



Architecture  
Engineering  
Environmental  
Land Surveying

**Stormwater Management Report  
Commercial Development  
20 East industrial Road  
Branford, CT**

Prepared for Submission To:  
**Town of Branford  
Inland Wetlands Commission**

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Prepared For:  
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## **Executive Summary**

This report has been prepared in support of an application by Peter G. Mandragouras, Trustee of the CVP Trust for a permit from the Town of Branford Inland Wetlands Commission for work within regulated areas on property located at 20 East Industrial Road. The Trustee Property is approximately 1.78 acres in size, and consists of a vacant parcel owned by Peter G. Mandragouras, Trustee of the CVP Trust, referred to as the "Trustee Property".

This application is being submitted in conjunction with two other applications for inland wetland permits on properties located adjacent to the Trustee Property, which include 569 East Main Street owned by 595 Corporate Circle and referred to as the "595 Property" and property located at 573 East Main Street (and including a portion of the properties located at 569 East Main Street, 20 East Industrial Road, and 26 East Industrial Road) referred to as the "Costco Property". The Trustee Property, the 595 Property, the Costco Property and the Connecticut Shellfish Property (26 East Industrial Road), (collectively referred to as the "Property") are all zoned Planned Development District, and are part of a Master Plan that was approved by the Branford Planning and Zoning Commission on July 9, 2015. As a condition of approval of the PDD and Master Plan, the Planning and Zoning Commission required that applications for inland wetland permits for the Property be submitted at the same time. The hydrology for the Property is analyzed in this application so as to ensure that a comprehensive approach to stormwater management is used for the entire scope of development included in the Master Plan.

The Property is roughly bordered by East Main Street (Route 1) on the north, Leetes Island Road on the west, East Industrial Road on the south and other lands to the east (see Figure AA-1). The area to be developed as part of the Trustee Application is currently vacant but has previously been used for farming, including corn and apples. The Trustee Property is surrounded by a mix of retail, commercial, industrial and motor vehicle related uses.

No portion of the Property is located in an Aquifer Protection District (APD) overlay zone. There are no known areas of concern with regard to any state and/or federally listed endangered, threatened or special concern species within the Property. The Connecticut Department of Energy and Environmental Protection Natural Diversity Data Base (NDDDB) map dated December 2014 can be found in Appendix A.

The Property generally slopes from the north to the south with the overall discharge points being two independent closed drainage systems at the southeastern and southwestern corners of the site. The Property discharges to two separate watersheds, with the western portion located in the Branford River Watershed and the eastern portion located in the South-Central Shoreline Watershed.

The proposed stormwater management system is designed to be in compliance with the current Town of Branford Inland Wetlands and Watercourses Regulations, the Town of Branford Zoning Regulations, the 2002 State of Connecticut Guidelines for Soil Erosion and Sediment Control, the 2004 State of Connecticut Stormwater Quality Manual, and State of Connecticut Department of Transportation Drainage Manual.

A HydroCad model, using TR-55 methodology, was developed to evaluate the existing and proposed drainage conditions both for the Costco Property as well as the Property. The results of the analyses demonstrate that there will be a decrease in peak stormwater runoff rates under

the developed site conditions for all storm events in accordance with the local and state regulations.

The Town of Branford Inland Wetlands and Watercourses Regulations, Section 7.5, Paragraph j, requires that the volume of stormwater runoff from the proposed development for all intensities and durations of rainfall up to the 100 year storm event shall not exceed the existing conditions volume of stormwater runoff or the applicant must demonstrate why this is not feasible or prudent. Infiltration of stormwater is the industry standard to address this type of regulation. In order to identify where and to what extent infiltration could be used, the applicant conducted extensive sub-surface investigations and reviewed the results obtained from on-site investigations by a previous applicant. The results of these extensive investigations demonstrate that there is virtually no sub-surface infiltration potential within the Property. As a result of this, although the applicant would greatly prefer to incorporate infiltration into the stormwater management design for this application, site conditions do not allow the applicant to take credit for infiltration in the stormwater model and thus reduce the volume of runoff post development.

Numerous Water Quality Best Management Practices (BMPs) have been incorporated into the project design for the Property and include catch basins with deep sumps, hooded catch basin outlets, stormwater management basins, sediment forebays, and hydrodynamic separators. Where topographically feasible, the use of low impact development standards were incorporated into the design to the maximum extent possible. These measures include the removal of curbing at pavement edges to allow the sheet flow of the pavement areas over a gravel diaphragm and into the stormwater management basins and micropools and low flow channels in the stormwater management basins. It should be noted that relief catch basins have been incorporated into the design of the areas for times in which the winter conditions with snow cover will create a natural curb like condition. Catch basins will capture any subsequent rainfall or snow melt discharge and discharge it through a hydrodynamic separator to the stormwater management basin. See Appendix B for site plans.

## **Introduction**

This report has been prepared in support of an application by Peter G. Mandragouras, Trustee of CVP Trust for a permit from the Town of Branford Inland Wetlands Commission for work within regulated areas on property located at 20 East Industrial Road. The Trustee Property is approximately 1.78 acres in size, and consists of a vacant parcel owned by Peter G. Mandragouras, Trustee of the CVP Trust, referred to as the "Trustee Property".

This application is being submitted in conjunction with two other applications for inland wetland permits on properties located adjacent to the Trustee Property, which including the 595 Property (the "595 Application") and the Costco Property (the Costco Application"). The Trustee Property, the 595 Property, the Costco Property and the Connecticut Shellfish Property (26 East Industrial Road), (collectively referred to as the "Property") are all zoned Planned Development District, and are part of a Master Plan that was approved by the Branford Planning and Zoning Commission on July 9, 2015. As a condition of approval of the PDD and Master Plan, the Planning and Zoning Commission required that applications for inland wetland permits for the Property be submitted at the same time. The hydrology for the Property is analyzed in this application so as to ensure that a comprehensive approach to stormwater management is used for the entire scope of development included in the Master Plan.

### **1. Existing Hydrologic Conditions**

The Property is located in New Haven County, Town of Branford, Connecticut. The coordinates for the approximate center of the Property are Latitude 41.299125 N and Longitude -72.761486 W.

The Property is roughly bordered by East Main Street (Route 1) on the north, Leetes Island Road on the west, East Industrial Road on the south and other lands to the east (see Figure AA-1). The area to be developed as part of the Trustee Application is currently vacant but has previously been used for farming, including corn and apples. The Trustee Property is surrounded by a mix of retail, commercial, industrial and motor vehicle related uses.

