Draft Detailed Project Report and Environmental Assessment

Local Flood Protection
Blackwater River
Salisbury, Massachusetts

May 2006

US Army Corps of Engineers
New England District

DRAFT DETAILED PROJECT REPORT
AND
ENVIRONMENTAL ASSESSMENT

LOCAL FLOOD PROTECTION
BLACKWATER RIVER

SALISBURY, MASSACHUSETTS

May 2006

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ENVIRONMENTAL ASSESSMENT, FONSI, and 404 (b) (1) EVALUATION

These documents follow the main report portion of the Detailed Project Report and contain a separate table of contents

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SECTION I

INTRODUCTION

Frequent flooding of low lying areas along the Blackwater River estuary prompted town of Salisbury and Commonwealth of Massachusetts officials to request Corps of Engineers assistance in alleviating these conditions. Initial requests for assistance concerned the effects to upstream flooding that may have resulted from replacement of the New Hampshire State Route 286 bridge over the Blackwater River. This bridge, situated in Seabrook, New Hampshire, was replaced by the New Hampshire Department of Transportation in 1991. A study completed in July 1995 under the Corps Flood Plain Management Services Program (Public Law 86-645) determined that high tide elevations for the high spring tide, 1-year event and 10-year event were higher than those experienced before the bridge was replaced. These increases were the greatest just upstream from the Route 286 bridge and tapered off further upstream. Based on the results of this analysis and continued serious flooding, the town of Salisbury requested further Federal assistance in finding a solution to this problem.

Study Authority

This report was prepared under authority contained in Section 205 of the 1948 Flood Control Act (Public Law 80-858), as amended. Section 205 is part of the U.S. Army Corps of Engineers Continuing Authorities Program, and provides authority to evaluate and correct flooding problems that are economically justified and within the Federal interest. In response to a letter request from the Salisbury Town Manager, an initial assessment of the flooding problems along the Blackwater River was conducted. Preliminary studies of flood prone areas determined that flood protection for the densely developed residential area between 9th Street and Florence Avenue was economically justified and further detailed studies were in the Federal interest. This lead to the preparation of a Feasibility Cost Sharing Agreement that specified the sharing of costs between the Federal government and the Commonwealth of Massachusetts, the non-Federal sponsor of the study. This Agreement was executed on January 4, 1999 and amended on June 26, 2002.

Purpose and Scope

The purpose of this study was to prepare a feasibility scope document that evaluates alternatives, identifies the plan that maximizes beneficial contributions to national economic development, and satisfies the requirements of the National Environmental Policy Act (NEPA). An additional purpose was to establish the level of support and willingness of the non-Federal sponsors to participate in recommended improvements. The report provides the basis on which the Chief of Engineers approves a project for construction and also the basis for proceeding to the plans and specifications phase.

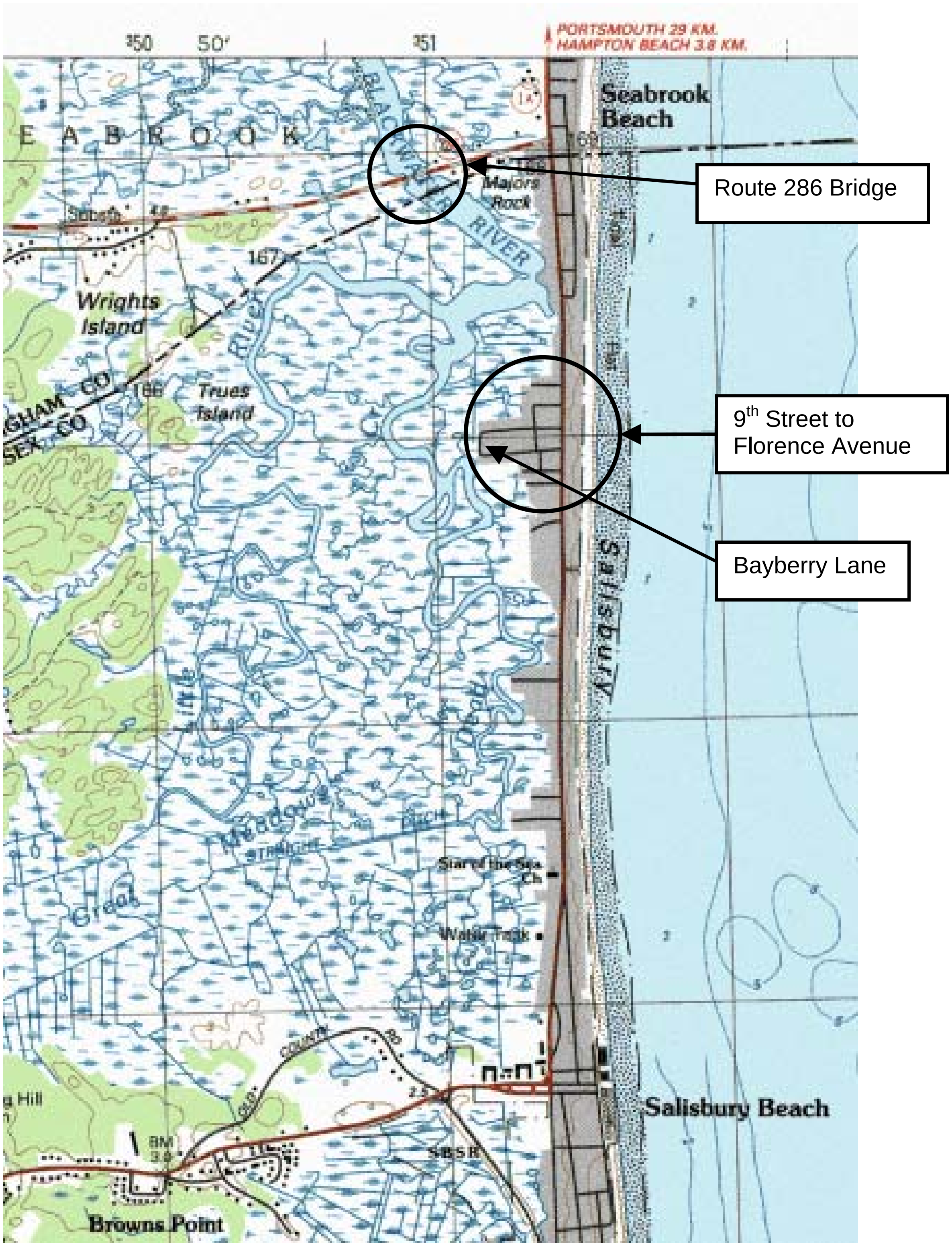
Study Area

Salisbury, Massachusetts is located along the Atlantic shoreline about 45 miles north of Boston, Massachusetts. The study area includes the eastern shore of the Blackwater River estuary extending from the Massachusetts/New Hampshire border south to Beach Road. The entire area is south of the Route 286 bridge that is just over the state border in Seabrook, New Hampshire. Previous studies in Salisbury identified four specific areas along the Blackwater River that are subject to periodic flooding. These areas consist of an area extending from 9th Street to Florence Avenue, Liberty Street, 16th and 17th Streets, and Beach Road. Initial evaluation of these areas determined that flood losses in three of these areas, Liberty Street, 16th and 17th Streets, and Beach Road, would be insufficient to justify Federal participation in flood damage reduction improvements in these areas. Protecting these areas would involve construction of lengthy dikes or walls, or significant modifications to existing structures. The costs of these improvements would clearly exceed attributable flood damage reduction benefits. However, the fourth area, 9th Street to Florence Avenue, experiences significantly higher flood damage due to the lower elevation of structures and roadways throughout the area. Initial evaluations determined that flood damage reduction measures could be economically justified in this area. Based on these initial findings, the study area was defined as the low-lying area bounded by 9th Street on the north and Florence Avenue on the south. This area is shown on Plate 1, Study Area.

The area under study is located along the eastern edge of the Blackwater estuary, also known as the Great Meadows saltmarsh. As shown on Plate 1, the area is situated along the landside edge of a coastal barrier beach. Development in this area is characterized by single-family residences. The proximity of the area to excellent beaches along the Atlantic Ocean made it a prime location for summer homes and cottages. However, with increased urbanization and direct commuter rail access to Boston, the majority of homes are now year round residences. A recently installed municipal sewer system in this section of Salisbury has also contributed to the change in real estate usage.

Pertinent Prior Studies and Reports

<u>Massachusetts Flood Plain Management Services, Effect of Route 286 Bridge on Flooding of the Blackwater River, Salisbury, Massachusetts</u> – This report, completed in July 1995 by the New England District, Corps of Engineers, utilized a one-dimensional model, UNET, to assess the effects of the 1991 replacement of the Route 286 bridge on upstream tidal flooding. The results of this study were briefly described in the introduction to this report.



Salisbury, Massachusetts
Study Area

Plate 1

Report and Study Process

The Detailed Project Report (DPR) reflects the planning process, beginning with a description of the flooding problem, identification of planning objectives and constraints, development and evaluation of alternative solutions, and selection of a recommended plan. Technical and nontechnical information is presented in the DPR to support the analysis of alternatives and the conclusions recommending Federal participation in a local protection project. The Environmental Assessment satisfies the requirements of NEPA, and report appendices provide detailed information that supports both plan formulation and design. The level of detail and extent of engineering work reflected in the technical appendices is sufficient to proceed directly to the preparation of plans and specifications.

SECTION II

PLANNING SETTING AND PROBLEM IDENTIFICATION

General Study Area Setting

The area under study is a relatively small neighborhood of single-family homes located behind a barrier beach and adjacent to the Blackwater River marsh. The Blackwater River drains an extensive tidal estuary that discharges into the Atlantic Ocean about 5 miles north of the study area at Hampton Harbor, New Hampshire. The river is a coastal stream with a total drainage area of about 8.9 square miles. Water levels in the estuary and marsh adjacent to the study area are influenced by the tides rather than by freshwater flows. The neighborhood under study is very low with ground elevations starting between 5 and 6 feet NGVD rising to around elevation 8 to 9 feet NGVD at Route 1A.

