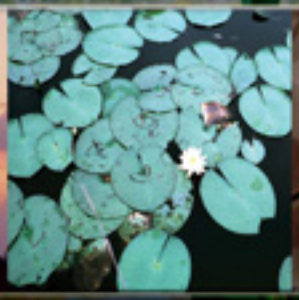
Appendix C

Constructed Wetland System - Conceptual Design
(Draft to be submitted under a separate cover)

Coastal Wetlands Reuse Rehydration Demonstration Project Constructed Wetland





Prepared for

Miami-Dade Water and Sewer Department

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CDM

and

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February 2007

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Introduction

SECTION 1

Introduction

1.1 Background

The Biscayne Bay Coastal Wetlands (BBCW) project under the Comprehensive Everglades Restoration Plan (CERP) proposes to reuse highly treated wastewater from the South District Wastewater Treatment Plant (WWTP) operated by the Miami-Dade Water and Sewer Department (MDWASD) as a source of rehydration water for wetland restoration. Phase 1 of the BBCW plan is being designed and constructed under the South Florida Water Management District (SFWMD) Acceler8 Program.

The Coastal Wetlands Reuse Rehydration Demonstration Project will include the construction of a wetland designed to receive up to 1 million gallons per day (mgd) of advanced treated wastewater from the proposed Coastal Wetlands Reuse Demonstration Pilot (CWRDP) plant treatment works at the WWTP. The constructed wetland element of the CWRDP project is designed to investigate the biological response of a coastal wetland to the advanced treatment reuse water. The CWRDP investigation will focus on the effect of the seasonality, water quality, hydraulic loading rate, hydraulic residence time, and depth of inundation on vegetation typical of the Biscayne Bay coastal wetlands similar to those proposed for rehydration under the Acceler8 and CERP programs. The demonstration constructed wetland is proposed to be designed as a series of two 2.5-acre (1-hectare) wetland cells with flexibility in flow distribution. The demonstration project will be located in a 14-acre parcel in the southwestern corner of the land parcel referred to as the Lennar Flow Way (see Exhibit 1-1). The key parameters will be evaluated relevant to reference vegetation within the existing coastal wetlands.

1.2 Organization

This document is organized as follows:

- **Section 2** presents a review of existing literature and areas of investigation proposed to support the constructed wetland design.
- **Section 3** presents conceptual designs for the proposed constructed wetland system, as well as permit requirements and schedule.
- **Section 4** provides a planning-level cost estimate.
- **Section 5** identifies models to support the constructed wetland design and operation.
- **Section 6** lists the works cited for this report.

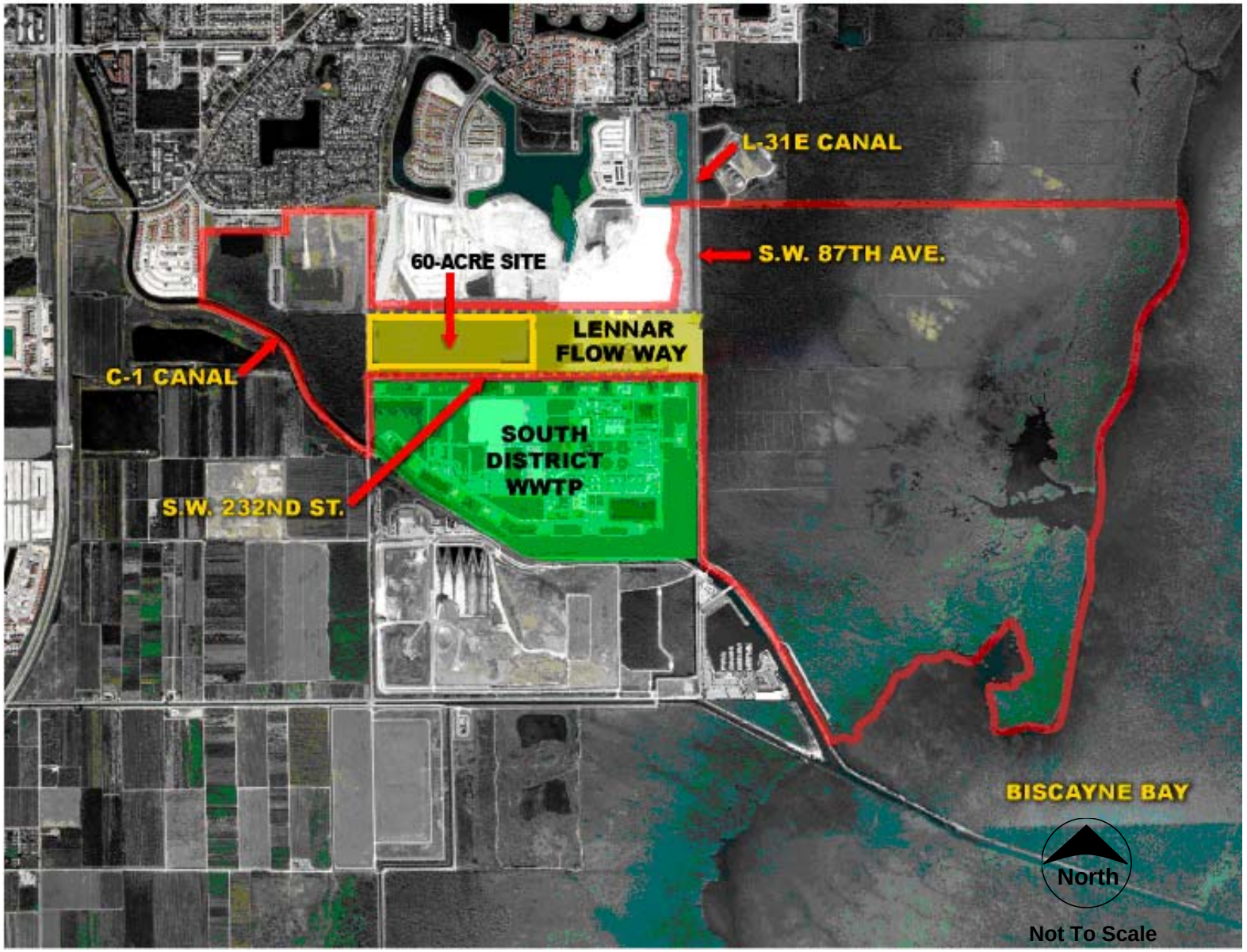

EXHIBIT 1-1
Project Location Map for Lennar/Cutler Flow Way

SECTION 2

Literature Review

SECTION 2

Literature Review

This section provides a summary of available information on the physical condition of the Lennar Flow Way, the past use of these lands, previous geotechnical and hydrologic site investigation reports, and the legal status of the flow way for use in the wetland rehydration project.

Design support data not included in the existing investigations, or not in sufficient density or site specificity, will be enhanced during the detail design phase. A plan of study, to fill these data gaps, is included in this section.

2.1 Biscayne Bay Coastal Wetland Project Status

The CERP Team has selected Alternative "O" as the Tentatively Selected Plan (TSP), which includes the Cutler Flow Way in the C-1 Flow Way component (see Exhibit 2-1). The C-1 Cutler Wetlands Flow Way site plan includes lands west of S.W. 97th Avenue, the Lennar Flow Way, and coastal wetlands east of S.W. 87th Avenue.

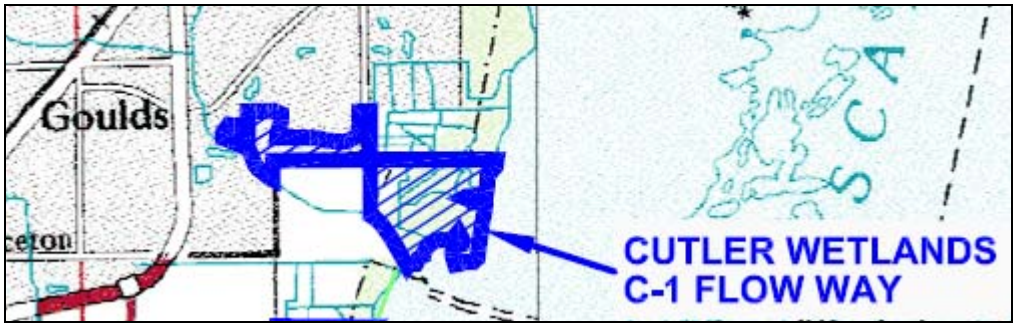

EXHIBIT 2-1
Alternative "O" – C-1 Flow Way Component

Alternative "O" provides for the rehydration of the coastal wetlands east of S.W. 87th Avenue, north of C-1 Canal, south of the eastward extension of S.W. 184th Street, and extending east to the western edge of Biscayne Bay. This alternative, which is the recommended TSP, included the pumping of 50 cubic feet per second (cfs) (33.3 mgd) of C-1 Canal water into the Lennar Flow Way mitigation wetland for polishing and eventual discharge to the coastal wetlands east of S.W. 87th Avenue. The reuse discharge will be continuous and provide increased annual quantities over the use of C-1 Canal pumpage. The C-1 Canal pumpage is limited in the dry season because of agricultural demands for irrigation water from the canals. The annual high water availability from the C-1 Canal of 16,400 acre-feet (ac-ft) is projected in the 80th percentile year through analysis of the historical coastal structures discharges. Exhibit 2-2 includes a summary of the water availability for coastal wetland rehydration from the C-1 Canal and the South District

WWTP, assuming a requested 50-cfs reuse water discharge from the South District WWTP. The reuse water will provide a more continuous base flow to the coastal wetlands.

EXHIBIT 2-2
Water Availability for Coastal Wetland Rehydration from the C-1 Canal and the South District WWTP

Water Source for the Coastal Wetlands (673 ac) (Average Year)	Wet Season Quantity (ac-ft) May–October (182.5 days) Meeder[1] rate of 1.07 ft/day/ac	Dry Season Quantity (ac-ft) November–April (182.5 days) Meeder[1] rate of 0.2 ft/day/ac
C-1 Canal	8,800	0
Daily rate	48 (0.07 ft/day/ac)	0 (0.0 ft/day/ac)
Reuse Water (South District WWTP)	18,100	18,100
Daily rate	99 (0.15 ft/day/ac)	99 (0.15 ft/day/ac)

Note:
[1]John F. Meeder, Restoration of the Black Creek Coastal Wetlands and Adjacent Nearshore Estuarine Zone of Biscayne Bay. August 16, 2002.

Meeder (2002) recommended rehydration values that are the current basis for the BBCW design. The coastal wetland rehydration values are 1.07 ft/day/ac in the wet season and 0.2 ft/day/ac in the dry season. The recommended values are considered to be +/– 50 percent of the required freshwater quantities, due to the normal daily variations of most of the site parameters and the variability of the source water.

2.2 Lennar Flow Way Site Conditions

The Acceler8 BBCW Project Team is designing Phase 1 of the CERP project. The Acceler8 Draft Basis of Design Report (BODR) was issued on January 6, 2006 (URS, 2006a), and the 30 percent design for the Cutler Wetlands C-1 Flow Way and the L-31E Culverts components of the BODR (30 percent BODR) was issued on November 14, 2006 (URS, 2006b). The 30 percent BODR concept includes a lined channel (modification from the piped concept in the January issue of the BODR) to transfer pumped C-1 Canal water through a land parcel referred to as the Cutler Flow Way to the coastal wetland spreader canal east of S.W. 87th Avenue.

