OPERATION PLAN
STORMWATER TREATMENT AREA 1 WEST

JUNE 2004

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

West Palm Beach, Florida

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I. PROJECT DESCRIPTION

Location. STA-1 West, together with its associated canals and the STA-1 Inflow Basin, is a primary component of the Everglades Construction Project mandated by the 1994 Everglades Forever Act (Section 373.4592, Florida Statutes). STA-1W is located within Sections 1, 2, 3, 6, 7, 10, 11, 12, 13, 14, 15, 22, 23, 26, 27, 34, Township 44 South, Range 39 East within Palm Beach County and is positioned immediately west of the Arthur R. Marshall Loxahatchee National Wildlife Refuge, also known as Water Conservation Area 1 (WCA-1) (see Figure 1).

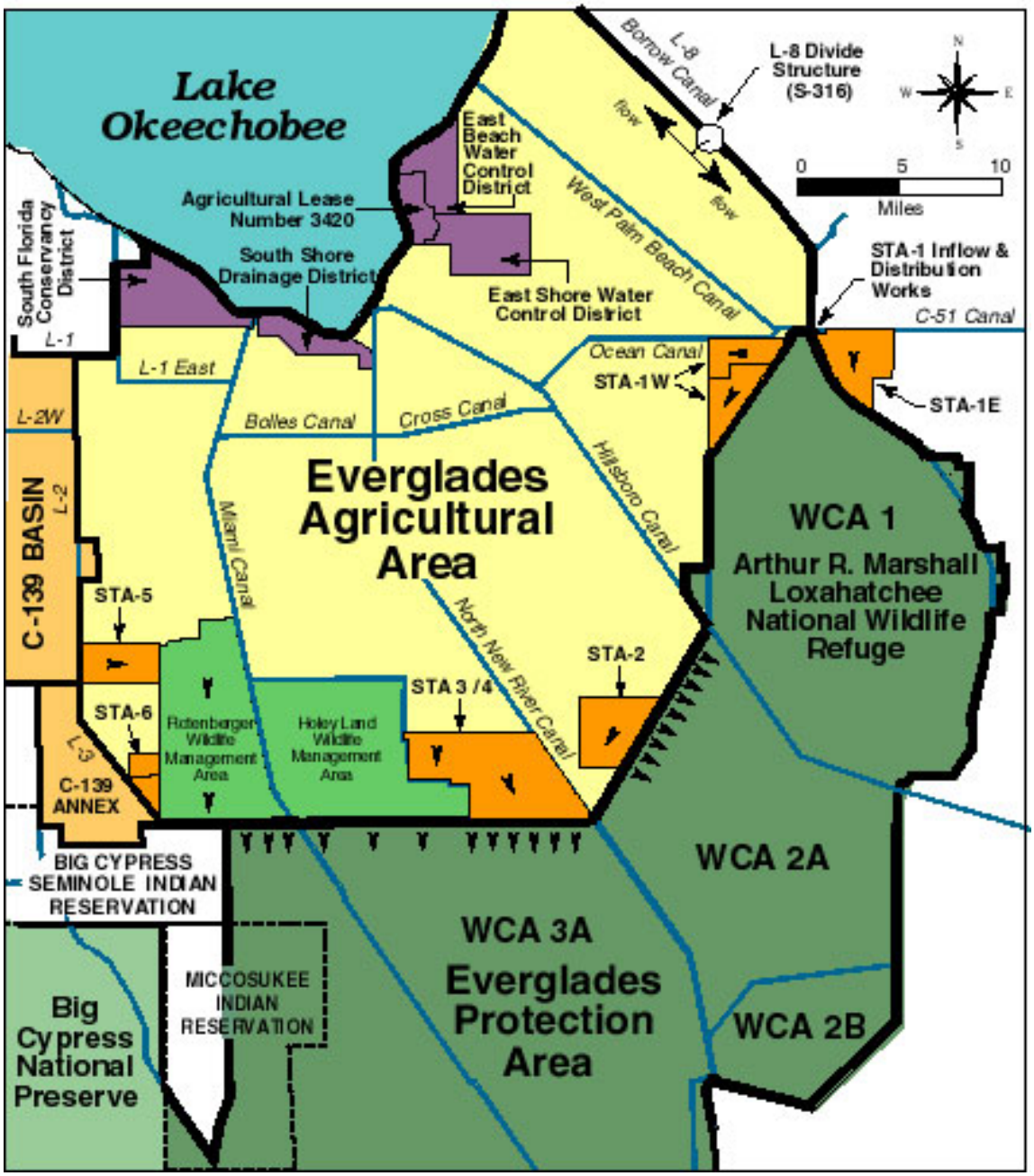
Interim Operations Prior To Construction Of STA-1 East.

Stormwater Runoff. Although STA-1W began operation in 1999, STA-1 East (STA-1E), which is under construction by the U.S. Army Corps of Engineers and will also treat waters flowing to WCA-1, will not be ready for full flow-through operations until after 2004. Until STA-1E is operating at full flow-through capacity, it is anticipated that an average of 31,000 acre-feet per year of S-5A basin runoff scheduled to go to STA-1E will continue to STA-1W. Offsetting this volume is a reduction in the runoff from the C-51W basin, anticipated to be diverted to STA-1W once STA-1E is fully operational. The net is an interim increase of 19,500 acre feet in the average annual flow assumed to go to STA-1W. Prior to completion of STA-1E, these waters may continue to flow to the Refuge, either as treated discharge from STA-1W or as untreated discharge through the STA-1 Inflow Basin.

BMP Replacement Water. Consistent with the Settlement Agreement and the EFA, the District is also required to offset flow reductions in EAA runoff due to BMPs. It is anticipated that BMP replacement water will be sent primarily to STA-3/4, however, for the S-5A basin, some of this BMP make-up water may be diverted to STA-1E. Consistent with the intended operations guidelines in the 1994 Conceptual Design, the BMP make-up water will be delivered to the STAs only if available treatment capacity exists. The District's BMP Replacement rule contains the flexibility to reduce delivery to the STAs "when the delivery is likely to cause hydraulic bypass around the STA or otherwise hinder its performance." It is anticipated that minimal BMP replacement water deliveries will be made during the Interim Period.

Southern L-8 Basin Runoff. During the 1979-1988 base period, approximately 50,700 acre feet per year (with an associated 3.5 metric tons of phosphorus) from the southern L-8 basin was discharged into the Refuge. CERP planning efforts underway include construction of diversion works that send waters from the southern L-8 basin to other areas, instead of the Refuge where the runoff goes today. Prior to completion of STA-1E and the diversion works, these waters may continue to flow to the Refuge, either as treated discharge from STA-1W or as untreated discharge through the STA-1 Inflow Basin.

Figure 1. Overview of the Everglades Construction Project.



STA-1 West Flow Patterns. The average annual inflow volume and Total Phosphorus (TP) load to STA-1W was estimated during design as approximately 142,853 acre-feet and 37,701 kilograms, respectively. STA-1W is designed to provide a total effective treatment area of 6,670 acres to treat stormwater runoff and limited Lake Okeechobee releases. Of the total effective treatment area necessary for STA-1W, 3,815 acres are contained in Cells 1 through 4, formerly known as the Everglades Nutrient Removal Project (ENR). The remaining 2,855 acres of treatment area are contained in the northerly expansion, designated as Treatment Cells 5A and 5B. Specific acreage areas for each cell within STA-1W are provided below:

Cell No.	Effective Treatment Area (ac.)
1	1,490
2	941
3	1,026
4	358
5A	562
5B	2,293

Pump station S-5A is the primary inflow structure for the overall STA-1W project. Stormwater runoff passes through S-5A into the STA-1 Inflow Basin, where it can be distributed to three locations: STA-1W treatment area (via structure G-302), STA-1E (when completed, through structure G-311), or WCA-1 under water supply or certain flood conditions (via structures G-300 and G-301).

Treatment Flow-ways. After passing through G-302, the inflow is distributed to three treatment flow-ways by means of the Inflow Canal (see Figure 2): the eastern flow-way consists of Cells 1 and 3; the western flow-way consists of Cells 2 and 4; and the northern flow-way consists of Cells 5A and 5B. During the design flow condition of 3,250 cfs, approximately 930 cfs (29%) will flow through the eastern flow-way, 850 cfs (26%) will flow through the western flow-way, and 1470 cfs (45%) will flow through the northern flow-way. Inflow is distributed to the eastern and western flow-ways through structure G-303, and into the northern flow-way through structures G-304A-J. Flows passing through G-303 are distributed either south into the eastern flow-way or west through structure G-255 into the western flow-way.

Eastern Flow-way Operation

The eastern flow-way is composed of Treatment Cells 1 and 3, and contains a total of 2,516 acres of effective treatment area. The area is covered by cattail or other emergent vegetation, as well as submerged aquatic vegetation (SAV), floating macrophyte and open water. A portion of Treatment Cell 3 also contains plantings of native Florida species and is referred to as a "mixed marsh" plant community, which has been allowed to develop in a natural manner.

Treatment in the eastern flow-way occurs as the water moves in a southwesterly direction across the marsh for a distance of approximately 5 miles. Treated water is discharged

into WCA-1 via the G-251outflow pump station. Under high flow conditions, some of the eastern flow-way water is conveyed through structures G-259 and G-308 into the Discharge Canal and to WCA-1 via the G-310 outflow pump station. An additional source of water to the eastern flow-way is seepage from the adjacent WCA-1, which is normally maintained at stages that are 2.5 - 5.5 feet higher than Cells 1 and 3.

Western Flow-way Operation

The western flow-way is composed of Treatment Cells 2 and 4, and contains a total of 1,299 acres of effective treatment area. The majority of the area is covered by submerged aquatic vegetation (SAV), floating macrophyte and open water, and the remaining area is covered with cattail or other emergent vegetation.

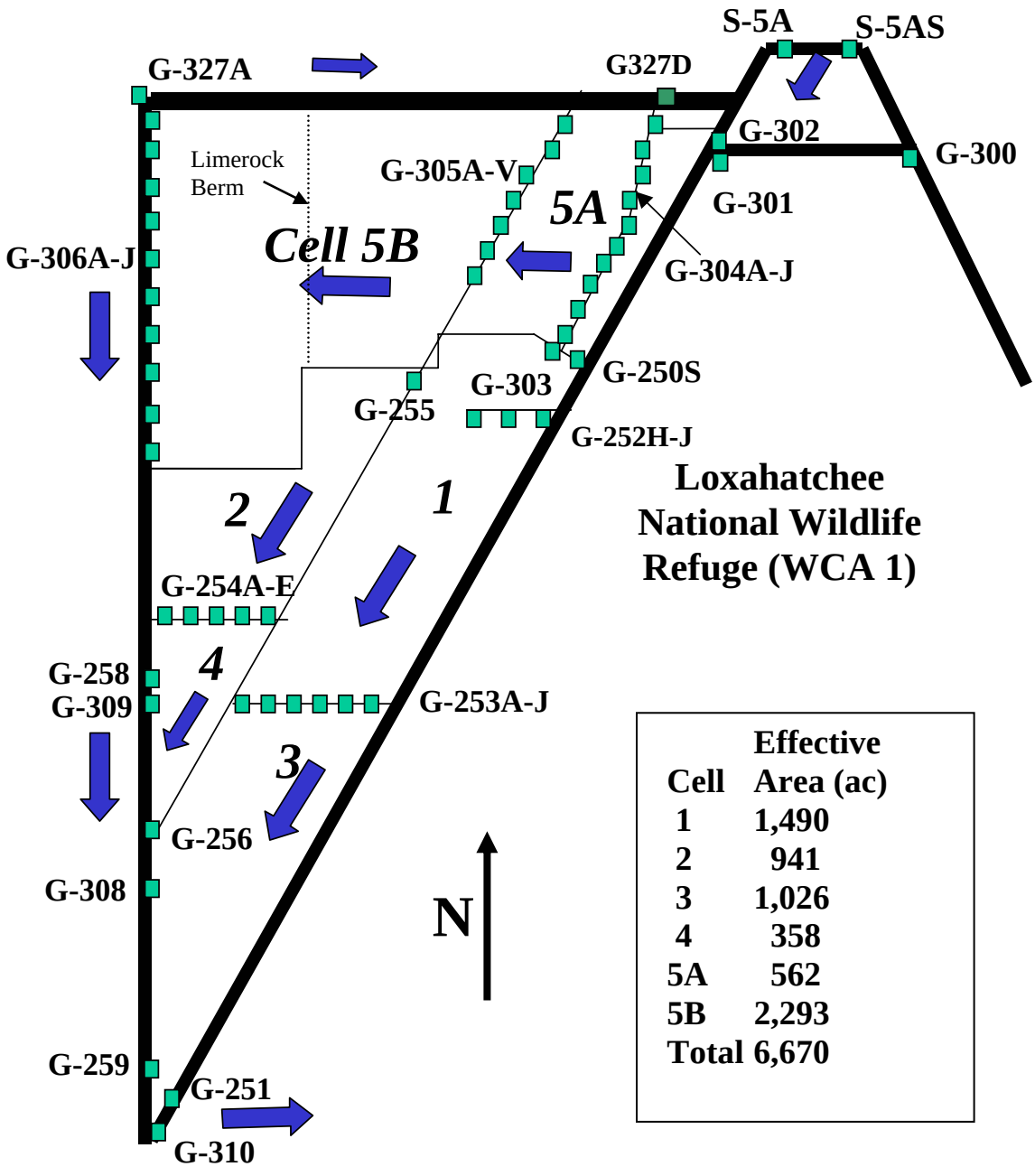
Treatment in the western flow-way occurs as the water moves in a southwest direction across the marsh for a distance of approximately 3.4 miles. Treated water is discharged into WCA-1 via the G-251 outflow pump station. Under high flow conditions, some of the western flow-way water is conveyed through structures G-258 and G-309 into the Discharge Canal and to WCA-1 via the G-310 outflow pump station. Seepage from the western flow-way is captured by the discharge canal and directed to WCA-1 via the G-310 outflow pump station.

Northern Flow-way Operation

The northern flow-way is composed of Treatment Cells 5A and 5B, and contains a total of 2,855 acres of effective treatment area. The two cells are separated by a levee supporting an electric transmission line; twenty-two culverts (G-305 A-V) along the levee allow water to flow between the two cells. The present vegetation management objective for this flow-way is to encourage emergent macrophytic vegetation in the approximately 562-acre eastern portion (Cell 5A) and encourage submerged aquatic vegetation (SAV) in the approximately 2,293-acre western portion (Cell 5B).

Treatment in the northern flow-way occurs as the water moves west across the marsh for a distance of approximately 3.6 miles. A limerock berm was constructed in Cell 5B to help redistribute flows and enhance phosphorus removal performance. Treated water exits Cell 5 through structures G-306A-J to the discharge canal leading to outflow pump station G-310. Seepage from Cell 5 that is intercepted by the north seepage collection canal is directed to Cell 1 via the G-250S pump station. Seepage along the western boundary of Cell 5B is captured by the discharge canal and directed to WCA-1 via the G-310 outflow pump station.

Figure 2. Schematic of STA-1 West Flows (not to scale)



Operations History. Flow-through operation of treatment cells 1 through 4 (the former ENR project) commenced in August 1994. As part of the STA-1W project, modifications to the existing internal levees and water control structures were required to provide additional peak flow capacity through these cells. Operation of the eastern and western flow-ways continued during these construction modifications. Treatment cells 5A and 5B and associated facilities were completed in March 1999. On May 11, 1999, the Florida Department of Environmental Protection (FDEP) issued the Everglades Forever Act permit (FL503074709) and the associated NPDES permit (FL0177692-001) for operation of the expanded STA-1W. Water quality monitoring data at the inlet and outlet locations for Cell 5 demonstrated a net improvement in total phosphorus, total mercury and methylmercury during January 2000, and hence, satisfied the "start-up" requirements in the state operating permits. Flow through operation of the northern flow-way commenced during July 2000. Full operation of STA-1W commenced in October 2000 when the G-310 outflow pump station was completed.

References. This *Operation Plan* for STA-1W was developed based upon the requirements of the FDEP permits mentioned above and the March 1997 Department of the Army Section 404 Permit No. 199404532 for the Everglades Construction Project. Materials utilized extensively in the preparation of this Plan include the February 15, 1994 *Conceptual Design, Everglades Protection Project*; June 5, 1996 Detailed Design Report; April 15, 1996 Hydraulic Analysis Report; October 30, 1996 Supplement to the Detailed Design Report; June 19, 1997 Supplement No.2 to the Detailed Design Report; the March 1999 STA-1W *Pollution Prevention Plan* (presented in Appendix I); and the December 1999 Hutcheon Engineers report *Impacts of Submerged Aquatic Vegetation on STA-1W Design and Operation*.

II. STRUCTURES & CANALS

The following section describes the water control structures and major canals associated with STA-1W. Photographs of major structures are provided in Appendix B.

A. INFLOW CONTROL FACILITIES

Pump station S-5A is the primary inflow structure for the overall STA-1W project. Stormwater runoff and lake releases pass through S-5A into the STA-1 Inflow Basin, where it can be distributed to three locations: STA-1W treatment area (via structure G-302), STA-1E (when completed, through structure G-311), or WCA-1 under water supply or certain flood conditions (via structures G-300 and G-301).

After passing through G-302, the inflow is distributed to three treatment flow-ways by means of the Inflow Canal (see Figure 2): the eastern flow-way consists of cells 1 and 3; the western flow-way consists of cells 2 and 4; and the northern flow-way consists of Cells 5A and 5B. Inflow is further distributed to the eastern and western flow-ways through structure G-303, and into the northern flow-way through structures G-304A-J. Flows passing through G-303 are distributed either south into the eastern flow-way or west through structure G-255 into the western flow-way. The following section describes these inflow control facilities - S-5A, G-302, the Inflow Canal, G-303, G-304, and G-255.

1. S-5A Pump Station

S-5A pump station provides flood protection to an upstream agricultural basin of approximately 230 square miles. The removal of stormwater runoff from the upstream basin has been, and will continue to be, the primary function of the S-5A pump station. In addition to flood control for the S-5A tributary basin, the S-5A Pump Station has been used to remove excess flows from the L-8 and C-51 basins as well as to convey excess water from Lake Okeechobee (when it is above its regulation schedule) to WCA-1. In some instances, it has been used to convey water from Lake Okeechobee to WCA-1 for the purpose of water supply for points downstream of the pump station. This structure is a six-unit pumping plant located on the south side of State Road 80 and the West Palm Beach Canal about 20 miles west of West Palm Beach. The pumping station is equipped with six pumps each rated at 800 cfs at a static head of 11.1 feet, with a combined capacity of 4,800 cfs.

Pump station headwater stages of 11.5 ft NGVD and 10.5 ft NGVD are maintained during irrigation and drainage seasons, respectively. The irrigation/drainage phase is a special designation, which indicates if the dominant agricultural activity is irrigation or drainage. The irrigation phase generally occurs in the winter and the drainage phase generally occurs in the summer. Brief periods of very wet or very dry weather at any time of year can initiate a change from one phase to the other. During the irrigation phase,

stages in the West Palm Beach canal are held higher; during the drainage phase, the goal is to keep these stages lower.

Pump Station Description:

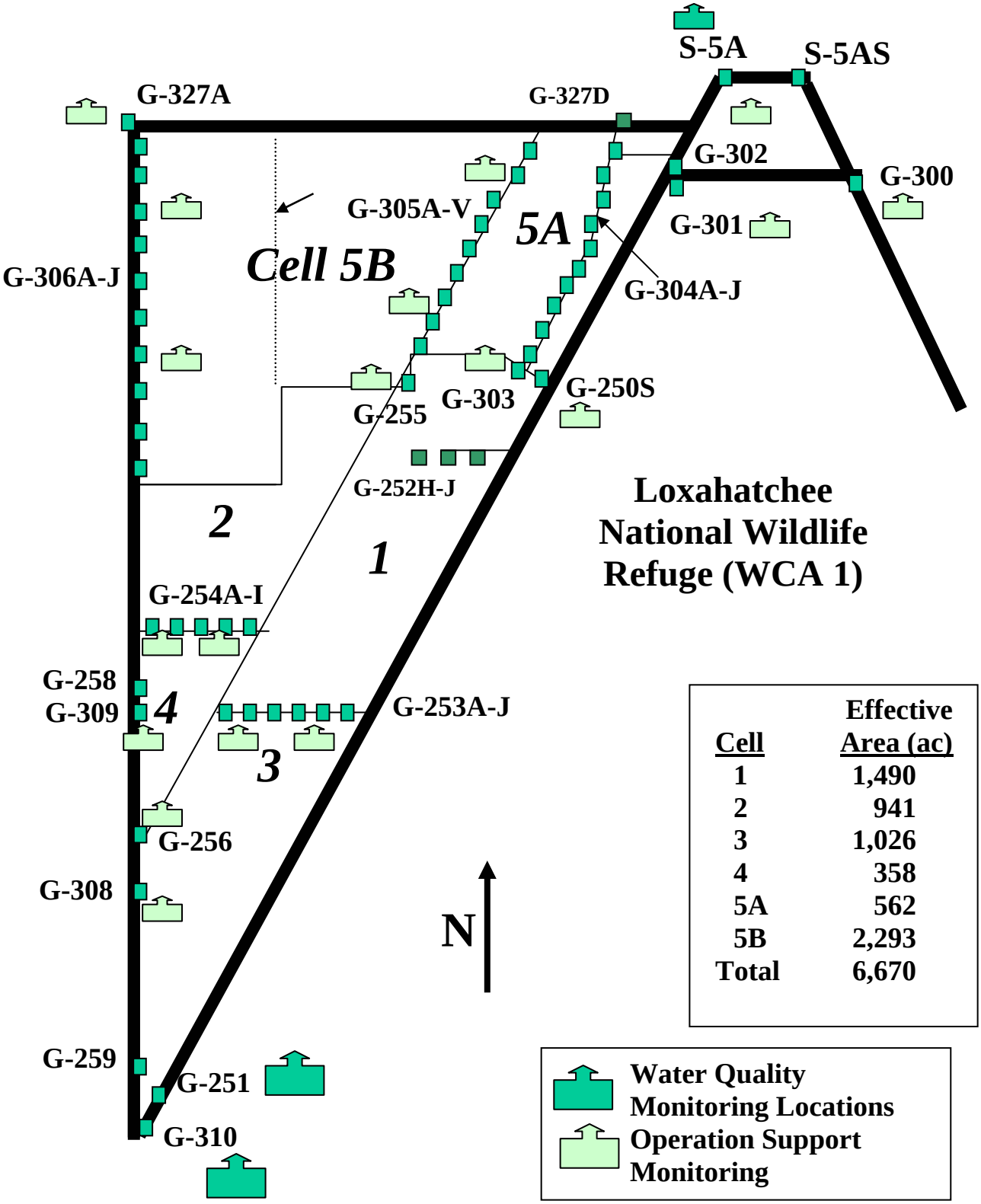
Number of Pumps:	6
Discharge Capacity (each pump):	800 cfs at 11.1 foot static head
Design headwater elevation:	13.0 ft NGVD
Design tailwater elevation:	24.1 ft NGVD
Pump size:	116-inch impeller
Pump Speed:	125 rpm
Engine Size:	1,600 Hp
Engine Speed:	714 rpm

Structure Operations:
Pump station headwater stages of 11.5 ft NGVD and 10.5 ft NGVD are maintained during irrigation and drainage seasons, respectively.

