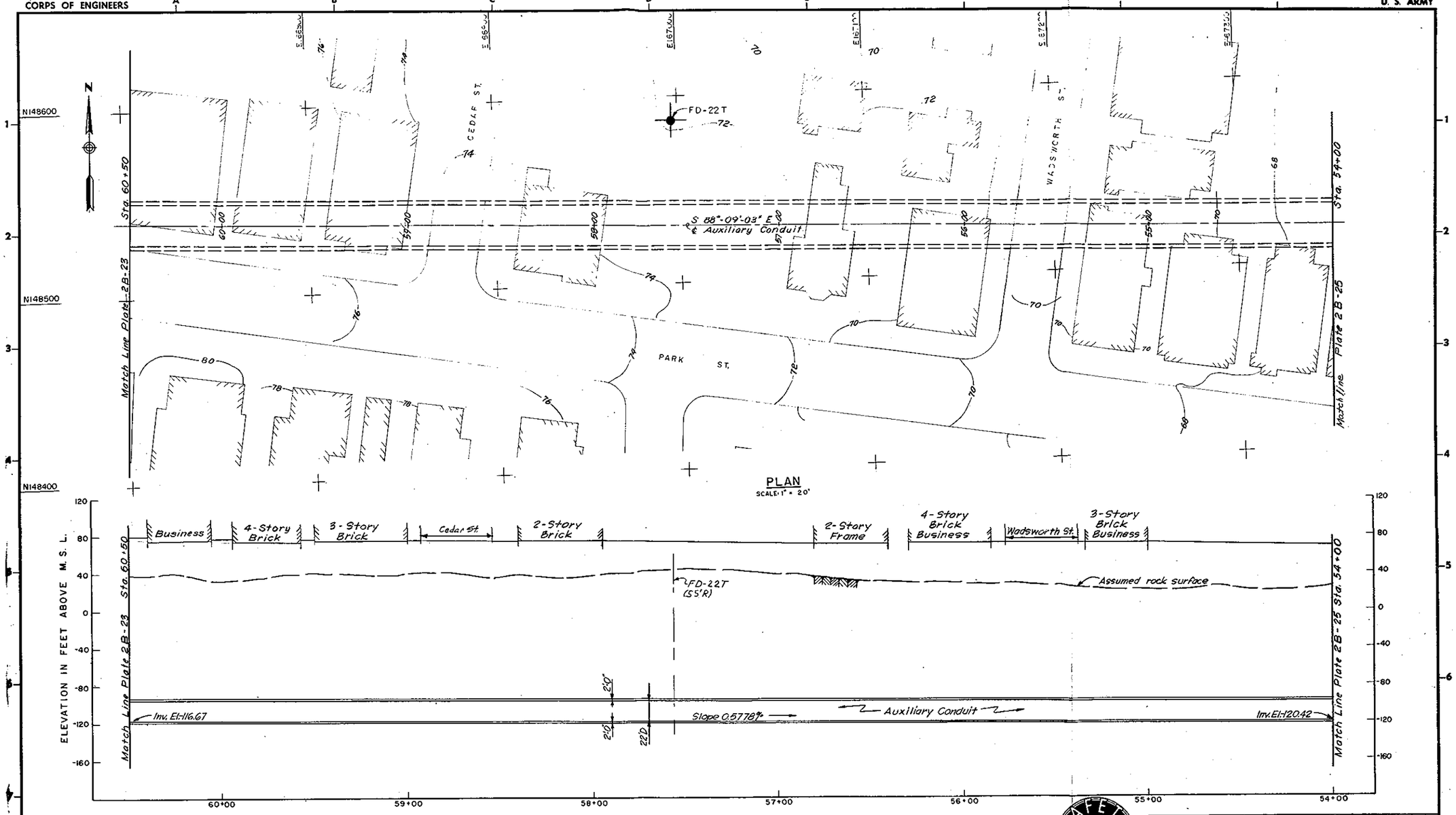
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT - SCHEME D
PLAN, PROFILE AND SECTION NO. 6
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

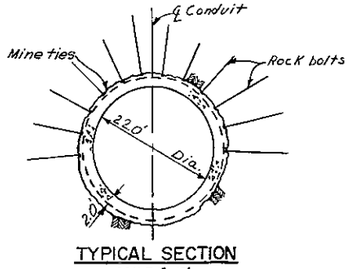
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-23

CORPS OF ENGINEERS U. S. ARMY



℄ PROFILE
SCALE: HORZ. 1" = 20'
VERT. 1" = 40'



TYPICAL SECTION
SCALE 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'
1" = 40' 40' 0 40' 80'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

SUBMITTED: CHIEF, SECTION
APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH
REVIEWED: PROJECT ENGINEER
APPROVAL RECOMMENDED: CHIEF BRANCH

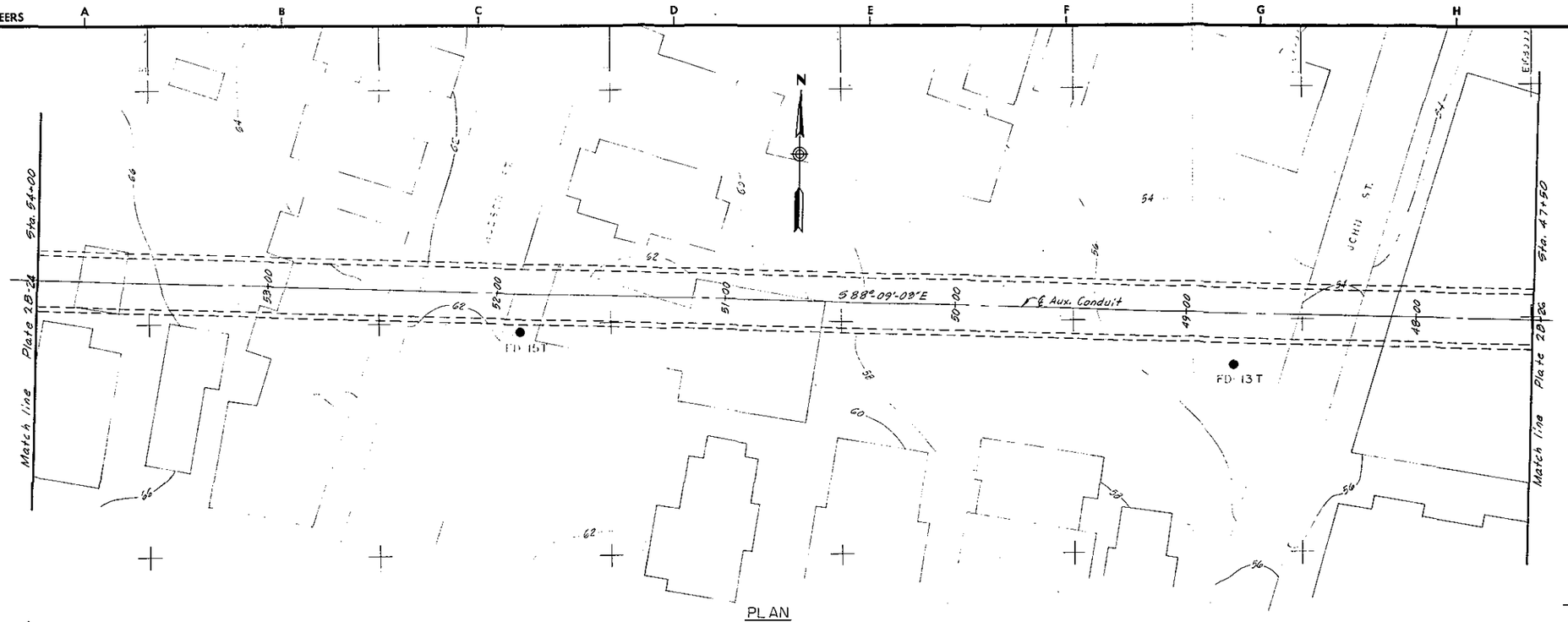
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME D
PLAN, PROFILE AND SECTION NO. 7
HARTFORD CONNECTICUT

APPROVED CHIEF, ENGINEERING DIVISION DATE

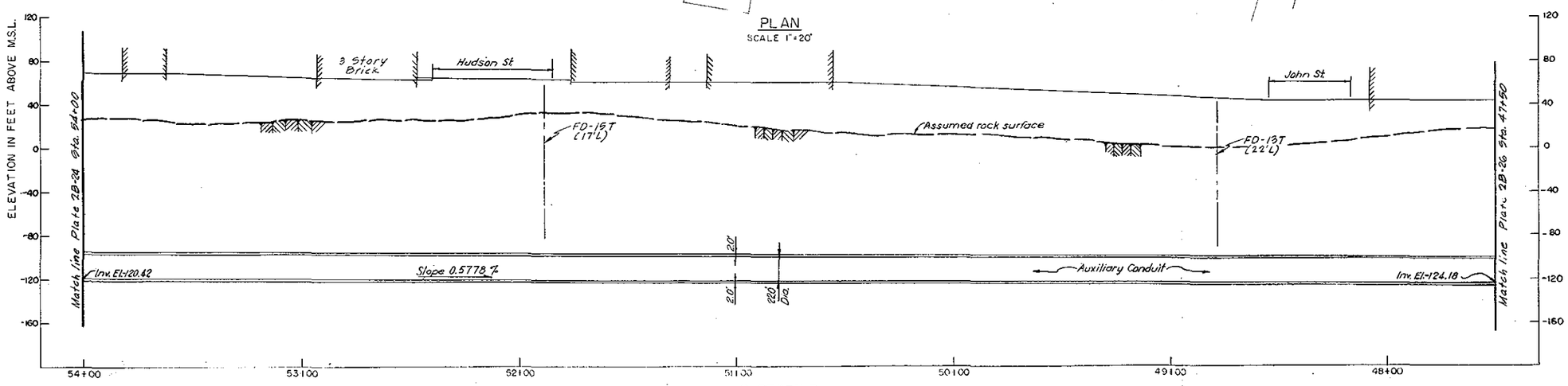
SCALE | SPEC. NO. | DRAWING NUMBER | SHEET

PLATE 2B-24

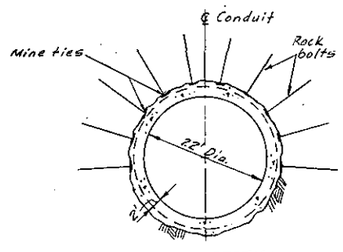
CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE 1"=20'



℄ PROFILE
SCALE: HORIZ 1"=20' VERT 1"=40'



TYPICAL SECTION
SCALE: 1"=10'

GRAPHIC SCALES
1"=20' 20' 0 20' 40'
1"=10' 10' 0 10' 20'
1"=40' 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

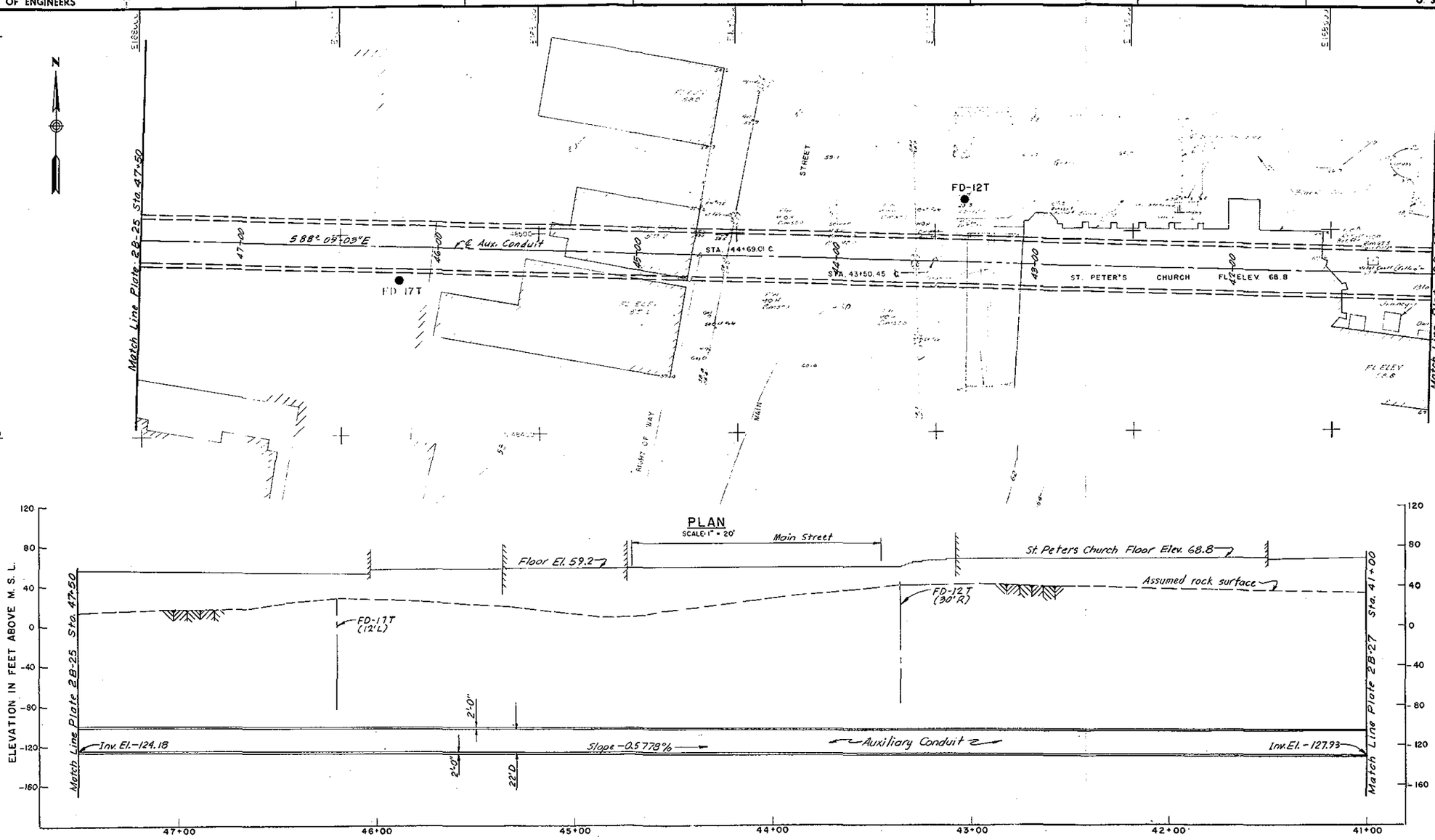
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT - SCHEME D
PLAN, PROFILE AND SECTION NO. 8
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-25

