Rahway River Basin, New Jersey
Coastal Storm Risk Management Feasibility Study

Appendix CIII
Geotechnical Engineering

Rahway River Basin (Tidal), Union County and Middlesex County, New Jersey

Coastal Storm Risk Management Feasibility Study

Appendix CIII: Geotechnical Engineering

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1.0 Introduction

This Geotechnical Appendix was prepared by the U.S. Army Corps of Engineers, New York District (CENAN) for the Rahway River Basin (Tidal) Coastal Storm Risk Management Feasibility Study. The document summarizes the results of a limited office study and field survey performed to inform the alternatives analysis.

2.0 Background

The Rahway River Basin is located in northeastern New Jersey in portions of Essex, Middlesex and Union Counties (Figure 1). The roughly crescent shaped basin is 83.3 square miles (53,300 acres) in area.

The Rahway River consists of the mainstem Rahway River and four branches. The river is approximately 24 miles long and generally flows from north to south. After the branches converge to form the mainstem, the river turns eastward and flows into the Arthur Kill (a tidal straight which connects Raritan and Newark Bays), and then to the Atlantic Ocean (Figure 2).

The study area is the tidally influenced lower portion of the Rahway River which extends roughly five miles upstream from the Arthur Kill, encompassing portions of the Cities of Linden and Rahway in Union County and the Borough of Carteret and Woodbridge Township in Middlesex County. The segment of the river this project area is concerned with is located in the Borough of Carteret, specifically on the right (south) bank of the Rahway River, and is bounded by the Rahway Valley Sewerage Authority wastewater treatment facility on the west, Joseph Medwick County Park to the south, and ties into high ground near Frederick Street to the east.

3.0 Purpose and Scope of Work

This purpose of this appendix was to collect and summarize all readily available existing geotechnical and geologic information on the Rahway River Tidal Basin area, assess the feasibility of constructing the conceptual project features, and provide recommendations for obtaining additional geotechnical data. No new borings or any other subsurface investigation was performed for this study.

4.0 Existing Conditions and Proposed Construction

4.1 Existing Conditions

The areas surrounding the proposed project alignment have been heavily developed. To the east and southeast, dozens of one to two-story single-family wood-framed residential structures are present. Joseph Medwick County Park, located to the south, contains numerous grass and turf playing fields as well as paved tennis courts, parking lots, and access roads. A mobile home community is present south of the study area and west of the park. Numerous single-story industrial buildings are present to the west of the mobile homes. The western end of the study area is bounded by the Rahway Valley Sewerage Authority wastewater treatment plant facility.

The proposed alignment footprint consists mostly of undeveloped lands. The western portion of the alignment is located in mostly wooded areas between the river and either the wastewater treatment plant, industrial buildings, or mobile homes. A man-made pond is located to the north of northeastern-most industrial buildings, though its purpose unclear. The central and eastern portion of the alignment consists of low-lying marsh with manmade drainage swales and natural creeks. The eastern alignment area consists of man-made land abutting the edge of the residential development, as evidenced by debris exposed at the ground surface, with some trees and overgrowth and a paved walking path.

A large pile-supported sanitary sewer pipe runs east-west through the project limits adjacent to the river, crossing the alignment at both the eastern and western ends. The sanitary sewer pipe is obscured by vegetation on aerial photography in the western limits, and may potentially run underground to the wastewater treatment plant. Overhead electric lines cross over the river, and a gas main crosses under the river, both near the industrial buildings on the west end of the alignment.

4.2 Proposed Construction

Numerous alternatives to alleviate flooding issues at the site were considered including: no action; constructions of a tide gate, levee/floodwalls, or breakwaters; flood proofing of flood prone structures; and buyouts. Discussion of these alternatives is presented in other sections of this report. Alternative 4a was the selected plan, and is anticipated to consist mostly of a levee, potentially with floodwalls at one and/or both ends of the alignment. Numerous drainage structures will cross the line of protection to alleviate internal drainage concerns. A road raising may also be incorporated. An overall view of Alternative 4A is shown on Figure 3A and an enlarged view is shown on Figure 3B.

5.0 Geotechnical/Geological Literature Review

5.1 Background

No geotechnical investigations are known to have been previously performed at the site, and no new borings or any explorations were performed as part of this study. Therefore, this appendix was prepared using only readily available information available via on-line search. The following sources of subsurface data in the project area were reviewed:

- United States Army Corps of Engineers (USACE);
- United States Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS);
- United States Geological Survey (USGS);
- New Jersey Department of Transportation (NJDOT); and
- New Jersey Department of Environmental Protection (NJDEP)

5.2 Regional Geology

The project area lies in the Piedmont province of the Appalachian Highlands (Figure 4). Per the *Bedrock Topography and Thickness of Pleistocene Deposits in Union County and Adjacent Areas, New Jersey*, "The major topographic features of the Piedmont province in Union County, New

Jersey are the Watchung Mountains, which consist of two parallel basaltic ridges (maximum altitudes about 550 feet), and gently rolling plain sloping from an altitude of about 100 to 150 feet along the eastern side of the Watchung Mountains to sea level at Arthur Kill. Rocks of the Newark Group, of Triassic age, which underlie Union County include the Brunswick Formation and Watchung Basalt. Deposits of Pleistocene age overlie the Triassic bedrock surface and vary greatly in thickness within short distances. The irregularity of the relief of the Triassic bedrock surfaces causes much of the variation in thickness of the Pleistocene age sediments. Sand and gravel deposits of Pleistocene age, valley-fill in stream valleys cut in Triassic consolidated rocks, are an important aquifer system in Union County." "Because of the distribution of the valley-fill aquifers is controlled by the configuration of the bedrock surface, delineation of the buried valley system is essential for development and management of the groundwater resources of the area."

5.3 Bedrock Geology

The 2017 *Bedrock Geologic Map of the Perth Amboy and Arthur Kill Quadrangles, Middlesex and Union Counties, New Jersey* prepared by NJDEP in cooperation with the U.S. Geological Survey shows the project area is underlain by bedrock of the Passaic Formation, which is described as "Interbedded sequence of reddish-brown and, less commonly, maroon or purple, fine to coarse-grained sandstone, siltstone, shaly siltstone, silty mudstone, and mudstone, separated by gray bed sequences composed of olive-gray, dark-gray, or black siltstone, silty mudstone, shale, and silty argillite. (Figure 5) The *Bedrock Topography and Thickness of Pleistocene Deposits in Union County and Adjacent Areas, NJ* indicates that rock is anticipated about 20 feet below mean sea level (Figure 6).

Rivers that drained Union County before the last glaciation cut deep valleys into the bedrock. The project alignment lies along one of these valleys cut into the bedrock: the Rahway Valley. Glaciers and glacial melt water from the most recent glacial period (Pleistocene Epoch) filled in the river valleys and covered the entire area with unconsolidated sediments consisting of unstratified and stratified deposits of clay, silt, sand and gravel. The 1974 *Bedrock Topography and Thickness of Pleistocene Deposits in Union County and Adjacent Areas, New Jersey* prepared by the U.S. Geological Society indicates approximately 40 feet of Pleistocene deposits are expected to be present on top of the bedrock in the site vicinity (Figure 7).

5.4 Surficial Geology

The Natural Resources Conservation Service (NRCS) (US Department of Agriculture) website maps the majority of the surface soils at the site as Transquaking mucky peat (TrkAv), with Boonton-Urban land complex (BouB) near the eastern end of the alignment and Urban Land (UR) to the west (Figure 8). Transquaking mucky peat is described as tidal marshes, very poorly drained mucky peat and muck to greater than 90 inches, with the depth of the water table at the ground surface. Boonton-Urban land complex is described as ground moraines consisting of coarse loamy basal till derived from basalt, with a depth to water table typically more than six and one-half feet. Urban Land is described as surface covered by pavement, concrete, buildings, and other structures underlain by disturbed and natural material.

5.5 Aerial Photography

Aerial photography of the site vicinity was available on the NJDEP "NJ-GeoWeb" website as well as Bing Maps and Google Earth. Photos from 1930, 1970, 1995, and 2019 were reviewed (Figures 9A through 9D). The 1930 photo shows the majority of the site is mostly undeveloped, with a few isolated structures and roads on the east and sides of the site. By 1970, most of the structures currently present had been constructed, including the residential neighborhood to the east of the site, the mobile home park, commercial buildings and wastewater treatment plant to the south and west. The large sanitary sewer pipeline is present, as is a man-made pond to the northeast of the commercial buildings. No significant changes of note were observed in later photos.

