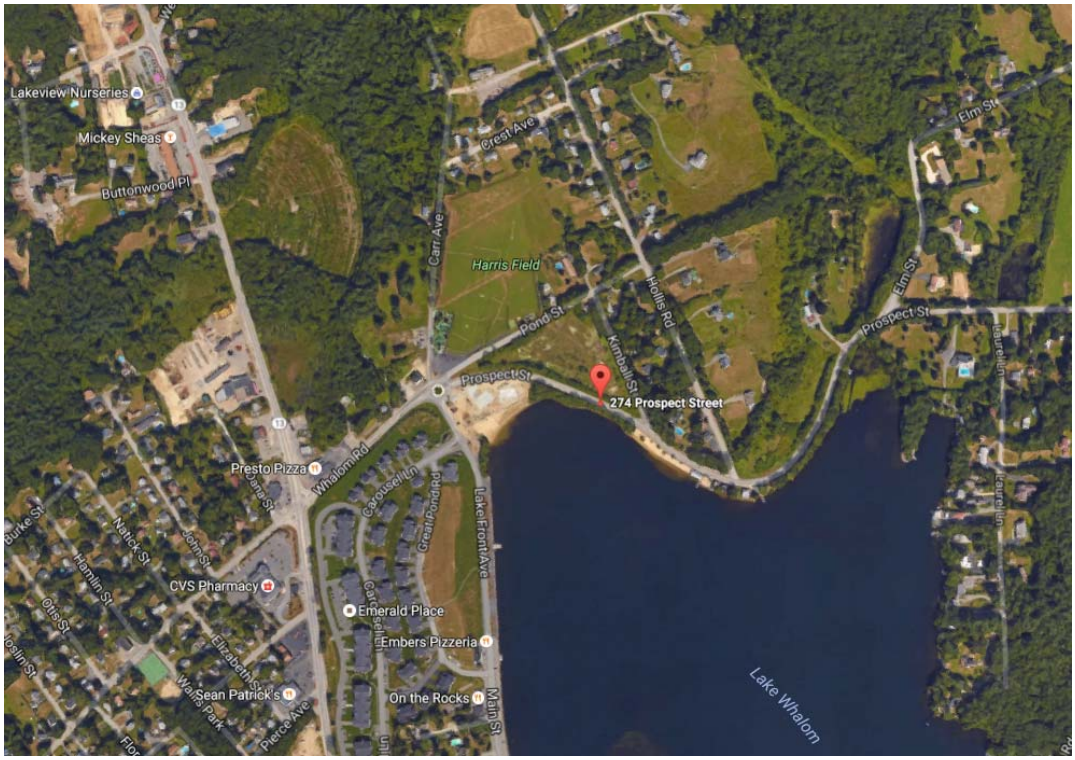
Stormwater Management System Design Report

Proposed 22-Unit Townhouse Development
274 Prospect Street
Lunenburg, MA



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1.0

DRAINAGE NARRATIVE

1.0 NARRATIVE

1.1 INTRODUCTION

On behalf of Apple Tree Realty Trust, Whitman & Bingham Associates, LLC has prepared this stormwater system analysis in accordance with the applicable local, state and federal regulations for the proposed 22-Unit Townhouse Development.

The Site is located in the southeastern portion of Lunenburg on Prospect Street, Pond Street, and Kimball Street. The project Site consists of approximately 3.53± acres. The majority of the project site is covered by scrub brush. An existing single-family residence is located in the northeast corner of the property.

The proposed plans include the development of an eleven (11) building, twenty-two (22) unit townhouse development, that will include the construction of 12 parking spaces to supplement the proposed garage and driveway of the respective individual units. The purpose of this stormwater analysis is to compare the pre-development conditions to the post development conditions resulting from the increase in impervious surface areas.

The proposed stormwater management system for the Site includes a combination of both flood control and water quality elements. The system on the Site includes a stormwater basin and grassed channels. The stormwater basin is proposed to discharge to the adjacent drainage system in Prospect Street.

The stormwater system has been designed to comply with the intent of Massachusetts DEP's Stormwater Management Policy guidelines, and with the criteria of the local permitting agencies of the Town of Lunenburg.

1.2 METHOD OF ANALYSIS

The enclosed hydrologic calculations utilize the runoff estimating techniques developed by the USDA Soil Conservation Service (SCS). The following publications were used in the preparation of this report:

1. "Urban Hydrology for Small Watersheds"[1]

2. "National Engineering Handbook, Hydrology, Section 4" (NEH-4)[2]

Using SCS publications and other texts on surface water hydrology, in conjunction with drainage software "HydroCAD" developed by Applied Microcomputer Systems[3], Whitman & Bingham Associates, LLC has calculated stormwater hydrographs, which provide the peak rates of runoff, for the Site. The drainage software program "HydroCAD" calculates runoff hydrographs using the same basic methodology as the TR-20 program entitled "Computer Programs for Project Formulations Hydrology, Technical Release Number 20" developed by SCS.

The total Site area was subdivided into multiple sub-watersheds for both the existing conditions and the proposed conditions. For each sub-watershed a series of hydrologic parameters were estimated and entered into the HydroCAD program.

For this application of HydroCAD the times of concentration (Tc) were computed by using the "Upland Method" which calculates the Tc utilizing land use and slope in conjunction with other land use variables. The Tc for a specific sub-watershed represents the time required for a droplet of water to travel from the most hydraulically distant point of the subwatershed to the design point. It is computed by summing the times it takes the water to travel through the different components of the subwatershed drainage system.

As a result of urbanization of an area (i.e., increase of impervious area), the time of concentration will be decreased since velocity of overland flow will be increased. As the time of concentration is decreased for a subwatershed, the peak flow rate will be increased for that particular subwatershed. The "upland method" estimates more accurate Tc's than other available methods.

1.3 SOILS

As part of the Soil Conservation Service's (SCS) hydrologic methodology, soils are classified as categories A through D, with A being very pervious (i.e. gravels, etc.) and D being very impervious (i.e. clays, muck, peat, etc.).

The four (4) soil classifications as defined by SCS are:

Group A — Generally have low runoff potential and have high infiltration rates. This group includes mainly sands and gravels consisting of deep, well to excessively drained media (sand, loamy sand, or sandy loam).

Group B — Soils in this classification have moderate infiltration rates and contain well drained soils with moderately fine to moderately coarse textures (silt loam or loam).

Group C — These soils have low infiltration rates and generally consist of a soil layer that prevents downward movement of water to the water table (sandy, clay, loam).

Group D — Soils under this group have high runoff potential since they are chiefly clay soils with high expansive capability. High water table, clay layers, nearly impervious material are all associated with this classification (clay loam, silty clay loam, sand clay, silty clay, or clay).

Soils throughout the Site were classified by the Soil Conservation Service (SCS) as the following soil groups:

Soil Group/Symbol	Hydrologic Runoff Class
Paxton fine sandy loam/305D	C
Woodbridge fine sandy loam/310B & 310C	C/D
Paxton-Urban land complex/622C	C

1.4 RUNOFF CURVE NUMBERS

There are several primary factors that affect the volume of runoff that is generated from a particular land use. These include surface treatment, cover type, and antecedent runoff condition, or how wet the soils are prior to the start of the rainfall event.

Hydraulic condition represents the effects of cover type and treatment on infiltration and runoff. Density of plant cover and forest litter heavily influences this condition. Good hydraulic condition indicates a low run-off potential due to heavy ground cover while poor hydraulic condition indicates poor cover (i.e. bare soil, etc.) and is indicative of comparatively high runoff potential.

The SCS uses a curve number (CN) in the calculations to represent the combination of hydraulic condition and soil type. As the curve number increases the amount of expected runoff is also increased. A curve number of 30 indicates a low potential for runoff while a number of 90 indicates a high potential. Curve numbers were selected for the various soil types and land uses found on the site in accordance with the following table. Weighted curve numbers for each sub-watershed were determined by land area of the different soil types.

The SCS runoff curve numbers used in all watershed modeling contained in this report are based upon the following Hydrologic Soil Group and their following land uses:

SURFACE TYPE	**HYDROLOGICAL SOIL GROUP**			
	A	**B**	**C**	**D**
	CURVE NUMBERS			
Pavement	98	98	98	98
Grass/Lawn (Good)	39	61	74	80
Wooded (Good)	30	55	70	77
Meadow	30	58	71	78
Gravel - Dirt Driveways	76	85	89	91
Residential 1/4 Acre Lots (38% Imp.)	61	75	83	87
Residential 1 Acre Lots (20% Imp.)	51	68	79	84
Residential 2 Acre Lots (12% Imp.)	46	65	77	82
Fallow/Bare Soil (Gravel Pit)	77	86	91	94

1.5 DESIGN CRITERIA

This stormwater system analysis was developed utilizing as the design storm's rainfall distribution a Type III, 24-hour tropical storm as developed by SCS. Type III represents Gulf of Mexico and Atlantic Coastal areas where tropical storms yield large 24-hour rainfall amounts. The storm frequencies and the corresponding rainfall depths were compiled from "Technical Paper No.40, Rainfall Frequency Atlas of the United States for Duration's from 30 minutes to 24 hours and Return Periods from 1 to 100 years." The specific storm depths that apply to the Lunenburg area are as follows:

Storm Frequency (years)	Rainfall Depth (inches)
100	6.6
50	5.8
25	5.3
10	4.5
2	3.0
1	2.5

The design of the stormwater basin was based on the containment and control of the 100-year storm event. Rainfall-runoff-routing calculations were completed for the 2, 10, 25 and 100 -year, 24-hour storms and the results are provided in Section 3.0.