Topography and Geology

The study area lies in the Boston Lowland Division of the New England Physiographic Province. The area consists of a fairly flat barrier beach that slopes gently down to the Blackwater River, a tidal estuary. The estuary and landward slope of the barrier beach consist of organic marine deposits, sand, and artificial fill in some areas. The barrier beach is primarily sand that is imbedded with silt and organic lenses, and is underlain by clay and silt. Bedrock in the area consists of Newburyport Quartz Diorite that is a dark gray granite-textured rock that is comprised mostly of feldspar. It is typically very hard and competent. The topography in the study area is generally flat. Most elevations in flood prone areas are less than 8 feet NGVD (National Geodetic Vertical Datum). A few high points along the barrier beach reach an elevation of about 20 feet NGVD.

Climatology

The town of Salisbury has a cool semi-humid climate typical of New England. The climate is somewhat less harsh than in the higher more inland locations of New England due to the moderating effect of adjacent ocean waters. Based on Boston data, the mean annual temperature is about 51 degrees. Average annual precipitation in Boston is 43 inches, distributed uniformly throughout the year. The mean annual snowfall at Boston is about 45 inches. Salisbury's location on an east-facing coastline exposes it to coastal storms that move northeasterly up the Atlantic coast and produce heavy rains, winds and accompanying high tides.

Tidal Hydrology and Hydraulics

The tide range at the study area is constantly varying in response to the relative positions of the earth, moon, sun and storms. Although exact tidal characteristics are not available at Salisbury, an approximation can be made from historic tide data at the Boston, Massachusetts and Portland, Maine National Ocean Survey (NOS) gages. Based on this data, tidal frequencies and stages were estimated at Hampton Harbor (see Appendix B). This information provides the basis for estimating water levels and tidal characteristics of the Blackwater River and marsh area, but water levels in the study area are impacted by the Route 286 bridge in Seabrook, New Hampshire and other physical characteristics of the estuary.

Tidal characteristics of the estuary were investigated in detail after it was noticed that replacement of the Route 286 bridge in 1991 had increased water levels in Salisbury. Under the Flood Plain Management Services program, the Corps of Engineers modeled the estuary area to determine the changes in water levels and tidal components. The resultant report, "Effect of Route 286 Bridge on Flooding of the Blackwater River Salisbury, Massachusetts", dated July 1995, was used for this study. Table 1 shows water surface elevations at Hampton Harbor and the study area (Bayberry Lane) for the storm events analyzed during the 1995 study. As shown in this table, replacement of the Route 286 bridge in 1991 with a bridge with a larger opening increased flood levels in the study area. Additional information concerning flood levels in other portions of the estuary can be found in Appendix B.

Table 1

Water Surface Elevations (feet, NGVD)

	10-Year	5-Year	2-Year	1-Year
Hampton Harbor	8.5	8.1	7.6	6.9
Bayberry Lane				
Existing Rt. 286 Bridge (1991)	7.3	7.0	6.7	6.1
Previous Bridge (1946)	6.2	6.1	6.0	5.6

Utilizing the results of studies of sea level rise by the Environmental Protection Agency (EPA), it was determined that potential gradual increases in sea level should be incorporated in the analysis of tidal hydraulics. Based on EPA's 1995 report entitled, "The Probability of Sea Level Rise", an anticipated gradual sea level rise of 0.8 foot over the next 50 years was used for this study. This increase was applied equally to all storm events (i.e. the elevation of the 1-year storm event would increase from 6.1 to 6.9 feet and the 5-year storm event from 7.0 to 7.8 feet).

Flood History

As shown in Table 1, replacement of the Route 286 bridge resulted in a significant increase in the flooding frequency to low lying areas in the study area. Roadways are flooded as often as 1-2 times per month and flooding to low lying homes is commonplace. This flooding causes serious safety problems as it impacts evacuation of residents, and the delivery of emergency medical, fire protection and other services. Figure 1 shows typical flooding along 11th Street. This event occurred in November 2002.

Expected Annual Flood Losses

Expected annual flood losses are determined by using a risk and uncertainty analysis as required by Corps policy (see Appendix C for details). Using this methodology, expected annual damages for the without project condition, which includes sea level rise, are $1,103,200.

Water Resources and Water Quality

The Blackwater River is a coastal river located in Salisbury, Massachusetts and Seabrook, New Hampshire. The headwaters of the Blackwater River begin in west Salisbury and the river flows easterly approximately 3 miles before turning northerly about 2 miles before the Route 286 bridge. From the bridge, the river runs northerly about 2 miles until it discharges into Hampton Harbor. The drainage area at the mouth of the Blackwater River is about 8.9 square miles with about one third of the drainage area having a ground surface less than 5 feet NGVD.

Smallpox Brook, the freshwater headwater of the Blackwater River, is designated as a Class B waterway. As such, Smallpox Brook is designated for uses of protection and propagation of fish, other aquatic life and wildlife; and for primary (i.e. swimming) and secondary contact recreation (i.e. boating). The Massachusetts Department of Environmental Protection (DEP) has not assigned a water quality classification to the Blackwater River.

Upland Environment

The project site is a densely populated residential area bordered by tidal marsh on three sides. Upland vegetation, characteristic of residential land use, includes a variety of ornamental planting and mowed lawn areas. Landscape plantings include some large red pine and scots pine in the Berry Lane area with maple, ash, arborvitae, willow and rose scattered throughout. The majority of the development extends to the wetland boundary with the exception of three small riparian areas. These are situated in the northern most part of the project, south of the western end of 12th Street, and an area along Florence Avenue in the southern most portion of the project area. The naturally occurring species observed in these areas included gray birch, black cherry,

Looking westerly – The Blackwater River is in the background

Looking easterly

Typical Flooding Along 11th Street – November 6, 2002

Figure 1

trembling aspen red cedar, bayberry, blueberry, red chokeberry and an especially noteworthy specimen of serviceberry in the riparian area near 12th Street.

Wetland Environment

In general, the densely populated residential properties in the project area delineate uplands from jurisdictional wetlands at this site. The tidally-influenced Blackwater River bisects a large 3.4 square mile marsh classified as Estuarine Intertidal Emergent Wetlands, the Blackwater Marshes. The Blackwater River flows north past the project area, over the Massachusetts border into New Hampshire where it discharges into Hampton Harbor and eventually the Atlantic Ocean.

The Blackwater Marsh, nearly a mile across at the project site, is characterized by a vegetative prevalence of salt hay grass, salt marsh cordgrass and spike grass. Other commonly observed species in the wetland and along the wetland/upland interface include seaside goldenrod, common reed (*Phragmites australis*), purple loosestrife, and common glasswort. High marsh salt hay grass is established in a few backyards due to the increase in tidal flushing.

Protected Species

The only Federally listed or proposed, threatened or endangered species under the jurisdiction of the U.S. Fish and Wildlife Service known to occur in the project area is the endangered piping plover. Piping plovers are known to nest on both Salisbury Beach (at/near the Salisbury Beach State Reservation) and at Seabrook immediately south of the State line (USFWS, 1999). Piping plovers require sandy coastal beaches that are relatively flat and free of vegetation. They also prefer the dry, light-colored sand found along the outer coastal shores.

Historic and Archaeological Resources

There are no known historic or archaeological resources within the project area.

Expected Future Conditions Without a Project

Based on the continued frequent inundation of property and streets in the study area, flooding will continue to have a profound affect on the study area. Roadway flooding will continue to occur as often as 1-2 times per month. This severely impacts access to the area and results in safety concerns and the need to evacuate some residents.

SECTION III

PLAN FORMULATION

This section describes the measures that were developed to meet the objective of flood damage reduction. The goal of the process was to assess alternative flood damage reduction measures and develop a comprehensive solution to problems along the Blackwater River.

Flood Control Measures

Alternative flood control measures that were developed based on a review of historic tide levels and related hydrologic and hydraulic information. A detailed hydraulic and hydrologic analysis (See Appendix B) was completed to establish and predict future flood stages. Predictions of future flood stages included an estimate of sea level rise over the next 50 years. This information was then used to develop expected flood damages. The methodology to select feasible and economically justifiable improvements follows guidance set forth in ER1105-2-100.

Measures typically considered to control flooding include both structural and non-structural features. Structural measures applicable to the study area involve construction of walls or dikes along or near the area of concern. Reducing the waterway opening at the Route 286 bridge to its previous size was discussed early in the planning process. However, this alternative was eliminated from further consideration as it would not meet Federal Clean Water Act guidelines for protection of wetlands, and securing State and local permits would be doubtful due to the wetland impacts of this tidal restriction. Resource agencies were in agreement with this determination as the benefits associated with the previous widening, which include the restoration of about ten acres of saltmarsh and increased tidal flushing, would be lost. Non-structural elements include consideration of raising first floor elevations of residences that are inundated, flood proofing, or purchasing/relocating residences from the affected flood plain. Flood proofing by installing temporary shields was considered impractical as all structures are of wood frame construction and cannot be easily floodproofed. Raising first floor elevations and purchasing homes were retained for further study.

Flood Control Alternatives

This section describes the flood control alternatives that were selected for further study. Assessment of the study area determined that the physical conditions of the site limit the top of protection for structural measures. Elevations in the area dictated that constructing a dike or wall with a top elevation exceeding elevation 8.0 feet N.G.V.D. would require two street gates across North End Boulevard (Route 1A). In addition, building these street gates would require some modifications to the coastal dune situated on the east side of the study area. Based on the high cost of street gates, impact to the coastal dune, and flood studies that indicate that the dune could be overtopped during rare flood events, a top elevation of 8.0 feet NGVD was selected for structural plans. Projects with this top elevation would initially provide protection from a 30–35 year flood. Considering projected sea level rise, this level of protection would gradually decrease to a 5-year flood over the next 50 years. A total of six plans to reduce flooding along the Blackwater River between 9th Street and Florence Avenue were evaluated. Three of these plans were structural measures and three were non-structural measures. Structural measures include a dike, floodwall or combination floodwall and dike. The alignment of all these plans was similar, beginning north of 9th Street, following the edge of the saltmarsh, and ending south of Florence Avenue. Due to the dense development of the study area, the line of protection was placed in a narrow corridor between existing homes and the saltmarsh, and in some areas the footprint of proposed structures extended into the wetland. Nonstructural plans developed for further study included; raising all homes with a first floor elevation below elevation 8.0, purchasing all homes with a first floor elevation below 8.0, and purchasing all homes and lots in the study area. The no action alternative was also retained for further study as a viable alternative and as a basis for comparison . In all cases, the potential for sea level rise and its impact on levels of protection were assessed. These alternatives are described in the following paragraphs.

