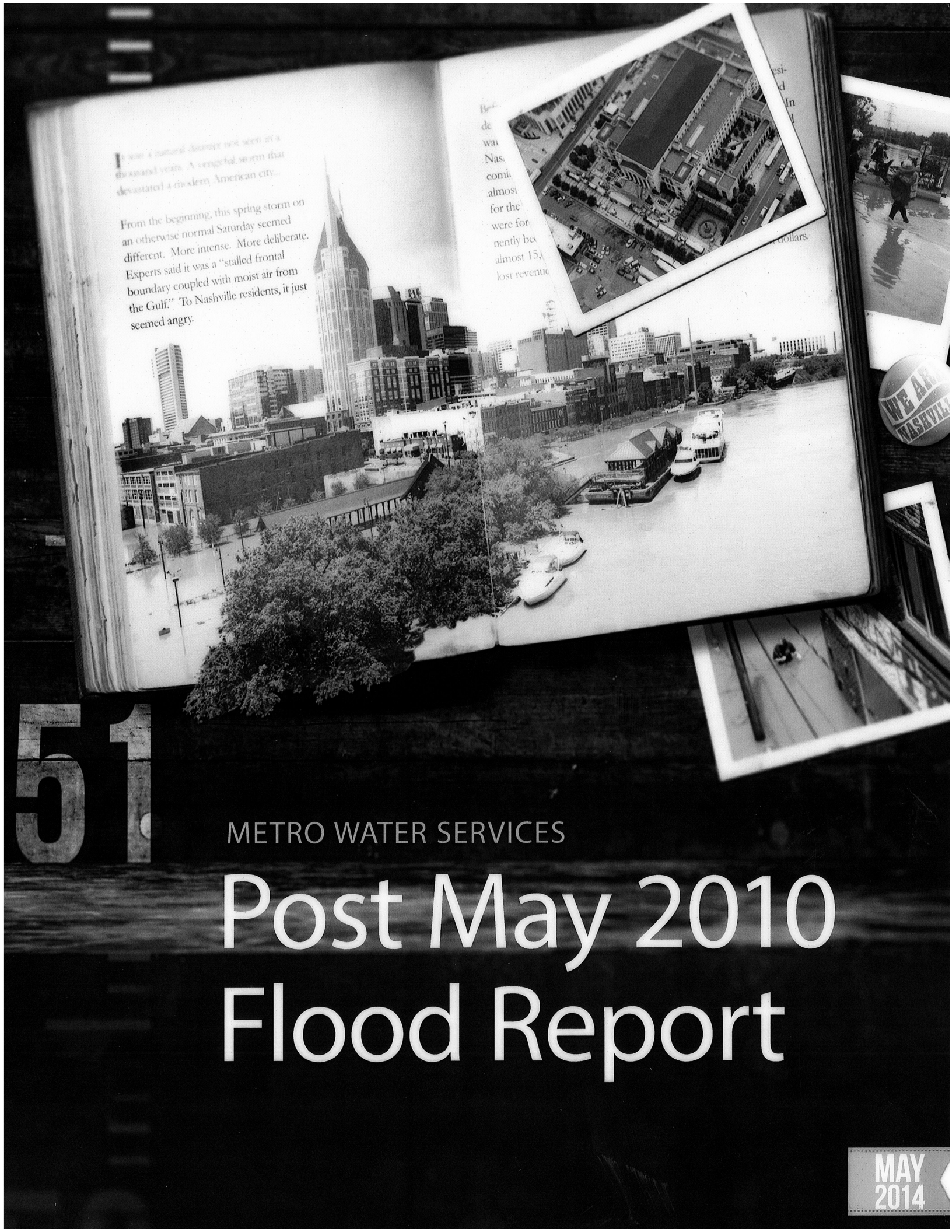

METRO WATER SERVICES

Post May 2010 Flood Report

MAY 2014

wastewater. Due to unfamiliar control, occasional *E. coli* and chlorine residual violations occurred.

