Appendix 5-14: Final Operation Plan PSTA Project in STA-3/4

SFWMD, February 2007

FINAL
OPERATION PLAN
PSTA PROJECT IN STA-3/4

FEBRUARY 2007

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

West Palm Beach, Florida

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PSTA PROJECT IN STA-3/4 STRUCTURE REFERENCE

Structure ID	Structure Type	Function	Design Capacity	Emergency Back-up Power	Operation Type	Page Containing Description	Notes
G-378E	120”x120” gated concrete box culvert	inflow control structure	396 cfs with HW of 13.8 ft NGVD and TW of 13.6 ft NGVD	No	locally remotely	4	
G-379E	72”x72” gated concrete box culvert	outflow control structure	396 cfs with HW of 12.9 ft NGVD and TW of 12.6 ft NGVD	No	locally remotely	5	
G-388	pump	PSTA cell outflow control structure	On/off stages are 10.25/9.75 ft NGVD.	No	locally remotely	4	
G-389A & B	two 84” diameter cmp culverts	inflow control structures	210 cfs for two culverts with HW of 13.3 ft NGVD and TW of 12.12 ft NGVD.	N/A	N/A	4	
G-390A &B	two 72”x72” gated concrete box culverts	inflow control structures	210 cfs for two culverts with HW of 13.45 ft NGVD and TW of 13.20 ft NGVD.	No	locally remotely	4	

I. PROJECT DESCRIPTION

The STA-3/4 PSTA Project is a 445-acre (162-ha) section of Cell 2B in STA-3/4. The primary objective of this project is to evaluate how well the PSTA technology can work when it is implemented at the 100-acre scale. The information gained from this medium-sized implementation may provide information about the cost and effort involved to implement the PSTA technology at a larger scale, for example at the 1,000-acre size.

This project consists of three parts, an Upper SAV Cell, PSTA Cell, and Lower SAV Cell. (See **Figure 1 and Figure 2**). The chief difference between the PSTA Cell and the two SAV Cells is that the peat substrate in the PSTA Cell was scraped down to caprock and removed, while the sediment in the Lower SAV Cell was not disturbed. As a consequence, the floor elevation of the PSTA Cell is approximately two feet lower than the adjacent SAV cells. The floor of the PSTA Cell is approximately 8 ft NGVD and the floor of the SAV Cells is approximately 9.7 ft NGVD. Note, all elevations in this document are referenced to datum NGVD 1929. A future effort will be required to convert the elevations to NAVD 1988 simultaneously with the effort to convert the control elevations in the project area.

Construction of all infrastructures (levees, culverts, gates, and the outflow pump station) has been completed and the project was flooded in Spring 2005 to begin establishing periphyton and SAV. Operation of G-388 began in August 2005. The telemetry system needed to operate the project did not become functional until July 2006. As a consequence, the project inflow and outflow gates (G-378E and G-379E, respectively) remained closed during WY2006 and the only inflows to the project were rainfall and seepage from adjacent treatment cells in STA-3/4. The project outflow pump station (G-388) was operated to remove excess seepage into the PSTA Cell and maintain a depth of approximately 24 inches.

