TOWN OF VINALHAVEN

DOWNTOWN DRAINAGE STUDY - FINAL

August 22, 2007
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Hill Road

August 22

Woodard & Curran

Practices

Clean Water Act

Water Street

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EXECUTIVE SUMMARY

In 2003, the Town of Vinalhaven began construction of a community-wide wastewater collection and treatment system. The new system was built to immediately replace approximately 260 individual wastewater treatment systems throughout the community, with a potential full build-out capacity to serve approximately 440 users.

The new wastewater collection and treatment system was sized to accommodate a reasonable growth in the Community based on the stated goals of the Town’s Comprehensive Plan. Although it is very early on in the operation of the system, the staff has observed significantly higher than expected flows during the spring and fall seasons. All communities in Maine experience increases in wastewater flows during these times of the year, resulting from infiltration and inflow sources, however, for a new system like this, the flows being observed were quite alarming. Direct inflow sources, like basement sump pumps, foundation drains, roof drains, etc. are likely connected to the collection system throughout the Community and are contributing to this significant flow increase during these periods.

In keeping with the goals of the Comprehensive Plan, the Town must ensure that the intended capacity of the wastewater collection and treatment system is maximized for the planned growth and anticipated development purposes, and therefore extraneous flows such as those suspected of contributing to this problem, must be removed. As a result, the Town has decided to proceed with developing a strategy for removing the extraneous flow sources. In order to accomplish this goal, a comprehensive drainage study throughout the newly sewered regions of Town was conducted. This ensures the best practical solution is developed that will consider the various challenges throughout different parts of Town.

The Town of Vinalhaven received a planning grant from the Maine Municipal Bond Bank to perform a community wide drainage study and develop a report of the findings including recommendations to improve the existing drainage systems. The Town retained Woodard & Curran to conduct the drainage study and develop the report. This report includes an assessment of the existing drainage systems throughout the study area.

With regard to drainage system components, the Town has never undergone a community wide drainage project to address overall system deficiencies. Projects have been conducted on an individual basis over time to address specific situations or problems with little thought about combining drainage areas into common discharge points or thinking on a global basis.

To better understand the capacity and deficiencies of the existing drainage system components in Vinalhaven, the quantity of runoff generated from various storm events was determined. From the topographical information obtained for the recent Town wide sewer system construction project, the study area was divided into 24 individual drainage areas. Some of the larger, more complex watersheds were divided into smaller sub-areas based on key drainage features such as culverts, catch basins, or other points of flow concentration. This allowed the sub-areas to be further analyzed as separate watersheds and evaluated for adequate capacity.

The digital base map of the wastewater collection system developed by Woodard & Curran was utilized for this study. HydroCAD 8.0, software developed for modeling stormwater systems, was used for determining the expected flows from each drainage area. The output of this modeling effort was used to develop a comprehensive system wide improvements plan.
From our analysis, it is clear that most of the stormwater conveyance systems in place throughout Vinalhaven are undersized for the drainage area they serve. In many instances the structures and pipes were likely installed as a stop gap to address a specific situation or issue without consideration of the upstream drainage areas. Shallow ledge may have also impacted the pipe sizes used for many of the culvert crossings and system components. Many of the streets are located within narrow right-of-ways which further impact and complicate the ability to install adequate drainage systems.

We have developed a series of conceptual improvements based on the findings of our analysis. The proposed projects have been prioritized into short term and long term recommendations. The concepts have been developed in accordance with typical design standards in Maine, where closed drainage systems are sized to accommodate the 10-year storm event, culverts and major drainage components are sized to meet the 25-year storm event, and all components within MDOT right-of-ways are sized to accommodate the 50-year storm. Most all of the improvements will not only accommodate stormwater runoff, but will also provide an opportunity to connect foundation, basement, and roof drains from individual residences directly to the stormwater system.

Based on the overall costs to improve the existing stormwater systems, a practical approach would be to phase the design and construction of each project such that high priority areas are built first with lower priority ones waiting for future years. An existing moratorium against construction within MDOT right-of-ways on the island due to recent construction will place all proposed improvements along these roads into being long term recommendations. Work within the traveled way of these roads can not be contemplated until at least as early as 2011.

Many projects have been combined with known future sidewalk construction projects. This should result in more cost effective solutions for improving specific drainage problems throughout Vinalhaven. Another way to realize cost savings is to pair the recommendations with road reconstruction projects, or utility improvements like water main replacement.

The findings of this report indicate that the cost to improve the stormwater systems throughout Town requires a significant capital investment. We have estimated that short term recommendations will cost approximately $697,000 to construct and that long term recommendations will cost approximately $2,156,000 to construct.

Sources of funding for projects of this type are typically loan based. Some competitive grant funding is available however it would likely go to applicants with significantly worse and previously known and identified pollution problems.

There are no reports of stormwater quality issues or concerns with non-point source pollution of the receiving waters in the community, primarily the Atlantic Ocean. Stormwater generated from construction activities is regulated and enforced by separate laws at the State level. These apply to development and construction activities on Vinalhaven. When implementing the improvements to the stormwater systems, we will encourage the Town to implement BMPs to ensure that the water quality within the Pond, the Harbor, and tributary receiving waters such as Indian Brook, will not diminish.
1. INTRODUCTION

1.1 GENERAL

The Town of Vinalhaven is an island community located in Knox County, located off the coast of Rockland. (Refer to Figure 1-1 for location and surrounding area). The island is comprised of one general area of concentrated population and development. This area spans a region nearly 2 miles long from Harbor Road east to Arcola Lane, more or less centered around East Main Street, West Main Street and High Street. The region consists of a mixture of residences, businesses, governmental properties, and facilities dedicated to a variety of commercial fishing. Outside of this region of concentrated population exists several smaller pockets of residential development.

Vinalhaven is a community where the local economy is heavily dependent on the commercial fishing industry, mainly relying on the harvesting of lobsters. Most of the other businesses throughout Town service the majority of the community which is employed in some form of commercial fishing. Based on the 2000 census data, the population of Vinalhaven is approximately 1,235.

In 2003, the Town of Vinalhaven began construction of a community-wide wastewater collection and treatment system. The new system was built to immediately replace approximately 260 individual wastewater treatment systems throughout the community, with a potential full build-out capacity to serve approximately 440 users.

The new wastewater collection and treatment system was sized to accommodate a reasonable growth in the Community based on the stated goals of the Town’s Comprehensive Plan. Although it is very early on in the operation of the system, the staff has observed significantly higher than expected flows during the spring and fall seasons. All communities in Maine experience increases in wastewater flows during these times of the year, resulting from infiltration and inflow sources, however, for a new system like this, the flows being observed are quite alarming. Direct inflow sources, like basement sump pumps, foundation drains, roof drains, etc. are likely connected to the collection system throughout the Community and are contributing to this significant flow increase during these periods.

In keeping with the goals of the Comprehensive Plan, the Town must ensure that the intended capacity of the wastewater collection and treatment system is maximized for the planned growth and anticipated development purposes, and therefore extraneous flows such as those suspected of contributing to this problem, must be removed. As a result, the Town has decided to proceed with developing a strategy for removing the extraneous flow sources. In order to accomplish this goal, a comprehensive drainage study throughout the newly sewered regions of Town must be conducted. This will ensure the best practical solution is developed that will consider the various challenges throughout different parts of Town.

The Town of Vinalhaven received a planning grant from the Maine Municipal Bond Bank to perform a community wide drainage study and develop a report of the findings including recommendations to improve the existing drainage systems. The Town retained Woodard & Curran to conduct the drainage study and develop the report. This report includes an assessment of the existing drainage systems throughout the study area.

This storm water study assesses the existing condition of the drainage components within the many drainage areas of the Village portion of Vinalhaven and provides a roadmap for upgrading the drainage system in a way that will allow the Town to understand the larger picture while proactively addressing individual system improvements.
The digital base map of the wastewater collection system developed by Woodard & Curran will be utilized for this study. HydroCAD 8.0, software developed for modeling stormwater systems has been used for determining the expected flows from each drainage area. The output of this modeling effort was used to develop a comprehensive system wide improvements plan. The plan provides a prioritized list of improvements that can be systematically implemented over the next several years as funding allows.
2. PROJECT APPROACH

2.1 GENERAL
The Town of Vinalhaven retained Woodard & Curran Inc. to evaluate the community’s overall public drainage system needs and to determine the feasibility of the Town developing necessary improvements. This report discusses the information that was gathered, the analysis that was performed, the options that were considered, and outlines several projects on a prioritized basis that the Town could build to improve the existing drainage systems in place throughout the community.

2.2 DESCRIPTION OF STUDY AREA
The study area is located adjacent to Indian Creek, Carvers Harbor and Carvers Pond on Vinalhaven Island, and contains the majority of the downtown portion of the town. The study area has been defined to be within the region where the new wastewater collection system was built. The downtown and surrounding areas of Vinalhaven consist of nearly level to steeply sloped terrain, rising from the shore to approximately 90 feet in elevation. Development is primarily residential, with some commercial and municipal properties located close to the downtown area and along the shore. The shoreline is very rocky with granite walls, piers, and wharves along much of its length.

2.3 INFORMATION GATHERING
On June 12, 2006, Woodard & Curran representatives visited the island and observed the existing condition of the public drainage system components and took several pictures of the community and the existing drainage systems. This information was then reviewed against the as-built drawings from the recent wastewater collection project to update the base plans for the project. In addition to this site visit, we have solicited input from the Town on known drainage issues and other areas that continue to be maintenance concerns.

Maps providing information on specific physical characteristics of the community as a whole were obtained and reviewed which included United States Geographical Survey (USGS) Topographic Quad sheets, Significant Sand and Gravel Aquifer maps, Surficial Bedrock Geology Maps, Soil Conservation Services (SCS) soils maps, Tax Maps, and aerial photographs. We also received a copy of the Vinalhaven Sidewalk Committee’s Condition Assessment and Maintenance & Development Plan prepared in the spring of 2006. This document is intended to be the framework for sidewalk construction projects for future years in Town.

