NEW WATER MODEL DEVELOPMENT AND CALIBRATION - HYDRAULICS

Technical Memorandum 2.2

B&V PROJECT NO. 402658

PREPARED FOR

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

19 MARCH 2020

BLACK & VEATCH

DONOHUE

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1 Introduction

Data analytics and modeling tools are key components to the development of an insightful and useful facility plan. The development of modeling tools provides a means to evaluate multiple future scenarios that may occur at a facility, and then develop infrastructure to provide the adaptability to continue a high level of service under these future scenarios. It is important to follow good modeling practice during the development of a calibrated and validated model to ensure a continued high level of quality and reliability. The International Water Association (IWA) Good Modelling Practice Unified Protocol is used as the framework for this project (Figure 1-1). The Unified Protocol consists of 5 major steps:

1. Project Definition
2. Data Collection and Reconciliation
3. Model Setup
4. Calibration and Validation
5. Simulation and Result Interpretation

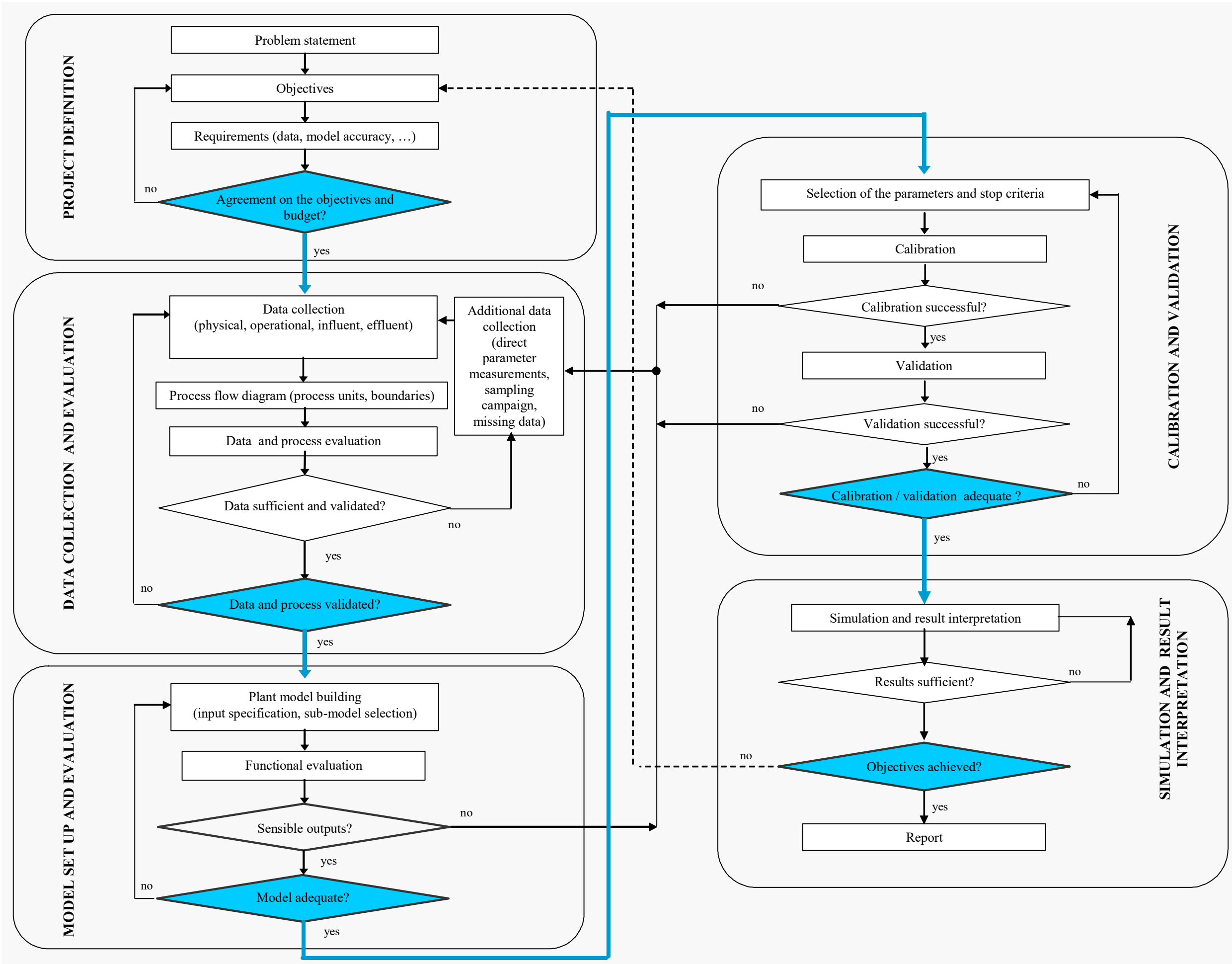

Figure 1-1: Good Modeling Practice Unified Protocol

This Technical Memorandum (TM 2.2) will document the first four steps of the Good Modeling Practice Protocol for the model development, calibration and validation. The fifth step, simulation and results interpretation, will be executed as part of the alternatives evaluation phase of the Facility Plan.

2 Project Definition

A hydraulic model for the purpose of this Facility Plan is a mathematical model of the surface water elevation of wastewater discharged at various flow rates into the Green Bay Metropolitan Sewerage District treatment facilities. The primary objective of this TM was to develop, calibrate, and validate plant hydraulic models that replicate actual hydraulic performance from the plant headworks to the plant discharge for the Green Bay Facility (GBF) and the De Pere Facility (DPF). The hydraulic models will be used during this Facility Plan evaluation to identify process bottlenecks and assess future infrastructure improvements. The purpose of the hydraulic model developed for this TM is for use as a tool to predict water surface elevations at any flow scenarios based on previous collected elevations during high flow events. The calibration correction factors have altered the model to more accurately depict the water level. NEW Water will also receive these models as deliverables for their future use. The following tasks were completed for the purpose of this TM 2.2:

1. Identified significant locations for field verification and marked the physical locations at GBF and DPF for high flow data collection
2. Prepared field data collection protocol and survey scope with the survey carried out on 8/29/19 and 9/4/19 for all significant elevations
3. Constructed models of forward flow hydraulics using plant drawings for each plant
    a. GBF North model
    b. GBF South model
    c. DPF model
4. Field data was gathered during high flow events by NEW Water on 9/10/19 and 9/11/19
    a. 9/10/19 AM data set used for calibration
    b. 9/10/19 PM data set used for first validation
    c. 9/11/19 PM data set used for second validation
5. Calibrated model was based on 9/10/19 field measurements
6. Validated model was based on 9/10/19 and 9/11/19 field measurements

Future uses of the model may include evaluating present and future hydraulic bottlenecks and assessing future improvements by running the model at different flow scenarios. These will be based on historic high flow event data and future flow projections developed during the Flows and Loads task (TM 2.1) for future design years.

3 Data Collection

To begin the modelling process, Donohue utilized past drawing sets to prepare a map of locations (points) that were hydraulically significant at each facility. Hydraulically significant is defined as points where measuring the surface water elevation during a high flow event would provide information about how a flow element behaved. Appendix A includes process flow diagrams for the facilities and the processes at each facility are listed below and the hydraulically significant areas were identified.

Green Bay Facility

- Preliminary Treatment
  - Screening
  - Parshall Flumes
- Primary Treatment
  - Primary Influent Channels
  - Primary Clarifier Basins
  - Primary Effluent Channels
- Secondary Treatment
  - *GBF North*
    - Aeration
      - Contact Basin Bypass
      - Contact Basins
      - Re-Aeration Basins
      - Mixed Liquor Channels
    - Secondary Treatment
      - Final Influent Channels
      - Final Clarifier Basins
      - Final Effluent Channels
  - *GBF South*
    - Aeration Basins
    - Mixed Liquor Channels
- Final Clarifier Basins
- Disinfection
  - Chlorine Contact Basins
  - Final Effluent Parshall Flumes

De Pere Facility

- Preliminary Treatment
  - Screening
  - Preliminary Treatment Units (PTUs)
- Secondary Treatment
  - Influent Channels
  - Anoxic Basins
  - Anoxic Basin Effluent Channels
  - Aeration Basins
  - Aeration Basin Effluent Channels
  - Intermediate Clarifiers
- Aeration Bypass Channels
- Final Clarifiers
- Gravity Filters
- UV Disinfection
- Parshall Flumes

After hydraulically significant point locations were identified, Donohue conducted a site visit to GBF and DPF with NEW Water staff to mark the physical locations of the points with tape and to identify a measure-down surface at each point. Measure-down surfaces are defined as a top of concrete or grating that could be used as a datum point when measuring to the surface water elevation. By surveying the measure-down surfaces, the distance measured down from the surface to the water level could be subtracted from the measure-down surface elevation to calculate the elevation of the water at each point.

Once identified, the measure-down surface elevations were surveyed. The GBF survey was conducted on 8/29/19 and the DPF survey was conducted on 9/4/19. In addition to the measure-down surfaces, the hydraulic control points such as weirs, gates, and flumes were also surveyed. Full lists and maps of hydraulically significant points and survey points are located in the Hydraulic Modeling Field Measurements Protocol memorandum provided in Appendix B.

3.1 FIELD DATA COLLECTION

Donohue requested that NEW Water staff gather field verification measurements at all hydraulically significant points for at least two high flow events. Two high flow event data sets are required so one dataset can be used in model calibration while the other data set can be use in model validation. Donohue defined a high flow event as an event above 50 mgd at GBF and above 20 mgd at DPF. Plant staff collected three sets of high flow event measurements. Each set provided a full profile of the actual water level through the facilities at the recorded flows. One set was used to calibrate the model while the remaining two sets were used to validate the model. The flows for these events are summarized in Table 3-1 and Table 3-2. The flow data was recorded as instantaneous influent flow rates during the field measurement time period. An average was calculated for these time periods for the purposes of the below summary tables.

Table 3-1: Flows at GBF during Field Measurements

DATE	AVERAGE INFLUENT FLOW (MGD)	AVERAGE GBF NORTH RAS FLOW (MGD)	AVERAGE FLOW TO GBF SOUTH (MGD)	AVERAGE GBF SOUTH RAS FLOW (MGD)
9/10/19	91.8	29.6	11.2	3.7
9/10/19	76	29.6	9.9	3.7
9/11/19	103.2	39	11.1	3.7
RAS = Returned Activated Sludge				

Table 3-2: Flows at DPF during Field Measurements

DATE	AVERAGE INFLUENT FLOW (MGD)	AVERAGE RAS FLOW (MGD)
9/10/19	24.8	8.0
9/10/19	19.3	8.0
9/11/19	32.3	8.1

4 Model Development

Three models were used to simulate each facilities hydraulics: GBF North, GBF South, and DPF. The hydraulic models were initially created based on sizes of existing tanks, channels, piping, weirs, and other structures and flow distributions found in existing record drawings.

The hydraulic model was developed to simulate flow paths through each facility, calculate hydraulic headloss, and predict water surface elevations at various flow scenarios. For this reason, additional field verification was required to confirm the structures were built as shown in the drawing sets and adjust the flow paths to match in what way NEW Water staff currently operate the facilities.

4.1 MODEL CONSTRUCTION

The models were developed in Microsoft Excel with the commonly used Manning's Equation and the Darcy-Weissbach Equation. Physical infrastructure including pipes, channels, orifices, baffles, gates, weirs, valves, racks/screens, launders, bends, transitions, flow control structures, and any other pertinent hydraulic features are each represented by a calculation element in the model.

Information such as structure elevations, dimensions and pipe sizes from the past drawing sets in Table 4-1 were used to provide the information for each element.

Table 4-1: Drawing Sets Used to Construct Models

PLANT	FILE NAME	YEAR
GBF	Green Bay Metropolitan Sewerage District Wastewater Treatment Facilities Contract 6 Basin Complex General Construction	1971
GBF	Green Bay Metropolitan Sewerage District Contract 30 North Complex	1989
GBF	Green Bay Metropolitan Sewerage District Contract 31 South Complex	1989
DPF	City of De Pere, Wisconsin Phase II Expansion of Wastewater Treatment Plant	1981
DPF	De Pere Wastewater Treatment Facility UV Disinfection System Expansion	2014

Relevant headloss equations were applied to each type of element (for example, the theoretical headloss through a pipe is calculated with different equations than headloss over a weir) to determine the most accurate headloss for each element. After establishing the headloss calculation through each element, the compilation of all elements allows a user to calculate the hydraulic grade line (HGL), or surface water elevation, along the entire flow path. Models were developed from the most downstream point of each facility to the upstream end because the downstream elements influence the upstream water surface elevations. Theoretically, the energy grade line (EGL) at any element should be the EGL at the element just downstream, plus any losses at the element in question. Therefore, every element is linked to the element just downstream except for in locations of hydraulic breaks.

Following construction of the model from past drawings, flow scenarios were evaluated. Each flows scenario is represented by a single column in Excel allowing multiple columns, or flow scenarios, to be simulated at once and compared.

The flow data simulated in the model for the calibration and validation for the GBF North Plant, GBF South Plant, and the DPF Plant are summarized in Tables 4-2, 4-3, and 4-4, respectively. The average forward flows and return activated sludge flows were from data supplied by NEW Water. Note that the flows labeled “Forward Flow to GBF South (MGD)” come off of the flows labeled “Influent Flow (MGD)” following primary treatment. Additional flows were estimated based on TM 2.1 Flows and Loads Projections.

Table 4-2: Simulated flow scenarios at GBF North

FLOW SCENARIO	DATE	INFLUENT FLOW (MGD)	RAS FLOW (MGD)	P&G FLOW (MGD)	FOX RIVER FIBER (MGD)
Calibration	9/10/19	91.8	29.6	3.65	0.66
Validation 1	9/10/19	76	29.6	3.75	0.24
Validation 2	9/11/19	103.2	39	3.89	0.64

Table 4-3: Simulated flow scenarios at GBF South

FLOW SCENARIO	DATE	FORWARD FLOW TO GBF SOUTH (MGD)	RAS FLOW (MGD)
Calibration	9/10/19	11.2	3.7
Validation 1	9/10/19	9.9	3.7
Validation 2	9/11/19	11.1	3.7

Table 4-4: Simulated flow scenarios at DPF

FLOW SCENARIO	DATE	AVERAGE FORWARD FLOW (MGD)	RAS FLOW (MGD)
Calibration	9/10/19	24.8	8.0
Validation 1	9/10/19	19.3	8.0
Validation 2	9/11/19	32.3	8.1

5 Calibration and Validation

The models were further developed during the calibration and validation steps using infrastructure verification, flow path verification, and observed operating conditions.

5.1 CALIBRATION

Calibration is the process in which model parameters are adjusted until the model predictions match the selected sets of measured performance data from the facility. The primary objective of calibration is to minimize error between the field measured dataset and model prediction. However, it is important to remember the objective is not to achieve a perfect fit since the model is a simplified version of the real facility. Over-fitting to one dataset might reduce the total error for that particular dataset but could reduce the model's overall predictive power and increase error in other flow scenarios.

The goal of the model calibration was to assess the level of agreement between observed plant hydraulic profile and model predictions, determine where and why the model and field measurements do not correlate with a specific element, and then adjust the model accordingly.

The model was adjusted by adding "calibration correction" elements to alter the headloss over an element and making note of the changes. It would be impossible to exactly calibrate the model so an accuracy threshold of 4" was established. Due to possible variations in measurements from plant conditions and human error (both measuring and modeling), it was assumed that if the model was within 4" of the value measured for an element, that element was within the calibration goals and did not require further adjustment.

The calibrated hydraulic profile in Figure 5-1 depicts the output of the GBF North model calibrated with the field measurements collected during the 91.8 mgd average influent flow set on 9/10/19. Water surface elevation values are provided in Appendix D.

Similarly, Figure 5-2 depicts the calibrated GBF South model against its field measurements collected during the 11.2 mgd average influent flow set on 9/10/19 and Figure 5-3 depicts the calibrated DPF model against its field measurements collected during the 24.8 mgd average influent flow set on 9/10/19.

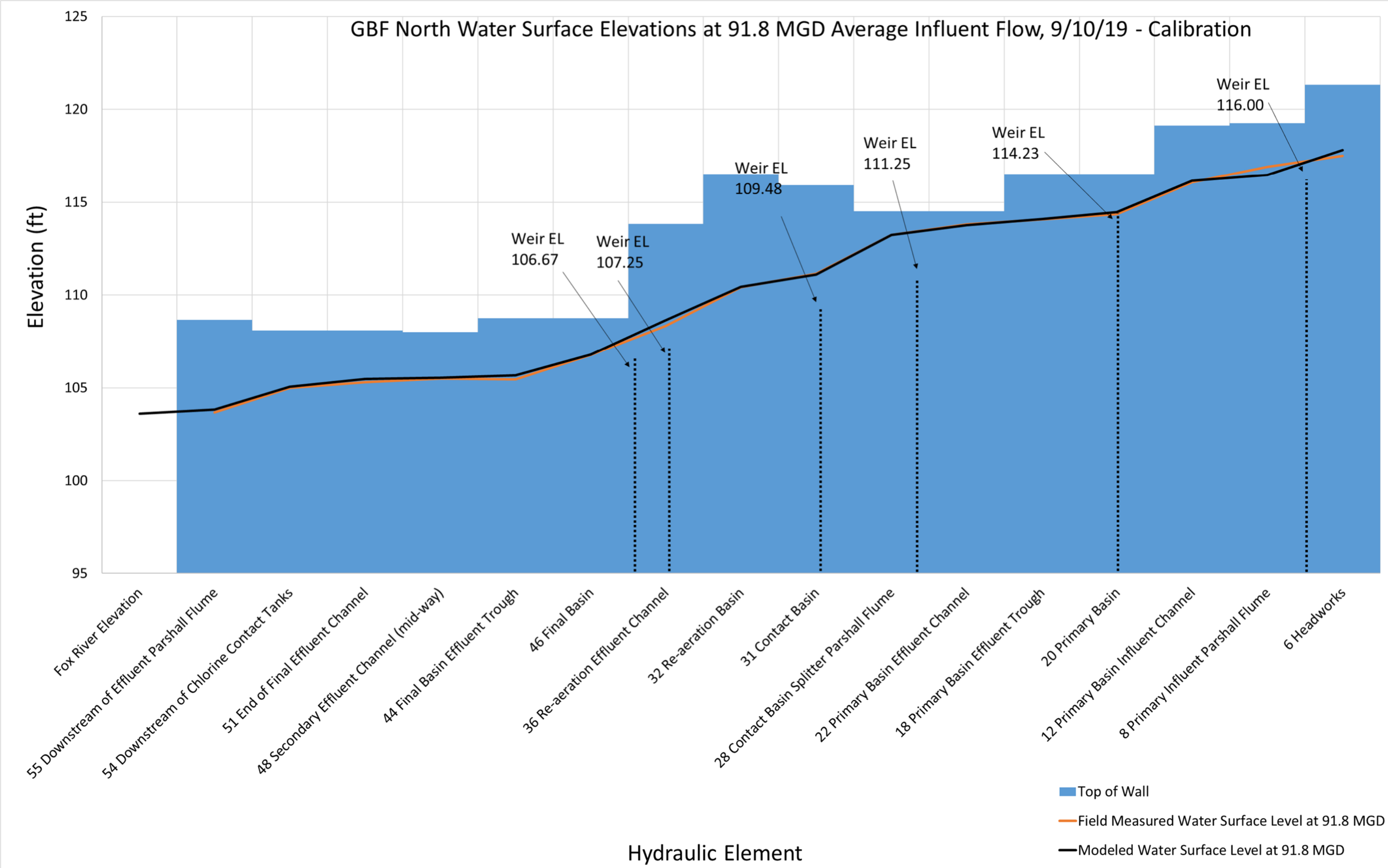

Figure 5-1: GBF North Hydraulic Profile – Calibrated from 91.8 mgd average influent flow set on 9/10/19

