Soil Survey of

GATEWAY NATIONAL RECREATION AREA, NEW YORK AND NEW JERSEY

A collaborative project of:

U.S. Dept. of Agriculture, Natural Resources Conservation Service
U.S. Dept. of Interior, National Park Service, Gateway National Recreation Area
In partnership with
Cornell University Agricultural Experiment Station
New York City Soil and Water Conservation District

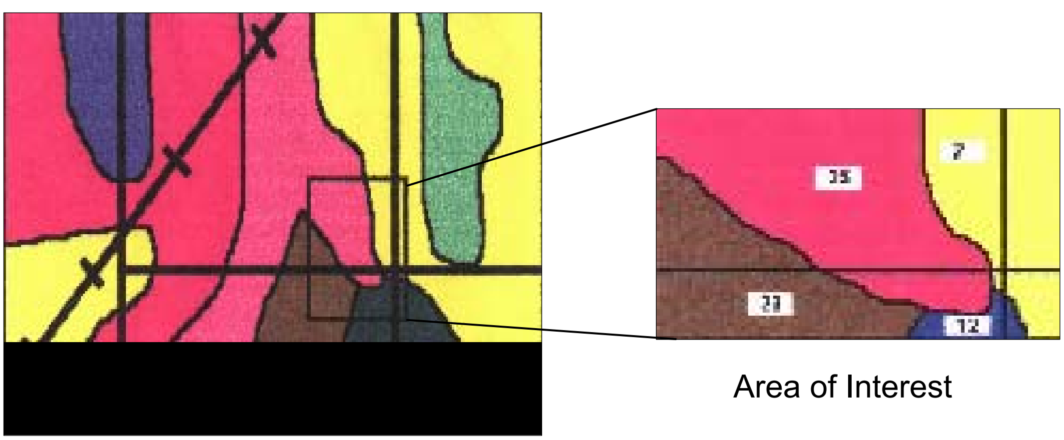
How To Use This Soil Survey

- Begin at the ***Table of Contents*** on ***page iii*** to find the list of sections in this survey. The survey is divided into two main parts: the general soil and urban environment information is located in the ***Description of Soil Survey Area*** section, and more detailed information about the soils can be found in the ***Detailed Soil Information*** section.

- To find a soil map of your area of interest, locate that area using the soil map index (jpeg photo), included in the disk with this survey. This index will allow you to locate the corresponding soil map photo for your area of interest. The soil map photos consist of soil map unit symbols for the Gateway National Recreation Area (GNRA) over an aerial photographic background. The GNRA Sandy Hook Unit soil maps were created using New Jersey Monmouth County 1997 - Orthophotography Universal Transverse Mercator Coordinate System (UTM) Zone 18N Zone North American Datum (NAD) 83 Orthophotography. The GNRA Staten Island and Jamaica Bay Wildlife Refuge Unit soil maps were created using New York City Department of Environmental Protection- New York City Landbase DoITT 1996- New York State Plane Coordinate System- Long Island NAD 83 Orthophotography.

- Once you have located your area of interest on the soil map, note the map unit symbol and any special symbols that are in that delineation. Turn to the soil map legend on ***page iv*** to find the map unit symbol and the map unit name and then turn to the corresponding page number in the ***Soil Map Unit Description*** section to get detailed information about the soil uses and soil properties.

- Conventional and special symbols found on the soil survey map are identified on the ***Conventional and Special Symbols Legend*** on ***page ix.***



Area of Interest

Map Sheet

Soil Surveys Can Help You

Soil surveys indicate the suitability and the limitations of areas for buildings, roads, runways, pipelines and other civil infrastructure, as well as recreational uses and wildlife habitat. Soil surveys are also used to plan soil and water conservation measures. Soils can be shallow to bedrock, seasonally wet, or subject to flooding, making them poorly suited for basements or underground installations. Organic and fill soils may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited for athletic fields and other recreational facilities.

Soil variability is a function of the soil forming factors: climate, organisms, relief, parent material, and time. A soil / landscape ‘model’ is used to predict soil patterns. However, the effects of human activities on soils in urban areas can be very complex, and often result in a highly variable soil distribution. Land use history becomes important when mapping soils in an urban environment.

This soil survey describes the properties of soils in the area and shows the locations of each soil on detailed maps. Among the important soil properties described in the soil survey are soil drainage class, permeability, depth to seasonal water table, flooding hazard, depth to bedrock, erodibility, acidity and alkalinity, slope, soil texture, and soil structure. Soil related problems can be anticipated and prevented through the use of soil surveys.

Soil data helps in planning, management, and conservation, and can be used in appraising the productive capacity, the environmental functions, and the value of the land. It can also help in identifying specific conservation problems in a given area, and in planning measures to reduce erosion, sedimentation, subsidence, slippage, wetness, runoff, and other hazards. Soil properties are a major consideration in selecting and planting trees, shrubs, and grasses for restoration and erosion control. Soil surveys describe soil properties that affect the growth and sustainability of such plants. Soil maps can help in planning the layout and maintenance of parks, wildlife areas, and other recreation facilities.

This soil survey will be integrated into the National Park Service information system for use in several ways. It will be utilized as a base layer in the Geographic Information System (GIS) database at Gateway. Because of the large mapping scale (1:4800), the soil survey will be a critical factor in many types of resource analysis, including: 1) Monitoring changes in the salt marsh over time; 2) Wildlife habitat mapping and analysis; 3) Identification of erosional and depositional processes, particularly related to salt marsh changes; 4) Site selection for vegetation restoration areas; 5) Identification of historic sites; 6) Site suitability analyses for cultural resource management; 7) Planning for visitor use facilities, including interpretive and recreational sites. Gateway’s staff will utilize the soils information in applications ranging from inventory monitoring of salt marshes and other natural and cultural resources, to long term planning decisions. The wide ranging utility of the soils information for the park is due to the quality of the data and the comprehensive information available in the NRCS soils database.

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This soil survey is a product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture -Natural Resources Conservation Service (formerly the Soil Conservation Service) and other federal, state, and local agencies.

Major fieldwork for this soil survey was completed in 1999. Soil names and descriptions were approved in 2001. Unless otherwise indicated, statements in this publication refer to conditions in Gateway National Recreation Area in 2001. This survey was made cooperatively by the United States Department of Agriculture-Natural Resources Conservation Service, the United States Department of Interior-National Park Service-Gateway National Recreation Area-Division of Natural Resources, the NYC Soil and Water Conservation District, and the Cornell University Agricultural Experimental Station.

This project was completed under NPS Agreement 1443-IA4520-96-001 and NRCS Agreement A-2C31-6-221.

Front Cover: Gateway National Recreation Area (GNRA) is located within the New York City metropolitan area. Soils of GNRA have an important role and function in the urban ecosystem. This picture in Jamaica Bay presents the interaction of five components of this ecosystem: soil, water, air, wildlife and humans (courtesy of Don Riepe, NPS).

Preface

Soil, air, water and nutrients are the fundamental non-living components of an ecosystem. The sun's energy drives the physical and chemical processes. The result is an abiotic environment that is favorable to supporting life, from the simplest of organisms to the most complex plants and animals.

The varied soils in the New York City metropolitan area are derived from a complex geology and topography, acted upon by climate, oceanic forces, and biotic and human interventions. In this coastal setting, the Gateway National Recreation Area was defined to include most of Jamaica Bay, portions of the Rockaway Peninsula and Staten Island in New York State, and all of Sandy Hook in New Jersey.

Gateway National Recreation Area was established in 1972, the nation's first urban national park, to preserve and protect natural and cultural resources of national significance, and to provide recreational opportunities. Within the national park, the Division of Natural Resources is responsible for inventorying and monitoring the flora, fauna, and other aspects of the environment. The Division of Natural Resources also defines, plans, and coordinates the implementation of all natural resources management and restoration needs.

This soil survey furnishes baseline data that will assist Gateway in managing its natural resources more efficiently. For example, maintaining vegetative communities is vital to sustaining the kind of environment that park-goers expect when visiting a national park facility. Soils are differentiated and characterized with respect to natural fertility, wetness, and a number of other parameters that contribute to plant growth, and determine adaptable species or species that are otherwise important to management. Another important natural resource concern is the restoration of indigenous plants vis-a-vis invasive species (about one-third to one-half of the recreation area's plants are alien). This costly enterprise is made much more efficient when plants are introduced to areas that have suitable soils, a prospect that is only made possible with accurate soil survey information. Additionally, soil survey data is important for the maintenance of buildings and roads and their construction, the development and maintenance of high use areas for foot traffic, predicting and managing storm water runoff, the location and conservation of cultural resources, and virtually every other aspect of natural resource management.

The park-wide soil survey will also provide an essential data layer for the Geographic Information System (GIS) database at Gateway National Recreation Area. GIS is a powerful spatial analysis tool that will integrate soil data with other natural resource data layers yielding information at relevant scales for decision makers at regional to national levels.

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Acknowledgments

This soil survey publication is a result of joint efforts by the United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) and United States Department of Interior (USDI) - National Park Service in partnership with The New York City Soil and Water Conservation District and Cornell University Agriculture Experiment Station. It is a culmination of a four year effort under the USDI - National Park Service Cooperative Agreement 1443-IA4520-96-001 and the USDA - Natural Resources Conservation Service Cooperative Agreement A-2C31-6-221.

Agencies and universities that were instrumental in this project include:

- USDI - National Park Service - Gateway National Recreation Area - Division of Natural Resources
- Cornell University
- University of Rhode Island
- Freehold Soil and Water Conservation District
- Columbia University, Lamont-Doherty Earth Observatory
- New York City Department of Parks and Recreation
- New York City Soil and Water Conservation District
- USDA - NRCS - National Soil Survey Center (Lincoln, NE)
- USDA - Natural Resources Conservation Service (NJ and NY)

We wish to thank volunteers for their assistance during field mapping: Paul Califano, Michael A. Infanti, Karen L. Johnson, Meredith A. Stelling - Freehold (NJ) Soil Conservation District; Kaled Alamarie - New York City Soil and Water Conservation District; and Samuel Camacho, David Diaz, Richard Kruzansky - USDA - NRCS Earth Team.

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We also wish to thank Niger Shaw and Dr. John T. Tanacredi, USDI – NPS, and Tyrone Goddard, USDA – NRCS, for coordinating this effort.

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Contents

Soil Map Legend - Numerical

Map Unit Symbol	Map Unit Name	Map Unit Description Page #
14	Beaches	81
14x	Beaches, rubbly	82
16	Bigapple coarse sand, 0 to 3 percent slopes	82
18	Bigapple coarse sand, 3 to 8 percent slopes	84
20	Bigapple coarse sand, 8 to 15 percent slopes	84
24	Bigapple coarse sand, 25 to 35 percent slopes	85
26	Bigapple sandy loam, 0 to 3 percent slopes, compacted surface	86
26x	Bigapple sandy loam, 0 to 3 percent slopes	86
28	Bigapple sandy loam, 3 to 8 percent slopes, compacted surface	87
45	Bigapple-Verrazano sandy loams, 3 to 8 percent slopes	90
47	Bigapple-Verrazano-Pavement & buildings complex, 0 to 5 percent slopes	91
49x	Bigapple coarse sand, 15 to 35 percent slopes, cemented substratum	84
64	Centralpark gravelly sandy loam, 0 to 3 percent slopes, compacted surface	100
70	Cheshire loam, 0 to 3 percent slopes	102
72	Cheshire loam, 3 to 8 percent slopes	103
74	Cheshire loam, 8 to 15 percent slopes	103
95x	Pavement & buildings-Breeze complex, 0 to 5 percent slopes	134
104	Foresthills loam, 0 to 3 percent slopes, compacted surface	107
106	Foresthills loam, 3 to 8 percent slopes, compacted surface	108
108	Fortress sand, 0 to 3 percent slopes	109
108xx	Fortress sandy loam, 0 to 3 percent slopes	111
110	Fortress sand, 3 to 8 percent slopes	110
111	Fortress-Pavement & buildings-Shea complex, 0 to 5 percent slopes	111
112	Water, fresh	147
114	Bulkhead fibric, 0 to 3 percent slopes	98
114x	Bulkhead-Pavement & buildings complex, 0 to 3 percent slopes	99
123x	Gravesend and Oldmill coarse sands, 0 to 8 percent slopes	112
124	Greatkills sandy loam, 0 to 3 percent slopes	114
136	Greenbelt loam, 3 to 8 percent slopes,compacted surface	118
138	Greenbelt loam, 8 to 15 percent slopes, compacted surface	118
139	Greenbelt loam, 15 to 25 percent slopes	116
139a	Greenbelt-Pavement & buildings complex, 3 to 8 percent slopes, cemented substratum	119
139x	Greenbelt loam, 25 to 60 percent slopes	117
149	Branford loam, 0 to 3 percent slopes	92
149g	Branford extremely gravelly loam, 0 to 3 percent slopes	94
149x	Branford-Pavement & buildings complex, 0 to 5 percent slopes	95
149y	Branford loamy sand, 0 to 3 percent slopes	95
149yy	Branford loam, 0 to 3 percent slopes, compacted surface	93
150	Hooksan fine sand, 0 to 3 percent slopes	121
152	Hooksan fine sand, 3 to 8 percent slopes	123
154	Hooksan fine sand, 8 to 15 percent slopes	123
156	Hooksan fine sand, 15 to 25 percent slopes	124
160	Hooksan sandy loam, 0 to 3 percent slopes, compacted surface	124
171	Hooksan-Verrazano-Pavement & buildings complex, 0 to 5 percent slopes	126
186	Ipswich mucky peat, tidal, frequently flooded	128
188	Ipswich mucky peat, tide flooded	130
196	Sandyhook mucky fine sandy loam, tidal, frequently flooded	140
198	Jamaica sand, frequently ponded	130
209g	Greatkills extremely gravelly sandy loam, 0 to 3 percent slopes	115

Soil Map Legend - Numerical (continued)

Map Unit Symbol	Map Unit Name	Map Unit Description Page #
216	Matunuck mucky peat, tidal, frequently flooded	132
218	Matunuck mucky peat, tide flooded	133
220	Mud flat, tide flooded	133
223	Pavement & buildings, 0 to 5 percent slopes, sandy substratum	133
223x	Centralpark-Pavement & buildings-Shea complex, 0 to 5 percent slopes	101
225	Pavement & buildings, 0 to 5 percent slopes, till substratum	134
227	Pavement & buildings, 0 to 5 percent slopes, wet substratum	134
231	Pavement & buildings-Bigapple-Verrazano complex, 0 to 5 percent slopes	134
234	Pavement & buildings-Greenbelt complex, 0 to 5 percent slopes	134
235	Pavement & buildings-Hooksan-Verrazano complex, 0 to 5 percent slopes	136
239a	Pavement & buildings-Foresthills-Canarsie complex, 0 to 5 percent slopes	135
242	Pawcatuck mucky peat, tide flooded	139
253	Pompton loam, 0 to 3 percent slopes	139
258	Rikers gravelly coarse sand, 0 to 3 percent slopes	139
268	Water, salt	147
270	Verrazano sandy loam, 0 to 3 percent slopes	143
272	Verrazano sandy loam, 0 to 3 percent slopes, compacted surface	145
277	Verrazano-Hooksan complex, 0 to 3 percent slopes	146
292	Wethersfield sandy loam, 3 to 8 percent slopes	147
294	Wethersfield sandy loam, 8 to 15 percent slopes	148
306	Wethersfield sandy loam, 15 to 25 percent slopes, compacted surface	149
313	Hooksan-Dune land complex, 0 to 3 percent slopes	125
314	Pavement & buildings-Shea complex, 0 to 5 percent slopes, sandy substratum	137
315	Hooksan-Dune land complex, 3 to 8 percent slopes	126
316	Barren sand, 0 to 3 percent slopes	79
316x	Barren sandy loam, 0 to 3 percent slope	80
317	Hooksan-Dune land complex, 8 to 15 percent slopes	126
319	Hooksan-Dune land complex, 15 to 25 percent slopes	126
323	Bigapple-Blown-out land complex, 0 to 3 percent slopes	88
325	Bigapple-Blown-out land complex, 3 to 8 percent slopes	89
329	Bigapple-Blown-out land complex, 15 to 25 percent slopes	89
342	Bigapple gravelly coarse sand, 0 to 3 percent slopes, refuse surface	85
344	Fortress gravelly sand, 0 to 3 percent slopes, refuse surface	110
346	Verrazano gravelly sandy loam, 0 to 3 percent slopes, refuse surface	146
348	Jamaica gravelly sand, frequently ponded, refuse surface	131
350	Barren gravelly sand, 0 to 3 percent slopes, refuse surface	80
352	Shea sandy loam, 0 to 3 percent slopes	142
356	Hooksan gravelly fine sand, 0 to 3 percent slopes, refuse surface	124
358	Breeze loamy sand, 0 to 3 percent slopes	95
360	Breeze loamy sand, 3 to 8 percent slopes	97
360x	Breeze loamy sand, 3 to 8 percent slopes, wet substratum	97
362	Breeze loamy sand, 8 to 15 percent slopes	97
390	Blown-out land	91
400	Bulkhead fibric, 0 to 3 percent slopes, very shallow	99
502	Hassock sandy loam, 0 to 3 percent slopes	120
504	Winhole sandy loam, 0 to 3 percent slope	149
506	Flatland sandy loam, 0 to 3 percent slopes	105
508	Fishkill sandy loam, 0 to 3 percent slopes	104
514	Inwood gravelly sandy loam, 8 to 15 percent slopes	127

Soil Map Legend - Alphabetical

Soil Map Legend – Alphabetical (continued)

Soil Map Legend - Alphabetical (continued)

Map Unit Symbol	Map Unit Name	Map Unit Description Page #
223	Pavement & buildings, 0 to 5 percent slopes, sandy substratum	133
225	Pavement & buildings, 0 to 5 percent slopes, till substratum	134
227	Pavement & buildings, 0 to 5 percent slopes, wet substratum	134
231	Pavement & buildings-Bigapple-Verrazano complex, 0 to 5 percent slopes	134
95x	Pavement & buildings-Breeze complex, 0 to 5 percent slopes	134
239a	Pavement & buildings-Foresthills-Canarsie complex, 0 to 5 percent slopes	135
234	Pavement & buildings-Greenbelt complex, 0 to 5 percent slopes	134
235	Pavement & buildings-Hooksan-Verrazano complex, 0 to 5 percent slopes	136
314	Pavement & buildings-Shea complex, 0 to 5 percent slopes, sandy substratum	137
242	Pawcatuck mucky peat, tide flooded	137
253	Pompton loam, 0 to 3 percent slopes	137
258	Rikers gravelly coarse sand, 0 to 3 percent slopes	139
196	Sandyhook mucky fine sandy loam, tidal, frequently flooded	140
352	Shea sandy loam, 0 to 3 percent slopes	142
346	Verrazano gravelly sandy loam, 0 to 3 percent slopes, refuse surface	146
270	Verrazano sandy loam, 0 to 3 percent slopes	143
272	Verrazano sandy loam, 0 to 3 percent slopes, compacted surface	145
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112	Water, fresh	147
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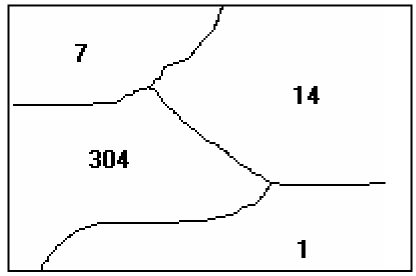
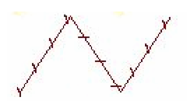
294	Wethersfield sandy loam, 8 to 15 percent slopes	148
306	Wethersfield sandy loam, 15 to 25 percent slopes, compacted surface	149
504	Winhole sandy loam, 0 to 3 percent slopes	149

Conventional and Special Symbols Legend

DESCRIPTION	SYMBOLS
SOIL DELINEATIONS AND LABELS	
DRAINAGE DITCH	
LEVEE	
JETTIES AND/OR SEAWALL	
SLOPE, SHORT STEEP	
PERENNIAL STREAM	
WET SPOT	

Summary of Figures and Tables

Summary of Figures and Tables (continued)

Summary of Figures and Tables (continued)

Foreword

The Natural Resources Conservation Service (NRCS) was born in the Dust Bowl days of the 1930's as the Soil Conservation Service (SCS). The agency has a long-standing tradition of providing quality service in protecting, maintaining, and enhancing our nation's natural resources. In 1994 the United States Department of Agriculture (USDA) removed NRCS from under the umbrella of farm agencies and placed it under the direction of the newly formed Under Secretary for Natural Resources and Environment with the Forest Service. This name change and realignment signaled a renewed interest in serving the urban communities, and more clearly described the agency's role in environmental protection and enhancement. The NRCS stands committed to government that works better and costs less - by cutting red tape, putting the client first, empowering employees to get results, and cutting back to basics. The agency is striving for a productive nation in harmony with a healthy land.

New York City was selected as a pilot project for both the agency's urban initiative and the Department of Agricultural Urban Initiative. Community leaders, non-profit organizations, city agencies, and elected officials identified local needs, issues and concerns for NRCS to address. NRCS partners overwhelmingly agreed that a comprehensive urban soil survey was needed in order to address the unique characteristics of urban soils as well as the specialized needs of urban customers.

The Gateway National Recreation Park Soil Survey is one of the first attempts made by NRCS scientists to map and provide detailed soil series information for human modified soils. The information published in this document will provide technical guidance for future land use and management decisions. It will also serve as a valuable data element for research projects in natural resources and an important environmental education tool. The non-traditional format and language are utilized to make the survey more user-friendly and helpful to both professionals and average citizens. Twenty two new soil series were developed as needed so users will have an accurate description of the soils in any location in comparison to the conventional soil surveys that only describe these areas as urban, Udorthents, human-made, or disturbed.

This partnership of NRCS with citizens, agencies, non-profits, and government representatives will continue to be the way the agency does business.

Joseph R. DelVecchio
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Introduction

The concept of urban national parks in the United States originated out of a grand experiment – an experiment out of necessity. Urban areas now claim the greater part of the American population. The impacts to natural and cultural resources in the urban ecosystem are symptomatic of the global deterioration of our resource base. Restoration, revitalization, and preservation of the remaining parcels of open space are no less important in urban areas. At a minimum, it will be here that we get the National Park Service message to the most people regarding a conservation ethic. This was, and still is, a monumental task.

In order to protect our parks' natural and cultural systems, first and foremost, we must begin to "know our resource." Inventorying and monitoring of flora and fauna, as well as abiotic components of ecosystems, are of the highest priority for natural resource managers in our national park units.

Systematic collection, sorting, recording, and identification of living organisms have been ongoing at Gateway for its relatively short twenty-five year history. Documentation of faunal populations in species listings is the first step in observing the level of biological diversity in the park. Herbarium reference specimens, coupled with a computerized plant species list, aid in determining habitat types and species composition. In both of these cases, however, it is important to characterize soil conditions as a critical element in the restoration efforts in those parts of the park impacted by development, human disturbance, or natural occurrences induced by anthropogenic activities.

It was found early on in the study of urban soils that the traditional view of the soil profile would need to be modified with the addition of "urban" classifications. When the USDA-NRCS suggested a park-wide soil survey in 1997, it was an opportune time to share our respective agencies' expertise to provide the type of data key to habitat preservation and our park-wide restoration efforts.

Soil Survey of Gateway National Recreation Area, New York and New Jersey

Luis A. Hernandez, Natural Resources Conservation Service

Soils surveyed by Mark Bramstedt, Steve Carlisle, Donald J. Fehrenbacher, Frederick Gilbert, Tyrone Goddard, Will Hanna, Luis A. Hernandez, Steve Seifried and Robert Tunstead, USDA-Natural Resources Conservation Service.

Soils sampled by Steve Carlisle, Luis A. Hernandez, Robert Tunstead and Steve Seifried, NRCS; John Galbraith and Patricia Gossett, Cornell University; Dean Dizcensa and Richard Kruzansky, New York City Department of Parks and Recreation; and Kaled Alamarie, New York City Soil & Water Conservation District.

Soils correlated by Steven W. Fischer and Luis A. Hernandez, NRCS.

Gateway National Recreation Area (GNRA) is located in New York and New Jersey (Figure 1). Its 25,300 acres are distributed in three New York City (NYC) counties (Kings, Queens and Richmond) and one New Jersey county (Monmouth). The park is divided into three management units: Jamaica Bay, Staten Island and Sandy Hook (Figure 1). It is the largest park in NYC and is administered by the United States Department of Interior-National Park Service.

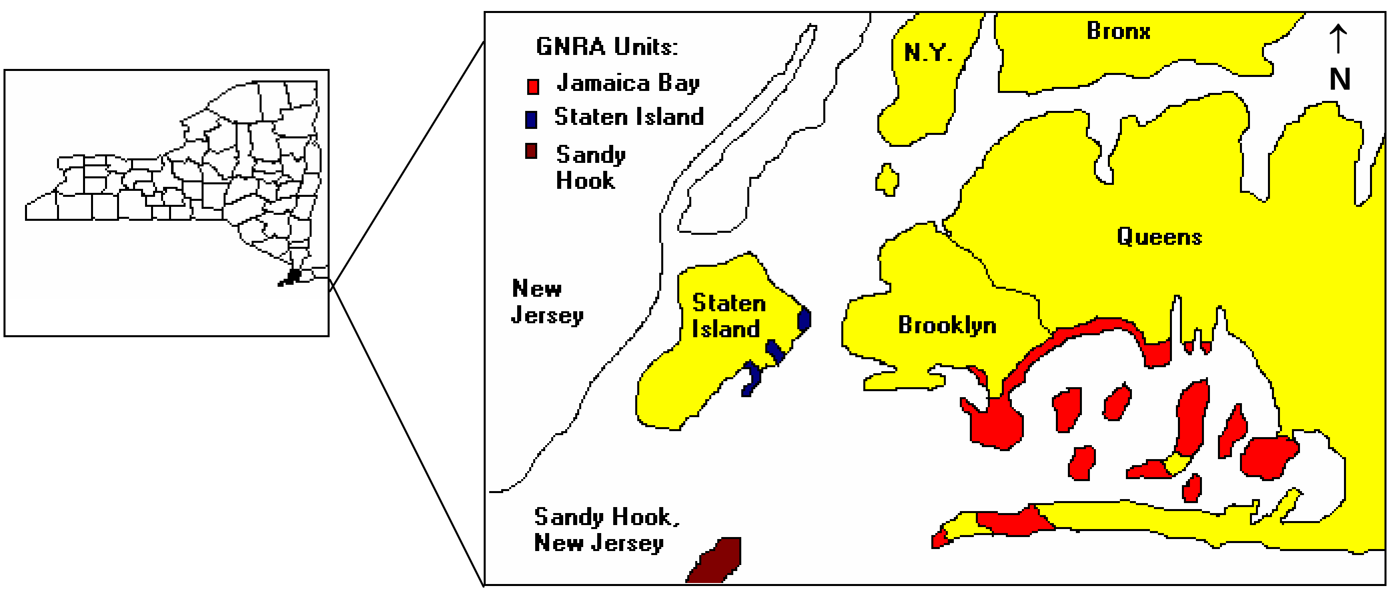

Figure 1. Location of the soil survey area.

Description of Soil Survey Area

This section gives general information about physiography and relief, climate, geology, land use history, vegetation, wildlife, hydrology, water infiltration and runoff, aquifers, groundwater flow, water quality, hydric soils, sedimentology of beaches and barrier island beaches, dynamics of beaches and barrier island beaches, and tidal marshes

Physiography and Relief

New York City, with a land area of 235,945 acres, is located on New York Bay at the mouth of the Hudson River. The terrain is surrounded by numerous waterways, and four of the five boroughs in the city are situated on islands. Extensive suburban areas border the city on the north, east, and west. New York City includes parts of three physiographic units: the New England Upland on the north and northwest, the Triassic Lowland on the southwest, and the Atlantic Coastal Plain along the southeast. Gateway National Recreation Area (GNRA) consists of about 5,350 acres of land in the Jamaica Bay Unit, 950 acres of land in the Staten Island Unit, and 2000 acres of land in the Sandy Hook Unit. All of the GNRA, including the Sandy Hook section in New Jersey, is generally considered to be part of the Atlantic Coastal Plain province. However, the Coastal Plain section of New York City was glaciated, while the Sandy Hook area and the rest of the Atlantic Coastal Plain to the south were not. Most of the park's landscapes are characterized by relatively flat to slightly undulating topography, with elevations ranging from sea level to less than 50 feet. The Fort Wadsworth section in northeastern Staten Island exhibits more striking relief, with steep bluffs and rolling hills, and elevations ranging from 150 feet to sea level.

Climate

The GNRA area is close to the path of most storm and frontal systems that move across the North American continent. Therefore, weather conditions affecting the GNRA most often approach from a westerly direction. GNRA experiences higher temperatures in summer and lower ones in winter than would otherwise be expected in a coastal area. However, the frequent passage of weather systems often helps reduce the length of both warm and cold spells, and is also a major factor in keeping periods of prolonged air stagnation to a minimum.

Although continental influence predominates, the oceanic influence is not absent. During the summer, local sea breezes blowing onshore from the cool water surface often moderate the afternoon heat. The effect of the sea breeze diminishes inland. On winter mornings, ocean temperatures are relatively warm compared to the land. This reinforces the city heat island effect, resulting in temperatures 10 to 20 degrees Fahrenheit higher in the central city as compared to the inland suburbs. The relatively warm water temperatures also delay the advent of winter snows. Conversely, the lag in warming of water temperatures keeps spring temperatures relatively cool. Ocean influenced areas experience smaller changes in daily and yearly temperatures.

The average temperatures are below freezing in December, January, and February (Figure 2). Summer weather is generally warm to hot, and the high humidity makes conditions uncomfortable. The average temperatures are above 70°F in June, July, and August. Based on the 1951 to 1980 period, the average first occurrence of 32°F in the fall is November 11 and the average last occurrence in the spring is April 1, resulting in an average freeze-free growing season of 207 days.

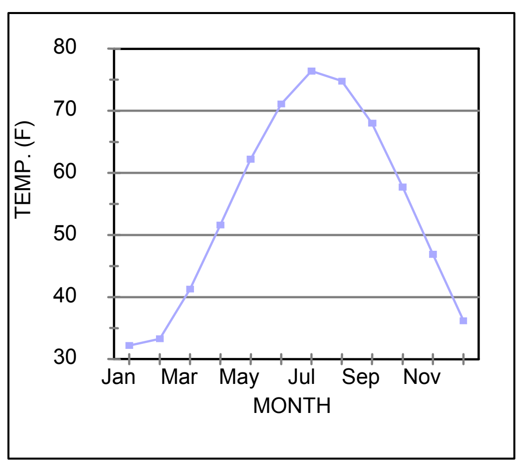

Figure 2. Average temperature (°F) by month during the past 87 years in Central Park, Manhattan (National Weather Center).

Precipitation is moderate and distributed fairly evenly throughout the year (Figure 3). Most of the rainfall from May through October comes from thunderstorms, usually of brief duration and sometimes intense. Heavy rains of long duration associated with tropical storms occur infrequently in late summer or fall. For the other months of the year precipitation is more likely to be associated with widespread storm areas, so that daylong rain, snow or a mixture of both is more common. Coastal storms, occurring most often in the fall and winter months, produce on occasion considerable amounts of precipitation and have been responsible for record rains, snows, and high winds.

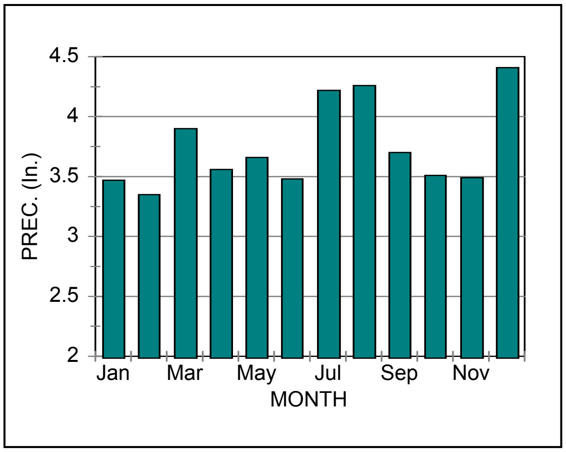

Figure 3. Average precipitation (in.) by month during the past 87 years in Central Park Manhattan (National Weather Center).

The average annual precipitation is reasonably uniform within the city but is higher in the northern and western suburbs and less on eastern Long Island. Annual snowfall totals also show a consistent increase to the north and west of the city with lesser amounts along the south shores and the eastern end of Long Island, reflecting the influence of the ocean waters. The average rainfall is 47 inches; the average snowfall is 29 inches.

The average annual temperature in the NYC metropolitan region has increased nearly 2^{o}F since 1900, and the rate and amount of temperature rise is projected to increase over the next 100 years due to anthropogenic, or human induced effects. According to global climate models cited by Rosenzweig and Solecki (2001), annual temperatures in the 2080's will increase from 4.4 to 10.2^{o}F. The authors also noted that there is a "substantial potential" that this increase in temperature will be accompanied by increases in extreme climatic events such as floods and droughts.

Geology and Parent Material

New York City's complex geology includes layers of crystalline bedrock, sedimentary rocks with associated igneous intrusives, coastal plain strata, glacial deposits from several episodes, and scattered postglacial materials. In many places these are topped off with miscellaneous human deposited, or "anthropogenic," materials, better known as fill.

The crystalline basement rocks, known as the Manhattan Prong of the New England Upland physiographic province, consist predominantly of gneiss, schist, and marble from the Precambrian and early Paleozoic (Table 1). The original sedimentary and igneous rocks were folded, faulted, and, in some places, melted and recrystallized during several cycles of mountain building. Bedrock exposures are common in Manhattan and the Bronx, but for the most part these rocks are buried beneath younger deposits in the rest of the city. Serpentinite, a greenish, metamorphosed, ultramafic (magnesium and iron rich) crystalline rock

Table 1. Geologic Time Scale

Era	Period	Epoch	Time (Million Years Ago)
Cenozoic	Quaternary	Holocene	Present to 0.01
		Pleistocene	0.01 to 1.6
	Tertiary		1.6 to 65
Mesozoic	Cretaceous		65 to ~130
	Jurassic		130 to 208
	Triassic		208 to 245
Paleozoic			245 to 544
Precambrian			544 to 4400

forms the backbone and the highest point in Staten Island. Triassic and Jurassic sedimentary rocks of the Newark Group unconformably overlie the basement rocks in the northwestern part of Staten Island. These are red beds of sandstone, siltstone and shale, a wedge of continental sediments deposited in a fault bound basin. Softer and more erodible than the crystalline rocks, outcrops of these strata are rare, but the materials are an important component of the glacial deposits in Staten Island. The red beds are intruded with a band of coarse-grained Palisades Diabase, an igneous rock which is much better exposed along the west bank of the Hudson in northern New Jersey. Similarly, diabase fragments are commonly found in glacial deposits in Staten Island, as well as Manhattan.

Coastal plain materials in New York City consist of unconsolidated deposits of Late Cretaceous age, eroded from the uplifted New England Upland to the west, and deposited in low-lying coastal areas. Both the Raritan Formation, with the basal Lloyd Sand and an overlying clay member, and the Magothy Formation are often interpreted as shallow water delta deposits (Figure 4). These formations contain gray sand and gravel mixed with layers of red, white, and black silt and clay, and it is often difficult to differentiate the two. Mineralogically, both of these coastal plain sediments are characterized by a relatively high degree of weathering. In Staten Island these deposits extend from Fort Wadsworth southwestward into New Jersey, overlying the Triassic strata. In Long Island, these materials sit atop the eroded crystalline rock surface. Several upper marine beds, the Matawan and Monmouth Groups, have additionally been identified in Long Island from deep borings. In most of Staten Island and Long Island, however, the Cretaceous materials lie beneath younger glacial deposits.

Most of New York City is blanketed by deposits from the Pleistocene, the ice age that began around 1.6 million years ago. These unconsolidated materials were left behind after several advances and retreats of the ice sheets in the northern hemisphere. Glacial deposits are commonly divided into two types: till and stratified sediments, or outwash. Glacial till refers to those materials deposited directly by the flowing ice. As till characteristically exhibits a wide range in particle size, from clay to boulder, it is described as unsorted. Till deposits also lack stratification, or layering, and can be as much as several hundred feet deep. These deposits are shallower in areas where the ice has done more scraping of the bedrock, commonly with harder, more resistant types of rock. Till can be subdivided into lodgement or basal till, and ablation till. The former describes the relatively dense material carried beneath the ice, and the latter is the looser material originating from either atop or within the ice, which drops down upon melting.

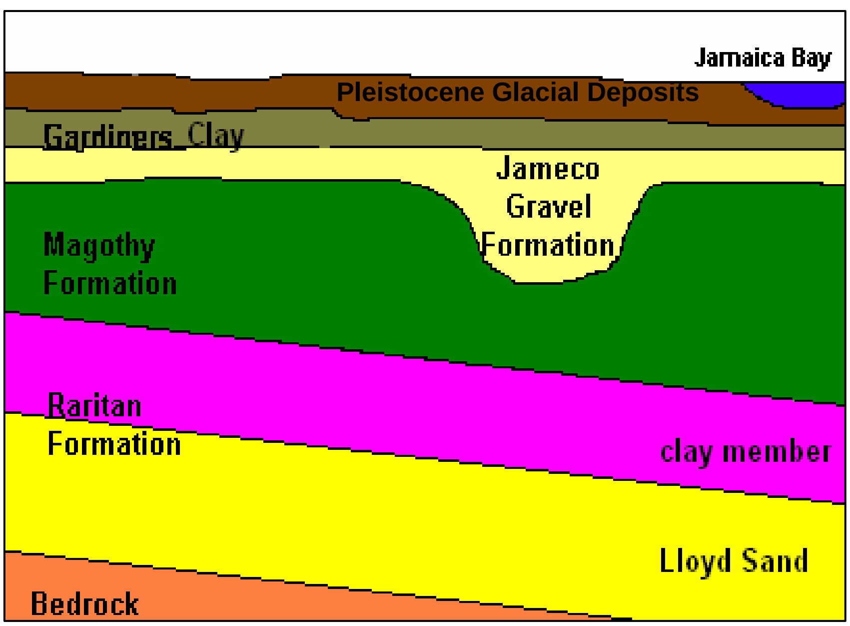

Figure 4. Long Island Stratigraphy

Glacial outwash is deposited by glacial meltwater. Outwash deposits are characterized by a narrower range of particle size, related to the energy of the depositional environment, from a fast moving stream at one extreme, to the slow sedimentation in a glacial lake at the other. Stratification, or layering, is common in outwash deposits.

Glaciation of the metropolitan area has not only provided most of our surficial materials, but has shaped the landscape as well. In general till areas are more rolling and sloping than outwash areas, and are occasionally marked by bedrock outcrops. Stratified sediments were laid down in valleys and broad, gently sloping outwash plains. The southernmost extent of the ice sheet is marked by a ridge, or east-west trending band of rolling hills, called a terminal moraine, formed by the material dropped at the melting edge of the glacier. New York City has two such moraines, forming the spines of the two eastern forks of Long Island. The southernmost, and older of the two, is called the Ronkonkoma Moraine. The northernmost is the Harbor Hill, extending across Queens and Brooklyn over into Staten Island at Fort Wadsworth (Figure 5). The Harbor Hill Moraine overrides the Ronkonkoma in north central Long Island. Material in the terminal moraine ranges from unsorted till to local bodies of roughly stratified and sorted sand and gravel. South of the terminal moraine in Long Island and Staten Island, streams of glacial meltwater flowed south, creating a gently sloping outwash plain of stratified and sorted gravel, sand, and silt. Till deposits cover most of Staten Island, whereas Long Island is predominantly outwash.

During the Quaternary Period, four major glacial advances into the northern United States have been identified, from oldest to youngest, as the Nebraskan, Kansan, Illinoian, and Wisconsinan. Some of the oldest glacial material in New York City is the sandy outwash of the Jameco Gravel, generally considered to represent the Illinoian stage. Above the Jameco is the Gardiners Clay, possibly an interglacial deposit following the Illinoian (Figure 4). Many geologists believe the

Figure 5. The terminal moraine (yellow) marks the maximum extent of the ice sheet. Outwash plains (white) were formed by meltwater stream deposits. Organic deposits (black) formed 4,000 years ago in a lagoon protected by barrier beaches (orange) (courtesy of NYC-Department of General Services, Subsurface Exploration Section).

rest of the city's glacial deposits are Wisconsinan, and that the Ronkonkoma and Harbor Hill Moraines represent different ice positions during this stage. Other scientists (Fuller, 1914: Sanders and Merguerian, 1994) have interpreted an older age for the Ronkonkoma and have suggested a total of four glaciations in New York City.

The climate warmed approximately 11,000 years ago and the Holocene, or post-glacial epoch, began. The ice sheet retreated to its present location and sea level rose to its current elevation. Erosional forces have since modified the outwash plain to create the present day shoreline. Wave action has created barrier islands and sand spits like Sandy Hook. Offshore winds then piled up sand into dunes. Organic materials and tide-carried sediments have accumulated to form tidal marshes.

According to Rosenzweig and Solecki (2001), projected global warming rates may bring about a sea level rise from 9.5 to 42.5 inches by the 2080's, which would have a dramatic effect on low-lying coastal landscapes.

Glacial till and outwash and post-glacial deposits, including marine and alluvial sediments, windblown and organic materials as well as human deposited materials all serve as parent material for soil formation. Most soils in the upland areas of GNRA are formed in glacial deposits. The landforms at the higher elevations of Fort Wadsworth are part of the terminal moraine. The glacial till of the Staten Island Unit is a characteristic red (7.5YR or redder according to Munsell Color Chart) loamy material with many angular and subrounded rock fragments. Most of the stones and boulders are the black and white speckled Palisades Diabase which is quite resistant to weathering by water and ice. Gravel and cobble sized rock fragments include the green to brown Staten Island Serpentinite, and the red shale, siltstone, and sandstone of the Newark Group.

Different types of soils can result from different types of glacial till. Wethersfield soils, which form in dense basal till deposits (Figure 6), contain a firm compacted layer. Cheshire soils form in the looser ablation till deposits, which are not dense. These soils have a "friable" consistence and do not have a compacted layer. Wethersfield soils are commonly found on flatter areas and north-facing slopes, while Cheshire soils are more common on south-facing and more complex slopes (Figure 6).

Areas covered by glacial outwash south of the terminal moraine in Staten Island include Miller Field and Great Kills. On the gently sloping plains, Branford and Pompton soils are formed in a mantle of loamy material over a coarser substratum (Figure 6). Pockets of eolian (windblown) sediment, or "loess," can also be found blanketing the surface in some areas.

The soils of Breezy Point and Sandy Hook are formed in a mantle of eolian and marine washed sand. These landforms are highly dynamic and can change readily with each coastal storm. Some areas have also been affected by human activities such as hydraulic filling or dredging to control erosion from hurricanes and nor'easters, and to maintain depth in nearby shipping channels. Soils found on the eolian and marine deposits within these portions of the park include Hooksan and Jamaica (Figure 7). On less stable landscapes the miscellaneous land units, Dune land and Beaches, are common. Soils formed in dredge filled areas include Bigapple, Fortress, and Barren. Verrazano soils are found where loamy fill has been placed over sandy materials.

The Jamaica Bay unit contains the largest proportion of tidal marsh within the park. Most of this marsh consists of organic deposits underlain by glacial outwash. In some areas, considerable amount of organic materials have accumulated since the retreat of the glacier. Tidal marsh soils include Ipswich, Pawcatuck, Matunuck, and Sandyhook. Tidal marsh landscapes are naturally gently sloping and subject to tidal flooding. Some of the younger, thinner organic deposits within the Bay may be underlain with hydraulic dredge sediments instead of glacial outwash, or may be located in high energy (wave and wind action) areas.

Following the settlement of the New York area, humans have moved and deposited earth materials, garbage, construction debris, coal ash, and hydraulic dredge to form artificial landscapes such as landfills, roads and buildings, levees, and recreational fields. Soils forming in these human deposited materials, often called "anthropogenic soils," include Barren, Bigapple, Breeze, Bulkhead, Canarsie,

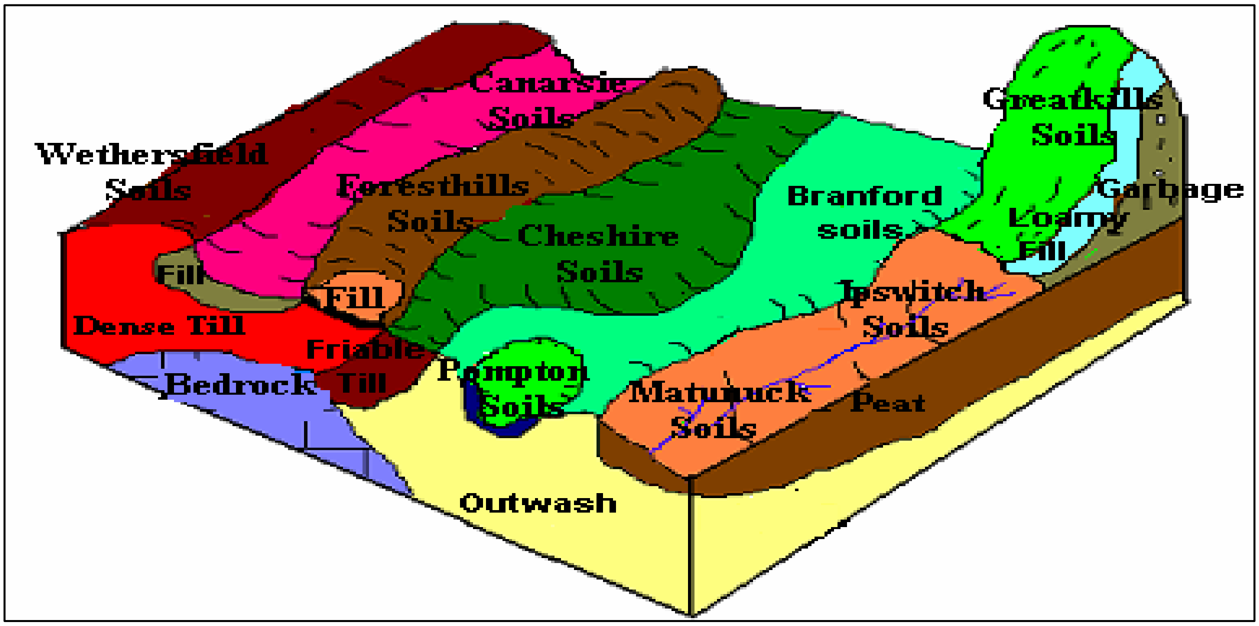

Figure 6. Pattern of soils developed in glacial till, glacial outwash, organic deposits and human made parent materials.

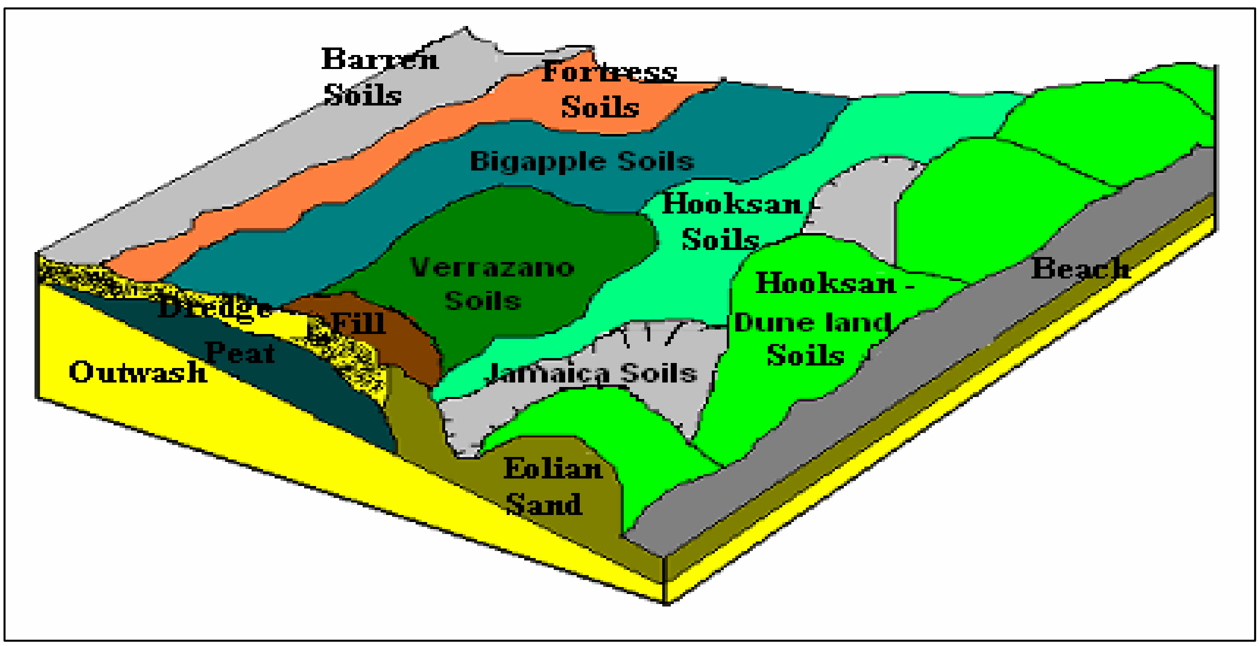

Figure 7. Pattern of soils developed in human made landscapes and eolian sediments.

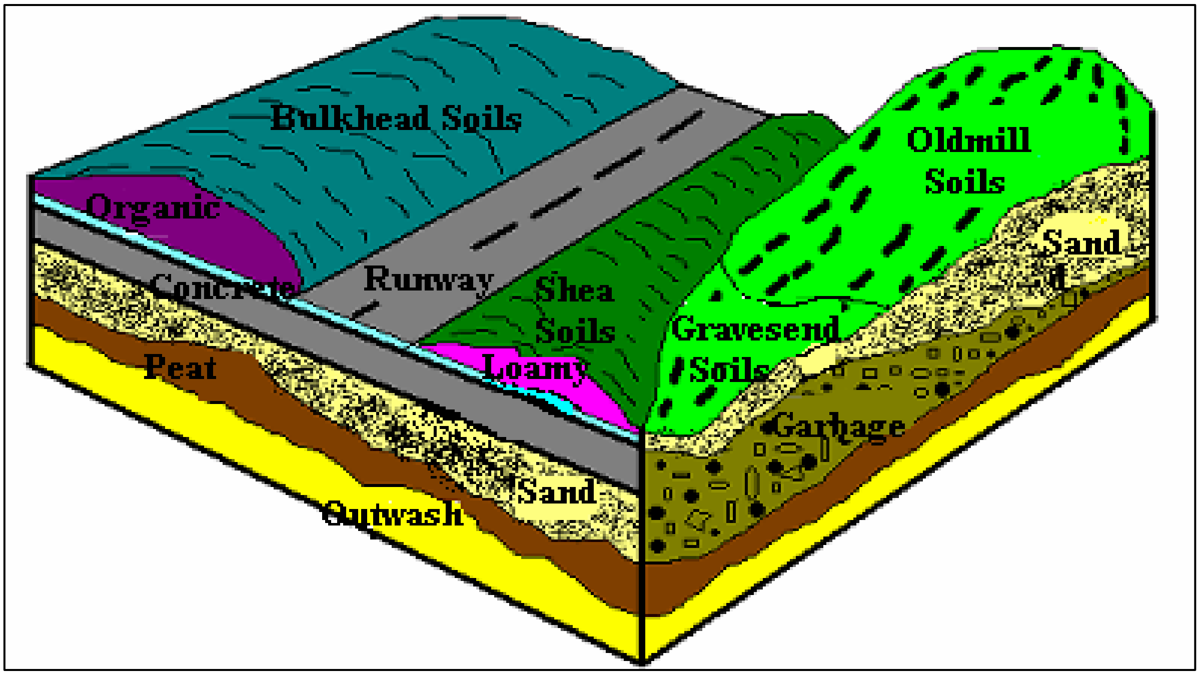

Figure 8. Pattern of soils developed in anthropogenic parent material

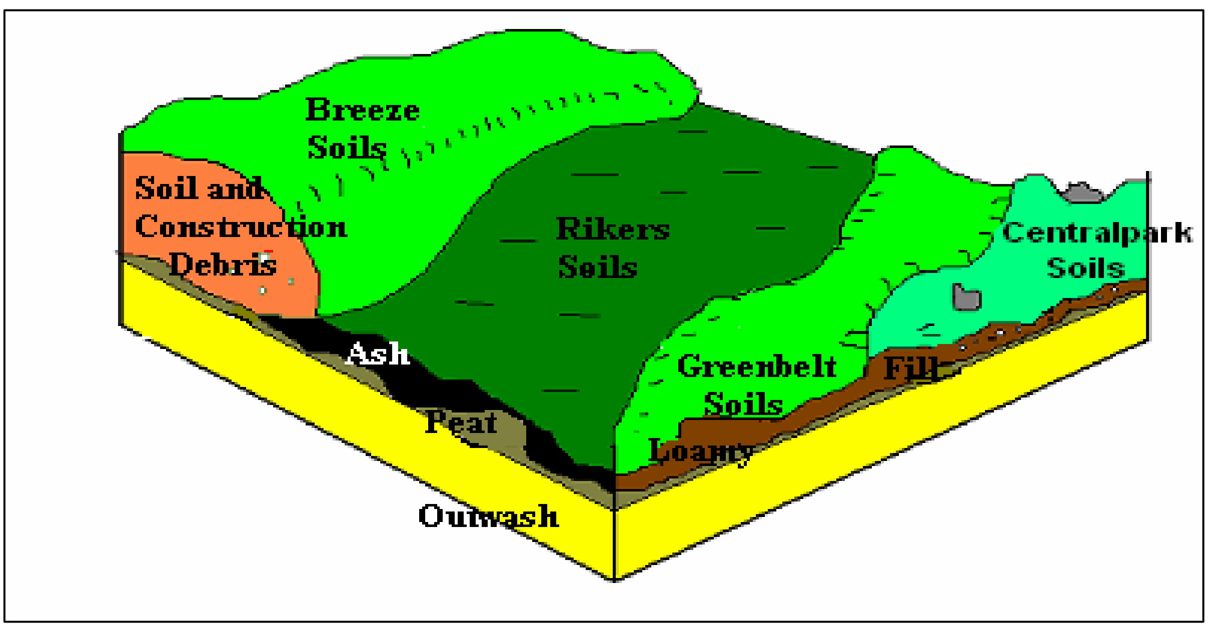

Figure 9. Pattern of soils developed in construction debris, coal ash and loamy fill

Centralpark, Fishkill, Flatland, Foresthills, Fortress, Gravesend, Greatkills, Greenbelt, Hassock, Inwood, Jamaica, Oldmill, Rikers, Shea, Verrazano and Winhole. Bulkhead and Shea soils are characterized by an underlying concrete or pavement layer; Oldmill and Gravesend soils are found in landfills (Figure 8). Centralpark and Greenbelt soils are formed in fill from natural soil materials; Breeze soils in a mixture of natural soil material with construction debris; Rikers soils in coal ash (Figure 9). These anthropogenic soils make up a considerable portion of the soil survey area.

One of the anthropogenic deposits of significant public interest in GNRA is the red sand of the Great Kills Park beaches. This beach has been a popular attraction for many years. In order to meet the demands of sunbathers, and to keep coastal erosion in check, there was a need for beach replenishment within Great Kills. The quickest and most economical beach replenishment tool of late has been the hydraulic pumping (dredging) of beach sand. The sand that was pumped up by the hydraulic dredges was red in color and is subsequently the sand that can be seen today on the beach. The red color is characteristic of the Pleistocene glacial deposits within the Great Kills Park area. These sands were pumped up from offshore sandbars that formed from coastal erosional processes and storms.

The red sand of Great Kills beach consists of primary minerals such as quartz and feldspar, silicate minerals which are highly resistant to weathering. Quartz is typically white or colorless, but can be coated by other soil materials such as iron, clay, or organic matter. In Great Kills Park the quartz particles are coated with hematite, an iron oxide that gives the sand a red or pink color.

Land Use History

When the U.S. Congress designated GNRA in 1972, it was part of an effort to bring the national park system closer to major cities. The purpose was to share the ethic of preserving and protecting outstanding natural and cultural resources, while using them in a sustainable manner for educational and recreational purposes. Three administrative units were designated (GATE 1976), corresponding to geographically separated land areas, the first two of which are in New York and the third in New Jersey. The GNRA consists of 270 miles of shoreline:

Jamaica Bay Unit -- 18,500 acres shoreline, dunes, uplands, wetlands, islands and waters in and adjacent to Jamaica Bay. This unit consists of three districts: North Shore District including Plumb Beach, Floyd Bennett Field, Bergen Beach, Canarsie Pier, Frank Charles Memorial Park, Hamilton Beach; Refuge District including the Jamaica Bay Wildlife Refuge; and the Breezy District including Jacob Riis Park, Fort Tilden, and Breezy Point Tip.

Staten Island Unit -- 2,100 acres of shoreline, dunes, uplands, wetlands, islands and waters of ocean and bays including Great Kills Park, Miller Field, Fort Wadsworth, Hoffman Island, and Swinburne Island.

Sandy Hook Unit -- 4,700 acres of shoreline, dunes, uplands, wetlands and waters of ocean and bays, with 6-1/2 miles of ocean beaches and bayside coves, including Fort Hancock and natural bushlands, woodlands, and holly forests.

American Indians occupied the present day site of the GNRA in New York and New Jersey before the Europeans arrived. The Jamaica Bay area supported villages of Canarsie and Rockaway American Indians, who engaged in cultivation, fishing, gathering shellfish, and possibly the manufacture of wampum from the seashells. The general area was settled by the Dutch in 1624, and subsequently taken over by the English in 1664. By the 1660’s, the American Indian presence at Jamaica Bay had dwindled to only a few families. Jamaica Bay's salt marsh meadows were used since colonial times to graze cattle and horses, and hay was cut for use in the farms and for sale in Brooklyn. Local farmers grew maize and diverse vegetables, and also kept sheep and chickens, all for family consumption as well as for sale. The history of this transition from American Indians to European occupancy was reviewed by Black (1981), and much of the following history is from his monograph.

Barren Island, now buried under Floyd Bennett Field (Figure 10) had a hotel by 1852, and seven factories by 1878. The number of factories doubled by 1911. Two of the earliest factories were fertilizer plants, which exported their products to Europe. Since the 1700’s, the waters of Jamaica Bay became increasingly important

Figure 10. Barren Island was a protective sand spit of a large tidal marsh (courtesy of Staten Island Institute of Arts and Sciences).

to the European settlers for clams, oysters, mussels, and fish. Fishing became an important industry after the Civil War. There also was hunting of waterfowl and other animals. Despite the popularity of the Bay, access remained restricted primarily to shallow-draft boats for a long time; a detailed map from the 1850's shows only one small road to Canarsie Point. Barren Island's industries, from 1859, produced fertilizers and fish oils. Up to 30 steamships fished the Menhaden and made deliveries to the processing plants. The fertilizer and fish oil industries peaked around 1900, and the main business became the disposal of refuse and dead animals from New York. But these were short lived, and by 1920 only two refuse processing plants remained, and these too were closed in 1934.

At nearby Mill Island in 1890, a large plant to smelt lead was opened. Another company bulk-headed salt marshes, and filled them to create 332 acres of uplands. The waters of Jamaica Bay were seriously contaminated by 1904, and by 1921 shell fishing was closed throughout the Bay. The topography of Jamaica Bay changed substantially during the twentieth century. Channels were dredged and salt marshes were filled, causing many small islands to disappear or merge with to adjacent islands to form a larger land mass. Streams were diverted, and creeks and shorelines were filled and bulkheaded. Summer cottages and recreation became increasingly important uses of Jamaica Bay's shoreline, except in places where pollution and landfills destroyed the salt marsh. Dredging and filling in the 1920's and 1930's transformed Barren Island into a peninsula of the mainland, bounding the west side of Jamaica Bay. Floyd Bennett Field emerged from the filled salt marshes and former Barren Island (Figure 11). The new peninsula became intensively developed with miles of concrete runways, large hangars for aircraft, and numerous support buildings. Today, the grasslands among the runways, and the brushlands and woodlands around the periphery are designated wildlife areas (GATE 1983).

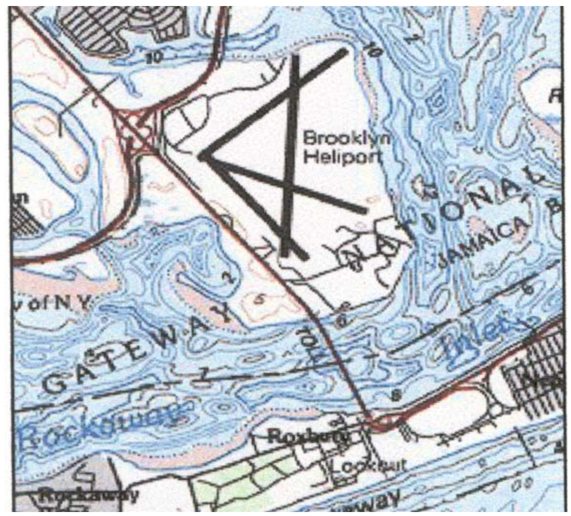

Figure 11. Floyd Bennett Field was built on organic soils (Ipswich, Pawcatuck, Matunuck) and eolian sediments (Hooksan) using dredge material from Jamaica Bay.

Other islands in Jamaica Bay also were covered with dredged materials, creating fewer but larger islands (Figure 12). The dredge fill for construction of a railroad across Jamaica Bay facilitated the establishment of new permanent communities, e.g. Broad Channel village (Figure 13). In the 1950's, the brackish lakes known as West Pond and East Pond were created on the filled lands at Rulers Bar Hassock, in the area that later became the Jamaica Bay Wildlife Refuge. The Refuge includes 2,474 acres of bay and islands, with woodlands, brushlands, grasslands, and salt marsh habitats (GATE 1979).

Two major landfills loom over the northern edge of Jamaica Bay, within the present-day GNRA (Figure 13). They are the Fountain Avenue and Pennsylvania Avenue Landfills. Each is about 80 feet high, and covers over 100 acres of former

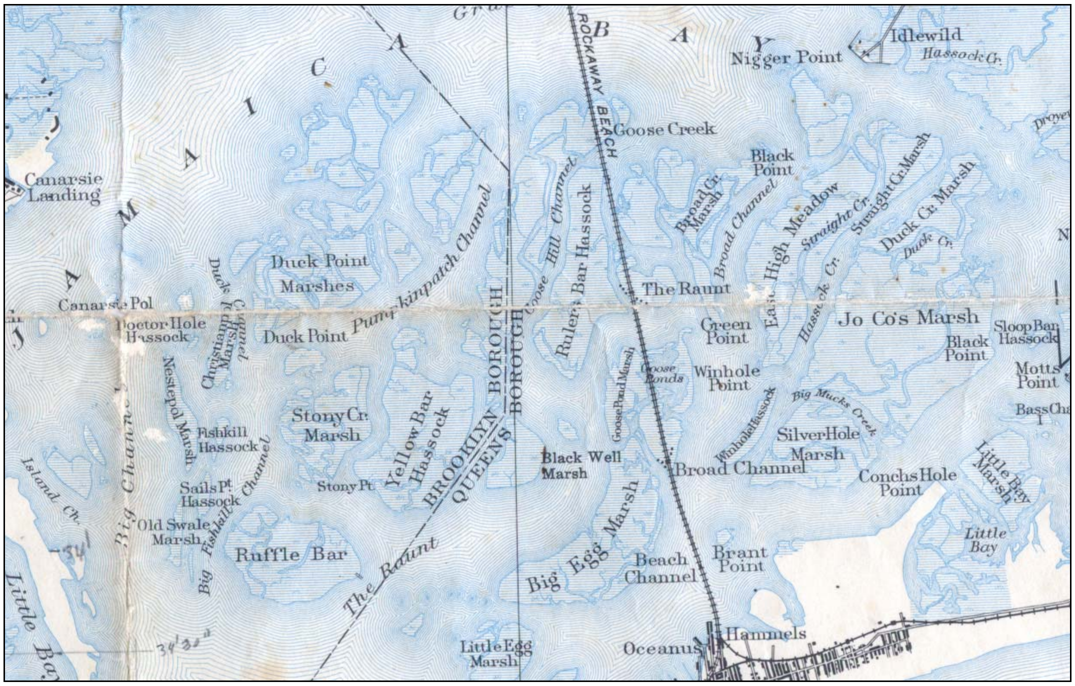

Figure 12. In 1800 Jamaica Bay consisted of many large and small tidal marsh islands. The area was used for hunting and fishing by Canarsie and Rockaway American Indians (courtesy of Staten Island Institute of Arts and Sciences).

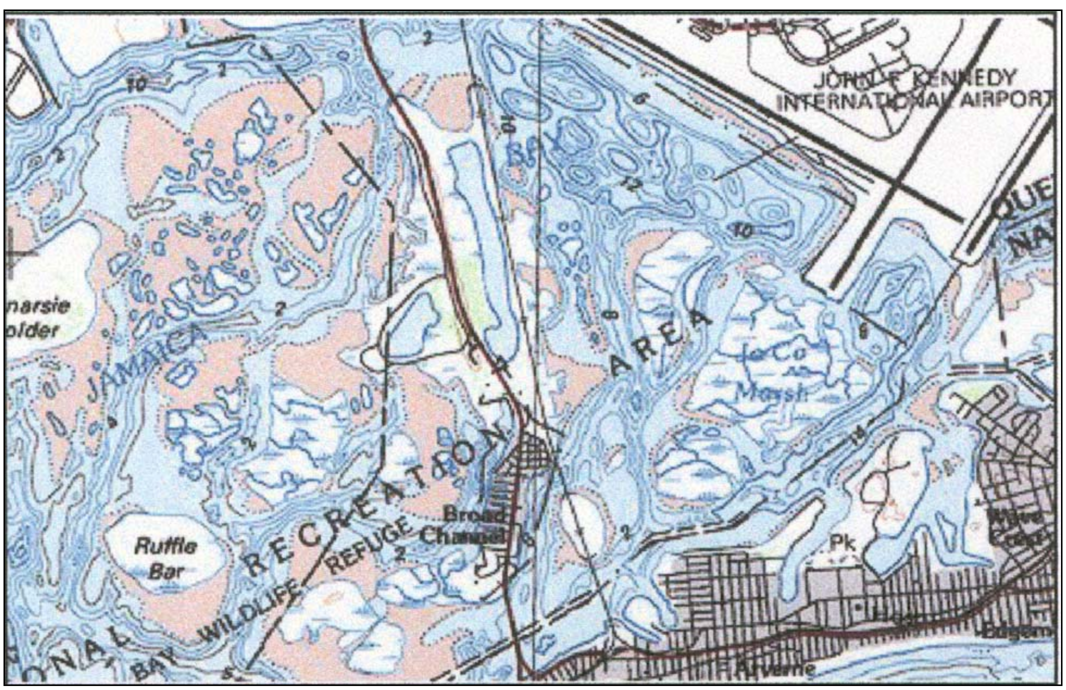

Figure 13. Many tidal marsh islands were filled with dredged materials. JFK airport (upper right corner), and the Pennsylvania Ave. and Fountain Ave. landfills (upper left corner) are built on former tidal marshes.

salt marsh. These contain household refuse, construction debris, sewage sludge, and hazardous chemicals. They will soon be sealed, planted with native plant species, and serve as wildlife habitat with low-intensity recreational uses. (GATE 1984).

The Rockaway Peninsula is a sand spit that separates Jamaica Bay from the ocean. The western portion of the Peninsula, from about a quarter mile east of the present-day Jacob Riis Park to Breezy Point Tip, did not exist prior to 1845. Back then, there were only a few sandbars. The present-day peninsula expanded 2.6 miles westward by 1889, and thereafter still another 2.5 miles further westward to form Breezy Point. The growing peninsula soon supported a tent and shack community, which became the present-day community of Breezy Point.

When the first humans found Staten Island between 10,000 and 7,000 years ago, they must have found an incredible coastal landscape. The Lenape (Delaware American Indians) would eventually occupy coastal New York and New Jersey. On Staten Island, they developed several villages: Arrochar and Oakwood (Figure 14).

Figure 14. The colonists arrived on Staten Island in the 1600's. Two Lenape American Indian villages were found: Arrochar (south of Fort Wadsworth) and Oakwood (Great Kills Park). By the mid-1800's, the southeast corner of the Island was composed of numerous farms, (most) 70 to 100 acres in size. Colonists crushed the shells from the Lenape's middens and added them along with eelgrass and algae from the ocean to fertilize the well drained Branford soils (courtesy of Staten Island Institute of Arts and Sciences).

The Staten Island southern sand spit shoreline has retreated about 900 feet landward from its 1836 position. At that time its dunes protected a salt marsh, which lay behind the sand spit (Figure 15). Crookes Point in Great Kills Park was a sand spit which, in the early 1900's, was washed through and became an island. A harbor bulkhead was constructed in the 1930's and 1940's, and dredge material was used to fill in the salt marshes and three creeks and connect Crookes Point to Staten Island (Figure 16). Sanitary landfills in the 1940's covered salt marsh behind the beach, rising to an elevation of 35 ft. The area became popular as a bathing beach in the 1960's (GATE 1990b).

Sandy Hook is a recurved sand spit, varying in width from several hundred feet to a mile. Several salt marshes lie along the western (bay side) of the peninsula. Sand dunes lining the peninsula's eastern side protect the grasslands, shrublands, woodlands, and Holly Forest from overwash flooding during most storms. The Sandy Hook lighthouse was constructed in 1764, and it has guided ships into the harbor ever since. It is the oldest operating lighthouse in the United States. Occupation by the U.S. Army began in 1813. Construction of a huge masonry fort occurred from 1859 to 1865. An ordnance proving ground was established from 1874 to 1878. Fort Hancock with houses and parade ground was created from 1895 to 1898. A hospital annex was built in 1917. World War II facilities (100 wooden buildings for up to 18,000 people) were constructed in 1941. Howard Marine Laboratory was built in 1993. Many of the structures from World War I and World War II have since been removed (GATE 1990a). The U.S. Coast Guard operates its Sandy Hook station on the northern tip of the peninsula, and it is the only remaining active military presence on the Hook (Tanacredi and Badger, 1995).

Figure 15. Great Kills Park in the year 1800.

Figure 16. Great Kills Park in the year 2000.

Vegetation

The natural vegetation of GNRA is mostly successional, and reflects past disturbance and alteration by humans (Figure 17). Besides the usual disturbances which one might expect in a densely populated urban area (i.e. forest cutting, conversion of once-forested land into cropland and pasture in colonial times, the filling of salt marshes along the coast and construction), there are large tracts composed of sandy dredge spoil (Bigapple, Fortress and Barren soils) heaped up in the early part of the 20th century to create new land (Floyd Bennett Field, Jamaica Bay Wildlife Refuge, Great Kills). In addition, the natural disturbance of shoreline dynamics, producing beaches and dunes, accounts for virtually all of Sandy Hook and most of Breezy Point. Three exceptions, relatively mature communities on ancient, mature soils are the "Swamp White Oak Forest" at Miller Field on Staten Island, the mixed hardwood woodlands on the hillsides at Fort Wadsworth on Staten Island, and the American Holly Forest on Sandy Hook. The first two of these are also highly disturbed as a result of selective cutting, burning, trampling, construction, dumping, alteration of drainage, and the invasion of exotic species. Many rare and endangered plant species have been found in various areas of Gateway. The reader is referred to Stalter et.al. (1996) for a list and discussion.

Ignoring obviously cultural landscapes we have the following vegetation groups, within GNRA, in approximate order of decreasing height: Forest and Woodland, Shrubland, and Grassland/Forbland. Those excluded are landscapes intentionally created and maintained by humans such as lawns, gardens, ornamental plantings, and fragmentary stands (less than 1 acre). The gardens include the North and South "Gardens" at the Jamaica Bay Wildlife Refuge that actually planted arboreta to look like natural forests or woodlands.

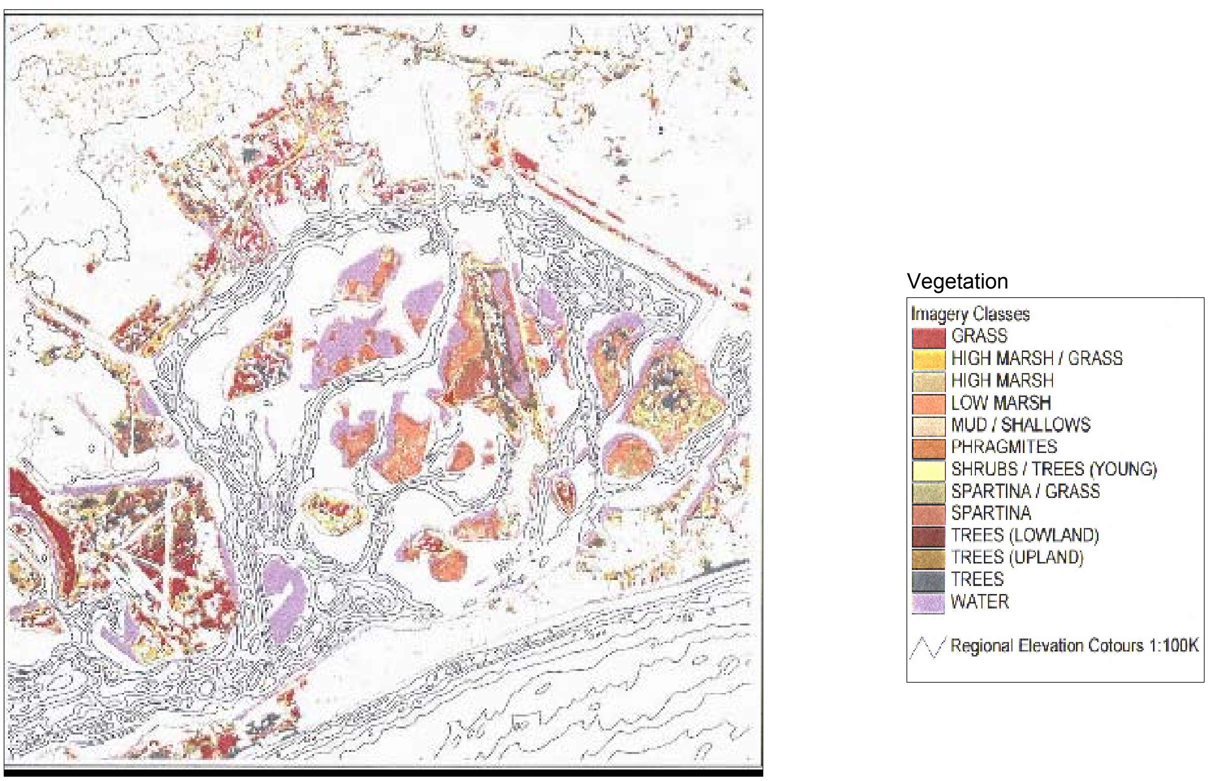

Figure 17. Vegetation map of Jamaica Bay Unit (courtesy of HydroQual, Inc.)

Forest and Woodland

American Holly Forest. A forest found on the west shore of Sandy Hook, at the north end of Spermaceti Cove, this stand is dominated only by American Holly (*Ilex opaca)*. The holly trees (Figure 18) are noteworthy for their large size and age, the largest and greatest in any holly forest in eastern North America (Stalter et. al., 1996).

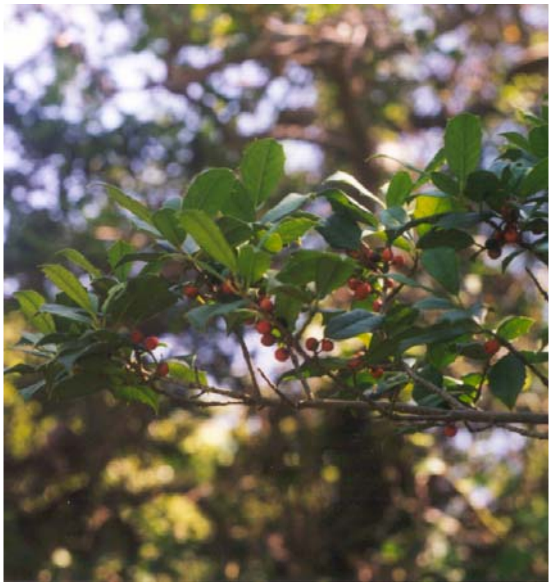

Figure 18. American Holly Tree in Sandy Hook, NJ.

The stand also is remarkable for the absence of other arboreal species; in other stands, oaks (*Quercus spp.)* are usually co-dominant with Holly (*I. Opaca)* (Stalter, et. al., 1996). The understory is a mixture of species also found in other hardwood forests. The one additional species noteworthy for its abundance is the Catbrier (*Smilax rotundifolia)*, which covers the trunks of many of the large trees. Except for trails, disturbance is not very evident and there are few exotics. Soils within this vegetative community include the very deep to bedrock and excessively drained Hooksan.

Red Cedar Woodland. A patch of large, old juniper trees (*Juniperus virginiana)* is found to the northeast of the Holly Forest at Sandy Hook.

"Swamp White Oak Forest". The name is misleading because this species (*Quercus bicolor)* dominates only a tiny portion of the tree stand at Miller Field. Red Maple (*Acer rubrum*), and other oaks (*Quercus spp.)* dominate most of the remainder. Numerous other tree and shrub species are present. In recent decades the flow of Moravian Creek, which traverses the area, was diverted. Since then, some species of plants and animals have disappeared or are on the decline, and this swamp forest may turn into an upland hardwood forest. The absence of seedlings due to trampling in many places, as well as abundance of exotics such as Japanese Knotweed (*Polygonum cuspidatum*) and Garlic Mustard (*Alliaria petiolata)*, are other signs of disturbance. The soils within this vegetative community include the very deep to bedrock and moderately well drained Pompton.

Mixed Hardwood Forest. These forests are found mostly on the hillsides sloping down towards New York Harbor at Fort Wadsworth, and include a mixture of maples (*Acer spp.),* oaks (*Quercus spp.*), poplars (*Populus grandidentata, P. deltoides*), Black Cherry (*Prunus serotina*), sycamores (*Platanus spp.*), elms (*Ulmus spp.*) and numerous others. Exotics such as Sycamore Maple (*Acer pseudoplatanus)* and Black Locust (*Robinia pseudoacacia)* are a high proportion of the trees in these forests. There is, curiously, one monospecific stand of Kentucky Coffee Tree (*Gymnocladus dioicus*), perhaps one hectare in extent, out of its range here and perhaps an escape from cultivation.