Data Acquisition and Telemetry:
Only local operation of this pump station is possible. Meteorological and hydrologic data are available to the West Palm Beach Control Room, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
Flow proportional, composite sampling for TP is required by the operating permits, and the necessary automatic sampling equipment is present at this site (see Figure 3).

Figure 3. STA-1W Water Quality Monitoring Locations



2. STA-1 Inflow Basin

The 272-acre STA-1 Inflow Basin provides the capability to convey discharges from Pump Station S-5A to STA-1W, WCA-1 and STA-1E (when completed). The physical facilities of STA-1 Inflow Basin consist of three automated control structures designated as G-300, G-301, and G-302; the L-7 and L-40 borrow canals; and a levee that separates the Inflow Basin from the north end of the WCA-1. Structures G-301, situated on the L-7 Borrow Canal and G-300, situated on the L-40 Borrow Canal are intended to act in parallel with a discharge capacity of 4,800 cfs to provide for full diversion of Pump Station S-5A directly to WCA-1 in the event of a need to divert under emergency or extreme inflow and rainfall conditions. Structures G-300 and G-301 may also be operated to allow for water supply deliveries from WCA-1 to the C-51 and L-8 Canals. The separation levee has a top elevation of 20.0 ft NGVD and a length of 6,100 ft.

3. G-302 Treatment Area Inflow Control Structure

Inflow structure G-302 consists of a concrete ogee-shaped spillway with two 20-foot wide vertical lift gates installed on the crest of the spillway at elevation 9.4 ft NGVD. G-302 is located at the head of the Inflow Canal for STA-1W. The design inflow rate for structure G-302 is 3,250 cfs at a headwater elevation of 18.0 ft NGVD and tailwater elevation of 15.8 ft NGVD. Structure G-302 provides the only external inflow source to STA-1W with the exception of direct rainfall and seepage from the Refuge. An 84-inch diameter pipe is located below the weir crest to allow uninterrupted conveyance of the north perimeter seepage canal to pump station G-250S. The peak seepage return flow rate via the enclosed pipe is approximately 100 cfs.

Structure Operations:
The G-302 structure will be operated in one of the three following modes:

- Manually
- Automatically in response to maintain water surface elevations in the downstream Inflow Canal at or below critical elevation during normal operation conditions.
- Remotely via telemetry from the District's Operations Control Center in West Palm Beach.

G-302 will be typically operated open or partially open. It will be closed when necessary to prevent S-5A flows from entering into STA-1W if interior stages are too high. This structure will be operated to keep tailwater stages below critical levels. When any of the flow-ways are taken off-line, flows through G-302 will need to be reduced or eliminated by partially or fully closing the structure.

Data Acquisition and Telemetry:
Automatic, manual and remote operation of this structure are possible. Telemetry required for remote operation has been provided. Headwater, tailwater and gate position information are available to the remote operators. Headwater and tailwater staff gauges and gate position readings are available for manual operation.

Water Quality Sampling:
Operating permit water quality sampling are being collected at this site.

4. Inflow Canal

The Inflow Canal begins at structure G-302 and conveys inflows to the treatment flow-ways. The canal initially extends westward then southwest and terminates at structure G-303. The total length of the Inflow Canal is approximately 9,000 ft (1.7 miles). The Inflow Canal has a bottom width of 60 ft at elevation –5.0 ft NGVD and side slopes of 2.5 to 1 (H:V). The top of the perimeter levee adjacent to the east bank canal is at elevation 19.0 ft NGVD with the toe of the levee (berm) at elevation 14.5 ft NGVD.

Based on canal modeling (Interconnected Channel and Pond Routing: ICPR V2.01; Hutcheon Engineers) under design flow conditions (3,250 cfs) the Inflow Canal velocities varied from 0.76 feet-per-second (fps) to 1.37 fps. The largest velocities occur at the upstream end of the canal and correspond to the largest flow rate (3,250 cfs) through the constant canal cross section. The maximum water surface elevation during design flow conditions is 15.70 ft NGVD. Under Standard Project Storm conditions (1,110 cfs) the canal velocities varied from 0 fps to 0.46 fps, with water surface elevations varying from 15.70 max to 15.30 ft NGVD. This drop in stage is attributed to the reduced inflow via G-302 (from 3,250 cfs design flow condition to 1,110 cfs for the SPS condition). Under Probable Maximum Storm conditions the average water surface elevation is 16.2 ft NGVD.

5. G-303 (Eastern and Western Flow-way Inflow Control Structure)

Structure G-303 consists of a concrete ogee-shaped spillway with two 16-foot-wide vertical lift gates installed on the crest of the spillway at elevation 9.1 ft NGVD. G-303 controls inflows to the eastern and western flow-ways. The design peak flow rate for structure G-303 is 1,780 cfs with a headwater elevation of 15.7 ft NGVD and a tailwater elevation of 14.46 ft NGVD. The maximum tailwater at G-303 should be kept at or below 14.46 ft NGVD.

Structure Operations:
The G-303 structure will be operated in one of the three following modes:

- Manually
- Automatically in response to headwater and tailwater.
- Remotely via telemetry from the District's Operations Control Center in West Palm Beach.

Data Acquisition and Telemetry:
Automatic, manual and remote operation of this structure are possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Telemetry required

for remote operation and status of each gate has been provided. Headwater, tailwater and gate position data are available to the remote operators, while headwater/tailwater staff gauges and gate position information are available for manual operation.

Water Quality Sampling:
No operating permit required water quality sampling is required at this structure. However, in an effort to further enhance the treatment area effectiveness through operational refinements this structure is being monitored.

6. G-255 (Western Flow-way Inflow Control Structure)

Structures G-255 A-G is a series of 7 culverts with risers located on the FPL Access Levee between Treatment Cells 1 and 2. These culverts are 72-inch x 54.5-ft corrugated metal pipes (cmp) with flashboards available for installation in the risers. The design peak flow per structure is 121.4 cfs (850 cfs total) with a headwater elevation of 14.44 ft NGVD and a tailwater elevation of 13.65 ft NGVD.

Operations:
The G-255 structures will normally be open. However, if it is desired to reduce the flow into the western flow-way, flashboards could be installed.

Data Acquisition and Telemetry:
Headwater and Tailwater data are available to the remote operators, while headwater/tailwater staff gauges are available for local observation.

Water Quality Sampling:
No operating permit water quality sampling is required for this site. However, in an effort to further enhance the treatment area effectiveness through operational refinements this structure is being monitored.

7. G-304A-J (Northern Flow-way Inflow Control Structures)

Flow structures G-304 A-J are a series of ten culverts located along the Inflow Canal and serve as inflow control for the northern flow-way. Flow control is achieved through the combination of weir boxes and vertical lift gates. Each structure consists of a 72-inch diameter x 96-ft long corrugated metal pipe fitted with a weir box (crest elevation 11.25 ft NGVD) and a 72-inch x 72-inch slide gate on its upstream end; each culvert flared end section on its downstream end. Maximum design inflow for structures G-304 is 1,470 cfs (147 cfs per structure) with a headwater elevation of 15.7 ft NGVD.

Structure Operations:
Manual operation of these structures is required. The G-304 structures will be operated to provide appropriate flows to the northern flow-way. These structures may be fully or partially closed to restrict flow into the northern flow-way.

Data Acquisition and Telemetry:
Headwater and tailwater data at G-304A and G-304J are available via telemetry to the remote operators, while headwater/tailwater staff gauges and gate position information are available for manual operation at each structure.

Water Quality Sampling:
No operating permit water quality sampling is required at this site.

B. INTERIOR FLOW CONTROL FACILITIES

1. G-252 (Eastern Flow-way)

Flow structures G-252 H-J are a series of three culverts with risers situated on the remaining north interior levee of Treatment Cell 1. These culverts are 72-inch x 54.5-ft cmp structures with flashboards available for installation in the risers.

Structure Operations:
Manual operation of these structures is required. These structures will normally be open.

Data Acquisition and Telemetry:
Headwater/tailwater staff gauges are available for local observation.

Water Quality Sampling:
No operating permit water quality sampling is required at this site.

2. G-253 (Eastern Flow-way)

Structures G-253 A-J are a series of ten culverts with risers situated on the interior levee between Treatment Cells 1 and 3. These culverts are 72-inch x 58-ft cmp structures with flashboards available for installation in the risers. The design peak flow per structure is 93 cfs (930 cfs total) with a headwater elevation of 13.90 ft NGVD and a tailwater elevation of 13.60 ft NGVD.

Structure Operations:
Manual operation of these structures is required. The G-253 structures will normally be open.

Data Acquisition and Telemetry:
Headwater and tailwater data is available for G-253E to the remote operators, while headwater/tailwater staff gauges are available for local observation.

Water Quality Sampling:
No operating permit water quality sampling is required at this site. However, in an effort to further enhance the treatment area effectiveness through operational refinements structures G-253 C & G are being monitored.

3. G-254 (Western Flow-way)

Structures G-254 A-E are a series of nine culverts with risers located on the interior levee between Treatment Cells 2 and 4. These culverts are 72-inch x 54.5-ft cmp structures with flashboards available for installation in the risers. The design peak flow per structure is 94.4 cfs (850 cfs total) with a headwater elevation of 13.40 ft NGVD and a tailwater elevation of 13.10 ft NGVD.

Structure Operations:
Manual operation of these structures is required. The G-254 structures will normally be open, but may be closed at times to optimize flows entering Cell 4.

Data Acquisition and Telemetry:
Headwater and tailwater data is available for G-254C to the remote operators, while headwater/tailwater staff gauges are available for local observation.

Water Quality Sampling:
No operating permit water quality sampling is required at this site. However, in an effort to further enhance the treatment area effectiveness through operational refinements structures G-254 B & D are being monitored.

4. G-256 (Western Flow-way)

Structures G-256 A-E are a series of 5 culverts with risers located on the southern end of Treatment Cell 4. These culverts are 72-inch x 54.5-ft cmp structures with flashboards available for installation in the risers. The design peak flow per structure is 30 cfs (150 cfs total) with a headwater elevation of 12.5 ft NGVD and tailwater elevation of 12.32 ft NGVD.

Structure Operations:
Manual operation of these structures is required. The G-256 structures will normally be open.

Data Acquisition and Telemetry:
Headwater and tailwater data are available to the remote operators, while headwater/tailwater staff gauges are available for local observation.

Water Quality Sampling:
No operation permit water quality sampling is required at this site. However, in an effort to further enhance the treatment area effectiveness through operational refinements this structure is being monitored.

5. G-257

This is a single, 72-inch x 58-ft cmp with riser structure located in the FPL access levee and has the ability to connect Treatment Cell 1 and Treatment Cell 4. This structure will typically remain closed with flashboards installed.

Operations:
Manual operation of these structures is required. The G-257 structure will normally be closed.

Data Acquisition and Telemetry:
No telemetry is present. Headwater/tailwater staff gauges are present for local observation.

Water Quality Sampling:
No operation permit water quality sampling is required at this site.

6. G-305 (Northern Flow-way)

Structures G-305 A-V is a series of 22 uncontrolled culverts situated in the levee between Treatment Cells 5A and 5B. These culverts are 84-inch x 62-ft cmp structures with flared end sections on both ends and an average invert elevation of 3.5 ft. NGVD. The design peak flow per structure is 66.8 cfs (1,470 cfs total) with a tailwater elevation of 12.70 ft NGVD.

Operations:
The G-305 structures will always be open.

Data Acquisition and Telemetry:
A manual reading of headwater and tailwater is available to the remote operators, while headwater/tailwater staff gauges are available for local observation.

Water Quality Sampling:
No operation permit water quality sampling is required at this site. However, in an effort to further enhance the treatment area effectiveness through operational refinements structures G-305 G & N are being monitored.

7. Limerock Berm (Northern Flow-way)

The Limerock Berm is a full-scale STA Enhancement project that was constructed in Cell 5 of STA-1W to help redistribute flow and enhance phosphorus removal performance. Construction of the Limerock Berm was completed between March and August of 2003. The Limerock Berm is approximately 6,900 feet long and consists of more than 22,000 tons of limerock material. The Limerock Berm has a crest width of 12 feet and a top elevation of 11.5’ NGVD. The project is currently in the monitoring phase and a report documenting the performance of the Limerock Berm is to be completed in 2006.

C. OUTFLOW CONTROL FACILITIES

1. G-251 (Eastern and Western Flow-ways)

Pump station G-251 is the primary outflow pump station serving the eastern and western flow-ways to discharge treated water into WCA-1. G-251 is equipped with six 36-inch diameter pumps, each with a maximum capacity of 75 cfs, for a total discharge capacity of 450 cfs.

Pump Station Description:

Number of Pumps:	6
Discharge Capacity (each pump):	75 cfs
Design Headwater elevation:	9.5 ft NGVD
Design low water (headwater) elevation:	7.5 ft NGVD
Design Tailwater elevation:	14.0 - 17.5 ft NGVD
Nominal pump operating speed:	373 rpm
Nominal "on" elevation:	as needed to maintain desired stage at G-308 HW.
Nominal "off" elevation:	as needed to maintain desired stage at G-308 HW.
Motor Speed:	373 rpm
Motor Size:	150 Hp
Centerline discharge connection:	14.5 ft NGVD
Pump station floor elevation:	19.75 ft NGVD
Intake floor elevation:	-0.33 ft NGVD

Structure Operations:
The G-251 pump station will be operated in one of the two following modes:

- Locally
- Remotely via telemetry from the District's Operations Control Center in West Palm Beach.

This pump station will operate depending on the On/Off stages described above.

Data Acquisition and Telemetry:
Local and remote operation of these structures is possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Headwater and tailwater data are also available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
Operating permit required flow proportional, composite sampling equipment for TP is present in the canal immediately upstream of pump station G-251 (see Figure 3).

2. Discharge Canal (All flow-ways)

The Discharge Canal extends along the western boundary of the project, from gated culvert G-327A located in the northwest corner of the STA south to the outflow pump station G-310. The canal conveys discharges from culverts G-306A-J, G-258, G-259, G-309 and G-308, as well as seepage from treatment cells 2, 3, 4 and 5 to the G-310 outflow pump station. At its origin near the G-327 A structure, the Discharge Canal was designed for a trapezoidal cross-section with a bottom width of 50 ft at elevation –5.0 ft NGVD and side slopes 2.5:1 (H:V). South of G-306J, the Discharge Canal was designed for a bottom width of 30 ft at elevation –5.0 ft NGVD. The Discharge Canal continues south with this design cross-section until it reaches just north of outflow structure G-309 at which point the canal bottom width once again widens to approximately 50 ft. This is to accommodate for G-309 and G-258 flows of up to 700 cfs. Just north of G-308, the design cross-section widens to 80 ft for the G-308 and G-259 inflows of up to 560 cfs and 70 cfs, respectively. The design canal cross-section expands just south of G-259 to a 100-ft wide bottom width, and continues at this cross-section to the outflow pump station. While the as-built cross sections deviate slightly from the design cross section, modeling conducted after construction demonstrated the design conveyance capacity was achieved. The total length of the Discharge Canal is approximately 30,000 ft (5.7 miles).

Using the as-built canal cross sections, normal flow conditions (2,800 cfs) were modeled using HEC-2, and estimated velocities in the Discharge Canal were simulated up to 2.65 feet-per-second (fps) in the south end of the canal (2000, Hutcheon Engineers). The water surface elevation during this flow condition ranged from 8.85 ft NGVD at the north end to 7.0 ft NGVD at the G-310 pump station. Under Standard Project Storm conditions (STA-1W inflow will be limited to 1,100 cfs and project discharges will reach 2,800 cfs), canal velocities varied from 0 fps to 1.2 fps, with water surface elevations ranging from 13.6 ft NGVD in the north to 13.25 ft NGVD at the G-310 pump station. Under Probable Maximum Storm conditions (0 cfs inflow and 2,800 cfs outflow), modeling estimates of the water surface elevations showed a level pool in the discharge canal of 16.1 ft NGVD.

3. G-310 (All flow-ways)

Pump station G-310 serves as the primary outflow pump station for Cell 5, and the secondary outflow pump station for the other cells. G-310 is located at the extreme southwest corner of STA-1W approximately 400 feet east and 1,500 feet north of the southeast corner of Section 34, Township 44 South, Range 39 East in Palm Beach County. G-310 is equipped with two 100 cfs, two 470 cfs and two 950 cfs pumps with a maximum facility design outflow pumping capacity of 3,040 cfs. Pump station G-310 works in concert with existing pump station G-251.

Pump Station Description:

Number of Pumps:	6
Discharge Capacity (combined):	3,040
Design Headwater elevation:	7.0 - 13.5 ft NGVD

Design low water (headwater) elevation:	7.0 ft NGVD
Design Tailwater elevation:	14.0 - 17.5 ft NGVD
Nominal pump operating speed:	
Electric:	440 rpm
Diesel 470-cfs:	177 rpm
Diesel 950-cfs:	125 rpm
Nominal "on" elevation:	refer to Section III B.
Nominal "off" elevation:	refer to Section III B.
Motor Speed:	
Electric:	440 rpm
Diesel:	720 rpm
Motor Size:	
2-100-cfs electric pumps:	200 hp
2- 470-cfs diesel pumps:	1020 hp
2-950-cfs diesel pumps:	1535hp
Centerline discharge connection:	
Electric:	23.25 ft NGVD
Diesel:	25.0 ft NGVD
Pump station floor elevation:	32 ft NGVD
Intake floor elevation:	
Electric:	-6.2 ft NGVD
470cfs diesels:	-4.68 ft NGVD
950cfs diesels:	-8.45 ft NGVD

Structure Operations:
All G-310 pumps have the capability to be operated locally or remotely. However, there are no plans to operate the diesel pumps remotely at this time. While the two G-310 electric pumps have remote operation capability, the four diesel pumps will continue to be operated locally. This pump station will operate depending on the On/Off stages described in Section III B.

Data Acquisition and Telemetry:
Local and remote operation of this pump station is possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Headwater and tailwater data are also available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
Operating permit required flow proportional, composite sampling equipment for TP is present at this site (see Figure 3). Regular grab samples are also collected at this site.

4. G-259 (Eastern and Western Flow-ways)

Structures G-259 and G-308 work together to allow discharge from the eastern and western flow-ways into the STA-1W Discharge Canal. G-308 is the primary structure used to convey water to the Discharge Canal. Structure G-259 will open as necessary to supplement the conveyance capacity of structure G-308. The operational goal is to

maintain G-308 structure headwater stage at or below a maximum elevation of 12.6 ft NGVD for storm events up to the design flow (3,250 cfs).

Structure G-259 is a single culvert extending from Treatment Cell 3 to the Discharge Canal along the western boundary of the ENR. This culvert is a 72-inch x 84-ft cmp flow structure with a sluice gate located at a point 28.5 ft in an east-west direction within the structure. Downstream of the sluice gate there is 50-ft of pipe. The design peak flow is 70 cfs with a headwater elevation 11.5 ft NGVD and a tailwater elevation of 7.1 ft NGVD.

Structure Operations:
The G-259 structure will be operated in one of the two following modes:

- Manually/Locally
- Remotely via telemetry from the District's Operations Control Center in West Palm Beach.