1.6 HYDROLOGICAL DESCRIPTIONS

1.6.1 PRE-DEVELOPMENT

As mentioned previously a majority of the 3.53± acre subject site is vacant scrub brush. A single-family home is located in the northeast corner of the Site. The site is bounded by Pond Street to the north and by Prospect Street to the south and by Kimball Street to the east.

The topography of the subject Site ranges from 520 (adjacent to Prospect Street) to 562 (adjacent to the intersection of Pond Street and Kimball Street). The site drains into the existing drainage system in Prospect Street

For purpose of this analysis, the Site was analyzed as one watershed. The watershed as outlined below, and can be located on the attached plan labeled "Pre-Development Watershed Delineation".

Subcatchment 1S:
Subcatchment 1S consists of 3.86± acres of scrub brush/meadow land cover. The subcatchment area is tributary to the existing drainage in Prospect Street.

1.6.2 POST-DEVELOPMENT

The proposed project consists of the construction of approximately 22,968 ft^2 of townhouses, individual driveways to each unit, 12 supplemental parking spaces and two entrance points from Pond Street and Kimball Street. (Refer to "Post-Development Watershed Delineation" plan for the proposed improvements and sub-watersheds.)

The entire Site will utilize grassed channels. The grassed channel system design is the initial water quality control element in the stormwater system. Surface runoff from the Site will be collected in the grassed channels and conveyed the stormwater basin. The Site utilizes the stormwater basin to hold and treat the stormwater, before releasing it at a controlled rate. The design of the stormwater basin also incorporate infiltration of the smaller more frequent storms into the underlying soil.

Consideration has been given to the potential for freezing conditions to limit the infiltration rate and a 6-inch wick drain in the basin's bottom is proposed to aid in the removal of water from the basins and thus reduce the potential for ice build-up at the surface.

The proposed stormwater basin has been designed to promote the removal of nitrites-nitrates, and phosphorous, which are significant nutrient loading factors, and to promote the recharge of the groundwater supply. The side slopes and bottom of the basin will be loamed and seeded to establish vegetation.

The outlets of the stormwater basin will be set above the bottom grade of the basin. The runoff from the more frequent smaller storm events will remain in the basin, interact with the plantings along within the basin and gradually infiltrate through the basin's bottom. The combination of plant interaction and infiltration will serve to remove sediment and nutrients from the runoff for the smaller events.

The stormwater basin's design also includes an emergency overflow spillway that is set above the 100-year design maximum water elevation. The purpose of the spillway is to provide a safe discharge point for any combination of conditions that leads to a greater volume of water within the basins than the 100-year design event.

In addition to providing groundwater infiltration and water quality enhancement, the proposed stormwater basin also mitigates the increases in peak rates of runoff due to the change in the land surface. As the hydrographs are hydraulically routed through the basin their peak rates are attenuated due to available storage.

Given the need to maintain the infiltration capacity at the basin, the basin was designed for ease of maintenance, as well as stability, and aesthetic values. The side slopes of the basin are graded to allow for access of light construction equipment for cleaning purposes when silt and organic accumulate within the basin. Given the objective of minimizing water quality impacts, an on-going system and Site maintenance program has been developed as part of the Stormwater Maintenance Program presented in Section 2.0.

The deposition of sediments in a stormwater basin is typically not spread uniformly over the bottom of the basin, and the larger and heavier particles tend to deposit at or near the inlets. The design

incorporates forebays at each inlet to facilitate natural sediment collection and assist with the subsequent mechanical removal of the sediments. The presence of forebays allows for fewer disturbances of the remaining basin bottom area.

1.7 CONCLUSIONS

The proposed stormwater management system achieves the series of design objectives or criteria established for this location. The stormwater basin will mitigate the increase in peak rates of runoff at the selected design point as outlined below:

Peak Flows at Design Point #99

Storm Event	Existing Conditions (cfs)	Proposed Conditions (cfs)
2 yr. storm	3.02	3.02
10 yr. storm	7.58	7.44
25 yr. storm	10.32	9.42
100 yr. storm	15.03	11.97

As shown in the tables above, the stormwater management system has been designed so that no negative impact, relative to the increase in peak runoff rates, will occur to abutting properties. The other design objectives or criteria that are achieved include:

a) Implementation of Best Management Practices to minimize water quality impacts. The water quality practices that are incorporated into the design are: grassed channels and infiltration of stormwater and the presence of vegetation within the stormwater basin.

b) Design of a storm water management system that meets or exceeds the requirements of the Massachusetts Wetland Protection Act and Massachusetts Stormwater Policy.

2.0

STORMWATER MAINTENANCE PROGRAM

2.0 Stormwater Maintenance Program

This project is a private townhouse development. The property owner will be responsible for the maintenance and operation of the proposed stormwater management system.

As presented within the description of the proposed stormwater management system, several management practices have been instituted to collect, mitigate and treat stormwater runoff from the proposed development. These include the following:

- Grassed Channels
- Retention of stormwater, within the proposed stormwater basin to facilitate recharge of the groundwater system and balancing of pre/post flows.
- Construction of a stormwater basin with associated outlets to mitigate pre and post peak development flows for all storm events (i.e. 2, 25 and 100 year storm events).
- Reduction of stormwater velocities to lessen sediment transport throughout the subject site.

All of the above items reflect mitigation measures to improve and maintain stormwater quality that will flow as groundwater to the existing neighboring wetland system. In order to assure proper operation of the stormwater facilities in the future, it is necessary for a stormwater maintenance program be instituted and followed.

The owner of the properties will be the owner of the storm water system described herein and responsible for the required maintenance and operation of the storm water. The proposed maintenance procedures and scheduling is as follows:

2.1 Construction Completion Maintenance

Once construction grading of the basin is completed, proper stabilization of all slopes within the Site and specifically the basin is required. Hay mulch, geotextile fabric, and hydroseeding are required to prevent necessary sediment transport to the basin bottom area. Haybales or siltfence will be required at the toe of interior basin slopes to prevent siltation of the exfiltration trenches or the basin bottom until the side slopes are stabilized.

2.2 Stormwater Basin Maintenance

The stormwater basin is a primary element of the Site's stormwater management program. Final treatment and infiltration of stormwater normally occurs within this mitigation structure. At a minimum, at 6 month intervals, the bottom of the basin requires inspection and removal of sediment if, during the inspection, an accumulation of 2" or more of sediment is found at several locations within the basin. In addition, routine inspections are required after each major storm event of 1" of rainfall or more. Additionally, the operation of the drainage system should be observed at least once every six months during a major storm event to evaluate its performance and note any deficiencies that may be occurring. Included within this report are sample inspection forms that should be completed to maintain proper records of necessary observations and required maintenance.

Heavier deposits of sediment are anticipated in the forebay area of the basin. Depending upon the timing and combination of storm events, winter sanding operations, street sweeping, and other factors additional sediment removal (under 6 months) may be required in the forebay area. A 6" PVC drain pipe should be installed vertically in the forebays of the basins to be used a sedimentation marker post. A line should be placed on the pipe at six (6) inches from the base of the forebay to denote at which time the forebay needs to be cleaned.

If persistent ponding of the basin's bottom is observed during routine inspections, this may indicate a significant reduction in the available exfiltration capacity. The cause of the reduction in capacity will need to be investigated. Additional removal of sediments and the reworking of the surface sand layer may be required to restore the infiltration capacity.

Inspection of stormwater basin's outlet is required. Accumulated debris, etc., is to be removed from the vicinity of the outflow. Additionally, interior inspection of the structure is necessary. Accumulated sediments within the outlet must be removed. The stormwater basin's emergency spillway shall be inspected on a regular basis. If there is evidence that an overflow event has occurred, the rip rap on the slope shall be examined to determine if repairs are required following the overflow event.

Due to the design of the interior slopes of the basin to accommodate construction equipment, it is anticipated that slope erosion should be minimal after the vegetation is established. If erosion of the slopes occurs, loam shall be replaced and standard methods used to re-establish proper vegetation cover. Fescues and reed canary grass seed mixtures, which are rapid growing and low maintenance, are recommended. Hay mulch or other suitable stabilizing techniques shall be utilized during the reseeding process.