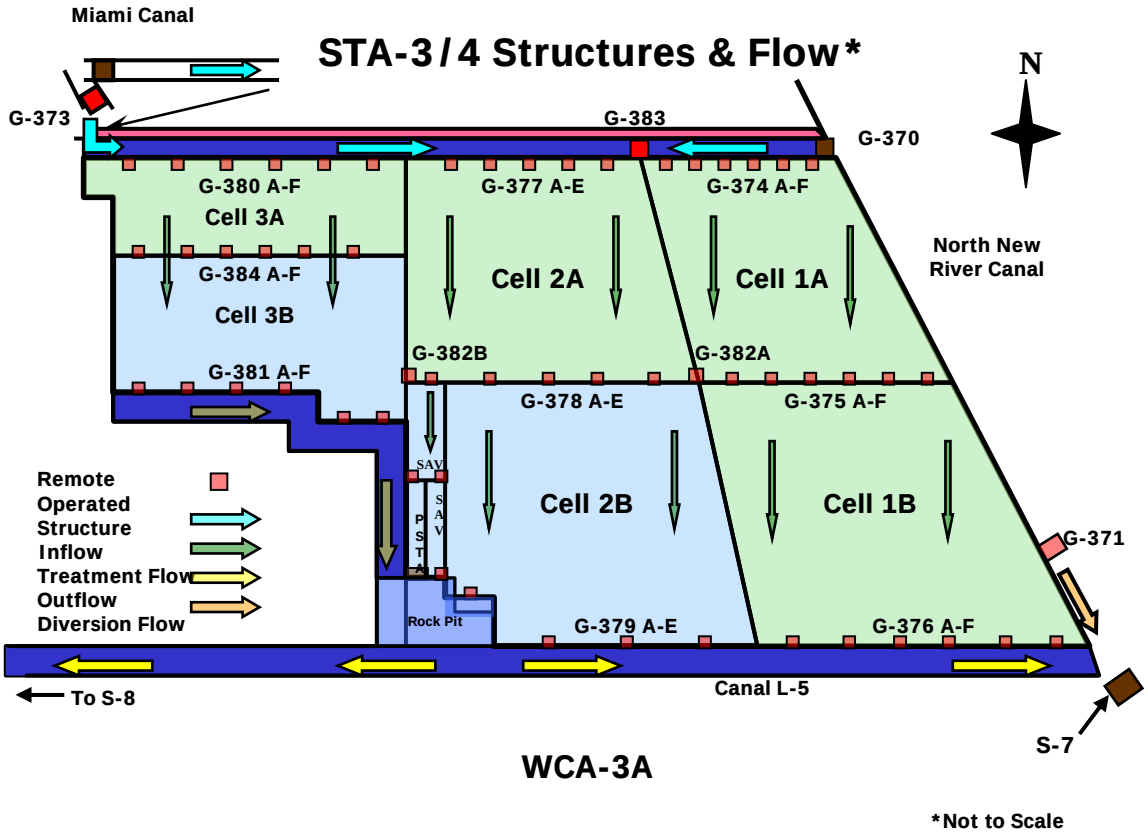


Figure 1. Location of the PSTA Project in STA-3/4

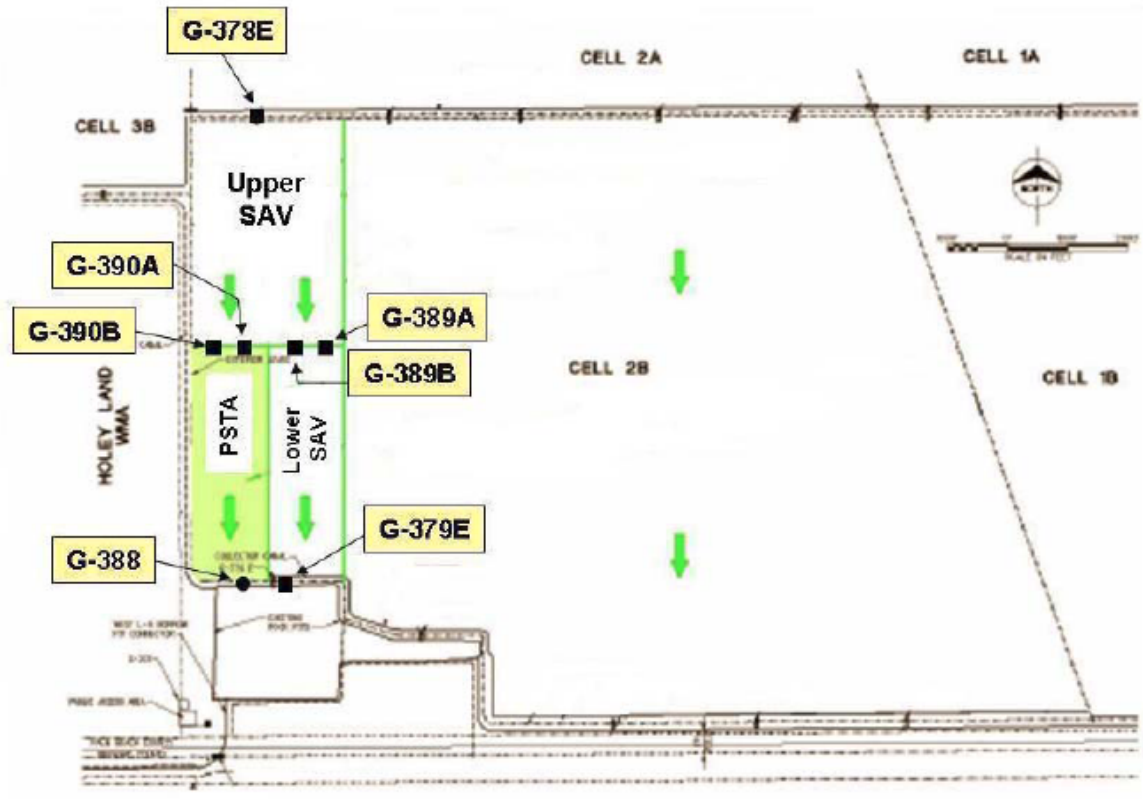


Figure 2. Schematic Diagram of the PSTA Project in STA-3/4

Table 1. Effective Treatment Area and Vegetation Type

Cell Name	Effective Treatment Area (ac.)	Target Vegetation
Upper SAV Cell	222	SAV
Lower SAV Cell	112	SAV
PSTA Cell	111	PSTA
Total	445	

II. STRUCTURES

- **G-389A and B**

Structures G-389A and B are two uncontrolled culverts and convey discharges from the Upper SAV Cell to the Lower SAV Cell. These two culverts are 84-inch CMP structures with flared end sections on both ends and an average invert elevation of 3.0 ft NGVD.

Telemetry required for headwater and tailwater is available. These two structures are not equipped with emergency back-up power. No operation is required.

- **G-390A and B**

Structures G-390A and B are two gated culverts and convey discharges from the Upper SAV Cell to the PSTA Cell. These two culverts are 72-inch concrete box culverts with headwalls on both ends and an average invert elevation of 2.0 ft NGVD.

Telemetry required for headwater and tailwater is available. These two structures can be operated locally or remotely, and are not equipped with emergency back-up power.

- **G-388**

G-388 is the outflow pump station to lift discharges from the PSTA Cell across the South Exterior Levee into the west borrow pit.

Number of Pumps:	2
Size and Type of Pumps:	42 inch vertical axial flow propeller pump
Rated Capacity:	100 cfs per unit
Power Source:	commercial electricity

Telemetry required for headwater and tailwater is available. This structure can be operated locally or remotely, and is not equipped with emergency back-up power.

- **G-378E**

Structure G-378E is a gated concrete box culvert. It serves as the inflow control structure for the PSTA project. This structure is identical to the other G-378 structures. A description of this structure is shown in Table 2.