Data Acquisition and Telemetry:
Local and remote operation of these structures are possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Telemetry required for remote operation and status of each gate has been provided. Headwater/tailwater stage and gate position data are also available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
No operating permit water quality sampling is required at this structure. However, in an effort to further enhance the treatment area effectiveness through operational refinements structures G-305 G & N are being monitored.

5. G-308 (Eastern and Western Flow-ways)

Structures G-259 and G-308 work together to allow discharge from the eastern and western flow-ways into the STA-1W Discharge Canal. G-308 is the primary structure used to convey water to the Discharge Canal. Structure G-259 will open as necessary to supplement the conveyance capacity of structure G-308. The operational goal is to maintain G-308 structure headwater stage at or below a maximum elevation of 12.6 ft NGVD for storm events up to the design flow (3,250 cfs).

G-308 is located along the southwest boundary of Treatment Cell 3 and will control discharges from the eastern and western flow-ways to the Discharge Canal. Structure G-308 consists of a single-bay reinforced concrete spillway with a 14-foot-wide vertical lift gate installed on the crest of an ogee shaped weir. The weir crest elevation is 7.4 ft NGVD. The design peak flow rate for structure G-308 is 560 cfs with a headwater elevation of 11.75 ft NGVD and a tailwater elevation of 7.5 ft NGVD.

Structure Operations:
The G-308 structure will be operated in one of the three following modes:

- Manually/Locally
- Automatically in response to headwater and tailwater.
- Remotely via telemetry from the District's Operations Center in West Palm Beach.

Water Quality Sampling:
No operating permit water quality sampling is required at this structure. However, in an effort to further enhance the treatment area effectiveness through operational refinements this structure is being monitored.

6. G-258 (Western Flow-way)

Structures G-258 and G-309 work together to allow discharge from the western flow-ways into the STA-1W Discharge Canal. G-309 is the primary structure used to convey water to the Discharge Canal. Structure G-258 will open as necessary to supplement the conveyance capacity of structure G-309. The operational goal is to maintain a maximum G-309 structure headwater stage elevation of 12.6 ft NGVD.

Structure G-258 is a single culvert extending from Treatment Cell 4 to the Discharge Canal. This culvert is a 72-inch x 85-ft cmp flow structure with a sluice gate located at a point 26-ft in an east-west direction within the structure. The design peak flow is 140 cfs with a headwater elevation of 12.6-ft NGVD and a tailwater elevation of 7.8 ft NGVD.

Structure Operations:
The G-258 structure will be operated in one of the two following modes:

- Manually/Local
- Remotely via telemetry from the District's Operations Control Center in West Palm Beach.

Data Acquisition and Telemetry:
Manual/Local and remote operation of this structure are possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Telemetry required for remote operation and status of the gate has been provided. Headwater/tailwater stage and gate position data are also available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
No operating permit water quality sampling is required at this structure. However, in an effort to further enhance the treatment area effectiveness through operational refinements structure G-258 is being monitored.

7. G-309 (Western Flow-way)

Structures G-258 and G-309 work together to allow discharge from the western flow-ways into the STA-1W Discharge Canal. G-309 is the primary structure used to convey water to the Discharge Canal. Structure G-258 will open as necessary to supplement the

conveyance capacity of structure G-309. The operational goal is to maintain a maximum G-309 structure headwater stage elevation of 12.6 ft NGVD.

Structure G-309 consists of a single-bay reinforced concrete spillway with a 14-foot-wide vertical lift gate installed on the crest of an ogee shaped weir. The weir crest elevation is 7.6 ft NGVD.

Structure Operations:
The G-309 structure will be operated in one of the three following modes:

- Manually
- Automatically in response to headwater and tailwater.
- Remotely via telemetry from the District's Operations Control Center in West Palm Beach.

The expected ranges of stages and flows over the expected range of operations are presented in Table 1.

Data Acquisition and Telemetry
Automatic, manual and remote operation of this structure are possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Telemetry required for remote operation and status of this gate has been provided. Headwater and Tailwater data are also available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
No operating permit water quality sampling is required at this structure. However, in an effort to further enhance the treatment area effectiveness through operational refinements this structure is being monitored.

8. G-306 (Northern Flow-way)

Structures G-306 A-J are a series of 10 weir gated culverts situated on the west perimeter levee of Treatment Cell 5B that convey discharges from Treatment Cell 5B to the Discharge Canal. These culverts are 72" x 130" cmp with 72" x 72" slide gates with electric motors and 11' x 9' weir boxes with crest elevations of 7.8 ft NGVD on the upstream end. The design peak flow per structure is 147 cfs (1,470 cfs total) with a headwater elevation of 11.5 ft NGVD and tailwater elevation of 9.0 ft NGVD.

Structure Operations:
The G-306 A-J structure will be operated in one of the two following modes:

- Locally/ Manually
- Remotely via telemetry from the District's Operations Center in West Palm Beach.

The G-306 structures will be operated to maintain Treatment Cell 5 stages at desired levels. The structure will be fully closed 1) during the initial "Start-Up" phase of operations, 2) when interior stages fall below prescribed levels during flow through

operations, and/or 3) when desired to prevent Treatment Cell 5 discharges for maintenance or performance purposes.

Data Acquisition and Telemetry:
Manual/local and remote operation of these structures are possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Telemetry required for remote operation and status of these gates has been provided. Headwater/tailwater stage and gate position data is also available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
No operation permit water quality sampling is required at this site. However, in an effort to further enhance the treatment area effectiveness through operational refinements structures G-306 C & G are being monitored.

D. DIVERSION FACILITIES

1. G-300 and G-301

Structures G-300 and G-301 are reinforced concrete ogee-shaped weir spillways with vertical gates installed on the crest of the spillway. G-300 is located within the existing L-40 Borrow Canal and structure G-301 is located within the existing L-7 Borrow Canal. G-300 is equipped with two 20-ft wide x 8.4-ft high gates while G-301 is equipped with three 22-ft wide x 11.7-ft high gates. Each roller gate is operated by a horizontally-mounted, hydraulically-actuated, piston/cylinder device. Each structure has four wing walls constructed of sheet piling projecting at a 45-degree angle from the corners of each structure. The wing walls have a concrete cap that supports a fence. A 15'-18' wide service bridge is provided for access across the spillway. The bridge is designed for an HS20-44 truckload. Structures G-300 and G-301 are intended to act in parallel and discharge the full 4,800 cfs (maximum capacity of pump station S-5A) directly to WCA-1 in the event of a need to divert this amount under emergency or extreme inflow and rainfall conditions. They may also be operated during water supply conditions to move water into WCA-1 or withdraw water from WCA-1.

The design elevation and length of the separation levee between the Inflow basin and Water Conservation Area 1 is 20.0 ft NGVD and 6,100 ft respectively.

STA-1 Inflow Basin structures, G-302, G-301, G-311 and G-300 located within the Inflow basin will be operated to maintain stages below 19.0 ft NGVD within the Inflow basin. Flow diversion to Water Conservation Area 1 via Inflow basin structures G-301 and G-300 will begin at Inflow basin stage elevations of 18.0 ft NGVD. Other operational strategies may be applied to maintain Inflow basin stage elevations below 19.0 ft NGVD for events smaller than the SPS and PMS conditions.

Structure Operations:
Remote and automatic operations of G-300 and G-301 are available to maintain headwater stages below 19.0 ft NGVD during Typical Operations (see "Typical Operations" below) and 19.4 ft NGVD for "Standard Project Storm Conditions.

Data Acquisition and Telemetry:
Telemetry for headwater and tailwater data are available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
Operating permit water quality sampling are being collected at this site.

E. SEEPAGE CONTROL FACILITIES

Pump stations G-310 and G-250S provide control of STA-1W seepage to ensure adjacent lands are not impacted by the project. The two 100-cfs pumps in G-310 provide this function (discussed above) and G-250S is described below.

1. G-250S

G-250S is a three-unit pumping station located adjacent to inflow structure G-303, and has a maximum total capacity of 201 cfs. However, hydraulic constraints in the north seepage canal limit the estimated maximum conveyance to approximately 120 cfs (see Figure 2). The station is equipped with three 36-inch diameter pumps driven by electric motors. The primary purpose of this station is to control the water stages in the seepage canal north of Treatment Cells 5A and 5B.

Pump Station Description:

Number of Pumps:	3
Discharge Capacity (each pump):	67 cfs
Design Headwater elevation:	7.25 ft NGVD
Design Tailwater elevation:	14.8 ft NGVD
Nominal pump operating speed:	383 rpm
Nominal "on" elevation:	8.5 ft NGVD
Nominal "off" elevation:	8.0 ft NGVD

Structure Operations:
The G-250S pump station will be operated in one of the two following modes:

- Locally
- Remotely via telemetry from the District's Operations Control Center in West Palm Beach.

This pump station will operate depending on the On/Off stages described above.

Data Acquisition and Telemetry:
Local and remote operation of these pumps are possible. Remote operation is from the SFWMD's West Palm Beach Operations Control Center. Headwater and tailwater data are also available to the remote operators, while headwater/tailwater staff gauges are available for local operation.

Water Quality Sampling:
There is no permit required water quality sampling at this station. However, in an effort to further enhance the treatment area effectiveness through operational refinements this structure is being monitored.

2. G-327A

Structure G-327A is a single gated culvert connecting the Discharge Canal along the western boundary of Treatment Cell 5 to the Seepage Canal along the northern boundary of Treatment Cell 5. This culvert is an 84-inch x 130-ft cmp flow structure with an 84 – inch diameter sluice gate to regulate flow. G-327A redirects STA-1W seepage or discharge from the Discharge Canal to the Seepage Canal, then eventually to the ENR Supply Canal and Treatment Cells 1 through 4 via G-250S when operated during Low-Flow periods. The estimated maximum discharge is approximately 100 cfs with a headwater elevation 9.0 ft NGVD and a tailwater elevation of 8.7 ft NGVD.

Structure Operations:
The G-327A structures will normally be closed and will be open only when necessary to direct seepage or discharge to the north perimeter seepage canal.

Data Acquisition and Telemetry:
Manual and remote operation of this structure are available. Telemetry required for headwater, tailwater and gate position data is available to remote observers. Headwater/tailwater staff gauges and gate position information are available for local operation.

Water Quality Sampling:
No operating permit water quality sampling is required at this site. However, in an effort to further enhance the treatment area effectiveness through operational refinements this structure is being monitored.

3. G-327C

Structure G-327C is a single culvert situated in the north perimeter Seepage Canal. This culvert is an 84-inch x 129-ft cmp uncontrolled equalizing flow structure. G-327C conveys flows through the northern portion of the FPL access levee within the Seepage Canal. The design peak flow is 100 cfs with a headwater elevation 8.4 ft NGVD and a tailwater elevation of 8.2 ft NGVD.

Structure Operations:
No operation required.

Data Acquisition and Telemetry:
No telemetry for headwater and tailwater data are available to the remote operators, while headwater/tailwater staff gauges are available for local observation.

Water Quality Sampling:
No operating permit water quality sampling is required at this site.

4. G-327D

Structure G-327D is a site that was established to accommodate a temporary pump to recirculate STA-1W seepage or discharges into Treatment Cell 5A. This structure, if installed, will connect to and withdraw from the North Perimeter Seepage Canal and discharge to the north end of the Treatment Cell 5A Spreader Canal adjacent to the Cell 5 Inflow Control Levee.

Structure Operations:
TBD

Data Acquisition and Telemetry:
TBD

Water Quality Sampling:
No operating permit water quality sampling is required at this site.

F. RELATED STRUCTURES

1. S-5AS

S-5AS is a reinforced concrete gated spillway that has historically been used to facilitate water supply releases from Water Conservation Area 1 to the L-10, L-12, L-8 and C-51 basins for irrigation. The structure is located adjacent to and east of the S-5A pump station, at the confluence of the L-8 and L-40 borrow canals. Two cable-operated vertical lift gates are manually controlled in accordance with operational criteria. Since the construction of the STA-1 Inflow Basin, operation of S-5AS for water supply will require reverse flows through diversion structures G-300 and G-301. This, in turn, will necessitate the closing of inflow structure G-302, preventing flows from entering STA-1W until irrigation supply demands are met.

In very rare instances, S-5AS gates may also be opened to pass floodwaters into Water Conservation Area 1 when the L-8 (headwater) stage exceeds the WCA 1 (tailwater) stage.

III. OPERATIONS

Introduction. This section describes the general operations associated with STA-1W. Operations are classified in the following modes:

1. Start-up operations
2. Normal operations
3. Extreme flow operations
4. Drought operations
5. Operations to take one or more treatment cells out of service, and
6. Future changes to optimize nutrient removal performance

Throughout this operation plan, an operational range of +/- 0.20 ft is applied to all the target stages, unless otherwise stated. For example, if the plan calls for a target stage of 12.0 ft NGVD, then the operational range is 11.8 – 12.2 ft NGVD.

A. START-UP PHASE OPERATIONS

Background. Treatment Cells 1 through 4 were constructed as the Everglades Nutrient Removal Project between 1989 and 1993, and completed Start-up operations in August 1994. Construction was completed on Cell 5 in March 1999, at which time the Cell 5 Start-up phase of operations was initiated. During this Start-up phase of operations, no discharges from Cell 5 were authorized by permit until total phosphorus, total mercury and methyl mercury samples demonstrated a net improvement compared to samples taken at the Cell 5 inlet structures. For phosphorus, this net improvement test compared 4-week geometric mean total phosphorus water column concentration from samples collected at pump station S-5A to samples collected at the upstream end of structures G-306 A, D and G. For the mercury species, samples collected at the interior of Cell 5 were compared to samples collected at the S-5A pump station. Cell 5 monitoring data collected during January 2000 documented that a net improvement in total phosphorus, total mercury and methyl mercury was achieved. Treatment Cells 1 through 4 remained fully operational during Treatment Cell 5 Start-up operations. Maximum allowable inflow capacities into the Cells 1 through 4 were limited to the maximum outflow capacity of pump station G-251 (450 cfs). STA-1W was deemed to be complete with Start-up operations in January 2000. From a permit perspective, completion of start-up of Cell 5 initiated the Stabilization phase of the project, which will continue until STA-1E is in full flow through operation.

B. NORMAL OPERATIONS

Normal Operations are defined as the operations of STA-1W for flows up to and including the Design Peak Flow Condition of 3,250 cfs.

1. General. Pump station S-5A provides the stormwater inflow for STA-1W. In general, the operation of S-5A, and subsequent operation of STA-1W, is determined by upstream water conditions (storm or water supply), adjusted for seasonal needs of the

tributary basin. When the tributary basin needs are focused on flood control, the stages in the upstream canal systems are held around 10.5 ft NGVD to facilitate this activity. When the tributary basin needs are centered on irrigation practices, the stages in the upstream canal systems are held higher (11.5 ft NGVD) to facilitate this activity. In practice, stages in excess of 12.0 ft NGVD or a rise in S-5A headwater stage of 0.5 feet per hour would be cause to initiate pumping at S-5A.

2. Normal Flow Operations are defined as operations of STA-1W for flows up to and including the Design Peak Flow Condition of 3,250 cfs. Inflow to STA-1W is through the STA-1 Inflow Basin via structure G-302, and outflows are discharged to the Refuge via G-251 and G-310. Downstream of G-302, flows are conveyed via the Inflow Canal to Treatment Cell 5 through structures G-304 A-J and to Cells 1-4 through structure G-303. Discharges from the treatment cells are conveyed to outflow pump station G-310 and G-251 at which point the treated flows are pumped into the Refuge. See Table 1 for stages and depths under normal operations.

Table 1. Summary of Target Stages and Depths for STA-1 West

Cell	Average Ground Elevation (NGVD)	Target Depth (ft)	Target Stage (NGVD)	Measured at Structure	Operational Structure
1	10.1	1.55	11.65	G-253 HW	N/A
2	9.45	1.50	10.95	G-254 HW	N/A
3	10.4	1.25	11.65	G-308 HW	Primary: G-251 Secondary: G-308/G-310
4	9.7	1.25	10.95	G-309 HW	Primary: G-308/G-310 Secondary: G-309/G-310
5	9.0 *	1.75	10.75	G-306 HW	G-306/G-310

Structures G-252, G-253, G-254, G-255, G-256, G-303 and G-304 (except G-304A) will normally be fully open. Structures G-258, G-259, G-306, G-308 and G-309 will normally be closed, except when discharging storm flows.

* Note: Field investigation by District staff in May 2004 indicated that ground elevation maybe be lower than previously thought. Further evaluations of recent survey data are ongoing and the ground elevations in Cell 5 may be adjusted again subsequent to those results. **Accordingly, once the true ground elevation has been resolved the hydraulic analyses contained within this document will be revisited and revised accordingly.**

Maximum Depths. The maximum operational depth for treatment cells 1, 2, 3, and 4 has been established at 4.5 ft above average ground elevation. This depth corresponds to a G-303 tailwater stage of 14.68 ft NGVD. It is considered desirable to limit the duration of this stage to no more than ten consecutive days. If this stage is reached and maintained for ten consecutive days, then the gates at G-303 should be lowered to allow tailwater stages at structure G-303 to recede to 12.68 ft NGVD. For Cell 5, the limiting factor that dictates the maximum depth is the protection of the north perimeter levee. Based on a hydraulic analysis by Hutcheon (1999) on the effects of SAV in Cell 5B, the current maximum water stage is 12.7 ft NGVD measured at the tailwater of G-305A; this corresponds to a depth of approximately 3.7 ft. In 2003 additional analysis were performed by District staff to assess the influence of the limerock berm on maximum depths within Cell 5. From these simulations, the G-304 downstream stages ranged from 12.77 ft NGVD on the south to 12.82 ft NGVD on the north. These stages are about 0.7

ft higher than the G-304 downstream stages in the previous analysis as a result of the construction of the limerock berm. These results indicate that the design peak flows will be contained within the existing levee system with the addition of the limerock berm. Additional information is provided in Section III.C. *Extreme Flow Operations.*

Design Peak Flow Condition. The June 1996 *Detailed Design Report* presented results of modeling steady-state Design Peak Flow Condition (3,250 cfs) through STA-1W using a constant Manning's "n" of 0.8 (Hutcheon 1996a). The 1-dimensional hydrodynamic model HEC-2 was used for Cells 1-4, while the 2-dimensional hydrodynamic model FESWMS-2D model was used for Cell 5. The October 1996 *Supplement to the Detailed Design Report* documented the effect of modeling the Design Peak Flow Condition through STA-1W using a depth-dependent Manning's "n" ("n"=1.3 for depths of 1.0 ft or lower; "n"=0.5 for depths of 3 feet or higher; and "n" varied linearly between 1.0 and 3 ft) (Hutcheon 1996b). The headwater at the G-306 structures was assumed to remain constant at 11.5 ft NGVD during both simulations. A key result was the estimated lowering of the stages throughout the treatment area. For example, the tailwater of the G-304A structure decreased from 13.8 ft NGVD to 13.0 ft NGVD. Without modulation of the G-304 gates during this flow event, there could be too much flow through Cell 5 and reduced flows through Cells 1, 2, 3 and 4; hence Hutcheon recommended adjusting the gates at G-304 as necessary to limit Cell 5 inflow to the design value 1,470 cfs. Prior to inundation of Cell 5 in March 1999, the District decided to encourage the growth of submerged aquatic vegetation (SAV) in Cell 5B in order to improve the phosphorus removal performance of the cell. Cell 5A was managed to encourage emergent vegetation. Studies conducted in Cells 1 and 4 indicated that SAV communities have a different vegetation roughness characteristic than an emergent system such as cattail, as presented in Figure 5. Additional hydraulic analyses were conducted for Cell 5 in order to account for the different vegetation roughness characteristics of SAV from that of cattail. These analyses confirmed the necessity to modulate flows through the G-304 structures in order to balance flows between the northern flow-way and the other two flow-ways. Three options were investigated to modulate flows through the G-304 structures, each of which would achieve the desired hydraulic distribution, including

1. installing weir plates at the box weirs upstream of the structures that would raise the crest elevation by an average of 1.59 ft, from an average of 11.28 ft NGVD to an average of 12.87 ft NGVD,
2. partially closing all ten of the G-304 gates, from 1.4 ft in the north (G-304A) to 1.85 ft in the south (G-304J), and
3. completely closing the gate at G-304A and leaving the remaining 9 open fully.

* Note: Option 3 was the selected option.

The resulting water surface elevations for the Design Peak Flow Condition are shown in Figure 5.

Summary of Structure Operations During Design Peak Flow Conditions:

- STA-1W inflow structure G-302 will be opened fully until the tailwater stage at G-303 reaches 14.7 feet, which corresponds to a depth of 4.5 feet (see Figures 6 and 7).

- Structures G-300 and G-301 will initially be closed. If the HW stage exceeds 18.0 ft NGVD, G-300 and G-301 will be opened to allow for diversion of flows to WCA-1.

- STA-1W inflow/interior/outflow control structures will be operated to maintain the target stages shown in the table below.

- Treatment Cell 5 outflow redirection control structure G-327 A will be closed.

