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COASTAL MANAGEMENT FOR TRADITIONAL VILLAGES: ROYAL OAK ASSESSMENT

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Prepared for Talbot County Office of Planning and Zoning

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Project Overview

Talbot County has over 600 miles of coastal shoreline that supports a diverse community and economy focusing on agriculture, recreation, manufacturing, and professional services. Talbot County's population is over 37,000 with Easton serving as the county seat (MD DBEC, 2011). Talbot County is a low-lying coastal area where local flooding is a concern. In addition, Talbot County has been identified as vulnerable to future sea level rise and/or coastal hazards (Titus (1998), IPCC (2007), Johnson (2000). In western Talbot County twelve communities in the "Bay Hundred" area were identified that require assistance to better manage non point source pollution from stormwater runoff. These twelve rural, waterfront Villages have similar topography and population. Established 100 to 300 years ago the Villages generally have single family residential homes that have little to no stormwater management and are served by wells and septic systems (CCI, 2010). The three villages identified as representative areas for study are Royal Oak, Newcomb, and Bellevue. The major concerns for these areas are stormwater management and shoreline erosion and three consulting agencies were tasked to characterize their respective Village and make recommendations for improvements that can be applied to all 12 Villages in the Bay Hundred area. Finally, future efforts to improve stormwater management and control shoreline erosion such as project implementation, management options, community outreach and education, and/or securing funding mechanisms are outcomes for this work.

Introduction

Center for Watershed Protection, Inc. (Center) worked with Talbot County Office of Planning and Zoning on the, "Coastal Management for Traditional Villages," project funded by the Coastal Communities Initiative (CCI). This CCI project focused on stormwater management and community coastal erosion concerns. As part of this CCI project, Center's objective was to characterize stormwater management in the Village of Royal Oak (Figure 1) and provide recommendations for stormwater management improvements. To incorporate future potential sea level rise impacts into field work and resulting recommendations, 0-2 foot inundation maps were used. Therefore, the sea level rise was a component of these recommendations, where appropriate.

The Village of Royal Oaks consists of large and small lot residential development bordering agricultural fields and tidal creeks: Oak Creek a tributary of the Miles River to the north, Upper Edge Creek and Solitude Creek off of Broad Creek to the south west, and Plaindealing Creek off of the Tred Avon River to the southeast. The major impervious surfaces are the rural two lane highways and scattered residential rooftops.

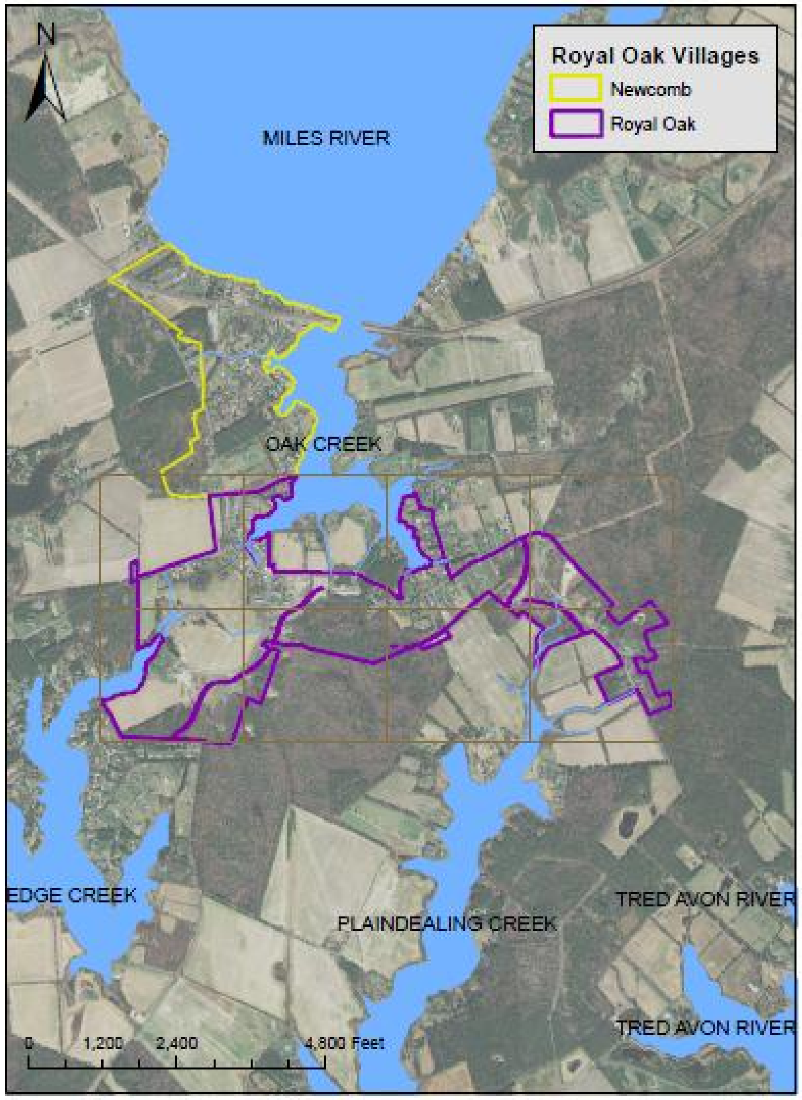


Figure 1. Village of Royal Oak map.

All the roads through the Village are low lying open section with roadside ditches, numerous culverts, and man-made channels draining to the adjacent creeks noted.

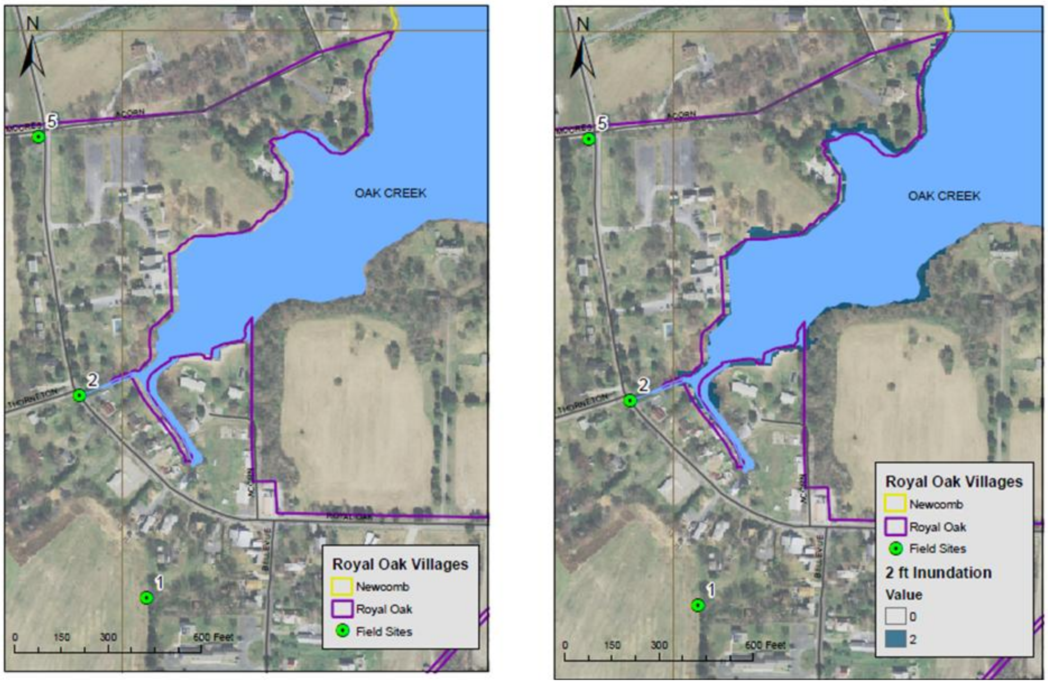
Methods

Community input and cooperation was the driving force for this project. The Center attended the team strategy meeting entitled, "Coastal Management for Traditional Villages," on November 18, 2010, to outline project objectives, goals, and timelines. The Center attended the first of two community meetings targeted for the three study area Villages entitled, "Talbot County Village Stormwater, Shoreline, and Sea Level Study Kickoff." At this meeting the community heard the project overview and provided feedback. The Center met with Royal Oak community members to discuss stormwater management issues in the area, target sites to investigate during field assessments, and assemble community members interested in participating in the field assessment. The outcome was a Royal Oak map with eight to ten sites identified for investigation and community member contact information for project participation (e.g., Frank Cavanaugh who is the Chairman of the 12 Village's Board, Stephen Luethy who is the Royal Oak representative, and Allen Fox, IV from Royal Oak). Field work was conducted on March 2, 2010, by two Center staff (Senior Stormwater Engineer & Watershed Planner), the community members identified above plus Steve (last name unknown), Vicky Carrasco with MD Sea Grant Consortium, and Martin Sokolich ,Project Manager for the Talbot County Office of Planning and Zoning's Long Range Planner.