The Cutler Wetlands C-1 Flow Way component of the BBCW project is bounded by the C-1 Canal and S.W. 232nd Street on the west and south, the extension of S.W. 224th Street on the north, and Biscayne Bay on the east. The Lennar Flow Way component of the Cutler Wetlands C-1 Flow Way is bounded by S.W. 97th Avenue on the west, S.W. 232nd Street on the south, the Lennar Development on the north, and S.W. 87th Avenue on the east. The investigations of the Lennar Flow Way component of the project conducted during the BODR preparation included the following background information:

- Historic land use in the Lennar Flow Way was agricultural and waste disposal (see Exhibit 2-3).
- Elevations on the Lennar Flow Way parcel in National Geodetic Vertical Datum (NGVD) 1929 are 4 feet to 6 feet on the site, 6.6 feet on the L-31E Canal bank, and 9.9 feet on the

crown of the road, S.W. 87th Avenue. The elevations in the coastal wetland west of S.W. 87th Avenue average 3 feet.

- Geotechnical borings and muck probes were conducted and provided the following characterization of the site:
  - Muck ranges from 0 to 4.0 feet, with an average of 0.5 feet
  - Limestone is 30 to 40 feet thick underlain by dense to fine sand 10 to 20 feet thick
  - Groundwater is an average of 3 to 4 feet below grade with an average elevation of 0 feet NGVD; there is limited to no tidal influence because of the freshwater head maintained in the coastal canal system

2.3 Lennar Flow Way Permit Conditions

The Lennar Flow Way received its designation from land negotiations occurring during the permitting process for the Lakes by the Bay – South Commons, which culminated in a SFWMD Environmental Resource Permit No. 13-01828-P issued on May 15, 2003. Within the permit Special Conditions 24 and 27, Lennar is required to provide, by no later than December 31, 2005, a flowage Conservation Easement or fee simple title to the SFWMD to a total of 160.33 acres consisting of marsh (138.08 acres), deep water habitat (15.67 acres), and a buffer upland (6.58 acres). The marsh is to be graded to an average elevation of 2 feet.

The SFWMD shall decide on the type of land conveyance (conservation easement or fee simple deed) based on land condition and other factors. If the SFWMD does not substantially construct the flowage way by December 31, 2011, the flowage way shall revert to the permittee, who must construct and maintain the original mitigation plan.

The SFWMD has determined that the construction of the lined channel in the Lennar Flow Way would constitute substantial construction and use of the flow way, meeting the intent of Special Condition 31.

Other parcels owned by the SFWMD within the flow way contribute to the entire flow way acreage, and that are not a part of the Lennar permit conditions.

The CWRDP project proposes to use 14 acres within the 60-acre TA500-001 Parcel (see Exhibit 2-3) to construct the wetland cells.

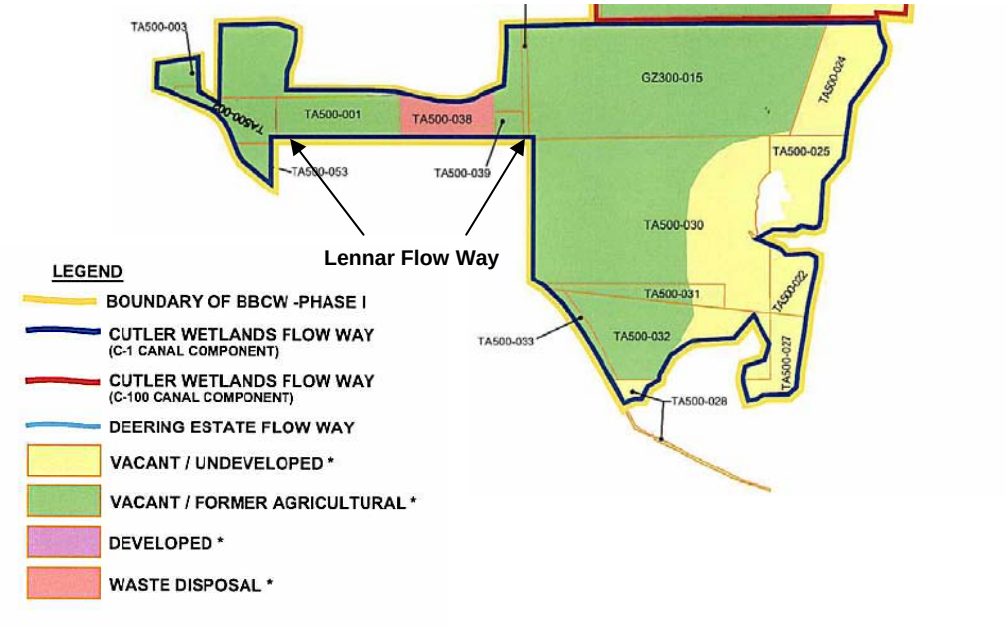

EXHIBIT 2-3
Historic Land Uses BBCW Parcels
Source: URS Corporation. *Draft Basis of Design Report.* January 2006.

2.4 Phase I and II Environmental Assessment Audits

In January 2007, Professional Services Industries, Inc. (PSI) reported back to the SFWMD on an Additional Assessment Report and Corrective Action Plan for the BBCW Project, Phase 1 Cutler Flow Way. In the report the earlier contamination assessment was reviewed and further field investigations were conducted. The report concluded that for Tract TA500-001 "no remedial action is planned." The investigation also included a screening level ecological risk assessment (SLERA) with consultations with the U.S. Fish and Wildlife Service (USFWS). There was no investigation of the northeastern portion of the tract because of the dense vegetation. **The health and safety (H&S) plan will be developed and incorporated into the geological and survey site investigation plans prior to commencing such activity.**

2.5 Acceler8 Proposed Cutler Flow Way Conveyance Alternatives

The BBCW project has been incorporated into the SFWMD accelerated CERP projects program (Acceler8). The CERP and Acceler8 project development teams have focused on rehydrating the BBCW using surface waters diverted from the C-1 Canal through the Cutler Flow Way to a header distribution canal located east of S.W. 87th Avenue. The Acceler8 design team indicated that supplemental water would be needed year-round beyond that which can be diverted from the C-1 Basin. The South District WWTP effluent represents a

potential year-round supplemental water source to support the coastal wetland rehydration similar to the base flow that hydrated the coastal wetlands historically.

Exhibit 2-4 shows the current approach proposed recently (November 2006) to convey the flow through a lined open canal. The lined channel would traverse the northern portion of Parcel TA500-001, through the northern segment of the Lennar mitigated wetland, and follow a diagonal path through Parcel TA500-039. The channel will discharge to a header channel constructed east of SW 87th Avenue and south of SW 232nd Street.

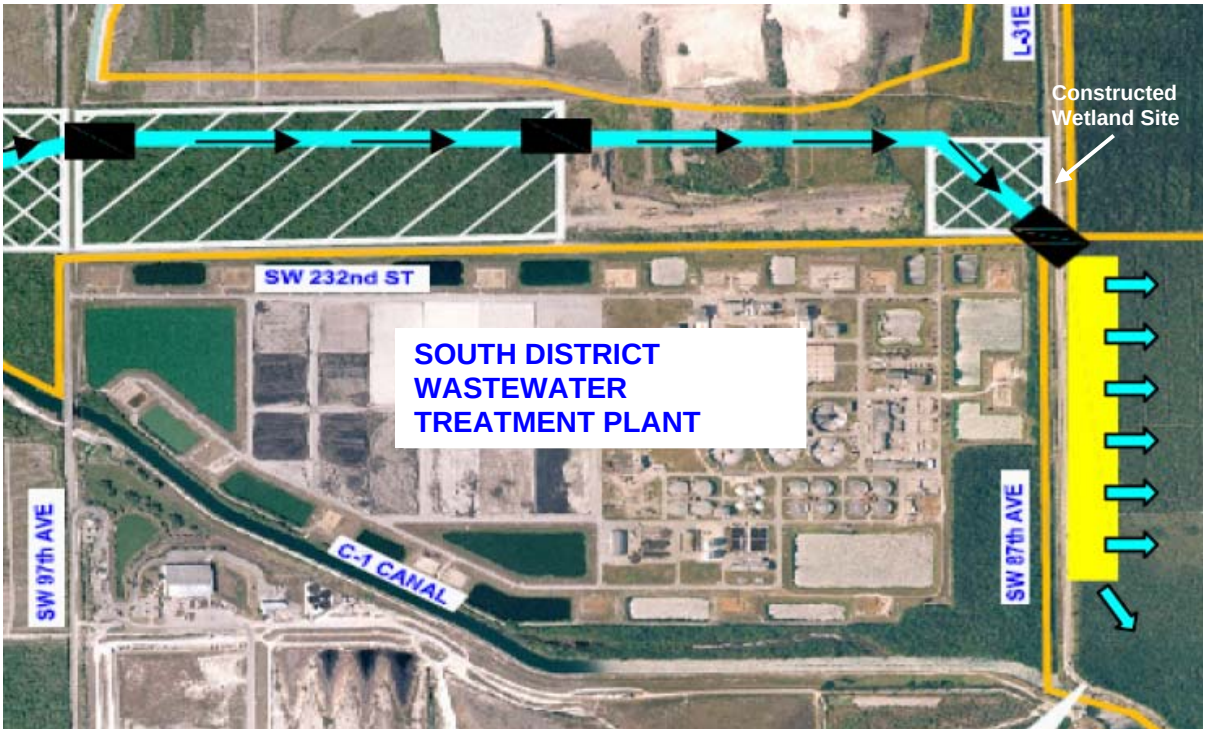

EXHIBIT 2-4
Alternative Acceler8 Conveyance Plan – Location of the Proposed Canal and Modified BBCW Spreader System
Source: URS Corporation. *30 Percent Basis of Design Report.* November 14, 2006.

The CERP program has selected BBCW Alternative "O" as a probable alternative to move forward into design. Alternative "O" includes the Cutler Flow Way and the coastal wetlands located east of the South District WWTP and S.W. 87th Avenue (see Exhibit 2-5). The infrastructure, spreader canals, and pump stations proposed to transfer C-1 water north of S.W. 232nd Street to the coastal wetlands south of the S.W. 184th Street extension is depicted on Exhibit 2-6.

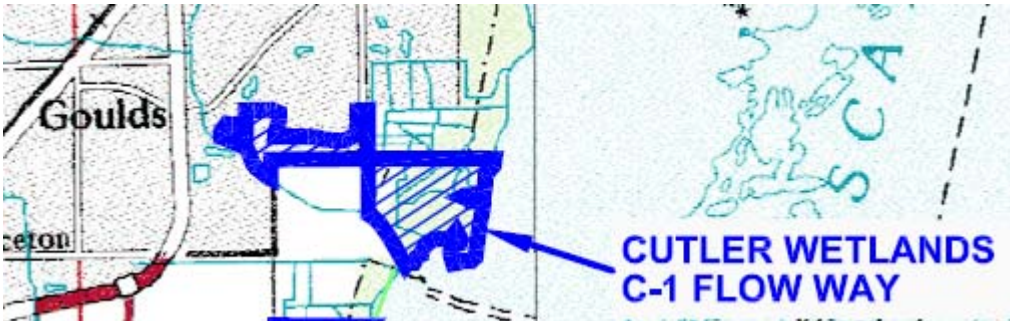

EXHIBIT 2-5
Alternative "O" Cutler Wetlands C-1 Flow Way
Source: URS Corporation. *30 Percent Design Basis of Design Report.* November 14, 2006.