CORPS OF ENGINEERS U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

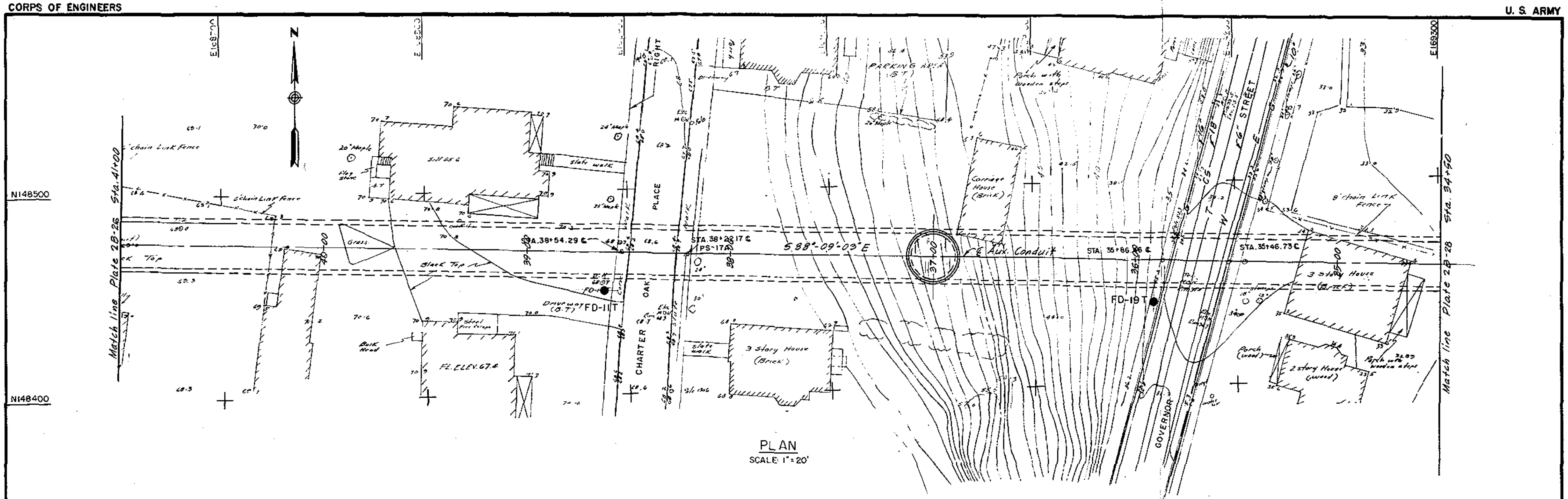
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME D
PLAN, PROFILE AND SECTION NO. 9
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

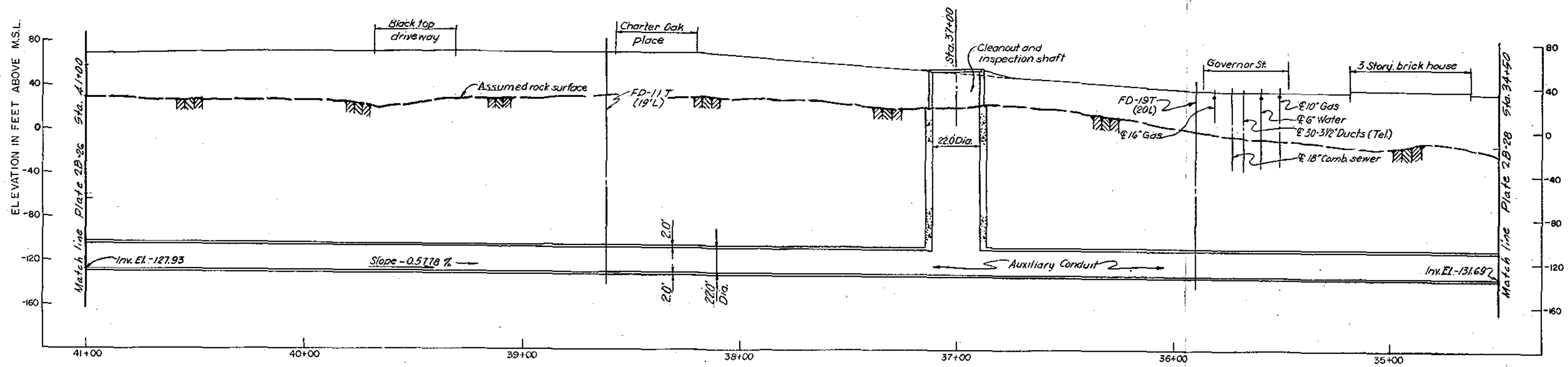
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-26

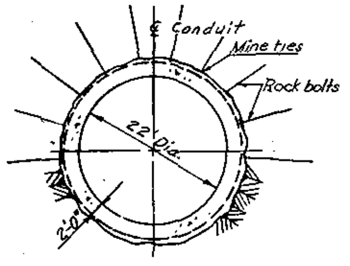
CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE: 1" = 20'



℄ PROFILE
SCALE: HORIZ. 1" = 20' VERT. 1" = 40'



TYPICAL SECTION
SCALE: 1" = 10'

SAFETY PAYS

GRAPHIC SCALES

1" = 20' : 20' 0 20' 40'
1" = 10' : 10' 0 10' 20'
1" = 40' : 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

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

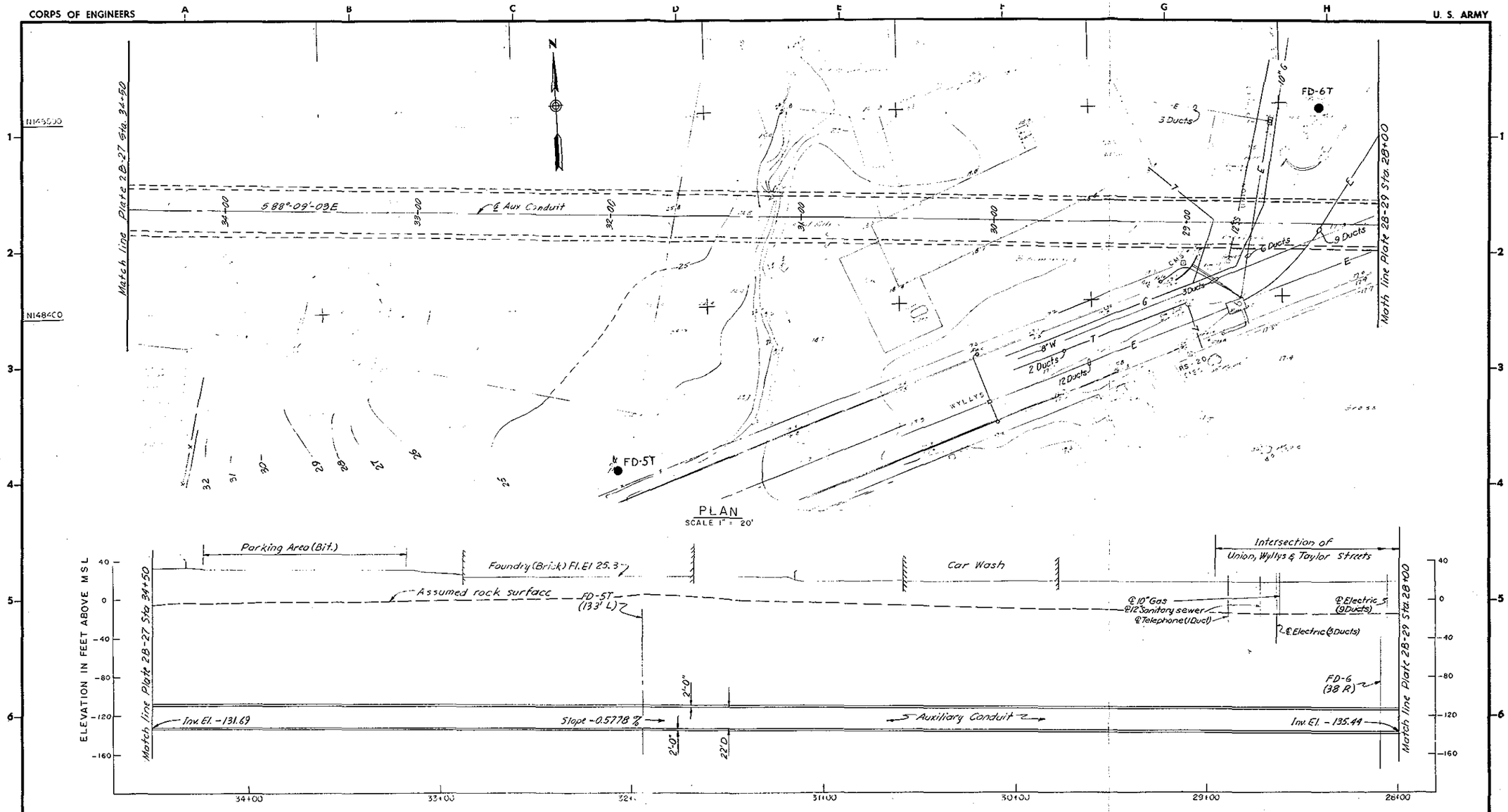
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF, BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT - SCHEME D
PLAN, PROFILE AND SECTION NO. 10
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-27

CORPS OF ENGINEERS U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

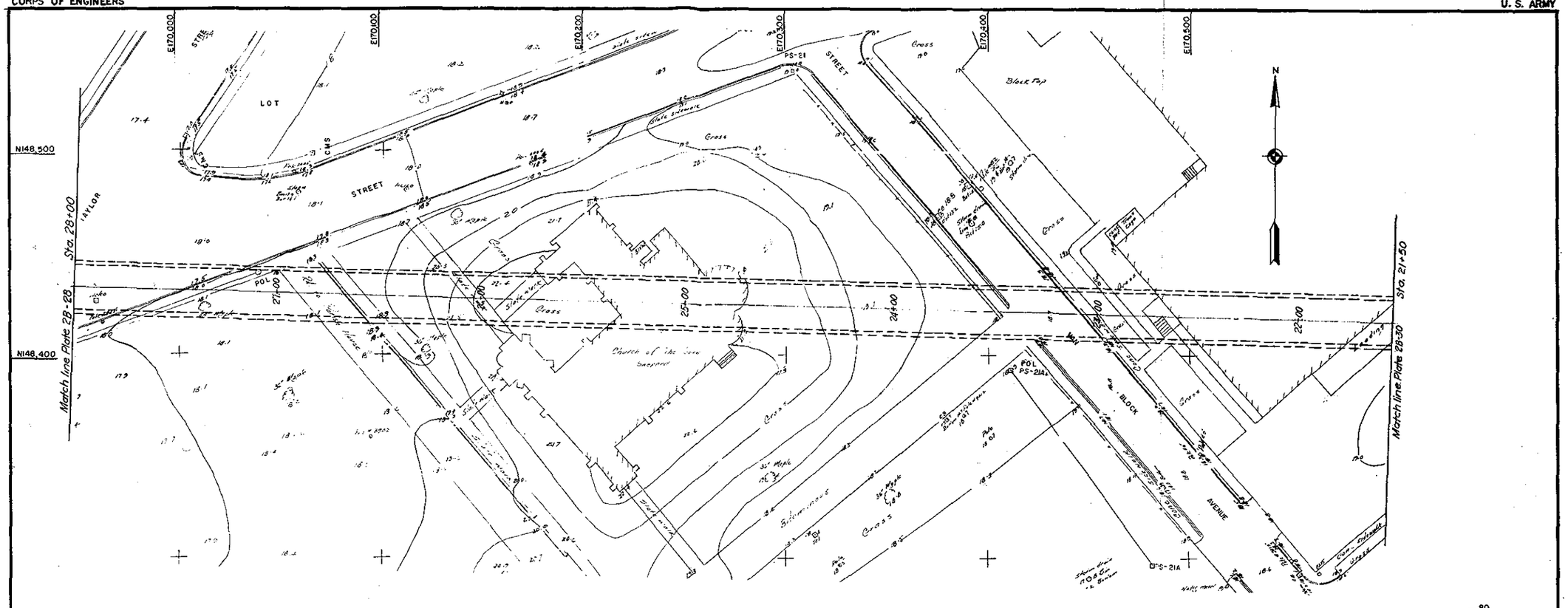
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME D
PLAN, PROFILE AND SECTION NO. II
HARTFORD CONNECTICUT

