Appendix 8-1: Wet Weather Operating Plan

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WET WEATHER OPERATING PLAN

BUFFALO SEWER AUTHORITY
WASTEWATER TREATMENT FACILITY

BUFFALO, NEW YORK

JUNE 2000
Revised August 2007

MALCOLM PIRNIE, INC.   June 2000

BUFFALO SEWER AUTHORITY
WET WEATHER OPERATING PLAN

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1.0 INTRODUCTION

This manual contains wet weather operating guidelines for the Buffalo Sewer Authority's (BSA) Bird Island Wastewater Treatment Plant (WWTP). The Buffalo Sewer Authority WWTP serves the City of Buffalo and several neighboring communities including entire areas or parts of the Towns of Cheektowaga, Lancaster and West Seneca and the Villages of Sloan, Lancaster and Depew. The WWTP provides preliminary, primary and secondary treatment to all dry weather flow entering the sewer system. The wastewater collection system in the City of Buffalo is a combined sewer system which collects both wastewater and storm water. During wet weather events, when storm water flow enters the combined sewer system, permitted combined sewer overflows can occur which discharge to the Niagara River, the Lake Erie Basin, the Buffalo River, Cazenovia Creek, Scajaquada Creek, Cornelius Creek and Black Rock Canal.

1.1 PLAN SCOPE

Under the terms of the BSA's State Pollutant Discharge Elimination System (SPDES) Permit dated July 1, 1999, the BSA must develop and submit a wet weather operating plan to the New York State Department of Environmental Conservation (NYSDEC) by July 1, 2000. The SPDES permit identifies three components of the plan:

- Description of procedures to operate unit processes to treat flows while not appreciably diminishing effluent quality or destabilizing treatment upon return to dry weather operation.
- Evaluation of procedures and facilities necessary for controlling peak flows through the primary and secondary treatment processes.
- Identification and evaluation of the disinfection needs and chlorine residuals for Outfall 001.

This document includes the first two plan elements and begins to address the third element listed in the SPDES permit. Specifically, this wet weather-operating plan identifies the procedures and facilities necessary for controlling peak flows through the WWTP (critical components) and describes current procedures for operating these facilities. An initial evaluation of primary clarifier disinfection during partial treatment mode was conducted during the Wet Weather Capacity Study.

The BSA is in the midst of an ongoing program of facility upgrade and improvement. To date, this program has focused on the WWTP with the installation of fine bubble aeration equipment, construction of a new grit facility, refurbishment an modifications to the anaerobic digesters, startup of new dewatering equipment, development of Standard Operating Procedures and the installation and subsequent expansion of supervisory control and data acquisition (SCADA) systems. BSA considers the wet weather operating plan to be a dynamic document subject to future updates and modifications pending the findings and capabilities provided by other ongoing BSA work efforts. Additional information on the scope and schedule of BSA's planned improvement program is presented in Section 1.3.

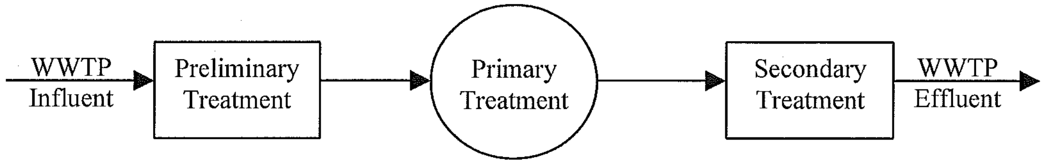
1.2 GOALS

The BSA Bird Island WWTP is operated to achieve the general goals of:

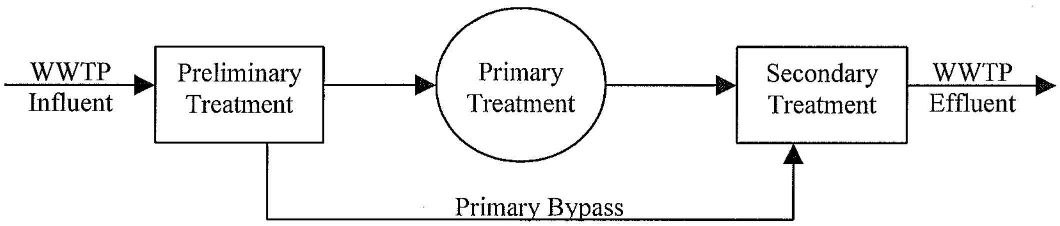
- Maximizing flow to the WWTP without jeopardizing WWTP performance.
- Maximizing flow receiving secondary treatment without causing a process upset.
- Protecting the water quality of receiving streams by meeting the SPDES permit.

To achieve these goals, the Bird Island WWTP can operate in one of three different modes:

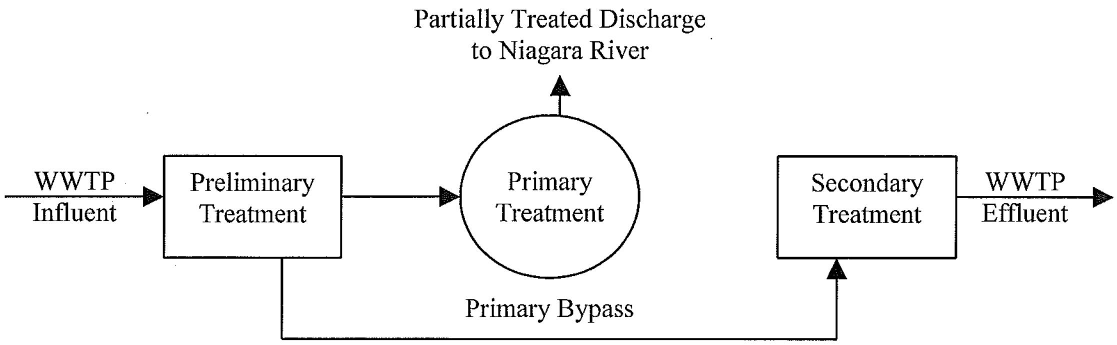
- Normal Mode: Used when the plant influent flow is less than or equal to 160 million gallons per day (mgd). All flow receives preliminary, primary and secondary treatment.



- Primary Bypass Mode: Used when the plant influent flow exceeds the capacity of the primary clarifiers, which is typically 160 mgd with all units in service. All flow receives preliminary treatment. Flows up to 160 mgd receive primary treatment. Flows in excess of 160 mgd bypass the primary clarifiers and join with the primary clarifier effluent flow to receive secondary treatment. All flow receives secondary treatment. This mode of operation is provided because the secondary treatment capacity of the Bird Island WWTP exceeds the primary treatment capacity.



- Partial Treatment Mode: Used when the plant influent flow exceeds the capacity of the secondary treatment system. All flow receives preliminary treatment. Flows up to the capacity of the secondary treatment system bypass the primary clarifiers and receive secondary treatment. Flows in excess of the secondary treatment capacity, pass through the primary clarifiers and are chlorinated prior to discharge to the Niagara River. In this treatment mode, in addition to functioning as sedimentation tanks, the primary clarifiers function as chlorine contact tanks for the flow not receiving secondary treatment.



The SPDES permit identifies goals of 450 mgd for flow receiving preliminary treatment and up to a minimum of 300 mgd through secondary treatment. BSA is attempting to operate the WWTP to achieve the specific goals for flow receiving preliminary treatment and secondary treatment as listed in the SPDES permit. However, the BSA considers these figures to be target values subject to modification based upon actual plant operating experience at these flows along with the observed performance of the collection system during wet weather events.

1.3 FACILITY UPGRADES

As previously stated, the BSA considers the wet weather operating plan to be a dynamic document subject to future updates and modifications. It is also subject to the findings and capabilities provided by other ongoing BSA work efforts at the WWTP and in the collection system. Planned improvements at the WWTP will further improve WWTP reliability and efficiency during wet weather events. Ongoing work efforts include:

Bird Island WWTP

- Implementation of the supervisory control and data acquisition (SCADA) system at the Bird Island Wastewater Treatment Plant and at key pumping stations. Currently, SCADA provides monitoring and control capability for most of the plant's wastewater treatment processes. Installation of initial SCADA equipment for monitoring and limited control of the existing solids handling processes was completed in May 2000. The solids handling SCADA system was recently expanded to include monitoring and control capabilities for all major solids handling unit operations including digesters 1 through 4 and centrifuge operation.

- A new grit pista system was installed in 2005. The twelve former grit collection channels were modified into six channels to maintain flow velocities to the new grit building now located north of our administration building. Eight vortex grit chambers and four belt conveyors were installed to transfer grit to four grit hoppers. Two diversion conduits were constructed around the existing Administration Building to provide headworks capacity of 600 mgd to flow through the new grit removal system.

- Improvements to the secondary system include the installation of new return activated sludge pumps, new waste activated pumps, and new final effluent supply pumps. New towbro collection systems have been installed in all 16 of the final clarifiers.

- During partial treatment events, a hydraulic bottleneck has been identified at the primary bypass butterfly control valves. The Authority has raised the weir at outfall 01A by approximately 5.5 inches to encourage additional flow through the butterfly valves allowing additional primary effluent to receive secondary treatment.

- The Authority is also evaluating a mode change in the secondary system from conventional plug flow to step feed in order to accommodate higher hydraulic loading of the secondary system at lower solids loading rates on the final clarifiers.

- The Authority intends to continue to pursue improved primary removals during wet weather flows by installing a baffle system in one of the primary clarifiers in order to beneficially change the velocity profile of the clarifier and improve the removal efficiencies through improved settling. A full scale pilot test is currently underway. An installation contract of a baffle in one primary clarifier has been awarded. Installation is anticipated by the end of the 2007 calendar year.

- Solids handling improvements. The Solids Handling Study completed in January 2000 identified improvements for the thickeners, digesters, dewatering and incineration. Implementation of these improvements along with additional SCADA capabilities is ongoing.

- In November of 2006 upgrades on four anaerobic digesters were completed. Upgrades include the cleaning of the four digesters, replacing the digester covers, adding high rate mixing pumps and mixing nozzles into each digester, cleaning of the sludge heat exchangers, modifying the hot water systems, adding new gas detection and digester gas monitoring instrumentation, adding automated feed and withdraw valves. Connection of the instruments to SCADA enabled automatic feeding and withdraw of sludge to the digesters, control of mixing pumps, monitoring of sludge flows to and from, cover heights, temperatures and gas flows. Connection to the SCADA system allowed the facility to shift from manual operation of the digestion process to remote operation.

- In January 2006, a new dewatering centrifuge was started. The centrifuge allowed production of a drier sludge cake resulting in a more consistent incinerator feed rate at lower moisture levels. Less moisture in the incinerator reduced stress related to evaporation reducing breakdowns and the need to operate two incinerators. Like the digesters, the centrifuge is also monitored from the SCADA system. Consistent, reliable operation of the centrifuge allows for remote operation of the dewatering process.

- The Authority intends to upgrade an incinerator in order to increase its capacity, improve emissions and equipment reliability, allowing improved effectiveness in maintaining the solids processing demands of the facility.

Collection System

- Update and application of the BSA's Storm Water Management Model (SWMM) to analysis of wet weather flows in the collection system. The BSA has installed flow measurement and sampling equipment throughout the collection system to support analysis of wet weather events using the SWMM model.

- Development of the combined sewer overflow (CSO) abatement plan in accordance with the Phase I Long Term Control Plan (LTCP) requirements specified in the United States Environmental Protection Agency's (USEPA) CSO Policy. The BSA's LTCP was submitted to the DEC and is currently awaiting DEC approval.

- Reduction in the number of active permitted CSOs from 58 to 53. These include Outfalls 030,034,041,043 and 045.

- Design of a floatable control facility for the Hamburg Drain CSO #017.

- Conduct a sewer separation study for the Cazenovia Creek CSO #035

- Evaluate alternative technologies to treat the Cornelius Creek, CSO #055 overflow such as Densedeg and Actiflow.

The wet weather-operating plan has been developed using a framework that supports inclusion of the findings from these ongoing work efforts. The specific procedures described in this plan are those currently in place for wet weather operation of the wastewater treatment plant.

2.0 CRITICAL COMPONENTS

In accordance with NYSDEC guidance, critical components are defined as processes that can significantly affect treatment of wet weather flow or can be significantly affected by wet weather flow. The BSA has identified the unit processes listed in Table 2-1 as the critical components of the Bird Island WWTP. For each unit process listed in Table 2-1, a specific wet weather operating objective is cited. These critical components are the unit processes for which operating guidelines are presented in Section 3.0.

TABLE 2-1

Buffalo Sewer Authority
Wet Weather Operating Plan
Critical Components – Bird Island Wastewater Treatment Plant

Unit Process	Wet Weather Operating Objective
Bar Racks	Maintain unrestricted flow through the bar racks. Prevent blockages.
Raw Wastewater Pumps	Sequence pump start/ stop and adjust speed of running variable-speed pumps to minimize hydraulic surges to downstream unit processes. Coordinate and communicate pump operational changes with settled wastewater pump station.
Screens	Prevent blinding of screen(s) that requires raw wastewater pump shutdown to clear.
Grit Removal	Maintain number of grit chambers in service as dictated by flow.
Plant Influent Flow Meters	Provide flow data essential to decision(s) to enter primary bypass or partial treatment mode of operation.
Primary Clarifiers	In normal or primary bypass mode of operation, remove settleable solids and floatables. In partial treatment mode, serve as the chlorine contact tank.
Diversion Channels	Provide headworks capacity of 600 mgd. Directs flow through the grit removal system

TABLE 2-1 (continued)

Buffalo Sewer Authority
Wet Weather Operating Plan
Critical Components – Bird Island Wastewater Treatment Plant

Unit Process	Wet Weather Operating Objective
Gate Chambers and Bypass Chlorination	Sequence opening/closing of river gates and Gate No. 17 to minimize hydraulic surges.
Settled Wastewater Pumps	Sequence pump start/ stop and adjust speed of running variable-speed pumps to minimize hydraulic surges to the activated sludge process. Coordinate and communicate pump operational changes with aeration station.
Activated Sludge Process	Manage settled wastewater flow distribution, sludge blanket levels and return activated sludge flows to avoid solids washout.
Effluent Chlorination	Provide adequate disinfection contact time by matching number of in-service contact tanks with plant flow. Maintain target chlorine residual.
Sludge Thickening	Maintain desired sludge float characteristics given varying ratio of primary to waste activated sludge.
Sampling and Samplers	Collect and analyze samples from Outfalls 001, 01A and 002 in accordance with the SPDES permit. Collect and analyze process control samples as necessary to control process operation. Refer to Appendix A1 for a Summary of the Buffalo Sewer Authority SPDGS Permit Limits. Refer to Appendix A-2 for Standard Operating procedures for sampling at Outfalls 001 and 01A.

3.0 WET WEATHER OPERATING GUIDELINES

Wet weather operating guidelines are presented in this section for each of the critical components of the Bird Island wastewater treatment plant. These guidelines outline tasks to be performed before, during and after a wet weather event. The wet weather operating guidelines are intended to serve as a quick reference during a wet weather event. The reader is referred to the BSA's published standard operating procedures and operations and maintenance manuals for more detailed discussion.

The wet weather operating guidelines are subject to periodic revision as the BSA continues implementation of a SCADA system and planned upgrades to several unit processes.

SECTION 1 - Bar Racks

1.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Bar Racks	3 – influent gates 2 - bar racks 2 - wet wells

1.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	All three influent gates normally maintained in the open position. Only closed to isolate equipment for repair.
Shift Supervisor	Operator	Check screenings hoppers. If full, write maintenance work order requesting hoppers be emptied in dumpster located in Screen and Grit building.
Shift Supervisor	Operator	Both bar racks in automatic operation making one run per hour consisting of three cycles per run.
Shift Supervisor	Operator	Monitor status of over travel alarms. Reset or notify shift supervisor, as appropriate.
Shift Supervisor	Operator	Visually inspect equipment. Confirm that cleaning rake is meshing with the bar rack.

<u>SECTION 1</u> **Bar Racks** (continued)

During Wet Weather Event		
Shift Supervisor	Operator	Monitor collection of screenings. Look for deviations in well level between the East and West wells. Visually inspect for differences in head across the bar racks.
Shift Supervisor	Operator	Increase schedule of runs and/or cycles or place cleaning rakes in continuous operation, as necessary.
Shift Supervisor	Operator	Monitor flows.
Shift Supervisor	Operator	Visually inspect equipment. Confirm that cleaning rake is meshing with the bar rack.
Shift Supervisor	Operator	If a severe blockage of the bar racks occur, reverse flow through the racks to clear the obstruction.
After Wet Weather Event		
Shift Supervisor	Operator	Monitor collection of screenings. Reduce schedule of runs and/or cycles as necessary to return to normal operating set points.
Shift Supervisor	Operator	Write maintenance work order requesting full hoppers be emptied in dumpster located in Screen and Grit building.
Shift Supervisor	I&E, Millwright	Repair any items that failed.

WHY DO WE DO THIS?
Protect downstream raw wastewater pumps from damage by large objects.
WHAT TRIGGERS THE CHANGE?
High flow rates.
WHAT CAN GO WRONG?
Cleaning rake over travel/overload. Cleaning rake does not mesh with bar rack and rides over collected screenings. Metal fatigue/failure of scraper blade that clears cleaning rake. Control failure. Power failure. Overflowing screenings hoppers.

SECTION 2 - Raw Wastewater Pumps

2.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Raw Wastewater Pumps	2 – variable speed pumps (120 mgd at max speed) 2 – dual speed pumps (60 mgd at low speed; 120 mgd at high speed) 2 – single speed pumps (120 mgd) 6 – pump discharge valves

2.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Normal operation of the wet well requires holding between a 10 to 13 foot level. The wet well high level alarm is set at 15 feet and the low level alarm is set at 8 feet.
Shift Supervisor	Operator	Raw Pump #3 or #4 (variable speed) is running in manual. To run in automatic, the variable speed pump has to be in remote and a pump sequence has to be chosen at the SCADA workstation. The pump speed set point is a wet well elevation of 11.5 feet. The speed set point, wet well high level alarm and low level alarm are adjustable by the shift supervisor.

During Wet Weather Event		
Shift Supervisor	Operator	As the well rises the variable speed pump increases to 100%. The flow increases from 50 mgd to 120 mgd.
Shift Supervisor	Operator	If the well continues to rise to 13 feet, notify primary, settled wastewater and aeration before starting a second pump. The required number of grit chambers must be online before a pump is added. If the wet weather event is characterized by a rapid increase in well levels and flow, go directly to a high-speed pump. For a less severe event, it may be possible to go to a low speed pump as the second pump on. Check that the corresponding screenings channel gates, both upstream and downstream, are fully open and the corresponding screen machine is started, and an additional grit chamber is added before starting the pump. With a second high-speed pump the flow ranges from 170 mgd to 240 mgd With a second low speed pump, the flow ranges from 120 mgd to 200 mgd. (bypassing of the primaries will occur. Monitor channel level in screen room below outfall 01A)
Shift Supervisor	Operator	When adding pumps, try to balance the number of pumps drawing from the East and West wells.
Shift Supervisor	Operator	If the well continues to rise to 13 feet, notify primary, settled wastewater and aeration before adding a third high-speed pump. Check that the corresponding screenings channel gates, both upstream and downstream, are fully open and the corresponding screen machine is started, and an additional grit chamber is added before starting the pump. The flow ranges between 290 mgd to 360 mgd. (Partial Treatment will be entered. Monitor channel level in screen room below outfall 01A))
Shift Supervisor	Operator	If the well continues to rise to 13 feet, notify primary, settled wastewater and aeration before adding a second variable speed pump, making sure that both variable speed pumps are running at the same speed. Check that the corresponding screenings channel gates, both upstream and downstream, are fully open and the corresponding screen machine is started, and an additional grit chamber is added before starting the pump. The flow ranges between 340 mgd to 480 mgd. (Plant will be in Partial Treatment. Diversion Channels will be added. Monitor channel level in screen room below outfall 01A)

SECTION 2 Raw Wastewater Pumps (continued)

Shift Supervisor	Operator	If the well continues to rise to 13 feet, notify primary, settled wastewater and aeration before adding a fifth pump on high speed, making sure both variable speed pumps are running at the same speed. . Check that the corresponding screenings channel gates, both upstream and downstream, are fully open and the corresponding screen machine is started, and an additional grit chamber is added before starting the pump. The flow ranges between 460 mgd to 600 mgd. (Plant will be in Partial Treatment. Diversion Channels in service. Monitor channel level in screen room below outfall 01A)
Shift Supervisor	Operator	As the well drops to 10 feet and both variable speed pumps are at minimum speed, notify primary, settled wastewater and aeration before stopping the fifth pump.
After Wet Weather Event		
Shift Supervisor	Operator	As the well drops to 10 feet and the variable speed pumps are at minimum speed, notify primary, settled wastewater and aeration before stopping the second variable speed pump.
Shift Supervisor	Operator	As the well drops to 10 feet and the variable speed pumps are at minimum speed, notify primary, settled wastewater and aeration before stopping the third pump.
Shift Supervisor	Operator	As the well drops to 10 feet and the variable speed pump #3 or 4 is at minimum speed notify primary, settled wastewater and aeration before stopping the second pump and switch to pump # 1 or 6 on low speed.
Shift Supervisor	Operator	As the well drops to 10 feet and the variable speed is at minimum speed, notify primary, settled wastewater and aeration before stopping pump #1 or 6(low speed).
Shift Supervisor	I&E, Millwright	Repair any failures. Investigate pump trip outs.

WHY DO WE DO THIS?
Minimize hydraulic surges to the secondary system, maximize the flow to the treatment plant while maximizing the storage capacity in the collection system and minimizing the use of CSOs. Optimize energy usage.
WHAT TRIGGERS THE CHANGE?
High flows trigger the change.
WHAT CAN GO WRONG?
Power failure. Pump fails to start. Pump not available because downstream screen is out-of-service. Pump kicks out. Screens blind necessitating pump shutdown. The sluice gates at discharge of grit channels may freeze.

SECTION 3 - Screens

3.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Screens	6 – mechanical screens 4 - conveyor belts 2 - screw compactors

3.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Make sure the number of screens in operation matches the number of in-service raw wastewater pumps.
Shift Supervisor	Operator	Make sure the rake mechanism operates automatically in timer mode.
Shift Supervisor	Operator	Make sure compacted screenings drop to floor and are loaded into dumpster.
Shift Supervisor	Operator	Inspect screens and channels for availability. Check conveyors and screw compactors.
During Wet Weather Event		
Shift Supervisor	Operator	Place additional screening units in service prior to start of additional raw wastewater pumps. Start screen in local to clear any debris in the channel. Return to auto mode once pump is running and screen is clear.
Shift Supervisor	Operator	Adjust timer settings for rake mechanism as necessary to remove screenings accumulation. Put rakes in continuous run mode if screenings loading is heavy.

Shift Supervisor	Operator	Monitor in-service screens to be sure they are not blinded.
Shift Supervisor	Operator	Inspect the conveyor belts to be sure they are collecting the screenings. Inspect discharge chutes from screw compactors for plugging.
After Wet Weather Event		
Shift Supervisor	Operator	Take screening units and/or conveyors out-of-service as raw wastewater pumps are stopped.
Shift Supervisor	Operator	Load accumulated screenings into dumpsters. Contact contractor to remove full dumpsters.
Shift Supervisor	Operator	If a screen has blinded and debris has accumulated ahead of the screen, then clean out channels.
Shift Supervisor	I&E, Millwright	Repair any failures.

WHY DO WE DO THIS?
Remove objects, usually floatables, larger than 0.75inch from the wastewater stream that could interfere with operation of downstream process equipment.
WHAT TRIGGERS THE CHANGE?
Starting additional raw wastewater pumps.
WHAT CAN GO WRONG?
Blinding of mechanical screen requires pump shutdown to clear. If channel water level is too high, rake will not cycle (motor submergence not allowed). Screw compactor over torques. High load on rake causes broken shear pin. Overflow will occur at Outfall 01A when the raw wastewater pump wet well elevation reaches 27 feet.

SECTION 4 - Diversion Channel

4.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Diversion Channel	3 – channels (east, west and bypass) 1 - piping system to deliver FE to bypass 3 – sets of stop logs 1 – stop log storage vault 7 – motor operated sluice gates

4.2 Wet Weather O & M Practices

WHO DOES IT?		\ WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Determine when to put in or take out diversion channels by flow or channel height.
Shift Supervisor	Operator	Monitor flows and screen room channel heights.
Shift Supervisor	Operator	Add RAW wastewater pumps and grit chambers as needed.

SECTION 4 Diversion Channel (continued)

During Wet Weather Event		
Shift Supervisor	Operator	Add diversion channels as needed by flow of approximately 390 mgd or to avoid flowing out 01A when level of channel in the screen room exceeds 14 ft, open gates 2, 3, 1, 4, and 7. .
Shift Supervisor	Operator	Increase schedule of runs and/or cycles or place cleaning rakes in continuous operation, as necessary.
After Wet Weather Event		
Shift Supervisor	Operator	As flows and channel levels decrease, close gates 2, 3, 1, 4, and 7.
Shift Supervisor	Operator	Pump down diversion channel.

WHY DO WE DO THIS?
To maximize flow to the treatment plant.
WHAT TRIGGERS THE CHANGE?
High flow rates.
WHAT CAN GO WRONG?
Equipment malfunctions such as a gate not responding or loss of a RAW wastewater pump. Grit chambers can fail.

SECTION 5 - Grit Removal

5.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Grit Removal	6 - grit channels 2 - diversion channels 8 - vortex grit pista chambers 4 - conveyor belts 4 - dumpsters

5.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Make sure the number of chambers in service is adequate as required by the influent flow (i.e., 1 for every 50-60 MGD). Note: grit chambers must be added prior to starting additional RAW pump
Shift Supervisor	Operator	Place diversion channels in service as flow and screen room channel heights dictate.
Shift Supervisor	Operator	Continue checking grit chambers for plugging.
Shift Supervisor	I&E, Millwright	Check all mechanical equipment. Make any necessary repairs.
During Wet Weather Event		
Shift Supervisor	Operator	Monitor in-service grit channels to be sure the collection systems are working. Make sure the screw conveyors are working.
Shift Supervisor	Operator	Regularly inspect grit hoppers for plugging.
After Wet Weather Event		
Shift Supervisor	Operator	Take grit chambers out of service as flow dictates. When taking chambers out of service, run purge cycle.

SECTION 5 - Grit Removal (Continued)

Shift Supervisor	Operator	Clean floors in grit room around belts, chambers, and dumpsters.
Shift Supervisor	Operator	Contact contractor to remove full dumpsters.
Shift Supervisor	Operator	If a grit channel has plugged, clean out the channel.
Shift Supervisor	Operator	Repair any failures.
Shift Supervisor	Operator	Record weight of disposed screenings and grit from contractor invoice.

WHY DO WE DO THIS?
Protect downstream moving mechanical equipment and pumps from abrasion and accompanying abnormal wear. Prevent accumulation of grit in aeration tanks and sludge digesters that can result in loss of usable volume.
WHAT TRIGGERS THE CHANGE?
Starting additional raw wastewater pumps.
WHAT CAN GO WRONG?
Plugging of pumps or lines, loss of mechanical seals. Loss of grit conveyors.

SECTION 6 - Plant Influent Flow Meters

6.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Plant Influent Flow Meters Diversion Channel Flow Meters Primary Influent Flow Meters	2 - magnetic flow meters 2 – ultrasonic flow meters 2 – ultrasonic flow meters

6.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Make sure flow meters operate properly.
Shift Supervisor	Operator	SCADA provides continuous monitoring and recording of flows.
Shift Supervisor	I&E, Outside Contractor	Calibrate meters at least annually.
During Wet Weather Event		
Shift Supervisor	Operator	Monitor flows recorded by SCADA.
After Wet Weather Event		
Shift Supervisor	I&E	Make any necessary repairs.

WHY DO WE DO THIS?
Plant influent flow measurement is critical to decision on when to begin primary bypass or partial treatment.
WHAT TRIGGERS THE CHANGE?
If all four primary clarifiers are in service, primary bypass begins when the plant influent flow exceeds 160 mgd. With one or more primary clarifiers out-of-service, primary bypass may begin at a lower flow. Partial treatment begins when plant influent flow exceeds the treatment capacity of the secondary system.
WHAT CAN GO WRONG?
Meter(s) lose calibration.
WHY DO WE DO THIS?
Plant influent flow measurement is critical to decision on when to begin primary bypass or partial treatment.

SECTION 7 - Primary Clarifiers

7.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Primary Clarifiers	4 - clarifiers 4 - skimmer arms & collector arms 2 – scum pit level sensors 6 – sludge grinders 6 – progressive cavity sludge pumps 1 – sludge flow meter

7.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Monitor flow rates to primaries.
Shift Supervisor	Operator	Periodically look at sample from bleeder line(s) to observe sludge characteristics.
Shift Supervisor	Operator	Ensure scum removal system is operating properly.
Shift Supervisor	Operator	Check skimmer and collector operation.
Shift Supervisor	Operator	If plant influent flow exceeds the capacity of the in-service primary clarifiers, then begin primary bypass mode of operation. Flows greater than the primary clarifier capacity will bypass primary clarifiers and go directly to settled wastewater pump station.
Shift Supervisor	Operator	Operate primary sludge pumps according to the schedule for normal operation (plant influent flow < secondary treatment capacity).
Shift Supervisor	Operator	Check sludge pump flow rates. Report any problems or abnormalities.
Shift Supervisor	Operator	Backflush any tanks as they plug.
Shift Supervisor	I&E, Millwright	Repair any malfunctions or equipment out of service.

During Wet Weather Event		
Shift Supervisor	Operator	Monitor plant influent flows. If desirable, change mode of primary sludge pump operation change from normal to partial treatment timer cycle when partial treatment mode is entered.
Shift Supervisor	Operator	In partial treatment, monitor primary influent flow.
Shift Supervisor	Operator	Periodically look at sample from bleeder line(s) to observe sludge characteristics. Look for air in sludge pump discharge. May be indication of plugged tank.
Shift Supervisor	Operator	Check PSF to Thickener flow meter. Change can indicate possible problems.
Shift Supervisor	Operator	Check flow rates from primary sludge pumps.
Shift Supervisor	I&E, Millwright	Repair equipment failures as needed.
After Wet Weather Event		
Shift Supervisor	Operator	Monitor plant influent and primary influent flows.
Shift Supervisor	Operator	Periodically look at sample from bleeder line(s) to observe sludge characteristics. Look for air in sludge pump discharge. May be indication of plugged tank.
Shift Supervisor	Operator	Return primary sludge pump timer cycle to normal mode when plant exits partial treatment mode.
Shift Supervisor	Operator	Take any plugged tanks out of service for clean out.
Shift Supervisor	I&E, Millwright	Repair any failures.

WHY DO WE DO THIS?
In normal or primary bypass mode of operation, the primary clarifiers remove settleable solids and floatables from up to 160 mgd of wastewater flow prior to secondary treatment. In partial treatment mode, in addition to removing settleable solids and floatables, the primary clarifiers function as chlorine contact tanks treating flows in excess of the secondary treatment capacity prior to discharge to the Niagara River.
WHAT TRIGGERS THE CHANGE?
Plant influent flows exceed secondary treatment capacity.
WHAT CAN GO WRONG?
Plugging of sludge withdrawal lines. Failure of sludge pump(s). Failure of collectors.

SECTION 8 - Bypass & Partial Treatment

8.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Gate Chamber No. 1	6 - sluice gates
Gate Chamber No. 2	2 - butterfly gates 1 - sluice gate
Outfall Structure	2 - sluice gates
Partial Treatment Chlorination	2 – 396 gph sodium hypochlorite pumps 2 – 3,000 gallon sodium hypochlorite storage tanks

8.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Make sure all gates are operational
Shift Supervisor	Operator	Check on sodium hypochorite levels and pumps.
Shift Supervisor	I&E, Millwright	Make any necessary repairs.
During Wet Weather Event		
Shift Supervisor	Operator	When the plant influent flow exceeds the primary clarifier capacity, enter primary bypass mode. Maintain Gate No. 20 in the fully open position. Gate No. 17 is fully open, Butterfly gates No. 15 and 16 are operated to control the primary influent flow to the primary clarifier capacity. Flows in excess of the primary clarifier capacity bypass primary treatment via gates No. 15 and 16.
Shift Supervisor	Operator	If the plant influent flow exceeds the secondary treatment capacity, then enter partial treatment mode.
Shift Supervisor	Operator	Manually start sodium hypochlorite feed pumps and monitor chlorine residual.

SECTION 8 - Bypass & Partial Treatment (continued)

Shift Supervisor	Operator	Modulate butterfly gates No. 15 and 16 so that secondary treatment capacity is not exceeded.
Shift Supervisor	Operator	Begin opening river gates No. 18 and 19 and closing gate No. 17.
Shift Supervisor	Operator	Approximately 15 minutes after initiating open/close sequence, balance flows to secondary system and partial treatment by modulating butterfly gates No. 15 and 16.
Shift Supervisor	Operator	Sample and analyze the discharge through the outfall structure in accordance with the SPDES permit.
Shift Supervisor	Operator	Monitor and record the flow receiving partial treatment.
After Wet Weather Event		
Shift Supervisor	Operator	When the plant influent flow drops below the capacity of the secondary treatment system, initiate return to primary bypass mode.
Shift Supervisor	Operator	Manually turn off the sodium hypochlorite pumps.
Shift Supervisor	Operator	Close river gates No. 18 and 19 and open gate No. 17.
Shift Supervisor	Operator	Begin adjusting butterfly gates No. 15 and 16 to balance flows to the primary clarifiers and secondary treatment. Flows in excess of the primary clarifier capacity will continue to bypass primary treatment.
Shift Supervisor	Operator	When the plant influent flow is less than the primary clarifier capacity, return to Normal Mode. Gate No. 20 is in the fully open position, gate No. 17 is fully open, butterfly gates No.15 & 16 are fully closed and the river gates No. 18 & 19 are fully closed.
Shift Supervisor	Operator	Check on sodium hypochlorite levels and pumps.

WHY DO WE DO THIS?
Minimize flow spikes to the secondary system. Maximize flow to the secondary system. Maximize the flow to the treatment plant, providing primary treatment for a part of the combined sewer flows, thus minimizing the overflows in the collection system.
WHAT TRIGGERS THE CHANGE?
Primary bypass mode is triggered when plant influent flows exceed 160 mgd. Partial treatment mode is triggered when plant influent flows exceed secondary treatment capacity.
WHAT CAN GO WRONG?
Sodium hypochlorite pump failure. Valve/gate failure.

SECTION 9 - Settled Wastewater Pumps

9.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Settled Wastewater Pumps	4 - variable speed pumps (120 mgd at maximum speed) 1 - constant speed pump (120 mgd) 2 - wet wells

9.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Supervisor	Operator	Normal operation of the wet well requires holding between a 19 to 24 foot level. SWW pumps will be started based on an increase in flow as measured by the plant influent flow meters or on the wet well reaching a high alarm level. The high alarm level can be adjusted at the SCADA workstation by the shift supervisor.
Shift Supervisor	Operator	At flows below 140 mgd, one variable speed pump is running. A second variable speed pump is added when flow exceeds 140 mgd or the well level reaches 24.5 ft. When another pump is called to run, the operator must notify Aeration that another pump is being put into service. The pump speed is adjusted to maintain the wet well level set point of 22 feet. The wet well level set point can be adjusted at the SCADA workstation by the shift supervisor.

SECTION 9 - Settled Wastewater Pumps (continued)

During Wet Weather Event		
Shift Supervisor	Operator	When in automatic mode, select pump sequence on whether both wet wells or only one wet well is available.
Shift Supervisor	Shift Supervisor	Notify SWW operator when Partial Treatment Mode is activated.
Shift Supervisor	Operator	Raw wastewater pump operator will notify settled wastewater pump station operator when a raw wastewater pump is added. When flow measured by plant influent flow meters exceeds 140 mgd or the well level exceeds 24.5 feet, the next pump in sequence should be started. When another pump is called to run,.the operator must notify Aeration that another pump is being put into service
Shift Supervisor	Operator	When flow measured by the plant influent flow meters exceeds 250 mgd or the well level exceeds 24.5 feet, the next pump in the sequence should be started. When this pump is called to run, the operator must notify Aeration that another pump is being put into service./
Shift Supervisor	Operator	No more than three settled wastewater pumps should be operated on full speed at any one time.
After Wet Weather Event		
Shift Supervisor	Operator	When the plant influent flow drops below 230 mgd or the well level drops below 17.5 feet, the third pump should be stopped. The remaining two pumps will increase in speed to maintain the flow. The operator notifies Aeration the third pump is shutting down.
Shift Supervisor	Operator	When the plant influent flow drops below 125 mgd or the well level drops below 17.5feet, the second pump should be stopped. The operator notifies Aeration the second pump is shutting down.
WHY DO WE DO THIS?		
Minimize hydraulic surges to the secondary system. Maximize the flow to the treatment plant while maximizing the storage capacity in the collection system and minimizing the use of CSOs. Optimize energy usage.		
WHAT TRIGGERS THE CHANGE?		
Starting additional raw wastewater pumps (up to a maximum of three pumps).		
WHAT CAN GO WRONG?		
Pump fails to start. Power failure. Too high a well level (27 feet) will overflow primary tank weir.		

SECTION 10 - Activated Sludge Process

10.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Aeration	16 - influent flow control valves 16 - influent magnetic flow meters 2 - influent channels 16 - aeration tanks 16 - dissolved oxygen probes 16 - air flow transmitters 16 - air flow control valves 2 - 3,000 hp blowers 2 - 5,000 hp blowers 6 - MLSS channels
RAS/WAS Pumping	16 - RAS magnetic flow meters 16 - RAS flow control valves 2 - RAS wet wells 6 - RAS well level monitors 6 - RAS pumps rated at 40 mgd @ 26 ft TDH 4 - WAS pumps rated at 700 gpm @ 40 ft TDH Check this
Secondary Clarification	16 - secondary clarifier influent gates 16 - secondary clarifiers 16 - skimmer arms and collector arms 16 - secondary clarifier effluent gates 16 - sludge blanket level monitors 16 - telescopic sludge flow control valves 9- scum pumps

10.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Superintendent	Operator	Make sure all available clarifiers are in service.

SECTION 10 - Activated Sludge Process (continued)

Shift Superintendent	Operator	SCADA monitors sludge blankets in clarifiers. Maintain target blanket level of 0-1 foot. Check collector arms in clarifiers.
Shift Superintendent	Operator	SCADA monitors dissolved oxygen levels in the aeration tanks. Adjust blower inlet guide vane position as needed to maintain DO setpoint.
Shift Superintendent	Operator	Monitor settleability characteristics and sludge quality
		Automatic-remote control of flow distribution to aeration tanks and secondary clarifiers
Shift Superintendent	Operator	Inspect scum beaches
Shift Superintendent	Operator	SCADA monitors WAS flow rate. Flow rate set to maintain target MCRT. SCADA controls pump speed to maintain flow setpoint.
Shift Superintendent	Operator	SCADA monitors RAS flow rate. Flow rate typically set at 40 % of SWW flow. Add second RAS pump if needed to maintain flow setpoint.
Shift Superintendent	Operator	Monitor SWW flow (sum of aeration tank influent flow meters). Communicate with SWW station on number of pumps in service and anticipated addition of pumps.
During Wet Weather Event		
Shift Superintendent	Operator	Adjust flow distribution to aeration tanks and final clarifiers as necessary to control influent and effluent channel levels and balance flows.
Shift Superintendent	Operator	SCADA continues to monitor sludge blanket levels in the clarifiers.
Shift Superintendent	Operator	Adjust the telescopic valves to control blanket level and RAS wet well levels. If necessary, reduce flow to clarifier(s) with excessive blanket depth.
Shift Superintendent	Operator	Monitor RAS flow rate. Maintain target return rate. Add second pump if necessary to maintain target return rate.
Shift Superintendent	Operator	Monitor effluent quality from the secondary clarifiers

Shift Superintendent	Operator	Monitor SWW flow (sum of aeration tank influent flow meters). Communicate with SWW station on number of pumps in service and anticipated addition of pumps.
After Wet Weather Event		
Shift Superintendent	Operator	Return control of flow distribution to automatic-remote .
Shift Superintendent	Operator	Return control of RAS pump speed to SCADA.
Shift Superintendent	Operator	SCADA monitor DO levels. Manual DO readings are taken with a hand held meter twice per shift. Adjust blower inlet guide vane as needed to maintain setpoint.
Shift Superintendent	Operator	Monitor SWW flow (sum of aeration tank influent flow meters). Communicate with SWW station on number of pumps in service and anticipated shutdown of pumps.
Shift Superintendent	Operator	Adjust telescopic valves for blanket control in clarifiers, and RAS wet well levels. SCADA continues to monitor sludge blanket levels in the clarifiers.
_WHY DO WE DO THIS?		
Provide process stability. Avoid solids washout. Minimize hydraulic and loading surges. Optimize energy usage. Optimize operating costs.		
WHAT TRIGGERS THE CHANGE?		
Increasing pump delivery from in-service settled wastewater pumps and/or starting additional settled wastewater pumps.		
WHAT CAN GO WRONG?		
Solids washout. Poor flow distribution to aeration tanks and/or secondary clarifiers. Imbalance of sludge blankets. Instrument failure. Pump failure. Ice build-up on clarifier collector arms. Telescopic valve failure.		