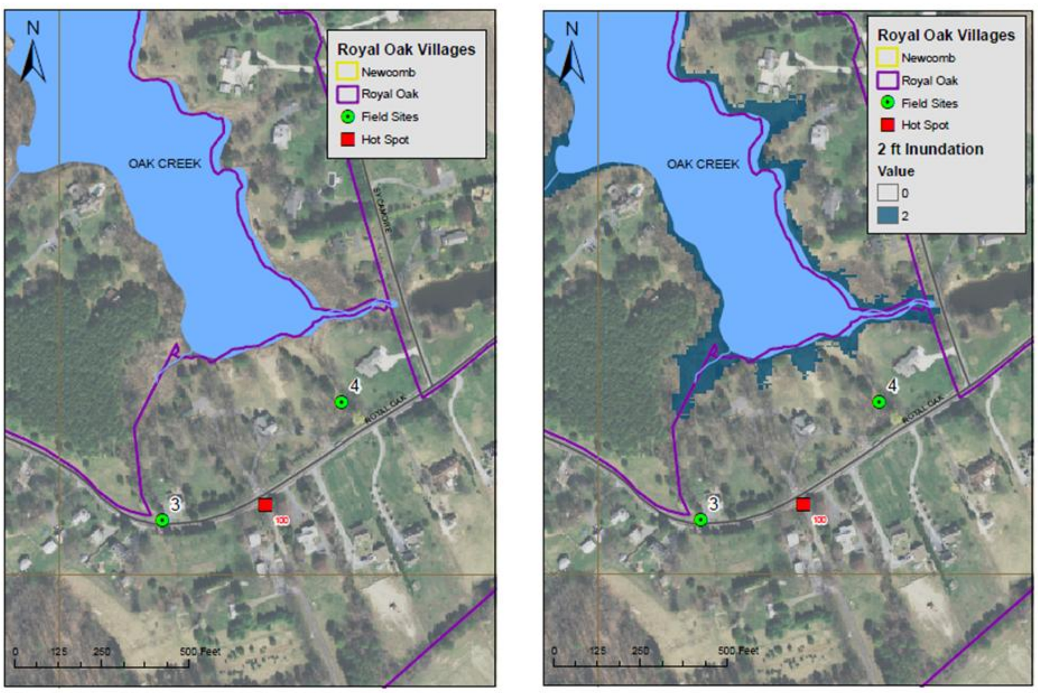
Before going into the field, Talbot County provided Geographical Information (GIS) that included typical site data (e.g., aerial imagery, contour lines, infrastructure, waterbodies, etc.). Prior to the field investigation, the Center compiled this GIS data and obtained the two foot inundation sea level rise data layer from the Maryland Department of Natural Resources (DNR) web mapping site "Merlin." This website is available online at: http://www.mdmerlin.net/mapper.html and includes parcels, historical shorelines, oyster bars, floodplains, sea level rise vulnerability, wetlands, and additional information. Desktop analysis was performed to identify potential areas for investigation, field maps were made and printed, and coordinate field work with the Village of Royal Oak stakeholders.

The Center used the Retrofit Reconnaissance Investigation (RRI) for stormwater management field investigations. The RRI identifies potential treatment practices designed to address stormwater quantity or quality where no practice previously existed. These treatment practices, also known as retrofits, are designed to store, infiltrate, and/or treat stormwater runoff from as much development as possible. Stormwater retrofits differ from "regular" treatment practices mainly in terms of when they are installed – they are installed well after development is complete, rather than during or even before construction. For this reason, stormwater retrofitting can sometimes be difficult. Finding the space available to install stormwater treatment practices without negatively impacting existing uses of the land is not always possible. For additional information about the RRI, refer the Schueler et al., 2007. In addition to the RRI, the Center field staff assessed the Village of Royal Oak for neighborhood investigations using the Neighborhood Site Assessment (NSA), looked for any "Hot Spots" using the Hot Spot Investigation (HSI). However, the major findings were based on the RRI assessment since only one Hot Spot was identified and the NSA findings are incorporated in the RRI results for this one neighborhood (or town). The overall objective for the RRI is to reduce stormwater runoff volumes and pollutants to the maximum extent practicable across the Village of Royal Oak drainage area given the rural and low development within the watershed. Additionally, photos were taken and logged.

The residential properties and drainage issues identified by the residents include cases of periodic or nuisance flooding. A site visit was conducted on Wednesday, March 2, 2011. Center staff, accompanied by the team members investigated each of the sites identified by the community to evaluate the public and private stormwater conveyance systems, and determine potential water quality and/or stormwater flooding retrofit opportunities. The area had experienced a moderate to light rainfall event the previous weekend and there was evidence of stormwater in several ditches, which is common in the winter and early spring. The Center utilized Village of Royal Oak Geographic Information System (GIS) maps that contained typical site information and land cover, as well as sea level rise data to identify retrofit areas and determine how sea level rise may impact project design. Two foot inundation sea level rise data was chosen since this represents the 50 year inundation scenario that is most relevant for stormwater infrastructure lifespan. See Figure 2 for an example of the sea level rise information at the sites.



(a)



(b)

Figure 2. Two foot inundation sea level rise maps were used in the field to inform future management options explored. In (a) the map on the left shows Sites 1, 2, and 5 with no sea level rise information and the map on the right identifies Sites 1, 2, and 5 with the two foot inundation information (shown in darker blue). In (b) the map on the left shows Sites 4 and 5 with no sea level rise information and the map on the right identifies Sites 4 and 5 with the two foot inundation information (shown in darker blue).

Village of Royal Oak Land Cover Summary

Using the GIS data provided by Talbot County, the following summary statistics were determined for the Village of Royal Oak (Table 1). The study area is rural with low impervious cover (<5%) consisting of primarily low density residential single family homes (residential parcels comprising approximately 50% of the land cover) and roads. This overall low level of impervious cover is generally considered to be within the accepted tolerance of stream hydrologic function and aquatic diversity. (Schueler, Fraley-McNeal, and Cappiella, 2009) Further, the low density of the impervious cover (that is, widely distributed in relatively small areas of rooftops, driveways, and roads) means that meaningful stormwater retrofits are unlikely (as confirmed by the field visit). However, several programmatic (non-structural) strategies, such as public education on general land and runoff management could be implemented to achieve significant pollutant load reductions on a watershed scale.

Table 1. Land cover analysis.

Feature	Area[1]	Percent of Total Land Cover
Village of Royal Oak (Total Area)	339 acres	
Residential Plots	172 acres	51%
Impervious Cover within Residential Plots[2]	8 acres	2%[3]
Forest Cover within Residential Plots	90 acres	27%[3]
Managed Turf within Residential Plots	74 acres	22%[3]
Roads	8 acres	2%
Other (open space, meadow, forest, unmanaged turf)	159 acres	47%

[1]Based on the resolution of the data up to 10% error is estimated.
[2] Impervious cover breakdown – driveways: 3 acres, Rooftops: 5 acres.
[3] Percentage of total area.

General Observations and Stormwater Quality Retrofits

The primary road through the Village of Royal Oak is Royal Oak Road (Route 329) which along with it's system of culverts and ditches are the central drainage features of the area. All five of the sites visited during this evaluation included Royal Oak Road and its associated drainage infrastructure. Each of the identified sites consists of, in part, relatively small roadway drainage systems (e.g., roadside ditches, cross culverts, drainage channels, and to a lesser degree pipe systems) that serve small suburban developed areas within relatively large rural agricultural and forested drainage areas. The sites visited were a result of the community meetings where residents identified areas of concern such as periodic road flooding and because they are highly visible areas adjacent to residences along the primary travel route through the Village of Royal Oak. In addition to the pre-identified sites the Center field team and volunteers assessed the Village of Royal Oak using a "windshield survey" (aka from vehicle).