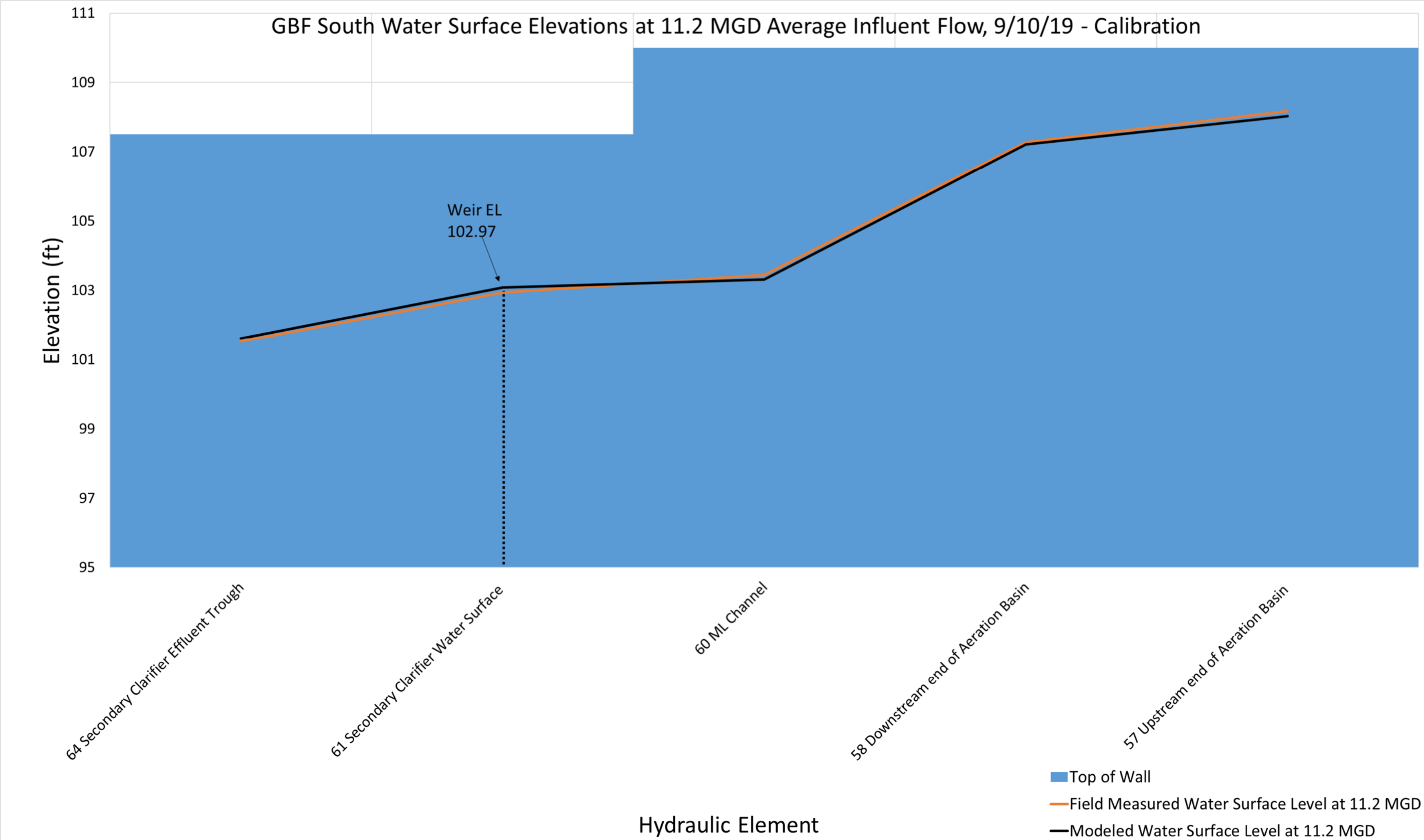

Figure 5-2: GBF South Hydraulic Profile – Calibrated from 11.2 mgd average influent flow set on 9/10/19

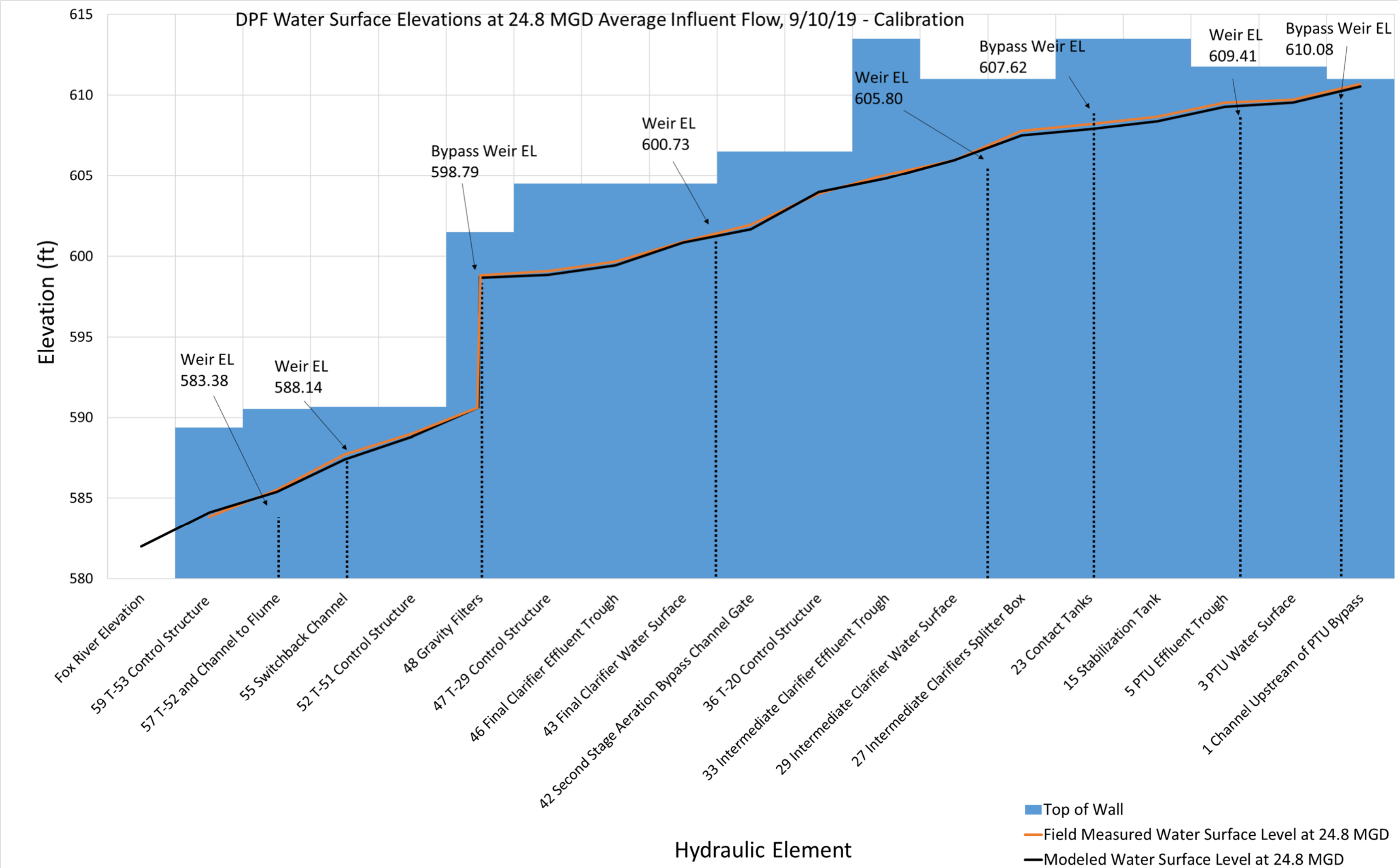

Figure 5-3: DPF Hydraulic Profile – Calibrated 24.8 mgd average influent flow set on 9/10/19

When a calibration correction is used it indicates there is something happening at an element that cannot be accounted for via data analysis or there is an unknown condition causing it to behave differently than it typically would be based on the data provided in record drawings. For this reason, documentation is kept for each element calibrated so elements can be re-evaluated and visually inspected at the facility. Some examples of these scenarios include buildup in a pipe causing a flow restriction or a stop log lodged permanently in a channel.

Common corrections for elements included the following:

1. Piping and channels – friction factor and restriction factors for fittings and changes in direction were revisited and adjusted
2. Weirs – adjustments were made from survey data results
3. Weir gates – adjustments were made from survey data results and operation staff input
4. General elevations – elevations from drawings were changed to the surveyed elevations at all elements they were taken

For future uses of the model, it is important that the most conservative basin and weir elevations and conditions are used to predict the water surface elevations at future simulated flows. However, sometimes less conservative elevations must be modeled for calibration. For example, if the water surface measurements were taken at Final Basin No. 1, the surveyed elevation of the weirs at Final Basin No. 1 must be used in the calibration, but when the model is used to predict water levels at future flows at the Final Basins, the highest clarifier weir should be used, even if it is not Final Basin No. 1. Otherwise the capacity of the facility processes may be over-estimated when simulating the model at future flows. Donohue has identified these items in the model spreadsheets.

5.2 VALIDATION

Once the model calibration is complete, at least one independent data set from each facility is required to validate the model and test its predictive power under an alternative flow condition. NEW Water staff returned three sets total, meaning that two sets could be used for validation. This provides additional accuracy for the final model.

Figure 5-4 and Figure 5-5 depict the Validation 1 and Validation 2 measured water surface levels, compared against the calibrated model's predicted water surface levels at GBF North at 76.0 mgd and 103.2 mgd, respectively.

Similarly, Figure 5-6 and Figure 5-7 depict the Validation 1 and Validation 2 measured water surface levels, compared against the calibrated model's predicted water surface levels at GBF South at 9.9 mgd and 11.1 mgd, respectively, while Figure 5-8 and Figure 5-9 depict the Validation 1 and Validation 2 measured water surface levels, compared against the calibrated model's predicted water surface levels at DPF at 19.3 mgd and 32.3 mgd, respectively.