On a bi-yearly basis the side slopes of the basin area will be mowed. The condition of the turf, the status of controlled tree growth, and evidence of differential settlement will be evaluated and if needed, corrective action will be taken. The outside toe of slope should be evaluated for evidence of ponding or leakage through the embankment. If evidence of leakage is apparent, an engineer will be engaged by the owner to evaluate the stability of the embankment and furnish recommendations regarding the structure.

2.3 Stormwater Maintenance Plan Data Sheets

Enclosed within the plan, is a "member roster" for the responsible party(s) for stormwater maintenance. It is recommended that the roster is completed and filed for future reference to aid in maintaining an adequate program. Additionally, storm water data sheets have been included to assist in record keeping of storm water events and required maintenance of the drainage system.

Whitman & Bingham Associates, LLC
Registered Engineers and Land Surveyors

Stormwater Maintenance Plan
Member Roster

Completed By:_____**Title:**_____**Date:**_____

Director:_____ **Title:**_____

Office Phone:_____

Responsibilities:_____

_____

_____

_____

_____

_____

_____

Member:_____ **Title:**_____

Office Phone:_____

Responsibilities:_____

_____

_____

_____

_____

_____

_____

Whitman & Bingham Associates, LLC
Registered Engineers and Land Surveyors

STORMWATER POLLUTION MAINTENANCE PLAN
INSPECTION AND MAINTENANCE REPORT FORM
(To be completed at 6 Month Intervals)

STORMWATER BASIN:

Basin ID#	Depth of Sediment in Basin	Condition of Basin Side Slopes	Any Evidence of Overtopping of the Embankment?	Condition of Outfall From Basin

MAINTENANCE REQUIRED FOR STORMWATER BASIN(S):

_____

_____

_____

_____

_____

_____

_____

_____

TO BE PERFORMED BY:_____**ON OR BEFORE:**_____

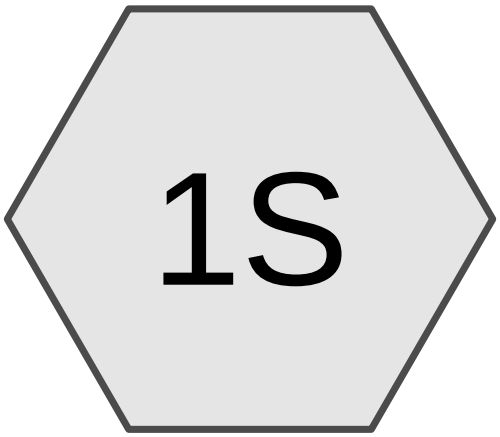
INSPECTED BY:_____**DATE:**_____

3.0

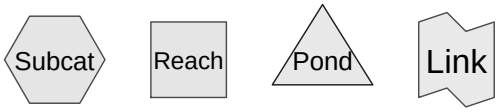
HYDROLOGICAL CALCULATIONS

3.1

PRE-DEVELOPMENT CALCULATIONS



Overland runoff toward Prospect Street



Drainage Diagram for 274 Prospect St - Pre
Prepared by Whitman & Bingham Associates, LLC 8/18/2016
HydroCAD® 7.10 s/n 000655 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff toward Prospect Street Runoff Area=3.860 ac Runoff Depth=0.76"
Flow Length=406' Tc=6.0 min CN=71 Runoff=3.02 cfs 0.245 af

Total Runoff Area = 3.860 ac Runoff Volume = 0.245 af Average Runoff Depth = 0.76"

Subcatchment 1S: Overland runoff toward Prospect Street

Runoff = 3.02 cfs @ 12.10 hrs, Volume= 0.245 af, Depth= 0.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Storm Event Rainfall=3.00"

Area (ac)	CN	Description
3.860	71	Meadow, non-grazed, HSG C

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	50	0.1200	0.3		**Sheet Flow, Path 1** Grass: Short n= 0.150 P2= 3.20"
2.6	356	0.1044	2.3		**Shallow Concentrated Flow, Path 2** Short Grass Pasture Kv= 7.0 fps
5.3	406	Total, Increased to minimum Tc = 6.0 min			

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff toward Prospect Street Runoff Area=3.860 ac Runoff Depth=1.75"
Flow Length=406' Tc=6.0 min CN=71 Runoff=7.58 cfs 0.562 af

Total Runoff Area = 3.860 ac Runoff Volume = 0.562 af Average Runoff Depth = 1.75"

Subcatchment 1S: Overland runoff toward Prospect Street

Runoff = 7.58 cfs @ 12.10 hrs, Volume= 0.562 af, Depth= 1.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Storm Event Rainfall=4.50"

Area (ac)	CN	Description
3.860	71	Meadow, non-grazed, HSG C

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	50	0.1200	0.3		**Sheet Flow, Path 1** Grass: Short n= 0.150 P2= 3.20"
2.6	356	0.1044	2.3		**Shallow Concentrated Flow, Path 2** Short Grass Pasture Kv= 7.0 fps
5.3	406	Total, Increased to minimum Tc = 6.0 min			

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff toward Prospect Street Runoff Area=3.860 ac Runoff Depth=2.35"
Flow Length=406' Tc=6.0 min CN=71 Runoff=10.32 cfs 0.755 af

Total Runoff Area = 3.860 ac Runoff Volume = 0.755 af Average Runoff Depth = 2.35"

Subcatchment 1S: Overland runoff toward Prospect Street

Runoff = 10.32 cfs @ 12.10 hrs, Volume= 0.755 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Storm Event Rainfall=5.30"

Area (ac)	CN	Description
3.860	71	Meadow, non-grazed, HSG C

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	50	0.1200	0.3		**Sheet Flow, Path 1** Grass: Short n= 0.150 P2= 3.20"
2.6	356	0.1044	2.3		**Shallow Concentrated Flow, Path 2** Short Grass Pasture Kv= 7.0 fps
5.3	406	Total, Increased to minimum Tc = 6.0 min			

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff toward Prospect Street Runoff Area=3.860 ac Runoff Depth=3.39"
Flow Length=406' Tc=6.0 min CN=71 Runoff=15.03 cfs 1.090 af

Total Runoff Area = 3.860 ac Runoff Volume = 1.090 af Average Runoff Depth = 3.39"

Subcatchment 1S: Overland runoff toward Prospect Street

Runoff = 15.03 cfs @ 12.09 hrs, Volume= 1.090 af, Depth= 3.39"

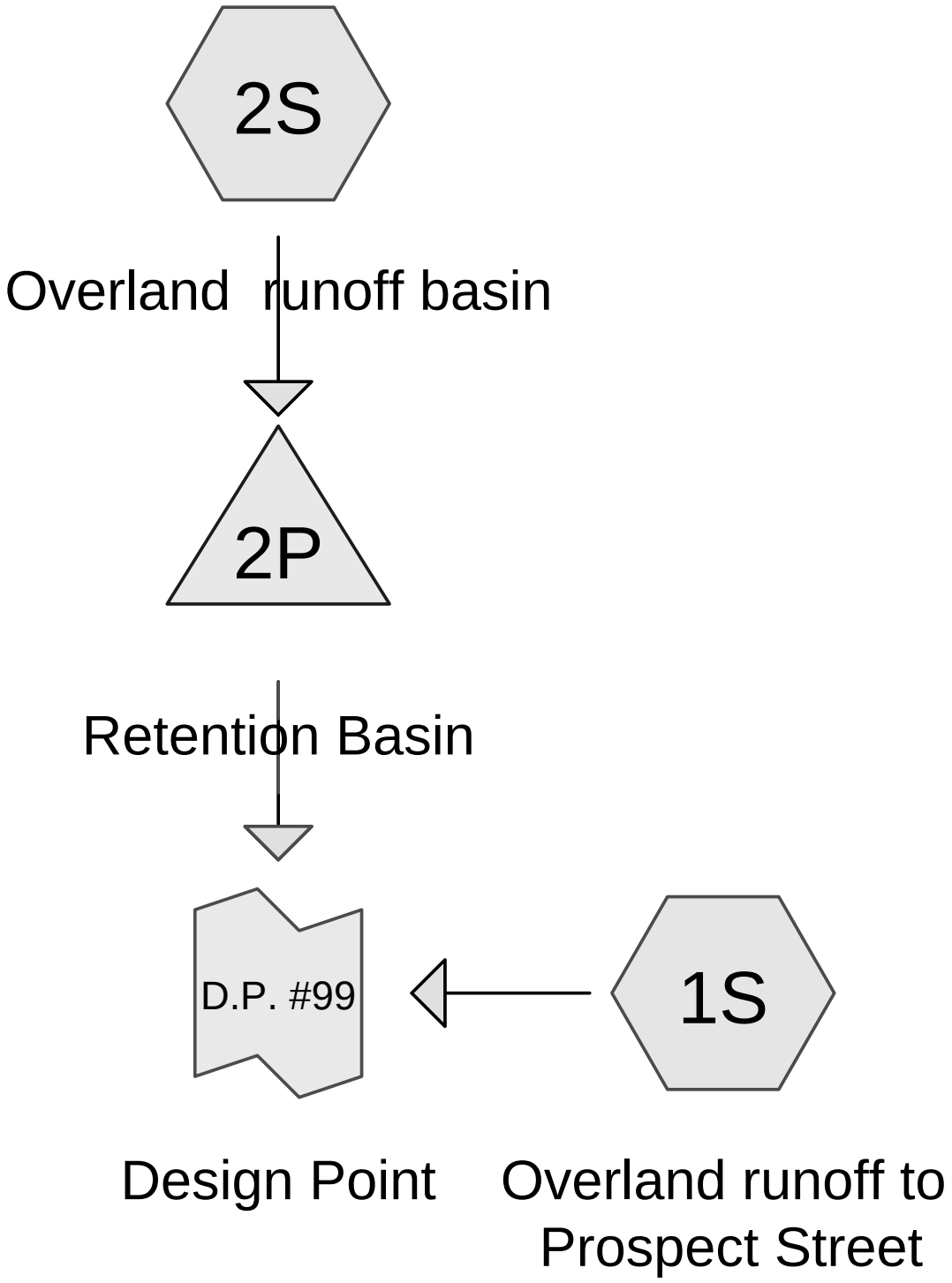
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Storm Event Rainfall=6.60"