From this information, the study area was divided into individual drainage areas. The drainage areas were analyzed with stormwater modeling software to determine the hydraulic capacity of each system and to develop recommendations for drainage system improvements.

2.4 EXISTING DRAINAGE SYSTEM
Development on Vinalhaven is very similar to that of other island communities. The best available land, typically closest to the ocean, has been developed in cluster fashion with many houses occupying small lots. Public water has been supplied to the residents of Vinalhaven for nearly 100 years with town-wide wastewater collection and treatment only available for three years. With regard to drainage system components, the Town has never undergone a community wide drainage project to address overall system
Deficiencies. Projects have been conducted on an individual basis over time to address specific situations or problems with little thought about combining drainage areas into common discharge points or thinking on a global basis.

To better understand the capacity and deficiencies of the existing drainage system components in Vinalhaven, the quantity of runoff generated from various storm events must be determined. In order to perform this task, we have to identify the many different drainage patterns and drainage areas that exist. Drainage areas are regions of land that drain or discharge to a common outlet location.

2.5 DRAINAGE AREA DEVELOPMENT

As discussed, a drainage area is a region of land where stormwater runoff drains to the same common location, which is typically the place of the lowest elevation within the region. In many cases the low point location is a catch basin, a culvert, a ditch, or a water body like a pond, stream, or the ocean. Many drainage areas can be considered a sub-drainage area of another. For instance, an area of land that drains to a series of catch basins and pipe may discharge onto another drainage area which may convey water to a larger water body. The relationship between drainage areas is very important. By determining the expected runoff in each drainage area without factoring the cumulative impacts of upstream drainage areas, critical system drainage components such as ditches or culverts may be significantly undersized which could lead to poor system performance, flooding, erosion and sedimentation concerns, or ultimately damage to Town infrastructure like roads and walkways.

Physical features such as buildings, slopes and ridges, roadways, etc define the boundaries of specific drainage areas. From the topographical information obtained for the recent Town wide sewer system construction project, the study area was divided into 24 individual drainage areas. Some of the larger, more complex watersheds were divided into smaller sub-drainage areas based on key drainage features such as culverts, catch basins, or other points of flow concentration. This allowed the sub-drainage areas to be further analyzed as separate watersheds and evaluated for adequate capacity. The drainage areas are shown on Figure 2-1 and Figure 2-2.

It is important to point out that in many parts of the study area, such as lands directly abutting the ocean that were not directly impacted by existing drainage system components, we did not analyze the drainage characteristics and estimate stormwater runoff. Stormwater runoff from these areas generally flows overland to the water. Since these areas did not impact existing drainage systems or roadways, and were located in areas that would not likely benefit from improvements or construction of new drainage system components, we did not quantify the stormwater generated.

2.6 DESCRIPTION OF DRAINAGE AREAS

The study area is located adjacent to Indian Creek, Carvers Harbor and Carvers Pond on Vinalhaven Island, and contains the majority of the downtown portion of the town. The downtown and surrounding areas of Vinalhaven consist of nearly level to steeply sloped terrain, rising from the shore to approximately 90 feet in elevation. Development is primarily residential, with some commercial and municipal properties located close to the downtown area and along the shore. The shoreline is very rocky with granite walls, piers, and wharves along much of its length. Soils generally consist of shallow Tunbridge and Lyman fine sandy loams mixed with areas of rock outcrop, open quarries, and Ordorthents-Urban land complexes. The soils are generally moderately well-drained, but their shallow depth to bedrock can result in excessive erosion or surface runoff. The following describes each drainage area in more detail.
**Drainage Area 1** consists of approximately 3 acres in the downtown area including the intersection of East Main, Chestnut, Carver, and School Streets. Shallow roadside ditches and a small network of catch basins collect runoff to a point adjacent to the Town garage, which then discharges to a pipe outlet at the shore.

**Drainage Area 2** is approximately 32.7 acres extending north from School Street across East Main Street, west past Carvers Street, and east out to Pequot Road. The land is characterized by dense to moderately spaced residential development, with moderately sloping grades. Drainage features are generally roadside ditches and cross-culverts under East Main Street and East Boston Road leading to Indian Creek. The drainage area collects into a depressed marshy basin and discharges into the creek through a single 18-inch CMP culvert crossing under School Street.

**Drainage Area 3** is an approximately 2.7 acre residential area adjacent to the east side of Chestnut Street. The land is moderately sloped with roadside ditches leading to a single cross-culvert under Chestnut Street.

**Drainage Area 4** is a small area bounded by Cottage and Cross Streets is entirely residential. Flow is collected from two short ditch sections and discharged to 12-inch CMP culvert draining towards Carvers Pond.

**Drainage Area 5** is approximately 5.2 acres and extends north and east from East Boston Road towards the school access road. It is partially wooded and contains several house lots. Drainage consists of shallow roadside ditches to a single 15-inch CMP culvert, discharging to Indian Creek.

**Drainage Area 6** is approximately 12.2 acres and contains a portion of the school property, a small wooded area, and several house lots to the east of East Boston Road. Drainage is generally overland to shallow ditches along East Boston Road, collecting into a 24-inch CMP culvert leading to Indian Creek.

**Drainage Area 7** is approximately 5.4 acres adjacent to Water Street and Atlantic Ave, and includes the hospital. Drainage is generally overland from the hospital site to a system of catch basins on Atlantic Avenue and Water Street. The system collects at a culvert extending from Water Street across Clam Shell Alley to the shore discharge.

**Drainage Area 8** is located between Leo’s Lane and Atlantic Avenue and east of Atlantic Avenue. It contains a mix of residential, wooded, and open quarry and ranges from gentle to steep slopes. Drainage is overland from the quarry to the road, where a roadside ditch collects and conveys runoff to a catch basin system that extends from Atlantic Avenue and down Leo’s Lane to a pipe discharge at the shore.

**Drainage Area 9** includes 6 acres between and to the northeast of Atlantic Avenue and Round the Mountain Road and consists of residential lots and partially wooded land. The grade is generally moderate to steep, with runoff traveling overland towards the road, where it is collected by roadside ditches. The ditches lead to a 15-inch cross-culvert and a basin inlet at the intersection of Atlantic Avenue and Round the Mountain Road. The culvert does not have an open discharge at the shore, but instead discharges into stone grout fill near the shore.

**Drainage Area 10** is approximately 0.6 acres located at the intersection of Atlantic Avenue and Mountain Road. This small area consists of residential lots with a mix of grass, trees, and shrubs. Drainage is primarily overland across the yards, driveways, and roadways to a catch basin inlet on Atlantic Avenue. The basin outlets in the vicinity of the 15-inch culvert serving Drainage Area 9.
Drainage Area 11 is 2 acres adjacent to Drainage Area 9 to the north of Round the Mountain Road and is very similar in topography and land cover. Flow is generally overland south to a shallow ditch, which terminates at a basin inlet and 12-inch culvert crossing Round the Mountain Road. The culvert terminates prior to reaching the shore, and flow continues down the slope to the edge of the water.

Drainage Area 12 totals 3.7 acres adjacent to Drainage Areas 9 and 11 along Round the Mountain Road. Runoff from this area is collected in a shallow ditch, which runs east towards the bridge crossing Indian Creek. There are currently no drainage structures, so runoff sheets across the road to the shore.

Drainage Area 13 is approximately 4.8 acres along High Street west to Mountain Street and including land between Lakeview and Summer Streets. This area is entirely residential and the streets generally have sidewalk and a system of catch basins. The high point of the system is at the western extent of the drainage area, near Mountain Street, and culvert sizes range from 6-inch to 20-inch. The system collects at the intersection of High and West Main Streets, discharging to Carvers Bay via a 20-inch culvert crossing West Main Street.

Drainage Area 14 is located along High Street to the west of Drainage Area 13 and consists of land between Starr and Mountain Streets. Runoff from the house lots is collected by ditches along Starr and High Streets, crosses Starr Street via a 12-inch CMP culvert, and is then discharged through a 15-inch CMP culvert under High Street toward Carvers Pond. The culvert beneath High Street was partially repaired with 12-inch CMP according to as-built records of sewer installation.

Drainage Area 15 is just less than 1 acre and lies adjacent to Drainage Area 13, paralleling a portion of High Street. The drainage is overland southeast to a culvert crossing West Main Street just southwest of its intersection with High Street. The culvert is 18-inch and outlets in the vicinity of the discharge point for Drainage Area 13.

Drainage Area 16 contains land to the northwest of West Main Street from the vicinity of the fire station to Blueberry Lane. It is approximately 3.9 acres and with a gentle to moderately steep slope. Overland and roadside runoff collects at the corner of the fire station lot and enters a 15-inch CMP culvert, which outlets at the shore.

Drainage Area 17 is 1 acre moderately to steeply sloped area between Drainage Areas 16 and 18. Runoff collects at the roadside and drains via a 12-inch CMP culvert crossing West Main Street. The culvert outlets in an area near the shore that leads to Carvers Bay.

Drainage Area 18 is approximately 11.3 acres and is generally moderately sloped. It extends north from West Main Street and Dolphin Street to Blueberry Lane. Runoff flow is primarily overland to shallow roadside ditches, collecting at West Main Street and conveyed to the shore via an 18-inch CMP culvert.

Drainage Area 19 is approximately 1 acre in size and is located between Dolphin Street and West Main Street. Runoff from the residential lots and roadway is allowed to cross West Main Street by surface flow and enter Carvers Bay.

Drainage Area 20 is located across West Main Street from the Maine Department of Transportation (MDOT) Ferry Terminal. It is 1.9 acres and extends from West Main Street north to Dolphin Street. Runoff is collected at a 15-inch CMP culvert, which crosses West Main Street and outlets at the shoreline.

Drainage Area 21 is 1.8 acres of the residential neighborhood along Mountain Street. Runoff generally runs southwest along Mountain Street in shallow ditches. A catch basin and 12-inch CMP culvert collect
flow at the intersection of Sands and Mountain Street that outlets to a drainage ditch running southwest along a sewer line easement.