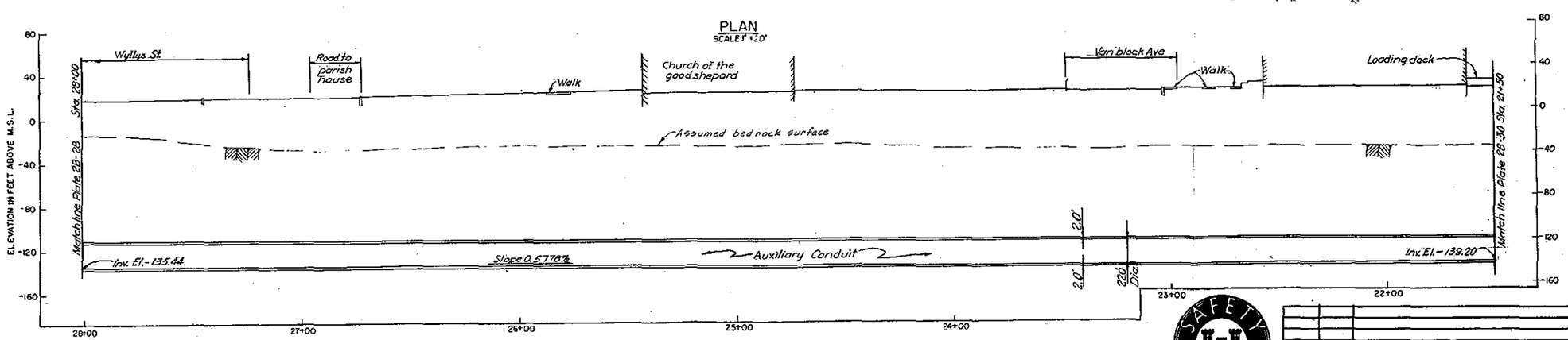
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

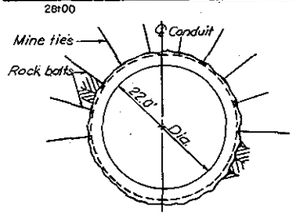
PLATE 2B-28



PLAN
SCALE 1" = 20'



℄ PROFILE AUXILIARY CONDUIT
SCALE: HORIZ. 1" = 20' VERT 1" = 40'



TYPICAL SECTION
SCALE 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'
1" = 40' 40' 0 40' 80'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT - SCHEME D
PLAN, PROFILE AND SECTION NO. 12
HARTFORD CONNECTICUT

APPROVED: DATE:
CHIEF, ENGINEERING DIVISION

SCALE SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS — U. S. ARMY

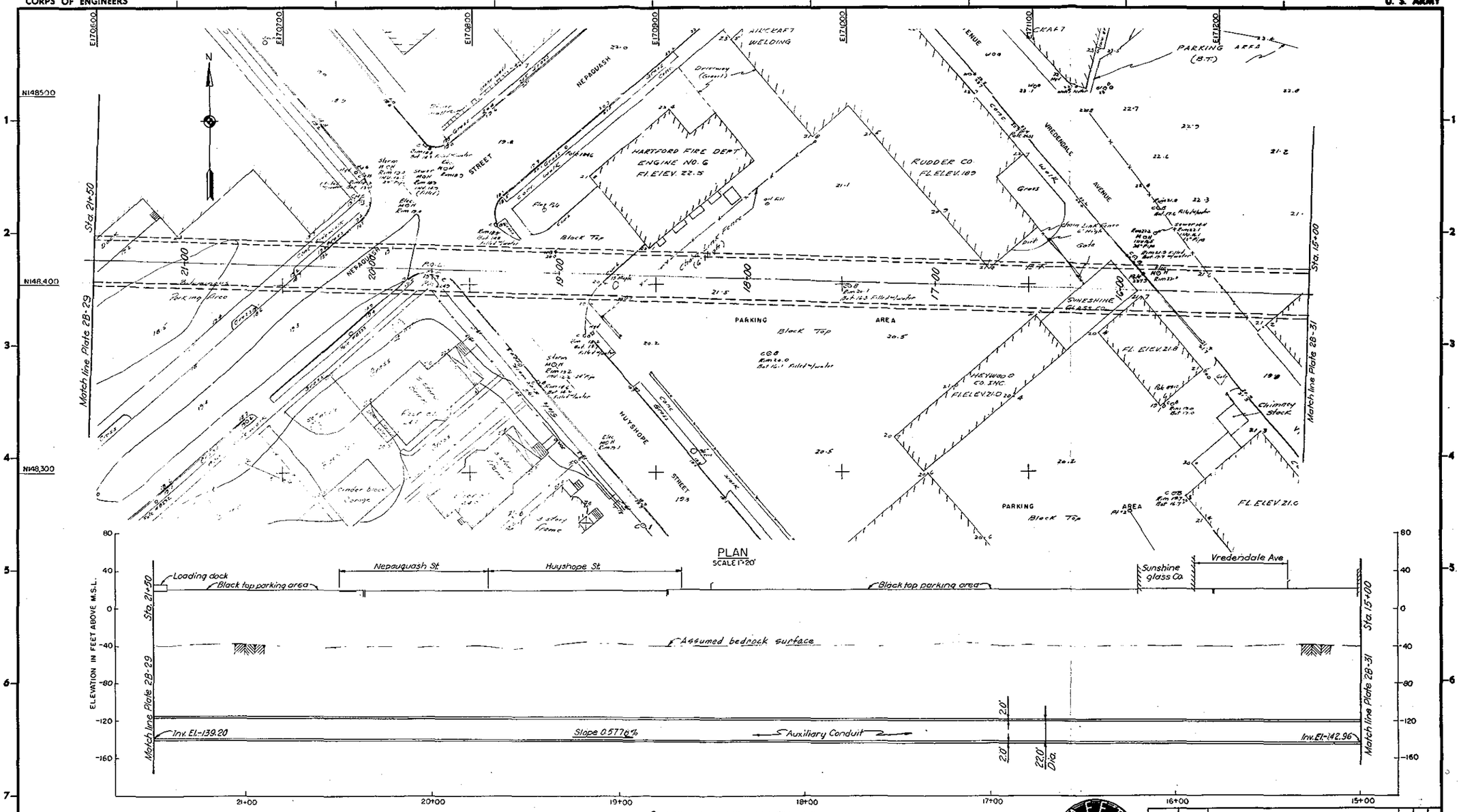
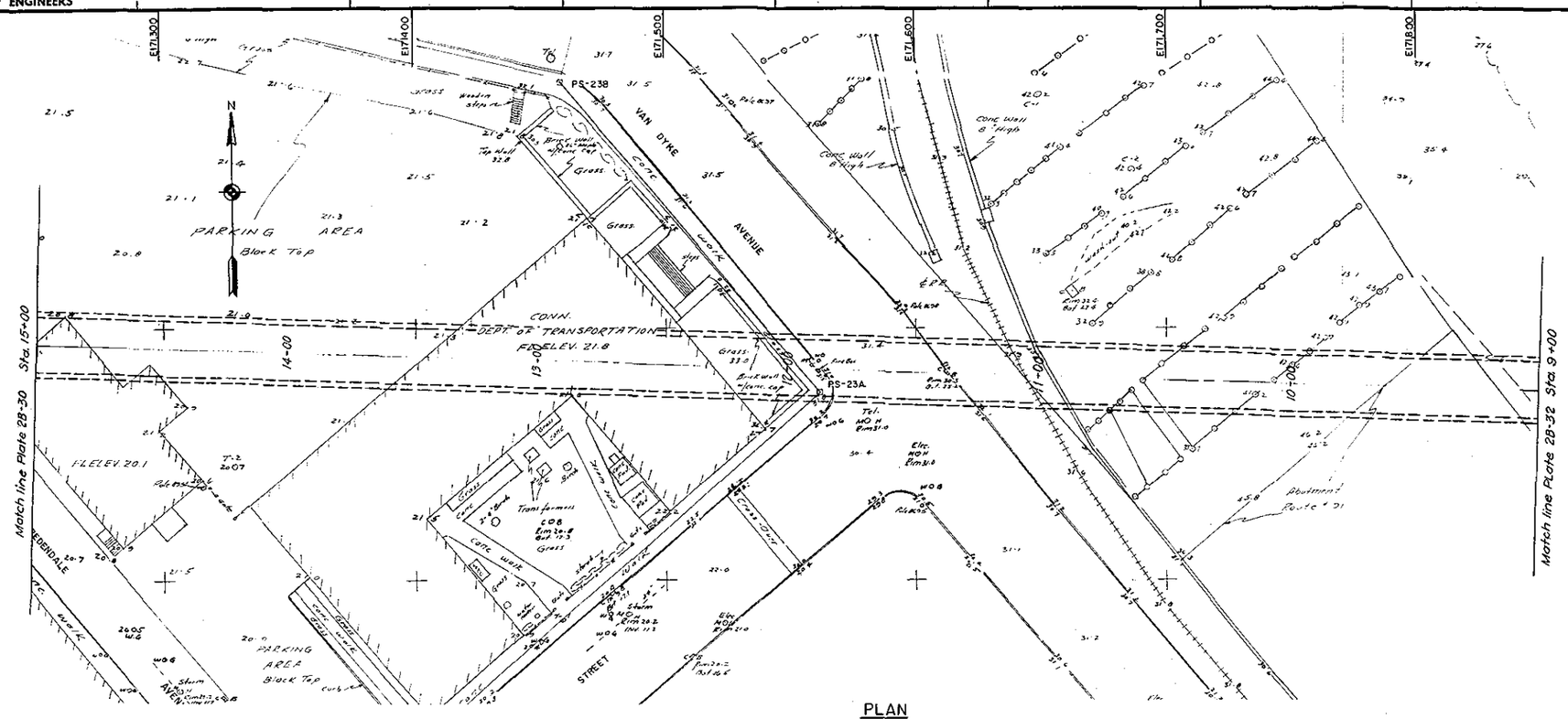
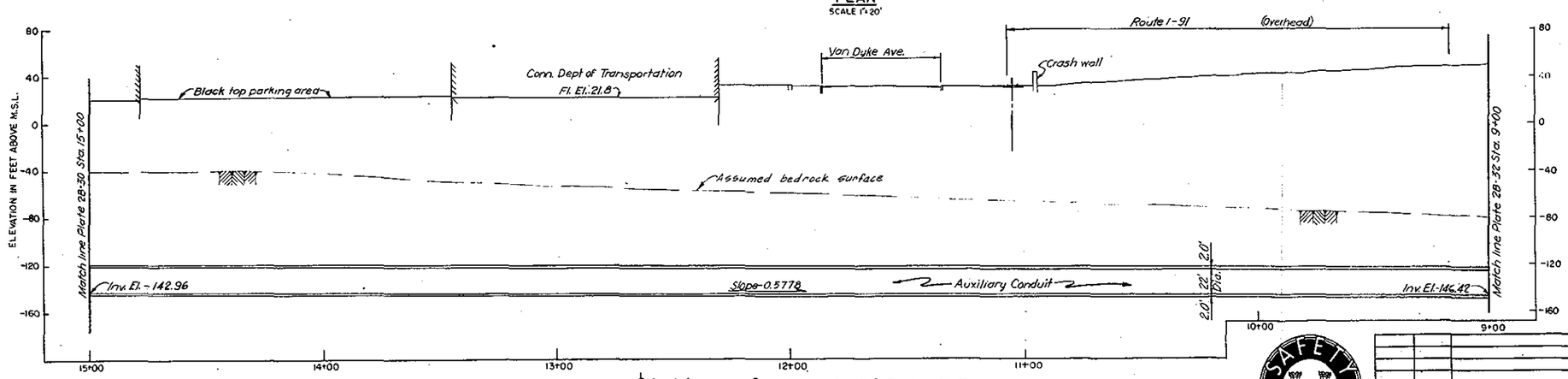


PLATE 2B-30

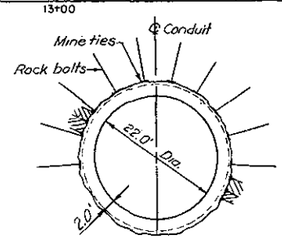
CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE 1"=20'



℄ PROFILE AUXILIARY CONDUIT
SCALE: HORIZ 1"=20'
VERT 1"=40'



TYPICAL SECTION
SCALE: 1"=10'

GRAPHIC SCALES
1"=20' 20' 0 20' 40'
1"=10' 10' 0 10' 20'
1"=40' 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