Originally created more than a century ago to protect New York Harbor, Fort Wadsworth was developed in several stages that involved the building of various bunkers and fortifications on these hillsides. Consequently, the land where these forests are now found was heavily disturbed in the past. But the most recent major disturbances probably occurred well back in the nineteenth century, giving near-climax vegetation and large trees time to develop. Soils are both natural and anthropogenic. Natural soils include the well drained and very deep to bedrock Wethersfield and Cheshire series. Anthropogenic soils include Greenbelt and Foresthills.

Somewhat similar forest is found along the Blue Dot Trail at Great Kills, apparently on old fill material. Soils found in the area include the well drained and very deep to bedrock Gravesend, Greatkills and Oldmill.

Successional Deciduous Forest. By far the greatest area of forested or wooded land at GNRA is of this type, dominated variously by poplars, Black Cherry, Grey Birch (*Betula populifolia*) or a combination of these species. Common exotics are White Mulberry (*Morus alba)*, and Tree-of-Heaven (*Ailanthus altissima*), the latter usually in monospecific patches, and Autumn Olive (*Eleagnus umbellata*), planted extensively at Floyd Bennett Field and the Wildlife Refuge at one time to attract birds. Large concentrations of such forest are found on old filled areas at the Wildlife Refuge: the North 40 and between the old runways at Floyd Bennett Field, on old dunes at Fort Tilden, at Crooke's Point in Great Kills, at various locations on Sandy Hook, and on the Pennsylvania Avenue and Fountain Avenue Landfills. Soils developed in dredge spoils include Bigapple, Fortress and Barren. The North 40 is dominated by fly ash soils: Winhole, Hassock, Fishkill and Flatland.

Shrublands

Bayberry Thicket. Bayberry (*Myrica pensylvanica)* thickets, up to 9' or 12' tall and often dense and impenetrable, are abundant in the North 40 at Floyd Bennett Field, on other parts of this field between the runways, at the Wildlife Refuge, on the landfills, and at Fort Tilden, Great Kills and Sandy Hook.

Sumac Groves. Extensive clones of sumac (either *Rhus typhina* or *R. copallina*) are interspersed with Bayberry thickets and successional deciduous forest.

Coastal Shrub Thickets. Along the shore, but inland from littoral grassland and forbland, are found mixtures of Bayberry, sumac and Beach Plum (*Prunus maritima*). Such thickets are found wherever there is a shoreline, as at Fort Tilden, Breezy Point, Great Kills, and Sandy Hook. Soils are the very deep to bedrock and sandy Hooksan and Bigapple

Grassland/Forbland

Phragmites Thicket. Typically 9' to 12' in height, taller than most of the shrub thickets described above, dense monocultures of the invasive Common Reed Grass (*Phragmites australis* and *P. communalis)* suppress the growth of most other species (Figure 19). Establishing itself in poorly drained soils, Phragmites spreads to well drained uplands and today is perhaps the most extensive plant formation at GNRA. Great extensions of Phragmites are found at the Wildlife Refuge, on the landfills, on other GNRA properties south of the Belt Parkway, at Floyd Bennett Field, Dead Horse Bay, east of Plumb Beach, at Great Kills, and at Sandy Hook. Soils in this vegetative community include Ipswich, Matunuck and Pawcatuck, especially where hydrology has been changed from saltwater to freshwater. Other soils in this vegetative community are Barren, Jamaica, Gravesend and Oldmill.

Figure 19. Phragmites (left) grows in soil with low salt concentrations; Cordgrass (right) can tolerate salt concentrations over 5,000 ppm..

Dune Grass Meadow. Dune grass (*Ammophila breviligulata*) is a nearly knee-high grass that dominates on unstabilized dunes (Figure 20) and sand flats. Typically, there is much open space between plants. It grows closest to the shore of any of the major graminoid species on high-energy coasts, sometimes nearly to the storm-tide line. Below that elevation, the sand is bare. *Ammophila* grows either in nearly pure stands here, or mixed with Seaside Goldenrod (*Solidago sempervirens*). *Ammophila* also grows mixed with other grasses and forbs on stable sands, often

Figure 20. Dune grass grows on unstable dunes along the Atlantic Ocean.

quite far from the coast, notably at Floyd Bennett Field and the Wildlife Refuge. It has been planted extensively at Plumb Beach in Jamaica Bay, and in the southern portion of Sandy Hook where, as in natural stands, it is effective in stabilizing shifting sands. Soils in this vegetative community include Hooksan and Bigapple.

Cordgrass Meadow. Smooth Cordgrass (*Spartina alterniflora*) grows in dense, mono-specific, waist-high stands in the intertidal zone along low-energy coasts. Soils in these areas include Ipswich, Pawcatuck, Matunuck and Sandyhook.

Figure 21. Cordgrass (right) and Salt Hay (left) grow on low energy zones of Jamaica Bay. Both species grow on organic and mineral soils subject to tide flooding.

Salt Hay Meadow. Salt Meadow Hay (*Spartina patens*), usually forms a zone by itself above Cordgrass (*S. alterniflora*) along low-energy coasts (Figure 21). This zone extends from about the mean high-tide line up to the highest reaches of the storm tides. Unlike *S. alterniflora*, however, *S. patens* can also be found mixed with other grasses or in nearly pure stands on well drained uplands, e.g. at Floyd Bennett Field, in the Wildlife Refuge, and in Spermacetti Cove at Sandy Hook.

Switchgrass Brake. The tall Switchgrass (*Panicum virgatum*), sometimes head-high, forms dense clumps that can be quite extensive. Generally, these monospecific clumps are "islands" within some other type of grassland. Soils in this vegetative community include Bigapple and Fortress.

Bluestem Meadow. These grasslands consist mostly of Little Bluestem (*Schizachyrium scoparium*), although Big Bluestem (*Andropogon virginicus*) may also be present or even dominant in places. These species are found from well drained uplands to areas quite near the coast, where they may be mixed with Dune Grass (*Ammophila*). The bluestems are often mixed with other grass species and typical grassland forbs, particularly composites (Asters-family Asteraceae). Some areas are being invaded and taken over by the exotic Oriental Bittersweet (*Celastrus orbiculatus*), most notably at the Wildlife Refuge, Floyd Bennett Field, and Great Kills.

Weeping Lovegrass Brake. This large, tuft-forming exotic Weeping Lovegrass (*Eragrostis curvula*) forms large, monospecific "islands" within other grasslands. Soils in this vegetative community include Bigapple and Fortress.

Silver Hay Grass Meadow. Silver Hair Grass (*Corynephorus canescens*) often dominates on sparsely vegetated, sandy uplands, notably on Floyd Bennett Field. It is associated with the co-dominant Camphorweed (*Heterotheca subaxillaris*), and a host of other less-abundant short grasses and forbs. The vegetation here is only a few inches high, with much bare ground.

Sedge Marsh. Here graminoid sedges (*Cyperus spp.* and *Rynchospera spp.*), rather than true grasses, dominate. Sometimes they are found with Bullrushes (*Scirpus spp.*) or patches of Cattail (*Typha latifolia*) or (*T. angustifolia*). Such stands are found in marshy fresh water areas at the Wildlife Refuge and at Floyd Bennett Field, where Phragmites has not yet taken over. Soils in these areas include Jamaica and Barren.

Mowed, Managed Grassland. The grasslands comprise much of the area between the old runways at Floyd Bennett Field (Figure 22). During the years when the Field was used as an airfield, woody species were suppressed. After abandonment by the Navy, woody vegetation began to take over. During the 1980's, an agreement was reached between GNRA and the New York City Audubon Society, which wanted to establish grasslands to replace those lost to development in the Hempstead Plains of Nassau County to the east. Accordingly, encroaching shrubs were removed, by large groups of volunteers, in those parts of the area still amenable to such treatment, and emerging woody plants have been suppressed by annual mowing in order

Figure 22. Grasslands occupy open areas between Floyd Bennett Field runways.

to provide habitat for open grassland nesting birds. Studies by Rudnicky et al. (1994) and Greller et al. (in press) have shown that the composition of this grassland is extremely variable, although many parts of it resemble the Bluestem meadow described above. Mowing has failed to suppress large dense patches of the invasive Japanese Knotweed (*Polygonum cuspidatum)*, which seems to be gaining ground year by year. Soils in this vegetative community include Bigapple, Fortress and Verrazano.

Mugwort Forbland. An invasive exotic forb, Mugwort (*Artemisia vulgaris*) forms solid stands up to head-high, particularly on the sites of old demolitions or where calcareous rubble has been dumped as fill. The density of these stands scarcely permits the establishment of any other species. Soils in these areas include Breeze and Inwood.

Thus, by far the greatest portion of GNRA's land is covered by either successional vegetation dominated by native species, or by disclimax vegetation dominated by exotic invasive species. Only a very small part of the total vegetation is anything resembling a climax community. The successional nature of upland communities is attributable, in most areas, to the relatively recent human controlled land building processes. Near the coast, however, the successional nature of the vegetation is due mostly to ongoing natural disturbance caused by wind and/or wave action. Disclimax, other than in cultural landscapes, is due to takeover by invasive species that form self-perpetuating monocultures ranging from small patches to many hectares in extent. The Floyd Bennett Field grasslands are intentionally being managed to maintain a state of disclimax. Humans are trying to promote the survival a monoculture of native prairie species.

Figure 23. The high wildlife diversity of Gateway provides passive recreation to park users.

Wildlife

GNRA is a maritime park, with about 270 miles of shoreline. Two-thirds of the park's area is salt marsh, bay, and ocean edge. The rest is barrier islands (with beaches and maritime scrubland or forest), maritime uplands (with grasslands, shrublands, and forest), artificial landfills, and a dozen small freshwater ponds and wetlands. Portions of the park are heavily developed with pavement and buildings, while other areas have a pristine appearance. The diverse habitats are conducive to varied and abundant wildlife (Figure 23).

At least two dozen species of wild and feral mammals currently occur within the three units of GNRA. The most prominent wild mammals are the Common Raccoon (*Procyon lotor*), Virginia Opossum (*Didelphis virginiana*), Eastern Cottontail (*Sylvilagus floridanus*), Eastern Gray Squirrel (*Sciurus carolinensis*), and several kinds of rats, mice, voles, and bats. Marine mammals, such as Atlantic Bottlenose Dolphin (*Tursiops truncatus*), Harbor Seal (*Phoca vitulina*), and several species of whales occasionally are seen within the park's waters. In the 1600's, along the edge of Jamaica Bay, there were White-tailed Deer (*Odocoileus virginianus*), Wapiti or American Elk (*Cervus elaphus*), Black Bear (*Ursus americanus*), American Beaver (*Castor canadensis*), and Woodchuck (*Marmota monax*), but they, and more than a dozen other mammalian species, now are locally extinct. The park's mammals are described in Tanacredi & Badger (1995), Cook (1989a), and O'Connell (1980); extirpated species are listed in Black (1981).

More than 325 bird species have been recorded within GNRA. Among the species that are state or federally endangered, threatened, or of special concern are the Roseate Tern (*Sterna dougallii*) and the Piping Plover (*Charadrius melodus*), which nest on the park's beaches. The barrier beach habitat also supports nesting colonies of Black Skimmer (*Rynchops nigra*), Common Tern (*Sterna hirundo*), and Least Tern (*Sterna antillarum*) (Figure 24). The Peregrine Falcon (Falco peregrinus) nests on the Verrazano Narrows Bridge that bisects Fort Wadsworth, and on the Marine Parkway-Gil Hodges Memorial Bridge. Artificial nest platforms and chimneys are nesting places of the Osprey (*Pandion haliaetus*). Floyd Bennett Field is the site of a grassland restoration site, providing a regionally important habitat for grassland-breeding birds. The salt marshes host nesting colonies of three gull species (*Larus spp*.). The park's varied brushlands, woodlands, and freshwater ponds provide essential habitats for hundreds of other resident and migratory bird species (Figure 25). Species lists are available in Davis et al. (1996), Tanacredi & Badger (1995), and Bourque & Bourque (1994).

Figure 24. Birds use barrier beaches for nesting

At least 25 species of reptiles and amphibians are found within GNRA. These include the Diamondback terrapin (*Malaclemys terrapin*) in the estuaries, 7 species of turtle in the uplands and freshwater wetlands, and several species of sea turtle that occasionally enter the park's waters. There are 6 kinds of snake; one of these, the Eastern Hognose Snake (*Heterodon platyrhinos*), was recently reintroduced to portions of the park (Tanacredi & Badger 1995). The 8 species of amphibians comprise salamanders, newts, toads, and frogs; one of these, the Northern Spring Peeper (*Hyla crucifer*) was reintroduced in some areas to serve as a food for the Eastern Hognose Snakes. In total, 15 of the park's 25 reptile and amphibian species have been reintroduced to appropriate habitats throughout the park (Cook 1989b, 1989c; Cook & Pinnock 1989; Cook & Tanacredi 1990).

The estuaries historically sustained a large and diverse fish population, so great in fact that up until the late 1800's many people made their living by fishing in the area. Currently 81 species of fish are reported from the estuarine and ocean waters of GNRA (Riepe et, al. 1987).

Figure 25. Fresh and salt water ponds provide habitat to a large number of migratory birds.

The shortnose sturgeon (*Acipenser brevirostrum*), listed as endangered by the National Marine Fisheries Service, is known to inhabit the Hudson River Basin and New York Harbor (Figure 26).

Figure 26. Shortnose Sturgeon

Invertebrates are largely unsurveyed within the park, with several exceptions: well over 50 species of butterfly are recorded within GNRA (Tanacredi & Badger 1995; Riepe et al. 1989). Some surveys also have been done of the dragonflies, damselflies, grasshoppers, mosquitoes, and ticks. At Sandy Hook Unit, there have been several introductions of the Northeastern Beach Tiger Beetle (Cicindela dorsalis), which is federally listed as a threatened species (Knisley and Hill 1998). Numerous plankton have been found, and shrimp, amphipods, horseshoe crabs (*Limulus polyphemus*) and lobsters are still present.

(Figure 27). Large numbers of mussels continue to make the waters around the GNRA their home. Studies of the aquatic invertebrates have focused more on the occurrence and effects of chemical contaminants in the organisms, rather than on a thorough inventory of species.

Figure 27. Horseshoe Crabs lay eggs on the estuarine sandy beaches in late May each year. Their eggs are an important food source for shore birds.

Hydrology

In the hydrologic cycle, water moves continuously between the atmosphere and the earth's surface, as well as beneath the surface. Key processes in the cycle include precipitation, infiltration, transpiration, and evaporation. Maintaining an adequate supply and acceptable quality of both surface water and groundwater are of the utmost importance to human habitation, recreation, wildlife and vegetation in and around GNRA.

Surface Water

GNRA encompasses 25,300 acres, 16,200 of which are surface water systems that include the Atlantic Ocean, estuarine bay areas, salt marshes and tidal mud flats, and freshwater wetlands and ponds. Each of these ecological systems supports numerous and diverse wildlife populations.

GNRA contains several freshwater ponds. The Jamaica Bay unit has 3 artificially created ponds: East Pond, West Pond, and Big John's Pond. Ephemeral ponds, those that dry up during drought conditions, can be found at Floyd Bennett Field, Fort Tilden, and Breezy Point. Return a Gift Pond, created in 1990-91, is an example.

The Staten Island unit has one artificially created ephemeral pond, located in Great Kills Park. The Sandy Hook unit has three permanent freshwater ponds: Nike Pond, Round Pond, and North Pond.

Freshwater ponds located in GNRA are primarily maintained by rainfall runoff, storm water and combined sewer outfalls, and infiltration from limited groundwater. All the freshwater ponds in GNRA are generally shallow (less than four feet deep), which is why many are ephemeral and exhibit eutrophic, or nutrient rich, conditions. East Pond in Jamaica Bay (Figure 28) is the only exception, with an isolated area having a depth up to 16 feet.

Little is known about freshwater bodies in GNRA, except for East Pond and West Pond located in the Jamaica Bay Wildlife Refuge. Water volume levels in these two ponds are controlled by drainage valves leading into Jamaica Bay. Both ponds contain slightly brackish to freshwater, with salinity readings of

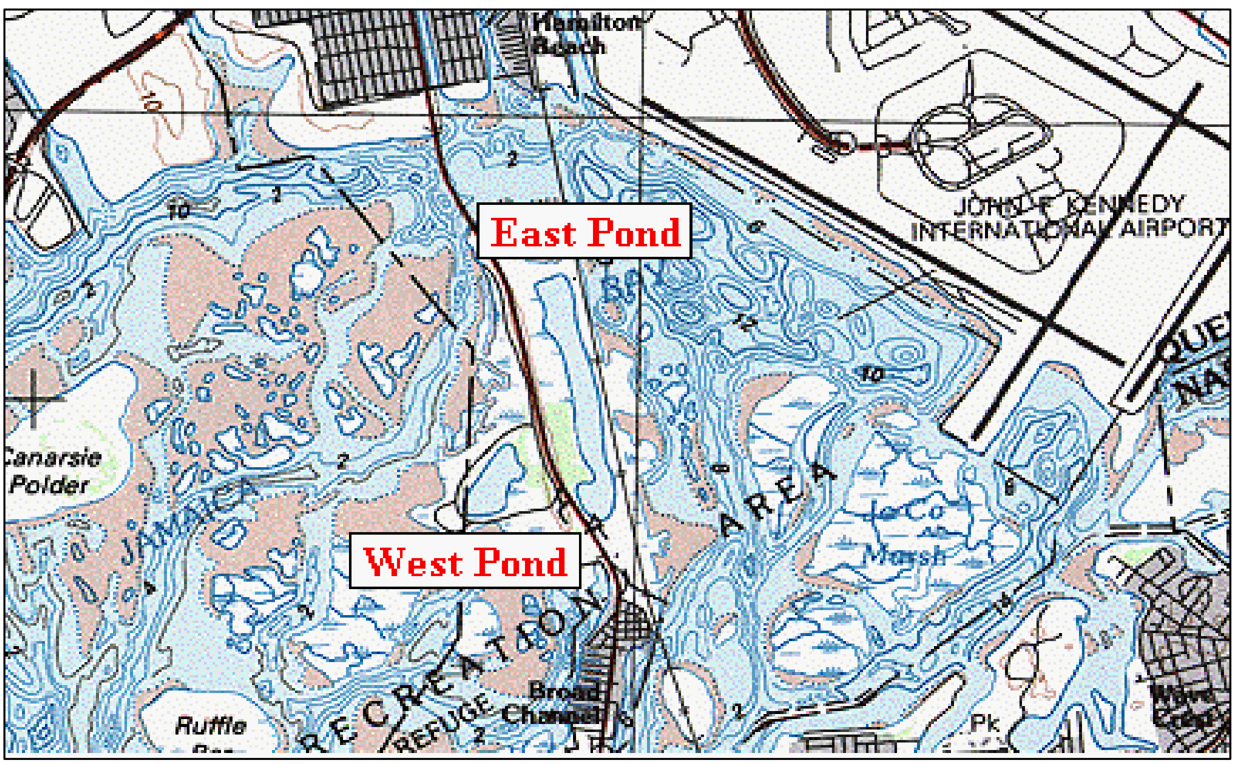

Figure 28. Location of East Pond and West Pond in Jamaica Bay.

1 to 3 parts per thousand (ppt) in East Pond; and 4 to 5 ppt in West Pond. Data analysis indicates that most of the salinity in these two water bodies is caused by back flow through the drainage valves during high tide phases in Jamaica Bay.

Due to the close proximity to urban, industrial, and residential areas, the freshwater and saltwater systems are continuously influenced by human activities. These human impacts can be illustrated in a number of examples: 1) Many swamps and marshes have been filled-in or drained. An example is swamp habitat loss from sewage line construction in the Swamp White Oak Forest at Miller Field. 2) On average, waste water treatment plants discharge 320 million gallons a day into Jamaica Bay. Those discharges increase during rainy weather and add to the nutrient load (i.e nitrogen and phosphorus) in water systems. 3) Storm water runoff from surrounding urban areas introduces contaminants into the water systems and sediments that affect the bay ecosystems. These include petroleum products, pesticides, herbicides, and heavy metals such as lead and mercury. 4) At least six landfills, adjacent to or within the park boundaries, have leached contaminated substances into the water systems, even though they have been closed a number of years.

Water Infiltration and Runoff

When rainfall reaches the earth's surface, it can move either into the soil (through infiltration) or over the soil (through runoff). Rainfall intensity, the infiltration rate, and the slope of the land are among the factors affecting water movement at the soil surface. Water that does not enter the soil can become the medium for soil erosion, removing valuable topsoil that can become a water pollutant. Wind, tides, waves, and human activities may also cause or accelerate soil erosion. On a geologic scale, most of the land itself in GNRA is the product of erosion and deposition. The tides and waves deposit eroded sediments as beaches that are then shaped by the wind into dunes.

Many of the soils in GNRA are sandy and contain gravel and coarse shell fragments. These coarse particle sizes allow for rapid movement of water into the soil, which reduces the potential for erosion. As water moves through the soil some is taken up by plants, some is lost to deep percolation, and some moves laterally to lower landscape positions creating wetter conditions in the low lying areas. The low moisture holding capacity of GNRA soils accentuates the differences in wetness across the landscape.

Humans also supply materials from waste disposal, dredging, and other earth moving activities to create land. Particle sizes in artificially deposited materials vary, and therefore, each anthropogenic soil has its own moisture holding capacity, infiltration rate, and hydraulic conductivity. There are several landfills with varying designs and materials compositions (Figure 29) within GNRA. Leachate from older, unregulated wasted dumps is a significant source of pollution.

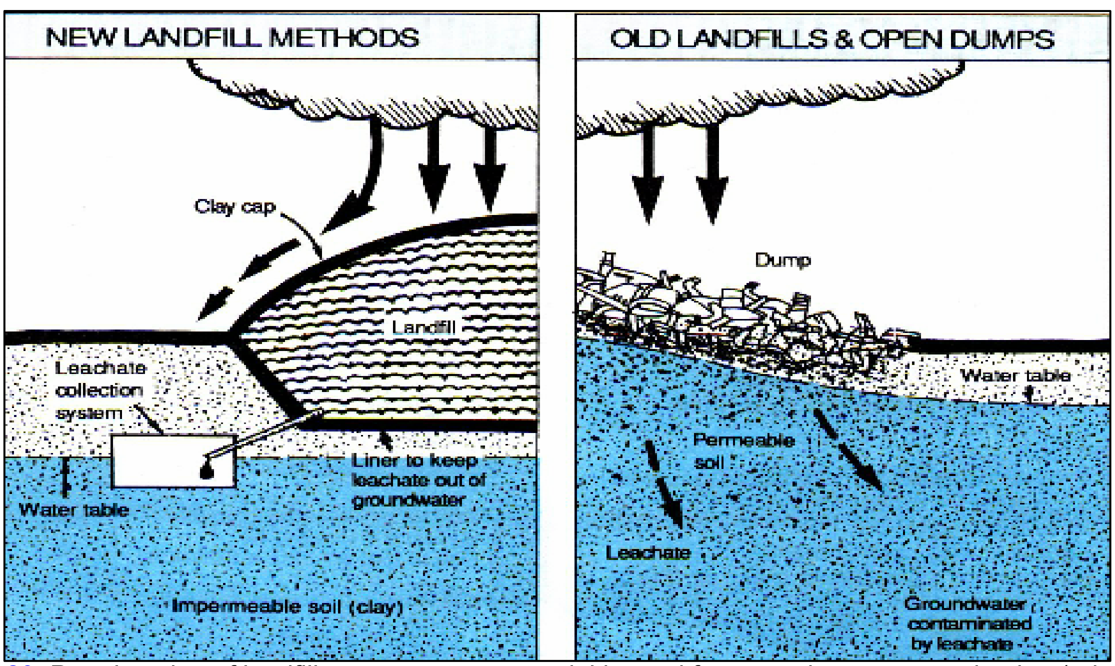

Figure 29. Poor location of landfills represents a potential hazard for groundwater contamination (adapted from Lyle S.R., 1988)

When the rate of precipitation exceeds the rate of infiltration, excess water runs off the soil and becomes an erosive force. Vegetation and leaf litter intercept the rain and protect the soil (Figure 30). Vegetation also protects the soil from wind and wave erosional forces. Drier upland soils may have only a sparse cover of vegetation, which would make them more susceptible to erosion, whereas the low-lying wet soils typically have denser plant cover, and are better protected from erosive forces. Plants also provide organic matter to the soil, which helps to retain moisture and assists in binding the soil particles together to resist erosion. Urban areas have many surfaces that absorb little or no water at all, such as roofs, pavement, and compacted soil surfaces. When vegetation is cleared and soil is compacted or paved over, rainwater is unable to soak into the ground, and more storm water runoff is generated (Figure 30). Human activities also add many pollutants to the landscape: manure from pets and farm animals; soil from construction sites and equipment; fertilizers and pesticides from landscaping; chemicals from industrial facilities, and oil and grease from automobiles.

As a result of their low moisture holding capacity and their limited development, sandy soils are more fragile and sensitive to disturbance. Paths and trails should be planned to direct traffic to more stable soil areas or constructed surfaces. Trails should be mulched and construction materials should be pervious in order to reduce runoff and control erosion. Recreational boating should follow all regulations to reduce wave action and shoreline erosion. Boaters should use established docks to protect beaches and dunes.

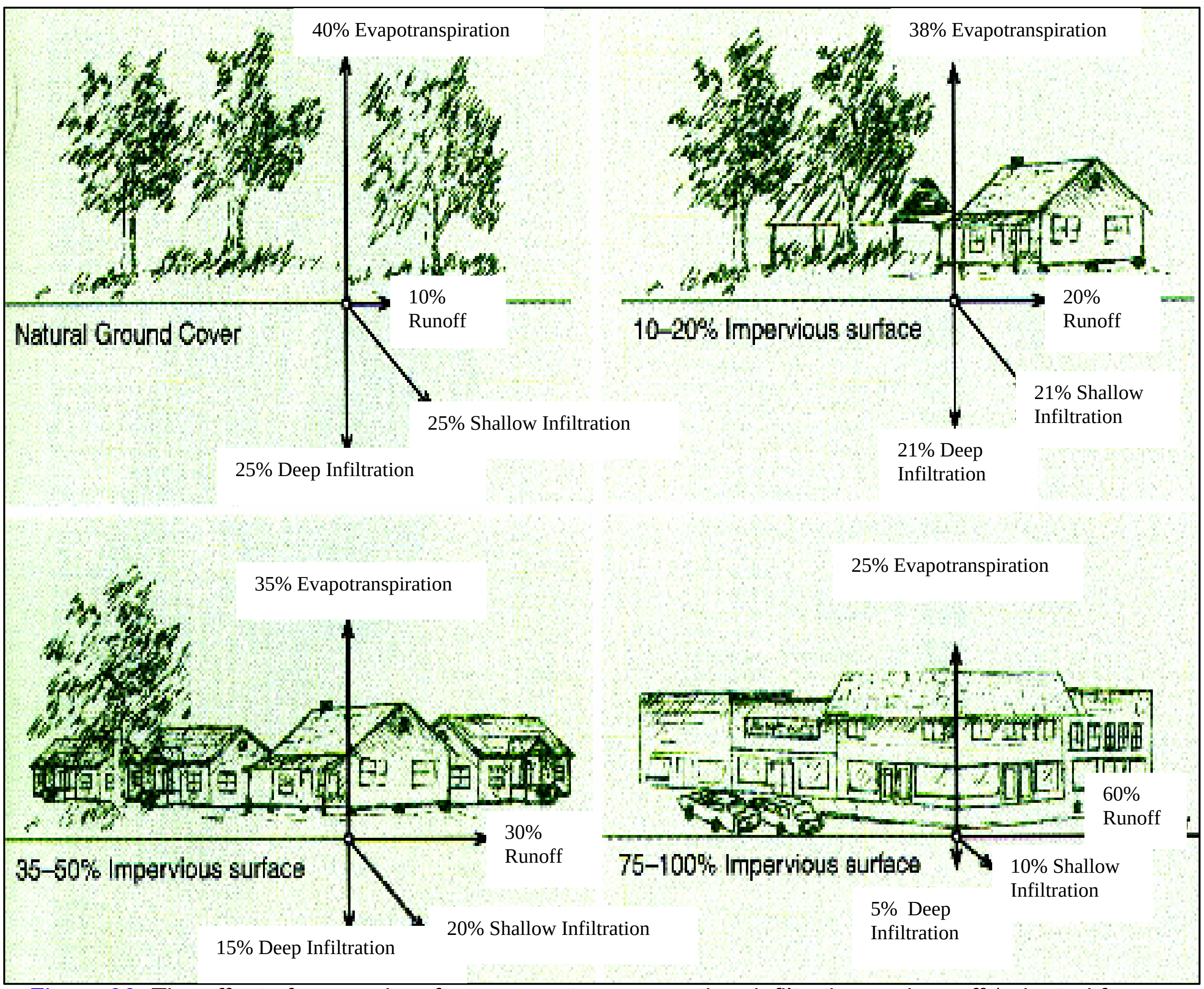

Figure 30. The effect of covered surfaces on water evaporation, infiltration and runoff (adapted from Fernald and Purdum, 1998).

Aquifers

Water beneath the surface can be divided into two main zones, an unsaturated zone and a saturated zone. In the unsaturated zone, pore space is filled with both air and water. The saturated zone, where pore space is filled completely with water, is considered groundwater. The upper surface of groundwater is referred to as the water table. The depth to the water table can range from zero, when it is at the soil surface, to hundreds or even thousands of feet deep. As precipitation is the main source of groundwater, the depth to water table varies seasonally and from year to year. It is usually near the surface around permanent bodies of surface water such as streams and wetlands. Rocks and unconsolidated sediments vary widely in their ability to store and transmit water. The water storing capacity is related to the total amount of pore space, or porosity, whereas the transmitting ability is dependent on the pore size and connectivity. An aquifer is a body of permeable rock or sediment capable of storing and transmitting significant quantities of water. In general, sand and gravel beds transmit and store water better than silts and clays. Sands and gravels make the best aquifers, or water-producing bodies, while clays and silts make better confining beds.

Four principal aquifers underlie GNRA on Long Island. From deepest to shallowest they include the Lloyd and the Magothy Aquifers in Cretaceous Coastal Plain sediments, and the Jameco and Upper Glacial Aquifers, both in Pleistocene glacial deposits (Figure 31). Potable freshwater in the aquifers can be bound laterally by a freshwater-saltwater transition zone that surrounds Long Island (Figure 32).

The crystalline bedrock that underlies Long Island has negligible permeability and functions as a hydrologic boundary or base for groundwater flow. The bedrock surface slopes southward at about 55 to 60 feet per mile in an arcuate pattern. The unconsolidated Raritan Formation, of Cretaceous age, dips and thickens southward, overlying the crystalline-bedrock surface. The Raritan consists of the Lloyd Sand Member and an upper, unnamed clay member. The Lloyd Sand consists of fine to coarse sand and gravel, commonly within a clayey matrix, and forms the Lloyd Aquifer, the lowermost principal aquifer. The Lloyd Aquifer is not found in the northwestern part of the island where the Lloyd Sand was extensively eroded prior to glaciation. The Lloyd Aquifer ranges in thickness from a few feet in places on the north side of the island, to about 500 feet in on the south side. The depth to the top of the aquifer ranges from about 200 to 1,500 feet below sea level.

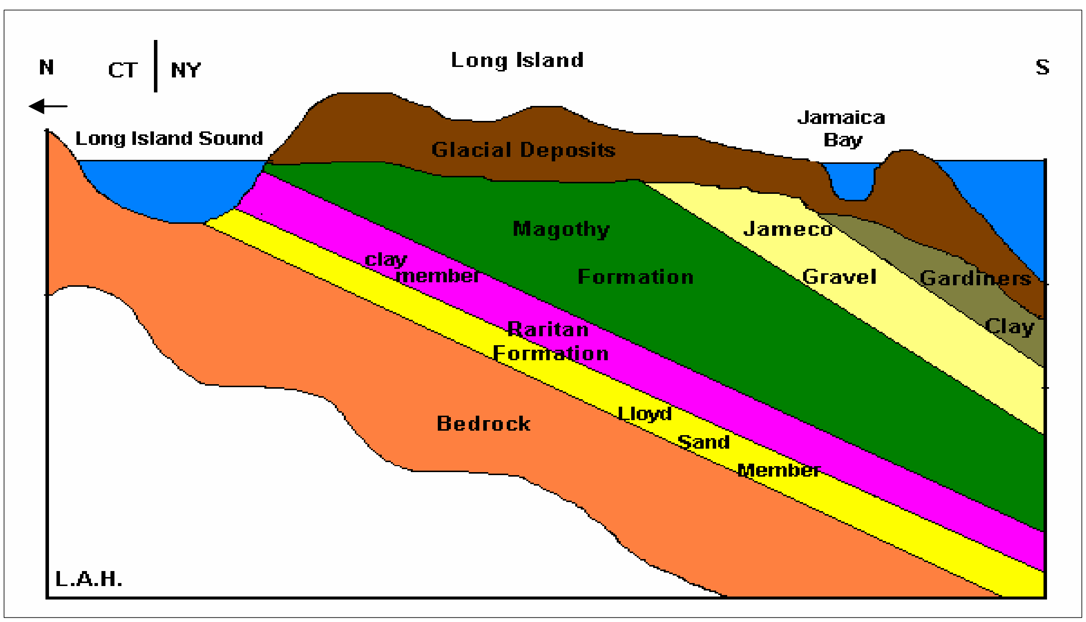

Figure 31. Coastal Plain sediments of Cretaceous age underlie glacial deposits on Long Island as shown in this idealized section of eastern Queens County. The Magothy Formation and the Lloyd Sand Member of the Raritan Formation form productive aquifers.

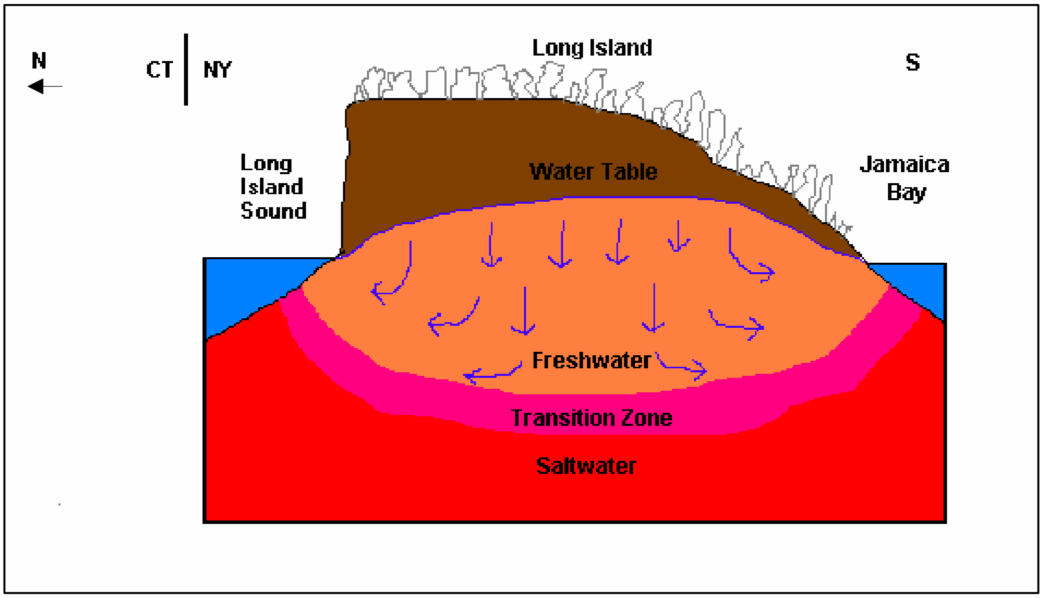

Figure 32. Freshwater floats above saltwater. A transition zone between freshwater and saltwater parallels the upward path of discharging freshwater. This transition zone is maintained in equilibrium at the periphery of the island.

The clay member of the Raritan Formation has a maximum thickness of about 300 feet and consists of massive silty clay with a few lenses of sand and lignite. It forms a leaky confining unit.

The Magothy Formation, which unconformably overlies the Raritan Formation, is composed of unconsolidated fine to medium quartzose sand with layers and lenses of clay, silt, and coarse sand and gravel. The coarsest material is present in the lower 50 to 100 feet of the formation. The Magothy was also extensively eroded prior to glaciation and is not found in the northwestern part of Long Island. The depth to the top of the Magothy Formation ranges from the land surface in isolated outcrop areas on the north shore, to about 600 feet below the surface on the south shore. The Magothy, which is an important aquifer, ranges in thickness from a featheredge in places on the north side of the island, to about 1,000 feet in the south shore. Pre-Pleistocene streams eroded several deep channels in the Magothy surface, two of which extend southeastward across the entire Long Island. The channel in Queens County was probably eroded by the ancestral Hudson River.

The Monmouth Group (not illustrated), represented by the Monmouth Greensand, serves as a confining unit where it overlies the Magothy along the southern edge of Brooklyn and Queens. The Monmouth Greensand is a clayey, glauconitic unit of Cretaceous age, similar in hydraulic character to the Raritan confining unit. Its thickness ranges up to about 150 feet.

The Jameco Gravel, the basal deposit of Pleistocene age, underlies parts of Kings and Queens Counties, and forms the local Jameco aquifer. Its thickness extends to about 200 feet in south-central Queens County. Jameco sediments include fine sand to gravel with some lenses of clay and silt and, for the most part, fill valleys eroded into the underlying Magothy Formation. In the south shore area, the Jameco is overlain by the Gardiners Clay, a clayey and silty deposit in the western half of its extent that becomes increasingly sandy to the east. It is thickest in Queens County, and thins to about 50 feet in the remainder of its extent. Where present, Gardiners Clay forms a confining unit that separates the Magothy and Jameco Aquifers from water bearing materials above.

Pleistocene glacial deposits blanket Queens and Brooklyn and reach a maximum thickness of about 600 feet in the Ronkonkoma Basin. The Upper Glacial Aquifer consists largely of coarse-textured glacial outwash deposits, exposed at the surface to the south of the Ronkonkoma and Harbor Hill Moraines. Glacial-lake deposits of clay and silt, with some sand and gravel layers, are present within the upper glacial aquifer in central and eastern Long Island. Marine clay of Pleistocene age also is present within the upper glacial aquifer in Queens. These glacial-lake deposits and marine sediments, along with unsorted and unstratified till, form local confining units where they overlie permeable outwash deposits.

Holocene deposits occur locally throughout GNRA in salt marshes, and along beaches and streams. These materials can extend to 50 feet thick, consisting of sand, silt, clay, organic muck, and shells, and generally overlie Pleistocene deposits at the surface. They are either unsaturated, or too thin and discontinuous to form aquifers, but in some areas may form local confining units.

Groundwater Flow

After rainwater infiltrates the soil, it flows downward through pores and cracks until it reaches the depth where the soil is saturated with water. The surface of this saturated zone is called the water table. The water table usually is not level but has some slope, which allows groundwater movement to occur (Figure 32).

Water flows readily through large pores in sand and gravel deposits, as well as within fractured bedrock deep beneath the land's surface. Within aquifers, groundwater behaves somewhat differently than surface waters such as streams or lakes. While surface waters flow downhill under the influence of gravity, groundwater flows toward areas having lower hydraulic pressure (i.e. lower "head"). Areas having higher head tend to be at relatively high elevations in the landscape (i.e., the terminal moraine). These locations are where groundwater is recharged, especially if the soil is sandy or gravelly. Areas with lower head tend to occur at lower landscape elevations, such as concave areas, valleys or near estuaries, and are often discharge zones. Groundwater commonly flows upward in these discharge zones, being forced against the pull of gravity by water higher in the aquifer that has greater hydraulic head.

Groundwater moves relatively slowly, traveling at a rate between a fraction of an inch and a few tens of feet per year, depending on the permeability of the aquifer. As a result of this extended period of time in which the water is in contact with aquifer materials, groundwater can dissolve many soluble materials.

GNRA is located within an estuarine ecosystem, and most park areas are located at low elevations or at sea level. Saltwater and tidal fluctuations influence groundwater within this area. High concentrations of dissolved salts and other minerals make seawater denser than freshwater. As a result, fresh groundwater floats as a separate layer above saltier marine groundwater within the aquifer (Figure 32). The thickness of the freshwater layer decreases with decreasing elevation, and the separation between salt and freshwater becomes less distinct within the area of tidal influence due to mixing. A map of the potentiometric surface of each of the principal aquifers represents the pressure surface to which water will rise in tightly cased wells open to the aquifer, and indicates the general direction of groundwater movement. Typical groundwater movement is down the hydraulic gradient and generally perpendicular to the potentiometric contours (Figures 33 and 34). The potentiometric surface of the unconfined upper glacial aquifer is the water table, which is the top of the saturated zone. Groundwater divides separate the movement of groundwater northward to Long Island Sound and southward to Jamaica Bay and the Atlantic Ocean. The estimated configuration of the potentiometric surface of the Upper Glacial Aquifer in Long Island under natural (predevelopment) conditions is shown in Figure 33. Groundwater withdrawals in these counties have lowered the potentiometric surface, changed its configuration, and produced characteristic circular cones of depression centered around the areas of withdrawal as shown in Figure 34.

The potentiometric surface of the Magothy Aquifer has a configuration similar to that of the Upper Glacial Aquifer, but is more subdued and slightly lower in altitude. The groundwater divide on the Magothy potentiometric surface nearly coincides with that on the potentiometric surface of the Upper Glacial Aquifer. Groundwater withdrawals from the Magothy Aquifer in Kings and Queens Counties have also lowered water levels in the aquifer below natural levels. The Magothy Aquifer is mostly unconfined, as is the Upper Glacial Aquifer, and the two aquifers function hydraulically as one. However, because the potentiometric surface of the

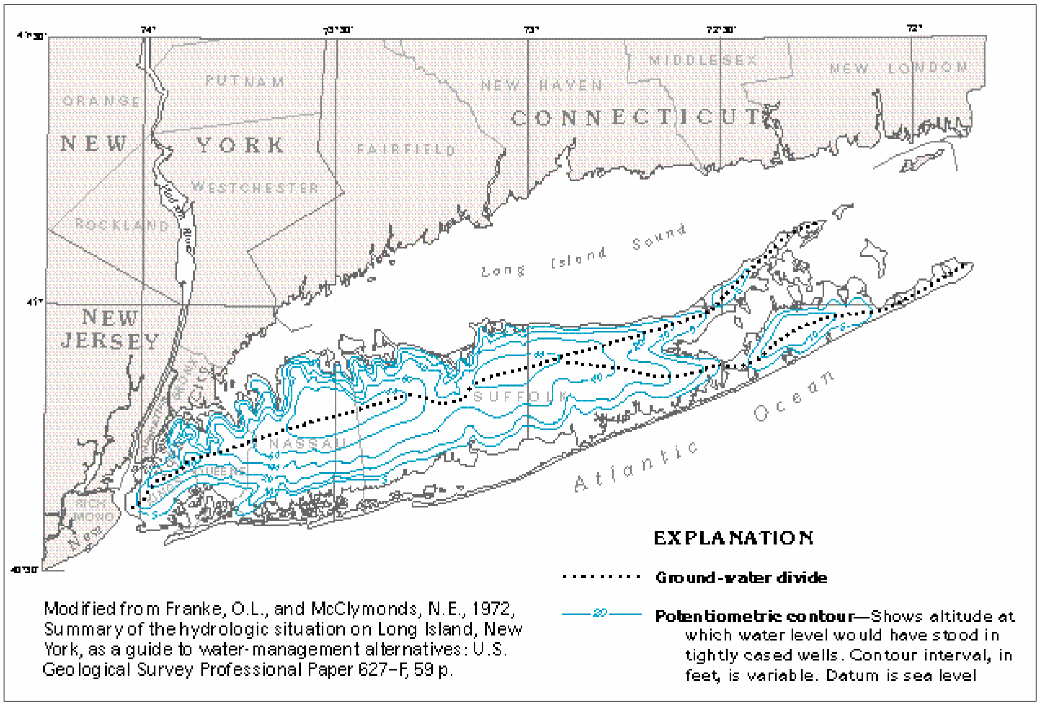

Figure 33. The estimated configuration of the potentiometric surface of the Upper Glacial Aquifer, prior to any large scale withdrawals, shows a smoothly sloping surface to the north and south.

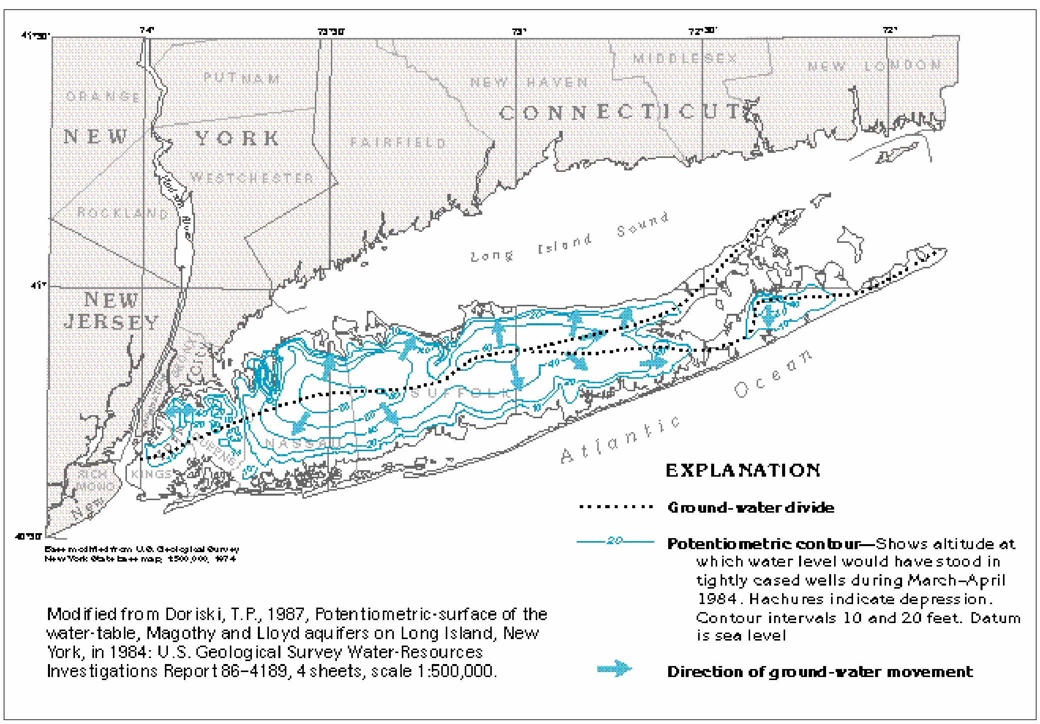

Figure 34. The potentiometric surface of the Upper Glacial Aquifer slopes gently to the north and south from a central high, except in the western part of the island where groundwater withdrawals have lowered the water table and created cones of depression.

Magothy is slightly lower than that of the Upper Glacial Aquifer, the vertical gradient is downward, and water moves downward from the Upper Glacial Aquifer to recharge the Magothy.

The Lloyd Aquifer is confined by the Raritan confining unit. The potentiometric surface is above the base of the confining unit, and rises to an altitude of 20 to 50 feet below that of the Magothy potentiometric surface in Nassau and Suffolk Counties. Thus, the vertical gradient is downward from the Magothy Aquifer to the Lloyd Aquifer, and water moves downward from the Magothy Aquifer to recharge the Lloyd Aquifer. Groundwater withdrawals from the Lloyd Aquifer in Kings and Queens Counties have lowered water levels in those two counties and in much of Nassau County. A large cone of depression dominates the potentiometric surface of the Lloyd Aquifer in the western part of Long Island. Water levels are more than 20 feet below sea level in an area that extends from Kings and Queens Counties into the western and southern parts of Nassau County. The large-scale withdrawals have shifted the groundwater divide in the Lloyd Aquifer northward in much of the western part of Long Island. Elsewhere, the divide is unaffected and is nearly coincident with that of the Upper Glacial and the Magothy Aquifers.

Movement of water through the unconsolidated deposits that underlie Long Island is a function of the hydraulic conductivity, or the capacity of the deposits to transmit water. The horizontal hydraulic conductivity of the Lloyd and the Magothy Aquifers is of a similar magnitude, but that of the Upper Glacial Aquifer is about six times greater. The horizontal hydraulic conductivity of the Gardiners and the Raritan confining units is several orders of magnitude less than that of the aquifers, and the vertical hydraulic conductivity of the upper two aquifers and both confining units is an order of magnitude less than their horizontal hydraulic conductivity. The horizontal hydraulic conductivity of the upper two aquifers is 10 to about 36 times that of their vertical hydraulic conductivity. Thus, under an equal hydraulic gradient, groundwater moves more rapidly horizontally than vertically through these units, and more rapidly through the Upper Glacial Aquifer than through the Magothy and the Lloyd Aquifers.

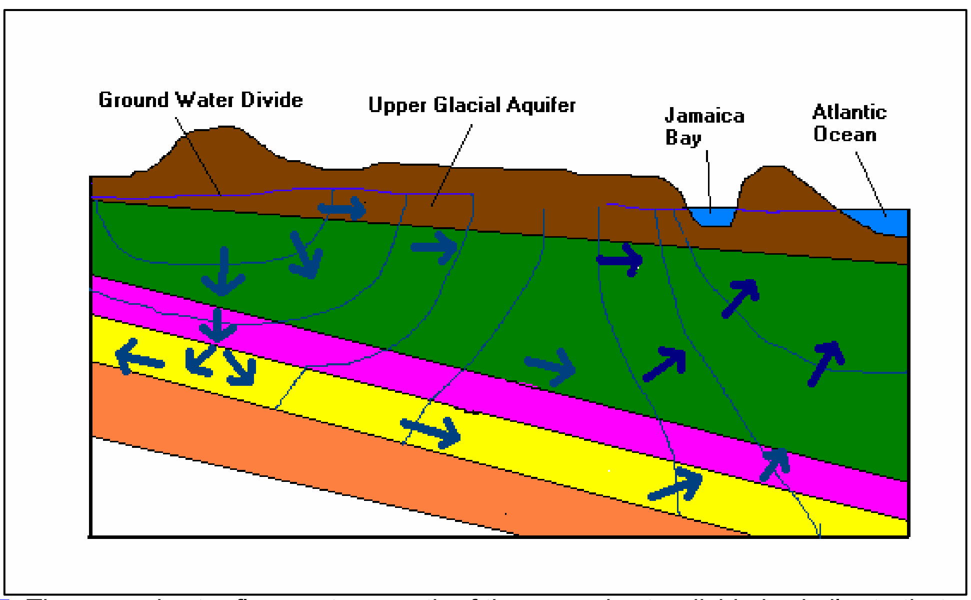

Figure 35. The groundwater flow system south of the groundwater divide is similar to that north of the divide; water moves downward and then horizontally in the aquifers, and finally moves upward to discharge into either Jamaica Bay or the Atlantic Ocean

The general pattern of water movement in each of the aquifers, as indicated in Figure 35, is from the groundwater divide southward to Jamaica Bay and the Atlantic Ocean. The distribution of hydraulic head in the three aquifers is shown in Figure 35 by hydraulic-head contours. The potentiometric surface of the Upper Glacial Aquifer slopes gently to the north and south from a central high, except in the western part of the island where groundwater withdrawals have lowered the water table and created cones of depression. Water enters the system as recharge at the groundwater divides where the hydraulic head is highest, then moves northward, southward, and downward, all directions of decreasing hydraulic head.

Thus, some of the water from precipitation that percolates downward into the Upper Glacial Aquifer continues to move downward into the Magothy Aquifer, through the Raritan confining unit, and into the Lloyd Aquifer. The groundwater divide of the Upper Glacial Aquifer is reflected in the Magothy and the Lloyd Aquifers (Figure 35), along the lines of section that represent natural, predevelopment conditions. Under actual withdrawal conditions, the divide of the Lloyd Aquifer would be shifted northward. The water that reaches each of the aquifers moves horizontally away from the divide toward discharge areas, but there also is a downward component that moves water into the underlying aquifers (Figure 35).

At discharge areas, water at depth moves nearly vertically upward either through overlying aquifers and confining units, or directly to aquifer subcrop areas where the water is discharged to the peripheral saltwater bodies. Note that hydraulic head contours are deflected by the Raritan confining unit because its low permeability retards the downward movement of the water.

Even though the clay has very low permeability, water does move through this confining unit. This flow system is present throughout Long Island where natural conditions prevail. Fresh groundwater is discharged along most of the periphery of the island. The discharge of freshwater, which is less dense than saltwater, prevents the saltwater from entering the aquifers. A transition zone between freshwater and saltwater is maintained, under equilibrium at the periphery of the island, which parallels the upward curve of the discharging freshwater (Figure 32). Equilibrium conditions, however, have been disturbed in Kings, Queens, and part of Nassau Counties, where groundwater withdrawals have lowered hydraulic heads in each of the aquifers (Figure 34) and, in some cases, reversed the direction of flow so that water moves toward the pumping wells. As a consequence, wedge shaped bodies of saltwater have entered the Upper Glacial, the Jameco, and the Magothy Aquifers. Saltwater also has undoubtedly moved inland in the Lloyd Aquifer, but data are not available to locate the present position of the saltwater wedge.

Water Quality

The changes in the quality of water as it moves through the hydrologic system in GNRA are described in Figure 36. Moisture laden air that moves over the ocean picks up salty spray. Precipitation removes salt, dust, and gases from the atmosphere as it falls to earth; the average dissolved solids concentration of precipitation has been reported to be about 10 milligrams per liter. Evapotranspiration concentrates and increases the dissolved solids concentration of the water. Natural processes, especially oxidation, modify dissolved solids concentrations and the chemical character of the water in the zone of aeration. Flow through the saturated zone tends to increase the dissolved solids concentration in the water, but since aquifer materials are virtually chemically inert, little change occurs.

Thus, the salient features of the natural water chemistry of the area are: 1) Natural freshwater has a remarkably low dissolved solids concentration; 2) The chemically inert materials that form the aquifer cause little change in the dissolved-solids concentration of the water as it moves through the groundwater flow system; 3) Mixing of freshwater and saltwater in the transition zone results in water with high concentrations of sodium chloride and dissolved solids; and 4) The pH of groundwater is commonly less than 6.0, which causes the water to be corrosive.

Groundwater contamination from various sources is a long-standing problem on Long Island. Saltwater encroachment from excessive groundwater withdrawals has rendered much of the groundwater in Kings and Queens Counties non-potable (Figure 37). In Nassau and Suffolk Counties, septic systems, oil and gas spills, and

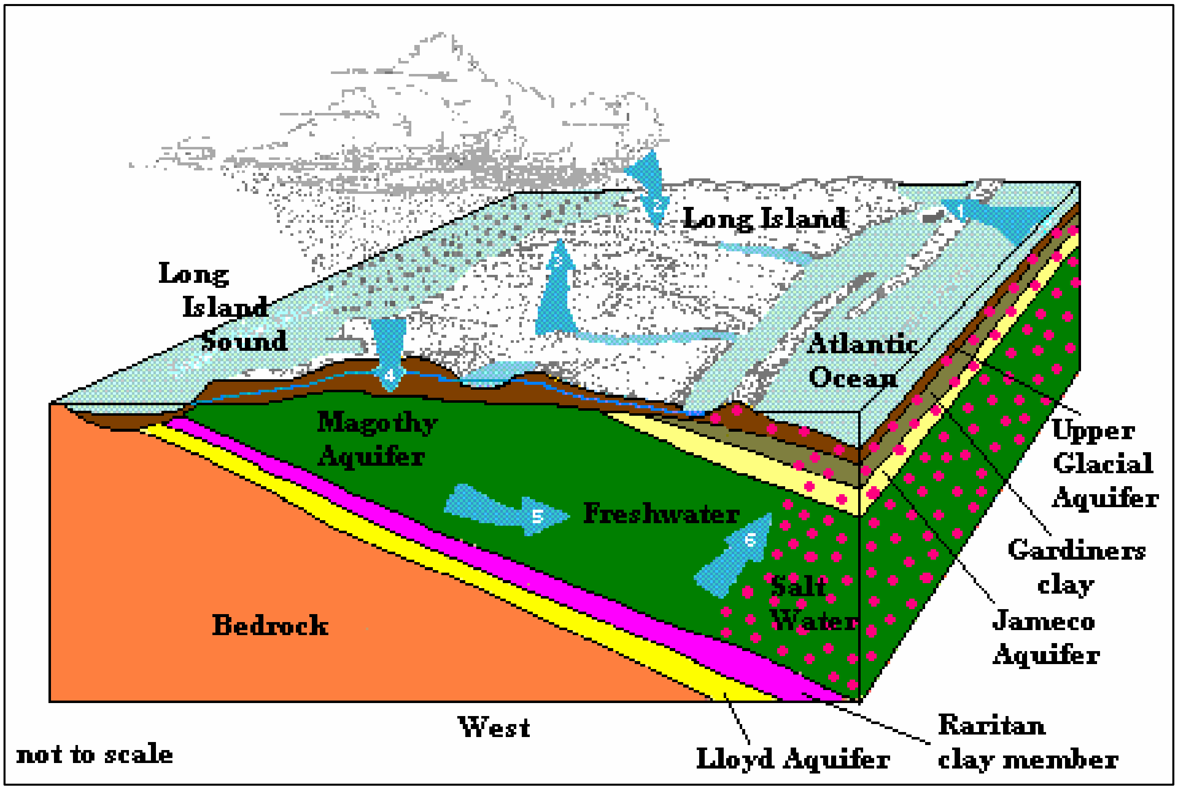

Figure 36. A number of processes affect water quality as the water moves through the groundwater flow system.

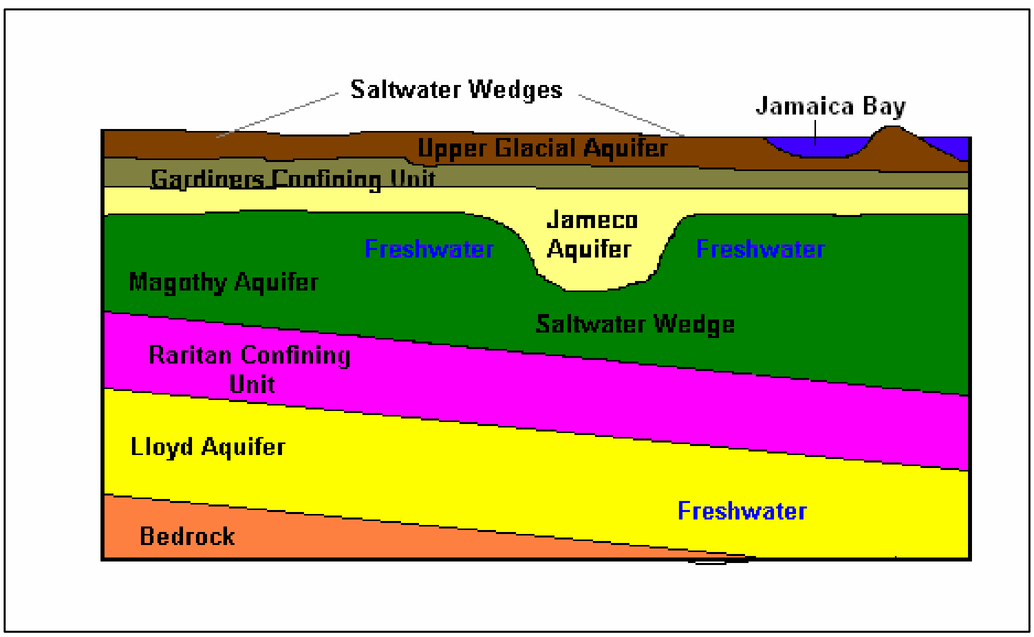

Figure 37. Saltwater has entered the Upper Glacial, Jameco, and Magothy aquifers in the southwestern part of Queens and Brooklyn as a result of large groundwater withdrawals that have disturbed equilibrium conditions.

pesticide use have contaminated much of the Upper Glacial Aquifer and forced most users to withdraw water from the Magothy Aquifer. In the remainder of Suffolk County, which is not densely populated, contamination generally is not a serious problem. On the eastern end of the island, however, truck farming has introduced some pesticide contaminants into the Upper Glacial Aquifer. Fresh groundwater withdrawals on this densely populated and urbanized island were about 469 million gallons per day during 1985. Public supply accounted for about 71 percent of the withdrawals, and withdrawals for industrial, mining, and thermoelectric power were estimated to be about 15 percent. Combined domestic, commercial, and agricultural uses accounted for the remaining 14 percent of total withdrawals.

Within the water cycle, potential threats to human health range from contaminated waters washing onto a bathing beach, to pesticides or oils leaching into the groundwater. The Jamaica Bay estuarine system, for example, is primarily supplied by freshwater from surface streams, rainwater runoff (storm and combined sewer), and sewage treatment plant effluent. Since 1976, the Division of Natural Resources (DNR) at GNRA has been inventorying and monitoring organisms associated with various Gateway habitats. Water quality testing parameters include physical, chemical and biological (Table 2).

Although water quality has improved over the past 20 years due to the Clean Water Act and substantial investment in sewage treatment plants, there are still problems associated with increased population and development. Long-term solutions will take more research, improvements in monitoring and remediation technology, and a better understanding of the interactions between the various components of the urban ecosystem.

Table 2. Testing parameters in a study of Jamaica Bay water quality (personal communication with Mark Ringenary, Water Quality Specialist, USDI-NPS-GNRA-Division of Natural Resources).

Physical	**Chemical**	**Biological**
Meteorological (wind, rain)	pH	Chlorophyll-a
Bathymetry	Nitrite/Nitrate	Coliform Bacteria
Tidal	Phosphates (total / Ortho)	
Temperature	Salinity/Conductivity	
Turbidity	Dissolved Oxygen	
Location in water columns	Chlorine	

Hydric Soils

Soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil are hydric soils. Poorly and very poorly drained soils are hydric; somewhat poorly drained soils can sometimes be hydric. Under prolonged saturation, actively growing plants and microorganisms can readily deplete oxygen in the soil. This lack of oxygen restricts aerobic root respiration and aerobic microbial reactions, and promotes several processes: 1) the transformation of several elements from an oxidized to a reduced chemical form; and 2) the accumulation of organic matter. Evidence of these processes is used in identifying hydric soils.

The microbial breakdown of soil organic matter is an oxidation-reduction process. Under aerobic conditions, organic matter is oxidized (looses electrons), and oxygen (O_2) is reduced (gains electrons), and combines with hydrogen to form water. The ultimate products of aerobic degradation are CO_2 and H_2O. When the soil is flooded, the amount of oxygen is decreased; with continued breakdown of organic matter the oxygen can be completely consumed, and the soil becomes anaerobic. Biodegradation of organic matter now continues under different conditions; as different groups of microbes go to work using different electron acceptors instead of oxygen. These processes are not as efficient or as complete as the aerobic one. Nitrates, manganese oxides, iron oxides, sulfates, and carbon dioxide are soil compounds that can be used as electron acceptors in anaerobic microbial reactions, in that order (Table 3). After the removal of oxygen, nitrate is the first soil component to be reduced, then manganese, then iron, and eventually sulfate and carbon dioxide.

These transformations bring about the translocation and/or accumulation of these elements, which can result in soil features (color, smell) useful in the identification of saturated zones in soil.

Nitrogen transformations in hydric soils can make the nutrient less available for plant uptake. However, excessive amounts of nitrate, the mobile form of nitrogen, can be reduced to gaseous nitrous oxide (N_2O) and nitrogen (N_2), preventing leaching losses.

Table 3. Oxidized and reduced forms of nitrogen, manganese, iron, sulfur and carbon (from Mitsch and Gosselink, 1993).

Element	Oxidized Form	Reduced Form
Nitrogen	NO_3^- (Nitrate)	N_2O, N_2, NH_4^+
Manganese	Mn^{+4} (Manganic)	Mn^{+2} (Manganous)
Iron	Fe^{+3} (Ferric)	Fe^{+2} (Ferrous)
Sulfur	SO_4^{-2} (Sulfate)	S^{-2} (Sulfide)
Carbon	CO_2 (Carbon Dioxide)	CH_4 (Methane)

In saturated soils, manganic (Mn^{+4}) compounds of manganese are reduced to more soluble manganous (Mn^{+2}) forms. Re-oxidized and re-deposited manganic oxides appear as black films or coats on soil particles.

Iron is an especially important coloring agent in soils. Oxidized, or ferric (Fe^{+3}), forms of iron give soils their characteristic brown, yellow, or red colors. When iron is reduced to the ferrous (Fe^{+2}) form, it becomes soluble, and can be removed from certain areas of the soil.

$$\underset{\text{Ferric}}{Fe(OH)_3} + \underset{\text{electron}}{e^-} + 3H^+ \rightarrow \underset{\text{Ferrous}}{Fe^{+2}} + 3H_2O$$

When the iron is removed, a gray color remains. If the iron is not removed and remains present in the ferrous form, **gley** colors, shades of bluish-gray or greenish gray, can result. Upon aeration, reduced iron can be re-oxidized and re-deposited, sometimes in the same horizon, resulting in a variegated or mottled color pattern. These soil color patterns, or **redoximorphic features**, resulting from saturation, can indicate the duration of the anaerobic state, ranging from brown with a few mottles to completely gray (Figure 38). Soils that are dominantly gray with brown or yellow mottles immediately below the surface are usually hydric.

Sulfates [$(S0_4)^{-2}$] in soil are reduced to sulfides (S^{-2}) when soils are nearly permanently saturated. The presence of hydrogen sulfide (H_2S) can be detected by the “rotten egg” odor, which is used as a hydric indicator. Sulfides can be toxic to microbes and plants, and, upon re-oxidation can lead to extremely acid conditions when sulfuric acid (H_2SO_4) is formed. Sulfides are more common in coastal wetlands than freshwater because of higher amounts of sulfate

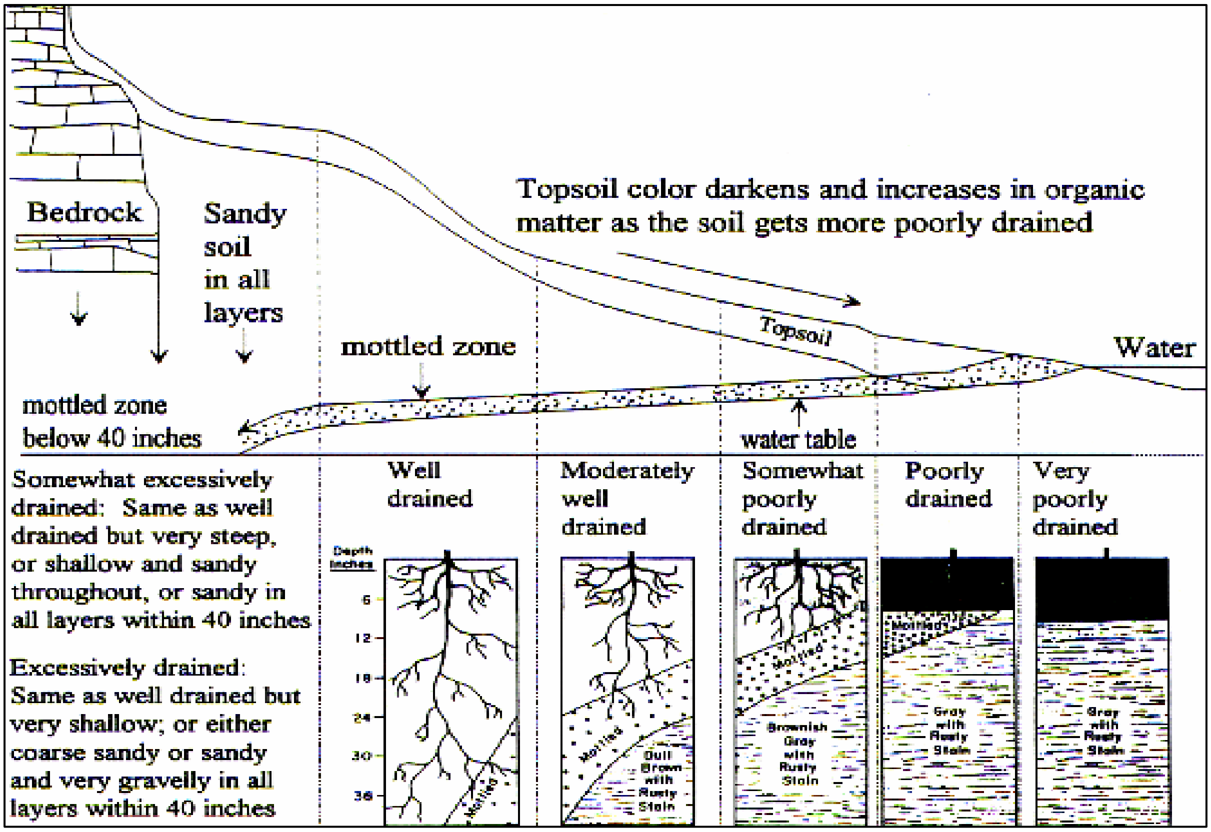

Figure 38. Root development, soil colors, water table depth, and drainage class in different parts of the landscape.

in seawater.

Certain bacteria can use CO_2 as an electron acceptor, resulting in the formation of methane (CH_4), or "swamp gas." Methane production is generally higher in freshwater environments.

Under anaerobic conditions, biodegradation and decomposition of organic matter proceed in a very inefficient and slow manner. If a soil is saturated at the surface for extended periods during the growing season, the rate of accumulation of organic matter can greatly exceed the rate of decomposition. Nearly all soils have some organic matter, but when the amount is greater than 20 to 35% (on a dry weight basis), it is considered to be organic soil material. If 16 inches or more of the upper 32 inches of a soil is organic soil material, the soil is considered an organic soil, or **histosol**. Organic soil material has a lower bulk density and a higher nutrient and water holding capacity than mineral soils. The term peat (or fibric material) is used to refer to organic material in which the plant parts are still recognizable, and muck (sapric material) for that which is highly decomposed, with no recognizable plant parts. Mucky peat (hemic material) is intermediate between the two. As organic materials further decompose the water holding capacity decreases while bulk density increases, and the color becomes darker.

Soil wetness can result from either an apparent or a perched water table (Figure 39). An apparent water table is the upper surface of the groundwater which extends vertically without interruption. Perched water tables exist where water is "perched" in a saturated zone overlying a restrictive layer with very low permeability. Unsaturated layers with higher permeability can be found below the restrictive layer. Perched water tables can be found in various landscape positions.

The formation of hydric soils takes place over a period of many years. The factors that lead to the development of hydric soils (flooding or ponding and the development of anaerobic conditions during the growing season) are also likely to result in the formation of some type of wetland. Hydric soils support the growth and reproduction of hydrophytic (water loving) vegetation. Commonly found herbaceous hydrophytic plants include cattails, rushes, sedges, spartina, and skunk cabbage. Woody plants include certain species of

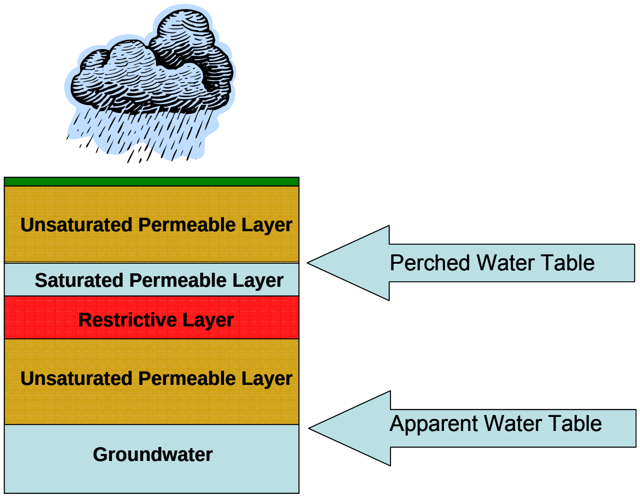

Figure 39. Restrictive layer perches water.

birch, dogwood, viburnum, and willows. Soils that are hydric and support the growth of hydrophytic vegetation and have wetland hydrology are wetlands as defined by law.

Hydric soils can be classified in one of two broad categories, either organic or mineral. Organic hydric soils developed in the decomposed remains of woody and herbaceous plants. Organic soils in GNRA that are hydric include the Ipswich and Pawcatuck series, found in tidal marshes and other low, swampy areas. Mineral hydric soils do not have a sufficient thickness of organic material to be classified as histosols. They may have a wide range of texture, from sand to clay. Soil colors can also vary from red to gray but tend to be very dark gray or black in the surface layer, with gray and mottled yellow or rusty brown in subsoil layers. Mineral soils in GNRA that are hydric include the Barren, Fishkill, Flatland, Jamaica, Matunuck, Sandyhook and Winhole series. Many of these soils are sandy with a high permeability. They are found in low-lying areas where a high regional water table makes conditions favorable for the development of a hydric soil.

Redoximorphic features, which give the soil its characteristic mottled color, can be used as an indicator of a hydric soil. However, certain conditions in mineral soils may mask redoximorphic features or inhibit their development. Red colored parent material, found on Staten Island, may contain iron minerals that are more resistant to reduction, making hydric soil determinations problematic. Sandy textured soils tend to have lower amounts of iron.

In instances of disturbance, soils may be altered to the extent that they are no longer hydric, or can become hydric. Some types of altered soils are drained, artificial and historic. Drainage is an attempt through human activities to decrease wetness. Ditches, levees, dams, or pumps may have altered these soils. Even with reduced wetness these altered soils maintain their hydric status. Artificial hydric soils are soils in which the wetness has been increased by human activities, e.g., constructed wetlands. Historic hydric soils have had additional soil material placed on top of the original soil by human activities to the extent that they are no longer hydric.

Dredging activities may also modify soils by removing submerged hydric materials and re-depositing them onto non-hydric landforms. The dredge material is then exposed to an aerobic, oxidizing environment. Some relic hydric redoximorphic features may persist, or new ones may develop. In GNRA soils that are formed in dredge material include Bigapple, Fortress, Barren, Jamaica, and Sandyhook.

Relict hydric soils are those that are no longer wet due to changes in the landscape or climate. Several morphological characteristics can suggest relic redoximorphic features. Contemporary redox concentrations have diffuse boundaries while relic redox concentrations may have sharp boundaries. Contemporary nodules and concretions have diffuse boundaries, irregular surfaces, and smooth, round red to yellow corona (halos) should be present. Relic nodules and concretions have sharp boundaries and smooth surfaces. Contemporary hydric soils may have iron depletions along stable macropores in which roots repeatedly grow that are not overlain by iron rich coatings. Relic hydric soils may have iron depletions along stable macropores in which roots repeatedly grow that are overlain by iron rich coatings.

Recognizing hydric soils and the boundary of hydric soil areas can be useful in defining the boundaries of wetlands. In the past, organic soils were considered worthless and used as garbage dumps. Within the last 10 or 15 years wetlands have been recognized as having many important functions and values. These include floodwater storage, floodwater conveyance, groundwater discharge or recharge, erosion control, wave attenuation, water quality protection, and plant and wildlife habitat.

Sedimentology of Beaches and Barrier Island Beaches

Longshore transport of sand by wave action is perhaps the most important process of shoreline dynamics (Figure 40). Longshore sand movement depends on the angle at which waves approach the beach and the amount of wave energy. Wave energy is a function of wavelength, wave frequency and wave height. This energy is derived from wind drag on the ocean's surface and is a function of wind speed, duration, and fetch.

The dominant wave action direction in GNRA is from the southeast, from prevailing wind zones and storm events in the tropics and the South Atlantic. Hurricanes during the summer season and cold fronts moving south during the winter season are responsible for intense periods of sediment transport and beach erosion or accumulation. The continuous supply of sediments from rivers, longshore currents, and marine currents on the continental shelf cause the shoreline to move down current and seaward. The evolution of the spits on the Rockaway Peninsula (Figure 41) and Sandy Hook Peninsula (Figure 42) are a testament of the migration processes during historic times.

The sorting action of waves and nearshore currents cause sand and gravel to accumulate nearshore on bars and on beaches, whereas currents transport the finer grains (silt and clay) to quieter water settings (deeper water, restricted bays, lagoons, or tidal flats). Either an increase in wave energy or a cut-off of sand supply will increase beach erosion. Stable beaches receive a constant supply of sand to replace what was removed by erosive forces.

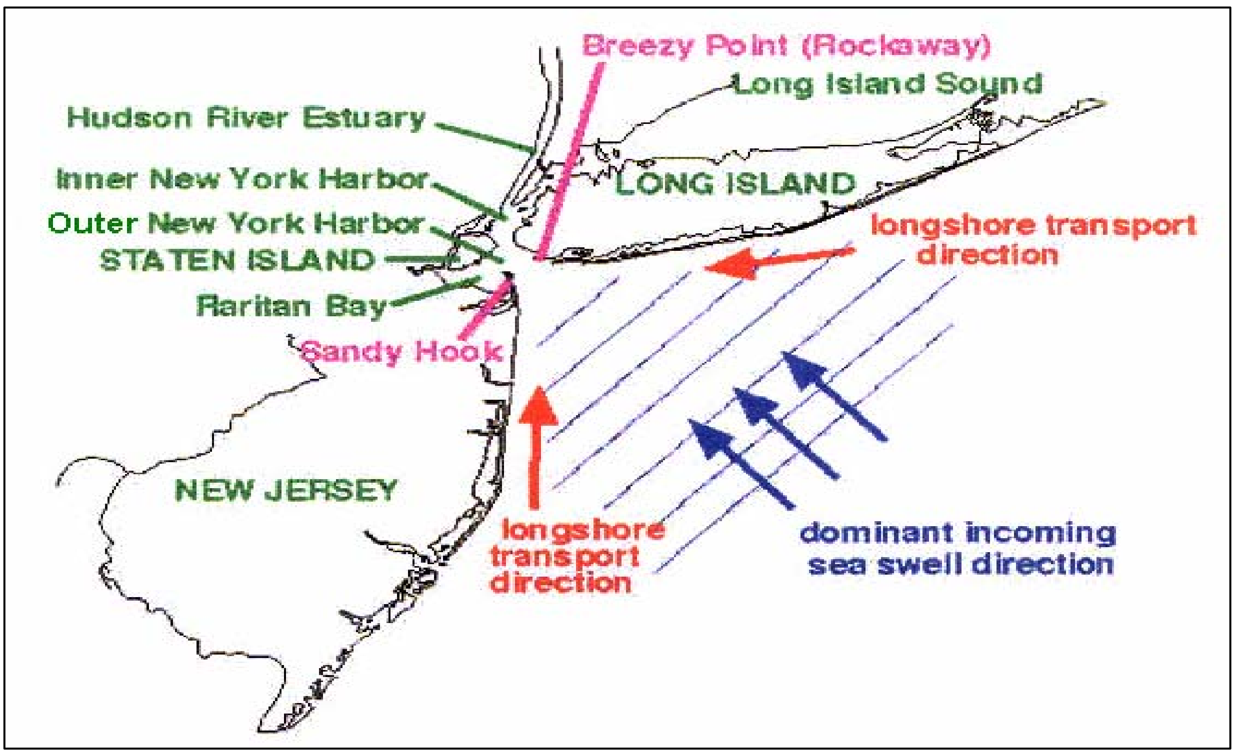

Figure 40. Shoreline dynamics consist of longshore transport and dominant sea swell direction (adapted from Stuffer and Messina, 1996).