SECTION 11 – Effluent Chlorination

11.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Effluent Chlorination	4 – influent gates 4– chlorine contact tanks rated at 90 mgd, each 4 – final effluent ultrasonic flow meters 3 – 5,000 gallon sodium hypochlorite storage tanks 1 – tank level monitor 3 – 528 gph metering pumps

11.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Superintendent	Operator	Make sure chlorine contact influent gates are operational. Typically, two chlorine contact tanks in service.
Shift Superintendent	Operator	Check on levels of sodium hypochlorite. If necessary, request delivery.
Shift Superintendent	Operator	Check pumps for proper operation.
Shift Superintendent	I&E, Millwright	Make any necessary repairs.
Shift Superintendent	Operator	Monitor chlorine residual with Hach kits every hour on the hour.
During Wet Weather Event		
Shift Superintendent	Operator	Monitor pump feed rate.
Shift Superintendent	Operator	Run Hach test to determine chlorine residual levels in final effluent. Adjust pump speed and/or stroke length as necessary to maintain target residual. Increase frequency of chlorine residual measurement as necessary to control feed pumps.

Shift Superintendent	Operator	As SWW flow increases, increase the number of chlorine contact tanks in service. Keep a minimum contact time for disinfection.
After Wet Weather Event		
Shift Superintendent	Operator	Reduce number of chlorine contact tanks in service as the SWW flow decreases.
Shift Superintendent	Operator	Monitor chlorine residual in final effluent. Adjust pump speed and/or stroke length, as needed, to meet target residual. In case of pump failure, the ability to feed by gravity is available.
Shift Superintendent	Operator	Check on levels of sodium hypochlorite. Request delivery, if necessary.
Shift Superintendent	Operator	Clean contact tanks, if necessary.
Shift Superintendent	I&E, Millwright	Make any necessary repairs.
WHY DO WE DO THIS?		
Maintain adequate disinfection in accordance with SPDES permit requirements.		
WHAT TRIGGERS THE CHANGE?		
Increasing pump delivery from in-service settled wastewater pumps and/or starting additional settled wastewater pumps.		
WHAT CAN GO WRONG?		
Deteriorating effluent quality and/or solids washout resulting in increased chlorine demand. Difficulty maintaining target residual with rapidly varying flow and effluent quality. Floatables interfere with ultrasonic flow measurement.		

SECTION 12 - Solids Handling: Thickeners

12.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Air Flotation Thickeners	10 – D.A.F. thickeners 10 – air/water tanks 10 – Sludge Pumps 10 – Screw conveyers 10 – Upper collector arms 10 – Lower collector arms

12.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Superintendent	Operator	Typically, four (4) DAF's in service. Co-thickening primary and waste activated sludge.
Shift Superintendent	Operator	Check polymer day tank and metering pumps.
Shift Superintendent	Operator	Check sludge blanket – too heavy or too light? Adjust skimmer speed, polymer and/or air as needed.
Shift Superintendent	Operator	Check bottom collector daily. If necessary, run flights and screw collector. Check sample line for quantity and quality of solids.
During Wet Weather Event		
Shift Superintendent	Operator	Monitor sludge entering the DAF. Make adjustments to maintain 5% or better, solids. Adjust skimmer speed, polymer and/or air as needed.
Shift Superintendent	Operator	Run Rise Test to have a 7-inch rise per 16 to 21 seconds. Adjust as needed.

<u>SECTION 12</u> - Solids Handling: Thickeners (continued)

After Wet Weather Event		
Shift Superintendent	Operator	Continue to monitor the thickeners; maintain 5% or better, solids. As the rate drops adjust the polymer, air, collection rates accordingly.
Shift Superintendent	Operator	Add thickeners as necessary to handle additional solids collected in primary clarifiers.
WHY DO WE DO THIS?		
Maintain target thickened solids concentration with varying ratio of primary to waste activated sludge.		
WHAT TRIGGERS THE CHANGE?		
Entering partial treatment mode.		
WHAT CAN GO WRONG?		
Failure of upper/lower collector mechanism. Plugged polymer day tank. Rotameters require cleaning. Excess solids in subnatant can clog float in retention tanks. Loss of air supply.		

SECTION 13 - Sampling

13.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Sampling	1 - Plant influent composite sampler 1 - Plant effluent automatic composite sampler

13.2 Wet Weather O & M Practices

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
Shift Superintendent	Operator	Check automatic sampler units for proper operation. Sampler on, sample not overflowing.
Shift Superintendent	Operator	Replace automatic composite sample jugs at midnight.
Shift Superintendent	Operator	Take manual hourly composite samples as a backup to the automatic sampler.
Shift Superintendent	Operator	Repair old tubing, bad sample suction lines.
Shift Superintendent	Operator	Partial treatment sample bottles for Outfalls 001 and 01A are kept at the Shift Superintendent's office. If a set of bottles is not at Sludge Pump and/or Main Pump, then call the Shift Superintendent for bottles. Additional sample bottles can be found in the labeled refrigerator in the Administration Building foyer.
During Wet Weather Event		
Shift Superintendent	Operator	Monitor operation of automatic samplers.
Shift Superintendent	Operator	If plant goes into partial treatment, Collect grab samples at Outfall 001 and plant influent according to SPDES permit requirements. Outfall 001 sample collected at weirs of in-service primary tanks. Plant influent bacteriological sample collected from N-con sampler.

SECTION 13 – Sampling (continued)

Shift Superintendent	Operator	Take first partial treatment (Outfall 001) samples 3 hours after the bypass valves are opened. If the bypass event lasts less than 3 hours, take samples before going out of partial treatment. Take a sample every 4 hours after the first sample has been taken until partial treatment ends.
Shift Superintendent	Operator	Analyze a portion of Outfall 001 sample for total residual chlorine using a Hach colorimeter and record results.
Shift Superintendent	Operator	Operator labels and dates samples from Outfall 001 and plant influent. Operator fills out chain of custody. Operator informs Shift Supervisor that samples have been taken. Deliver samples to the laboratory. Sign chain of custody sheet.
Shift Superintendent	Operator	If Outfall 01A is activated, take sample at sink in the inlet room. A single grab sample once per event is required. Operator labels and dates samples. Operator fills out chain of custody. Operator informs Shift Supervisor that samples have been taken. Deliver samples to the laboratory. Sign chain of custody sheet.
Shift Superintendent	Operator	Normal business hours of the laboratory are 8 am – 4 pm Monday through Friday. After business hours or when no laboratory personnel are available, the samples should be left in the refrigerator in the Administration Building foyer and the chain of custody sheet in the mail slot labeled Partial Treatment Chain of Custody forms.
Shift Superintendent	Operator	If samples are collected between 4 pm and 1 am on a weekday or between 12 noon and 1 am on a weekend or holiday, the shift supervisor is responsible for calling in a chemist to set up the laboratory analyses.
After Wet Weather Event		
Shift Superintendent	Operator	Check automatic sampler units for proper operation.
Shift Superintendent	Operator	Repair old tubing, bad sample suction lines.
WHY DO WE DO THIS?		
Monitor water quality of discharges to the Niagara River via Outfalls 001, 01A and 002.		
WHAT TRIGGERS THE CHANGE?		
Sampling at Outfall 001 is initiated when the plant enters partial treatment mode. Sampling at Outfall 01A is initiated when an overflow occurs at this location.		
WHAT CAN GO WRONG?		
Power failures. Plugged sample lines. Emergency back up is manual collection and compositing of samples.		

4.0 CONTACTS

A list of contacts who can provide advice or assistance during a wet weather event is presented in Table 4-1.

TABLE 4-1

Buffalo Sewer Authority
Wet Weather Operating Plan

LIST OF CONTACTS

Agency	Title	Contact Information
Municipal		
Buffalo Sewer Authority Wastewater Treatment Plant Foot of West Ferry Street 90 West Ferry Street Buffalo, NY 14213	James Keller, Jr. Treatment Plant Superintendent	883-1820 (ext. 201) Cell phone 432-6058 Email: jkeller@sa.ci.buffalo.ny.us Home: 687-1389
	Roberta L. Gaiek, P.E. Treatment Plant Administrator	883-1820 (ext. 208) Cell phone 982-9483
	Angel Rivera Superintendent of Mechanical Maintenance	883-1820 (ext. 217) Cell phone 432-6059
	Gary Aures Associate Chemist Laboratory Director	For sampling, follow standard operating procedures. For emergencies, contact: Gary Aures: Home: 826-8220 Pager: 774-4506

TABLE 4-1 (continued)

Buffalo Sewer Authority
Wet Weather Operating Plan

LIST OF CONTACTS

Regulatory NYSDEC 270 Michigan Avenue Buffalo, NY 14203	 Robert Smythe Environmental Engineer I	 851-7070
Emergency [(1)] Follow the listed notification sequence in the event a worker, outside contractor or visitor requires emergency care.	 Call 911 Call both guard houses Call both bridges Call the Shift Superintendents	 Call 911 South Guard House – ext. 224 North Guard House – ext. 223 (If guard house extension is busy, press *21). West Ferry Street 851-5689 International 876-5670 Ext. 221/222 Pager no. 774-4501/774-4502 Cell phone 913-4246 Call on two-way radio
Services Bison (NaOCI supplier) Allied National Fuel Gas National Grid Quackenbush Company, Inc. 495 Kennedy Road Cheektowaga, NY 14227 Ferguson Electric 321 Ellicott Street Buffalo, NY 14203	 Dave Sydor Jack Sturm Dispatch 614-3385 or 3386 Larry Szalay Angelo Veanes	 895-2707 614-3333 Weekend 614-3333 #1 1-800-444-3130 1-800-867-5222 894-4355 852-2010

Notes:
1. Additional resources include the laboratory Chemical Hygiene Plan.

APPENDIX A-1

BUFFALO SEWER AUTHORITY SPDES PERMIT LIMITS

Buffalo Sewer Authority SPDES Permit Limits – Effective 7/1/2004

Final Effluent Discharge # 002

Conventional Pollutants:

Parameter	Frequency	Limit		Type
Flow	12 mo rolling avg	180 MGD		Continuous
BOD	30 d ave	30 mg/L	45,000 #/d	1/d 24 hr comp
BOD	7 d ave	45 mg/L	67,500 #/d	1/d 24 hr comp
TSS	30 d ave	30 mg/L	45,000 #/d	1/d 24 hr comp
TSS	7 d ave	45 mg/L	67,500 #/d	1/d 24 hr comp
Fecal Coliform	30 d GM	200/100ml		1/day grab
Fecal Coliform	7 d GM	400/100ml		1/day grab
PH	6 grabs/day	6.0 – 9.0		6/d grab
Chlorine Residual	6 grabs/day	2.0 mg/L daily max (no min)		6/d grab
Settleable Solids	6 grabs/day	0.3ml/L daily ave		6/d grab
Phosphorus	30 d ave	1.0 mg/L as P		1/d 24 hr comp
Ammonia	30 d ave	monitor, mg/L as NH3		1/mo 24hr comp
Nitrogen, TKN	30 d ave	monitor, mg/L as N		1/mo 24hr comp
Temperature	6/d grab	monitor		6/d grab

Notes:
Influent and Effluent sampling on all above except Fecal coliform, chlorine residual and phosphorus. Effluent values shall not exceed 15% of inflect values for BOD and TSS (pounds) for flows up to 180 MGD. (85% removal)
Pending development and approval of the Wet Weather Operating Plan (7/1/2000), the permittee shall attempt to use outfall 002 exclusively for all discharges up to a minimum of 300MGD.

Toxic Pollutants

Effluent Parameter	Frequency	Limit	Type
Phenol, Total	2/month	36.6 lbs/d	24 hr comp

Special Monitoring Requirements:
Quarterly influent and effluent scan for priority pollutants.
A one time, short-term, high-intensity monitoring program for Mercury consisting of sampling on 3 consecutive operating days. Results should be expressed in both concentration and mass.
Review and evaluation of the monitoring results may result in permit revisions to include additional monitoring requirements and/or effluent limitations.

Action Level Requirements (Type 1)

Effluent Parameter	Frequency	Limit	Type
Aniline	2/mo	30.0 lbs/d	24 hr comp

If action limits are exceeded, permit shall undertake a short-term high-intensity monitoring program for at least three operating days. If high levels are confirmed, the permit may be reopened for consideration of revised action levels or effluent limits.

Action Level Requirements (Type 2)

Effluent Parameter	Action level
Cadmium (T)	30.0
Chromium (T)	21.3
Copper (T)	42.1
Copper (dissolved)	monitor
Lead (T)	66.2
Nickel (T)	43.8
Zinc (T)	389.2
Zinc (dissolved)	monitor
Cyanide (T)	90.0
Bis (2-ethylehexyl) Phthalate	16.7

Minimum monitoring requirements are 2 samples/month, 24 hour composite. Results shall be reported in lbs/day.
If discharges of any substances exceed their respective action level:

1. **For four of six consecutive samples, or**
2. **For tow of six consecutive samples by 20% or more, or**
3. **For any 1 sample by 50% or more**

The permittee must undertake a short-term high-intensity monitoring program for at least three consecutive operating days. If levels higher than the action limits are confirmed, the permit may be reopened for consideration of revised action levels or effluent limits.

Toxicity Testing Program – Tier 1 Acute Test

Effluent toxicity testing (48 hr EC50 and 48 hr LC50 in % effluent for both a vertebrate and invertebrate specie) shall begin 4 years from the effective date of the permit (7/99) and last for one year. A final decision regarding additional monitoring and/or implementation of a toxicity reduction evaluation will be made by the DEC based on the results of the one year of testing.

Secondary Treatment By-Pass 001

Routine Monitoring Requirements

Parameter	Frequency	Type	Location
Flow, MG	Continuous	recorder/totalizer	Effluent
BOD, 5-day mg.L	1/event	Comp	Effluent
TSS mg/L	1/event	Comp	Effluent
Fecal Coliforms/100ml	1/event	grab	Influent and Effluent
Oil and Grease	1/event	grab	Effluent
Sett. Solids	1/event	grab	Effluent
Chlorine residual	1/event	grab	Effluent

Pending approval of the WWOP, all flows to the headworks capacity and not passed through 002 shall be passed through 001.
Flow shall be continuously recorded and totalized. Flow reported shall be the total discharged for the calendar month.
BOD and TSS samples shall be composites of grab samples, one taken every four hours.
Grab samples shall be taken every 4 hours during each event.

Headworks By-Pass 01A

Routine Monitoring Requirements

Parameter	Frequency	Type	Location
Flow, MG	1/event	estimated	Influent
BOD, 5-day mg/L	1/event	grab	Effluent
TSS mg/L	1/event	grab	Effluent
Oil and Grease	1/event	grab	Effluent
Sett. Solids	1/event	grab	Effluent

This outfall is for emergency use only.

APPENDIX A-2

STANDARD OPERATING PROCEDURES
BSA TREATMENT PLANT SAMPLING PROGRAM

SOP No.	Revision No.	Effective Date	Page
SA-EMERG	2	AUG 23 2006	Page 1 of 3

Title: Sampling Procedure for Emergency Disruption of Service

Reviewed and Approved By:	Signature	Date
G. Aures/Author	Gary T. Aures	8/23/06
D. Glab/QA Coordinator	Deborah M. Glab	8/23/06
G. Aures/Lab Director	Gary T. Aures	8/23/06
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	Dawn M. Panebianco	8-23-06
	[illegible]	8-23-06
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	[illegible]	9-10-06
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QA Coordinator

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6.1.1 Scope and Application

This procedure applies to an emergency situation where a disruption of service has occurred. A disruption of service is defined as any set of circumstances that result in a loss of flow to the secondary treatment plant outflow 002. The sampling plan that is outlined here applies to wastewater flows through the overflow outfall 01A or through bypass outfall 001.

6.1.2 Worst Case Scenario

Loss of electrical power with discharge of chlorinated raw sewage through overflow outfall 01A (Screen Room)

6.1.2.1 Sampling

6.1.2.1.1 Hourly grabs. One gallon of chlorinated raw sewage in one gallon plastic bottle.

6.1.2.1.2 Every two hours take an additional sample for bacteriological analyses in bacti bottle.

6.1.2.2 Analyses

6.1.2.2.1 **Operator**
Hourly chlorine residual.

6.1.2.2.2 **Laboratory**

- *Hourly* pH, Settleable Solids.
- *Every two hours,* fecal coliform.
- *Every four hours,* take two liters from gallon container and preserve for Grease and Oil analyses.
- *Composite per event,* not to exceed 24 hours, analyzed for BOD and total suspended solids.

6.1.3 Second Worst Case Scenario
Primary treatment only and discharge of chlorinated primary effluent through bypass outfall 001.

6.1.3.1 Sampling

6.1.3.1.1 Hourly grabs. One gallon of chlorinated raw sewage in one gallon plastic bottle.

6.1.3.1.2 Every two hours take an additional sample for bacteriological analyses in bacti bottle.

6.1.3.1.3 Every four hours take a bacteriological sample at Main Pump.

6.1.3.2 Analyses

6.1.3.2.1 **Operator**
Hourly chlorine residual.

6.1.3.2.2 **Laboratory**

SOP No. SA-EMERG	Revision No. 2	Effective Date AUG 23 2006	Page Page 3 of 3

- *Hourly* pH, Settleable Solids.
- *Every two hours*, fecal coliform.
- *Every four hours*, take two liters from gallon container and preserve for Grease and Oil analyses. Analyze bacteriological sample from Main Pump.
- *Composite per event*, not to exceed 24 hours, analyzed for BOD and total suspended solids.

6.1.4 Sampling containers and chlorine analyzer. (Both scenarios)

6.1.4.1 Sufficient sample bottles for a 6 hour event will be left at Main Pump and will be labeled "EMERG EVENT – MP"

6.1.4.2 Sufficient sample bottles for a 6 hour event will be left at Sludge Pump and will be labeled "EMERG – SP"

6.1.4.3 A calibrated Hach chlorine colorimeter will be left with sufficient reagents for a 24 hour event, at both Main Pump and at Sludge Pump.

6.1.5 Staffing. (Both scenarios)

6.1.5.1 The laboratory will be staffed as needed during the event depending on the severity and the length of the event.

6.1.5.2 The Laboratory Director will be on call (pager # 774-4506) 24 hours / day.

SOP No.	Revision No.	Effective Date	Page
SA-MPUMP	3	AUG 23 2006	Page 1 of 6

Title: Sampling Procedure for Main Pump Station

Reviewed and Approved By:	Signature	Date
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G. Aures/Lab Director	Gary T. Aures	8/23/06
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	[illegible]	9-5-06
	[illegible]	9-10-06
	[illegible]	9-11-06

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QA Coordinator

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6.2.1 Scope and Application

This procedure applies only to samples taken at the Main Pump Station. Samples are taken to satisfy requirements of SPDES Permit #NY0028410 issued to the Buffalo Sewer Authority effective July 1, 1999. Samples are also taken to determine the efficiency of the treatment process. Additional special sampling may be required occasionally. In the event of special sampling, instructions will precede the time of sampling.

6.2.2 Samples

6.2.2.1 RAW Auto Composite

The RAW auto composite sample is an automatic flow composited sample of plant influent. The sampling point is located in the wet well at 40 to 60% height of water level. This location is in compliance with EPA guidelines and is positioned to collect a representative portion of the incoming waste stream. An automatic N-Con sampler which is located in the sample room on the first floor of Main Pump collects a flow determined portion of the stream and deposits the portion into a 2.5 gallon plastic jug. This sample is required by the BSA SPDES permit and is used to determine removal of pollutants.

6.2.2.1.1 Equipment Needed

6.2.2.1.1.1 One 2.5 gallon plastic jug labeled "RAW – Auto M,W,F" for samples collected Monday, Wednesday and Friday.

6.2.2.1.1.2 One 2.5 gallon plastic jug labeled "RAW – Auto T,Th,Sa" for samples collected Tuesday, Thursday, and Saturday.

6.2.2.1.1.3 One 2.5 gallon plastic jug labeled "RAW – Auto Sun" for samples collected Sunday.

6.2.2.1.2 Procedure

Sample bottles will be delivered by the laboratory every afternoon except Sunday. Sunday bottles are delivered on Friday along with the Saturday bottles. If a bottle is missing notify the laboratory immediately (ext. 230 or ext. 238) or the Shift Super.

6.2.2.1.2.1 At midnight, replace the partially full sample jug from inside the N-Con sampler with an empty, appropriately labeled sample jug. Be sure to place the drop hose inside the container so that the sample from the auto sampler is collected inside the jug.

6.2.2.1.2.2 Place the partially full sample container from the previous day inside the refrigerator in the sample room for collection by the laboratory.

6.2.2.2 RAW Manual Composite

The RAW manual composite sample is taken as a confirming sample or as a backup to the RAW auto composite sample. This sample is taken at the grates prior to the screens in the screen room. The sample must be taken in an active and flowing channel.

6.2.2.2.1 **Equipment Needed**

6.2.2.2.1.1 One 1 gallon plastic jug labeled "RAW – Manual M,W,F" for samples collected Monday, Wednesday and Friday.

6.2.2.2.1.2 One 1 gallon plastic jug labeled "RAW – Manual T,Th,Sa" for samples collected Tuesday, Thursday, and Saturday.

6.2.2.2.1.3 One 1 gallon plastic jug labeled "RAW – Manual Sun" for samples collected Sunday.

6.2.2.2.1.4 Dipper or pail with rope.

6.2.2.2.1.5 Graduated 250 mL cylinder.

6.2.2.2.2 **Procedure**

6.2.2.2.2.1 Each hour, for 24 hours, starting at midnight, collect a sample of plant influent from an active pre-screen channel by lowering a bucket or dipper into the channel. Take care when raising the sample to avoid scraping the sides, walls or grates of the channel so that no extraneous material falls into the sample container.

6.2.2.2.2.2 From each hourly sample collected, measure a volume in milliliters equivalent to half of the incoming flow. Pour the measured amount into the 1 gallon plastic composite jug labeled for the appropriate day. For example, if the flow equals 120 MGD at the time of the sample, then pour 60 mL of sample into the plastic jug for that hourly sample. Keep the composite jug in the refrigerator until it is picked up by the laboratory.

6.2.2.2.2.3 Fill out the chain of custody log (Form Q050). Enter the time each hourly portion of sample is collected for the 24 hour composite sample, enter the flow in MGD at the hour of collection and enter the volume of sample in milliliters taken for the composite. Measure the volume in inches of sample in the composite jug at the end of the shift.

6.2.2.2.2.4 Sign the chain of custody log at the end of each shift under "sample relinquished by".

6.2.2.2.2.5 Operators on the 8-4 shift and the 4-12 shift: sign under "samples received by" at the beginning of each shift. The laboratory will pick up the sample and the chain of custody sheet each morning except for Sunday. Saturday and Sunday samples and chains of custody will be picked up on Monday morning.

6.2.2.3 RAW Grab Samples

The RAW grab samples are individual samples of plant influent. The location of this sample is the same as the manual composite sample, which is the Screen room at the grates upstream of the screens. Each shift takes two grab samples. The times for these samples are: 1AM, 5AM, 9AM, 1PM, 5PM and 9PM. These samples are also required by the BSA SPDES Permit.

6.2.2.3.1 **Equipment Needed**

6.2.2.3.1.1 Six 2 liter plastic wide mouth bottles labeled "RAW" followed by the time (see above) and the day; M,W,F or Tu, Th, Sa or Sun.

6.2.2.3.1.2 Dipper or pail with rope.

6.2.2.3.2 **Procedure**

6.2.2.3.2.1 Every 4 hours, for 24 hours, starting at midnight, and at the times prescribed above, collect a sample of plant influent from an active pre-screen channel by lowering a bucket or dipper into the channel. Take care when raising the sample to avoid scraping the sides, walls or grates of the channel so that no extraneous material falls into the sample container.

6.2.2.3.2.2 Fill the appropriate 2 liter container about ¾ full and refrigerate.

6.2.2.3.2.3 Enter the time each grab sample is taken on the chain of custody sheet. The samples and the chain of custody sheet will be picked up by the laboratory.

6.2.2.4 RAW Bacti Sample

This sample is taken on the first Wednesday of each month. The laboratory will drop off a bacti bottle with the proper label. The bacti sample is used to calculate removal of coliform bacteria.

6.2.2.4.1 **Equipment needed**

6.2.2.4.1.1 One 250 mL sterile bacteriological sample bottle labeled "RAW 9AM".

6.2.2.4.2 **Procedure**

6.2.2.4.2.1 Fill the bacti bottle about ¾ full. Do not rinse or overflow the bottle, do not set the cap down. The sample may be taken from the collection basin at the top of the N-Con sampler. If the N-Con sampler is out of service then the sample should be taken at the same place as the RAW manual composite and the RAW grab samples.

6.2.2.4.2.2 Refrigerate the sample.

6.2.2.4.2.3 The sample and the chain of custody sheet will be picked up by the laboratory.

SOP No.	Revision No.	Effective Date	Page
SA-OF01A	4	AUG 23 2006	Page 1 of 2

Title: Sampling Procedure for Overflow Outfall 01A

Reviewed and Approved By:	Signature	Date
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D. Glab/QA Coordinator	Deborah M Glab	8/23/06
G. Aures/Lab Director	Gary J. Aures	8/23/06
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	Dawn M. Panebianco	8-23-06
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QA Coordinator

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6.3.1 Purpose

This section describes the method of sampling to be followed when the plant is discharging at the headworks bypass through outfall 01A.

6.3.2 Scope and Application

This procedure applies only to outfall #01A and is in compliance with SPDES Permit #NY0028410 (Permit) issued to the Buffalo Sewer Authority and effective July 1, 1999. The Permit requires grab samples to be taken once per event, regardless of the number of events per day. See attachment for Page 9 of Permit – Part 1. *This sampling procedure is meant to satisfy permit requirements and is not intended to replace routine process testing which the operator feels is necessary to establish the status of the process.*

6.3.3 Procedure

SOP No.	Revision No.	Effective Date	Page
SA-OF01A	4	AUG 23 2006	Page 2 of 2

Take overflow samples once during the bypass event.

Main Pump

1. Overflow sample bottles are kept at the Shift Superintendent's office. If a set of bottles are not at Main Pump, call SS for bottles.
2. The sample bottle used for this event is a 1 gallon jug with handle. Each bottle will be accompanied by a chain of custody sheet (See Form Q007 in Appendix B - a copy of Form Q007 may be attached to an uncontrolled copy of this SOP).
3. Take sample at sample sink in the inlet room. Take care not to scrape sides of sink or to collect unrepresentative solids. Fill gallon jug to a level between the two red lines drawn on the jug.
4. Label 1 gallon jug with time, date and initials in spaces given for that purpose.
5. Fill out chain of custody sheet completely.
6. Inform SS that sample has been taken.
7. If SS is to deliver sample to Laboratory, he must sign chain of custody sheet next to "Received by: ". Fill in date and time that operator or sampler has relinquished the sample (See attached example).

6.3.4 Safety

Take all necessary precautions to avoid contact with wastewater. Wear protective clothing and gloves when taking samples.

6.3.5 Attachments

1. Chain of custody Form Q007 (example)
2. Page 9 of SPDES Permit Part 1

SOP No.	Revision No.	Effective Date	Page
SA-PT001	4	AUG 23 2006	Page 1 of 2

Title: Sampling Procedure for Partial Treatment Outfall 001

Reviewed and Approved By:	Signature	Date
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D. Glab/QA Coordinator	Deborah M Glab	8/23/06
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6.4.1 Purpose

This section describes the method of sampling to be followed when the plant is in partial treatment and is discharging primary effluent through outfall 001.

6.4.2 Scope and Application

This procedure applies only to outfall #001 and is in compliance with SPDES Permit #NY0028410 (Permit) issued to the Buffalo Sewer Authority and effective July 1, 1999. The Permit requires grab samples to be taken every 4 hours per event, regardless of the number of events per day. See attachment for Page 9 of Permit – Part 1. *This sampling procedure is meant to satisfy permit requirements and is not intended to replace routine process testing which the operator feels is necessary to establish the status of the process.*

6.4.3 Procedure

Take partial treatment samples 3 hours after the bypass valves are opened. If the bypass event lasts less than 3 hours, take the samples before going out of partial treatment.

Sludge Pump

1. Partial treatment sample bottles are kept at the Shift Superintendent's office. If a set of bottles are not at Sludge Pump, call SS for bottles.
2. Each set of sample bottles for Sludge Pump contains a 1 gallon jug with handle, a bacteriological sample bottle with a sodium sulfite tablet and a chain of custody sheet (See Form Q007 in Appendix B - a copy of Form Q007 may be attached to an uncontrolled copy of this SOP).
3. Use plastic dipper to take sample at outfall conduit. Fill gallon jug to a level between the two red lines drawn on the jug.
4. Fill a bacti sample bottle to approximately ¾ full.
5. Analyze a portion of sample for total residual chlorine using a Hach colorimeter and record results.
6. Label 1 gallon jug and bacti sample bottle with time, date and initials in spaces given for that purpose.
7. Fill out chain of custody sheet completely.
8. Inform SS that sample has been taken.
9. If SS is to deliver sample to Laboratory, he must sign chain of custody sheet next to "Received by: ". Fill in date and time that operator or sampler has relinquished the sample (See attached example). Normal business hours for the laboratory are 8:00 AM to 4:00 PM, Mon. – Fri. After business hours or whenever there are no Laboratory personnel available, leave the samples in the Administration building foyer fridge and the completed Chain of Custody Sheet (Form Q007) in the mail slot labeled "Partial Treatment Chain of Custody forms". The mail slot is located on the wall next to the Laboratory office door.
10. Take a sample every 4 hours after the first sample has been taken. Example: Bypass valves are opened at 7PM. Take sample at 10PM. Take another sample at 2AM. Take another sample at 6AM. Bypass valves are closed at 7AM.

6.4.4 Safety

Take all necessary precautions to avoid contact with wastewater. Wear protective clothing and gloves when taking samples.

6.4.5 Attachments

1. Chain of custody Form Q007(example)
2. Page 9 of SPDES Permit Part 1

Sample Source	Code	Analyses	Type	Frequency	Reporting Deadlines	Notes
Plant Influent	RAW	BOD	24 hr. comp.	1/day	Analysis Complete	1, 3
		Total Susp. Solids	24 hr. comp.	1/day	Analysis Complete	1, 3
		TKN	24 hr. comp.	1/month	Analysis Complete	1
		Ammonia	24 hr. comp.	1/month	Analysis Complete	1
		pH	Grab	1am, 5am, 9am 1pm, 5pm, 9pm	Analysis Complete	1, 3
		Sett. Solids	Grab	1am, 5am, 9am 1pm, 5pm, 9pm	Analysis Complete	1, 3
		Total Coliform	Grab	1/month	Analysis Complete	9
		Phenols (Total), CN, Aniliine, Bis-2-EHP, Cd, Cr, Cu, Pb, Ni, Zn	24 hr. comp.	2/month	15th of following month	1
		Priority Pollutant Scan plus all aniline compounds		1/3 months	Feb, May, Aug, Nov	1
Primary Effluent	PFO	Total Susp. Solids	24 hr. comp.	1/day	Analysis Complete	3
Raw Sludge	PSF	pH	24 hr. comp.	1/day	Analysis Complete	3
		Total Solids	24 hr. comp.	1/day	Analysis Complete	3
		Volatile Matter	24 hr. comp.	1/day	Analysis Complete	3
Grit	Grit	Total Solids	Grab	1/day	Analysis Complete	3
		Volatile Matter	Grab	1/day	Analysis Complete	3
		TCLP	Grab	1/year	ASAP after Jan 1	7
Aeration Tank Influent	ATI	BOD	24 hr. comp.	1/day	Analysis Complete	3
		Total Suspended Solids	24 hr. comp.	1/day	Analysis Complete	3
		Ammonia-N	24 hr. comp.	2/week	Analysis Complete	9
		Nitrite-N	24 hr. comp.	As needed	Analysis Complete	9
		Nitrate-N	24 hr. comp.	As needed	Analysis Complete	9
Mixed Liquors	ML	MLSS	Grab	1/day/trough	Analysis Complete	3

Mixed Liquors (Cont.)	ML	Settled Volume, 30 min	Grab	1/day/trough	Analysis Complete	3
		SVI	Grab	1/day/trough	Analysis Complete	3
		Microscopic Exam	Grab	3/week/battery	Analysis Complete	8
		OUR	Grab	2/week/battery	Analysis Complete	8
		OCR	Grab	2/week/battery	Analysis Complete	8
		RR	Grab	2/week/battery	Analysis Complete	8
Clarifier Effluent	CFO	Ammonia-N	Grab	As needed	Analysis Complete	9
		Nitrite-N	Grab		Analysis Complete	9
		Nitrate-N	Grab		Analysis Complete	9
Final Effluent	FE	BOD	24 hr. comp.	1/day	Analysis Complete	1,3
		Total Susp. Solids	24 hr. comp.	1/day	Analysis Complete	1,3
		Phosphorus	24 hr. comp.	1/day	Analysis Complete	1,3
		TKN	24 hr. comp.	1/month	Analysis Complete	1
		Ammonia	24 hr. comp.	1/month	Analysis Complete	1
		Fecal Coliforms	Grab	6am	Analysis Complete	1,3
		pH	Grab	2am, 6am, 10am 2pm, 6pm, 10pm	Analysis Complete	1,3
		Sett. Solids	Grab	2am, 6am, 10am 12am, 4am, 8am 2pm, 6pm, 10pm 12pm, 4pm, 8pm	Analysis Complete	1,3
		Cyanide, Total	Grab	2/month	15th of following month	1,2
		Metals: Cd, Cr, Cu, Pb, Ni, Zn	24 hr. comp.	2/month	15th of following month	1,2
		Phenols (Total)	24 hr. comp.	1/month	15th of following month	1,2
		Bis(2-ethylhexyl) phthalate	24 hr. comp.	2/month	15th of following month	1
		Aniline	24 hr. comp.	2/month	15th of following month	1
		Priority Pollutant Scan	24 hr. comp.	4/year	Feb, May, Aug, Nov	1
		Biomonitoring	24 hr. comp.	As required by DEC	Quarterly	1,2

Return Activated Sludge	RAS	Total Susp. Solids Volatile Matter	24 hr. comp. 24 hr. comp.	1/day 1/day	Analysis Complete Analysis Complete	3 3
Thickener Influent	TFI	Total Susp. Solids	24 hr. comp.	1/day	Analysis Complete	3
Thickener Subnatant	TFO	Total Susp. Solids	24 hr. comp.	1/day	Analysis Complete	3
Thickened Sludge	TSF	Total Solids Volatile Matter	24 hr. comp. 24 hr. comp.	1/day 1/day	Analysis Complete Analysis Complete	3 3
Digester Sludge Digester Sludge	DIG#	pH Alkalinity Total solids Volatile Matter Volatile Acids ORP	Grab Grab Grab Grab Grab Grab	Each Dig./week or as required by Process	Analysis Complete Analysis Complete Analysis Complete Analysis Complete Analysis Complete Analysis Complete	3 3 3 3 3 3
Filter Feed	FFI	pH Total Solids Volatile Matter	24 hr. comp. 24 hr. comp. 24 hr. comp.	1/day 1/day 1/day	Analysis Complete Analysis Complete Analysis Complete	3 3 3
Filtrate Liquor	FFO	Total Solids	24 hr. comp.	1/day	Analysis Complete	3
Filter Cake	Cake East and Cake West	Total Solids Volatile Matter Metals (503) As, Be, Cd, Cr, Pb, Hg, Ni TCLP and Aniline series	24 hr. comp. 24 hr. comp. Grab 24 hr comp	1/day 1/day 1/belt /month 1/belt/cal. year	Analysis Complete Analysis Complete Semi-annually ASAP after Jan 1	3 3 4 7
Ash	ASH	Volatile Matter TCLP	Grab 1 year comp.	1/day 1year	Analysis Complete Jan 1st	3 7
Overflow	001A	BOD Total Susp. Solids Settleable Solids pH HEM	Grab Grab Grab Grab Grab	1/event 1/event 1/event 1/event 1/event	Analysis Complete Analysis Complete Analysis Complete Analysis Complete Analysis Complete	1 1 1 9 1
Partial Treatment	001	BOD	Comp	1/event	Analysis Complete	1

Partial Treatment (Cont.)	001	Total Susp. Solids	Comp	1/event	Analysis Complete	1
		Settleable Solids	Grab	1/ 4 hrs/event	Analysis Complete	1
		Fecal coliform	Grab	1/ 4 hrs/event	Analysis Complete	1
		HEM	Grab	1/ 4 hrs/event	Analysis Complete	1
		pH	Grab	1/ 4 hrs/event	Analysis Complete	9
Materials	Hypochlorite	Specific Gravity	Grab	1/truckload	Analysis Complete	10
	Polymer	Total Solids	Grab	As needed	Analysis Complete	10
Industrial Waste	IW #	BOD pH Total Susp. Solids Phosphates	24 hr. comp or Grab	Up to 6/week	Analysis Complete	11
		Metals, Organics, HEM		As schedule allows	Analysis Complete	11

Notes:

1. Discharge Monitoring Report (DMR), or required for SPDES compliance.
2. Priority Pollutant Summary Report
3. Facility Operations Report (formerly the BMW-88) excluding attachments
4. 503 Regs. Annual Summary
5. Compounds detected at or above detection limit must be reported in the Facility Operations Report (92-15-7).
6. Substance of Concern Summary Report.
7. TCLP Analyses summary (IW sends out samples and receives report from contracted lab).
8. Process Report, Weekly
9. Process data.
10. Materials Quality Control
11. Industrial Waste Report

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Appendix 8-2: BSA NFA Final

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Imagine the result

In association with

Buffalo Sewer Authority

NO FEASIBLE ALTERNATIVE EVALUATION FOR THE BIRD ISLAND WWTP

August 2, 2013

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Tables

Figures

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1. EXECUTIVE SUMMARY

The No Feasible Alternative (NFA) evaluation for the Buffalo Sewer Authority's (BSA's) Bird Island Wastewater Treatment Plant (WWTP) supports the preparation of the Long Term Control Plan (LTCP) for abatement of combined sewer overflows (CSOs).

The WWTP service area contains both sanitary sewer systems and combined sewer systems. The tributary municipalities are served by separate sanitary sewer systems while the BSA-owned system is predominantly combined. The Bird Island WWTP was designed to operate in three different modes as described below. Normally, all flow conveyed to the WWTP receives primary and then secondary treatment and is disinfected and discharged through Outfall 002. However the treatment capacity of the primary treatment process is less than the capacity of the secondary treatment process and once the capacity of the primary treatment process is exceeded, the plant enters "primary bypass mode" wherein the flow in excess of the primary treatment capacity is conveyed directly to the secondary treatment process and treated along with primary effluent. In primary bypass mode, flows which exceed the capacity of the primary system bypass the primary clarifiers and are sent directly to the secondary process. All plant flows receive secondary treatment, are disinfected and discharged through Outfall 002. When wet weather influent flows exceed the capacity of the secondary treatment process, the plant operates in "partial treatment mode". In partial treatment mode, the majority of the plant influent flow is conveyed directly to secondary treatment, disinfected and discharged through Outfall 002. Plant flow in excess of the secondary treatment capacity is conveyed to the primary clarifiers operating "in parallel" to secondary treatment. This excess flow undergoes primary settling and disinfection and is discharged through Outfall 001. Partial treatment mode was designed to maximize treatment of wet weather flows at the WWTP.

This NFA analysis was conducted for the WWTP to identify and evaluate feasible alternatives to provide a higher level of treatment for wet weather flows reaching the WWTP that currently do not receive secondary treatment while maintaining the plant existing sustained peak flow capacity of 560 MGD. The NFA analysis provides a description of the applicable state and federal regulations and policies, a summary of the existing treatment capacities, planned improvements to increase WWTP capacity, and the evaluation of alternatives to maximize treatment of flows.

The following sections document the results of the NFA analysis for the WWTP.

Section 2 – Regulations and Policies – This section identifies the regulations associated with CSOs and plant bypasses.

