SEMINOLE COUNTY, *Florida*

Black Hammock Restoration and Floodplain Treatment System Design Preliminary Design Evaluation

October 2013

Draft Letter Report

CDM Smith

Black Hammock Restoration and Floodplain Treatment System Design

Preliminary Design Letter Report

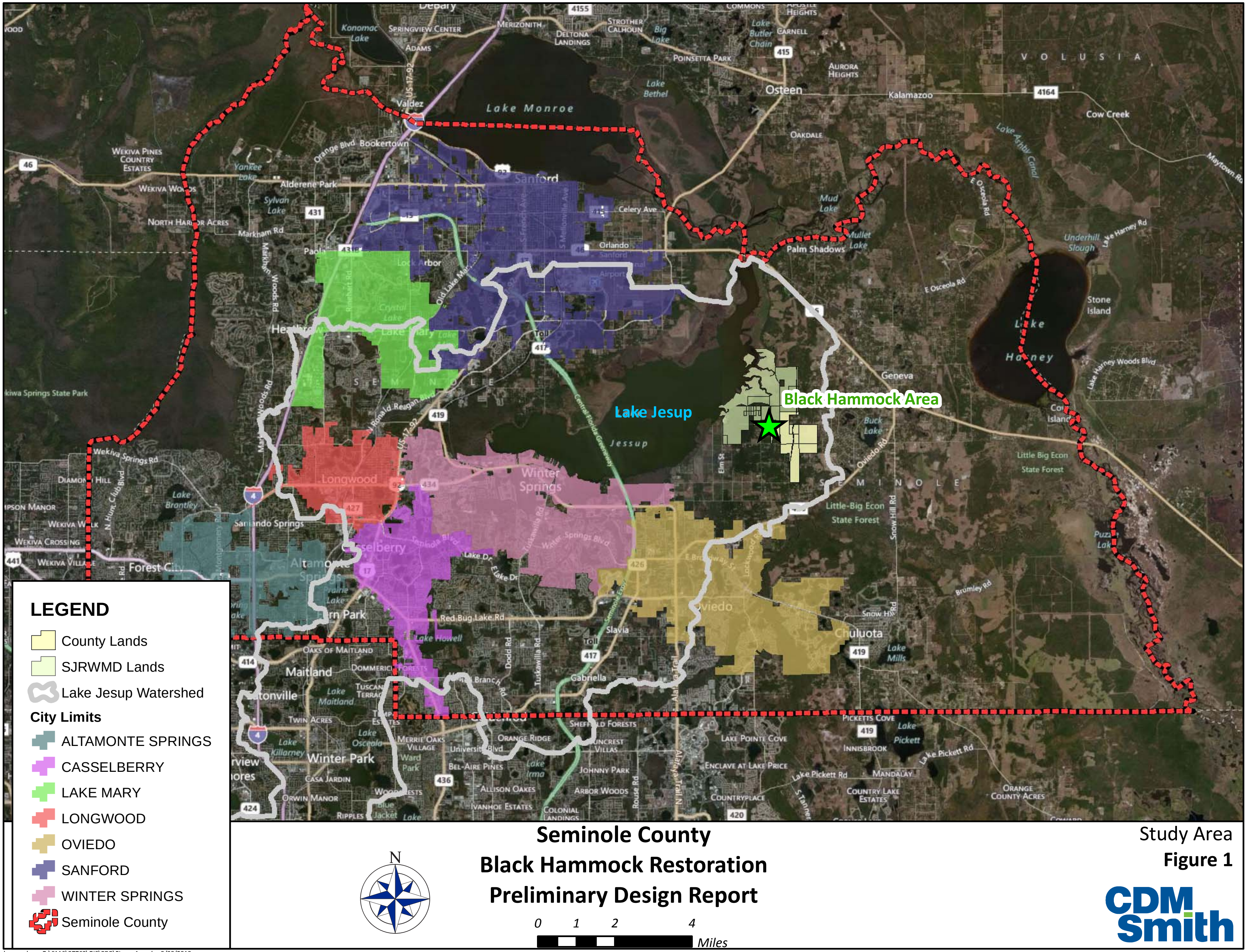
1.0 Purpose

Seminole County (the County) retained CDM Smith Inc. to perform a preliminary (Phase I) design evaluation of the Black Hammock Restoration and Floodplain Treatment. This preliminary design work is being performed in support of and compliance with Florida Department of Environmental Protection (FDEP) Grant Agreement Number S0636 for the Black Hammock Flow Way Project with Seminole County.

In 2008, the St. Johns River Water Management District (SJRWMD), the FDEP and Florida Fish and Wildlife Conservation Commission (FWC) developed an interagency restoration strategy to address external nutrient loading and in-lake nutrient concentrations in Lake Jesup. Lake Jesup is an impaired water body and has an adopted Total Maximum Daily Load (TMDL) for unionized ammonia and nutrients. A Basin Management Action Plan (BMAP) was subsequently adopted by FDEP in 2010 to implement the TDML for the lake. The Black Hammock area was identified in the interagency plan as an area with potential sources of high nutrient concentration runoff. One of the recommendations in the plan was to re-channel the flow in the area through serpentine creek beds, thereby increasing residence time and nutrient uptake. The SJRWMD further expanded upon the interagency plan recommendations and developed the *Preliminary Design Considerations for the Rehabilitation /Reconstruction of Salt and Sweetwater Creeks in the Black Hammock of Lake Jesup Florida* (2012). In early 2013, the County received a grant from FDEP to implement (design and construction of) restoration activities in Salt and Sweetwater Creeks. This preliminary design report (PDR) further evaluates Salt and Sweetwater Creeks for restoration opportunities and recommends a final design alternative.

2.0 Study Area and Background

Lake Jesup has a surface area of approximately 10,660 acres and is located in central Seminole County (**Figure 1**). Its watershed is approximately 86,382 acres and includes a large portion of Seminole County and several other municipalities including Orange County, the Cities of Winter Springs, Altamonte Springs, Casselberry, Eatonville, Lake Mary, Longwood, Maitland, Orlando, Oviedo, Sanford and Winter Park. The Black Hammock area is located on the southeast shore of Lake Jesup and is generally defined on the south by SR 426 and the City of Oviedo city limits, on the east and north by Lake Jesup and on the west by Geneva. Stormwater runoff in the Black Hammock area is generally conveyed to Lake Jesup via three main tributaries that flow through the Black Hammock area and ultimately discharge to Lake Jesup. These include Shortcut Canal, Sweetwater Creek and Salt Creek (**Figure 2**). These three channelized systems are interconnected through the Howard Avenue ditch and have an overall tributary area of approximately 7,763 acres, which is slightly less than 9 percent of the overall Lake Jesup watershed and primarily within unincorporated areas. The area tributary to Salt and Sweetwater Creeks is approximately 5,608 acres and is comprised primarily of wetlands, agricultural and rural residential areas.

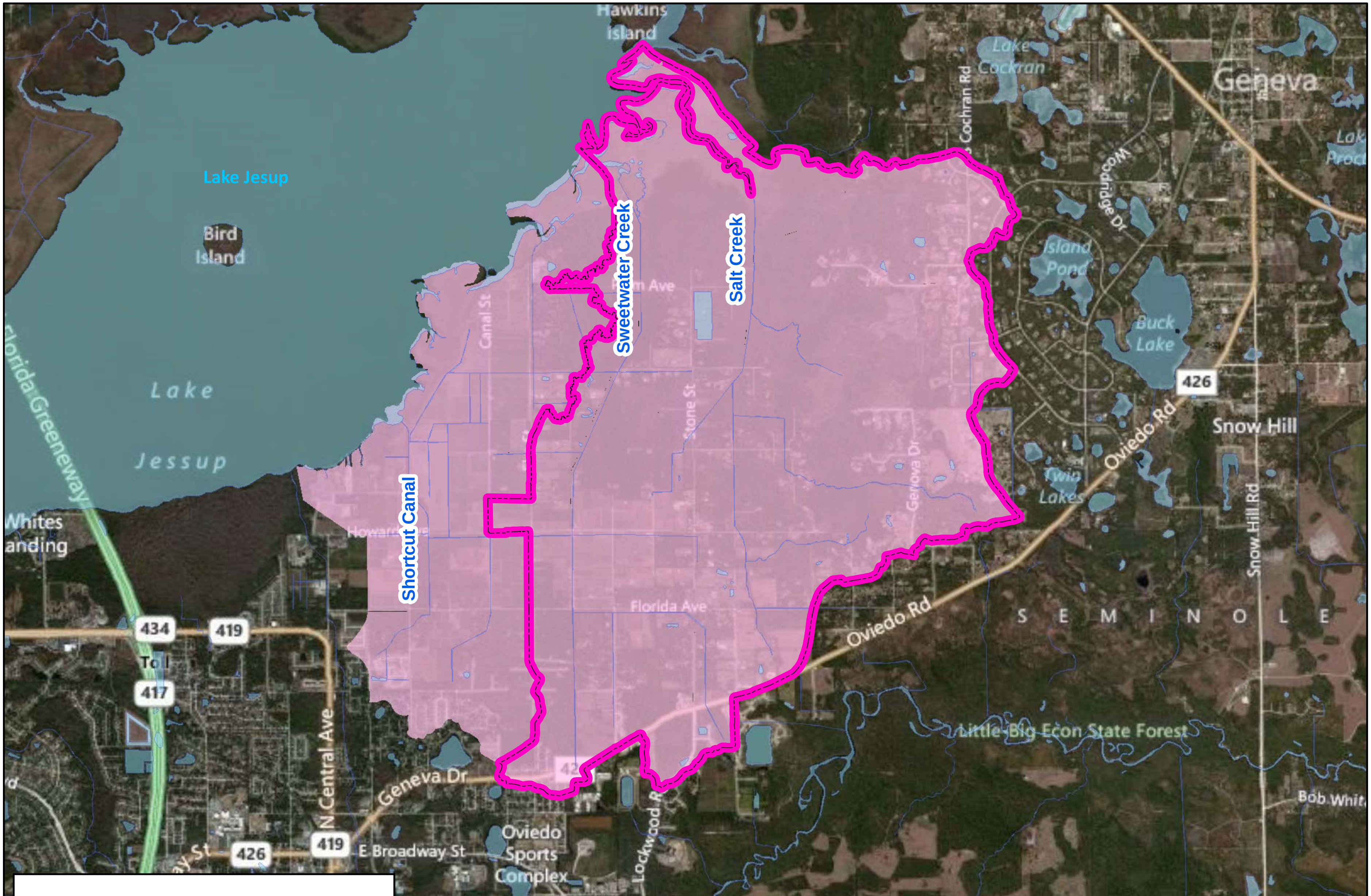


Seminole County
Black Hammock Restoration
Preliminary Design Report

Study Area
Figure 1

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 1.mxd 9/30/2013



LEGEND

- Sweetwater/Salt Creek Subbasin
- Water Bodies
- Shortcut, Sweetwater and Salt Tributary Area

Seminole County
Black Hammock Restoration
Preliminary Design Report

0 0.5 1 2 Miles

N

Black Hammock Tributary Area
Figure 2

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 2_subbasin.mxd 9/30/2013

The region around Lake Jesup was a substantial producer of citrus in the late 1800s, followed by celery and other truck crops through much of the early and mid-1900s (Francke, 1983). During the 1920s portions of both Salt and Sweetwater Creeks downstream of Packard Avenue were dredged and straightened to enable farming and agricultural activities in the area (Figure 1). Agricultural activities have degraded much of the original character of the contributing watersheds of these creeks (SJRWMD, 2012).

Much of the excavated fill appears to have been deposited along the straightened banks of the excavated creeks (spoil banks), effectively cutting off normal creek flow through the historical meanders. Today, both Sweetwater and Salt Creeks are channelized systems that convey storm flows efficiently to Lake Jesup for flood control purposes. The meanders are now connected to the main creek channels only during storm events or elevated downstream stages in Lake Jesup. Today, the presence of the meanders is most pronounced along Salt Creek.

Other than those associated with newer development in the study area, there are currently no best management practices (BMPs) in place to control nutrients or other pollutants in the Sweetwater and Salt Creek tributary areas (SJRWMD, 2012).In order to reduce nutrient loadings to Lake Jesup, the SJRWMD proposed a conceptual framework of wetland treatment through restoration of relic streams in portions of Salt and Sweetwater Creeks. Both the SJRWMD and the County own significant areas of land within the study area (Figure 1), thus these areas are the focus of where potential improvements can be implemented. The SJRWMD identified Salt Creek as the best candidate for this type of rehabilitation based on the physical evidence of meandering flow ways adjacent to the spoil berms but also made recommendations for Sweetwater Creek. The SJRWMD has made the distinction that the proposed project is better defined as rehabilitation since the goal is to reestablish functional value and not to put the creeks back to their original condition (TNC, 1998).

The Lake Jesup BMAP (FDEP, 2010) requires the reduction of external sources of total phosphorus (TP) in the watershed while the role of nitrogen fixation and in-lake nutrient cycling are better understood. The Lake Jesup BMAP requires the stakeholders to achieve a watershed-wide load reduction of 18,748 lbs/yr of TP over a 15-year timeframe. Of that load reduction, Seminole County is required to achieve a load reduction of 6,411 lb/yr of TP or a little more than one-third of the total watershed load reduction.

SJRWMD performed independent pollutant load calculations for Salt and Sweetwater Creeks and estimated that these systems contribute significant nutrient loads to Lake Jesup on an annual basis(12.5 and 2.1 tons/year of total kjeldahl nitrogen [TKN] and TP, respectively) (SJRWMD, 2012). The long-term average measured in-stream nutrient concentrations also currently exceed the downstream targets for the lake established by the Lake Jesup TMDL (**Table 1)**.

Table 1 Salt and Sweetwater Creek Nutrient Concentrations

Water Body	TN (mg/l)	TP (mg/l)
Salt Creek	2.77	0.252
Sweetwater Creek	1.46	0.338
Lake Jesup Target	**1.27**	**0.096**

3.0 Existing Data and Analysis

In order to develop and further refine the concepts presented in the *Preliminary Design Considerations for the Rehabilitation /Reconstruction of Salt and Sweetwater Creeks in the Black Hammock of Lake Jesup Florida* (SJRWMD, 2012), CDM Smith compiled and reviewed existing data. Much of these data were also used in developing a detailed hydrologic and hydraulic (H&H) stormwater model (Section 4).

3.1 Topography

The digital elevation model (DEM) for eastern Seminole and portions of Orange County (SJRWMD, 2009) is a light detection and ranging (LiDAR) dataset that was used as the primary source of topographic information for the study area. The model raster dataset had a grid cell size of 5 feet which was useful in referencing elevations in the low-lying areas of the study area where there are small changes in elevation. The 1-foot topographic contours (**Figure 3**) included as part of this dataset were used to refine subbasin and hydrologic units (HUs) previously delineated as part of the Lake Jesup Basin Engineering Study and Drainage Inventory (CDM Smith, 2001). There is a defined ridge on the eastern boundary of the study area that is approximately elevation 60 ft-NAVD88 at its highest point. There is a significant decrease in elevation closer to the lake where the floodplain areas range from 1-4 feet NAVD88. Elevations along the southern boundary range from 30 to 60 feet NAVD88.

3.2 Soils

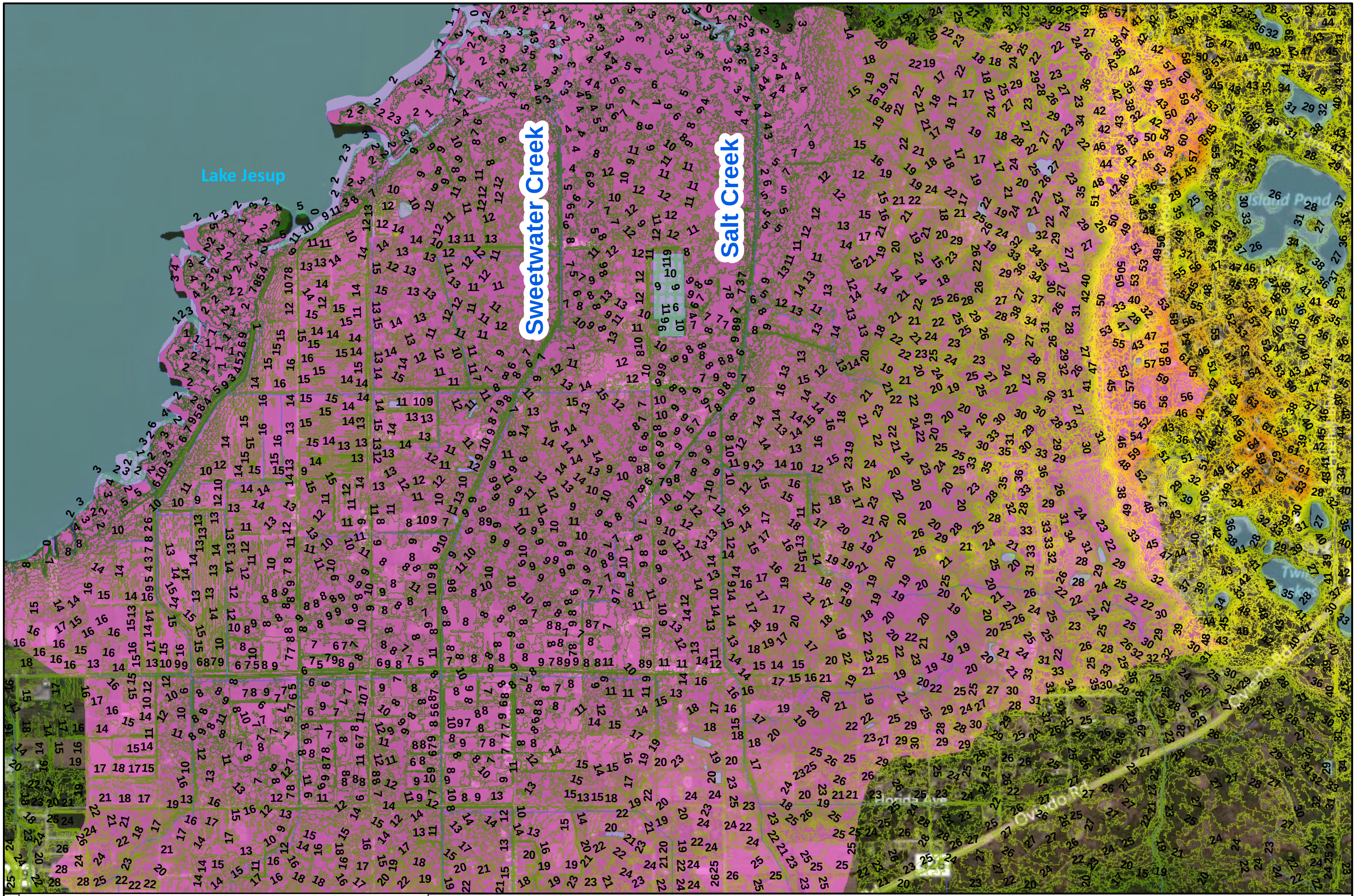
Table 2 lists the acreages of the corresponding National Resource Conservation Service (NRCS) hydrologic soils group classifications identified in the study area. Hydrologic soil groups in the study area are shown on **Figure 4**. In general, "D" type soils comprise approximately 52 percent of the study area while "B/D" type soils account for 35 percent. These types of soils tend to have higher runoff potential (i.e., less infiltration) than "A" soils.

Table 2 Hydrologic Soils Summary

Soil Hydrologic Group	Area (Acres)	Percent
A	428.8	7.7%
B/D	1,979.7	35.3%
C	231.4	4.1%
D	2928.0	52.2%
Water	40.1	0.7%
Total	5608.0	100%

3.3 Existing Land Use

The 2009 Land Use/Land Cover GIS coverage available from the SJRWMD was used to identify land uses in the study area. This coverage assigns the Florida Land Use Cover and Classification System (FLUCCS) codes to each individual land use polygon. For simplification purposes, the codes were grouped into general land use categories as shown in **Table 3**. The area tributary to the Salt and Sweetwater Creek systems is approximately 5,608 acres and is comprised primarily of wetlands, agricultural and rural residential areas. Wetlands occupy the largest land area (52 percent of the tributary area). The land use coverage for the study area is also shown on **Figure 5**.



LEGEND

- Water Bodies
- Shortcut, Sweetwater and Salt Tributary Area

Source: SJRWMD, 209

honourdm G:\6116\97760\GIS\PDR\Figure 3_topo.mxd 9/30/2013

Seminole County
Black Hammock Restoration
Preliminary Design Report

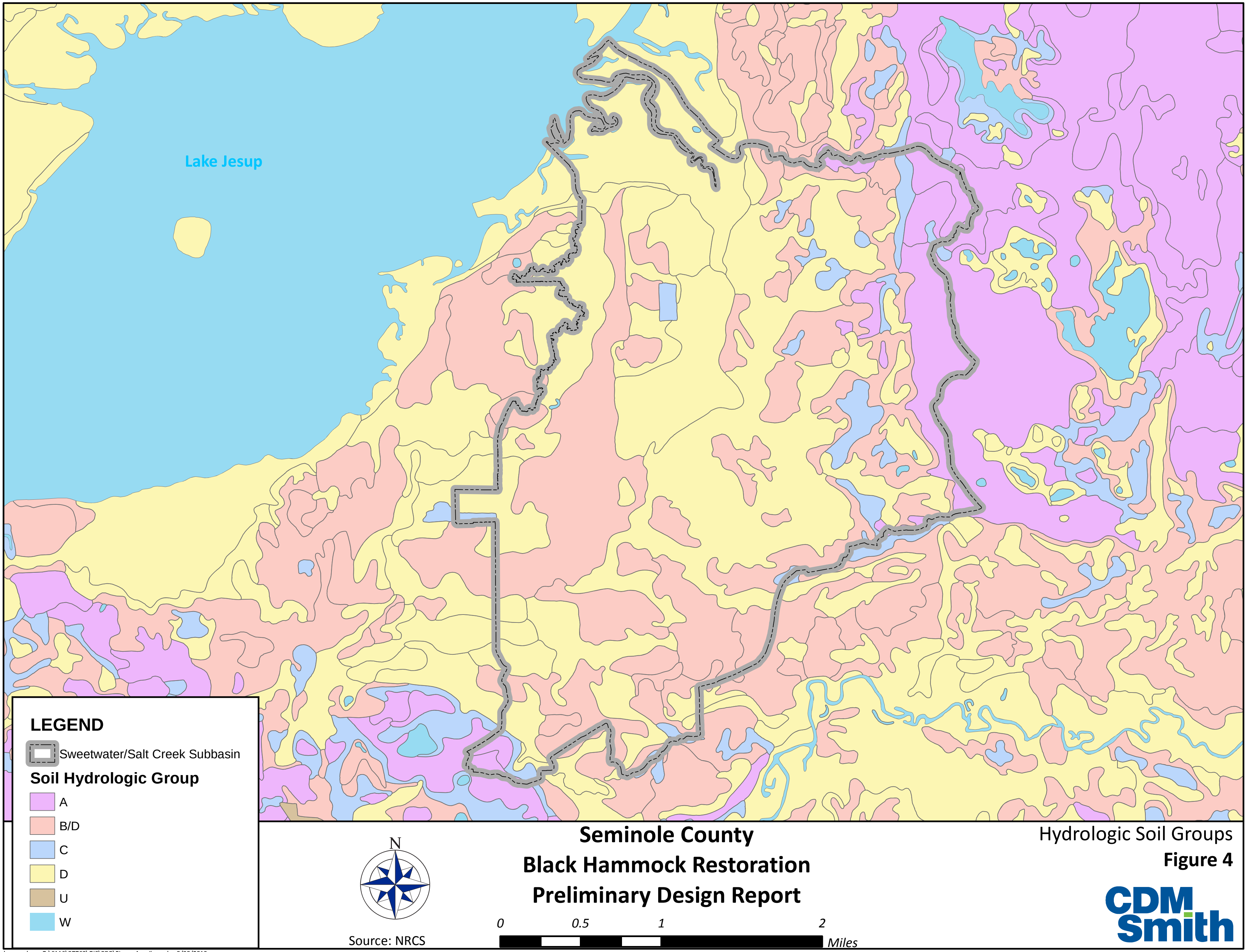
0 0.25 0.5 1
Miles

N

1-foot Topographic Contours

Figure 3

CDM Smith



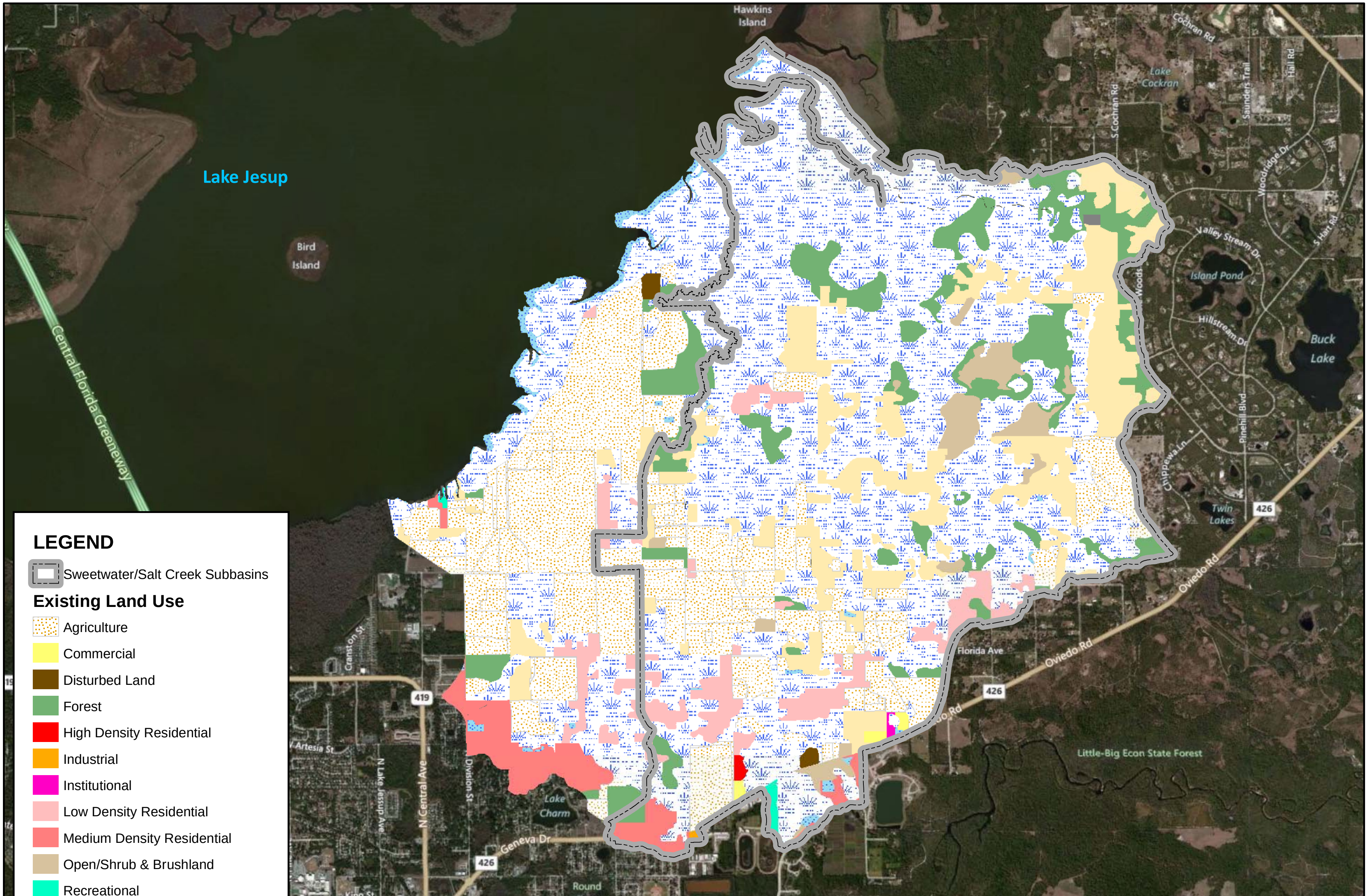
Seminole County
Black Hammock Restoration
Preliminary Design Report

Hydrologic Soil Groups

Figure 4

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 4_soils.mxd 9/30/2013



N

Seminole County

Black Hammock Restoration

Preliminary Design Report

0 0.25 0.5 1 Miles

Source: SJRWMD, 2009

Existing Land Use

Figure 5

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 5_landuse.mxd 9/30/2013

Table 3 Existing Land Use Summary

Soil Hydrologic Group	Area (Acres)	Percent
Agriculture	812.0	14.5%
Commercial	14.7	0.3%
Disturbed Land	6.4	0.1%
Forest	513.0	9.1%
High Density Residential	5.9	0.1%
Industrial	5.3	0.1%
Institutional	3.8	0.1%
Low Density Residential	231.2	4.1%
Medium Density Residential	73.9	1.3%
Open/Shrub & Brushland	166.5	3.0%
Recreational	12.9	0.2%
Rural Residential	793.9	14.2%
Utilities	3.5	0.1%
Water	48.1	0.9%
Wetlands	2916.6	52.0%
Total	5,607.7	100%

3.4 Hydrogeologic Conditions

Due to the proximity to Lake Jesup and low-lying areas where the conceptual improvements are being considered, it was necessary to understand the hydrogeologic conditions in the study area. In order of occurrence from the land surface, there are three distinct hydrogeologic units within Seminole County and the Black Hammock area: the surficial aquifer, the intermediate confining unit, and the Floridan Aquifer (Spechler and Halford, 2001; Barraclough, 1962; Schellentrager and Hurt, 1990; and Tibbals, 1990). **Figure 6** shows the hydrogeologic units and corresponding geologic units in an east-west direction through Seminole County taken from literature (Spechler and Halford, 2001). The location of the cross section within Seminole County is shown on **Figure 7**.

In the vicinity of Black Hammock, the surficial deposits, which include the surficial aquifer system (SAS), extend from land surface to the top of the upper confining bed of the intermediate confining unit (ICU). The surficial aquifer system ranges in thickness from 15 to 35 feet. The ICU is generally composed of mostly clay and sandy, phosphatic limestone and ranges in thickness from 15 ft to 50 ft. The Floridan aquifer system (FAS) consists of thick sequence of limestone and dolomite and is the principal source of drinking water in Seminole County. The thickness of the FAS in the vicinity of Black Hammock is in excess of 2,000 feet.

Groundwater levels in wells that tap the surficial aquifer system fluctuate seasonally in response to rainfall. The water-table unit receives most of its recharge directly from rainfall. The rainy season usually lasts from June through September, when more than half of the annual rainfall occurs.

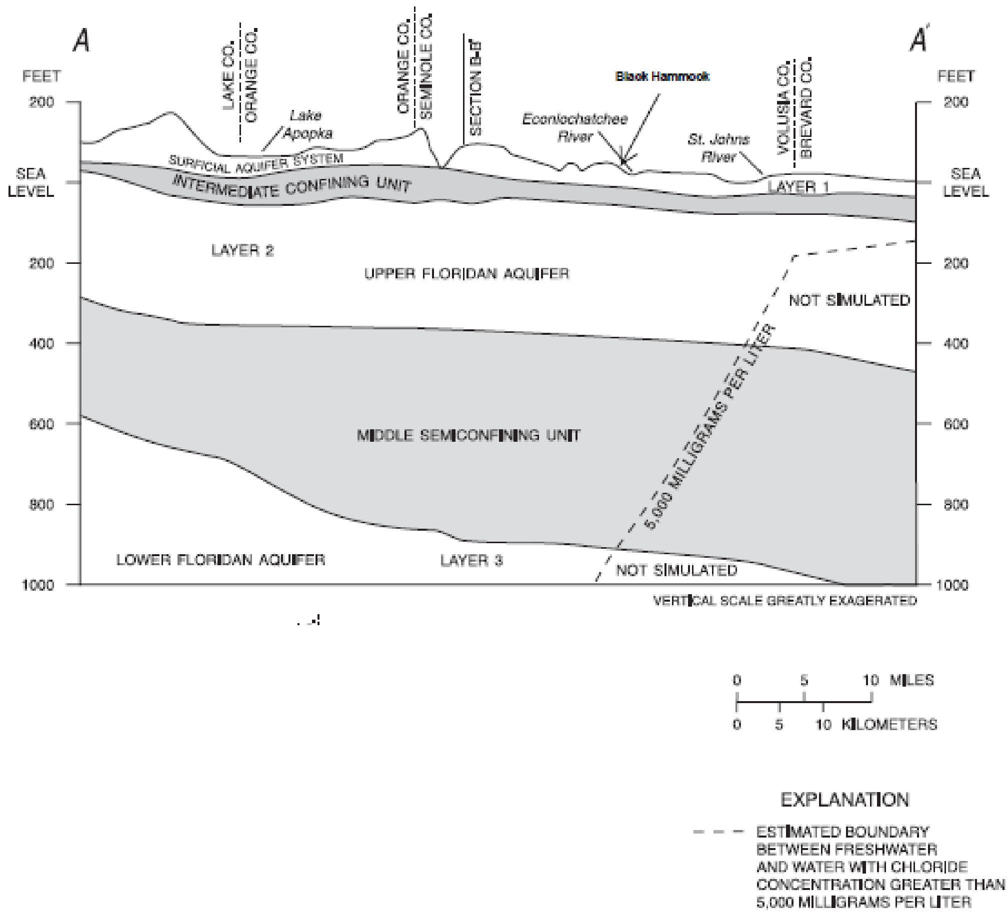
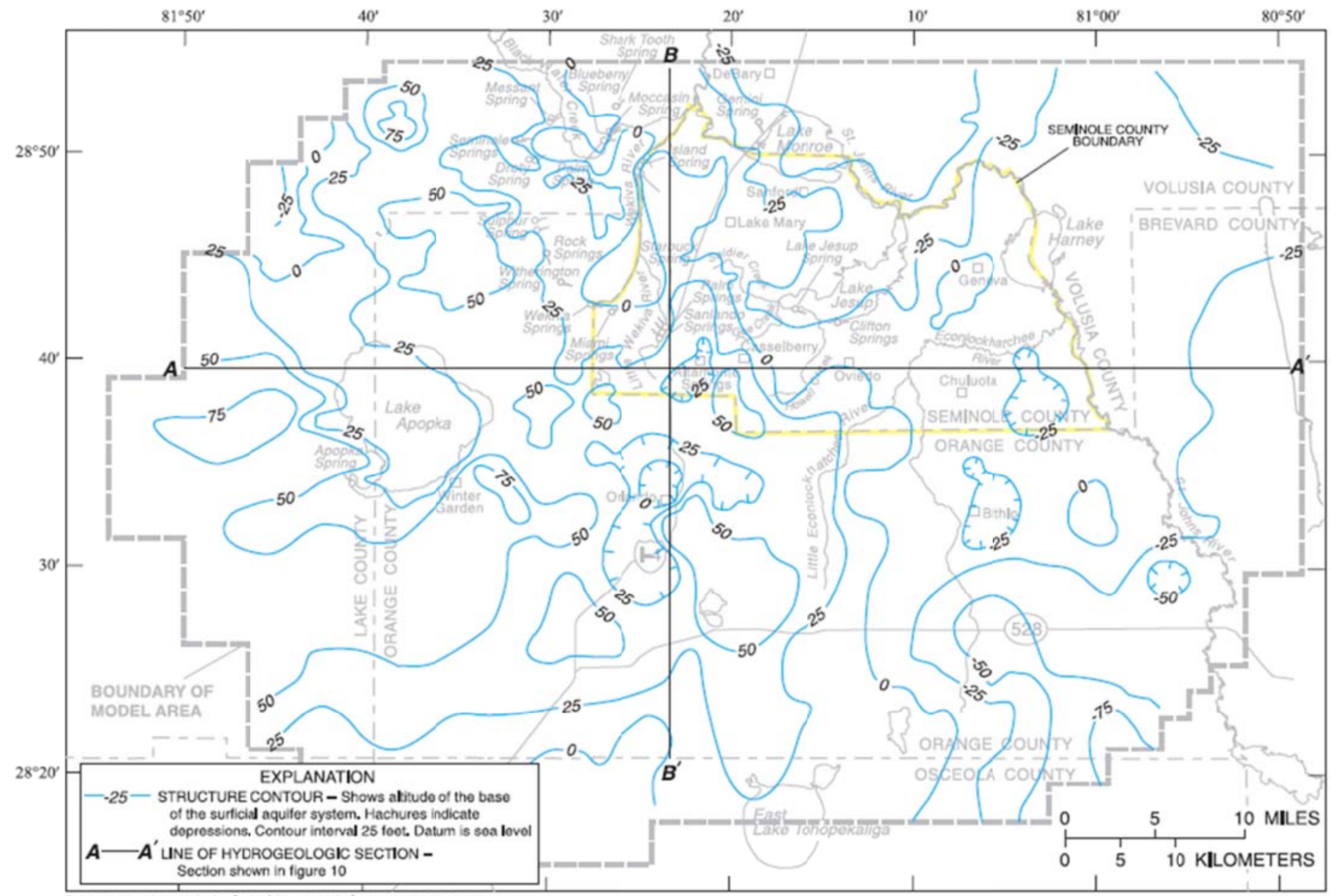


Figure 6 West-East Hydrogeologic Cross-Section through Seminole County, Florida (*Source: Spechler and Halford, 2001*)



Base modified from U.S. Geological Survey digital data, 1:100,000, 1985
Universal Transverse Mercator projection, zone 17

Figure 7 Location of Seminole County Hydrogeologic Cross-Sections
(*Source: Spechler and Halford, 2001*)

According to the NRCS (Schellentrager and Hurt, 1990), the water table in Black Hammock is very close to land surface year around (2.0 ft above land surface to 2.0 ft below land surface). The water table does not fluctuate much between the wet and dry seasons (1 to 3 feet) since the majority of the surface and near surface soils are poorly drained (NRCS hydrologic soil class D or B/D) . Surface soils consist of muck (Canova and Terra Ceia series), mucky fine sands (Felda and Manatee and Nittaw series) and poorly drained sands (Basinger and Delray, and Manatee, Floridana and Holopaw series). Topographic elevations range from 4 to 14 feet NAVD88.

The potentiometric surface of the FAS also responds to rainfall but with a slight delayed response since the aquifer is recharged in the higher areas of western Orange and Seminole Counties. Potentiometric surface elevations in the Upper Floridan aquifer (UFA) were reviewed for the period of 2000 through 2006. In this time period, 2000 and 2006 were significantly below average rainfall years (32.8 and 34.5 inches at the NOAA Sanford station). In 2006, there was little seasonal difference in potentiometric surface elevations in the UFA between the end of the dry season (May) and the end of the wet season (September). Potentiometric surface elevations of the UFA ranged from 20 to 25 feet NGVD in May and September 2006.

2001 was a near average rainfall year (52.7 inches) and 2002 was a high rainfall year (66.2 inches). In May 2001, the potentiometric surface elevations of the UFA in May ranged from 15 to 20 feet NGVD and ranged from 20 to 25 feet NGVD in September 2001. In May 2002, the ranges of potentiometric surface elevations in May and September were the same as for 2001.

The potentiometric surface elevations UFA are above the land surface throughout the Black Hammock area. Wells that tap the UFA would be free flowing even at the end of the dry season in a very low rainfall year. If for any reason the ICU is breached during construction activities, a spring or free flowing conditions from the UFA would readily occur followed by localized flooding. This condition was observed when a suspected well was uncovered during excavation work for the Parkstone development's drainage system in 2000. The Parkstone subdivision is located on the south shore of Lake Jesup (approximately 5 miles west of Black Hammock). An uncontrollable flow situation developed at that time and the SJRWMD was called in to assess the situation. The developer and the SJRWMD attempted to plug or cap this well, but, unfortunately, these efforts failed. Attempts to plug the well failed because the well casing could not be found and the actual source of the flow could not be isolated. Since there was no discernible casing it was not possible to cap the well. After several attempts to stop the flow, the decision was made to build a structure around the flow area and route the flow to Lake Jesup. Similar free-flowing artesian conditions were also encountered in the early 1990s during construction of the pilings for the SR 417 Lake Jesup Bridge Crossing and more recently for the Solary Canal Stormwater Treatment Area that was recently constructed. There are also a few natural springs such as Clifton Springs and Lake Jesup Spring, which exist along the south shore of Lake Jesup (Spechler and Halford, 2001: Scott et al., 2004).

Baseflow values in Salt and Sweetwater Creeks used in this evaluation were based on review of estimated baseflow for these creeks from the Watershed Supply Impact Study (WSIS) Hydrologic Simulation Program – Fortran (HSPF) model (SJRWMD). Baseflow estimates for the WSIS HSPF model represent the estimated groundwater flux from the shallow aquifer as determined by the total Active Groundwater Outflow (AGWO) from the contributing Salt and Sweetwater subbasins. The simulation period for the WSIS HSPF model for Salt and Sweetwater Creek is from 1975 through 2008.

3.5 Wetlands and Listed Species

The majority of the proposed project area is surface water (creek) and wetland. The wetlands within the Salt and Sweetwater Creek subbasin are generally defined as freshwater forested/shrub wetland by the National Wetlands Inventory. The wetlands within the study area are further classified into the following categories as shown on **Figure 8**:

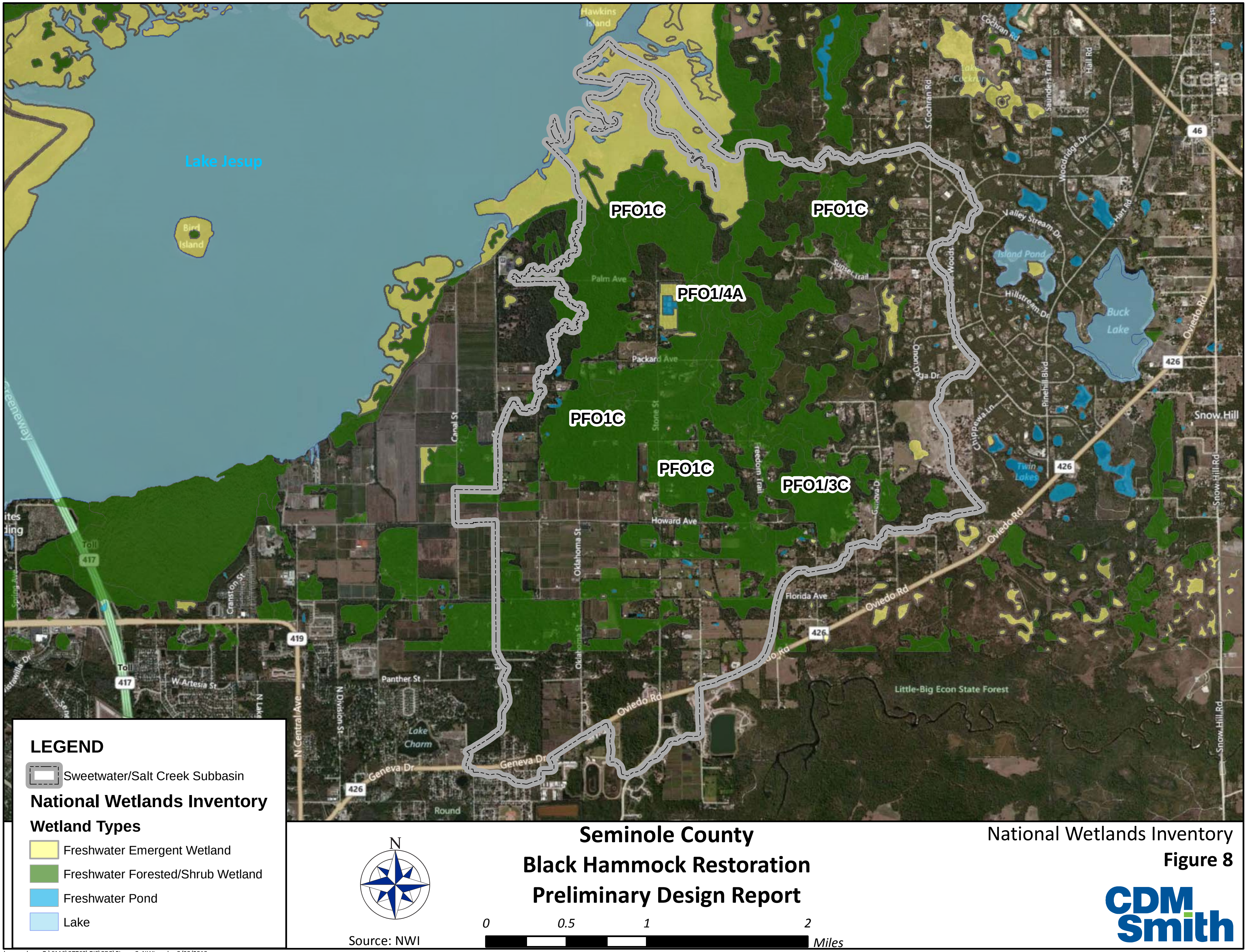
- PFO1C - Palustrine, Forested, Broad-Leaved Deciduous, Seasonally Flooded
- PFO1/3C - Palustrine, Forested, Broad-Leaved Deciduous, Broad-Leaved-Evergeen, Seasonally Flooded
- PFO1/4A - Palustrine, Forested, Broad-Leaved Deciduous, Needle-Leaved Evergreen, Temporarily Flooded

Based on the Florida Natural Areas Inventory (FNAI) database and biodiversity matrix report, there are no documented occurrences of threatened, endangered, or rare species within the project area. Likely listed species within the project area include eastern indigo snake (*Drymarchon couperi*), wood stork (*Mycteria americana*), and bald eagle (*Haliaeetus leucocephalus*).

4.0 Hydrologic and Hydraulic (H&H) Analysis

In order to identify and further refine concepts presented in the *Preliminary Design Considerations for the Rehabilitation /Reconstruction of Salt and Sweetwater Creeks in the Black Hammock of Lake Jesup Florida* (SJRWMD, 2012), CDM Smith developed a detailed hydrologic and hydraulic (H&H) stormwater model of the study area. The H&H modeling originally developed for the *Lake Jesup Basin Engineering Study and Drainage Inventory* (CDM Smith, 2001) was used as the basis for the H&H modeling for this PDR. The original 2001 modeling was performed using the Interconnected Channel and Pond Routing (ICPR) model developed by Streamline Technologies. The ICPR model was subsequently converted using the USEPA Stormwater Management Model Version 5.0.022 (SWMM5) by CDM Smith in 2008 to assist the County with some flooding investigations in the upper reaches of the study area.

SWMM5 is a dynamic hydrologic, hydraulic, and water quality model capable of performing design storm event and long-term continuous simulations of surface rainfall, evaporation, runoff, infiltration and groundwater base flow, hydraulic storage and routing in open channel and pipe systems, water quality, and BMPs. The hydrologic component (formerly called RUNOFF) operates by applying precipitation across HUs, and then through overland flow and infiltration conveying surface runoff and groundwater base flow to loading points in the user-defined stormwater management system. Runoff and base flow hydrographs for these loading points provide input for hydraulic routing in downstream reaches. The hydraulic flow routing routine of SWMM5 (formerly called EXTRAN) uses a link-node (also called conduit-junction) representation of the stormwater management system to dynamically route flows using the Saint-Venant equation for gradually-varied unsteady flow.



Source: NWI

Seminole County
Black Hammock Restoration
Preliminary Design Report

National Wetlands Inventory
Figure 8

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 8_NWI.mxd 9/30/2013

In addition to simulating design storm events for permitting purposes, it was also desirable from a design standpoint to simulate longer periods of time to capture the behavior of the Salt and Sweetwater Creek systems during average, wet and dry years and how the stages and flows in these systems are influenced by the downstream levels in Lake Jesup. Due to potential project constraints (i.e., lower elevations), it was necessary to simulate baseflow conditions as well as the smaller more frequent rainfall events in order to predict how the conceptual improvements can attenuate the resulting flows.

4.1 SWMM5 Model Update

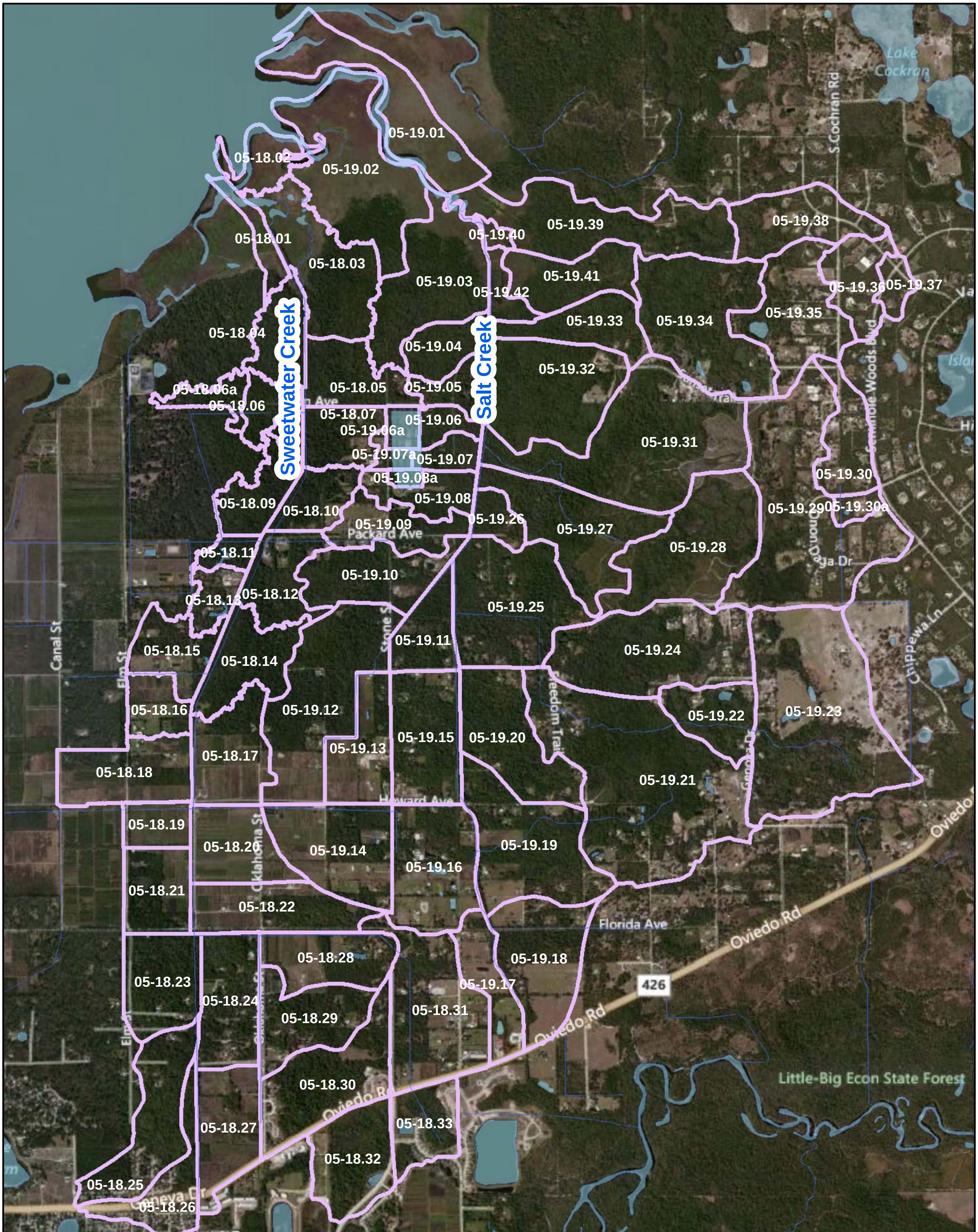
As part of this PDR, the SWMM5 was updated to reflect current conditions including refined hydrology based on more recent topographic and land use information previously discussed. Detailed survey information was also collected as part of this effort and the SWMM5 was subsequently updated to incorporate the collected data.

4.1.1 Hydrologic Model Updates

The hydrologic model component of SWMM5 simulates the rates of runoff generated from HUs using a non-linear reservoir approximation (Manning's equation). Topographic data (Section 3.1), soils (Section 3.2), and land use data (Section 3.3) are used to develop a series of parameters including overland flow width and slope, overland roughness coefficients, initial abstraction, and soil infiltration and storage. The SWMM method uses these parameters to calculate a runoff hydrograph for each HU; these hydrographs are routed to the specified node in the hydraulic model component.

HU delineations developed for the 2001 study were used as the basis for the hydrologic model development. Unit boundaries were modified using the most recent LiDAR topography (Section 3.1). Additionally, several HUs were further subdivided to provide the necessary resolution to model newly-added hydraulic conduits and storage areas. The refined HU boundaries are provided on **Figure 9**. **Table A-1** of **Attachment A** shows the values used in the calculation of the area-weighted overland flow parameters. HUs identified with the prefix 05-18 represent the Sweetwater Creek system where as those with the prefix 05-19 represent the Salt Creek tributary area.

Land use data were used to estimate imperviousness, surface friction factors, and initial abstractions for each HU. Existing land use conditions were obtained using the SJRWMD land use/land cover data (2009). For the hydrologic analysis, the land uses were grouped into categories of relatively homogeneous geophysical parameters. Figure 5 previously showed the land use in the study area. The percent imperviousness of each HU is one of the parameters used by the SWMM5 hydrologic model to determine the volume and rate of surface water runoff. A summary of the land use categories is presented in **Table 4**.



LEGEND

- Water Bodies
- Hydrologic Units

N

Seminole County
Black Hammock Restoration
Preliminary Design Report

0 0.25 0.5 1 *Miles*

Hydrologic Units
Figure 9

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 9_HUs.mxd 9/30/2013

Additionally, the table lists the percent of Directly Connected Impervious Area (DCIA) and the percent of Non-DCIA (NDCIA) assigned to each land use category. The DCIA represents all the impervious surfaces that are directly connected to the stormwater system. The NDCIA represents the impervious surfaces that have a pervious buffer prior to discharge into the stormwater system. Based on this information, the area-weighted average percent imperviousness for each HU was computed using the percent of each land use category within a HU for existing land use conditions.

Table 4 Hydrologic Parameters by Land Use

Land Use Category	% Impervious	% DCIA	Impervious Manning's n	Pervious Manning's n	Impervious Initial Abstraction (in)	Pervious Initial Abstraction (in)
Agriculture	3	1	0.015	0.03	0.1	0.25
Commercial	80	80	0.015	0.25	0.1	0.25
Disturbed Land	3	1	0.015	0.30	0.1	0.25
Forest	3	1	0.015	0.04	0.1	0.25
High Density Residential	50	40	0.015	0.25	0.1	0.25
Industrial	70	70	0.015	0.25	0.1	0.25
Institutional	60	50	0.015	0.25	0.1	0.25
Low Density Residential	15	7.5	0.015	0.25	0.1	0.25
Medium Density Residential	30	20	0.015	0.25	0.1	0.25
Open/Shrub & Brushland	3	1	0.015	0.30	0.1	0.25
Recreational	90	81	0.015	0.25	0.1	0.25
Rural Residential	15	7.5	0.015	0.25	0.1	0.25
Utilities	100	100	0.024	0.06	0.1	0.10
Water	65	65	0.100	0.40	0.5	0.50

Each soil type was assigned a soil series and a hydrologic soil group (HSG) designated by NRCS. HSG "A" is comprised of soils having very high infiltration potential and low runoff potential. Hydrologic HSG "D" is characterized by soils with a very low infiltration potential and a high runoff potential. HSGs "B" and "C" are designated between these two categories. For the purposes of this study, dual class soil groups were initially assigned to the more conservative value (lower infiltration potential).

Soil group percentages for each HU were estimated by overlaying a map of the HU boundaries on the NRCS soil map. From the overlay map, the percentage of each soil group within a HU was estimated using GIS tools. The infiltration database was developed using the Horton equation soil parameters. HSGs for the study area were previously shown on Figure 4.

Table A-2 of Appendix A tabulates the soil classification by percentage for each HU. The re-classified soils were then used to determine weighted Horton soil characteristics including maximum and minimum infiltration rates, and soil storage. The Horton infiltration equation option in SWMM5 was used to calculate the rate and volume of water that infiltrates into the soil. Based on this equation, infiltration is computed as:

$$f_t = f_{min} + (f_{max} - f_{min})e^{kt}$$

where:

f_t = the infiltration capacity of the soil (in/hr) at time t;

f_{min} = the minimum (or final) infiltration capacity (in/ hr);

f_{max} = the maximum (or initial) infiltration capacity (in/hr);

k = an exponential decay constant (hr^{-1}); and

t = time (hr).

The decay constant, k, is an empirical parameter that controls the rate of decrease in infiltration capacity during a rainfall event. The infiltration rate is expected to decrease exponentially from the maximum capacity down to the minimum capacity. For example, a lower decay constant gives a slower rate of decrease in infiltration capacity, and a higher decay constant forces the infiltration capacity to reach its minimum value more quickly. Area-weighted infiltration parameters were computed based on the percentage of each HSG within each HU. Infiltration parameters are weighted by the proportion of pervious and NDCIA surfaces in each HU. Although no infiltration occurs over NDCIA surfaces, the resulting runoff is directed to an infiltrating pervious surface area. Soil storage varies depending on antecedent moisture condition (AMC). The SWMM5 model for the study area uses average wet season antecedent moisture condition (AMC II), which may be defined as the soil condition when the previous 5-day rainfall volume totals between 1.4 and 2.1 inches. Using this condition produces conservative results that might be typical of wet season rain events.

Table 5 below displays the soil parameters by soil type (hydrologic group) for the AMC II. The percent by area of each soil type within a HU is combined with the global parameters to calculate each HUs specific infiltration parameters. Groundwater was considered in the hydrologic model by use of infiltration rates and soil storage. SWMM5 considers increasing groundwater elevations and saturated conditions when groundwater rises to land surface.

Table 5 Global Soil Parameters

Soil Type	Max Infiltration Rate (in/hr)	Min Infiltration Rate (in/hr)	Decay Rate (1/sec x 10^{-4})	Dry Time (days)	Soil Storage (in)
A	14	1	3	5	12
B	9	0.5	3	5	8
C	6	0.25	3	5	5
D	4	0.1	3	5	4

4.1.2 Hydraulic Model Updates

The hydraulic components of the 2001 model were reviewed and updated to include survey data collected under this effort as well as to include additional refinements required for preliminary design. Updates included:

- Refining the representation of storage areas using the 2009 LiDAR information, specifically in the eastern portions of the Salt Creek subbasin
- Defining several of the historic meanders adjacent to Salt Creek

- Further refining the connectivity of several of the systems adjacent to the creek that interact with the meanders and the main channel
- Re-defining the channel overbanks using the 2009 LiDAR

More specific details for channel inverts and elevations were obtained through collecting survey. Southeastern Surveying and Mapping Corp. (SSMC) collected survey information in the early summer of 2013 along both portions of Salt and Sweetwater Creek. The survey points are shown on **Figure 10** to show the extent of the information collected. Selection of the survey locations were based on a number of items including: options proposed in the in the *Preliminary Design Considerations for the Rehabilitation /Reconstruction of Salt and Sweetwater Creeks in the Black Hammock of Lake Jesup Florida* (SJRWMD, 2012); review of the aerial photography to identify relic streams; confirmation of relic streams using LiDAR information; field reconnaissance observations; and property access/boundary issues. Specifications for the collection of survey information included the following:

- Salt Creek Main Channel (north of Palm Ave.) - Cross-sections were captured at 200-foot intervals along the main realigned channel approximately 3,000 feet in length beginning at the easterly extension of Palm Avenue heading north. Cross-sections began on the west top of bank and extended east to the termination of the spoil berm or to the natural ground east of the spoil berm and included obtaining water levels and a centerline and east top of bank profile. The centerline and east top of bank profile was also obtained at 50 foot intervals unless the system was relatively uniform.
- Northern Meander of Salt Creek - The original meandering channel was followed for approximately 1,300 feet and a centerline profile at all visible changes in direction was obtained as well as one cross section at the beginning, one at the end and four additional in-between. Water levels and centerline profile at 50-foot intervals (or abrupt changes) if the system is relatively uniform were also obtained.
- Salt Creek Main Channel (south of Palm Ave.) - Cross-sections were captured at 400-foot intervals along the main realigned channel approximately 1,700 feet. Cross sections began on the west top of bank and extended to the east top of bank and included obtaining water levels and a centerline and west top of bank profile. The centerline and west top of bank profile was also obtained at 50-foot intervals unless the system was relatively uniform.
- Southern Meanders of Salt Creek - The original meandering channel on the west side of Salt Creek (south of Palm Ave.) was followed for approximately 1,900 feet in length and a centerline profile at all visible changes in direction was obtained as well as cross sections at 300-foot intervals. Water levels and centerline profile at 200-foot intervals (or abrupt changes) if the system is relatively uniform were also obtained.
- Culvert Road Crossings – Road crossings (including road overflows) on the main stem (Packard Ave., Independence Ave., Van Arsdale Ave., Howard Ave., Florida Ave.), west stem (Stone Street) and the east stem (Independence Ave., Freedom Trail) of Salt Creek were all captured).
- Sweetwater Creek – Five open channel cross sections were captured. The two most northern cross-sections extend from top of bank to top of bank and beyond to capture a 1,000-foot cross-section width (500 feet out from centerline of channel to the east and west) including water levels and the centerline profile.

LEGEND

- Sweetwater Survey Points
- Salt Creek Survey Points
- Water Bodies
- Sweetwater/Salt Creek Subbasin

N

0 0.5 1 Miles

Seminole County
Black Hammock Restoration
Preliminary Design Report

Survey Points
Figure 10

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 10_survey.mxd 9/30/2013

5.0 Alternatives Analysis

Both long-term continuous and design-storm event simulations were evaluated to establish baseline conditions for the Salt and Sweetwater Creek systems. The existing baseline conditions were then used to develop proposed conditions and perform alternative analyses. The long-term continuous simulation was used to analyze proposed improvements under typical conditions whereas the design storm event simulations were run to satisfy future permitting conditions and to confirm no impacts upstream or downstream of the project area. Rainfall for the years 1997 through 2001 were used for the long term continuous simulation (**Table 6**). Hourly rainfall data from Orlando International Airport (OIA) were used. Rainfall data from the Sanford Experiment Station were also considered, however the data set was not as complete as the data for OIA and included inconsistencies between the hourly and daily measurements. Additionally, long-term measured average daily stages for Lake Jesup were also used over the 5-year time period in order to establish the downstream boundary condition and take into account the fluctuating levels in Lake Jesup over time and their influence on the upstream system (**Table 7**).

Table 6 Orlando International Airport Rainfall Data

Year	Rainfall (in.)
1997	60.71
1998	42.19
1999	51.51
2000	28.25
2001	52.91
5-year Average	**47.11**

Table 7 Lake Jesup Stages (1997-2001)

Statistic	Elevation (ft-NAVD88)
Average Stage	2.4
Minimum Stage	-0.8
Maximum Stage	5.0

For the long-term continuous simulation, baseflow within Salt and Sweetwater Creeks was also an important component to consider in the analysis, especially during extended periods without rainfall. Baseflow values of 1.6 to 5.0 cfs in Salt Creek and 1.1 to 3.4 cfs in Sweetwater Creek for the dry and wet seasons, respectively were used in the model.

5.1 Proposed Alternatives for Salt Creek

Based on field reconnaissance of the Salt Creek system and detailed survey information collected by SSMC, it was evident that there were several opportunities along Salt Creek to restore flow from the main channel into the floodplain meander areas in order to promote attenuation and water quality treatment of flows. The survey also indicated that most of the meander areas were deeper than the main channel, which would also help facilitate flow into and through these areas. The historic meanders were initially identified through review of detailed 1-foot topographic (LiDAR) information available from the SJRWMD. Topographic data were available in both contour and digital elevation model (DEM) format. The DEM proved more useful in identifying the pronounced meander areas (**Figure 11**) compared to the 1-foot contours due to the slight elevation change in most of these areas. These areas were then confirmed through field reconnaissance and survey. Both the County and the SJRWMD owned significant portions of lands in the Salt Creek subbasin, which are shown on **Figure 12**. From review of Figure 12, a portion on the west side of Salt Creek can be seen that is privately owned; however, the property owners are favorable to restoration on portions of their land so that is why the North Central meander was also considered in the analysis.

In order to promote flow into the meanders, two general alternatives were considered:

1. Removal of a portion of the spoil berm to re-establish the historical connection of Salt Creek to the meander

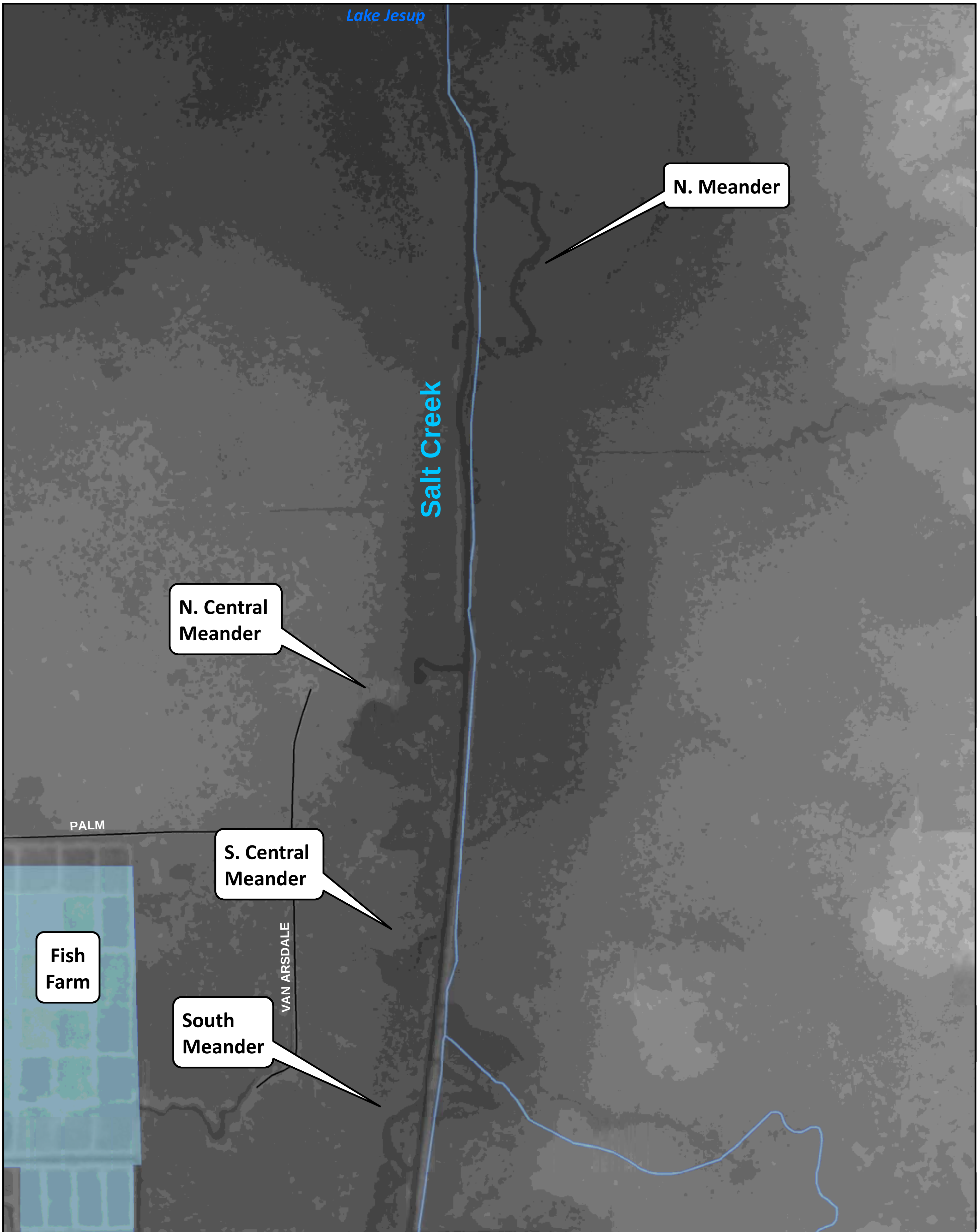
2. Removal of a portion of the spoil berm to re-establish the historical connection of Salt Creek to the meander **and** inclusion of 1-foot-high (low flow) diversion weirs in Salt Creek at the entrances to the South and North meanders.

Both of these alternatives were incorporated into the long-term continuous simulation analysis, evaluated and further refined.

Alternative 1
Under Alternative 1, removing the spoil berm will include grading from Salt Creek (at the creek bottom elevation at each meander) to 40 to 100 feet into the meander. Improvements to the meanders will include grading to remove a portion of the existing spoil berm and to achieve a stable channel into the meander. Rip-rap or other stabilization measures at the Salt Creek/meander connections is also proposed. The spoil bank at the downstream connection of the meander back into Salt Creek will also be removed as needed (only required at the South meander). Alternative 1 is shown graphically on **Figures 13a, 13b and 13c.**

Alternative 2
Alternative 2 is identical to Alternative 1 with the addition of 1-foot high diversion weirs within the main channel of Salt Creek near the entrances to the South and North meanders. The concept behind the low-flow diversion weirs is to promote additional flow into the meanders. Diversion weirs were not proposed at the South Central meander because due to the existing meander topography and proposed grading improvements, flow into the meander is already the preferred hydraulic path. A diversion weir was also not proposed at the North Central meander because the downstream connection of the meander back to Salt Creek passes through private property and existing culverts. Alternative 2 is shown graphically on **Figures 14a and 14b.**

Culvert and Baffle Box Improvements
In addition to the channel improvements described under Alternatives 1 and 2, the County also expressed interest in replacing several of the upstream culverts in the Salt Creek system. The current culvert configuration in the Salt Creek system creates the potential for both frequent debris blockages and increased flooding concerns. Improvements in this area will benefit the local Black Hammock residents by improving conveyance, decreasing flooding depths and overtopping of roadways and decreased frequency of debris blockages.



LEGEND

Water Bodies

Streets

N

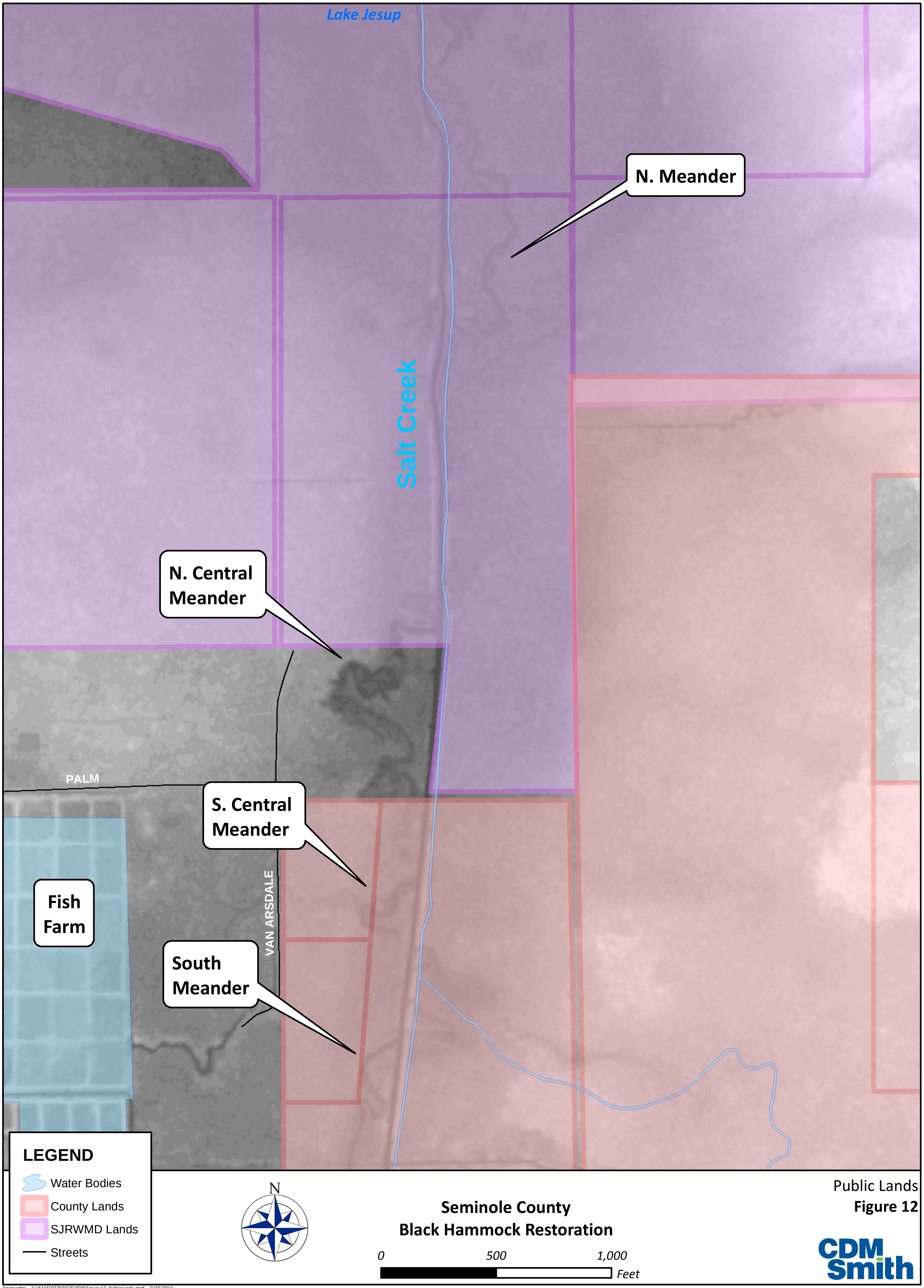
Seminole County
Black Hammock Restoration
Preliminary Design Report

0 500 1,000 Feet

Historical Meanders
Figure 11

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 11_DEM.mxd 9/30/2013

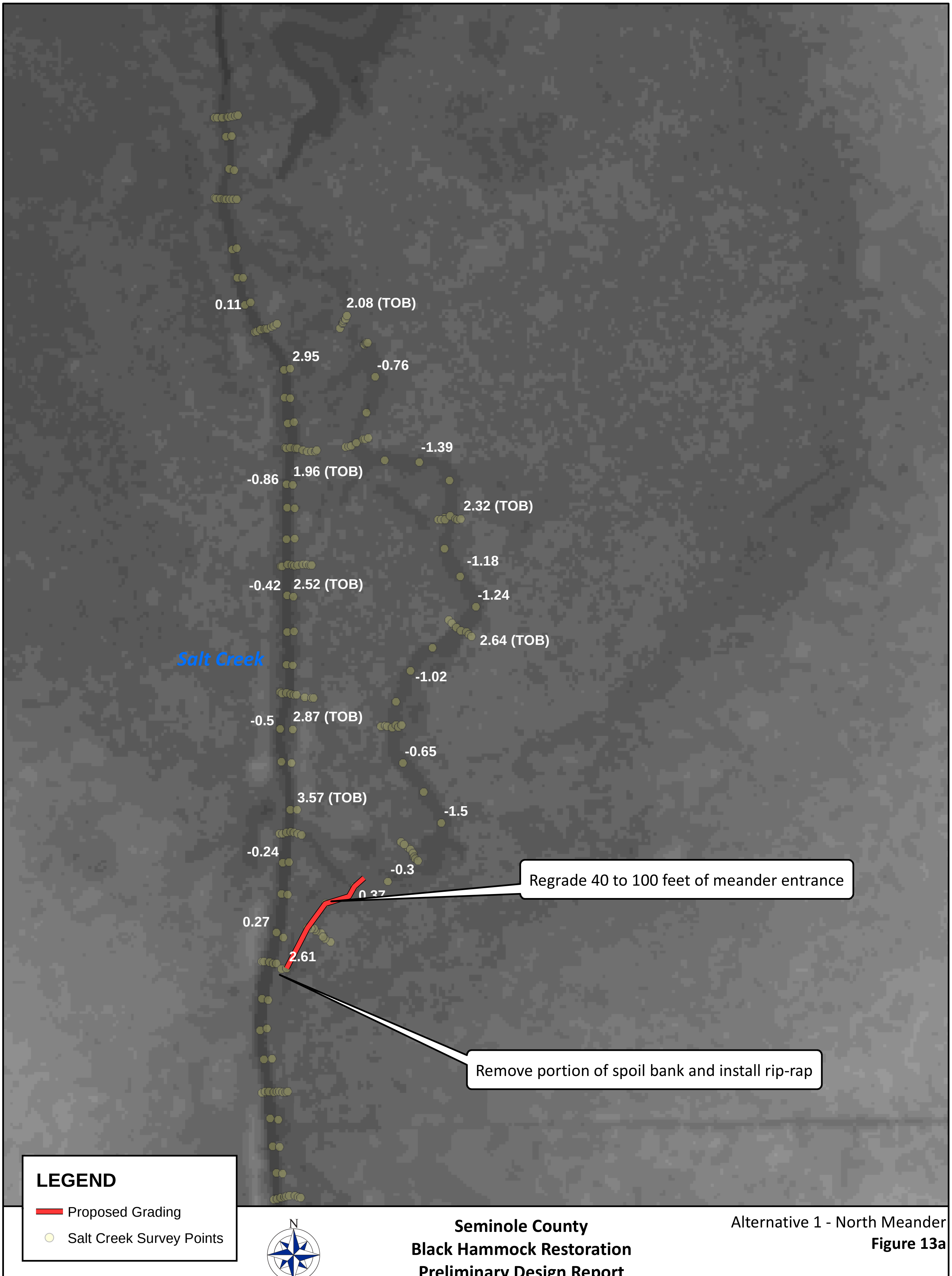


Seminole County
Black Hammock Restoration

Public Lands
Figure 12

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 12_PublicLands.mxd 9/30/2013



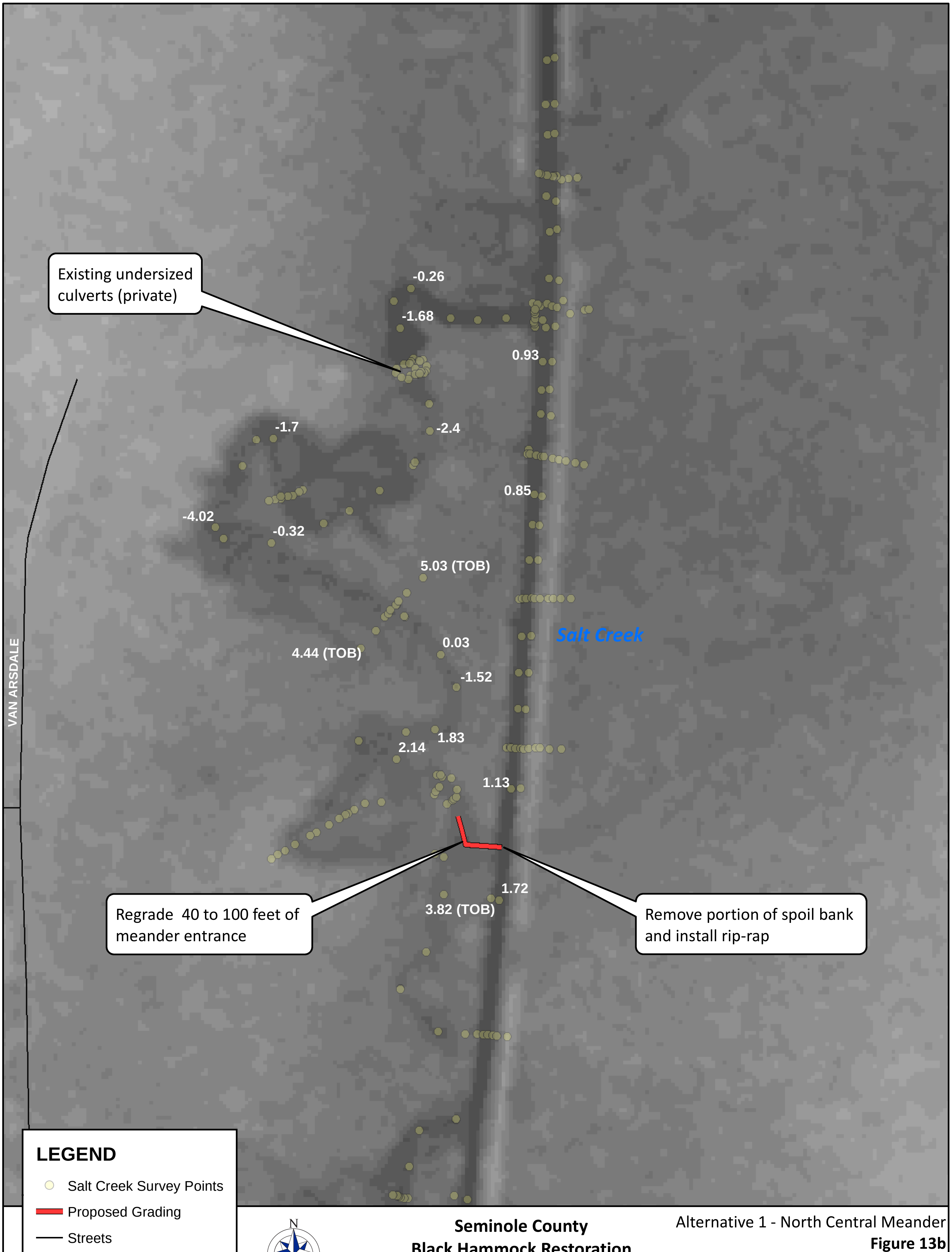
All elevations reference NAVD88
TOB - Top of Bank

Seminole County
Black Hammock Restoration
Preliminary Design Report

Alternative 1 - North Meander
Figure 13a

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 13a_Alt1_N.mxd 9/30/2013



LEGEND

- Salt Creek Survey Points
- Proposed Grading
- Streets

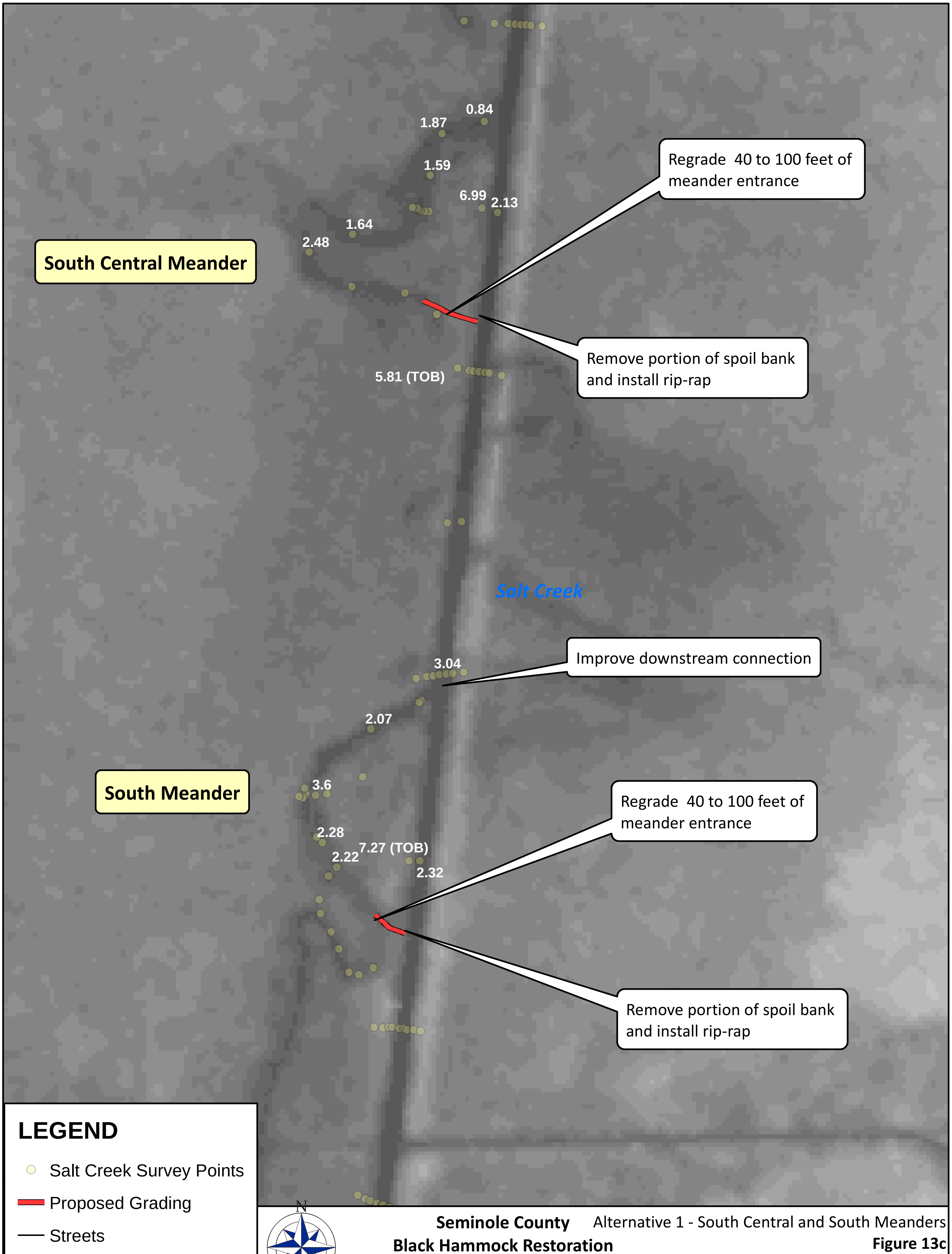
All elevations reference NAVD88
TOB - Top of Bank

Seminole County
Black Hammock Restoration
Preliminary Design Report

Alternative 1 - North Central Meander
Figure 13b

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 13b_Alt1_NCM.mxd 9/30/2013



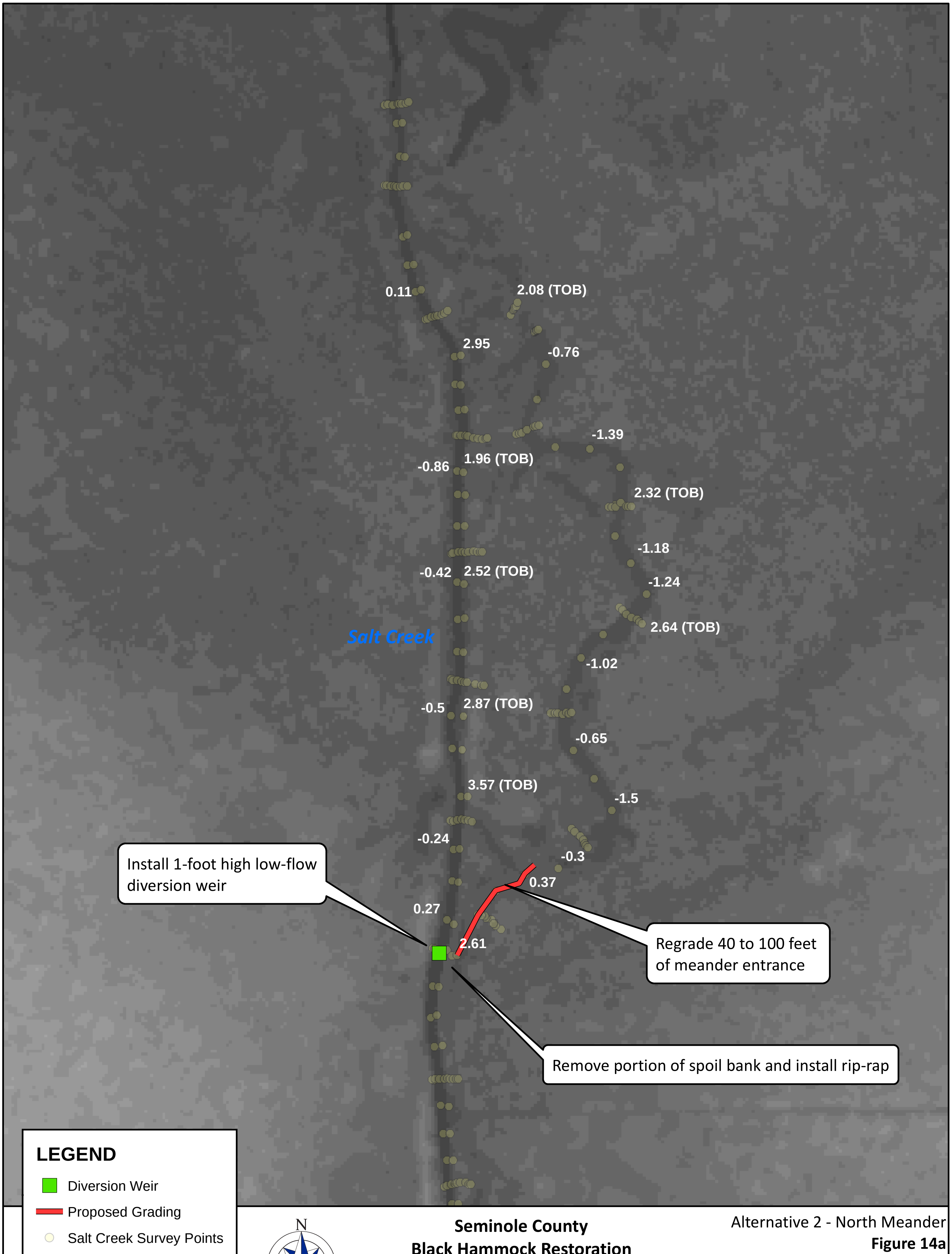
All elevations reference NAVD88
TOB - Top of Bank

Seminole County
Black Hammock Restoration
Preliminary Design Report

Alternative 1 - South Central and South Meanders
Figure 13c

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Fig 13c_Alt1_SSCM.mxd 9/30/2013



All elevations reference NAVD88

TOB - Top of Bank

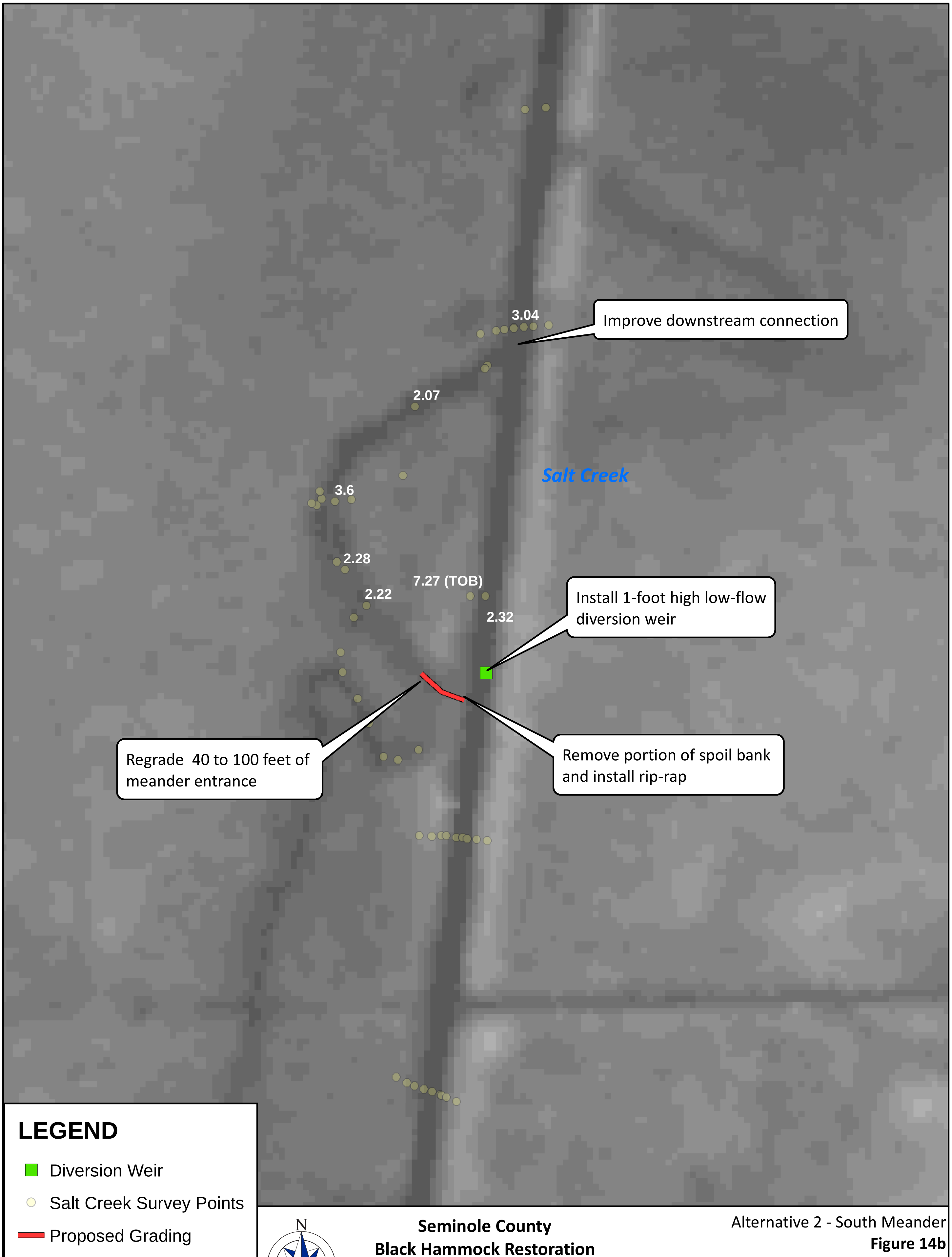
Seminole County
Black Hammock Restoration
Preliminary Design Report

Alternative 2 - North Meander

Figure 14a

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Fig 14_Alt2.mxd 9/30/2013



All elevations reference NAVD88
TOB - Top of Bank

Seminole County
Black Hammock Restoration
Preliminary Design Report

Alternative 2 - South Meander
Figure 14b

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Fig 14b_Alt2_SM.mxd 9/30/2013

Survey and evaluation of several of the major culvert crossings in the Salt Creek system (**Figure 15**) revealed that some of these culverts are inconsistently sized (i.e., flow capacity decreases from upstream to downstream culvert), overtop during storm events and routinely get blocked by debris. CDM Smith recommends replacing most of these culverts with larger horizontal elliptical reinforced concrete pipe (HERCP) or equivalent concrete box culverts (CBCs) as shown on Figure 15. Furthermore, as an additional measure to reduce the potential for culvert blockage, floating debris booms may be considered at the upstream end of selected culvert crossings to divert floating debris to the side of the channel. Since the configurations of the channel and culvert crossings vary considerably, site-specific design for each of the booms would be needed. Further, to increase effectiveness the booms, regular maintenance of the trapped debris would be needed.

In order to further improve water quality, the County will also consider the option of installing a baffle box at the Packard Avenue crossing that can be equipped with filter media to enhance removal of total nitrogen (TN) and TP.

5.1.1 H&H Results

As described above, Alternatives 1 and 2 were designed to restore a portion of flow from the main Salt Creek channel into the floodplain meander areas in order to promote attenuation and water quality treatment of flows. The survey also indicates that many of the meander areas are deeper than the main channel. A 5-year long-term continuous simulation was run to evaluate the existing and proposed conditions for both Alternatives 1 and 2. **Table 8** summarizes the results of the SWMM5 analysis.

Table 8 SWMM 5 Results for Meander Improvements

Meander	Existing			Alternative 1			Alternative 2		
	Avg	Max	Days[2]	Avg	Max	Days[2]	Avg	Max	Days[2]
South (stage[1])	3.7	7.6	50	3.4	7.6	264	3.6	7.6	365
South (flow[1])	1.0	102		2.7	142		5.9	160	
South Central (stage[1])	3.3	7.3	22	3.0	7.4	191	3.0	7.4	192
South Central (flow[1])	0.2	108		2.1	131		2.1	131	
North Central (stage[1])	2.9	6.6	24	2.8	6.6	57	2.8	6.6	57
North Central (flow[1])	0.5	37		1.0	45		1.0	42	
North (stage[1])	1.9	6.0	55	1.9	6.0	345	1.9	6.0	344
North (flow[1])	0.9	102		4.3	127		4.7	124	

1. All reported stages reference NAVD88; all flows are in cfs
2. Days = average number of days per year that meander carries flow (1 cfs or greater)

The SWMM5 results for the culvert crossings for the 5- and 10-year/24-hour design storm events are shown in **Table 9**. The intent of culvert replacement is to reduce the frequency of debris blockage at the crossings and to better convey storm flows through the culvert instead of over the top of road, which will improve stormwater management and reduce undermining of the structures and erosion of streambanks. In order to focus on the conveyance capacity of the subject culverts during these moderate design storms simulations, a constant Lake Jesup tailwater elevation of 1.85 feet NAVD (approximate seasonal high water) was used. This tailwater elevation is based on review of the long-term (1997 through 2013) measured daily stages for Lake Jesup. For these data, 75% of the daily Lake Jesup stages were less than or equal to 1.85 feet NAVD.

LEGEND

- Salt Creek Survey Points
- Water Bodies
- Streets

N

Seminole County
Black Hammock Restoration
Preliminary Design Report

0 500 1,000
Feet

Proposed Culvert Replacements - Salt Creek

Figure 15

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Fig 14.mxd 9/30/2013

Table 9 SWMM 5 Results for Culvert Replacements

Culvert Crossing	Top of Road Elevation (ft-NAVD88)	Peak 5-year/24-hour Stage (ft-NAVD88)			Peak 10-year/24-hour Stage (ft-NAVD88)		
		Existing	Alt 1	Alt 2	Existing	Alt 1	Alt 2
Florida	19.8	21.0	20.9	20.9	21.2	21.1	21.1
Howard	14.3	13.8	13.5	13.5	13.9	13.6	13.6
Van Arsdale	13.6	11.8	11.9	11.9	11.9	12.0	12.0
Independence (main)	11.2	11.6	11.1	11.1	11.7	11.3	11.3
Freedom	17.3	17.9	17.6	17.6	18.2	17.8	17.8
Independence (east)	15.3	15.9	15.6	15.6	16.2	15.8	15.8
Stone	9.9	8.6	8.5	8.5	8.8	8.7	8.7
Packard	8.1/9.1	8.9	8.8	8.8	9.1	9.0	9.0

1. Results based on a constant tailwater elevation of 1.85 feet NAVD (approximate seasonal high water for Lake Jesup)
2. Packard Avenue is proposed to be raised approximately 1 foot from 8.1 to 9.1 feet NAVD at the culvert crossing

From the results shown in Tables 8 and 9, the following observations were made:

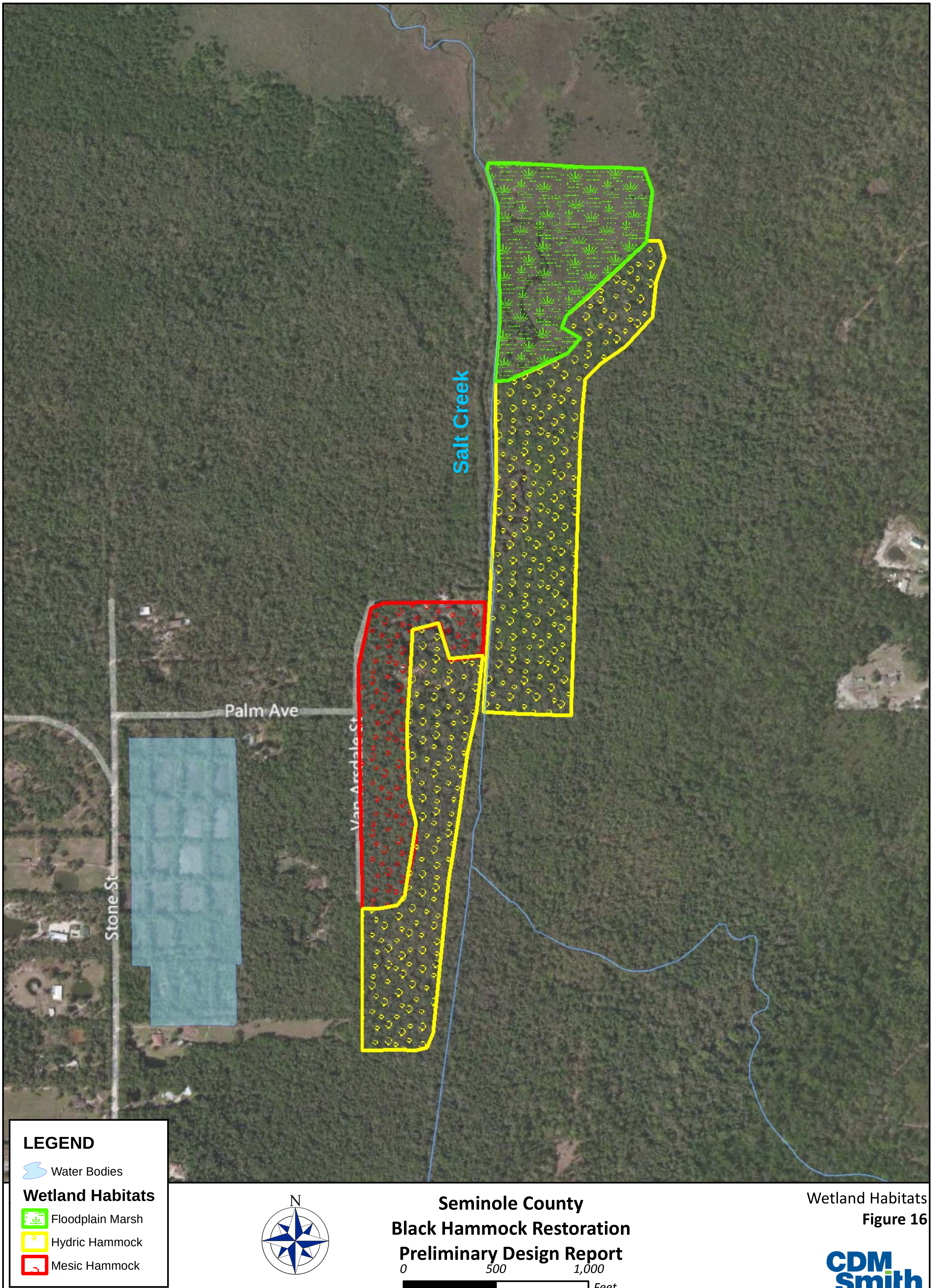
- Neither of the alternatives has a significant influence on stage in the meanders compared to existing conditions.
- Under Alternative 1, the average flow through the meanders increases by at 20 to 40 percent over existing conditions depending on the meander.
- Under Alternative 2, the average flow increases over existing condition are very similar to the Alternative 1 results.
- Both alternatives have a significant effect on how often (i.e., number of days) the meanders convey flow. The number of days the meanders receive flow is almost identical for the South Central, North Central and North meanders under Alternatives 1 and 2.
- The numbers of days the meanders receive flow increases significantly under Alternative 2 for the South meander.

As indicated in the results above, proposed conditions are characterized by somewhat higher flows through the project area and the meanders. These higher flows are due to the improved culvert crossings and hydraulic access to the meanders. Final proposed design configurations will ultimately depend upon permitability of flows and stages within and downstream of the project area.

5.1.2 Wetlands Evaluation

The majority of the proposed project area is surface water (creek) and wetland. The wetland communities within and adjacent to the meanders include hydric hammock, mesic hammock, and floodplain marsh (**Figure 16**). Small upland areas exist next to Salt Creek that are the result of berming and spoil bank deposits from the channelization of the creek. These upland areas are limited to the berms within 10 to 15 feet of the channel bank.

The historic channel meanders typically contain stagnant pools of standing water, mucky soils, and vegetative communities that indicate inundation during the majority of the year. The North meander



Seminole County
Black Hammock Restoration
Preliminary Design Report

Wetland Habitats
Figure 16

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 16 Wetland types.mxd 9/30/2013 has several exotic species present that require inundated conditions including alligator weed (*Alternanthera philoxeroides*) and duckweed (*Lemna minor*). This meander contains a thick layer of muck. The other meanders have a mix of aquatic and obligate wetland vegetation including giant leather fern (*Acrostichum danaeifolium*), swamp rosemallow (*Hibiscus grandiflorus*), bacopa (*Bacopa monnieri*), buttonbush (*Cephalanthus occidentalis*), and pickerel weed (*Pontederia cordata*). While not as thick as in the North meander, these areas have a layer of muck indicating historic inundation over a long period. Reconnecting these meanders would benefit aquatic fauna such as small fish, fish larvae, and macroinvertebrate by providing additional habitat and oxygenated water in these areas. Wetland vegetative communities also would likely increase in these areas with increased populations and diversity.

Floodplain marsh habitat in the project area consists of an expansive scrub shrub wetland heavily influenced by Lake Jesup. This habitat type surrounds the North meander and adjacent areas. Directly to the west of the North meander is a thick monoculture of swamp rosemallow. Additional species present include salt bush (*Baccharis halimifolia*) and red maple (*Acer rubrum*). During the field visit, the water table was less than 6 inches below ground surface (bgs). Hydrologic indicators suggest that recent seasonal high water levels (SHWL) were approximately 0 to 6 inches above ground surface (ags). Historic hydrologic indicators such as water marks and lichen lines suggest that historic SHWLs were up to 2 to 3.5 feet ags. These areas could benefit from increased volume of flow and slightly higher stages during baseflow conditions.

Hydric hammock habitat in the project area contains forested wetlands with cabbage palm (*Sabal palmetto*) as a canopy dominant. Other species present in the canopy include water oak (*Quercus nigra*), American elm (*Ulmus americana*), red maple, and sweetgum (*Liquidambar styraciflua*). Live oak (*Quercus virginiana*) and slash pine (*Pinus elliottii*) are present in areas at slightly higher elevations. Groundcover is sparse and includes toothed midsorus fern (*Blecknum serrulatum*) and various panic grasses (*Panicum* spp.). Lichen lines and other hydrologic indicators in these areas suggest that SHWLs are at or below ground surface. Historic hydrologic indicators such as water marks and lichen lines suggest that historic SHWLs were 2 to 3.5 feet ags. These areas could benefit from increased volume of flow and slightly higher stages during baseflow conditions.

Mesic hammock habitat in the project area contains forested wetland areas that are at slightly higher elevations than hydric hammock. Cabbage palm is a canopy dominant but eastern red cedar (*Juniperus virginiana*), live oak, and slash pine are more prevalent in the canopy compared to hydric hammocks. Understory species include caesar weed (*Urena lobata*), American beautyberry (*Callicarpa americana*), and saw palmetto (*Serenoa repens*). No hydrologic indicators of SHWLs were present above ground surface suggesting that these areas are not frequently flooded. Evidence of subsidence was also observed throughout these areas indicating that historically this habitat was more frequently inundated. Historic hydrologic indicators such as water marks and lichen lines suggest that historic SHWLs were approximately 1.5 feet ags. Feral hog (*Sus scrofa*) rooting was extensive in these mesic hammock areas. These mesic hammocks were likely hydric hammocks historically and are now transitioning to mesic upland habitat. This area would benefit from increased frequency of inundation.

The nearest FWC-monitored eagles nest is approximately 1,600 feet from the project impacts. No state or federally listed species were observed during the site visits. The proposed project is not likely to impact any state or federally listed species. During the USACE permitting process, any potential project impacts to federally listed species will be addressed. Any potential impacts to state listed species would be coordinated with FWC directly.

5.1.3 Pollutant Load Analysis

CDM Smith performed a review of published removal efficiencies for stream restoration BMPs from available literature sources. There are currently no published removal efficiencies for stream restoration based on review of the accepted removal rates published by FDEP (for TMDL and BMAP purposes) as well as in the Draft Statewide Stormwater Rule (FDEP, 2010). The most recent and comprehensive work that standardizes an approach for pollutant load reduction credits for stream restoration BMPs is associated with the Chesapeake Bay TMDL. An expert panel was charged with reviewing the available science on the nutrient (e.g., TN and TP) and sediment removal performance associated with qualifying urban stream restoration projects. Based on its research review, the panel developed four general protocols that can be used to define the pollutant load reductions associated with individual stream restoration projects as outlined in the *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (Schueler et. al., 2013).

Each protocol has an associated methodology for estimating load reduction for nutrients and/or total suspended solids (TSS) for a particular type of stream restoration project. Upon review of the protocols, Protocol 3 (Credit for Floodplain Reconnection Volume) appears to be the most applicable to the alternatives proposed for Black Hammock. This protocol provides an annual mass sediment and nutrient reduction credit for projects that reconnect stream channels to the floodplain over a wide range of storm events. Credit for baseflow is also given for projects with more frequent floodplain connectivity and established floodplain wetlands. A wetland-like treatment is used to compute the load reduction attributable to floodplain deposition, plant uptake, denitrification and other biological and physical processes. This method assumes that TSS, TN and TP removal occurs only for that volume of annual flow that is effectively in contact with the floodplain. For planning purposes, a series of curves are used to relate the floodplain reconnection volume to the effective depth of rainfall treated in the floodplain, which in turn are used to define the nutrient removal rate that is applied to pollutant loads delivered to the project. Designs that divert more stream runoff onto the floodplain during smaller storm events (e.g., 0.25 or 0.5 inch) receive greater nutrient removal credit than designs that interact with the floodplain during only infrequent (larger) events. The floodplain connection volume afforded by a project is equated to a wetland volume so that a wetland removal efficiency can be applied. The panel reasoned that the function of the increased floodplain connection volume would behave in the same fashion as a restored floodplain wetland. Depending on the characteristics of the floodplain reconnection, removal efficiencies for TN and TP can range from 0 to 16 percent and 0 to 24 percent, respectively.

The input parameters for each meanders along Salt Creek were calculated using GIS topographic information and the SWMM5 output results from the continuous simulation. Based on the available floodplain storage volume at each of the meanders along Salt Creek and the rainfall depth at which flow enters each of the meanders, the parameters are summarized in **Table 10**. In actuality, rainfall does not need to occur for flow to enter the meanders under the proposed alternatives as a portion of Salt Creek baseflow will already be conveyed through these areas. However, the lowest rainfall threshold used in the methodology previously described is 0.1 inch; therefore, this is the value that is used for estimating a nutrient removal efficiency.

Table 10 Stream Restoration Pollutant Load Removal Input Parameters

Meander	Available Floodplain Storage (ac-ft)	Upstream Tributary Area (ac)	Floodplain Storage Volume[1] (in)	Rainfall Depth at which Flow is initiated (in)
South	3.1	2095.2	0.02	0.1
South Central	7.0	2604.9	0.03	0.1
North Central	11.5	2632.1	0.05	0.1
North	28.0	3214.8	0.10	0.1

1.Floodplain Storage Volume is reported in inches over the upstream tributary area

Using the input parameters in Table 10 and the curves used to relate the floodplain reconnection volume to the effective depth of rainfall treated in the floodplain (**Attachment B**), the resulting removal efficiency for TN and TP are 7 and 11 percent, respectively. Since most of the meanders have actual floodplain storage volumes less than 0.1 inch (minimum threshold on the curves) over the upstream tributary area, the entire floodplain storage (0.21 inch) was used to estimate an overall removal efficiency taking improvements at all of the meanders into consideration.

Using measured water quality data for TN and TP in Salt Creek (at the Packard Avenue sampling station from 1997 through 2012) and annual average flows computed by the SWMM5 model over the 5-year continuous simulation, CDM Smith estimated the nutrient load at Packard Avenue (proposed baffle box location) as well as at each of the meander entrances.

The load removal associated with the baffle box was calculated using standard removal efficiencies available from FDEP. These results are shown in **Table 11**. As the meanders are located downstream of the proposed baffle box, the resulting concentration subsequent to the baffle box treatment was calculated based on average flow rate (6.1 cfs) and the reduced load. The resulting TN and TP concentrations were then used to calculate the loads downstream at each of the meander entrances. Since there were no water quality data collected between Packard Avenue and the lake, CDM Smith assumed the TN and TP concentrations were consistent throughout the remainder of the Salt Creek system. The resulting loads at each meander are shown in **Table 12**. If filtration media is incorporated into the baffle box treatment, additional nutrient removal can be achieved.

Table 11 Packard Ave. Baffle Box Estimated Nutrient Load Removal

Pollutant	Average Concentration (mg/l)	Average Load (lbs/yr)	Removal Efficiency (%)	Load Removal (lbs/yr)	Resulting Concentration (mg/l)
TN	1.5	18,371	19.1	3,509	1.69
TP	0.26	3,148	15.5	2,660	0.30

Table 12 Salt Creek Estimated TN and TP Pollutant Load

Meander	Average TN (mg/l)	Average TN Load (lbs/yr)	Average TP (mg/l)	Average TP Load (lbs/yr)
South	1.69	25,080	0.3	4,489
South Central	1.69	25,909	0.3	4,637
North Central	1.69	26,805	0.3	4,798
North	1.69	29,028	0.3	5,195
Average:	1.69	**26,706**	0.3	**4,780**

Since TN and TP load varies throughout the Salt Creek system (moving from upstream to downstream) and pollutant loading is typically reported as an average annual load, the average load in the project area was used to estimate the load reduction under proposed conditions. Using the stream restoration removal efficiencies for TN and TP of 7 and 11 percent, respectively, the anticipated load reduction in Salt Creek is 1,869 lbs/yr of TN and 526 lb/yr of TP. The total project load removal (considering the baffle box and stream restoration) is summarized in **Table 13**.

Table 13 Estimated Project Load Removal – Salt Creek

Pollutant	Baffle Box Load Removal (lb/yr)	Stream Restoration Removal (lb/yr)	Total Project Load Removal (lb/yr)	Total Project Load Reduction (%)
TN	3,509	1,869	5,378	24
TP	488	526	1,014	26

5.2 Proposed Alternatives for Sweetwater Creek

As mentioned previously, Salt Creek presented most of the opportunities for floodplain restoration due to the number of historical meanders, topography and their locations within publicly owned parcels during the evaluation. However, as part of this effort, CDM Smith also performed a field reconnaissance of portions of Sweetwater Creek and collected limited channel cross section survey data. The area along the western lateral as well as the floodplain area to the west of Sweetwater Creek just north of the lateral were visually inspected in May 2013. SJRWMD also owns a large portion of land in this vicinity. The public property boundaries and cross-section locations are shown on **Figure 17**.

There is a pronounced depressional area just to the west of the spoil bank along Sweetwater Creek that was saturated at the time of the field reconnaissance. This area intercepts overland flow from the west and surface water is captured in these depressional areas. SSMC collected detailed information for several cross-sections along Sweetwater Creek in order to survey the main channel as well as these defined depressional areas on either side of the spoil banks. The results of the survey indicate that these depressional areas are still significantly higher (on the order of 3.5 to 4 feet) than the invert channel bottom of the main stem of Sweetwater Creek (**Figure 18**). Unlike Salt Creek, significant excavation, diversion, and/or structural controls would be needed in order to direct flow from Sweetwater Creek into these floodplain areas while also retaining the existing overland flow that the floodplain areas currently receive.

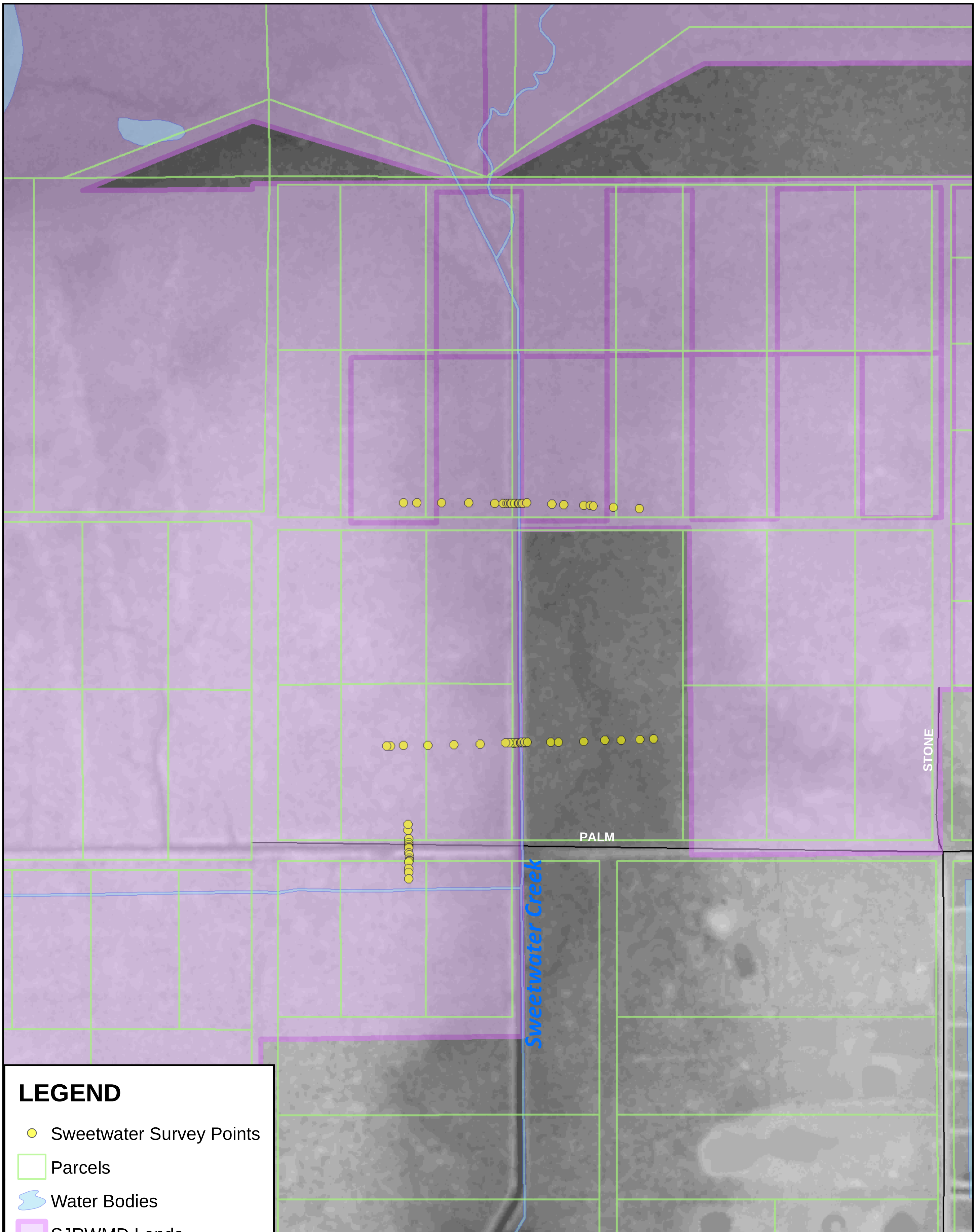
The goal of restoration efforts in the Salt and Sweetwater Creek systems is to restore flow to the existing floodplain and wetland areas to provide passive treatment that requires little to no long-term maintenance. To restore flow to the areas in Sweetwater Creek, a significantly engineered system would be required, thus increasing impacts to the existing system and the need for long-term maintenance. A more significant diversion weir would also increase the frequency that debris has the potential to cause additional blockages and increase upstream flood stages. The public property boundaries also limit the extents of restoration that can be provided (Figure 17).

In order to provide some water quality benefit in this subbasin, the County may consider replacing the one of the three existing 60-inch diameter culverts at the intersection of Howard Avenue and Kansas Street with a baffle box to reduce pollutant loading to Sweetwater Creek from upstream areas. The baffle box can also be equipped with media filtration to further reduce nutrients.

Using measured water quality data for TN and TP in Sweetwater Creek (at the Howard Avenue sampling station from 2004 through 2012) and annual average flows computed by the SWMM5 model over the 5-year continuous simulation, CDM Smith estimated the nutrient load at Howard Avenue (proposed baffle box location). There are currently three 60-inch corrugated metal pipes (CMPs) at this crossing. Due to the size of the baffle box required, it is most likely that only one of the 60-inch CMPs can be cost-effectively retrofitted. Therefore, CDM Smith assumed that one-third of the total average flow (1.57 cfs) at this location has the potential to be treated. The load removal associated with the baffle box was calculated using standard removal efficiencies available from FDEP. These results are shown in **Table 14**.

Table 14 Howard Ave. Baffle Box Estimated Nutrient Load Removal

Pollutant	Average Concentration (mg/l)	Average Load (lbs/yr)	Removal Efficiency (%)	Load Removal (lbs/yr)
TN	1.5	1,533	19.1	293
TP	0.4	415	15.5	64



All elevations reference NAVD88
TOB - Top of Bank

N

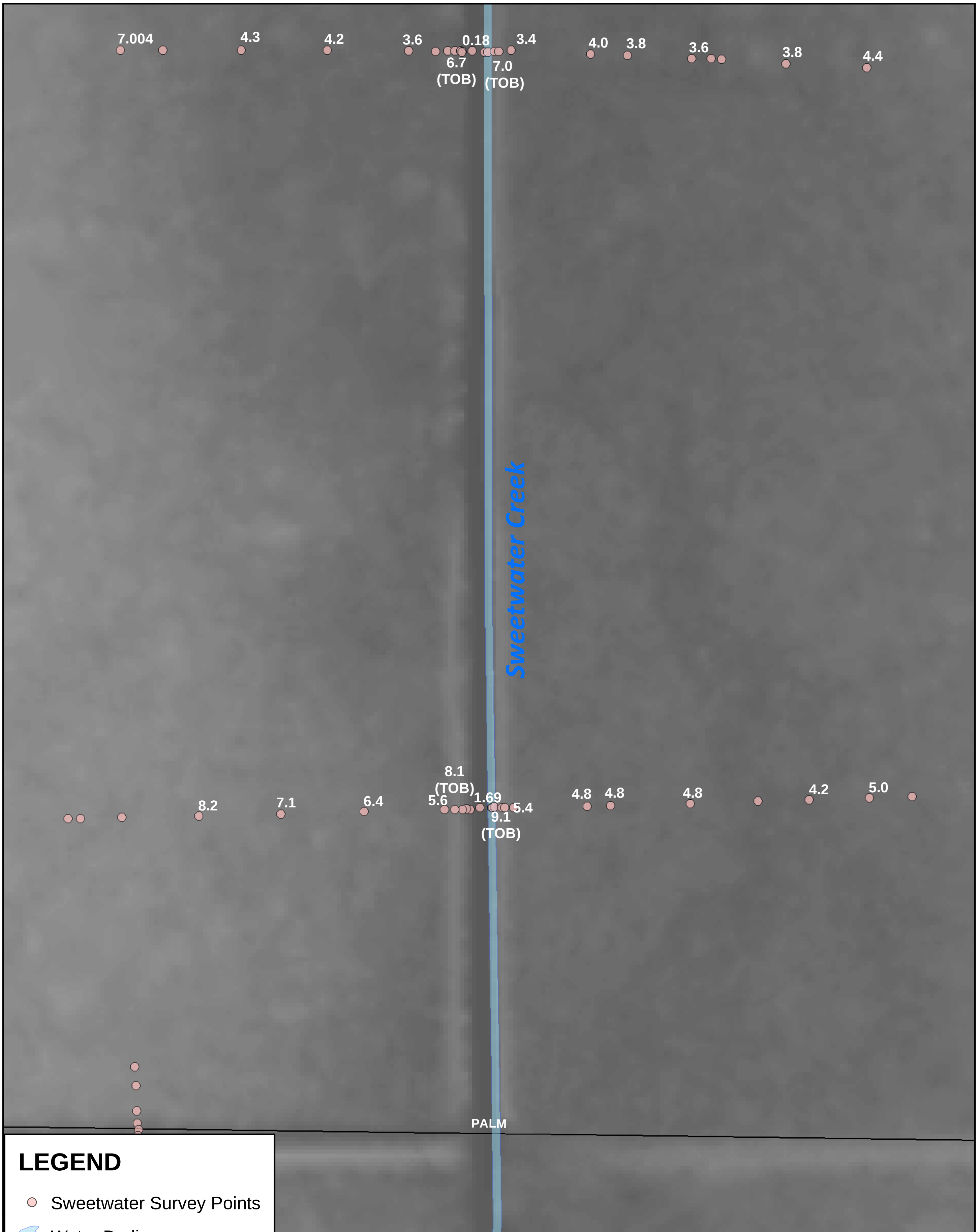
0 250 500
Feet

Seminole County
Black Hammock Restoration
Preliminary Design Report

Sweetwater Creek Cross-Section Locations
Figure 17

CDM Smith

honourdm G:\6116\97760\GIS\PDR\Figure 17_Sweetwater.mxd 9/30/2013



All elevations reference NAVD88
TOB - Top of Bank

N

0 125 250 Feet

Seminole County
Black Hammock Restoration
Preliminary Design Report

Sweetwater Creek Downstream Cross-Sections
Figure 18

CDM Smith

6.0 Cost Estimates

CDM Smith prepared a construction cost estimate based on the level of detail provided as a result of the preliminary design analysis. Since the construction of the proposed alternatives is also contingent on grant monies, care was taken to develop proposed alternatives that could still be constructed within the available funding budget. Therefore, during the preliminary design process, CDM Smith completed several iterations of cost estimates to maximize the improvements within the allotted funding. Based on CDM Smith's opinion of probable cost, Alternative 2 for Salt Creek as well as the culvert replacements and baffle box improvements within the Salt Creek system can be constructed within the allowable funding budget. The opinion of probable construction cost for the aforementioned improvements is $1,521,000. This includes a 30 percent contingency. A detailed breakdown of the construction cost estimate is provided in **Attachment C**. It is important to note that since these costs are based on preliminary design data, they are not considered final construction costs.

CDM Smith also performed a limited cost-effectiveness evaluation for nutrient removal based on the preliminary design cost estimate for Alternative 2 for Salt Creek and the addition of the baffle box at Packard Avenue. Based on the load removal estimates for TN and TP shown in Table 13, the resulting cost-effectiveness is $283/lb and $1,500/lb of TN and TP removed, respectively. This estimate does not consider anticipated long-term operation and maintenance (O&M) costs. Long-term O&M costs and performance of the system once constructed will better define the actual cost-effectiveness of the project in terms of load removal. This effectiveness may improve with the addition of filtration media to the baffle box design.

7.0 Conclusions and Recommendations

The evaluation performed for the proposed project indicates that flows from Salt Creek can be conveyed to the four selected historic floodplain meanders in order to promote attenuation and water quality treatment. Both alternatives (1 and 2) significantly increase the flow frequency and rates associated with baseflow and moderate storm events that are conveyed to the meanders (with Alternative 2 demonstrating the greater increase) compared to existing conditions. Increases in stages to the surrounding areas are minimal; however, private property considerations will need to be given to improvements at the North Central meander before proceeding with implementation. Preliminary wetland assessments have indicated that the proposed project will not impact surrounding habitats (i.e., transition between wetland and upland) and the wetlands within the meanders would benefit from increased frequency of inundation. No endangered or listed species were identified in the study area as a part of this evaluation. Proposed improvements in Salt Creek (baffle box and stream restoration) is anticipated to reduce TN and TP by 5,378 and 1,014 lbs/yr, respectively. The addition of media filtration to the baffle box design will also further reduce nutrient loading.

Sweetwater Creek does not afford as many readily available opportunities for stream restoration as does Salt Creek. This is mainly due to property ownership and topographic constraints. A baffle box was considered at the Howard Avenue crossing and is anticipated to reduce TN and TP by 293 and 64 lbs/yr, respectively. However, due to the anticipated cost of a baffle box at this location (which can only treat one-third of the flow), this alternative was deemed not to be cost-effective at this time and is therefore not part of the recommended alternative for the next phase.

A preliminary design cost estimate was prepared with the goal of reflecting a set of improvements that are within the allowable funding budget. The opinion of probable construction cost for the Salt Creek improvements (i.e., Alternative 2 and culvert replacements and baffle box improvements) is $1,521,000. These estimated costs also meet the constraints of the available project funding. Based on the preliminary design cost estimate and feedback from technical stakeholders, the following improvements were selected for further design consideration under Phase II (final design):

1. Salt Creek – Stream Restoration Alternative 2

2. Salt Creek – Culvert Replacements

3. Salt Creek – Packard Avenue Culvert Replacement with Baffle Box (media filtration will also be strongly considered with the design of the baffle box)

Based on the pollutant load removal estimates for TN and TP, the resulting cost-effectiveness of the proposed project (stream restoration and baffle box) is $283/lb and $1,500/lb of TN and TP removed, respectively.

In addition to the recommended alternatives for final design and construction in the next phase, it is recommended to perform further investigation of potential additional design options that may be considered for implementation in the future (based on available funding) including:

- Additional survey of the former fish farm will be required to further evaluate the potential of the property (currently owned by the State of Florida) as a potential water quality treatment facility for nonpoint source runoff.

- Additional investigation and survey in the Sweetwater Creek system to further identify cost-effective and feasible options for nutrient removal.

- Additional survey and probing of muck depths in the meander areas and lateral tributary canals to determine feasibility of muck removal in these systems.

Attachment A
SWMM5 Hydrologic Input Parameter Spreadsheet

Table A-1 Area-Weighted Overland Flow Parameters

Hydrologic Unit	Area (ac)	Weighted Slope (ft/ft)	Weighted Length (ft)	Subbasin Area (ft^2)	Flow Width (ft)
05-16.01	162.9	0.001	2,692	9,326,569	3,465
05-17.00	214.1	0.001	3,853	21,393,547	5,552
05-17.01	491.1	0.001	5,035	21,393,547	4,249
05-17.02	50.4	0.001	1,861	2,196,216	1,180
05-17.03	200.4	0.001	2,708	8,727,601	3,223
05-17.03b	49.7	0.003	2,340	2,164,062	925
05-17.04	71.6	0.010	1,326	3,119,035	2,353
05-17.05	64.8	0.002	1,781	2,823,987	1,586
05-17.06	91.0	0.003	2,015	3,963,869	1,967
05-17.07	76.9	0.002	2,496	3,351,096	1,343
05-17.08	73.7	0.009	1,687	3,210,328	1,903
05-17.09	142.0	0.011	4,929	6,184,266	1,255
05-17.10	188.7	0.010	4,648	8,221,319	1,769
05-17.11	37.6	0.001	2,136	1,636,934	766
05-17.12	58.9	0.002	4,853	2,564,213	528
05-17.13	185.5	0.002	6,989	8,081,646	1,156
05-18.01	20.1	0.002	595	876,421	1,473
05-18.02	31.3	0.002	2,109	1,362,453	646
05-18.03	99.4	0.002	5,384	4,331,062	804
05-18.04	43.4	0.005	1,500	1,888,928	1,259
05-18.05	54.9	0.003	3,142	2,391,212	761
05-18.06	46.3	0.002	3,029	2,016,008	666
05-18.07	42.7	0.008	1,411	1,860,577	1,319
05-18.08	9.6	0.009	992	417,004	421
05-18.09	41.7	0.002	2,999	1,818,477	606
05-18.10	37.9	0.007	2,075	1,648,856	795
05-18.11	15.0	0.004	1,468	655,156	446
05-18.12	52.8	0.005	2,504	2,299,125	918
05-18.13	23.8	0.001	1,234	1,036,125	839
05-18.14	62.9	0.005	2,383	2,738,977	1,150
05-18.15	47.1	0.008	1,797	2,051,243	1,142
05-18.16	32.3	0.002	2,178	1,407,358	646
05-18.17	69.6	0.003	1,904	3,032,133	1,593

Hydrologic Unit	Area (ac)	Weighted Slope (ft/ft)	Weighted Length (ft)	Subbasin Area (ft^2)	Flow Width (ft)
05-18.18	74.2	0.002	2,845	3,232,256	1,136
05-18.19	28.2	0.001	1,387	1,230,090	887
05-18.20	62.8	0.002	2,078	2,737,298	1,318
05-18.21	52.7	0.002	1,780	2,293,975	1,289
05-18.22	74.0	0.002	2,541	3,222,489	1,268
05-18.23	68.1	0.008	2,368	2,967,203	1,253
05-18.24	72.9	0.006	2,861	3,173,986	1,109
05-18.25	86.4	0.011	4,163	3,764,333	904
05-18.26	52.2	0.016	2,242	2,272,411	1,014
05-18.27	69.2	0.002	1,944	3,014,332	1,551
05-18.28	63.1	0.004	2,471	2,747,016	1,112
05-18.29	69.1	0.004	1,778	3,007,854	1,692
05-18.30	99.4	0.001	1,790	4,328,319	2,418
05-18.31	122.0	0.002	3,472	5,313,965	1,530
05-18.32	71.9	0.002	2,647	3,132,396	1,184
05-18.33	48.1	0.008	1,455	2,097,266	1,441
05-19.01	100.6	0.001	5,914	3,173,986	537
05-19.02	147.0	0.002	2,339	3,764,333	1,610
05-19.03	110.7	0.003	2,302	2,272,411	987
05-19.04	35.8	0.004	1,820	3,014,332	1,656
05-19.05	27.2	0.005	1,886	2,747,016	1,456
05-19.06	29.6	0.005	1,875	3,007,854	1,604
05-19.07	28.2	0.003	2,480	4,328,319	1,746
05-19.08	41.1	0.004	2,339	5,313,965	2,272
05-19.09	49.0	0.002	2,955	3,132,396	1,060
05-19.10	71.5	0.002	2,727	2,097,266	769
05-19.11	43.7	0.001	1,280	4,382,098	3,425
05-19.12	141.0	0.002	2,698	6,404,246	2,373
05-19.13	60.6	0.002	2,729	4,821,434	1,767
05-19.14	94.9	0.004	1,911	1,561,333	817
05-19.15	85.4	0.002	2,130	1,183,229	556
05-19.16	95.4	0.004	1,762	1,289,667	732
05-19.17	46.8	0.001	1,888	1,228,339	651

Hydrologic Unit	Area (ac)	Weighted Slope (ft/ft)	Weighted Length (ft)	Subbasin Area (ft^2)	Flow Width (ft)
05-19.18	93.4	0.006	1,514	1,790,492	1,183
05-19.19	122.7	0.005	2,724	2,134,804	784
05-19.20	91.4	0.004	1,947	3,113,424	1,599
05-19.21	262.0	0.003	5,395	1,902,177	353
05-19.22	49.2	0.001	1,580	6,143,849	3,889
05-19.23	229.5	0.008	2,881	2,641,018	917
05-19.24	142.6	0.003	2,702	4,132,642	1,530
05-19.25	126.2	0.002	2,222	3,720,725	1,674
05-19.26	21.0	0.001	2,699	4,153,992	1,539
05-19.27	103.1	0.001	4,180	2,037,522	487
05-19.28	124.8	0.001	2,628	4,067,542	1,548
05-19.29	205.0	0.001	3,076	5,342,990	1,737
05-19.30	49.2	0.001	1,206	3,982,382	3,301
05-19.30a	11.2	0.001	737	11,411,885	15,493
05-19.31	192.0	0.001	3,367	2,143,559	637
05-19.32	119.1	0.001	2,707	9,998,420	3,693
05-19.33	52.4	0.001	3,580	6,210,519	1,735
05-19.34	134.5	0.001	2,588	5,499,254	2,125
05-19.35	92.0	0.001	2,276	913,888	402
05-19.36	44.6	0.001	1,258	4,491,411	3,571
05-19.37	15.6	0.001	813	5,435,887	6,687
05-19.38	65.4	0.001	2,998	8,930,025	2,979
05-19.39	125.5	0.001	2,895	2,142,282	740
05-19.40	6.4	0.001	713	486,577	682
05-19.41	59.5	0.001	2,897	8,365,001	2,887
05-19.42	17.8	0.001	1,194	5,187,303	4,345

Attachment B
Floodplain Reconnection Volume Curves

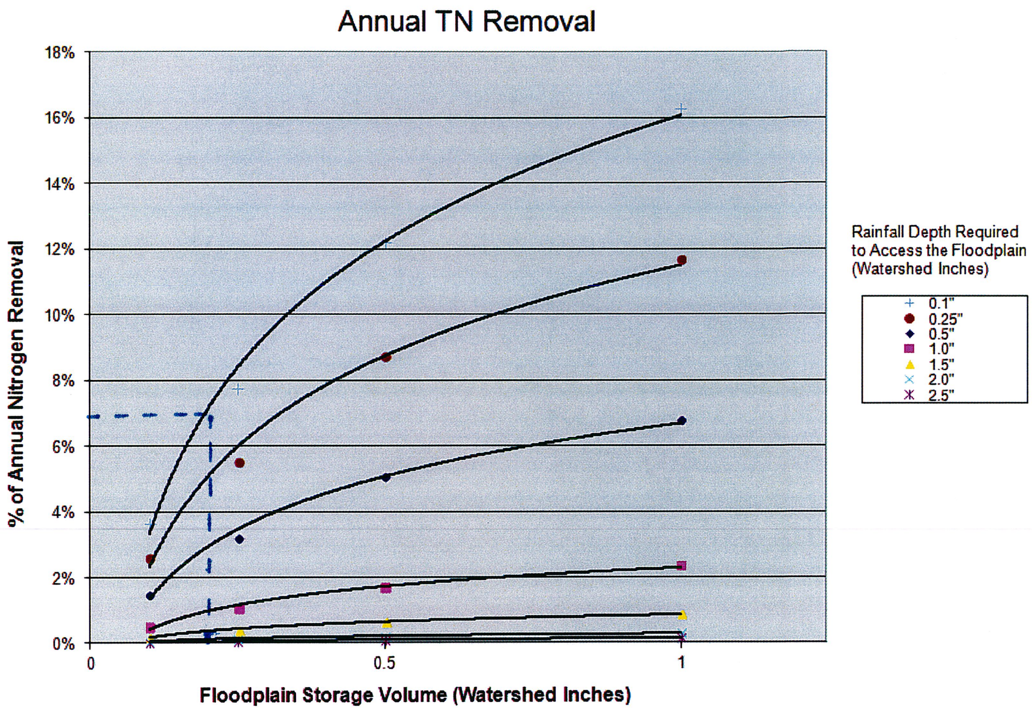


Figure 4. Annual TN removal as a function of floodplain storage volume for several rainfall thresholds that allow runoff to access the floodplain.

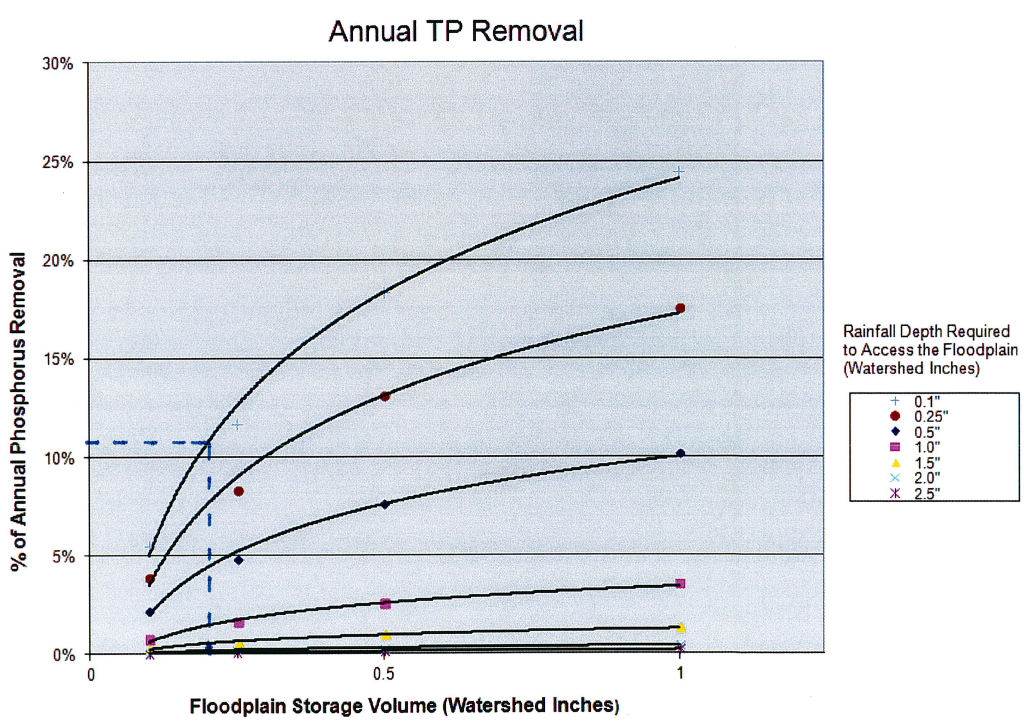


Figure 5. Annual TP removal as a function of floodplain storage volume for several rainfall thresholds that allow runoff to access the floodplain.

Source: *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (Schueler et. al. 2013).

Attachment C

Opinion of Probable Cost

Black Hammock Drainage
Realignment of Drainage Channel
Opinion of Probable Construction Cost, September 2013, Concept Design

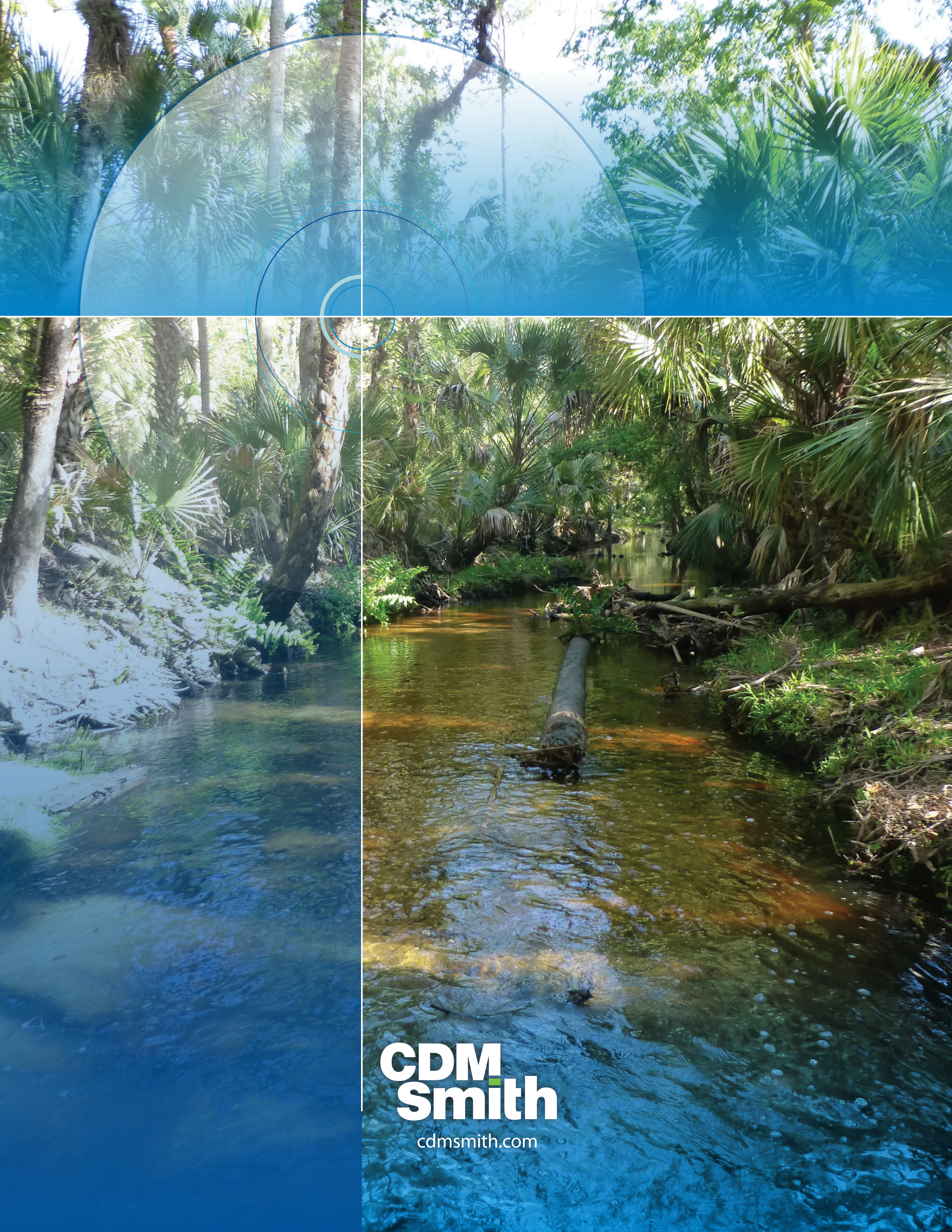
Project name	Black Hammock Drainage Seminole County FL
Client	CDM Smith
Estimator	RWR
Labor rate table	FL 12 Labor Orlando
Equipment rate table	00 13 Equip Rate BOF
Project	Drainage
Major Process	Channel Excavation
OPCC Type	OPCC
Design Level	Concept
Reviewed by	
ENR 20 City CCI	Sept. 2013 - 9551.58
Notes	This is an Opinion of Probable Construction Cost (OPCC) only, as defined by the documents provided at the level of design indicated above. CDM Smith has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM Smith does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Impact Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. Assumptions: No rock excavation is required. Only nominal dewatering is needed. No consideration for contaminated soils or hazardous materials is included (i.e. asbestos, lead, etc). Temporary parking/storage/staging is available within the limits of construction. Based on a normal 40 hour work week with no overtime.
Report format	Sorted by 'Area/95CSI Sctn/Element' 'Detail' summary Allocate addons Combine items

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
05 Mobilization, Demobilization & Staging Area								
02300 Earthwork								
05.02300.3140 Mobilization, Demobilization & Staging Area	1.00 ls					33,310	33,310.29 /ls	33,310
02300 Earthwork						33,310		33,310
05 Mobilization, Demobilization & Staging Area						**33,310**		**33,310**
10 Cut/Fill Meandering Channel Including Clearing & By-Pass Pumping								
02240 By-Pass Pumping								
10.02240.3100 By-Pass Pumping	1.00 ls	14,730	37,958	2,791	9,110	3,517	68,106.04 /ls	68,106
02240 By-Pass Pumping		14,730	37,958	2,791	9,110	3,517		68,106
02300 Earthwork								
10.02300.3100 Clear & Excavate Meandering Channel	780.00 cy	9,430			7,709		21.97 /cy	17,138
02300 Earthwork		9,430			7,709			17,138
10 Cut/Fill Meandering Channel Including Clearing & By-Pass Pumping		**24,159**	**37,958**	**2,791**	**16,819**	**3,517**		**85,244**
20 Rip Rap Bank & Shore								
02300 Earthwork								
20.02300.3105 Rubble Rip Rap Bank & Shore	320.00 cy	10,300	32,378		7,098		155.55 /cy	49,775
02300 Earthwork		10,300	32,378		7,098			49,775
20 Rip Rap Bank & Shore	**207.00 LF**	**10,300**	**32,378**		**7,098**		**240.46 /LF**	**49,775**
25 Culvert Replacement								
02600 Drainage & Containment - Remove & Replace								
25.02600.3101 Florida Ave. - 3' X 5' Precast Box Culvert	70.00 lf	10,740	47,951	1,417	8,121	586	983.07 /lf	68,815
25.02600.3106 Howard Ave. - 3' X 5' Precast Box Culvert	70.00 lf	10,740	47,951	1,417	8,121	586	983.07 /lf	68,815
25.02600.3111 Van Arsdale - 3' X 5' Precast Box Culvert	35.00 lf	8,711	33,561	1,058	6,087	586	1,428.66 /lf	50,003
25.02600.3116 Independence (Main) - 3' X 6' Precast Box Culvert	40.00 lf	8,996	38,940	1,108	6,373	586	1,400.10 /lf	56,004
25.02600.3121 Freedom Trail - 3' X 4' Precast Box Culvert	30.00 lf	8,491	30,264	1,007	5,870	586	1,540.60 /lf	46,218
25.02600.3122 Independence (East) - 3' X 6' Precast Box Culvert	40.00 lf	8,996	38,940	1,108	6,373	586	1,400.10 /lf	56,004
25.02600.3125 Packard - 4' X 8' Precast Box Culvert	60.00 lf	10,655	59,610	1,417	8,034	586	1,338.36 /lf	80,302
25.02600.3126 Packard - NSBB 12-20 Baffle Box by Suntree	1.00 ea	12,961	202,710	457	16,450	1,466	234,044.70 /ea	234,045
25.02600.3130 Haul Removed Pipe To Seminole Co. Landfill	1.00 ls	5,322		3,953	7,916		17,191.43 /ls	17,191
25.02600.3150 Dewatering Road Crossings Inc. Baffle Box	1.00 ls	15,333	55,072	13,955	20,951		105,311.18 /ls	105,311
02600 Drainage & Containment - Remove & Replace		100,944	555,001	26,898	94,296	5,569		782,708
25 Culvert Replacement		**100,944**	**555,001**	**26,898**	**94,296**	**5,569**		**782,708**
30 Roadway Repair								
02700 Roadway Repair at Pipe Crossings								
30.02700.3105 Replace Asphalt & Limerock Road Crossings	1.00 ls	7,010	5,206	1,693	4,551		18,459.76 /ls	18,460
30.02700.3110 Raise 200' of Packard Road 1'	1.00 ls	2,023	10,644	5,097	2,821		20,585.70 /ls	20,586
02700 Roadway Repair at Pipe Crossings		9,033	15,850	6,790	7,372			39,045
30 Roadway Repair		**9,033**	**15,850**	**6,790**	**7,372**			**39,045**
35 Construct Access Roads								
02750 Access Roads								
35.02750.3105 Access Road N. Meander	1.00 ls	21,466	18,063	8,479	9,555		57,561.96 /ls	57,562
35.02750.3110 Access Road N. Central Meander	1.00 ls	5,786	3,423	1,393	3,182		13,783.76 /ls	13,784
35.02750.3115 Access Road S. Central Meander	1.00 ls	13,150	9,693	3,797	5,243		31,883.06 /ls	31,883
35.02750.3120 Access Road S. Meander	1.00 ls	9,977	6,845	2,786	4,782		24,391.17 /ls	24,391
02750 Access Roads		50,379	38,024	16,456	22,761			127,620
35 Construct Access Roads		**50,379**	**38,024**	**16,456**	**22,761**			**127,620**
40 Silt Fence, Turbidity Barriers & Gabion Weirs Channel Area								
02315 Silt Fence & Turbidity Barriers								
40.02315.3105 Silt Fence & Turbidity Barriers	1.00 ls	6,518	5,246			879	12,643.81 /ls	12,644
02315 Silt Fence & Turbidity Barriers		6,518	5,246			879		12,644
02370 Turbidity Barriers								
40.02370.3110 30' X 10' 1' Gabion Mattress	2.00 ea	4,420	4,391		2,797		5,803.60 /ea	11,607
40.02370.3115 30' X 5' 1' Gabion Weir	2.00 ea	1,516	1,098		1,313		1,963.47 /ea	3,927
40.02370.3120 10' X 5' X 2' Gabion Bank Tie In	4.00 ea	2,275	1,275		1,641		1,297.58 /ea	5,190

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
02370 Turbidity Barriers		8,211	6,763		5,750			20,724
40 Silt Fence, Turbidity Barriers & Gabion Weirs Channel Area		**14,729**	**12,010**		**5,750**	**879**		**33,368**
45 Maintenance of Traffic								
01250 Maintenance of Traffic								
45.01250.3100 Maintenance of Traffic	1.00 ls	7,133			55	11,907	19,094.76 /ls	19,095
01250 Maintenance of Traffic		7,133			55	11,907		19,095
45 Maintenance of Traffic		**7,133**			**55**	**11,907**		**19,095**

Estimate Totals

Description	Amount	Totals	Hours	Rate
Direct Costs				
Labor	216,678		4,672 hrs	
Material	691,219			
Subcontract	52,935			
Equipment	154,151		4,696 hrs	
Other	55,183			
Total Cost of Construction:	**1,170,166**	**1,170,166**		
Construction Contingency 30%	351,050			30.00 %
Total		***1,521,216***		


CDM Smith
cdmsmith.com