

2021 Progress Report

An examination and discussion of Woodbridge Township responses to the CVA report's original recommendations

1. *Coordinate community outreach and education on flood vulnerabilities*

Response: Greenable Woodbridge Show – which highlights flood risk and hazards (below includes show with runtimes). Titled: “Floodplain Management - Greenable Woodbridge TV Show” & below please find evidence of public outreach and discussion regarding floodplain management.

2. *Consider completing a climate risk assessment for the municipal water utilities using EPA's Climate Resilience Evaluation and Awareness Tool (CREAT).*

Response: The Township has established an on-going relationship with Middlesex Water Company in order to collaborate with regard to storm-water water run-off and increased precipitation due to climate change. Model projections shown within the CREAT tool helped Township staff members of the Woodbridge Green Infrastructure team analyze the conditions associated with long-term effects of increased rainfall runoff intensity, and how to approach storm-water mitigation compressively through important partnerships with the utility. To date Middlesex Water Company has help construct three of the Township's last five rain gardens.

3. *Share the results of the Coastal Vulnerability Assessment with owners and managers of vulnerable and at-risk non-residential properties and work together to develop mitigation and adaptation strategies.*

Response: Attached as a separate PDF document please find outreach letters and documents which include annual outreach pertaining to EPA Right to Know Businesses. Titled: “Annual Outreach to Right to Know Businesses in SFHA”

4. *Incorporate the results of the Coastal Vulnerability Assessment into the municipal master plan with short-term and long-term strategies for protecting and adapting the community assets and vulnerable areas.*

4a and 4b below are suggested options within the initial CVA report. Under each option is a note discussing how the suggestion was put into action.

4 a) Identify natural resources that serve as protective flood mitigation measures (e.g. wetlands), and provide recommendations for maintenance and management in the conservation plan element.

Response: The goal of Township's floodplain restoration projects are to enhance ecological uplift and flood storage capacity through the restoration of a Phragmites

monoculture to a native vegetation. The projects proposes to convey stormwater and flood waters from the adjacent developed area to the Woodbridge River. These designs increase the flood storage potential of the existing landscape using natural ecological features and re-establishes native wetland vegetation appropriate to the region and the expected site conditions. This restored habitat will provide improved water quality and biodiversity. See attached below: Post Restoration Monitoring Plan; Forested Wetland Design Plans (Construction late-Sept. 2021); No Mow signage, Restored Parcels Map.

4 b) Identify planning policies for mitigation and adaptation strategies to protect properties from future flooding, including sea level rise and extreme storm events, in the land use plan element.

Response: The Township of Woodbridge has established an Open Space Conservation/Resiliency Zone (OSC/R) to help minimize the risk to residences within floodplains, and to reduce the amount of flood damage sustained during future flood events. The areas designated as within the Open Space Conservation/Resiliency Zone are located within the Watson Avenue, Crampton Avenue, South Roberts Street, and Saints Field neighborhoods of the Township.

Below please find an attached a copy of the Township's OSC/R Zone ordinance which codifies the design criteria associated with structures within this area as well as permitted uses, street arrangement, landscaping restrictions, buffer requirements, and required registration for all property owners in the OSC/R Zone. A change in tenancy of a structure within the OSC/R Zone triggers building design standards, and as per (OSC/R Zone Ordinance) Section B (2), new construction is not permitted (please see OSC/R ordinance, attached). These efforts were undertaken to protect the health and safety of citizens and to mitigate current and future flood losses.

5. *Cross-reference the Coastal Vulnerability Assessment in relevant sections of the municipal master plan, floodplain management plan, emergency operations plan and all hazards mitigation plan.*

Response: Below please find an attached a copy of the Township's floodplain Management Plan from 2018-2020; Please see the CVA noted as Appendix H in the Table Of Contents (in 2020 the Township began using said plan as a resource mechanism and adopted the County All-Hazard Mitigation Plan as it's floodplain management plan).

6. *Consider partnering with the state, county or non-profits on an in-stream channel and floodplain restoration for the South Branch Rahway River to address fluvial erosion hazards to public roads and other infrastructure.*

Response: The Township is currently in discussion with the County regarding design plans to address fluvial erosion hazards at said location. Furthermore, at-risk

infrastructure and populations along the South Branch Rahway River includes single-family homes, multi-family apartments and condominiums, senior citizen populations, retail establishments, and highly frequented commercial structures within the Metro Park section of Iselin. Furthermore, the Metro Park Train Station serves as a hub for commuters, as it prevails as a primary stopping point along New York City's northeast coordinator line. With that in mind, the Township must also consider how to best ensure the safety of those who utilize this transit resource in relation to a potential flood event. Although the Township has tremendous flood response mechanisms, our emergency operation teams do not have access to real-time flood inundation monitoring along the South Branch. Accordingly, we have engaged the USGS in conversations focused on this type of service. Our interest has been met with a welcoming prospect of potential future development to review said opportunity with a variety of entities and experts.

7. *Consider expanding and enforcing riparian buffer requirements along all waterways and buffer requirements along wetlands.*

Response: The Township is considering this mechanism with regard to current watershed master planning efforts. Further analysis is required before decision-making processes can occur.

8. Consider the use of living shorelines to protect community assets against shoreline erosion.

Response: Cliff Rd. Adjacent to the Municipal Boat Launch is under Conceptual Design for a Living Shoreline and additional ecological enhancements. A living shoreline project would seek to address terrestrial and marine habitat enhancement and beatification along the shoreline of Boynton Beach (Sewaren) would need to be capable of attenuating tidal energy and mild boat wakes. In addition, living shoreline considerations should also take into account improved viewsapes and socioeconomic factors that might lead to an increase in the creation of new fish foraging areas and/ or passive recreational activities such as kayaking and birding. These circumstances lend to the consideration of implementing living shoreline techniques that incorporate natural vegetation, such as Smooth Cordgrass (*Spartina alterniflora*), biodegradable organic materials (coir fiber logs), potential beach nourishment, and low-profile sills or breakwaters such as rock structures, wave attenuation devices, or bivalve shell bags.

Biodegradable coir fiber logs placed along the shoreline edge may provide a contained area for sediment to accumulate and native vegetation to grow. A living shoreline which encompasses said techniques can provide benefits associated with healthy habitats including biodiversity, wave attenuation, and improved viewsheds. Breakwaters or sills may be constructed parallel to the shoreline and designed to reduce a higher amount of wave energy experienced by the shoreline directly behind it. A vegetated shoreline and coir fiber logs may be established behind the structures for additional enhancement. The project is currently in engineering and design as of 2021.

9. Consider revising the municipal stormwater management and sewer plans to reflect the results of the CVA.

Response: The Township is considering this mechanism with regard to current watershed master planning efforts. Further analysis is required before decision-making processes can occur.

Long-Term Planning Process

The Township is over 350 years old, consists of ten unincorporated towns, and encompasses approximately 24 square miles, including approximately 3,000 acres of regulated Special Flood Hazard Areas in tidal and fluvial floodplains. Coastal areas of utmost concern for flood risk are located adjacent to the Woodbridge River, its tidal tributaries and the Arthur Kill. Areas of great concern for fluvial flooding are located primarily along the South Branch Rahway River which crosses western segments of the Township, within the Colonia and Iselin sections. Ensuring that we continue to grow our floodplain management program in such areas is a high priority for the Township.

With regard to the coastal floodplain surrounding the Woodbridge River, the Township has been extremely successful in removing people and structures from flood risk through the NJDEP Blue Acres Program, and restoring said areas to best ensure natural floodplain functions. These groundbreaking initiatives have enhanced ecological value and flood storage capacity, and led to the Township being awarded, by the New Jersey Association for Floodplain Management, for its outstanding programs focused on reducing flood risk and restoring natural functions. Thus, long term efforts within said area will focus on continuing to enhance this work to restore natural floodplain functions and passive recreational use.

The Colonia section of Woodbridge is still impacted repeatedly by fluvial flooding from the South Branch Rahway River. The most vital next step in our floodplain management program is the development of a real-time streamflow/ flood-inundation-mapping system for the South Branch Rahway River (a non-tidal stream) to help community engagement, outreach, and emergency response efforts.



Woodbridge Township

RUTGERS
New Jersey Agricultural
Experiment Station

Plan for Ecological Restoration & Stormwater Management Blue Acres Area

Port Reading, Woodbridge Township, Middlesex County

Public Information Meeting
March 26, 2019 ~ 5:00 – 7:00 PM

Overview: The Township of Woodbridge, in conjunction with the Rutgers Cooperative Extension (RCE), is formulating a plan to implement ecological restoration and stormwater management improvement(s) in the Port Reading section of Woodbridge Township.

The project area is located at the intersection of Fourth Street and East Tappan Street within the New Jersey Blue Acres zone and contains six former residential lots. Proposed improvements include the construction of three rain gardens (totaling 3,060 sq. ft.); native tree and shrub planting(s); and the establishment of 0.3 acres of meadow.

The objective of the restoration plan is to increase both the aesthetic and conservation value of the newly acquired open space and to manage stormwater runoff from an approximately 0.3 +/- acre drainage area.

Rutgers Cooperative Extension (RCE) will be conducting turf management activities within Blue Acres zones on Fourth Street and East Tappan Street to prepare the grounds for subsequent ecological restoration. Treatments will occur on three separate occasions between May and September, 2019.

Neighbors can expect to see RCE and/or Woodbridge Township personnel on-site applying a commonly used broad-spectrum herbicide. Signs will be erected in treated

area(s) indicating the date and time when it is safe for people and pets to re-enter (approximately two hours after application). Treated areas will be replanted with native warm-season grasses and wildflowers in the Fall 2019. The ecological restoration and stormwater management improvement is scheduled to be completed by June 2019.

Public Information Meeting: Area residents are invited to attend a Public Information Meeting at the Cypress Recreation Center, 881 West Avenue, Port Reading, on **Wed., March 26, 2019 from 5:00 - 7:00 PM.**

For Further Information Contact:

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Sincerely,

John E. McCormac
Mayor
Woodbridge Township



Example of a Rain Garden: A rain garden is a garden of native shrubs, perennials, and flowers planted in a small depression, which is generally formed on a natural slope. It is designed to temporarily hold and soak in rain water runoff that flows from roofs, driveways, patios or lawns.



**WOODBIDGE RIVER FLOODPLAIN
POST-RESTORATION MONITORING AND
MAINTENANCE PROGRAM**
Woodbridge Township
Middlesex County, New Jersey

June 2021

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Cover Photograph:

View of a Woodbridge River floodplain forest restoration site near Watson Avenue.

TABLE OF CONTENTS

| | | |
|------------|--|-----------|
| 1.0 | INTRODUCTION AND BACKGROUND..... | 1 |
| 2.0 | PHYSICAL MONITORING | 4 |
| 2.1 | Surface Water Quality Sampling..... | 4 |
| 3.0 | BIOLOGICAL MONITORING | 6 |
| 3.1 | Birds | 6 |
| 3.2 | Amphibians..... | 9 |
| 3.3 | Benthic Macroinvertebrates..... | 11 |
| 4.0 | VEGETATION MONITORING AND MAINTENANCE..... | 12 |
| 4.1 | Pre-Restoration Site Conditions and Preparation | 12 |
| 4.2 | Post-Restoration Monitoring and Maintenance | 15 |
| 4.3 | Stormwater Management..... | 19 |
| 5.0 | MAINTENANCE SCHEDULE | 20 |
| 6.0 | REFERENCES | 22 |

LIST OF FIGURES

- Figure 1 Woodbridge Township, New Jersey boundary and waterways
- Figure 2 Surface Water Quality monitoring locations
- Figure 3 Avian monitoring locations
- Figure 4 Baltimore oriole (*Icterus galbula*) perched on a tree shelter within a restored forested floodplain project area adjacent to the former Watson Avenue
- Figure 5 Baseline amphibian survey locations within the Woodbridge River floodplain
- Figure 6 Representative photo of herbicide application to *Phragmites* regrowth in an area that was recently mowed
- Figure 7 Representative photo of turf grass management in preparation for meadow installation
- Figure 8 Installation of tree shelter over a native planting
- Figure 9 Herbaceous plantings protected with snow fencing, grid wire, and mylar flagging to help deter Canada goose herbivory

LIST OF TABLES

- Table 1 Water quality monitoring locations within the Woodbridge River floodplain
- Table 2 Avian point count site locations and habitat descriptions

1.0 INTRODUCTION AND BACKGROUND

Dense urbanization has significantly modified New Jersey's natural landscape, reducing the ecological and economic benefits it provides. Low-lying developed areas in close proximity to surface waters are particularly affected. During storms, these locations receive elevated stormwater inputs from upland areas and storm surge from overflowing riverbanks and marsh fringes. The resulting flooding severely jeopardizes health and human safety, compromises the integrity of development and infrastructure, and furthers environmental degradation through sediment and chemical pollutant deposition into adjacent ecosystems. Improving resiliency in urbanized coastal areas requires an integrated approach of shoreline retreat, ecological restoration, and green infrastructure construction, coupled with community education and acceptance of resilience strategies through tangible socioeconomic outcomes.

Woodbridge Township (~100,000 residents) is located within the *coastal shoreline county* of Middlesex, NJ, USA. It is a demonstrated environmentally conscious community and has received silver certification from the Sustainable Jersey program for 10 out of the last 11 years. The Township covers ~24 mi² and is bounded by several major waterways, including the Rahway River to the north, the Arthur Kill to the east, and the Raritan River to the south (Figure 1). The eastern half of the Township is bisected by the Woodbridge River, which flows north to south and discharges to the Arthur Kill. Developed areas adjacent to these waterways have been severely impacted by flooding, and they continue to be at significant risk due to the exacerbated effects of climate change. In 2013, Woodbridge Township initiated a strategic plan to improve community resiliency against climate hazards, focusing first on shoreline retreat. The Township secured funds through the NJ Blue Acres Program to acquire properties located within the 100-yr floodplains of the surrounding water bodies. Through the Blue Acres initiative, residents voluntarily sell their properties to the State of New Jersey. These parcels then become permanently protected open space and are either aggregated into nearby state parks or managed by local government entities through a memorandum of understanding. By 2020, the Township had acquired ~190 lots located within five separate communities, including Avenel, Colonia, Port Reading, Sewaren and Watson-Crampton.

Following acquisition, the Township established an Open Space Conservation/Resiliency Zone (OSC/R) in and around the floodplains to help minimize the risk to residences, reduce the amount of flood damage sustained during future flood events, and enhance biodiversity. The OSC/R Zone ordinance codifies the design criteria associated with structures within this area as well as permitted uses, street arrangement, landscaping restrictions, buffer requirements, and required registration for all property owners within it. In addition, building design standards within the OSC/R are triggered at any proposed demolition, addition, reconstruction, renovation, or change in tenancy. The areas designated as within the Open Space Conservation/Resiliency Zone are located within Watson-Crampton, Sewaren and Port Reading neighborhoods of the Township.

The Township then partnered with Rutgers Cooperative Extension (RCE) to better understand opportunities for maximizing community resilience in these areas through ecologically centered land stewardship. In 2016, RCE completed the *Woodbridge Township Open Space and Flood*

Plain Restoration Plan, which included recommendations for ecological restoration, stormwater management and flood storage, landscape buffer establishment, and increased public access. Roughly 87% of the properties (165 lots) are concentrated along the Woodbridge River floodplain within the neighborhoods of Avenel, Watson-Crampton and Sewaren.

With financial support from the National Fish and Wildlife Coastal Resilience Fund, as well as partnership with Woodbridge Township, RCE has prepared detailed construction drawings for ecological restoration and green infrastructure interventions in the Avenel, Watson-Crampton, and Sewaren neighborhoods. This document outlines the monitoring and maintenance activities needed to follow the post-construction progress of the resilience strategy and ensure that its trajectory meets the previously identified goals of: 1) restoring ecological function to the Woodbridge River floodplain; 2) increasing habitat value and biodiversity; and 3) increasing the public amenities supported by the newly acquired open space.

The program outlined here will be used to determine if the restoration projects were completed as designed (implementation monitoring), assess post-project site conditions and document changes resulting from implemented projects (performance monitoring), and provide guidance on how to maintain native plantings and green infrastructure in restored areas. RCE will use the baseline conditions determined from the 2019-2020 ecological monitoring program to quantitatively assess the physical and biological changes that may result from restoration efforts. Primary monitoring objectives are as follows:

- Evaluate the effectiveness of the restoration;
- Assess progress toward restoration goals;
- Document changes in physical and biological parameters over time; and
- Document maintenance needs and enhancement opportunities.

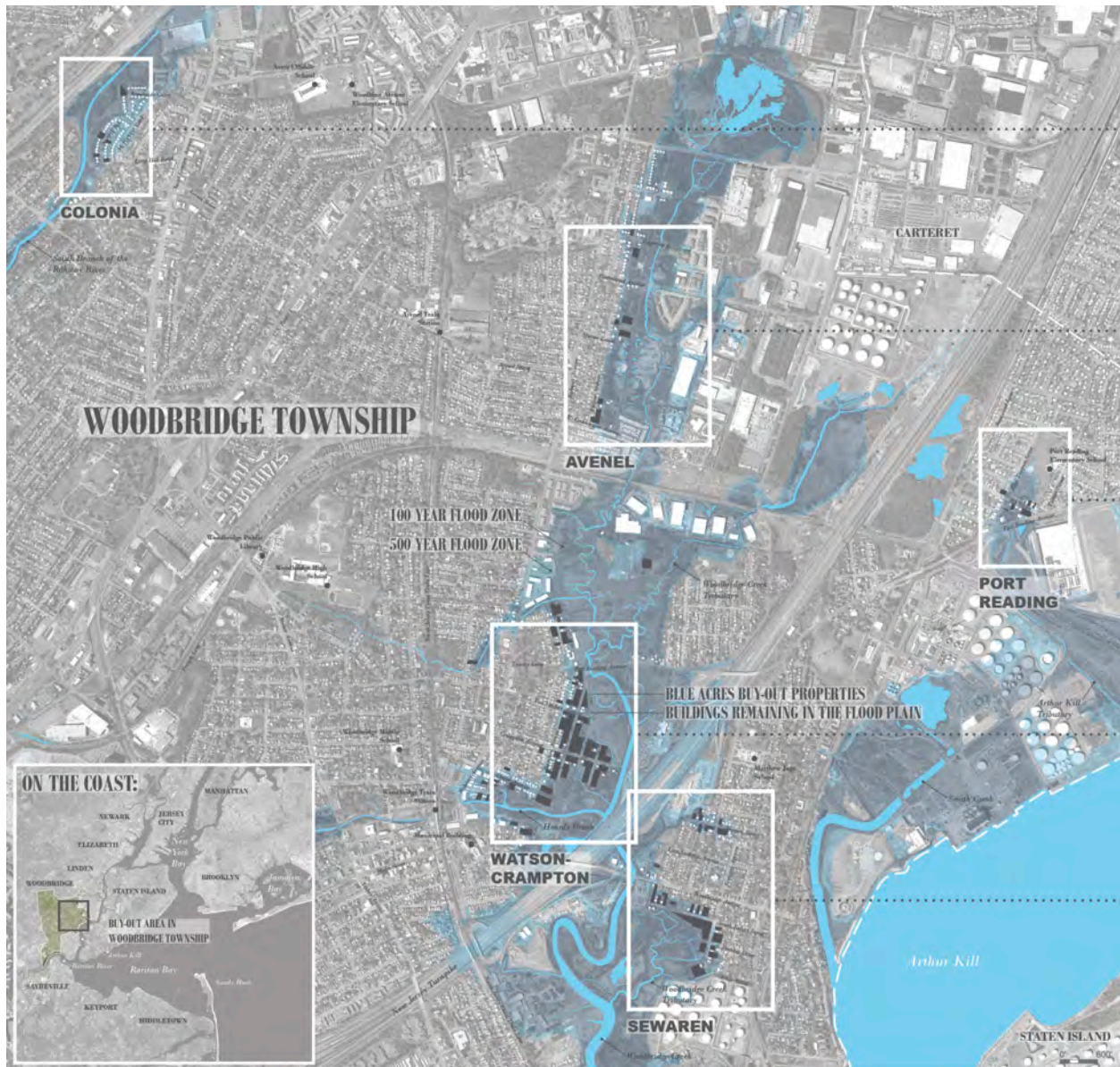


Figure 1: Woodbridge Township, New Jersey boundary and waterways

2.0 PHYSICAL MONITORING

2.1 Surface Water Quality Sampling

Baseline Monitoring and Results Summary

Rutgers Cooperative Extension (RCE) performed surface water quality monitoring along the Woodbridge River in 2019 at four established monitoring locations. One sampling site is located downstream of the Ernie Oros Wildlife Preserve in Avenel. The remaining three sites are located immediately downstream of each of the project neighborhoods of Avenel, Watson-Crampton and Sewaren (Table 1; Figure 2). Surface water quality sampling is conducted to assess the current input of nutrients (i.e., total phosphorus, nitrate, and nitrite), total suspended solids, total solids, pH, and dissolved oxygen levels along the Woodbridge River.

Baseline sampling indicated violations of the surface water quality criteria for total phosphorus, and occasional violations of nitrates and total suspended solids. Oxygen, pH and nitrite did not appear to be parameters of concern for the Woodbridge River. From these monitoring results, RCE will be able to measure water quality improvements that may result from the implementation of targeted restoration and green infrastructure interventions throughout the project area.

Post-restoration Monitoring Schedule and Success Criteria

The NJDEP's Integrated Water Quality Monitoring and Assessment Methods indicate that if the frequency of water quality results exceeds the water quality criteria twice within a five-year period, then the waterway's quality may be compromised (NJDEP, 2015). Therefore, RCE recommends that the post-construction surface water quality monitoring occur every 2 years.

Success Criterion: Reduce mean total phosphorous by $\geq 50\%$ to comply with the surface water quality standard: concentrations of total P shall not exceed 0.100mg/L.

Table 1. Water quality monitoring locations within the Woodbridge River floodplain

| Location | Description | Coordinates |
|----------|--|-----------------------------|
| Site 1 | Woodbridge River south of Omar Ave | 40°35'03.6" N 74°15'46.1" W |
| Site 2 | Woodbridge River at Port Reading JCT/CSX Trenton Sub/Manville Yard MP35.8 track crossing | 40°34'17.2" N 74°15'58.9" W |
| Site 3 | Woodbridge River immediately north of a NJ Turnpike overpass | 40°33'25.8" N 74°16'03.1" W |
| Site 4 | Woodbridge River near Shell Oil holdings; off of Arbor St | 40°32'57.5" N 74°15'52.9" W |

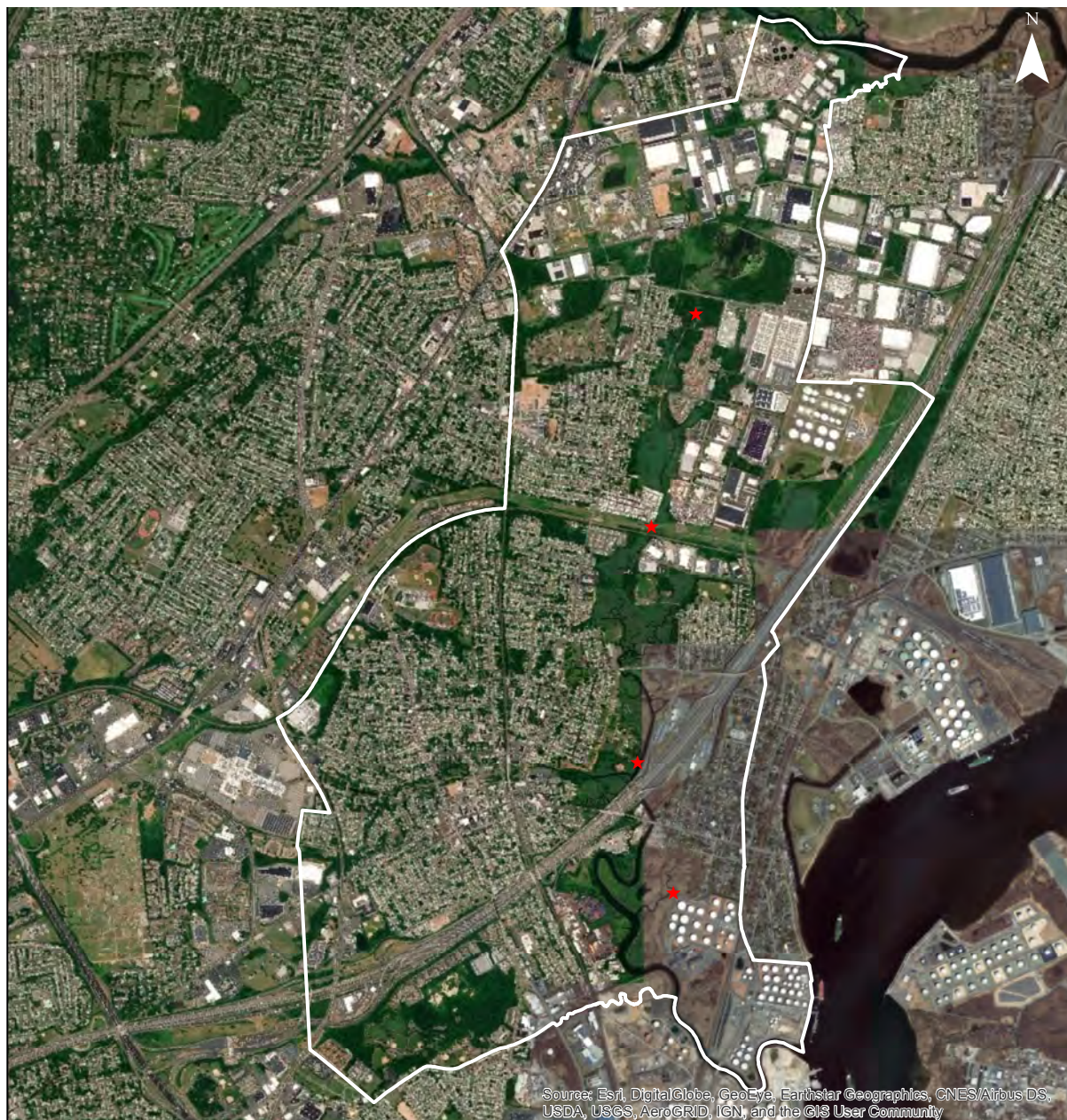


Figure 2: Surface Water Quality monitoring locations

3.0 BIOLOGICAL MONITORING

3.1 Birds

Baseline Monitoring and Results Summary

RCE conducted point count bird surveys in 2019 to establish a baseline avian species inventory along the Woodbridge River corridor. We chose five permanent points representing the range of habitats available (Table 2; Figure 3). These habitats include meadow, *Phragmites*-dominated marsh, tidal river, saltmarsh and woodland (Figure 4). RCE recorded 26 total species and calculated an average Shannon Diversity Index of 2.46 across the four sites.

Point counts are the most widely used quantitative method to monitor bird populations (Ralph et al. 1995). Point counts took place on mornings with fair conditions in the absence of rain or high wind (<10mph). A trained observer arrived at the first point count location within an hour after sunrise and visited points sequentially. Upon arriving at a point, the observer waited for 3 minutes to allow surrounding birds to acclimate and resume normal activity (Rosenstock et al. 2002). After the 3-minute waiting period, the observer started a timer and recorded all birds observed within a 10-minute period, including both the species and the number of individuals (Ralph et al. 1995). If the observer was unsure about the number of individuals present due to potential individual movements between observations, they conservatively recorded the minimum number of individuals likely to have been observed during the 10-minute period.

Post-restoration Monitoring Schedule and Success Criteria

To assess the impact of ecological restoration activities on the resident avian communities within the project areas, point count bird surveys should be conducted at a frequency of once per year. The surveys should occur once in May and once in early June, following the protocol used for the baseline monitoring. RCE expects species diversity to increase post-construction, especially as *Phragmites*-dominated marsh habitat (which had the lowest diversity) is converted back into native plant-dominated habitats.

Success Criterion: Increase avian species diversity by 20%.

Table 2: Avian point count site locations and habitat descriptions

| Point Count Site | Location | Habitat Class |
|------------------|-----------------------|--------------------------------|
| WB01 | 40.577844, -74.26575 | Meadow |
| WB02 | 40.562303, -74.267882 | <i>Phragmites</i> Marsh |
| WB03 | 40.557597, -74.270241 | Tidal River (Woodbridge River) |
| WB04 | 40.549574, -74.264199 | Woodland |
| WB05 | 40.586546, -74.262348 | Saltmarsh |



Figure 3: Avian monitoring locations



Figure 4: Baltimore oriole (*Icterus galbula*) perched on a tree shelter within a restored forested floodplain project area adjacent to the former Watson Avenue

3.2 Amphibians

Baseline Monitoring and Results Summary

RCE performed frog and toad call monitoring at 19 sites along the Woodbridge River floodplain in 2019 to create a baseline species inventory (Figure 5). Frogs and toads can be easily identified by their unique breeding vocalizations. For each survey, RCE spent 3 – 5 minutes at each site and recorded any frog or toad call heard. Surveys occurred bi-weekly on rainy nights from April – June. RCE identified 3 amphibian species utilizing the Woodbridge River, but they only occurred in or near the Ernie Oros Wildlife Preserve and were virtually absent in more developed areas of the Woodbridge River.

Because amphibians require both terrestrial and aquatic habitats to complete their life stages, they are particularly sensitive to ecosystem stressors such as contamination, land-use change, hydrology and climate. Therefore, they are excellent indicators of habitat quality and provide a measure with which to assess ecological health (Smrekar and Byrne, 2015).

Post-restoration Monitoring Schedule and Success Criteria

To assess the impact of ecological restoration activities on the resident amphibian communities within the project areas, frog and toad call surveys should be conducted at a frequency of once per year. Surveys should occur from April - June, following the protocol used for the baseline monitoring. While there is unlikely to be an increase in species diversity due to surrounding development, RCE expects there to be an increase in abundance of the three resident species, and a further range expansion from the Ernie Oros Wildlife Preserve into nearby connected sites.