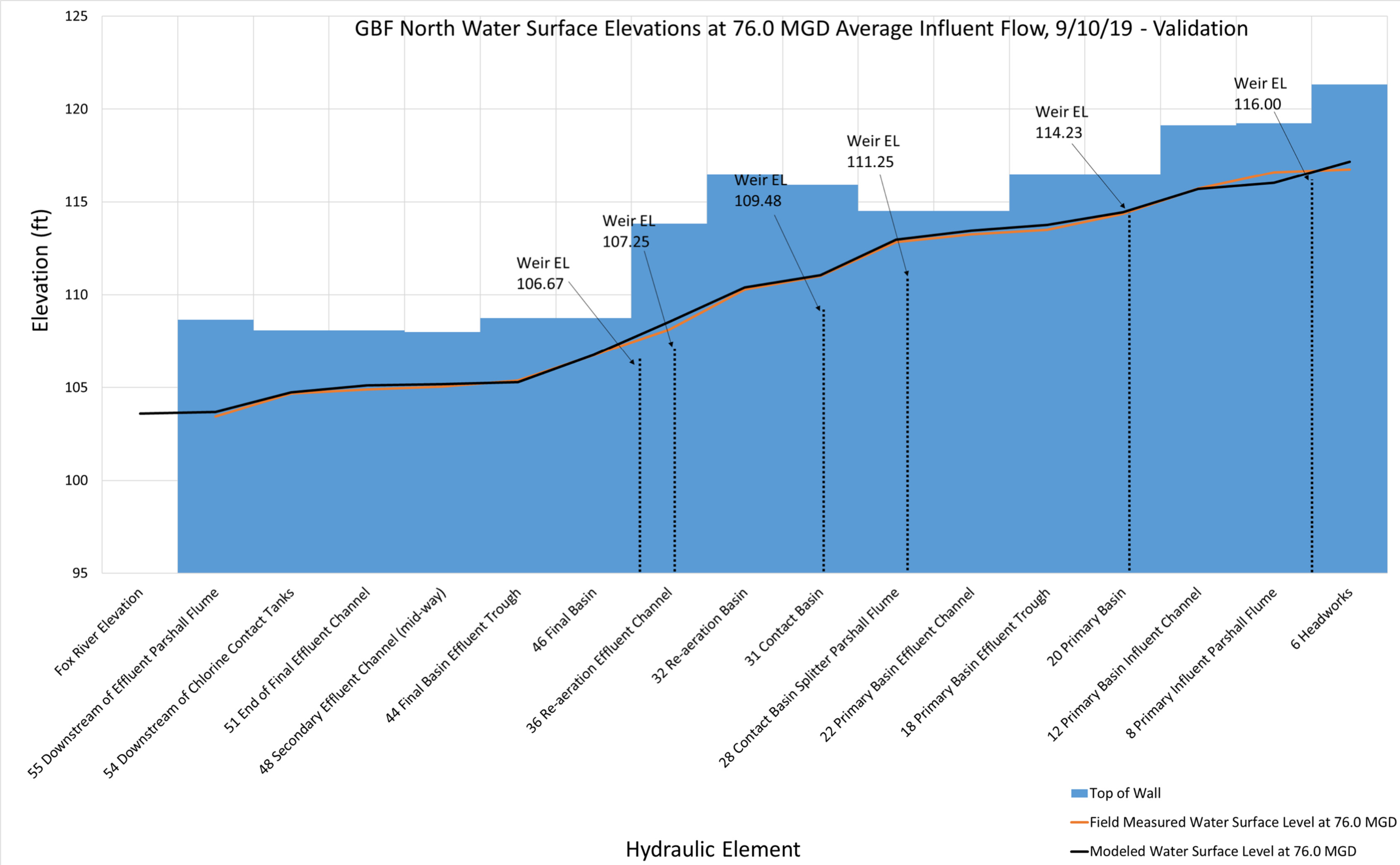

Figure 5-4: GBF North Hydraulic Profile – Validation 1 GBF North at 76.0 mgd

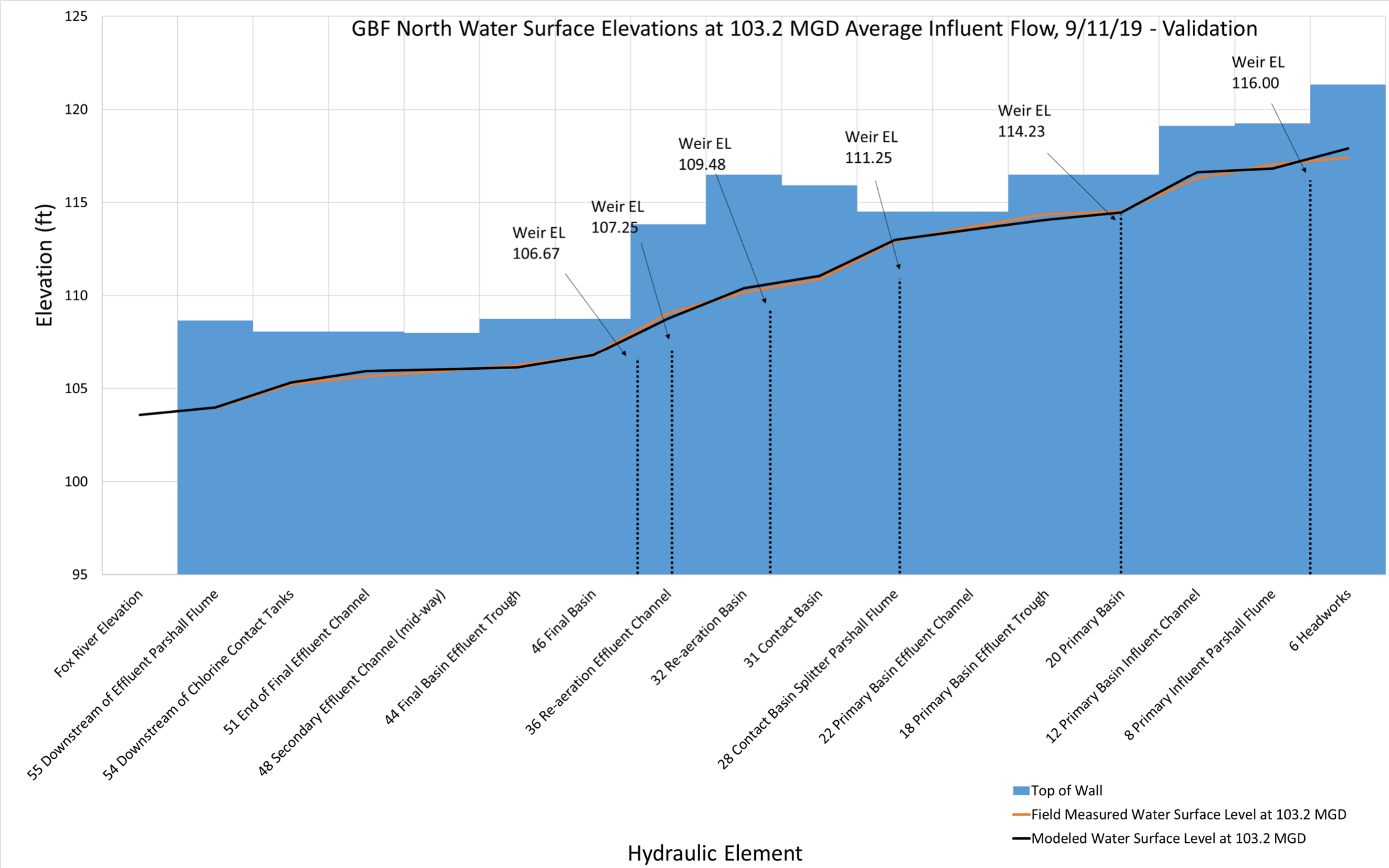

Figure 5-5: GBF North Hydraulic Profile – Validation 2 GBF North at 103.2 mgd

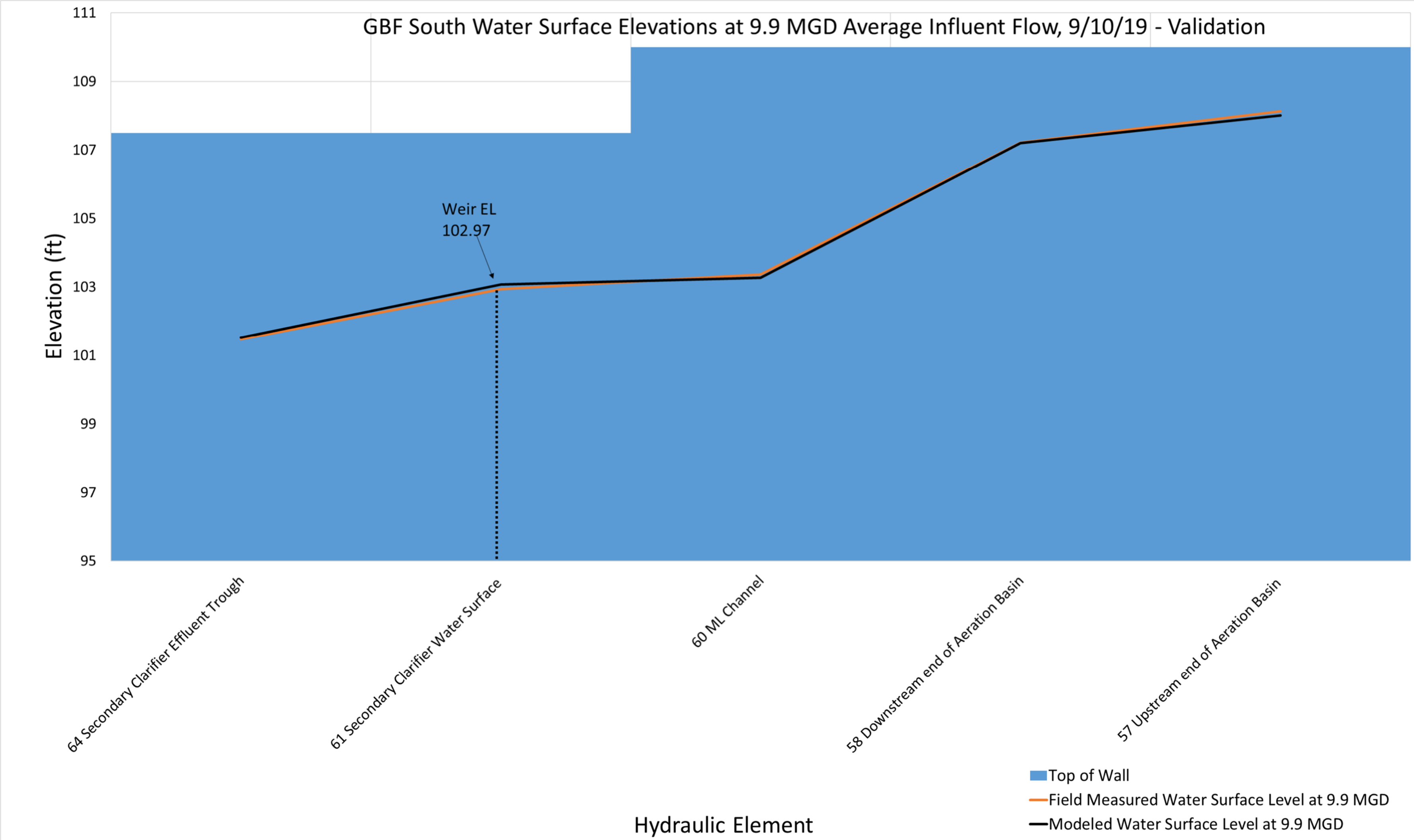

Figure 5-6: GBF South Hydraulic Profile – Validation 1 GBF South at 9.9 mgd

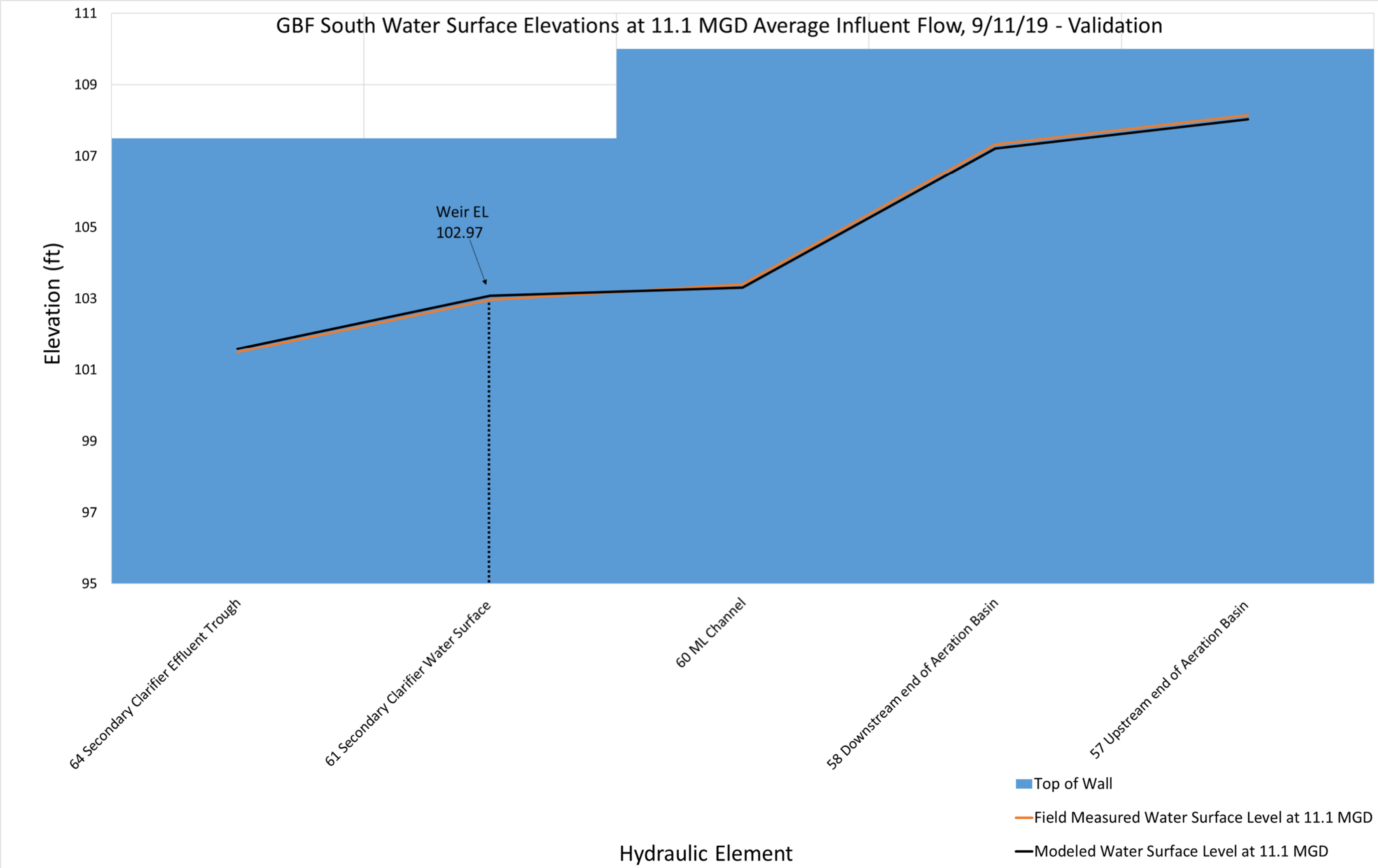

Figure 5-7: GBF South Hydraulic Profile – Validation 2 GBF South at 11.1 mgd

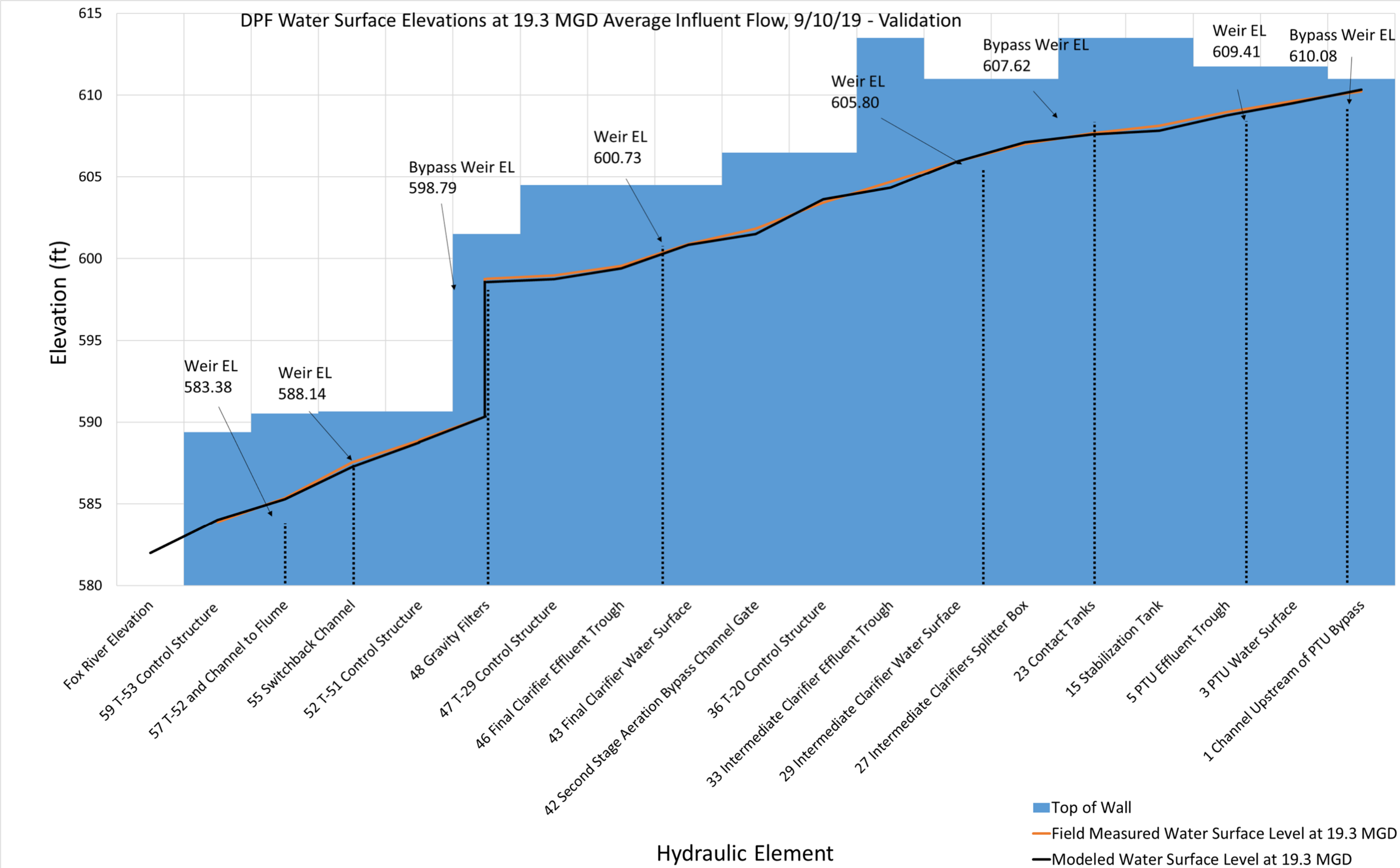

Figure 5-8: DPF Hydraulic Profile – Validation 1 DPF at 19.3 mgd

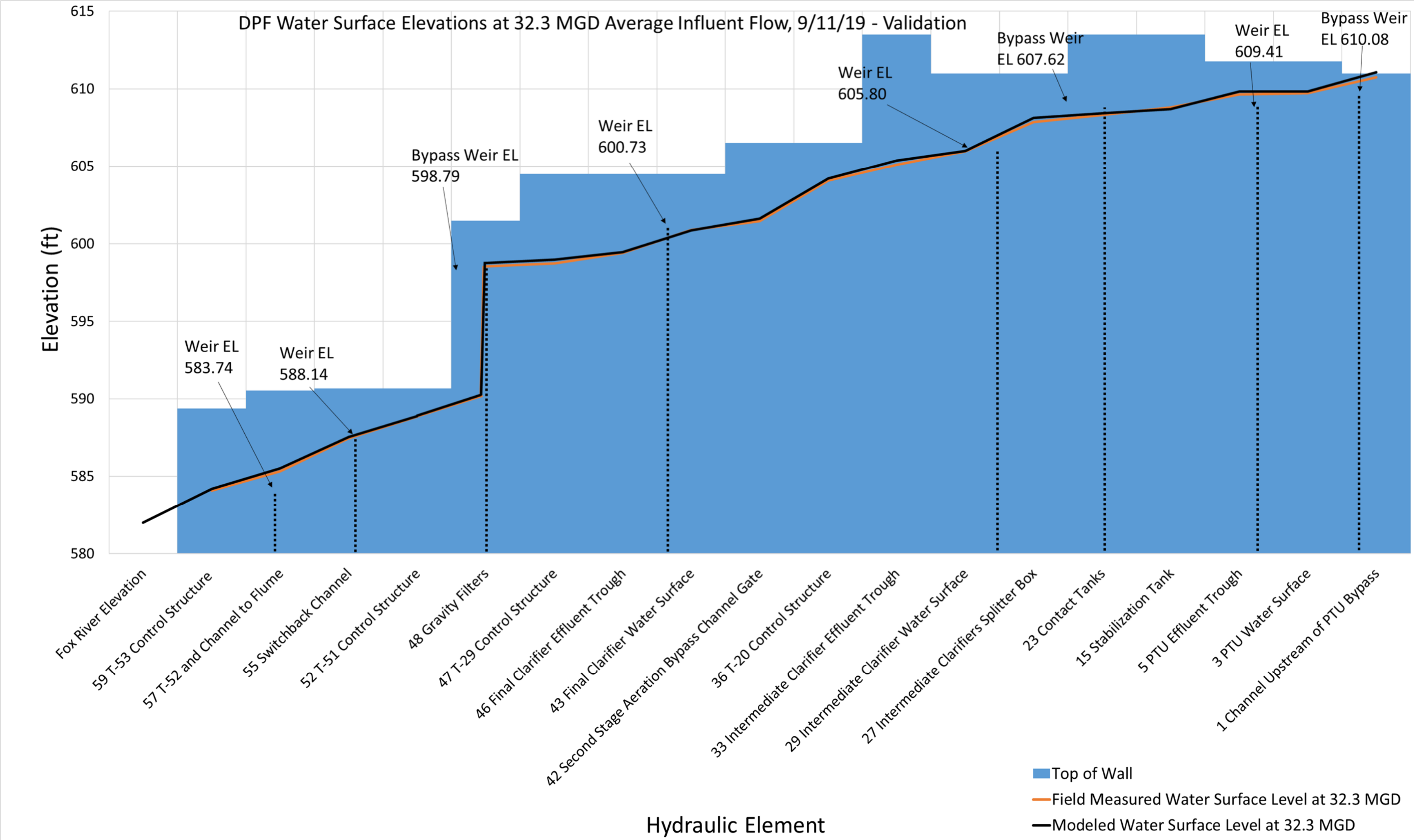

Figure 5-9: DPF Hydraulic Profile – Validation 2 DPF at 32.3 mgd

The model is accurate within 4-inches. Elements in which the validation graph results in greater than +/- 4-inch difference between the model predicted water surface level and the field measured surface level require additional iterations of re-calibration and re-validation. Again, the differing elements in the calibrated model are corrected with calibration corrections and documentation, and the validation results are re-examined until the model predicted and field measured water surface level lines are within the accepted 4-inch range. Calibration K-factors are factors that increase or decrease the theoretical headloss calculation at an element to output a headloss value that matches the real-world headloss at that element, rather than the theoretical headloss. In other words, calibration K-factors are outside of the typical K-factor range for an element type, however, their use allows construction of a model that reflects real field measurements. Before designing any improvements at the elements in the below tables, it is recommended that they are investigated further to reconcile or identify the reasons for returning head loss calculations different than what would be theoretically expected.

Table 5-1: Summary of Calibration Corrections for the GBF North Facility

ELEMENT	CALIBRATION
Weir downstream of Aeration Basin	Edited weir elevation for calibration to accurately represent the HGL
Primary Basin No. 3 Influent Piping	Added calibration K-factor
Channel just Upstream of Dropbox into Primary Basin No. 3	Added calibration K-factor

Table 5-2: Summary of Calibration Corrections for the GBF South Facility

ELEMENT	CALIBRATION
Aeration Basin Effluent Weir	Edited weir elevation for calibration to accurately represent the HGL
Aeration Basin Baffle Wall	Edited baffle wall elevation for calibration to accurately represent the HGL
Final Basin Influent Piping	Added K-factor for calibration

Table 5-3: Summary of Calibration Corrections for the DPF Facility

ELEMENT	CALIBRATION
Channel immediately upstream of T-52	Added calibration K-factor
Channel between Switchback Channel and Parshall Flume	Added calibration K-factor
Weir Upstream of Final Clarifier Dropbox (SG-B94)	Added calibration K-factor
Second Stage Aeration Bypass Channel Gate at T-20 (S-30)	Added calibration K-factor
Gate (G-46)	Added calibration K-factor
South Intermediate Clarifier Influent Piping from Splitter Box	Added calibration K-factor
Channel between Splitter Box and Contact Tanks Effluent Channel	Added calibration K-factor
Stabilization Basin and Contact Basins	Added calibration K-factor
Gate out of PTU	Added calibration K-factor

With all elements calibrated and validated, multiple flow scenarios for future flow can be simulated and evaluated. This will provide guidance on the impact of future flows and possible future projects to be considered to accommodate future flows.

6 Areas of Further Development

Donohue conducted a site visit to the NEW Water facilities on October 24th, 2019 to interview staff, collect additional field measurements, investigate and measure a few identified weir elevations, clarify the weir gate protocol during high flow events, and search for hydraulic elements that exist at the facilities but are not evident in past drawings. Donohue has incorporated the findings from this site visit into the models and re-calibrated them based on their implications. Donohue has also considered the flow from DPF to GBF within the models as well as the DPF final clarifier RAS flow.

Significant items discussed, verified, or discovered on October 24th are detailed in the list below. The hydraulic profile graphs did not change drastically as a result of incorporating these field measurements which use the HGL line is the driver for the calibrations.

1. Discussed weir gate control at both facilities. This includes whether gates were open, closed, or partially open at the time field measurements were collected. Donohue and NEW Water staff also discussed specific weir gates and direction to model them open, closed, or partially open when simulating future flows to represent their predicted operation in the future.
2. Field measured channel between Contact Basins and Re-Aeration Basins at GBF North since past drawings for key measurements in this area were illegible.
3. Investigated wetwell at GBF Thickening Building where flow from the South facility is pumped back to the North facility and documented operating setpoints.
4. Discovered stop log causing obstruction to flow (resulting in large headloss) between Stabilization Tank and Contact Tank at DPF.
5. Obtained insight from NEW Water staff regarding historical estimates of when bypasses operate and which bypasses were in operation during field measurement collection.
6. Discussed typical operation of UV bypass (bypassed gate is manually opened around 30 mgd but was not in use during recorded September high flow events)
7. Discovered stop log causing obstruction to flow (and resulting in headloss) in Control Structure T-53 at DPF.
8. Discovered and field measured elevation of weir in Control Structure T-52 at DPF.
9. NEW Water staff is looking back at data from 9/10/19 to determine which three Aeration Basins were online at GBF North.

NEW Water staff also discussed three areas they already identify as areas of concern for high water levels. These areas will be examined closely in the Simulation and Result Interpretation step:

1. GBF Primary Basins
2. DPF Preliminary Treatment Units
3. DPF Preliminary Treatment Unit effluent channel 90-degree turn to the Stabilization Tanks

7 Future Uses of Model

Now that the calibrated and validated plant-wide hydraulic models are complete, the models will have three uses. The immediate use will be to model future flows evaluated in the Infrastructure Gap Analysis and identify areas of the plant that are hydraulically limiting the facilities at these flows. The second is hydraulic analysis of upgrade alternatives during the evaluation phase of this Facility Plan. Finally, the models will be a powerful tool for NEW Water to use during future projects. When future upgrades are designed and constructed, the models can be updated and continue to be utilized for future studies.

