

AS-BUILT SURVEY

EAST CALOOSAHATCHEE RIVER

FLOATING AQUATIC VEGETATIVE TILLING PROJECT

19, TOWNSHIP 44 SOUTH, R

HENDRY COUNTY, FLORIDA

ABBREVIATIONS:

AC. = ACRE
A.C. = AIR CONDITIONER
A.K.A. = ALSO KNOWN AS
ALUM. = ALUMINUM
APPR. = APPROXIMATE
AVE. = AVENUE
BLDG. = BUILDING
BLVD. = BOULEVARD
BM = BENCHMARK
BOC = BACK OF CURB
BOW = BACK OF WALK
BSM = BUREAU OF SURVEYING AND MAPPING
(C) = CALCULATED
C&A = COONER & ASSOCIATES, INC.
CATV = CABLE TELEVISION
CB = CATCH BASIN
CBS = CONCRETE BLOCK STRUCTURE
C.C.R. = CERTIFIED CORNER RECORD
CDB = CHORD BEARING
CH = CHORD
CL = CENTERLINE
CLF = CHAIN LINK FENCE
CM = CONCRETE MONUMENT
CMP = CORRUGATED METAL PIPE
C.Q. = CLEANOUT
CONC. = CONCRETE
CONT. = CONTROL
COR. = CORNER
CORP. = CORPORATION
C.P. = CONTROL POINT
C.R. = COUNTY ROAD
CT. = COURT
C.U.E. = COUNTY UTILITY EASEMENT
(D) = DEED
D.E. = DRAINAGE EASEMENT
(DESC.) = DESCRIPTION
DH = DRILL HOLE
DIA. = DIAMETER
DR. = DRIVE
DWG. = DRAWING
EL. = ELEVATION
ELEC. = ELECTRIC
EOP = EDGE OF PAVEMENT
EOW = EDGE OF WATER
ESMT. = EASEMENT
EXIST. = EXISTING
(F) = FIELD
FDEP = FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
FDOT = FLORIDA DEPARTMENT OF TRANSPORTATION
FEMA = FLORIDA EMERGENCY MANAGEMENT AGENCY
F.F. = FINISHED FLOOR
FND = FOUND
OR FP&L = FLORIDA POWER & LIGHT
F.S. = FLORIDA STATUTES
FT. = FOOT / FEET
GLO = GENERAL LAND OFFICE
GPS = GLOBAL POSITIONING SYSTEM
GRND = GROUND
I.D. = IDENTIFICATION
I.D.D. = IONA DRAINAGE DISTRICT
I.N. = INSTRUMENT NUMBER
INC. = INCORPORATED
INV. = INVERT
I.P. = IRON PIPE
IR = IRON ROD (5/8" DIA. U.O.N.)
OR IR&C = IRON ROD & CAP
IRR. = IRRIGATION
L = LENGTH
LABINS = LAND BOUNDARY INFORMATION SYSTEM (STATE OF FLORIDA)
LAT = LATITUDE
LB = LICENSED BUSINESS
LN. = LANE
LONG = LONGITUDE
LS = LICENSED SURVEYOR
LT = LEFT
(M) = MEASURED
ME = MITERED END
MH = MANHOLE
MHWL = MEAN HIGH WATER LINE
MISC. = MISCELLANEOUS
MON = MONUMENT
NAD = NORTH AMERICAN DATUM
NAVD = NORTH AMERICAN VERTICAL DATUM
NGS = NATIONAL GEODETIC SURVEY
NGVD = NATIONAL GEODETIC VERTICAL DATUM (1929)
No. = NUMBER
N.T.S. = NOT TO SCALE
N.T.T. = NAIL & TIN TAB
OIH = OVERHANG
O.H.W.L. = ORDINARY HIGH WATER LINE
O.H.W.M. = ORDINARY HIGH WATER MARK
O.R. = OFFICIAL RECORD BOOK / PAGE
(P) = PLAT
PB = PLAT BOOK
P.C. = POINT OF CURVATURE
PCP = PERMANENT CONTROL POINT
PG (S) = PAGE(S)
P.I. = POINT OF INTERSECTION
PKN&D = PARKER-KALON NAIL & DISK
PKWY. = PARKWAY
PL = PROPERTY LINE
PLS = PROFESSIONAL LAND SURVEYOR
P.O.B. = POINT OF BEGINNING
P.O.C. = POINT OF COMMENCEMENT
P.O.T. = POINT OF TERMINUS
PP = POWER POLE
P.R.M. = PERMANENT REFERENCE MONUMENT
PROP. = PROPERTY
PSM = PROFESSIONAL SURVEYOR AND MAPPER
PT. = POINT
P.T. = POINT OF TANGENCY
P.U.E. = PUBLIC UTILITY EASEMENT
PVC = POLY VINYL CHLORIDE
R = RADIUS OR RIGHT
(R) = RECORD
RCP = REINFORCED CONCRETE PIPE
RGE = RANGE
RLS = REGISTERED LAND SURVEYOR
R.R. = RAILROAD
RT = RIGHT
RTA = RIGHT ANGLE
RW = RIGHT-OF-WAY
SEC. = SECTION
S.F. = SQUARE FEET
SFWMD = SOUTH FLORIDA WATER MANAGEMENT DISTRICT
SH. = SHEET
S.R. = STATE ROAD
S.S. = SANITARY SEWER
STA. = STATION
ST. = STREET
SWFWMD = SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
T = TANGENT
TEL = TELEPHONE
TIIF = TRUSTEES OF THE INTERNAL IMPROVEMENT
THE STATE OF FLORIDA
TIITF = BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT
TRUST FUND OF THE STATE OF FLORIDA
TOB = TOP OF BANK
TOS = TOE OF SLOPE
TRANS. = TRANSITION
TWP = TOWNSHIP
TYP = TYPICAL
U.E. = UTILITY EASEMENT
U.O.N. = UNLESS OTHERWISE NOTED
USGS = UNITED STATES GEOLOGICAL SURVEY
w/ = WITH
Y.D. = YARD DRAIN
Δ = DELTA ANGLE
± = MORE OR LESS
= NUMBER
** = STAMPING OF CAP OR DISK

WATER & SOIL SOLUTIONS, LLC

FOR:

REVISION	DATE

DWG DATE:	8-5-14
SURVEY DATE:	7-15-14
DRAWN BY:	R.J.O.
CHECKED BY:	S.U.

COUNTY:	HENDRY
SEC.:	SEC. 18 & 19 - 44 - 32
PROJECT NO.:	140705
DRAWING NO.:	140705-ASB NGVD 29

AS-BUILT SURVEY
EAST CALOOSAHATCHEE RIVER
FLOATING AQUATIC VEGETATIVE TILLING PROJECT
HENDRY COUNTY, FLORIDA

1 OF 8

NOTES

1. THE CERTIFICATE OF AUTHORIZATION NUMBER OF COONER & ASSOCIATES, INC. IS LB-0006773.
2. NO ABSTRACT OF TITLE OR TITLE INSURANCE COMMITMENT WAS REVIEWED AS PART OF THIS SURVEY.
3. THIS SURVEY IS SUBJECT TO ANY FACTS THAT MAY BE DISCLOSED BY A FULL AND ACCURATE TITLE SEARCH.
4. IMPROVEMENTS ON OR ADJACENT TO THE SUBJECT PARCEL HAVE NOT BEEN LOCATED EXCEPT AS SHOWN. NO SUB-SURFACE FOUNDATIONS HAVE BEEN LOCATED AS PART OF THIS SURVEY.
5. THERE ARE NO VISIBLE ENCROACHMENTS OTHER THAN ANY SHOWN.
6. THIS SURVEY DOES NOT MAKE ANY REPRESENTATIONS AS TO ZONING OR DEVELOPMENT RESTRICTIONS ON THE SUBJECT PARCEL.
7. THIS SURVEY DOES NOT REFLECT CHEMICAL CHARACTERISTICS OF THE SURVEYED PARCEL.
8. ALL NOTED RECORDING REFERENCES ARE FROM THE PUBLIC RECORDS OF HENDRY COUNTY.
9. LOCATIONS SHOWN ON THIS SURVEY MAP ARE STATE PLANE COORDINATE FOR THE FLORIDA EAST ZONE, NAD '83/90 ADJUSTMENT BASED ON TIES TO THE NGS HIGH PRECISION CONTROL POINTS "K 530" AND "H 530".
10. THE ON-SITE HORIZONTAL CONTROL AND TIES TO CONTROL MONUMENTS SHOWN WERE ESTABLISHED BY RTK (REAL TIME KINEMATIC) GPS METHODS USING A TRIMBLE MODEL 5800 UNIT (DUAL FREQUENCY).
11. ALL DISTANCES ARE IN FEET AND DECIMALS THEREOF UNLESS OTHERWISE NOTED.
12. COORDINATES, ELEVATIONS AND DISTANCES SHOWN ARE MEASURED OR CALCULATED FROM FIELD TIES UNLESS OTHERWISE NOTED.
13. DATE OF LAST FIELD WORK: 7-29-14; FIELD BOOK 389, PAGES 12-39.
14. THIS SURVEY OR THE COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND THE ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER. OTHERWISE THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY.
15. ADDITIONS OR DELETIONS TO SURVEY MAPS OR REPORTS BY OTHER THAN THE SIGNING PARTY OR PARTIES IS PROHIBITED WITHOUT THE WRITTEN CONSENT OF THE SIGNING PARTY OR PARTIES.
16. NO ENVIRONMENTAL AUDIT OR JURISDICTIONAL DELINEATION WAS MADE AS PART OF THIS SURVEY.
17. ANY ADJOINING DEED CITES ARE FOR "INFORMATIONAL PURPOSES ONLY"; NO SURVEY WAS MADE OF ADJOINING LANDS.
18. ELEVATIONS SHOWN HEREON ARE IN THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29) AND ARE BASED ON TIES TO NGS MONUMENTS "K 530" AND "H 530". LEVELING INFORMATION WAS COLLECTED IN NAVD 88 AND CONVERTED TO NGVD 29 USING CORPSCON CONVERSION PROGRAM.
19. THIS MAP IS INTENDED TO BE DISPLAYED AT A SCALE OF 1" = 1500' OR SMALLER.
20. BACKGROUND AERIAL IMAGE OBTAINED FROM LAND BOUNDARY INFORMATION SYSTEM (STATE OF FLORIDA) DATED 2011. RELATIVE POSITIONAL ACCURACY OF AERIAL IMAGERY NOT FIELD VERIFIED. IMAGE IS FOR INFORMATIONAL PURPOSES ONLY.
21. GREYED OUT CONSTRUCTION PLAN IMAGE SHOWN ON SHEETS 4 THROUGH 8 OF 8 WAS PROVIDED BY FEDERICO, LAMB & ASSOCIATES, INC.

LEGEND:

Symbol	Description	Symbol	Description	Symbol	Description	Symbol	Description
	AIR RELEASE VALVE		FLAG POLE		SPRINKLER		FOUND CONCRETE MONUMENT
	BACKFLOW PREVENTER		FORCE MAIN		STEEL POST		FOUND DRILL HOLE
	BENCH MARK		FORCE MAIN AIR RELEASE VALVE		TELEPHONE BOX OR VAULT		FOUND IRON ROD
	BOLLARD		GAS PIPELINE MARKER		TELEPHONE CANISTER		FOUND IRON ROD & CAP
	CABLE RISER		GUARD RAIL		TELEPHONE FLAG		FOUND NAIL
	CABLE TV BOX		GUY POLE		TELEPHONE MANHOLE		FOUND NAIL & DISK
	CATCH BASIN		GUY WIRE		TELEPHONE RISER		FOUND PARKER KALON NAIL
	CENTERLINE		HOSE BIB		TOE OF SLOPE		FOUND PARKER KALON NAIL & DISK
	CLEANOUT		IRRIGATION BOX		TOP OF BANK		SET CONCRETE MONUMENT
	COORDINATE NUMBER		IRRIGATION VALVE		TRAFFIC SIGNAL BOX		SET DRILL HOLE
	CONCRETE POWER POLE		LIGHT POLE		TRAFFIC SIGNAL POLE		SET 5/8" IRON ROD & CAP "LB 6773"
	DRAINAGE MANHOLE		MAIL BOX		UNDERGROUND UTILITIES		SET 5/8" PARKER KALON NAIL & DIS PT. LB 6773" U.O.N.
	ELECTRICAL BOX		MITERED END		WATER MAIN		
	ELECTRIC METER		WELL		WATER LINE FLAG		
	ELECTRIC LINE		OVERHEAD POWER LINE		WATER METER		
	ELECTRIC FLAG		OVERHEAD TELEPHONE LINE		WATER VALVE		
	EXISTING ELEVATION		POWER POLE		WOOD SUPPORT POLE		
	FENCE - BARBED WIRE		POWER POLE w/RISER		YARD DRAIN		
	FENCE - CHAIN LINK		RECLAIM WATER LINE FLAG		CROSS WALK SIGNAL POLE		
	FENCE - WOOD		SEWER LINE FLAG		CROSS WALK BUTTON POLE		
	FIBER OPTIC MARKER / POST		SANITARY SEWER LINE		BUSH		
	FIBER OPTIC BOX		SEWER MANHOLE		CABBAGE PALM		
	FIRE HYDRANT		SEWER VALVE		OAK TREE		
	FIRE VALVE		SECURITY SENSOR		PALM TREE		
			SIGN SINGLE POST		PINE TREE		
			SIGN DOUBLE POST		SHADE TREE (VARIOUS TYPE)		

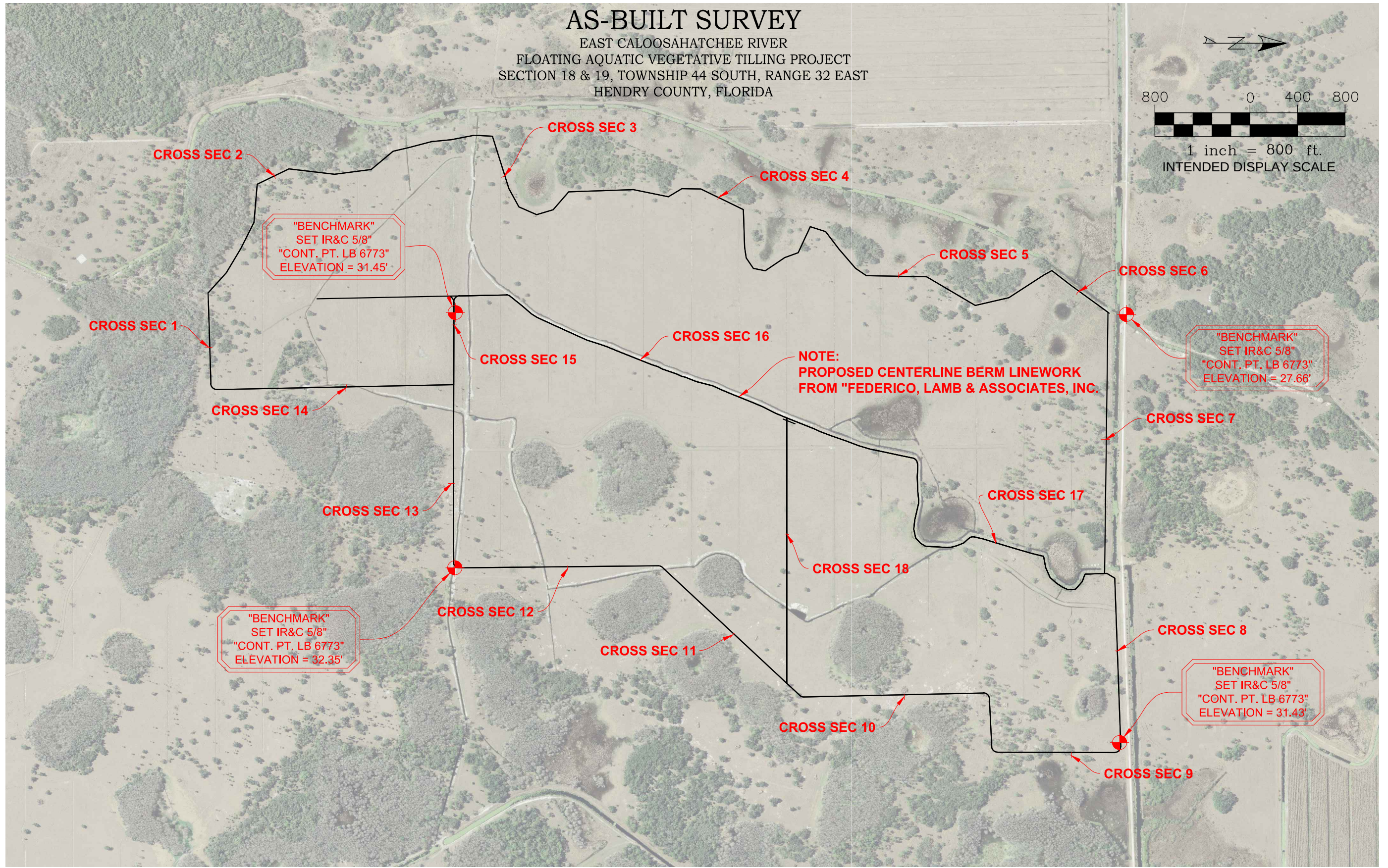
SCOTT R. URQUHART
PROFESSIONAL SURVEYOR AND MAPPER
FLORIDA CERTIFICATE NO. 6524
(FOR THE FIRM - LB 6773)
SIGNED THIS ____ DAY OF _____, 2014

COONER & ASSOCIATES, INC.

FOCAL GEOMATICS

5670 Zip Drive
Fort Myers, FL 33901
Tel: 239.277.0722
Fax: 239.277.7179

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GOONER & ASSOCIATES, INC.
FOCAL
GEOMATICS

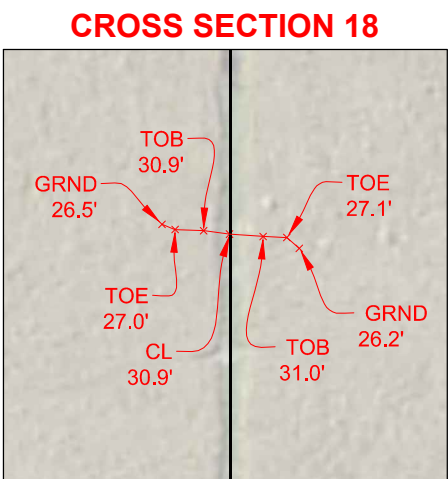
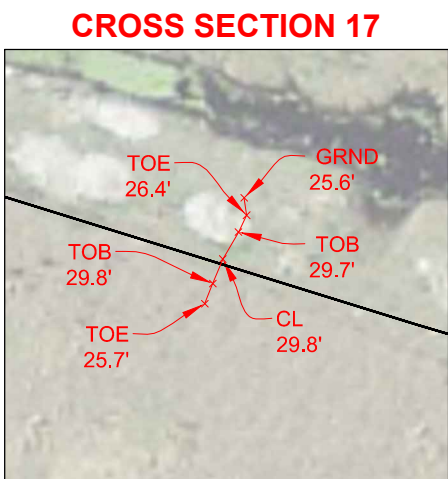
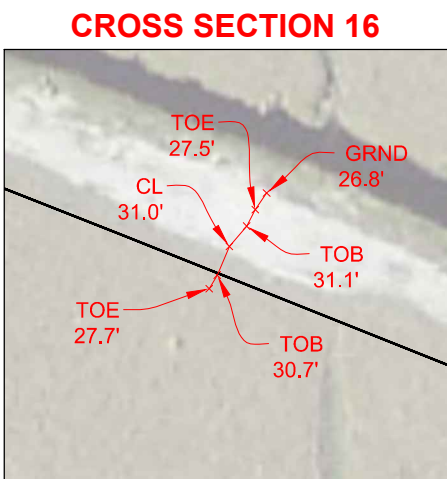
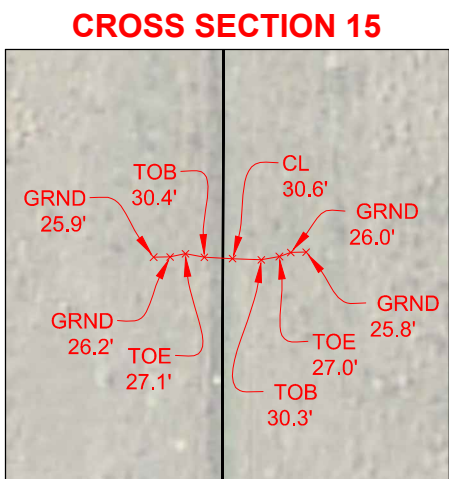
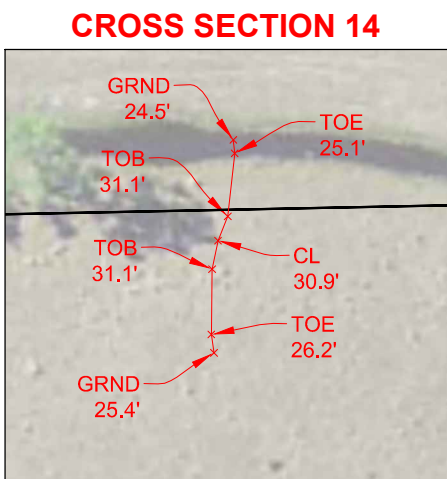
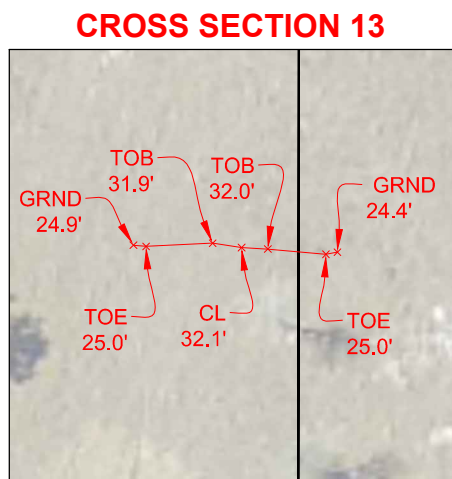
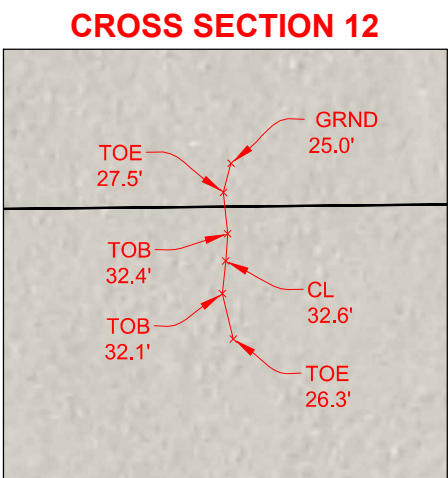
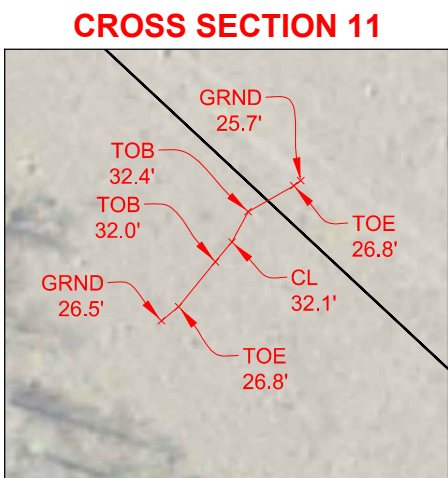
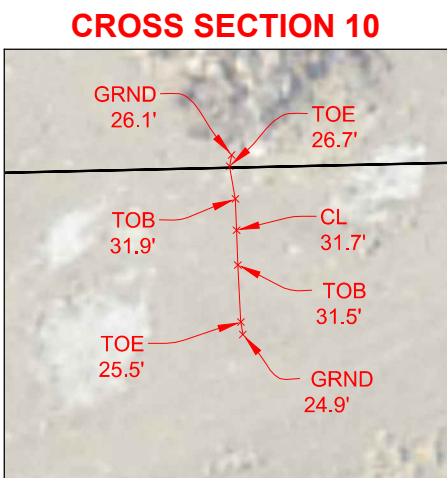
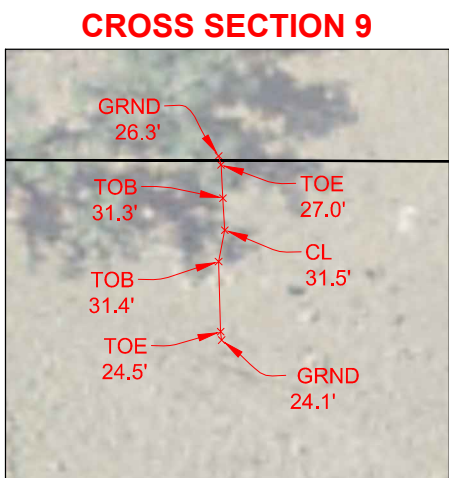
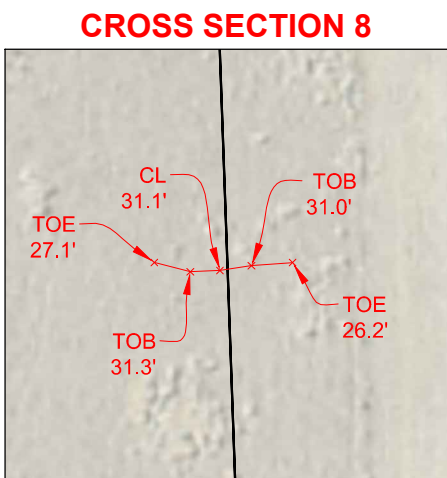
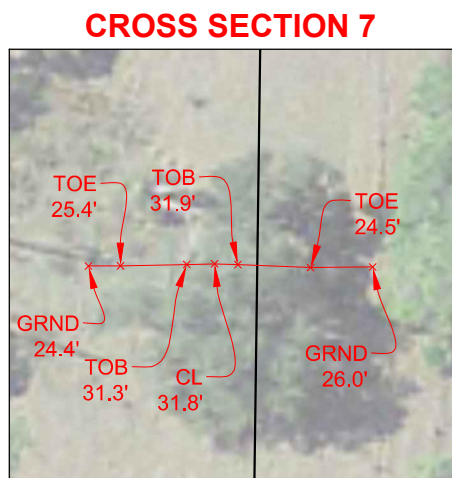
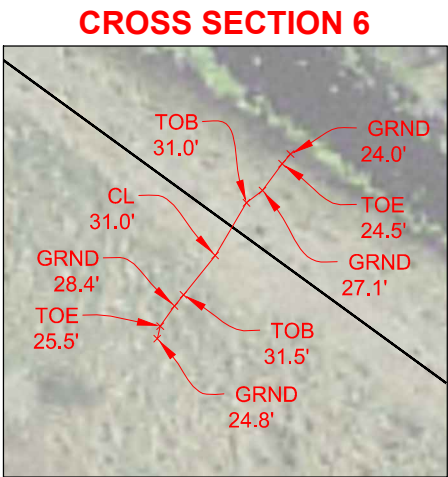
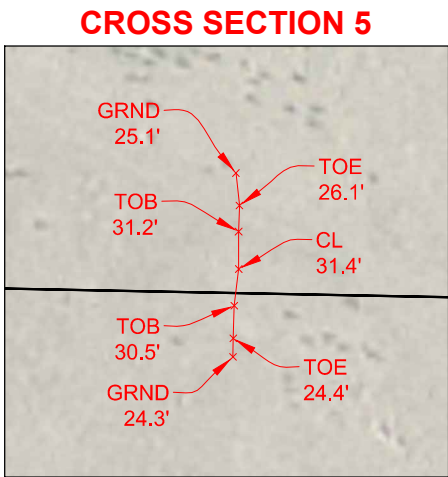
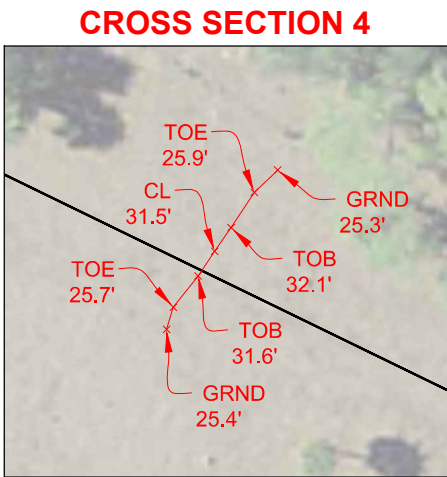
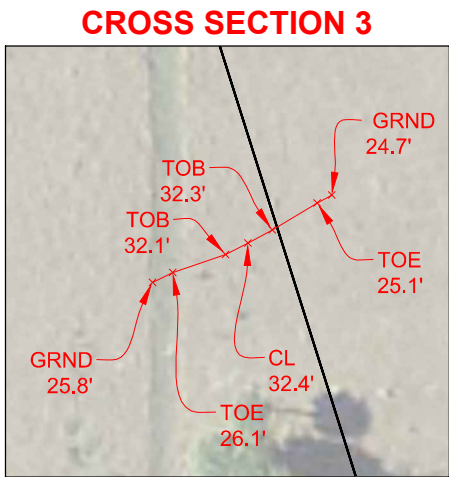
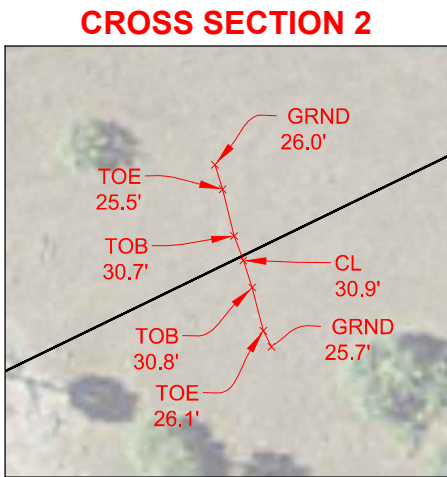
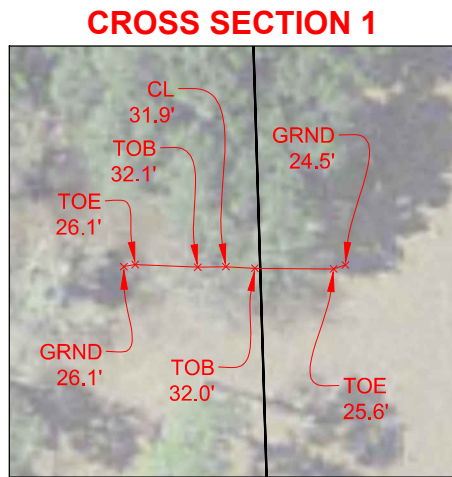
5670 Zip Drive
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AS-BUILT SURVEY
EAST CALOOSAHATCHEE RIVER
FLOATING AQUATIC VEGETATIVE TILLING PROJECT
HENDRY COUNTY, FLORIDA