Section 3 – Existing Facilities - This section describes the existing WWTP wastewater treatment facilities and the typical year influent flows.

Section 4 – Wet Weather Capacity Evaluation – This section summarizes the treatment capacities of the existing primary and secondary treatment systems.

Section 5 – Wet Weather Flow Alternative Development and Screening – This section identifies additional alternatives evaluated at the request of the Agencies to provide additional treatment capacity for wet weather flows. While the BSA does not believe that such alternatives are necessary as part of the LTCP, it agreed to provide this evaluation as part of the LTCP approval discussions with the USEPA and NYSDEC. The BSA made clear at the time it agreed to perform these additional evaluations that adding a major treatment upgrade/expansion to the WWTP would require an extension of the implementation schedule in the proposed 2012 LTCP Update. Note that all of these alternatives are challenging from a technical, financial, and sequencing perspective. The feasible alternatives are presented in greater detail with descriptions, layouts, and capital and operations cost estimates. These alternatives are graphically shown in Figure 1-1 and further described below and within the body of the report.

These alternatives were evaluated in conjunction with the collection system alternatives developed for the LTCP to mitigate CSOs to ensure that the entire program costs and impacts are taken into consideration.

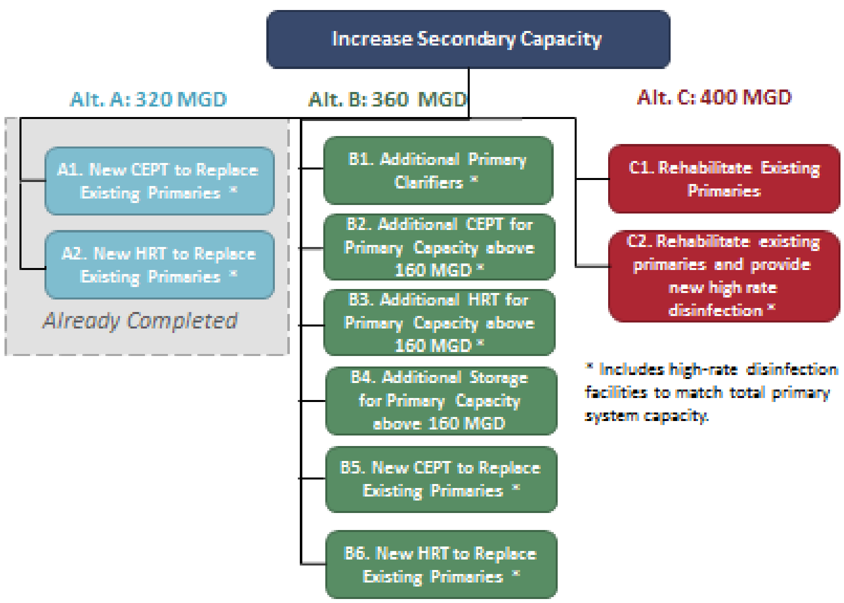


Figure 1-1: Summary of Evaluated Alternatives

Alternatives A1 and A2 considered the existing hydraulic capacity of the secondary treatment process of 320 MGD, which would require providing 240 MGD of primary treatment capacity. Two primary treatment alternatives were evaluated as described below.

- Alternative A1 – Replace existing primary clarifiers with a new 240-MGD chemically enhanced primary treatment (CEPT) process, followed by a 240 MGD high-rate disinfection system for CEPT effluent.

- Alternative A2 – Replace existing primary clarifiers with a new 240-MGD high-rate treatment (HRT) process, followed by a 240 MGD high-rate disinfection system for HRT effluent.

Alternatives B1 through B6 consider increasing the secondary treatment sustained peak flow capacity up to 360 MGD with the remaining 200 MGD treated in the primary treatment process. The alternatives vary by the means in which 200 MGD of primary treatment capacity is achieved.

- Alternative B1 – Construct an additional 40-MGD primary clarifier to achieve a total 200 MGD of primary treatment capacity in partial treatment mode, followed by a 200-MGD high-rate disinfection system. Chlorine addition at the head of the primary clarifiers would be discontinued.

- Alternative B2 - Install a 40-MGD CEPT process to be used in parallel with the existing primary clarifiers, followed by a new 200-MGD high-rate disinfection process. Chlorine addition at the head of the existing primary clarifiers would be discontinued.

- Alternative B3 - Install a 40-MGD HRT process to be used in parallel with the existing primary clarifiers, followed by a new 200-MGD high-rate disinfection process. Chlorine addition at the head of the existing primary clarifiers would be discontinued.

- Alternative B4 – Install a storage tank to store influent plant flows in excess of 520 MGD and return the stored flows to the WWTP after the wet weather event subsides for full treatment. In this treatment scenario, chlorine would continue to be added at the head of the primary clarifiers for disinfection of flows discharged through Outfall 001 during partial treatment.

- Alternative B5 – Install a 200-MGD CEPT process to completely replace the existing primary clarifiers, followed by a new 200-MGD high-rate disinfection process.

- Alternative B6 – Install a 200-MGD HRT process to completely replace the existing primary clarifiers, followed by a new 200-MGD high-rate disinfection process.

Alternatives C1 and C2 consider hydraulic and process improvements to the existing secondary treatment process to treat sustained peak flows up to 400 MGD in partial treatment mode, while maintaining the existing primary treatment process capacity of 160 MGD. The two alternatives are described below.

- Alternative C1 - Perform continued upkeep of the existing primary clarifiers to keep them in good working order for both primary settling and disinfection of up to 160 MGD.

- Alternative C2 – Implement improvements outlined as Alternative C1, but also install a new 160-MGD high-rate disinfection facility to disinfect primary effluent in partial treatment mode.

Table 1-1 summarizes the project costs for all alternatives.

Table 1-1: Summary of Estimated Project Costs, Annual O&M Costs, and 20-year life cycle costs (LCC)

Alternative		New Process Sizing (MGD)	CCT Sizing (MGD)	Prob Proj Cost, $M	Annual O&M, $M	20-year LCC, $M
A1	Primary CEPT	240	240	$ 64.9	$ 0.55	$72.3
A2	Primary HRT	240	240	$ 81.9	$ 2.75	$119.3
B1	Add 1 Primary Clar	40	200	$ 23.2	$ 0.29	$27.2
B2	Increm CEPT	40	200	$ 32.2	$ 0.40	$37.6
B3	Increm HRT	40	200	$ 31.7	$ 0.72	$41.6
B4	Storage	200	N/A	$ 121.6	$ 0.27	$125.3
B5	Primary CEPT	200	200	$ 60.6	$ 0.46	$66.9
B6	Primary HRT	200	200	$ 69.3	$ 2.69	$105.9
C1	Current + Sec. Treatment Improvements	160	N/A	$ 30.4	$ 0.28	$34.2
C2	Current + Sec. Treatment Improvements	160	160	$ 40.5	$ 0.34	$45.1

Each alternative was scored on a number of criteria which were weighted according to importance in the decision-making process, including:

- Process Performance
- Capital Cost
- Operations & Maintenance (O&M) Costs
- Design Complexity & Constructability
- Maintenance of Plant Operations (MOPO)
- Operability

These economic and non-economic evaluations resulted in the BSA identifying Alternative C2 as the preferred WWTP alternative for implementation because it:

- Maximizes secondary treatment of plant wet weather flows.
- Optimizes primary effluent disinfection.

- Has low life-cycle capital and annual O&M costs.
- Involves relatively straightforward construction with minimal impact to other plant treatment processes during construction.
- Can be implemented within the available land at the WWTP.
- Is similar to current treatment plant operations.

Alternative C2 includes the following improvements:

- Replacement of the sludge and scum collection systems in each of the four existing primary clarifiers.
- Replacement of the primary sludge pumps.
- Miscellaneous other repairs required to ensure that the primary clarifiers remain functional.
- Addition of a new chlorine contact tank and associated chemical storage and feed equipment downstream of the existing four primary clarifiers to provide a minimum 5-min detention time for high-rate disinfection for primary effluent flows up to 160 MGD when operating in the partial treatment mode.
- Construction of two new secondary clarifiers; one in each secondary system battery.
- Improving hydraulics through the sixteen existing secondary clarifiers by providing forty-six additional orifices in the peripheral influent channel of each secondary clarifier.
- Expanding the existing chlorine contact tank following the secondary treatment process by adding a new tank to disinfect a total secondary process effluent of 400 MGD, with a contact time of 15 minutes.

The estimated capital cost for the implementation of Alternative C2 is approximately $40.5 million. With annual additional O&M costs of $282,000, the 20-year life cycle cost was estimated at $44.3 million dollars. Given the high cost of this alternative, an adjustment of the proposed 2012 LTCP Update Schedule will be necessary if this treatment upgrade is to be included in the LTCP.

2. REGULATIONS AND POLICIES

2.1 Review of Applicable Regulations and Policies Regarding Peak Flow Management Alternatives

Until recently, many treatment plants conducted NFA evaluations to support bypassing of secondary treatment processes during peak flow events. However, earlier this year, the United States Court of Appeals for the Eighth Circuit held that the USEPA lacks the authority to regulate wet weather flow management practices on the POTW site and that the USEPA could not require NFA evaluations. Whether or not the likelihood that the bypass policy/NFA no longer applies, the BSA completed the NFA and recommended a feasible alternative to current primary bypass practices, and will install this alternative assuming Agency approval of the previously requested LTCP schedule changes. The evaluation included in this report demonstrates that the proposed treatment regime in the LTCP Update – as it may be amended with the C2 treatment plant upgrade alternative discussed above – is consistent with the CSO Policy requirements.

Step 1 – Documenting the Appropriateness of a CSO Bypass

Excessive flows conveyed to a treatment process can result in washout of that process. As stated in the US EPA CSO Control Policy: "For the purposes of applying this regulation to CSO permittees, "severe property damage" could include situations where flows above a certain level wash out the POTW's secondary treatment system."

A bypass may be warranted under circumstances where the flows conveyed to the POTW exceed the secondary unit process capacity. The first step of the NFA evaluation is to compare the flows reaching the POTW to the treatment capacity of the primary and secondary processes.

Step 2 – Identifying Feasible Alternatives

If it is determined that flows to the POTW exceed the existing secondary treatment process capacity, alternatives are then identified and evaluated to determine the feasibility of increasing secondary treatment capacity or providing a higher level of primary treatment. The CSO Control Policy states that the: "EPA further believes that the feasible alternatives requirement of the regulation could be met if the record shows that the secondary treatment system is properly operated and maintained, that the system has been designed to meet secondary limits for flows greater than the peak dry weather flow, plus an appropriate quantity of wet weather flow, and that it is **either technically or financially infeasible** to provide secondary treatment at the existing facilities for greater amounts of wet weather flow."

The CSO Control Policy also provides guidance for evaluating alternatives that minimize the adverse impacts of the bypass: "The feasible alternatives analysis should include, for example, considerations of enhanced primary treatment (e.g., chemical addition) and nonbiological secondary treatment. Other bases supporting a finding of no feasible alternatives may also be available on a case by case basis. As part of possible adverse effects resulting from the bypass, the permitting authority should also ensure that the bypass will not cause exceedances of Water Quality Standards (WQS)."

If the secondary treatment capacity is less than the wet weather flows through the headworks, a bypass around secondary treatment may be needed to protect the integrity of the treatment process.

The key requirement in the US EPA CSO Control Policy is that: "The CSO-related bypass provision in the permit should also make it clear that all wet weather flows passing the headworks of the POTW treatment plant will receive at least primary clarification and solids and floatables removal and disposal, and disinfection, where necessary, and any other treatment that can reasonably be provided."

This voluntary NFA evaluation for the BSA's Bird Island WWTP considers the above policies by:

- Estimating wet weather flows reaching the WWTP during wet weather conditions.
- Confirming that the secondary treatment process is operated properly and can receive flows with an acceptable wet weather peaking factor for the total combined influent flow at the WWTP.
- Identifying alternatives to provide additional secondary treatment capacity.
- Identifying alternatives for improved treatment and evaluating the benefit from those alternatives to address the two major pollutants of concern – TSS and fecal coliform.

3. EXISTING FACILITIES

3.1 Bird Island WWTP

The BSA owns and operates the Bird Island WWTP located at the foot of West Ferry Street in Buffalo, New York. The WWTP receives combined sewer flow from the City of Buffalo, as well as all or part of nine tributary communities. Discharge from the WWTP is to the Niagara River through the main WWTP outfall from the secondary system (Outfall 002) and primary treatment outfall (Outfall 001) only under wet weather flow conditions.

Additionally, the WWTP is equipped with outfall 01A upstream of the plant headworks designed and operated as an emergency bypass to protect the treatment plant and collection system during extreme flows exceeding the plant capacity and/or equipment or process failure.

The plant was originally placed into service in 1938 as a primary treatment plant with secondary treatment facilities constructed during the late 1970's in response to the Clean Water Act. The WWTP, which provides primary and secondary treatment, disinfection and solids handling was designed, and is permitted, for a 12-month rolling average flow of 180 MGD. Currently the Plant treats an annual average of approximately 130 MGD.

The wet stream treatment facilities include:

- Two manually-cleaned coarse bar racks
- Raw Wastewater Pump Station (RWWPS) containing six pumps to lift the raw influent to the plant headworks
- Six mechanically-cleaned fine bar screens for continuous removal of coarse solids from the influent wastewater
- Eight vortex grit tanks for removal of inorganic matter such as sand, cinders, and other small pieces of mineral matter
- Four primary settling tanks to remove organic and inorganic settleable solids
- Sodium hypochlorite system for primary effluent under partial treatment
- Settled Wastewater Pumping Station (SWWPS) containing five pumps to lift the primary effluent to the activated sludge system
- Ferric chloride addition to secondary influent for phosphorus removal
- Activated sludge system consisting of sixteen four-pass aeration tanks (also can be operated as eight, eight-pass tanks)
- Sixteen final clarifiers
- Four chlorine contact tanks
- Sodium hypochlorite facilities for disinfection of plant final effluent

Disinfected secondary effluent is discharged through Outfall 002. The effluent limitations for this discharge set forth in the current SPDES permit are 30 mg/L and 45 mg/L for the monthly and 7 day averages, respectively, for both TSS and BOD_5. The permit limitations for fecal coliform are a 30-day geometric mean of 200/100 ml and a 7-day geometric mean of 400 /100 ml. The permit also contains a maximum limit for chlorine residual of 2.0 mg/l daily maximum.

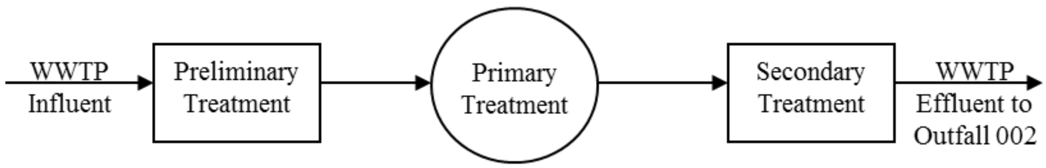
The SPDES permit allows all flows up to the plant headworks capacity and not passed through Outfall 002 to be discharged through Outfall 001 following primary clarification and disinfection. The permit requires that these flows be monitored for a range of parameters, including TSS, BOD_5 and fecal coliform. Similar to Outfall 002, Outfall 001 also has a chlorine limit of 2.0 mg/L daily maximum chlorine residual.

Figure 3-1 presents an aerial view of the plant and shows the main treatment units and wastewater flow through the plant.

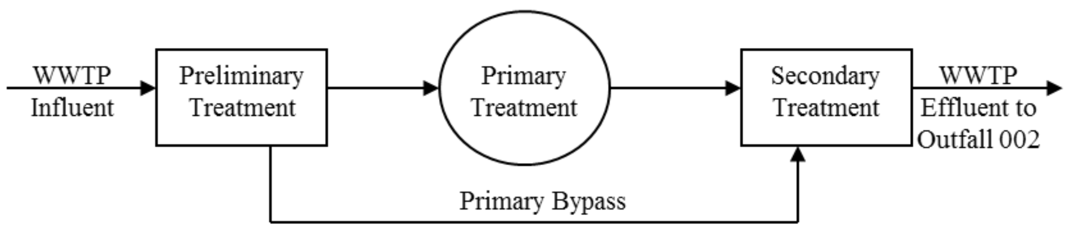
Figure 3-1: Bird Island WWTP Aerial View (source: Google Map)

The WWTP can operate in any of three operating modes depending on the influent flow as follows:

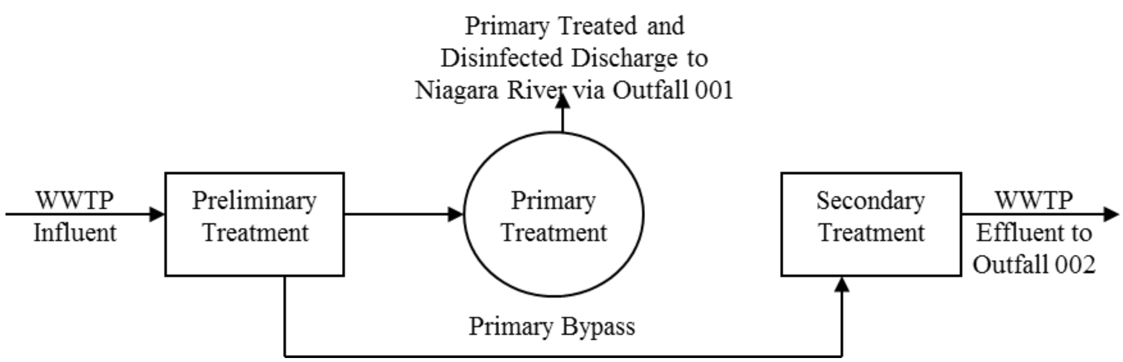
Normal Mode is used under dry weather and minor wet weather conditions, when the plant influent flow is less than or equal to 160 MGD. All flow receives preliminary, primary and secondary treatment, and disinfection. Plant effluent discharges through outfall 002.



Primary Bypass Mode is used under wet weather conditions when plant influent flow exceeds 160 MGD with all units in service. The flow passes through the headworks and receives preliminary treatment (screening and grit removal). Flows up to 160 MGD receive primary treatment. Flows in excess of 160 MGD bypass the primary clarifiers and is conveyed with along with primary effluent to the secondary treatment process. All flow receives secondary treatment and disinfection and discharges through outfall 002.



Partial Treatment Mode is used under wet weather conditions, when the plant influent flow exceeds the capacity of the secondary treatment system (~320 MGD). All flow receives preliminary treatment. Flow up to the secondary treatment capacity is directed to the secondary treatment process, treated, disinfected, and discharged through outfall 002. Flow in excess of the secondary treatment capacity receives primary treatment only and is disinfected and discharged via outfall 001. In this mode, the primary clarifiers also function as chlorine contact tanks for flows not receiving secondary treatment.



The WWTP's State Pollutant Discharge Elimination System (SPDES) permit includes the following requirements for wet weather flows:

- Outfall 001 (at the effluent end of the primary clarifiers) should be monitored for TSS and fecal coliform.

- Outfall 001 has a limit of 2 mg/L for maximum total residual chlorine (TRC).

- Per Footnote 1 to the SPDES Permit Outfall 001 monitoring table, "*Flows shall be managed in accordance with the Wet Weather Operations Plan. All flows up to the headworks capacity and not passed through outfall 002 shall be passed through outfall 001.*"

- Per Section VII - Best Management Practices for Combined Sewer Overflows for maximizing flow to POTW, *"…The treatment plant shall be capable of receiving and treating: the peak design hydraulic loading rates for all process units, i.e. a minimum of 450 MGD through the plant headworks; and a minimum of 300 MGD through the secondary treatment works during wet weather in accordance with the Wet Weather Operating Plan...".*

The 2007 BSA Wet Weather Operating Plan describes the three operating modes and identifies the critical components of the plant affected by wet weather flow. Each critical component – equipment or unit process – has a corresponding wet weather operating objective and a set of guidelines for tasks to be performed prior to, during, and after a wet weather event.

While the BSA currently uses all three operating modes as described above, a current hydraulic bottleneck at the primary bypass chamber upstream of the primary clarifiers currently prevents flows greater than approximately 270 MGD from reaching the secondary treatment process ***during partial treatment mode only***. During normal operation and primary bypass mode, the plant can convey up to 360 MGD of flow to the secondary process through this chamber. Improvements to this chamber are currently being implemented. Therefore, the alternatives in this NFA evaluation assume that these improvements have been completed. Additionally, this hydraulic bottleneck is believed to trigger occasional activations of plant emergency Outfall 01A upstream of the headworks fine screens during partial treatment mode events in response to significant storm events.

3.3 Review of Historical Plant Influent Flow

From January 2008 to January 2013, the pumped influent plant flow averaged 130 MGD. Daily total flows ranged from 74 MGD to a maximum of 461 MGD. Figure 3-2 shows the daily total flow frequency distribution for the historical plant influent flow dataset.

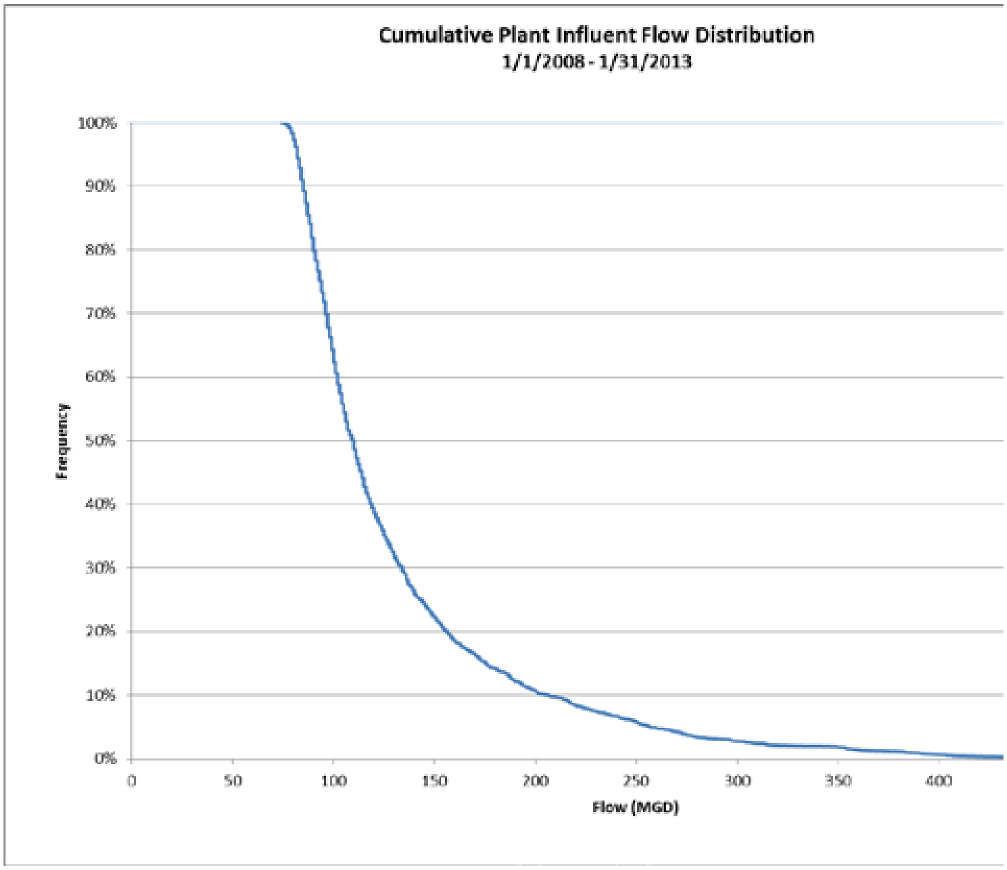


Figure 3-2: Plant Total Daily Influent Pumped Flow Distribution

3.4 Model-Predicted Typical Year Flows

A collection system hydraulic model was developed and used with the 1993 typical year precipitation dataset developed for the 2012 BSA LTCP Update, to project the typical year flows, including peak wet weather flows. The typical year hydrograph projects the hourly flows in the collection system that reach the siphon upstream of the WWTP. The flow information was analyzed to estimate the duration of time that certain flow thresholds ranges are exceeded in a typical year. This information is presented in Table 3-1.

Table 3-1: Percent of Typical Year Flows Conveyed to WWTP

Flow Rate (MGD)	% of Time at or Exceeds	Annualized Hrs at or Exceeds	Annualized Days at or Exceeds
100	94.67%	8,292	345.5
150	59.06%	5,174	215.6
200	13.86%	1,214	50.6
250	6.29%	551	23.0
300	4.41%	386	16.1
320	3.93%	345	14.4
350	3.21%	281	11.7
360	2.99%	262	10.9
400	2.37%	208	8.6
450	1.52%	134	5.6
500	0.89%	78	3.3
520	0.73%	64	2.7
550	0.57%	50	2.1
560	0.0%	0	0

The two flow distributions presented above show similar results for the infrequent occurrence of peak wet weather flows. It should be noted that Figure 3-2 is based on daily total flow while Table 3-1 is based on 15-min flow data.

4. WET WEATHER TREATMENT CAPACITY

This section summarizes the wet weather capacity for the primary and secondary treatment processes. Information used in this evaluation includes:

- Recent WWTP operating data (Jan 2008 – Jan 2013).
- Bird Island WWTP Wet Weather Capacity Evaluation, Malcolm Pirnie, Inc., May 2004 (the "2004 Report")
- Hydraulic Modeling results from 2013
- 1993 Modified Typical Year Data used in the 2012 LTCP
- Report of Primary Clarifier Studies at the Buffalo Sewer Authority Bird Island WWTP, CPE Services, Inc., July 2004

The BSA has demonstrated through operational changes and capital improvements, both completed and ongoing, that the plant is currently maximizing the treatment of wet weather flows using a combination of each of the three operational modes, including partial treatment once secondary treatment capacity is exceeded. Based on the original plant design, historical operations and review of the existing treatment processes, the primary and secondary processes have the following wet weather treatment capacities during partial treatment mode.

- 240 MGD in the primary treatment process. Note that, per the Agencies request, the BSA is willing to limit future peak flow capacity of the existing primary clarifiers to 160 MGD.
- 320 MGD sustained/360 MGD instantaneous in secondary treatment processes following completion of the primary bypass modification project mentioned previously.

Historically however, operation of the secondary treatment process in partial treatment mode has been limited hydraulically. In the existing primary bypass chamber, the elevation of the existing primary clarifiers is such that under partial treatment mode, the primary clarifiers have received flow of up to 240 MGD and the secondary system flow has been, at times, limited to 270 MGD. No problems are observed under normal and primary bypass modes. An ongoing project is currently modifying the configuration in the primary bypass chamber to address this hydraulic bottleneck and at its completion, will allow up to 400 MGD sustained flow to the secondary treatment process in partial treatment mode.

Improvements to optimize the treatment of flows at the WWTP were considered in conjunction with improvements to the collection system as outlined in the Recommended

Alternative UA2 in the BSA's 2012 LTCP Update. The goal was to identify projects which will provide the highest benefit-to-cost ratio system-wide. Therefore, the system-wide recommended alternative provides a mix of new wet weather treatment and storage facilities located within the collection system, a robust green infrastructure program, along with improvements at the plant as outlined in this NFA evaluation. Section 5 summarizes the evaluated alternatives that could potentially provide enhanced treatment during the relatively few days when the plant enters partial treatment mode. Additionally, Section 5 includes consideration of the regulatory agencies' request to evaluate other options for disinfection of primary effluent flows not receiving secondary treatment.

4.1 Flows Reaching the WWTP

To address comments made by the USEPA and NYSDEC about maximizing flows to the WWTP, hydraulic conditions in the influent interceptors were evaluated under existing conditions (using the Revised Baseline conditions model) as well as the Recommended Alternative in the 2012 LTCP Update. Peak flows in both interceptors (North and South), as well as in the WWTP influent, were compared to assess current operating conditions as well as proposed conditions within the North Relief sewer under the 2012 LTCP Update Recommended Alternative. Overflow volumes and timing of activation at CSO-055 (Cornelius Creek) were also evaluated to assess the impact of proposed alternatives on that overflow. CSO-055 was selected for evaluation as the CSO most sensitive to North Interceptor and WWTP capacity and operation. This evaluation confirms that the BSA is currently maximizing wet weather flows and volumes conveyed to the WWTP and that the proposed improvements in the 2012 LTCP Update Recommended Alternative increase the duration at which the WWTP treats flows greater than 520 and up to 560 MGD, delay the onset of upstream overflows, and significantly reduce overflow volumes and activations.

Figure 4-1 shows the peak hydraulic grade line (HGL) in the North Interceptor under Revised Baseline conditions for the largest typical year event, while Figure 4-2 shows the peak HGL for the largest typical year event for the 2012 LTCP Update Recommended Alternative (including the North Relief line). Under both scenarios, the capacity of the WWTP was modeled with influent flows of 560 MGD. Figures 4-1 and 4-2 show that the North Interceptor has capacity limitations that are evident upstream of the siphon near CSO-004. However, downstream of CSO-004 WWTP, peak flow limitations appear to have a greater impact on interceptor conveyance capacity as compared to pipe limitations. The addition of the North Relief line provides additional conveyance capacity for the North Interceptor system (up to 23 percent increase in peak flows conveyed to the WWTP for the largest typical year event).

Additionally, the North Relief line recommended as part of the 2012 LTCP Update Recommended Alternative extends the plant peak flow duration and reduces estimated CSO volumes to Black Rock Canal and Niagara River. Table 4-1 shows that the improvements within the 2012 LTCP Update Recommended Alternative increase the time that the WWTP can receive and treat higher flows when compared to Revised

Baseline conditions. For example, the time at which the WWTP receives and treats flows in excess of 520 MGD and up to 560 MGD, increasing from 1.2 days to almost 3 days.

Table 4-1: Cumulative Frequency Analysis of Peak Flows at the WWTP (WWTP Capacity = 560 MGD)

Flow Rate (MGD)	Revised Baseline		2012 LTCP Update Recommended Alternative (WWTP at 560 MGD)	
	Annualized Hrs at or Exceeds	Annualized Days at or Exceeds	Annualized Hrs at or Exceeds	Annualized Days at or Exceeds
500	41	1.7	78	3.3
520	28	1.2	64	2.7
550	23	0.7	50	2.1
560	7	0.3	20	0.8

As previously discussed in the BSA response letter dated March 1, 2013, any additional increase in the WWTP capacity was considered to be cost-prohibitive, and instead, the recommended 2012 LTCP Update Recommended Alternative UA2 considered a new standalone pump station and force main to convey additional wet weather flows to Bird Island for subsequent treatment at a new HRT facility. In order to estimate to what extent, if any, the plant headworks capacity limits the amount of flows delivered to the WWTP, the 2012 LTCP Update Recommended Alternative model was run with the WWTP capacity increased to 600 MGD. The model results, summarized on Table 4-2, indicate that increasing the WWTP capacity to 600 MGD provides little additional benefit, with the frequency of flows in excess of 560 MGD occurring only an additional 23 hours as compared to the WWTP at 560 MGD capacity.

Table 4-2: Cumulative Frequency Analysis of Peak Flows at the WWTP

Flow Rate (MGD)	Revised Baseline		Recommended Alternative (Plant at 560 MGD)		Recommended Alternative (Plant at 600 MGD)	
	Annualized Hrs at or Exceeds	Annualized Days at or Exceeds	Annualized Hrs at or Exceeds	Annualized Days at or Exceeds	Annualized Hrs at or Exceeds	Annualized Days at or Exceeds
500	41	1.7	78	3.3	79	3.3
520	28	1.2	64	2.7	66	2.8
550	23	0.7	50	2.1	50	2.1
560	***7***	***0.3***	***20***	***0.8***	***43***	***1.8***
600	0	0	0	0	13	0.5

The improved WWTP operation can also be evaluated by noting the projected operation of CSO-055. This CSO, at the most upstream point of the North Interceptor, is affected by a combination of North Interceptor capacity and WWTP capacity. This combination makes CSO-055 most sensitive to the operation of these facilities. Figure 4-3 shows the improvement to CSO-055 based on the combination of recommended improvements within the CSO-055 basin as part of the Recommended Alternative. The recommended improvements include raising the weir at SPP-1 by one foot, implementing green infrastructure in the tributary catchment, off-line storage tank at Military Road, and the construction of the North Interceptor Relief line. Taken together, these improvements, as shown in Figure 4-3, reduce the overall CSO volumes as well as move the time and flow rate at which the CSO discharges. In this example for the 5th largest storm event, CSO-055 discharges when plant flows are around 230 MGD under the Revised Baseline conditions. With the recommended improvements, CSO-055 does not discharge until plant flows reach nearly 510 MGD. While the proposed relief line does provide significant reductions at CSO-055 (over 30 percent decrease in annual volumes), increasing the plant capacity to 600 MGD would have resulted in only slightly moderate additional reductions in annual CSO volumes under the Recommended Alternative scenario. This implies that CSO-055 is affected by the system hydraulic grade line more so than by the plant flow limitations.

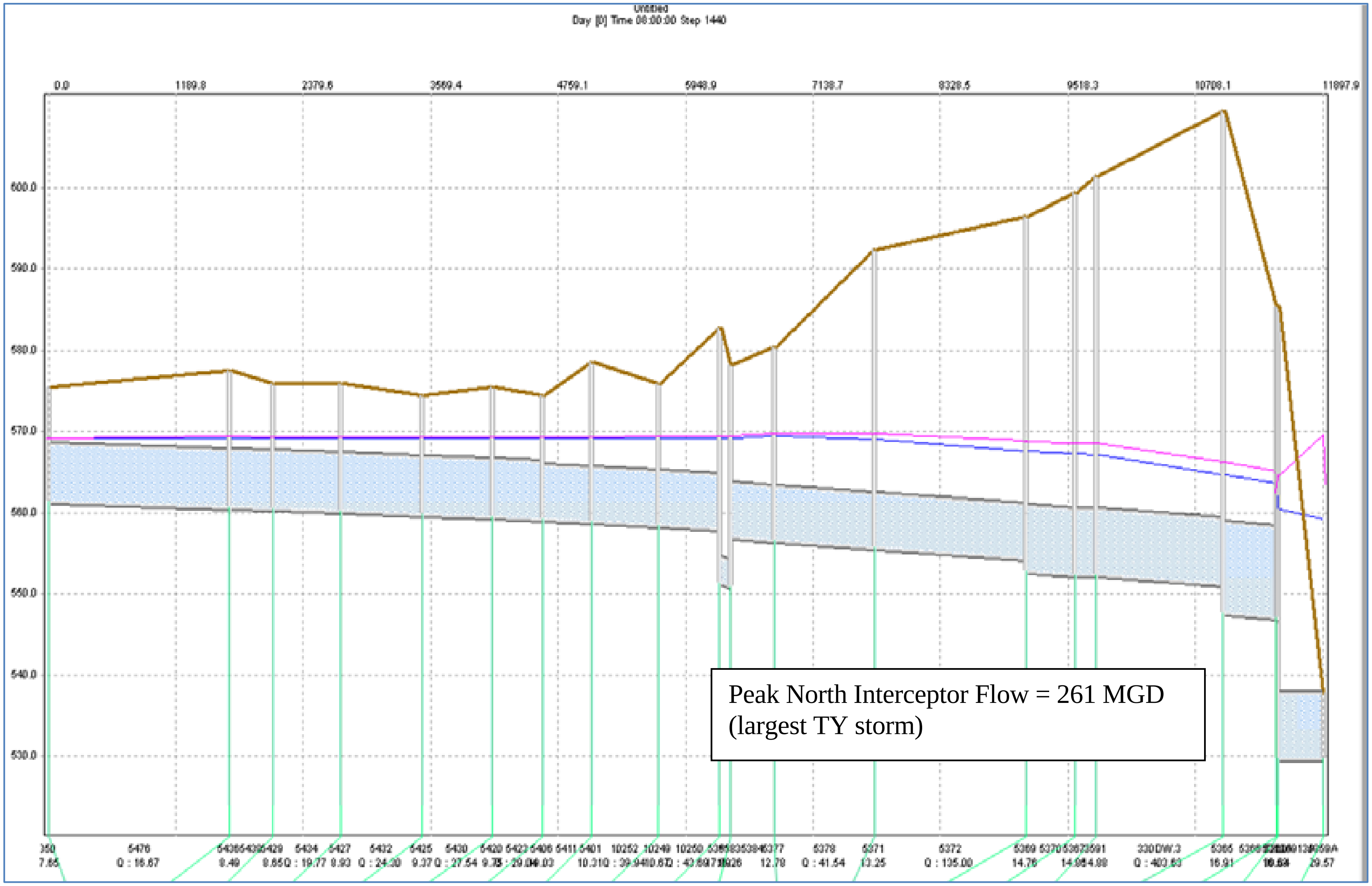


Figure 4-1: Peak HGL in North Interceptor under Revised Baseline Conditions

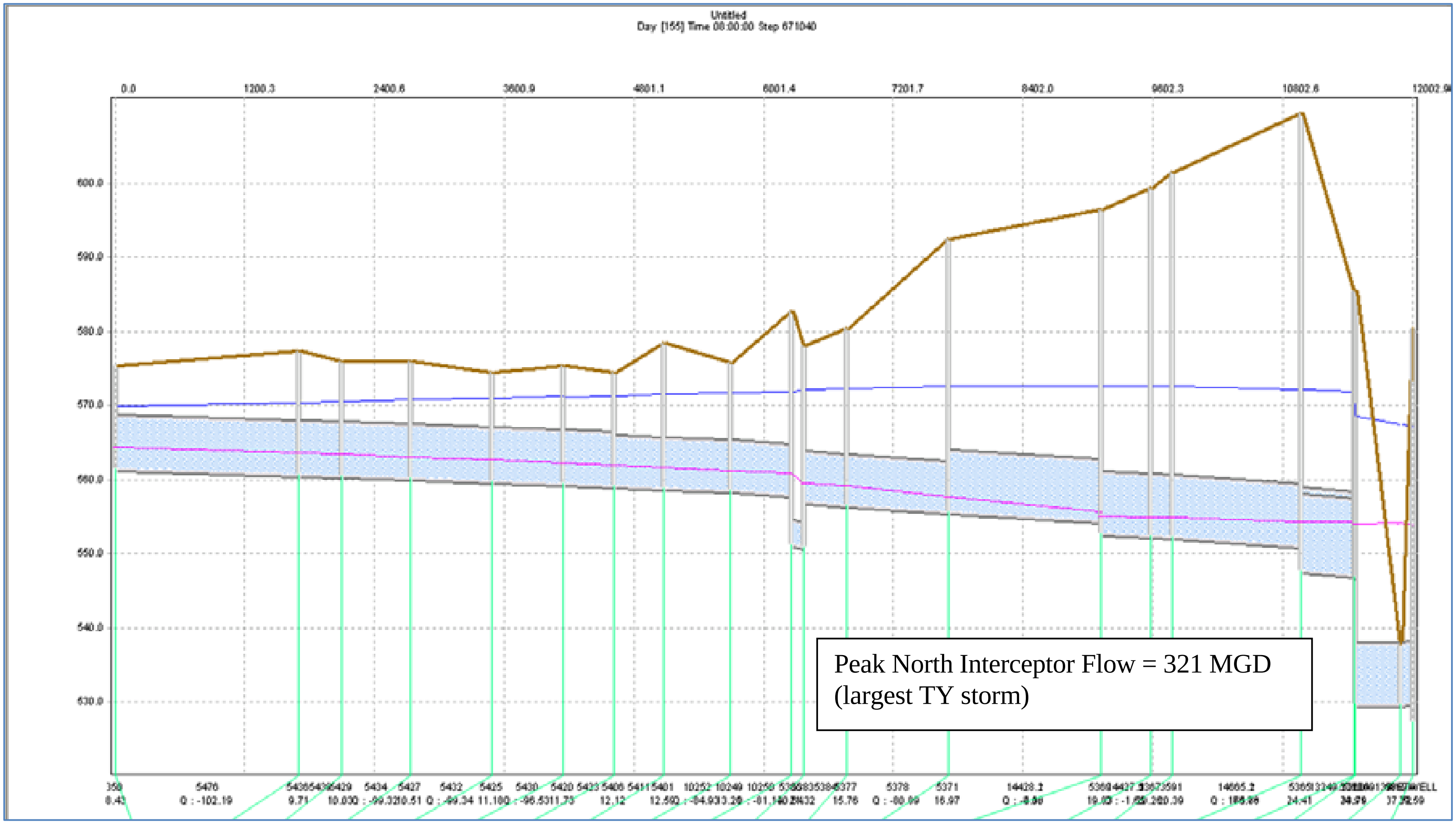


Figure 4-2: North Interceptor Peak Hydraulic Grade Lines for 2012 LTCP Update Recommended Alternative

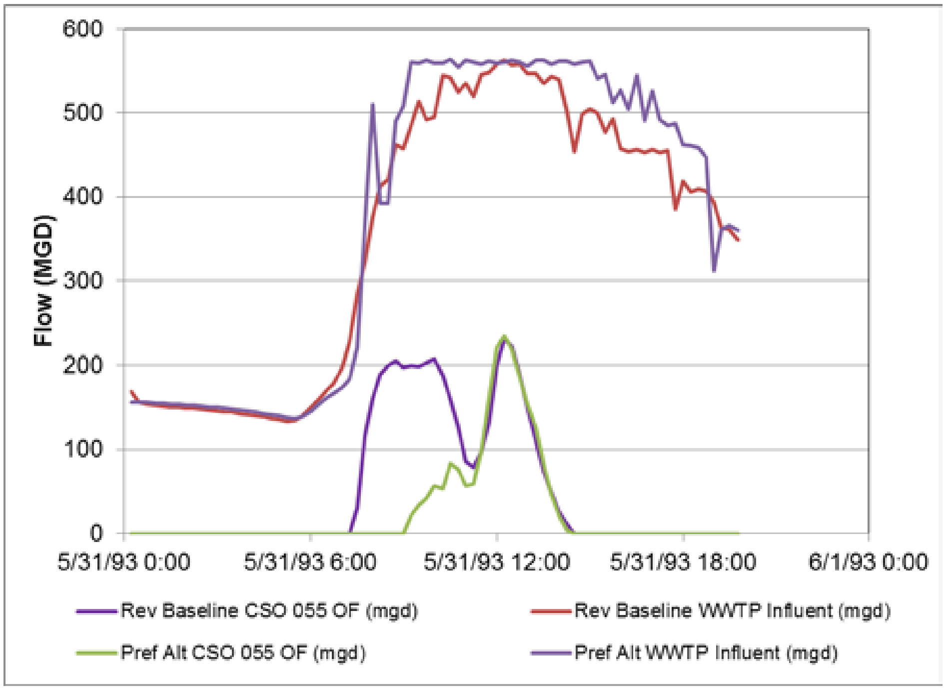


Figure 4-3: CSO 055 Discharge & WWTP Influent Flows for the 5th Largest Overflow Event (where Pref Alt data refers to the Recommended Alternative in the 2012 LTCP Update Revision)

4.2 Primary Treatment

Raw wastewater is pumped from downstream of the coarse bar screens by the pumps in the Raw Wastewater Pump Station (RWWPS) to the fine screen influent channel, where it flows by gravity through the fine screens, grit removal chamber, and to the primary influent chamber. The RWWPS contains six wastewater pumps that pump out of two wet wells (3 pumps per wet well). Two of the 120-MGD pumps operate at constant speed and two 120-MGD pumps are variable-speed. The remaining two pumps (dual-speed) each have a maximum rated capacity of 120 MGD at the full speed of 180 rpm and a capacity of 60 MGD at a reduced speed of 157 rpm. According to the WWTP's O&M manual, the pumps were designed to pump the entire capacity (563 MGD) of the intercepting sewer into the plant. The pumps are controlled via liquid level in the two wet wells.