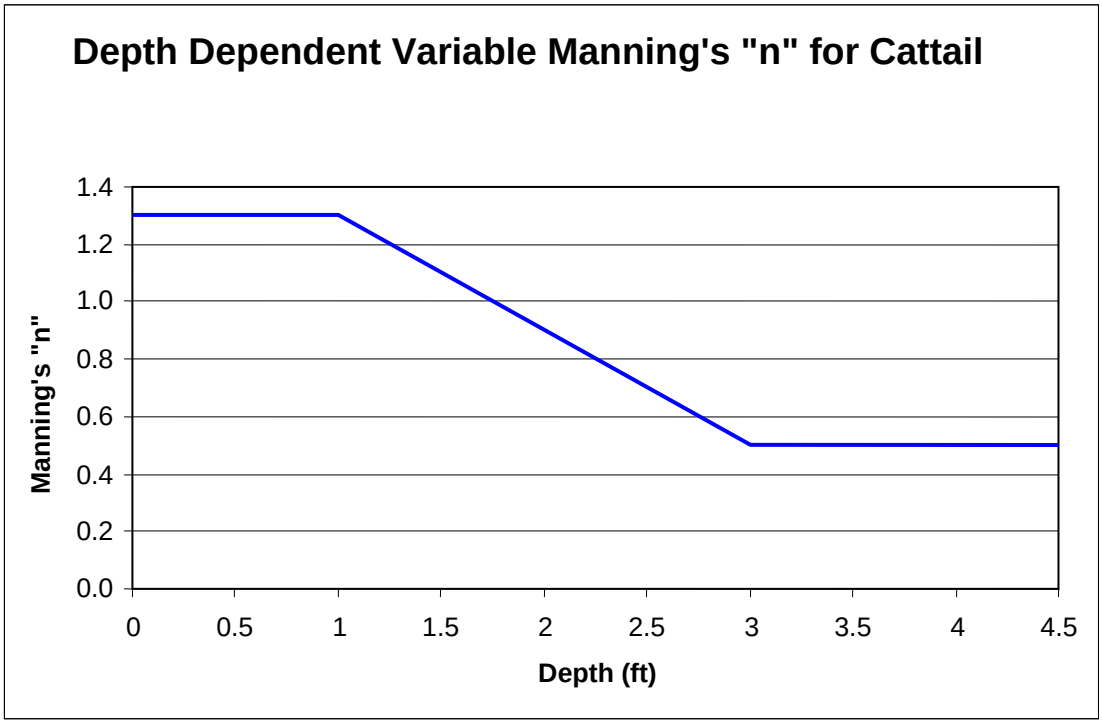
- G-310 pump operations: For storm flows less than 1000 cfs (as measured by the combined flows at G-306, G-308, G-309, G-258 and G-259), a pump-on stage of 8.5 ft is recommended, with a pump-off stage of 8.0 ft. For storm flows greater than or equal to 1000 cfs, a pump-on stage of 7.5 ft is recommended, with a pump-off stage of 7.0 ft.

- Seepage inflow pumping via G-250S and STA outflow pumping via G-251 and G-310 will occur as required.

Simulated Stages and Flows at Design Peak Flow Condition (3,250 cfs)

Structure	Headwater ft NGVD	Tailwater ft NGVD	Flow cfs	Gate opening feet
G-258	12.6	7.8	140	fully open
G-259	11.5	7.1	70	fully open
G-302	18.0	15.8	3,250	fully open
G-303	15.7	14.46	1,760	fully open
G-304A-J	15.7-15.8	12.7-12.82	1,470	G-304A closed; others open
G-306A-J	11.5	8.3-9.0	1,470	fully open
G-308	11.75	7.5	560	open 3.3 feet
G-309	12.61	7.8	560	open 3.1 feet
G-251	varies	varies	450	N/A
G-310	varies	varies	2,800	N/A

Figure 4. Depth-dependency of Manning's "n"



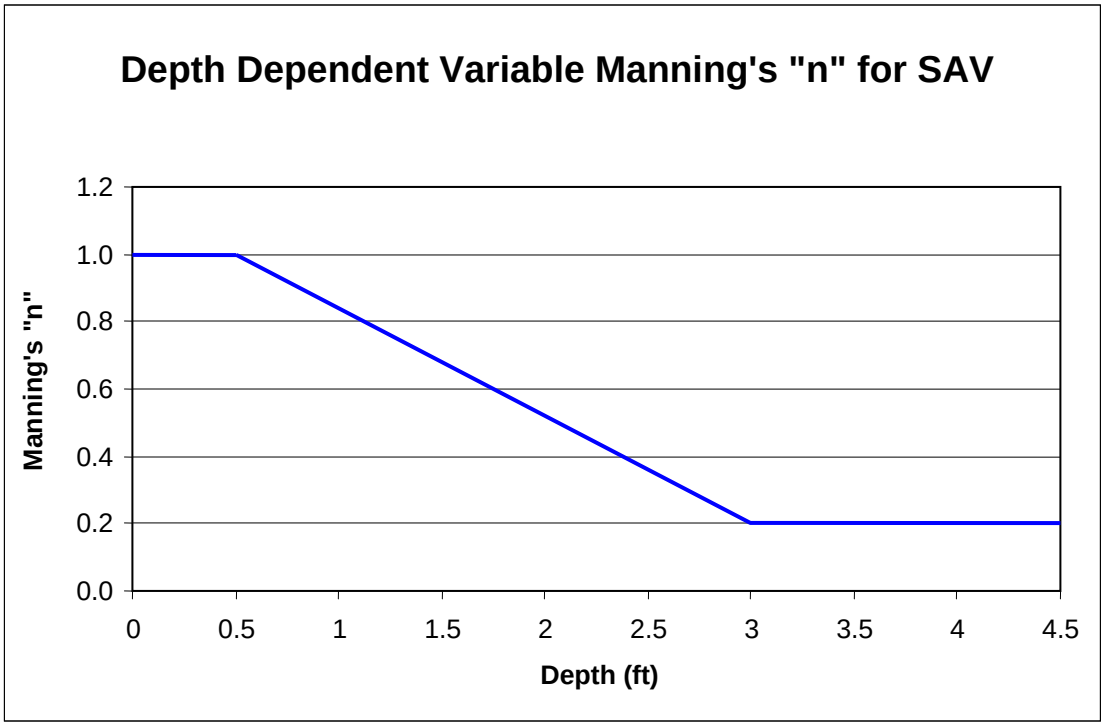
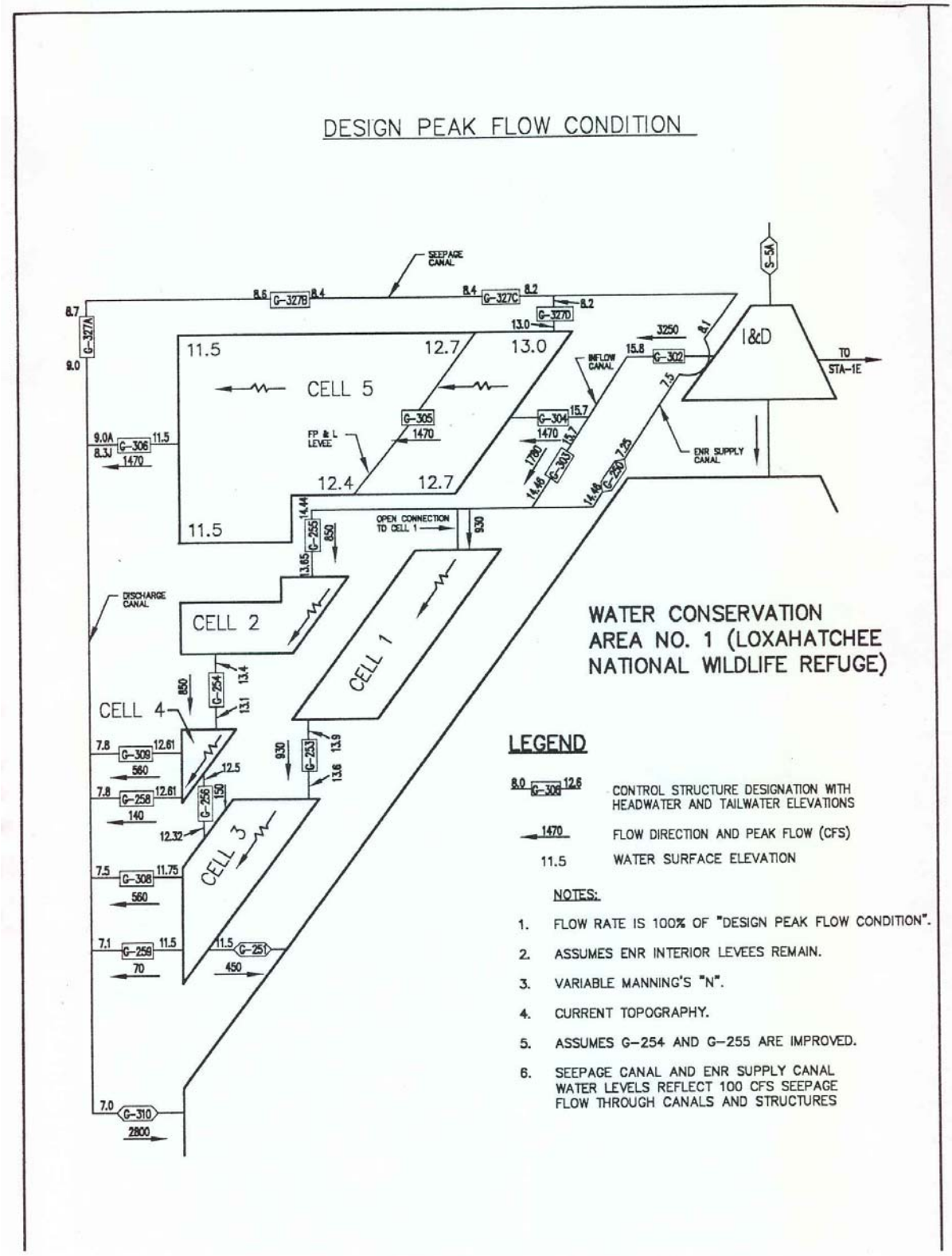


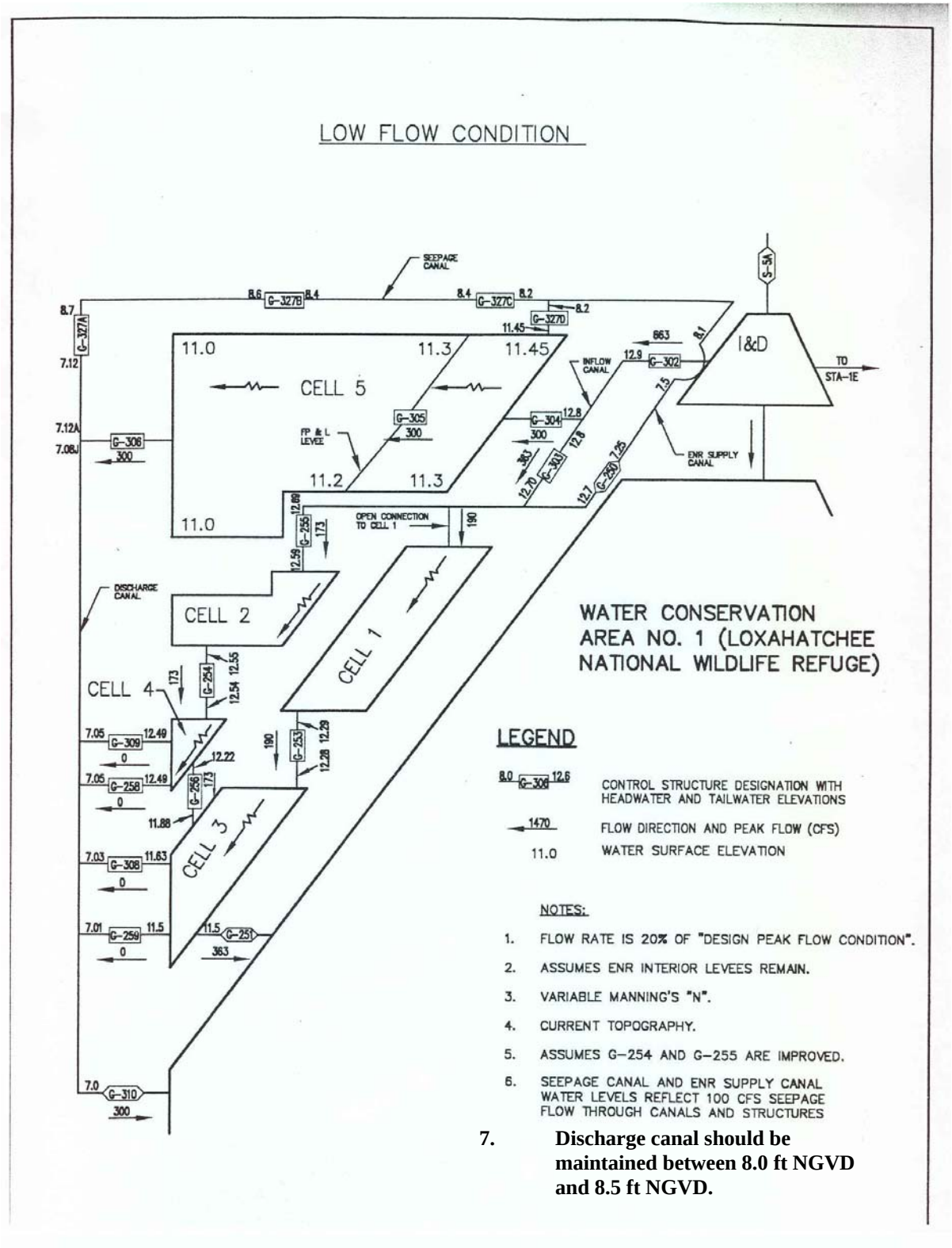
Figure 5. Design Peak Flow Condition



3. Low Flow Condition. The October 1996 *Supplement to the Detailed Design Report* documented the effect of modeling steady-state low flow condition (633 cfs) through STA-1W using a depth-dependent Manning's "n". This low flow condition approximates 20 percent of the design flow condition. The 1-dimensional hydrodynamic model HEC-2 was used for Cells 1-4, while the 2-dimensional hydrodynamic model FESWMS-2D model was used for Cell 5. Additional analyses were performed by District staff to account for the change in vegetation community in Cell 5, and all of the three options to modulate the G-304 gates were adequate to pass the low flows. The resulting water surface elevations for the low flow condition are shown in Figure 8 (Hutcheon Engineers, STA-1West As-built Construction Drawings, September 2000, modified by District January 2001). Please note that during low flow conditions, instead of maintaining a headwater of 7.0 ft at G-310 as shown in Figure 8, a pump-on stage of 8.5 ft is recommended for a flow of 300 cfs, with a pump-off stage of 8.0 ft.

During certain low flow conditions, redirection of seepage and treated flows from the Discharge Canal to G-250S is possible via gated culvert G-327A. Total seepage flows to G-250S are estimated to range from 44 to 74 cfs. STA flow redirection capacity is approximately 75-100 cfs. Flow redirection is accomplished by first allowing the water stage in the Discharge Canal to rise to elevation 8.0-9.0 ft NGVD, at which point gated culvert G-327A is opened, allowing discharges from the Discharge Canal to flow into the Seepage Canal along the northern boundary of the STA. Flows are conveyed east and then south in the Seepage Canal to seepage pump station G-250S where subsequent discharges occur into Cell 1. Flow redirection into Treatment Cell 5 may also be possible with the installation of temporary pumping facilities at site G-327D, located along the north boundary of Cell 5A.

Figure 6. Low Flow Condition



C. EXTREME FLOW OPERATIONS

STA-1W has been designed to accommodate estimated inflows resulting from extreme precipitation events, the Standard Project Storm (SPS) and the Probable Maximum Storm (PMS) as described below. Inflows resulting from precipitation events smaller than the SPS and PMS events should fall under "Normal Operating Conditions" for the STA.

Discretion in the operation of STA-1W structures is reserved by the District Operations staff to account for flood protection, excess precipitation and upstream and downstream conditions. The following discussion is offered only as general guidance.

Stages within STA-1W will rise and fall with the passing of the extreme storm event, and will be influenced by the rainfall amount, the stage at the initiation of rainfall, the operations during the event, and the volume of pumping before and during the event.

1. Standard Project Storm

The Standard Project Storm (SPS; 120% of the 100 year/24-hour storm) rainfall depth is estimated as 23.6 inches for a 24-hour duration over a 10-square mile basin area. During an SPS event, it is recommended to restrict inflow through structure G-302 to 1,110 cfs. For an SPS event, the estimated STA-1 Inflow Basin maximum stage elevation was estimated as 19.4 ft NGVD. Flows will be conveyed to Treatment Cell 5 through structures G-304 A-J (maximum rate for SPS event: 1,110 cfs). No inflows will be conveyed to the existing ENR project through structure G-303 (maximum rate for SPS event: 0 cfs). Pumped inflows and SPS rainfall flows will travel in a westerly direction within Treatment Cell 5 and in a southwesterly direction within Cells 1 - 4, subsequently being discharged to the Discharge Canal via outflow structures G-306 A-J, G-309, G-258, G-308, and G-259 (nominal capacities: 1,470 cfs, 560 cfs, 140 cfs, 560 cfs, 70 cfs, respectively).

Effects of SAV on Cell 5 Operations. The exterior levees were designed to protect against overtopping during extreme storm events due to wind setup and wave run up. In general, the top of the levee was established as the greater of two criteria – either 3.0 ft freeboard on top of a 4.5 ft water depth, or the height necessary to contain the wind and wave effects during the SPS and PMS events. The interior vegetation of an STA indirectly affects operation guidelines as a result of hydraulic energy losses associated with resistance to flow. In hydraulic modeling, this resistance to flow is often expressed as the Manning's "n" roughness factor. This resistance to flow influences the hydraulic conveyance capacity of the treatment area with associated influence on operating levels and levee design. In addition, the height and type of vegetation influences the wave runup and wind setup, both of which influence the maximum allowable operating depths of treatment cells.

Cell 5 of STA-1W was originally designed under the assumption that cattails or other emergent vegetation would dominate the treatment cell. Hutcheon Engineers originally modeled Cell 5 hydraulics with a constant Manning's "n" (Hutcheon 1996). Subsequently,

they performed revised hydrodynamic modeling with a depth-dependent Manning's "n" (n=1.5 for depths of 0.5 ft or lower; n=1.5 for depths of 3 feet or higher; and n varies linearly between 0.5 and 3 ft). The levees and control structures were subsequently designed with this roughness function. The maximum stage simulated in Cell 5B was approximately 14.2 ft NGVD for the Standard Project Storm and approximately 15.9 ft for the Probable Maximum Storm (Hutcheon Engineers June 19, 1999). The combined wave runup and wind setup for the SPS (119 mph wind speed) was 2.1 ft and 1.0 foot for the PMS (71 mph wind speed) (Hutcheon Engineers June 19, 1999).

Based on superior phosphorus removal performance of Cell 4 in the ENR project, in March 1999 the District decided to start up Cell 5B with submerged aquatic vegetation (SAV) instead of cattails or other emergent vegetation. Cell 5A was managed to encourage emergent vegetation.

The District asked Hutcheon to determine the effects of SAV on the operation guidelines for Cell 5B. In December 1999 Hutcheon produced the report “Impacts of Submerged Aquatic Vegetation on STA-1W Design and Operation.” In that report, Hutcheon used a Manning’s “n” of 0.06 based on guidance contained within USGS Water Supply Paper 2339. Unknown to Hutcheon at the time of their analysis, Manning’s “n” estimates had been obtained for an SAV cell, Cell 4, of the ENR project by the District and other consultants during the STA design. These estimates ranged from an n of 0.2 to 1.3 (Brown & Caldwell 1996, Kadlec 1999, and Guardo 1996), representing significantly higher resistance to flow than used in 1999 Hutcheon analysis. Hence, for a mature SAV community, a Manning’s “n” of 0.06 does not appear to be appropriate. However, during the start-up period of Cell 5B, and other similar treatment areas with little or no rooted vegetation, the use of a Manning’s “n” of 0.06 may be appropriate. Using this low value, which may be appropriate with little or no rooted growth in the treatment area, Hutcheon made the following estimates and operational recommendations for peak flow events (3,250 cfs) through STA-1W:

1. The combined wind and wave effects increased by 2.6 ft for the SPS and 2.3 ft for the PMS.
2. With the decrease in Manning's "n", the design flow can be accommodated at a lower flow depth with Cell 5.
3. With the lower depths in Cell 5A and Cell 5B, in order to balance the STA-1W flow between Cell 5 and the remainder of STA-1W, the G-304 inlet structures will need to be modulated. The 1999 Hutcheon report recommends that the top 2.2 ft of culvert cross section be blocked (i.e., open 3.8 ft) and the G-306 outlet structures should be adjusted such that the top 1 ft of the culvert is blocked (i.e., open 5 ft). In preparation for a large storm, these gates should be opened fully to provide maximum flow capacity.
4. Cell 5 should be operated such that the G-305 tailwater stage does not exceed 12.7 ft during the SPS (23.6 inches in 24 hours with 119 mph winds) and that the G-305 tailwater stage does not exceed 14.0 ft during the PMS (47.6 inches in 24 hours with 71 mph winds). Given the uncertainties with extreme storm forecasting, the report recommends that Cell 5 should be operated such that the G-305 tailwater stage does not exceed 12.7 ft during any extreme event.