Structural Alternatives

Alternative 1- Dike To Elevation 8.0 feet NGVD – This alternative consists of an earthen dike that would begin at elevation 8.0 behind homes on the north side of 9th Street, follow the periphery of the salt marsh on the west side of the study area, and terminate at elevation 8.0 behind homes on the south side of Florence Avenue. The total length of the dike would be about 2560 feet. The dike would have a top width of 5 feet and have side slopes at 1 vertical on 2.5 horizontal. The dike would be constructed from impervious fill and be finished with 6 inches of topsoil that would be seeded. Rainfall from the area behind the dike would be collected by a drainage system and discharged at 2 pumping stations. These stations would be located at current discharge points on Berry Lane and at the end of Lewis Avenue. This plan is shown on Plates 2 and 3.

Alternative 2 – Floodwall To Elevation 8.0 feet NGVD – This plan consists of a vinyl sheet pile floodwall that would follow the same general alignment as Alternative 1. At most locations, the floodwall would be placed immediately landward of the wetland boundary. The plan would include a landward berm with a side slope of 1 vertical on 2 horizontal where there is sufficient space available between the wall and existing structures. The total length of the floodwall would be about 2765 feet. This plan, shown on Plates 4 and 5, would also include pumping stations on Berry Lane and at the end of Lewis Avenue to discharge interior drainage.

Alternative 3 - Combination Floodwall and Dike To Elevation 8.0 feet NGVD – This alternative is a combination of alternatives 1 and 2 above and would include about 1500 feet of dike and about 1210 feet of floodwall. The alignment of the dike and wall also follows the edge of the salt marsh. Pumping stations on Berry Lane and Lewis Avenue are also included to discharge runoff that would accumulate behind the protective works. This alternative is shown on Plates 6 and 7.

Nonstructural Alternatives

<u>Alternative 4 - Raise All Homes With A First Floor Elevation Below 8.0</u> – This alternative consists of raising the 33 homes within the study area that have a first floor elevation less than elevation 8.0. The home would be taken off its existing foundation and the foundation would be replaced or modified so that when the home was lowered, the first floor elevation would be above potential flood heights (elevation 10.0). All utility connections, primarily water and sewer lines, would be extended, and new exterior stairways would be constructed.

<u>Alternative 5 - Purchase All Homes With A First Floor Elevation Below 8.0</u> – This plan involves purchasing the 33 homes with a first floor elevation below 8.0. After purchase, the homes and other improvements would be demolished and/or removed from the lot. This would create about 5 acres of open space in the project area. As the costs associated with this plan would exceed its benefits, this plan was eliminated as a potential flood damage reduction alternative. In addition, the community did not support this alternative as roadway flooding would continue to impact the evacuation and delivery of emergency services to remaining homes.

<u>Alternative 6 - Purchase All Homes and Lots in Study Area</u> – This alternative includes purchasing all 133 properties in the project area. This consists of 125 developed lots (with homes) and 8 undeveloped lots. Following purchase, all homes and other improvements, including roads and utilities, would be removed and the area restored. This would create about 20 acres of open space. This alternative was eliminated from further consideration as the costs associated with purchasing all private property in the area would far exceed the flood damage reduction benefits of this alternative.

<u>Alternative 7 - No Action</u> – Under the No Action Alternative, no improvements or modifications would be made in the study area to reduce flood losses and frequent flooding of this area would continue to be a problem. Under current conditions, a 10-year flood event would cause an estimated $1,138,200 in damages to 135 residential structures. Twenty of these homes would have first floor flooding. In addition to damage to structures, extensive roadway flooding would continue to occur throughout the study area.

Screening of Alternative Flood Control Plans

Table 2 shows a summary of total first costs, and annual costs and benefits for the seven flood control alternatives under consideration. As discussed in Appendix C, benefits and costs are made comparable by conversion to average annual equivalents. Annual costs for construction were computed based on a project life of 50 years and interest rate of 5-1/8 percent as specified in the Federal Register. Total annual costs include costs for maintenance of the structures and appurtenant features.

Selection of the National Economic Development (NED) Plan

Based on the Principles and Guidelines for Water and Related Land Resources adopted by the Water Resources Council, the plan that maximizes net benefits, known as the NED plan, is recommended by the Corps of Engineers. As shown in Table C-9 in Appendix C, the plan with the greatest excess of benefits over cost (net benefits) is Alternative 2 – Floodwall to elevation 8.0. This plan is the NED plan.

Selection of Preferred Flood Control Plan

The floodwall was also acceptable to both the Town and residents based on its lesser impact on property and cost. The plan also had the smallest impact on adjacent wetlands. After selection of this alternative, changes were made to improve its function and further minimize impacts. These improvements include changing two very short sections of dike to walls and realigning the protective works in several areas. The revised and final selected plan is shown on Plates 8 and 9.

Table 2

ALTERNATIVE FLOOD CONTROL MEASURES
SALISBURY, MASSACHUSETTS FEASIBILITY STUDY

ALTERNATIVE		PROJECT COSTS: FLOOD CONTROL COSTS: CONSTRUCTION COSTS	REAL ESTATE COSTS	TOTAL PROJECT COST	ANNUAL COSTS: ANNUAL PROJECT COSTS	ANNUAL O & M COSTS	TOTAL ANNUAL COSTS	ANNUAL BENEFITS	BENEFIT/COST RATIO	RETAINED FOR FURTHER STUDY
1	CONSTRUCT A DIKE TO ELEVATION 8.0	$2,032,000	$930,000	$2,962,000	$183,100	$6,300	$189,400	$921,900	4.9	YES
2	CONSTRUCT A FLOODWALL TO ELEVATION 8.0	$1,550,000	$510,000	$2,060,000	$127,400	$5,000	$132,400	$921,900	7.0	YES
3	CONSTRUCT A COMBINATION FLOODWALL AND DIKE TO ELEVATION 8.0	$1,552,000	$770,000	$2,322,000	$143,600	$5,600	$149,200	$921,900	6.2	YES
4	RAISE ALL HOMES WITH A FIRST FLOOR ELEVATION BELOW 8.0	$2,460,000	0	$2,460,000	$152,100	0	$152,100	$476,500	3.1	YES
5	PURCHASE ALL HOMES WITH A FIRST FLOOR ELEVATION BELOW 8.0	(See Note)	$14,700,000	$14,700,000	$909,000	0	$909,000	$608,000	0.7	NO
6	PURCHASE ALL HOMES AND LOTS IN STUDY AREA	(See Note)	$55,140,000	$55,140,000	$3,409,900	0	$3,409,900	$1,103,200	0.3	NO
7	NO ACTION	0	0	0	0	0	0	0	N/A	YES

Note: Demolition costs not estimated for alternatives 5 and 6.

SECTION IV

DESCRIPTION OF RECOMMENDED PLAN

Plan Features

The recommended plan to reduce flood damages along the Blackwater River consists primarily of two sections of floodwall having a total length of about 2,765 feet, and two pumping stations. The floodwall is a relatively low structure, having an average height of 2-3 feet and a top elevation of 8.0 feet above N.G.V.D. (National Geodetic Vertical Datum). The material currently proposed for the floodwall is vinyl sheet piling. A wooden, aluminum or vinyl cap would be placed on the sheet piling. In addition, soil would be placed against the landside face of the sheet pile wall at most locations to form a slope of 1 vertical on 2 horizontal. This landside berm, which would be topsoiled and seeded with grass, would add structural stability to wall sections exceeding 2 feet in height and minimize the visual impact of the wall. This plan is shown on Plates 8 and 9.

The first section of floodwall would begin on the northern edge of properties on the north side of 9th Street. From this point it would extend westerly to the edge of the saltmarsh, turn southerly along the saltmarsh past the end of 9th Street, turn in a somewhat westerly direction past a home on 10th Street, turn southerly past the end of 10th Street, turn westerly along the saltmarsh behind homes on 11th Street, and turn southerly along the western side of Bayberry Lane to its end at a high point near the end of 12th Street. The second section of floodwall would begin behind homes on the south side of 12th Street, extends easterly along these properties, turn southerly following the saltmarsh past the ends of Lewis and Florence Avenues, and turn easterly to end a high point behind homes on the south side of Florence Avenue. In most areas, the floodwall would be very close to the edge of the saltmarsh. Construction of the floodwall will include the filling and replication of several small saltmarsh wetland areas along alignment of the floodwall.

Pumping stations will be required at two locations along the floodwall to provide for discharge of rainfall and other interior drainage during periods of high water along the Blackwater River. Both pumping stations would be located in underground concrete structures along the alignment of existing storm drains, and adjacent to existing outfalls into the saltmarsh. The largest pump station would be located under Bayberry Lane at the point where storm drains from 11th and 12th Streets converge and discharge into the Blackwater River. The station would have a pumping capacity of 26 cubic feet per second. The second underground pumping station would be located at the western end of Lewis Avenue along the alignment of the existing storm drains. The capacity of this smaller pumping station would be 5 cubic feet per second. Storm drainage from Florence Avenue would be conveyed to this pump station via a new storm drain connecting the Lewis and Florence Avenue storm drains. An emergency generator, located near the Bayberry Lane pumping station and connected to the Lewis Avenue pumping station via underground cable, would ensure operation of these pumps under all conditions.

Design Considerations

The following summarizes the design considerations developed for major project features. Additional surveys, and detailed structural and mechanical design will be accomplished as required during the plans and specifications phase to complete design of these features.