EXHIBIT 2-6
Alternative "O" C-1 Flow Way Infrastructure
Source: URS Corporation. *30 Percent Design Basis of Design Report.* November 14, 2006.

Alternative "O" is in the TSP and currently in the preliminary stages of planning and design within the CERP Project Implementation Report (PIR) process. The 30 percent design BODR (dated November 14, 2006) describes Alternative "O" TSP as:

> *including "… a Cutler Wetlands Flow Way designed to transport freshwater from the C-12 Canal through open flow ways and spreader swales to wetlands and remnant creeks located on the open coast, between the C-1 and the C-100 Canals, and … incorporates delivery of 50 cfs of freshwater, pumped from the C-1 Canal water onto designated mitigation land adjoining Lennar's Lakes by the Sea Development. This mitigation area, referred to as the Cutler Flow Way, would polish C-1 Canal water, and deliver this water as surface flow to a spreader swale and ultimately to coastal wetlands situated east of SW 87th Avenue. The flow way described in Alternative 'O' would be bermed but not lined. The 50 cfs freshwater delivery of C-1 Canal water would subsequently be replaced by Miami-Dade County reuse water, when this reuse contribution becomes available sometime in the future."*

This alternative recommends that reuse water would flow through the Lennar mitigation wetland, the wetland would polish the water, and then discharge the water to the coastal wetlands east of S.W. 87th Avenue.

Alternative "O" also includes the pumping of approximately 400 cfs of C-1 Canal water to a spreader canal, and eventually to the coastal wetlands north of S.W. 224th Street (see Exhibit 2-6).

2.6 Site Geological Considerations

The local geology was investigated during Acceler8's characterization of the Cutler Flow Way. Geological borings and related investigations were conducted at the locations indicated in Exhibit 2-7. Subsurface conditions presented in Exhibit 2-8 for CB-19 are assumed to be representative of the proposed constructed wetland site.

EXHIBIT 2-7
Site Boring and Probe Locations
Source: URS Corporation. *Draft Basis of Design Report.* January 2006.

The site geotechnical investigation indicated that the Core Boring (CB-19) surface elevation was at 4.7 feet NGVD and the groundwater was 4.5 feet below the ground surface. The subsurface material is limestone. The muck probes (MP-2 and MP-3) indicated a muck thickness from 0.33 to 0.83 foot. The ground surface elevation at MP-3 was indicated to be 4.8 feet NGVD. The elevational difference between the geotechnical investigation (4.8 feet) and the original site cross-section survey (2.5 feet) is about 2.3 feet. The final engineering design will be based on new topographic survey data to confirm the site elevations within the footprint of the constructed wetland cells.

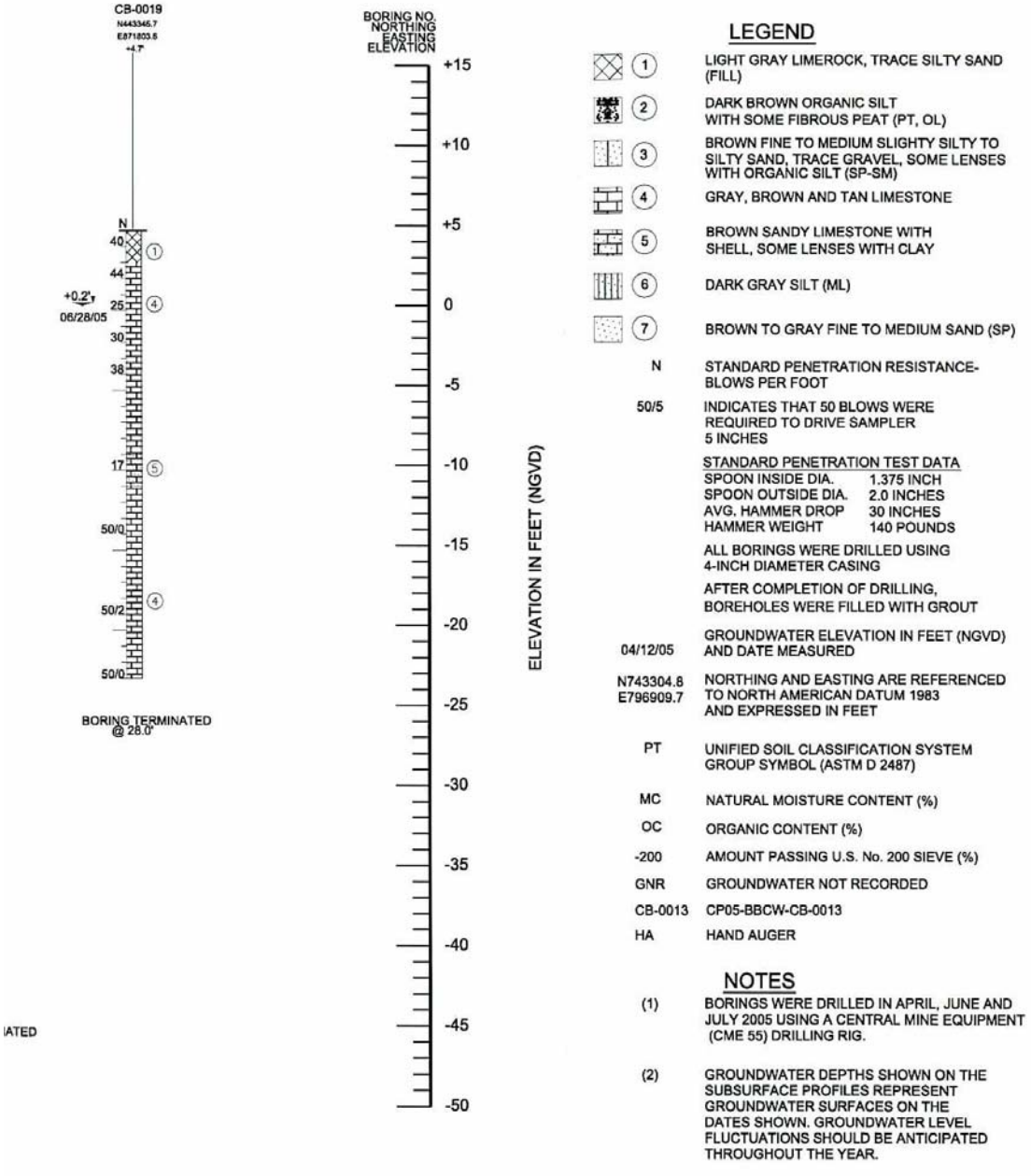

EXHIBIT 2-8
Selected Site Geotechnical Data – Results for CB-19
Source: URS Corporation. *Draft Basis of Design Report.* January 2006.

The site subsurface is composed of porous limestone with some peat layers below 0 foot elevation. The groundwater elevation has been shown to vary at or below 2.0 feet NGVD with an average elevation of 0.0 foot. The site ground elevation varies between 4.7 feet and 2.5 feet NGVD. Muck thickness on the site is approximately 0.5 foot. The hydraulic conductivity was measured between 1.22 and 8.3E-6 cfs per square foot (ft^2) per foot of head (SFWMD Method). These characteristics may be significant as the design of this constructed wetland system progresses.

2.7 Site Data Gaps and Plan of Study

The initial investigations on the proposed constructed wetland site have not included the data or density of data need for design in the following areas:

- Geotechnical borings within the proposed 2.5-acre cells need to be densified to provide supporting data for the water balance modeling, and berm and cell foundation analysis. Exhibit 2-9 illustrates the recommended minimum spacing for the core borings.
- Core borings are to be conducted where water resource features are proposed to be constructed and where earthwork cut and/or fill will be part of the over all berm, wetland, or other.
- North-south surveys though the cells are to be 100-foot on center (OC), and east-west surveys are to mimic the outer edge of the spreader canals.
- Topographic surveys of the site are necessary to design the constructed wetland cells and should be comprehensive.
- Vertical elevation (NGVD 1929) and horizontal data should be collected on 100-foot OC survey lines; on 25-foot spacings; or where physical features indicate a significant change in topography as referenced on Exhibit 2-10.
- Groundwater monitoring wells should be installed during construction on the four geographic corners of the constructed wetland to support the water balance modeling.
- Survey of the control wetland transect (refer to Exhibit 2-11 for recommended location) and vegetative characteristics, which will include a survey of the control wetland.

The exact location of the transect will be field selected based on the ease of access, limited presence of exotic vegetation, and reduced influence of the historic mosquito ditches.

The survey and geotechnical investigations should use the same spacing as the constructed wetland investigation. The biological sections should be coincident with the survey lines, 100 feet OC (three lines) with continuous qualitative description of the vegetative composition. Meter plots should be staked every 50 feet along the transect (18 stations) for quantitative assessment of the wetland diversity and habitat. The South District WWTP rain gauge will be used for the constructed wetland site.