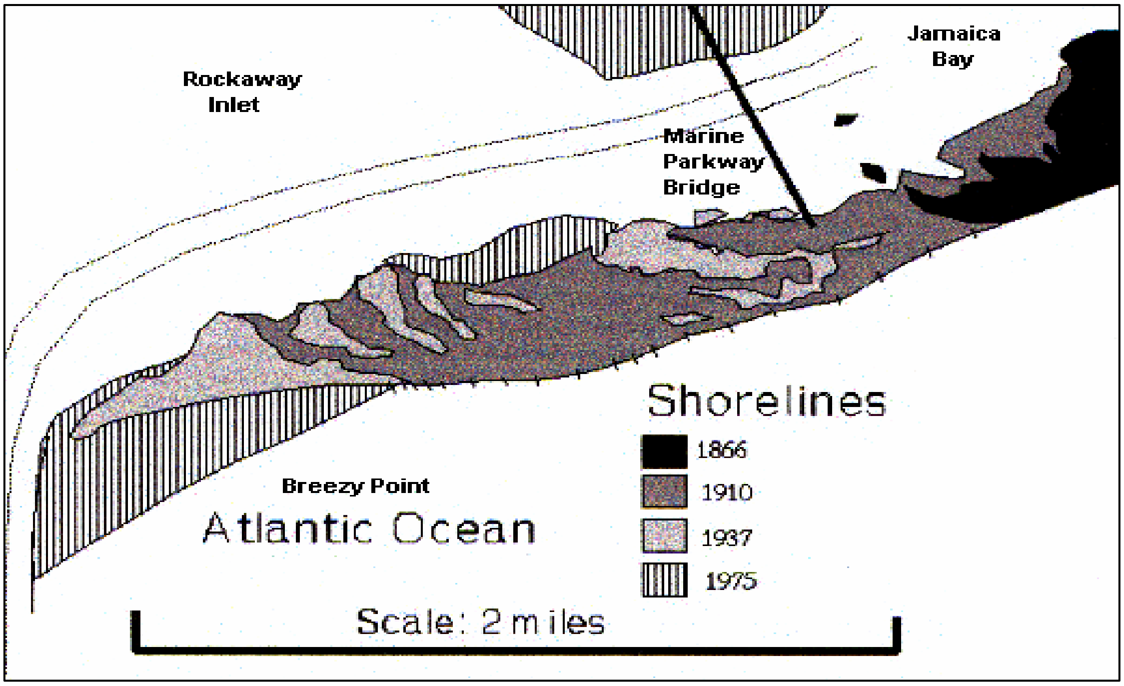

Figure 41. Process of the growth of Breezy Point Spit, Rockaway, Queens from 1866 to present (adapted from Stuffer and Messina 1996).

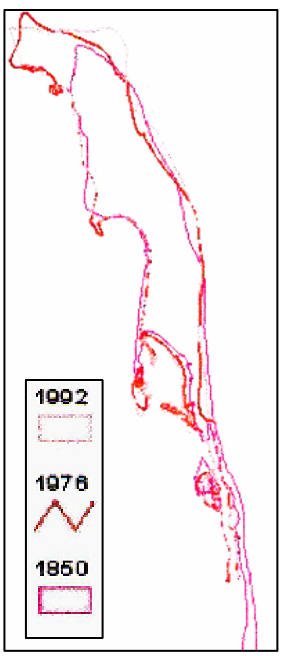

Figure 42. Sandy Hook shoreline changes from 1850 to present (courtesy of URI)

Dynamics of Beaches and Barrier Island Beaches

Soils and the essential features of a barrier island are illustrated in Figure 43. In general, offshore bars store sand eroded during storms. During quieter periods the sand migrates back to the beach, maintaining a continuous cycling of materials. The rise and fall of the tide keeps the lower beach moist. Where the swash of the waves stops on the upper beach, shell material and other debris accumulates (dominantly clam shells). This temporal accumulation of debris is called the wrackline. A wrackline consist of a variety of materials that accumulate where the highest swash stops and/or partially sinks into the sand, leaving objects stranded.

The back beach area is only flooded during winter storms and during the highest spring tide surges. Winter coastal winds dry out the back beach area and redistribute some of the sand to the back beach dunes. Back beach dunes frequently reach 20 to 30 feet in elevation in undisturbed localities, and may take several decades to centuries to form. In the past dunes were commonly sacrificed to add sand to beaches and to allow coastal residents a better view.

Beaches are constantly changing. Each year the spits on the end of barrier islands grow longer. Eventually a storm will come along and strip much of the sand away and deposit it on offshore bars or onto the shore of the next island down current. As sea level continues to rise, the barrier islands migrate landward. In regions where tectonic forces are causing the land to slowly rise, old beaches and barrier islands are left stranded, forming inland ridges parallel to shore. When the sand supply increases, islands grow, when it is reduced, islands erode. The variability of sand supply in the past was a reflection of climate and sea level change.

When the glaciers were rapidly melting, huge amounts of sand were contributed to regional shorelines. However, as the glacier receded, the sand supply dwindled and sea level continued to rise, drowning older barrier islands. Sand ridges on the continental shelf are, in part, the eroded remnants of submerged barrier complexes.

Sea level has been rising worldwide for the past 18,000 years due to the melting of the ice sheets and the thermal expansion of the oceans. The rate of sea level rise over the past 80 years, measured at Sandy Hook and Atlantic City, NJ, is about 3.8 mm/year. This would result in an increase of 38 cm (15 inches) in 100 years, but this rate could be accelerated by human–induced global warming. According to Rosenzweig and Solecki (2001), projected global warming rates may bring about a sea level rise from 9.5 to 42.5 inches by the 2080's. If the polar ice sheets were to melt completely, sea level would rise by about 70 meters (NJGS, 1998). This would result in a substantial loss of coastal land and wildlife habitat.

Coastal areas are becoming more crowded every year in the United States. In 1960 an average of 187 people were living on each square mile of coastal land (excluding that in Alaska). This population density increased to 273 people per square mile by 1994, and is expected to reach 327 by 2015. Population densities are highest along the East Coast, especially in the Northeast (Bureau of the Census, 1994). Shoreline erosion is a natural process but, in many cases, it is accelerated by intensive land use and mismanagement.

Almost every shoreline erosion problem is unique and must be dealt with individually. There is a variety of erosion control methods. Structural methods such as bulkheads, groins, revetments and riprap are often effective. But they are expensive to build and maintain, and may have adverse environmental effects. Transplanting salt marsh vegetation is an alternative erosion control method that is relatively inexpensive and effective on some shorelines. Establishing vegetation is much cheaper than structural methods of erosion control, and the new marsh provides habitat, food and nutrients for organisms in the surrounding estuarine waters.

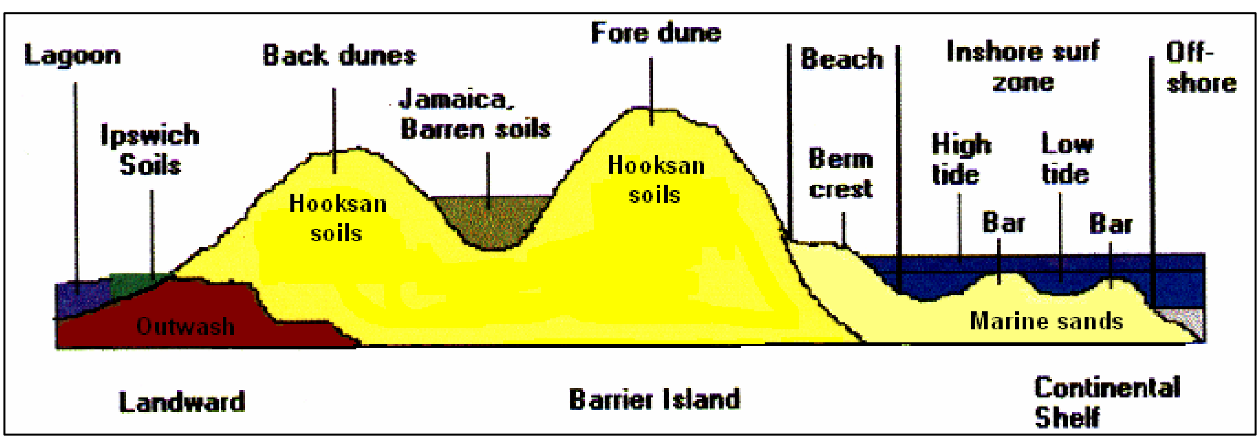

Figure 43. Soils and features of a GNRA barrier island (adapted from Stuffer and Messina, 1996).

Tidal Marshes of GNRA

The jig-saw puzzle of broken land found on a topographic map at the center of Jamaica Bay is among New York City's most striking geographic features. The pieces are salt marsh islands; tidewater grasslands that colonized post-glacial outwash plains at the terminus of many creeks and streams on Long Island. They are buffered from punishing Atlantic storms by a necklace of barrier island beaches. The Jamaica Bay salt marshes are home to millions of macro-organisms and untold amounts of micro-organisms (Figure 44) that demonstrate why salt marshes are one of the most productive ecosystems on earth. The last remaining expanses are a reminder of New York City's once vast maritime resource and since they are still abundant with fish, shellfish, birds and mammals, now is an ideal time to explore new opportunities for their management and protection.

Ironically, most of the tens of thousands of acres of lowlands that helped establish colonial New York commerce required filling in order to continue to support it! An international airport, businesses, homes, and highways are just a few of the modern day necessities that replaced the marshes.

At the beginning of the twenty-first century, the question we might ask is this: Is this the last vestige of a vanquished resource long past its heyday; or is it a sustainable and productive system, even as its size dwindles and human impacts broaden? The answer can be subjective based on what one perceives the state of the resource to be. "It smells, and it's dirty" or "it is a wonderful recreational place" are two common perceptions.

Researchers have studied the marine environment of Gateway National Park because health of the ecosystem is constantly being debated. The fate of the resource is continuously at stake and empirical evidence is needed to answer difficult management questions. There are many resource components in the marine environment. This section focuses on one - marshland; with the emphasis on land and the soils that form it, the grasses that anchor it and the forces that shape it. Some of the more intriguing questions scientists have been asking about the Gateway marshes are whether they are sustainable at the current level of management and protection. Are more aggressive protections needed? Are more active management strategies required?

Figure 44. Salt marshes provide habitat to a large number of marine organisms.

Many other components of Raritan and Jamaica Bay ecosystems (fisheries, shellfish, submerged vegetation) have evidenced serious decline. What then is the status of tidal marshland? Is decline reversible or inevitable?

What makes these questions of sustainability so challenging is inherent to the very nature of salt marsh systems. It is important to understand the complexities of the system before further consideration of the questions that are posed. Scientists have discovered that salt marsh systems are the product of the dynamic conditions in which they exist. Relative to other systems, such as mountain and valley formation, salt marshes form very rapidly and survive a constant barrage of change. An example can be found here in the geological history of lower Brooklyn and Queens, New York. As glaciers receded and sea levels rose at the beginning of the post-glacial epoch, newly formed land on the outwash plain became available to plant communities. Lowland valleys flooded with seawater, and salt marshes formed. As seawaters continued to flood the interior coastline, freshwater and upland species gave way to salt marsh species. It is estimated that today's mid-Atlantic marshes are no more than three thousand to five thousand years of age. The post-glacial epoch is a history of dramatic coastline changes. What pattern of salt marsh development will exist if humans maintain a lengthy presence in these lowlands and at the same time sea levels continue to rise? Without available land to colonize, how will the salt marshes respond to the stasis brought on by human populations?

Historical coastline formation provides an example of salt marsh system dynamics on a macro-level. On a micro-level it is easy to see the dynamic system at work. A flux is created by the daily ebb and flow of diurnal tides, changing tidal amplitudes, rising and falling salinity and nutrient levels, scouring and accretion of sediments. Very few plants and animal species have succeeded in this challenging environment. Those few species that have the necessary adaptive mechanisms are found in great abundance. Competition for the land resource is low. The result is low species diversity. It could be said of the species that do survive, that they do so in spite of, and also because of, the challenging conditions.

Intensive human use not only exaggerates a given set of hostile conditions, it presents a whole new set of conditions to be met. In New York City, development and minor filling activities have not curtailed. Unprecedented amounts of nutrients and pollutants flow from pipes at storm water outfall points along the bay. In fact, marshes contribute to sediment capture, they reduce turbidity in the water column, and they are essential to the nutrient cycling dynamics within shallow water systems. But, can we expect that the remaining marshlands of Jamaica Bay or Raritan Bay fully serve this function? Some bay and estuary species such as Eel Grass (*Zostera marina*) have already stopped responding to the challenge and are wholly or nearly extirpated from the New York Harbor Estuary. Another question arises. What other critical species of our urban estuary may no longer continue to respond?

North American mid-Atlantic salt marshes exist at the elevation that is flooded by high tides and left exposed by low tides. This gray area in between land and sea is called the intertidal zone (Figure 45). Within the intertidal zone are distinct plant communities. At Jamaica Bay and throughout much of the Atlantic Coast, the dominant plant of the salt marsh is a grass species called Smooth Cordgrass, *Spartina alterniflora*. *S. alterniflora* is flooded daily by the tides. The community that is dominated by *S. alterniflora* is called the low marsh.

The demands on life forms in the low marsh are so challenging that a single species such as *S. alterniflora* can constitute more than 99% of all biomass production among vascular plants within that zone.

Gradient patterns of salinity, freshwater and nutrient availability and variable hydrologic flow shape distinct vegetative patterns within the intertidal zone. The low marsh itself is a patchwork of varying plant heights due to the presence of low form and tall form *S. alterniflora*. Though identical species, the different forms are the results of resource availability or limitations along the gradient.

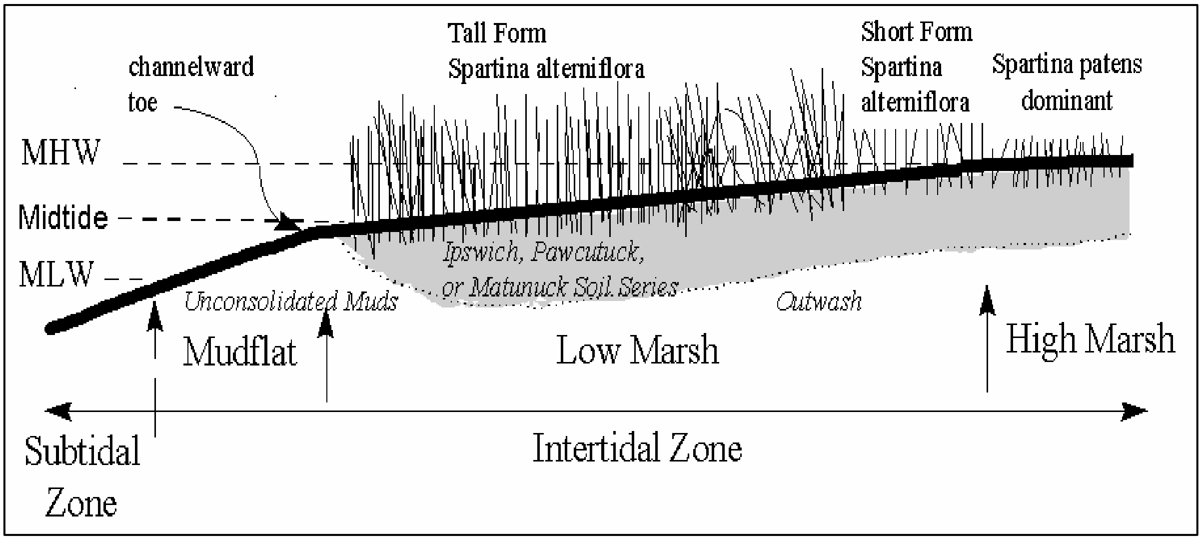

Figure 45. The intertidal zone between the mean low water (MLW) and mean high water (MHW) is in a protected marine environment. Typical shoreline profile of Jamaica Bay salt marsh as it existed prior to human disturbance and as it exists today in several locations. Subject to moderate current energy and wave action. Topography is marked by gradual slopes and large expanses of salt marsh vegetation.

In a salt marsh, the full intertidal zone is comprised of low marsh, high marsh and mudflats. High marsh occupies the highest elevation. Tidal flow is limited in the upper reaches of the intertidal zone. Surface flow reaches the high marsh only on the highest tides of the lunar calendar (spring tides). One or two floods per year are enough to sustain the salt tolerant species and eliminate competition from freshwater species. In New York, high marshes are dominated by Salt Meadow Hay (*Spartina patens*). Other plants may dominate as well: Spike Grass (*Distichlis spicata*); Black Grass (*Juncus gerardi*); or Glasswort (*Salicornia europea*). Open flats occupy the lowest part of the intertidal zone. Mud flats or sand flats contain no vascular plants. The unconsolidated, often water-saturated sediments are an inhospitable medium for plant growth. The surface and near surface are host to an array of estuarine invertebrates including snails, bivalves, and shrimp like organisms.

Since these flats are left unprotected without plant cover, they are subject to movement and re-deposition during major storm events. This can lead to new formations of vegetated marsh or to its decline if the re-deposited sediments smother an existing vegetated patch.

Salt marshes are exceptional in their ability to maintain the soils they have created, and also in their ability to rapidly colonize newly available lands such as wind or storm swept deposits of sand. A new colony of salt marsh grasses begins when a few plants establish themselves on coarse-grained mineral deposits or unconsolidated mud. Grasses offer resistance to the flow of water as it moves through the colony. This results in decreased turbidity as the fine-grained suspended solids and suspended nutrients drop out of the water column and are deposited on the surface. Fine-grained silts and clays are rapidly integrated into the soil matrix. The soil matrix consists of mineral sediments trapped in a fibrous blanket of roots and rhizomes. The plant communities are also affected by the organisms that dwell within them. Some species of salt marsh macro-invertebrates are so abundant that they dramatically affect the character of the soils and assist in soil formation. Fiddler crabs (*Uca spp.*) produce burrowing tunnels that improve the drainage and flow of soil pore water. Ribbed mussels (*Guekensia demissa*) anchor the soil surface and contribute to sediment accretion and soil building.

Salt marshes cover nearly 13,000 acres of the vegetated cover within the GNRA. Low marsh is the dominant cover type. High marsh is less common now, due to the last four centuries of human expansion. Well over ten thousand acres in the back bay were filled for residential development in what are now neighborhoods in Brooklyn, Queens and Staten Island. As low marsh occupies the more difficult terrain, much of it has been spared. The open water marsh islands of Jamaica Bay once contained low marsh stretching uninterrupted for miles, separated only by a network of drainage channels and tributaries. These marshes were characterized by gradual slopes and gently tapered banks. Jamaica Bay's Joco Marsh and Silver Hole Marsh, both island marshes, are the largest and most pristine. They are relatively free of adverse impacts and are most closely representative of pre-urbanized shoreline morphology (Figure 45). A typical pattern found in GNRA's urbanized salt marshes are narrow bands of vegetation adjacent to filled land on one side, and the open bay, channel, or tributary on the other (Figure 46).

While the Jamaica Bay Unit does contain extensive island salt marshes numbering hundreds of acres, many more hundreds of acres adjoin the mainland and the periphery of filled land. Some are sheltered behind the barrier beaches. A typical pattern found in GNRA's urbanized salt marshes are narrow bands of vegetation adjacent to filled land on one side and the open bay, channel, or tributary on the other (Figure 46).

Narrow bands of salt marsh are often referred to as 'fringing marshes' by scientists who study them. Fringe marshes are indicative of a fragmented resource, the remnants of a much larger system. They provide less service to the marine environment, due to their size and variety of impacts. Fringe marshes occupy a much greater amount of the total GNRA marsh area than they did prior to urban development. The exact amount is uncertain. As has been demonstrated in other habitat types, e.g., forested areas, fragmentation has led to a decline in salt marsh dependent wildlife species and an increase in species that occupy the edges. Breeding birds such as Clapper Rail, Seaside Sparrow and Sharp-tailed Sparrow have given way to Red-winged Blackbirds, and Marsh Wrens. Muskrats have given way to terrestrial species like Raccoon and Rabbits.

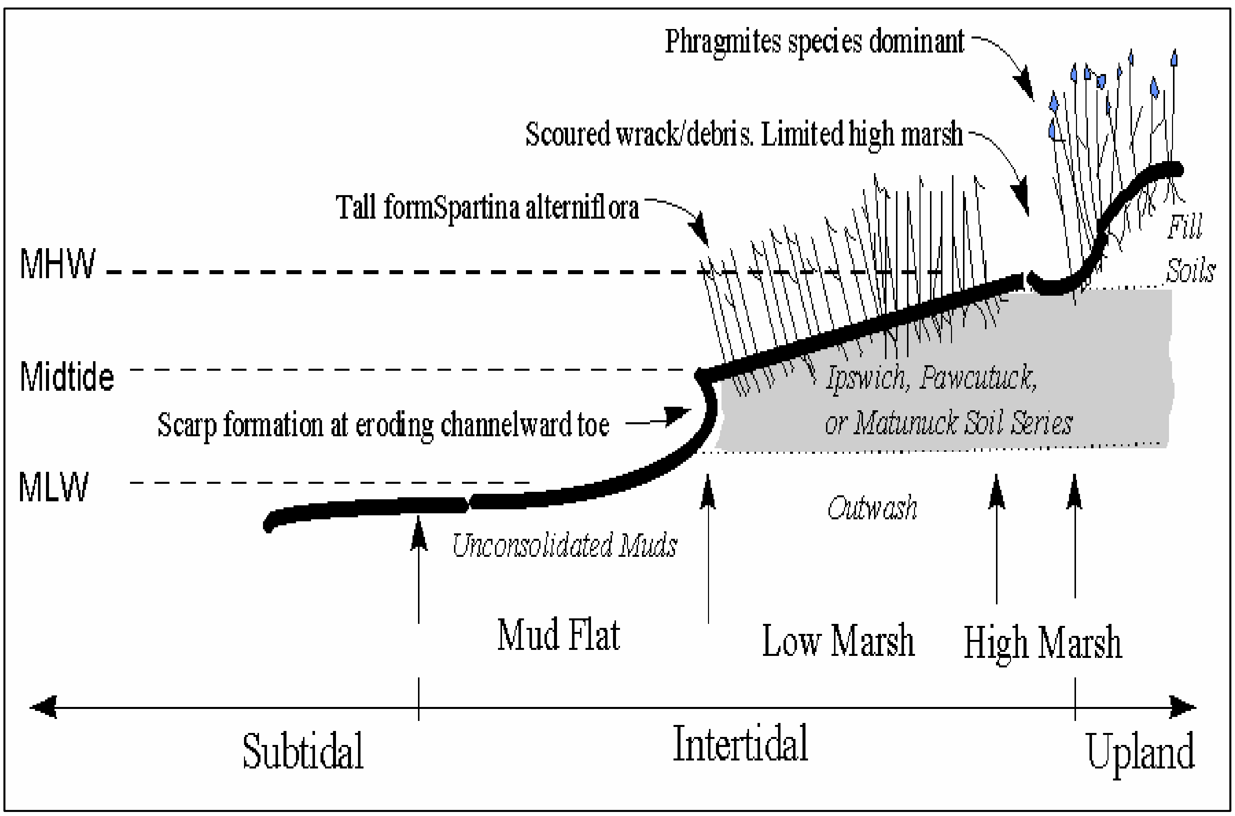

Figure 46. The intertidal zone between Mean Low Water (MLW) and Mean High Water (MHW) is in a protected marine environment. Typical shoreline profile at a fringing marsh in Jamaica Bay, showing the observed effects of filled land on a marsh profile. Toe formation typically in close proximity to boat traffic or open fetch.

Fringing marshes are poorer quality fish habitat because there are few, if any, minor tributaries and creeks that shallow water fish can use for protection and breeding. When a fringe marsh is adjacent to a navigational channel, it is less likely to have significant shallow water habitat (depth <12 feet). Often enough, the open adjacent water drops rapidly to lower depths where there are large predatory fish and crabs. A tiny marsh resident such as the Striped Killifish, or a young, transitory Bluefish or Striped Bass, becomes the prey.

Upland areas adjacent to the marsh are largely created with urban fill or dredged materials. Filling has led to an increase in the total acreage of disturbed meadows. Disturbed meadows form on filled land, or within an impoundment. An impoundment occurs not from direct filling but from other structures, such as dikes, which block free hydrologic flow. Impoundments were created in Jamaica Bay for wildlife management in 1953. Often an impoundment is the accidental byproduct of rail and highway corridors.

Impoundments may be subject to flooding by storm tides and may contain salt marsh species. Typically they are dominated by meadow species with limited salt tolerance. Common Reed Grass, *Phragmites australis* and *P. communalis* are common sights in disturbed meadows at all three GNRA Units. Nearly all of the built lands adjacent to Jamaica Bay and most of the park interior of the Great Kills Unit are disturbed former salt marshes. By the 1960's Jamaica Bay had 13,000 acres of tidal marsh remaining, but had lost 12,000 acres. Today the loss of New York City's salt marshes since colonial settlement is estimated to be between 80% and 95%.

Most marshes were marginalized by human development prior to the inception of Gateway, except at Sandy Hook where natural forces, referred to as high energy zones, continue to marginalize marsh development. High energy zones tend to form beach profiles. The Sandy Hook Unit contains a few small marshes in protected coves. The best examples are Spermacetti Cove, observable on the west side of the peninsula as you approach the beach recreation areas, and further north, at Horseshoe Cove, highly trafficked by fisherman and school busloads of children.

There is an exciting phenomenon in a two-acre site at the Great Kills Unit. A new marsh is forming on the beaches where high energy waves have eroded away the steep shoreline bank. As the bank erodes, a historic marsh peat soil is exposed. The underlying marsh once extended hundreds of acres but has been buried since the 1930's by urban fill. Now decades later, the exposed peat soil has been recolonized by salt marsh grasses (Figure 47).

Figure 47. Former tidal marsh filled with sandy dredge. The buried muck may contain viable seeds from former vegetation. Salt marsh vegetation can be established again if hydrology is restored.

The two-acre site has become a favorite among birders who enjoy the increased diversity of species brought by the tiny marsh on Raritan Bay. Park visitors can witness this fascinating sight across from the new Ranger Station at the beach-front parking lot. Information like this can inspire optimism but still leave questions unanswered regarding the long term sustainability of the overall system and its components. Examining the Gateway marshes by use of soils as an indicator of system sustainability can help to answer these questions. Geographic Information System (GIS) mapping can generate information such as the total number of acres lost or gained, acreage of high marsh or low marsh, or it can track changes in shoreline morphology. It can do this for any specified location within the study area. GIS can be used as a storehouse of very detailed ground survey information including soils, vegetative cover, and sediment migration. This information can then be used to determine correlations between tidal marsh characteristics.

By examining the soil profile, including texture, structure, thickness, horizonation, organic matter content, and rooting patterns, the development of tidal marshes can be evaluated. In Sandyhook soils, salt grasses have colonized urban fill to form a whole new youthful marsh. At the other extreme is the highly developed Ipswich, with the greatest depth of organic matter, more than 51 inches. This depth of organic matter ranges from 0 to 8, 8 to 16, and 16 to 51 inches in Sandyhook, Matunuck, and Pawcatuck soils, respectively. Although this may suggest a simple comparison to determine relative age or origin, this is not necessarily the case. Variable environmental conditions may make it difficult to offer simple explanations as to origin or age. A thin layer of organic matter may indicate a newly developing salt marsh or a highly disturbed one. The type of organic matter, peat, muck, or mucky peat, may also indicate the stage of development or decomposition of the organic soil. Location and surrounding factors are critical determinants, and can make the difference between a young, advancing marsh, or an old declining one.

Conditions that affect vegetation will ultimately affect soil. The reverse is also true. When the underlying peat/muck fails, the vegetation fails, resulting in a loss of essential habitat. Typically the marsh undergoes natural gains and losses. Accretion of marshes results from the deposition of sediments in low energy waters, which are then trapped and held by existing vegetation (Figure 48). Increases in the sediment load result in the accretion of marshes. Ribbed

Figure 48. Salt marsh accretion has been observed in many low energy areas of GNRA.

mussels augment this increase by creating biosediments that may be exported during ebb tides. Although dense mussel masses may protect marsh edges and delay erosion of the bank, they can also be problematic. Algae feeding mussels deplete oxygen levels, which creates an environment detrimental to the sustainability of vegetation within inland pools on marshes. The accretion on the edges of marshes also causes a loss of low marsh that is inhibiting to species dependent on this habitat. Soil losses are a result of slumping, undercutting, surface erosion, steep vertical banks or disturbed vegetative patches. Petroleum spills, marine debris and floatables, commercial and recreational boat traffic, and combined sewer outfalls all exacerbate or compound natural effects.

The effects of human disturbance are evident on shoreline morphology. This is why successive decades of GIS based soil data will be revealing and may ultimately answer our most difficult questions about the sustainability of urban bay marshes.

Restoration ecologists, scientists who recreate or restore natural systems, have come to recognize the value of existing marsh soils when attempting to restore lost function. In the Arthur Kill waterway separating Staten Island from New Jersey, researchers have found that the presence or absence of remnant peat soils is a factor in the success of revegetating marshes damaged by a 1990 oil spill. And while seedling planting has been successful, marine invertebrates have been slow to respond and utilize the root-soil matrices as a host. However successful, the restoration is not comparable to healthy systems, due to the system wide degradation of the Arthur Kill. Because of the limitations of restoration to achieve small miracles, it is imperative that we put our greatest effort towards protecting and preserving the existing resource.

Excluding the losses to dredging and filling, the area of salt marsh islands in Jamaica Bay has decreased by 50% since 1924. In 2001, the National Park Service convened a panel of salt marsh specialists to evaluate the likely causes of this accelerated rate of marsh loss, and to make recommendations on short-term and long-term research priorities.Their conclusion was that numerous interrelated factors were to blame for the loss of salt marsh islands:

1) Dredging of channels and the bay bottom has created a sediment deficit, and increasing wave energy from winds and tides increases erosion of the island edges; 2) The westward extension of Rockaway Peninsula and the construction of a terminal groin has reduced sediment movement from the ocean to the bay; 3) Ribbed mussels create a poor environment for saltwater cordgrass survival; 4) Accumulated plant debris, or wrack, smothers marsh vegetation; 5) Waterfowl eat patches of marsh vegetation, leaving bare flats prone to erosion; 6) Contaminants from landfills may be reducing the vigor of salt marsh vegetation; 7) Boat wakes; 8) Sea level rise.

Suggested near-term investigations include:

- Build back recently submerged marshes;
- Quantify the effects of ribbed mussels and sea lettuce on saltwater cordgrass vigor and survival;
- Evaluate the role of contaminants;
- Map wrack distribution;
- Provide long term monitoring.

These investigations will increase our understanding of the disappearance of this valuable resource, and assist in restoring and maintaining the beauty and biological diversity of Jamaica Bay.

Detailed Soil Information

This section gives specific information about soil forming processes, soil horizons, how this survey was made, soil temperature, soil survey activities in NYC, classification of soils, soil map unit information, laboratory data, soil quality in Gateway National Recreation Area, soil map unit descriptions, and laboratory data results.

Soil Forming Processes

Soils are natural, three-dimensional bodies at the earth's surface that form as a result of the interaction of climate, living organisms, and relief, as they alter parent material over time (Jenny, 1941). Soil scientists study the interaction of these factors to predict soil patterns over the landscape. Four general soil forming processes act on parent material: additions, losses, translocations, and transformations (Simonson, 1959).

Urban soils are a vital component of the urban ecosystem. The most dominant soil forming factor in the urban environment is the human organism (Bullock and Gregory, 1991; Craul, 1992; Fanning and Fanning, 1989). Human impacts are called "anthropogenesis" (ICOMANTH, 1998). The energy humans use to modify natural landforms can be compared with the energy used by water, ice or wind to modify landforms or generate new parent material.

Hans Jenny (1941), a pioneer researcher on how soils form, established an equation to characterize the interaction of the five soil forming factors:

$$S\ (f) = PM, C, O, R, T$$

Parent material (PM) refers to that great variety of unconsolidated organic and mineral material in which soil formation begins (Figure 49). It determines the mineral and chemical makeup of the soil and exerts a strong influence on the rate that soil forming processes take place.

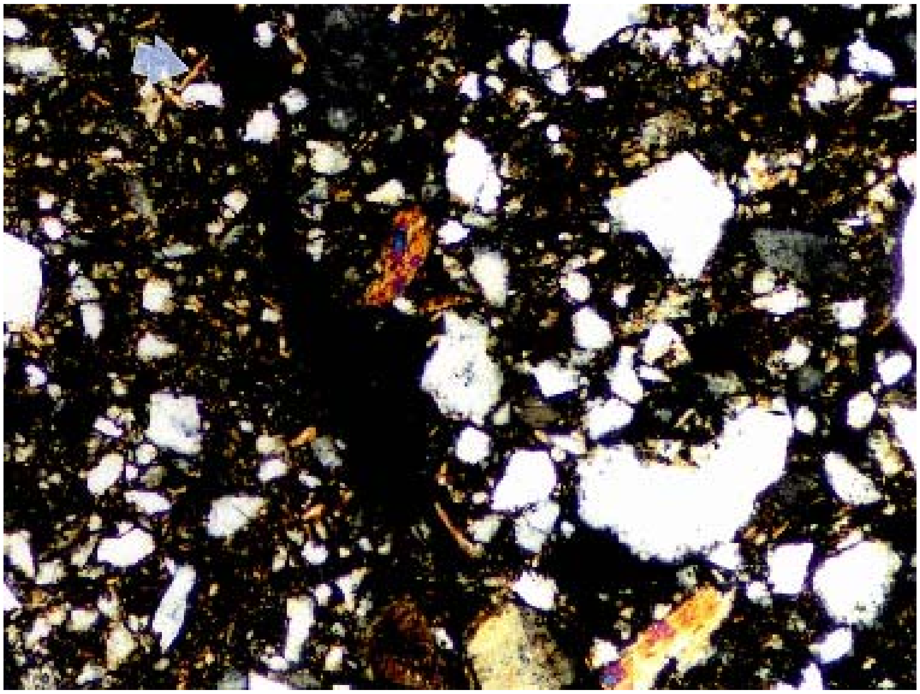

Figure 49. Photomicrograph (cross-polarized light) showing soil particles, mineral composition, and pore space. Parent material is subject to weathering and transformation by soil forming factors. This results in soil particles that consist of different kinds of minerals. Sand grains consist of quartz, potassium feldspars, and some hornblende minerals (yellow-orange grain along channel). Elongated coarse-silt sized grains (note arrow in upper left corner) are biotite and muscovite.

Mineral material includes partially weathered rock, ash from volcanoes, sediments moved and deposited by wind, water or humans, or ground up rock deposited by glaciers. Organic materials include fresh peat, muck and organic waste. Soil development may take place quicker in materials that are more permeable to water. Dense, massive materials can be resistant to soil formation processes. In soils developed from sandy parent material, such as Bigapple and Hooksan soils, the A horizon may be a little darker than its parent material, but the B horizon tends to have a similar color, texture, and chemical composition.

Climate (C) is a major factor in determining the types of plant and animal life on and in the soil. It determines the amount of water available for weathering reactions and for the transport of soluble constituents. Soil temperature also determines the rate of reactions in soils. In general, soils in warmer, more humid areas exhibit the highest weathering rates.

Warm, moist climates encourage rapid plant growth, and thus high organic matter production. The opposite is true for cold, dry climates. Organic matter decomposition is also accelerated in warm, moist climates. Under the control of climate, freezing and thawing, and wetting and drying processes physically break parent material apart.

Rain dissolves more soluble soil constituents and transports them deeper into the soil. Organic acids dissolved in percolating water, and acid rain from urban environments also increase dissolution and mineral breakdown. Weathering is a continual process of physical and chemical alteration of rocks and minerals. Leaching of soluble materials takes place as the soil water moves down and out of the soil. Sandy soils such as Breeze, and soils with sandy substrata such as Branford and Verrazano have the highest leaching rates.

All living organisms (O), including humans, plants, animals, bacteria, and fungi, affect soil formation. Human activity, or “anthropogenesis” (ICOMATH, 1998), is the most significant soil forming process in this survey area. Humans can excavate tunnels under rivers and lakes, transform tidal marshes into sandy islands, and in general, change the landscape. In GNRA many tidal marshes were filled with different materials such as dredge, coal ash, or construction debris. Soils such as Bigapple, Fortress, Barren, Gravesend, and Greatkills were formed as a result of tidal marsh reclamation by humans. Humans have changed soil properties in rural and urban environments by plowing, mining, deep-ripping dense layers, draining wetlands, flooding soils, adding lime, pesticides, fertilizers and causing severe erosion.

Plants affect soil development by supplying upper layers with organic matter, recycling nutrients from lower to upper layers, and helping to prevent erosion. In general, deep rooted plants contribute more to soil development than shallow rooted plants because the passages they create allow greater water movement, which in turn aids in leaching. Leaves, twigs, and bark from large plants fall onto the soil and are broken down by fungi, bacteria, insects, earthworms, and burrowing animals. These organisms eat and break down organic matter, releasing plant nutrients.

Earthworms and burrowing animals keep the soil open and loose. Microscopic organisms and the humus they produce also act as a kind of glue to hold soil particles together in aggregates. Well-aggregated soil is ideal for providing the right combination of air and water to plant roots.

Relief (R) or landscape position causes localized changes in soil moisture and temperature. It is partly the slope and the shape of the land surface, as well as the position of the land in relation to the water table. When rain falls on the land, water begins to move downward by the force of gravity, either through the soil or across the surface to a lower elevation. Even though an area has similar soil-forming factors of climate, organisms, parent material, and time, drier soils at higher elevations may be quite different from the wetter soils where water accumulates. Wetter areas may have reducing conditions that will inhibit proper root growth for plants that require a balance of soil oxygen, water, and nutrients. Soils developed in lower landscape positions that are wet for long periods of time do not develop well defined horizons, and have thick, dark colored surfaces with grayish subsoils.

Steepness, shape, and length of slope are important because they influence the rate at which water flows into or off the soil. If unprotected, soils on slopes may erode leaving a thinner surface layer. Eroded soils tend to be less fertile and have less available water than non-eroded soils of the same series.

Aspect, or orientation of slope, affects soil temperature. For most of the continental United States, soils on north-facing slopes tend to be cooler and wetter than soils on south-facing slopes. Soils on north-facing slopes tend to be less droughty.

Time (T) is required for soil horizon formation. The longer a soil surface has been exposed to soil-forming agents like rain and growing plants, the greater the development of the soil profile. Soils composed of recent alluvium, loess, colluvium, or disturbed soils may show very little horizon development.

Soils on older, stable surfaces generally have well defined horizons because the rate of soil formation has exceeded the rate of geologic erosion or deposition. As soils age, many of the original, or primary minerals are weathered, many new, or secondary minerals are formed, and soils become more leached, more acid, and generally higher in clay.

In some soils, thousands of years are needed for significant changes to take place in the parent material. The darkening of topsoil by organic matter and the development of soil structure near the surface are exceptions, and may take place in shorter periods of time. Marsh soils undergo continuous deposition and have thick dark surface horizons, yet they have not been in place long enough for the soil forming processes to make distinct differences in the subsoil layers. Most soils in the survey area have formed during last 100 years, a relatively short period in soil formation time.

Soil Horizons

The soil forming processes result in the development of distinct layers called soil horizons. Soil horizons can be seen in vertical cuts where roads have been cut through hills, where streams have scoured through valleys, in road and building excavations, or in other areas where the soil is exposed. The vertical arrangement of horizons is called a soil profile (Figure 50).

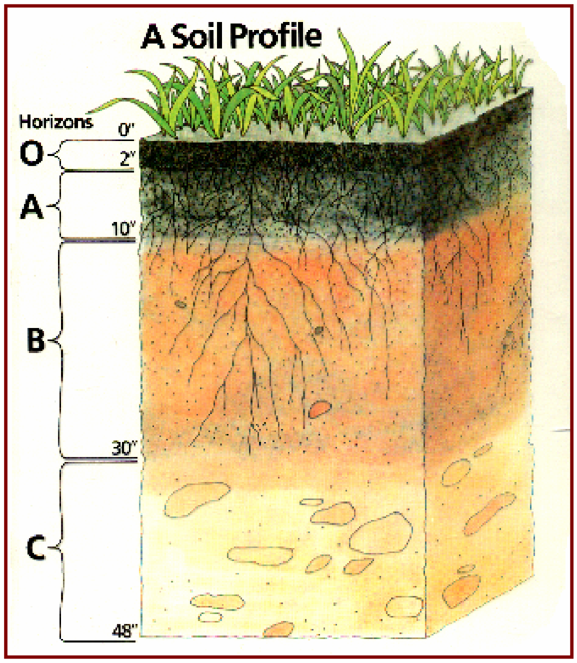

Figure 50. A soil profile is a sequence of soil horizons.

The soil profile extends from the surface down into material that is little affected by soil formation processes. Many profiles contain four major types of horizons: O horizon (organic material), A horizon (topsoil or mineral surface), B horizon (subsoil), and C horizon (substratum). Horizon nomenclature reflects the dominant process(es) taking place, and each horizon can often be subdivided into specific layers that have a unique identity. The thickness of each layer varies with location. These horizons are more prominent in undisturbed areas of GNRA in Miller Field, Fort Wadsworth and Sandy Hook. It is more difficult to distinguish horizons in disturbed soils due to their relatively young age. Some GNRA soils contain human made layers such as concrete or asphalt. NRCS is developing new horizon designations for these cases.

The uppermost layer generally is an organic horizon, or 0 horizon. It consists of fresh and decaying plant residue from such sources as leaves, needles, twigs, moss, lichens, and other organic material accumulations. Subdivisions of Oa, Oe, Oi are used to identify levels of decomposition. The 0 horizon is dark because decomposition is producing humus. An O horizon may not be found on disturbed sites, or where there is insufficient organic input.

Below the O horizon is the A horizon. The A horizon is predominantly mineral material. The accumulation of organic matter takes place as plant residue decomposes. This process darkens the surface layer and helps to form an A horizon. This horizon is where most root activity occurs and is usually the most productive layer of soil. Wetter soils such as Pompton have thicker and darker A horizons.

Some soils form an E horizon just below the A horizon. An E, or eluvial horizon, is a mineral horizon in which silicate clay, iron, aluminum, or some combination of these have been eluviated, or leached. This results in a lighter-colored horizon in which sand- and/or silt-sized quartz or other resistant minerals have been concentrated. It has less organic matter than the A horizon, and can be differentiated from the underlying B horizon by its paler color or lighter texture.

B horizons are zones of accumulation, or horizons which have developed pedogenic (from soil forming processes) color or structure. The B horizon is usually lighter colored, denser, and lower in organic matter than the A horizon. The B horizon can be further defined by the materials that make up the accumulation, such as "t" in the form of "Bt", which notes that clay has accumulated. Clay particles are transported downward in suspension with soil water from the E horizon and redeposited in the B horizon as films and linings in pores and root channels. Other illuvial concentrations or accumulations include iron, aluminum, humus, carbonates, gypsum, or silica. Subsoil horizons that do not have recognizable accumulations but show color and/or structural differences from adjacent horizons are designated "Bw". Cheshire, Centralpark, Greenbelt and Weathersfield soils have Bw horizons.

Still deeper is the C horizon or substratum. Unconsolidated parent material is found in this horizon, with no evidence of soil forming processes. The C horizon usually contains less clay, or other weathered minerals than the B horizon above it. Some soils have a soft bedrock horizon that is given the designation “Cr.” C horizons described as "2C" consist of different material, usually of an older age, than horizons which overlie it. Verrazano and Branford soils have 2C horizons.

The lowest layer in a soil profile, the R horizon, is bedrock. Bedrock can be within a few inches of the surface or many feet below the surface. In the soil survey area, bedrock is very deep (at 60" or deeper) and is not described.

How This Soil Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in GNRA. This information includes descriptions of the soils and miscellaneous areas (pavement and buildings, beaches, mud flats, rock outcrops, and blown-out land), their locations, and a discussion of their quality, potentials, limitations and management for specified uses. Soil scientists used geologic and historical maps, topographic quadrangles, aerial photography, land use maps, tide charts, wetland maps, infrared photography, and remote sensing to understand the occurrence, patterns and behavior of soils. They observed the steepness, length, and shape of the slopes; the general pattern of drainage; the exotic and native plants; land use history and its impact on soil formation; and the kinds of parent materials. Many holes were dug across the landscape in order to describe soil profiles (Figure 51).

The soils and miscellaneous areas in the survey are located in an orderly pattern that is related to the parent material, geomorphology, relief, climate, vegetation and land use of the area. Each kind of soil and miscellaneous area is associated with a particular kind of parent material, landscape segment and landscape position. By observing the soils and miscellaneous areas in the survey area and relating them to parent material and position on the landscape, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict, with a considerable degree of accuracy, the kind of soil or miscellaneous area at a specific location on the landscape (Soil Survey Staff, 1993).

Figure 51. Soil Scientist using a Dutch auger to examine the soil profile

Commonly, individual soils on the landscape merge into one another as their characteristics change gradually. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, and the parent material and land use, are sufficient to verify predictions of the kinds of soil in the area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted the color, texture, size and shape of soil aggregates, kinds and amounts of coarse fragments (natural and human made), distribution of plant roots, soil reaction, compaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, soil scientists assigned the soils to taxonomic classes. Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. These classes are used as a basis to compare and classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile (Soil Survey Staff, 1993).

While a soil survey is in progress, samples of some of the soils in the area are collected for laboratory analyses and for engineering tests. Soil pits were opened to expose soil profiles. Bulk samples from each horizon were collected to a depth of 6 feet. In addition, four clod samples were taken from each horizon to determine bulk density and water holding capacity. Samples were prepared and shipped to the National Soil Survey Center (Lincoln, NE) for laboratory analyses. Soil scientists interpret the data from these analyses and tests, as well as the field- observed characteristics and the soil properties, to determine the expected behavior of the soil under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses and under different levels of management. Some interpretations were modified to fit local conditions, and some new interpretations were developed to meet local needs. Data was assembled from other sources, such as research information and the field experience of specialists.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant similar bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, roads, and ponds, all of which help in locating boundaries accurately. These soil boundary lines were then transferred to computer format by digitizing the maps, creating a data set that could then be utilized as a base layer in the GIS database at the park. This gives researchers a portrayal of soil types, soil formation processes, and losses and gains, and the precise locations in which they occur, using a format that allows for many levels of analysis.

Some of the tools used by soil scientists to produce soil maps in this soil survey included: Geographic Positioning System (GPS) receivers, Ground Penetrating Radar (GPR) unit, (Figure 52), soil temperature sensors, augers (Dutch, bucket and peat), tile spade, clinometer, compaction meter, hand lens, and Munsell color chart (Soil Survey Staff, 1993).

Ground Penetrating Radar

Soil scientists used the GPR to assess subsurface soil properties and site conditions. GPR is an impulse radar system designed for relatively shallow investigations (Doolittle, 1987). A radar system operates by radiating short pulses of high frequency, electromagnetic energy into the ground from a transmitting antenna. Whenever a pulse contacts electrical properties, a portion of the energy is reflected back to the receiving antenna. By moving an antenna along the soil surface, GPR can provide a continuous profile of the subsurface (Figure 53).

Figure 52. Soil Scientist using Ground Penetrating Radar to map and detect subsurface soil features.

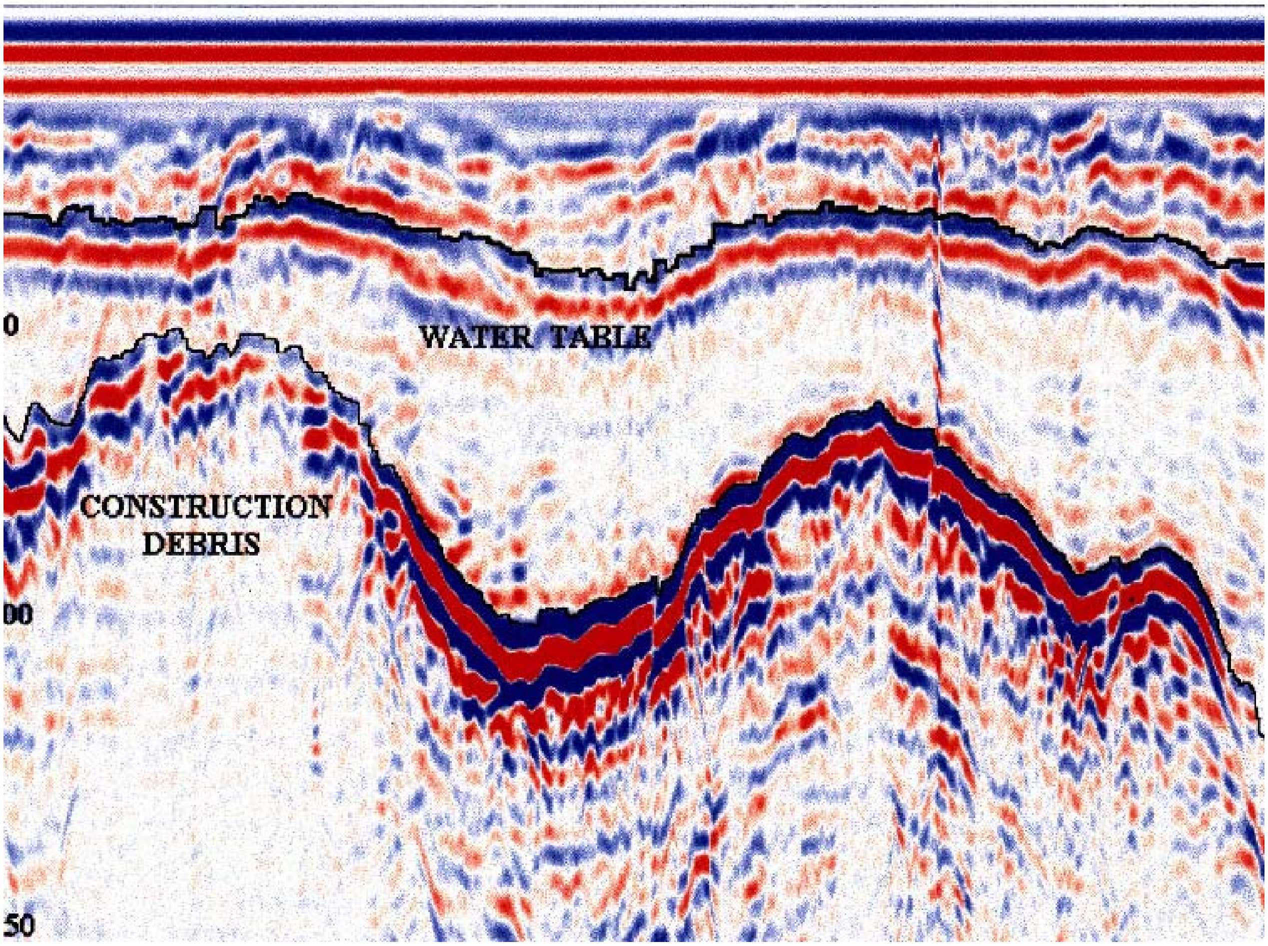

Figure 53. GPR profile showing fresh water and buried construction debris.

Advantages of GPR include continuous spatial coverage, speed of operation, flexible observation depth, moderate to high resolution of subsurface features, and greater confidence in site assessments. Results from GPR surveys are interpretable in the field. This technology can provide, in a relatively short time, the large number of observations needed for site characterization and resource assessments.

Maps prepared from correctly interpreted data provide the basis for evaluating site conditions, locating sampling sites, determining depth to peat layers (Figure 54), fresh water table (Figure 55) and salt water intrusions, and planning further investigations (Doolittle and Collins, 1995). GPR is noninvasive and has not been used extensively in urban environments. GPR and other geophysical tools will play an increasing role in urban soil survey activities within the United States. Present uses of GPR within urban areas include: determining the depths of soil horizons; selecting monitoring well sites; detecting buried utilities, artifacts or hazardous waste containers; delineating and mapping buried landfill boundaries; locating underground storage tanks, drums and utility lines; mapping bedrock surfaces, fractures, and areas affected by salt water intrusion; profiling geomorphic and stratigraphic features; and detecting non-pedogenic limiting layers (Doolittle et. al., 1997).

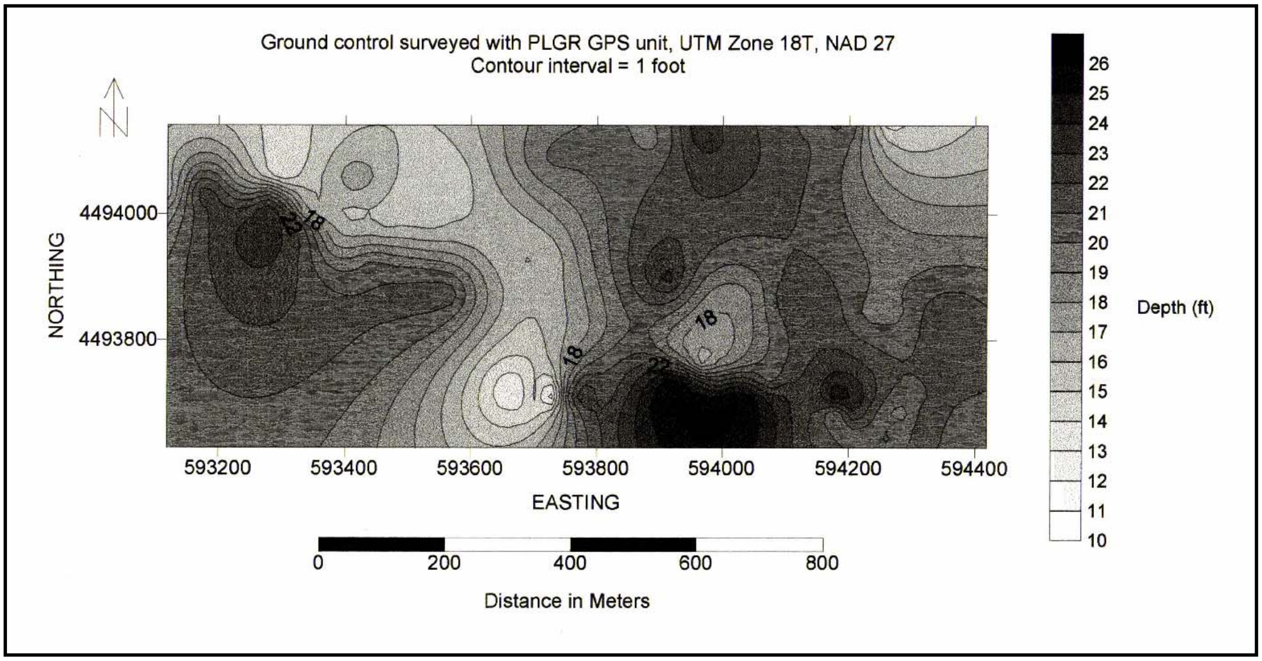

Figure 54. Ground Penetrating Radar interpretative map of depth to buried peat layer in Floyd Bennett Field.

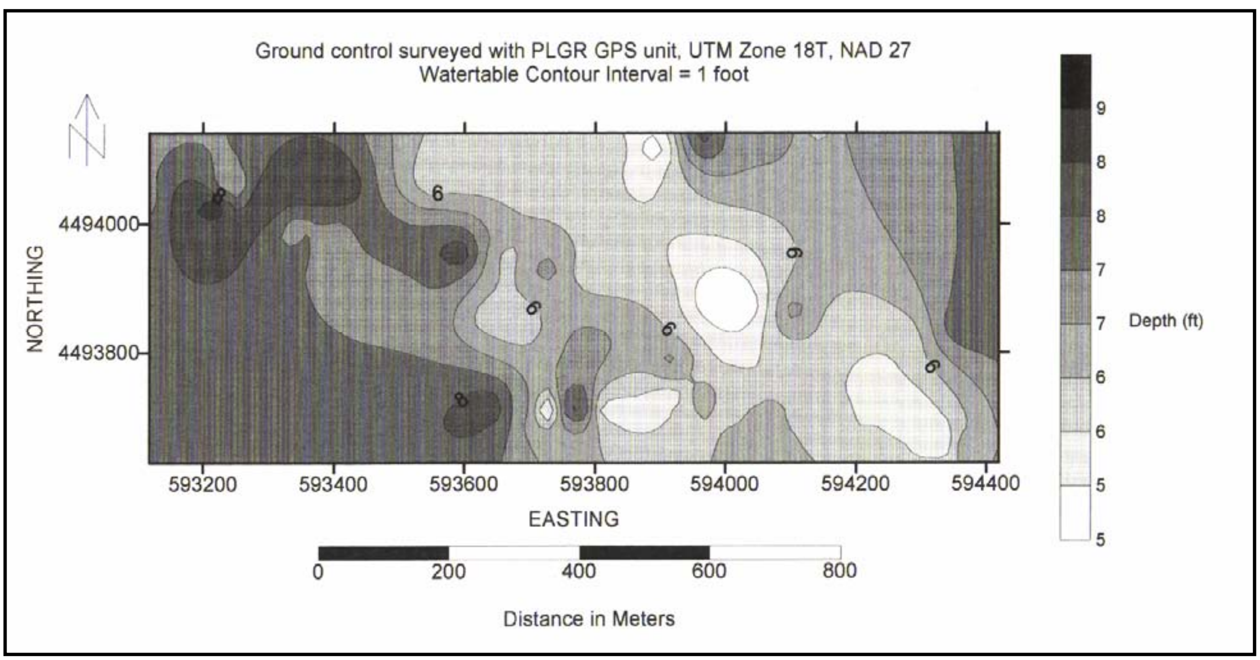

Figure 55. Ground Penetrating Radar Interpretive map of depth to fresh ground water in Floyd Bennett Field.

Soil Temperature

Soil moisture and soil temperature regimes are major components of soil climate (Soil Survey Staff, 1999). Soil Taxonomy, the national soil classification system, has specific criteria for soil climate regimes. Knowledge of soil climate is important to: 1) Understand the development and formation of specific soils, 2) Consistently classify and map soils accurately and, 3) Apply that knowledge to the use and management of soils, plants, and water (Soil Survey Staff, 1999).

Temperature in anthropogenic soils has not been studied in detail. Soil and air temperature were monitored in NYC as part of the NRCS Global Change Initiative (Kimble et al., 1999; Mount et al., 1999). This is the first time that soil temperature in an urban environment has been documented during a progressive soil survey. The NYC Temperature Study consists of 10 sites located in Manhattan, Staten Island, Brooklyn, Queens and Monmouth County, NJ. Of the nine sites within NYC, five are located in GNRA. Soil temperature data loggers can store 1,800 data points from periods ranging from 15 minutes to 360 days (Mount et. al., 1999). Their certified temperature threshold is ± 0.7°F (± 0.4°F). Prior to installation of the sites in GNRA park, temperature loggers were programmed to collect data every 4 hours and 48 minutes for 360 days, about five times each day. At each site a 9 inch long PVC pipe with a 4 inch diameter housed three temperature loggers and a desiccant pack to absorb excess moisture (Figure 56). Holes drilled in the PVC pipe allow 6 foot sensor leads to exit outside while the temperature loggers are protected from the weather elements. A hole was dug with a sharpshooter to a depth of 20 inches (50 cm) at each site. Site data were then collected and the soils were briefly examined to gather a taxonomic classification. One temperature sensor lead was tied to a tree sapling to capture air temperature and was generally placed from two to three feet above the soil surface. Two soil temperature sensor leads were installed at each site - one at a 4 inch soil depth and one at a 20 inch soil depth. Finally, the PVC pipe was buried at about 4 inches and covered with soil.

Data was downloaded after retrieval of the temperature loggers. Once downloaded, the temperature signatures were examined for each of the sites. For this study, loggers collected more than 20,000 data points within GNRA.

Figure 56. Soil Scientist Installing soil temperature sensors in Sandy Hook, NJ.

Temperature data were averaged by month for each of the sites and an annual mean was then determined and graphed. In addition to an annual mean, the Mean Summer Temperature (MST) and the Mean Winter Temperature (MWT) were calculated to assess the extreme seasonal variation at each of the sites. Monthly temperature signatures are presented for Bigapple soils (Figure 57), Hooksan soils (Figure 58) and Greatkills soils (Figure 59).

The Mean Annual Soil Temperature (MAST) of the Bigapple soil at 20 inches is 54.3°F. The MAST of the Hooksan soil at the same depth is 52.9°F, 1.4°F cooler than the Bigapple soil (Figure 60). The MAST of the Greatkills soil in a 60-year old landfill area on Latourette Park (Staten Island) is 73.9°F at 20 inches. This site is 20.2°F warmer than a control site located in the adjacent woods, 19.6° F warmer than the Bigapple soil, and 21°F warmer than the Hooksan soil in the Holly Forest, Sandy Hook. Soil temperature in the Greatkills soils is strongly impacted by exothermic activity, resulting in a soil temperature regime that classifies as hyperthermic (Soil Survey Staff, 1999). Along with the increase in the air temperature, this has brought about a microclimate at the landfill area of Staten Island that contributes to global warming. Similar temperature patterns are expected to occur in all GNRA landfills.

The soil temperature study in NYC demonstrates the extent of land use effects on soil temperature (Mount, 1999). Some of the important site properties that affect this shift include cover type (vegetation, humus layer, snow carpet, asphalt, etc., vs. bare soil) slope, and aspect.

Anthropogenic activities in NYC have increased the MAST.

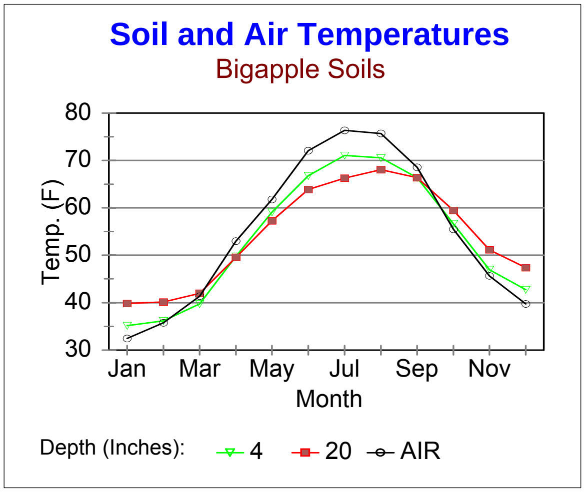

Figure 57. Temperature signature of Bigapple soils.

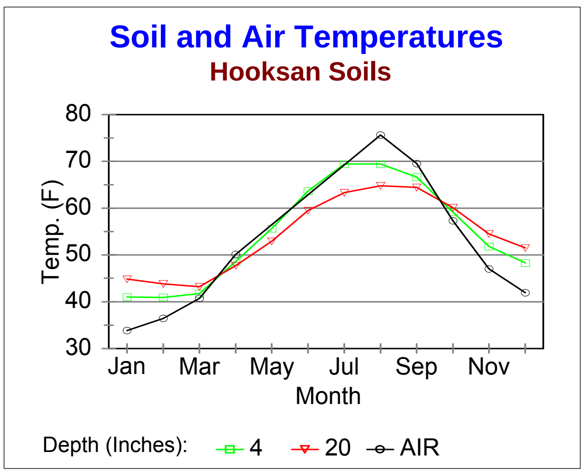

Figure 58. Temperature signature of Hooksan soils.

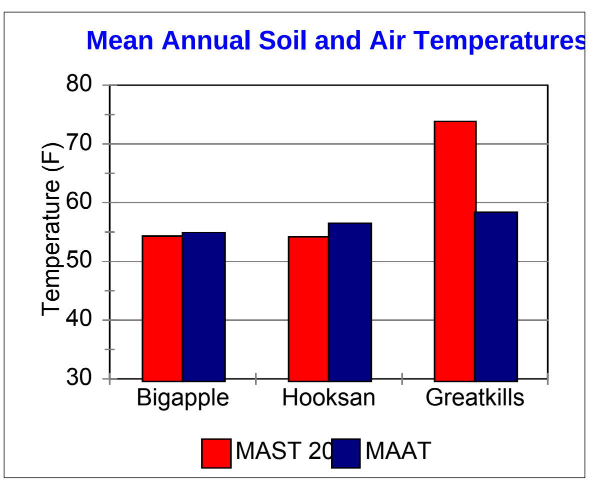

Figure 59. Temperature signatures of Greatkills soils.

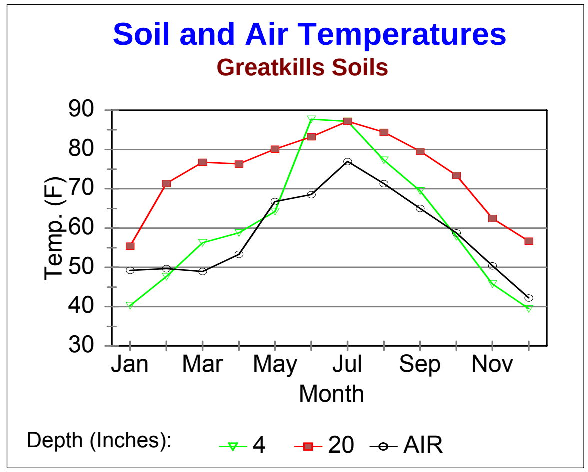

Figure 60. Mean Annual Soil Temperature at 20 inches (MAST 20) and Mean Annual Atmospheric Temperature (MAAT) are higher for Greatkills soils than for Bigapple and Hooksan soils.

Soil Survey Activities in NYC

This survey area has been mapped at two levels of detail. A medium intensity soil survey (NYC Reconnaissance Soil Survey (NYC-RSS) has also been conducted for the five boroughs that make up NYC (Goddard et al., 1998; Goddard et. al., 1997; Hernandez and Galbraith, 1997; Hernandez et al., 1998b) at the 1:62,500 (1"=1 mile) scale. This survey provides basic information about patterns and distribution of soils throughout the soil survey area (Figure 61). Sandy Hook had been previously surveyed using a mapping scale at 1:15,840 (Jablonski and Baumley, 1989). The current mapping consists of a high intensity soil survey, using a scale at 1:4,800 (1" = 400'). This level of mapping provides more detailed soil information, with map units that are narrowly defined. The smallest possible delineation determined in the survey area is about 0.25 acre. This level of detail was selected to meet the anticipated long-term use of the survey, and the map units were designed for that use. Map unit boundaries were plotted and verified at closely spaced intervals. At the less detailed level (1:62,500), map units are broadly defined. The transfer of the soil map to a digital product was done in order to interface the information contained in the soil survey with the existing GNRA database of the park.

Figure 61. Medium intensity soil survey of a portion of Jamaica Bay

A data set containing detailed characteristics of a particular soil is linked to the precise ground coordinates. Some of the information the NRCS collects comes from the ground-based surveys and still others from aerial imagery. The first decade of this century should produce survey information that can be closely compared to succeeding generations of information. This will allow us to project the rates of loss or gain of vegetative cover, track the migration of sediments or the development of soils. Subsequently, we can determine what organisms are most likely to be affected by these changes, including ourselves.

A detailed picture is forthcoming with the completion of the first ground survey of GNRA's soils using the latest mapping technology. This soil survey was completed using standard NRCS protocol, but the difference is in the new and innovative techniques and methods of data capture.

The descriptions, names, and delineations of the soils in this survey area do not fully agree with those of the soils in adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in series concepts, or variations in the intensity of mapping or in the extent of the soils in the survey areas.

Classification of Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff 1975). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field, or inferred from those observations, or from laboratory measurements. Table 4 shows the classification of the soils in the Survey Area. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is *Entisol*, which is a recently formed, or young soil.

SUBORDER. Each order is divided into suborders, primarily on the basis of properties that influence soil genesis and are important to plant growth, or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is *Aquent* (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is *Sulfaquent* (*Sulf*, meaning sulfides, plus *aquent*, the suborder of the Entisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is *Typic Sulfaquents*.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties, and other characteristics that affect management. Generally, these properties are examined below the plow depth, i.e., beneath the zone of high biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, thickness of the root zone, consistence, moisture equivalent, slope, and presence of permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is *Sandy, mixed, mesic Typic Sulfaquents.*

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series. The soils in a series are derived form the same type of parent material.

Urban soils have been a subject of study for many soil scientists (Bullock and Gregory, 1991; Craul, 1992; Evans, 1997; Fanning and Fanning, 1989; Sencindiver, 1977; Short, 1983; Short et. al., 1986). Several National Cooperative Soil Surveys (NCSS) have been published without interpretative information for human modified soils (Benham, 1982; Levin and Griffin, 1990; Smith, 1976).

In the past, soils that were drastically altered by human activity were classed at the great group level of Soil Taxonomy (Soil Survey Staff, 1999) as “Udorthents,” rather than classified to the more specific soil series level that other soils were. The great group level does not carry information specific enough to allow interpretations relative to use and management as provided by the soil series level of classification. Efforts have been made by several soil scientists to develop a systematic classification system of human disturbed soils. Sencindiver (1977) proposed a classification system for soils disturbed during mining activities. Fanning and Fanning (1989) proposed special diagnostic characteristics for human modified soils. Evans (1997) proposed the use of relational properties to map human modified soils. None of these proposals have been adopted in the National Soil Classification System or Soil Taxonomy. In 1999, the second

Table 4. Family level provisional classification of the soil series.

Soil Series	Family Level Class
Till Soils	
Cheshire	Coarse-loamy, mixed, semiactive, mesic Typic Dystrudepts
**Wethersfield	Coarse-loamy, mixed, superactive, mesic Oxyaquic Dystrudepts
Outwash Soils	
Branford	Coarse-loamy over sandy or sandy skeletal, mixed, active, mesic Typic Dystrudepts
Pompton	Coarse-loamy, mixed, active, mesic Aquic Dystrudepts
Eolian Soils	
Barren, Jamaica	Mixed, mesic Typic Psammaquents
Fortress	Mixed, mesic Aquic Udipsamments
Hooksan	Mesic, uncoated, Typic Quartzipsamments
Tidal Marsh Soils	
Ipswich	Euic, mesic Typic Sulfihemists
Pawcatuck	Sandy or sandy-skeletal, mixed, euic, mesic Terric Sulfihemists
Matunuck, Sandyhook	Sandy, mixed, mesic Typic Sulfaquents
Human-Altered Urban Soils	
Barren, Jamaica	Mixed, mesic Typic Psammaquents
Bigapple, Breeze	Mixed, mesic Typic Udipsamments
Bulkhead	Mixed, dysic, thermic Typic Udifolists
Greenbelt, Foresthills	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Canarsie	Coarse-loamy, mixed, superactive, nonacid, mesic Typic Udorthents
Centralpark	Loamy-skeletal, mixed,superactive, mesic Typic Dystrudepts
Fishkill	Coarse-loamy, mixed, active, nonacid, mesic Typic Endoaquents
Flatland	Coarse-loamy, mixed, active, nonacid, mesic Typic Endoaquents
Fortress	Mixed, mesic Aquic Udipsamments
Gravesend	Sandy-skeletal, mixed, hyperthermic Typic Udorthents
Greatkills	Loamy-skeletal, mixed, superactive, nonacid, hyperthermic, Typic Udorthents
Hassock	Coarse-loamy, mixed, active, nonacid, mesic Typic Udorthents
Inwood	Fragmental, mixed, mesic Typic Udorthents
Oldmill	Sandy, mixed, hyperthermic Typic Udorthents
Rikers	Sandy-skeletal, mixed, mesic Typic Udorthents
Shea	Coarse-loamy, mixed, active, nonacid, mesic Typic Udorthents
Verrazano	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, nonacid, mesic Typic Udorthents
Winhole	Coarse-loamy, mixed, active, nonacid, mesic Aquic Udorthents

**Taxadjunct, Cation-Exchange activity class is out of the range of characteristics for Wethersfield series.

edition of Soil Taxonomy was published without addressing taxonomic classes for anthropogenic soils (Soil Survey Staff, 1999).

In 1997 NRCS, in partnership with Cornell University and the NYC Soil and Water Conservation District, published “Soil Survey of South Latourette Park, Staten Island, New York City (Hernandez and Galbraith, 1997a).” The South Latourette Soil Survey is the first modern NRCS survey that provides interpretative data for human disturbed soils. Five new soil series concepts were developed in order to attach specific interpretative data to human modified soils. A soil series is a grouping of soils that have similar texture, color, thickness, chemical properties, and density of the major subsoil horizons. Properties of each soil series are stored in National Soil Interpretation System (NASIS) database that is used to provide specific recommendations for use of the soil.

Soil occurrence in urban environments can be predicted with the use of historical records and land use. Many newly formed soils show some visual evidence of soil forming processes, or pedogenesis, but laboratory data does not support any movement or accumulation of materials as expected during the pedogenic process.

Human disturbed soils cannot be grouped in taxonomic classes based on the level of development of the soil. These soils can be grouped in taxonomic classes based on properties that result from human activity. In some situations, these soils contain undisturbed diagnostic horizons that can be use to classify human modified soils at the soil series level.

In NYC, soils are grouped according to properties imparted by human activity. Many of these soil properties were identified during this soil survey. Additional research and field testing in other regions are necessary to determine the applicability of these properties in a systematic classification system. The following are examples of soil properties used to group urban soil in soils series and phases:

1. **Type of parent material** - Dredge, human refuse, construction debris, organic waste, and other fill materials.

2. **Thickness of transported material** - Less than 10 inches, 10 to 20 inches, 20 to 40 inches, Greater than 40 inches.

3. **Presence, depth, and pattern of any pedogenic horizon formed in place or left after disturbance** - Duripan after deep-ripping, Depth to dense layer after cutting/filling.

4. **Presence, type, and percentage of human artifacts (larger than 2 mm)** - Less than 10 percent by volume of artifacts is considered a “clean” soil.

5. **Effect of fragments larger than 2 mm on particle size family** - More than 35 percent by volume coarse fragments is skeletal, more than 90 percent is fragmental.

6**. Effect of landscape position on drainage class** - Dredge soils in depressions behave similarly to sandy soils in depressions.

7. **Soil compaction** – It is important to design map units according to land use.

8. **Carbon distribution** – Decreasing with depth, increasing with depth, irregular with depth.

9. **Base saturation status** - Urban soil base saturation status normally is 50 percent or higher.

10. **Heavy metals** - Strong correlation with land use history.

11. **Soil temperature** - Soils in landfills have higher Mean Annual Soil Temperature due to heat released from garbage decomposition.

In GNRA, human influenced soils are extensive and are of major importance to the use and management of the park. The park itself represents an important and limited land resource for millions of park users and NYC residents. Reflecting this importance and recognizing the need for more soil-specific information, twenty-two new soil series and interpretation records have been made for the drastically human-influenced soils which carry relatively narrowly defined ranges of characteristics and soil interpretations for urban land use.

The Barren series consists of very deep, somewhat poorly drained soils formed in more than 40 inches of sandy dredge fill. This soil does not have a layer that is impermeable to water or restricts root penetration within the top six feet. Soil scientists observed a thin layer (less than 1 inch) in the subsoil that resembles a placic horizon (Figure 62). Barren soils contain less than 20 percent (by volume) coarse fragments, with less than 10 percent human made coarse fragments, or artifacts, of coal, slag, brick, glass and metals.

The Bigapple series consists of very deep, well drained soils formed in more than 40 inches of sandy dredge fill. This soil does not have a layer that is impermeable to water or restricts root penetration within the top six feet. Soil scientists observed a thin layer (less than 1 inch) in the subsoil that resembles a placic horizon (Figure 62). Bigapple soils contain less than 20 percent (by volume) coarse fragments, with less than 10 percent human made coarse fragments, or artifacts, of coal, slag, brick, glass and metals.

The Breeze series consists of very deep, well drained soils formed in mixture of sandy fill and demolished construction debris more than 40 inches thick. This soil does not have a layer that is impermeable to water or restricts root penetration within the top six feet, but the subsoil may have been compacted by heavy machinery as it was deposited. Breeze soils contain 10 to 34 percent of human made coarse fragments, or artifacts, in the control section.

The Bulkhead series consists of very deep to bedrock, well drained soils formed in a layer of organic fill less than 20 inches thick above an impermeable layer (concrete, asphalt, etc.), over sand. These soils may have high temperature and methane concentrations due to organic decomposition. Bulkhead soils contain less than 10 percent (by volume) human made coarse fragments, or artifacts, of coal, slag, brick, glass and metals.

Figure 62. Soil horizons may restrict root penetration and water infiltration. This picture is showing a Placic horizon (dark gray) restricting root penetration. Placic horizons form when iron is oxidized and along with organic carbon cement soil particles forming an “iron like” layer. These layers are used to classify and predict behavior of soils.

The Canarsie series consists of very deep, well drained soils, formed where the top 10 to 20 inches of the natural soil has been removed, before being covered with 12 to 39 inches of replacement topsoil. The covered soil typically has a fragipan or dense till within 40 inches, and often has been compacted by heavy machinery in most layers. The new soil has root and water-restrictive features much closer to the surface than the surrounding undisturbed soils. Coarse fragments range from 1 to 30 percent, with less than 10 percent human made artifacts.

The Centralpark series consists of very deep, well drained soils formed in more than 40 inches of loamy fill with greater than 35 percent rock fragments. This material has been piled on a natural surface that may or may not have had its topsoil layer removed before being covered. These soils do not have a fragipan or dense till within the top six feet, but the subsoil may have been compacted by heavy machinery as it was being deposited. Centralpark soils have less than 10 percent human made coarse fragments, or artifacts.

The Fishkill series consists of very deep, poorly drained soils formed in more than 40 inches of incinerator fly ash fill. These soils do not have a layer that is impermeable to water or restricts root penetration within the top six feet, and contain less than 10 percent human made coarse fragments of coal, slag, brick, glass and metals.

