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Department of Natural Resources

Deep Creek Lake: A Sediment Study

Garrett County Maryland

DGS Project No. P-008-132-010

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Executive Summary

Located in Garrett County in Western Maryland, Deep Creek Lake has been a source of recreation and tourism since its creation in 1925. Throughout its history, sediment has accumulated in the lake, especially within the coves. The sediment accumulation, coupled with an increased concentration of Submerged Aquatic Vegetation (SAV), has led to decreased water depth in some of the coves. A number of residents have expressed concern over the water shallow depth in these coves since there is decreased access by some boat owners and some residents have stated that they no longer have boat dock access. Decreased water levels and boat access could reduce the amount of recreational activities and therefore cause adverse economic impacts throughout the region. As a result of these concerns, the Maryland Department of General Services (DGS) and Department of Natural Resources (DNR) have commissioned a study to determine possible solutions.

The purpose of this study is to 1) determine sediment sources; 2) assess the impacts of sediment removal versus no removal; and 3) determine possible solutions. The results of the study and recommendation for action are detailed in the following report.

Determining the source of the sediment that is being deposited within Deep Creek Lake is a key component of this study. Without identifying the source and finding a way to alleviate the problem, sediment will continue to accumulate in Deep Creek Lake. Removing the accumulated sediment by dredging and other methods would restore boat and dock access to the affected coves but would be a short-term solution that may need to be repeated if other solutions are not implemented. Additionally, this maintenance activity of removing sediment is costly and has environmental and economic impacts. Therefore, identifying both the sediment sources and sustainable solutions can be seen as investments in the future of the lake area.

Sediment runoff within the watershed comes from multiple sources. These sources have been identified and detailed in the report. They include runoff from agricultural practices, development, improper erosion and sediment controls, roadside ditches, shoreline erosion, and stream degradation. A supplemental handbook and BMP pamphlet have been included with this report. They further describe the sources of sediment, methods of erosion, and various potential solutions to address the problem.

Removing the sediment that has accumulated within Deep Creek Lake will be a significant undertaking. Several options for dredging the material were examined in this study, including hydraulic, mechanical dry and mechanical wet dredging. Recommendations for action were made based on several factors, including cost and minimizing economic, environmental, and recreational impacts. Each of the potential impacts has several different components. In order to clearly weigh the options and determine a best course of action, a decision matrix has been completed and included as an appendix to this report.

After careful consideration of all of the options, the no dredge/implement sediment reduction measures option is recommended. At current levels, sediment accumulation is not causing any major problems within Deep Creek Lake. In fact, the sediment volume that has accumulated in the past few decades has only decreased the volume of the lake by less than one percent. Removal of the sediment accumulation via dredging would be a highly intensive and costly effort. Instead, reducing the amount of sediment inflow to Deep Creek Lake is recommended.

To help reduce sedimentation in these coves, several steps should be taken to minimize the amount of sediment that reaches Deep Creek Lake. These actions include monitoring the stream networks for degradation, conducting a bathymetric survey every 5-10 years (in order to calculate sediment volumes), implementing BMPs across the watershed at known sediment sources, and holding all new development to standards such that no new sediment sources contribute to the lake. In addition, performing stream restoration throughout the watershed will greatly improve the health of the lake. Impaired streams in the watershed are a source of sediment to the coves, so restoration efforts will significantly reduce the amount of sediment delivered to the coves. The only way to measure this reduction is through stream monitoring. Several suggested practices are outlined in the supplemental BMP manual and pamphlet. Together, these actions can lead to a reduction in sediment runoff to Deep Creek Lake. Therefore, the recommended course of action is to leave the sediment levels within Deep Creek Lake undisturbed, but to take steps to prevent further sediment runoff throughout the watershed. The research and calculations that were used to reach this conclusion are detailed in the following report.

Introduction

Deep Creek Lake was created in 1925 when the hydroelectric project was constructed. In 1980, Department of Natural Resources (DNR) agreed to take over management of recreation and access.

Deep Creek Lake has a surface area of approximately 3,900 acres with a storage volume of 106,000 acre-feet ($115x10^6$ cubic meters) at the elevation of 2462. The lake fluctuates from an elevation of 2462 feet in late spring to 2455 feet to 2457 feet in the winter. The total drainage area of Deep Creek Lake is 64.7 square miles, with approximately 65 miles of shoreline.

The primary reason for this study is to investigate registered complaints from several property owners of decreased water depths due to sedimentation within Deep Creek Lake. From 1925 to 2012, there has been an accumulation of over one million cubic yards (620 acre-feet) in Deep Creek Lake. This accumulation accounts for 0.6% of the lake's volume. While the coves impacted by the sediment accrual tend to be in the southern half of the lake, the aggradation in the northern coves accounts for only a small portion of the total.

DNR has compiled a series of reports over the last several years that were used as a basis of this report. The following is an abbreviated list of reports that were reviewed and used to develop the alternative sediment management scenarios. See Appendix A for complete list.

1. *Banks, W. and Gellis, (2007-2008). "A. Core Collection and Radiometric Dating in Deep Creek Lake, Garrett County, Maryland". U.S. Geological Survey.*
2. *Environmental Resources Management, Inc. (2007). "Assessment of Water Quality Impacts from Potential Land Development. Deep Creek Lake, Garrett County, Maryland".*
3. *Environmental Resources Management, Inc. (2004). "Deep Creek Lake Boating and Commercial Use Carrying Capacity Study". Maryland Department of Natural Resources.*
4. *Kelsey, R.H. and S.L. Powell. (2011).* "Deep Creek. Lake Baseline Assessment Report.*" EcoCheck.*
5. *Landry, J.B., Raves, R.R., Lewandowski, M.J., and Karrh, L. (2012) "Deep Creek Lake Submerged Aquatic Vegetation Survey, Year 3." Department of Natural Resources.*
6. *Maryland Department of the Environment. (2012). "Watershed Report for Biological Impairment of the Deep Creek Watershed in Garrett County, Maryland." U.S. Environmental Protection Agency.*
7. *Ortt, R. (2012). "Analytical Report for Maryland Geological Survey". Maryland Geological Survey.* Provided by Maryland Geological Survey.
8. *Ortt, R. and Manship, V. (2011). "Deep Creek Lake Sediment Accumulation Study: A Map Reconnaissance of Selected Coves." Department of Natural Resources.* Provided by Maryland Geological Survey.
9. *Wells, D. and Ortt, R. (2011). "Deep Creek Lake Sediment Study: Physical and Chemical Characteristics of Lake Sediments." Department of Natural Resources.* Provided by Maryland Geological Survey.

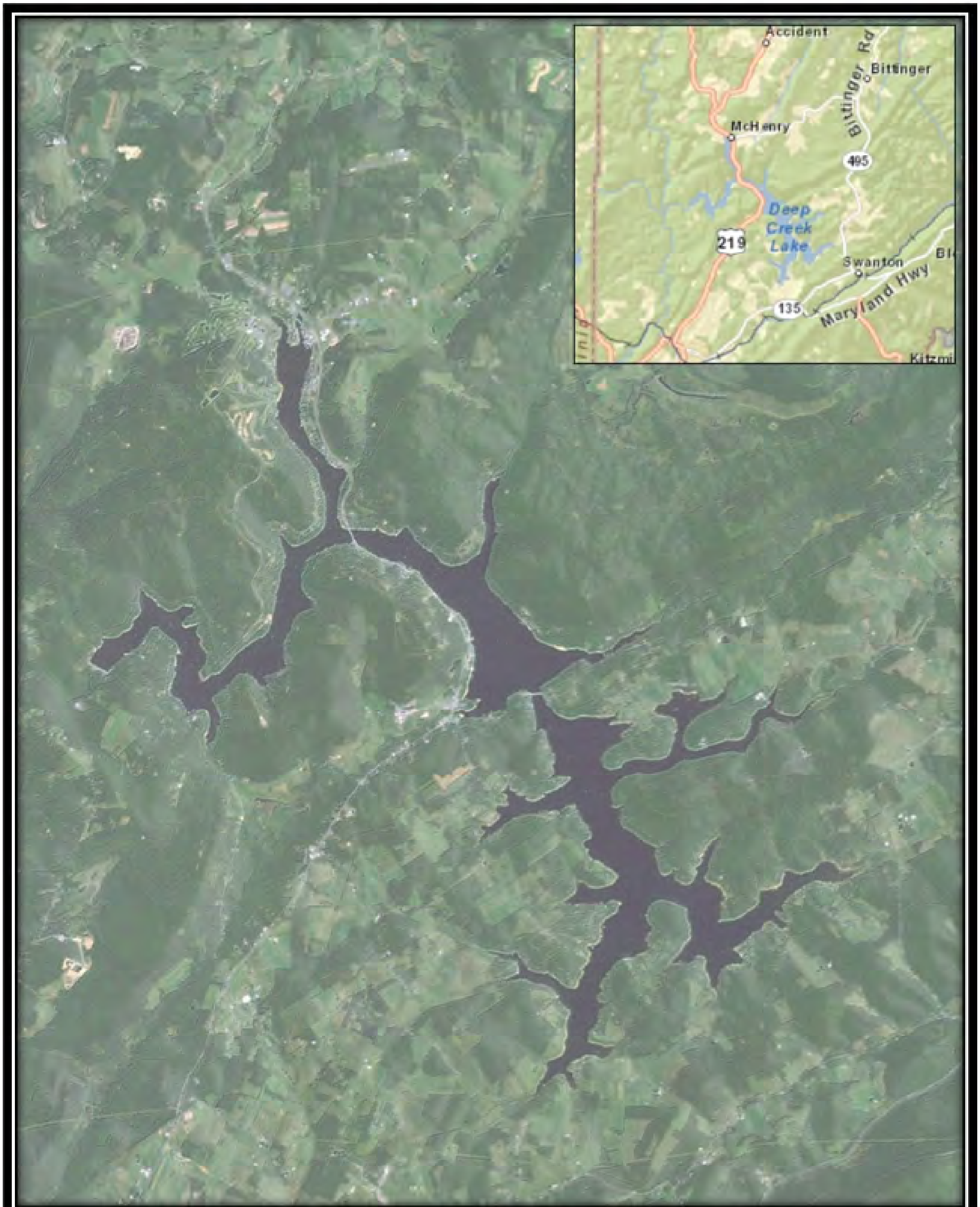


Figure 1.1: Site Location

Problem Statement

The purpose of this report is to identify the best alternatives to handle the issue of sediment accumulation and to identify the impacts to the environment, economy, and recreation of Deep Creek Lake and recommend a strategy for managing sediment accumulation. Per the scope of work, three alternatives were analyzed for managing the sediment accumulation using dredging options, 1) Dispose at Landfill, 2) Dispose at Quarry Site, and 3) Dispose at site to–be- determined adjacent to Lake. Costs estimates were developed for hydraulic and mechanical (wet and dry) dredging and a no dredge/implement sediment reduction measures option. The costs equal the monies spent on dredging, and the impacts to the environment, recreation, and economy. The cost estimate for the no dredge/implement sediment reduction measures alternative was developed for the potential economic losses that the increase in sediment volume will cause.

Section 1: Sediment Accrual Rates

The focus of this report is how to manage the current sediment volumes. The sediment accrual could have occurred during a small number of large storm events or it may have occurred through a slow, continuous accumulation. Based on core samples, sediment has been accumulating since 1925. For purposes of this report, 1925 is considered to be the baseline.

DNR provided the following calculations based on the difference between the 1925 and 2012 bathymetry. The volumes discussed in this report here forth are based on the difference between these two bathymetry models.

The coves that accrued more than one foot of sediment were the focus of this study. Based on the criteria of one foot or more of sediment accrual, the following ten (10) coves were included in the study. The total sediment accumulation within the ten coves considered in this study is approximately 272,000 cubic yards. Table 1.1 uses maps from DNR with approximate areas and average depths with a 25% reduction to account for the slopes coming into the shores.

Table 1.1 – Estimated Sediment Volumes from 1925 - Present*

Site	Approximate Drainage Area (acres)	Sediment Volume (cubic feet)	Average depth (feet)	Area of Sediment Accrued (square feet)
Arrowhead Cove	1859	421,875	1.0	427,500
Pawn Run Cove	1479	1,323,000	2.7	490,500
Penn Cove	879	866,700	2.3	270,000
Chadderton School Cove	590	816,480	1.8	453,600
Turkey Neck Cove	223	286,200	1.0	288,900
Hazelhurst Cove	475	880,200	1.0	882,000
Poland Run Cove	940	472,500	1.0	472,500
Deep Creek Cove	1230	993,600	1.6	625,500
Green Glade Cove	589	3,213,000	1.4	2,280,600
Harvey's Peninsula Cove	351	502,200	1.3	386,100
TOTAL	**8616**	**9,775,755**	**1.5**	**6,577,200**

*See Appendix B for maps provided by DNR

The following figure displays the coves that are proposed for sediment management:

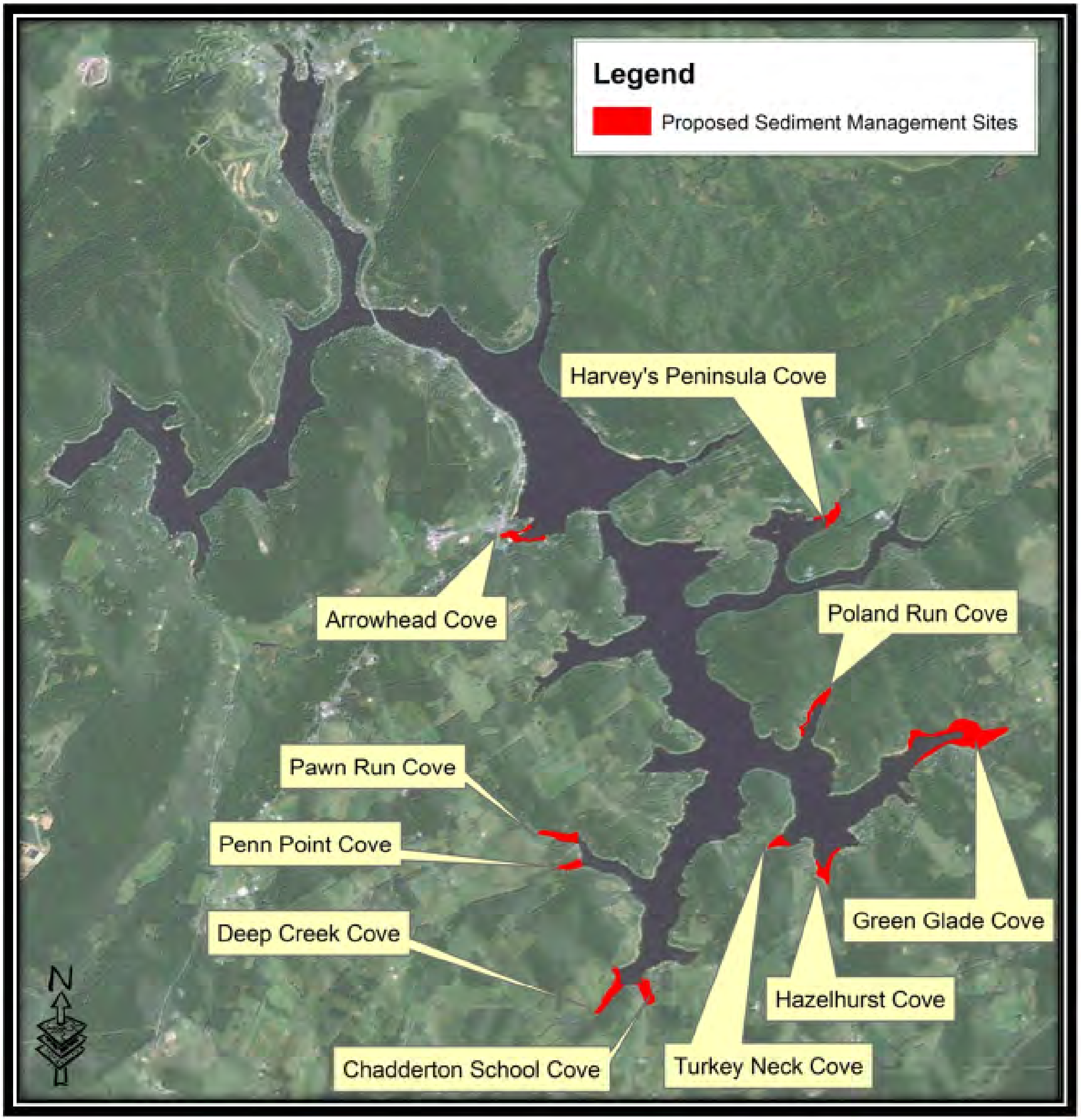


Figure 1.2 – Coves with Potential Sediment Management

Section 2: Soils, Geology, and Land Cover of Watersheds

The coves that have sediment accrual (since 1925) of over one foot have been closely examined to determine what characteristics the coves had in common. An analysis shows that while all of the watersheds consist of the hydrologic soil groups (HSG) “B” and “C”, watersheds in the southern half of the lake also have a considerable portions of HSG “D” soils. When completely wet, HSG “D” soils have a high runoff potential with a clay texture, whereas HSG “C” soils have a moderately high runoff potential when thoroughly wet, and HSG “B” soils have a moderately low runoff potential (NRCS). Productive soils, such as the HSG “D” soils in the watershed tend to have agricultural land use since these are the most suitable for productive farming. These soils also tend to be more readily erodible, and combined with the topography of the region, lead to increased soil erosion. This and urban land use appear to be major contributing factors to sedimentation within the ten coves under consideration.

With regard to the geology surrounding the lake, the Casselman syncline and the Deer Park Anticline formations within western Maryland divide Deep Creek Lake. According to the Watershed Report provided by the Maryland Department of the Environment (MDE), the northern half of Deep Creek Lake is located within the Casselman Syncline (MDE). Shale, sandstones, and coal beds are exposed here. The following watersheds are in Casselman Basin geological basin: Meadow Mountain, Cherry Creek Cove, and Cherry Creek. Adjacent to the Casselman Syncline is the Deer Park Anticline, which exposes rock formations similar to that of the Devonian and lower Mississippian periods. Within this formation, different shale and sandstones are exposed. Watersheds within the anticline include: Thayerville, Hoop Pole Run, Pawn Run, Blakeslee, Upper Deep Creek, Green Glade Run, North Glade Run, and Meadow Mountain Run (Maryland Geological Survey). The differences in the two formations expose the age of the rocks and thus the differences between the geology of the northern and southern watersheds.

Land use throughout the watershed is varied. A description of land use broken down by watersheds can be found in Table 2.1. In addition, a map delineating land uses is included in an exhibit after the table. Delineation of the watersheds reveals that the majority of the land throughout Deep Creek Lake is forested. However, there is a significant concentration of disturbed land. These areas have been primarily used for agriculture and urban development. Although a high presence of agriculture generally leads to higher sediment erosion rates, the location of the agriculture within the watershed plays a much larger role in the sedimentation rate downstream. In areas where a forested buffer is present before the stream outfalls to the cove, streams tend to be less eroded and the coves have a lower volume of sedimentation accumulation. This trend is prevalent throughout the watershed, and indicates that land use plays a key role in the rate of sedimentation within each of the coves.

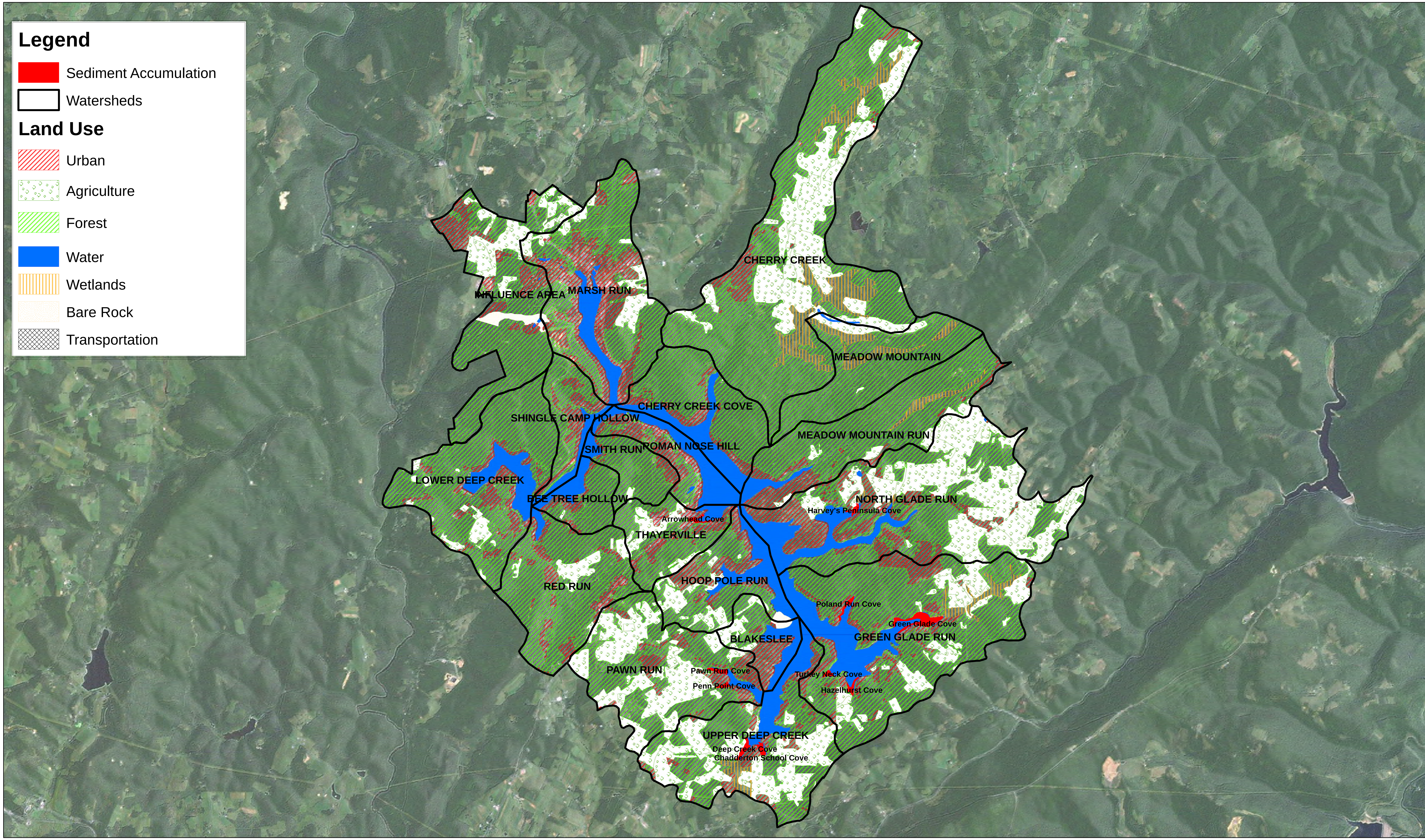
The results of the characteristic analysis display many similarities. Although the hydrologic soil groups vary within each cove, there are many similarities across the Deep Creek Lake watershed. One key variation is that watersheds that lead to the coves with the highest amount of sedimentation all have a high area dedicated to agriculture and urban development, primarily at the downstream end of the contributing stream. This factor is likely what drives the rate of sedimentation within the coves. The table below describes area, land uses, soil types and slopes in each watershed. Coves with a significant rate of sediment accumulation often have a high rate of agriculture and development. For example, the Pawn Run watershed has a high rate of sediment accumulation and a high rate of development (60%). A watershed of comparable size is Red Run has a lower rate of development (28%) and no problems with sedimentation in the area. Marsh Run is an example with a high level of development (43%) and low agriculture (9.6%).

The following table describes the overall analysis of characteristics:

Table 2.1 – Watershed Properties*

WATERSHED NAME	Coves Proposed For Sediment Management	Area (acres)	Average Slope (%)	Urban	Agriculture	Forest	Wetlands	Barren Land	Main Soil Type	% Water	% of B	% of C	% of D
BEE TREE HOLLOW		597	9.3%	25.2%	0.0%	74.8%	0.0%	0.0%	C	20	2	78	0
BLAKESLEE		659	2.9%	39.3%	21.3%	35.9%	0.0%	3.5%	B/C	27	32	29	12
CHERRY CREEK		6,204	3.1%	6.4%	28.3%	55.5%	9.7%	0.0%	C	0	24	41	27
CHERRY CREEK COVE		1,642	8.9%	18.5%	0.1%	81.5%	0.0%	0.0%	C	20	39	40	1
HOOP POLE RUN		1,415	3.6%	34.0%	19.6%	44.6%	0.0%	1.7%	C	14	20	57	9
INFLUENCE AREA		2,457	9.0%	20.8%	17.0%	58.8%	0.0%	3.4%	C	25	25	45	5
LOWER DEEP CREEK		2,828	4.8%	23.1%	5.0%	71.9%	0.0%	0.0%	C	10	30	59	1
MARSH RUN		3,033	4.1%	43.0%	9.6%	47.1%	0.0%	0.3%	C	10	33	54	3
MEADOW MOUNTAIN		1,707	6.4%	0.0%	6.8%	82.2%	10.9%	0.0%	C	1	28	52	19
MEADOW MOUNTAIN RUN		2,364	5.9%	20.3%	5.0%	71.3%	3.5%	0.0%	C	4	25	63	8
RED RUN		2,163	3.4%	19.9%	8.1%	72.0%	0.0%	0.0%	C	10	32	48	6
ROMAN NOSE HILL		857	18.1%	63.2%	0.7%	36.1%	0.0%	0.0%	C	3	27	63	7
SMITH RUN		645	4.8%	13.8%	1.9%	84.3%	0.0%	0.0%	C	2	28	56	14
GREEN GLADE RUN	Green Glade, Poland Run, Turkey Neck, Hazelhurst	4,691	3.6%	18.5%	15.2%	63.5%	2.8%	0.0%	C	45	18	35	2
NORTH GLADE RUN	Harvey's Peninsula	4,853	4.6%	23.5%	44.1%	32.1%	0.4%	0.0%	B	16	50	34	0
PAWN RUN	Pawn Run, Penn Point	2,647	2.7%	17.6%	42.0%	40.4%	0.0%	0.0%	C	8	17	74	1
THAYERVILLE	Arrowhead	1,038	5.7%	25.7%	19.1%	55.2%	0.0%	0.0%	B	7	52	34	8
UPPER DEEP CREEK	Deep Creek, Chadderton	2,841	4.6%	14.3%	42.1%	40.9%	2.7%	0.0%	C	11	7	72	10

*Highlighted watersheds represent areas where coves have significant sediment accumulation. See Exhibit 2 for map.



DEEP CREEK LAKE
Land Use
Department of Natural Resources

N

1" = 10,000 feet

WBCM

Sheet No.
Sheet 1

EXHIBIT 2

Drawn By:

Checked by:

Date:

Section 3: Sediment Sources

There are a variety of sources from which the lake is receiving sediment. They include (but are not limited to):

- *Agriculture*
- *Development (including sediment pollution during construction)*
- *Roadside Ditches*
- *Shoreline Erosion*
- *Stream Degradation*

Land use and development are the primary factors that determine the volume of sediment that erodes and is deposited downstream. Anthropogenic changes, such as agriculture and urban development, create areas that are susceptible to erosion. However, some of these areas are able to recover from the erosion. The land use plays a key role in how much erosion occurs, but the land use in proximity to the stream has a larger effect on the amount of sediment accumulation. Areas that have forested buffers tend to have streams that have a lower rate of erosion and sedimentation, which was confirmed in the field during site visits. Site visits were made to investigate the various each sediment sources (see Appendix I: Site Visit Photo Log). Each of the sources of sediment within Deep Creek Lake are outlined and described below.

Agriculture: The agricultural land use areas tend to be in locations with erodible soils and in low-lying areas of the valley. Aerial photography, GIS mapping, and field investigation reveal that there are agricultural tracts close to the lake shoreline observed in most of the watersheds where coves have accumulated more than one foot of sediment. One exception is the Cherry Creek Watershed, which has a large amount of agriculture (28.3%) but little to no sediment accumulation. This may be due to the approximately 7,000 feet of forested buffer between the agriculture and cove shoreline.

Agricultural use within the Deep Creek Lake watershed includes livestock and crop production. Certain areas have been eroded from livestock, especially areas around streams. The following picture shows a stream bank which has been eroded and made unstable by cattle. The grain/crop farming also plays into the role into the sediment deposition in the coves. In addition, if timber harvesting was completed in the past, it could have played a role in sediment deposition for Deep Creek Lake as well. It is unknown whether or not this took place or to what extent.

Opportunities to mitigate sediment deposition in the lake include fencing streams to prevent livestock from entering them, and planting vegetative and forested buffers around streams that go through crop production. Conservation practices such as no till and crop rotation will also assist in mitigating the sediment accrual.

Stream going through an agricultural field with bank damage due to livestock

Development: Residential and commercial development within the watershed has also caused erosion and subsequent sedimentation within the coves. In many areas, formerly forested watersheds have been converted into residential land uses. There are many one- and two-acre lots with single residences, but there are also a number of townhomes, condominiums, and hotels. For each of these land uses, natural vegetation (shrubs and trees) have been replaced with lawns and impervious surfaces. Natural vegetation has very negligible sediment and nutrient runoff. In addition, most of the upstream runoff going to natural areas is captured before it can reach the lake. By clearing this land for development, both erosion and the amount of sediment runoff are increased. The sediment and nutrient runoff from developed lands have a negative effect on the lake.

Developed lot

Other residential sites maintained the trees and other natural vegetation. The trees and shrubs that exist in the undisturbed areas help to prevent erosion. These practices exhibit good Environmental Site Design. Other design practices include minimizing land clearing, maintaining a vegetative buffer in proximity to the water, and tree preservation. The following photo is an example of a more natural area that has not been converted to grass lawn.

Undeveloped land

In addition to existing development, new construction projects can play a role in causing sediment runoff. Whenever land in the area gets disturbed, improper erosion and sediment controls (E&SC) could cause significant amounts of sediment laden runoff to reach the lake. Several examples of poor construction practices that were discovered are detailed below. Disturbed earth during construction needs to be properly stabilized. This source of sediment is only temporary and causes only small amounts to reach the lake.

The solution to this is strictly enforcing any E&SC during construction. If the construction site is less than 5,000 square feet or 100 cubic yards, no permit is required for E&SC. Therefore, educating the public on how disturbed soil is washed into streams (and ultimately the lake) during rain events is the most effective solution. In cases where the stockpiles are directly adjacent to the streams, there needs to be additional prevention measures.

The picture below shows a site where construction has disturbed the earth. The stockpile of dirt has no sediment control in place to prevent sediment from reaching the nearby stream. This may be because the disturbed area was less than 5,000 square feet and has a volume of less than 100 cubic yards. However, if there are many of these sites around the watershed, the amount of sediment accumulation quickly adds up.

Home Improvement with soil disturbance and no silt fence

Installation of sand valleyball court, no containment of disturbed soils, directly adjacent to lake

Soil pile from construction, directly adjacent to stream

Other projects, including construction of new utility lines, also can cause sediment discharges. This is especially important in areas that are immediately adjacent to streams. Often times, these projects are small enough that they do not require a permit. Sediment can easily be washed away from the site and into the streams. Although the individual projects disturb a small volume of sediment, all of the projects throughout the watershed can add a significant amount of volume to the sediment accumulation in the lake. Once again, public education about this problem can lead to solutions and prevent much of the sediment input to the lake.

Utility line for two new lots, disturbed soil directly adjacent to stream

Roadside Ditches: Many roadside drainage ditches had vegetated and stable channel sections. There were a few observed cases where roadside ditches and other infrastructure had some slope failures causing erosion. The ditches observed during the site visits were relatively small and conveyed local roadway flows. The estimated sediment volumes are on the scale of a less than a hundred cubic yards. For instance, in the photograph below, a roadside slope is failing due to the steep side slope and because it appears this area is used for vehicular access, denuding the vegetation and causing erosion. The area upstream of the slope is used as an overflow for boat storage for a marina.

Based on the length of the area and the slope, a rough estimate of 170 cubic yards (approximately 100 feet long with a depth and height of 3 feet) is estimated for the volume of erosion from the area if the site were left unmitigated. In this case, removing pedestrian and vehicle traffic from the slope would likely remedy the problem.

Overflow parking area, slope failure causing erosion

Another roadside ditch is shown below. The potential sediment from these ditches likely only accounts for a small portion of the total sediment volume of concern. If the ditch was recently constructed, there may be small amounts of erosion before vegetation grows on the banks to stabilize it. Stabilization of the roadside ditches with vegetation would mitigate the sediment erosion and transport problem.

Roadside ditch

Shoreline Erosion: Another important potential source of sediment within the lake is shoreline erosion. Reports and field visits reveal that natural shoreline erosion appears to be minimal. A comparison of the bathymetric surveys between 1972 and 2012 shows that the shoreline from each survey is similar. In some areas, the current shoreline does appear to vary from the 1972 survey by approximately 5-15 feet. This variation is considered to be minimal. A few photographs detailing a relatively stable shoreline are shown below.

Shoreline adjacent to Frontage Road

Shoreline view

Although natural shoreline degradation appears to be minimal, there have been some contributions from anthropogenic sources. Two sources that were identified in the field are foot traffic and boat access. Pedestrian traffic along some areas of the shoreline has resulted in the vegetative cover die off and therefore erosion that is deposited directly into the lake. When boats such as canoes and kayaks are pulled onto the shore repeatedly, the vegetative cover can also be removed.

The two photographs below show areas where both boat and pedestrian traffic has degraded the vegetation along the shoreline. In the first picture, the area appears to be spread out over a significant area. In the second picture, the area to the right is where boats are pulled from the water. Over time, enough boats have been pulled out of this area that the vegetation has died off. This can cause sediment to be washed into the lake.

Shoreline area with heavy pedestrian traffic

Shoreline erosion adjacent to home site and picnic area with lake access

A solution to this problem would be limiting recreational access to specific entry points to the shoreline. Pedestrian traffic could be eliminated by planting shrubs and erecting educational and directional signage. By directing recreational users towards a specific location, regions where vegetation die-off is occurring would be limited to managed areas. The addition of vegetation through these impacted areas can also stabilize the bank and reduce erosion. Armoring the banks is also an option although it is an expensive option for individual homeowners.

Stream Degradation: Stream degradation throughout the lake's watershed appears to be a source of sediment. Several streams throughout the watershed were examined for erosion potential. Site visits showed that the streams in both the northern and southern halves of the lake are relatively stable. Some small areas of erosion were observed. For instance, in the stream shown in the photograph below, the bank has some signs of erosion. However, the majority of the remainder of the stream was stable.

Left bank erosion in tributary stream

Many streams and riparian areas that have been significantly disturbed in the Deep Creek Lake watershed have degraded and tend to be located in the southern part of the watershed. Furthermore, degraded streams were found to be located upstream of coves with reported excess sedimentation while relatively stable streams were located upstream of coves with little or no reported sedimentation problems. The streams with the lowest visual ratings tended to be surrounded by agricultural land uses.

An example of a stable stream is shown below. This stream is stable due to the vegetated riparian area (note the trees and shrubs). In addition, the watershed to this stream is primarily forested, with some urban development with minimal agricultural lands in the watershed. The stream banks are vegetated, and the stream has a good riparian buffer resulting in minimal stream erosion.

Stream leading to Marsh Run Cove

The larger streams in the watershed tend to be extremely stable. Boulders and bedrock were present in these areas. The photograph below was taken in the northern portion of Deep Creek Lake. It is in an area that is forested and is extremely stable. Upstream of this outfall is a large agricultural area. However, because of the large forested area that the stream goes through, the stream gets to a steady state and there is no active stream degradation. In addition, since this portion is in the northern part of the watershed, its soils fall within the Casselman Syncline. Due to the large forested area that the stream passes through before entering the lake, this stream is not actively degrading, and is therefore not contributing a significant amount of sediment to the coves.

Stream restoration is one solution to fix degrading streams. Stream restoration is the re-establishment of the general structure, function, and self-sustaining behavior of the stream system that existed prior to disturbance. It is a holistic process that requires an understanding of all physical and biological components of the stream system and its watershed. Restoration includes a broad range of measures, including the removal of watershed disturbances that are causing stream instability; installation of structures and planting of vegetation to protect streambanks and provide habitat; and the reshaping or replacement of unstable stream reaches into appropriately designed functional streams and associated floodplains (NC State).

To reduce further sedimentation, stream restoration should take place in the most severely eroded stream channels. Stream restoration can be completed by public or private entities and grants could be used to fund such projects. However, small improvements by individual property owners such as planting vegetated buffers for streams traversing their properties would be beneficial in reducing sedimentation into downstream coves. Individual property owners could also limit stream access on their property to reduce bank erosion.

Stream leading to Cherry Creek Cove

Streams in the southern part of the watershed vary from their counterparts in the north. The stream pictured below is located within the southern geomorphic soil, in a low lying area with adjacent agricultural fields. The stream is murky due to the presence of sediment, which likely originated as runoff from the agricultural fields. Although the stream itself is not actively eroding due to the low gradient and vegetated buffer, it is transporting a significant amount of sediment from upstream sources.

Stream leading to Penn Cove

In general, there appears to be minimal erosion coming from stream degradation. However, to prevent any erosion from happening in the future, upstream development should be monitored. If development throughout the area continues, preventative measures will need to be taken. In areas where stream erosion is occurring, several practices could mitigate the loss. For instance, vegetative stream banks and stabilization matting could prevent further erosion. In addition, ensuring that vegetative filter strips line the stream banks will help decrease the velocity of the incoming runoff, and will further prevent stream degradation.

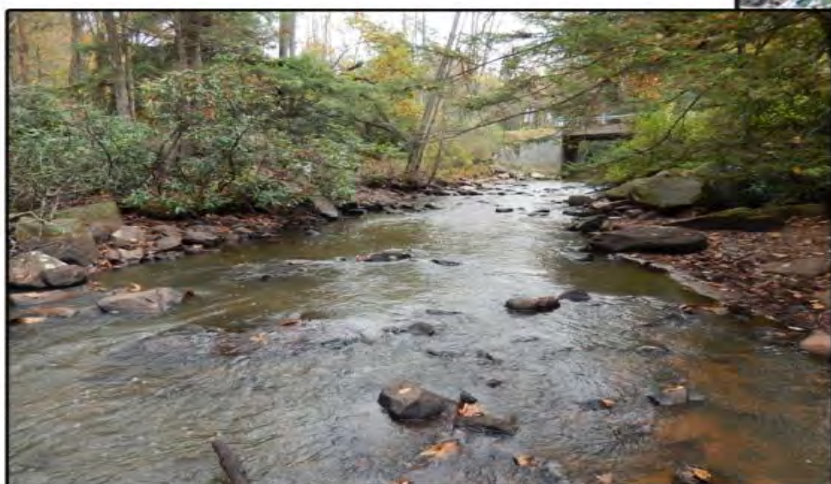
The size of the watersheds does not appear to play a major role in sediment accrual within the individual coves. Both small and large watersheds have sizeable amounts of sediment accretion within the coves into which they drain. For instance, although Thayerville is one of the smaller watersheds within Deep Creek Lake, Arrowhead Cove (found within Thayerville) has 11,719 cubic yards of sediment. This is compared to the largest watershed, North Glade, which has 13,950 cubic yards documented in Harvey's Peninsula Cove. With drastically different drainage areas but similar amounts of accrual, Thayerville and North Glade demonstrate that the size of the watershed does not play a part with increased sediment.

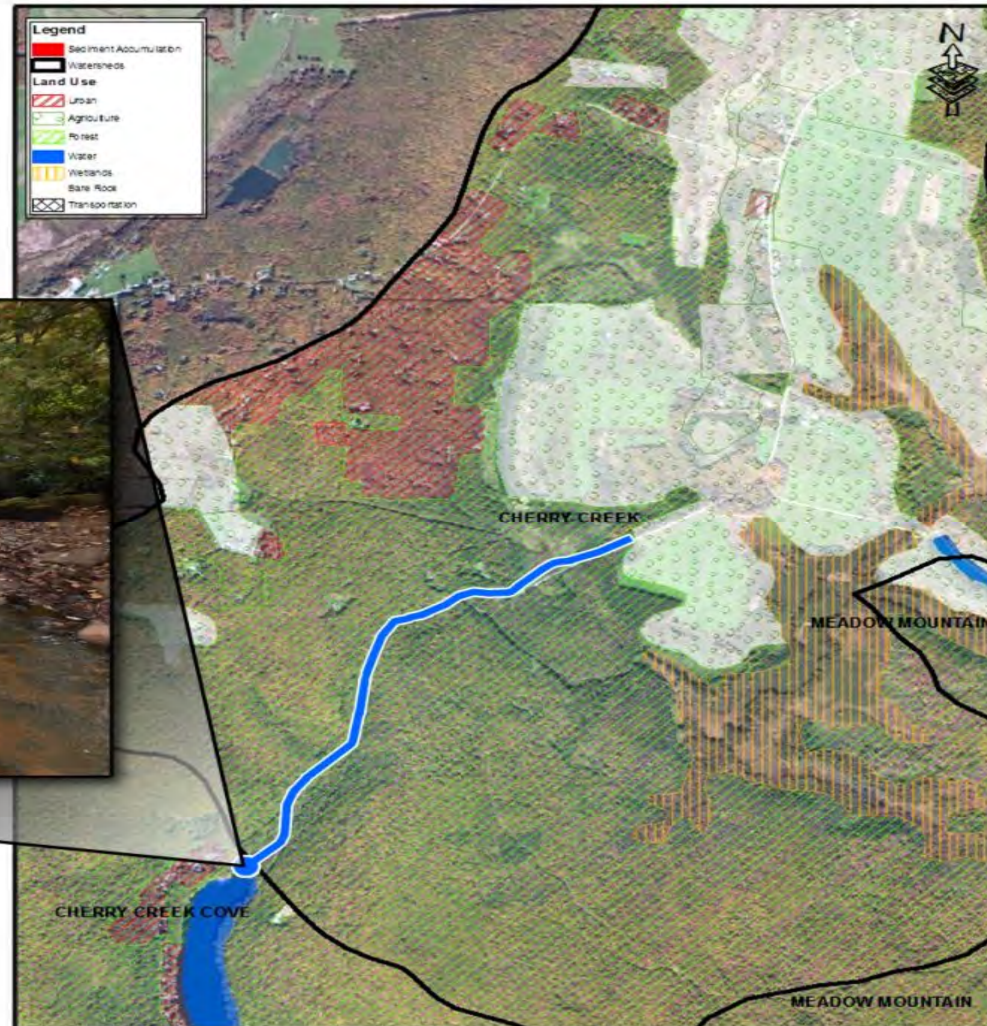
The soils and geology of the watersheds play a role in determining the potential for erosion. However, land use throughout the watershed appears to have a greater influence on the amount of sediment runoff. While it contributes to some amount of sediment erosion, urban development throughout the watershed appears to have a minor role. For instance, Roman Nose Hill Watershed is highly developed with steep slopes but no sediment accumulation is observed. Shingle Camp Hollow Watershed is similarly an example of high development but also without sediment accumulation. On the other hand, Poland Run and Turkey Neck are examples of coves within watersheds with less agriculture upstream. These are two coves with the least amount of sediment out of the ten selected for the study.

Multiple sources of sediment erosion and runoff have led to an accumulation of particulates within Deep Creek Lake. There are many potential sources of erosion, each of which has been described above. While each of the sources has contributed to the sediment accumulation in Deep Creek Lake, it appears that the majority of sediment accumulation comes from runoff of agricultural fields. This runoff can be minimized by preventing livestock from entering streams, planting vegetative buffers along the areas, and practicing conservation practices within each watershed. Implementing these practices will help minimize the volume of sediment entering the lake, and will therefore help to slow sediment accumulation.

The following three graphics display the stream conditions in relation to each of the land uses within the watershed.

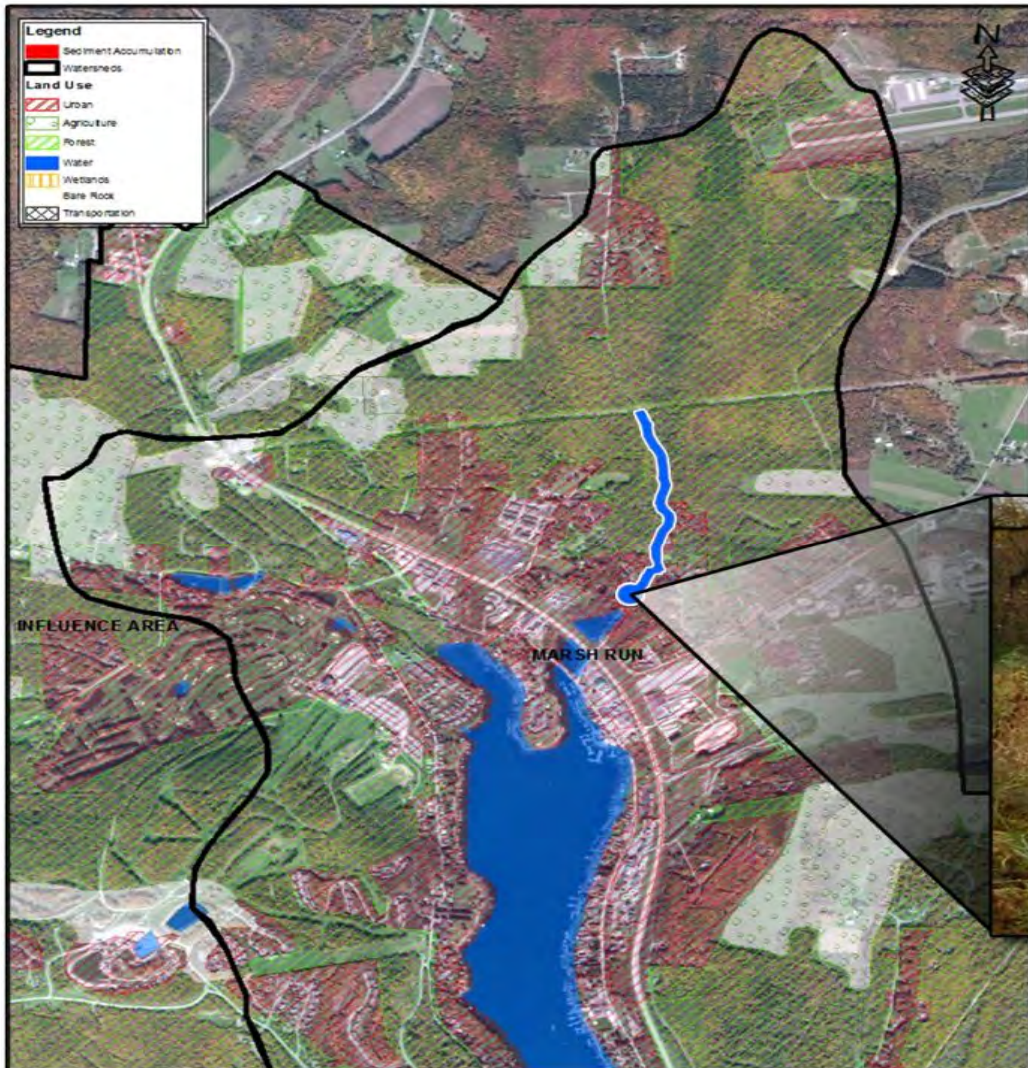
Cherry Creek Cove





Although agricultural land use is located at the headwaters, 5 miles of forested buffer and forested riparian area result in a stable stream.

Figure 3.1: Example of a Stable Stream with Forested Buffer



Marsh Run Cove

Although the watershed is urbanized, the riparian area surrounding stream and upland forest results in a stable stream.