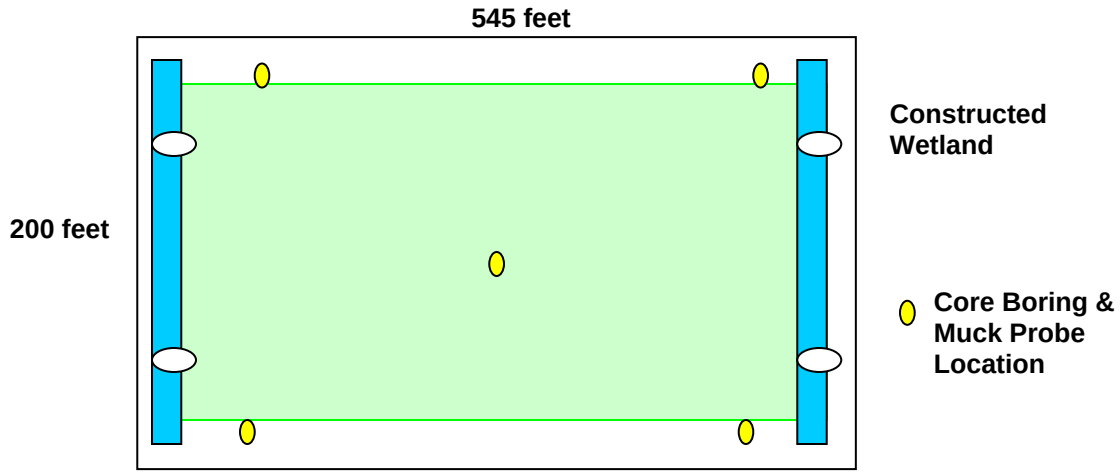

EXHIBIT 2-9
Geotechnical Investigation - Additional Boring/Core Locations

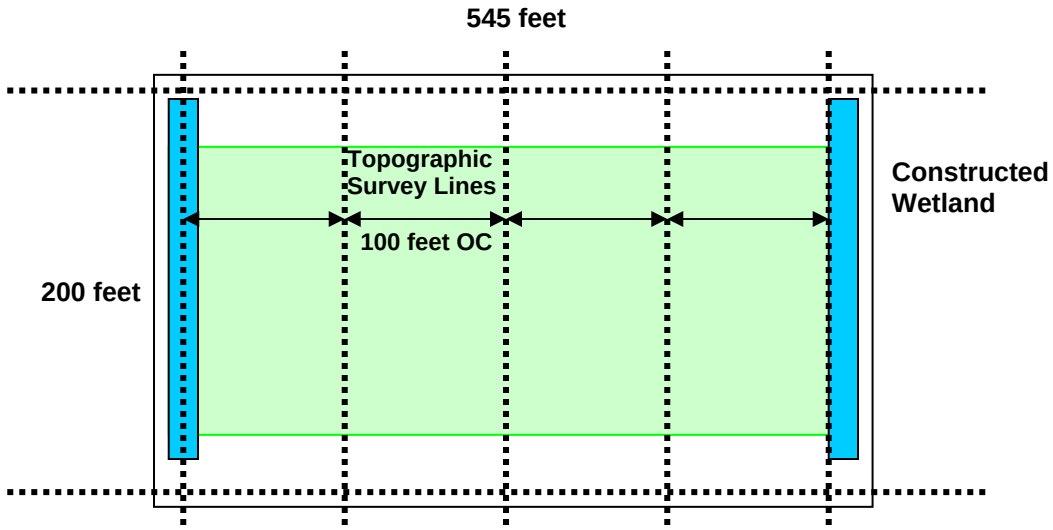

EXHIBIT 2-10
Topographic Survey

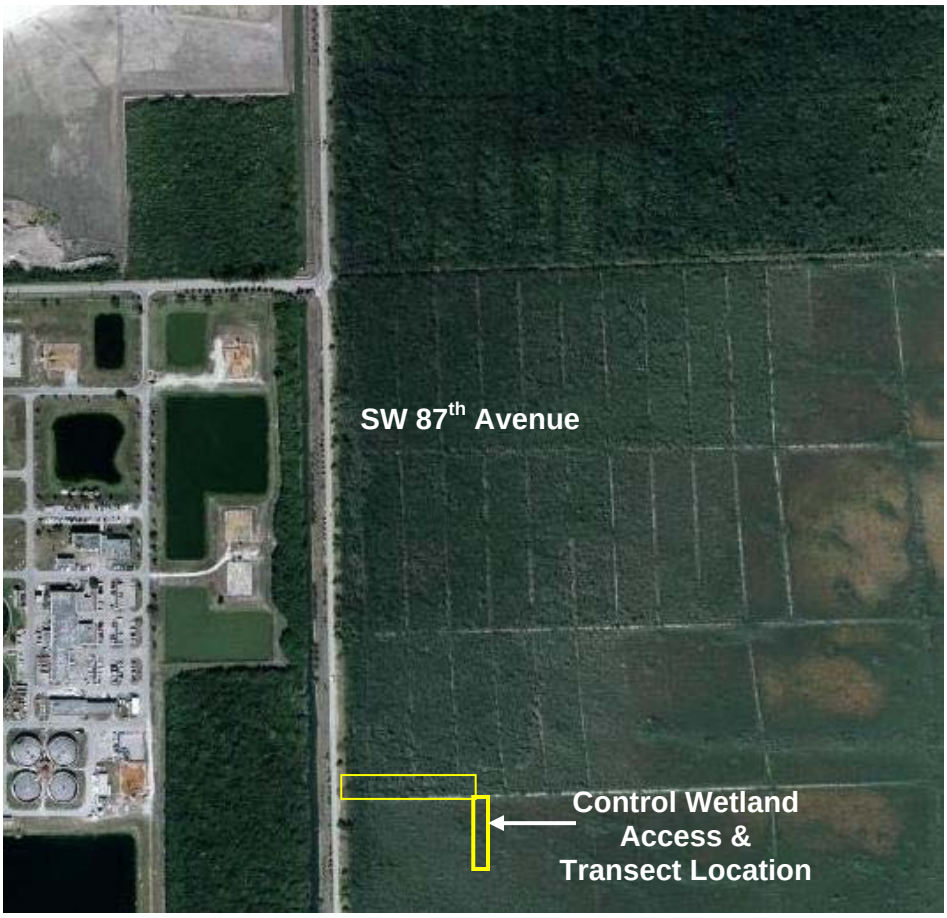

EXHIBIT 2-11
Control Wetland Proposed Site Location

2.8 Summary

The survey and geotechnical investigations on the control wetland site can begin immediately upon site approval by the SFWMD.

Data investigations that have supported the BBCW Project BODR have not fully defined the constructed wetland site. Site-specific information gaps will be investigated in Phase II of the design process. Site-specific data will be gathered to support the constructed wetland design in topographic and geotechnical information requirements.

The control wetland transect in the existing coastal wetlands will be selected based on the following:

- Access from S.W. 87th Avenue, which will minimize impacts to the existing wetlands
- Native wetland area not impacted by mosquito ditching
- A wetland site representative of the native coastal freshwater vegetation diversity

The wetland characterization of vegetation types and density will be used in designing the planting plan for the constructed wetland cells.

SECTION 3

Conceptual Plan

SECTION 3

Conceptual Plan

This section addresses the conceptual design and areas of investigation for the proposed constructed wetland system. The conceptual design information provided herein is preliminary and subject to refinement as more information becomes available regarding the selected site, and the stakeholder input from various resource management agencies. However, the concepts outlined herein are expected to frame the final design of the demonstration system assuming the current treatment objectives remain applicable. Agency review comments regarding the conceptual design information presented will be important for guiding project development toward regulatory approval and implementation.

3.1 Wetland Interface with the Pilot Plant and/or South District WWTP

A process layout indicating the interface between the Wastewater Reuse Demonstration Pilot (WRDP) and the constructed wetland is presented in Exhibit 3-1. The process train provides for the WRDP to treat the South District WWTP effluent, with subsequent discharge of the demonstration plant effluent (reuse water) to the constructed wetland to investigate the "biological response" of the coastal wetland plants to the WRDP reuse water.

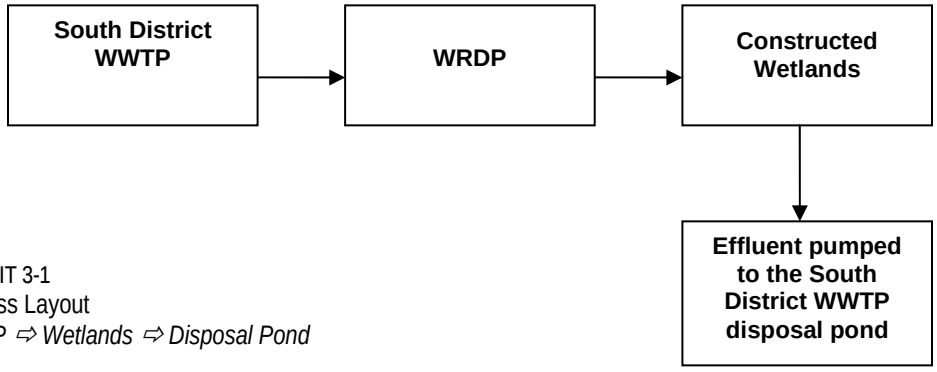

EXHIBIT 3-1
Process Layout
WRDP ⇨ Wetlands ⇨ Disposal Pond

3.1.1 Site Selection

Three locations at the South District WWTP facility were reviewed by the CDM Team during a project site visit for placement of the WRDP Phase 1. Based on this review, the recommended location is at the northeast corner of the South District WWTP site, west of the entrance road between the exterior fence and the injection well, and east of the FP&L substation site (Exhibit 3-2). This site has access to power, water, and effluent; it is located away from the normal WWTP activity and is less likely to be disturbed during the South District WWTP upgrade construction.

The Cutler Flow Way consists of 397 acres that include a deep wetland zone, an uncleared 60-acre upland parcel, the Lennar Development mitigation wetland, the remnants of the C&D landfill, and a 10-acre parcel currently covered with exotic and native vegetation. The constructed wetland site is proposed to be located on the 60-acre site in the southwest corner of the Cutler Flow Way (see Exhibit 3-2). The site was recommended by the Acceler8 SFWMD Project Manager. The only Acceler8 activity proposed in the constructed wetland demonstration site is vegetation removal. The site is located north of S.W. 232nd Street and east of SW 97th Avenue.

Outflows from the constructed wetland are proposed to be discharged directly into a permitted onsite overflow pond immediately south of S.W. 232nd Street, and south of the constructed wetland.

EXHIBIT 3-2
Site Plan for the Constructed Wetland – 60-Acre Parcel – the Lennar Flow Way

The Acceler8 BBCW Project is maintaining the diagonal alignment of the lined channel across the 10-acre parcel (TA500-039) in the southeast corner of the Lennar Flow Way. The MDWASD Coastal Wetland Reuse Rehydration project has been requested to relocate the

proposed constructed wetland cells from the 10-acre parcel in the southeast corner of the Lennar Flow Way to the southwest corner of the flow way in the 60-acre upland parcel (TA500-001) also owned by the SFMWD. The site location is consistent with the use of the northern 300 feet of the 60-acre parcel for the lined channel, which includes greater than a 100-foot buffer between the channel and the constructed wetland site. The lined channel is designed to convey water from the C-1 Canal west of SW 97th Avenue to the north-south coastal wetland header distribution system east of SW 87th Avenue and south of the eastward extension of SW 232nd Street.

The land use approval process includes the submittal of the land request from MDWASD legal staff to SFWMD legal offices. Recent land uses agreements between MDWASD and the SFWMD have established standard conditions and other legal conditions for land exchanges or long term use. The process is expected to require 60 to 90 days for land use approval and transfer of management documents.

The land area requested is depicted in Exhibit 3-2 and in the line drawing included as Exhibit 3-3.