Appendix A

Process Flow Diagrams

Green Bay Facility Flow Schematic

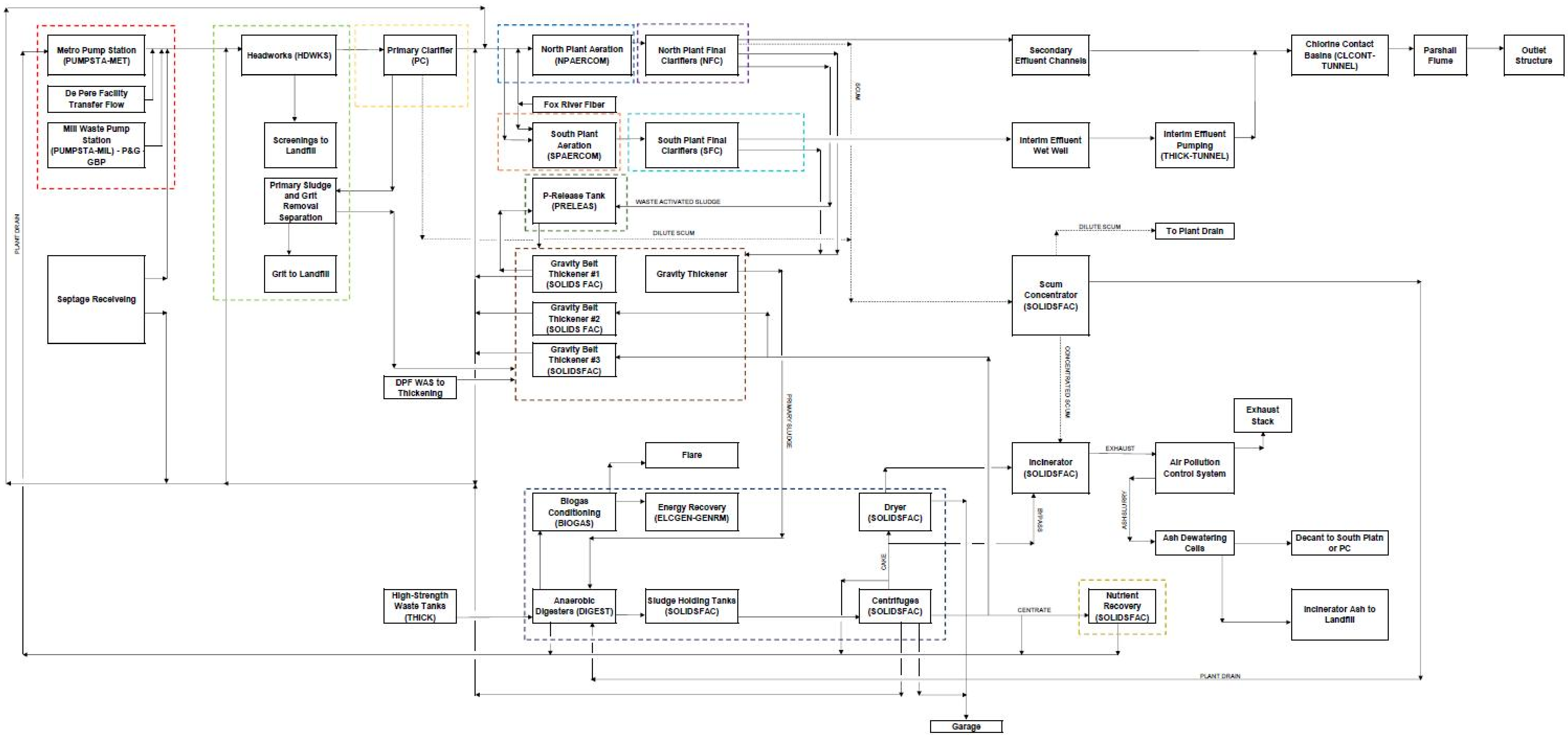

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Figure A-1 GBF Process Flow Schematic

De Pere Facility Flow Schematic

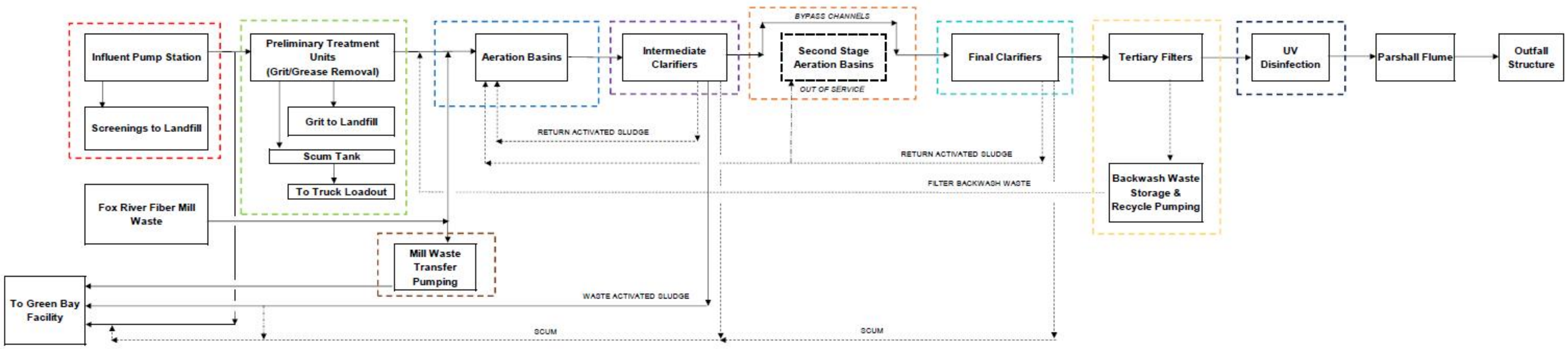

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Figure A-2 DPF Process Flow Schematic

Appendix B

Hydraulic Modeling Field Measurements Protocol

Hydraulic Modeling Field Measurements Protocol

NEW WATER
FACILITY PLAN

To: Bill Angoli/NEW Water

From: Nathan Cassity/Donohue

Copy: Leon Downing, Dave Diehl, Paul Boersma/Black & Veatch
Elaina Plinke, Emily Maher/Donohue

Subject: Hydraulic Modeling Field Measurements Protocol

Background
NEW Water is beginning a facility plan project for both the Green Bay Facility (GBF) and the De Pere Facility (DPF). As part of this work Donohue is preparing forward flow hydraulic models for both facilities as an assessment tool for the facility plan. The following protocol describes water surface field measurements to be collected by NEW Water staff during high flow events to allow for calibration and validation of the models.

Model Setup
Initially, the hydraulic models are constructed using project record drawings. To confirm the accuracy of the record drawings, two sets of survey points will be collected by a surveying subconsultant, Wisconsin Land Surveying, Inc.

1. Hydraulic control point elevations
2. Structure elevations at water surface measurement locations

Hydraulic control point elevations provide confirmation that the models are reflective of the present-day process structures. The information gathered on this list will be in the form of elevations shot by surveyors and will be used to confirm that the elevations of facility weirs, flumes, and other control structures match the record drawings.

Gathering the structure elevations at water surface measurement locations provides an accurate reference point for each of the identified water surface measurement locations. The structure at each of these locations is usually a top of concrete or a top of grating that is accessible for taking a field measurement down to the water surface.

Field Measurements for Calibration and Validation
Donohue is requesting NEW Water staff collect a series of water surface measurements during high flow events to identify the actual water levels experienced at known flow conditions. Ideally NEW Water is able to collect sets of measurements for two to three high flow events over the next few months.

After receiving the first set of water surface measurements, Donohue will begin the calibration stage. This is done by modifying the models as needed to reflect the water surface levels seen during an actual high flow event. Subsequent sets of measurements will be used in the validation stage. Validation is used to confirm that running the models at flows higher and lower than the calibration flow still results in accurate results.

Following this process, Donohue will form conclusions about the flows at which the facilities can adequately convey all flows, incurs its first flood (a flood is considered any event when freeboard becomes less than 6”), and has major flooding at multiple plant processes.

Water Surface Measurement Plan

A Field Measurement Log Sheet is included as Attachment A to this protocol. These locations have been numbered and marked with pieces of tape during our site walkthrough on July 25th. Guidelines for measuring water surface levels include the following:

1. If possible, take measurements in the middle of the channels/basins (ie away from walls).
2. Record the time that each point is measured.
3. Record the measurement from the structure down to the water surface
4. After the field measurements have been completed, record the following from SCADA based on the time each measurement was taken
    a. Influent Flow
    b. RAS Flow
    c. Water level readings from level sensors

Green Bay Facility North

The list of water surface measurements at GBF North are listed in Table 1. A location map is included as Attachment B. Donohue requests the plant to take a set of measurements on days when the GBF flow is above 50 MGD.

Table 1 GBF North Water Surface Measurement Points

POINT NUMBER	LOCATION
5	Downstream of screens (north) – Top of grating
6	Downstream of screens (south) – Top of grating
7	Parshall Flume downstream of screens (north) – Top of grating
8	Parshall Flume downstream of screens (south) – Top of grating
11	At gate just upstream of piping to north primary basins – Top of grating
12	At gate just upstream of piping to south primary basins – Top of grating
15	At Primary Basin No. 1 launder – Top of concrete
18	At Primary Basin No. 3 launder – Top of support
19	Primary Basin No. 1 bridge – Top of grating
20	Primary Basin No. 3 bridge – Top of grating
21	At grating just east of Mechanical Building East (north) – Top of grating
22	At grating just east of Mechanical Building East (south) – Top of grating
23	Primary effluent channel upstream of aeration splitter weir gates – Top of grating

27	Upstream of Contact Basin No. 1 Parshall Flume (north) – Top of grating
28	Upstream of Contact Basin No. 3 Parshall Flume (south) – Top of grating
29	West end of Contact Basin No. 1 as shown – Top of concrete
30	West end of Reaeration Basin No. 1 as shown – Top of concrete
31	West end of Contact Basin No. 3 as shown – Top of concrete
32	West end of Reaeration Basin No. 3 as shown – Top of concrete
35	West end of Mixed Liquor Channel adjacent to Contact Basin No. 2 – Top of grating
36	West end of Mixed Liquor Channel adjacent to Contact Basin No. 4 – Top of grating
41	At Final Basin No. 1 launder – Top of concrete
44	At Final Basin No. 5 launder – Top of concrete
45	Final Basin No. 1 bridge – Top of grating
46	Final Basin No. 5 bridge – Top of grating
47	Secondary effluent channel (north) – Top of grating
48	Secondary effluent channel (south) – Top of grating
49	South plant secondary effluent and north plant bypass channel – Top of grating
50	Just upstream of gate to Chlorine Contact Basin No. 1 – Top of angle
51	Just upstream of gate to Chlorine Contact Basin No. 2 – Top of angle
52	Upstream of Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete
53	At bridge over Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete
54	Upstream of Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete
55	At bridge over Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete
56	At Primary Basin No. 3 – primary effluent diversion box to GBF South – Top of concrete

Green Bay Facility South

The list of water surface measurements at GBF South are listed in Table 2. A location map is included as Attachment C. Donohue requests the plant to take a set of measurements on days when the GBF flow is above 50 MGD. Note: if only one aeration basin is in operation, the first two points can be taken in the operating basin.

Table 2 GBF South Water Surface Measurement Points

POINT NUMBER	LOCATION
57	Upstream end of Aeration Basin No. 2 – Top of concrete
58	Downstream end of Aeration Basin No. 2 – Top of concrete
59	Channel just south of Mechanical Building – Top of grating
60	Channel just north of Electrical Building – Top of grating
61	Secondary Clarifier No. 1 bridge – Top of support
62	Secondary Clarifier No. 2 bridge – Top of support
64	At Secondary Clarifier No. 1 launder – Top of concrete
66	At Secondary Clarifier No. 2 launder – Top of concrete

De Pere Facility

The list of water surface measurements at DPF are listed in Table 3. A location map is included as Attachment D. Donohue requests the plant to take a set of measurements on days when the DPF flow is above 20 MGD.

Table 3 DPF Water Surface Measurement Points

POINT NUMBER	LOCATION
1	Approach to Preliminary Treatment Unit bypass weir – Top of grating
3	North Preliminary Treatment Unit bridge – Top of grating
5	At North Preliminary Treatment Unit launder – Top of concrete
6	South Preliminary Treatment Unit bridge – Top of grating
9	Downstream of Preliminary Treatment Unit bypass gate – Top of grating
10	North Anoxic Basin influent channel – Top of grating
11	South Anoxic Basin influent channel – Top of grating
14	Upstream end of north Anoxic Basin – Top of concrete
15	Upstream end of south Anoxic Basin – Top of concrete
22	North Aeration Basin – Top of concrete
23	South Aeration Basin – Top of concrete
26	North Aeration Basin effluent channel – Top of grating
27	South Aeration Basin effluent channel – Top of grating
28	North Intermediate Clarifier bridge – Top of grating
29	South Intermediate Clarifier bridge – Top of grating
32	At North Intermediate Clarifier launder – Top of grating
35	At South Intermediate Clarifier launder – Top of grating
36	Splitter Box T-20 – Top of grating
42	At north gate just upstream of piping to final clarifiers – Top of grating
43	Southwest Final Clarifier bridge – Top of steel
46	Southwest Final Clarifier launder (from bridge) – Top of steel
47	CS T-29 – Top of grating
48	CS T-31 – Top of grating
52	T-51 – Top of concrete
55	Channel on west side of UV Disinfection Building as shown – Top of grating
57	Final Effluent Flume – Top of concrete
59	CS T-53 – Top of grating

GBF North Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: ____________

Recorded by: ____

	Measurement #1			Measurement #2			Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Description	Comments/Observations
5													Downstream of screens (north) – Top of grating	
6													Downstream of screens (south) – Top of grating	
7													Parshall Flume downstream of screens (north) – Top of grating	
8													Parshall Flume downstream of screens (south) – Top of grating	
11													At gate just upstream of piping to north primary basins – Top of grating	
12													At gate just upstream of piping to south primary basins – Top of grating	
15													At Primary Basin No. 1 launder – Top of concrete	
18													At Primary Basin No. 3 launder – Top of support	
19													Primary Basin No. 1 bridge – Top of grating	
20													Primary Basin No. 3 bridge – Top of grating	
21													At grating just east of Mechanical Building East (north) – Top of grating	
22													At grating just east of Mechanical Building East (south) – Top of grating	
23													Primary effluent channel upstream of aeration splitter weir gates – Top of grating	
27													Upstream of Contact Basin No. 1 Parshall Flume (north) – Top of grating	
28													Upstream of Contact Basin No. 3 Parshall Flume (south) – Top of grating	
29													West end of Contact Basin No. 1 as shown – Top of concrete	
30													West end of Reaeration Basin No. 1 as shown – Top of concrete	
31													West end of Contact Basin No. 3 as shown – Top of concrete	
32													West end of Reaeration Basin No. 3 as shown – Top of concrete	
35													West end of Mixed Liquor Channel adjacent to Contact Basin No. 2 – Top of grating	
36													West end of Mixed Liquor Channel adjacent to Contact Basin No. 4 – Top of grating	
41													At Final Basin No. 1 launder – Top of concrete	
44													At Final Basin No. 5 launder – Top of concrete	
45													Final Basin No. 1 bridge – Top of grating	
46													Final Basin No. 5 bridge – Top of grating	
47													Secondary effluent channel (north) – Top of grating	
48													Secondary effluent channel (south) – Top of grating	
49													South plant secondary effluent and north plant bypass channel – Top of grating	
50													Just upstream of gate to Chlorine Contact Basin No. 1 – Top of angle	
51													Just upstream of gate to Chlorine Contact Basin No. 2 – Top of angle	
52													Upstream of Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete	
53													At bridge over Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete	
54													Upstream of Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete	
55													At bridge over Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete	
56													At Primary Basin No. 3 – primary effluent diversion box to GBF South – Top of concrete	

GBF South Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: ____________

Recorded by: ____

	Measurement #1			Measurement #2			Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Description	Comments/Observations
57													Upstream end of Aeration Basin No. 2 – Top of concrete	
58													Downstream end of Aeration Basin No. 2 – Top of concrete	
59													Channel just south of Mechanical Building – Top of grating	
60													Channel just north of Electrical Building – Top of grating	
61													Secondary Clarifier No. 1 bridge – Top of support	
62													Secondary Clarifier No. 2 bridge – Top of support	
64													At Secondary Clarifier No. 1 launder – Top of concrete	
66													At Secondary Clarifier No. 2 launder – Top of concrete	

NOTES

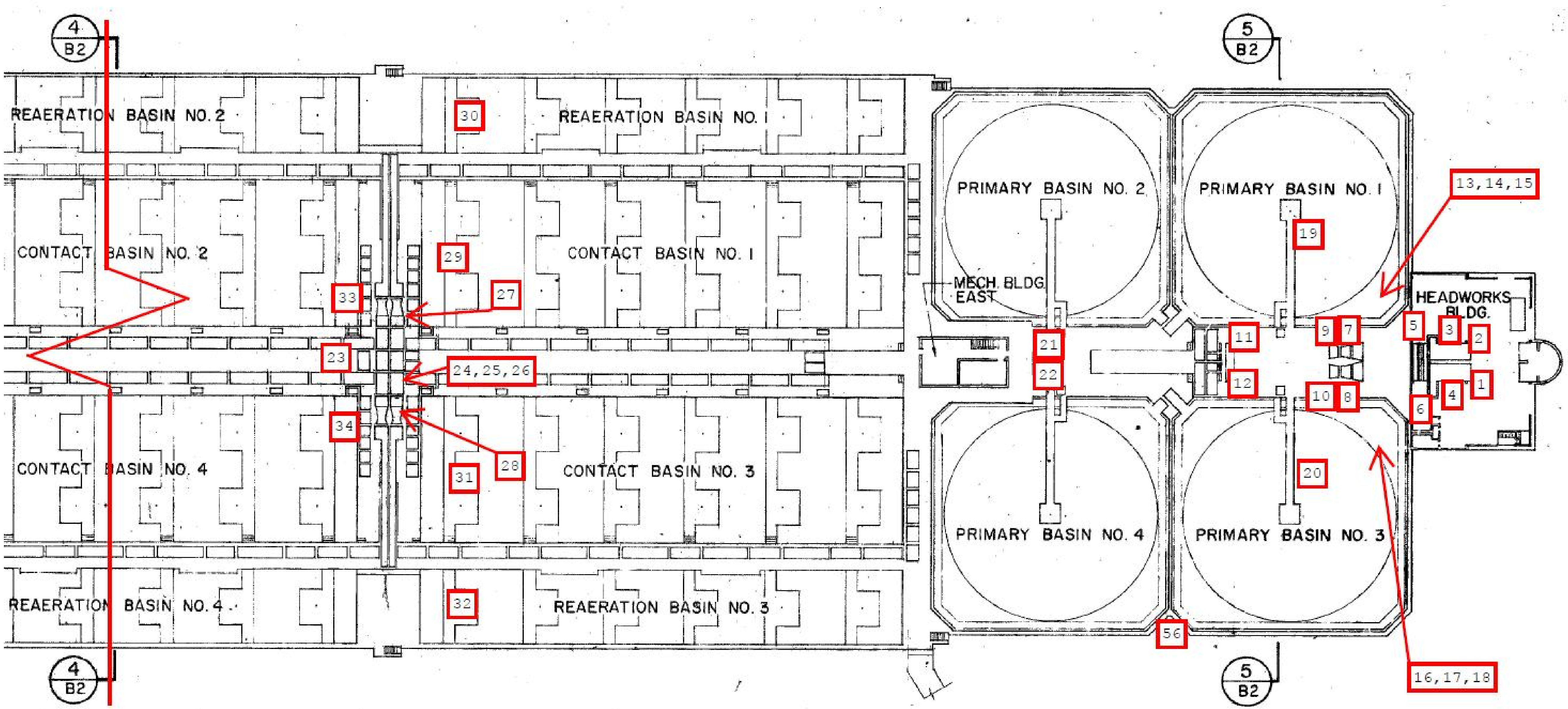
DPF Plant Hydraulic Evaluation - Field Point High Flow Measurements