Vinyl sheet piling was selected for its corrosion resistance and ease of installation. The wall will be capped with pressure treated lumber or an aluminum or vinyl cap for uniform appearance and safety.

All floodwall alignments were selected to minimize the impacts to adjacent wetlands. In addition, as building lots in the study area are small, minimizing physical as well as aesthetic impacts to property owners was also an important consideration.

The proposed pumping stations will include submersible pumps to allow the stations to be constructed within existing streets. Both stations will have gravity conduits with flap valve closures to allow interior drainage to flow into the river under normal conditions. These stations were designed to intercept local drainage lines and are located adjacent to existing storm drainage outfalls. Considering the increased potential for overtopping of the floodwall due to sea level rise, the pumping station and discharge lines were designed to allow the interior to drain during one low tide cycle in the event that the protection is overtopped by a coastal flood.

Construction Considerations

Construction would require a moderately sized work force with varied construction skills, largely in the heavy equipment and semi-skilled and skilled labor trades. Within the Boston area there are a sufficient number of workers that could commute to work and not require housing in the project area. Since roads in the project area, particularly North End Boulevard, are heavily traveled, particularly during the summer months, minimizing traffic impacts and maximizing safety will be a concern.

The staging areas that are identified in this report are along existing roadways and should be sufficient for construction activities. Bayberry Lane, which connects the ends of 11th and 12th Streets, will be closed off during construction.

The project site is approximately 4 miles from Interstate 95. Good quality state and city roads exist between Interstate 95 and the project site. Although the proposed alignment is situated behind residential structures, it easily can be reached from the ends of six streets. It also could be reached by obtaining easements between the residential structures. Operation of construction equipment along the alignment and on easements between residential structures will require a gravel working mat or equivalent because there are soft soil zones.

Relatively small amounts of impervious fill, topsoil, wood, and concrete will be required to construct the project features. They are readily available in the project area. A moderate amount of vinyl sheet pile would also be required. It could easily be shipped by truck to the project site from where it is manufactured.

Summary of Plan Costs, Accomplishments, Benefits and Impacts

Project Costs

Total Project Costs - Total project costs of the recommended plan are shown in the table below. These costs, totaling $2,060,000, include direct construction costs; contingencies of 25 percent; preparation of plans and specifications; construction management; and real estate acquisition.

Total Project Costs
(12/2005 Price Levels)

Work Items	Cost
Construction Cost of Floodwall, Pumping Stations and Appurtenant Structures	$1,080,000
Prepare Plans and Specifications	250,000
Construction Management	120,000
Real Estate Cost	510,000
Total Cost	$2,060,000

Apportionment of Costs - Projects implemented under Section 205 of the Flood Control Act of 1948, as amended, have the same project cost sharing requirements as flood control projects implemented under specific Congressional authorization. The non-Federal sponsor must provide all LERRD (lands, easements, rights-of-way, relocations and disposal areas) necessary for the project. The minimum non-Federal share of all structural flood control costs incurred subsequent to the feasibility phase is 35 percent. Five percent of the non-Federal sponsor's share shall be in cash. If the value of credited LERRD plus the five percent is less than 35 percent, additional cash is required to reach this minimum percentage. Based on the estimated cost shown above, costs would be apportioned, $1,339,000 Federal and $721,000 non-Federal ($211,000 cash and $510,000 LERRD).

Operation, Maintenance, Repair, Replacement and Rehabilitation Costs – These OMRR&R costs are a 100 percent non-Federal requirement. Costs include maintenance of project features, periodic inspection of the floodwall and operation of the pumping stations, and replacement of pumps as necessary. The average annual cost of the above maintenance items is estimated at approximately $5,000.

Flood Damage Reduction Benefits

The recommended plan will provide significant flood control benefits to the residential area between 9th Street to Florence Avenue. The expected flood damage reduction is estimated at about $921,900 annually. Considering the impacts that frequent flooding have had to this area, this will have an extremely positive impact on the properties surrounding the river. Protected properties include 135 homes situated throughout the study area and the numerous roads that are flooded on a very frequent basis. The plan will initially provide protection from a 30-35 year flood at the top of protection. Considering projected sea level rise, this level of protection will gradually decrease to a 5-year flood over the project's 50-year life. Major benefits will accrue to several low areas, such as the western ends of 11th Street and Lewis Avenue, that are currently flooded as often as 1-2 times a month during certain times of the year.

Environmental Effects

Water Resources - The floodwall will be installed in the upland and high marsh area by a pile driver in the dry with minimal disturbance of soils. Flooding occurs approximately once monthly during extreme high tides or during storm events. Proper erosion control measures will assure minimal impacts to water resources. The landward berm will be constructed once the floodwall is complete and seeded to stabilize soils. Homeowners will be permitted to landscape the berm with shrubs, which will buffer the marsh and benefit wildlife to some degree.

Upland Environment – The landside berm will provide aesthetic benefits and will supplement a wildlife buffer along the perimeter of the marsh. In addition, wind driven sands will follow the berm contours, blowing over the floodwall to be deposited into the marsh. This process of sediment transport and marsh aggregation is important in keeping step with sea-level rise and compaction of underlying peat.

Wetland Environment - Construction of the proposed floodwall would permanently fill 1,195 square feet of salt marsh and restrict tidal flooding to 1,890 square feet of salt marsh for a total salt marsh impact of 3,085 square feet. As shown on Plates EA-5 and EA-6, the wetland mitigation plan will restore and create 3,907 square feet of wetland and enhance 5,838 square feet that is presently dominated by *Phragmites*.

Fish and Wildlife – The proposed project will not affect fish likely to occur in the Blackwater River estuary and no impacts to wildlife are expected to occur as a result of the project.

Protected Resources – Although the piping plover are known to occur in the vicinity of the project area, it is unlikely that they would utilize the proposed project area due to the high level of human disturbance and the lack of preferred habitat in the project area. Therefore, there will be no impact to this species as a result of the proposed project.

Essential Fish Habitat - Direct impacts to fish species of concern and essential fish habitat in the project area were avoided or minimized to the maximum extent practicable through the planning and design process. The incorporation of sediment control measures and mitigation of impacts to high marsh habitat should protect the interests of the Magnuson-Stevens Fisheries Conservation Act for EFH in the project area.

Historic and Archaeological Resources - There are no known historic or archaeological resources within the project area. Therefore, the proposed flood control measures will have no impact upon any structure or site of historic, architectural, or archaeological significance.

SECTION V

SUMMARY OF STUDY COORDINATION

Coordination efforts during the feasibility study have included numerous meetings with resource agencies to discuss proposed plans and their impacts. Several public information meetings were also held in Salisbury to discuss alternative flood damage reduction plans. These meetings were well attended by local residents. One of these public information meetings was held on Saturday to maximize public participation. It was followed with a visit to the project site to allow residents to ask specific questions concerning alternatives.

The following is a list of agencies and groups that participated in coordination meetings held during the study:

Federal Agencies
- U. S. Fish and Wildlife Service
- U. S. Environmental Protection Agency
- National Marine Fisheries Service

Commonwealth of Massachusetts
- Department of Environmental Management
- Department of Environmental Protection
- Massachusetts Division of Fisheries and Wildlife
- Massachusetts Division of Marine Fisheries
- Massachusetts Historical Commission

Town of Salisbury
- Conservation Commission
- Town Manager
- Department of Public Works
- Planning Department

Citizens' Group
- Salisbury Beach Betterment Association

The final recommended plan will be coordinated with fish and wildlife resource agencies to obtain their comments. Agencies to be included in this review process are the US Fish and Wildlife Service, National Marine Fisheries Service and the Massachusetts Division of Fisheries and Wildlife, and Division of Marine Fisheries.

A Federal Congressman, State Senator and State Representative, and local officials have been very involved in the study through participation at coordination and working group meetings.

SECTION VI

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Findings and Conclusions

During evaluation of the flooding problems along the Blackwater River, all potentially feasible measures to solve these problems were evaluated. Flood control solutions included purchase of flood prone structures, raising structures, and constructing dikes and/or floodwalls along the periphery of the flood prone area. These measures were coordinated with study participants at periodic coordination meetings.

A total of six plans to reduce flooding along the Blackwater River between 9th Street and Florence Avenue were evaluated. These plans were developed based on physical conditions of the site that limit the top of protection for structural measures. Elevation 8.0 feet N.G.V.D. was chosen because exceeding this elevation would require two street gates across North End Boulevard (Route 1A) and modifications to a coastal dune situated on the east side of the study area. These features would add significant costs, and alteration near or along the dune would cause coastal zone management concerns.

The six plans that were evaluated included three structural measures with a top elevation of 8.0 feet. These were a floodwall, dike, or combination dike and floodwall along the periphery of the flood prone area. The three non-structural measures included raising homes with a first floor elevation below 8.0, purchase and removal of all homes with a first floor elevation below 8.0, and purchase and removal of all homes in the study area. A comparison of benefits and costs determined that constructing a floodwall was the NED plan. This plan was also the locally preferred plan as it minimized the amount of land required for the project, and resulted in the least impact to adjacent wetland areas.

Based on analysis of costs, and public views and desires, a plan consisting of a floodwall with a top elevation of 8.0 feet, and pumping stations and other appurtenant structures to discharge interior runoff was selected as the locally preferred and recommended plan.

Recommendations

I recommend that the plan selected herein to reduce flood damage along the Blackwater River in Salisbury, Massachusetts, shown on Plates 8 and 9, be authorized for construction funding with such modifications as the Chief of Engineers may deem advisable; at a total estimated first cost of $2,060,000.

Flood control elements of the plan will initially provide protection from a 30-35 year flood at the top of protection. This level of protection will gradually decrease to a 5-year flood over the project's projected 50-year life due to projected sea level increases.

This recommendation is subject to the provision that qualified non-Federal sponsors agree to the following items of local cooperation and provisions of the Water Resources Development Acts of 1986 and 1996.