The site visits included interviews with the property owners, where possible, to capture the historic anecdotal evidence of the drainage or water quality issues. In most cases, there was evidence of standing water or indicators of out of bank flow (e.g., leaf litter patterns, flattened grass, etc.), and the eye witness accounts provided confirmation of the conditions and assisted the investigating team's retrofit assessment. A common theme at all the sites was the frequency and duration of the observed flooding summarized as follows:

1. The reported flooding occurred during extremely large or intense storms and
2. The duration of the out of channel flow or nuisance flooding was limited to a few hours after the storm event.

This evidence indicates that these systems likely perform as designed during the more frequent and small storm events, with the amount of nuisance flooding increasing as storm intensity and duration increase.

The field sites visited and one Hot Spot identified are indicated on the map in Figure 3. A detailed assessment for all sites is in the Village of Royal Oak Stormwater Retrofit Assessments section.

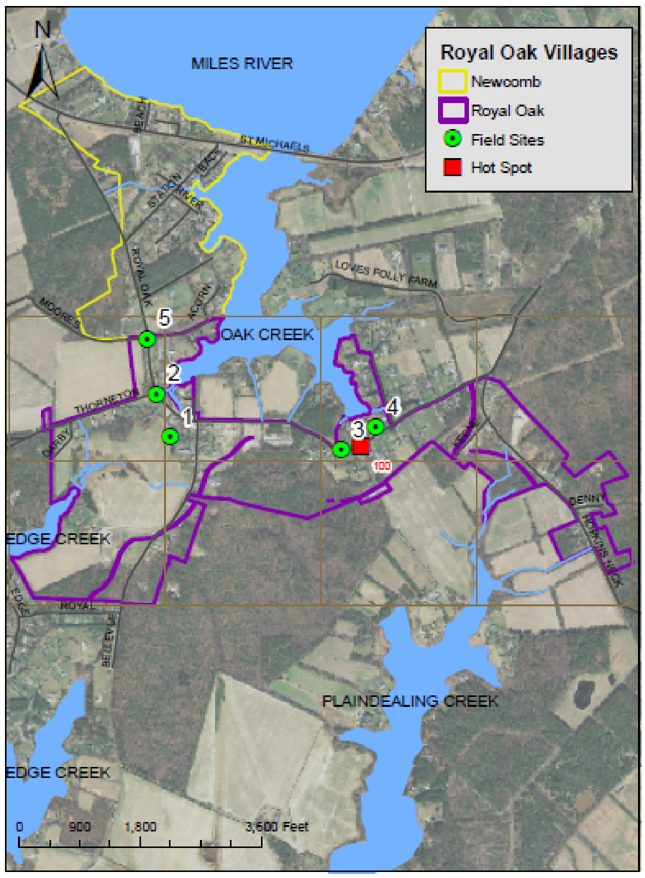


Figure 3. Field sites 1, 2, 3, 4, 5 and one Hot Spot (#100) are identified.

The field site visits also indicated that there are few structural retrofit opportunities to reduce stormwater runoff volume or pollutant load. The impervious cover is almost exclusively roadway, and isolated driveways and rooftops in this agricultural and recreational focused village. While the opportunities for small scale retrofits such as rain barrels and rain gardens at individual residences are available, they would serve primarily as educational tools for the community and not a significant source of water quality and/or quantity improvement.

The Village of Royal Oak retrofit opportunities are categorized as the following: 1) drainage system upgrades; 2) drainage and ditch system maintenance; 3) structural water quality retrofit improvements; 4) non-structural water quality retrofits; and/or 5) a combination of 1 through 4. These stormwater retrofit opportunities are described here:

Drainage System Upgrades: The drainage system described in Site 1 represents the most extensive system observed: multiple inlets and underground pipe alignments connecting private and public (County and State road) drainage systems, including possible field connections. Similarly, the system described in Site 2, while much simpler, was also difficult to accurately assess. The observed alignment of what appeared to be single run pipes or culverts did not continue to the expected terminus inlet (no pipe outlet or connection located in the field), indicating a possible underground horizontal bend or field connection.

Note:

A *horizontal bend* consists of gradually changing the alignment of the pipe by beveling the pipe alignment at each joint. There is a maximum bevel for different pipe materials and joint configurations, beyond which water can escape the pipe, and/or soil or pipe bedding material can enter the pipe – potentially undermining the grade above the pipe. In addition, the hydraulic design of storm drain systems rarely consider the hydraulic losses of horizontal bends, thereby inadvertently under sizing the system for the design flow.

A *field connection* consists of a smaller pipe connected to a larger pipe by cutting directly into the diameter of the larger pipe without a manhole or junction box. This technique is used often when new pipe systems are added in older developed areas. Field connections will significantly impact the drainage system by: 1) reducing the flow capacity of the larger system creating hydraulic losses within the pipe; 2) potentially adding flow beyond the design flow capacity; and 3) creating a condition that will snag debris such as branches, leaf litter, and/or trash in an inaccessible location further reducing the flow capacity of the system.

In addition, several culverts were in disrepair at the entrance due to the impact of vehicles that partially run off the road or large trucks that cut the intersection corners and run their tires into the ditch.

Drainage system upgrades would include a prioritized list of system components identified at Sites 1, 2, 3 and 5. Upgrades include eliminating field connections and horizontal bends by adding manhole structures or junction boxes, the installation of headwall or end wall sections as needed to improve culvert entrance hydraulics and capacity, and the replacement of old and broken pipe (or sections of pipe). Identifying and prioritizing the upgrades would include using video inspection equipment or other means of investigating the actual alignment and pipe system condition.

Unfortunately, the upgrades to the drainage system do not necessarily translate to measured water quality benefits. While flooding conditions may add to overall water quality impairments by destabilizing soil, killing vegetation, or washing debris and trash into the adjacent creeks, there were no specific improvements associated with drainage upgrades that related to water quality noted at the five sites investigated. In fact, only one "Hot Spot" was identified and consisted of a potential sewer manhole overflow. This Hot Spot was located at Schoolhouse Lane and Royal Oak Road (see Figure 3).

Drainage and Ditch System Maintenance: The roads and ditch systems exist in a low lying area with low relief (0 to 8 feet above sea level) throughout Royal Oak. Soil characteristics that range from high clay to high sand content (or a soil complex with varying combinations of the two) create ditch conditions that are highly variable and in some cases difficult to maintain. Many of the ditches (Site 3 & Site 5) hold standing water. Additional ditches were observed to have silted in up to one-half of the flow capacity.

It is evident that periodic maintenance of the system over the years to remove sediment and restore the ditch invert down to the elevation of the culvert has resulted in very rectangular ditch cross sections: a flat bottom invert with vertical side slopes. This is generally considered unsafe when positioned within the roadway clear zone; i. e.,: adjacent to the travel lane without any shoulder or guardrail, as noted by caution signs within the Village of Royal Oak that warn motorists of the drop off immediately adjacent to the road surface. Over time, these vertical ditch sides will slough into the channel creating a "vee" ditch geometry with less flow capacity and a new raised invert elevation (typically above the culvert invert). Gradually the sediment level will equalize in the adjacent culverts further reducing the hydraulic capacity and increasing the frequency of minor flooding over the roadway.

Other sections along Royal Oak Road have been graded to provide a more gradual ditch section with 2:1 or even 3:1 vegetated side slopes. This ditch geometry is much more stable and maintainable. Where possible, future ditch maintenance should attempt to implement this broader ditch section if the grade adjacent to the road is suitable and there is available right-of-way.

The traditional methods and equipment for roadside ditch maintenance can often create more water quality issues by clearing vegetation and mobilizing sediment. Instead, periodic maintenance focused on keeping the ditch inverts and culvert entrances clear of debris and woody vegetation will be more effective in reducing the frequency of minor road flooding while also reducing the export of sediment from the ditches that typically results from traditional ditch maintenance. While periodic traditional ditch maintenance is critical to maintaining the integrity of the pavement surface and providing a means to keep the roadway surface dry, there is generally minimal water quality benefit.