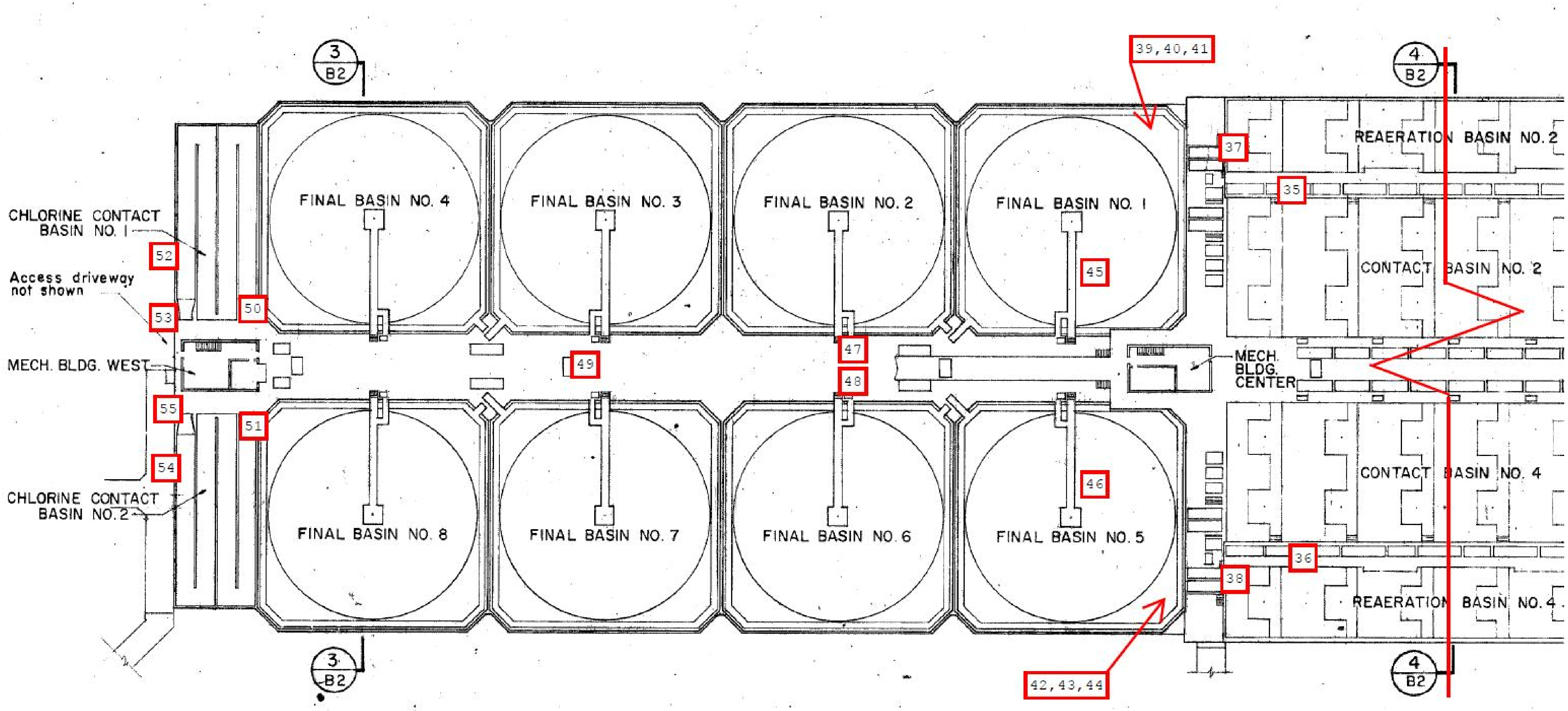
Date: ___________

Recorded by: ______________________________________

	Measurement #1			Measurement #2			Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Time	Influent Flow (MGD)	Depth to Water (inches)	Description	Comments/Observations
1													Approach to Preliminary Treatment Unit bypass weir – Top of grating	
3													North Preliminary Treatment Unit bridge – Top of grating	
5													At North Preliminary Treatment Unit launder – Top of concrete	
6													South Preliminary Treatment Unit bridge – Top of grating	
9													Downstream of Preliminary Treatment Unit bypass gate – Top of grating	
10													North Anoxic Basin influent channel – Top of grating	
11													South Anoxic Basin influent channel – Top of grating	
14													Upstream end of north Anoxic Basin – Top of concrete	
15													Upstream end of south Anoxic Basin – Top of concrete	
22													North Aeration Basin – Top of concrete	
23													South Aeration Basin – Top of concrete	
26													North Aeration Basin effluent channel – Top of grating	
27													South Aeration Basin effluent channel – Top of grating	
28													North Intermediate Clarifier bridge – Top of grating	
29													South Intermediate Clarifier bridge – Top of grating	
32													At North Intermediate Clarifier launder – Top of grating	
35													At South Intermediate Clarifier launder – Top of grating	Observe and comment if there is a water level drop after convergence of clarifier flows
36													Splitter Box T-20 – Top of grating	
42													At north gate just upstream of piping to final clarifiers – Top of grating	
43													Southwest Final Clarifier bridge – Top of steel	
46													Southwest Final Clarifier launder (from bridge) – Top of steel	
47													CS T-29 – Top of grating	
48													CS T-31 – Top of grating	Observe and comment if there is flow through the filter bypasses (just east of this point)
52													T-51 – Top of concrete	
55													Channel on west side of UV Disinfection Building as shown – Top of grating	
57													Final Effluent Flume – Top of concrete	
59													CS T-53 – Top of grating	

Attachment B
Facility Plan - Hydraulic Modeling Field Measurements
GBF North Plant Field Measurements Location Map




3
B2
39,40,41
4
B2
37
REAERATION BASIN NO. 2
35
CHLORINE CONTACT
BASIN NO. 1
FINAL BASIN NO. 4
FINAL BASIN NO. 3
FINAL BASIN NO. 2
FINAL BASIN NO. 1
52
45
CONTACT BASIN NO. 2
Access driveway
not shown
53
50
47
MECH.
BLDG.
CENTER
MECH. BLDG. WEST
49
48
55
51
54
46
CONTACT BASIN NO. 4
CHLORINE CONTACT
BASIN NO. 2
FINAL BASIN NO. 8
FINAL BASIN NO. 7
FINAL BASIN NO. 6
FINAL BASIN NO. 5
36
38
REAERATION BASIN NO. 4
3
B2
42,43,44
4
B2

Points Locations – GBF North

1. South Bar screen influent at level element – Top of grating (survey only)

2. North bar screen influent at level element – Top of grating (survey only)

3. North Bar screen effluent at level element – Top of grating (survey only)

4. South Bar screen effluent at level element – Top of grating (survey only)

Points Locations – GBF North

5. Downstream of screens (north) – Top of grating

6. Downstream of screens (south) – Top of grating

7. Parshall Flume downstream of screens (north) – Top of grating

8. Parshall Flume downstream of screens (south) – Top of grating

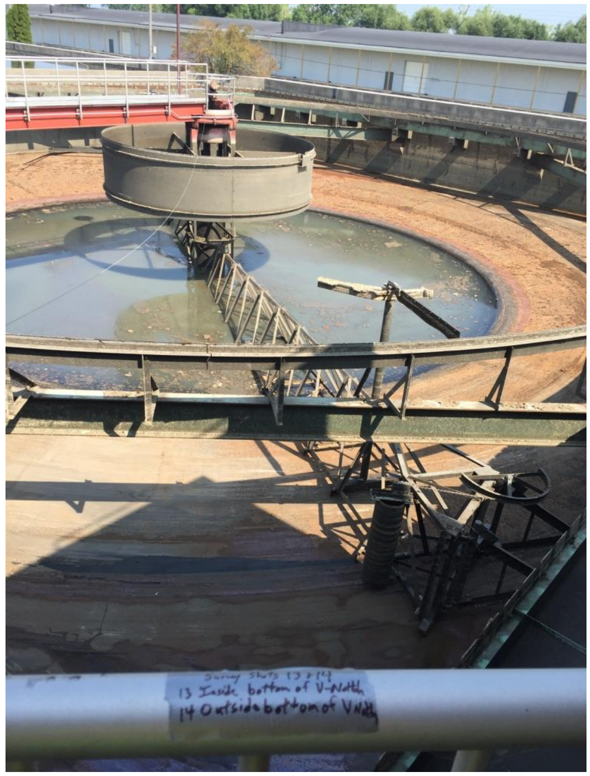
9. Lip of Parshall Flume downstream of screens (north) – Bottom of channel (survey only)

10. Lip of Parshall Flume downstream of screens (south) – Bottom of channel (survey only)

11. At gate just upstream of piping to north primary basins – Top of grating

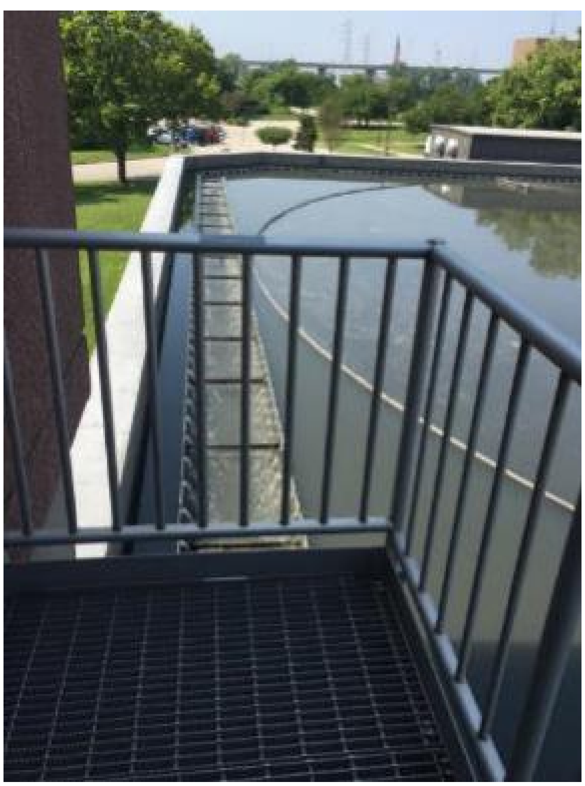

12. At gate just upstream of piping to south primary basins – Top of grating


13. At Primary Basin No. 1 launder – Inside bottom of V-notch weir (see 14 for photos) (survey only)
14. At Primary Basin No. 1 launder – Outside bottom of V-notch weir (survey only)



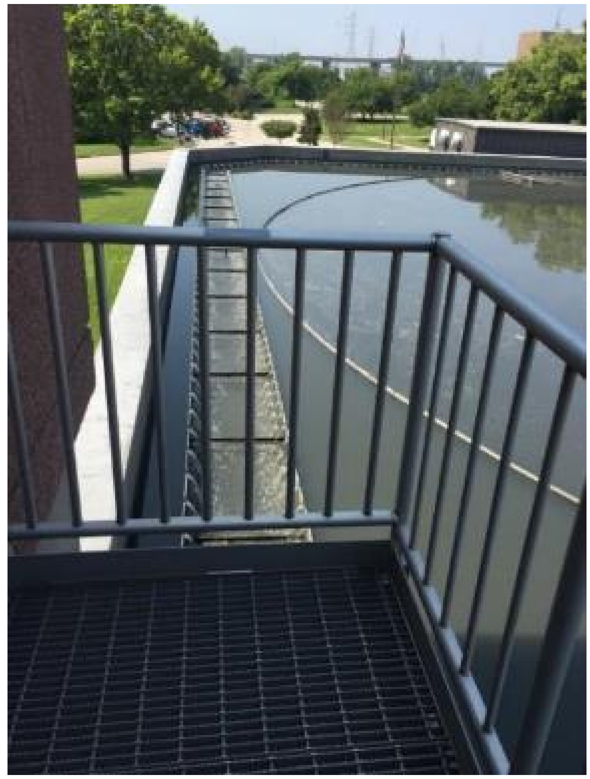
15. At Primary Basin No. 1 launder – Top of concrete

16. At Primary Basin No. 3 launder – Inside bottom of V-notch weir (see 17 for photos) (survey only)
17. At Primary Basin No. 3 launder – Outside bottom of V-notch weir (survey only)

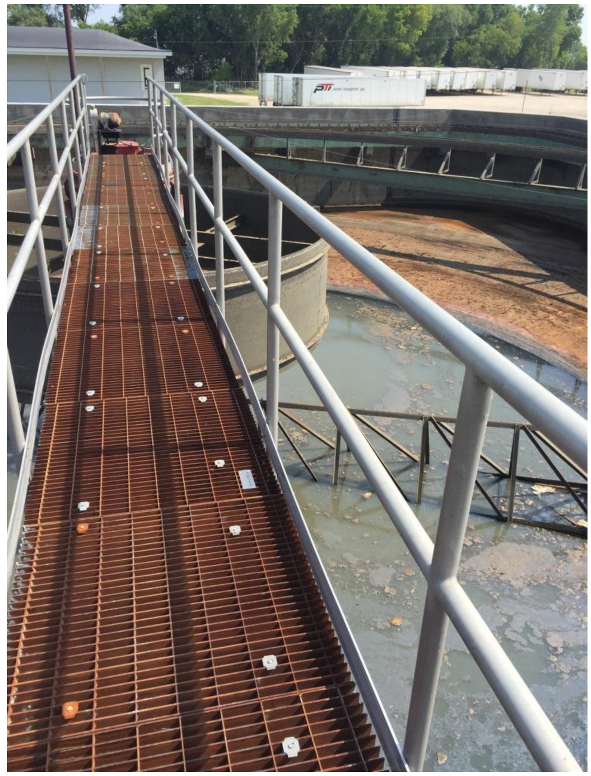


Points Locations – GBF North

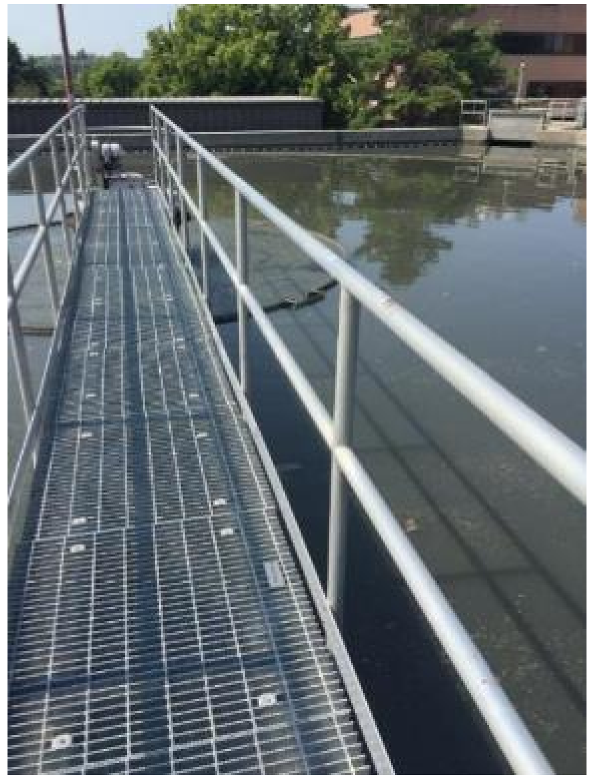
18. At Primary Basin No. 3 launder – Top of support



19. Primary Basin No. 1 bridge – Top of grating



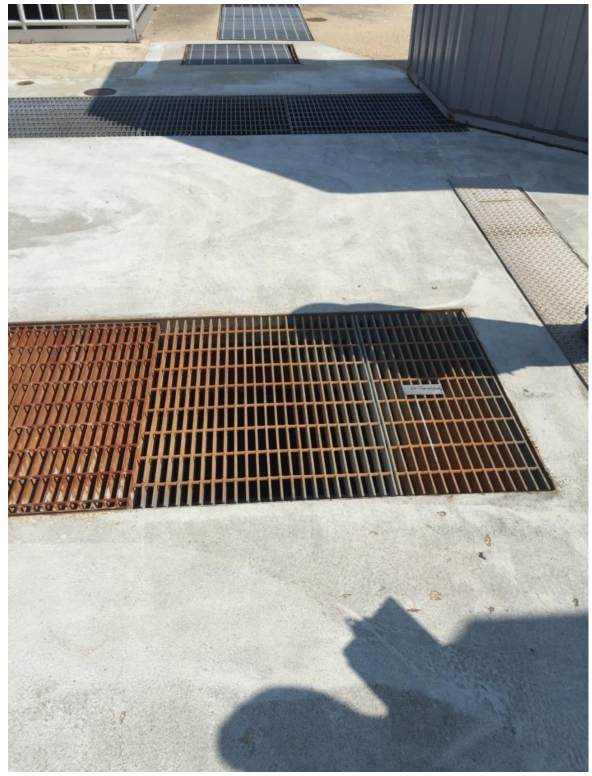
20. Primary Basin No. 3 bridge – Top of grating



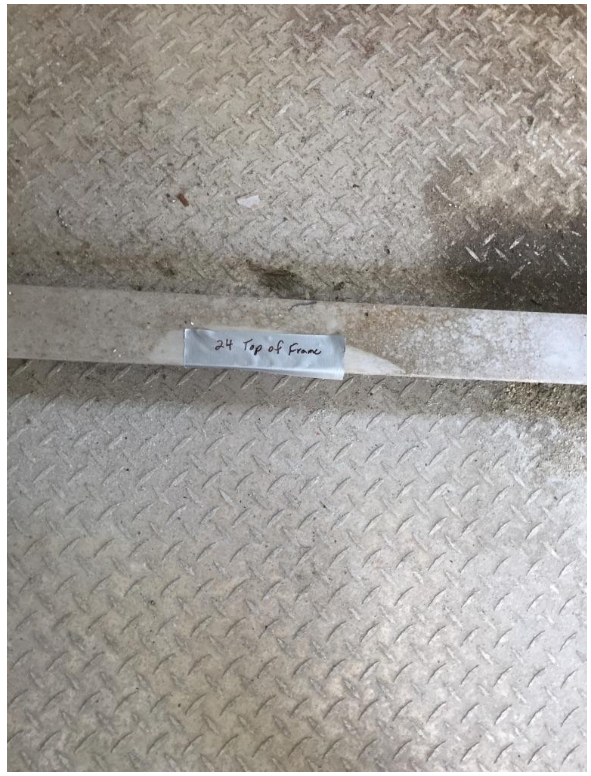
21. At grating just east of Mechanical Building East (north) – Top of grating

22. At grating just east of Mechanical Building East (south) – Top of grating (see 21 for additional photo)

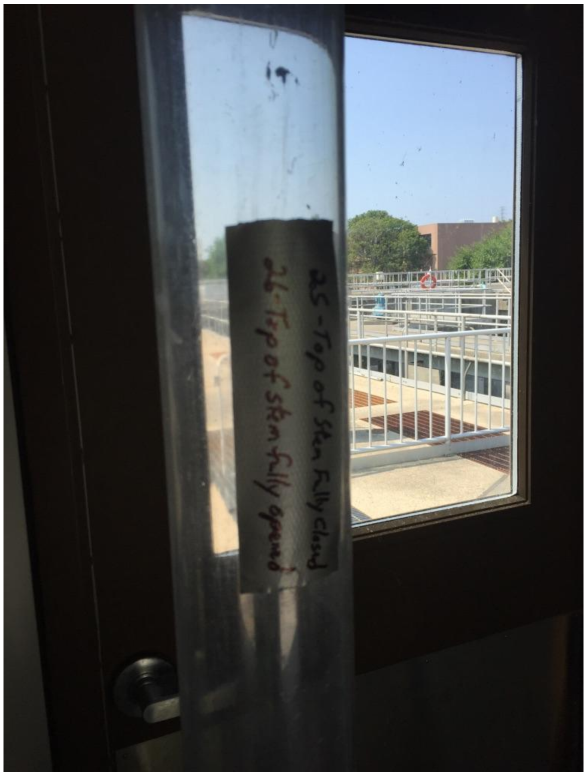
23. Primary effluent channel upstream of aeration splitter weir gates – Top of grating