Primary treatment facilities include four circular clarifiers that were constructed in the late 1930's. Recent rehabilitation projects include repair of concrete and sludge collectors in the early 1990's and replacement of the scum collection system in 2003. Physical characteristics of the primary clarifiers are shown in Table 4-3.

Table 4-3: Primary Clarifier Physical Characteristics

Characteristic	Units	Value	
		Each	Total
No. of units		-	4
Diameter	ft.	160	-
Side Water Depth	ft.	14.5	-
Area	sq. ft.	20,100	80,400
Volume	Mgal.	2.4	9.6
Weir length	ft.	503	2,010

4.2.1 Design Parameters for Primary Clarifiers

When the WWTP was designed, a maximum recommended surface overflow rate (SOR) for the primary clarifiers was 3,000 gallons per day per square foot (gpd/sf). This SOR translates to a maximum flow of 240 MGD to the primary clarifiers or 60 MGD per clarifier. However, the guidelines of the 2004 *Recommended Standards for Wastewater Facilities* (commonly called 'Ten States Standards,) reduced the recommended maximum SORs for primary settling tanks to 2,000 gpd/sf and the NYSDEC has recommended to the BSA that this SOR be used when considering the primary clarifiers. This SOR is equivalent to a hydraulic flow of 160 MGD to the existing clarifiers, or 40 MGD per clarifier, a decrease of 33 percent in the overall primary treatment process capacity.

4.2.2 Current Primary Treatment Performance

Raw wastewater and primary clarifier influent flow and wastewater statistics for the period from January 1, 2008 through January 30, 2013 were evaluated to assess current primary treatment performance. Table 4-4 summarizes raw wastewater and primary influent daily data.

Within this dataset, there were 306 days (or approximately 61 times per year) that partial treatment mode was activated with reported primary effluent discharge volumes ranging from 1 MG to 1,260 MG.

Table 4-4: Primary Clarifier Influent Flow
January 1, 2008 through January 30, 2013

	WWTP Raw Wastewater		Primary Clarifier Influent Flow	
Statistic	**Flow (MGD)**	**TSS (mg/L)**	**Partial Treatment Mode Not Activated (MGD)**	**Partial Treatment Mode Activated (MGD)**
Average	131	96	97	127
Max	521*	496**	187	242

Notes: * March 11, 2009
** June 21, 2011 at 314 MGD Average Raw Influent Flow

Influent flow per clarifier averaged 36 MGD per clarifier (SOR = 1,768 gpd/sf).

Primary clarifier TSS removal performance when partial treatment mode was not activated is summarized in Table 4-5. The data indicate that effluent TSS concentrations remain relatively constant over the entire range of SORs. Average TSS removal performance shows a slight decline as SOR increases but does not appear to be statistically or, more importantly, environmentally significant.

Table 4-5: Primary Clarifier Performance
January 1, 2008 through January 30, 2013

	< 1,500 gpd/sf (30 MGD / clarifier)			1,500 to 2,000 gpd/sf (30 to 40 MGD / clarifier)			>2,000 gpd/sf (40 MGD / clarifier)		
Statistic	Influent TSS mg/L	Effluent TSS mg/l	TSS Removal %	Influent TSS mg/L	Effluent TSS mg/l	TSS Removal %	Influent TSS mg/L	Effluent TSS mg/l	TSS Removal %
No. of Days from 2008 to Jan 2013	478			860			426		
Max	288 (1/24/10)	54	81%	416 (9/20/11)	78	81%	496 (6/22/11)	92	81%
Min	36 (12/21/09)	40	-11%[2]	22 (3/6/11)	20	9%	30 (3/7/2011)	26	13%
Average	96	52	46%	93	52	44%	93	56	40%

Notes:
1. Statistics shown are for days that partial treatment mode was not activated and exclude days when primary influent flow meters were not reading properly (approximately 3 percent of the total data period).
2. In this case, primary influent TSS is less than the effluent indicating little to no improvement in solids removal, most likely attributed to very dilute flow.

Primary clarifier effluent TSS for days that partial treatment
was not activated and days that partial treatment mode was activated for the period from January 1, 2008 through January 30, 2013 are shown in Table 4-6.

Table 4-6: Primary Clarifier Effluent Performance Comparison

January 1, 2008 through January 30, 2013

	Normal Operating Conditions	Partially Treated Flow	
	Primary Effluent TSS (mg/L)	TSS (mg/L)	BOD (mg/L)
Average	52	88	54
Max	254	344	124
Min	10	1	1

Note: Statistics shown exclude days when primary influent flow meters were not reading properly.

4.2.3 Primary Treatment Performance Investigations

Several investigations were undertaken by the BSA in the mid-2000s to evaluate the effectiveness and potential enhancements to primary treatment performance. The investigations included hydraulic testing, adding chemicals to the existing primary clarifiers for enhanced settling, and the installation of an energy dissipating baffle in one primary clarifier.

4.2.4 Hydraulic Characteristics Testing

The BSA retained CPE Services, Inc. in 2004 to evaluate the performance of the existing four primary clarifiers under high flow conditions. One of the primary clarifiers was subjected to an influent flow rate of 40 MGD and a second to a 60 MGD flow. Dye addition, vertical solids profiling, and drogue current measurements were then performed to evaluate the clarifier performance under the given flows and loads.

The clarifier evaluation indicated that:

1. The higher flow rate of 64 MGD per clarifier appears to limit the effectiveness of the primary clarifiers for TSS removal. Performance of the clarifier at 43 MGD resulted in better performance than the clarifier tested at 64 MGD.
2. Concentration currents and downward and outward velocities within the clarifiers limit the formation of a sludge blanket at higher flow rates.

3. The existing sludge collection mechanisms and effluent weir configuration were adequate for their particular functions.

CPE Services, Inc. made several recommendations to improve clarifier performance under higher flows, including the use of larger diameter center wells and separate energy-dissipating inlets to improve the distribution of flow and flocculation of wastewater solids. The report also noted that these improvements would likely be more effective if chemical addition was also employed. Testing of a sloped peripheral baffle supported from the outer wall was also recommended.

4.2.5 Full-Scale Primary Treatment Testing

The BSA performed testing on the addition of ferric chloride and polymer to one primary clarifier. However, testing results were mixed with no conclusive evidence to suggest that chemical addition significantly improved performance. However, with additional modifications to the existing clarifiers, as discussed in Section 4.1.6, the use of ferric chloride and polymer was again tried and it was found that 53 percent of TSS and 31 percent of BOD_5 was removed. Therefore, it appears that the use of chemicals plus additional improvements in terms of clarifier baffling did increase the performance of the clarifiers. This is most likely because the baffled inlet provides improved hydraulic mixing conditions for flocculation with the chemicals.

4.2.6 Full-Scale Baffle Testing

The BSA installed a Flocculating Energy Dissipating Well Arrangement (FEDWA™) in primary clarifier No. 2 in December 2007. Side by side testing of the FEDWA™-baffled primary clarifier and one without the baffle was performed and results reported in the WEFTEC 2010 proceedings (Applegate et.al). Testing was performed at a target SOR of 3,000 gpd/sf. The following activities were also performed:

- Computational fluid dynamics (CFD) modeling to project the hydraulic improvements
- Dye dispersion and velocity (drogue) testing to confirm the hydraulic improvements
- System performance data analysis of side-by-side testing of clarifiers with and without the baffle

The dye and drogue testing (dye and drogue) demonstrated that the FEDWA™ baffle improved performance and reduced the bottom velocity currents with reduced solids scour. The baffled inlet also provided better flocculation and settling. The data show that the baffled clarifier averaged higher TSS and BOD removals than the unmodified clarifier over four days of intensive sampling. Primary clarifier No. 2 achieved 5 percent to 20 percent greater TSS removal and 4 percent to 30 percent greater BOD removal at SORs between 2,000 gpd/sf and 2,500 gpd/sf, than observed in the unmodified clarifier. Additionally, the test results suggested that the baffled inlet resulted in a more concentrated underflow solids concentration. However, the BSA ultimately decided that the incremental benefit of adding the FEDWA™ baffle system to the remaining clarifiers was not worth the extra cost involved, and therefore, baffles were not installed in the remaining clarifiers.

4.2.7 Recent Hydraulic Modeling of the Primary Bypass Chamber

Historically, the primary bypass has been hydraulically limited to approximately 270 MGD of flow to the secondary treatment in the Partial Treatment Mode. The flow bottleneck became more apparent following a change in the Activated Sludge system from conventional activated sludge mode to step feed mode in May 2008. This change lowered the solids loading to the final clarifiers and removed hydraulic limitations of the secondary system during wet weather. It was realized that by operating in this mode, the secondary system could now process peak design flows of up to 360 MGD. However, only about 270 MGD can hydraulically pass through the primary bypass channel during partial treatment events.

In dry weather, flows enter the WWTP's raw sewage wet well and are lifted by up to five influent pumps to the fine screen channels, and then to the vortex grit removal system via two 9-ft by 9-ft concrete channels to the primary bypass structure. Flows are then directed through the primary clarifiers, enter the lower level effluent channels, pass through sluice gate 18 and enter the settled wastewater pumping station for conveyance to the secondary treatment process. Due to the elevation and configuration of the existing primary clarifiers, flow that enters the primary bypass structure preferentially flows through the clarifiers rather than to the settled wastewater pumping station wet well. Due to this restriction, flow to the secondary processes is currently limited to approximately 270 MGD during partial treatment.

The culmination of recent modeling efforts was the development of the design of modifications to the primary bypass structure to achieve an instantaneous primary bypass capacity of 360 MGD during partial treatment mode. The design includes modifications to the existing primary influent channels in the primary bypass area to allow additional flow to bypass primary treatment and go directly to the primary effluent channel and the settled wastewater pump station wet well during partial treatment. These modifications consist of the following:

- Construction of a below-grade structure on the east side of the existing Primary Effluent Junction Chamber connecting it to the north wall of the Primary Influent Channel;
- Installation of two new sluice gates on the east face of the Primary Effluent Junction Chamber;

- Demolition of portions of existing Primary Influent Channel walls to provide openings for flow to move into a new chamber; and

- Providing stop logs and stop log supports in both of the Primary Influent Channels for isolation of these channels in the future.

Figure 4-4 shows a schematic of the proposed modifications.

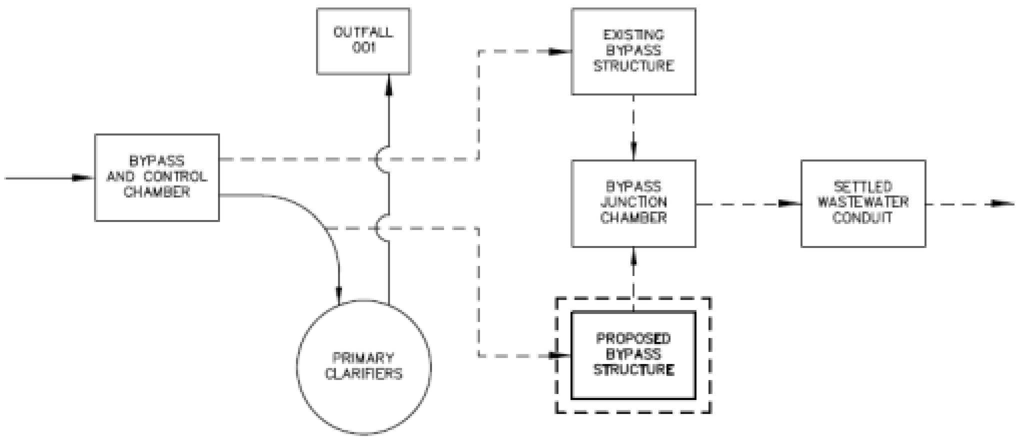


Figure 4-4: Proposed Partial Treatment Flow Schematic

4.2.8 Existing Primary Treatment Capacity

While the WWTP has previously processed flows of up to 240 MGD through the primary clarifiers with good results, the BSA is willing to consider the Agencies' request to limit the total primary treatment capacity to 160 MGD (or 40 MGD per clarifier) for 2012 LTCP Update planning purposes, corresponding to a maximum surface overflow rate of 2,000 gpd/sf cited in the most recent guidelines in the Ten States Standards document.

4.3 Primary Effluent Disinfection

As per the facility's discharge permit, the BSA disinfects all primary effluent when operating in the partial treatment mode. Currently, sodium hypochlorite is added at the influent box to each pair of clarifiers. Disinfection is provided in conjunction with the clarification process prior to discharge to Outfall 001. The chemical feed system is manually operated with WWTP staff adjusting feed rates as plant flows and operation vary. Outfall 001 has daily maximum chlorine residual limitation of 2.0 mg/Land a requirement to monitor fecal coliform levels. As such, the BSA's operating strategy appropriately targets compliance with the effluent chlorine residual.

The existing primary clarifiers provide a detention time of approximately 86 minutes at a maximum flow of 160 MGD and which significantly exceeds the Ten States Standards guideline for a 15-minute minimum contact time for conventional disinfection.

The plant data for the January 2008 through 2013 period indicate significant variability in primary effluent fecal coliform levels during partial treatment operation. Daily values ranged significantly.

4.4 Secondary Treatment

4.4.1 Design Parameters for Secondary Treatment Process

The secondary treatment system at the WWTP is an activated sludge process configured to operate in conventional plug flow, step feed, and contact stabilization modes of operation. The system includes 16 four-pass aeration tanks and 16 final clarifiers arranged in two batteries (“A” and “B”). Each battery has eight aeration tanks and eight final clarifiers, two blowers, three return activated sludge (RAS) pumps, and two waste activated sludge (WAS) pumps. Table 4-6 summarizes the design parameters for the existing system.

Primary effluent and raw wastewater bypassing primary treatment in primary bypass mode is pumped to the aeration tanks using the Settled Wastewater Pumping Station (SWWPS).

Table 4-7: Secondary Treatment System

Characteristic	Units	Value	
		Each	Total
Aeration Tanks			
No. of units		-	16
Surface area	sq. ft.	19,200	307,200
Depth	ft.	15	-
Volume	Mgal.	2.15	34.4
Final Clarifiers			
No. of units			16
Diameter	ft.	130	-
Side water depth	ft.	12	-
Surface area	sq. ft.	13,333	213,330

4.4.1.1 Settled Wastewater Pumping Station

The settled wastewater pumps convey flow from the settled water wet well to the activated sludge process. Both primary effluent and flow that bypasses the primary clarifiers feed the settled water wet well.

The settled water pump station contains five pumps: four variable speed pumps (Pumps No. 1, 2, 5, 6) and one constant speed pump (Pump No. 3). Pumps No. 1, 2 & 3 are on east side of the station and Pumps No. 5 and 6 are on west side. There is no Pump No. 4, but there is an area reserved for the addition of a 6th pump, if necessary, in the future.

Each pump has a capacity of 83,400 gpm or 120 MGD at approximately 88 percent speed, so with four pumps in operation, approximately 480 MGD can be conveyed to the secondary treatment process. If all pumps are at full speed, the estimated capacity is approximately 140 MGD per each pump.

4.4.1.2 Aeration Tanks

The aeration tanks are currently operated in step feed mode, with primary effluent fed to passes 1 and 5 and RAS fed to pass 1 (tanks are operated in pairs, forming four eight pass tanks in each battery). Process modeling indicates that the capacity of the aeration tanks operating in step feed mode to be 360 MGD, with the capacity limited by the secondary clarifiers, and not the aeration tanks themselves.

4.4.1.3 Secondary Clarifiers

As indicated in Table 4-7, there are sixteen final clarifiers or eight clarifiers in each battery. Each clarifier currently has approximately 48 six-inch diameter and 14 eight-inch diameter orifices in the bottom of the peripheral influent trough, spaced at approximately 6.5-ft apart. Flow is fed to the clarifiers down through the influent orifices and into the clarifiers. Clarifier effluent flows over the clarifier weirs and into the effluent channel, which is located just inside the clarifier influent channel.

4.4.1.4 Chlorine Contact Tanks

The four existing chlorine contact tanks are each 120 feet by 75 feet, with a side water depth of 15 feet, and six passes in each tank. They are designed to meet the Ten States Standards recommended minimum contact time guideline of 15 minutes at a peak flow of 360 MGD. Therefore, the chlorine contacts provide adequate capacity for the Alternative B scenarios.

The existing sodium hypochlorite chemical feed systems, located in the Chlorination Building, was designed and constructed in 1999-2000 to provide disinfection up to the 360 MGD capacity of the secondary treatment process.

4.4.2 Previous Modeling of Secondary Treatment Process (Process and Hydraulics)

Prior to the 2004 WWTP wet weather capacity evaluations, the WWTP operations staff has reported problems with solids washout during extreme wet weather conditions. In order to assess the system performance and evaluate the observed capacity concerns, the BSA has completed a number of studies as part of the 2004 LTCP submittal including:

- ***Computer process modeling to evaluate alternate modes of operation.*** The GPS-X dynamic computer model was used to develop a model of the secondary treatment process. The model was calibrated to historical operating conditions using 2000-2001 data and used the then-current configuration of plug flow in the four-pass activated sludge tanks. The calibrated model was used with a simulated wet weather event utilizing historical WWTP hourly flows and projected influent TSS and BOD concentrations to simulate first flush loadings and subsequent loadings to the secondary system. A maximum flow rate of 360 MGD was used.

- ***Hydraulic modeling to determine hydraulic capacity*****.** A hydraulic analysis for the secondary treatment system included the treatment processes from the Settled Wastewater Pump Station to Plant Outfall 002. The downstream boundary condition was the maximum water surface elevation of the Niagara River, from the 1970s WWTP design drawings. The evaluation considered both plug flow and step feed operation with varying numbers of aeration tanks and 15 of the 16 final clarifiers in service.

The modeling considered a maximum secondary system hydraulic capacity of 360 MGD for both plug flow and step feed operating modes. At this flow, and with 15 of the 16 final clarifiers in service, the model projected water surface elevations that would not result in the overflow of any secondary system tank or chamber walls. However, under the 2004 modeled conditions, the projected solids loading rates (SLR) exceeded 50 pounds per day per square foot (lb/d/sf), the maximum recommended rate guideline from the 2004 Ten States Standards at flows greater than 260 MGD at the historical average mixed liquor suspended solids (MLSS) concentration of 3,270 mg/L with a 40 percent return sludge rate. As a result, several alternatives were voluntarily evaluated to achieve better performance in the secondary process were developed and evaluated at that time. These alternative modes included:

1. Continuing plug flow operation at a lower SRT;
2. Modifying each aeration tank to operate in a 4-pass step feed configurations; and
3. Using two aeration tanks in series and modifying and operating them to operate as eight 8-pass aeration tanks.

Each alternative was evaluated using a maximum MLSS concentration of 2,500 mg/L to the final clarifiers and assuming 15 of 16 final clarifiers in operation with the maximum solids loading rate of 40 lb/d/sf. The 40 lb/d/sf loading rate is less than the maximum loading rate guideline suggested in Ten States Standards of 50 lbs/d/sf. The model also assumed that average flow conditions preceded the wet weather event. The results projected peak solids flux rates less than the 40 lb/d/sf target, no washout of solids, and plant effluent containing less than 15 mg/L TSS and BOD_5. The results also indicated the oxygen supply capability of the existing diffusers were sufficient for all alternatives for average and peak flow conditions based on an assumed diffuser oxygen transfer performance factor (alpha value).

Conclusions of the 2004 hydraulic and process modeling were:

- Enhanced compliance with SPDES effluent discharge permit limits could be achieved for the step feed alternatives for flows up to 360 MGD.

- The alternatives could achieve the discharge limits with reasonable capital costs.

- Step feed operation would result in more reliable operation at higher flows than the plug flow operation and would have lower sludge production. The step feed alternatives were also expected to improve sludge settleability and provide additional operational flexibility during wet weather events.

- The construction of three additional secondary clarifiers may increase benefits to the WWTP, by reducing the hydraulic and solids loadings on the clarifiers, offering additional solids storage during wet weather events, and providing process redundancy.

The 2004 Report recommended that the BSA do the following:

- Conduct a full-scale trial in step feed mode using two aeration tanks in series and influent feed distribution of 50 percent-0-50 percent-0 in the four passes, respectively;

- Clean the fine-bubble diffusers in nine aeration tanks to improve oxygen transfer efficiencies;

- Retrofit the final clarifiers with TowBro® suction manifold type sludge collection mechanisms to maximize final clarifier performance;

- Install electric actuators on gates between the aeration tanks ;

- Install a polymer feed system to improve wet weather performance of the final clarifiers;

- Remove grit and solids from the aeration tanks;

- Raise the headworks overflow weir by approximately 0.5 feet to allow more flow to be conveyed to the secondary system during partial treatment mode.

4.4.3 Secondary Treatment Improvements

Within the last decade, the BSA implemented a number of measures to improve secondary treatment capacity and performance. The most significant modification was to implement step feed mode to reduce the solids load on the final clarifiers and the potential for solids washout during peak flow conditions. The change was implemented by plant staff in September 2007, when Battery A aeration tanks were switched to step feed operation.

The eight tanks in Battery A were modified to step feed mode. Each set of two tanks was combined to form one eight-pass tank, with primary effluent fed to passes 1 and 5 and RAS fed to pass 1. Following this change, BSA staff reported processing sustained secondary flows in excess of 280 MGD and up to a peak instantaneous flow of 360 MGD during primary bypass operation for more than 20 wet weather events without activating partial treatment mode. Staff also indicated that treatment performance and settleability (as measured by SVI) in the “A” aeration tanks during the first six months of operation in step feed mode improved as compared to the “B” aeration tanks. Subsequently, the battery “B” aeration tanks were also switched to step feed operation. Following the step feed modifications, WWTP operating staff confirmed the secondary treatment system can reasonably handle an instantaneous peak wet weather flow of 360 MGD and sustained peak daily flow of 320 MGD without solids washout in the clarifiers. However, as indicated previously, the current primary bypass chamber limits the amount of raw wastewater that can be conveyed to the SWWPS and the secondary treatment process in partial treatment mode.

In addition to step feed implementation and raising the headworks overflow weir by 0.5 ft, additional capital and physical improvements completed since 2004 include:

- Installation of new return activated sludge pumps and new waste activated sludge pumps for better control of solids.

- Installation of new TowBro® suction manifold-type sludge collection mechanisms on all 16 final clarifiers.

4.4.4 Current Secondary Treatment Performance

Secondary process data for the period from January 1, 2008 through January 30, 2013 were evaluated. Aeration tank influent flow averaged 108.4 MGD. Final clarifier operating data indicated surface overflow rates averaging 584 gpd/sf and ranging from 191 gpd/sf to 1,321 gpd/sf. Solids loading rates averaged 20 lbs/d/sf with a range from 2.9

lbs/d/sf to 49 lbs/d/sf. Overall operation of the secondary system was within recommended industry standards.

Effluent TSS and BOD_5 removals demonstrated consistently good performance over a wide range of flows. Final effluent TSS and BOD_5 concentrations averaged 7 mg/l and 8 mg/l, respectively.

4.4.5 Recent Update of the Secondary System Hydraulic Model

For the development of this NFA evaluation, the existing secondary system hydraulic model originally developed in 2004 was reviewed and updated. This newer model incorporates the changes in operation made by the BSA staff since the 2004 LTCP including:

- Operating the activated sludge tanks in step-feed mode with two tanks in series.
- Returning 40 percent of the secondary system influent flow to the head of Pass 1 in the first tank of set of step-feed tanks.

The longest hydraulic path was modeled and is from the aeration tank influent channel in Battery A to the effluent weir of Final Clarifier No. 6. The path then continues from the effluent channel of Final Clarifier No.1 to Chlorine Contact Tank No. 1 to the Niagara River. It was assumed that the influent butterfly valve to Final Clarifier No. 6 was fully open, however, discussion with the BSA indicates that the plant currently throttles the influent butterfly valves to balance flow between the final clarifiers. Modeling also assumed that a pair of aeration tanks was out of service in Battery B and that one final clarifier in each battery was out of service. All four chlorine contact tanks were assumed to be in service.

The hydraulic model was further validated by field data collected on May 28, 2013 during a wet weather event. Depth-to-water measurements were collected at eleven locations within the secondary system and flow date corresponding to the same time period was obtained from the BSA. This check of the model using the filed data showed that the influent butterfly valves to the final clarifiers were most likely throttled during the data collection and the model was validated to be accurate.

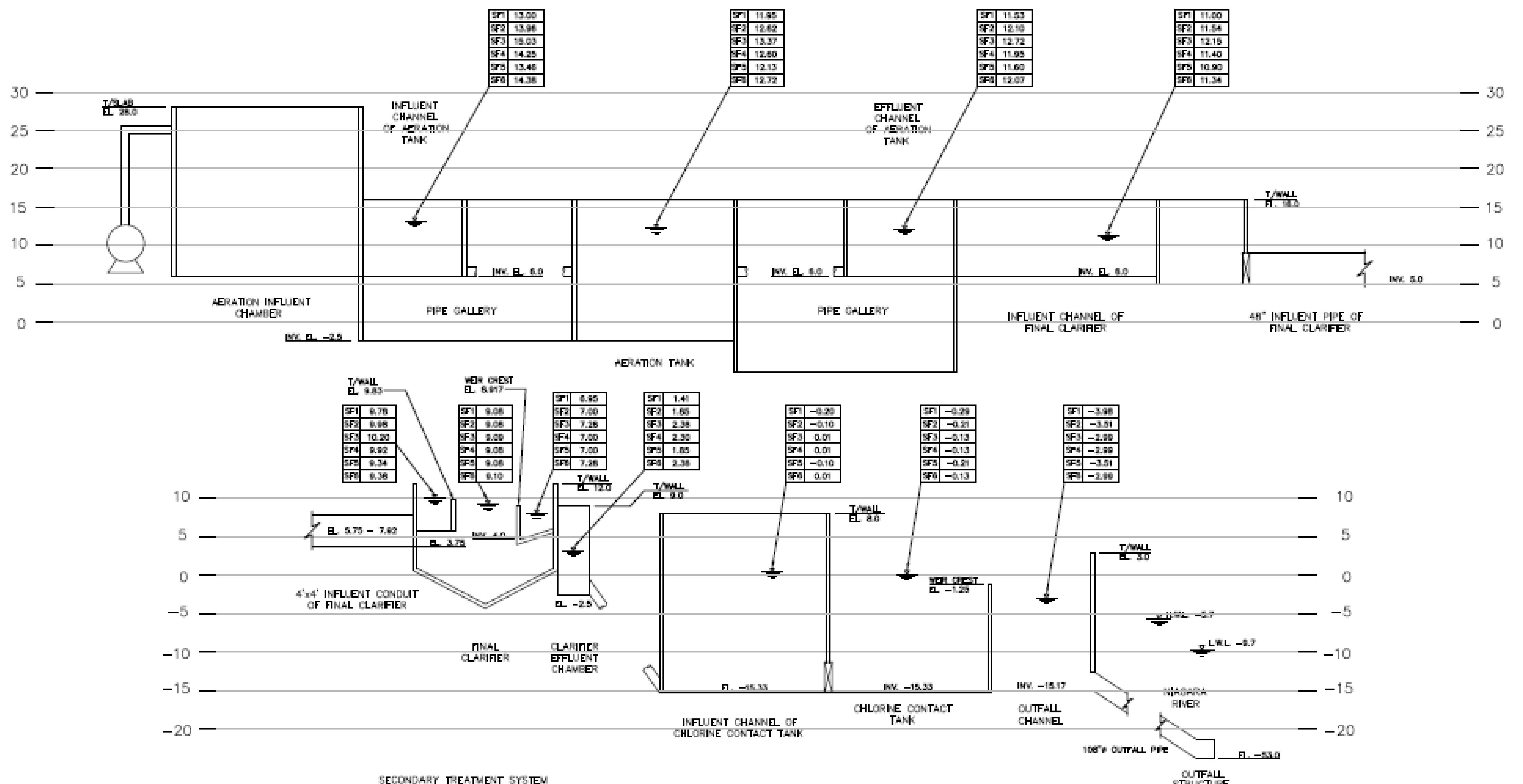
The model was then used to predict water surface elevations for several different flow scenarios as summarized in Table 4-8. The hydraulic profile is shown in Figure 4-5.

Table 4-8: Model Scenario Configurations

				Tanks in Service (Battery A only)		
Scenario	**Configuration**	**Flow (MGD)**	**RAS**	**Aeration Tanks**	**Final Clarifiers**	**Chlorine Contact Tanks**
1	Existing	320	40%	8	7	4
2	Existing	360	40%	8	7	4
3	Existing	400	40%	8	7	4
4	Added Final Clarifiers	400	40%	8	8	4
5	Added Orifices	360	40%	8	7	4
6	Added Orifices	400	40%	8	7	4

A memorandum summarizing the entire hydraulic modeling effort is included as Appendix1, but the results are briefly summarized below.

Existing Configuration - At a secondary treatment process influent flow of 320 MGD, the desired minimum amount of freeboard of six (6)-inches was observed at the peripheral final clarifier influent channel (limiting location for hydraulics within the secondary treatment process). At ***sustained*** flows of 360 MGD and 400 MGD and RAS flow of 40 percent the freeboard cannot be maintained without overtopping the influent channel wall into the clarifier effluent troughs; however, plant staff indicated that they are able to handle up to 360 MGD for shorter periods of time without adverse water surface elevations. The remainder of the secondary system is able to maintain at least 12-inches of freeboard.



SECONDARY TREATMENT SYSTEM
FLOW DISTRIBUTIONS THROUGH PROPOSED SYSTEM – STEP FEED

FLOW UNIT: mgd

SYMBOL	SCENARIO	SETUP	FLOW (mgd)	FLOW SPLIT		AERATION TANKS		FINAL CLARIFIERS		CHLORINE CONTACT TANK	
				BAT A	BAT B	No. OF TANKS	FLOW/PAIR	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF TANKS	FLOW/TANK
SF1	1	EXISTING	320	182.9	137.1	14/16	64.0	15/16	36.6	4/4	80
SF2	2	EXISTING	360	205.7	154.3	14/16	72.0	15/16	41.1	4/4	90
SF3	3	EXISTING	400	228.6	171.4	14/16	80.0	15/16	45.7	4/4	100
SF4	4	ADD CLARIFIER	400	228.6	171.4	14/16	80.0	17/18	40.0	4/4	100
SF5	5	ADD ORIFICES	360	205.7	154.3	14/16	72.0	15/16	41.1	4/4	90
SF6	6	ADD ORIFICES	400	228.6	171.4	14/16	80.0	15/16	45.7	4/4	100

NOTE:

1. WATER LEVELS ARE BASED ON HYDRAULIC MODEL RUNS FOR THE BATTERY WITH THE HIGHEST FLOW PER TANK (ASSUMED BATTERY A)/CLARIFIER FOR CONSERVATIVE PURPOSES.
2. No. OF PAIRS REPRESENTS PAIRS OF TANKS FOR STEP–FEED MODE (I.E. TWO TANKS IN SERIES EQUALS 1 PAIR)

Figure 4-5: Secondary Treatment Process Hydraulic Profile

Additional Final Clarifiers – The addition of two final clarifiers was evaluated to determine the effect on hydraulic capacity, but it was found that at 400 MGD, the clarifier influent channel wall will continue to be overtopped. At least 12 inches of freeboard was maintained at all other locations within the secondary system.

Additional Influent Orifices – Additional orifices in the clarifier influent channels were also evaluated to provide additional freeboard. The model indicated that 47 and 62 additional orifices would be required to handle sustained flows of 360 MGD and 400 MGD, respectively.

Raise Inside Channel Wall of Final Clarifier Influent Channel – Alternatively, the channel wall between the clarifier influent and effluent channels could be raised approximately 10-inches in order to prevent overtopping of the wall in between the two channels, in lieu of adding orifices. It is noted that raising the wall at this location will not affect water surface elevations at any other point within the secondary treatment process.

Based on the modeling, the current ***sustained*** maximum hydraulic capacity for the secondary treatment system is 320 MGD. As indicated previously, it is possible to pass up to 360 MGD for a short period of time, but there is the potential for short circuiting in the final clarifiers by overtopping the influent channel walls into the clarifier effluent channels.

The only other potential hydraulic restriction in the secondary system is the final clarifier influent butterfly valves used to distribute flow to the final clarifiers. It is recommended butterfly valves be left fully open during high flows to eliminate unnecessary head loss.

4.4.6 Recent Review of the Secondary System Process Model

Previous biological process modeling conduction in 2004 indicated that solids loading rates exceeded 50 pounds per day per square foot (lbs/d/sf) at an averaged mixed liquor suspended solids (MLSS) concentration of 3,270 mg/L and a 40 percent return sludge rate. This conclusion led to the BSA switching operation of the secondary treatment process by using two aeration tanks in series and modifying and operating them to operate as eight 8-pass step-feed aeration tanks as shown in Figure 4-6.

Following a review of the historical operating data from the WWTP since step feed mode was implemented, significant improvements to the secondary treatment process were noted. Most significantly, solids loading to the final clarifiers, especially under higher flows were greatly reduced as shown in Figure 4-6. Under peak flow conditions, the maximum solids loading rate is approximately 35 lbs/d/sf, with 14 of the 16 final clarifiers in service. However, the hydraulic loading rate is approximately 1,928 gpd/sf with 14 clarifiers in service and approximately 1,600 gpd/sf with 16 clarifiers in service. While recommended surface overflow rates in commonly-used design guidance are closer to 1,200 gpd/sf, operating data for the WWTP has shown very good performance (especially in terms of SPDES permit compliance) at the higher loading rates, with an average of 8.8 mg/L TSS (high of 15 mg/L TSS) and 5.9 mg/L BOD (high of 8.9 mg/L BOD) in the final effluent at the higher surface loading rates. With the modeling efforts and historical plant data, it is observed that the clarifier solids loading rate appears to be the limiting factor and by implementing step feed operation, the BSA has kept solids loading rates at reasonable levels and have achieved good performance even under the higher surface overflow rates.

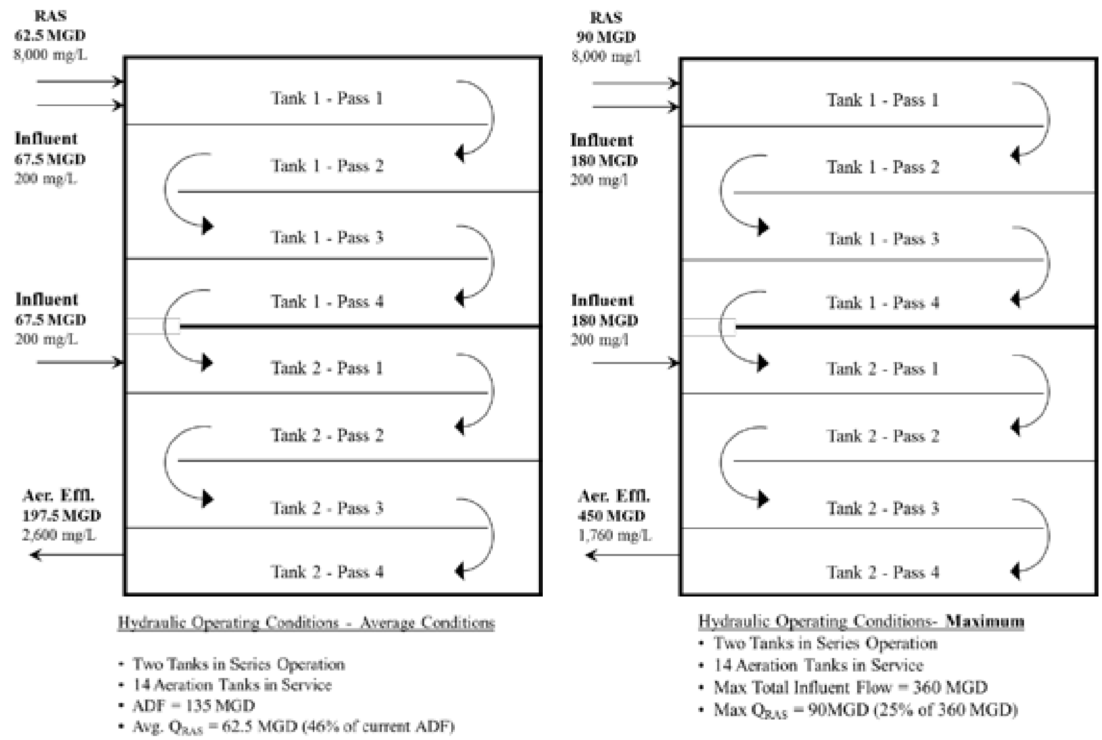


Figure 4-6: Step Feed Operation under Average (left) and Maximum (right) Flow Conditions

4.4.7 Capacity of the Secondary Treatment Process

As indicated previously, the most recent hydraulic modeling effort confirmed a maximum sustained flow capacity of 320 MGD in the secondary treatment process, with instantaneous flows higher than 320 MGD able to be handled, with 15 of 16 aeration tanks in service and 14 of the 16 clarifiers in service. Process modeling and historical plant operation has indicated that 360 MGD can be adequately treated in the secondary treatment process, provided that step feed operation is used to keep solids loading rates within the secondary clarifiers to minimum levels.

The limiting hydraulic factor is the peripheral secondary clarifier influent channel and therefore, to achieve sustained flows higher than 320 MGD through the secondary treatment process, the addition of orifices in the influent channels is required. To achieve higher flows of up to 400 MGD, additional clarifiers are recommended to keep hydraulic overflow rates in the range of 1,600 to 1,700 gpd/sf, as is currently observed at peak flows through the secondary treatment process. The proposed improvements are further discussed in Section 5.0, along with the descriptions of the individual alternatives evaluated.