No portion of the Property is located in an Aquifer Protection District (APD) overlay zone. There are no known areas of concern with regard to any state and/or federally listed endangered, threatened or special concern species within the Property. The Connecticut Department of Energy and Environmental Protection Natural Diversity Data Base (NDDB) map dated December 2014 can be found in Appendix A. There are no mapped floodplains on the Property according to the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map (FIRM), panel 09009C0467J, New Haven County, Connecticut (See Appendix A for the FEMA Map of the area).

Topography on the Property ranges from an elevation of approximately 125-feet in the center of the northern property line of the Property, to an elevation of approximately 90-feet at East Industrial Road in the vicinity of the I-95 ramps. The soils are generally poorly drained with the majority of the soils having a Hydrologic Soil Group Rating of C or D. Since the soils naturally occurring within the Property do not have percolation rates which would be conducive to infiltration, the hydrologic modeling for the Costco Application, the 595 Application and the Trustee Application are highly conservative and do not account for any exfiltration within the stormwater management basins.

The Property contains the following soil types:

Map unit symbol	Map unit name	Rating
6	Wilbraham and Menlo soils, extremely stony	D
40B	Ludlow silt loam, 3 to 8 percent slopes	C
77C	Cheshire-Holyoke complex, 3 to 15 percent slopes, very rocky	B
87B	Wethersfield loam, 3 to 8 percent slopes	C
306	Udorthents-Urban land complex	B
307	Urban land	D

Soils information, including a soil report and map of the Property and contributing offsite flow areas have been generated from the United States Department of Agriculture Natural Resources Conservation Service (NRCS) web soil survey website can be found in Appendix A.

The Trustee Property is currently vacant land that has been overgrown with various plants, along the northern and western boundaries including native woodlands as well as invasive species. The majority of the Trustee Property was historically used as an orchard; however, the majority of these areas have now been overgrown. The front of the site is a grassed field that is mowed periodically.

The Property, in its existing condition, drains to the southwestern and southeastern corners of the entire area due to a natural ridge running north to south through the approximate center of the site. The stormwater discharge from the western portion of the Property flows to, and is captured in, the existing closed drainage system at the southwest corner of Leetes Island Road and East Industrial Road. This closed drainage system eventually discharges to the Branford River, which outlets to the Long Island Sound through Branford Harbor. The western portion of the Property is part of the Branford River Watershed. The eastern portion flows through the Costco Property and is captured by a 24" reinforced concrete pipe (RCP) located west of the Trustee Parcel of land, and is discharged to the closed drainage system existing in the eastern portion of East Industrial Road adjacent to the I-95, Exit 56 entrance and exit ramps. This closed drainage system eventually discharges to the Van Wie Pond and ultimately to the Long Island Sound. This portion of the Property is part of the South-Central Shoreline Watershed. The Trustee Property is completely located in the eastern portion of the Property that discharges to the South-Central Shoreline Watershed.

In addition, approximately 60% of the stormwater from adjacent development to the north, located at 30-36 East Industrial Road discharges thru a 24-inch RCP to an approximately 4 feet deep drainage ditch behind the Shellfish property. This water continues behind the Shellfish Property, the Trustee Property and 16 East Industrial Road (the "Brown Property") in the ditch and discharges to a 24-inch RCP that goes through the Brown Property and discharges to East Industrial Road. The stormwater from this adjacent property was approved to discharge stormwater to East Industrial Road and not through the proposed Costco Property. Multiple approved plans for 30-36 East Industrial Road all show the site's stormwater discharging directly to East Industrial Road and not through the Cooke, Connecticut Shellfish, Trustee and

Brown Properties. This additional stormwater being conveyed through the subject application's properties was included in the analysis herein and is included in the culvert sizings for the affected proposed crossings. Based on numerous field visits before and after rain events, the applicant's engineer has observed no flooding in this area.

Six areas of wetlands or watercourses are located within the Property (Only one of which is located on the Trustee Property). Three wetland habitat types are present, including wooded swamps, scrub-shrub swamp, and ponds. Wetlands 1, 2, 3 and 4 are wooded swamps; Wetland 1 also contains an intermittent watercourse. Wetland 5 and the northernmost portion of Wetland 1 contain pond habitat. Wetland 6 is a very narrow, east-west swale or ditch that appears to have been excavated to control drainage from the northern portion of the site and direct it away from the developable areas along East Industrial Road. More detailed information on the wetlands and habitat are found in the Wetland Delineation Inventory, Functional Analysis and Impact Assessment, East Industrial Road, Leetes Island Road, and East Main Street, Branford, Connecticut prepared by Michael S. Klein, Environmental Planning Services, LLC dated August 10, 2015.



## 2. Developed Hydrologic Conditions

As part of a comprehensive Master Planning effort, the project area underwent numerous design alternatives to determine the most environmentally sensitive design that will allow the development of the Costco Property, the 595 Property and the Trustee Property to function well from an operational standard, and conform to all local, state and federal requirements while creating a cohesive commercial retail center to be enjoyed by the residents of Branford and the surrounding area.

The proposed stormwater drainage system has been designed to meet the standards of the Town of Branford, as well as the 2004 State of Connecticut Stormwater Quality Manual, the 2002 State of Connecticut Guidelines for Soil Erosion and Sediment Control and State of Connecticut Department of Transportation Drainage Manual.

Under the proposed conditions, the proposed development of the Property will utilize several onsite stormwater management basins to limit and mitigate potential stormwater impacts from development. The approved Master Plan shows the construction of three pad sites in the northwestern corner of the Property, identified as Pad 1, Pad 2 and Pad 3. These commercial buildings have been designed to be approximately 20,000, 2,340 and 32,940 square feet in size, respectively. There will be associated parking areas, landscaped islands, and drive aisles associated with each individual pad site area. A portion of Pad 1, as well as the entire Pad 3 area, will discharge to Stormwater Management Basin "G" for peak storm mitigation and pollutant removal. The remaining portion of Pad 1, all of Pad 2, and the parking areas directly adjacent to these pad sites will drain to Stormwater Management Basin "F" for peak storm mitigation and pollutant removal.