The Flatland series consists of very deep, somewhat poorly drained soils formed in more than 40 inches of incinerator fly ash fill. These soils do not have a layer that is impermeable to water or restricts root penetration within the top six feet, and contain less than 10 percent human made coarse fragments of coal, slag, brick, glass and metals.

The Foresthills series consists of very deep, well drained soils formed in 10 to 39 inches of loamy fill. This material has been placed on a natural surface that may or may not have had its topsoil layer removed before being covered. The covered soil typically has a fragipan or dense till within 18 to 36 inches before burial, and after burial these features are found within 40 to 60 inches. These soils do not have the root- and water-restrictive features within the root zone that can be found in surrounding undisturbed soils. Coarse fragments range from 1 to 20 percent, with less than 10 percent human made artifacts.

The Fortress series consists of very deep, moderately well drained soils formed in more than 40 inches of dredge fill. These soils do not have a layer that is impermeable to water or restricts root penetration within the top six feet. Soil scientists observed a thin layer (less than 1 inch) in the subsoil that resembles a placic horizon. Coarse fragments range from 0 to 20 percent, with less than 10 percent human made artifacts.

The Gravesend series consists of very deep, well drained soils, formed where an abandoned household landfill of 5 feet or more in thickness has been capped with a thin layer of sandy materials up to 24 inches thick. Much of the household refuse acts like rock fragments do in natural soils. Gravesend soils do not have a water- or root-restrictive plastic membrane, and the subsoil is loose and porous in most places.

The Greatkills series consists of very deep, well drained soils, formed where an abandoned household landfill of 5 feet or more in thickness has been capped with a thin layer of loamy fill up to 24 inches thick. Much of the household refuse acts like rock fragments do in natural soils. These soils do not have a water- or root-restrictive plastic membrane, and the subsoil is loose and porous in most places.

The Greenbelt series consists of very deep, well drained soils formed in more than 40 inches of loamy fill. This material has been piled on a natural surface that may or may not have had its topsoil layer removed before being covered. These soils do not have a fragipan or dense till within the top six feet, but the subsoil may have been compacted by heavy machinery as it was being deposited. Coarse fragments range from 1 to 20 percent, with less than 10 percent human made artifacts. Some pedons occur as thick caps in old landfills.

The Hassock series consists of very deep, well drained soils formed in more than 40 inches of incinerator fly ash fill. These soils do not have a layer that is impermeable to water or restricts root penetration within the top six feet, and contain less than 10 percent human made coarse fragments of coal, slag, brick, glass and metals.

The Inwood series consists of very deep, well drained soils formed in more than 40 inches of demolished construction debris and rubble. These soils do not have a layer that is impermeable to water or restricts root penetration within the top six feet, but the subsoil may have been compacted by heavy machinery as it was deposited. The volume of coarse fragments, both human made and natural, in the control section exceeds 90 percent.

The Jamaica series consists of very deep, poorly drained soils formed in more than 40 inches of dredge or eolian sand. These soils do not have a layer that is impermeable to water or restricts root penetration within the top six feet. Soil scientists observed a thin layer less than 1 inch) in the subsoil that resembles a placic horizon. Coarse fragment content is less than 20 percent, with less than 10 percent human made artifacts.

The Oldmill series consists of very deep, well drained soils, formed where an abandoned household landfill of 5 feet or more in thickness has been capped with a layer of sandy fill up to 25 to 40 inches thick. Much of the household refuse acts like rock fragments do in natural soils. These soils do not have a water- or root-restrictive plastic membrane, and the subsoil is loose and porous in most places.

The Rikers series consists of very deep, somewhat excessively drained soils formed in more than 40 inches of coal ash fill. This soil does not have a layer that is impermeable to water or restricts root penetration within the top six feet. Carboniferous coarse fragments, known as *carboliths*, range from 5 to 75 percent.

The Sandyhook series consists of very deep, very poorly drained soils formed in thick sandy sediments with an organic surface layer less than eight inches thick. Soil scientists observed a thin layer (less than 1 inch) in the subsoil that resembles a placic horizon. These soils contain less than 10 percent human made coarse fragments, or artifacts, and are inundated by saltwater at high tide.

The Shea series consists of very deep to bedrock, well drained soils where less than 20 inches of loamy fill has been piled on a impermeable layer (asphalt, concrete, etc.) Coarse fragments range from 0 to 25 percent, with less than 10 percent human made coarse fragments, or artifacts.

The Verrazano series consists of very deep, well drained soils formed in less than 40 inches of loamy fill that has been piled on sandy sediments. The original sandy soil may or may not have had its topsoil removed before being covered. These soils have a contrasting particle size class (coarse-loamy over sandy), at a depth ranging from 12 to 36 inches. The subsoil in the loamy material may have been compacted by heavy machinery as it was being deposited. Coarse fragments range from 0 to 20 percent, with less than 10 percent human made coarse fragments, or artifacts.

The Winhole series consists of very deep, moderately well drained soils, formed where more than 40 inches of incinerator fly ash fill has been piled on a natural surface or water. These soils do not have a layer that is impermeable to water or restricts root penetration within the top six feet, and contain less than 10 percent human made coarse fragments of coal, slag, brick, glass and metals.

The soil series that have been described in the soil survey of the GNRA will serve as models for developing the structure of a broader classification system for urban soils.

Eight established series were also used to describe the natural soils within GNRA:

The Branford series consists of very deep, well drained soils formed in loamy over sandy and gravelly outwash deposits, derived mainly from red sedimentary rocks, with some diabase and and basalt. Thickness of the solum ranges from 20 to 40 inches and typically corresponds to the depth of contrasting sand or sand and gravel. Coarse fragments, mainly rounded pebbles, range from 0 to 30 percent in the solum, and 10 to 65 percent in the substratum.

The Cheshire series consists of very deep, well drained, loamy soils formed in supraglacial till derived from red sandstone, shale, and conglomerate, with some diabase and basalt. The solum ranges from 20 to 38 inches. Coarse fragments, mostly subrounded gravel, range from 5 to 35 percent by volume throughout the soil.

The Hooksan series consists of very deep, excessively drained soils formed in eolian sands or sandy marine sediments. Coarse fragments range from 0 to 5% throughout the profile, consisting mostly of shell fragments.

The Ipswich series consists of very deep, very poorly drained soils formed in thick organic deposits greater than 51 inches in depth. These soils are inundated by saltwater at high tide.

The Matunuck series consists of very deep, very poorly drained soils formed in thick sandy sediments with a thin organic surface layer ranging from 8 to 16 inches. These soils are inundated by saltwater at high tide.

The Pawcatuck series consists of very deep, very poorly drained soils formed in sandy sediments with an organic surface layer ranging from 16 to 51 inches. These soils are inundated by saltwater at high tide.

The Pompton series consists of very deep, moderately well drained soils formed in glacial outwash deposits or water-sorted sediments. Coarse fragments, primarily granitic gneiss, range from 0 to 35 percent through the solum, and from 0 to 75 percent in the C horizon.

The Wethersfield series consists of very deep to bedrock, well drained soils formed in dense glacial till on upland plains. These soils have formed in acid glacial till derived mostly from red sandstone, shale and conglomerate, with some diabase and basalt. Thickness of the solum is commonly 20 to 40 inches, and typically corresponds to the depth to the dense substratum. Coarse fragments range from 5 to 25 percent in the solum, and 5 to 35 percent in the substratum.

Soil Map Unit Information

The soil maps for this survey are based on photographic images taken in 1988 (Sandy Hook Unit), 1994 (Jamaica Bay Unit), and 1998 (Staten Island Unit). The scale of the map is 1:4,800, which means that one inch of distance on the map is equal to 4,800 inches (400 feet) of ground distance.

The map units on the detailed soil maps included in the disk with this survey represent the soils in the survey area. The Soil Map Unit Descriptions in the following section, along with the soil map, can be used to determine the risks, qualities, limitations and potential for specific land uses at any location in the survey area, and to prevent failures caused by unfavorable soil properties. This information can be used to plan the use of soils for range management, water management, wildlife management, construction work, urban forestry, recreation and other urban uses. Special terms can be looked up in the glossary, or in the reference manuals.

Map unit symbol: Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named. A numeric symbol identifying the soil precedes the map unit name in the soil descriptions. The legend at the beginning of this survey (**page iv** to **ix**) relates the map unit symbols (numbers) on the map and to the names of the soil map units and identifies the conventional and special symbols used on the map. For example, the areas on the map labeled with the number 150 are identified as Hooksan fine sand, 0 to 3 percent slopes, and the special symbol that looks like a line of dots identifies areas steeper than its map unit range.

Map unit name: Soils that have profiles that are similar make up a soil series. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soil series can be divided into soil phases according to the Soil Survey Manual (Soil Survey Staff, 1993) based on differences in surface texture, underlying material, coarse fragments on the surface, slope, compaction and other characteristics listed in the National Soil Survey Handbook (Soil Survey Staff, 1996). The name of the phase is identified in the map unit name and commonly indicates a feature that affects use or management. For example, Hooksan soils in some heavily used areas of GNRA have a compacted surface layer and are different from adjacent Hooksan soils.

Because soils differ in the size and shape of their areas, and in degree of contrast with adjacent soils, they must be mapped accordingly. Four different kinds of map units are utilized in order to define these changes: *consociations, complexes, associations,* and *undifferentiated groups* (Soil Survey Manual, 1993).

A *consociation* is a delineated area that is dominated by a single soil taxon (or miscellaneous area) and similar soils. At least one-half of the pedons in a consociation must be of the same soil components.

Comparatively, some map units are made up of two or more major soils, or one or more soils and a miscellaneous area. These map units are called soil *complexes*. The soils in a *complex* are either in an intricate pattern or, such a small area that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Hooksan – Verrazano - Pavement & buildings complex, 0 to 5 percent slopes is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually, but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be composed of only one of the named soils, or it can be composed of all of them. Gravesend and Oldmill coarse sands, 0 to 8 percent slopes, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soil other than those for which the map unit is named. Some of these *inclusions* have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on soil maps.

This survey includes also *miscellaneous areas*. Such areas have little or no vegetation. Beaches, pavement and buildings, and mud flats are examples. Miscellaneous areas are shown on the soil maps.

Map unit descriptions: Each description consists of an introduction (general facts about the soil), composition, parent material, typical profile, physical and chemical properties, soil and water features, soil potentials, and limitations for use to be considered in planning.

Introduction: The introduction section has information about drainage class, depth class, parent material; and location of the soil within GNRA.

Composition: Some map units, such as Bigapple -Verrazano, 3 to 8 percent slopes, are complexes of two or more soils which occur in such an intricate pattern or in such small areas that they can not be shown separately on the soil maps (Soil Survey Staff, 1993). Most map units contain inclusions, soils that commonly occur as small scattered areas within the map unit.

Parent Material: The material that each soil derived from is listed. For example, Bigapple soils mainly developed from dredge material.

Typical Profile: Typical soil profile photos are provided for almost every soil found in the soil survey area. Soil profile descriptions of real soils examined and sampled in the park are provided in the Appendix section. Landscape photos are provided for soils without a profile picture. Complete laboratory data for each sampled soil is provided in the Appendix section.

Physical and Chemical Properties: The source classes for available water holding capacity, excavation difficulty, index of erosion susceptibility (K factor), permeability, soil pH, root limiting layer- restriction kind, soluble salts (organic soils only), soil tolerance to erosion (T Factor), and wind erodibility group are listed in the glossary.

Soil and Water Features: Corrosion risk for uncoated steel and concrete apply only to those materials if they are in contact with the soil. The source classes for flooding frequency, frost action, hydrologic group, ponding frequency, and soil surface runoff are listed in the glossary. The potential of pesticide losses are given for each map unit. More soluble pesticides can be leached through the soil profile into groundwater. Pesticides adsorbed by soil particles (clay and organic matter) can be lost in runoff to surface waters if the particles they are attached to are eroded.

Soil Potentials: The risks of Pesticide Losses are given for each map unit. More soluble pesticides can be leached through the soil profile into groundwater. Pesticides adsorbed by soil particles (clay and organic matter) can be lost in runoff to surface waters if the particles they are attached to are eroded. Corrosion risk for uncoated steel and concrete apply only to those materials if they are in contact with the soil. The source classes for Frost Action, Topsoil, Sand Source, Reconstruction Materials (fill) and Shallow Excavations are explained with each rating.

Limitations for Use: The limitations and suitability ratings are identified for each class. Limitations and suitability ratings are explained in the glossary or reference manuals.

Table 5 shows the relationship between parent material, relief, and drainage class of soils.

Table 6 gives the acreage and proportionate extent of each map unit.

Table 5. The relationship between parent material, relief (landscape position), and drainage class of the soils.

Soil characteristics and parent material	Excessively drained	Somewhat excessively drained	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained
SOILS DEVELOPED ON TILL PLAINS							
Very deep to bedrock, medium textured soils formed in dense glacial till			Wethersfield				
Very deep to bedrock, moderately coarse textured soils formed in friable glacial till			Cheshire				
SOILS DEVELOPED ON OUTWASH PLAINS							
Very deep to bedrock, medium textured soils formed in glaciofluvial sediments			Branford	Pompton			
SOILS DEVELOPED ON BARRIER BEACHES							
Very deep to bedrock, coarse textured soils developed in eolian deposits	Hooksan			Fortress	Barren	Jamaica	

Table 5. The relationship between parent material, relief (landscape position), and drainage class of the soils (continued).

SOILS DEVELOPED IN TIDAL MARSHES

Soil characteristics and parent material	Excessively drained	Somewhat excessively drained	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained
Very deep to bedrock soils formed in thick (>51 inches) moderately decomposed organic matter							Ipswich
Very deep to bedrock soils formed in 16 to 51 inches of moderately decomposed organic matter over sand							Pawcatuck
Very deep to bedrock soils formed in 8 to 16 inches of moderately decomposed organic matter over sand							Matunuck
Very deep to bedrock soils formed in less than 8 inches of moderately decomposed organic matter over sand							Sandyhook

Table 5. The relationship between parent material, relief (landscape position), and drainage class of the soils (continued).

Soil characteristics and parent material	Excessively drained	Somewhat excessively drained	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained
SOILS FORMED ON HUMAN CONSTRUCTED LANDFORMS							
Very deep to bedrock, coarse textured soils formed in dredge material			Bigapple	Fortress	Barren	Jamaica	
Very deep to bedrock, shallow to dense till soils formed in moderately coarse fill (12-39 inches)			Canarsie				
Very deep to bedrock, deep to dense till soils formed in medium and moderately coarse textured fill (10-39 inches)			Foresthills				
Very deep to bedrock, soils formed in medium and moderately coarse fill (40-80 inches)			Greenbelt				

Table 5. The relationship between parent material, relief (landscape position), and drainage class of the soils (continued).

Soil characteristics and parent material	Excessively drained	Somewhat excessively drained	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained
SOILS FORMED ON HUMAN CONSTRUCTED LANDFORMS (continued)							
Very deep to bedrock soils formed in medium and moderately coarse textured fill (40-80 inches) with many gravel, cobble, and stone fragments			Centralpark				
Very deep to bedrock soils formed in coarse textured fill (40-80 inches) intermingled with demolished construction debris			Breeze				
Very deep to bedrock soils formed in demolished construction debris (40-80 inches)			Inwood				
Very deep to bedrock soils formed in moderately coarse textured fill over partially decom-posed human refuse			Greatkills				

Table 5. The relationship between parent material, relief (landscape position), and drainage class of the soils (continued).

Soil characteristics and parent material	Excessively drained	Somewhat excessively drained	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained
SOILS FORMED ON HUMAN CONSTRUCTED LANDFORMS (continued)							
Very deep to bedrock soils formed in coarse textured fill over partially decomposed household garbage			Gravesend Oldmill				
Very deep to bedrock soils formed in coal/fly ash			Rikers Hassock	Winhole	Flatland	Fishkill	
Very deep to bedrock soils formed in moderately coarse textured fill (10-20 inches) over an impermeable asphalt layer			Shea				
Very deep to bedrock soils formed in medium textured fill (12-36 inches) over sands			Verrazano				

Table 6: Acreage and proportionate extent of the soils.

Map Symbol	Soil Name	Acres	Percent
14	Beaches	671.5	8.09
14x	Beaches, rubbly	3.6	0.04
16	Bigapple coarse sand, 0 to 3 percent slopes	493.4	5.95
18	Bigapple coarse sand, 3 to 8 percent slopes	306.9	3.70
20	Bigapple coarse sand, 8 to 15 percent slopes	18.9	0.23
24	Bigapple coarse sand, 25 to 35 percent slopes	9.2	0.11
26	Bigapple sandy loam, 0 to 3 percent slopes, compacted surface	46.3	0.56
26x	Bigapple sandy loam, 0 to 3 percent slopes	39.1	0.47
28	Bigapple sandy loam, 3 to 8 percent slopes, compacted surface	6.1	0.07
45	Bigapple-Verrazano sandy loams, 3 to 8 percent slopes	4.7	0.06
47	Bigapple-Verrazano-Pavement & buildings complex, 0 to 5 percent slopes	54.6	0.66
49x	Bigapple coarse sand, 15 to 35 percent slopes, cemented substratum	22.0	0.26
64	Centralpark sandy loam, 0 to 3 percent slopes, compacted surface	1.1	0.01
70	Cheshire loam, 0 to 3 percent slopes	4.3	0.05
72	Cheshire loam, 3 to 8 percent slopes	7.2	0.09
74	Cheshire loam, 8 to 15 percent slopes	6.2	0.07
95x	Pavement & buildings-Breeze complex, 0 to 5 percent slopes	2.1	0.03
104	Foresthills loam, 0 to 3 percent slopes, compacted surface	7.7	0.09
106	Foresthills loam, 3 to 8 percent slopes, compacted surface	2.4	0.03
108	Fortress sand, 0 to 3 percent slopes	243.0	2.93
108xx	Fortress sandy loam, 0 to 3 percent slopes	53.6	0.65
110	Fortress sand, 3 to 8 percent slopes	10.9	0.13
111	Fortress-Pavement & buildings-Shea complex, 0 to 5 percent slopes	2.2	0.03
112	Water, fresh	171.4	2.07
114	Bulkhead fibric, 0 to 3 percent slopes	7.1	0.09
114x	Bulkhead-Pavement & buildings complex, 0 to 3 percent slopes	6.2	0.07
123x	Gravesend-Oldmill coarse sand, 0 to 8 percent slopes	571.2	6.88
124	Greatkills sandy loam, 0 to 3 percent slopes	29.7	0.36
136	Greenbelt loam, 3 to 8 percent slopes, compacted surface	23.8	0.29
138	Greenbelt loam, 8 to 15 percent slopes, compacted surface	2.3	0.03
139	Greenbelt loam, 15 to 25 percent slopes	8.4	0.10
139a	Greenbelt-Pavement & buildings complex, 3 to 8 percent slopes, cemented substratum	7.9	0.10
139x	Greenbelt loam, 25 to 60 percent slopes	16.4	0.20
149	Branford loam, 0 to 3 percent slopes	103.2	1.24
149g	Branford extremely gravelly loam, 0 to 3 percent slopes	0.8	0.01
149x	Branford-Pavement & buildings complex, 0 to 5 percent slopes	7.5	0.09
149y	Branford loamy sand, 0 to 3 percent slopes	2.9	0.04
149yy	Branford loam, 0 to 3 percent slopes, compacted surface	18.2	0.22
150	Hooksan fine sand, 0 to 3 percent slopes	269.5	3.25
152	Hooksan fine sand, 3 to 8 percent slopes	492.9	5.94
154	Hooksan fine sand, 8 to 15 percent slopes	19.2	0.23
156	Hooksan fine sand, 15 to 25 percent slopes	3.6	0.04
160	Hooksan sandy loam, 0 to 3 percent slopes, compacted surface	41.0	0.49
171	Hooksan-Verrazano-Pavement & buildings complex, 0 to 5 percent slopes	72.6	0.88
186	Ipswich mucky peat, tidal, frequently flooded	133.9	1.61
188	Ipswich mucky peat, tide flooded	692.9	8.35
196	Sandyhook mucky fine sandy loam, tidal, frequently flooded	174.2	2.10
198	Jamaica sand, frequently ponded	415.8	5.01
209g	Greatkills extremely gravelly sandy loam, 0 to 3 percent slopes	1.9	0.02
216	Matunuck mucky peat, tidal, frequently flooded	31.8	0.38
218	Matunuck mucky peat, tide flooded	82.2	0.99

Table 6: Acreage and proportionate extent of the soils (continued).

Map Symbol	Soil Name	Acres	Percent
220	Mud flat, tide flooded	180.6	2.18
223	Pavement & buildings, 0 to 5 percent slopes, sandy substratum	600.2	7.23
223x	Centralpark-Pavement & buildings-Shea complex, 0 to 5 percent slopes	14.0	0.17
225	Pavement & buildings, 0 to 5 percent slopes, till substratum	41.3	0.50
227	Pavement & buildings, 0 to 5 percent slopes, wet substratum	6.6	0.08
231	Pavement & buildings-Bigapple-Verrazano complex, 0 to 5 percent slopes	67.6	0.81
234	Pavement & buildings-Greenbelt complex, 0 to 5 percent slopes	28.6	0.35
235	Pavement & buildings-Hooksan-Verrazano complex, 0 to 5 percent slopes	70.1	0.84
239a	Pavement & buildings-Foresthills-Canarsie complex, 0 to 5 percent slopes	14.3	0.17
242	Pawcatuck mucky peat, tide flooded	242.7	2.92
253	Pompton loam, 0 to 3 percent slopes	9.5	0.11
258	Rikers gravelly coarse sand, 0 to 3 percent slopes	3.5	0.04
268	Water, salt	17.4	0.21
270	Verrazano sandy loam, 0 to 3 percent slopes	124.0	1.49
272	Verrazano sandy loam, 0 to 3 percent slopes, compacted surface	62.7	0.76
277	Verrazano-Hooksan complex, 0 to 3 percent slopes	6.3	0.08
292	Wethersfield sandy loam, 3 to 8 percent slopes	4.7	0.06
294	Wethersfield sandy loam, 8 to 15 percent slopes	4.8	0.06
306	Wethersfield sandy loam, 15 to 25 percent slopes, compacted surface	2.7	0.03
313	Hooksan-Dune land complex, 0 to 3 percent slopes	161.3	1.94
314	Pavement & buildings-Shea complex, 0 to 5 percent slopes, sandy substratum	3.0	0.04
315	Hooksan-Dune land complex, 3 to 8 percent slopes	558.3	6.73
316	Barren sand, 0 to 3 percent slopes	191.4	2.31
316x	Barren sandy loam, 0 to 3 percent slope	5.9	0.07
317	Hooksan-Dune land complex, 8 to 15 percent slopes	97.0	1.17
319	Hooksan-Dune land complex, 15 to 25 percent slopes	3.5	0.04
323	Bigapple-Blown-out land complex, 0 to 3 percent slopes	40.3	0.49
325	Bigapple-Blown-out land complex, 3 to 8 percent slopes	10.9	0.13
329	Bigapple-Blown-out land complex, 15 to 25 percent slopes	2.4	0.03
342	Bigapple gravelly coarse sand, 0 to 3 percent slopes, refuse surface	80.7	0.97
344	Fortress gravelly sand, 0 to 3 percent slopes, refuse surface	7.0	0.08
346	Verrazano gravelly sandy loam, 0 to 3 percent slopes, refuse surface	7.7	0.09
348	Jamaica gravelly sand, frequently ponded, refuse surface	0.4	*
350	Barren gravelly sand, 0 to 3 percent slopes, refuse surface	3.7	0.04
352	Shea sandy loam, 0 to 3 percent slopes	0.4	*
356	Hooksan gravelly fine sand, 0 to 3 percent slopes, refuse surface	61.3	0.74
358	Breeze loamy sand, 0 to 3 percent slopes	14.7	0.18
360	Breeze loamy sand, 3 to 8 percent slopes	7.7	0.09
360x	Breeze loamy sand, 3 to 8 percent slopes, wet substratum	8.6	0.10
362	Breeze loamy sand, 8 to 15 percent slopes	3.8	0.05
390	Blown-out land	10.3	0.12
400	Bulkhead fibric, 0 to 3 percent slopes, very shallow	2.3	0.03
502	Hassock sandy loam, 0 to 3 percent slopes	2.6	0.03
504	Winhole sandy loam, 0 to 3 percent slope	8.8	0.11
506	Flatland sandy loam, 0 to 3 percent slopes	45.8	0.55
508	Fishkill sandy loam, 0 to 3 percent slopes	29.0	0.35
514	Inwood gravelly sandy loam, 8 to 15 percent slopes	1.8	0.02
	Total	8,298.0	100.00

*Less than 0.01 percent

Laboratory Data

Sampling of selected soils for lab analyses was completed during the mapping phase of this project. A representative pedon of each soil series was sampled according to NRCS protocols (Soil Survey Staff, 1993). A soil pit approximately 5' x 6' was excavated to a depth of 6'. The soil profile was exposed and described, and bulk soil samples were taken from each horizon. In addition, four clod samples were taken from each soil horizon to determine bulk density and water retention. Laboratory data results are presented in the Appendix section. As additional analyses are conducted in the near future, they will be made available online and in new publications.

Soil pH influences the solubility and/or plant availability of nutrients (Figure 63). It also affects root growth, microbial activity, and chemical reactions in the soil (Brady and Weil, 1996). A pH range of 6 to 7 is generally more favorable for plant growth because most nutrients are readily soluble and available for plant uptake in this range. However, some plants have optimal pH requirements above or below this range. Soils that have a pH below 5.5 generally have low solubility of calcium, magnesium, and phosphorus. At these low pH values, the solubility of aluminum, iron, and boron is high; and molybdenum is low. At pH 7.8 or more, calcium, magnesium, and molybdenum are more readily available. High pH soils may have an inadequate supply of iron, manganese, cooper, zinc, phosphorus and boron for optimum plant growth.

Laboratory results for pH on topsoil from selected fill and natural soils are presented in Figure 64. Fill soils containing construction debris fragments (Breeze and Canarsie) commonly have higher pH values than clean fill soils (Bigapple) and natural soils (Cheshire and Hooksan). Concrete and cement fragments serve as liming materials, raising soil pH levels.

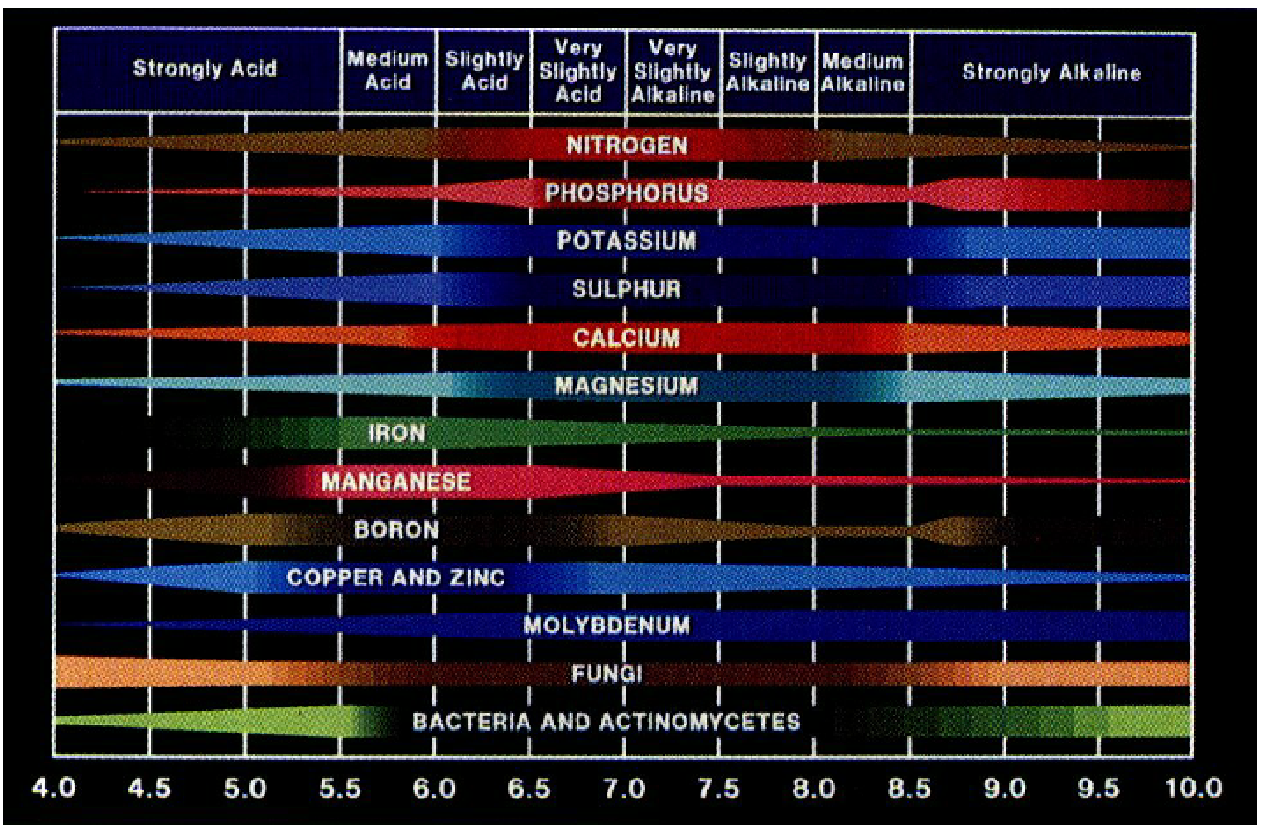

Figure 63. Effect of pH on availability of different soil nutrients.

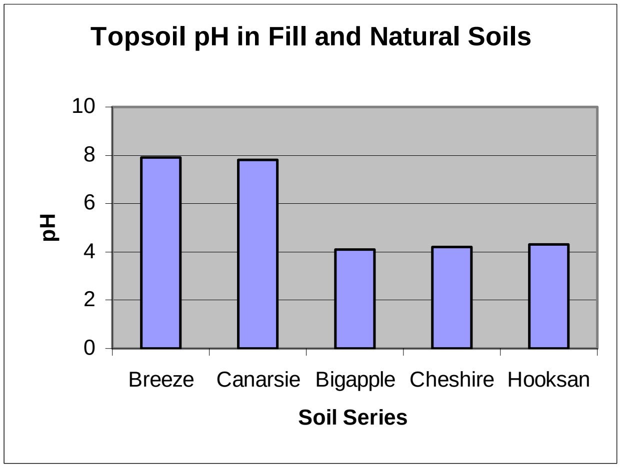

Figure 64. Soils containing human artifacts (i.e. bricks, concrete, glass, etc) generally have higher pH values than "clean" soils. Soil pH is a measure of the acidity or alkalinity in the soil. It regulates nutrient availability in the soil.

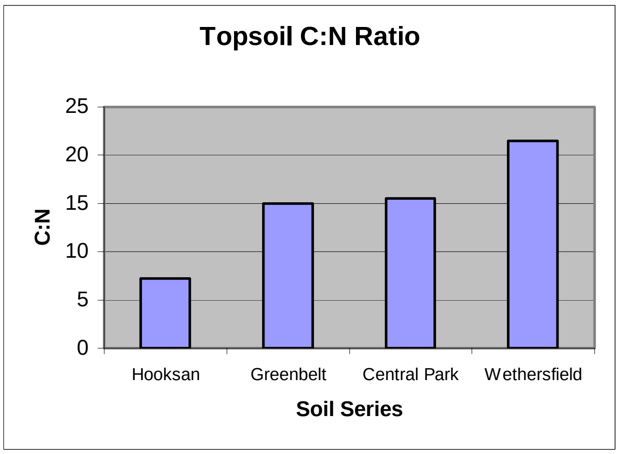

Figure 65. Fill (Greenbelt and Centralpark) and sandy soils (Hooksan) have lower C:N rations than natural soils (Wethersfield).

The ratio of carbon to nitrogen (C:N) in organic materials has important effects on decomposition rates and nutrient dynamics in the soil. The C:N ratio of organic materials can range from 13:1 in alfalfa hay, to 60:1 in corn stover, to 600:1 in spruce sawdust. In general, younger and greener materials have a lower C:N ratio that more mature or woodier types. Those materials with the low C:N ratio will be metabolized more readily, as N the released from their breakdown is sufficient to meet the needs of the microbial community. However, plant and organic material with a higher C:N ratio will require a longer period of time for decomposition. As microorganisms use up the available nitrogen from the materials they are breaking down, the ecosystem may suffer from a temporary nitrogen depression. Microbes will likely scavenge nitrogen from the soil solution, causing nearby plants to suffer from a nitrogen deficiency. The rate of decomposition of organic materials is also influenced by pH, soil moisture and aeration, and temperature.

Laboratory results of the topsoil C:N ratio for fill and natural soils are presented in Figure 65. Hooksan, a sandy soil with a sparse grass and herbaceous vegetative cover, has the lowest C:N ratio. Greenbelt and Central Park are loamy fill soils with better established shrub and herbaceous vegetation, which provides organic inputs with a higher C:N ratio. Wethersfield is a natural soil associated with hardwoods that are supplying more mature, carbon-rich litter to the surface.

The amount of water available for plant growth is the primary factor controlling the production of plant materials. In humid and temperate regions, organic matter accumulates over time due to low decomposition rates in the winter season. In soils saturated with water (hydric soils), organic matter decomposition is not as efficient as in aerobic environments. High organic matter contents are typical of soils that are saturated at the surface for significant periods of time during the growing season.

Air temperature, soil fertility, drainage class and texture also control the amount of organic matter. Sandy soils do not have the water or nutrient holding capacity of loamy or clayey soils, and, in general, do not produce as much vegetation. Sandy soils also contain less clay, which is attracted to organic matter in the soil. Clay particles can coat organic matter and act as a physical barrier to decomposing organisms, effectively reducing the available surfaces. For all of these reasons, sandy soils generally do not contain as much organic matter as loamy or clayey soils (Figure 66). The amount of soil organic matter is controlled by a balance between additions of plant and animal materials, and losses by decomposition. Both additions and losses are very strongly influenced by management activities. Tilling and fertilizing a soil often leads to increased microbial activity and a decrease in organic matter.

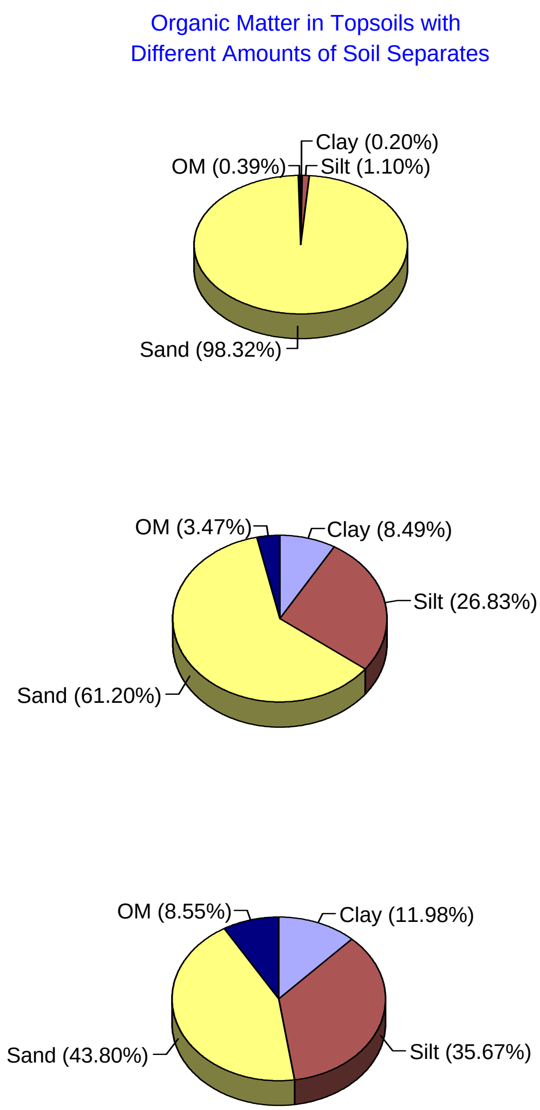

Figure 66. Hooksan (top) soils are sandier and contain less organic matter than loamy soils (Centralpark (middle) and Cheshire soils (bottom).

Other factors that may inhibit organic matter decomposition include toxic levels of elements (aluminum, manganese, boron, selenium chloride), excessive soluble salts, and organic phytotoxins in plant materials. The type of plant is also important, as legumes are more readily decomposed than grasses.

Laboratory results for organic matter in topsoil from two fill soils (Greenbelt and Canarsie) and two natural soils (Cheshire and Wethersfield) are presented in Figure 67. These results suggest that younger fill soils contain less organic matter than natural soils. Organic matter builds up slowly in soil over time, eventually reaching a steady state.

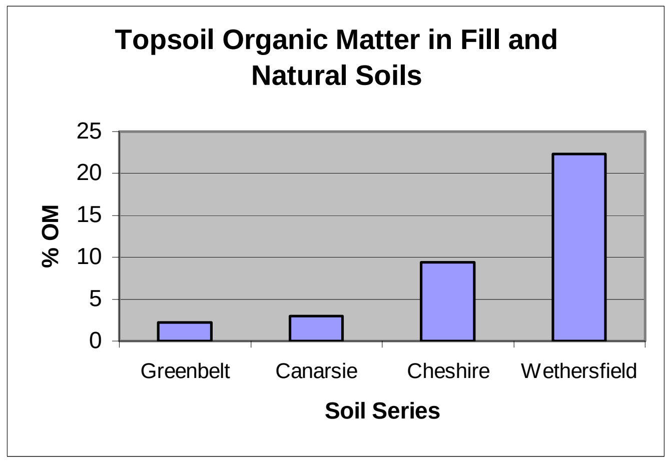

Figure 67. Young fill soils (Greenbelt and Canarsie) contain less organic matter than older natural soils (Cheshire and Wethersfield).

Soil water sustains plant growth. The amount of water available for plants is expressed as the available water capacity (AWC). The available water can be expressed as a percent volume, or as a depth of water per depth of soil (in inches). The AWC is affected by organic matter and texture, including the amount of rock fragments. The AWC increases with increasing amounts of organic matter and clay. Rock fragments reduce the AWC in direct proportion to their volume, unless the rocks are porous.

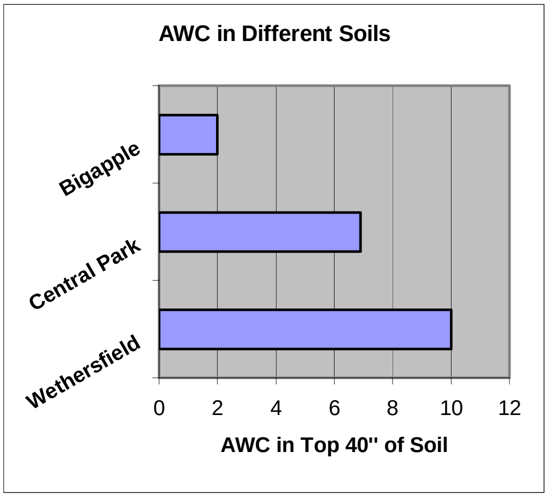

Figure 68. The amount of available water increases from a sandy Bigapple soil to loamier Centralpark and Wethersfield soils. A high percentage of sand in Bigapple soils, and rock fragments in Centralpark soils, limits available water to plants.

The AWC of two loamy soils (Wethersfield and Centralpark) and a sandy soil (Bigapple) are presented in Figure 68. Wethersfield soils have more available water than Centralpark soils as they contain more organic matter and fewer rock fragments. Bigapple soils hold less available water than Wethersfield and Centralpark soils as they have less total pore space, fewer small pores, and less organic matter.

The general effect of soil compaction on the movement of water in the soil is presented in Figure 69. Soil compaction occurs when soil particles are pressed together, reducing the pore space between them. This increases the weight of the solids per unit volume of soil (bulk density). Soil compaction occurs in response to pressure (weight per unit area) exerted by field machinery or human traffic. The risk of compaction is greatest when soils are wet. Compaction restricts rooting depth, which reduces the uptake of water and nutrients by plants.

Soil compaction decreases total pore space, especially the volume of large interconnected pores. It increases the proportion of water-filled pore space at “field capacity,” and results in a higher thermal conductivity, causing greater extremes in soil temperature. Compaction also affects the activity of soil organisms by decreasing the rate of decomposition of soil

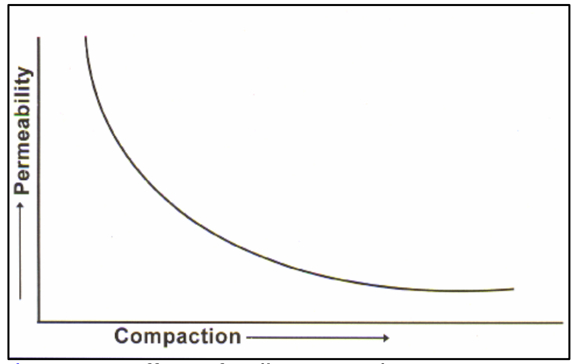

Figure 69. Effect of soil compaction on permeability.

organic matter and subsequent release of nutrients.

Soil organic matter promotes the aggregation of soil particles. Increased aggregate stability increases the amount of large interconnected pores, and helps prevent compaction and decrease erosion. It also increases permeability and plant available water. Additions of manure, compost, or other organic materials can improve soil structure, helping to resist compaction.

Soil Quality in Gateway National Recreation Area

Soil, water, and air are the three main components of our environment. Just as water quality and air quality are important to life on earth, so is soil quality. Soil quality describes the capacity of the soil to carry out crucial functions that affect plant, animal, and human health, as well as water and atmospheric quality. Healthy ecosystems are dependent on high quality soil, water, and atmospheric conditions. In urban areas, high quality soils can absorb and store large amounts of rainfall and atmospheric gases, filter and adsorb contaminants from water and air, provide an optimum chemical and physical environment for microbes, plants, arthropods, and animals, and support roads and buildings without failure. They are not prone to excessive runoff or erosion, and do not contain harmful concentrations of salts, heavy metals, or other materials.

As certain physical, chemical and biological soil properties can change with use and management, soil quality can change as well. Soil properties that affect the ability of the soil to absorb and store rainfall include texture, organic matter, structure, and porosity. In Gateway

National Recreation Area, infiltration into the surface layer is generally high except in those map units with compacted surfaces that have a higher bulk density due to recurrent foot or vehicular traffic. These compacted conditions reduce the capacity of the soil to store plant available water by decreasing the soil porosity. Compacted soils also have reduced air movement and gas exchange in the root zone. This can lead to nutrient losses and toxic gas build-up near the roots. Erosion is more likely to occur on compacted soils due to reduced infiltration and higher runoff. When cartographically feasible, such areas are represented by a map unit with a compact surface layer phase. Permeability in the near surface is generally moderate to rapid except in areas represented by compacted surface phase map units, where it is moderately slow.

In general, soils that are located on unpaved roads or laneways, or in other places where there is frequent foot or vehicular traffic, have lower infiltration and slower permeability near the surface. Compaction can also occur when loamy soil materials are redeposited as “fill” by humans. The compaction in these soils is created when heavy equipment is used to transport, deposit and grade the original fill materials. These conditions can be present in Greenbelt, Centralpark and Verrazano soils. Soils with moderate permeability rates have a moderate to high capacity for storing plant available water. Uncompacted medium textured (loamy) soils have moderate permeability rates. The sandy Hooksan, Jamaica, Bigapple, and Fortress soils have permeabilities that are too high for optimum retention and storage of plant available water.

A high quality soil will have a diverse macro and microorganism population that can decompose organic matter and release nutrients. This condition permits efficient recycling of urban waste products encountered in the soil. Soils with a good balance of plant available water and aeration, favorable pH and nutrient levels, and an adequate organic matter supply will support a healthy microbial population.

Soil respiration is the production of carbon dioxide (CO_2) as a result of biological activity in the soil by microorganisms, live roots, arthropods and earthworms. Soil respiration can be used as a biological indicator of soil quality. Figure 70 shows soil respiration rates for some anthropogenic soils. Breeze soils, which have low organic matter and high pH values, have less microbial activity than the wetter Jamaica and Fortress soils. Jamaica soils are poorly drained and Fortress soils are moderately well drained. These soils accumulate organic matter due to a high water table during late fall, winter and spring. During the summer, evapo-transpiration is high. The water table drops to the subsoil, leaving most of the soil pores within the topsoil occupied by air. This situation creates favorable conditions for microbial activity due to the high concentrations of organic matter and oxygen.

Salinity, or salt content, is an important chemical property of a soil that can affect or limit its use. The electrical conductivity of a soil solution or a soil water mixture is measured to assess the salt content in soils. Ipswich soils are naturally high in salinity since these soils formed in tidal flats. Plant types on saline soils will be limited to salt tolerant species.

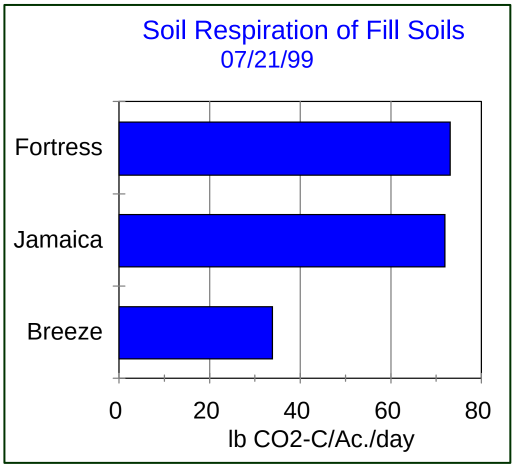

Figure 70. Soil respiration is used as an biological indicator of soil quality. Breeze soils have high pH, low organic matter and lower AWC than Jamaica and Fortress soils. These soil properties affect soil respiration.

Many of the soils in Gateway National Recreation Area are well suited for roads and buildings. Notable exceptions are organic soils like Ipswich that lack bearing strength, and mineral soils with high water tables like Jamaica that are too wet. However, these soils perform a different, but no less important role in sustaining the biological productivity and diversity of the salt marsh ecosystem.

A high quality soil in the urban environment supports healthy vegetation, thereby creating a greenspace that improves the quality of life. This vegetation can also moderate the elevated temperatures generated by the urban matrix through the natural cooling process of evapotranspiration. A decrease in the soil quality in the park may have far reaching off-site effects. If the surface layer of a soil is poorly managed, the result will likely be compaction and exposure of bare soil. These conditions can lead to excessive increases in runoff and erosion, and potential flooding. Downstream contamination of water bodies with sediments and non-point source pollutants will result.

The Gateway National Recreation Area Soil Survey can serve as a stepping stone for more surveys, more public support, and a better understanding of urban soils. A greater percentage of the world’s population is now living in urban areas, and public concern about the environment and health is high. Exorbitant real estate prices, suburban sprawl, and the loss of open space are pressing issues for most of our citizens. Land use decisions based on sound soils information are more critical than ever.

Soil Map Unit Descriptions

316 – Barren Sand, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock and somewhat poorly drained Barren soils. These soils have formed in a thick mantle of sandy dredge materials, transported and modified by human activity. Barren soils are found in Floyd Bennett Field, Jamaica Bay, Wildlife Refuge, Bergen Beach, and Sandy Hook.

COMPOSITION:

Barren and similar soils: 90 percent
Inclusions: 10 percent – Bigapple, Fortress, and Jamaica soils

PARENT MATERIAL:
Sandy dredge materials

A

Bw

Bg1

Bg2

C

Figure 71. Barren soil profile. Soil description and laboratory data are available in Appendix 1.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.07 to 0.09 inches of water per inch of soil
Subsoil/Substratum: 0.05 to 0.08 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.10; **Kf Factor**: 0.10

Permeability Class: Rapid

Range in Soil pH: Very strongly acid to slightly alkaline

T Factor: 5

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Between 10 and 24 inches from November through May

Potential Frost Action: Moderate

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe – wetness, seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Ponding Hazard Frequency and Duration: Rare ponding for very brief periods throughout the year

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Severe limitation – ponding

Local Roads and Streets: Severe limitation - ponding

Shallow Excavations: Severe limitation-cutbanks cave, wetness, ponding

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, low fertility

Topsoil: Poor – too sandy

Recreation

Camp Areas: Severe limitation – too sandy, ponding

Paths and Trails: Severe limitation – too sandy, ponding

Picnic Areas: Severe limitation – too sandy, ponding

Off Road Motorcycle Trails: Severe limitation – too sandy, ponding

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – cutbanks cave

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation –High available water capacity

Seedling Mortality: Moderate limitation – wetness

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – wetness, too sandy

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too sandy

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, low salt

Habitat for Burrowing Mammals and Reptiles: Poor – wetness, too sandy, ponding

Upland Coniferous Trees for use as Wildlife Habitat: Poor – wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor – wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – wetness, too sandy

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – wetness, too sandy

350 – Barren gravelly sand, 0 to 3 percent slopes, refuse surface

Same as map unit 316 except:

Surface layer: Gravelly sand

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 – 0.08 inches of water per inch of soil

Kw Factor: 0.05; **Kf Factor**: 0.10

LIMITATIONS FOR USE:

Playgrounds: Severe limitation – too sandy, ponding, small stones

316x – Barren sandy loam, 0 to 3 percent slopes

Same as map unit 316 except:

Surface layer: Sandy loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.13 – 0.15 inches of water per inch of soil

Kw Factor: 0.24; **Kf Factor**: 0.24

Permeability Class: Moderately rapid in the surface horizon and rapid below

T Factor: 4

Wind Erodibility Group: 3

LIMITATIONS FOR USE:

Construction Materials

Soil Reconstruction Material for Drastically Disturbed Areas: Fair – Droughty, low fertility

Recreation

Camp Areas: Severe limitation – ponding

Paths and Trails: Severe limitation – ponding

Picnic Areas: Severe limitation – ponding

Playgrounds: Severe limitation – ponding

Off Road Motorcycle Trails: Severe limitation – ponding

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – wetness

Freshwater Wetland Plants for Use as Wildlife Habitat: Fair – depth to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – low salt

Habitat for Burrowing Mammals and Reptiles: Poor – wetness, ponding

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – wetness

14 – Beaches

INTRODUCTION:

This unit consists of nearly level to gently sloping areas of sand of sand and gravel adjacent to the Atlantic Ocean. The sand may be underlain by muck and other non soil material. These areas are inundated twice each day with salt water at high tide. Beaches are not considered soil because they do not support vegetation, and are frequently reworked by wave and wind action. Beaches can be observed along shorelines in all Gateway units. The width and shape of Beaches can change during each major storm.

COMPOSITION:

Beaches and similar miscellaneous areas: 90 percent
Inclusions: 10 percent – Hooksan, Pawcatuck, Ipswich, Bigapple, Sandyhook, Barren, Jamaica, Matunuck, and Verrazano soils

PARENT MATERIAL:
Marine sediments

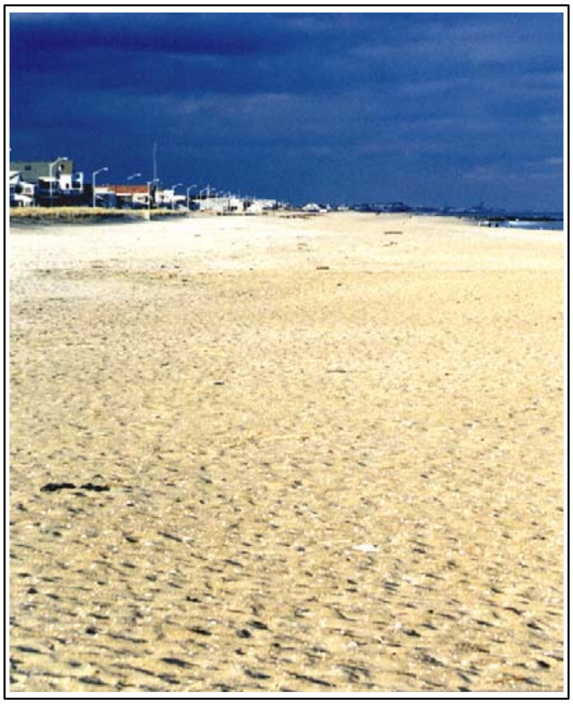

Figure 72. Beach landscape.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity: 0.05 – 0.07 inches of water per inch of soil throughout

Excavation Difficulty: Low

Kw Factor: 0.15; **Kf Factor**: 0.15

Permeability Class: Very Rapid

Range in pH: Strongly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: High

Potential Frost Action: None

Pesticide Loss Potential – Leaching: Severe

Pesticide Loss Potential – Soil Surface Runoff: Severe – Flooding

LIMITATIONS FOR USE:

Severe limitation: Poorly suited for all uses due to tidal flooding.

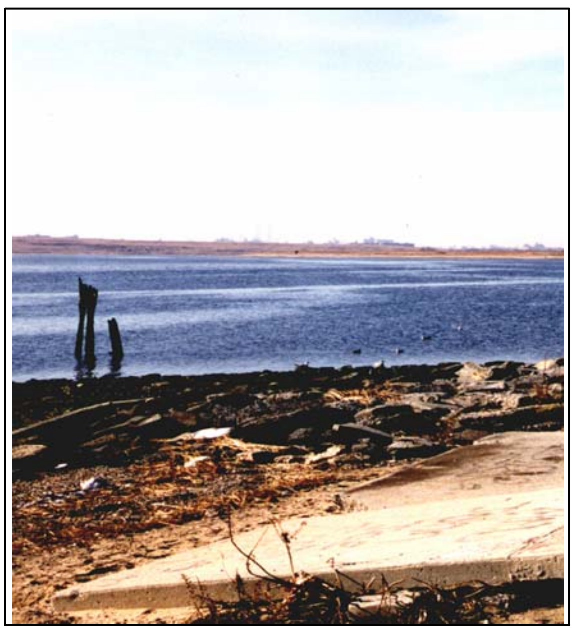

Figure 73. Rubbly Beach Landscape

14x – Beaches, rubbly

Same as map unit 14 except:

Surface layer: rubbly

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface: 0.03 – 0.06 inches of water per inch of soil

Excavation Difficulty: Very high

Kw Factor: 0.05; **Kf Factor**: 0.15

Root Limiting Layer, Restriction Kind: Boulder and stone-sized coarse fragments on the surface

Wind Erodibility Group: 8

16 – Bigapple coarse sand, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Bigapple soils. These soils have formed in a thick mantle of sandy dredge materials, transported and modified by human activity. Bigapple soils are found in Floyd Bennett Field, Jamaica Bay Wildlife Refuge, and Sandy Hook.

COMPOSITION:

Bigapple and similar soils: 90 percent
Inclusions: 10 percent – Fortress, Barren, Verrazano, Jamaica and Hooksan soils.

PARENT MATERIAL:

Sandy dredge materials

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.04 – 0.06 inches of water per inch of soil
Subsoil/Substratum: 0.02 to 0.08 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.05; **Kf Factor**: 0.05

Permeability Class: Rapid

Range in pH: Strongly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

A
E
Bw
C1
C2
C3
C4

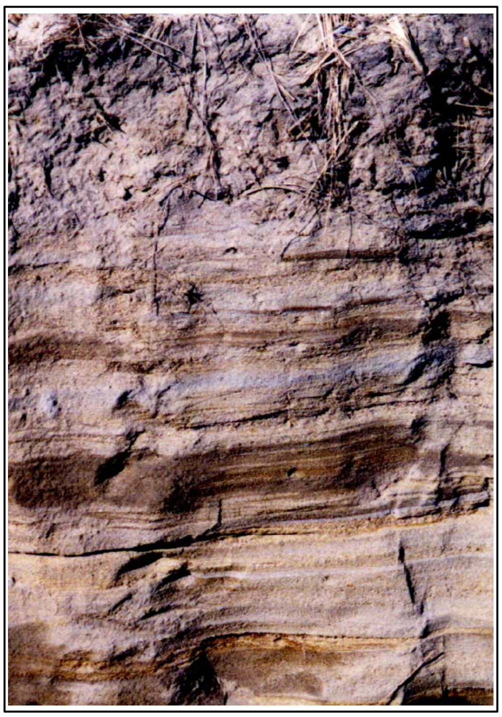

Figure 74. Bigapple soil profile. Soil description and laboratory data are available in Appendix 2.

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Low

Pesticide Loss Potential – Leaching: Severe – low adsorption and seepage

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Very Low

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Severe limitation – too sandy

Local Roads and Streets: Slight limitation

Shallow Excavations: Severe limitation – cutbanks cave

<u>Construction Materials</u>

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, soil blowing, droughty, too acid

Topsoil: Poor – too sandy

<u>Recreation</u>

Camp Areas: Severe limitation – too sandy

Paths and Trails: Severe limitation – too sandy

Picnic Areas: Severe limitation – too sandy

Playgrounds: Severe limitation – too sandy

Off Road Motorcycle Trails: Severe limitation – too sandy

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Severe limitation – cutbanks cave, deep to water

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation – too acid

Seedling Mortality: Moderate limitation - droughty

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, too deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water, low salt, too acid

Habitat for Burrowing Mammals and Reptiles: Poor – too sandy

Upland Coniferous Trees for use as Wildlife Habitat: Fair - droughty

Upland Deciduous Trees for use as Wildlife Habitat: Fair - droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor –too sandy

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor –too sandy

18 – Bigapple coarse sand, 3 to 8 percent slopes

Same as map unit 16 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Recreation

Playgrounds: Severe limitation – too sandy, slope

20 - Bigapple coarse sand, 8 to 15 percent slopes

Same as map unit 16 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Local Roads and Streets: Moderate limitation – slope

Recreation

Playgrounds: Severe limitation – too sandy, slope

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

24 – Bigapple coarse sand, 25 to 35 percent slopes

Same as map unit 16 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Leaching: Severe – seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – too sandy, slope

Local Roads and Streets: Severe limitation – slope

Shallow Excavations: Severe limitation - slope

Construction Materials

Topsoil: Poor – too sandy

Recreation

Camp Areas: Severe limitation – too sandy, slope

Paths and Trails: Severe limitation – too sandy, slope

Picnic Areas: Severe limitation – too sandy, slope

Playgrounds: Severe limitation – too sandy, slope

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy, slope

49x – Bigapple coarse sand, 15 to 35 percent slopes, cemented substratum

Same as map unit 16 except:

Substratum – Cemented (below 60'')

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Leaching: Severe - seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Medium

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – too sandy, slope

Local Roads and Streets: Severe limitation – slope

Shallow Excavations: Severe limitation – cutbanks cave, slope

Construction Materials

Topsoil: Poor – too sandy, slope

Recreation

Camp Areas: Severe limitation – too sandy, slope

Paths and Trails: Severe limitation – too sandy, slope

Picnic Areas: Severe limitation – too sandy, slope

Playgrounds: Severe limitation – too sandy, slope

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy, slope

342 – Bigapple gravelly coarse sand, 0 to 3 percent slopes, refuse surface

Same as map unit 16 except:

Surface layer – Gravelly coarse sand

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.03 – 0.05 inches of water per inch of soil

Kw Factor: 0.02; **Kf Factor**: 0.05

LIMITATIONS FOR USE:

Recreation

Playgrounds: Severe limitation – too sandy, slope

26x – Bigapple sandy loam, 0 to 3 percent slopes

Same as map unit 16 except:

Surface layer – Sandy loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.13 – 0.15 inches of water per inch of soil

Kw Factor: 0.24; **Kf Factor**: 0.24

T Factor: 4

Wind Erodibility Group: 3

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – droughty

Construction Materials

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, low fertility, droughty

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation – slope

Off Road Motorcycle Trails: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair - droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor –deep to water, low salt, too acid

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair - droughty

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair - droughty

26 – Bigapple sandy loam, 0 to 3 percent slopes, compacted surface

Same as map unit 16 except:

Surface layer – Sandy loam, compacted surface

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.04 – 0.11 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.37; **Kf Factor**: 0.37

Permeability Class: Moderately slow in the compacted surface horizon and rapid below

Root Limiting Layer, Restriction Kind: Dense material – compacted surface

T Factor: 2

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Hydrologic Group: C

Pesticide Loss Potential – Leaching: Severe – seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – Dense material (compacted surface)

Construction Materials

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, low fertility, droughty

Recreation

Camp Areas: Severe limitation – dense layer (compacted surface)

Paths and Trails: Severe limitation – dense layer (compacted surface)

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – dense layer (compacted surface)

Off Road Motorcycle Trails: Slight limitation

Woodland Management

Seedling Mortality: Severe limitation – restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt, too acid

Habitat for Burrowing Mammals and Reptiles: Poor – too sandy, dense layer (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – root depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – root depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – root depth (compacted surface)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair - droughty

28 – Bigapple sandy loam, 3 to 8 percent slopes, compacted surface

Same as 16 except::

Surface layer – Sandy loam, compacted surface

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12’’): 0.04 – 0.11 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.37; **Kf Factor**: 0.37

Permeability Class: Moderately slow in the compacted surface horizon and rapid below

Root Limiting Layer, Restriction Kind: Dense material – compacted surface

T Factor: 2

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Hydrologic Group: C

Pesticide Loss Potential – Leaching: Severe – seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – Dense material (compacted surface)

Recreation

Camp Areas: Severe limitation – dense layer (compacted surface)

Paths and Trails: Severe limitation – dense layer (compacted surface)

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – dense layer (compacted surface)

Off Road Motorcycle Trails: Slight limitation

Woodland Management

Seedling Mortality: Severe limitation – restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt, too acid

Habitat for Burrowing Mammals and Reptiles: Poor – too sandy, dense layer (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – root depth (compacted surface)
Upland Deciduous Trees for use as Wildlife Habitat: Poor – root depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – root depth (compacted surface)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair - droughty

323 – Bigapple – Blown-out land complex, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well rained Bigapple soils and areas of Blown-out land, so intermingled that it was not practical to map them separately. Areas of Bigapple soils are generally vegetated with Bayberry, grasses, milkweed, Ailanthus, and other plant species. Areas of Blown-out land are not vegetated. This map unit is found in Floyd Bennett Field and Jamaica Bay Wildlife Refuge.

COMPOSITION:

Bigapple and similar soils: 50 percent
Blown-out land: 45 percent
Inclusions: 5 percent Fortress, Barren, and Jamaica

Bigapple:Same as map unit 16
Blown-out land: Same as map unit 390

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Leaching: Severe – low adsorption, seepage

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – Moderate limitation – droughty

Local Roads and Streets: Slight limitation

Shallow Excavations: Severe limitation – cutbanks cave

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – soil blowing, too sandy, low fertility

Recreation

Camp Areas: Severe limitation – too sandy, slope

Paths and Trails: Severe limitation – too sandy, slope

Picnic Areas: Severe limitation – too sandy, slope

Playgrounds: Severe limitation – too sandy, slope

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – cutbanks cave, deep to water

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition: Moderate limitation – available water capacity

Seedling Mortality: Moderate limitation - droughty

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy
Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water, low salt

Habitat for Burrowing Mammals and Reptiles: Poor – too sandy

Upland Coniferous Trees for use as Wildlife Habitat: Fair - droughty

Upland Deciduous Trees for use as Wildlife Habitat: Fair - droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – too sandy

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – too sandy

325 – Bigapple – Blown-out land complex, 3 to 8 percent slopes

COMPOSITION:

Bigapple and similar soils: 50 percent
Blown-out land: 45 percent
Inclusions: 5 percent Fortress, Barren, and Jamaica

Bigapple: Same as map unit 18

Blown-out land: Same as map unit 390

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate - excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Recreation

Playgrounds: Severe limitation – too sandy, slope

329 - Bigapple – Blown-out land complex, 15 to 25 percent slopes

COMPOSITION:
Bigapple and similar soils: 50 percent
Blown-out land: 45 percent
Inclusions: 5 percent Hooksan and Dune land

Bigapple: Same as map unit 16 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Leaching: Severe – seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – too sandy, slope

Local Roads and Streets: Severe limitation - slope

Shallow Excavations: Severe limitation – cutbanks cave, slope

Construction Materials

Topsoil: Poor – too sandy, slope

Recreation

Camp Areas: Severe limitation – too sandy, slope

Paths and Trails: Severe limitation – too sandy, slope

Playgrounds: Severe limitation – too sandy, slope

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

Blown-out land: Same as map unit 325 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Leaching: Severe – seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – too sandy slope

Local Roads and Streets: Severe limitation - slope

Shallow Excavations: Severe limitation – cutbanks cave, slope

Construction Materials

Topsoil: Poor – too sandy, slope

Recreation

Camp Areas: Severe limitation – too sandy

Paths and Trails: Severe limitation – too sandy

Playgrounds: Severe limitation – too sandy

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

45 – Bigapple – Verrazano sandy loams, 3 to 8 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Bigapple soils and Verrazano soils, so intermingled that it was not practical to map them separately.

COMPOSITION:

Bigapple and similar soils: 60 percent
Verrazano soils: 35 percent
Inclusions: 5 percent - Big coarse sand, Fortress, Barren and Jamaica

Bigapple: Same as map unit 26x except:

PHYSICAL AND CHEMICAL PROPERTIES:

Surface Runoff Class: Low

LIMITATIONS FOR USE:

__Recreation__

Playgrounds: Severe limitation – slope

47 – Bigapple – Verrazano – Pavement & buildings complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Bigapple and Verrazano soils and the areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Bigapple and Verrazano soils generally occur in open areas between buildings sidewalks, roads and parking lots.

COMPOSITION:

Bigapple and similar soils: 40 percent
Verrazano soils: 35 percent
Pavement & Buildings: 20 percent
Inclusions: 5 percent – Bigapple sand, Fortress, Barren and Jamaica

Surface layer – Sandy loam

Bigapple soils: Same as map unit 26x
Verrazano soils: Same as map unit 270

Pavement & Buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

390 – Blown-out Land

INTRODUCTION:

This unit consists of areas of shirting, windblown sand, where most of all of the soil material has been removed by extreme wind erosion. These areas are generally shallow depressions with a flat or irregular surface, and are sometimes devoid of vegetation. Blown-out land is found in Sandy Hook, Breezy Point, Bergen Beach, Jamaica Bay Wildlife Refuge, Plumb Beach, Great Kills Park, Fort Wadsworth and Fort Tilden.

COMPOSITION:

Blown-out land and similar miscellaneous areas: 85 percent
Inclusions: 15 percent – Hooksan, Bigapple, Dune land, Jamaica and Sandy Hook

PARENT MATERIAL:
Eolian sands

Surface layer – Fine sand or sand

Figure 75. Landscape of Blown-out land

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity: 0.05 to 0.07 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.15; **Kf Factor**: 0.15

Permeability Class: Very Rapid

Range in Soil pH: Strongly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Low

Potential Frost Action: None

Hydrologic Group: A

Soil Ratings vary with slope. See map units 323, 325, and 329 for Ratings of slope phases for Blown-out land.

149 - Branford loam, 0 to 3 percent slopes

INTRODUCTION:

This map unit consists of very deep to bedrock, well drained Branford soils. These soils have formed in loamy soils materials over stratified sand and gravel. Branford soils are found in Miller Field.

COMPOSITION:

Branford and similar soils: 90 percent
Inclusions: 10 percent – Pompton, Shea, Verrazano and Hooksan soils

PARENT MATERIAL:
Glacial outwash

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
- **Surface (0-12'')**: 0.04 to 0.24 inches of water per inch of soil
- **Subsoil/Substratum:** 0.01 to 0.22 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.32; **Kf Factor**: 0.32

Permeability Class: Moderate or moderately rapid in the solum, moderately rapid or rapid in the substratum

Range in Soil pH: Strongly acid to slightly acid

T Factor: 3

Figure 76. Branford soil profile. Soil description and partial laboratory data are available in Appendix 3.

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Moderate – seepage (sandy substratum)

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Slight limitation

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Severe limitation – cutbanks cave

Construction Materials

Sand Source: Probable – sandy substratum

Soil Reconstruction Material for Drastically Disturbed Areas: Fair – low fertility, droughty, too acid

Topsoil: Fair – thin layer

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation – slope

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – deep to water, cutbanks cave

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation – available water capacity

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Good

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor –deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Habitat for Burrowing Mammals and Reptiles: Good

Upland Coniferous Trees for use as Wildlife Habitat: Good

Upland Deciduous Trees for use as Wildlife Habitat: Good

Upland Shrubs and Vines for Use as Wildlife Habitat: Good

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Good

149yy – Branford loam, 0 to 3 percent, slopes, compacted surfaced

Same as map unit 149 except:

Surface layer – compacted surface

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 to 0.16 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.43; **Kf Factor**: 0.43

Permeability Class: Moderately slow in the compacted surface, moderate or moderately rapid in the solum, moderately rapid or rapid in the substratum

Root Limiting Layer, Restriction Kind: Dense material – compacted surface

T Factor: 3

SOIL AND WATER FEATURES:

Hydrologic Group: C

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – Dense material (compacted surface)

Recreation

Camp Areas: Severe limitation – dense layer (compacted surface)

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – dense layer (compacted surface)

Woodland Management

Plant Competition: Moderate limitation – available water capacity

Seedling Mortality: Severe limitation – restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Habitat for Burrowing Mammals and Reptiles: Poor – rooting depth (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

149g – Branford extremely gravelly loam, 0 to 3 percent slopes

Same as map unit 149 except:

Surface Layer: Extremely gravelly loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.02 to 0.09 inches of water

Kw Factor: 0.05; **Kf Factor**: 0.32

Wind Erodibility Group: 8

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – small stones

Construction Material

Sand Source: Improbable – small stones

Soil Reconstruction Material for Drastically Disturbed Areas: Poor - droughty

Topsoil: Fair – thin layer, small stones

Recreation

Camp Areas: Severe limitation – small stones

Paths and Trails: Severe limitation – small stones

Picnic Areas: Severe limitation – small stones

Playgrounds: Severe limitation – small stones

Off Road Motorcycle Trails: Severe limitation – small stones

Woodland Management

Plant Competition: Moderate limitation – available water capacity

Seedling Mortality: Severe limitation – rock fragments

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too gravelly

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – too gravelly

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – too gravelly

149y – Branford extremely gravelly loam, 0 to 3 percent slopes

Same as map unit 149 except:

Surface layer: Loamy sand

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.10 to 0.12 inches of water

Kw Factor: 0.17; **Kf Factor**: 0.17

Wind Erodibility Group: 2

LIMITATIONS FOR USE:

Construction Material

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – soil blowing

Recreation

Camp Areas: Moderate limitation – too sandy

Paths and Trails: Moderate limitation – too sandy

Picnic Areas: Moderate limitation – too sandy

Playgrounds: Moderate limitation – too sandy

Woodland Management

Plant Competition: Moderate limitation – available water capacity

Seedling Mortality: Moderate limitation - droughty

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair – too sandy

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair – too sandy

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – too sandy

149x – Branford – Pavement and Buildings complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Branford soils and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Branford soils generally occur in open areas between buildings, sidewalks, roads, and parking lots. This map unit is found in Miller Field.

COMPOSITION:

Branford and similar soils: 60 percent
Pavement & buildings: 35 percent
Inclusions: 5 percent – Pompton, Shea, and Verrazano soils

Branford soils: Same as map unit 149

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

358 – Breeze loamy sand, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Breeze soils. These soils have formed in a thick mantle of sandy materials intermingled with demolished construction debris. Breeze soils are found in Fort Tilden and Floyd Bennett Field.

COMPOSITION:
Breeze and similar soils: 90 percent
Inclusions: 10 percent – Bigapple, Hooksan, and Verrazano

PARENT MATERIALS:
Sandy fill intermingled with construction debris

Figure 77. Breeze soil profile. Soil description and laboratory data are available in Appendix 4.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.10 to 0.12 inches of water per inch of soil
Subsoil/Substratum: 0.03 to 0.07 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.15; **Kf Factor**: 0.17

Permeability Class: Rapid

Range in Soil pH: Moderately acid to moderately alkaline

T Factor: 2

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Low

Hydrologic Group: A

Pesticide Loss Potential – Leaching: Severe – seepage, low adsorption

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation - droughty

Local Roads and Streets: Slight limitation

Shallow Excavations: Severe limitation – cutbanks cave

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – soil blowing, droughty, too sandy, low fertility

Topsoil: Poor – too sandy

Recreation

Camp Areas: Moderate limitation – too sandy

Paths and Trails: Moderate limitation – too sandy

Picnic Areas: Moderate limitation – too sandy

Playgrounds: Moderate limitation – too sandy

Off Road Motorcycle Trails: Moderate limitation – too sandy

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Severe limitation –cutbanks cave, no water

Pond Reservoir Area: Severe limitation – seepage

<u>Woodland Management</u>

Plant Competition: Severe limitation – too alkaline

Seedling Mortality: Moderate limitation - droughty

<u>Wildlife Habitat</u>

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair – too sandy, droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor –deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Habitat for Burrowing Mammals and Reptiles: Poor – too sandy

Upland Coniferous Trees for use as Wildlife Habitat: Fair - droughty

Upland Deciduous Trees for use as Wildlife Habitat: Fair - droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair – too sandy, droughty

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – too sandy, droughty

360 – Breeze loamy sandy, 3 to 8 percent slopes

Same as map unit 358 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

<u>Recreation</u>

Playgrounds: Severe limitation - slope

360x – Breeze loamy sand, 3 to 8 percent slopes, wet substratum

Same as map unit 360 except:

Depth to Seasonal Water Table: Between 24 and 48 inches from November through May

362 – Breeze loamy sand, 3 to 8 percent slopes, wet substratum

Same as map unit 360 except:

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Moderate limitation - droughty

Local Roads and Streets: Moderate limitation - slope

<u>Recreation</u>

Playgrounds: Severe limitation – slope

<u>Water Management</u>

Pond Reservoir Area: Severe limitation – seepage, slope

114 - Bulkhead, fibric, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of the shallow (<20'') to concrete, well drained Bulkhead soils. The soils have formed in a thin mantle of organic waste overlying an impermeable layer of concrete of pavement. Bulkhead soils are found in Floyd Bennett Field.

COMPOSITION:

Bulkhead and similar soils: 95 percent
Inclusions: 5 percent – Pavement & buildings, and scattered areas with organic mantle thicker than 20 inches

Figure 78. Profile of Bulkhead soil. Soil description is available in Appendix 5.

PARENT MATERIAL:
Organic Waste

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.55 to 0.65 inches of water per inch of soil
Substratum: Negligible (concrete layer)

Excavation Difficulty: Very high in concrete layer, otherwise low

Permeability Class: Very rapid in the organic soil, impermeable in the concrete layer

Range in Soil pH: Extremely acid or dysic (<4.5)

Root Limiting Layer, Restriction Kind: Cemented horizon: ~ 8-inch concrete layer

T Factor: 2

Wind Erodibility Group: 7

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Moderate

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: None

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe - seepage

Pesticide Loss Potential – Soil Surface Runoff: Severe – excess runoff

Ponding Hazard Frequency and Duration: Rare ponding for very brief periods throughout the year

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – Cemented pan (concrete layer), ponding

Local Roads and Streets: Severe limitation – cemented pan (concrete layer), ponding

Shallow Excavations: Severe limitation – cemented pan (concrete layer), ponding

<u>Construction Materials</u>

Sand Source: Improbable – excess humus (wood pieces & fibers)

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – thin layer

Topsoil: Poor – cemented pan (concrete layer), excess humus (wood pieces & fibers), thin layer

<u>Recreation</u>

Camp Areas: Severe limitation – cemented pan (concrete layer), excess humus (wood pieces & fibers), ponding

Paths and Trails: Severe limitation –excess humus (wood pieces & fibers), ponding

Picnic Areas: Severe limitation – cemented pan (concrete layer), ponding

Playgrounds: Severe limitation – cemented pan (concrete layer), ponding

Off Road Motorcycle Trails: Severe limitation – excess humus (wood pieces & fibers), ponding

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Severe limitation – no water

Pond Reservoir Area: Severe limitation – cemented pan (concrete layer)

<u>Woodland Management</u>

Plant Competition: Severe limitation – high available water capacity, too acid

Seedling Mortality: Moderate limitation – restrictive layer

<u>Wildlife Habitat</u>

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth, percs slowly (concrete layer)

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor –deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt, too acid

Habitat for Burrowing Mammals and Reptiles: Poor – ponding

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (concrete layer)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (concrete layer)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – excess humus (wood pieces and fibers), rooting depth (concrete layer)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Well suited

400 – Bulkhead fibric, 0 to 3 percent slopes, very shallow

Same as map unit 114 except:

Very shallow (<10'' to concrete)

PHYSICAL AND CHEMICAL PROPERTIES:

T Factor: 1

LIMITATIONS FOR USE:

<u>Woodland Management:</u>

Seedling Mortality: Severe limitation – restrictive layer

<u>Wildlife Management</u>

Habitat for Burrowing Mammals and Reptiles: Poor – cemented pan (concrete layer), ponding

114x – Bulkhead-Pavement & buildings complex, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of shallow (<20'') to concrete or pavement, well drained Bulkhead soils and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. This map unit is found in Floyd Bennett Field.

COMPOSITION:

Bulkhead and similar soils: 55 percent
Pavement & buildings: 40 percent
Inclusions: 5 percent – scattered areas with organic mantle thicker than 20 inches

Bulkhead soils: Same as map unit 114

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

64 – Centralpark gravelly sandy loam, 0 to 3 percent slopes, compacted surface

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Centralpark soils. These soils have formed in a thick mantle of loamy fill containing a high percentage of natural rock fragments. Centralpark soils are found throughout Gateway.

COMPOSITION:

Centralpark and similar soils: 90 percent
Inclusions: 10 percent – Greenbelt, Breeze, and Inwood soils

PARENT MATERIAL:

"Clean" fill (less then 10 percent by volume of artifacts)

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:

- **Surface (0-12'')**: 0.03 to 0.08 inches of water per inch of soil
- **Subsoil (12-36'')**: 0.02 to 0.08 inches of water per inch of soil
- **Substratum (>36'')**: 0.02 to 0.19 inches of water per inch of soil

Excavation Difficulty: High

Kw Factor: 0.15; **Kf Factor**: 0.24

Permeability Class: Moderately slow in the compacted surface and moderate below

Figure 79. Profile of Centralpark soil. Soil description and laboratory data are available in Appendix 6.

Range in Soil pH: Very strongly acid to slightly alkaline

T Factor: 2

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: C

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – dense material (compacted surface)

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Moderate limitation – large stones

Construction Materials

Sand Source: Improbable - large stones

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – droughty, too stony

Topsoil: Poor – small and large stones

Recreation

Camp Areas: Severe limitation – dense layer (compacted surface)

Paths and Trails: Slight limitation

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – dense layer (compacted surface)

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation –no water

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation – available water capacity

Seedling Mortality: Severe limitation – restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor –deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Habitat for Burrowing Mammals and Reptiles: Poor – dense layer (compacted surface), rock fragments

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor - rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – droughty

223x – Centralpark-Shea-Pavement & buildings complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Centralpark soils, the shallow (<20'') to concrete, well drained Shea soils, and areas of Pavement & buildings, so intermingled it was not practical to map them separately. Centralpark soils have formed in a thick mantle of loamy fill, and Shea soils have formed in a thin mantle of loamy fill overlying an impermeable layer of concrete of asphalt. This map unit is found in Floyd Bennett Field.

