

Department of Natural Resources  
MARYLAND GEOLOGICAL SURVEY  
Jeffery P. Halka, Director

**COASTAL AND ENVIRONMENTAL GEOSCIENCE PROGRAM  
FILE REPORT NO. 11-06**

**Deep Creek Lake Sediment Accumulation Study:  
A map reconnaissance of selected coves**

by  
Richard A. Ortt, Jr.  
and  
Vince Manship

Prepared For  
**Department of Natural Resources**  
Maryland Park Service

**October, 2011**

# **Deep Creek Lake Sediment Accumulation Study: A map reconnaissance of selected coves**

## **EXECUTIVE SUMMARY**

Ten coves were studied in Deep Creek Lake for sedimentation which may have occurred since 1970. These coves were from different geographical parts of the lake, and they were selected based on varying land uses, watershed types, geology, terrain, and the DNR Park Manager input.

Current depths of the lake surveyed between 2007 and 2011 were compared to a historical DNR bathymetry map from the early 1970s. The difference between the current depths and the historical depths capture the sedimentation which occurred over the last forty years.

Of the ten studied sites, two sites demonstrated that they are erosional, four sites demonstrated no changes, and four sites demonstrated sediment deposition.

Where sedimentation is occurring, it is following a very standard deltaic deposition process where the headwaters of the coves have an increased sedimentation rate while the more distant portions of the lake from the stream inputs show little sedimentation. The data in this study shows that where sedimentation is occurring, it is occurring between zero and nine hundred feet from the cove headwaters (stream inputs). Beyond nine hundred feet from the headwaters, sediment accumulation is confined to isolated areas in water depths greater than 20 feet.

A majority of the observed sediment accumulation is between 0.5 and 2.5 feet over this forty year period. Of the 108 observations, there were three observations of 3 foot sediment accumulations amounts.

In over eighty-seven percent of the observed sedimentation locations, less than ten percent of the navigable water depth was impaired. Isolated locations showed a maximum of thirty-eight percent impairment from the 1970s depth (ex. 3 feet of sediment has accumulated where in 1970 there was 8 feet of water depth).

Additional studies to quantify the sedimentation throughout the lake, and the sources of sedimentation are recommended.

## **TABLE OF CONTENTS**

Executive Summary

Table of Contents

Introduction

    Objective

    Study Area

    Historical Studies

Methods

Results and Discussion

Summary and Conclusions

Recommendations

Acknowledgements

References

Appendices

    Appendix A: Individual Cove Comparisons

## INTRODUCTION

With the recent acquisition of Deep Creek Lake into the public lands managed by the State of Maryland, Department of Natural Resources (DNR), increased development of the surrounding land and with a growing public concern of sedimentation within the lake, an examination of Deep Creek Lake was initiated to assess the current conditions of this resource.

In the summer of 2010, Deep Creek Lake Management and concerned citizen groups solicited the Resources Assessment service (RAS) to assist in determining the amount of sediment which had accumulated on the lake bottom, specifically in shallow water environments where boating access is hindered.

In cooperation with DNR Engineering, RAS initiated a reconnaissance survey to identify the size and scope of sedimentation occurring in the lake.

### Objectives

In order to obtain a general knowledge of the amount of sedimentation occurring in the shallow water environments of Deep Creek Lake, the Maryland Geological Survey (MGS), a program within DNR's Resource Assessment Service (RAS), and DNR Engineering surveyed current sediment elevations and compared them to a historical map to determine the accumulated sediment in ten selected coves. This reconnaissance survey only examines changes which occurred between the present and the historical map date. Various natural or manmade cycles of sedimentation may have occurred between these two points in time which will not be captured in this study. The results of this analysis are presented in this report.

### Study Area

Deep Creek Lake is located in Garrett County. The lake was formed in 1925 when the Youghiogeny Hydroelectric Company constructed a dam across Deep Creek. The lake is presently owned and managed by Maryland Department of Natural Resources.

The Deep Creek Lake watershed is located within the Appalachian Plateau Physiographic Region of Maryland. The bedrock of this region consists principally of gently folded sedimentary rock comprised of shale, siltstone, and sandstone of mixed marine and non-marine origins. Folding has produced elongated arches, or anticlines, trending NE to SW across the region that expose the oldest formations at the surface. In the intervening synclinal basins, coal-bearing strata of Pennsylvanian and Permian ages are preserved. The northern half of Deep Creek Lake is located on broad syncline, called the Casselman Basin. Meadow Mountain is the eastern border of this structure. The lake perimeter is steep within this structure. The rock exposed here are brown colored sandstones and shales of a Mississippian age formation called the Mauch Chunk. Within the State Park, the 200 to 300-foot thick Greenbrier Limestone underlies the lake, contributing calcium carbonate to the water. Calcium carbonate may buffer the lake from acidic runoff from adjacent coal deposits. The Cherry Branch tributary drains the coal bearing formations and is thought to contribute a significant portion of the acidity to the lake (MDE, 2002).

The dam and immediately adjacent areas lie within the Upper Youghiogheny coal basin. Here sandstones and shales of the Allegheny /Pottsville formation of Lower Pennsylvanian age (325 million years old) are exposed. Some lower coal beds may also be exposed.

The southern half of the lake lies within the Deer Park Anticline composed of the (1) brown colored sandstones and shales of the Pocono Formation of Lower Mississippian age (350 million years old) then (2) further southeast, red to reddish brown sandstones and shales of the Hampshire Formation of Upper Devonian age (365 million years old) and finally (3) Devonian series of formations, comprise of predominately greywacke, siltstone and shale, sandstones and conglomerates. Unlike the northern half of the lake, the topography along the perimeter of the lake within the anticline structure is flatter and gentler.

### **Historical Studies**

No historical studies of the sediments in Deep Creek Lake have been found earlier than 2010. In 2010, the United States Geological Survey (USGS) published results of cores collected in Deep Creek Lake during 2007 (Banks et al., 2010) and a report is in preparation which summarizes ground penetrating radar records collected in 2007. Concurrent with this publication, a report documenting the surficial sediment chemistry of Deep Creek Lake is published (Wells and Ortt, 2011).

USGS analyzed five cores using Cesium dating methods where they identified the 1963 sediment horizon within the sediment. The cores were collected within the cove areas of the lake. The USGS results showed a sediment accumulation between 1963 and 2007 (the collection year of the cores) ranged between 4.03 inches and 11.9 inches (Banks et al., 2010).

## **METHODS**

### **Bathymetric and Topographic Map Comparison**

Ten study sites (Figure 1) were selected for this study based on land use, slope, soil types, sub-watershed size, and the State Park Manager concerns.

Current elevations within these study sites were obtained using traditional land surveying methods in October 2010 and in May 2011. These elevations were converted to depths using the defined full pool level elevation (2462 feet MSL) equal to the zero depth of the lake. Verification of the vertical conversion was performed by taking elevations of the water at each site and comparing those elevations with the recorded elevation of the water at the dam. Horizontal accuracy of the collected elevations is +/-0.05 feet and vertical accuracy of the surveyed points is +/- 0.05 feet. These elevations were imported into ESRI ArcInfo documenting the current depths of the lake.