**Drainage Area 22** lies northwest of Drainage Area 21 and contains most of the land between Mountain and Starr Street. Road surface and shallow drainage ditches collect flow from the area to an 8-inch culvert crossing Starr Street.

**Drainage Area 23** is located along Sands Road beneath and between Mountain Street and Sands Road. It is located to the west of Drainage Area 20. Road surface and shallow drainage ditches collect flow along Sands Road with a fairly well defined drainage way carrying flow from the end of Mountain Street above.

**Drainage Area 24** is located along Main Street near the bridge crossing from the east part of the Village to the west part of the Village. The area is currently served by shallow catch basins and a series of pipes with several discharges, mostly into the grout fill in the area. The area is generally flat.
3. HYDROLOGY ANALYSIS

3.1 10, 25, AND 50 YEAR STORM EVENT HYDROLOGY ANALYSIS

A drainage system model has been prepared using HydroCAD version 8.0 software by HydroCAD Software Solutions, LLC, on a desktop personal computer running under the Windows XP operating system. Methodologies used in the model are based on the Soil Conservation Service’s TR-20 and TR-55 methods. The base plan for model is the topographic plan developed for the recent wastewater project.

This computer model is used to simulate and determine the expected stormwater runoff within each individual drainage area. To create the model, several items are required including the estimated rainfall intensity, drainage area size, drainage area cover type (vegetated, urbanized, paved, etc.), soil characteristics within each drainage area, and existing drainage components within each drainage area (ditches, pipes, catch basins, etc.).

A Type III storm using 4.4 inches for the 24-hour 10-year storm, 5.1 inches for the 24-hour 25-year storm and 5.5 inches for the 24-hour 50-year storm event was used for the model. This information was obtained from the Maine Stormwater BMP Manual Table 2-1, revised January 2006. It is common practice in Maine to design closed drainage systems (systems with catch basins, manholes, and pipes connected together) or other conveyance systems to meet the 10-year storm event and design culverts under roadways and other major drainage structures to meet the 25-year storm event. The Maine Department of Transportation (MDOT) typically considers the 50-year storm event as the design storm for cross culverts and drainage systems within their right-of-way. Our discussions with MDOT have indicated that for Vinalhaven, the 50-year storm event should be considered for all systems located within the MDOT right-of-way. For the purposes of this study, we will consider the 10-year storm event criteria for closed drainage systems, the 25-year storm event for culverts crossing Town roads as well as outfall pipes, and the 50-year storm event for culverts crossing MDOT roads.

Soils information used in the computations was obtained from the Soil Survey of Knox County, Maine, United States Department of Agriculture Soil Conservation Service.

The flow lines used to model the times of concentration are shown on Figures 2-1 and 2-2. The time of concentration (Tc) paths for the subcatchments were selected to represent the most hydrologically remote point of the watershed. The Tc paths are shown respectively on the previously mentioned figures. Note that the Tc computations contain time calculations using TR55 sheet flow and both TR55 and Upland Method. The Upland Method permits a better estimation of travel time for shallow concentrated flow and open channel flow because it has provisions for many land surface conditions, rather than just paved or unpaved surfaces which are presented in TR55.

3.2 RESULTS

The expected stormwater runoff volumes within each drainage and sub-drainage area resulting from the analysis of our model have been provided in Table 3-1. HydroCAD generated reports are included in the Appendix of this report.
### Table 3-1 – Stormwater Modeling Results

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Sub-Area it Drains to</th>
<th>Area (acres)</th>
<th>10 Year, 24 Hour Storm</th>
<th>25 Year, 24 Hour Storm</th>
<th>50 Year, 24 Hour Storm</th>
<th>Drainage Area Discharge Pipe/System</th>
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<tr>
<td></td>
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<td></td>
<td>Peak Flow In (cfs)</td>
<td>Peak Flow In (cfs)</td>
<td>Peak Flow In (cfs)</td>
<td>Peak Flow Capacity (cfs)</td>
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<td>1B</td>
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<td>4.13</td>
<td>4.5</td>
<td>See overall</td>
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<tr>
<td></td>
<td>1C</td>
<td>0.76</td>
<td>3.26</td>
<td>3.89</td>
<td>4.25</td>
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<td>1B &amp; 1C Overall</td>
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<td>85.8 (water level 1.8' above top of pipe)</td>
<td>105.9 (water level 2.3' above top of pipe)</td>
<td>116.5 (water level 2.5' above top of pipe)</td>
<td>5.2 (without detention above the top of the pipe)</td>
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<td>Sub-Area it Drains to</td>
<td>Area (acres)</td>
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<td>25 YEAR, 24 HOUR STORM</td>
<td>50 YEAR, 24 HOUR STORM</td>
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<td>8.39</td>
<td>9.79</td>
<td>10.58</td>
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</table>
3.3 DISCUSSION OF RESULTS

3.3.1 General

From our analysis, it is clear that most of the stormwater conveyance systems in place throughout Vinalhaven are undersized for the drainage area they serve. In many instances the structures and pipes were likely installed as a stop gap to address a specific situation or issue without consideration of the upstream drainage areas. Shallow ledge may have also impacted the pipe sizes used for many of the culvert crossings. Many of the streets are located within narrow right of ways which further impact the ability to install adequate drainage systems.

As is shown in Table 3-1, only 2 drainage areas (DA-4 and DA-6) have a discharge drainage pipe able to pass the peak flow runoff generated. The existing drainage pipe handling the discharge from DA-6 is unable to handle the runoff without flooding during the 25-year storm event. Additionally, all the culvert crossings and storm water systems we analyzed on West Main Street and East Main Street are undersized and cannot accommodate the MDOT design standard 50-year storm event. The following sections will outline the issues identified with the more complex drainage areas and their inclusive sub-drainage areas.

3.3.2 Drainage Area 1

Drainage Area 1 contains two outfalls. Sub-drainage area 1A collects run-off from closed system located at the intersections of East Main Street with Carvers Street and Chestnut Streets. The runoff drains into a ditch along the blasted ledge wall behind the existing Public Works facility and discharges to the ocean.

Stormwater runoff from a closed storm drain system located at the intersection of Chestnut Street and East Main Street in sub-drainage area 1C drains into a closed system located in the driveway for the Public Works facility and Water Company building through sub-drainage area 1B.

Both closed systems from the sub-drainage areas are capable of accommodating the 10-year storm event, however only the system that drains sub-drainage area 1C is capable of accommodating the 25 and 50-year storm events. The limiting factor of both systems is the outfall portion. Both outfalls are not capable of accommodating the 10-year storm event.

The outfall site is an ideal location for accommodating stormwater runoff from improvements constructed within the Carvers Street, Brighton Avenue, and Chestnut Street neighborhoods, as well as those built along East Main Street just west of Pleasant Street. To accommodate the runoff, improvements will be required to the closed systems along East Main Street and located within the yard of the Public Works facility.

Given the narrow right-of-ways and pavement widths for the side streets in this watershed, stormwater improvements have likely been difficult to construct in the past. That is evidenced by the many shallow swales and surface features built to direct stormwater runoff. Most of the streets utilize surface methods without many ditches or closed system components to direct stormwater runoff towards East Main Street. With the new wastewater system components in the road along with the water main, the construction of improvements will be challenging, but not impossible. In most of the streets, the water and sewer mains occupy each edge of the roadway. This will require new stormwater piping to be installed in the middle of the streets, with shallow inlet structures to be installed where conflicts with the sewer and water system will not arise.
3.3.3 Drainage Area 2

Our analysis indicated that each of the culverts along East Main Street was found to be undersized for even the 10-Year storm. The existing 12-inch CMP culvert connecting sub-drainage area 2B to sub-drainage area 2A was estimated to receive between 10 and 14 cubic feet per second (cfs) of runoff, with a carrying capacity of 2.2 cfs. The culverts between sub-areas 2C and 2D are also undersized and are being addressed with the construction of a new ditch and new culverts with the East Main Street Sidewalk project. The cross-culvert in East Main Street, to the east of Cottage Street, also appears to be undersized for the flows coming from sub-drainage areas 2C through 2F.

Drainage in Sub-areas 2G through 2J is also limited by undersized culverts at all the key collection points. 2J is connected to 2G by a 12-inch CMP culvert that appears to have enough capacity for the 10-year runoff. Where 2H and 2I flow into 2G, the drainage system consisting of culverts and closed pipe does not appear to have enough capacity for the 10-year storm, let alone the MDOT 50-year storm mandate. The areas drain through an existing culvert crossing at East Boston Road. This culvert is 12-inch CMP pipe and is undersized based on our analysis. Our discussions with the Public Works Department have indicated that they have had icing and flooding issues at this crossing in the past.

The numerous sub-drainage areas drain into Indian Creek, which outlets to the ocean by way of an 18-inch CMP culvert crossing School Street. The marshy area upstream appears to act as a detention pond for storm flows, rising as much as 4 feet above the invert elevation for the 50-year storm. Under this scenario, it is likely that flooding over School Street has occurred in the past.

Given that most of the system along East Main Street is undersized, and the existing culvert crossing School Street that handles the entire drainage area further contributes to flooding of upstream areas, we would recommend improving the system from the lowest region to the highest. This means that we would recommend replacing the existing culvert crossing at School Street with a larger diameter pipe, or multiple pipes, as the first project in the watershed, with several (depending upon available funds) closed system improvements in following years. As with Drainage area 1, the side streets off from East Main Street in this drainage area are very similar and will likely present similar challenges when improvements are considered to install components to address surface runoff and connect the individual residential foundation, roof, and basement drains.