1. Provide a minimum of 35 percent, but not to exceed 50 percent of total project costs allocated to structural flood damage reduction, as further specified below:

(a) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

(b) Provide, during construction, a minimum cash contribution equal to 5 percent of total project costs allocated to structural flood control;

(c) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(d) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(e) Provide, during construction, any additional costs as necessary to make its total contribution equal to a minimum of 35 percent but not to exceed 50 percent of total project costs allocated to structural flood control; and

2. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

3. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

4. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

5. Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

6. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

7. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

8. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

9. Agree that, as between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

10. Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might reduce the level of protection the project affords, hinder its operation and maintenance, or interfere with its proper function, such as any new development on project lands or the addition of facilities which would degrade the benefits of the project.

11. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act. Crediting for relocations performed within the Project boundaries is subject to satisfactory compliance with applicable Federal labor laws covering non-Federal construction, including, but not limited to the Davis-Bacon Act (40 USC 276a et seq), the Contract Work Hours and Safety Act (40 USC 327 et seq), and the Copeland Anti-Kickback Act (40 USC 276c). Crediting may be withheld, in whole or in part, as a result of the non-Federal Sponsor's failure to comply with its obligations under these laws.

12. Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army" and Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), requiring non-Federal participation and implementation of flood plain management plans. The non-Federal sponsor is also required to comply with all applicable Federal labor standards and requirements including but not limited to the Davis-Bacon Act (40 USC 276a et seq), the Contract Work Hours and Safety Act (40 USC 327 et seq), and the Copeland Anti-Kickback Act (40 USC 276c). Crediting may be withheld, in whole or in part, as a result of the non-Federal Sponsor's failure to comply with its obligations under these laws.

13. Provide the non-federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement.

14. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

15. Do not use Federal funds to meet the non-Federal sponsor’s share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

16. Inform affected interests, at least annually, regarding the limitations of the protection afforded by the project, and prepare a flood plain management plan designed to reduce the impact of future flood events in the study area.

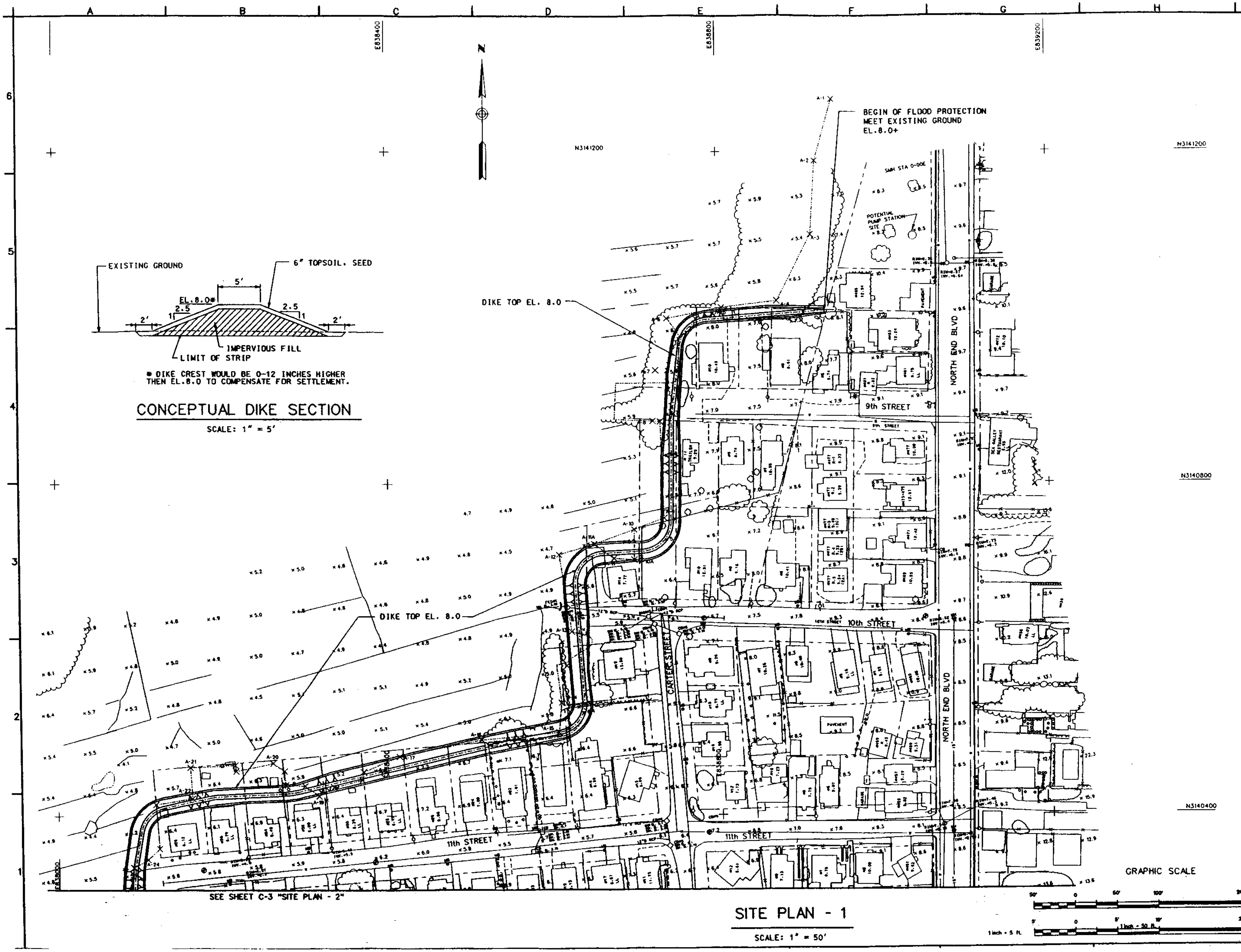
17. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

I have considered all significant aspects including overall public interest; environmental, social and economic effects; and engineering and financial feasibility in concluding that the recommended plan meets the objectives of this study subject to the results of studies concerning modification of the recommended plan, final review comments, and financial commitment.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are authorized for implementation funding.

Date

Curtis L. Thalken
Colonel, Corps of Engineers
District Engineer



SITE PLAN - 1

SCALE: 1" = 50'

US Army Corps of Engineers
New England District

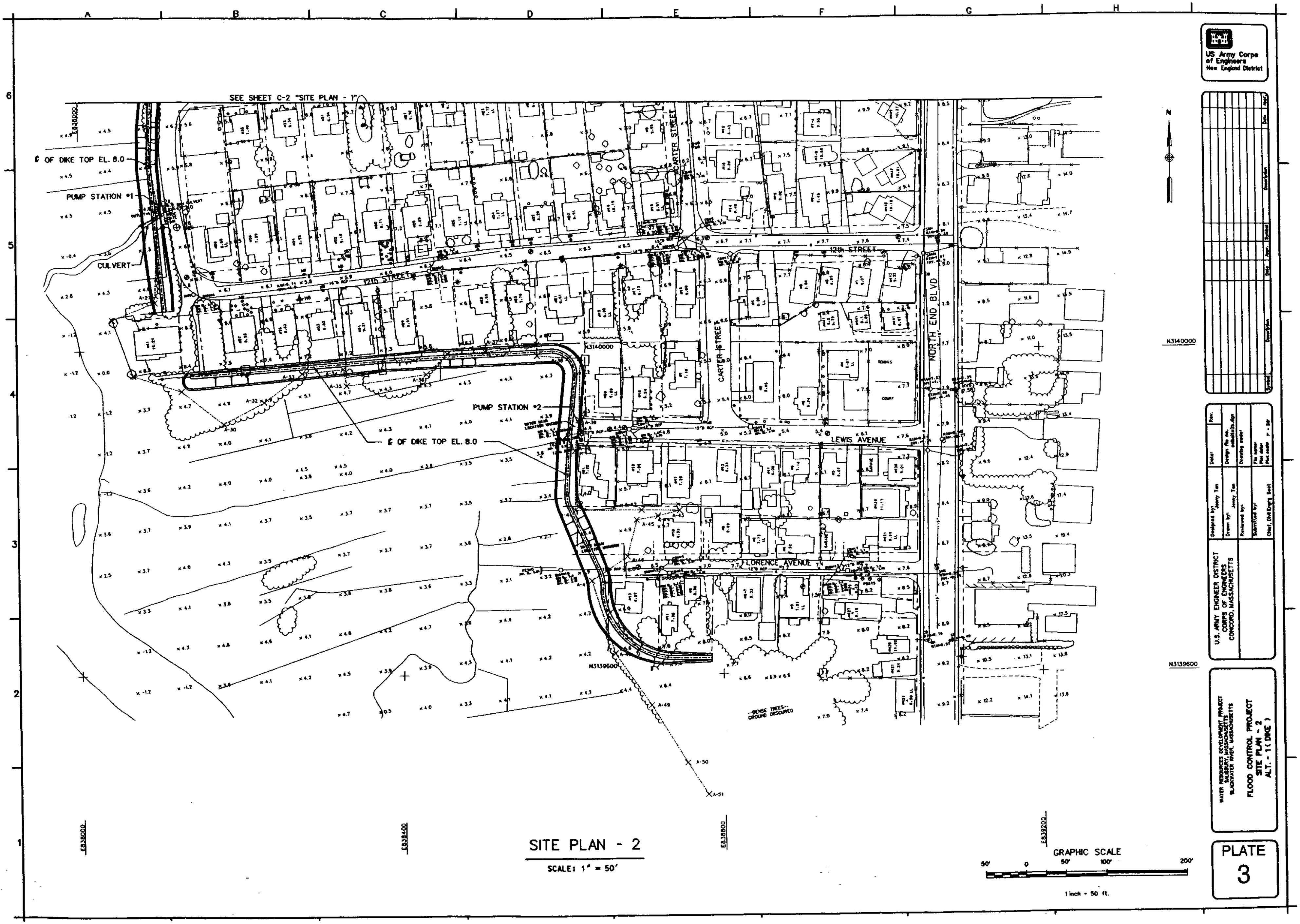
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