Figure 3.2: Example of a Stable Stream with Meadow/Forested Riparian Area

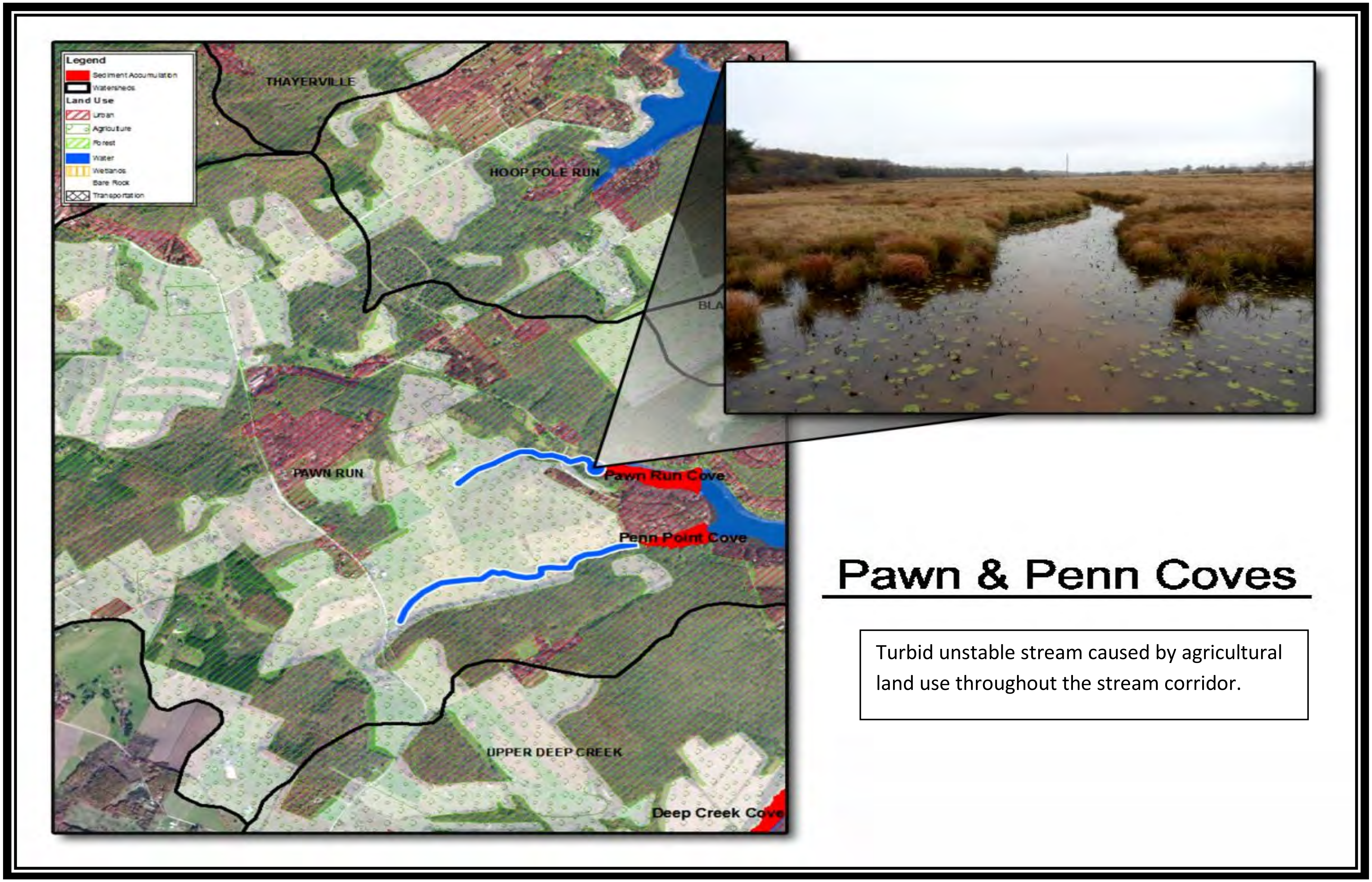


Figure 3.3: Example of a Turbid Stream Surrounded by Agricultural Land Use

Section 4: Dredging Options

Prior to the start of a dredging operation, several items must be verified. MDE requires that all disposal sites must be located upstream of the site and outside of the 100-year floodplain. The sites reviewed for this study meet these criteria. In addition, the following steps would need to be taken:

- *Individual Cove Assessments – Each cove would require an individual study and design for final environmental analysis, final design, and public notice. It is estimated that individual cove studies and permits would require twelve months or more to obtain.*
    - *Environmental Permits – MDE Permits would need to be obtained. It is likely this process would take a minimum of one year obtain. It is likely that this could take up to three years to obtain.*
- *Drawdown – Twelve (12) months of notice is required for any draw down of the lake.*

There are three primary dredging options, hydraulic, mechanical wet and mechanical dry. A typical cove has approximately 25,000 cubic yards of sediment.

Typically, hydraulic dredging is less expensive and faster than mechanical dredging. The following describes the basic mechanisms behind dredging methods:

Hydraulic Dredging – Hydraulic dredges pump a mixture of dredged sediment and water from the bottom of the cove to an enclosed pipeline and then to an on-shore location. The sediment is then transported from the location to the ultimate disposal site. Other equipment needed for pipeline dredging includes a “cutterhead”, which is a method to release sediment and ensure efficient removal. Additionally, this type of hydraulic dredging is fixed to a barge and then hauled to the site. This option can be cost effective due to the continuous disposal from channel bottom straight to the site (USACE).

Mechanical (Wet) Dredging – Wet mechanical dredging involves excavating sediment from the bottom of the lake and lifting it mechanically to the surface. Sediment is then transported via barge or truck to the disposal site. This type of dredging is known to work well in small, confined areas, specifically reservoirs, harbors, and lakes. Like hydraulic dredging, the dredged material is fixed to a barge and hauled to the disposal site. However, wet mechanical dredging can consist of two barges to be used in conjunction to make the process more continuous. With this method, mechanical dredging can be appropriate for hauling sediment long distances (USACE). Turbidity will be a concern for wet mechanical dredging and therefore turbidity curtains will be required downstream of the proposed dredging areas to reduce turbidity in deeper parts of the lake.

Mechanical (Dry) Dredging – Dry mechanical dredging involves lowering the lake to expose the sediments to drying or freezing conditions. Cofferdams or sheet piles may also be used to prevent water from the lake from entering the dredging area. Additionally, streams entering the coves will need to be diverted via pipes and/or pumps to keep the sediments dry during excavation. Conventional earthmoving equipment such as bulldozers, scrapers, backhoes, and draglines are used to remove the sediment. The equipment either works from shore or moves down onto the dewatered lakebed. The sediment may be stockpiled on shore to facilitate dewatering of the soils by gravity drainage. Within approximately three weeks the residual soil moisture should be reduced sufficiently drained to load onto dump trucks and hauled to a disposal location. Alternatively, the wet soils could be loaded directly onto dump trucks, but this is not recommended because more trucks will be needed and turbid water would leak from the trucks to the disposal sites.

The following table estimates the area that would be impacted by the dredging operations in each cove:

Table 4.1 – Area Impacted by Dredging

Name	Area (Acres)
Arrowhead Cove	9.9
Chadderton School Cove	10.4
Deep Creek Cove	14.3
Harvey's Peninsula Cove	8.9
Penn Point Cove	6.2
Penn Run Cove	11.2
Poland Run Cove	10.6
Sky Valley Cove	30.9
Green Glade Cove	52.9
Turkey Neck Cove	6.7
Hazelhurst Cove	10.3
Total	**172**

*See Appendix B for proposed dredging site maps provided by DNR

The total area impacted is 172 acres, representing 4.4% of the total lake surface. If coves are dredged at separate times, at most 1.4% of the lake surface would be closed.

Furthermore, the work hours would likely be limited to the hours of the State Park (7am to 10pm). There may be potential to work during the night, but this option was not considered for this study. It is also assumed the contractor will be able to control the water level within 15 feet +/- for operational purposes (Note: This falls outside the Rule Band). If the ability to control the water surface elevation is eliminated, then there will be an increase in removal costs. Costs will be discussed further in Section 11.

Section 5: No Dredging Option

The no dredge/implement sediment reduction measures alternative was also reviewed. The past studies and reports, historic aerials, land uses, soils, and geology were all reviewed prior to analyzing the alternatives.

With the no dredge/implement sediment reduction measures option, there must be monitoring on the following:

- *Lost Tax Revenue* – Garrett County will lose approximately $250,000 per year in decreased tax revenue (see Section 8; per data provided on 12/13/2013 by Garrett County Economic Development).
- *Sediment accumulation* – It is recommended at a minimum, every ten (10) years that a bathymetric survey is completed and sediment accumulation be reviewed.
- *Stream condition* – It is recommended stream conditions upstream of the lake are monitored using DNR Maryland Biological Stream Sampling (MBSS).

The following Best Management Practices are recommended to manage the sediment:

- *Monitor stream erosion rates*
- *Monitor shoreline erosion rates*
- *Monitor all development*
    - *Meet current MDE requirements for all new construction and encourage existing homeowners to retrofit properties, and strictly enforce all erosion and sediment control at development sites.*
- *Enforce strict guidelines for agricultural fields.*
- *Enforce buffer strip owned by DNR around the perimeter of the lake where it was not previously enforced. The buffer strip is defined by COMAR as an area above the 2,462 feet lake elevation and not presently fenced or posted by the Department of Natural Resources to limit or exclude use by the public.*
- *Increase vegetation around the lake.*
- *Remove any unnecessary impervious area.*

The environmental impact of not dredging is as follows:

- There would be no immediate negative consequences for the economic, health or safety aspects of the citizens of the Deep Creek Lake watershed. The added depth of sediment has not been enough to deter the docking or the recreational boating or fishing on the lake.
- Although it may be true that there are some docks that are becoming unusable due to sediment accumulation, this would be a case by case situation to tailor the work specifically required to reopen navigation.
- The main effect of not dredging the lake at this time would be the continual increase of water temperature over time. The effect of this would be on the cold fish populations that need cooler waters to live and breed in. Over an extended period of time, the continual deposition of sediment would increase the lake's temperature.

Section 6: Environmental Impacts

Over time, Deep Creek Lake has become rich with aquatic vegetation and wildlife, primarily consisting of various fish species, macro-invertebrates, and submerged aquatic vegetation (SAV). All of these organisms are indicators of the health of a body of water. Dredging in areas where these organisms are abundant has the potential to impair the water quality and to create environmental instability. The environmental impacts of dredging were closely analyzed to determine any potential effects on the lake.

Deep Creek Lake is currently in mesotrophic conditions, meaning that it has an intermediate level of nutrient production (ERM, Inc.). Since 1969, there has been very little change to the Trophic State Indicator (TSI). The TSI has ranged between 30-50 over the last forty plus years. "Mesotrophic lakes have the potential to be the most biologically diverse type of lake and tend to support a higher number of rare plant species than the other lake types. Macro-invertebrates are well represented in mesotrophic lakes including important groups such as dragonflies, stoneflies, mayflies and water beetles" (Kelsey and Powell). Being a mesotrophic lake, it is evident that Deep Creek Lake has the potential to be biologically diverse and any harmful impacts to its environment must be minimized.

SAV Presence and Risks - The Submerged Aquatic Vegetation (SAV) is considered to be a key organism for determining the water quality of that lake. Ranging from 2.3 meters to 6.3 meters (7.5 feet to 20.7 feet) deep, all of the SAV plants within Deep Creek Lake were recorded in the photic zone. Out of the six coves investigated for SAV by DNR, only one was found to be in the potential sediment management coves. Deep Creek Cove was investigated for SAV and found to have expansive bed dominated by *Elodea canadensis* and co-dominated by the macroalgae, *Nitella flexilis*. The invasive, *Myriophyllum spicatum,* was also present in low amounts over several years of monitoring. It has been determined that Elodea is the most common SAV in Deep Creek Lake, accounting for more than 90% of all SAV and a significant amount of the SAV in the southern most portion of the lake (MD DNR).

Conducted over a three year period, the SAV survey showed that *Myriophyllum spicatum* (Eurasian Watermilfoil) is present in Deep Creek Lake. However, a biologist from DNR determined that *Myriophyllum spicatum* is not an issue for Deep Creek Lake at this time, though it does require monitoring. Any type of disturbance could create an unbalance in the ecological realm that could cause an increase of invasive species in the lake bed. A survey of the shoreline indicated that 86 acres of this Eurasian watermilfoil were present in the Deep Creek Lake. The last SAV Survey (2012) estimated that the remaining 94% of available benthic habitat is free of Eurasian watermilfoil.

The use of herbicide treatments for eliminating invasive species such as *Myriophyllum spicatum* will also cause eradication of the majority of SAV in the application area. It is recommended to wait for the results of pilot tests to determine whether herbicide Endothall or mechanical harvesting of *Myriophyllum spicatum* is more effective for the cost and desired effect. It is also recommended to utilize the June 2013 survey EWM results for a current record of their locations.

Regardless of the sediment removal method, the loss of SAV and macro benthic invertebrates will occur and is detrimental to the ecology of Deep Creek Lake. If it is determined that there is no *Myriophyllum spicatum* present, then harvesting the SAV is possible for replanting dredged area or connecting adjacent seed bank (provided that is part of the plan). Therefore the two Rare, Threatened and Endangered Species (RTEs) of SAV, Elodea and the macroalgae, are at risk of being destroyed during sediment removal operations.

Harvesting SAV – Options for controlling SAV are harvesting, herbicide, and mechanical controls. These options can reduce the negative impacts of SAVs. The removal of SAV could increase the area boats could navigate, but it could limit swimming and fishing.

Elodea create thick, dense mats of SAV within the water, which is the cause of many problems that the boaters face in the summer months. Harvesting during the summer is possible and would suffice in keeping the channels and docks clean, thereby allowing boating activities to remain undisturbed. Harvesting elodea is also important since excessive SAV can result in vegetative decay and low oxygen, which can lead to noxious odors and fish kills. This restricts fish habitat and creates oxygen depletion conditions in the sediment. It eventually leads to the release of phosphorus into the water column, thereby increasing algae growth and blooms. Another means of controlling elodea is by removing the rhizomes from the sediment. This can reduce the amount of time of re-cutting SAV and provide longer control.

Drawbacks of mechanical harvesting include repetitive procedures, timing of harvest, high costs for equipment and labor, and most significantly, fragmentation. Fragmentation is the process where fragments of cut plants that are removed properly can disperse from the treatment area and spread to other portions of the lake or to downstream water bodies through currents. This can result in enhanced propagation of those plants that spread primarily from fragmentation, such as Eurasian watermilfoil. Furthermore, if both native and fast-growing exotic plants are cut to the same degree, the exotic plants (often the original target for harvesting) may grow faster and dominate the entire plant community. Tests should be conducted to see if this is the response of E. watermilfoil over Elodea.

Other Options – The alternatives to mechanical harvesting of SAV consist of replanting after sediment removal, drawdown of water during off season times, or use of chemical herbicides. Replanting after sediment removal using the harvested material or seed bank from the remaining SAV can facilitate regeneration of the desired species after sediment removal. Another option is the drawdown of water. While the drawdown shows no decrease on Elodea, the process does show a strong decrease of Eurasian watermilfoil, which cover 86 acres of Deep Creek Lake. The last alternative, chemical treatment, includes the herbicides 2-4, D, or Fluridone, both which eliminate aquatic weeds by their roots. However, because of the delayed nature of toxicity, the herbicide is best applied during the early growth phase of the target plant, usually spring or early summer. Application would most likely be in season and prevent swimming and fishing in the immediate area.

Fish Spawning and Harvesting - The fish species that are at risk for impacts of dredging are those that primarily spawn both in the spring and the fall periods. Major game fish such as the Northern pike and the Walleye spawn in the very early spring. Most trout spawn in the late fall time frame. This leaves a small window of opportunity for dredging sediments. Specific game fish spawning periods are as follows:

- *Brown trout and Brook trout – Brown trout spawn a week or two later than Brook trout, generally from late October through November.*
- *Northern pike – spawning takes place soon after ice-out when temperatures reach* 35^0 *F in shallow waters and hatch within six to 29 days depending on water temperature.*
- *Chain pickerel – spawn in the early spring when water temperatures approach* 50^0 *F.*
- *Yellow perch – spawn in late April.*
- *Walleye – spawn in the early spring usually just after ice-out when water temperature are just between 30 –* 50^0*F. The reproducing population was established in 1983. Current regulation protects walleye from harvest during the spawning period, from March 1 through April 15.*
- *Largemouth bass – spawn as early as March or as late as June, depending on water temperature.*

In addition to the spawning periods, fish are also sensitive during the peak of summer, when there is a high surface temperature within the lake. This leads to the development a strong thermocline. The thermocline reduces the oxygen level in the deeper regions of the lake (greater than 21 feet), causing the water to become hypoxic (less than 2ppm). Dredging would cause this effect to be exacerbated due to the cold water releases. Care would need to be taken during dredging to prevent this effect from occurring.

Water Quality Impacts – Dredging activities can release elements and chemicals that are contained within the sediment. Deep Creek Lake reports that sulfur (S), arsenic (As), chromium (Cr), antimony (Sb), and lead (Pb) were found at significant concentrations during the core sampling analysis. The sources of these elements, their concentrations, their impacts on lake from the removal process, and the impacts on disposal sites vary for each individual area. Sources of these elements are most likely acid mine drainage and/or atmospheric deposition as well as coal deposits from the surrounding watersheds. Furthermore, anthropogenic activities are most likely the primary sources for Pb concentrations. According to the DNR study, the northern half of the lake's watershed is high in S-contained bottom sediments, with concentrations that are significantly higher than other freshwater lakes within Maryland. Similarly, As, Cr, and Sb have higher enrichment factor (EF) values in Deep Creek Lake when compared to another freshwater lake with comparable physiography and geochemistry (DNR). Although the levels of sediment chemicals and elements for Deep Creek Lake are higher than other freshwater lakes, the levels are not of concern at this time based on the report.

The impacts of removing the sediment can vary slightly depending on the type of dredging performed. In general, due to the suction mechanism, hydraulic dredging will stir more elements than mechanical dredging when water is drawn down and evacuated. Still, both will cause the release of some elements into the lake, which plants and animals may then uptake. Similarly, disposing of the dredged material may contaminate the disposal site. Based on the study provided by DNR, however, there is no evidence that the level of bottom sediment contaminants would prevent disposal at any given site.

The following matrix (Table 6.1) provides the impacts of each dredging option on the SAV, macroalgae, benthic organisms, E. waterfoil, and fish species, and also provides the best time period to close the lake to avoid further harming these species. A scoring system is also included to weigh the severity of the impact of each activity for each species.

The matrix shows that the biological impacts of dredging are severe and any benefits are limited to physical gains. These gains include increased freeboard for better access to the piers when the quantity of water in the lake increases. Biological impacts vary, although they could include a small decrease in aquatic vegetation due to the deeper water. In general, the impacts of mechanical dredging on the species appear to have a more severe impact due to the drawdown of water in Deep Creek Lake.

Table 6.1 – Time Matrix of the Impacts on Vegetation and Wildlife of Deep Creek Lake

Species of Concern	Species' Category	Ideal Time Closure Period	Impacts of Hydraulic Dredging	Impacts of Mechanical Dredging	Impacts of No Dredge
Elodea canadensi	SAV	March - June	**Disadvantage**: Creates Fragmentation; disturbs fish/macro habitat	**Disadvantage**: Creates Fragmentation **Advantage**: If replanted in dredged areas; Removes excess vegetation	No change in 5 year time frame.
			Score: 1	**Score: 2**	**Score: 5**
Macroalgae	SAV	March - June	**Disadvantage**: Creates Fragmentation; disturbs fish/macro habitat	**Disadvantage**: Creates Fragmentation **Advantage**: If replanted in dredged areas; Removes excess vegetation	No change in 5 year time frame.
			Score: 1	**Score: 2**	**Score: 5**
Eurasian Waterfoil	SAV	December - February	**Disadvantage**: Creates Fragmentation; disturbs fish/macro habitat **Advantage**: Removes the invasive	**Disadvantage**: Creates Fragmentation **Advantage**: Provides desired effect	No change in 5 year time frame.
			Score: 1	**Score: 2**	**Score: 5**
Benthic Organisms	Benthic	December - February	**Disadvantage**: All organisms removed	**Disadvantage**: All organisms removed	No change in 5 year time frame.
			Score: 1	**Score: 2**	**Score: 5**
Largemouth bass	Fish	March or as late as June	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	No change in 5 year time frame.
			Score: 1	**Score: 3**	**Score: 5**
Smallmouth bass	Fish	March or as late as June	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	No change in 5 year time frame.
			Score: 1	**Score: 3**	**Score: 5**
Chain pickerel	Fish	March - April	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	No change in 5 year time frame.
			Score: 1	**Score: 3**	**Score: 5**
Northern Pike	Fish	Early February - Mid April	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	No change in 5 year time frame.
			Score: 1	**Score: 3**	**Score: 5**
Yellow perch	Fish	late April	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	No change in 5 year time frame.
			Score: 1	**Score: 3**	**Score: 5**
Walleye	Fish	March 1 through April 15	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	No change in 5 year time frame.
			Score: 1	**Score: 3**	**Score: 5**
Brook and Brown trout	Fish	late October through November	**Disadvantage:** Removal of benthic organisms (food) **Advantage:** Trout will still remain after dredging operations	**Disadvantage**: Disturbs fish/macro habitat, loss of temporary breeding/rearing young	No change in 5 year time frame.
			Score: 1	**Score: 3**	**Score: 5**
Overall Score			**Score: 11**	**Score: 29**	**Score: 55**

Scores are based on a 0-5 scale, with '0' being the worst impact and '5' being the best.

Time Considerations for Dredging - The considerations for dredging with the fish habitat and social-economic considerations will keep dredging operations limited to end of Labor Day to Memorial Day. If sediment removal is a priority, dredging operations can be performed all year long. Using a strategy of one or two coves at a time will allow all coves to be completely dredged over a three to five year period.

Further Studies - Rare, Threatened and Endangered Species (RTEs) are both in the Deep Creek Lake and just outside of the lake. The only known animal RTE in the lake is *Pygonodon grandis* (Giant Floater Freshwater Mussel). The SAV Report found two species of *Potamogeton spp*. which are rare and at the time were considered extirpated from Maryland waters. This may require further study and sampling during summer months to complete a comprehensive study of the entire lake for other populations of these species. Additionally, environmental assessment should be conducted prior to any further planning to see if all sites under consideration are available for potential dredging.

Section 7: Recreational Impacts

The overall impact to recreation will be minimal only if any dredging that is done is completed within specific time frames. The recreational activity impacts the tourism, hotel room stays, and traffic. The timing of any potential dredging would be critical. The four main recreational impacts are: 1) boating, 2) fishing, 3) swimming and 4) white water rafting. Deep Creek Lake has a gross surface area of 3,628 acres (with a net of 2,939 acres, the reduction accounting for the 100’ no-wake zone). Furthermore, dredging procedures would negatively affect the SAV and impact fishing. On the other hand, dredging would increase the area that boats could reach. Based on Table 7.1, the maximum area that would be closed is 4.5%. Only a fraction of this area would be additional area for boating. Based on the assumption that boats need a minimum of 3 feet of water to operate, the boat access is increased by only 1% within the coves that are dredged. In the interim, the coves that are shut down for the dredging operation would have short term impacts to the recreational activities.

The typical boating uses are: Motor boats, Fishing Boats, Sail Boats, Canoes/Kayaks, and Waterskiing Boats. A majority of the work will be done within the 100’ no-wake zone. The following table presents the total area of lake that would be closed for dredging operations:

Table 7.1 – Area of Water Closed for Construction (in acres)

Name	Area (Acres)	Percent of Total Lake Area (%)	Area Outside 100' No-Wake Zone (Acres)	Percent Outside 100' No-Wake Zone (%)
Arrowhead Cove	12.33	0.32	2.53	0.06
Chadderton School Cove	13.03	0.33	4.68	0.12
Deep Creek Cove	17.92	0.46	5.04	0.13
Harvey's Peninsula Cove	11.11	0.28	3.11	0.08
Penn Point Cove	7.71	0.20	1.55	0.04
Pawn Run Cove	14.01	0.36	3.4	0.09
Poland Run Cove	13.19	0.34	3.67	0.09
Green Glade Cove	66.1	1.69	31.51	0.81
Turkey Neck Cove	8.40	0.22	3.01	0.08
Hazelhurst Cove	12.81	0.33	3.85	0.10
Total	**176.61**	**4.53**	**62.35**	**0.0160**

The following table presents the number of recreational users potentially impacted during the following months:

Table 7.2 – Number of Recreational Lake Users on Deep Creek Lake over Time*

Year	Time Period								
	4-Jul	July 8-14	July 17-21	July 24-28	ıly 30-Aug	Aug 7-11	Aug 14-18	Aug 21-26	Labor Day
1990	300	352	299	294	292	271	214	0	403
1991	213	391	0	0	0	292	351	331	301
1992	347	0	219	0	323	365	0	249	180
1993	407	280	0	285	0	319	0	382	403
1994	318	214	0	364	317	392	0	221	272
1995	190	359	409	297	373	135	228	408	391
1996	321	347	452	336	0	288	338	432	519
1997	434	294	0	261	283	370	319	261	507
1998	262	0	0	0	0	0	0	0	0
1999	0	0	275	357	0	0	0	139	170
2000	471	0	0	248	305	0	0	0	0
2001	278	301	354	0	276	0	346	233	493
2002	374	188	268	0	248	366	235	266	206
2003	340	152	0	152	104	0	309	246	0
2004	431	0	314	310	313	0	0	0	0
2005	358	0	0	0	245	285	304	279	320
2006	258	209	125	0	189	354	284	239	262
2007	171	281	179	337	0	0	233		380
2008	292	203	224	0	0	209	196	249	356
2009	173	186	155	284	416	376	429	253	388
2010	531	203	228	294	361	326	0	310	277
2011	340	273	313	288	299	0	0	207	415
2012	365	365	157	259	163	209	320	301	267

*'0' indicates that the aerial count did not take because weather grounded the flight.

DNR provided data the monthly averages for months when no aerial counts were taken. The following numbers are the average boat users in October: 145, November: 45, and April: 32. During the months of December, January, February, and March, the lake is typically iced over.

Historical boat counts from aerials display the trends for recreational lake users, as seen in the following figure for Labor Day (See Appendix D for all time periods from July 4th to September 1st; data provided by DNR):

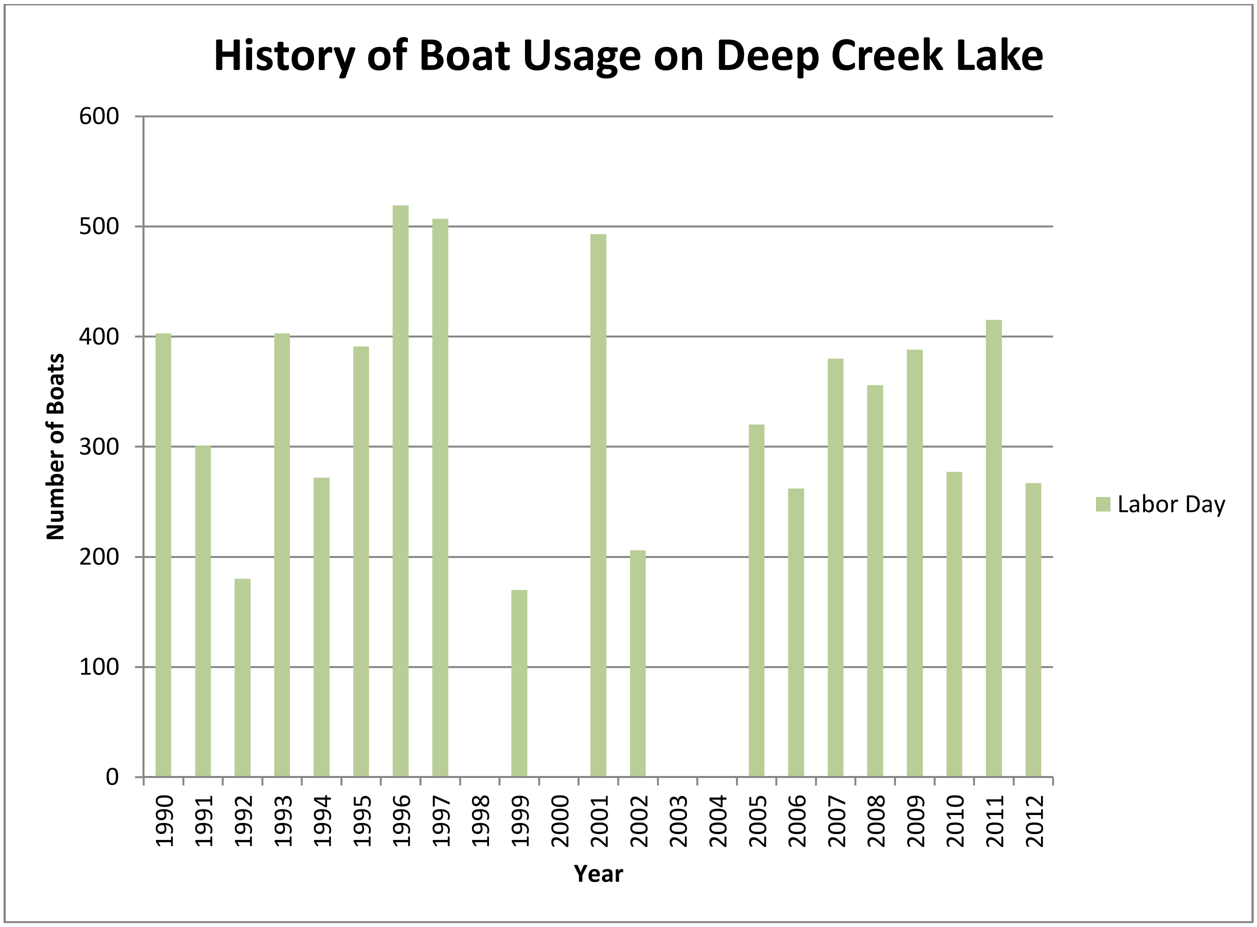


Figure 7.1 – Number of Boats seen on Labor Day

*A value of '0' indicates that the aerial count did not take because weather grounded the flight.

The following table details the impacts of each dredging option (including no dredging) on each of the main recreational activities. The peak time that these activities are performed is also included.

Table 7.3 – Time Matrix of the Impacts on Recreational Activities within Deep Creek Lake

Recreational Activity	Peak Use Time	Impacts of Hydraulic Dredging	Impacts of Mechanical Dredging	Impacts of No Dredge
Boating	May-September	**Disadvantage:** Short term impacts to cove access. **Advantage:** Increase areas where boats could reach.	**Disadvantage:** Short term impacts to cove access. **Advantage:** Increase areas where boats could reach.	No change in 5 year time frame.
		Score: 4	**Score: 2**	**Score: 5**
Fishing	May-September	**Disadvantage:** Short term impacts to cove access. Disruption of fish habitat and breeding ground.	**Disadvantage:** Short term impacts to cove access. Disruption of fish habitat and breeding ground.	No change in 5 year time frame.
		Score: 4	**Score: 2**	**Score: 5**
Swimming	May-September	**Disadvantage:** Short term impacts to cove access. Impacts to water quality. **Advantage:** Increase areas for swimming in the long term.	**Disadvantage:** Short term impacts to cove access. Lower water level possible in areas of dredging. **Advantage:** Increase areas for swimming in the long term.	No change in 5 year time frame.
		Score: 4	**Score: 2**	**Score: 5**
White Water Rafting	May-September	**Disadvantage:** Short term impacts to cove access.	**Disadvantage:** Short term impacts to cove access. Lower water level possible in areas of dredging.	No change in 5 year time frame.
		Score: 4	**Score: 2**	**Score: 5**
Overall Score		**Score: 16**	**Score: 8**	**Score: 20**

Based on the number of boats that are on the lake in any given month, dredging should aim to be completed during the 'off-peak' months. These would roughly be from Labor Day until Memorial Day. This will minimize the impacts to recreation and tourism in the area. Since both of these sectors have large economic impacts within Garrett County and the Deep Creek Lake area, effort should be taken to minimize any impacts that dredging creates. In order to ensure that the recreational activities are minimally impacted, the time frames of September to December and March to May are recommended, as the lake is typically frozen from December to March.

Section 8: Economic Impacts

Tourism generates an economic benefit of roughly $350 million per year within Garrett County. It is estimated that a majority of Garrett County's tourism comes from the Deep Creek Lake area. This has been taken into consideration when analyzing the various dredging practices and the associated time frames.

The construction for dredging was limited to the following two time frames due to the fact that the economic impact outside of these periods would be too great. If dredging must occur outside of these windows, the exact economic impact would need to be analyzed. Further study would be required to determine the full impact, which is beyond the scope of this study.

This study limits dredging operation to these two windows:

- March to Memorial Day (with all equipment removed and all operations completed prior to Memorial Day Weekend)

- Labor Day to December (with all equipment removed and all operations completed prior to Christmas due to ice-over of the lake)

Dredging cannot occur from December to March, as the lake is typically frozen.

There are many potential economic impacts from the scenarios. Mechanical dredging (dry) could impact the releases from the dam which would negatively impact the revenue generated from the whitewater rafting industry. Without the releases, the cold water fish downstream of the dam could also suffer which impacts the tourism generated from fishing and fly fishing.

The following table separates the number of waterfront properties at each cove that would potentially be impacted by the dredging practice:

Table 8.1 – Properties Impacted*

Site	Number of Properties Impacted
Arrowhead Cove	70
Pawn Run Cove	24
Penn Cove	12
Chadderton School Cove	24
Turkey Neck Cove	21
Hazelhurst Cove	28
Poland Run Cove	25
Deep Creek Cove	32
Green Glade Cove	80
Harvey's Peninsula Cove	24
TOTAL	**340**

*See Appendix E for Parcel Maps provided by Garrett County

The total number of private docks throughout the Deep Creek Lake area is estimated to be 1,626 with an additional 97 common docks where 1,560 slips are shared. There are an additional 132 docks held by hotels and restaurants. There will be approximately 340 properties impacted by dredging operations.

District 18 (which contains most of the Deep Creek Lake Watershed) accounts for more than 50% of Garrett County's property tax revenue. It is difficult to estimate the exact impact to the properties because many of the properties had marginal water access originally. In an attempt to look at the worst case scenario, it is assumed that all properties had water and dock access.

Allowing Deep Creek Lake to remain in its current state would allow sediment to continue to accumulate. As sediment continues to build up in the lake, the lake front continues to degrade. This causes property values to decrease, which in turn causes a loss in tax revenue for Garrett County.

The loss in property value and property tax have been analyzed for a cost analysis. Two tables have been included for this scenario. Table 8.2 is the economic impacts of dredging and not dredging over 3 periods of time. Table 8.3 expands on the values in the event that the actions are accomplished in one time period. For a more detailed cost estimate, see Appendix C. The full estimate provided by Garrett County can be found in Appendix H.

Table 8.2 – Economic Impacts over a 3 Year Period

Management Option Economic Impacts		
Measured Criteria	No Dredging	Dredging
Tourism Dollars	$ 5,400,000.00	$ 8,900,000.00
Property Value	$ 7,500,000.00	$ -
Annual Tax Income	$ 742,500.00	$ 477,796.50

Table 8.3 – Economic Impacts over a 1 Year Period

Management Option Economic Impacts		
Measured Criteria	No Dredging	Dredging
Tourism Dollars	$ 1,800,000.00	$ 8,900,000.00
Property Value	$ 2,500,000.00	$ -
Annual Tax Income	$ 247,500.00	$ 477,796.50

The tables provided by the Garrett County Economic Development detail the economic losses associated with each of the types of dredging, as well as a no-dredge option. For comparison, the cost of implementing sediment reduction measures has not been included in these tables. The amount of tourism generated, property value, and annual tax income remain the same for each of the dredging options. That is due to the fact that the type of dredging that is performed does not have any impact on the long term economics in the area. The time frames for when the dredging occurs also do not impact the long term economics. These columns have therefore been combined into dredge vs. no dredge options.

The largest impact of not dredging is in the variation in the amount of tourism dollars that are available to Garrett County. A continuation of sediment accumulation in the coves will impact the tourism in the region, as described in Section 7. Property values and therefore tax revenue will also be negatively affected. Overall, not dredging or implementing sediment reduction measures will decrease the economic value of the Deep Creek Lake region.

Section 9: Disposal Analysis

Several options for a disposal site were discussed prior to the initiation of the project but only three are feasible both in terms of logistics and costs: a public landfill, a quarry site, and agricultural/open space tracts of land.

Garrett County Landfill – The County's landfill (located at 3118 Oakland Sang Run Road, Oakland, MD 21550) presents an opportunity that will create positives for both DNR and Garrett County. The landfill needs additional fill material for cap and has the capacity to accept over 300,000 cubic yards of material. Access to the landfill is possible through Oakland Sang Run Road. With respect to additional expenses, there would be no cost for acquiring land. An additional bonus would be the potential partnering opportunity with the Garrett County Department of Solid Waste and Recycling.

Quarry Site – Within Garrett County there is a closed quarry site (strip mine) located off of Garrett Highway, north of Quarry Road. Access would be off of Sand Flat Road to the southern coves. The site is able to accept approximately 65,000 cubic yards of material. However, if all of the coves are dredged, the quarry site will not be able hold all the dredged material. Nevertheless the quarry site can still be utilized as a temporary storage area if the coves are dredged on a varied schedule.

Agricultural/Open Space – The location of an agricultural or open space disposal site is undetermined for the purposes of this study. The size of the parcel of land needed would vary by each cove. The site would have to be zoned for agriculture and within one mile maximum of the lake. The site would either need to be purchased or rented. Garrett County provided a land value of $6,000 per acre for land that would fit the previously described requirements.

The haul lengths for each of the proposed dredging sites are included below. The haul routes were calculated using the combination of the shortest available route and the consideration of which roads were suitable to heavy loading. The local roads will likely be acceptable if only one way traffic is used. This would require Maintenance of Traffic (MOT) with the use of flagmen. During off-peak seasons, the impact to traffic was considered to be minimal. Since the location of the agricultural land is undetermined, it has not been included in Table 9.1.

Table 9.1 – Haul Lengths (in miles)

Site	Garrett County Landfill	Quarry Site
Arrowhead Cove*	6.1	0.4*
Pawn Run Cove	8.0	6.5
Penn Cove	8.0	6.5
Chadderton School Cove	11.6	8.5
Turkey Neck Cove	14.9	11.6
Hazelhurst Cove	14.9	11.6
Poland Run Cove*	19.9	10.9*
Deep Creek Cove	11.6	8.5
Green Glade Cove*	15.8	10.3*
Harvey's Peninsula Cove*	24.7	3.5*

*If the landfill or quarry site are used for disposal, it is recommended that Arrowhead Cove, Poland Run, and Harvey's Peninsula be exported to the quarry site. A portion of Green Glade Cove could also be exported to the quarry site. The other sites would utilize the landfill.

It also was assumed that in order to handle the traffic, all local roads require repair with tar and chip application post dredging. The total local lane miles were calculated and a unit price was applied and included in the cost estimate. The sections of County maintained road were also included in this total. Freeways and arterials were not included in the estimate for re-paving. Roadway replacements for both dredging types are the same, since the same routes would be utilized in either scenario.

Hauling fees also vary by dredging type. Since the trucks that remove the material from the mechanical wet dredging process must be watertight, they cost $110 per hour, as opposed to the hydraulic dredging, where the cost is $85 per hour. The cost for the trucks removing material from the mechanical dry dredging sites would be $125 per hour. In addition, the trucks that can mobilize the materials from the hydraulic dredging can hold 20 cubic yards, while the trucks that carry the materials from both mechanical dredging processes hold 10 cubic yards, and will therefore require more trips to the landfill.

The haul costs to transport the sediment to the Garrett County Landfill or Quarry Site exceed the cost of acquiring land for disposal in each of the coves. One exception, Arrowhead Cove, could be pumped directly the Quarry Site. Overall, however, using agricultural land/open space to dispose of the material is the least expensive option. Detailed cost estimates with the varying disposal costs are in Appendix C.

Section 10: Existing Infrastructure Analysis

If dredging occurs in Deep Creek Lake, the roads will bear an additional load due to all of the dump trucks and equipment. However, it has been determined that in their current state, the roads can handle the additional load. An additional consideration is the maintenance of traffic (MOT), which will require a flagging operation with one-way traffic.

The Glendale Bridge was researched to determine the total load capacity. The bridge was found to be unrestricted, and therefore has a legal loading limit of 80,000 pounds. Based on the load capacity, it was determined that the bridge could handle dump trucks needed to transport the dredge material to the landfill or quarry site.

It is recommended that if dredging takes place, DNR will work with Garrett County and Maryland State Highway Administration (SHA) to identify the roads that will be used as haul routes and to assess the life cycle of each road. It is likely that the pavement of the road is not suited to handle the load from construction equipment. For the cost estimate, it is assumed the local/private roads will need to be tarred and chipped post construction. The roads are typically 24 feet wide with no shoulders, curbs, or gutters. The estimate assumed that the tar and chip would apply to the entire roadway. The Right of Way (ROW) is assumed to be 40 feet in the event that additional paving were to be needed; however, it is assumed ROW is not issue.

Section 11: Cost Analysis

Cost analyses were composed for all three types of dredging practices. The first scenario, Scenario 1, examines the costs related to hydraulic dredging. Scenarios 2 and 3 show costs for mechanical dredging; Scenario 2 shows the wet process and Scenario 3 shows the cost for the dry process.

The cost analyses vary due to the different types of equipment that are required for each dredging process. Hydraulic dredging will require sediment to be removed from the lake, pumped approximately one mile away to the shoreline, and processed. During the processing, the sediment will be forced through a belt filter and caked. This process is often referred to as pressing. Material that is dredged through a mechanical wet process will utilize sectional barges, while the material that is dredged through mechanical dry processes will utilize cranes and excavators. The cost of mobilizing this equipment varies, as does the cost of running the equipment, both of which result in cost estimate variations.

If the disposal site is set to be agricultural land or open space, each cove will first require acquisition of site access. It was assumed that the cost of the site acquisition would be $6,000 for each acre in the vicinity of the cove. The land will also need to be restored to original condition once dredging is complete. Most likely, this will require replacing vegetation and removing any temporary structures.

In addition, each cove will require a mobilization cost, which is $200,000 for hydraulic dredging (utilizing pumps and trucks), $100,000 for mechanical wet dredging (sectional barge and trucks), and $75,000 for mechanical dry dredging (excavators and trucks). The cost estimates are extremely sensitive to the mobilization costs associated with each practice. If wet mechanical dredging is used, it could add $4.5 million in additional costs if the coves were completed at separate times. For the purposes of this study, it is assumed that three mobilization costs are applied to the ten coves.

Once dredged, the material will need to be processed, and then hauled by truck to either the Garrett County Landfill, quarry site, or a site to be determined (located within a mile of the shoreline). Due to the varying costs to transport the sediment, the cost estimate in the following tables does not include the cost of roadway replacements or haul cost. These are included in the cost estimate in Appendix C. The cost estimate includes cleaning all equipment prior to placement in Deep Creek Lake to reduce the risk of invasive species introduction to the ecosystem.

Dredging the material will cost $25 per cubic yard for both hydraulic and mechanical wet dredging processes. The cost for mechanical dry process, however, is $55 per cubic yard. The processing fees also vary, ranging from $20 per cubic yard for hydraulic dredging to $42 per cubic yard for mechanical wet dredging. The material from the mechanical dry dredging process does not need much processing, so the cost for that operation is $5 per cubic yard.

If it is determined that dredging is required, Scenario 1 (utilization of hydraulic dredging) is cheaper than both Scenario 2 (which uses mechanical wet dredging) and Scenario 3 (mechanical dry dredging). From a cost standpoint, hydraulic dredging is the best option. A summary of the cost analysis breakdown for each scenario can be found in Tables 11.1 – 11.3.

See Appendix C for detailed cost estimates. In addition, see Appendix H for the references that are specific to the cost estimate.

Table 11.1 – Cost Estimate for Scenario 1

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS		
SCENARIO 1 - HYDRAULIC DREDGING		
ITEM DESCRIPTION		**Total Cost**
Pawn Run Cove (49,000 yd^3)	$	1,973,750.00
Penn Cove (32,100 yd^3)	$	1,173,375.00
Chadderton School Cove (30,240 yd^3)	$	1,110,600.00
Turkey Neck Cove (10,600 yd^3)	$	387,750.00
Hazelhurst Cove (32,600 yd^3)	$	1,190,250.00
Deep Creek Cove (36,800 yd^3)	$	1,332,000.00
Green Glade Cove (119,000 yd^3)	$	4,148,250.00
Arrowhead Cove (15,625 yd^3)	$	575,343.75
Poland Run Cove (17,500 yd^3)	$	650,625.00
Harvey's Peninsula Cove (18,600 yd^3)	$	687,750.00
Subtotal	$	13,229,693.75
E&S control (8%)	$	1,058,375.50
Survey/Staking (2%)	$	264,593.88
Contingency (10%)	$	1,322,969.38
TOTAL =	**$**	**15,875,632.50**

Table 11.2 – Cost Estimate for Scenario 2

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS		
SCENARIO 2 - MECHANICAL WET DREDGING		
ITEM DESCRIPTION	**Total Cost**	
Pawn Run Cove (49,000 yd^3)	$	2,682,250.00
Penn Cove (32,100 yd^3)	$	1,703,025.00
Chadderton School Cove (30,240 yd^3)	$	1,609,560.00
Turkey Neck Cove (10,600 yd^3)	$	562,650.00
Hazelhurst Cove (32,600 yd^3)	$	1,728,150.00
Deep Creek Cove (36,800 yd^3)	$	1,939,200.00
Green Glade Cove (119,000 yd^3)	$	6,111,750.00
Arrowhead Cove (15,625 yd^3)	$	833,156.25
Poland Run Cove (17,500 yd^3)	$	939,375.00
Harvey's Peninsula Cove (18,600 yd^3)	$	994,650.00
Subtotal	$	19,103,766.25
E&S control (8%)	$	1,528,301.30
Survey/Staking (2%)	$	382,075.33
Contingency (10%)	$	1,910,376.63
TOTAL =	**$**	**22,924,519.50**

Table 11.3 – Cost Estimate for Scenario 3

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS		
SCENARIO 3 - MECHANICAL DRY DREDGING		
ITEM DESCRIPTION	**Total Cost**	
Pawn Run Cove (49,000 yd^3)	$	2,400,000.00
Penn Cove (32,100 yd^3)	$	1,534,500.00
Chadderton School Cove (30,240 yd^3)	$	1,450,800.00
Turkey Neck Cove (10,600 yd^3)	$	507,000.00
Hazelhurst Cove (32,600 yd^3)	$	1,607,000.00
Deep Creek Cove (36,800 yd^3)	$	1,746,000.00
Green Glade Cove (119,000 yd^3)	$	5,487,000.00
Arrowhead Cove (15,625 yd^3)	$	763,125.00
Poland Run Cove (17,500 yd^3)	$	847,500.00
Harvey's Peninsula Cove (18,600 yd^3)	$	897,000.00
Subtotal	$	17,239,925.00
E&S control (8%)	$	1,379,194.00
Survey/Staking (2%)	$	344,798.50
Contingency (10%)	$	1,723,992.50
TOTAL =	**$**	**20,687,910.00**

Section 12: Permitting and Regulatory

The permitting and regulatory agencies could pose a problem and potentially stop any potential dredging in Deep Creek Lake. Dredging will require following an extremely strict set of regulations, which will also include following an extremely lengthy process for obtaining specific permits. Detailed studies for each cove will have to be completed in order to obtain these permits.

The permits will consist of attaining the Army Corps of Engineering Section 404 Permit and a Maryland Wetlands Permit, amongst others depending on the type of dredging performed. The permitting will take several years to complete. In addition, it is not guaranteed the project will be permitted. There must be sufficient reason to dredge according to MDE regulations.

The Section 404 permit is required for legally discharging dredged material while a wetlands permit is needed to complete any work within a wetland area. If impacts occur while performing work in wetlands, MDE requires a one to one replacement. Moreover, MDE requires a complete discussion of the proposed project within the wetlands permit application. See Appendix F for the Federal/State applications for the alteration of non-tidal wetlands.

According to a presentation given by MDE, areas impacted that are greater than 5,000 square feet will necessitate ample discussion of the following: the purpose of the project, alternatives analysis, avoidance and mitigation, water quality, endangered or sensitive species, historical preservation, and mitigation; specific issues such as the stability of lake (sediment sources, potential impacts after completion, and expected life of project), the means for water diversion and dewatering, and finally, proper disposal of the dredged material.