3.3.4 Drainage Area 13

This area is drained by a system of catch basins along High Street between its intersection with West Main Street and Mountain Street. The entire drainage area collects at the intersection of High Street and West Main Street, where a 20-inch CMP culvert extends from the catch basin system across West Main and outlets directly to the ocean. This culvert appears to be the limiting component in the drainage system. A 30-inch culvert at a similar slope would be more appropriate for the 50-year storm runoff rate estimated by the model.
4. STORMWATER QUALITY

4.1 GENERAL

The Village area of Vinalhaven has not experienced a rise in residential and commercial development in recent years, however increases in development have been experienced in the more rural areas of Town. This typically leads to an increase in impervious land area, however given most of the underlying soils, which are ledge and rock, it is likely that the newly developed land does not exhibit characteristics typical to this type of conversion. Undeveloped land such as forestland promotes stormwater infiltration into the subsurface regions, which provides valuable recharge to the groundwater aquifers. Roadways and rooftops, however, are impervious. Rainfall or snow melting off of impervious land collects and flows into various drainage systems. As a result, the conversion of natural land to impervious land results in increased levels of runoff during rainfall events or during periods of snowmelt. In addition to the lack of groundwater recharge, stormwater flow from impervious land often collects, concentrates and delivers pollutants into natural water bodies.

Since runoff from roads, parking lots, saturated yards, roofs, and many other impervious surfaces has been collected and conveyed to the closest, most accessible water body, many are now experiencing a rise in pollution. Receiving waters include wetlands, ponds, rivers, streams, or oceans. Unfortunately, direct discharge of stormwater to natural water bodies can prove to be detrimental to those water bodies. We are not aware of acute issues or concerns in Vinalhaven that have arisen from stormwater pollution and as such have not provided specific recommendations for improvements that are driven by poor or substandard water quality. Even though there are no concerns at the present time, increases in development will lead to an increase in impervious land and will raise the potential for stormwater pollution to occur. Through knowledge of the regulations, the devices that can be implemented to reduce the impacts of stormwater pollution, and proper maintenance of existing systems, the Town can work towards a goal of controlling stormwater pollution.

The following is intended to outline the history of legislation that has been enacted to address stormwater pollution and how it applies to many communities throughout the nation and the state.

4.2 CLEAN WATER ACT – PHASE I AND PHASE II NPDES

The quality of stormwater and the impact it has on receiving waters is a heavily discussed topic today. In the 1970’s, the Clean Water Act was passed. This legislation was the early framework for improving many impaired water bodies throughout the United States. It was primarily aimed at addressing point source pollution. Point source pollution is defined as pollution originating from a single point such as pipes, ditches, wells, vessels, and containers. Many of the early offenders that were brought into compliance were municipal wastewater collection systems and industrial polluters that included activities like food processing, paper making, and metallurgy.

In 1990, the Environmental Protection Agency (EPA) promulgated Phase I of its National Stormwater Program under the auspices of the National Pollution Discharge Elimination System (NPDES) permitting process, which is an extended arm of the Clean Water Act. It was becoming clearer that with the point source pollutants being addressed, pollution was still occurring and was coming from sources not originally considered. The new rules addressed stormwater runoff from medium and large municipalities generally serving a population of 100,000, construction activity that would disturb 5 acres or more, and 10 categories of industrial activity. The regulation reached out further in 1999 with the passing of the Phase II rules. The Phase II rules reached out to the smaller municipal stormwater systems within
urbanized areas as defined by the 2000 census. Both Phase I and Phase II regulations have taken aim at a larger threat to our lakes, streams, and oceans, which is non-point source pollution. Non point source pollution is defined as pollution from numerous widespread locations or sources that have no well-defined points of origin and may originate from land use activities and/or from the atmosphere. Examples include leaching of excess fertilizer from lawns, sediments carried during storms from unvegetated areas, contaminants from animal wastes, etc.

One part of the Phase I and II regulations was that each community impacted by the rules had to develop a Community wide stormwater management program. A stormwater management program consists of an education outreach piece to inform the citizens of the impacts that daily activities have on runoff and ultimately the receiving waters of the Community, as well as methods to reduce pollutant streams into the waters, including illicit discharges. Illicit discharges are generally described as any discharge to a municipal separate storm sewer system that is not entirely comprised of stormwater. Examples of illicit discharges are sanitary sewer pipes directly connected to the storm system, dumping of materials such as oils, gasoline, or other similar fluids into the system through a catch basin grate or an open ditch, or a shop floor drain connected to the system.

Vinalhaven is not on the list of municipalities impacted by the Phase I or Phase II regulation and is therefore not directly impacted by any of this legislation. Future residential, commercial, and industrial development on Vinalhaven however would typically be governed under three separate Laws through the Maine Stormwater Program: The Site Location of Development law (Site Law), Stormwater Management Law, and Waste Discharge Law (MEPDES). The following is a brief summary of each.

### 4.2.1 Site Location of Development Law

This law requires review of developments that may have a substantial effect upon the environment. These types of developments include developments such as projects occupying more than 20 acres, metallic mineral and advanced exploration projects, large structures and subdivisions, and oil terminal facilities. A permit is issued if the project meets applicable standards addressing areas such as stormwater management, groundwater protection, infrastructure, wildlife and fisheries, noise, and unusual natural areas.

Applicants of developments that fall into this regulatory category are required to prepare a pre-development and post-development hydrology analysis. The development is required to meet stormwater quality and quantity thresholds. Because many of these developments like large subdivisions significantly alter the landscape and produce much more stormwater runoff, detention basins are included with the designs to address both quality and quantity concerns. The ponds attenuate flows to allow many suspended solids in the stormwater stream the opportunity to settle out and not get carried through to downstream waters. The ponds are also designed such that the rate at which the stormwater leaves the pond is controlled and is not increased beyond existing discharge rates, thereby protecting downstream ditches, swales, channels, and other site features from experiencing erosion. The applicable standards are governed by the Stormwater Management Law.

### 4.2.2 Stormwater Management Law

Maine's Stormwater Management Law provides stormwater standards for projects located in organized areas that include one acre of more of disturbed area. Standards for treatment of stormwater are based on further project thresholds including whether or not it will result in 20,000 square feet or more of impervious area or 5 acres or more of developed area in the watershed of a lake most at risk or urban
impaired stream. Projects in Vinalhaven that may meet this standard would be subdivision construction or similar large scale residential development. This process is administered by the Department of Environmental Protection and does not require local action or oversight.

4.2.3 Waste Discharge Law

The waste discharge law requires that a license be obtained for the discharge of pollutants to a stream, river, or lake of the state, or to the ocean. Typical discharges include sanitary waste water and process water from industrial or commercial activities. A license is also required for the discharge of pollutants to groundwater, except for subsurface disposal systems installed under the State Plumbing Code. None of the community wide drainage systems in Vinalhaven are regulated under the waste discharge law, however the existing wastewater collection system is.

4.3 EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES

As we described earlier, the quality of stormwater from construction activities, primarily resulting from erosion and sedimentation, is becoming as scrutinized as the quantity of stormwater generated from a project site. As a result, state and federal agencies have been promoting, and in instances where they have the authority, require the use of stormwater Best Management Practices (BMPs). BMPs include structural and vegetative practices to provide protection against erosion and sediment discharge from sites under construction.

In 2006, the Maine Department of Environmental Protection (MDEP) outlined four goals for use of BMPs including effective pollutant removal, cooling, channel protection, and flood control. All construction projects that will occur on Vinalhaven with the potential to create erosion or sediment transportation concerns, including residential construction, are required to implement BMP’s during construction. Table 4-1 outlines common measures that could be used during construction activities in Vinalhaven, especially many of the recommendations that will be presented as a result of our hydrology analysis.
Table 4-1 – Commonly Utilized Erosion and Sediment Control BMPs

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>TEMPORARY MEASURES</th>
<th>PERMANENT MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill slopes</td>
<td>Mulch for slopes to be seeded</td>
<td>Seeding to establish vegetation</td>
</tr>
<tr>
<td></td>
<td>Silt fence down gradient of slopes</td>
<td></td>
</tr>
<tr>
<td>Earthen drainage channels</td>
<td>Stone check dams and Erosion Control Blanket</td>
<td>Seeding to establish vegetation</td>
</tr>
<tr>
<td>Culvert inlets and outlets</td>
<td>Hay bales</td>
<td>Riprap</td>
</tr>
<tr>
<td>Disturbed natural slopes</td>
<td>Mulch</td>
<td>Seeding to establish vegetation</td>
</tr>
<tr>
<td></td>
<td>Erosion Control Blankets</td>
<td>Natural vegetated filter strips</td>
</tr>
<tr>
<td></td>
<td>Silt fence down gradient of slopes</td>
<td></td>
</tr>
<tr>
<td>Pipe trenches</td>
<td>Mulch</td>
<td>Seeding to establish vegetation</td>
</tr>
</tbody>
</table>

4.4 STORMWATER CONTROLS/MANAGEMENT OF RUNOFF

Erosion control measures are most effective if they are well maintained. If drainage control structures are not working properly they can cause downstream environmental damage. Sediment caught in catch basins and ponds keep the pollutants from reaching the receiving waters.

Storm water management facilities should be regularly inspected to ensure that they remain in good operating condition. Inspections should focus on locating areas of erosion damage and evidence of siltation.

Slopes, ditches, and the areas around inlet and outlet structures should be regularly inspected for signs of erosion. If an inspection reveals that erosion is occurring, as evidenced by bare soil or siltation, the vegetation in that area must be replanted. If the erosion occurs during the non-growing season (late fall to early spring) the area should be heavily mulched, or otherwise protected until the growing season when vegetation can be established. Wherever erosion is a recurring problem, the reason for the erosion, should be identified, and corrected.

Maintenance is performed on sections of the storm drainage system on an as-needed basis. The Town contracts the services of E.C. Barry of Gardiner on an annual basis. In the spring of the year, they come to Vinalhaven with equipment to sweep the streets and remove debris from various catch basins throughout the Town. Whenever necessary, Public Works will manually remove debris from basins, inlet grates, or drainage ways. When a drain line becomes plugged, the Town uses pumper trucks from the Fire Department to remove the obstruction. All maintenance and inspection activities are performed by the Public Works Department. This program should continue on an annual basis. Furthermore, the Town should be proactive in inspecting the various systems on a frequent basis to ensure proper system performance.
5. RECOMMENDED IMPROVEMENTS

5.1 GENERAL

The following outlines our recommendations for drainage system improvements throughout Vinalhaven. When developing recommendations for overall drainage system improvements, we have considered pairing many with the construction of several sidewalk projects throughout the community. In the spring of 2006, the Vinalhaven Sidewalk Committee developed a Condition Assessment and Maintenance Development Plan for the existing sidewalk network throughout Vinalhaven and provided recommendations for improvements on a prioritized basis. Woodard & Curran reviewed the document and assisted the Committee with construction cost estimates for the sidewalk improvements. Based on the hydraulic analysis conducted as part of this study, and the resulting drainage system deficiencies, we believe many of the sidewalk projects can be combined with drainage improvement recommendations and built as one project.