Table 2. PSTA Project Inflow Control Structure G-378E

Control Structure Description	G-378E
Culvert / Gate Size (H x W)	10' x 10'
Culvert Length (including wingwalls)	123 ft
Culvert Invert	0.0 ft NGVD
Design Inflow (each culvert)	396 cfs
Design Max. Headwater Elevation	13.8 ft NGVD
Design Low Water Elevation (HW)	10.9 ft NGVD
Standard Project Storm Elevation (HW)	16.8 ft NGVD
Design Max. Tailwater Elevation	13.5 ft NGVD
Design Low Water Elevation (TW)	10.9 ft NGVD
Standard Project Storm Elevation (TW)	16.5 ft NGVD
HW/TW Data via Telemetry	G-378C

Remote and local operations of this structure are possible. In the event of loss of electrical power at the site, this structure can be manually operated with hydraulic or electric wrenches.

Headwater and tailwater data are available via telemetry to the remote operators while headwater/tailwater staff gauges are also available at these locations. Gate position at each structure is monitored remotely.

- **G-379E**

Control Structure G-379E is a gated concrete box culvert. It serves as the outflow control structure for the Lower SAV Cell. This structure is identical to the other G-379 structures. A description of this structure is shown in Table 3.

Table 3. PSTA Project Outflow Control Structure G-379E

Control Structure Description	G-379E
Culvert / Gate Size (H x W)	10' x 10'
Culvert Length (including wingwalls)	123 ft
Culvert Invert	0.0 ft NGVD
Design Inflow (each culvert)	396 cfs
Design Max. Headwater Elevation	12.9 ft NGVD
Design Low Water Elevation (HW)	10.9 ft NGVD
Standard Project Storm Elevation (HW)	15.9 ft NGVD
Design Max. Tailwater Elevation	12.6 ft NGVD
Design Low Water Elevation (TW)	10.0 ft NGVD
Standard Project Storm Elevation (TW)	15.6 ft NGVD

Remote and local operations of this structure are possible. In the event of loss of electrical power at the site, this structure can be manually operated by means of a portable generator or hydraulic/electric powered maintenance equipment.