The specific method of dredging should be considered when discussing permitting. The following are the three types of dredging and issues of obtaining permits:

(1) *Hydraulic dredging – According to MDE, obtaining a permit for hydraulic dredging is a difficult and lengthy process.*

(2) *Mechanical dredging in the dry – Applying for a permit to mechanically dredge in the dry is difficult since this method of dredging requires the drawdown of water, which will violate the Rule Band. Going below the Rule Band will impact the Deep Creek Station, WISP & ASCI, and the lakeside property owners. Specifically for the Power Plant, this will cause generation to occur at less profitable times. Furthermore for WISP and ASCI, the drawdown of water will impact their ability to create snow during the winter months. There is also an impact to the whitewater rafting and cold fisheries if releases are not able to happen. Lastly, for the lakeside property owners, going below the rule band will cause them to lose access to the lake.*

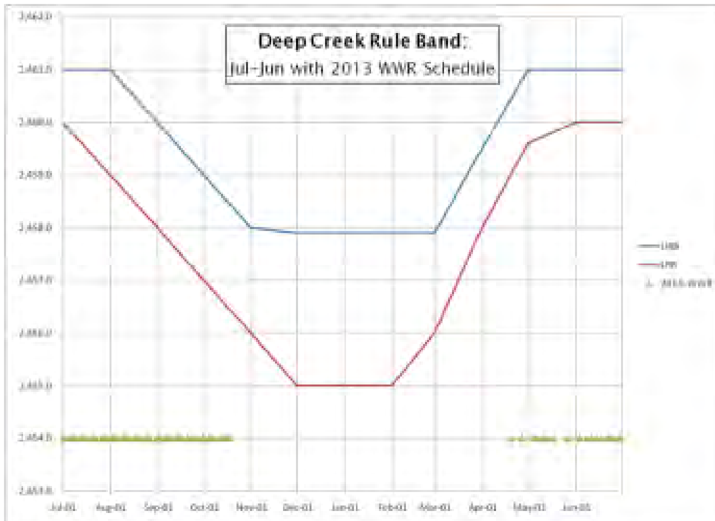


Figure 12.1 – Rule Band Elevations (taken from MDE presentation)

(3) *Mechanical dredging in the wet – The difficulty of obtaining a permit for mechanical dredging in the wet is due to MDE's requirement for a scientific stated purpose for an issue with the lake. Recreational issues were not among the qualified reasons.*

In addition to the general application process for dredging, a permit is required for the disposal site, referred to as the "Dredged Material Placement Permit". This permit would be required for either the landfill, quarry site, or any other potential site. An operational plan for the site is also mandatory for this permit application. The proposed landfill disposal site has such a plan. An operational plan for the quarry site would need to be created if chosen as the disposal location.

Section 13: Decision Matrix

The Decision Matrix weighted the following items to guide the selection for the recommendation:

- Environmental Impacts – Fish, benthic, SAV, and invasive were examined specifically. There are many species contained in each of these categories.
- Economy – Economic impacts to tourism, hotel occupancy, service industry, rental property, property value, and local economy.
- Recreation – The ability for recreational boating, fishing, whitewater rafting, and swimming to continue.
- Construction Cost – The relative cost compared to the other construction costs within the study which includes cost of ROW and permitting.

The full decision matrix can be found in Appendix J.

Section 14: Conclusions

The study reviewed the environmental, recreational, and economic impacts of removing sediment through various dredging processes. Alternatives for 1) Hydraulic Dredging, 2) Mechanical (wet) Dredging, and 3) Mechanical (dry) dredging were reviewed. Two sites were examined under these alternatives for disposal of the sediment. The no dredge/implement sediment reduction measures alternative was also reviewed. The past studies and reports, historic aerials, land uses, soils, and geology were all reviewed prior to analyzing the alternatives.

- *Currently, the lake volume is approximately 106,000 acre-feet. The sediment accumulation over the past 42 years of record has shown a decrease in lake volume of 620 acre-feet. The ten coves identified for this study only represent 168 acre-feet of sediment that would potentially be dredged. This represents only 0.16% percent of the lake volume.*
- *The Maryland Department of the Environment may not issue a permit for the project to move forward, particularly for hydraulic dredging.*
- *The increase in sediment has no observed negative impacts to the lake or ecological conditions.*
- *The lake is currently in a mesotrophic state. The loss of the SAV that follows dredging practices would negatively impact the ecosystem of the lake.*

With the no dredge/implement sediment reduction measures option, the following must be monitored:

- *Lost Tax Revenue – Garrett County will lose approximately $250,000 per year in decreased tax revenue (per data provided on 12/13/2013 by Garrett County Economic Development).*
- *Sediment accumulation – It is recommended at a minimum, every ten (10) years that a bathymetric survey is completed and sediment accumulation be reviewed.*
- *Stream condition – It is recommended stream conditions upstream of the lake are monitored using DNR MBSS.*

The following Best Management Practices are recommended in the interim to manage the sediment:

- *Monitor stream erosion rates*
- *Monitor shoreline erosion rates*
- *Monitor all development*
    - *Meet current MDE requirements for all new construction and encourage existing homeowners to retrofit properties.*
- *Enforce strict guidelines for agricultural fields.*
- *Enforce buffer strip owned by DNR around the perimeter of the lake where it was not previously enforced. The buffer strip is defined by COMAR as an area above the 2,462 feet lake elevation and not presently fenced or posted by the Department of Natural Resources to limit or exclude use by the public.*
    - *Add vegetation, remove impervious area, and create a continuous buffer strip for the entire shoreline.*

The environmental impact of not dredging is as follows:

- *There would be no immediate negative consequences for the economic, health or safety aspects of the overall community.*

- *The main effect of not dredging the lake at this time would be the continual increase of water temperature over time. The effect of this would be on the cold fish populations that need cooler waters to live and breed in. As time passes, the continual deposition of sediment would increase the lake's temperature over an extended period.*

Based on the sediment studies above the advantages to dredging the lake are few. If a dredging option were deemed necessary by the community, it is recommended that hydraulic dredging be used in the September to December and March to May time frame to minimize the environmental and recreational impact.

- *Hydraulic dredging is less expensive and has less overall impact than mechanical dredging. Both mechanical and hydraulic dredging would eliminate the SAV in the area that is dredged. The impacts to the fish species would also be the same.*
    - *Although the permitting of a hydraulic dredging operation is more difficult, other lakes within Maryland have been hydraulically dredged.*

The following environmental impacts of hydraulic dredging, if used:

- *The dredging option would require many environmental studies to determine the full impacts.*
- *There would also be the impacts to the aesthetics and recreational values while dredging operations took place.*
- *There would also be the chance that invasive species such as Eurasian watermilfoil would increase its foothold in the newly disturbed areas through fragmentation.*
- *It would also take years for dredged areas to recover biologically. Depending on the type of dredging method that is used there may also be decline in the water quality.*
- *The source of the sediment that is being deposited in the coves of Deep Creek Lake needs to be identified. Shoreline erosion over 88 years may be the main contributor to the deposition along the shoreline. Most of this is from wave action and weathering over this time. In addition, this is also a case of absent stormwater management and riparian buffer where the houses were built prior to implementation. This increase in impervious surface also increases stormwater runoff which further degrades the banks of the shoreline.*

The recommended alternative is the no dredge/implement sediment reduction measures option at this point. At current levels, sediment accumulation is not causing any major problems within Deep Creek Lake. In fact, the sediment volume that has accumulated since the dam was constructed has decreased the volume of the lake by less than one percent. Removal of the sediment accumulation via dredging would be a highly intensive and costly effort. Instead, reducing the amount of sediment inflow to Deep Creek Lake is recommended.

Reducing sediment inflow to Deep Creek Lake could be completed with several actions. These actions include monitoring the stream networks for degradation, stream restoration for impaired streams, conducting a bathymetric survey every 5-10 years, implementing BMPs across the watershed at known sediment sources, and holding all new development to standards such that no new sediment sources contribute to the lake. Together, these actions can lead to a reduction in sediment runoff to Deep Creek Lake. Therefore, the recommended course of action is to not dredge Deep Creek Lake, but to take steps to prevent further sediment runoff throughout the watershed.

APPENDIX A

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10. *Ortt, R. and Manship, V. (2011). "Deep Creek Lake Sediment Accumulation Study: A Map Reconnaissance of Selected Coves." Department of Natural Resources.* Provided by Maryland Geological Survey.
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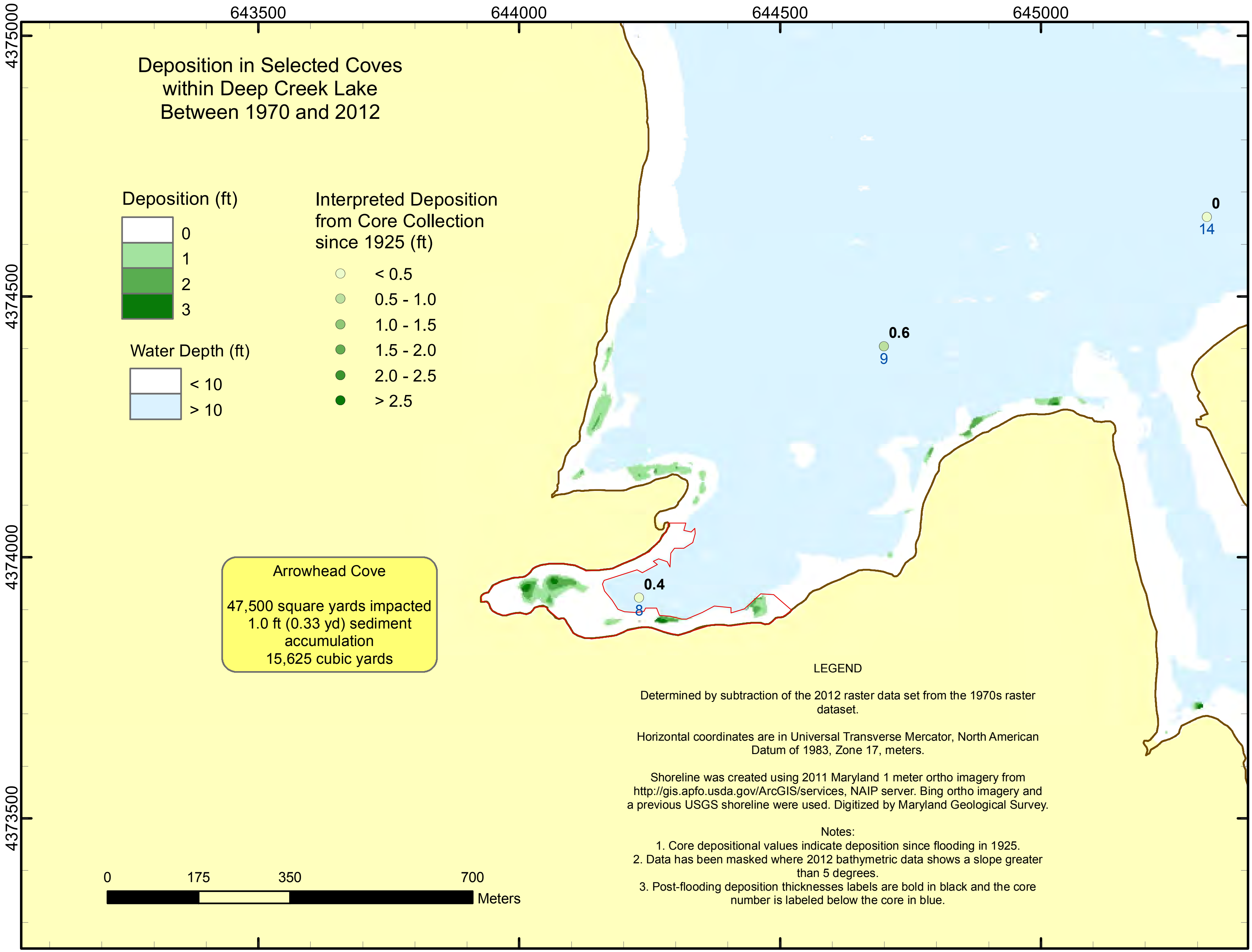
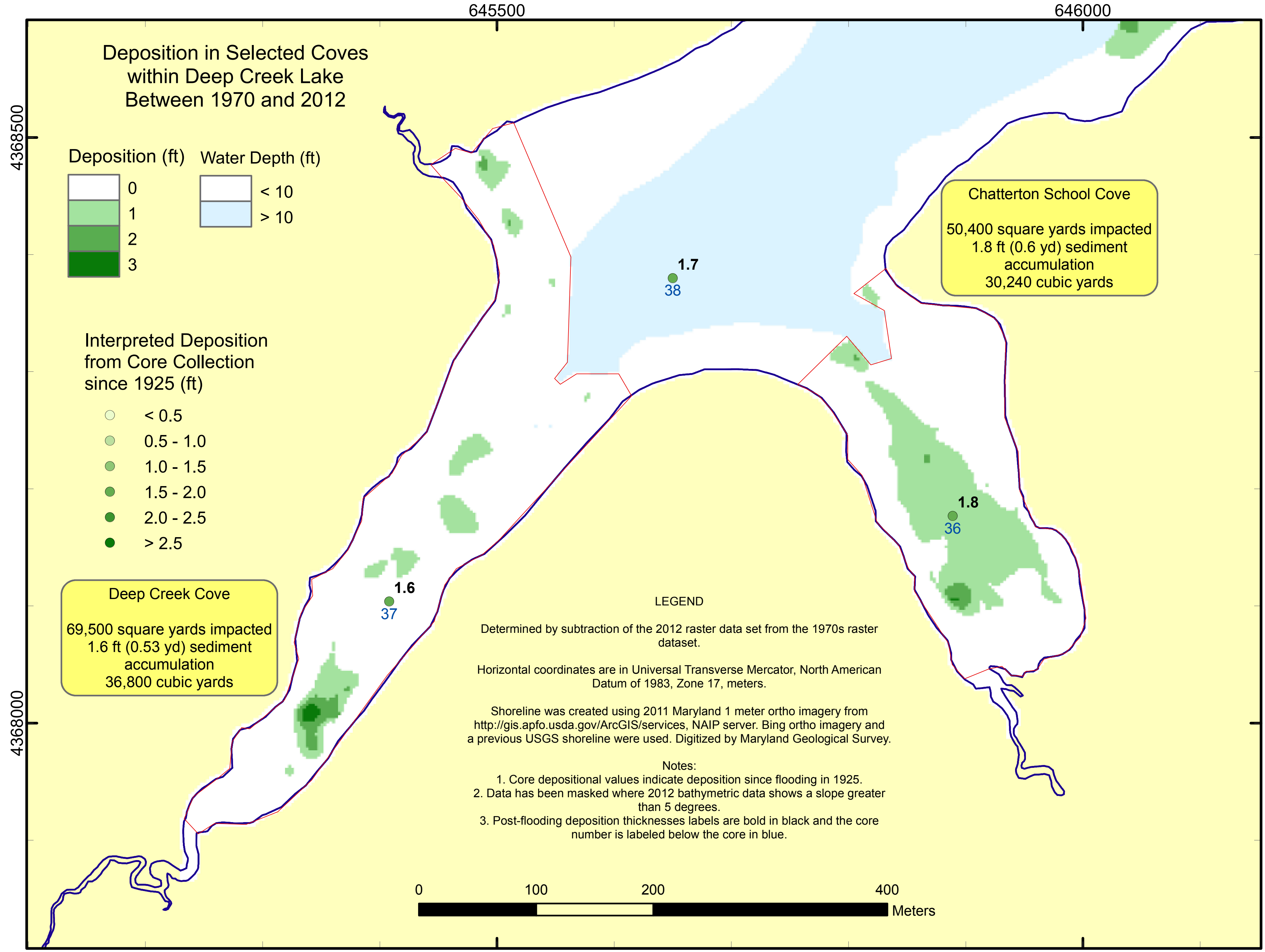
12. *Rivers, S. (2011). "Survey and Management of Maryland's Fishery Resources, Annual 2011 Performance Report". Maryland Department of Natural Resources.*
13. *United States Army Corps of Engineering. (2002). "What is Dredging?" USACE Education Center, http://education.usace.army.mil/navigation/dredging.html (June 2, 2013).*
14. *Wells, D. and Ortt, R. (2011). "Deep Creek Lake Sediment Study: Physical and Chemical Characteristics of Lake Sediments." Department of Natural Resources.* Provided by Maryland Geological Survey.

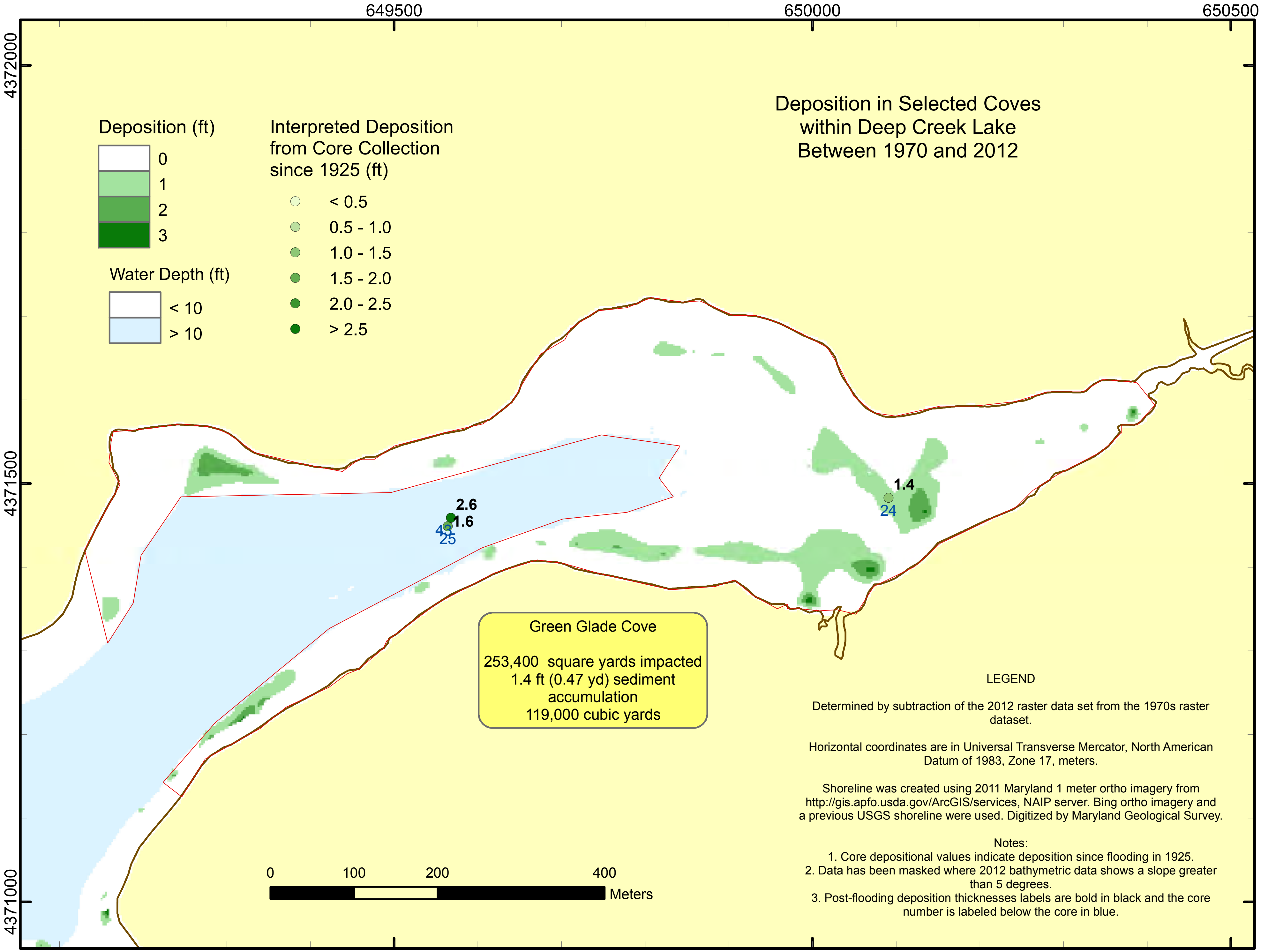
APPENDIX B

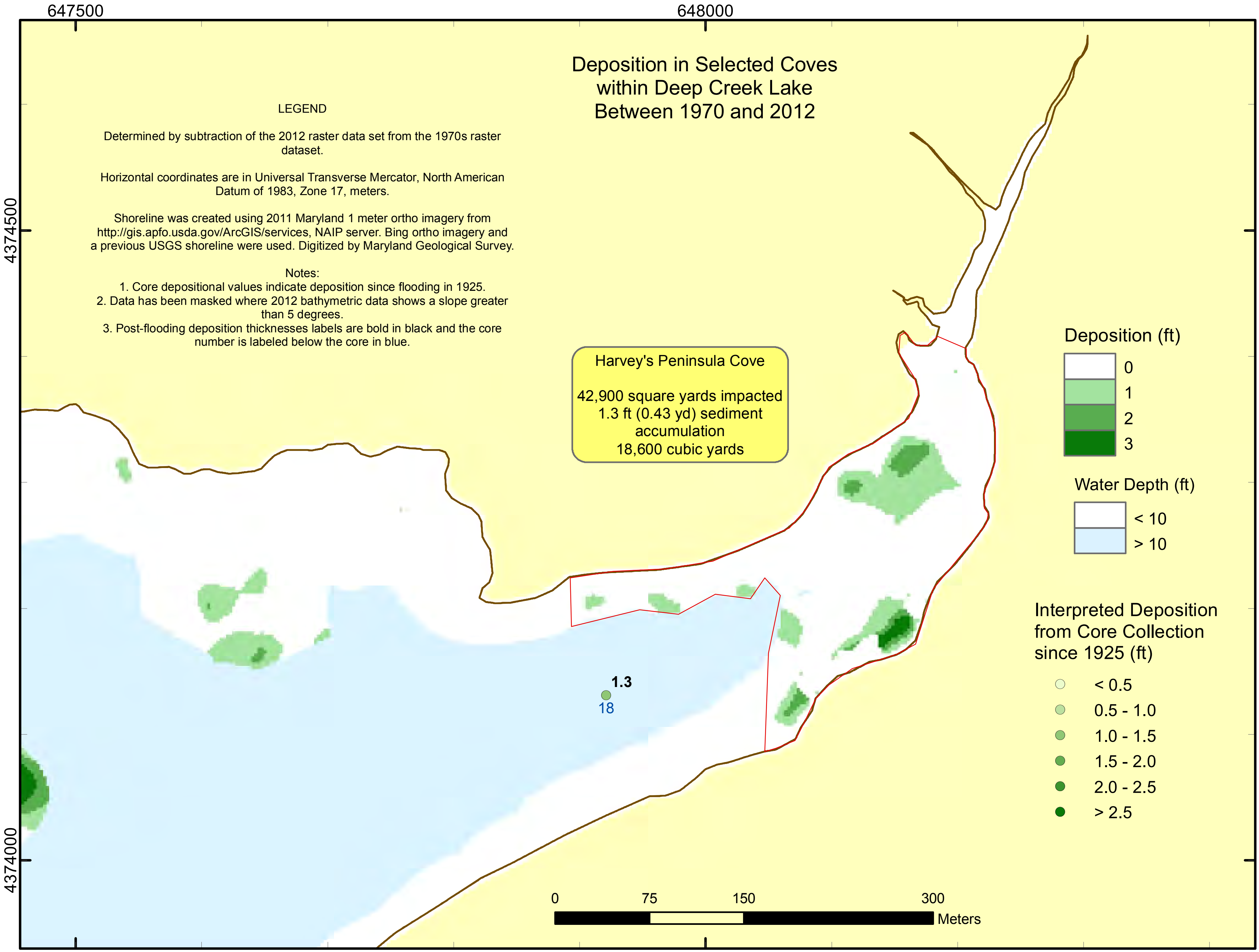
PROPOSED DREDGE SITES IN DEEP CREEK LAKE


Deposition in Selected Coves
within Deep Creek Lake
Between 1970 and 2012
643500
644000
644500
645000
4375000
4374500
4374000
4373500
Deposition (ft)
0
1
2
3
Water Depth (ft)
< 10
> 10
Interpreted Deposition
from Core Collection
since 1925 (ft)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
0
14
0.6
9
0.4
8
Arrowhead Cove
47,500 square yards impacted
1.0 ft (0.33 yd) sediment
accumulation
15,625 cubic yards
LEGEND
Determined by subtraction of the 2012 raster data set from the 1970s raster dataset.
Horizontal coordinates are in Universal Transverse Mercator, North American Datum of 1983, Zone 17, meters.
Shoreline was created using 2011 Maryland 1 meter ortho imagery from http://gis.apfo.usda.gov/ArcGIS/services, NAIP server. Bing ortho imagery and a previous USGS shoreline were used. Digitized by Maryland Geological Survey.
Notes:
1. Core depositional values indicate deposition since flooding in 1925.
2. Data has been masked where 2012 bathymetric data shows a slope greater than 5 degrees.
3. Post-flooding deposition thicknesses labels are bold in black and the core number is labeled below the core in blue.
0
175
350
700
Meters

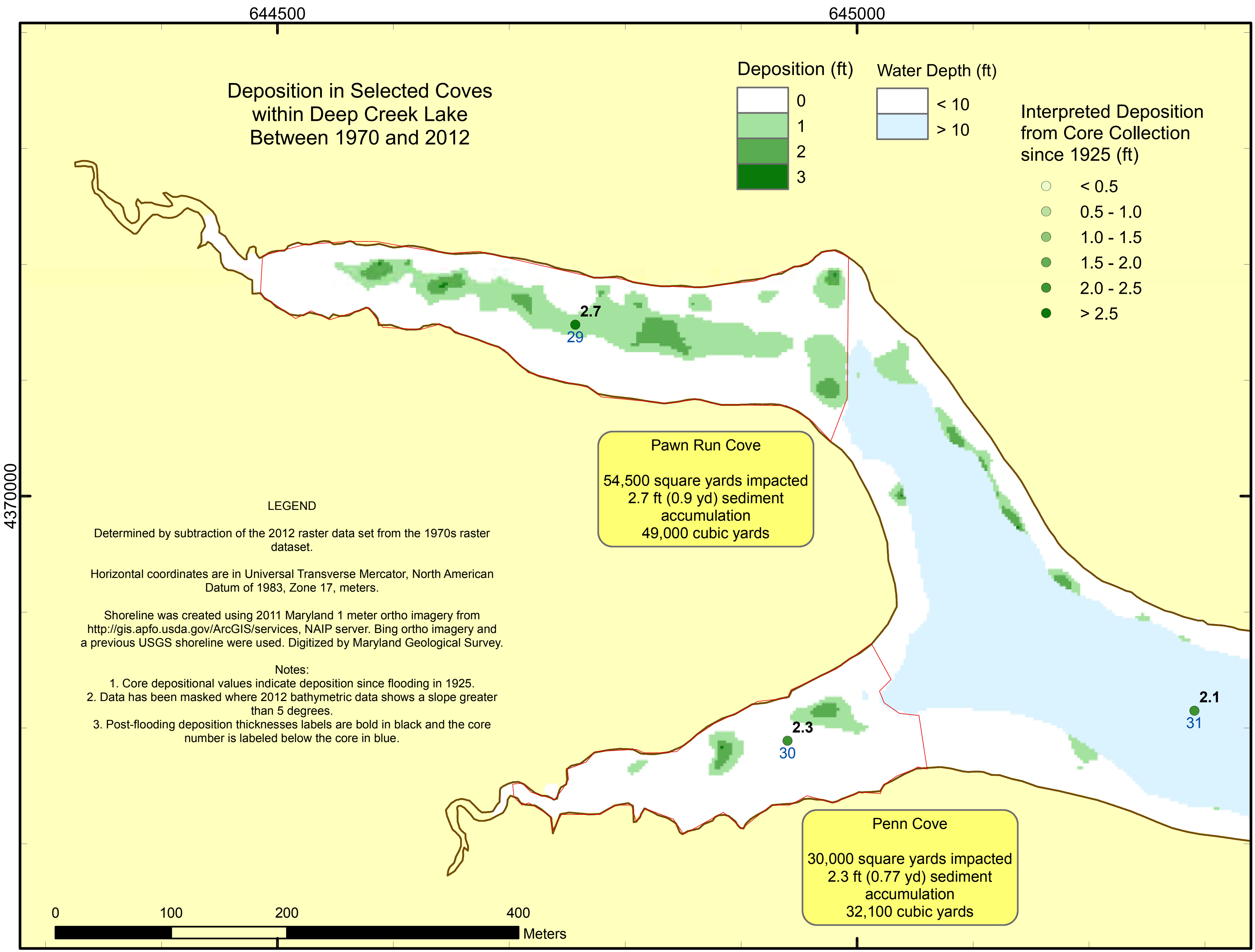


645500
646000
4368500
4368000
Deposition in Selected Coves within Deep Creek Lake Between 1970 and 2012
Deposition (ft)
0
1
2
3
Water Depth (ft)
< 10
> 10
Interpreted Deposition from Core Collection since 1925 (ft)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
Chatterton School Cove
50,400 square yards impacted
1.8 ft (0.6 yd) sediment accumulation
30,240 cubic yards
Deep Creek Cove
69,500 square yards impacted
1.6 ft (0.53 yd) sediment accumulation
36,800 cubic yards
1.7
38
1.8
36
1.6
37
LEGEND
Determined by subtraction of the 2012 raster data set from the 1970s raster dataset.
Horizontal coordinates are in Universal Transverse Mercator, North American Datum of 1983, Zone 17, meters.
Shoreline was created using 2011 Maryland 1 meter ortho imagery from http://gis.apfo.usda.gov/ArcGIS/services, NAIP server. Bing ortho imagery and a previous USGS shoreline were used. Digitized by Maryland Geological Survey.
Notes:
1. Core depositional values indicate deposition since flooding in 1925.
2. Data has been masked where 2012 bathymetric data shows a slope greater than 5 degrees.
3. Post-flooding deposition thicknesses labels are bold in black and the core number is labeled below the core in blue.
0
100
200
400
Meters

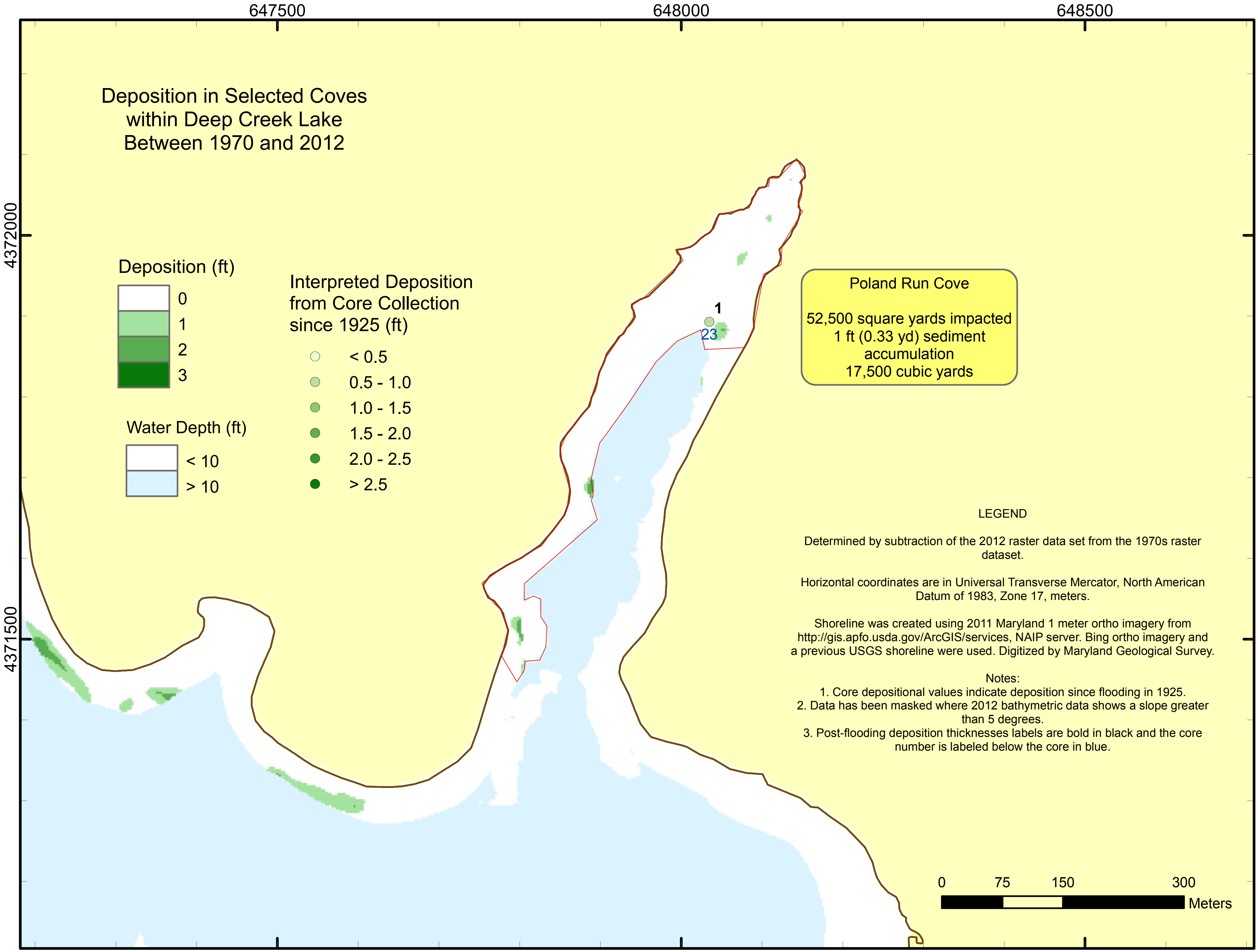

649500
650000
650500
4372000
4371500
4371000
Deposition in Selected Coves
within Deep Creek Lake
Between 1970 and 2012
Deposition (ft)
0
1
2
3
Water Depth (ft)
< 10
> 10
Interpreted Deposition
from Core Collection
since 1925 (ft)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
2.6
1.6
25
1.4
24
Green Glade Cove
253,400 square yards impacted
1.4 ft (0.47 yd) sediment
accumulation
119,000 cubic yards
0
100
200
400
Meters
LEGEND
Determined by subtraction of the 2012 raster data set from the 1970s raster dataset.
Horizontal coordinates are in Universal Transverse Mercator, North American Datum of 1983, Zone 17, meters.
Shoreline was created using 2011 Maryland 1 meter ortho imagery from http://gis.apfo.usda.gov/ArcGIS/services, NAIP server. Bing ortho imagery and a previous USGS shoreline were used. Digitized by Maryland Geological Survey.
Notes:
1. Core depositional values indicate deposition since flooding in 1925.
2. Data has been masked where 2012 bathymetric data shows a slope greater than 5 degrees.
3. Post-flooding deposition thicknesses labels are bold in black and the core number is labeled below the core in blue.

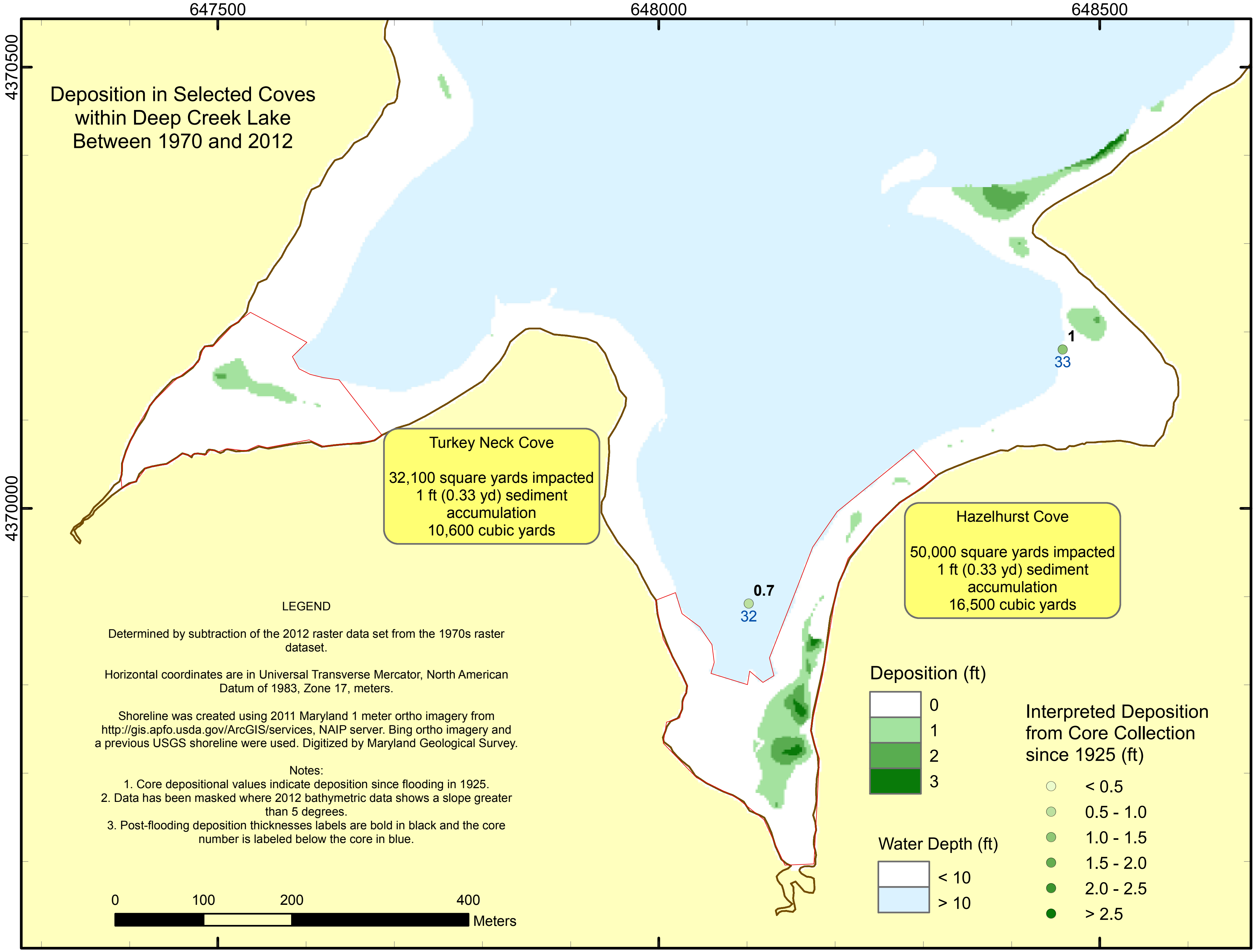


647500
648000
4374500
4374000
Deposition in Selected Coves
within Deep Creek Lake
Between 1970 and 2012
LEGEND
Determined by subtraction of the 2012 raster data set from the 1970s raster dataset.
Horizontal coordinates are in Universal Transverse Mercator, North American Datum of 1983, Zone 17, meters.
Shoreline was created using 2011 Maryland 1 meter ortho imagery from http://gis.apfo.usda.gov/ArcGIS/services, NAIP server. Bing ortho imagery and a previous USGS shoreline were used. Digitized by Maryland Geological Survey.
Notes:
1. Core depositional values indicate deposition since flooding in 1925.
2. Data has been masked where 2012 bathymetric data shows a slope greater than 5 degrees.
3. Post-flooding deposition thicknesses labels are bold in black and the core number is labeled below the core in blue.
Harvey's Peninsula Cove
42,900 square yards impacted
1.3 ft (0.43 yd) sediment accumulation
18,600 cubic yards
Deposition (ft)
0
1
2
3
Water Depth (ft)
< 10
> 10
Interpreted Deposition from Core Collection since 1925 (ft)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
1.3
18
0
75
150
300
Meters



644500
645000
4370000
Deposition in Selected Coves
within Deep Creek Lake
Between 1970 and 2012
Deposition (ft)
0
1
2
3
Water Depth (ft)
< 10
> 10
Interpreted Deposition
from Core Collection
since 1925 (ft)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
2.7
29
Pawn Run Cove
54,500 square yards impacted
2.7 ft (0.9 yd) sediment
accumulation
49,000 cubic yards
LEGEND
Determined by subtraction of the 2012 raster data set from the 1970s raster dataset.
Horizontal coordinates are in Universal Transverse Mercator, North American Datum of 1983, Zone 17, meters.
Shoreline was created using 2011 Maryland 1 meter ortho imagery from http://gis.apfo.usda.gov/ArcGIS/services, NAIP server. Bing ortho imagery and a previous USGS shoreline were used. Digitized by Maryland Geological Survey.
Notes:
1. Core depositional values indicate deposition since flooding in 1925.
2. Data has been masked where 2012 bathymetric data shows a slope greater than 5 degrees.
3. Post-flooding deposition thicknesses labels are bold in black and the core number is labeled below the core in blue.
2.3
30
2.1
31
Penn Cove
30,000 square yards impacted
2.3 ft (0.77 yd) sediment
accumulation
32,100 cubic yards
0
100
200
400
Meters


647500
648000
648500
4372000
4371500
Deposition in Selected Coves
within Deep Creek Lake
Between 1970 and 2012
Deposition (ft)
0
1
2
3
Water Depth (ft)
< 10
> 10
Interpreted Deposition
from Core Collection
since 1925 (ft)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
1
23
Poland Run Cove
52,500 square yards impacted
1 ft (0.33 yd) sediment
accumulation
17,500 cubic yards
LEGEND
Determined by subtraction of the 2012 raster data set from the 1970s raster dataset.
Horizontal coordinates are in Universal Transverse Mercator, North American Datum of 1983, Zone 17, meters.
Shoreline was created using 2011 Maryland 1 meter ortho imagery from http://gis.apfo.usda.gov/ArcGIS/services, NAIP server. Bing ortho imagery and a previous USGS shoreline were used. Digitized by Maryland Geological Survey.
Notes:
1. Core depositional values indicate deposition since flooding in 1925.
2. Data has been masked where 2012 bathymetric data shows a slope greater than 5 degrees.
3. Post-flooding deposition thicknesses labels are bold in black and the core number is labeled below the core in blue.
0
75
150
300
Meters



647500
648000
648500
4370500
4370000
Deposition in Selected Coves within Deep Creek Lake Between 1970 and 2012
Turkey Neck Cove
32,100 square yards impacted
1 ft (0.33 yd) sediment accumulation
10,600 cubic yards
Hazelhurst Cove
50,000 square yards impacted
1 ft (0.33 yd) sediment accumulation
16,500 cubic yards
1
33
0.7
32
LEGEND
Determined by subtraction of the 2012 raster data set from the 1970s raster dataset.
Horizontal coordinates are in Universal Transverse Mercator, North American Datum of 1983, Zone 17, meters.
Shoreline was created using 2011 Maryland 1 meter ortho imagery from http://gis.apfo.usda.gov/ArcGIS/services, NAIP server. Bing ortho imagery and a previous USGS shoreline were used. Digitized by Maryland Geological Survey.
Notes:
1. Core depositional values indicate deposition since flooding in 1925.
2. Data has been masked where 2012 bathymetric data shows a slope greater than 5 degrees.
3. Post-flooding deposition thicknesses labels are bold in black and the core number is labeled below the core in blue.
Deposition (ft)
0
1
2
3
Water Depth (ft)
< 10
> 10
Interpreted Deposition from Core Collection since 1925 (ft)
< 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
0
100
200
400
Meters

APPENDIX C

COST ESTIMATES

Cost Estimate Analysis

Cost analyses were composed for all three types of dredging practices. The first scenario, Scenario 1, examines the costs related to hydraulic dredging. Scenarios 2 and 3 show costs for mechanical dredging; Scenario 2 shows the wet process and Scenario 3 shows the cost for the dry process. A description of the types of dredging is listed below.

Description of dredging types

Hydraulic Dredging – Hydraulic dredges pump a mixture of dredged sediment and water from the bottom of the cove to an enclosed pipeline and then to an on-shore location. The sediment is then transported from the location to the ultimate disposal site. Other equipment needed for pipeline dredging includes a "cutterhead", which is a method to release sediment and ensure efficient removal. Additionally, this type of hydraulic dredging is fixed to a barge and then hauled to the site. This option can be cost effective due to the continuous disposal from channel bottom straight to the site (USACE).

Mechanical (Wet) Dredging – Mechanical dredging involves excavating sediment from the bottom of the lake and lifting it mechanically to the surface. Sediment is then transported via barge or truck to the disposal site. This type of dredging is known to work well in small, confined areas, specifically reservoirs, harbors, and lakes. Like hydraulic dredging, the dredged material is fixed to a barge and hauled to the disposal site. However, wet mechanical dredging can consist of two barges to be used in conjunction to make the process more continuous. With this method, mechanical dredging can be appropriate for hauling sediment long distances (USACE). Turbidity will be a concern for wet mechanical dredging and therefore turbidity curtains will be required downstream of the proposed dredging areas to reduce turbidity in deeper parts of the lake.

Mechanical (Dry) Dredging – Dry mechanical dredging involves lowering the lake to expose the sediments to drying or freezing conditions. Cofferdams or sheet piles may also be used to prevent water from the lake from entering the dredging area. Additionally, streams entering the coves will need to be diverted via pipes and/or pumps to keep the sediments dry during excavation. Conventional earthmoving equipment such as bulldozers, scrapers, backhoes, and draglines are used to remove the sediment. The equipment either works from shore or moves down onto the dewatered lakebed. The sediment may be stockpiled on shore to facilitate dewatering of the soils by gravity drainage. Within approximately three weeks the residual soil moisture should be reduced sufficiently to load onto dump trucks and hauled to a disposal location. Alternatively, the wet soils could be loaded directly onto dump trucks, but this is not recommended because more trucks will be needed and turbid water would leak from the trucks to the disposal sites.

Cost variations in the estimates

The costs that are associated with each of the types of dredging vary. A description that details the cost estimate is included in the report and is reproduced below.

If the disposal site is set to be agricultural land or open space, each cove will first require acquisition of site access. It was assumed that the cost of the site acquisition would be $6,000 for each acre in the vicinity of the cove. The land will also need to be restored to original condition once dredging is complete. Most likely, this will require replacing vegetation and removing any temporary structures.

In addition, each cove will require a mobilization cost, which is $200,000 for hydraulic dredging (utilizing pumps and trucks), $100,000 for mechanical wet dredging (sectional barge and trucks), and $75,000 for mechanical dry dredging (excavators and trucks). The cost estimates are extremely sensitive to the mobilization costs associated with each practice. If mechanical dredging is used in the wet, it could add $4.5 million in additional costs if the coves were completed at separate times. For the purposes of this study, it is assumed that three mobilization costs are applied to the ten coves.

Once dredged, the material will need to be processed, and then hauled by truck to either the Garrett County Landfill, quarry site, or a site to be determined (located within a mile of the shoreline). Due to the varying costs to transport the sediment, the cost estimate in the following tables does not include the cost of roadway replacements or haul cost. These are included in the cost estimate in Appendix D. The cost estimate includes cleaning all equipment prior to placement in Deep Creek Lake to reduce the risk of invasive species introduction to the ecosystem.

Dredging the material will cost $25 per cubic yard for both hydraulic and mechanical wet dredging processes. The cost for mechanical dry process, however, is $55 per cubic yard. The processing fees also vary, ranging from $20 per cubic yard for hydraulic dredging to $42 per cubic yard for mechanical wet dredging. The material from the mechanical dry dredging process does not need much processing, so the cost for that operation is $5 per cubic yard.