It is important to point out that East Main Street, West Main Street, and High Street are considered State owned and maintained highways. Any recommended improvements that we have developed in this report will likely require review and approval by MDOT prior to implementation. Additionally, we feel that the State may be willing to contribute financially to the construction of many of these improvements. In cooperation with the State, the Town may be able to have many of the recommended improvements constructed by MDOT as part of future projects for improving the roads.

As you know, West Main Street, East Main Street, and High Street were recently paved. As a result, the roads are under a 5-year moratorium for development which means no work can be completed that will impact the traveled way for at least 5 years, therefore pushing any of the recommended projects out further into the future from a planning perspective. We have conservatively factored the moratorium and recommended projects on State roads accordingly.

In many communities, drainage improvements are typically constructed in conjunction with road reconstruction projects or utility projects. Economy of scale savings are realized when the improvements are built at the same time as heavier earthwork tasks such as roadway excavation. As such, we recommend the Town consider combining many of the improvements listed in this report with future road reconstruction projects or combined with a local water main replacement project. As with the proposed improvements within the State right-of-way, this will require some preliminary discussions with the local water company to determine their schedule for proposed distribution system improvements. Combining drainage work with road reconstruction projects may make the overall project costs higher but the Town may realize savings in the drainage components when compared to the estimates we have provided.

The recommendations we have included in this report also consider the extraneous flows that have been experienced to date within the sanitary sewer system. By installing closed drainage systems in parts of Town where stormwater runoff issues are identified, water from sump pumps, basement drains, and roof drains can be taken out of the sanitary wastewater system and connected directly to the new stormwater system. As we discussed earlier, illicit discharges may become a problem if drains from garages or other commercial facilities are connected. These types of facilities have the potential for direct discharge of oils and other fluids. Because of the many narrow streets in Town and the presence of water and sewer mains, installation of closed storm drainage systems will be challenging.
5.2 COST ESTIMATES

A cost analysis was completed for each of the recommended improvements. The cost estimates presented are based on the information gathered to date and would require significant survey, soils, and modeling work to be further refined. For most of the projects, we have proposed replacing structures and pipes with systems at the same elevations and slopes as the existing components. During detailed design, proposed pipes, structures, and elevations can be evaluated and modified to suit the conditions at each site. Construction costs are based upon our experience using historical unit costs from similar projects, engineering and construction administration and inspection costs are typically fifteen percent (15%) of the construction costs, other project costs including land acquisition, special studies, easement work, legal fees, permitting, fees, and interest on interim financing are typically five to ten percent (5% to 10%) of the construction costs. A construction contingency of fifteen percent (15%) has been included.

In order to develop reasonable cost estimates for this study phase, many assumptions must be made to compare costs for the different options and to account for unknowns. One significant factor in the cost of installing stormwater pipes and structures is the depth required and the presence of ledge. Because this is a potentially large portion of the pipe cost, we have relied on the ledge depths throughout Town as reported during construction and shown on the as-built drawings from the wastewater collection project. In areas where ledge quantities have not been identified such as cross country locations, the cost estimates include conservative assumptions. We have based our ledge assumptions on this information; however recognize that ledge probes should be conducted for many of the recommended projects as part of the preliminary design effort to better refine these costs, especially for pipes constructed in cross-country areas.

Bituminous pavement for construction within roadways on Vinalhaven will be expensive and can fluctuate significantly based on current and anticipated future market prices as well as the amount of work being performed at one time. Our estimates have assumed bituminous pavement will be delivered to the island using the Island Transporter. If enough projects are constructed at one time, a savings can be realized with the erection of a temporary pavement plant on the island, similar to the one utilized recently by MDOT during their paving project throughout the Island.

5.3 EASEMENT PROCUREMENT

Many of the stormwater systems in place on Vinalhaven are located on public property or within a Town or State owned right-of-way. As is the case, many of the systems analyzed contain a discharge either directly to a water body or to a nearby water body, and most of the time, these pipes are located on private property. It is very likely that many of the systems were built before the necessity of obtaining permanent easements for maintenance rights however in today’s changing climate, and given the nature of coastal property conversions, it is in the Town’s best interest to secure permanent easements for many of the existing drainage system components located on private property.

Many of the drainage systems in Vinalhaven have been constructed of corrugated metal pipe, of which most are showing signs of age with visible deterioration, structural damage, and corrosion. As a result, many of these system components are either being recommended for replacement now or will require some level of rehabilitation in the coming years. We have not performed deed research to determine if any of these systems have easements associated with them. We recommend the Town pursue obtaining permanent maintenance easements for all the existing systems that are on private property. The most efficient approach to obtain the easements is to gather them with each individual drainage project when they are built.
5.4 DITCH MAINTENANCE

In many areas throughout Town, especially in the more rural sections, stormwater is conveyed along the side of roads primarily by ditches and culverts. Ditches are important for roadways as they provide a means to drain water away from the subbase gravel materials to keep frost action at a minimum thereby maintaining the condition of the road surface. They are also used in many instances as a way to convey stormwater from higher regions to lower regions. Annual or bi-annual ditch maintenance should be conducted on a system wide basis. This work includes removing winter sand from both the roadway shoulder and the ditches to allow water to get in and move through the ditch, removal of excess vegetation to maintain positive flow in the ditches, and stabilization and rehabilitation as necessary including re-establishing vegetation or installing stone or riprap materials. We have not outlined specific construction projects where ditch rehabilitation is necessary however recommend the Town, along with annual and bi-annual maintenance of the storm systems, continue to address existing ditches.

5.5 PRIORITIZED RECOMMENDATIONS

The recommendations discussed within this report are of little value unless they are organized into a prioritized action plan. The following recommendations fall into two categories: short term and long term. Broadly speaking, Short Term Recommendations are those that can offer significant improvements to the streets and neighborhoods where they are located. Addressing the high priority areas in the short term, defined as within the next five years, will provide the most benefit to the Town. Long Term Recommendations include the continual improvement of the overall drainage system in Town with the construction of new closed drainage systems, improvements to existing undersized ditches and pipe systems, and the replacement of existing pipes considered to be in poor condition. As previously discussed, we have had to consider work to be completed within the right of way of State maintained roads as part of the Long Term recommendations however in many cases, these areas should be considered as high a priority as many of the short-term recommendations.

5.5.1 Short-Term Recommendations

5.5.1.1 Culvert Replacements – Phase I

Many of the culverts throughout Town are in poor condition and require replacement. According to Public Works, many have been in place for more than 20 years and are likely beyond their useful design life. We have outlined several culverts that we believe should be replaced with new smooth interior, corrugated exterior high density polyethylene (HDPE) storm drains. HDPE pipe provides greater capacity for a given diameter when compared to pipe made from corrugated metal. Additionally, HDPE is corrosion resistant and will be better suited for long term use in a coastal environment like Vinalhaven. We have divided culvert replacements into Short Term, or Phase I recommendations and Long Term, or Phase II recommendations. The short term culvert replacements primarily included those that are located in Town roads. Given the moratorium in place on East Main Street, West Main Street, and High Street, culvert replacements can only be performed in the next five years on Town maintained roads. Although we are recommending HDPE culvert materials, MDOT has historically used reinforced concrete pipe (RCP) materials for large culvert crossings and as a result may require this as part of the proposed improvements.

Many culverts in Town are the ultimate discharge pipe for the given drainage area. In areas, such as along East Boston Road and School Street, the existing culverts are not only the ultimate discharge pipe
for the drainage area, their replacement should be considered as a first step to improving other sub-
standard and undersized drainage system components located in the higher regions of the drainage area.

The following Table outlines the culverts that we believe should be considered for replacement in the
short term including an estimated cost to construct. The cost estimates provided do not include easement
procurement costs. Please note that the costs provided are similar between the smaller sizes (18-inch and
below) and the larger sizes (24-inch and above). Culvert replacement does not realize the same economy
of scale cost savings that closed drainage system construction does. The pipe costs are typically
significantly less than the labor costs for each crossing and therefore a 12-inch culvert replacement can
cost the same as an 18-inch culvert replacement. Larger diameter pipes such as 24-inch, 30-inch, and 36-
inch culverts can cost more to replace than smaller diameter pipes. These pipes are typically more labor
intensive to handle and require wider trenches and more trench repair materials (pavement, gravels, seed
and mulch). We have outlined each culvert scheduled for replacement in Figures 5-1 and 5-2.

**Table 5-1 – Phase I Culvert Replacements**

<table>
<thead>
<tr>
<th>DRAINAGE AREA</th>
<th>EXISTING CULVERT</th>
<th>PROPOSED CULVERT</th>
<th>ESTIMATED COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA-2A</td>
<td>18” CMP</td>
<td>2 – 18” HDPE</td>
<td>$10,000</td>
</tr>
<tr>
<td>DA-2G</td>
<td>12” CMP</td>
<td>2 – 24” HDPE</td>
<td>$12,000</td>
</tr>
<tr>
<td>DA-3</td>
<td>12” CMP</td>
<td>24” HDPE</td>
<td>$8,000</td>
</tr>
<tr>
<td>DA-5</td>
<td>15” CMP</td>
<td>24” HDPE</td>
<td>$8,000</td>
</tr>
<tr>
<td>DA-6</td>
<td>24” CMP</td>
<td>30” HDPE</td>
<td>$8,000</td>
</tr>
<tr>
<td>DA-11</td>
<td>12” CMP</td>
<td>18” HDPE</td>
<td>$5,000</td>
</tr>
<tr>
<td>DA-21</td>
<td>12” CMP</td>
<td>18” HDPE AND BASIN</td>
<td>$10,000</td>
</tr>
<tr>
<td>DA-22</td>
<td>8” HDPE</td>
<td>18” HDPE</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL</td>
<td>$66,000</td>
</tr>
</tbody>
</table>

The culvert replacements recommended for DA-2A, DA-2G, DA-5, and DA-6 should be considered
during a proposed future sidewalk construction project. The Development Plan prepared by the Sidewalk
Committee recommended extending the existing sidewalk system down East Boston Road and School
Street to the back walkway behind the school. The Town has been presented with costs to construct the
new sidewalks. It is not clear if closed drainage system components would be beneficial in this area and
therefore we have not included associated costs for this type of system in this report.