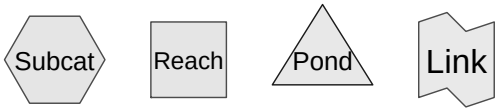
Area (ac)	CN	Description
3.860	71	Meadow, non-grazed, HSG C

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	50	0.1200	0.3		**Sheet Flow, Path 1** Grass: Short n= 0.150 P2= 3.20"
2.6	356	0.1044	2.3		**Shallow Concentrated Flow, Path 2** Short Grass Pasture Kv= 7.0 fps
5.3	406	Total, Increased to minimum Tc = 6.0 min			

3.2

POST-DEVELOPMENT CALCULATIONS





Drainage Diagram for 274 Prospect St - Post
Prepared by Whitman & Bingham Associates, LLC 8/18/2016
HydroCAD® 7.10 s/n 000655 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff to Prospect Street Runoff Area=0.570 ac Runoff Depth=0.81"
Flow Length=20' Tc=6.0 min CN=72 Runoff=0.48 cfs 0.038 af

Subcatchment 2S: Overland runoff basin Runoff Area=3.290 ac Runoff Depth=1.38"
Flow Length=387' Tc=6.0 min CN=82 Runoff=5.19 cfs 0.378 af

Pond 2P: Retention Basin Peak Elev=521.10' Storage=4,770 cf Inflow=5.19 cfs 0.378 af
Primary=2.74 cfs 0.333 af Secondary=0.00 cfs 0.000 af Outflow=2.74 cfs 0.333 af

Link D.P. #99: Design Point Inflow=3.02 cfs 0.371 af
Primary=3.02 cfs 0.371 af

Total Runoff Area = 3.860 ac Runoff Volume = 0.416 af Average Runoff Depth = 1.29"

Subcatchment 1S: Overland runoff to Prospect Street

Runoff = 0.48 cfs @ 12.10 hrs, Volume= 0.038 af, Depth= 0.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Storm Event Rainfall=3.00"

Area (ac)	CN	Description
0.310	71	Meadow, non-grazed, HSG C
0.260	74	>75% Grass cover, Good, HSG C
0.570	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	20		0.1		**Direct Entry, Path 1**
5.0	20	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: Overland runoff basin

Runoff = 5.19 cfs @ 12.10 hrs, Volume= 0.378 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Storm Event Rainfall=3.00"

Area (ac)	CN	Description
1.168	98	Paved parking & roofs
1.911	74	>75% Grass cover, Good, HSG C
0.211	71	Meadow, non-grazed, HSG C
3.290	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.2		**Sheet Flow, Path 1** Grass: Dense n= 0.240 P2= 3.20"
0.0	30	0.4667	11.0		**Shallow Concentrated Flow, Path 2** Unpaved Kv= 16.1 fps
1.1	227	0.0176	3.4	20.50	**Channel Flow, Path 3** Area= 6.0 sf Perim= 16.0' r= 0.38' n= 0.030 Earth, grassed & winding
0.3	80	0.0100	5.3	6.46	**Circular Channel (pipe), Path 4** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
5.0	387	Total, Increased to minimum Tc = 6.0 min			

Pond 2P: Retention Basin

Inflow Area =	3.290 ac,	Inflow Depth =	1.38"	for	2-Year Storm Event event
Inflow =	5.19 cfs @	12.10 hrs,	Volume=	0.378 af	
Outflow =	2.74 cfs @	12.26 hrs,	Volume=	0.333 af,	Atten= 47%, Lag= 9.8 min
Primary =	2.74 cfs @	12.26 hrs,	Volume=	0.333 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 521.10' @ 12.26 hrs Surf.Area= 5,366 sf Storage= 4,770 cf
Plug-Flow detention time= 113.3 min calculated for 0.332 af (88% of inflow)
Center-of-Mass det. time= 58.2 min (897.7 - 839.4)

Volume	Invert	Avail.Storage	Storage Description
#1	520.00'	21,404 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
520.00	3,310	0	0
522.00	7,051	10,361	10,361
523.10	13,027	11,043	21,404

Device	Routing	Invert	Outlet Devices
#1	Primary	520.50'	**12.0" x 20.0' long Culvert X 2.00** Ke= 0.600 Outlet Invert= 520.30' S= 0.0100 '/' Cc= 0.900 n= 0.012
#2	Primary	520.70'	**12.0" x 18.0' long Culvert** Ke= 0.600 Outlet Invert= 520.52' S= 0.0100 '/' Cc= 0.900 n= 0.012
#3	Secondary	522.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=2.73 cfs @ 12.26 hrs HW=521.10' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.19 cfs @ 3.2 fps)
└─**2=Culvert** (Barrel Controls 0.54 cfs @ 2.7 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=520.00' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Link D.P. #99: Design Point

Inflow Area =	3.860 ac,	Inflow Depth >	1.15"	for	2-Year Storm Event event
Inflow =	3.02 cfs @	12.24 hrs,	Volume=	0.371 af	
Primary =	3.02 cfs @	12.24 hrs,	Volume=	0.371 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff to Prospect Street Runoff Area=0.570 ac Runoff Depth=1.82"
Flow Length=20' Tc=6.0 min CN=72 Runoff=1.17 cfs 0.086 af

Subcatchment 2S: Overland runoff basin Runoff Area=3.290 ac Runoff Depth=2.64"
Flow Length=387' Tc=6.0 min CN=82 Runoff=9.96 cfs 0.723 af

Pond 2P: Retention Basin Peak Elev=521.51' Storage=7,107 cf Inflow=9.96 cfs 0.723 af
Primary=6.56 cfs 0.677 af Secondary=0.00 cfs 0.000 af Outflow=6.56 cfs 0.677 af

Link D.P. #99: Design Point Inflow=7.44 cfs 0.764 af
Primary=7.44 cfs 0.764 af

Total Runoff Area = 3.860 ac Runoff Volume = 0.809 af Average Runoff Depth = 2.52"

Subcatchment 1S: Overland runoff to Prospect Street

Runoff = 1.17 cfs @ 12.10 hrs, Volume= 0.086 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Storm Event Rainfall=4.50"

Area (ac)	CN	Description
0.310	71	Meadow, non-grazed, HSG C
0.260	74	>75% Grass cover, Good, HSG C
0.570	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	20		0.1		**Direct Entry, Path 1**
5.0	20	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: Overland runoff basin

Runoff = 9.96 cfs @ 12.09 hrs, Volume= 0.723 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Storm Event Rainfall=4.50"

Area (ac)	CN	Description
1.168	98	Paved parking & roofs
1.911	74	>75% Grass cover, Good, HSG C
0.211	71	Meadow, non-grazed, HSG C
3.290	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.2		**Sheet Flow, Path 1** Grass: Dense n= 0.240 P2= 3.20"
0.0	30	0.4667	11.0		**Shallow Concentrated Flow, Path 2** Unpaved Kv= 16.1 fps
1.1	227	0.0176	3.4	20.50	**Channel Flow, Path 3** Area= 6.0 sf Perim= 16.0' r= 0.38' n= 0.030 Earth, grassed & winding
0.3	80	0.0100	5.3	6.46	**Circular Channel (pipe), Path 4** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
5.0	387	Total, Increased to minimum Tc = 6.0 min			

Pond 2P: Retention Basin

Inflow Area =	3.290 ac,	Inflow Depth =	2.64"	for	10-Year Storm Event event
Inflow =	9.96 cfs @	12.09 hrs,	Volume=	0.723 af	
Outflow =	6.56 cfs @	12.19 hrs,	Volume=	0.677 af,	Atten= 34%, Lag= 6.1 min
Primary =	6.56 cfs @	12.19 hrs,	Volume=	0.677 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 521.51' @ 12.19 hrs Surf.Area= 6,127 sf Storage= 7,107 cf
Plug-Flow detention time= 75.0 min calculated for 0.677 af (94% of inflow)
Center-of-Mass det. time= 41.6 min (862.3 - 820.7)