Headwater and tailwater data are available via telemetry to the remote operators while headwater/tailwater staff gauges are also available at these locations. Gate position at this structure is monitored remotely.

III. OPERATIONS

3.1 Operation Criteria

The operational intent is to maintain an average depth of 2.0 ft in the PSTA Cell. For the SAV Cells, the target stage and the minimum stage are the same as the other SAV Cells in STA-3/4. Table 4 summarizes the operational stage requirements in details.

Table 4. PSTA Project Operational Stage Requirements

Cell	Reference Ground Elevation (ft NGVD)[1]	Target Depth (ft)	Target Stage (ft NGVD)[2, 3, 4]	Minimum Stage (ft NGVD)[4]	Measured at Structure
Upper SAV Cell	9.7	1.25	11.0	10.2	G-378E TW
Lower SAV Cell	9.7	1.25	11.0	10.2	G-379E HW
PSTA Cell	8.0	2.00	10.0	N/A	G-390B TW

1. The reference ground elevations are established based on the mean of the survey points.
2. Unless otherwise noted, the operating ranges are +/- 0.20 ft of target stage for SAV Cells and +/- 0.25 ft of target stage for the PSTA Cell.
3. Minimum stage is established to prevent scouring of the cell bottom. It may be higher than the minimum depth required by the vegetation to avoid dry out. The target stage is rounded to one decimal place.
4. Site-specific circumstances in the cells may result in deviations from this target stage based on the District staff's best professional judgment.

3.2 Normal Operation

Normal operation of the STA-3/4 PSTA Project is defined as flows up to and including the Design Peak Flow Condition of 210 cfs with full coverage of a periphyton dominated plant community. Based on the 8.0 ft NGVD reference ground elevation in the PSTA Cell, water stage in the PSTA Cell should be controlled to an average elevation of 10.0 ft NGVD by the outflow pump station, with a pump operation range of 10.25/9.75 ft NGVD.

The Upper SAV Cell and the Lower SAV Cell will be operated the same as the other SAV Cells in STA-3/4. The target stage is 1.25 feet above the reference ground elevation and the minimum stage is 0.5 feet above the reference ground elevation. Please refer to Table 4 for details.

During storm events, the stage for the PSTA Cell should be maintained at 10.0 ft NGVD. The peak stages for the SAV Cells are consistent with the other STA-3/4 SAV Cells as summarized in Table 5 below.

Table 5. Design Storm Event Stages and Flows

Structure ID	Peak HW Stage (ft NGVD)	Peak TW Stage (ft NGVD)	Peak Discharge Rate (cfs)
G-378E	13.80	13.50	396
G-379E	12.90	12.60	396
G-390A & B	14.45	13.20	210

G-390A and B gate operations will be based on the headwater, tailwater, and targeted Hydraulic Residence Time (HRT). The current recommended HRT is 5 days. Appendix I presents the different gate openings corresponding to an HRT of 5 days and the target stage of 10.0 ft NGVD within the PSTA Cell. The typical G-390A and B gate operation shall involve setting gate openings once a day as summarized below.

1. Read the headwater stage at G-390A and B (there is a single value for both structures).
2. Find this stage in Appendix I and set the gate openings accordingly.

The outflow pump station, G-388, runs on automatic mode, so operator intervention is not needed. The depth in the PSTA Cell is controlled by a float switch that turns the G-388 pumps on and off. G-388 has a total pumping capacity of 200 cfs.

Because of the elevation difference between the PSTA Cell and the adjacent SAV cells, seepage can be a significant inflow source to the PSTA Cell. The current operational recommendations did not take into account the seepage inflow because there is no seepage data available. The operational recommendations may be revised based on operational experience and any other pertinent information.

3.3 Standard Project Storm Operation

The Standard Project Storm (SPS) is defined for STA-3/4 as a 36-inch rainfall for a 3-day duration storm. Under the condition of the SPS, normal operation of the PSTA Cell may be superseded by consideration for the overall STA-3/4 facility.

3.4 Dry Conditions and Drought Conditions Operation

During dry conditions and/or drought conditions, if the stage in the adjacent SAV Cells is equal to or below the 11.0 ft NGVD target stage, the G-390A and B gates should be closed and pump station G-388 should be shut off to equalize the water levels between the PSTA Cell and the Lower SAV Cell. This may result in a temporarily high stage in the PSTA Cell but will reduce the loss of water from STA-3/4 due to the seepage from adjacent cells being pumped out of the PSTA Cell through G-388.