5. As is the standard District practice, STA-1W will be drawn down in anticipation of a pending large storm such as a hurricane. The Hutcheon report recommended 30 hours of pumping to maintain stages in Cell 5B at less than 12.7 ft during SPS conditions with 1,100 cfs through G-302. A shortened pre-pumping period can be achieved by keeping G-302 closed during the storm.

As the SAV continues to grow in within Cell 5B, the resistance to flow should increase considerably, possibly attaining Manning's "n" similar to that observed in Cell 4 (ranging from 0.2 to 1.3). Using the Cell 4 Manning's "n" values (see Figure 4), District staff analyzed flow conditions up to the design peak flow of 1,470 cfs through Cell 5. Recommendations include:

1. Design flows can be achieved at lower depths than originally anticipated. A stage of 13.0 ft at G-304A was simulated for the 1,470 cfs scenario.
2. To balance flows between Cell 5 and the other flow-ways, the flow through the G-304 structure will need to be modulated. This can be accomplished by completely closing the gate at G-304A and leaving the remaining 9 open fully.
3. No modulation of G-306 structures will be necessary as a result of the SAV community. However, to balance flows through the G-306 structures from north to south (as the tailwater is assumed to decrease from 9.0 ft to 8.3 ft in the discharge canal), the gates could be modulated, e.g., the G-306J gate could be closed approximately 2.4 ft (i.e., open 3.6 ft) and still pass the design capacity of 147 cfs at a headwater of 11.5 ft. **The G-306 structures are currently being evaluated and rating curves should be available shortly. It is recommended to start with the gates open fully, and Operations staff can make appropriate adjustments as conditions are monitored.**
4. While the Hutcheon recommendation to keep stages in Cell 5 at or below 12.7 ft was appropriate while there was very little rooted vegetation with Cell 5, as Cell 5 becomes established with more rooted vegetation, the maximum stage can increase above 12.7 ft. Analyses are presently underway to determine the maximum allowable depth of a "fully mature" SAV community (such as that observed in Cell 4) in Cell 5B. In the interim, the 12.7 ft is a conservative estimate of the maximum allowable stage in Cell 5B. It is recommended that periodic estimates of Manning's "n" be obtained in Cell 5A and 5B during the first 2-5 years of vegetation establishment to update the estimate of maximum allowable depth. Further analysis conducted by District staff in March 2003 following the construction of the limerock berm concluded that this assumption is still valid and that downstream stages at G-304 ranged from 12.77 ft NGVD and 12.82 ft NGVD.

Summary of STA Structure Operations During SPS Event:

- STA-1W inflow structure G-302 will be partially opened, allowing up to maximum inflow of 1,110 cfs. This will be achieved through modulation of the G-302 gates, thus creating a "Submerged Controlled Flow" condition across G-302 (see Figure 6).

- If the STA-1 Inflow Basin stage exceeds 18.0 ft, structures G-300 and G-301 will be fully opened (Uncontrolled Submerged Flow). Stages/operations within the Inflow Basin will be monitored so as to not exceed maximum stage of 19.4 ft NGVD (see Figures 9 through 12).

- The gates at G-303 and G-327A will be closed. All other inflow/interior/outflow flow control structures will be fully opened.

- Seepage return via pump station G-250S and STA outflow via pump stations G-251 and G-310 will occur simultaneously.

- Operational discretion for structure operations is reserved by the District Operations staff, to account for flood protection, excess precipitation and upstream and downstream conditions. Treatment Cell depths are predicted to exceed the "Design Flow Operations" range of 0.50 ft NGVD to 4.50 ft NGVD above average Treatment Cell ground elevation.

- In Cell 5B, due to the combination of long fetch and submerged aquatic vegetation, the G-305 tailwater stage (in Cell 5B) should be maintained below 12.7 ft.

2. Probable Maximum Storm Event

The Probable Maximum Storm (PMS) rainfall depth is estimated as 47.2 inches for a 24-hour duration over a 10 square mile basin area. The PMS precipitation is defined as theoretically the greatest depth of precipitation for a given duration that is physically possible over a given area at a particular geographical location at a certain time of the year. The estimated return frequency for a storm of this magnitude is somewhere between 500 and 1000 years. During a PMS event there should be no inflow into the STA via G-302 (maximum rate for PMS event: 0 cfs) and outflows generated from direct rainfall on the project will be discharged simultaneously via G-251 and G-310. PMS rainfall flows will travel in a westerly direction within Treatment Cell 5 and in a southwesterly direction within Cells 1 - 4, subsequently being discharged to the Discharge Canal via outflow structures G-306 A-J, G-309, G-258, G-308, and G-259 (maximum capacities; 1,470 cfs, 560 cfs, 140 cfs, 560 cfs, 70 cfs respectively).

For a PMS event, the design allows for water to flow over the top of the levee separating the STA-1 Inflow Basin from the Refuge. For a PMS event, the estimated STA-1 Inflow Basin maximum stage elevation is 20.5 ft NGVD.

STA Physical Structure Operations During PMS Event:

- If a storm of a PMS magnitude is expected, pumping stations G-310 and G-251 should be operated as much as 30 hours in advance of the storm to lower stages in the treatment area.

- STA-1W inflow structure G-302 will be fully closed. No inflows will be allowed into STA-1W via G-302 during this event.

- Inflow basin Diversion Structure G-300 and G-301 will be fully opened. For this event condition, flows will overtop the Inflow basin Separation Levee (top elevation 20.0 ft NGVD, length is 6,100 ft). Levee overflow rate is estimated at 5,300 cfs.

- Recirculation control structure G-327 A will be closed. All other inflow/interior/outflow flow control structures will be fully opened.

- Seepage inflow pumping via G-250S and STA outflow pumping via G-251 and G-310 will occur simultaneously.

- Operational discretion for physical structure manipulations are reserved by SFWMD Operations Division to account for flood protection, excess precipitation and upstream and downstream conditions. Treatment Cell depths will exceed the "Design Flow Operations" range of 0.50 ft NGVD to 4.50 ft NGVD above average Treatment Cell ground elevation.

- To protect against overtopping of the northern perimeter levee due to wind and wave effects, the G-305 tailwater stage (in Cell 5B) should be maintained below 12.7 ft.

D. DROUGHT OPERATIONS

In accordance with the operating permit, to the greatest extent practicable, operations of STA-1W will maintain stages at or above 0.5 feet above the average ground elevation in the treatment cells to minimize potential negative effects of drought on subsequent project performance. Operating the STA at the recommended target depths in Table 1 will help achieve this goal. The ability to maintain this minimum water elevation is determined primarily by the availability of water from the upstream watershed and on rainfall. In the extreme case that there is no water available from the upstream watershed and/or from rain, the treatment cells may dry out. After an extended dryout, there is a potential that the water quality improvement performance of subsequent discharges of water from treatment cells may be adversely affected. The severity and duration of the dry conditions that may lead to reduced project performance is currently unknown, as is the magnitude and duration of the potential depression of project performance. Analysis of the monthly compliance monitoring data collected at the project outflow monitoring station will be useful in making these determinations.

If the 12-month flow-weighted average Total Phosphorus concentration exceeds FDEP permit compliance requirements and this exceedance can be related to dryout, then the Annual Report will identify the causes and specify remediation measures.

Summary of Operations During Drought Events:

- Inflow structures G-302, G-303 and G-304 A-J will be open to allow for available inflows to enter the treatment cells.

- Outflow structures G-306 A-J, G-309, G-308, G-259 and G-258 will be closed to detain available water within the treatment cells.

- All interior structures will remain open.

- Culvert structure G-327 A will be opened to direct available discharge canal flows back into the treatment cells.

- Outflow pump station G-310 and G-251 will not discharge until desirable water levels and vegetative conditions within treatment cells have improved allowing for discharge and the closing of structure G-327 A.

E. TREATMENT CELLS OUT OF SERVICE

Treatment cells and/or flow-ways may be isolated, or "taken off-line", when deemed necessary or desirable. Treatment Cells 5A and 5B can be taken off-line by closing structures G-304 A-J and G-306 A-J. Treatment Cells 1 through 4 can be taken off-line by closing G-303. Treatment flow-ways 1/3 and 2/4 also have the capability of being taken off-line independently through manipulation of their various inflow and outflow structures or the use of coffer dams.

F. PERFORMANCE OPTIMIZATION

Improvements and enhancements recommended for STA-1W consist of Alternative 2 as it is presented in the October, 2002 *Evaluation of Alternatives for the ECP Basins*. That alternative includes the following component elements:

- Construction of a small seepage pumping station (designated as G-327B) near the northeast corner of Cell 5B, included in the design to permit withdrawal from the seepage canal to maintain stages in the SAV Cell 5B. The station is assigned a preliminary capacity of 65 cfs (equal to a maximum daily evaporation rate of 0.24"/day in Cell 5A and 5B, and an estimated seepage loss from the cell of 0.30"/day);
- Herbicide treatment of Cell 3 for removal of emergent macrophyte vegetation to permit development of SAV. That treatment was considered as applicable to the

entire 1,026-acre nominal area of Cell 3, despite limiting the effective area to 700 acres in the analysis;

- Replacement of existing Structure G-255 with a fully operable control structure (nominal capacity of approximately 585 cfs). It will also be necessary to extend power from G-303 to the new structure;
- Construction of a new levee across Cell 2, together with a series of culverts for improved flow distribution. Those structures are anticipated to consist of corrugated metal culverts with stop log risers (total of six 84" culverts);
- Construction of a new levee across Cell 1, together with a series of fully operable control structures. The nominal combined capacity of those structures would be 1,105 cfs; they are expected to consist of the hydraulic equivalent of four gated 8'x8' reinforced concrete box culverts (RCBs). The construction of a new power line would be required for those structures;
- Herbicide treatment in those parts of Cells 1 and 2 to be converted to SAV.
- In addition, a new structure (G-256) will be constructed to discharge directly to the discharge canal.

A schematic diagram of STA-1W, modified as recommended herein, is presented in Figure 2.6.

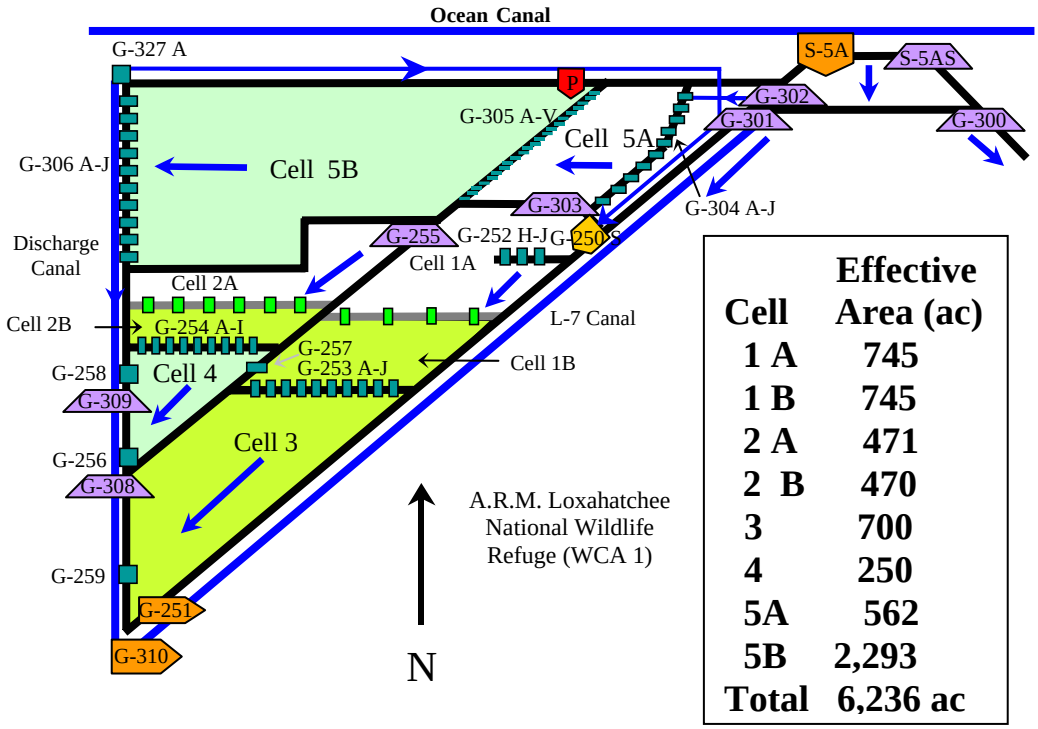


Figure 2.6 Schematic Diagram of Enhanced STA-1W

In Figure 2.6, those areas presently developed in SAV are shown lightly shaded; those additional areas recommended for conversion to SAV are shown in slightly darker shading.

IV. HYDROPATTERN RESTORATION

Discharges from STA-1W will be conveyed to the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1) via outflow pump stations G-251 and G-310. There are no hydropattern changes expected as a result of the operation of STA-1W.

V. ADDITIONAL FLOWS AND BMP MAKE-UP WATER

1. STA-1W Design Inflow Volumes and Loads

STA-1W acting in combination with other elements of the Everglades Construction Project is intended to reduce the long-term flow-weighted average concentration of Total Phosphorus (TP) in runoff to the interim goal of 50 parts-per-billion (ppb) prior to their discharge to WCA-1. The following design inflow volumes and loads for STA-1W were developed during the Basin-Specific Feasibility Studies Evaluation of Alternatives for the ECP Basins (Burns and McDonnell, October 2002). The flows were produced by the SFWMM simulation referred to as BASERR2R.

The S-5A and C-51 West drainage basins both will be served by STA-1W. Based on the simulation results, the S-5A and C-51 West basins will have a combined average annual inflow volume of 139,891 acre-feet and an average annual TP load of 23,860 kilograms.

Annual simulated values ranged from 71,500 to 235,400 acre feet per year and from 12,900 to 55,000 kg/yr. An average annual volume of 294 acre-feet will be sent to STA-1W from Lake Okeechobee to maintain minimum depths in the STA based on the simulation results. The average annual TP load associated with this water is 50 kilograms. Also based on the simulation results, BMP Makeup Water will be sent from Lake Okeechobee to STA-1W at an average annual inflow volume of 20,149 acre-feet and an average annual TP load of 3,490 kilograms. Although BMP Makeup Water was simulated to be treated in STA-1W, the preferred receiving location for Lake Okeechobee releases including BMP Makeup Water is STA-3/4.

The total average annual design inflow volume and TP load to STA-1W is determined as 160,334 acre-feet and 27,400 kilograms.

2. STA-1W Potential BMP Make-Up Water Volumes

When sufficient capacity exists, STA-1W may be utilized to treat additional Lake Okeechobee regulatory releases and to replace the estimated volume of water held within the EAA due to the BMP program (referred to as BMP Make-Up Water). As described above, EAA-BMP Make-Up Water could be sent to STA-1W at an annual average inflow of 20,149 acre-feet and 3,490 kilograms TP load.

Due to the variability and discretion of BMP Make-Up Water volumes as they apply to STA-1W, and the historic period of record variability of the S-5A Basin runoff volume (see "Stormwater Treatment Area 1 West Pollution Prevention Plan") to the EPA (Everglades Protection Area), it is expected that the range in annual average inflow volumes and loads will fluctuate (see Figure 13).

Operationally, it is the District's intent to send all BMP Make-Up water to STA-3/4 for treatment prior to discharge to the EPA. STA-1W would only be used in the event that capacity exists and STA-3/4 was unavailable.

3. STA-1W Potential Volumes/Loads Prior to STA-1E Operation

STA-1W design inflow volumes and TP loads as described above are determined to be 160,334 acre-feet and 27,400 kilograms respectively. The S-5A basin is the primary inflow volume and load source for STA-1W. The average annual inflow volumes and loads to STA-1W assume that 22,552 acre-feet runoff volume and 3,700 kilograms TP load is directed from the S-5A basin to STA-1E. Annual values ranged from 560 to 59,200 acre feet per year and less than 100 to 10,700 kg/yr. Until the development of STA-1E flow through operations, and associated diversion structures, it is anticipated that this additional volume and load could be directed to STA-1W or to WCA-1 (see Appendix I - Pollution Prevention Plan).

VI. COORDINATION WITH OTHER PLANS

As modifications to the Central and Southern Florida Project are analyzed through the Lower East Coast Regional Water Supply Plan (LECRWSP), Lake Okeechobee Regulation Schedule Study (LORSS), and Comprehensive Everglades Restoration Program (CERP), the hydraulic and treatment capacities of the current STA designs will be evaluated. If it is deemed necessary, these studies will recommend additional treatment facilities. The operational plans for the STAs will be reviewed by SFWMD staff involved with the aforementioned studies, and modified for consistency with said studies accordingly.

VII. PERMITS FOR OPERATION OF STA-1 WEST

A. EVERGLADES FOREVER ACT PERMIT NO. 50-3074709

On May 12, 1999, the Florida Department of Environmental Protection (FDEP) issued an Everglades Forever Act (EFA) permit to the District for construction, operation and maintenance of STA-1W. Accordingly, the STA-1W Operation Plan must be consistent with the following requirements of the EFA permit.

Project Operation and Maintenance. By operating in accordance with the following items, the objectives of the ECP will be achieved, as outlined in the EFA, §373.4592(9)(e) and §373.4592 (9)(h), F.S.

(a) the Conceptual Design Document for the Everglades Protection Project, dated February 15, 1994,
(b) the General, Detailed and Supplements to the Detailed Design documents for STA-1W, dated August 1995, June 5, 1996, October 30, 1996 and June 19, 1997, respectively,
(c) the Detailed Design Report for the Inflow and Distribution Works, September 29, 1996,
(d) the Detailed Design Report for Pump Stations G-310 and G-335, January 1997,
(e) the Pollution Prevention Plan (PPP) dated March 12, 1999,
(f) Rule 40E-63 of the Florida Administrative Code,
(g) the STA optimization research plan, (RAM 5),
(h) the requirements of specific condition 9 of the EFA permit, and
(i) the operational experience from the Everglades Nutrient Removal Project (ENR) and STA 6, Section 1, as appropriate.

To the extent that there is a conflict with the above items, the permit conditions shall control. If the permitted facilities are demonstrated to be not achieving compliance with the requirements of the EFA permit, the District will modify the Operation Plan as appropriate. STA-1 West operation activities may be further modified for standard engineering practices pursuant to §373.4592(9)(j)(3), F.S., or for technological advances pursuant to §373.4592(9)(j)(2), F.S.

Operations Plan. In compliance with specific condition 9 of the EFA permit, the

operation plan for STA-1W was submitted to FDEP in June 1999. The current changes in the operating plan reflect updated information and refined operational objectives gained since the completion of the plan in June 1999. This operation plan contains specific provisions for operation of the STA-1W project components, and includes the information required in specific condition 9 (A-D).

Interim Operations. Although STA-1W began operation in 1999, STA-1 East (STA-1E), which is to be constructed by the U.S. Army Corps of Engineers, and which will also treat waters flowing to the A. R. Marshall Loxahatchee National Wildlife Refuge (Refuge), will not begin Start-up operations until 2004 and will not be ready for full flow-through operations until possibly 2005, with completely stabilized discharge expected about one year later. Until STA-1E is operating at full flow-through capacity, it is anticipated that an average of 31,000 acre feet per year of S-5A basin runoff scheduled to go to STA-1E will continue to go through the S-5A pump station. Offsetting this volume is a reduction in the runoff from the C-51W basin contemplated to be diverted to STA-1W once STA 1E is fully operational. The net is an interim increase of 19,500 acre feet in the average annual flow assumed to go to STA-1W. Prior to completion of STA-1E, these waters will continue to flow to the Refuge, either as treated discharge from STA-1W or as untreated discharge through the STA-1 Inflow and Distribution Works.

Consistent with the Settlement Agreement and the EFA, the District is also required to offset flow reductions in EAA runoff due to BMPs. It is anticipated that BMP replacement water will be sent to STA-3/4, however, for the S-5A basin, some of this BMP make-up water is also contemplated to be diverted to STA-1E. Consistent with the intended operations guidelines in the 1994 Conceptual Design, the BMP make-up water will be delivered to the STAs only if available treatment capacity exists. The District's BMP Replacement rule contains the flexibility to reduce delivery to the STAs "when the delivery is likely to cause hydraulic bypass around the STA or otherwise hinder its performance." It is anticipated that minimal BMP replacement water deliveries will be made during the Interim Period.

During the 1979-1988 base period, approximately 50,700 acre feet per year (with an associated 3.5 metric tons of phosphorus) from the southern L-8 basin was discharged into the Refuge. District planning efforts underway include construction of diversion works that send waters from the southern L-8 basin to Lake Okeechobee and other areas, instead of the Refuge where the runoff goes today. In accordance with the load reduction targets of the proposed modified settlement agreement and conceptual design, the southern L-8 basin water will be diverted, with a current schedule of 2003. Prior to completion of STA-1E and the diversion works, these waters may continue to flow to the Refuge, either as treated discharge from STA-1W or as untreated discharge through the STA-1 Inflow and Distribution Works.

It is important to note that all of these waters historically flowed to the Refuge. STA-1E will treat waters from the S-5A Basin and the C-51 Basin, which historically flowed to the Refuge. BMP make up waters come from Lake Okeechobee to compensate for the reduction in volume of waters reaching the Refuge because of the implementation of Best Management Practices. Finally, waters which will eventually be diverted to Lake Okeechobee or other points through the L-8 Diversion Projects have historically reached the Refuge. Thus, no new discharges of waters are flowing to the Everglades or the Refuge. A summary of historic, interim and ultimate operations is presented in Exhibit 1.