The portion of the Property that abuts East Industrial Road, including Pads 4, 5, 6, and 7, have proposed building sizes of approximately 8,084 SF, 6,250 SF, 9,500 SF, and 2,312 SF respectively. Proposed Pad 4 and Pad 5, along with the associated parking areas, landscaped islands, and driveways, will discharge to an underground detention system for peak flow mitigation. Proposed Pad 6 and a portion of the retail development connector roadway system will drain to Stormwater Management Basin "E" for peak storm mitigation and pollutant removal. Proposed Pad 7 (Trustee Parcel), along with the associated parking and landscape areas, will drain to Stormwater Management Basin "D" for peak storm mitigation and pollutant removal. The stormwater management basin will be preceded by a hydrodynamic separator for all flows going to the basin

There are three independent Stormwater Management Basins proposed as part of the Costco Application. The first basin will mitigate the peak flow and sediment removal from the Gas Station Fueling facility that is located in the southeastern portion of the Costco Property. The stormwater management basin will be preceded by a hydrodynamic separator for all flows going to the basin, as well as an oil and water separator for the stormwater discharge that originates from the portion of the site that contains the actual fueling facility island. The southern half of the building, as well as the majority of the parking area will discharge to Stormwater Management Basin "B" for peak storm mitigation and pollutant removal. The remaining northern portion of the building, and a small amount of stormwater discharge from the drive aisle behind the building, will discharge to Stormwater Management Basin "A" for peak storm mitigation and pollutant removal.

The stormwater will be captured in Connecticut Department of Transportation (CTDOT) catch basins. The grates of the structures will be built to the CTDOT standard, although the sumps

will be four feet deep instead of the CTDOT standard of two feet. This will create greater sediment removal. The closed drainage system will discharge through a hydrodynamic separator and discharge into the various stormwater management basins to be constructed throughout the Property.

Section 7.5, Paragraph j. of the Town of Branford Inland Wetlands and Watercourses Regulations requires that the pre and post stormwater runoff rates and volume hydrographs be essentially the same or the applicant is to demonstrate why this is not feasible or prudent. The applicant conducted a thorough investigation of on-site soil conditions and determined that there is essentially no infiltration capacity on site. Therefore, without infiltration capacity, it is not feasible or prudent to decrease the total volume of runoff from this site post construction. We note that there are no current regulations at the state level mandating the reduction of the stormwater volumes generated by the development of any parcel of land. For this application, as well as the applications for the 595 Property and the Trustee Property, the peak flow rates of the stormwater exiting the site have not been increased between the pre and post construction conditions.

### **3. Existing Site Conditions**

The Trustee Property, which is the subject of this application, is approximately 1.78 acres in size, and consists of 20 East Industrial Road which is a vacant parcel owned by Peter G. Mandragouras, Trustee of the CVP Trust.

The Trustee Property has been overgrown with various plants, including native woodlands as well as invasive species along the northern boundary. The majority of the property was historically used as an orchard and/or cultivated farmland. The southern portion of the site is a grassed field that is mowed periodically during the year.

The soils are generally poorly drained with the majority of the soils having a Hydrologic Soil Group Rating of C or D. Since the soils naturally occurring within the Property do not have percolation rates which would be conducive to infiltration, the hydrologic modeling for the Trustee Property are highly conservative and do not account for any exfiltration within the stormwater.

The wetlands channel along the northern boundary of the site will not be disturbed during the construction of the Trustee project.

The Trustee Property, in its existing condition, drains to the southern boundary of the site. The stormwater discharge from flows overland through the vacant Trustee Property, to the East Industrial Road gutter and is captured by the closed drainage system existing in the eastern portion of East Industrial Road adjacent to the I-95, Exit 56 entrance and exit ramps. This closed drainage system eventually discharges to the Van Wie Pond and ultimately to the Long Island Sound. This portion of the Property is part of the South-Central Shoreline Watershed.

Additional hydrologic information for the Trustee Property is found in Section 2 above.

### **4. Proposed Site Conditions**

The proposed stormwater drainage system for the Trustee Property development has been designed to meet the standards of the Town of Branford, as well as the 2004 State of

Connecticut Stormwater Quality Manual, the 2002 State of Connecticut Guidelines for Soil Erosion and Sediment Control and State of Connecticut Department of Transportation Drainage Manual.

The proposed impervious coverage for the Trustee Property is approximately 57% of the site. The impervious coverage for the adjusted lot area (pursuant to the Zoning Regulations) is approximately 58%.

The stormwater will be captured in Connecticut Department of Transportation (CTDOT) catch basins. The grates of the structures will be built to the CTDOT standard, although the sumps will be four feet deep instead of the CTDOT standard of two feet. This will create greater sediment removal. The closed drainage system will discharge through a hydrodynamic separator and discharge into the stormwater management basin to be constructed on the Property.

As stated in the 2004 Connecticut Stormwater Quality Manual, page 6-1, the State of Connecticut has adopted the 80% Total Suspended Solids (TSS) removal goal based on the EPA guidance and its widespread use as a target stormwater quality performance standard. TSS is considered a suitable target pollutant constituent for removal because of its widespread impact on water quality and aquatic habitat degradation, because other pollutants including heavy metals, bacteria and organic chemicals adsorb to sediment particles, and because it is the most frequent and consistent sampled stormwater constituent. The use of deep sump hooded catch basins, a regular pavement sweeping schedule, and hydrodynamic separators alone would net a TSS removal of approximately 83% for the individual drainage areas before going to the Stormwater Management Basin. The area of the Trustee Property which will discharge to the Ponds with pocket pools have a TSS Removal rate of over 90%. This is based on a conservative approach of the Hydrodynamic Separator obtaining a 75% removal rate of TSS, while field testing for the State of New Jersey, the University of New Hampshire, the Massachusetts Department of Environmental Protection, and the United States Environmental Protection Agency have stated that hydrodynamic separator units have a much greater efficiency for TSS removal. According to the 2004 Connecticut Stormwater Quality Manual, the use of "Stormwater Ponds" such as the Wet Pond, Micropool Extended Detention Pond, and the Pocket Pond have a significant benefit of removing pollutants such as sediment, phosphorus, nitrogen, and metals, as well as a partial benefit of removing pathogens and dissolved pollutants. The Trustee Property will achieve a TSS Removal rate of over 94%. Calculations can be found in Appendix E.

Section 7.5, Paragraph j. of the Town of Branford Inland Wetlands and Watercourses Regulations requires that the pre and post stormwater runoff rates and volume hydrographs be essentially the same or the applicant is to demonstrate why this is not feasible or prudent. The applicant conducted a thorough investigation of on-site soil conditions and determined that there is essentially no infiltration capacity on site. Therefore, without infiltration capacity, it is not feasible or prudent to decrease the total volume of runoff from this site post construction. We note that there are no current regulations at the state level mandating the reduction of the stormwater volumes generated by the development of any parcel of land. For this application, the peak flow rates of the stormwater exiting the site have not been increased between the pre and post construction conditions.

## 5. Stormwater Management

### A. Existing Drainage Patterns

The existing drainage patterns analyzed in this report depict the existing drainage from the site and adjacent surrounding areas that are ultimately conveyed to two ultimate Design Points. The existing drainage areas are shown on attached drawing ED-01 in Appendix B.