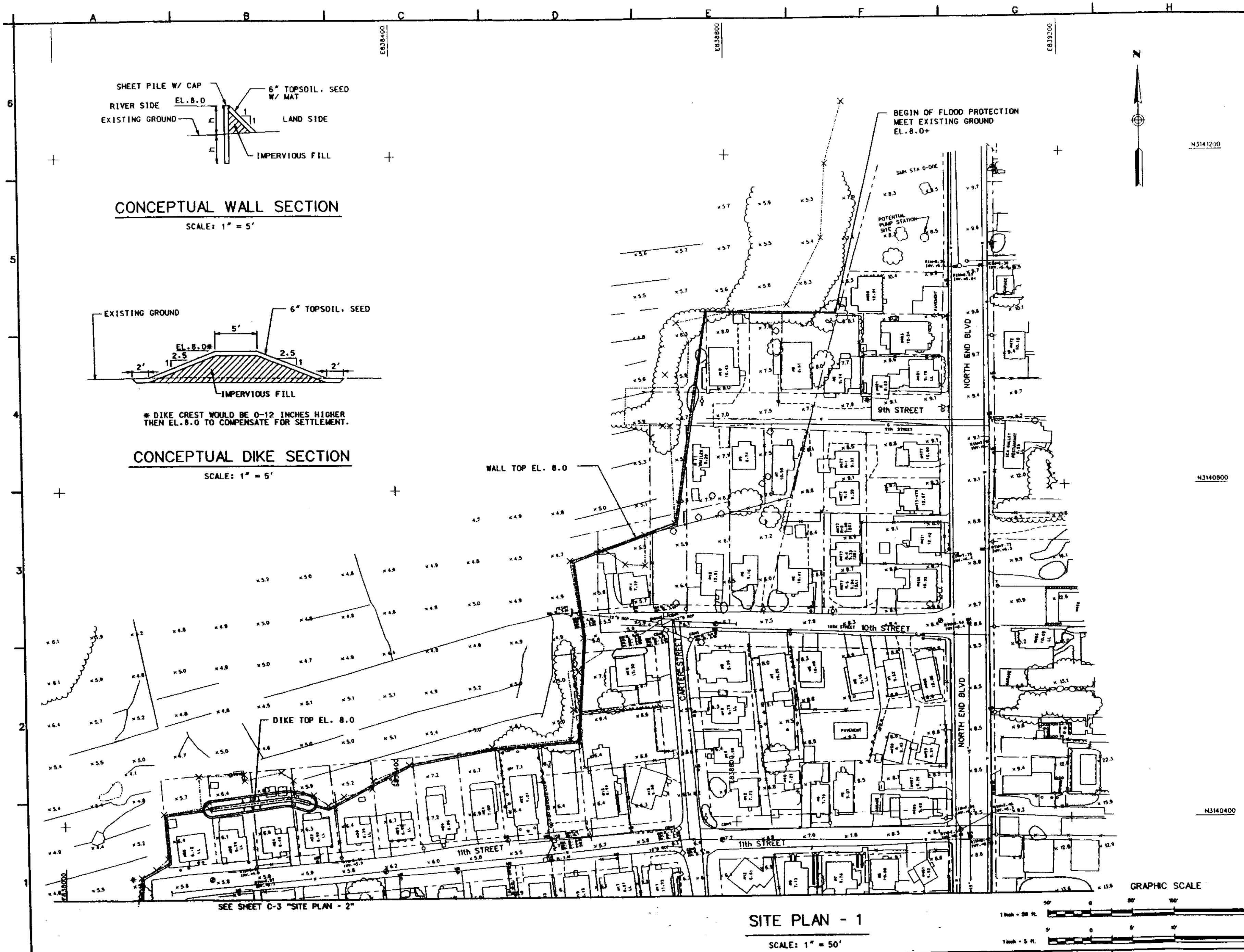
Designed by: Jenny Tan
Drawn by: Jenny Tan

WATER RESOURCES DEVELOPMENT PROJECT
SALISBURY, MASSACHUSETTS
BLACKWATER RIVER, MASSACHUSETTS

FLOOD CONTROL PROJECT
SITE PLAN - 1
ALT. - 1 (DIKE)

PLATE
2


SEE SHEET C-2 "SITE PLAN - 1"
℄ OF DIKE TOP EL. 8.0
PUMP STATION #1
CULVERT
12th STREET
CARTER STREET
NORTH END BLVD
LEWIS AVENUE
FLORENCE AVENUE
PUMP STATION #2
℄ OF DIKE TOP EL. 8.0
N3140000
N3139600
E838000
E838400
E838800
E839200
DENSE TREES-GROUND OBSCURED
SITE PLAN - 2
SCALE: 1" = 50'
GRAPHIC SCALE
1 inch = 50 ft.
US Army Corps of Engineers
New England District
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS
WATER RESOURCES DEVELOPMENT PROJECT
SALISBURY, MASSACHUSETTS
BLACKWATER RIVER, MASSACHUSETTS
FLOOD CONTROL PROJECT
SITE PLAN - 2
ALT. - 1 (DIKE)
PLATE
3



US Army Corps of Engineers
New England District

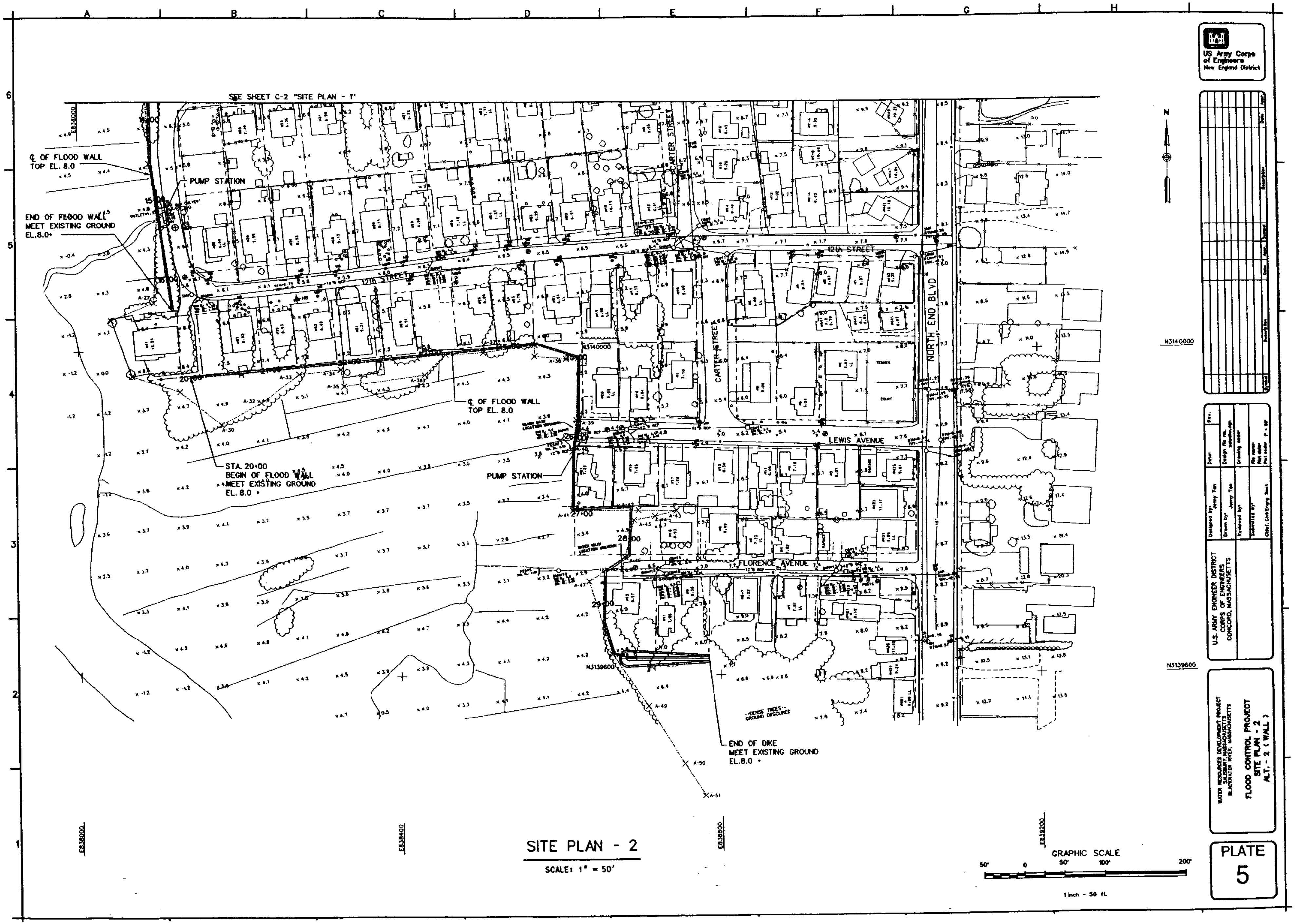
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
SALISBURY, MASSACHUSETTS
BLACKWATER RIVER, MASSACHUSETTS

FLOOD CONTROL PROJECT
SITE PLAN - 1
ALT. - 2 (WALL)