COMPOSITION:

Centralpark soils: 35 percent
Shea soils: 35 percent
Pavement & buildings: 25 percent
Inclusions: 5 percent – Bulkhead, Breeze, and Greenbelt soils

Centralpark soils: Same as map unit 64
Shea soils: Same as map unit 352
Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

70 – Cheshire loam, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Cheshire soils. These soils have formed in friable glacial till derived mostly from red sedimentary rocks. Cheshire soils are found in Fort Wadsworth, and in the northern part of Great Kills Park along Hylan Boulevard.

COMPOSITION:

Cheshire and similar soils: 85 percent
Inclusions: 15 percent – Greenbelt, Foresthills, Wethersfield and Branford soils

PARENT MATERIAL:

Friable glacial till

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.14 – 0.24 inches of water per inch of soil
Subsoil/Substratum (12-36"): 0.10 to 0.20 inches of water per inch of soil
Substratum (36"+): 0.08 to 0.18 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.24; **Kf Factor**: 0.28

Permeability Class: Moderate or moderately rapid

A

Bw1

Bw2

Bw3

C

Figure 80. Profile of Cheshire soil. Soil description and laboratory data are available in Appendix 7.

Range in pH: Extremely acid to moderately acid in the surface; very strongly acid to moderately acid below

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Low

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Slight limitation

Local Roads and Streets: Slight limitation

Shallow Excavations: Slight limitation

Construction Materials

Sand Source: Improbable – excess fines

Soil Reconstruction Material for Drastically Disturbed Areas: Low fertility, too acid

Topsoil: Fair – small stones

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation – small stones, slope

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – no water

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition: Severe limitation – high available water capacity, too acid

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Good

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt, too acid

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Good

Upland Coniferous Trees for use as Wildlife Habitat: Good

Upland Deciduous Trees for use as Wildlife Habitat: Good

Upland Shrubs and Vines for Use as Wildlife Habitat: Good

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Good

72 – Cheshire loam, 3 to 8 percent slopes

Same as map unit 70 except:

SOIL AND WATER FEATURES:

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Recreation

Playgrounds: Severe limitation – slope

74 – Cheshire loam, 8 to 15 percent slopes

Same as map unit 70 except:

SOIL AND WATER FEATURES:

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – slope

Local Road and Streets: Moderate limitation – slope

Shallow Excavations: Moderate limitation – slope

Construction Materials

Topsoil: Fair – small stones, slope

Recreation

Camp Areas: Moderate limitation – slope

Picnic Areas: Moderate limitation – slope

Playgrounds: Severe limitation – slope

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

508 – Fishkill sandy loam, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, poorly drained Cheshire soils. These soils have formed in a thick mantle of industrial "fly ash" mixed with demolished construction debris. Fishkill soils are found in the North 40 zone of Floyd Bennett Field.

COMPOSITION:

Fishkill and similar soils: 85 percent
Inclusions: 15 percent – Rikers, Bigapple, Fortress, Flatland, Hassock and Winhole

PARENT MATERIAL:

Incinerator fly ash

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.10 – 0.18 inches of water per inch of soil
Subsoil/Substratum: 0.08 to 0.13 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.20; **Kf Factor**: 0.24

Permeability Class: Moderate

Range in pH: Slightly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Low

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: Between 0 and 10 inches from November through May

Potential Frost Action: High

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe – wetness

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – wetness, ponding

Local Roads and Streets: Severe limitation – wetness, ponding

Shallow Excavations: Severe limitation – wetness, ponding

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Fair – too sandy

Topsoil: Poor - wetness

Recreation

Camp Areas: Severe limitation – wetness, ponding

Paths and Trails: Severe limitation – wetness, ponding

Picnic Areas: Severe limitation – wetness, ponding

Playgrounds: Severe limitation – wetness, ponding

Off Road Motorcycle Trails: Severe limitation – wetness, ponding

Water Management

Excavated Ponds (Aquifer-Fed): Moderate limitation – slow refill

Pond Reservoir Area: Moderate limitation - seepage

Woodland Management

Plant Competition: Severe limitation – high available water capacity

Seedling Mortality: Severe limitation – wetness

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor - wetness

Freshwater Wetland Plants for Use as Wildlife Habitat: Good

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – wetness, ponding

Upland Coniferous Trees for use as Wildlife Habitat: Poor - wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor – wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – wetness

506 – Flatland sandy loam, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, somewhat poorly drained Flatland soils. These soils have formed in a thick mantle of industrial "fly ash" mixed with demolished construction debris. Fishkill soils are found in the North 40 zone of Floyd Bennett Field.

COMPOSITION:

Fishkill and similar soils: 85 percent
Inclusions: 15 percent – Rikers, Bigapple, Fortress, Fishkill, Hassock and Winhole

PARENT MATERIAL:

Incinerator fly ash

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
- **Surface (0-12'')**: 0.10 – 0.16 inches of water per inch of soil
- **Subsoil/Substratum**: 0.08 to 0.13 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.20; **Kf Factor**: 0.24

Permeability Class: Moderate

Range in pH: Slightly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Low

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: Between 10 and 24 inches from November through May

Potential Frost Action: High

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe – wetness

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Ponding Hazard Frequency and Duration: Rare ponding for brief periods throughout the year

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – ponding

Local Roads and Streets: Severe limitation – wetness, ponding

Shallow Excavations: Severe limitation – wetness, ponding

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Fair – too sandy

Topsoil: Poor - wetness

Recreation

Camp Areas: Severe limitation – wetness, ponding

Paths and Trails: Severe limitation – wetness, ponding

Picnic Areas: Severe limitation – wetness, ponding

Playgrounds: Severe limitation – wetness, ponding

Off Road Motorcycle Trails: Severe limitation – wetness, ponding

Water Management

Excavated Ponds (Aquifer-Fed): Moderate limitation – slow refill

Pond Reservoir Area: Moderate limitation - seepage

Woodland Management

Plant Competition: Severe limitation – high available water capacity

Seedling Mortality: Severe limitation – wetness

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor - wetness

Freshwater Wetland Plants for Use as Wildlife Habitat: Fair – depth to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – wetness, ponding

Upland Coniferous Trees for use as Wildlife Habitat: Poor - wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor – wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – wetness

104 – Foresthills loam, 0 to 3 percent slopes, compacted surface

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Foresthills soils. These soils formed in a thin mantle of loamy fill overlying natural soil. Foresthills soils are found in Fort Wadsworth and in scattered areas of Greatkills Park along Hylan Boulevard.

COMPOSITION:

Foresthills and similar soils: 90 percent
Inclusions: 10 percent – Wethersfield, Greenbelt, Centralpark, and Canarsie soils

PARENT MATERIAL:

Loamy fill over glacial till

Figure 81. Profile of Foresthills soil. Soil description is available in appendix 10.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 – 0.17 inches of water per inch of soil
Subsoil/Substratum (12-36"): 0.11 to 0.19 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.32; **Kf Factor**: 0.37

Permeability Class: Moderately slow in the compacted surface, moderate in the subsoil, and moderately slow in the substratum

Range in pH: Very strongly acid to slightly acid in the loamy cap, very strongly acid to neutral in the subsoil and substratum

Root Limiting Layer, Restriction Kind: Dense material: compacted surface, Cd horizon 40 – 60 inches

T Factor: 2

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Low

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Severe – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – dense material (compacted surface)

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Moderate limitation – dense layer

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Fair – low fertility, too acid

Topsoil: Fair – small stones

Recreation

Camp Areas: Severe limitation – dense layer (compacted surface)

Paths and Trails: Slight limitation

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – dense layer (compacted surface)

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – no water

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition: Severe limitation – high available water capacity

Seedling Mortality: Severe limitation – restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – dense layer (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Good

106 – Foresthills loam, 3 to 8 percent slopes compacted surface

Same as map unit 104 except:

SOIL AND WATER FEATURES:

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Recreation

Playgrounds: Severe limitation – slope, dense layer (compacted surface)

108 – Fortress sand, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, moderately well drained Fortress soils. These soils have formed in a thick mantle of sandy materials, transported and modified by human activity (dredging). Fortress soils are found in Jamaica Bay Wildlife Refuge and Sandy Hook.

COMPOSITION:

Cheshire and similar soils: 90 percent
Inclusions: 10 percent – Bigapple, Barren, and Jamaica soils

PARENT MATERIAL:

Sandy dredge materials

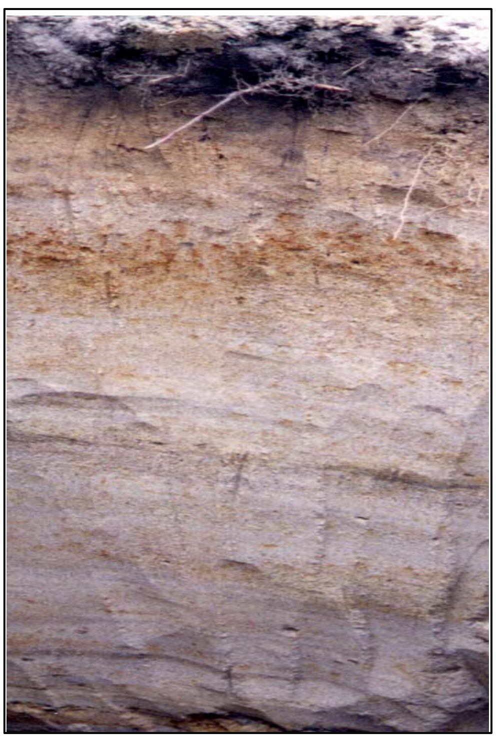

Figure 82. Profile of Fortress soil. Soil description and laboratory data are available in Appendix 11.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.07 – 0.09 inches of water per inch of soil
Subsoil/Substratum (12-36"): 0.05 to 0.08 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.10; **Kf Factor**: 0.10

Permeability Class: Rapid

Range in pH: Strongly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Between 24 and 48 inches from November through May

Potential Frost Action: Moderate

Hydrologic Group: A

Pesticide Loss Potential – Leaching: Severe – low adsorption and seepage

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – droughty, too sandy

Local Roads and Streets: Moderate limitation, frost action

Shallow Excavations: Severe limitation – cutbanks cave

Construction Materials

Sand Source: Improbable – Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, low fertility, soil blowing, droughty, too acid

Topsoil: Poor – too sandy

<u>Recreation</u>

Camp Areas: Severe limitation – too sandy

Paths and Trails: Severe limitation – too sandy

Picnic Areas: Severe limitation – too sandy

Playgrounds: Severe limitation – too sandy

Off Road Motorcycle Trails: Severe limitation – too sandy

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Moderate limitation – deep to water, cutbanks cave

Pond Reservoir Area: Severe limitation - seepage

<u>Woodland Management</u>

Plant Competition: Moderate limitation – high available water capacity

Seedling Mortality: Moderate limitation - droughty

<u>Wildlife Habitat</u>

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water, low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – too sandy

Upland Coniferous Trees for use as Wildlife Habitat: Fair – droughty

Upland Deciduous Trees for use as Wildlife Habitat: Fair – droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – too sandy

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – too sandy

110 – Fortress sand, 3 to 8 percent slopes

Same as map unit 108 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

<u>Recreation</u>

Playgrounds: Severe limitation – too sandy, slope

344 – Fortress gravelly sand, 0 to 3 percent slopes, refuse surface

Same as map unit 108 except:

Surface layer: Gravelly sand, refuse

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 – 0.08 inches of water per inch of soil

Kw Factor: 0.05; **Kf Factor**: 0.10

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Moderate limitation – droughty, too sandy, small stones

<u>Recreation</u>

Playgrounds: Severe limitation – too sandy, small stones

108xx – Fortress sandy loam, 0 to 3 percent slopes

Same as map unit 108 except:

Surface layer: sandy loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.13 – 0.15 inches of water per inch of soil

Kw Factor: 0.24; **Kf Factor**: 0.24

Permeability Class: Moderately rapid in the surface horizon, and rapid below

T Factor: 4

Wind Erodibility Group: 3

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – droughty

Construction Material

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, low fertility, droughty, too acid

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation – slope

Off Road Motorcycle Trails: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair – droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Upland Coniferous Trees for use as Wildlife Habitat: Good

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair – droughty

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – droughty

111 – Fortress-Shea-Pavement & buildings complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, moderately well drained Fortress soils, the shallow (<20") to concrete or asphalt, well drained Shea soils, and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Fortress and Shea soils generally occur in open areas between buildings, sidewalks, roads and parking lots. The map unit is found in Floyd Bennett Field and Miller Field.

COMPOSITION:

Fortress soils: 40 percent
Shea soils: 35 percent
Pavement & buildings: 20 percent
Inclusions: 5 percent

Fortress soils: same as map unit 108

Shea soils: same as map unit 352

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

Figure 83. Landscape of Fortress-Shea-Pavement & buildings complex, 0 to 5 percent slopes.

123x – Gravesend and Oldmill coarse sands, 0 to 8 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Gravesend and Oldmill soils, so intermingled that it was not practical to map them separately. Gravesend and Oldmill soils have formed in a thin mantle of sandy materials overlying human refuse. These soils are found in Spring Creek Park, Great Kills Park, Dead Horse Bay, and Sandy Hook.

COMPOSITION:

Gravesend and similar soils: 65 percent
Oldmill and similar soils: 30 percent
Inclusions: 5 percent – Breeze, Inwood, and Sandyhook soils

PARENT MATERIAL:

Sandy fill over landfill material (household refuse)

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.04 – 0.09 inches of water per inch of soil
Subsoil/Substratum: 0.02 to 0.08 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.05; **Kf Factor**: 0.05

Permeability Class: Rapid

Range in pH: Extremely acid to slightly alkaline in the sandy cap, and estimated to be neutral in the garbage layers.

Root Limiting Layer, Restriction Kind: Abrupt textural change – garbage fragments are greater than 60 percent

T Factor: 3

Figure 84. Vegetated cutbank of Gravesend soil. Soil description and laboratory data are available in Appendix 12. Oldmill soil description is available in Appendix 13.

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Very low

Hydrologic Group: A

Pesticide Loss Potential – Leaching: Severe - seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

HAZARD (for all uses) – methane gas emissions

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – droughty, too sandy

Local Roads and Streets: Severe limitation –artifactual

Shallow Excavations: Severe limitation – cutbanks cave, artifactual

Construction Materials

Sand Source: Improbable – artifactual

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, droughty, soil blowing

Topsoil: Poor – too sandy, small and large stones

Recreation

Camp Areas: Severe limitation – too sandy

Paths and Trails: Severe limitation – too sandy

Picnic Areas: Severe limitation – too sandy

Playgrounds: Severe limitation – too sandy, slope

Off Road Motorcycle Trails: Severe limitation – too sandy

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – no water, artifactual

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition: Severe limitation – too acid

Seedling Mortality: Moderate limitation – droughty, restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy, too droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water, low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – too sandy

Upland Coniferous Trees for use as Wildlife Habitat: Poor – droughty, extreme soil temperatures

Upland Deciduous Trees for use as Wildlife Habitat: Fair – droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – too sandy, extreme soil temperatures

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – too sandy, droughty

124 – Greatkills sandy loam, 0 to 8 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Greatkills soils. These soils have formed in a thin mantle of loamy fill overlying human refuse. Greatkills soils are found in Great Kills Park.

COMPOSITION:

Greatkills and similar soils: 85 percent
Inclusions: 15 percent – Inwood soils, an unnamed soil with a fill cap 24 to 40 inches thick, and an unnamed soil with a fill cap less than 10 inches thick

PARENT MATERIAL:

Loamy fill over landfill material (household refuse)

A

Bw

C

2C

Figure 85. Profile of Greatkills soil. Soil description and laboratory data are available in Appendix 14.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12'')): 0.09 – 0.15 inches of water per inch of soil
Subsoil/Substratum: 0.04 to 0.08 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.24; **Kf Factor**: 0.28

Permeability Class: Moderate or moderately slow

Range in pH: Strongly acid to moderately alkalinein the loamy cap, and estimated to be neutral in the garbage layer

Root Limiting Layer, Restriction Kind: Abrupt textural change – garbage fragments are greater than 60 percent

T Factor: 2

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: C

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

HAZARD (for all uses) – methane gas emissions

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Moderate limitation – droughty

Local Roads and Streets:
Severe limitation – extremely artifactual

Shallow Excavations:
Moderate limitation – extremely artifactual

Construction Materials

Sand Source: Improbable – excess fines, extremely artifactual

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – extremely artifactual (refuse materials), droughty substratum

Topsoil: Poor – small and large stones, area reclaim

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation – small stones, slope

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – no water, large stones

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition:
Moderate limitation – high available water capacity

Seedling Mortality:
Moderate limitation – restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair - droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – coarse fragments

Upland Coniferous Trees for use as Wildlife Habitat: Poor – extreme soil temperatures

Upland Deciduous Trees for use as Wildlife Habitat: Fair – droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – extreme soil temperatures

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – droughty

209g – Greatkills extremely gravelly sandy loam, 0 to 3 percent slopes

Same as map unit 124 except:

Surface layer: Extremely gravelly sandy loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.02 – 0.09 inches of water per inch of soil

Kw Factor: 0.05; **Kf Factor**: 0.28

Wind Erodibility Group: 8

LIMITATIONS FOR USE:

HAZARD (for all uses) - methane gas emissions

Building Site Development

Lawns, Landscaping, and Golf Fairways:
Severe limitation – small stones

Recreation

Camp Areas: Severe limitation – small stones

Paths and Trails: Severe limitation – small stones

Picnic Areas: Severe limitation – small stones

Playgrounds: Severe limitation – small stones

Off Road Motorcycle Trails: Severe limitation – small stones

Woodland Management

Seedling Mortality:
Severe limitation – extremely artifactural

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too gravelly

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – extreme soil temperatures, too gravelly

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – too gravelly

139 – Greenbelt loam, 15 to 25 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Greenbelt soils. These soils have formed in a thick mantle of loamy fill. Greenbelt soils are found in Fort Wadsworth.

COMPOSITION:

Greenbelt and similar soils: 95 percent
Inclusions: 5 percent – Wethersfield, Canarsie, Cheshire, Centralpark, and Foresthills soils

PARENT MATERIAL:

Loamy fill

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.18 – 0.22 inches of water per inch of soil
Subsoil/Substratum: 0.13 to 0.22 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.28; **Kf Factor**: 0.32

Permeability Class: Moderate

Range in pH: Extremely acid to slightly acid

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Severe – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways:
Severe limitation – slope

Local Roads and Streets:
Severe limitation – slope

Shallow Excavations: Severe limitation – slope

Construction Materials

Sand Source: Improbable – excess fines

Soil Reconstruction Material for Drastically Disturbed Areas: Fair – too acid, low fertility

Topsoil: Poor – slope

A

Bw

C1

C2

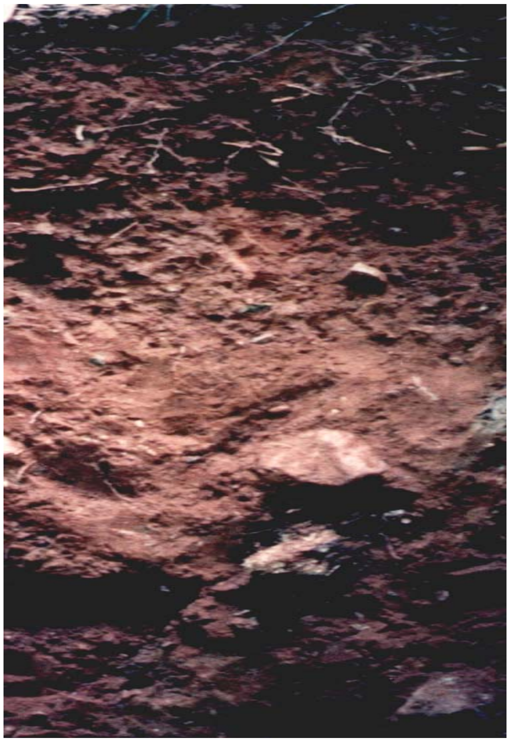

Figure 86. Profile of Greenbelt soil. Soil description and laboratory data are available in Appendix 15.

Recreation

Camp Areas: Severe limitation – slope

Paths and Trails: Moderate limitation – slope

Picnic Areas: Severe limitation – slope

Playgrounds: Severe limitation – slope

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – no water

Pond Reservoir Area: Severe limitation - slope

Woodland Management

Plant Competition: Severe limitation – high available water capacity, too acid

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair - slope

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Good

Upland Coniferous Trees for use as Wildlife Habitat: Good

Upland Deciduous Trees for use as Wildlife Habitat: Good

Upland Shrubs and Vines for Use as Wildlife Habitat: Good

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Good

139x – Greenbelt loam, 25 to 60 percent slopes

Same as map unit 139 except:

LIMITATIONS FOR USE:

Recreation

Paths and Trails: Severe limitation – slope

Off Road Motorcycle Trails: Severe limitation – slope

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – slope

136 – Greenbelt loam, 3 to 8 percent slopes, compacted surface

Same as map unit 139 except:

Surface layer: compacted surface

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 – 0.17 inches of water per inch of soil

Kw Factor: 0.32; **Kf Factor**: 0.37

Permeability Class: Moderately slow in the compacted surface

Root Limiting Layer, Restriction Kind: Dense material – compacted surface

T Factor: 2

SOIL AND WATER FEATURES:

Hydrologic Group: C

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – dense material (compacted surface)

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Slight limitation

Construction Materials

Topsoil: Fair – small & large stones

Recreation

Camp Areas: Severe limitation – dense layer (compacted surface)

Paths and Trails: Slight limitation

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – slope, dense layer (compacted surface)

Water Management

Pond Reservoir Area: Severe limitation - slope

Woodland Management

Seedling Mortality: Severe limitation – restricting layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – dense layer (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Good

138 – Greenbelt loam, 8 to 15 percent slopes, compacted surface

Same as map unit 139 except:

Surface layer: compacted surface

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 – 0.17 inches of water per inch of soil

Kw Factor: 0.32; **Kf Factor**: 0.37

Permeability Class: Moderately slow in the compacted surface

Root Limiting Layer, Restriction Kind: Dense material – compacted surface

T Factor: 2

SOIL AND WATER FEATURES:

Hydrologic Group: C

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Severe limitation – dense material (compacted surface)

Local Roads and Streets: Moderate limitation – frost action, slope

Shallow Excavations: Moderate limitation - slope

<u>Construction Materials</u>

Topsoil: Fair – small & large stones, slope

<u>Recreation</u>

Camp Areas: Severe limitation – dense layer (compacted surface)

Paths and Trails: Slight limitation

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – slope, dense layer (compacted surface)

<u>Woodland Management</u>

Seedling Mortality: Severe limitation – restricting layer

<u>Wildlife Habitat</u>

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – dense layer (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

139a – Greenbelt loam-Pavement & buildings complex, 3 to 8 percent slopes, cemented substratum

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Greenbelt soils and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. This map unit is found in Fort Wadsworth.

COMPOSITION:

Greenbelt and similar soils: 60 percent
Pavement & buildings: 35 percent
Inclusions: 5 percent – Shea and Centralpark soils

Greenbelt soils: same as map unit 139 except:

Substratum – Concrete layer below 60 inches

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Substratum: Negligible in concrete layer

Excavation Difficulty: Very high in concrete layer, otherwise moderate

Permeability Class: Impermeable in concrete layer

Root Limiting Layer, Restriction Kind: Concrete layer below 60 inches

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Slight limitation

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Slight limitation

Construction Materials

Topsoil: Fair – small & large stones

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Water Management

Pond Reservoir Area: Moderate limitation – seepage, slope

Woodland Management

Plant Competition: Severe limitation – high available water capacity, too acid

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Good

502 – Hassock sandy loam, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Hassock soils. These soils have formed in a thick mantle of industrial "fly ash." Hassock soils are found in the North 40 zone of Floyd Bennett Field.

COMPOSITION:

Hassock and similar soils: 85 percent
Inclusions: 15 percent – Rikers, Bigapple, Fortress, Fishkill, Flatland and Winhole

PARENT MATERIAL:
Incinerator fly ash

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.10 to 0.15 inches of water per inch of soil
Subsoil/Substratum: 0.08 to 0.13 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.17; **Kf Factor**: 0.24

Permeability Class: Moderately rapid

Range in pH: Slightly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Low

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Moderate – low adsorption

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Slight limitation

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Moderate limitation – wetness

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Fair – too sandy

Topsoil: Fair – small stones

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation – slope, small stones

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Moderate limitation – deep to water

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition: Severe limitation – high available water capacity

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Good

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Good

Upland Coniferous Trees for use as Wildlife Habitat: Good

Upland Deciduous Trees for use as Wildlife Habitat: Good

Upland Shrubs and Vines for Use as Wildlife Habitat: Good

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Good

150 – Hooksan fine sand, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, well drained Hooksan soils. These soils have formed in marine sediment transported and reworked by wind action. Hooksan soils are found in Sandy Hook, Great Kills Park, Breezy Point, and Fort Tilden.

COMPOSITION:

Hooksan and similar soils: 85 percent
Inclusions: 15 percent – Bigapple, Dune land, Ipswich, Matunuck, Pawcatuck and Jamaica

PARENT MATERIAL:
Sandy Materials

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 to 0.09 inches of water per inch of soil
Subsoil/Substratum: 0.05 to 0.07 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.10; **Kf Factor**: 0.10

Permeability Class: Very rapid

Range in pH: Extremely acid to neutral in the A horizon, strongly acid to moderately alkaline in the C horizons

Root Limiting Layer, Restriction Kind: None

T Factor: 5

A

C

Figure 87. Profile of Hooksan soil. Soil description and laboratory data are available in Appendix 17.

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 72 inches

Potential Frost Action: None

Hydrologic Group: A

Pesticide Loss Potential – Leaching: Severe – low adsorption, seepage

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – too sandy, droughty

Local Roads and Streets: Slight limitation

Shallow Excavations: Severe limitation – cutbanks cave

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, thin layer, soil blowing, low fertility, too acid

Topsoil: Poor – too sandy

Recreation

Camp Areas: Severe limitation – too sandy

Paths and Trails: Severe limitation – too sandy

Picnic Areas: Severe limitation – too sandy

Playgrounds: Severe limitation – too sandy

Off Road Motorcycle Trails: Severe limitation – too sandy

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – no water, cutbanks cave

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition: Severe limitation – too acid

Seedling Mortality: Moderate limitation – droughty

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair – too sandy, droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, low salt, too acid

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – too sandy

Upland Coniferous Trees for use as Wildlife Habitat: Fair – droughty

Upland Deciduous Trees for use as Wildlife Habitat: Fair – too sandy, droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair – too sandy, droughty

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – too sandy, droughty

152 – Hooksan fine sand, 3 to 8 percent slopes

Same as map unit 150 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Recreation

Playgrounds: Severe limitation – too sandy, slope

154 – Hooksan fine sand, 8 to 15 percent slopes

Same as map unit 150 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – too sandy, droughty, slope

Local Roads and Streets: Moderate limitation – slope

Recreation

Playgrounds: Severe limitation – too sandy, slope

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

156 – Hooksan fine sand, 15 to 25 percent slopes

Same as map unit 150 except:

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Leaching: Severe - seepage

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – dense material (compacted surface)

Construction Material

Topsoil: Poor – too sandy, slope

Recreation

Camp Areas: Severe limitation – too sandy, slope

Picnic Areas: Severe limitation – too sandy, slope

Playgrounds: Severe limitation – too sandy, slope

Water Management

Pond Reservoir Area: Severe limitation – seepage, slope

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair – too sandy, droughty, slope

356 – Hooksan gravelly fine sand, 0 to 3 percent slopes, refuse surface

Same as map unit 150 except:

Surface layer: Gravelly fine sand

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 to 0.09 inches of water per inch of soil
Subsoil/Substratum: 0.05 to 0.07 inches of water per inch of soil

Kw Factor: 0.05; **Kf Factor**: 0.10

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – too sandy, droughty, small stones

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, thin layer, soil blowing, low fertility

Topsoil: Poor – too sandy

Recreation

Playgrounds: Severe limitation – too sandy, small stones

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair – too sandy, too gravelly, droughty

160 – Hooksan sandy loam, 0 to 3 percent slopes, compacted surface

Surface layer: compacted surface, sandy loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.04 to 0.11 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.37; **Kf Factor**: 0.37

Permeability Class: Moderately slow (compacted surface)

Root Limiting Layer, Restriction Kind: Dense material – compacted surface

T Factor: 2

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Hydrologic Group: C

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Construction Materials

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, low fertility

Recreation

Camp Areas: Severe limitation – dense layer (compacted surface)

Paths and Trails: Slight limitation

Picnic Areas: Severe limitation – dense layer (compacted surface)

Playgrounds: Severe limitation – dense layer (compacted surface)

Off Road Motorcycle Trails: Slight limitation

Woodland Management

Seedling Mortality: Severe limitation – restricting layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – too sandy, dense layer (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – droughty

313 – Hooksan – Dune land complex, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, excessively drained Hooksan soils and areas of Dune land, so intermingled that it was not practical to map them separately. **Dune land** consists of sand in hills or ridges and intervening troughs, drifted and piled up by the wind, and either actively shifting or so recently stabilized that no soil horizons have developed. Areas of Hooksan soils generally support beach grass and a few shrubs and trees. Areas of Dune land are not vegetated and subject to wind action. This map unit is found in Sandy Hook, Great Kills Park, Breezy Point, and Fort Tilden.

COMPOSITION:

Hooksan soils: 50 percent
Dune land: 45 percent
Inclusions: 5 percent – Jamaica, Verrazano and Breeze soils

Hooksan soils: Same as map unit 150

Dune land: Same as Blown-out land in map unit 323

315 – Hooksan – Dune land complex, 3 to 8 percent slopes

COMPOSITION:

Hooksan soils: 55 percent
Dune land: 40 percent
Inclusions: 5 percent – Jamaica, Verrazano and Breeze soils

Hooksan soils: Same as map unit 152

Dune land: Same as Blown-out land in map unit 325

319 - Hooksan - Dune land complex, 15 to 25 percent slopes

COMPOSITION:

Hooksan soils: 60 percent
Dune land: 35 percent

Inclusions: 5 percent - Verrazano, Fortress and Breeze

Hooksan soils: Same as map unit 156

Dune land: Same as Blown-out land in map unit 329

171 - Hooksan-Verrazano-Pavement & buildings complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, excessively drained Hooksan soils, the very deep to bedrock, well drained Verrazano soils, and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. This map unit occurs mainly in Sandy Hook, Greatkills Park, Breezy Point and Fort Tilden.

COMPOSITION:

Hooksan soils: 40 percent
Verrazano soils: 30 percent
Pavement & buildings: 25 percent
Inclusions: 5 percent - Jamaica and Breeze

Hooksan soils: Same as map unit 150

Verrazano soils: Same as map unit 270

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water and restricts root penetration.

Figure 88. Landscape of Hooksan – Dune land complex, 3 to 8 percent slopes.

514 - Inwood gravelly sandy loam, 8 to 15 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Inwood soils. These soils have formed in a thick mantle of demolished construction debris and rubble. Inwood soils are found in Floyd Bennett Field and in scattered areas throughout Gateway.

COMPOSITION:

Inwood soils: 90 percent
Inclusions: 10 percent - Breeze, Centralpark and Greenbelt soils

PARENT MATERIAL:

Fill with construction debris

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
 Surface (0-12"): 0.08 to 0.13 inches of water per inch of soil
 Subsoil/Substratum: Negligible to 0.08 inches of water per inch of soil

Excavation Difficulty: High

Kw Factor: 0.20 **Kf Factor**: 0.24

Permeability Class: Moderately rapid

Range in Soil pH: Very strongly acid to neutral

Root Limiting Layer, Restriction Kind: Abrupt textural change - coarse fragments are greater than 60 percent.

T Factor: 2

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Low

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Moderate - low adsorption

Pesticide Loss Potential – Soil Surface Runoff: Moderate - excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Severe limitation - droughty

Local Roads and Streets: Severe limitation - large stones (debris fragments)

Shallow Excavations: Severe limitation - large stones (debris fragments)

<u>Construction Materials</u>

Sand Source: Improbable - small and large fragments

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too cobbly, too stony (debris fragments), droughty

Topsoil: Poor - small and large stones (debris fragments), area reclaim

<u>Recreation</u>

Camp Areas: Moderate limitation – slope, small stones

Paths and Trails: Slight limitation

Picnic Areas: Moderate limitation – slope, small stones

Playgrounds: Severe limitation - slope, small stones

Off Road Motorcycle Trails: Slight limitation

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Severe limitation - no water, large stones

Pond Reservoir Area: Severe limitation – seepage, slope

Woodland Management

Plant Competition: Slight limitation

Seedling Mortality: Moderate limitation – rock fragments, restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor - droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor - deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor - deep to water, low salt

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – too gravelly

Upland Coniferous Trees for Use as Wildlife Habitat: Poor - droughty

Upland Deciduous Trees for Use as Wildlife Habitat: Poor - droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – droughty

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor - droughty

186 - Ipswich mucky peat, tidal, frequently flooded

INTRODUCTION:

This unit consists of the very deep to bedrock, very poorly drained Ipswich soils. These soils have formed in thick organic deposits subject to tidal flooding. Ipswich soils are found in Jamaica Bay Wildlife Refuge and Sandy Hook.

COMPOSITION:

Ipswich soils: 85 percent
Inclusions: 15 percent - Mud flats, Pawcatuck, Matunuck, Sandyhook soils

PARENT MATERIAL:

Organic deposits

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
0.45 to 0.55 inches of water per inch of soil throughout

Excavation Difficulty: Low

Permeability Class: Moderate to rapid
Range in Soil pH: Strongly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

Soluble Salts: 5,000 to 35,000 parts per million

T Factor: 3

Figure 89. Landscape of Ipswich soil. Soil description is available in Appendix 19.

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal Water Table: From 0 to 12 inches above the surface throughout the year

Flooding Hazard Frequency and Duration: Frequent flooding for very brief periods throughout the year

Potential Frost Action: None

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe - wetness

Pesticide Loss Potential – Soil Surface Runoff: Severe - flooding

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – excess humus, excess salt, excess sulfur, wetness, flooding,

Local Roads and Streets: Severe limitation - flooding, low strength, wetness

Shallow Excavations: Severe limitation - excess humus, wetness

Construction Materials

Sand Source: Improbable - excess humus

Soil Reconstruction Material for Drastically Disturbed Areas: Poor - excess salts

Topsoil: Poor - excess humus, excess salts, wetness

Recreation

Camp Areas: Severe limitation - flooding, wetness, excess humus, excess salt

Paths and Trails: Severe limitation - wetness, excess humus

Picnic Areas: Severe limitation - wetness, excess humus, excess salts

Playgrounds: Severe limitation - flooding, wetness, excess humus, excess salts

Off Road Motorcycle Trails: Severe limitation - wetness, excess humus

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation - salt water

Pond Reservoir Area: Severe limitation - seepage

Woodland Management

Plant Competition: Severe limitation - high available water capacity

Seedling Mortality: Severe limitation – organic, wetness

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor - excess humus, wetness, flooding, excess salts

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor - excess salts

Saline Water Wetland Plants for Use as Wildlife Habitat: Fair - excess humus, too acid

Soil Used as Burrow Wildlife Habitat Component for Burrowing Mammals and Reptiles: Poor – flooding, wetness

Upland Coniferous Trees for Use as Wildlife Habitat: Poor – wetness

Upland Deciduous Trees for Use as Wildlife Habitat: Poor - wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor - excess salts, wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor - excess salts, wetness

188 - Ipswich mucky peat, tide flooded

Same as map unit 186 except:

SOIL AND WATER FEATURES:

Flooding Hazard Frequency and Duration: Very frequent flooding for very brief periods throughout the year

198 – Jamaica sand, frequently ponded

INTRODUCTION:

This unit consists of the very deep to bedrock, poorly drained Jamaica soils. These soils have developed in sandy materials on broad flats between dunes, in depressional areas and on human made landscapes.

COMPOSITION:

Jamaica soils: 95 percent
Inclusions: 5 percent – Bigapple, Fortress, Barren, and Hooksan soils.

Figure 90. Profile of Jamaica soil. Soil description and laboratory data are available in available in Appendix 20.

PARENT MATERIAL:
Sandy materials

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.07 to 0.09 inches of water per inch of soil
Substratum (>32''): 0.05 to 0.08 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.10; **Kf Factor**: 0.10

Permeability Class: Rapid

Range in Soil pH: Extremely acid to moderately acid

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: Between 0 and 10 inches from November through May

Potential Frost Action: Moderate

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe – wetness, seepage

Pesticide Loss Potential – Soil Surface Runoff: Severe – ponding

Ponding Hazard Frequency and Duration: Frequent ponding for very brief periods throughout the year

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – ponding, wetness

Local Roads and Streets: Severe limitation – ponding, wetness

Shallow Excavations: Severe limitation – ponding, wetness, cutbanks cave

Construction Materials

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, soil blowing, low fertility

Topsoil: Poor – excess wetness, too sandy

Recreation

Camp Areas: Severe limitation – ponding, wetness, too sandy

Paths and Trails: Severe limitation – ponding, wetness, too sandy

Picnic Areas: Severe limitation – ponding, wetness, too sandy

Playgrounds: Severe limitation – ponding, wetness, too sandy

Off Road Motorcycle Trails: Severe limitation – ponding, wetness, too sandy

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation –cutbanks cave

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation – too acid

Seedling Mortality: Severe limitation - wetness

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy, wetness, ponding

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, low salt, too acid

Habitat for Burrowing Mammals and Reptiles: Poor – too sandy, wetness, ponding

Upland Coniferous Trees for use as Wildlife Habitat: Poor - wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor - wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor - wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – wetness

348 – Jamaica gravelly sand, frequently ponded, refuse surface

Sam as map unit 198 except:

Surface layer: Gravelly sand

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.05 to 0.08 inches of water per inch of soil

Kw Factor: 0.05; **Kf Factor**: 0.10

LIMITATIONS FOR USE:

Playgrounds: Severe limitation – ponding, wetness, too sandy, small stones

216 – Matunuck mucky peat, tidal frequently flooded

INTRODUCTION:

This unit consists of very deep to bedrock, very poorly drained Matunuck soils. These soils have formed in thin organic deposits underlain by sands, and subject to tidal flooding. Matunuck soils are found in Jamaica Bay Wildlife Refuge and Sandy Hook.

COMPOSITION:

Matunuck soils: 85 percent
Inclusions: 15 percent – Mud flats, Pawcatuck, Ipswich, and Sandyhook soils.

PARENT MATERIAL:
Organic deposits

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-8''): 0.45 to 0.55 inches of water per inch of soil
Substratum: 0.05 to 0.07 inches of water per inch of soil

Excavation Difficulty: Low

Permeability Class: Rapid in organic surface and very rapid in underlying sand

Range in Soil pH: Strongly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

Soluble Salts: 1,000 to 40,000 parts per million

T Factor: 2

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: Between 0 and 12 inches above the surface throughout the year

Potential Frost Action: None

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe – wetness, seepage (sandy substratum)

Pesticide Loss Potential – Soil Surface Runoff: Severe – flooding

Ponding Hazard Frequency and Duration: Frequent ponding for very brief periods throughout the year

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – excess humus, ponding excess salt, excess sulfur, wetness, flooding

Local Roads and Streets: Severe limitation – flooding, wetness, low strength

Shallow Excavations: Severe limitation – wetness, cutbanks cave

Construction Materials

Sand Source: Improbable – excess humus

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – excess salts, too sandy, thin layer

Topsoil: Poor – too sandy, excess salts, wetness

Recreation

Camp Areas: Severe limitation – flooding, wetness, excess humus, excess salts

Paths and Trails: Severe limitation – wetness, excess humus

Picnic Areas: Severe limitation – flooding, wetness, excess humus, excess salts

Playgrounds: Severe limitation – flooding, wetness, excess humus, excess salts

Off Road Motorcycle Trails: Severe limitation – flooding, wetness, excess humus

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – salty water cutbanks cave

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation –high available water capacity

Seedling Mortality: Severe limitation – organic, wetness

Wildlife Habitat
Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – excess humus, wetness, ponding, flooding, excess salts.

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – excess salts

Saline Water Wetland Plants for Use as Wildlife Habitat: Fair – excess humus too acid

Habitat for Burrowing Mammals and Reptiles: Poor –flooding, too sandy, wetness

Upland Coniferous Trees for use as Wildlife Habitat: Poor - wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor - wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor - wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – wetness, excess salts

218 - Matunuck mucky peat, tide flooded

Same as map unit 216 except:

SOIL AND WATER FEATURES:

Flooding Hazard Frequency and Duration: Very frequent flooding for very brief periods throughout the year

220 – Mud flat, tide flooded

INTRODUCTION:

This unit consists of unvegetated areas flooded during the high tide and exposed during the low tide.

Figure 91. Landscape of Mud flat during low tide.

LIMITATIONS FOR USE:

Severe limitation: Poorly suited for all uses due to tidal flooding.

223 – Pavement & buildings, 0 to 5 percent slopes, sandy substratum

INTRODUCTION:

This unit consists of areas covered by 85 percent of more of Pavement & buildings; underlain by sandy materials such as eolian, dredge or outwash sediments.

225 – Pavement & buildings, 0 to 5 percent slopes, till substratum

INTRODUCTION:

This unit consists of areas covered by 85 percent or more of Pavement & buildings, underlain by glacial till.

227 – Pavement & buildings, 0 to 5 percent slopes, wet substratum

INTRODUCTION:

This unit consists of areas covered by 85 percent or ore of Pavement & buildings, underlain by filled marshes or water.

Depth to Seasonal Water Table: Between 24 and 48 inches from November through May.

231 – Pavement & buildings-Bigapple-Verrazano complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Bigapple and Verrazano soils, and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Bigapple and Verrazano soils generally occur in vacant lots of open areas between buildings, sidewalks, and roads.

COMPOSITION:

Pavement & Buildings: 55 percent
Bigapple soils: 20 percent
Verrazano soils: 20 percent
Inclusions: 5 percent – Bigapple sandy loam, Jamaica and Barren

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

Bigapple soils: Same as map unit 150

Verrazano soils: Same as map unit 270

95x – Pavement & buildings – Breeze complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Breeze soils and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Breeze soils generally occur in vacant lots of open areas between buildings, sidewalks and roads.

Pavement & Buildings: 60 percent
Breeze soils: 35 percent
Inclusions: 5 percent – Bigapple, Verrazano, and Blown-out land

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

Breeze soils: Same as map unit 358

234 – Pavement & buildings – Greenbelt complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Greenbelt soils and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Greenbelt soils generally occur in vacant lots of open areas between buildings, sidewalks, and roads.

COMPOSITION:

Pavement & Buildings: 65 percent
Greenbelt soils: 30 percent
Inclusions: 5 percent – Centralpark, Shea, and Breeze

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

Greenbelt soils: Same as map unit 136

SOIL AND WATER FEATURES:

Surface Runoff Class: Low

Recreation

Playgrounds: Severe – limitation dense layer (compacted surface)

239a – Pavement & buildings-Foresthills-Canarsie complex, 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Foresthills and Canarsie soils and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Foresthills and Canarsie soils generally occur in vacant lots of open areas between buildings, sidewalks and roads.

COMPOSITION:

Pavement & buildings: 55 percent
Foresthills soils: 20 percent
Canarsie soils: 20 percent
Inclusions: 5 percent – Wethersfield and Greenbelt

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

Foresthills soils: Same as map unit 104

Canarsie soils: These are very deep to bedrock, well drained soils with a thin mantle (less than 40 inches) of loamy fill over a truncated subsoil or substratum. The underlying soil typically has a fragipan or dense basal till within 40 inches and often has been compacted by heavy machinery in most layers.

Surface layer: Sandy loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-2''): 0.12 to 0.19 inches of water per inch of soil
Subsoil (2-10''): 0.11 to 0.17 inches of water per inch of soil
Substratum (>10+''): 0.07 to 0.11 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.20; **Kf Factor**: 0.24

Permeability Class: Moderate or moderately rapid in the upper soils, slow in compacted subsoil or till or substratum

Range in Soil pH: Strongly acid to moderately alkaline in fill, very strongly acid to neutral in the truncated soil.

Root Limiting Layer, Restriction Kind: Dense material: Cd-horizon starts between 12 to 39 inches

T Factor: 2

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: C

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe to moderate limitation – dense material (dense layer)

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Moderate limitation – dense layer

__Construction Materials__

Sand Source: Probable

Soil Reconstruction Material for Drastically Disturbed Areas: Poor – low fertility

Topsoil: Poor – area reclaim

__Recreation__

Camp Areas: Moderate limitation – percs slowly

Paths and Trails: Slight limitation

Picnic Areas: Moderate limitation – percs slowly

Playgrounds: Moderate limitation – percs slowly

Off Road Motorcycle Trails: Slight limitation

__Water Management__

Excavated Ponds (Aquifer-Fed): Severe limitation – slow refill

Pond Reservoir Area: Moderate limitation – slope

__Woodland Management__

Plant Competition: Severe limitation – too alkaline

Seedling Mortality: Slight to moderate limitation – restricting layer

__Wildlife Habitat__

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (dense layer)

Freshwater Wetland Plants for Use as Wildlife Habitat: Fair –deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – low salt

Habitat for Burrowing Mammals and Reptiles: Fair – dense layer

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (dense layer)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (dense layer)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (dense layer)

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Good

235 – Pavement & buildings-Hooksan-Verrazano complex 0 to 5 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, excessively drained Hooksan soils, and the very deep to bedrock, well drained Verrazano soils, and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Hooksan and Verrazano soils generally occur in vacant lots of open areas between buildings, sidewalks and roads.

COMPOSITION:

Pavement & buildings: 55 percent
Hooksan soils: 20 percent
Verrazano soils: 20 percent
Inclusions: 5 percent – Jamaica and Hooksan sandy loam

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

Hooksan soils: Same as map unit 150

Verrazano soils: Same as map unit 270

314 – Pavement & buildings – Shea complex, 0 to 5 percent slopes, sandy substratum

INTRODUCTION:

This unit consists of the shallow to concrete (<20''), well drained Shea soils and areas of Pavement & buildings, so intermingled that it was not practical to map them separately. Areas of Shea soils generally occur in vacant lots of open areas between buildings, sidewalks and roads.

COMPOSITION:

Pavement & buildings: 65 percent
Shea soils: 30 percent
Inclusions: 5 percent – Shea, very shallow Bigapple and Breeze soils

Pavement & buildings: Soil information is not provided for this map unit component because it is impermeable to water, restricts root penetration, and is not considered soil.

Shea soils: Same as map unit 352

242 – Pawcatuck mucky peat, tide flooded

Same as map unit 186 except:

COMPOSITION:

Pawcatuck: 85 percent
Inclusions: 15 percent – Mud flats, Ipswich, Matunuck, Sandyhook soils

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface/Subsoil: 0.45 to 0.55 inches of water per inch of soil
Substratum: 0.05 to 0.10 inches of water per inch of soil
Permeability Class: Moderate to rapid in organic layers and very rapid in underlying sands

T Factor: 2

SOIL AND WATER FEATURES:

Flooding Hazard Frequency and Duration: Very frequent flooding for very brief periods throughout the year

Pesticide Loss Potential – Leaching: Severe – wetness, seepage (sandy substratum)

Wildlife Habitat

Habitat for Burrowing Mammals and Reptiles: Poor – flooding, wetness, too sandy (substratum)

253 – Pompton loam, 0 to 3 percent slopes

INTRODUCTION:

This map unit consists of very deep to bedrock, moderately well drained Pompton soils. These soils have formed in outwash sediments in low lying areas and depressions. Pompton soils are found in a wet area of Miller Field

COMPOSITION:

Pompton soils: 95 percent
Inclusions: 5 percent – Branford, Cheshire and Wethersfield soils

PARENT MATERIAL:
Outwash sediments

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.20 to 0.22 inches of water per inch of soil
Subsoil/Substratum: 0.11 to 0.18 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.24; **Kf Factor**: 0.24

Permeability Class: Moderately rapid in the solum, moderately rapid to very rapid in the substratum

Range in Soil pH: Very strongly acid to moderately acid

T Factor: 3

Wind Erodibility Group: 5

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Moderate

Depth to Seasonal High Water Table: Between 18 and 40 inches from November through May

Potential Frost Action: High

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Severe - wetness

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Ponding Hazard Frequency and Duration: Rare ponding for very brief periods throughout the year

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation - ponding

Local Roads and Streets: Severe limitation – frost action, ponding

Shallow Excavations: Severe limitation – wetness, cutbanks cave, ponding

Construction Materials

Sand Source: Probable

Reconstruction Material for Drastically Disturbed Areas: Fair – too acid

Topsoil: Fair – small stones

Recreation

Camp Areas: Severe limitation - ponding

Paths and Trails: Severe limitation - ponding

Picnic Areas: Severe limitation - ponding
Playgrounds: Severe limitation - ponding

Off Road Motorcycle Trails: Severe limitation – ponding

Water Management

Excavated Ponds (Aquifer-Fed): Slight limitation

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation – high available water capacity

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair – wetness, ponding

Freshwater Wetland Plants for Use as Wildlife Habitat: Fair deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – low salt

Habitat for Burrowing Mammals and Reptiles: Poor - ponding

Upland Coniferous Trees for use as Wildlife Habitat: Fair - wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor - wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair - wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – wetness

258 – Rikers gravelly coarse sand, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, somewhat excessively drained Rikers soils. These soils have formed in a thick mantle of coal ash. Rikers soils are found in scattered areas throughout Gateway.

COMPOSITION:

Rikers soils: 95 percent
Inclusions: 5 percent – Hassock, Bigapple, and Verrazano soils

PARENT MATERIAL:
Coal ash and coal

A
C1
C2
C3
C4

Figure 92. Profile of Rikers soil. Soil description and laboratory data are available in Appendix 25.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.03 to 0.05 inches of water per inch of soil
Subsoil/Substratum: 0.01 to 0.04 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.05; **Kf Factor**: 0.05

Permeability Class: Rapid

Range in Soil pH: Strongly acid to neutral

T Factor: 5

Wind Erodibility Group: 1

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 60 inches

Potential Frost Action: Low

Hydrologic Group: A

Pesticide Loss Potential – Leaching: Severe - seepage

Pesticide Loss Potential – Soil Surface Runoff: Very low

Ponding Hazard Frequency and Duration: Rare ponding for very brief periods throughout the year

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Severe limitation – too sandy, droughty

Local Roads and Streets: Slight limitation

Shallow Excavations: Severe limitation – cutbanks cave

<u>Construction Materials</u>

Sand Source: Improbable – small stones

Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, droughty, soil blowing

Topsoil: Poor – too sandy, thin layer, small stones

Recreation

Camp Areas: Severe limitation – too sandy

Paths and Trails: Severe limitation – too sandy

Picnic Areas: Severe limitation – too sandy

Playgrounds: Severe limitation – too sandy

Off Road Motorcycle Trails: Severe limitation – too sandy

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – no water, cutbanks cave

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Slight limitation

Seedling Mortality: Severe limitation - droughty

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – too sandy, droughty

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – too sandy, deep to water, low salt

Habitat for Burrowing Mammals and Reptiles: Poor – too sandy to gravelly

Upland Coniferous Trees for use as Wildlife Habitat: Poor - droughty

Upland Deciduous Trees for use as Wildlife Habitat: Poor - droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – too sandy, droughty

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – too sandy

196 – Sandyhook mucky fine sandy loam, frequently flooded

INTRODUCTION:

This unit consists of the very deep to bedrock, very poorly drained Sandyhook soils. These soils have developed in sandy materials subject to flooding during high tide and storms. Sandyhook soils are found in Sandy Hook and Jamaica Bay Wildlife Refuge.

COMPOSITION:

Sandyhook soils: 95 percent
Inclusions: 5 percent – Matunuck, Pawcatuck, Mud flats, and Beaches

PARENT MATERIAL:
Sandy sediments

Figure 93. Landscape of Sandyhook soil. Soil description is available in Appendix 26.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.16 to 0.22 inches of water per inch of soil
Subsoil/Substratum: 0.05 to 0.07 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.20; **Kf Factor**: 0.20

Permeability Class: Rapid

Range in Soil pH: Moderately acid to moderately alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 4

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: From 0 to 12 inches above the surface throughout the year

Flooding Hazard Frequency and Duration: Frequent flooding for very brief periods throughout the year

Potential Frost Action: None

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Severe – wetness, seepage

Pesticide Loss Potential – Soil Surface Runoff: Severe - flooding

Ponding Hazard Frequency and Duration: Rare ponding for very brief periods throughout the year

Surface Runoff Class: Negligible

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – wetness, excess salts, flooding, excess sulfur

Local Roads and Streets: Severe limitation – flooding, wetness

Shallow Excavations: Severe limitation – cutbanks cave, wetness

Construction Materials

Sand Source: Probable

Reconstruction Material for Drastically Disturbed Areas: Poor – excess salts, too sandy

Topsoil: Poor – excess salts, wetness, too sandy

Recreation

Camp Areas: Severe limitation –flooding, excess salts

Paths and Trails: Moderate limitation - flooding

Picnic Areas: Severe limitation –excess salts

Playgrounds: Severe limitation – flooding, wetness, excess salts

Off Road Motorcycle Trails: Severe limitation – wetness

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – salty water, cutbanks cave

Pond Reservoir Area: Severe limitation – seepage

Woodland Management

Plant Competition: Severe limitation – too alkaline

Seedling Mortality: Severe limitation - wetness

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – wetness, flooding

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – excess salts

Saline Water Wetland Plants for Use as Wildlife Habitat: Good

Habitat for Burrowing Mammals and Reptiles: Poor – flooding, wetness, too sandy

Upland Coniferous Trees for use as Wildlife Habitat: Poor - wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor - wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – excess salts, wetness

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – excess salts, wetness

352 – Shea sandy loam, 0 to 3 percent

INTRODUCTION:

This unit consists of the shallow (<20'') to concrete of asphalt, well drained Shea soils. These soils have formed in a thin loamy mantle overlying an impermeable human made layer. Shea soils are found in Floyd Bennett Field and Miller Field.

COMPOSITION:

Shea soils: 95 percent
Inclusions: 5 percent – Pavement & buildings and Bulkhead soils

PARENT MATERIAL:
Loamy fill

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-16''): 0.11 to 0.15 inches of water per inch of soil
Subsoil/Substratum: Negligible (asphalt layer)

Excavation Difficulty: High

Kw Factor: 0.24; **Kf Factor**: 0.24

Permeability Class: Moderate in the loamy cap, impermeable in the asphalt layer

Range in Soil pH: Strongly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: Cemented horizon – 8-inch asphalt layer

T Factor: 2

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: D

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Severe – excess runoff

Surface Runoff Class: Very high

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – cemented pan (asphalt layer)

Local Roads and Streets: Severe limitation – cemented pan (asphalt layer)

Shallow Excavations: Severe limitation – cemented pan (asphalt layer)

Construction Materials

Sand Source: Improbable impermeable asphalt

Reconstruction Material for Drastically Disturbed Areas: Poor – thin layer

Topsoil: Poor – cemented pan (asphalt layer)

Recreation

Camp Areas: Severe limitation – cemented pan (asphalt layer)

Paths and Trails: Severe limitation - cemented pan (asphalt layer)

Picnic Areas: Severe limitation – cemented pan (asphalt layer)

Playgrounds: Severe limitation – cemented pan (asphalt layer)

Off Road Motorcycle Trails: Slight limitation

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Severe limitation – salty water, cutbanks cave

Pond Reservoir Area: Severe limitation – seepage

<u>Woodland Management</u>

Plant Competition: Moderate limitation – high available water capacity

Seedling Mortality: Moderate limitation – restrictive layer

<u>Wildlife Habitat</u>

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (asphalt layer), percs slowly

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – rooting depth (asphalt layer), percs slowly

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – depth to water, low salt

Habitat for Burrowing Mammals and Reptiles: Fair – cemented pan (asphalt layer)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (asphalt layer), percs slowly

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (asphalt layer), percs slowly Poor - wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (asphalt layer), percs slowly

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Poor – drought

270 – Verrazano sandy loam, 0 to 3 percent slopes

INTRODUCTION:

This Unit consists of the very deep to bedrock, well drained Verrazano soils. These soils have formed in a thin mantle of human- transported loamy material overlying sandy sediments. Verrazano soils are found in Floyd Bennett Field, Jamaica Bay Wildlife Refuge, Sandy Hook, and Fort Tilden.

COMPOSITION:

Verrazano soils: 90 percent
Inclusions: 10 percent – Hooksan, Bigapple, Fortress, and Greenbelt soils

PARENT MATERIAL:

Loamy fill overlying sand

Figure 94. Profile of Verrazano soil. Soil description and laboratory data are available in Appendix 28.

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.13 to 0.15 inches of water per inch of soil
Subsoil (12-24''): 0.12 to 0.19 inches of water per inch of soil
Substratum (24''+): 0.05 to 0.07 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.24; **Kf Factor**: 0.24

Permeability Class: Moderate in the loamy surface to very rapid in the substratum

Range in Soil pH: Extremely acid to slightly acid in loamy mantle, and from very strongly acid to slightly alkaline in sandy substratum

Root Limiting Layer, Restriction Kind: None

T Factor: 2

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: High

Corrosion Risk for Uncoated Steel: High

Depth to Seasonal High Water Table: Greater than 40 inches

Potential Frost Action: Moderate

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Moderate – low adsorption, seepage (sandy substratum)

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: Low

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Slight to moderate limitation – droughty (sandy substratum)

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Severe limitation – cutbanks cave

<u>Construction Materials</u>

Sand Source: Probable – sandy substratum

Reconstruction Material for Drastically Disturbed Areas: Poor – too sandy, too acid, low fertility

Topsoil: Poor – thin layer, too sandy

<u>Recreation</u>

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation - slope

Off Road Motorcycle Trails: Slight limitation

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Severe limitation – no water

Pond Reservoir Area: Severe limitation – seepage

<u>Woodland Management</u>

Plant Competition: Severe limitation – too acid

Seedling Mortality: Slight limitation

<u>Wildlife Habitat</u>

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Good

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – deep to water, too acid, low salt

Habitat for Burrowing Mammals and Reptiles: Good

Upland Coniferous Trees for use as Wildlife Habitat: Good

Upland Deciduous Trees for use as Wildlife Habitat: Good

Upland Shrubs and Vines for Use as Wildlife Habitat: Good

272 – Verrazano sandy loam, 0 to 3 percent slopes, compacted surface

Same as map unit 270 except:

Surface layer: Compacted surface

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.04 to 0.11 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.37; **Kf Factor**: 0.37

Permeability Class: Moderately slow (compacted surface)

Range in Soil pH: Extremely acid to slightly acid in loamy mantle, and from very strongly acid to slightly alkaline in sandy substratum

Root Limiting Layer, Restriction Kind: Dense material – compacted surface

SOIL AND WATER FEATURES:

Hydrologic Group: C

Pesticide Loss Potential – Leaching: Moderate –seepage (sandy substratum)

Pesticide Loss Potential – Soil Surface Runoff: Severe – excess runoff

Surface Runoff Class: Medium

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – dense material (compacted surface)

Local Roads and Streets: Severe limitation – frost action

Recreation

Camp Areas: Severe limitation – dense material (compacted surface)

Picnic Areas: Severe limitation – dense material (compacted surface)

Playgrounds: Severe limitation – dense material (compacted surface)

Woodland Management

Seedling Mortality: Severe limitation – restrictive layer

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Habitat for Burrowing Mammals and Reptiles: Poor – dense layer (compacted surface)

Upland Coniferous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Deciduous Trees for use as Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

346 – Verrazano gravelly sandy loam, 0 to 3 percent slopes, refuse surface

Same as map unit 270 except:

Surface layer – Gravelly sandy loam

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.04 to 0.11 inches of water per inch of soil

Wind Erodibility Group: 5

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – droughty (sandy substratum), small stones

Recreation

Camp Areas: Moderate limitation – small stones

Picnic Areas: Moderate limitation – small stones

Playgrounds: Severe limitation – small stones

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface)

Upland Shrubs and Vines for Use as Wildlife Habitat: Poor – rooting depth (compacted surface)

277 – Verrazano – Hooksan sandy loams, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock well drained Verrazano, and excessively drained Hooksan soils, so intermingled that it is not practical to map them separately. These soils occur throughout Gateway.

COMPOSITION:

Verrazano soils: 50 percent
Hooksan soils: 40 percent
Inclusions: 10 percent – Fortress, Barren, and Jamaica

Verrazano soils: Same as map unit 270

Hooksan soils: Same as map unit 150 except:

Surface layer – Sandy loam

PARENT MATERIAL:
Loamy fill overlying sand

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.13 to 0.15 inches of water per inch of soil

Kw Factor: 0.24; **Kf Factor**: 0.24

Permeability Class: Moderately rapid in the surface

T Factor: 4

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation - droughty

Recreation

Camp Areas: Slight limitation

Paths and Trails: Slight limitation

Picnic Areas: Slight limitation

Playgrounds: Moderate limitation - slope

Off Road Motorcycle Trails: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair - droughty

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair - droughty

Upland Wild Herbaceous Plants for Use as Wildlife Habitat: Fair – droughty

112 – Water, fresh

268 – Water, salt

292 – Wethersfield gravelly sandy loam, 3 to 8 percent slopes

INTRODUCTION:

This unit consists of the very deep to bedrock, well drained Wethersfield soils. These soils have formed in glacial till derived from red shale and sandstone, Wethersfield soils are found in Fort Wadsworth.

COMPOSITION:

Wethersfield soils: 90 percent
Inclusions: 10 percent – Foresthills, Canarsie, Ludlow and Greenbelt soils

PARENT MATERIAL:
Dense glacial till

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.11 to 0.45 inches of water per inch of soil
Subsoil/Substratum: 0.09 to 0.12 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.20; **Kf Factor**: 0.24

Permeability Class: Moderately rapid of moderate in the solum, slow or very slow in the substratum

Range in Soil pH: Extremely acid moderately acid

Root Limiting Layer, Restriction Kind: Dense material: Cd-horizon starts between 20 to 40 inches

T Factor: 3

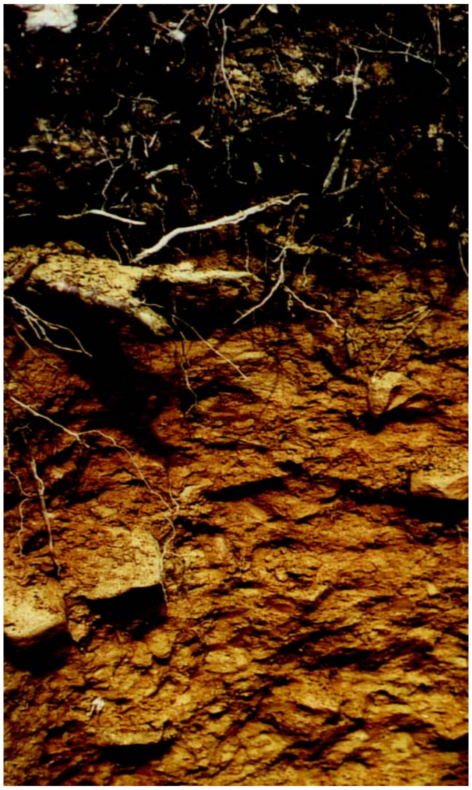

Figure 95. Profile of Wethersfield soil. Soil description and laboratory data are available in Appendix. 29.

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Moderate

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Perched between 22 and 35 inches from November through May

Potential Frost Action: Moderate

Hydrologic Group: C

Pesticide Loss Potential – Leaching: Slight

Pesticide Loss Potential – Soil Surface Runoff: Moderate – excess runoff

Surface Runoff Class: High

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – dense material (dense layer)

Local Roads and Streets: Moderate limitation – frost action, wetness

Shallow Excavations: Moderate limitation – dense layer, wetness

Construction Materials

Sand Source: Improbable – excess fines

Reconstruction Material for Drastically Disturbed Areas: Poor – too acid, low fertility

Topsoil: Fair – small stones, area reclaim, large stones

Recreation

Camp Areas: Severe limitation – percs slowly

Paths and Trails: Moderate limitation - wetness

Picnic Areas: Severe limitation – percs slowly

Playgrounds: Severe limitation – slope, percs slowly

Off Road Motorcycle Trails: Slight limitation

Water Management

Excavated Ponds (Aquifer-Fed): Severe limitation – slow refill

Pond Reservoir Area: Moderate limitation – slope

Woodland Management

Plant Competition: Severe limitation – too acid

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – percs slowly

Freshwater Wetland Plants for Use as Wildlife Habitat: Poor – too acid

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – low salt, too acid

Habitat for Burrowing Mammals and Reptiles: Good

Upland Coniferous Trees for use as Wildlife Habitat: Fair – rooting depth (dense layer)

Upland Deciduous Trees for use as Wildlife Habitat: Fair – rooting depth (dense layer)

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair – rooting depth (dense layer)

294 – Wethersfield sandy loam, 8 to 15 percent slopes

Same as map unit 292 except:

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Moderate limitation – slope, dense material (dense layer)

Local Roads and Streets: Moderate limitation – frost action, wetness, slope

Shallow Excavations: Moderate limitation – dense layer, slope, wetness

Construction Materials

Topsoil: Fair – small stones, area reclaim, slope, large stones

Water Management

Pond Reservoir Area: Severe limitation – slope

306 – Wethersfield sandy loam, 15 to 25 percent slopes, compacted surface

Same as map unit 292 except:

Surface layer: Compacted surface

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.03 to 0.11 inches of water per inch of soil

Excavation Difficulty: Moderate

Kw Factor: 0.32; **Kf Factor**: 0.37

Permeability Class: Moderately slow (compacted surface)

Root Limiting Layer, Restriction Kind: Dense material: Cd-horizon starts between 20 to 40 inches, compacted surface

T Factor: 2

SOIL AND WATER FEATURES:

Pesticide Loss Potential – Soil Surface Runoff: Severe – excess runoff

Surface Runoff Class: Very high

LIMITATIONS FOR USE:

Building Site Development

Lawns, Landscaping, and Golf Fairways: Severe limitation – slope, dense material (compacted surface)

Local Roads and Streets: Severe limitation – frost action, slope

Shallow Excavations: Severe limitation – slope

Construction Materials

Topsoil: Poor - slope

Recreation

Camp Areas: Severe limitation – slope, dense layer (compacted surface), percs slowly

Paths and Trails: Moderate limitation – slope

Picnic Areas: Severe limitation – slope, dense layer (compacted surface), percs slowly

Playgrounds: Severe limitation – slope, dense layer (compacted surface), percs slowly

Water Management

Pond Reservoir Area: Severe limitation – slope

Woodland Management

Seedling Mortality: Slight limitation

Wildlife Habitat

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Poor – rooting depth (compacted surface), percs slowly

Habitat for Burrowing Mammals and Reptiles: Good

Upland Coniferous Trees for use as Wildlife Habitat: Fair – rooting depth (dense layer)

Upland Deciduous Trees for use as Wildlife Habitat: Fair – rooting depth (dense layer)

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair – rooting depth (dense layer)

504 – Winhole sandy loam, 0 to 3 percent slopes

INTRODUCTION:

This unit consists of very deep to bedrock, moderately well drained Winhole series. These soils have formed in a thick mantle of industrial "fly ash". Winhole soils are found in the North 40 zone of Floyd Bennett Field.

COMPOSITION:

Winhole soils: 85 percent
Inclusions: 15 percent – Rikers, Bigapple, Fortress, Fishkill, Hassock, and Flatland soils

PARENT MATERIAL:
Incinerated fly ash

PHYSICAL AND CHEMICAL PROPERTIES:

Available Water Capacity:
Surface (0-12''): 0.10 to 0.15 inches of water per inch of soil
Subsoil/Substratum: 0.08 to 0.13 inches of water per inch of soil

Excavation Difficulty: Low

Kw Factor: 0.20; **Kf Factor**: 0.24

Permeability Class: Moderate

Range in Soil pH: Slightly acid to slightly alkaline

Root Limiting Layer, Restriction Kind: None

T Factor: 5

Wind Erodibility Group: 3

SOIL AND WATER FEATURES:

Corrosion Risk for Concrete: Low

Corrosion Risk for Uncoated Steel: Low

Depth to Seasonal High Water Table: Between 24 and 40 inches from November through May
Potential Frost Action: High

Hydrologic Group: B

Pesticide Loss Potential – Leaching: Moderate - wetness

Pesticide Loss Potential – Soil Surface Runoff: Slight

Surface Runoff Class: Very low

LIMITATIONS FOR USE:

<u>Building Site Development</u>

Lawns, Landscaping, and Golf Fairways: Slight limitation

Local Roads and Streets: Moderate limitation – frost action

Shallow Excavations: Severe limitation - wetness

<u>Construction Materials</u>

Sand Source: Probable

Reconstruction Material for Drastically Disturbed Areas: Fair – too sandy

Topsoil: Fair – small stones

<u>Recreation</u>

Camp Areas: Moderate limitation- wetness

Paths and Trails: Slight limitation

Picnic Areas: Moderate limitation - wetness

Playgrounds: Moderate limitation – wetness

Off Road Motorcycle Trails: Moderate limitation - wetness

<u>Water Management</u>

Excavated Ponds (Aquifer-Fed): Moderate limitation – deep to water, slow refill

Pond Reservoir Area: Moderate limitation – seepage

<u>Woodland Management</u>

Plant Competition: Severe limitation – high available water capacity

Seedling Mortality: Slight limitation

<u>Wildlife Habitat</u>

Domestic Grasses and Legumes for Use as Food and Cover for Wildlife Habitat: Fair - wetness

Freshwater Wetland Plants for Use as Wildlife Habitat: Fair – deep to water

Saline Water Wetland Plants for Use as Wildlife Habitat: Poor – low salt

Habitat for Burrowing Mammals and Reptiles: Fair - wetness

Upland Coniferous Trees for use as Wildlife Habitat: Fair –wetness

Upland Deciduous Trees for use as Wildlife Habitat: Poor – wetness

Upland Shrubs and Vines for Use as Wildlife Habitat: Fair - wetness

Appendix 1. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 99NY047002 Soil Series: Barren

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 36 minutes 13 seconds N
Longitude: 73 degrees 53 minutes 19 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 135°**
Slope Shape: Linear-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: Toeslope **Geomorphic Component: Base slope**
Geographically Associated Soils: Bigapple, Fortress, Jamaica
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 10 to 24 inches **Water Table Kind: Apparent** **Duration: Nov. through May**
Flooding Information
Frequency: None
Ponding Information
Frequency: Rare
Duration: Very brief
Official Series Classification: Mixed, mesic Typic Psammaquents
Moisture Regime: Aquic moisture regime
Landuse: Park land
Permeability: Rapid
Natural Drainage Class: Somewhat poorly drained
Parent material: Sandy dredge materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 5 inches; Particle size class - sandy, less than 35 percent (by volume) coarse fragments
Described by: L. A. Hernandez and R. B. Tunstead

A - 0 to 5 in.; very dark grayish brown (10YR 3/2) sand; weak very fine granular structure; very friable; common fine and medium roots throughout; very strongly acid; abrupt wavy boundary.

Bw - 5 to11 in.; olive brown (2.5Y 4/3) sand; weak very fine and fine subangular blocky structure; very friable; few very fine, fine, and medium roots throughout; common medium distinct yellowish brown (10YR 5/6) and gray (10YR 6/1) redoximorphic features; strongly acid; clear wavy boundary.

Bg1 - 11 to 17 in.; light brownish gray (2.5Y 6/2) sand; massive; very friable; few very fine roots throughout; few medium distinct yellowish brown (10YR 5/6) redoximorphic features; moderately acid; clear wavy boundary.

Bg2 - 17 to 35 in.; gray (2.5Y 6/1) fine sand; massive; very friable; few, very fine roots throughout; few medium distinct yellowish brown (10YR 5/6) redoximorphic features; moderately acid; gradual wavy boundary.

C - 35 to 65 in.; grayish brown (2.5Y 5/2) sand; massive; very friable; 13 percent gravel; moderately alkaline

Appendix 1. Selected soil pedon descriptions with physical and chemical analyses (continued)

S99NY-047-002; BARREN LABORATORY DATA

PEDON 99P 562, SAMPLES 99P 3508- 3512

GENERAL METHODS 1B1A, 2A1, 2B

			-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
			(- - -TOTAL - - -)			(- -CLAY- -)		(- -SILT- -)		(- - - - - -SAND- - - - - - -)						(-COARSE FRACTIONS(MM)-)				(>2MM)
			CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	- - - - WEIGHT - - - -				WT
SAMPLE	DEPTH	HORIZON	LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	PCT OF
NO.	(In)		.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	WHOLE
			<- - - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				SOIL
99P3508S	0- 5	A	0.5	4.4	95.1			1.2	3.2	2.1	45.1	38.1	8.6	1.2	2	TR	--	93	2
99P3509S	5- 11	Bw	0.4	2.3	97.3			1.0	1.3	3.6	48.4	39.3	5.8	0.2	TR	--	--	94	--
99P3510S	11- 17	Bg	--	0.6	99.4			--	0.6	1.8	42.2	46.2	8.2	1.0	--	--	--	98	--
99P3511S	17- 35	Cg1	--	0.8	99.2			0.4	0.4	2.1	70.6	24.0	2.5	--	--	--	--	97	--
99P3512S	35- 65	Cg2	2.6	7.8	89.6			4.0	3.8	2.7	35.2	39.9	8.3	3.5	4	7	10	90	21

	ORGN	TOTAL	EXTR	TOTAL	(- - DITH-CIT - -)			(RATIO/CLAY)		(ATTERBERG)		(- BULK DENSITY -)			COLE	(- - -WATER CONTENT - -)				WRD
	C	N	P	S	EXTRACTABLE				15	- LIMITS -		FIELD	1/3	OVEN	WHOLE	FIELD	1/10	1/3	15	WHOLE
DEPTH					FE	AL	MN	CEC	BAR	LL	PI	MOIST	BAR	DRY	SOIL	MOIST	BAR	BAR	BAR	SOIL
(In)	6A1c	6B4a	6S3b	6R3c	6C2h	6G7g	6D2g	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT OF <2MM -->						PCT <0.4MM		<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->				CM/CM
0- 5																			1.6	
5- 11													1.55	1.63	0.017		12.7	12.5	1.3	0.17
11- 17																			1.1	
17- 35													1.40	2.06	0.137		8.3	7.6	1.2	0.09
35- 65									0.54										1.4	

	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
	(- NH4OAC EXTRACTABLE BASES -)					ACID-	EXTR	(- - - -CEC - - -)			AL	-BASE SAT-		CO3 AS	RES.		COND.	(- - -PH - - -)		
	CA	MG	NA	K	SUM	ITY	AL	SUM	NH4-	BASES	SAT	SUM	NH4	CACO3	OHMS		MMHOS		CACL2	H2O
DEPTH	5B5a	5B5a	5B5a	5B5a	BASES			CATS	OAC	+ AL			OAC	<2MM	/CM		/CM		.01M	
(In)	6N2i	6O2h	6P2f	6Q2f		6H5a	6G9c	5A3a	5A8b	5A3b	5G1	5C3	5C1	6E1h	8E1		8I		8C1f	8C1f
	<- - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - - ->										<- - - - - -PCT - - - ->								1:2	1:1
0- 5						2.6	--	2.6											4.3	5.0
5- 11						1.5	--	1.5											4.4	5.1
11- 17						1.3	--	1.3											5.0	5.6
17- 35						0.2		0.2											5.2	5.8
35- 65														3					7.7	8.2

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 1. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING <-INCHES-> 3	2	3/2	1	3/4	3/8	<-NUMBER-> 4	10	40	200	PSDA SIEVE <-MICRONS-> 20	5	2	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN <-MILLIMETER-> 1.	.5	.25	.10	.05	DIAMETERS(mm) AT <-PERCENTILE-> 60	50	10	ATTERBERG <-PCT> LL	PI	GRADATION UNIFMTY CU	CURVTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
99P3508S	0- 5	A	100	100	100	100	100	100	100	98	79	6	2	1	TR	97	88	51	7	5	0.30	0.245	0.107			2.8	0.8
99P3509S	5- 11	Bw	100	100	100	100	100	100	100	100	84	5	1	1	TR	100	94	55	6	3	0.27	0.229	0.107			2.6	0.8
99P3510S	11- 17	Bg	FRACTIONS NOT DETERIMINED																								
99P3511S	17- 35	Cg1	FRACTIONS NOT DETERIMINED																								
99P3512S	35- 65	Cg2	100	97	95	92	90	87	83	80	63	10	5	3	2	77	71	39	10	8	0.40	0.320	0.086			4.6	1.0

DEPTH (In.)	(WEIGHT FRACTIONS) ---WHOLE SOIL (mm)- <------PCT of WHOLE SOIL-----> >2	250-UP	250 -75	75 -2	75 -20	20 -5	5 -2	<2	-<75 mm FRACTION-- <--PCT OF <75 mm-> 75 -2	75 -20	20 -5	5 -2	<2		(WEIGHT PER UNIT VOLUME G/CC) ------WHOLE SOIL------ SOIL SURVEY 1/3 BAR	OVEN-DRY	ENGINEERING MOIST	SATURATED	-------<2 mm FRACTION------- --SOIL SURVEY-- 1/3 BAR	15 BAR	OVEN-DRY	ENGINEERING MOIST	SATURATED	(VOID) --RATIOS-- AT 1/3 BAR WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 5	2	--	--	2	--	TR	2	98	2	--	TR	2	98		1.46										
5- 11	--	--	--	--	--	--	--	100	--	--	--	--	100		1.55	1.63	1.75	1.97	1.55	1.62	1.63	1.74	1.97	0.71	0.71
11- 17	--	--	--	--	--	--	--	100	--	--	--	--	100		1.45										
17- 35	--	--	--	--	--	--	--	100	--	--	--	--	100		1.40	2.06	1.51	1.87	1.40	1.44	2.06	1.51	1.87	0.89	0.89
35- 65	20	--	--	20	10	7	3	80	20	10	7	3	80		1.59										

DEPTH (In.)	(VOLUME FRACTIONS (mm) at 1/3 BAR---) ----WHOLE SOIL <---------------PCT of WHOLE SOIL----------------> >2	250 -UP	250 -75	75 -2	75 -20	20 -5	5 -2	<2	2- .05	.05- .002	LT .002	PORES D	PORES F	(C/N) RAT -IO	(RATIOS to CLAY) --------<2 mm FRACTION------- FINE CLAY	---CEC-- SUM CATS	NH4- OAC	15 BAR H2O	LEP 1/3 BAR	(LINEAR EXTENSIBILITY) WHOLE SOIL <-1/3 BAR to (PCT)---> 15 BAR	OVEN -DRY	--<2 mm-- 15 BAR	OVEN -DRY	(WRD) <--In/In-> WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 5	1	--	--	1	--	TR	1	99	51	2		45				5.20		3.20							
5- 11	--	--	--	--	--	--	--	100	56	1		21	20			3.75		3.25	4.250	1.5	1.7	1.5	1.7	0.17	0.17
11- 17	--	--	--	--	--	--	--	100	54			45													
17- 35	--	--	--	--	--	--	--	100	53			36	11							0.9	13.7	0.9	13.7	0.09	0.09
35- 65	12	--	--	12	6	4	2	88	43	4	1	40						0.54							

DEPTH (In.)	(WEIGHT FRACTIONS-CLAY FREE) (--WHOLE SOIL--) PCT of >2mm+SAND+SILT > >2	75 -2	20 -2	2- .05	.05- .002	LT .002	(--<2 mm FRACTION----) ------SANDS------- <------PCT of SAND+SILT-------> VC	C	M	F	VF	SILTS C	SILTS F	CLAY	(-TEXTURE--) (DETERMINED) IN FIELD	BY PSDA	(--PSDA(mm)---) <---PCT of 2mm---> (SAND 2- .05	SILT .05- .002	CLAY) LT .002	(PH) CA-CL2 .01M	(-ELECTRICAL) RES-IST. OHMS	CON-DUCT. MMHOS	<		>
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 5	2	2	2	94	4	TR	1	9	38	45	2	3	1	1		S	95.1	4.4	0.5	4.3					
5- 11				98	2	TR	TR	6	39	49	4	1	1	TR		S	97.3	2.3	0.4	4.4					
11- 17				99	1		1	8	46	42	2	1				S	99.4	0.6	--	5.0					
17- 35				99	1			2	24	71	2	TR	TR			FS	99.2	0.8	--	5.2					
35- 65	20	20	10	73	6	2	4	9	41	36	3	4	4	3		S	89.6	7.8	2.6	7.7					

Appendix 2 . Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: S98NY047001 Soil Series: Bigapple

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 35 minutes 56.4 seconds N
Longitude: 73 degrees 53 minutes 41.5 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 360°**
Slope Shape: Linear-linear
Elevation: 12 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Interfluve**
Geographically Associated Soils: Fortress, Barren, Jamaica
Climate Information: **Precipitation: 40 to 50 inches per year**
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Mixed, mesic Typic Udipsamments
Moisture Regime: Udic moisture regime
Landuse: Wildlife Habitat
Permeability: Rapid
Natural Drainage Class: Well drained
Parent material: Sandy dredge materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 4 inches
Described by: J. M. Galbraith, L.A. Hernandez and R. B. Tunstead

A - 0 to 4 in.; very dark gray (10YR 3/1) coarse sand; single grain; loose; common very fine, fine, and medium roots throughout; 1 percent gravel; extremely acid; clear smooth boundary.