Volume	Invert	Avail.Storage	Storage Description
#1	520.00'	21,404 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
520.00	3,310	0	0
522.00	7,051	10,361	10,361
523.10	13,027	11,043	21,404

Device	Routing	Invert	Outlet Devices
#1	Primary	520.50'	**12.0" x 20.0' long Culvert X 2.00** Ke= 0.600 Outlet Invert= 520.30' S= 0.0100 '/' Cc= 0.900 n= 0.012
#2	Primary	520.70'	**12.0" x 18.0' long Culvert** Ke= 0.600 Outlet Invert= 520.52' S= 0.0100 '/' Cc= 0.900 n= 0.012
#3	Secondary	522.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=6.54 cfs @ 12.19 hrs HW=521.50' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 4.82 cfs @ 3.8 fps)
└─**2=Culvert** (Barrel Controls 1.73 cfs @ 3.5 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=520.00' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Link D.P. #99: Design Point

Inflow Area =	3.860 ac,	Inflow Depth >	2.37"	for	10-Year Storm Event event
Inflow =	7.44 cfs @	12.17 hrs,	Volume=	0.764 af	
Primary =	7.44 cfs @	12.17 hrs,	Volume=	0.764 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff to Prospect Street Runoff Area=0.570 ac Runoff Depth=2.43"
Flow Length=20' Tc=6.0 min CN=72 Runoff=1.58 cfs 0.115 af

Subcatchment 2S: Overland runoff basin Runoff Area=3.290 ac Runoff Depth=3.35"
Flow Length=387' Tc=6.0 min CN=82 Runoff=12.59 cfs 0.918 af

Pond 2P: Retention Basin Peak Elev=521.69' Storage=8,271 cf Inflow=12.59 cfs 0.918 af
Primary=8.23 cfs 0.873 af Secondary=0.00 cfs 0.000 af Outflow=8.23 cfs 0.873 af

Link D.P. #99: Design Point Inflow=9.42 cfs 0.988 af
Primary=9.42 cfs 0.988 af

Total Runoff Area = 3.860 ac Runoff Volume = 1.034 af Average Runoff Depth = 3.21"

Subcatchment 1S: Overland runoff to Prospect Street

Runoff = 1.58 cfs @ 12.10 hrs, Volume= 0.115 af, Depth= 2.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Storm Event Rainfall=5.30"

Area (ac)	CN	Description
0.310	71	Meadow, non-grazed, HSG C
0.260	74	>75% Grass cover, Good, HSG C
0.570	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	20		0.1		**Direct Entry, Path 1**
5.0	20	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: Overland runoff basin

Runoff = 12.59 cfs @ 12.09 hrs, Volume= 0.918 af, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Storm Event Rainfall=5.30"

Area (ac)	CN	Description
1.168	98	Paved parking & roofs
1.911	74	>75% Grass cover, Good, HSG C
0.211	71	Meadow, non-grazed, HSG C
3.290	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.2		**Sheet Flow, Path 1** Grass: Dense n= 0.240 P2= 3.20"
0.0	30	0.4667	11.0		**Shallow Concentrated Flow, Path 2** Unpaved Kv= 16.1 fps
1.1	227	0.0176	3.4	20.50	**Channel Flow, Path 3** Area= 6.0 sf Perim= 16.0' r= 0.38' n= 0.030 Earth, grassed & winding
0.3	80	0.0100	5.3	6.46	**Circular Channel (pipe), Path 4** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
5.0	387	Total, Increased to minimum Tc = 6.0 min			

Pond 2P: Retention Basin

Inflow Area =	3.290 ac,	Inflow Depth =	3.35"	for	25-Year Storm Event event
Inflow =	12.59 cfs @	12.09 hrs,	Volume=	0.918 af	
Outflow =	8.23 cfs @	12.19 hrs,	Volume=	0.873 af,	Atten= 35%, Lag= 6.1 min
Primary =	8.23 cfs @	12.19 hrs,	Volume=	0.873 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 521.69' @ 12.19 hrs Surf.Area= 6,473 sf Storage= 8,271 cf
Plug-Flow detention time= 65.0 min calculated for 0.873 af (95% of inflow)
Center-of-Mass det. time= 37.8 min (851.7 - 813.9)

Volume	Invert	Avail.Storage	Storage Description
#1	520.00'	21,404 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
520.00	3,310	0	0
522.00	7,051	10,361	10,361
523.10	13,027	11,043	21,404

Device	Routing	Invert	Outlet Devices
#1	Primary	520.50'	**12.0" x 20.0' long Culvert X 2.00** Ke= 0.600 Outlet Invert= 520.30' S= 0.0100 '/' Cc= 0.900 n= 0.012
#2	Primary	520.70'	**12.0" x 18.0' long Culvert** Ke= 0.600 Outlet Invert= 520.52' S= 0.0100 '/' Cc= 0.900 n= 0.012
#3	Secondary	522.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=8.21 cfs @ 12.19 hrs HW=521.69' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 5.88 cfs @ 3.7 fps)
└─**2=Culvert** (Barrel Controls 2.33 cfs @ 3.7 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=520.00' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Link D.P. #99: Design Point

Inflow Area =	3.860 ac,	Inflow Depth >	3.07"	for	25-Year Storm Event event
Inflow =	9.42 cfs @	12.17 hrs,	Volume=	0.988 af	
Primary =	9.42 cfs @	12.17 hrs,	Volume=	0.988 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Overland runoff to Prospect Street Runoff Area=0.570 ac Runoff Depth=3.49"
Flow Length=20' Tc=6.0 min CN=72 Runoff=2.29 cfs 0.166 af

Subcatchment 2S: Overland runoff basin Runoff Area=3.290 ac Runoff Depth=4.54"
Flow Length=387' Tc=6.0 min CN=82 Runoff=16.92 cfs 1.245 af

Pond 2P: Retention Basin Peak Elev=522.01' Storage=10,455 cf Inflow=16.92 cfs 1.245 af
Primary=10.28 cfs 1.200 af Secondary=0.04 cfs 0.000 af Outflow=10.32 cfs 1.200 af

Link D.P. #99: Design Point Inflow=11.97 cfs 1.366 af
Primary=11.97 cfs 1.366 af

Total Runoff Area = 3.860 ac Runoff Volume = 1.411 af Average Runoff Depth = 4.39"

Subcatchment 1S: Overland runoff to Prospect Street

Runoff = 2.29 cfs @ 12.09 hrs, Volume= 0.166 af, Depth= 3.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Storm Event Rainfall=6.60"

Area (ac)	CN	Description
0.310	71	Meadow, non-grazed, HSG C
0.260	74	>75% Grass cover, Good, HSG C
0.570	72	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	20		0.1		**Direct Entry, Path 1**
5.0	20	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: Overland runoff basin

Runoff = 16.92 cfs @ 12.09 hrs, Volume= 1.245 af, Depth= 4.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Storm Event Rainfall=6.60"

Area (ac)	CN	Description
1.168	98	Paved parking & roofs
1.911	74	>75% Grass cover, Good, HSG C
0.211	71	Meadow, non-grazed, HSG C
3.290	82	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.1600	0.2		**Sheet Flow, Path 1** Grass: Dense n= 0.240 P2= 3.20"
0.0	30	0.4667	11.0		**Shallow Concentrated Flow, Path 2** Unpaved Kv= 16.1 fps
1.1	227	0.0176	3.4	20.50	**Channel Flow, Path 3** Area= 6.0 sf Perim= 16.0' r= 0.38' n= 0.030 Earth, grassed & winding
0.3	80	0.0100	5.3	6.46	**Circular Channel (pipe), Path 4** Diam= 15.0" Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
5.0	387	Total, Increased to minimum Tc = 6.0 min			

Pond 2P: Retention Basin

Inflow Area =	3.290 ac,	Inflow Depth =	4.54"	for	100-Year Storm Event event
Inflow =	16.92 cfs @	12.09 hrs,	Volume=	1.245 af	
Outflow =	10.32 cfs @	12.20 hrs,	Volume=	1.200 af,	Atten= 39%, Lag= 6.9 min
Primary =	10.28 cfs @	12.21 hrs,	Volume=	1.200 af	
Secondary =	0.04 cfs @	12.20 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 522.01' @ 12.20 hrs Surf.Area= 7,123 sf Storage= 10,455 cf
Plug-Flow detention time= 54.2 min calculated for 1.198 af (96% of inflow)
Center-of-Mass det. time= 33.9 min (839.1 - 805.2)

Volume	Invert	Avail.Storage	Storage Description
#1	520.00'	21,404 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
520.00	3,310	0	0
522.00	7,051	10,361	10,361
523.10	13,027	11,043	21,404