Designed by: Jenny Tan
Drawn by: Jenny Tan
Date: 1999

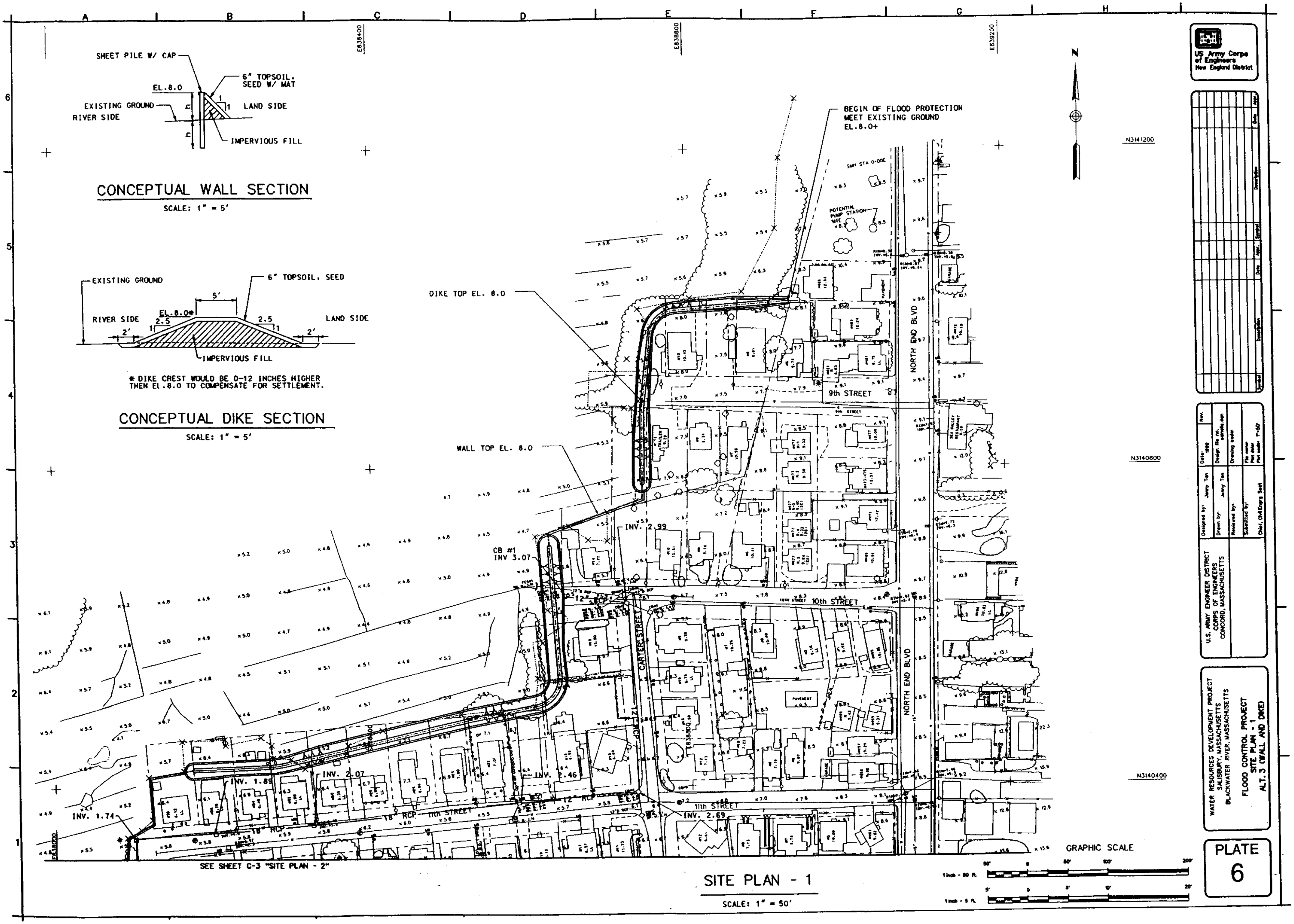
PLATE
4



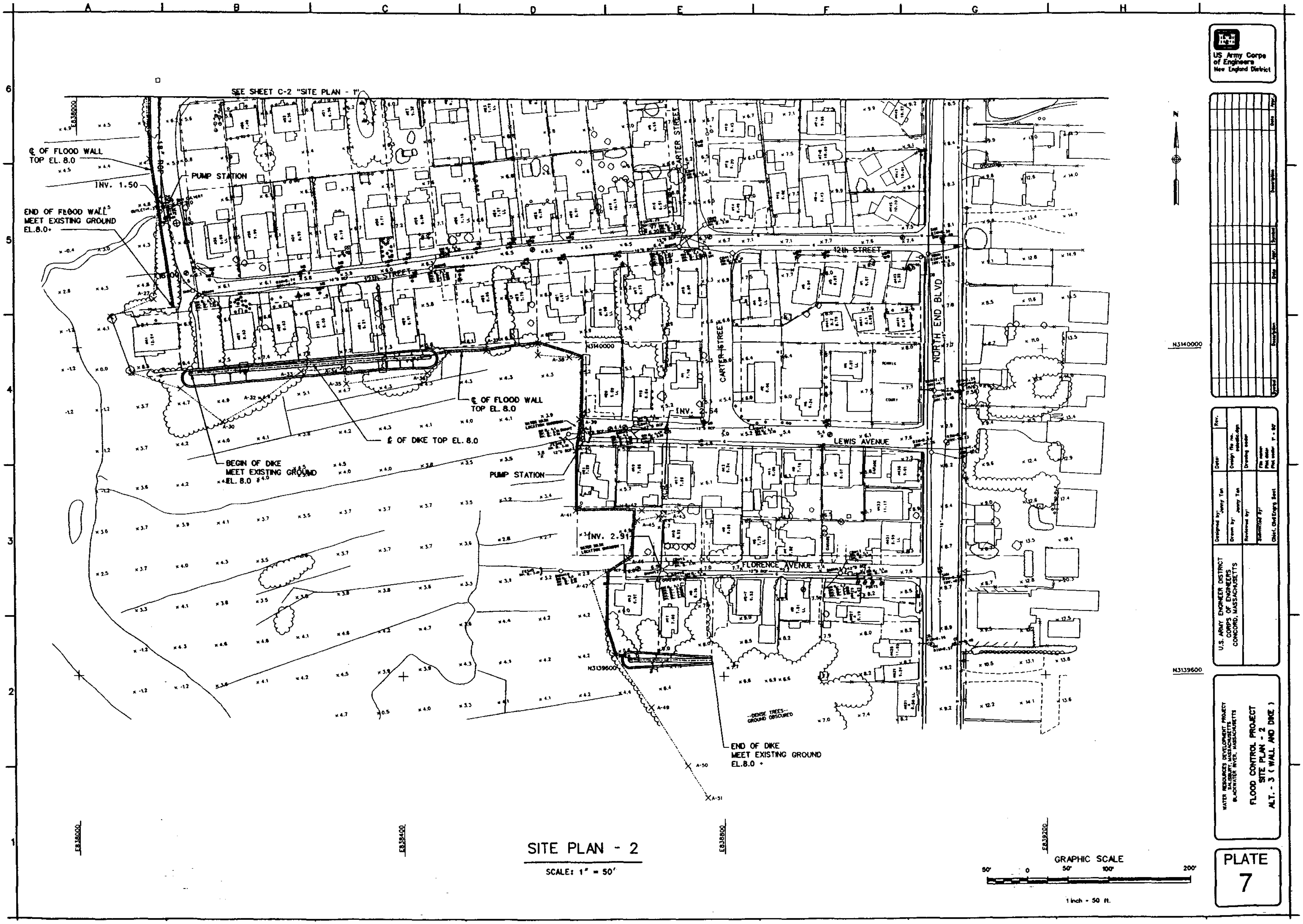
SITE PLAN - 2

SCALE: 1" = 50'