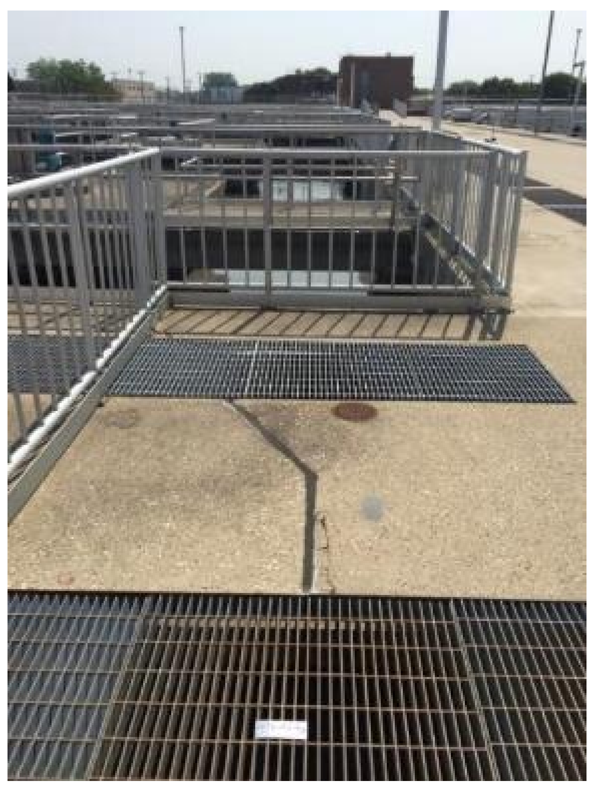
24. South aeration splitter weir gate – Top of frame (survey only)



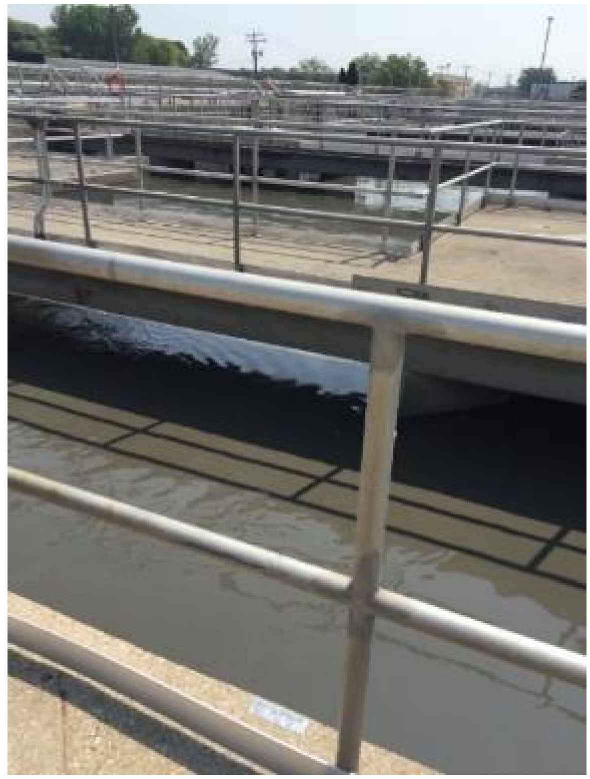
25. South aeration splitter weir gate – Top of stem fully closed (see 26 for photo) (survey only)
26. South aeration splitter weir gate – Top of stem fully opened (survey only)



27. Upstream of Contact Basin No. 1 Parshall Flume (north) – Top of grating



28. Upstream of Contact Basin No. 3 Parshall Flume (south) – Top of grating
29. West end of Contact Basin No. 1 as shown – Top of concrete

30. West end of Reaeration Basin No. 1 as shown – Top of concrete


31. West end of Contact Basin No. 3 as shown – Top of concrete

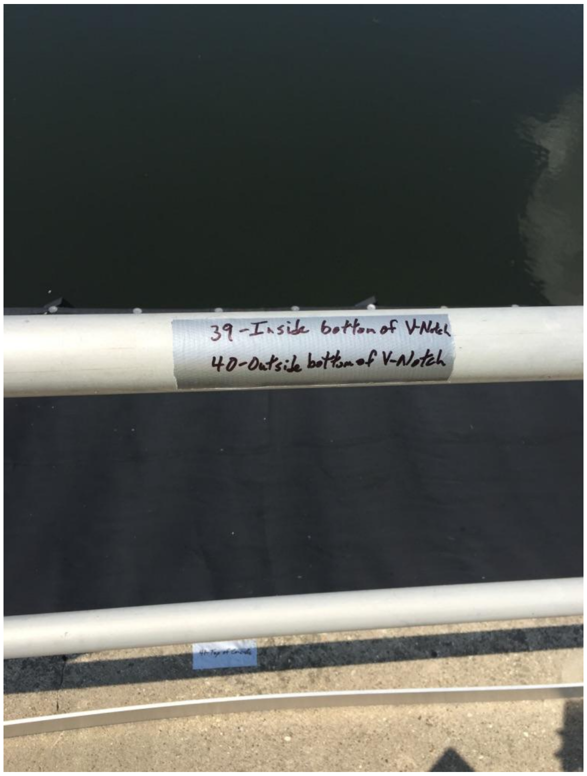
32. West end of Reaeration Basin No. 3 as shown – Top of concrete

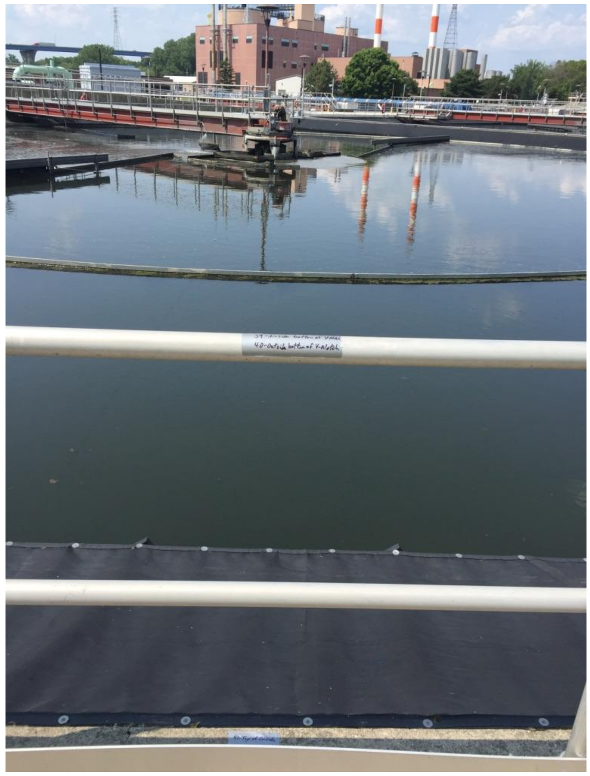
33. East end of Contact Basin No. 2 – Top of weir (see 34 for photos of similar weir on Contact Basin No. 4) (survey only)
34. East end of Contact Basin No. 4 as shown – Top of weir (survey only)

35. West end of Mixed Liquor Channel adjacent to Contact Basin No. 2 – Top of grating (see 36 for photos of similar point on Contact Basin No. 4 Mixed Liquor Channel)
36. West end of Mixed Liquor Channel adjacent to Contact Basin No. 4 – Top of grating


37. Weir just upstream of piping to Final Basins (north) – Top of weir (see 38 for photos of similar point on south channel) (survey only)
38. Weir just upstream of piping to Final Basins (south) – Top of weir (survey only)


39. At Final Basin No. 1 launder – Inside bottom of V-notch weir (see 40 for photos) (survey only)
40. At Final Basin No. 1 launder – Outside bottom of V-notch weir (survey only)



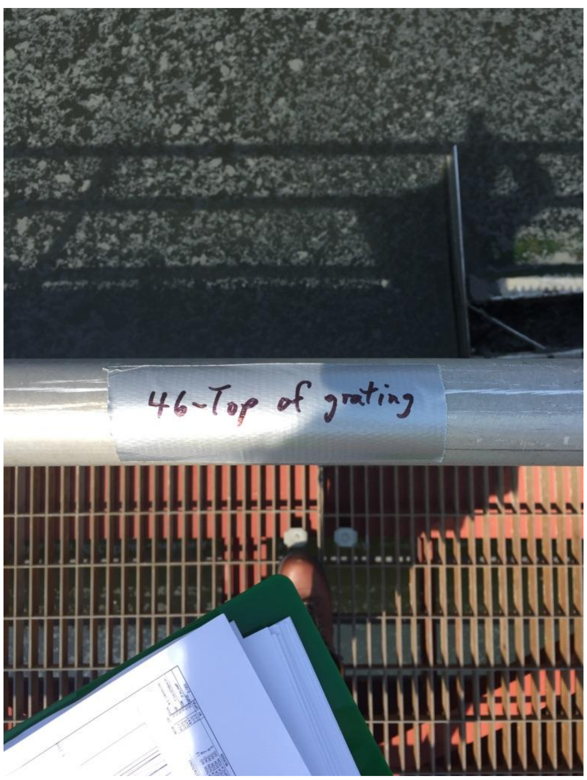


41. At Final Basin No. 1 launder – Top of concrete (see 40 for location)

42. At Final Basin No. 5 launder – Inside bottom of V-notch weir (see 43 for photos) (survey only)
43. At Final Basin No. 5 launder – Outside bottom of V-notch (survey only)

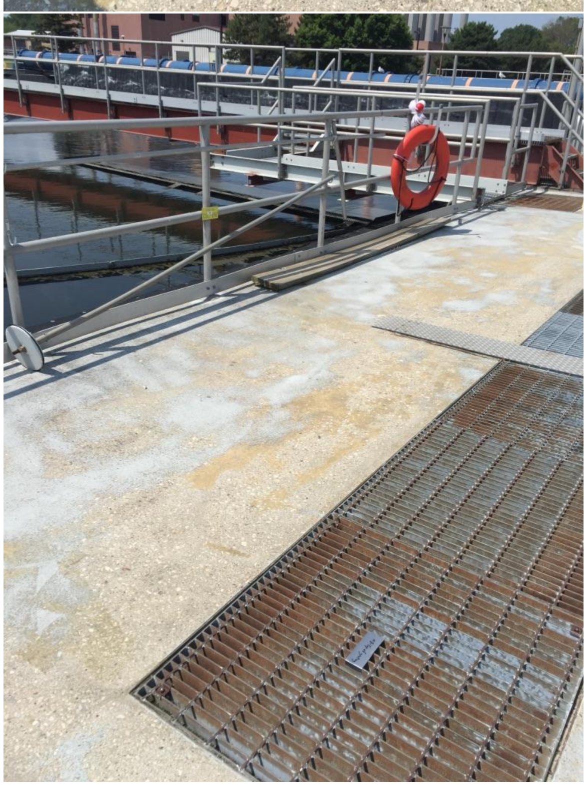
44. At Final Basin No. 5 launder – Top of concrete (see 43 for location)

45. Final Basin No. 1 bridge – Top of grating (see 46 for photos of similar point on Final Basin No. 5)
46. Final Basin No. 5 bridge – Top of grating



47. Secondary effluent channel (north) – Top of grating

48. Secondary effluent channel (south) – Top of grating



49. South plant secondary effluent and north plant bypass channel – Top of grating

50. Just upstream of gate to Chlorine Contact Basin No. 1 – Top of angle

51. Just upstream of gate to Chlorine Contact Basin No. 2 – Top of angle

52. Upstream of Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete

53. At bridge over Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete

54. Upstream of Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete

55. At bridge over Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete

56. At Primary Basin No. 3 – primary effluent diversion box to GBF South – Top of concrete

Attachment C
Facility Plan - Hydraulic Modeling Field Measurements
GBF South Plant Field Measurements Location Map

09-13-93 .DWG
57
AERATION BASIN No.4
AERATION BASIN No.3
PRIMARY CLARIFIER No.4
PRIMARY CLARIFIER No.3
TUNNEL G
TUNNEL K
TUNNEL L
TUNNEL M
TUNNEL U
MAINTENANCE BUILDING
ADMINISTRATION BUILDING
PUMP STATION
HUMAN RESOURCES BUILDING
AERATION BASIN No.1
AERATION BASIN No.2
QUINCY STREET
TEMPORARY CONSTRUCTION PARKING IN THIS AREA
MATCH LINE SEE DWG G31-Y101
22 1/2 ° ELBOW STA 2+47.11 N 4368.67 E 3172.13
CURB INLET TYPE B IN INV 98.46 OUT INV 98.36
STA 3+97.00 N 4220.17 E 3114.77
CONTRACT NO. 30
THIS CONTRACT
CONNECT TO EXISTING GAS PIPE
RELOCATE EXISTING GAS LINE
CURB INLET, TYPE A OUT INV 98.60 SEE 2 G31-Y104 (TYP OF 2)
MANHOLE #4 w/ TYPE A COVER N 4209.00 E 3059.00 RIM EL 103.90 IN INV 96.28 OUT INV 96.18 SEE 1 TYP
22 1/2 ° ELBOW STA 4+44.52 N 4186.27 E 3096.58
STA 5+21.79 N 4109.00 E 3096.58
POST MOUNTED TEST STATION SEE 14
CURB INLET TYPE B OUT INV 98.57
REMOVE AND PLUG EXISTING 6"SS AS REQUIRED
MANHOLE #3 w/ TYPE A COVER N 4209.00, E 3173.00 RIM EL 103.90 IN INV 95.77 (WEST) IN INV 98.24 (NORTH) OUT INV 95.47
MANHOLE #2 w/ TYPE B COVER N 4088.00, E 3173.00 RIM EL 101.50 INV 95.14 SEE 2 TYP
RELOCATE EXISTING HYDRANT
HYDRANT N 4021.50 E 3251.00 SEE 12
MANHOLE #6 w/ TYPE B COVER N 4126.00, E 2725.00 RIM EL 102.50 IN INV 97.82 OUT INV 97.72
CURB INLET TYPE B OUT INV 98.60
MANHOLE #5 w/ TYPE A COVER N 4126.00, E 2996.41 RIM EL 103.50 IN INV 96.72 (WEST) IN INV 98.58 (NORTH) OUT INV 96.62
MANHOLE #1 w/ TYPE B COVER N 3988.37, E 3173.00 RIM EL 99.50 IN INV 93.15 OUT INV 92.85
REMOVE EXISTING CURB INLET (TYP) ALL EXISTING PIPE TO BE REMOVED OR ABANDONED
CURB INLET TYPE B OUT INV 96.04 SEE 1 G31-Y104 TYP
CURB INLET TYPE C OUT INV 95.94 SEE 1 G31-Y104
CONNECT TO EXISTING GAS PIPE
REMOVE EXISTING AREA INLET (TYP)
72" INFLUENT
108" INFLUENT
N 4500
N 4250
N 4000
E 2750
E 3000
E 3200
E 3500
SCALE 1"=30'
0 30 60 90
RECORD DRAWINGS
Revisions Drawn by K.C.YEUNG Date SEP 1993
THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.
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VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.
3 9-93 RECORD DRAWINGS
2 9-92 CONTRACT MODIFICATION NO. 10
1 4-90 ADDENDUM NO. 2
NO. DATE REVISION BY APVD
DSGN T.GILGENBACK
DR T.GILGENBACH
CHK P.KLAMPE
APVD D.GEE
GREEN BAY METROPOLITAN SEWERAGE DISTRICT
GREEN BAY, WISCONSIN
SOUTH COMPLEX
SITEWORK
YARD PIPEING PLAN
CH2M HILL
SHEET 26
DWG NO. G31-Y102
DATE DEC 1989
PROJ NO. GLO22633
OVERLAY IDENTIFICATION
PROJ. NO.
CONTRACT
COMPOSITE
OVERLAY
SCREEN

57. Upstream end of Aeration Basin No. 2 – Top of concrete

58. Downstream end of Aeration Basin No. 2 – Top of concrete

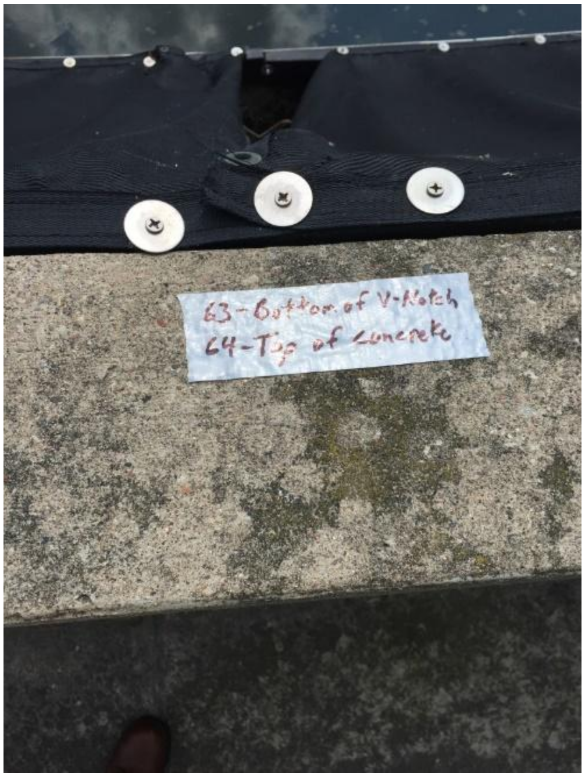
59. Channel just south of Mechanical Building – Top of grating

60. Channel just north of Electrical Building – Top of grating

61. Secondary Clarifier No. 1 bridge – Top of support

62. Secondary Clarifier No. 2 bridge – Top of support

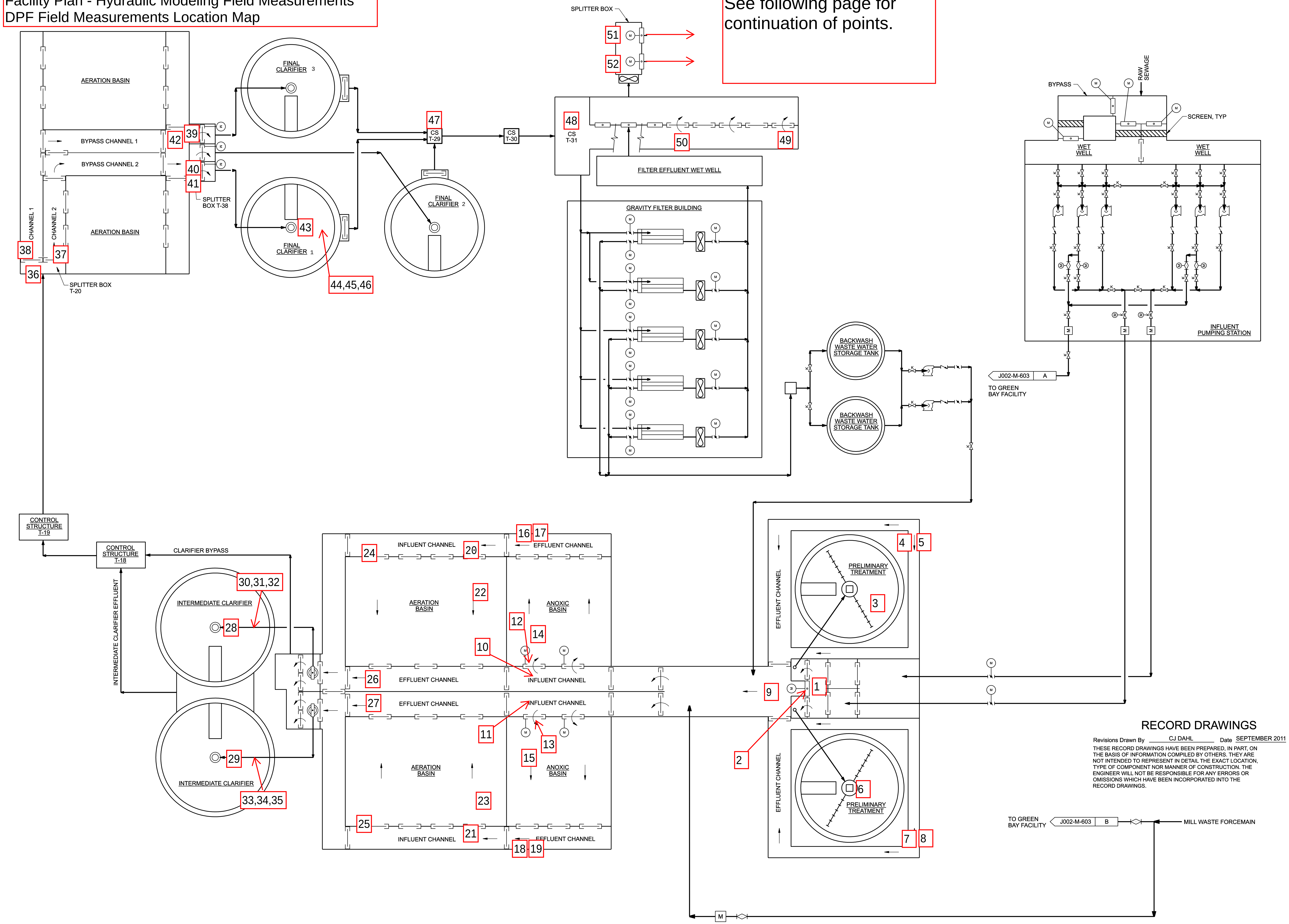
63. At Secondary Clarifier No. 1 launder – Bottom of V-notch weir (see 64 for photos) (survey only)
64. At Secondary Clarifier No. 1 launder – Top of concrete



65. At Secondary Clarifier No. 2 launder – Bottom of V-notch weir (see 66 for photos) (survey only)
66. At Secondary Clarifier No. 2 launder – Top of concrete

Attachment D
Facility Plan - Hydraulic Modeling Field Measurements
DPF Field Measurements Location Map

See following page for continuation of points.