Structural Stormwater Quality Retrofits: There are limited opportunities for structural stormwater retrofits due primarily to the limited amount of impervious cover within the sites investigated. Most of the drainage areas consist of scattered impervious cover with rooftops providing the most likely opportunity through the use of rain barrels and rain gardens at the downspouts. These small scale stormwater retrofits will serve as an excellent public education campaign, however, the drainage problems at the five sites as identified by the citizens are not caused by these impervious areas. Flooding was likely due to the large drainage areas, the relatively small drainage systems (small ditch cross sections and the undersized or partially clogged culverts), and large and intense storm events. These intense storms are likely to increase in duration and frequency along coastal communities (IPCC, 2007).

Another potential structural retrofit option is the roadside ditches. However, due to the geometry of the ditches and the proximity to the road, the sites investigated did not represent a viable retrofit option.

Site 3 and Site 4 include potential structural retrofits that include the following:

- Channel stabilization of the small area of the channel on Site 3, along with strict implementation of Environmental Site Design (ESD) with any new development upstream; and
- Soil amendments and landscaping in the upper drainage areas of Site 5.

As noted above, however, the amount of impervious cover to these locations is minimal, and the current conditions do not reflect water quality impacts. It should also be noted that a non-structural stormwater retrofit using the application of an urban nutrient management plan at Site 5 (and community wide) for managed turf areas would be more cost effective and establish more readily measureable nutrient reductions. This is discussed further in the non-structural retrofit section below.

Non-Structural Water Quality Retrofits: Non-Structural water quality retrofits can include a variety of programs or policies that are directed towards reducing the pollutant load to the drainage system and creeks in the Village of Royal Oak. The establishment of an incentive program to install rain barrels and/or rain gardens represents a non-structural approach (incentives) to implementing small scale structural practices (rain barrels). Also, creating a public education and incentive program to implement urban nutrient management throughout the Village of Royal Oak is recommended. This could include components targeting professional landscape and lawn service contractors, residential "do-it-yourself" homeowners, pet waste management, and water conservation measures.

For example, programs that promote smaller discrete stormwater management options such as rain gardens and/or rain barrels installed by individual property owners could yield significant stormwater management benefits as the program expands over time to more residents of Royal Oak. Likewise, programs that promote better landscape and turf management practices can influence the potential stormwater pollutant load from a much greater drainage area than any structural practices can manage. Utilizing a focused outreach effort at a community wide scale can reduce pollutants entering receiving waters in the Village of Royal Oak.

Village of Royal Oak Stormwater Retrofit Assessments

Five sites were visited during field evaluations and are detailed here including a site introduction, drainage description, recommendations, and water quality benefit (if applicable).

Site 1

Introduction

Site 1 is located approximately south of 25913 Royal Oak Road (38 ° 44' 30.47 N, 76° 10' 44.89 W). Site 1 has a combination of nuisance flooding issues and a potential water quality retrofit. Field photos are included in Table 2. This area represents a typical drainage situation that occurs when what appears to be a minor change in the watershed can have significant consequences. In this case, the farm field in the southwest quadrant of the Site 1 Picture Index in Figure 4 was previously managed through conventional tilling. Over the past 5 years (approximate), the farming practice transitioned to "no-till" and a vegetated buffer was added. According to Steve (last name unknown) (owner of Property A shown in the Picture Index in Figure 4) and Allan "Jay" Fox (owner of Property B shown in the Picture Index in Figure 4) whose residences front the south side of Royal Oak Road near 25913 Royal Oak Road, this has resulted in an increase in nuisance flooding during relatively large rainstorms.

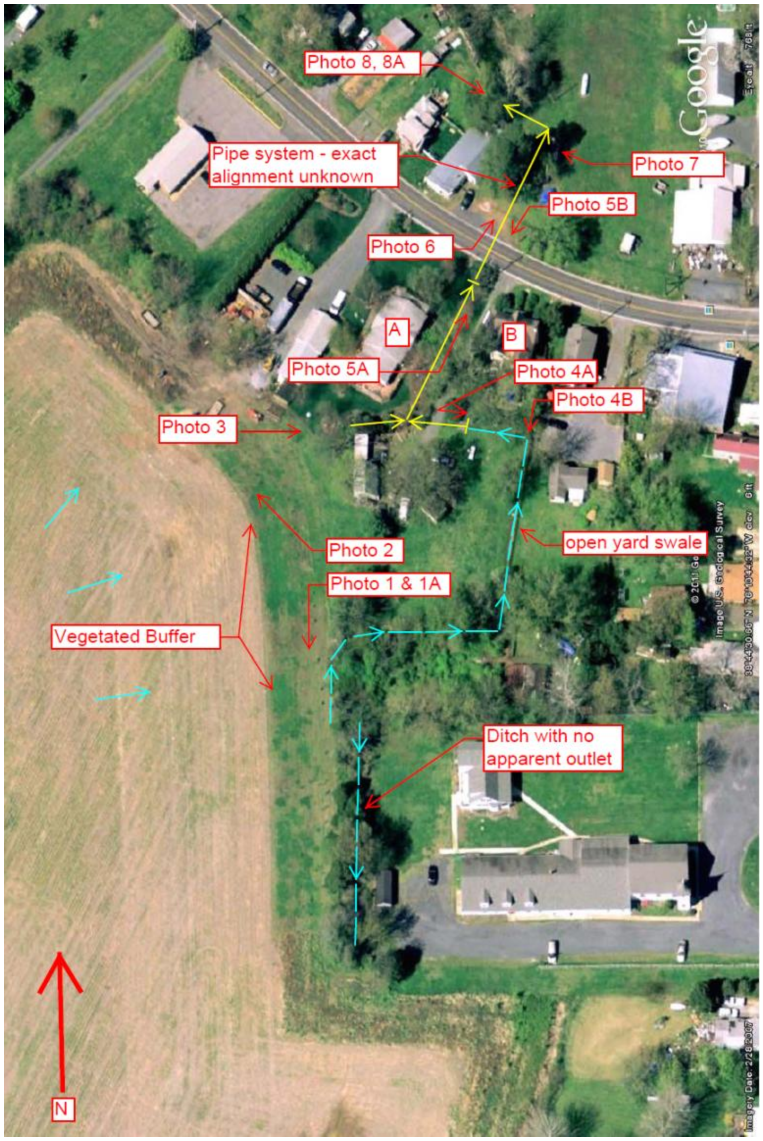


Figure 4. Site 1 picture index.

Table 2. Site 1 field photos.	
	

Table 2. Site 1 field photos.	
 Site 1 - Photo 2	 Site 1 - Photo 3
 Site 1 - Photo 4A	 Site 1 - Photo 4B
 Site 1 - Photo 5A	 Site 1 - Photo 5B

Table 2. Site 1 field photos.	
 Site 1 - Photo 6	 Site 1 - Photo 7
 Site 1 - Photo 8	 Site 1 - Photo 8A

<u>Drainage Description</u>
The natural drainage divide between Oak Creek to the north and Upper Edge Creek to the south in the area of Site 1 is located somewhere in the vicinity of the rear of the properties along Royal Oak Road. The local high point of the sub-drainage shed is approximately in the center of the field and the drainage area that appears to drain to the north is approximated by the area shown in the Site 1 (Table 2 & Figure 4). The previous tilling operations provided a release for this runoff to the south along the eastern edge of the field (before the buffer was installed) where it continued to follow a small ditch system into two small ponds in series before draining into Upper Edge Creek. Upon the introduction of the “no-till” practice and the vegetated buffer (Photos 1 and 2), the residents indicate that the sub-drainage shed of the farm field is now draining through their properties towards Oak Creek to the north.

The drainage pattern to Oak Creek is complicated by the introduction of a rather complex drainage system. The flow from the farm field enters the residential properties through at least two independent paths:

1. The first starts with field runoff conveyed in a shallow depression (Photo 1A) that feeds a small ditch that runs the perimeter of the Fox property (Photo 4B) before entering a pipe system (Photo 4A).
2. The second collects the runoff from the field in small ditches immediately adjacent to the downstream side of the vegetated buffer and conveys runoff to a small pipe system (12” plastic pipe in background of Photo 3).