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 1 - HYDRAULIC DREDGING				
ITEM DESCRIPTION	**Unit**	**Unit/Cost**	**Total Amount**	**Total Cost**
Group 1: To Garrett County Landfill				
Pawn Run Cove (49,000 yd^3)				$ 2,445,954.00
Mobilization	LS	$ 200,000.00	1	$ 200,000.00
Dredging	CY	$ 25.00	36,750	$ 918,750.00
Processing	CY	$ 20.00	36,750	$ 735,000.00
Roadway Replacements	MI	$ 456,192.00	1.0	$ 456,192.00
Haul Cost (Hourly)	HR	$ 85.00	1,470	$ 124,984.00
Haul Cost (Per Trip)	EA	$ 6.00	1,838	$ 11,028.00
Penn Cove (32,100 yd^3)				$ 1,628,663.00
Dredging	CY	$ 25.00	24,075	$ 601,875.00
Processing	CY	$ 20.00	24,075	$ 481,500.00
Roadway Replacements	MI	$ 456,192.00	1.0	$ 456,192.00
Haul Cost (Hourly)	HR	$ 85.00	963	$ 81,872.00
Haul Cost (Per Trip)	EA	$ 6.00	1,204	$ 7,224.00
Chadderton School Cove (30,240 yd^3)				$ 2,279,696.40
Dredging	CY	$ 25.00	22,680	$ 567,000.00
Processing	CY	$ 20.00	22,680	$ 453,600.00
Roadway Replacements	MI	$ 1,140,480.00	1.0	$ 1,140,480.00
Haul Cost (Hourly)	HR	$ 85.00	1,315	$ 111,812.40
Haul Cost (Per Trip)	EA	$ 6.00	1,134	$ 6,804.00
Turkey Neck Cove (10,600 yd^3)				$ 1,741,104.70
Mobilization	LS	$ 75,000.00	1	$ 75,000.00
Dredging	CY	$ 25.00	7,950	$ 198,750.00
Processing	CY	$ 20.00	7,950	$ 159,000.00
Roadway Replacements	MI	$ 1,330,560.00	1.0	$ 1,330,560.00
Haul Cost (Hourly)	HR	$ 85.00	593	$ 50,406.70
Haul Cost (Per Trip)	EA	$ 6.00	398	$ 2,388.00
Hazelhurst Cove (32,600 yd^3)				$ 2,793,529.25
Dredging	CY	$ 25.00	24,450	$ 611,250.00
Processing	CY	$ 20.00	24,450	$ 489,000.00
Roadway Replacements	MI	$ 1,254,528.00	1.0	$ 1,254,528.00
Haul Cost (Hourly)	HR	$ 85.00	5,075	$ 431,413.25
Haul Cost (Per Trip)	EA	$ 6.00	1,223	$ 7,338.00
Deep Creek Cove (36,800 yd^3)				$ 2,526,828.00
Dredging	CY	$ 25.00	27,600	$ 690,000.00
Processing	CY	$ 20.00	27,600	$ 552,000.00
Roadway Replacements	MI	$ 1,140,480.00	1.0	$ 1,140,480.00
Haul Cost (Hourly)	HR	$ 85.00	1,601	$ 136,068.00
Haul Cost (Per Trip)	EA	$ 6.00	1,380	$ 8,280.00
Green Glade Cove (119,000 yd^3)				$ 3,442,746.60
Dredging	CY	$ 25.00	44,625	$ 1,115,625.00
Processing	CY	$ 20.00	44,625	$ 892,500.00
Roadway Replacements	MI	$ 1,121,472.00	1.0	$ 1,121,472.00
Haul Cost (Hourly)	HR	$ 85.00	3,527	$ 299,757.60
Haul Cost (Per Trip)	EA	$ 6.00	2,232	$ 13,392.00

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 1 - HYDRAULIC DREDGING				
ITEM DESCRIPTION	**Unit**	**Unit/Cost**	**Total Amount**	**Total Cost**
Group 2: To Quarry Site				
Arrowhead Cove (15,625 yd^3)				$ 607,852.15
Mobilization	LS	$ 75,000.00	1	$ 75,000.00
Dredging	CY	$ 25.00	11,719	$ 292,968.75
Processing	CY	$ 20.00	11,719	$ 234,375.00
Roadway Replacements	MI	$ -	0	$ -
Haul Cost (Hourly)	HR	$ 85.00	23	$ 1,992.40
Haul Cost (Per Trip)	EA	$ 6.00	586	$ 3,516.00
Poland Run Cove (17,500 yd^3)				$ 2,002,774.05
Dredging	CY	$ 25.00	13,125	$ 328,125.00
Processing	CY	$ 20.00	13,125	$ 262,500.00
Roadway Replacements	MI	$ 1,347,336.00	1.0	$ 1,347,336.00
Haul Cost (Hourly)	HR	$ 85.00	716	$ 60,871.05
Haul Cost (Per Trip)	EA	$ 6.00	657	$ 3,942.00
Green Glade Cove (119,000 yd^3)				$ 3,300,384.60
Dredging	CY	$ 25.00	44,625	$ 1,115,625.00
Processing	CY	$ 20.00	44,625	$ 892,500.00
Roadway Replacements	MI	$ 1,083,456.00	1.0	$ 1,083,456.00
Haul Cost (Hourly)	HR	$ 85.00	2,299	$ 195,411.60
Haul Cost (Per Trip)	EA	$ 6.00	2,232	$ 13,392.00
Harvey's Peninsula Cove (18,600 yd^3)				$ 1,220,351.50
Dredging	CY	$ 25.00	13,950	$ 348,750.00
Processing	CY	$ 20.00	13,950	$ 279,000.00
Roadway Replacements	MI	$ 567,648.00	1.0	$ 567,648.00
Haul Cost (Hourly)	HR	$ 85.00	244	$ 20,765.50
Haul Cost (Per Trip)	EA	$ 6.00	698	$ 4,188.00
			Subtotal	$ 23,989,884.25
			E&S control (8%)	$ 1,919,190.74
			Survey/Staking (2%)	$ 479,797.69
			Contingency (10%)	$ 2,398,988.43
			TOTAL =	**$ 28,787,861.10**

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 1 - HYDRAULIC DREDGING				
ITEM DESCRIPTION	**Unit**	**Unit/Cost**	**Total Amount**	**Total Cost**
Pawn Run Cove (49,000 yd^3)				$ 1,973,750.00
Mobilization	LS	$ 200,000.00	1	$ 200,000.00
Site Acquisition (20 acres)	EA	$ 6,000.00	20	$ 120,000.00
Dredging	CY	$ 25.00	36,750	$ 918,750.00
Processing	CY	$ 20.00	36,750	$ 735,000.00
Penn Cove (32,100 yd^3)				$ 1,173,375.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	24,075	$ 601,875.00
Processing	CY	$ 20.00	24,075	$ 481,500.00
Chadderton School Cove (30,240 yd^3)				$ 1,110,600.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	22,680	$ 567,000.00
Processing	CY	$ 20.00	22,680	$ 453,600.00
Turkey Neck Cove (10,600 yd^3)				$ 387,750.00
Mobilization	LS	$ 75,000.00	1	$ 75,000.00
Site Acquisition (5 acres)	EA	$ 6,000.00	5	$ 30,000.00
Dredging	CY	$ 25.00	7,950	$ 198,750.00
Processing	CY	$ 20.00	7,950	$ 159,000.00
Hazelhurst Cove (32,600 yd^3)				$ 1,190,250.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	24,450	$ 611,250.00
Processing	CY	$ 20.00	24,450	$ 489,000.00
Deep Creek Cove (36,800 yd^3)				$ 1,332,000.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	27,600	$ 690,000.00
Processing	CY	$ 20.00	27,600	$ 552,000.00
Green Glade Cove (119,000 yd^3)				$ 4,148,250.00
Site Acquisition (22 acres)	EA	$ 6,000.00	22	$ 132,000.00
Dredging	CY	$ 25.00	89,250	$ 2,231,250.00
Processing	CY	$ 20.00	89,250	$ 1,785,000.00
Arrowhead Cove (15,625 yd^3)				$ 575,343.75
Mobilization	LS	$ 75,000.00	1	$ 75,000.00
Site Acquisition (8 acres)	EA	$ 6,000.00	8	$ 48,000.00
Dredging	CY	$ 25.00	11,719	$ 292,968.75
Processing	CY	$ 20.00	11,719	$ 234,375.00
Poland Run Cove (17,500 yd^3)				$ 650,625.00
Site Acquisition (10 acres)	EA	$ 6,000.00	10	$ 60,000.00
Dredging	CY	$ 25.00	13,125	$ 328,125.00
Processing	CY	$ 20.00	13,125	$ 262,500.00
Harvey's Peninsula Cove (18,600 yd^3)				$ 687,750.00
Site Acquisition (10 acres)	EA	$ 6,000.00	10	$ 60,000.00
Dredging	CY	$ 25.00	13,950	$ 348,750.00
Processing	CY	$ 20.00	13,950	$ 279,000.00
			Subtotal	$ 13,229,693.75
			E&S control (8%)	$ 1,058,375.50
			Survey/Staking (2%)	$ 264,593.88
			Contingency (10%)	$ 1,322,969.38
			TOTAL =	**$ 15,875,632.50**

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 2 - MECHANICAL WET DREDGING				
ITEM DESCRIPTION	**Unit**	**Unit/Cost**	**Total Amount**	**Total Cost**
Group 1: To Garrett County Landfill				
Pawn Run Cove (49,000 yd^3)				$ 3,363,892.00
Mobilization	LS	$ 100,000.00	1	$ 100,000.00
Dredging	CY	$ 25.00	36,750	$ 918,750.00
Processing	CY	$ 42.00	36,750	$ 1,543,500.00
Roadway Replacements	MI	$ 456,192.00	1.0	$ 456,192.00
Haul Cost (Hourly)	HR	$ 110.00	2,940	$ 323,400.00
Haul Cost (Per Trip)	EA	$ 6.00	3,675	$ 22,050.00
Penn Cove (32,100 yd^3)				$ 2,295,569.00
Dredging	CY	$ 25.00	24,075	$ 601,875.00
Processing	CY	$ 42.00	24,075	$ 1,011,150.00
Roadway Replacements	MI	$ 456,192.00	1.0	$ 456,192.00
Haul Cost (Hourly)	HR	$ 110.00	1,926	$ 211,904.00
Haul Cost (Per Trip)	EA	$ 6.00	2,408	$ 14,448.00
Chadderton School Cove (30,240 yd^3)				$ 2,963,044.80
Dredging	CY	$ 25.00	22,680	$ 567,000.00
Processing	CY	$ 42.00	22,680	$ 952,560.00
Roadway Replacements	MI	$ 1,140,480.00	1.0	$ 1,140,480.00
Haul Cost (Hourly)	HR	$ 110.00	2,631	$ 289,396.80
Haul Cost (Per Trip)	EA	$ 6.00	2,268	$ 13,608.00
Turkey Neck Cove (10,600 yd^3)				$ 2,048,280.50
Mobilization	LS	$ 50,000.00	1	$ 50,000.00
Dredging	CY	$ 25.00	7,950	$ 198,750.00
Processing	CY	$ 42.00	7,950	$ 333,900.00
Roadway Replacements	MI	$ 1,330,560.00	1.0	$ 1,330,560.00
Haul Cost (Hourly)	HR	$ 110.00	1,185	$ 130,300.50
Haul Cost (Per Trip)	EA	$ 6.00	795	$ 4,770.00
Hazelhurst Cove (32,600 yd^3)				$ 4,023,490.50
Dredging	CY	$ 25.00	24,450	$ 611,250.00
Processing	CY	$ 42.00	24,450	$ 1,026,900.00
Roadway Replacements	MI	$ 1,254,528.00	1.0	$ 1,254,528.00
Haul Cost (Hourly)	HR	$ 110.00	10,147	$ 1,116,142.50
Haul Cost (Per Trip)	EA	$ 6.00	2,445	$ 14,670.00
Deep Creek Cove (36,800 yd^3)				$ 3,358,416.00
Dredging	CY	$ 25.00	27,600	$ 690,000.00
Processing	CY	$ 42.00	27,600	$ 1,159,200.00
Roadway Replacements	MI	$ 1,140,480.00	1.0	$ 1,140,480.00
Haul Cost (Hourly)	HR	$ 110.00	3,202	$ 352,176.00
Haul Cost (Per Trip)	EA	$ 6.00	2,760	$ 16,560.00
Green Glade Cove (119,000 yd^3)				$ 4,913,794.40
Dredging	CY	$ 25.00	44,625	$ 1,115,625.00
Processing	CY	$ 42.00	44,625	$ 1,874,250.00
Roadway Replacements	MI	$ 1,121,472.00	1.0	$ 1,121,472.00
Haul Cost (Hourly)	HR	$ 110.00	7,052	$ 775,669.40
Haul Cost (Per Trip)	EA	$ 6.00	4,463	$ 26,778.00

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 2 - MECHANICAL WET DREDGING						
ITEM DESCRIPTION	**Unit**	**Unit/Cost**		**Total Amount**	**Total Cost**	
Group 2: To Quarry Site						
Arrowhead Cove (15,625 yd^3)					$	847,345.05
Mobilization	LS	$	50,000.00	1	$	50,000.00
Dredging	CY	$	25.00	11,719	$	292,968.75
Processing	CY	$	42.00	11,719	$	492,187.50
Roadway Replacements	MI	$	-	1	$	-
Haul Cost (Hourly)	HR	$	110.00	47	$	5,156.80
Haul Cost (Per Trip)	EA	$	6.00	1,172	$	7,032.00
Poland Run Cove (17,500 yd^3)					$	2,392,017.70
Dredging	CY	$	25.00	13,125	$	328,125.00
Processing	CY	$	42.00	13,125	$	551,250.00
Roadway Replacements	MI	$	1,347,336.00	1.0	$	1,347,336.00
Haul Cost (Hourly)	HR	$	110.00	1,431	$	157,428.70
Haul Cost (Per Trip)	EA	$	6.00	1,313	$	7,878.00
Green Glade Cove (119,000 yd^3)					$	4,605,766.90
Dredging	CY	$	25.00	44,625	$	1,115,625.00
Processing	CY	$	42.00	44,625	$	1,874,250.00
Roadway Replacements	MI	$	1,083,456.00	1.0	$	1,083,456.00
Haul Cost (Hourly)	HR	$	110.00	4,597	$	505,657.90
Haul Cost (Per Trip)	EA	$	6.00	4,463	$	26,778.00
Harvey's Peninsula Cove (18,600 yd^3)					$	1,564,375.50
Dredging	CY	$	25.00	13,950	$	348,750.00
Processing	CY	$	42.00	13,950	$	585,900.00
Roadway Replacements	MI	$	567,648.00	1.0	$	567,648.00
Haul Cost (Hourly)	HR	$	110.00	488	$	53,707.50
Haul Cost (Per Trip)	EA	$	6.00	1,395	$	8,370.00
				Subtotal	$	32,375,992.35
				E&S control (8%)	$	2,590,079.39
				Survey/Staking (2%)	$	647,519.85
				Contingency (10%)	$	3,237,599.24
				TOTAL =	**$**	**38,851,190.82**

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS
SCENARIO 2 - MECHANICAL WET DREDGING

ITEM DESCRIPTION	Unit	Unit/Cost	Total Amount	Total Cost
Pawn Run Cove (49,000 yd^3)				$ 2,682,250.00
Mobilization	LS	$ 100,000.00	1	$ 100,000.00
Site Acquisition (20 acres)	EA	$ 6,000.00	20	$ 120,000.00
Dredging	CY	$ 25.00	36,750	$ 918,750.00
Processing	CY	$ 42.00	36,750	$ 1,543,500.00
Penn Cove (32,100 yd^3)				$ 1,703,025.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	24,075	$ 601,875.00
Processing	CY	$ 42.00	24,075	$ 1,011,150.00
Chadderton School Cove (30,240 yd^3)				$ 1,609,560.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	22,680	$ 567,000.00
Processing	CY	$ 42.00	22,680	$ 952,560.00
Turkey Neck Cove (10,600 yd^3)				$ 562,650.00
Mobilization	LS	$ 50,000.00	1	$ 50,000.00
Site Acquisition (5 acres)	EA	$ 6,000.00	5	$ 30,000.00
Dredging	CY	$ 25.00	7,950	$ 198,750.00
Processing	CY	$ 42.00	7,950	$ 333,900.00
Hazelhurst Cove (32,600 yd^3)				$ 1,728,150.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	24,450	$ 611,250.00
Processing	CY	$ 42.00	24,450	$ 1,026,900.00
Deep Creek Cove (36,800 yd^3)				$ 1,939,200.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 25.00	27,600	$ 690,000.00
Processing	CY	$ 42.00	27,600	$ 1,159,200.00
Green Glade Cove (119,000 yd^3)				$ 6,111,750.00
Site Acquisition (22 acres)	EA	$ 6,000.00	22	$ 132,000.00
Dredging	CY	$ 25.00	89,250	$ 2,231,250.00
Processing	CY	$ 42.00	89,250	$ 3,748,500.00
Arrowhead Cove (15,625 yd^3)				$ 833,156.25
Mobilization	LS	$ 50,000.00	1	$ 50,000.00
Site Acquisition (8 acres)	EA	$ 6,000.00	8	$ 48,000.00
Dredging	CY	$ 25.00	11,719	$ 292,968.75
Processing	CY	$ 42.00	11,719	$ 492,187.50
Poland Run Cove (17,500 yd^3)				$ 939,375.00
Site Acquisition (10 acres)	EA	$ 6,000.00	10	$ 60,000.00
Dredging	CY	$ 25.00	13,125	$ 328,125.00
Processing	CY	$ 42.00	13,125	$ 551,250.00
Harvey's Peninsula Cove (18,600 yd^3)				$ 994,650.00
Site Acquisition (10 acres)	EA	$ 6,000.00	10	$ 60,000.00
Dredging	CY	$ 25.00	13,950	$ 348,750.00
Processing	CY	$ 42.00	13,950	$ 585,900.00
			Subtotal	$ 19,103,766.25
			E&S control (8%)	$ 1,528,301.30
			Survey/Staking (2%)	$ 382,075.33
			Contingency (10%)	$ 1,910,376.63
			TOTAL =	**$ 22,924,519.50**

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 3 - MECHANICAL DRY DREDGING				
ITEM DESCRIPTION	**Unit**	**Unit/Cost**	**Total Amount**	**Total Cost**
Group 1: To Garrett County Landfill				
Pawn Run Cove (49,000 yd^3)				$ 3,125,742.00
Mobilization	LS	$ 75,000.00	1	$ 75,000.00
Dredging	CY	$ 55.00	36,750	$ 2,021,250.00
Processing	CY	$ 5.00	36,750	$ 183,750.00
Roadway Replacements	MI	$ 456,192.00	1.0	$ 456,192.00
Haul Cost (Hourly)	HR	$ 125.00	2,940	$ 367,500.00
Haul Cost (Per Trip)	EA	$ 6.00	3,675	$ 22,050.00
Penn Cove (32,100 yd^3)				$ 2,155,940.00
Dredging	CY	$ 55.00	24,075	$ 1,324,125.00
Processing	CY	$ 5.00	24,075	$ 120,375.00
Roadway Replacements	MI	$ 456,192.00	1.0	$ 456,192.00
Haul Cost (Hourly)	HR	$ 125.00	1,926	$ 240,800.00
Haul Cost (Per Trip)	EA	$ 6.00	2,408	$ 14,448.00
Chadderton School Cove (30,240 yd^3)				$ 2,843,748.00
Dredging	CY	$ 55.00	22,680	$ 1,247,400.00
Processing	CY	$ 5.00	22,680	$ 113,400.00
Roadway Replacements	MI	$ 1,140,480.00	1.0	$ 1,140,480.00
Haul Cost (Hourly)	HR	$ 125.00	2,631	$ 328,860.00
Haul Cost (Per Trip)	EA	$ 6.00	2,268	$ 13,608.00
Turkey Neck Cove (10,600 yd^3)				$ 1,960,398.75
Dredging	CY	$ 55.00	7,950	$ 437,250.00
Processing	CY	$ 5.00	7,950	$ 39,750.00
Roadway Replacements	MI	$ 1,330,560.00	1.0	$ 1,330,560.00
Haul Cost (Hourly)	HR	$ 125.00	1,185	$ 148,068.75
Haul Cost (Per Trip)	EA	$ 6.00	795	$ 4,770.00
Hazelhurst Cove (32,600 yd^3)				$ 4,054,541.75
Mobilization	LS	$ 50,000.00	1	$ 50,000.00
Dredging	CY	$ 55.00	24,450	$ 1,344,750.00
Processing	CY	$ 5.00	24,450	$ 122,250.00
Roadway Replacements	MI	$ 1,254,528.00	1.0	$ 1,254,528.00
Haul Cost (Hourly)	HR	$ 125.00	10,147	$ 1,268,343.75
Haul Cost (Per Trip)	EA	$ 6.00	2,445	$ 14,670.00
Deep Creek Cove (36,800 yd^3)				$ 3,213,240.00
Dredging	CY	$ 55.00	27,600	$ 1,518,000.00
Processing	CY	$ 5.00	27,600	$ 138,000.00
Roadway Replacements	MI	$ 1,140,480.00	1.0	$ 1,140,480.00
Haul Cost (Hourly)	HR	$ 125.00	3,202	$ 400,200.00
Haul Cost (Per Trip)	EA	$ 6.00	2,760	$ 16,560.00
Green Glade Cove (119,000 yd^3)				$ 4,707,192.50
Dredging	CY	$ 55.00	44,625	$ 2,454,375.00
Processing	CY	$ 5.00	44,625	$ 223,125.00
Roadway Replacements	MI	$ 1,121,472.00	1.0	$ 1,121,472.00
Haul Cost (Hourly)	HR	$ 125.00	7,052	$ 881,442.50
Haul Cost (Per Trip)	EA	$ 6.00	4,463	$ 26,778.00

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 3 - MECHANICAL DRY DREDGING				
ITEM DESCRIPTION	**Unit**	**Unit/Cost**	**Total Amount**	**Total Cost**
Group 2: To Quarry Site				
Arrowhead Cove (15,625 yd^3)				$ 766,017.00
Mobilization	LS	$ 50,000.00	1	$ 50,000.00
Dredging	CY	$ 55.00	11,719	$ 644,531.25
Processing	CY	$ 5.00	11,719	$ 58,593.75
Roadway Replacements	MI	$ -	1	$ -
Haul Cost (Hourly)	HR	$ 125.00	47	$ 5,860.00
Haul Cost (Per Trip)	EA	$ 6.00	1,172	$ 7,032.00
Poland Run Cove (17,500 yd^3)				$ 2,321,610.25
Dredging	CY	$ 55.00	13,125	$ 721,875.00
Processing	CY	$ 5.00	13,125	$ 65,625.00
Roadway Replacements	MI	$ 1,347,336.00	1.0	$ 1,347,336.00
Haul Cost (Hourly)	HR	$ 125.00	1,431	$ 178,896.25
Haul Cost (Per Trip)	EA	$ 6.00	1,313	$ 7,878.00
Green Glade Cove (119,000 yd^3)				$ 4,362,345.25
Dredging	CY	$ 55.00	44,625	$ 2,454,375.00
Processing	CY	$ 5.00	44,625	$ 223,125.00
Roadway Replacements	MI	$ 1,083,456.00	1.0	$ 1,083,456.00
Haul Cost (Hourly)	HR	$ 125.00	4,597	$ 574,611.25
Haul Cost (Per Trip)	EA	$ 6.00	4,463	$ 26,778.00
Harvey's Peninsula Cove (18,600 yd^3)				$ 1,474,049.25
Dredging	CY	$ 55.00	13,950	$ 767,250.00
Processing	CY	$ 5.00	13,950	$ 69,750.00
Roadway Replacements	MI	$ 567,648.00	1.0	$ 567,648.00
Haul Cost (Hourly)	HR	$ 125.00	488	$ 61,031.25
Haul Cost (Per Trip)	EA	$ 6.00	1,395	$ 8,370.00
			Subtotal	$ 30,984,824.75
			E&S control (8%)	$ 2,478,785.98
			Survey/Staking (2%)	$ 619,696.50
			Contingency (10%)	$ 3,098,482.48
			TOTAL =	**$ 37,181,789.70**

DEEP CREEK LAKE - ALTERNATIVE ANALYSIS SCENARIO 3 - MECHANICAL DRY DREDGING				
ITEM DESCRIPTION	**Unit**	**Unit/Cost**	**Total Amount**	**Total Cost**
Pawn Run Cove (49,000 yd^3)				$ 2,400,000.00
Mobilization	LS	$ 75,000.00	1	$ 75,000.00
Site Acquisition (20 acres)	EA	$ 6,000.00	20	$ 120,000.00
Dredging	CY	$ 55.00	36,750	$ 2,021,250.00
Processing	CY	$ 5.00	36,750	$ 183,750.00
Penn Cove (32,100 yd^3)				$ 1,534,500.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 55.00	24,075	$ 1,324,125.00
Processing	CY	$ 5.00	24,075	$ 120,375.00
Chadderton School Cove (30,240 yd^3)				$ 1,450,800.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 55.00	22,680	$ 1,247,400.00
Processing	CY	$ 5.00	22,680	$ 113,400.00
Turkey Neck Cove (10,600 yd^3)				$ 507,000.00
Site Acquisition (5 acres)	EA	$ 6,000.00	5	$ 30,000.00
Dredging	CY	$ 55.00	7,950	$ 437,250.00
Processing	CY	$ 5.00	7,950	$ 39,750.00
Hazelhurst Cove (32,600 yd^3)				$ 1,607,000.00
Mobilization	LS	$ 50,000.00	1	$ 50,000.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 55.00	24,450	$ 1,344,750.00
Processing	CY	$ 5.00	24,450	$ 122,250.00
Deep Creek Cove (36,800 yd^3)				$ 1,746,000.00
Site Acquisition (15 acres)	EA	$ 6,000.00	15	$ 90,000.00
Dredging	CY	$ 55.00	27,600	$ 1,518,000.00
Processing	CY	$ 5.00	27,600	$ 138,000.00
Green Glade Cove (119,000 yd^3)				$ 5,487,000.00
Site Acquisition (22 acres)	EA	$ 6,000.00	22	$ 132,000.00
Dredging	CY	$ 55.00	89,250	$ 4,908,750.00
Processing	CY	$ 5.00	89,250	$ 446,250.00
Arrowhead Cove (15,625 yd^3)				$ 763,125.00
Mobilization	LS	$ 50,000.00	1	$ 50,000.00
Site Acquisition (8 acres)	EA	$ 6,000.00	10	$ 60,000.00
Dredging	CY	$ 55.00	11,719	$ 644,531.25
Processing	CY	$ 5.00	11,719	$ 58,593.75
Poland Run Cove (17,500 yd^3)				$ 847,500.00
Site Acquisition (10 acres)	EA	$ 6,000.00	10	$ 60,000.00
Dredging	CY	$ 55.00	13,125	$ 721,875.00
Processing	CY	$ 5.00	13,125	$ 65,625.00
Harvey's Peninsula Cove (18,600 yd^3)				$ 897,000.00
Site Acquisition (10 acres)	EA	$ 6,000.00	10	$ 60,000.00
Dredging	CY	$ 55.00	13,950	$ 767,250.00
Processing	CY	$ 5.00	13,950	$ 69,750.00
			Subtotal	$ 17,239,925.00
			E&S control (8%)	$ 1,379,194.00
			Survey/Staking (2%)	$ 344,798.50
			Contingency (10%)	$ 1,723,992.50
			TOTAL =	**$ 20,687,910.00**

APPENDIX D

HISTORICAL RECORDS OF RECREATIONAL USERS

WBCM
ARCHITECTURE ENGINEERING CONSTRUCTION

Charles Griffith

From: Null, Eric <ENull@dnr.state.md.us>
Sent: Wednesday, October 02, 2013 11:21 AM
To: Charles Griffith
Subject: RE: Daily Launch Ramp Fee Counts for Deep Creek Lake

The aerial counts were only done from July 4th to Labor Day but I have a monthly average for October 145, November 45 and April 32. December, January, February, and March we are usually iced over.

Eric Null
Natural Resource Planner III
Deep Creek Lake NRMA
898 State Park Road
Swanton, MD 21561
301-387-4111

From: Charles Griffith [mailto:cgriffith@wbcm.com]
Sent: Wednesday, October 02, 2013 11:18 AM
To: Null, Eric
Cc: Ortt, Richard; Mostafa Izadi; Hurt, Michele
Subject: RE: Daily Launch Ramp Fee Counts for Deep Creek Lake

Is there any information available for non-peak season? The aerial counts were also during peak seasons.

From: Null, Eric [mailto:ENull@dnr.state.md.us]
Sent: Wednesday, October 02, 2013 11:15 AM
To: Charles Griffith
Subject: RE: Daily Launch Ramp Fee Counts for Deep Creek Lake

I have a yearly average of 2700 boats that launch from our ramp. Monthly three year averages for the peak season are May 359, June 542, July 758, August 522, Sept 260. As far as daily boat counts that survey the whole lake they would be our aerial counts.

Eric Null
Natural Resource Planner III
Deep Creek Lake NRMA
898 State Park Road
Swanton, MD 21561
301-387-4111

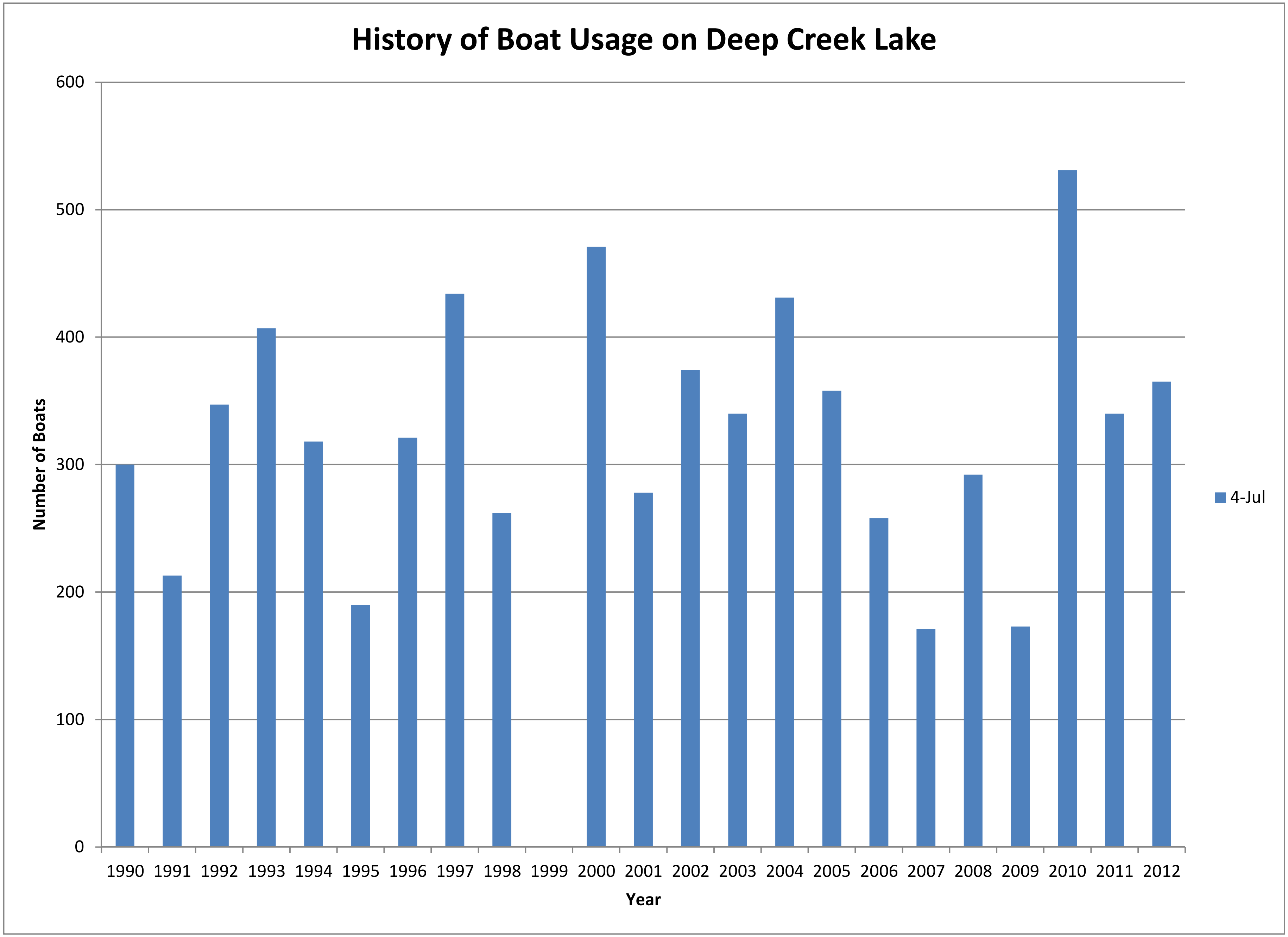
From: Charles Griffith [mailto:cgriffith@wbcm.com]
Sent: Wednesday, September 25, 2013 3:24 PM
To: Null, Eric
Cc: Mostafa Izadi; Ortt, Richard
Subject: Daily Launch Ramp Fee Counts for Deep Creek Lake

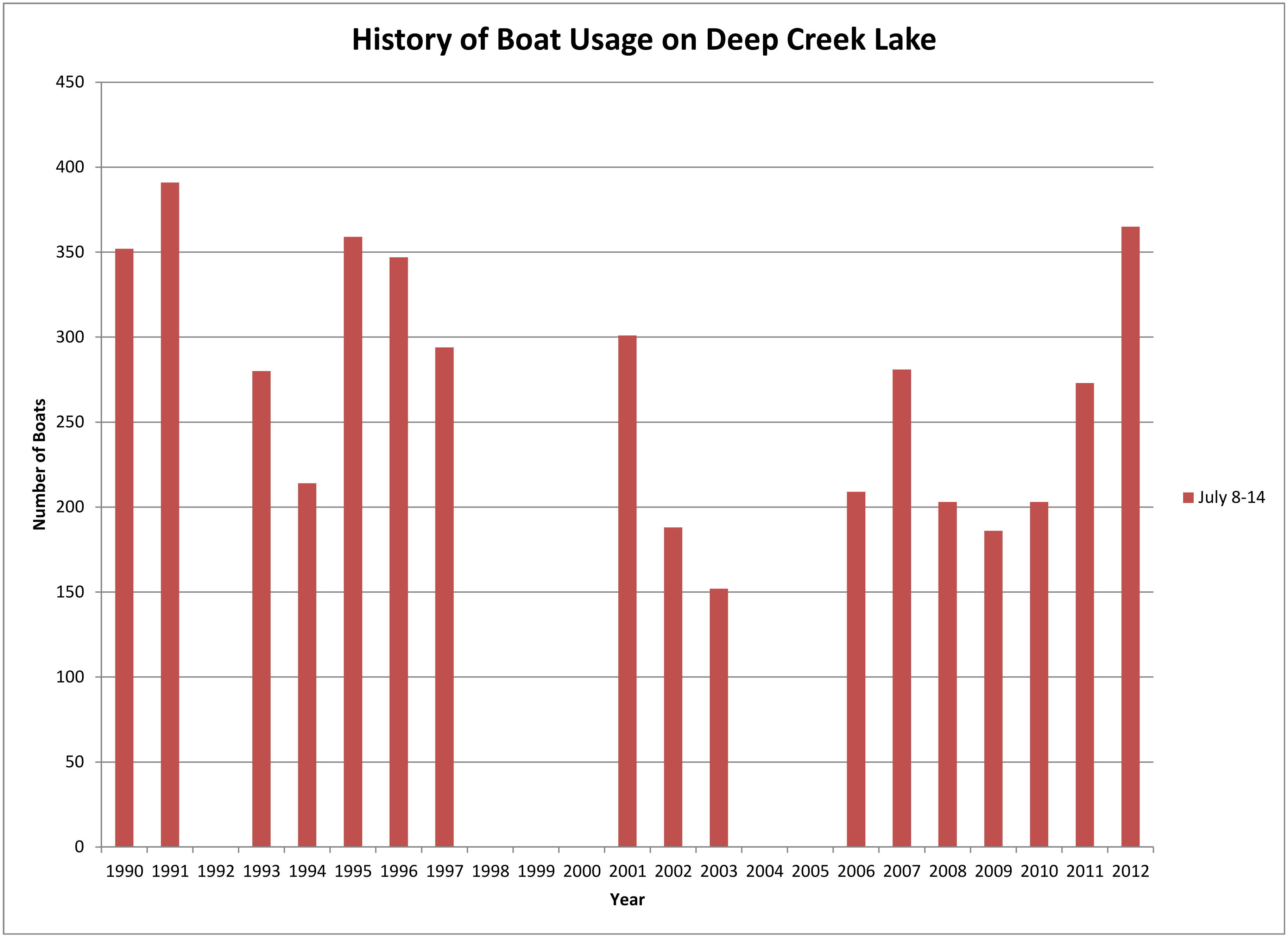
Eric,
Richard mentioned that there should be daily counts based off the launch ramp fees paid. If it is possible, could you provide these counts for the last three years. Thanks.

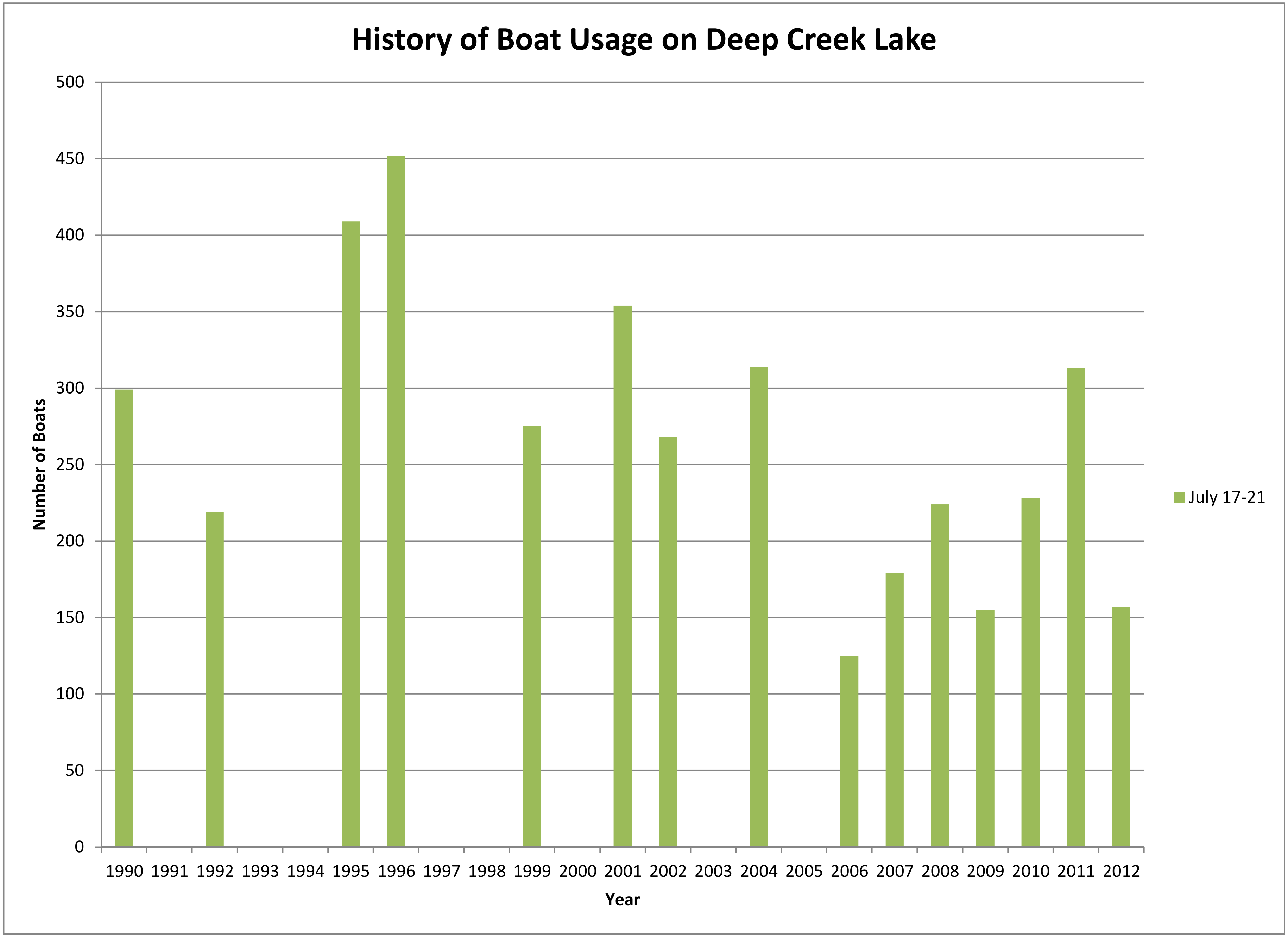
-Charlie

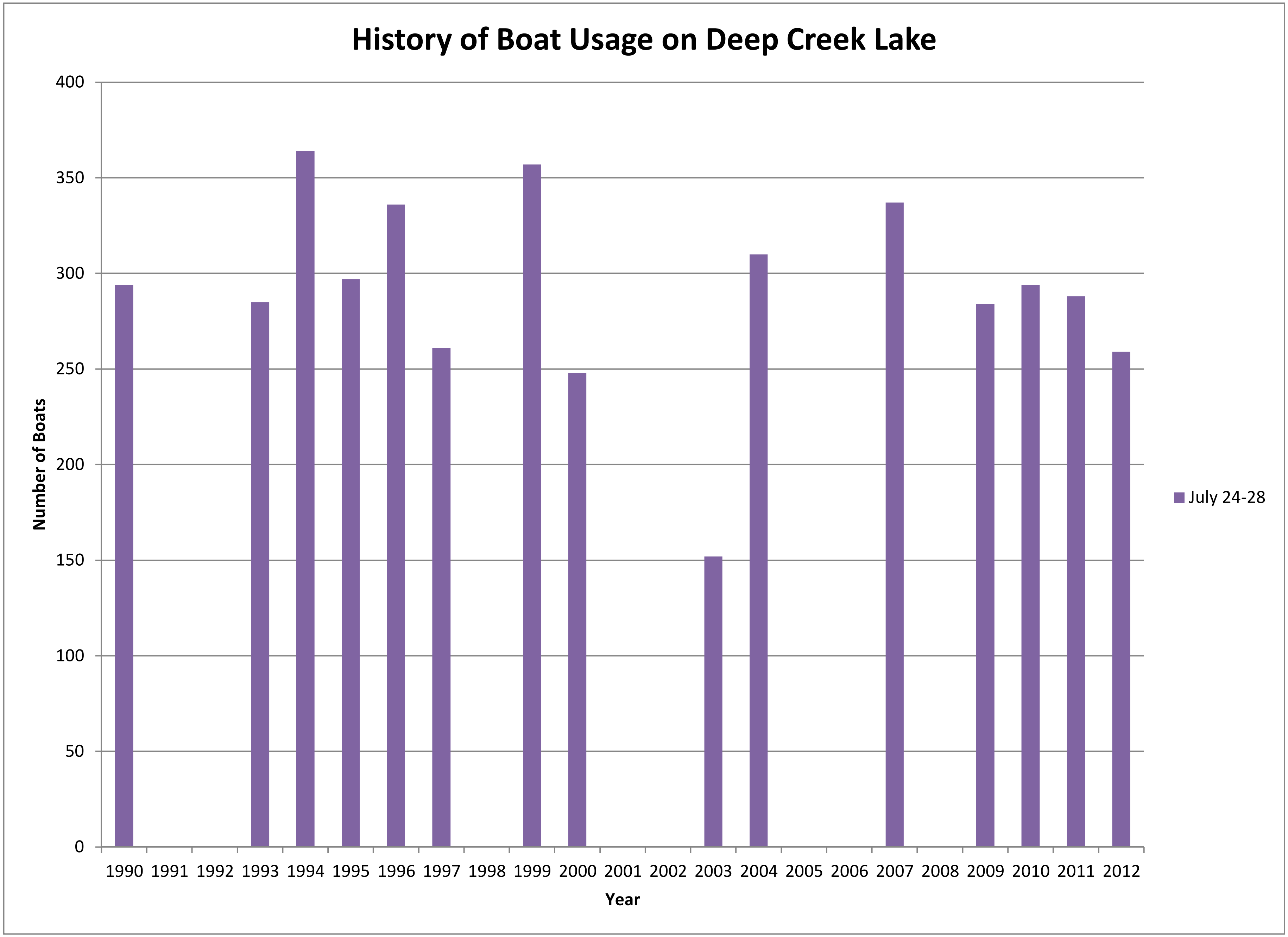
Charles Griffith, P. E.
Project Manager***, Environmental Water Resources***

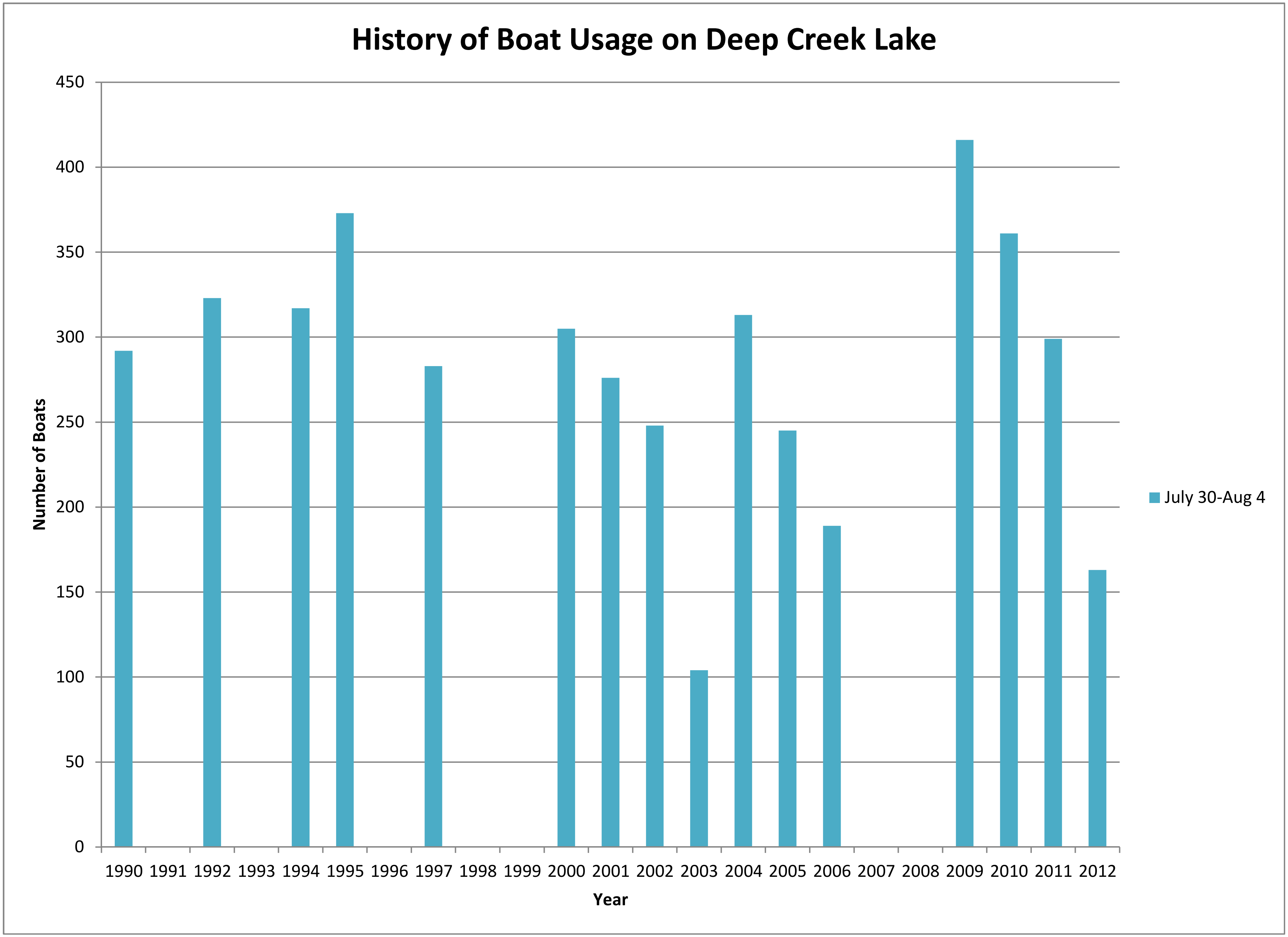
WHITNEY BAILEY COX & MAGNANI, LLC
849 Fairmount Ave Suite 100 Baltimore, MD 21286
MAIN 410.512.4500 DIRECT 410-512-4557 FAX 410.324.4100


History of Boat Usage on Deep Creek Lake
Number of Boats
600
500
400
300
200
100
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
4-Jul