RECORD DRAWINGS

Revisions Drawn By CJ DAHL Date SEPTEMBER 2011

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

CH2MHILL

DE PERE & GREEN BAY FACILITY UPGRADES
DE PERE AND GREEN BAY, WI
GREEN BAY MSD
GREEN BAY, WI

GENERAL
LIQUID TREATMENT SCHEMATIC

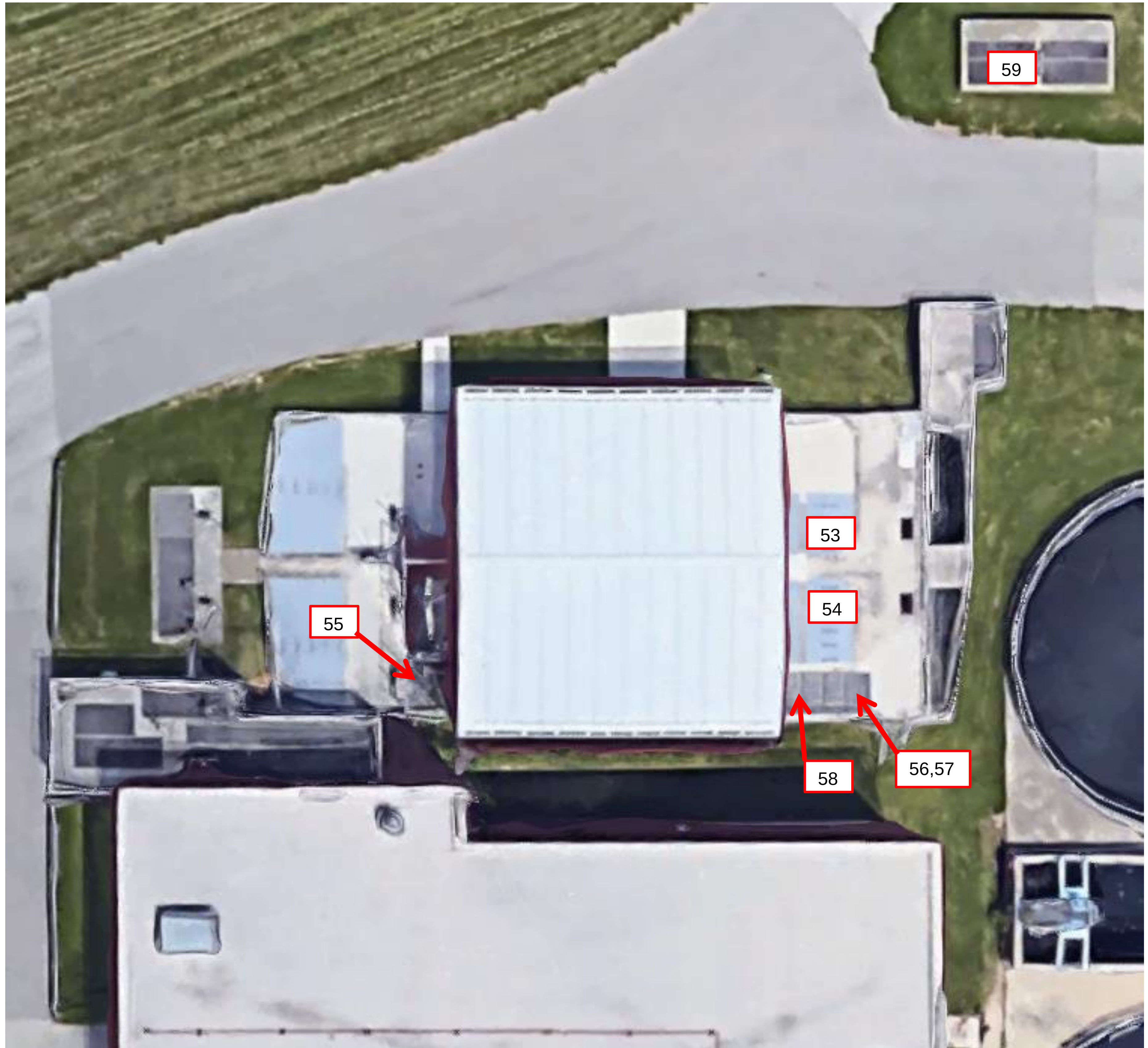
DSGN DJ GALL | DR MA REICHERT | CHK | APVD D GEE
RECORD DRAWING REVISION 09/11 CJD DG

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.

DATE	JANUARY 2009
PROJ	130972
DWG	J002-M-602
SHEET	14

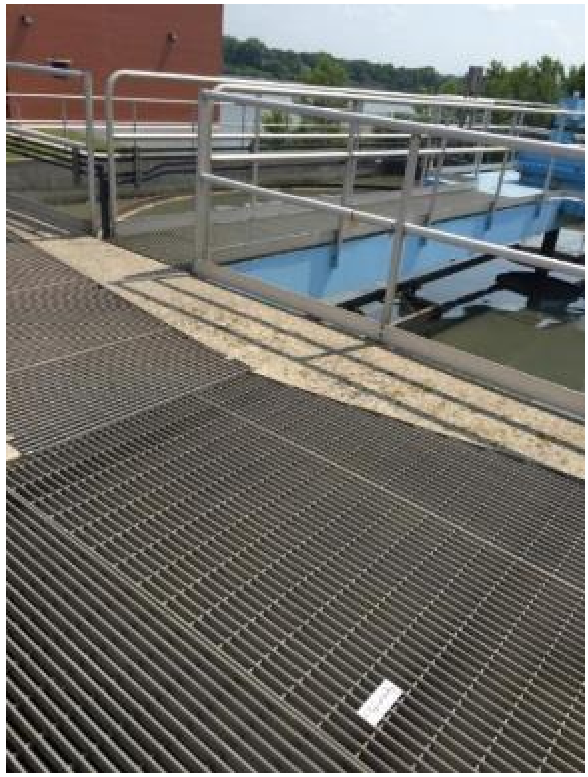
RECORD DRAWING

PLOT TIME: 2:55:09 PM PLOT DATE: 1/12/2012 MICROSTATION FILENAME: dnj002m602.dgn


59
53
54
55
58
56,57

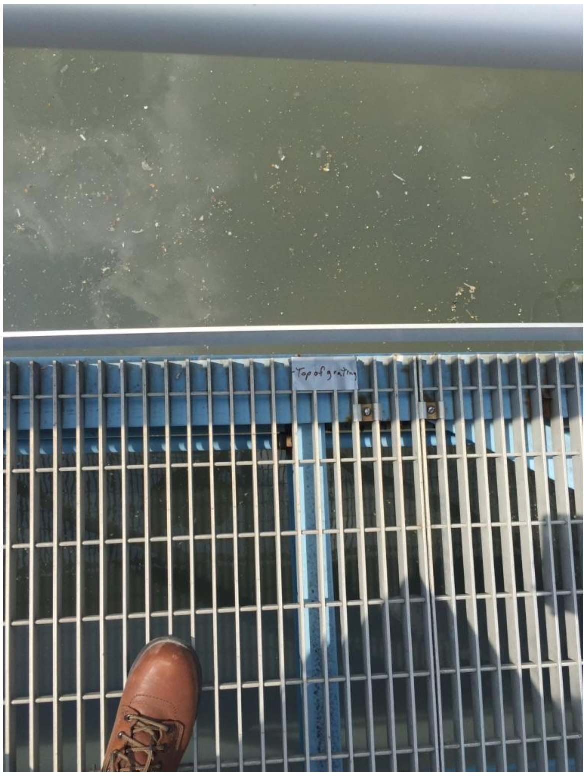
Points Locations – DPF

1. Approach to Preliminary Treatment Unit bypass weir – Top of grating

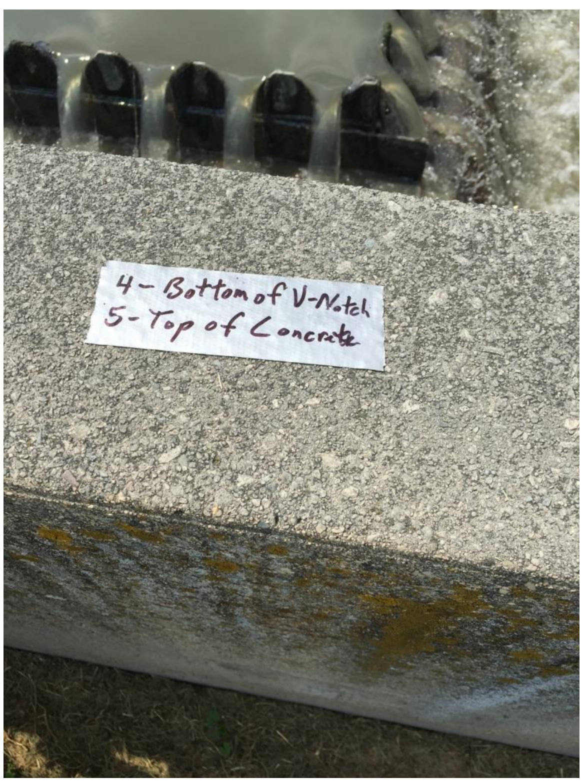


2. Preliminary Treatment Unit bypass weir – Top of gate (survey only)

3. North Preliminary Treatment Unit bridge – Top of grating

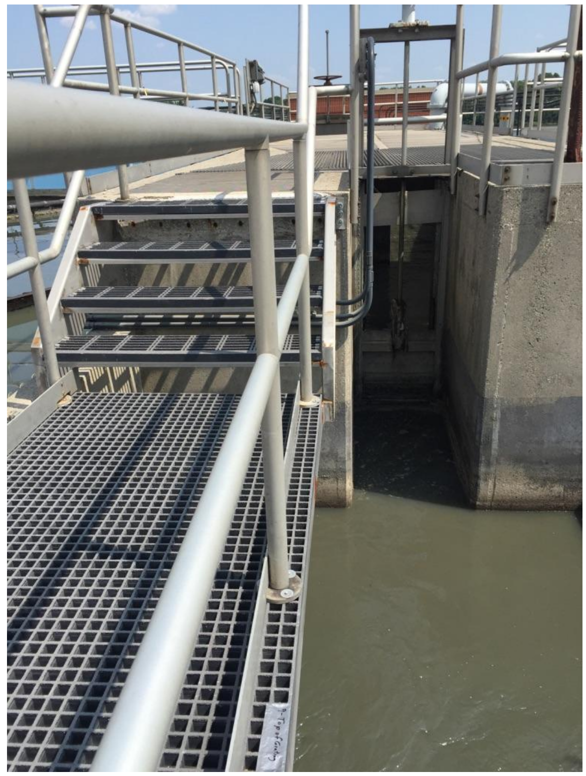


4. At North Preliminary Treatment Unit launder – Bottom of V-notch weir (see 5 for photo) (survey only)
5. At North Preliminary Treatment Unit launder – Top of concrete



6. South Preliminary Treatment Unit bridge – Top of grating

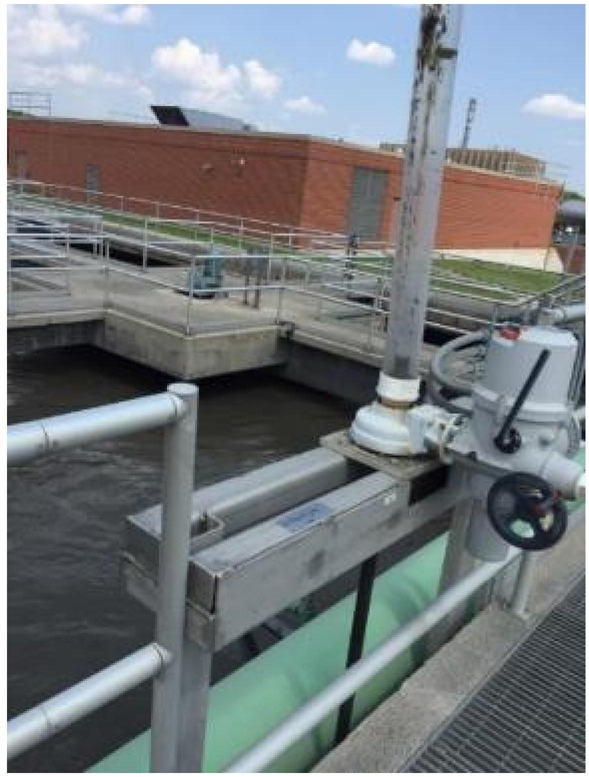
7. At South Preliminary Treatment Unit launder – Bottom of V-notch weir (at south east corner of unit) (survey only)
8. At South Preliminary Treatment Unit launder – Top of concrete (at south east corner of unit) (survey only)
9. Downstream of Preliminary Treatment Unit bypass gate – Top of grating



10. North Anoxic Basin influent channel – Top of grating (see 11 for location)

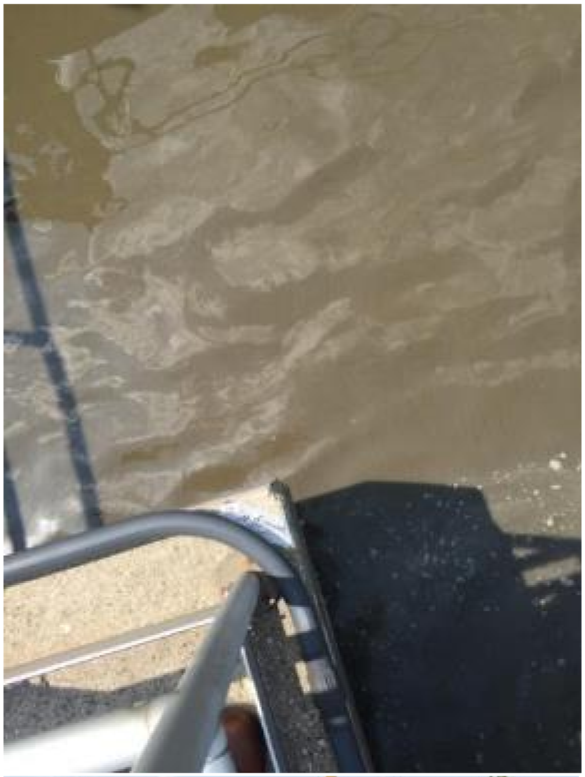
11. South Anoxic Basin influent channel – Top of grating

12. North Anoxic Basin gate (2nd gate from the east) – Top of gate (survey only)



13. South Anoxic Basin gate (2nd gate from the east) – Top of gate (survey only)

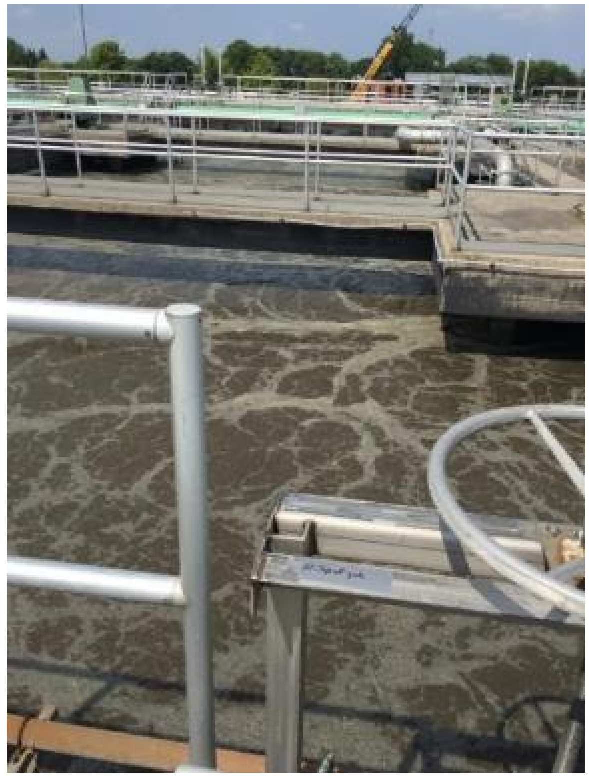
14. Upstream end of north Anoxic Basin – Top of concrete (see 15 for location of similar point on south train)
15. Upstream end of south Anoxic Basin – Top of concrete



16. North Anoxic Basin effluent channel – Bottom of channel (see 17 for photo) (survey only)
17. North Anoxic Basin effluent channel level element – Top of concrete Wall (survey only)

18. South Anoxic Basin effluent channel – Bottom of channel (see 19 for photo) (survey only)
19. South Anoxic Basin effluent channel level element – Top of concrete wall (survey only)

20. North Aeration Basin influent channel gate (east-most gate) – Top of gate (see 21 for similar point on south Aeration Basin Influent Channel) (survey only)
21. South Aeration Basin influent channel gate (east-most gate) – Top of gate (survey only)



22. North Aeration Basin – Top of concrete (see 23 for similar point on south Aeration Basin)
23. South Aeration Basin – Top of concrete

24. North Aeration Basin influent gate (west-most gate) – Top of gate when fully open (survey only)

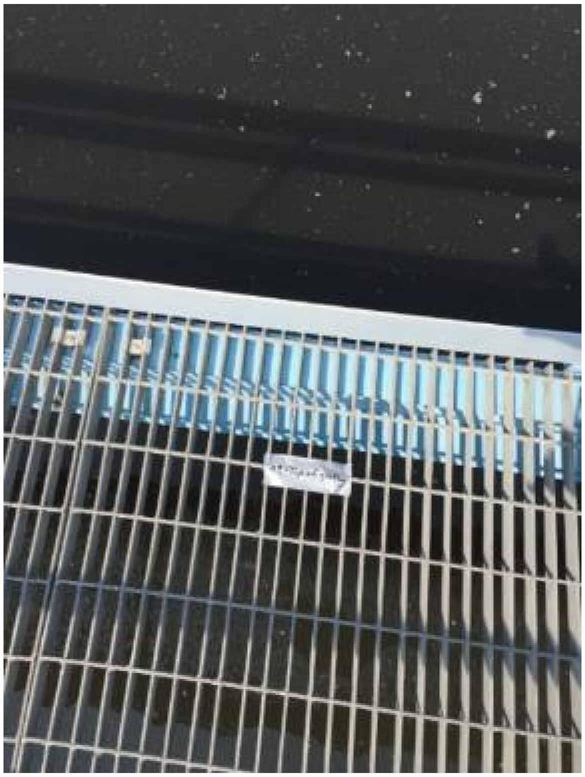
25. South Aeration Basin influent gate (west-most gate) – Top of gate when fully open (survey only)

