ACORN ENGINEERING, INC.

STORMWATER MANAGEMENT REPORT

Prepared For:

Redfern Properties, LLC
Munjoy Heights
79 Walnut Street
Portland, Maine 04101

Prepared By:

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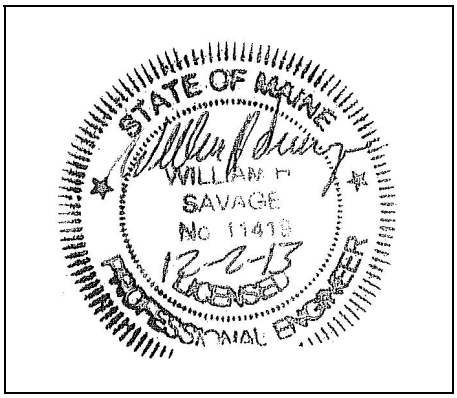

November 2013
Revised 11/27/13

INTRODUCTION

The Stormwater Report was revised to include an additional level of detail for our Final Submission and to respond to written comments from Woodard & Curran dated November 20, 2013.

Acorn Engineering, Inc. has been retained by Redfern Properties, LLC to provide civil engineering services for the proposed development of Munjoy Heights located at 79 Walnut Street in Portland, Maine. Munjoy Heights is a 29-unit vertical urban infill development set on the western slopes of Munjoy Hill. At the private driveway elevation each two to four story unit will have a dedicated garage with approximately 1,900 to 2,400 square feet (sf) of livable space comprised of units with 3 bedrooms.

A stormwater analysis will be prepared to demonstrate that the project will meet the following requirements of the City of Portland (the City):

- City of Portland Land Use Ordinance Chapter 14, Article V. Site Plan Section 14-523. Required Approvals and Applicability (F) Level III Site Plan Review.
- City of Portland Technical Manual – Section 5 – Portland Stormwater Management Standards and Maine DEP Chapter 500 Stormwater Management.

On July 19th, 2013 representatives of Acorn Engineering met with David Margolis-Pineo and Doug Roncarati to discuss the proposed stormwater connection to the municipal sewer system. Potential locations include the intersection of Eastern Promenade and Washington Avenue, East Cove Street, the intersection of Washington Avenue and Fox Street as well as the intersection of Sheridan Street and Walnut Street.

At the meeting Acorn Engineering was informed that the storm sewer located at the Walnut Street and Sheridan Street intersection towards Washington Avenue has been identified by the City as a proposed green infrastructure storm sewer separation project. The green infrastructure storm sewer separation project is part of the City of Portland's Combined Sewer Overflow Tier III Improvement Plan and that the cost of such improvements would be paid for and implemented by the City.

Based upon our discussion, both parties agreed that connecting the proposed Munjoy Heights storm drainage to the existing Walnut Street combined sewer would be the best course of action and would facilitate the future connection to the separated municipal storm drainage network.

The proposed project will include the redevelopment of existing impervious area including rooftops, asphalt and gravel driveways and parking. The current course of action is to provide water quality treatment to the stormwater through filtration utilizing a Maine Department of Environmental Protection - Underdrained Subsurface Sand Filter and Bioretention Cell (Rain Garden) approved stormwater Best Management Practice (BMP). This development shall incorporate green infrastructure to provide water quality treatment for no less than 95% of the new impervious area and 80% of the developed area.

The stormwater analysis is documented with supporting calculations and reports attached to this narrative.

EXISTING CONDITIONS

The proposed project is located to the west of 79 Walnut Street in Portland. The proposed lot is a combination of multiple properties which presently include Portland Tax Map 012, Block H, Lots 1, 3, 5, 7, 9 (portion), 13, 17 and 22, Block G, Lot 6, and Block F, Lots 2 (portion), 4, 7, 18, 19 and 20 that consists of 66,624 square feet (1.53 acres) of land area. Portland has zoned this area as an R-6 Residential Zone. An existing conditions plan has been prepared by Nadeau Land Surveys of Portland, Maine dated 11/11/2013.