3.5 Deviations from Normal Operating Criteria

This Operation Plan is meant to be updated regularly based on field observations of stage-flow relationships, structure flow calibrations, revised structure flow rating calibrations, PSTA performance and optimization research, and potentially other factors. Best professional judgment on the part of the District's Operations staff shall be used in the operation of the structures if necessary to deviate from these guidelines to account for flood protection, excess precipitation, site specific conditions, and upstream and downstream conditions.

3.6 Pre-storm Operation

For this project, none of the structures is equipped with emergency back-up power. If a major storm is predicted, the structures should be operated in anticipation that power will be lost during the storm event, such that the water levels in the treatment cells are reduced to, or below, the target stages in Table 4. Pre-storm operations are therefore accompanied by some risk that a drawdown may be implemented and the actual amount of rainfall does not match the predicted amount, with the result that after the storm passes, the target stages are not met. The biological consequences of this operation could be potential damage to the vegetation if a source of water is not available after such a pre-storm drawdown and related less-than-predicted rainfall. Such an occurrence in the dry season could result in even higher risk of damage to the vegetation if a source of water can not be found for an extended period of time.

IV. COORDINATION WITH OTHER PROJECTS

While trying to meet the operational intent as described above, this project shall be operated in a manner such that the performance of STA-3/4 is not impacted.

V. **REFERENCES**

1. Stormwater Treatment Area-3/4 PSTA Demonstration Project Works Construction Drawings, 100% Submittal, NOVA Consulting, Inc., December 2003.

2. Operation Plan for Stormwater Treatment Area-3/4, South Florida Water Management District, May 2004.

3. Stormwater Treatment Area-3/4 PSTA Demonstration Project Outflow Pump Station Design Drawings, South Florida Water Management District, April 2004.

APPENDIX I

FLOW COMPUTATION EQUATIONS FOR G-390A AND B CULVERTS IN STA-3/4

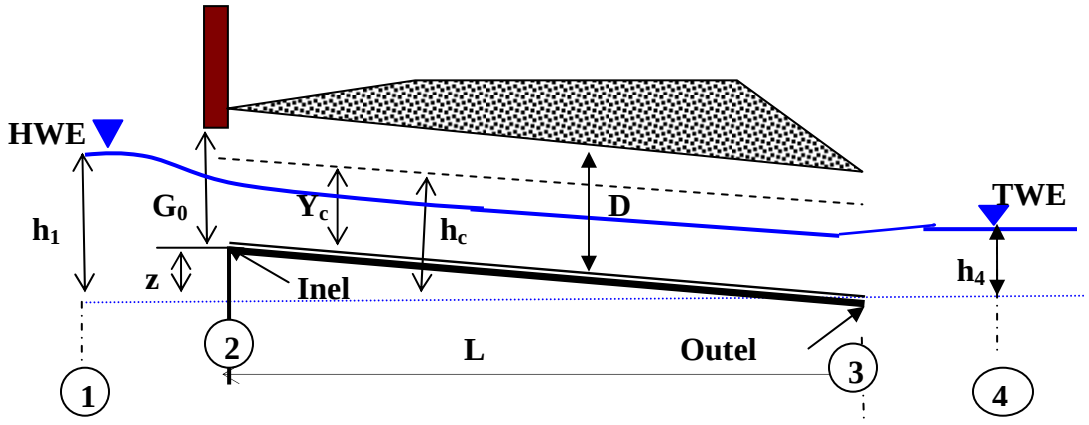
FLOW COMPUTATION EQUATIONS FOR G-390A & B IN STA-3/4

This document describes the equations developed for Type-4 flows for box culverts.

(Ver. 07)

SYMBOLS

HWE	Upstream water head (feet)
TWE	Downstream water tail (feet)
h_1	HWE – intel (feet)
h_4	TWE – outel (feet)
Yc	Critical depth (feet)
Inel	Inlet elevation (feet)
Outel	Outlet elevation (feet)
D	Culvert height (feet)
Z	Elevation offset (Inel – Outel)
S_c	Critical slope
g	Acceleration due to gravity, 32.2 ft/sec^2
Ag	Area of gate opening (square feet)
Go	Gate opening (feet)
Q	Flow rate through the culvert (cfs)
B	Culvert width (feet)
L	Culvert length (feet)
C_d	Discharge coefficient



Classification: **TYPE-4 FLOW (Full Pipe Flow)**

Restrictions: $\frac{h_1 - z}{G_0} > 1.0$ and $\frac{h_4}{D} > 1.0$ (both inlet and outlet of culvert are submerged.)