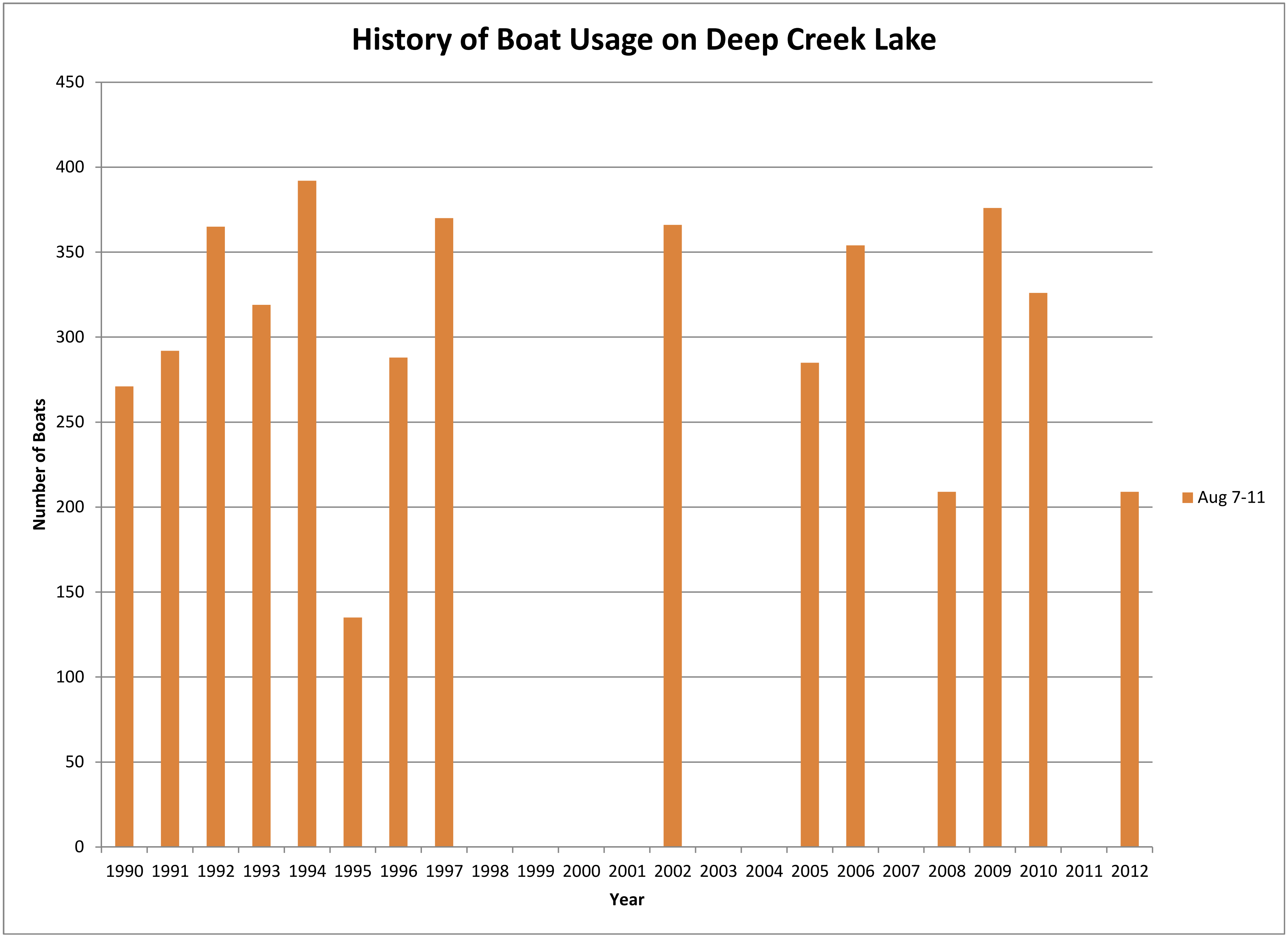

History of Boat Usage on Deep Creek Lake
Number of Boats
0
50
100
150
200
250
300
350
400
450
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
July 8-14


History of Boat Usage on Deep Creek Lake
Number of Boats
0
50
100
150
200
250
300
350
400
450
500
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
July 17-21

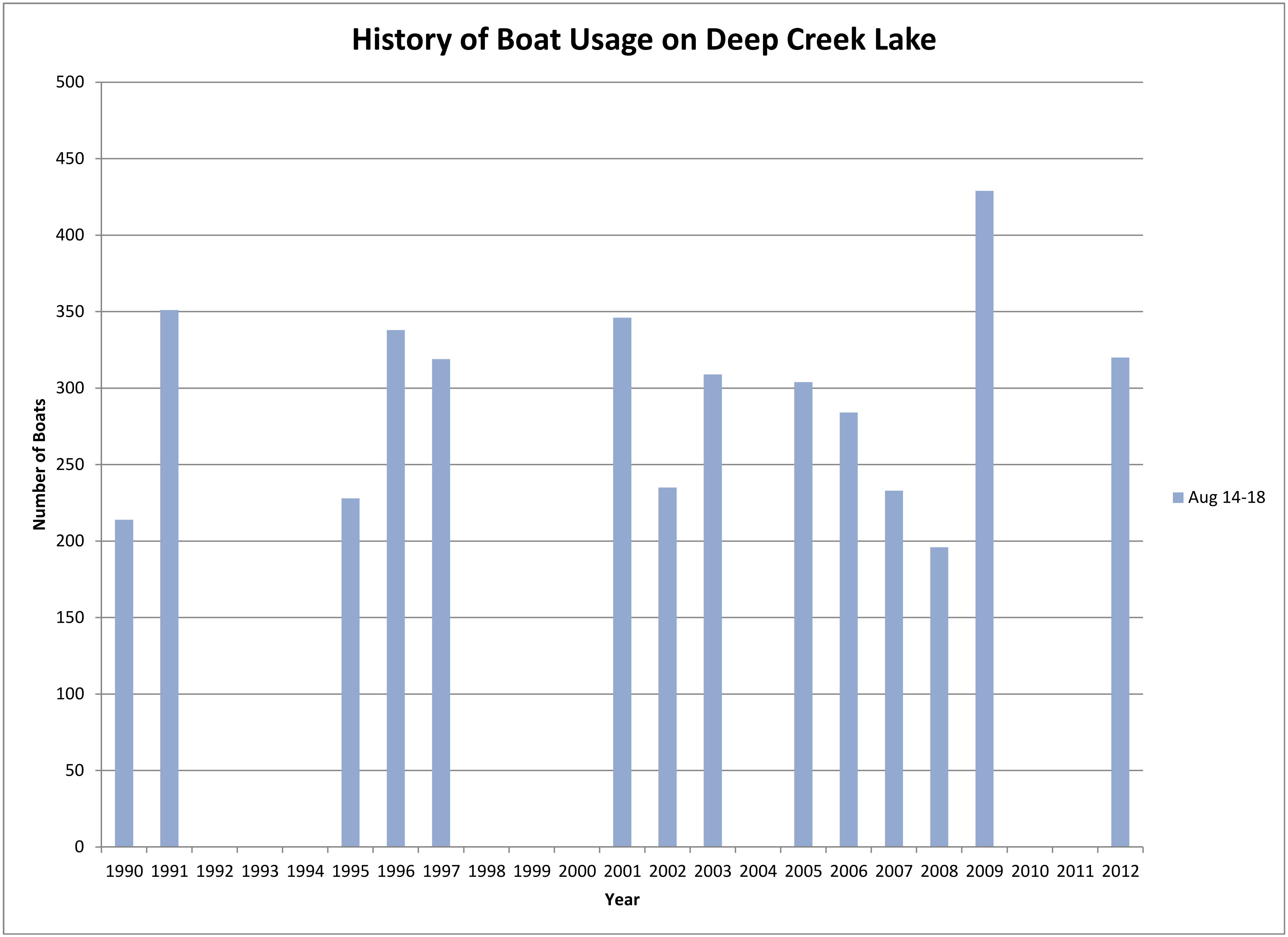

History of Boat Usage on Deep Creek Lake
Number of Boats
0
50
100
150
200
250
300
350
400
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
July 24-28



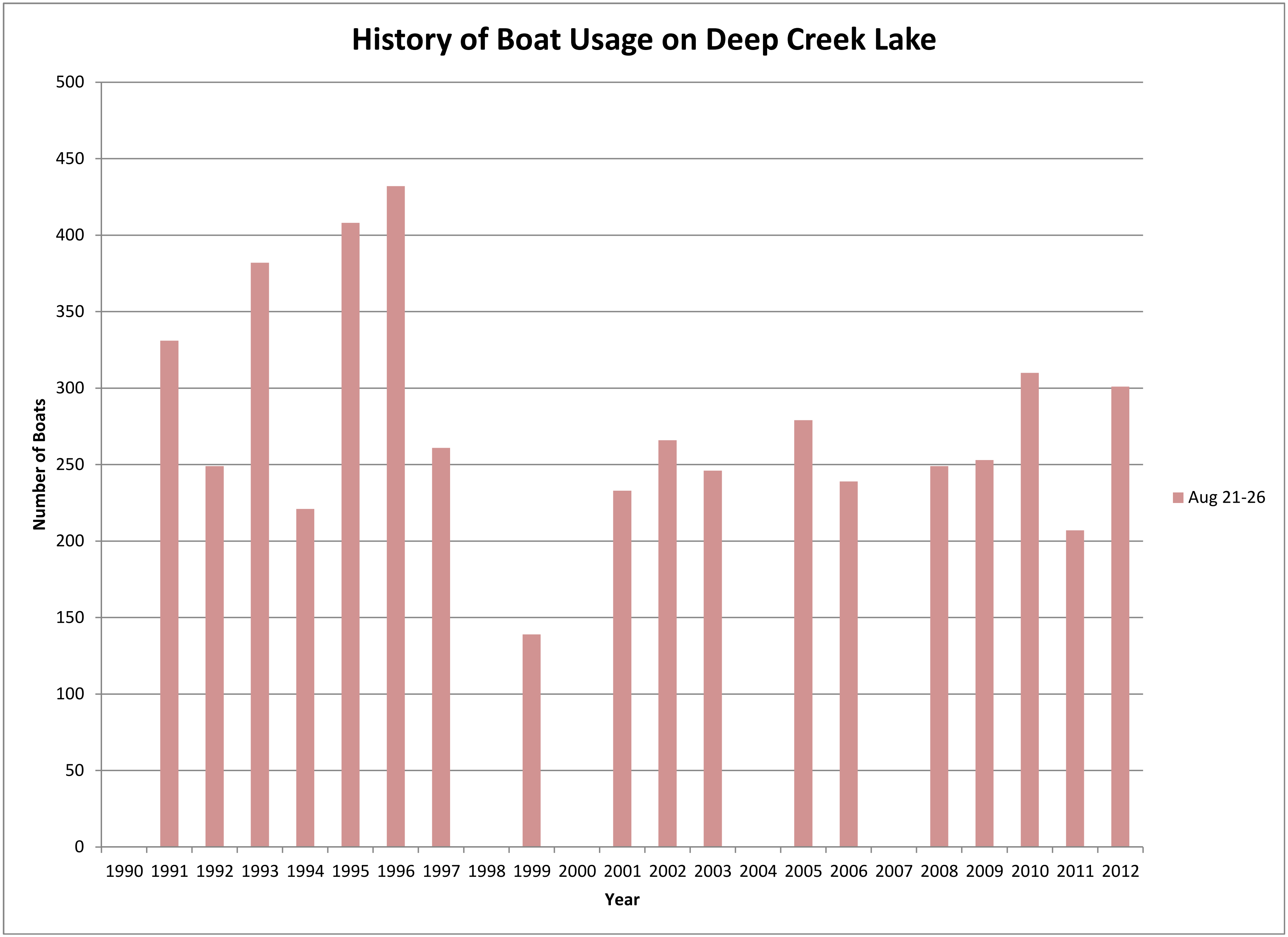
History of Boat Usage on Deep Creek Lake
Number of Boats
450
400
350
300
250
200
150
100
50
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
July 30-Aug 4

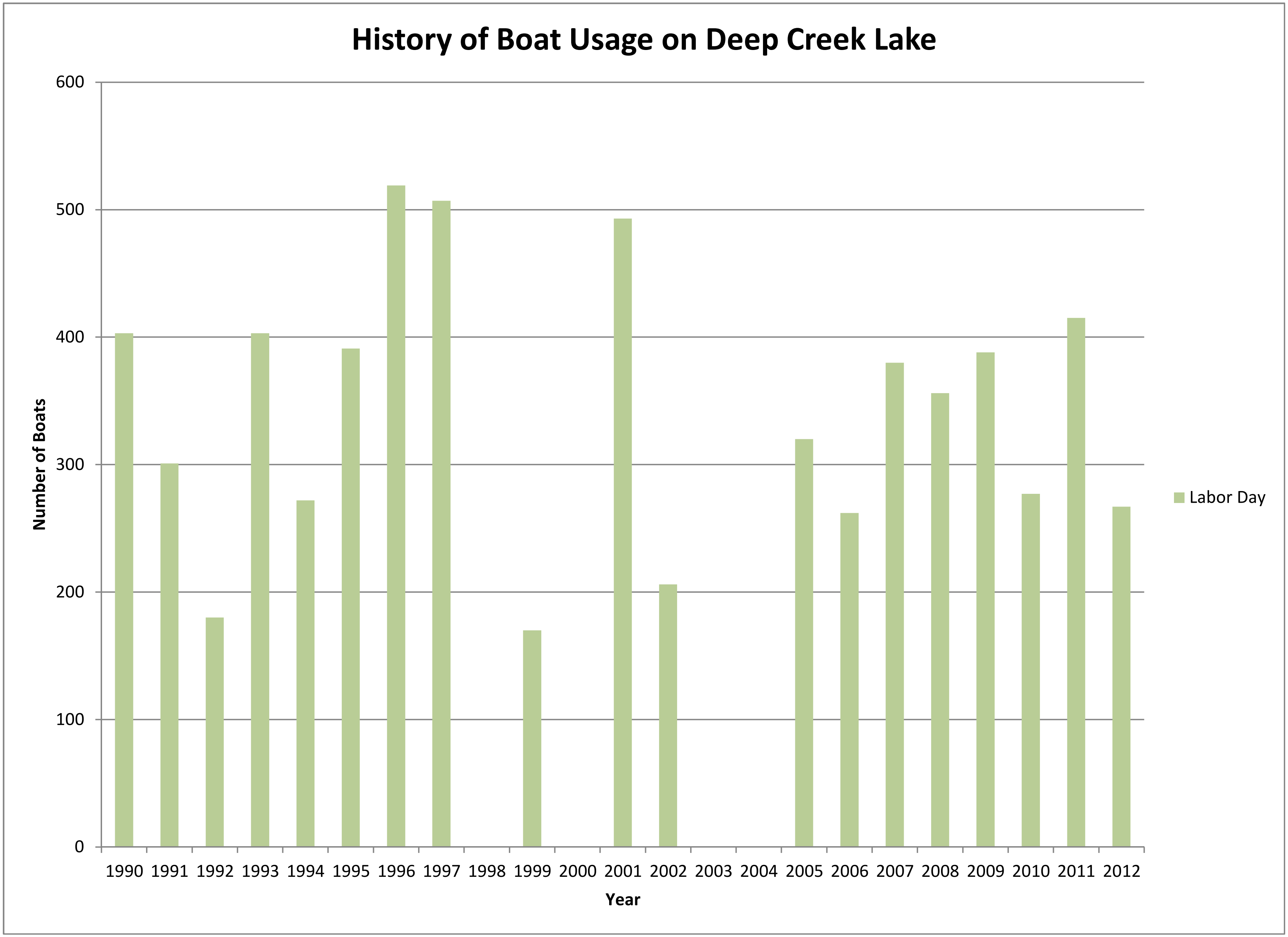


History of Boat Usage on Deep Creek Lake
Number of Boats
0
50
100
150
200
250
300
350
400
450
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year
Aug 7-11



History of Boat Usage on Deep Creek Lake
Number of Boats
500
450
400
350
300
250
200
150
100
50
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year
Aug 14-18

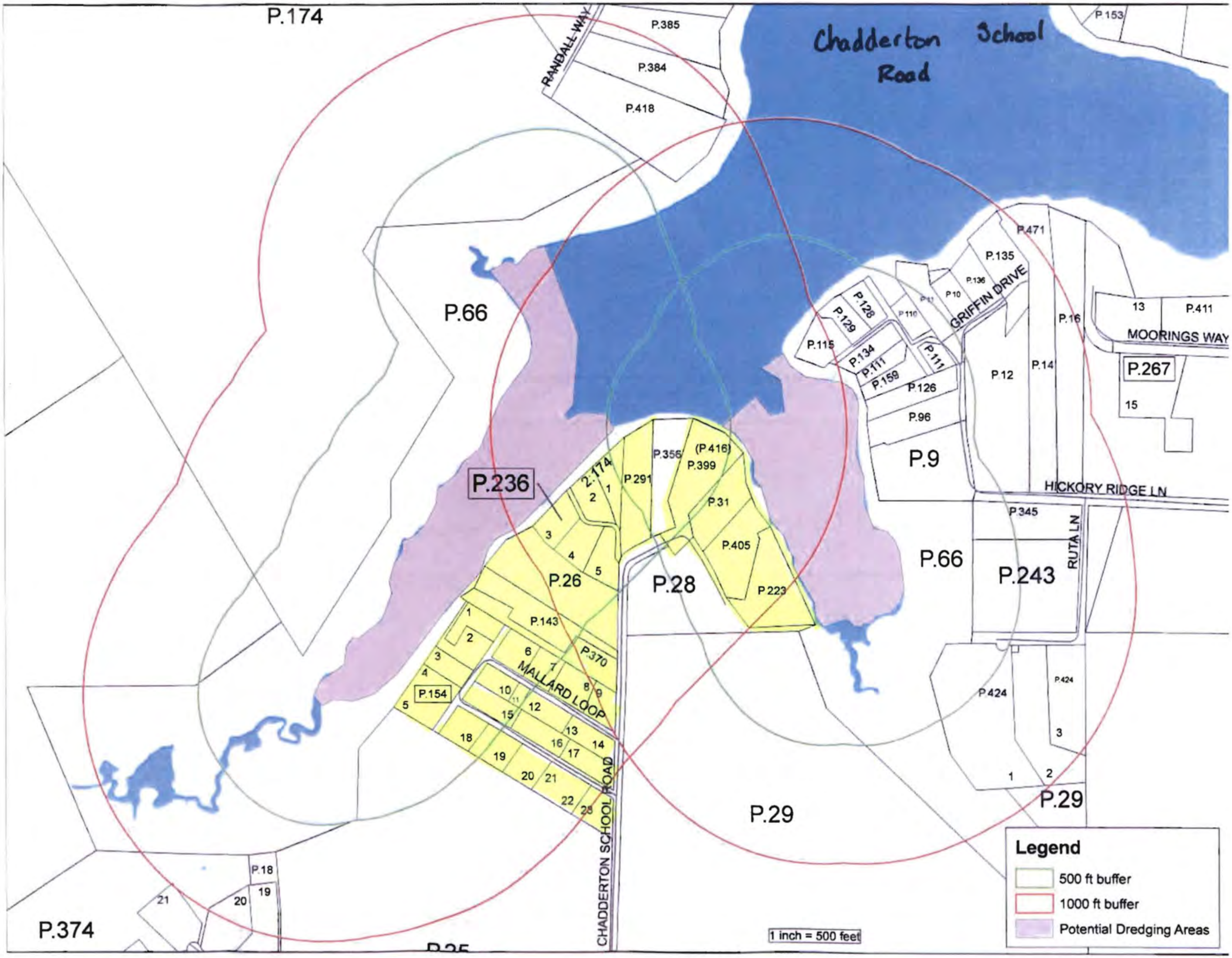

History of Boat Usage on Deep Creek Lake
Number of Boats
500
450
400
350
300
250
200
150
100
50
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
Aug 21-26

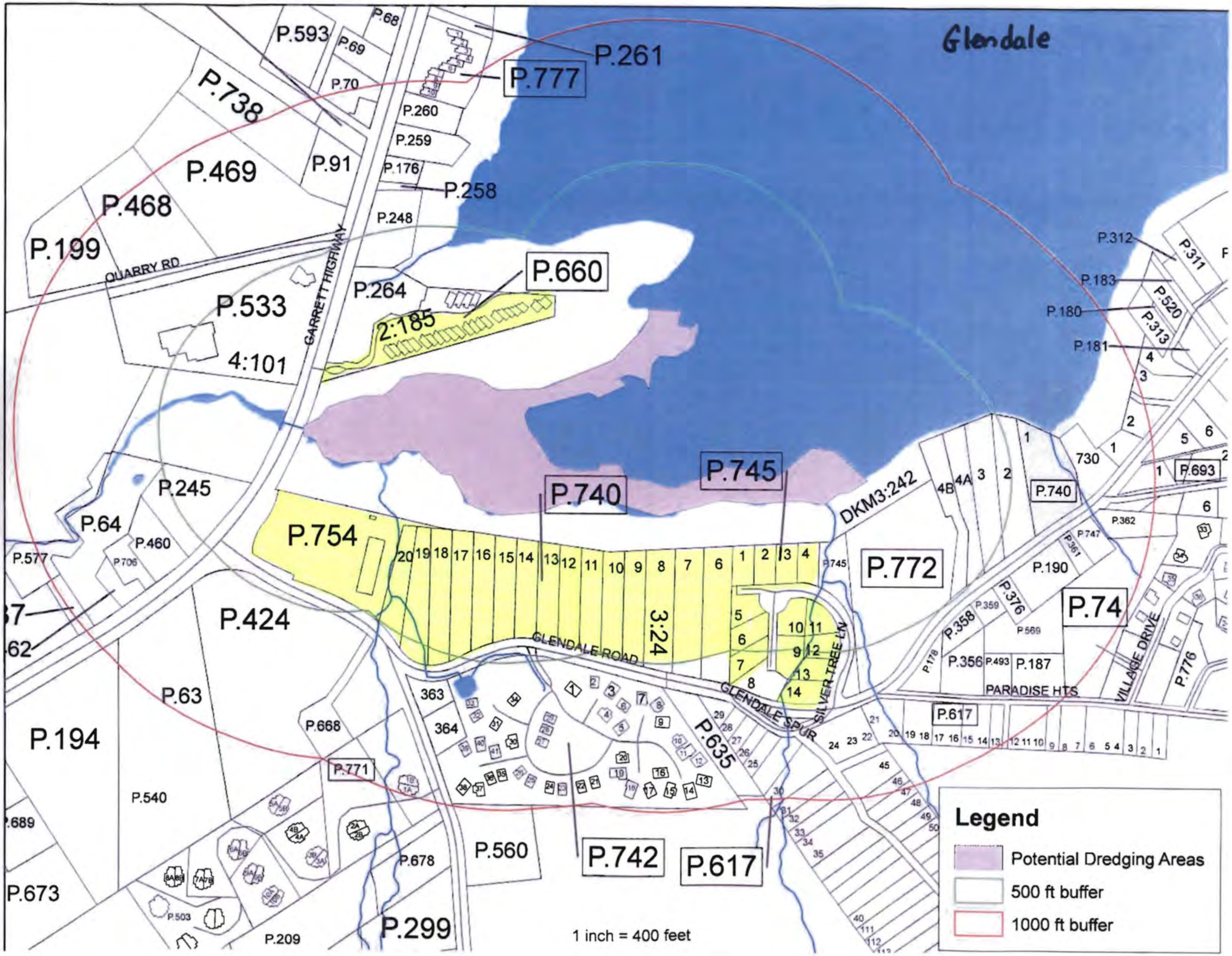


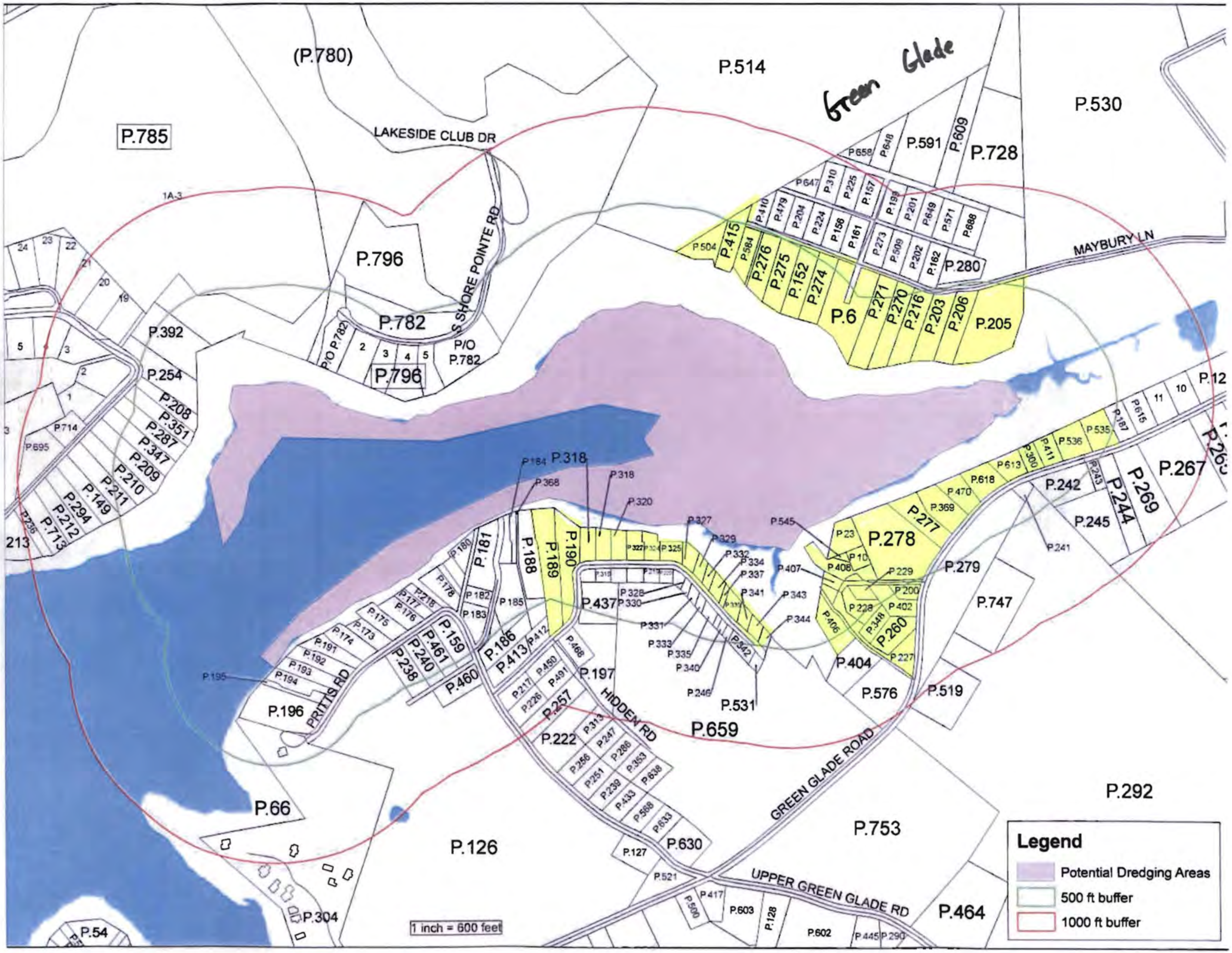
History of Boat Usage on Deep Creek Lake
600
500
400
300
200
100
0
Number of Boats
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year
Labor Day

APPENDIX E

PARCEL MAPS

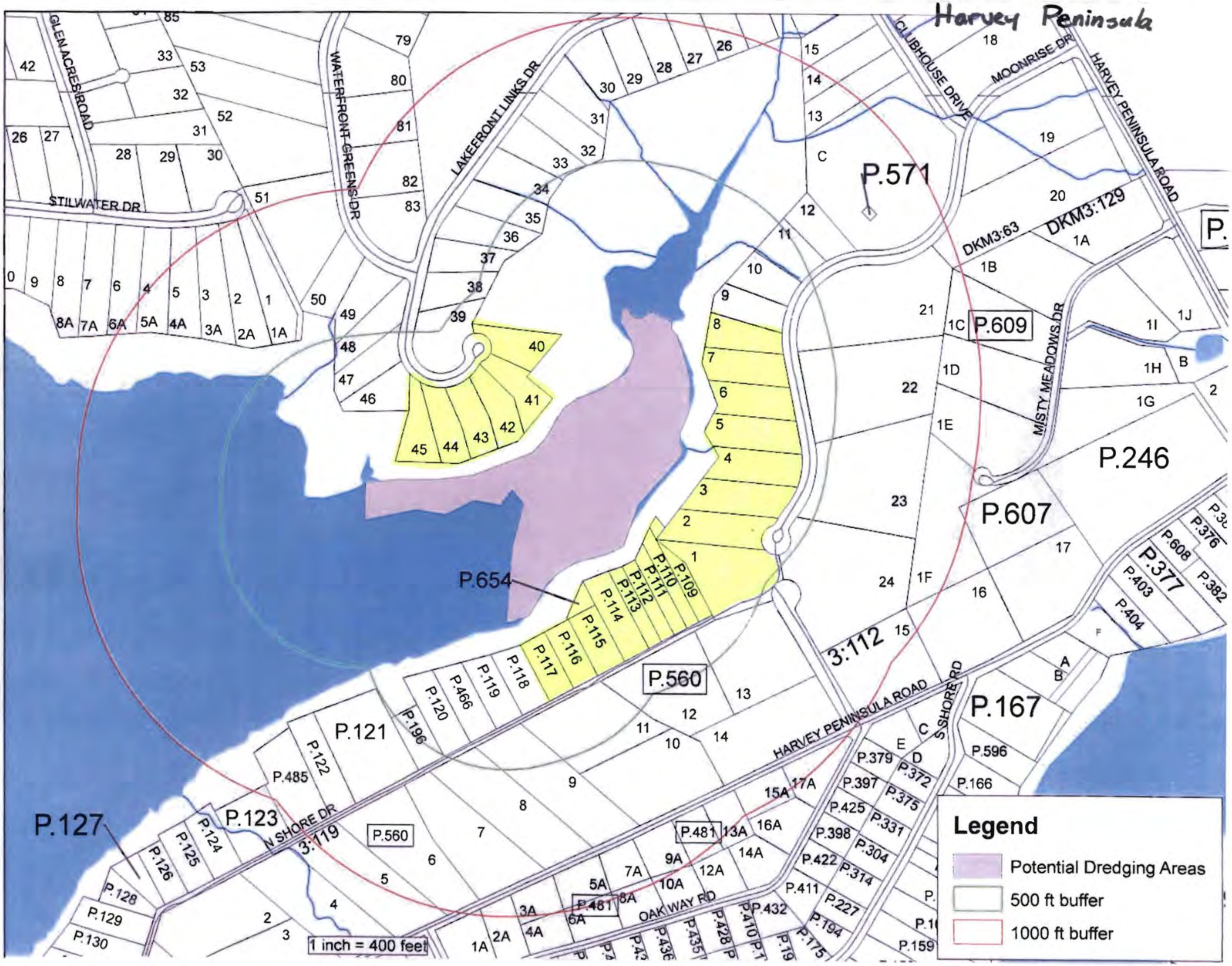

Chadderton School Road
P.174
RANDALL WAY
P.385
P.384
P.418
P.153
P.66
P.471
P.135
P.136
P.10
P.110
P.128
P.129
P.115
GRIFFIN DRIVE
P.16
13
P.411
MOORINGS WAY
P.267
15
P.134
P.111
P.159
P.126
P.12
P.14
P.96
P.9
P.236
P.356
(P.416)
P.399
P.291
P.31
HICKORY RIDGE LN
P.345
P.405
P.66
P.243
RUTA LN
P.26
P.28
P.223
P.143
P.370
MALLARD LOOP
P.154
P.424
3
1
2
P.29
P.29
CHADDERTON SCHOOL ROAD
P.18
19
20
21
P.374
1 inch = 500 feet
Legend
500 ft buffer
1000 ft buffer
Potential Dredging Areas

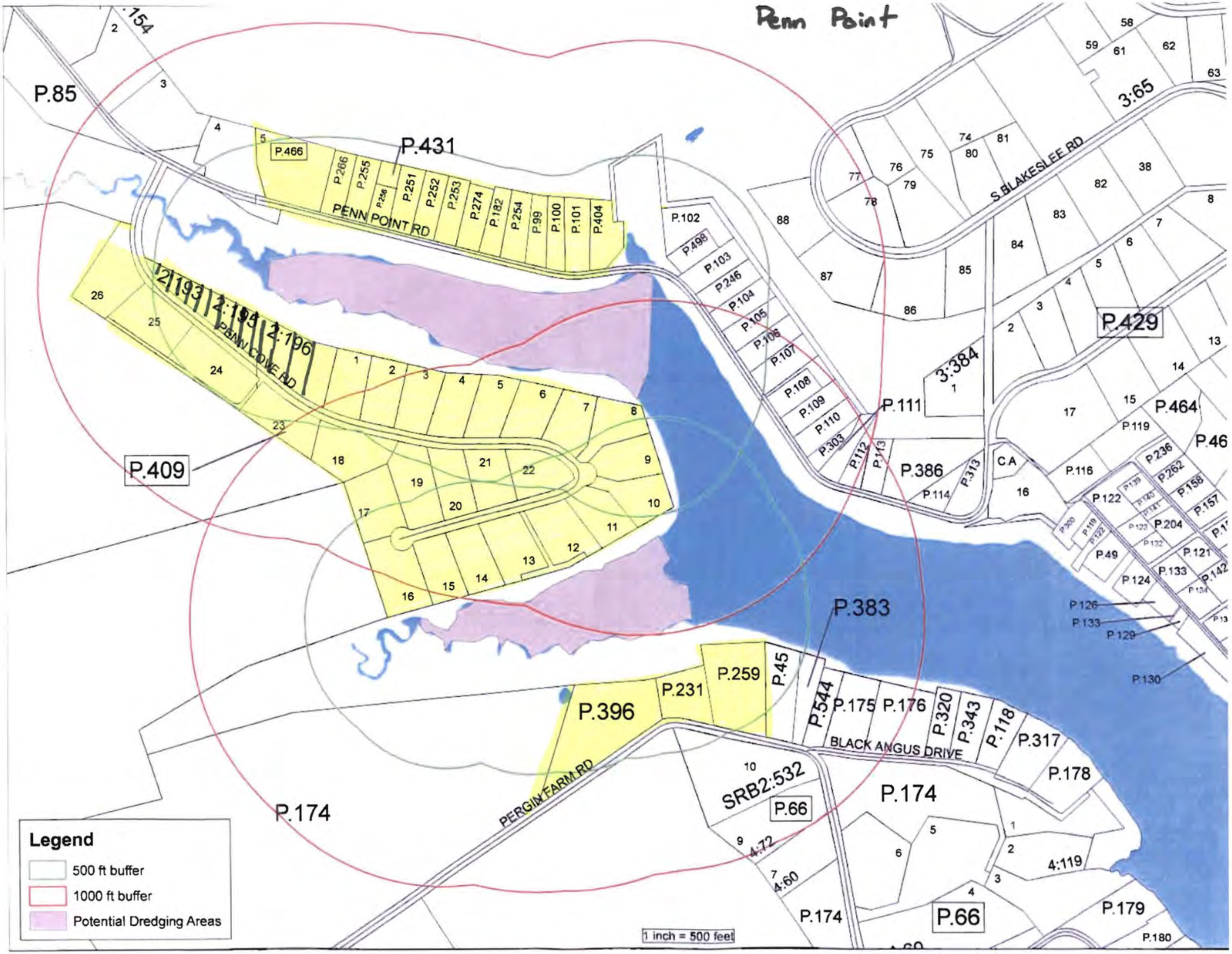

Glendale
P.261
P.777
P.738
P.593
P.469
P.468
P.199
P.91
P.258
P.660
QUARRY RD
GARRETT HIGHWAY
P.264
P.533
2:185
4:101
P.745
P.740
P.245
P.64
P.460
P.577
P.754
P.772
P.74
DKM3:242
P.424
3:24
GLENDALE ROAD
GLENDALE SPUR
SILVER TREE LN
PARADISE HTS
VILLAGE DRIVE
P.63
P.194
P.668
P.771
P.635
P.617
P.540
P.560
P.742
P.299
P.678
P.673
P.209
P.689
P.190
P.187
P.356
P.358
P.376
P.776
P.693
P.312
P.311
P.183
P.520
P.180
P.313
P.181
730
1 inch = 400 feet
Legend
Potential Dredging Areas
500 ft buffer
1000 ft buffer

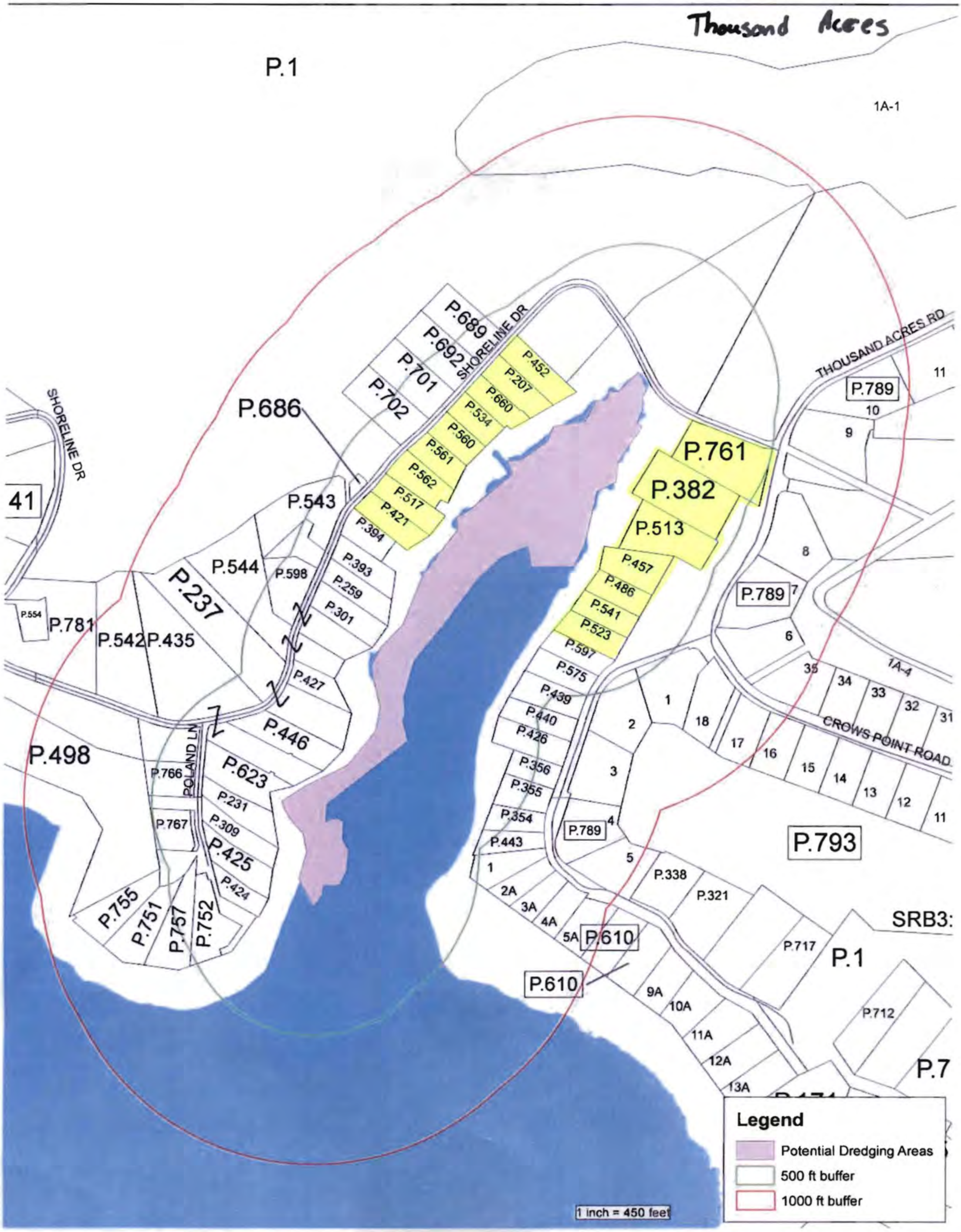


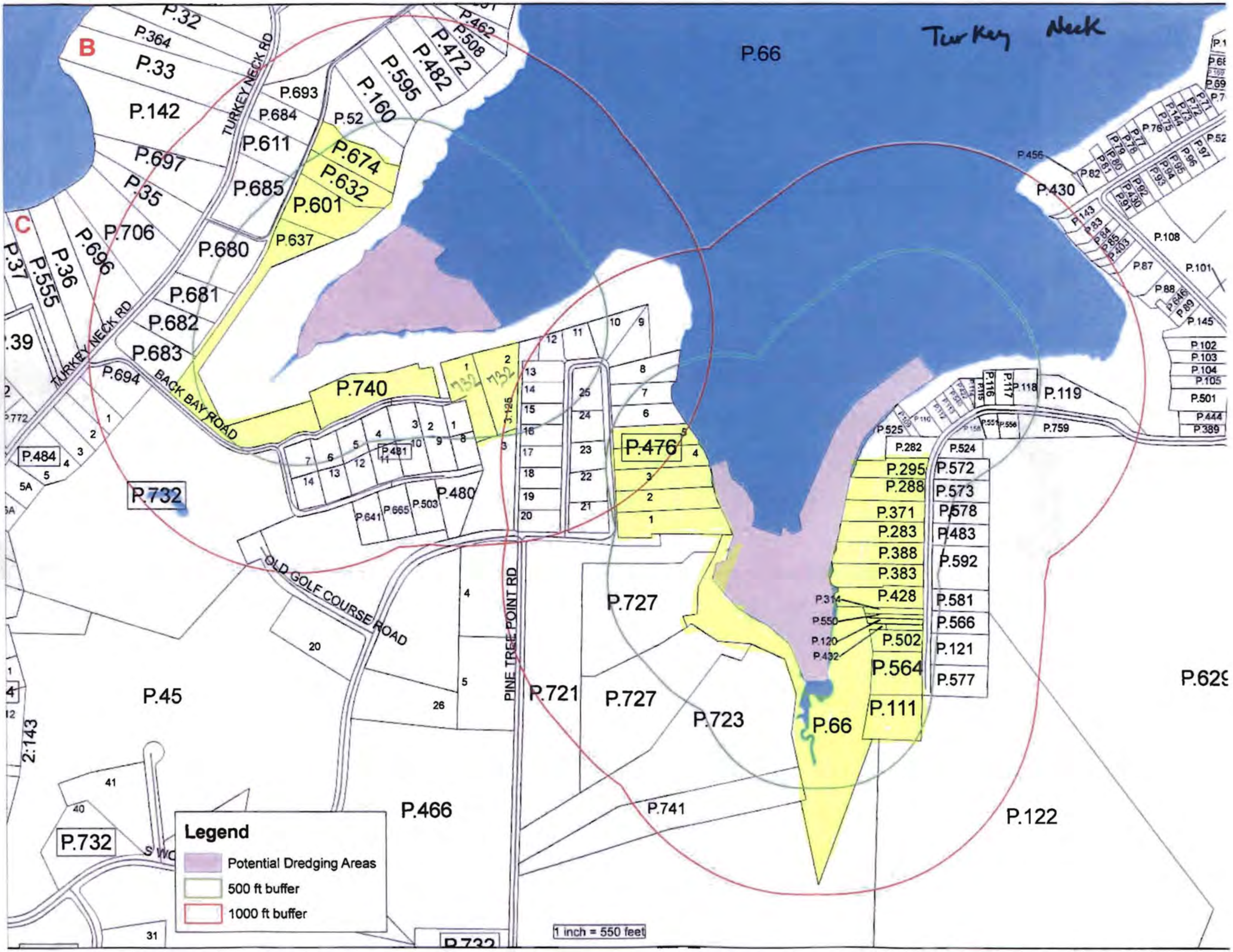
Green Glade
(P.780)
P.514
P.530
P.785
LAKESIDE CLUB DR
1A-3
S SHORE POINTE RD
P.796
P.782
P/O P.782
P.392
P.254
P.591
P.609
P.728
P.658
P.648
MAYBURY LN
P.280
P.415
P.504
P.276
P.275
P.152
P.274
P.6
P.271
P.270
P.216
P.203
P.206
P.205
P.318
P.320
P.189
P.190
P.188
P.181
P.437
P.278
P.277
P.279
P.260
P.404
P.576
P.519
P.747
P.242
P.245
P.244
P.269
P.267
P.159
P.461
P.240
P.238
P.186
P.413
P.460
P.197
P.257
P.222
P.196
PRITTS RD
HIDDEN RD
P.531
P.659
GREEN GLADE ROAD
P.292
P.753
P.66
P.126
P.630
P.127
UPPER GREEN GLADE RD
P.464
P.304
P.54
1 inch = 600 feet
Legend
Potential Dredging Areas
500 ft buffer
1000 ft buffer

Harvey Peninsula




Penn Point
P.85
P.431
P.466
PENN POINT RD
P.266
P.255
P.251
P.252
P.253
P.274
P.182
P.254
P.99
P.100
P.101
P.404
P.102
P.498
P.103
P.246
P.104
P.105
P.106
P.107
P.108
P.109
P.110
P.303
P.111
P.112
P.113
P.386
P.114
P.313
2:193
2:195
2:196
PENN COVE RD
P.409
3:65
S BLAKESLEE RD
3:384
P.429
P.464
P.119
P.116
P.236
P.262
P.158
P.157
P.122
P.204
P.49
P.121
P.124
P.133
P.142
P.126
P.129
P.130
C A
P.383
P.45
P.259
P.231
P.396
P.544
P.175
P.176
P.320
P.343
P.118
P.317
BLACK ANGUS DRIVE
P.178
SRB2:532
P.66
P.174
PERGIN FARM RD
4:72
4:60
4:119
P.179
P.180
Legend
500 ft buffer
1000 ft buffer
Potential Dredging Areas
1 inch = 500 feet


Thousand Acres
P.1
1A-1
SHORELINE DR
THOUSAND ACRES RD
CROWS POINT ROAD
POLAND LN
P.689
P.692
P.701
P.702
P.686
P.452
P.207
P.660
P.534
P.560
P.561
P.562
P.517
P.421
P.394
P.543
P.544
P.598
P.393
P.259
P.301
P.237
P.554
P.781
P.542
P.435
P.427
P.446
P.498
P.766
P.623
P.231
P.767
P.309
P.425
P.424
P.755
P.751
P.757
P.752
41
P.761
P.382
P.513
P.457
P.486
P.541
P.523
P.597
P.575
P.439
P.440
P.426
P.356
P.355
P.354
P.443
P.789
P.793
P.338
P.321
P.717
P.610
P.712
P.7
SRB3:
1A-4
Legend
Potential Dredging Areas
500 ft buffer
1000 ft buffer
1 inch = 450 feet


Turkey Neck
B
C
P.66
TURKEY NECK RD
BACK BAY ROAD
OLD GOLF COURSE ROAD
PINE TREE POINT RD
P.32
P.364
P.33
P.142
P.697
P.35
P.706
P.696
P.36
P.555
P.37
P.693
P.684
P.611
P.685
P.680
P.681
P.682
P.683
P.694
P.52
P.160
P.595
P.482
P.472
P.508
P.462
P.674
P.632
P.601
P.637
P.740
P.732
P.476
P.481
P.480
P.641
P.665
P.503
P.484
P.772
P.727
P.721
P.723
P.741
P.45
P.466
P.122
P.430
P.456
P.108
P.87
P.88
P.101
P.145
P.102
P.103
P.104
P.105
P.501
P.444
P.389
P.119
P.759
P.525
P.282
P.524
P.295
P.572
P.288
P.573
P.371
P.578
P.283
P.483
P.388
P.592
P.383
P.428
P.581
P.566
P.314
P.550
P.120
P.432
P.502
P.121
P.564
P.577
P.111
2:143
Legend
Potential Dredging Areas
500 ft buffer
1000 ft buffer
1 inch = 550 feet

APPENDIX F

PERMIT APPLICATIONS

ATTENTION: PIER & PILING APPLICANTS

1. **Please complete and sign the Joint Federal/State Application Form.**

2. **Please sign this Notification Form and submit it with your Joint Federal/State Application.**

State of Maryland Pier and Piling Notification Form

PRIVATE WATERFRONT PROPERTY OWNERS AND NON-MARINA COMMERCIAL WATERFRONT PROPERTY OWNERS are not required to obtain an authorization from the State of Maryland to construct and install structures in tidal waters of the State of Maryland provided that they agree to perform the activities in accordance with the special and general conditions described below and submit a Joint Federal/State Application.

If a proposal does NOT meet the conditions of this authorization, DNR will notify the project proponent within 10 days of receipt of application. **IF YOU DO NOT HEAR FROM THE STATE WITHIN 10 DAYS AFTER YOU SEND IN YOUR SIGNED NOTIFICATION FORM YOU CAN ASSUME YOU MEET THE NOTIFICATION FORM CRITERIA.**

SPECIAL CONDITIONS

Private piers, boat hoists or lifts, mooring piles, and osprey poles that meet all of the following criteria are exempt from obtaining a license or permit directly from MDE where local authorization has been granted.