Abutting Uses:

- North R-6 Zone - Volunteers of America and Residences
- West R-6 Zone - Northern Burner Supply
- South R-6 and B2B Zone - Single and Multi-Family Residential
- East R-6 Zone - Single and Multi-Family Residential

The existing vacated paper street will also be claimed and is 20,684 square feet (0.47 acres) of land area. There is an existing two story building residing on Block H, Lot 9 which shall remain with a reconfigured lot line. The single family on Block F, Lot 19 and 20 and multi-family on Block H, Lot 17 shall be removed.

The majority of the project area is comprised of tree cover with grassed areas adjacent to the single and multi-family properties. Impervious areas include the existing buildings as well as paved and gravel driveways. From southeast to northwest the existing grades go from gradual to relatively steep with much of the slope at approximately 25%.

The project area presently drains towards Washington Ave before entering the municipal combined sewer system. The Washington Ave combined sewer conveys flow towards Anderson St and ultimately on to the Portland Water District - East End Wastewater Treatment Facility. At this location inflow enters the system through existing separated drainage from Sheridan Street and then recombines into the combined sewer that recombines within Walnut Street. The Walnut Street CSO crosses Washington Ave at which time it runs parallel to a separate drainage system. The distance between the separated drainage is approximately 382 ft. Separating the 382 ft. of CSO is part of the green infrastructure storm sewer separation project described within the City of Portland's Combined Sewer Overflow Tier III Improvement Plan.

The project team is not aware of the presence of any existing significant natural features located on the site. Given the urban setting, existing free-draining soils and steep slopes a field inventory of significant natural feature was not undertaken. The project is not located within a watershed classified as an Urban Impaired Stream.

PROPOSED DEVELOPMENT

Munjoy Heights is a twenty nine unit vertical urban infill development set on the western slopes of Munjoy Hill. At the private driveway elevation each two to four story unit will

have a dedicated garage with a minimum of one parking space with additional room for solid waste/recycling. Parking will be supplemented with five surface parking spaces to be used by residents and their guests. To minimize the developments footprint and amount of impervious area, the driveway is reduced to a minimum width of twenty feet and the units have been clustered together.

The driveway grading profile will follow the natural topography with proposed 1% slopes. As described in the existing conditions, the significant topographic relief will occur from East to West. The goal of the project is to work with the existing conditions, specifically topography. To the greatest extent practical this is achieved through the reduction of surface parking through the use of garage parking spaces, a reduction in the overall private driveway width and terracing the townhomes into the slope. Terracing will be completed through stepped foundations and retaining walls. The retaining walls are setback a minimum distance of 8-10 ft to from the building to reduce the size of the developments footprint while providing access to the exterior of the buildings. Summit Geoengineering Services in coordination with Structural Integrity Consulting Engineering will provide the retaining wall design for the building permit application. The retaining walls shall be of made of durable and attractive materials with a high architectural quality.

The landscaping plan includes aggressive planting of trees and shrubs. The re-vegetation strategy proposes native plants in densely planted woodland gardens that native forest plant communities. The landscaping will complement the contemporary townhomes while offering environmental benefits such as reducing the heat island effect, stormwater quality treatment, reduce erosion, provide wildlife habitat and screen the proposed retaining walls from abutting residences. The landscaping design has been provided by Soren Deniord Design Studio.

The development will be served by the Portland Water District, underground power/cable/communications, natural gas and the municipal sewer system. Solid waste and recycling will be contracted through a private waste disposal and recycling provider.

The project anticipates incorporating Maine DEP approved stormwater Best Management Practices to meet the General and Flooding Standards.

GENERAL STANDARDS - WATER QUALITY

The development shall provide water quality treatment for no less than 95% of the new impervious area and 80% of the developed area. The project includes the redevelopment of existing impervious area including rooftops, asphalt and gravel driveways and parking. Water quality treatment shall be provided through the use of an Underdrained Subsurface Sand Filter and Bioretention Cell. From herein the Bioretention Cell shall be referred to as a Rain Garden.