5. WET WEATHER FLOW ALTERNATIVE EVALUATION

A matrix of wet weather flow treatment alternatives has been developed based on discussions between the BSA and the USEPA and the NYSDEC at a February 12, 2013 meeting, subsequently documented in the NFA Work Plan submitted to the regulatory agencies on March 1, 2013 and revised based on the USEPA response dated March 21, 2013. The wet weather flow alternatives matrix is presented on Figure 5-1.

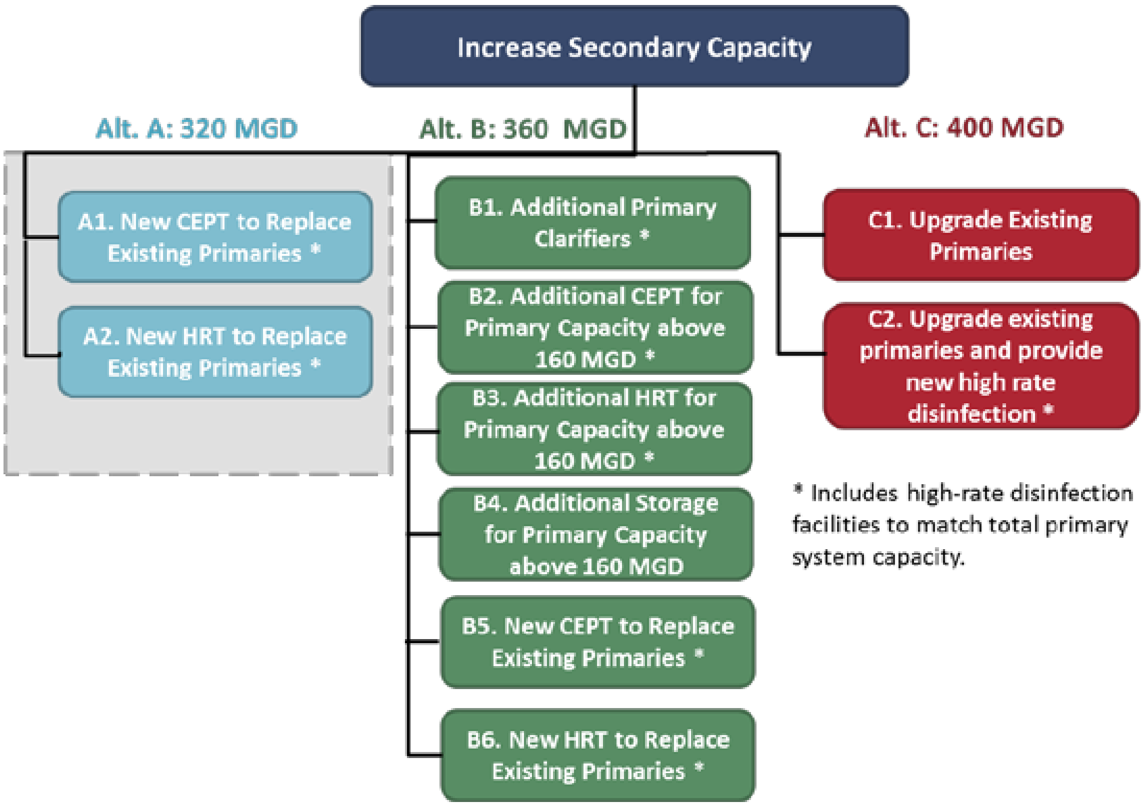


Figure 5-1: Summary of Evaluated Alternatives

The following assumptions were agreed upon with the Agencies for the purpose of these evaluations

- The maximum peak flows to the WWTP are limited to 560 MGD.
- BSA is willing to de-rate the existing primary clarifiers to a total capacity of 160 MGD (or 40 MGD per clarifier) in response to the Agencies' request.

- Unless otherwise noted, primary treatment alternatives that expanded the primary treatment capacity considered a separate chlorine contact tank to be used for high-rate disinfection of partially-treated flow under wet weather conditions.

Three groups of alternatives (A, B and C) correspond to evaluated improvements for increasing the capacity of the secondary treatment process. While the existing secondary system conditions will serve as baseline (Alternative A, as shown in Figure 5-1), two additional secondary system capacity alternatives were evaluated and include:

- Alternative B – Increase the secondary process capacity to reliably handle a sustained flow of 360 MGD

- Alternative C – Increase the secondary process capacity to reliably handle a sustained flow of up to 400 MGD

As shown, the wet weather flow alternatives primarily focus on first optimizing the amount of flow through the secondary treatment process and then further improving treatment performance of the primary treatment process under the partial treatment mode. Potential benefits of increasing the secondary system capacity in terms of reduced frequency and volume of the typical year partial treatment events are summarized in Table 5.1.

Table 5-1: Typical Year Partial Treatment Events and Volumes

	Alternatives A Secondary capacity 320 MGD	**Alternatives B Secondary capacity 360 MGD**	**Alternatives C Secondary capacity 400 MGD**
Estimated Number of Partial Treatment Events	47	42	41
Predicted Volume Receiving Primary Treatment and Disinfection and not receiving Secondary Treatment (MG/yr)	1,040	716	464

The alternatives assume that improvements to the primary bypass chamber have been completed to address the existing hydraulic bottleneck. Those improvements are expected to be complete in the third quarter of 2014.

In addition to treatment alternatives, a storage alternative was evaluated to limit flow into the primary treatment process such that the flows to the existing clarifiers will be limited to the hydraulic loading rate guideline in the current Ten States Standards.

A brief summary of considered alternatives is provided below, followed by a more detailed description of each alternative:

- Secondary Treatment Alternatives A (approximately 320 MGD conveyed to the secondary treatment process):

    - Alternative A1 – Replace existing primary clarifiers with a new CEPT process with a capacity of up to 240 MGD (evaluation already completed as part of the 2012 LTCP). A new 240 MGD high-rate disinfection system for the CEPT is also considered under this alternative.

    - Alternative A2 – Replace existing primary clarifiers with a new HRT process with a capacity of up to 240 MGD (evaluation already completed as part of the 2012 LTCP). As with Alternative A1, a new 240-MGD high-rate disinfection system is also included in this alternative.

- Secondary Treatment Alternative B - These alternatives involve improvements to the secondary treatment process to reliably treat up to 360 MGD (i.e., installing additional orifices in the secondary clarifier influent channel) and improvements to the primary treatment process to treat up to 200 MGD as follows:

    - Alternative B1 – Construct an additional primary clarifier to treat approximately 40 MGD of additional capacity to achieve a total 200 MGD of primary treatment capacity in partial treatment mode, followed by a new 200-MGD chlorine contact tank for high-rate disinfection (i.e., larger dose of chlorine at a shortened chlorine contact tank of 5 minutes at peak flows).

    - Alternative B2 - Install a CEPT process sized for 40 MGD, followed by a new high-rate disinfection process sized for high-rate disinfection of up to 200 MGD. The new CEPT unit would be used in parallel with the existing primary clarifiers.

    - Alternative B3 - Install an HRT process sized for 40 MGD, followed by a new high-rate disinfection process sized for high-rate disinfection of up to 200 MGD. As with Alternative B2, the new HRT process would be used in parallel with the existing primary clarifiers.

    - Alternative B4 – Install a 13 million gallon storage tank to store influent plant flows in excess of 520 MGD (360 MGD of secondary treatment capacity, plus 160 MGD of primary treatment capacity). The stored flows would then be sent through the secondary treatment system after the wet weather event subsides.

    - Alternative B5 – Install a CEPT process sized to handle up to 200 MGD to replace the existing primary treatment process, followed by a new high-rate disinfection process also sized for 200 MGD. This CEPT process would completely replace the existing clarifiers and would be sized approximately 40 MGD smaller than the process proposed for Alternative A1 as more flow would be directed to the secondary treatment process under the 'B' alternatives as opposed to the 'A' alternatives.

- Alternative B6 – Install an HRT process sized to handle up to 200 MGD, followed by a new high-rate disinfection process also sized for 200 MGD. The sizing of this alternative follows the same logic as Alternative B5, above.

- Secondary Treatment Alternative C – This set of alternatives involves improvements to the secondary treatment process to reliably treat up to 400 MGD in partial treatment mode (i.e., two additional secondary clarifiers, expansion of the existing secondary chlorine contact tank to accommodate an additional 40 MGD of flow at a minimum 15 min. contact time, and the addition of orifices in the secondary clarifier influent channels) and maintaining the existing primary treatment process of 160 MGD as follows:

  - Alternative C1 – Identify needed improvements to the existing primary clarifiers and upgrade them as necessary to keep them in good working order. The existing primary clarifiers will be used for primary treatment and disinfection of flows up to 160 MGD.

  - Alternative C2 – Consider installing a separate 160 MGD high-rate disinfection facility in addition to performing the improvements described under Alternative C1. This alternative was added at the Agencies' request.

5.1 Description of Technologies Considered

5.1.1 Technologies for Increasing Secondary Treatment Capacity

5.1.1.1 Modifications to WWTP to Get to a Sustained Secondary Treatment System Capacity of 360 MGD

As described previously in Section 4, the plant has been able to treat sustained flows of up to 320 MGD in the secondary treatment process and up to 360 MGD in normal and primary bypass modes. However, as indicated above, a hydraulic bottleneck at the primary bypass chamber currently prohibits flows greater than approximately 270 MGD from reaching the secondary system during partial treatment mode. Improvements to the primary bypass have been designed and are expected to be implemented by the third quarter of 2014. All alternatives considered below build on this system improvement.

5.1.1.2 Additional Secondary Clarifiers to Achieve Higher Sustained Secondary Treatment System Capacities

In increasing the overall treatment capacity of the secondary treatment process to 400 MGD, the installation of addition secondary clarifiers was considered. Additional secondary clarifiers would increase overall redundancy within the secondary treatment process, but would not provide any appreciable additional treatment efficiencies at flows up to 360 MGD. Recent plant operating data indicate that by switching to step feed mode in 2008 and 2009, plant staff has been able to maintain solids loading rates under the 50 lbs/d/sf maximum loading rate, while achieving an overall 92 percent TSS reduction efficiency. At higher flows up to 400 MGD, it is projected that two additional secondary clarifiers would be required to maintain appropriate solids and hydraulic loading rates to the clarifiers.

5.1.2 Technologies for Increasing Primary Treatment Capacity

5.1.2.1 Retain Existing Primary Settling Tanks

As considered by corresponding alternatives, the existing four primary treatment tanks will continue to be maintained to handle a peak flow of 160 MGD during partial treatment mode. The existing tanks are functional, but dated, and like any other clarifiers will require periodic upgrade and repair to be kept in service. These tanks have historically achieved an average solids removal rate of approximately 40 percent and are expected to continue achieving similar or better performance with adding inlet baffles to three clarifiers as described below as well as by limiting the peak flows which reach the primaries during wet weather. The current tanks also serve as chlorine contact tanks for primary effluent disinfection during partial treatment; note however that this practice was assumed to remain unchanged only for alternative C1. Alternatives that considered retaining the existing primary clarifiers only assumed that their scum and sludge collection equipment and primary sludge pumps would be replaced.

5.1.2.2 *Additional Primary Settling Tanks*

The installation of additional primary settling tanks would improve performance and increase treatment redundancy by reducing the overall hydraulic loading rate to each clarifier. Ten State Standards guidelines recommend a maximum hydraulic loading rate of 2,000 gpd/sf at design peak hourly flows, and any additional primary settling tanks would be sized to achieve that surface overflow rate at design peak hourly flow.

5.1.2.3 Chemically Enhanced Primary Treatment (CEPT)

New CEPT facilities were considered and involve the addition of metal salts and coagulant chemicals (polymer) to the primary influent flow to increase flocculation and settling of solids. For CEPT operation, a coagulant (such as ferric chloride) would be added to a rapid mix chamber. In this chamber, intense mixing with a short detention time disperses the coagulant throughout the primary influent. A typical ferric chloride dose in the rapid mix chamber of a CEPT facility is 30 mg/L, and a typical hydraulic detention time is approximately 1 minute.

CEPT can result in effective removal of suspended solids at higher surface overflow rates associated with wet weather flows. Required facilities include chemical mixing and flocculation tankage, primary settling tanks and chemical handling facilities. As an added benefit, CEPT tanks can be operated, without chemical addition, as primary clarifiers for average influent flows.

Upstream of the primary clarifiers, rapid mix and flocculation basins would be required to create floc particles. A low dose of polymer (< 0.5 mg/L) can be added, if necessary, to further promote enhanced flocculation. A typical CEPT flocculation basin has a hydraulic detention time of 20 minutes under less intense mixing action than within the rapid mix zone. The longer detention time and gentler mixing creates ideal conditions for floc formation. Figure 5-2 illustrates the CEPT process.

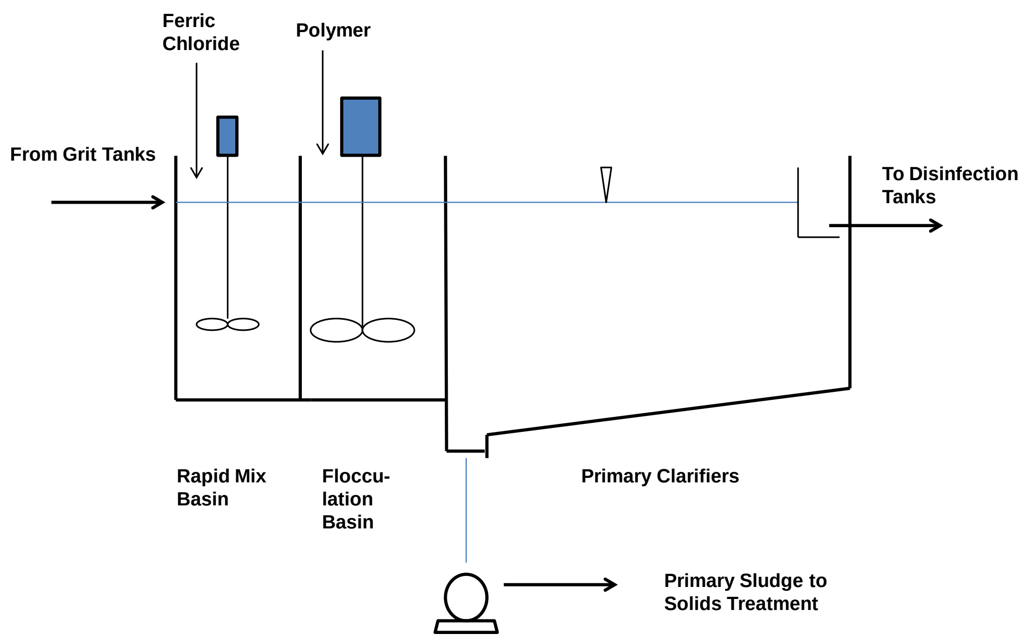


Figure 5-2: CEPT Process Schematic

5.1.2.4 Ballasted Flocculation (High Rate Treatment)

Ballasted flocculation, or high rate treatment (HRT), is a process that utilizes ballast materials (particles of sand or thickened sludge) in conjunction with chemical addition to enhance the flocculation and settling of solids. This technology has been shown to achieve an average solids removal rate of 80 to 85 percent. Implementing this technology includes construction of mixing, flocculation and settling tanks and the associated chemical and support facilities. While achieving high solids removal rates, this technology has higher capital and operation costs and tends to be more complex than other solids removal technologies.

HRT technologies typically treat higher flows at SORs of around 30,000 gpd/sf, but can also operate at higher SORs. These overflow rates are 15 times greater than that of newly constructed conventional primary clarifiers. The higher allowable SORs allow for a smaller process footprint while achieving adequate solids removals.

Two HRT technologies considered were the Actiflo® process and the Densadeg® process. The Actiflo® process uses microsand-enhanced flocculation and settling. A schematic of the Actiflo® process is presented on Figure 5-3. A coagulant, such as ferric chloride, is added to the wastewater in a rapid mix tank. The coagulated wastewater enters a second tank, called the injection tank, where polymer and microsand (80 to 120 micron) are added. The microsand provides a large contact area to accelerate the settling of floc while polymer causes destabilized suspended solids to bind to the microsand. The particles agglomerate in the maturation tank and grow into high-density flocs known as microsand ballasted flocs, which settle quickly at the bottom of a settling tank. The efficiency of settling is further increased by the use of lamella tubes in the settling zone.

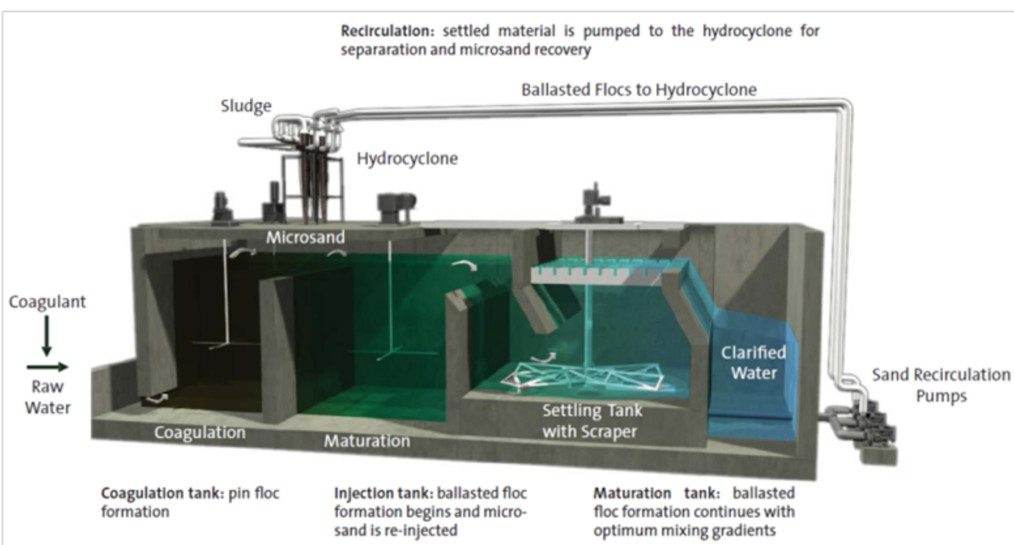


Figure 5-3: HRT Actiflo® Schematic

The solids/microsand mixture collected in the settling zone is pumped to hydrocyclones where the solids are separated from the microsand by centrifugal force. The recovered microsand is re-injected into the process and the solids discharged to the plant's solids handling process train for further processing. The Actiflo® system produces a relatively thin sludge, typically less than 0.5 percent solids.

The Densadeg® process incorporates three process zones: the reactor zone, the pre-settling/thickener zone, and the clarification zone. The process, shown in Figure 5-4, is similar to the Actiflo® process except that thickened sludge is used to aid in floc formation. In the rapid mix zone, influent wastewater is combined with a coagulant and then with polymer in the subsequent reactor zone. A portion of the thickened sludge from the settling/thickener zone is also injected into the reactor zone and the wastewater/sludge mixture is further flocculated through more intense mixing in a draft tube. Ultimately, the slurry passes over a submerged weir into the clarifier/thickener zone. Here, separation of the solids and supernatant occurs.

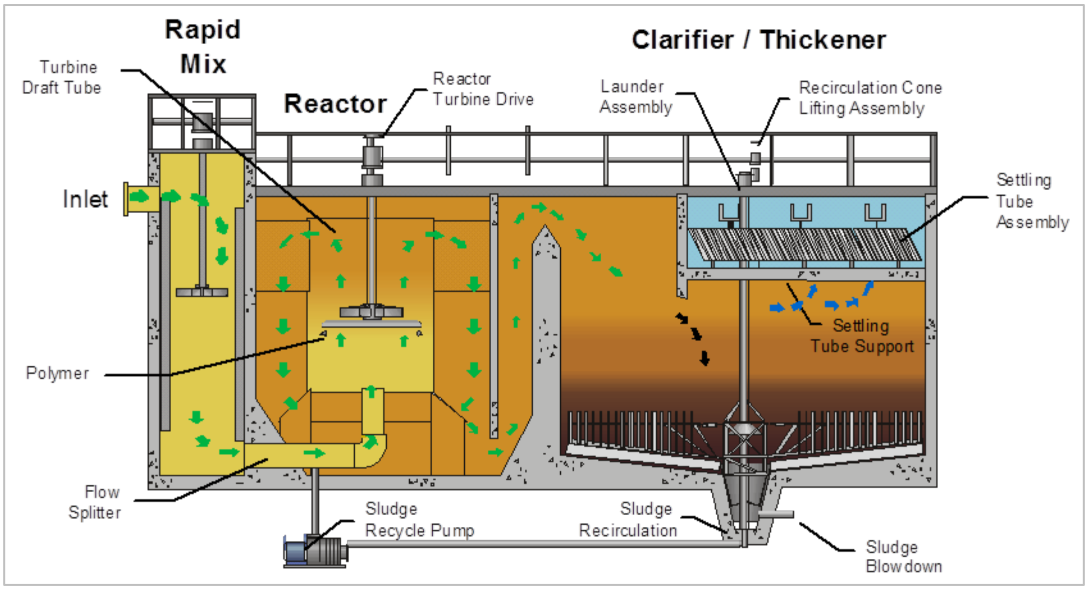


Figure 5-4: HRT Densadeg® Schematic

The dense sludge produced by the Densadeg® process settles to the bottom of the clarification zone and is thickened to approximately 2 percent to 4 percent. The supernatant flows upward in the thickener/clarifier through lamella tubes, which provide high-rate removal of the remaining solids. The clarified effluent is collected via a series of weir troughs.

HRT facilities can be used in conjunction with the existing primary clarifiers or could completely replace the primary clarifiers. If replacing the existing clarifiers, a minimum number of HRT tanks would need to operate continuously in full HRT mode during dry weather, because the clarification/thickening zone does not provide enough surface area to act as effective clarifiers without the ballast and chemicals. During wet weather, additional HRT tanks would be placed in service with the effluent conveyed to secondary treatment. Once influent flow exceeds the secondary treatment capacity, the HRT effluent would discharge directly to the WWTP outfall.

Implementation of HRT technologies typically requires complex design and construction issues. However, the HRT technologies still provide significant treatment benefits. Similar to CEPT, separate disinfection facilities are required for HRT technologies.

5.1.2.5 Storage

In lieu of providing treatment via additional clarifiers, CEPT, HRT, or a combination of these technologies, storage facilities that provide wet weather equalization of peak flows into the WWTP that exceed the primary clarifier capacity could be used. Equalization volume at the WWTP would be sized to capture and store primary influent flow in excess of the stipulated (for purposes of this evaluation) primary clarifier capacity of 160 MGD and the secondary system capacity of 320 or 360 MGD.

The excess wastewater is typically stored until wet weather flows subside and secondary treatment capacity is available, at which point the stored wastewater would be bled back into the system at a controlled rate. A detailed evaluation of the "typical year" hydrograph of flows reaching the plant was performed to identify the potential storage volumes that would be required. This evaluation indicated that to fully capture the remainder of flow conveyed to the treatment plant, a storage tank with a capacity of approximately 13 to 30 MG would be required. Thirteen million gallons are required if the sustained capacity of the secondary treatment system is 360 MGD and 30 million gallons are required at the current sustained treatment capacity of the secondary treatment system of 320 MGD. These storage volumes are in addition to those considered within the collection system. Note that providing 30 MG of equalization for alternatives with the secondary system capacity of 320 MGD was considered unfeasible.

There are currently no existing plant facilities that could be converted into storage tanks and little available space for the construction of new storage facilities. The only potential location for a storage tank is the ash lagoon site. Additionally, plant hydraulics may require a new pump station to convey primary influent flows to the storage tank and a second station to pump the tank contents back to the primary clarifiers. Plant site space limitations also impact the ability to site any new pumping stations.

5.1.3 Disinfection Technologies

Although water quality modeling efforts previously undertaken suggest that CSO-related discharges do not preclude the attainment of water quality standards in the Niagara River, the BSA's SPDES permit requires that primary effluent not receiving subsequent secondary treatment receive disinfection prior to discharge from Outfall 001. Currently this process uses sodium hypochlorite dosed to the primary clarifier influent distribution boxes and relies on the clarifier volume for contact time. As stated previously, one of the regulatory agency comments on the NFA submitted with the 2012 LTCP involved their concern relative to the effectiveness of this process and therefore, additional disinfection of primary effluent is included in the alternatives evaluation.

5.1.3.1 Chlorination

Liquid sodium hypochlorite is currently used at the plant and is an effective bactericide and virucide when provided with adequate contact time with wastewater. It is relatively simple and safe to use. Chlorine gas was not considered due to greater safety requirements for handling and storage. While safer than chlorine gas, sodium hypochlorite requires space for on-site storage and can gradually lose strength over time. However, because it is safer, sodium hypochlorite disinfection was evaluated for treating primary effluent not receiving secondary treatment.

While there is no official definition of high-rate disinfection (HRD), wet weather practitioners have used the term to define disinfection that occurs in a shortened period of time using a high dose of disinfection agent with intense mixing. The most common chemicals used with HRD are liquid sodium hypochlorite for disinfection and liquid sodium bisulfite as a dechlorination chemical. Other possible disinfection chemicals available include gaseous chlorine and gaseous sodium dioxide for disinfection and dechlorination, respectively. While contact times vary, five minutes is typically used for disinfection and one minute for dechlorination in HRD.

5.1.3.2 Ultraviolet Radiation (UV)

Ultraviolet radiation is an effective bactericide and virucide for wastewater treatment when properly dosed in water with low solids and metals content. UV disinfection creates no residual toxicity or disinfection byproducts and has a smaller footprint than sodium hypochlorite facilities. However, UV disinfection has higher capital and operations costs, has specific hydraulic energy requirements, and has poorer performance in water with the high levels of suspended solids or metal cations such as ferric chloride.

Flows receiving primary treatment only are likely to have higher levels of suspended solids that reduce the effectiveness of UV as a disinfectant. Other disadvantages of installing a UV system for wet weather flows at the BSA's WWTP include complex operation, use of second disinfection technology at the WWTP, and the required UV lamp warm-up time. In general, UV disinfection is more suitable and effective for continuous operation with higher quality secondary effluent rather than the intermittent operations associated with wet weather treatment; therefore UV disinfection was not retained for further consideration.

5.1.3.3 Ozone

Ozone is an extremely reactive oxidant and is generally an effective bactericide and virucide. Ozone disinfection does not produce dissolved solids and is not affected by the ammonium ion or pH fluctuations. The major disadvantage of ozone is the high capital, energy, and operations costs associated with ozone generation and storage facilities. The presence of oxidizable compounds also reduces the effectiveness of ozone disinfection. Ozone disinfection in wastewater treatment is currently not widespread; many ozone applications for wastewater treatment are only for odor control and soluble refractory organics removal. Furthermore, partially treated flows contain levels of organic and nitrogen compounds that reduce the effectiveness of ozone. The high capital and operating cost, lack of comparably sized units in service, and potential issues with effectiveness of disinfection of primary effluent resulted in the elimination of ozone from further consideration.

5.1.3.4 Disinfection Technology Selected for Consideration

Sodium hypochlorite is currently utilized at the WWTP and the continued use of this technology is recommended for the wet weather treatment alternatives. Storage facilities and pumping systems already exist as does adequate operating and standby power. Finally, and most importantly, operations staff is familiar with the use and safety procedures for sodium hypochlorite. As discussed earlier in this section, two sodium hypochlorite disinfection approaches are considered for the evaluations and are included in the corresponding wet weather flow treatment alternatives:

1. Continued disinfection in the existing primary clarifiers (alternative C1 only).
2. High-rate disinfection of the primary effluent in a dedicated chlorine contact tank. A chlorine contact tank providing a minimum of 5 minutes at peak flow, along with high intensity mixing of the disinfectant into the flow stream at the sodium hypochlorite addition point was considered.

Additionally, expanding the existing final effluent chlorine contact tank capacity may be required to maintain the secondary effluent disinfection contact time of 15 minutes for the alternatives that consider increasing the secondary system treatment capacity to 400 MGD.

5.2 Alternatives Development

The treatment technologies described previously and compiled into the ten alternatives shown on Figure 5-1 are further developed and evaluated in this section. Detailed descriptions, layouts, and capital and O&M cost estimates for each alternative are provided below.

Total project costs presented herein are based on the engineer's estimate of probable total capital costs with a construction contingency of 20 percent. Total project costs also include allowances for engineering, administrative and legal costs. The O&M costs include labor, material and chemicals, and equipment power costs to address wet weather peak flow events and general maintenance requirements. All costs are based on 2013 dollars.

5.2.1 Maintain Existing Secondary Treatment Capacity of 320 MGD (Alternatives A)

The following describes those alternatives available for treating flows in excess of a sustained secondary treatment capacity of 320 MGD, when operating in the partial treatment mode. Under these alternatives, 320 MGD would bypass the primary clarifiers and be conveyed to the secondary treatment process for treatment, with the remainder of the flow receiving some degree of primary treatment and disinfection.

No modifications are required to the existing secondary treatment process to implement these alternatives, as the plant already is able to convey and treat this much flow through the aeration tanks, secondary clarifiers, and chlorine contact tanks.

5.2.1.1 Alternative A1 – CEPT to Replace Existing Primary Clarifiers

5.2.1.1.1 Description

Alternative A1 provides primary treatment of all plant flows in excess of 320 MGD by replacing the existing four primary clarifiers with new CEPT tanks, to treat up to 240 MGD, as shown on Figures 5-5 and 5-6. The CEPT system would be designed to achieve a maximum design SOR of 4,000 gpd/sf. Ferric chloride and polymer would be added during wet weather to provide flocculation and enhanced solids settling at higher surface overflow rates than conventional primary clarifiers. This alternative also includes the construction of a new high-rate chlorine contact tank (CCT) for disinfection of CEPT effluent.

Plant modifications required for this alternative include:

- Construction of a new primary influent conduit from the Grit Building to the new CEPT tanks.

- Installation of a new ferric chloride and polymer dosing system in the new primary influent conduit.

- Construction of a new Chemical Storage Building for ferric chloride and polymer.

- Construction of six 20-ft long, 20-ft wide, 10-ft deep rapid mix chambers, with one 20-HP mixer per chamber.

- Construction of six 15-ft long, 50-ft wide, 10-ft deep flocculation basins, with two 5-HP mixers per basin.

- Construction of six 200-ft long, 50-ft wide, 14-ft side water depth (SWD) CEPT tanks.

- Construction of new solids removal equipment and piping to convey settled sludge to the existing primary sludge pumps and/or new primary sludge pumps to handle the additional sludge generated in the CEPT process.

- Installation of new chlorine contact tank (CCT), sodium hypochlorite feed equipment, and mixers. The CCT would be sized to achieve a contact time of 5 minutes at a peak flow of 240 MGD.

- Construction of new conduits to connect the CEPT tanks to the secondary treatment system and existing Outfall 001.

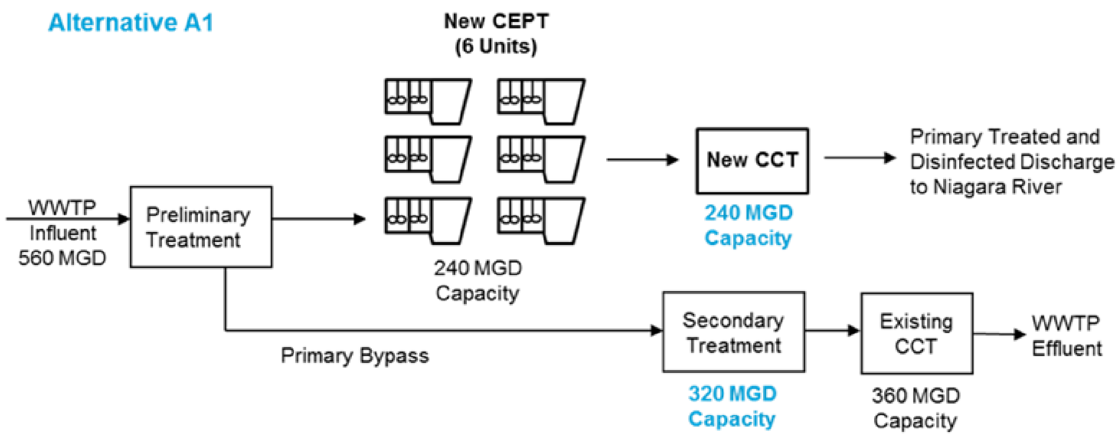


Figure 5-5: Process Flow Diagram for Alternative A1

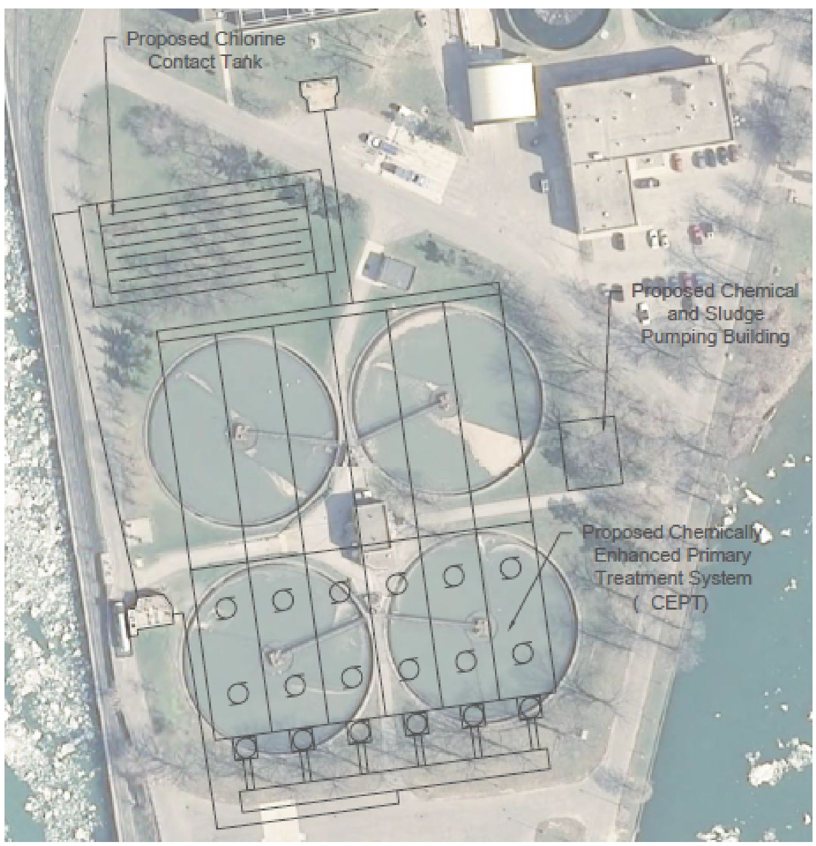


Figure 5-6: Preliminary Site Layout for Alternative A1

5.2.1.1.2 Proposed Operation

The proposed operation of the improvements described in Alternative A1 would depend on the influent flows to the plant, as follows:

- Flows below 240 MGD - The plant would operate in "normal" mode with the new CEPT tanks acting as conventional primary clarifiers with no chemical addition.
- Primary effluent would subsequently be conveyed to the secondary treatment process and the chlorine contact tanks and discharged through plant Outfall 002.
- Flows from 240 MGD to 320 MGD - When the plant influent exceeds 240 MGD, the plant would begin to transition to "primary bypass" mode with increasing plant influent conveyed directly through secondary treatment and processed along with primary effluent. CEPT operation would be initiated at an influent flow of 300 MGD in anticipation of influent flows further increasing above 320 MGD. All flow would be disinfected in the effluent CCT and discharged through Outfall 002.
- Flows Over 320 MGD up to 560 MGD - When the plant influent exceeds 320 MGD, 320 MGD would bypass the primary treatment process and be conveyed directly to secondary treatment and disinfection prior to discharge through Outfall 002. The remainder of the influent flow, up to 240 MGD, would be treated in the CEPT units, followed by disinfection in a new CCT prior to discharge through existing Outfall 001.

5.2.1.1.3 Benefits and Implementation Feasibility

Under this alternative, the flow receiving primary treatment only prior to discharge through Outfall 001 in wet weather conditions would receive a higher level of treatment. Typically, the removal of TSS via a CEPT process averages 60 to 90 percent versus 50 to 70 percent using conventional primary clarification without chemicals. This technology also has the ability to be used as conventional primary treatment without the use of chemicals during average flow conditions. Finally, more flow (up to 240 MGD) would be able to be handled under this alternative than the 160 MGD current primary treatment process.

The installation of a high-rate disinfection tank would allow for post-disinfection of primary effluent in partial treatment mode and the existing practice of feeding chlorine upstream of the primary clarifiers would be discontinued. As such, disinfection performance may be improved over currently operation as most of the solids would have been removed before disinfection, thereby decreasing chlorine demand.

However, construction of this alternative would have a great impact on the operation of the plant, at least during the construction period. For implementation of Alternative A1, all four existing primary clarifiers will need to be taken out of service. During construction, the plant capacity would be restricted to 320 MGD sustained/360 MGD instantaneous through the secondary treatment process only, eliminating both the normal and partial treatment modes, until construction is complete.

It is expected that the O&M costs under Alternative A would be higher than the costs for the existing primary clarifiers, mainly due to the additional chemicals (metal salt and a polymer) that would be fed during wet weather conditions, as well as the energy required to effectively mix the chemicals into the flow stream.

5.2.1.1.4 Cost Estimate

The engineer's estimate of probable total project cost for the new CEPT tanks and associated facilities under Alternative A1 is $64.9 million. The estimated annual O&M cost of $550,000 are based on a CEPT operation of approximately 345 hours in a typical year when plant flows exceed 320 MGD, with the CEPT tanks in conventional primary clarifier operation the remainder of the time.

5.2.1.2 Alternative A2 – HRT to Replace Existing Primary Clarifiers

5.2.1.2.1 Description

An alternative for achieving primary treatment of flows in excess of the capacity of the secondary treatment is HRT. The proposed process schematic and a preliminary layout of this alternative are shown on Figures 5-7 and 5-8, respectively. The HRT system would replace the existing primary clarifiers to treat dry weather and wet weather flows up to 240 MGD.

The modifications required for this alternative are as follows:

- Construction of a new, primary influent conduit from the existing Grit Building to the new HRT tanks.
- Installation of one new fine screen immediately upstream of the HRT units (Actiflo only).
- Construction of a new Chemical Storage Building for ferric chloride and polymer.
- Installation of six new HRT (Actiflo®/Densadeg® Type) Units. The design of the system would depend on the manufacturer of the equipment as follows:
    - Actiflo® - each HRT train includes four process tanks: coagulation, injection, maturation, and settling. Each train also includes three sets of sludge/sand recirculation pumps and three sets of hydrocyclones to separate sludge from microsand.
    - Densadeg® - each HRT train includes three process tanks: rapid mix, reaction, and settling/thickening. Each train includes two sludge recirculation pumps and one sludge waste pump.
- Installation of new slide gates upstream and downstream of each HRT unit.
- Construction of a new building for the HRT equipment.

- Installation of a new 240 MGD high-rate disinfection chlorine contact tank (CCT) and new sodium hypochlorite feed equipment and mixers, sized the same as the CCT and chemical systems designed under Alternative A1.
- Construction of two effluent conduits: one to the secondary treatment processes and a second to Outfall 001 to be used during partial treatment mode.