Likewise, the replacement of the culvert in DA-3 could be completed in association with a sidewalk
construction project. The Sidewalk Committee indicated there is an existing sidewalk on the street that
has been overgrown with vegetation. From our site visit, there was an existing flat area on the high side
of the street that appeared to possibly have been a sidewalk. It was elevated from the road surface and
located between granite curb and a granite retaining wall. The Committee did not recommend the
redevelopment of this sidewalk as one of the Tier 1, 2, of 3 improvements, however it was mentioned as a
project that the Town should consider in the future.
5.5.1.2 East Main Street Sidewalk and Drainage Improvements – Pleasant Street to Clayter Hill Road

In the spring of 2006, Woodard & Curran worked with the Town to develop concepts for improving the existing sidewalk and drainage system along East Main Street between Clayter Hill Road and Pleasant Street. Based on the concepts forwarded to the Town for their review, they agreed to move forward with the construction of a 4-foot wide sidewalk and improvements to the existing drainage system. The project includes lowering the sidewalk grade in most areas to make it closer to the street elevation. This requires the construction of a new retaining wall on the back side of the sidewalk. Additionally, the existing drainage system will be improved by construction of a new ditch and installation of larger storm drain culverts. The project is presently targeted for construction during the summer of 2007. The proposed improvements are outlined on Figure 5-3.

5.5.1.3 Atlantic Avenue and Water Street

In the spring of 2006, a multi-day storm event wreaked havoc on the existing drainage system servicing the Atlantic Avenue and Water Street neighborhoods. This area is identified as Drainage Area 7 for purposes of this study. Heavy rains and undersized drainage system components lead to flooding of Water Street which damaged the existing sidewalk and private property in this area. The Town asked Woodard & Curran to study the area and develop a preliminary design to improve the drainage system.

We were able to analyze this part of Town and have determined that the existing drainage system is well undersized. From our model analysis, we estimated that the existing drainage system in place along Atlantic Avenue and Water Street is capable of accommodating the 2 to 5-year storm event. As we have pointed out in this report, the typical storm event we design around for municipal closed systems is the 10-year event.

We developed and forwarded the Town a preliminary design to accommodate the 10-year storm event for the closed portion of the system and the 25-year storm event for the outfall pipe. The design included the construction of a new ocean discharge that directed most of the new stormwater pipe along Town roads. This was required due to the shallow grades of the existing sewer system on Clamshell Alley and the anticipated direct conflict between the system and any proposed storm drain.

In December 2006, the Town moved forward with an alternate plan that included construction of 2 catch basins on Atlantic Avenue connected to 3 catch basins and 12-inch pipe on Water Street. The existing ditch along Water Street was filled in. The new system connected to the existing discharge pipe system that crosses Water Street and ultimately outlets to the ocean. Woodard & Curran was consulted on this project and recommended that given the project was a phased approach of an overall solution, the Town should next consider working from the outlet of the system, up to the newly installed components on Water Street.

To further improve the system and protect Water Street from flooding again, we would recommend the Town replace the existing outfall pipe system. This has been identified as the limiting factor in the existing drainage system. Depending upon the depth of the existing system at its crossing with Clamshell Alley, it may be necessary to install up to as many as three new pipes with a new box type structure. We have assumed the project will consist of three new 12-inch stormdrains in the same location as the existing outlet. The proposed improvements are outlined on Figure 5-4.
5.5.1.4 Atlantic Avenue and Leo’s Lane

From our discussions with the Public Works Department, the existing closed drainage system on Atlantic Avenue and Leo’s Lane is in need of repair. As the Public Works Department indicated, and our analysis confirmed, the system does not have enough catchment or enough structures to allow runoff to get into the closed system. As such, during peak runoff periods typically associated with spring melt, water crosses the Atlantic Avenue/Water Street/Leo’s Lane intersection and creates icing and flooding problems for those residents immediate to the intersection. The outfall pipe is smaller than the existing pipes that convey stormwater from catch basin to catch basin, and is mangled which likely further reduces its effective discharge capacity. Our analysis has indicated that the existing system, in an undamaged or uncompromised condition, is not able to accommodate the 10-year storm event.

As a result, we would recommend the Town replace the existing closed system. A permanent easement for maintenance purposes must be obtained from the property owner at the intersection of Atlantic Avenue, Water Street, and Leo’s Lane would be required.

This is a project that likely will be more efficiently built if paired with the proposed reconstruction of the sidewalk along Atlantic Avenue. This may also be coupled with the construction of the extension of the existing sidewalk to the Lane’s Island Bridge. Both sidewalk projects were rated as Tier 1 or highest priority construction projects in the Condition Assessment developed by the Vinalhaven Sidewalk Committee. Each sidewalk project would also require an extension of the closed drainage system with new catch basins and drain pipe. We also recommend combining this work with improving the drainage system at the intersection of Atlantic Avenue and Round the Mountain Road. The proposed improvements are outlined on Figure 5-5.
5.5.1.5 Estimated Cost of Implementing Short Term Recommendations

The estimated project costs to construct the improvements are shown in Table 5-2. These estimates are intended to include Engineering, survey, permitting, easements (where appropriate), excavation, materials (pipe, bedding and backfill, and paving), labor, and surface restoration. Costs for ledge removal have been estimated based on the information that is available from previous construction. The implementation of these Short Term Recommendations is expected to cost slightly less than $700,000.

Table 5-2 – Estimate of Anticipated Costs of Short Term Upgrade Recommendations

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>APPROXIMATE COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culvert Replacements – Phase I</td>
<td>$ 66,000</td>
</tr>
<tr>
<td>East Main St. Sidewalk and Drainage Improvements</td>
<td>$ 50,000</td>
</tr>
<tr>
<td>Atlantic Avenue and Water Street</td>
<td>$ 96,000</td>
</tr>
<tr>
<td>Atlantic Avenue and Leo’s Lane (including sidewalks)</td>
<td>$485,000</td>
</tr>
<tr>
<td><strong>TOTAL OF RECOMMENDED SHORT TERM PROJECTS</strong></td>
<td><strong>$697,000</strong></td>
</tr>
</tbody>
</table>

5.5.2 Long-Term Recommendations

5.5.2.1 Culvert Replacement – Phase II

Phase II culvert replacements primarily include those that are located in State roads. Given the moratorium in place on East Main Street, West Main Street, and High Street, this work can not be performed until at least 2011. The following Table outlines the culverts that we believe should be considered for replacement in the long term including an estimated cost to replace. The cost estimates provided do not include easement procurement costs. We have outlined each culvert scheduled for replacement in Figures 5-1 and 5-2.

Table 5-3 – Phase II Culvert Replacements

<table>
<thead>
<tr>
<th>EXISTING CULVERT SIZE</th>
<th>PROPOSED CULVERT SIZE</th>
<th>ESTIMATED COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA-2E</td>
<td>20” CMP</td>
<td>30” HDPE</td>
</tr>
<tr>
<td>DA-13</td>
<td>20” CMP</td>
<td>30” HDPE</td>
</tr>
<tr>
<td>DA-14</td>
<td>18” CMP</td>
<td>24” HDPE</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>$24,000</strong></td>
</tr>
</tbody>
</table>

5.5.2.2 West Main Street

West Main Street is currently broken into several drainage areas, primarily as a result of the way in which the closed system components have been constructed over the years. The drainage areas discharge to the ocean through as many as 6 different outfall pipes. Each one of the pipes inspected appeared to be
corrugated metal and in poor condition. Many exhibited corrosion and deteriorated sections. This part of Town has been described by Public Works as a problem area. They have indicated that minor flooding can occur from time to time and that many of the outfalls are not capable of handling the runoff from the catch basins they are connected. Our analysis confirmed that the existing systems are undersized for the required design storm events and should be replaced and upsized.

Through our analysis we have been able to develop a conceptual system layout that will include nearly 8 new catch basins, several feet of varying sized pipe, and the replacement of two existing outfalls with new larger HDPE outfall pipes. This would eliminate the need for four of the six existing outfalls.

Additionally, we recommend the Town consider rebuilding the existing sidewalk along West Main Street and to provide for its extension to the Ferry Terminal in conjunction with the construction of the drainage improvements. The sidewalk projects were recommended by the Vinalhaven Sidewalk Committee in 2006. It is not clear if the existing outfalls that we have recommended to be replaced are located within permanent maintenance easements. This should be determined prior to construction. The conceptual layout of the proposed improvements is outlined in Figure 5-6.

Although this recommendation has been considered as a Long Term improvement due to the moratorium in place, it should be noted that we would recommend this area be addressed as soon as work can be performed in this right-of-way. Once the moratorium is lifted, this recommendation should be placed at the very top, even higher than the work items on the Short Term list.

5.5.2.3 East Main Street – Public Works Garage Lot

The existing Public Works garage facility lot is an ideal location to accommodate stormwater runoff from East Main Street, and most of the sub-areas of Drainage Area 1. Both outfalls and closed system components that serve the sub-drainage areas are undersized. We recommend directing all storm water from the intersection of East Main Street and Chestnut and Carvers Street to one location, the existing catch basin in the parking lot of the Public Works garage. In order to accommodate subsurface drainage from homes along a majority of Carvers Street, we also recommend installing a portion of a closed drainage system consisting of inlets, manholes, and drainage pipe.

This project can be accomplished with the installation of 12 new catch basins, five new storm drain manholes, some new curb along Carvers Street and several hundred feet of 15-inch pipe along with a new 18-inch outfall pipe. The conceptual layout of the proposed improvements is outlined in Figure 5-7.