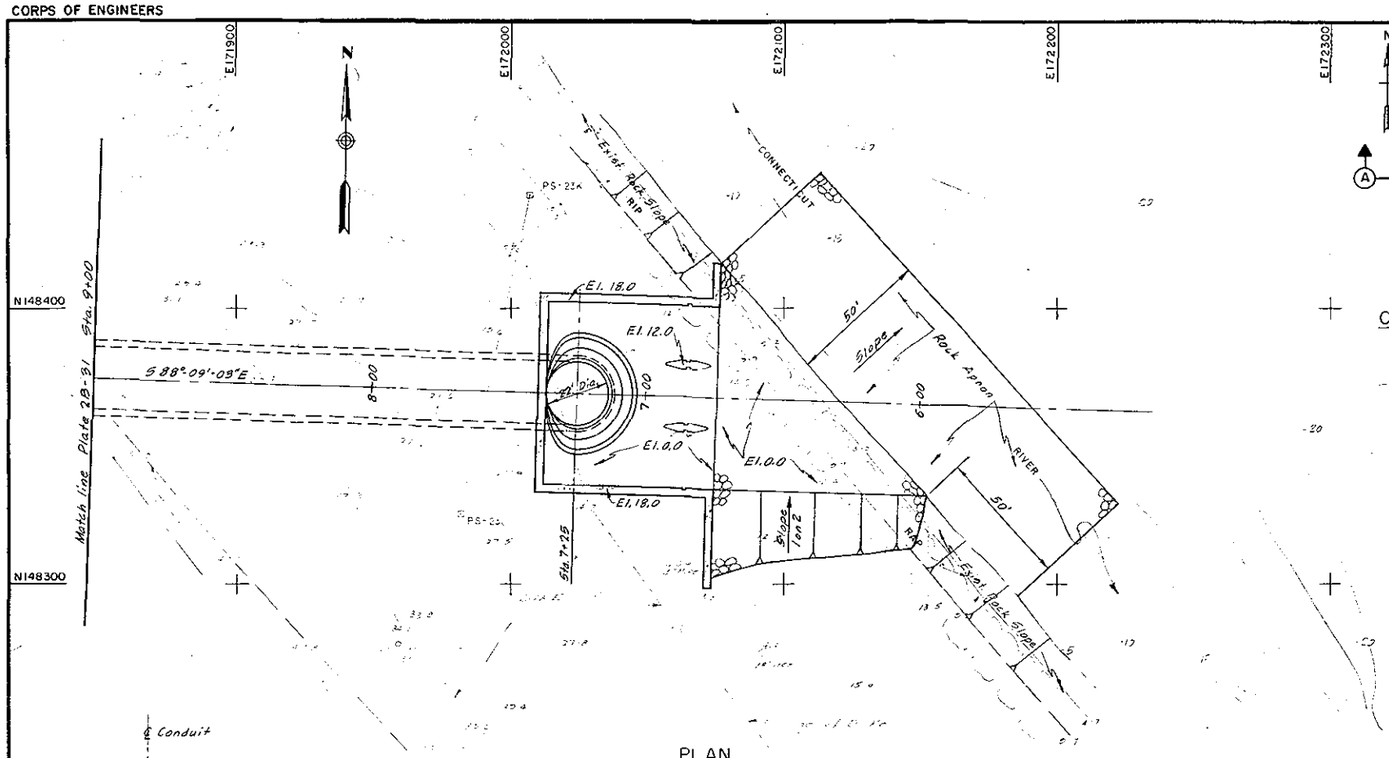
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF, BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT - SCHEME D
PLAN, PROFILE AND SECTION NO. 14
HARTFORD CONNECTICUT

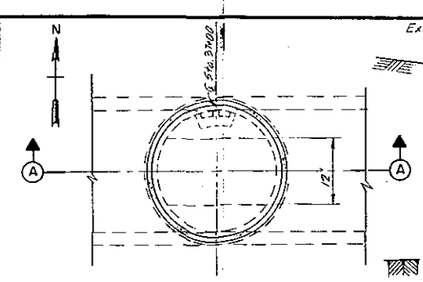
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

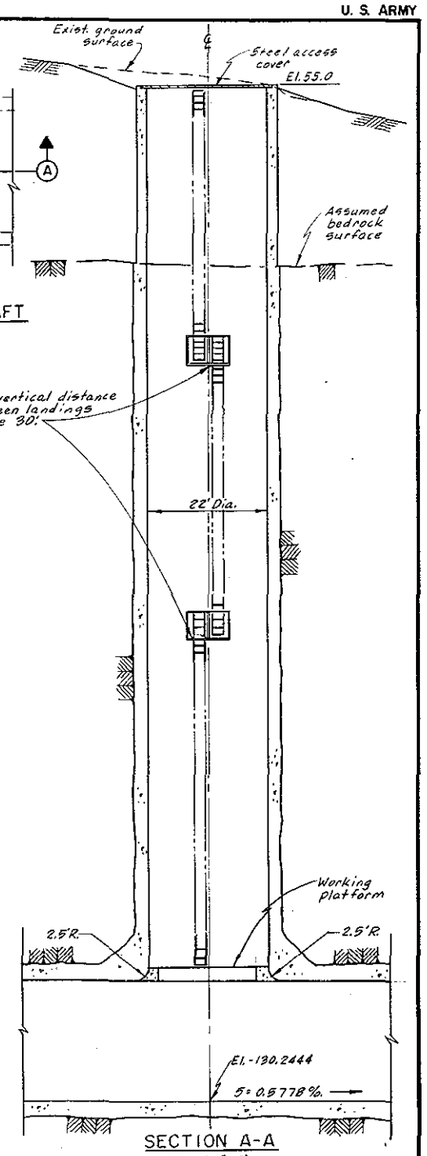
PLATE 2B-31



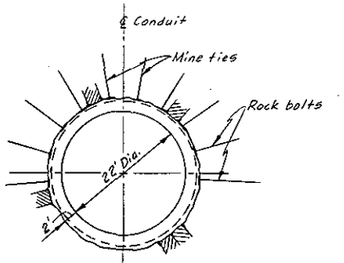
PLAN
SCALE: 1" = 20'



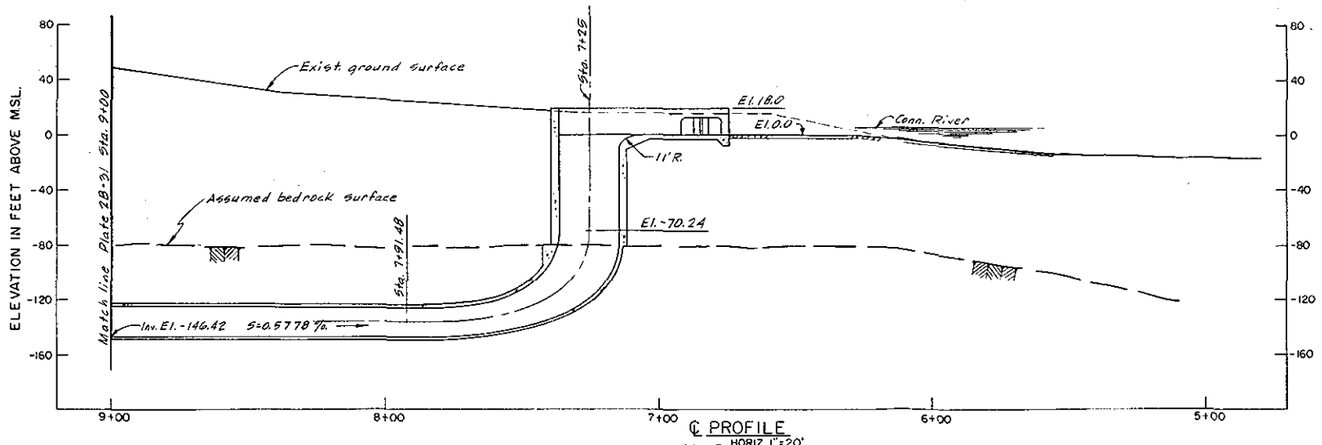
CLEANOUT AND INSPECTION SHAFT
PLAN
SCALE: 1" = 10'



SECTION A-A
SCALE: 1" = 10'



TYPICAL SECTION
SCALE: 1" = 10'



℄ PROFILE
SCALE: HORIZ. 1" = 20'
VERT. 1" = 40'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'
1" = 40' 40' 0 40' 80'

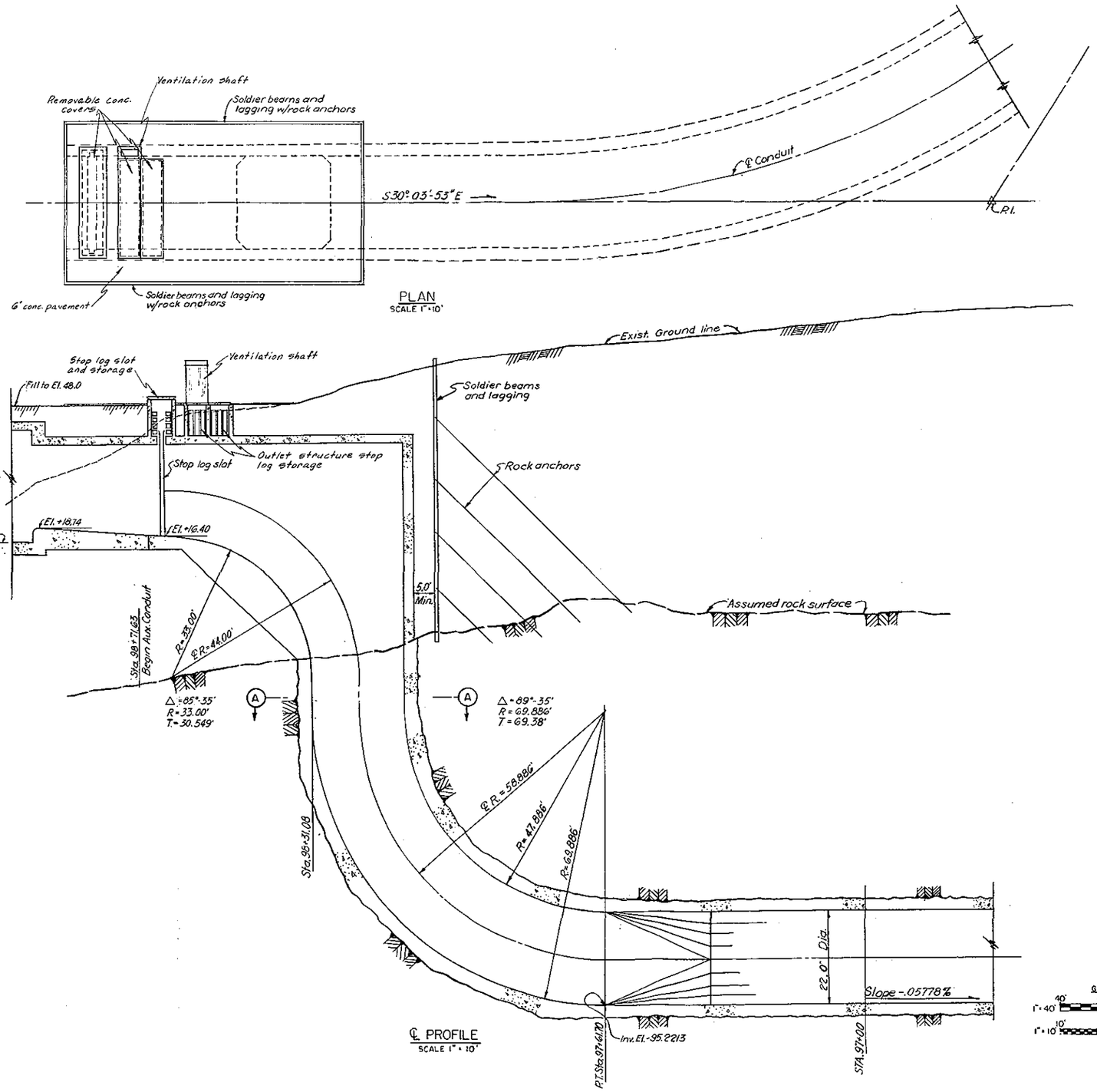
REVISION	DATE	DESCRIPTION	BY

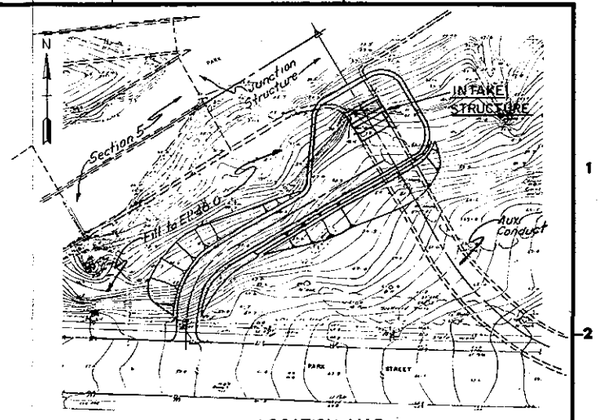
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF, BRANCH

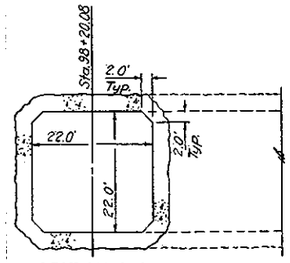
WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME "D"
PLAN, PROFILE AND SECTION NO. 15
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS A B C D E F G H U. S ARMY





LOCATION MAP
SCALE 1" = 40'



SECTION A-A
SCALE 1" = 10'

GRAPHIC SCALES
1" = 40' 40' 0 40' 80'
1" = 10' 10' 0 10' 20'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT - SCHEME D
INTAKE STRUCTURE