Device	Routing	Invert	Outlet Devices
#1	Primary	520.50'	**12.0" x 20.0' long Culvert X 2.00** Ke= 0.600 Outlet Invert= 520.30' S= 0.0100 '/' Cc= 0.900 n= 0.012
#2	Primary	520.70'	**12.0" x 18.0' long Culvert** Ke= 0.600 Outlet Invert= 520.52' S= 0.0100 '/' Cc= 0.900 n= 0.012
#3	Secondary	522.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=10.27 cfs @ 12.21 hrs HW=522.01' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 7.13 cfs @ 4.5 fps)
└─**2=Culvert** (Barrel Controls 3.14 cfs @ 4.0 fps)

Secondary OutFlow Max=0.04 cfs @ 12.20 hrs HW=522.01' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 0.04 cfs @ 0.3 fps)

Link D.P. #99: Design Point

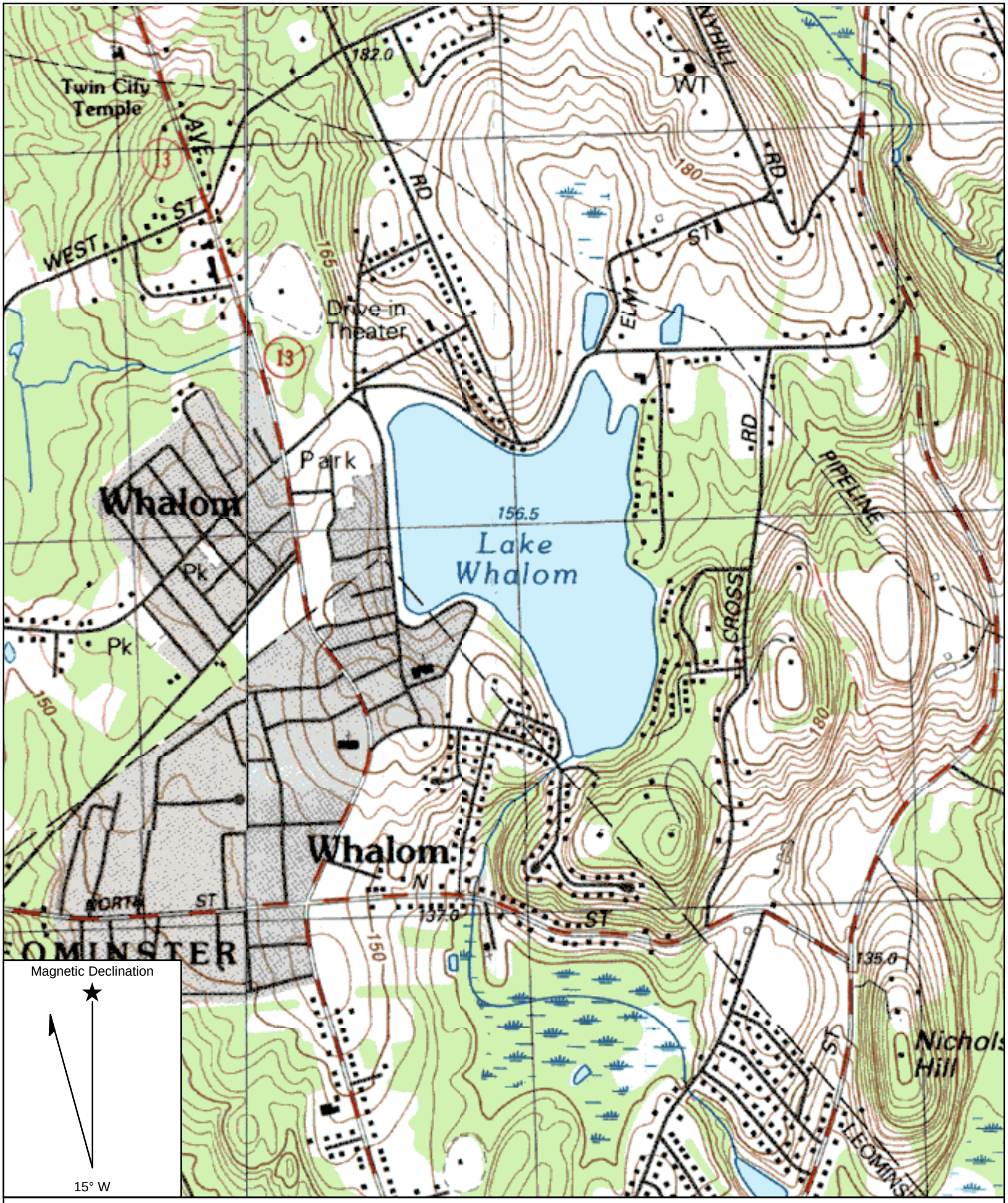
Inflow Area =	3.860 ac,	Inflow Depth >	4.25"	for	100-Year Storm Event event
Inflow =	11.97 cfs @	12.16 hrs,	Volume=	1.366 af	
Primary =	11.97 cfs @	12.16 hrs,	Volume=	1.366 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

FIGURES

FIGURE 1

LOCUS MAP



Name: AYER
Date: 8/18/2016
Scale: 1 inch equals 1000 feet

Location: 042° 34' 22.07" N 071° 44' 30.73" W NAD 27
Caption: 274 Prospect Street
Lunenburg, MA

Copyright (C) 1998, Maptech, Inc.

FIGURE 2

SCS SOIL MAP

Hydrologic Soil Group—Worcester County, Massachusetts, Northeastern Part
(274 Prospect Street - Lunenburg, MA)

Map Scale: 1:1,950 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 10, Sep 28, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 8, 2011—Apr 9, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Worcester County, Massachusetts, Northeastern Part (MA613)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Water		1.0	11.5%
305D	Paxton fine sandy loam, 15 to 25 percent slopes	C	1.3	14.5%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	1.8	19.9%
310C	Woodbridge fine sandy loam, 8 to 15 percent slopes	C/D	2.3	24.7%
622C	Paxton-Urban land complex, 8 to 15 percent slopes	C	2.7	29.4%
Totals for Area of Interest			**9.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

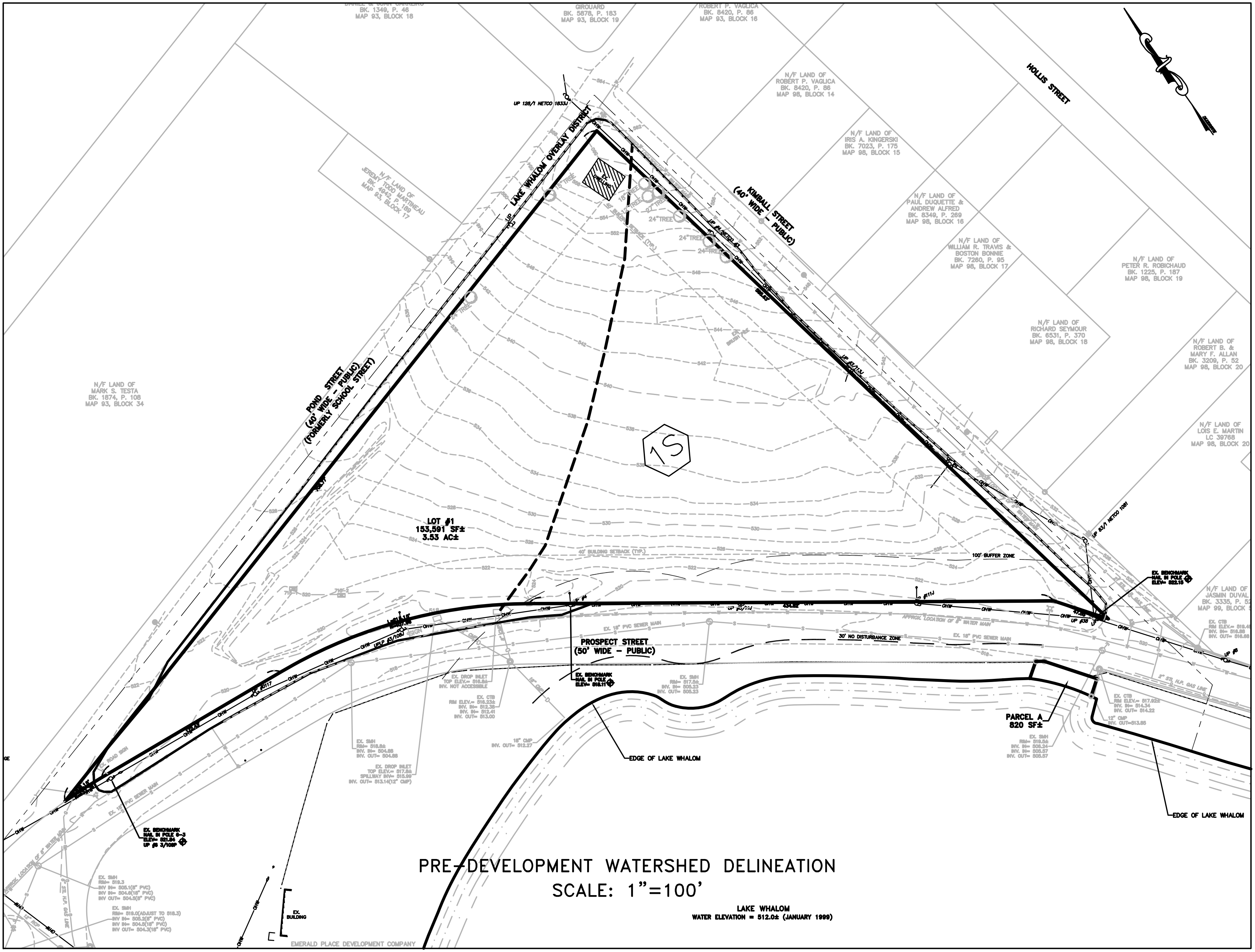
Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