The underdrained subsurface sand filter BMP (USSF) was sized to meet or exceed the requirements set forth within the MDEP Volume III: BMPs Technical Design Manual Section 7.3. Filtration BMPs have been shown to be very effective at removing a wide range of pollutants from stormwater runoff. The stormwater runoff shall first flow into the StormTech Isolator Row which shall provide initial treatment. The stormwater shall be detained within the chambers and surrounding aggregate before flowing vertically through

the sand filter layer. The treated stormwater shall then be collected within perforated pipes and released slowly by the outlet control structure at an attenuated rate.

The treatment of the impervious surface is as follows:

Table 1 - Impervious Treatment Area Table

	Existing Impervious Area (SF)	Proposed Total Impervious Area (SF)	Proposed Impervious Area with No Treatment (SF)	Proposed Impervious Area with Treatment (SF)	Net change in Impervious Area (SF)	% Overall New Imp. Area Treated
USSF BMP	11,628	43,603	644	42,959	31,975	134%

The treatment of the developed surface is as follows:

Table 2 - Developed Treatment Area Table

	Developed Area (SF)	Developed Area with No Treatment	% Overall Developed Area Treated **
USSF BMP	64,148	9,113	86%

As shown above the project anticipates meeting and exceeding the required treatment for new impervious surfaces and the overall developed area through the use of the underdrained subsurface sand filter and rain garden BMP.

A calculation for rain garden is necessary to meet the requirements as defined in the Volume III: BMPs Technical Design Manual, Chapter 7.2, the surface area of the filter shall be no less than the sum of 7% of the tributary impervious area and 3% of the tributary vegetated area. The filter area is calculated by the following formula:

$$[(\text{Imp. SF} \times 0.07) + (\text{Veg. SF} \times 0.03)] = \text{Filter Area (SF)}$$

Please refer to Table 3 below.

A calculation for sand filter area is necessary to meet the requirements below the surface of the USSF. As defined in the Volume III: BMPs Technical Design Manual, Chapter 7, the surface area of the filter shall be no less than the sum of 5% of the tributary impervious area and 2% of the tributary vegetated area. The filter area is calculated by the following formula:

$$[(\text{Imp. SF} \times 0.05) + (\text{Veg. SF} \times 0.02)] = \text{Filter Area (SF)}$$

Please refer to Table 3 below.

Table 3 – Total Filter Surface Area, displays the proposed Rain Garden and USSF sizing requirements, actual size and the percentage of required area.

Table 3 –Total Filter Surface Area			
	Required Filter Area (SF)	Actual Filter Area (SF)	Percentage of Required Area (%)
Rain Garden BMP	549	338	62%
USSF BMP	2,391	2814	118%
Total	2,940	3,152	**107%**

The outflow from the Rain Garden is then tributary to the USSF where additional water quality treatment and attenuation is provided. As shown, the size of the combined soil filter area will meet and exceed the surface area requirements.

The StormTech Isolator Row length was sized to meet and exceed the 0.2 cfs for each SC-740 based upon the one year peak flow rate. The project anticipates the use of nine isolator rows which shall meet the required amount for a one year peak flow rate of 1.5 cfs.

In accordance with the Volume III: BMPs Technical Design Manual, a water quality volume of 1.0 inches times the tributary impervious area plus 0.4 inches times the tributary disturbed area is required to be treated by the Rain Garden and USSF. The water quality volume is calculated by the following formula:

$$\left(\frac{\text{Imp. SF x 1.0"}}{\text{12"/1'}}\right) + \left(\frac{\text{Veg. SF x 0.4"}}{\text{12"/1'}}\right) = \text{Treatment Volume (CF)}$$

The proposed water quality volume is as follows:

Table 4 - Water Quality Volume Table				
	Disturbed Area (SF)	Impervious Area (SF)	Treatment Volume Required (CF)	Treatment Volume Provided
Rain Garden	1,555	7,177	**650**	**210**
USSF BMP	22,601	35,782	**3,735**	**4,855**
Total	24,156	42,959	**4,385**	**5,065**

As shown, the size of the combined water quality volume will meet and exceed the treatment volume requirements.