COUNTY:	HENDRY	DWG DATE:	8-5-14	FOR:	DATE
SEC:	SEC. 18 & 19 - 44 - 32	SURVEY DATE:	7-15-14		
PROJECT NO.:	140705	DRAWN BY:	R.J.O.		
DRAWING NO.:	140705-ASB NGVD 29	CHECKED BY:	S.U.		

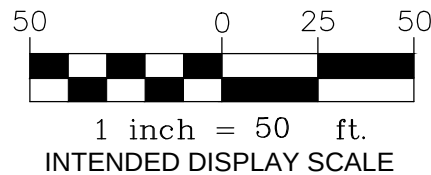
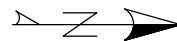
WATER & SOIL SOLUTIONS, LLC

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AS-BUILT SURVEY

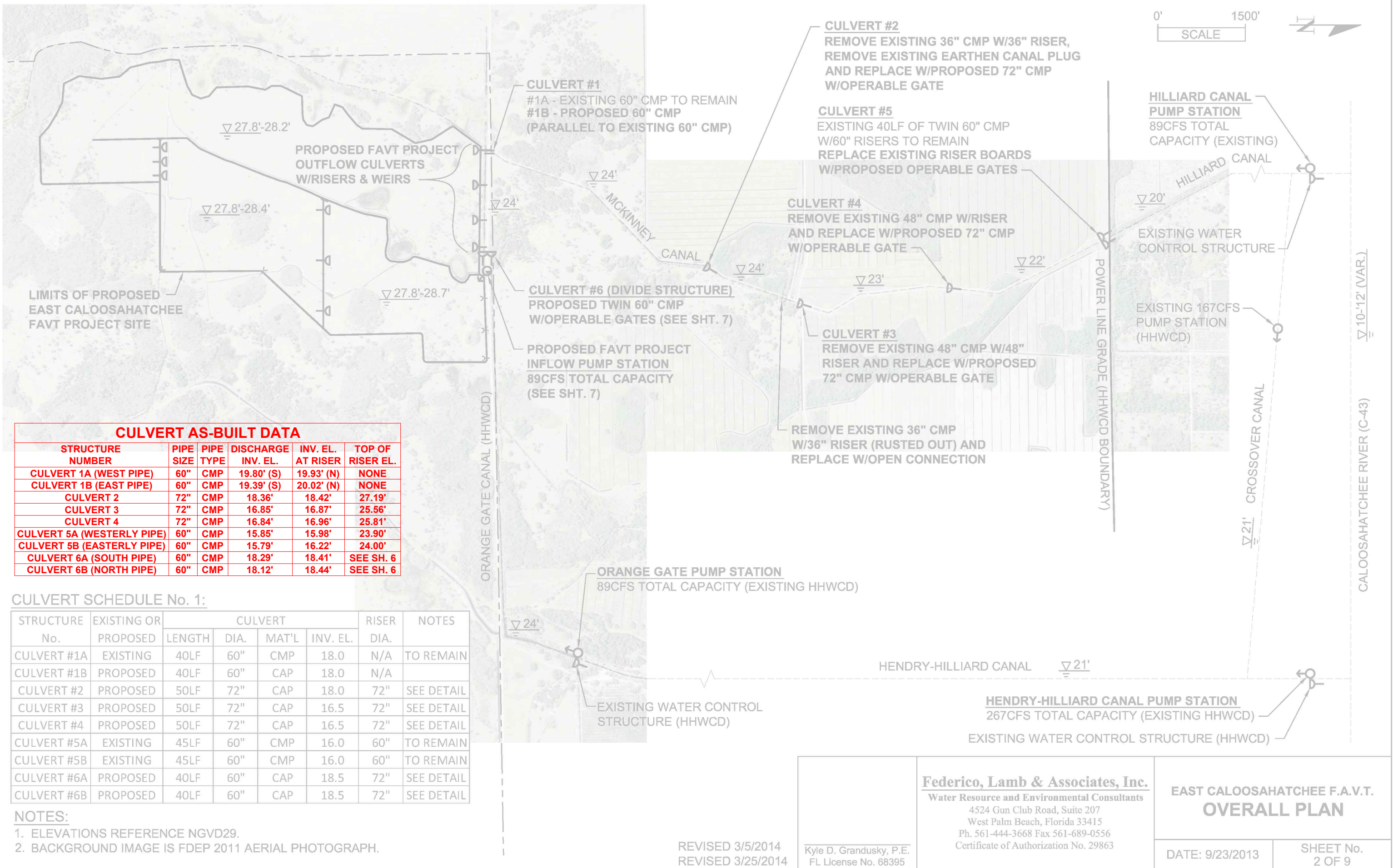
EAST CALOOSAHATCHEE RIVER
FLOATING AQUATIC VEGETATIVE TILLING PROJECT
SECTION 18 & 19, TOWNSHIP 44 SOUTH, RANGE 32 EAST
HENDRY COUNTY, FLORIDA



GOONER & ASSOCIATES, INC.
FOCAL
GEOMATICS

5670 Zip Drive
Fort Myers, FL 33905
Tel: 239.277.0722
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FOR: WATER & SOIL SOLUTIONS, LLC					
COUNTY:	HENDRY	DWG DATE:	8-5-14	DATE:	
SEC.:	SEC. 18 & 19 - 44 - 32	SURVEY DATE:	7-15-14	REVISION:	
PROJECT NO.:	140705	DRAWN BY:	R.J.O.		
DRAWING NO.:	140705-ASB NGVD 29	CHECKED BY:	S.U.		
AS-BUILT SURVEY EAST CALOOSAHATCHEE RIVER FLOATING AQUATIC VEGETATIVE TILLING PROJECT HENDRY COUNTY, FLORIDA					
					3 OF 8



CULVERT AS-BUILT DATA

STRUCTURE NUMBER	PIPE SIZE	PIPE TYPE	DISCHARGE INV. EL.	INV. EL. AT RISER	TOP OF RISER EL.
CULVERT 1A (WEST PIPE)	60"	CMP	19.80' (S)	19.93' (N)	NONE
CULVERT 1B (EAST PIPE)	60"	CMP	19.39' (S)	20.02' (N)	NONE
CULVERT 2	72"	CMP	18.36'	18.42'	27.19'
CULVERT 3	72"	CMP	16.85'	16.87'	25.56'
CULVERT 4	72"	CMP	16.84'	16.96'	25.81'
CULVERT 5A (WESTERLY PIPE)	60"	CMP	15.85'	15.98'	23.90'
CULVERT 5B (EASTERLY PIPE)	60"	CMP	15.79'	16.22'	24.00'
CULVERT 6A (SOUTH PIPE)	60"	CMP	18.29'	18.41'	SEE SH. 6
CULVERT 6B (NORTH PIPE)	60"	CMP	18.12'	18.44'	SEE SH. 6

CULVERT SCHEDULE No. 1:

STRUCTURE No.	EXISTING OR PROPOSED	CULVERT				RISER DIA.	NOTES
		LENGTH	DIA.	MAT'L	INV. EL.		
CULVERT #1A	EXISTING	40LF	60"	CMP	18.0	N/A	TO REMAIN
CULVERT #1B	PROPOSED	40LF	60"	CAP	18.0	N/A	
CULVERT #2	PROPOSED	50LF	72"	CAP	18.0	72"	SEE DETAIL
CULVERT #3	PROPOSED	50LF	72"	CAP	16.5	72"	SEE DETAIL
CULVERT #4	PROPOSED	50LF	72"	CAP	16.5	72"	SEE DETAIL
CULVERT #5A	EXISTING	45LF	60"	CMP	16.0	60"	TO REMAIN
CULVERT #5B	EXISTING	45LF	60"	CMP	16.0	60"	TO REMAIN
CULVERT #6A	PROPOSED	40LF	60"	CAP	18.5	72"	SEE DETAIL
CULVERT #6B	PROPOSED	40LF	60"	CAP	18.5	72"	SEE DETAIL

NOTES:

1. ELEVATIONS REFERENCE NGVD29.
2. BACKGROUND IMAGE IS FDEP 2011 AERIAL PHOTOGRAPH.

REVISED 3/5/2014
REVISED 3/25/2014

Kyle D. Grandusky, P.E.
FL License No. 68395

Federico, Lamb & Associates, Inc.
Water Resource and Environmental Consultants
4524 Gun Club Road, Suite 207
West Palm Beach, Florida 33415
Ph. 561-444-3668 Fax 561-689-0556
Certificate of Authorization No. 29863

EAST CALOOSAHATCHEE F.A.V.T.
OVERALL PLAN

DATE: 9/23/2013

SHEET No.
2 OF 9

CULVERT AS-BUILT DATA					
STRUCTURE NUMBER	PIPE SIZE	PIPE TYPE	DISCHARGE INV. EL.	INV. EL. AT RISER	TOP OF RISER EL.
D1-A	48"	CMP	21.37'	21.36'	28.92'
D2-A	48"	CMP	21.38'	21.35'	28.89'
D3-A	48"	CMP	21.30'	21.21'	28.94'
D4-A	48"	CMP	21.36'	21.31'	28.93'
D5-A	48"	CMP	21.32'	21.33'	28.87'
D6-A	48"	CMP	20.93'	21.11'	28.75'
D7-B	48"	CMP	19.85'	20.17'	SEE SH. 8
D8-B	48"	CMP	20.06'	20.18'	SEE SH. 8
D9-B	48"	CMP	20.68'	20.29'	SEE SH. 8
D10-B	48"	CMP	20.02'	20.21'	SEE SH. 8
D11-C	48"	CMP	19.82'	20.15'	28.99'
D12-C	48"	CMP	19.86'	20.19'	29.19'
D13-C	48"	CMP	19.99'	20.22'	29.09'
D14-C	48"	CMP	20.84'	20.43'	29.18'
D15-C	48"	CMP	20.43'	21.25'	29.26'

CULVERT SCHEDULE No.2:

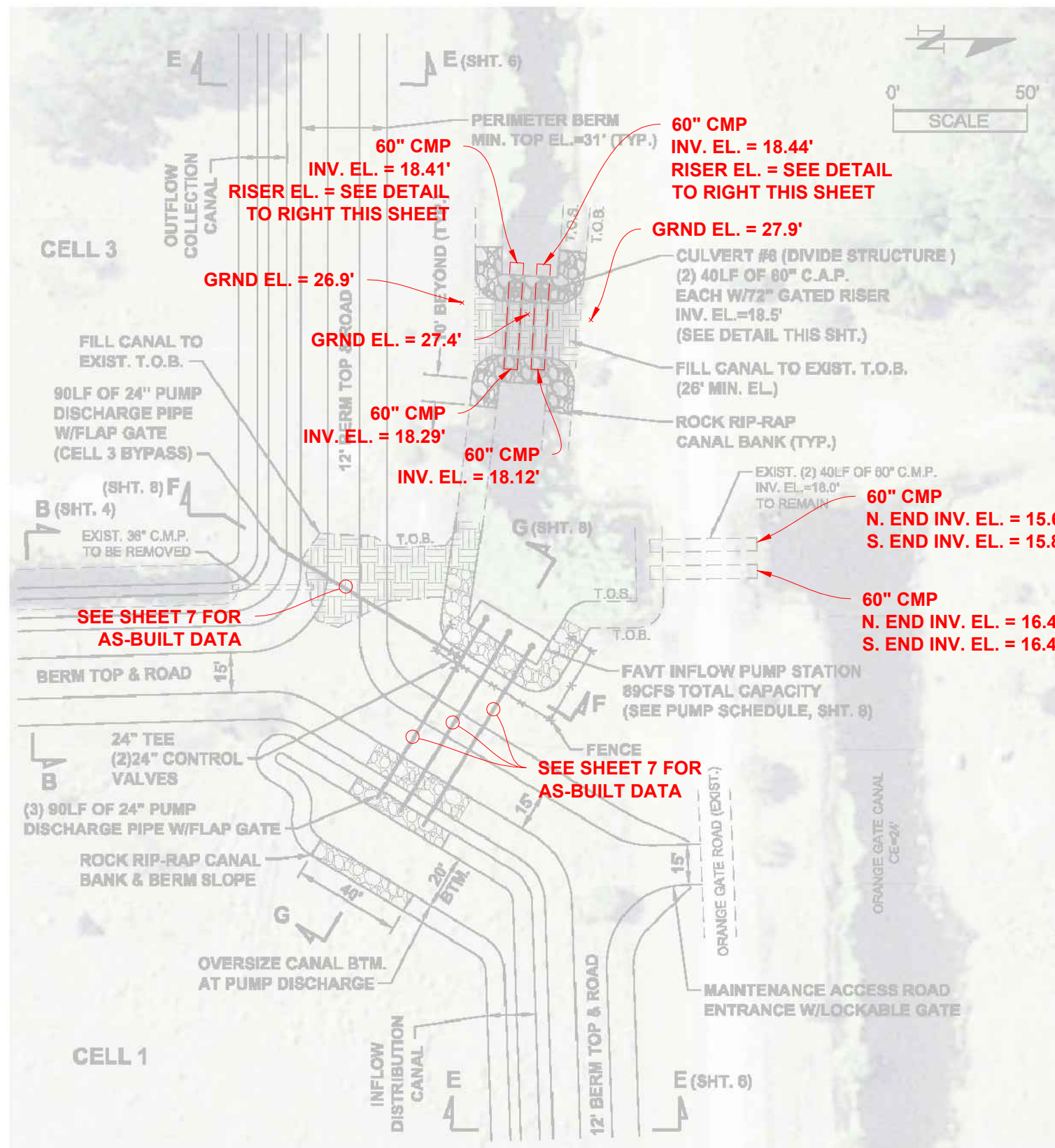
STRUCTURE No.	CULVERT			
	LENGTH	DIA.	MAT'L	INV. EL.
D1-A	50LF	48"	CAP	21.5
D2-A	50LF	48"	CAP	21.5
D3-A	50LF	48"	CAP	21.5
D4-A	50LF	48"	CAP	21.5
D5-A	50LF	48"	CAP	21.5
D6-A	50LF	48"	CAP	21.5
D7-B	105LF	48"	CAP	20.0
D8-B	105LF	48"	CAP	20.0
D9-B	105LF	48"	CAP	20.0
D10-B	105LF	48"	CAP	20.0
D11-C	150LF	48"	CAP	20.0
D12-C	150LF	48"	CAP	20.0
D13-C	150LF	48"	CAP	20.0
D14-C	60LF	48"	CAP	20.0
D15-C	60LF	48"	CAP	20.0

ABBREVIATIONS:
FAV = FLOATING AQUATIC VEGETATION
SAV = SUBMERGED AQUATIC VEGETATION
CAP = CORRUGATED ALUMINUM PIPE
D1-A = DRAINAGE STRUCTURE #1, TYPE A (SEE DETAIL SHT.)

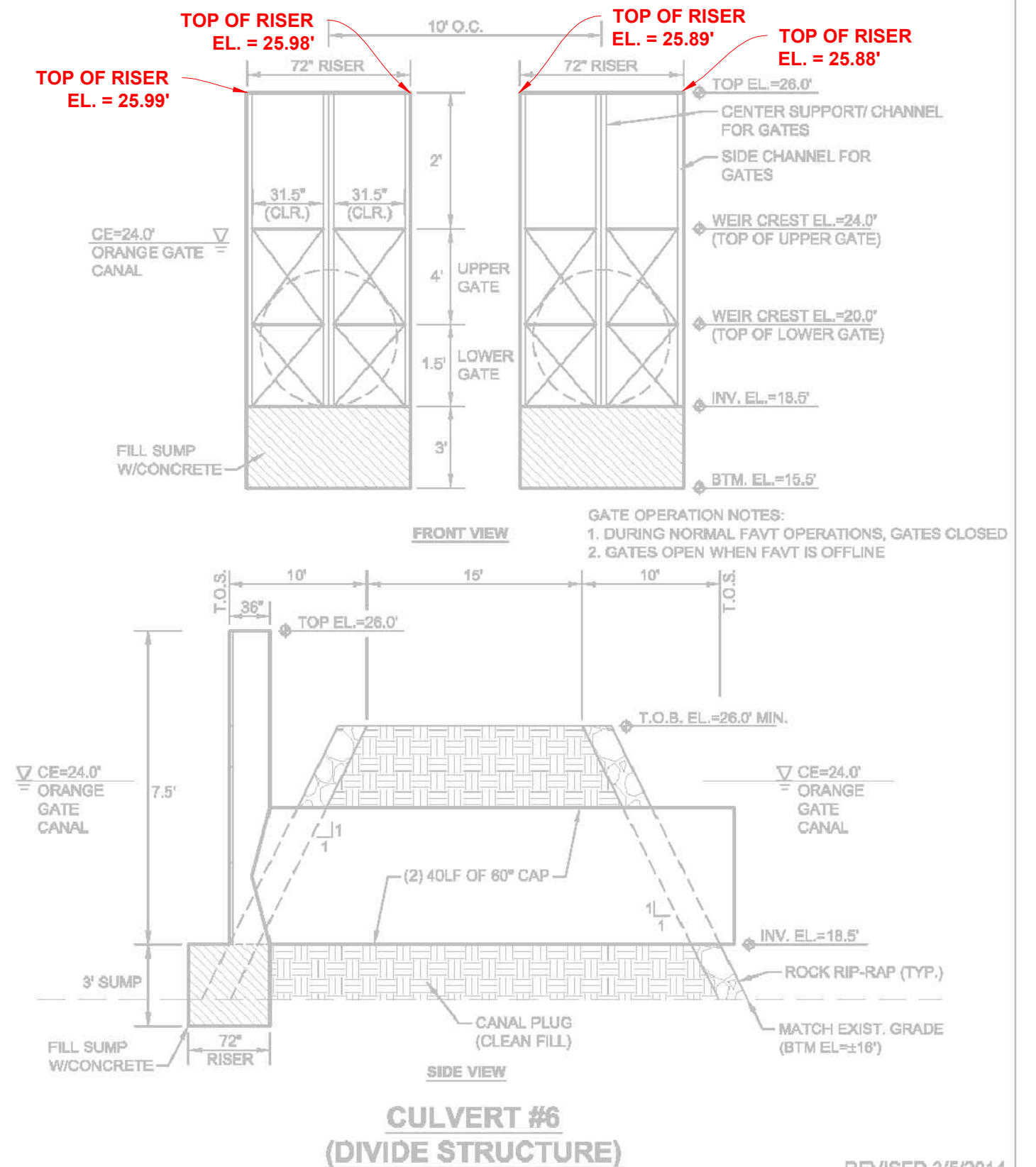
Federico, Lamb & Associates, Inc.
Water Resource and Environmental Consultants
4524 Gun Club Road, Suite 207
West Palm Beach, Florida 33415
Ph. 561-444-3668 Fax 561-689-0556
Certificate of Authorization No. 29863

EAST CALOOSAHATCHEE F.A.V.T.
SITE PLAN

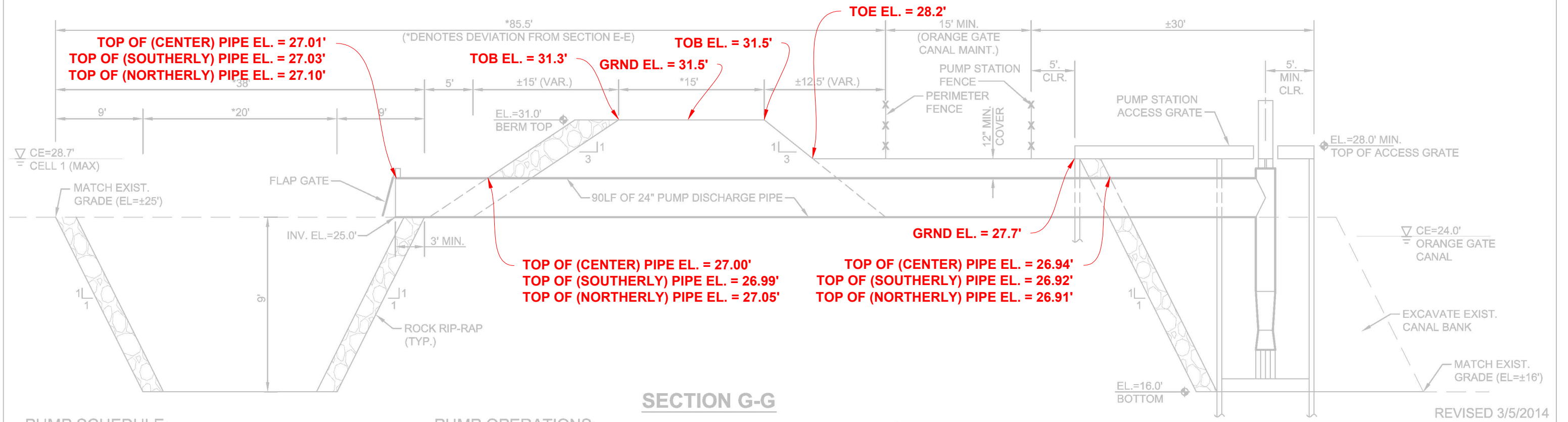
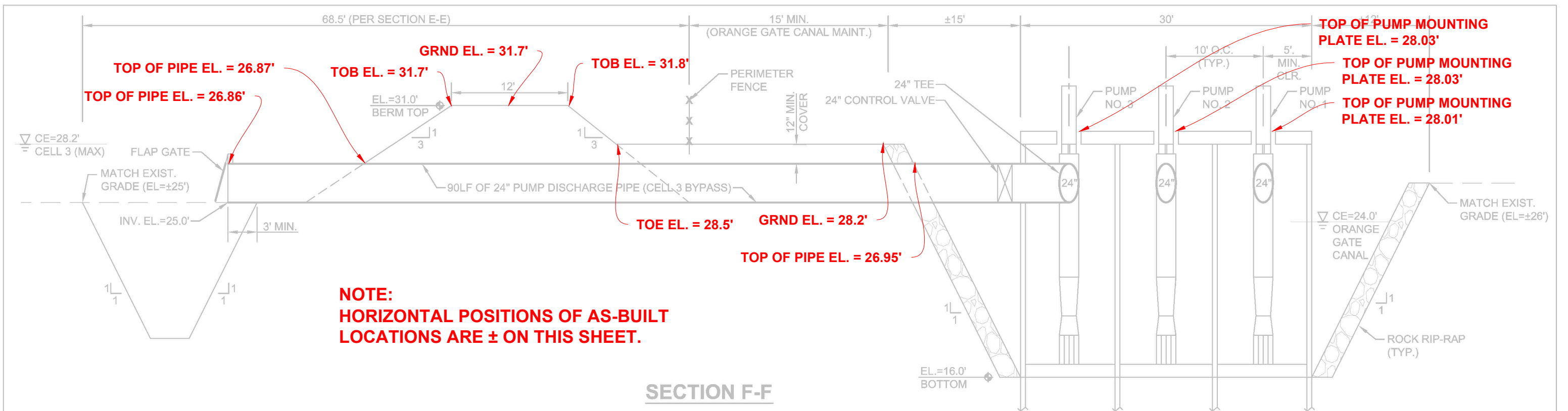
DATE: 9/23/2013
SHEET No. 3 OF 9



NOTES:
 1. ELEVATIONS REFERENCE NGVD29.
 2. BACKGROUND IMAGE IS FDEP 2011 AERIAL PHOTOGRAPH.



Federico, Lamb & Associates, Inc. Water Resource and Environmental Consultants 4524 Gun Club Road, Suite 207 West Palm Beach, Florida 33415 Ph. 561-444-3668 Fax 561-689-0556 Certificate of Authorization No. 29863		EAST CALOOSA HATCHEE F.A.V.T. INFLOW PUMP STATION & DIVIDE STRUCTURE	
Kyle D. Grandusky, P.E. FL License No. 68395		DATE: 9/23/2013	SHEET No. 7 OF 9



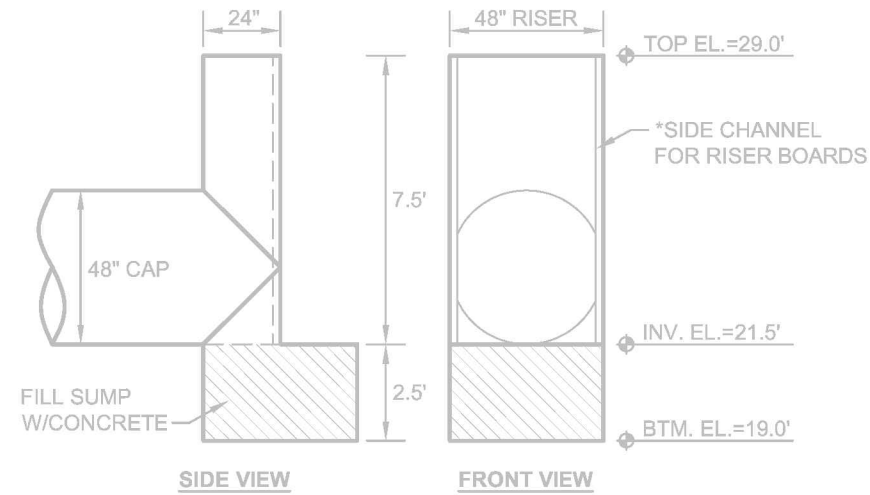
PUMP SCHEDULE:

	PUMP		MOTOR		DESIGN	
	TYPE	DIA.	TYPE	H.P.	RATE	TDH
PUMP NO. 1	AXIAL FLOW	24"	ELEC.	75	35.6CFS	13.9'
PUMP NO. 2	AXIAL FLOW	20"	ELEC.	50	26.7CFS	10.5'
PUMP NO. 3	AXIAL FLOW	20"	ELEC.	50	26.7CFS	10.5'

PUMP OPERATIONS:

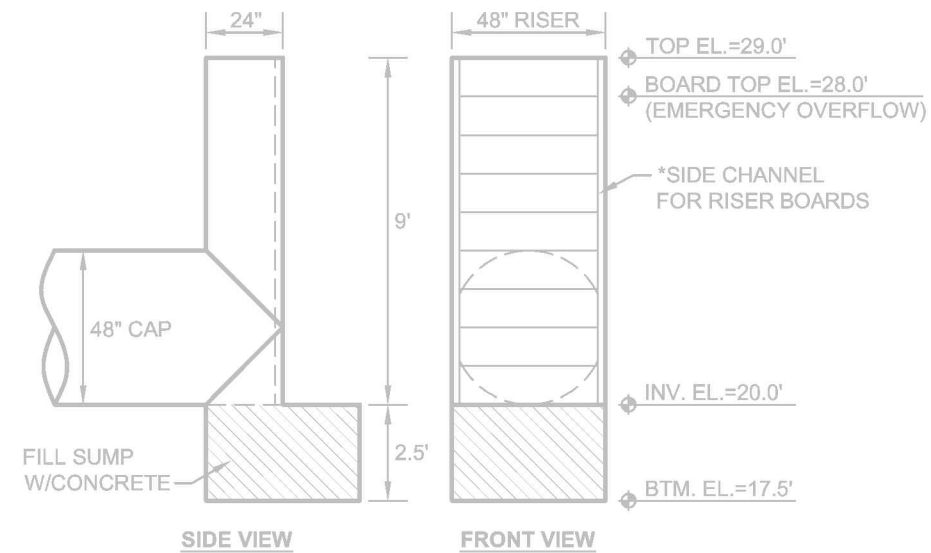
ALL PUMPS OFF IF:
CELL 1 STAGE > 28', OR
ORANGE GATE CANAL STAGE (EAST OF DIVIDE) < 22'

Kyle D. Grandusky, P.E. FL License No. 68395	Federico, Lamb & Associates, Inc. Water Resource and Environmental Consultants 4524 Gun Club Road, Suite 207 West Palm Beach, Florida 33415 Ph. 561-444-3668 Fax 561-689-0556 Certificate of Authorization No. 29863	EAST CALOOSAHATCHEE F.A.V.T. INFLOW PUMP STATION SECTIONS	
		DATE: 9/23/2013	SHEET No. 8 OF 9



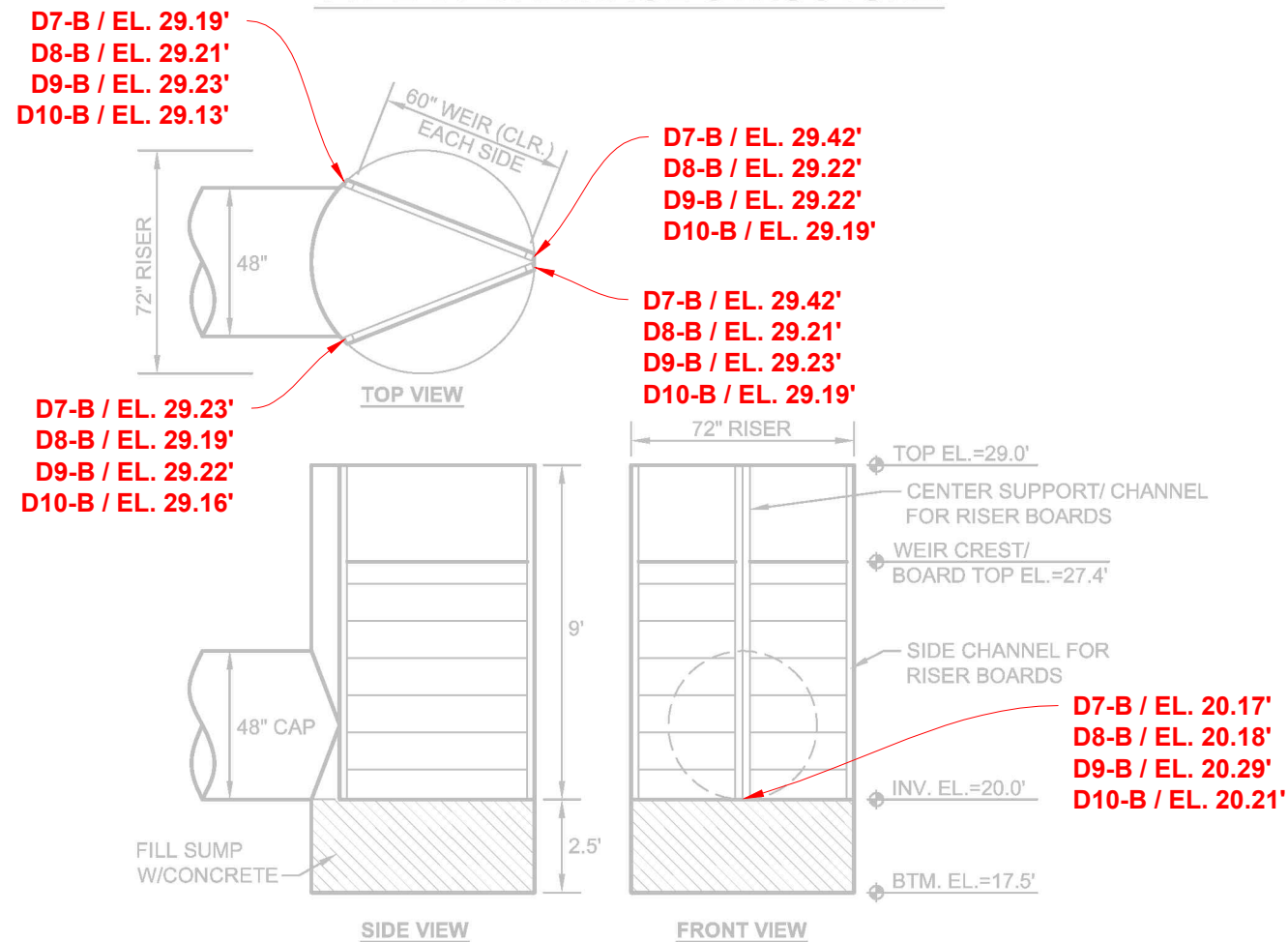
- *NOTES:
 1. DURING NORMAL OPERATION, BOARDS REMOVED.
 2. BOARDS ONLY IN PLACE FOR PERIODIC CELL DRAWDOWN

TYPE 'A' DRAINAGE STRUCTURE

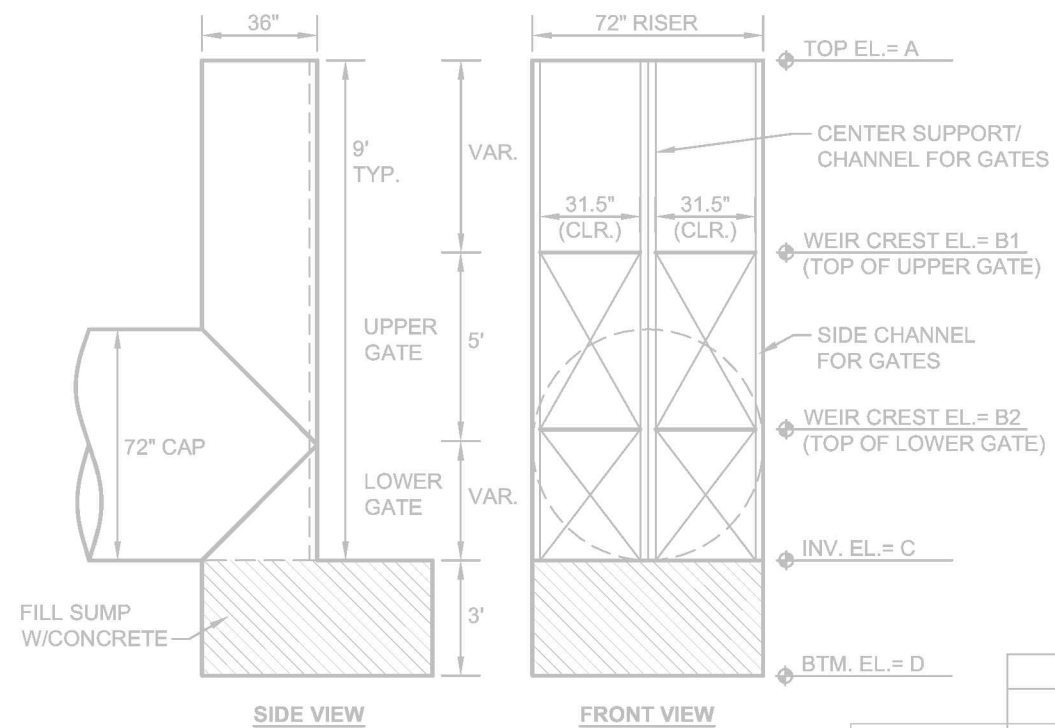


- *NOTES:
 1. DURING NORMAL OPERATION, BOARDS IN PLACE UP TO EL.=28.0'
 2. BOARDS REMOVED ONLY FOR PERIODIC CELL DRAWDOWN

TYPE 'C' DRAINAGE STRUCTURE



TYPE 'B' DRAINAGE STRUCTURE



CULVERT #2, #3 & #4

	ELEVATIONS (FT) NGVD29				
	A	B1	B2	C	D
CULVERT #2	27.0	24.0	19.0	18.0	15.0
CULVERT #3	25.5	24.0	19.0	16.5	13.5
CULVERT #4	25.5	23.0	18.0	16.5	13.5

REVISED 3/5/2014

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**EAST CALOOSAHATCHEE F.A.V.T.
 DRAINAGE STRUCTURE
 DETAILS**

DATE: 9/23/2013

SHEET No.
 9 OF 9

Implementation of Floating Aquatic Vegetative Tilling Technology in the Caloosahatchee River Watershed

Task 17 Deliverable: Final Report

Site 1

Prepared for:

**Florida Department of Agriculture and Consumer Service
(FDACS)**

Contract #020211

Prepared by:

**Water & Soil Solutions, LLC
Loxahatchee, FL**

August 28, 2014

Revised August 29, 2014

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Glossary of Acronyms

Al:	Aluminum
Ammonia-N	Ammonia-Nitrogen
Ca:	Calcium
ca.:	Circa
cfs:	Cubic Feet per Second
DOP:	Dissolved Organic P
EAV:	Emergent Aquatic Vegetation
FAV:	Floating Aquatic Vegetation
FAVT:	Floating Aquatic Vegetative Tilling
Fe:	Iron
FT:	Feet
FT NGVD:	National geodetic vertical datum
gal:	Gallons
HHWCD:	Hendry-Hilliard Water Control District
IFAS:	Institute of Food and Agricultural Sciences
LE:	Leaf Elongation
µg/L:	Micrograms per Liter
mg/L:	Milligrams per Liter
MOU:	Memorandum of Understanding
NO _x -N	Nitrate + Nitrite
N:	Nitrogen
OM:	Organic Matter
P:	Phosphorus
PP:	Particulate Phosphorus
PSR:	P Saturation Ratio
SAV:	Submerged Aquatic Vegetation
SFWMD:	South Florida Water Management District
SPSC:	Soil P Storage Capacity
SRP:	Soluble reactive P
STAs:	Stormwater Treatment Area
TC:	Total Carbon

TKN:	Total Kjeldahl Nitrogen
TN:	Total Nitrogen
TON:	Total Organic Nitrogen
TP:	Total Phosphorus
WSSLLC	Water & Soil Solutions, LLC
WSP:	Water Soluble Phosphorus

Executive Summary

Floating Aquatic Vegetative Tilling (FAVT) systems utilize a novel approach to enhance phosphorus (P) and nitrogen (N) removal from surface waters. The technology uses the direct assimilation of nutrients from the water column through the use of floating plant roots, as compared to plants rooted in the soil. Rather than periodically harvesting the plants, which is costly and inefficient due to the high water content of the vegetation, all of the biomass is rapidly incorporated directly into the soil via tilling during the dry season. FAVT systems therefore operate similarly to a conventional treatment wetland by storing P in the soil, but they accomplish P removal more efficiently and at a significantly faster rate.

During the current contract period, Water & Soil Solutions, LLC (WWSLLC) deployed an approximately 523-acre FAVT wetland treatment facility in the Hendry-Hilliard Water Control District (HHWCD) in the East Caloosahatchee River Sub-Watershed southwest of Lake Okeechobee. The goal of this effort is to cost effectively remove P and N in the East Caloosahatchee River Sub-Watershed through the treatment of waters employing the patented technology in a man-made flow-through treatment marsh. At this site, floating aquatic vegetation (FAV) species common to the adjacent canals will be utilized.

The system commenced operations during June 2014 and was in the initialization phase at the end of this reporting period. To facilitate vegetative growth, the ponds were inundated with local water control district run-off/drainage. After there is sufficient vegetative biomass, the system will begin discharge subject to sufficient inflow volumes. Total phosphorus (TP) concentration in the inflow stream initially averaged 260 micrograms per liter ($\mu\text{g/L}$). These P levels are substantially higher than those observed earlier in the prior Field Evaluation and Testing phases, likely due to the greater influence of local basin runoff at this time. Total nitrogen (TN) concentration averaged 1.88 mg/L.

The expansion of introduced FAV was evaluated in the opening two cells (Cells 1 and 2) of the system flow path during the initialization phase. As anticipated, the most robust early FAV growth had occurred in Cell 1, closest to the inflow point. FAV plants in Cell 2 were typically smaller and sparser at this time. Similarly, the initial grow-in of the submerged

aquatic vegetation (SAV) inoculum in the back end of Cell 2 and throughout Cell 3 appeared successful, with new growth evident at most monitoring locations.

During the construction of the East Caloosahatchee River project, preliminary field evaluations and testing were conducted. For the canal water monitoring program, routine grab samples were taken from the project Inflow Canal and the upstream Pump Station #1 site (Hendry-Hilliard Canal Pump Station). Water chemistry was, on average, similar at both canal sampling sites over the course of the monitoring period from November 2013 through June 2014. Increases in P and N concentrations during the wet season were more pronounced at the Inflow Canal monitoring site, however, reflecting the contribution of local basin runoff upstream of the project site. Mean concentrations of TP during the Evaluation and Testing Periods were 101 µg/L at both canal sites, while mean TN concentrations were 1.56 and 1.40 mg/L at the Inflow Canal and Pump Station #1 sites, respectively. Internal (within the project boundary) monitoring of water chemistry during September and October 2013 (pre-inundation) indicated that TP concentrations in an interior drainage canal and a cypress dome were consistently lower than TP concentrations in the Inflow Canal.

Based on results of vegetation surveys and plant mesocosm studies, water hyacinth was selected for inoculating FAV into Cells 1 and 2 of the wetland, during June 2014. Cattail (*Typha*) was selected as a candidate species for cultivation on the vegetated earthen berms that provide internal compartmentalization within the individual wetland cells. *Thalia geniculata*, will be planted in concert with cattail on the vegetated berms. *Thalia* reportedly has greater tolerance to periodic drydown compared to giant bulrush.

Soil characterization studies were performed prior to the onset of construction activities to provide guidance as to the potential release of nutrients upon initial flooding, and to provide baseline information prior to the tilling activities that will take place during dry seasons. The release of soil nutrients predicted by these tests and a previously reported flooded soil core flux study suggest that water will need to be held in the wetland (with no discharge) for a period of time after initial flooding, to allow for vegetative assimilation and microbial processes to reduce “first-flush” constituent concentrations. During the

initialization period, inflow canal water was added to flood the wetland and to maintain water levels at desired stages for vegetation grow-in, but Cell 3 outflow culverts were closed to discharge at that time.

To provide insight into the most appropriate tilling equipment and techniques for “burying” FAV given the soil conditions at the wetland site, we conducted several soil-vegetation tilling trials in May 2014. A Nammco disk plow and a John Deere moldboard plow were tested both on undisked (with surface vegetation intact) and previously disked (to break up surface vegetation) parcels. Based on these trials, an “optimum” protocol for “burial” of FAV biomass at this site during periods of wetland cell drydown was developed. It is anticipated that the first full-scale tilling effort in Cells 1 and 2 will be performed in spring 2015 following grow-in of the FAV standing crop (during summer/fall 2014), and at a time when there is little to no basin rainfall.

Introduction

WSSLLC has completed the deployment of an approximately 523-acre FAVT wetland treatment facility in the HHWCD in the East Caloosahatchee River Sub-Watershed southwest of Lake Okeechobee. The watershed is located in the Northern Everglades west of Lake Okeechobee. The project site is part of a large parcel of private land (Sections 18 & 19/ Township 44 South/ Range 32 East) on the southern side of the Caloosahatchee River (Figure 1). The purpose of the project is to cost effectively remove P and N from regional canals, including surface waters of the HHWCD and the Caloosahatchee River (C-43 Canal), using the patented FAVT technology in a man-made flow-through treatment marsh. This document encompasses the Final Report for the project period.

Infrastructure Status or Modifications/Improvements

On June 26, the project was accepted by FDACS and initialization of the facility commenced. A schematic of the project components is shown in Figure 2.

The facility components were deployed as follows:

1. Excavation and embankments
 - a. Floating Aquatic Vegetation (FAV) pond, associated conveyance system, berms & vegetation stocking
 - b. Submerged Aquatic Vegetation (SAV) pond, associated conveyance system, berms & vegetation stocking
2. Inflow and outflow conveyance and installation
3. Erosion control; site security; and fencing
4. Inflow water pump station fabrication and installation including earthwork
5. Divide structure on inflow canal
6. Inflow plumbing & electrical
7. Instrumentation including flow meter, automatic sampler and remote monitoring
8. Vehicular access and ramps
9. Shade structure and project signage

The design of the project considered the existing infrastructure on the project site and within the HHWCD, as well as the hydrologic and chemical characteristics of the water to be treated from both the Caloosahatchee River and local agricultural runoff that is destined for the River. Note that the original project area contemplated during earlier phases of project planning and design totaled 648 acres. The area was subsequently reduced to 523 acres to preserve existing prehistoric archaeological sites discovered upon completion of an archeological assessment of the site.

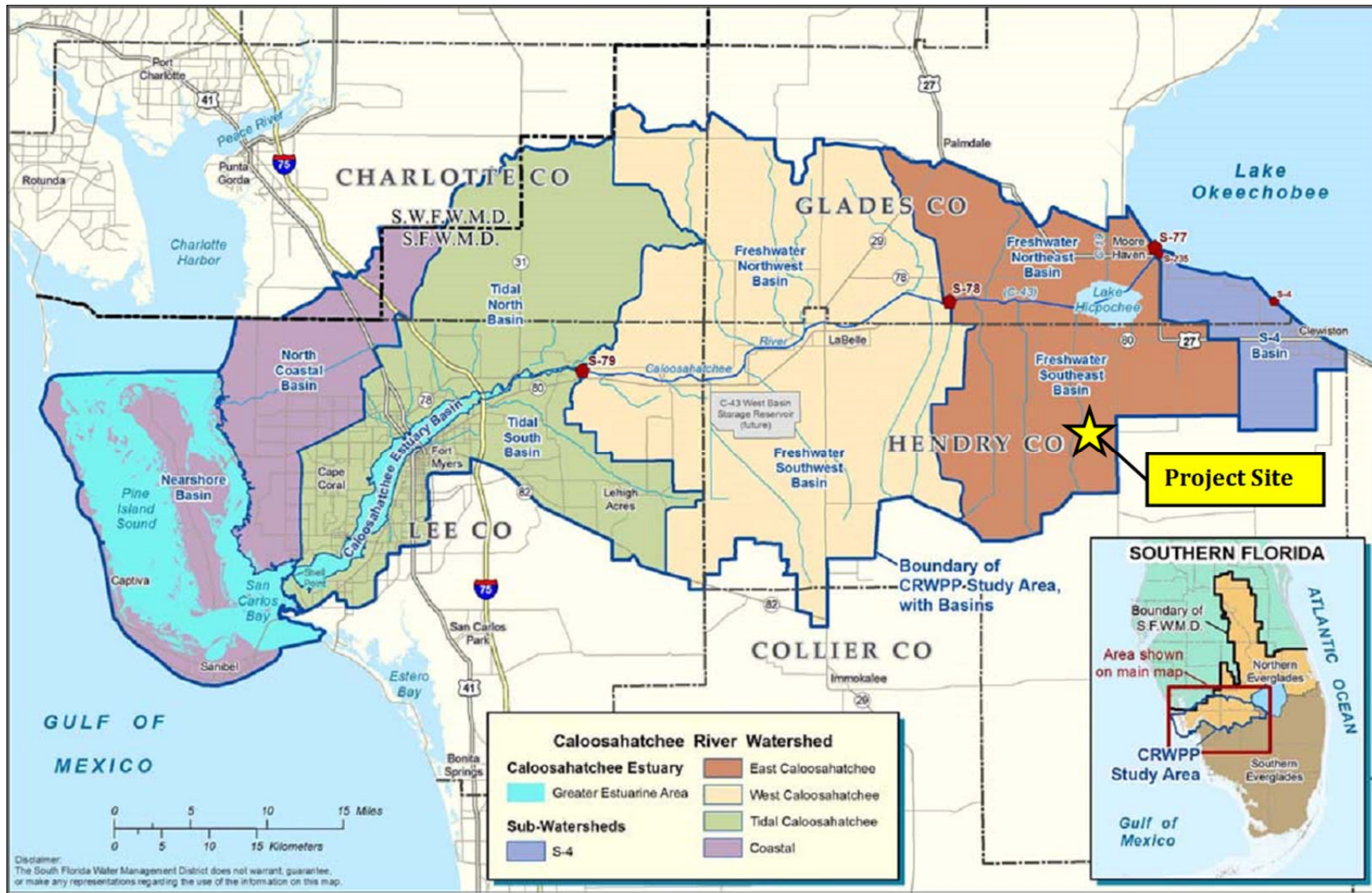


Figure 1. Project Location within the Watershed (Source – Caloosahatchee River Watershed Protection Plan January 2009).

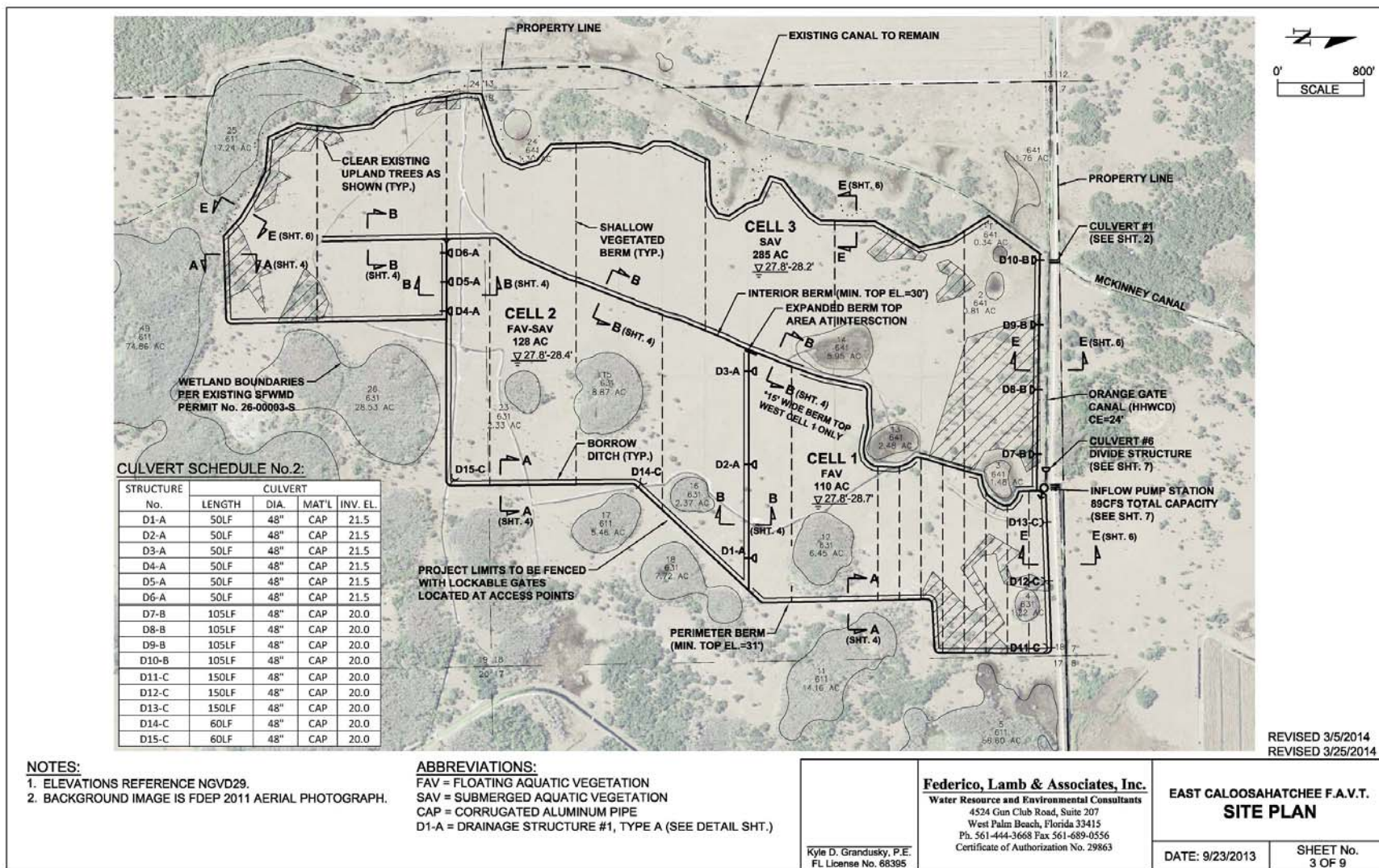


Figure 2. Final Schematic of East Caloosahatchee River FAVT Project Components.

Water Conveyance System

The HHWCD operates a network of existing canals, pump stations, and water control structures to provide flood protection and irrigation water supply to lands within the HHWCD service area. The following existing HHWCD facilities are used to convey surface water to and from the FAVT project site:

- Hendry-Hilliard Canal Pump Station. The pump station withdraws surface water from the Caloosahatchee River {South Florida Water Management District (SFWMD) C-43 Canal} via Lake Hicpochee for the purpose of irrigation water supply. The pump station lifts water from the C-43 Canal with a normal water elevation of varying from 10 feet (FT) to 12 FT National Geodatic Vertical Datum (NGVD29) into the Hendry-Hilliard Canal. The pump operates on floats to maintain water levels in the Hendry-Hilliard Canal at elevation 21 FT. The total pump station capacity is 267 cubic feet per second (cfs).
- Hendry-Hilliard Canal. The 6.3-mile long canal is oriented north-south, with the north end terminating at the Hendry-Hilliard Canal Pump Station and the south end terminating at the Orange Gate Pump Station. This is a primary conveyance for flood protection and water supply within the HHWCD. The canal water level is maintained at 21 FT NGVD29. A water control structure exists at the north end of the canal adjacent to the Hendry-Hilliard Canal Pump Station for the purpose of flood protection, which discharges into the C-43 Canal.
- Orange Gate Pump Station. The pump station withdraws surface water from the Hendry-Hilliard Canal for the purpose of supplying irrigation water to the southern reaches of the HHWCD. The pump station lifts water from 21 FT NGVD29 into the Orange Gate Canal. The pump operates on floats to maintain water levels in the Orange Gate Canal at elevation 24 FT. The total pump station capacity is 89 cfs.
- Orange Gate Canal. The 5-mile long canal is oriented east-west, with the east end terminating at the Orange Gate Pump Station and the west end terminating at the western limits of the HHWCD. For reference, the midpoint of the FAVT project site

is located about 1.4 miles west of the Orange Gate Pump Station. This conveyance provides flood protection and water supply to the southern reaches of the HHWCD. The canal water level is maintained at 24 FT NGVD29. A water control structure exists at the east end of the canal adjacent to the Orange Gate Pump Station for the purpose of flood protection, which discharges into the Hendry-Hilliard Canal. Also, about 1.8 miles west of the Orange Gate Pump Station there exists an open culvert connection to the McKinney Canal which outfalls north into the Hilliard Canal, which ultimately discharges to the C-43 Canal.

- McKinney Canal. The 2.2-mile long canal is oriented north-south, with the south end terminating at the Orange Gate Canal and the north end terminating at Java Avenue (the power line grade). The power line grade is also considered the southern limit of the Hilliard Canal (described below). This conveyance provides flood protection and water supply to the western reaches of the HHWCD north of the Orange Gate Canal. The maintained canal water level steps down from 24 FT NGVD29 at the southern extent to 22 FT at the north end. Culverts with flashboard-risers are used to maintain the various water levels as determined by the needs of the adjacent agricultural land uses. A water control structure exists at the north end of the canal at the powerline grade for the purpose of flood protection, which discharges into the Hilliard Canal, which ultimately discharges to the C-43 Canal.
- Hilliard Canal. The 5.5-mile long canal is oriented north-south, with the south end terminating at Java Avenue (the power line grade) and the north end terminating at a water control structure (adjacent to the Hilliard Canal Pump Station) located approximately 1 mile north of the C-43 Canal. This conveyance provides flood protection and water supply to a secondary basin of the HHWCD referred to as the Hilliard Canal Group. The canal water level is maintained at 20 FT NGVD29. A water control structure exists at the north end of the canal for the purpose of flood protection, which discharges into the 1-mile stretch of canal north of the Hilliard Canal Pump Station, which terminates at the C-43 Canal with a water control structure. The Hilliard Canal Pump Station provides irrigation water supply to the

Hilliard Canal Group basin from the C-43 Canal; however, this pump station is not utilized to convey water to or from the FAVT project site.

The FAVT project flow path and water conveyance facilities are depicted in Figure 3.

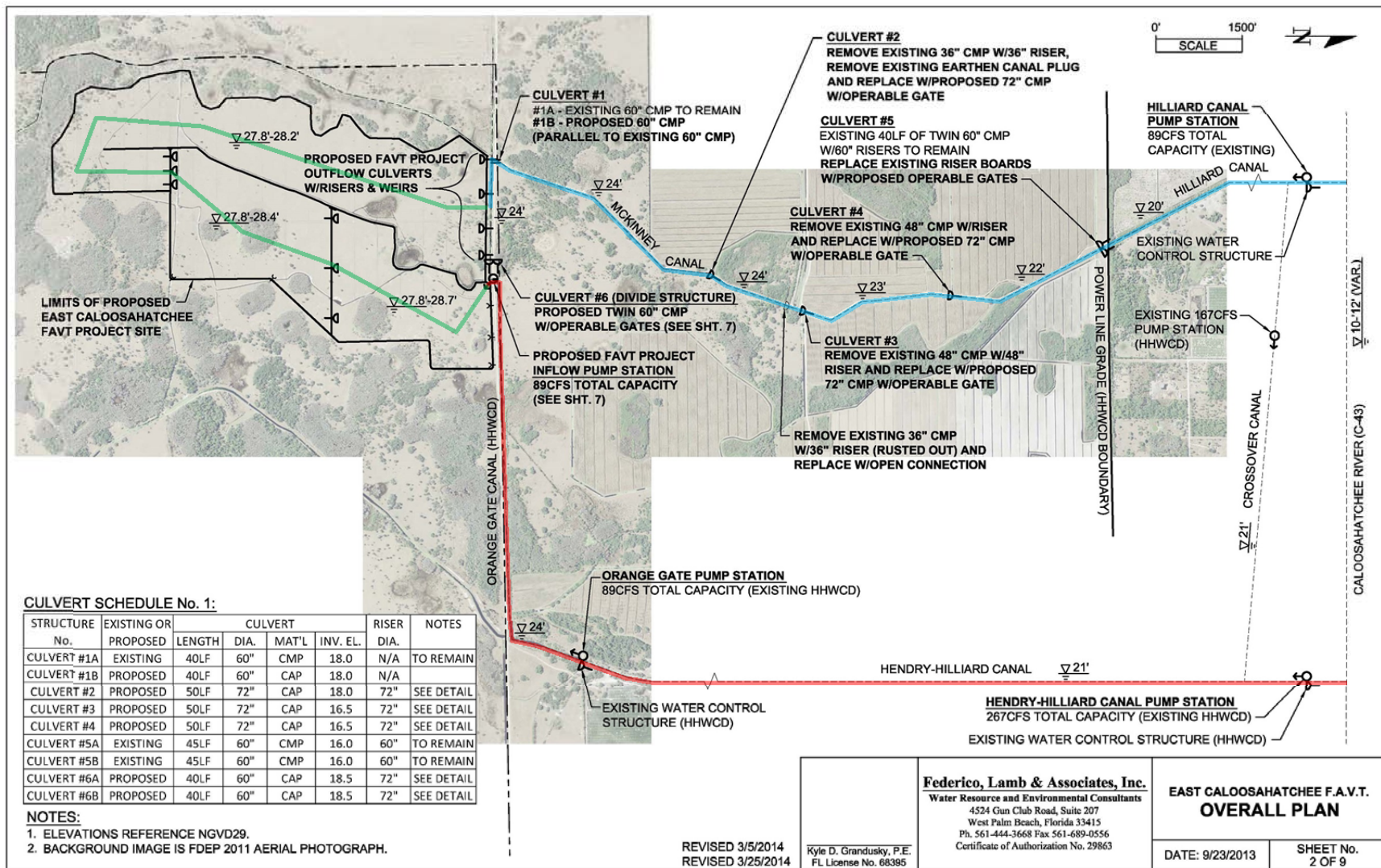


Figure 3. Schematic of FAVT Project flow path and associated water conveyance facilities, with the inflow path from C-43 Canal highlighted red, the FAVT wetland treatment path green and the outflow return path to the C-43 Canal blue.

FAVT System Unit Processes

FAVT systems utilize a novel approach to enhance P and N removal from surface waters. Many species of FAV, such as water hyacinth, are known to rapidly assimilate P and N, but their high nutrient uptake rate can only be sustained if the plants are maintained at an optimal density. The ideal coverage is usually achieved by periodic harvesting; however, since FAV are predominantly water, mechanical removal of the biomass is costly and inefficient. FAVT overcomes these constraints by using the following operational approach: (1) the FAV wetland is operated for an initial growing season, during which time the FAV assimilate nutrients and grow to a high density; (2) the wetland is drained during the dry season, thereby stranding the FAV on the soil; (3) after a natural drying process, the plant material is tilled into the soil together with its associated nutrients; (4) the wetland is reflooded; and (5) FAV that are stored in deeper zones are used to repopulate the wetland for the subsequent growth period. During this post-tilling process, water is held in the wetland without discharge for several weeks to provide time for the vegetation and water column nutrient levels to equilibrate. It is anticipated that tilling will be performed on a yearly basis (approximately) at the Project site.

FAVT systems therefore operate similarly to a conventional treatment wetland by storing P in the soil, but they accomplish P removal more efficiently and at a significantly faster rate. The technology uses the direct assimilation of nutrients from the water column through the use of floating plant roots (as compared to plants rooted in the soil), and all of the biomass is rapidly incorporated directly into the soil through tilling. The process thereby results in a reduction of up to 80% of land needed for treatment as compared to traditional wetland treatment systems. It is expected that the FAVT system will provide P reductions in the range of 3 to 15 g P/m²-yr, depending on the growth rate of the FAV, which will be linked to factors such as the P loading rate, speciation of P in the inflow waters and availability of inorganic N and other macro- and micro-nutrients in the inflow waters. Similarly, N removal can be extremely high in FAV systems (up to 250 g N/m²-yr) when the supply of inorganic N is high in the inflow waters. An effort to estimate total P and N mass removal by the East Caloosahatchee River Project has not yet been made due to uncertainties of key underlying variables, such as water availability and nutrient levels.

At this site, FAV species common to the adjacent canals will be utilized, for example, water hyacinth. Maximum growth (and P uptake) rates of this species occur in the summer, which coincides with the periods of highest runoff flows available for treatment.

As noted above, soils are the ultimate storage reservoir for P within all treatment wetlands. In conventional systems, emergent plant based wetlands such as the front-end cells of the Everglades Stormwater Treatment Areas (STAs), most of the soil P is associated with organic matter (OM), with lesser amounts associated with minerals such as calcium (Ca), aluminum (Al) and iron (Fe). An important aspect of the FAVT tilling approach is that it accelerates the rate of transferring not only P, but also OM and inorganic P-sorbing compounds into permanent storage.

Optimization & Monitoring during Initialization Phase

The goal of this optimization and monitoring effort is to collect, analyze and report water quality, water flow, vegetation and soil data to facilitate optimization of the East Caloosahatchee FAVT system in an environmentally sound manner and in accordance with established protocols. During the initialization period, the optimization and monitoring plan was implemented as discussed below.

System Flow and Water Chemistry

The system commenced operations on June 26, 2014 and is in the initialization phase. The ponds are being inundated with local water control district run-off/drainage to facilitate vegetative growth. After there is sufficient vegetative biomass, the system will begin discharge, subject to sufficient inflow volumes. Flow measurements and inflow monitoring data for TP and other water quality parameters are presented below.

System inflow, measured at the Project Inflow Pump Station, commenced at a rate of 6.9 cfs during the first 6 days of pumping and was increased to 59 cfs after 2 weeks (Figure 4). During the initialization period through 7/15/14, the daily mean inflow rate ranged from 3.1 to 60.9 cfs and averaged 22.4 cfs, with a median value of 19.4 cfs.

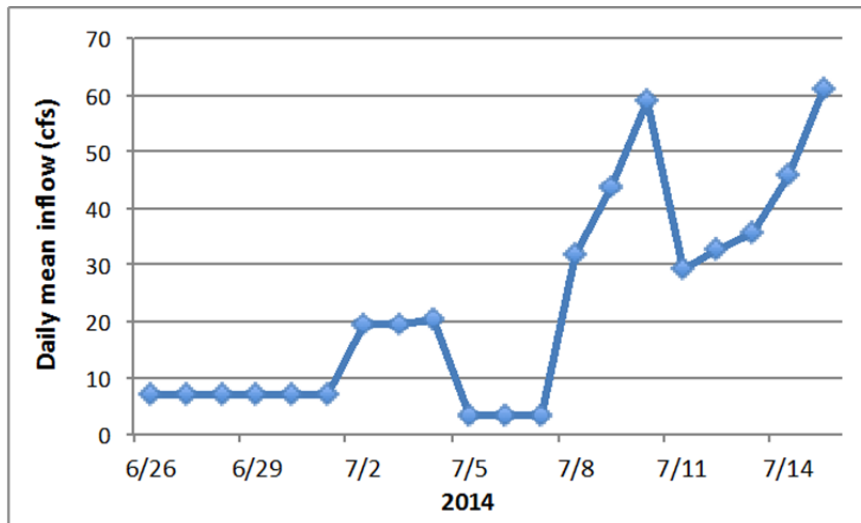


Figure 4. System inflow measurements during project initialization phase.

Water quality monitoring was conducted at the Cell 1 inflow basin on 7/1/14 and 7/15/14 during the initialization period. This sampling site was previously referred to as “Inflow Canal”, located immediately east of the new “Cell 1 inflow” sampling point. Water quality parameters tested included: total phosphorus (TP); soluble reactive phosphorus (SRP); dissolved organic phosphorus (DOP); particulate phosphorus (PP); total nitrogen (TN); total organic nitrogen (TON); ammonia-nitrogen (ammonia-N); nitrate+nitrite (NO_x-N); alkalinity; and pH. All tests were performed according to standard methods of water quality analysis.

Inflow nutrient concentrations were relatively invariant between the two monitoring events (Table 1). TP concentration in the inflow stream averaged 260 µg/L, with SRP accounting for approximately 50%, and DOP and PP about 25% each, of total inflow P. These P levels are substantially higher than those observed in dry season months during the prior Field Evaluation and Testing phases (see Figure 7) due to the greater influence of local basin runoff at this time. TN concentration averaged 1.88 mg/L, nearly all of which was present as TON. Alkalinity and pH levels were characteristic of moderately pH-buffered waters, likely due to the influence of subsurface limerock in the upstream canals.

Table 1. Monitoring results for inflow water chemistry (Cell 1 Inflow) during the project initialization phase, through 7/15/14. n.s. = no sample.

Parameter	Units	Sample Date	
		7/1/14	7/15/14
TP	µg/L	274	246
SRP	µg/L	121	140
DOP	µg/L	72	62
PP	µg/L	81	44
Ammonia-N	mg N/L	0.035	0.165
NO _x -N	mg N/L	0.019	0.150
TKN	mg N/L	1.800	1.800
TON	mg N/L	1.765	1.635
TN	mg N/L	1.819	1.950
Alkalinity	mg/L	200	<i>n.s.</i>
pH	pH	7.49	7.11
Temperature	°C	27.9	27.7

Vegetation Management

During the initialization phase, the spread of the previously inoculated FAV was evaluated in Cells 1 and 2. As anticipated, the most robust initial FAV growth occurred in Cell 1 (Figure 5) closest to the inflow point. FAV plants in Cell 2 were typically smaller and sparser at this time. Similarly, the initial grow-in of the SAV inoculum in the back end of Cell 2 and throughout Cell 3 appeared successful, with new growth evident at most monitoring locations (Figure 6).



Figure 5. FAV Colonization of Cell 1 during the initialization period.



Figure 6. SAV colonization in the back end of Cell 2 during the initialization period.

Field Evaluation and Testing

During the construction of the East Caloosahatchee River project, preliminary field evaluations and testing were conducted including pre-inundation soil analyses; soil reflux studies; water quality testing of inflow canal waters; water quality and vegetation assessments within both wetland communities (FAV and SAV); and development of operational protocols and optimization review among SFWMD, HHWCD, FDACS and the property owner. A synopsis of the findings (with updated data, where available) from these Field Evaluation and Testing Periods is provided below.

Canal Water Quality Monitoring

The canal water monitoring program consisted of grab sampling at several locations within the HHWCD including the project Inflow Canal and the upstream Pump Station #1 site on the Hendry/Hilliard Canal. Water samples were analyzed for the same parameters listed in the previous section, using standard methods of analysis. Monitoring was initiated on 9/19/13 at the Inflow Canal site, and on 11/19/13 at the Pump Station #1 site. Monitoring results for the two canal sites are summarized and compared in Table 2, for the period 11/19/13 – 7/15/14, while time-series plots of the monitoring data (beginning 9/19/13) are shown in Figure 7 through Figure 16.

Concentrations of TP and SRP were similar in range and central tendency (mean values) at both canal sampling sites (Table 2). On average, SRP accounted for roughly half of the total P concentration at both sites. TP and SRP concentrations exhibited a distinct seasonal trend, i.e., increasing during wet season months, at the Inflow Canal site, and a weaker seasonal trend with higher short-term variability at the Pump Station #1 site (Figure 7 and Figure 8). DOP and PP accounted for roughly 25% of total P, on average, at both canal sites (Table 2), but both DOP and PP exhibited greater variability at the Inflow Canal site primarily during the latter part of the monitoring period (Figure 9 and Figure 10). Higher concentrations of DOP and PP during this time may have been associated with herbicide treatment of nuisance vegetation in the Inflow Canal.

Total N in canal waters was primarily comprised of organic N (Table 2). Concentrations were similar at both canal sites, and exhibited a moderate seasonal trend of elevated

concentrations during the wet season (Figure 11 and Figure 12). Inorganic N (ammonia-N and NO_x-N) represented a relatively small fraction of TN at the two canal sites, although substantially elevated concentrations of ammonia-N (primarily Pump Station #1) and NO_x-N (Inflow Canal) were measured during May – July 2014 (Figure 13 and Figure 14).

Alkalinity exhibited moderate short-term variability with no detectable seasonal trend at both canal sites for the duration of the monitoring period (Figure 15). The pH levels were almost exclusively greater than 7.0 at both sites and ranged upward to levels of 7.5 – 7.7 (Figure 16). Short-term variability in pH was somewhat more pronounced at the Inflow Canal site; seasonal trends were not observed for either canal site. In general surface water chemistry was similar at the inflow and upstream canal sites (Table 2).

Table 2. Summary statistics for surface water chemistry at the project Inflow Canal and Pump Station #1 (Hendry/Hilliard Canal Pump Station) monitoring sites, for the period 11/19/13 – 7/15/14.

Sample collection sites are shown in Figure 3. Note that the Inflow Canal sampling point was moved immediately downstream to the Cell 1 Inflow Basin, adjacent to new Project Inflow Pump Station, on 7/1/14.

Parameter	Units	Statistic	Inflow Canal	Pump station #1
TP	µg/L	Mean	101	101
		Min	30	46
		Max	280	236
SRP	µg/L	Mean	44	54
		Min	8	15
		Max	148	157
DOP	µg/L	Mean	28	21
		Min	7	5
		Max	95	49
PP	µg/L	Mean	28	25
		Min	6	11
		Max	104	55
TN	mg/L	Mean	1.56	1.40
		Min	0.98	1.11
		Max	3.30	1.77
TON	mg/L	Mean	1.29	1.26
		Min	0.94	1.04
		Max	1.98	1.62
Ammonia-N	mg/L	Mean	0.056	0.088
		Min	0.010	0.021
		Max	0.185	0.295
NOx-N	mg/L	Mean	0.222	0.053
		Min	0.008	0.008
		Max	1.300	0.140
Alkalinity	mg/L (as CaCO ₃)	Mean	166	145
		Min	124	116
		Max	211	193
pH	Units	Mean	7.3	7.3
		Min	6.9	7.0
		Max	7.7	7.5

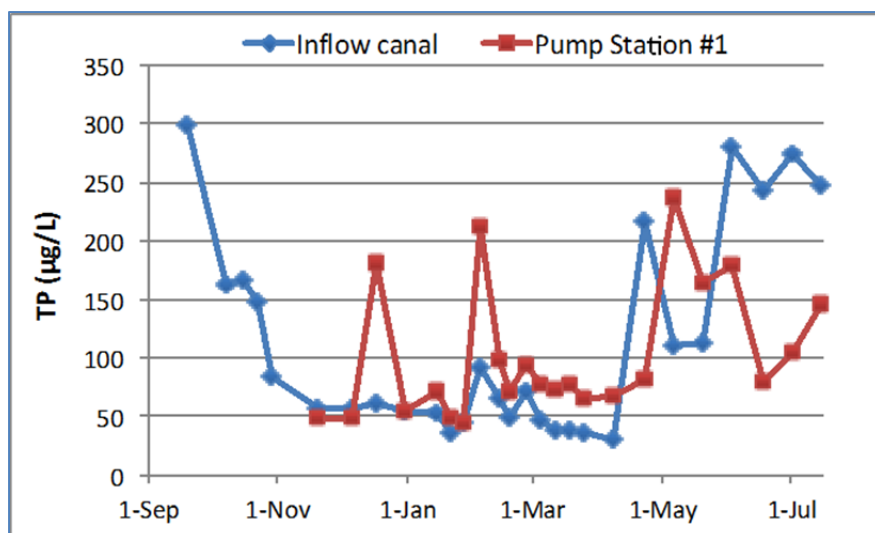


Figure 7. Time series plots of TP in inflow canal water and at upstream pump station #1, during the 2013 - 2014 pre-construction monitoring period.

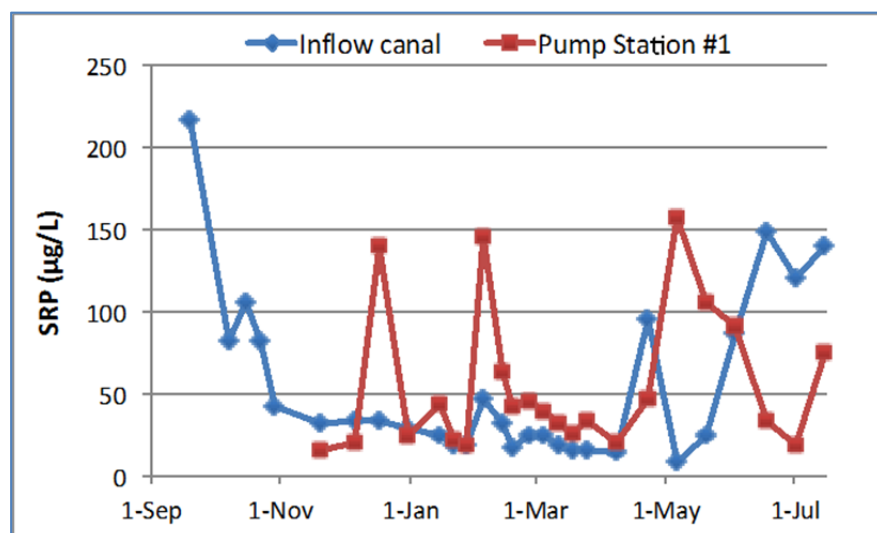


Figure 8. Time series plots of SRP in inflow canal water and at upstream pump station #1), during the 2013 - 2014 pre-construction monitoring period.

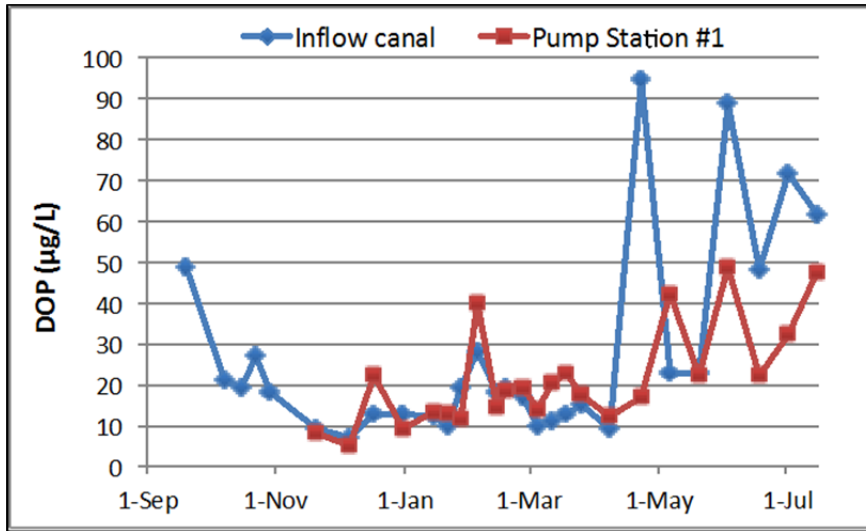


Figure 9. Time series plots of DOP in inflow canal water and at upstream pump station #1 during the 2013 – 2014 pre-construction monitoring period.

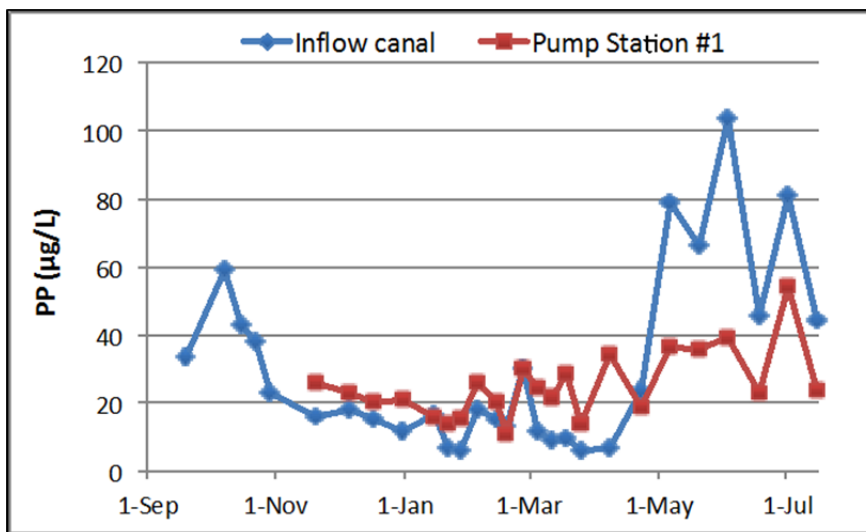


Figure 10. Time series plots of PP in inflow canal water and at upstream pump station #1 during the 2013 – 2014 pre-construction monitoring period.

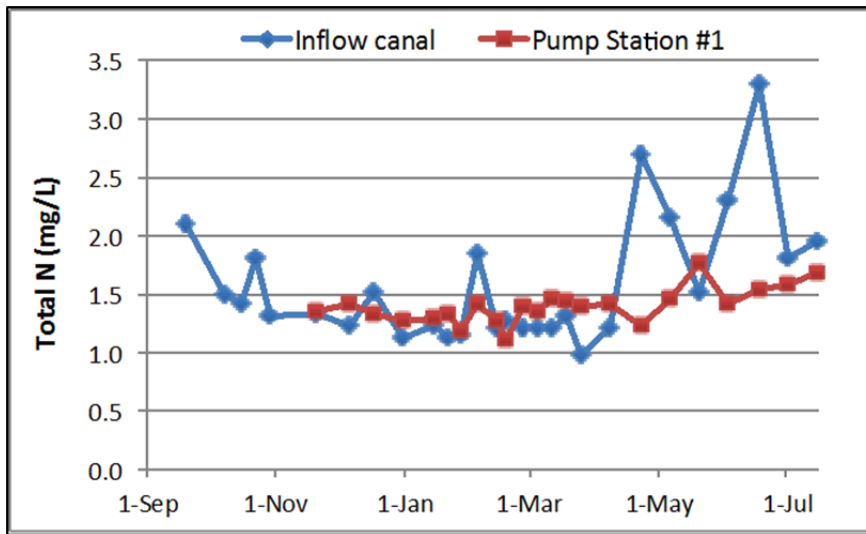


Figure 11. Time series plots of TN in inflow canal water and at upstream pump station #1 during the 2013 – 2014 pre-construction monitoring period.

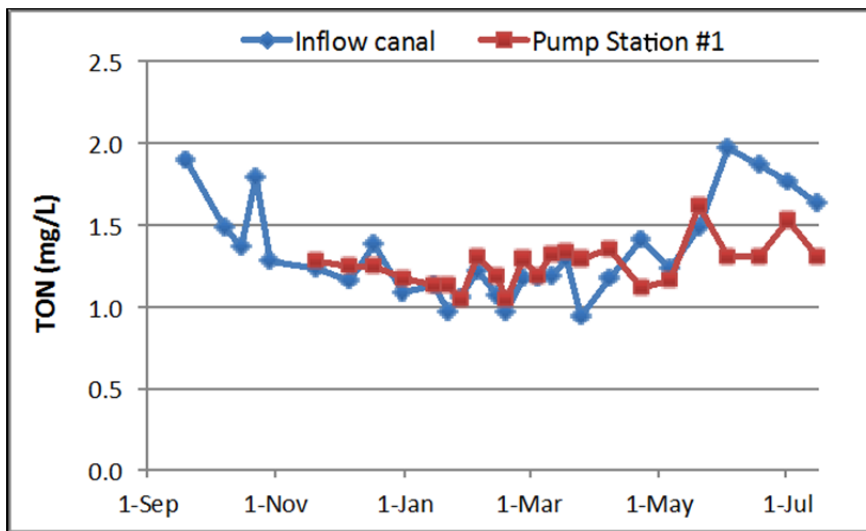


Figure 12. Time series plots of TON in inflow canal water and at upstream pump station #1 during the 2013 – 2014 pre-construction monitoring period.

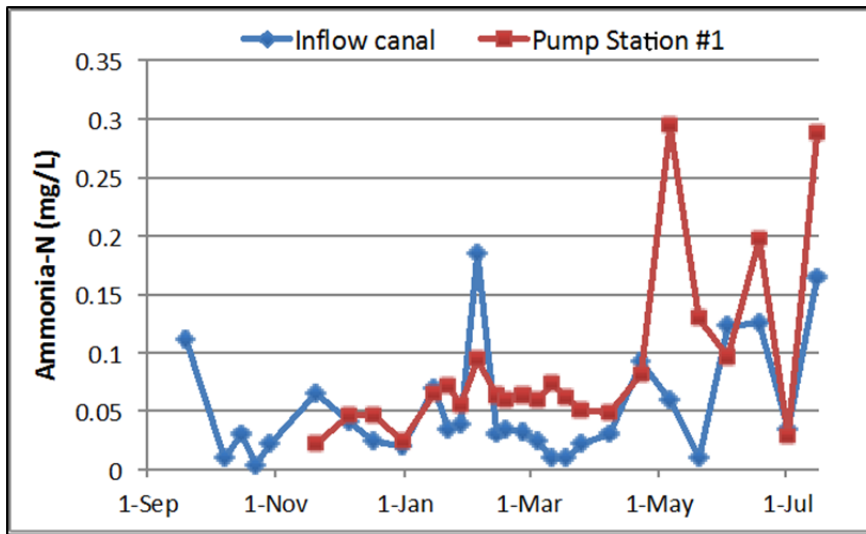


Figure 13. Time series plots of ammonia-N in inflow canal water and at upstream pump station #1 during the 2013 - 2014 pre-construction monitoring period.

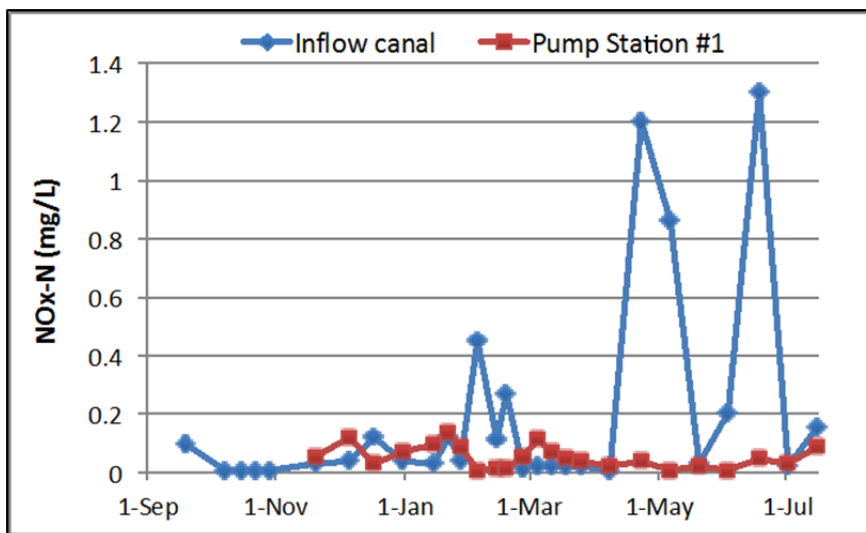


Figure 14. Time series plots of NO_x-N in inflow canal water and at upstream pump station #1 during the 2013 - 2014 pre-construction monitoring period.

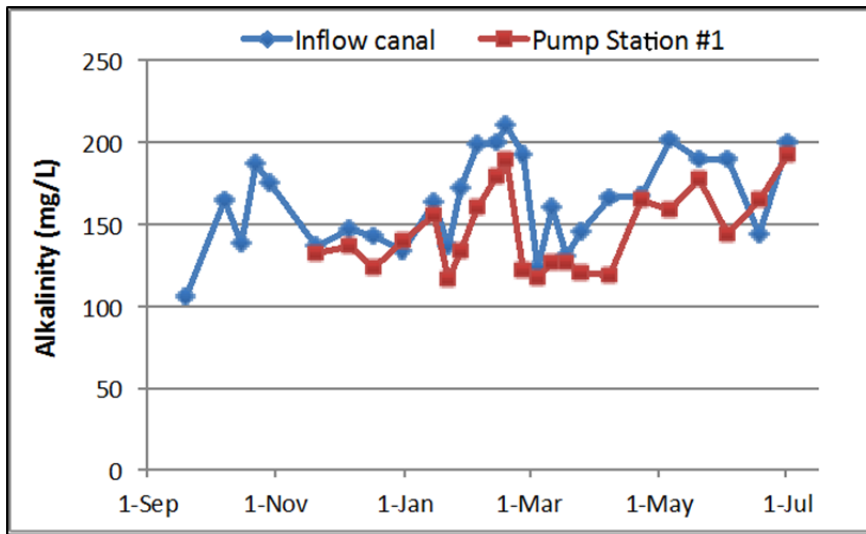


Figure 15. Time series plots of alkalinity in inflow canal water and at upstream pump station #1 during the 2013- 2014 pre-construction monitoring period.

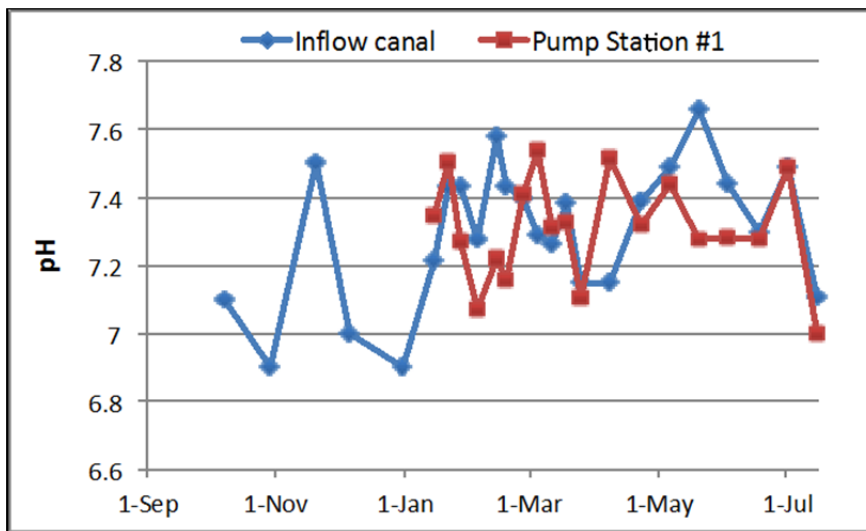


Figure 16. Time series plots of pH in inflow canal water and at the upstream pump station #1 during the 2013 – 2014 pre-construction monitoring period.

Internal Water Quality Monitoring

During Period 1 (pre-inundation), chemical characteristics of waters were evaluated within Cells 1 and 2 concurrent with the Inflow Canal sampling events during both “flowing” and “non-flowing” conditions. Water quality sampling was conducted on September 19, 2013 (all canals/ditches “flowing”) and repeated on a weekly basis from October 7-22, 2013 for the inflow canal, interior ditch and cypress dome sites (Figure 17). No flow was observed on these latter sampling dates. Water samples were analyzed for TP, SRP, DOP, PP, total Kjeldahl N (TKN = ammonia + organic N), ammonia-N, NOx-N, and alkalinity.

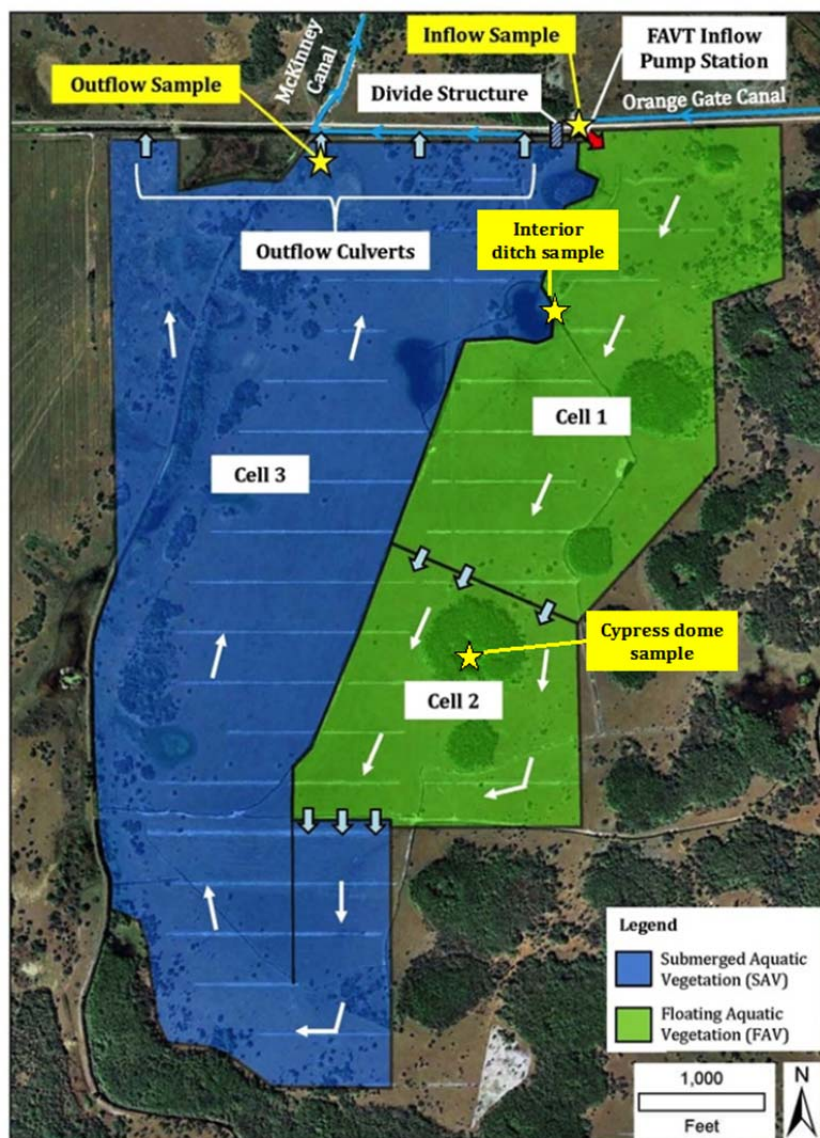


Figure 17. Detailed system configuration with water sampling locations.

During the period from September 19 through October 22, 2013, a decrease in nutrients measurements, including all forms of N and P, was observed at all three collection sites (Table 3). At the same time, alkalinity levels increased at all of the sites. Short-term temporal changes during September-October likely reflect decreasing rainfall and associated stormwater runoff, near the end of the wet season. Given the lack of flow data, it is difficult to draw a conclusion as to water quality trends.

Mean TP concentration was significantly greater ($P < 0.05$) in the inflow canal than in the interior ditch samples, and also greater than, but not significantly, the mean TP concentration at the cypress dome site. A similar pattern among sites was observed for mean SRP concentration, with inflow SRP being significantly greater than SRP in the interior ditch. DOP concentrations were highest in the cypress dome but only slightly lower in the inflow canal, while levels were significantly lower in the interior ditch. Conversely, PP concentration was highest in the interior ditch and inflow canal and significantly lower in the cypress dome. SRP was the predominant form of P in the inflow canal and, to a somewhat lesser extent, in the cypress dome, while only about 10 percent of TP was in the form of SRP in the interior ditch. DOP accounted for roughly one-third of TP in the cypress dome but only 15-25 percent in the interior ditch and 10-20 percent in the inflow canal. Particulate P accounted for a high percentage (about 75%) of TP in the interior ditch, compared with circa (ca.) 25 and <20 percent, respectively, in the inflow canal and cypress dome.

Table 3. Chemical analysis of surface water collected at the inflow canal, interior ditch and cypress dome during September – October 2013.

Sample collection sites are shown in Figure 17.

Parameter	Units	Sample Date	Inflow canal	Interior ditch	Cypress dome
TP	µg/L	9/19/13	299	74	183
		10/7/13	162	76	n.s.
		10/15/13	167	65	68
		10/22/13	147	57	78
SRP	µg/L	9/19/13	216	7	117
		10/7/13	82	11	n.s.
		10/15/13	105	6	28
		10/22/13	82	8	32
DOP	µg/L	9/19/13	49	17	48
		10/7/13	21	12	n.s.
		10/15/13	19	12	26
		10/22/13	27	12	30
PP	µg/L	9/19/13	34	50	18
		10/7/13	59	53	n.s.
		10/15/13	43	47	14
		10/22/13	38	37	16
Alkalinity	mg CaCO ₃ /L	9/19/13	106	176	46
		10/7/13	164	343	n.s.
		10/15/13	138	309	48
		10/22/13	186	300	50
Ammonia-N	mg/L	9/19/13	0.11	0.115	0.023
		10/7/13	0.01	0.121	n.s.
		10/15/13	0.031	0.051	0.028
		10/22/13	<0.007	0.017	0.013
NO ₃ +NO ₂ -N	mg/L	9/19/13	0.1	0.023	0.016
		10/7/13	0.008	0.019	n.s.
		10/15/13	0.008	0.016	0.008
		10/22/13	0.008	0.008	0.008
TKN	mg/L	9/19/13	2.0	2.5	1.4
		10/7/13	1.5	2.5	n.s.
		10/15/13	1.4	2.1	1.3
		10/22/13	1.8	2.5	1.2

n.s. = no sample

Site Vegetation Assessments

Plant Survey and Tissue Analysis

Vegetative assessments were conducted during the contract period to document any remaining FAV or SAV stands that would prove suitable as an inoculum upon system startup. A survey of existing appropriate FAV and SAV vegetation was conducted, within the project site and in canals along the perimeter of the site, on September 19, 2013. As part of this field event, samples of selected plant species were collected for tissue analysis from four locations. Water hyacinth plants were collected from the inflow canal, interior ditch and outflow canal water sample sites (Figure 17), while water lettuce was collected from the inflow canal. In addition, three representative species of SAV were collected from the cypress dome water sample site: lemon bacopa, coontail and bladderwort. Plant samples were transported to the lab for analysis of TP, TN, Total Carbon (TC) and ash content.

Our vegetation surveys performed during Period 1 demonstrated the presence of three key FAV species in the inflow canal: water hyacinth, water lettuce and pennywort (Figure 18). Of these, water hyacinth and water lettuce were most prolific in the inflow canal waters. Within the FAVT parcel itself, only water hyacinth was observed in the field ditches, and no large-leaved floating species were observed in the cypress domes.

No SAV was observed in the inflow canal waters, but several species were observed internal to the wetland parcel. Within one of the cypress domes, three SAV species were detected: *Bacopa caroliniana*, *Ceratophyllum demersum*, and *Utricularia sp.* (Figure 19). Within the field ditches, fragments of *Ceratophyllum* were observed at several locations within the parcel (Figure 20).



Figure 18. Water hyacinth (upper left), water lettuce (lower right) and pennywort (upper right) rafts in the inflow canal.

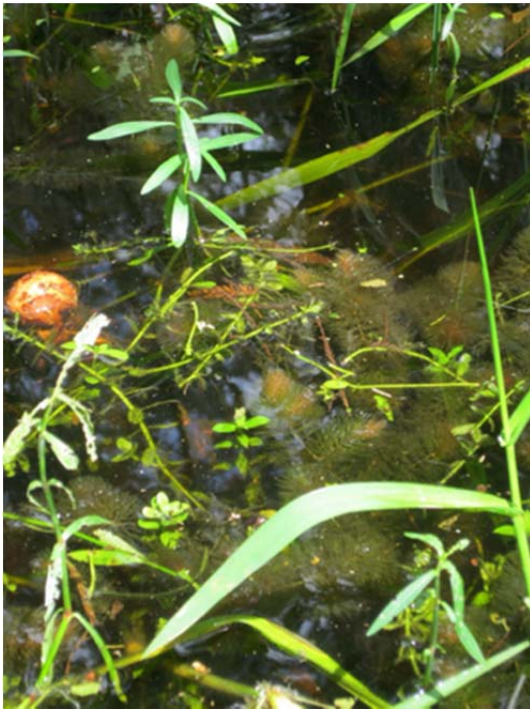


Figure 19. Interior of cypress dome at the site 2-2 (top) and close-up of SAV assemblage (bottom), which includes *Ceratophyllum*, *Bacopa* and *Utricularia*, within the cypress dome.

This and other domes serve as *refugia*, and should also prove to be an inoculation source for SAV in the FAVT system.



Figure 20. SAV (*Ceratophyllum*) fragments observed in an interior canal in Cell 2.

Tissue analyses of plants collected in mid-September demonstrate that the FAV and SAV vegetation was relatively nutrient enriched (Table 4). During a sampling effort performed by DB Environmental, Inc. in summer 2002 in the eastern flow path of STA-1W in Palm Beach County, water hyacinth tissue N and P levels averaged 0.92% and 1,090 mg/kg, respectively, substantially lower than concentrations observed for plants within and adjacent to the present FAVT site. Water lettuce at STA-1W exhibited tissue concentrations of 1.53% (N) and 1740 mg/kg (P), also substantially lower than for the plants analyzed in the present study. It should be noted that the higher tissue nutrient levels observed for water hyacinths at the inflow canal site, relative to the interior FAVT sites, was likely due to the higher inorganic N and P levels in the water column along with the relatively high flows at this location, which would tend to provide a continuous supply of nutrients to the floating plants.

The 2002 assessment of STA-1W vegetation also included tissue analyses of *Ceratophyllum demersum*. In that study, *Ceratophyllum* tissue N, P and ash levels averaged 1.58%, 2,050

mg/kg, and 57%. As was noted with the floating species, the *Ceratophyllum* at the present FAVT site appears more nutrient enriched than the plants in STA-1W (Table 6). The higher ash content of the STA-1W plants, by contrast, is probably due to the high Ca levels of the inflow waters to that STA. Once flowing conditions are established, it is likely that Ca enrichment of the SAV community in the FAVT wetland also will occur, a factor that should stimulate soil P retention and enhance back-end phosphorus “polishing” in the wetland.

Table 4. Plant tissue concentrations for samples collected on 9/19/13. Concentrations are presented on a plant dry weight basis.

Plant species	Location	TP (mg/kg)	Ash (%)	TC (%)	TN (%)	% Dry Weight
<i>Bacopa</i>	Cypress dome	3560	15.5	40.6	2.08	6.35
<i>Ceratophyllum</i>	Cypress dome	3890	20	38.1	1.95	5.76
<i>Utricularia</i>	Cypress dome	2680	16.1	40.6	2.63	4.85
Water Hyacinth	Interior ditch	1370	19.7	37.3	1.67	6.85
Water Hyacinth	Inflow canal	5320	18.4	37.3	2.38	6.09
Water Hyacinth	Outflow canal	2290	13.9	39.2	1.43	8.68
Water Lettuce	Inflow canal	5550	22.9	35.9	3.46	4.84

Initial FAV Growth and Nutrient Uptake Measurements

To gain insight into potential nutrient removal rates by floating vegetation, a plant growth study was performed to evaluate biomass production and nutrient uptake rates by the two dominant FAV species occurring at the site, water hyacinth and water lettuce. Table 5 depicts initial tissue nutrient levels of vegetation stocked at the inflow canal and the interior ditch locations (10/7/13) and nutrient concentrations for the inflow canal site during a subsequent sampling event. As noted during our earlier, September 2013 plant survey, the water hyacinths in the inflow canal were significantly more nutrient-enriched than those collected from the interior ditch location. Also note that the inflow canal served as the inoculation source for water lettuce growth trials at both locations, hence “initial” tissue levels were equal at both sites.

Tissue N and P concentration decreased in both water hyacinth and water lettuce plants in the inflow canal between the October and December tissue sampling events, following the decreasing trends in N and P concentrations in surface water at that site. Similarly, the

increase in plant tissue N:P ratio observed for both species reflects the decrease in surface water P concentrations relative to N.

Growth of both species declined during the course of the study, most likely due to decreasing P availability, enhanced by seasonal effects such as decreasing light availability and temperature. The rapid initial decline in bioavailable nutrient concentrations coincided with the cessation of canal flows due to the lack of rainfall.

Table 5. Plant tissue analysis (mean and standard error for triplicate growth chambers) for water hyacinth and water lettuce stocked in growth chambers at the inflow canal and interior ditch.

Water lettuce plants for both sites were collected in the inflow canal due to lack of availability at the interior ditch. Plant samples were not available at the interior ditch site during the 12/17/13 sampling event, due to dry conditions.

Parameter	Units	Date	Hyacinth				Water lettuce			
			Inflow canal		Interior ditch		Inflow canal		Interior ditch	
			<i>Mean</i>	<i>SE</i>	<i>Mean</i>	<i>SE</i>	<i>Mean</i>	<i>SE</i>	<i>Mean</i>	<i>SE</i>
TP	mg/kg	10/7/13	5137	80	1190	84	5337	163	5337	163
		12/17/13	4053	58	ND	ND	4137	70	ND	ND
TN	%	10/7/13	2.27	0.02	1.36	0.09	3.29	0.22	3.29	0.22
		12/17/13	2.20	0.01	ND	ND	2.70	0.03	ND	ND
N:P ratio		10/7/13	4.4	0.03	11.5	0.09	6.2	0.33	6.2	0.33
		12/17/13	5.4	0.07	ND	ND	6.5	0.06	ND	ND
TC	%	10/7/13	40.7	0.1	40.8	0.5	38.4	1.0	38.4	1.0
		12/17/13	39.1	0.2	ND	ND	36.6	0.2	ND	ND
Ash	%	10/7/13	17.5	0.2	17.3	0.9	23.7	1.7	23.7	1.7
		12/17/13	17.3	0.4	ND	ND	21.9	0.4	ND	ND
% Dry Weight	%	10/7/13	6.4	0.2	9.4	0.4	4.6	0.1	4.6	0.1
		12/17/13	6.4	0.4	ND	ND	6.2	0.3	ND	ND

Hyacinth growth rate was consistently higher than that of water lettuce; maximum incremental growth rates, recorded in early October at the outset of the study, were 26.4 and 39.1 g (dry)/m²-day for hyacinth, and 15.7 and 13.8 g (dry)/m²-day for water lettuce in the inflow canal and interior ditch, respectively. Mean growth rates for hyacinth and water lettuce during the study were 6.1 and 1.7 g (dry)/m²-day at the inflow canal site (Table 6). The mean calculated P uptake rates calculated for hyacinth and water lettuce at the inflow canal site were 28.2 and 8.2 mg/m²-day, respectively.

For comparison of growth and nutrient uptake at the two study sites, mean values were also calculated for the initial 3-week period for the inflow site (Table 6). Mean water hyacinth growth rate for the inflow canal site during this period was lower than for the interior ditch site (14.1 vs. 20.5 g (dry)/m²-day, respectively). Mean growth rates for water lettuce, on the other hand, were comparable at both sites (ca. 7 g (dry)/m²-day), and substantially lower than water hyacinth growth rates at the respective sites. Despite lower growth rates, nutrient uptake rate for water hyacinth was much higher at the inflow canal site than at the interior ditch site, a reflection of the higher nutrient content of hyacinths growing in the inflow canal. The discrepancy in hyacinth nutrient uptake between the two sites was greater for P uptake than for N uptake, as the 3-week mean rate for P at the inflow canal site was 73 mg P/m²-day, compared with a rate of 24 mg P/m²-day at the interior ditch site. For water lettuce, uptake rates for both N and P were similar at both the inflow canal and interior ditch sites.

The growth rates observed during this assessment are within the ranges previously reported for rapidly growing stands of water hyacinth and water lettuce. Despite the declining growth rates observed in this study, the higher mean rates noted in Table 6 should be readily sustainable within the full-scale FAVT wetland, once flowing conditions are established and maintained.

Table 6. Mean ($\pm$ SE) daily growth rate and estimated P and N uptake for hyacinth and water lettuce. The periods of record were 10/17/13-1/28/14 for the inflow canal site and 10/17/13-10/29/13 for the interior ditch site. Mean values for the inflow canal during the 10/17/13-10/29/13 period are shown in parentheses for comparison with interior ditch means.

Parameter	Units	Hyacinth				Water lettuce			
		Inflow canal		Interior ditch		Inflow canal		Interior ditch	
		<i>Mean</i>	<i>SE</i>	<i>Mean</i>	<i>SE</i>	<i>Mean</i>	<i>SE</i>	<i>Mean</i>	<i>SE</i>
Growth rate	g/m ² -day	6.1 (14.1)	0.5	20.5	1.2	1.7 (7.1)	0.1	7.3	1.0
P uptake	mg P/m ² -day	28.2 (72.7)	2.4	24.3	2.0	8.2 (38)	0.6	39.1	5.7
N uptake	mg N/m ² -day	137 (321)	11.8	279	23	52 (237)	3.2	244	49

Plant Growth and Nutrient Uptake Mesocosm Studies

EAV Field Mesocosm Study

An on-site mesocosm study was established during late December 2013 to evaluate growth characteristics of three species of emergent aquatic vegetation (EAV) under consideration for inclusion in the wetland treatment system (Figure 21). The purpose of the EAV study was to facilitate selection of appropriate specie(s) for planting on the vegetated berms (slightly elevated above the rest of the wetland), to provide internal compartmentalization in the FAV and SAV cells.



Figure 21. Mesocosm facility at the Hilliard project site, adjacent to the inflow canal. Pictured are the EAV (foreground) and SAV mesocosms.

A total of nine mesocosm tanks were established containing monocultures of three different species of emergent macrophytes: bulrush (*Scirpus sp.*), cattail (*Typha sp.*) and spikerush (*Eleocharis sp.*), with three replicate mesocosms per species.

Following planting of the EAV species (typically 5 plants per mesocosm), water from the inflow canal was pumped into the mesocosms to create a floodwater depth of 6 inches {15 centimeters (cm)}. The mesocosms were operated as batch-feed systems, where the floodwater was exchanged on a bi-weekly basis. Plant growth was monitored by means of biweekly measurement of leaf growth (i.e., elongation) in each mesocosm tank, wherein total length of all leaves was measured from the soil surface to leaf tip. Incremental increase in leaf length, expressed as cm/day, was used as a surrogate measure of plant growth.

Plant tissue nutrient analysis for the three EAV species performed at the outset of the mesocosm study, reflected moderate within-species variability in tissue N and P

concentrations (Table 7). Mean N and P concentrations were highest in cattail and lowest in spikerush.

Leaf elongation (LE) rate was consistently greater for bulrush and was typically lowest for spikerush during the seven growth measurement periods (Figure 22). Bulrush LE rate increased rapidly between the first and second measurement periods, then steadily decreased through the last period. A slight decreasing trend in LE rate was observed for cattail and spikerush subsequent to the second measurement period. The general decrease in LE rate during the latter portion of the period was likely due to increasingly limited resources, e.g., nutrients and light, associated with high plant densities.

Overall, all three EAV species appear to thrive while rooted in the site's mineral soils flooded with inflow canal waters. Cattail and giant bulrush exhibited the highest LE rates and therefore may prove to be suitable candidates for incorporation into the vegetated berms with the FAV and SAV cells. Spikerush may also be suitable if an additional plant species is to be used. Although LE rates were relatively low, the greater increase in leaf count observed for spikerush is indicative of its lateral growth potential.

Table 7. Plant tissue analysis for EAV species in field mesocosms at the Hilliard project site. Plant samples were collected from triplicate mesocosms for each of the tree EAV species at the initiation of study.

Species	Rep	TP mg/kg	TN %	TC %	% DW %	Ash %
Cattail	1	3020	1.21	41.9	10.9	12.9
	2	2360	1.65	41.1	8.9	15.5
	3	3140	1.57	41.3	8.5	15.4
Bulrush	1	1620	0.91	41.4	9.4	12
	2	2380	1.56	41.8	6.0	11.9
	3	1640	1.21	43.2	7.0	12.1
Spikerush	1	710	1.03	44.0	11.1	9.11
	2	1160	1.20	42.7	11.6	11.7
	3	380	0.71	44.2	11.0	8.29

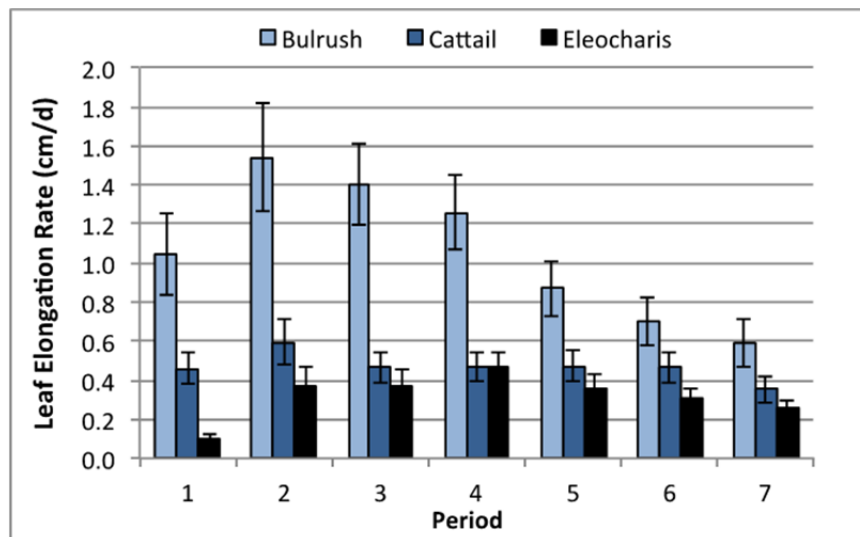


Figure 22. Mean ($\pm$ S.E.) leaf elongation rate for bulrush, cattail and spikerush plants during each of seven growth measurement periods (1/14/14 – 4/22/14). Values for replicate EAV mesocosm tanks were averaged.

SAV Field Mesocosm Study

A second on-site mesocosm study was initiated in mid-January 2014 to evaluate the nutrient removal potential of three SAV species under consideration for inclusion in the wetland treatment system: *Potamogeton sp.*, *Ceratophyllum sp.* and *Najas sp.* The nine mesocosms tanks used for the SAV study were situated adjacent to the EAV mesocosms and the inflow canal (Figure 21). The mesocosms were filled with a shallow layer (ca. 3 inches / 7.5 cm) of on-site soil, collected from the Cell 1 region of the project site. The overlying floodwater was pumped from the inflow canal and maintained at a nominal depth of 16 inches (41 cm), providing a total water volume of 86 gallons (gal) (326 L). The mesocosms were operated as batch-feed systems, where the floodwater was exchanged on a bi-weekly basis.

Mesocosm floodwater was sampled for chemical analysis at the end of each flooding cycle, and canal (mesocosm inflow) water was sampled at the beginning of each new cycle. Water samples were analyzed for TP, TSP, SRP, ammonia-N, NO_x-N, TKN and alkalinity. In situ measurements of water pH and temperature were performed at the time of each sampling event.

Results of the SAV mesocosm study indicate favorable rates of TP removal for all three SAV species (Figure 23; Table 8), particularly in view of the relatively low P concentrations (mean = 59 µg/L) in the feed (“inflow”) water during this period. TP removal varied considerably among flooding cycles, due to differences in initial (canal water) TP concentration. Similarly, TP removal rate was greater during the first week of the flooding cycle than for the full 2-week cycle in response to decreasing P concentration (Figure 23). TP concentrations were reduced by an average of 75, 68 and 61 percent in the *Potamogeton*, *Ceratophyllum* and *Najas* mesocosms during the reporting period (Table 8). Mean final TP concentrations in the mesocosm floodwater were 14, 17 and 22 µg/L, respectively. Mass removal of P was modest, due to the low inflow P concentrations: 0.54, 0.51 and 0.45 mg/m²-d, equivalent to 0.20, 0.18 and 0.16 g/m²-yr, for *Potamogeton*, *Ceratophyllum* and *Najas*, respectively.

Reduction in TN concentration was minimal overall, and only *Ceratophyllum* demonstrated positive TN removal (average of 1 percent removal) (Table 8). The low removal rates observed here are not unexpected, as inflow TN concentrations were relatively low, approaching the theoretical minimum level found in treatment wetland outflows. It should also be noted that the average increase in TN concentration (final minus initial TN) for the *Najas* and *Potamogeton* mesocosms was relatively small (0.13 and 0.24 mg/L, respectively).

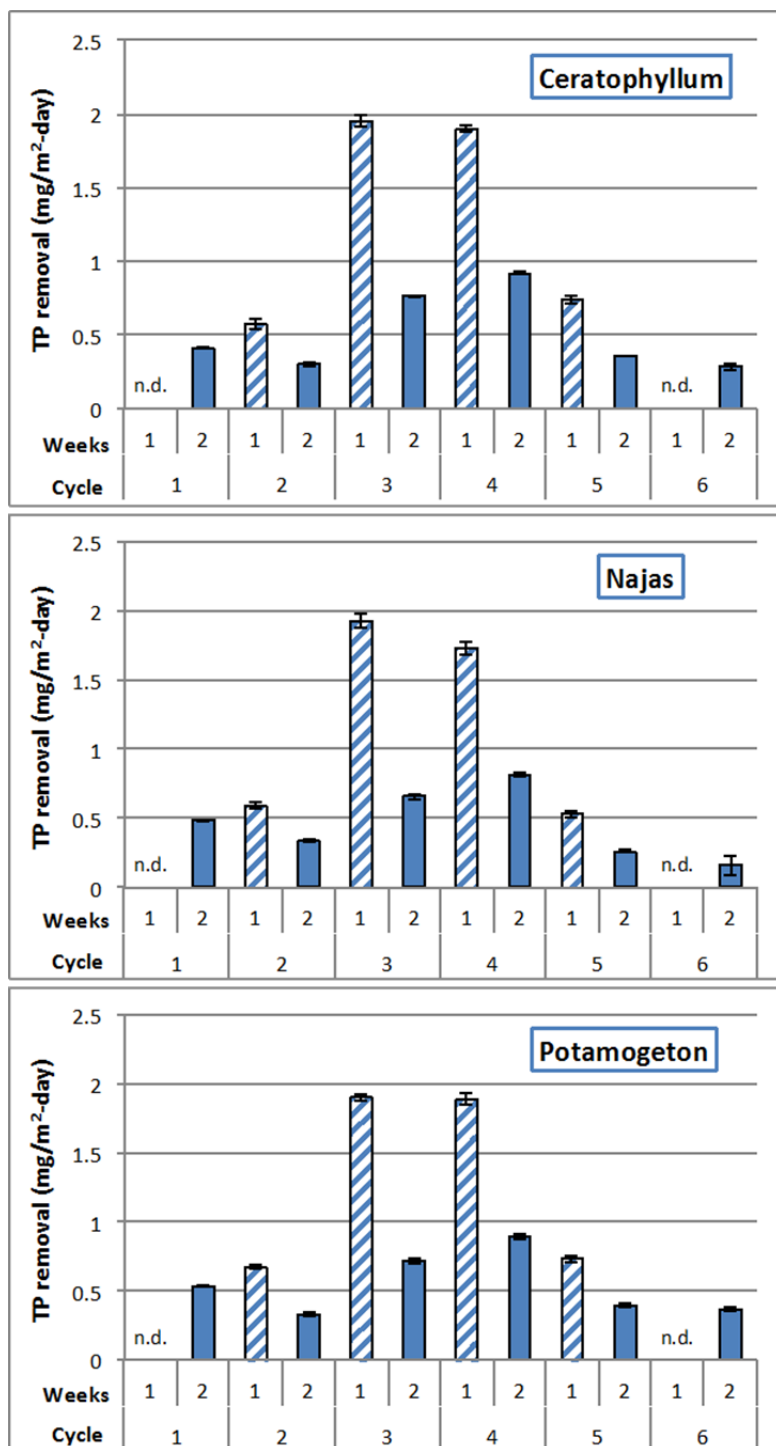


Figure 23. Mass P removal rates during each SAV mesocosm flooding cycle. Rates were calculated for Week 1 (hatched bars) and for the full 2-week period for each cycle (solid bars). n.d.= no data for Week 1 only, during cycles 1 and 6.

Table 8. Summary data for TP and TN concentrations, percent removal and mass removal during six flooding cycles in SAV mesocosms at the Hilliard project site. Values are overall means for triplicate mesocosm tanks for the POR 1/14/14 – 4/8/14.

Parameter	Units	SAV species	TP	TN
Initial concentration	µg/L	All	59	1.15
Final concentration	µg/L	Ceratophyllum	17	1.13
		Najas	22	1.26
		Potamogeton	14	1.37
Percent removal	%	Ceratophyllum	68%	1%
		Najas	61%	-11%
		Potamogeton	75%	-20%
Mass removal	mg/m ² -d	Ceratophyllum	0.51	0.31
		Najas	0.45	-1.26
		Potamogeton	0.54	-2.65
	g/m ² -yr	Ceratophyllum	0.18	0.11
		Najas	0.16	-0.46
		Potamogeton	0.20	-0.97

Vegetation Inoculation and Planting

As noted above, our vegetation surveys performed during fall 2013 demonstrated the presence of three key FAV species in the inflow canal: water hyacinth, water lettuce and pennywort. In April 2014, however, the HHWCD contracted for an aerial herbicide application to eliminate unwanted vegetation in their District canals. Based on our May 2014 surveys, this herbicide application eliminated all stands of *Pistia* and *Hydrocotyle*. However, we did locate three nearby healthy stands of *Eichhornia*: one in the Hendry-Hilliard canal, one in the McKinney canal, and one within the site itself, near the recently fabricated pump station. During June 2014, these stands therefore were used as donor sites for inoculating FAV into Cells 1 and 2 of the wetland.

In contrast with the *Eichhornia*, most of the SAV previously observed in the site field ditches was eliminated due to construction activities and dry season conditions. However, during late May 2014 some small stands of *Ceratophyllum* and *Utricularia* were successfully located within and adjacent to several onsite cypress domes. These stands were utilized as

a donor site for plant material, and upon flooding of the wetland we also transported additional SAV species from off-site to increase the diversity of desired species (such as *Potamogeton*).

Following review of our EAV growth study findings, cattail was selected as a candidate species for cultivation on the vegetated earthen berms that provide internal compartmentalization within the individual wetland cells. While giant bulrush exhibited favorable growth in the mesocosms, we anticipate that it will be subjected to excessive stress during the 1 – 2 month drydown period that Cell 1 and 2 will experience each dry season during the FAV tilling process. We therefore selected an alternative species, *Thalia geniculata*, to be planted in concert with cattail on the vegetated berms. *Thalia* reportedly has greater tolerance to periodic drydown than does giant bulrush.

Soil Assessments

Soil characterization studies were performed prior to the onset of construction activities to provide guidance as to the potential release of nutrients upon initial flooding, and to provide baseline information prior to the tilling activities that will take place every dry season.

Soil samples were collected for chemical analysis on September 19, 2013 at 40 locations within the project boundaries (Figure 24). Sampling sites were distributed among Cells 1 (18 sites), 2 (10 sites) and 3 (12 sites), with the highest density of sampling sites located toward the upstream end of the treatment system site. Soil samples were collected with a bucket auger (Figure 25), to a depth of 15 cm (6 inches). Prior to sampling, vegetation (primarily grass species) and associated “thatch” (e.g., dead plant material and surface root mat) were removed to expose the surface of the top-soil. This step was performed to exclude plant material from the soil sample and to effectively mimic the conditions that will be imposed (i.e., sod removal) prior to inundation of the site.

Soils from all sampling sites were analyzed for TP, TN, TC and ash content using standard methods of analysis. In addition, we performed two standard soil-test extraction procedures on soils from each site, the water extraction and Mehlich-1 (a.k.a. dilute double

acid) extraction. The filtered solution from the water extraction was analyzed for dissolved P, and the filtrate from the Mehlich-1 extraction was analyzed for dissolved P, Fe and Al, using standard methods.

Concentrations of Mehlich-1 P, Fe and Al were used to calculate P Saturation Ratios (PSR) and Soil P Storage Capacity (SPSC) for each sampled site, as follows:

$$\text{PSR} = (\text{Mehlich1 P}/31) / [(\text{Mehlich-1 Fe}/56) + (\text{Mehlich-1 Al}/27)] , \text{ and}$$

$$\text{SPSC} = (\text{Threshold PSR} - \text{Soil PSR}) * \text{Mehlich 1}-[(\text{Fe}/56) + (\text{Al}/27)] * 31 * x \text{ (mg/kg)},$$

where $x = 1.3$, is a conversion factor using Mehlich-1 values rather than the oxalate-extractable concentrations for which the equation was originally derived. The threshold PSR is the soil PSR above which the P concentration in soil solution abruptly increases. A threshold PSR of 0.1 was previously experimentally determined for manure-impacted sandy soils (e.g. Spodosols) in south/central Florida (Nair et al. 2010a).

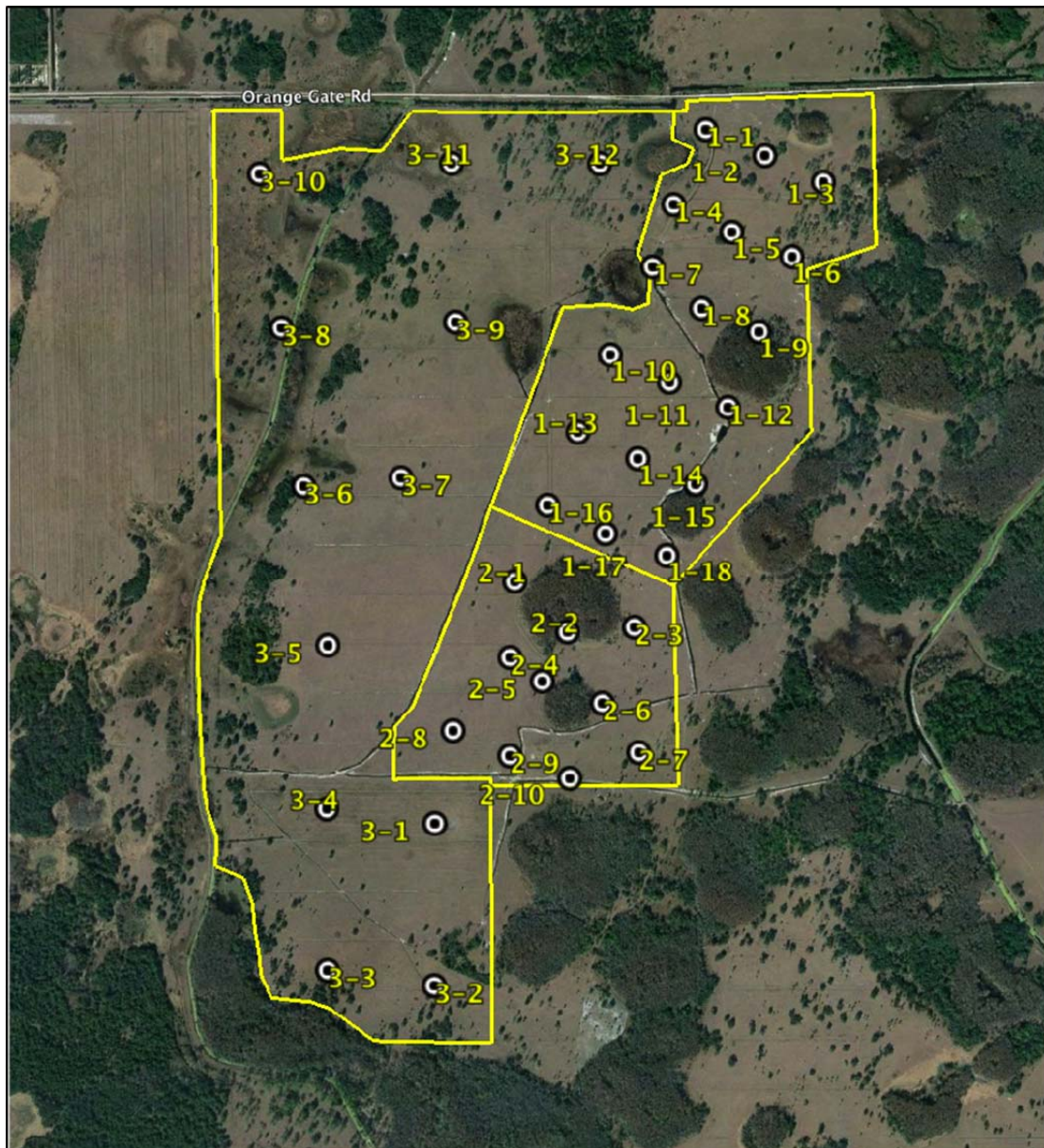


Figure 24. Site map depicting 40 soil sampling stations within the FAVT project boundary, sampled 9/19/13 during the pre-inundation site evaluation.



Figure 25. Soil collection using a bucket auger. Soil samples were collected at 40 sites within the FAVT project boundaries for initial chemical characterization.

Total P, N and C Analysis

Results of pre-inundation analysis of soil TP, TN, TC and ash (mineral) content are presented in Table 9. Vegetation (typically grasses) and associated “thatch” were removed from the soil surface prior to collection of the samples, which served to mimic the scenario of a field where sod has been harvested. Although some of the soil series represented at the project site are classified as “depressional”, surface soils at all sites were sandy and low in OM content relative to typical wetland soils. For example, the median soil organic matter content was 2.0%, with 90-percentile and maximum levels of 4.6% and 8.8%, respectively.

Total P and total N content were, accordingly, relatively low in these top-soils. Maximum TP and TN concentrations were 184 mg/kg and 0.465%, respectively, compared with median and 90-percentile values of 39 and 76 mg/kg for TP and 0.043 and 0.116% for TN. The TN content was highly correlated with OM content ($r=0.874$; $P<0.0001$), while TP content showed a somewhat lower, but significant, correlation with OM content ($r=0.628$; $P<0.0001$). This suggests that soil P is associated with inorganic compounds containing Fe

or Al, in addition to organic compounds in the soil OM matrix. Given the typically acidic soil pH levels in the project area (Source: USDA Soil Survey for Hendry County), it is unlikely that Ca is a major controlling factor in soil P mobility.

Concentrations of soil TC, OM, TP and TN were not significantly different among soil series or among FAVT Cells 1, 2 and 3. Thus, spatial variability of these soil properties appeared to be “random”, and may be related to spatial and temporal patterns of livestock usage.

Table 9. Results of initial soil chemical analysis for the project site. Soils were sampled to a depth of 15 cm. Sample collection date was 9/19/13.

Station ID	TP mg/kg	Ash %	TC %	TN %
1-1	34	97.6	1.46	0.043
1-2	36	96.9	1.71	0.106
1-3	65	93.6	3.55	0.185
1-4	20	99.1	0.854	0.043
1-5	51	96.2	2.04	0.138
1-6	33	97.4	1.35	0.095
1-7	76	98.1	1.23	0.112
1-8	15	98.5	1.06	0.043
1-9	24	98.9	0.567	0.043
1-10	59	98.3	0.66	0.043
1-11	63	98	0.961	0.043
1-12	76	97.1	1.73	0.043
1-13	49	98.1	1.24	0.043
1-14	59	98.2	1.09	0.043
1-15	47	98.5	0.962	0.043
1-16	43	96.2	1.93	0.086
1-17	55	97.4	1.75	0.108
1-18	33	97.8	1.46	0.043
2-1	22	98.1	1.39	0.043
2-2	59	97.9	1.21	0.106
2-3	56	94.8	2.89	0.101
2-4	22	98	1.34	0.043
2-5	48	97.8	1.21	0.043
2-6	83	97.5	1.36	0.043
2-7	29	98.6	0.747	0.043
2-8	20	98.5	0.966	0.043
2-9	22	98.8	0.559	0.043
2-10	46	97.1	1.94	0.043
3-1	28	98.3	0.956	0.043
3-2	25	98.1	1.22	0.043
3-3	59	95.3	3.06	0.117
3-4	19	98.4	1.05	0.043
3-5	40	96.2	2.46	0.116
3-6	37	98.5	0.841	0.043
3-7	36	97.4	1.68	0.092
3-8	22	98.4	0.615	0.043
3-9	37	98.1	1.43	0.043
3-10	184	96.7	2.21	0.111
3-11	182	91.2	5.48	0.457
3-12	38	98.4	1.09	0.043

Soil P Loss Potential and P Storage Capacity

Determination of water extractable soil test P (STP) concentrations is commonly used for agricultural soils in Florida and the southeastern U.S. because of its correlation with SRP concentrations in field runoff. The Mehlich 1 soil test for P, also known as the dilute double acid extraction, extracts P from Al, Fe and Ca phosphates and is best suited to acid soils (pH < 6.5) with low cation exchange capacities (< 10 cmol/kg) and OM contents (< 5%). Thus, water extractable P (water soluble P) can be regarded as an indicator of readily leached soil P, while Mehlich-extractable P includes forms of P more tightly bound to the soil, primarily by Fe or Al compounds in non-calcitic soils.

The tendency for a soil to leach P to underlying groundwater, or to overlying floodwater, when inundated is dependent on multiple factors related to storage capacity and antecedent P loading. Accordingly, a number of indices of potential soil P loss and/or P storage have been developed for various soils and climatic regions. Two such indices that have been designed for use in south Florida's sandy pasture soils (e.g., Spodosols) are the PSR and SPSC (Nair et al, 2010a,b). The PSR is a more precise indicator of P loss risk than traditional STP analysis (e.g., Mehlich-1), whereas the SPSC adds a capacity dimension that enables the prediction of how much P can be loaded prior to the onset of significant risk. Here we use these indices as semi-quantitative indicators of potential short-term soil P loss following inundation, which can be readily determined for a large number of sampling sites.

The ratio of sorbed P (P held by the soil) to the sum of the components (Fe and Al) to which it is mainly sorbed is a useful indicator of the "change point", or threshold PSR, at which a soil becomes a P source to the environment. In other words, the risk of phosphorus release greatly increases when the PSR exceeds the threshold. A PSR of ca. 0.1 was previously determined for manure-impacted Spodosols by Institute of Food and Agricultural Sciences (IFAS) researchers. The SPSC is a calculation that accounts for P loss risks arising from previous loading as well as inherently low P sorption capacity. It provides a direct estimate of the amount of P a soil can hold before exceeding a threshold soil equilibrium concentration, i.e., before the soil becomes an environmental risk. Hence it captures the

high risk for soils with very low inherent P retention capacity but that have low STP concentration and PSR. It also identifies soils with elevated STP that still have additional capacity to store P due to their relatively high P retention capacity.

Results of analysis of water-soluble P (WSP) and Mehlich-1 extractable Al, Fe and P for soils collected at 40 sampling locations are shown in Table 10. Water-soluble P is an easily determined, but less precise, indicator of the amount of P that will be released from a soil when in contact with water (runoff or flooding). Also shown are values calculated for PSR and SPSC, and an assessment of risk/no risk for soil P loss based on negative or positive values, respectively, of SPSC. Note that the PSR provides the same information for risk of P loss, since the assigned value for threshold PSR (0.1 in this case, determined from analysis of a large number of similar soils) determines the transition point (positive to negative) for SPSC. However, SPSC also provides a theoretical value for the magnitude of P loss or retention, which, at a minimum, can be used to compare the potential extent of P loss or retention among sampling sites.

Data for soil TP, WSP, PSR and SPSC were grouped and summarized according to location with respect to the proposed FAV and SAV cells (Cells 1, 2 and 3; Figure 26). Summary values for the respective treatment cells suggest that, on the whole, soils in Cells 1 and 2 represent a slight risk for P loss upon inundation, while Cell 3 soils may represent a somewhat greater risk. However, it should be noted that variability of P-related soil properties is relatively high within each cell (more so in Cell 3), due in part to the heterogeneous nature of manure impact, but also to differences in inherent soil properties (Table 9). Note also that the mean and median values shown in Figure 26 represent the potential “net effect” of soil condition, with respect to P loss potential.

Results of the previously reported flooded soil core flux study for 10 selected soil characterization locations within the Hilliard project site indicated widely-ranging rates of soil P flux upon inundation, ranging from negligible (0.2) to 26 $\mu\text{g P/m}^2\text{-day}$. Determinations of the risk of soil P loss using the PSR and SPSC soil P indices were in relatively good agreement with the core flux study results, and allowed for assessment of soils at all 40 soil sampling sites. The release of soil nutrients predicted by these tests

suggests that water will need to be held in the wetland (with no discharge) for a period of time after initial flooding, to allow for vegetative assimilation and microbial processes to reduce “first-flush” constituent concentrations. During the initialization period, inflow canal water therefore was added to fill the wetland, and to maintain water levels at desired stages for vegetation grow-in, but Cell 3 outflow culverts were closed to discharge at this time.

Table 10. Results of water extraction for P (WSP) and Mehlich – 1 extraction for Al, Fe and P, for soils collected at 40 locations at the Hilliard project site. PSR and SPSC were calculated as outlined in the Methodology section.

Locations of sampling sites are shown in Figure 24.

Station ID	WSP mg/kg	Mehlich-1 Al mg/kg	Mehlich-1 Fe mg/kg	Mehlich-1 P mg/kg	PSR	SPSC mg/kg	Risk for P release
1-1	5	29	8.4	4.5	0.12	-0.92	Y
1-2	5.2	19	2	6.7	0.29	-5.73	Y
1-3	10.1	21	9	7.5	0.26	-5.97	Y
1-4	1.5	22	13	2.6	0.08	0.84	
1-5	6.1	20	11	6.9	0.24	-5.19	Y
1-6	6.3	21	4.8	5.8	0.22	-4.06	Y
1-7	3.2	26	12	17.8	0.49	-18.40	Y
1-8	1.3	17	26	2.7	0.08	0.90	
1-9	1.5	11	6.7	1.8	0.11	-0.22	Y
1-10	0.5	37	21	3	0.06	3.13	
1-11	2.1	21	16	2.7	0.08	0.78	
1-12	2.7	32	9.4	2.4	0.06	2.33	
1-13	1.9	33	12	2.5	0.06	2.54	
1-14	2	25	18	3.7	0.10	0.22	
1-15	2	39	2	3	0.07	2.07	
1-16	4.5	36	7.8	5.3	0.12	-0.96	Y
1-17	2	27	34	6.7	0.13	-2.23	Y
1-18	3.3	37	23	3.9	0.07	2.11	
2-1	1.4	49	20	3	0.04	4.85	
2-2	2.6	60	6.3	6	0.08	1.61	
2-3	3.4	54	8.2	4	0.06	3.45	
2-4	1.6	27	8.8	5.5	0.15	-2.49	Y
2-5	1.2	62	19	2.5	0.03	7.37	
2-6	1.8	34	8.2	3.7	0.08	0.85	
2-7	3.5	17	2	4	0.19	-2.52	Y
2-8	3.9	13	4.6	4	0.23	-2.93	Y
2-9	1.9	21	5.5	2.7	0.10	0.02	
2-10	4.9	18	6.8	4.1	0.17	-2.15	Y
3-1	3.4	14	2	3.7	0.22	-2.58	Y
3-2	4.8	16	7.7	4.5	0.20	-2.91	Y
3-3	6.5	44	12	6.8	0.12	-1.41	Y
3-4	3.5	6.6	2	3.2	0.37	-3.03	Y
3-5	5.6	13	7.2	5.1	0.27	-4.17	Y
3-6	10.5	15	5.2	8.7	0.43	-8.70	Y
3-7	3.9	17	12	4.8	0.18	-2.84	Y
3-8	3.6	7.6	2	3.7	0.38	-3.53	Y
3-9	1.3	45	88	3.3	0.03	8.76	
3-10	2.2	69	14	74.3	0.85	-85.28	Y
3-11	2.4	169	24	4.5	0.02	21.10	
3-12	2.6	41	16	4.4	0.08	1.55	

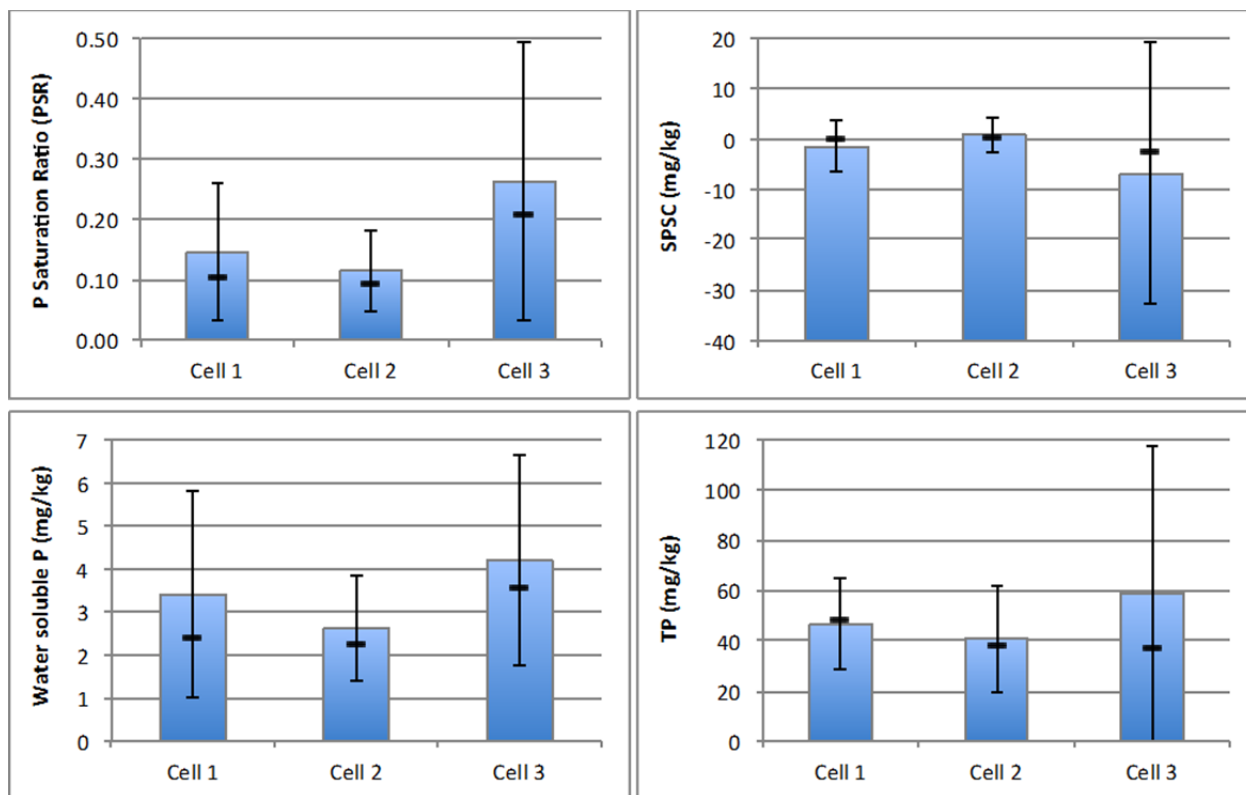


Figure 26. Mean (bar height), median (horizontal lines) and standard deviation (error bars) of P loss potential, storage capacity, WSP and TP values calculated for sites within the proposed boundaries of Cells 1, 2 and 3 of the Hilliard treatment wetland.

Soil-Vegetation Tilling Trials

Several trials were performed in May 2014 to provide insight into the most appropriate tilling equipment and techniques for “burying” FAV, given the soil conditions at the wetland site. A Nammco disk plow and a John Deere moldboard plow (Figure 27) were tested both on undisked (with surface vegetation intact) and previously disked (to break up surface vegetation) parcels.



Figure 27. Moldboard (left) and disk (right) plows.

Based on these trials, the “optimum” protocol for “burial” of FAV biomass at this site during periods of wetland cell drydown will be as follows:

1. Make two passes of a small disc (each pass at a different angle) to break apart and chop the stranded floating vegetation.
2. Plow under the chopped biomass, using either a large Nammco or Baker disk plow
3. Make a final pass with a disc or other implement to smooth out the soil. This will eliminate isolation and ponding of water during the subsequent dry season, and facilitate more rapid drydown of the wetland.

We anticipate that the first full-scale tilling effort in Cells 1 and 2 will be performed in spring 2015, following grow-in of the FAV standing crop (during summer/fall 2014), and at a time when there is little to no basin rainfall.

Permitting and Operating Agreement Requirements

The authorizations and agreements obtained from the SFWMD and HHWCD for the construction and operation of the FAVT Project require inspection, monitoring and reporting as described below.

Memorandum of Understanding

A Memorandum of Understanding (MOU) between the SFWMD, HHWCD and WSSLLC for the operation of the FAVT project has been agreed upon by the three parties. The MOU allows for pass-through of water to and from the FAVT Project from the C-43 Canal using conveyance facilities of the HHWCD; protects the consumptive water use rights of existing legal users; and establishes monitoring and reporting requirements to be implemented by WSSLLC. A copy of the executed MOU is contained in Appendix I.

The MOU identifies the sources of water the FAVT project can treat, which primarily includes local runoff in HHWCD canals and discharges from Lake Okeechobee in the C-43 Canal. The MOU contains conditions under which the project can be operated to treat water from either source, and requires monitoring and reporting to demonstrate compliance with the conditions. Parameters to be monitored include canal stages within HHWCD, discharges from Lake Okeechobee to the C-43 Canal and salinity conditions within the Caloosahatchee Estuary. Daily values of the monitoring parameters will be included in the monthly monitoring report submitted to SFWMD.

In addition to monitoring inflow and outflow quantities of the FAVT project treatment wetland, additional flow monitoring is required by the MOU within the HHWCD conveyance system such that consumptive water use withdrawals by HHWCD from the C-43 Canal can be accounted for separately from FAVT Project withdrawals from the C-43 Canal. Daily flow values will be monitored and included in the monthly monitoring report submitted to SFWMD.

The MOU also requires a copy of the Final Technical Report (as prepared for FDACS in accordance with contract requirements) and verification of continued operational funding to be submitted annually to SFWMD.

Annual Above Ground Impoundment Inspection

The SFWMD issued an Environmental Resource Permit Exemption (Permit No. 26-00003-S-04, Application No. 130930-20) for the FAVT Project. SFWMD staff has requested the above ground impoundment system associated with the FAVT Project be inspected annually and reported to the SFWMD concurrently with the adjoining permitted above ground impoundment system associated with the Hopedelage agricultural development (Application Nos. 931228-2 and 101019-32).

Environmental Monitoring of Existing Wetland

No permitting was required for environmental monitoring of wetlands during the contract period.

GIS Data Layers & As-Built Drawings

GIS data layers associated with the FAVT Project include both 'point' and 'polygon' features. FAVT project culverts, pumps, and monitoring points are provided as point features. The FAVT project boundary and cell boundaries are provided as polygon features. The watershed area within the HHWCD being served by FAVT project is also provided as a polygon feature. Figure 28 is an overlay of the GIS data layers on an aerial photograph. An electronic copy of the complete set of GIS data layers are being transmitted with this Report and are available in the FDACS Dropbox (Filename EDFAVT_GIS Data Layers).

Water & Soil Solutions contracted with a surveyor licensed in the State of Florida (Cooner & Associates, Inc.) to collect as-built survey data in the field and prepare the final as-built survey drawings. The as-built drawings are contained in Appendix II.

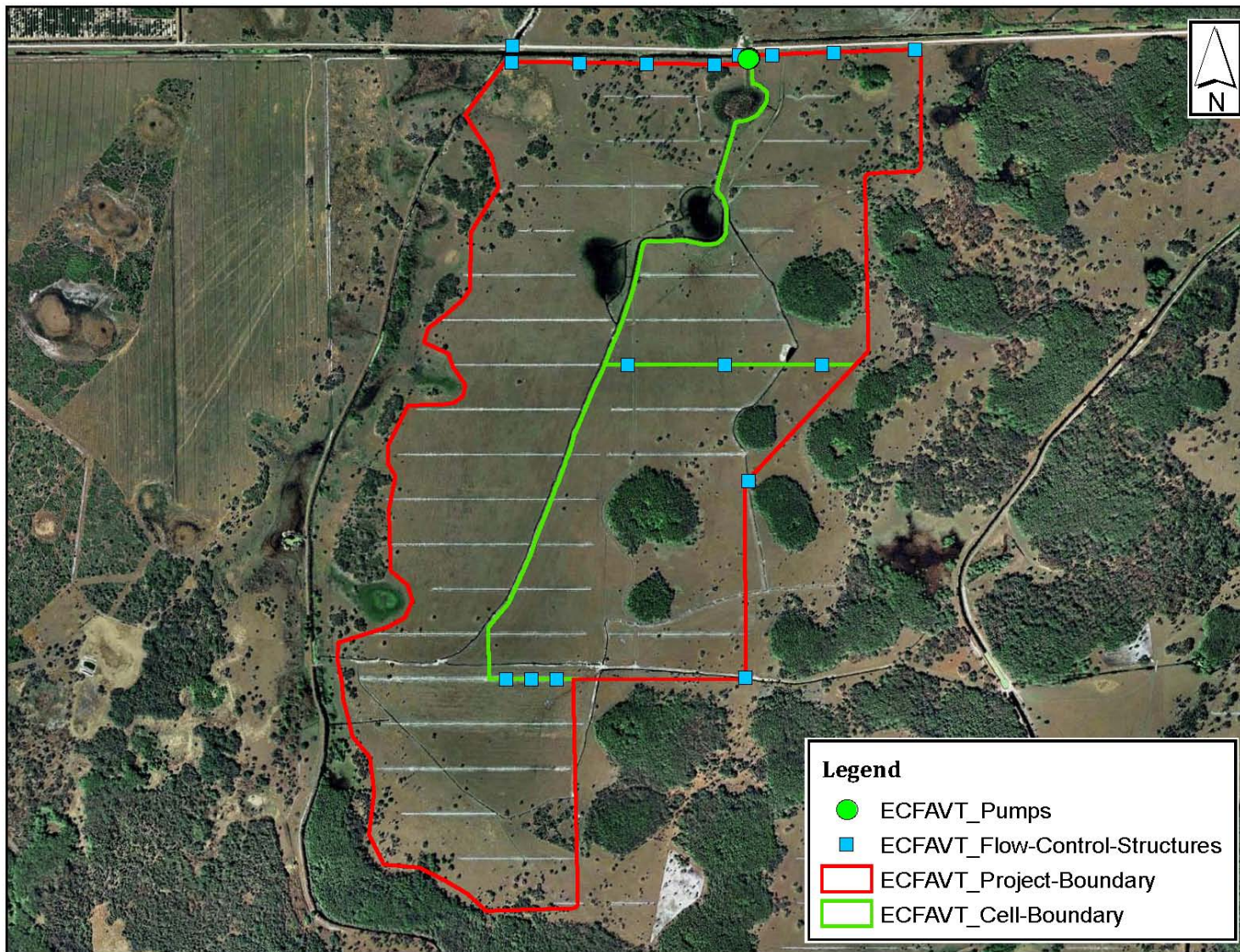


Figure 28. Overlay of FAVT GIS Data Layers on an Aerial Photograph

Appendices

Appendix I. Memorandum of Understanding: South Florida Water Management District, Hendry-Williard Water Control District, and Water and Soil Solutions, LLC, Regarding Operation and Monitoring of the East Caloosahatchee River FAVT Project.
(Click to open linked file.)

**MEMORANDUM OF UNDERSTANDING BETWEEN THE SOUTH FLORIDA
WATER MANAGEMENT DISTRICT, HENDRY-HILLIARD WATER CONTROL
DISTRICT, AND WATER AND SOIL SOLUTIONS, LLC, REGARDING
OPERATION AND MONITORING OF THE EAST CALOOSAHATCHEE RIVER
FLOATING AQUATIC VEGETATIVE TILLING PROJECT**

THIS MEMORANDUM OF UNDERSTANDING ("MOU") is made and entered into by and between the SOUTH FLORIDA WATER MANAGEMENT DISTRICT ("DISTRICT"), HENDRY-HILLIARD WATER CONTROL DISTRICT ("HHWCD"), and WATER AND SOIL SOLUTIONS, LLC ("WSS"), collectively referred to as the PARTIES.

WITNESSETH:

WHEREAS, the DISTRICT is a public corporation of the State of Florida existing by virtue of Chapter 25270, Laws of Florida, 1949, and operating pursuant to Chapter 373, Florida Statutes, and Chapter 40E, Florida Administrative Code, as a multipurpose water management district, and whose mailing address is PO Box 24680, West Palm Beach, Florida 33416-4880;

WHEREAS, the HHWCD is a public corporation of the State of Florida existing by virtue of Chapter 86-394, Laws of Florida, as now existing and authorized by Chapter 2000-452, Laws of Florida, and operating as a water control district pursuant to Chapter 298, Fla. Stat., and whose mailing address is 5500 Flaghouse Road, Clewiston, Florida 33440;

WHEREAS, WSS is a Florida limited liability company whose mailing address is 16112 East Duran Road, Loxahatchee, Florida 33470;

WHEREAS, Section 373.083(1), Fla. Stat., authorizes the DISTRICT to enter into contracts with other public agencies, private corporations or other persons;

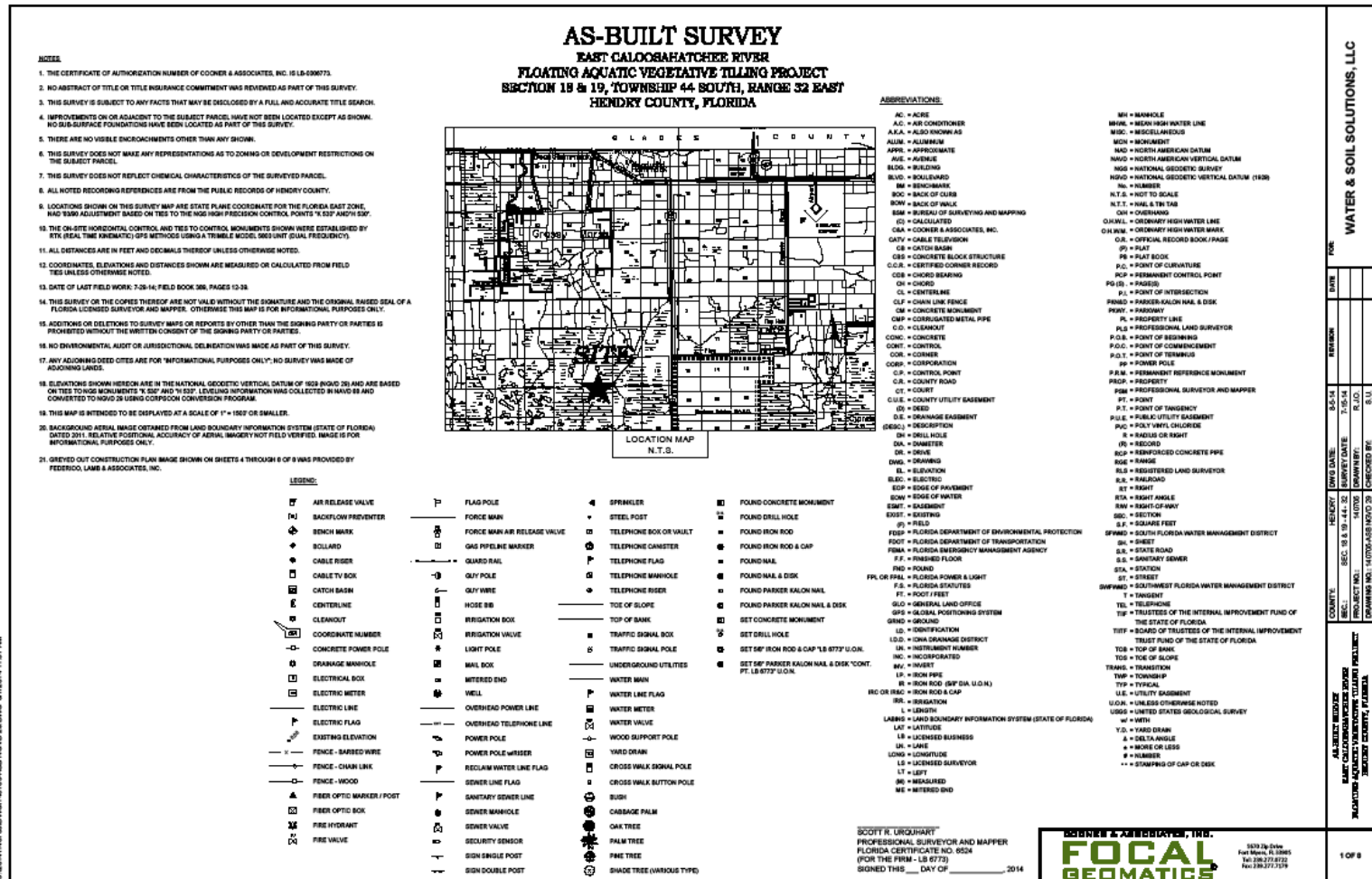
WHEREAS, HHWCD holds Consumptive Use Permit Number 26-00003-W, authorizing the diversion and impoundment of up to 56,522 million gallons of water from the C-43 Canal per year in order to maintain canal elevations and serve agricultural uses;

WHEREAS, HHWCD also holds Consumptive Use Permit Number 22-00189-W, authorizing the diversion and impoundment of up to 5,310 million gallons of water from the C-43 Canal per year in order to maintain canal elevations and serve agricultural uses;

WHEREAS, WSS uses a patented technology known as Floating Aquatic Vegetative Tilling ("FAVT") to remove phosphorus and nitrogen from surface waters;

WHEREAS, Marlin W. Hilliard Revocable Trust owns certain undeveloped property lying within Sections 18 and 19, Township 44 South, Range 32 East upon which it has allowed WSS to design, construct, and operate a FAVT pilot project referred to as the East Caloosahatchee River Floating Aquatic Vegetative Tilling Project. A map depicting

Appendix II. East Caloosahatchee River FAVT Project As-built Survey Drawings prepared by Cooner & Associates, Inc. (eight drawing sheets total).
(Click to open linked file.)



References

Nair, V. D., W. G. Harris, and D. Chakraborty. 2010a. An indicator for risk of phosphorus loss from sandy soils. Fact Sheet SL333. Florida Cooperative Extension Service, IFAS, University of Florida, Gainesville.

Nair, V. D., W. G. Harris, D. Chakraborty, and M. Chrysostome. 2010b. Understanding soil phosphorus storage capacity. Fact Sheet SL336. Florida Cooperative Extension Service, IFAS, University of Florida, Gainesville.

**MEMORANDUM OF UNDERSTANDING BETWEEN THE SOUTH FLORIDA
WATER MANAGEMENT DISTRICT, HENDRY-HILLIARD WATER CONTROL
DISTRICT, AND WATER AND SOIL SOLUTIONS, LLC, REGARDING
OPERATION AND MONITORING OF THE EAST CALOOSA HATCHEE RIVER
FLOATING AQUATIC VEGETATIVE TILLING PROJECT**

THIS MEMORANDUM OF UNDERSTANDING ("MOU") is made and entered into by and between the SOUTH FLORIDA WATER MANAGEMENT DISTRICT ("DISTRICT"), HENDRY-HILLIARD WATER CONTROL DISTRICT ("HHWCD"), and WATER AND SOIL SOLUTIONS, LLC ("WSS"), collectively referred to as the PARTIES.

WITNESSETH:

WHEREAS, the DISTRICT is a public corporation of the State of Florida existing by virtue of Chapter 25270, Laws of Florida, 1949, and operating pursuant to Chapter 373, Florida Statutes, and Chapter 40E, Florida Administrative Code, as a multipurpose water management district, and whose mailing address is PO Box 24680, West Palm Beach, Florida 33416-4680;

WHEREAS, the HHWCD is a public corporation of the State of Florida existing by virtue of Chapter 86-394, Laws of Florida, as now existing and authorized by Chapter 2000-452, Laws of Florida, and operating as a water control district pursuant to Chapter 298, Fla. Stat., and whose mailing address is 5500 Flaghole Road, Clewiston, Florida 33440;

WHEREAS, WSS is a Florida limited liability company whose mailing address is 16112 East Duran Road, Loxahatchee, Florida 33470;

WHEREAS, Section 373.083(1), Fla. Stat., authorizes the DISTRICT to enter into contracts with other public agencies, private corporations or other persons;

WHEREAS, HHWCD holds Consumptive Use Permit Number 26-00003-W, authorizing the diversion and impoundment of up to 56,522 million gallons of water from the C-43 Canal per year in order to maintain canal elevations and serve agricultural uses;

WHEREAS, HHWCD also holds Consumptive Use Permit Number 22-00189-W, authorizing the diversion and impoundment of up to 5,310 million gallons of water from the C-43 Canal per year in order to maintain canal elevations and serve agricultural uses;

WHEREAS, WSS uses a patented technology known as Floating Aquatic Vegetative Tilling ("FAVT") to remove phosphorus and nitrogen from surface waters;

WHEREAS, Marlin W. Hilliard Revocable Trust owns certain undeveloped property lying within Sections 18 and 19, Township 44 South, Range 32 East upon which it has allowed WSS to design, construct, and operate a FAVT pilot project referred to as the East Caloosahatchee River Floating Aquatic Vegetative Tilling Project. A map depicting

the FAVT Project location, flow path, and water control facilities is attached hereto as Exhibit A;

WHEREAS, the FAVT Project is a 523-acre treatment reservoir consisting of three shallow above-ground impoundment cells configured in a series containing aquatic vegetation. A map depicting the FAVT Site Plan is attached hereto as Exhibit B;

WHEREAS, WSS received exemption 26-00003-S-04 for the construction of the FAVT Project;

WHEREAS, the purpose of the FAVT Project is to remove phosphorus and nitrogen from stormwater captured in HHWCD's canals and the easternmost reach of the Caloosahatchee River (C-43 Canal), which is located between S-77 and S-78;

WHEREAS, the Florida Department of Agriculture and Consumer Services ("FDACS") has provided funding for the 2014-2015 Fiscal Year to fund the FAVT Project;

WHEREAS, whether FDACS funds this project in future is uncertain at this time; and,

WHEREAS, the DISTRICT wishes to promote a cooperative relationship between itself, HHWCD, and WSS for the purpose of exploring opportunities to reduce nitrogen and phosphorus levels.

NOW THEREFORE, in consideration of the foregoing premises, and the mutual covenants, terms, and conditions contained herein, the PARTIES agree to the following:

I. The FAVT Project shall be operated in accordance with the protocol set forth below:

A. Local Runoff:

- i. HHWCD shall notify WSS when local runoff within the boundaries of HHWCD is available. Local runoff is deemed available when the water elevation of the Orange Gate Canal exceeds 24 feet NGVD or the water elevation of the Hendry Hilliard Canal exceeds 21 feet NGVD without pumping by HHWCD's Pump Station (District ID 42460). HHWCD's boundaries and Pump Station (Location #1) are shown on Exhibit C.
- ii. Upon notification from HHWCD that local runoff is available, WSS may pump water into the FAVT Project from the Orange Gate Canal.

B. C-43 Diversion:

- i. When local runoff is not available and all of the conditions set forth below are met, WSS may request HHWCD divert water from the C-43 Canal into the Hendry-Hilliard Canal via HHWCD's Pump Station (District ID 42460).

1. The 7-day average flow released from S-79 is greater than 800 cubic feet per second (cfs) or an equivalent average daily release volume of 1,586.8 acre-feet per day;
 2. The 30-day salinity of the Caloosahatchee River, as measured at the Ft. Myers (Yacht Basin) salinity station (latitude 263907.260, longitude 815209.296), is less than 10 parts per thousand (ppt);
 3. The previous day average salinity of the Caloosahatchee River, as measured at the Ft. Myers salinity station, is less than 18 ppt; and,
 4. Lake Okeechobee is within the low, intermediate, or high operational sub-bands of the 2008 Lake Okeechobee Regulation Schedule ("LORS08") and regulatory releases are being conducted by the United States Army Corps of Engineers at S-77 and the same (or higher flow) is being passed downstream through S-78 and S-79.
 5. However, HHWCD shall not divert water from the C-43 Canal when Lake Okeechobee is within the LORS08 low or intermediate operational sub-bands and the releases being conducted at S-77 are to supplement flows of the base-flow type measured at S-79 ("S-79 up to 450 cfs S-80 up to 200 cfs").
- ii. WSS shall obtain the 7-day average flow at S-79 and the daily flows at S-77, S-78, and S-79 by referring to <http://w3.saj.usace.army.mil/h2o/reports.htm> and selecting Lake Okeechobee & Vicinity Report.
 - iii. WSS shall calculate the salinity at the Fort Myers station (site name FMYER) from specific conductivity and temperature using the PSS78 equation (UNESCO 1983: Algorithms for computation of fundamental properties of seawater. UNESCO technical papers in Marine Science 44: 1-55) by referring to the District's DBHydro database at <http://www.sfwmd.gov/portal/page/portal/xweb%20environmental%20monitoring/dbhydro%20application>.
 - iv. WSS shall obtain the United States Army Corps of Engineers regulatory release decisions for Lake Okeechobee via discharges at S-77 and S-79 from the news releases published at <http://www/saj.usace.army.mil/Media/NewsReleases.aspx>.
 - v. WSS shall determine when the conditions described in Section I.B.i are met and notify HHWCD that diversion for C-43 is warranted. Upon acknowledgement from HHWCD that water levels within the Orange

Gate Canal exceed 24 feet NGVD, WSS may operate the FAVT Project.

- vi. HHWCD will provide any necessary instruction to WSS regarding the FAVT Project inflow pump rate and outflow discharge rates depending upon ongoing water control operations within HHWCD, including agricultural irrigation supply and flood control. HHWCD will include any limitations on operating the FAVT outflow culverts based on localized conditions.

- C. Water may not be pumped into the FAVT Project when the DISTRICT has issued a water shortage warning or declared water shortage for surface water within the Lake Okeechobee Service Area.

- II. The following monitoring plan shall be implemented when the FAVT Project is operational:

- A. HHWCD shall:

- i. Measure the amount of water in million gallons diverted from the C-43 Canal through its Pump Station (noted as Location #1 on Exhibit C) on a daily basis and provide the same to WSS.

Pumping for the purpose of operating the FAVT Project shall be reported separately from pumping to meet demands set forth in Permit Numbers 26-00003-W and 22-00189-W.

- ii. Measure the water levels in canals at the locations described below and depicted on Exhibit C on a daily basis and provide the same to WSS. Water levels will be measured in feet and referenced to NGVD1929.

- 1. Hendry Hilliard canal on the south side of the pump station at Location #1;

- 2. Orange Gate Canal at Location #2;

- B. WSS shall:

- i. Measure the amount of water in million gallons pumped into the FAVT Project via the FAVT Project Inflow Pump Station (noted as Location #2 on Exhibit C) on a daily basis.

- ii. Measure the amount of water in million gallons flowing out of the FAVT Project at the FAVT Project Outflow Culverts (noted as Location #3 on Exhibit C) on a daily basis.

- iii. Measure water levels downstream of the FAVT Project at the locations described below and depicted on Exhibit C on a daily basis. Water levels will be measured in feet and referenced to NGVD1929.

- 1. McKinney Canal on the south side of Location #4; and,
- 2. Hilliard Canal on the upstream side of the culvert at Location #6.

WSS may also measure the amount of water flowing into these canals as a result of the FAVT Project on a daily basis. The amount of water flowing into the canals shall be reported in million gallons (MG).

C. Submittals to the DISTRICT:

- i. WSS shall submit the monitoring data it collects as well as the data provided to it by HHWCD to the DISTRICT on a monthly basis.
- ii. Within 15 days of execution of this MOU, WSS and the DISTRICT shall agree on a reporting form to be used to provide the monthly data submittal.
- iii. The first report shall be due to the DISTRICT 30 days from commencement of operation of the FAVT Project.
- iv. The conditions referenced in Section I.B.i that occurred when the HHWCD Pump Station was operated to divert water from the C-43 Canal into the Hendry Hilliard Canal (e.g., salinity and 7-day average flow at S-79 readings, the LORS08 sub-band) shall be included in the report.
- v. Beginning on September 30, 2015 and continuing on September 30th of each year thereafter, WSS shall submit a copy of the FAVT Project Final Annual Report prepared for FDACS to the DISTRICT.
- vi. All reports required by the MOU shall reference HHWCD's consumptive use permit numbers and this MOU and be submitted to the DISTRICT's Water Use Bureau LOSA Section Leader via regular mail using Mail Stop Code 9312 or via electronic mail via wucompliance@sfwmd.gov.

D. HHWCD and/or WSS shall notify the DISTRICT via electronic mail to wucompliance@sfwmd.gov within 24 hours of initial commencement of operation of the FAVT Project.

E. The DISTRICT shall file the monthly reports received from WSS in the permit files for Permit Numbers 26-00003-W and 22-00189-W.

- III. Notwithstanding the operational protocol set forth in Section I., WSS, in coordination with HHWCD, may operate the FAVT Project anytime while not exceeding the volumes stated in Permit Number 26-00003-W.
- IV. The operation of the FAVT Project shall not interfere with the existing legal users within Permit Nos. 26-00003-W or 22-00189-W. The operation of the FAVT Project shall not interfere with the existing drainage of lands within Permit Nos. 26-00003-W or 22-00189-W.
- V. Notices to HHWCD shall be sent to HHWCD via regular mail at the above address, attention Wayne Smith, or via electronic mail to Wcs_hb@yahoo.com.
- VI. Notices to WSS shall be sent to WSS via regular mail at the above address, attention Thomas DeBusk, or via electronic mail to tom@dbenv.com.
- VII. Violations of the MOU:
 - A. HHWCD and WSS are jointly and severally liable for compliance with the operational protocol set forth in Section I. If either HHWCD or WSS violate the operational protocol, the DISTRICT shall send HHWCD and WSS a warning letter.
 - i. HHWCD and WSS shall immediately comply with the operational protocol upon receipt of the warning letter.
 - ii. If a second violation of the operational protocol occurs, the DISTRICT may send a written notice of termination of the MOU to HHWCD and WSS.
 - B. If WSS fails to submit a monitoring report, the DISTRICT shall send WSS a warning letter. WSS shall submit any missing monitoring reports within 7 days of receipt of the warning letter. If WSS fails to provide the reports within 7 days of receipt of the warning letter, the DISTRICT may send a written notice of termination of the MOU to HHWCD and WSS.
- VIII. The term of this MOU shall commence upon its complete execution by all PARTIES and shall remain in effect for five years provided WSS submits annual documentation of funding from FDACS to the DISTRICT, or upon written notice of termination from the DISTRICT, whichever occurs first. Documentation of funding shall be submitted to the DISTRICT on August 1, 2015 and each August 1st thereafter.
- IX. MISCELLANEOUS PROVISIONS:
 - A. This MOU and the rights and obligation of the PARTIES are to be governed by, construed, and interpreted in accordance with the laws of the State of Florida.

- B. In the event of any legal proceedings arising from this MOU, venue for such proceedings shall be in the Fifteenth Judicial Circuit of Florida if filed in state court and the Southern District of Florida – West Palm Beach if filed in federal court.
- C. In such legal proceedings, the PARTIES hereby consent to trial by the court and waive the right to seek a jury trial as to any issues so triable.
- D. The PARTIES are responsible for their own attorney's fees and other court costs related to enforcement of the terms of this MOU.
- E. The PARTIES acknowledge that this MOU is a negotiated MOU, and that in no event shall the terms be construed against any party on the basis that such party, or their counsel, drafted this MOU.
- F. Nothing in this MOU is intended to constitute issuance of a consumptive use permit.
- G. This MOU constitutes the entire MOU between the PARTIES and may not be amended or modified unless agreed to and approved in writing by all PARTIES.
- H. No assignment, delegation, transfer, or novation of this MOU, or any part hereof, shall be made unless approved in writing by all PARTIES.
- I. This MOU is solely for the benefit of the PARTIES and no right or cause of action shall accrue to the benefit of any third party.
- J. This MOU authorizes HHWCD and WSS to take actions under Chapter 373, Fla. Stat., as provided herein. This MOU does not relieve HHWCD or WSS from the requirements to obtain any other federal, state, or local authorizations.
- K. This MOU does not grant any legal right to water as set forth in Chapter 373 Fla. Stat., and associated DISTRICT rules and regulations over the water diverted for and treated by the FAVT Project under this MOU.
- L. This MOU shall not be construed as a substitute for, or waiver of, any right of way, surface water management, water use, or other permits required under the DISTRICT's rules and regulations.
- M. This MOU does not convey any property right to HHWCD or WSS, nor any rights and privileges other than those specified in this MOU.
- N. The DISTRICT may terminate the MOU with or without cause at any time upon written notice to HHWCD and WSS.

- X. EXECUTION IN COUNTERPARTS: This MOU may be executed in counterparts, each of which shall be an original and all of which shall constitute the same instrument.

SOUTH FLORIDA WATER
MANAGEMENT DISTRICT
By its Governing Board

Daniel O'Keefe
Daniel O'Keefe, Chairman

Legal Form Approved:

Jennifer Bokankowitz
Jennifer Bokankowitz, Esq.

Attested:

Jackie McGowan
District Clerk/Assistant Secretary
Date: Aug 14, 2014



HENDRY-HILLIARD WATER
CONTROL DISTRICT
By its Board of Supervisors

Ken Smith
Print Name: Ken Smith
Print Title: Supervisor

Legal Form Approved:

Therese H. Grandison
Therese H. Grandison, Esq.

Attested:

Anthony Faleria
Print Name: Anthony Faleria
Date: July 16, 2014

WATER AND SOIL SOLUTIONS, LLC

Thomas DeBusk
Thomas DeBusk, Managing Member
Date: July 25, 2014

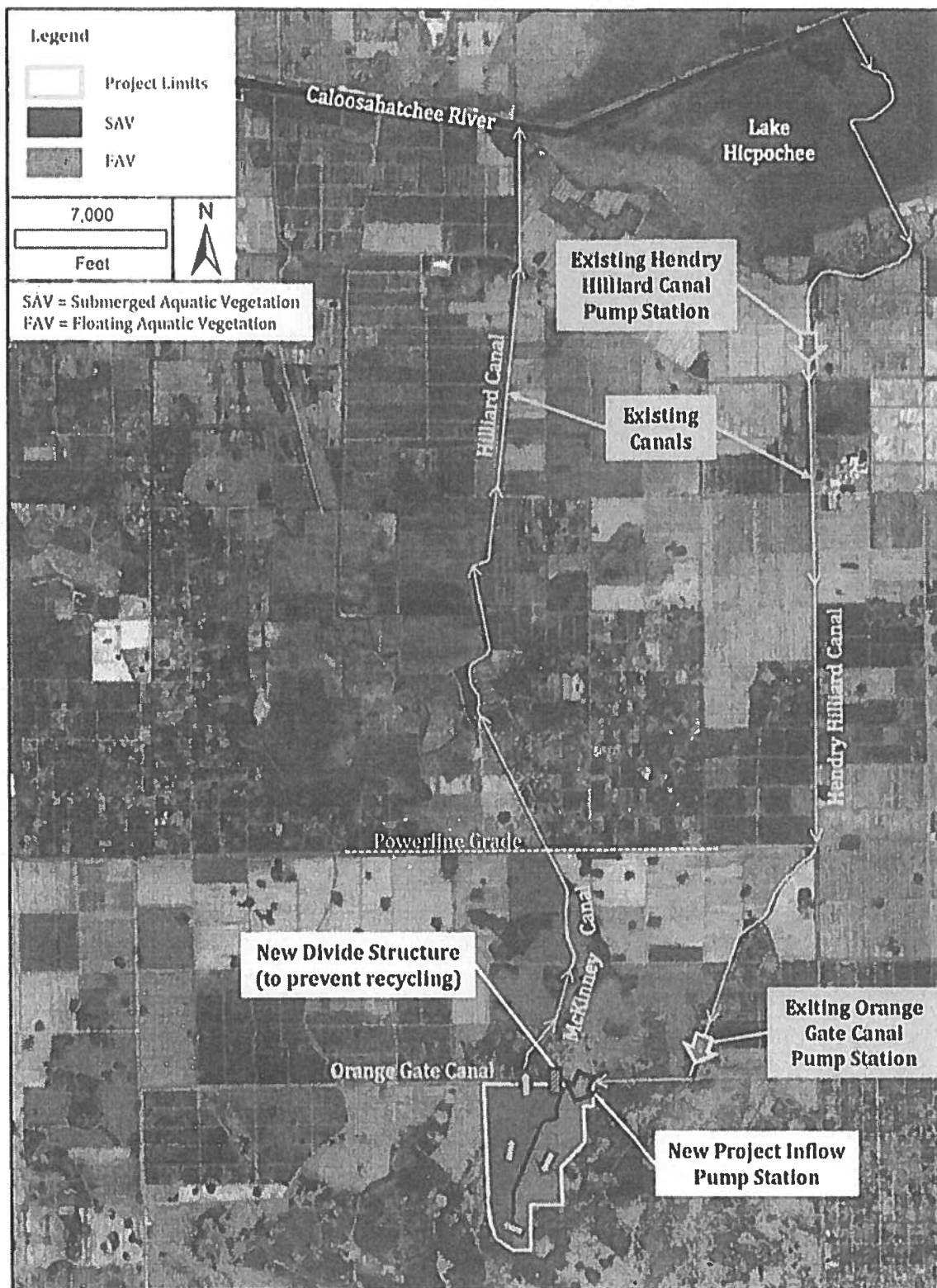
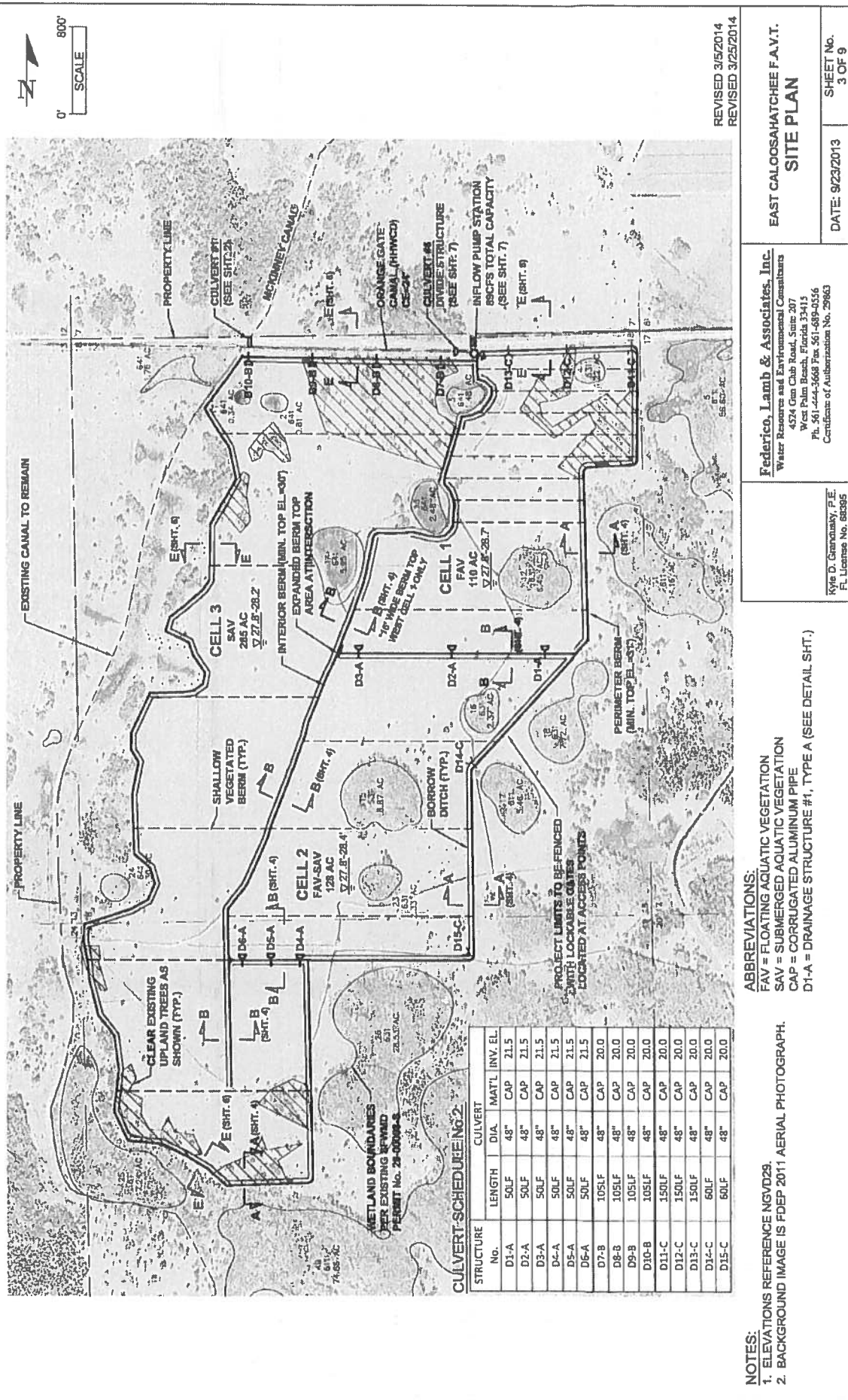


Figure 1. FAVT Project location, flow path and associated water control facilities.



NOTES:
 1. ELEVATIONS REFERENCE NGVD29.
 2. BACKGROUND IMAGE IS FDEP 2011 AERIAL PHOTOGRAPH.

ABBREVIATIONS:
 FAV = FLOATING AQUATIC VEGETATION
 SAV = SUBMERGED AQUATIC VEGETATION
 CAP = CORRUGATED ALUMINUM PIPE
 D1-A = DRAINAGE STRUCTURE #1, TYPE A (SEE DETAIL SHT.)

Federico, Lamb & Associates, Inc.
 Water Resources and Environmental Consultants
 4524 Gun Club Road, Suite 207
 West Palm Beach, Florida 33415
 Ph. 561-444-3668 Fax 561-689-0556
 Certificate of Authorization No. 29863

East Caloosahatchee F.A.V.T.
SITE PLAN

DATE: 9/23/2013 SHEET No. 3 OF 9

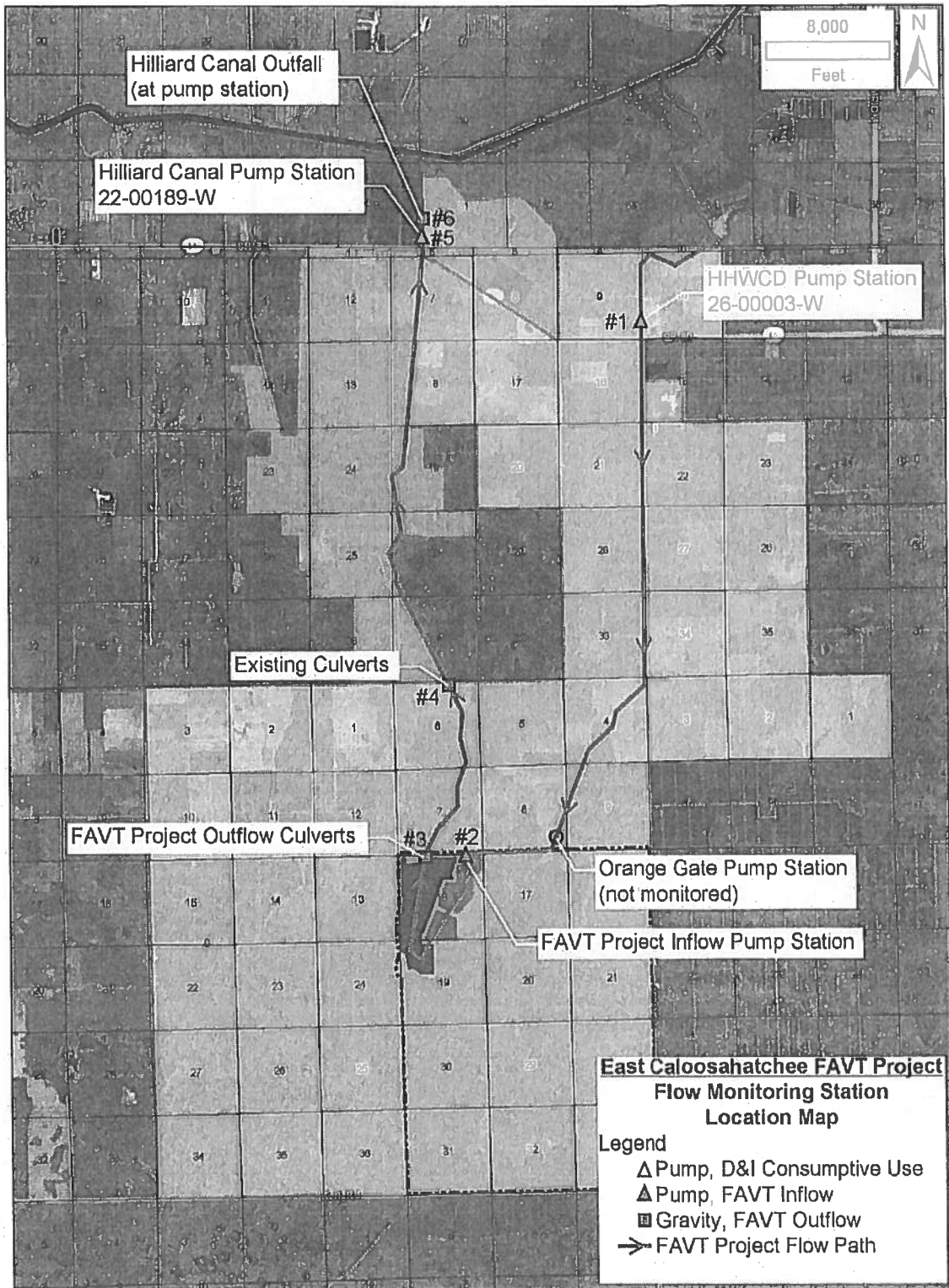


Figure 2. FAVT Project flow path, flow monitoring locations, and consumptive water use permit boundaries. The light tan shading covers the Hendry-Hilliard Water Control District permit area (26-00003-W) and the dark tan shading covers the Hilliard Canal Group permit area (22-00189-W).