1. Only one pier, and four boat hoists or lifts per property;
2. Width of the main section of the pier is not greater than 6 feet;
3. Total area of all fixed and floating auxiliary platforms including T's, L's, and step down platforms does not exceed 200 square feet and are not located over vegetated wetlands;
4. Platforms are not constructed within the landward 50% of the main pier section;
5. Project does not include more than six mooring piles or create more than four boat slips;
6. Project does not include more than two osprey poles per property;
7. A maximum of two, 3-foot wide finger piers not exceeding 50 percent of the proposed slip length are constructed on the landward side of the end of a private pier;
8. Project meets the minimum extended property line setback requirements established by the local jurisdictions in which the activity is proposed;
9. In localities where there are no set back requirements, structure(s) is constructed in a manner so as not to obstruct ingress and egress from adjacent properties;
10. Piers over vegetated tidal wetlands are constructed a minimum of 3 feet above the wetlands;
11. Pier does not extend within 100 feet of a ski course approved by DNR;
12. Pier does not extend more than 100 feet channelward of the mean high water line and/or vegetated tidal wetlands; or a distance of 25 percent of the width of the waterway, which ever is less;
13. Project does not obstruct the flow of the tide; and
14. A signed copy of this notification with a completed Joint Federal/State Application including plans is sent to the Regulatory Services Coordination Office 10 days prior to the start of any construction.

GENERAL CONDITIONS

1. Property owners must comply with all Federal, State and local requirements and regulations, including the State of Maryland's Chesapeake Bay Critical Area Criteria where applicable, pertaining to construction and installation of structure(s). Any structure(s) installed shall be constructed in such a manner to comply with local (County and or City) setback requirements, so as not to obstruct ingress and egress from adjacent properties.

2. A pier may be constructed in and over marsh areas to allow access provided that these areas are not disturbed. Piers shall be attached to uplands above the mean high water line so that shading of marsh and disturbance of fish and wildlife habitat are minimized. Mooring piles are not authorized in marsh areas for the purposes of boat moorings unless sufficient water depth allows mooring without alteration of the marsh. Heavy equipment utilized in pier construction over marshes shall be placed on mats or other suitable material to minimize damage to the marsh.

3. No structure(s) is allowed under this authorization if another similar type of structure(s) exists on the same property, unless the proposed work is an extension to an existing pier and the total resulting structure does not exceed the limits of this authorization, or unless the total number of auxiliary structures or Osprey poles will not exceed the limits of this authorization.

4. No petroleum dispensing apparatus may be placed or stored on piers or floating docks.

5. MDE reserves the right to determine whether or not a particular structure(s) qualifies for this authorization.

6. The shared use of piers, auxiliary structures and/or mooring piles by adjoining property owners is encouraged and strongly recommended wherever possible.

7. Mooring pile(s) allowed by this authorization will be used only for the purpose of mooring vessels by residential waterfront property owners and non-marina commercial property owners.

8. The property owner shall maintain the activity allowed by this authorization in good condition and in compliance with the terms and conditions of this authorization.

9. The property owner shall allow representatives from MDE to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of this authorization.

10. This authorization does not convey any public or private property rights. The land and water below the pier and the air above remain property of the State of Maryland.

11. This authorization does not allow any injury to the property or rights of others.

12. The State of Maryland does not assume any liability for the following:

    a. Damages to the authorized project as a result of other permitted or unpermitted activities or from natural causes;

    b. Damages to the authorized project as a result of current or future activities undertaken by or on behalf of the State of Maryland in the public interest;

    c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity allowed by this authorization;

    d. Design or construction deficiencies associated with the authorized work; and

    e. Damage claims associated with any future modification, suspension, or revocation of this authorization.

13. MDE may re-evaluate its decision on this authorization or any authority granted under it at any time circumstances warrant. Circumstances that could require a re-evaluation include, but are not limited to, the following:

    a. The property owner fails to comply with the terms and conditions of this authorization;

    b. The information provided by the property owner in the notification form is false, incomplete, or inaccurate; and

    c. Significant new information becomes available which was not considered in reaching the original public interest decision.

    Such a re-evaluation may result in a determination that it is appropriate to use the suspension, modification, revocation or enforcement procedures such as those contained in Title 9.

14. The property owner's use of the allowed activity must not interfere with the public's right to free navigation on all navigable waters of the State.

I have read and understand the criteria set forth in this Notification Form and will perform all work herein described in accordance with the conditions.

SIGNATURE OF PROPERTY OWNER ______________________________

Address: ______________________________ **County:** ____________________

____

Date: ______________________________

Contiguous Property Owner and Appropriate Local Official Notification Certification Form

☐ I have notified and provided plans of my proposal to perform work in tidal wetlands to all property owners contiguous to my property located at the address listed below.

☐ In Person

☐ By Certified Mail

☐ I have notified and provided plans of my proposal to perform work in tidal wetlands to the Director of Planning in the County in which my project is located:

☐ In Person

☐ By Certified Mail

Project Site Address

____
(Name of Property Owner)

____
(Project Site Street Address)

____
(City, State, Zip Code)

Please list below all of the contiguous property owners notified. Attach additional pages if necessary.

Names	Addresses

____
(Signature)

____
(Printed Name)

Wetlands and Waterways Program:
Checklist for Floodplain, Waterway, Tidal or Nontidal Wetland Applications

- ☐ Processing Fee Enclosed
- ☐ Exempt from Processing Fee

- ☐ Applicant's name, mailing address, telephone number, email address and fax number
- ☐ Authorized agent's (or primary contact and other contact) names, mailing addresses, telephone numbers, email addresses and fax numbers
- ☐ Any existing authorization numbers or previously assigned numbers
- ☐ General description of project purpose and proposed activity.
- ☐ The name of the city or town, waterbody, and county where the project is located
- ☐ Clear directions to project site
- ☐ Latitude and longitude from a central location within the project limits

Wetland, Waterway/Stream, Buffer, Floodplain Description

- ☐ Itemized calculation of all permanent and temporary wetland, stream, buffer, floodplain impacts
- ☐ A delineation report of the area of all wetlands and buffers on the site and associated wetland data sheets. The report map should include the location of all streams, 100-year floodplains?, open water and other surface waters on the site the limits of Chesapeake Bay Resource Protection Areas (RPAs), Wetland types should be noted according to their Cowardin (USFWS-National Wetlands Inventory) classification or similar terminology.
- ☐ Description of How Impacts were Avoided or Reduced
- ☐ Mitigation Proposal, if applicable

Plans

- ☐ A detailed vicinity map of the project area, including the project boundary. The map should identify the project site, property boundaries, and adjacent property owners
- ☐ Plans showing distance of all proposed structures to all contiguous property lines and any appropriate County or State property line building restriction setbacks, right-of-ways and/or easements

☐ A plan view depicting existing and proposed conditions and structures. All plan view sketches should include, but are not limited to: north arrow; existing and proposed contours and/or grades; limit of surface water areas; ebb and flow direction of all water bodies (e.g., streams, tidal waters); applicant name and address; all horizontal dimensions of all proposed structures and impacts, existing conditions of the project site which includes all existing structures at or near the project site including neighbors; existing areas of wetland vegetation or mapped wetlands and buffers; the project boundary and a boundary demarcating the limits of disturbance. A section view showing existing and proposed conditions and structures.

☐ A description of construction access and methodology and a proposed construction schedule, with an estimated completion date

☐ Description of stabilization for temporary impacts

ALL Tidal Projects

☐ Plans on 8.5” x 11” paper; Plans are to be legible and not cluttered; usable written scale no smaller than 1” = 100’, Dimensions of proposed structures must be represented.

☐ Plan views should include Mean High Water Line (MHWL) and Mean Low Water Line (MLWL; referenced to 0.0’). *If MHWL or MLWL are to be altered during construction the proposed MHWL and MLWL should also be labeled*

☐ Plan views should include water depths marked as either contours or spot depths that extend across the width of the waterway.

☐ Plan view should include the maximum channelward extent beyond mean high water of all proposed structures and impacts

☐ Plan view should include the distance across the waterway, perpendicular to the proposed worksite, to the opposite shoreline and maximum fetch for the project worksite; *include multiple bearings and/or summer-winter wind direction if possible*

☐ Dredge material management plan (*for dredging projects only*) including type of dredging, location of dredged material placement site, handling and transport method for dredge material, the dimensions and detailed design of the proposed dredged material placement site including a plan and cross section drawing of dewatering area (*if proposed*), maximum volume of dredged material, and an acceptance letter from the operator of the dredged material placement site.

☐ **ALL Non-Tidal Projects**: Large-sized impacts map (at a scale no smaller than 1" = 200'); use match lines if the entire site cannot fit on one sheet at this scale

JOINT FEDERAL/STATE APPLICATION FOR THE ALTERATION OF ANY FLOODPLAIN, WATERWAY, TIDAL OR NONTIDAL WETLAND IN MARYLAND

FOR AGENCY USE ONLY

Application Number ______________________ **Date Determined Complete** ______________________
Date Received by State ______________________ **Date(s) Returned** ______________________
Date Received by Corps ______________________ ______________________
Type of State permit needed ______________________ **Date of Field Review** ______________________
Type of Corps permit needed ______________________ **Agency Performed Field Review** ______________________

++

- Please submit 1 original and 6 copies of this form, required maps and plans to the Wetlands and Waterways Program as noted on the last page of this form.
- Any application which is not completed in full or is accompanied by poor quality drawings may be considered incomplete and result in a time delay to the applicant.

Please check one of the following:

RESUBMITTAL: ____ **APPLICATION AMENDMENT:** ____ **MODIFICATION TO AN EXISTING PERMIT:** ________
JURISDICTIONAL DETERMINATION ONLY ____ **APPLYING FOR AUTHORIZATION** ____
PREVIOUSLY ASSIGNED NUMBER (RESUBMITTALS AND AMENDMENTS) ______________
DATE ______________________

1. APPLICANT INFORMATION:

APPLICANT NAME:

A. Name: ______________________ B. Daytime Telephone: ______________
C. Company: ______________________ D. Email Address: ______________
E. Address: ______________________
F. City: ______________________ State: ____________ Zip: ________

AGENT/ENGINEER INFORMATION:

A. Name: ______________________ B. Daytime Telephone: ______________
C. Company: ______________________ D. Email Address: ______________
E. Address: ______________________
F. City: ______________________ State: ____________ Zip: ________

ENVIRONMENTAL CONSULTANT:

A. Name: ______________________ B. Daytime Telephone: ______________
C. Company: ______________________ D. Email Address: ______________
E. Address: ______________________
F. City: ______________________ State: ____________ Zip: ________

CONTRACTOR (If known): ______________________

A. Name: ______________________ B. Daytime Telephone: ______________
C. Company: ______________________ D. Email Address: ______________
E. Address: ______________________
F. City: ______________________ State: ____________ Zip: ________

PRINCIPAL CONTACT:

A. Name: ______________________ B. Daytime Telephone: ______________
C. Company: ______________________ D. Email Address: ______________
E. Address: ______________________
F. City: ______________________ State: ____________ Zip: ________

2. PROJECT DESCRIPTION

a. GIVE WRITTEN DESCRIPTION OF PROJECT:

____

Has any portion of the project been completed? ______ Yes ______ No If yes, explain __________________

Is this a residential subdivision or commercial development? ______ Yes ______ No
If yes, total number of acres on property ______ acres

b. ACTIVITY: Check all activities that are proposed in the wetland, waterway, floodplain, and nontidal wetland buffer as appropriate.

A. ______ filling
B. ______ dredging
C. ______ excavating
D. ______ flooding or impounding water
E. ______ draining
F. ______ grading
G. ______ removing or destroying vegetation
H. ______ building structures

Area for item(s) checked: Wetland ____________ (sq. ft.) Buffer (Nontidal Wetland Only) __________ (sq. ft.)
Expanded Buffer (Nontidal Wetland Only) __________ (sq. ft.)
Area of stream impact ____________ (sq. ft.)
Length of stream affected ____________ (linear feet)

c. TYPE OF PROJECTS: Project Dimensions

For each activity, give overall length and width (in feet), in columns 1 and 2. For multiple activities, give total area of disturbance in square feet in column 3. For activities in tidal waters, give maximum distance channelward (in feet) in column 4. For dam or small ponds, give average depth (in feet) for the completed project in column 5. Give the volume of fill or dredged material in column 6.

		Length (Ft.) 1	Width (Ft.) 2	Area Sq. Ft. 3	Maximum/Average Channelward Encroachment 4		Pond Depth 5	Volume of fill/dredge material (cubic yards) below MHW or OHW 6
A. ______	Bulkhead	____	____		____	____		____
B. ______	Revetment	____	____		____			____
C. ______	Vegetative Stabilization	____	____		____	____		____
D. ______	Gabions	____	____		____	____		____
E. ______	Groins	____	____		____	____		____
F. ______	Jetties	____	____		____	____		____
G. ______	Boat Ramp	____	____		____	____		____
H. ______	Pier	____	____		____	____		
I. ______	Breakwater	____	____		____	____		____
J. ______	Repair & Maintenance	____	____	____	____	____		____
K. ______	Road Crossing	____	____	____				____
L. ______	Utility Line	____	____	____				____
M. ______	Outfall Construction	____	____	____	____	____		____
N. ______	Small Pond	____	____	____			____	____
O. ______	Dam	____	____	____			____	____
P. ______	Lot Fill	____	____	____				____
Q. ______	Building Structures	____	____	____	____	____		____
R. ______	Culvert	____	____	____				____
S. ______	Bridge	____	____	____	____	____		____
T. ______	Stream Channelization	____	____	____	____	____		____
U. ______	Parking Area	____	____	____				____
V. ______	Dredging	____	____	____	____	____		____

1. ______ New 2. ______ Maintenance 3. ______ Hydraulic 4. ______ Mechanical

W. ______ Other (explain) ________________________________

d. PROJECT PURPOSE: Give brief written description of the project purpose:

____
____
____
____
____
____
____

3. PROJECT LOCATION:

a. LOCATION INFORMATION:

A. County: __________ B. City: __________ C. Name of waterway or closest waterway __________

D. State stream use class designation: __________

E. Site Address or Location: __________

____

F. Directions from nearest intersection of two state roads: __________

____

____

____

G. Is your project located in the Chesapeake Bay Critical Area (generally within 1,000 feet of tidal waters or tidal wetlands)?: _____ Yes _____ No

H. County Book Map Coordinates (Alexandria Drafting Co.); Excluding Garrett and Somerset Counties:
Map: __________ Letter: __________ Number: __________ (to the nearest tenth)

I. FEMA Floodplain Map Panel Number (if known): __________

J. 1. __________ latitude 2. __________ longitude

b. ACTIVITY LOCATION: Check one or more of the following as appropriate for the type of wetland/waterway where you are proposing an activity:

A. _____ Tidal Waters

B. _____ Tidal Wetlands

C. _____ Special Aquatic Site (e.g., mudflat, vegetated shallows)

D. _____ Nontidal Wetland

E. _____ 25-foot buffer (nontidal wetlands only)

F. _____ 100-foot buffer (nontidal wetland of special State concern)

G. _____ In stream channel
1. _____ Tidal 2. _____ Nontidal

H. _____ 100-year floodplain (outside stream channel)

I. _____ River, lake, pond

J. _____ Other (Explain)
____
____

c. LAND USE:

A. Current Use of Parcel Is: 1. _____ Agriculture: Has SCS designated project site as a prior converted cropland? _____ Yes _____ No 2. _____ Wooded 3. _____ Marsh/Swamp 4. _____ Developed 5. _____ Other __________

B. Present Zoning Is: 1. ____ Residential 2. ____ Commercial/Industrial 3. ____ Agriculture 4. ____ Marina 5. ____ Other

C. Project complies with current zoning _____ Yes _____ No

THE FOLLOWING INFORMATION IS REQUIRED BY THE STATE (blocks 4-7):

4. REDUCTION OF IMPACTS: Explain measures taken or considered to avoid or minimize wetland losses in F. Also check Items A-E if any of these apply to your project.

A. _____ Reduced the area of disturbance

B. _____ Reduced size/scope of project

C. _____ Relocated structures

D. _____ Redesigned project

E. _____ Other __________

F. Explanation ______________________________

Describe reasons why impacts were not avoided or reduced in Q. Also check Items G-P that apply to your project.

G. ______ Cost
H. ______ Extensive wetlands on site
I. ______ Engineering/design constraints
J. ______ Other natural features
K. ______ Parcel size
L. ______ Other regulatory requirement
M. ______ Failure to accomplish project purpose
N. ______ Safety/public welfare issue
O. ______ Inadequate zoning
P. ______ Other ______________

Q. Description ______________________________

5. LETTER OF EXEMPTION: If you are applying for a letter of exemption for activities in nontidal wetlands and/or their buffers, explain why the project qualifies:

A. ______ No significant plant or wildlife value and wetland impact
   1. ______ Less than 5,000 square feet
   2. ______ In an isolated nontidal wetland less than 1 acre in size
B. ______ Repair existing structure/fill
C. ______ Mitigation Project
D. ______ Utility Line
   1. ______ Overhead
   2. ______ Underground
E. Other (explain) ______________________________

F. ______ Check here if you are **not** applying for a letter of exemption.

IF YOU ARE APPLYING FOR A LETTER OF EXEMPTION, PROCEED TO BLOCK 11

6. ALTERNATIVE SITE ANALYSIS: Explain why other sites that were considered for this project were rejected in M. Also check any items in D-L if they apply to your project. **(If you are applying for a letter of exemption, do not complete this block):**

A. ______ 1 site
B. ______ 2 - 4 sites
C. ______ 5 or more sites

Alternative sites were rejected/not considered for the following reason(s):

D. ______ Cost
E. ______ Lack of availability
F. ______ Failure to meet project purpose
G. ______ Located outside general/market area
H. ______ Greater wetlands impact
I. ______ Water dependency
J. ______ Inadequate zoning
K. ______ Engineering/design constraints
L. ______ Other ______________

M. Explanation: ______________________________

7. PUBLIC NEED: Describe the public need or benefits that the project will provide in F. Also check Items in A-E that apply to your project. **(If you are applying for a letter of exemption, do not complete this block):**

A. ______ Economic
B. ______ Safety
C. ______ Health/welfare
D. ______ Does not provide public benefits
E. ______ Other ______________

F. Description ______________________________

8. OTHER APPROVALS NEEDED/GRANTED:

A. Agency	B. Date Sought	C. Decision 1. Granted	2. Denied	D. Decision Date	E. Other Status

9. MITIGATION PLAN: Please provide the following information:

a. Description of a monetary compensation proposal, if applicable (for **state requirements** only). Attach another sheet if necessary. ____________________

b. Give a brief description of the proposed mitigation project. ____________________

c. Describe why you selected your proposed mitigation site, including what other areas were considered and why they were rejected. ____________________

d. Describe how the mitigation site will be protected in the future. ____________________

10. HAVE ADJACENT PROPERTY OWNERS BEEN NOTIFIED?: A. ______ Yes B. ______ No

Provide names and mailing addresses below (Use separate sheet, if necessary):

a. ____________________ b. ____________________ c. ____________________

11. HISTORIC PROPERTIES: Is your project located in the vicinity of historic properties? (For example: structures over 50 years old, archeological sites, shell mounds, Indian or Colonial artifacts). Provide any supplemental information in Section 13.

A. ______ Yes B. ______ No C. ______ Unknown

12. ADDITIONAL INFORMATION: Use this space for detailed responses to any of the previous items. Attach another sheet if necessary:

____

Check box if data is enclosed for any one or more of the following (see checklist for required information):

A. _____ Soil borings
B. _____ Wetland data sheets
C. _____ Photographs
D. _____ Field surveys
E. _____ Alternate site analysis
F. _____ Market analysis
G. _____ Site plan
H. _____ Avoidance and minimization analysis

I. _____ Other (explain) ____

CERTIFICATION:

I hereby designate and authorize the agent named above to act on my behalf in the processing of this application and to furnish any information that is requested. I certify that the information on this form and on the attached plans and specifications is true and accurate to the best of my knowledge and belief. I understand that any of the agencies involved in authorizing the proposed works may request information in addition to that set forth herein as may be deemed appropriate in considering this proposal. I certify that all Waters of the United States have been identified and delineated on site, and that all jurisdictional wetlands have been delineated in accordance with the Corps of Engineers Wetlands Delineation Manual (Wetlands Research Program Technical Report Y-87-1). I grant permission to the agencies responsible for authorization of this work, or their duly authorized representative, to enter the project site for inspection purposes during working hours. I will abide by the conditions of the permit or license if issued and will not begin work without the appropriate authorization. I also certify that the proposed works are consistent with Maryland's Coastal Zone Management Plan. I understand that none of the information contained in the application form is confidential and that I may request that additional required information be considered confidential under applicable laws. I further understand that failure of the landowner to sign the application will result in the application being deemed incomplete.

LANDOWNER MUST SIGN: ________________________________ DATE: ______________

WHERE TO MAIL APPLICATION

Maryland Department of the Environment
Water Management Administration
Regulatory Services Coordination Office
1800 Washington Boulevard, Suite 430
Baltimore, Maryland 21230
Telephone: (410) 537-3762
1-800-876-0200

BEFORE YOU MAIL… DON'T FORGET…

- **SIGN AND DATE THE APPLICATION. THE LANDOWNER MUST SIGN.**
- **SEVEN (7) COPIES OF ALL DOCUMENTS (APPLICATION, PLANS, MAPS, REPORTS, ETC.) MUST BE RECEIVED TO BEGIN OUR REVIEW.**
- **INCLUDE FIVE COPIES OF A VICINITY MAP (LOCATION MAP) WITH THE PROJECT SITE PINPOINTED.**
- **SEND AN APPLICATION FEE OF $750 ALONG WITH A COPY OF THE FIRST PAGE OF THE APPLICATION TO MARYLAND DEPARTMENT OF THE ENVIRONMENT, P.O. BOX 2057, BALTIMORE, MD 21203-2057. PLEASE REFER TO OUR WEBSITE http://www.mde.state.md.us/wetlands FOR FURTHER INSTRUCTIONS.**

**SAMPLE PLANS MAY BE OBTAINED BY PHONE (1-800-876-0200)
OR E-MAIL acunabaugh@mde.state.md.us.**

SUPPLEMENTARY INFORMATION TO BE INCLUDED ON PLANS, DRAWINGS, OR VICINITY MAPS

In addition to the information indicated on the previous pages, you should include the following on the 8 1/2 x 11 site plans and any blueprints you have submitted:

1. Delineation of any wetland buffers or expanded buffers, clearly marked and differentiated.

2. Location of mitigation area, if proposed on the same site as the project.

Note: If you are proposing a complex project you may wish to submit engineering blueprints of your project with the application form to expedite review.

Mitigation Location Map: If you are proposing that nontidal wetland mitigation be done at a different location than the proposed project, you should submit a map showing the location of the mitigation site in relation to the proposed nontidal wetland losses.

WETLAND DELINEATION

Wetlands should be identified according to methods described in the publication Corps of Engineers Wetlands Delineation Manual (Wetlands Research Program Technical Report Y-87-1). Copies of the manual may be obtained by calling the U. S. Government Printing Office at 202-783-3238 and requesting document #024-010-00-683-8 at a cost of $7.50. Wetlands must be shown on all plans submitted with the application. All wetlands on site must be delineated and shown on the overall site plan. 8½ x 11 inch plans with topography showing relation of the wetlands and project impacts must be submitted. Copies of the wetland reports and data sheets used in making the determination be included with your application submittal.

Regulatory Agencies

Federal Permits

U.S. Army Corps of Engineers
Baltimore District
Attention: CENAB-OP-R
P. O. Box 1715
Baltimore, MD 21203-1715
Telephone: (410) 962-3670

Coastal Zone Consistency Statement

MD Dept. of the Environment
Water Management Administration
Wetlands and Waterways Program
1800 Washington Blvd, Ste 430
Baltimore, MD 21230
Telephone: (410) 537-3745

State Authorizations

MD Dept. of the Environment
Water Management Administration
Tidal Wetlands Division
1800 Washington Blvd, Ste 430
Baltimore, MD 21230
Telephone: (410) 537-3837

MD Dept. of the Environment
Water Management Administration
Nontidal Wetlands and Waterways Division
1800 Washington Blvd, Ste 430
Baltimore, MD 21230
Telephone: (410) 537-3768

APPENDIX G

BEST MANAGEMENT PRACTICES PAMPHLETS

Best Management Practices

While removing sediment is a more immediate fix for alleviating the increased sedimentation in the coves, practicing the suggested best management practices will reduce the rate of sedimentation for Deep Creek Lake over time. Such practices recommended for lakeside owners and community members include implementing the following:

(1) Vegetative Buffers/Strips – *Vegetated buffers are areas of natural or established vegetation maintained to protect the water quality of neighboring areas. Buffer zones slow stormwater runoff, provide an area where runoff can permeate the soil, contribute to ground water recharge, and filter sediment. Slowing runoff also helps to prevent soil erosion and streambank collapse. They can be used in any area that is able to support vegetation. They are most effective and beneficial on floodplains, near wetlands, along streambanks, and on unstable slopes. For homeowners whose lots abut Deep Creek Lake and its tributaries, buffers are a simple and effective BMP for protecting water quality. Homeowners can locate vegetated buffers in low areas on their lots that receive sheet flow runoff, such as the rear of a yard sloping away from a house or a lake shoreline.*

Vegetated buffer tips:

- *Vegetated buffers work well with sheet flows, but they are not appropriate for mitigating concentrated stormwater flows.*
- *Vegetated buffers should contain a mixture of native trees and shrubs. A good source for potential native plants can be found at http://ww.nativeplantcenter.net/guides/chesapeakenatives.pdf*

(2) Rain Barrels – *Cisterns and rain barrels harvest and store rainwater collected from roofs. By storing and diverting runoff, these devices help reduce the flooding and erosion caused by stormwater runoff. And because they contain no salts or sediment, they can provide "soft" chemical-free water for garden or lawn irrigation, reducing water bills and conserving municipal water supplies. Practices that store rooftop runoff, such as cisterns and rain barrels, are the simplest of all of the on-lot treatment systems. Some of these practices are available commercially and can be applied in a wide variety of site conditions.*

Rain Barrel Tips:

- *These practices require homeowners to perform some basic maintenance and winterization.*
- *For homeowners who do not enjoy landscaping, it may be difficult to find uses for water stored in rain barrels or cisterns, since the water is not potable.*
- *Some of these practices may be impractical on small lots.*
- *Rain barrels can be installed at one or more downspouts by homeowners and with their relative popularity interested homeowners can find a large amount of additional information on the Internet.*

(3) Grass Pavers – *Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used. Homeowners may consider grass paving as an alternative to other paved surfaces in an infrequently used driveway, overflow parking area, or boat/trailer storage area. A variety of grass paving materials are available on the market. Grass paving units are designed to carry vehicular loading and may be composed of different types of materials. The pavers are typically covered with sod to make the areas indistinguishable from other grassed areas. Grass pavers allow water quality benefits by allowing storm water to infiltrate into the underlying soils and by the filtering of storm water as it flows through the grass. Grass pavers provide a more aesthetically pleasing site and reduce the impact of complete asphalt surfaces. Grass pavers reduce the runoff volume and extend the time of concentration for a particular site. Some pavers provide enough infiltration to be considered a pervious area.*

Grass Paver Tips:

- *After installation of grass / turf pavers, maintenance is very minimal. It should be treated as if it were part of your front lawns. Therefore, you would water and mow the grass pavers system.*
- *Grass pavers should not be used for frequently traveled or parked-in areas, although segments of, or entire driveways that don't receive heavy parking lot use may be appropriate.*
- *Seeded turf grass is the most common infill used with grass pavers and usually consists of a Kentucky bluegrass/perennial rye mix.*

(4) Rain Gardens – *Bioretention areas, or rain gardens, are landscaping features adapted to provide on-site treatment of stormwater runoff. They are commonly located in parking lot islands or within small pockets of residential land uses. Homeowners can locate rain gardens where they will receive runoff from roof gutter down spouts or surface runoff from paved driveways or patios. Surface runoff is directed into shallow, landscaped depressions. These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems. During storms, runoff will pond above the mulch and soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the mulch and prepared soil mix. The filtered runoff can be collected in a perforated underdrain and returned to the storm drain system.*

Rain Garden Tips:

- *Bioretention areas can be applied in almost any soils or topography, since runoff percolates through a man-made soil bed and is returned to the stormwater system*
- *Bioretention areas are best applied to relatively shallow slopes (usually about 5 percent).*
- *Bioretention areas should usually be used on small sites (i.e., 5 acres or less).*

- *It is preferable to plant the area with native vegetation, or plants that provide habitat value, where possible, such as Red Maple, Black Gum, Soft Rush, Switchgrass, Broomsedge and Cardinal Flower.*

See Appendix G for the Pamphlets to be distributed as part of the study.

REMEMBER

In Garrett County, our storm water management system has to protect the largest inland body of water in Maryland. The tributary and surface water management features work together to help Deep Creek continue to meet recreation, aesthetic and habitat needs. Garrett County homeowners collectively have a great influence over the quality of storm water. We hope this Best Management Practice brochure has given you some ideas on how you can be a part of the team to restore Deep Creek and meet Garrett County's future urban water needs. This brochure is intended to get you started.

For more information contact:

Maryland Department of Natural Resources
580 Taylor Avenue - Annapolis, MD 21401
1-877-620-8DNR / www.dnr.state.md.us

Prepared by:

WBCM
ARCHITECTURE ENGINEERING CONSTRUCTION

www.wbcm.com

LANDSCAPE BEST MANAGEMENT PRACTICES

FOR DEEP CREEK LAKE

GARRETT COUNTY, MARYLAND

MARYLAND DEPARTMENT OF NATURAL RESOURCES

BMPs

LANDSCAPE BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) are guidelines for landscape maintenance that keep landscapes visually attractive while conserving our water resources, reducing pollution and protecting our fragile environment. By implementing simple BMPs recommended in this manual, urban landscapes can better coexist with the natural environment.

WHY DO WE NEED BMPs?

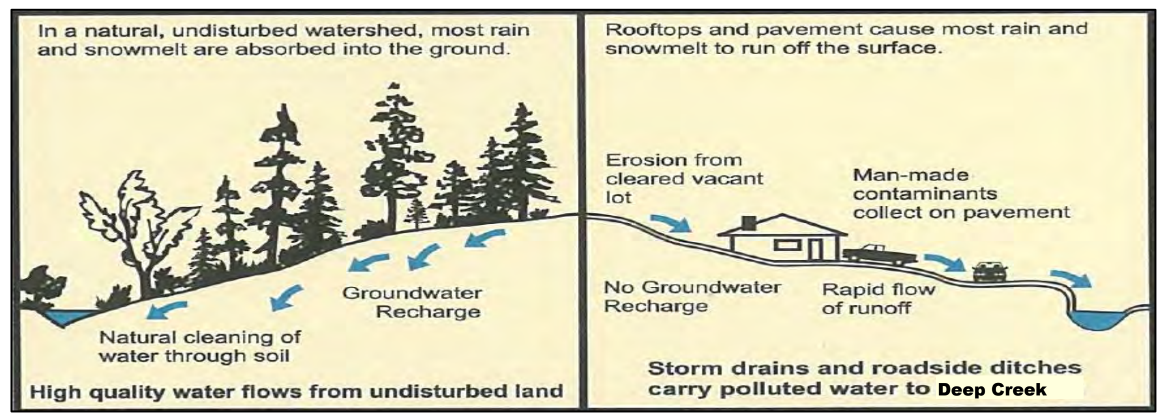
Since 1925, when the Deep Creek hydroelectric project created Deep Creek Lake in what was once valleys and farms, the area has grown into an enormously popular tourist destination. Land use transformations have greatly impacted our shorelines. Impervious surfaces such as roads and parking lots decrease the land's ability to absorb, filter, and store rain water before it flows into the lake. The natural process of sedimentation, where soil is deposited through erosion into waterbodies, is now a great concern. Estimates of the annual loading are as high as 40,000 tons.

SOURCES OF SEDIMENTAION

When it rains in Garrett County, sediment washes off roads and other hard surfaces and is often carried by storm water into the lake's tributaries. Natural, gradual shoreline erosion is also contributing to the sediment loading. Fortunately, there are ways to reduce the amount of sediment entering the receiving waters.

SEDIMENT IMPACTS

Sediment is a talked-about topic in the Deep Creek watershed. While water quality continues to meet regulatory standards, the lake's eroding shorelines threaten the lake's aesthetic value, by making waters murky. Drinking water treatment becomes more difficult and costly with the need for more filtration. Plant life struggles when sunlight can't reach as far below the surface. Fish have more difficulty finding food in the turgid water. And bottom-dwelling species such as insect larvae are sometimes buried too deeply to survive.



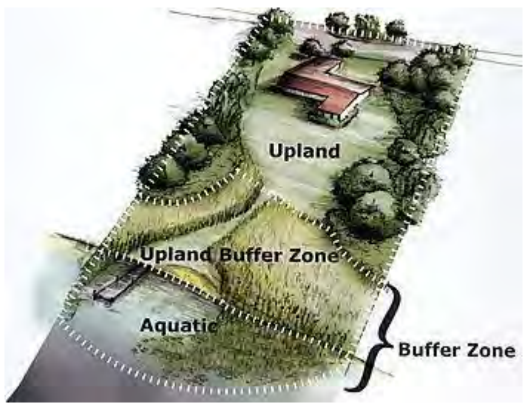
Source: Nevada Tahoe Conservation District

WHAT YOU CAN DO TO HELP…

VEGETATED BUFFERS/STRIPS

Vegetated buffers are areas of natural or established vegetation maintained to protect the water quality of neighboring areas. Buffer zones slow stormwater runoff, provide an area where runoff can permeate the soil, contribute to ground water recharge, and filter sediment. Slowing runoff also helps to prevent soil erosion and streambank collapse.

Vegetated buffers can be used in any area able to support vegetation. They are most effective and beneficial on floodplains, near wetlands, along streambanks, and on unstable slopes. For homeowners whose lots abut Deep Creek Lake and its tributaries, buffers are a simple and effective BMP for protecting water quality. Homeowners can locate vegetated buffers in low areas on their lots that receive sheet flow runoff, such as the rear of a yard sloping away from a house, ora lake shoreline.



Source: www.co.douglas.mn.us

VEGETATED BUFFER TIPS:

- Vegetated buffers work well with sheet flows, but they are not appropriate for mitigating concentrated stormwater flows.
- Vegetated buffers should contain a mixture of native trees and shrubs. A good source for potential native plants can be found at http://ww.nativeplantcenter.net/guides/chesapeakenatives.pdf

Source: EPA

RAIN BARRELS

Cisterns and rain barrels harvest and store rainwater collected from roofs. By storing and diverting runoff, these devices help reduce the flooding and erosion caused by stormwater runoff. And because they contain no salts or sediment, they can provide "soft" chemical-free water for garden or lawn irrigation, reducing water bills and conserving municipal water supplies.

Source: Rainbarrelsrus.com

Practices that store rooftop runoff, such as cisterns and rain barrels, are the simplest of all of the on-lot treatment systems. Some of these practices are available commercially and can be applied in a wide variety of site conditions. If the home is a rental property, rain barrels may not be the best option because they are only effective is someone uses the water between storm events.

RAIN BARREL TIPS:

- These practices require homeowners to perform some basic maintenance and winterization.
- For homeowners who do not enjoy landscaping, it may be difficult to find uses for water stored in rain barrels or cisterns, since the water is not potable.
- Some of these practices may be impractical on small lots.
- Rain barrels can be installed at one or more downspouts by homeowners and with their relative popularity interested homeowners can find a large amount of additional information on the Internet.

Source: EPA

GRASS PAVERS

Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used, Homeowners may consider grass paving as an alternative to other paved surfaces in an infrequently used driveway, overflow parking area, or boat/trailer storage area. A variety of grass paving materials are available on the market. Grass paving units are designed to carry vehicular loading and may be composed of different types of materials. The pavers are typically covered with sod to make the areas indistinguishable from other grassed areas. Grass pavers allow water quality benefits by allowing storm water to infiltrate into the underlying soils and by the filtering of storm water as it flows through the grass. Grass pavers provide a more aesthetically pleasing site and reduce the impact of complete asphalt surfaces. Grass pavers reduce the runoff volume and extend the time of concentration for a particular site. Some pavers provide enough infiltration to be considered a pervious area. (**Source: South Carolina Department of Health and Environmental Control**)

Source: Patiopavers.freevar.com

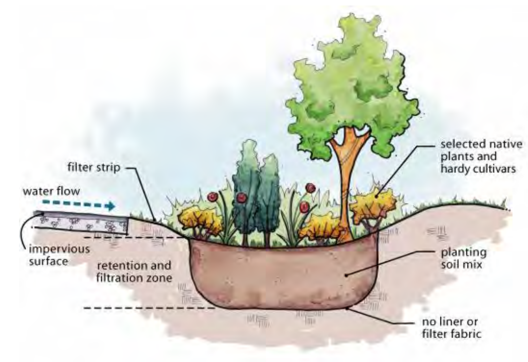
GRASS PAVER TIPS:

- After installation of grass / turf pavers, maintenance is very minimal. It should be treated as if it were part of your front lawns. Therefore, you would water and mow the grass pavers system.
- Grass pavers should not be used for frequently traveled or parked-in areas, although segments of, or entire driveways that don't receive heavy parking lot use may be appropriate.
- Seeded turf grass is the most common infill used with grass pavers and usually consists of a Kentucky bluegrass/perennial rye mix.

Source: ecodepotusa.com

RAIN GARDENS

Bioretention areas, or rain gardens, are landscaping features adapted to provide on-site treatment of stormwater runoff. They are commonly located in parking lot islands or within small pockets of residential land uses. Homeowners can locate rain gardens where they will receive runoff from roof gutter down spouts or surface runoff from paved driveways or patios. Surface runoff is directed into shallow, landscaped depressions. These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems. During storms, runoff ponds above the mulch and soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the mulch and prepared soil mix. The filtered runoff can be collected in a perforated underdrain and returned to the storm drain system.



Source: Snohomish Conservation District.

RAIN GARDEN TIPS:

- Bioretention areas can be applied in almost any soils or topography, since runoff percolates through a man-made soil bed and is returned to the stormwater system
- Bioretention areas are best applied to relatively shallow slopes (usually about 5 percent).
- Bioretention areas should usually be used on small sites (i.e., 5 acres or less).
- It is preferable to plant the area with native vegetation, or plants that provide habitat value, where possible, such as Red Maple, Black Gum, Soft Rush, Switchgrass, Broomsedge and Cardinal Flower.

Source: EPA

MINIMIZING SEDIMENT TRANSPORT INTO DEEP CREEK LAKE

A GUIDANCE HANDBOOK FOR LAND PLANNING AND CONSTRUCTION PRACTICES

Draft Review Submission: July 12, 2013

Maryland Department
of Natural Resources

Acknowledgements

This guidance handbook for Deep Creek Lake would not have been possible without the time and effort put in by multiple organizations and individuals. Whitney, Bailey, Cox & Magnani wishes to thank the following funders, agencies, consulting firms and staff:

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Whitney, Bailey, Cox & Magnani, LLC

Prepared by:

WBCM
ARCHITECTURE ENGINEERING CONSTRUCTION

Whitney, Bailey, Cox & Magnani LLC

Front cover photo: Kayla Clem

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SUMMARY

Since 1925, when the Deep Creek hydroelectric project created Deep Creek Lake in what was once valleys and farms, the area has grown into an enormously popular tourist destination. Deep forests, diverse wildlife, and rich river valleys, combined with a close proximity to major metropolitan areas such as Pittsburgh, Washington and Baltimore, attract a wide variety of recreational users.

Over the years land use transformation have begun to greatly affect the 65 miles of shoreline. Impervious surfaces such as roads and parking lots decrease the land's ability to absorb, filter and store rain water before it flows into the lake. The natural process of sedimentation, where soil is deposited through erosion into waterbodies, is now a great concern. Estimates of the annual loading are as high as 40,000 tons.

Sediment is a talked-about topic in the Deep Creek watershed. While water quality continues to meet regulatory standards, the lake's eroding shorelines threaten the lake's aesthetic value by making waters murky. Drinking water treatment becomes more difficult and costly with the need for more filtration. Plantlife struggles when sunlight can't reach as far below the surface. Fish have more difficulty finding food in the turgid water. And bottom-dwelling species such as clams and insect larvae are sometimes buried too deeply to survive.

The purpose of this guidance manual is to describe potential best management practices that may be used on a voluntary basis to help prevent soil erosion that contributes to the sedimentation of Deep Creek Lake. This manual is divided into three parts:

Part 1: Erosion and Sediment Control Principles
Part 2: Erosion Control Practices for Existing and Proposed Development
Part 3: Agricultural Programs and Practices

Part 1 provides an overview and description of the erosion and sedimentation process and the damage this can cause, while also discussing basics of control procedures. Part 2 is geared towards home owners associations, commercial sites, and developers of small residential communities and commercial areas. It provides an overview of several specific best management practices that may be implement during or post construction to control erosion and reduce the amount of sediment contributed to the lake. Part 3 is geared towards agricultural land use and provides an overview of potential conservation practices as well as resources for additional information and other available programs.

In situations where a development activity would trigger a regulatory requirement or permitting process that references a design or standards manual that document would take precedence over this guidance document.

PART 1: EROSION AND SEDIMENT CONTROL PRINCIPLES

THE EROSION PROCESS

Soil erosion is the process by which the land's surface is worn away by the action of wind, water, ice and gravity. Natural, or geologic erosion has been occurring at a relatively slow rate since the earth was formed, and is a tremendous factor in creating the earth as we know it today. The picturesque mountains of the west, the rolling farmlands of the Piedmont, and the productive estuaries of the Coastal Zone are all products of geologic erosion and sedimentation. Except for some cases of shoreline and stream channel erosion, natural erosion occurs at a very slow and uniform rate and remains a vital factor in maintaining environmental balance.

Water-generated erosion is unquestionably the most severe type of erosion, particularly in developing areas; it is, therefore, the problem to which this handbook is primarily addressed. It is helpful to think of the erosive action of water as the effects on the energy developed by rain as it falls, or as the energy derived from its motion as it runs off the land surface. The force of falling raindrops is applied vertically, and force of flowing water is applied horizontally. Although the direction of the forces created is different, they both perform work in detaching and moving soil particles.

Water-generated erosion can be broken down into the following types:

<u>Raindrop erosion</u> is the first effect on a rainstorm on the soil. Raindrop impact dislodges soil particles and splashes them into the air. These detached particles are then vulnerable to the next type of erosion.

<u>Sheet erosion</u> is the erosion caused by the shallow flow of water as it runs off the land. These very shallow moving sheets of water are seldom the detaching agent, but the flow transports soil particles which are detached by raindrop impact and splash. The shallow surface flow rarely moves as a uniform sheet for more than a few feet on land surfaces before concentrating in the surface irregularities.

<u>Rill erosion</u> is the erosion which develops as the shallow surface flow begins to concentrate in the low spots of the irregular contours of the surface. As the flow changes from the shallow sheet flow to deeper flow in these low areas, the velocity and disturbance of flow increase. The energy of this concentrated flow is able to both detach and transport soil materials. This action begins to cut small channels of its own. Rills are small but well-defined channels which are at most only a few inches in depth. They are easily obliterated by harrowing or other surface treatments.

<u>Gully erosion</u> occurs as the flow in rills comes together in larger and larger channels. The major difference between gully and rill erosion is a matter of magnitude. Gullies are too large to be repaired with conventional tillage equipment and usually require heavy equipment and special techniques for stabilization.

Channel erosion occurs as the volume and velocity of flow causes movement of the stream bed and bank materials.

FACTORS INFLUENCING EROSION

The erosion potential of any area is determined by four principal factors: The characteristics of its soil, its vegetative cover, its topography and its climate. Although each of these factors is discussed separately herein, they are inter-related in determining erosion potential.

Soil characteristics which influence the potential for erosion by rainfall and runoff are those properties which affect the infiltration capacity of a soil and those which affect the resistance of the soil to detachment and being carried away by falling or flowing water. The following four factors are important in determining soil erodibility:

1. Soil texture (particle size and gradation)
2. Percentage of organic contents
3. Soil structure
4. Soil permeability

Soils containing high percentages of fine sands and silt are normally the most erodible. As the clay and organic matter content of these soils increases, the erodibility decreases. Clays act as binder to soil particles, thus reducing erodibility. However, while clays have tendency to resist erosion, once eroded, they are easily transported by water. Soils high in organic matter have a more stable structure which improves their permeability. Such solid resist raindrop detachment and infiltrate more rainwater. Clear, well-drained and well-graded gravel and gravel-sand mixtures are usually the least erodible soils. Soils with high infiltration rates and permeabilities either prevent or delay and reduce the amount of runoff.

Vegetative cover plays an extremely important role in controlling erosion as it provides the following five benefits:

1. Shields the soil surface from raindrop impact
2. Root systems hold soil particles in place
3. Slows the velocity of runoff
4. Removes subsurface water between rainfalls through the process of evaporation

By limiting and staging the removal of existing vegetation and by decreasing the area and duration of exposure, soil erosion and sedimentation can be significantly reduced. Special consideration should be given to the maintenance of existing vegetative cover on areas of high erosion potential such as moderately to highly erodible soils, steep slopes, drainageways, and the banks of streams.

Topography. The size, shape, and slope characteristics of a watershed influence the amount and rate of runoff. As both slope length and gradient increase, the rate of runoff increases and the potential for erosion in magnified. Slope orientation can also be a factor in determining erosion potential. For example, a slope that faces south and contains droughty soils may have such poor growing conditions that vegetative cover will be difficult to reestablish.

Climate. The frequency, intensity, and duration of rainfall are fundamental factors in determining the amounts of runoff produced in a given area. As both the volume and velocity of runoff increases, the capacity of runoff to detach and transport soil particles also increases. Where storms are frequent, intense, or of long duration, erosion risks are high. Seasonal changes in temperature, as well as variations in rainfall, help to define the high erosion risk period of the year. When precipitation falls as snow, no erosion will take place. However, when the temperature rises, melting snow adds to runoff, and erosion hazards are high. Because the ground is still partially frozen, it absorptive capacity is reduced. Frozen soils are relatively erosion-resistant; however, they are subject to uplift by freezing action and are usually very easily eroded upon thawing. This freeze/thaw process particularly affects the far Western Maryland counties.

SEDIMENTATION

Normally, runoff builds up rapidly to a peak and then diminishes. Excessive quantities of sediment are derived by erosion, principally during the higher flows. During lower flows, as the velocity of runoff decreases, the transported materials are deposited to be picked up by later peak flows. In this way, sediments are carries downslope, or downstream, intermittently and progressively from their source or point of origin.

SEDIMENT POLLUTION AND DAMAGE

Sediment pollution is soil out of place. It is a product of the activities of man which lead to severe soil loss. When these large quantities of soil enter our waters, then sediment pollution occurs.

Excessive quantities of sediment cause costly damage to waters and to private and public lands. Obstruction of stream channels by masses of deposited sediment reduces their hydraulic capacity which, in turn, causes an increase in subsequent flood crests and a consequent increase in the frequency of damaging storm events.

Sediment rill drainage channels, especially along highways and railroads, and plugs culverts and storm drainage systems, thus necessitating frequent and costly maintenance. Municipal and industrial water supply reservoirs lose storage capacity, the usefulness of recreational impoundments is impaired or destroyed, navigable channels must be continually dredged and the cost of water purification preparatory to domestic or industrial use becomes excessive – and sometimes exorbitant.

In an aquatic environment, the general effect of fine-graded sediments such as clays, silts, and fins sands is to reduce drastically both the kinds and the amounts of organisms present. Sediments alter the existing aquatic environment by screening out sunlight and by changing the rate and the amount of heat radiation. Particles of silt settling on stream and lake bottoms from a blanket which creates a hostile environment for the organisms living there and literally smothers many of them and their eggs. The disastrous effect (upon commercially valuable finfish and shellfish populations) of excessive amounts of silt entering estuarine waters was widely publicized in the case of Chesapeake Bay following flooding of its main tributary, the Susquehanna River, caused by Hurricane “Agnes” in 1972.