5.6 New Jersey Well Search

A quarter mile radius well search from the approximate center of the study area (NJ State Plane Coordinate System feet, Easting = 562380 Northing = 643319) was conducted on the NJDEP "XY well search database" website. The well search database contains records for all approved/accepted well and boring documents received by the NJDEP that have been electronically data managed, including permit applications (boring and well), well records, and abandonment reports. There may be permits generated for wells and borings that were not drilled. There may also be wells drilled without final well records submitted to the NJDEP. The XY well search returned nearly 800 results within the search area quarter mile radius. Individual well records for these wells are not available electronically; however, records, if available on file at NJDEP, may be obtained for a fee through the Division of Water and Geoscience.

5.7Adjacent Subsurface Investigations by Others

5.7.1 Route 1 & 9 Overpass – Rahway, NJ

Several borings were performed for New Jersey Department of Transportation (NJDOT) in 1995 for a new Route 1 & 9 bridge over the Rahway River, which is located approximately 4,700 feet west of the subject site (Figure 10). The soils adjacent to the river are mapped as Boonton-Urban Land (BovB) and Urban Land (UL) on the NCRS website, both similar to the subject site. Boring logs on the south side of the river show approximately five to nine feet of gravel/silt/sand soils underlain by weathered siltstone to the completion depths of 19 to 26 feet below grade (Figures 11A & 11B). Rock core recoveries (REC) of 66 to 100 percent were recorded within a few feet of the weathered rock surface, though Rock Quality Designation (RQD) was generally very poor.

5.7.2 New Jersey Turnpike Ramp – Carteret, NJ

Several borings were performed in 1995 for a new New Jersey Turnpike ramp, which is located approximately 3,200 feet east of the subject site (Figure 10). The soils are mapped as Transquaking mucky peat soils (TrkAv) and Urban Land (UL) on the NCRS website, both similar to the subject site. Boring logs closest to the site in the "UR" mapped area encountered relatively hard sandy silt and dense silty sands to the maximum depths explored, approximately 21.5 feet below grade (Figures 12A & 12B). It's unclear on the logs if these materials are fill materials, but based on the high relative densities the materials were most likely placed in lifts and compacted in a controlled manner. Boring logs in areas mapped as "TrkAv" encountered relatively hard silts and sandy silts to the maximum depths explored, approximately 21.5 feet below grade. It's unclear on the logs if these materials are fill materials, but based on the high relative densities the materials were most likely placed in lifts and compacted in a controlled manner. No rock was encountered in any of the noted borings performed for this project.

5.8 Earthquake Considerations

Per the New Jersey Geological and Water Survey (NJGS) website, New Jersey does not get many earthquakes, and most felt in the state are small (Figure 13). Records for the New York City area have been kept for 300 years and provide good information for estimating the frequency of earthquakes in New Jersey. Earthquakes with a maximum intensity of VII have occurred in the New York City area in 1737, 1783, and 1884. One intensity VI, four intensity V's, and at least three intensity III shocks have also occurred in the New York area over the last 300 years (Figure 14).

Based on information published on NJGS information, Middlesex County is considered to have low liquefaction potential (Figure 15). However, given that the site is mapped as likely being underlain by stratified deposits of unconsolidated materials, there is potential for some liquefaction. Therefore, the possibility should be carefully analyzed once the subsurface investigation has been performed at the site.

6.0 Feasibility of Constructing the Conceptual Project Features

No geotechnical investigation was performed as part of this study, and USACE currently does not have any information on any geotechnical investigations performed on or near the proposed project alignment. However, based on the previously discussed soil conditions mapped for the project vicinity and the limited borings performed within one mile of the site, the majority of the site is anticipated to be underlain by a surficial layer of soft organic soils underlain by loose to medium dense stratified, unconsolidated deposits of glacial outwash materials. The organic materials would need to be removed below any proposed levee areas due to the excessive settlement that would occur when levee loading is applied. The underlying stratified deposits could likely support the proposed levee, however some settlement would be expected to occur given that these materials are recent deposits and unconsolidated. Levee overbuild could likely account for the settlement to ensure the final levee height meets the required level of protection. Given the short duration of storm events (anticipated to last only one or two tide cycles), and the anticipated stratified deposits, sheetpile seepage cutoffs may not be necessary. Permeability testing during the subsurface investigation would help inform the necessity of any cutoffs. A cross section of the currently levee concept is shown on Figure 16.

Any floodwalls, drainage structures, etc. would need to be pile supported. Bedrock is anticipated within about 40-50 feet of the existing grades, so small diameter micro piles such as the type successfully being installed on several nearby USACE projects would be ideal given their ease of installation and contractors familiar with their construction. Piles would have relatively small axial loads which could easily be supported by the bedrock anticipated at depths of about 40 feet below grade, but large lateral loads; therefore piles for walls would be battered to provide increased lateral capacity. The piles would be socketed into bedrock by at least 10 feet. The floodwalls would likely require sheetpile cutoffs to help contain seepage.

Numerous existing utilities including sanitary sewer, gas, and electric are present at the western end of the project. Floodwall construction would be preferred over levees in these areas due to the settlement that would occur upon placement of levee materials and the damage that this would cause to the utilities. Close coordination with utility companies will be required during design.

Given the proximity of the project to the river, construction dewatering will be a significant concern. The results of borings and in-place permeability testing will help determine the required degree of effort.

7.0 Recommendations for Future Geotechnical Work

A full geotechnical/geologic subsurface investigation is required in order to proceed with design of the proposed features. The investigation should be performed in accordance with the guidance presented in EM 1110-1-1804 Geotechnical Investigations, EM 1110-2-1913 Design and Construction of Levees, as well as any other applicable guidance for any other proposed features being considered (such as EM 1110-2-2502 Retaining and Flood Walls). For planning purposes, a geotechnical boring should be performed every 250 feet along the length of the alignment, and the borings would likely extend up to about 50-60 feet deep, with 5 to 10 feet of rock core in each boring. Undisturbed samples should be collected of any soft or compressible fine-grained soil layers, and in-place permeability testing should be performed during the field work in both soil and rock strata. Rock strength tests and soil classification tests should be performed.