The Property is separated into two overall points of interest which contain 6 sub areas of interest with twelve contributing Drainage Areas. The Trustee Property is contained within the southeastern portion of the existing site area, more specifically Existing Drainage Area 52, described below. Since the entire Property was analyzed at a hydrologic level, all areas of the Property are described below.

Existing Drainage Area 10 discharges to Design Point (DP) 1 and is approximately 4.08 acres and is tributary to the Branford River (DP 1000) point of interest. This area is primarily undeveloped woods, wetlands and fields, with a small area of impervious gravel driveway surface. This area has Urban Land Soil with a D Hydrologic Group. This area does not currently contain any stormwater management features or drainage structures within it. This portion of the Property drains to the gutter of East Industrial Road and flows west to the intersection of Leetes Island Road.

Existing Drainage Area 20 discharges to Design Point (DP) 2 and is approximately 6.95 acres and is tributary to the Branford River (DP 1000) point of interest. This area is primarily undeveloped woods, wetlands and fields, with a small area of impervious gravel driveway surface. This area contains soils with the Hydrologic Group B, C and Urban Land Soil with a D Hydrologic Group. This area does not currently contain any stormwater management features or drainage systems on site. This portion of the Property drains to the south and is captured in an 8-inch pipe along the southern property line that eventually discharges to the closed drainage system in East Industrial Road at the intersection with Leetes Island Road.

Existing Drainage Area 30 discharges to Design Point (DP) 3 and is approximately 2.19 acres and is tributary to the Branford River (DP 1000) point of interest. This area mainly consists of an existing wetland/pond and associated upland area (woods). This area contains soils with the Hydrologic Group C and Urban Land Soil with a D Hydrologic Group. The pond discharges through a 24" RCP along the southern property line that eventually discharges to the closed drainage system in East Industrial Road at the intersection with Leetes Island Road.

Existing Drainage Area 40 discharges to Design Point (DP) 4 and is approximately 5.68 acres and is tributary to the Branford River (DP 1000) point of interest. This area mainly consists of an existing wetland and associated upland area (woods). This area contains soils with the Hydrologic Group B, C and Urban Land Soil with a D Hydrologic Group. The pond discharges through another 24" RCP along the southern property line that eventually discharges to the closed drainage system in East Industrial Road at the intersection with Leetes Island Road.

Existing Drainage Area 41 discharges to Design Point (DP) 4 and is approximately 3.97 acres and is tributary to the Branford River (DP 1000) point of interest. This area is mainly consists of an existing wetland and associated upland area (woods). This area contains soils with the Hydrologic Group B, C and Urban Land Soil with a D Hydrologic Group. This sub catchment area was separated out from DA 40 as it drains to an independent wetland system. This drainage area discharges to Drainage Area 40 and its outlet.

Existing Drainage Area 50 discharges to Design Point (DP) 5 and is approximately 9.89 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of a pond, an existing wetland and associated upland area (woods). This area contains soils with the Hydrologic Group B, C and D. This drainage area discharges to a 24" RCP that is adjacent to the western property line of the Trustee Parcel (DP 5 is modeled as the mouth of the 24" RCP). This 24" RCP discharges to a 24" RCP in East Industrial Road, thru the TA property in a 24" RCP, onto state property and under I-95 just west of the Exit 56 entrance and exit ramps in 30" ACCMP. On the south side of I-95 the stormwater flows thru open and closed drainage systems to a wetland system and into the Van Wie Pond.

Existing Drainage Area 51 does not discharge to an interim design point and is approximately 1.83 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of an industrial use building and associated parking lots and driveways. This area contains soils with the Hydrologic Group B. This 24" RCP discharges to a 24" RCP in East Industrial Road, thru the TA property in a 24" RCP, onto state property and under I-95 just west of the Exit 56 entrance and exit ramps in 30" ACCMP. On the south side of I-95 the stormwater flows thru open and closed drainage systems to a wetland system and into the Van Wie Pond.

Existing Drainage Area 52 does not discharge to an interim design point and is approximately 4.08 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of a commercial use building (Connecticut Shellfish) and associated parking lots and driveways. This area contains soils with the Hydrologic Group B. This 24" RCP discharges to a 24" RCP in East Industrial Road, thru the TA property in a 24" RCP, onto state property and under I-95 just west of the Exit 56 entrance and exit ramps in 30" ACCMP. On the south side of I-95 the stormwater flows thru open and closed drainage systems to a wetland system and into the Van Wie Pond.

Existing Drainage Area 57 discharges to Design Point (DP) 5 and is approximately 9.62 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of an existing commercial/office building complex and upland wooded area. This area contains soils with the Hydrologic Group B and C. This drainage area discharges to DP 5 though a drainage channel at the mouth of the existing closed drainage system of the abutting commercial/office buildings.

Existing Drainage Area 60 discharges to Design Point (DP) 6 and is approximately 11.35 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of a pond, an existing wetland and associated upland area (woods). This area contains soils with the Hydrologic Group B, C and D. This drainage area discharges to DA 50, but was separated from DA 50 to be able to ensure the volume of water that is discharged to the wetland and pond system is not significantly altered between the existing and proposed conditions.

Existing Drainage Area 62 discharges to Design Point (DP) 6 and is approximately 5.10 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of residential homes and woods. This area drains through Drainage Area 60, an existing drainage channel that traverses the site north to south and eventually discharges to DP 5. This area contains soils with the Hydrologic Group B and C.

Existing Drainage Area 70 discharges to Design Point (DP) 7 and is approximately 5.10 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of woods and a pond. This area flows into the existing farm pond along the northern boundary of the Property and eventually discharges to DP 5, which is the existing 24" RCP located along the abutting property boundary. This area contains soils with the Hydrologic Group C and D.

Existing Drainage Area 71 discharges to Design Point (DP) 7 and is approximately 3.87 acres and is tributary to the South-Central Shoreline Watershed (DP 2000) point of interest. This area is primarily composed of a commercial building, a portion of East Main Street, woods and a pond. This area drains through a pipe system under East Main Street, and discharges into the existing farm pond contained within DA 70. This area contains soils with the Hydrologic Group C and D.

The total drainage area studied totals 73.59-acres and has an existing impervious coverage percentage of approximately 24.3%.

The existing drainage areas with runoff curve numbers, time of concentration paths can be found on drawings ED-01 in Appendix B.

The soils in the area of the Property are classified by United States Department of Agriculture Natural Resources Conservation Service and consist primarily of type "B", "C" and "D" rated soils, with "D" rated soils in areas of urban land and wetlands. Please refer to Appendix A, Figure 2: NRCS Soil Survey Map with Hydrologic Soil Group Data, for soils and their classifications in the Master Plan area.

The geotechnical investigations that were conducted on the Property typically encountered topsoil over medium dense to very dense (occasionally surficially loose) glacial till, underlain by a layer of weathered bedrock underlain by competent bedrock, generally inferred by auger refusals. Competent bedrock was cored in three borings. Groundwater was encountered in several of the explorations. However, this was primarily perched water trapped above the dense glacial till or bedrock. Additional localized perched water conditions may also develop during extended periods of wet weather as water infiltrating the surface soils becomes trapped above the glacial till/bedrock. Groundwater was measured in nine boreholes and four test pits at depths ranging from approximately 2 to 7.5 feet below the existing ground surface, corresponding approximately to elevations ranging from 105 to 122.2 feet mean sea level (msl). Specific conditions encountered at each exploration location are indicated on the individual exploration logs. Stratification boundaries on the exploration logs represent the approximate location of changes in soil/rock types; in situ, the transition between materials may be gradual. The geotechnical explorations with regards to the hydrology of the site can be found in Appendix F.

**Table 1**  
**Pre-development Drainage Area Characteristics**

<b>Drainage Area ID</b>	<b>Area (ac)</b>	<b>Composite Curve Number (CN)</b>	<b>Time of Concentration (minutes)</b>
10	4.08	76	24.1
20	6.95	76	55.9
30	2.19	76	22.5
40	5.68	77	28.2
41	3.97	74	26.0
50	9.88	71	68.6
51	1.83	84	21.2
52	4.08	79	34.3
57	8.61	87	38.0
60	11.35	85	83.8
62	5.10	80	53.1
70	5.95	76	37.9
71	3.87	91	43.3

Peak flows for all analyzed storms discharge to an existing stormwater drainage system and are summarized in Table 2. Details may be found in Appendix C.

**Table 2**  
**Pre-development Conditions Peak Flows**

<b>Analysis Point</b>	<b>Peak Flow (cfs)</b>			
	<b>2-yr</b>	<b>10-yr</b>	<b>25-yr</b>	<b>100-yr</b>
POI-1000 Branford River Watershed	15.37	33.24	39.99	56.30
POI-2000 South-Central Basin Watershed	16.93	34.67	45.94	73.81

## B. Proposed Drainage Patterns

The drainage analysis for the proposed site construction encompasses the same tributary drainage area of the 73.59-acres as described in the existing conditions section 5A above. The impervious coverage percentage for the developed conditions is approximately 53%. The proposed drainage areas with runoff curve numbers, time of concentration paths and soil types can be found on drawings PD-01 in Appendix B. The proposed drainage has been designed to reduce peak stormwater discharge rates leaving the site.

Just as the existing conditions hydrology, discussed above, the project area hydrology is also broken down into two overall points of interest with 26 contributing Drainage Areas.

Overall, there is a net reduction in peak discharge from the each of two points of study for the 2-year, 10-year, 25-year, and 100-year storm events as seen in Table 6 below.

As with the existing conditions, the proposed conditions were evaluated at a hydrologic level for the entire Property. However the portion of the site which is being developed as part of the Trustee application and drainage report is primarily for the area 540 draining to the DP 5, which is tributary to the South-Central Shoreline Watershed (DP 2000).

Proposed Drainage Areas 100, 110 and 120 discharge to Design Point (DP) 1 and are approximately 0.40, 2.33 and 1.49 acres, respectively. DA 100 is the small portion of the project site that will continue to discharge directly to the gutter of East Industrial Road, as it did in the pre-construction condition. DA 110 will contain Pad 4 and Pad 5 and discharge to an underground detention system for peak flow attenuation. DA 120 will contain Pad 6 and discharges to a Stormwater Management Basin.

Proposed Drainage Area 210 discharges to DP2 and is the small portion of offsite flow to the gutter of East Main Street and Leetes Island Road. This is primarily grassed areas that will have a very small flow.

Proposed Drainage Area 300, 310, 320 and 330 discharge to DP 3 and are approximately 0.80, 3.78, 2.29 and 0.85 acres, respectively. DA 300 is the portion of the site that contains the existing pond and wetland system. There are no significant changes to this drainage area. DA 310 contains Pad 3, and discharges to a Stormwater Management Basin. DA 320 contains a portion of Pad 1 and all of Pad 2 and discharges to a Stormwater Management Basin. DA 330 contains a portion of Pad 1 and discharges to a stormwater management basin.

Proposed Drainage Areas 400, 410 and 420 discharge to DP 4 and are approximately 2.92, 0.29, and 0.13 acres, respectively. DA 400 and DA 420 are wetland and woodland areas which are largely unchanged in the proposed condition. DA 410 contains a connector roadway that connects the western and eastern portion of the sites with the abutting grocery store directly to the south. This portion of the site transects DA 400 and DA 420.

Proposed Drainage Areas 500, 501, 502, 510, 520, 570, 600, 620, 700, and 710 are the general areas in which the proposed Costco Development (submitted under separate cover) will be built. DA 500, DA 501 and DA 502 are approximately 4.85, 1.17, and 0.31 acres in size, respectively, and are typically the wetland systems found in Existing DA 500. The separate numbering of the drainage areas represents the transecting of the areas with the roadways servicing the entire Master Plan area. DA 510 and DA 520 are approximately 2.87 and 9.66 acres, respectively, and contain the building and parking areas of the Costco Wholesale project. These areas both

drain to a Stormwater Management Basin for sediment and contaminant removal. DA 521 contains the area of the Stormwater Management Basin that DA 520 discharges to. DA 525 is approximately 1.83 acres and discharges to a Stormwater Management Basin. DA 526 is a small portion of roadway that cannot drain to any stormwater management basin due to the topography of the roadway so it will be discharged through a hydrodynamic separator. DA 570, DA 600, DA 620, DA 700 and DA 710 are approximately 7.88, 11.35, 5.10, 3.03 and 3.92 acres respectively and are largely unchanged compared to those areas under the existing conditions (Existing DA 57, DA 60, DA 62, DA 70 and DA 71). This 24" RCP discharges to a 24" RCP in East Industrial Road, thru the TA property in a 24" RCP, onto state property and under I-95 just west of the Exit 56 entrance and exit ramps in 30" ACCMP. On the south side of I-95 the stormwater flows thru open and closed drainage systems to a wetland system and into the Van Wie Pond.