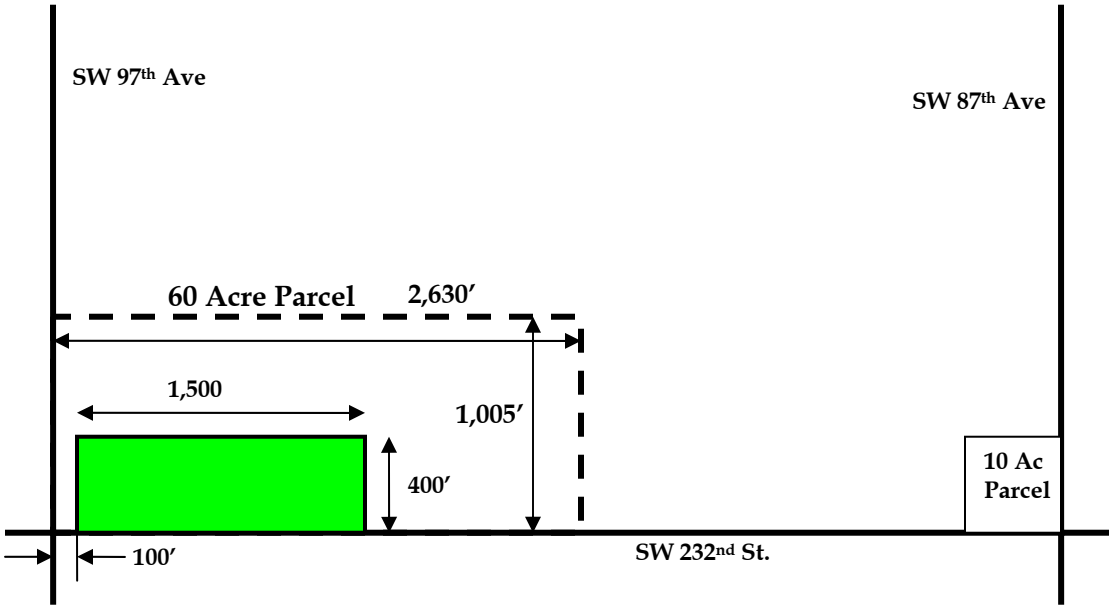

EXHIBIT 3-3
Dimensions of the Constructed Wetland Site within the 60-acre Parcel

3.1.2 Site Layout

The layout of the constructed wetland demonstration system will depend on the "biological response" options to be tested, the water balance control available to the Coastal Wetlands Reuse Rehydration Demonstration Project Team, and the configuration of the CWRDP coastal wetland cells within the 60-acre parcel. The two-cell constructed wetland layout (see Exhibit 3-4) was designed with flexibility to redirect the flow from one wetland cell to the other to test various loading rates, residence times, and seepage influence on the coastal

wetland system. The testing protocol has not been selected, but includes options for the following scenarios:

- Diversity of vegetation, which mimics the existing coastal wetlands
- Test the "biological responses" of the coastal wetland vegetation to the WRDP treated reuse water and the L-31E Canal water to mimic the discharges from the C-1 Canal
- Varying hydraulic loading rates, which represent the various options in daily volume of reuse water provided to the coastal wetlands from the South District WWTP
- Variations in the inundation (depth of water) that the coastal wetlands experience

The layout configuration assumes two 2.5-acre wetland ponds, as shown schematically in Exhibit 3-4, with the remainder of the site for berms, pump station (if applicable), and buffer from the proposed Acceler8 lined channel located along the northern boundary of the 60-acre parcel, and the unacceptable section of the 60-acre parcel east of the site. The wetland system will be configured as shown in Exhibit 3-5. Conceptually, the constructed wetland would include access along the berms and temporary boardwalks for water quality sampling and vegetation monitoring.

The 14-acre constructed wetland site will have berms on the north and east sides to separate the site from the remainder of the 60-acre parcel. The location of the mitigation wetland within the Lennar Flow Way is shown on Exhibit 3-6.

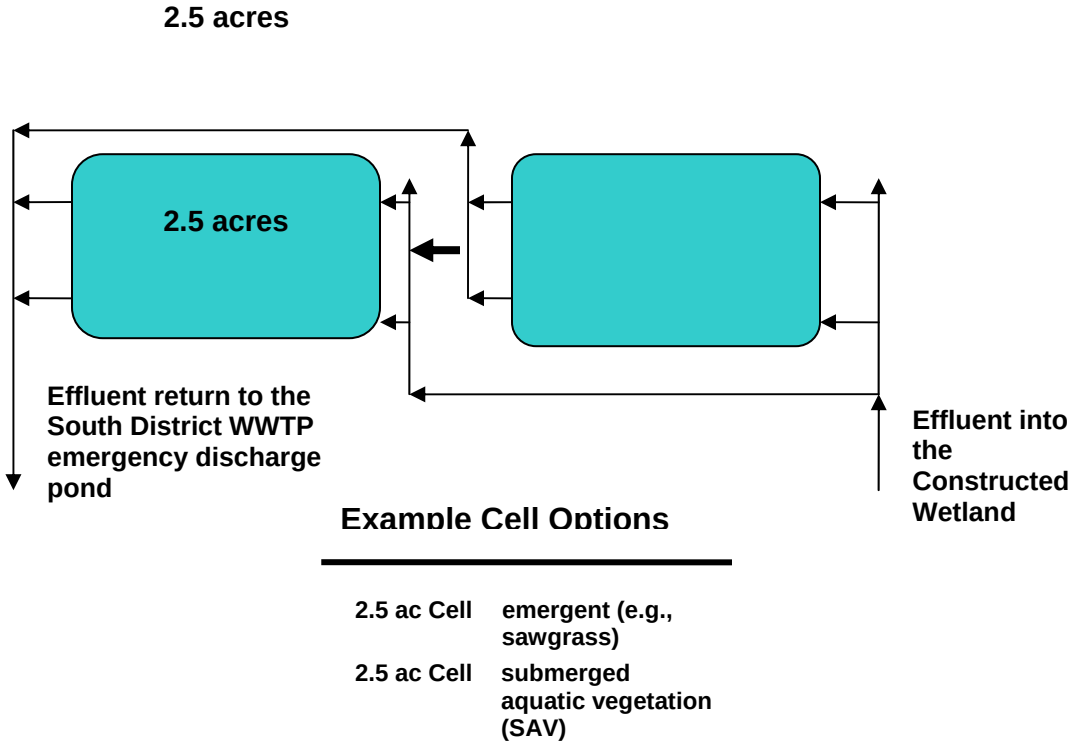

EXHIBIT 3-4
Initial Conceptual Wetland Site Layout

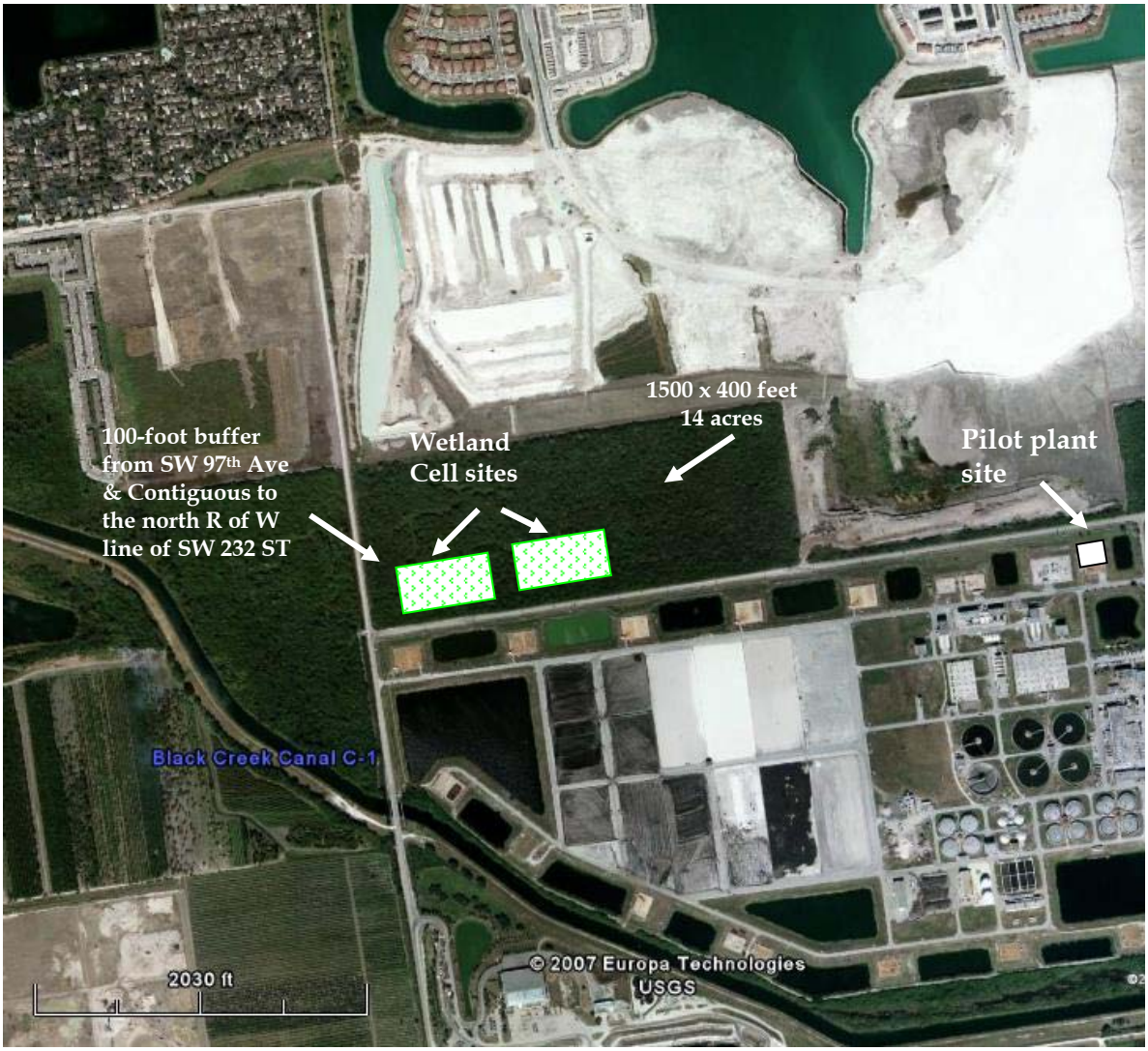

EXHIBIT 3-5
Proposed Constructed Wetland Demonstration Site Configuration

EXHIBIT 3-6
Cutler Flow Way Parcels – Mitigation Wetland Relationship to the 60-Acre Constructed Wetland Site

It is proposed that for the constructed wetland, no discharge should occur from the wetland to surface waters of the state, at least initially. Instead, for this demonstration project, it is proposed that the outflow from the constructed wetland be pumped back via pipeline into the South District WWTP site and disposed of by discharge into the emergency discharge pond shown in Exhibit 3-5. A portion of the inflow into the constructed wetland system is expected to infiltrate into the groundwater. The final effluent quantity to be discharged into the permitted pond within the WWTP fence line is expected on average to be less than the 1 mgd of reuse water pumped to the wetland. Stormwater inflows to the wetland will be included in the overall water balance and attenuated through infiltration, evapo-transpiration, and pumped to the pond. Operational schedules for the constructed wetland would need to be established during final design. The schedule should address a continuous flow of reuse water to the constructed wetlands, the frequency of sampling to test the biological response of the constructed wetland vegetation species that are being studied, and the comparison to the control site transect within the native coastal wetlands.

3.2 Constructed Wetland Design

The design of the constructed wetland is based on demonstrated success of similar systems whose design is based on sheet flow distribution of the inflow water through the wetland. The Acceler8 project is based on the same principle shown with their selection of the header canals to rehydrate the coastal wetlands. The constructed wetland is designed to provide an even distribution of inflow through the wetland. The "sheet flow" is developed through an inflow spreader canal at the head of the wetland and a collection canal at the outflow to reduce short circuiting by not "drawing" the water to a single outflow structure. This design produces the highest probability of even flow across the wetland cell and reducing no flow areas within the wetland. Exhibit 3-7 illustrates the design cross-sections for the constructed wetland cells, and Exhibit 3-8 presents the site plan with the spreader and collection canals, and inflow and outflow systems.

The design of the constructed wetland cells should consider the edge effect of the berms. The length of the edge along the flow way is reflected in the plan form or ratio of the cell width to the length. The wider the cell the less edge effect impacts the total flow within the cell. The more often the water can be redistributed within a demonstration system, cell to cell or open water body redistribution, the less short-circuiting will occur. A cell width greater than 150 feet should be designed to reduce edge effects. A plan form of 2.5:1 to 4:1 is recommended. Based on this guidance, a 2.5-acre wetland cell is the minimum recommended for this "biological response" investigation. The plan form calculations are presented in Exhibit 3-9. The calculations take the square footage of the cell and investigates various length and width dimensions to meet the desired design parameters, cell width greater than 150 feet, and a plan form ratio between 2.5:1 to 4:1 (length to width).