There are no as-built stormwater drawings to verify the configuration of the pipe system below this point. Figure 5 provides a best estimate of the system including drainage inlets serving Royal Oak Road. It is important to note the following:

- The pipe systems indicated in Photo 3 and 4A connect at 180 degrees with no maintenance access;
- The area circled in Photo 5A: this is a pipe connection of what was previously an open ditch; this area is a low point between the driveways and Royal Oak Road that routinely ponds water and the surface condition indicates that water enters the pipe system through the ground, likely carrying a significant volume of sediment into the pipe;
- Inlets on Royal Oak Road (one in each direction – east and west) field connect into this system at an undetermined location without any maintenance access;
- The pipe system continues across Royal Oak Road and makes at least two 90 degree bends (vicinity of Photo 7) without any maintenance access, before discharging into Oak Creek. (Construction of a sewer connection from the house on the north side of Royal Oak Road indicated no conflict with, or evidence of, the drainage system; and
- The outfall of this system is shown in Photo 8 & 8A, and is in disrepair. The last pipe section has separated and fallen into Oak Creek. Rip rap and other construction debris was periodically placed around the outfall to stabilize the bank and outfall pipe.

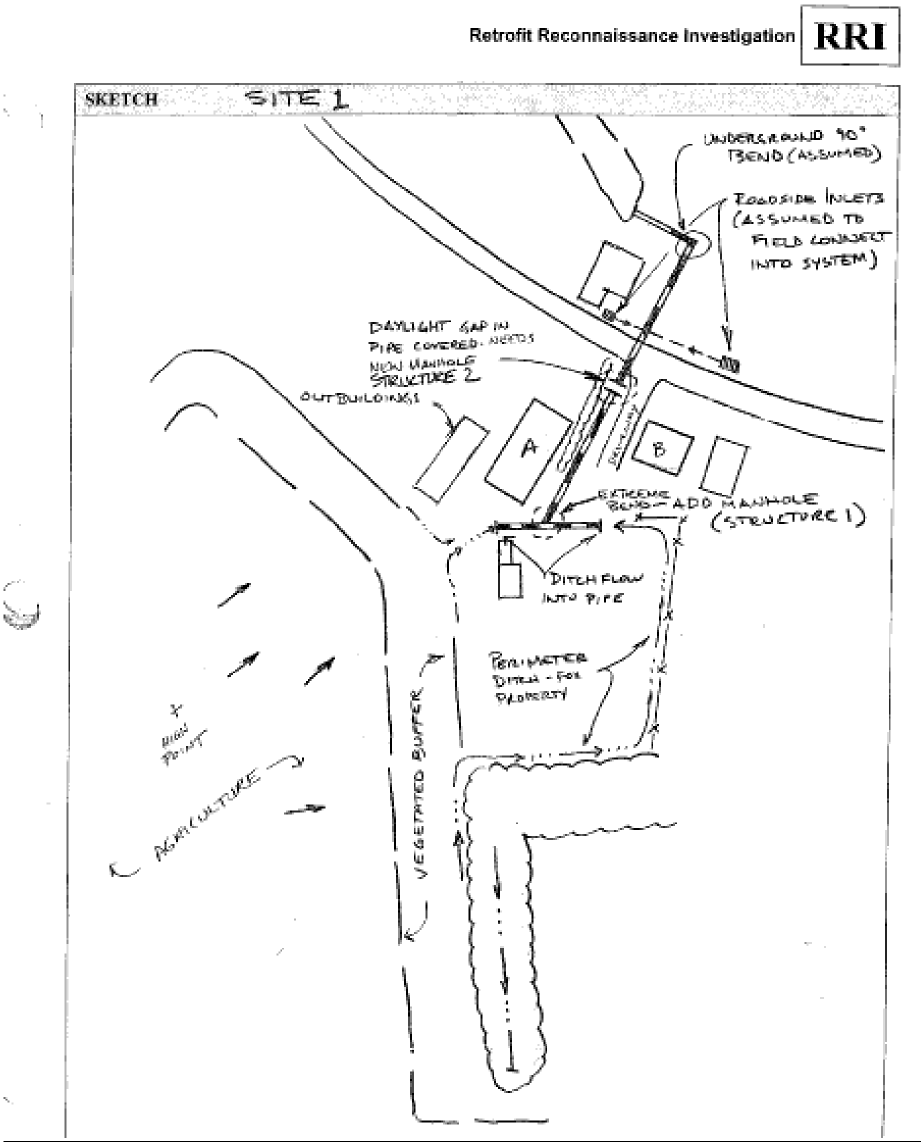


Figure 5. Site 1 system was sketched from field work and includes drainage inlets serving Royal Oak Road.

Recommendations

Recommendations to alleviate flooding include:

1. Install a manhole, inlet, or access structure at the 180 degree connection (structure 1 in Figure 5. Since this is a small system on private property, it is likely a homeowner installation.
2. Install inlet structure at location identified in Photo 5A (Structure 2 in Figure 5). Investigate the condition of pipe in both directions. Possible video of pipe under Royal Oak Road will help identify potential drainage problems associated with the State highway (or county) system in Royal Oak Road, and possibly locate the alignment of the system on the north side of Royal Oak Road. The owner of Property A indicated that he would install this junction since he had previously made the connection.
3. Install maintenance access (or cleanout) at the 90 degree bends in the system on the north side of Royal Oak Road.
4. Repair outlet of pipe system at Oak Creek.

Anecdotal evidence indicates that the periodic nuisance flooding in the residential area recedes in a reasonable period of time after the rain event. Therefore, it is expected that the drainage system under Royal Oak Road, when properly maintained, will be adequate for the drainage area (including the farm field). This can be verified once the system alignment and grades are identified.

If the system is not adequate, the drainage from the farm field can be redirected to its historic drainage pattern by leveling the low areas on the back side of the buffer that currently allow runoff to enter the residential properties. The flow should then be directed on the back side of the buffer towards the south (reversing the direction of the flow in Photo 1A) by re-establishing a short section of ditch through the field to reconnect with the main ditch system leading to the small ponds on the southern edge of the field. It is important to then establish (or re-establish) a buffer for this ditch to help maintain the efficacy of the small ponds (by filtering sediment and nutrients prior to entering the ponds).

Finally, sea level rise mapping did not indicate additional retrofits at this site. However, higher water levels at the outfall pipe should be considered when restabalizing this shoreline area.

<u>Water Quality Benefit</u>
Repairing the outfall of the pipe system and protecting the adjacent banks in the immediate area will be a load reduction practice similar to *stream restoration* or *structural* or *non-structural shoreline stabilization* (USEPA, In prep). The extent of the stabilization at the outfall will determine the extent of the load reduction credit. In addition, repairing the pipe system at the outfall and at the junction referenced in Photo 5A will eliminate the conveyance of soil fines from the pipe bedding and bank material and therefore represents an additional potential water quality benefit (although very difficult to numerically quantify).

The farm drainage is currently filtered through an *Agricultural Grass Buffer*; additional plantings currently in place may qualify the buffer for additional water quality performance (to that of a *Forested Buffer*). Therefore, the recommendation to redirect the farm field runoff to Upper Edge Creek must redirect the runoff <u>after</u> it has passed through the buffer in order to maintain the existing water quality benefits. Secondly, any additional ditching through the field in order to connect this drainage to the existing ditch system should be similarly buffered in order to maintain the water quality benefit. (The *Agricultural Grass Buffer* efficiency credit is 46% total nitrogen (TN); 42% total phosphorus (TP); and 56% total suspended solids (TSS)).

Site 2

<u>Introduction</u>
Site 2 consists of nuisance flooding at the intersection of Thorneton Road and Royal Oak Road (38 ° 44' 36.98" N, 76° 10' 47.73" W). The information from citizens indicates that the flooding occurs only during large or intense storm events. Field photos are included in Table 3 and Figure 6 gives the picture index.

Figure 6. Site 2 picture index.