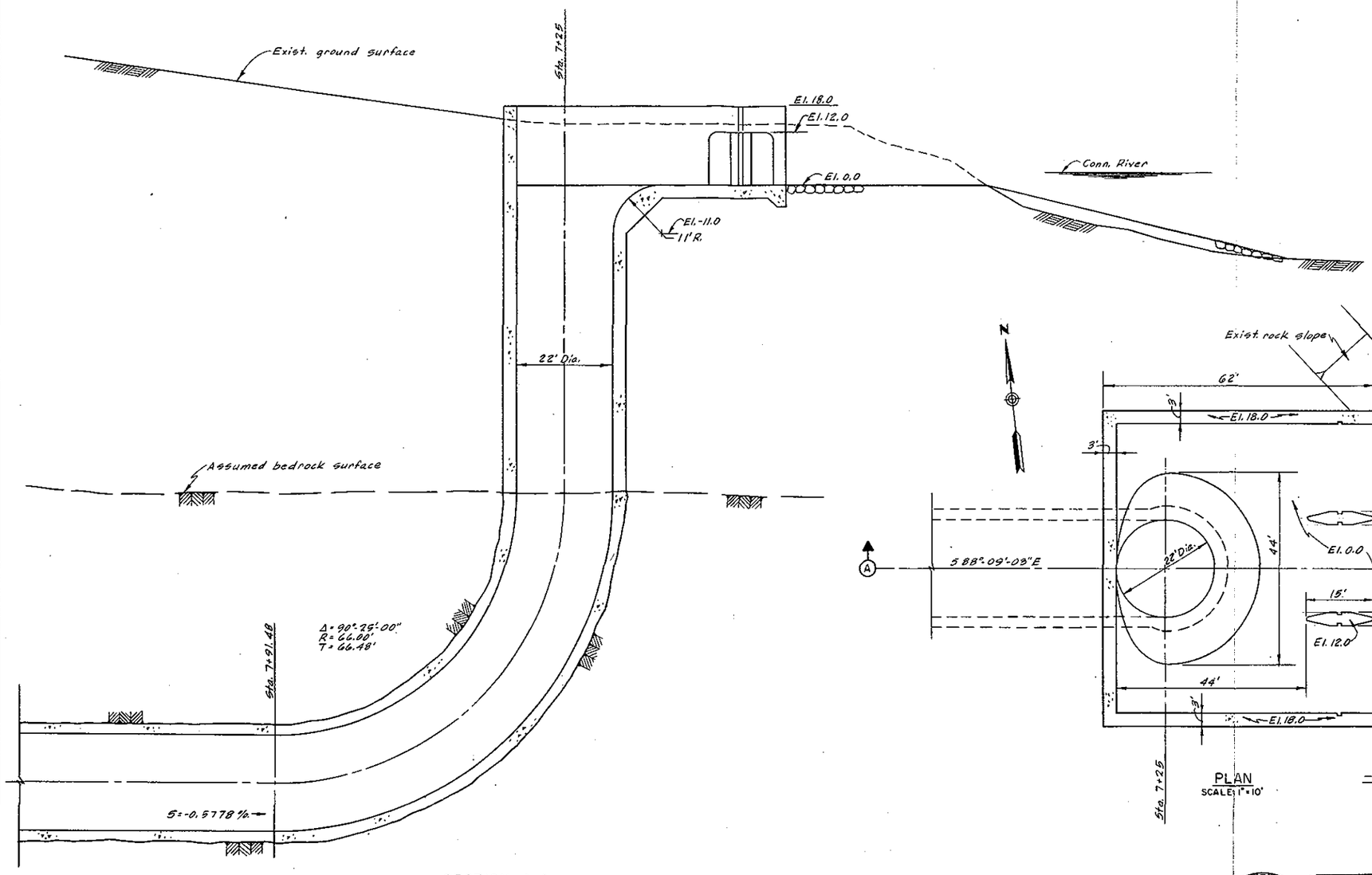
HARTFORD CONNECTICUT

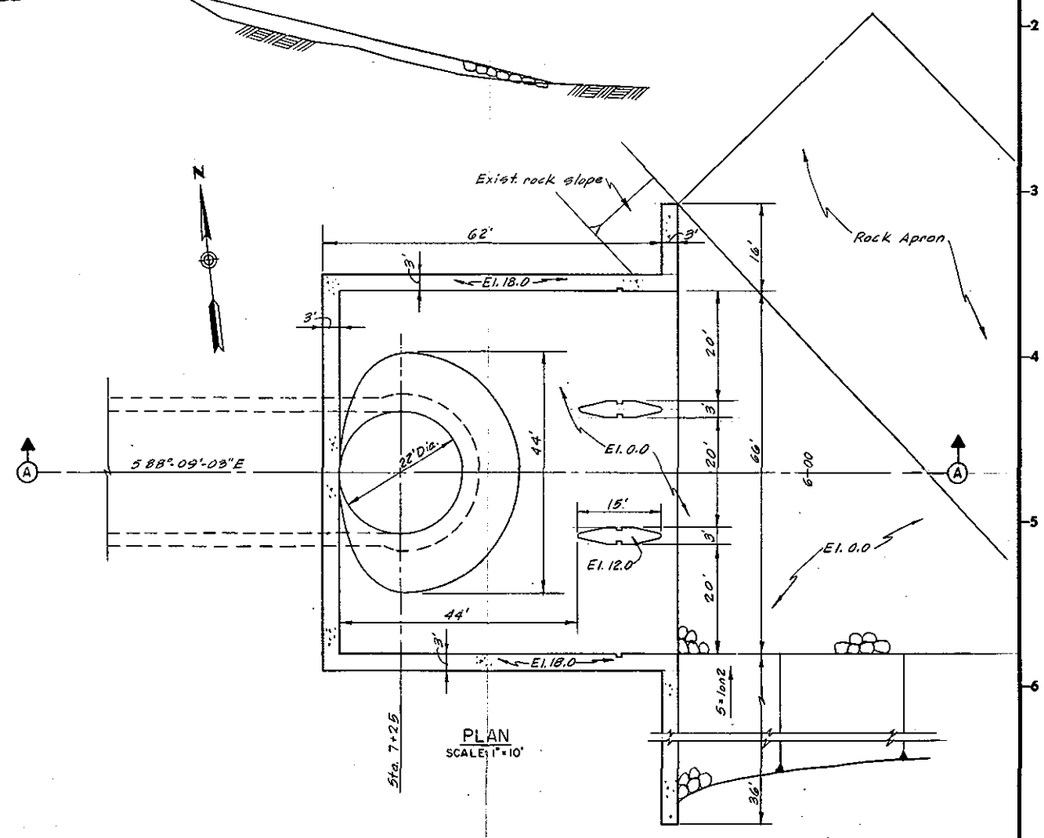
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-33

CORPS OF ENGINEERS U. S. ARMY





GRAPHIC SCALES
1" = 10' 10' 0 10' 20'

REVISION	DATE	DESCRIPTION	BY

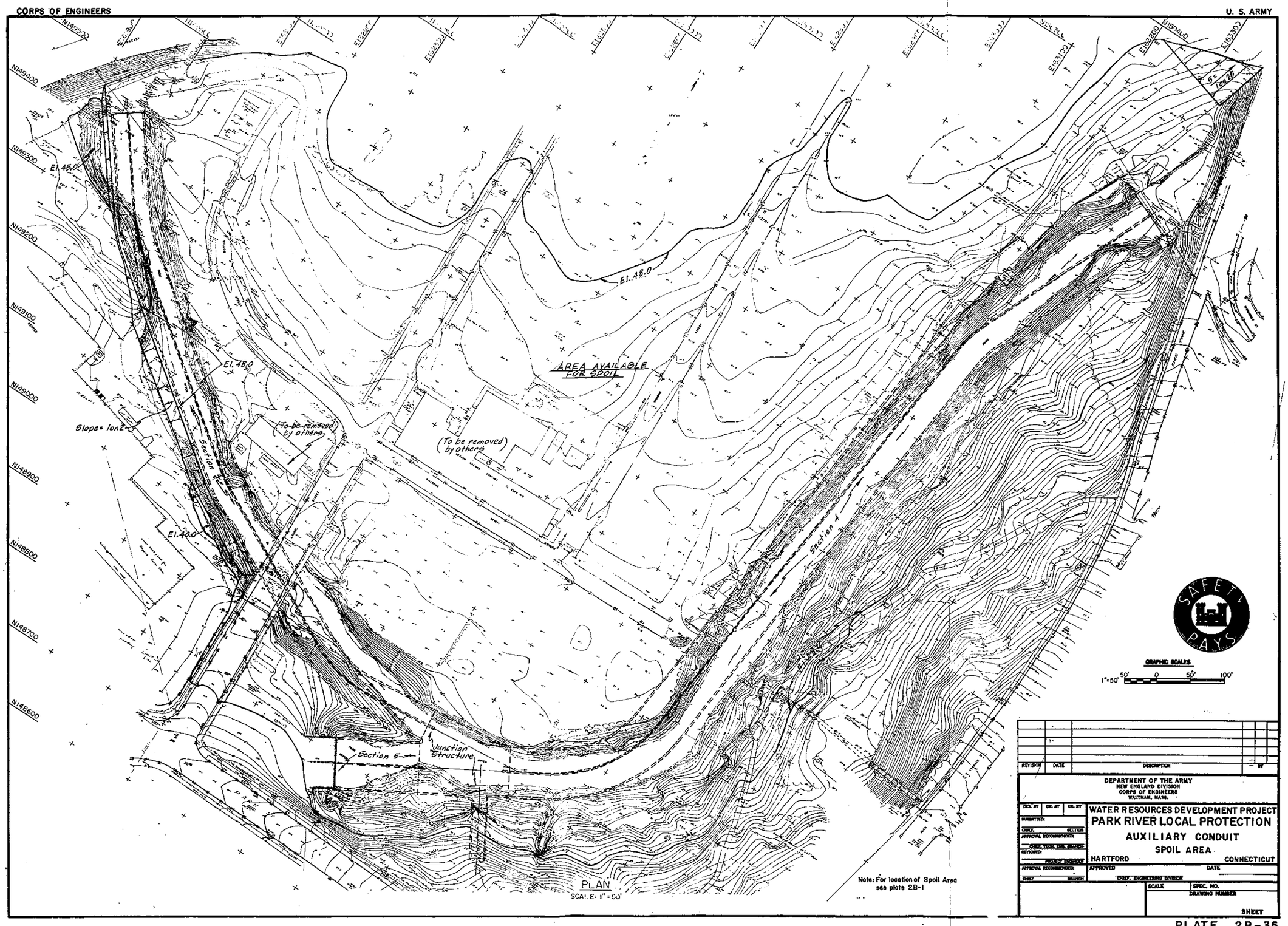
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SCHEME "D"
OUTLET STRUCTURE
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-34



REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
SPOIL AREA

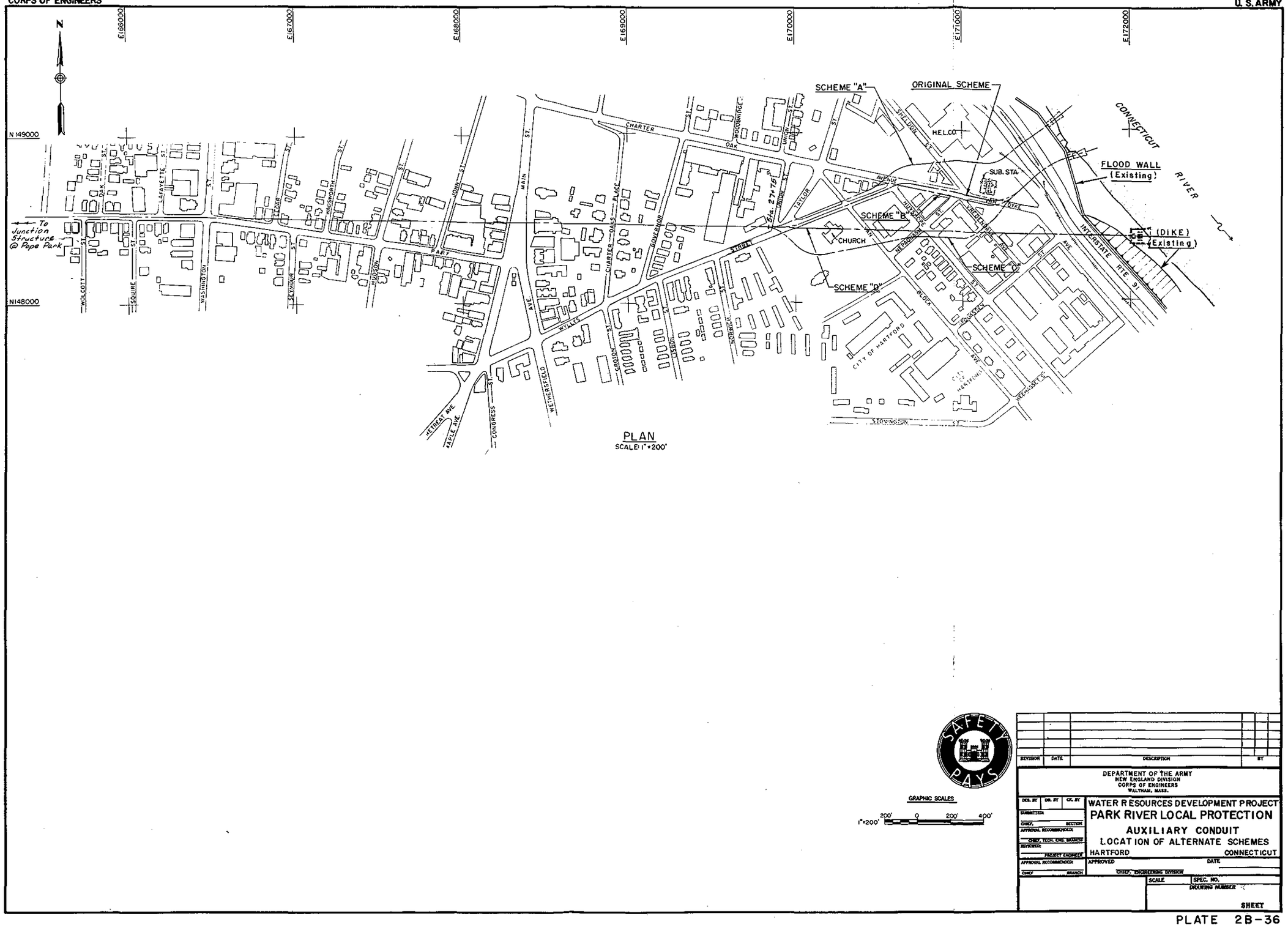
HARTFORD CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS

U. S. ARMY



PLAN
SCALE: 1" = 200'

GRAPHIC SCALES
1" = 200' 200' 0 200' 400'

REVISION	DATE	DESCRIPTION	BY

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

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
AUXILIARY CONDUIT
LOCATION OF ALTERNATE SCHEMES
HARTFORD CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 2B-36

APPENDIX A

ATTORNEY'S REPORT

APPENDIX A

ATTORNEY'S REPORT

RE: Park River Local Protection Project, Connecticut
Utilities and Roads

1. Public Law 90-483, 90th Congress, 2nd Session, approved 13 August 1968, provided for a Flood Control Project on the Park River in the City of Hartford, Connecticut. This project is authorized substantially in accordance with the recommendation of the Chief of Engineers in Senate Document No. 43, 90th Congress, 1st Session, at a then estimated cost of $30,300,000.00.