The 30 percent BODR indicated that the Cutler Flow Way wetland would be hydrated by pumping 50 cfs of C-1 Canal water into the 397 acres of the Cutler Flow Way. The hydraulic loading rates (assuming variable supply rates) for the Cutler Flow Way and the identified coastal wetlands are presented in Exhibit 3-10. The coastal wetland (current public ownership) that will be hydrated by the ultimate pumping from the C-1 Canal, and the available reuse water for the South District WWTP, is approximately 673 acres. The

calculations take various inflow rates up to the 1 mgd and converts that volume to cubic feet per day entering the wetland. The cubic feet per day entering the wetland is divided by the wetland square footage to determine the feet per day of hydraulic loading in centimeters per day (cm/day).

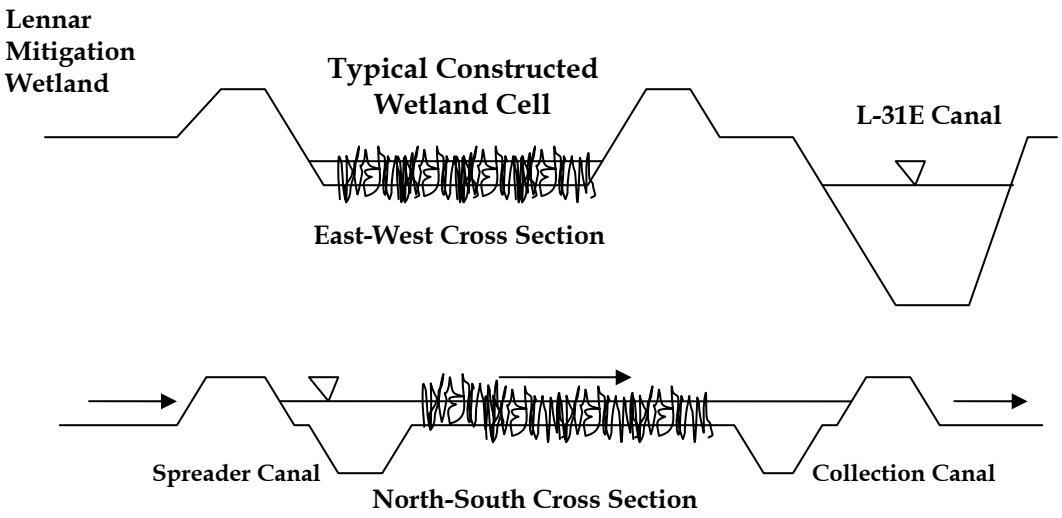

EXHIBIT 3-7
Typical Constructed Wetland Cell Cross-Sections

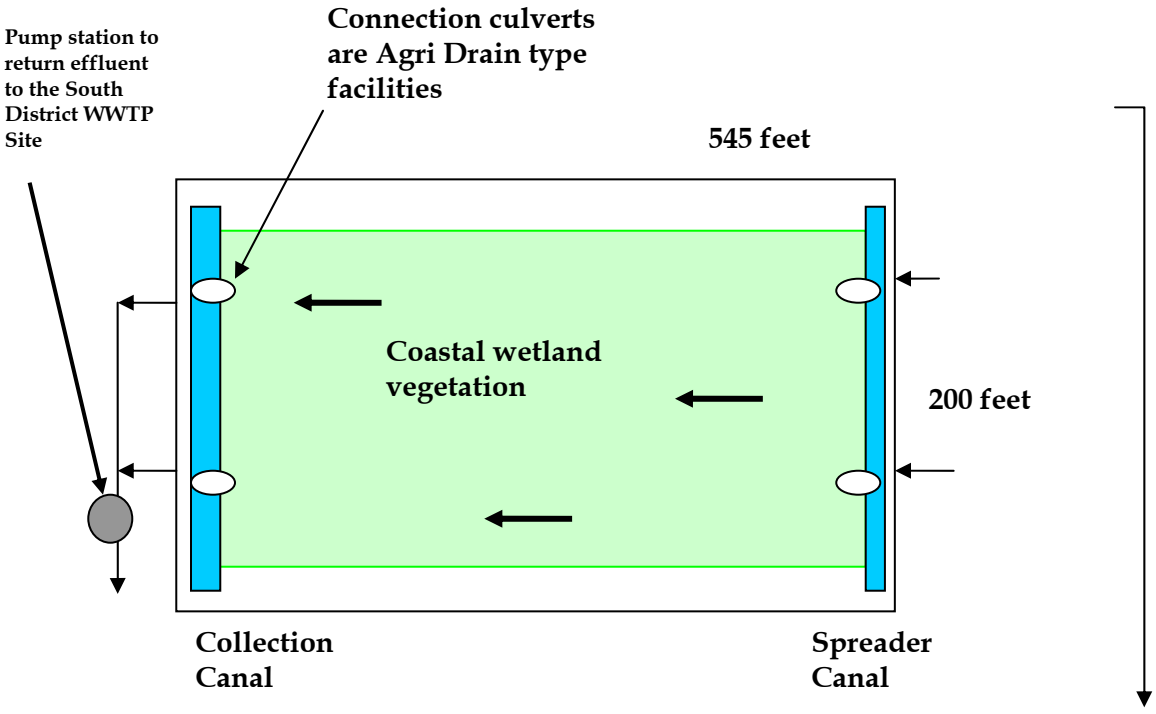

EXHIBIT 3-8
Constructed Wetland Cell Site Plan – Typical Layout

EXHIBIT 3-9
Constructed Wetland Plan Form - Determination of the Wetland Dimensions

Acres	Square Feet (ft^2)	Width (feet)	Length (feet)	Plan Factor (L/W) X:1
0.5	21,780	100	218	2
0.5	21,780	148	148	1
1	43,560	100	436	4
1	43,560	209	209	1
2.5	108,900	100	1,089	11
2.5	108,900	200	545	3[a]
2.5	108,900	300	363	1
2.5	108,900	330	330	1
5	217,800	100	2,178	22
5	217,800	200	1,089	5
5	217,800	300	726	2
5	217,800	467	467	1

[a] Selected plan form

The hydraulic loading rate is compared for each of the wetland cell acreage and inflow rate combinations in Exhibit 3-10. The predicted loading rate of the full-scale system to the coastal wetlands is used as guidance in designing the constructed wetlands' cell sizes and their respective inflow rates.

EXHIBIT 3-10
Constructed Wetland Hydraulic Loading Rates
BBCW Constructed Wetland Design Calculations

Inflow			Wetland Size		Loading Rate		
cfs	mgd	cf/day	acres	ft^2	ac-ft/day	ft/day	cm/day
Constructed Wetland System							
0.375	0.3	32,400	2.5	108,900	1	0.30	9.1
0.75	0.5	64,800	2.5	108,900	1	0.60	18.1
1.125	0.8	97,200	2.5	108,900	2	0.89	27.2
1.5	1.0	129,600	2.5	108,900	3	1.19	36.3
0.375	0.3	32,400	5	217,800	1	0.15	4.5
0.75	0.5	64,800	5	217,800	1	0.30	9.1
1.125	0.8	97,200	5	217,800	2	0.45	13.6
1.5	1.0	129,600	5	217,800	3	0.60	18.1

EXHIBIT 3-10
Constructed Wetland Hydraulic Loading Rates
BBCW Constructed Wetland Design Calculations

Inflow			Wetland Size		Loading Rate		
cfs	mgd	cf/day	acres	ft^2	ac-ft/day	ft/day	cm/day
Full System Application							
50	33.3	4,320,000	397	17,293,320	99	0.25	7.6
100	66.7	8,640,000	397	17,293,320	198	0.50	15.2
200	133.3	17,280,000	397	17,293,320	397	1.00	30.5
300	200.0	25,920,000	397	17,293,320	595	1.50	45.7
400	266.7	34,560,000	397	17,293,320	793	2.00	60.9
Coastal Wetlands East of S.W. 87th Avenue							
50	33.3	4,320,000	673	29,315,880	99	0.15	4.5
100	66.7	8,640,000	673	29,315,880	198	0.29	9.0
200	133.3	17,280,000	673	29,315,880	397	0.59	18.0
300	200.0	25,920,000	673	29,315,880	595	0.88	26.9
400	266.7	34,560,000	673	29,315,880	793	1.18	35.9

Based on plan form analysis and the desirable range of loading rates, the minimum dimensions of the cell (see Exhibit 3-8) should be:

- Size 2.5 acres
- Width 200 feet
- Length 545 feet
- plan form 3:1 (L:W)

The hydraulic loading rate of the system should be designed to mimic the initial hydration of the Lennar Wetlands (397 acres) with 50 cfs of reuse water. As shown in Exhibit 3-10, the hydraulic loading rate is 7 cm/day. The normal range of loading rates for constructed wetlands is 4 to 12 cm/day. The typical residence time is from 2 to 10 days in a constructed wetland (see Exhibit 3-11).

Site layout parameters for the two 2.5-acre wetland cells provide a residence time of 3.8 to 0.8 days. The Cutler Flow Way has 397 acres and projected residence times of 1.6 to 0.2 days with the 50 cfs flow rate.

Based on proposed spreader canals and inflow rates, the coastal wetland areas east of S.W. 87th Avenue are projected to have a residence time of 3.8 to 0.5 days (see Exhibit 3-11). The calculations for the residence time assumes an inflow cfs and a plan form of 200 feet to calculate the velocity of the inflow reuse water. The length of the cell (545 feet) is divided by the velocity to determine the residence time, converted to days.

EXHIBIT 3-11

Constructed Wetland Cell Site Plan – Typical Water Residence Time Within the Cells

		Cell Dimensions			
	Acres	2.5	5	397	673
	Width	545	1,090	1,200	3,000
	Length	200	200	5,600	5,450
		Residence Time Calculations			
		Velocity		**Residence Time**	
cfs	**Acres**	**cf/day**	**ft/sec**	**sec**	**days**
0.375	2.5	32,400	0.002	290,667	3.4
0.75	2.5	64,800	0.004	145,333	1.7
1.125	2.5	97,200	0.006	96,889	1.1
1.5	2.5	129,600	0.008	72,667	0.8
0.375	5	32,400	0.002	581,333	6.7
0.75	5	64,800	0.004	290,667	3.4
1.125	5	97,200	0.006	193,778	2.2
1.5	5	129,600	0.008	145,333	1.7
		Full System Application			
50	397	4,320,000	0.042	134,400	1.6
100	397	8,640,000	0.083	67,200	0.8
200	397	17,280,000	0.167	33,600	0.4
300	397	25,920,000	0.250	22,400	0.3
400	397	34,560,000	0.333	16,800	0.2
		Coastal Wetlands East of S.W. 87th Avenue			
50	673	4,320,000	0.017	327,000	3.8
100	673	8,640,000	0.033	163,500	1.9
200	673	17,280,000	0.067	81,750	0.9
300	673	25,920,000	0.100	54,500	0.6
400	673	34,560,000	0.133	40,875	0.5

3.2.1 Effluent Return Concepts

After the reuse effluent has passed through the wetland and the wetland vegetation has been monitored to measure impacts within the constructed wetland, the final effluent from the wetland will be returned to the WWTP site as described previously. The effluent is not

proposed to be discharged to the existing coastal wetlands east of S.W. 87th Avenue during the course of this pilot demonstration project because of the following:

- Volume of the water (<1 mgd) is insufficient to measure in the spreader canal
- Discharge east of S.W. 87th Avenue would require a National Pollutant Discharge Elimination System (NPDES) permit
- Effluent can be controlled on the WWTP site and discharged into a permitted overflow discharge pond
- Inability to adequately sample and determine impact from the effluent on the natural coastal wetlands
- Reduction of possible introduction of discharge contaminants to the coastal wetlands and Biscayne Bay

The concept of returning the treated effluent to the South District WWTP emergency overflow pond also provides the opportunity to test a coastal wetland mesocosm, if determined beneficial and feasible. The intent of this component of the pilot project would be to sample the benthic invertebrate population and observe possible impacts from the application of the reuse water. The amount of water being returned is anticipated to be minor, compared to the 1 mgd inflow to the constructed wetland.