Figures

Figure 1 – Map of New Jersey with Site Location

Figure 2 – Map of Rahway River Watershed

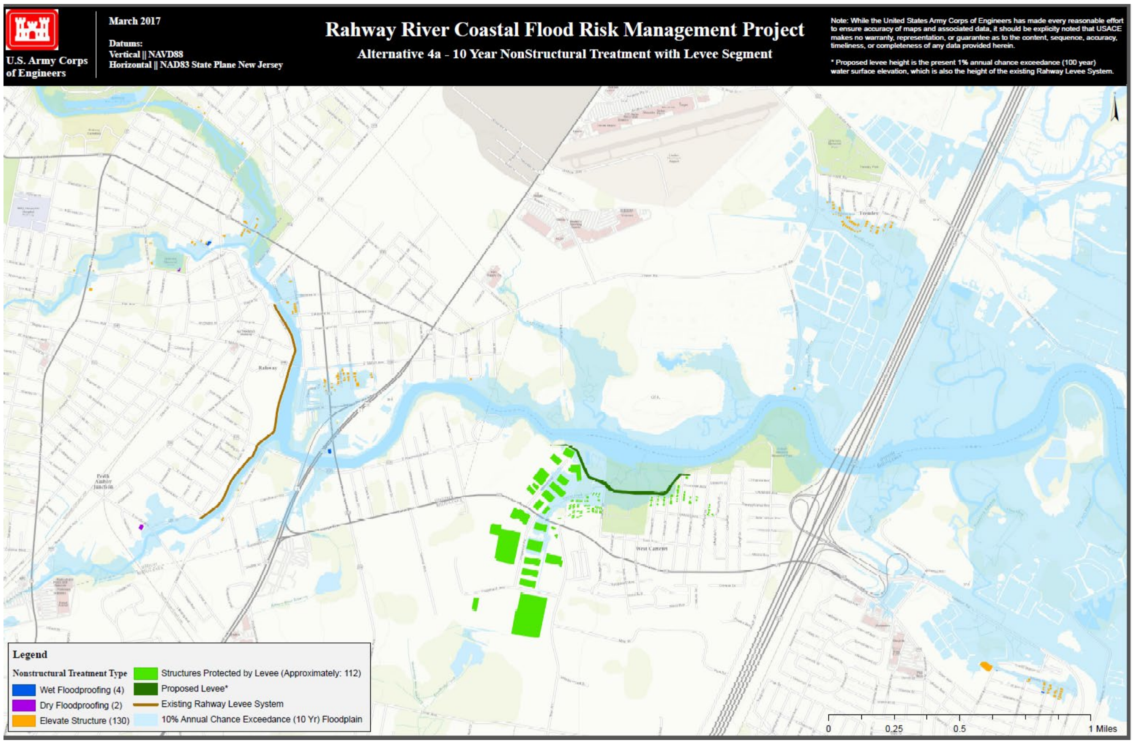


Figure 3A - Alternative 4A General View

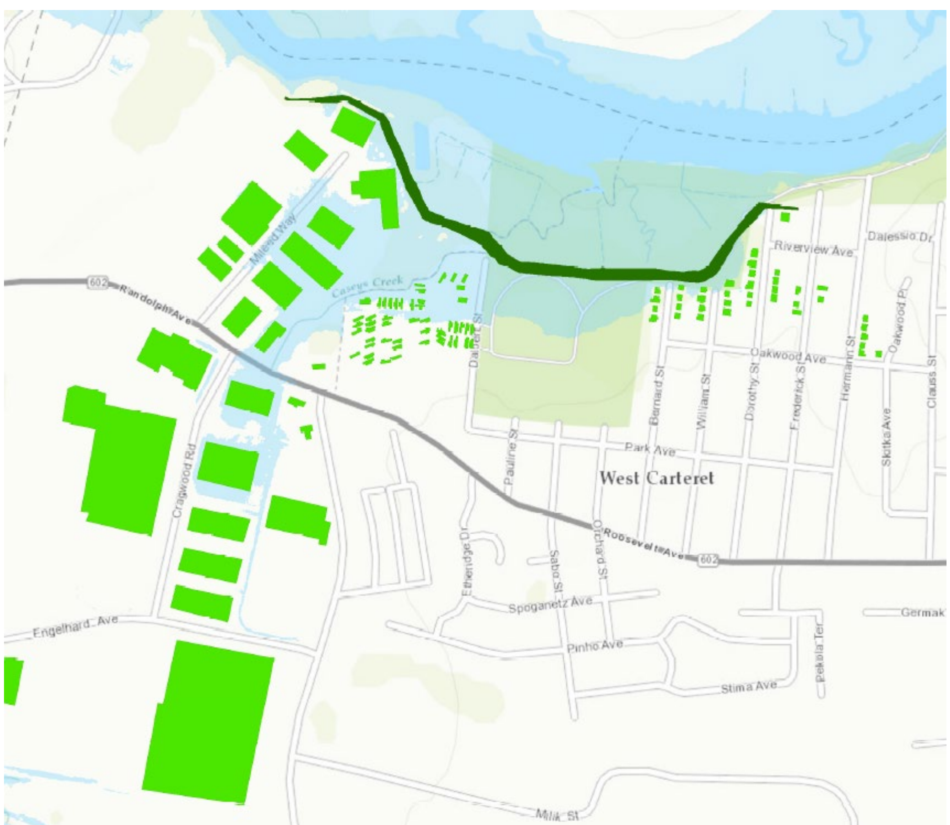


Figure 3B - Alternative 4A Enlarged View

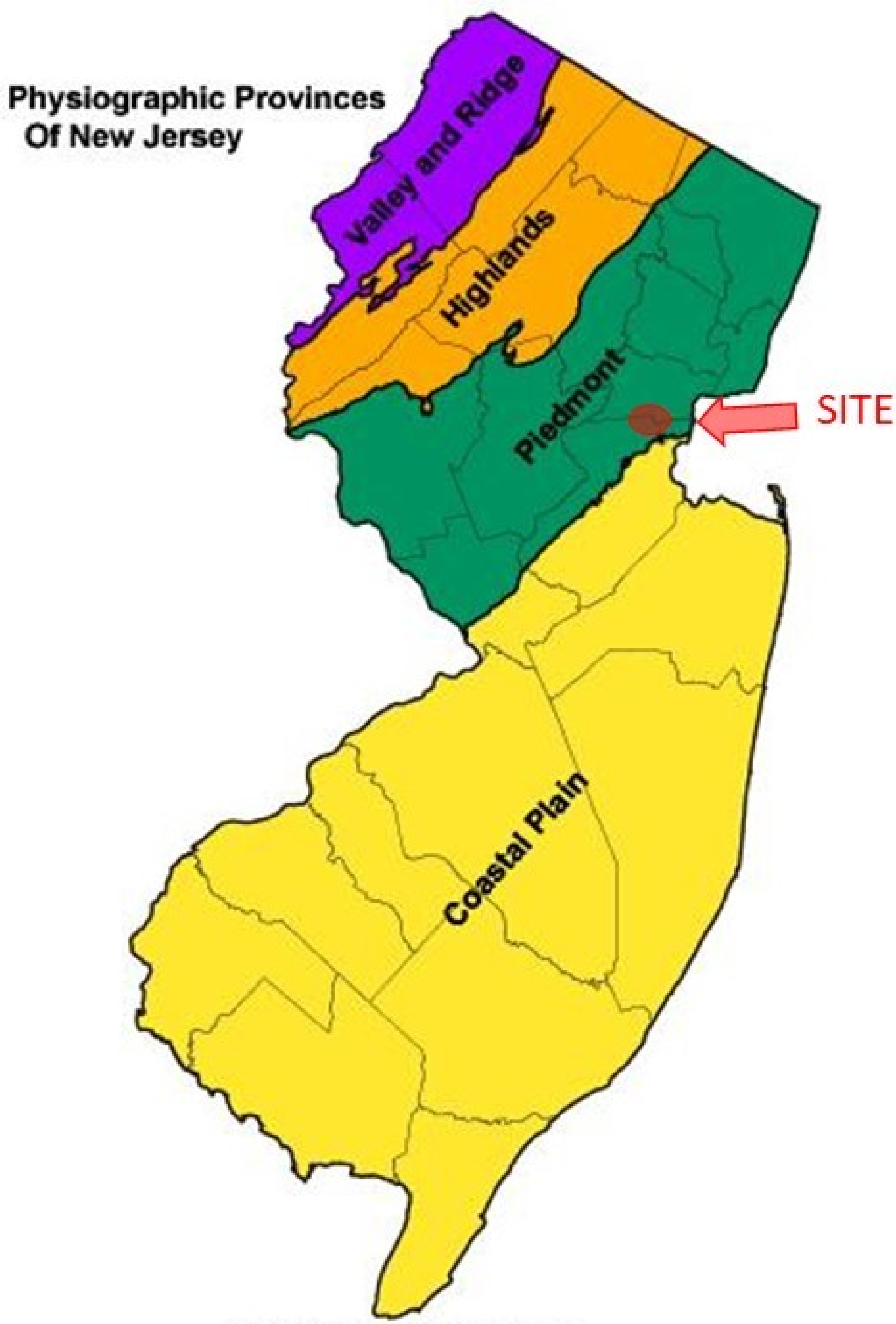


Figure 4: Physiographic Provinces of New Jersey

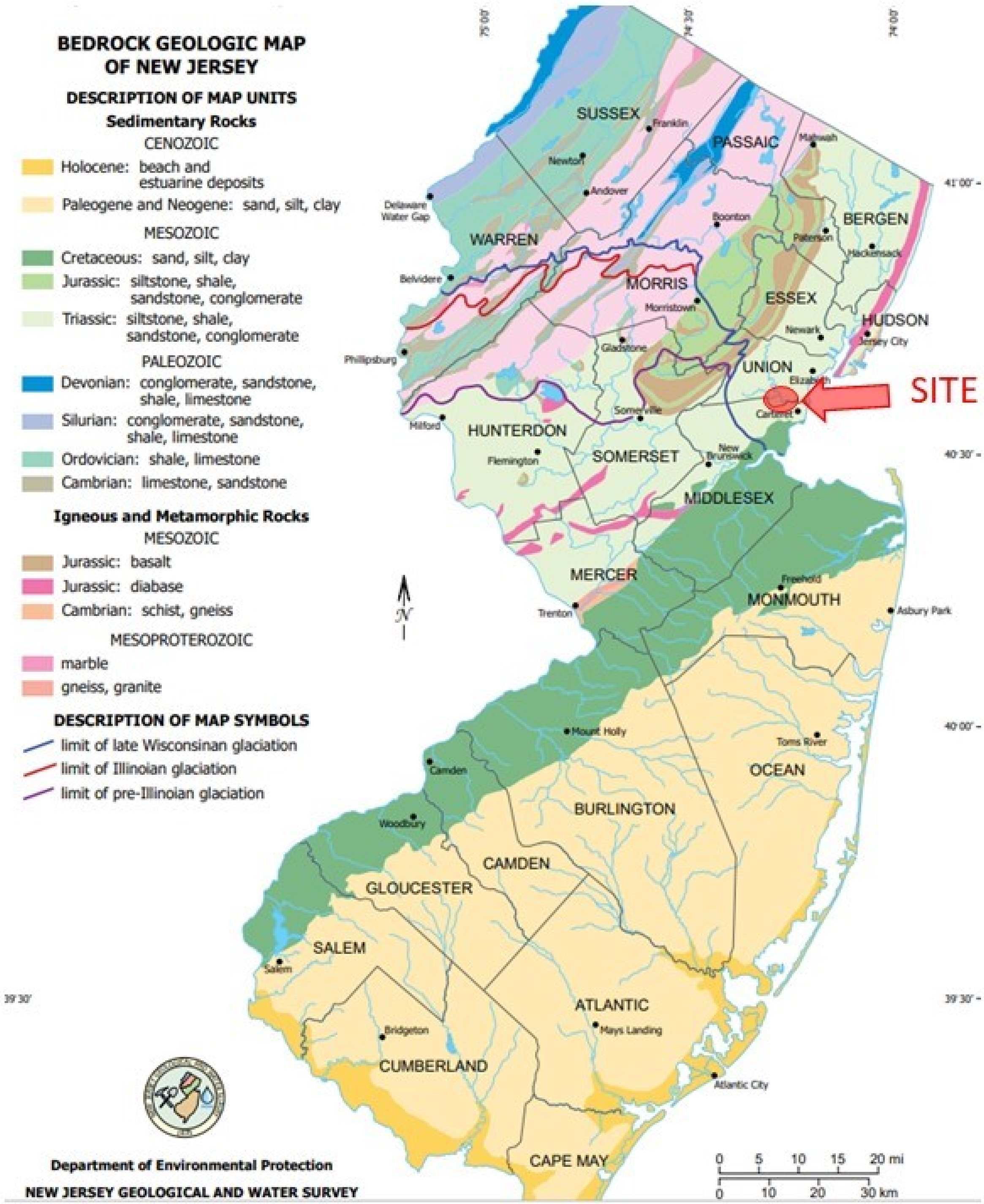


Figure 5: Bedrock Geology Map of New Jersey

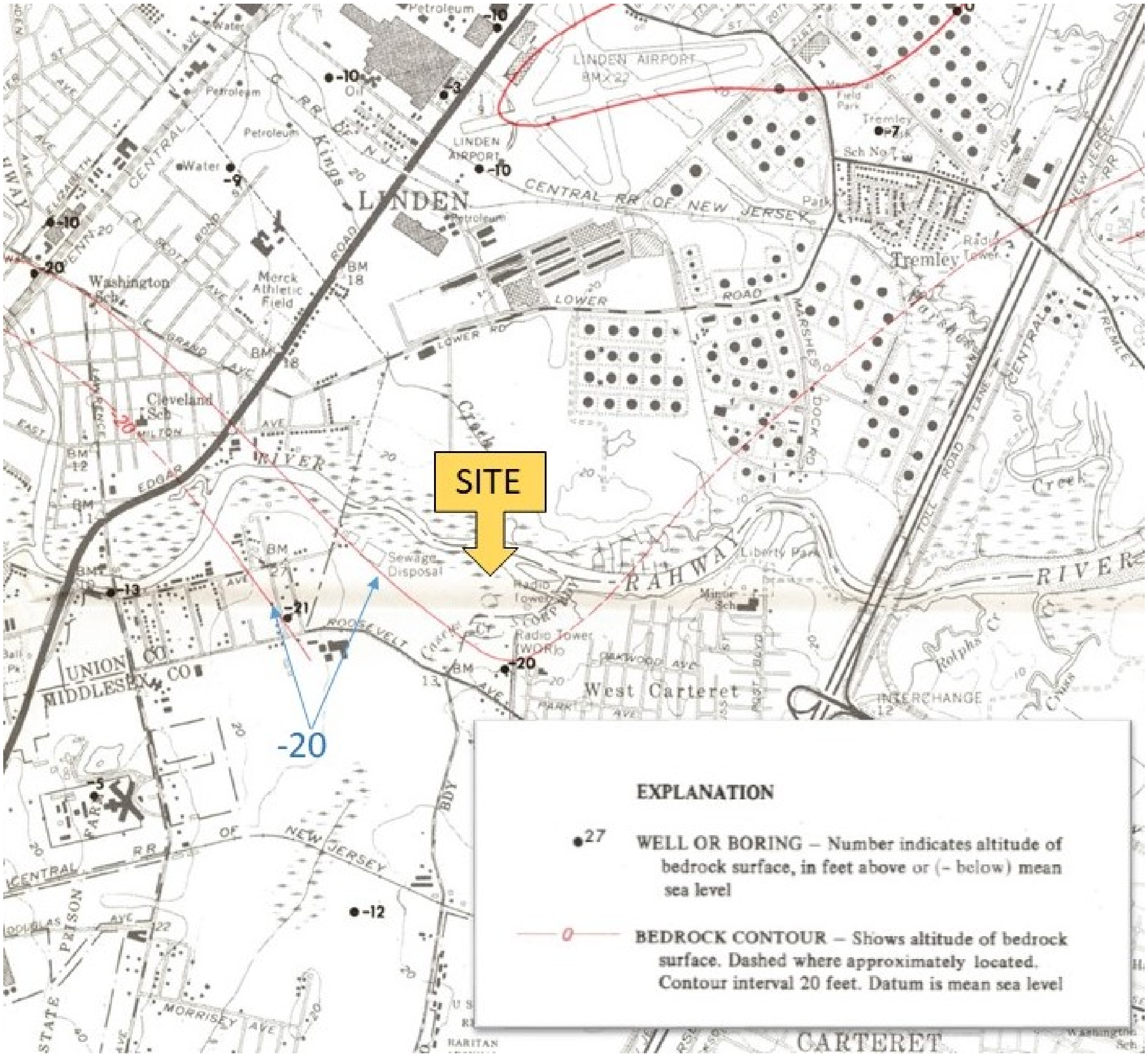


Figure 6: Bedrock Topography Map of Site Vicinity

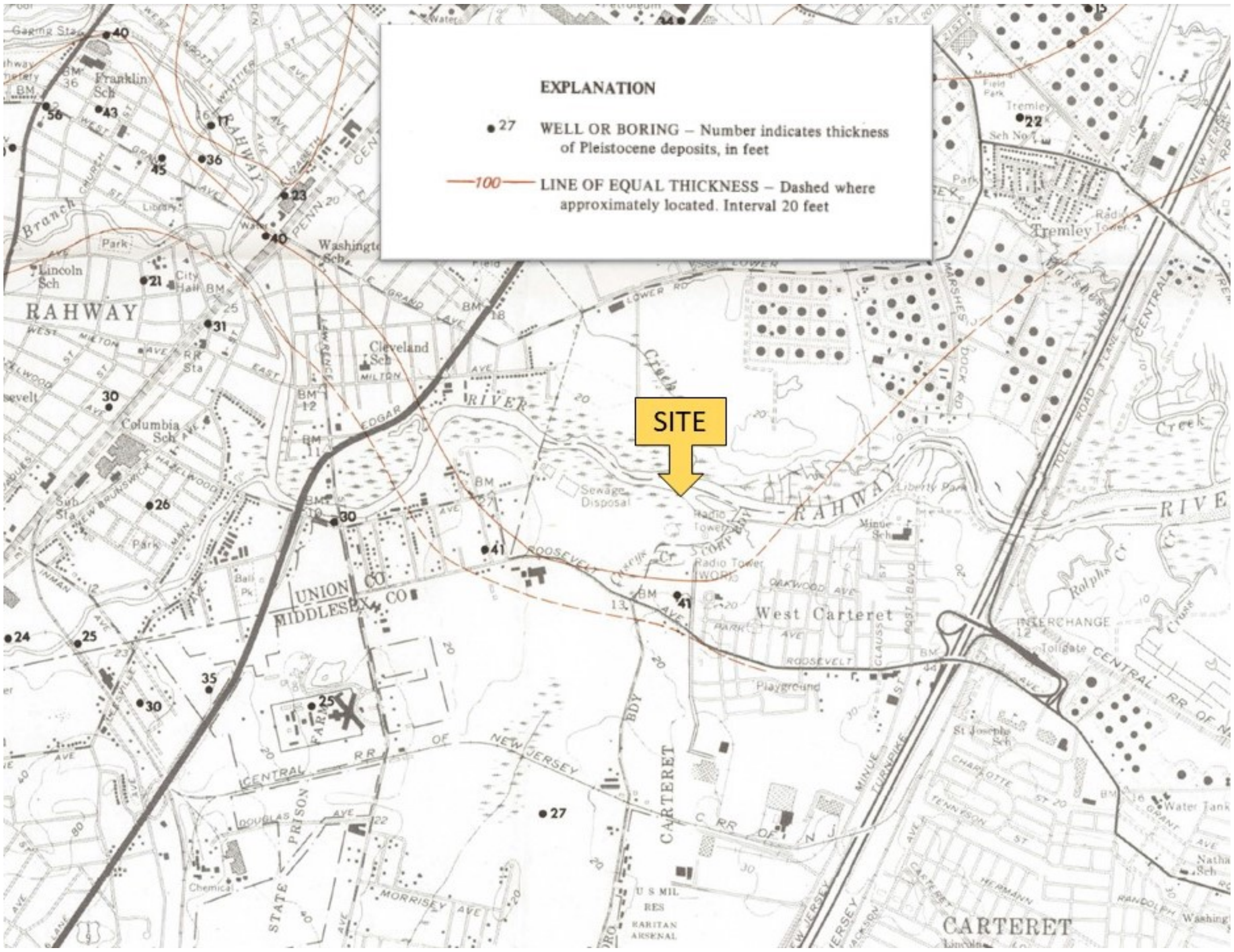


Figure 7: Map of Pleistocene Deposit Thickness in Site Vicinity

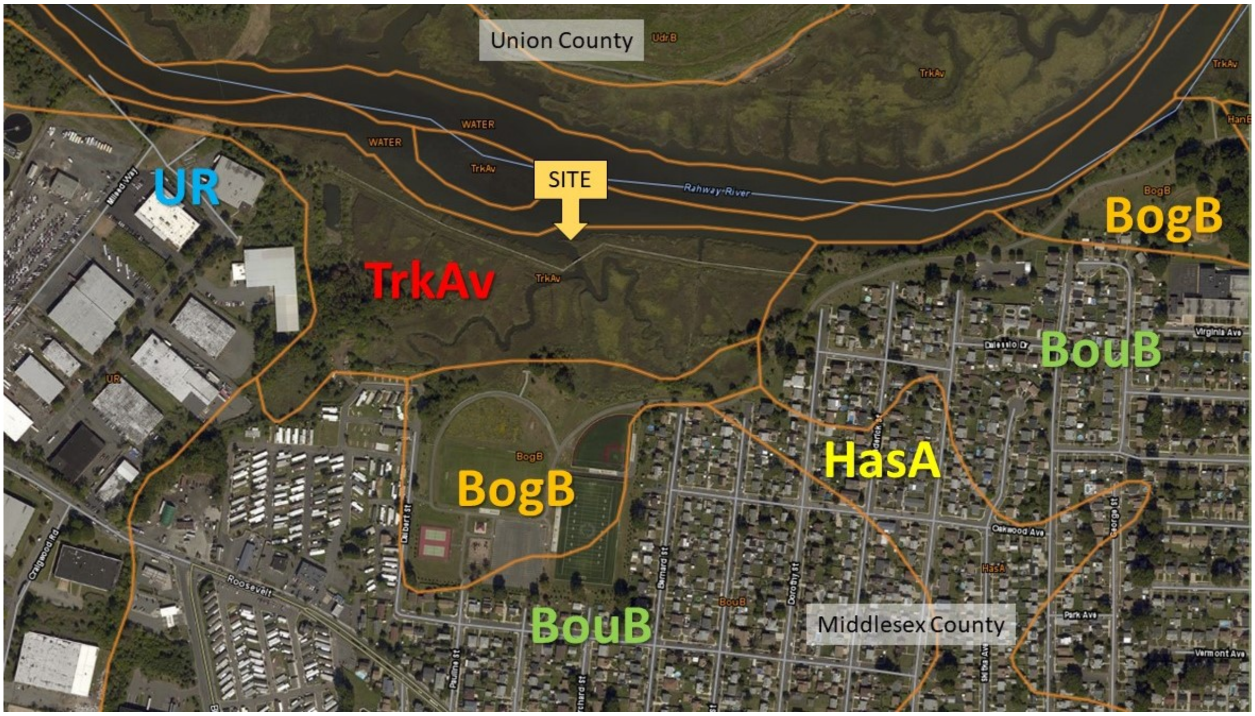


Figure 8: NRCS Soil Map of Site Vicinity

Figure 9A: 1930 Aerial Photograph of the Site Vicinity

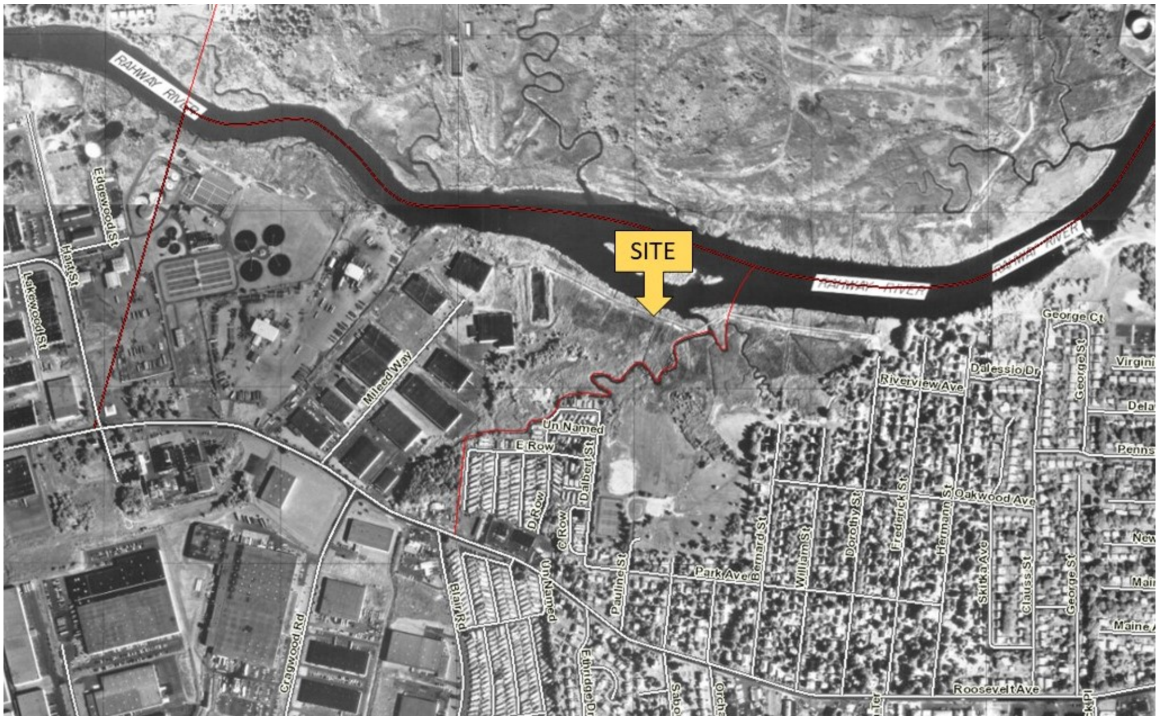


Figure 9B: 1970 Aerial Photograph of the Site Vicinity

Figure 9C: 1995 Aerial Photograph of the Site Vicinity

Figure 9D: 2015 Aerial Photograph of the Site Vicinity

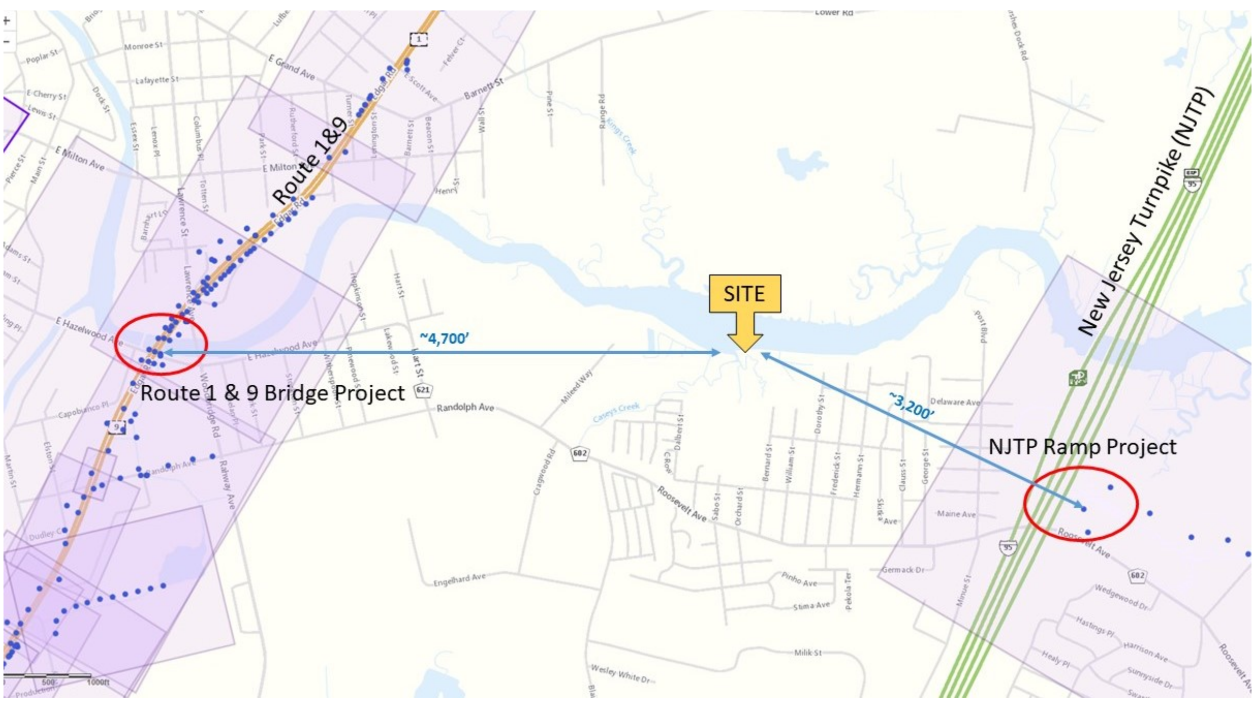


Figure 10: Map of Nearby NJDOT Geotechnical Investigations

GANNETT FLEMING, INC.
NEW JERSEY DEPARTMENT OF TRANSPORTATION

ROUTE: U.S. 1 & 9 LOCAL NAME: Structure Boring TEST HOLE NO. S-4
SECTION: 1K & 3M
STATION: 1344+84 OFFSET: 63 LT REF. LINE: Prop. Rte U.S. 1 & 9 G. L. EL: -1.6
BORINGS MADE BY: ADT, Inc. DATE STARTED: 9/8/95
INSPECTOR: Glenn Hutchins DATE COMPLETED: 9/12/95

El. G.W.T.
0 HR. Boring DATE:
located in Rahway River
24 HR. (Tidal) DATE:
________ft. P.P. Inst. DATE:

Depth	Casing Blows	Sample No.	Depth		Blows on Spoon 0 / / 6	6 / /12	12/ /18	Rec.	Sample ID and Profiles Changes	
	40	S-1	0.0'	1.5'	10	12	30	1.0'	Black SILT, little f Sand, little Organics Pp < 0.1 TSF	0.2
	115								Red c (-) mf SAND, some mf Gravel, little Silt	
	45									
	52									
5	50									
	33	S-2	5.0'	6.5'	35	55	55	1.1'	Same, except some Silt (Rollerbit through boulder 6.4'-8.4')	
	25									
	29									
	58									9.5
10	120									
	MUD									
		S-3	11.5'	12.2'	80	100/ 0.2'		0.6'	Red Clayey SILT, some f Sand, little mf Gravel (very severely weathered SILTSTONE) (Advanced hole to 16.5' by rollerbit)	
15										
	16.5	R-1	16.5'	21.5'	CORE			5.0'		16.5
					REC	=	100%		Red SILTSTONE, moderately hard to hard, moderately to slightly weathered, closely spaced joints, 20°-40°, closely spaced fractures, pred. horizontal fractures.	
					RQD	=	29%			
20										
		R-2	21.5'	26.5'	CORE			5.0'		
					REC	=	100%			
					RQD	=	84%		Less fractures from 23.5'-26.5'	
25										
									End of Boring 26.5'	26.5
30										
35										
40										

Nominal I.D. of Drive Pipe 2 1/2" 3 1/2" 4"
Nominal I.D. of Split Barrel Sampler 1 1/2"
Weight of hammer on Drive Pipe 300 lbs.
Weight of hammer on Split Barrel Sampler 140 lbs.
Drop of hammer on Drive Pipe 24"
Drop of hammer on Split Barrel Sampler 30"

The subsurface information shown hereon was obtained for State design and estimate purposes. It is made available to authorized users only that they may have access to the same information available to the State. It is presented in good faith, but is not intended as a substitute for investigations, interpretation or judgement of such authorized users.

New Jersey Department of Transportation
Bureau of Geotechnical Engineering

Core Dia. NX

Approximate Change in Strata ________

Soil descriptions represent a field identification after D.M. Burmister unless otherwise noted.

Inferred Change in Strata _ _ _ _ _ _ _

Figure 11A – NJDOT Soil Boring Log from Route 1 & 9 Bridge Project

GANNETT FLEMING, INC.
NEW JERSEY DEPARTMENT OF TRANSPORTATION

ROUTE: U.S. 1 & 9 LOCAL NAME: Structure Boring TEST HOLE NO. S-6
SECTION: 1K & 3M
STATION: 1345+15 OFFSET: 61 RT REF. LINE: Prop. Rte U.S. 1 & 9 G. L. EL: -1.6
BORINGS MADE BY: ADT, Inc. DATE STARTED: 9/1/95 | El. G.W.T.
INSPECTOR: Glenn Hutchins DATE COMPLETED: 9/8/95 | 0 HR. DATE:
24 HR. DATE:
0 ft. P.P. Inst. DATE:

Depth	Casing Blows	Sample No.	Depth		Blows on Spoon 0/ /6	6/ /12	12/ /18	Rec.	Sample ID and Profiles Changes	
	12	S-1	0.0'	1.5'	3	1	1	0.4'	Black mf GRAVEL, and mf (+) Sand,	
	58								some Silt	2.0
	66	S-2	2.5'	4.0'	8	7	13	0.7'	Red cmf GRAVEL, and cmf Sand, some	
	48								Silt	
5	71									
	55									
	72									7.0
7.5		S-3	7.5'	9.0'	3	2	8	0.3'	Red SILT, little f Sand	
	Roller									9.0
10	Bit	S-4	9.0'	10.5'	5	31	100	0.9'	Red Clayey SILT, little (-) f Sand	
									(Weathered Siltstone Bedrock)	
	12.0									12.0
		R-1	12.0'	17.0'	CORE			3.3'	Red SILTSTONE, medium hard,	
					REC	=	66%		moderately to slightly weathered,	
15					RQD	=	10%		very closely to closely spaced	
									fractures	
		R-2	17.0'	19.0'	CORE			2.0'	(very broken 14.0'- 17.0';	
					REC	=	100%		severely weathered 18.9'- 19.0')	
					RQD	=	0%			
20		*S-5	19.0'	19.5'	100			0.0'		19.5
									End of Boring 19.5'	
25										
30										
									* Core barrel plugged on attempt to core from 19.0'. Spoon was driven and tip of spoon broke off in hole. Boring terminated.	
35										
40										

Nominal I.D. of Drive Pipe 2 1/2" 3 1/2" 4"
Nominal I.D. of Split Barrel Sampler 1 1/2"
Weight of hammer on Drive Pipe 300 lbs.
Weight of hammer on Split Barrel Sampler 140 lbs.
Drop of hammer on Drive Pipe 24"
Drop of hammer on Split Barrel Sampler 30"

The subsurface information shown hereon was obtained for State design and estimate purposes. It is made available to authorized users only that they may have access to the same information available to the State. It is presented in good faith, but is not intended as a substitute for investigations, interpretation or judgement of such authorized users.

New Jersey Department of Transportation
Bureau of Geotechnical Engineering

Core Dia. NX

Approximate Change in Strata ______

Inferred Change in Strata _ _ _ _ _ _ _

Soil descriptions represent a field identification after D.M. Burmister unless otherwise noted.

Figure 11A – NJDOT Soil Boring Log from Route 1 & 9 Bridge Project

Form SO-2 2/79 NEW JERSEY DEPARTMENT OF TRANSPORTATION Field #B-40

ROUTE: LOCAL NAME: Roadway Boring TEST HOLE NO. 342W-128

SECTION: Carteret Industrial Rd., FAUS #M-8695 (101)

STATION: 132+00 OFFSET: 20' Rt. REFERENCE LINE: Survey BL GROUND LINE ELEVATION: +22.3'

BORINGS MADE BY: Rubino DATE STARTED: 5-2-83

INSPECTOR: Maccarillo DATE COMPLETED: 5-2-83

Elevation G.W.T.
0 Hr. +16.3' Date: 5-2-83
24 Hr. +19.3' Date: 5-2-83
______ ft. P.P. Installed Date:

CASING BLOWS	SAMPLE NO. DEPTH			Blows on Spoon 0/6	6/12	12/18	REC.	Sample ID and Profile Change	
14	S-1	0.0'	1.5'	18	21	26	0.6'	Brown CF SAND, some Silt, little CF Gravel	
27									
59	S-2	1.5'	3.0'	28	123	74	0.7'	Red CF Sand, some Silt, some CF Gravel	
40									
14	S-3	3.0'	4.5'	41	40	38	1.0'	Brown SILT some, F Sand	
15	S-4	4.5'	6.0'	10	11	13	0.9'	Red SILT and, CF Sand, little CF Gravel	
27									
25	S-5	6.0'	7.5'	6	16	13	1.2'	Same	
23	S-6	7.5'	9.0'	12	14	16	1.5'	Red SILT trace, F Sand	
19									
31	S-7	9.0'	10.5'	14	26	27	1.5'	Red SILT little, F Sand, trace MF Gravel	
52	S-8	10.5'	12.0'	29	33	34	1.5'	Red CF SAND, trace Silt, little (+) CF Gravel	
32									
28	S-9	12.0'	13.5'	22	26	29	1.5'	Red CF SAND, little Silt, little CF Gravel	
21									
21	S-10	13.5'	15.0'	13	13	15	1.0'	Red SILT and, CF Sand, some CF Gravel	
25									
32									
45									
30									
	S-11	20.0'	21.5'	33	75	70	1.0'	Same	
									21.5'
								Bottom of Hole	

Nominal I.D. of Drive Pipe	2½" XX
Nominal I.D. of Split Barrel Sampler	1½"
Weight of hammer on Drive Pipe	300 lbs.
Weight of hammer on Split Barrel Sampler	140 lbs.
Drop of hammer on Drive Pipe	24"
Drop of hammer on Split Barrel Sampler	30"

Core Dia. ______

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The Information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State if he finds that the actual conditions do not conform to those indicated by this log.

New Jersey Department of Transportation

Bureau of Geotechnical Engineering

Figure 12A – NJDOT Soil Boring Log from NJTP Project

Form SO-2 2/79 NEW JERSEY DEPARTMENT OF TRANSPORTATION Field #B-41

ROUTE: LOCAL NAME: Roadway Boring TEST HOLE NO. 342W-129

SECTION: Carteret Industrial Road, FAUS #M-8695 (101)

STATION: 136+00 OFFSET: 00 REFERENCE LINE: Survey BL GROUND LINE ELEVATION: +20.3'

BORINGS MADE BY: Colangelo DATE STARTED: 5-3-83

INSPECTOR: Maccarillo DATE COMPLETED: 5-3-83

Elevation G.W.T.		Date
0 Hr.	+12.3'	5-3-83
24 Hr.	+14.3' Caved & Dry	5-4-83
______ ft. P.P. Installed		Date:

Depth	Casing Blows	Sample No.	Depth		Blows on Spoon 0/6	6/12	12/18	Rec.	Sample ID and Profile Change	
	43	S-1	0.0'	1.5'	27	45	74	0.3'	Brown CF SAND, trace Silt, some CF Gravel	
	26									
	18	S-2	1.5'	3.0'	23	16	18	1.4'	Red SILT and, CF Sand, some CF Gravel	
	20									
5	21	S-3	3.0'	4.5'	19	28	29	1.5'	Same	
	36	S-4	4.5'	6.0'	17	22	25	1.2'	Same	
	34									
	32	S-5	6.0'	7.5'	15	15	17	1.2'	Red SILT little, CF Sand	
	24									
10	40	S-6	7.5'	9.0'	13	14	15	1.5'	Same	
	32	S-7	9.0'	10.5'	13	16	18	1.5'	Red SILT and, CF Sand, some CF Gravel	
	33									
	30	S-8	10.5'	12.0'	14	15	17	0.4'	Same	
	30	S-9	12.0'	13.5'	11	14	14	1.5'	Same	
15	29	S-10	13.5'	15.0'	12	15	18	1.5'	Same	
	25									
	45									
	68									
	89									
20	112									
		S-11	20.0'	21.5'	38	49	80	1.5'	Same	
									Bottom of Hole	21.5'
25										
30										
35										
40										

Nominal I.D. of Drive Pipe	2½" XXX
Nominal I.D. of Split Barrel Sampler	1½"
Weight of hammer on Drive Pipe	300 lbs.
Weight of hammer on Split Barrel Sampler	140 lbs.
Drop of hammer on Drive Pipe	24"
Drop of hammer on Split Barrel Sampler	30"

Core Dia. ______

Soil descriptions represent a field identification after D.M. Burmister unless otherwise noted.

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State if he finds that the actual conditions do not conform to those indicated by this log.

New Jersey Department of Transportation

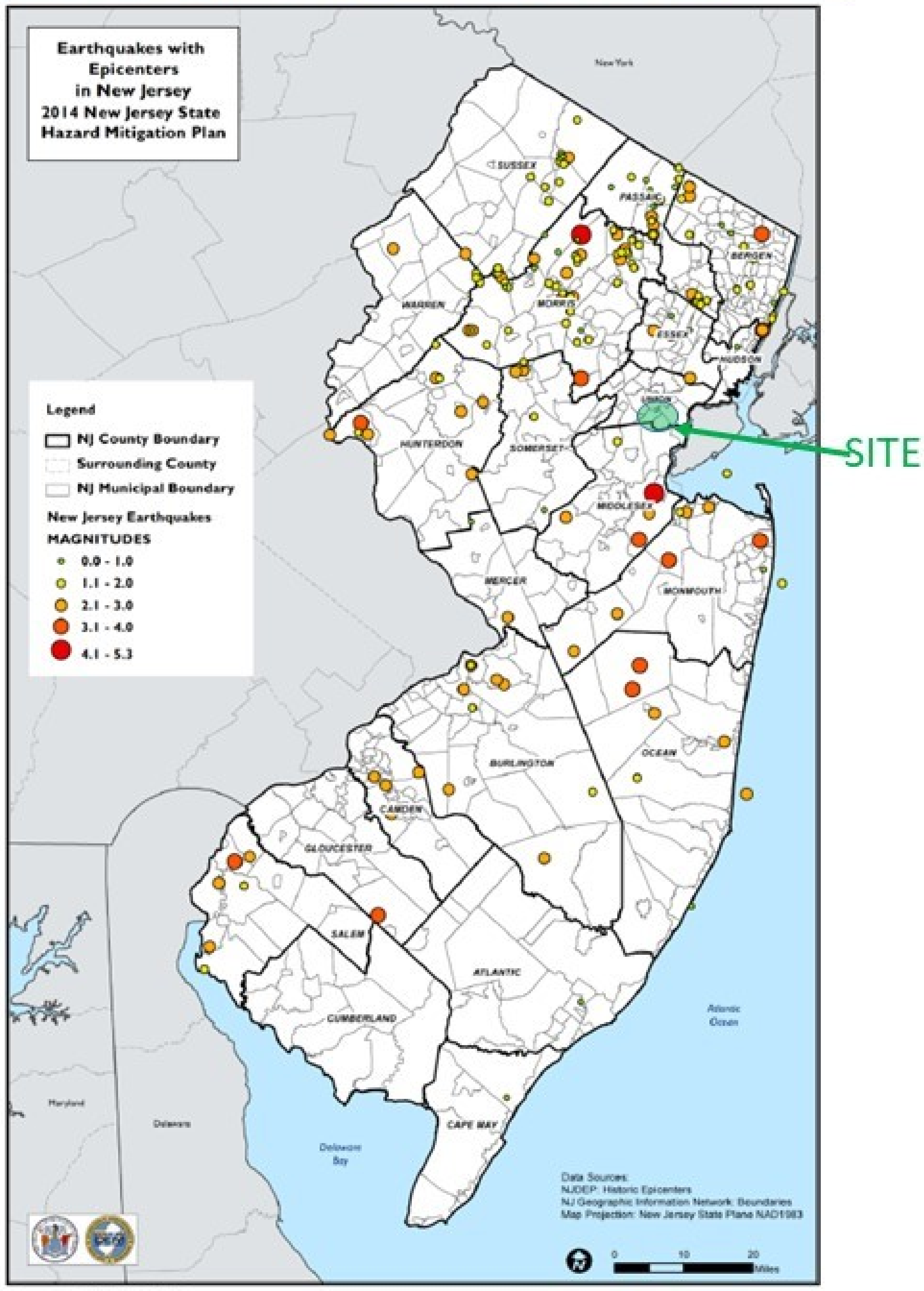
Bureau of Geotechnical Engineering

Approximate Change in Strata ______

Inferred Change in Strata - - - - - -

Figure 12B – NJDOT Soil Boring Log from NJTP Project

Figure 5.5-11. Earthquakes with Epicenters in New Jersey, 1783 to 2012



Source: NJDEP 2012

Figure 13 – Earthquakes with Epicenters in NJ

Damaging Earthquakes Felt in New Jersey

Location	Year	Magnitude[1]	Intensity[2] Max. / in NJ	Comments
New York City	1737		VII / VII	Chimneys down in New York City. Felt in Boston, Massachusetts and Philadelphia, Pennsylvania.
Cape Ann, Massachusetts .	1755	6.0	VIII / IV	Chimneys and brick buildings down in Boston. Its tsunami grounded boats in the West Indies
West of New York City	1783		VII / VII	Felt from New Hampshire to Pennsylvania.
New Madrid, Missouri	1811-1812	8.0-8.8	XII / IV-V	Four great earthquakes. Changed course of Mississippi River. Town of New Madrid destroyed. Loss of life low due to sparse settlement. Damage in Chicago.
New York City	1884	5.5	VII / VII	Toppled chimneys in New York City and New Jersey. Cracked masonry from Hartford, Connecticut to West Chester, Pennsylvania. Felt from Maine to Virginia, and eastern Ohio.
Charleston, South Carolina	1886	7.7	X / IV	Sixty killed. Over 10,000 chimneys down.
New Jersey Coast	1927		VII / VII	Several chimneys down from Asbury Park to Long Branch.

1 Richter Scale
2 Modified Mercalli Scale

Figure 14 – Damaging Earthquakes Felt in NJ

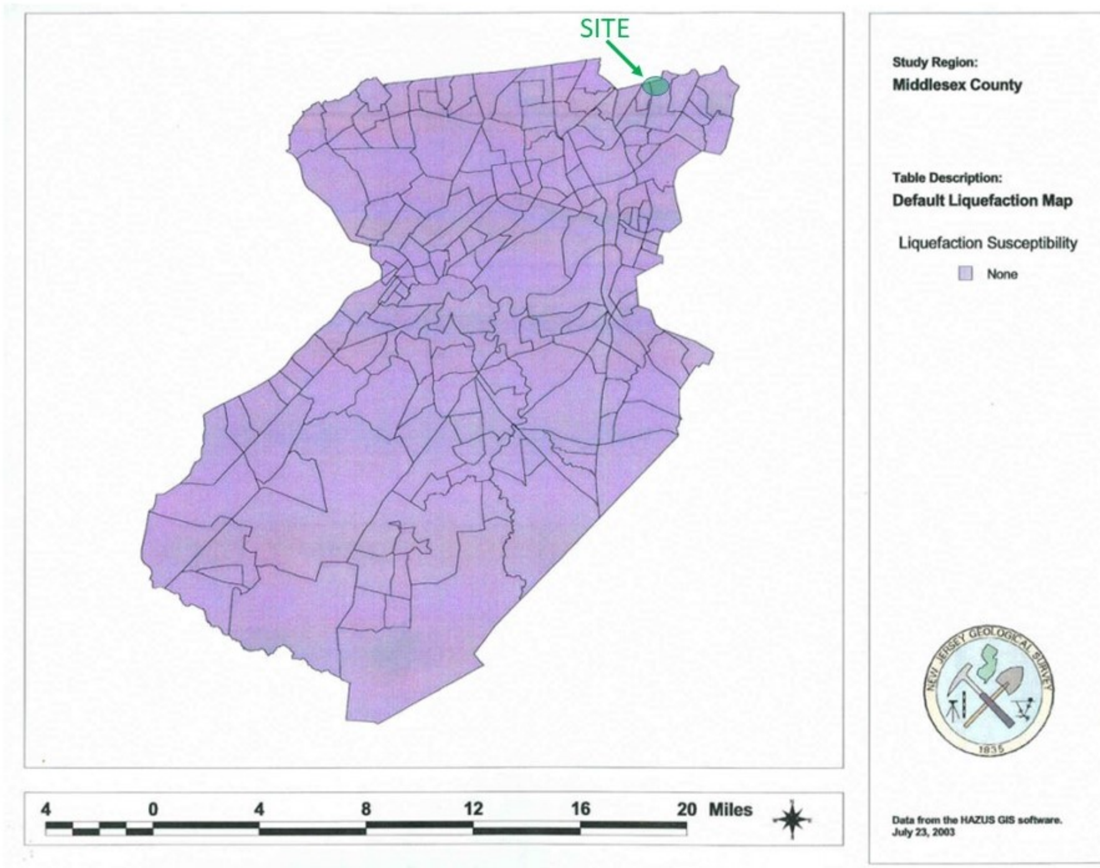


Figure 15 – Liquefaction Susceptibility of Soils in Middlesex County

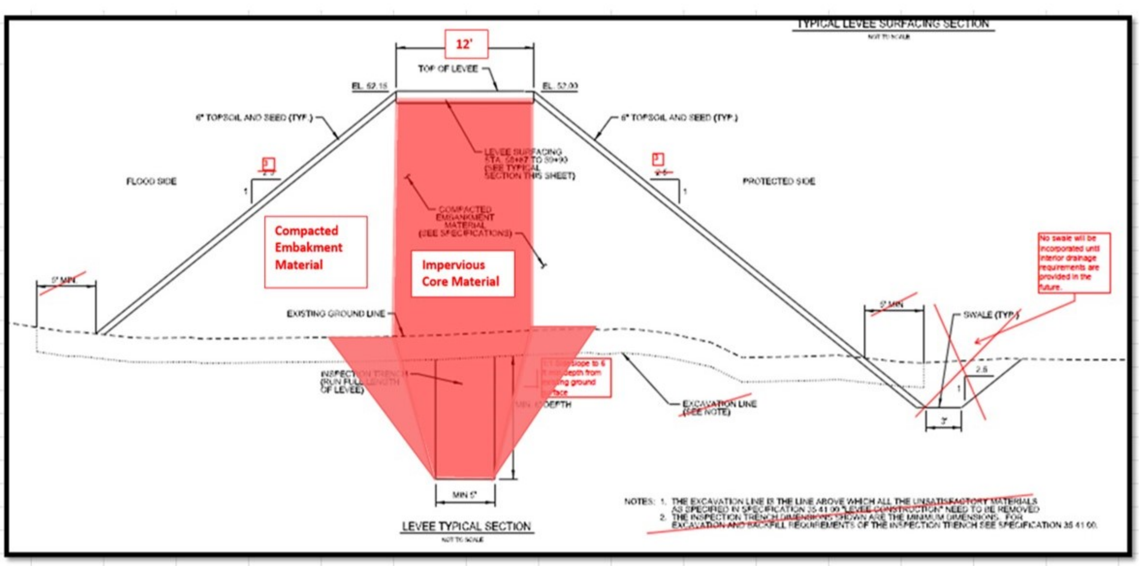


Figure 16 – Proposed Levee Cross Section