Emergency Conditions. The EFA permit allows discharges from STA-1W or diversion of waters from the STA-1W inflow structures through the G-301 structure in accordance with Section 373.439, F.S., or when water conditions within STA-1W may damage existing marsh vegetation. The District is required to notify the FDEP within 48 hours of such an occurrence. The permit requires that such notification to contain information regarding the circumstances related to the discharge, as well as a projection regarding the anticipated duration of the discharge. In the event any such discharge extends beyond the period specified in the original notification, the District is required to notify the FDEP within 48 hours of the continuation of the discharge, and such notice shall contain additional information regarding the circumstances causing the need for the discharge.

B. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (FDEP PERMIT NO. FL0177962)

On May 11, 1999, the FDEP issued a draft National Pollutant Discharge Elimination System (NPDES) permit for STA-1W and associated works. The STA-1W Operations Plan is consistent with the following requirements of the NPDES permit.

Section V. Operation and Maintenance Requirements

A. Operation of Treatment and Disposal Facilities

1. The operation of STA-1W and associated works is consistent with the permit application and supporting documents (see Section III for details.)
2. The operation of STA-1W is under the supervision of a person who is qualified by formal training and/or practical experience in the field of water pollution control. The operation of STA-1W is under the supervision of Gary F. Goforth, P.E., Ph.D., who is qualified by both formal training and practical experience in the field of water pollution control.

Section VII. Other Specific Conditions

D. Specific Conditions related to the Pollution Prevention Plan

1. The STA-1W Pollution Prevention Plan (PPP) is incorporated and made part of the NPDES permit (see Appendix III for the STA-1W PPP).
2. The STA-1W Project shall be operated in accordance with the PPP. To the extent that there is a conflict with the PPP itself or the application of the PPP and this permit, the permit conditions shall control.

   If the permitted facilities are demonstrated to be not achieving compliance with the requirements of the NPDES permit, the District will modify the PPP or the operation plan as appropriate.

Section VIII. General Conditions

G. Operation and Maintenance Responsibilities. The District shall at all times properly operate and maintain the facility and systems of treatment and

control, and related appurtenances, that are installed and used to achieve compliance with the conditions of the NPDES permit. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to maintain or achieve compliance with the conditions of the permit.

V. Bypass Provisions. Bypass is prohibited, unless the District demonstrates it was unavoidable to prevent loss of life, personal injury, or severe property damage and there were no feasible alternatives to bypass (see NPDES permit for more details). Bypass may occur which does not cause effluent limitations to be exceeded if it is essential maintenance to assure efficient operation (see NPDES permit for more details). "Bypass" shall mean the intentional diversion of waste streams from any portion of the treatment works. The term "bypass" does not include waters diverted around the entire STA-1W project, e.g., through structure G-301. For STA-1W, it is physically impossible to bypass with the current project components.

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Burns and McDonnell 2003. Everglades Protection Area Tributary Basins Long Term Plan for Achieving Water Quality Goals

Appendix A: Operational Design Envelope

The *Everglades Protection Area Tributary Basins Long Term Plan for Achieving Water Quality Goals* recommends structural, vegetative and operational enhancements for each STA, and provides a predicted range of long-term average outflow phosphorus concentrations once the enhancements are completed. Refinement of the operational strategies for the STAs is required to optimize the phosphorus removal performance of the STAs and to ensure that the STAs are not subject to overload from inflow volume or nutrients. In addition, assessment of annual or long-term performance is aided by a comparison of actual loading to the loading that was anticipated during the design of the treatment areas, and the subsequent design of the STA enhancements. The paper "The Operational Design Envelope for the STAs" develops the operational range for inflow volume and phosphorus loads that were anticipated for each STA, and recommends a method for utilizing the resulting information to assist in tactical operational decisions. The following method provides a tactical (e.g., monthly) operational guidance to ensure that the STAs are operated within their design envelope to the maximum extent practicable.

The operational design envelopes presented in the following tables and figures can be used to track the status of each STA relative to long-term cumulative inflow volumes and loads. This information will form a basis to assist with monthly operational decisions and keep the STAs solidly within their design envelopes.

1. Actual monthly and 12-month cumulative flows and phosphorus loads are monitored for each STA. Presently, flow data are available approximately 4-6 weeks after field measurement. Efforts are underway to streamline data processing and reduce this lag time. Estimates of phosphorus loads depend on this flow data, so phosphorus loads are also approximately 4-6 weeks behind collection dates.

2. Comparison of actual flows and loads to the monthly and annual ranges presented in the following tables can be made monthly. If deviations are observed, an immediate evaluation of the causes of the deviations should be conducted. Options for bringing the flows and loads back in the range depicted in the operational design envelopes should be identified, evaluated and implemented.

3. For discretionary operations, such as Lake Okeechobee releases and inter-basin transfer of water (when available), both the monthly and annual cumulative values can be utilized to provide guidance.

   Lake Okeechobee release example:

   Flow-way 1 of STA-3/4 recently began flow-through operation. This flow-way contains approximately 6,500 acres, or about 40% of the STAs' total effective treatment area. A target for Lake releases during the month of March can be obtained from the cumulative monthly design envelope. The 31-year average of simulated flow into STA-3/4 during March is 46,759 acre feet (see appendix 4). Assuming uniform distribution through the flow-ways, approximately 40%, or 18,420 acre feet was set as the target for flow-way 1. This equates to about 300 cfs. Since the STA is still in stabilization, the average value was selected, as opposed to the maximum value, which would have been 82,831 acre feet during the month. Had the STA been in operation for the previous 12 months, we could compare the cumulative actual flow/load with the simulated range and use the lower of the 12-month cumulative or monthly cumulative balance. For example, had the previous 11-month cumulative flow been 620,000 acre feet (assuming the entire STA was operational), the balance available to reach the average annual inflow volume would be (655,853 – 620,000 =) 35,853 acre feet. Since this is less than the March average of 46,759 acre feet, the target for discretionary releases would be 35,853 acre feet.

Table A.1: Design Monthly Flow and Loading to STA-1W

Month	30-day min		30-day ave		30-day max	
	Flow	Load	Flow	Load	Flow	Load
Jan	1,055	192	8,825	1,769	31,946	6,793
Feb	-	-	5,864	1,155	35,933	7,551
Mar	-	-	7,167	1,493	38,949	8,374
Apr	-	-	3,164	645	27,025	5,627
May	-	-	6,589	1,095	29,365	4,832
Jun	-	-	18,084	2,909	52,192	8,327
Jul	382	52	20,426	3,243	39,789	6,577
Aug	942	129	23,343	3,712	52,587	8,616
Sep	2,877	391	24,598	3,965	50,458	8,523
Oct	1,584	274	20,030	3,303	47,426	8,047
Nov	1,604	275	10,488	1,972	33,430	6,805
Dec	-	-	8,909	1,664	30,854	6,379
Minimum	-	-	3,164	645	27,025	4,832
Average	704	109	13,124	2,244	39,918	7,279
Maximum	2,877	391	24,598	3,965	52,587	8,616

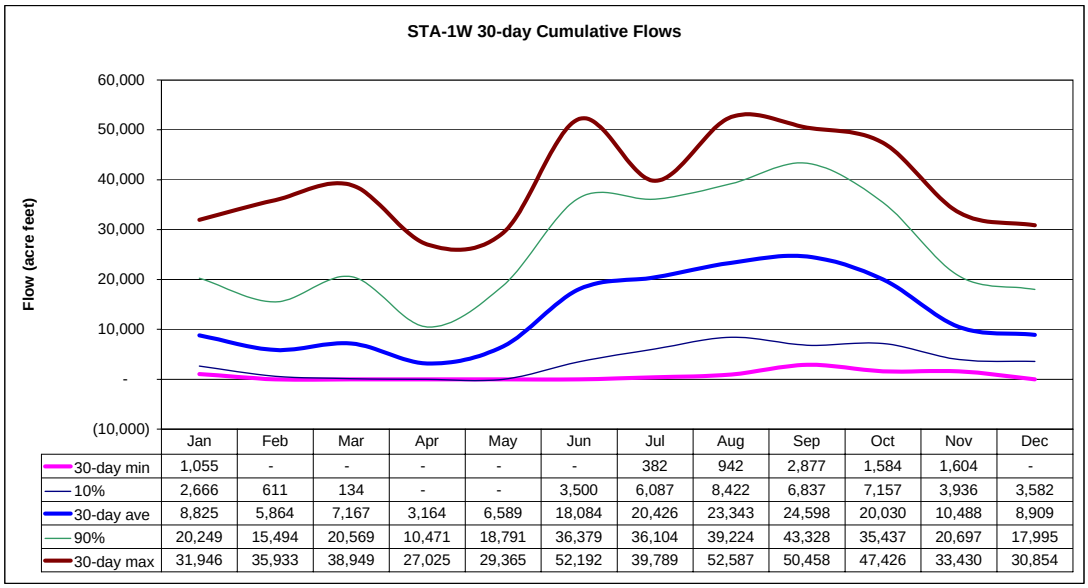
Table A.2: Design Annual Flow and Loading to STA-1W

Month	365-day min		365-day ave		365-day max	
	Flow	Load	Flow	Load	Flow	Load
Jan	84,896	14,807	160,350	27,423	226,891	39,848
Feb	85,476	14,829	160,321	27,417	226,460	39,362
Mar	88,593	15,487	160,517	27,461	231,987	40,795
Apr	88,323	14,325	160,445	27,447	233,532	40,790
May	76,187	12,404	160,507	27,460	236,932	41,740
Jun	61,831	10,117	159,822	27,339	236,382	41,583
Jul	78,067	13,044	159,531	27,299	263,227	46,093
Aug	83,815	13,999	159,635	27,321	261,733	45,972
Sep	77,235	12,478	159,332	27,272	234,054	39,859
Oct	71,152	11,452	159,612	27,318	216,643	37,268
Nov	72,771	11,737	160,049	27,389	215,894	37,223
Dec	71,627	11,534	159,698	27,324	235,679	41,777
Minimum	61,831	10,117	159,332	27,272	215,894	37,223
Average	78,331	13,018	159,985	27,372	234,951	41,026
Maximum	88,593	15,487	160,517	27,461	263,227	46,093

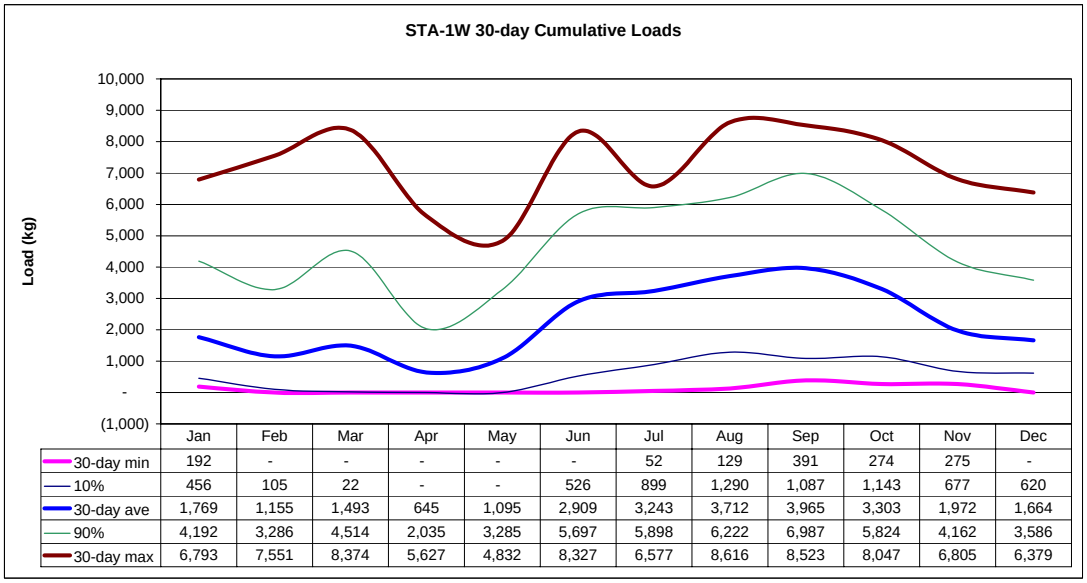
Table A.3: Design 3-year Flow and Loading to STA-1W

Month	3-yr min		3-yr ave		3-yr max	
	Flow	Load	Flow	Load	Flow	Load
Jan	347,543	56,753	473,638	81,003	629,784	107,212
Feb	352,824	57,972	473,351	80,934	630,799	107,291
Mar	348,413	58,186	474,046	81,094	627,058	106,611
Apr	354,700	58,109	473,643	81,000	627,058	106,611
May	346,846	56,543	475,218	81,253	629,720	107,078
Jun	367,283	59,863	474,822	81,205	615,483	105,531
Jul	364,974	61,611	473,405	80,980	626,183	106,430
Aug	356,167	60,553	473,157	80,946	645,708	109,707
Sep	354,165	60,143	474,321	81,141	638,935	108,603
Oct	361,095	59,657	473,472	81,024	620,119	105,551
Nov	349,624	57,112	475,120	81,350	624,361	106,270
Dec	346,465	56,793	475,672	81,501	627,601	106,834
Minimum	346,465	56,543	473,157	80,934	615,483	105,531
Average	354,175	58,608	474,155	81,119	628,655	106,990
Maximum	367,283	61,611	475,672	81,501	645,708	109,707

Figure A.1: Monthly Design Envelope for STA-1W

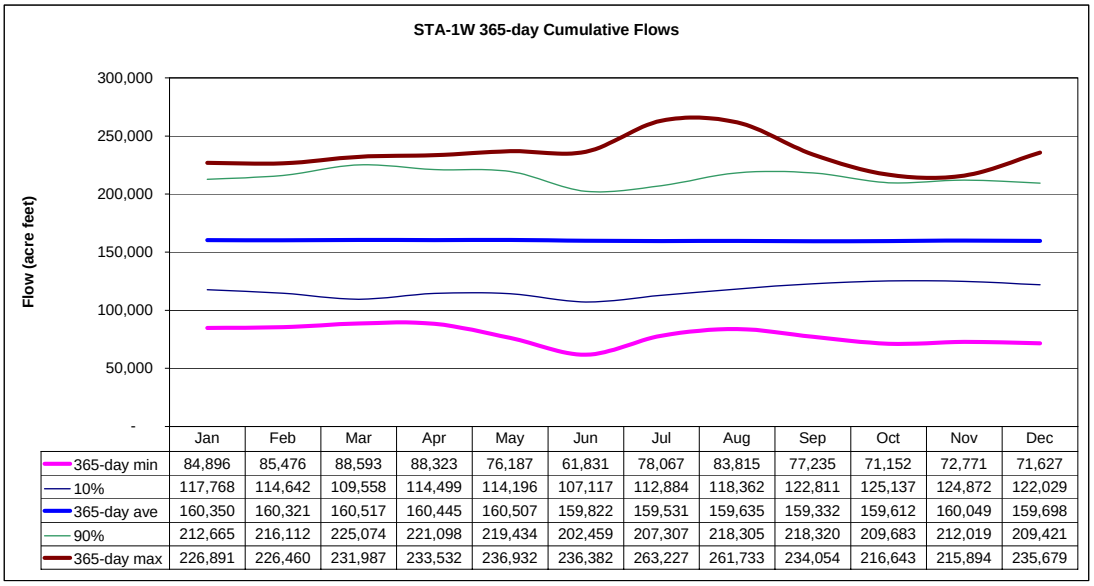


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
30-day min	1,055	-	-	-	-	-	382	942	2,877	1,584	1,604	-
10%	2,666	611	134	-	-	3,500	6,087	8,422	6,837	7,157	3,936	3,582
30-day ave	8,825	5,864	7,167	3,164	6,589	18,084	20,426	23,343	24,598	20,030	10,488	8,909
90%	20,249	15,494	20,569	10,471	18,791	36,379	36,104	39,224	43,328	35,437	20,697	17,995
30-day max	31,946	35,933	38,949	27,025	29,365	52,192	39,789	52,587	50,458	47,426	33,430	30,854

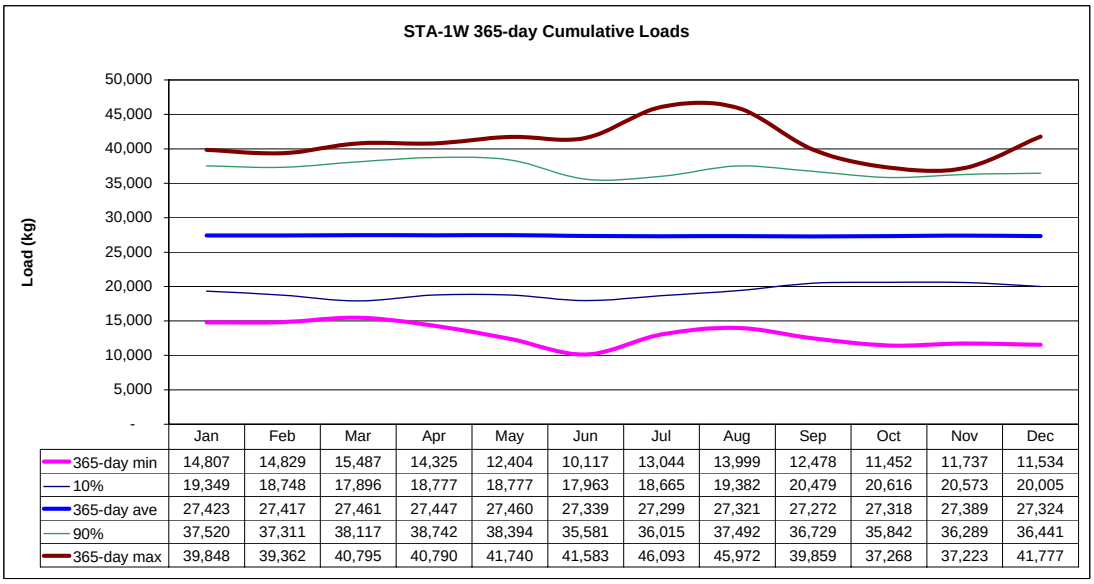


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
30-day min	192	-	-	-	-	-	52	129	391	274	275	-
10%	456	105	22	-	-	526	899	1,290	1,087	1,143	677	620
30-day ave	1,769	1,155	1,493	645	1,095	2,909	3,243	3,712	3,965	3,303	1,972	1,664
90%	4,192	3,286	4,514	2,035	3,285	5,697	5,898	6,222	6,987	5,824	4,162	3,586
30-day max	6,793	7,551	8,374	5,627	4,832	8,327	6,577	8,616	8,523	8,047	6,805	6,379

Figure A.2: Annual Design Envelope for STA-1W

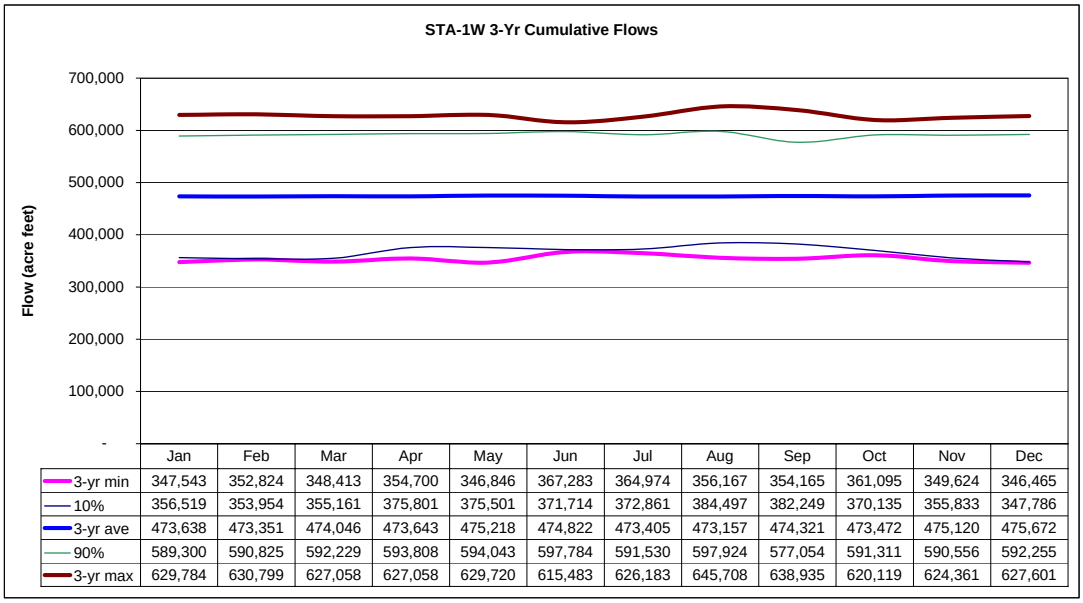


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
365-day min	84,896	85,476	88,593	88,323	76,187	61,831	78,067	83,815	77,235	71,152	72,771	71,627
10%	117,768	114,642	109,558	114,499	114,196	107,117	112,884	118,362	122,811	125,137	124,872	122,029
365-day ave	160,350	160,321	160,517	160,445	160,507	159,822	159,531	159,635	159,332	159,612	160,049	159,698
90%	212,665	216,112	225,074	221,098	219,434	202,459	207,307	218,305	218,320	209,683	212,019	209,421
365-day max	226,891	226,460	231,987	233,532	236,932	236,382	263,227	261,733	234,054	216,643	215,894	235,679