- Primary Treatment Systems and Contents (located in Tunnel System) - During and after the flood event, the DCWWTP continued to receive flow from off-site pump stations, which resulted in an accumulation of primary sludge in the primary clarifiers. Restoring primary pumping capabilities and removing primary sludge was essential to the success of the secondary treatment systems and was therefore given priority.
- Secondary Treatment System (located in Tunnel System) – Damage to the secondary treatment system was responsible for the biochemical oxygen demand (BOD), ammonia, and effluent total suspended solids (TSS) permit violations. Recovery of the secondary treatment system required restoration of return sludge pumping and a complete restart of the biological system, culminating with restoration of the ammonia removing bacteria over 1.5 months after the flood event. Table 3.1 summarizes the permit violations that were experienced during this time.

Table 3.1: NPDES Permit Violations Resulting from May 2010 Flood

Parameter	Days in Violation[1]	Weeks in Violation[1]	Months in Violation
Effluent BOD	19	3	1
Effluent Ammonia	9	3	2
Effluent E Coli	11	1	-
Effluent Chlorine Residual	26	-	-

[1] *Includes the period of time that the plant was flooded and without power; sampling did not occur.*

Based on the permit violations discussed above, a conservative number of days that wastewater treatment service was lost at the DCWWTP is 50 days. This period is equal to the number of days between the flood event and restoration of secondary treatment, specifically, ammonia removal.

3.4 Central WWTP Biosolids Facility

3.4.1 Description of Flood Damage

The Biosolids Facility is composed of dissolved air flotation thickening (DAFTs), anaerobic digestion, centrifugal dewatering, and thermal drying for handling of the solids waste stream from the Central and Whites Creek WWTPs. The facility is designed to process 138 dry tons per day of sludge and produces a dried pellet product for beneficial reuse. Major process components include:

- Four DAFTs;
- Four Anaerobic Digesters;
- One Digested Sludge Storage Tank;
- Five Dewatering Centrifuges;
- Two Triple Pass Rotary Drum Dryers; and
- Truck Loading.

Figure 3.8 illustrated the extent of flooding at the Biosolids facility.

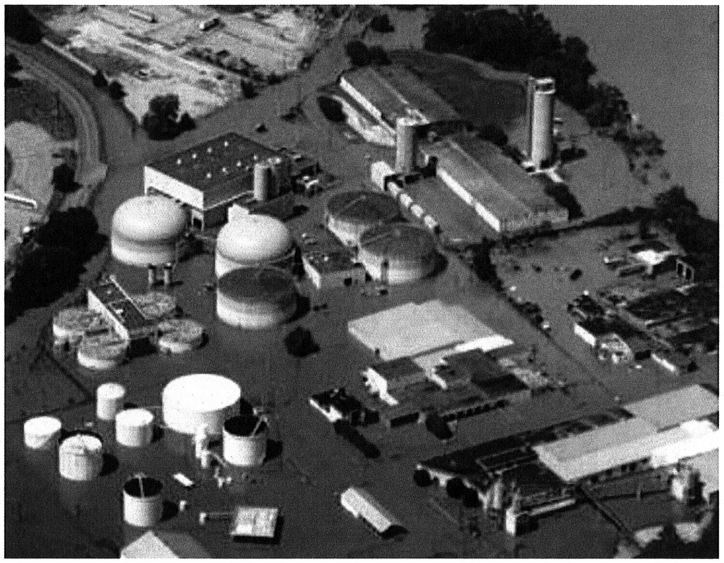

Figure 3.8: Flooding at Biosolids Facility

Figure 3.9 is an aerial photograph with building locations.