The distribution pipe to the wetland and the return pipe to the South District WWTP facility will be either directionally drilled under S.W. 232nd Street or open cut. The site visit data collection and the preliminary information indicate that the utilities located in the S.W. 232nd Street right-of-way are deep, and would not present a conflict to the construction of the proposed distribution and return flow pipes.

3.2.2 Existing Utilities

The construction of the wetland and the connecting infrastructure will require the crossing of S.W. 232 Street at two locations, the inflow from the demonstration plant and the discharge from the wetland to the overflow ponds on the South District WWTP site. Both crossings are proposed to be pumped and include the installation of 6-inch-diameter polyvinyl chloride (PVC) pipe under S.W. 232 Street. The road crossing is tentatively proposed to be constructed via directional drilling. The BODR indicated the location of a 72-inch-diameter concrete reinforced sanitary sewer force main pipe along the centerline of S.W. 232 Street. Verification of the force main location is necessary prior to directional drilling.

Electrical service is located on the South District WWTP site, which can be used for powering the pump station(s) on the discharge side of the wetland and if the scenario for use of L-31E water is considered to compare similar water quality to that of the C-1 Canal, which will support the wetland hydration in the future.

3.2.3 Layout Concept

The constructed wetland is graphically depicted in Exhibit 3-12. The site layout is presented for relative siting and relationship to the other system components.

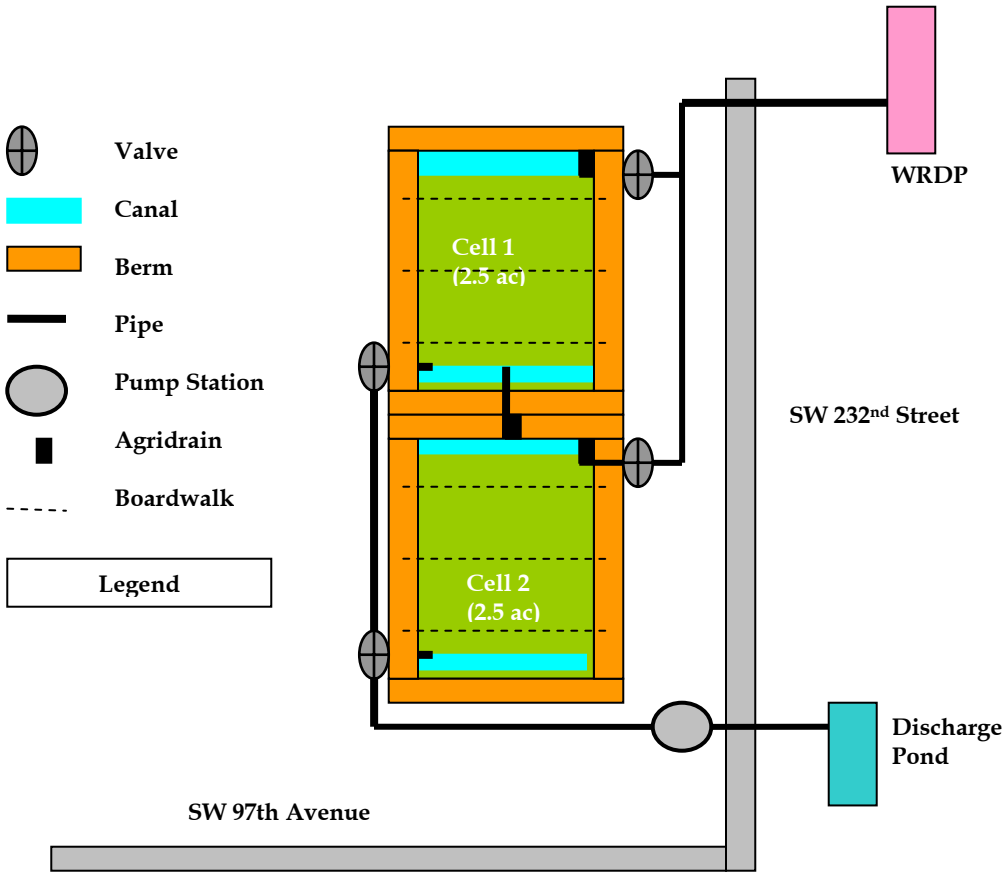

EXHIBIT 3-12
Constructed Wetland Site Layout

The berm construction is assumed to be in material balance with the cell excavation (see Exhibit 3-13). If additional fill is required, it will be obtained from the 14-acre site.

EXHIBIT 3-13
Constructed Wetland Berm Design

3.2.4 Control Wetland Transect

The delineation of a control wetland transect within the existing 697 acres of proposed coastal wetland rehydration is herein recommended but is not part of the demonstration project at this time. The control transect would assist in separating the existing conditions from the impact of the reuse water on the constructed wetland vegetation. The control transect would provide the following input to the constructed wetland "biological response" testing program:

- Delineation of the site downstream of the MDWASD wetlands for long-term monitoring of wetland improvements and/or impacts
- Characterization of the wetland vegetation for planting of the constructed wetland cells
- Measurement of the natural (existing) inflow water quality, depth of inundation, and seasonality
- Existing rainfall frequency, quantity, and residence

The control wetland transect would be delineated and characterized, and background monitoring started during the construction phase of the constructed wetland project.

3.2.5 Construction Phasing

The construction of the wetland cells includes the following activities:

- Clearing of the vegetation for the entire 14-acre parcel
- Retaining as much of the muck top soil as possible
- Excavating spreader (distribution) and collection channels, with the excavated material used to create berms between cells
- Installing ground cover for erosion protection on the berms
- Directional drilling inflow pipe and discharge pipe under S.W. 232nd Street
- Installing inflow and discharge water control structures (Agri Drains with culverts) in the cells (two inflow and two discharge structures per cell)
- Establishing temporary sampling walkways in each cell
- Installing pump station, , discharge lines, and electrical service
- Installing eight to ten piezometers and water quality monitoring stations around the 10 acres to measure groundwater elevation with water level monitors
- Installing access roadway, fence, and gate
- Installing a rain gauge and site markers to delineate the control wetland transect
- Planting the coastal wetland vegetation

3.2.6 Constructed Wetland Operation

The constructed wetland will be operated to demonstrate the biological response of the reuse water application on coastal wetlands and wetland systems within the Cutler Flow Way. The system protocol will be established to provide the following information:

- Water balance within the system – seepage rates based on operating depths with the same or similar geotechnical conditions
- Vegetative grow-in rate and preferential vegetation management needs
- Start-up requirements to enhance vegetation growth through reuse water level management
- Grow-in and start-up will require three growing seasons
- Coastal wetland impact monitoring scenarios with different treatment paths, residence times, and loading rates
- Wet season and dry season variation in groundwater levels and seepage rates
- Improved water quality achieved under different operating conditions may also be investigated

3.3 Permit Requirements and Preliminary Schedule

A list of permits required to design and construct the wetland and its pump system is provided in the Exhibit 3-14. Note that these permits do not include those required for the demonstration treatment plant (done by others). A preliminary estimate of the time it will take to obtain the permits and a brief description of each permit is also provided in the Exhibit 3-14. The length of time is based on the date of the pre-application meeting, to the initial application submittal ending with the permit issuance. Pre-application meetings with the various agencies will confirm the assumptions identified in this section and clarify the schedule times for each permit. The permit applications need to be submitted by May 5, 2007, in accordance with the Interim Water Use Agreement between Miami-Dade County and the District.

The permitting will include the review of the existing SFWMD Phase I audits of the 60-acre parcel and the contiguous parcel to the west to confirm the use of the parcel for the wetland demonstration and the necessary site preparation, if any, required based on the audit information and recommendations.

EXHIBIT 3-14
Permit Requirements and Anticipated Schedule

Agency	Permit Type	Approximate Schedule to Obtain Permit (Based on Preapplication Meeting, Submittal of Application to Permit Issuance
I. Federal		
US Army Corps of Engineers	Section 404 CWA/Joint Dredge/Fill ERP application 1. Includes Protected Species Coordination w/ USFWS 2. Cultural Resource Approval-SHPO	12 months to 18 months
II. State		
Florida Department of Environmental Protection	Comprehensive Everglades Restoration Plan Regulation Act (CERPRA)-Dredge/Fill, Stormwater, Wetland 1. Includes Protected Species Coordination with FFWC 2. Cultural Resource Approval-SHPO	9 to 12 months
	NPDES Construction Activity NOI	1 month
	Air Permit- Discharge from Pump	9 to 12 months Assume that this permit will not be needed based upon the use of an electric motor/pump – consultation with FDEP will be conducted
III. Local		
SFWMD	Temporary Dewatering Permit for Construction	2 months – this permit is obtained by the contractor
	Water Use Permit for Pump Allocation	9 to 12 months Assume that this permit will not be needed since the supply of water is the reuse water from the Pilot Plant – consultation with SFWMD will be conducted
Miami Dade DERM	Class IV Permit (Wetlands)	10 to 13 months – after consultation with DERM this permit may not be needed due to the actual construction of the wetland from existing uplands

EXHIBIT 3-14
Permit Requirements and Anticipated Schedule

Agency	Permit Type	Approximate Schedule to Obtain Permit (Based on Preapplication Meeting, Submittal of Application to Permit Issuance
	Class II Permit - Stormwater	10 to 13 months – after consultation with DERM this permit may not be needed since the only stormwater treated/handled is the water falling on the wetland and discharged back to the South District WWTP
	Class V Permit- Temporary Dewatering	2 months – this permit is obtained by the contractor
	Tree Removal Permit	May not be necessary since all of the trees to be removed on the 10 acres are believed to be exotics. A site review will be conducted prior to site clearing to confirm the assumptions.
Miami Dade Public Works	Maintenance of Traffic for SW 232nd St, Work in ROW Utilities	3 to 4 months - the construction within the S.W. 232 Street right-of-way is anticipated to be limited to directional drilling of two 6" to 8" diameter pipes, which will be used for the inflow and discharge flows. The pipes will connect the SDWWTP and the pilot treatment wetland.
FPL	Utility Permits for Work in ROW	3 to 4 months – power for the two onsite pump stations will require access to electrical service and possible construction within the FPL ROW
Miami Dade Planning	Land Use Planning	3 to 4 months
Miami Dade Building Department	Building Permit-structural, electrical	3 to 9 months

3.4 Summary

The recommended constructed wetland site layout is a two-cell system, each cell being 1 to 2.5 acres in size. The cells will be vegetated with coastal vegetation plants similar in diversity to a coastal wetland site. The controlled wetland transect will be delineated in the existing native coastal wetlands directly east of the South District WWTP, east of S.W. 87th Avenue, and sited in the County-owned parcel south of the proposed spreader canal. The control wetland transect will be monitored to identify natural vegetation changes not related to the reuse water testing.