2. The proposed project area is within the City of Hartford, and several city streets and one state highway will be affected. There are telephone lines, gas lines, electric lines, water and sewer lines, steam lines, a railroad line and a floodwall that will interfere with the construction and maintenance of the project. Therefore, relocation, rearrangement or alteration of those utilities will be required. There are no cemeteries within the proposed project area.

a. The names of all parties having jurisdiction over, or title to the facilities or utilities to be relocated or altered are shown in the following pages of this report. This information was obtained from the pertinent city land records and special statutes where the instruments are recorded. Where such instruments are available the owners of the utilities or facilities furnished copies of such records as possessed which show evidence of title to the land.

b. Where a public utility will be destroyed or damaged due to operation of a Civil Works project and relocation or alteration of the facility is required to continue service to the public, as a matter of policy the Government may assume the cost of relocating or altering the facility, but not the cost of a new right of way, when in fact the utility owner is not presently vested with a compensable interest in the existing right of way. Negotiations will be conducted accordingly and under authority of Section 2 of the Flood Control Act of 1938, 52 Stat. 1215, 33 U.S.C. 701 c-1.

I. UTILITIES

1. The Southern New England Telephone Company was incorporated by a Special Act of the Connecticut Legislature in 1882. (Special Laws of Connecticut, Volume IX, Page 605). Section 1 thereof provides that the company shall be capable in law to "purchase, sell, grant or receive all kinds of property ----- and generally to do and execute all acts, manners and things as such corporation shall deem necessary and convenient to carry out the powers and privileges granted -----". Section 1 further provides that "the company is authorized to lay and maintain its wires and conduit for its wires, in, through and under any public street or highway in any city, borough or town in which said company now maintains or may hereafter maintain its telephone and wires ------".

Title 16, Section 228 of the Connecticut General Statutes (1958) authorizes telephone companies to construct and maintain telephone lines upon any highway or across any waters in the State, by erection and maintenance of the necessary fixtures, including posts, piers or abutments for sustaining wires.

Title 16, Section 237 of the Connecticut General Statutes (1958) provides that no prescriptive rights shall accrue to any company or corporation by virtue of its having wires passing over or through any land or buildings.

The Southern New England Telephone Company maintains and operates underground lines which are within the proposed box conduit and auxiliary conduit project area. The lines will be affected by the Government project, thus requiring relocation, rearrangement or alteration. The public road locations are occupied by virtue of statutory authority and the Charter of the Company. It is my opinion that the Southern New England Telephone Company has a compensable interest in the public street locations and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of lines, but not the cost of a new right of way.

2. The Connecticut Natural Gas Corporation was formed by the merger of the Hartford Gas Company and the New Britain Gas Light Company on September 5, 1968 and is recorded in the City of Hartford Land Records at Volume 1210, Page 715.

The Hartford Gas Company was incorporated by Special Act of the Connecticut Legislature in 1848. (Special Laws of Connecticut Volume III, Page 568). The company was incorporated under the name of the Hartford City Gas Light Company and was subsequently changed to the Hartford Gas Company in 1927 by a Special Act of the Connecticut Legislature. (Special Laws of Connecticut, Volume XX, Page 387).

The company charter in Section 2 provides that the Company "shall be empowered to lay down their gas pipes and to erect gas posts and burners and reflectors in the streets, alleys, lanes, avenues, or public grounds of the City of Hartford and to do all things necessary

to light said city and the dwellings, stores and other places situated therein; provided that the streets, side and cross walks, public grounds, lanes and avenues shall not be injured, but all left in as good and perfect condition as before the laying of said pipes or the erection of said posts.

The Connecticut Natural Gas Corporation operates and maintains gas mains in the streets within the project area. The mains will be affected by the Government project, thus requiring relocation, rearrangement or alteration. The public road locations are operated by virtue of authority given to the Company in its charter. It is my opinion that the Connecticut Natural Gas Corporation has a compensable interest in the public street locations and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of mains, but not the cost of the new right of way.

3. The Hartford Electric Light Company was incorporated by Special Act of the Connecticut Legislature in 1881. (Special Laws of Connecticut, Volume IX, Page 212). Section 3 of said Act provides in part that said corporation "is hereby empowered and authorized to manufacture and sell electric light and electricity within the city and town of Hartford for any purpose whatever and may light any public or private buildings or grounds, streets, avenues, lanes, parks and squares within said territory by means of electricity conducted by wires through, over or along or across the streets ------ provided that before said corporation shall erect any structures, or suspend any wires upon or over streets or public grounds of said city, the consent of the common council of said city first be obtained and all such structures shall be erected and maintained subject to the approval of the board of street commissioners of said city".

The Hartford Electric Light Company operates and maintains electric lines in the streets within the project area. The lines will be affected by the Government project, thus requiring relocation, rearrangement or alteration. The street locations are operated by virtue of authority given the company in its special charter. It is my opinion that the Hartford Electric Light Company has a compensable interest in the street locations and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of lines, but not the cost of a new right of way.

4. The Metropolitan District of Hartford County is a regional water, sewerage and planning agency that services the County of Hartford, of which the City of Hartford is a part. It was incorporated by a Special Act of the Connecticut Legislature in 1929. (Special Laws of Connecticut, Volume XX, Page 1204). Section 54 of said Special Act enumerates the powers of said Board and states in part ----- "to lay and construct and alter public sewers through

the highways and streets including turnpikes, roads, alleys and public grounds within said district and through the private enclosures within the same; - - - -". Subsequently in 1931 by an additional Special Act of the Connecticut Legislature, the Board's charter was amended to include water supply for the district. (Special Laws of Connecticut, Volume XXI, Page 1074)

The Metropolitan District of Hartford County maintains and operates water and sewerage lines which are within the proposed Box Conduit and Auxiliary Conduit project area. The lines will be affected by the Government project, thus requiring relocation, rearrangement and/or alteration. These public street locations are occupied by virtue of the authority granted the Board in its charter. It is my opinion that the Metropolitan District of Hartford County has a compensable interest in the public street locations and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of lines, but not the cost of a new right of way.

5. The Hartford Steam Company was incorporated by Special Act of the Connecticut Legislature in 1879. (Special Laws of Connecticut, Volume VIII, Page 272). Section 3 of said Act authorized and empowered the company to "manufacture, use and sell steam within the City of Hartford for any purpose and can heat any public or private building within said territory by means of steam or hot water conducted in pipes through the streets and public grounds of said city -------- but before using any of the streets or public grounds of said city for the purposes of this Act the consent of the common council shall be obtained and said consent being obtained said corporation shall be empowered to lay down their steam and hot water pipes and radiators or other apparatus necessary -------".

The Hartford Steam Company operates and maintains underground water pipes which are within the proposed Auxiliary Conduit area. The lines will be affected by the Government project, thus requiring relocation, rearrangement and/or alteration. The street locations are occupied by virtue of authority granted the company in its charter. It is my opinion that the Hartford Steam Company has a compensable interest in the public street locations and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of pipes, but not the cost of a new right of way.

6. The Penn Central Transportation Company was incorporated under the laws of the Commonwealth of Pennsylvania. It acquired all the assets, both real and personal, of the New York, New Haven and Hartford Railroad Company by virtue of an order of the Federal District Court for the District of Connecticut in proceedings for the Reorganization of the latter. Said conveyance is recorded in the City of Hartford land records at Book 1222, Page 105.

The New York, New Haven and Hartford Railroad Company was incorporated as a result of a Special Act of the Connecticut Legislature in 1871. (Special Laws of Connecticut, Volume VII, Page 252.) This Act merged two other corporate railroads into the above-named corporation.

The Penn Central Transportation Company has a single line within the Auxiliary Conduit area. The line will be affected by the Government project thus requiring relocation, rearrangement or alteration. The railroad has an easement interest in said railroad line as recorded in the City of Hartford Land Records, in Volume 774, Page 359. It is my opinion that the Penn Central Transportation Company has a compensable interest in this location and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of tracks.

7. At the end of the Auxiliary Conduit it will be necessary to cut through an existing floodwall to allow the conduit to empty into the Connecticut River. This floodwall is the property of the City of Hartford and under control of the Hartford Flood Control Commission. The property was acquired by the city in 1944 as evidenced by a deed recorded in Book 774, Page 352. in the City of Hartford Land Records.

The Greater Hartford Flood Control Commission was enacted by a Special Act of the Connecticut Legislature in 1941. (Special Laws of Connecticut, Volume XXIII, Page 1187). In 1943 the charter was amended and under Section 7 it provides in part that "the City of Hartford shall have the power to act for elimination, prevention and control of flooding and flood damage in the territory drained by the Park River and its tributaries, and the territory adjacent thereto" ------- "and all such power shall be exercised in the name and on behalf of the City -------". Section 7 also provides that the City may "provide for, construct or arrange for construction of, supervise, operate, maintain and dispose of dikes, flood control reservoirs, storm sewers and storm sewer systems, wall embankments, conduits, bridges, highways, roads, embankments, sidewalks, pumping and flood control stations and other walks, structures and appurtenances. Close or relocate any town

or city street, road or passway at any time affected or threatened by flood damage -------". This legislation also authorizes the City to arrange for the diking by whatever means necessary on the west bank of the Connecticut River (Special Acts of Connecticut, Volume XXIV, Page 51).

In view of the language of the authorizing document (See Page 52, Paragraph 57-(4), Senate Document No. 43, 90th Congress, 1st Session) and the fact that the City has fee ownership of the land involved herein, it is my opinion that the City has a compensable interest and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of the floodwall. As the City is the non-federal sponsor of the project, it is not anticipated that a separate relocation agreement will be necessary.

II. ROADS

1. The law relating to highways is found in the General Statutes of Connecticut, Revision of 1958, Title 13a.

Section 3(a) provides "that the Highway Commissioner may plan, design, lay out, construct, alter, reconstruct, improve, relocate, maintain, repair, widen and grade any state highway whenever in his judgment the interest of the state so requires. Except when otherwise provided by statute, he shall exercise exclusive jurisdiction over all such highways, and shall have the same powers relating to the state highway system as are given to the selectmen of towns, the mayor and common council of any city, and the warden and burgesses of any borough in relation to highways within their respective municipalities ----".

Section 14 provides that "there shall be a system of state highways which shall include (a) state primary highways which are highways serving the predominant flow of traffic between the principal towns of this state and between such towns and similar towns of the surrounding states; (b) state secondary highways, which are connecting and feeder highways which supplement the state primary system by serving the predominant flow of traffic between the smaller towns of the state and between such towns and other towns in this state and in surrounding states; and (c) state special service highways, which are highways which provide access from the primary and secondary systems of state highways to federal and state facilities".

Section 15. "All sections of the national system of interstate and defense highways in Connecticut, commonly known as the interstate highway system, as provided for in the Federal Aid Highway Act of 1956, as amended, shall be included in the state highway system."

Section 42. "The Commissioner may take into the state highway system any highway, section of highway or appurtenances thereto when said Commissioner finds it is in the best interest of the state to do so, and such highway, section of highway-----".

Section 73. "(a) Real property defined. 'Real property', as used in this section, includes land and buildings and any estate, interest or right in land."