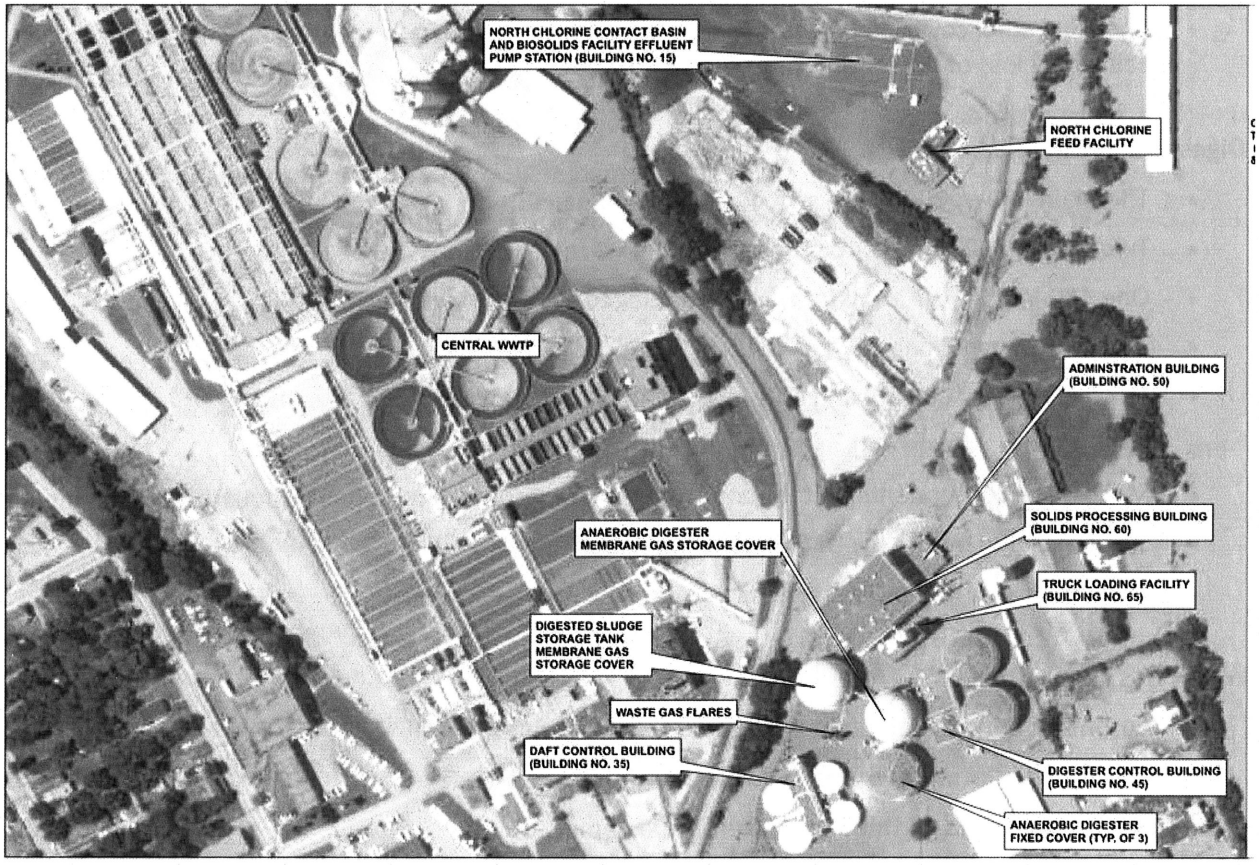

Figure 3.9: Aerial Photo with Building Locations

Damages to the facility due to this flood include:

Site Electrical

- The 13.8-kV loop was de-energized prior to the flood waters entering the facility. The 13.8-kV switchgear (1), pad mounted switches (2), and pad mounted transformers (8) were all partially submerged by the flood waters and damaged.

DAFT Control (Bldg 35)

- 19 pumps were damaged in the building.
- A number of instruments were damaged in this building (pressure switches, level switches, level transmitters, and valve actuators).
- The instrumentation and controls for the DAFT polymer feed system were heavily damaged.

Anaerobic Digesters (Bldg 40)

- The digester gas storage membrane covers on Digester Nos. 4 and 5 were damaged due to deflation because of loss of power to the Dystor Blowers and loss of digester gas.
- The fixed steel cover on Digester No. 1 was compromised due to foaming during the flood caused by loss of power and subsequent mixing.

Digester Control (Bldg 45)

- The main 480-V, 2000-amp switchgear was damaged.
- Two 480-V, 800-amp motor control centers were damaged.
- One 480-V, 150-KVA transformer was damaged.
- The control panel and UPS power backup were damaged.
- The Supervisory Control and Data Acquisition (SCADA) workstation was damaged.
- Several level transmitters and pressure switches were damaged.
- Mechanical components on the natural gas and digester gas train on the boilers were damaged.
- Six pumps and motors were damaged in the building.
- The equipment in the Digester Gas Compressor Room was damaged.