Once the water quality volume is known an artificial rainfall event is created within HydroCAD, to mimic a storm event which equals the water quality volume. Based upon the artificial rainfall event the depth of the water quality volume within the chamber system will not exceed 18 inches, as required.

Provided the infiltration rates of the water quality volume through the sand filter are variable a water quality outlet is modeled to provide the required minimum 24-hour release time. This is completed by adjusting the rainfall amount in HydroCAD until the inflow volume is equal to or greater than the calculated treatment volume. The storm events are modeled as type III, 24-hour storm events in HydroCAD.

A vertical orifice is modeled in HydroCAD at the outlet control structure. The orifice diameter is sized to detain the stormwater for an approximate period of 24 hours. The orifice shall be placed at the end of the larger outfall pipe on the outlet control structure baffle to be inspected or replaced if necessary. The orifice is intended to be a PVC cap placed on the outfall pipe (no glue) with the orifice drilled into the cap eccentrically. The PVC cap can be easily inspected, removed or replaced if necessary. The orifice for the water quantity volume is then set above the peak elevation determined for the water quality volume.

FLOODING STANDARD – WATER QUANTITY

The proposed project was modeled using HydroCAD to verify that the post-development conditions do not exceed the pre-development conditions. A 24-hour SCS Type III storm distribution for the 2, 10, and 25 year storm events were used. The corresponding rainfall amounts for these storms are 3.00", 4.70", and 5.50" respectively.

Due to the numerous variables, and inherent inaccuracies with the modeling program used to calculate stormwater runoff it is custom at Acorn Engineering, Inc. to round to the nearest whole number. However due to the small size of the project the stormwater runoff shall be rounded to the nearest tenth of a cubic feet per second (cfs).

Time of Concentration (T_c)

In our initial submission a time of concentration (T_c) of 5 minutes was applied to each subcatchment for both the pre and post-development condition, given the urban setting, and steep slopes. This was a conservative approach that in the post-development condition would result in the two separate subcatchments peak flow rates combining at the reach at the same time. Using different Tc's can result in a multiple peak flow rates and can result in an overall lower combined peak flow. For this submission we have revised the direct entry method to provide a unique time of concentration for each subcatchment.

The Pre and Post Development HydroCAD Calculations and Maps describe and depict the time of concentrations length, slope and condition for the sheet and shallow concentrated flow. Given the steep slopes a sheet flow length greater than 80 feet was not used. As previously described the goal of the landscaping plan is to design a densely planted woodland gardens nearly the entirety of the unbuilt space. Although the goal is a *woodland* garden a Manning's Number for Grass: Dense was used versus Woods: Light Underbrush. This would provide a more conservative result or higher peak flow rate.

Curve Number

Within the initial submission conservative curve number (CN) runoff values were used within the subcatchments for the impervious area and landscaped area. The stormwater

calculations were modified to use the more appropriate CN values in the post development condition, as follows:

- 75% Grass Cover, Good to Woods/Grass Combination Good
- Pavement to Concrete Pavers (Compacted Gravel)

Given the aggressive landscaping plan is to design a densely planted woodland gardens the Woods/Grass Combination was deemed a more appropriate CN value. For the concrete pavers the effective CN value would be that of the base material.

Pre-development Calculations

Given the prior agreement with the City to outlet the development's stormwater within Walnut Street the pre-development condition was modeled as one subcatchment to determine the net impact of the development.

- Subcatchment 1 – The subcatchment area is defined to the North, West and South by the property line and to West by the extents of the area tributary to the development.

A Pre-development Watershed Map developed for this project can be viewed in Attachment A, and a copy of the HydroCAD calculations is included within Attachment D, or this report. Peak flow rates for the storm events are as follows:

Table 5 – Pre-Development Peak Stormwater Flows

Drainage Area	2 – Year Storm Event (cfs)	10 – Year Storm Event (cfs)	25 – Year Storm Event (cfs)
POI #1	0.5	2.5	3.7

Post-development Calculations:

The one predevelopment subcatchment was broken into two separate subcatchments for the post-development condition.