"(b) Condemnation. The commissioner may take any land he finds necessary for the layout, alteration, extension, widening, change of grade or improvement of any state highway and the owner of such land shall be paid by the state for all damages and the state shall receive from such owner the amount or value of all benefits resulting from such taking, layout, alteration, extension, widening, change of grade or other improvement. The assessment of such damages and of such benefits shall be made by the commissioner and filed by him with the clerk of the superior court in the county in which the land affected is located, and such clerk shall give notice of such assessment to each owner of land affected thereby by mailing to each a copy of the same, postage prepaid, and, at any time after such assessment has been made by said commissioner, the physical construction of such layout, alteration, extension, widening, change of grade or other improvement may be made."

"(c) Purchase. The commissioner may purchase any land and take a deed thereof in the name of the state when such land is needed in connection with the layout, construction, repair, reconstruction or maintenance of any state highway or bridge, and any land or buildings or both, necessary, in his opinion, for the efficient accomplishment of the foregoing purpose, provided any purchase of such land or land and buildings in an amount in excess of the sum of three thousand dollars shall be approved by a state referee. The commissioner, with the advice and consent of the attorney general, may settle and compromise any claim by any person, firm or corporation claiming to be aggrieved by such layout, construction, reconstruction, repair or maintenance by the payment of money, the transfer of other land acquired for or in connection with highway purposes, or otherwise."

"(g) State-owned property. When the highway commissioner finds it necessary that real property, the title to which is in the state of Connecticut and which is under the custody and control of any state department, commission or institution, be taken for the purpose of drainage, construction, alteration, reconstruction, improvement, relocation, widening and change of grade of any highway to be constructed under his supervision, he shall petition the commissioner of finance and control that custody of such real property be transferred to him as highway commissioner. ------"

Section 75. "Determination of value of flood-damaged land. Whenever the commissioner takes any land he may find necessary for the layout, alteration, extension, widening, change of grade or improvement of any state highway, pursuant to the provisions of subsection (b) of section 13a-73 and sections 13a-74 and 13a-78, the state shall pay the owner just compensation therefor. In determining the amount of all benefits received by the owner resulting from taking such land and the amount of damages for taking such land as suffered loss due to flood or any other natural disaster occurring from August 18 to October 31, 1955, due consideration shall be given to the real and potential value of the land based upon its use and location, that is, the value which the property would have were it deemed to be restored to the productive uses it had prior to August 18, 1955, and in arriving at such value there shall be used a sum not less than the full valuation of the real property by the assessors of the town in which the property is located for the last-completed grand list of such town less the amount of any payment received by the owner from any public or private agency for damage to such real property. Any grantee who took title to any such real property between August 18, 1955, and December 23, 1955, shall receive benefits in accordance with this section for the flood-damaged property and the record owner as of August 17, 1955, shall be entitled to such benefits for the improvements on such real property as of August 18, 1955; provided no compensation has been received therefor by any other person from the state. This section shall be effective only as to any land determined to be taken by the highway commissioner before July 1, 1963."

Section 80. "Sale or lease of land by commissioner. The commissioner, with the advice and consent of the commissioner of finance and control, may sell, lease and convey, in the name of the state, or otherwise dispose of, or enter into agreements concerning, any land and buildings owned by the state and obtained for or in connection with highway purposes or for the efficient accomplishment of the foregoing purposes or formerly used for highway purposes, which real property is not necessary for such purposes."

Interstate 91 is a part of the State of Connecticut highway system under the control of the State Highway Commissioner. The Auxiliary Conduit section of the project will interfere with this highway, thus requiring relocation, rearrangement or alteration. The highway is owned in fee by the State of Connecticut, as evidenced by a deed recorded at the City of Hartford Land Records in Volume 1052, Page 502. It is my opinion that the State of Connecticut has a compensable interest in this location and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of this road.

2. Farmington Avenue, Laurel Street, Broad Street, Flower Street, Park Street, Cedar Street, Wadsworth Street, Hudson Street, John Street, Main Street, Wyllys Street, Governor Street, Van Dyke Avenue and Charter Oak Avenue and Place are all city streets under the control of the City of Hartford. Said streets are within the project area. The streets will be affected by the Government project thus requiring relocation, rearrangement or alteration.

The City of Hartford was incorporated in 1874 by a Special Act of the Connecticut Legislature (Special Laws of Connecticut Volume I, Page 368). The latest charter revision was in 1943 (Special Laws of Connecticut, Volume XXIII, Page 1187). The revision provides in part that the Common Council has the exclusive power to make, lay out and establish highways and streets, public parks and walks. The Connecticut General Statutes (1958), Title 7, Section 194, provides in part that all cities have the power to lay out, construct, alter, maintain, repair, control and operate streets, alleys, boulevards, bridges, underpasses, curbs and gutters necessary to carrying on the government of a city.

In view of the general and special laws of Connecticut, it is the opinion of the undersigned that the City of Hartford has a compensable interest in the aforementioned streets and is entitled to the reasonable cost of any necessary relocation, rearrangement and/or alteration of the streets. As the City is the non-federal sponsor of the project, it is not anticipated that a separate relocation agreement will be necessary.

15 October 1974

Frederick W. Colman

FREDERICK W. COLMAN
Attorney Advisor
Real Estate Division

APPENDIX B

DOCUMENTS OF COMMENT AND CONCURRENCE
PARK RIVER LOCAL PROTECTION
HARTFORD, CONNECTICUT

CONTENTS

DOCUMENT DATED	AGENCY	EXHIBIT
8 Nov 74	City of Hartford Bond Authorization	1

CITY OF HARTFORD

OFFICE OF THE TOWN and CITY CLERK

550 MAIN STREET

HARTFORD, CONNECTICUT

MEMBER

ROBERT J. GALLIVAN
TOWN & CITY CLERK

ROBERT D. DELANEY
DEPUTY TOWN & CITY CLERK

JOHN J. DALY
ASSISTANT TOWN CLERK

November 8, 1974

THIS IS TO CERTIFY That the following question was approved by the voters at the November 5, 1974, State and Special City Election, of the City of Hartford, Connecticut.

For ordinance authorizing $3,000,000 Bonds to provide funds for City's share toward total cost for completion of Park River Flood Control Project.

YES - 13,384 NO - 5,350

Attest:

Robert J. Gallivan
ROBERT J. GALLIVAN,
Town and City Clerk.

cc: Colonel John H. Mason and Project Manager, Mr. Edwin Coffin of New England Division, Department of Army Corps of Engineers.

EXHIBIT 1

APPENDIX C

CONSULTANT'S REPORT

SOIL AND ROCK ENGINEERING CONSULTATION · DESIGN · TESTING

GEOTECHNICAL ENGINEERS INC.
1017 MAIN STREET · WINCHESTER · MASSACHUSETTS 01890 (617) 729-1625

STEVE J. POULOS
RONALD C. HIRSCHFELD
DANIEL P. LAGATTA
RICHARD F. MURDOCK

ASSOCIATE
GONZALO CASTRO

November 11, 1974
Project 74212

U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Attention: Mr. Lawrence Parente

Subject: Hartford Tunnel Project
Contract No. DACW 33-75-M-0422

Gentlemen:

This letter report is a summary of the observations that I made during our meeting on subject project at the Corps of Engineers office in Waltham on November 6, 1974.

These observations are based on the information that was presented to me during that meeting. I have previously discussed with Mr. Blackey the possible usefulness of in-situ stress measurements as part of the tunnel-lining design, but have not reviewed any other information about the project and have not analyzed in depth the information presented at the meeting. Consequently, my observations consist primarily of questions and suggestions concerning the continuing studies that the Corps of Engineers staff is making.

DISCHARGE SHAFT

It is my understanding that the design of the discharge shaft is based on the following information:

1. Inside diameter = 22 feet

2. Soil profile: 30-40 feet of sand and gravel at the surface, about 40 feet of varved clay, a thin layer of bouldery glacial till, bedrock.

3. Existing ground elevation = +12 feet

4. Flood protection during construction for flood levels up to +44 feet

5. Radius of transition section from vertical shaft to tunnel = 2 x tunnel diameter.

6. No structures close to the shaft location. I-91 pavement about 130 feet from shaft, toe of I-91 embankment adjacent to shaft.

The following methods of constructing the shaft through the overburden soils were discussed:

1. Slurry-trench wall

2. Pneumatic caisson

3. Open caisson

4. Freezing

The possibility of excavation in the dry using conventional sheeting and bracing was not discussed in detail.

From the information presented at the meeting it does not appear that there are geologic or construction requirements that would make it technically necessary to use one specific method of construction such as slurry trench, pneumatic caisson, or freezing. Rough cost estimates should be made now for the purpose of eliminating from further consideration all but one or two of the technically feasible methods.

It is my understanding that there are borings close to the site of the proposed discharge shaft, but none at the exact site. It is essential that one or more borings be made to determine the engineering properties of the soil and rock at the shaft site. In addition, if the open caisson method or pneumatic-caisson method is selected as the most economical, a number of wash borings should be made to define the rock surface under the edge of the caisson, and rock should be cored at the bottom of each hole to (1) determine the quality of the rock, (2) avoid mistaking a boulder in the till for bedrock.

Through proper use of excavation, jetting, and weight application it should be possible to control the sinking of an open caisson through the overburden. Special care will have to be taken to ensure that a sound, watertight contact is made between the bottom edge of the caisson and bedrock.

With respect to flood protection during construction, an economic analysis should be made of various schemes for preventing flood damage and minimizing shutdown during construction. Some of the schemes discussed were: (1) extend the shaft upward temporarily to the level of desired protection; (2) build a cofferdam around the working area; (3) build the shaft extension (or cofferdam) to an elevation less than the maximum anticipated flood level and use a large plug to seal off the top of the shaft when floods exceed the elevation of the top of the extension (or cofferdam). An economic analysis, based on flood frequency predictions, cost of delays during construction, additional costs of construction related to higher levels of flood protection (e.g., cost of raising tunnel muck to a higher elevation), and cost of damage due to flooding during construction, should be made to determine the optimum.

The curved transition section between the vertical shaft and the tunnel starts immediately at the bedrock surface. Because jointing, weathering, and other defects are commonly most pronounced at the rock surface, the problems of constructing the transition section may be more severe than they would be if the transition section were to begin at a lower elevation. Some additional study is warranted to determine if it is economical and feasible to lower the transition section.

INTAKE SHAFT

It is my understanding that the intake shaft will be constructed in a cut that is supported by conventional sheeting-and-bracing, that the location of the intake shaft and transition structure is fixed and that the location of the cut is outside the area of unstable slope in Pope Park.

We spent very little time discussing the design and construction of the intake shaft. No major problems were identified during that discussion.

INTERMEDIATE SHAFT

An intermediate access and cleanout shaft is planned. Based on the information presented during the discussion, it is not clear to me whether the need for the shaft has been fully substantiated or whether alternate schemes of access and cleanout (involving the intake or discharge shafts) have been thoroughly studied.

The intermediate shaft could result in cost savings during construction because of (1) shorter haul distances for the muck from upstream of the shaft, (2) provision of access during flood periods when tunnel construction might otherwise be shut down, and (3) allowing a tunneling machine to be backed up past the shaft (without having to be dismantled and removed from the tunnel) so that conventional drilling and blasting techniques could be used to excavate through the basalt dike that is upstream of the tunnel.

It would appear that additional technical and economic studies need to be made concerning the shaft.

No major technical problems concerning construction of the shaft were identified during our discussion.

TUNNEL

The proposed tunnel will be 22 feet in diameter and 9,000 feet long. It is planned to drive all of the tunnel from the discharge-shaft end. Most of the length of the tunnel will be in sandstone and shale; it is estimated that about 400 feet will be through a basalt dike.

At the time of the meeting the physical properties had not yet been measured.

It is my understanding that core recovery in the sandstone and shales using NX barrels was very poor, but that the recovery using 4-inch barrels was excellent. The 4-inch core exhibits some fractures along the bedding planes (which are relatively flat-lying) and a few steeply inclined joints, some of which show slickensiding and other evidence of movement.

Strength and hardness data for both the shale/sandstone and the basalt will be needed for the purpose of evaluating the feasibility of using a tunneling machine on the project. Based on my cursory review, it appears that the shale/sandstone would be suited to machine tunneling, but that the basalt dike is probably not.

GENERAL COMMENT

In my opinion, the cost estimating and technical studies for this project would be enhanced by consulting a tunneling-machine manufacturer and a contractor who has very recent experience in constructing shafts and tunnels under conditions similar to those that prevail at this project.