Waste Gas Flares (Bldg 46)

- Automatic condensate drain actuator was damaged.
- Control transformers for the control panels were damaged.
- Electric actuators on the flare louvers were damaged.
- Insulation in the flares was damaged.

Solids Processing (Bldg 60)

- The main 480-V, 4000-amp switchgear (SWGR-1 and SWGR-2) was damaged.
- One 480-V, 800-amp and two 480-V, 1600-amp motor control centers were damaged.
- Two 5-KVA UPS units were damaged.
- Two 45-KVA transformers were damaged.
- Ten pumps and motors were damaged in the building.
- A number of instruments were damaged in this building (pressure switches, level switches, level transmitters, and valve actuators).
- The instrumentation and controls for the centrifuge polymer feed system were heavily damaged.
- The solids dryer system sustained significant damage to mechanical and instrumentation components located on the first floor.

RTO (Bldg 60)

- The majority of the damage was to the variable frequency drives, PLC, and control system components.

Truck Loading (Bldg 65)

- The truck scale was damaged due to the flood.
- The air compressors and air dryers were damaged.
- The lighting transformer and panels were damaged.

Recycle Pump Station (Bldg 80)

- The motors on the pumps were damaged.
- All of the electrical equipment in the dry well was damaged.
- All of the instruments were damaged (pressure switches, level switches, level transmitters, and flow meter).
- All of the heating and ventilating equipment in the dry well was damaged.

FOG (Bldg 75)

- The motors on the pumps were damaged.
- All of the electrical equipment in the dry well was damaged.
- All of the instruments were damaged (pressure switches, level switches, level transmitters, and flow meter).
- The fats, oils, and greases (FOG) screen equipment was damaged.
- All of the heating and ventilating equipment in the dry well was damaged.

Figure 5.9: Flip-Up Type Flood Gate during Dry (left) and Flooded (right) Scenarios

5.3.3 Cost of Mitigation Measures

A cost estimate has been developed for the mitigation scope of work. The estimate includes the installed cost of the flood wall, pump stations, and associated work. The estimate was based on preliminary design drawings and details, including the height of sheet piling required, additions and modifications to the storm water system to collect and remove the large infrequent runoff, flood gates and access points, sealing below grade penetrations in the sheet piling, and isolating gravity sewers so that back up from outside the perimeter wall does not occur.

Mitigation Item	Cost
DCWWTP Perimeter Flood Wall	$ 9,260,000

5.3.4 Status of Mitigation Measures

MWS submitted the HMPs described in 5.3.1 to FEMA in August 2011 for review and approval. The Benefit/Cost ratio for the proposed HMP is greater than 1.0 which makes it eligible for reimbursement from FEMA. However, MWS has not received a formal response from FEMA regarding the eligibility of the HMP for reimbursement.

5.4 Central WWTP Biosolids Facility

5.4.1 Summary of Mitigation Measures

To prevent future damage to the Biosolids Facility, a plant-wide perimeter flood wall will need to be constructed to the flood protection elevation of 421.00 feet. (rounded up from the elevation of the flood of record (418.84 feet) plus two feet). A perimeter flood wall around the entire Biosolids Facility will prevent flood waters from entering the site, alleviating future flooding. This project would provide full protection of all structures and equipment on site up to the protection elevation.

Refer to the drawing in Appendix B showing the proposed layout of the flood wall and Figure5.10 showing a rendering of the flood wall at the entrance to the Biosolids Facility. As part of this project, a drainage system will be required to remove stormwater and infiltration within the protected area. Additionally, penetrations through the flood wall will require sealing to minimize infiltration.

Figure 5.10: Flood Wall Rendering

The following sections present the structural requirements of the flood wall, site drainage and pumping requirements, and issues associated with maintaining the power to the site during a flood event.

5.4.1.1 Structural Requirements

The perimeter flood wall will utilize a sheet piling system with PVC walls installed with conventional pile driving equipment. The sheet piling will extend into the ground twice the height above ground. Sheet piling will be notched at buried utility/pipe crossing locations, and concrete collars will be installed to seal the gap between the sheet piling and the utility/pipe. Concrete collars will also provide additional support for the sheet piling. Where flood gates are located, concrete posts will provide a water-tight seal between the interrupted sheet pile locations and the flood gates. In general, the sheet pile flood wall will protrude about five feet above grade.