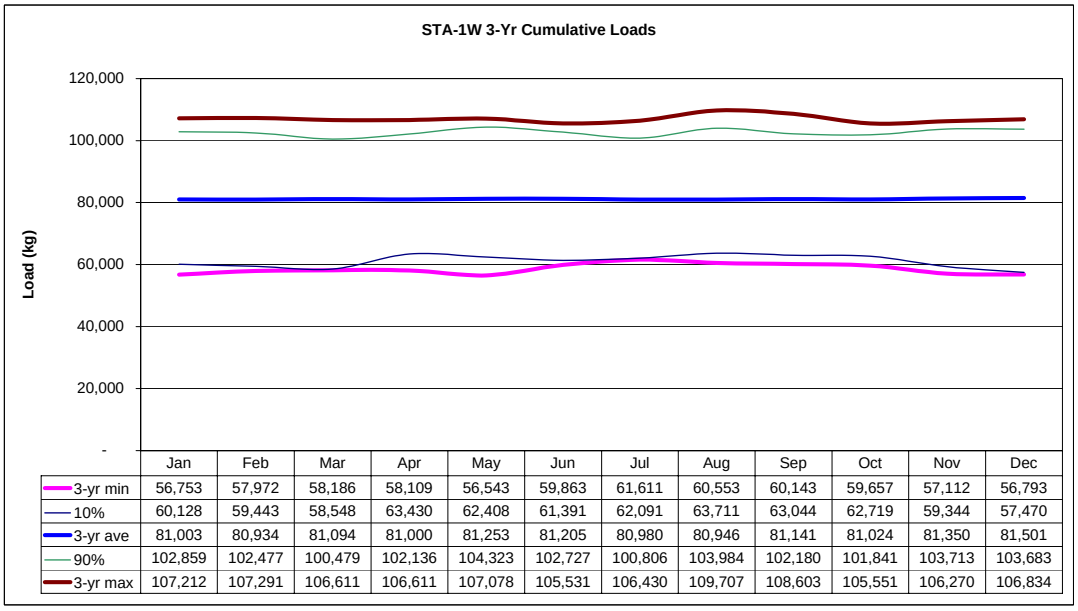


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
365-day min	14,807	14,829	15,487	14,325	12,404	10,117	13,044	13,999	12,478	11,452	11,737	11,534
10%	19,349	18,748	17,896	18,777	18,777	17,963	18,665	19,382	20,479	20,616	20,573	20,005
365-day ave	27,423	27,417	27,461	27,447	27,460	27,339	27,299	27,321	27,272	27,318	27,389	27,324
90%	37,520	37,311	38,117	38,742	38,394	35,581	36,015	37,492	36,729	35,842	36,289	36,441
365-day max	39,848	39,362	40,795	40,790	41,740	41,583	46,093	45,972	39,859	37,268	37,223	41,777

Figure A.3: 3-year Design Envelope for STA-1W



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3-yr min	347,543	352,824	348,413	354,700	346,846	367,283	364,974	356,167	354,165	361,095	349,624	346,465
10%	356,519	353,954	355,161	375,801	375,501	371,714	372,861	384,497	382,249	370,135	355,833	347,786
3-yr ave	473,638	473,351	474,046	473,643	475,218	474,822	473,405	473,157	474,321	473,472	475,120	475,672
90%	589,300	590,825	592,229	593,808	594,043	597,784	591,530	597,924	577,054	591,311	590,556	592,255
3-yr max	629,784	630,799	627,058	627,058	629,720	615,483	626,183	645,708	638,935	620,119	624,361	627,601



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3-yr min	56,753	57,972	58,186	58,109	56,543	59,863	61,611	60,553	60,143	59,657	57,112	56,793
10%	60,128	59,443	58,548	63,430	62,408	61,391	62,091	63,711	63,044	62,719	59,344	57,470
3-yr ave	81,003	80,934	81,094	81,000	81,253	81,205	80,980	80,946	81,141	81,024	81,350	81,501
90%	102,859	102,477	100,479	102,136	104,323	102,727	100,806	103,984	102,180	101,841	103,713	103,683
3-yr max	107,212	107,291	106,611	106,611	107,078	105,531	106,430	109,707	108,603	105,551	106,270	106,834

Appendix B: Structure Photos

Structure G-251

Structure G-300

Structures G-301 & G302

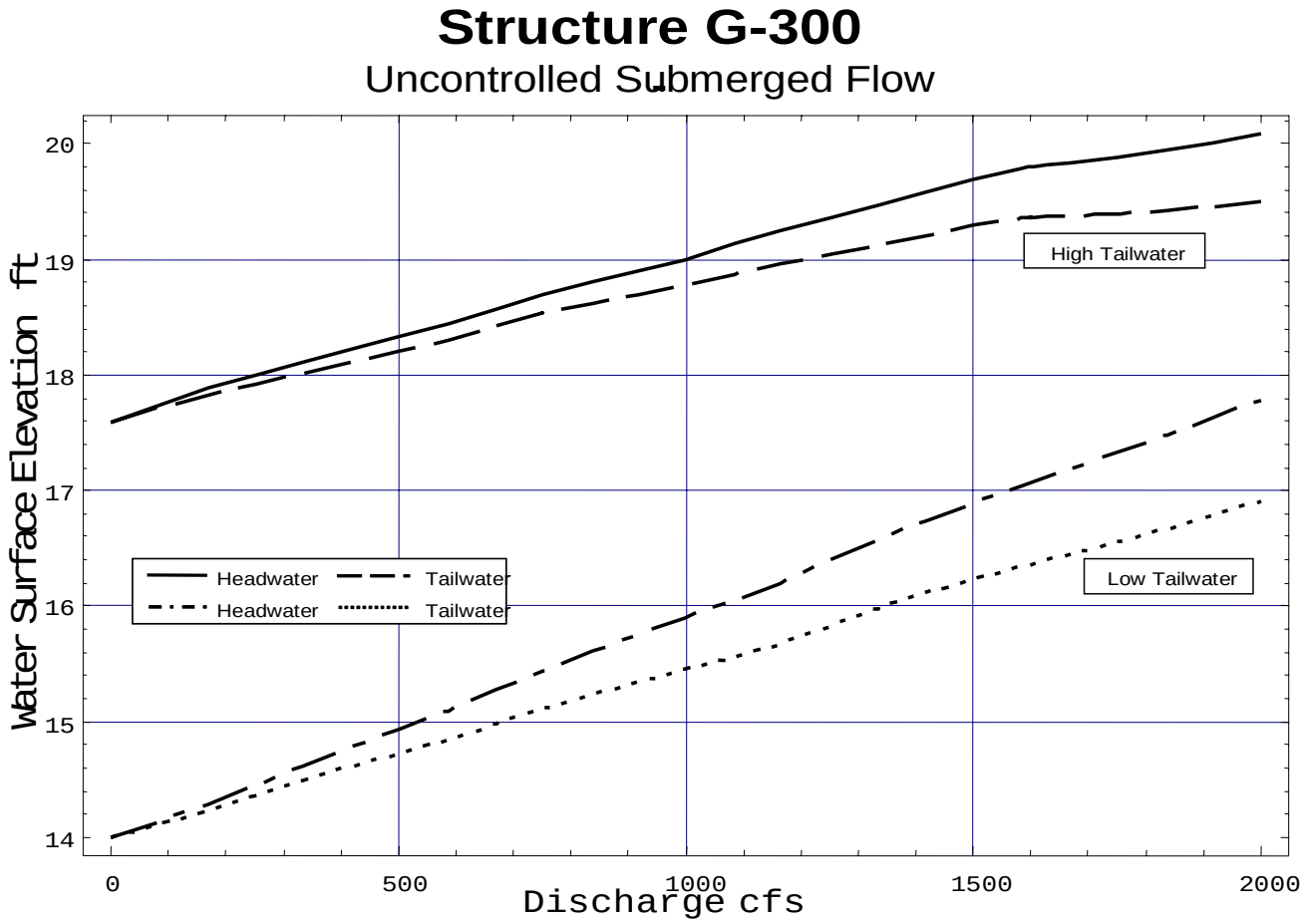
Structures G-306 A-J

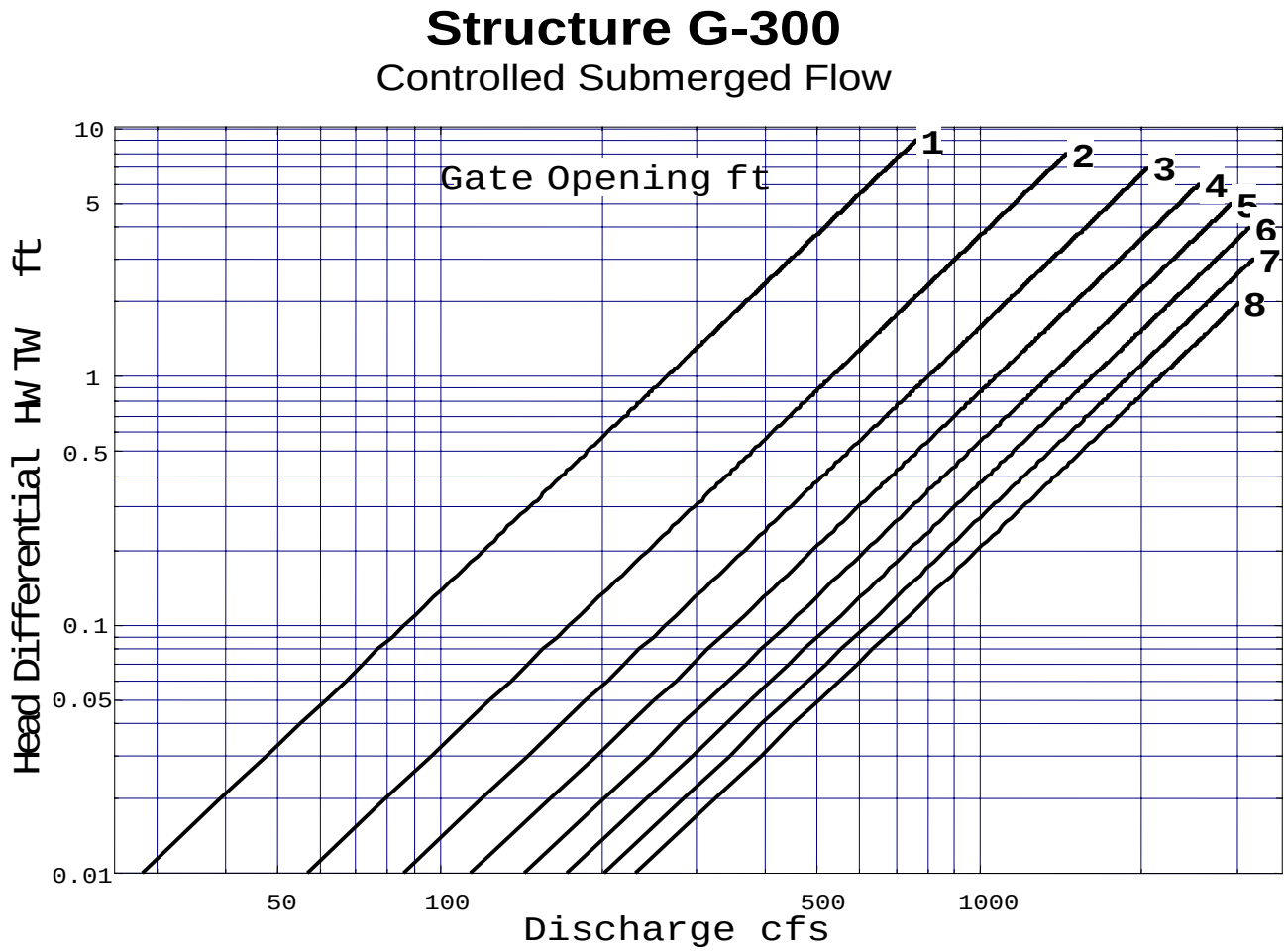
Structure G-309

Structure G-310

Limerock Berm in Cell 5

Appendix C: Rating Curves


Structure G-300
Uncontrolled Submerged Flow
Water Surface Elevation ft
Discharge cfs
20
19
18
17
16
15
14
0
500
1000
1500
2000
High Tailwater
Low Tailwater
Headwater
Tailwater
Headwater
Tailwater


Structure G-300
Controlled Submerged Flow
Gate Opening ft
1
2
3
4
5
6
7
8
10
5
1
0.5
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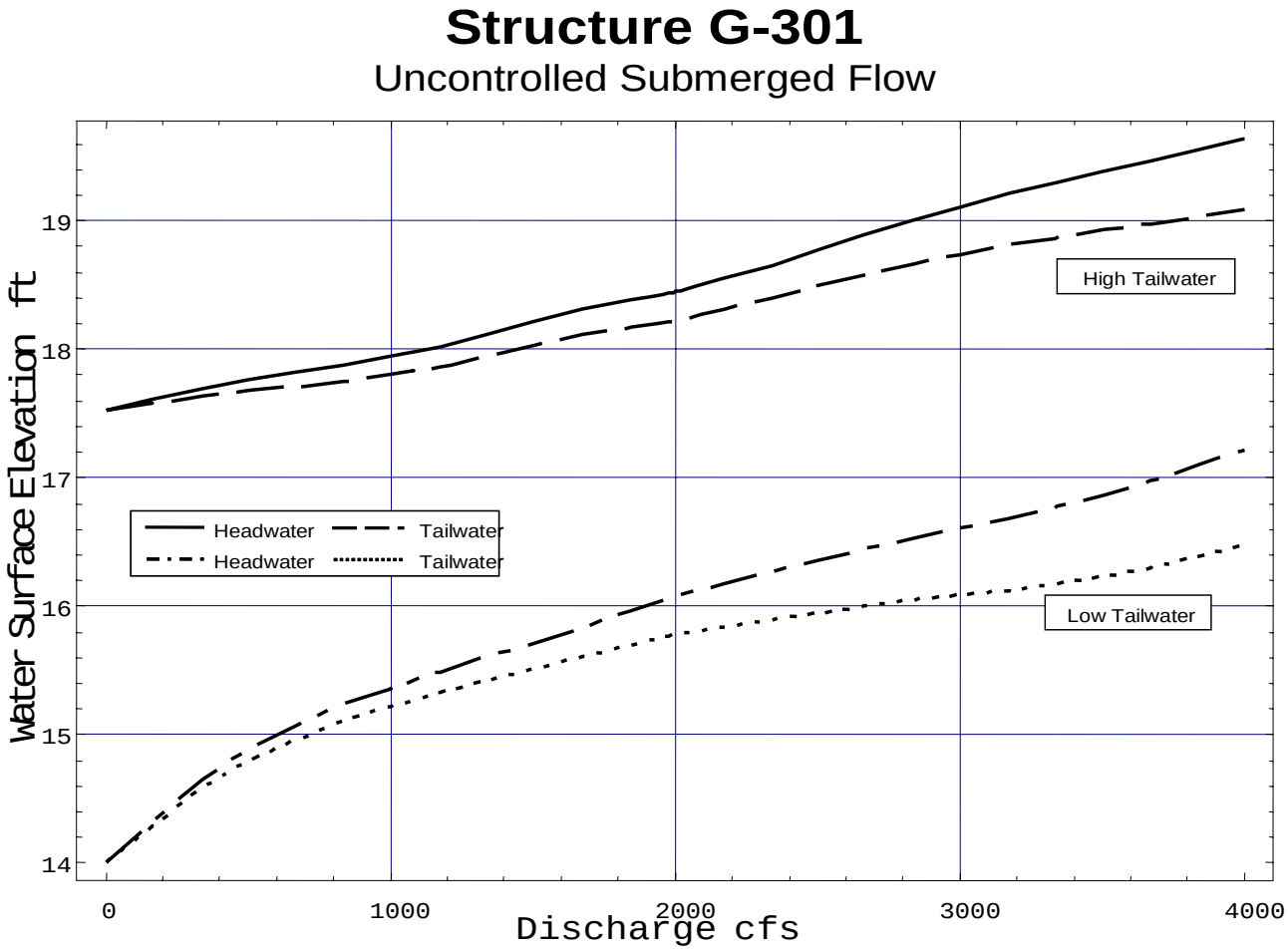
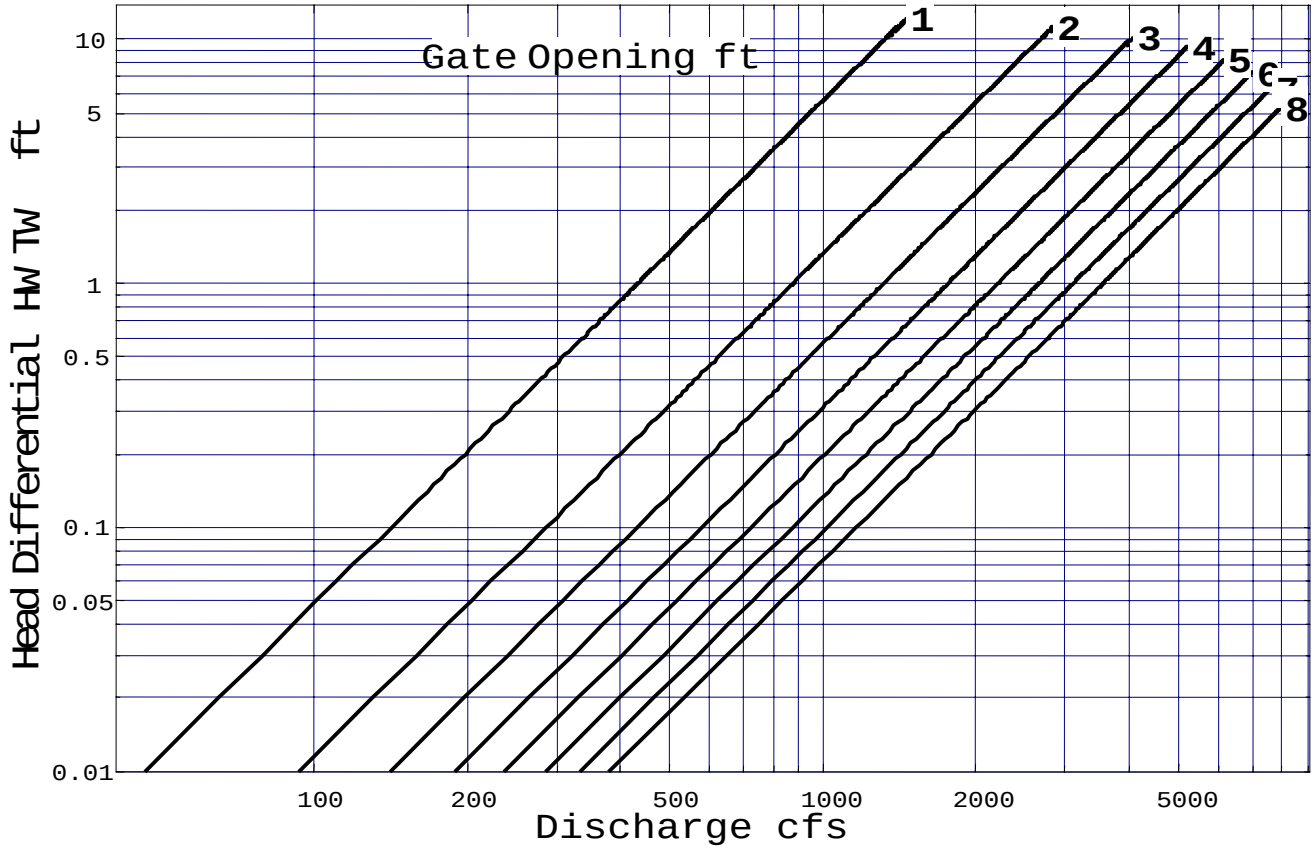
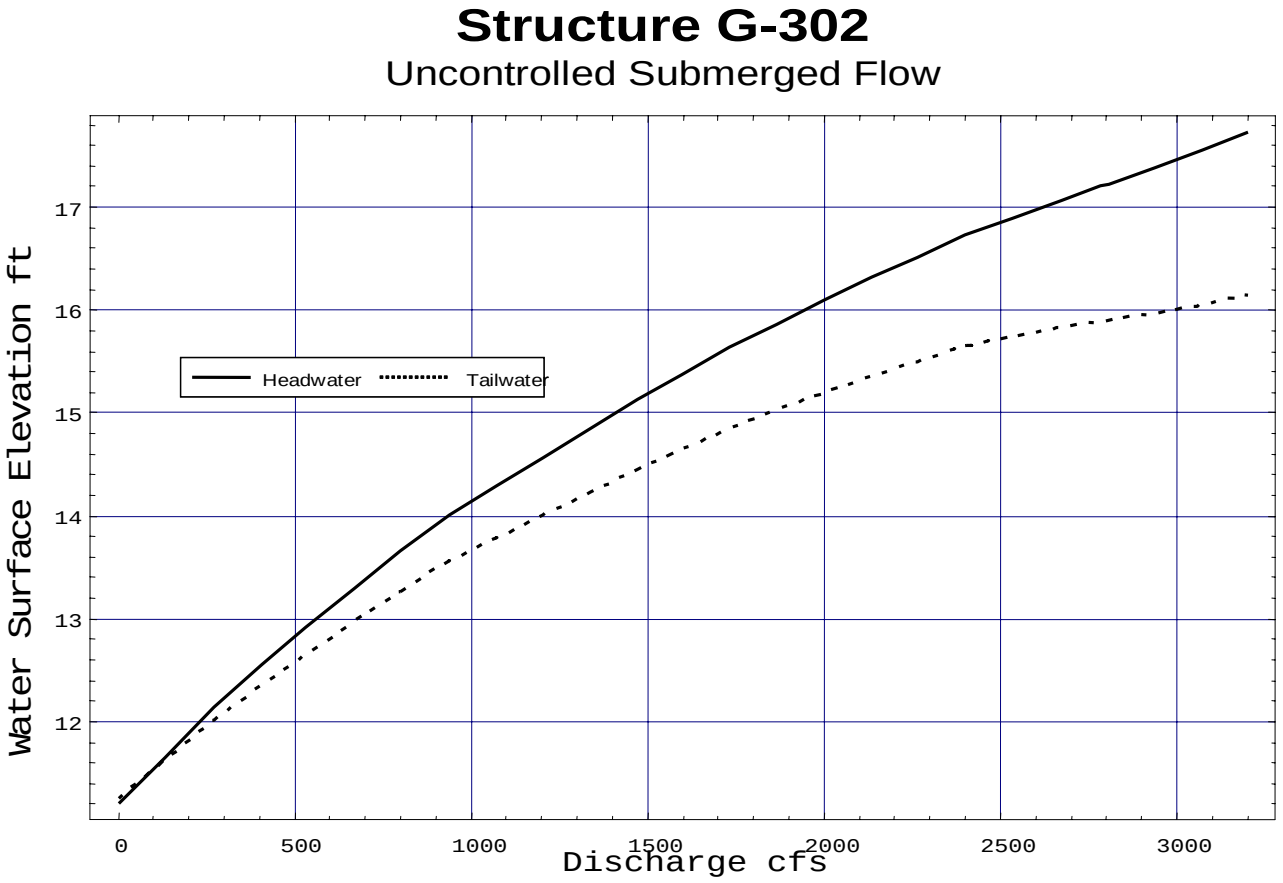
0.05
0.01
Head Differential Hw Tw ft
50
100
500
1000
Discharge cfs