Success Criterion: Increase American bullfrog (*Lithobates catesbeianus*), green frog (*Lithobates clamitans*), and northern spring peeper (*Pseudacris crucifer*) presence south of the Ernie Oros Wildlife Preserve to at least three additional survey sites.



Figure 5: Baseline amphibian survey locations within the Woodbridge River floodplain

3.3 Benthic Macroinvertebrates

Baseline Monitoring and Results Summary

RCE performed baseline benthic macroinvertebrate sampling in 2020 at 4 sites along the Woodbridge River. At each site, RCE attached 3 Hester-Dendy samplers to a metal T-post using zipties. The samplers were positioned in the euphotic zone (depth of ~0.3 m), and the T-posts were hammered into the substrate. Each T-post was secured to the river bank with a rope. After a 6-week deployment in late summer (mid July – late August), RCE retrieved the samplers. Each Hester-Dendy sampler was then disassembled, and the contents of each individual hardboard scraped into a collection cup, which was filled with 95% ethanol to preserve the specimens. RCE then sorted through each sample at a Rutgers University laboratory and identified the specimens to family level when possible.

Benthic macroinvertebrates (BMI) include small aquatic animals and aquatic larval stages of insects that live on the bottom of waterbodies. Examples include dragonfly and stonefly larvae, snails, worms and beetles. They are typically found on rocks, vegetation and logs, or are burrowed into bottom substrate. Benthic macroinvertebrates are often used to indicate the biological condition of a waterbody because they spend all or the majority of their lives in water, and different species have predictable tolerances to pollution. Healthy water bodies should contain a wide variety of macroinvertebrate taxa, including those that are pollution intolerant (EPA, 2016).

RCE used the Hilsenhoff Family Biotic Index (FBI) to evaluate water quality of the sample sites based on the benthic invertebrate community (Hilsenhoff, 1988). This method assigns individual taxa of benthic arthropods with a pollution-tolerance value. These values range from 0 to 10, with 0 describing taxa that are least tolerant to pollution, and 10 describing taxa that are most tolerant to pollution. The FBI for the Woodbridge River sites ranged from 4.10 to 5.55, indicating that the water quality is very good (possible slight organic pollution) to fair (fairly substantial pollution likely).

Post-restoration Monitoring Schedule and Success Criteria

To assess the impact of ecological restoration activities on the benthic macroinvertebrate community within the project areas, sampling should be conducted every 2 years, in alignment with the surface water quality monitoring which occurs at the same 4 survey sites.

Success criteria: Receive an FBI score of ≤ 5.00 at all four sites, which would indicate organic pollution as good (some organic pollution probable) to excellent (organic pollution unlikely).

4.0 VEGETATION MONITORING AND MAINTENANCE

The success of ecological restoration and green infrastructure interventions relies heavily on the successful establishment of native vegetation. New plantings will require routine monitoring and maintenance to promote establishment. Relevant stressors on new plantings include herbivory, temperature and water stress, and competition from weeds. This document provides recommendations and best practices for preparing and maintaining sites upon completion of restoration activities.

4.1 Pre-Restoration Site Conditions and Preparation

The project area is a mosaic of moderate to highly disturbed habitats characteristic of the central New Jersey urban landscape. Dominant ecotypes within the currently unmanaged portions of the area include saline and *Phragmites*-dominated marshlands, deciduous woodland, and scrub/shrub habitat. Common invasive species include *Phragmites* (*Phragmites australis*), mugwort (*Artemisia vulgaris*), mile-a-minute (*Polygonum perfoliatum*), Japanese knotweed (*Fallopia japonica*), Amur honeysuckle (*Lonicera maackii*), Japanese barberry (*Berberis thunbergii*), and tree-of-heaven (*Ailanthus altissima*).

Debris/Litter Removal

Prior to restoration implementation, the Township should remove all debris and litter from the project area. This task can be completed through a volunteer effort in coordination with the Woodbridge Township Department of Public Works.

Phragmites Management

Some project areas are dominated by *Phragmites*, which can be reduced using a combination of mechanical and chemical control. The winter prior to restoration implementation, the dead standing *Phragmites* should be mowed, where possible, once before March 15th (to prevent impacts to nesting birds). The area should be mowed a second time after July 15th and allowed to regrow at least 30 days. In late-August to mid-October, the *Phragmites* should be treated with Rodeo® or an equivalent version of glyphosate, which is safe for use in aquatic habitats (Figure 6).

Invasive Woody Shrubs and Vines Management

Species such as Japanese barberry, common privet (*Ligustrum vulgare*), multiflora rose (*Rosa multiflora*), amur honeysuckle, Japanese honeysuckle (*Lonicera japonica*), lilac (*Syringa vulgaris*), and oriental bittersweet (*Celastrus orbiculatus*) should be controlled using the cut-stump method. First, pruning shears, hand saws, or similar tools are used to manually remove aboveground plant material. Immediately after cutting, a concentrated glyphosate solution should be applied to the stumps to prevent regrowth.



Figure 6: Representative photo of herbicide application to *Phragmites* regrowth in an area that was recently mowed

Invasive Tree Management

Species such as Norway maple (*Acer platanoides*), tree of heaven, callery pear (*Pyrus calleryana*), white mulberry (*Morus alba*), sweet cherry (*Prunus avium*), and Chinese elm (*Ulmus parvifolia*) are common throughout the project area. Seedlings of invasive trees can be removed manually or by applying herbicide, depending on the level of infestation. Trees <6 inches diameter at breast height (DBH) can be felled using handsaws and the cut-stump method (see above). Larger trees (>6 inches DBH) can be controlled using the frill girdle method, which consists of cutting a single line of overlapping downward axe cuts around the trunk and applying herbicide into the ‘frills’ using a squeeze bottle. The cuts will be deep enough to remove the vascular cambium (inner bark) of the tree. Over time, these resulting dead trees called ‘snags’ will become valuable wildlife habitat (foraging habitat, nesting sites, perching sites, etc.). Tree of heaven, which can resprout vigorously, cannot be controlled using the above stated mechanical methods. To control this species, the injection method should be used, which involves making evenly spaced downward-angled cuts into the sapwood around the tree trunk with an axe, then immediately applying a high concentration of glyphosate herbicide into the cut.

Other Herbaceous Plants

Invasive herbaceous plants such as garlic mustard (*Alliaria petiolata*), Japanese knotweed, mile-a-minute, Japanese stiltgrass (*Microstegium vimineum*), Asiatic day flower (*Commelina communis*) are controlled by applying glyphosate herbicide using backpack sprayers, which allow for targeted application and decreased risk of damaging non-target species. During late summer, perennial species are preparing for dormancy by sending sugars into their rhizomes for storage, which will help circulate the herbicide throughout the plant and increase effectiveness. Repeated spraying will be necessary to kill re-sprouting individuals.

Turf Management

Prior to meadow establishment, turf grass and all non-native plants must be removed from the site. This can be achieved through 2 – 3 applications of a nonselective systemic herbicide such as glyphosate during the growing season (Figure 7). The first two applications should occur in mid-May and mid-July. If turf grass or other species continues to re-grow, the area can be treated a third time in late August or early September.



Figure 7: Representative photo of turf grass management in preparation for meadow installation

4.2 Post-Restoration Monitoring and Maintenance

Protection from Herbivory

All newly planted trees and shrubs should be protected with 3 to 5-ft tree shelters (i.e. Tubex®) to protect the plantings from herbivory. These hard-plastic cylindrical tubes force saplings to grow above the reach of deer browse, while also protecting them from ground-feeding mammals such as rabbits, mice and voles. In addition to physical protection, the shelters are constructed of translucent, UV-stabilized plastic which creates a greenhouse microclimate of high humidity, reduced air movement, and lower light intensity inside the shelter, ultimately increasing sapling growth rate.

Tree shelters should be supported with a durable 1-inch square stake at a height of at least two thirds of the tube length and installed at least 12 inches below ground. Tree shelters should then be secured to the stake by a minimum of 2 strong zip ties (Figure 8). While plant height is below the top of the tube, each shelter should be adorned with netting on the top to prevent songbirds from entering the tubes and getting trapped inside. The bird netting must be removed when the plant reaches the top of the tube to avoid terminal bud deformation, which can lead to decreased vertical growth and stem quality of the plant.

Tube shelters should be inspected at least twice per year (and preferably more) to fix any slanted or tipped over shelters, replace broken or rotten stakes, remove old leaves and debris from the bottom of the shelter, and remove any small mammal nests inside the shelter. Routine maintenance will help the trees stay free of disease and pests.



Figure 8: Installation of tree shelter over a native planting

Herbaceous wetland plants should be protected from goose damage using typical exclusion practices. Heavy plastic snow fencing supported by 3-5' high sturdy posts should be erected around the perimeter of the planted areas. Overhead grids of monofilament line or Kevlar wire should be constructed above the plantings at a spacing of 2-6 ft. Grids should be adorned with mylar tape (Figure 9).



Figure 9: Herbaceous plantings protected with snow fencing, grid wire, and mylar flagging to help deter Canada goose herbivory

Watering

Throughout the first growing season after planting (April - November), newly installed trees should be watered weekly at a rate of 1-1.5 gallons per inch of stem caliper. Plants can be watered using a slow trickle from a hose; larger trees (>1" caliper) can be watered using tree bags (e.g., Treegator®) to provide a slow and consistent supply of water. Newly installed herbaceous plants

should be at a rate of ~1” per week. During the second and third growing seasons, plants should be watered as needed, particularly during hot and dry spells.

Weeding

For a period of three years, a 3-ft radius around all new woody plantings should be kept clear of emerging seedlings (both native and invasive) to reduce competition for water and nutrients. This is accomplished through either mechanical methods (i.e. weed trimmer) or careful glyphosate application around each planting using backpack sprayers. The tree tubes lack ventilation holes on the first 12 inches closest to the ground to protect the plantings from herbicide drift.

Invasive Species Management

The project area should be monitored throughout the growing season for the presence of invasive species for at least 5 years. Three of the most common invasive plant species found throughout the Woodbridge River project area are *Phragmites*, mile-a-minute, and mugwort.

Phragmites

After restoration implementation, any recurring *Phragmites* growth should be manually cut (i.e. hand shears or brush hog, where feasible), taking care to avoid damaging native plantings. If dense stands regrow in upland zones where woody vegetation was planted, mowing or brush-hogging around native plantings should occur twice throughout the growing season, followed by treatment with glyphosate, as described in section 4.1. Eventually, canopy cover in upland restoration zones will help to shade out *Phragmites* growth due to drier conditions; however, *Phragmites* in wetter areas will require ongoing management as seed and rhizomes will continually invade from the surrounding environment.

Mile-a-minute

Mile-a-minute is an annual vine that can grow up to 6 inches per day and will quickly smother restoration plantings if left unchecked. This plant should be removed manually in early summer before it goes to seed, which can remain viable in the soil up to 5 years. Additional seeds are often brought in from neighboring areas through bird droppings. The United States Department of Agriculture has released a mile-a-minute biocontrol (the weevil, *Rhinoncomimus latipes*) in New Jersey which may provide benefits to the project area in future years.

Project areas with dense mile-a-minute infestations can be treated with a preemergent herbicide such as prodiamine to prevent the plant from germinating. This type of herbicide has little effect on plants that are already present. The herbicide should be applied 2 – 3 weeks prior to the germination, then followed up in May and June with manual removal or with an application of glyphosate to treat any missed areas.

Mugwort

Mugwort is an herbaceous perennial that can outcompete native plantings and form dense stands in upland areas. Mugwort should be controlled with repeated applications of a systemic non-selective herbicide, such as glyphosate, using backpack sprayers. Extreme care must be given to avoid herbicide contact with desirable plants.

Woody Species

After restoration implementation, invasive woody species including shrubs, trees, and vines that were treated during pre-restoration preparation should be checked each growing season for signs of regrowth or re-establishment. Small seedlings can be manually removed or sprayed with glyphosate. Any larger individual plants should be treated using the cut-stump method or the injection method.

Note: This report describes appropriate management strategies for common invasive plant species in the New York – New Jersey region that have been documented within the project area. It is important to be mindful of the potential for new and emerging threats, and to eradicate colonizing invasive species before they establish a population.

4.3 Stormwater Management

Stormwater conveyance and outlet control systems manage runoff volumes from surrounding urban areas to reduce flooding. Without proper routine inspection and maintenance, these systems may lose some or all of their functional capacity. Lack of adequate maintenance could lead to failures. Vegetated swales and depressions should be monitored bi-monthly (every other month), and after severe storms. These areas should be kept free of debris, rocks, branches and litter to promote the movement of stormwater through the system. If erosion of the swale is observed (i.e. percent cover of vegetation is reduced to <90% of original planting), replacement plantings should be installed as part of corrective maintenance measures.

5.0 MAINTENANCE SCHEDULE

Regularly scheduled maintenance inspections of restored areas should be performed at least twice each year. The primary purpose of these inspections is to ascertain the operational condition and safety of the project areas, particularly the condition of green infrastructure and other safety-related aspects. Inspections also provide information on the effectiveness of regularly scheduled preventative maintenance procedures and will help to identify where changes in the extent and scheduling of the procedures are warranted. Finally, site inspections should also be used to determine the need for and timing of corrective maintenance procedures. The table below indicates the frequency with which both preventative and corrective measures should occur, broken into restoration phases.

| | Pre-restoration | Post-Restoration | | |
|------------------------------------|-----------------|--------------------------|--------------------------|----------------------|
| | | Year 1 | Years 1-3 | Years 3+ |
| Task | Frequency | Frequency | Frequency | Frequency |
| General | | | | |
| Litter/Debris Removal | as needed | * | 1x/year | 1x/year |
| Safety Inspection | * | * | 1x/year | 1x/year |
| Vegetation | | | | |
| Plant health monitoring | * | | | |
| Inspection | * | 1x/year | 2x/year | 1x/year |
| Re-planting | * | * | as needed | as needed |
| Invasive Species Management | as needed | | | |
| Inspection | * | weekly | 2x/year | 2x/year |
| Corrective Action | * | | as needed | as needed |
| Herbivory Protection | | | | |
| Inspection | * | weekly | 2x/year | 2x/year |
| Repair | * | as needed | as needed | as needed |
| Removal | * | * | * | as needed |
| Watering | * | weekly | as needed | * |
| Weeding (3' radius) | * | 1x/month | 1x/month | * |
| Stormwater | | | | |
| Inspection of green infrastructure | * | 1x/2 months | 1x/4 months | 2x/year |
| Maintenance and cleaning | * | 1x/3 months as needed | 1x/6 months as needed | 1x/year as needed |
| Replanting of swale vegetation | * | as needed | as needed | as needed |

Physical and biological monitoring should occur for up to five years post-construction. RCE will use the baseline conditions from the 2019-2020 ecological monitoring program to compare the results of the post-restoration monitoring, in order to evaluate the effectiveness of the restoration,

assess progress toward restoration goals and success criteria, and document changes in physical and biological parameters over time. The table below indicates the frequency with which physical and biological monitoring should occur.

| | Pre-restoration | Post-Restoration | | | | |
|--------------------------------|-----------------|------------------|---------|---------|---------|---------|
| | | Year 1 | Year 2 | Years 3 | Year 4 | Year 5 |
| Task | Frequency | Frequency | | | | |
| Physical Monitoring | | | | | | |
| Surface Water Quality Sampling | * | | 1x/year | | 1x/year | |
| Biological Monitoring | | | | | | |
| Birds | * | 1x/year | 1x/year | 1x/year | 1x/year | 1x/year |
| Amphibians | * | 1x/year | 1x/year | 1x/year | 1x/year | 1x/year |
| Benthic Macroinvertebrates | * | | 1x/year | | 1x/year | |

6.0 REFERENCES

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- New Jersey Department of Environmental Protection (NJDEP). 2015. 2014 Integrated Water Quality Monitoring and Assessment Methods. https://www.state.nj.us/dep/wms/bears/docs/2014_final_methods_document_and_response_to_comments.pdf
- Ralph, C.J, J.R. Sauer, S. Droege. Technical editors. 1995. Monitoring Bird Populations by Point Counts. Gen. Tech. Rep. PSW-GTR-149. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.
- Rosenstock, S.S., D.R. Anderson, K.M. Giesen, T. Leukering, and M.F. Carter. 2002. Landbird counting techniques: Current practices and an alternative. *The Auk* 119(1):46-53.
- Smrekar, B.D., and M.W. Byrne. 2015. Anuran Community Monitoring at Fort Frederica National Monument; 2014 Data Summary. U.S. Department of the Interior, National Park Service, Natural Resources Stewardship and Science, Fort Collins, CO.

WATSON-CRAMPTON FORESTED WETLAND RESTORATION

TOWNSHIP OF WOODBRIDGE MIDDLESEX COUNTY, NEW JERSEY

BLOCK 563.16, LOT 121,124,127,129,131,145
BLOCK 563.17, LOT 157,179,181,183,187
BLOCK 563.33, LOT 1

PROJECT DESCRIPTION:

THIS PROJECT PROPOSES CONSTRUCTION OF A WETLAND DESIGNED TO CONVEY STORM WATER FROM ADJACENT DEVELOPED AREA TO THE WOODBRIDGE RIVER. THE WETLAND DESIGN REDIRECTS FLOW FROM THREE EXISTING SWALES THROUGH A SERIES OF VEGETATED DEPRESSIONS AND OPEN POOLS, WHERE WATER WILL BE TEMPORARILY STORED AND FILTERED. THE DESIGN INCREASES THE FLOOD STORAGE POTENTIAL OF THE EXISTING LANDSCAPE USING NATURAL ECOLOGICAL FEATURES AND REESTABLISHES NATIVE WETLAND VEGETATION APPROPRIATE TO THE REGION AND THE EXPECTED SITE CONDITIONS.

LOCATION MAP:



LEGEND:

- EXISTING DRAINAGE AREA
- EDGE OF PAVEMENT
- ⚡----- EXISTING CENTERLINE
- +—— EXISTING FENCE
- ~~~~~ EXISTING TREELINE
- EXISTING TREE
- ▨ EXISTING BUILDING
- ⊕ EXISTING UTILITY POLE
- ▩ EXISTING CATCH BASIN
- EXISTING CONTOURS
- PROPERTY LINES
- +—— LIMIT OF WORK
- ▨ AREA TO BE DEPAVED
- PROPOSED CONTOURS

LIST OF DRAWINGS:

| SHEET NAME | TITLE |
|------------|---|
| COVER | COVER SHEET |
| P-1 | EXISTING CONDITIONS AND DEMOLITION PLAN |
| P-2 | PROPOSED SITE PLAN |
| P-3 | WETLAND ZONE DIAGRAM |
| P-4 | PLANTING PLAN |
| DT-1 | PLANTING DETAILS |
| DT-2 | SOIL EROSION & SEDIMENT CONTROL DETAILS |

GENERAL NOTES:

- SURVEY CONDUCTED BY RUTGERS COOPERATIVE EXTENSION WATER RESOURCES PROGRAM. SURVEY ELEVATIONS WERE ADJUSTED TO NAVD88.

REVISIONS

| No. | DATE | DESCRIPTION |
|-----|-----------|-------------------------|
| 1 | 8/28/2020 | REV. PER NJDEP COMMENTS |
| 2 | 9/2/2020 | REV. PER NJDEP COMMENTS |
| | | |
| | | |
| | | |

WATSON-CRAMPTON
FORESTED WETLAND RESTORATION
TOWNSHIP OF WOODBRIDGE
MIDDLESEX COUNTY, NJ

RUTGERS
New Jersey Agricultural
Experiment Station

CHRISTOPHER C. OBROPTA, Ph.D., P.E.
PROFESSIONAL ENGINEER - NJ LICENSE # 37532

DRAWN
ML

CHECKED
JB

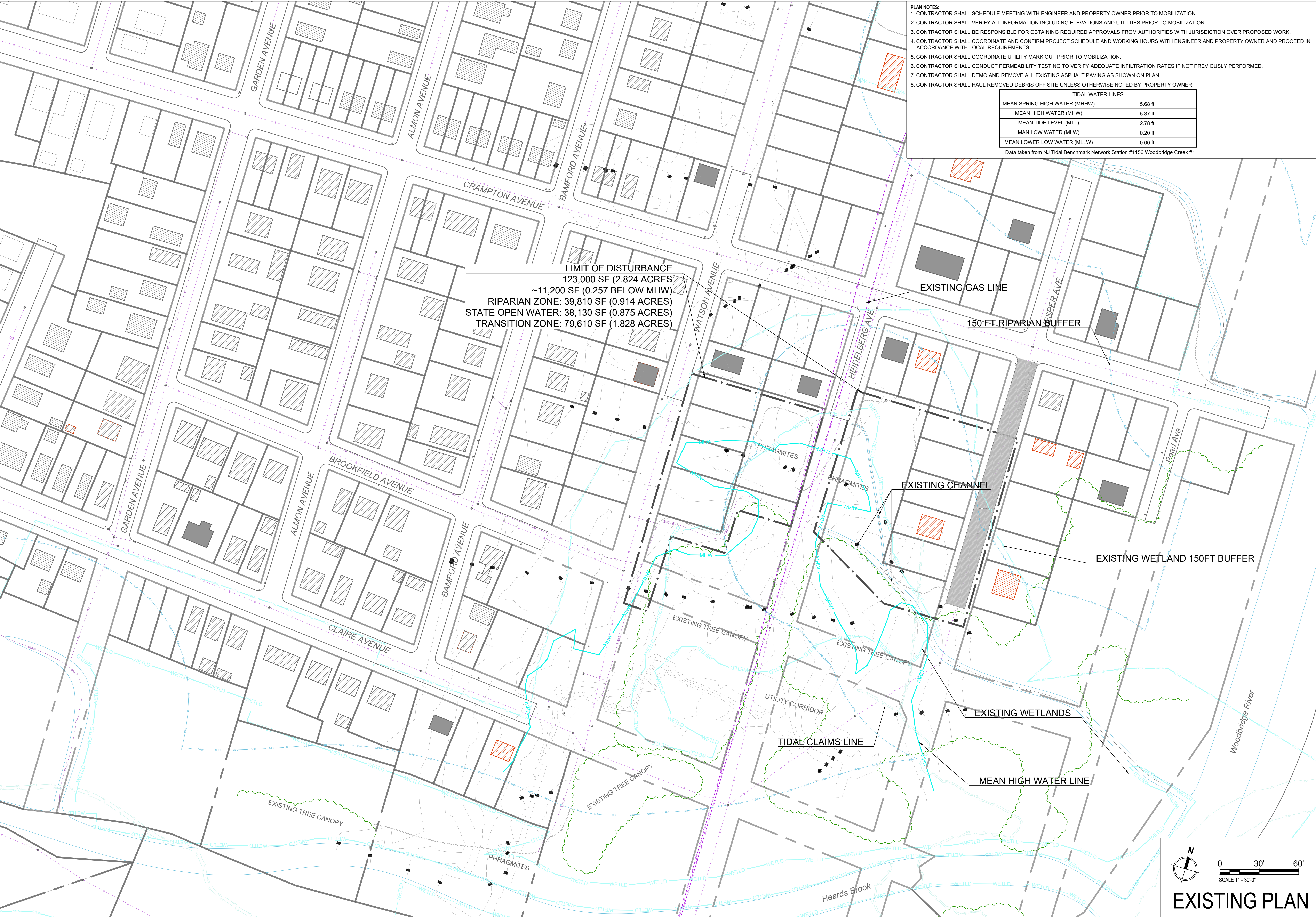
APPROVED
BM

DATE
09/09/2020

DATE
09/09/2020

REV. 1

SHEET NAME
COVER

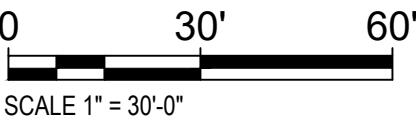
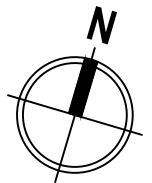


LIMIT OF DISTURBANCE
123,000 SF (2.824 ACRES)
~11,200 SF (0.257 BELOW MHW)
RIPARIAN ZONE: 39,810 SF (0.914 ACRES)
STATE OPEN WATER: 38,130 SF (0.875 ACRES)
TRANSITION ZONE: 79,610 SF (1.828 ACRES)

- PLAN NOTES:
1. CONTRACTOR SHALL SCHEDULE MEETING WITH ENGINEER AND PROPERTY OWNER PRIOR TO MOBILIZATION.
 2. CONTRACTOR SHALL VERIFY ALL INFORMATION INCLUDING ELEVATIONS AND UTILITIES PRIOR TO MOBILIZATION.
 3. CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING REQUIRED APPROVALS FROM AUTHORITIES WITH JURISDICTION OVER PROPOSED WORK.
 4. CONTRACTOR SHALL COORDINATE AND CONFIRM PROJECT SCHEDULE AND WORKING HOURS WITH ENGINEER AND PROPERTY OWNER AND PROCEED IN ACCORDANCE WITH LOCAL REQUIREMENTS.
 5. CONTRACTOR SHALL COORDINATE UTILITY MARK OUT PRIOR TO MOBILIZATION.
 6. CONTRACTOR SHALL CONDUCT PERMEABILITY TESTING TO VERIFY ADEQUATE INFILTRATION RATES IF NOT PREVIOUSLY PERFORMED.
 7. CONTRACTOR SHALL DEMO AND REMOVE ALL EXISTING ASPHALT PAVING AS SHOWN ON PLAN.
 8. CONTRACTOR SHALL HAUL REMOVED DEBRIS OFF SITE UNLESS OTHERWISE NOTED BY PROPERTY OWNER.

| TIDAL WATER LINES | |
|-------------------------------|---------|
| MEAN SPRING HIGH WATER (MHHW) | 5.68 ft |
| MEAN HIGH WATER (MHW) | 5.37 ft |
| MEAN TIDE LEVEL (MTL) | 2.78 ft |
| MAN LOW WATER (MLW) | 0.20 ft |
| MEAN LOWER LOW WATER (MLLW) | 0.00 ft |

Data taken from NJ Tidal Benchmark Network Station #1156 Woodbridge Creek #1



EXISTING PLAN

WATSON-CRAMPTON
FORESTED WETLAND RESTORATION
TOWNSHIP OF WOODBRIDGE
MIDDLESEX COUNTY, NJ

REVISIONS

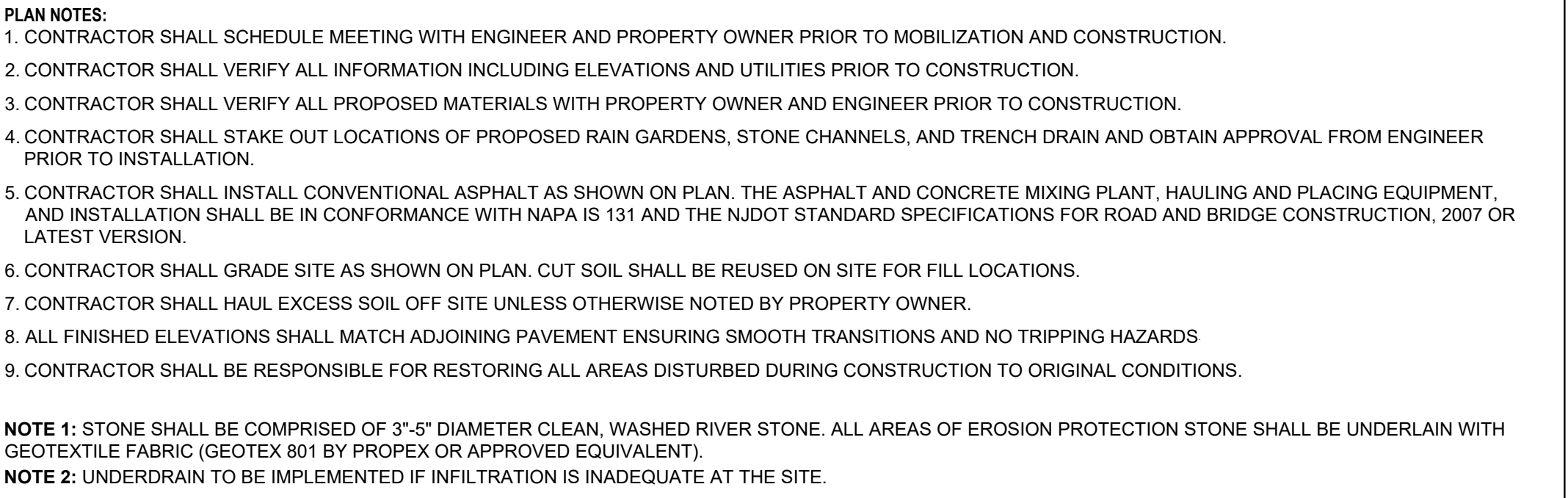
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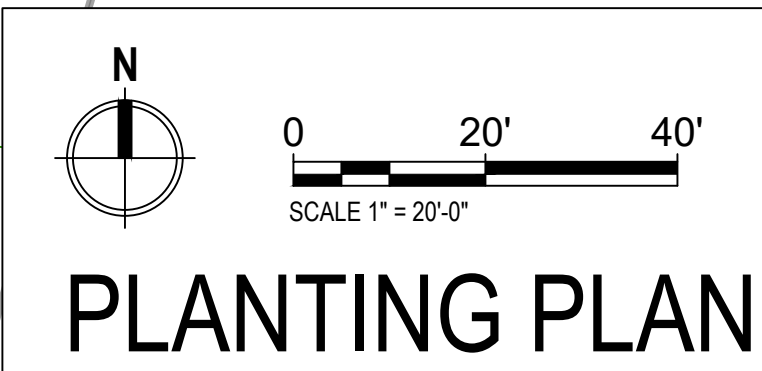
CHRISTOPHER C. OBROPTA, Ph.D., P.E.
PROFESSIONAL ENGINEER - NJ LICENSE # 57532

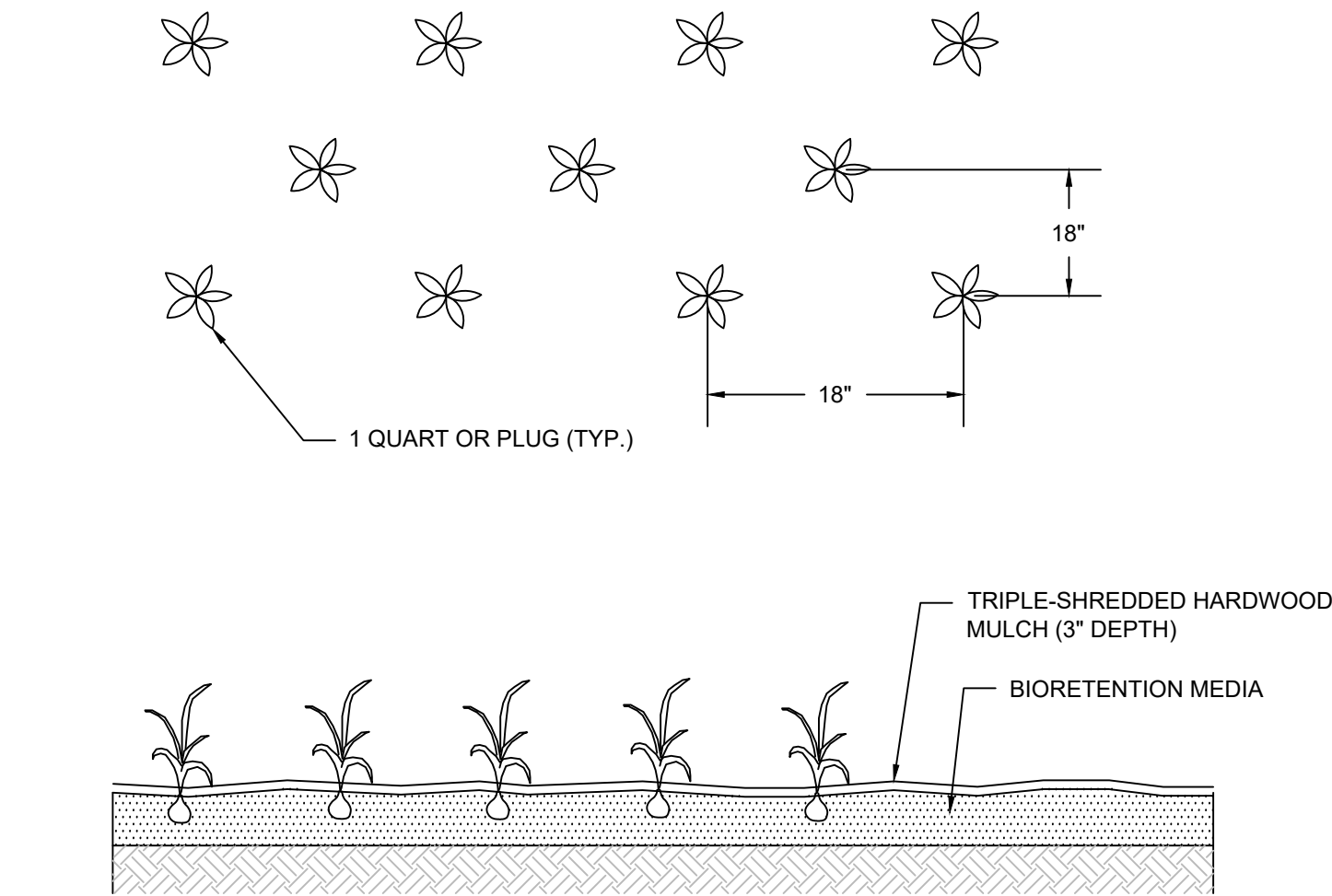
DATE 09/09/2020

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|-------------|---------------|----------------|
| DRAWN ML | CHECKED JB | APPROVED BM |
|-------------|---------------|----------------|

SHEET NAME
P-1

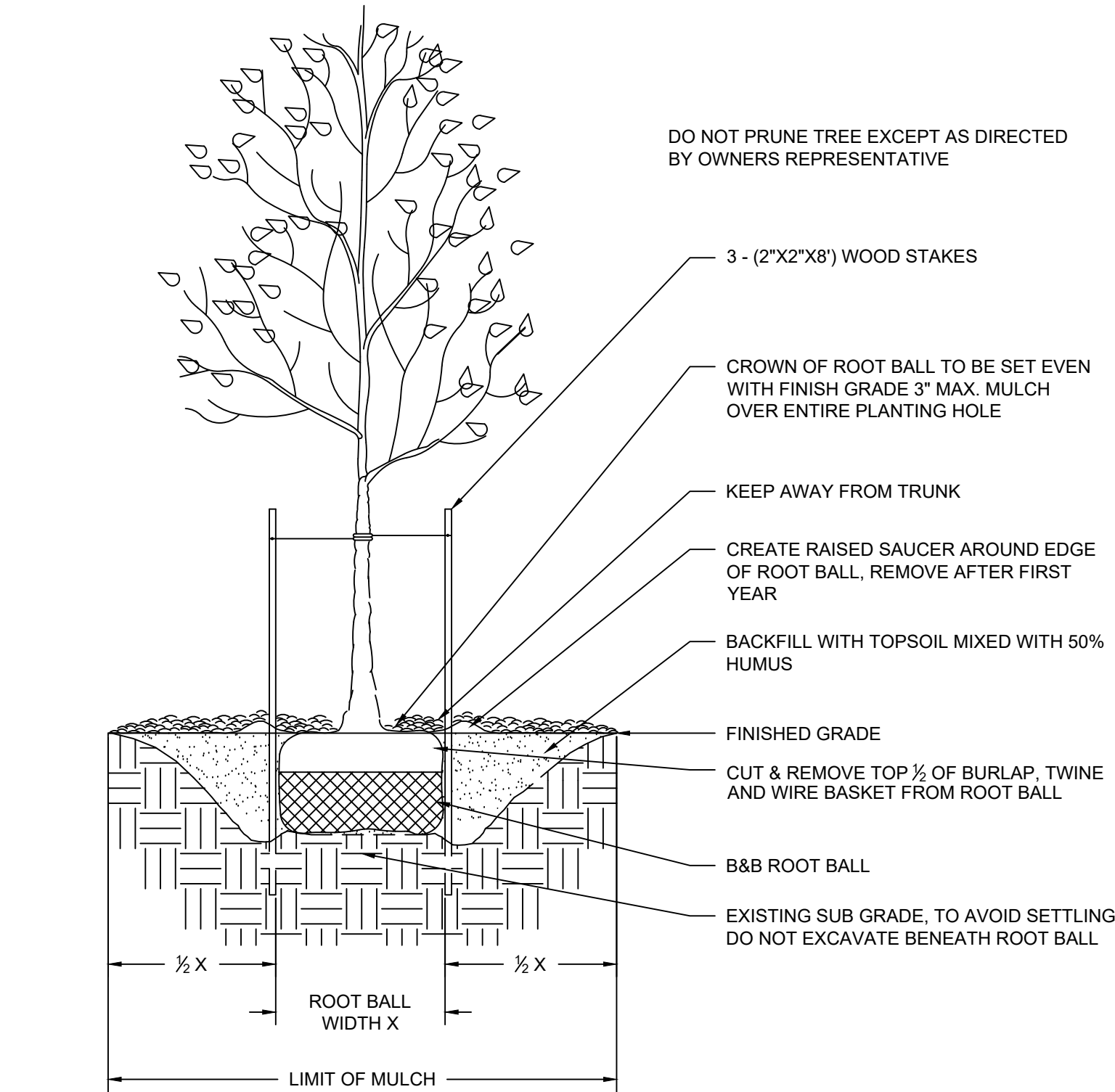
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1
DT-1

HERBACEOUS PLUG PLANTING DETAIL
N.T.S.



- NOTES:
- DO NOT DAMAGE MAIN ROOTS OR ROOT BALL WHEN INSTALLING TREE STAKE.
 - WATER THOROUGHLY AFTER INSTALLATION.
 - REMOVE SAUCER AND STAKES TWO YEARS OR LESS AFTER INSTALLATION.
 - CONTRACTOR IS NOT TO USE TREE WRAP.

2
DT-1

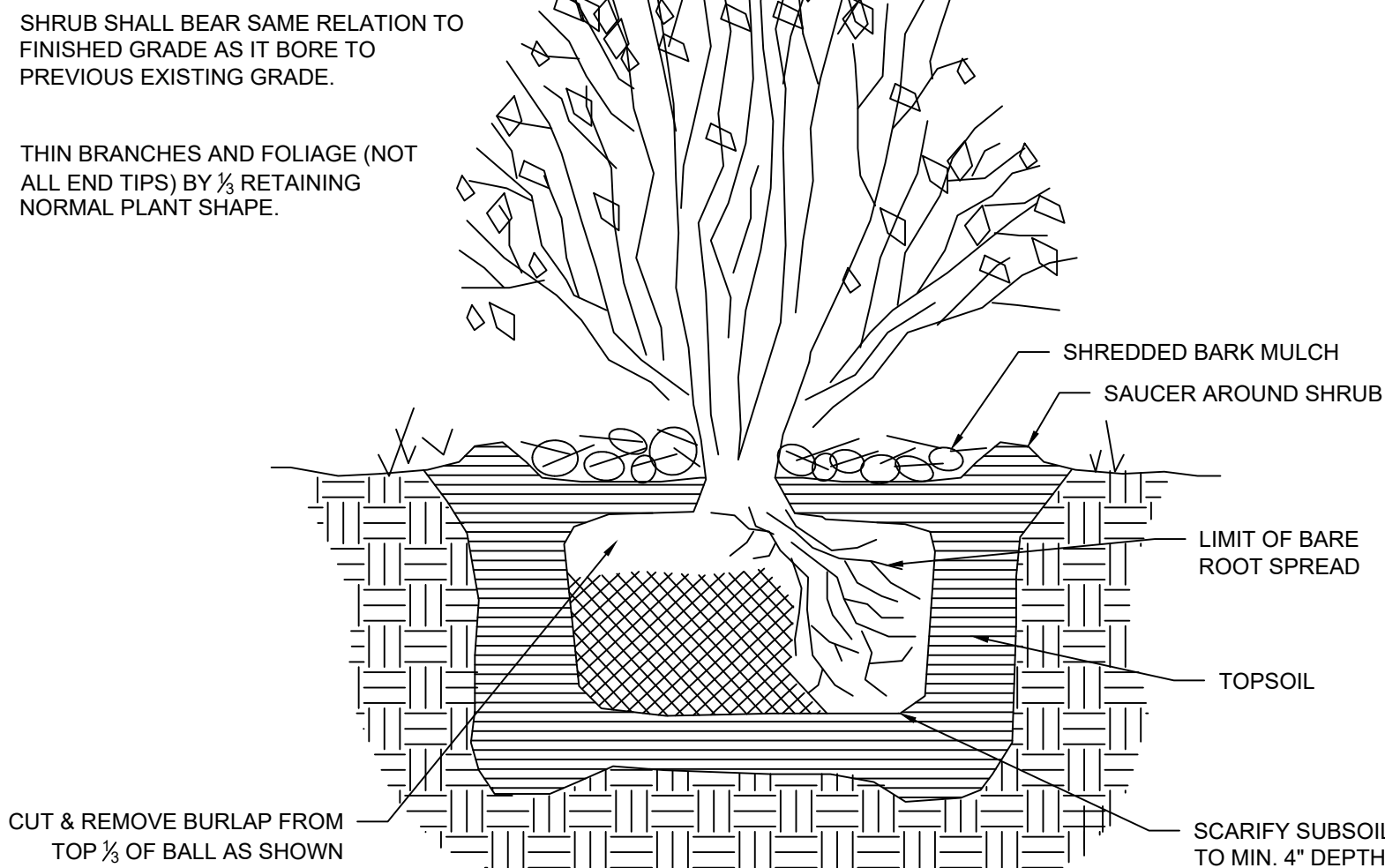
TREE PLANTING DETAIL
N.T.S.

OPEN LAWN AND TURF AREAS

- SEED ALL REMAINING PARK AREAS WITH TURF TYPE FALL FESCUE AND PERENNIAL RYEGRASS BLEND (LOFTS - SUMMER STRESS MIX II OR APPROVED EQUIVALENT). INSTALL AT A RATE OF 350 LBS. PER ACRE PER MANUFACTURERS SPECIFICATIONS.
- TOPSOILING, SEEDING AND MULCHING NOTES
- ANY UNDISTURBED AREA ON WHICH ACTIVITY HAS CEASED AND WHICH WILL REMAIN EXPOSED FOR MORE THAN 10 DAYS MUST BE SEEDED AND MULCHED IMMEDIATELY. DURING NON-GERMINATING PERIODS, MULCH MUST BE APPLIED AT THE REQUIRED RATES. DISTURBED AREAS WHICH ARE NOT AT FINISHED GRADE AND WHICH WILL BE REDISTURBED WITHIN 1 YEAR SHALL BE SEEDED AND MULCHED WITH A QUICK GROWING TEMPORARY SEEDING MIXTURE AND MULCH. DISTURBED AREAS WHICH ARE EITHER AT FINISHED GRADE OR WILL NOT BE REDISTURBED WITHIN 1 YEAR MUST BE SEEDED AND MULCHED WITH A PERMANENT SEED MIXTURE AND MULCH.
 - DIVERSIONS, CHANNELS, SEDIMENTATION BASINS, SEDIMENT TRAPS, AND STOCKPILES MUST BE SEEDED AND MULCHED IMMEDIATELY.
 - GRADED AREAS SHALL BE TEMPORARILY SEEDED AND MULCHED IMMEDIATELY FOLLOWING EARTH MOVING PROCEDURES. TEMPORARY SEED SHALL BE ANNUAL RYE GRASS APPLIED AT A RATE OF 3 LBS. PER 1000 SQ. FT.
 - AFTER SEEDING, HAY OR STRAW MULCH MUST BE APPLIED AT A RATE OF AT LEAST 3.0 TONS PER ACRE. MULCH SHALL BE ANCHORED BY EITHER CRIMPING WITH A COULTER IMPLEMENT, OR BY STAPLING BIODEGRADABLE NETTING TO THE SURFACE.
 - SITE PREPARATION TO UPLAND AREAS: APPLY 1 TON OF AGRICULTURAL-GRADE LIMESTONE PER ACRE PLUS 10-20-10 FERTILIZER AT THE RATE OF 500 LB. PER ACRE. WORK IN WHERE POSSIBLE. SEEDING OF DISTURBED UPLAND AREAS (BEYOND LIMITS OF RIPARIAN ENHANCEMENT AREA) TO BE DONE USING MIX OF FINE FESCUE AT 35 LBS/ACRE (PURE LIVE SEED) PLUS PERENNIAL RYEGRASS AT 15 LBS/ACRE (PURE LIVE SEED).
 - TOPSOIL SHALL BE A CLEAN FRIABLE LOAM WITH SUFFICIENT ORGANIC CONTENT (2.75%) TO PROMOTE PLANT VIGOR. AMENDMENTS SHALL BE ADDED AS NEEDED TO IMPROVE DEFICIENT SOILS. TOPSOIL SHALL BE RETURNED AT A LOOSE DEPTH OF FIVE INCHES TO ALLOW FOR SETTLEMENT.
 - ESTABLISH PERMANENT SEEDING AS SOON AS POSSIBLE AFTER FINAL GRADING IS COMPLETE. UNLESS OTHERWISE INDICATED, PERMANENT SEEDING SHALL BE SEED MIXTURE SPECIFIED IN TABLE.
 - SEE TABLES FOR SEED SPECIES MIXTURE AND APPLICATION RATES.
 - SEED MIXES ARE AVAILABLE AT ERNST CONSERVATION SEEDS IN MEADVILLE, PA. WEBSITE: WWW.ERNSTSEED.COM OR PHONE: 1-800-873-3321.
 - NATIVE SHRUBS AND HERBACEOUS PLUGS ARE AVAILABLE AT PINELANDS NURSERY AND SUPPLY, COLUMBUS NJ. WEBSITE: WWW.PINELANDSNURSERY.COM OR PHONE 1-800-667-2729

GENERAL LANDSCAPING NOTES

- ALL PLANT MATERIALS SHALL CONFIRM TO THE AMERICAN ASSOCIATION OF NURSERYMEN'S AMERICAN STANDARD FOR NURSERY STOCK (LATEST EDITION)
- INSPECTION OF PLANTING BEDS - THE LANDSCAPE ARCHITECT SHALL INSPECT ALL PLANTING AREAS BEFORE ANY TOPSOILING OR PLANTING IS BEGUN TO INSURE THAT ADEQUATE DRAINAGE EXISTS. IF ANY AREAS TO BE LANDSCAPED SHOW EVIDENCE OF POOR DRAINAGE, THE LANDSCAPE ARCHITECT SHALL NOTIFY THE OWNER IMMEDIATELY FOR CORRECTIVE ACTION
- THE LANDSCAPE ARCHITECT SHALL APPROVE ALL PLANT MATERIAL AND STAKED PLANT LOCATIONS PRIOR TO INSTALLATION. ALL HERBACEOUS PLUG PLANTINGS SHALL BE A MINIMUM 3 INCH DEPTH. PLUGS SHALL BE PLANTED 1 FOOT O.C. AS INDICATED ON PLAN.
- ALL TREES, SHRUBS, AND GROUNDCOVER SHALL BE PLACED IN CONTINUOUS MULCHED BEDS 4" IN DEPTH. MUCH SHALL BE TRIPLE SHREDDED HARDWOOD.
- ALL TREES, SHRUBS, AND GROUNDCOVER SHALL BE AS SPECIFIED AND SHALL BE INSTALLED IN ACCORDANCE WITH THE DETAILS AND COMMENTS NOTED ON THE DRAWINGS.
- TOPSOIL SHALL BE PROVIDED BY THE LANDSCAPE CONTRACTOR FOR PLANTING ACCORDING TO THE PLANS AND DETAILS.
- PREPARED TOPSOIL FOR BACKFILLING AROUND TREE BALLS SHALL BE A MIXTURE OF VOLUME OF THE FOLLOWING MATERIALS IN QUANTITIES SPECIFIED: ½ COMPOST, ½ TOPSOIL
- ALL HERBACEOUS PLUG PLANTINGS SHALL BE MINIMUM 3 INCH DEPTH. PLUGS SHALL BE PLANTED 1 FOOT O.C. AS INDICATED ON PLAN.



- NOTES:
- DEER PROTECTION REQUIRED AROUND SHRUB PLANTINGS.

3
DT-1

SHRUB PLANTING DETAIL
N.T.S.

PROJECT PLANT LIST

| Zone | Latin Name | Common Name | % | Growth Habit | Wetland Status |
|----------------------------------|---|----------------------------|-----|--------------|----------------|
| Emergent Marsh Zone 1 (OBL) | <i>Juncus effusus</i> | soft rush | 30% | grass-like | FACW |
| | <i>Peltandra virginica</i> | arrow arum | 10% | herb | OBL |
| | <i>Pontederia cordata</i> | pickerelweed | 10% | herb | OBL |
| | <i>Schoenoplectus pungens</i> | common threesquare blurush | 25% | grass-like | OBL |
| | <i>Schoenoplectus robustus/Bolboschoenus robustus</i> | saltmarsh bulrush | 25% | grass-like | OBL |
| Emergent Marsh Zone 2 (OBL) | <i>Juncus effusus</i> | soft rush | 30% | grass-like | FACW |
| | <i>Peltandra virginica</i> | arrow arum | 10% | herb | OBL |
| | <i>Distichlis spicata</i> | salt grass | 30% | grass-like | OBL |
| | <i>Schoenoplectus robustus/Bolboschoenus robustus</i> | saltmarsh bulrush | 30% | grass-like | OBL |
| Emergent Marsh Zone 3 (OBL/FACW) | <i>Distichlis spicata</i> | salt grass | 20% | grass-like | OBL |
| | <i>Hibiscus moscheutos</i> | swamp rose-mallow | 15% | forb/herb | OBL |
| | <i>Iris prismatica</i> | slender blueflag iris | 15% | herb | OBL |
| | <i>Juncus effusus</i> | soft rush | 10% | grass-like | OBL |
| | <i>Juncus gerardii</i> | black needle rush | 20% | grass-like | OBL |
| | <i>Spartina patens</i> | saltmeadow cordgrass | 20% | grass | FACW |
| Transition Zone 1 (FACW/FAC) | <i>Asclepias incarnata</i> | swamp milkweed | 6% | herb | OBL |
| | <i>Distichlis spicata</i> | spike grass | 15% | grass-like | FACW |
| | <i>Eupatorium fistulosum</i> | Tall Joe Pye Weed | 8% | herb | FACW |
| | <i>Iva frutescens</i> | marsh elder | 15% | shrub | FACW |
| | <i>Juncus gerardii</i> | black needle rush | 15% | grass-like | FACW |
| | <i>Solidago sempervirens</i> | seaside goldenrod | 6% | herb | FACW |
| | <i>Spartina patens</i> | saltmeadow cordgrass | 15% | grass | FACW |
| | <i>Symphyotrichum novi-belgii/Aster novi-belgii</i> | New York aster | 6% | forb/herb | FACW |
| | <i>Teucrium canadense</i> | Canada germander | 6% | forb/herb | FACW |
| | <i>Verbena hastata</i> | blue vervain | 8% | herb | FACW |
| Transition Zone 2 (FACW/FAC) | <i>Andropogon gerardii</i> | big bluestem | 5% | grass-like | FAC |
| | <i>Andropogon virginicus</i> | broomsedge | 12% | grass-like | FACU |
| | <i>Asclepias incarnata</i> | swamp milkweed | 5% | herb | OBL |
| | <i>Asclepias tuberosa</i> | butterfly milkweed | 5% | herb | UPL |
| | <i>Baccharis halimifolia</i> | groundsel bush | 12% | shrub | FACW |
| | <i>Eupatorium purpureum</i> | purple Joe-pye | 5% | herb | FAC |
| | <i>Helioopsis helianthoides</i> | ox eye sunflower | 5% | herb | FACU |
| | <i>Iva frutescens</i> | marsh elder | 12% | shrub | FACW |
| | <i>Panicum virgatum</i> | switchgrass | 12% | grass-like | FAC |
| | <i>Schizachyrium scoparium</i> | little bluestem | 17% | grass-like | FACU |
| | <i>Solidago canadensis</i> | Canadian goldenrod | 5% | herb | FAC |
| | <i>Symphyotrichum novi-belgii/Aster novi-belgii</i> | New York aster | 5% | herb | FACW |
| Maritime Forest (Mix) | <i>Amelanchier canadensis</i> | serviceberry | 10% | shrub | FAC |
| | <i>Clethra alnifolia</i> | sweet pepperbush | 10% | shrub | FAC |
| | <i>Ilex opaca</i> | American holly | 10% | tree | FACU |
| | <i>Juniperus virginiana</i> | eastern redcedar | 15% | tree | FACU |
| | <i>Liquidambar styraciflua</i> | sweetgum | 10% | tree | FAC |
| | <i>Prunus serotina</i> | black cherry | 15% | tree | FACU |
| | <i>Rhododendron viscosom</i> | swamp azalea | 10% | shrub | FACW |
| | <i>Sassafras albidum</i> | sassafras | 10% | tree | FACU |
| | <i>Viburnum dentatum</i> | arrowwood | 10% | shrub | FAC |
| Upland Woodland (Mix) | <i>Acer rubrum</i> | red maple | 5% | tree | FAC |
| | <i>Acer saccharinum</i> | silver maple | 5% | tree | FACW |
| | <i>Aronia melanocarpa</i> | black chokeberry | 5% | shrub | FAC |