Equation: $$Q = CA_0 \sqrt{\frac{2g(HWE - TWE)}{\left(\frac{A_0}{A_G}\right)^2 + 2C^2\left(1 - \frac{A_0}{A_G} + \frac{gn^2 L}{(1.49)^2 R_0^{4/3}}\right)}} \quad (1)$$

Where C = 0.85

$$A_0 = B * D \quad (2)$$

$$A_G = B * G_o \quad (3)$$

$$R_0 = A_0 / 2(B + D) \quad (4)$$

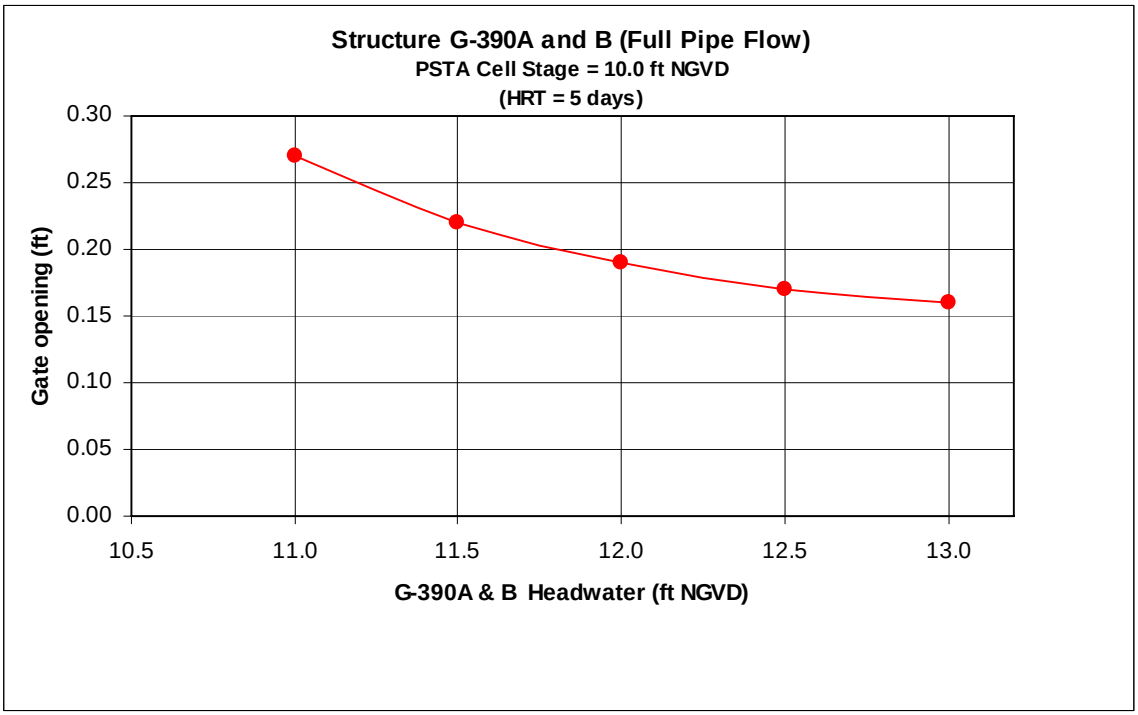
n = 0.012 - 0.024

G-390A and B Gate Opening

Target Stage in the PSTA Cell: 10.00 ft NGVD
HRT = 5 days

G-390A & B HW (ft NGVD)	Gate Opening* (ft)
11.0	0.3
11.5	0.2
12.0	0.2
12.5	0.2
13.0	0.2

* The gate opening is rounded to one decimal place.


Structure G-390A and B (Full Pipe Flow)
PSTA Cell Stage = 10.0 ft NGVD
(HRT = 5 days)
Gate opening (ft)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
10.5
11.0
11.5
12.0
12.5
13.0
G-390A & B Headwater (ft NGVD)

APPENDIX II
HISTORY OF REVISIONS

Currently no revisions.