USGS and Maryland Department of the Environment (MDE) bathymetry soundings from 2007 and 2008 were also imported into ESRI ArcInfo providing additional coverage. Horizontal

accuracy of the collected points is estimated to be +/- 9 feet and vertical accuracy is estimated to be +/- 0.25 feet. (Banks et al, 2010)

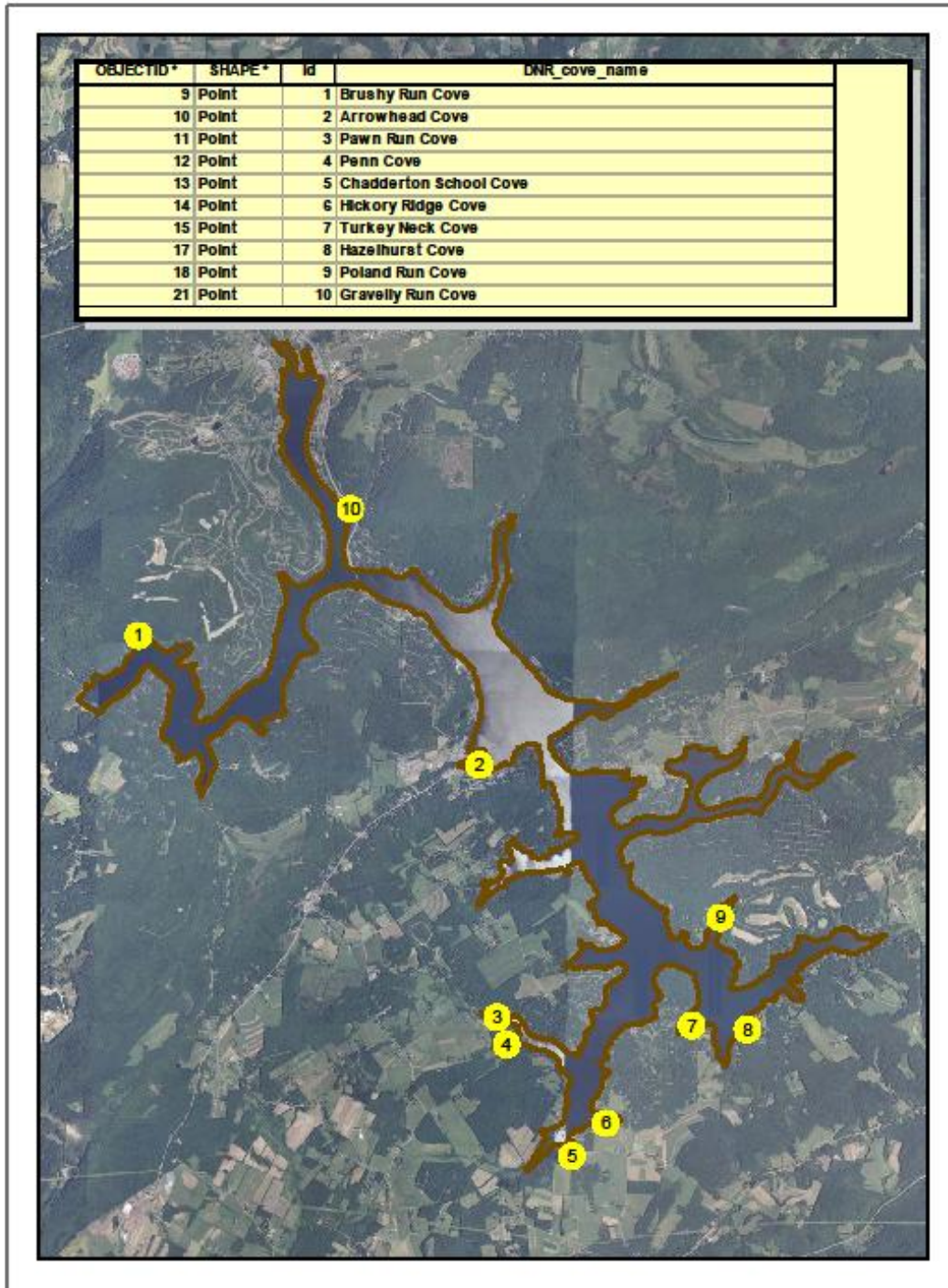
The only historical map which has been found of Deep Creek Lake at a usable scale for sediment documentation is a 1970s era Department of Natural Resources 1:10,000 scale Bathymetric Chart. This map series has been used for other historical reservoir comparisons, and it has proven to be accurate to within 1 foot of depth. (Ortt et al, 1999; Banks and LaMotte, 1999). The horizontal coordinates of the map have been stretched in places making for imperfect alignment with the existing shoreline. However, the general bathymetry for what we are using the maps is accurate using the general shape of the shoreline.

The historical map was scanned and georeferenced using the annotated Maryland State Plane Coordinate NAD27(North American Datum 27) tic marks placed on the map. This was then converted to a Universal Transverse Mercator, NAD83 (North American Datum 1983) referenced image. This map provided the historical GIS layer documenting the depths of the lake in the early 1970s.

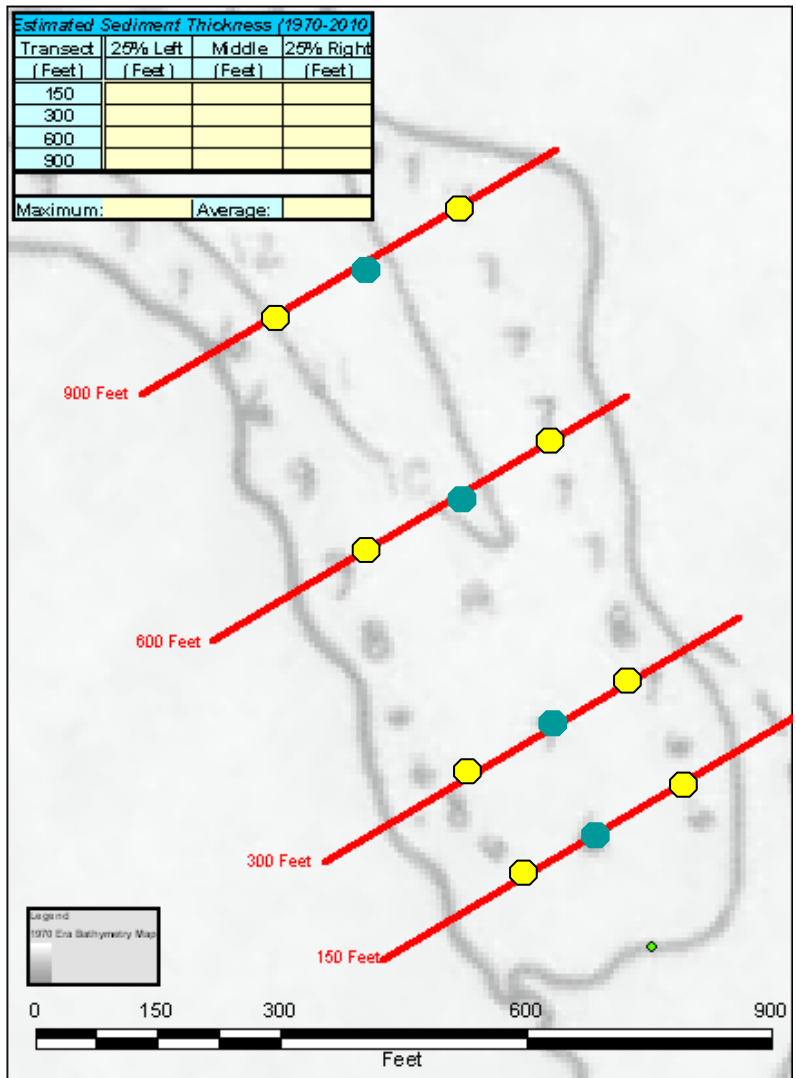
A grid was drawn for standardization in each studied cove beginning at the headwater section of the cove. Transects were drawn from shoreline to shoreline at 150, 300, 600, and 900 feet from the headwaters of the cove. Points along these transects were selected at 25%, 50%, and 75% distances between shorelines (Figure 2). At these points, the current elevation and the historical depths were compared.