| | <i>Carya ovata</i> | shagbark hickory | 5% | tree | FACU |
| | <i>Celtis occidentalis</i> | hackberry | 5% | tree | FACU |
| | <i>Cornus amomum</i> | silky dogwood | 5% | tree | FACU |
| | <i>Cornus florida</i> | flowering dogwood | 5% | tree | FACW |
| | <i>Juglans nigra</i> | black walnut | 5% | tree | FACU |
| | <i>Juniperus virginiana</i> | eastern red cedar | 5% | tree | FACU |
| | <i>Lindera benzoin</i> | spicebush | 5% | shrub | FAC |
| | <i>Liquidambar styraciflua</i> | sweetgum | 5% | tree | FAC |
| | <i>Nyssa sylvatica</i> | blackgum | 5% | tree | FAC |
| | <i>Platanus occidentalis</i> | American sycamore | 5% | tree | FACW |
| | <i>Prunus serotina</i> | black cherry | 5% | tree | FACU |
| | <i>Quercus bicolor</i> | swamp white oak | 5% | tree | FACW |
| | <i>Quercus coccinea</i> | scarlet oak | 5% | tree | UPL |
| | <i>Quercus palustris</i> | pin oak | 5% | tree | FACW |
| | <i>Quercus phellos</i> | willow oak | 5% | tree | FAC |
| | <i>Sambucus canadensis</i> | elderberry | 5% | shrub | FACW |
| | <i>Viburnum dentatum</i> | arrowwood | 5% | shrub | FAC |

CHRISTOPHER C. OBROPTA, Ph.D., P.E.
PROFESSIONAL ENGINEER - NJ LICENSE # 37532

| REVISIONS | DATE | DESCRIPTION |
|-----------|-----------|-------------------------|
| No. | DATE | DESCRIPTION |
| 1 | 8/28/2020 | REV. PER NUDEP COMMENTS |
| 2 | 9/9/2020 | REV. PER NUDEP COMMENTS |

WATSON-CRAMPTON
FORESTED WETLAND RESTORATION
TOWNSHIP OF WOODBRIDGE
MIDDLESEX COUNTY, NJ

RUTGERS
New Jersey Agricultural
Experiment Station

SHEET NAME

DT-1

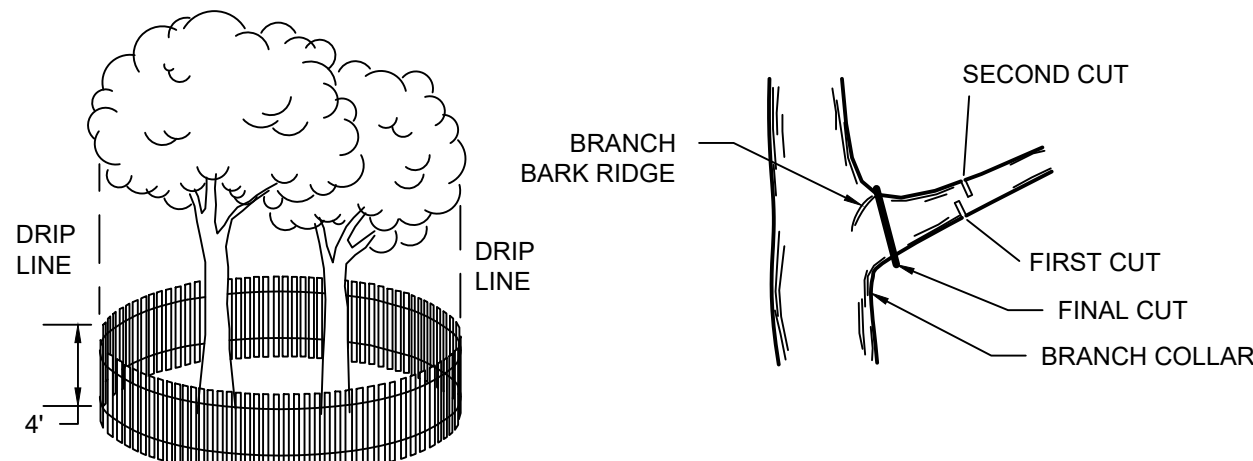
DATE 08/09/2020
REV 1 08/09/2020
APPROVED BM
CHECKED JB
DRAWN ML

- REFER TO FREEHOLD SOIL CONSERVATION DISTRICT FOR LATEST STANDARDS AND GUIDELINES.
- ALL APPLICABLE EROSION AND SEDIMENT CONTROL PRACTICES SHALL BE IN PLACE PRIOR TO ANY GRADING OPERATION AND/OR INSTALLATION OF PROPOSED STRUCTURES OR UTILITIES.
- SOIL EROSION AND SEDIMENT CONTROL PRACTICES ON THIS PLAN SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY.
- APPLICABLE EROSION AND SEDIMENT CONTROL PRACTICES SHALL BE LEFT IN PLACE UNTIL CONSTRUCTION IS COMPLETED AND/OR THE AREA IS STABILIZED. AFTER RESTORATION IS COMPLETE, TEMPORARY CONTROL MEASURES SHALL BE REMOVED AND DISPOSED OF PROPERLY.
- THE CONTRACTOR SHALL PERFORM ALL WORK, FURNISH ALL MATERIALS AND INSTALL ALL MEASURES REQUIRED TO REASONABLY CONTROL SOIL EROSION RESULTING FROM CONSTRUCTION OPERATIONS AND PREVENT EXCESSIVE FLOW OF SEDIMENT FROM THE CONSTRUCTION SITE.
- ANY DISTURBED AREA THAT IS TO BE LEFT EXPOSED FOR MORE THAN TEN (10) DAYS AND NOT SUBJECT TO CONSTRUCTION TRAFFIC SHALL IMMEDIATELY RECEIVE A TEMPORARY SEEDING AND FERTILIZATION IN ACCORDANCE WITH THE NEW JERSEY STANDARDS AND THEIR RATES SHOULD BE INCLUDED IN THE NARRATIVE. IF THE SEASON PROHIBITS TEMPORARY SEEDING, THE DISTURBED AREAS WILL BE MULCHED WITH SALT HAY OR EQUIVALENT AND ANCHORED IN ACCORDANCE WITH THE NEW JERSEY STANDARDS (I.E. PEG AND TWINE, MULCH NETTING OR LIQUID MULCH BINDER).
- IT SHALL BE THE RESPONSIBILITY OF THE DEVELOPER TO PROVIDE CONFIRMATION OF LIME, FERTILIZER AND SEED APPLICATION AND RATES OF APPLICATION AT THE REQUEST OF THE CAMDEN COUNTY SOIL CONSERVATION DISTRICT.
- ALL CRITICAL AREAS SUBJECT TO EROSION WILL RECEIVE A TEMPORARY SEEDING IN COMBINATION WITH STRAW MULCH AT A RATE OF 2 TONS PER ACRE, ACCORDING TO THE NEW JERSEY STANDARDS IMMEDIATELY FOLLOWING ROUGH GRADING.
- THE SITE SHALL AT ALL TIMES BE GRADED AND MAINTAINED SUCH THAT ALL STORMWATER RUNOFF IS DIVERTED TO SOIL EROSION AND SEDIMENT CONTROL FACILITIES.
- ALL SEDIMENTATION STRUCTURES WILL BE INSPECTED AND MAINTAINED ON A REGULAR BASIS AND AFTER EVERY STORM EVENT.
- A CRUSHED STONE, TIRE CLEANING PAD WILL BE INSTALLED WHEREVER A CONSTRUCTION ACCESS EXISTS. THE STABILIZED PAD WILL BE INSTALLED ACCORDING TO THE STANDARD FOR STABILIZED CONSTRUCTION ACCESS
- ALL DRIVEWAYS MUST BE STABILIZED WITH 2 ½" CRUSHED STONE OR SUBBASE PRIOR TO INDIVIDUAL LOT CONSTRUCTION.
- PAVED ROADWAYS MUST BE KEPT CLEAN AT ALL TIMES.
- ALL CATCH BASIN INLETS WILL BE PROTECTED ACCORDING TO THE CERTIFIED PLAN.
- ALL STORM DRAINAGE OUTLETS WILL BE STABILIZED, AS REQUIRED, BEFORE THE DISCHARGE POINTS BECOME OPERATIONAL.
- ALL DEWATERING OPERATIONS MUST DISCHARGE DIRECTLY INTO A SEDIMENT FILTER AREA. THE SEDIMENT FILTER SHOULD BE COMPOSED OF A SUITABLE SEDIMENT FILTER FABRIC. (SEE DETAIL) THE BASIN MUST BE DEWATERED TO NORMAL POOL WITHIN 10 DAYS OF THE DESIGN STORM.
- NJSA 4:24-39, ET SEQ. REQUIRES THAT NO CERTIFICATE OF OCCUPANCY BE ISSUED BEFORE ALL PROVISIONS OF THE CERTIFIED SOIL EROSION AND SEDIMENT CONTROL PLAN HAVE BEEN COMPLIED WITH FOR PERMANENT MEASURES. ALL SITE WORK FOR THE PROJECT MUST BE COMPLETED PRIOR TO THE DISTRICT ISSUING A REPORT OF COMPLIANCE AS A PREREQUISITE TO THE ISSUANCE OF A CERTIFICATE OF OCCUPANCY BY THE MUNICIPALITY.
- MULCHING IS REQUIRED ON ALL SEEDED AREAS TO INSURE AGAINST EROSION BEFORE GRASS IS ESTABLISHED TO PROMOTE EARLIER VEGETATION COVER.
- OFFSITE SEDIMENT DISTURBANCE MAY REQUIRE ADDITIONAL CONTROL MEASURES TO BE DETERMINED BY THE EROSION CONTROL INSPECTOR.
- A COPY OF THE CERTIFIED SOIL EROSION AND SEDIMENT CONTROL PLAN MUST BE MAINTAINED ON THE PROJECT SITE DURING CONSTRUCTION.
- THE CAMDEN COUNTY SOIL CONSERVATION DISTRICT SHALL BE NOTIFIED 72 HOURS PRIOR TO ANY LAND DISTURBANCE.
- ANY CONVEYANCE OF THIS PROJECT PRIOR TO ITS COMPLETION WILL TRANSFER FULL RESPONSIBILITY FOR COMPLIANCE WITH THE CERTIFIED PLAN TO ANY SUBSEQUENT OWNERS.
- IMMEDIATELY AFTER THE COMPLETION OF STRIPPING AND STOCKPILING OF TOPSOIL, THE STOCKPILE MUST BE STABILIZED ACCORDING TO THE STANDARD FOR TEMPORARY VEGETATIVE COVER. STABILIZE TOPSOIL PILE WITH STRAW MULCH FOR PROTECTION IF THE SEASON DOES NOT PERMIT THE APPLICATION AND ESTABLISHMENT OF TEMPORARY SEEDING. ALL SOIL STOCKPILES ARE NOT TO BE LOCATED WITHIN FIFTY (50) FEET OF A FLOODPLAIN, SLOPE, ROADWAY OR DRAINAGE FACILITY AND THE BASE MUST BE PROTECTED WITH A SEDIMENT BARRIER.
- ANY CHANGES TO THE SITE PLAN WILL REQUIRE THE SUBMISSION OF A REVISED SOIL EROSION AND SEDIMENT CONTROL PLAN TO THE CAMDEN COUNTY SOIL CONSERVATION DISTRICT. THE REVISED PLAN MUST BE IN ACCORDANCE WITH THE CURRENT NEW JERSEY STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL.
- METHODS FOR THE MANAGEMENT OF HIGH ACID PRODUCING SOILS SHALL BE IN ACCORDANCE WITH THE STANDARDS. HIGH ACID PRODUCING SOILS ARE THOSE FOUND TO CONTAIN IRON SULFIDES OR HAVE A pH OF 4 OR LESS.
- TEMPORARY AND PERMANENT SEEDING MEASURES MUST BE APPLIED ACCORDING TO THE NEW JERSEY STANDARDS, AND MULCHED WITH SALT HAY OR EQUIVALENT AND ANCHORED IN ACCORDANCE WITH THE NEW JERSEY STANDARDS (I.E. PEG AND TWINE, MULCH NETTING OR LIQUID MULCH BINDER).
- MAXIMUM SIDE SLOPES OF ALL EXPOSED SURFACES SHALL NOT BE CONSTRUCTED STEEPER THAN 3:1 UNLESS OTHERWISE APPROVED BY THE DISTRICT.
- ADJOINING PROPERTIES SHALL BE PROTECTED FROM EXCAVATION AND FILLING OPERATIONS ON THE PROPOSED SITE.
- USE STAGED CONSTRUCTION METHODS TO MINIMIZE EXPOSED SURFACES, WHERE APPLICABLE.
- ALL VEGETATIVE MATERIAL SHALL BE SELECTED IN ACCORDANCE WITH AMERICAN STANDARDS FOR NURSERY STOCK OF THE AMERICAN ASSOCIATION OF THE NURSERYMEN AND IN ACCORDANCE WITH THE NEW JERSEY STANDARDS.
- NATURAL VEGETATION AND SPECIES SHALL BE RETAINED WHERE SPECIFIED ON THE LANDSCAPE PLAN.
- THE SOIL EROSION INSPECTOR MAY REQUIRE ADDITIONAL SOIL EROSION MEASURES TO BE INSTALLED, AS DIRECTED BY THE DISTRICT INSPECTOR.
- ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE CONSTRUCTED AND MAINTAINED IN ACCORDANCE WITH THE "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY" PREPARED BY THE NEW JERSEY STATE SOIL CONSERVATION COMMITTEE, 1999, INCORPORATED HEREIN BY REFERENCE, AS AMENDED AND SUPPLEMENTED. COPIES OF THE "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY" ARE AVAILABLE FOR A FEE FROM THE NEW JERSEY DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION COMMITTEE, OR FROM THE OFFICE OF ANY OF THE 16 LOCAL CONSERVATION DISTRICTS.
- DISTURBED AREAS THAT WILL BE EXPOSED IN EXCESS OF 10 DAYS SHALL BE TEMPORARILY SEEDED AND/OR MULCHED UNTIL PROPER WEATHER CONDITIONS EXIST FOR ESTABLISHMENT OF A PERMANENT VEGETATIVE COVER.

35. THE SPECIFICATIONS WHICH SPELL OUT THE ENVIRONMENTAL AND CULTURAL RESOURCE PROTECTION/RESTORATION FROM N.J.A.C. 7:22-10.11 AND N.J.A.C. 7:22-10.12, SHALL HAVE PRECEDENCE OVER OTHER POTENTIALLY CONTRADICTORY LANGUAGE CONTAINED ELSEWHERE IN THE DESIGN CONTRACT DOCUMENTS. IN INSTANCES WHERE THE PROVISIONS OF A DEPARTMENT-ISSUED PERMIT CONTRADICT A PROVISION OF THE SPECIFICATIONS (INCLUDING THOSE IDENTIFIED IN ENVIRONMENTAL ASSESSMENT REQUIREMENTS FOR STATE ASSISTED ENVIRONMENTAL INFRASTRUCTURE FACILITIES, N.J.A.C. 7:22-10), THE ENVIRONMENTAL RESOURCES PROTECTION AND/OR RESTORATION AND CULTURAL RESOURCE MITIGATION MEASURES IDENTIFIED IN THE DEPARTMENT-ISSUED PERMIT SHALL GOVERN.

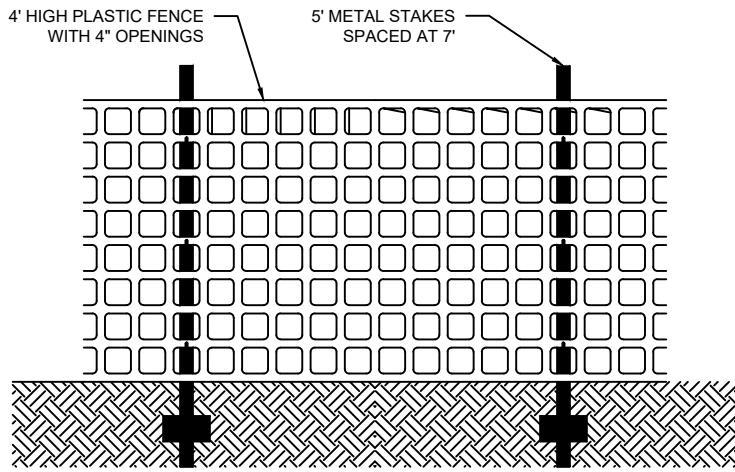
Prohibited Construction Procedures

- DUMPING OF SPOIL MATERIAL INTO ANY STREAM CORRIDOR, ANY WETLANDS, ANY VERNAL HABITATS, ANY SURFACE WATERS, ANY SITES LISTED OR ELIGIBLE FOR LISTING ON THE NEW JERSEY OR NATIONAL REGISTERS OF HISTORIC PLACES, OR AT UNSPECIFIED LOCATIONS.
- INDISCRIMINATE, ARBITRARY , OR CAPRICIOUS OPERATION OF EQUIPMENT IN ANY STREAM CORRIDORS, WETLANDS, VERNAL HABITATS OR SURFACE WATERS.
- PUMPING OF SILT LADEN WATER FROM TRENCHES OR OTHER EXCAVATIONS INTO ANY SURFACE WATER, STREAM CORRIDORS, WETLANDS, OR VERNAL HABITATS.
- DAMAGING VEGETATION ADJACENT TO OR OUTSIDE OF THE ACCESS ROAD OR THE RIGHT OF WAY.
- DISPOSAL OF TREES, BRUSH, AND OTHER DEBRIS IN ANY STREAM CORRIDORS, WETLANDS, VERNAL HABITATS, SURFACE WATERS, OR AT UNSPECIFIED LOCATIONS.
- PERMANENT OR UNSPECIFIED ALTERATION OF THE FLOW LINE OF ANY STREAM.
- OPEN BURNING OF PROJECT DEBRIS.
- USE OF CALCIUM CHLORIDE, PETROLEUM PRODUCTS, OR OTHER CHEMICALS FOR DUST CONTROL.
- USE OF ASPHALTIC MULCH BINDERS.
- ANY UNPERMITTED DISCHARGE OF SEWAGE.

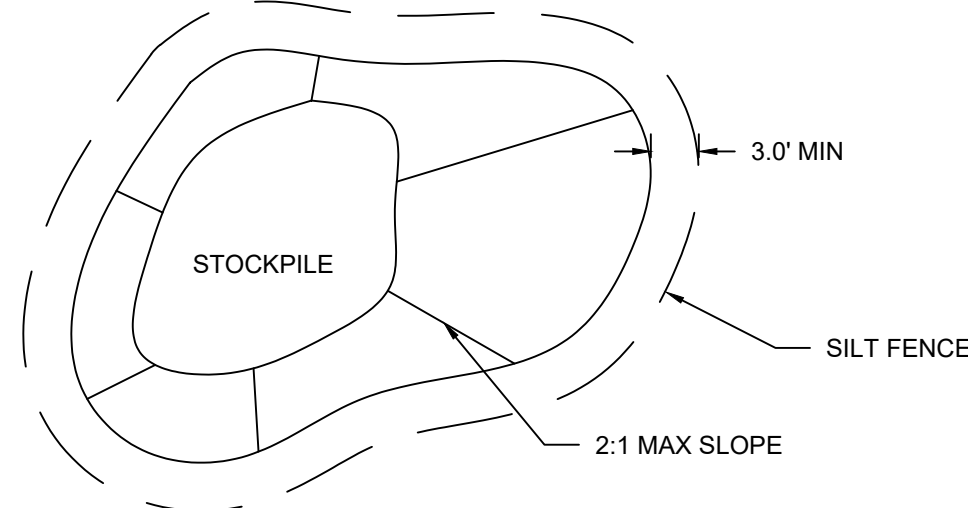


- NOTES:
- TREE PROTECTION SHALL BE PROVIDED FOR ANY AND ALL TREES TO BE PROTECTED DURING AND AFTER CONSTRUCTION.
 - 4 FOOT HIGH SNOW FENCE SHALL BE PLACED AT THE DRIP LINE OF THE TREE AND ENCIRCLE THE ENTIRE TREE.
 - ROOTS SHALL NOT BE CUT IN ANY AREA INSIDE THE DRIP LINE OF THE BRANCHES.
 - TREE LIMB REMOVAL, WHERE NECESSARY, WILL BE DONE FLUSH WITH TRUNK OR MAIN LIMB, GOOD GRADE OF TREE PAINT AND BE PERFORMED UNDER THE SUPERVISION OF A LICENSED NURSERYMAN.

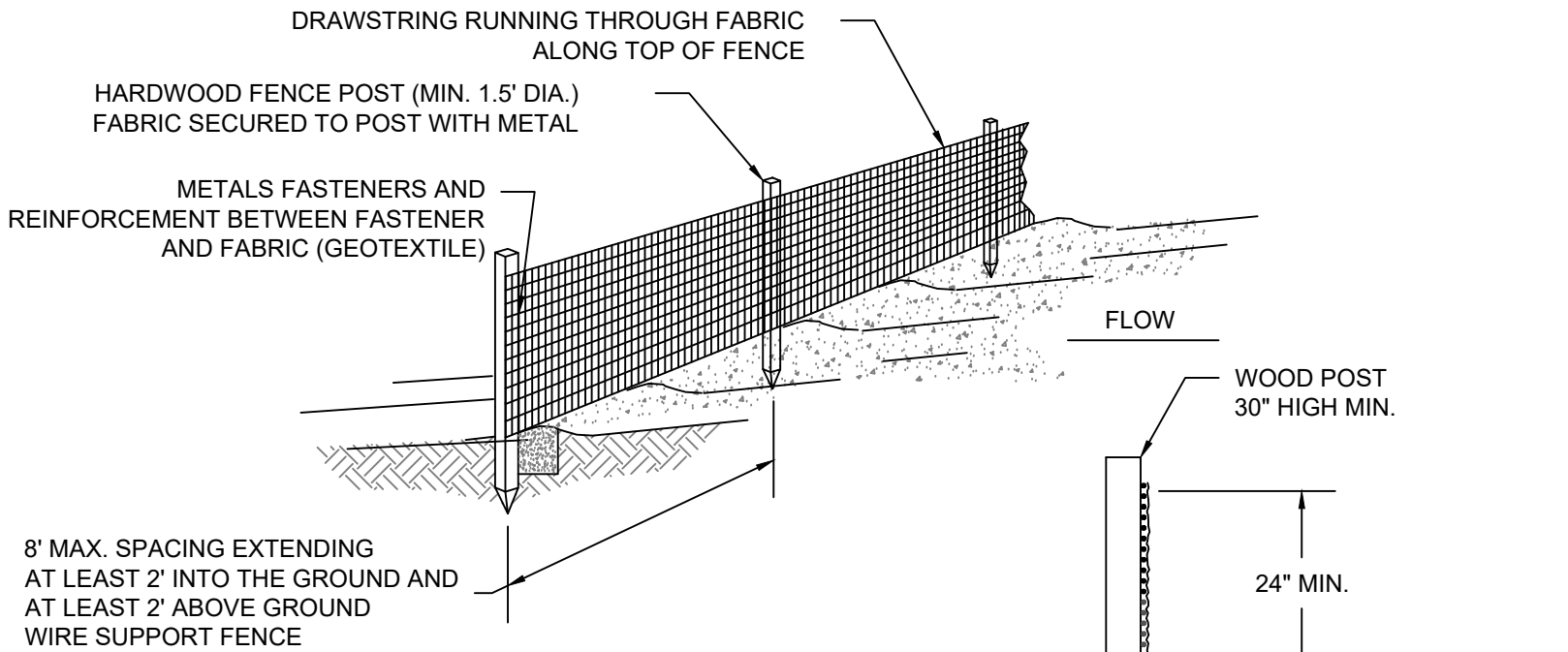
1 TREE PROTECTION AND LIMB REMOVAL
DT-2 N.T.S.



3 ORANGE BARRIER FENCE
DT-2 N.T.S.

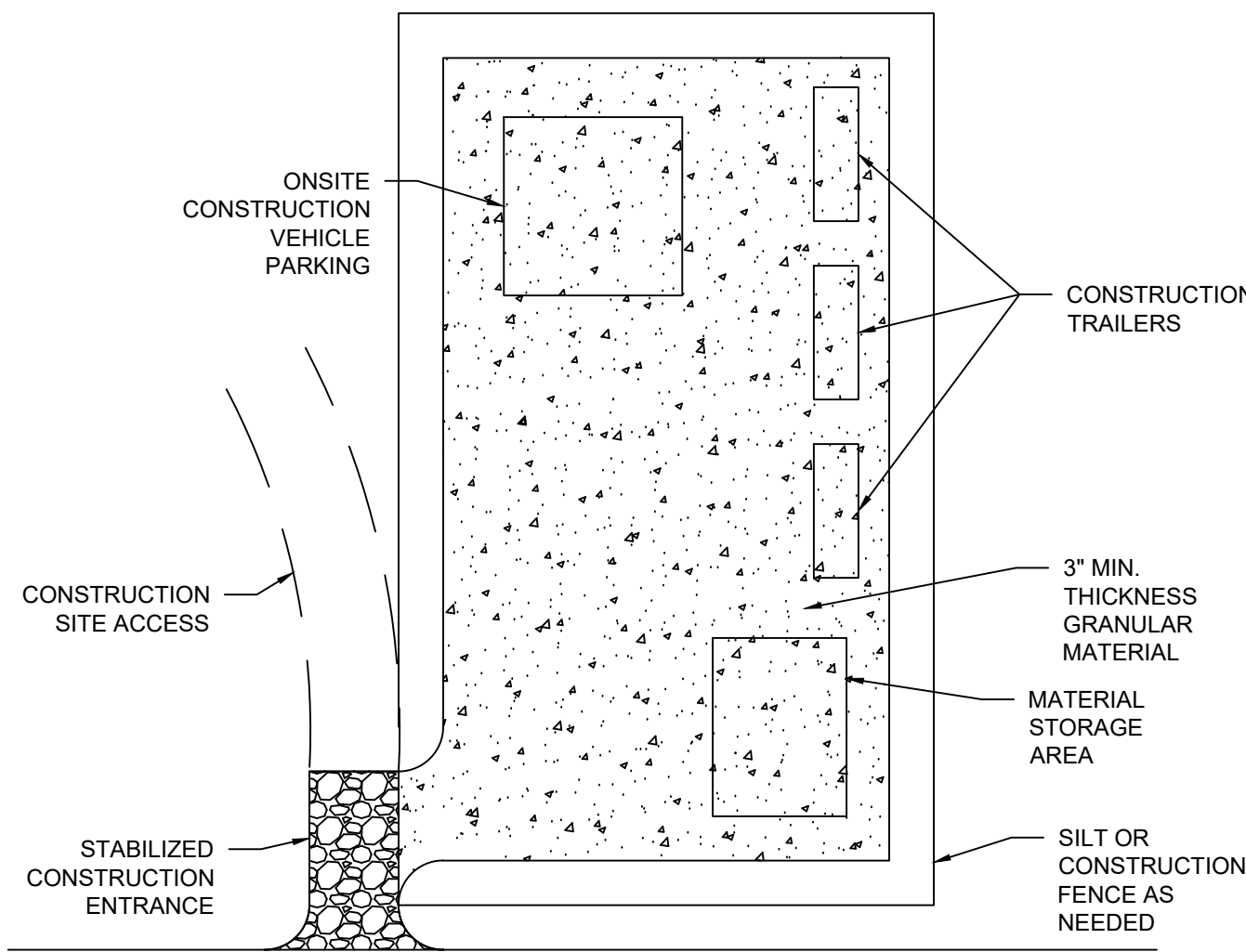


5 STOCKPILING AREA DETAIL
DT-2 N.T.S.

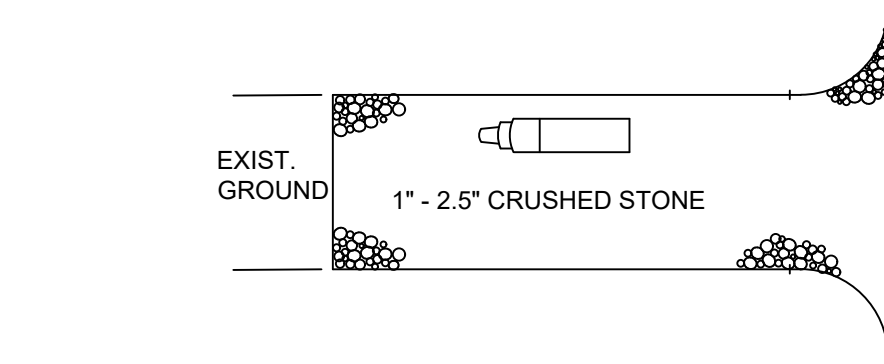
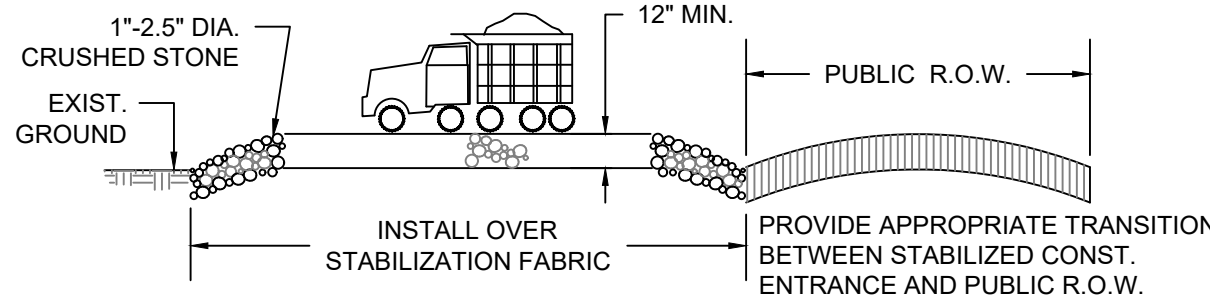


- NOTES:
- SILT FENCE SHALL BE PLACED ALONG SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
 - INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY. (9" MAX. RECOMMENDED STORAGE HEIGHT.
 - REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.
 - PLACE SILT FENCE AROUND ALL STOCKPILE AREAS AND AROUND STAGING AREAS AS NEEDED AND AT LOCATIONS SHOWN ON THE SOIL EROSION PLAN.
 - THE SLOPE OF THE LAND FOR AT LEAST 30 FEET ADJACENT TO ANY SILT FENCE SHALL NOT EXCEED 5%.
 - SILT FENCE SHALL REMAIN IN PLACE FOR THE DURATION OF THE PROJECT UNLESS OTHERWISE DIRECTED BY ENGINEER.

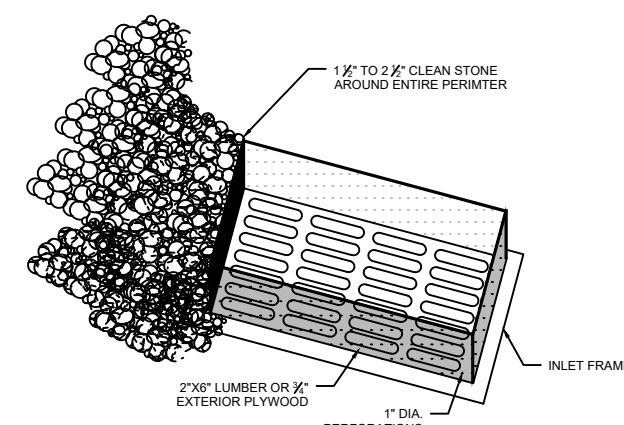
7 SILT FENCE
DT-2 N.T.S.



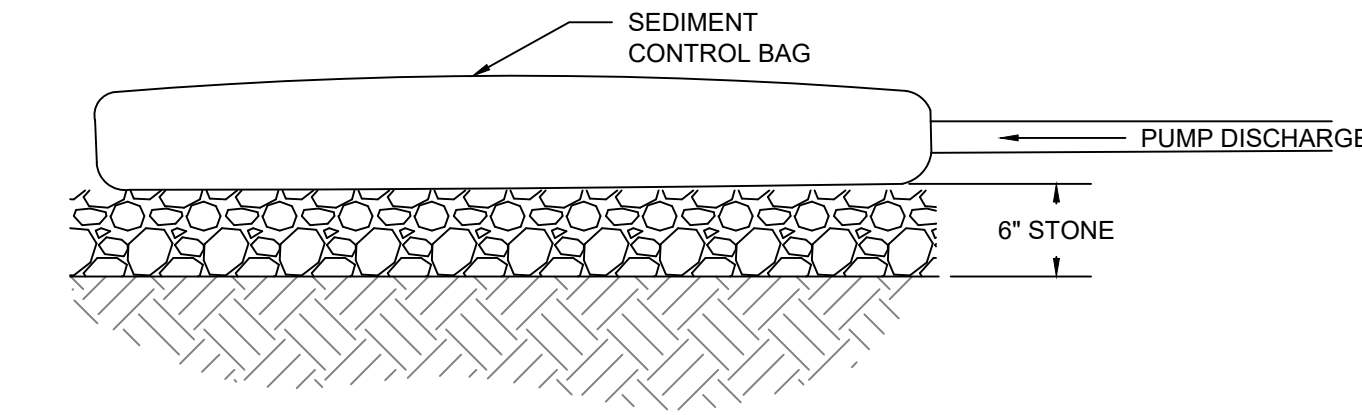
8 STAGING AREA DETAIL
DT-2 N.T.S.



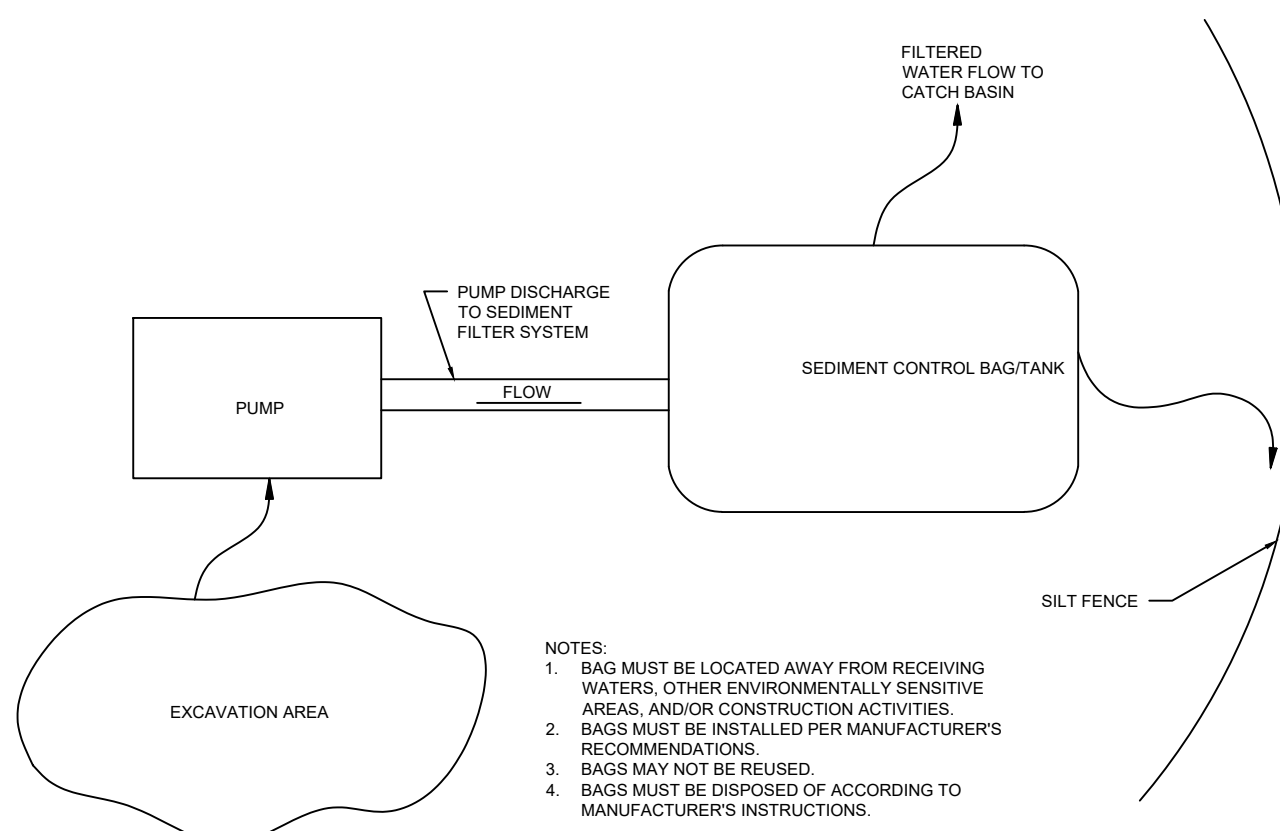
2 CONSTRUCTION ENTRANCE
DT-2 N.T.S.



4 INLET PROTECTION
DT-2 N.T.S.



6 DEWATERING ELEVATION DETAIL
DT-2 N.T.S.



- NOTES:
- BAG MUST BE LOCATED AWAY FROM RECEIVING WATERS, OTHER ENVIRONMENTALLY SENSITIVE AREAS, AND/OR CONSTRUCTION ACTIVITIES.
 - BAGS MUST BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.