5.5.2.4 Brighton Avenue and Carvers Street

These streets are currently served by an undersized series of catch basins and storm pipes, most of which are located on private property. The streets and right-of-way widths are narrow and with the existing utilities in the street, there is little room for new stormwater system components. As mentioned above, the model has indicated that the expected quantity of runoff from this area far exceeds the capacity of the drainage system components it discharges to on East Main Street. We recommend installing a closed drainage system on each street as shown on Figure 5-8. As with the existing system components, some of the system will be located on private property. A drain pipe is required between the two streets and the ultimate discharge will cross private property. As a result, an easement must be obtained to construct the improvements and perpetually maintain them. The system will include catch basins and pipe sized to accommodate the 10-year storm event.
As with any other closed system, the proposed improvements will work more efficiently and collect a larger percentage of the stormwater runoff if curbing is installed on the streets in various locations, therefore we recommend installing some curbing to promote positive drainage into the closed system. The existing road and resulting right-of-way appear to be too narrow to construct a ditched system to accommodate the runoff generated in this neighborhood.

5.5.2.5 Pleasant Street and Cottage Street

As with Brighton Avenue and Carvers Street, Pleasant Street and Cottage Street will require a similar type of drainage system. The new drainage system on each street will include catch basins, storm drains, and some curbing to promote positive drainage. The system will include a cross country pipe to connect the system on Pleasant Street with that on Cottage Street, where it will ultimately discharge into the ditched system along East Main Street currently scheduled for construction with the proposed East Main Street Sidewalk project. The Town will be required to obtain a temporary construction and permanent maintenance easement for the system improvements to be located on private property. It is important to point out that the culvert replacement scheduled for Drainage area 2E outlined in Table 5-3 must be constructed prior to the construction of these improvements. The conceptual layout of the improvements is shown on Figure 5-9.

5.5.2.6 East Main Street/Pequot Road – Clayter Hill Road to Arcola Lane

Stormwater runoff along the northern side of East Main Street from Clayter Hill Road to the Beaver Dam Road tends to flow along side the shoulder and esplanade between the road and the existing sidewalk. It ultimately discharges into the existing ditch scheduled for rehabilitation with the proposed short term recommendations just west of Clayter Hill Road. Stormwater runoff in this area can be managed more efficiently with a closed system consisting of the installation of new catch basins and structure to structure piping. Given the steep grades in this section of road, installation of a closed system will also minimize the potential for erosion along the shoulder. As with other proposed improvements, curbing installed on the back edge of the shoulder will promote positive drainage into each catch basin.

Further out East Main Street, in the section where the road turns into the Pequot Road, from the Beaver Dam Road to Arcola Lane, stormwater runoff is managed with a closed drainage system consisting of catch basins and 12-inch plastic drainage pipe. The closed system is broken with a culvert discharge to the ditch which flows overland for several feet and then drains into another closed system. The system discharges via a 15-inch plastic culvert to the west and behind N/F Conway. The existing system components along the street and the outfall are undersized to accommodate the design storm requirements. The entire system should be improved with the construction of new catch basins, pipe, and outfall. Curbing should also be considered along the new drainage system components to promote positive drainage into the catch basin structures. The conceptual layout of the improvements is shown on Figure 5-10.

5.5.2.7 Sands Road

From our visit, it is not clear what, if any systems are in place to accommodate the stormwater runoff from the regions above and the area along the northern side of Sands Road. This is a part of Town that the Sidewalk Committee has recommended an extension of the sidewalk system. When the sidewalk construction project is considered, we recommend combining it with drainage system improvements along the northern side of the road. This will include the installation of several culverts, riprap lined ditches, and an outlet to the ocean. The Town will be required to obtain temporary construction and
permanent maintenance easements for the outfall. The conceptual layout of the proposed system is shown on Figure 5-11.

5.5.2.8 Downtown Main Street

The analysis of the immediate downtown part of the village area, at the bridge crossing between the Pond and the Harbor indicated a fragmented system with more than one discharge. The drainage system consists of various catch basins and outlet pipe systems. From our visit, and a review of the Sidewalk Committee’s Development Plan, it is apparent that the existing curbing in this area is too high to allow stormwater to drain away from many of the businesses along this part of Main Street and into the existing catch basins. Without lowering the road grade, there are some opportunities to remove the high curbing along the street to help. Recommendations to improve this section have been included in the Development Plan and cost estimates were developed by Woodard & Curran for these improvements. In addition to these changes, we would recommend installing a new closed system with one common outfall to serve this part of Town. The system will collect stormwater through a variety of basins and convey the water to the existing catch basin and ultimately through an outlet in the parking lot with new storm drain pipe. The conceptual layout of the proposed system is shown on Figure 5-12.

5.5.2.9 Estimated Cost of Implementing Long Term Recommendations

The estimated project costs to construct the improvements are shown in Table 5-4. These estimates are intended to include Engineering, survey, permitting, easements (where appropriate), excavation, materials (pipe, structures, bedding and backfill, and paving), labor, and surface restoration. Costs for ledge removal have been estimated based on the information that is available from previous construction.

The implementation of these Long Term Recommendations is expected to cost approximately $2,156,000.

Table 5-4 – Estimate of Anticipated Costs of Long Term Upgrade Recommendations

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>APPROXIMATE COST</th>
</tr>
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<tbody>
<tr>
<td>Culvert Replacement – Phase II</td>
<td>$ 24,000</td>
</tr>
<tr>
<td>West Main Street</td>
<td>$ 329,500</td>
</tr>
<tr>
<td>East Main Street – Public Works Garage Lot</td>
<td>$ 351,250</td>
</tr>
<tr>
<td>Brighton Avenue and Carvers Streets</td>
<td>$ 236,250</td>
</tr>
<tr>
<td>Pleasant Street and Cottage Street</td>
<td>$ 285,500</td>
</tr>
<tr>
<td>East Main Street/Pequot Road – Clayter Hill to Arcola Lane</td>
<td>$ 439,000</td>
</tr>
<tr>
<td>Sands Road</td>
<td>$ 305,500</td>
</tr>
<tr>
<td>Downtown Main Street</td>
<td>$ 185,000</td>
</tr>
<tr>
<td><strong>TOTAL OF RECOMMENDED LONG TERM PROJECTS</strong></td>
<td><strong>$2,156,000</strong></td>
</tr>
</tbody>
</table>
NOTE:
1. SIDEWALK CONSTRUCTION PROPOSED ALONG SANDS ROAD NOT SHOWN FOR CLARITY.
6. PROJECT FINANCING

6.1 OVERVIEW

Unlike public utilities such as water and wastewater, there are not as many options available for funding stormwater improvement projects. Given that municipal stormwater systems are not operated and maintained from user rates, improvements through construction projects are typically voted on by the Town and are considered as Capital Improvements funded in large part by taxation. If it were more common for stormwater utilities to be funded by user rates, like water and wastewater systems, then more options would likely be available. Because of this, most projects of this type are funded by loans secured by the Town and paid back like other costly purchases made by Towns, through taxation. Grants or grant/loan packages for this type of work are not common. Low interest rate loans from the Maine Municipal Bond Bank (MMBB) and Rural Development are available.

Although it is not common, some communities in Maine, like Augusta and Lewiston, have established stormwater utility districts. The purposes of the districts are to develop a structure that can enforce regulation at the local level and to provide a mechanism to fund stormwater utility improvements throughout the community. Fees are assessed to properties within the community based on the amount of impervious area that exists. The fees are typically one third to one fourth that of an average wastewater or water user fees. This provides equity throughout the community as it funds Capital Improvements by all contributors to the system. By funding projects through taxation, many non-profit and tax exempt properties do not contribute and therefore the project costs are spread amongst a smaller group of individuals which as a result raises their taxes. In Lewiston, they have found that by using this approach to fund a nearly $2,000,000 worth of stormwater improvement projects, they have estimated that the average tax payer would pay nearly one fourth what they would have if the projects were financed directly through taxation.

To help promote system improvements and protect watersheds, a few funding opportunities in the forms of grants are available through the Environmental Protection Agency (EPA) and DEP. We have listed them in this report however, based on the selection criteria for the funding; it is very unlikely that any of the projects recommended in this report will qualify. The grants are typically awarded to applicants with the goal of restoring or protecting a valuable watershed which could be a sensitive lake or stream or a drinking water supply.

6.2 LOAN PROGRAMS

6.2.1 Rural Development

Rural Development funds numerous utility projects for towns and districts which meet their criteria. The population of the town must be below 10,000 people. Current loan rates are 4.5 percent for 30-years. Applications are accepted throughout the year, but must be accompanied by an engineering report. An additional effort consisting of an environmental review would be required in addition to this report to satisfy their funding concerns.

6.2.2 Maine Department of Environmental Protection

Given the infiltration and inflow sources in the existing wastewater system, a new storm drain system will allow roof, basement, and foundation drains to be removed from the sanitary system, these projects may likely qualify for funding through this program. Loan money is available through the Clean Water State
Revolving Loan Fund (SRF) at 2-percent below the market interest rates for terms up to 20-years. Applications to the SRF program generally occur twice per year in April and October to coincide with the MMBB schedule of bond sales. MMBB assists the MDEP in the administration of the SRF program.

6.3 GRANT PROGRAMS

6.3.1 Maine Department of Environmental Protection/US EPA

MDEP administers an EPA program that provides the funding of projects to prevent or reduce non-point source pollutant loadings entering water resources so that beneficial uses of the water resources are maintained or restored. The funding is granted based on a competitive proposal process. A key component of the selection criteria is the size and value of the watershed. At the present time, the proposal process and available funding is too prescriptive and narrow in scale and scope for Vinalhaven to be awarded any money. If either the selection criteria stated in the RFP changes or the receiving waters in Vinalhaven become an identified pollution concern, then the town may qualify for funding through this program.