- Subcatchment 1 – This is comprised of the offsite and project development area tributary to the USSF which outlets to Walnut Street.
- Subcatchment 2 – This subcatchment is characterized as the landscaped area downhill of the driveway and proposed sidewalk to East Cove St.
- Subcatchment 3 - This is comprised of the project development area tributary to the Rain Garden which outlets to the USSF.

The post development calculations include changes to the land use, and the compensation provided by the detention facility. The following table represents comparison of predevelopment and post-development condition peak runoff rates for the proposed development and tributary area.

Table 6 – Comparison of Peak Flows						
Drainage Area	2 – Year Storm Event (cfs)		10 – Year Storm Event (cfs)		25 – Year Storm Event (cfs)	
	Pre	Post	Pre	Post	Pre	Post
POI #1	0.5	0.4	2.5	2.2	3.7	3.0

As shown in Table 6 the net impact of the post development peak flows shall remain at or below the predevelopment levels. A Post-development Watershed Map developed for this project can be viewed in Attachment A, and a copy of the HydroCAD calculations is included within Attachment D, of this report.

The 100-year storm event was modeled to determine whether a 12" outlet would restrict the conveyance of stormwater. The results determine that the 12" outlet can withhold the 100-year peak flow of 5.7 cfs and has the potential to outlet 10.2 cfs of stormwater flow. Given the relative small peak flows the rational method was not utilized to size the storm drains.

Conveyance of Flow to Walnut Street

As a result of further refinement of the stormwater report and calculations the proposed peak stormwater flows to Walnut Street have decreased from the prior submission.

Table 7 – Comparison of Peak Flows to Walnut						
Drainage Area	2 – Year Storm Event (cfs)		10 – Year Storm Event (cfs)		25 – Year Storm Event (cfs)	
	Prior	Post	Prior	Post	Prior	Post
POI #1	0.6	0.3	2.6	2.0	3.8	2.8

Down Gradient Property Owners:

The post development (proposed) peak stormwater surface flows tributary to the down gradient property owners shall remain below the predevelopment (existing) levels. This is a result of the project's LID techniques, subsurface detention, terracing the development, extensive landscaping and diverting a portion of the tributary area.

SOILS

Onsite soil information includes the following:

- Summit Geoengineering Services – Preliminary Geotechnical Report, dated July 2013.
- Summit Geoengineering Services – Soil Boring Logs, Dated September 26, 2013.
- Mark Hampton Associates, Inc. – Hydrological Classification of Soils Letter, dated August 25, 2013.

Given the soils information, listed above, no onsite wastewater is proposed, deep fills/cuts the applicant does not intend to perform a more intense hydric soil boundary delineation

because of the waiver requirements set forth in the City of Portland Technical Manual – Section 7 – Soil Survey, Rev. 6/17/12 are met.

The area within and surrounding the project includes soils types listed in the table below. The susceptibility of soils to erosion is indicated on a relative "K" scale of values over a range of 0.02 to 0.69. Higher "K" values indicate more erodible soils.

Table 3 - "K" Value		
Soils Type	**Subsurface**	**Substratum**
Hinckley	.17	.17

The soil "K" values for the soils, listed above, show a low susceptibility to erosion. The site's susceptibility to erosion is from the Soil Conservation Service Medium Intensity Soil Survey for Cumberland County. Although soil "K" values for the soils show a low susceptibility to erosion, implementation of the proposed Erosion & Sedimentation Measures by the contractor will be of the utmost importance, given the long sustained slopes.

Conclusion

The proposed development was designed to meet the requirements implemented by the MDEP under the Stormwater Management Statute (38 M.R.S.A. § 420-D) as well as the City of Portland Technical Manual – Section 5 – Portland Stormwater Management Standards. As a result the design of the proposed development and stormwater system does not anticipate to create erosion, drainage or runoff problems either in the development or with respect to adjoining properties.

Attachments

Attachment A: Pre Development Watershed Map
Attachment B: Post Development Watershed Map
Attachment C: Mark Hampton Associates, Inc. – Hydrological Classification of Soils Letter, dated August 25, 2013
Attachment D: HydroCAD Calculations
Attachment E: Stormwater Operation and Maintenance Plan