 - BAGS MAY NOT BE REUSED.
 - BAGS MUST BE DISPOSED OF ACCORDING TO MANUFACTURER'S INSTRUCTIONS.

9 DEWATERING PLAN DETAIL
DT-2 N.T.S.

CHRISTOPHER C. OBROPTA, Ph.D., P.E.

PROFESSIONAL ENGINEER - NJ LICENSE # 57532

DATE 08/09/2020
REV 1 08/09/2020

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WATSON-CRAMPTON
FORESTED WETLAND RESTORATION
TOWNSHIP OF WOODBRIDGE
MIDDLESEX COUNTY, NJ

SOIL EROSION AND SEDIMENT CONTROL DETAILS

RUTGERS
New Jersey Agricultural
Experiment Station

SHEET NAME

DT-2

NO MOWING

WOODBIDGE TOWNSHIP OPEN SPACE CONSERVATION/RESILIENCY ZONE



This land has been designated by Woodbridge Township and the State of New Jersey as open space and is being managed to restore the ecological function of the existing floodplain. This natural landscape increases your community's resiliency to flooding and other climate change impacts.



RUTGERS

Mayor John E. McCormac
Produced by Rutgers Cooperative
Extension in partnership with
Woodbridge Township.





Legend

- FOREST
- GREEN SPACE
- MEADOW
- RECENTLY PLANTED

0 100 200 400
Feet



Restored Blue Acres Properties in Woodbridge Township

Watson-Crampton Neighborhood
Updated July 2021



Wildlife Conservation
and Management

Composed by: Isabelle Zocco 7/19/2021
Projection System: NAD_1983_StatePlane_
NJ_FIPS_2900_Feet

Planting Palette for Restored Blue Acres Properties in Woodbridge Township

| <i>Forest</i> | |
|--------------------------------|--------------------|
| Scientific Name | Common Name |
| <i>Acer rubrum</i> | Red Maple |
| <i>Acer saccharum</i> | Sugar Maple |
| <i>Amelanchier canadensis</i> | Serviceberry |
| <i>Aronia melanocarpa</i> | Black Chokeberry |
| <i>Betula nigra</i> | River Birch |
| <i>Celtis occidentalis</i> | Hackberry |
| <i>Cercis canadensis</i> | Eastern Redbud |
| <i>Cornus amomum</i> | Silky Dogwood |
| <i>Cornus florida</i> | Flowering Dogwood |
| <i>Juglans nigra</i> | Black Walnut |
| <i>Juniperus virginiana</i> | Eastern Red Cedar |
| <i>Lindera benzoin</i> | Spicebush |
| <i>Liquidambar styraciflua</i> | Sweetgum |
| <i>Liriodendron tulipifera</i> | Tulip Tree |
| <i>Nyssa sylvatica</i> | Black Gum |
| <i>Platanus occidentalis</i> | American Sycamore |
| <i>Prunus serotina</i> | Black Cherry |
| <i>Quercus bicolor</i> | Swamp White Oak |
| <i>Quercus coccinea</i> | Scarlet Oak |
| <i>Quercus palustris</i> | Pin Oak |
| <i>Quercus phellos</i> | Willow Oak |
| <i>Quercus rubra</i> | Northern Red Oak |
| <i>Sambucus canadensis</i> | Elderberry |
| <i>Viburnum dentatum</i> | Arrowwood Viburnum |

| <i>Green Space</i> | |
|--------------------------------|-------------------|
| Scientific Name | Common Name |
| <i>Acer saccharum</i> | Sugar Maple |
| <i>Amelanchier canadensis</i> | Serviceberry |
| <i>Betula nigra</i> | River Birch |
| <i>Cercis canadensis</i> | Eastern Redbud |
| <i>Crataegus macrocarpa</i> | Bigfruit Hawthorn |
| <i>Liquidambar styraciflua</i> | Sweet Gum |
| <i>Liriodendron tulipifera</i> | Tulip Tree |
| <i>Malus sp.</i> | Crabapple |
| <i>Nyssa sylvatica</i> | Black Gum |
| <i>Prunus serotina</i> | Black Cherry |
| <i>Quercus bicolor</i> | Swamp White Oak |
| <i>Quercus rubra</i> | Northern Red Oak |

| <i>Meadow</i> | |
|-----------------------------------|-----------------------|
| Scientific Name | Common Name |
| <i>Allium cernuum</i> | Nodding Pink Onion |
| <i>Andropogon gerardii</i> | Big Bluestem |
| <i>Andropogon virginicus</i> | Broomsedge Bluestem |
| <i>Asclepias incarnata</i> | Swamp Milkweed |
| <i>Asclepias syriaca</i> | Common Milkweed |
| <i>Baptisia australis</i> | Blue False Indigo |
| <i>Chamaecrista fasciculata</i> | Partridge Pea |
| <i>Chrysopsis mariana</i> | Maryland Golden Aster |
| <i>Coreopsis lanceolata</i> | Lanceleaf Tickseed |
| <i>Echinacea purpurea</i> | Purple Coneflower |
| <i>Elymus canadensis</i> | Canada Wild Rye |
| <i>Elymus virginicus</i> | Virginia Wildrye |
| <i>Eryngium yuccifolium</i> | Rattlesnake Master |
| <i>Eupatorium coelestinum</i> | Blue Mistflower |
| <i>Eupatorium purpureum</i> | Sweet Joe-pye Weed |
| <i>Euthamia graminifolia</i> | Flat-top Goldentop |
| <i>Helenium autumnale</i> | Common Sneezeweed |
| <i>Heliopsis helianthoides</i> | Smooth Oxeye |
| <i>Liatris spicata</i> | Dense Blazingstar |
| <i>Monarda fistulosa</i> | Bergamot |
| <i>Monarda punctata</i> | Spotted Beebalm |
| <i>Panicum virgatum</i> | Switchgrass |
| <i>Parthenium integrifolium</i> | Wild Quinine |
| <i>Penstemon digitalis</i> | Foxglove Beardtongue |
| <i>Penstemon hirsutus</i> | Hairy Beardtongue |
| <i>Ratibida pinnata</i> | Yellow Coneflower |
| <i>Rudbeckia hirta</i> | Black-eyed Susan |
| <i>Rudbeckia triloba</i> | Brown-eyed Susan |
| <i>Schizachyrium scoparium</i> | Little Bluestem |
| <i>Solidago nemoralis</i> | Old Field Goldenrod |
| <i>Solidago rigida</i> | Stiff Goldenrod |
| <i>Solidago sempervirens</i> | Seaside Goldenrod |
| <i>Sorghastrum nutans</i> | Indiangrass |
| <i>Symphyotrichum laevis</i> | Smooth Aster |
| <i>Symphyotrichum novi-belgii</i> | New York Aster |
| <i>Tridens flavus</i> | Purpletop |
| <i>Verbena hastata</i> | Blue Vervain |
| <i>Vernonia noveboracensis</i> | New York Ironweed |
| <i>Veronicastrum virginicum</i> | Culvers Root |
| <i>Zizia aurea</i> | Golden Alexanders |

D. Other Provisions and Requirements

- (1) Off-street parking is required subject to the requirements of Section 150-78 of this article.
- (2) Landscaping is required subject to the requirements of Section 150-79 of this article.

E. When Public-Quasi-Public zoned property is sold or transferred to an adjacent property owner, the Public-Quasi-Public zoning of the property being sold or transferred shall become the same zoning as the adjacent property of which the sold or transferred PQP-zoned property is becoming a part. [Added 10-29-13 by Ord. No. 13-48]

**§ 150-41.1 OSC/R Open Space Conservation/Resiliency Zone.
[Added 9-6-2016 by Ord. No. 2016-52]**

A. Purpose. The purpose of the OSC/R Open Space Conservation/Resiliency Zone is to help minimize the number of residences within floodplains in order to reduce the amount of flood damage sustained during future flood events. The areas designated as within the OSC/R Zone are located within the Watson Crampton, South Roberts, and Saints Field neighborhoods of the Township.

B. Permitted Uses.

- (1) Unimproved open space. Unimproved open space is intended to preserve lands in a natural state for recreation and conservation purposes and shall include wetlands, woodlands, wildlife preserves, manmade and natural bodies of water, scenic areas, hedgerows and tree-lines, and natural wooded areas. Improvements in unimproved open space shall be limited to the following: woodland trails, footpaths, jogging trails, bridle paths, bicycle paths, dog parks, and nature walks; unimproved roads for access to unimproved open space sites; lighting; retaining walls; and other features necessary to protect the land or people who will use the unimproved open space.
- (2) Existing residential structures. Existing residential structures subject to their current zoning standards may remain. New construction is not permitted.

C. Design Standards.

- (1) The intent of the design standards is to promote the safety, wellbeing, and general welfare of the residents that remain within the OSC/R Zone and to protect them from future flood events.

- (2) Building design. Building design standards are triggered at any proposed demolition, addition, reconstruction, renovation or change in tenancy. The following are design standards relating to the existing residential structures.
- (a) Structures shall be elevated to FEMA standards. The top of the lowest floor must be elevated at least one foot above the base flood elevation.
 - (b) All structures must be properly anchored to resist collapse, flotation, and lateral movement.
 - (c) Homes can be elevated on perimeter foundation walls, or on piles, piers or columns.
 - (d) Valves shall be placed on the building's sewerage line to prevent backflow during storm events.
 - (e) Flood vents are required for foundation walls.
 - (f) Utilities including mechanical equipment such as generators, HVAC systems, electrical, heating, air-conditioning equipment, plumbing, etc. shall be located above the base flood elevation.
 - (g) Basements are not permitted. Enclosed areas below elevated structure (below lowest floor) are permitted to be used only for parking, building access, and storage.
 - (h) Flood damage-resistant construction materials shall be used below the base flood elevation.
- (3) Streets.
- (a) Street arrangement.
 - [1] Existing roadways. Existing roadways that provide access to remaining properties within the OSC/R Zone shall remain and be converted to 10-foot wide driveways with the exception of Crampton Avenue in the Watson Crampton Neighborhood. Crampton Avenue in the Watson Crampton neighborhood shall be reduced to an 18-foot wide cartway. All other existing roadways shall be removed and the land allowed to return to its natural state.
 - [2] Driveways. Driveways do not require curbs, sidewalks or parking lanes.

- (4) Landscaping. Vegetation shall be planted in accordance with the recommendations made in the Flood Plain Restoration Plan prepared by the Rutgers Cooperative Extension, dated January 29, 2016. As determined in that Plan, vegetation shall be planted based on its habitat: Edge, Floodplain Forest, Meadow, Saline Marsh, and Scrub/Shrub. The Plan is incorporated by reference.
- (5) Buffer requirement. A minimum 12-foot wide buffer is required where the OSC/R Zone abuts the adjacent residential zone. The buffer is to be designed to provide a visual buffer to the residential zone and shall be planted with soil-appropriate plants.
- (6) Registration required. All properties in the OSC/R Zone shall be required to register annually, free of charge. Registration will include initial inspection, and reinspection from time to time, as may be necessary. Failure to register within ninety (90) days of the adoption of this section, and each year thereafter, by January 15th, shall constitute a violation in accordance with 150-97(A)(1) of this Article, carrying a fine of up to \$2,000 a day. A separate offense shall be deemed to be committed on each day during or on which the violation occurs or continues.

Editor's Note: Section 150-41.1 was adopted September 6, 2016 by Ord. No. 2016-52.

§ 150-42. Planned Development
[Added 12-21-1993 by Ord. No. 93-105]

- A. Purpose. The purpose of these provisions is to provide a range of flexibility within which special land use situations and conditions may be accommodated.
- B. Planned development option. As an alternative to conventional development, the Planning Board may authorize planned developments for areas designated PD on the Zoning Map in accordance with plans and proposals which conform to the requirements of this section. The standards herein establish the limits of discretionary action which may be taken by the approving authority administering these provisions. [Amended 10-6-1998 by Ord. No. 98-71]
 - (1) Standards for type, density or intensity of use. Planned developments may be approved by the Planning Board in conformity with the standards governing the type and density or intensity of use set forth by this subsection and those set forth for each PD-designated area.
 - (a) The minimum tract size shall be five acres.

SECOND READING

17-32 D.

AN ORDINANCE AMENDING ORDINANCE #16-52 OF THE REVISED ORDINANCES OF THE TOWNSHIP OF WOODBRIDGE

BE IT ORDAINED BY THE MUNICIPAL COUNCIL OF THE TOWNSHIP OF WOODBRIDGE that Ordinance #16-52, adopted September 6, 2016 is hereby amended as follows:

Chapter 150, Article 1, Section 150-4 *Definitions*, is hereby amended to include the following additional definition:

"Ordinary Maintenance," shall be defined as the following and would be permitted without mitigation,

1. Roof replacement with like materials;
2. The painting of interior rooms or the exterior of the home;
3. The repair or replacement of any part of a porch or stoop, [when deemed necessary,] that if ignored would directly result in the access point becoming unsafe;
4. The replacement of kitchen cabinet(s) when damaged;
5. The repair or replacement of any interior or exterior trim, decoration or moldings;
6. The repair or replacement of any floor covering, with equally valued materials; (or "like for like materials")
7. Replacement of domestic washing machines, dishwashers or stoves;
8. Repairs or replacements of any exterior home siding with like for like materials;
9. Installation, repair or replacement of any interior finish of less than 20% of the wall area, of a single wall, within a single room. Including plaster and drywall;
10. The replacement of glass in any window or door;
11. Emergency plumbing and electrical repairs and/or replacement of any system, so long as the replacement is with like for like materials and not considered an upgrade;
12. Repairs or replacement of any structural building element in a De Minimis area that if ignored would directly result in the building becoming unsafe;
13. The repair or replacement of any driveway or walkway with like for like materials-no expansion will be permitted;
14. Repair or replacement of the buildings H.V.A.C. systems without upgrade or expansion. Air conditioning units will not be installed where there was not one before; and

15. Any repair or replacement not dissimilar to the ones listed above.

When completing "Ordinary Maintenance" it is the homeowner's responsibility to ensure they are abiding by all rules/sanctions, have obtained all necessary permits and are in conformance with all zoning ordinances."

Chapter 150, Article 3, Section 150-41.1 *Open Space Conservation/Resiliency (OSC/R) Zone, C. Design Standards, (2) Building Design* is hereby amended to read as follows:

"(2) Building Design. Building design standards are triggered at any proposed demolition, addition, reconstruction, renovation, sale or conveyance of the property, or change in tenancy. Reconstruction and/or renovation work that is limited to "Ordinary Maintenance" as set forth in Section 150-4 shall not trigger building design standards. Where Building design standards are triggered due to a sale or conveyance of the property, or due to a change in tenancy, the buyer or the new tenant of the property will not be permitted to occupy the property until it is brought into compliance with all provisions of this section. In the event building design standards are triggered for any reason and the property owner fails to comply with all provisions of this section, the property owner shall be charged with a violation of this section and in accordance with 150-97(A)(1) of this Article, may be assessed a fine of up to \$2,000.00 per day. A separate offense shall be deemed to be committed on each day during or on which the violation occurs or continues.

All ordinances or parts of ordinances inconsistent with or in conflict with this ordinance are hereby repealed to the extent of such inconsistency.

If any section, paragraph, clause or provision of this ordinance shall be adjudged invalid, such adjudication shall apply only to the section, paragraph, clause or provision so adjudged and the remainder of the ordinance shall be deemed valid and effective.

This ordinance shall become effective 20 days after adoption and publication according to law.

ADOPTED: MAR 07 2017

I hereby certify that the above is a true and exact copy of the Ordinance adopted by the Municipal Council of the Township of Woodbridge at their Regular Meeting held on
MAR 07 2017



JOHN M. MITCH, RMC, CMC, CMR
MUNICIPAL CLERK



Township of Woodbridge Floodplain Management Plan

Prepared for:

Township of Woodbridge

Prepared by:

Najarian Associates

&

Woodbridge Township Division of Engineering

Version 1: 2018

TABLE OF CONTENTS

| | |
|---|----|
| B1. Introduction..... | 3 |
| B2. Woodbridge Township Profile..... | 4 |
| B3. Known Causes of Flooding (Assessing the Hazard)..... | 8 |
| B4. Flooding Vulnerability (Assessing the Problem)..... | 11 |
| B5. Flooding Vulnerability (Assessing the Problem - <i>Fluvial Emphasis</i>)..... | 19 |
| References..... | 25 |

(C) Appendices..... Review of Possible Activities, Goals, and Action Plan

Appendix A: Middlesex County Hazard Mitigation Plan (Woodbridge Township)

Appendix B: Analysis of Flood-Prone Structures (Twp. GIS approx. grade and flood depth)

Appendix C: Open Space, Conservation and Resiliency Zone Ordinance

Appendix D: Municipal Flood Damage Prevention Ordinance

Appendix E: Woodbridge Twp. Open Space & Floodplain Restoration Plan

Appendix F: Hydrologic & Hydraulic Modeling & Flood Reduction Strategies *Heards Brook Watershed Edgar Street Neighborhood, Woodbridge Twp.*)

Appendix G: Strategic Recovery Planning Report (*Post Super Storm Sandy*)

Appendix H: Coastal Vulnerability Assessment

Appendix I: USACE Woodbridge River Basin Flood Damage Reduction and Ecosystem Restoration Report

Appendix J: Building Ecological Solutions to Coastal Community Hazards

Appendix K: Climate Adaptation: Flooding Risk Maps

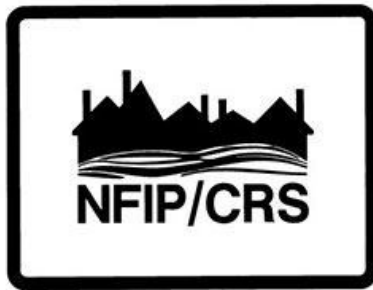
Appendix L: Impervious Cover Reduction Action Plan

Appendix M : Implementing Community-Led Outreach to Achieve Pollution Prevention in Flood Risk Areas

Appendix N: Action Plan and Goals

B1. Introduction

Woodbridge Township has participated in various federal, state, county and local government and private sector programs aimed at reducing flooding impacts within the Township. In the aftermath of Super Storm Sandy, the Township connected flood victims with the Federal Emergency Management Agency (FEMA) and other assistance agencies. Also, the Township participated in the New Jersey Department of Environmental Protection's Blue Acres Program, which has already acquired and removed 139 residential properties from the Township's Special Flood Hazard Areas (SFHAs). Despite such ongoing programs, flooding problems persist at a number of low-lying properties within the Township.



To reduce flood damages, and increasing flood-insurance costs, Woodbridge Township is in the process of joining Federal Emergency Management Agency's (FEMA's) Community Rating System (CRS) Program. This Program encourages and recognizes community floodplain management and planning activities that exceed the minimum requirements of the National Flood Insurance Program (NFIP). CRS rewards such activities by discounting flood insurance premiums for policy holders within a participating community. CRS goals are summarized as follows:

- to reduce and avoid flood damage to insurable property;
- to strengthen and support the insurance aspects of the NFIP; and
- to foster comprehensive floodplain management.

By supporting these common goals, Woodbridge Township property owners will become more flood resilient, and less burdened by rising insurance costs. Accordingly, this report was prepared to:

1. Help minimize risks to human life within hazardous floodplains, and reduce the amount of flood damage sustained during future flood events.
2. Enhance Township resilience and increase hazard mitigation preparedness by improving readiness for climate related emergency situations.
3. Strengthen the Township's economic vulnerability in relation to special flood hazard area's (SFHA) and sea level rise (based on global estimates by the year 2050).
4. Strengthen the Township's vulnerability to critical infrastructure and community assets in relation to special flood hazard area's (SFHA) and sea level rise (based on global estimates by the year 2050).
5. Protect and enhance natural floodplain functions in order to safeguard and promote biodiversity and ecological integrity.



Woodbridge Twp. Post-Super Storm Sandy

B2. Woodbridge Township Profile

Woodbridge Township is a large municipality occupying 24,507 square miles (63.473 km²) in Middlesex County, New Jersey (Figure 1a). The Township includes 23.213 square miles of land and 1.294 square miles of water. Woodbridge has several unincorporated communities and neighborhoods -- Avenel, Colonia, Fords, Iselin, Port Reading, Sewaren, Woodbridge Proper – which, collectively, make up Woodbridge Township (Figure 2). Other unincorporated communities, localities and place names located partially or completely within the township include Boynton Beach, Demarest Hill Top, Edgars, Fairfield, Hazelton, Hopelawn, Keasbey, Lynn Woodoaks, Menlo Park Terrace, Ostrander, Saint Stephens, Sand Hills, Shore View, Union and Woodbridge Oaks.

Woodbridge Township (Figure 1B) is bordered to the east by the Arthur Kill tidal strait and to the south by the tidal Raritan River. The Woodbridge River extends from its headwaters (in the northeastern corner of the Township) to the Arthur Kill. The Township has a history of tidal flooding in low-lying areas adjacent to these waterways, including: (a) the Woodbridge Proper section, along the Woodbridge River and its tributaries, (b) the Sewaren and Port Reading sections, along the Arthur Kill; and (c) the Keasbey section, along the Raritan River. Also, fluvial flooding occurs along Pumpkin Path Brook with flows northerly from Colonia to the Township of Clark, and from the South Branch Rahway River, which crosses western sections of the Township, within the Colonia and Iselin sections. Approximately 19% (5.5 square miles) of Woodbridge Township lies within FEMA's Special Flood Hazard Area (SFHA) (Figure 3), primarily areas adjacent to the Woodbridge River, Arthur Kill and South Branch Rahway River.

Woodbridge is an older community that was originally built to maximize waterfront access for regional industry (Middlesex County, 2010). Adjacent neighborhoods were built to support these industrial waterfront operations. Over 75 percent of the homes had been built before 1979, resulting in many vulnerable pre-FIRM structures. FEMA's statistics for Woodbridge Township indicate that there are presently 433 Pre-FIRM flood insurance policies in force (versus 119 Post-FIRM policies).

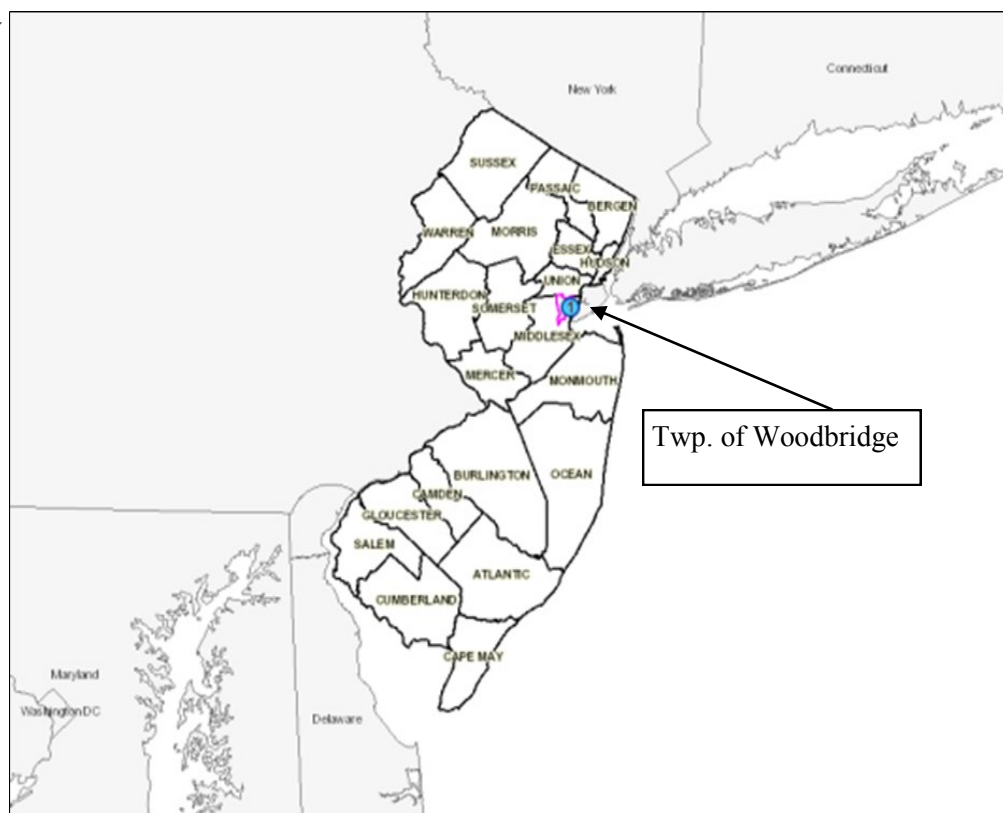


Figure 1A: Woodbridge Township location (Source: NJ GeoWeb))

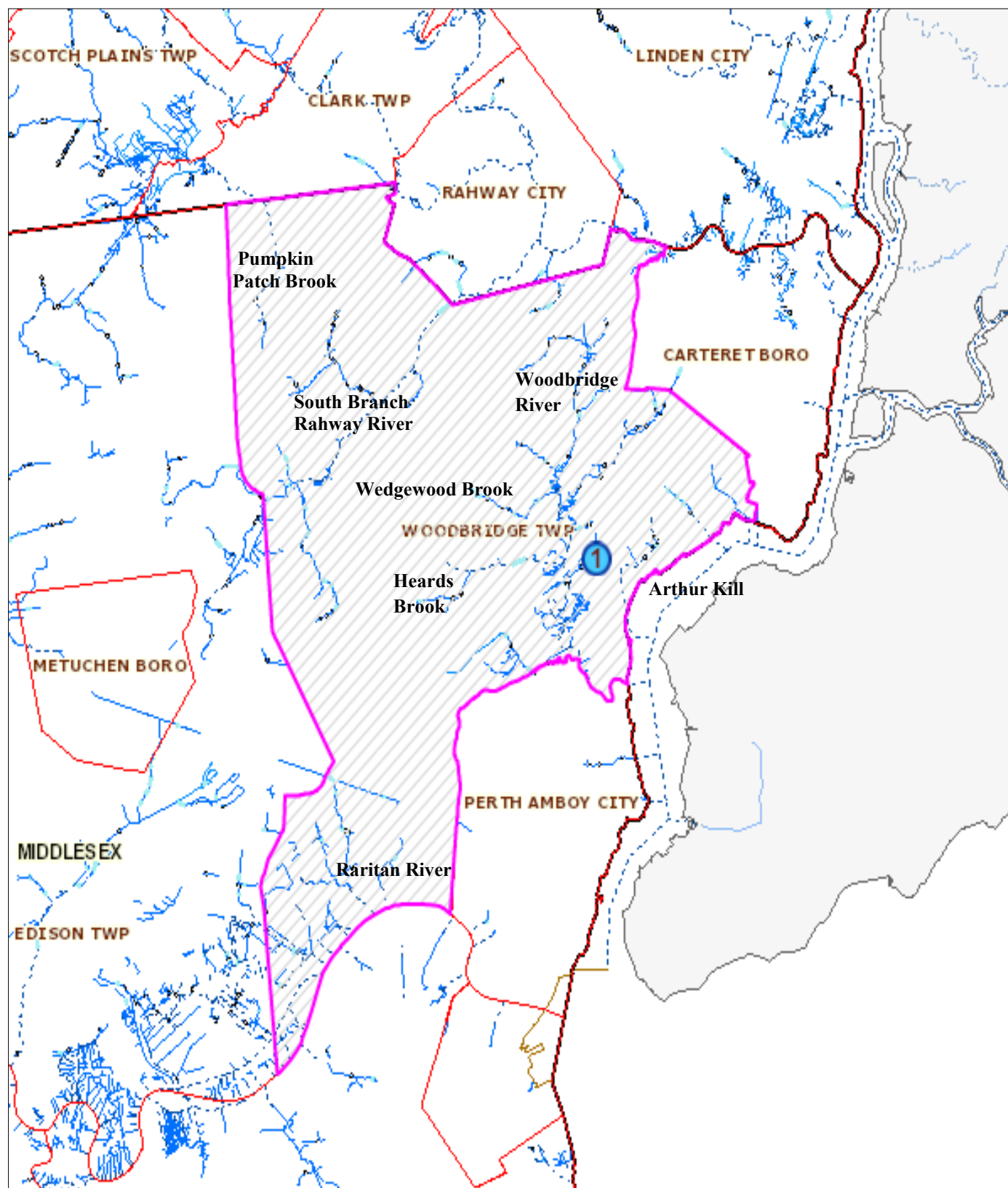
B2. Woodbridge Township Profile (continued)

Figure 1B: Woodbridge Township water bodies. (Source: NJ GeoWeb)

B2. Woodbridge Township Profile (continued)

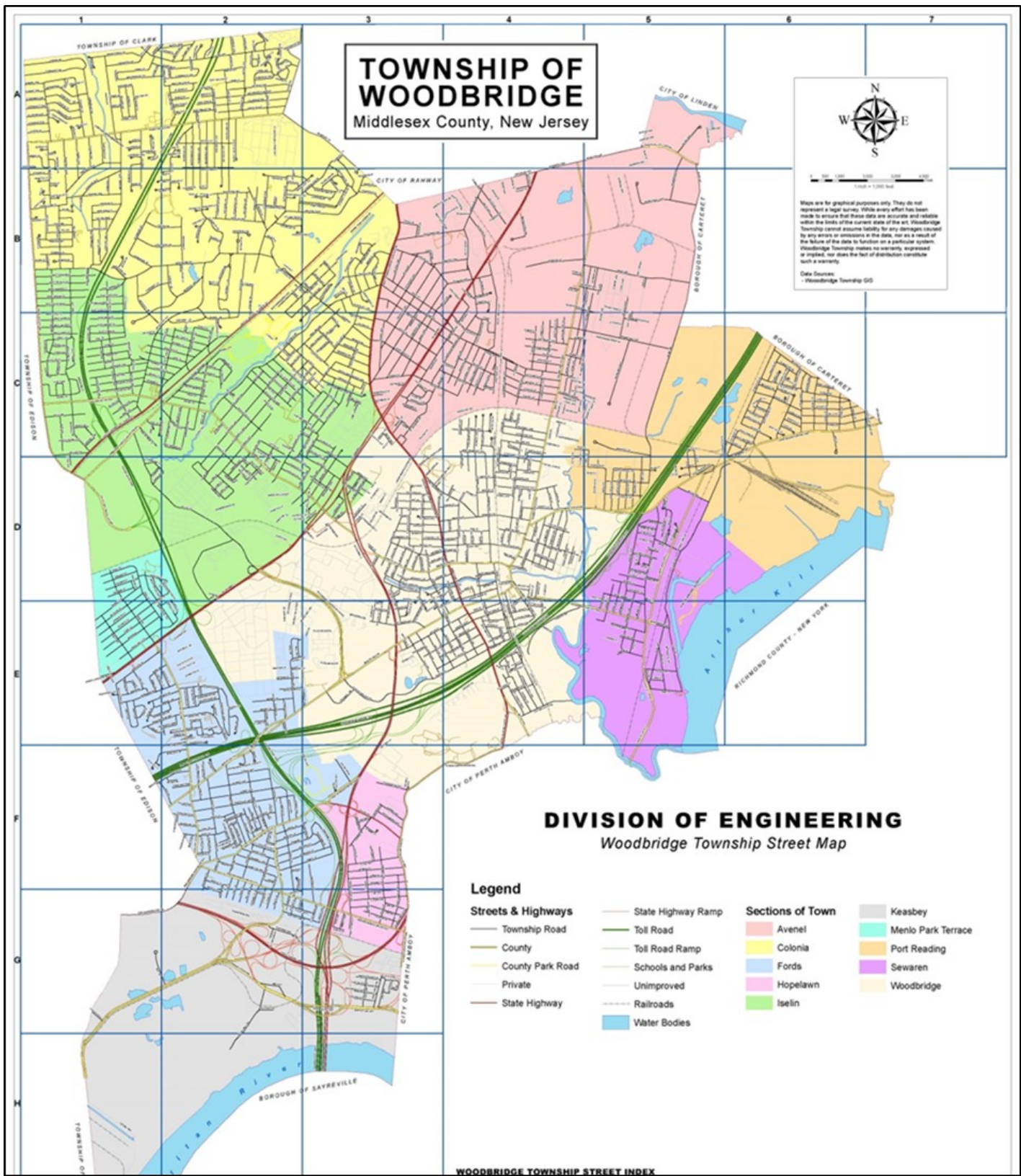


Figure 2: Woodbridge communities (Source: Woodbridge Township Engineering Department).

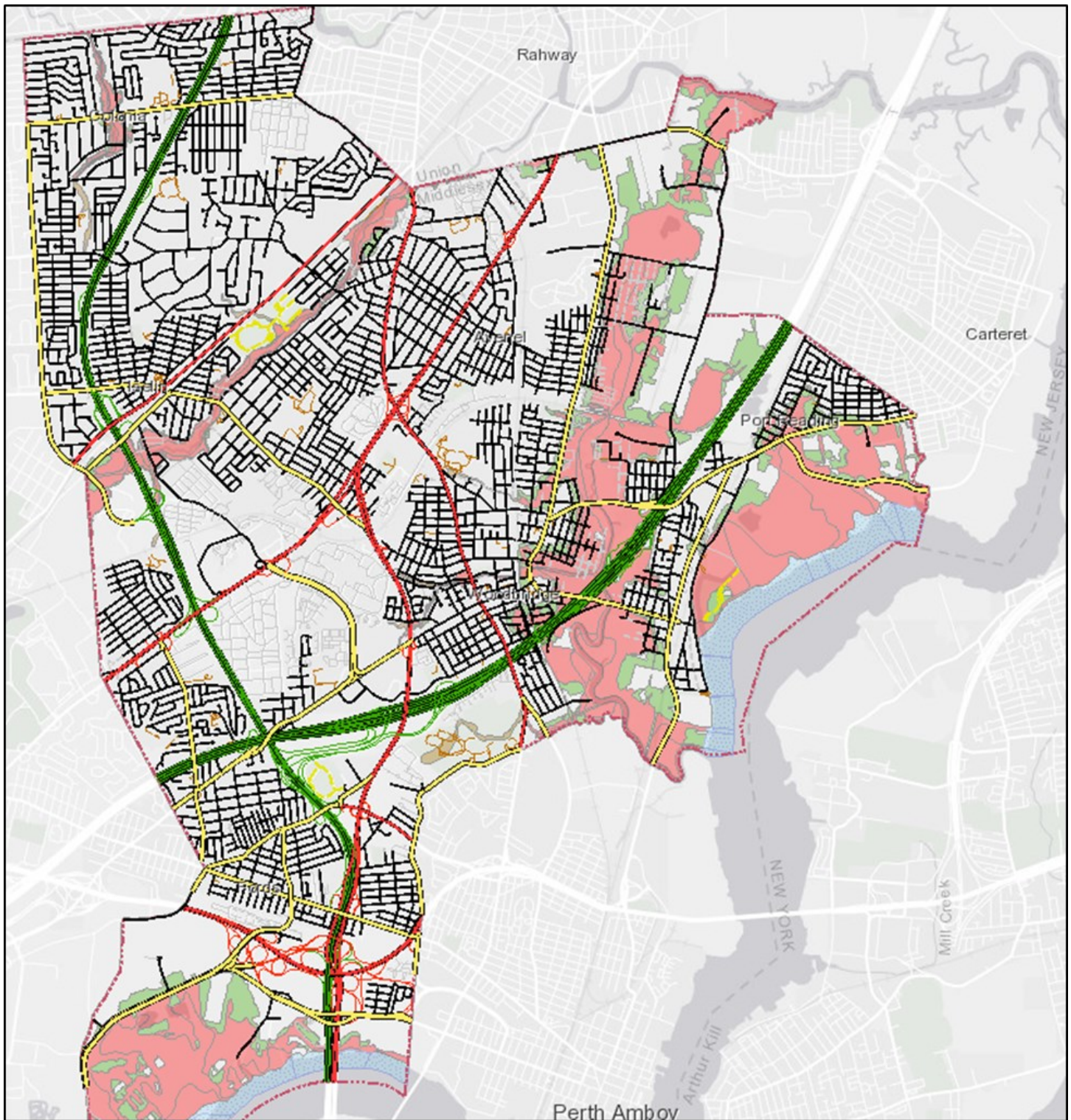
B2. Woodbridge Township Profile (continued)

Figure 3: FEMA's 2014 Preliminary Flood Zones (Source: FEMA and Woodbridge Township GIS). Pink areas represent three SFHAs along: (1) South Branch Rahway River (western sections); (2) Woodbridge River (central sections); (3) Arthur Kill (eastern sections); and Pumpkin Patch Brook (north western section).

B3. Known Causes of Flooding (Assessing the Hazard)

Flood damages in Woodbridge Township are caused by tidal and fluvial flooding. Tidal flooding is caused by coastal storms, which consist of two general types: (1) tropical storms and hurricanes; and (2) extra-tropical storms or nor'easters. The former consist of warm-core, cyclonic systems generated in the tropics. These systems derive their energy from oceanic heat and evaporation. Nor'easters are cold core, cyclonic systems that usually form in areas where strong surface temperature gradients coincide with a strong jet stream aloft (Figure 4). Intense winds generated by both of these storms tend to pile water against the coast-line, and raise tide levels above normal to create a "storm surge." Other factors contributing to storm surge include falling atmospheric pressure levels, mildly sloping coasts and "setup" due to breaking waves.