The coastal wetland cells will receive up to 1 mgd of pumped treated effluent (reuse water) from the demonstration plant, which will be distributed into a spreader canal, flow through the wetland, collected in a second canal, and gravity-transferred to a second cell or pumped back to the South District WWTP site, and discharged into an existing overflow pond. The reuse water from the WRDP will be pumped into the constructed wetland cells to test the "biological response" of the coastal vegetation to the reuse water.

The next phase of the project will include the following:

- Site inspection to select the control wetland transect and further investigate the 14-acre constructed wetland site
- Review of the Phase I/II ESA recommendations for the 14-acre site in the Cutler Flow Way
- Further definition of the "biological response" parameters and probable range of values
- Detail design of the constructed wetland, including sampling of coastal wetland
- Preparation of permitting applications by May 5, 2007
- Continued coordination with the SFWMD Project Manager for the BBCW Acceler8 Project design team

The schedule for the constructed wetland will include a two-season (summer growing season) grow-in period and a third season of monitoring. The project could continue monitoring beyond this timeframe depending on the pilot plant operations, the BBCW Acceler8 project construction schedule, and the County's data requirements for supporting reuse water application in the CERP projects.

SECTION 4

Preliminary Planning-Level Cost Estimate

SECTION 4

Preliminary Planning-Level Cost Estimate

4.1 Assumptions

The following assumptions are also considered reasonable:

- The excavation of the top 2.5 feet of muck and rock is feasible based on the construction of the Lennar Mitigation Wetland, which is designed to the same invert elevation and same rock material.
- Wetland vegetation, similar to that represented in the coastal wetland east of S.W. 87th Avenue, can be locally purchased within the project budget, and the vegetation will survive replanting.
- The constructed wetland 14-acre site is available from the SFWMD and can be used for the CWRDP project as per SFWMD recommendations.
- Cell dimensions are 200 feet by 545 feet, interior berm faces.
- The berm dimensions are outside toe at 4.5 feet elevation, the crest top at 10 feet elevation, the inside wetland invert at elevation 2 feet, and the berm side slopes are at 3:1 (H:V).
- This berm configuration will use all of the excavated material and not require offsite disposal of the excavated rock and soil.
- The construction of the wetland and the connecting infrastructure will require the crossing of S.W. 232 Street at two locations, the inflow from the pilot plant and the discharge from the wetland to the overflow ponds on the South District WWTP site. Both crossings are proposed to be pumped and include the installation of 6-inch-diameter PVC pipe under S.W. 232 Street. The road crossing is tentatively proposed to be constructed via directional drilling. The BODR indicated the location of a 72-inch-diameter concrete reinforced sanitary sewer force main pipe along the centerline of S.W. 232 Street. Verification of the force main location is necessary prior to directional drilling.
- Electrical service is located at the South District WWTP site, which can be used for powering the pump station(s) on the discharge side of the wetland.

4.2 Planning-Level Cost Estimate

The planning-level cost estimate is based on the best available unit cost information and is presented in December 2006 dollars (ENR CCI=2.5 percent). The 60 percent and 90 percent cost estimates will refine the reliability of the estimate and incorporate more recent bidding experience in the CERP and Acceler8 projects.

The cost estimate presented in Exhibit 4-1 is preliminary and is not intended for budgeting nor procurement activities. The construction cost for the Constructed Wetland is estimated at approximately $1,587,500.

EXHIBIT 4-1
Planning-Level Cost Estimate

Constructed Wetland Component	Units	Quantities (2 Cells)	Unit Cost	Total Cost	Assumptions
Clearing & Grubbing[1]	ac	8	$30,000	$240,000	Existing vegetation removal and clearing of roots and foreign material
Excavation of the Cells from elevation 4.5 feet to 2 feet[1]	yd^3	20,200	$8	$161,600	0.5 feet muck and 2 feet of rock – all fill put into berms with inverted structure
Construction of the berms[1]	yd^3	19,700	$10	$197,000	Berms are at 15-foot crest width and 10-foot elevation, 3:1 slopes (H:V), at 6.4 cy/lf
Installation of the inflow and discharge Agridrains	ea	8	$8,000	$64,000	Discharge drainage structures
Pipes – inflow and outflow - & valves	lf (6-inch HDPE pipe)	4,800	$8	$38,400	6-inch pipe to inflow spreader canals and from the discharge collection canals
Valves – inflow and discharge	Ea	5	$1,000	$5,000	7 valves on the 6-inch lines at inflow and outflow locations
Installation of the pump station (s)	Ea	1	$88,000	$88,000	695 gpm (1.5 ft^3/s) – capacity one discharge PS for the SD WWTP and one intake PS from the L-31E Canal
Directional drilling for the two crossings under S.W. 232 St.	Lf	400	$ 50	$25,000	6-inch pipe crossings each direction – 50-foot each side of S.W. 232nd St. right of way + $5,000 Mob/Demob
Headwalls – inlet and outfall	Ea	16	$2,000	$32,000	Sand-cement rip-rap construction per FDOT specifications
Metal Sampling Boardwalk	Lf	1,290	$50	$74,500	Temporary metal boardwalk to sample in the cells at three locations perpendicular to flow
Installation of the monitoring wells	Ea	6	$10,000	$60,000	One groundwater monitoring well on each corner of the wetland site

EXHIBIT 4-1
Planning-Level Cost Estimate

Constructed Wetland Component	Units	Quantities (2 Cells)	Unit Cost	Total Cost	Assumptions
Planting of the wetland species	ft^2	214,000	$1.00	$214,000,000	Assume two plants per ft^2
Water Quality Samplers	Ea	4	$10,000	$40,000	Water quality sampling at the inflow, each cell outflow
Subtotal				**$1,239,500**	
Mobilization				**$80,000**	
Bonds and Insurance				**$20,000**	
Contingency (20%)				**$248,000**	
		Grand Total Construction Cost		**$1,587,500**	

Notes:
[1]A portion of these costs to be prorated to the remediation requirement and paid by the land owner
Assumes that the cut and fill material balance, and it not, fill may be obtained from the site
ac=acre(s)
yd^3=cubic yard(s)
yd^2=square yard(s)
ea=each
lf=linear foot (feet)
ft^2=square foot (feet)
HDPE=high-density polyethylene

SECTION 5

Planning-Level Modeling of Flows and Wetland Rehydration Performance

SECTION 5

Planning-Level Modeling of Flows and Wetland Rehydration Performance

The design of the constructed wetland can be enhanced through use of first order models, spreadsheet models, and other conventional proprietary or public domain models that provide an understanding of the hydraulic loading rates related to wetland cell sizing, the predicted water balance for the system, and capacity of the system to tolerate water depths within the cells and impacts on the coastal wetland vegetation. Spreadsheet-based first order models of the proposed constructed wetland have been evaluated for use within the design process for the constructed wetland segment of the WRDP. The purpose of such a model is to help guide wetland sizing decisions based on vegetation composition, anticipated loading rates, and operating schedule of the system.

Design support data not included in the existing investigations, or not in sufficient density or site specificity to support the design models, will be enhanced during the detail design phase. A plan of study, to fill these data gaps, is addressed later in this section.

5.1 Wetland Sizing

The Kadlec/Knight first order spreadsheet model has been the basis for the (Walker/Kadlec, 2005) Dynamic Model of Stormwater Treatment Areas (DMSTA) model used for sizing of the Stormwater Treatment Areas in the SFWMD Everglades Construction Project, CERP, and Acceler8 projects. The DMSTA model is proposed to be used for the sizing of the "constructed wetland" and determining loading rates of the coastal wetlands. The vegetation type and density, and background levels of the parameter of choice are also input parameters to the model. The use of this accepted model will facilitate literature comparisons of the project results to other constructed and natural wetland systems within Florida and throughout the United States.

5.2 Groundwater Seepage Analysis

The interaction of the inflow to the constructed wetland with the surficial aquifer is part of the design analysis, specifically the water balance of the pilot project. Historically the water balance analysis is focused on the seepage, evapotranspiration, and infiltration losses of the system through the use of a groundwater model. The application of a spreadsheet based model to simulate the losses through the berms and into the shallow aquifer, is recommended because of the relatively small cell size (2.5 acres) of the proposed constructed wetland. The qualitative observations of the contiguous Lennar mitigation wetland indicated that water will be retained in a rain driven constructed wetland during the wet season. Excessive loss of the reuse water inflow to the shallow aquifer is not anticipated. The reuse water base flow interaction with the shallow aquifer will be monitored in the constructed wetland cells to assist in calibration of the spreadsheet groundwater model. The impact of reuse water rehydration on the coastal wetland vegetation in the wetland cells

and the contribution of the system to the historic groundwater base flow will be evaluated using the spreadsheet model.

5.3 Simulating Surface Water Impacts to the Constructed Wetlands

External surface water impacts from the constructed wetland component of the reuse pilot coastal wetland rehydration project are not being evaluated within the context of the investigation. These considerations are being addressed in the SFWMD components of the CERP and Acceler8 projects. The constructed wetland surface water modeling requirements relate to the water movement within the two 2.5-acre cells. The decreased size of the two 2.5-acre cells limits the use of two-dimensional (2-D) hydrodynamic models such as Finite Element Surface Water Modeling System (FESWMS) (Froehlich, 1989). The water movement within the system will tend to be driven by the variation in vegetation density, pre-existing farm and mosquito ditches, or other irrigation ditches existing on the property that have not been degraded. Observations, dye experiments, and the possible development of a surface water spreadsheet model are the supporting models/tools that will be investigated quarterly for application of the right tool to conduct the evaluation of impacts to the coastal wetland system. There is no channel flow modeling required in Phase II of the constructed wetland tasking.

5.4 Water Balance – Period of Record

Modeling of the volume of surface water within the wetland cells will require the use of a water balance model that can evaluate the losses and storage over an extended period of record. The variation of source water from the reuse pilot plant facility and rainfall, and losses of water through evaporation, infiltration, plant use, and outflow pumpage are required to be simulated for operational management of the constructed wetland cells, and to understand the water balance of the system for water demand predict during full scale implementation of the coastal wetland rehydration process with reuse water. The use of the Natural Resource Conservation Service (NRCS) Soil Plant Atmosphere Water (SPAW) Model is recommended for predicting the hydrologic budget of the constructed wetland. SPAW is a daily time step hydrologic budget model that can simulate pumped inflow, precipitation, evaporation, and plant use (uptake and transpiration) of water within the system. The model does not predict lateral groundwater movement or losses.

SECTION 6

Works Cited

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