5.4.1.2 Site Drainage and Pumping

A perimeter flood protection approach will require provisions to protect the internal area against storm events and backing up of site drainage and sewer piping. A stormwater collection and drainage system, including in-ground, packaged pump stations, with two submersible pumps each, will be sized based upon the 500-year rainfall event and site-specific conditions with a safety factor for seepage under the flood walls and inside the protected area. This arrangement provides for 100% backup pumping capability, if needed, but will allow both pumps to be operated simultaneously if the storm intensity is higher than the design assumptions. If the water level inside the flood wall exceeds this flow rate of the permanent stormwater pumps, portable pumps and piping will be used to supplement the permanently installed pumps.

Additionally, sanitary and storm sewer piping will be provided with automatically actuating isolation valves to prevent the sewer from backing up inside the perimeter wall.

5.4.1.3 Electrical Distribution

The main electrical power distribution located in the yard will be protected from flooding as part of the perimeter flood wall protection. It is imperative that the primary power conductors and conduits that feed the main switchgear are flood proofed to prevent the infiltration of flood waters through the conduits and into the electrical gear. The electrical conduits which pass to the other side of the perimeter wall will need to be sealed to keep water from entering the site. Annual maintenance to check the integrity of the seal will need to be performed. An alternative would be to raise the conduit above the flood protection level in a "goose-neck" to prevent flood waters entering the equipment.

5.4.1.4 Flood Gates

Flood gates will be required at the front and at the rear of the facility. Self-actuating flood gates are recommended.

5.4.2 Cost of Mitigation Measures

A cost estimate has been developed for the mitigation scope of work. The estimate includes the installed cost of the flood wall, pump stations, and associated work. The estimate was based on preliminary design drawings and details, including the height of sheet piling required, additions and modifications to the stormwater system to collect and remove the large infrequent runoff, flood gates and access points, sealing below grade penetrations in the sheet piling, and isolating gravity sewers so that back up from outside the perimeter wall does not occur.

Mitigation Item	Cost
Central Biosolids Perimeter Flood Wall	$5,200,000

5.4.3 Status of Mitigation Measures

MWS submitted the HMPs described in 5.3.1 to FEMA in August 2011 for review and approval. The Benefit/Cost ratio for the proposed HMP is greater than 1.0 which makes it eligible for reimbursement from FEMA. However, MWS has not received a formal response from FEMA regarding the eligibility of the HMP for reimbursement.

One of the systems that was flooded during the May 2010 event was the Effluent Pumping Station (EPS). The EPS pumps effluent to the Biosolids Facility for process water. The pumps, electrical equipment, and valve actuators were all damaged during the flood. MWS is currently constructing a new EPS that will be constructed to two feet above the May 2010. This facility would be outside the proposed perimeter flood wall and, therefore, would require its own flood mitigation measures. The construction cost of the new EPS is $3.6 million.

Figure 5.11: Central Biosolids Facility EPS under construction

5.5 Whites Creek Wastewater Treatment Plant

5.5.1 Summary of Mitigation Measures

No mitigation measures were developed for the flood damages at the WCWWTP. To prevent similar damages from future flooding, all empty basins will be filled with water prior to the flood event.

5.6 Central Wastewater Treatment Plant

5.6.1 Summary of Mitigation Measures

Mitigation measures were developed to minimize damage to the Central WWTP in the event of a flood up to an elevation of 421.00. The mitigation measures included the following general categories:

- Dry floodproofing of the hothouse, sealing conduits entering the hothouse, installing sumps and sump pumping to collect seepage that enters the building, and protecting the pull boxes inside of the building.
- Raising the electrical switch on the east side of North Secondary Clarifiers 5 & 6.
- Preventing leakage from electrical conduits via junction boxes by relocating or raising above flood level or sealing.
- Protecting equipment in the Central Pump Station mechanical room from flooding.
- Installing berms, curbs, or other measures to prevent surface water from entering the stairwells and other entrances into the tunnels from sheet flow and ponding at the flood mitigation elevation (421.00).
- Sealing wall penetrations, joints, cracks, and other points of potential groundwater infiltration into the tunnels.
- Installing bulkheads in the tunnel system to minimize the migration of flood/ground water into other sections of the tunnel, such as from the old south tunnel areas.
- Installing sumps and sump pumps in sections of the tunnel to collect the seepage that enters the

tunnel system.