As noted above, Woodbridge Township has a history of tidal flooding. The most extreme flooding occurred in 2012 during Super Storm Sandy, when the U.S. Geological Survey measured a High Water Mark (HWM) elevation of 12.5 feet NAVD88 at Station #NJMID07292, adjacent to the lower Woodbridge River. All low-lying areas adjacent to the Woodbridge River and Arthur Kill were inundated during this Storm, as illustrated in maps prepared by the U.S. Geological Service (Figure 5).

Sandy's peak storm tide of approximately 12.5 feet NAVD88 in the lower Woodbridge River was an extreme water level. Based on published scientific analyses conducted by NOAA, Super Storm Sandy corresponded approximately to a 295-year storm event at Sandy Hook, New Jersey, and a 1,570-year storm event at the Battery, New York. FEMA's 2014 Preliminary Flood Insurance Study (FIS) for Middlesex County reported 100-year Still Water Elevations (SWELs) of approximately 12-13 feet NAVD in the Woodbridge River. Presently, these relatively high 100-year SWELs are being revised by FEMA.

Besides Sandy, Woodbridge Township has experienced several other major coastal storm events, including Hurricane Donna (1960); the Great Nor'easter of December 1992, and Tropical Storm Irene (2011). While storm tide data are unavailable for Woodbridge River during such events, data are available at NOAA's primary gaging station at Sandy Hook, NJ. Here, measured peak storm tides are *typically about 10% lower* than in Woodbridge Creek. Figure 6 compares peak water levels for the ten highest recorded storm tides at Sandy Hook. As illustrated, the second tier of peak storm tides ranged from approximately 6-8 feet NAVD88 at Sandy Hook, or about 3-5 feet lower than Super Storm Sandy's peak tide.

Thus, these second-tier coastal storm events – which occur at decadal intervals, on-average -- also caused flooding in low-lying areas of the Township (i.e., where ground elevations are less than about 7-9 feet, NAVD88). As the lowest ground elevations at the outer edges of developed areas of the Township are approximately 5-6 feet NAVD88, these decadal storm events have the potential to cause up to 4 feet of inundation. Note that some of these events (e.g., Tropical Storm Irene and Floyd) were accompanied by intense rainfall, which exacerbated flooding impacts.



(B3. Known Causes of Flooding (continued))

Figure 4: Typical paths of nor'easter



Figure 5: Approximate area of inundation in Woodbridge during Super Storm Sandy (Source: USGS Sandy Storm Sandy Tide Mapper)

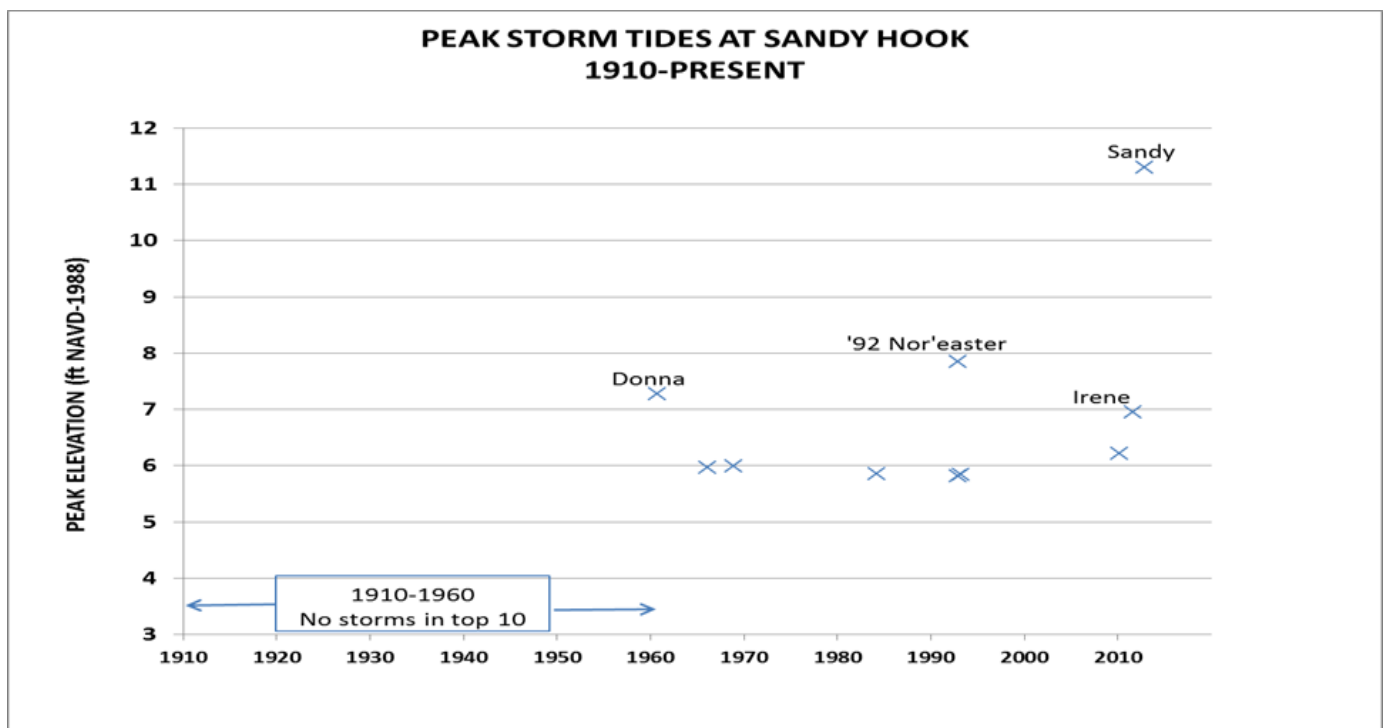


Figure 6: Top ten peak storm tide elevations at Sandy Hook, NJ (Data Source: NOAA CO-OPS). Peak storm tide at Sandy Hook is estimated. The highest tidal elevation recorded by NOAA at Sandy Hook during Super Storm Sandy was actually 10.4 feet NAVD88, when the tide gage stopped recording shortly before the peak tide occurred. NOAA estimates that that actual peak tide during Sandy was around 11.3 feet NAVD88, based on USGS HWMs for Sandy Hook sites NJMON07327 and NJMID072.

B3. Known Causes of Flooding (continued)

Besides tidal flooding, fluvial flooding damages structures and properties within certain areas of Woodbridge Township. Fluvial flooding in Woodbridge Township is exacerbated by its highly urbanized land cover distribution. Nearly 80 percent of the Township's land area has been classified as urban cover, which includes a mixture of industrial, commercial, and residential land uses. The Township has redeveloped some of its underutilized parcels and older industrial areas. Open space is limited primarily to parks and water areas.

The Township has a high degree of impervious cover, which limits infiltration. In addition, the Township has some steep slopes. Maximum topographic elevations range from about: (a) 120 feet above Mean Sea Level (MSL) in the Colonia, Iselin, Fords sections; (b) 80 feet above MSL in Avenel; (c) 40 feet above MSL in Woodbridge Proper, and (d) 20 feet above MSL in the Port Reading and Seawaren sections. The latter three areas slope downward to sea level. The combination of predominant impervious cover and fairly steep slopes results in "flashy," urban runoff conditions, with fluvial flooding impacts in poorly drained areas.

Areas where fluvial flooding occurs include the northwestern section of Woodbridge Township along the South Branch Rahway River and Pumpkin Patch Brook (e.g., in the Colonia section). The South Branch of the Rahway River's 11.6 square mile watershed drains intensively developed portions of four towns: Rahway, Woodbridge, Metuchen, and Edison. Repetitive flooding is associated with extreme rainfall events, especially in "flashy" areas having poor drainage. Common causes of such problems include:

- ⇒ Urbanization and limited infiltration of rainfall due to enlarged impervious surfaces;
- ⇒ Enhanced flood flows, stream bank erosion and sediment deposition in channel interiors;
- ⇒ Insufficient downstream conveyance of stream flood flows due to undersized culverts at bridge/road crossings and/or narrowed stream channels; and
- ⇒ Insufficient flood storage capacity within the watershed.

The high-flow, flashy nature of Woodbridge streams leads to increased flood flows and, in turn, results in higher flood elevations, increased velocities, and wider floodplains -- all leading to increased flood damages during major rainfall events. Urban development also contributes to fluvial flooding in the upper reaches of creeks and tributaries of the tidal Woodbridge River, especially when prolonged coastal storms (e.g., nor'easters) elevate water levels at their downstream boundaries. These include reaches of Heards Brook and upper Wedgewood Brook. The combined effect of tidal flooding, fluvial flooding and upstream flow constrictions increases the *duration* of flooding impacts in upper reaches of the Woodbridge River. This effect was demonstrated during a tidal monitoring study of the Woodbridge River (Najarian Associates 2001). This study included observations at four tide monitoring stations in Woodbridge during the January 3, 1999 nor'easter. Observed river tide records at each station are shown in Figure 7, along with corresponding tidal elevations monitored by NOAA at the tip of Manhattan Island at the Battery, New York. During this event, coastal sea levels rose approximately 2 feet (Figure 8) in response to this moderate storm, which was accompanied by 3 inches of local rainfall (Figure 8).

During this event, the tide at one of the aforementioned Najarian Associates monitoring stations (near the mouth of Woodbridge Creek) was slightly higher than the tide at Battery or Sandy Hook. Peak storm elevations (nearly 5 ft NAVD88 on January 3, 1999) were nearly the same at all stations within the Creek following this storm event. However, *nearly three days elapsed before water levels subsided* to pre-storm levels at the most upstream monitoring station 4 (near the Ideal Manufactured Home Park, IMHP), indicating slow drainage, but no further peak amplification.

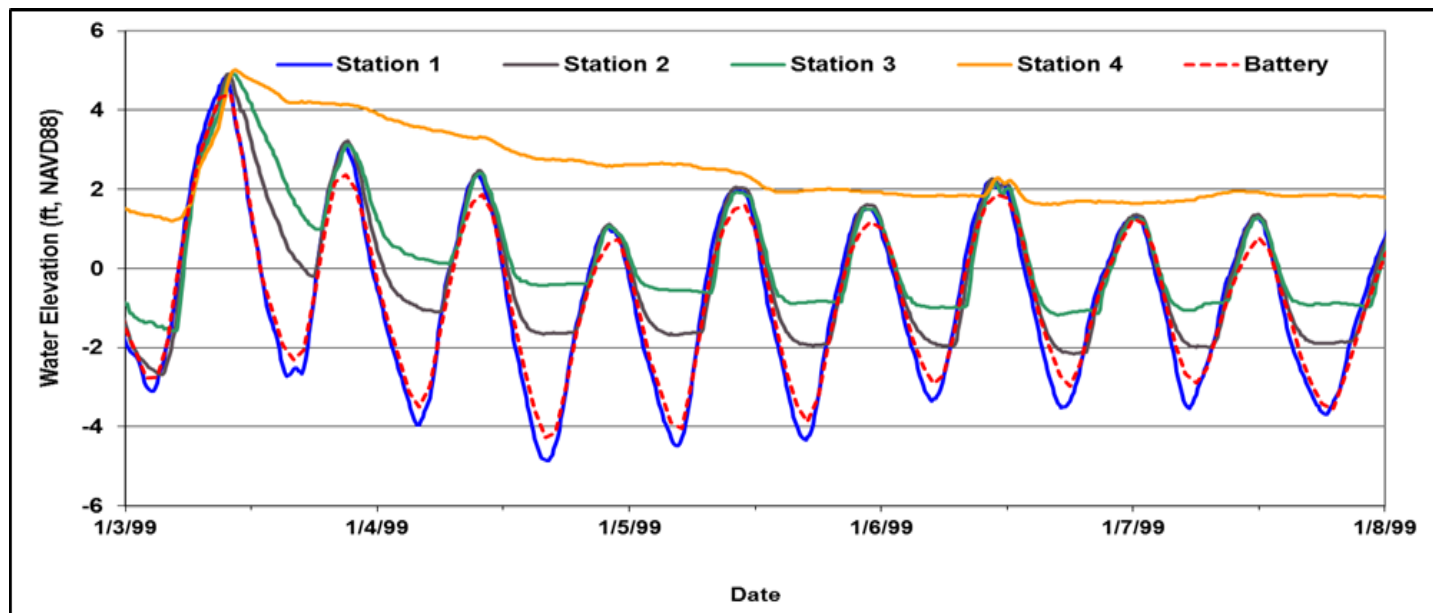
B3. Known Causes of Flooding (continued)

Figure 7

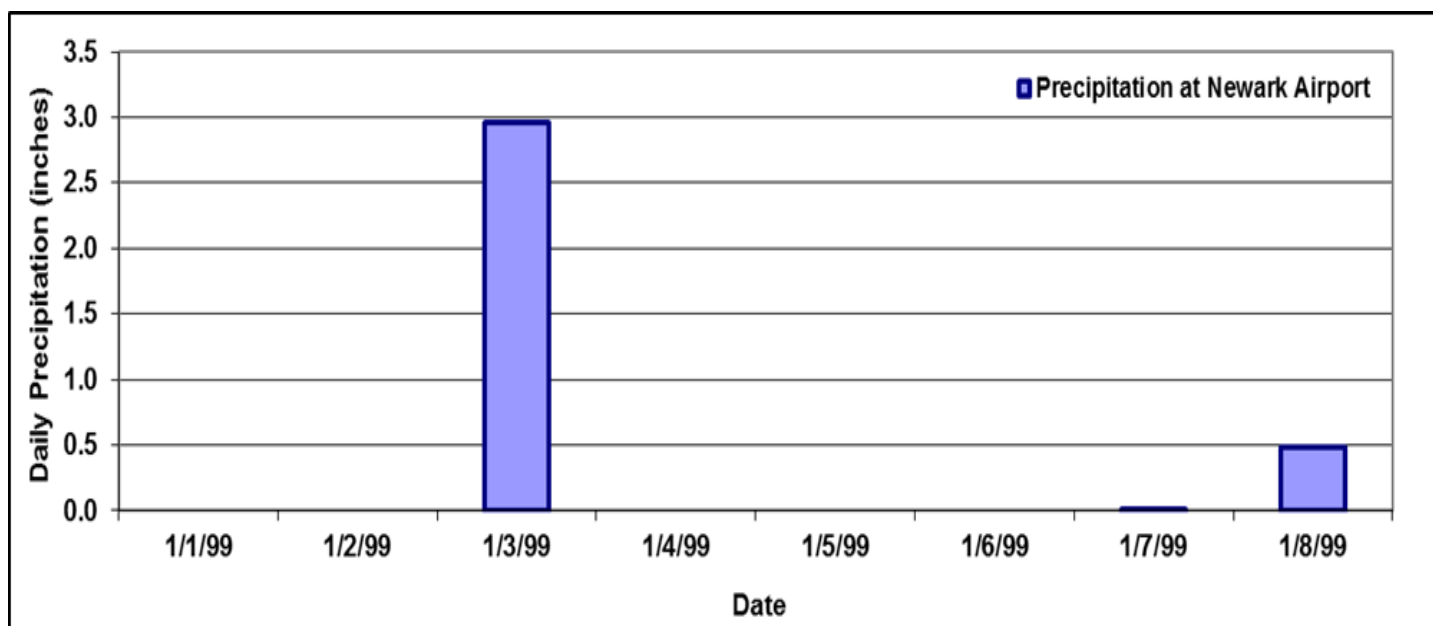


Figure 8

B4. Flooding Vulnerability

FEMA is in the process of updating the Flood Insurance Rate Maps (FIRMs) for Woodbridge Township. The previously adopted and effective FIRMs are dated July 6, 2010. The Preliminary FIRMS – which were issued in 2014 (presently being revised by FEMA) delineate the extent of FEMA’s Special Flood Hazard Area (SFHA; a.k.a. 100-year floodplain), contoured Base Flood Elevations (BFEs; a.k.a. FEMA 100-year flood elevations), and various other flood-map features. Within the SFHAs depicted in these maps (expanded floodplain) many new structures are vulnerable to flooding impacts.

B4. Flooding Vulnerability (Continued)

Figure 10 (page 13) displays the distribution of flood-prone structures within SHHAs prior to the recent NJDEP Blue Acres Buyout Program. The displayed structures within the blue-shaded areas are located within the effective (2010), 100-year floodplain delineated below the 9 foot (NAVD88) ground elevation contour.

Historically, both the Crampton Avenue neighborhood (CAN) and Ideal Manufactured Home Park (IMHP) were considered to be among the most vulnerable to storm surge impacts (USACE 2007; Heyer, Gruel & Associates 2015). The CAN is located in the Woodbridge proper section and Woodbridge River's tidal floodplain, just upstream of the NJ Turnpike crossing (Figure 11). The IMHP is located in the Avenel Section of the River's tidal floodplain, just upstream of the Port Reading Railroad Bridge crossing (Figure 11). The flood vulnerability of these areas was assessed in a detailed reconnaissance study conducted by the USACE, New York District in 1999 (USACE 2007).

Flooding in the CAN is characterized as a recurring problem caused by tidal surges combined with storm-water runoff, which collectively impact low-lying residential areas with ground elevations of approximately 6-7 feet NAVD88 (USACE 2007). Tidal and riverine flooding at the IMHP is also recurring due to its location on the Woodbridge River tidal floodplain and its low ground elevations, which vary from 5-19 feet NAVD88. Also, the duration of flooding impacts is prolonged, as noted above.

In 2007, the Corps initiated the Woodbridge River Basin Flood Damage Reduction and Ecosystem Restoration Study to identify possible flood control and ecosystem restoration measures within the Basin, though no such measures were approved by the USACE. However, many structures in the CAN have already been acquired and demolished as a result of the ongoing Blue Acres Buyout Program. Figure 10 (page 13) displays the status of this Program in this neighborhood and surrounding areas



Figure 9: Heidelberg Ave. (CAN) Post-Super Storm Sandy

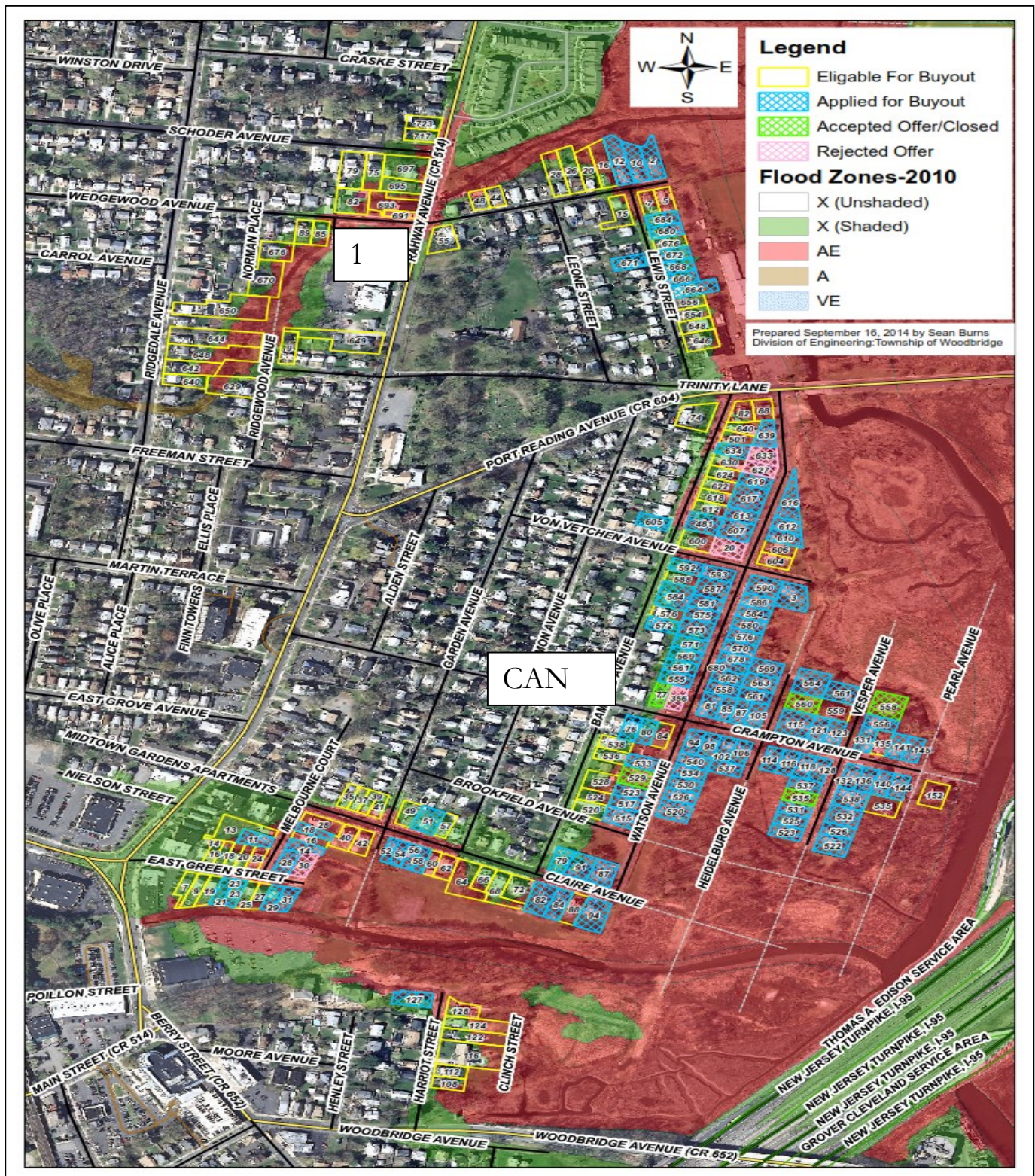
B4. Flooding Vulnerability (continued)

Figure 10: Status of Blue Acres Buyout program in CAN and Wedgewood Avenue Neighborhood (Area 1)

B4. Flooding Vulnerability (continued)

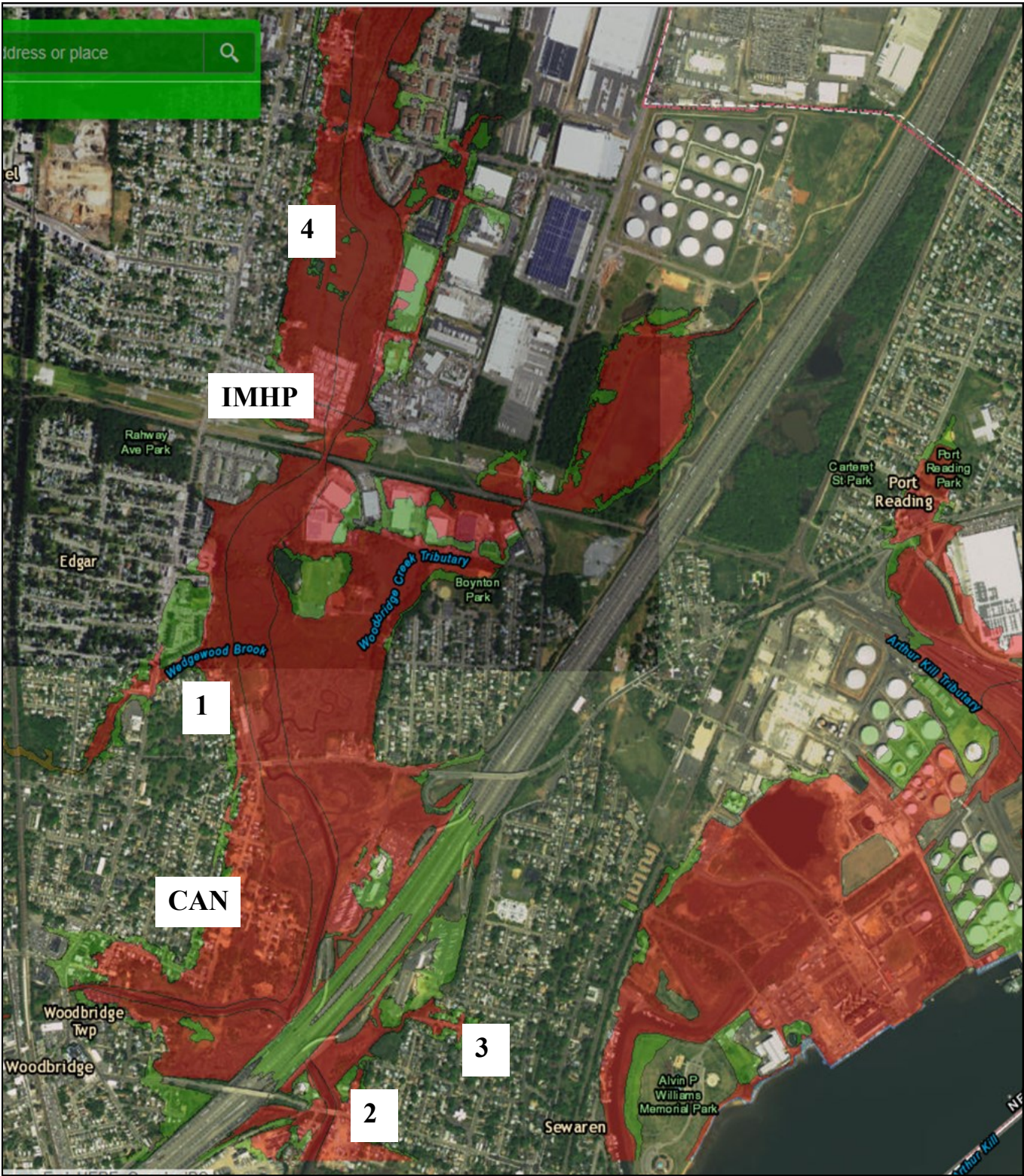


Figure 11: Location of neighborhoods vulnerable to tidal flooding (adopted 2010 FIRM SFHA below 9 feet NAVD88, as displayed on Woodbridge Township GIS)

B4. Flooding Vulnerability (Continued)

Besides the CAN and IMHP, there are several other low-lying developed areas near the Woodbridge River/marshes that are susceptible to tidal flooding. As identified in Figure 11, these other areas include: (1) the Wedgewood Avenue neighborhood along Wedgewood Brook; (2) the Austin Street, South Roberts Street and Seawaren Avenue neighborhoods on the south side of the NJ Turnpike crossing (Figure 13); (3) the Vernon Street and Seawaren Avenue neighborhoods, also on the south side of the NJ Turnpike; (4) the upper Woodbridge River tidal floodplain along Blanford Avenue, Borman Avenue and Edgarton Boulevard in the Avenel section; and (5) the Fourth Street neighborhood in the Port Reading Section. Like the CAN, many structures are also being acquired and demolished in each of these areas as a result of the ongoing Blue Acres Buyout Program. The buyouts in neighborhood (1) along Wedgewood Avenue are displayed in Figure 10, while the buyouts in neighborhoods (2), (3), (4) and (5) are illustrated in Figures 12-17, respectively.

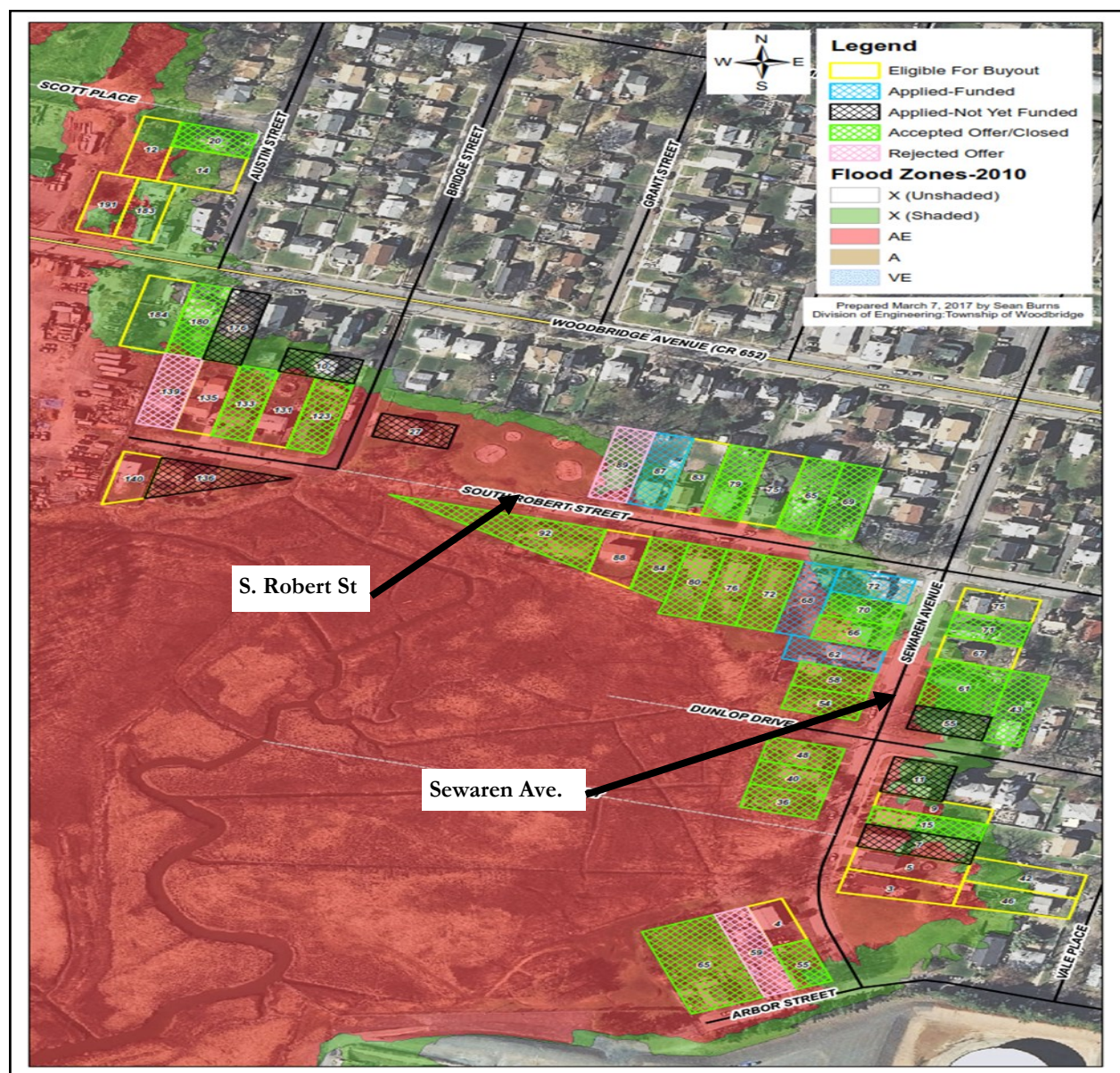