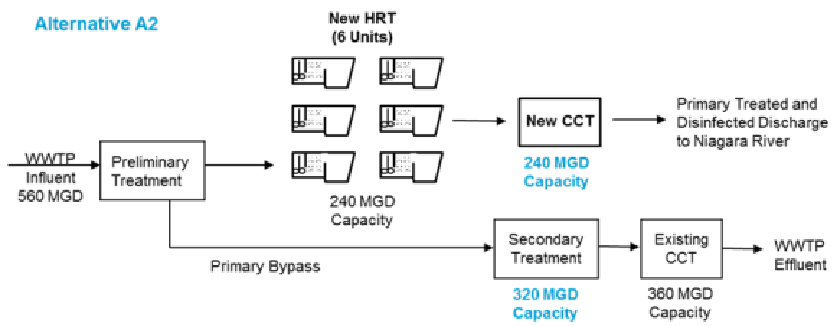


Figure 5-7: Process Flow Diagram for Actiflo® HRT System proposed under Alternative A2

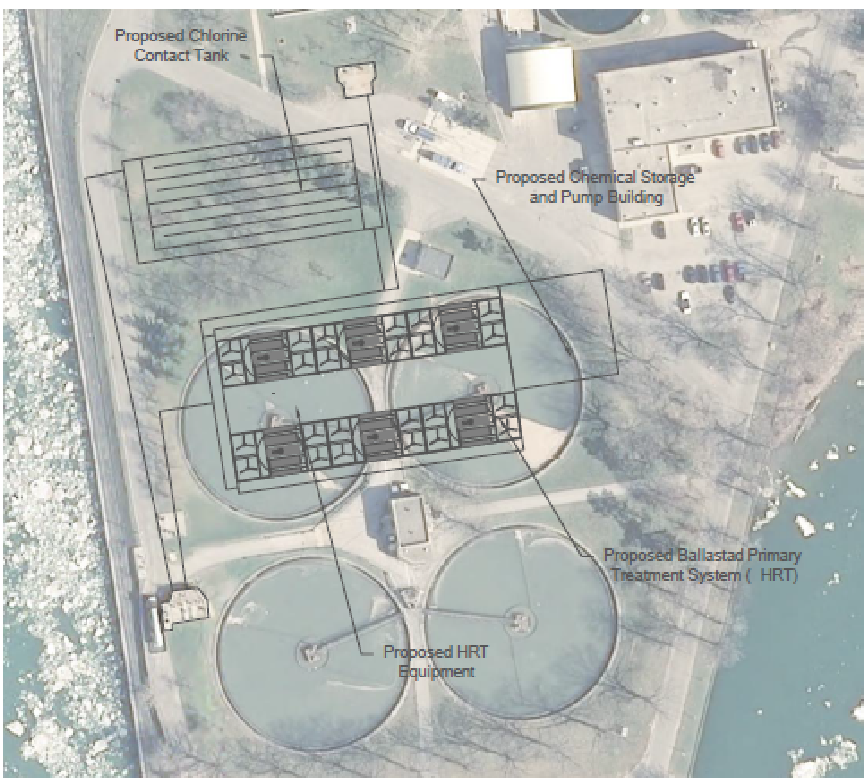


Figure 5-8: Preliminary Site Layout for Alternative A2

Unlike the CEPT system described under Alternative A1, HRT systems do not work effectively without chemical addition at average plant flows. Therefore up to three of the six HRT units would be required (with associated chemical addition) under average flow conditions.

5.2.1.2.2 Operation

The proposed operation of the improvements described in Alternative A2 would depend on the influent flows to the plant, as follows:

- Flows up to 320 MGD - Up to three of the six HRT units operate in full HRT mode for average flows with all effluent treated in secondary treatment. As plant flow increases, additional HRT units will be brought on-line as required, while allowing for the startup time of the additional units.

- Flows over 320 MGD up to 560 MGD - When the plant influent exceeds 320 MGD, screened plant influent up to 320 MGD is conveyed directly to and treated through secondary treatment and the remaining flow up to 240 MGD is treated with the HRT systems, followed by disinfection, prior to discharge through Outfall 001.

5.2.1.2.3 Benefits and Implementation Feasibility

Similar to Alternative A1, the amount of flow receiving primary treatment only prior to discharge through Outfall 001 in wet weather conditions would receive a higher level of treatment. HRT processes average 80 to 85 percent TSS removal versus 50 to 70 percent using conventional primary clarification without chemicals. However, unlike the CEPT process, HRT technology requires chemical and ballast addition under all flow conditions, contributing to higher O&M costs than other treatment technologies. However, the removal of solids under all flow conditions would be enhanced.

The cost of HRT systems also tends to be higher than other technologies due to its many components (i.e., tankage, mixers, chemical pumps, chemical storage, ballast, pumps, etc.). However, HRT systems have a smaller footprint than other technologies.

Construction of this alternative would have a great impact on the operation of the plant, with the removal of all four primary clarifiers from operation and eliminating partial treatment mode for the duration of the construction period. As with Alternative A1, the plant capacity would be restricted to 320 MGD sustained/360 MGD instantaneous through the secondary treatment process only until construction is complete.

This alternative will also eliminate the current practice of feeding chlorine upstream of the primary clarifiers, with the use of a new high-rate disinfection chlorine contact tank that would treat the total primary effluent flow of 240 MGD.

5.2.1.2.4 Cost Estimates

The engineer's estimate of probable total project cost for HRT systems sized up to 240 MGD is $81.9 million. The estimated annual O&M costs are based on operation of the HRT with varying numbers of units 24 hours per day, 7 days per week. In estimating O&M costs, it was assumed that up to three HRT units will be in operation for average influent plant flows and all units would be in operation approximately 345 hours when plant flows exceed 320 MGD. The estimated annual O&M cost is $2,750,000.

5.2.2 Increase Secondary Treatment Capacity to 360 MGD (Alternative B)

The following describes those alternatives available for treating flows in excess of a sustained secondary treatment capacity of 360 MGD, primarily through partial treatment mode. Under these alternatives, 360 MGD would bypass the primary clarifiers and be conveyed to the secondary treatment process for treatment, with the remainder of the flow receiving primary treatment. Some modifications are required to the existing secondary treatment process to implement these alternatives, as described below.

5.2.2.1 Required Secondary Treatment System Improvements

Recent hydraulic modeling efforts indicated that some secondary system improvements will be necessary in order to provide sustained peak flow capacity of 360 MGD. Improvements required in the secondary treatment process are detailed below.

5.2.2.1.1 Clarifiers

To hydraulically carry 360 MGD flow and provide a minimum of 6-inches of freeboard between the clarifier influent channel and effluent channel, additional influent orifices are required in the peripheral influent channels in each secondary clarifier. Each clarifier currently has approximately 48 six-inch diameter and 14 eight-inch diameter orifices in the bottom of the peripheral influent trough, spaced at approximately 6.5-ft apart. To convey 360 MGD through the clarifiers and still maintain the required 6-inches of freeboard at the wall separating the clarifier influent and effluent channels, it is estimated that 47 seven-inch diameter orifices (or equivalent) would need to be added to each clarifier influent peripheral channel.

5.2.2.2 Alternative B1 - Additional Primary Clarifiers with Disinfection

5.2.2.2.1 Description

Alternative B1 provides primary treatment of all plant flows in excess of 360 MGD by utilizing the 160 MGD capacity of the existing clarifiers and adding one new clarifier and 200-MGD chlorine contact tank for high-rate disinfection of partially treated flows prior to discharge via Outfall 001, as shown on Figure 5-9 and 5-10. The new clarifier would be designed to achieve a maximum design SOR of 2,000 gpd/sf, in accordance with Ten States' Standards guidance.

In addition to the modifications to the secondary treatment process as outlined in Section 5.2.2.1 above, plant modifications required for this alternative include:

- Construction of one new 160-ft diameter clarifier with sludge and scum collection system.
- Construction of new conduit from primary clarifier splitter box to the new clarifier.
- Construction of new conduits to connect the additional clarifier(s) to the secondary treatment system and existing Outfall 001.
- Installation of a new chlorine contact tank (CCT), sodium hypochlorite feed equipment, and mixers. The CCT would be sized to achieve a minimum contact time of 5 minutes at a peak flow of 200 MGD.

As demonstrated on Figure 5-10, this alternative would be very difficult to implement as there currently is not enough space at the site of the existing primary clarifiers to fit both a fifth primary clarifier and a 240 MGD chlorine contact tank. Additionally, the hydraulic grade line of the treatment facility may not accommodate the additional clarifier. At the same time, the Agencies have indicated that they did not prefer the continued practice of chlorination in the existing primary clarifiers during partial treatment mode. As such this alternative was eliminated from further consideration.

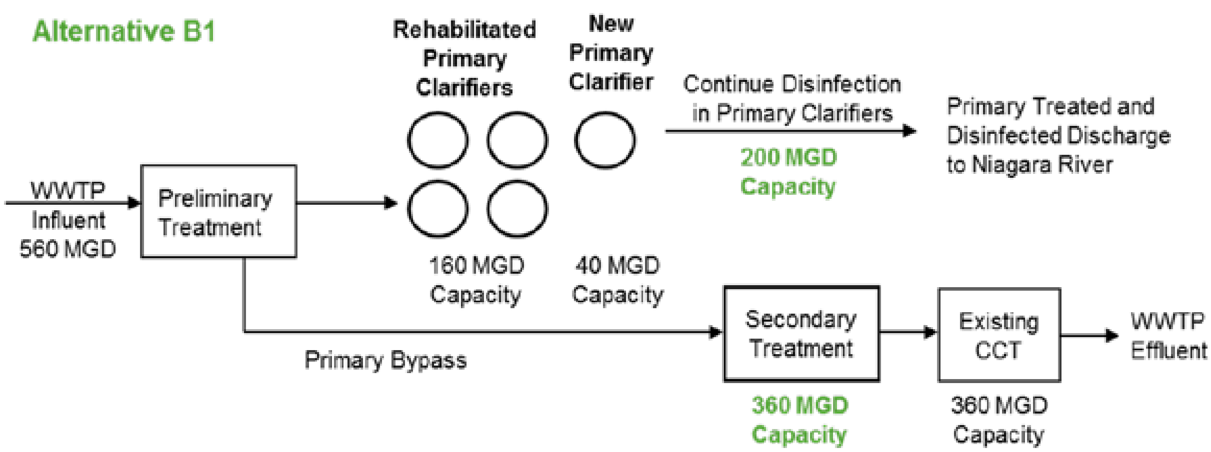


Figure 5-9: Process Flow Diagram for Alternative B1

Figure 5-10: Preliminary Site Layout of Alternative B1

5.2.2.3 Alternative B2 - Additional CEPT with Disinfection

5.2.2.3.1 Description

Alternative B2 is similar to Alternative B1 in that it would utilize the 160 MGD capacity of the existing clarifiers, but in lieu of providing another clarifier, a CEPT tank would be constructed to provide treatment of up to 40 MGD of additional flow to the primary treatment process during partial treatment mode. This alternative is shown on Figures 5-11 and 5-12. As with Alternative A1, the CEPT system would be designed to achieve a maximum design SOR of 4,000 gpd/sf. Ferric chloride and polymer would be added at the CEPT unit during wet weather to provide flocculation and enhanced solids settling at the higher surface overflow rates. This alternative also includes the construction of a new chlorine contact tank (CCT) for disinfection of flow receiving partial treatment (200 MGD) from the proposed CEPT tank) from both the existing primary clarifiers and the new CEPT unit. Major capital improvements required for this alternative include:

- Construction of a new conduit from the primary clarifier splitter chamber to the CEPT unit.

- Installation of a new ferric chloride and polymer dosing system in the CEPT influent conduit.
- Construction of a new Chemical Storage Building for ferric chloride and polymer.
- Construction of one 20-ft long, 20-ft wide, 10-ft deep rapid mix chamber, with a 20-HP mixer.
- Construction of one 15-ft long, 50-ft wide, 10-ft deep flocculation basin, with two 5-HP mixers.
- Construction of one 200-ft long, 50-ft wide, 14-ft side water depth (SWD) CEPT tank.
- Construction of new solids removal equipment and piping to convey settled sludge from the new CEPT unit.
- Installation of a new high-rate disinfection chlorine contact tank (CCT), sodium hypochlorite feed equipment, and mixers. The CCT would be sized to achieve a contact time of 5 minutes at a peak flow of 200 MGD.
- Construction of two effluent conduits: one from the CEPT tank to the secondary treatment process and a second from the CEPT tank to the new chlorine contact tank.
- Installation of new instrumentation and controls to allow the existing primary clarifiers to be used preferentially over the new CEPT unit during normal flow conditions.

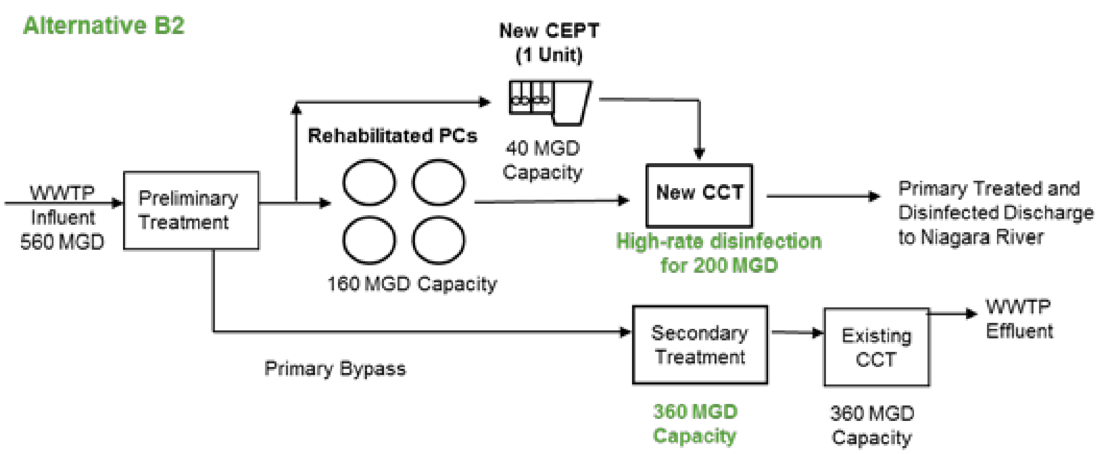


Figure 5-11: Process Flow Diagram of Alternative B2

Figure 5-12: Preliminary Site Layout of Alternative B2

5.2.2.3.2 Proposed Operation

The proposed operation of the improvements described in Alternative B2 is as follows:

- Flows below 160 MGD - The plant would operate in "normal" mode using the existing primary clarifiers. Primary effluent would subsequently be conveyed to the secondary treatment process and the main plant chlorine contact tanks and discharged through plant Outfall 002.

- Flows from 160 MGD to 360 MGD - When the plant influent exceeds 160 MGD (the capacity of the existing primary clarifiers, the plant would transition to full "primary bypass" mode with increasing plant influent conveyed directly through secondary treatment and processed along with primary effluent. All flow would be disinfected in the main plant's CCT and discharged through Outfall 002.

- Flows over 360 MGD up to 520 MGD - When the plant influent exceeds 360 MGD, 360 MGD would be conveyed directly to secondary treatment and disinfection prior to discharge through Outfall 002. The remainder of the influent flow, up to 160 MGD, would be treated in the existing primary clarifiers, followed by disinfection in a new CCT prior to discharge through existing Outfall 001.

- Flows Over 520 MGD up to 560 MGD - When the plant influent exceeds 360 MGD, 360 MGD would bypass the primary treatment process entirely and be conveyed directly to secondary treatment and disinfection prior to discharge through Outfall 002. A maximum flow of 160 MGD would be treated in the existing primary clarifiers and up to 40 MGD of additional flow would be treated by the new CEPT unit and followed by disinfection in the new CCT prior to discharge through existing Outfall 001.

Operation of the existing treatment processes at the plant and the proposed new CEPT tank is structured as described above, so as to take advantage of the existing processes on-site, while minimizing the amount of ferric chloride and polymer used. In this operating scheme, the use of the CEPT process is limited to only the highest flows to the plant in the range of 520 to 560 MGD.

5.2.2.3.3 Benefits and Implementation Feasibility

This alternative increases the capacity of the primary treatment system from 160 MGD to 200 MGD; however, only the new CEPT tank will use the addition of chemicals (a metal salt and polymer) for enhanced clarification. However, this will also mean that plant staff will have to operate two different primary treatment processes during wet weather: the existing primary clarifiers and the new CEPT unit.

Design of the new CEPT unit to operate in conjunction with the existing clarifiers is more difficult from a hydraulic standpoint than simply replacing the entire primary treatment process, as was done in Alternatives A1 and A2. Further modifications would be required to the primary bypass chamber in order to appropriately balance flow between the four existing primary clarifiers and the new CEPT unit. However, construction of the new CEPT unit would be much easier than the CEPT furnished in Alternative A1, because the existing primary clarifiers would be retained. Retaining the existing primary clarifiers also allows the WWTP to operate in its current three operational modes, including partial treatment under high flow conditions, for the duration of construction.

The high-rate disinfection chlorine contact tank would allow for post-disinfection for the total amount of primary effluent from the existing primary clarifiers and new CEPT unit in partial treatment mode. As such, the existing practice of feeding chlorine upstream of the primary clarifiers and using the clarifier volume to achieve disinfection contact time would be discontinued. In this treatment mode, disinfection performance may be improved over current operation as most of the solids would have been removed prior to disinfection, decreasing overall chlorine demand for the primary effluent.

5.2.2.3.4 Cost Estimate

The engineer's estimate of probable total project cost for the new CEPT tank and associated facilities as described above is $32.2 million. The estimated annual O&M costs are based on a CEPT operation of approximately 64 hours for a typical year when plant flows exceed 520 MGD. The estimated annual O&M cost of the CEPT unit is $400,000. The existing primary clarifiers would continue to be maintained as is current practice.

5.2.2.4 Alternative B3 - Additional Treatment Capacity in the Form of HRT

5.2.2.4.1 Description

In lieu of adding a 40 MGD CEPT tank to operate in parallel with the existing primary clarifiers, a similarly-sized HRT unit could be installed. The process flow diagram for Alternative B3 is shown on Figure 5-13. This alternative includes the construction of a new 200-MGD capacity high-rate disinfection chlorine contact tank (CCT) for disinfection of flow receiving partial treatment. The layout for this alternative at the WWTP is shown in Figure 5-14.

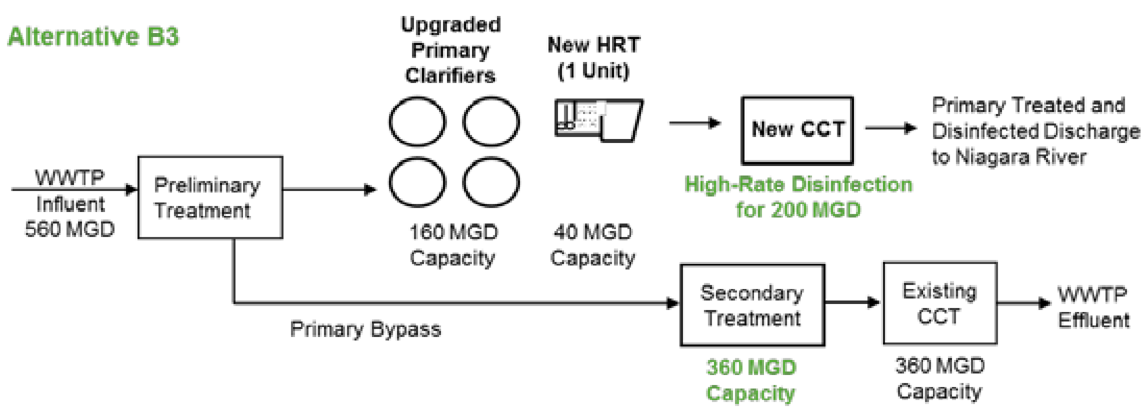


Figure 5-13: Process Flow Diagram for New HRT system Proposed Under Alternative B3

Figure 5-14: Preliminary Site Layout of Alternative B3

The modifications required for Alternative B3 are as follows:

- Construction of a new conduit from the primary clarifier splitter chamber to the HRT unit.
- Installation of one new fine screen immediately upstream of the HRT unit (Actiflo only).
- Construction of a new Chemical Storage Building for ferric chloride and polymer.
- Installation of one new 40-MGD HRT (Actiflo/Densadeg ® Type) train. The design of the system would depend on the manufacturer of the equipment as outlined in Alternative A2.
- Installation of new slide gates upstream and downstream of the HRT unit.
- Construction of a new building for the HRT equipment.
- Installation of a new high-rate chlorine contact tank (CCT) and new sodium hypochlorite feed equipment and mixers, sized to adequately disinfect up to 200 MGD of flow after primary treatment.

- Construction of two effluent conduits: one from the HRT to the secondary treatment process and a second from the HRT to the new chlorine contact tank.

- Installation of new instrumentation and controls to allow the HRT train to be used preferentially over the existing primary clarifiers during normal flow conditions.

5.2.2.4.2 Proposed Operation

The proposed operation of the improvements described in Alternative B3 is as follows:

- Flows up to 160 MGD - The plant would operate in “normal” mode using the existing primary clarifiers and the new HRT unit. The effluent from the primary treatment process would subsequently be conveyed to the secondary treatment process and the main plant chlorine contact tanks and discharged through plant Outfall 002.

- Flows from 160 MGD to 360 MGD - When the plant influent approaches 160 MGD (the capacity of the existing primary clarifiers), the plant would transition to full “primary bypass” mode with increasing plant influent conveyed directly through secondary treatment and treated along with flows passing through the primary treatment system. All flow would be disinfected in the main plant’s CCT and discharged through Outfall 002. Critical to this operation is maintaining at least some flow through the HRT unit.

- Flows Over 360 MGD up to 520 MGD - When the plant influent exceeds 360 MGD, 360 MGD would bypass the primary treatment process entirely and be conveyed directly to secondary treatment and then to disinfection prior to discharge through Outfall 002. The remainder of the influent flow, up to 160 MGD, would be treated in the HRT and existing primary clarifiers and followed by disinfection in a new CCT prior to discharge through existing Outfall 001.

- Flows Over 520 MGD up to 560 MGD - When the plant influent exceeds 520 MGD, 360 MGD would continue to bypass the primary treatment process and be conveyed directly to secondary treatment and disinfection prior to discharge through Outfall 002. A maximum flow of 160 MGD would be treated in the existing primary clarifiers and up to 40 MGD of additional flow would be treated by the new HRT unit, followed by high-rate disinfection in a new CCT prior to discharge through existing Outfall 001.

5.2.2.4.3 Benefits and Implementation Feasibility

Alternative B3 increases the capacity of the primary treatment system from 160 MGD to 200 MGD by adding a HRT unit to operate in conjunction with the existing primary clarifiers. However, this will also mean that plant staff will have to operate two different primary treatment processes during wet weather: the existing primary clarifiers and the new

HRT unit. As discussed in Section 5.1, HRT processes typically involve a lot of equipment that must be operated and maintained, leading to relatively high O&M costs as compared to other alternatives.

As with Alternative B2, the addition of an HRT unit to operate is more difficult to design from a hydraulic standpoint than replacing the primary treatment process. Flow will need to be balanced at the primary clarifier bypass chamber to ensure that flow is equally distributed between the existing clarifiers and the HRT unit. Construction of the single HRT unit, however, would be simplified because of its smaller footprint, allowing the primary clarifiers to stay in operation for the duration of construction.

The installation of a high-rate disinfection tank would allow for post-disinfection of primary effluent from the existing primary clarifiers and new HRT unit in partial treatment mode and the existing practice of feeding chlorine upstream of the primary clarifiers would be discontinued. As such, disinfection performance may be enhanced over the current operation as most of the solids would have been removed before disinfection, thereby decreasing chlorine demand.

5.2.2.4.4 Cost Estimate

The engineer's estimate of probable total project cost for the HRT process and associated facilities as described in Alternative B3 is $31.7 million. The estimated annual O&M costs are based on an estimated operation of approximately 262 hours for a typical year when plant flows exceed 360 MGD. The estimated annual O&M cost of the HRT unit is $720,000. The existing primary clarifiers would continue to be maintained as they are.

5.2.2.5 Alternative B4 - Additional Storage

5.2.2.5.1 Description

This alternative involves the construction of a new storage facility at the WWTP that would store flow in excess of 520 MGD (after treating 160 MGD in the existing primary clarifiers and up to 360 MGD in the secondary treatment process).Thirteen million gallons of storage would be required, as detailed in Section 5.1.2.5 of this report. A process flow schematic is presented in Figure 5-15 and the proposed layout is shown in Figure 5-16.

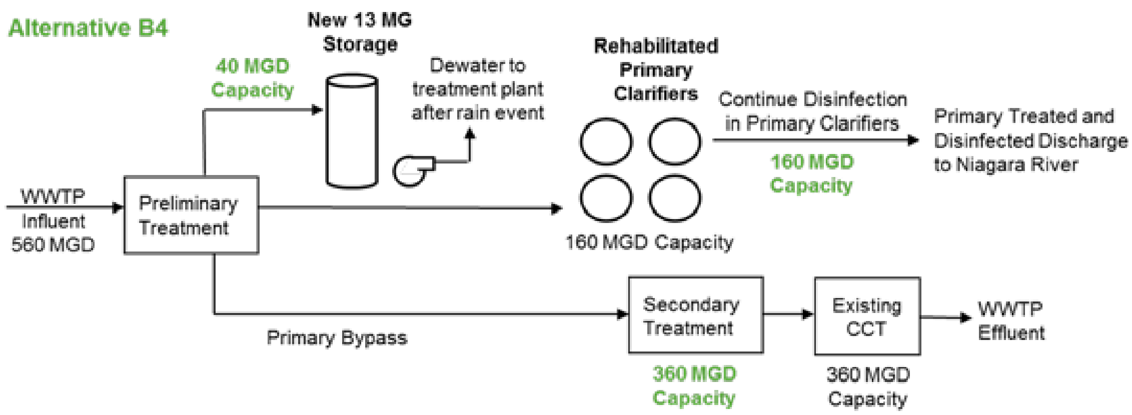


Figure 5-15: Process Flow Diagram for Alternative B4

Figure 5-16: Process Flow Diagram for Alternative B4

5.2.2.5.2 Proposed Operation

The proposed operation for the storage alternative would be as follows.

- Flows below 160 MGD - The plant would operate in “normal” mode using the existing primary clarifiers. Primary effluent would subsequently be conveyed to the secondary treatment process and the main plant chlorine contact tanks and discharged through plant Outfall 002.

- Flows from 160 MGD to 360 MGD - When the plant influent exceeds 160 MGD (the capacity of the existing primary clarifiers), the plant would transition to full “primary bypass” mode with increasing plant influent conveyed directly through secondary treatment and processed along with primary effluent. All flow would be disinfected in the main plant’s CCT and discharged through Outfall 002.

- Flows Over 360 MGD up to 520 MGD - When the plant influent exceeds 360 MGD, 360 MGD would bypass the primary treatment process entirely and be conveyed directly to secondary treatment and disinfection prior to discharge through Outfall 002. The remainder of the influent flow, up to 160 MGD, would be treated in the existing primary clarifiers and followed by disinfection in a new CCT prior to discharge through existing Outfall 001.

- Flows Over 520 MGD up to 560 MGD - When the plant influent exceeds 520 MGD, any flows over that amount would be pumped to a new storage tank on the north end of the treatment plant site, until the peak flows through the WWTP subside. The stored flows would then be conveyed back to the settled wastewater pump station via gravity for subsequent treatment and disinfection and then discharged through Outfall 002.

5.2.2.5.3 Benefits and Implementation Feasibility

This alternative was originally conceived to locate the required storage tank near the primary clarifiers to minimize the amount of piping required to convey flows to and from the storage tank. Figure 5-16 shows the 13 million gallon tank as a storage shaft. Flow in excess of the secondary and primary treatment capacities (360 MGD and 160 MGD) would be conveyed by gravity to the storage shaft. Following the wet weather event, the storage shaft would be dewatered to the settled wastewater pump station using a storage shaft pump station that would convey the contents to the WWTP for treatment following the wet weather event.

However, this initial concept was dismissed as being extremely difficult, due to the depth and footprint required for the storage shaft, the existing soils, the presence of rock, and groundwater levels at the WWTP. An alternate storage configuration was subsequently evaluated which involved building a 13 million gallon storage tank in the area of the former ash lagoons at the north end of the WWTP site. However, this location would require pumping of primary flow from the primary bypass chamber to the storage tank during partial treatment mode, requiring larger pumps than those required for the storage shaft option. In addition, this alternate configuration would require extensively more pipe to convey flow to and from the storage tank.

5.2.2.5.4 Cost Estimate

The engineer's estimate of probable total construction cost for a storage tank and associated pumping facilities is $121.6 million. The estimated annual O&M costs are based on a use of the storage tank for approximately 64 hours for a typical year when plant flows exceed 520 MGD. The estimated annual O&M cost of the pumping facility associated with the storage tank is $270,000. The primary clarifiers would continue to be maintained as they currently are.

5.2.2.6 Alternative B5 - CEPT to Replace Existing Primary Clarifiers

5.2.2.6.1 Description

This alternative is similar to Alternative A1, except in this case, the CEPT facilities with a capacity of up to 200 MGD would be required. With a secondary treatment capacity of up to 360 MGD, more flow can be processed through the secondary treatment processes, decreasing the size of the CEPT units for the primary treatment process, as opposed to the CEPT unit proposed under Alternative A1. The process flow diagram for this alternative is shown in Figure 5-17.

The CEPT facility would consist of five new tanks that provide 50,000 sf of tank surface area to operate at a target SOR of 4,000 gpd/sf at 200 MGD. The CEPT tanks would operate as conventional primary clarifiers, with no chemical addition, during average flow conditions. As wet weather flows increase, chemical addition would only commence as influent flows approach the secondary treatment capacity. This approach allows sufficient time to initiate the chemical feed and mixing facilities before influent flows exceed the secondary treatment capacity at which time the CEPT effluent would discharge to Outfall 001. Figure 5-18 shows the layout of the new CEPT system under this alternative.

New high-rate disinfection facilities would be required for this alternative and similar to the CEPT and HRT alternatives discussed previously, additional solids generation will potentially be a concern and therefore a new sludge pumping system will likely be required.

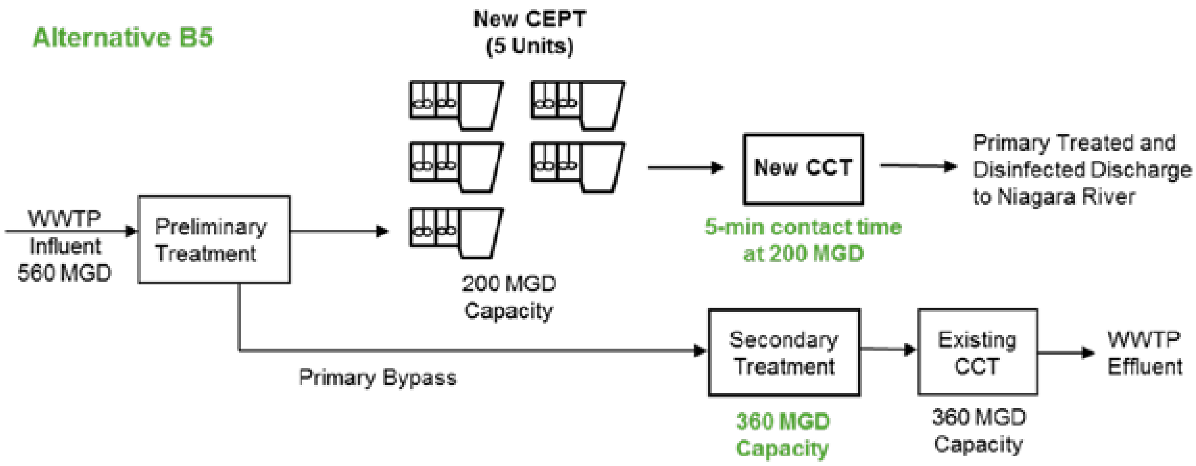


Figure 5-17: Process Flow Diagram for Alternative B5

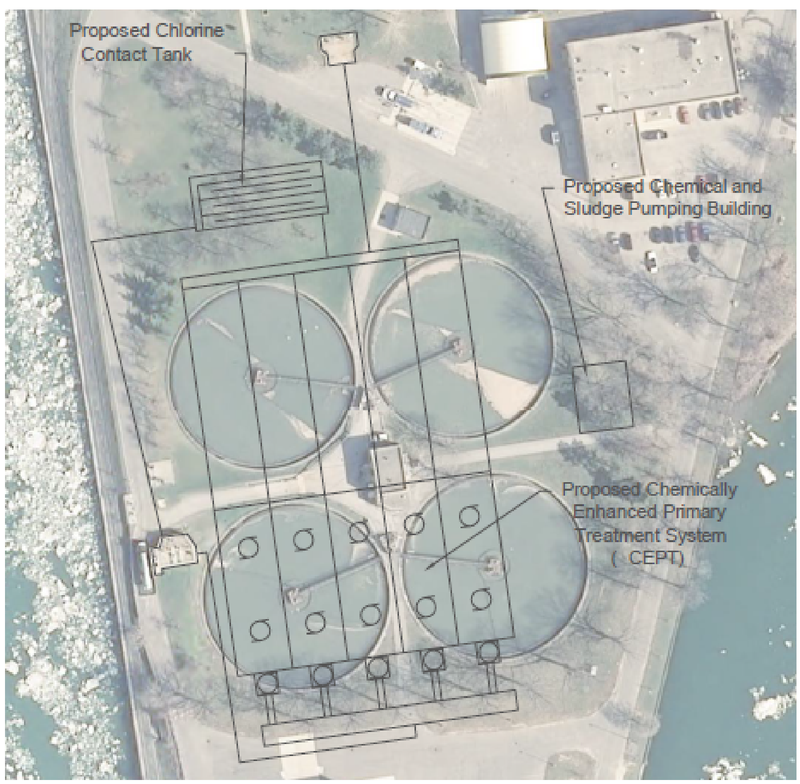


Figure 5-18: Preliminary Site Layout of Alternative B5

5.2.2.6.2 Proposed Operation

The proposed operation of the improvements in this alternative is as follows:

- Flows below 200 MGD - The plant would operate in "normal" mode with the new CEPT tanks acting as conventional primary clarifiers with no chemical addition. Primary effluent would subsequently be conveyed to the secondary treatment process and the chlorine contact tanks and discharged through plant Outfall 002.

- Flows from 200 MGD to 360 MGD - When the plant influent exceeds 200 MGD, the plant would begin to transition to "primary bypass" mode with increasing plant influent conveyed directly through secondary treatment and processed along with primary effluent. CEPT operation in the primary clarifiers would be initiated at an influent flow of 440 MGD in anticipation of influent flows further increasing above 360 MGD. All flow would be disinfected in the effluent CCT and discharged through Outfall 002.

- Flows Over 360 MGD up to 560 MGD - When the plant influent exceeds 360 MGD, 360 MGD would bypass the primary treatment process and be conveyed directly to secondary treatment and disinfection prior to discharge through Outfall 002. The remainder of the influent flow, up to 200 MGD, would be treated in the CEPT units, followed by disinfection in a new CCT prior to discharge through existing Outfall 001.

5.2.2.6.3 Benefits and Feasibility of Implementation

This CEPT system would involve the same advantages and disadvantages as discussed for Alternative A1, but would be sized for 200 MGD (i.e., 40 MGD smaller than the CEPT system proposed under Alternative A1). As with most of the other alternatives, it would be followed by a high-rate disinfection chlorine contact tank, which would eliminate the current practice of pre-chlorination of primary influent during partial treatment.

However, this alternative has the advantage that more of the flow is redirected to the secondary treatment process, which averages approximately 90 percent TSS removal, as compared to the 70 percent average removal in the CEPT unit. Therefore the amount of solids captured in this alternative is estimated to be greater than the previous alternatives. However, over the ten to eleven days the system is expected to operate, this additional treatment removal will not be significant from a water quality perspective.

5.2.2.6.4 Cost Estimate

The engineer's estimate of probable total construction cost for the new 200-MGD CEPT tanks and associated facilities is $61.5 million. The estimated annual O&M costs are based on a CEPT operation of approximately 262 hours for a typical year when plant flows exceed 320 MGD, with the CEPT tanks in conventional primary clarifier operation the remainder of the time. The estimated annual O&M cost is $460,000.

5.2.2.7 Alternative B6 - HRT to Replace Existing Primary Clarifiers

5.2.2.7.1 Description

In this alternative, an HRT system would replace the existing primary clarifiers to treat dry weather and wet weather flows up to 200 MGD. The process flow diagram is shown in Figure 5-19 and the layout of the processes at the site is shown on Figure 5-20.

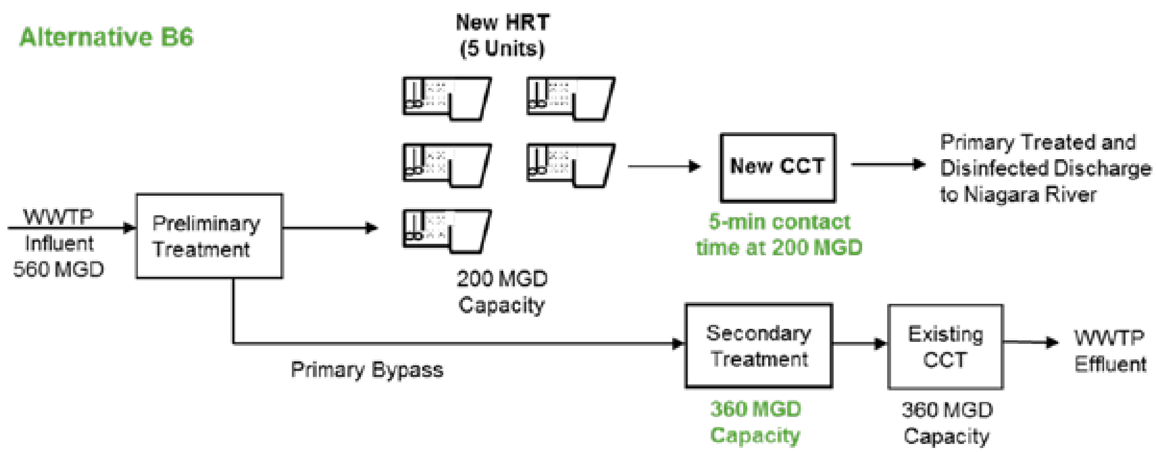


Figure 5-19: Process Flow Diagram for Alternative B6

Figure 5-20: Preliminary Site Layout of Alternative B6

The modifications required for this alternative are as follows:

- Construction of a new, primary influent conduit from the existing Grit Building to the new HRT tanks.
- Installation of one new fine screen immediately upstream of the HRT units (Actiflo only).
- Construction of a new Chemical Storage Building for ferric chloride and polymer.
- Installation of five new HRT (Actiflo/Densadeg ® Type) Units. The design of the system would depend on the manufacturer of the equipment as follows:
  - Actiflo ® - each HRT train includes four process tanks: coagulation, injection, maturation, and settling. Each train also includes three sets of sludge/sand recirculation pumps and three sets of hydrocyclones to separate sludge from microsand.
  - Densadeg ® - each HRT train includes three process tanks: rapid mix, reaction, and settling/thickening. Each train includes two sludge recirculation pumps and one sludge waste pump.
- Installation of new slide gates upstream and downstream of each HRT unit.
- Construction of a new building for the HRT equipment.
- Installation of a new high-rate chlorine contact tank (CCT) and new sodium hypochlorite feed equipment and mixers to disinfect up to 200 MGD.
- Construction of two effluent conduits: one to the secondary treatment processes and a second to Outfall 001 to be used during partial treatment mode.

Up to three of the five HRT units (with associated chemical addition) are required to be in operation under average flow conditions to maintain the HRTs in good working condition, so that additional ones can be put into operation as the flows increase.

5.2.2.7.2 Operation

The proposed operation of the improvements described in Alternative B6 would depend on the influent flows to the plant, as follows:

- Flows below 200 MGD - The plant would operate in “normal” mode with three of the five HRT units operating under normal flow conditions and providing primary treatment with additional units placed into operation up to the full 200-MGD capacity of the primary treatment system. Effluent from the HRT units would subsequently be conveyed to the secondary treatment process and the chlorine contact tanks and discharged through plant Outfall 002.

- Flows from 200 MGD to 360 MGD - When the plant influent exceeds 200 MGD, the plant would begin to transition to “primary bypass” mode with increasing plant influent conveyed directly to secondary treatment and processed along with primary effluent. All flow would be disinfected in the effluent CCT and discharged through Outfall 002.

- Flows Over 360 MGD up to 560 MGD - When the plant influent exceeds 360 MGD, 360 MGD would bypass the primary treatment process and be conveyed directly to secondary treatment and disinfection prior to discharge through Outfall 002. The remainder of the influent flow, up to 200 MGD, would be treated in the HRT units, followed by disinfection in a new CCT prior to discharge through existing Outfall 001.

5.2.2.7.3 Benefits and Feasibility of Implementation

As with Alternatives A1, A2, and B5, the replacement of the primary treatment process with an alternate 200-MGD process would be very complex from a design and construction standpoint. The existing primary clarifiers would not be able to be kept in operation for the duration of construction, effectively limiting the plant capacity to 360 MGD (secondary process capacity). In addition, the HRT systems include a lot of tanks and equipment that must be maintained, as well as the use of a significant amount of chemicals. As such, the O&M costs for the HRT option tends to be significantly greater than any of the other alternatives evaluated. Also, capital costs for HRT system are typically more expensive than the other options because of the large amount of equipment required, despite the smaller physical footprint. Because of the high costs associated with building and maintaining this type of system, it would be difficult to implement at the WWTP.

5.2.2.7.4 Cost Estimates

The engineer’s estimate of probable total project cost for HRT systems sized up to 200 MGD is $69.3 million. The estimated annual O&M costs are based on operation of the HRT with varying numbers of units 24 hours per day, 7 days per week. In estimating O&M costs, it was assumed that up to three HRT units will be in operation for average influent plant flows and all units would be in operation approximately 262 hours per year when plant flows exceed 360 MGD. The estimated annual O&M cost is $2,690,000.