The comparison was made by subtracting the current depths documented by the DNR, USGS, and MDE surveys from the depths annotated on the historical map. When the horizontal locations of the comparison points did not align with the data, data points were interpolated and the best professional estimate was provided. When the historical map was horizontally offset from the actual coordinates, the generalized shape of the shoreline was used to align the historic data.

## Deep Creek Lake -- Selected Coves for Sediment Study



**Figure 1.** Selected Coves. Selected coves for this study are represented by yellow circles, labeled with the site number.



**Figure 2.** Drawn Transect Lines and Study Points. Chadderton School Cove with 150, 300, 600, and 900 foot transects drawn over the historical bathymetry. The yellow and blue points along the transects highlight the 25%, 50%, and 75% shoreline width locations where the current and historical depth comparison occurs.



## **RESULTS AND DISCUSSION**

Observations of the current depths and the historical depths were performed in all selected coves along the transect lines. The differences between these depths were recorded in site diagrams found in Appendix A, and they are summarized in Table 1.

One hundred and twenty points were observed for sedimentation within the ten selected sites. Twelve comparisons were unable to be performed due to a lack of historical data. Of the remaining one hundred eight observations, eleven observations showed negative accumulation (erosion)(<-0.5 feet accumulation), sixty-four showed no change, and thirty-three showed sediment accumulation (>0.5 feet accumulation).

To summarize the specific site datasets an average and maximum statistic was calculated for each site. (Table 1)

Transect		150			300			600			900			Statistics	
Site		Left	Middle	Right	Left	Middle	Right	Left	Middle	Right	Left	Middle	Right	Max	Average
Site 1	Brushy Run Cove	-2	-2	-2	-3	-2	0	0	0	0	No H Data	1	0	1.0	-0.9
Site 2	Arrowhead Cove	0.5	0	0.5	3	3	1	1	2	0	0	0.7	0	3.0	1.0
Site 3	Pawn Run Cove	0	1	0	0	0	0	1	1.5	1	0.3	2	1	2.0	0.7
Site 4	Penn Cove	No H Data	No H Data	No H Data	0	0	0	0	1.5	No H Data	0	0	2	2.0	0.4
Site 5	Chadderton School Cove	0.9	0.6	1	3	1	1.5	0	2.5	0	0	2	0	3.0	1.0
Site 6	Hickory Ridge Cove	0	0	No H Data	0	2	1	0	1	0	0	0	0	2.0	0.4
Site 7	Turkey Neck Cove	No H Data	No H Data	No H Data	0	-1	0	0	0.5	0	0	0	0	0.5	-0.1
Site 8	Hazelhurst Cove	0.1	0.1	0.1	0	0	0	0	0	0	0	0	0	0.1	0.0
Site 9	Poland Run Cove	No H Data	No H Data	No H Data	2.5	1.5	2.5	0.5	0.5	2	1	0.5	0	2.5	1.2
Site 10	Gravelly Run Cove	-3	-4	-4	0	-3	-1	0	0	0	0	1	1	1.0	-1.1

**Table 1.** Estimated sediment thickness observations in feet. All comparisons between the current lake bottom and the historical 1970s lake bottom are presented. Where no historical data was available for comparison, the observation is marked with “No H Data”. Positive numbers represent deposition. Negative numbers represent erosion (the site is deeper now than in the 1970s). A maximum and average of the observations were calculated to assist in summarizing the results.

## SUMMARY AND CONCLUSIONS

Over the last forty years, sedimentation and erosion processes have been occurring in Deep Creek Lake.

Where sedimentation is occurring, it is following a very standard deltaic deposition process where the headwaters of the coves have an increased sedimentation rate while the more distant portions of the lake from the stream inputs show little sedimentation. The data in this study shows that where sedimentation is occurring, it is occurring between zero and nine hundred feet from the cove headwaters (stream inputs). Analysis beyond nine hundred feet from the headwaters shows very little accumulation. Where there is accumulation beyond nine hundred feet from the headwaters, it is confined to water depths greater than twenty feet.

Of the ten sites studied, two sites demonstrated erosional patterns, four sites demonstrated no appreciable change, and four sites demonstrated depositional patterns over the last forty years.

The sites classified as erosional demonstrated an average of more than 0.5 feet sediment lost. From the standpoint of a boater, these sites became deeper. Site 1 (Brushy Run) and Site 10(Gravelly Run), both located in the northern portion of the lake, are the sites which demonstrate this erosional pattern. The bottoms of both of these coves are lined with gravel, cobble, and boulders. While not measured, it was observed that these sites have very strong storm water flows which likely create enough energy to evacuate the sediment from these coves.

Four sites demonstrated no appreciable change as defined by showing an average of an average of 0.5 foot or less of erosion or deposition. Site 4 (Penn Cove), Site 6 (Hickory Ridge), Site 7 (Turkey Neck), and Site 8 (Hazelhurst), all from the southern end of the lake are in this category. A small drainage basin may be attributable to these results for Site 6 (Hickory Ridge), Site 7 (Turkey Neck), and Site 8 (Hazelhurst). However, Site 4 (Penn Cove) has a relatively large drainage area. Site 4 (Penn Cove) sedimentation may also be underestimated due to a lack of historical data along the most upstream transect.

Four sites demonstrated sediment accumulation with an average accumulation of more than 0.5 foot. Site 2 (Arrowhead), Site 3 (Pawn Run), and Site 9 (Poland Run) demonstrate sediment accumulation throughout the studied part of the cove ranging from zero to three feet. Site 5 (Chadderton School) demonstrates a different sediment accretion pattern with area wide sediment accretion occurring within three hundred feet of the cove headwaters which then grades to a pattern of deposition concentrated in the deeper central channel portions of the cove. More information is needed to determine the source for this sedimentation.

These findings concur with the USGS cesium dating study where sediment accumulation ranged between 4.03 inches and 11.9 inches between 1963 and 2007

(Banks et al., 2010).

In order to address the recreational boating impact of this sedimentation, the highest observed sediment accretion points were compared to the 1970 historical water depth to determine the percentage of decreased navigable water depth due to sedimentation. These points are not indicative of the whole cove, and they should be understood as the worst-case for decreased navigation within the lake.