E - 4 to 8 in.; brown (10YR 4/3) sand; single grain; loose; common very fine, fine, and medium roots throughout; 1 percent gravel; extremely acid; clear smooth boundary.

Bw - 8 to 15 in.; 90 percent yellowish brown (10YR 5/8) and 10 percent gray (2.5Y 5/1) stratified sand; weak medium subangular blocky structure; very friable; common very fine to medium roots throughout; common coarse distinct yellowish brown (10YR 5/8) redoximorphic features; 1 percent gravel; very strongly acid; clear smooth boundary.

C1 - 15 to 28 in.; 85 percent light olive brown (2.5Y 5/4), 10 percent yellowish brown (10YR 5/8), and 5 percent gray (2.5Y 5/1) stratified coarse sand; massive; very friable; common very fine roots throughout; common coarse distinct yellowish red (5YR 5/8) redoximorphic features; 5 percent gravel; very strongly acid; clear smooth boundary.

C2 - 28 to 42 in.; 85 percent light olive brown (2.5Y 5/4), 10 percent yellowish brown (10YR 5/8), and 5 percent gray (2.5Y 5/1) stratified coarse sand; massive; very friable; common very fine roots throughout; common coarse distinct yellowish brown (10YR 5/6) redoximorphic features; 1 percent gravel; very strongly acid; clear smooth boundary.

C3 - 42 to 48 in.; 80 percent light yellowish brown (2.5Y 6/4), 10 percent gray (2.5Y 5/1), and 10 percent yellowish brown (10YR 5/8) stratified sand; massive; very friable; common coarse distinct dusky red (10R 3/4) redoximorphic features and “ironstone-like” concretions; 2 percent gravel; very strongly acid; clear smooth boundary.

C4 - 48 to 65 in.; 90 percent brownish yellow (10YR 6/8) and 10 percent gray (2.5Y 5/1) stratified sand; massive; very friable; 2 percent gravel; slightly acid.

Appendix 2. Selected soil pedon descriptions with physical and chemical analyses (continued).

S98NY-047-001; BIGAPPLE LABORATORY DATA
- PEDON 98P 354, SAMPLES 98P 2083- 2089
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In)	HORIZON	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
			(- - -TOTAL	- - -)		(- -CLAY- -)		(- -SILT- -)		(- - - - -	- -SAND- -		- - - -)		(-COARSE FRACTIONS(MM)-)				(>2MM)
			CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	- - - - WEIGHT	- - - -			WT
			LT .002	.002 -.05	.05 -2	LT .0002	LT .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	PCT OF WHOLE SOIL
			<- - - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
98P2083S	0- 4	A	0.9	3.4	95.7			2.0	1.4	3.1	20.2	46.1	21.2	5.1	TR	--	--	93	TR
98P2084S	4- 8	E	1.0	2.8	96.2			1.1	1.7	2.6	21.2	51.3	18.4	2.7	TR	--	--	94	TR
98P2085S	8- 15	Bw	1.0	1.5	97.5			TR	1.5	1.7	15.9	51.4	24.8	3.7	1	TR	--	96	1
98P2086S	15- 28	C1	1.1	1.6	97.3			0.5	1.1	1.8	14.0	43.7	27.1	10.7	5	TR	--	96	5
98P2087S	28- 42	C2	0.3	1.7	98.0			0.4	1.3	4.2	22.3	44.6	22.7	4.2	1	TR	--	94	1
98P2088S	42- 48	C3	0.6	1.6	97.8			0.2	1.4	2.8	27.0	48.8	15.1	4.1	1	1	--	95	2
98P2089S	48- 65	C4	0.1	0.8	99.1			--	0.8	1.2	21.6	52.9	18.9	4.5	1	1	--	98	2

Column numbers printed: -1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	(- - DITH-CIT EXTRACTABLE FE 6C2f OF	- -) AL 6G7e <2MM	MN 6D2e -->	(RATIO/CLAY) CEC 8D1	15 BAR 8D1	(ATTERBERG - LIMITS - LL 4F1 PCT	) PI 4F <0.4MM	(- BULK DENSITY FIELD MOIST 4A5 <- -	1/3 BAR 4A1d G/CC	-) OVEN DRY 4A1h - - ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT FIELD MOIST 4B4 <- -	1/10 BAR 4B1c -PCT OF	1/3 BAR 4B1c <2MM	- -) 15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 4			7		0.66	0.32	0.07												3.2	
4- 8					0.68	0.33	0.07	1.90	1.50										1.5	
8- 15					0.64	0.33	0.07	1.30	1.10										1.1	
15- 28					0.82	0.34	0.07	1.00	0.64										0.7	
28- 42					0.74	0.34	0.07												0.6	
42- 48					0.92	0.34	0.07												0.9	
48- 65					0.68	0.33	0.07												0.7	

AVERAGES, DEPTH 25-100: PCT CLAY 1 PCT .1-75MM 95

Appendix 2. Selected soil pedon descriptions with physical and chemical analyses (continued).

DEPTH (In)	-1-- CA 5B5a 6N2f	-2-- MG 5B5a 6O2e	-3-- NA 5B5a 6P2c	-4-- K 5B5a 6Q2c	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7-- EXTR AL 6G9c	-8-- (- - - -CEC SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- BASES + AL 5A3b - - -)	-11- AL SAT 5G1	-12- -BASE SUM 5C3	-13- SAT- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1g	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18-	-19- (- - - -PH CACL2 .01M 8C1f 1:2	-20- - - -) H2O 8C1f 1:1
	<- - - -	- - - -	- - - -	- - - -	-MEQ /	100 G -	- - - -	- - - -	- - - -	- - ->	<- - - -	- -PCT -	- - - ->							
0- 4	1.9	0.3	--	0.3	2.5	4.1	0.5	6.6	3.4	3.0	17	38	74						3.8	4.1
4- 8	--	0.1	--	0.3	0.4	1.5	0.8	1.9	1.9	1.2	67	21	21						4.0	4.2
8- 15	1.4	0.1	--	0.4	1.9	1.1	0.7	3.0	1.3	2.6	27	63	100						4.3	4.5
15- 28	--	0.1	--	0.4	0.5	0.8	0.2	1.3	1.1	0.7	29	38	45						4.5	4.9
28- 42	1.5	--	--	--	1.5	0.9	0.3	2.4	1.0	1.8	17	63	100						4.4	4.8
42- 48	--	0.1	--	0.4	0.5	0.7	0.2	1.2	0.9	0.7	29	42	56						4.4	4.9
48- 65	1.9	0.1	--	0.3	2.3	--		2.3	0.9			100	100						5.8	6.2

SAMPLE No.	DEPTH (In.)	HORIZON	1 (3)	2 (2)	3 (3/2)	4 (1)	5 (3/4)	6 (3/8)	7 (4)	8 (10)	9 (40)	10 (200)	11 (20)	12 (5)	13 (2)	14 (1.)	15 (.5)	16 (.25)	17 (.10)	18 (.05)	19 (60)	20 (50)	21 (10)	22 (LL)	23 (PI)	24 (UNI-FMTY CU)	25 (CUR-VTUR CC)
			E N G I N E E R I N G P E R C E N T A G E <-----I N C H E S----->						P A S S I N G <-N U M B E R->				P S D A S I E V E <-MICRONS->			USDA <--- MILLIMETER --->					CUMULATIVE CURVE FRACTIONS(<75mm) DIAMETERS(mm) AT <--PERCENTILE-->			ATTER-BERG <-PCT>		GRADATION	
98P2083S	0- 4	A	100	100	100	100	100	100	100	100	62	6	3	2	1	95	74	28	7	4	0.41	0.350	0.113			3.6	1.5
98P2084S	4- 8	E	100	100	100	100	100	100	100	100	66	5	2	1	1	97	79	28	6	4	0.39	0.338	0.117			3.3	1.5
98P2085S	8- 15	Bw	100	100	100	100	100	100	100	99	58	3	1	1	1	95	71	20	4	2	0.43	0.377	0.141			3.1	1.4
98P2086S	15- 28	C1	100	100	100	100	100	100	100	95	49	4	2	1	1	85	59	18	4	3	0.51	0.430	0.148			3.5	1.2
98P2087S	28- 42	C2	100	100	100	100	100	100	100	99	61	4	1	TR	TR	95	72	28	6	2	0.41	0.352	0.117			3.5	1.4
98P2088S	42- 48	C3	100	100	100	100	100	100	99	98	67	4	1	1	1	94	79	31	5	2	0.38	0.328	0.119			3.2	1.3
98P2089S	48- 65	C4	F R A C T I O N S N O T D E T E R I M I N E D																								

DEPTH (In.)	26 (>2)	27 (250 -UP)	28 (250 -75)	29 (75 -2)	30 (75 -20)	31 (20 -5)	32 (5 -2)	33 (<2)	34 (75 -2)	35 (75 -20)	36 (20 -5)	37 (5 -2)	38 (<2)	39	40 (SOIL SURVEY 1/3 BAR)	41 (OVEN -DRY)	42 (ENGINEERING MOIST)	43 (SATUR -ATED)	44 (SOIL SURVEY 1/3 BAR)	45 (15 BAR)	46 (OVEN -DRY)	47 (ENGINEERING MOIST)	48 (SATUR -ATED)	49 (AT 1/3 WHOLE SOIL)	50 (BAR <2 mm)
	(W E I G H T ---W H O L E <------PCT of WHOLE SOIL----->				S O I L (mm)-				F R A C T I O N S) -<75 mm FRACTION-- <--PCT OF <75 mm->						(W E I G H T P E R ------WHOLE SOIL------				U N I T V O L U M E -------<2 mm FRACTION-------					G/CC)(VOID) --RATIOS--	
0- 4	TR	--	--	--	--	--	TR	100	--	--	--	TR	100		1.45										
4- 8	TR	--	--	--	--	--	TR	100	--	--	--	TR	100		1.45										
8- 15	1	--	--	1	--	--	1	99	1	--	--	1	99		1.46										
15- 28	5	--	--	5	--	TR	5	95	5	--	TR	5	95		1.49										
28- 42	1	--	--	1	--	TR	1	99	1	--	TR	1	99		1.46										
42- 48	2	--	--	2	--	1	1	98	2	--	1	1	98		1.46										
48- 65	2	--	--	2	--	1	1	98	2	--	1	1	98		1.46										

Appendix 2. Selected soil pedon descriptions with physical and chemical analyses (continued).

DEPTH	(V O L U M E							F R A C T I O N S						)(C/)	(R A T I O S to C L A Y)				(LINEAR EXTENSIBILITY)				(W R D)	
	----W H O L E			S O I L (mm)				a t 1/3 B A R					---(/N)		--------<2 mm FRACTION-------				WHOLE SOIL		--<2 mm--		WHOLE	<2
DEPTH	>2	250	250	75	75	20	5		2-	.05-	LT	PORES		RAT	FINE	---C E C--		15	LEP	<-1/3 BAR to		(PCT)--->		SOIL	mm
(In.)		-UP	-75	-2	-20	-5	-2	<2	.05	.002	.002	D	F	-IO	CLAY	SUM	NH4-	BAR	1/3	15	OVEN	15	OVEN		
	<---------------PCT of WHOLE SOIL---------------->															CATS	OAC	H2O	BAR	BAR	-DRY	BAR	-DRY	<--In/In->	
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 4	TR	--	--	--	--	--	TR	100	52	2	1	45				7.33	3.78	3.56							
4- 8	TR	--	--	--	--	--	TR	100	53	2	1	45				1.90	1.90	1.50							
8- 15	1	--	--	1	--	--	1	99	54	1	1	45				3.00	1.30	1.10							
15- 28	3	--	--	3	--	TR	3	97	52	1	1	44				1.18	1.00	0.64							
28- 42	1	--	--	1	--	TR	1	99	54	1		45				8.00	3.33	2.00							
42- 48	1	--	--	1	--	1	1	99	54	1		45				2.00	1.50	1.50							
48- 65	1	--	--	1	--	1	1	99	53			45				23.00	9.00	7.00							

DEPTH	(W E I G H T						F R A C T I O N S - C L A Y						F R E E)		(-TEXTURE--)	(--P S D A(mm)---)			(PH)	(-ELECTRICAL)<				>
	(--W H O L E		S O I L--)				(--<2 mm	F R A C T I O N ----)							(DETERMINED)	(SAND	SILT	CLAY)	CA-	RES-	CON-	<		>
DEPTH	>2	75	20	2-	.05-	LT	------SANDS-------					SILTS		CL	IN	BY	2-	.05-	LT	CL2	IST.	DUCT.	<		>
(In.)		-2	-2	.05	.002	.002	VC	C	M	F	VF	C	F	AY	FIELD	PSDA	.05	.002	.002	.01M	OHMS	MMHOS	<		>
	PCT of >2mm+SAND+SILT >						<------PCT of SAND+SILT------->								<---<2 mm-->		<---PCT of 2mm--->			<----- <2mm ----->			<--------------->	
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 4				97	3	1	5	21	47	20	3	1	2	1		COS	95.7	3.4	0.9	3.8					
4- 8				97	3	1	3	19	52	21	3	2	1	1		S	96.2	2.8	1.0	4.0					
8- 15	1	1	1	97	1	1	4	25	52	16	2	2		1		S	97.5	1.5	1.0	4.3					
15- 28	5	5	5	93	2	1	11	27	44	14	2	1	1	1		COS	97.3	1.6	1.1	4.5					
28- 42	1	1	1	97	2	TR	4	23	45	22	4	1	TR	TR		COS	98.0	1.7	0.3	4.4					
42- 48	2	2	2	96	2	1	4	15	49	27	3	1	TR	1		S	97.8	1.6	0.6	4.4					
48- 65	2	2	2	97	1	TR	5	19	53	22	1	1		TR		S	99.1	0.8	0.1	5.8					

Appendix 3. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: S99NY085001 Soil Series: Branford

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: The Narrows
Latitude: 40 degrees 34 minutes 04 seconds N
Longitude: 74 degrees 05 minutes 42 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 110°**
Slope Shape: Linear-linear
Elevation: 5 feet
Physiography:
Local: Outwash Plain **Major: Glaciated Coastal Plain**
Hillslope - Profile Position: **Geomorphic Component: slope**
Geographically Associated Soils: Pompton
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Typic Dystrudepts
Moisture Regime: Udic moisture regime
Landuse: Parkland
Permeability: Moderate or moderately rapid in the surface and subsoil; rapid or very rapid in the substratum
Natural Drainage Class: Well drained
Parent material: Glacial Outwash
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon (0-8"), Cambic horizon (8-29")
Described by: L.A. Hernandez and R.B. Tunstead

Ap - 0 to 8 inches; dark grayish brown (10YR 4/2) loam; weak fine granular structure; very friable; common fine and medium roots; 2 percent gravel; slightly acid; abrupt smooth boundary.

Bw1 - 8 to 16 inches; dark yellowish brown (10YR 4/4) loam; weak fine and medium subangular blocky structure; friable; 5 percent gravel; moderately acid; clear smooth boundary.

Bw2 - 16 to 29 inches; strong brown (7.5YR 4/6) gravelly loam; weak fine and medium subangular blocky structure; friable; 20 percent gravel; moderately acid; clear wavy boundary.

BC - 29 to 32 inches; brown (7.5YR 4/4) very gravelly sandy loam; massive; friable; 40 percent gravel; strongly acid; gradual wavy boundary.

2C - 32 to 72 inches; yellowish red (5YR 4/6) sand; massive; loose; 50 percent gravel; strongly acid.