5.2.3 Increase Secondary Treatment Capacity to 400 MGD

5.2.3.1 Required Secondary Treatment and Disinfection System Improvements

5.2.3.1.1 Secondary Clarifiers

While the sixteen existing secondary clarifiers can hydraulically handle up to 400 MGD with the addition of forty-six 6.3-inch orifices at the peripheral influent channel to each clarifier; the hydraulic loading rates on each clarifier is relatively high when compared to typical design loading rates. Therefore, an additional two clarifiers (one additional clarifier per battery) would be required to maintain peak surface loading rates of around 1,600-1,700 gpd/sf. While this surface loading rate is higher than that suggested by guidelines in Ten States Standards, the clarifiers have been able to handle this flow, because at the same time, step feed operation of the aeration tanks have maintained maximum solids loading rates of approximately 35 lbs/d/sf to the clarifiers with fourteen of the sixteen clarifiers in operation, which is significantly less than the 50 lbs/d/sf maximum solids loading rate guidelines indicated in Ten States Standards. With lower solids loading rates, the existing clarifiers have performed well, consistently removing solids and BOD to less than 10 mg/L in the effluent. Two additional clarifiers are recommended under this set of alternatives, however, to maintain existing hydraulic surface overflow rates and provide additional operating flexibility.

5.2.3.1.2 Chlorine Contact Tanks

The existing final effluent disinfection system is sized to provide a minimum of 15 minutes of contact time at a peak flow of 360 MGD. To disinfect a total flow of up to 400 MGD, a fifth chlorine contact tank is required. This tank would be sized to hold 417,000 gallons to provide a minimum contact tank of 15 minutes at the additional peak flows of 40 MGD. Additional hypochlorite pumping and storage capacity may also be required to be able to feed the chlorine into solution for use in the fifth contact tank.

5.2.3.2 Alternative C1 – Maintain Existing Primary Clarifiers

5.2.3.2.1 Description

Alternative C1 (Figures 5-21 and 5-22) assumes that the use of existing four primary clarifiers is continued to treat flows up to 160 MGD in normal and partial treatment modes. While no additional tanks are required, there will be some costs associated with upgrades required to keep them in reliable operating condition. Under this alternative, the current practice of feeding sodium hypochlorite at the primary influent and using the clarifier volume to achieve the required chlorine contact time is continued; however, the Agencies have indicated that this is not their preferred alternative. As such, Alternative C2, described in Section 5.2.3.3, will include a chlorine contact tank.

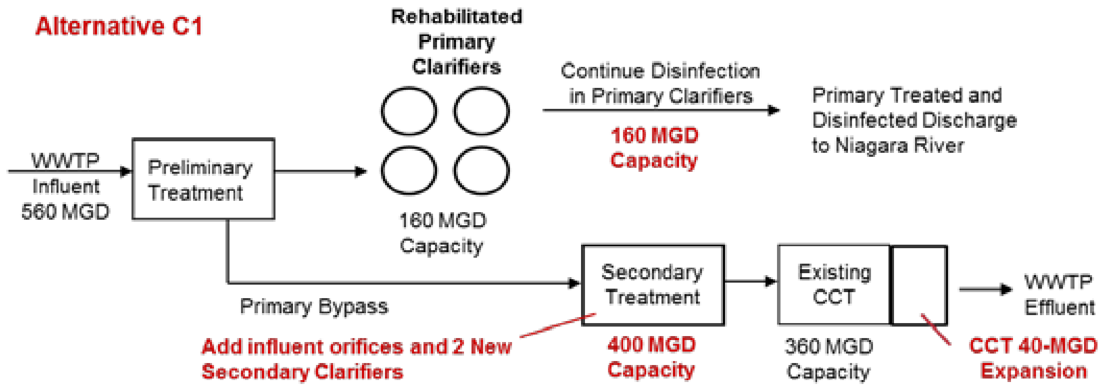


Figure 5-21: Process Flow Diagram for Alternative C1

Figure 5-22: Preliminary Site Layout of Alternative C1

The modifications required for this alternative, in addition to the secondary treatment process modifications summarized above to achieve a 400-MGD capacity in the secondary treatment process, are as follows:

- Replacement of the sludge and scum collection systems in each of the primary clarifiers.
- Replacement of the primary sludge pumps.
- Miscellaneous other repairs required to keep the clarifiers in good working condition.

5.2.3.2.2 Proposed Operation

Under Alternative C1, the proposed plant operation is as follows:

- *Flows below 160 MGD* - The plant operates in “normal” mode with primary and secondary treatment in series up to 160 MGD.
- *Flows Over 160 MGD up to 400 MGD* - When the plant influent exceeds 160 MGD, the plant operates in “primary bypass” mode with up to 240 MGD of screened plant influent conveyed directly to the secondary treatment process, with the remainder of the flow (up to 160 MGD) treated in series through primary and secondary treatment.
- *Flows Over 400 MGD up to 560 MGD* - When the plant influent exceeds 400 MGD, partial treatment mode is activated where screened plant influent up to 400 MGD is conveyed to and treated in the secondary treatment process and the remaining flow (up to 160 MGD) receives primary treatment in the existing primary clarifiers, as is current practice.

5.2.3.2.3 Benefits and Implementation Feasibility

The “C” alternatives promote the expansion of the secondary treatment process capacity to optimize treatment of flows in normal, primary bypass, and partial treatment modes. Under Alternative C1, up to 400 MGD would be conveyed to the secondary treatment process and be conveyed through the main plant chlorine contact tanks prior to discharge. As discussed previously, TSS removals of up to 90 percent can be achieved in the secondary system. With a reduced flow of 160 MGD going to the primary clarifiers, primary performance is expected to improve with the lower hydraulic loading rates applied.

In addition, this alternative is very favorable in the maintenance of plant operations during construction. Because most of the construction deals with secondary system improvements of adding two clarifiers and extending the existing chlorine contact tank, the plant can continue to run in its current operational modes for the duration of construction. Construction should also not severely impede normal operation and maintenance activities due to the greater amount of space available at the north end of the site, as opposed to the area around the primary clarifiers.

However, this option does not include the chlorine contact tank at the primary clarifiers. Under Alternative C1, the current practice of adding chlorine upstream of the primary clarifiers and using the volume of the primary clarifiers to achieve the required contact time would be continued.

5.2.3.2.4 Cost Estimate

The estimate of probable project cost is approximately $30.4 million. Estimated annual O&M cost is $280,000.

5.2.3.3 Alternative C2 – Maintain Existing Primary Clarifiers and Add Primary Effluent Disinfection

5.2.3.3.1 Description

Alternative C2 (Figures 5-23 and 5-24) also retains the existing four primary clarifiers to handle up to 160 MGD through the primary treatment process in partial treatment mode, however, it does include the additional provision of a high-rate disinfection chlorine contact tank and associated sodium hypochlorite storage and feed systems for the disinfection of primary effluent prior to discharge through Outfall 001. Under this alternative, the existing primary clarifiers would not be used in achieving the required disinfectant contact time as is current practice; but instead, sodium hypochlorite would be injected at the head of a new chlorine contact tank, sized to provide a contact time of 5 minutes at the peak flow of 160 MGD, to be located adjacent to the existing primary clarifiers.

5.2.3.3.2 Proposed Operation

The operation of this alternative is identical to the operation of Alternative C1, except that flows passing through the primary clarifiers during partial treatment would not receive disinfection within the clarifiers, but downstream of the clarifiers in a new chlorine contact tank prior to discharge through Outfall 001.

5.2.3.3.3 Benefits and Implementation Feasibility

As with Alternative C1, Alternative C2 involves the expansion of the secondary treatment process capacity to 400 MGD to optimize treatment of flows in normal, primary bypass, and partial treatment modes. This greater secondary treatment capacity will result in higher TSS capture and more efficient disinfection of flows up to 400 MGD in the main plant chlorine contact tank. Design and construction is further simplified for the reasons given in the narrative for Alternative C1.

However, this alternative improves upon Alternative C1 by including a high-rate disinfection chlorine contact tank at the primary clarifiers for more effective disinfection of flows during partial treatment mode.

5.2.3.3.4 Cost Estimate

The capital cost for Alternative C2 is approximately $40.5 million. Annual O&M is estimated at $340,000.

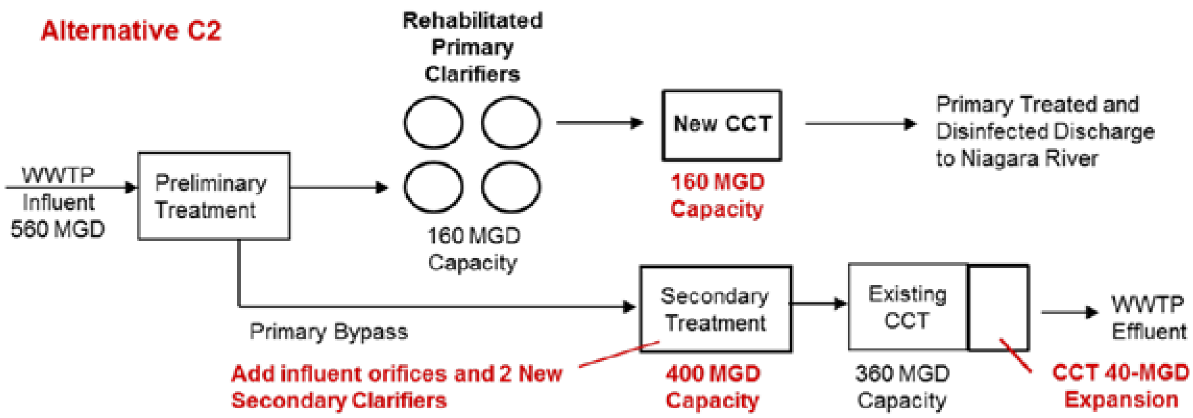


Figure 5-23: Process Flow Diagram for Alternative C2

Figure 5-24: Preliminary Site Layout of Alternative C2

5.3 Comparison and Evaluation of Alternatives

Table 5-2 presents the summary of projected project, annual O&M, and 20-year life cycle costs for the alternatives. As can be observed, Alternative C1 has the lowest life cycle cost, followed by Alternatives B2 and B1. The HRT alternatives (A2, B3, and B6) tended to have the highest O&M costs, which had a significant impact on the overall 20-year life cycle cost.

Table 5-2: Summary of Estimated Project Costs, Annual O&M Costs, and 20-year life cycle costs (LCC)

Alternative		New Process Sizing (MGD)	CCT Sizing (MGD)	Prob Proj Cost, $M	Annual O&M, $M	20-year LCC, $M
A1	Primary CEPT	240	240	$ 64.9	$ 0.55	$72.3
A2	Primary HRT	240	240	$ 81.9	$ 2.75	$119.3
B1	Add 1 Primary Clar	40	200	$ 23.2	$ 0.29	$27.2
B2	Increm CEPT	40	200	$ 32.2	$ 0.40	$37.6
B3	Increm HRT	40	200	$ 31.7	$ 0.72	$41.6
B4	Storage	200	N/A	$ 121.6	$ 0.27	$125.3
B5	Primary CEPT	200	200	$ 60.6	$ 0.46	$66.9
B6	Primary HRT	200	200	$ 69.3	$ 2.69	$105.9
C1	Current + Sec. Treatment Improvements	160	N/A	$ 30.4	$ 0.28	$34.2
C2	Current + Sec. Treatment Improvements	160	160	$ 40.5	$ 0.34	$45.1

While not a water quality consideration, for alternative performance comparison only, evaluations considered estimated TSS removals for the estimated typical year volume discharged through Outfall 001. The projected TSS removals estimated for each alternative are based on:

- the average WWTP TSS influent concentration;
- estimated volume distribution between the primary and secondary treatment systems as well as the volume distribution between various primary treatment technologies within the same alternative (e.g. B2 and B3) ;
- an assumed TSS removal corresponding to the type of treatment used in each alternative
  - CEPT – Assumed 70 percent TSS removal
  - HRT – Assumed 85 percent TSS removal
  - Primary clarification – Assumed 60 percent TSS removal
- Secondary treatment process during partial treatment mode – Assumed 90 percent TSS removal

The expected removal of TSS is specific to each alternative. Table 5-1 presents TSS removal performance for each alternative during the typical year including:

- Estimated total annual lbs of TSS removed for the estimated volume of wet weather flows currently discharged through outfall 001 (1,040 MG). Note that as the secondary treatment capacity increases, the volume discharged through outfall 001 decreases (as summarized in Table 5-1).
- Estimated total annual lbs of TSS removed by the WWTP for everyday operations and secondary system bypass events (sum of Outfalls 001 and 002)
- Estimated 20-year life cycle costs for each alternatives per 1 lb of TSS removed from the
- Estimated volume of wet weather flows currently discharged through outfall 001 (1,040 MG).

Table 5-3: Summary of TSS Removed in Partial Treatment Mode for All Alternatives

Alternative		Primary Volume (MG)	TSS Removal in Primary Treatment (tpy)	TSS Removal in Secondary Treatment (tpy)	Total TSS Removed in Partial Treatment Mode (tpy)
A1	CEPT	1040.2	279	0	279
A2	HRT	1040.2	339	0	339
B1	Add 1 Clar	716.0	165	112	277
B2	Increm CEPT	716.0	170	112	282
B3	Increm HRT	716.0	179	112	290
B4	Increm Stor	716.0	165	112	277
B5	CEPT	716.0	192	112	304
B6	HRT	716.0	233	112	345
C1	Current	463.7	107	199	306
C2	Current+CCT	463.7	107	199	306

As can be seen from this summary, the relative performance of each alternative is very similar and the annual lbs of TSS removed during the partial treatment events are negligible to the overall plant removals, as shown in Figure 5-25.

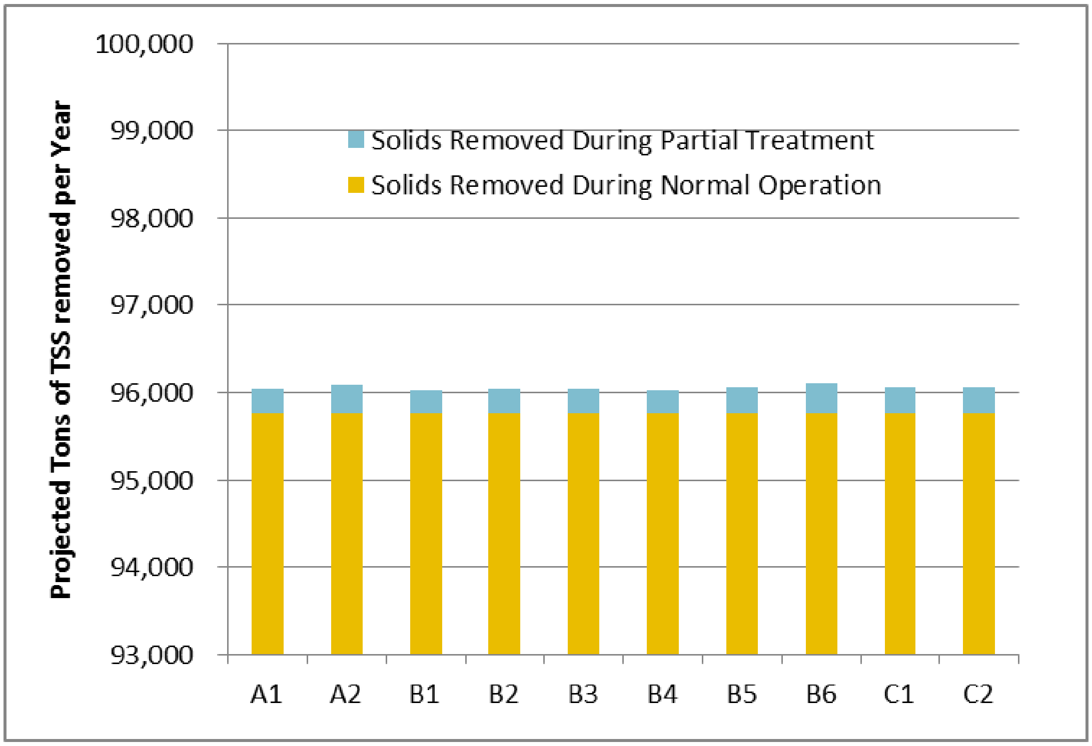


Figure 5-25: Summary of Solids Removed in Primary and Secondary Treatment Processes

To incorporate this information as well as other discussions presented in each alternative discussion, each alternative was scored on a number of non-economic criteria. Each criterion was weighted according to importance. As seen in the list below, TSS Removal/Process Performance was weighted most heavily, following by Maintenance of Plant Operations during construction. The evaluated criteria included:

- Process Performance (Relative weight of 25 out of 100) - ability of the alternative to achieve a higher level of treatment performance than what is received currently under partial treatment flow conditions
- Capital Cost (Relative weight of 15 out of 100) – total project cost as shown above in Table 5-2
- Operations & Maintenance (O&M) Costs (Relative weight of 10 out of 100) – estimated annual O&M costs as shown above in Table 5-2
- Design Complexity & Constructability (Relative weight of 15 out of 100) – the relative difficulty in siting (both hydraulically and physically) and constructing a specific alternative

- Maintenance of Plant Operations (MOPO) (Relative weight of 20 out of 100)- the ability to maintain existing plant treatment processes and modes in operation during construction
- Operability (Relative weight of 15 out of 100) – Relative complexity of operation of the proposed alternative in conjunction with the existing treatment processes on-site.

After weights were established for each criterion, each alternative was scored in regard to each alternative, using a score from 1 to 3. A score of 1 indicates that the alternative did not meet the criteria, whereas a score of 3 indicated that the alternative met the criteria and a score of 2 indicated that the alternative somewhat met the criteria.

The estimated performance results and discussions on pros and cons of each alternative (presented within each alternative description) were used along with the relative project and O&M costs in the ranking process as shown in Table 5-4.

Table 5-4: Summary of Scoring of Alternatives

	Process Performance/ TSS Removal	Capital Cost	O&M Cost	Constructability	MOPO	Operability	SUM
Alternative A1	50	30	20	30	40	30	200
Alternative A2	75	15	10	45	40	15	200
Alternative B1	0[1]	45	30	0[1]	60	45	180
Alternative B2	50	45	30	30	60	15	230
Alternative B3	50	45	20	45	60	15	235
Alternative B4	50	15	30	15	60	15	185
Alternative B5	75	30	30	30	40	45	250
Alternative B6	75	30	10	45	40	15	215
Alternative C1	50	45	30	45	60	45	275
Alternative C2	75	45	30	45	60	45	300

Note: 1. While the scoring system uses 1 to 3, values of 0 were assigned to two of the criteria under Alternative B1 as it would be impossible to construct both a new primary clarifier and chlorine contact tank near the existing primary clarifiers, and even if it could be constructed, Agency approval would be unlikely.

Based on the results shown in Table 5-4, Alternative C2 received the highest score, followed by Alternatives C1 and B5. The advantages of Alternative C2 over other alternatives include:

- Maximize secondary treatment capacity.
- Reliable disinfection of Outfall 001 discharges.
- Relatively low project cost per lb of TSS removed, while still removing more TSS than most of the other alternatives, with the exception of the HRT alternatives.
- A moderate life-cycle cost, mainly due to the relatively low O&M cost.
- Constructability of this alternative is relatively straightforward with the addition of one clarifier to each secondary process battery and the addition to the existing secondary effluent chlorine contact tank. When the plant was designed, the footprint proposed for the new tanks were set aside for future expansion.
- The plant will be able to remain in operation during construction as the new tanks can be built while still allowing plant staff access to the existing plant structures and equipment; thereby not compromising ability to continue compliance with the SPDES permit.
- Relatively easy operability as the plant will continue operating the secondary treatment process, with additional tankage, and shifting the chlorine addition point from upstream of the primary clarifiers to a new chlorine contact tank downstream of the existing primary clarifiers. Otherwise, the primary clarifiers will continue to be operated using the same strategies as currently practiced at the WWTP.

5.4 Conclusions and Recommendations

This evaluation looked at a host of alternatives, providing different "mixes" of primary and secondary treatment during partial treatment mode. After an objective scoring of economic and non-economic criteria, Alternative C2 is the preferred WWTP alternative to the extent that the BSA will include a primary/secondary treatment upgrade project in the updated LTCP.

Alternative C2 includes the following improvements to the primary treatment process:

- Replacement of the sludge and scum collection systems in each of the four existing primary clarifiers.
- Replacement of the primary sludge pumps.
- Miscellaneous other repairs required to keep the clarifiers in good working condition.

- Addition of a new chlorine contact tank and associated chemical storage and feed equipment downstream of the existing four primary clarifiers to provide a minimum 5-min detention time for high-rate disinfection of up to 160 MGD.

Alternative C2 also includes the following improvements to the secondary treatment process:

- Construction of two new secondary clarifiers; with one being located within each battery.

- Improving hydraulics through the sixteen existing secondary clarifiers by providing forty-six additional orifices in the secondary clarifier peripheral influent channel.

- Installation of a new chlorine contact tank following the secondary treatment process to be able to disinfect an additional 40 MGD, with a contact time of at least 15 minutes at the peak flow of 40 MGD.

These improvements are shown schematically in Figure 5-28 and allow the plant to operate consistent with current operations, according to the following operational scheme, with the exception that more flow is directed to the secondary treatment process as influent flows to the plant increase.

- Flows below 160 MGD - The plant operates in “normal” mode with primary and secondary treatment in series up to 160 MGD. All flow receives both primary and secondary treatment and are disinfected in the main plant chlorine contact tanks and discharged through Outfall 002.

- Flows Over 160 MGD up to 400 MGD - When the plant influent exceeds 160 MGD, the plant operates in “primary bypass” mode with up to 240 MGD of screened plant influent conveyed directly to the secondary treatment process, with the remainder of the flow (up to 160 MGD) treated in series through primary and secondary treatment. All flow is disinfected in the main plant chlorine contact tanks and discharged through Outfall 002.

- Flows Over 400 MGD up to 560 MGD - When the plant influent exceeds 400 MGD, partial treatment mode is activated where screened plant influent up to 400 MGD is conveyed directly to and treated in the secondary treatment process (bypassing primary treatment), disinfected using the main plant chlorine contact tanks, and discharged through Outfall 002. The remaining flow (up to 160 MGD) is directed to the four existing primary clarifiers and then passed through a new chlorine contact tank for high-rate disinfection prior to discharge through Outfall 001.

The estimated project cost for the implementation of Alternative C2 is approximately $40.5 million. With annual additional O&M costs of $282,000, the 20-year life cycle cost was estimated at $44.3 million dollars.

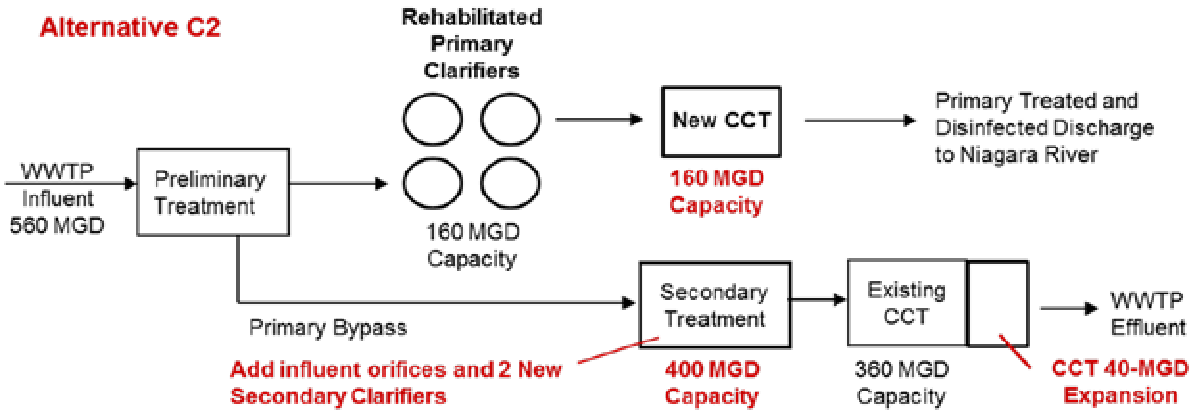


Figure 5-26: Process Flow Diagram of Preferred Alternative C2

Alternative C2 also satisfies the regulatory requirements for a No-Feasible Alternative analysis, as discussed in Section 2, namely, "If it is determined that flows to the POTW exceed the existing secondary treatment process capacity, alternatives are then identified and evaluated to determine the feasibility of increasing secondary treatment capacity or providing a higher level of primary treatment." This alternative involves increasing the capacity of the secondary treatment process to 400 MGD, providing greater levels of treatment to flows up to 400 MGD, while providing a higher level of primary treatment by purposefully limiting the flow to the existing primary clarifiers to 160 MGD, allowing for lower surface overflow rates to improve clarifier performance. Finally, Alternative C2 provides separate disinfection of partially treated flows in the primary system through a new high-rate chlorine contact tank, while discontinuing the practice of adding chlorine upstream of the primary clarifiers.

Given a high cost of the recommended alternative, a schedule beyond that proposed in the 2012 LTCP Update will be necessary.

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Appendix 1: BSA Bird Island WWTP – Secondary System Hydraulic Analysis Summary

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MEMO

To:
Mike Quinn
Jerry Kleyman

Copies:
Lisa Derrigan
Angela Hintz

From:
Claire Sichko
Laura Zima

Date:
June 26, 2013

ARCADIS Project No.:
01777122.0000

Subject:
BSA Bird Island WWTP – Secondary System Hydraulic Analysis Summary

---

1 Background

This memo will summarize the hydraulic analysis completed to determine the feasibility of increasing the hydraulic capacity of the secondary treatment processes at the Buffalo Sewer Authority's (BSA's) Bird Island Wastewater Treatment Plant (WWTP) that was completed as part of the NFA evaluation.

2 Hydraulic Model Update

The hydraulic model of the existing secondary system previously developed as part of the BSA Wet Weather Operating Plan/CSO Long Term Control Plan (LTCP) was reviewed and compared to plant design drawings and updated as necessary. The original Secondary System Hydraulic Capacity Evaluation Memo (April 30, 2004) is included as Attachment 1.

2.1 Hydraulic Model Software

The ARCADIS in-house computer model Profile, was used to model the existing secondary system from the settled wastewater pumping station to the treatment plant outfall. In Profile, hydraulic elements that are part of the treatment plant are linked together in a specific sequence to represent the longest hydraulic flow path within a treatment plant. The model generates energy and hydraulic grade lines for the entire sequence of elements that represents segments of the treatment plant based on the following major equations and assumptions.

- Headloss calculations for pipes and conduits flowing full were performed using the Darcy-Weisbach equation. Nikuradse's roughness (e) was assumed as follows:
    - o e = 0.005 for steel pipe
- Headloss calculations for open channels and closed conduits not always flowing full were performed using the Manning equation. Backwater curves for the open channel flows were computed using direct-step method. The following n-values were used:
    - o n = 0.013 for concrete channels and conduits
- Headloss calculations for pipe and open channel minor losses were performed using the energy equation and corresponding minor loss coefficients (k-values).
- Headloss calculations for control elements were performed using standard head-discharge equations.

2.2 Hydraulic Model Assumptions

The downstream boundary condition used for the secondary system is the maximum surface elevation for the Niagara River as presented on original WWTP drawings (Elevation -5.7 feet). Although this elevation may be higher than the current river levels, it provides a conservative estimate, as stated in the original Secondary System Hydraulic Capacity Evaluation Memo. The water surface elevation of the river does not impact capacity because it is well below the CCT effluent weirs.

The aeration tanks were assumed to be operating in step feed mode with two tanks in series.

The return activated sludge (RAS) flow is assumed to be 40 percent of the secondary system influent flow and is introduced at the head of Pass 1 In the first tank in each step feed set, and pulled of the final clarifiers prior to the flow exiting the tanks. This assumption models the worst-case condition, as RAS flow percentages are expected to be lower (approximately 25% of forward flow) at higher secondary system flows such as 360 MGD and greater.

The longest hydraulic path has been modeled and is from the aeration tank influent channel in Battery A to the effluent weir of Final Clarifier No. 6. The path then continues from the effluent channel of Final Clarifier No.1 to Chlorine Contact Tank No. 1 to the Niagara River. For this hydraulic flow path, it was assumed that the influent butterfly valve to Final Clarifier No. 6 was fully open. Based on a discussion with the WWTP staff, the plant currently throttles the influent butterfly valves to help balance flow between the final clarifiers. It is recommended that this valve is left fully open to maximize the current hydraulic capacity of the secondary system. Based on the hydraulic analysis, even if this valve is only slightly throttled, there is potential of reduced freeboard in the aeration tank influent channels.

As stated in the original Secondary System Hydraulic Capacity Evaluation Memo, both batteries cannot be modeled simultaneously in the Profile model; therefore the battery estimated to have the greater headloss was modeled, which is Battery A. Battery A is farther from the chlorine contact tanks and has a greater length of piping compared to Battery B.

A pair of aeration tanks is assumed to be out of service in Battery B (one step feed set). One final clarifier is assumed to be out of service in each battery. All of the chlorine contact tanks are assumed to be in-service.

The final clarifier influent feed channel is sloped around the circumference of the tank and due to limitations with the Profile model, this change in elevation cannot be modeled. The width of the channel can be varied in the model, therefore, the channel width was modified to yield an equivalent cross-sectional area over the length of the channel. This assumption is conservative because the wetted perimeter of the feed channel is higher under the modeled configuration, resulting in slightly higher head loss. This is how the final clarifier influent feed channel was modeled in the original model as well.

2.3 Field Data Collection and Model Validation

To further validate the hydraulic model, field data was collected during a wet weather event at the WWTP on May 28, 2013. Depth-to-water measurements were collected at 11 locations within the secondary system from the aeration tank influent channel to the chlorine contact tank effluent channel. Figures 1 and 2 show the locations where the measurements were collected. Water surface elevations were calculated by subtracting the depth to water measurements from the reference elevation where the measurement was taken (based on design drawing elevations). Flow data was provided by the WWTP for the time period when the data collection was completed. Information was also provided detailing any units out of service in the secondary system. During the validation effort, the hydraulic models were set up to reflect the conditions of the plant during the data collection period. The model was executed and the predicted results have been compared with the measured data. The measurements and modeled results are included as Attachment 2.

The modeled results assuming fully open influent butterfly valves to the final clarifiers were not consistent with measurements. The modeled results showed lower values by approximately 5 feet at the upstream most point. The butterfly valves were throttled in the model by increasing the minor loss coefficient of the valve. The minor loss coefficient that shows the most comparable modeled hydraulic grade line values to the water surface elevation values measured was approximately 27, which correlates to a 35 percent open butterfly valve upstream of Final Clarifier No. 6. Therefore, this valve was assumed to have been throttled during the wet weather data collection.

It is also assumed that Point 3 and 4 (measurements inside the aeration tanks) are incorrect due to an incorrect reference elevation. The water surface elevation inside the aeration tanks cannot be lower than the downstream water surface elevation. Therefore, these points were not considered in the validation.

Based on the field data collection, the model was validated to be accurate based on the consistency between the measured data and modeled results assuming the throttled butterfly valve upstream of Final Clarifier No. 6.

3 Hydraulic Modeling Results

Several scenarios were evaluated with different flows and alternatives for potentially increasing the secondary system capacity. The scenarios evaluated are summarized in Table 2.

Table 1: Model Scenario Configurations

				Tanks in Service (Battery A)		
Scenario	**Alternative**	**Flow**	**RAS**	**Aeration Tanks**	**Final Clarifiers**	**Chlorine Contact Tanks**
1	Existing	320	40%	8	7	4
2	Existing	360	40%	8	7	4
3	Existing	400	40%	8	7	4
4	Added Final Clarifiers	400	40%	8	8	4
5	Added Orifices	360	40%	8	7	4
6	Added Orifices	400	40%	8	7	4

A hydraulic profile showing water surface elevations throughout the secondary system is included as Attachment 3.

3.1 Existing Configuration

The existing maximum hydraulic capacity for the secondary system is 320 mgd limited by the freeboard in the final clarifier influent channel inside wall (wall dividing the influent channel from the effluent channel, elevation 9.8 feet). At a flow of 320 mgd (Scenario 1 from Table 2-1) there are approximately 0.6 inches of freeboard. Throughout the rest of the secondary system for Scenario 1, there are more than 12 inches of freeboard from the top of channel and tank walls, and at least a 3-inch free drop from the final clarifier and CCT effluent weirs. According to the model, for the existing plant configuration and assumed RAS rates and tanks out of service, 360 mgd cannot pass through the plant (Scenario 2 from Table 2-1) without overtopping the inside wall in the final clarifiers. Based on the model results, the inside channel wall will be overtopped by approximately 1.8 inches. Based on a discussion with the plant staff, this is consistent with actual observations at the plant when the flows are approximately 360 mgd to the secondary system. The existing plant configuration cannot pass 400 mgd (Scenario 3) without overtopping the inside wall in the final clarifiers. Based on the model results, the inside channel wall will be overtopped by approximately 4.4 inches. Throughout the rest of the secondary system for Scenario 2 and 3, there are more than 12 inches of freeboard from the top of channel and tank walls, and at least a 3-inch free drop from the final clarifier and CCT effluent weirs.

3.2 Alternatives analysis

Several alternatives were evaluated to increase the secondary system hydraulic capacity to flows of 360 mgd and 400 mgd without overtopping the inside wall of the final clarifier influent channels. The alternatives included adding a final clarifier to each battery, adding orifices to the final clarifier influent channel, or raising the inside channel wall of the final clarifier influent channel.

3.2.1 Additional Final Clarifiers

Adding additional final clarifiers was evaluated as an alternative to the existing configuration. Two final clarifiers were added, one to each battery. The addition of these final clarifiers does not provide sufficient hydraulic capacity for 400 mgd, still limited by the freeboard in the final clarifier influent channel inside wall. Based on the model results, the inside channel wall will continue to be overtopped by approximately 1.1 inches. Throughout the rest of the secondary system for Scenario 4, there are more than 12 inches of freeboard from the top of channel and tank walls, and at least a 3-inch free drop from the final clarifier and CCT effluent weirs. Please note that an additional clarifier for each battery was still considered for the 400 mgd scenario due to process capacity considerations.

3.2.2 Additional Influent Orifices

Additional influent orifices in the final clarifier influent channels was evaluated as an alternative to additional final clarifiers to help reduce the water surface elevation in the final clarifier influent channel. A total of 47 additional influent orifices (increase of 75%) spaced evenly around the perimeter of the final clarifier influent channel will provide 5.8 inches of freeboard for a flow of 360 mgd. A total of 62 additional influent orifices (increase of 100%) spaced evenly around the perimeter of the final clarifier influent channel will provide 5.4 inches of freeboard for a flow of 400 mgd, assuming no new clarifiers are added. Forty-six additional orifices will be required in each clarifier if two additional clarifiers are added to maintain sufficient process capacity, as opposed to just hydraulic capacity.Throughout the rest of the secondary system for Scenario 5 and 6, there are more than 12 inches of freeboard from the top of channel and tank walls, and at least a 3-inch free drop from the final clarifier and CCT effluent weirs.

3.2.3 Raise Inside Channel Wall of Final Clarifier Influent Channel

As discussed in Section 3.1, for the existing configuration with 400 mgd, the Final Clarifier Influent Channel inside channel wall would have to be raised 10.4 inches to an elevation of 10.7 ft to provide 6 inches of freeboard for a flow of 400 mgd, if no new clarifiers are provided; however, it is projected that up to two additional secondary clarifiers will be required from a process standpoint if flows up to 400 MGD are passed through the secondary system. This will provide 8.7 inches of freeboard for a flow of 360 mgd. This modification will not change the water surface elevations for these two flow conditions, it will just provide additional freeboard by raising the inside wall elevation. Therefore, the water surface elevations for Scenarios 2 and 3 are representative of the water surface elevations for the final clarifier inside channel wall modification.

4 Summary and Recommendations

The current maximum hydraulic capacity for the secondary treatment system at the WWTP is 320 mgd limited by the freeboard in the final clarifier influent channel. It is possible to pass 360 mgd under current conditions for a short period of time, but there is a potential for short circuiting in the final clarifiers where the influent channel inside channel wall may overtop and the influent mixed liquor flow would pass directly into the final clarifier effluent channel. . The secondary system hydraulic capacity can be increased to 360 mgd by either adding 46 additional orifices to each of the final clarifier influent channels, or raising the elevation of the top of the final clarifier influent channel inside wall to 10.7 ft. In addition to considering two additional final clarifiers (one for each battery) to address the process capacity considerations, the secondary system hydraulic capacity can be increased to 400 mgd by adding 62 additional orifices to each of the existing sixteen final clarifier influent channels, adding two new clarifiers and adding 46 additional orifices to each of the existing sixteen final clarifier influent channels, or raising the elevation of the top of the final clarifier influent channel inside wall to 10.7 ft.

The only other potential hydraulic restriction that could potentially create issues in the secondary system is the final clarifier influent butterfly valves that are used to help distribute flow between the final clarifiers. It is recommended that the butterfly valves to the farthest clarifier in each battery are left fully open during high flows as to not create unnecessary headloss. If the final clarifier influent valves are throttled too much, there is a potential for significantly reduced freeboard in the aeration tank influent channels.

