4.21. Lake Shipp

Background

Physical and chemical characteristics specific to Lake Shipp are presented here in the context of relevant regulatory criteria and requirements (Table 4-42). Lake Shipp (WBID 1521D), a lake in the WHCL Southern Chain, is hydrologically connected to lakes May and Lulu via constructed navigable canals (Photo 4-24, Figure 4-86). In 2005, Lake Shipp was declared verified impaired based on elevated TSI values (>60). A TMDL was adopted for the Southern Chain of the WHCL, including Lake Shipp (FDEP 2007), and Lake Shipp was subsequently delisted from impairment by FDEP in 2010. Based on the modeled external TP load to Lake Shipp, a 65 percent reduction in TP load (145 kg TP/year) is required to comply with the TSI criteria of 60 (FDEP 2007). The TP, TN, and chlorophyll *a* geometric mean for Lake Shipp for the period of 1997 to 2007 and corresponding EPA NNC water quality targets are listed in Table 4-42. To comply with the NNC, concentration reductions of 42 percent for TP, 43 percent for TN, and 67 percent for chlorophyll *a* are required.

A summary of water quality statistics for Lake Shipp is presented in Table 4-43. Lake Shipp historically received point source discharges from two WWTFs (Robert Brothers vegetable and Bordo's citrus processing plant). While the effluent discharges have been eliminated, the discharges resulted in nutrient and sediment accumulation in the lake bottom. An inverse relationship between lake levels and both TP and chlorophyll *a* concentrations may suggest sediment resuspension resulting in a decline in water quality. *Hydrilla* eradication projects are performed regularly treating up to 19 percent of the lake surface area in some years. The median chlorophyll *a*, TN and TP concentrations continue to exceed the NNC targets provided by EPA for Lake Shipp. Chlorophyll *a* concentrations in Lake Shipp are elevated above 20 µg/L consistently (Figure 4-87). A statistically significant trend in chlorophyll *a* concentrations from 1983 to 2007 was observed (seasonal Kendall-Tau, p=0.10). No water quality restoration projects have been implemented in Lake Shipp in order to improve water quality. Improvements in water quality of Lake Shipp, which is adjacent to a terminal lake, could result in little benefit farther downstream.

The Lake Shipp watershed is 534 acres in size and includes 378 acres (71 percent) of developed lands compared to 156 acres (29 percent) of undeveloped land. The 2000-2007 median color value (20 PCU) was below 40 PCU indicating the lake is a clear (non-colored) lake and specific conductivity data indicate the lake is alkaline. The lake area, perimeter, water depth, and volume statistics are based on a water level elevation of 129 feet in June 2007. Bathymetry data are available for Lake Shipp for the June 2007 water level elevation (Figure 4-88). A water level of 130 feet was reported in August 2010, reflecting a 1.0 foot increase in water elevation when compared to 2007. The subsequent changes in overall surface area, water depth, and volume of the lake should be considered during the development and implementation of water quality restoration projects.

Water Quality Restoration Project Selection and Priorities

Based on Lake Shipp water quality and the surrounding watershed characteristics, four potential water quality restoration projects were identified using the WHCL WQMP decision key (Figure

4-89). The decision key presents the factors on which yes/no decisions were based and used to identify and select water quality improvement projects. Projects to address water quality, nutrient and sediment loading, and reduced lake levels are proposed. The projects are listed in order of priority, based on expected water quality improvements. A detailed discussion of the potential water quality restoration implications for each project can be found in Section 3.0.

- Project 1: Stormwater Infiltration Areas (SIAs)
- Project 2: Sediment Removal/Inactivation
- Project 3: SAV Planting/Management or FTWs
- Project 4: EAV Planting/Management

Table 4-42. Physical, chemical, and regulatory characteristics of Lake Shipp.

Physical			
Location in chain	Southern	**High infiltration soils (acres)**	364 (68 percent)
Relation to other lakes	Adjacent to Terminal	**Developed land (acres)**	378 (71 percent)
Watershed area (acres)	534	**Undeveloped land (acres)**	156 (29 percent)
Lake area (acres)*	274	**Median water depth (feet)***	4.5
Perimeter (feet)*	15,064	**Maximum water depth (feet)***	14.5
Surface area: lake volume ratio*	0.18	**Volume (acre-feet)***	1,533
Watershed to surface area ratio*	1.95		
Water Chemistry			
Locally-derived: acidic or alkaline	Alkaline	**Clear or colored**	Clear
Geometric mean chlorophyll *a* (µg/L)	60	**NNC chlorophyll *a* target (µg/L)**	20
Geometric mean TN (mg/L)	1.76	**NNC TN target (mg/L)**	1.00
Geometric mean TP (mg/L)	0.052	**NNC TP target (mg/L)**	0.030
Regulatory Data			
Impaired	Yes	**TMDL status**	Required†
Chlorophyll *a* trend	No trend**	**TP concentration reduction required**	42 percent

*at a water level elevation of 129 feet
**presented in section 5.0
†TMDL adopted

Photo 4-24. Boat docks located on Lake Shipp.

Table 4-43. Lake Shipp water quality summary for 1997 to 2007.

Parameter	N	Minimum	Median	Maximum
Chlorophyll *a* (µg/L)	101	22	46	92
Color (PCU)	27	5	20	25
Conductivity (µmhos/cm)	32	191	227	365
Dissolved oxygen (mg/L)	32	5.85	8.59	10.27
pH	32	6.8	7.79	8.71
Secchi depth (feet)	102	0.8	1.4	3.2
Total nitrogen (mg/L)	103	0.09	1.41	2.58
Total phosphorus (mg/L)	98	0.01	0.058	0.139

Figure 4-86. Lake Shipp and associated watershed.

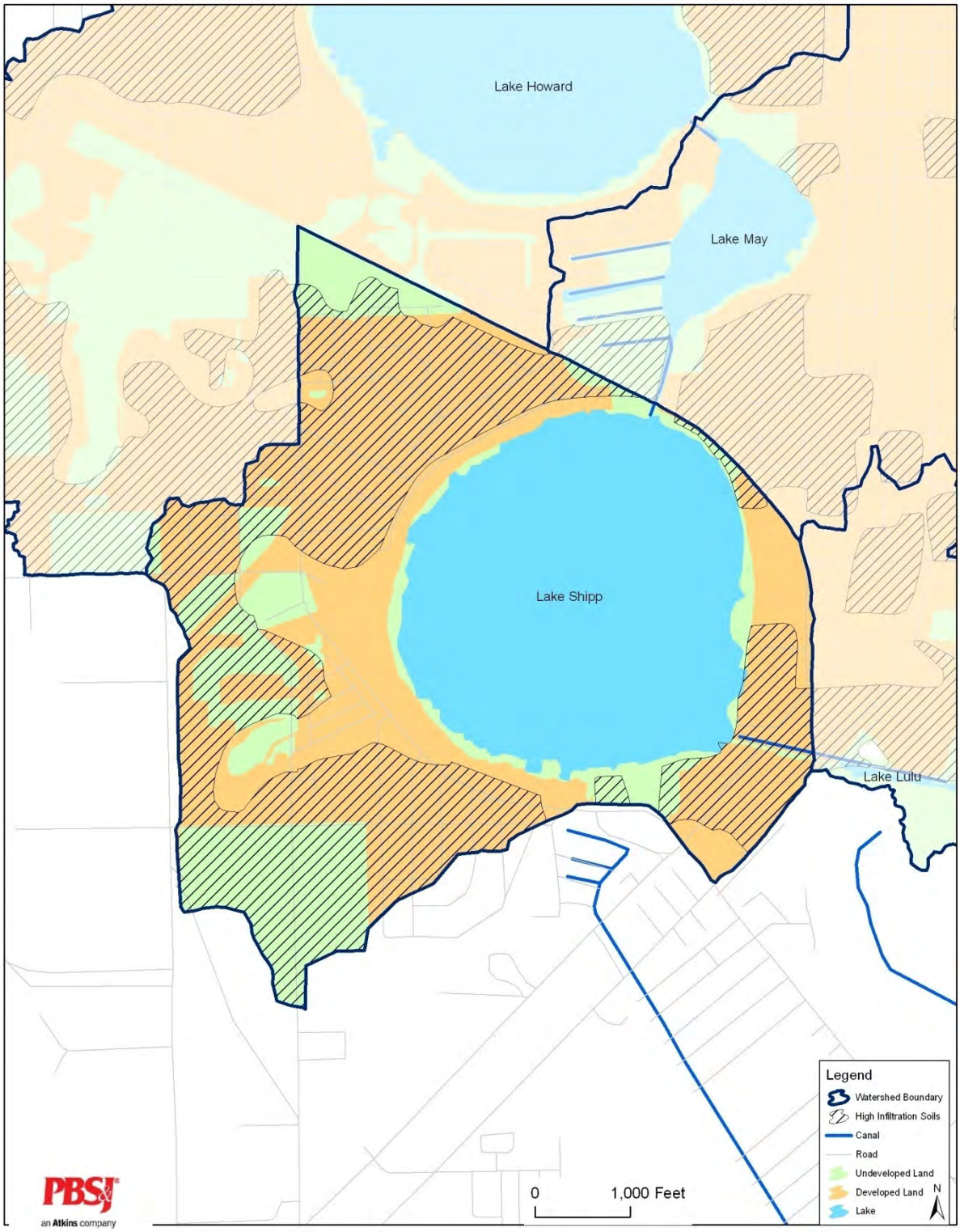


Figure 4-87. Lake Shipp chlorophyll *a* concentrations and *Hydrilla* treatment history using available data from 1983 to 2007.

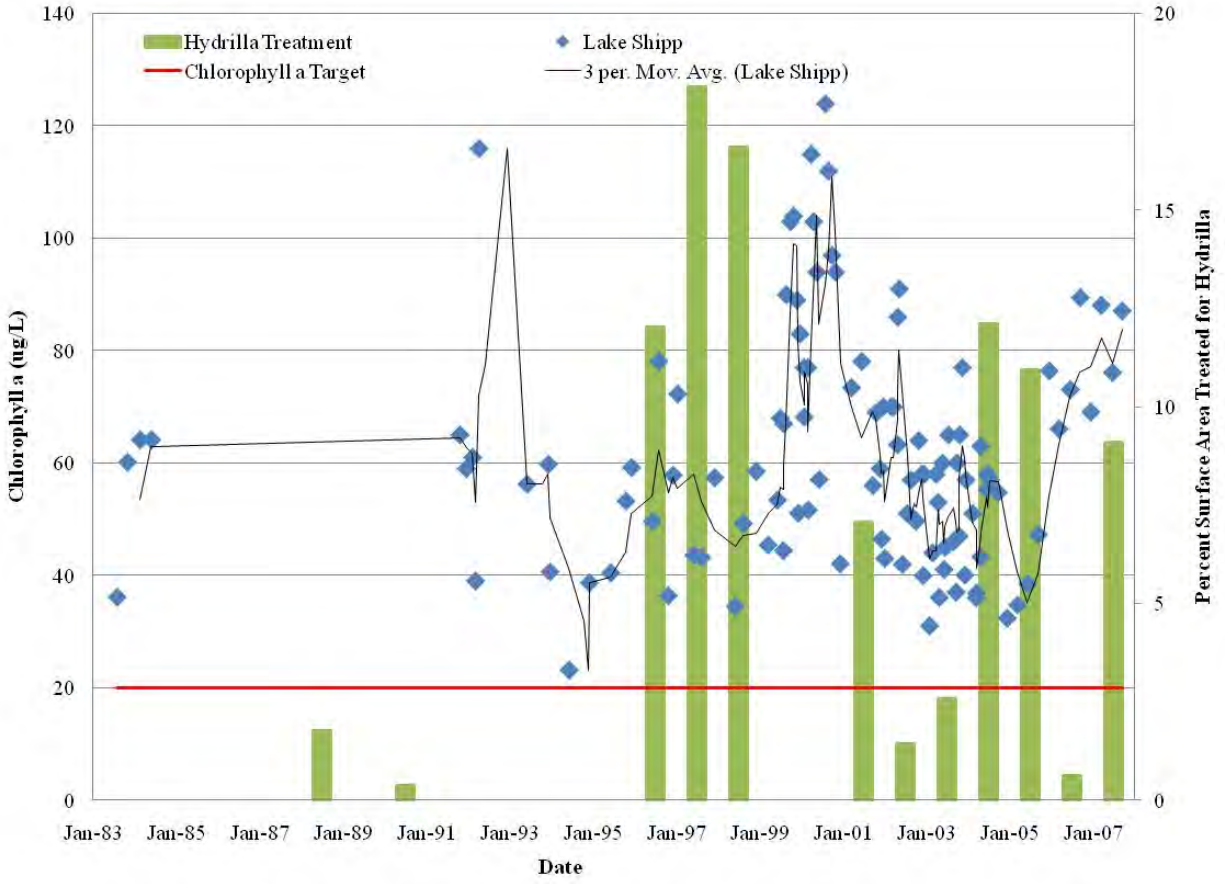
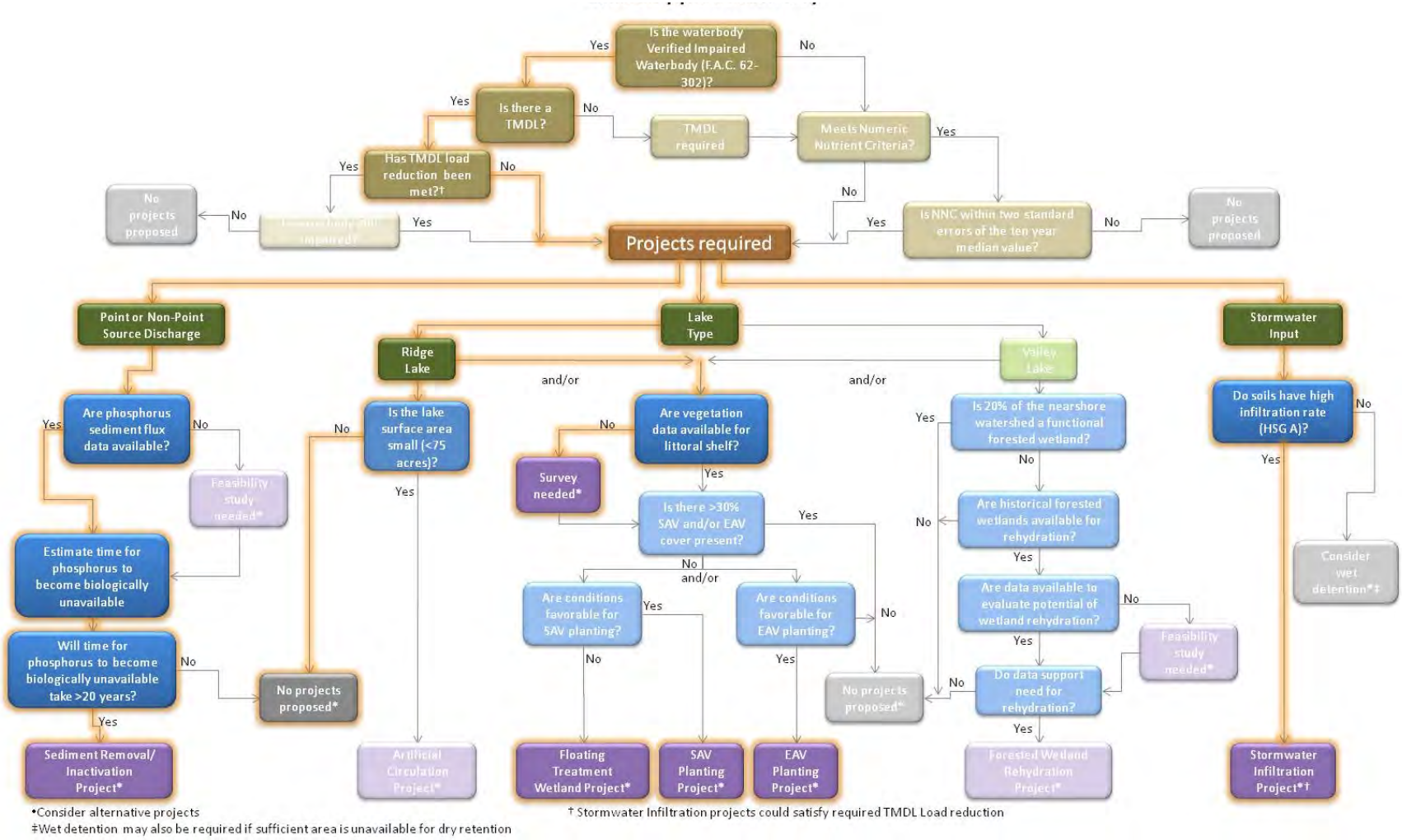


Figure 4-88. Lake Shipp bathymetry (June 2007) at water level elevation = 129 feet (Polk County Water Atlas).

Figure 4-89. Lake Shipp decision key: highlighted path shows decision process.



Project 1: Stormwater Infiltration Areas (SIAs)

The Lake Shipp watershed has approximately 364 acres (68 percent of the watershed) classified as high infiltration soils. A TMDL has been established for Lake Shipp, and as such, the SIA design should be focused on satisfying the TMDL requirements. SIA projects would need to encompass approximately 11 percent (60 acres) of the watershed in order to accomplish an annual 145 kg reduction in TP loads to Lake Shipp. Acres of SIA estimated to meet the TP NNC was 47 (nine percent of the watershed) for a 42 percent phosphorus reduction in Lake Shipp to meet its NNC. Sixty-eight percent of the watershed is characterized by high infiltration soils; therefore, it may be feasible to satisfy the TMDL load reduction through SIA implementation.

Project 2: Sediment Removal/Inactivation

Historical point source discharges to Lake Shipp from WWTFs require further evaluation of the potential internal phosphorus load from the lake bottom sediments. The City of Winter Haven funded a Sediment Removal Feasibility Study performed by ERD to evaluate the sediment characteristics, phosphorus flux, and volume (ERD 2010). An estimate of the length of time until the pool of available phosphorus within the bottom sediments returns to background conditions was calculated using TP concentration in the sediments, the percent of available phosphorus and bulk density. Approximately 76 years are required for phosphorus concentrations to return to background conditions. Therefore, sediment removal/inactivation is recommended to address internal phosphorus loads. A cost estimate for sediment removal/inactivation has been completed by ERD (2010).

Sediment Removal: Costs associated with hydraulic dredging can be highly variable depending upon a variety of factors such as dredge capacity, availability of disposal areas, and distance to disposal areas, sludge dewatering requirements, booster pump requirements, and final sediment disposal. Since none of these factors have been fully evaluated at this time, a general sediment dredging cost of approximately $10.00 per cubic yard is assumed for this analysis. This value assumes that a shoreline dewatering facility would be used. A summary of estimated costs for hydraulic dredging in Lake Shipp based on the previously determined organic sediment volumes, estimated dredging costs is $4,872,300. An estimated 302 ac-ft (487,227 cubic yards) of organic material would be removed.

Sediment Inactivation: A summary of estimated application costs for sediment inactivation in Lake Shipp is given based on an application of 10:1 Al:P ratio. This estimate assumes an alum volume of 1,000,489 gallons and a sodium aluminate volume of 250,122 gallons would be applied over two applications within a 6-12 month time period. It is assumed that the alum and sodium aluminate are purchased at a government contract price. Planning and mobilization costs are estimated to be approximately $5000 per application, which includes initial planning, mobilization of equipment to the site, demobilization at the completion of the application process, and clean-up. A labor rate of $125/hour is assumed that includes labor costs, water quality monitoring, expenses, equipment rental, insurance, mileage, and application equipment fees. The estimated cost for sediment inactivation in Lake Shipp is $1,939,766 or approximately $969,903 per application.

A representative from Phoslock® has been contacted to provide a cost estimate for Phoslock® application to Lake Shipp to provide a cost comparison.

Project 3: SAV Planting or FTWs

SAV Planting

In Lake Shipp, *Hydrilla* eradication has been completed over as much as 49 percent of the lake surface area attributing to the continued degradation in water quality. A survey of existing SAV cover in Lake Shipp is recommended due to the lack of sufficient data to calculate percent lake cover. Based on the results of the SAV survey, conclusions regarding SAV planting can be determined. If SAV cover is less than 30 percent, lake conditions should be evaluated to assess if additional SAV is viable based on the soil condition, water clarity and water depth. *Hydrilla* harvesting may be required for successful establishment of selected SAV plants.

SAV plants should not be planted in water depths greater than 2 feet based on the median secchi depth values (1.4 feet). The maximum planting effort could result in vegetation cover of approximately 12 percent of the lake bottom (34 acres). Due to the extensive organic material located in Lake Shipp, it is recommended that SAV planting be performed after sediment removal/inactivation, if completed. If sediment removal is completed, the planting area would need to be recalculated using updated bathymetry data.

Cost Estimate: $170,000 (estimate based on previous purchase and installation cost of $0.90 per plant provided by EarthBalance®, additional funds included for maintenance)

FTWs

If the feasibility study indicates that more than 30 percent of Lake Shipp has SAV cover, FTW may be considered. The installation of floating mats with appropriate aquatic vegetation would be expected to assimilate nutrients from the water column.

Project 4: EAV Planting

A survey of existing shoreline vegetation surrounding Lake Shipp is recommended due to the lack of sufficient data at this time. Based on the results of the shoreline survey, conclusions and recommendations regarding emergent aquatic or woody vegetation planting can be determined. If limited shoreline vegetation is present, shoreline conditions should be evaluated to assess if vegetation planting is viable based on the soil conditions, slope, water level and inundation frequency and wave disturbance.