- 38% (3 feet of sediment in 8 feet of water in 1970) in Chadderton School
- 33% (3 feet of sediment in 9 feet of water in 1970) in Arrowhead
- 28% (2.5 feet of sediment in 9 feet of water in 1970) in Poland Run
- 17% (1.5 feet of sediment in 9 feet of water in 1970) in Pawn Run
- 15% (1.5 feet of sediment in 10 feet of water in 1970) in Penn
- All other sites demonstrate less than a 10% loss of water depth.

## **RECOMMENDATIONS**

This study is a map reconnaissance study which requires field validation of the results. Coring and geophysical surveys are recommended to validate the results collected through this study.

Land use and sub-watershed size is the only apparent discriminator for the amount of observed sediment accumulation. Further research into land use patterns, slope analysis, and watershed drainage is recommended to identify and quantify the sediment transport to the lake.

The above recommendations can be addressed through the implementation of Phase II of the DNR Sediment Management Plan for Deep Creek Lake.

## **ACKNOWLEDGEMENTS**

The authors wish to acknowledge Kevin Wooster (DNR), John Flatley (DNR), and Norman Johnson (DNR) for their support in field surveying, and Guy Goddard (DNR) for his support in processing the field surveys and CAD design. Darlene Wells is also acknowledged for her geologic interpretation and documentation of the Deep Creek Lake study area. William S. Banks (USGS) and Andrew E. LaMotte (USGS) are also acknowledged for their cooperation and assistance in the use of their collected data for this study.

## REFERENCES

Banks, W.S., Davies, W.J., Gellis, A.C., LaMotte, A.E., McPherson, W.S., and Soeder, D.J., 2010, Hydrologic Data for Deep Creek Lake and Selected Tributaries, Garrett County, Maryland, 2007-08: U.S. Geological Survey Open-File Report 2010-1092, available online at <http://md.water.usgs.gov/deepcreek/>

Banks, W.S.L., and LaMotte, A.E., 1999, Sediment accumulation and water volume in Loch Raven Reservoir, Baltimore County, Maryland: U.S. Geological Survey Water-Resources Investigations Report 99-4240.

MDE (Maryland Department of the Environment), 2002, Total Maximum Daily Load of Mercury for Deep Creek Lake, Garrett County, Maryland, Final Rpt submitted to US EPA, Region III.

MDE (Maryland Department of the Environment), 2010, Watershed report for Biological Impairment of the Deep Creek Lake Watershed in Garrett County, Maryland: Biological Stressor Identification Analysis \_Results and Interpretation, Final report submitted to US EPA, Region III.

Ortt, Jr., R.A., Kerhin, R.T., Wells, D.V., and Cornwell, J., 1999, Bathymetric Survey and Sedimentation Analysis of Loch Raven and Prettyboy Reservoirs: Maryland Geological Survey, Coastal and Estuarine Geology Program, File Report 99-04, 89 p.

Ortt, Jr., R. and Wells D. V., 2010, Sedimentation analysis of New Germany Lake: Baltimore, Md., Maryland Geological Survey, Coastal and Estuarine Geology File Report No. 10-02, 81 p.

Wells, D.V., Hill, J., Ortt, Jr., R. and Van Ryswick, S., 2007, Sediment Mapping and Sediment Oxygen Demand of Triadelphia and Rocky Gorge Reservoirs. Coastal and Estuarine Geology Program, FR 07-02, 47 p.

Wells, D.V. and Ortt, Jr., R., 2011, Deep Creek Lake Sediment Study: Physical and Chemical Characteristics of Lake Sediments: Maryland Geological Survey, Coastal and Estuarine Geology File Report No. 11-05, 44 p.

Wetzel, R.G., 1983, *Limnology*, 2<sup>nd</sup> Edition. Saunders College Publishing, NY.

## Appendix A

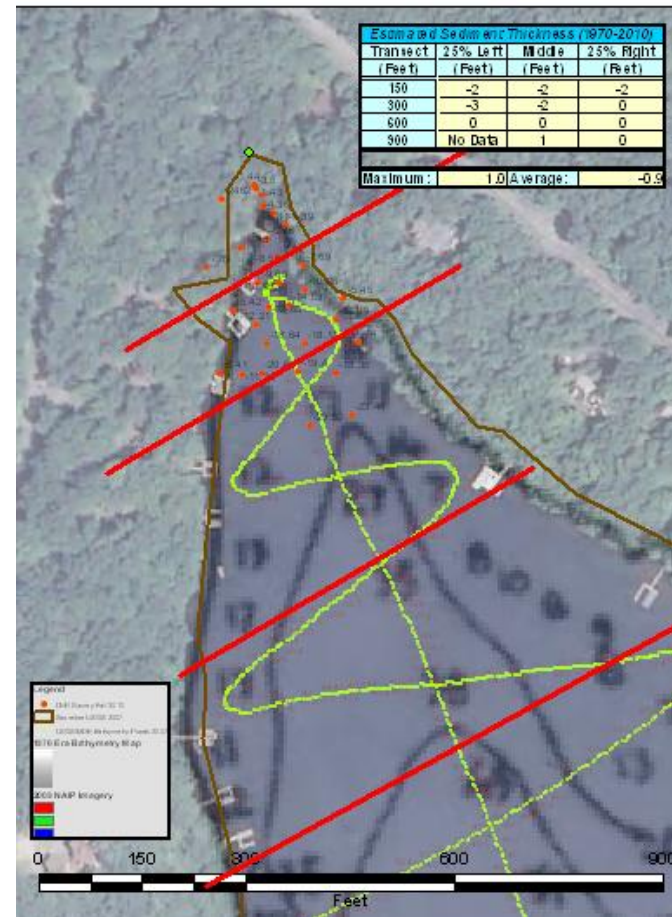
### Individual Cove Comparisons

**Pages A-2 thru A-11.** Selected Cove Comparisons. 1970s map is hand drawn and presented over 2010 USDA NAIP imagery. Orange points are collected survey points from DNR in Fall 2010 and Spring 2011. Green points are USGS/MDE bathymetry points collected in 2007 and 2008. Where annotated, the red lines represent the 150, 300, 600, and 900 foot transects used for this comparison. Estimated Sediment thicknesses from the comparison are presented in the attached tables. Left and right are oriented as looking into the lake from the cove headwaters. For comparison, the horizontal coordinates of the 1970s map were manipulated to meet the current shoreline of the lake.