Table 3. Site 2 field photos.	
	

Table 3. Site 2 field photos.

 Site 2 - Photo 3	 Site 2 - Photo 4
 Site 2 - Photo 5	 Site 2 – Photo 6
 Site 2 - Photo 6A	

<u>Drainage Description</u>
The drainage system serving the intersection is anchored by a large culvert that crosses under Royal Oak Road and discharges directly into a long channel (Photo 6 and 6A) that connects to the adjacent upper finger of Oak Creek as the drainage the outfall from Site 1. A series of inlets serving Royal Oak and Thorneton Road connect at some point and discharge to the single outlet.

Similar to Site 1, there are limited manholes, junction boxes, or access points to verify the alignment and/or condition of the pipe system.

Photos 2, 3, 4 and 5 show inlet pipes that connect to a large grate inlet (Photo 1), however, since only 3 incoming pipes were observed, there is likely an alternate alignment. Also, along the alignment of the pipe depicted in Photo 3 is a connection of another 15 inch diameter pipe and since no junction box is evident, it is assumed that this is a field connection. A more thorough investigation of these systems in required in order to evaluate if there is any drainage system upgrade or reconstruction required. It should also be noted that the entrance of the 18 inch CMP pipe on Thorneton Road is crushed (Photo 5).

Finally, the invert of the primary culvert under Royal Oak Road, a 32 inch by 48 inch (approximate) horizontally elliptical corrugated metal pipe (HECMP), is rusted out at the outlet and may begin to undermine the outlet and the road embankment if not repaired. The outfall channel appears to be stable and is held on one side by a bulkhead.

Recommendations

The nuisance flooding of the intersection is likely caused by a combination of increased volumes of runoff associated with land conversions and decreased conveyance capacity caused by clogging and poor hydraulics of the drainage system. As noted above, the exact alignment of the drainage system is not known; therefore the first recommendation is to verify the location, alignment, and condition of the pipes. Additional recommendations are the following:

1. Verify the location, alignment, and condition of the pipe system serving the intersection of Thorneton and Royal Oak Road;
2. Identify any pipe junctions that are without an access manhole or junction box; and
3. Clean out the entrance of the culverts and verify the working condition of the pipes.

Finally, sea level rise mapping did not indicate additional retrofits at this site.

Water Quality Benefit

Typical nuisance flooding problems do not usually contribute to water quality problems unless the flood waters cause excessive erosion or other impacts to upland areas that normally are not subject to periodic inundation. There was no evidence of erosion or other impacts in the vicinity of Site 2.

Site 3

<u>Introduction</u>

Site 3 represents a typical roadway cross-culvert condition where the flow velocity during storm events serves to keep the culvert clear of sediment. This site is located to the west of the Schoolhouse Lane and Royal Oak Road intersection on Royal Oak (38 ° 44' 28.28" N, 76° 10' 12.85" W). However, the condition of the downstream channel shows the beginning signs of scour where the channel makes a slight bend within a confined section adjacent to the road. The citizen interest in this as a retrofit project was due to the potential for continuing erosion under current conditions, as well as possible accelerated erosion into the future (in conjunction with a currently proposed development in the upper reaches of this sub-watershed). Resident(s) report losing a tree and potential to loose land due to increased erosion. Field photos are included in Table 4 and Figure 7 gives the picture index.

Figure 7. Site 3 picture index.

Table 4. Site 3 field photos.

<u>Drainage Description</u>

The upper portion of the contributing drainage shed to the cross culvert consists of forested wetlands. Closer to the road, the area is clear with a small the drainage consisting of a small shallow channel with thick vegetation (Photo 1). The area where the flow enters the roadway culvert is well maintained (clear of woody vegetation) and the culvert itself is in good condition (Photo 2).

The roadway culvert includes a field connection. The driveway on the east side of the culvert outlet (Photo 3) has a small culvert that connects directly into the roadway culvert approximately three feet upstream of the outlet. This driveway culvert connects one of the four roadside ditches that connect to this channel – two on the upstream side and two on the downstream side. The reports of periodic flooding over the roadway may be the result of the hydraulics caused by the field connection as well as the hydraulics of the contributing ditches; although the issue of potential channel erosion below the culvert (Photo 3 & 4) is more of a concern than flooding.

Recommendations
There are no obvious retrofit opportunities or fixes to this system of ditches and the cross culvert. The ongoing management practice of maintaining this area as a close-cropped lawn is contributing to the erosion. The area of channel now currently experiencing erosion may benefit from minor stabilization with biodegradable mating and vegetation. The plantings appropriate for this area should be relatively strong rooted ground cover rather than a bushy or thick shrub that would restrict the flow in the channel.

The timing of the proposed development upstream of this location will determine the stormwater management requirements. Ideally, the project should be required to comply with the Maryland Environmental Site Design requirements as adopted in Talbot County. This represents the best strategy for controlling any increases in runoff volume and peak flow rate.

Finally, sea level rise mapping did not indicate additional retrofits at this site.

Water Quality Benefit
No retrofit proposed.

Site 4

Introduction

Site 4 is located between Schoolhouse Lane and Sycamore Lane on Royal Oak Road's northern side (38 ° 44' 30.85" N, 76° 10' 06.12" W). Site 4 is a heavily landscaped and maintained section of a channel that collects runoff from upstream roadside ditches as well as relatively new single-family large lot developments that is conveyed through a roadway cross-culvert. There is no evidence of flooding or channel erosion. However, there were reports of periodic flooding over the road. Field photos are included in Table 5 and Figure 8 gives the picture index.

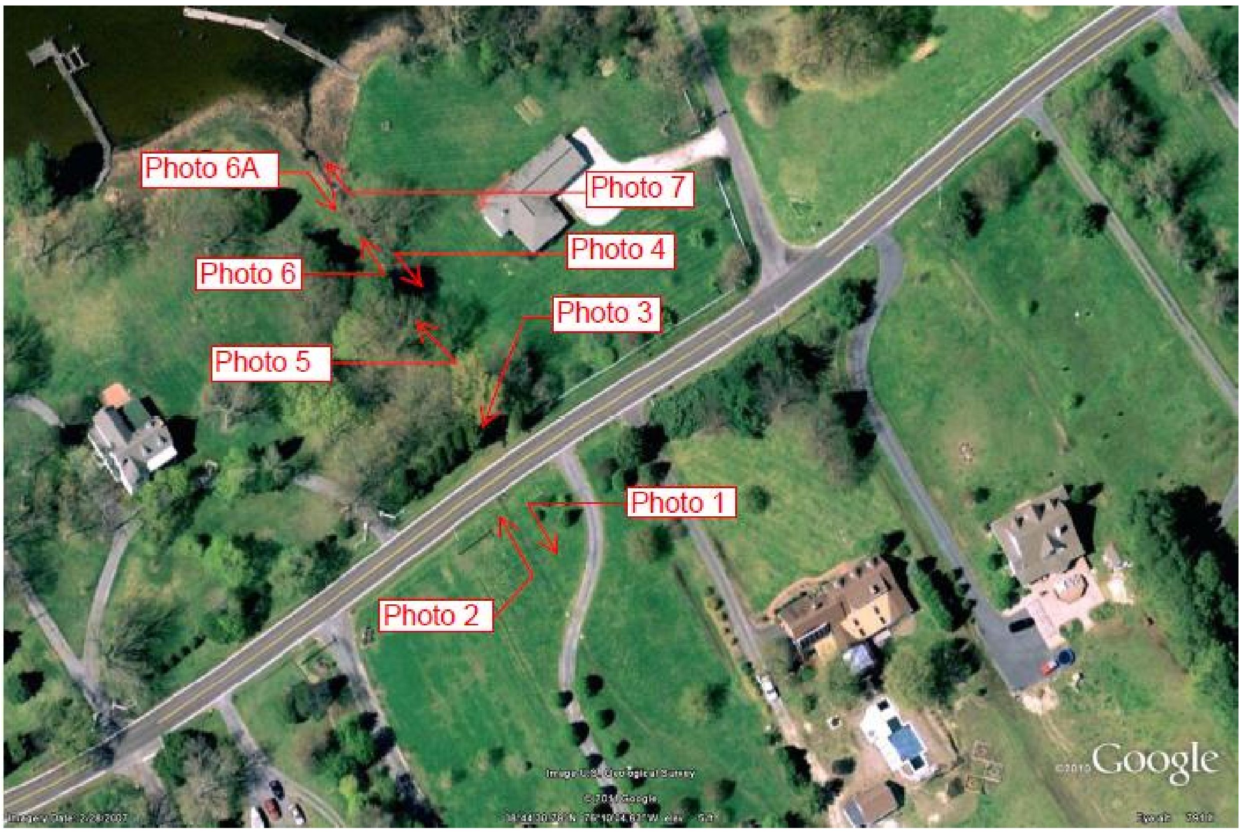


Figure 8. Site 4 picture index.

Table 5. Site 4 field photos.

Table 5. Site 4 field photos.

<u>Drainage Description</u>
The upper drainage area to the roadway cross-culvert consists of managed lawn. A broad flat swale gradually becomes more defined as it approaches the culvert (Photo 1 & 2). Typical for roadway culverts in the area, there is very little headwater depth available for the roadway cross-culvert to carry large storm flows. Therefore, the water is likely to back up during large storms and overtop the road. Also, this could occur in smaller storms (e.g., < 1 inch rainfall) if the culvert becomes clogged with leaves or debris (Photo 3).

This drainage channel has been incorporated into the private property landscaping (Photo 4), including a decorative bridge (Photo 5) and a landscape pond (Photo 6 & 6A). The landscape pond has a thick layer of organic material (leaves and bud shatter) on the pond bottom. The channel continues until below the landscape pond and then discharges to the upper finger of Oak Creek (Photo 7).

<u>Recommendations</u>
There were no apparent retrofit needs for this drainage area. The small pond traps a significant amount of leaf litter and additional organic debris moving through the channel. The outlet structure and the flat grade combine to maintain a stable channel all the way to the receiving waters of Oak Creek.

The upper portion of the channel (upgrade) – south of Royal Oak Road (Photo 1), could be retrofit with a shallow bioretention area to help reduce nutrient loads associated with managed turf in the upper drainage area, thereby improving the aesthetic conditions of the existing landscape pond. The proposed shallow bioretention area could consist of a heavy planting of herbaceous, local vegetation and include a six inch ponding area with a permeable berm. The permeable berm is proposed in lieu of an underdrain since there is no option to “daylight” an underdrain due to the flat grades.

Finally, sea level rise mapping did not indicate additional retrofits at this site.

Cost Estimate
Approximate Drainage Area: 0.48 acres
Approximate Impervious Cover: 0.1 acres
Typical Bioretention Surface Area (SA) = 5% of impervious cover; SA = 220 ft^2
Approximate Cost = \$15/ft^2 of surface area = \$3,300.

Water Quality Benefit
Bioretention is credited with 50% TP reduction as per the MD Critical Areas Guidance, and generally accepted removal efficiencies for TN and TSS of 60% and 80% respectively.
As noted in the recommendations, however, given the relatively small drainage area and correspondingly high cost per pound effectiveness, a well formulated urban nutrient management plan would potentially have a much greater water quality benefit in terms of the total area covered or “treatment area” and cost. A general urban nutrient management plan is detailed in the “Maryland Nutrient Management Law/Urban Nutrient Management” section that follows.

Site 5

<u>Introduction</u>
Site 5 consists of the intersection of Royal Oak Road with Acorn Road to the east and Moores Road to the west (38° 44’ 44.56” N, 76° 10’ 49.36” W). The Site description should also include the drainage ditches along the alignment of both sides of Royal Oak Road (north and southbound lanes, on both sides of the intersection). The drainage ditches are in relatively good shape; however they also contain what appears to be standing water. Similar to the other sites investigated, sites, these ditches appear to be operating at less than full capacity due to siltation and standing water. Field photos are included in Table 6.

Table 6. Site 5 field photos.	
 Site 5 - Photo 1	 Site 5 - Photo 2
 Site 5 - Photo 3	 Site 5 - Photo 3A

Table 6. Site 5 field photos.

Drainage Description
The grade along Royal Oak Road is extremely flat, such that it is very difficult to determine the direction of the flow without a very accurate level. The drainage ditches at the site were all holding water. The roadside ditches appeared to contain sediment and/or organic material.

Recommendations
There is no retrofit recommendation for this site. However, if flooding is a major concern and/or observed often at the site, delineating the drainage area is recommended and should be based on survey data. Roadside ditches should then be assessed to determine if they are functioning as designed. The survey data can help guide improvements if it is determined that the ditches are inadequate for the road conditions.

Finally, sea level rise mapping did not indicate additional retrofits.

Water Quality Benefit
No retrofit proposed.

Hot Spot Investigation

A manhole that covers the pump station overflow was found in the field. This Hot Spot (Site Number 100) was located on the corner of Schoolhouse Lane and Royal Oak Road (38° 44’ 28.23” N, 76° 10’ 9.09” W). The site is indicated in Figure 3 with a red box. The overflow was documented (Table 7) and phoned into Talbot County Planning and Zoning Division. The City of Saint Michael’s waste water treatment staff investigated this within hours of the original identification. Groundwater infiltrates the well, rises, and comes out of the manhole. It was tested that afternoon and contained no evidence of sewage contamination. This site often overflows according to the Royal Oak residents.

Table 7. Hot Spot investigation field photos.	
	

Summary

The Village of Royal Oak is a low lying coastal community containing a system of culverts and ditches that represent the central drainage features of the area, and is a representative area in the Traditional Villages located in Talbot County, Maryland. This study was carried out to analyze and describe existing conditions and develop management and implementation strategies where possible. In addition, management and implementation strategies incorporated the two foot sea level rise predictions. The Center performed field work in coordination with local stakeholders and project partners, assessed the area, and compiled this information to provide potential stormwater management options (i.e., retrofits) for the Village of Royal Oak.

The Center gathered background information through the internal kick off meeting and first community meeting. The information gathered included areas in the Village of Royal Oak where flooding or other problems existed, volunteers to participate in field work, flooding pictures, and additional study area information. The Center's analysis of the Village of Royal Oak resulted in the selection of five sites for management options. Each of the identified sites consists of, in part, relatively small roadway drainage systems (e.g., roadside ditches, cross culverts, drainage channels, and to a lesser degree pipe systems) that serve small suburban developed areas within relatively large rural agricultural and forested drainage areas. For each site the drainage area was assessed, potential stormwater retrofits were recommended, additional non-structural recommendations reported, and/or the water quality benefit was determined. In addition, sea level maps for the area were consulted in the field so that any potential retrofit's impact by two foot sea level rise inundation could be determined. There were no instances where this potential sea level rise impacted the retrofit design or recommendation. However, using sea level projections for coastal areas is important and this data should be incorporated into each planning, stormwater, and/or watershed planning effort for Talbot County.

Improving current drainage systems was recommended for Site 1 and 2 and included: 1) determining what infrastructure exists; 2) providing the infrastructure location; 3) gaining access to the system(s); and 4) performing system inspection and maintenance, if needed. For the Village of Royal Oak, drainage system upgrades, drainage and ditch system maintenance, structural stormwater quality retrofits, and non-structural water quality retrofits were recommended and discussed. Additional, recommendations for the Village of Royal Oak include: 1) a need to find and transfer the state highway stormwater infrastructure; 2) determine where easements or additional natural resource protection elements exist, especially along roadways; 4) use non-structural stormwater management and watershed planning since the study area contained low impervious cover and represented a rural landscape. Examples of non-structural stormwater management practices include urban nutrient management, pet waste education and outreach, and an incentive program to promote rainwater harvesting and other small scale management options.

Typical Royal Oak Management Strategies

Typical engineered stormwater retrofits (e.g., bioretention, grass swales, etc.) were not identified in the Village of Royal Oak. Royal Oak has very low impervious cover and low relief (0 to 8 feet). Existing impervious cover in the form of rooftops are disconnected to turf areas. Remaining impervious cover in Royal Oak are roads. The areas where road retrofits (e.g., swales) would be built are narrow and ownership rights and easement acquisition could prove costly compared to the water quality benefit. The lack of existing stormwater infrastructure makes typical urban retrofitting more difficult.

Generally, the prioritization ranking of nutrient reduction projects routinely places urban retrofits as the most costly (and therefore least cost effective in terms of dollars per pound of reduction). Other source sectors, such as agriculture, shoreline erosion, and septic likely contribute a far greater load in this particular watershed and therefore have more potential for cost effective reductions. However, based on the large percentage of land cover in residential use, it makes sense that the urban sector should be explored to the maximum extent practicable. Programs such as rooftop disconnection, rain barrels, and rain gardens can serve as a public outreach mechanism though most impervious cover is already disconnected. Rain gardens appear to be the most useful retrofit option which was identified at the community meeting as a desirable option. These efforts will likely have little measureable effect in terms of computed project specific nutrient reductions; however, the effect could be significant if they serve to educate the citizens of Royal Oak on more environmental land and runoff management strategies.

Typical Rain Gardens

Rain gardens are a stormwater management practice that can offer water quality benefit to receiving waters, localized flood control, and serve as an educational tool in the community. Several lots were identified (Figure 9) to serve as a typical rain garden retrofit. *Micro-Bioretention* are also known as *Rain Gardens* are small, distributed practices designed to treat runoff from small areas, such as individual rooftops, driveways and other on-lot features in single-family detached residential developments. Inflow is typically sheet flow or can be concentrated flow with energy dissipation, when located at downspouts.

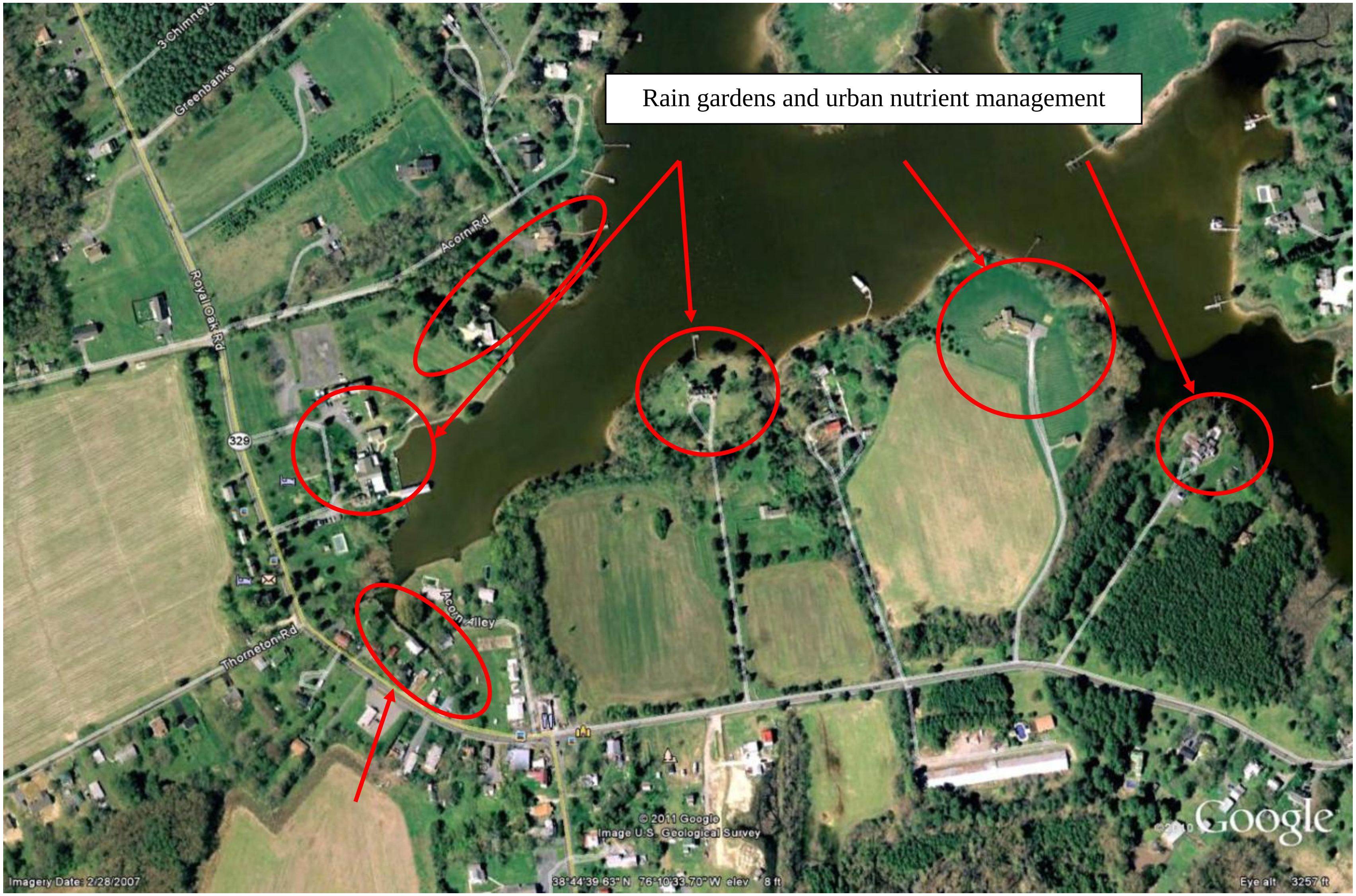


Figure 9. Typical rain garden retrofits near Royal Oak Road and Acorn Road.

Maryland Nutrient Management Law/Urban Nutrient Management

In an effort to reduce nutrient loading from urban and suburban turf areas the state of Maryland passed the Lawn Fertilizer Bill (SB 487 & HB 573). The bill amends the Maryland Commercial Fertilizer law under the Agriculture Article. The law only pertains to fertilizer applied for turf care, fertilizer used in agricultural production is not covered. The bill affects both the content of fertilizer and behavior at the residential and commercial scale. The bill applies to do-it-yourself (DIY), golf course, and commercial applicators.

Fertilizer Contents- The bill requires that turf fertilizer contain no more than 0.7 pounds of water soluble N and no more than 0.9 lbs if total N per 1,000 square feet, and at least 20% of the N shall be slow release. It also requires that lawn fertilizer contain no P except when specifically labeled for establishing vegetation, repairing turf to as determined by a soil test.

Use Restrictions- The law prohibits applying fertilizer to frozen ground and impervious surfaces, DIY, and commercial application before March 1st or after November 15th. Additionally the law prohibits fertilizer application within 15 feet of a water body (10 ft if using a drop spreader). It requires that professional applicators must be certified by Maryland Department of Agriculture (MDA), trained by a certification program approved by MDA or be working under the direct supervision of a certified professional fertilizer applicator.

Load Reduction- The legislation and its enforcement is estimated to reduce phosphorus runoff from urban loads by 15%. This represents 20% of the phosphorus reduction MD needs to achieve statewide as part of the Chesapeake Bay Total Maximum Daily Load (TMDL).

Talbot Septic Systems

Talbot County has already implemented one of the most significant strategies to reduce nutrient loads from suburban and rural communities by connecting households with traditional septic systems to a wastewater treatment plant (WWTP), which has a lower nitrogen load than traditional septic systems. An alternative to hooking up to the WWTP is to convert the traditional septic system to a best available technology (BAT) septic system.

Maryland Department of the Environment (MDE) outlined guidance from the Chesapeake Bay Program to determine nitrogen loadings from septic systems in “2006 TMDL Implementation Guidance for Local Governments.” While there are many variables that affect the nitrogen loading from a given septic system, the guidelines assume that on average, 9.5 pounds of nitrogen per person per year will be delivered to a septic drain field and, in the critical area (within 1000-ft of a tidal body of water), 80% of the nitrogen will be delivered to the nearest body of water. These assumptions, combined with 2010 Census data of 2.20 people/household for Talbot County, lead to an average annual septic system loading rate of 16.72 pounds TN per household.

9.5 lbs TN x (0.8) x 2.20 people/household = 16.72 lbs (pounds) TN / household

Depending on the technology implemented at the WWTP this total N load per household could be reduced by approximately 90% by taking the household off septic and onto the WWTP.

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