FIGURE 3

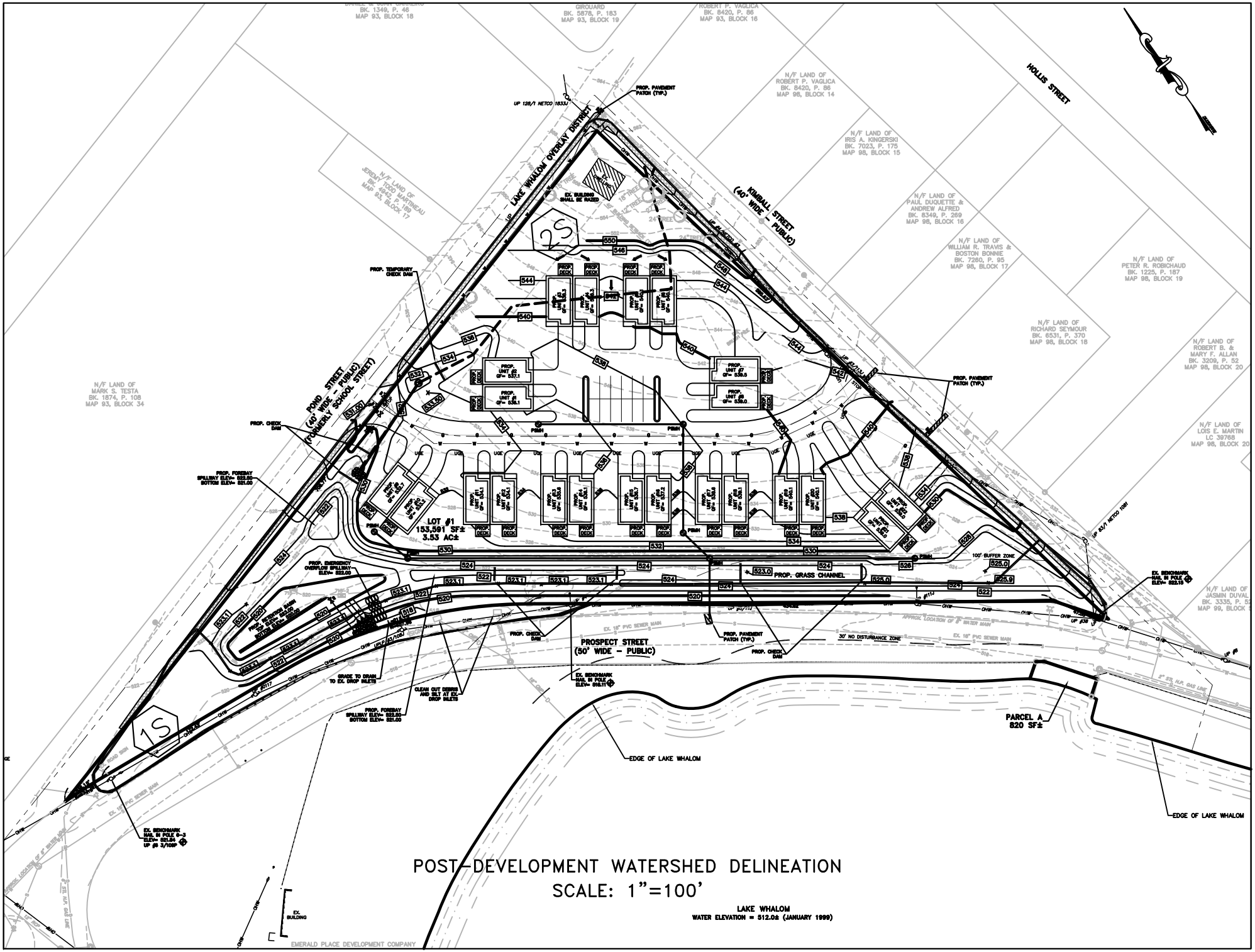
PRE-DEVELOPMENT WATERSHED DELINEATION



PRE-DEVELOPMENT WATERSHED DELINEATION
SCALE: 1"=100'

FIGURE 4

POST-DEVELOPMENT WATERSHED DELINEATION



POST-DEVELOPMENT WATERSHED DELINEATION

SCALE: 1"=100'

LAKE WHALOM
WATER ELEVATION = 512.0± (JANUARY 1999)

APPENDIX A

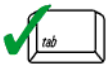
MA DEP STORMWATER CHECKLIST

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☒ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☒ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☒ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☐ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX B

STORMWATER REPORT

PROJECT TYPE

The project type is New Development.

The Site is located in the southeastern portion of Lunenburg on Prospect Street, Pond Street, and Kimball Street. The project Site consists of approximately 3.53± acres. The majority of the project site is covered by scrub brush. An existing single-family residence is located in the northeast corner of the property.

The proposed plans include the development of an eleven (11) building, twenty-two (22) unit townhouse development, that will include the construction of 12 parking spaces to supplement the proposed garage and driveway of the respective individual units.

STANDARD 1: No New Untreated Discharges

The project does not include any new untreated discharges. The drainage system has one (1) outfall locations with the stormwater being treated and peak attenuation occurring prior to discharge.

Utilizing outlet protection charts ("Erosion & Sediment Control Handbook", Goldman, Jackson & Bursztynsky) based upon pipe sizes and discharge rates, a rip rap apron was sized for the discharge points.

STANDARD 2: Peak Rate Attenuation

The project has been designed with stormwater controls such that the post-development peak rates of run-off from the project are consistent or less than pre-development rates. (Refer to the Stormwater Management Design Report.)

Peak Flows at Design Point #99

Storm Event	Existing Conditions (cfs)	Proposed Conditions (cfs)
2 yr. storm	3.02	3.02
10 yr. storm	7.58	7.44
25 yr. storm	10.32	9.42
100 yr. storm	15.03	11.97

STANDARD 3: Recharge

The required recharge volume is as follows:

Rv = F x impervious area

Total Additional Impervious Area = 50,878 sq. ft.
100% - "C" soil group

Rv = (0.25in/12 in/ft)*(50,878)
Rv = 1,060 **cu. ft.**

Utilizing the "Static" Method, the storage volume provided within the proposed stormwater basin under the elevation of the orifice in the outlet structure is 1,077 cu. ft.

The drawdown time for the proposed stormwater basin is calculated as follows:

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Rv= 1,060 cu. ft.
K = 0.27 in/hr
Bottom Area = 3,310 sq. ft.

Time = (1,060 cu. ft.)/[(0.27 in/hour/12in/ft)(3,310 sq. ft.)] = 14 hours < 72 hours

STANDARD 4: Water Quality

The TSS Removal Rate for the stormwater treatment system is 85% (see attached TSS Removal Spreadsheet).

STANDARD 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The project does not contain Land Uses with Higher Potential Pollutant Loads (LUHPPLs).

STANDARD 6: Critical Areas

The project does not require review by the Natural Heritage and Endangered Species Program due to its proximity to a critical area.

STANDARD 7: Redevelopments and Other Projects Subject to the Standards only the max. practicable

The project has been designed as New Development.

STANDARD 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

Erosion control measures are shown on the attached plans. The project will be covered by a NPDES Construction General Permit and the SWPPP will be submitted prior to land disturbance.

STANDARD 9: Operation and Maintenance Plan

This project is a private residential townhouse development. The property owner will be responsible for the maintenance and operation of the proposed stormwater management system.

As presented within the description of the proposed stormwater management system, several management practices have been instituted to collect, mitigate and treat stormwater runoff from the proposed development. These include the following:

- Grassed Channels
- Retention of stormwater, within the proposed stormwater basin to facilitate recharge of the groundwater system and balancing of pre/post flows.
- Construction of a stormwater basin with an associated outlet to mitigate pre and post peak development flows for all storm events (i.e. 2, 10, 25 and 100 year storm events).
- Reduction of stormwater velocities to lessen sediment transport throughout the subject site.

All of the above items reflect mitigation measures to improve and maintain stormwater quality that will flow as groundwater to the existing neighboring wetland system. In order to assure proper operation of the stormwater facilities in the future, it is necessary for a stormwater maintenance program be instituted and followed.

The proposed maintenance procedures and scheduling is as follows:

Construction Completion Maintenance

Once construction grading of the basin is completed, proper stabilization of all slopes within the Site and specifically the basin is required. Hay mulch, geotextile fabric, and hydroseeding are required to prevent necessary sediment transport to the basin bottom area. Haybales or siltfence will be required at the toe of interior basin slopes to prevent siltation of the exfiltration trenches or the basin bottom until the side slopes are stabilized.