Structure G-301
Uncontrolled Submerged Flow
Water Surface Elevation ft
19
18
17
16
15
14
0
1000
2000
3000
4000
Discharge cfs
High Tailwater
Low Tailwater
Headwater
Tailwater
Headwater
Tailwater

Structure G-301

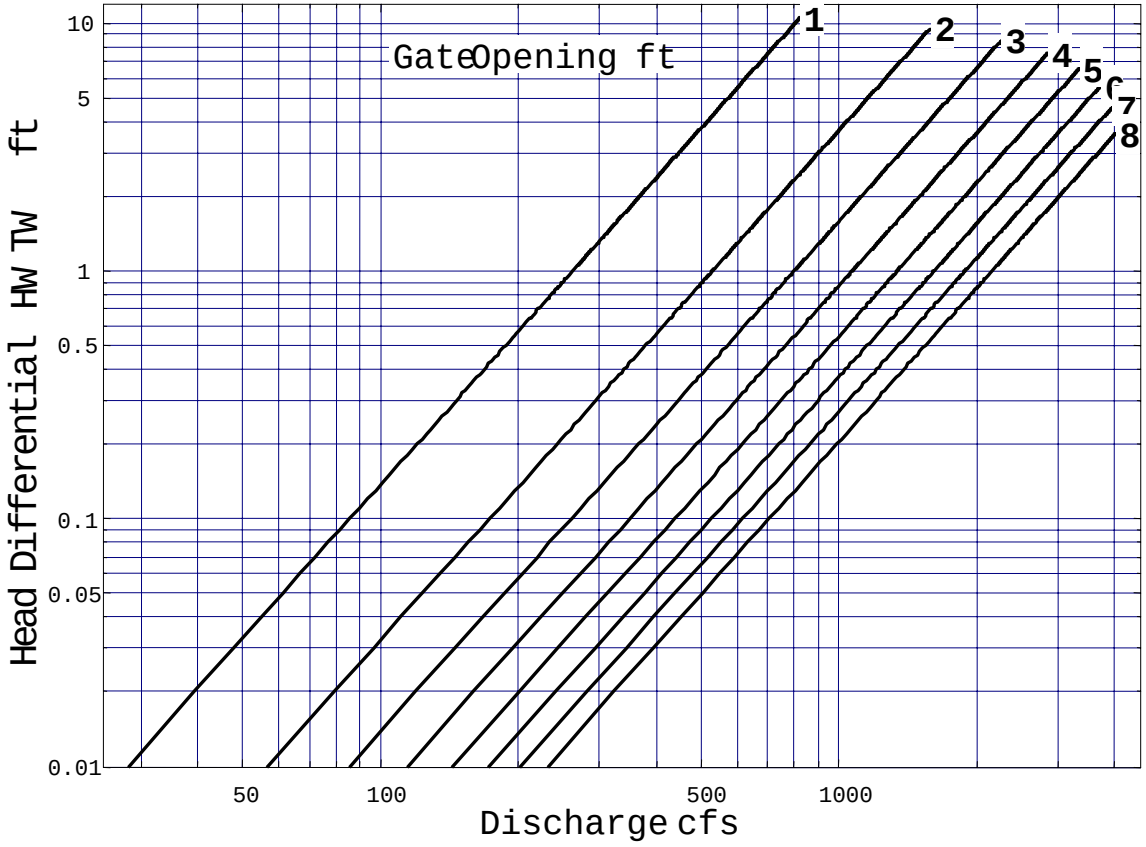
Controlled Submerged Flow



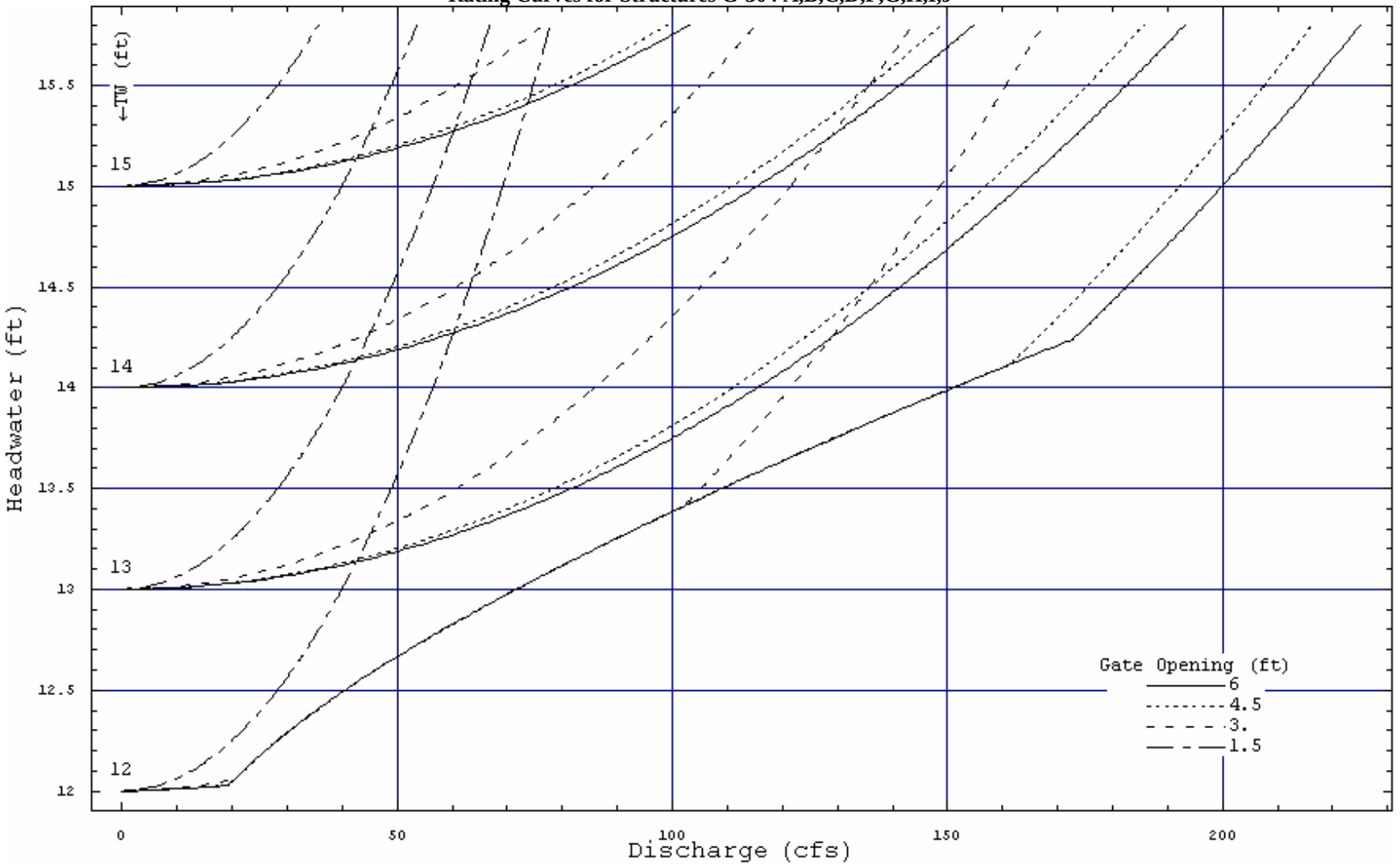

Structure G-302
Uncontrolled Submerged Flow
Water Surface Elevation ft
17
16
15
14
13
12
Headwater
Tailwater
0
500
1000
1500
2000
2500
3000
Discharge cfs

Structure G-302

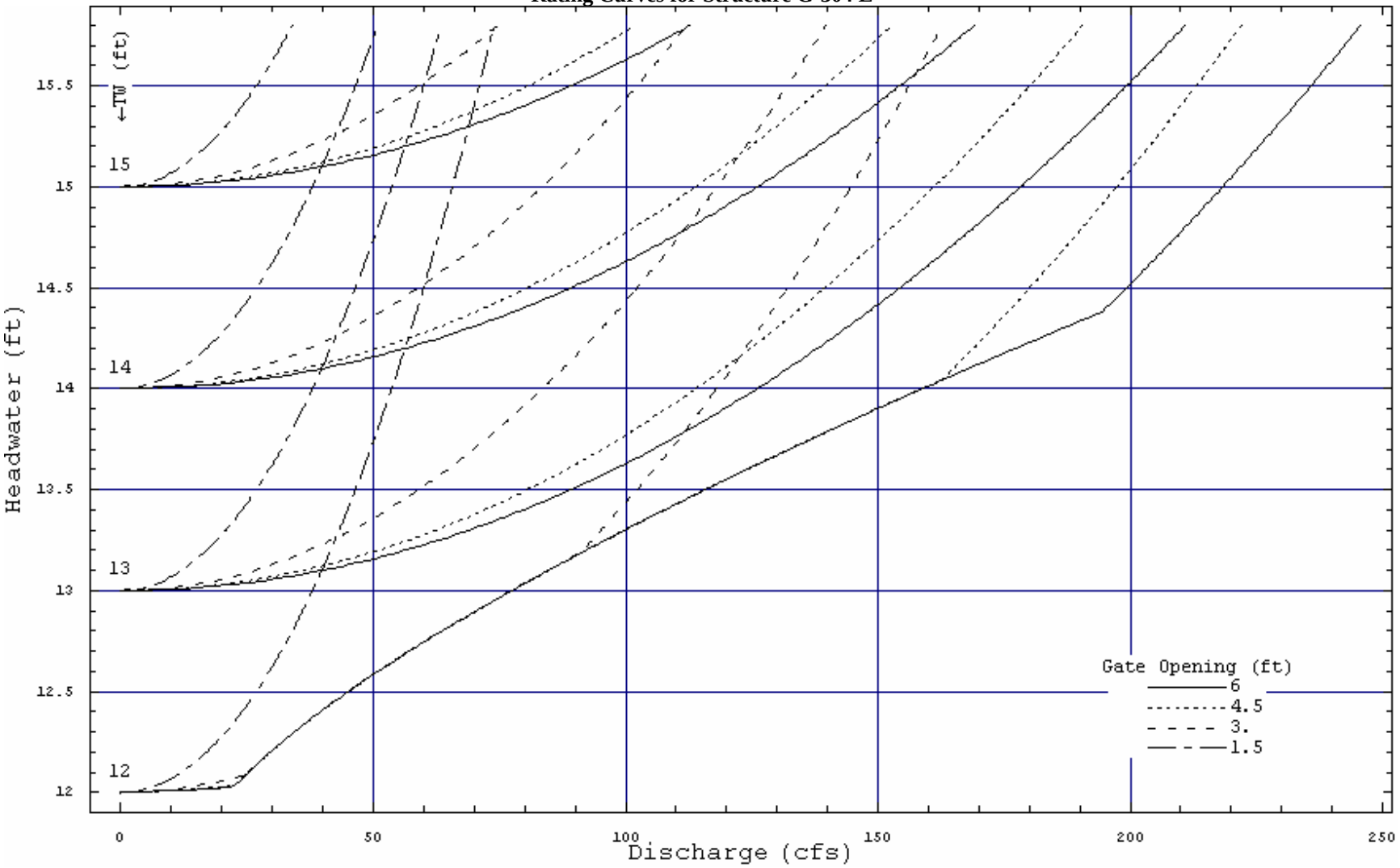
Controlled Submerged Flow



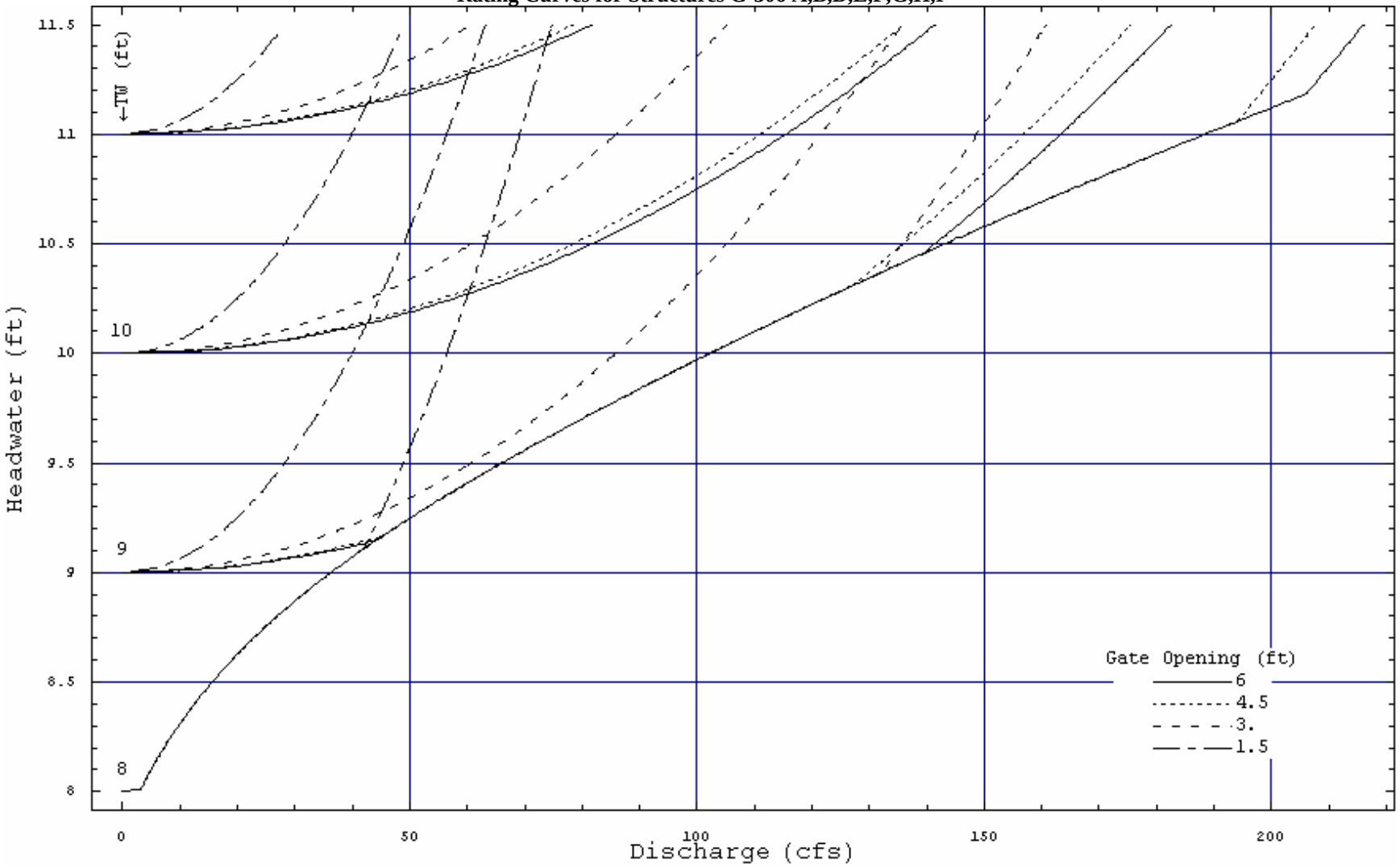
Rating Curves for Structures G-304 A,B,C,D,F,G,H,I,J



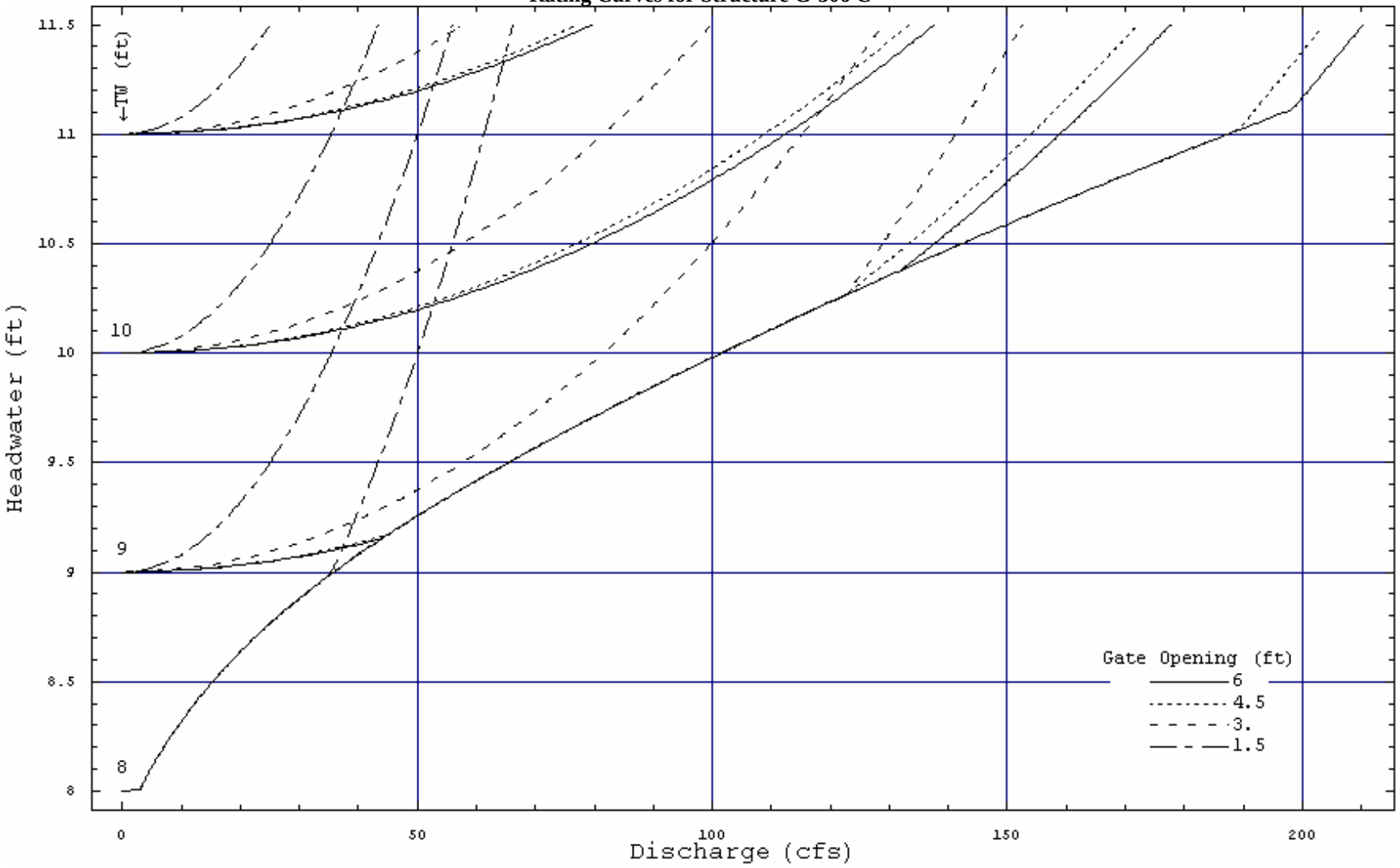
Rating Curves for Structure G-304 E



Rating Curves for Structures G-306 A,B,D,E,F,G,H,I



Rating Curves for Structure G-306 C



Rating Curves for Structure G-306 J