The remaining Proposed Drainage Areas (530, 540, 550, and 560), discharge directly to DP 2000. DA 530, DA 540, DA 550, and DA 560 are approximately 1.47, 1.03, 2.10, and 1.16 acres each respectively, and are typically the wetland systems found in existing DA 53 and DA 54, the overland areas that drain directly to the gutter or closed drainage system of East Industrial Road. DA 530 remains largely unchanged from the existing condition (DA 53) and is an abutter's parcel of land. DA 540 is being permitted under this application as the Trustee Property. This DA is approximately 1.28 acres and discharges to a stormwater management Basin and is preceded by a hydrodynamic separator. DA 550 is the abutting Connecticut Shellfish Property and remains largely unchanged with the exception of minor grading and parking lot configuration changes. These changes actually increase the pervious cover on the site. DA 560 is a small portion of roadway and lawn area which is not captured by a closed drainage systems that discharges to a stormwater management basin. This portion of the roadway discharges directly to the closed drainage system contained in East Industrial Road, and stormwater will pass through a hydrodynamic separator to remove sediment from the stormwater. This 24" RCP discharges to a 24" RCP in East Industrial Road, thru the TA property in a 24" RCP, onto state property and under I-95 just west of the Exit 56 entrance and exit ramps in 30" ACCMP. On the south side of I-95 the stormwater flows thru open and closed drainage systems to a wetland system and into the Van Wie Pond.

Characteristics of the proposed drainage areas are summarized in Table 3 below.

**Table 3  
Post-development Drainage Area Characteristics**

<b>Drainage Area ID</b>	<b>Area (ac)</b>	<b>Composite Curve Number (CN)</b>	<b>Time of Concentration (minutes)</b>
100	0.40	85	5.0
110	2.33	95	5.0
120	1.49	87	5.0
210	1.76	85	10.3
300	0.82	82	5.0
310	3.78	92	5.0
320	2.29	88	5.6
330	0.85	97	5.0
400	2.91	77	13.3
410	0.29	96	5.0
420	0.12	81	5.0
500	1.84	79	68.6
501	1.17	75	14.5
502	0.29	69	5.0
510	2.87	93	5.0
520	9.66	96	5.0
521	1.57	79	5.0
525	1.83	89	5.0
526	0.18	87	5.0
530	1.47	88	5.0
540	1.03	90	5.0
550	2.10	93	5.0
560	1.16	86	20.3
570	7.88	87	30.4
600	11.35	84	83.8
620	5.10	80	53.1
700	3.03	81	29.9
710	3.92	91	43.3

Peak flows for all analyzed storms discharge to the existing stormwater drainage system are summarized in Table 4; details may be found in Appendix C.

**Table 4  
Post-development Conditions Peak Flow**

Analysis Point	Peak Flow (cfs)			
	2-yr	10-yr	25-yr	100-yr
POI-1000 Branford River Watershed	15.30	30.23	35.80	49.08
POI-2000 South- Central Basin Watershed	16.68	33.09	39.60	63.08

C. Hydrology Study of Project and Hydrology Impact to Project Wetlands

A hydrologic study was completed for the project area to quantify the peak rate of stormwater runoff as a result of this project. To accurately compare these two components, an analysis of the tributary watershed area to the design points for existing and proposed conditions was determined as the 'control' limit of areas considered. Drainage computations took the entire Property into consideration.

Curve numbers were taken from Tables 2-2a and 2-2b of USDA TR-55, 2<sup>nd</sup> Edition, June 1986. A Type III storm distribution with an average antecedent moisture condition was used. Times of concentration were calculated using methods presented in the TR-55 Manual.

Peak flow rates were calculated using the software package HydroCAD, Version 10.00, with a time increment of 0.05 hours. The results can be found in Appendices C and D. Maps showing existing and proposed condition drainage areas can be found in Appendix B. Rainfall depths of New Haven County were used for the calculation of peak flow rates and are listed in Table 5.

**Table 5  
Rainfall**

Return Period	24-hr Rainfall Depth
2-year	3.3 inches
10-year	5.0 inches
25-year	5.6 inches
100-year	7.1 inches

The following chart reflects a summary of the peak rate of runoff from the 2, 10, 25, and 100-year rainfall events. Hydrology data can also be found in Appendices C and D.

**Table 6  
Existing vs. Proposed Peak Rates of Runoff (Point of Analysis)**

<b>Drainage Area</b>	<b>Peak Flow Rate in Cubic Feet per Second (c.f.s.)</b>			
	<b>2-Year</b>	<b>10-Year</b>	<b>25-year</b>	<b>100-Year</b>
<b>POI-1000</b>				
Existing	15.37	33.24	39.99	56.30
Proposed	15.30	30.23	35.80	49.08
Percent Change	-0.4%	-8.9%	-10.3%	-12.7%
<b>POI-2000</b>				
Existing	16.93	34.67	45.94	73.81
Proposed	16.68	33.09	39.60	63.08
Percent Change	-1.0%	-4.4%	-13.8%	-14.5%

Table 6 demonstrates that the proposed storm drainage and management system, as designed, will result in an overall reduction in peak discharge of runoff from the Property for all storm events.

Careful consideration was taken into account not to adversely affect any wetlands, watercourses, or any environmentally sensitive areas downstream of the proposed development. A portion of the clean stormwater runoff from the development will be released into the upland review areas of the wetlands to maintain appropriate moisture levels.

Sediment forebays and riprap outlet protection have been designed to treat the stormwater for water quality and to mitigate erosion at outlets draining to these areas.

D. Infiltration

Extensive soils testing was conducted by Terracon for the Applicant on the Property. Based on the results of the testing, Terracon concluded that the soils have low permeability across the Property and are not suited to the use of infiltration systems for stormwater management. The results of the testing are included in Appendix F of this report. This conclusion is consistent with soils testing conducted by the previous applicant, Churchill and Banks, LLC.

Based on the permeability testing results, the Applicant did not take credit for any soils infiltration in designing the stormwater management system for this application therefore, the sizing of the system components are conservative.

The post construction volume of stormwater leaving the Trustee Property is greater than the pre development stormwater volume leaving the Trustee Property. Due to the poor on site soils and inability to infiltrate stormwater on site, it is not feasible or prudent to design the proposed site improvements to include a decrease in the total volume of post development stormwater runoff.

## E. Stormwater Quality

Along with the reduction of peak stormwater discharge rates, an important element of the proposed drainage system is to improve the quality of stormwater discharge leaving the Property. To do this, numerous Best Management Practices (BMPs) have been implemented in this design.

The most basic preventive measure of the stormwater treatment train is to implement regular sweeping of the paved areas and annual cleaning of the catch basin sumps and hydrodynamic separators. The operations and maintenance manuals for each of the three applications will have a standard required pavement sweeping schedule.