Sediment Forebay Maintenance

Heavier deposits of sediment are anticipated in the forebay area of the basin. The forebays are required to be inspected monthly and cleaned on a quarterly basis. Depending upon the timing and combination of storm events, winter sanding operations, street sweeping, and other factors additional sediment removal may be required in the forebay area. A 6” PVC drain pipe should be installed vertically in the forebays of the basin to be used a sedimentation marker post. A line should be placed on the pipe at six (6) inches from the base of the forebay to denote at which time the forebay needs to be cleaned.

Grass in the forebay should be kept between 3 inches and 6 inches in height. Any areas within the forebays that are disturbed during maintenance should be reseeded or resodded; and if reseeding is used, incorporate practices such as hydroseeding with a tackifier, blanket or similar practice to insure that no scour takes place in the forebay, while the seeds germinate and develops roots.

Stormwater Basin Maintenance

The stormwater basin is a primary element of the Site's stormwater management program. Final treatment and infiltration of stormwater normally occurs within this mitigation structure. At a minimum, at 6 month intervals, the bottom of the basin requires inspection and removal of sediment if, during the inspection, an accumulation of 2" or more of sediment is found at several locations within the basin. In addition, routine inspections are required after each major storm event of 1" of rainfall or more. Additionally, the operation of the drainage system should be observed at least once every six months during a major storm event to evaluate its performance and note any deficiencies that may be occurring. Included within this report are sample inspection forms that should be completed to maintain proper records of necessary observations and required maintenance.

If persistent ponding of the basin's bottom is observed during routine inspections, this may indicate a significant reduction in the available exfiltration capacity. The cause of the reduction in capacity will need to be investigated. Additional removal of sediments and the reworking of the surface sand layer may be required to restore the infiltration capacity.

Inspection of stormwater basin's outlet is required. Accumulated debris, etc., is to be removed from the vicinity of the outflow. Additionally, interior inspection of the structure is necessary. Accumulated sediments within the outlet must be removed. The stormwater basin's emergency spillway shall be inspected on a regular basis. If there is evidence that an overflow event has occurred, the rip rap on the slope shall be examined to determine if repairs are required following the overflow event.

Due to the design of the interior slopes of the basin to accommodate construction equipment, it is anticipated that slope erosion should be minimal after the vegetation is established. If erosion of the slopes occurs, loam shall be replaced and standard methods used to re-establish proper vegetation cover. Fescues and reed canary grass seed mixtures, which are rapid growing and low maintenance, are recommended. Hay mulch or other suitable stabilizing techniques shall be utilized during the reseeding process.

On a bi-yearly basis the side slopes of the basin area will be mowed. The condition of the turf, the status of controlled tree growth, and evidence of differential settlement will be evaluated and if needed, corrective action will be taken. The outside toe of slope should be evaluated for evidence of ponding or leakage through the embankment. If evidence of leakage is apparent, an engineer will be engaged by the owner to evaluate the stability of the embankment and furnish recommendations regarding the structure.

Source Controls

In the event of a spill of petroleum products or hazardous substances, certain measures must be taken and include the following:

- A spill control and containment kit (containing, for example, absorbent materials, acid neutralizing powder, brooms, dust pans, mops, rags, gloves, goggles, plastic and metal trash containers, first aid equipment) should be readily available.
- All spills shall be cleaned up immediately after discovery.
- All measures must be taken to contain and abate the spill and to prevent the discharge of the Hazardous Substance or Oil to storm water or off-site. (The spill area must be kept well ventilated and personnel must wear appropriate protective clothing to prevent injury from contact with the Hazardous Substances.)
- In the event of a spill discharging to the stormwater system, the spill should be contained with the hooded catch basins and/or oil chambers of the water quality units. Any hazardous material found within the catch basins or water quality units should be removed immediately by a licensed liquid waste handler.
- The owner should be familiar with the spill reporting requirements of the Massachusetts Contingency Plan (310 CMR 40.0000).

Contact Numbers:

Town of Lunenburg Fire Department – Emergency – 911
Office – 978-582-4155

MADEP Emergency Response - 1-888-304-1133

Snow & Ice Management

- Snow should be stored in areas of the site such that any snowmelt is directed and captured by the drainage system.
- Avoid disposing of snow on top of storm drain catch basins or in stormwater drainage swales or ditches. Snow combined with sand and debris may block a storm drainage system, causing localized flooding. A high volume of sand, sediment, and litter released from melting snow also may be quickly transported through the system into surface water.
- Sand shall be the primary de-icing agent.
- After spring snow melt has occurred, snow storage areas should be cleaned of all trash, debris and accumulated sands.

Stormwater Maintenance Plan Data Sheets

Enclosed within the plan, is a “member roster” for the responsible party(s) for stormwater maintenance. It is recommended that the roster is completed and filed for future reference to aid in maintaining an adequate program. Additionally, storm water data sheets have been included to assist in record keeping of storm water events and required maintenance of the drainage system.

Whitman & Bingham Associates, LLC
Registered Engineers and Land Surveyors

Stormwater Maintenance Plan
Member Roster

Completed By:_____Title:_____Date:_____

Director:_____ **Title:_____**

Office Phone:_____

Responsibilities:_____

Member:_____ **Title:_____**

Office Phone:_____

Responsibilities:_____

Whitman & Bingham Associates, LLC
Registered Engineers and Land Surveyors

STORMWATER POLLUTION MAINTENANCE PLAN

INSPECTION AND MAINTENANCE REPORT FORM
(To be completed at 6 Month Intervals)

STORMWATER BASIN:

Basin ID#	Depth of Sediment in Basin	Condition of Basin Side Slopes	Any Evidence of Overtopping of the Embankment?	Condition of Outfall From Basin

MAINTENANCE REQUIRED FOR STORMWATER BASIN:

_____

_____

_____

_____

_____

_____

_____

_____

TO BE PERFORMED BY:_____**ON OR BEFORE:**_____

INSPECTED BY:_____**DATE:**_____

STANDARD 10: Prohibition of Illicit Discharges

This project is a townhouse development. It is not anticipated that there will be any illicit discharges into the Town of Lunenburg's drainage system.

APPENDIX C

TSS REMOVAL CALCULATIONS

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: 274 Prospect Street, Lunenburg, MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	**0.50**	**1.00**	**0.50**	**0.50**
Infiltration Basin	**0.70**	**0.50**	**0.35**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**

Total TSS Removal = **85%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **Apple Tree Realty Trust**
Prepared By: **WRF**
Date: **8/15/2016**

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

APPENDIX D

SOIL TESTING RESULTS

715-1

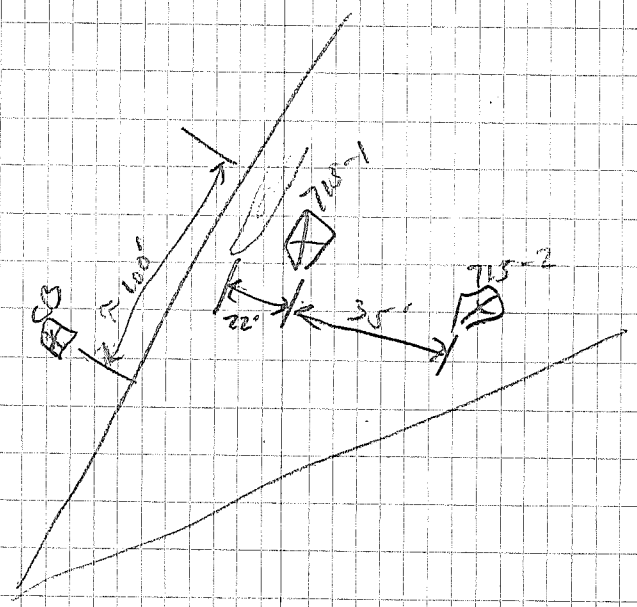
0-48" FILL
48"-96" C. L.S. 2.5Y 6/4
weep 72" NO REF mottles
obs mottle ESHGW 48" 7.5YR 4/6
2.5Y 5/1

715-2
0-48" FILL
48"-96" C
weep 72" NO REF
obs mottle ESHGW 48" mottles
7.5YR 4/6
2.5Y 5/1

7-7-15

274 Prospect Street
Lansburg
MFP — WGA
Bob Gray — Dan Gamroth
Excavating

FOR STORMWATER



[1]"Urban Hydrology for Small Watersheds (Technical Release Number 55); Engineering Division, United States Dept. of Agriculture, Soil Conservation Service (Jan. 1975).

[2]"National Engineering Handbook Section 4-Hydrology"; United States Dept. of Agriculture, Soil Conservation Service (March 1985)

[3]"HydroCAD" Drainage software developed by Applied Microcomputer, Page Hill Road, Chocorua, NH; Tel. (603) 927-RAIN Copyrights 1986-2005. (version 7.10)