MALCOLM PIRNIE | ARCADIS

Figure 1

Title: Aeration Tank and Final Clarifier Field Measurement Locations

Project Name: Secondary System Hydraulic Analysis Summary

Project Location: BSA Bird Island WWTP

Project Number:01777122.0000

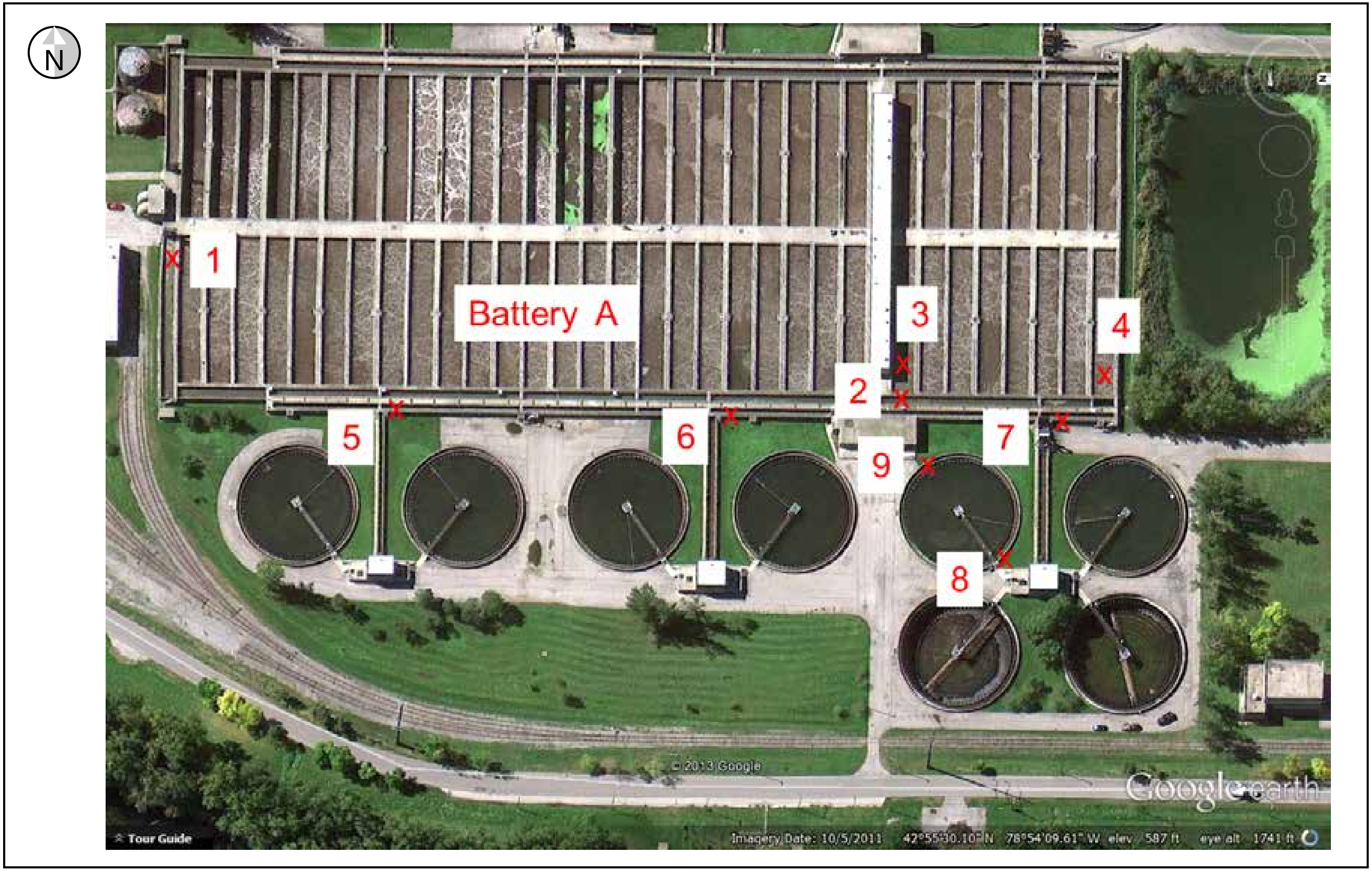


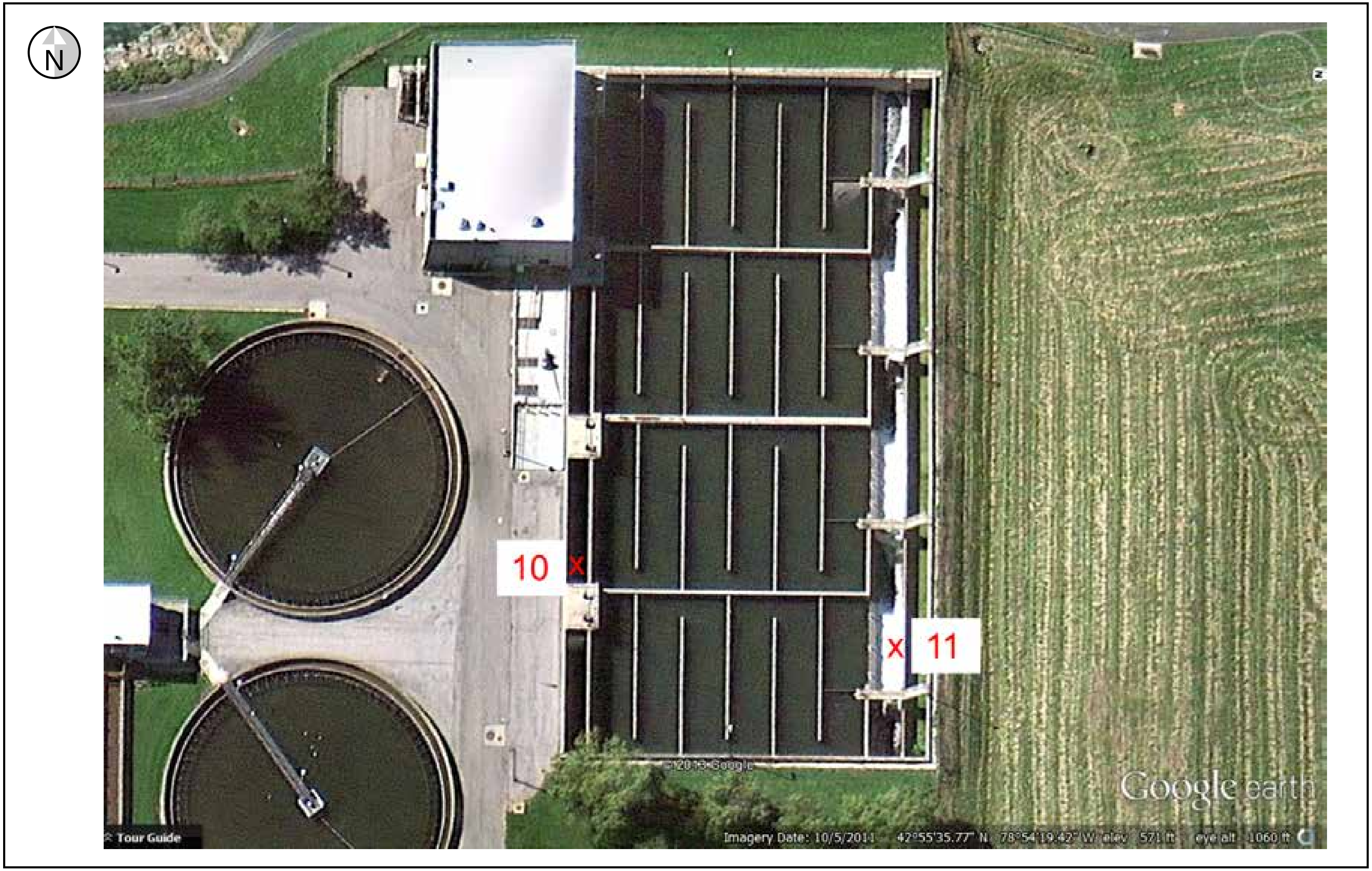
Figure 2

Title: Chlorine Contact Tank Field Measurement Locations

Project Name: Secondary System Hydraulic Analysis Summary

Project Location: BSA Bird Island WWTP

Project Number:01777122.0000



MALCOLM PIRNIE

TECHNICAL MEMORANDUM NO. 5

To: Buffalo Sewer Authority **Date:** December 16, 2002

Copy: File: 1777-086, CC **FINAL:** April 30, 2004

From: Malcolm Pirnie, Inc.

Re: Buffalo Sewer Authority (BSA) Wet Weather Operating Plan/CSO Long Term Control Plan (LTCP)
Bird Island Wastewater Treatment Plant (WWTP) Wet Weather Capacity Evaluation
Secondary System Hydraulic Capacity Evaluation (Task 4.2)

The BSA is currently developing an LTCP for CSO control that will map a course of action to achieve compliance with the Federal and State CSO Policy. The overall goal of the Wet Weather Capacity Study is to evaluate potential operating and/or capital improvements that will enable the WWTP to handle wet weather flows of up to 600 MGD. The recommendations of this study will then feed into the overall list of compliance alternatives developed and evaluated in the LTCP. The goal for the secondary system evaluation is to optimize the secondary system performance at flows up to 360 MGD. As part of this study, Malcolm Pirnie evaluated maximizing the secondary system process capacity in conjunction with different operating modes of the secondary activated sludge process (Technical Memorandum No. 3, April 30, 2004). In addition to evaluating process capacity, the physical hydraulic capacity of the secondary system must be evaluated to verify the maximum flow that the secondary system is capable of processing. The objective is to verify that the secondary system has sufficient hydraulic capacity to process 360 MGD and to evaluate the maximum hydraulic capacity of the secondary system. Both current and future potential operating modes (as identified in Technical Memorandum No. 3) were modeled to estimate the water surface elevations under peak flows of 360 MGD. This memorandum presents the results of our hydraulic capacity evaluation of the secondary system at the Bird Island WWTP.

1.0 APPROACH

Malcolm Pirnie's in-house computer program, "Profile" was used to develop a hydraulic profile of the existing secondary system from the settled wastewater pumping station to the treatment plant outfall. In the Profile model, hydraulic elements that are part of the treatment plant are linked together in a specific sequence. The model generates energy and hydraulic grade lines for the entire sequence of elements that represent segments of the treatment plant based on the following major equations and assumptions:

- Head loss calculations for pipes and conduits flowing full were performed using the Hazen-Williams equation. Hazen-Williams coefficients (C-factors) for piping were assumed as follows:

  - Steel Pipe
    - 48-inch diameter pipe (30 years old) - C=100

- Head loss calculations for open channels were performed using the Manning Equation. Backwater curves for the open channel flows were computed using direct-step method. The following n-values were used:

  - Concrete Channels
    - All – n = 0.013

- Head loss calculations for pipe and open channel minor losses were performed using the energy equation and corresponding minor loss coefficients (k-values).

- Head loss calculations for control elements were performed using standard head-discharge equations.

The downstream boundary condition used for the secondary system is the maximum water surface elevation data for the Niagara River as presented on original WWTP drawings (Elevation -5.7 feet). Although this elevation may be higher than the current river levels, it provides a conservative estimate.

The process capacity evaluations identified two feasible future operating modes: continued plug flow operation with lower MLSS concentrations and step feed mode with two tanks in series (flow distribution 50%/0/50%/0). The Profile model was configured to run the following scenarios at a secondary system influent flow of 360 MGD (not including recycle flow):

1. Existing plug flow mode with 15 aeration tanks and 15 final clarifiers.
2. Existing plug flow mode with 12 aeration tanks and 15 final clarifiers.
3. Step feed mode (two tanks in series) with 7 pairs of aeration tanks (four pairs on Battery A and three pairs on Battery B) and 15 final clarifiers.
4. Step feed mode (two tanks in series) with 6 pairs of aeration tanks (three pairs on each side) and 15 final clarifiers.

Based on the process capacity evaluation of the secondary system, the major limiting factor is the capacity of the final clarifiers. Therefore, all scenarios considered included a maximum number of clarifiers with only one unit out of service.

Another future option that was considered during the process capacity evaluation was the construction of additional final clarifiers. Based on the current configuration of the secondary system, there is space available for construction of up to three additional final clarifiers: two on Battery A and one on Battery B. The above model scenarios also were conducted with the potential additional clarifiers as follows:

1A. Existing plug flow mode with 15 aeration tanks and 18 clarifiers.
3A. Step feed mode (two tanks in series) with 7 pairs of aeration tanks (four pairs on Battery A and three pairs on Battery B) and 18 clarifiers.

The model also was used to estimate the maximum hydraulic capacity of the secondary system under plug flow and step feed operations. The maximum capacity is determined as the maximum flow through the secondary system that will not cause the tank and chamber walls to overflow. The following scenarios were modeled to estimate the maximum flow:

5. Existing plug flow mode with 16 aeration tanks and 16 clarifiers in service.
6. Step feed mode (two tanks in series) with 8 pairs of aeration tanks and 16 clarifiers.

The following assumptions regarding secondary system operation were made to develop the hydraulic profile under all scenarios:

- For each scenario at 360 MGD influent flow, the RAS flow was assumed to be 40% or 144 MGD.
- Both Batteries could not be modeled simultaneously in the Profile model; therefore, the battery estimated to have the greater head loss was modeled, which is Battery A. Battery A is further from the chlorine contact tank and has a greater length of piping compared to Battery B.
- Under scenarios with an uneven number of aeration tanks and clarifiers in operation, the flow split was such that Battery A received higher flow than Battery B and the number of tanks in service for Battery A was selected to yield a higher flow per tank than Battery B, which was included in the model.
- At least one aeration tank and one final clarifier were out of service, except for the maximum hydraulic capacity scenario where all 16 aeration tanks and final clarifiers were on-line.
- The final clarifier influent feed channel is sloped around the circumference of the tank and due to limitations with the Profile model, this change in elevation could not be modeled; however, the modeled width of the channel can be varied. Therefore, the channel width was modified to yield an equivalent cross-sectional area over the length of the channel. This assumption is conservative because the wetted perimeter of the feed channel is higher under the modeled configuration, resulting in slightly higher head loss.

2.0 MODEL RESULTS

A hydraulic profile of the secondary treatment system showing the results from Scenarios 1, 2, and 5 (plug flow mode) is presented on Figure 1. The Profile model results indicate that under plug flow operation (Scenario 1) at 360 MGD, the secondary system has sufficient capacity based on the fact that the water surface elevations are below tank and chamber wall elevations (i.e., no overflowing of walls), and the final clarifier weirs are not submerged. Under Scenario 2, with less aeration tanks in operation (i.e, more flow per aeration tank) representing a more conservative approach, the water surface elevations in the final clarifiers are virtually identical to those under Scenario 1, but slightly increase in the aeration tanks upstream of the final clarifiers (approximately 0.4 foot difference in aeration tank levels). However, there is still sufficient capacity.

The maximum hydraulic capacity of the secondary system in plug flow mode (Scenario 5) was determined to be approximately 432 MGD. The Profile model predicts that at 432 MGD the water surface elevation in the final clarifier influent feed channel will start to exceed the elevation of the top of the common wall between the influent and effluent channels of the final clarifiers (i.e., mixed liquor will overflow into the final clarifier effluent channel).

A hydraulic profile of the secondary treatment system showing the results from Scenarios 3, 4, and 6 (step feed mode) is presented on Figure 2. The Profile model results indicate that under step feed operation with seven pairs operating (Scenario 3) at 360 MGD, the secondary system has sufficient capacity based on the fact that the water surface elevations are below tank and chamber wall elevations (i.e., no overflowing of walls), and the final clarifier weirs are not submerged. Under Scenario 4, with only 6 pairs in operation, the water surface elevations in the final clarifiers are identical to those under Scenario 3, but slightly increase in the aeration tanks upstream of the final clarifiers (approximately 0.2 foot difference in aeration tank levels). However, there is still sufficient capacity.

Similar to the plug flow scenario, the maximum hydraulic capacity of the secondary system in step feed mode (Scenario 6) was determined to be approximately 432 MGD. The Profile model predicts that at 432 MGD the water surface elevation in the final clarifier influent feed channel will start to exceed the elevation of the top of the common wall between the influent and effluent channels of the final clarifiers.

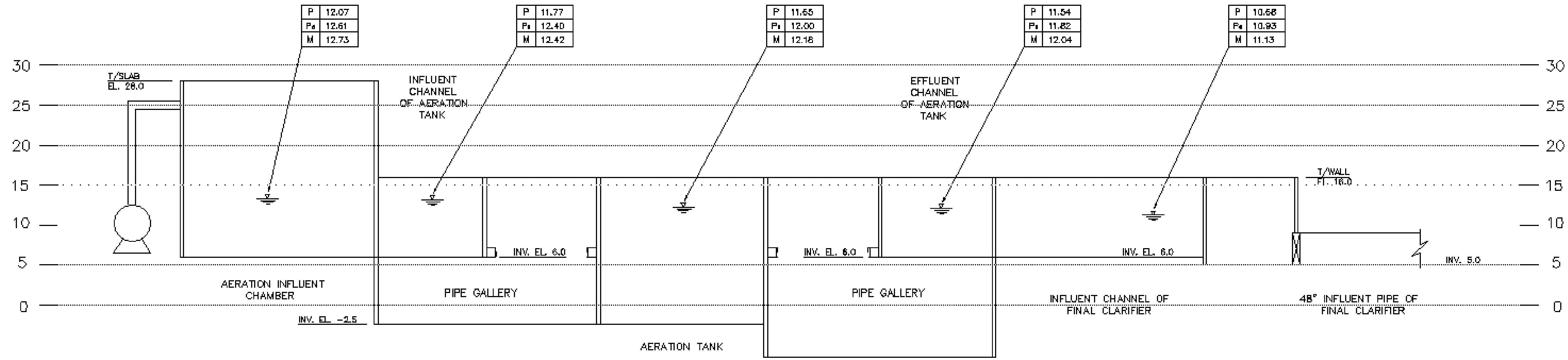
The Profile model results for the current plug flow mode of operation were compared to the proposed step feed operating mode model results to examine how switching to a step feed mode will affect water surface elevations in the aeration tanks and final clarifiers. The water surface elevations in the final clarifiers are virtually identical under both plug flow and step feed, mostly because the flow to each clarifier is roughly the same under either operating mode. The water surface elevations in the final clarifier influent feed channel under the two different operating modes differed by 0.1 feet or less, mostly because of differences in how the mixed liquor is discharged from the aeration tanks and how it is distributed along the influent feed channel. The water surface elevations in the aeration tanks under step feed mode were approximately 0.4 to 0.7 feet higher than under plug flow mode due to increased head loss through the aeration tanks under step feed mode. Although the model simulations were conducted under peak flow conditions, it is expected that the water surface elevations under average flow conditions also would slightly increase under the step feed mode compared to plug flow mode. However, the changes in flow routing within the aeration tanks for step feed mode do not appear to have a significant impact on the secondary system hydraulic capacity.

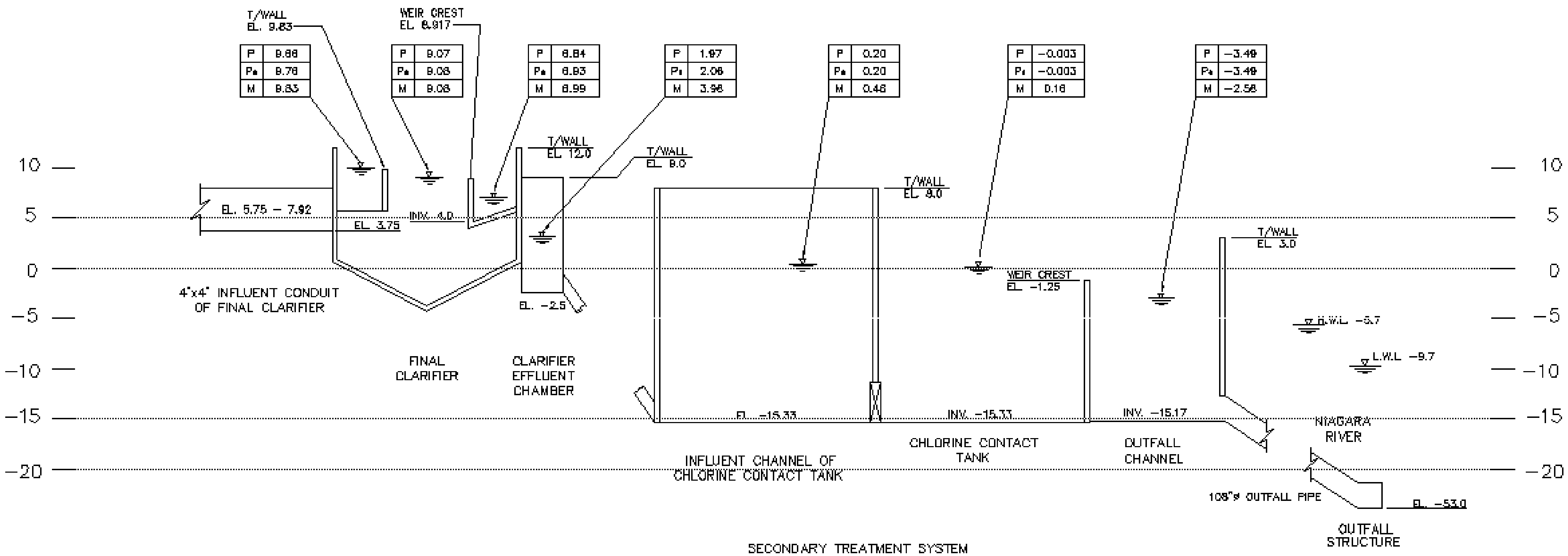
The hydraulic profiles for Scenarios 1A and 3A, with additional final clarifiers are presented on Figure 3. The Profile model predicts construction of additional clarifiers will lower the water surface elevation in the final clarifiers and in the aeration tanks. Under Scenario 1A (plug flow mode), reduced head losses in the clarifiers and clarifier influent feed channels will drop the water surface elevation in the influent feed channel by approximately 0.4 feet, resulting in a similar elevation drop upstream in the aeration tanks. The Profile model predicted similar water surface elevation decreases for the step feed mode (Scenario 3A).

3.0 SUMMARY AND CONCLUSIONS

The hydraulic Profile modeling indicates that the secondary system has sufficient hydraulic capacity to handle flows up to 360 MGD under both plug flow and step feed operating modes. At the same time, with 15 clarifiers in service and the conservative assumption of 40% RAS flow, there is very little freeboard in the final clarifier influent feed channel; therefore, 360 MGD is the maximum hydraulic capacity of the secondary system. Additionally, as discussed in Technical Memorandum No. 3, Secondary Treatment System Capacity Evaluation (dated April 30, 2004), the process capacity of the secondary system also is limited to 360 MGD.

ATTACHMENT 1





NOTE:

1. WATER LEVELS ARE BASED ON HYDRAULIC MODEL RUNS FOR THE BATTERY WITH THE HIGHEST FLOW PER TANK (ASSUMED BATTERY A)/CLARIFIER FOR CONSERVATIVE PURPOSES.

SECONDARY TREATMENT SYSTEM
FLOW DISTRIBUTIONS THROUGH EXISTING SYSTEM

FLOW UNIT: mgd

SYMBOL	SCENARIO	FLOW (mgd)	FLOW SPLIT		AERATION INF. CHANNEL		AERATION TANKS - BATTERY A		AERATION TANKS - BATTERY B		FINAL CLARIFIERS - BATTERY A		FINAL CLARIFIERS - BATTERY B		CHLORINE CONTACT TANK	
			BAT A	BAT B	No. OF CHAMB.	FLOW/CHAMB.	No. OF TANKS	FLOW/TANK	No. OF TANKS	FLOW/TANK	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF TANKS	FLOW/TANK
P	1	360	192	168	1	360	8	24.0	7	24.0	8	24.0	7	24.0	3	120.0
P₂	2	360	180	180	1	360	6	30.0	6	30.0	7	25.7	8	22.5	3	120.0
M	5	432	216	216	1	432	8	27.0	8	27.0	8	27.0	8	27.0	3	144.0

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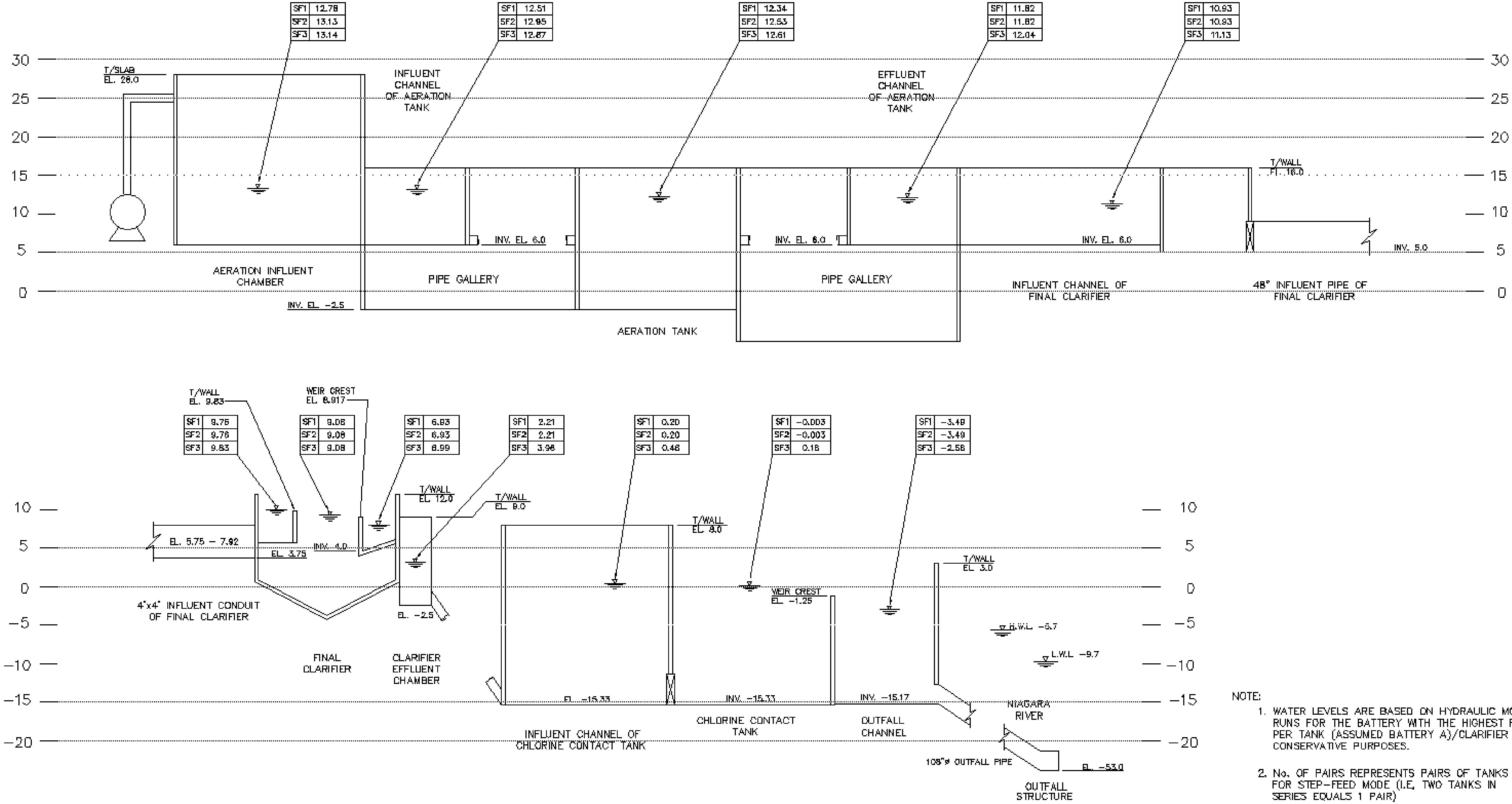
FIGURE 1

EXISTING SECONDARY TREATMENT SYSTEM
HYDRAULIC PROFILE - PLUG FLOW



NOTE:

1. WATER LEVELS ARE BASED ON HYDRAULIC MODEL RUNS FOR THE BATTERY WITH THE HIGHEST FLOW PER TANK (ASSUMED BATTERY A)/CLARIFIER FOR CONSERVATIVE PURPOSES.
2. No. OF PAIRS REPRESENTS PAIRS OF TANKS FOR STEP-FEED MODE (I.E. TWO TANKS IN SERIES EQUALS 1 PAIR)

SECONDARY TREATMENT SYSTEM
FLOW DISTRIBUTIONS THROUGH PROPOSED SYSTEM – STEP FEED

FLOW UNIT: mgd

SYMBOL	SCENARIO	FLOW (mgd)	FLOW SPLIT		AERATION INF. CHANNEL		AERATION TANKS – BATTERY A		AERATION TANKS – BATTERY B		FINAL CLARIFIERS – BATTERY A		FINAL CLARIFIERS – BATTERY B		CHLORINE CONTACT TANK	
			BAT A	BAT B	No. OF CHAMB.	FLOW/CHAMB.	No. OF PAIRS	FLOW/PAIR	No. OF PAIRS	FLOW/PAIR	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF TANKS	FLOW/TANK
SF1	3	360	206	154	1	360	4	51.4	3	51.4	8	25.7	7	22.0	3	120
SF2	4	360	180	180	1	360	3	60.0	3	60.0	7	25.7	8	22.5	3	120
SF3	6	432	216	216	1	432	4	54.0	4	54.0	8	27.0	8	27.0	3	144

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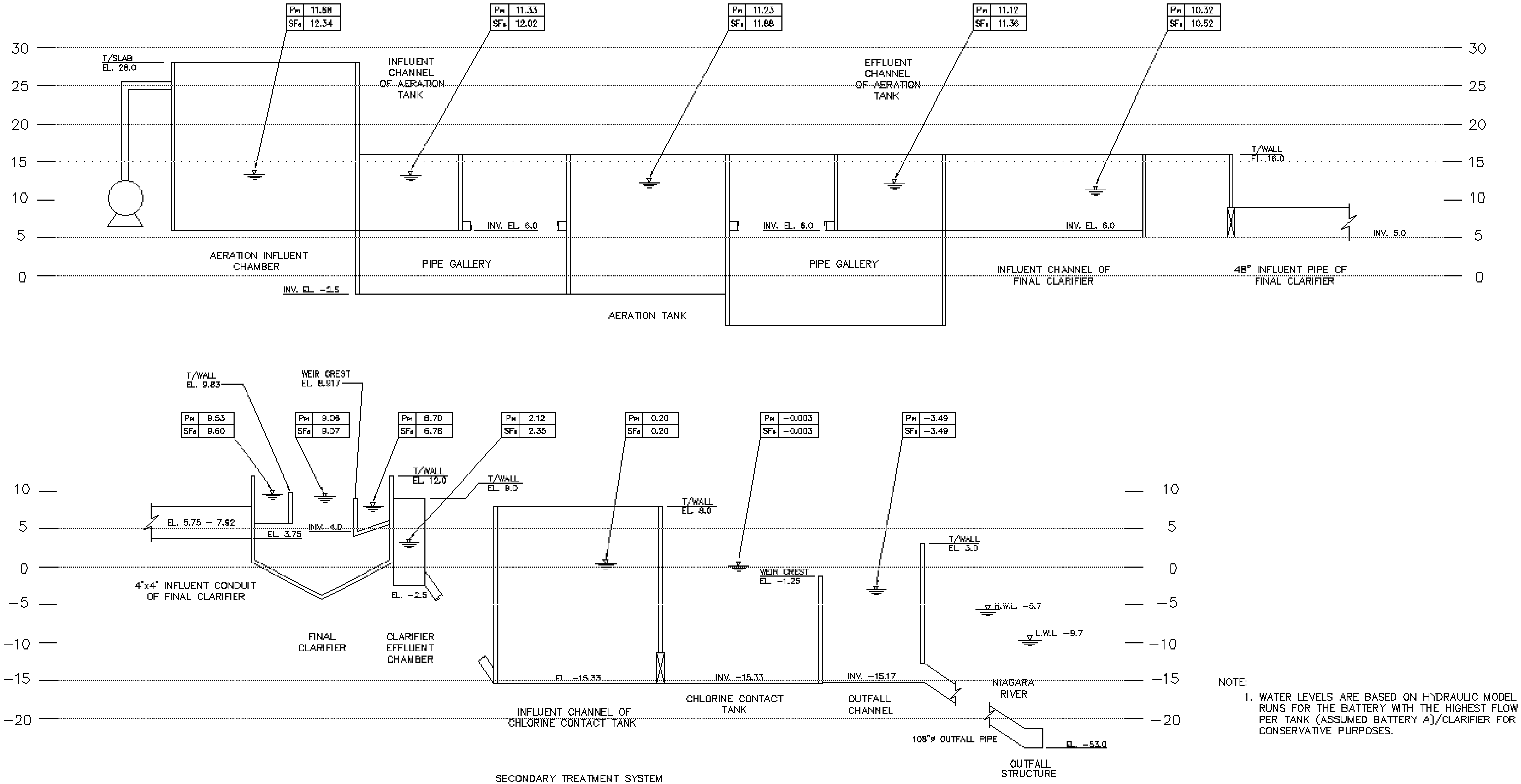
BIRD ISLAND WASTEWATER TREATMENT PLANT
WET WEATHER CAPACITY STUDY

FIGURE 2
PROPOSED SECONDARY TREATMENT SYSTEM
HYDRAULIC PROFILE – STEP FEED

ATTACHMENT 1



SECONDARY TREATMENT SYSTEM
FLOW DISTRIBUTIONS THROUGH PROPOSED SYSTEM

FLOW UNIT: mgd

SYMBOL	SCENARIO	FLOW (mgd)	FLOW SPLIT		AERATION INF. CHANNEL		AERATION TANKS – BATTERY A		AERATION TANKS – BATTERY B		FINAL CLARIFIERS – BATTERY A		FINAL CLARIFIERS – BATTERY B		CHLORINE CONTACT TANK	
			BAT A	BAT B	No. OF CHAMB.	FLOW/CHAMB.	No. OF TANKS	FLOW/TANK	No. OF TANKS	FLOW/TANK	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF TANKS	FLOW/TANK
Pm	1A	360	192	168	1	360	8	24.0	7	24.0	9	21.3	9	18.7	3	120
					No. OF CHAMB.	FLOW/CHAMB.	No. OF PAIRS	FLOW/PAIR	No. OF PAIRS	FLOW/PAIR	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF TANKS	FLOW/TANK
SF1	3A	360	206	154	1	360	4	51.4	3	51.4	9	22.9	9	17.1	3	120

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WET WEATHER CAPACITY STUDY

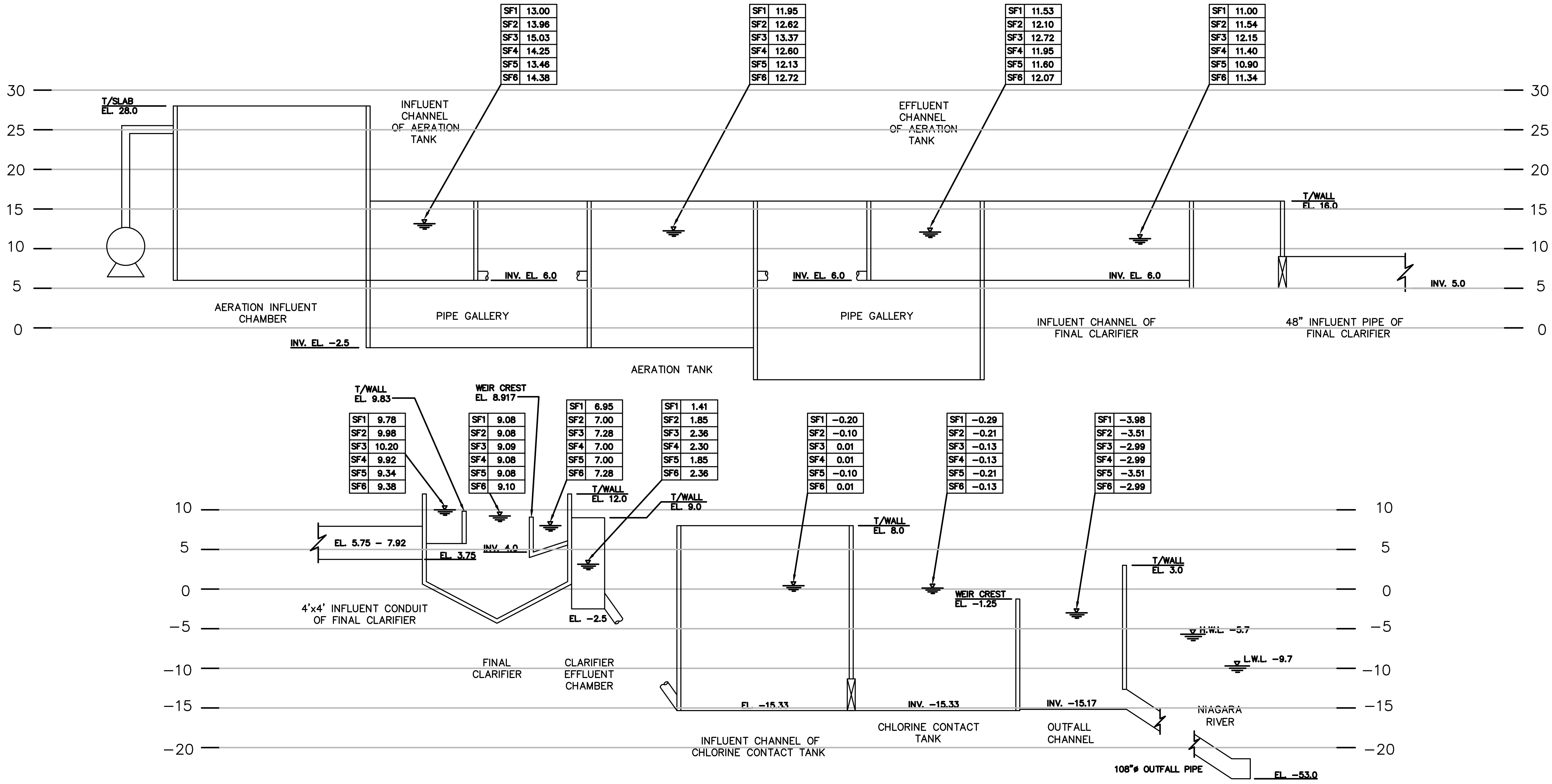
FIGURE 3

PROPOSED SECONDARY TREATMENT SYSTEM
HYDRAULIC PROFILE–ADDITIONAL CLARIFIERS

Measurement of Water Surface Elevations
Tuesday, May 28, 2013

When measurements were taken, Battery B, Aeration Tank 4 was out of service, all other ATs were in service.
14 out of 16 clarifiers were in service – the 2 out of service clarifiers were Clarifier 1 of Battery A and Clarifier 1 of Battery B.

Point	Time	Measured Value (inches)	Reference Elevation (ft)	Ref Point	WSEL	Average WSEL	Modeled	Modeled with Throttle
1	12:36	12	16	Platform	15.00	14.71	9.88	14.80
1	13:06	15.125	16	Platform	14.74			
1	13:27	15.25	16	Platform	14.73			
1	13:50	16.5	16	Platform	14.63			
1	14:13	18.25	16	Platform	14.48			
2	12:29	11.75	16	Platform	15.02	14.68	9.87	14.80
2	12:57	15.25	16	Platform	14.73			
2	13:22	16.625	16	Platform	14.61			
2	13:46	17.125	16	Platform	14.57			
2	14:08	18.25	16	Platform	14.48			
3	12:30	27.875	16	Platform	13.68	13.59	9.68	14.59
3	12:59	28.375	16	Platform	13.64			
3	13:23	29.25	16	Platform	13.56			
3	13:47	29.5	16	Platform	13.54			
3	14:09	29.875	16	Platform	13.51			
4	12:27	28.875	15.5	Platform	13.09	13.00	9.67	14.59
4	12:56	29.5	15.5	Platform	13.04			
4	13:21	30	15.5	Platform	13.00			
4	13:45	30.5	15.5	Platform	12.96			
4	14:07	31.25	15.5	Platform	12.90			
5	12:34	28.25	16	Platform	13.65	14.40	9.59	14.52
5	13:03	16	16	Platform	14.67			
5	13:25	16.125	16	Platform	14.66			
5	13:48	16.875	16	Platform	14.59			
5	14:11	18.75	16	Platform	14.44			
6	12:32	31.875	16	Platform	13.34	14.36	9.59	14.52
6	13:01	14.5	16	Platform	14.79			
6	13:24	16.5	16	Platform	14.63			
6	13:47	17.125	16	Platform	14.57			
6	14:10	18.25	16	Platform	14.48			
7	12:25	29.375	16	Platform	13.55	13.49	9.59	14.52
7	12:55	34.625	16	Platform	13.11			
7	13:20	17	16	Platform	14.58			
7	13:44	33.75	16	Platform	13.19			
7	14:06	35.75	16	Platform	13.02			
8	12:23	30.375	12	Outside Wall	9.47	9.46	9.16	9.16
8	12:54	30.375	12	Outside Wall	9.47			
8	13:19	30.625	12	Outside Wall	9.45			
8	13:43	30.625	12	Outside Wall	9.45			
8	14:04	30.25	12	Outside Wall	9.48			
9	12:52	31.625	12	Outside Wall	9.36	9.41	9.17	9.17
9	13:16	31	12	Outside Wall	9.42			
9	13:42	32	12	Outside Wall	9.33			
9	14:03	30.75	12	Outside Wall	9.44			
9	14:27	30.25	12	Outside Wall	9.48			
10	12:44	93.25	8	Outside Wall	0.23	0.08	-0.65	-0.65
10	13:09	95.25	8	Outside Wall	0.06			
10	13:35	96.25	8	Outside Wall	-0.02			
10	13:57	95	8	Outside Wall	0.08			
10	14:20	95.5	8	Outside Wall	0.04			
11	12:45	119	1.5	Lower Platform	-8.42	-8.77	River Elev. Unknown	
11	13:11	124.5	1.5	Lower Platform	-8.88			
11	13:36	124.75	1.5	Lower Platform	-8.90			
11	13:59	122.875	1.5	Lower Platform	-8.74			
11	14:22	125	1.5	Lower Platform	-8.92			



SECONDARY TREATMENT SYSTEM
FLOW DISTRIBUTIONS THROUGH PROPOSED SYSTEM – STEP FEED

FLOW UNIT: mgd

SYMBOL	SCENARIO	SETUP	FLOW (mgd)	FLOW SPLIT		AERATION TANKS		FINAL CLARIFIERS		CHLORINE CONTACT TANK	
				BAT A	BAT B	No. OF TANKS	FLOW/PAIR	No. OF CLARIFIERS	FLOW/CLARIFIER	No. OF TANKS	FLOW/TANK
SF1	1	EXISTING	320	182.9	137.1	14/16	64.0	15/16	36.6	4/4	80
SF2	2	EXISTING	360	205.7	154.3	14/16	72.0	15/16	41.1	4/4	90
SF3	3	EXISTING	400	228.6	171.4	14/16	80.0	15/16	45.7	4/4	100
SF4	4	ADD CLARIFIER	400	228.6	171.4	14/16	80.0	17/18	40.0	4/4	100
SF5	5	ADD ORIFICES	360	205.7	154.3	14/16	72.0	15/16	41.1	4/4	90
SF6	6	ADD ORIFICES	400	228.6	171.4	14/16	80.0	15/16	45.7	4/4	100

NOTE:

1. WATER LEVELS ARE BASED ON HYDRAULIC MODEL RUNS FOR THE BATTERY WITH THE HIGHEST FLOW PER TANK (ASSUMED BATTERY A)/CLARIFIER FOR CONSERVATIVE PURPOSES.
2. No. OF PAIRS REPRESENTS PAIRS OF TANKS FOR STEP-FEED MODE (I.E, TWO TANKS IN SERIES EQUALS 1 PAIR)

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The Water Division of ARCADIS

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FIGURE 2
PROPOSED SECONDARY TREATMENT SYSTEM
HYDRAULIC PROFILE – STEP FEED