All catch basins in parking and/or paved areas will have a minimum of four-foot deep sumps to collect sediment carried in the runoff. Catch basins in grassed areas will also have four-foot deep sumps. The standard sump required by the CTDOT drainage manual is 2 feet. The additional 2 feet of sump depth will help to remove more sediment from the stormwater runoff.

All catch basin outlets will be fitted with 'hoods' which trap floating debris in the individual catch basin so they can be removed during regular maintenance.

The lawn and landscaped areas also provide a secondary level of filtration and infiltration. No quantifiable credit is given to the infiltration that will occur in this green space, but it does contribute to water quality.

A CTDOT approved hydrodynamic separator will be installed downstream of the stormwater collection system on the site. This type of unit has been proven to improve stormwater quality. The unit has been designed, analyzed and sized in "in-line" and "off line" configurations based on the Water Quality Flow (WQF) anticipated and per the 2004 Connecticut Stormwater Quality Manual. The "in-line" or "off line" hydrodynamic separators have been proven to provide TSS removal rates in excess of the minimum 80% total suspended solid removal required, but the stormwater treatment train calculations have taken a conservative approach and used a TSS removal rate of only 75%. This is based on a conservative approach of the Hydrodynamic Separator obtaining a 75% removal rate of TSS, while field testing for the State of New Jersey, the University of New Hampshire, the Massachusetts Department of Environmental Protection, and the United States Environmental Protection Agency have stated that HDS units have a much greater efficiency for TSS removal.

The areas of the site which will discharge to the micropool extended detention basin have the a TSS Removal rate of over 90%. The 2004 Connecticut Stormwater Quality Manual has determined that the use of "Stormwater Ponds" such as the Wet Pond, Micropool Extended Detention Pond, and the Pocket Pond have a significant benefit of removing pollutants such as sediment, phosphorus, nitrogen, and metals, as well as a partial benefit of removing pathogens and dissolved pollutants. The Trustee Parcel will achieve a TSS Removal rate of over 94%. Calculations can be found in Appendix E.

The water quality unit is sized to treat the Water Quality Flow (WQF), aka the "first flush", per the 2004 Connecticut Stormwater Quality Manual.

Outlet protection measures are provided at the drainage outlet point (see Appendix D for Outlet Protection Calculations). Riprap outlet protection will be installed for energy dissipation of scour velocities and additional water quality treatment.

The Stormwater Management Basin has been designed to provide storage volume for a 100-year storm event and the CTDOT approved hydrodynamic separators will be installed at the end of the collection system on the site and prior to discharging into the Stormwater Management Basin. As standalone systems as discussed above, the hydrodynamic separators and stormwater management basin will achieve at least the 80% TSS removal guidelines. In series, as proposed herein, and with the other proposed BMPs, the stormwater management system will exceed all requirements for water quality.

In addition, the stormwater runoff from the Trustee Roof is routed through the proposed stormwater management system. This roof stormwater is recognized by the regulatory agencies as clean. This clean roof water represents 7.1% of the stormwater runoff from the Trustee Property. If the soils were suitable for infiltration, this stormwater would have been discharged to an underground infiltration system. All of the calculations assume this roof runoff is "dirty" for the purposed of this application, therefore the proposed systems removal efficiencies contained herein for TSS and other stormwater constituents is conservative.

#### F. Pipe Sizing Calculations

The hydraulic study of the on-site drainage system has been designed to comply with the requirements set forth in the Town of Branford Regulations and the State of Connecticut Department of Transportation Drainage Manual.

The proposed drainage systems have been sized to convey the 10-year storm event to their respective discharge points without ponding or surcharging above the catch basin / manhole grates. Connecticut Rainfall Intensity-Duration (Table B-2.1) was utilized. The site drainage system improvements have been designed to comply with the requirements set forth in the State of Connecticut Department of Transportation Drainage Manual, dated 2000, as amended. Drainage areas contributing to each catch basin have been determined and are found in Appendix E. The minimum pipe size maintained onsite is 12 inches.

Tailwater elevations for the stormwater management areas and flared end sections are based on the 10-year design storm.

StormCAD version 8i by Haestad Methods, utilizing the Rational Method, was used to model the proposed drainage system. Calculation data can be found in Appendix E.

## **Summary**

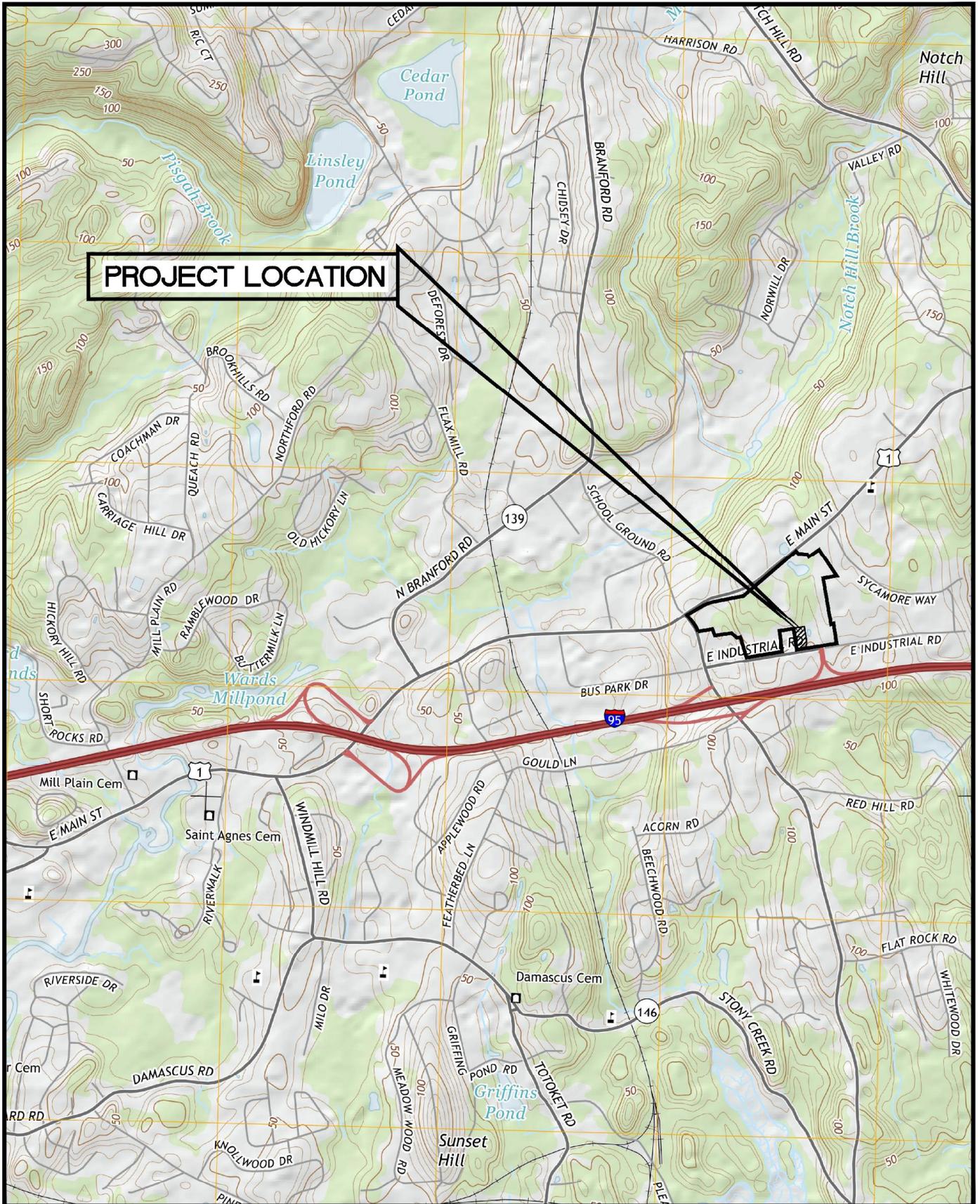
With the implementation of the stormwater management system designed for this project, there will be no negative impacts on-site or on downstream properties or off-site storm drainage systems from the proposed development.

Existing runoff discharge points will be maintained in the proposed design and appropriate measures are included to ensure that drainage will continue to flow to existing locations.

The stormwater detention systems have been designed to reduce peak flow rates.

The on-site drainage collection system is sized for the 10-year storm to operate without ponding or surcharging and numerous measures have been implemented to improve stormwater quality including stormwater management basins with sediment forebays and micropools, hydrodynamic separators, catch basin sumps, and hooded outlets.

This report, as noted above, has been prepared to compliment the submitted project plans as well as to represent the technical basis for the designs presented herein. In consideration of the overall project we conclude that all technical concerns and design parameters set forth by the Town and State, as presently identified, have been fully met.



**LOCATION MAP**  
 PROPOSED COMMERCIAL DEVELOPMENT  
 20 EAST INDUSTRIAL ROAD  
 BRANFORD, CT

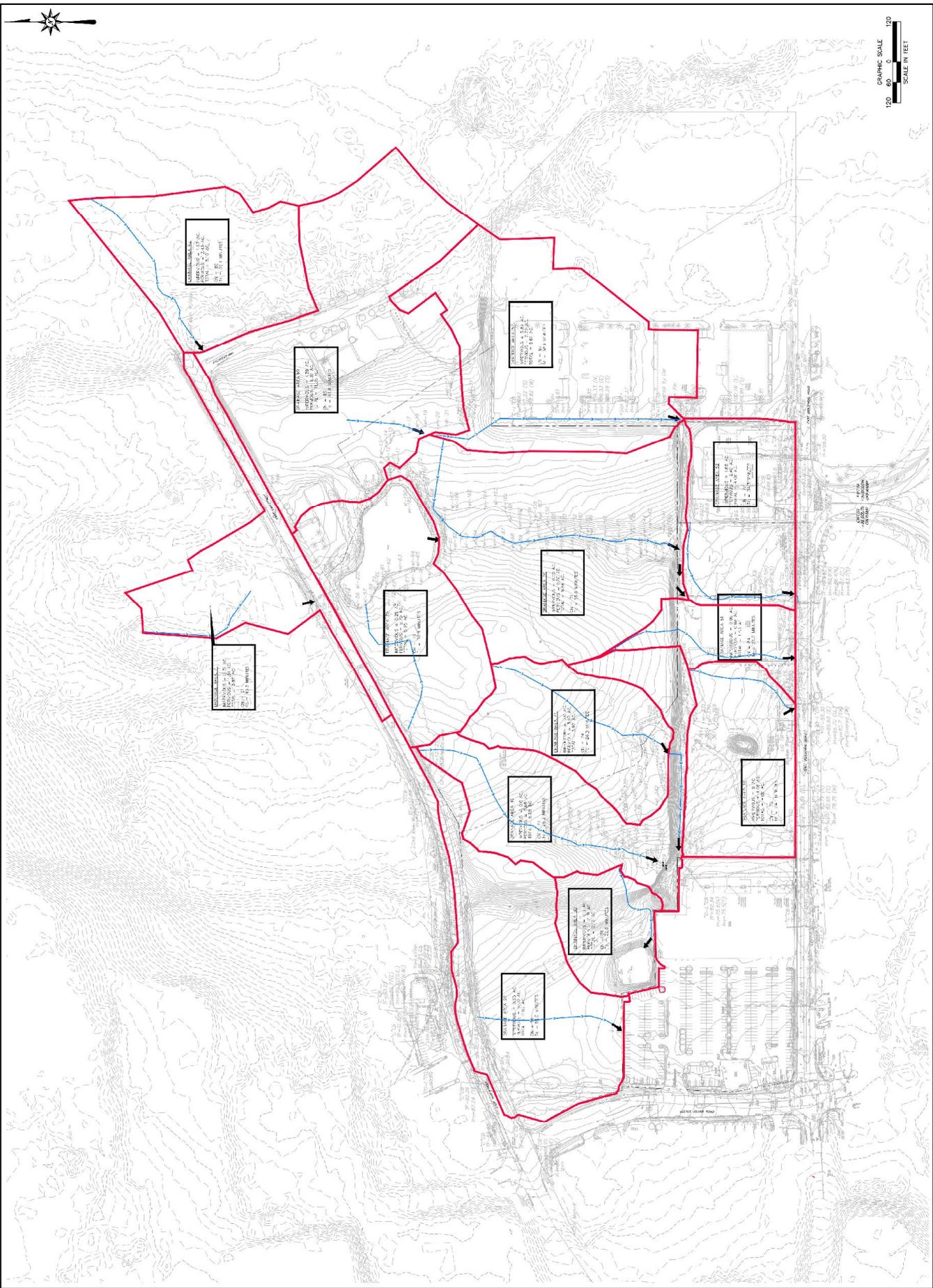
Designed  
 Drawn  
 Checked  
 Approved  
 Scale  
 Project No.  
 Date  
 CAD File

M.A.A.  
 M.A.A.

1"=2,000'  
 11C3707  
 08/11/2015  
 LOC11C370701

**FIGURE 1**

Xref (s):



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