### Site 1 Brushy Run Cove

Estimated Sediment Thickness (1970-2010)			
Transect (Feet)	25% Left (Feet)	Middle (Feet)	25% Right (Feet)
150	-2	-2	-2
300	-3	-2	0
600	0	0	0
900	No Data	1	0
<b>Maximum:</b>	1.0	<b>Average:</b>	-0.9

Detail of Site 1  
Brushy Run Cove



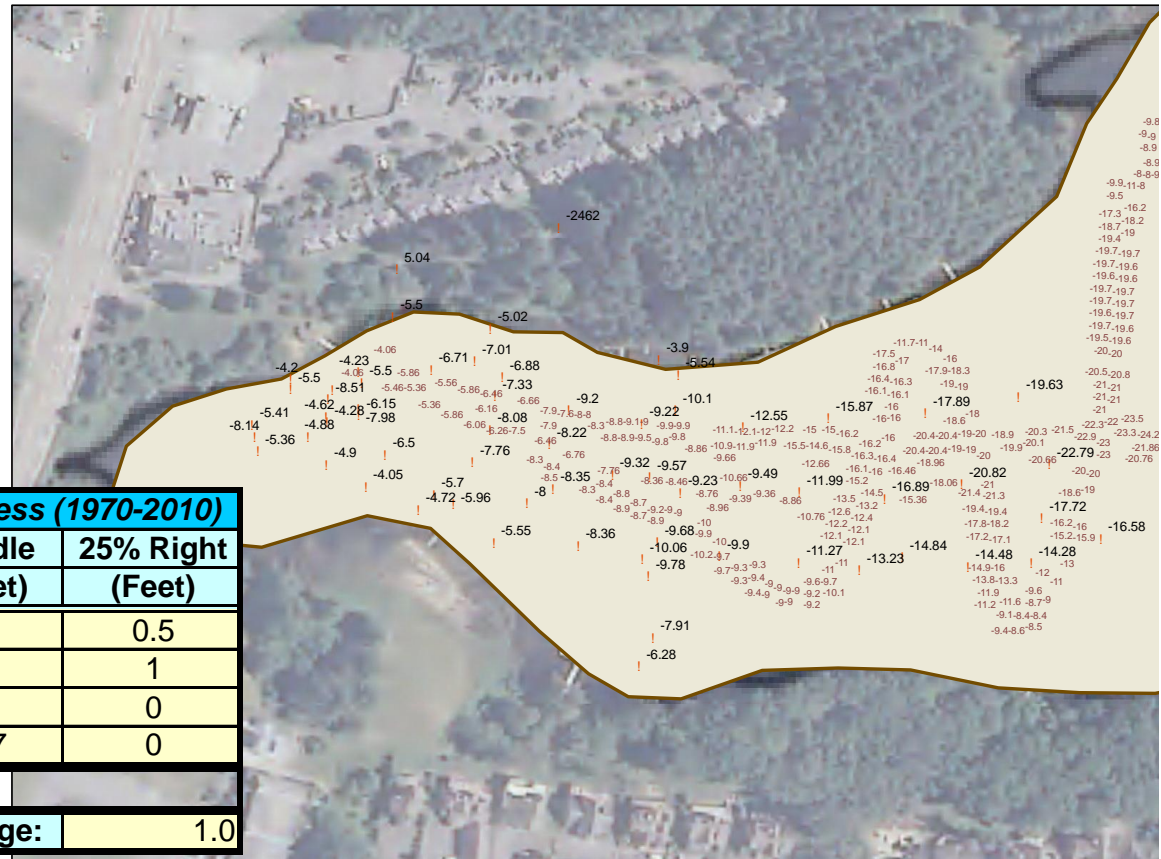


# MARYLAND DEPARTMENT OF NATURAL RESOURCES

## Deep Creek Lake Sediment Summary

### Deep Creek Lake Detail of Site 2 Arrowhead Cove

### Site 2 Arrowhead Cove



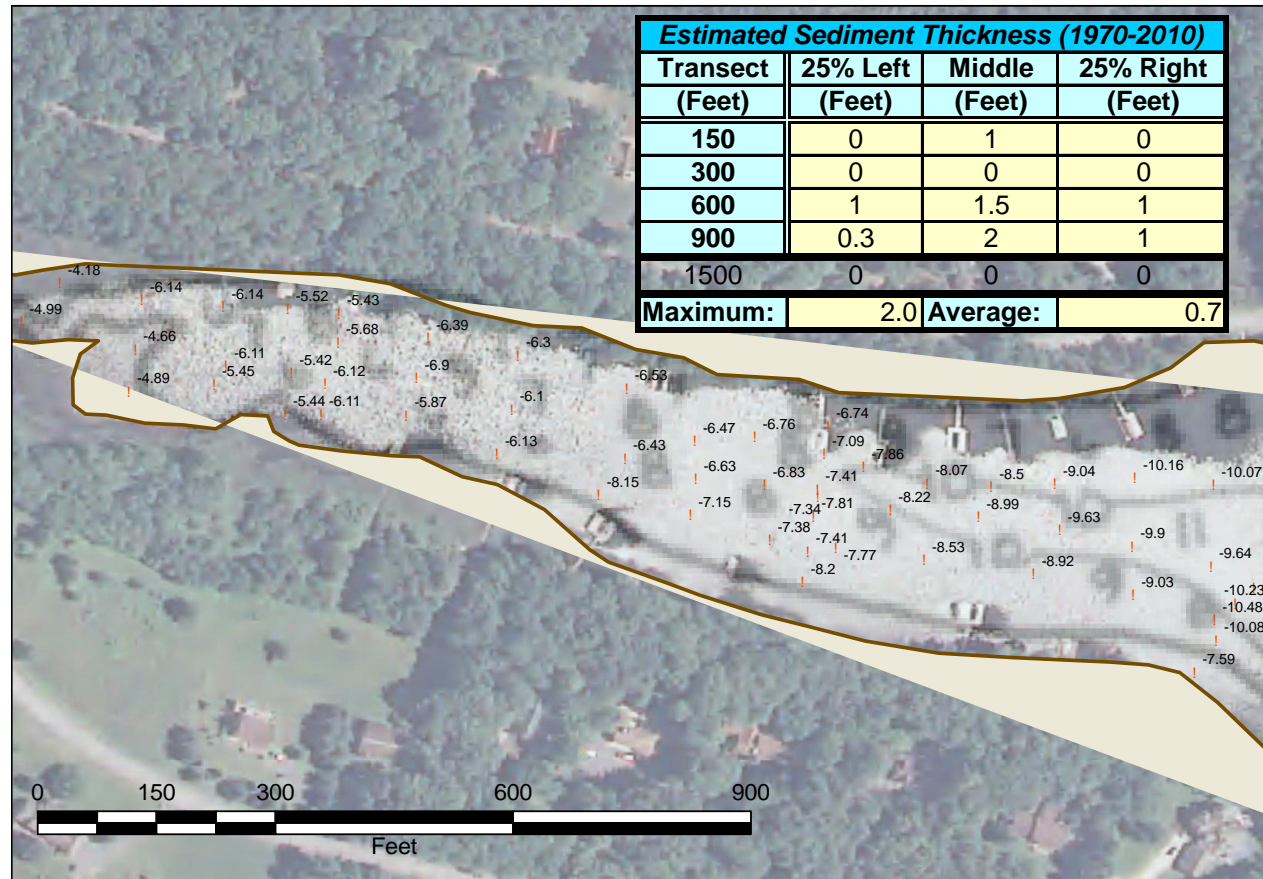
Estimated Sediment Thickness (1970-2010)			
Transect (Feet)	25% Left (Feet)	Middle (Feet)	25% Right (Feet)
150	0.5	0	0.5
300	3	3	1
600	1	2	0
900	0	0.7	0
<hr/>			
<b>Maximum:</b>	3.0	<b>Average:</b>	1.0





### Site 3 Pawn Run Cove

### Deep Creek Lake Detail of Site 3 Pawn Run Cove





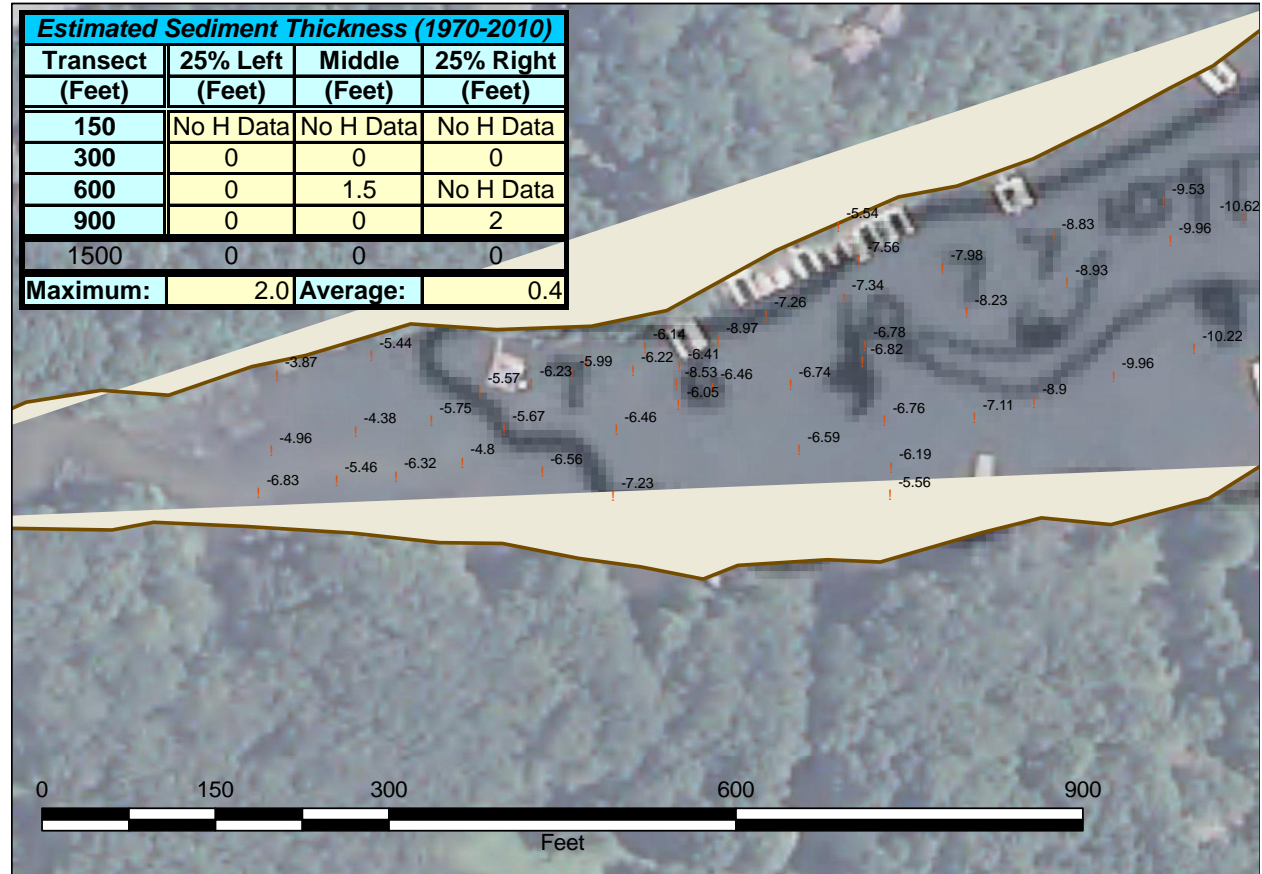
# MARYLAND DEPARTMENT OF NATURAL RESOURCES

## Deep Creek Lake Sediment Summary

### Site 4 Penn Cove

### Deep Creek Lake Detail of Site 4 Penn Cove

– No Historical Depth data upstream of the 300 foot transect





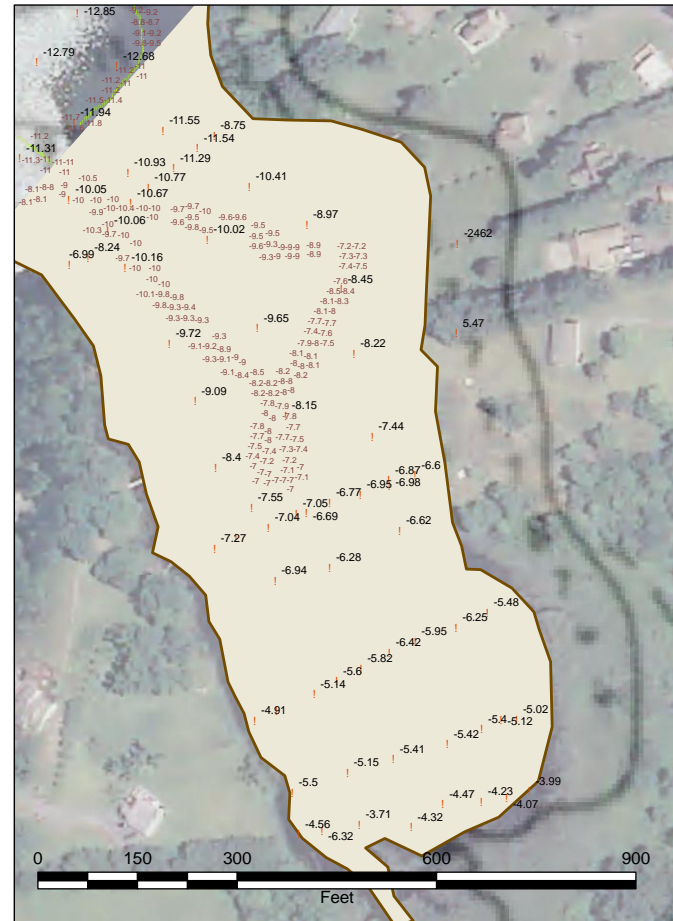
# MARYLAND DEPARTMENT OF NATURAL RESOURCES

## Deep Creek Lake Sediment Summary

Deep Creek Lake  
Detail of Site 5  
Chadderton Schoolhouse Cove

### Site 5 Chadderton Schoolhouse Cove

<b>Estimated Sediment Thickness (1970-2010)</b>			
<b>Transect (Feet)</b>	<b>25% Left (Feet)</b>	<b>Middle (Feet)</b>	<b>25% Right (Feet)</b>
150	0.9	0.6	1
300	3	1	1.5
600	0	2.5	0
900	0	2	0
<b>Maximum: 3.0 Average: 1.0</b>			







# MARYLAND DEPARTMENT OF NATURAL RESOURCES

## Deep Creek Lake Sediment Summary

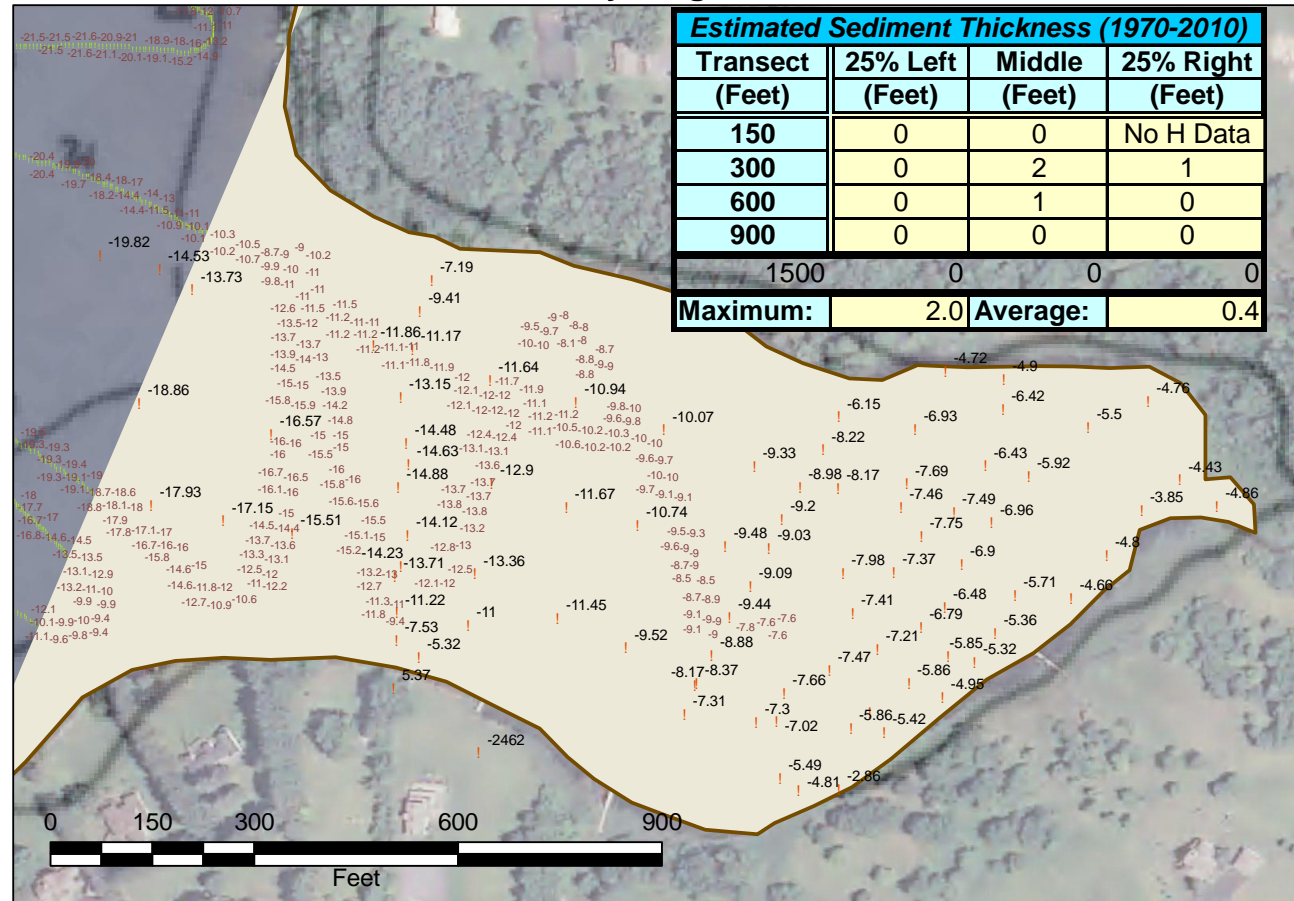
Deep Creek Lake

Detail of Site 6

Hickory Ridge Cove

Site 6

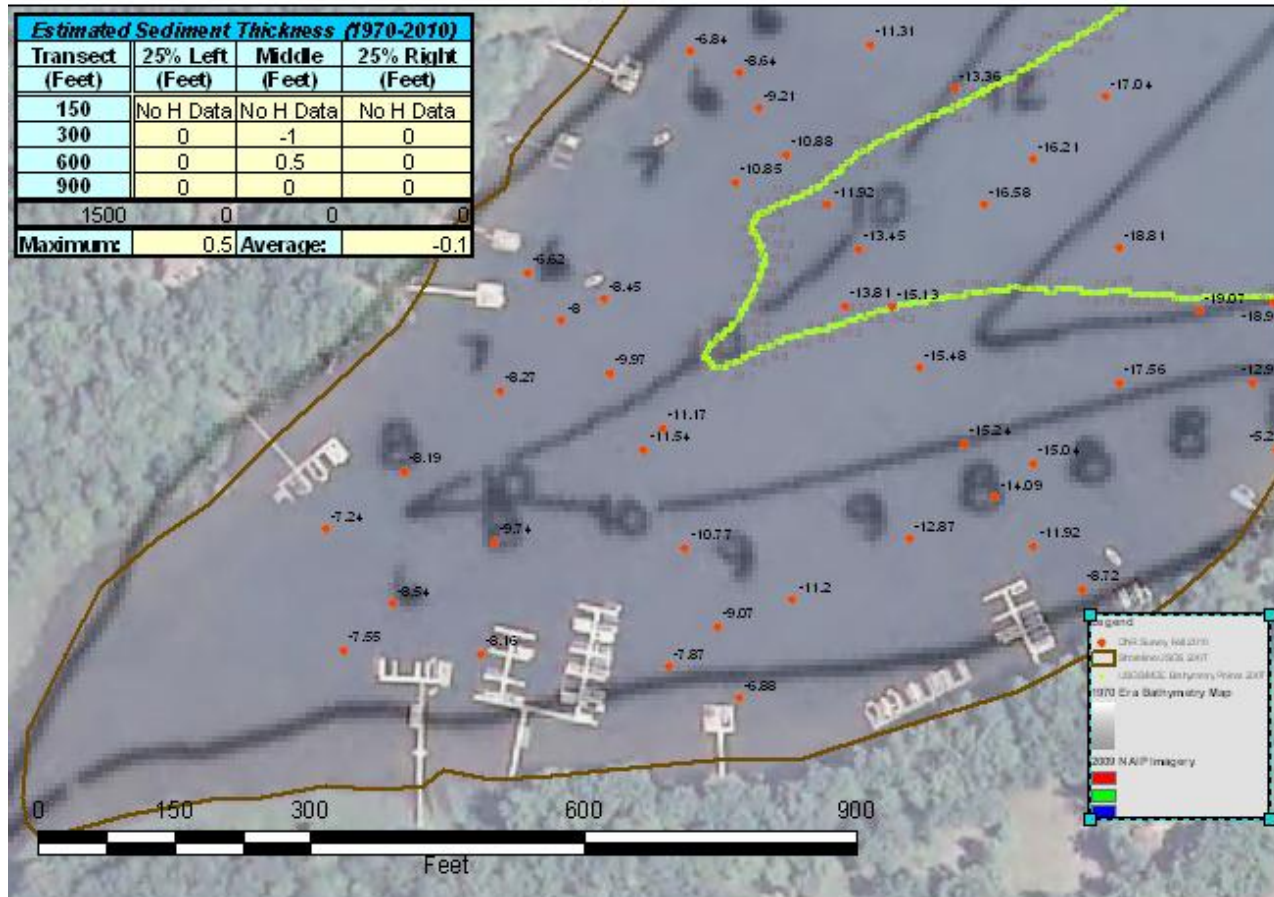
Hickory Ridge Cove



### Site 7

### Turkey Neck Cove

### Detail of Site 7 Turkey Neck Cove



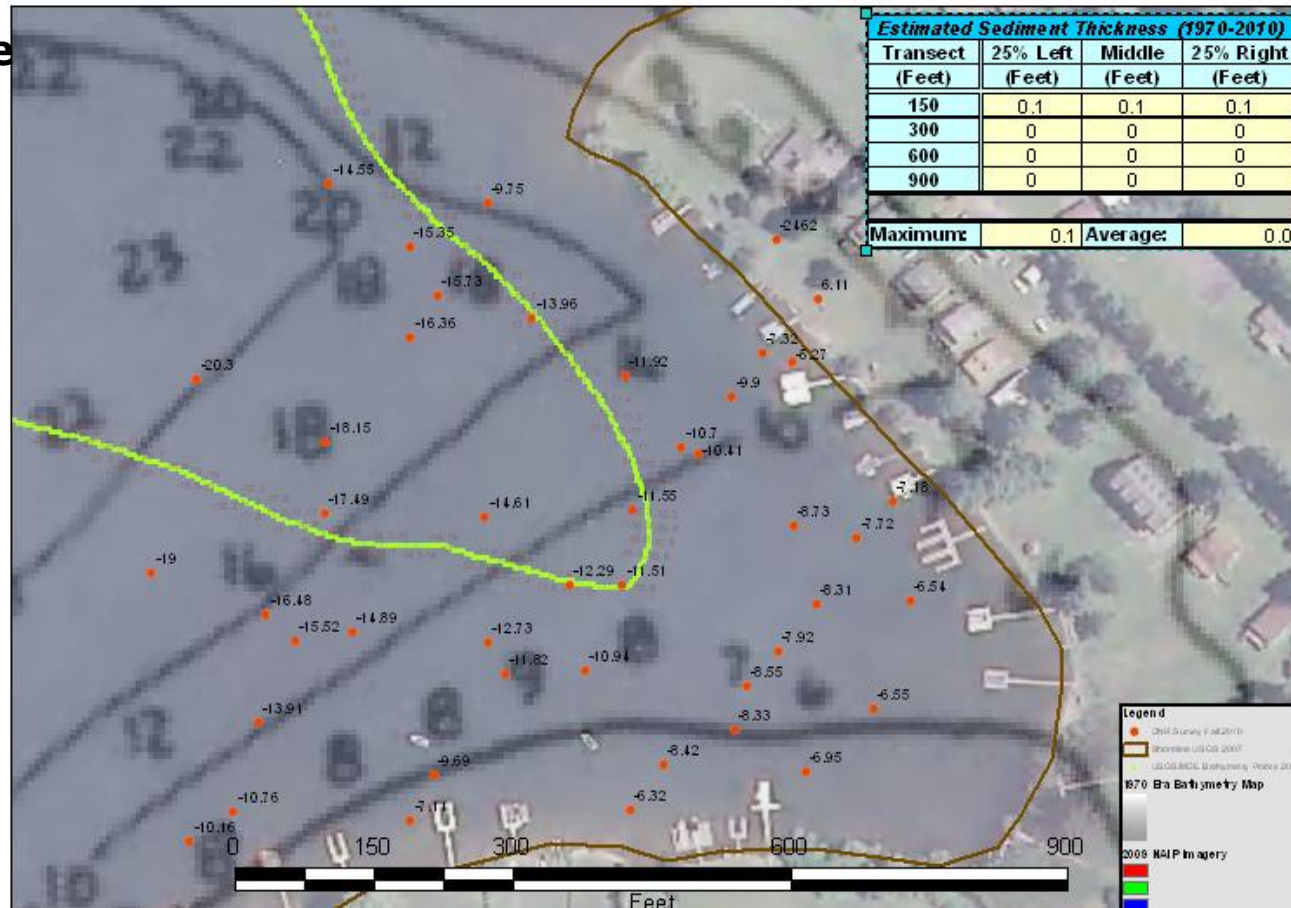
- No Historical Depth data upstream of the 150 foot transect

### Site 8

### Hazelhurst Cove

### Detail of Site 8 Hazelhurst Cove

- Transects were run from current shoreline.
- **Historical shoreline shows approx. 150 feet of unknown depth of lake is now marsh.**

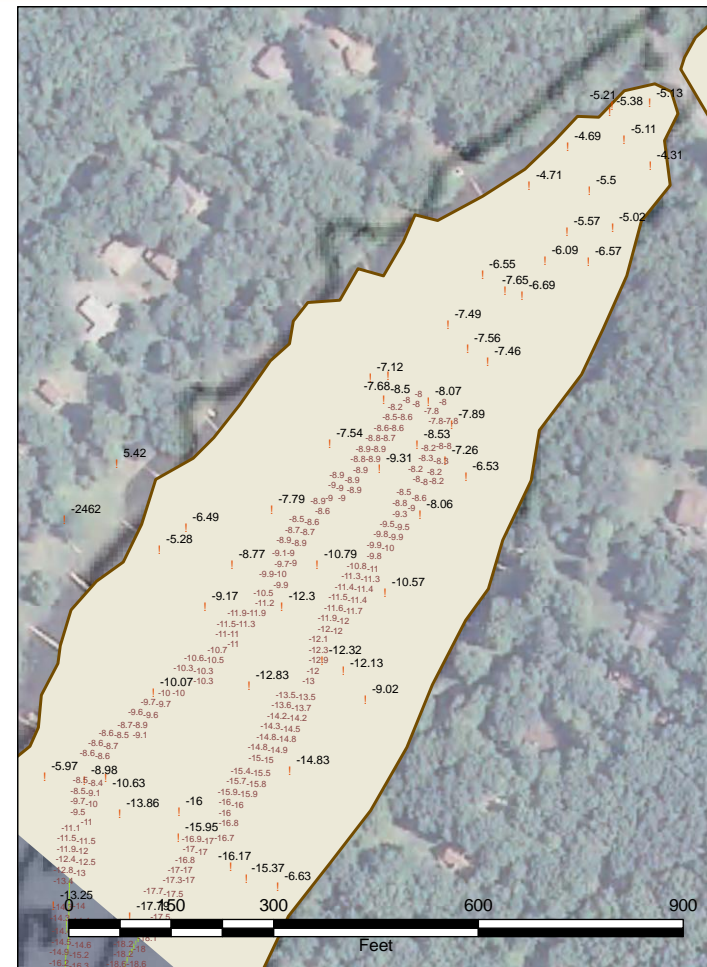




### Site 9 Poland Run Cove

<b>Estimated Sediment Thickness (1970-2010)</b>			
<b>Transect (Feet)</b>	<b>25% Left (Feet)</b>	<b>Middle (Feet)</b>	<b>25% Right (Feet)</b>
150	No H. Data	No H. Data	No H. Data
300	2.5	1.5	2.5
600	0.5	0.5	2
900	1	0.5	0
1500	0	0	0
<b>Maximum:</b>	<b>2.5</b>	<b>Average:</b>	<b>1.2</b>

- Road Bed / Bridge is installed limiting flow into cove and creating settling pond upstream of culvert.



### Site 10 Gravelly Run Cove

#### Detail of Site 10 Gravelly Run Cove

- Transects were run from current shoreline.
- Significant modifications have been made to this site since 1970.
- No sediment delta was observed at the mouth of the culverts during low water conditions