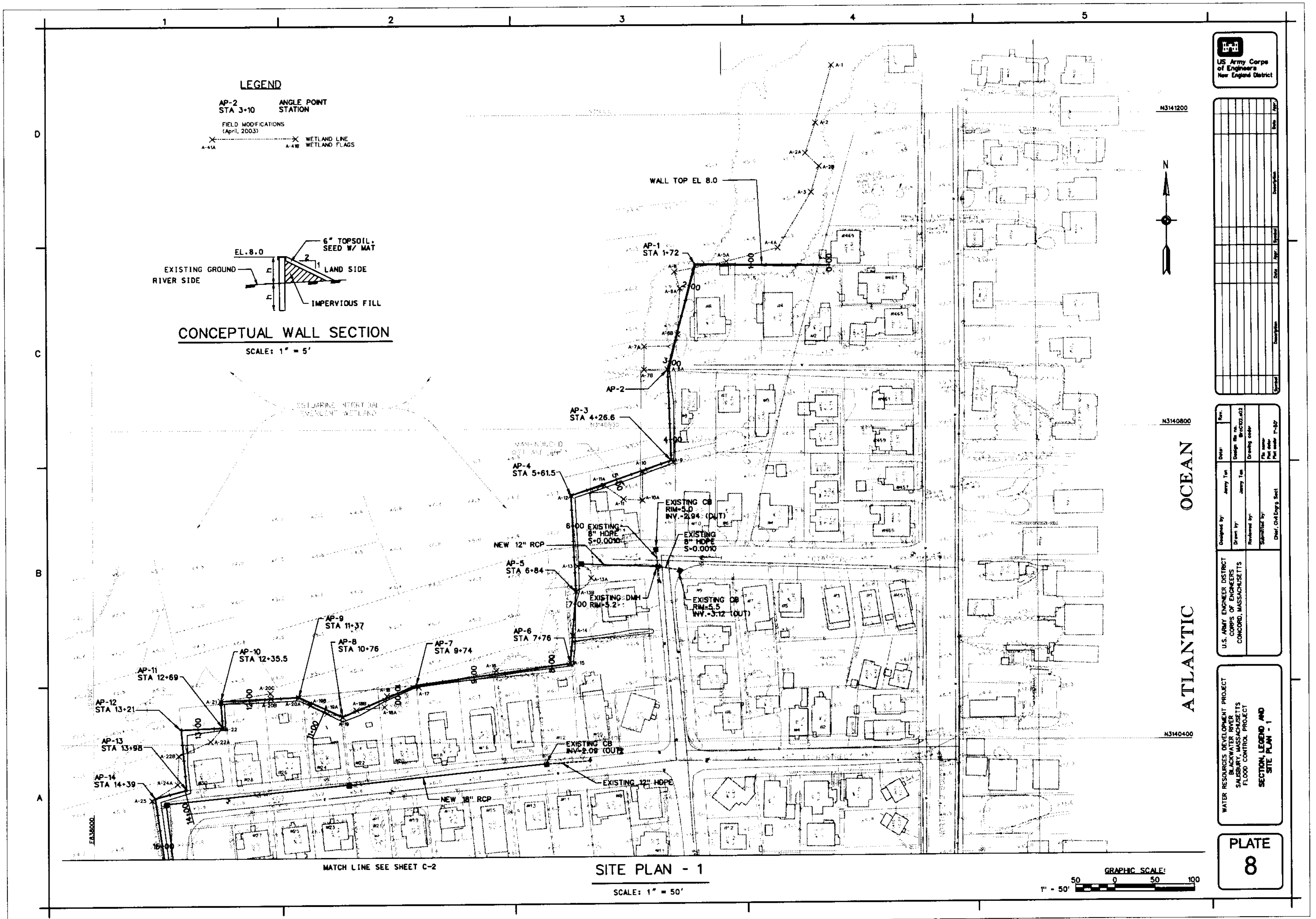
PLATE 5



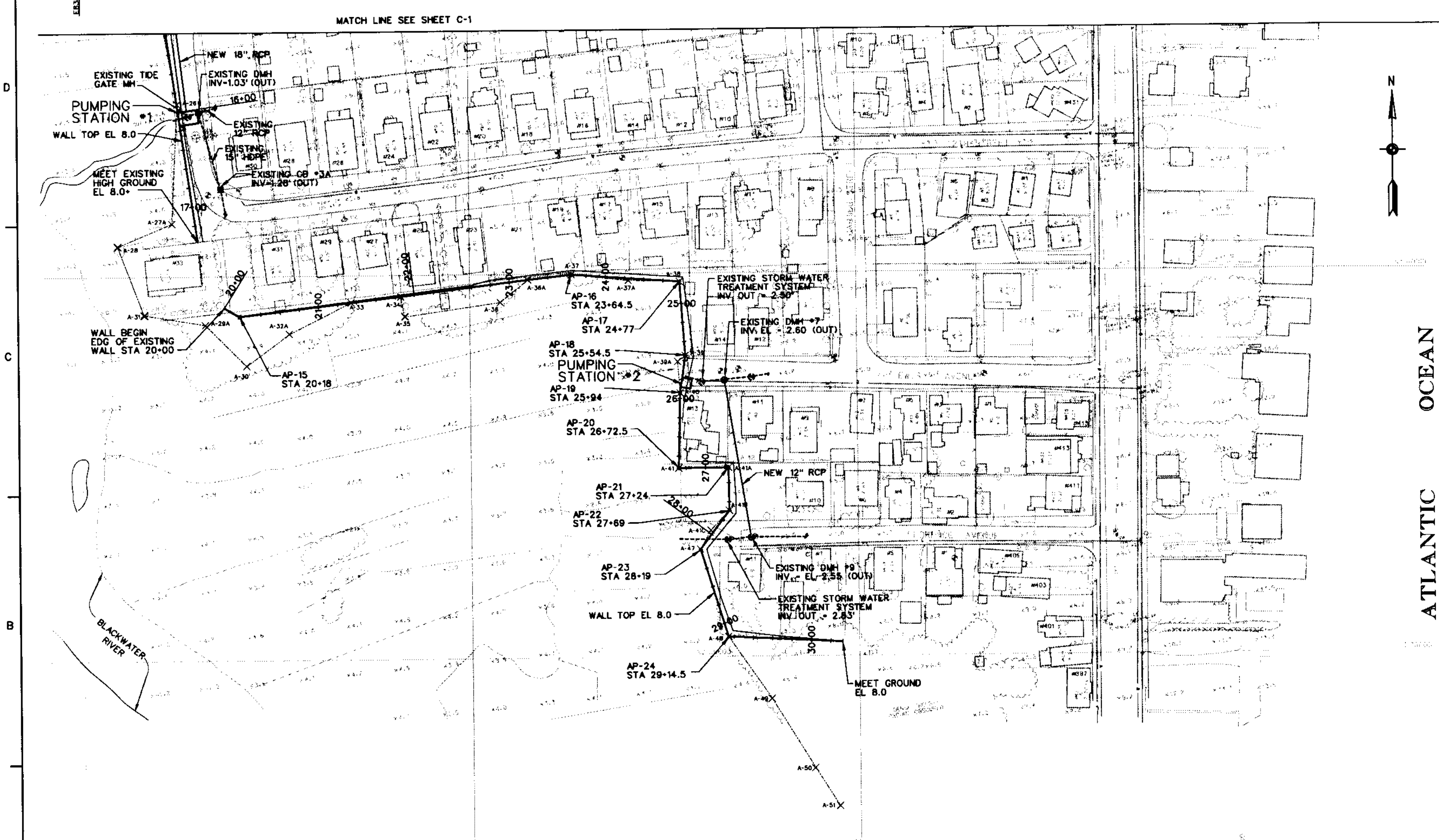
SHEET PILE W/ CAP
6" TOPSOIL, SEED W/ MAT
EL.8.0
EXISTING GROUND
RIVER SIDE
LAND SIDE
IMPERVIOUS FILL
CONCEPTUAL WALL SECTION
SCALE: 1" = 5'
EXISTING GROUND
6" TOPSOIL, SEED
RIVER SIDE
EL.8.0*
LAND SIDE
IMPERVIOUS FILL
* DIKE CREST WOULD BE 0-12 INCHES HIGHER THEN EL.8.0 TO COMPENSATE FOR SETTLEMENT.
CONCEPTUAL DIKE SECTION
SCALE: 1" = 5'
BEGIN OF FLOOD PROTECTION MEET EXISTING GROUND EL.8.0+
POTENTIAL PUMP STATION SITE
DIKE TOP EL. 8.0
WALL TOP EL. 8.0
9th STREET
10th STREET
11th STREET
NORTH END BLVD
CARTER STREET
CB #1 INV 3.07
INV. 2.99
INV. 2.07
INV. 1.89
INV. 2.46
INV. 2.69
INV. 1.74
12" RCP
18" RCP
N3141200
N3140800
N3140400
E838400
E838800
E839200
SEE SHEET C-3 "SITE PLAN - 2"
SITE PLAN - 1
SCALE: 1" = 50'
GRAPHIC SCALE
US Army Corps of Engineers New England District
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS
Designed by: Jenny Tan
Drawn by: Jenny Tan
Reviewed by:
Submitted by:
Chief, Civil Engrg Sect
Date: 1999
WATER RESOURCES DEVELOPMENT PROJECT
SALISBURY, MASSACHUSETTS
BLACKWATER RIVER, MASSACHUSETTS
FLOOD CONTROL PROJECT
SITE PLAN - 1
ALT. 3 (WALL AND DIKE)
PLATE
6



US Army Corps of Engineers
New England District
SEE SHEET C-2 "SITE PLAN - 1"
℄ OF FLOOD WALL
TOP EL. 8.0
PUMP STATION
INV. 1.50
END OF FLOOD WALL
MEET EXISTING GROUND
EL.8.0+
12th STREET
CARTER STREET
NORTH END BLVD
℄ OF FLOOD WALL
TOP EL. 8.0
℄ OF DIKE TOP EL. 8.0
BEGIN OF DIKE
MEET EXISTING GROUND
EL. 8.0
INV. 2.54
LEWIS AVENUE
PUMP STATION
INV. 2.51
FLORENCE AVENUE
END OF DIKE
MEET EXISTING GROUND
EL.8.0 +
N3140000
N3139600
E838000
E838400
E838800
E839200
SITE PLAN - 2
SCALE: 1" = 50'
GRAPHIC SCALE
1 inch = 50 ft.
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS
FLOOD CONTROL PROJECT
SITE PLAN - 2
ALT. - 3 (WALL AND DIKE)
PLATE
7



US Army Corps of Engineers New England District
LEGEND
AP-2 STA 3+10 ANGLE POINT STATION
FIELD MODIFICATIONS (April, 2003)
WETLAND LINE
WETLAND FLAGS
EL.8.0
6" TOPSOIL. SEED W/ MAT
EXISTING GROUND
RIVER SIDE
LAND SIDE
IMPERVIOUS FILL
CONCEPTUAL WALL SECTION
SCALE: 1" = 5'
WALL TOP EL 8.0
AP-1 STA 1+72
AP-2
AP-3 STA 4+26.6
AP-4 STA 5+61.5
AP-5 STA 6+84
AP-6 STA 7+76
AP-7 STA 9+74
AP-8 STA 10+76
AP-9 STA 11+37
AP-10 STA 12+35.5
AP-11 STA 12+69
AP-12 STA 13+21
AP-13 STA 13+98
AP-14 STA 14+39
EXISTING CB RIM=5.0 INV.=2.94 (OUT)
EXISTING 8" HDPE S=0.0010
EXISTING 8" HDPE S=0.0010
NEW 12" RCP
EXISTING DMH RIM=5.2
EXISTING CB RIM=5.5 INV.=3.12 (OUT)
EXISTING CB INV.=2.09 (OUT)
EXISTING 12" HDPE
NEW 18" RCP
N3141200
N3140800
N3140400
N
ATLANTIC OCEAN
MATCH LINE SEE SHEET C-2
SITE PLAN - 1
SCALE: 1" = 50'
GRAPHIC SCALE
50 0 50 100
1" - 50'
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS
Designed by: Jenny Tan
Drawn by: Jenny Tan
Reviewed by:
Submitted by: Chief, Civil Engrg Sect
WATER RESOURCES DEVELOPMENT PROJECT BLACKWATER RIVER SALISBURY, MASSACHUSETTS FLOOD CONTROL PROJECT
SECTION, LEGEND AND SITE PLAN - 1
PLATE 8



SITE PLAN - 2

SCALE: 1" = 50'

GRAPHIC SCALE: 1" = 50' — 50 0 50 100

US Army Corps of Engineers New England District

Symbol	Description	Date	Appr.

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS

Designed by: Jenny Tan	Date:	Rev.
Drawn by: Jenny Tan	Design file no. BrcC103.s03	
Reviewed by:	Drawing code:	
Submitted by: Chief, General Engrg Sect	File name: Plot date: Plot scale: 1"=50'	

WATER RESOURCES DEVELOPMENT PROJECT
BLACKWATER RIVER
SALISBURY, MASSACHUSETTS
FLOOD CONTROL PROJECT

SITE PLAN - 2

PLATE 9