6.3.2 Department of Economic and Community Development

Community Development Block Grants (CDBG) funding is administered by the Department of Economic and Community Development under two programs: the Public Infrastructure Facilities (PFI) Grant and the Economic Development Infrastructure (EDI) Grant. The PFI Grants are aimed at providing low to moderate income communities with the ability to upgrade their infrastructure, so eligibility is based on community income levels. EDI Grants are directed toward projects that will encourage or support employment opportunities for low to moderate income people and can therefore be used to benefit business that employ low to moderate income people. The maximum award is $500,000 per year or $1,000,000 over a two year period.

The application process for PFI grants usually begins toward the end of the calendar year with grant disbursement the following spring in order to coincide with the construction season. EDI Grant applications usually occur three times per year, typically in February, May, and August. Competition for CDBG grants is significant and towns usually retain grant writers to prepare the applications. To be considered for these funds, applicants must prove that the project will be built within an area where most of the residents qualify as low to moderate income. Income data from the latest government census is usually used for this however in the case of a project that will impact a specific section of the community, income surveys can be conducted to reflect the actual economic conditions of those that will benefit from the improvements.

6.4 OTHER

6.4.1 Maine Department of Transportation

As we previously discussed, many of the proposed improvements are within State maintained roadways. It is likely that many improvements can be implemented along with some of MDOT’s future road construction projects. The Town should reach out to MDOT staff and share the information contained in this report. The more they are aware of the Town’s intentions, the more likely they will incorporate your ideas into their routine maintenance and construction projects and provide some level of cost sharing.
7. SUMMARY AND CONCLUSIONS

7.1 SUMMARY

This report describes the results of a study conducted to quantify stormwater runoff within the village area of Vinalhaven, identify the deficiencies within each existing stormwater system, and provide recommended solutions to improve each system.

Most all of the existing stormwater systems in place in Vinalhaven are undersized. In Maine, it is common design practice for closed drainage systems to be able to accommodate the 10-year storm event, for culverts and major drainage components to meet the 25-year storm event, and for all components within MDOT right-of-ways to accommodate the 50-year storm event.

We have developed a series of conceptual improvements based on the findings of our analysis. The proposed projects have been prioritized into short term and long term recommendations. Many of the proposed projects will provide an opportunity to remove the extraneous flows from the sump pumps, foundation drains, basement drains, and roof drains from individual residences that currently discharge into the sanitary sewer system. An existing moratorium against construction within MDOT right-of-ways on the island due to recent construction will place all proposed improvements within State roads into being long term recommendations.

There are no reports of stormwater quality issues or concerns with non-point source pollution of the receiving waters in the community, primarily the Atlantic Ocean. The Town is not specifically regulated or required to develop a Stormwater Management Plan or a Stormwater Quality Protection Plan. Stormwater generated from construction activities is regulated and enforced by separate laws at the State level. These apply to development and construction activities on Vinalhaven.

7.2 CONCLUSIONS

The findings of this report indicate that the cost to improve the stormwater systems throughout Town requires a significant capital investment. We have estimated that short term recommendations will cost approximately $697,000 to construct and that long term recommendations will cost approximately $2,156,000 to construct. Based on the overall costs to improve the existing stormwater systems, a practical approach would be to phase the design and construction of each project such that high priority areas are built first with lower priority ones waiting for future years. Many of these projects have been paired with sidewalk construction projects to realize an economy of scale cost savings. Another way to realize cost savings is to pair the projects with road or utility reconstruction projects throughout Town.

Many of the improvements are located within State owned or maintained right-of-ways. The existing moratorium against construction within the roadway of State maintained roads has been factored into prioritization and implementation of project improvements. The Town should approach the State to discuss opportunities to have them share in the cost of many of these improvements as part of upcoming road reconstruction or maintenance projects.

Most sources of funding for projects of this type are loan based. Some competitive grant funding is available however it would likely go to applicants with significantly worse and previously known and identified pollution problems. As stated, we are unaware of any water quality concerns with the waters surrounding the immediate village area of Vinalhaven caused by pollution within stormwater. When implementing the improvements to the stormwater systems, we will encourage the Town to implement BMPs to ensure that the water quality within the Pond, the Harbor and tributary receiving waters such as Indian Brook, will not diminish.
APPENDIX – RESULTS OF HYDROCAD ANALYSIS
<table>
<thead>
<tr>
<th>Drainage Area Subarea</th>
<th>Area (acres)</th>
<th>10 Year, 24 Hour Storm Peak Flow In (cfs)</th>
<th>25 Year, 24 Hour Storm Peak Flow In (cfs)</th>
<th>50 Year, 24 Hour Storm Peak Flow In (cfs)</th>
<th>Existing Drainage Drainage Notes</th>
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<tr>
<td>1 A</td>
<td>1.021</td>
<td>3.73</td>
<td>7.47</td>
<td>8.15</td>
<td>4.8 15&quot; CMP 15&quot; HDPE Estimated slope for 15&quot; CMP culvert</td>
</tr>
<tr>
<td>1 B</td>
<td>0.813</td>
<td>3.47</td>
<td>4.13</td>
<td>4.5</td>
<td>See overall</td>
</tr>
<tr>
<td>1 C</td>
<td>0.758</td>
<td>3.26</td>
<td>3.89</td>
<td>4.25</td>
<td>4.5 15&quot; CMP None 15&quot; CMP connecting CB's</td>
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<tr>
<td>1 D</td>
<td>0.798</td>
<td>3.4</td>
<td>4.05</td>
<td>4.43</td>
<td>3.6 12&quot; CMP 15&quot; HDPE</td>
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<tr>
<td>DA 1B &amp; 1C Overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1B and 1C drain via the 15&quot; culvert crossing the DPW lot</td>
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<tr>
<td>DA 1A &amp; 1D Overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1A and 1D appear to drain via the ditch along the ledge wall at the DPW lot</td>
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<td>2 A</td>
<td>7.927</td>
<td>20.18</td>
<td>24.42</td>
<td>26.85</td>
<td>See DA2 overall 16&quot; CMP</td>
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<td>2 B</td>
<td>4.214</td>
<td>10.48</td>
<td>12.94</td>
<td>14.34</td>
<td>2.2 12&quot; CMP 24&quot; HDPE</td>
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<td>Collection Point</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>2 C</td>
<td>7.703</td>
<td>20.3</td>
<td>24.6</td>
<td>27.1</td>
<td>8.1 20&quot; CMP 36&quot; HDPE</td>
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<td>2 D</td>
<td>1.12</td>
<td>4.26</td>
<td>5.15</td>
<td>5.65</td>
<td>4.3 12&quot; CMP (sidewalk project)</td>
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<td>2 E</td>
<td>1.808</td>
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<td>6.29</td>
<td>6.91</td>
<td>3.0 12&quot; CMP (sidewalk project)</td>
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<td>2 F</td>
<td>2.022</td>
<td>9.75</td>
<td>11.85</td>
<td>13.05</td>
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<td></td>
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<td>2 G</td>
<td>2.153</td>
<td>5.74</td>
<td>6.98</td>
<td>7.69</td>
<td>3.0 12&quot; CMP 15&quot; HDPE</td>
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<td>2 H</td>
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<td>38.3</td>
<td>42.7</td>
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<td>2 J</td>
<td>1.747</td>
<td>4.99</td>
<td>6.16</td>
<td>6.83</td>
<td>5.8 15&quot; CMP 18&quot; HDPE</td>
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<td>2 K</td>
<td>2.398</td>
<td>5.64</td>
<td>6.96</td>
<td>7.72</td>
<td>7.1 15&quot; CMP 24&quot; HDPE</td>
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<td>2 L</td>
<td>0.506</td>
<td>1.34</td>
<td>1.65</td>
<td>1.83</td>
<td>3.2 12&quot; CMP None</td>
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<tr>
<td>DA 2 Overall</td>
<td>32.679</td>
<td>85.8 (water level 1.1 ft above top of pipe)</td>
<td>105.9 (water level 2.3' above top of pipe)</td>
<td>116.5 (water level 2.5' above top of pipe)</td>
<td>5.2 (without detention above the top of the pipe) 18&quot; CMP 2 18&quot; CMP Outlet preceded by pond</td>
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<tr>
<td>3</td>
<td>2.975</td>
<td>8.14</td>
<td>10.04</td>
<td>11.13</td>
<td>2.2 12&quot; CMP 24&quot; HDPE Estimated from contours, 12&quot; CMP confirmed by DPW</td>
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<tr>
<td>4</td>
<td>0.617</td>
<td>1.72</td>
<td>2.14</td>
<td>2.39</td>
<td>2.9 12&quot; CMP None</td>
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<td>5.186</td>
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<td>13.61</td>
<td>3.4 15&quot; CMP 24&quot; HDPE Estimated capacity. DPW could not locate discharge end</td>
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<td>6</td>
<td>12.23</td>
<td>13.36</td>
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<td>21.7 24&quot; CMP 30&quot; HDPE</td>
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<td>4 18&quot; CMP 24&quot; HDPE Existing 18&quot; CMP to Clamshell Alley, 12&quot; HDPE outlet</td>
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<td>8</td>
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<td>21.66</td>
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<td>9</td>
<td>5.999</td>
<td>16.7</td>
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<td>5.9 15&quot; CMP 24&quot; HDPE Outlet buried in grout fill, new pipe should extend to shore</td>
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<td>10</td>
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<td>5.87</td>
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</tr>
<tr>
<td>Drainage Area</td>
<td>Subarea</td>
<td>Area (acres)</td>
<td>Peak Flow In (cfs) 10 Year, 24 Hour Storm</td>
<td>Peak Flow In (cfs) 25 Year, 24 Hour Storm</td>
<td>Peak Flow In (cfs) 50 Year, 24 Hour Storm</td>
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<td>3.73</td>
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<td>1.542</td>
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<td></td>
<td>DA 13 Overall</td>
<td>4.813</td>
<td>15.2</td>
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<td>DA 14 Overall</td>
<td>2.73</td>
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<td>15</td>
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<td>14.5</td>
<td>23.5</td>
<td>30</td>
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Peak Flow In from individual drainage areas before critical drainage structures or combined with upstream drainages.

Peak Flow Capacity: Approximate flow capacity of existing drainage systems.

? Unknown pipe size, length, or invert information.