Coarser-grained materials also blanket bottom areas to suppress aquatic life found in these areas. Where currents are sufficiently strong to move the bedload, the abrasive action of these materials in motion accelerates channel scour and has an even more severely deleterious effect upon aquatic life. The aesthetic attraction of many streams, lakes, and reservoirs used for swimming, boating, fishing, and other water-related recreational activities has been seriously impaired or destroyed by bank cutting and channel scour – accelerated by the higher flood stages induced by sedimentation.

EROSION AND SEDIMENT HAZARDS ASSOCIATED WITH LAND DEVELOPMENT

The principal effect land development activities have on the natural or geologic erosion process consists of exposing disturbed soils to precipitation and to surface storm runoff. Shaping of land for construction or development purposes alters the soil cover and the soil in many ways, often detrimentally affecting on-site drainage and storm runoff patterns and eventually the off-site stream and stream flow characteristics. Protective vegetation is reduced or removed, excavations are made, topography is altered and the removed soil material is stockpiled often without protective cover. In effect, the physical properties of the soil itself are changed. The development process in such that many citizens of a locality may be adversely affected even by development of areas of only limited size. Uncontrolled erosion and sediment from these areas often causes considerable economic damage to individuals. Surface water pollution, channel and reservoir siltation and damage to public facilities, as well as to private property, are come on many examples of problems caused by uncontrolled erosion and sedimentation.

Potential hazards associated with development include:

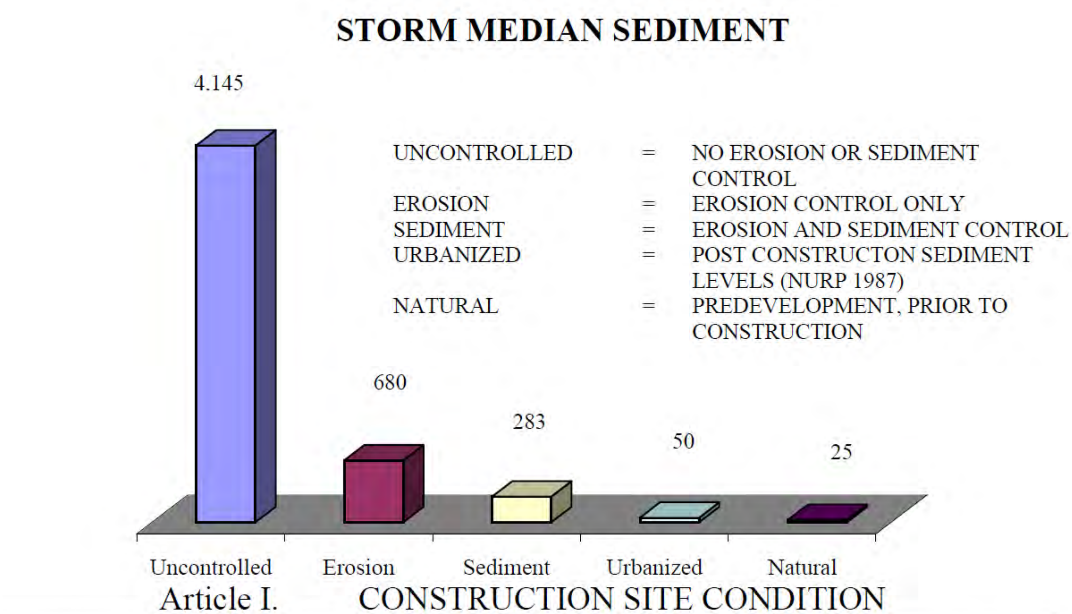
1. A large increase in areas exposed to storm runoff and soil erosion.
2. Increased volumes of storm runoff, accelerated soil erosion and sediment yield and higher peak flows caused by:
   a. Removal of existing protective vegetative cover.
   b. Exposure to underlying soil or geologic formations which are less pervious and/or more erodible than original soil surface.
   c. Reduced capacity of exposed soils to absorb rainfall due to compaction caused by heavy equipment.
   d. Enlarged drainage areas caused by grading operations, diversions, and street constructions.
   e. Prolonged exposure of unprotected disturbed areas due to scheduling problems and/or delayed construction.
   f. Shortened times of concentration of surface runoff caused by altering steepness, distance and surface roughness and through installation of “improved” storm drainage facilities.
   g. Increased impervious surfaces associated with the construction of streets, buildings, sidewalks and paved driveways and parking lots.
3. Alteration of the groundwater regime that may adversely affect drainage systems, slope stability and survival of existing and/or newly established vegetation.
4. Creation of south and west directional exposure of property which may hinder plant growth due to adverse temperature and moisture conditions.
5. Exposure to subsurface materials that are rocky, acid, droughty or otherwise unfavorable to the establishment of vegetation.
6. Adverse alteration of surface runoff patterns by construction and development.

Increases in sedimentation yield higher levels of nutrients and toxicants. The result of high sediment loading can have a profound effect on the environment. Sediment acts like a magnet to toxicants and trace metals. Additionally, the soil introduces nutrients into streams and groundwater. The net effect is to create strata known as diagenesis. This activity decreases the oxygen available to support other aquatic life. Even more startling is the apparent ability to sediment to act as a long term memory or storage media for toxicants. Studies show that pollutants such as DDT, DDE, PCBs and chlordane whose use has been banned or highly restricted, can still be found at detectable levels in sediment deposited years ago in the bottom of streams and rivers. It has been demonstrated that urbanization and associated sedimentation reduces the diversity of the fish populations in streams as well as the organisms that fish feed on.

Responsible development requires that steps be taken to control erosion and sedimentation from construction sites. **Figure1** demonstrates the ability of good erosion and sediment controls, versus no controls, in minimizing the detrimental effects of sedimentation.

This figure also demonstrates the fact that once a naturally vegetated area has been developed, sediment level can be twice the pre-development rate. It is well known that the erosion and sediment threat is greatest during construction; once development is complete (stabilization techniques implemented), there is a drastic decrease in the pollutant level yield.

Figure 1: Effectiveness of Sediment Control on Reducing Pollution



Source: Performance of Current Sediment Control Measures at Maryland Construction Sites, Virginia Erosion and Sediment Control Handbook

DOLLARS AND SENSE

It is well known that urbanization has the following effects:

- Accelerated Rate of Soil Erosion
- Increase in the Peak Discharge and Total Volume of Stormwater
- Increase Potential for “Flash” Flooding
- Decreased Groundwater Recharge

- Increased Temperature in Natural Receiving Channels
- Increased Pollutant Loading to Receiving Waters

Each of these factors has and associated cost. The Maryland Department of the Environment attempts to minimize these costs by regulating land-disturbing activities in the State. All of the citizens of Maryland stand to gain when local erosion and sediment control (E&S) programs are effective and developers follow responsible management procedures. The new results are dollars saved and a direct benefit to the environment.

BASIC PRINCIPLES OF DESIGN AND CONTROL

For an erosion and sediment control program to be effective, it is imperative that provisions for sediment control measures be made in the planning stage. These planned measures, when conscientiously and expeditiously applied during construction, will result in orderly development, which minimizes environmental degradation. From the previous discussion about erosion and sediment control processes and the factors affecting erosion, basic technical principles can be formulated to assist the project planner or designer in providing for effective sediment control. These principles should be utilized to the maximum extent possible on all projects.

1. Plan the development to fit the particular topography, soils, drainage patterns and natural vegetation of the site.

Detailed planning should be employed to assure that roadways, buildings, and other permanent features of the development conform to the natural characteristics of the site. Large graded areas should be located on the most level portion of the site. Areas subject to flooding should be avoided, and floodplains should be kept free from filling and other development. Areas with steep slopes, erodible soils and soils with severe limitations for the intended use should not be utilized without first overcoming the limitations through sound engineering practices. For instance, long steep slopes can be broken by benching, terracing, or construction diversion structures and thus will not become an erosion problem or transfer a problem down the grade.

Erosion control, development and maintenance costs can be minimized by selecting a site suitable by its nature for a specific proposed activity, rather than by attempting to modify a site to perform to a proposed activity. This kind of planning can be more easily accomplished where there is a general land-use plan based upon a comprehensive inventory of soils, water and other related resources.

2. Minimize the extent of the area exposed at one time and duration of exposure.

When earth changes are required and the natural vegetation is removed, keep the area and the duration of exposure to a minimum. Plan the phases or stages of development so that only the areas which are actively being developed are exposed. All other areas should have a good cover of temporary or permanent vegetation or mulch. Grading should be completed as soon as possible after it is begun. Immediately after grading is completed, permanent vegetative cover should be established in the area. As cut slopes are made and as fill slopes are brought up to grade, these areas should be revegetated as the work progresses. This is known as staged seeding. Minimizing grading of large or critical areas during the seasons of maximum erosion potential – spring thaw in February and March and the thunderstorm season from May through September reduces the risk of erosion (60).

3. Apply erosion control practices to prevent excessive on-site damage.

This third principal relates to using practices that control erosion on a site to prevent excessive sediment from being produced. Keep soil covered as much as possible with temporary or permanent vegetation or with various mulch materials. Special grading methods such as roughening a slope on the contour or tracking with a cleated dozer may be used. Other practices include diversion structures to divert surface runoff from exposed soils and grade stabilization to control surface water.

"Gross" erosion in the form of gullies must be prevented by these water control devices. Lesser types of erosion such as sheet or rill erosion should be prevented but, often, scheduling or the large number of practices required makes this impractical. However, when erosion is not adequately controlled at the source, sediment control for the project as a whole is more difficult and expensive.

4. Apply perimeter control practices to protect the disturbed area from off-site runoff and to prevent sedimentation damage to area below the development site.

This principle relates to using practices that effectively isolate the development site from surrounding properties and especially to controlling sediment once it is produced and preventing its transport form the site.

Diversions, dikes, sediment traps, vegetative filters and sediment basins are examples of practices which control Sediment. Vegetative and structural sediment control measures can be classified as either temporary or permanent depending on whether or not they will remain in use after development is complete. Generally, sediment can be retained by two methods: a) filtering runoff as it flows through an area, and b) impounding the sediment-laden runoff for a period of time so that the soil particulates settle out. Many practices are combination of these two methods. The best way to control sediment, however, is to prevent erosion as discussed in the third principle.

5. Keep runoff velocities low and retain runoff on the site.

The removal of existing vegetative cover and the resulting increase in impermeable surface area during development will increase both the volume and velocity of runoff. These increases must be taken into account when providing natural vegetative cover can keep stormwater velocities low and limit erosion hazards. Runoff from the development should be safely conveyed to a stable outlet using storm drains, diversions, stable waterways, riprapped channels or similar measures. Consideration should be given to the installation of stromwater retention or detention structures when there is potential for flooding and damage to downstream facilities resulting from increased runoff from the site. Conveyance systems should be designed to withstand the velocities or projected peak discharges. These facilities should be operational as soon as possible after the start of construction.

6. Stabilize disturbed area immediately after final grade has been attained.

Permanent structures, temporary or permanent vegetation, and mulch, or a combination of these measures should be employed as quickly as possible after the land is disturbed. Temporary vegetation and mulches can be most effective where or when it is not practical to establish permanent vegetation. Such temporary measures should be employed immediately after rough grading is completed if a delay is anticipated in obtaining finished grade. The finished slope of a cut or fill should be stable, and ease of maintenance should be considered in the design. Stabilize roadways, parking areas, and paved areas with a gravel sub-base whenever possible.

7. Implement a thorough maintenance and follow-up program.

This last principle is vital to the success of the other six principles. A site cannot be effectively controlled without thorough, periodic checks of the erosion and sediment control practices.

These practices must be maintained just as construction equipment must be maintained and materials checked and inventoried. An example of applying this principle would be to start a routine “end of day check” to make sure that all control practices are working properly. Usually, these seven principles are integrated into a system of vegetative and structural measures along with management techniques and the “Minimum Standards” to develop a plan to prevent erosion and control sediment. In most cases, a combination of limited grading, limited time if exposure, and a judicious selection of erosion control practices and sediment trapping facilities will prove to be the most practical method of controlling erosion and the associated production and transport of sediment.

REFERENCES:
1. Virginia Department of Conservation and Recreation, “Erosion and Sediment Control Handbook”.
2. Metropolitan Washington Council of Governments, “Performance of Current Sediment Control Measures at Maryland Construction Sites”.

PART 2: EROSION CONTROL PRACTICES FOR EXISTING AND PROPOSED DEVELOPMENTS

OVERVIEW

Erosion control can be incorporated into new and existing landscapes to prevent soil from washing away. In many cases the control methods will not only prevent the transport of soil in storm runoff, but will enhance the landscape by holding back valuable soil nutrients.

The three basic methods to reduce erosion and prevent transporting of sediment and pollutants to streams and bodies of water are:

- Reduce runoff velocity and maintain sheet flow to encourage disposition of sediments in upland areas.
- Employ filtering practices that capture sediments and pollutants before they reach waterways.
- Stabilize upland and stream bank soil so that erosion resistant vegetation can become established.

These methods can be implemented in new developments through gently sloped or terraced grading and landscaping techniques, utilizing some vegetated swales for storm runoff collection in lieu of all closed pipe systems, and employing engineered bioretention in upland areas.

Existing developed sites and stream banks can be retrofitted with micro-scale bioretention, landscaping, soil stabilization, and proprietary manufactured devices that could significantly reduce sediment and pollutant loading in local streams and Deep Creek Lake.

LAND GRADING AND LANDSCAPE PRACTICES

Vegetated Filter Strip

A vegetated filter strip is a densely vegetated strip of land graded to accept runoff from upstream development as overland sheet flow. It may adopt any naturally vegetated form, from grassy meadow to small forest (see **Figure 2**).

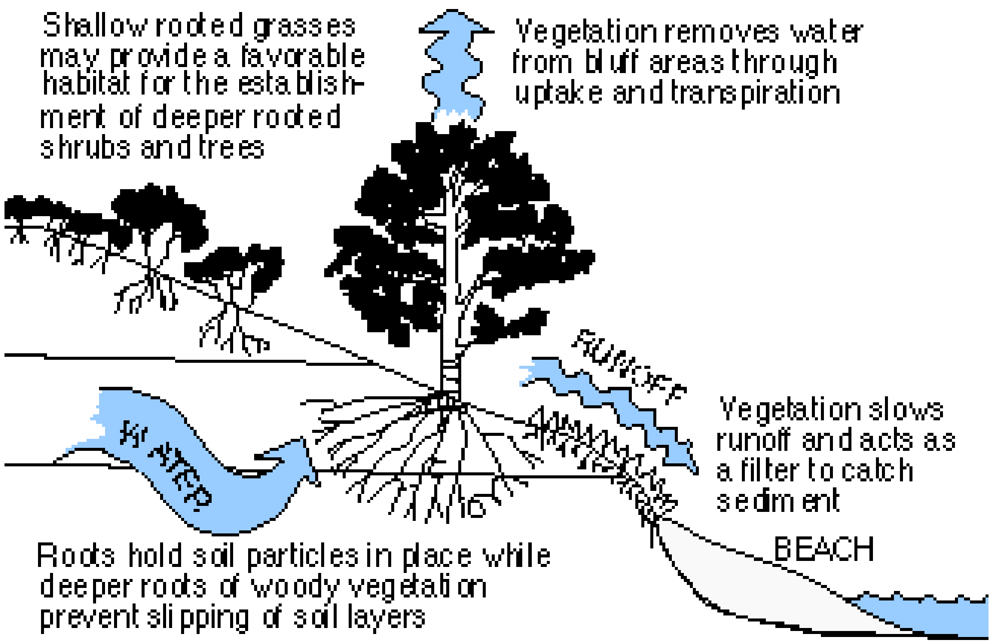
The purpose of a vegetated filter strip is to enhance the quality of stormwater runoff through filtration, sediment deposition, infiltration and absorption.

A vegetated filter strip may be used as pretreatment in conjunction with a primary stormwater management Best Management Practice (BMP), or water pollution control, feature. This reduces the sediment and particulate pollutant load that could reach the primary BMP, which, in turn, reduces the BMP’s maintenance costs and enhances its removal capabilities.

Vegetated filter strips rely on their flat cross-slope and dense vegetation to enhance water quality. Their flat cross-slope assures that runoff remains as sheet flow while filtering through the vegetation. There is limited ponding or storage associated with these strips, so they are ineffective for reducing peak discharges. Vegetated filter strips may lower runoff velocities and, sometimes, runoff volume. Typically, however, the volume reduction is not adequate for controlling stream channel erosion or flooding.

Vegetated filter strips have historically been used and proven successful on agricultural lands, primarily due to their low runoff volumes. In urban settings, filter strips are most effective in treating runoff from isolated impervious areas such as rooftops, small parking areas, and other small impervious areas. Filter strips should not be used to control large impervious areas.

Figure 2: Vegetated Filter Strip



Source: University of Minnesota

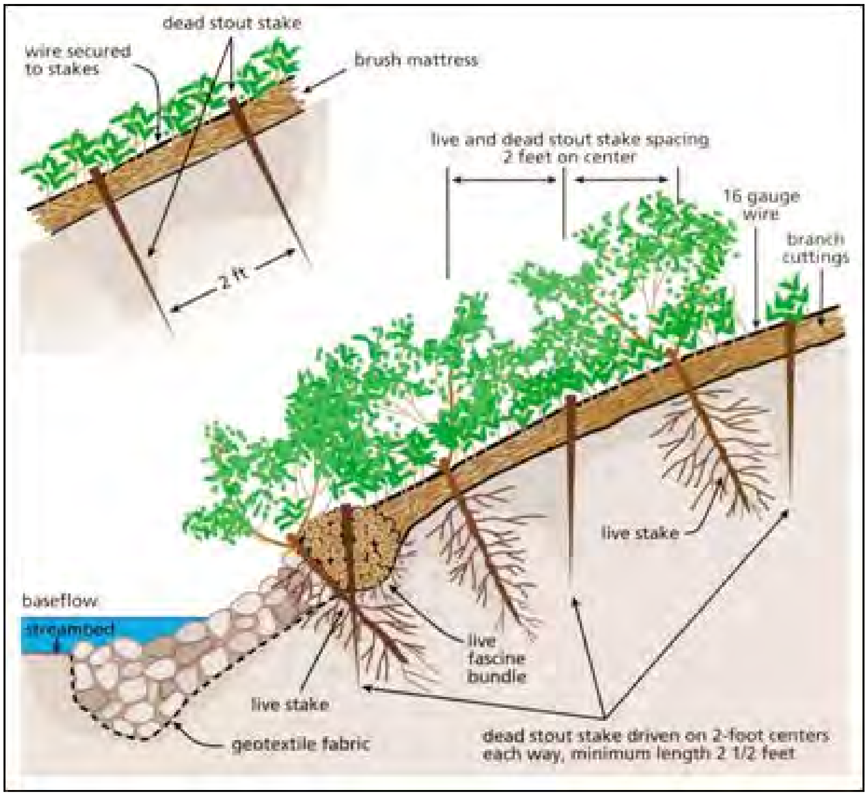
Vegetated Stream Bank Stabilization

This is a method where dense vegetation is established along stream banks to protect them from the erosive forces of flowing water (see **Figure 3**).

As a result of upstream development stream channels that were once parabolic in shape and covered in vegetation are often transformed into wide rectangular channels with barren banks. Stabilization of the stream banks utilizing living plants instead of or in conjunction with structures has many advantages. The degree of protection, which may be low to start with, increases as the plants grow and spread. The repair and maintenance of structures is unnecessary where self-maintaining stream bank plants are established. The protection provided by natural vegetation is more reliable and effective where the cover consists of natural plant communities which are native to the region.

Planting vegetation is less damaging to the environment than installing structures. Vegetation also provides habitat for fish and wildlife and is aesthetically pleasing. Plants provide erosion protection to stream banks by reducing stream velocity, binding soil in place with a root mat and covering the soil surface when high flows tend to flatten vegetation against the banks.

Figure 3: Vegetated Stream Bank Stabilization



Source: USDA - NRCS EFH Chapter-16

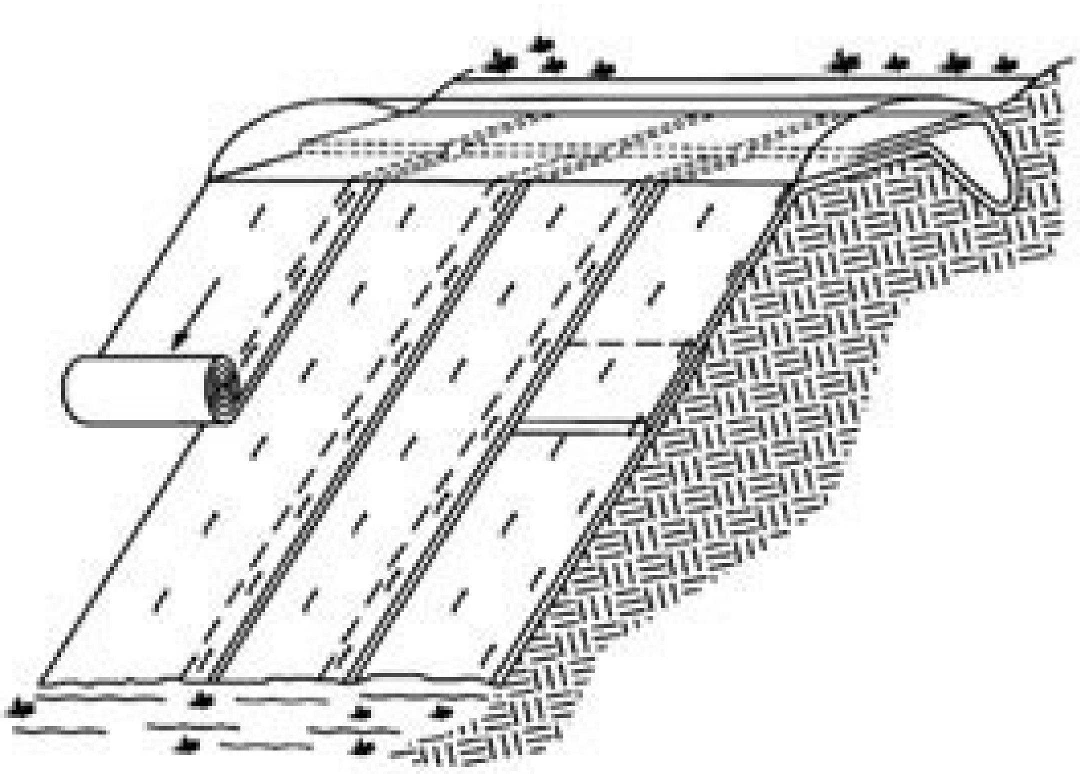
Soil Stabilization Blankets And Matting

The installation of a protective covering (blanket) or a soil stabilization mat on a prepared planting area of an existing eroded slope or newly graded steep slope, channel or shoreline (see **Figure 4**).

These devices aid in controlling erosion on critical areas by providing a microclimate which protects young vegetation and promotes its establishment. In addition, some types of soil stabilization mats are also used to raise the maximum permissible velocity of turf grass stands in channelized areas by “reinforcing the turf” to resist the forces of erosion during storm events.

This practice can be applied on short, steep slopes where erosive hazard is high and planting is likely to be too slow in providing adequate protective cover; in vegetated channels where the velocity of design flow exceeds “allowable” velocity; on stream banks or tidal shorelines where moving water is likely to wash out new plantings; or In areas where the forces of wind prevent standard mulching practices from remaining in place until vegetation becomes established.

Figure 4: Slope Stabilization Matting



Source: Nedia Enterprises Inc.

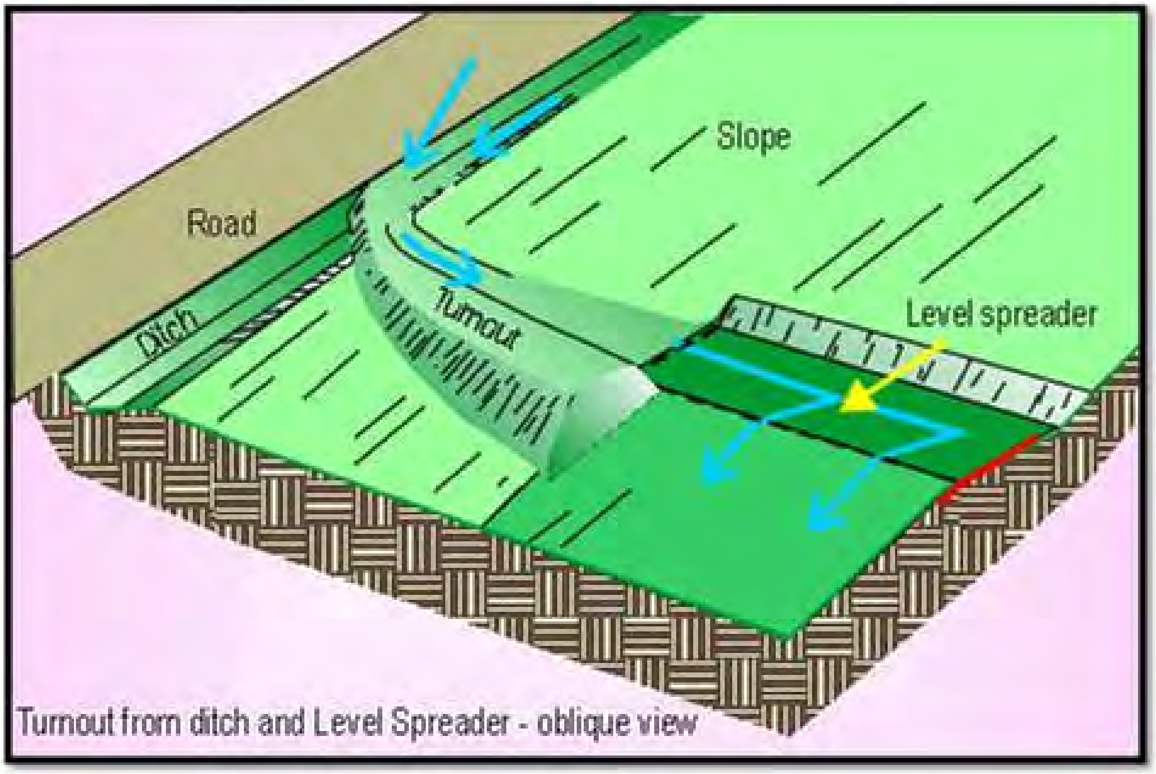
Level Spreader

A level spreader is one of the most efficient ways of creating diffuse or sheet flow from concentrated flows and releasing it uniformly onto vegetatively stabilized areas (see **Figure 5**).

It can be of structural or non-structural construction. Concentrated flows enter the spreader through a pipe, ditch, or swale and are redistributed throughout a long linear shallow trench or behind a low berm, exiting the device as sheet flow.

These devices are effective in reducing storm runoff velocity so that sediments and pollutants can settle out before they enter stream or aquatic systems.

Figure 5: Level Spreader



Source: Vermont DEC

ENGINEERED PRACTICES

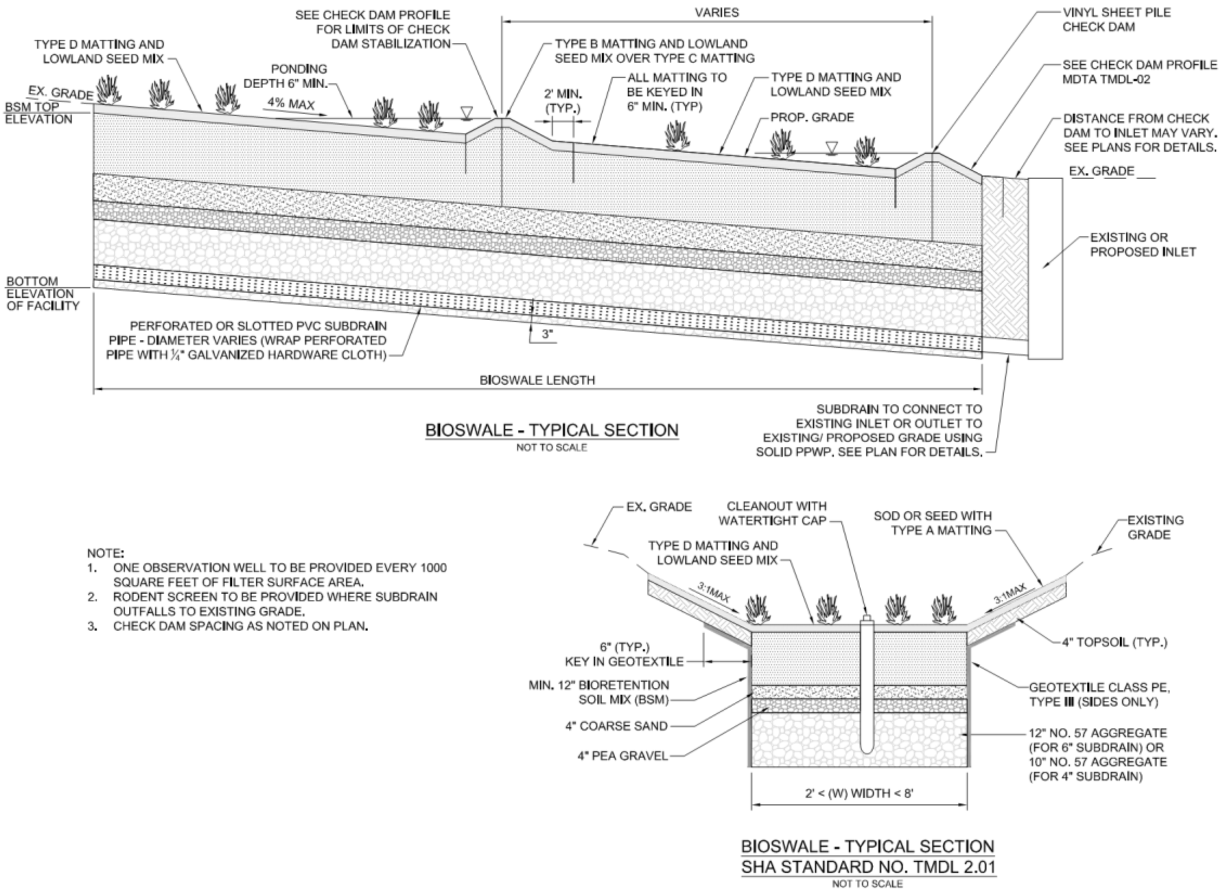
Bio-Swale

Also known as dry swales, these are essentially bioretention cells that are shallow linear channels covered with erosion resistant turf or plantings that can withstand concentrated storm flows (see **Figure 6**).

The swales are designed with slopes, under 5% and check dams are strategically placed in the swale to create temporary ponding which allows settling out of sediment and particulate pollutants. The vegetation or turf also filters out sediments and increases the opportunity for infiltration or absorption of soluble pollutants.

Bio-Swales are most effective when applied in linear configurations parallel to contributing impervious areas, such as roads and parking lots. They are also used to treat turf intensive land uses such as sports fields and golf courses.

Figure 6: Bio-swale



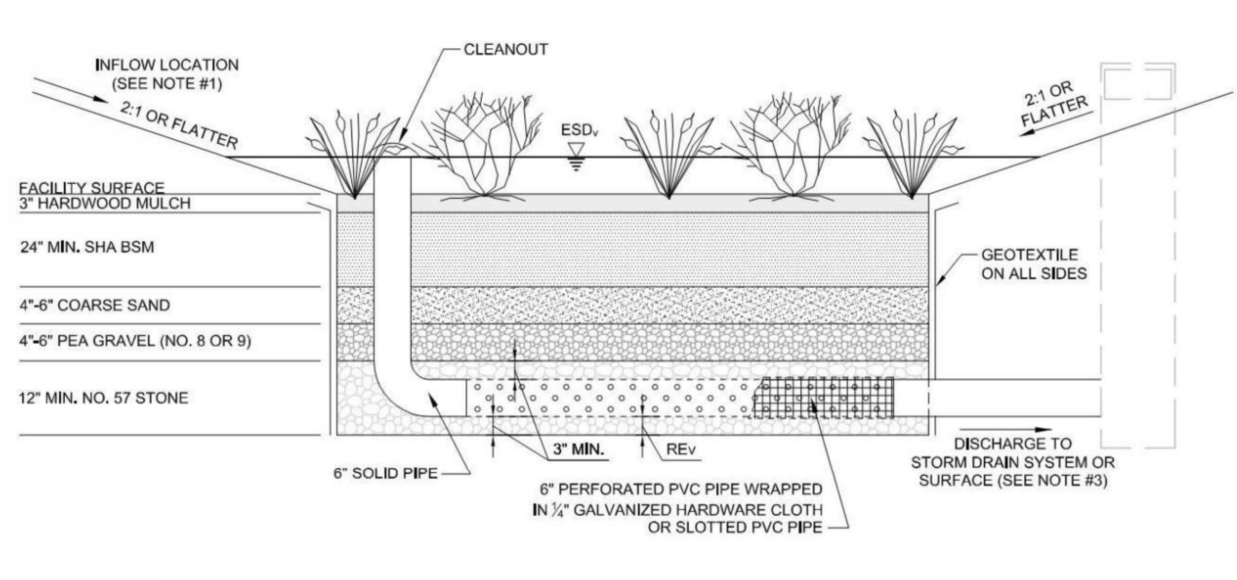
Bioretention/Rain Garden

Bioretention practices capture and treat runoff from previous and impervious areas by passing it through a filter bed of sand, soil, and organic matter. Filtered stormwater is either returned to the conveyance system or partially infiltrated into the soil. These particles are landscaped with drought tolerant native plants and grasses which also can tolerate brief inundation by water.

Individual bioretention facilities can serve highly impervious drainage areas less than two (2) acres in size. Surface runoff is directed into a shallow landscape depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary component of a bioretention practice is the filter bed, which has a mixture of sand, soil, and organic material as the filtering media with a surface mulch layer. During storms, runoff temporarily ponds 6 to 12 inches above the mulch layer and then rapidly filters through the bed. Normally, the filtered runoff is collected in an underdrain and returned to the storm drain system. The underdrain consists of a perforated pipe in a gravel layer installed along the bottom of the filter bed (see **Figure 7)**.

Bioretention facilities' Ponding Characteristics are an effective velocity-reducing practice which also promulgate settling out sediment and pollutants before they can reach waterways and bodies of water. They can be applied in almost any new site development or redevelopment project.

Figure 7: Bioretention/Rain Garden



DESIGN NOTES:

1. FACILITY SHOULD BE LOCATED OFFLINE WHENEVER POSSIBLE.
2. ADDITIONAL GRASS OR RIP RAP SPILLWAY MUST BE PROVIDED TO PASS 10-YEAR STORM IN A SAFE AND NON-EROSIVE MANNER. THE DEPTH OF STANDING WATER ABOVE THE FACILITY SURFACE SHOULD NOT EXCEED 3 FEET FOR THE 10-YEAR STORM.
3. UNDERDRAIN MUST HAVE A STABLE, NON-EROSIVE DISCHARGE.
4. A MINIMUM OF ONE OBSERVATION WELL MUST BE PROVIDED FOR EVERY 1000SF OF FILTER SURFACE AREA.
5. A MINIMUM OF SIX-INCH FREEBOARD FOR 10-YEAR STORM MUST BE PROVIDED.
6. DO NOT INSTALL GEOTEXTILE ALONG THE TOP, BOTTOM, OR ANY HORIZONTAL LAYER.

SECTION

SECTION FOR BIORETENTION WITHOUT RISER

NOT TO SCALE

Structural Streambank Stabilization

This is a method of stabilizing the banks of streams and rivers with permanent structural methods.

These practices protect the banks from the erosion forces of flowing water where velocities exceed 5 ft/sec., or where vegetative stabilization is inappropriate. They reduce the transport of sediments to downstream receiving waters and, by trapping sediments from upstream areas, provide an environment where some erosion resistant vegetation may establish itself.

Structural stabilization may consist of heavy angular stone (riprap, see Figure 8), rock-filled wire baskets (gabions), groins, jetties, or, in severe cases, concrete armoring. There are also manufactured products that can be utilized as part of an overall stabilization plan.

Figure 8: Riprap Used for Structural Stream Bank Stabilization

Source: Blount County Government

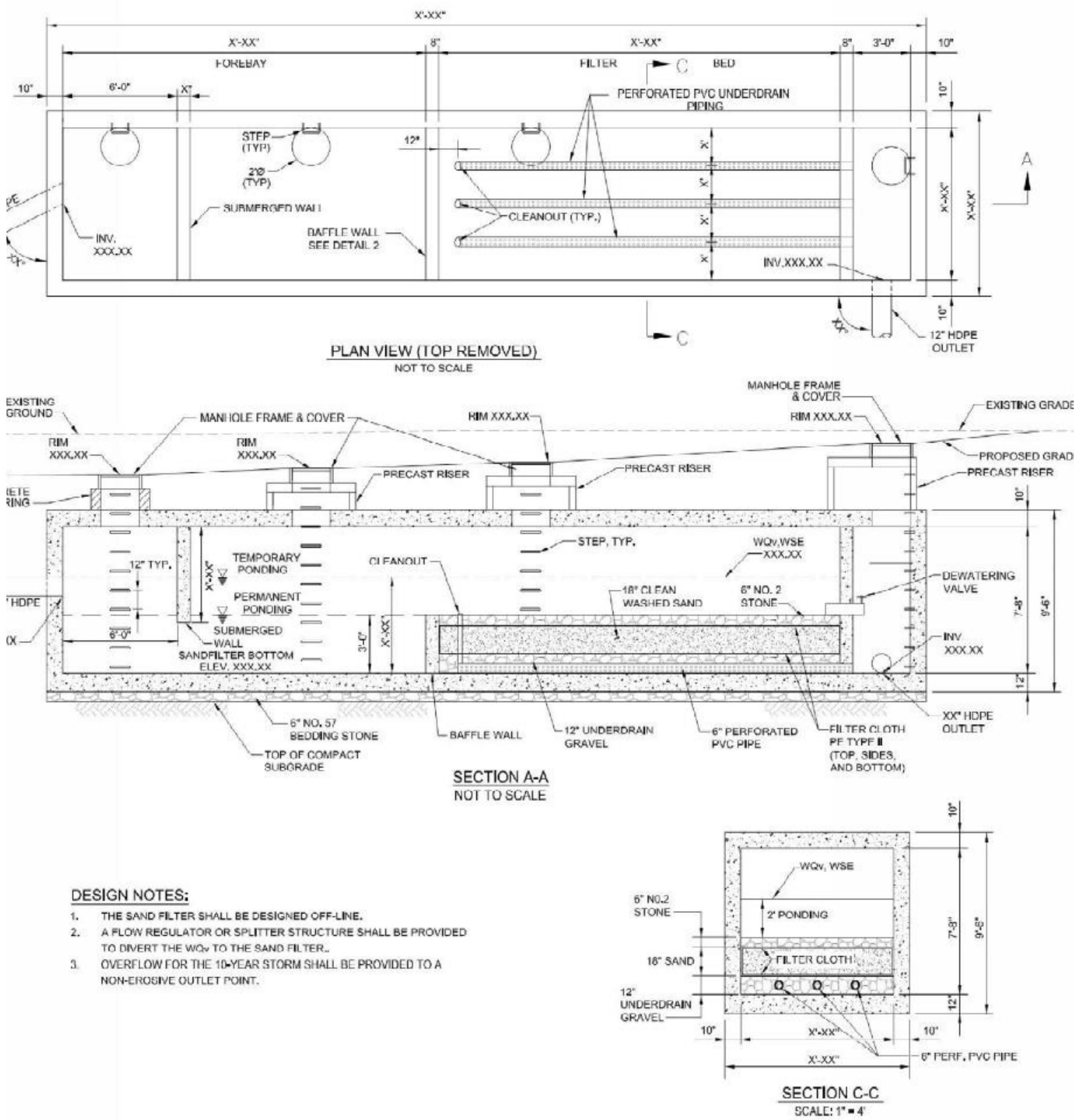
Sand Filters

These practices capture and temporarily store a storm volume and pass it through a filter bed of sand. The filtered runoff is returned to the conveyance system or allowed to partially infiltrate into the soil. They can be a non-structural, structural, or pre-manufactured design (see **Figure 9**).

Surface sand filters can treat larger drainage areas, underground sand filters are an option when space is limited, and a perimeter sand filter is most practical for small sites with flat terrain. A pre-treatment or storage chamber can be incorporated into the facility to allow transported sediment and pollutants to settle out.

These devices are most effectively used to treat smaller parking lots and when redeveloping commercial sites or renovating/expanding existing parking lots. However, they are appropriate for industrial, institutional, or municipal site as well.

Figure 9: Sand Filter



DESIGN NOTES:

1. THE SAND FILTER SHALL BE DESIGNED OFF-LINE.
2. A FLOW REGULATOR OR SPLITTER STRUCTURE SHALL BE PROVIDED TO DIVERT THE WQv TO THE SAND FILTER.
3. OVERFLOW FOR THE 10-YEAR STORM SHALL BE PROVIDED TO A NON-EROSIVE OUTLET POINT.

PART 3: AGRICULTURAL PROGRAMS AND PRACTICES

Farmers are some of our nation's greatest environmental stewards. This notion is perhaps better exemplified in the Deep Creek watershed than anywhere else. Residents and visitors to Deep Creek Lake enjoy ample fishing and unparalleled beauty thanks in part to efforts to protect farmland and promote environmental stewardship of that land in the watershed surrounding the lake. Success in keeping water clean in the Deep Creek watershed is due in part to farmers protecting their land and managing it as a natural water filter, as well as targeted investments made by government agencies in farmland conservation programs and staff to work with farmers. This section highlights government funding opportunities as well as small-scale BMPs Deep Creek area farmers can employ to contribute to the continued well-being of the lake.

Agricultural Practices
The United States Department of Agriculture's Natural Resources Conservation Service (NRCS) publishes technical guidance documents intended to help farmers get started with and successfully implement conservation practices such as:

Integrated Pest Management - Site-specific combinations of pest prevention, pest avoidance, pest monitoring and pest suppression strategies aimed at minimizing the risks of off- and on-site pesticides to the environment. Techniques covered include crop rotation, use of pest resistant and pest-free seeds, and pest scouting.
(http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044470.pdf)

Nutrient Management - The managing of the amount, source placement, form and timing of the application of plant nutrients and soil amendment in order to conserve nutrients, minimize pollution, protect air quality and maintain soil health. Techniques covered include soil nutrient testing, timed application and drainage water management.
(http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046433.pdf)

Conservation Crop Rotation **-** The growing of crops in a recurring sequence on the same field with the goal of reducing erosion, managing pests and maintaining soil quality. Techniques covered include contour farming, residue management and use of cover crops.
(http://www.awqa.org/pubs/conservation/NRCSPractices/ConservCropRotation.pdf)

Prescribed Grazing – The managing of the harvesting of vegetation with grazing and/or browsing animals with the goal of improving species composition, water quality and watershed function. Techniques covered include minimization of concentrated livestock areas and enhancing rangeland diversity. (http://efotg.sc.egov.usda.gov//references/public/NE/NE528.pdf)

Agricultural Programs
Additionally, a broad network of agency partners, agricultural service providers and other resources are available to farmers in the Deep Creek Lake Watershed to protect water quality. One of the primary players and funding partners, for such conservation work is NRCS. Among the federal conservation programs NRCS helps to implement include:

Agricultural Management Assistance (AMA). The AMA program provides financial and technical assistance to agricultural producers to voluntarily address water quality and erosion control measures through conservation. Additionally the program pays a portion of the installation cost of features such as irrigation structures or for transitions to organic farming. For more information visit
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/ama/
.
Conservation Reserve Program (CRP). The CRP encourages farmers to convert highly erodible cropland and other environmentally sensitive land to vegetative cover. Farmers receive annual rental payments for converting erodible cropland into filter strips, buffers or vegetative cover. For more information visit
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1041269

Environmental Quality Incentive Program (EQIP). The EQIP provides technical assistance, cost-share payments and incentive payments to assist with environmental and conservation improvements on land used for agricultural production. The program caters toward producers underserved by other government programs (e.g., beginning farmers and ranchers, socially disadvantaged producers). For more information visit
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?&cid=stelprdb1044009

Wetlands Reserve Program (WRP). The WRP offers technical and financial assistance to landowners interested in restoring and protecting wetlands on their property. Landowners retain the rights to access, title and water use in exchange for conservation easements. For more information visit
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands/

Wildlife Habitat Incentives Program (WHIP). The WHIP offers financial incentives to agricultural landowners who maintain habitat for fish and wildlife. The NRCS provides technical and cost-share assistance to landowners who make conservation efforts for habitats of Maryland species such as Golden-Winged Warbler and Bog Turtle. More information can be obtained at
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/md/programs/?cid=nrcs144p2_025648

In addition to the conservation practices listed here, many of the site-specific BMPs mentioned in the previous sections of this manual can be applied to small farms and non-industrial agricultural operations. Land grading and landscape practices such as vegetated filter strips are viable where impervious area treatment is an acre or less. Rip rap bank stabilization can be applied wherever slopes are less than 2:1. And rain gardens can treat areas with drainage areas of less than 5 acres.

REFERENCES:

1. Maryland Department of the Environment, “2000 Maryland Stormwater Design Manual Volumes I & II.
2. Virginia Department of Conservation and Recreation, “Erosion and Sediment Control Handbook, Third Edition 1992”.
3. Virginia Department of Conservation & Recreation, “Virginia Stormwater Management Handbook, First Edition, 1999”.

APPENDIX H

COST ESTIMATE REFERENCES

PART 1

Economic Impacts Developed by

Garrett County Economic Development

Charles Griffith

From: Logan Marks <lmarks@garrettcounty.org>
Sent: Friday, December 13, 2013 3:45 PM
To: Ortt, Richard; Charles Griffith; Michael Koch
Cc: Mostafa Izadi -DGS- (mostafa.izadi@maryland.gov); Michael, Bruce; Monty Pagenhardt
Subject: RE: Economic Impacts Table
Attachments: GarrettCountyEconomicImpactsTable (1).xls

Categories: Filed by Newforma

Attached is the finalized table.

The numbers for property value impacts for the dredging situation were all 0, because if dredging were to take place it would be protecting the property value not decreasing it. There could be outlying real estate trends or dead periods in home sales but no major impacts that need included.

The no action numbers were set up as follows:

No Action for all 10 coves at once:

the total estimated value of property value decrease is 36 million but we estimate that to occur over a 15 year amortization period, so the number included in the cell is how far along into the period the impact would be i.e (36 million/15)x1

For the 3 year scenario same situation but 3 years into the amortization cycle i.e (36 million/15)x3

Same setup for tourism impacts, the total impact was dived by 15 and included for how far along in the cycle it would be.

The income tax numbers were calculated using multiplying the property value cell by the tax rate, and then the tourism was split into the respective categories and multiplied by the 6% accommodations tax rate and the 4.5% amusement tax rate.

If I confused you at all or you need further explanation let me know.

Happy Holidays

Thanks!

Logan Marks
Economic Analyst

Garrett County Economic Development

Office: 301-334-8981
Mobile: 301-616-9949

From: Ortt, Richard [ROrtt@dnr.state.md.us]

Economic Impacts
Provided by Logan Marks at Garrett County Economic Development

If accomplished over 3 periods of time. Likely over 3 different years (3 coves one year; 3 coves next year; 4 coves two years+)

Management Option Economic Impacts							
Measured Criteria	No Action	Hydraulic Dredging		Mechanical (Wet) Dredging		Mechanical Dry Dredging (Excavation)	
		Labor Day-31DEC	March-Memorial Day	Labor Day-31DEC	March-Memorial Day	Labor Day-31DEC	March-Memorial Day
Tourism Dollars	$ 5,400,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00
Property Value	$ 7,500,000.00	0	0	0	0	0	0
Tax Income (Annual)	$ 742,500.00	$ 477,796.50	$ 477,796.50	$ 477,796.50	$ 477,796.50	$ 477,796.50	$ 477,796.50
Local Employment							
Other???							

(NO ACTION) NUMBERS ARE ANNUAL

Property Value's total decrease with no action is estimated at 36 million, a 15 year period was used to project it on an annual basis

If accomplished all at one time (one 3-4 month period for all 10 coves)

Management Option Economic Impacts							
Measured Criteria	No Action	Hydraulic Dredging		Mechanical (Wet) Dredging		Mechanical Dry Dredging (Excavation)	
		Labor Day-31DEC	March-Memorial Day	Labor Day-31DEC	March-Memorial Day	Labor Day-31DEC	March-Memorial Day
Tourism Dollars	$ 1,800,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00	$ 8,900,000.00
Property Value	$ 2,500,000.00	0	0	0	0	0	0
Tax Income (Annual)	$ 247,500.00	$ 477,796.50	$ 477,796.50	$ 477,796.50	$ 477,796.50	$ 477,796.50	$ 477,796.50
Local Employment							
Other???							