Figure 12: Status of Blue Acres Buyout program in S. Robert Street- Sewaren Avenue

B4. Flooding Vulnerability (Continued)

Figure 13: Status of Blue Acres Buyout program in Vernon Street Neighborhood (Area 3)

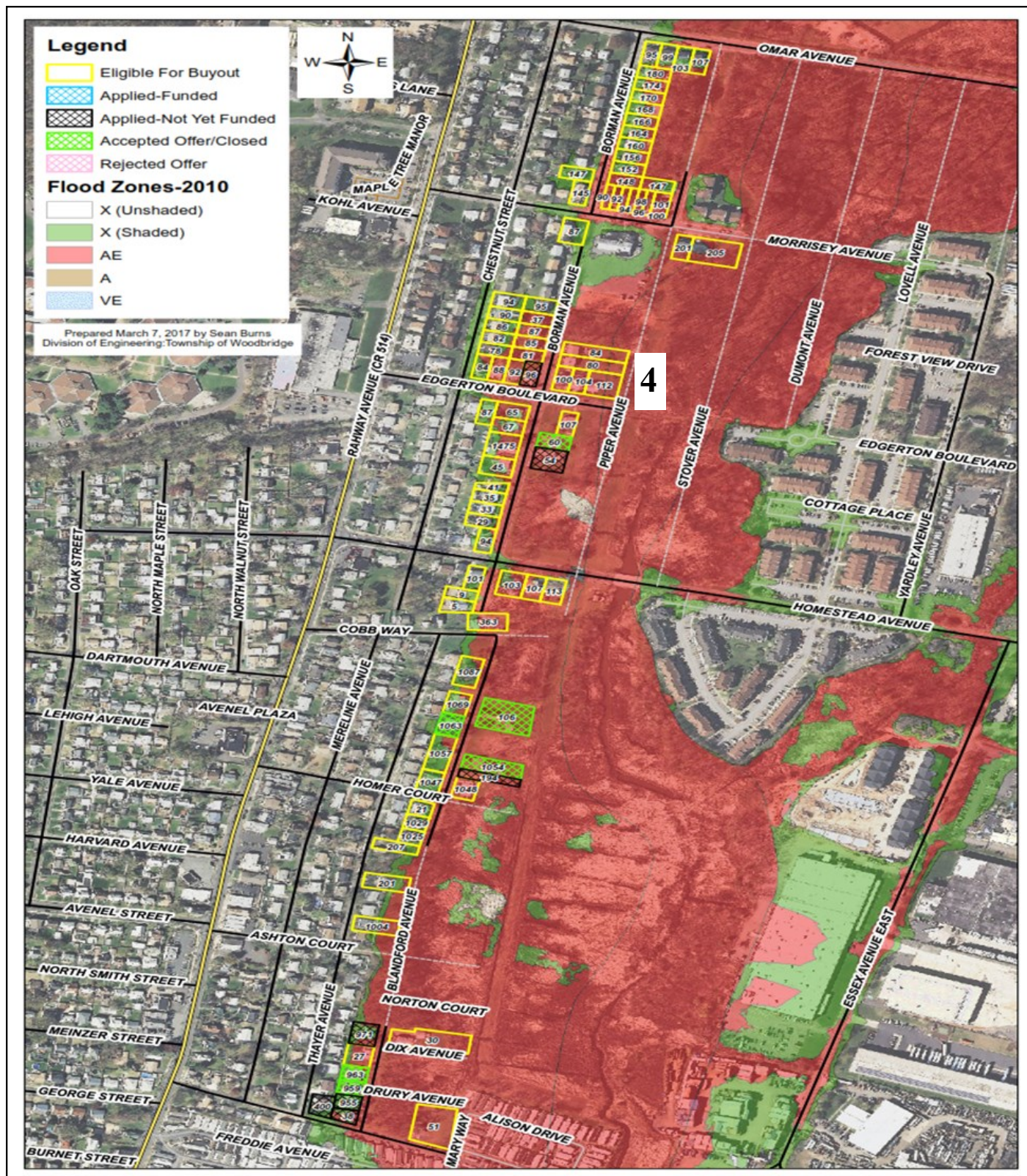
B4. Flooding Vulnerability (Continued)

Figure 14 Status of Blue Acres Buyout program in Blanford Avenue, Borman Avenue, and Edgerton Boulevard Neighborhoods along upper Woodbridge River (Area 4)

B4. Flooding Vulnerability (Continued)



Figure 15: Status of Blue Acres Buyout program in Fourth Avenue Neighborhood (Area 5) In Port Reading section

B4. Flooding Vulnerability (Continued)

As illustrated, the Blue Acres Program has been highly effective in reducing the Township's vulnerability to future flooding impacts. It is anticipated that this program will eliminate over 139 structures from the most flood-prone areas of the Township.

While storm surge is an important concern, wind wave impacts are generally not significant in Woodbridge Township due to the inland location of most insured structures. Thus, Coastal A Zones are limited. In the Woodbridge Proper section, Coastal A Zones in the PFIRMs are confined to adjacent tidal marsh areas near the Turnpike crossing of the Woodbridge River, and appear to encroach on only two structures (Figure 16). Since this PFIRM is being revised by FEMA, no further information is available at this time.



Figure 16: Coastal A Zone in 2014 PFIRM around Woodbridge River marsh crosses two homes in CAN

B5. Flooding Vulnerability (Fluvial Emphasis)

Neighborhoods most vulnerable to *fluvial* flooding impacts are located mainly along the **South Branch Rahway River**, and **Pumpkin Patch Brook** within the western (and north western) sections of the Township (Figure 1B). Sub-urban development in Clark and Woodbridge Township has led to increased surface water run-off and long-standing cases of over-banking flooding along Pumpkin Patch Brook (Figure 19). In addition, Woodbridge, Rahway, Metuchen and Edison, are within the 11.6 square miles of the South Branch Rahway River Watershed. Reduced impervious cover in these areas has created a river with high flows, increased velocities, higher flood elevations and wider floodplains. The South Branch Rahway River, through Merrill Park, has experienced severe erosion and lost much aquatic/channel bank vegetation over the last two decades. Downstream flow constraints -- such as bridges, culverts or narrow channels -- cause backwater effects and contribute to upstream flooding. For example, during Hurricane Irene (August, 2011), the residents along McFarlane Road (Figure 17), Brookside Court and North Hill Road (Figure 18) incurred significant flood damages. This flow conveyance problem is not easily solved, since there are always concerns that increasing the culvert/channel size at the Route 35 crossing may cause downstream impacts, and since land is unavailable for constructing adequate flood storage/detention basins. However, North Hill Road property owners have applied for Blue Acres Program buyouts, as illustrated in Figure 18.

B5. Flooding Vulnerability (Fluvial Emphasis)

Figure 17: Neighborhood vulnerable to fluvial flooding along South Branch Raritan River near Route 35 crossing (2010 FIRM SFHA, as displayed on Woodbridge Township GIS)

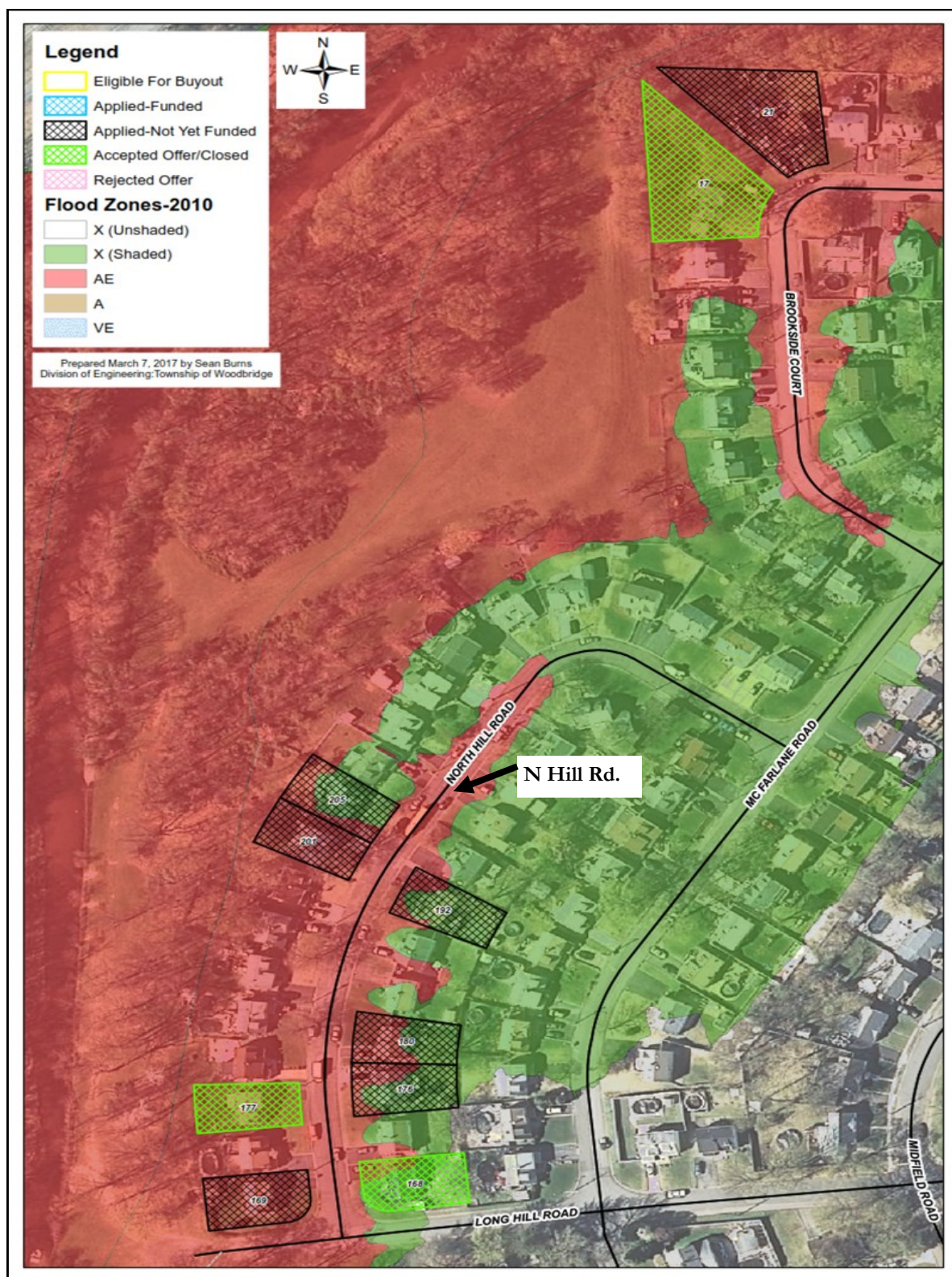
B5. Flooding Vulnerability (Fluvial Emphasis)

Figure 18: Status of Blue Acres Buyout Program for North Hill Road Neighborhood along South Branch Raritan River

B5. Flooding Vulnerability (Fluvial Emphasis)

To the south, riverine flooding also occurs in non-tidal streams that discharge to tidal rivers and creeks. For example, the high-flow, flashy nature of the reach of **Heards Brook** extending from just upstream of Elmwood Avenue to its confluence with the Woodbridge River has been improved to handle major storm events. The stream crossing at Elmwood Avenue (Figure 19) is 44 feet wide, at School Street is 42 feet wide, and the culvert from Pearl Street to Rahway Avenue is 25-to-30 feet wide and 9-to-10 feet high. The channel sections between crossings have also been improved, with a 30-foot width at the bottom and 50-foot width at the top. However, the Route 35 culvert, which is approximately 12 feet-wide by 6-feet high, has not been enlarged, and continues to cause flooding upstream of the crossing. For example, during Hurricane Irene (August of 2011) areas upstream of the Heards Brook's crossing at Route 35 were flooded, as the Route 35 crossing was overtopped.



Figure 19: Neighborhood vulnerable to fluvial flooding along Heards Brook near Elmwood Avenue and Rt. 35 (2010 FIRM SFHA, as displayed on Woodbridge Township GIS)

B5. Flooding Vulnerability (Fluvial Emphasis)

Vulnerable, low-lying neighborhoods located upstream of this Route 35 crossing include a low point in Edgar Street (Figure 19), which extends to an elevation of approximately 24 feet NAVD88 at structures along the south side of Edgar Street. There is a second low point which has an elevation of less than 22 feet in the rear area of the homes on the south side of Edgar Street, between Edgar Street and N. Park Drive. N. Park Drive also has a low point of approximately 21.5 feet NAVD88, which floods during a 2-year storm event according to recent hydraulic studies (Najarian Associates, 2013). Hydraulic model studies suggest that the 100-year storm event has potential to flood the area to a depth of 3 feet (Najarian Associates, 2013).

Flooding south of Heards Brook occurs along S. Park Drive, which has a low point of approximately 22.5 feet, and may also flood during a 2-year storm event. Likewise, the high-flow, flashy nature of the non-tidal Wedgewood Brook (Figure 20) leads to flood damage during storm events. The main downstream flow constraint in Wedgewood Brook is the railroad crossing (Figure 20). This crossing consists of twin 48” culverts. Both the crossings upstream and downstream of this crossing are larger, and therefore have more capacity to carry flood flows. The upstream crossings at Barron Avenue (Figure 20) and Harrell Avenue crossings are 12 to 13 feet wide and 3 to 3.5 feet high; both larger than the Railroad Bridge culverts. During Hurricane Irene in late August of 2011, areas upstream of the Wedgewood Brook’s crossing at the Railroad Bridge were flooded, including the Barron Avenue neighborhood.

The low point in Barron Avenue (Figure 20), at the Wedgewood Brook crossing, has an elevation of approximately 16.6 feet. Upstream of the Barron Avenue crossing is Harrell Avenue, which has a low point of approximately 19.6 feet. Model analyses (Najarian Associates, 2013) indicate that the 100-year storm has potential to flood the area to a depth of over 9 feet. Structures as far upstream as Greco Lane also have the potential to be flooded during a major storm event. Approximately 42 residential structures could be affected by the 100-year storm event. The Najarian Associates analysis also revealed that the railroad culverts downstream of the Barron Avenue neighborhood provide a major backwater effect to areas upstream. Since the Railroad Bridge is acting as a berm and creating storage in the floodplain upstream, any increase in the rate of flow through the railroad culvert would, unfortunately, increase flood elevations downstream of the railroad crossing.



Figure 20: Neighborhood vulnerable to fluvial flooding along Wedgewood Brook near railroad crossing (2010 FIRM SFHA, as displayed on Woodbridge Township GIS)

B5. Flooding Vulnerability (Fluvial Emphasis)

To the north west, riverine flooding also occurs in non-tidal Category two stream known as **Pumpkin Patch Brook** which flows northerly towards the Township of Clark (Figure 21) . Pumpkin Patch Brook discharges to the Robinsons Branch of the Rahway River, and suffers similar drainage issues in regards to receiving high volumes of surface water run-off from impervious sub-urban development. For example, overbank flooding associated with the aforementioned water body has caused localized damage concerns in the Jordan Road neighborhood. Within this neighborhood (just upstream of the Inman Avenue crossing) the estimated ground elevation is 66.5 ft NAVD. Further, some flood-prone structures in this neighborhood possess basements and therefore are at an increased risk to receive flood damage, as the FEMA delineated 100 year flood elevation at this location is 66 ft. NAVD.



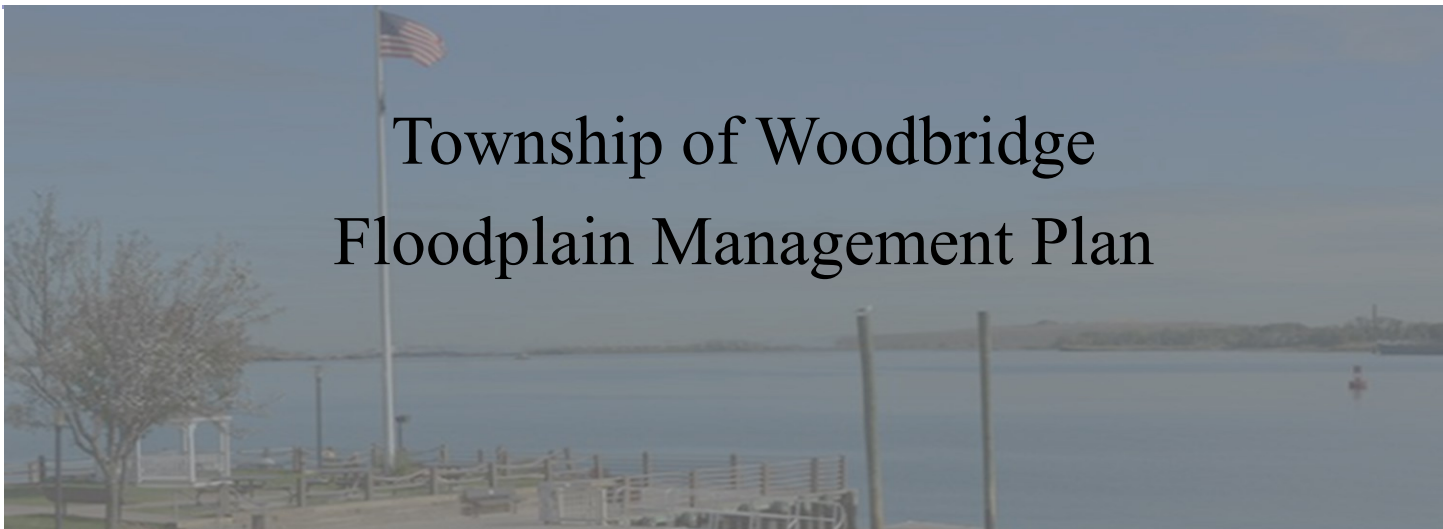
Figure 21: Neighborhood vulnerable to fluvial flooding along Pumpkin Patch Brook near Jordan Road (2010 FIRM SFHA, as displayed on Woodbridge Township GIS)



Township of Woodbridge Floodplain Management Plan

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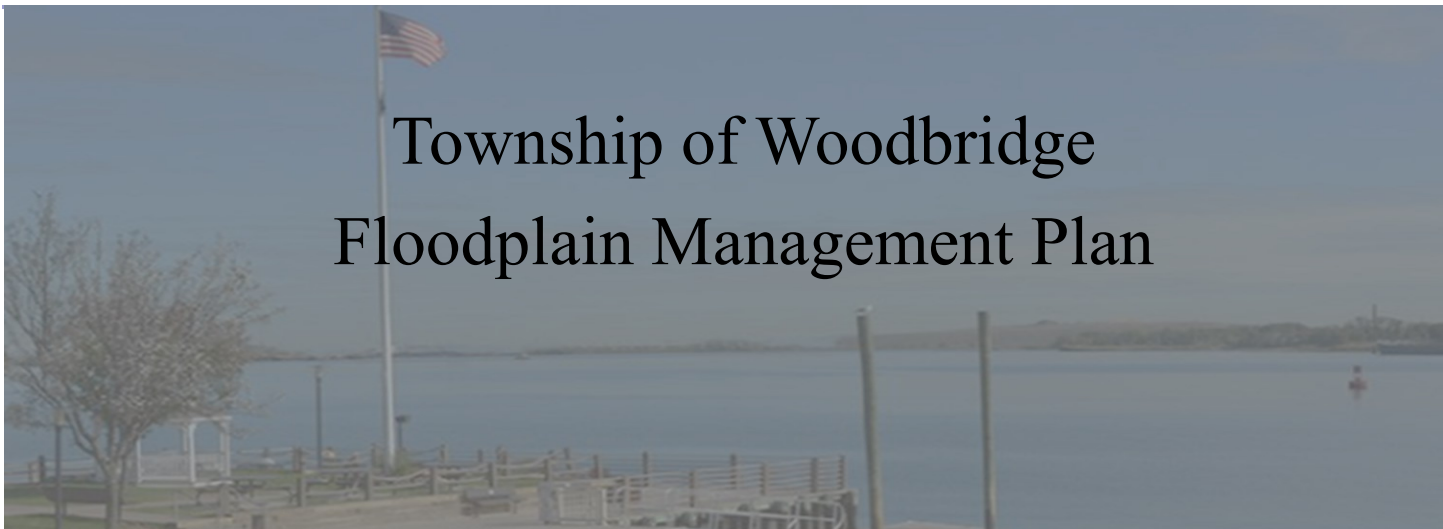


Township of Woodbridge Floodplain Management Plan

Appendix A

Middlesex County Hazard Mitigation Plan (Woodbridge Township)

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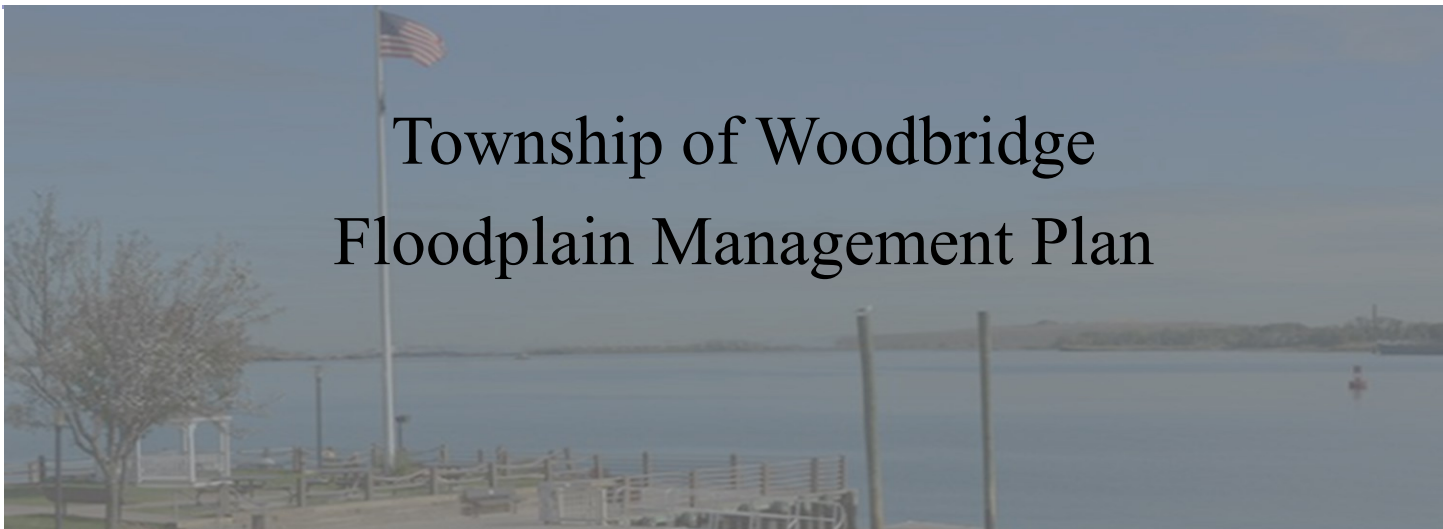


Township of Woodbridge Floodplain Management Plan

Appendix B

Appendix B: Analysis of Flood-Prone Structures (Twp. GIS approx. grade and flood depth)

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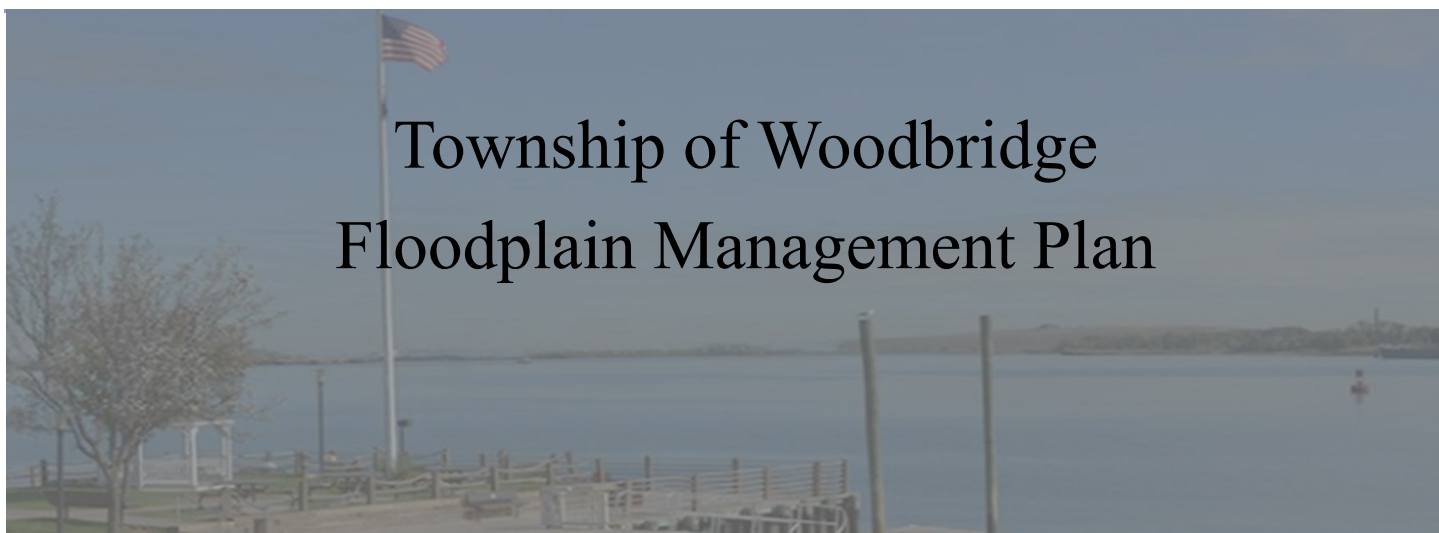


Township of Woodbridge Floodplain Management Plan

Appendix C

Open Space Conservation and Resiliency Zone (OSC/ R) Ordinance

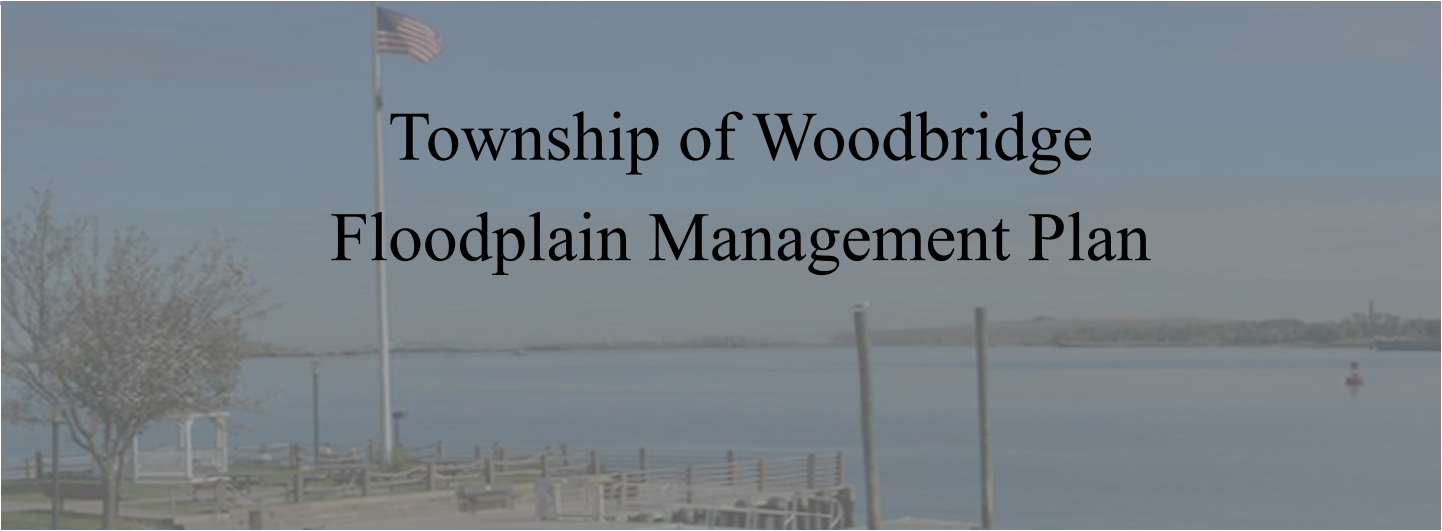
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Appendix D

Municipal Flood Damage Prevention Ordinance

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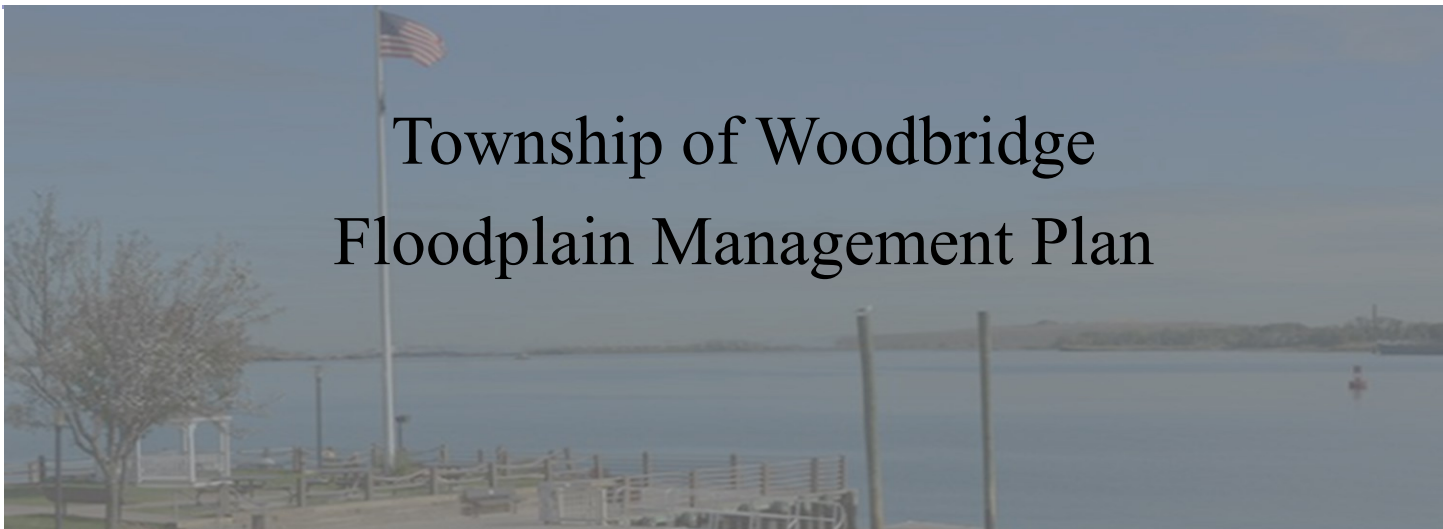


Township of Woodbridge Floodplain Management Plan

Appendix E

Woodbridge Twp. Open Space & Floodplain Restoration Plan

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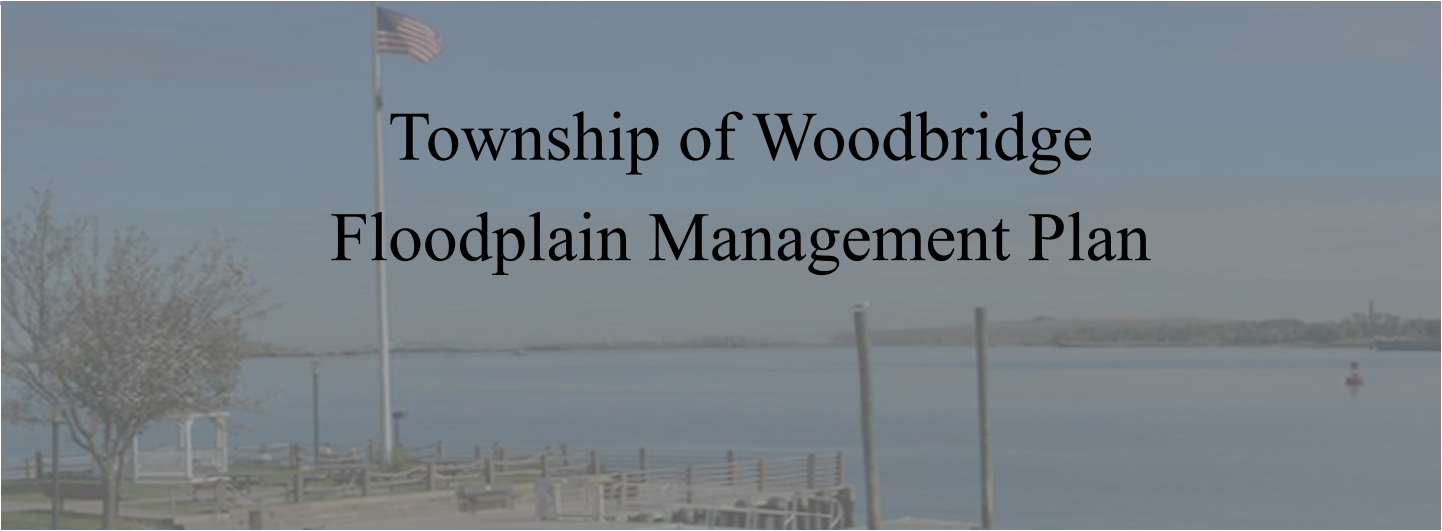


Township of Woodbridge Floodplain Management Plan

Appendix F

Hydrologic & Hydraulic Modeling & Flood Reduction Strategies
(Heards Brook Watershed Edgar Street Neighborhood, Woodbridge Twp.)

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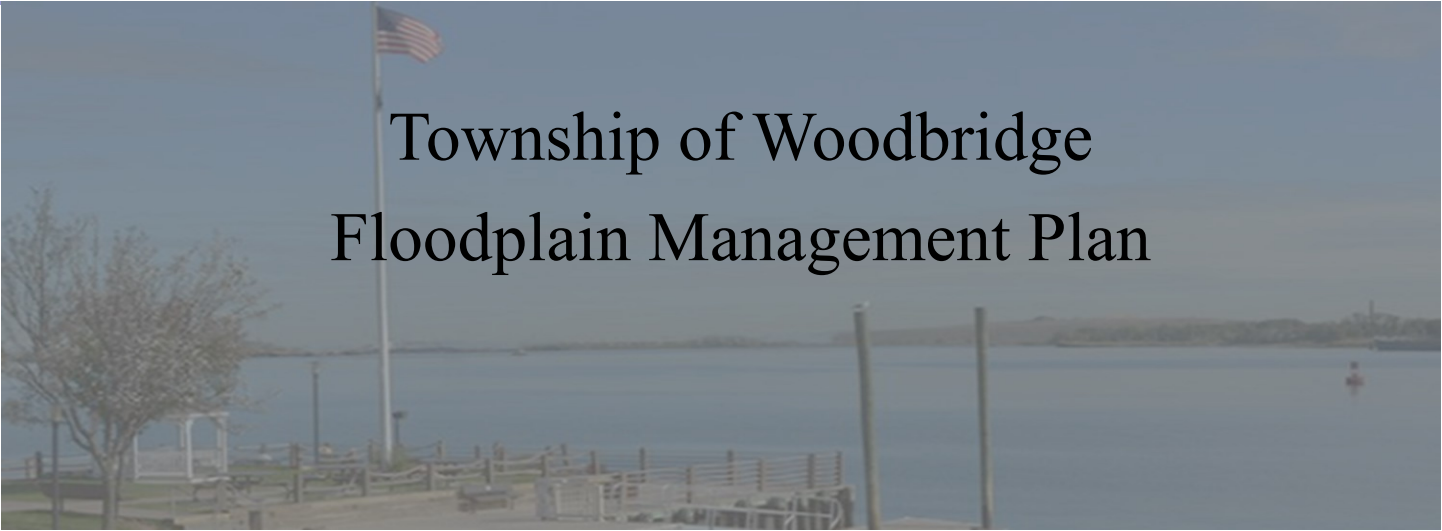


Township of Woodbridge Floodplain Management Plan

Appendix G

Coastal Vulnerability Assessment

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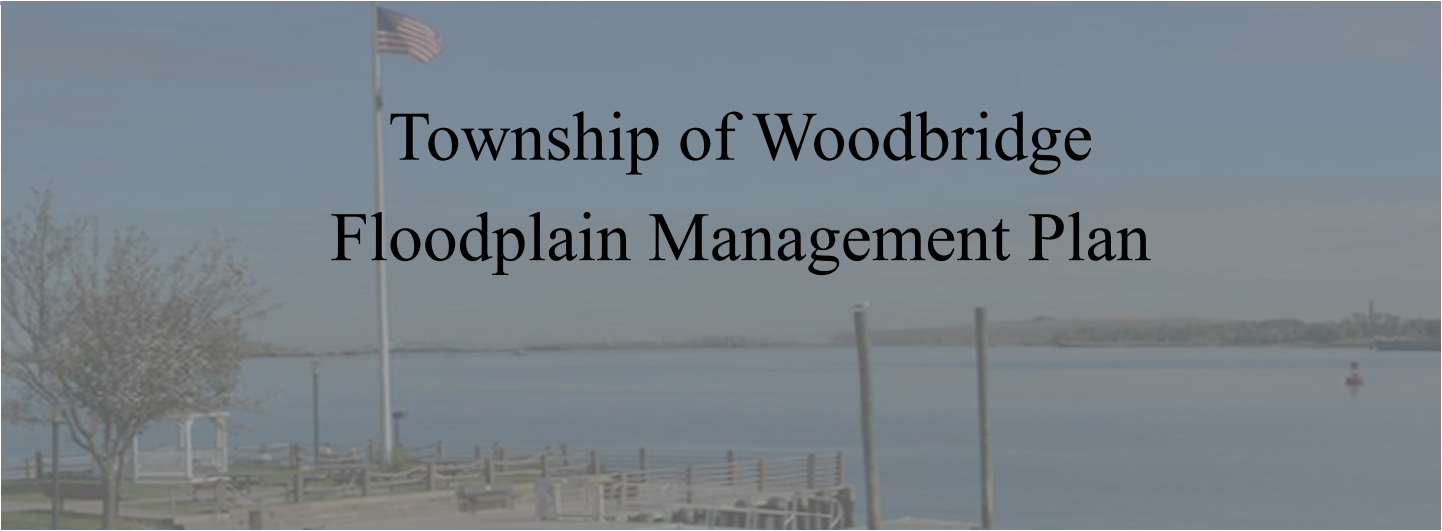


Township of Woodbridge Floodplain Management Plan

Appendix H

Strategic Recovery Planning Report *(Post Super Storm Sandy)*

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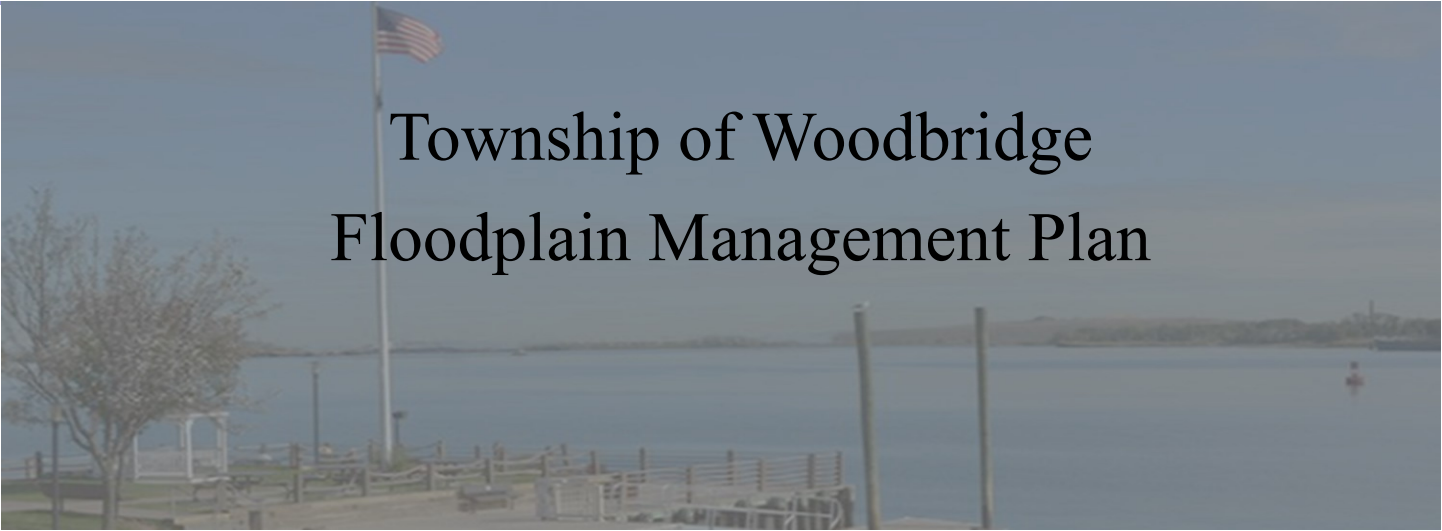


Township of Woodbridge Floodplain Management Plan

Appendix I

USACE Woodbridge River Basin Flood Damage Reduction and Ecosystem Restoration Report

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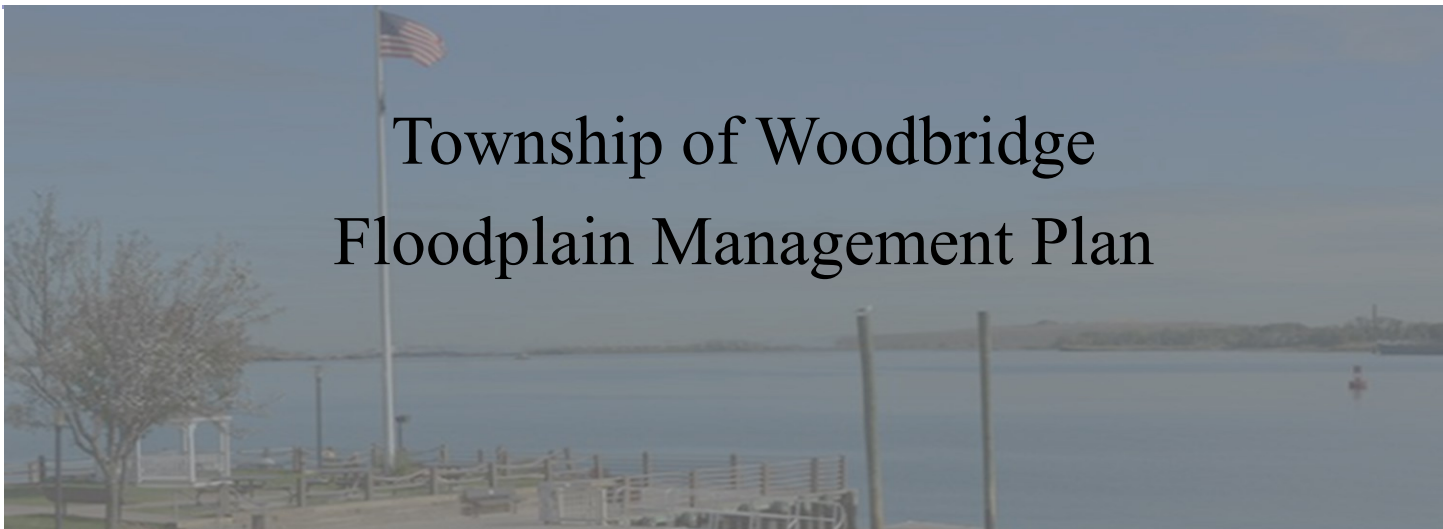


Township of Woodbridge Floodplain Management Plan

Appendix J

Building Ecological Solutions to Coastal Community Hazards

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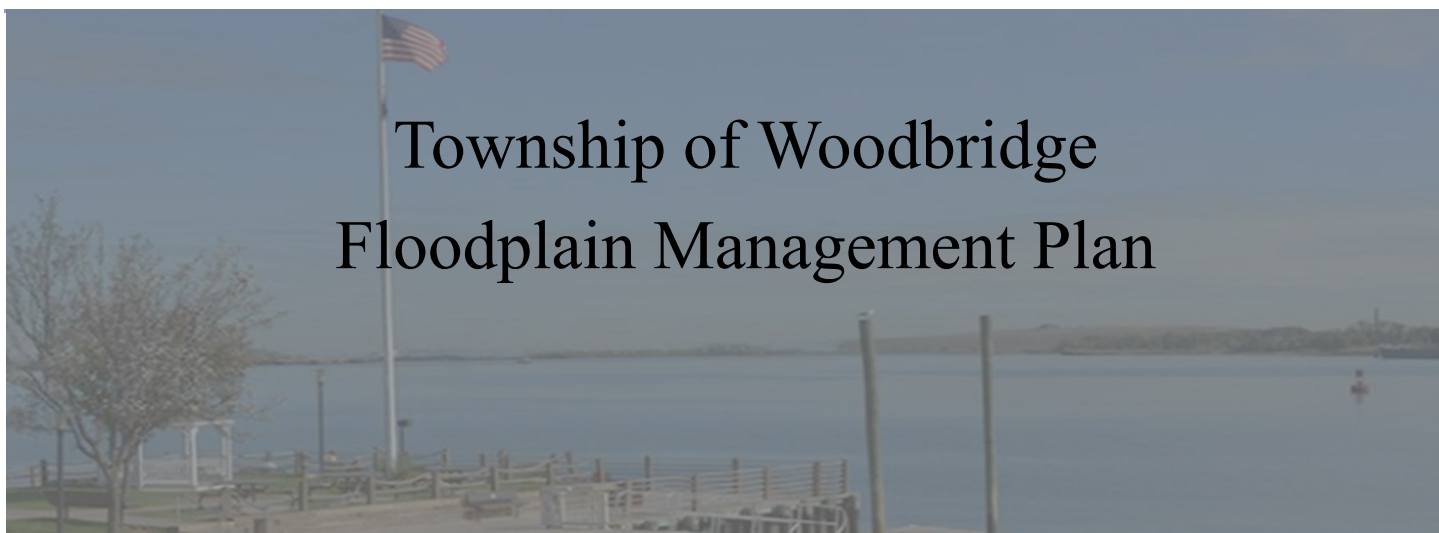


Township of Woodbridge Floodplain Management Plan

Appendix K

Climate Adaptation: Flooding Risk Maps

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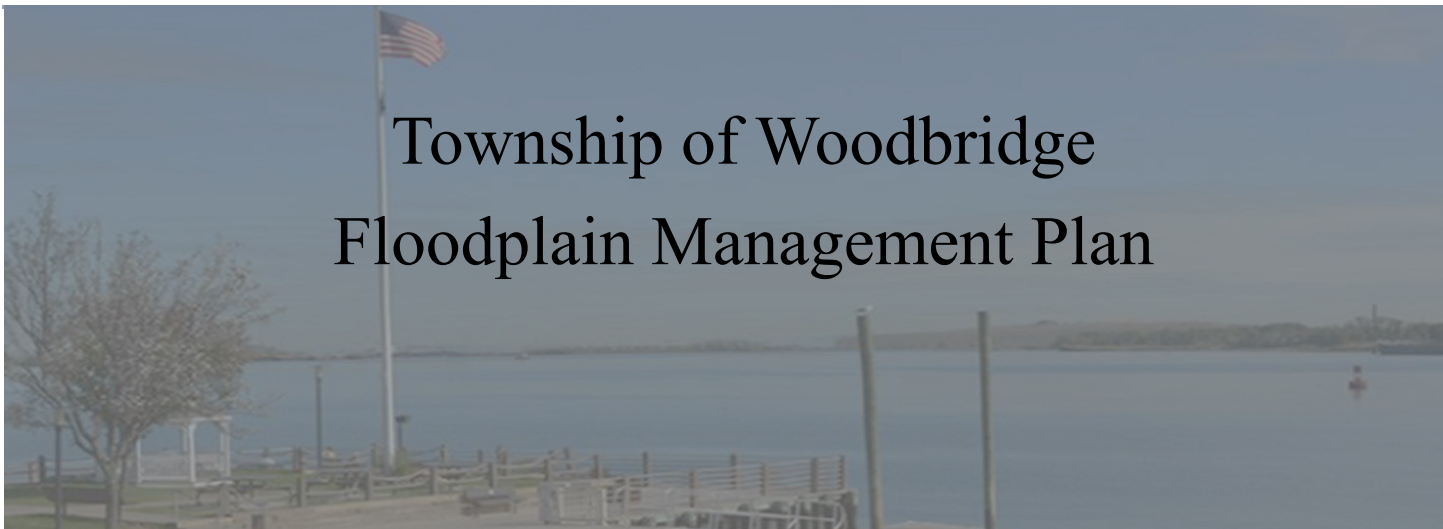


Township of Woodbridge Floodplain Management Plan

Appendix L

Impervious Cover Reduction Action Plan

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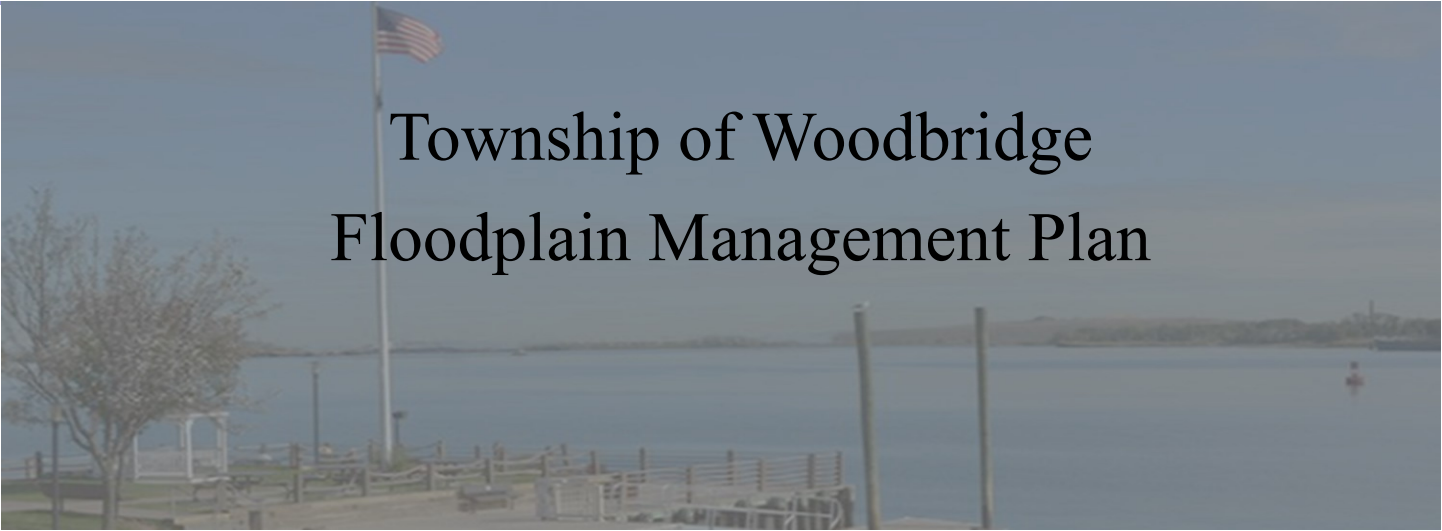


Township of Woodbridge Floodplain Management Plan

Appendix M

Implementing Community-Led Outreach to Achieve Pollution Prevention in Flood Risk Areas

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Township of Woodbridge Floodplain Management Plan

Appendix N

Action Plan and Goals

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