- Providing power generation and discharge pipe connections for portable sump pumps in case of power failure.
- Replacing highly vulnerable pumps with dry pit submersibles, if possible.
- Evaluating check valve on stormwater outfall with possible stormwater pump station.
- Providing recommendations on protecting critical process equipment that should remain in service, such as the screw pumps.
- Replacing existing actuators with submersible ones on valves below grade.

Table 5.1 summarizes the various mitigation measures recommended for specific areas of the Central WWTP.

Table 5.1: Mitigation Measures Recommended for Facilities at the Central WWTP

Area	Scope of Work
North Grit Facility (Area 2)	• Temporary closures at door openings • Seal tunnel wall penetrations/joints
North Primary Settling Tanks (Area 3)	• Temporary closures at door openings • Portable pump and provisions • Seal tunnel wall penetrations/joints
South Primary Settling Tanks (Area 3)	• Portable pump and provisions • Seal tunnel wall penetrations/joints
North Aeration Tanks (Area 4)	• Temporary closures at door openings • Elevate two HVAC units • Seal tunnel wall penetrations/joints
Middle Secondary Clarifier Tanks (Area 5)	• Temporary closures at door openings • Portable pump and provisions • Concrete repair at clarifier walls • Seal tunnel wall penetrations/joints
North Secondary Clarifier Tanks (Area 5)	• Temporary closures at door openings • Portable pump and provisions • Seal tunnel wall penetrations/joints
South Aeration Tunnel (Area 6)	• Bulkhead • Portable pump and provisions • Seal tunnel wall penetrations/joints
Process Center (Area 7)	• Temporary closures at door openings • Portable pump and provisions • Curb at equipment access hatch • Curb at HVAC vent • Seal tunnel wall penetrations/joints • Replacement of tank drainage and backwash pumps
Tertiary Filters (Area 8)	• Seal pipe chase from Operations Center • Seal expansion joints

Area	Scope of Work
Operations Center (Area 9)	• Portable pump and provisions • Seal four air vents into crawl space
Maintenance Center (Area 10)	• Elevate HVAC unit • Repair concrete in basement • Seal tunnel wall penetrations/joints
Sludge Transfer Station (Area 11)	• Temporary closures at door openings • Portable pump and provisions • Seal tunnel wall penetrations/joints
Blower Building (Area 13)	• Temporary closures at door openings • Seal tunnel wall penetrations/joints
Chlorine Contact and Effluent Pump Station (Area 15)	• N/A
Central Pumping Station (Area 18)	• Temporary closures at door openings and stairwell entrances • Portable pump in mechanical room • Elevate raw water pump coolers • Elevate outdoor pad mounted drains
Central Electrical Building (Hothouse) and Site Electrical	• Install sump and sump pump • Flood proof structure • Seal conduits • Elevate 13.8 kv switchgear

5.6.2 Cost of Mitigation Measures

A cost estimate has been developed from the mitigation scope of work. The estimate includes the installed cost of all of the dry and wet floodproofing measures identified in Table 5.1 to prevent floodwaters from penetrating structures and damaging process equipment.

Mitigation Item	Cost
Central WWTP Mitigation Measures	$3,300,000

5.7 Wastewater Collection and Conveyance System

5.7.1 Summary of Mitigation Measures

5.7.1.1 28th Avenue Pump Station

To prevent future damage to the 28th Avenue Pump Station, new power and sensor cables for the submersible pumps will need to be installed to the protected elevation. The pumps were damaged due to conduit infiltration of flood water through the junction boxes in the dry well. The proposed cables will be routed from the pumps to a junction box located above the protected elevation. From the junction box, a cable will be routed along the back wall of the electrical room to the existing motor control center from above. The existing pump cable conduits will be sealed off. The existing telemetry panel will be