(NO ACTION) NUMBERS ARE ANNUAL ON A 15 YEAR PERIOD

Property Value's total decrease with no action is estimated at 36 million, a 15 year period was used to project it on an annual basis

Tourism Value's total decrease with no action is estimated at 27 million which would grdaully increase the the total number also used was a 15 year period to get to the total value

PART 2

External Sources

Erickson Consulting Engineers, Inc.
7201 Delainey Court, Sarasota., FL 34240
Telephone: (941) 373-6460
www.ericksonconsultingengineers.com

November 30, 2012

Gregg Strakaluse, PE
City Engineer, City of Naples
295 Riverside Circle
Naples, FL 34102

RE: 90% Engineer's Estimate of Probable Construction Cost
Project Title: Port Royal Habitat Island and Canal Dredging Project

Dear Gregg,

We have completed the Engineer's Estimate of Probable Construction Cost for the Port Royal Habitat Island and Canal Dredging Project. As you are aware, we are approximately 85% through the state FDEP permit process and approximately 50-60% through the federal permit process on this project. As such, the project design for the habitat island and canal dredging efforts has reached the stage at which we can provide you with a reasonable estimate of construction cost. Pending receipt of the regulatory permits, project bidding and subsequent commencement of construction is anticipated in Spring 2013.

This engineer's opinion of probable construction cost was developed based upon ECE's experience on similar sized dredging projects as well as consultations with qualified construction contractors and the acquisition of quotes from various material and service suppliers. Actual construction costs will vary depending on final permit conditions, material and contractor availability, economic climate and final site conditions encountered at the time of construction.

SCOPE OF WORK

The scope of work for which this cost estimate was prepared consists of two major work components: (1) canal dredging and (2) habitat island construction.

4. Habitat Island Creation (inclusive of sediment dewatering and handling and island stabilization)
5. Habitat Island Vegetation (to further stabilize the island and provide for an enhanced habitat for birds and other biological species)

Table 2 below provides the Engineer's Estimate of Probable Construction Cost for the Project.

Table 2. 90% Engineer's Estimate of Probable Construction Cost

Item No.	Description of Item	Unit	Est. Unit Cost	Est. Quantity	Est. Total
1	Mobilization/Demobilization	LS	$220,000.00	1	$220,000.00
2	Survey	LS	$11,000.00	1	$11,000.00
3	Dredging[1]				
3a	Cutlass Cove	CY	$9.00	3,220	$28,980.00
3b	Doubloon Bay Entrance	CY	$10.00	2,180	$21,800.00
3c	Doubloon Bay	CY	$10.00	1,520	$15,200.00
3d	Harbor Head	CY	$8.50	5,650	$48,025.00
3e	Galleon Cove	CY	$8.50	7,020	$59,670.00
3f	Champney Bay	CY	$10.00	2,610	$26,100.00
3g	Galleon Cove Oyster Shell Removal (Re-Used for Oyster Reef Creation at Habitat Island)	CY	$18.00	65	$1,170.00
3h	Furnish and Deliver Polymer and Associated Injection Equipment			TBD	$150,000.00
				Dredging Sub-Total	*$350,945.00*
4	Habitat Island Creation				
4a	Furnish and Deliver 45' Circ Perimeter Geotubes	LF	$44.40	665	$61,817.56
4b	Furnish and Deliver 30' Perimeter Geotubes	LF	$31.15	300	$9,345.00
4c	Furnish and Deliver 15' Circ Perimeter Geotubes	LF	$18.48	400	$7,392.00
4d	Furnish and Deliver Scour Apron (single)	LF	$16.62	1,500	$24,930.00
4e	Furnish and Deliver Stone for Rock Overlay (Limestone Rip Rap, 125 pcf min, 24-36")	Ton	$25.65	2,580	$66,182.16
4f	Furnish and Deliver Geoweb	SF	$1.86	40,065	$74,370.25
4g	Furnish and Deliver Crushed Shell (8" Thick)	Ton	$39.64	92	$3,647.25
4h	Furnish and Deliver Oyster Shell and Mesh Bags	Ton	$64.13	650	$41,684.50
4i	Install Island Foundation System (Geoweb Layer)	SF	$1.75	40,065	$70,113.75
4j	Fill and Install 45' Circ Perimeter Geotubes	LF	$90.00	665	$59,850.00
4k	Fill and Install 30' Circ Perimeter Geotubes	LF	$90.00	300	$27,000.00

Source No. 2

City of Virginia Beach

OFFICE OF THE CITY MANAGER
(757)-385-4242
FAX (757) 427-5626

VBgov.com
MUNICIPAL CENTER
BUILDING 1, ROOM 234
2401 COURTHOUSE DRIVE
VIRGINIA BEACH, VA 23456-9001

September 10, 2010

The Honorable Mayor
and Members of City Council

Subject: Neighborhood Dredging Special Service District Policy Report

Dear Mayor and Councilmembers:

At the request of the Old Donation Creek Waterway Association (ODCWA) and endorsed by District Councilman and Vice Mayor Louis Jones, the staff has worked diligently over the last eighteen months to resurrect and develop a partnership between the City and the neighborhood waterfront property owners to create a Special Service District. Attached is a Policy Report which provides the consensual agreement for neighborhood dredging projects which will accomplish two very significant initiatives: 1) The ability of our residents to recapture their access to navigable channels in the Lynnhaven and 2), to attack the number one cause for the degradation of the Lynnhaven's water quality - siltation of the sandy bottom.

Using ODCWA as a real project example, this Policy Report lays out the project segments, engineering and construction, and the funding necessary to bring a long sought after solution to assist our citizens.

As we have scheduled a briefing for this coming Tuesday, September 14, I encourage you to review the attached document and to bring it to the Council session as we will cover the concepts in detail.

Should you have any questions please do not hesitate to contact Dave Hansen or me.

With Pride in Our City,

James K. Spore

JKS/DLH/s

Attachment

c: Mark Stiles
Dave Hansen

Environmental and Permit Considerations:
A thorough evaluation of wetlands impacts will be necessary to obtain the required environmental permits for this proposal. This detailed assessment will occur during the design stage of the proposal. The channel locations will be selected using the criteria of avoiding wetlands impacts where possible, minimizing impacts if avoidance is not possible, and mitigating any unavoidable impacts to vegetated wetlands. These constraints may result in properties fronting Old Donation Creek being discounted from the potential SSD due to extensive vegetated wetland impacts that would prevent them from being connected to the neighborhood channel. Should they wish to construct extra-long piers individual homeowners will be responsible for obtaining their permits. In these cases, we would encourage multiple families to cost share the use of a single pier to a multi-vessel dock positioned adjacent to the neighborhood channel.

Initial Estimate of Project Costs:
The costs for developing and implementing this proposal include survey and design, permit acquisition, bid document preparation, construction administration, real estate (easement) dedications, actual construction, periodic monitoring, and annual maintenance of navigation markers.

The preliminary channel layout includes approximately 1,200 feet of City-funded spur channel and 4,650 feet of SSD funded neighborhood navigation channel. A hydrographic survey of Old Donation Creek was conducted by Langley & McDonald, P.C., in 2008. Based on that survey and the anticipated channel widths and depths, it is estimated that the City-funded spur channel would require approximately 2,667 cubic yards of dredging, and that the neighborhood SSD-funded channel would involve approximately 10,333 cubic yards of dredging.

The cost for mechanical dredging, scow transport, material transfer, trucking and disposal is currently estimated at $30 per cubic yard. Accordingly, it is estimated that construction costs alone will be approximately $80,000 for the City-funded channel and $310,000 for the neighborhood SSD channel. With the projected cost of fuel and labor expected to rise, a 5% cost escalation per year should be applied for the second and third dredge cycles.

The cost for dredging individual channels and basins will vary widely, depending on existing water depth, distance to connect to the neighborhood channel, and the size and geometry of the turning basin. This work could be more expensive than open channel dredging as working around and near dock structures and mooring pilings may be less productive and increase the risk of damage to structures. It is estimated that the cost for construction of each individual channel and basin, to be funded entirely by the individual property owner, will range from a low of $5,000 to as much as $20,000 for their initial dredging.

Surveys, design, permit acquisition, bid document preparation and construction administration for smaller scale navigation projects typically runs 20% of construction. Assuming that no significant issues arise, it is assumed that easement acquisition could be accomplished within this amount.

Accordingly, it is estimated that these 'overhead' items would be approximately $20,000 for the City-funded portion of the work, approximately $60,000 for the neighborhood SSD-funded portion of the work, and approximately $1,000 to $4,000 for each individual channel.

Both the City-funded spur channel and the SSD-funded neighborhood channel will require adequate marking for safe navigation. It is estimated that three markers will be needed along the City spur channel, and as many as nine markers will be needed along the network of SSD neighborhood channels. Installation of these markers is estimated at $2,000 each. This equates to an estimated additional $6,000 (three markers) of upfront City construction costs, and $18,000 (nine markers) for the SSD funded channels. Regular maintenance and replacement of these navigation aids will be required, and should be budgeted at 10% of installation costs annually. Individual property owners may elect to have private aids installed for the longer individual channels; those costs would be borne directly by the property owner.

The total project costs include design and construction plus 20% for survey, permitting, contracting and construction administration as well as navigation aid installation. The initial dredging is estimated to cost $492,000, with the City and Community portions as follows:

- City portion: $ 103,212
- SSD portion: $ 393,588
- Individual channels: $6,000 to $24,000 each, with an average of $12,000 for each participant.

Project Construction Timeline:
Surveying, design, permit acquisition and bid document preparation for navigation projects can normally be accomplished in 12 to 18 months. Easement acquisition can be accomplished concurrent with those activities. Bidding and contract award consumes a four month period. Accordingly, it is estimated that construction could commence 16 to 22 months from the establishment of the SSD. For planning purposes, construction of the City and neighborhood segments with 13,000 cubic yards of dredging, and up to 66 individual basins, is estimated to take 12 months.

It is important to note that some navigation dredging permit actions have taken more than 2 years to complete. Furthermore, the time to accomplish real estate acquisition is also highly variable. All easements must be obtained prior to construction; one unresolved title defect, or reluctant owner, could slow the entire project.

It is estimated that construction commencement could reasonably occur within 2 years following the approval of a City Council Ordinance establishing the SSD.

Dredging Cycles:
The SSD should be in place for at least three dredging cycles due to additional stormwater siltation and the sluffing of the sides in filling the box cut created by mechanical dredging. After three cyclic dredging efforts this sluffing effect is expected to be significantly reduced thereby creating a relatively stable channel system. The first dredging will require the largest effort. As stated before, the City and neighborhood channels amount to 13,000 cubic yards.

As the Lynnhaven waterfront is nearly fully built-out, the siltation rate has significantly slowed. The current projection is that the second dredging should be scheduled seven years following completion of the initial effort. This second dredging should involve a reduced quantity. This second dredging is anticipated to only require the removal of 70% of the original quantities. The third dredging, 14 years after the first, should only require the removal of 50% of the original dredged amount. These percentages are based on the estimated side sluffing which will occur over time. Establishing a three dredge cycle and the periods between them are key to establishing the funding schedule for the cost participation agreement.

Some discussion is likely to occur with the neighborhood applicants regarding the frequency of the dredging cycles; specifically with a focus on reducing the annual SSD costs by spreading out the period of the dredging cycles. Of concern would be the condition created whereby the follow-on dredge cycles have been spaced so far apart that the navigation channels have become impacted prior to the funding schedule creating necessary equity in accordance with the SSD ordinance. We have established the dredge cycle period to be seven years in order to assure the neighborhoods that the second and third dredge cycles will occur in a timely manner so as to ensure continuous navigable use of the channels. Extending the period would create risks to the neighborhoods as well as to the City to accelerate the follow on dredging prior to funding levels being accumulated.

Community Channel Dredging Cost Estimate:
Using the frequency and quantity assumptions above, it is anticipated that the SSD rate (¢ per $100 assessed valuation) should be established to fund 100% of the neighborhood costs through the third dredging. Applying a 5% annual cost escalation, this means dredging costs are $30 per cubic yard cost in the first cycle; $40.20 per cubic yard seven years later; and $56.47 per cubic yard in the third cycle.

With the initial dredging of the neighborhood channel consisting of 10,330 cubic yards dredged, the second dredging will require the removal of 7,233 cubic yards, and the third dredging in year 16, the removal of 5,167 cubic yards. The costs of these three dredging efforts are:

Dredge Cycle	Cubic Yards*	Costs/Cubic Yard**	Cost ***
1	10,330	$30.00	$ 393,588
2	7,233	$40.20	$ 348,920
3	5,167	$56.57	$ 350,757
TOTAL	22,730	Average $42.25	$1,093,265

* Assumes a 3 foot dredge depth to -4 feet below mean low water
** Assesses a 5% yearly cost escalator
*** Includes 20% design and administrative cost for each dredging and the navigation aids in the first year dredging

Due to fluctuating real estate values, no change in assessed value is incorporated. The current FY11 assessed value of the 66 properties is $43,012,700. It is expected the first dredging will not occur until two years of SSD collection have occurred.

Therefore, the total SSD period will be 16 years at a rate of 15.9¢ per $100 assessed valuation. The SSD is projected to cover the entire cost of three dredging events over a 16 year period; however since the initial cost and timing of the first dredging will exceed the pace of SSD collections in years 3, 4, 5, and then again in years 9 and 10 for the second dredging, the General Fund may have to supplement the first two dredgings provided the SSD reimburses the General Fund for the portion of the SSD neighborhood channel dredging it supplemented. A spreadsheet displaying the SSD annual taxes generated, the cumulative SSD amounts, and the dredging costs is shown in Attachment C. This annual SSD rate can be adjusted, and it is recommended this rate be reviewed every four years during the life of the SSD.

At $43,012,700 assessed value for the 66 properties, each 1¢ raises $4,301. At the end of the 16th year, and prior to the third dredging, the SSD would have to collect $1,093,265, subject to cost estimates and assessment adjustments. All funds collected via neighborhood SSDs would be accounted for in separate SSD fund accounts. The additional SSD rate for this neighborhood will sunset after the 16th year unless renewed.

City Channel Dredging Funding:
City appropriations would be made on an annual basis in amounts determined by the project cost and the frequency of dredging. For the Old Donation Creek cost participation project, the City portion of the spur channel dredging is:

Dredge	Cubic Yards*	Costs/Cubic Yard**	Cost ***
1	2,667	$30.00	$ 103,212
2	1,867	$40.20	$ 90,064
3	1,334	$56.57	$ 90,557
TOTAL		Average $42.25	$ 283,833

* Assumes a 3 foot dredge depth to reach -4 feet below mean low water

** Assesses a 5% yearly cost escalator

*** Includes 20% design and administrative cost for each dredging and the navigation aids in the first year

Also shown on Attachment C is the appropriation schedule for annual budgeting through year 16 of the project. This funding schedule covers the City portion of the three dredging as well as the advanced funding necessary to supplement the neighborhood SSD for the first two dredging. Because the neighborhood SSD is required to fully fund their portion of the three dredging cycles, the City appropriation in the out years is significantly less.

Combined City and SSD Channel Dredging Funding:
A Community Dredging CIP would be created to account for all dredging cost participation projects. The combined total of funding for the City and SSD portions of the Old Donation Creek neighborhood dredging project are:

Dredge	City (20.6%)	SSD (79.4%	Total
1	$103,212	$393,588	$496,800
2	$90,064	$348,920	$438,984
3	$90,557	$350,757	$441,314
TOTAL	$283,833	$1,093,265	$ 1,377,098

Dredging Cost Estimate

An estimate of probable costs to dredge 11,000 cubic yards of sediment from Lake Columbia is presented in Table 2. In formulating this estimate, it was assumed that a dredge material disposal site can be found in close proximity to the lake and that special disposal restrictions will not be required. If this is the case, the estimated cost per cubic yard of dredged material would range from $12 to $18. Engineering, permit acquisition, and construction oversight are estimated at approximately 15 percent of dredging costs. Contingency funds allow for any unforeseen costs and are estimated at 10 percent of project costs.

If a suitable disposal site cannot be secured in close proximity to the proposed dredge area, costs related to trucking of dredge spoils, or the use of a booster pump and additional pipe to get to the disposal site could increase dredge costs dramatically.

As an alternative to hydraulic dredging, the possibility of conducting a drawdown of Lake Columbia to facilitate dredging was also evaluated. However, it does not appear that the gate on the dam spillway is operational (SME Consultants, 2000). Therefore, it would not allow the level of Lake Columbia to be lowered. In addition, a drawdown could pose significant fishery and recreational use impacts which could complicate MDEQ permit acquisition. Given the likelihood of regulatory and operational hurdles, this option was not evaluated further.

Table 2
Lake Columbia Dredging Project
Estimate of Probable Cost

Work Element	Estimate of Probable Costs	
Dredge 11,000 Cubic Yards	$132,000 - $198,000	$12-$18
Engineering, Permit Acquisition, Construction Oversight (15%)	$19,800 - $29,700	
Contingency (10%)	$13,200 - $19,800	
TOTAL	**$165,000 - $247,500**	$15-$22.52

GOOSE CREEK SEDIMENTATION SURVEY

A field survey of Goose Creek was conducted by staff from Progressive on August 14, 2007 to identify possible sources of sediment input to Lake Columbia (Figure 7). The survey started at the confluence area immediately north of Cement City Road and continued upstream to just above the old railroad crossing (Appendix C and Figure 8). At this point, Goose Creek traverses a large wetland. In addition, there are several lakes upstream of these wetlands that likely prevent the downstream migration of significant quantities of sediment (Figure 8). In general, this stretch of Goose Creek was in good condition and contained natural meanders, and

Figure 7. Goose Creek stream survey

Source No. 4

Comparison of Dredging Alternatives for Moses Lake

Cardno ENTRIX
Shaping the Future

5 Sediment and Erosion Control

Sedimentation and erosion control increases in difficulty commensurate with the size, scale and type of dredging operation. In general, the dredging operation with the smallest project footprint would have the lowest potential to cause erosion and generate sediment from project activities. As such, the smaller project footprint of the water-based hydraulic dredge operation would create the least potential for erosion while the land-based mechanical dredging operation would have the greatest potential for sedimentation due to access and activity required in, and near, Moses Lake.

With respect to dredging process and the generation of sediment, if a barge-mounted excavator or clam-shell dredge was to be used, containment of the fallback dredge material would be required. This would likely require the incorporation of a turbidity curtain around the dredging operations to prevent downstream sedimentation and degradation of water quality. This system would not be required for the hydraulic dredge operation as the dredged materials would be contained within the dredge hose which eliminate fallback of the dredge material.

6 Hydraulic versus Mechanical Dredging Costs

Dredging costs are highly variable and driven by type of dredging operations, land costs for dewatering sites, weather, topography, and characteristics of bottom sediments. These variables are such that cost estimates need to be based on site-specific circumstances. Consequently, there is no set "unit cost" applicable to dredging, but general estimates and ranges that can be inferred from previous projects. The main factor to consider when estimating a cost range is the type of sediment as it can have a significant effect on production, and therefore on unit costs. Environmental permitting, mobilization and demobilization, disposal of the dredged material and lake bottom conditions (e.g., treed, stumps or smooth) can also affect unit costs by a factor of two to four. Distance to the dredged solids dewatering site can affect unit costs, as would length of hose needed for hydraulic dredging and type and amount of heavy equipment for mechanical dredging. Land costs for dewatering areas can also significantly add to the cost depending on the dredge locations setting (rural, suburban or urban).

Based on available documentation, $9 to $11 per cubic yard would be a reasonable beginning point for the cost of hydraulic dredging of Moses Lake. This estimate does not include the cost of land acquisition, mobilization and demobilization, environmental permitting, dewatering basin construction, disposal, and other associated unit costs.

Mechanical dredging adds additional variables including the type of mechanical dredging proposed (land-based or barge based), engineering design, equipment purchase or rental, and whether a cofferdam or turbidity curtain would be required. A general estimate including mobilization and all labor and equipment would range from $25 to $35 per cubic yard for barge mounted dredging, and $30 to $40 per cubic yard for dry dredging depending on variables (based on 2011-12 costs for Crane Valley Seismic Retrofit Project barged-based dredging of 56,000 cubic yards). This estimate does not include the cost of land acquisition, environmental permitting, disposal, and other associated unit costs.

Table 1-2 Cost Comparison

	Hydraulic Dredging	Barge Mounted Mechanical Dredging	Dry Mechanical Dredging
Permit Cost[1]	$40,000 (Nationwide Permit)	$40,000 (Nationwide Permit) - $125,000 (Individual Project Permit)	$40,000 (Nationwide Permit) - $125,000 (Individual Project Permit)
Engineering Cost	Minimal	Minimal	$300,000-$500,000
Dredging Cost	$9-$11 cubic yard	$25-$35 cubic yard	$30-$40 cubic yard

Source No. 5

SOUTH FORK RIVANNA RESERVOIR DREDGING FEASIBILITY STUDY

DREDGING ALTERNATIVES REPORT

Prepared for

Rivanna Water and Sewer Authority

695 Moores Creek Lane

Charlottesville, Virginia 22902

Prepared by

HDR Engineering, Inc.

4480 Cox Road - Suite 103

Glen Allen, Virginia 23060

June 9, 2010

Dredging Part I – Hydraulic Dredging Reservoir Segments 1 – 3; Mechanical Dewatering and Material Recovery

- Dredging volume = 290,324 cy
- Cost = $7,766,518 to $12,973,515; cost would be partially off-set by sale of materials
- Cost per cy is $27 to $45 (does not include potential off-set by reuse of materials).

Dredging Part II – Hydraulic Dredging Reservoir Segments 4 – 9 and/or Ivy Creek; Dewatering with Confined Dike Facilities, No Material Recovery

- Dredging volume = 835,686 cy
- Cost = $26,271,273 to $27,219,996 ($6,989,249 to $7,937,972 Dredging + $19,282,024 Confined Dike Facilities)
- Cost per cy = $33

Part I & Part II Combined Dredging

- Dredging volume = 1,126,010 cy
- Cost = $34,037,791 to $40,193,511 (Does not include potential off-set from material recovery)
- Cost per cy = $31 to $36

Potential Material Recovery from Part I Dredging

- 189,097 cy of sand and 101,227 cy of remaining sediment
- Cost Recovery for Sand = $4,774,699 to $9,469,978
- Cost Recovery for Remaining Sediment = $126,534 to $2,133,865 if used as topsoil; (-$177,147) to $1,222,822 if used as fill.

Where a negative cost difference exists, the dredged material is unlikely to be selected for reuse on the basis of price alone.

Table 6. Estimated Costs of Hydraulic Dredging[1]				
Work Item	**Unit Cost**	**Number of Units**	**Work Item Cost (low range)**	**Work Item Cost (high range)**
Mobilization of Dredge Equipment	$250,000	2 to 3	$500,000	$750,000
VA Rowing Association Lease	$1,096 per ac per year	3 to 5 years 2 ac	$6,576	$10,960
Staging Site Improvements	$50,000 to $100,000	1	$50,000	$100,000
* Dredging	$6.00/cy	790,587 to 835,686 cy	$4,743,522	$5,014,116
Final Demobilization	$150,000 to $250,000	1	$150,000	$250,000
Staging Site Restoration	$75,000 to $150,000	1	$75,000	$150,000
Subtotal			**$5,525,098**	**$6,275,076**
Project Design & Permitting	10 % of costs	1	$552,510	$627,508
Contingency	15% of costs	1	$911,641	$1,035,388
Total			**$6,989,249**	**$7,937,972**
Cost per cy			**$8.84**	**$9.4**

[1] Note that these costs do not include costs of sediment dewatering or placement.

Mobilization of dredge equipment includes the contractor's initial costs for assembling, transporting, and launching the necessary dredge equipment, including the dredge barge, pipeline equipment, and auxiliary boats and support equipment. There are also interim mobilization costs including a partial demobilization at the end of each dredging season and a re-mobilization at the beginning of the next season for the duration of the project.

HDR has assumed that a lease would be established for use of the Virginia Rowing Association site, and that such lease would provide further detail on site use restrictions, site restoration requirements, and a negotiated fee or compensation rate for the temporary use of the site. HDR is unable to identify the actual compensation rate at this time, as this would be subject to negotiation between the Virginia Rowing Association and RWSA (or other project proponent). For the purposes of this study, HDR has estimated a compensation rate of 2.0 times the current assessed tax on the occupied land. HDR has identified this rate to cover land owner costs and provide an incentive. The Virginia Rowing Association site has an assessed land value of $486,000 for 6.58 acres (not counting buildings and improvements). The current Albemarle County tax rate is 0.742% per $100 of assessed value. Property tax on the land only is therefore approximately $3,606 for 2010, or $548 per acre. The staging area and roadway would occupy approximately 2 acres, therefore a compensation cost estimate of $2,192 per year (2 x 2 acres x $548/acre) is assumed for the purposes of this study. A lease period of 3 to 5 years is assumed.

*Much lower volumes at Deep Creek Lake

Table 9. Estimated Costs for Hydraulic Dredging & Mechanical Dewatering with Materials Recovery				
Work Item	**Unit Cost**	**Number of Units**	**Work Item Cost (low range)**	**Work Item Cost (high range)**
Mobilization of Dredge & Dewatering Equipment	$150,000	3 to 4	$450,000	$600,000
Connelly Lease	$570 per ac per yr	5 years 2 acres	$5,700	$5,700
Staging Site Improvements	$150,000 to $250,000	1	$150,000	$250,000
Dredging	$6 to $8 cy	290,324 cy	$1,741,944	$2,322,592
Mechanical Dewatering & Material Separation[1]	$8 to $10/cy	290,324 cy	$2,322,592	$2,903,240
Material Transport	$7/cy to $13/cy	174,194 – 290,324 cy	$1,219,358	$3,774,212
Final demobilization of Dredge & Dewatering Equipment	$150,000 to 200,000	1	$150,000	$200,000
Staging Site Restoration	$100,000 to $200,000	1	$100,000	$200,000
Subtotal			**$6,139,594**	**$10,255,744**
Project Design & Permitting	10 percent	1	$613,900	$1,025,574
Contingency	15 percent	1	$1,013,024	$1,692,198
Total			**$7,766,518**	**$12,973,515**
Cost per cy			**$27**	**$45**

[1] Assumes high percentage of sand

Mobilization of dredge equipment includes the contractor's initial costs for assembling, transporting, and launching the necessary dredge and dewatering equipment, including the dredge barge, pipeline equipment and auxiliary boats and support equipment. There are also interim mobilization costs including demobilization at the end of each dredging season and a re-mobilization at the beginning of the next season for the duration of the project. HDR's cost estimate is based on recent mobilization costs for similar dredging projects with mechanical dewatering. Due to the risk of flooding of the staging site, the interim demobilization would likely involve movement of most or all equipment off site, increasing mobilization costs.

HDR has assumed that a lease would be established for use of the Connelly site, and that such lease would provide further detail on site use restrictions, site restoration requirements, and a negotiated fee or

APPENDIX I

SITE VISIT PHOTO LOG

Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: Point Run Cove	Date: 05-06-2013

Photo#312

Photo #313 Single lot with trees and vegetation

Photo #314

Photo #315 Trees, Hills and Slopes

Photo #317

Photo #318 Marshy Area

Photo #320 Looking out from Cove

Photo #321 Vegetation within Lake

Photo #322 Grasses within Lake

Photo #323

Photo #324

Photo #325

Photo #327

Photo #328

Photo #329

Photo #330

Photo #331 Grass area in gentle slopes

Photo #332

Photo #333

Photo #334

Photo #335

Photo #336

Photo #337

Photo #338

Photo #339

Photo #341

Photo #343 Grass turf lawn with trees removed

Photo #344 Removable Floating Dock

Photo #346

Photo #347

Photo #348

Comments:……………………………………………………………………………………………………
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Project Description: Deep Creek Lake Sediment Study Location: Penn Cove	Date: 05-06-2013

Photo #350

Photo #351

Photo #352

Photo #353

Comments:……………………………………………………………………………………………
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Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: Deep Creek Cove	Date: 05-06-2013

Photo #356

Photo #357

Photo #358

Photo #359

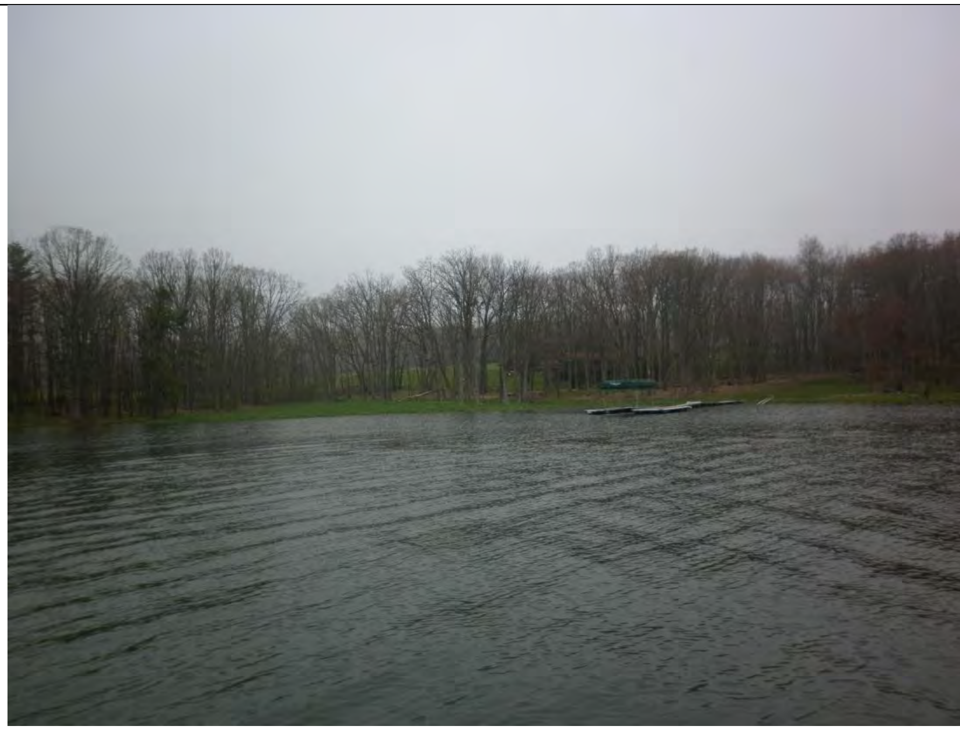

Photo #360

Photo #361

Photo #362 Single lot with turf grass, trees partially removed

Photo #363 Single lot with turf grass, trees partially removed

Comments:…………………………………………………………………………………………………
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Project Description: Deep Creek Lake Sediment Study Location: Chadderton School Cove	Date: 05-06-2013

Photo #365 Trees and shrubs with homes

Photo #366

Photo #368

Photo #369

Comments:…………………………………………………………………………………………………
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Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: XXX Cove	Date: 05-06-2013

Photo #373 Single lot home with trees

Photo #374

Photo #376 Taken at Downstream, approximately 200 feet downstream of POI

Photo #378

Comments:……………………………………………………………………………………………
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Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: Cove	Date: 05-06-2013

Photo #381 New development (north)

Photo #382

Photo #383

Photo #384 Single lot with trees

Photo #385

Photo #386

Photo #387

Photo #388

Comments:…………………………………………………………………………………………………
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Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: Primary Dock Access	Date: 05-06-2013

Photo #389 Taken at Downstream, approximately 200 feet downstream of POI

Photo #390 Taken at Downstream, approximately 200 feet downstream of POI

Photo #391

Comments:……………………………………………………………………………………………………
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Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: Developed/Commercial Areas	Date: 05-06-2013

Photo #392 Commercial

Photo #393 Resort Area

Photo #394 Resort Area

Photo #395

Comments:…………………………………………………………………………………………………
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Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: Dam and Hydroplant	Date: 05-06-2013

Photo #397

Photo #398

Photo #399 Hydroelectric Plant

Photo #400 Dam

Photo #401 Close-up of Dam

Photo #402 Spillway

Photo #403

Photo #404

Photo #405

Photo #407

Comments:……………………………………………………………………………………………
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Deep Creek Lake – Photo Log

Project Description: Deep Creek Lake Sediment Study Location: Streets/Drainage Ditches	Date: 05-07-2013

Photo #408

Photo #409 Typical public road – 2 lanes, no curb/gutter

Photo #410

Photo #411 Gabion outlet protection

Photo #412 Private floating dock

Photo #413

Photo #414

Photo #415

Photo #417 Typical distance between homes

Photo #418 Roadside drainage ditch

Photo #420 Roadside drainage ditch

Photo #421 Eroded outfall

Photo #423 Roadside drainage ditch

Photo #424 Outfall erosion

Photo #425 Boat docks

Photo #426 Loading dock parking lot

Photo #427 Loading dock parking lot

Comments:…………………………………………………………………………………………………
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APPENDIX J

DECISION MATRIX

DEEP CREEK LAKE SEDIMENT STUDY - DECISION MATRIX

Environmental Impacts - Fish, Benthic, SAV, and Invasive were examined specifically. There are many species contained in each of these.

Economy - Economic Impact to Tourism, Hotel Occupancy, Service Industry, Rental Property, Property Value, and Local Economy

Recreation - The ability for Recreational Boating, Fishing, Whitewater Rafting, and Swimming to continue

Construction Cost - The relative cost compared to the other construction costs within the study which includes cost of ROW and Permitting

Impacts	Weighing Factor	Impacts of Hydraulic Dredging		Impacts of Mechanical (Wet) Dredging		Impacts of Mechanical (Dry) Dredging		No Dredging
		March to Memorial Day	Labor Day to December	March to Memorial Day	Labor Day to December	March to Memorial Day	Labor Day to December	
Environmental Impacts	**20**							
Fish	5	1	1	3	2	2	1	5
Benthic	5	1	1	3	2	2	1	5
SAV	5	1	1	3	2	2	1	5
Invasive	5	1	1	3	2	2	1	5
Economy	**20**							
Economic Impact	10	5	5	5	5	4	4	1
Stimulate Local Economy	10	3	3	3	3	5	5	1
Recreational Impact	**20**							
Recreational Boating	5	4	4	2	2	1	1	5
Fishing	5	4	4	2	2	1	1	5
Whitewater Rafting	5	4	4	2	2	1	1	5
Swimming	5	4	4	2	2	1	1	5
Construction Cost	**20**							
Capital Costs	15	3	3	1	1	2	2	5
ROW	5	2	2	1	1	1	1	5
Permitting	0	1	1	3	2	2	1	5
TOTAL		**235**	**235**	**200**	**180**	**185**	**165**	**320**

High Score = Best Case Scenario, Scoring as follows: 1 = Worst Negative Impact, 2 = Negative Impact, 3 = Neutral, 4 = Minimal/Positive Impact, 5 = No/Best Impact

EXHIBITS

DEEP CREEK LAKE
Watershed Boundary
Department of Natural Resources

N

1" = 10,000 feet

WHITNEY BAILEY COX & MAGNANI, LLC
849 Fairmount Ave. Suite 100 Baltimore, MD 21286
Tel. 410-512-4500 Fax. 410-324-4100
www.wbcm.com

WBCM
ARCHITECTURE ENGINEERING CONSTRUCTION

Sheet No.
Sheet 1

EXHIBIT 1

Drawn By:

Checked by:

Date:

DEEP CREEK LAKE
Land Use
Department of Natural Resources

N

1" = 10,000 feet

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ARCHITECTURE ENGINEERING CONSTRUCTION

Sheet No.
Sheet 1

EXHIBIT 2

Drawn By:

Checked by:

Date:

DEEP CREEK LAKE
Soil Map
Department of Natural Resources

N

1" = 6,000 feet

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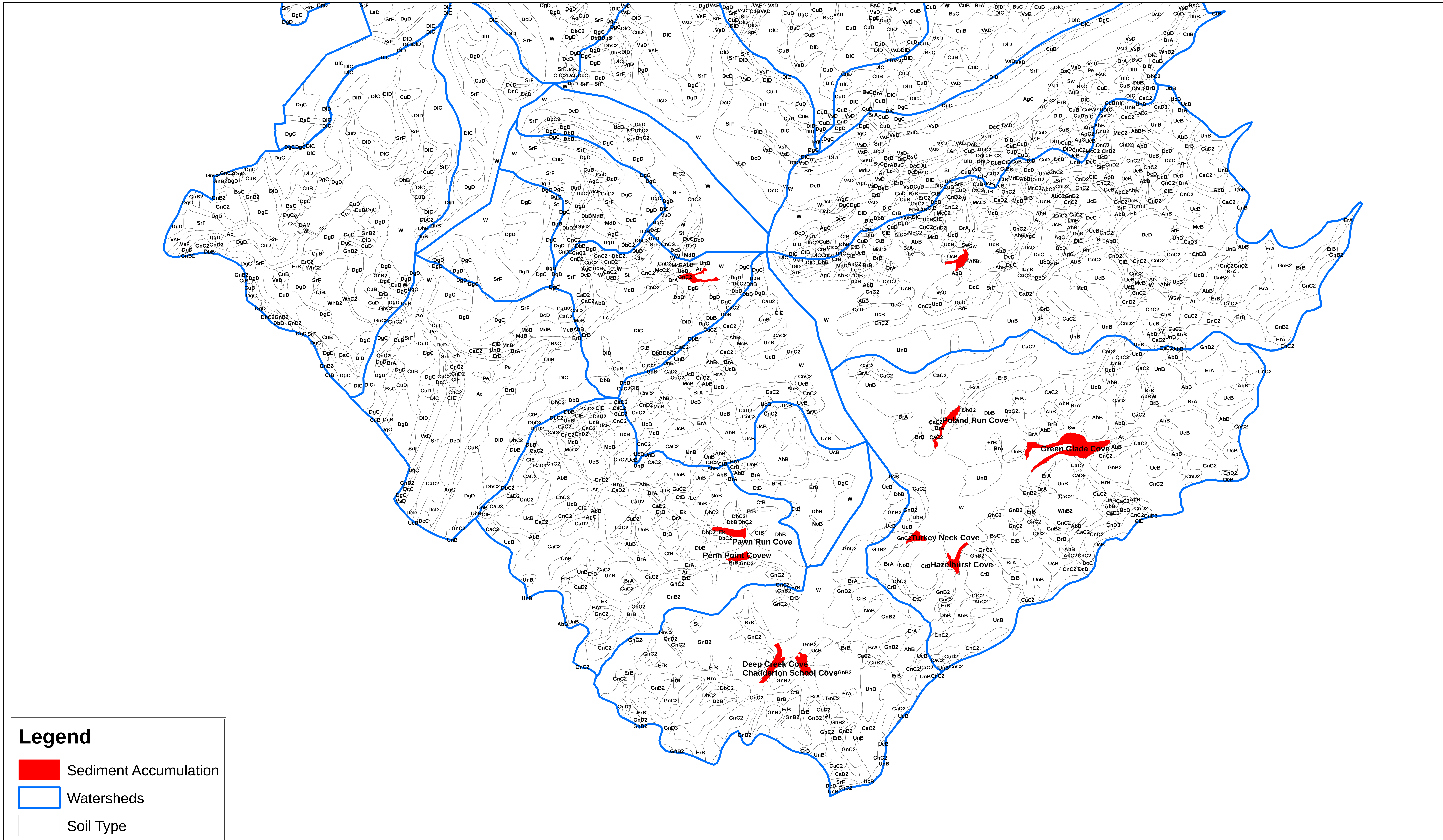
Sheet No.
Sheet 1

EXHIBIT 3A

Drawn By:

Checked by:

Date:



DEEP CREEK LAKE
Soil Map
Department of Natural Resources

N

1" = 6,000 feet

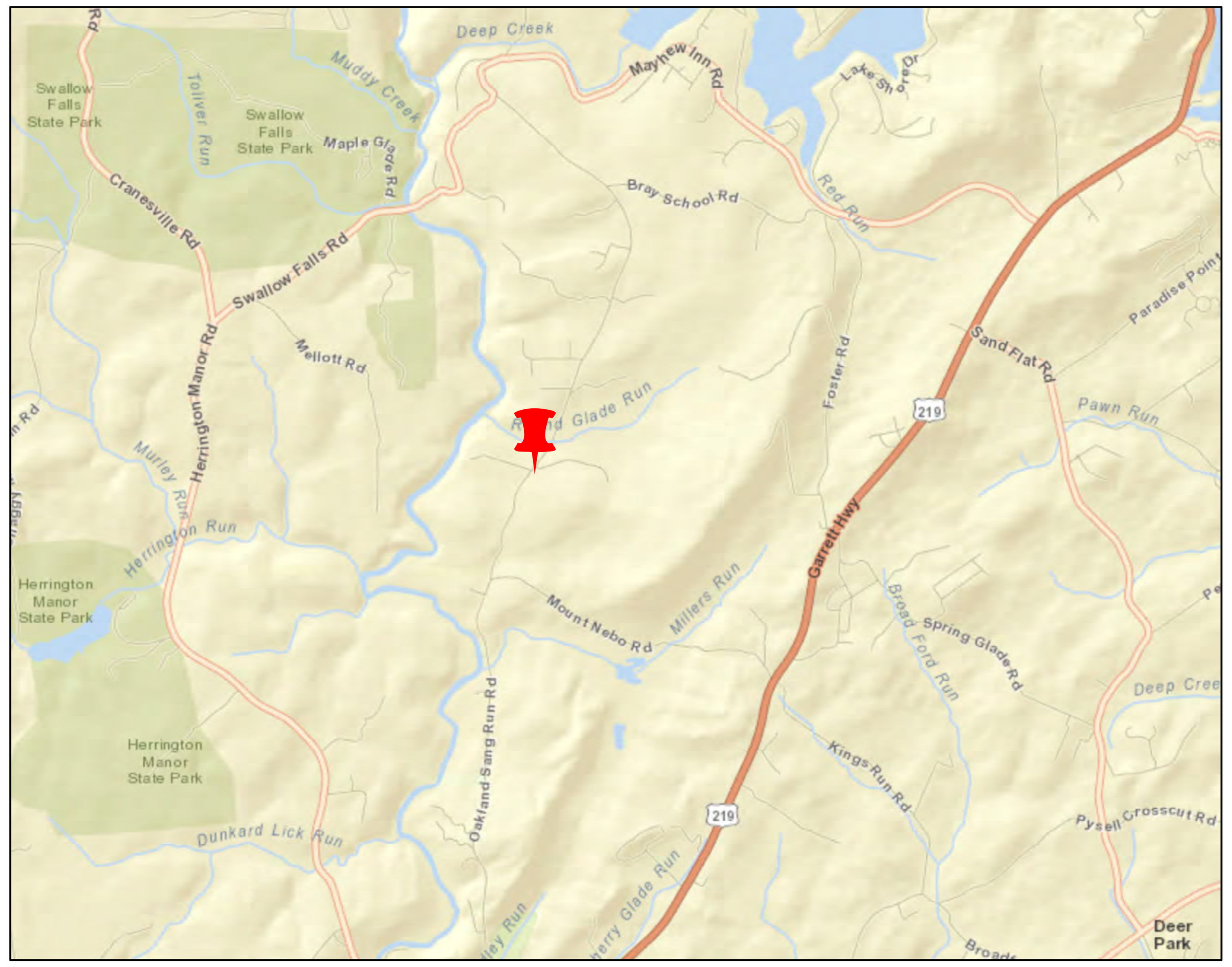
Sheet No.
Sheet 1

EXHIBIT 3B

Drawn By:

Checked by:

Date:

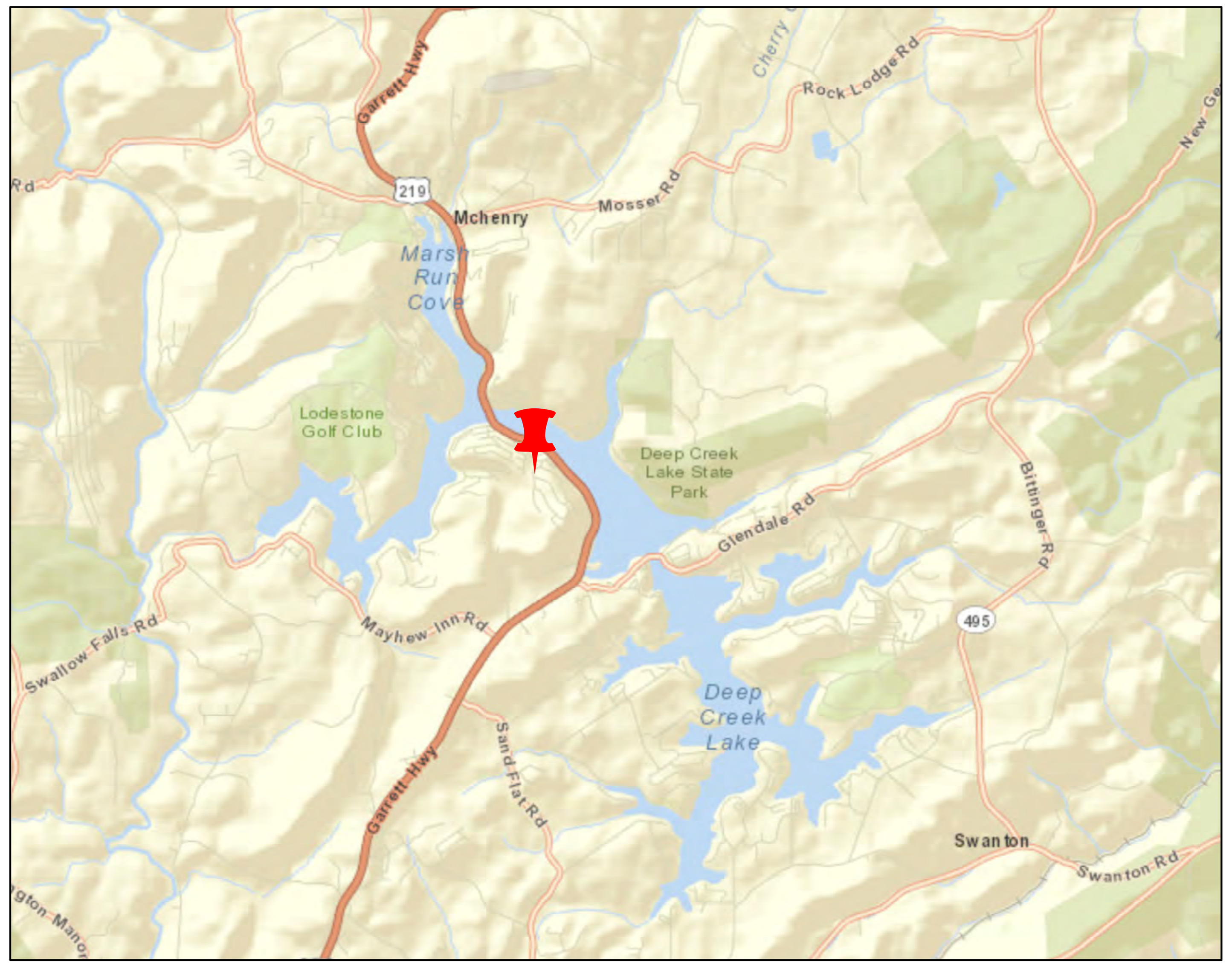


Vicinity Map **1" = 2 miles**

Minimum Storage Volume = 300,000 cubic yards
Maximum Storage Volume = Undetermined

Aerial Image
1" = 1,000 feet

DEEP CREEK LAKE **Landfill Site** **Department of Natural Resources**	WHITNEY BAILEY COX & MAGNANI, LLC 849 Fairmount Ave. Suite 100 Baltimore, MD 21286 Tel. 410-512-4500 Fax. 410-324-4100 www.wbcm.com WBCM ARCHITECTURE ENGINEERING CONSTRUCTION	**Sheet No.** **Sheet 1**	**EXHIBIT 4** **Drawn By:** **Checked by:** **Date:**



Vicinity Map **1 in = 2 miles**

Storage Volume = 65,000 cubic yards
Calculated using GEOPAK

Aerial Image
1" = 400 feet

DEEP CREEK LAKE
Quarry Site
Department of Natural Resources

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Sheet No.
Sheet 1

EXHIBIT 5

Drawn By:

Checked by:

Date: