SPANGLER
ENVIRONMENTAL, INC.

Sediment Impairment Evaluation

Uwharrie Upper & Lower Lakes (± 15.75 acre site)
James Landing Subdivision
Jamestown, North Carolina
27282

Prepared for:

James Landing Homeowners Association

Prepared by:

Spangler Environmental, Inc.

4338 Bland Road

Raleigh, North Carolina 27609

A. Callahan Rieder
Project Environmental Scientist

James A Spangler, CEI, A. M. ASCE
Project Manager/President

June, 2013

I. Sediment Impairment Evaluation Procedure

Spangler Environmental, Inc. performed an evaluation of sedimentation as indicated by lake substrate contours and sediment stratigraphy on June 11, 2013. This evaluation was conducted to establish a preliminary dataset of lake sediment information to aid in the assessment of lake health.

Field procedures included the establishment of set of transects creating a grid-pattern of measurement points. These locations were identified relative to the North Carolina state plane coordinate system using a Trimble® Geo-XT hand-held GPS capable of measuring X- and Y-coordinates to sub-meter accuracy. The GPS database and associated geo-statistical models have been retained for future reference and sample-point reproduction in the course of future follow-up studies. A grid of measurement points approximately 125-feet or less on center (108 data points spread over 14.53 acres) was traversed via boat on June 11, 2013. The depth-from-water-surface to existing lakebed substrate was then measured. Water surface elevation was referenced to an arbitrary "zero elevation" datum via traditional methods such that future measurements can be referenced to this datum regardless of potential variation in water surface elevation due to precipitation or drought. Each lake was assigned a datum. References to water surface and sediment elevations for a particular lake correspond exclusively to the datum that has been assigned to that lake. The upper lake located northeast of the dam corresponds to datum 1 while the lower lake located southwest of the dam corresponds to datum 2. The location of datum 1 is the iron ring lip of the manhole found near the top of the dam while the location of datum 2 is the iron ring lip of the manhole near the lower lake (see Photo 1, below). All lake depths are reported as depths from these "zero elevation" datums.

An evaluation of sediment stratigraphy was undertaken following the measurement of sediment depths. Six points were identified where hydrologic conditions would likely allow for clear stratification of sediment layers (see Exhibit 4). These points were chosen near the confluence of the lake with a stream input or dam outlet pipe in order to sample areas where sediment was likely to settle out of the water column. Clear plastic tubes were advanced into the lake substrate, retrieved, and evaluated for evidence of seasonal deposition (stratification of sediments separated by leaf letter, variations in soil texture and/or color, or other indicators of sediment deposition).

II. Observations

On the date of investigation, the lake surface elevation of the upper lake was 2 feet 2.75 inches above datum 1, or summarized as 2.23 fad (feet above datum), while the lake surface elevation of the lower lake was 3 feet 10.50 inches below datum 2, or summarized as 3.87 fbd (feet below datum). It was noted during field observation that the water level of both lakes was significantly higher than what is suggested by vegetation and shoreline features as average conditions.

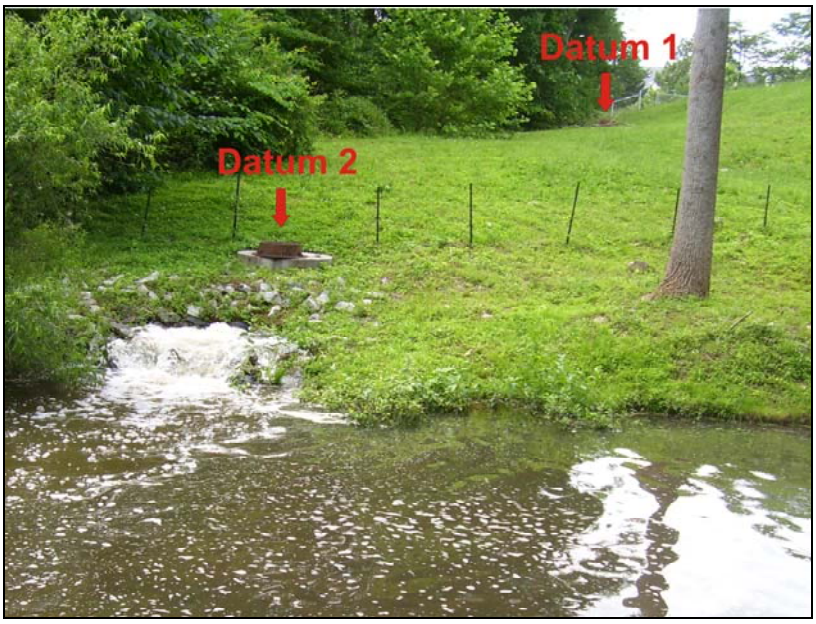


Photo 1: "Zero elevation" datum locations

A. Lake Depth

Depths to substrate were measured no closer than 4 feet from shore in order to avoid measurement complications introduced by shoreline protection devices and certain locations of highly-erodible shoreline. At the upper lake, depths to substrate ranged from 1.23 fad to 15.87 fbd (equivalently one foot to about 17.6 feet from the lake surface). At the lower lake, depths to substrate ranged from 4.87fbd to 12.07 fbd (equivalently one foot to about 8.2 feet from the lake surface). A scaled exhibit showing the measured lake substrate contours is attached as Exhibit 1.

B. Sediment Depth

Sediment stratification sample #1 revealed approximately 0.18 feet of sediment recently deposited since the accumulation of a layer of brightly colored clay soil (see Exhibit 6, Photo #1). This brightly colored clay layer may correspond with a period of development northwest of the upper lake that delivered disturbed soils to the lake through atypical runoff events or may be the result of increased oxygenation of the lake substrate from a previous summer. Sediment stratification sample #2 revealed approximately 0.14 feet of sediment recently deposited above an older silty clay layer (see Exhibit 6, Photo #2). Sediment stratification sample #2 revealed approximately 0.25 feet of sediment recently deposited above an older silty clay layer (see Exhibit 6, Photo #3). Sediment stratification sample #4 was inconclusive with respect to stratigraphy, as coarse-grained substrate was encountered uniformly to a depth of approximately 1.1 feet (see Exhibit 6, Photo #4). The elevated water levels on the date of sampling made it difficult to discern where the boundary of the lake would be found under normal conditions and as such, it is unclear whether the sample was gathered in an optimal location. Sediment stratification sample #5 was inconclusive with respect to stratigraphy, as coarse-grained substrate was

encountered uniformly to a depth of approximately 1 foot (see Exhibit 6, Photo #6). Due to the proximity of this sample location to the dam outflow into the lower lake, as well as field observation indicating that water flow around this location can reach substantial velocity, it is likely that all organic material and sediment that is not of significantly coarse nature is carried out into deeper portions of the lake downgradient. Sediment stratification sample #6 revealed approximately 0.44 feet of sediment recently deposited above an older silty clay layer (see Exhibit 6, Photo #7).

III. Findings

The drainage sub-basin associated with these two lakes has an estimated area of approximately 385 acres (see Exhibit 1). The contributing sub-basin is undergoing significant development pressure, mainly from residential development. It is unclear to what extent physical water quality protection measures such as storm water best management practices and dedicated stream buffers are in place throughout the sub-basin based off the limited scope of this assessment.

Initial sediment analysis has been limited to locations with a near-shore proximity to discharge locations from the surrounding watershed. The sediments measured at sample points 1,2,3, and 6 are very fine grained (see exhibit 6). These fine-grained sediments can be re-suspended as flow rates increase (during storm events, for example) and can stay in suspension for significant periods of time. Sediments measured at points 4 and 5 are course grained and relatively homogenous. It is likely that the velocity vector of water flow at these locations has prevented seasonally variable accumulation of organic matter and differential sediment layering. Core samples 4 and 5 indicate that there are substantive differences in water velocity rates at different stream/input locations and as a result, sedimentation rates are expected to vary based on these differences. Until such a time that turbidity measurements are taken for the lake and sediment depth sampling protocol are repeated, it is not possible to conclude where sediment is migrating at the highest rates and how it will affect the lake in the future.

Areas near sediment sample point #4 and sediment sample point #6 may require close examination in future analysis. Field observation revealed emergent depositional sediment features near these points that indicate an abundance of sediment being introduced to the lake from the corresponding streams. Findings indicating that seasonal sediment accumulation was highest at sediment sample point #6 are consistent with field observations of nearby emergent sediment features.

IV. Conclusion

Sediment at both lakes appears to have accumulated differentially along the lake bottom relative to the distance from a confluence with a stream input to the lake. Areas near stream inputs appear to have accumulated more sediment while areas further away from inputs appear to have accumulated less. Also, it appears that areas of the lake in close

proximity to development have accumulated more sediment than areas of the lake nearer to undeveloped regions (See Exhibits 2,3,4,5). This suggests that areas of the lake closer to stream inputs and nearer to developed areas of the watershed are expected to experience the greatest impacts from sediment accumulation. Special attention should be given to these areas in future analysis.

Further sets of measurements taken at later dates after sediment has had time to accumulate are required in order to draw conclusions as to the rate of sediment deposition and the identification of problematic areas. Once sampling protocols are repeated, the findings can be used to inform predictions about sediment translocation and lake storage capacity.

V. Recommendations

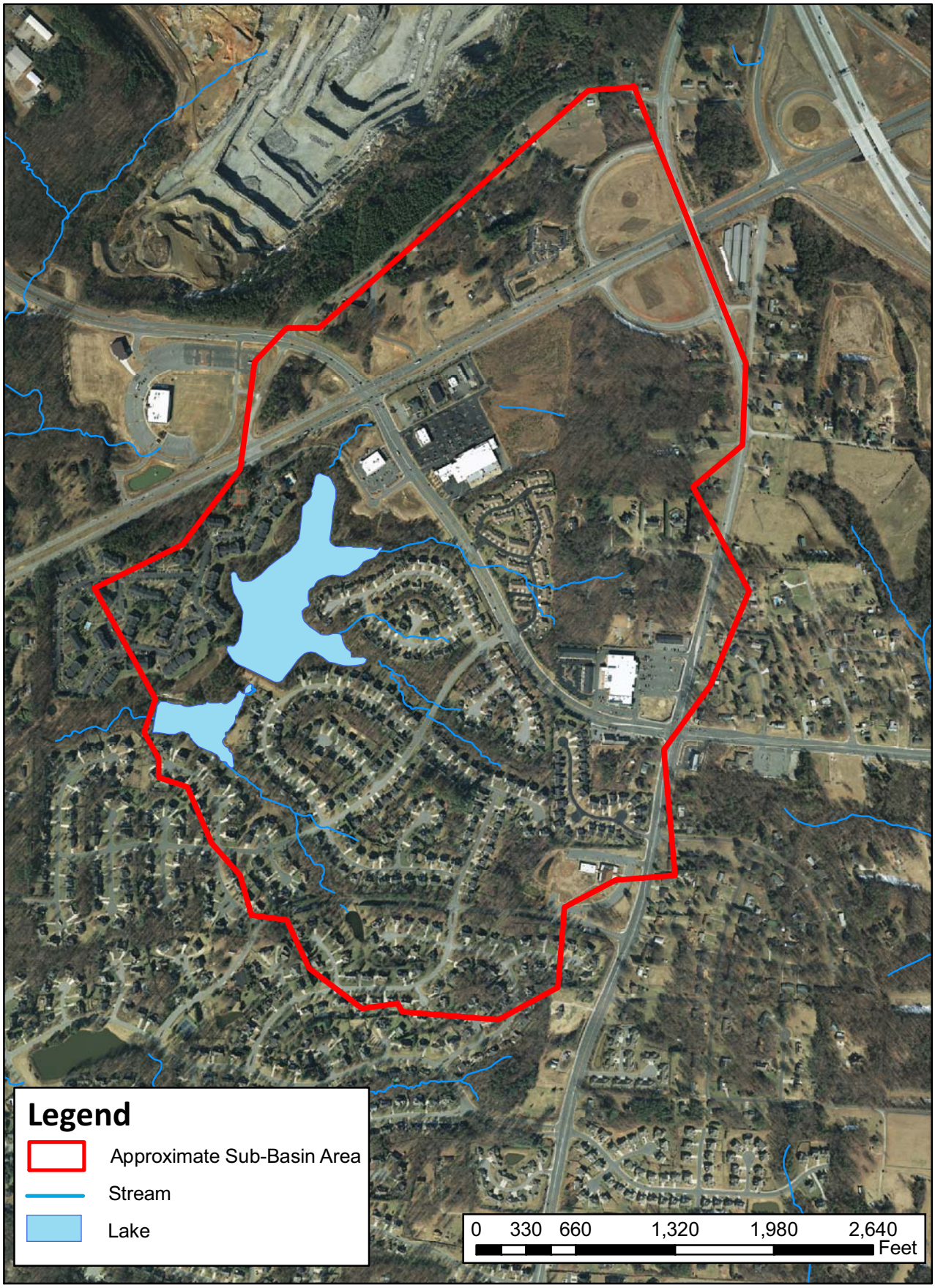
Future studies should include repeating the contour measurements and performing a more comprehensive stratigraphy analysis of sediment deposits in transects across both lake beds from stream/input locations to dam outlets. A recommended study interval should be no greater than bi-annually, such that rates of sediment deposition and geographic accumulation trends can be ascertained. These studies will allow comparative analysis that can be used to determine projected rates of lake storage loss, identify areas suffering the greatest impact for sedimentation, and allow for a prognostication of lake health for the coming years. These future studies will also be used to assess the need for turbidity measurements, a dam O&M plan, and remedial measures.

It is recommended that future investigation of the lake include an assessment of the dam and outlet structures to ensure that the dam is operating in a satisfactory manner. Field reconnaissance revealed that the water level of the lake was substantially higher than normal pool elevation after the previous day's rainfall event. A more static water level is preferred for the aesthetic nature of the lakes, the full utilization of homeowner's properties, and to prevent lake shore subsidence and accelerated erosion. A hydrologic assessment to determine appropriate drawdown during periods of minimal precipitation, and throughput during periods of high precipitation, should be undertaken to identify an operational routine that would allow for maintaining a more static water level.

Avoidance of erosion and sedimentation is preferable to minimization of erosion/sedimentation, and that in turn is preferable to mitigating sediment damage after it occurs. The scope and type of remedial or mitigative measures that will be necessary to manage sediment inputs are contingent upon whether sediment is primarily originating from in-lake sources or watershed sources. In lake sources include such factors as un-protected shorelines, subsidence of the lakebed substrate below the waterline, sediment translocation within the lakebed, and non-standardized waterfront construction of bulkheads, piers, irrigation pumps, and other lake accesses. Watershed sources include such factors as erosion from near-lake slopes, uncontrolled landscaping erosion, land disturbance in support of development, storm water runoff from streets, stream bank erosion, and substrate suspension of streambeds. Further analysis is required in order to

distinguish all contributing sources of the sediment and identify the most effective and appropriate mitigation measures. It is recommended that the next investigation include an assessment of watershed sources of sediment for the sub-basin so that recommendations can be made for the adoption of appropriate mitigative measures.

Contingent on the findings of the suggested ongoing lake assessments, future reports should identify sources of potential funding or cost-sharing for water quality improvement projects if they are deemed necessary. Various programs in the past have been applicable to one or more of the water quality improvement strategies that may be necessary or desirable at James Landing.



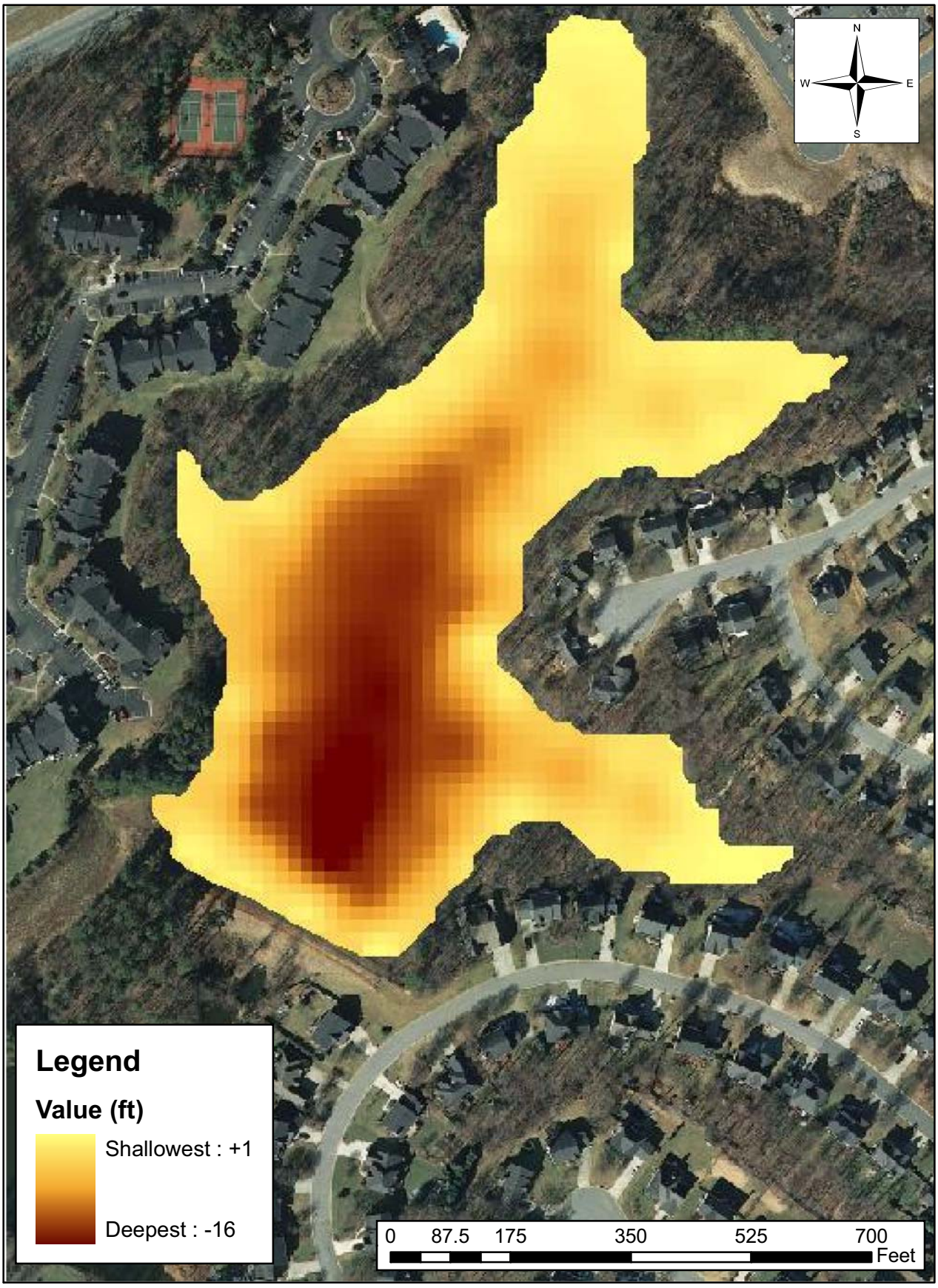
James Landing

4610 Crowne Lake Cir
Jamestown, NC
6/27/13

SPANGLER
ENVIRONMENTAL, INC.
4338 Bland Road Raleigh, NC 27609
919-875-4288

Exhibit 1
Approximate Drainage
Sub-Basin Area

map source:
NCOneMap 2010 Orthoimagery



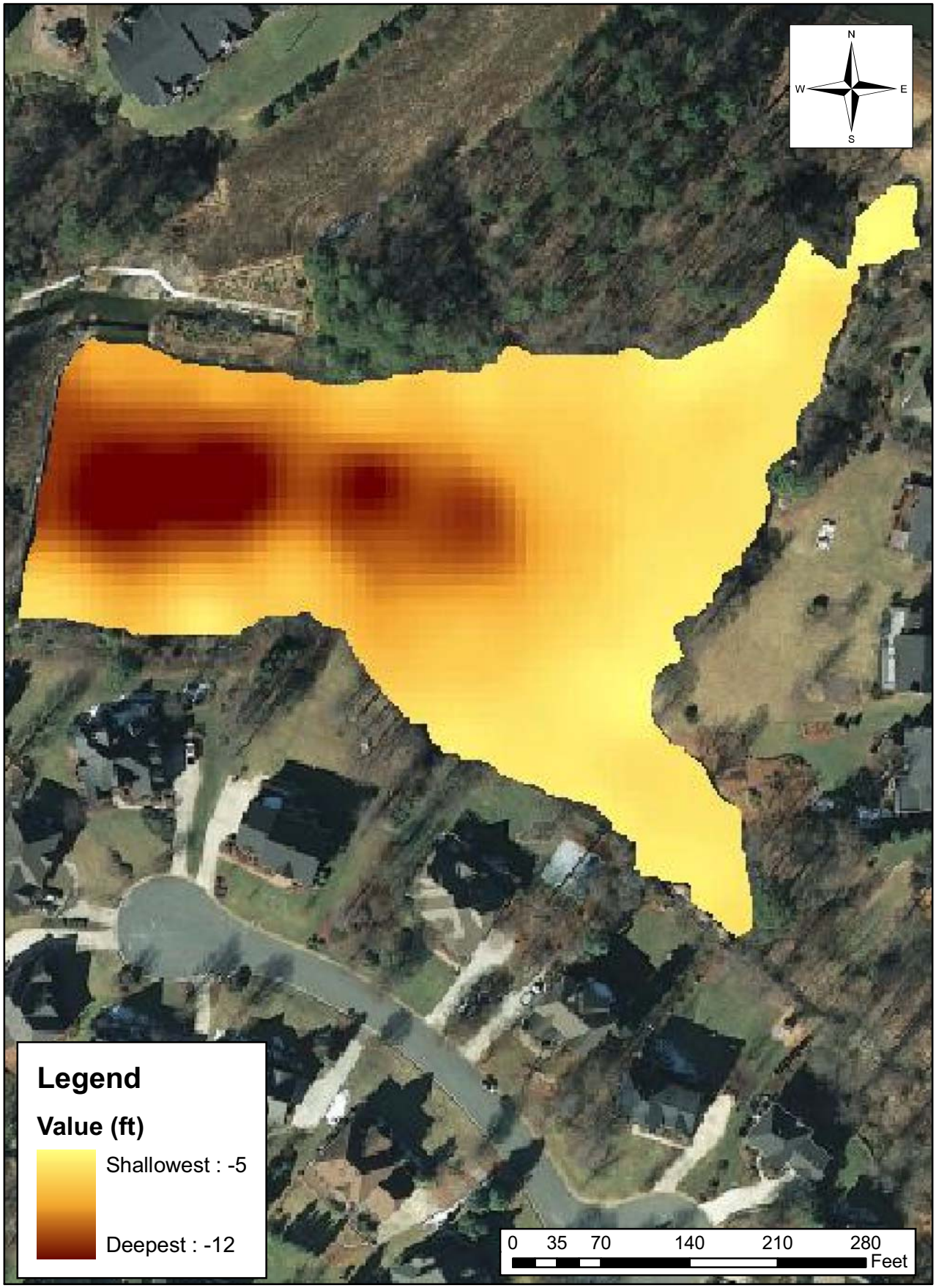
James Landing

4610 Crowne Lake Cir
Jamestown, NC
6/27/13

SPANGLER
ENVIRONMENTAL, INC.
4338 Bland Road Raleigh, NC 27609
919-875-4288

Exhibit 2
Sediment Depths of Upper Lake
Relative to Datum 1

map source:
IDW Raster Interpolation of field data



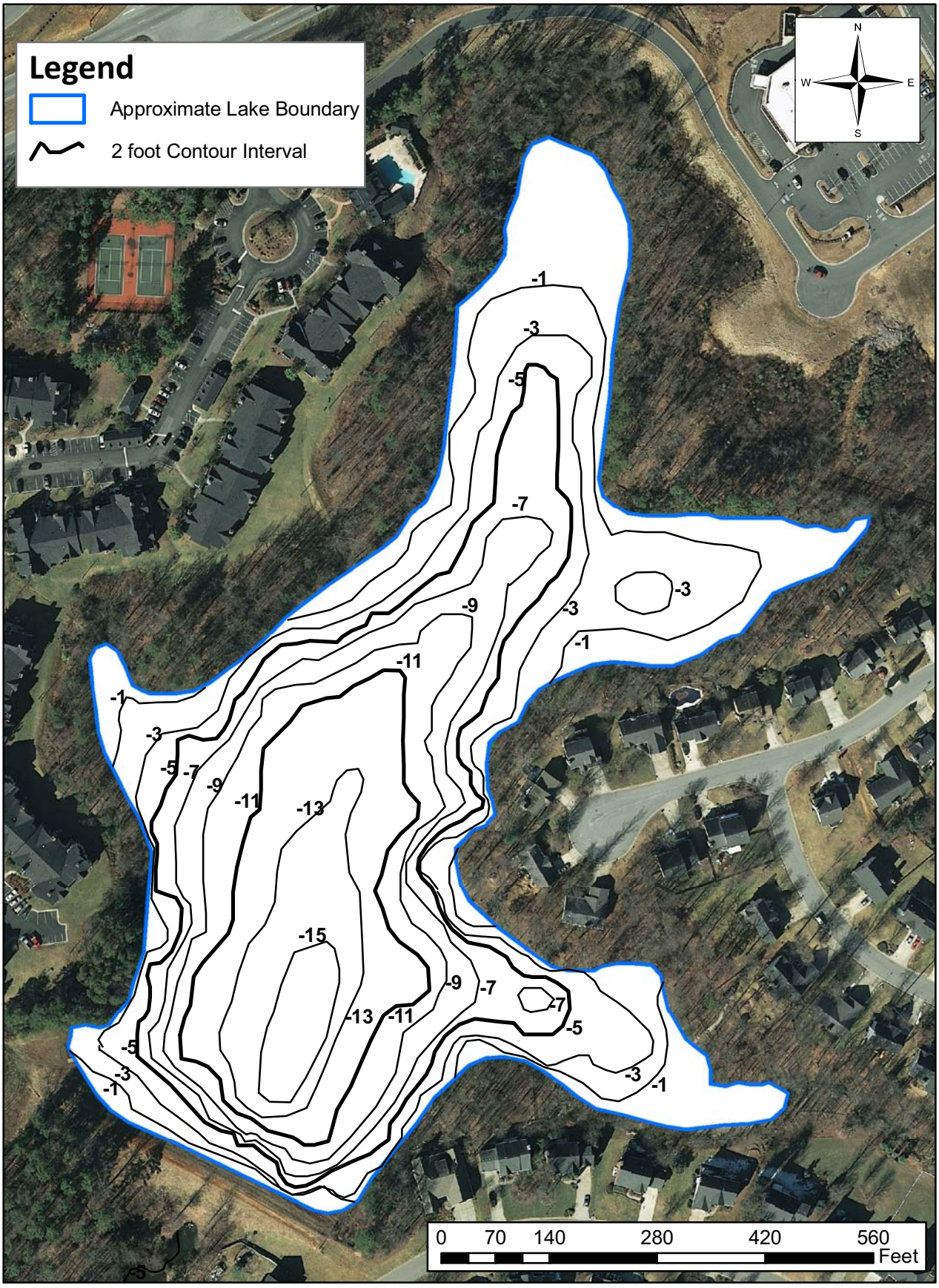
James Landing

4610 Crowne Lake Cir
Jamestown, NC
6/27/13

SPANGLER
ENVIRONMENTAL, INC.
4338 Bland Road Raleigh, NC 27609
919-875-4288

Exhibit 3
Sediment Depths of Lower Lake
Relative to Datum 2

map source:
IDW Raster Interpolation of field data



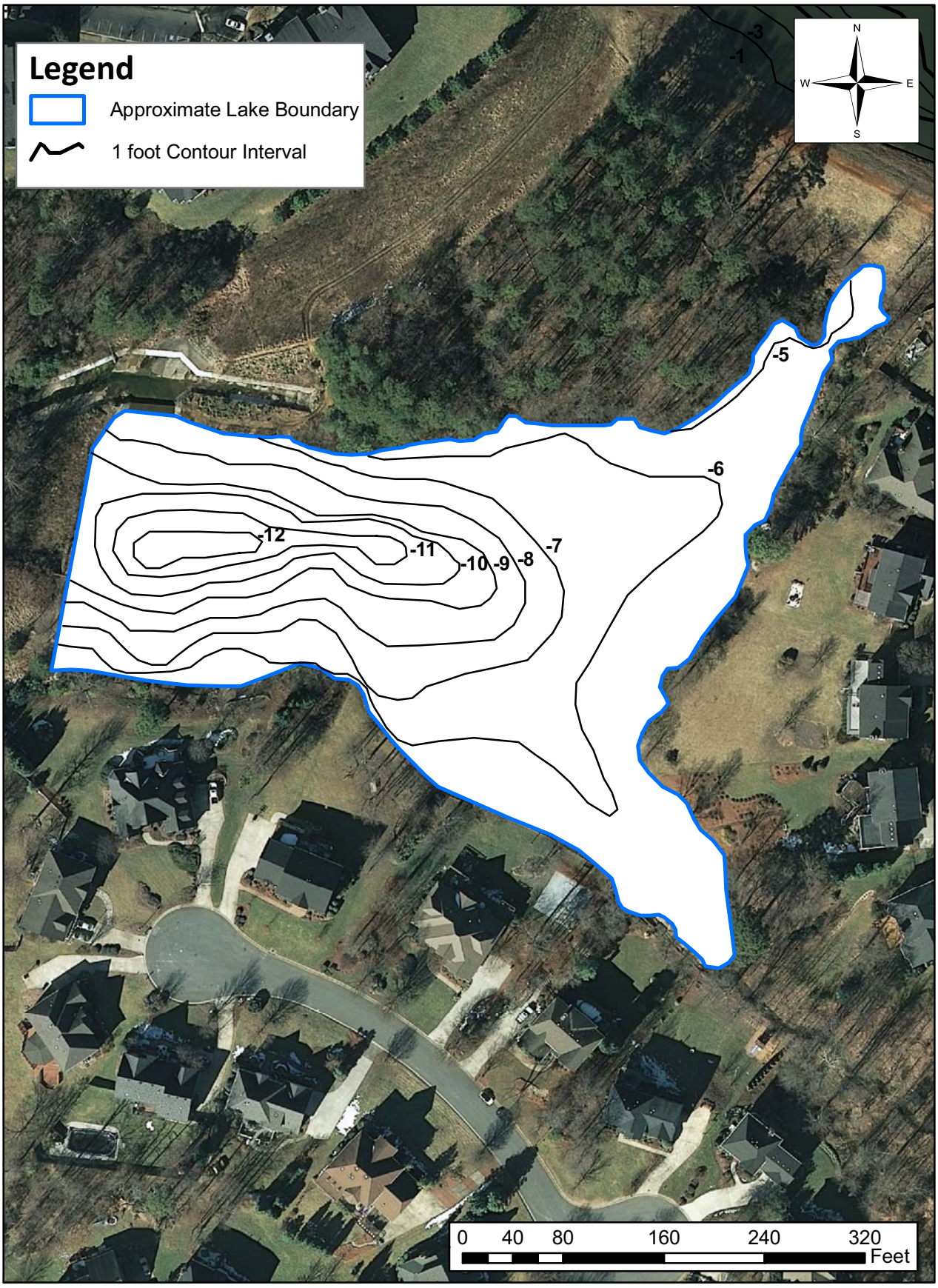
James Landing

4610 Crowne Lake Cir
Jamestown, NC
6/27/13

SPANGLER
ENVIRONMENTAL, INC.
4338 Bland Road Raleigh, NC 27609
919-875-4288

Exhibit 4
Bathymetric Contours of Upper Lake Relative to Datum 1

map source:
Contour estimations based on field data



James Landing

4610 Crowne Lake Cir
Jamestown, NC
6/27/13

SPANGLER
ENVIRONMENTAL, INC.
4338 Bland Road Raleigh, NC 27609
919-875-4288

Exhibit 5
Bathymetric Contours of Lower Lake Relative to Datum 2

map source:
Contour estimations based on field data

Exhibit 6- Sediment Core Sample Photos

Photo 1: Sample #1, West lobe of large lake

Photo 2: Sample #2, Southeast lobe of large lake

Photo 3: Sample #3, Northeast lobe of large lake

Photo 4: Sample #4, North lobe of large lake

Photo 5: All sediment cores taken from large lake

Photo 6: Sample #5, North lobe of small lake


Photo 7: Sample #6, Southeast lobe of small lake