Appendix 3. Selected soil pedon descriptions with physical and chemical analyses (continued).

```
S99NY-085-003; BRANFORD LABORATORY DATA
- PEDON   99P 566, SAMPLES 99P 3523- 3523
- GENERAL METHODS  1B1A, 2A1, 2B

            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-
--------- ------------------------------------------------------------------------------------------------------------------------
                             (- - -TOTAL - - -)(- -CLAY- -)(- -SILT- -)(- - - -  - -SAND- -  - - - -)(-COARSE FRACTIONS(MM)-)(>2MM)
                              CLAY  SILT  SAND  FINE   CO3  FINE COARSE  VF     F     M     C    VC   - - - - WEIGHT - - - -   WT
SAMPLE     DEPTH   HORIZON     LT  .002  .05    LT    LT  .002  .02   .05   .10   .25    .5     1    2     5    20     .1- PCT OF
 NO.       (In)               .002  -.05    -2 .0002  .002  -.02  -.05  -.10  -.25  -.50    -1    -2   -5   -20   -75    75  WHOLE
                              <- - - - - - - - - - - - - PCT OF <2MM  (3A1) - - - - - - - - - - - - - ->  <- PCT OF <75MM(3B1)->  SOIL
99P3523S   10-40   C2          9.0  26.0  65.0              12.1  13.9   6.0  11.6  19.3  17.1  11.0   12    16     2     71  30
--------- ------------------------------------------------------------------------------------------------------------------------
            ORGN TOTAL  EXTR TOTAL (- - DITH-CIT - -)(RATIO/CLAY)(ATTERBERG )(- BULK DENSITY -) COLE (- - -WATER CONTENT - -)  WRD
             C     N     P     S       EXTRACTABLE          15    - LIMITS -  FIELD  1/3  OVEN WHOLE FIELD  1/10   1/3    15  WHOLE
 DEPTH                              FE    AL    MN   CEC   BAR   LL    PI   MOIST  BAR  DRY   SOIL MOIST   BAR   BAR   BAR  SOIL
 (In)       6A1c  6B4a  6S3b  6R3c  6C2h  6G7g  6D2g   8D1   8D1  4F1    4F   4A5   4A1d  4A1h  4D1   4B4   4B1c  4B1c  4B2a  4C1
            PCT   <2MM   PPM <- PERCENT  OF  <2MM -->            PCT <0.4MM  <- - G/CC - - -> CM/CM  <- - -PCT OF <2MM - -> CM/CM

 10-40                                                  0.57                                                        5.14
--------- ------------------------------------------------------------------------------------------------------------------------
            -1--  -2--  -3--  -4--  -5--  -6--  -7--  -8--  -9--  -10-  -11-  -12-  -13-  -14-  -15-  -16-  -17-  -18-  -19-  -20-
--------- ------------------------------------------------------------------------------------------------------------------------
           (- NH4OAC EXTRACTABLE BASES -) ACID- EXTR (- - - -CEC - - -)  AL   -BASE SAT- CO3 AS RES.        COND.(- - - -PH - - -)
             CA    MG    NA     K   SUM    ITY    AL   SUM   NH4-  BASES  SAT    SUM   NH4  CACO3 OHMS        MMHOS       CACL2  H2O
 DEPTH      5B5a  5B5a  5B5a  5B5a BASES              CATS   OAC  + AL               OAC  <2MM   /CM          /CM        .01M
 (In)       6N2i  6O2h  6P2f  6Q2f        6H5a  6G9c  5A3a  5A8b  5A3b   5G1   5C3   5C1  6E1h  8E1          8I         8C1f  8C1f
            <- - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - ->  <- - - - -PCT - - - ->                         1:2   1:1

 10-40                                     4.3   0.3   4.3                                                          4.8   5.5
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Appendix 4 . Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 99NY081001 Soil Series: Breeze

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 33 minutes 40 seconds N
Longitude: 73 degrees 54 minutes 59 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 13 percent **Aspect: 338°**
Slope Shape: Convex-convex
Elevation: 20 feet
Physiography:
Local: Fill **Major: Barrier Island**
Hillslope - Profile Position: Shoulder **Geomorphic Component: Side slope**
Geographically Associated Soils: Bigapple, Barren, Fortress, Hooksan, and Jamaica
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Mixed, mesic Typic Udipsamments
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Rapid
Natural Drainage Class: Well drained
Parent material: Sandy fill with construction debris
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 6 inches; Particle size class - sandy, with 10 to 35 percent (by volume) coarse fragments
Described by: L. A. Hernandez and R. B. Tunstead

A - 0 to 6 in.; brown (10YR 5/3) loamy sand, pale brown (10YR 6/3) dry; weak very fine granular structure; very friable; many very fine and fine plus common medium roots throughout; 13 percent gravel-sized construction debris fragments; moderately alkaline; clear wavy boundary.

Bw - 6 to 14 in.; yellowish brown (10YR 5/4) gravelly sand; weak very fine subangular blocky structure; very friable; many very fine and fine roots throughout; 15 gravel-sized coarse fragments (12 percent construction debris and 3 percent rock fragments); moderately alkaline; gradual wavy boundary.

C1 - 14 to 26 in.; yellowish brown (10YR 5/4) gravelly sand; single grain; loose; few very fine roots throughout; 15 percent gravel-sized construction debris fragments; moderately alkaline; gradual wavy boundary.

C2 - 26 to 65 in.; yellowish brown (10YR 5/4) gravelly sand; single grain; loose; 20 percent gravel-sized coarse fragments (15 percent construction debris and 5 percent rock fragments); neutral.

Appendix 4. Selected soil pedon descriptions with physical and chemical analyses (continued).

S99NY-081-001; BREEZE LABORATORY DATA
- PEDON 99P 565, SAMPLES 99P 3519- 3522
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In) -1-- -2--	HORIZON -3--	-4-- (- - -TOTAL - - -) CLAY LT .002	-5-- SILT .002 -.05	-6-- SAND .05 -2	-7-- (- -CLAY- -) FINE LT .0002	-8-- CO3 LT .002	-9-- (- -SILT- -) FINE .002 -.02	-10- COARSE .02 -.05	-11- (- - - - - -SAND- - - - - - -) VF .05 -.10	-12- F .10 -.25	-13- M .25 -.50	-14- C .5 -1	-15- VC 1 -2	-16- (-COARSE FRACTIONS(MM)-) - - - - WEIGHT - - - - 2 -5	-17- 5 -20	-18- 20 -75	-19- .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - -				PCT OF <2MM (3A1)	- - - - - - - - - - - - - ->							<- PCT OF <75MM(3B1)->				
99P3519S	0- 6	A	3.7	9.9	86.4			3.3	6.6	2.8	32.0	38.1	9.4	4.1	6	9	6	87	21
99P3520S	6- 14	Bw	2.8	7.5	89.7			2.7	4.8	3.1	35.3	40.0	6.9	4.4	6	9	3	89	18
99P3521S	14- 26	C1	1.9	6.5	91.6			2.2	4.3	2.4	28.4	47.5	9.4	3.9	6	8	4	91	18
99P3522S	26- 65	C2	--	1.5	98.5			--	1.5	1.3	35.0	54.8	7.3	0.1	--	--	--	97	--

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g OF	MN 6D2g <2MM -->	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT	PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- - G/CC	1/3 BAR 4A1d	OVEN DRY 4A1h - - ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- -	1/10 BAR 4B1c -PCT OF	1/3 BAR 4B1c <2MM	15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 6									0.68										2.5	
6- 14									0.61										1.7	
14- 26									0.58										1.1	
26- 65																			0.8	

DEPTH (In)	-1-- (- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	-2-- MG 5B5a 6O2h	-3-- NA 5B5a 6P2f	-4-- K 5B5a 6Q2f	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7-- EXTR AL 6G9c	-8-- (- - - -CEC - - -) SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- BASES + AL 5A3b	-11- AL SAT 5G1	-12- -BASE SAT- SUM 5C3	-13- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1h	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18-	-19- (- - - -PH - - -) CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<- - - - - - - - - - - -				-MEQ / 100 G	- - - - - - - - - - - -				->	<- - - - -	-PCT	- - - ->							
0- 6						--								4					7.3	7.9
6- 14														5					7.6	8.0
14- 26														8					7.7	8.2
26- 65						--													6.0	6.7

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 4. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING SIEVE, INCHES: 3	2	3/2	1	3/4	3/8	NUMBER: 4	10	40	200	PSDA MICRONS: 20	5	2	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN, MILLIMETER: 1.	.5	.25	.10	.05	DIAMETERS(mm) AT PERCENTILE: 60	50	10	ATTERBERG (PCT): LL	PI	GRADATION UNIFMTY CU	CURVTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
99P3519S	0- 6	A	100	98	97	95	94	90	85	79	61	12	6	4	3	76	68	38	13	11	0.41	0.328	0.044			9.4	1.9
99P3520S	6- 14	Bw	100	99	99	98	97	93	88	82	64	10	5	3	2	78	73	40	11	8	0.38	0.309	0.076			5.0	1.1
99P3521S	14- 26	C1	100	99	98	97	96	92	88	82	61	8	3	2	2	79	71	32	9	7	0.41	0.344	0.105			3.9	1.2
99P3522S	26- 65	C2	FRACTIONS NOT DETERMINED																								

DEPTH (In.)	WEIGHT FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL: >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	<75 mm FRACTION, PCT OF <75 mm: 75-2	75-20	20-5	5-2	<2		WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL, SOIL SURVEY: 1/3 BAR	OVEN-DRY	ENGINEERING: MOIST	SATURATED	<2 mm FRACTION, SOIL SURVEY: 1/3 BAR	15 BAR	OVEN-DRY	ENGINEERING: MOIST	SATURATED	VOID RATIOS AT 1/3 BAR: WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 6	21	--	--	21	6	9	6	79	21	6	9	6	79		1.60										
6- 14	18	--	--	18	3	9	6	82	18	3	9	6	82		1.58										
14- 26	18	--	--	18	4	8	6	82	18	4	8	6	82		1.57										
26- 65	--	--	--	--	--	--	--	100	--	--	--	--	100		1.45										

DEPTH (In.)	VOLUME FRACTIONS at 1/3 BAR, WHOLE SOIL (mm), PCT of WHOLE SOIL: >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	2-.05	.05-.002	LT .002	PORES D	PORES F	(C/) (/N) RATIO	RATIOS to CLAY, <2 mm FRACTION: FINE CLAY	CEC SUM CATS	CEC NH4-OAC	15 BAR H2O	LEP 1/3 BAR	LINEAR EXTENSIBILITY <-1/3 BAR to (PCT)--->, WHOLE SOIL: 15 BAR	OVEN-DRY	<2 mm: 15 BAR	OVEN-DRY	WRD <--In/In->: WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 6	13	--	--	13	4	5	4	87	42	5	2	40						0.68							
6- 14	11	--	--	11	2	5	4	89	43	4	1	40						0.61							
14- 26	11	--	--	11	2	5	4	89	45	3	1	41						0.58							
26- 65	--	--	--	--	--	--	--	100	54	1		45													

DEPTH (In.)	WEIGHT FRACTIONS - CLAY FREE, WHOLE SOIL, PCT of >2mm+SAND+SILT: >2	75-2	20-2	2-.05	.05-.002	LT .002	<2 mm FRACTION, PCT of SAND+SILT, SANDS: VC	C	M	F	VF	SILTS: C	F	CLAY	TEXTURE (DETERMINED): IN FIELD	BY PSDA	PSDA (mm), PCT of <2mm: SAND 2-.05	SILT .05-.002	CLAY LT .002	PH CACL2 .01M	ELECTRICAL <2mm: RES-IST. OHMS	CON-DUCT. MMHOS			
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 6	22	22	15	70	8	3	4	10	40	33	3	7	3	4		LS	86.4	9.9	3.7	7.3					
6- 14	18	18	15	75	6	2	5	7	41	36	3	5	3	3		S	89.7	7.5	2.8	7.6					
14- 26	18	18	14	76	5	2	4	10	48	29	2	4	2	2		S	91.6	6.5	1.9	7.7					
26- 65				98	1		TR	7	55	35	1	1				S	98.5	1.5	--	6.0					

Appendix 5. **Selected soil pedon descriptions.**

Soil Survey Site Identification #: Soil Series: Bulkhead

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 35 minutes 23.7 seconds N
Longitude: 73 degrees 53 minutes 28.5 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 190°**
Slope Shape: Linear-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Slope**
Geographically Associated Soils: Barren, Bigapple, Breeze, Fortress, Jamaica, Shea, and Verrazano
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 40 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: Rare
Duration: Very brief

Official Series Classification: Mixed, dysic, thermic Typic Udifolists
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Very rapid over an impermeable concrete layer
Natural Drainage Class: well drained
Parent material: Thin mantle of chopped up wood chips overlying an impermeable concrete layer
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Fibric soil material, 0 to 8 inch zone, has 85 percent slightly decomposed and 15 percent undecomposed organic material; Ckqm horizon, a rigid human-made concrete layer; Thermic temperature regime is estimated due to a high rate of organic matter decomposition, however, rate of organic matter decomposition may decrease over time; A very shallow phase has been mapped.
Note: Reaction class is Dysic (pH <4.5).
Described by: L. A. Hernandez and R.B. Tunstead

Oi - 0 to 15 inches; very dark brown (10YR 2/2) fibric soil material; 85 percent slightly decomposed needles and branches and 15 percent wood chips; single grain; loose; few very fine roots; abrupt smooth boundary.

2Ckqm - 15 to 23 inches; slightly weathered concrete; massive

3C - 23 to 65 inches; light yellowish brown (2.5Y 6/4) sand; massive; very friabl

Appendix 6. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 95NY085013 Soil Series: Canarsie

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 34 minutes 33.75 seconds N
Longitude: 74 degrees 9 minutes 37.2 seconds W
Description Category: Full pedon description
Pedon Category: Type location for the series
Slope Characteristics Information
Slope: 1 percent **Aspect: 225°**
Slope Shape: Convex-Linear
Elevation: 65 feet
Physiography:
Local: Cut/fill **Major: Glaciated upland**
Hillslope - Profile Position: **Geomorphic Component: Side slope**
Geographically Associated Soils: Foresthills, Wethersfield, Cheshire, Greenbelt, Centralpark
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: May occur above Cd **Water Table Kind: Perched**
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Coarse-loamy, mixed, superactive, nonacid, mesic Typic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderate to moderately slow in the surface and uncompacted subsoil, and slow in the compacted subsoil and dense till substratum
Natural Drainage Class: Well drained
Parent material: Anthropotransported soil material over dense glacial till
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 20 inches
Diagnostic Features: Ochric epipedon, 0 to 5 inches; the truncated soil begins at the top of the 2Cd horizon
Described by: J. M. Galbraith, L. A. Hernandez, and S. T. Seifried
Note: Lithochromic mottles have formed from rock weathering.

A - 0 to 2 in.; dark brown (7.5YR 3/2) sandy loam; moderate medium granular structure; very friable; many very fine and fine plus common medium roots throughout; 5 percent gravel; slightly alkaline; clear smooth boundary.

Bw - 2 to 5 in.; dark reddish brown (5YR 3/4) sandy loam; moderate fine subangular blocky structure; friable; many very fine and fine plus common medium roots throughout, very few inside the subangular blocky structured peds; very few fine pores; 10 percent gravel and 1 percent cobbles; moderately alkaline; clear smooth boundary.

BC - 5 to 10 in.; dark reddish brown (5YR 3/4) fine sandy loam; moderate thick (1/8 to 1/4 inch thick) platy structure; firm; many very fine and fine plus common medium roots throughout, very few inside the platy structured peds; very few fine pores; 10 percent gravel and 1 percent cobbles; moderately alkaline; abrupt wavy boundary.

C - 10 to 20 in.; dark red (2.5YR 3/6) gravelly sandy loam; weak very thick (1/3 to 1 inch thick) platy structure; very firm; common very fine and fine roots between peds; 20 percent gravel and 10 percent cobbles; no weathering rind or saprolite around rock fragments; moderately acid; abrupt wavy boundary.

2Cd - 20 to 72 in.; dark red (2.5YR 3/6) sandy loam; massive; firm; few very fine roots throughout; 10 percent gravel; weathering rinds or saprolite around most rock fragments; moderately alkaline.

Appendix 6. Selected soil pedon descriptions with physical and chemical analyses (continued).

S95NY-085-013; CANARSIE LABORATORY DATA
- PEDON 96P 168, SAMPLES 96P 1364- 1368
- GENERAL METHODS 1B1A, 2A1, 2B

			-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-
			(- - -TOTAL	- - -)		(- -CLAY- -)		(- -SILT- -)		(- - - -	- -SAND-	-	- - - -)	
			CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC
SAMPLE	DEPTH	HORIZON	LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1
NO.	(In)		.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2
			<- - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - ->											
96P1364S	0- 2	A	8.4	29.2	62.4			15.6	13.6	12.3	19.7	17.1	9.2	4.1
96P1365S	2- 5	Bw	9.5	30.6	59.9			16.9	13.7	10.7	17.4	14.9	10.0	6.9
96P1366S	5- 10	BC	9.7	35.3	55.0		1.0	20.8	14.5	10.6	15.4	14.1	9.6	5.3
96P1367S	10- 20	C	9.3	32.6	58.1			18.7	13.9	9.7	14.1	13.9	10.7	9.7
96P1368S	20- 40	2Cd	7.7	32.3	60.0			16.1	16.2	12.4	16.6	16.7	9.2	5.1

Note: the column numbers above are printed as -1-- through -15- across the full page width (positions 1–3 over the sample, depth and horizon columns).

	ORGN	TOTAL	EXTR	TOTAL	(- - DITH-CIT	- -)		(RATIO/CLAY)		(ATTERBERG	)	(- BULK	DENSITY -)		COLE	(- - -WATER	CONTENT	- -)		WRD
	C	N	P	S		EXTRACTABLE			15	- LIMITS	-	FIELD	1/3	OVEN	WHOLE	FIELD	1/10	1/3	15	WHOLE
DEPTH					FE	AL	MN	CEC	BAR	LL	PI	MOIST	BAR	DRY	SOIL	MOIST	BAR	BAR	BAR	SOIL
(In)	6A1c	6B4a	6S3b	6R3c	6C2b	6G7a	6D2a	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT	OF	<2MM -->				PCT <0.4MM		<- - G/CC	- - ->		CM/CM	<- - -PCT	OF <2MM	- ->		CM/CM
0- 2	1.92	0.138			1.2	0.1	0.1	1.11	0.71										6.0	
2- 5	0.70	0.039			1.3	0.2	0.1	0.75	0.55										5.2	
5- 10	0.31	0.005			1.4	0.2	0.1	0.73	0.57										5.5	
10- 20	0.18	0.005			1.3	0.2	0.1	0.68	0.52										4.8	
20- 40	0.02	0.002			1.2	0.1	0.1	0.86	0.55										4.2	

AVERAGES, DEPTH 25-100: PCT CLAY 8 PCT .1-75MM 72

	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
	(- NH4OAC	EXTRACTABLE	BASES -)			ACID-	EXTR	(- - -	-CEC	- - -)	AL	-BASE	SAT-	CO3 AS	RES.		COND.	(- - -	-PH -	- -)
	CA	MG	NA	K	SUM	ITY	AL	SUM	NH4-	BASES	SAT	SUM	NH4	CACO3	OHMS		MMHOS		CACL2	H2O
DEPTH	5B5a	5B5a	5B5a	5B5a	BASES			CATS	OAC	+ AL			OAC	<2MM	/CM		/CM		.01M	
(In)	6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	5A3a	5A8b	5A3b	5G1	5C3	5C1	6E1g	8E1		8I		8C1f	8C1f
	<- - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - ->										<- - - - -PCT - - - ->								1:2	1:1
0- 2		3.0	--	TR		1.5			9.3				100	1					7.1	7.6
2- 5		2.7	0.2	0.9		0.7			7.1				100	2					7.4	7.9
5- 10		3.3	0.3	0.7					7.1			100	100	5					7.7	8.2
10- 20		5.4	0.4	0.7					6.3			100	100	9					7.6	8.1
20- 40	3.1	3.1	0.4	0.8	7.4	1.0		8.4	6.6			88	100	--					7.1	8.0

Appendix 7. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 95NY085032 Soil Series: Centralpark

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 34 minutes 15.3 seconds N
Longitude: 74 degrees 9 minutes 55.4 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 2 percent **Aspect: 260°**
Slope Shape: Convex-linear
Elevation: 20 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Side slope**
Geographically Associated Soils: Greenbelt, Greatkills, Freshkills
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information **Ponding Information**
Frequency: None **Frequency: None**

Official Series Classification: Loamy-skeletal, mixed, superactive, mesic Typic Dystrudepts
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderately slow in the compacted surface, moderate below
Natural Drainage Class: Well drained
Parent material: Anthropotransported natural soil materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 2 inches; buried soil begins at the top of the Ab horizon
Described by: J. M. Galbraith, L. A. Hernandez, and S. T. Seifried
Note: Lithochromic mottles have formed as a result of rock weathering.

A - 0 to 2 in.; dark brown (7.5YR 3/3) gravelly sandy loam; weak medium granular structure; very friable; many very fine and fine plus common medium and coarse roots throughout; 26 percent gravel-sized coarse fragments (24 percent rock fragments and 2 percent glass fragments), and 1 percent cobbles; neutral; clear wavy boundary.

Bw - 2 to 11 in.; brown (7.5YR 4/3) extremely gravelly sandy loam; weak medium subangular blocky structure; friable; common very fine and fine plus few medium and coarse roots throughout; few fine and medium pores; 45 percent gravel-sized coarse fragments (43 percent rock fragments and 2 percent glass fragments), 10 percent cobbles, and 10 percent stones; neutral; clear wavy boundary.

C1 - 11 to 19 in.; brown (7.5YR 4/3) very stony coarse sandy loam; massive; friable; common very fine, few fine and medium roots throughout; 25 percent gravel-sized coarse fragments (24 percent rock fragments and 1 percent glass fragments), 10 percent cobbles, and 15 percent stones; slightly alkaline; clear wavy boundary.

C2 - 19 to 40 in.; reddish brown (5YR 4/3) extremely stony sandy loam; massive; firm; few fine and medium roots throughout; 40 percent gravel, 15 percent cobbles, and 20 percent stones; slightly alkaline; gradual smooth boundary.

C3 - 40 to 55 in.; reddish brown (5YR 4/4) extremely stony sandy loam; massive; friable; few fine and medium roots throughout; 16 percent gravel, 15 percent cobbles, and 20 percent stones; slightly alkaline; abrupt smooth boundary.

Ab - 55 to 56 in.; black (N 2.5/0) mucky silt loam; massive; compacted; friable; few fine and medium roots throughout; neutral; clear smooth boundary.

Bwb - 56 to 80 in.; brown (7.5YR 4/3) loam; friable; few fine and medium roots throughout; moderately acid.

Appendix 7. Selected soil pedon descriptions with physical and chemical analyses (continued).

S95NY-085-032; CENTRALPARK LABORATORY DATA
- PEDON 96P 172, SAMPLES 96P 1379- 1383
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In)	HORIZON	-4-- (- - -TOTAL - - -) CLAY LT .002	-5-- SILT .002 -.05	-6-- SAND .05 -2	-7-- (- -CLAY- -) FINE LT .0002	-8-- CO3 LT .002	-9-- (- -SILT- -) FINE .002 -.02	-10- COARSE .02 -.05	-11- (- - - - - -SAND- - - - - - -) VF .05 -.10	-12- F .10 -.25	-13- M .25 -.50	-14- C .5 -1	-15- VC 1 -2	-16- (-COARSE FRACTIONS(MM)-) - - - - WEIGHT - - - - 2 -5	-17- 5 -20	-18- 20 -75	-19- .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - - PCT OF <2MM (3A1)											- - - - - - - - - - - - - ->	<- PCT OF <75MM(3B1)->				SOIL
96P1379S	0- 2	A	8.8	27.8	63.4			14.4	13.4	9.0	13.5	17.9	14.5	8.5	14	23	--	71	38
96P1380N	2- 11	Bw1	10.8	29.8	59.4			15.9	13.9	8.7	13.3	17.7	13.3	6.4	28	29	--	79	63
96P1381N	11- 18	C1	9.8	28.1	62.1			15.8	12.3	7.7	11.4	16.4	15.4	11.2	14	27	1	74	50
96P1382N	18- 40	C2	9.5	28.4	62.1			15.8	12.6	7.8	12.2	17.9	15.7	8.5	18	30	7	79	64
96P1383S	40- 55	C3	10.7	29.9	59.4			17.0	12.9	8.5	13.1	17.4	12.7	7.7	12	25	1	70	51

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2b	AL 6G7a OF	MN 6D2a <2MM -->	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT	PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- -	1/3 BAR 4A1d G/CC	OVEN DRY 4A1h - - ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- -	1/10 BAR 4B1c -PCT OF	1/3 BAR 4B1c <2MM	15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 2	2.15	0.138			1.4	0.2	0.1	1.14	0.89										7.8	
2- 11	0.56	0.042			1.5	0.2	0.1	0.83	0.56										6.0	
11- 18	0.27	0.011			1.5	0.2	0.1	0.88	0.56										5.5	
18- 40	0.37	0.012			1.5	0.2	0.1	0.92	0.58										5.5	
40- 55	0.33	0.016			1.4	0.2	0.1	0.79	0.54										5.8	

AVERAGES, DEPTH 25-100: PCT CLAY 10

DEPTH (In)	-1-- (- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2e	-2-- MG 5B5a 6O2d	-3-- NA 5B5a 6P2b	-4-- K 5B5a 6Q2b	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7-- EXTR AL 6G9c	-8-- (- - - -CEC - - -) SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- BASES + AL 5A3b	-11- AL SAT 5G1	-12- -BASE SAT- SUM 5C3	-13- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1g	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18-	-19- (- - - -PH - - -) CACL2 .01M 8C1f	-20- H2O 8C1f
	<- - - - - - - - - - - - -				-MEQ / 100 G - - -			- - - - - - - -		- ->	<- - - - -	-PCT -	- - - ->						1:2	1:1
0- 2	4.4	4.5	0.1	1.0	10.0	2.7		12.7	10.0			79	100						6.2	6.7
2- 11	3.7	3.6	0.1	1.1	8.5	1.8		10.3	9.0			83	94						6.6	7.2
11- 18	4.2	3.1	0.7	1.4	9.4	1.5		10.9	8.6			86	100						6.7	7.5
18- 40	4.6	3.0	0.1	0.6	8.3	1.9		10.2	8.7			81	95						6.8	7.4
40- 55	7.9	3.1	0.1	--	11.1	2.0		13.1	8.4			85	100						6.9	7.6

ANALYSES: S= ALL ON SIEVED <2mm BASIS N= >2mm FRACTIONS NOT DETERMINED

Appendix 7. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING SIEVE: INCHES 3	2	3/2	1	3/4	3/8	NUMBER 4	10	40	200	PSDA MICRONS 20	5	2	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN MILLIMETER 1.	.5	.25	.10	.05	DIAMETERS(mm) AT PERCENTILE 60	50	10	ATTERBERG LL (PCT)	PI (PCT)	GRADATION UNIFMTY CU	CURVTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
96P1379S	0- 2	A	100	100	100	100	100	89	77	63	46	26	15	9	6	58	49	37	29	23.	1.36	0.560	0.006			>100	1.6
96P1380N	2- 11	Bw1	100	100	100	100	100	86	71	43	33	20	11	7	5	40	35	27	21	17	3.36	2.476	0.012			>100	2.7
96P1381N	11- 18	C1	100	100	100	99	99	86	72	58	40	25	15	9	6	52	43	33	26	22	2.26	0.890	0.006			>100	2.0
96P1382N	18- 40	C2	100	98	97	94	93	78	63	45	32	19	11	7	4	41	34	26	21	17	4.08	2.536	0.013			>100	2.4
96P1383S	40- 55	C3	100	100	100	99	99	87	74	62	47	28	17	11	7	57	49	39	30	25	1.50	0.529	0.004			>100	1.4

DEPTH (In.)	WEIGHT FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL: >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	<75 mm FRACTION, PCT OF <75 mm: 75-2	75-20	20-5	5-2	<2		WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL: SOIL SURVEY 1/3 BAR	SOIL SURVEY OVEN-DRY	ENGINEERING MOIST	ENGINEERING SATURATED	<2 mm FRACTION: SOIL SURVEY 1/3 BAR	SOIL SURVEY 15 BAR	SOIL SURVEY OVEN-DRY	ENGINEERING MOIST	ENGINEERING SATURATED	VOID RATIOS AT 1/3 BAR: WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 2	38	--	2	36	--	23	14	62	37	--	23	14	63		1.74										
2- 11	63	--	13	50	--	25	24	37	57	--	29	28	43		2.02										
11- 18	50	--	14	36	1	23	12	50	42	1	27	14	58		1.87										
18- 40	64	--	20	44	6	24	14	36	55	7	30	18	45		2.03										
40- 55	51	--	21	30	1	20	9	49	38	1	25	12	62		1.89										

DEPTH (In.)	VOLUME FRACTIONS at 1/3 BAR, WHOLE SOIL (mm), PCT of WHOLE SOIL: >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	2-.05	.05-.002	LT .002	PORES D	PORES F	(C/N) RATIO	RATIOS to CLAY, <2 mm FRACTION: FINE CLAY	CEC SUM CATS	CEC NH4-OAC	15 BAR H2O	LEP 1/3 BAR	LINEAR EXTENSIBILITY <-1/3 BAR to (PCT)---> WHOLE SOIL 15 BAR	WHOLE SOIL OVEN-DRY	<2 mm 15 BAR	<2 mm OVEN-DRY	WRD (In/In) WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 2	25	--	1	24	--	15	9	75	26	12	4	34		16		1.44	1.14	0.89							
2- 11	49	--	10	39	--	19	18	51	17	9	3	24		13		0.95	0.83	0.56							
11- 18	36	--	10	26	1	16	9	64	22	10	3	29		24		1.11	0.88	0.56							
18- 40	48	--	15	33	5	18	11	52	17	8	3	23		31		1.07	0.92	0.58							
40- 55	36	--	15	21	1	14	6	64	21	11	4	29		21		1.22	0.79	0.54							

Appendix 7. Selected soil pedon descriptions with physical and chemical analyses (continued).

DEPTH (In.)	WEIGHT FRACTIONS - CLAY FREE: WHOLE SOIL >2	75 -2	20 -2	2- .05	.05- .002	LT .002	<2 mm FRACTION: SANDS VC	C	M	F	VF	SILTS C	F	CLAY	TEXTURE (DETERMINED) IN FIELD	BY PSDA	PSDA (mm): SAND 2- .05	SILT .05- .002	CLAY LT .002	PH CA-CL2 .01M	ELECTRICAL: RES-IST. OHMS	CON-DUCT. MMHOS			
	PCT of >2mm+SAND+SILT						PCT of SAND+SILT								<2 mm		PCT of 2mm				<2mm				
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 2	40	38	39	42	18	6	9	16	20	15	10	15	16	10	SL	SL	63.4	27.8	8.8	6.2					
2- 11	66	52	51	23	11	4	7	15	20	15	10	16	18	12	L	SL	59.4	29.8	10.8	6.6					
11- 18	53	38	37	33	15	5	12	17	18	13	9	14	18	11	SL	COSL	62.1	28.1	9.8	6.7					
18- 40	66	46	39	23	11	4	9	17	20	13	9	14	17	10	SL	SL	62.1	28.4	9.5	6.8					
40- 55	54	32	31	31	15	6	9	14	19	15	10	14	19	12	SL	SL	59.4	29.9	10.7	6.9					

Appendix 8. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 95NY085044 Soil Series: Cheshire

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 34 minutes 21 seconds N
Longitude: 74 degrees 9 minutes 12 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 8 percent **Aspect: 240°**
Slope Shape: Linear-convex
Elevation: 72 feet
Physiography:
Local: Ridge **Major: Glaciated upland**
Hillslope - Profile Position: Backslope **Geomorphic Component: Side slope**
Geographically Associated Soils: Wethersfield, Branford
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Coarse-loamy, mixed, semiactive, mesic Typic Dystrudepts
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderate or moderately rapid
Natural Drainage Class: Well drained
Parent material: Friable glacial till
Plant Association: Hardwoods
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 2 inches; Cambic horizon, 2 to 28 inches
Described by: J. M. Galbraith and L. A. Hernandez

A - 0 to 2 in.; dark brown (7.5YR 3/2) loam; moderate very fine granular structure; very friable; common very fine to fine roots throughout; 8 percent gravel; extremely acid; clear smooth boundary.

Bw1 - 2 to 5 in.; reddish brown (5YR 4/3) loam; strong fine granular structure; very friable; common very fine to medium roots throughout; common medium distinct brown (7.5YR 4/4) redoximorphic features; common very fine and fine pores; 6 percent gravel; very strongly acid; clear smooth boundary.

Bw2 - 5 to 10 in.; yellowish red (5YR 4/6) fine sandy loam; moderate medium subangular blocky and weak thin platy structure; friable; common very fine and fine roots throughout; common very fine and fine pores; 6 percent gravel and 1 percent cobbles; very strongly acid; clear wavy boundary.

Bw3 - 10 to 28 in.; reddish brown (2.5YR 4/4) loam; weak thick platy and moderate medium subangular blocky structure; friable; common very fine roots throughout; common very fine and fine interstitial pores; 7 percent gravel and 1 percent cobbles; very strongly acid; gradual wavy boundary.

C - 28 to 60 in.; dark reddish brown (2.5YR 3/4) gravelly sandy loam; weak thick platy structure; friable; common very fine and fine interstitial pores; 19 percent gravel and 5 percent cobbles; strongly acid.

Appendix 8. Selected soil pedon descriptions with physical and chemical analyses (continued).

S95NY-085-044; CHESHIRE LABORATORY DATA
- PEDON 96P 179, SAMPLES 96P 1428- 1432
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In) -1--	HORIZON -2-- -3--	-4-- TOTAL CLAY LT .002	-5-- TOTAL SILT .002 -.05	-6-- TOTAL SAND .05 -2	-7-- CLAY FINE LT .0002	-8-- CLAY CO3 LT .002	-9-- SILT FINE .002 -.02	-10- SILT COARSE .02 -.05	-11- SAND VF .05 -.10	-12- SAND F .10 -.25	-13- SAND M .25 -.50	-14- SAND C .5 -1	-15- SAND VC 1 -2	-16- COARSE FRACTIONS(MM) WEIGHT 2 -5	-17- COARSE FRACTIONS(MM) WEIGHT 5 -20	-18- COARSE FRACTIONS(MM) WEIGHT 20 -75	-19- COARSE FRACTIONS(MM) WEIGHT .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - - PCT OF <2MM (3A1)											- - ->	<- PCT OF <75MM(3B1)->				SOIL
96P1428S	0- 2	A	13.1	39.0	47.9			22.2	16.8	11.7	16.5	12.0	5.3	2.4	4	7	3	45	14
96P1429S	2- 5	Bw1	10.8	37.8	51.4			21.0	16.8	12.5	18.3	13.3	5.5	1.8	4	4	3	46	11
96P1430S	5- 10	Bw2	11.2	36.4	52.4			20.5	15.9	11.7	18.3	13.4	6.0	3.0	6	4	1	47	13
96P1431S	10- 28	Bw3	13.9	34.8	51.3			18.7	16.1	12.2	17.9	13.8	4.7	2.7	5	5	2	46	14
96P1432S	28- 60	C	9.7	30.4	59.9			15.6	14.8	12.5	14.4	14.9	10.6	7.5	7	12	13	64	37

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	DITH-CIT EXTRACTABLE FE 6C2b OF	DITH-CIT EXTRACTABLE AL 6G7a <2MM	DITH-CIT EXTRACTABLE MN 6D2a -->	(RATIO/CLAY) CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG - LIMITS -) LL 4F1 PCT	(ATTERBERG - LIMITS -) PI 4F <0.4MM	(- BULK DENSITY -) FIELD MOIST 4A5 <- -	(- BULK DENSITY -) 1/3 BAR 4A1d G/CC	(- BULK DENSITY -) OVEN DRY 4A1h - - ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- -	1/10 BAR 4B1c -PCT OF	1/3 BAR 4B1c <2MM	15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 2	5.50	0.412			1.4	0.3	0.1	1.48	0.91										11.9	
2- 5	0.89	0.080			1.2	0.3	0.1	0.58	0.41										4.4	
5- 10	0.50	0.052			1.2	0.2	0.1	0.48	0.38										4.2	
10- 28	0.30	1.809			1.4	0.2	0.1	0.43	0.42										5.8	
28- 60	0.06	0.028			1.4	0.2	0.1	0.60	0.52										5.0	

AVERAGES, DEPTH 25-100: PCT CLAY 12 PCT .1-75MM 53

DEPTH (In)	-1-- CA 5B5a 6N2e	-2-- MG 5B5a 6O2d	-3-- NA 5B5a 6P2b	-4-- K 5B5a 6Q2b	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7-- EXTR AL 6G9c	-8-- CEC SUM CATS 5A3a	-9-- CEC NH4-OAC 5A8b	-10- CEC BASES + AL 5A3b	-11- AL SAT 5G1	-12- BASE SAT- SUM 5C3	-13- BASE SAT- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1g	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18-	-19- PH CACL2 .01M 8C1f	-20- PH H2O 8C1f
	<- - - - - - - - - - -				-MEQ / 100 G	- - - - - - - - - -				->	<- - - -	-PCT	- - - ->						1:2	1:1
0- 2	4.9	1.6	0.1	0.1	6.7	20.1	1.3	26.8	19.4	8.0	16	25	35						3.9	4.2
2- 5	1.5	0.6	0.5	0.3	2.9	8.1	1.3	11.0	6.3	4.2	31	26	46						4.0	4.5
5- 10	3.6	0.6	0.7	--	4.9	6.5	1.5	11.4	5.4	6.4	23	43	91						4.1	4.7
10- 28	2.0	0.9	0.4	0.4	3.7	6.5	1.8	10.2	6.0	5.5	33	36	62						4.1	4.8
28- 60	5.9	1.1	0.4	--	7.4	3.5	0.3	10.9	5.8	7.7	4	68	100						4.6	5.3

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 8. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING SIEVE, INCHES 3	2	3/2	1	3/4	3/8	NUMBER 4	10	40	200	PSDA MICRONS 20	5	2	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN, MILLIMETER 1.	.5	.25	.10	.05	DIAMETERS(mm) AT PERCENTILE 60	50	10	ATTERBERG (PCT) LL	PI	GRADATION UNIFMTY CU	CURVTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
96P1428S	0- 2	A	100	99	99	98	97	94	90	86	77	50	30	19	11	84	79	69	55	45	0.14	0.072	0.002			90.2	1.7
96P1429S	2- 5	Bw1	100	99	99	98	97	95	93	89	80	50	28	17	10	87	83	71	54	43	0.14	0.076	0.002			65.4	1.7
96P1430S	5- 10	Bw2	100	100	100	99	99	97	95	90	79	49	29	17	10	87	82	70	53	43	0.14	0.080	0.002			73.6	1.7
96P1431S	10- 28	Bw3	100	99	99	98	98	96	93	88	78	49	29	19	12	86	81	69	54	43	0.15	0.079	0.001			>100	2.5
96P1432S	28- 60	C	100	96	94	90	87	81	75	68	53	32	17	11	7	63	56	46	36	27	0.76	0.339	0.004			>100	1.2

DEPTH (In.)	WEIGHT FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	<75 mm FRACTION, PCT OF <75 mm 75-2	75-20	20-5	5-2	<2		WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL, SOIL SURVEY 1/3 BAR	OVEN-DRY	ENGINEERING MOIST	SATURATED	<2 mm FRACTION, SOIL SURVEY 1/3 BAR	15 BAR	OVEN-DRY	ENGINEERING MOIST	SATURATED	VOID RATIOS AT 1/3 BAR WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 2	14	--	--	14	3	7	4	86	14	3	7	4	86		1.55										
2- 5	11	--	--	11	3	4	4	89	11	3	4	4	89		1.53										
5- 10	12	--	2	10	1	4	5	88	10	1	4	5	90		1.53										
10- 28	14	--	2	12	2	5	5	86	12	2	5	5	88		1.54										
28- 60	37	--	8	29	12	11	6	63	32	13	12	7	68		1.74										

DEPTH (In.)	VOLUME FRACTIONS, WHOLE SOIL (mm) at 1/3 BAR, PCT of WHOLE SOIL >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	2-.05	.05-.002	LT .002	PORES D	PORES F	(C/) (/N) RAT-IO	RATIOS to CLAY, <2 mm FRACTION FINE CLAY	CEC SUM CATS	CEC NH4-OAC	15 BAR H2O	LINEAR EXTENSIBILITY LEP 1/3 BAR	WHOLE SOIL <-1/3 BAR to (PCT) 15 BAR	OVEN-DRY	<2 mm 15 BAR	OVEN-DRY	WRD <--In/In-> WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 2	8	--	--	8	2	4	2	92	24	20	7	41		13		2.05	1.48	0.91							
2- 5	6	--	--	6	2	2	2	94	27	20	6	42		11		1.02	0.58	0.41							
5- 10	7	--	1	6	1	2	3	93	27	19	6	42		10		1.02	0.48	0.38							
10- 28	8	--	1	7	1	3	3	92	26	18	7	42				0.73	0.43	0.42							
28- 60	25	--	5	19	8	7	4	75	25	13	4	34		2		1.12	0.60	0.52							

Appendix 8. Selected soil pedon descriptions with physical and chemical analyses (continued).

DEPTH (In.)	(W E I G H T						F R A C T I O N S - C L A Y F R E E)								(-TEXTURE--)		(--P S D A(mm)---)			(PH)	(-ELECTRICAL)				
	(--W H O L E S O I L--)						(--<2 mm F R A C T I O N ----)								(DETERMINED)										
	>2	75 -2	20 -2	2- .05	.05- .002	LT .002	SANDS VC	C	M	F	VF	SILTS C	F	CLAY	IN FIELD	BY PSDA	SAND 2- .05	SILT .05- .002	CLAY LT .002	CA- CL2 .01M	RES- IST. OHMS	CON- DUCT. MMHOS			
	PCT of >2mm+SAND+SILT						PCT of SAND+SILT								<2 mm		PCT of 2mm			<2mm					
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 2	16	16	12	46	38	13	3	6	14	19	13	19	26	15		L	47.9	39.0	13.1	3.9					
2- 5	12	12	9	51	37	11	2	6	15	21	14	19	24	12		L	51.4	37.8	10.8	4.0					
5- 10	13	11	10	51	36	11	3	7	15	21	13	18	23	13	L	FSL	52.4	36.4	11.2	4.1					
10- 28	16	14	11	50	34	14	3	5	16	21	14	19	22	16	L	L	51.3	34.8	13.9	4.1					
28- 60	39	31	18	40	20	7	8	12	17	16	14	16	17	11	FSL	SL	59.9	30.4	9.7	4.6					

Appendix 9. Selected soil pedon descriptions.

Soil Survey Site Identification #: S99NY047005 Soil Series: Fishkill

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 35 minutes 48.73 seconds N
Longitude: 73 degrees 53 minutes 51.26 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 2 percent **Aspect: 220°**
Slope Shape: Convex-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Slope**
Geographically Associated Soils: These deposits do not have any correlation to existing soils and may occur anywhere.
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 0 to 10 inches **Water Table Kind: Apparent** **Duration: Nov. through May**
Flooding Information
Frequency: None
Ponding Information
Frequency: Rare
Duration: Very brief

Official Series Classification: Coarse-loamy, mixed, active, nonacid, mesic Typic Endoaquents
Moisture Regime: Aquic moisture regime
Landuse: Park land
Permeability: Moderate
Natural Drainage Class: Poorly drained
Parent material: Incinerator fly ash
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon-the zone from 0 to 3 inches; Rock fragments in the particle-size control section average less than 35 percent by volume; Aquic conditions - within 10 inches.
Described by: L. A. Hernandez and K. Alamarie

A - 0 to 3 inches; very dark gray (10YR 3/1) sandy loam; weak very fine granular structure; very friable; many very fine and fine roots throughout; 5 percent gravel-sized coarse fragments (2 percent brick, 1 percent metal, 1 percent glass, and 1 percent rock fragments); neutral; clear smooth boundary.

C1 - 3 to 13 inches; brown (10YR 5/3) coarse sandy loam; massive; very friable; few very fine roots throughout; few fine distinct yellowish brown (10YR 5/8) redoximorphic features; 10 percent gravel-sized coarse fragments (4 percent brick, 2 percent metal, 2 percent glass, and 2 percent rock fragments); neutral; clear wavy boundary.

C2 - 13 to 19 inches; gray (10YR 6/1) coarse sandy loam; massive; very friable; few coarse prominent yellowish brown (10YR 5/8) redoximorphic features; 10 percent gravel sized coarse fragments (4 percent brick, 1 percent metal, 1 percent glass, 2 percent carboliths, and 2 percent rock fragments); neutral; clear wavy boundary.

C3 - 19 to 25 inches; gray (10YR 5/1) coarse sandy loam; massive; very friable; few fine distinct yellowish brown (10YR 5/8) redoximorphic features; 10 percent gravel-sized coarse fragments (4 percent brick, 1 percent metal, 1 percent glass, 2 percent carboliths, and 2 percent rock fragments); neutral; clear wavy boundary.

C4 - 25 to 37 inches; grayish brown (10YR 5/2) coarse sandy loam; massive; very friable; few fine distinct yellowish brown (10YR 5/8) redoximorphic features; 10 percent gravel-sized coarse fragments (5 percent brick, 1 percent metal, 1 percent glass, 2 percent carboliths, and 1 percent rock fragments); neutral.

C5 - 37 to 65 inches; pale brown (10YR 6/3) coarse sandy loam; massive; very friable; common coarse prominent yellowish brown (10YR 5/8) redoximorphic features; 10 percent gravel-sized coarse fragments (5 percent brick, 1 percent metal, 1 percent glass, 2 percent carboliths and 1 percent rock fragments); neutral.

Appendix 10. Selected soil pedon descriptions.

Soil Survey Site Identification #: S99NY047005 Soil Series: Flatland

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 35 minutes 59.34 seconds N
Longitude: 73 degrees 54 minutes 3.38 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 220°**
Slope Shape: Convex-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Slope**
Geographically Associated Soils: These deposits do not have any correlation to existing soils and may occur anywhere.
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 10 to 24 inches **Water Table Kind: Apparent** **Duration: Nov. through May**
Flooding Information
Frequency: None
Ponding Information
Frequency: Rare
Duration: Very brief

Official Series Classification: Coarse-loamy, mixed, active, nonacid, mesic Typic Endoaquents
Moisture Regime: Aquic moisture regime
Landuse: Park land
Permeability: Moderate
Natural Drainage Class: Somewhat poorly drained
Parent material: Incinerator fly ash
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon-the zone from 0 to 3 inches; Rock fragments in the particle size control section average less than 35 percent by volume; Aquic conditions - between 10 to 24 inches.
Described by: L. A. Hernandez and K. Alamarie

A - 0 to 6 inches; brown (10YR 4/3) sandy loam; weak very fine granular structure; very friable; many very fine and fine roots throughout; 5 percent gravel-sized coarse fragments (2 percent brick, 1 percent metal, 1 percent glass, and 1 percent rock fragments); neutral; clear smooth boundary .

C1 - 6 to 16 inches; yellowish brown (10YR 5/4) coarse sandy loam; massive; very friable; many very fine and fine roots throughout; few coarse prominent reddish yellow (7.5 YR 6/6) redoximorphic features; 10 percent gravel-sized coarse fragments (4 percent brick, 2 percent metal, 2 percent glass, and 2 percent rock fragments); neutral; clear wavy boundary.

C2 - 16 to 30 inches; yellowish brown (10YR 5/4) sandy loam; massive; very friable; common fine distinct dark yellowish brown (10YR 4/6) and few fine faint grayish brown (10YR 5/2) redoximorphic features; 10 percent gravel-sized coarse fragments (4 percent brick, 1 percent metal, 1 percent glass, 2 percent carboliths, and 2 percent rock fragments); neutral; clear wavy boundary.

C3 - 30 to 37 inches; yellowish brown (10YR 5/4) coarse sandy loam; massive; very friable; many fine distinct dark yellowish brown (10YR 4/6) and common fine distinct grayish brown (10YR 5/2) redoximorphic features; 10 percent gravel-sized coarse fragments (4 percent brick, 1 percent metal, 1 percent glass, 2 percent carboliths, and 2 percent rock fragments); neutral; clear wavy boundary.

C4 - 37 to 65 inches; light brownish gray (10YR 6/2) gravelly coarse sandy loam; massive; very friable; few fine distinct dark yellowish brown (10YR 4/6) redoximorphic features; 15 percent gravel-sized coarse fragments (5 percent brick, 2 percent metal, 5 percent glass, 2 percent carboliths, and 1 percent rock fragments); neutral.

Appendix 11. Selected soil pedon descriptions.

Soil Survey Site Identification #: S95NY085-045 Soil Series: Foresthills

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 34 minutes 28.85 seconds N
Longitude: 74 degrees 9 minutes 42.93 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 5 percent **Aspect: 210°**
Slope Shape: Convex-linear
Elevation: 50 feet
Physiography:
Local: Fill **Major: Glaciated upland**
Hillslope - Profile Position: Shoulder **Geomorphic Component: Slope**
Geographically Associated Soils: Greenbelt, Canarsie, Centralpark, Greatkills
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information **Ponding Information**
Frequency: None **Frequency: None**

Official Series Classification: Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderately slow in the compacted surface and moderate below
Natural Drainage Class: Well drained
Parent material: Thin mantle less than 40 inches thick of anthropotransported material
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 7 inches (A and Bw horizon); buried soil occurs starting 15 inches (the Ab horizon).
Described by: J. M. Galbraith and L. A. Hernandez
Note: Lithochromic mottles have formed as a result of rock weathering.

A - 0 to 2 inches; very dark grayish brown (10YR 3/2) loam; weak coarse subangular blocky structure; very friable; common very fine and fine plus many medium and coarse roots; many medium and coarse pores; 5 percent gravel, 1 percent cobbles and 1 percent stones; moderately acid; clear smooth boundary.

Bw - 2 to 15 inches; variegated 60 percent brown (7.5YR 4/4) silt loam, 25 percent yellowish red (5YR 4/6) loam, and 15 percent black (10YR 2/1) loam; weak coarse subangular blocky structure; very friable; common very fine and fine plus few medium and coarse roots; common medium distinct yellowish red (5YR 5/6) and light brownish gray (10YR 6/2) lithochromic mottles; few very fine pores; 5 percent gravel and 1 percent cobbles; strongly acid; abrupt smooth boundary.

Ab - 15 to 17 inches; black (10YR 2/1) loam; weak medium subangular blocky structure; very friable; many very fine and fine plus few medium and coarse roots; few very fine pores; 1 percent gravel and 1 percent cobbles; moderately acid; abrupt smooth boundary.

BAb - 17 to 28 inches; brown (7.5YR 4/3) loam; weak medium subangular blocky structure; very friable; common very fine and fine roots; few very fine and fine pores; 5 percent gravel and 1 percent cobbles; strongly acid; clear smooth boundary.

Bwb - 28 to 42 inches; reddish brown (5YR 4/4) loam; weak medium subangular blocky structure; friable; common very fine plus few fine roots; few very fine and fine pores; 5 percent gravel and 1 percent cobbles; strongly acid; clear wavy boundary.

Appendix 12. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 99NY047003 Soil Series: Fortress

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 36 minutes 15.3 seconds N
Longitude: 73 degrees 53 minutes 8.7 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 5°**
Slope Shape: Linear-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Side slope**
Geographically Associated Soils: Barren, Bigapple, Jamaica
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 24 to 48 inches **Water Table Kind: Apparent** **Duration: Nov. through May**
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Mixed, mesic Aquic Udipsamments
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Rapid
Natural Drainage Class: Moderately well drained
Parent material: Sandy dredge materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 8 inches; Particle size class - sandy, average less than 35 percent (by volume) coarse fragments
Described by: L. A. Hernandez and R. B. Tunstead

A - 0 to 8 in.; grayish brown (2.5Y 5/2) sand; weak very fine granular structure; very friable; common very fine and fine roots throughout; strongly acid; abrupt wavy boundary.

Bw - 8 to 12 in.; light olive brown (2.5Y 5/6) stratified sand; weak very fine subangular blocky structure; very friable; few fine roots throughout; few fine faint brownish yellow (10YR 6/8) redoximorphic features; neutral; clear wavy boundary.

C1 - 12 to 33 in.; light gray (2.5Y 7/2) stratified sand; massive; very friable; many fine distinct brownish yellow (10YR 6/8) redoximorphic features; neutral; clear wavy boundary.

C2 - 33 to 48 in.; light gray (2.5Y 7/2) stratified sand; massive; very friable; common fine distinct brownish yellow (10YR 6/8) redoximorphic features; neutral; clear wavy boundary.

C3 - 48 to 65 in.; olive gray (5Y 5/2) stratified sand; massive; very friable; common medium distinct gray (5Y 6/1) and brownish yellow (10YR 6/8) redoximorphic features; slightly acid.

Appendix 12. Selected soil pedon descriptions with physical and chemical analyses (continued).

S99NY-047-003; FORTRESS LABORATORY DATA
- PEDON 99P 563, SAMPLES 99P 3513- 3517
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In)	HORIZON	-4-- (- - -TOTAL - - -) CLAY LT .002	-5-- SILT .002 -.05	-6-- SAND .05 -2	-7-- (- -CLAY- -) FINE LT .0002	-8-- CO3 LT .002	-9-- (- -SILT- -) FINE .002 -.02	-10- COARSE .02 -.05	-11- (- - - - - -SAND- - - - - -) VF .05 -.10	-12- F .10 -.25	-13- M .25 -.50	-14- C .5 -1	-15- VC 1 -2	-16- (-COARSE FRACTIONS(MM)-) - - - - WEIGHT - - - - 2 -5	-17- 5 -20	-18- 20 -75	-19- .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
99P3513S	0- 8	A	1.3	3.2	95.5			1.3	1.9	2.9	22.4	45.3	20.7	4.2	1	1	1	93	3
99P3514S	8- 12	Bw	0.6	1.2	98.2			0.2	1.0	1.2	23.4	54.8	16.4	2.4	TR	TR	TR	97	TR
99P3515S	12- 33	C1	0.5	2.9	96.6			0.7	2.2	0.5	25.5	54.9	14.7	1.0	--	--	--	96	--
99P3516S	33- 48	C2	0.3	1.4	98.3			0.8	0.6	3.2	39.5	46.5	8.6	0.5	TR	TR	--	95	--
99P3517S	48- 65	Cg	1.7	4.0	94.3			1.7	2.3	3.5	32.4	47.0	10.7	0.7	TR	--	--	91	--

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h OF	AL 6G7g <2MM -->	MN 6D2g	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1 PCT <0.4MM	PI 4F	(- BULK DENSITY -) FIELD MOIST 4A5 <- - G/CC	1/3 BAR 4A1d	OVEN DRY 4A1h - - ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT - -) FIELD MOIST 4B4 <- - -PCT OF <2MM - ->	1/10 BAR 4B1c	1/3 BAR 4B1c	15 BAR 4B2a	WRD WHOLE SOIL 4C1 CM/CM
0- 8									1.00										1.3	
8- 12													1.31	1.62	0.073		10.0	8.8	0.8	0.10
12- 33																			0.7	
33- 48													1.46	2.12	0.132		8.2	7.6	0.7	0.10
48- 65									0.82				1.59	2.13	0.102		11.5	11.0	1.4	0.15

DEPTH (In)	-1-- (- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	-2-- MG 5B5a 6O2h	-3-- NA 5B5a 6P2f	-4-- K 5B5a 6Q2f	-5-- SUM BASES	-6-- ACID- ITY 6H5a	-7-- EXTR AL 6G9c	-8-- (- - - -CEC - - -) SUM CATS 5A3a	-9-- NH4- OAC 5A8b	-10- BASES + AL 5A3b	-11- AL SAT 5G1	-12- -BASE SAT- SUM 5C3	-13- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1h	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18- (- - - -PH - - -)	-19- CACL2 .01M 8C1f	-20- H2O 8C1f
	<- - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - - ->										<- - - - -PCT - - - ->								1:2	1:1
0- 8						2.0	--	2.0											4.9	5.4
8- 12						0.8		0.8											6.1	6.6
12- 33						--													6.2	6.8
33- 48						--													5.9	6.7
48- 65						0.7		0.7											5.8	6.5

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 12. Selected soil pedon descriptions with physical and chemical analyses (contined).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING SIEVE, INCHES 3 (1)	2 (2)	3/2 (3)	1 (4)	3/4 (5)	3/8 (6)	NUMBER 4 (7)	10 (8)	40 (9)	200 (10)	PSDA SIEVE MICRONS 20 (11)	5 (12)	2 (13)	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN, MILLIMETER 1. (14)	.5 (15)	.25 (16)	.10 (17)	.05 (18)	DIAMETERS(mm) AT PERCENTILE 60 (19)	50 (20)	10 (21)	ATTERBERG PCT LL (22)	PI (23)	GRADATION UNIFMTY CU (24)	CURVTUR CC (25)
99P3513S	0- 8	A	100	100	100	99	99	99	98	97	62	6	3	2	1	93	73	29	7	4	0.41	0.349	0.113			3.6	1.4
99P3514S	8- 12	Bw	100	100	100	100	100	100	100	100	67	2	1	1	1	98	81	26	3	2	0.38	0.337	0.132			2.9	1.4
99P3515S	12- 33	C1	100	100	100	100	100	100	100	100	70	4	1	1	1	99	84	29	4	3	0.37	0.324	0.125			3.0	1.4
99P3516S	33- 48	C2	100	100	100	100	100	100	100	100	79	4	1	1	TR	100	91	44	5	2	0.32	0.272	0.113			2.8	0.9
99P3517S	48- 65	Cg	100	100	100	100	100	100	100	100	77	8	3	2	2	99	89	42	9	6	0.33	0.283	0.102			3.2	1.0

DEPTH (In.)	WEIGHT FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL >2 (26)	250-UP (27)	250-75 (28)	75-2 (29)	75-20 (30)	20-5 (31)	5-2 (32)	<2 (33)	<75 mm FRACTION, PCT OF <75 mm 75-2 (34)	75-20 (35)	20-5 (36)	5-2 (37)	<2 (38)	(39)	WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL, SOIL SURVEY 1/3 BAR (40)	OVEN-DRY (41)	ENGINEERING MOIST (42)	SATURATED (43)	<2 mm FRACTION, SOIL SURVEY 1/3 BAR (44)	15 BAR (45)	OVEN-DRY (46)	ENGINEERING MOIST (47)	SATURATED (48)	VOID RATIOS AT 1/3 BAR WHOLE SOIL (49)	<2 mm (50)
0- 8	3	--	--	3	1	1	1	97	3	1	1	1	97		1.47										
8- 12	TR	--	--	--	TR	TR	TR	100	--	TR	TR	TR	100		1.32	1.63	1.44	1.82	1.31	1.60	1.62	1.43	1.82	1.01	1.02
12- 33	--	--	--	--	--	--	--	100	--	--	--	--	100		1.45										
33- 48	--	--	--	--	--	--	--	100	--	--	--	--	100		1.46	2.12	1.58	1.91	1.46	2.07	2.12	1.57	1.91	0.82	0.82
48- 65	--	--	--	--	--	--	--	100	--	--	--	--	100		1.59	2.13	1.76	1.99	1.59	2.07	2.13	1.76	1.99	0.67	0.67

DEPTH (In.)	VOLUME FRACTIONS, WHOLE SOIL (mm) at 1/3 BAR, PCT of WHOLE SOIL >2 (51)	250-UP (52)	250-75 (53)	75-2 (54)	75-20 (55)	20-5 (56)	5-2 (57)	<2 (58)	2-.05 (59)	.05-.002 (60)	LT .002 (61)	PORES D (62)	PORES F (63)	(C/N) RATIO (64)	RATIOS to CLAY, <2 mm FRACTION, FINE CLAY (65)	CEC SUM CATS (66)	CEC NH4-OAC (67)	15 BAR H2O (68)	LEP 1/3 BAR (69)	LINEAR EXTENSIBILITY <-1/3 BAR to (PCT), WHOLE SOIL 15 BAR (70)	WHOLE SOIL OVEN-DRY (71)	<2 mm 15 BAR (72)	<2 mm OVEN-DRY (73)	WRD In/In WHOLE SOIL (74)	WRD <2 mm (75)
0- 8	2	--	--	2	1	1	1	98	52	2	1	45				1.54		1.00							
8- 12	TR	--	--	--	TR	TR	TR	100	49	1		38	12			1.33		1.33	12.167	6.6	7.3	6.9	7.3	0.11	0.10
12- 33	--	--	--	--	--	--	--	100	53	2		45						1.40							
33- 48	--	--	--	--	--	--	--	100	54	1		33	12					2.33	44.000	11.8	13.2	12.3	13.2	0.10	0.10
48- 65	--	--	--	--	--	--	--	100	56	2	1	23	17			0.41		0.82	6.000	9.2	10.2	9.2	10.2	0.15	0.15

DEPTH (In.)	WEIGHT FRACTIONS - CLAY FREE, WHOLE SOIL, PCT of >2mm+SAND+SILT >2 (76)	75-2 (77)	20-2 (78)	2-.05 (79)	.05-.002 (80)	LT .002 (81)	<2 mm FRACTION, PCT of SAND+SILT, SANDS VC (82)	C (83)	M (84)	F (85)	VF (86)	SILTS C (87)	SILTS F (88)	CLAY (89)	TEXTURE (DETERMINED) IN FIELD (90)	BY PSDA (91)	PSDA (mm), PCT of 2mm, SAND 2-.05 (92)	SILT .05-.002 (93)	CLAY LT .002 (94)	PH CaCl2 .01M (95)	ELECTRICAL, <2mm, RESIST. OHMS (96)	CONDUCT. MMHOS (97)	(98)	(99)	(100)
0- 8	3	3	2	94	3	1	4	21	46	23	3	2	1	1		S	95.5	3.2	1.3	4.9					
8- 12				99	1	1	2	16	55	24	1	1	TR	1		S	98.2	1.2	0.6	6.1					
12- 33				97	3	1	1	15	55	26	1	2	1	1		S	96.6	2.9	0.5	6.2					
33- 48				99	1	TR	1	9	47	40	3	1	1	TR		S	98.3	1.4	0.3	5.9					
48- 65				96	4	2	1	11	48	33	4	2	2	2		S	94.3	4.0	1.7	5.8					

Appendix 13. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 97NY081008 Soil Series: Gravesend

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Jamaica
Latitude: 40 degrees 38 minutes 52.1 seconds N
Longitude: 73 degrees 50 minutes 49 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 3 percent **Aspect: 330°**
Slope Shape: Convex-linear
Elevation: 8 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: Shoulder **Geomorphic Component: Side slope**
Geographically Associated Soils: Oldmill, Greatkills, Breeze, Bigapple
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Sandy-skeletal, mixed, hyperthermic Typic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Rapid
Natural Drainage Class: Well drained
Parent material: Household garbage, construction debris and other discarded materials layered with anthropotransported natural soil material

Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 2 inches; Non-cambic pedogenic horizon, 2 to 8 inches
Described by: J. M. Galbraith, L. A. Hernandez, and R. B. Tunstead

Notes: Manufactured objects (artifacts) that act like rock fragments account for more than 65 percent of the total coarse fragment content in the particle size control section. Anthropotransported soil constitutes about one third of the volume of the soil/garbage mixture. Lab data is not available on the garbage subsoil because of possible hazardous material content; according to the NYC Department of Environmental Conservation, Division of Hazardous Waste Remediation. Many landfill areas were unregulated at the time of filling and may contain chemicals that are toxic to plant roots. In addition, some areas develop anaerobic conditions in the subsoil due to methane gas emissions. Some pedons contain pockets of air where organic garbage has decomposed, and are subject to collapses under heavy equipment or weight. Soil temperature data is available for this site complements of NSSC Lincoln, NE. The internal soil temperature has been modified by high levels of biological activity from rapid decomposition of garbage. The classification as hyperthermic is debatable, but is supported by field measurements. The area would typically be mesic.

A - 0 to 2 in.; very dark gray (10YR 3/1) coarse sand; weak fine and medium subangular blocky structure; very friable, non-sticky and non-plastic; common medium and coarse plus many fine roots throughout; 5 percent gravel; strongly acid; clear smooth boundary.

Bw - 2 to 8 in.; light yellowish brown (2.5Y 6/4) coarse sand; single grain; loose, non-sticky and non-plastic; common fine and medium roots throughout; 5 percent gravel; moderately acid; clear wavy boundary.

C1 - 8 to 20 in.; grayish brown (2.5Y 5/2) coarse sand; single grain; loose, non-sticky and non-plastic; common fine roots throughout; many coarse faint olive brown (2.5Y 4/3) and common coarse prominent yellowish brown (10YR 5/8) redoximorphic features; 3 percent gravel; very strongly acid; abrupt wavy boundary.

2C2 - 20 to 79 in.; very dark grayish brown (2.5Y 3/2) extremely cobbly coarse sand; single grain; loose, slightly sticky and slightly plastic; many coarse prominent yellowish red (5YR 5/6) redoximorphic features; 15 percent cobble-sized biodegradable artifacts such as cardboard, and paper, and 40 percent cobble-sized non-biodegradable artifacts including metal, concrete, glass, and rubber; 15 percent gravel-sized rock fragments; neutral.

Appendix 13. Selected soil pedon descriptions with physical and chemical analyses (continued).

S97NY-081-008; GRAVESEND LABORATORY DATA
- PEDON 98P 67, SAMPLES 98P 477- 479
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	-1-- DEPTH (In)	-2-- HORIZON	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- - -TOTAL	- - -)		(- -CLAY- -)		(- -SILT- -)		(- - - -	- -SAND- -		- - - -)		(-COARSE FRACTIONS(MM)-)				(>2MM)
				CLAY LT .002	SILT .002 -.05	SAND .05 -2	FINE LT .0002	CO3 LT .002	FINE .002 -.02	COARSE .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	- - - - WEIGHT 2 -5	5 -20	20 -75	- - - - .1- 75	WT PCT OF WHOLE SOIL
				<- - - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
98P 477S	0- 2	A1		2.9	7.5	89.6			3.9	3.6	3.0	18.5	40.8	21.5	5.8	3	2	--	87	5
98P 478S	2- 8	A2		2.5	6.6	90.9			3.7	2.9	3.6	22.3	39.8	20.1	5.1	3	2	TR	88	5
98P 479S	8- 20	C1		1.7	4.4	93.9			2.8	1.6	2.3	17.3	41.0	25.0	8.3	3	2	--	92	5

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	(- - DITH-CIT EXTRACTABLE FE 6C2b	AL 6G7a OF	- -) MN 6D2a <2MM -->	(RATIO/CLAY) CEC 8D1	15 BAR 8D1	(ATTERBERG - LIMITS - LL 4F1 PCT <0.4MM	) PI 4F	(- BULK DENSITY FIELD MOIST 4A5 <- - G/CC	1/3 BAR 4A1d	-) OVEN DRY 4A1h - - ->	COLE WHOLE SOIL 4D1 CM/CM	(- - -WATER CONTENT FIELD MOIST 4B4 <- - -PCT OF <2MM	1/10 BAR 4B1c	1/3 BAR 4B1c	- -) 15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 2	3.68							4.59	3.86										11.2	
2- 8	1.20							1.76	1.08										2.7	
8- 20	0.78							1.12	1.12										1.9	

DEPTH (In)	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
	(- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2e	MG 5B5a 6O2d	NA 5B5a 6P2b	K 5B5a 6Q2b	SUM BASES	ACID- ITY 6H5a	EXTR AL 6G9c	(- - - -CEC SUM CATS 5A3a	NH4- OAC 5A8b	- - -) BASES + AL 5A3b	AL SAT 5G1	-BASE SAT- SUM 5C3	NH4 OAC 5C1	CO3 AS CACO3 <2MM 6E1g	RES. OHMS /CM 8E1		COND. MMHOS /CM 8I		(- - - -PH CACL2 .01M 8C1f 1:2	- - -) H2O 8C1f 1:1
	<- - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - - ->										<- - - - -PCT - - - ->									
0- 2	4.1	2.3	--	TR	6.4	7.3	--	13.7	13.3			47	48						5.0	5.4
2- 8	2.6	1.7	0.1	1.1	5.5	2.4		7.9	4.4			70	100						5.4	5.9
8- 20	1.5	0.4	--	0.1	2.0	1.5	0.1	3.5	1.9	2.1	5	57	100						4.6	4.8

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 13. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING, INCHES 3 (1)	2 (2)	3/2 (3)	1 (4)	3/4 (5)	3/8 (6)	NUMBER 4 (7)	10 (8)	40 (9)	200 (10)	PSDA SIEVE, MICRONS 20 (11)	5 (12)	2 (13)	CUMULATIVE CURVE FRACTIONS (<75mm) USDA LESS THAN, MILLIMETER 1. (14)	.5 (15)	.25 (16)	.10 (17)	.05 (18)	DIAMETERS (mm) AT PERCENTILE 60 (19)	50 (20)	10 (21)	ATTERBERG PCT LL (22)	PI (23)	GRADATION UNIFMTY CU (24)	CURVTUR CC (25)
98P 477S	0- 2	A1	100	100	100	100	100	99	98	95	59	11	6	4	3	89	69	30	13	10	0.43	0.356	0.051			8.3	2.8
98P 478S	2- 8	A2	100	100	100	100	100	99	98	95	62	11	6	4	2	90	71	33	12	9	0.41	0.340	0.066			6.2	1.8
98P 479S	8- 20	C1	100	100	100	100	100	99	98	95	54	7	4	3	2	87	63	24	8	6	0.47	0.394	0.112			4.2	1.4

DEPTH (In.)	WEIGHT FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL >2 (26)	250-UP (27)	250-75 (28)	75-2 (29)	75-20 (30)	20-5 (31)	5-2 (32)	<2 (33)	<75 mm FRACTION, PCT OF <75 mm 75-2 (34)	75-20 (35)	20-5 (36)	5-2 (37)	<2 (38)	(39)	WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL, SOIL SURVEY 1/3 BAR (40)	OVEN-DRY (41)	ENGINEERING MOIST (42)	SATURATED (43)	<2 mm FRACTION, SOIL SURVEY 1/3 BAR (44)	15 BAR (45)	OVEN-DRY (46)	ENGINEERING MOIST (47)	SATURATED (48)	VOID RATIOS AT 1/3 BAR, WHOLE SOIL (49)	<2 mm (50)
0- 2	5	--	--	5	--	2	3	95	5	--	2	3	95		1.48										
2- 8	5	--	--	5	TR	2	3	95	5	TR	2	3	95		1.49										
8- 20	5	--	--	5	--	2	3	95	5	--	2	3	95		1.48										

DEPTH (In.)	VOLUME FRACTIONS at 1/3 BAR, WHOLE SOIL (mm), PCT of WHOLE SOIL >2 (51)	250-UP (52)	250-75 (53)	75-2 (54)	75-20 (55)	20-5 (56)	5-2 (57)	<2 (58)	2-.05 (59)	.05-.002 (60)	LT .002 (61)	PORES D (62)	PORES F (63)	(C/N) RATIO (64)	RATIOS to CLAY, <2 mm FRACTION, FINE CLAY (65)	CEC SUM CATS (66)	CEC NH4-OAC (67)	15 BAR H2O (68)	LINEAR EXTENSIBILITY, WHOLE SOIL LEP 1/3 BAR (69)	<2 mm 15 BAR (70)	<1/3 BAR to (PCT) OVEN-DRY (71)	15 BAR (72)	OVEN-DRY (73)	WRD, In/In, WHOLE SOIL (74)	<2 mm (75)
0- 2	3	--	--	3	--	1	2	97	48	4	2	44				4.72	4.59	3.86							
2- 8	3	--	--	3	TR	1	2	97	48	4	1	44				3.16	1.76	1.08							
8- 20	3	--	--	3	--	1	2	97	50	2	1	44				2.06	1.12	1.12							

DEPTH (In.)	WEIGHT FRACTIONS - CLAY FREE, WHOLE SOIL, PCT of >2mm+SAND+SILT >2 (76)	75-2 (77)	20-2 (78)	2-.05 (79)	.05-.002 (80)	LT .002 (81)	<2 mm FRACTION, PCT of SAND+SILT, SANDS VC (82)	C (83)	M (84)	F (85)	VF (86)	SILTS C (87)	SILTS F (88)	CLAY (89)	TEXTURE (DETERMINED) IN FIELD (90)	BY PSDA (91)	PSDA (mm), PCT of 2mm, SAND 2-.05 (92)	SILT .05-.002 (93)	CLAY LT .002 (94)	PH CACL2 .01M (95)	ELECTRICAL, <2mm, RESIST. OHMS (96)	CONDUCT. MMHOS (97)	(98)	(99)	(100)
0- 2	5	5	5	88	7	3	6	22	42	19	3	4	4	3		COS	89.6	7.5	2.9	5.0					
2- 8	5	5	5	88	6	2	5	21	41	23	4	3	4	3		COS	90.9	6.6	2.5	5.4					
8- 20	5	5	5	91	4	2	8	25	42	18	2	2	3	2		COS	93.9	4.4	1.7	4.6					

Appendix 14. Selected soil pedon descriptions with chemical and physical analyses.

Soil Survey Site Identification #: 95NY085006 Soil Series: Greatkills

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 34 minutes 15 seconds N
Longitude: 74 degrees 10 minutes 2 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information

Slope: 2 percent **Aspect: 270°**
Slope Shape: Convex-linear

Elevation: 20 feet

Physiography:

Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Side slope**

Geographically Associated Soils: Freshkills, Gravesend, Oldmill, Greenbelt, Centralpark
Climate Information

Precipitation: 40 to 50 inches per year

Water Table Information

Water Table Depth: Below 80 inches

Flooding Information **Ponding Information**
Frequency: None **Frequency: None**

Official Series Classification: Loamy-skeletal, mixed, superactive, nonacid, hyperthermic Typic Udorthents
Moisture Regime: Udic moisture regimeLanduse: Park land
Permeability: Moderate to moderately slow
Natural Drainage Class: Well drained
Parent material: Household garbage, construction debris and other discarded materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 7 inches
Described by: J. M. Galbraith and L. A. Hernandez

Notes: Lab data is not available on the garbage subsoil because of possible hazardous material content. Manufactured objects (artifacts) that act like rock fragments account for more than 80 percent of the total coarse fragment content in the particle-size control section. Anthropotransported soil constitutes about one-third of the volume of the soil/garbage mixture; the anthropotransported soil materials are nearly always from Dystrudepts, however, the nature of the garbage (concrete, gypsum) may weather into a soil that has properties of Typic or Dystric Eutrudepts. Ground Penetrating Radar (GPR) and Electromagnetic Induction (EM38 and EM31) data are available. Many landfill areas were unregulated at the time of filling and may contain chemicals that are toxic to plant roots. In addition, some areas develop anaerobic conditions in the subsoil due to methane gas emissions. Field observations suggest that many pedons contain pockets of air where organic garbage has decomposed, and are subject to collapse under heavy equipment. Soil temperature data are available for this site complements of NSSC Lincoln, NE.

A - 0 to 2 in.; dark brown (7.5YR 3/2) sandy loam; weak medium granular structure; very friable; many very fine and fine plus common medium and coarse roots throughout; common coarse 3/4 inch thick, hollow Phragmites rhizomes; 10 percent gravel-sized rock fragments; slightly acid; abrupt smooth boundary.

Bw - 2 to 7 in.; dark reddish brown (5YR 3/4) gravelly sandy loam; weak medium subangular blocky and platy structure; friable; common fine roots throughout; common coarse rhizomes; 20 percent gravel-sized rock fragments; neutral; clear wavy boundary.

C - 7 to 12 in.; dark reddish brown (5YR 3/4) gravelly sandy loam; weak medium platy structure; firm; few very fine roots throughout; common coarse rhizomes; 20 percent gravel-sized rock fragments; 5 percent gravel -sized glass fragments; moderately alkaline; clear wavy boundary.

2C - 12 to 80 in.; brown (7.5YR 4/4) extremely cobbly sandy loam; massive; friable; few medium and coarse roots throughout; few coarse rhizomes to a depth of 152 cm; 15 percent cobble-sized biodegradable artifacts such as wood, cardboard, and paper, 40 percent cobble-sized non-biodegradable artifacts such as bricks, concrete, metal, plastic bags, glass bottles, plastic toys and objects, and rubber pipes, and 2 percent stone-sized artifacts of concrete and tires; 5 percent cobble-sized rock fragments; neutral.

Appendix 14. Selected pedon descriptions with physical and chemical analyses (continued).

S95NY-085-006; GREATKILLS LABORATORY DATA
- PEDON 96P 167, SAMPLES 96P 1361- 1363
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In)	HORIZON	-4-- TOTAL CLAY LT .002	-5-- TOTAL SILT .002 -.05	-6-- TOTAL SAND .05 -2	-7-- CLAY FINE LT .0002	-8-- CLAY CO3 LT .002	-9-- SILT FINE .002 -.02	-10- SILT COARSE .02 -.05	-11- SAND VF .05 -.10	-12- SAND F .10 -.25	-13- SAND M .25 -.50	-14- SAND C .5 -1	-15- SAND VC 1 -2	-16- COARSE FRACTIONS (MM) WEIGHT 2 -5	-17- WEIGHT 5 -20	-18- WEIGHT 20 -75	-19- WEIGHT .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - - PCT OF <2MM	(3A1) - - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - ->	<- PCT OF <75MM(3B1)->				
96P1361S	0- 2	A	9.9	28.3	61.8			15.8	12.5	8.9	16.9	17.5	12.4	6.1	8	5	--	59	13
96P1362S	2- 7	Bw1	11.4	27.5	61.1			16.4	11.1	8.6	14.2	15.6	12.1	10.6	11	17	1	66	29
96P1363S	7- 12	BC	10.5	29.4	60.1		0.7	16.9	12.5	8.5	15.5	17.4	12.1	6.6	16	25	--	71	41

DEPTH (In)	-1-- ORGN C 6A1c PCT	-2-- TOTAL N 6B4a <2MM	-3-- EXTR P 6S3b PPM	-4-- TOTAL S 6R3c	-5-- DITH-CIT EXTRACTABLE FE 6C2b	-6-- AL 6G7a	-7-- MN 6D2a	-8-- (RATIO/CLAY) CEC 8D1	-9-- 15 BAR 8D1	-10- (ATTERBERG - LIMITS -) LL 4F1	-11- PI 4F	-12- (BULK DENSITY) FIELD MOIST 4A5	-13- 1/3 BAR 4A1d	-14- OVEN DRY 4A1h	-15- COLE WHOLE SOIL 4D1	-16- (WATER CONTENT) FIELD MOIST 4B4	-17- 1/10 BAR 4B1c	-18- 1/3 BAR 4B1c	-19- 15 BAR 4B2a	-20- WRD WHOLE SOIL 4C1
				<- PERCENT	OF	<2MM -->				PCT <0.4MM		<- - G/CC	- -	- ->	CM/CM	<- - -PCT OF	<2MM	- -	- ->	CM/CM
0- 2	4.77	0.365	37		1.5	0.1	0.1	1.65	1.23										12.2	
2- 7	1.36	0.117	1		1.6	0.1	0.1	0.88	0.56										6.4	
7- 12	1.49	0.097	8		2.1	0.1	0.1	0.84	0.59										6.2	

DEPTH (In)	-1-- (NH4OAC EXTRACTABLE BASES) CA 5B5a 6N2e	-2-- MG 5B5a 6O2d	-3-- NA 5B5a 6P2b	-4-- K 5B5a 6Q2b	-5-- SUM BASES	-6-- ACID-ITY 6H5a	-7-- EXTR AL 6G9c	-8-- (CEC) SUM CATS 5A3a	-9-- NH4-OAC 5A8b	-10- BASES + AL 5A3b	-11- AL SAT 5G1	-12- BASE SAT- SUM 5C3	-13- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1g	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18-	-19- (PH) CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<- - - - - - -	- - -	- - -	- - -	-MEQ / 100 G	- - -	- - -	- - -	- - -	- ->	<- - -	- - -PCT	- - -	- ->						
0- 2	11.6	4.3	--	1.6	17.5	4.4		21.9	16.3			80	100	TR					6.2	6.5
2- 7	5.8	3.0	0.1	0.9	9.8	2.3		12.1	10.0			81	98						6.4	6.9
7- 12		2.3	0.1	--					8.8			100	100	1					7.5	7.9

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 14. **Selected soil pedon descriptions with physical and chemical analyses (continued).**

SAMPLE No.	DEPTH (In.)	HORIZON	1 ENGINEERING PERCENTAGE PASSING, INCHES 3	2 INCHES 2	3 INCHES 3/2	4 INCHES 1	5 INCHES 3/4	6 INCHES 3/8	7 NUMBER 4	8 NUMBER 10	9 NUMBER 40	10 NUMBER 200	11 PSDA SIEVE MICRONS 20	12 MICRONS 5	13 MICRONS 2	14 CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN MILLIMETER 1.	15 .5	16 .25	17 .10	18 .05	19 DIAMETERS(mm) AT PERCENTILE 60	20 50	21 10	22 ATTERBERG LL (PCT)	23 PI (PCT)	24 GRADATION UNIFMTY CU	25 CURVTUR CC
96P1361S	0- 2	A	100	100	100	100	100	98	95	87	67	38	22	14	9	82	71	56	41	33	0.30	0.175	0.003			>100	1.9
96P1362S	2- 7	Bw1	100	100	100	99	99	91	82	71	52	31	20	13	8	63	55	44	34	28	0.76	0.368	0.003			>100	1.9
96P1363S	7- 12	BC	100	100	100	100	100	88	75	59	45	26	16	10	6	55	48	38	29	24	2.11	0.609	0.005			>100	1.3

DEPTH (In.)	26 WEIGHT FRACTIONS, WHOLE SOIL (mm) >2 (PCT of WHOLE SOIL)	27 250-UP	28 250-75	29 75-2	30 75-20	31 20-5	32 5-2	33 <2	34 <75 mm FRACTION 75-2 (PCT OF <75 mm)	35 75-20	36 20-5	37 5-2	38 <2	39	40 WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL, SOIL SURVEY 1/3 BAR	41 SOIL SURVEY OVEN-DRY	42 ENGINEERING MOIST	43 ENGINEERING SATURATED	44 <2 mm FRACTION, SOIL SURVEY 1/3 BAR	45 SOIL SURVEY 15 BAR	46 SOIL SURVEY OVEN-DRY	47 ENGINEERING MOIST	48 ENGINEERING SATURATED	49 VOID RATIOS AT 1/3 BAR WHOLE SOIL	50 VOID RATIOS AT 1/3 BAR <2 mm
0- 2	13	--	--	13	--	5	8	87	13	--	5	8	87		1.53										
2- 7	29	--	--	29	1	17	11	71	29	1	17	11	71		1.67										
7- 12	41	--	--	41	--	24	16	59	41	--	25	16	59		1.77										

DEPTH (In.)	51 VOLUME FRACTIONS, WHOLE SOIL (mm) at 1/3 BAR >2 (PCT of WHOLE SOIL)	52 250-UP	53 250-75	54 75-2	55 75-20	56 20-5	57 5-2	58 <2	59 2-.05	60 .05-.002	61 LT .002	62 PORES D	63 F	64 (C/)(/N) RATIO	65 RATIOS to CLAY, <2 mm FRACTION, FINE CLAY	66 CEC SUM CATS	67 CEC NH4-OAC	68 15 BAR H2O	69 LINEAR EXTENSIBILITY, WHOLE SOIL LEP 1/3 BAR	70 1/3 BAR to 15 BAR (PCT)	71 OVEN-DRY	72 <2 mm 15 BAR	73 OVEN-DRY	74 WRD WHOLE SOIL (In/In)	75 WRD <2 mm
0- 2	7	--	--	7	--	3	5	93	31	14	5	42		13		2.21	1.65	1.23							
2- 7	18	--	--	18	1	11	7	82	27	12	5	37		12		1.06	0.88	0.56							
7- 12	28	--	--	28	--	17	11	72	24	12	4	33		15		1.90	0.84	0.59							

DEPTH (In.)	76 WEIGHT FRACTIONS - CLAY FREE, WHOLE SOIL >2 (PCT of >2mm+SAND+SILT)	77 75-2	78 20-2	79 <2 mm FRACTION 2-.05	80 .05-.002	81 LT .002	82 SANDS VC (PCT of SAND+SILT)	83 C	84 M	85 F	86 VF	87 SILTS C	88 F	89 CLAY	90 TEXTURE DETERMINED IN FIELD	91 BY PSDA	92 PSDA(mm) SAND 2-.05 (PCT of <2mm)	93 SILT .05-.002	94 CLAY LT .002	95 PH CACL2 .01M	96 ELECTRICAL RESIST. OHMS (<2mm)	97 CONDUCT. MMHOS	98	99	100
0- 2	14	14	14	59	27	9	7	14	19	19	10	14	18	11	L	SL	61.8	28.3	9.9	6.2					
2- 7	32	32	30	47	21	9	12	14	18	16	10	13	19	13	L	SL	61.1	27.5	11.4	6.4					
7- 12	44	44	44	38	18	7	7	14	19	17	9	14	19	12	L	SL	60.1	29.4	10.5	7.5					

Appendix 15. Selected soil pedon description with physical and chemical analyses.

Soil Survey Site Identification #: 95NY085033 Soil Series: Greenbelt

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 34 minutes 31.41 seconds N
Longitude: 74 degrees 9 minutes 44.5 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 55 percent **Aspect: 210°**
Slope Shape: Convex-Linear
Elevation: 75 feet
Physiography:
Local: Fill **Major: Glaciated upland**
Hillslope - Profile Position: Shoulder **Geomorphic Component: Side slope**
Geographically Associated Soils: Centralpark, Canarsie, Foresthills
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches **Water Table Kind: Apparent**
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderate; moderately slow in the surface if compacted
Natural Drainage Class: Well drained
Parent material: Anthropotransported natural soil materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; buried soil from the Ab horizon and below
Described by: J. M. Galbraith, L. A. Hernandez, and S. T. Seifried
Note: Lithochromic mottles have formed as a result of rock weathering.

A - 0 to 3 in.; brown (7.5YR 4/4) loam; weak medium subangular blocky structure; very friable; many very fine to coarse roots throughout; common fine pores; 2 percent cobbles, and 2 percent stones; very strongly acid; clear wavy boundary.

Bw - 3 to 13 in.; yellowish red (5YR 4/6) gravelly loam; moderate medium subangular blocky and platy structure; friable; common very fine and fine plus few medium roots throughout; few medium distinct strong brown (7.5YR 5/6) mottles; many fine and medium pores; 15 percent gravel, 1 percent cobbles, and 1 percent stones; moderately acid; clear wavy boundary.

C1 - 13 to 27 in.; reddish brown (2.5YR 4/4) gravelly loam; massive; firm; common fine and medium plus few coarse roots throughout; common, medium distinct brown (7.5YR 4/3) and few medium distinct strong brown (7.5YR 5/6) mottles; common very fine pores; 18 percent gravel, 5 percent cobbles, and 1 percent stones; moderately acid; clear wavy boundary.

C2 - 27 to 57 in.; reddish brown (2.5YR 4/4) gravelly loam; massive; firm; few fine and medium roots throughout; common, medium distinct brown (7.5YR 4/3) and few medium distinct strong brown (7.5YR 5/6) mottles; few fine to coarse pores; 9 percent gravel, 5 percent cobbles, and 3 percent stones; moderately acid; abrupt smooth boundary.

Ab - 57 to 58 in.; dark brown (7.5YR 3/2) loam; weak medium granular structure; very friable; many very fine to coarse roots throughout; 5 percent gravel and 5 percent cobbles; extremely acid; clear smooth boundary.

Bwb - 58 to 65 in.; yellowish red (5YR 4/6) loam; moderate medium subangular blocky structure; very friable; common fine to coarse roots throughout; common, very fine to medium pores; 8 percent gravel and 5 percent cobbles; very strongly acid.

Appendix 15. Selected soil pedon descriptions with physical and chemical analyses (continued).

S95NY-085-033; GREENBELT LABORATORY DATA
- PEDON 96P 173, SAMPLES 96P 1384- 1389
- GENERAL METHODS 1B1A, 2A1, 2B

			-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
						(- - -TOTAL	- - -)	(- -CLAY-	-)	(- -SILT-	-)	(- - - -	- -SAND-	-	- - -	-)	(-COARSE FRACTIONS(MM)-)					(>2MM)
						CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	- - - - WEIGHT		- - - -		WT
SAMPLE	DEPTH	HORIZON				LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	PCT OF
NO.	(In)					.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	WHOLE
						<- - - -	- - - - -	- - - PCT OF	<2MM	(3A1) - -	- - - -	- - - -	- - - -	- - -	- - -	->	<- PCT OF	<75MM(3B1)->				SOIL
96P1384S	0- 3	A				12.1	40.2	47.7			23.4	16.8	12.9	16.8	10.9	4.9	2.2	--	14	--	35	4
96P1385S	3- 13	Bw				12.4	36.4	51.2			23.2	13.2	10.9	13.7	12.0	9.0	5.6	9	14	1	55	25
96P1386S	13- 27	C1				13.1	38.8	48.1			23.8	15.0	11.2	14.8	11.4	6.9	3.8	15	15	TR	56	35
96P1387S	27- 57	C2				13.5	39.0	47.5			23.8	15.2	12.0	15.9	11.9	5.9	1.8	7	8	TR	45	22
96P1388S	57- 58	Ab				11.5	43.9	44.6			26.0	17.9	13.1	15.9	10.1	3.8	1.7	2	4	--	36	14
96P1389S	58- 65	Bwb				12.4	42.4	45.2			25.9	16.5	12.5	16.2	10.4	4.3	1.8	5	6	1	41	19

	ORGN	TOTAL	EXTR	TOTAL	(- - DITH-CIT	- -)		(RATIO/CLAY)		(ATTERBERG	)	(- BULK DENSITY	-)		COLE	(- - -WATER CONTENT		- -)		WRD
	C	N	P	S		EXTRACTABLE			15	- LIMITS -		FIELD	1/3	OVEN	WHOLE	FIELD	1/10	1/3	15	WHOLE
DEPTH					FE	AL	MN	CEC	BAR	LL	PI	MOIST	BAR	DRY	SOIL	MOIST	BAR	BAR	BAR	SOIL
(In)	6A1c	6B4a	6S3b	6R3c	6C2b	6G7a	6D2a	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT	OF	<2MM -->				PCT	<0.4MM	<- -	G/CC -	- ->	CM/CM	<- -	-PCT OF	<2MM	- ->	CM/CM
0- 3	0.98	0.066			1.4	0.2	0.1	0.74	0.51										6.2	
3- 13	0.20	0.009			1.5	0.2	0.1	0.77	0.46										5.7	
13- 27	0.21	0.011			1.5	0.2	0.1	0.68	0.46										6.0	
27- 57	0.28	0.011			1.6	0.2	0.1	0.64	0.43										5.8	
57- 58	8.40	0.545			1.5	0.4	0.1	2.26	1.67										19.2	
58- 65	1.61	0.097			1.5	0.3	0.1	0.82	0.48										6.0	

AVERAGES, DEPTH 25-100: PCT CLAY 13 PCT .1-75MM 64

	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
	(- NH4OAC	EXTRACTABLE	BASES	-)		ACID-	EXTR	(- - -	-CEC	- - -)	AL	-BASE	SAT-	CO3 AS	RES.		COND.	(- - -	-PH -	- -)
	CA	MG	NA	K	SUM	ITY	AL	SUM	NH4-	BASES	SAT	SUM	NH4	CACO3	OHMS		MMHOS		CACL2	H2O
DEPTH	5B5a	5B5a	5B5a	5B5a	BASES			CATS	OAC	+ AL			OAC	<2MM	/CM		/CM		.01M	
(In)	6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	5A3a	5A8b	5A3b	5G1	5C3	5C1	6E1g	8E1		8I		8C1f	8C1f
	<- - -	- - -	- - -	- - -	-MEQ /	100 G	- - -	- - -	- - -	- ->	<- - -	- -PCT	- - -	->					1:2	1:1
0- 3	--	2.8	0.3	--	3.1	7.2	1.1	10.3	9.0	4.2	26	30	34						4.2	5.0
3- 13	--	5.5	0.2	--	5.7	3.1	0.1	8.8	9.5	5.8	2	65	60						5.0	5.9
13- 27	--	5.0	--	--	5.0	4.0	0.2	9.0	8.9	5.2	4	56	56						4.9	5.8
27- 57	--	5.1	0.1	--	5.2	4.2	0.1	9.4	8.7	5.3	2	55	60						5.1	6.0
57- 58	--	2.0	--	--	2.0	25.0	2.5	27.0	26.0	4.5	56	7	8						3.8	4.4
58- 65	--	0.9	--	--	0.9	11.9	3.3	12.8	10.2	4.2	79	7	9						3.9	4.5

Appendix 15. **Selected soil pedon descriptions with physical and chemical analyses (continued).**

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING, INCHES: 3	2	3/2	1	3/4	3/8	NUMBER: 4	10	40	200	PSDA SIEVE, MICRONS: 20	5	2	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN, MILLIMETER: 1.	.5	.25	.10	.05	DIAMETERS(mm) AT PERCENTILE: 60	50	10	ATTERBERG (PCT): LL	PI	GRADATION UNI-FMTY CU	CUR-VTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
96P1384S	0- 3	A	100	100	100	100	100	100	100	100	90	60	35	21	12	98	93	82	65	52	0.08	0.044	0.001			56.4	1.3
96P1385S	3- 13	Bw	100	100	100	99	99	92	85	76	63	42	27	16	9	72	65	56	45	37	0.34	0.150	0.002			>100	0.9
96P1386S	13- 27	C1	100	100	100	100	100	93	85	70	61	41	26	16	9	67	63	55	44	36	0.40	0.167	0.002			>100	0.9
96P1387S	27- 57	C2	100	100	100	100	100	96	92	85	76	50	32	20	11	83	78	68	55	45	0.14	0.072	0.001			95.5	1.3
96P1388S	57- 58	Ab	100	100	100	100	100	98	96	94	86	59	35	21	11	92	89	79	64	52	0.08	0.045	0.002			46.4	1.1
96P1389S	58- 65	Bwb	100	100	100	99	99	96	93	88	80	54	34	20	11	86	83	73	59	48	0.11	0.056	0.002			63.7	1.1

DEPTH (In.)	WEIGHT FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL: >2	250 -UP	250 -75	75 -2	75 -20	20 -5	5 -2	<2	<75 mm FRACTION, PCT OF <75 mm: 75 -2	75 -20	20 -5	5 -2	<2		WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL: SOIL SURVEY 1/3 BAR	OVEN -DRY	ENGINEERING MOIST	SATUR -ATED	<2 mm FRACTION: SOIL SURVEY 1/3 BAR	15 BAR	OVEN -DRY	ENGINEERING MOIST	SATUR -ATED	VOID RATIOS AT 1/3 BAR: WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 3	4	--	4	--	--	--	--	96	--	--	--	--	100		1.45										
3- 13	26	--	2	24	1	14	9	74	24	1	14	9	76		1.63										
13- 27	36	--	8	28	TR	14	14	64	30	TR	15	15	70		1.73										
27- 57	22	--	8	14	TR	7	6	78	15	TR	8	7	85		1.62										
57- 58	14	--	9	5	--	4	2	86	6	--	4	2	94		1.55										
58- 65	19	--	8	11	1	6	5	81	12	1	6	5	88		1.59										

DEPTH (In.)	VOLUME FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL: >2	250 -UP	250 -75	75 -2	75 -20	20 -5	5 -2	<2	at 1/3 BAR: 2- .05	.05- .002	LT .002	PORES D	F	(C/N) RAT -IO	RATIOS to CLAY, <2 mm FRACTION: FINE CLAY	CEC SUM CATS	CEC NH4- OAC	15 BAR H2O	LINEAR EXTENSIBILITY, WHOLE SOIL: LEP 1/3 BAR	<-1/3 BAR to (PCT)--->: 15 BAR	OVEN -DRY	<2 mm: 15 BAR	OVEN -DRY	WRD (<--In/In->): WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 3	2	--	2	--	--	--	--	98	26	22	7	45		15		0.85	0.74	0.51							
3- 13	16	--	1	15	1	9	6	84	24	17	6	38		22		0.71	0.77	0.46							
13- 27	23	--	5	18	TR	9	9	77	20	16	5	35		19		0.69	0.68	0.46							
27- 57	13	--	5	9	TR	4	4	87	22	18	6	39		26		0.70	0.64	0.43							
57- 58	8	--	5	3	--	2	1	92	23	22	6	41		15		2.35	2.26	1.67							
58- 65	11	--	5	7	1	4	3	89	22	21	6	40		17		1.03	0.82	0.48							

Appendix 16. Selected soil pedon descriptions.

Soil Survey Site Identification #: S99NY047005 Soil Series: Hassock

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 35 minutes 52 seconds N
Longitude: 73 degrees 54 minutes 03 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 2 percent **Aspect: 190°**
Slope Shape: Convex-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Slope**
Geographically Associated Soils: These deposits do not have any correlation to existing soils and may occur anywhere.
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 40 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Coarse-loamy, mixed, active, non-acid, mesic Typic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderately rapid
Natural Drainage Class: Well drained
Parent material: Incinerator fly ash
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; Rock fragments in the particle size control section average less than 35 percent by volume.

Described by: L. A. Hernandez and K. Alamarie

A - 0 to 3 inches; very dark grayish brown (10YR 3/2) sandy loam; weak very fine granular structure; very friable; many very fine and fine roots throughout; 10 percent coarse fragments (4 percent bricks, 2 percent metals, 2 percent glass, 2 percent natural rock fragments); neutral; clear smooth boundary (2 to 5 inches thick).

C1 - 3 to 16 inches; very dark gray (10YR 3/1) coarse sandy loam; massive; very friable; many very fine and fine roots throughout; few coarse prominent reddish yellow (7.5 YR 6/6) redoximorphic features; 10 percent coarse fragments (4 percent bricks, 2 percent metals, 2 percent glass, 2 percent natural rock fragments); neutral; clear wavy boundary.

C2 - 16 to 28 inches; dark gray (10YR 4/1) coarse sandy loam; massive; very friable; many coarse prominent strong brown (7.5YR 5/8) redoximorphic features; 10 percent coarse fragments (4 percent bricks, 1 percent metals, 1 percent glass, 2 percent carboliths, 2 percent natural rock fragments); neutral; clear wavy boundary.

C3 - 28 to 65 inches; dark gray (10YR 4/1) coarse sandy loam; massive; very friable; 10 percent coarse fragments (4 percent bricks, 1 percent metals, 1 percent glass, 2 percent carboliths, 2 percent natural rock fragments); neutral.

Appendix 17. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 97NY081006 Soil Series: Hooksan

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 33 minutes 37.2 seconds N
Longitude: 73 degrees 53 minutes 24.8 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 25 percent **Aspect: 10°**
Slope Shape: Convex-Linear
Elevation: 12 feet
Physiography:
Local: Dune sand **Major: Barrier Island**
Hillslope - Profile Position: Shoulder **Geomorphic Component: Side slope**
Geographically Associated Soils: Jamaica, Ipswich, Matunuck, Pawcatuck
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Below 80 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Mesic, uncoated Typic Quartzipsamments
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Very rapid
Natural Drainage Class: Excessively drained
Parent material: Sandy eolian sediments
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches
Described by: J. M. Galbraith and R. B. Tunstead

A - 0 to 3 in.; olive brown (2.5Y 4/4) fine sand; single grain; loose; many fine plus common medium and coarse roots throughout; extremely acid; gradual wavy boundary.

C1 - 3 to 29 in.; light olive brown (2.5Y 5/3) fine sand; single grain; loose; many fine plus common medium and coarse roots throughout; very strongly acid; diffuse wavy boundary.

C2 - 29 to 80 in.; light olive brown (2.5Y 5/3) fine sand; single grain; loose; common fine and medium roots throughout; moderately acid.

Appendix 17. Selected soil pedon descriptions with physical and chemical analyses (continued).

S97NY-081-006; HOOKSAN LABORATORY DATA
- PEDON 98P 66, SAMPLES 98P 474- 476
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In)	HORIZON	-1--	-2--	-3--	-4-- (- - -TOTAL - - -) CLAY LT .002	-5-- SILT .002 -.05	-6-- SAND .05 -2	-7-- (- -CLAY- -) FINE LT .0002	-8-- CO3 LT .002	-9-- (- -SILT- -) FINE .002 -.02	-10- COARSE .02 -.05	-11- (- - - - - -SAND- - - - - -) VF .05 -.10	-12- F .10 -.25	-13- M .25 -.50	-14- C .5 -1	-15- VC 1 -2	-16- (-COARSE FRACTIONS(MM)-) - - - - WEIGHT - - - - 2 -5	-17- 5 -20	-18- 20 -75	-19- .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
						<- - - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				
98P 474S	0- 3	A				0.2	1.1	98.7			0.6	0.5	4.0	71.8	22.5	0.3	0.1	--	--	--	95	--
98P 475S	3- 29	C1				--	1.0	99.0			0.4	0.6	3.8	71.3	23.6	0.3	--	--	--	--	95	--
98P 476S	29- 80	C2				0.1	1.6	98.3			0.5	1.1	2.0	59.0	35.8	1.5	TR	TR	TR	--	96	TR

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c	(- - DITH-CIT - -) EXTRACTABLE FE 6C2b	AL 6G7a	MN 6D2a	CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG - LIMITS -) LL 4F1	PI 4F	(- BULK DENSITY -) FIELD MOIST 4A5	1/3 BAR 4A1d	OVEN DRY 4A1h	COLE WHOLE SOIL 4D1	(- - -WATER CONTENT - -) FIELD MOIST 4B4	1/10 BAR 4B1c	1/3 BAR 4B1c	15 BAR 4B2a	WRD WHOLE SOIL 4C1
				<- PERCENT OF <2MM -->						PCT <0.4MM		<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->				CM/CM
0- 3	0.23	0.034																	1.0	
3- 29	0.09	0.002																	0.5	
29- 80	0.05	0.018																	0.4	

AVERAGES, DEPTH 25-100: PCT CLAY 0 PCT .1-75MM 96

DEPTH (CM)	-1-- (- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2e	-2-- MG 5B5a 6O2d	-3-- NA 5B5a 6P2b	-4-- K 5B5a 6Q2b	-5-- SUM BASES	-6-- ACID- ITY 6H5a	-7-- EXTR AL 6G9c	-8-- (- - - -CEC - - -) SUM CATS 5A3a	-9-- NH4- OAC 5A8b	-10- BASES + AL 5A3b	-11- AL SAT 5G1	-12- -BASE SAT- SUM 5C3	-13- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1g	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18-	-19- (- - - -PH - - -) CACL2 .01M 8C1f	-20- H2O 8C1f
	<- - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - ->										<- - - - -PCT - - - ->								1:2	1:1
0- 3	--	0.2	--	0.2	0.4	0.7	0.1	1.1	0.4	0.5	20	36	100						4.1	4.4
3- 29	--	0.1	0.1	--	0.2	0.9	0.2	1.1	1.0	0.4	50	18	20						4.5	5.0
29- 80	0.5	0.1	--	--	0.6	1.0		1.6	0.9			38	67						5.2	5.8

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 17. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING, INCHES 3	2	3/2	1	3/4	3/8	NUMBER 4	10	40	200	PSDA SIEVE, MICRONS 20	5	2	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN, MILLIMETER 1.	.5	.25	.10	.05	DIAMETERS(mm) AT PERCENTILE 60	50	10	ATTERBERG PCT LL	PI	GRADATION UNIFMTY CU	CURVTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
98P 474S	0- 3	A	100	100	100	100	100	100	100	100	94	4	1	TR	TR	100	100	77	5	1	0.20	0.177	0.106			1.9	0.9
98P 475S	3- 29	C1	FRACTIONS NOT DETERMINED																								
98P 476S	29- 80	C2	FRACTIONS NOT DETERMINED																								

DEPTH (In.)	WEIGHT FRACTIONS, WHOLE SOIL (mm), PCT of WHOLE SOIL >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	<75 mm FRACTION, PCT OF <75 mm 75-2	75-20	20-5	5-2	<2		WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL, SOIL SURVEY 1/3 BAR	SOIL SURVEY OVEN-DRY	ENGINEERING MOIST	ENGINEERING SATURATED	<2 mm FRACTION, SOIL SURVEY 1/3 BAR	SOIL SURVEY 15 BAR	SOIL SURVEY OVEN-DRY	ENGINEERING MOIST	ENGINEERING SATURATED	VOID RATIOS AT 1/3 BAR WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 3	--	--	--	--	--	--	--	100	--	--	--	--	100		1.45										
3- 29	--	--	--	--	--	--	--	100	--	--	--	--	100		1.45										
29- 80	TR	--	--	--	--	TR	--	100	--	--	TR	--	100		1.45										

DEPTH (In.)	VOLUME FRACTIONS, WHOLE SOIL (mm) at 1/3 BAR, PCT of WHOLE SOIL >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	2-.05	.05-.002	LT .002	PORES D	PORES F	(C/N) RAT-IO	RATIOS to CLAY, <2 mm FRACTION, FINE CLAY	C E C- SUM CATS	C E C- NH4-OAC	15 BAR H2O	LEP 1/3 BAR	LINEAR EXTENSIBILITY (PCT) WHOLE SOIL 1/3 BAR to 15 BAR	WHOLE SOIL 1/3 BAR to OVEN-DRY	<2 mm 1/3 BAR to 15 BAR	<2 mm 1/3 BAR to OVEN-DRY	W R D (In/In) WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 3	--	--	--	--	--	--	--	100	54	1		45		7		5.50	2.00	5.00							
3- 29	--	--	--	--	--	--	--	100	54	1		45		47											
29- 80	TR	--	--	--	--	TR	--	100	54	1		45		3		16.00	9.00	4.00							

DEPTH (In.)	WEIGHT FRACTIONS - CLAY FREE, WHOLE SOIL, PCT of >2mm+SAND+SILT >2	75-2	20-2	2-.05	.05-.002	LT .002	<2 mm FRACTION, SANDS, PCT of SAND+SILT VC	C	M	F	VF	SILTS C	SILTS F	CLAY	TEXTURE (DETERMINED) <2 mm IN FIELD	BY PSDA	PSDA(mm), PCT of 2mm SAND 2-.05	SILT .05-.002	CLAY LT .002	PH, <2mm CaCl2 .01M	ELECTRICAL RES-IST. OHMS	CON-DUCT. MMHOS			
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 3				99	1	TR	TR	TR	23	72	4	1	1	TR		FS	98.7	1.1	0.2	4.1					
3- 29				99	1			TR	24	71	4	1	TR			FS	99.0	1.0	--	4.5					
29- 80				98	2	TR		2	36	59	2	1	1	TR		FS	98.3	1.6	0.1	5.2					

Appendix 18. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Inwood

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Flushing
Latitude: 40 degrees 48 minutes 46 seconds N
Longitude: 73 degrees 52 minutes 3 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 3 percent **Aspect: 270°**
Slope Shape: Convex-linear
Elevation: 15 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: Shoulder **Geomorphic Component: Slope**
Geographically Associated Soils: Canarsie, Centralpark, Foresthills, and Greenbelt
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information **Ponding Information**
Frequency: None **Frequency: None**

Official Series Classification: Fragmental, mixed, mesic Typic Udorthents
Moisture Regime: Udic Moisture regime
Landuse: Park land
Permeability: Moderately rapid, but can be moderately slow in the surface if compacted
Natural Drainage Class: Well drained
Parent material: Thick mantle of demolished construction debris intermingled with anthropotransported natural soil material
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; Particle size family - fragmental (10-40 inches).
Described by: L. A. Hernandez and R.B. Tunstead

A - 0 to 6 inches; yellowish brown (10YR 5/4) gravelly sandy loam; weak fine platy structure; very friable; common fine and very fine roots; 15 percent gravel-sized coarse fragments (10 percent asphalt and bricks, 5 percent gneiss); neutral; gradual wavy boundary.

Bw - 6 to 12 inches; yellowish brown (10YR 5/4) very gravelly sandy loam; weak fine subangular blocky structure; very friable; common fine and very fine roots; 40 percent gravel-sized coarse fragments (35 percent asphalt and bricks, 5 percent gneiss); neutral; gradual wavy boundary.

C 1 - 12 to 16 inches; yellowish brown (10YR 5/6) very gravelly sandy loam; massive; very friable; few fine roots; 45 percent gravel-sized coarse fragments (35 percent asphalt and bricks, 10 percent gneiss); neutral; abrupt smooth boundary.

C2 - 16 to 65 inches; yellowish brown (10YR 5/6) extremely stony sandy loam; massive; 90 percent stone-sized coarse fragments (35 percent concrete, 20 percent metal debris, 10 percent wood, 5 percent brick, 5 percent plastic, 5 percent metal wire, and 10 percent gneiss).

Appendix 19. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Ipswich

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Jamaica
Latitude: 40 degrees 37 minutes 36 seconds N
Longitude: 73 degrees 47 minutes 57 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 0 percent **Aspect: 60°**
Slope Shape: Concave-linear
Elevation: 0 feet (at sea level)
Physiography:
Local: Tidal marsh **Major: Glaciated coastal plain**
Hillslope - Profile Position: Toeslope **Geomorphic Component: Base slope**
Geographically Associated Soils: Matunuck, Pawcatunck, Sandyhook
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 0 to 12 inches above **Water Table Kind: Apparent** **Duration: Throughout the year**

Flooding Information
Frequency: Frequent
Duration: very brief

Ponding Information
Frequency: None

Official Series Classification: Euic, mesic Typic Sulfihemists
Moisture Regime: Aquic moisture regime
Landuse: Wildlife refuge
Permeability: Rapid
Natural Drainage Class: Very poorly drained
Parent material: Organic sediments
Plant Association: Grass and herbaceous cover
Diagnostic Features: Histic Epipedon
Described by: F. Gilbert and W. Hanna

Oel -- 0 to 20 inches; brown (10YR 4/3 and 10YR 5/3) mucky peat; 85 percent fibers, 30 percent rubbed; many fine and common medium roots; 5 percent mineral material; neutral; gradual smooth boundary.

Oe2 -- 20 to 40 inches; very dark grayish brown (2.5Y 3/2) mucky peat; 70 percent fibers, 20 percent rubbed; few fine roots; 10 percent mineral material; neutral; gradual smooth boundary.

Oe3 -- 40 to 72 inches; dark gray (5Y 4/1) and olive gray (5Y 4/2) mucky peat; 70 percent fibers, 25 percent rubbed; 25 percent mineral material; slightly alkaline.

Appendix 20. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 99NY047001 Soil Series: Jamaica

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 35 minutes 59 seconds N
Longitude: 73 degrees 53 minutes 20 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 90°**
Slope Shape: Linear-Concave
Elevation: 8 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: Toeslope **Geomorphic Component: Base slope**
Geographically Associated Soils: Barren, Bigapple, Hooksan
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 0 to 10 inches **Water Table Kind: Apparent** **Duration: Nov. through May**
Flooding Information
Frequency: None
Duration: Very long
Ponding Information
Frequency: Frequently
Runoff: Negligible **Type of Erosion: Water** **Degree of Erosion: Class 1**

Official Series Classification: Mixed, mesic Typic Psammaquents
Moisture Regime: Aquic moisture regime
Landuse: Park land
Permeability: Rapid
Natural Drainage Class: Poorly drained
Parent material: Sandy dredge materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; Particle size class - sandy, less than 35 percent (by volume) coarse fragments

Described by: L. A. Hernandez and R. B. Tunstead

A - 0 to 3 in.; black (10YR 2/1) sand; moderate fine granular structure; friable; many fine, common medium, and few coarse roots throughout; very strongly acid; abrupt irregular boundary.

C1 - 3 to 11 in.; gray (2.5Y 6/1) sand; massive; friable; few fine, medium and coarse roots throughout; few fine distinct brown (7.5YR 4/4) redoximorphic concentrations; very strongly acid; clear wavy boundary.

C2 - 11 to 27 in.; grayish brown (2.5Y 5/2) fine sand; massive; friable; few fine roots throughout; common coarse distinct brown (7.5YR 4/4) redoximorphic concentrations; very strongly acid; abrupt wavy boundary.

C3 - 27 to 65 in.; light gray (2.5Y 7/1) fine sand; massive; friable; many fine distinct brown (10YR 5/3) redoximorphic concentrations; extremely acid.

Appendix 20. Selected soil pedon descriptions with physical and chemical analyses (continued).

S99NY-047-001; JAMAICA LABORATORY DATA
- PEDON 99P 561, SAMPLES 99P 3504- 3507
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In)	HORIZON	-4-- (- - -TOTAL CLAY LT .002	-5-- TOTAL SILT .002 -.05	-6-- TOTAL - - -) SAND .05 -2	-7-- (- -CLAY- -) FINE LT .0002	-8-- CLAY CO3 LT .002	-9-- (- -SILT- -) FINE .002 -.02	-10- SILT COARSE .02 -.05	-11- (- - - - - -SAND- VF .05 -.10	-12- SAND F .10 -.25	-13- SAND M .25 -.50	-14- SAND C .5 -1	-15- SAND - - - -) VC 1 -2	-16- (-COARSE FRACTIONS(MM)-) WEIGHT 2 -5	-17- WEIGHT 5 -20	-18- WEIGHT 20 -75	-19- WEIGHT .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
			<- - - - - - - - - - - - - - PCT OF <2MM (3A1)											- - - - - - - - - - - - - ->	<- PCT OF <75MM(3B1)->				SOIL
99P3504S	0- 3	A	0.2	4.2	95.6			2.0	2.2	0.7	40.1	45.0	8.3	1.5	1	TR	--	95	1
99P3505S	3- 11	Bg1	--	1.1	98.9			0.2	0.9	0.9	41.9	49.2	5.9	1.0	1	TR	--	98	1
99P3506S	11- 27	Bg2	--	0.4	99.6			--	0.4	1.2	54.1	43.4	0.9	--	--	--	--	98	--
99P3507S	27- 65	Cg	--	--	100.0			--	--	0.7	54.9	43.5	0.9	--	--	--	--	99	--

DEPTH (In)	ORGN C 6A1c	TOTAL N 6B4a	EXTR P 6S3b	TOTAL S 6R3c	(- - DITH-CIT - -) EXTRACTABLE FE 6C2h	AL 6G7g	MN 6D2g	(RATIO/CLAY) CEC 8D1	15 BAR 8D1	(ATTERBERG) - LIMITS - LL 4F1	PI 4F	(- BULK DENSITY -) FIELD MOIST 4A5	1/3 BAR 4A1d	OVEN DRY 4A1h	COLE WHOLE SOIL 4D1	(- - -WATER CONTENT - -) FIELD MOIST 4B4	1/10 BAR 4B1c	1/3 BAR 4B1c	15 BAR 4B2a	WRD WHOLE SOIL 4C1
	PCT	<2MM	PPM	<- PERCENT	OF	<2MM -->				PCT <0.4MM		<- - G/CC		- - ->	CM/CM	<- - -PCT OF <2MM			- ->	CM/CM
0- 3																			7.7	
3- 11													1.59	1.89	0.059		13.1	12.6	1.0	0.18
11- 27													1.80	2.05	0.044		8.3	7.7	1.1	0.12
27- 65													1.57	1.86	0.058		5.9	5.6	0.9	0.07

DEPTH (In)	-1-- (- NH4OAC EXTRACTABLE BASES -) CA 5B5a 6N2i	-2-- MG 5B5a 6O2h	-3-- NA 5B5a 6P2f	-4-- K 5B5a 6Q2f	-5-- SUM BASES	-6-- ACID- ITY 6H5a	-7-- EXTR AL 6G9c	-8-- (- - - -CEC - - -) SUM CATS 5A3a	-9-- NH4- OAC 5A8b	-10- BASES + AL 5A3b	-11- AL SAT 5G1	-12- -BASE SAT- SUM 5C3	-13- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1h	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18- (- - - -PH	-19- CACL2 .01M 8C1f 1:2	-20- - - -) H2O 8C1f 1:1
	<- - - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - - ->										<- - - - -PCT - - - ->									
0- 3						3.6	--	3.6											4.1	5.0
3- 11						0.4	--	0.4											4.3	4.9
11- 27						--	--												4.6	5.0
27- 65						1.3	0.4	1.3											3.5	3.9

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 20. **Selected soil pedon descriptions with physical and chemical analyses (continued).**

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING <-INCHES-> 3	2	3/2	1	3/4	3/8	<-NUMBER-> 4	10	40	200	PSDA SIEVE <-MICRONS-> 20	5	2	CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN <--- MILLIMETER ---> 1.	.5	.25	.10	.05	DIAMETERS(mm) AT <--PERCENTILE--> 60	50	10	ATTERBERG <-PCT> LL	PI	GRADATION UNIFMTY CU	CURVTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
99P3504S	0- 3	A	100	100	100	100	100	100	100	99	78	5	2	1	TR	98	89	45	5	4	0.32	0.271	0.112			2.8	0.9
99P3505S	3- 11	Bg1	FRACTIONS NOT DETERMINED																								
99P3506S	11- 27	Bg2	FRACTIONS NOT DETERMINED																								
99P3507S	27- 65	Cg	FRACTIONS NOT DETERMINED																								

DEPTH (In.)	(WEIGHT FRACTIONS) WHOLE SOIL (mm) <-PCT of WHOLE SOIL-> >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	<75 mm FRACTION <--PCT OF <75 mm-> 75-2	75-20	20-5	5-2	<2		(WEIGHT PER UNIT VOLUME G/CC) WHOLE SOIL SOIL SURVEY 1/3 BAR	OVEN-DRY	ENGINEERING MOIST	SATURATED	<2 mm FRACTION SOIL SURVEY 1/3 BAR	15 BAR	OVEN-DRY	ENGINEERING MOIST	SATURATED	(VOID RATIOS) AT 1/3 BAR WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 3	1	--	--	1	--	TR	1	99	1	--	TR	1	99		1.46										
3- 11	1	--	--	1	--	--	1	99	1	--	--	1	99		1.60	1.90	1.79	2.00	1.59	1.62	1.89	1.79	1.99	0.66	0.67
11- 27	--	--	--	--	--	--	--	100	--	--	--	--	100		1.80	2.05	1.94	2.12	1.80	1.82	2.05	1.94	2.12	0.47	0.47
27- 65	--	--	--	--	--	--	--	100	--	--	--	--	100		1.57	1.86	1.66	1.98	1.57	1.58	1.86	1.66	1.98	0.69	0.69

DEPTH (In.)	(VOLUME FRACTIONS) WHOLE SOIL (mm) at 1/3 BAR <-PCT of WHOLE SOIL-> >2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	2-.05	.05-.002	LT .002	PORES D	PORES F	(C/N) RATIO	(RATIOS to CLAY) <2 mm FRACTION FINE CLAY	CEC SUM CATS	CEC NH4-OAC	15 BAR H2O	LEP 1/3 BAR	(LINEAR EXTENSIBILITY (PCT)) WHOLE SOIL <-1/3 BAR to 15 BAR	OVEN-DRY	<2 mm 15 BAR	OVEN-DRY	(WRD) <--In/In-> WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 3	1	--	--	1	--	TR	1	99	53	2		45				18.00		38.50							
3- 11	1	--	--	1	--	--	1	99	60	1		21	19							0.6	5.9	0.6	5.9	0.18	0.18
11- 27	--	--	--	--	--	--	--	100	67			18	14							0.4	4.4	0.4	4.4	0.12	0.12
27- 65	--	--	--	--	--	--	--	100	59			32	9							0.2	5.8	0.2	5.8	0.07	0.07

Appendix 20. **Selected soil pedon descriptions with physical and chemical analyses (continued).**

DEPTH (In.)	>2	75 -2	20 -2	2- .05	.05- .002	LT .002	VC	C	M	F	VF	C	F	CLAY	IN FIELD	BY PSDA	SAND 2- .05	SILT .05- .002	CLAY LT .002	PH CA-CL2 .01M	RES-IST. OHMS	CON-DUCT. MMHOS			
	(W E I G H T F R A C T I O N S - C L A Y F R E E) (--W H O L E S O I L--)						(--<2 mm F R A C T I O N ----) SANDS					SILTS			(-TEXTURE--) (DETERMINED)		(--P S D A(mm)---)			(PH)	(-ELECTRICAL)		< >		
	PCT of >2mm+SAND+SILT >						<------PCT of SAND+SILT------->								<---<2 mm-->		<---PCT of 2mm--->			<----- <2mm ----->			<--------------->		
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 3	1	1	1	95	4	TR	2	8	45	40	1	2	2	TR		S	95.6	4.2	0.2	4.1					
3- 11	1	1	1	98	1		1	6	49	42	1	1	TR			S	98.9	1.1	--	4.3					
11- 27				100	TR			1	43	54	1	TR				FS	99.6	0.4	--	4.6					