Sincerely yours,

Ronald C Hirschfeld

Ronald C. Hirschfeld

RCH:kmb

APPENDIX D

PROJECT COST AND ESTIMATES

TABLE D-1

ESTIMATED FIRST COST
(November 1974 Price Level)

SUMMARY

Non-Federal		
01.	Lands and Damages	$ 1,000,000
02.	Relocations	400,000
	Total non-Federal First Cost	1,400,000
Federal		
13.	Pumping Plants	$ 1,300,000
15.1	Conduit Extension	26,100,000
15.2	Auxiliary Conduit	33,500,000
30.	Engineering & Design	4,800,000
31.	Supervision & Administration	4,000,000
	Total Federal First Cost	$69,700,000
TOTAL FIRST COST		71,100,000

TABLE D-2

ESTIMATED TOTAL INVESTMENT
(3 1/4% Interest)

Federal	
First Cost	$69,700,000
Interest During Construction (.05688)	3,965,000
Total Federal Investment	$73,665,000
Non-Federal	
First Cost	$ 1,400,000
Interest During Construction (.05688)	80,000
Total Non-Federal Investment	$ 1,480,000
TOTAL INVESTMENT	$75,145,000

TABLE D-3

ESTIMATED ANNUAL COSTS
(100-Year Life)
(3 1/4% Interest)

Federal		
Interest & Amortization on Investment (.03388 x $73,665,000)		$2,496,000
Non-Federal		
Interest & Amortization on Investment (.03388 x $1,480,000)	$50,000	
Major Replacements (25 Years) (.026539 x $802,000) 1,000,000 (oct 77)	21,000	
Maintenance & Operation	53,000	
Total Non-Federal		124,000
TOTAL ANNUAL COSTS		$2,620,000
TOTAL ANNUAL BENEFITS		$3,349,500
BENEFIT-COST RATIO		1.3 to 1

3 1/4
PW

25 .44952
50 .20207
75 .09083
.74242 x .03388 = 0.02515

.04083
100. .78325 x .03388 = 0.026537 X

6 5/8
.20115
25 .04046
50 .00813
75 .24974 x .06635 = 0.01657

16,500

TABLE D-4

DETAILED COST ESTIMATE
(November 1974 Price Level)

01. Lands and Damages

CONDUIT EXTENSION

Nature of Interest	Acreage	Real Estate Costs
Permanent Easement or Fee	1.55	$ 120,000
Temporary Construction Easement	17.89	440,000
Spoil Area	15.35	0
Total Acreage and Costs	34.79	$ 560,000

AUXILIARY CONDUIT - Scheme "A"

Nature of Interest	Acreage	Real Estate Costs
Permanent Easement	7.80	$ 208,000
Improvements		24,000
Temporary Construction Easements	11.00	168,000
Total Acreage and Costs	18.8	$ 400,000
Total Real Estate Costs		$ 960,000
Real Estate Owned by the Greater Hartford Flood Commission	9.50	300,000
Total-Lands and Damages-With SCHEME "A"	63.09	$1,260,000

11.05 acres

TABLE D-5

DETAILED COST ESTIMATE
(November 1974 Price Level)

01. Lands and Damages

CONDUIT EXTENSION

Nature of Interest	Acreage	Real Estate Costs
Permanent Easement or Fee	1.55	$ 120,000
Temporary Construction Easement	17.89	440,000
Spoil Area	15.35	0
Total Acreage and Costs	34.79	$ 560,000

AUXILIARY CONDUIT - Scheme "D"

Nature of Interest	Acreage	Real Estate Costs
Permanent Subsurface Easements	8.50	$ 110,000
Permanent Surface Easements	0.10	30,000
Temporary Construction Easements	8.00	0
	16.60	$ 140,000
Total Real Estate Costs		$ 700,000
Real Estate Owned by the Greater Hartford Flood Commission	9.50	300,000
Total-Lands and Damages-With SCHEME "D"	60.89	$1,000,000

02. Relocations

Conduit Extension

Replacement of:		
Broad Street	$ 51,000	
Flower Street	51,000	
Laurel Street	41,000	
Farmington Avenue	48,000	
Replace Street Drains	102,000	
Move 2-car garage-Lorraine St.	2,000	
Engineering and Design	18,000	
Supervision and Inspection	17,000	
Contingencies	70,000	
Sub-Total		$400,000

Auxiliary Conduit - SCHEME "A" only

Replacement of:		
Taylor Street	9,000	
Van Block Avenue	11,000	
Charter Oak Avenue	4,000	
Sheldon Street	4,000	
Replacement of Street Drains	26,000	
78" Sewer - Van Block Ave.	54,000	
78" Storm Drain - Van Block Ave.	48,000	
Engineering & Design	10,000	
Supervision & Inspection	9,000	
Contingencies	35,000	
Sub-Total		$210,000
Total-Relocations-With SCHEME "A"		$610,000

	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
13.	Pumping Plants				
	Pope Park Pumping Station (Formerly Riverside Station)				
	Earthwork				
	Excavation	3,200	C.Y.	4.00	$ 12,800
	Backfill	2,600	C.Y.	3.00	7,800
	Concrete-Including Cement	850	C.Y.	40.00	34,000
	Forms - Vertical	14,500	S.F.	1.80	26,100
	Forms - Supported	1,400	S.F.	2.50	3,500
	Reinf. steel	88	Ton	800.00	70,400
	Superstructure	1	Job	L.S.	46,000
	Site work	1	Job	L.S.	20,400
	Mechanical work	1	Job	L.S.	382,000
	Electrical work				
	Interior	1	Job	L.S.	17,500
	Service	1	Job	L.S.	6,500
	Sub-Total				$ 627,000
	Armory Pumping Station				
	Substructure - (Existing)				Existing
	Superstructure	1	Job	L.S.	74,800
	Site work	1	Job	L.S.	29,200
	Mechanical work	1	Job	L.S.	366,000
	Electrical work				
	Interior	1	Job	L.S.	22,700
	Service	1	Job	L.S.	7,300
					$ 500,000
					$1,127,000
	Contingencies				173,000
					1,300,000
30.	Engineering & Design				8% 104,000
31.	Supervision & Administration				6.6 86,000
	Total - Pumping Plants				$1,490,000

Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
15.1 Conduit Extension				
Preparation of site	1	Job	L.S	$ 15,000
Removal of Bridges	1	Job	L.S.	100,000
Removal of Buildings	1	Job	L.S.	50,000
Prot. of Existing Str.	1	Job	L.S.	30,000
Sandbags	1100	100	200.00	220,000
Maint. & Control of Traffic	1	Job	L.S.	10,000
25' Flume	660	L.F.	115.00	75,900
25' Flume, Reused	3,000	L.F.	50.00	150,000
Excavation				
Earth, Common	237,200	C.Y.	4.00	948,800
Rock, Structure	16,300	C.Y.	21.00	342,300
Borrow & Place				
Stone Protection	260	C.Y.	30.00	7,800
Processed Gravel	2,550	C.Y.	6.00	15,300
Gravel Fill	600	C.Y.	7.10	4,260
Compacted Earth Fill	248,500	C.Y.	3.00	745,500
Pervious Fill	52,700	C.Y.	6.60	347,820
Conduit				
Bearing Piles	33,100	L.F.	15.15	501,500
Batter Piles	9,200	L.F.	20.00	184,000
Piling, Steel Sheet, Walls	6,000	S.F.	12.00	72,000
Piling, Steel Sheet, Constr.	54,400	S.F.	10.00	544,000
Piling, Steel Sheet, Constr. Reused	12,400	S.F.	6.00	74,400
Soldier Beams	4,700	L.F.	25.00	117,500
Soldier Beams, Reused	8,700	L.F.	20.00	174,000
Lagging, Wooden	41,000	S.F.	2.00	82,000
Lagging, Wooden, Reused	45,000	S.F.	1.50	67,500
Struct. Steel Bracing	453,000	LB.	0.45	203,900
Struct. Steel Bracing, Reused	337,000	LB.	0.30	101,100
Earth Anchors	190	EA.	800.00	152,000
Rock Anchors	400	EA.	800.00	320,000

Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
15.1 Conduit Extension (Cont'd)				
Concrete Conduit	68,900	C.Y.	100.00	$ 6,890,000
Concrete I Walls	300	C.Y.	140.00	42,000
Concrete T Walls	1,000	C.Y.	110.00	110,000
Concrete Spillway	240	C.Y.	120.00	28,800
Concrete Fill	6,500	C.Y.	50.00	325,000
Cement	505,000	CWT	2.70	1,363,500
Steel Reinforcing	13,000,000	LB	0.40	5,200,000
Water Stops	25,000	L.F.	6.00	150,000
Drainage Facilities				
Temp. 24" Drain	300	L.F.	6.00	1,800
12" Drain Pipe	8,400	L.F.	4.00	33,600
High Level Storm Drains	1	Job	L.S.	352,000
Low Level Storm Drains	1	Job	L.S.	470,000
Trash Gate	1	Job	L.S.	12,000
Removal and replacement:				
Sewer Line-Broad St.	1	Job	L.S.	8,000
Gas Lines	1	Job	L.S.	42,000
Electric Lines	1	Job	L.S.	800,000
Telephone Lines	1	Job	L.S.	740,000
Other Utilities	1	Job	L.S.	115,000
Topsoiling	87,000	S.Y.	2.00	174,000
Seeding	18	AC.	2500.00	45,000
Landscaping	1	Job	L.S.	160,000
				22,719,280
Contingencies				3,380,720
				26,100,000
30. Engineering & Design				2,090,000
31. Supervision & Administration				1,720,000
Total-Conduit Extensions				$29,910,000

15.2 Auxiliary Conduit (Sh. 1 of 3)

Description	SCHEME A Estimated Quantity	Unit	Unit Price	Estimated Amount	SCHEME D Estimated Quantity	Unit	Unit Price	Estimated Amount
Preparation of site	1	Job	L.S.	20,000	1	Job	L.S.	20,000
Main. and control of traffic	1	Job	L.S.	100,000	1	Job	L.S.	100,000
Control of water	1	Job	L.S.	200,000	1	Job	L.S.	200,000
Protection and repairs to existing structures	1	Job	L.S.	750,000				0
Removal of underground structures	1	Job	L.S.	100,000				0
Excavation								
Earth, common	85,000	C.Y.	4.00	340,000	11,000	C.Y.	4.00	44,000
Earth, tunnel	19,000	C.Y.	78.00	1,482,000				0
Rock, structure	1,300	C.Y.	21.00	27,300	11,000	C.Y.	21.00	231,000
Rock, tunnel	133,000	C.Y.	39.00	5,187,000	200,000	C.Y.	43.00	8,600,000
Borrow								
Pervious	7,000	C.Y.	4.50	31,500				0
Gravel	800	C.Y.	5.00	4,000	1,000	C.Y.	5.00	5,000
Placing								
Random backfill	24,000	C.Y.	2.10	50,400	1,500	C.Y.	2.10	3,150
Pervious backfill	7,000	C.Y.	2.10	14,700				0
Gravel	750	C.Y.	2.10	1,575	1,000	C.Y.	2.10	2,100
Stone protection	30	C.Y.	30.00	900	1,000	C.Y.	30.00	30,000
Dumped rock	1,000	C.Y.	20.00	20,000				0

15.2 Auxiliary Conduit (cont'd) (Sh. 2 of 3)

Description	SCHEME A Estimated Quantity	Unit	Unit Price	Estimated Amount	SCHEME D Estimated Quantity	Unit	Unit Price	Estimated Amount
Furnishing and driving steel sheet piling, incl. bracing	4,400	S.F.	18.00	79,200				0
Slurry trench, reinforced, braced	545,000	C.F.	15.50	8,447,500				0
Tunnel support steel								
Tunnel in rock and earth	6,280,000	LBS	0.67	4,207,600				0
Earth anchors and rock anchors	260	EA	800.00	208,000	200	EA	800.00	160,000
Rock bolts	7,700	EA	100.00	770,000	18,000	EA	100.00	1,800,000
Soldier beams, bracing, lagging	13,000	S.F.	6.00	78,000	15,000	S.F.	6.00	90,000
Liner plate-tunnel in earth	1,300,000	LBS	0.67	871,000				
Concrete, mass	2,000	C.Y.	73.00	146,000	4,000	C.Y.	73.00	292,000
Concrete, reinforced conduit in open cut	18,000	C.Y.	150.00	2,700,000				0
Concrete, tunnel lining	47,000	C.Y.	165.00	7,755,000	74,000	C.Y.	165.00	12,210,000
Grout, tunnel rock	20,000	C.F.	12.00	240,000	5,000	C.F.	12.00	60,000
Gunite	5,000	C.Y.	405.00	2,025,000				0
Water stops	28,500	L.F.	6.00	171,000	29,000	L.F.	6.00	174,000
Misc. metals	23,000	LBS	1.00	23,000	40,000	LB	1.00	40,000
Tunnel ventilation	1	Job	L.S.	100,000	1	Job	L.S.	125,000
Stop logs	1	Job	L.S.	15,000	1	Job	L.S.	15,000
Tunnel, mine ties				0	240,000	LBS	0.50	120,000
Concrete, reinforced Tunnel in rock				0	4,000	C.Y.	155.00	620,000
Concrete, caisson				0	1	Job	L.S.	2,000,000

15.2 Auxiliary Concuit (cont'd) (Sh. 3 of 3)

Description	SCHEME A Estimated Quantity	Unit	Unit Price	Estimated Amount	SCHEME D Estimated Quantity	Unit	Unit Price	Estimated Amount
Removal and replacement:								
Water lines, sewer lines, and drainage facilities	1	Job	L.S.	1,180,000				0
Electrical and telephone lines	1	Job	L.S.	700,000				0
Gas lines	1	Job	L.S.	52,000				0
Railroad track	1	Job	L.S.	50,000				0
Cofferdam	1	Job	L.S.	570,000	1	Job	L.S.	950,000
Seeded topsoil	5300	S.Y.	1.80	9,540	20,000	S.Y.	1.80	36,000
Chain link fence	250	L.F.	6.00	1,500				0
				38,728,715				27,927,250
Contingencies				7,771,285				5,572,750
				46,500,000				33,500,000
30. Engineering and Design				3,720,000				2,680,000
31. Supervision and Administration				3,070,000				2,210,000
Total - Auxiliary Conduit				$53,290,000				$38,390,000
TOTAL PROJECT FIRST COST				$86,470,000				$71,100,000