27- 65				100				1	43	55	1					FS	100.0	--	--	3.5					

Appendix 21. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Matunuck

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Far Rockaway
Latitude: 40 degrees 37 minutes 29.5 seconds N
Longitude: 73 degrees 52 minutes 51 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 0 percent **Aspect: 140°**
Slope Shape: Concave-Linear
Elevation: 0 feet (at sea level)
Physiography:
Local: Tidal marsh **Major: Glaciated coastal plain**
Hillslope B Profile Position: Toeslope **Geomorphic Component: Base slope**
Geographically Associated Soils: Ipswich, Pawcatuck, Sandyhook
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 0 to12 inches above **Water Table Kind: Apparent** **Duration: Throughout the year**
Flooding Information
Frequency: Frequent
Duration: very brief
Ponding Information
Frequency: None

Official Series Classification: Sandy, mixed, mesic Typic Sulfaquents
Moisture Regime: Aquic moisture regime
Landuse: Wildlife refuge
Permeability: Rapid
Natural Drainage Class: Very poorly drained
Parent material: Marine sands
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon
Described by: F. Gilbert and W. Hanna

Oe - 0 to 8 inches; black (10YR 2/1) mucky peat; 80 percent fibers, 20 percent rubbed; weak fine subangular blocky structure; very friable; many coarse roots; neutral; abrupt smooth boundary.

C - 8 to 72 inches; dark gray (2.5Y 4/1) sand; single grain; loose; few medium roots; neutral.

Appendix 22. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Oldmill

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Jamaica
Latitude: 40 degrees 38 minutes 46.7 seconds N
Longitude: 73 degrees 50 minutes 50.9 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 3 percent **Aspect: 210°**
Slope Shape: Convex-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: Shoulder **Geomorphic Component: Slope**
Geographically Associated Soils: Bigapple, Fortress, Gravesend, Jamaica, and Breeze
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Below 60 inches
Flooding Information **Ponding Information**
Frequency: None **Frequency: None**

Official Series Classification: Sandy, mixed, hyperthermic Typic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Landfill
Permeability: Rapid
Natural Drainage Class: Well drained
Parent material: Mantle of anthropotransported natural soil material less than 40 inches thick
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon (0-2")
Described by: L. A. Hernandez and R.B. Tunstead

A - 0 to 2 inches; very dark grayish brown (2.5Y 3/2) gravelly fine sand; weak very fine subangular blocky structure; very friable; non-sticky and non-plastic; few coarse and common very fine and fine roots throughout; 15 percent gravel-sized non-biodegradable artifacts of glass, brick, plastic; strongly acid; clear wavy boundary.

Bw - 2 to 11 inches; light olive brown (2.5Y 5/3) gravelly fine sand; single grain; loose; non-sticky and non-plastic; few very fine and fine roots throughout; 20 percent gravel-sized non-biodegradable artifacts of glass, brick, plastic; moderately acid; clear wavy boundary.

C1 - 11 to 18 inches; light yellowish brown (2.5Y 6/4) gravelly fine sand; single grain; loose; non-sticky and non-plastic; few very fine and fine roots throughout; 20 percent gravel-sized non-biodegradable artifacts of glass, brick, plastic; moderately acid; clear wavy boundary.

C2 - 18 to 33 inches; yellow (2.5Y 7/6) gravelly fine sand; single grain; loose, non-sticky and non-plastic; few coarse prominent strong brown (7.5YR 5/6) redoximorphic features; 20 percent gravel-sized non-biodegradable artifacts of glass, brick, plastic; moderately acid; abrupt wavy boundary.

2C3 - 33 to 65 inches; black (10YR 2/1) extremely cobbly fine sand; single grain; loose, slightly sticky and slightly plastic; common coarse prominent strong brown (7.5YR 5/6) redoximorphic features; 20 percent cobble-sized biodegradable artifacts such as cardboard, and paper and 40 percent cobble-sized non-biodegradable artifacts such as metal, brick, concrete, and glass; neutral.

Appendix 23. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Pawcatuck

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Far Rockaway
Latitude: 40 degrees 26 minutes 56 seconds N
Longitude: 73 degrees 59 minutes 52 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 0 percent **Aspect: 260°**
Slope Shape: Concave-Linear
Elevation: 0 feet (at sea level)
Physiography:
Local: Tidal marsh **Major: Glaciated coastal plain**
Hillslope - Profile Position: Toeslope **Geomorphic Component: Base slope**
Geographically Associated Soils: Ipswich, Matunuck, Sandyhook
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 0 to 12 inches above **Water Table Kind: Apparent** **Duration: Throughout the year**
Flooding Information
Frequency: Frequent
Duration: very brief
Ponding Information
Frequency: None

Official Series Classification: Sandy or sandy-skeletal, mixed, euic, mesic Terric Sulfihemists
Moisture Regime: Aquic moisture regime
Landuse: Wildlife Refuge
Permeability: Moderate to rapid in organic layers; very rapid in underlying sands.
Natural Drainage Class: Very poorly drained
Parent material: Organics over marine sands
Plant Association: Grass and herbaceous cover
Diagnostic Features: Histic epipedon
Described by: F. Gilbert and W. Hanna

Oel - 0 to 8 inches; very dark gray (5Y 3/1) mucky peat; 80 percent fibers, 30 percent rubbed; massive; friable; many fine and common medium roots; neutral; abrupt smooth boundary.

Oe2 - 8 to 24 inches; dark gray (2.5Y 4/1) mucky peat; 50 percent fibers, 20 percent rubbed; massive; friable; few fine roots; neutral; clear smooth boundary.

2C - 24 to 72 inches; dark gray (N 4/0) loamy sand; single grain; loose; neutral.

Appendix 24. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Pompton

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: The Narrows
Latitude: 40 degrees 34 minutes 20 seconds N
Longitude: 74 degrees 06 minutes 11 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 30°**
Slope Shape: Linear-Linear
Elevation: 15 feet
Physiography:
Local: Outwash plain **Major: Glaciated coastal plain**
Hillslope - Profile Position: **Geomorphic Component: Slope**
Geographically Associated Soils: Branford
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 18 to 40 inches **Water Table Kind: Apparent** **Duration: Nov. through May**
Flooding Information
Frequency: None
Ponding Information
Frequency: Rare
Duration: Very brief

Official Series Classification: Coarse-loamy, active, mixed, mesic Aquic Dystrudepts
Moisture Regime: Udic moisture regime
Landuse: Swamp forest
Permeability: Moderately rapid or rapid
Natural Drainage Class: Moderately well drained
Parent material: Glacial outwash
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon (0-10"), Cambic horizon (10-40")
Described by: L. A. Hernandez and R.B. Tunstead

Ap - 0 to 10 inches; very dark grayish brown (10YR 3/2) loam; weak fine granular parting to weak fine subangular blocky structure; very friable; common fine and medium roots throughout; 3 percent gravel; moderately acid; abrupt smooth boundary.

Bwl - 10 to 20 inches; brown (7.5YR 5/4) loam; moderate medium subangular blocky structure; very friable; fine and medium roots throughout; common medium faint strong brown (7.5YR 5/6) and few medium distinct yellowish brown (10YR 5/8) redoximorphic features; 3 percent gravel; moderately acid; clear wavy boundary.

Bw2 - 20 to 40 inches; strong brown (7.5YR 4/6) loam; moderate medium and coarse subangular blocky structure; very friable; fine roots throughout; common fine and medium faint brown (7.5YR 5/4) and few fine distinct pinkish gray (7.5YR 6/2) redoximorphic features; 5 percent gravel; moderately acid.

C - 40 to 72 inches; strong brown (7.5YR 4/6) sandy loam; few fine distinct light gray (10YR 7/2) silty lenses and common fine faint strong brown (7.5YR 5/6) redoximorphic features; weak medium subangular blocky structure; very friable; moderately acid.

Appendix 25. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 95NY085007 Soil Series: Rikers

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 35 minutes 37 seconds N
Longitude: 74 degrees 8 minutes 27 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 5 percent **Aspect: 225°**
Slope Shape: Convex-Linear
Elevation: 200 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: Summit **Geomorphic Component: Interfluve**
Geographically Associated Soils: These soils can be associated with any soil
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None
Runoff: Very low **Type of Erosion: Water** **Degree of Erosion: None**

Official Series Classification: Sandy-skeletal, mixed, mesic Typic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Waste disposal land
Permeability: Rapid
Natural Drainage Class: Somewhat excessively drained
Parent material: Unburned coal and coal ash
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; coarse fragments of carboliths make up less than one-fourth of the total rock fragments in the particle-size control section, coal slag makes up the rest. These two types of fragments combined average more than 35 percent by volume.
Described by: J. M. Galbraith and L.A. Hernandez

A - 0 to 3 in.; very dark gray (10YR 3/1) gravelly coarse sand; single-grain and structureless except for very fine aggregates clinging to roots; loose; many very fine and fine roots; 5 percent gravel-sized carboliths, plus 20 percent porous, glassy, gravel-sized rock-like fragments of coal slag; strongly acid; clear smooth boundary.

C1 - 3 to 17 in.; very dark gray (10YR 3/1) gravelly coarse sand; single grain and structureless except for very fine aggregates clinging to roots in the rhizosphere; loose; common very fine and fine roots throughout; 5 percent gravel-sized carboliths, plus 25 percent porous, glassy, gravel sized rock-like fragments of coal slag; strongly acid; clear wavy boundary.

C2 - 17 to 32 in.; very dark gray (10YR 3/1) stratified very gravelly coarse sand; single-grain and structureless; loose; few very fine roots throughout; 10 percent gravel-sized carboliths, 50 percent porous, glassy, gravel-sized rock-like fragments of coal slag; strongly acid; abrupt wavy boundary.

C3 - 32 to 80 in.; very dark gray (10YR 3/1) stratified very gravelly coarse sand; single-grain and structureless; loose; 5 percent gravel-sized carboliths, 55 percent porous, glassy, gravel-sized rock-like fragments of coal slag; moderately acid.

Appendix 25. Selected soil pedon descriptions with physical and chemical analyses (continued).

S95NY-085-007; RIKER LABORATORY DATA
- PEDON 96P 298, SAMPLES 96P 2372- 2375
- GENERAL METHODS 1B1A, 2A1, 2B

SAMPLE NO.	DEPTH (In)	HORIZON	-4- CLAY LT .002 (TOTAL)	-5- SILT .002 -.05 (TOTAL)	-6- SAND .05 -2 (TOTAL)	-7- FINE LT .0002 (CLAY)	-8- CO3 LT .002 (CLAY)	-9- FINE .002 -.02 (SILT)	-10- COARSE .02 -.05 (SILT)	-11- VF .05 -.10 (SAND)	-12- F .10 -.25 (SAND)	-13- M .25 -.50 (SAND)	-14- C .5 -1 (SAND)	-15- VC 1 -2 (SAND)	-16- 2 -5 (COARSE FRACTIONS(MM) WEIGHT)	-17- 5 -20	-18- 20 -75	-19- .1- 75	-20- (>2MM) WT PCT OF WHOLE SOIL
			<- - PCT OF <2MM (3A1)											- ->	<- PCT OF <75MM(3B1)			->	SOIL
96P2372S	0- 3	A	0.4	6.4	93.2			3.4	3.0	6.7	18.8	23.7	22.4	21.6	22	13	2	91	37
96P2373S	3- 17	C1	0.3	6.9	92.8			3.6	3.3	6.0	16.5	23.0	23.2	24.1	23	11	1	91	35
96P2374S	17- 32	C2	0.5	7.0	92.5			3.9	3.1	6.7	18.2	22.2	24.0	21.4	36	11	1	93	48
96P2375S	32- 80	C3	0.1	6.6	93.3			2.8	3.8	8.1	19.6	23.1	23.2	19.3	30	15	1	92	46

DEPTH (In)	-1- ORGN C 6A1c	-2- TOTAL N 6B4a	-3- EXTR P 6S3b	-4- TOTAL S 6R3c	-5- DITH-CIT EXTRACTABLE FE 6C2b	-6- AL 6G7a	-7- MN 6D2a	-8- (RATIO/CLAY) CEC 8D1	-9- 15 BAR 8D1	-10- (ATTERBERG - LIMITS -) LL 4F1	-11- PI 4F	-12- (BULK DENSITY) FIELD MOIST 4A5	-13- 1/3 BAR 4A1d	-14- OVEN DRY 4A1h	-15- COLE WHOLE SOIL 4D1	-16- (WATER CONTENT) FIELD MOIST 4B4	-17- 1/10 BAR 4B1c	-18- 1/3 BAR 4B1c	-19- 15 BAR 4B2a	-20- WRD WHOLE SOIL 4C1
	PCT	<2MM	PPM	<- PERCENT	OF	<2MM -->				PCT <0.4MM		<- - G/CC		- ->	CM/CM	<- - -PCT OF <2MM			- ->	CM/CM
0- 3	4.03	0.518		0.4															8.3	
3- 17	1.74	0.459		0.4															5.4	
17- 32	2.56	0.513		0.4															4.9	
32- 80	1.46	0.319		0.3															5.5	

DEPTH (In)	-1- (NH4OAC EXTRACTABLE BASES) CA 5B5a 6N2e	-2- MG 5B5a 6O2d	-3- NA 5B5a 6P2b	-4- K 5B5a 6Q2b	-5- SUM BASES	-6- ACID- ITY 6H5a	-7- EXTR AL 6G9c	-8- (CEC) SUM CATS 5A3a	-9- NH4- OAC 5A8b	-10- BASES + AL 5A3b	-11- AL SAT 5G1	-12- BASE SAT- SUM 5C3	-13- NH4 OAC 5C1	-14- CO3 AS CACO3 <2MM 6E1g	-15- RES. OHMS /CM 8E1	-16-	-17- COND. MMHOS /CM 8I	-18- (PH) NAF 8C1d	-19- CACL2 .01M 8C1f 1:2	-20- H2O 8C1f 1:1
	<- - - - -				-MEQ / 100 G					- ->	<- - - - -PCT		- - ->							
0- 3	5.9	1.6	0.1	0.9	8.5	11.0	--	19.5	13.8			44	62					7.6	4.8	5.4
3- 17	3.1	0.5	0.2	0.5	4.3	6.9	0.1	11.2	9.1	4.4	2	38	47					7.8	4.6	5.3
17- 32	3.2	0.5	0.2	0.3	4.2	9.4	0.3	13.6	10.0	4.5	7	31	42					7.8	4.7	5.4
32- 80	4.2	1.0	0.2	0.2	5.6	6.2	--	11.8	8.4			47	67					7.8	4.9	5.6

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Appendix 25. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE	DEPTH	HORIZON	ENGINEERING PERCENTAGE PASSING SIEVE <-----INCHES----->						<-NUMBER->				PSDA SIEVE <-MICRONS->			CUMULATIVE CURVE FRACTIONS(<75mm) USDA LESS THAN <--- MILLIMETER --->					DIAMETERS(mm) AT <--PERCENTILE-->			ATTERBERG <-PCT>		GRADATION	
No.	(In.)		3	2	3/2	1	3/4	3/8	4	10	40	200	20	5	2	1.	.5	.25	.10	.05	60	50	10	LL	PI	UNI-FMTY CU	CUR-VTUR CC
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
96P2372S	0- 3	A	100	99	99	98	98	92	85	63	32	7	2	1	TR	49	35	20	9	4	1.72	1.031	0.112			15.3	0.8
96P2373S	3- 17	C1	100	100	100	99	99	94	88	65	30	7	3	1	TR	49	34	19	9	5	1.60	1.030	0.113			14.2	0.9
96P2374S	17- 32	C2	100	100	100	99	99	94	88	52	25	6	2	1	TR	41	28	17	7	4	2.42	1.766	0.129			18.8	1.0
96P2375S	32- 80	C3	FRACTIONS NOT DETERMINED																								

DEPTH	(WEIGHT FRACTIONS) ---WHOLE SOIL (mm)- <------PCT of WHOLE SOIL----->								-<75 mm FRACTION-- <--PCT OF <75 mm->						(WEIGHT PER UNIT VOLUME G/CC) ------WHOLE SOIL------ SOIL SURVEY		ENGINEERING		-------<2 mm FRACTION------- --SOIL SURVEY--			ENGINEERING		(VOID) --RATIOS-- AT 1/3 BAR	
(In.)	>2	250 -UP	250 -75	75 -2	75 -20	20 -5	5 -2	<2	75 -2	75 -20	20 -5	5 -2	<2		1/3 BAR	OVEN -DRY	MOIST	SATUR -ATED	1/3 BAR	15 BAR	OVEN -DRY	MOIST	SATUR -ATED	WHOLE SOIL	<2 mm
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0- 3	37	--	--	37	2	13	22	63	37	2	13	22	63		1.75										
3- 17	35	--	--	35	1	11	23	65	35	1	11	23	65		1.73										
17- 32	48	--	--	48	1	11	36	52	48	1	11	36	52		1.84										
32- 80	46	--	--	46	1	15	30	54	46	1	15	30	54		1.83										

DEPTH	(VOLUME FRACTIONS) ----WHOLE SOIL (mm) at 1/3 BAR--- <---------------PCT of WHOLE SOIL--------------->												(C/)(/N)	(RATIOS to CLAY) --------<2 mm FRACTION-------					(LINEAR EXTENSIBILITY) WHOLE SOIL <-1/3 BAR to (PCT)--->		--<2 mm--		(W R D) <--In/In->	
(In.)	>2	250 -UP	250 -75	75 -2	75 -20	20 -5	5 -2	<2	2- .05	.05- .002	LT .002	PORES D	PORES F	RAT -IO	FINE CLAY	---CEC-- SUM CATS	NH4- OAC	15 BAR H2O	LEP 1/3 BAR	15 BAR	OVEN -DRY	15 BAR	OVEN -DRY	WHOLE SOIL	<2 mm
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
0- 3	25	--	--	25	1	9	15	75	39	3		34		8		48.75	34.50	20.75							
3- 17	23	--	--	23	1	7	15	77	39	3		35		4		37.33	30.33	18.00							
17- 32	33	--	--	33	1	8	25	67	33	3		31		5		27.20	20.00	9.80							
32- 80	32	--	--	32	1	10	21	68	35	3		31		5		118.00	84.00	55.00							

DEPTH	(WEIGHT FRACTIONS-CLAY FREE) (--WHOLE SOIL--) PCT of >2mm+SAND+SILT >						(--<2 mm FRACTION----) <------PCT of SAND+SILT-------> ------SANDS-------					SILTS		CL AY	(-TEXTURE--)(DETERMINED) <---<2 mm-->		(--PSDA(mm)---)(SAND SILT CLAY) <---PCT of 2mm--->			(PH) <----- <2mm ----->	(-ELECTRICAL)<		< >		
(In.)	>2	75 -2	20 -2	2- .05	.05- .002	LT .002	VC	C	M	F	VF	C	F		IN FIELD	BY PSDA	2- .05	.05- .002	LT .002	CA- CL2 .01M	RES- IST. OHMS	CON- DUCT. MMHOS			
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 3	37	37	35	59	4	TR	22	22	24	19	7	3	3	TR		COS	93.2	6.4	0.4	4.8					
3- 17	35	35	34	60	4	TR	24	23	23	17	6	3	4	TR		COS	92.8	6.9	0.3	4.6					
17- 32	48	48	47	48	4	TR	22	24	22	18	7	3	4	1		COS	92.5	7.0	0.5	4.7					
32- 80	46	46	45	50	4	TR	19	23	23	20	8	4	3	TR		COS	93.3	6.6	0.1	4.9					

Appendix 26. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Sandyhook

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Far Rockaway
Latitude: 40 degrees 35 minutes 47 seconds N
Longitude: 73 degrees 50 minutes 20 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 348°**
Slope Shape: Concave-Linear
Elevation: 0 feet (at sea level)
Physiography:
Local: Barrier beach **Major: Glaciated coastal plain**
Hillslope - Profile Position: Toeslope **Geomorphic Component: Base slope**
Geographically Associated Soils: Barren, Fortress, Hooksan, Ipswich, Matunuck and Pawcatuck
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 0 to 12 inches above **Water Table Kind: Apparent** **Duration: Throughout the year**
Flooding Information
Frequency: Frequent
Duration: very brief
Ponding Information
Frequency: None

Official Series Classification: Sandy, mixed, mesic Typic Sulfaquents
Moisture Regime: Aquic moisture regime
Landuse: Wildlife refuge
Permeability: Rapid
Natural Drainage Class: Very poorly drained
Parent material: Sandy materials
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon - up to 3 inches thick; Particle size class - sandy, less than 10 percent coarse fragments.
Described by: F. Gilbert and W. Hanna

A - 0 to 3 inches; dark gray (2.5Y 4/1) mucky fine sandy loam; weak fine granular structure; very friable; many fine and medium roots; neutral; abrupt smooth boundary.

AC - 3 to 12 inches; gray (2.5Y 6/1) fine sandy loam; weak fine granular structure; very friable; common fine and medium roots; common fine distinct dark yellowish brown (10YR 4/4) oxidized rhizosphere redoximorphic features; neutral; clear smooth boundary.

Cl - 12 to 16 inches; gray (5Y 5/1) sand; single grain; loose; few medium roots; few fine distinct dark yellowish brown (10YR 4/4) oxidized rhizosphere redoximorphic features; neutral; gradual smooth boundary.

C2 - 16 to 26 inches; gray (5Y 5/1) sand; single grain; loose; moderately alkaline; gradual smooth boundary.

C3 - 26 to 72 inches; gray (N 5/0) sand; single grain; loose; moderately alkaline.

Appendix 27. Selected soil pedon descriptions.

Soil Survey Site Identification #: Soil Series: Shea

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Jamaica
Latitude: 40 degrees 44 minutes 43 seconds N
Longitude: 73 degrees 50 minutes 30 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 80°**
Slope Shape: linear- linear
Elevation: 15 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope Profile Position: **Geomorphic Component: Slope**
Geographically Associated Soils: Bulkhead, Centralpark, Greenbelt, and Inwood
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information **Ponding Information**
Frequency: None **Frequency: None**

Official Series Classification: Coarse-loamy, mixed, active, nonacid, mesic Typic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderate in loamy fill, impermeable asphalt layer
Natural Drainage Class: Well drained
Parent material: thin loamy mantle of anthropotransported natural loamy soil materials overlying an impermeable asphalt layer
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; 2Cm horizon, rigid asphalt layer; A diagnostic horizon has been proposed to designate concrete and asphalt layers.
Described by: L. A. Hernandez and R.B. Tunstead

A - 0 to 3 inches; dark yellowish brown (10YR 3/4) sandy loam; weak very fine subangular blocky structure; very friable; many very fine and fine, and few medium and coarse roots; 1 percent gravel; strongly acid; clear wavy boundary.

Bw - 3 to 11 inches; dark yellowish brown (10YR 4/4) sandy loam; weak very fine subangular blocky structure; very friable; many very fine and fine roots; 1 percent gravel; moderately acid; clear wavy boundary.

C - 11 to 16 inches; dark yellowish brown (10YR 4/6) sandy loam; massive structure; very friable; common very fine roots; 8 percent gravel (3 percent coal ash, 2 percent asphalt fragments, and 3 percent natural rock fragments); moderately acid; abrupt smooth boundary

2Cm - 16 to 24 inches; unweathered impermeable asphalt; massive; rigid.

3C - 24 to 65 inches; dark yellowish brown (10YR 4/4) sandy loam; massive; friable.

Appendix 28. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #: 98NY081001 Soil Series: Verrazano

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 33 minutes 48.1 seconds N
Longitude: 73 degrees 52 minutes 47.6 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 1 percent **Aspect: 20°**
Slope Shape: Linear-Linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Barrier Island**
Hillslope - Profile Position: **Geomorphic Component: Side slope**
Geographically Associated Soils: Hooksan, Bigapple, Fortress, Barren, Jamaica
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: Greater than 72 inches
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, nonacid, mesic Typic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderate in the surface and subsoil; rapid in substratum (moderately slow in the surface if compacted)
Natural Drainage Class: Well Drained
Parent material: Loamy fill over sandy sediments
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; Non-cambic horizon, 3 to 17 inches
Described by: J. M. Galbraith, L. A. Hernandez, and R. B. Tunstead

A - 0 to 3 in.; very dark gray (10YR 3/1) sandy loam; moderate medium subangular blocky structure; very friable; common very fine and fine roots throughout; common very fine and fine tubular pores; extremely acid; clear smooth boundary.

Bw - 3 to 17 in.; very dark grayish brown (10YR 3/2) sandy loam; moderate medium subangular blocky structure; friable; common very fine and fine roots throughout; common very fine and fine tubular pores; 6 percent gravel; very strongly acid; clear wavy boundary.

BC - 17 to 24 in.; very dark grayish brown (10YR 3/2) loam; moderate medium subangular blocky structure; friable; common very fine and fine roots throughout; few medium distinct strong brown (7.5YR 5/6) redoximorphic features inherited from anthropotransported parent material; common very fine and fine tubular pores; 5 percent gravel; strongly acid; abrupt wavy boundary.

2C1 - 24 to 60 in.; 95 percent light yellowish brown (2.5Y 6/3) and 5 percent reddish gray (5YR 5/2) sand; massive; very friable; common very fine roots throughout; 2 percent gravel; moderately acid; clear wavy boundary.

2C2 - 60 to 80 in.; light olive brown (2.5Y 5/3) sand; massive; very friable; 1 percent gravel; slightly acid.

Appendix 28. Selected soil pedon descriptions with physical and chemical analyses (continued).

S98NY-081-001; VERAZANO LABORATORY DATA
- PEDON 98P 353, SAMPLES 98P 2078- 2082
- GENERAL METHODS 1B1A, 2A1, 2B

			-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
			(- - -TOTAL - - -)			(- -CLAY- -)		(- -SILT- -)		(- - - - - -SAND- - - - - -)					(-COARSE FRACTIONS(MM)-)				(>2MM)
			CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	- - - - WEIGHT - - - -				WT
SAMPLE	DEPTH	HORIZON	LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	PCT OF
NO.	(In)		.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	WHOLE
			<- - - - - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - - - - - ->												<- PCT OF <75MM(3B1)->				SOIL
98P2078S	0- 3	A	9.8	33.5	56.7			17.6	15.9	6.5	18.4	22.9	7.7	1.2	TR	TR	--	50	--
98P2079S	3- 17	Bw	10.3	33.3	56.4			18.4	14.9	7.4	17.5	21.4	7.5	2.6	3	3	--	52	6
98P2080N	17- 24	BC	10.9	41.9	47.2			21.5	20.4	5.5	8.5	17.9	12.1	3.2					
98P2081S	24- 60	2C1	0.2	0.9	98.9			--	0.9	1.1	49.6	45.6	2.3	0.3	1	1	--	98	2
98P2082S	60- 80	2C2	--	0.4	99.6			0.2	0.2	0.4	30.0	62.5	6.0	0.7	TR	TR	--	99	TR

	ORGN	TOTAL	EXTR	TOTAL	(- - DITH-CIT - -)			(RATIO/CLAY)		(ATTERBERG)		(- BULK DENSITY -)			COLE	(- - -WATER CONTENT - -)				WRD
	C	N	P	S	EXTRACTABLE				15	- LIMITS -		FIELD	1/3	OVEN	WHOLE	FIELD	1/10	1/3	15	WHOLE
DEPTH					FE	AL	MN	CEC	BAR	LL	PI	MOIST	BAR	DRY	SOIL	MOIST	BAR	BAR	BAR	SOIL
(In)	6A1c	6B4a	6S3b	6R3c	6C2f	6G7e	6D2e	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT OF <2MM -->						PCT <0.4MM		<- - G/CC - - ->			CM/CM	<- - -PCT OF <2MM - ->				CM/CM
0- 3		0.361	242		1.04	0.44	0.09	1.37	1.23				1.13	1.25	0.034			32.6	12.1	0.23
3- 17		0.148			1.11	0.48	0.09	0.94	0.57				1.29	1.36	0.017			23.0	5.9	0.21
17- 24		0.123			1.24	0.45	0.09	0.68	0.47				1.41	1.46	0.011			20.7	5.1	0.21
24- 60		0.030			0.37	0.20	0.05												0.5	
60- 80					0.41	0.26	0.06												0.6	

AVERAGES, DEPTH 25-100: PCT CLAY 5

	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
	(- NH4OAC EXTRACTABLE BASES -)					ACID-	EXTR	(- - - -CEC - - -)			AL	-BASE SAT-		CO3 AS	RES.		COND.	(- - - -PH - - -)		
	CA	MG	NA	K	SUM	ITY	AL	SUM	NH4-	BASES	SAT	SUM	NH4	CACO3	OHMS		MMHOS		CACL2	H2O
DEPTH	5B5a	5B5a	5B5a	5B5a	BASES			CATS	OAC	+ AL			OAC	<2MM	/CM		/CM		.01M	
(In)	6N2f	6O2e	6P2c	6Q2c		6H5a	6G9c	5A3a	5A8b	5A3b	5G1	5C3	5C1	6E1g	8E1		8I		8C1f	8C1f
	<- - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - - ->										<- - - - -PCT - - - ->								1:2	1:1
0- 3	2.0	1.5	0.2	0.7	4.4	15.3	1.6	19.7	13.4	6.0	27	22	33						4.2	4.4
3- 17	0.5	0.5	0.2	0.4	1.6	13.1	2.5	14.7	9.7	4.1	61	11	16						4.1	4.6
17- 24	2.8	0.7	0.1	0.3	3.9	7.2	1.1	11.1	7.4	5.0	22	35	53						4.6	5.2
24- 60	1.8	0.1	TR	0.2	2.1	0.1		2.2	0.6			95	100						5.5	6.0
60- 80	1.9	0.2	0.1	0.2	2.4	--		2.4	0.6			100	100						5.9	6.3

Appendix 28. Selected soil pedon descriptions with physical and chemical analyses (continued).

SAMPLE No.	DEPTH (In.)	HORIZON	ENGINEERING PERCENTAGE PASSING SIEVE: INCHES 3 (1)	2 (2)	3/2 (3)	1 (4)	3/4 (5)	3/8 (6)	NUMBER 4 (7)	10 (8)	40 (9)	200 (10)	PSDA MICRONS 20 (11)	5 (12)	2 (13)	CUMULATIVE CURVE FRACTIONS (<75mm) USDA LESS THAN MILLIMETER 1. (14)	.5 (15)	.25 (16)	.10 (17)	.05 (18)	DIAMETERS(mm) AT PERCENTILE 60 (19)	50 (20)	10 (21)	ATTERBERG PCT LL (22)	PI (23)	GRADATION UNIFMTY CU (24)	CURVTUR CC (25)
98P2078S	0- 3	A	100	100	100	100	100	100	100	100	85	47	27	17	10	99	91	68	50	43	0.17	0.101	0.002			80.9	1.6
98P2079S	3- 17	Bw	100	100	100	100	100	99	97	94	79	45	27	17	10	92	85	64	48	41	0.20	0.112	0.002			93.8	1.5
98P2080N	17- 24	BC	100	100	100	100	100	98	96	93	75	52	30	18	10	90	79	62	54	49	0.20	0.056	0.002			>100	1.0
98P2081S	24- 60	2C1	100	100	100	100	100	100	99	98	84	2	TR	TR	TR	98	95	51	2	1	0.29	0.246	0.116			2.5	0.9
98P2082S	60- 0	2C2	FRACTIONS NOT DETERIMINED																								

DEPTH (In.)	WEIGHT FRACTIONS, PCT of WHOLE SOIL (mm): >2 (26)	250-UP (27)	250-75 (28)	75-2 (29)	75-20 (30)	20-5 (31)	5-2 (32)	<2 (33)	<75 mm FRACTION, PCT OF <75 mm: 75-2 (34)	75-20 (35)	20-5 (36)	5-2 (37)	<2 (38)	(39)	WEIGHT PER UNIT VOLUME G/CC, WHOLE SOIL: SOIL SURVEY 1/3 BAR (40)	SOIL SURVEY OVEN-DRY (41)	ENGINEERING MOIST (42)	ENGINEERING SATURATED (43)	<2 mm FRACTION: SOIL SURVEY 1/3 BAR (44)	SOIL SURVEY 15 BAR (45)	SOIL SURVEY OVEN-DRY (46)	ENGINEERING MOIST (47)	ENGINEERING SATURATED (48)	VOID RATIOS AT 1/3 BAR: WHOLE SOIL (49)	<2 mm (50)
0- 3	TR	--	--	--	--	--	TR	100	--	--	--	TR	100		1.13	1.25	1.50	1.70	1.13	1.21	1.25	1.50	1.70	1.35	1.35
3- 17	6	--	--	6	--	3	3	94	6	--	3	3	94		1.33	1.40	1.62	1.83	1.29	1.35	1.36	1.59	1.80	0.99	1.05
17- 24	7	--	--	7	--	4	3	93	7	--	4	3	93		1.46	1.51	1.74	1.91	1.41	1.45	1.46	1.70	1.88	0.82	0.88
24- 60	2	--	--	2	--	1	1	98	2	--	1	1	98		1.46										
60- 0	TR	--	--	--	--	TR	TR	100	--	--	TR	TR	100		1.45										

DEPTH (In.)	VOLUME FRACTIONS at 1/3 BAR, PCT of WHOLE SOIL (mm): >2 (51)	250-UP (52)	250-75 (53)	75-2 (54)	75-20 (55)	20-5 (56)	5-2 (57)	<2 (58)	2-.05 (59)	.05-.002 (60)	LT .002 (61)	PORES D (62)	PORES F (63)	(C/N) RATIO (64)	RATIOS to CLAY, <2 mm FRACTION: FINE CLAY (65)	CEC SUM CATS (66)	CEC NH4-OAC (67)	15 BAR H2O (68)	LEP 1/3 BAR (69)	LINEAR EXTENSIBILITY <-1/3 BAR to (PCT): WHOLE SOIL 15 BAR (70)	WHOLE SOIL OVEN-DRY (71)	<2 mm 15 BAR (72)	<2 mm OVEN-DRY (73)	WRD In/In: WHOLE SOIL (74)	<2 mm (75)
0- 3	TR	--	--	--	--	--	TR	100	24	14	4	20	37			2.01	1.37	1.23	0.347	2.3	3.4	2.3	3.4	0.23	0.23
3- 17	3	--	--	3	--	2	2	97	27	16	5	21	29			1.43	0.94	0.57	0.175	1.2	1.7	1.5	1.8	0.21	0.22
17- 24	4	--	--	4	--	2	2	96	24	21	6	17	28			1.02	0.68	0.47	0.110	0.9	1.1	0.9	1.2	0.21	0.22
24- 60	1	--	--	1	--	1	1	99	53			45				11.00	3.00	2.50							
60- 0	TR	--	--	--	--	TR	TR	100	54			45													

Appendix 28. Selected soil pedon descriptions with physical and chemical analyses (continued).

DEPTH (In.)	(W E I G H T F R A C T I O N S - C L A Y F R E E) (--W H O L E S O I L--)						(--<2 mm F R A C T I O N ----)								(-TEXTURE--) (DETERMINED)		(--P S D A(mm)---)			(PH)	(-ELECTRICAL)		< >		
	>2	75 -2	20 -2	2- .05	.05- .002	LT .002	VC	C	M	F	VF	SILTS C	SILTS F	CLAY	IN FIELD	BY PSDA	SAND 2- .05	SILT .05- .002	CLAY LT .002	CA-CL2 .01M	RES-IST. OHMS	CON-DUCT. MMHOS	< >	< >	< >
	PCT of >2mm+SAND+SILT >						<------PCT of SAND+SILT------->								<---<2 mm-->		<---PCT of 2mm--->			<----- <2mm ----->			<--------------->		
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0- 3				63	37	11	1	9	25	20	7	18	20	11		SL	56.7	33.5	9.8	4.2					
3- 17	7	7	7	59	35	11	3	8	24	20	8	17	21	11		SL	56.4	33.3	10.3	4.1					
17- 24	8	8	8	49	43	11	4	14	20	10	6	23	24	12		L	47.2	41.9	10.9	4.6					
24- 60	2	2	2	97	1	TR	TR	2	46	50	1	1		TR		S	98.9	0.9	0.2	5.5					
60- 0				100	TR		1	6	63	30	TR	TR	TR			S	99.6	0.4	--	5.9					

Appendix 29. Selected soil pedon descriptions with physical and chemical analyses.

Soil Survey Site Identification #:S95NY085035 Soil Series: **Wethersfield

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Arthur Kill
Latitude: 40 degrees 34 minutes 24.25 seconds N
Longitude: 74 degrees 9 minutes 26.53 seconds W
Description Category: Full pedon description
Pedon Category: Typical pedon for series
Slope Characteristics Information
- **Slope: 8 percent** — **Aspect: 280°**
- **Slope Shape: Linear-Convex**

Elevation: 132 feet
Physiography:
- **Local: Ridge** — **Major: Terminal Moraine**
- **Hillslope - Profile Position: Shoulder** — **Geomorphic Component: Side slope**

Geographically Associated Soils: Cheshire
Climate Information
- **Precipitation: 40 to 50 inches per year**

Water Table Information
- **Water Table Depth: 22 to 35 inches** — **Water Table Kind: Perched** — **Duration: Nov. through May**

Flooding Information
- **Frequency: None**

Ponding Information
- **Frequency: None**

Official Series Classification: ** Coarse-loamy, mixed, superactive, mesic Oxyaquic Dystrudepts
Moisture Regime: Udic moisture regime
Landuse: Park land
Permeability: Moderate in surface and subsoil and slow to very slow in the substratum
Natural Drainage Class: Well drained
Parent material: Dense glacial till
Plant Association: Hardwoods
Particle Size Control Section: 10 to 35 inches
Diagnostic Features: Ochric epipedon, 0 to 10 inches; Cambic horizon, 22 to 35 inches; Dense basal till substratum, 35 to 63 inches
Described by: J. M. Galbraith and L. A. Hernandez

Oa - 0 to 2 in.; very dark brown (10YR 2/2) highly decomposed organic material; many very fine to coarse roots throughout; 5 percent gravel, 2 percent cobble and 5 percent stone; extremely acid; abrupt smooth boundary.

Ap - 2 to 10 in.; brown (10YR 4/3) gravelly sandy loam; weak medium subangular blocky structure; very friable; many very fine to coarse roots throughout; common fine pores; 31 percent gravel and 2 percent cobbles; extremely acid; abrupt wavy boundary.

E - 10 to 14 in.; strong brown (7.5YR 5/6) gravelly sandy loam; weak medium subangular blocky structure; friable; common very fine to coarse roots throughout; common fine pores; 14 percent gravel and 5 percent cobbles; moderately acid; clear wavy boundary.

BE - 14 to 22 in.; yellowish red (5YR 4/6) gravelly coarse sandy loam; weak coarse subangular blocky structure; friable; common very fine and fine roots throughout; common very fine pores; 12 percent gravel and 5 percent stone; very strongly acid; clear wavy boundary.

Bw - 22 to 35 in.; reddish brown (2.5YR 4/4) gravelly sandy loam; weak coarse subangular blocky structure; friable; common very fine and fine roots; common coarse faint reddish brown (5YR 4/4) and red (2.5YR 4/6) redoximorphic features; common fine pores; 23 percent gravel and 5 percent cobbles; very strongly acid; clear wavy boundary.

Cd1 - 35 to 43 in.; red (2.5YR 4/6) very gravelly sandy loam; massive; firm; common fine and medium pores; 35 percent gravel and 5 percent cobbles; very strongly acid; diffuse wavy boundary.

Cd2 - 43 to 63 in.; red (2.5YR 4/6) gravelly sandy loam; massive; firm; common fine and medium pores; 27 percent gravel and 5 percent cobbles; very strongly acid.
**** Taxadjunct, CEC activity class is out of the range of characteristics for Wethersfield series.**

Appendix 29. Selected soil pedon descriptions with physical and chemical analyses (continued).

S95NY-085-035; WETHERSFIELD LABORATORY DATA

SAMPLE NO.	DEPTH (In)	HORIZON	-4-- CLAY LT .002	-5-- SILT .002 -.05	-6-- SAND .05 -2	-7-- FINE CLAY LT .0002	-8-- CO3 CLAY LT .002	-9-- FINE SILT .002 -.02	-10- COARSE SILT .02 -.05	-11- VF SAND .05 -.10	-12- F SAND .10 -.25	-13- M SAND .25 -.50	-14- C SAND .5 -1	-15 VC SAND 1 -2
			<- - -	- - -	- - -	- - -	- PCT OF <2MM	(3A1) - -	- - -	- - -	- - -	- - -	- - -	- ->
96P1399H	0- 0	L												
96P1400H	0- 2	Oa												
96P1401S	2- 10	Ap	6.9	28.0	65.1			15.9	12.1	9.1	16.7	20.9	11.5	6.9
96P1402S	10- 14	BE1	5.4	26.1	68.5			15.1	11.0	9.5	16.6	21.4	13.6	7.4
96P1403S	14- 22	BE2	5.2	25.8	69.0			14.9	10.9	8.6	15.1	20.2	14.6	10.5
96P1404S	22- 35	Bw	7.1	26.1	66.8			14.8	11.3	9.7	15.2	19.7	14.6	7.6
96P1405S	35- 43	Cd1	9.2	30.3	60.5			17.2	13.1	10.3	14.4	18.0	12.3	5.5
96P1406S	43- 63	Cd2	9.1	27.2	63.7			15.3	12.0	10.2	15.4	18.9	12.7	6.5

DEPTH (In)	ORGN C 6A1c PCT	TOTAL N 6B4a <2MM	EXTR P 6S3b PPM	TOTAL S 6R3c <- PERCENT	DITH-CIT EXTRACTABLE FE 6C2b	DITH-CIT EXTRACTABLE AL 6G7a OF	DITH-CIT EXTRACTABLE MN 6D2a <2MM -->	(RATIO/CLAY) CEC 8D1	(RATIO/CLAY) 15 BAR 8D1	(ATTERBERG LIMITS) LL 4F1 PCT	(ATTERBERG LIMITS) PI 4F <0.4MM	(BULK DENSITY) FIELD MOIST 4A5 <- -	(BULK DENSITY) 1/3 BAR 4A1d G/CC	(BULK DENSITY) OVEN DRY 4A1h - - ->	COLE WHOLE SOIL 4D1 CM/CM	(WATER CONTENT) FIELD MOIST 4B4 <- -	(WATER CONTENT) 1/10 BAR 4B1c -PCT	(WATER CONTENT) 1/3 BAR 4B1c OF <2MM	(WATER CONTENT) 15 BAR 4B2a - ->	WRD WHOLE SOIL 4C1 CM/CM
0- 0	41.0	1.814																	132.0	
0- 2	12.8	0.590		0.1															20.0	
2- 10	2.70	0.150			1.1	0.3	0.1	1.33	0.94										6.5	
10- 14	0.93	0.044			1.0	0.2	0.1	0.89	0.59										3.2	
14- 22	0.23	0.005			1.0	0.2	0.1	0.73	0.52										2.7	
22- 35	0.07	0.006			1.2	0.2	0.1	0.65	0.52										3.7	
35- 43	0.08	0.001			1.3	0.2	0.1	0.61	0.46										4.2	
43- 63	0.03	0.001			1.2	0.2	0.1	0.57	0.44										4.0	

AVERAGES, DEPTH 25-100: PCT CLAY 7 PCT .1-75MM 74

Appendix 29. Selected soil pedon descriptions with physical and chemical analyses (continued).

DEPTH (In)	-1--	-2--	-3--	-4--	-5--	-6--	-7--	-8--	-9--	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
	(- NH4OAC EXTRACTABLE BASES -)					ACID-	EXTR	(- - - -CEC - - -)			AL	-BASE SAT-		CO3 AS	RES.		COND.	(- - - -PH - - -)		
	CA 5B5a 6N2e	MG 5B5a 6O2d	NA 5B5a 6P2b	K 5B5a 6Q2b	SUM BASES	ITY 6H5a	AL 6G9c	SUM CATS 5A3a	NH4- OAC 5A8b	BASES + AL 5A3b	SAT 5G1	SUM 5C3	NH4 OAC 5C1	CACO3 <2MM 6E1g	OHMS /CM 8E1		MMHOS /CM 8I		CACL2 .01M 8C1f	H2O 8C1f
	<- - - - - - - - - - - - -MEQ / 100 G - - - - - - - - - - - - ->										<- - - - -PCT - - - - ->								1:2	1:1
0- 0																				
0- 2	1.2	2.4	0.9	1.5	6.0	31.2		37.2	34.9			16	17						3.4	4.0
2- 10	TR	0.3	0.9	0.5	1.7	14.1	2.9	15.8	9.2	4.6	63	11	18						3.9	4.3
10- 14	TR	0.3	0.4	0.5	1.2	6.4	1.2	7.6	4.8	2.4	50	16	25						4.2	5.8
14- 22	--	0.3	0.3	1.1	1.7	3.6	1.1	5.3	3.8	2.8	39	32	45						4.2	4.6
22- 35	0.6	0.9	0.9	0.9	3.3	4.2	0.7	7.5	4.6	4.0	17	44	72						4.2	4.9
35- 43	0.3	0.9	0.4	0.7	2.3	5.0	1.8	7.3	5.6	4.1	44	32	41						4.0	4.6
43- 63	0.7	0.5	0.6	0.8	2.6	4.9	1.1	7.5	5.2	3.7	30	35	50						4.2	4.8

Appendix 30. Selected soil pedon descriptions.

Soil Survey Site Identification #: S99NY047005 Soil Series: Winhole

Major Land Resource Area (MLRA): 149B
Soil Survey Area Name: National Park Service, Gateway National Recreation Area
Quadrangle Name: Coney Island
Latitude: 40 degrees 35 minutes 47.74 seconds N
Longitude: 73 degrees 54 minutes 0.52 seconds W
Description Category: Full pedon description
Pedon Category: Type location for series
Slope Characteristics Information
Slope: 2 percent **Aspect: 50°**
Slope Shape: Convex-linear
Elevation: 10 feet
Physiography:
Local: Fill **Major: Human made land**
Hillslope - Profile Position: **Geomorphic Component: Slope**
Geographically Associated Soils: These deposits do not have any correlation to existing soils and may occur anywhere.
Climate Information
Precipitation: 40 to 50 inches per year
Water Table Information
Water Table Depth: 24 to 40 inches **Water Table Kind: Apparent** **Duration: Nov. through May**
Flooding Information
Frequency: None
Ponding Information
Frequency: None

Official Series Classification: Coarse-loamy, mixed, active, nonacid, mesic Aquic Udorthents
Moisture Regime: Udic moisture regime
Landuse: Wildlife refuge
Permeability: Moderate
Natural Drainage Class: Moderately well drained
Parent material: Incinerator fly ash
Plant Association: Grass and herbaceous cover
Particle Size Control Section: 10 to 40 inches
Diagnostic Features: Ochric epipedon, 0 to 3 inches; Rock fragments in the particle size control section average less than 35 percent by volume; Aquic conditions - between 24 to 40 inches.
Described by: L. A. Hernandez and K. Alamarie

A - 0 to 6 inches; very dark grayish brown (10YR 3/2) sandy loam; weak very fine granular structure; very friable; many very fine and fine roots throughout; 5 percent coarse fragments (2 percent bricks, 1 percent metals, 1 percent glass, 1 percent natural rock fragments); neutral; clear smooth boundary.

C1 - 6 to 20 inches; yellowish brown (10YR 5/4) sandy loam; massive; very friable; few coarse prominent reddish yellow (7.5 YR 6/6) redoximorphic features; many very fine and fine roots throughout; 10 percent coarse fragments (4 percent bricks, 2 percent metals, 2 percent glass, 2 percent natural rock fragments); neutral; clear wavy boundary.

C2 - 20 to 30 inches; pale brown (10YR 6/3) sandy loam; massive; very friable; many coarse prominent strong brown (7.5YR 5/8) redoximorphic features; 10 percent coarse fragments (4 percent bricks, 1 percent metals, 1 percent glass, 2 percent carboliths, 2 percent natural rock fragments); neutral; clear wavy boundary.

C3 - 30 to 45 inches; yellowish brown (10YR 5/6) sandy loam; massive; very friable; few fine distinct light brownish gray (10YR 6/2) redoximorphic features; 10 percent coarse fragments (4 percent bricks, 1 percent metals, 1 percent glass, 2 percent carboliths, 2 percent natural rock fragments); neutral; clear wavy boundary.

C4 - 45 to 65 inches; yellowish brown (10YR 5/6) gravelly sandy loam; massive; very friable; few fine distinct light brownish gray (10YR 6/2) redoximorphic features; 15 percent coarse fragments (5 percent bricks, 2 percent metals, 5 percent glass, 2 percent carboliths, 1 percent natural rock fragments); neutral.

Glossary

ablation till The loose or friable, relatively permeable material, either contained within or accumulated on the surface of a glacier, and deposited during the melting of glacial ice.

aerobic In the presence of molecular oxygen, or referring to an organism requiring the presence of oxygen for growth.

aggregation The process whereby primary soil particles (sand, silt, clay) are bound together in a larger aggregate or clod.

allophane Aluminosilicate mineral with a partially random arrangement of atoms, which usually occurs as exceedingly small spherical particles, common in soils formed from volcanic ash. Allophane has a low bulk density, high water and nutrient holding capacity, and a high amount of potential adsorbing surface.

alluvium Sediments deposited by the flowing water of streams and rivers. Alluvium occurs on terraces well above present day hydrology, on present flood plains or deltas, or as a fan at the base of a slope. Textures of alluvium can range from sand to clay, and coarse fragments such as gravel can be found.

anaerobic In the absence of molecular oxygen, or referring to an organism which is found in the absence of molecular oxygen.

amorphous material Clay sized mineral soil material without regular crystalline form, characterized by a very high amount of potential adsorbing surface.

anthropogenic Having a strong human influence. Anthropopedogenesis refers to soil forming processes resulting from human activity. Anthropogeomorphic, or anthrogeomorphic activities include excavation, (anthropo)transport, and (anthropic) deposition that result in the alteration of the shape of a natural landform, or the creation of an artificial landform.

aquic A soil moisture regime nearly free of dissolved oxygen due to saturation by groundwater or its capillary fringe.

aquifer A saturated, permeable geologic unit of sediment or rock that can transmit significant quantities of water.

artifacts Human altered material, observed in the >2mm fraction, including coal ash, iron ore slag, asphalt; human refuse such as garbage or sewage sludge; human processed natural materials such as lumber; and human manufactured material such as plastic, fiberglass, brick, cinder block, concrete, iron and steel, organic byproducts, and other building debris. Garbage or refuse fragments include food and household cooking waste, soiled rags and paper cleaning products, broken household objects, empty glass, paper, and plastic containers and bags, mail, magazines, and newspapers, and simple household construction materials normally disposed of by homeowners and transported to dumps and landfills.

artificial drainage Lowering of a groundwater table.

artificial land form An area in the landscape as large or larger than a polypedon that has evidence of mining or reclamation, excavation more than 50 cm deep, or anthropic deposition more than 50 cm thick. Evidence may be morphological, chemical, mineralogical, historical, or comparative polypedon/land form study.

available water capacity The capability of a soil to hold water available for use by most plants; the difference between the amount of soil water at field capacity and the amount at wilting point. The units of expression are either percent by volume, or inches of water per inch of soil (in in^{-1}).

backslope The hillslope position that forms the steepest, and generally linear, middle portion of the slope. In profile, the backslope is bordered by the convex shoulder above, and the concave footslope below.

basal till Unconsolidated material deposited and compacted beneath a glacier, and having a relatively high bulk density.

baseflow That portion of stream flow derived from the seepage of groundwater.

beach A gently sloping area adjacent to a lake or ocean water body that lies between the low and high water marks, which is devoid of vegetation, and is composed of unconsolidated material, typically sand or gravel which was deposited by waves or tides.

bedrock A general term for the solid rock that underlies the soil and other unconsolidated material, or is exposed at the ground surface.

bioremediation The use of biological agents to reclaim soil and water polluted by substances hazardous to the environment or human health.

boulders Coarse fragments greater than 600 mm (24 inches) in diameter.

bulk density The mass of dry soil per unit volume.

buried soil Soil covered by an alluvial, loess, or other surficial mantle of more recent deposition, usually to a depth greater than 50 cm.

camp areas A soil interpretation or rating for tracts of land used intensively as sites for tents, trailers, campers, and the accompanying activities of outdoor living. Areas require such site preparation as shaping and leveling in the areas used for tents and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Areas are also subject to heavy foot traffic and some vehicular traffic.

carbolith Carbolith is a name coined at West Virginia University to describe dark colored sedimentary rocks that will make a black or very dark (Munsell color value of 3 or less) streak or powder. Carboliths consists of coal not scheduled for mining, impure waste coal, bone coal, high carbon siltstones, and high carbon shales; Coal ash supplies accumulated over more than one hundred years of time when hard coal was the main source of heating and producer of heat for production of electricity. The material often contains debris tossed in furnaces during burning. Areas used as railroad beds contain buried railroad ties and large pieces of coal used as ballast.

catena A sequence of soils across a landscape, of about the same age, derived from similar parent material, and occurring under similar climatic conditions, but having different characteristics due to variation in relief and in drainage.

cation A positively charged ion. Among the more common cations found in soils are hydrogen (H^+), aluminum (Al^{+3}), calcium (Ca^{+2}), magnesium (Mg^{+2}), and potassium (K^+). Most heavy metals also exist as cations in the soil environment.

cation exchange A rapid, reversible process by which an adsorbed cation, or positively charged ion, is replaced by another cation on a negatively charged clay or organic matter particle in soil. Upon their replacement, cations enter the soil solution, where they can be taken up by plants, react with other soil constituents, or be carried away with drainage water.

cation-exchange activity class Cation exchange capacity (CEC) is the sum of exchangeable cations, that a soil can adsorb, often measured at pH 7.0, and usually expressed in centimoles of charge per kilogram of soil. The activity class, the CEC to clay ratio, serves as an index of clay activity. CEC activity classes are:

Superactive	0.60 or more
Active	0.40 to 0.60
Semiactive	0.20 to 0.40
Subactive	Less than 0.24

channer A thin, flat coarse fragment measuring up to 150 mm (6 inches) on the long axis.

chroma The relative purity, strength, or saturation of a color, inversely related to grayness. One of the three variables of color, displayed on a Munsell color page horizontally, and increasing from left to right.

clay Mineral soil separate consisting of particles less than 0.002 millimeters in diameter, usually characterized by a high surface area and an electrical charge. Clay particles impart a sticky and plastic feel to moist soils.

clean fill or soil Soil material containing less than 10 percent by volume of artifacts is considered “clean.”

cobble A coarse fragment 75 to 250 mm (3 to 10 inches) in diameter.

colluvium Unconsolidated, unsorted earth material being transported or deposited on sideslopes and/or at the base of slopes by mass movement (e.g., gravitational forces) and by local, unconcentrated runoff.

compaction The process by which the soil grains are rearranged to decrease void space and bring them into closer contact with one another, thereby increasing the bulk density.

complex (soil complex) A map unit with two kinds of soil so intermixed that it is not practical to separate them at the map scale being used.

consistence Degree of cohesion and adhesion of the soil mass, or the resistance of aggregated soil material to deformation or rupture. Consistence is dependent upon moisture content.

control section That part of the soil profile on which classification is based. The thickness and depth may vary, but for many soils it is the area between 10 inches and 40 inches below the soil surface.

corrosion Soil-induced chemical action that dissolves or weakens concrete or uncoated steel, affected by soil moisture, texture, acidity and soluble salt content. Corrosivity ratings are given for two of the common structural materials, uncoated steel and concrete. The classes for risk of corrosion are low, moderate, and high.

cut An excavated channel or area that has been stripped of some material.

delineation An individual polygon shown by a closed boundary on a soil map.

delta A deposit formed when a stream or river drops its sediment load upon entering a body of quieter water. The resulting landform is nearly flat or gently sloping and usually in the shape of a fan.

depth classes Used to denote depth to bedrock or root restriction:

Very shallow	<25 cm	(<10 inches)
Shallow	25 to 50 cm	(10 to 20 inches)
Moderately deep	50 to 100 cm	(20 to 40 inches)
Deep	100 to 150 cm	(40 to 60 inches)
Very deep	$\geq$ 150 cm	($\geq$60 inches)

deposit Material left in a new position by a natural transporting agent such as water, wind, ice, or gravity, or by human activity.

depression A relatively sunken part of the Earth's surface, especially a low-lying area surrounded by higher ground.

diabase A dark-gray to black, medium-grained igneous rock composed mainly of feldspar and pyroxene.

disclimax A relatively stable ecological community often including kinds of organisms foreign to the region and displacing the climax because of disturbance, especially by humans.

domestic grasses and legumes for use as food and cover for wildlife habitat A soil interpretation or rating for growing grasses and legumes, which are a component of specific local habitat requirements for targeted and non targeted species of wildlife. The purpose of this rating is to provide guidelines in the selection of soils, sites, and plant species for wildlife habitat and not to reflect commercial agronomic production.

drainage class Natural drainage class refers to the frequency and duration of wet periods under conditions similar to those under which the soil developed. Alteration of the water regime by man, either through drainage or irrigation, is not a consideration unless the alterations have significantly changed the morphology of the soil. The classes are:

Excessively drained - Water is removed very rapidly. The occurrence of internal free water commonly is very rare or very deep (>1.5 m). The soils are commonly coarse-textured and have a very high hydraulic conductivity or are very shallow (25 cm deep).

Somewhat excessively drained - Water is removed from the soil rapidly. Internal free water occurrence commonly is very rare or very deep. The soils are commonly coarse-textured and have a high hydraulic conductivity or are very shallow.

Well drained - Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep (1 – 1.5 m) or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit growth of roots for significant periods during most growing seasons. The soils are mainly free of the deep to redoximorphic features that are related to wetness.

Moderately well drained - Water is removed from the soil somewhat slowly during some periods of the year. Internal free water occurrence commonly is moderately deep (50 cm - 1 m) and transitory through permanent. The soils are wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. They commonly have a moderately low or lower saturated hydraulic conductivity in a layer within the upper 1 m, periodically receive high rainfall, or both.

Somewhat poorly drained - Water is removed slowly so that the soil is wet at a shallow depth (25 cm – 50 cm) for significant periods during the growing season. The occurrence of internal free water commonly is shallow to moderately deep and transitory to permanent. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: low or very low saturated hydraulic conductivity, a high water table, additional water from seepage, or nearly continuous rainfall.

Poorly drained - Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. The occurrence of internal free water is shallow or very shallow (< 25 cm) and common or persistent. Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow-depth. Free water at shallow depth is usually present. This water table is commonly the result of low or very low saturated hydraulic conductivity of nearly continuous rainfall, or of a combination of these.

Very poorly drained - Water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season. The occurrence of internal free water is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. These areas are commonly level or depressed and frequently ponded. If rainfall is high or nearly continuous, slope gradients may be greater.

dredge or dredged material Accumulated sediments removed from a subaqueous environment, usually to facilitate shipping, and redeposited by mechanical activities.

drumlin A low, smooth, elongated oval hill, mound, or ridge of compact till that may have a bedrock or stratified drift core. The longer axis is parallel to the general direction of glacier flow.

dump An area of smooth or uneven accumulations of general human refuse and/or waste earth material that may be capable of supporting vegetation.

dune A low mound, ridge, bank or hill of loose, windblown, granular material (generally sand), either bare or covered with vegetation, capable of movement from place to place, but always retaining its characteristic shape.

ecosystem The living and nonliving components of an environment and their related functioning as one unit.

eluviation The removal of soil material in suspension (or in solution) from a layer or layers of a soil. Another term for eluviation is leaching.

Entisols In Soil Taxonomy, a soil order representing the young, or recently formed mineral soils that have no distinct pedogenic horizons.

eolian Pertaining to earth material transported and deposited by the wind including dune sands, sand sheets, and loess deposits.

erosion The wearing away of the land surface by rain or irrigation water, wind, ice or other natural or anthropogenic agents that abrade, detach and remove geologic parent material or soil from one point on the earth's surface and deposit it elsewhere.

esker A long, narrow, sinuous, steep-sided ridge composed of irregularly stratified sand and gravel that was deposited by a subglacial or supraglacial stream flowing between ice walls, or in an ice tunnel of a retreating glacier, and was left behind when the ice melted.

estuary A seaward end, or the wide funnel-shaped tidal mouth, of a river valley, where fresh water comes into contact with seawater and where tidal effects are evident.

evapotranspiration The combined loss of water by both evaporation from the soil surface and by transpiration from plants.

excavation difficulty class The ease of digging a pit or trench to 6 feet in moist soil. The classes are:

Low - Can be excavated with a spade using only arm-applied pressure.
Moderate - Excavation can be accomplished quite easily by foot pressure on a spade
High - Excavation with a spade can be accomplished, but is easier with a full length pick using an over-the-head swing.
Very High - Excavation with hand tools is markedly difficult but is possible in a reasonable period of time with a small backhoe.
Extremely High - Excavation is nearly impossible without a large backhoe.

excavated ponds (aquifer-fed) A soil interpretation or rating for a body of water created by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface.

exothermic A process that gives off heat, which is transferred to the surroundings.

exotic (species) A species not native to the place where found.

extractable acidity A measure of exchangeable hydrogen ions that may become active by cation exchange. It includes all of the acidity generated by the replacement of exchangeable hydrogen and aluminum, and is a measure of the “potential” acidity of a soil.

extractable aluminum The amount of aluminum extracted in a 1 normal potassium chloride solution, which approximates exchangeable aluminum. It is a measure of the “active” acidity in acid soils, and is related to the immediate lime requirement.

fertility (soil) The relative ability of a soil to supply the nutrients essential to plant growth.

fibric material Organic soil material that, after rubbing between fingers, contains 3/4 or more recognizable fibers of undecomposed plant remains. Bulk density is very low and water holding capacity is very high. Equivalent to peat.

field capacity The water content remaining in a soil a few days after a soaking rain, after free drainage is negligible.

fill Human made deposits of natural earth materials and/or waste materials, used to level, raise, or cap an area.

flag or flagstone A flat shaped rock fragment measuring 150 to 380 mm (6-15 inches) on the long axis.

flooding The temporary covering of the soil surface by flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides, or any combination of sources. Shallow water standing or flowing that is not concentrated as local runoff during or shortly after rain or snow melt is excluded from the definition of flooding. Standing water (ponding) or water that forms a permanent covering is also excluded from the definition.

flooding frequency class The number of times flooding occurs over a period of time, expressed as a class. The classes of flooding are defined as follows:

None - No reasonable possibility of flooding; near 0 percent chance of flooding in any year or lessthan 1 time in 500 years.
Very Rare - Flooding is very unlikely but possible under extremely unusual weather conditions; less than 1 percent chance of flooding in any year or less than 1 time in 100 years but more than 1 time in 500 years.
Rare - Flooding unlikely but possible under unusual weather conditions; 1 to 5 percent chance of flooding in any year or nearly 1 to 5 times in 100 years

Occasional - Flooding is expected infrequently under usual weather conditions; 5 to 50 percent chance of flooding in any year or 5 to 50 times in 100 years
Frequent - Flooding is likely to occur often under usual weather conditions; more than a 50 percent chance of flooding in any year or more than 50 times in 100 years, but less than a 50 percent chance of flooding in all months in any year.
Very Frequent - Flooding is likely to occur very often under usual weather conditions; more than a 50 percent chance of flooding in all months of any year.

flooding duration class The average duration of inundation per flood occurrence is defined for five classes as follows:

Extremely Brief	0.1 to < 4.0 hours
Very Brief	4 to < 48 hours
Brief	2 to < 7 days
Long	7 to < 30 days
Very Long	≥ 30 days

floodplain The nearly level plain that borders a stream and is subject to inundation under flood-stage conditions.

footslope The hillslope landscape position that forms the inner, gently inclined surface at the base of a slope. Footslopes occur between the backslope and toeslope of a hillside.

forb A non-graminoid herbaceous plant.

formation (stratigraphy) The fundamental unit in the local distribution and of an igneous, sedimentary, or metamorphic rock, or unconsolidated deposit, which exhibits a distinctive set of identifiable features over a limited area, and tends to represent a fairly uniform environment at the time of formation or deposition.

fragipan A dense subsoil horizon that restricts roots and severely limits water conductivity, except in a few widely spaced vertical cracks, that usually shows evidence of some redoximorphic features.

freshwater wetland plants for use as wildlife habitat A soil interpretation or rating for growing wetland herbaceous vegetation and shrubs that are adapted to wet soil conditions. Floating or submerged aquatics are excluded from use in this guide.

frost action Freezing and thawing of moist soil that can damage roads, buildings, and plant roots.

frost action, potential A soil interpretation or rating of the susceptibility to upward or lateral movement by the formation of segregated ice lenses. It rates the potential of frost heave and the subsequent loss of soil strength when the ground thaws. The potential frost action classes are low, moderate, and high

glacial drift All material transported by a glacier and deposited directly by or from the ice, or by running water emanating from a glacier.

glacial outwash Mainly coarse (sand and gravel) deposits, removed or “washed out” beyond the glacier by meltwater streams, that exhibit both stratification and sorting, with decreasing grain size downstream.

glacial till Unsorted, unstratified glacial materials consisting of clay, silt, sand, and gravel to boulder sized rock fragments transported and deposited by glacial ice. The two types of glacial till are ablation (friable) and lodgement (dense).

glaciers Large masses of ice that formed, in part, on land by the compaction and recrystallization of snow. These masses move under the stress of their own weight.

glaciofluvial deposits Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and sorted in accordance with the energy of the meltwater stream, and may occur in the form of outwash plains, deltas, kames, and eskers.

glaciolacustrine deposits Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice.

glauconite A micaceous clay mineral, generally found as a green and black sand-sized pellet in Tertiary and Cretaceous greensand deposits on the Coastal Plain. It has a high water and nutrient holding capacity, and has long been used as a soil amendment.

gleyed A soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors through the soil mass or in mottles among the colors. Gleying occurs under reducing conditions, by which iron is reduced to the ferrous state.

graminoid Any of the grass-like plants, including grasses, sedges and rushes.

gravel A coarse fragment 2 to 75 mm in diameter.

gravelly soil material Material that is over 15 percent (volume) of coarse fragments, predominantly gravel sized.

ground moraine Commonly an extensive, low relief area of till, having an uneven or undulating surface, consisting of rock and mineral debris dragged along, in, on, or beneath a glacier. This material may include both lodgement and ablation till.

ground water That portion of the water below the surface of the ground at a pressure equal to or greater than atmospheric.

gully (erosion) A channel resulting from erosion and caused by the concentrated but intermittent flow of water, usually during and immediately following heavy rains.

habitat The place where a given organism lives.

heavy metals Those metals which have a relatively high atomic mass (densities >5.0 megagrams per cubic meter). In soils, these include the elements Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, and Zn.

hemic soil material Organic soil material at an intermediate degree of decomposition that contains, after rubbing, 1/6 to 3/4 recognizable fibers of undecomposed plant remains. Equivalent to mucky peat.

Histosols In Soil Taxonomy, a soil order representing the organic soils. Histosols have organic soil materials in more than half of the upper 80 cm, or overlying rock or fragmental materials and/or filling the interstitial areas.

Holocene Epoch that covers the last 10,000 years, also referred to as Recent or Post-Glacial.

horizon (master soil horizons) A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. An uppercase letter represents the major horizon types. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The master horizons are:

O Horizons - Layers dominated by organic material.
A Horizons - Mineral horizons, at or near the surface or below an O horizon, with an accumulation of organic matter.
E Horizons - Mineral horizons in which the main feature is loss of clay, iron, and/or organic matter.

<u>B Horizons</u> - Mineral horizons that formed below an A, E, or O horizon. B horizons also must also have one or more of the following: (1) accumulation of clay, sesquioxides, and/or organic matter; (2) more strongly expressed soil structure; or (3) redder or browner colors relative to those in the A and C horizons.
<u>C Horizons</u> - Mineral horizons that have minimal affect by soil-forming processes and does not have the properties of an O, A, E, or B horizon.
<u>R Layers</u> - Consolidated, usually hard, unweathered bedrock beneath the soil.

hue A measure of the chromatic composition of light that reaches the eye. The individual pages in a Munsell color book are hues themselves.

humus Decomposed organic matter in soils, exclusive of undecayed plant and animal tissues, their "partial decomposition" products, and the soil biomass.

hydric soils Soils that are wet long enough to periodically produce anaerobic conditions, thereby influencing the growth of plants

hydrologic cycle The fate of water from the time of precipitation until the water has been returned to the atmosphere by evaporation and is again ready to be precipitated.

hydrologic group A soil interpretation or rating system for runoff potential. The soil properties that influence this potential are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not a factor. The classes are:
<u>A</u> - Saturated hydraulic conductivity is very high or in the upper half of high and internal free water occurrence is very deep.
<u>B</u> - Saturated hydraulic conductivity is in the lower half of high or in the upper half of moderately high and free water occurrence is deep or very deep.
<u>C</u> - Saturated hydraulic conductivity is in the lower half of moderately high or in the upper half of moderately low and internal free water occurrence is deeper than shallow.
<u>D</u> - Saturated hydraulic conductivity is below the upper half of moderately low, and/or internal free water occurrence is shallow or very shallow and transitory through permanent.

hydrophyte A plant which is able to grow in waterlogged conditions

hyperthermic A soil temperature regime that has mean annual soil temperatures of 22°C (72°F)and higher

igneous rock A rock formed from the cooling and solidification of magma, and that has not been changed appreciably by heat and/or pressure since its formation.

illuviation The process of deposition of soil material removed from one horizon to another in the soil; usually from an upper to a lower horizon in the soil profile.

Inceptisols In Soil Taxonomy, immature soils with few diagnostic features. Inceptisols have one or more pedogenic horizons in which mineral materials other than carbonates or amorphous silica have been altered or removed, but not accumulated to a significant degree.

infiltration The entry of water into soil.

interflow That portion of rainfall that infiltrates into the soil and moves laterally through the upper soil horizons until intercepted by a stream channel, or until it returns to the surface at some point downslope from its point of infiltration.

K factor The soil erodibility factor, a relative index of susceptibility of bare, cultivated soil to particle detachment and transport by rainfall. K is affected by soil particle size, percent organic matter, soil structure, and soil permeability. Kf is the factor for the fine earth fraction of the soil; Kw is the factor for the whole soil, including coarse fragments.

kame A low mound, knob, hummock, or short irregular ridge, composed of stratified sand and gravel deposited by a subglacial stream, a supraglacial stream, or a ponded deposit on the surface or at the margin of stagnant ice.

kettle A steep-sided, bowl-shaped depression, commonly without surface drainage in glacial drift deposits, formed by the melting of a large, detached block of stagnant ice that had been wholly or partially buried in the drift. Standing water or saturated conditions usually occur in the bottom of these depressions.

lawns, landscaping, and golf fairways A soil interpretation or rating for establishing and maintaining turf for lawns and golf fairways and ornamental trees and shrubs for residential or commercial landscaping.

leaching The removal of dissolvable and suspendable material from soil by downward moving water.

levee A natural or artificial embankment along the margin of a river or other water body which can prevent or confine flooding.

lignite (brown coal) A carbonaceous fuel intermediate between coal and peat, brown or yellowish in color and woody in texture.

limitations for use Limiting factors in soil interpretations or ratings for various uses. A complete list of soil limiting features is available in National Soil Survey Handbook. Some limiting feature phrases are:

- Area Reclaim - Area is difficult to establish good vegetation on after soil is removed
- Depth to garbage - Household garbage occurs within 20 inches
- Excess humus - Soil organic matter is destroyed readily by vehicle traffic
- Frost action - The upper soil is susceptible to expansion and collapse from frost formation and melting
- Large stones - Stones must be removed for lawns and recreation areas
- Low strength (or Subsidence) - Soil is not strong enough to support heavy vehicles or buildings
- Methane gas emissions - Methane gas is emitted as household garbage decomposes
- Organic soil - Tree seedlings require mineral soil for root stability
- Restricted layer - A layer occurs within 20 inches that restricts root growth
- Seepage - Water moves very rapidly into aquifers and deep layers.
- Small stones (or rock fragments) - Too much gravel, not enough fine soil material
- Thin layer - The suitable layer of soil is too thin
- Wetness - Water table is high enough to affect land use

limitation ratings The degree of limitation that restricts the use of a site for a specific purpose.

- Slight - This rating is given to soils that have properties favorable for the use. This degree of limitation is minor and can be overcome easily. Good performance and low maintenance can be expected.
- Moderate - This rating is given to soils that have properties moderately favorable for the use. This degree of limitation can be overcome or modified by special planning, design or maintenance. The expected performance of the structure or other planned use is somewhat less desirable than for soils rated slight.
- Severe - This rating is given to soils that have one or more properties unfavorable for the rated use. This degree of limitation generally requires major soil reclamation, special design, or intensive maintenance. Soil of the soils, however, can be improved by reducing or removing the soil feature that limits use; but in most situations, it is difficult and costly to alter the soil or to design a structure so as to compensate for a severe degree of limitation.

litter The surface layer of the forest floor which is not in an advanced stage of decomposition, usually consisting of freshly fallen leaves, needles, twigs, stems, bark, and fruits.

local roads and streets A soil interpretation or rating for roads and streets that have all-weather surfacing (commonly of asphalt or concrete) and that are expected to carry automobile traffic year-round.

lodgement till Material deposited from the base of the glacier, characterized by compact, fissile or platy structure and containing coarse fragments oriented with their long axes generally parallel to the direction of ice movement.

loess Material transported and deposited by wind and consisting of predominantly silt-sized particles.

made land Areas filled with earth, or with earth and trash mixed, usually by or under the control of man.

map unit A conceptual group of one to many delineations or polygons, identified by the same name in a soil survey, that represent similar landscape areas.

marsh A wet area, periodically inundated with standing or slow moving water, that has grassy or herbaceous hydrophytic vegetation and often little peat accumulation; the water may be salt, brackish or fresh.

mesic A soil temperature regime that has mean annual soil temperatures between 8 and 15°C (46 to 59°F).

metamorphic rock A rock derived from preexisting rocks that has been altered physically, chemically, and /or mineralogically as a result of natural geological process, principally heat and pressure, originating within the earth. The preexisting rocks may have been igneous, sedimentary, or another form of metamorphic rock.

mineral soil A soil consisting predominantly of, and having its properties determined predominantly by, mineral material. It usually contains less than 35 percent organic matter by weight (less than 21 to 31% if saturated with water), but may contain an organic surface layer up to 30 cm (12 inches) thick.

miscellaneous areas A land area having little or no soil and thus supporting little or no vegetation without major reclamation. Includes areas such as beaches, dumps, rock outcrop, and mud flats. The term is used in defining soil survey map units.

moisture status (soil) The mean monthly soil water state at a specified depth. The water state classes used in soil moisture status are dry, moist, and wet. These classes are defined as follows:

Dry	$\geq$ 15 bar suction
Moist	< 15 bar to $\geq$ 0.00001 bar
Wet	< 0.00001 bar; free water present (satiated wet)

moraine An accumulation of glacial drift, with an initial topographic expression of its own, built chiefly by the direct action of glacial ice. Ground moraine and end moraine.

morphology (soil) The visible characteristics of the soil or any of its parts.

mottles Spots or blotches of different color or shades of color interspersed with the dominant color.

muck Highly decomposed organic soil material in which the original plant parts are not recognizable. Usually darker in color, higher in bulk density, and lower in water holding capacity than peat.

mucky A textural modifier that indicates a high organic matter content (>10 % by weight) in a mineral soil.

mucky peat Organic soil material of an intermediate stage of decomposition, in which a significant part of the original plant parts are recognizable and a significant part is not.

Munsell color system A color designation system that specifies the relative degree of the three variables of color: hue, value, and chroma.

native species A plant that has grown in the region since the last glaciation, and before European settlement.

Newark Group Sedimentary and associated igneous rocks of late Triassic and early Jurassic age.

niche The particular role that a given species plays in the ecosystem.

nutrient Elements or compounds essential as raw materials for organism growth and development.

off-road motorcycle trails A soil interpretation or rating for recreational use. Little or no preparation is done to the trail, and the surface is not vegetated or surfaced. Considerable compaction of the soil on the trail is expected.

organic soil material Soil material which contains 20 to 30 percent (by weight) or more organic matter if saturated at times, and 35 percent or more organic matter if never saturated.

oxidation The loss of one or more electrons by an ion or molecule.

parent material The unconsolidated, and more or less chemically weathered mineral or organic matter, from which a soil is developed by pedogenic processes.

particle size The effective diameter of a particle measured by sedimentation, sieving, or micrometric methods.

paths and trails A soil interpretation or rating for walking, horseback riding, and similar uses. Areas require little or no cutting or filling.

peat Slightly decomposed organic soil material in which the original plant parts are recognizable.

pedon The smallest three dimensional body of soil with lateral dimensions large enough to permit the study of horizon shapes and relations. Its area ranges from 1 to 10 square meters.

pedogenesis The process of soil formation.

permeability The ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. The permeability classes are:

	(in hr^{-1})	(μms^{-1})
Very rapid	$\geq$20	$\geq$141
Rapid	6-<20	42-141
Moderately rapid	2-<6	14-42
Moderate	0.6-<2	4-14
Moderately slow	0.2-<0.6	1.4-4
Slow	0.06-<0.2	0.42-1.4
Very Slow	0.0015-<0.06	0.01-0.42
Impermeable	0.00-<0.0015	0.00-0.01

permanent wilting point Soil water content at which indicator plants, growing in the soil, wilt and fail to recover.

pesticide loss potential A soil interpretation or rating of the potential for pesticides to be transported by percolating water below the plant zone (leaching) or surface runoff beyond the field boundary where the pesticide was applied. Pesticides in ground–water solution are leached from the soil surface layer and transported vertically through the soil and vadose zone by percolating water. Pesticides can also be transported by surface runoff as either pesticides in solution or pesticides adsorbed to sediments suspended in runoff. The soil rating for leaching of pesticides is based on the potential for soils to retain pesticides within the boundaries of the root zone. The soil rating for soil surface runoff of pesticides is based on the potential for soils to retain pesticides within the boundaries of the field where they are applied. Pesticides are considered to be applied to bare soil by either surface or aerial methods.

phase (soil) A Utilitarian grouping of soils defined by soil or environmental features that are not class differentia used in U.S. system of soil taxonomy, e.g., surface texture, surficial rock fragments, rock outcrops, substratum, special soil water conditions, etc. Phase identifications are introduced into soil names by adding them to a taxon name as modifiers.

picnic areas A soil interpretation or rating for natural or landscaped tracts used primarily for preparing meals and eating outdoors. Areas are subject to heavy foot traffic.

placic horizon A black to dark reddish mineral soil horizon that is usually thin but that may range from 1mm to 25mm in thickness. The placic horizon is commonly cemented with iron and is slowly permeable or impenetrable to water and roots.

plant competition A soil interpretation or rating of the likelihood that plants other than desired species will become established during revegetation efforts, and that their presence will affect seedling establishment and the growth of desired species.

playgrounds A soil interpretation or rating for areas used intensively for games, such as baseball and football, and similar activities. Playgrounds require a nearly level soil that is free of stones and that can withstand heavy foot traffic and still maintain adequate vegetation.

Pleistocene The first of two epochs of the Quaternary Period. The Pleistocene lasted from about 1.65 million until 10,000 years ago, and was marked by several glacial and interglacial episodes in the northern hemisphere.

polypedon A group of contiguous similar pedons The limits of a polypedon are reached where there is no soil or where the pedons have characteristics that differ significantly.

ponding Standing water in a closed depression, removed only by deep percolation, transpiration, or evaporation or by a combination of these processes. Ponding of soils is classified according to depth, frequency, duration, and the beginning and ending months in which standing water is observed.

ponding frequency class Soil rating system for the number of ponding events over a period of time. The ponding frequency classes are:

<u>None</u> - No reasonable possibility of ponding, near 0 percent chance of ponding in any year

<u>Rare</u> - Ponding unlikely but possible under unusual weather conditions; from nearly 0 to 5 percent chance of ponding in any year or nearly 0 to 5 times in 100 years

<u>Occasional</u> - Ponding is expected infrequently under usual weather conditions; 5 to 50 percent chance of ponding in any year or nearly 5 to 50 times in 100 years

<u>Frequent</u> - Ponding is likely to occur under usual weather conditions; more than 50 percent chance in any year or more than 50 times in 100 years

ponding duration classes The average duration, or length of time, of the ponding occurrence is expressed in four classes as follows:

Very Brief	< 2 days
Brief	2 to < 7 days
Long	7 to < 30 days
Very Long	$\geq$ 30 days

pond reservoir area A soil interpretation or rating for an area that holds water behind a dam or embarkment.

pore space The portion of soil bulk volume occupied by soil pores.

porosity The volume of pores in a soil sample (nonsolid volume), divided by the bulk volume of the sample.

profile (soil) A vertical section of the soil through all its horizons and extending into the C horizon.

quality (soil) The capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health.

reaction (soil reaction, pH) A measure of acidity or alkalinity of a soil, expressed in pH values. The reaction classes are:

Extremely acid – pH value below 4.5
Very Strongly acid - pH value between 4.5 to 5.0
Strongly acid - pH value between 5.1 to 5.5
Moderately acid - pH value between 5.6 to 6.0
Slightly acid - pH value between 6.1 to 6.5
Neutral - pH value between 6.6 to 7.3
Mildly alkaline - pH value between 7.4 to 7.8
Moderately alkaline - pH value between 7.9 to 8.4
Strongly alkaline - pH value between 8.5 to 9.0
Very strongly alkaline - pH value of 9.1 and higher.

recessional moraine An end or lateral moraine, built during a temporary but significant halt in the retreat of a glacier. Also, a moraine built during a minor readvance of the ice front during a period of recession.

reconnaissance Preliminary research.

reconstruction materials An interpretation or rating of the potential of soil for use as a source of fill material.

redox Reduction-oxidation, or the transfer of electrons.

redoximorphic features Soil properties associated with wetness that result from the reduction and oxidation of iron and manganese compounds in the soil after saturation with water and desaturation, respectively.

reduction The gain of one or more electrons by an ion or molecule.

restrictive layer A soil or rock layer that inhibits the movement of water and/or roots through the soil.

restriction kind The type of nearly continuous layer that has one or more physical properties that significantly reduce the movement of water and air through the soil, or that otherwise provides an unfavorable root environment. Cemented layers, dense layers, abrupt or stratified layers, strongly contrasting textures, and fragipan layers are example of soil layers that are restrictions.

rill (erosion) A small, intermittent water course with steep sides; usually only several centimeters deep.

rock fragments Unattached pieces of rock 2 mm in diameter or larger that are strongly cemented and are resistant to rupturing. Examples, increasing in size, are gravels, channers, cobbles, flags, stones, and boulders.

runoff That portion of precipitation or irrigation on an land area which does not infiltrate, but instead is discharged from the area.

runoff class, surface An interpretation or rating of the potential runoff hazard from a soil based on plant cover, slope, and surface texture. Higher classes have more chance of causing erosion. The runoff classes are negligible, very low, low, medium, high, and very high

saline water wetland plants for use as wildlife habitat A soil interpretation or rating for growing saline-tolerant wetland herbaceous vegetation and shrubs that are adapted to wet soil conditions. Floating or submerged aquatics are excluded from use in this guide.

salinity (soil) A measure of soluble salts in soil based on electrical conductivity. Only salt tolerant plants can grow in soil with high salinity levels.

sample (soil) A part of a population taken to estimate a parameter of the whole population.

sand Mineral soil separate consisting of particles from 2.0 to 0.05 mm in diameter. Sand particles impart a gritty feel to moist soil. Most sand grains consist of quartz.

sand source A soil interpretation or rating for use as a construction material, with particles ranging in size from 0.074 mm (sieve #200) to 4.75 mm (sieve #4) in diameter.

sapric material Highly decomposed organic soil material that contains, after rubbing, less than 1/6 recognizable fibers of undecomposed plant remains. Bulk densities in these materials are usually very low. Equivalent to muck.

saturation A soil water content when all the voids between soil particles are filled with water.

saturated hydraulic conductivity (KSAT) Rate of water movement though soil under (field) saturated conditions. The classes, in inches/hour, are:

Very High	$\geq$14.17
High	14.17 to 1.417
Moderately High	1.417 to 0.1417
Moderately Low	0.1417 to 0.01417
Low	0.01417 to 0.001417
Very Low	<.001417

sediment Transported and deposited particles or aggregates derived from rocks, soil, or biological material.

series (soil series) A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. Members of a soil series are derived from similar parent material.

serpentine A mineral group of magnesium bearing layer silicates, sometimes found with high amounts of nickel and chromium. Serpentine rock, or serpentinite, is usually apple-green to black, formed from the metamorphosis of an ultramafic igneous rock.

sesquioxides A general term for oxides and hydroxides of iron and aluminum.

sheet (erosion) The removal of a relatively uniform thin layer of soil from the land surface by rainfall and largely unchanneled surface runoff (sheet flow).

shoulder The hillslope position that forms the uppermost inclined surface near the top of a slope. If present, it comprises the transition zone from backslope to summit. This position is dominantly convex in profile and erosional in origin.

shrub A woody plant in which several erect spreading stems arise from the ground.

side slope The slope bounding a drainageway and lying between the drainageway and the adjacent interfluve. It is generally linear along the slope width and overland flow is parallel down the slope.

silt Mineral soil separate consisting of particles that range in diameter 0.05 to 0.002 mm. Silt particles impart a smooth feel to moist soil, without the stickiness and plasticity of clay.

slope The inclination of the land surface from the horizontal. Percent slope is the vertical distance divided by the horizontal distance, multiplied by 100.

soil A natural or anthropogenic, three-dimensional body at the earth's surface, capable of supporting plants, with properties resulting from climate and living plants and animals acting on parent material, as controlled by relief over periods of time.

soil reconstruction material for drastically disturbed areas A soil rating or interpretation for the process of replacing layers of soil material or unconsolidated geologic material, or both, in surface mining. A vertical sequence is needed of such quality and thickness that a favorable medium for plant growth is provided.

soil used as burrow wildlife habitat component for burrowing mammals and reptiles A soil interpretation or rating according to its potential to be used by mammals and specific species of reptiles that excavated burrows.

solum The upper part of a soil profile, including the A, E, and B horizons, in which the processes of soil formation are active.

stone Coarse fragments between 250 and 600 mm (10 –24”) in diameter if rounded, and 380 to 600 mm (15-24”) if flat.

structure (soil) The combination or arrangement of primary soil particles into secondary units or peds. The size, shape, and grade are all used to describe soil structure. The following are soil structure shapes:
  Granular - Small spherical, with curved or very irregular faces.
  Blocky - Units are block-like with sub-rounded and planar faces.
  Platy - Flat and tabular-like units.

subordinate distinctions within master horizons and layers
  a - Highly decomposed organic material where rubbed fiber content averages <1/6 of the volume.
  b - Identifiable buried genetic horizons in a mineral soil.
  c - Concretions or nodules with iron, aluminum, manganese or titanium cement.
  d - Physical root restriction, either natural or manmade such as dense basal till, plow pans, and mechanically compacted zones.
  e - Organic material of intermediate decomposition in which rubbed fiver content is 1/6 to 2/5 of the volume.
  f - Frozen soil in which the horizon or layer contains permanent ice.
  g - Strong gleying in which iron has been reduced and removed during soil formation or in which iron has been preserved in a reduced state because of saturation with stagnant water.

h - Illuvial accumulation of organic matter in the form of amorphous, dispersible organic matter-sesquioxide complexes.
i - Slightly decomposed organic material in which rubbed fiber content is more than about 2/5 of the volume.
k - Accumulation of pedogenic carbonates, commonly calcium carbonate.
m - Continuous or nearly continuous cementation or induration of the soil matrix by carbonates (km), silica (qm), iron (sm), gypsum (ym), carbonates and silica (kqm), or salts more soluble than gypsum (zm).
n - Accumulation of sodium on the exchange complex sufficient to yield a morphological appearance of a natric horizon.
o - Residual accumulation of sesquioxides.
p - Plowing or other disturbance of the surface layer by cultivation, pasturing or similar uses.
q - Accumulation of secondary silica.
r - Weathered or soft bedrock including saprolite; partly consolidated soft sandstone, siltstone or shale; or dense till that roots penetrate only along joint planes and are sufficiently incoherent to permit hand digging with a spade.
s - Illuvial accumulation of sesquioxides and organic matter in the form of illuvial, amorphous, dispersible organic matter-sesquioxide complexes if both organic matter and sesquioxide components are significant and the value and chroma of the horizon are >3.
ss - Presence of slickensides.
t - Accumulation of silicate clay that either has formed in the horizon and is subsequently translocated or has been moved into it by illuviation.
v - Plinthite which is composed of iron-rich, humus-poor, reddish material that is firm or very firm when moist and that hardens irreversibly when exposed to the atmosphere under repeated wetting and drying.
w - Development of color or structure in a horizon but with little or no apparent illuvial accumulation of materials.
x - Fragic or fragipan characteristics that result in genetically developed firmness, brittleness, or high bulk density.
y - Accumulation of gypsum.
z - Accumulation of salts more soluble than gypsum.

subsoil That portion of the soil profile below the topsoil and above the parent material. It includes the E and B soil horizons.

substratum The C horizons and R layers below the depth of noticeable soil development; often the parent material of the soil above.

succession A series of organisms that follow one after another in a progression

suitability ratings Ranking system which identifies the degree that a soil is favorable for a given use.
Good or well suited - The soil has properties favorable for the use. There are no soil limitations. Food performance and low maintenance can be expected. Vegetation or other attributes can easily be maintained, improved, or established.
Fair or suited - The soil is moderately favorable for the use. One or more soil properties make these soil less desirable than those rated good or well suited. Vegetation or other attributes can be maintained, improved, or established; but a more intensive management effort is need to maintain the resource base.
Poor or poorly suited - The soil has one or more propertied unfavorable for the use. Overcoming the unfavorable property requires special design, extra maintenance, or costly alteration. Vegetation or other attributes are difficult to establish or maintain.

summit The highest point of any landform remnant, hill, or mountain.

supraglacial Carried upon, deposited from, or pertaining to the top surface of a glacier or ice sheet.

swamp An area saturated with water throughout much of the year but with the surface of the soil usually not deeply submerged. Usually characterized by tree or shrub vegetation.

T factor Soil loss tolerance, or the maximum rate of annual soil erosion at which the quality of a soil as a medium for plant growth can be maintained. As limiting or less favorable soil layers become closer to the surface, the relative ability of a soil to maintain its productivity through natural and managed processes decreases, and soil loss tolerance decreases.

taxajunct A soil that is correlated as a recognized, existing soil series for the purpose of expediency. They are so like the soils of the defined series in morphology, composition, and behavior that little or nothing is gained by adding a new series.

taxon In the context of soil survey, a class at any categorical level in the U.S. system of soil taxonomy.

terrace An old alluvial floodplain, usually level, that borders a river, a lake, or the sea, and is higher than modern floodplains.

texture (soil) The relative proportions of sand, silt, and clay particles. The basic textural classes are: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The dominant sand size (very fine to coarse) is described in sand, loamy sand, and sandy loam classes.

texture groups (soil) Broad groups or classes of texture.

<u>Coarse textured</u>- Sands (coarse sand, sand, fine sand, very fine sand) and Loamy sands (loamy coarse sand, loamy sand loamy fine sand, loamy very fine sand)
<u>Moderately coarse –textured</u> – Coarse sandy loam, sandy loam, fine sandy loam
<u>Medium textured</u> – Very fine sandy loam, loam, silt loam, silt
<u>Moderately fine-textured</u> – Clay loam, sandy clay loam, silty clay loam
<u>Fine textured</u> – Sandy clay, silty clay, clay

tidal flats Areas of nearly flat, barren mud periodically covered by tidal waters. Normally these materials have an excess of soluble salt.

tilth (soil) The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

toeslope The hillslope position that forms a gently inclined surface at the base of a slope. Toeslopes in profile are commonly gentle and linear, and are constructional surfaces forming the lower part of a slope continuum that grades to a valley or closed depression.

toposequence A sequence of related soils that differ, one from the other, primarily because of topography as a soil-formation factor.

topsoil A soil interpretation or rating for potential use as a source of topsoil. Topsoil is the upper part of the soil, generally with the highest organic matter content, and is best suited for plant growth.

transitional horizons Two kinds of transitional horizons are recognized. In one, the horizon is dominated by properties of one master horizon but has subordinate properties of another. Two capital letter symbols are used, such as AB, EB, BE, or BC. The master horizon symbol that is given first designates the kind of master horizon whose properties dominate the transitional horizon.
The classes are as follows:

AB - A horizon with characteristics of both an overlying A horizon and an underlying B horizon, but which is more like the A than the B.
EB - A horizon with characteristics of both and overlying E horizon and an underlying B horizon, but which is more like the E than the B.
BE - A horizon with characteristics of both an overlying E horizon and an underlying B horizon, but which is more like the B than the E.
BC - A horizon with characteristics of both an overlying B horizon and an underlying C horizon, but which is more like the B than the C.
CB - A horizon with characteristics of both an overlying B horizon and an underlying C horizon, but which is more like the C than the B.

tree A woody plant, with a single trunk unbranched for several feet above the ground, 20 feet or taller at maturity.

truncated Having lost all or part of the upper soil horizon or horizons by removal through erosion, excavation, etc.

udic A soil moisture regime that is not dry for as long as 90 cumulative days in most years. It is common to soils of humid areas with well-distributed rainfall.

Udorthents In Soil Taxonomy, a broad (Great Group level) classification of non wetland, poorly developed soils in humid parts of the U.S.

ultramafic (rock) An igneous rock that consists almost entirely of magnesium and iron minerals, with no feldspar or quartz.

unconformity Surface of contact between strata which represents a hiatus in geologic record due to a combination of erosion and of a break in sedimentation.

unsaturated flow The movement of water in soil when the pores are not filled to capacity with water.

urban land A miscellaneous area so altered or obstructed by urban works or structures that identification of soils is not feasible.

upland coniferous trees for use as wildlife habitat A soil interpretation or rating for growing coniferous trees that meet specific local habitat requirements for targeted and nontargeted species of wildlife. The species include low stature conifers. Commonly, upland conifers trees are established through natural processes, are seeded, or are transplanted. Many species of conifer often grow in soil conditions that are harsher than those required for hardwoods.

upland deciduous trees for use as wildlife habitat A soil interpretation or rating for growing deciduous trees that meet specific local habitat requirements for targeted and nontargeted species of wildlife. Commonly, deciduous trees are established through natural processes, are seeded, or are transplanted. In general, they require better soil conditions than conifers.

upland shrubs and vines for use as wildlife habitat A soil interpretation or rating for growing a diverse upland shrub and vine community. The plants are adapted to soil conditions that are drier than those common in the moist riparian and wetland zones but that are not as dry as those in the upland desert area.

upland wild herbaceous plants for as wildlife habitat A soil interpretation or rating for growing a diverse
upland herbaceous plant community adapted to soil conditions that are drier than those common in the moist riparian and wetland zones but that are not as dry as those in the upland desert areas.

value (color) The degree of lightness or darkness of a color in relation to neutral gray scale. Value runs vertically on a page within the Munsell color book.

water table The upper surface of ground water or that level in the ground where the water is at atmospheric pressure. A perched water table is a saturated layer that is separated from any underlying saturated layers by an unsaturated layer.

weathering All physical and chemical changes produced in rocks, at or near the earth's surface, by atmospheric agents.

wetland A transitional are between aquatic and terrestrial ecosystems that is inundated or saturated for long enough periods to produce hydric soils and support appropriate wetland vegetation.

wind erodibility group A set of classes given integer designations from 1 through 8, based on compositional properties of the surface horizon that are considered to affect susceptibility to wind erosion.

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Gateway National Recreation Area
Soil Map Index