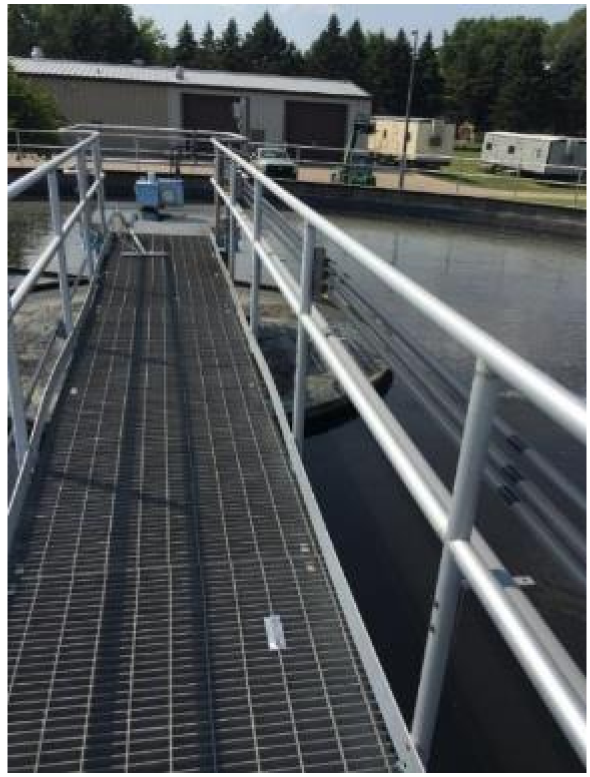
26. North Aeration Basin effluent channel – Top of grating (see 27 for additional photo)

27. South Aeration Basin effluent channel – Top of grating

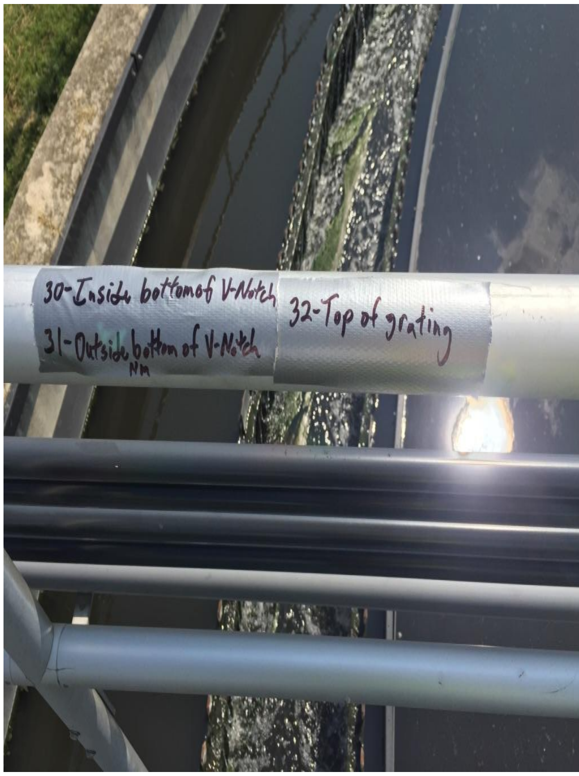
28. North Intermediate Clarifier bridge – Top of grating

29. South Intermediate Clarifier bridge – Top of grating





30. At North Intermediate Clarifier launder – Inside bottom of V-notch weir (see 32 for photos) (survey only)
31. At North Intermediate Clarifier launder – Outside bottom of V-notch weir (see 32 for photos) (survey only)
32. At North Intermediate Clarifier launder – Top of grating



33. At South Intermediate Clarifier launder – Inside bottom of V-notch weir (see 35 for photos) (survey only)
34. At South Intermediate Clarifier launder – Outside bottom of V-notch weir (see 35 for photos) (survey only)
35. At South Intermediate Clarifier launder – Top of grating

36. Splitter Box T-20 – Top of grating

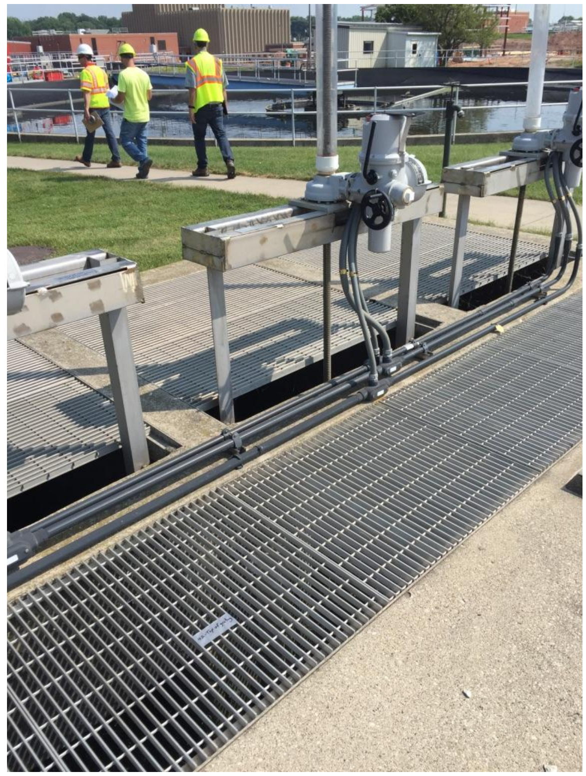
37. Gate at upstream end of Channel 2 (at Aeration Basins) – Bottom of gate (see 38 for additional photo) (survey only)

38. Gate between Splitter Box T-20 and Channel 1 (at Aeration Basins) – Bottom of gate (survey only)

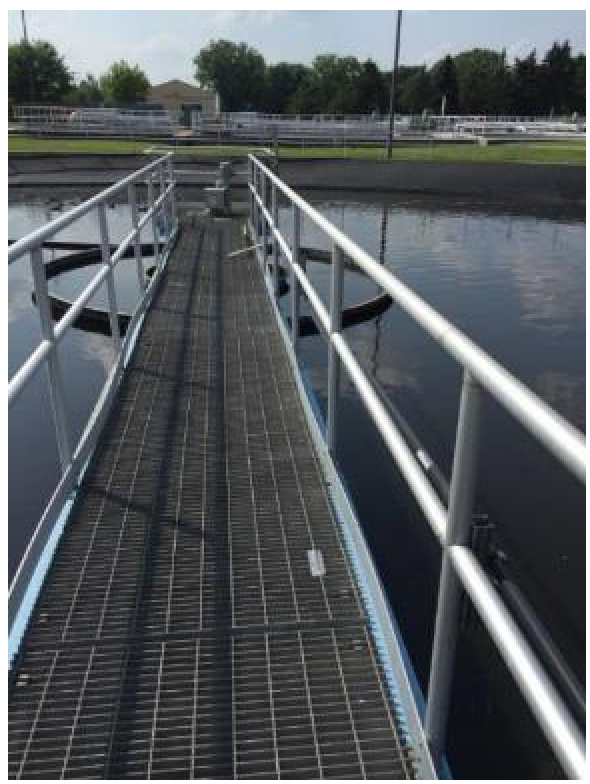
39. At north gate just upstream of piping to final clarifiers – Top of weir, found on upstream side of wall (survey only)

40. At south gate just upstream of piping to final clarifiers – Top of weir (see 41 for photo) (survey only)
41. At south gate just upstream of piping to final clarifiers – Top of gate (survey only)

42. At north gate just upstream of piping to final clarifiers – Top of grating



43. Southwest Final Clarifier bridge – Top of steel

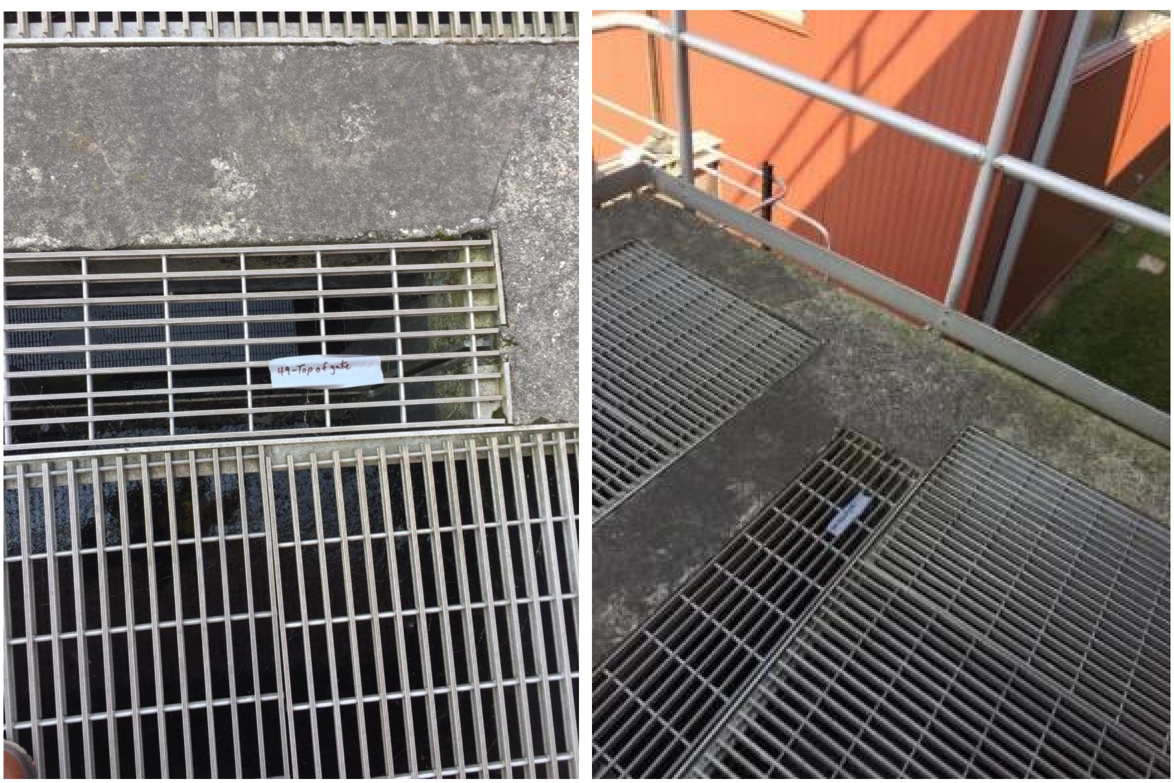
44. Southwest Final Clarifier launder (from bridge) – Inside bottom of V-notch weir (see 45 for photo) (survey only)
45. Southwest Final Clarifier launder (from bridge) – Outside bottom of V-notch weir (survey only)

46. Southwest Final Clarifier launder (from bridge) – Top of steel

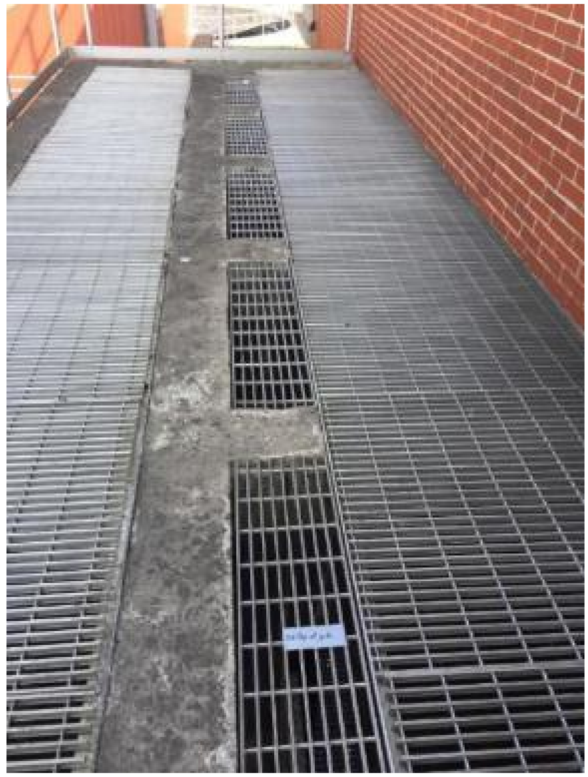
47. CS T-29 – Top of grating

48. CS T-31 – Top of grating

49. Filter bypass overflow (east) – Top of gate (survey only)



50. Filter bypass overflow (west) – Top of gate (survey only)

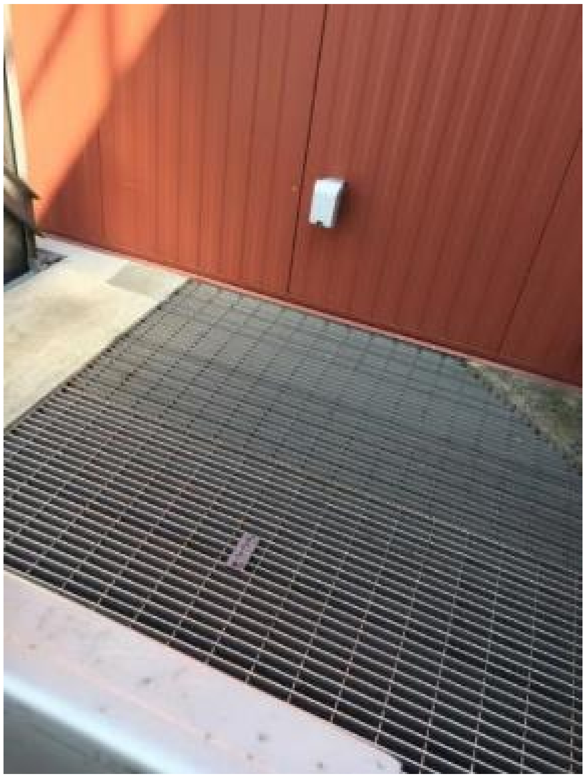


51. T-51 – Bottom of channel (see 52 for photo) (survey only)
52. T-51 – Top of concrete

53. North channel downstream of UV – Top of weir (underneath grating) (survey only)

54. South channel downstream of UV – Top of weir (underneath grating) (survey only)

55. Channel on west side of UV Disinfection Building as shown – Top of grating



56. Final Effluent Flume – Edge of flume bottom (see 57 for photo) (survey only)
57. Final Effluent Flume – Top of concrete

58. Final Effluent Flume – Top of concrete (survey only)

59. CS T-53 – Top of grating

Appendix C

Field Measurements from September 10 and 11, 2019

GBF North Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: 09/10/19

Recorded by: CNM/JB

	Measurement #1			Measurement #2			Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Description	Comments/Observations
5	11:11 AM	93.9	3.65	2:28 PM	76.0	4.21							Downstream of screens (north) – Top of grating	3 Aeration basins online while measuring
6	11:11 AM	93.9	3.69	2:28 PM	76.0	4.42							Downstream of screens (south) – Top of grating	
7	11:13 AM	95.5	2.97	2:30 PM	75.5	3.35							Parshall Flume downstream of screens (north) – Top of grating	
8	11:13 AM	95.5	2.96	2:30 PM	75.5	3.27							Parshall Flume downstream of screens (south) – Top of grating	
11	11:14 AM	95.3	3.04	2:35 PM	79.0	3.49							At gate just upstream of piping to north primary basins – Top of grating	
12	11:14 AM	95.3	3.04	2:35 PM	79.0	3.39							At gate just upstream of piping to south primary basins – Top of grating	
15	11:17 AM	93.1	6.35	2:31 PM	76.2	6.90							At Primary Basin No. 1 launder – Top of concrete	
18	11:19 AM	92.4	7.04	2:34 PM	76.7	7.60							At Primary Basin No. 3 launder – Top of support	
19	11:21 AM	93.0	3.95	2:35 PM	79.0	3.96							Primary Basin No. 1 bridge – Top of grating	
20	11:21 AM	93.0	3.98	2:34 PM	76.7	3.98							Primary Basin No. 3 bridge – Top of grating	
21	11:23 AM	94.5	2.74	2:36 PM	76.0	3.29							At grating just east of Mechanical Building East (north) – Top of grating	
22	11:23 AM	94.5	2.7	2:36 PM	76.0	3.26							At grating just east of Mechanical Building East (south) – Top of grating	
23	11:29 AM	93.4	0.97	2:39 PM	75.2	1.41							Primary effluent channel upstream of aeration splitter weir gates – Top of grating	
27	11:26 AM	93.4	1.42	2:40 PM	75.3	1.80							Upstream of Contact Basin No. 1 Parshall Flume (north) – Top of grating	
28	11:26 AM	93.4	1.27	2:37 PM	77.8	1.67							Upstream of Contact Basin No. 3 Parshall Flume (south) – Top of grating	
29	11:29 AM	92.8	3.45	2:42 PM	76.0	3.62							West end of Contact Basin No. 1 as shown – Top of concrete	
30	11:29 AM	92.8	5.85	2:43 PM	75.2	6.31							West end of Reaeration Basin No. 1 as shown – Top of concrete	
31	11:31 AM	92.6	3.35	2:37 PM	77.8	3.48							West end of Contact Basin No. 3 as shown – Top of concrete	
32	11:31 AM	92.6	6.05	2:38 PM	80.5	6.19							West end of Reaeration Basin No. 3 as shown – Top of concrete	
35	11:44 AM	89.5	7.25	2:45 PM	80.7	7.69							West end of Mixed Liquor Channel adjacent to Contact Basin No. 2 – Top of grating	
36	11:32 AM	94.0	8.24	2:50 PM	74.8	8.45							West end of Mixed Liquor Channel adjacent to Contact Basin No. 4 – Top of grating	
41	11:44 AM	89.5	2.57	2:47 PM	74.8	2.64							At Final Basin No. 1 launder – Top of concrete	
44	11:06 AM	96.3	3.37	2:48 PM	73.8	3.44							At Final Basin No. 5 launder – Top of concrete	
45	11:46 AM	89.1	3.96	2:53 PM	74.7	3.99							Final Basin No. 1 bridge – Top of grating	
46	11:48 AM	89.5	4.01	2:51 PM	74.5	4.03							Final Basin No. 5 bridge – Top of grating	
47	11:47 AM	88.9	3.30	2:52 PM	78.8	3.78							Secondary effluent channel (north) – Top of grating	
48	11:47 AM	88.9	3.44	2:53 PM	74.7	3.89							Secondary effluent channel (south) – Top of grating	
49	11:50 AM	89.9	3.62	2:54 PM	74.5	3.81							South plant secondary effluent and north plant bypass channel – Top of grating	
50	11:51 AM	88.9	3.30	2:55 PM	74.1	3.73							Just upstream of gate to Chlorine Contact Basin No. 1 – Top of angle	
51	11:56 AM	89.5	3.31	2:57 PM	73.9	3.71							Just upstream of gate to Chlorine Contact Basin No. 2 – Top of angle	
52	11:52 AM	88.4	3.84	2:55 PM	74.1	4.16							Upstream of Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete	
53	11:52 AM	88.4	5.19	2:56 PM	74.1	5.39							At bridge over Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete	
54	11:54 AM	87.5	3.80	2:56 PM	74.1	4.13							Upstream of Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete	
55	11:54 AM	87.5	5.09	2:57 PM	73.9	5.31							At bridge over Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete	
56	12:04 PM	86.6	1.84	3:00 PM	74.2	1.85							At Primary Basin No. 3 – primary effluent diversion box to GBF South – Top of concrete	

GBF North Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: 09/11/19

Recorded by: CNM/JB

	Measurement #1			Measurement #2			Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Description	Comments/Observations
5	1:53 PM	104.4	3.80										Downstream of screens (north) – Top of grating	4 Aeration basins online while measuring
6	1:53 PM	104.4	3.74										Downstream of screens (south) – Top of grating	
7	1:56 PM	105.0	2.82										Parshall Flume downstream of screens (north) – Top of grating	
8	1:56 PM	105.0	2.82										Parshall Flume downstream of screens (south) – Top of grating	
11	1:59 PM	105.3	2.81										At gate just upstream of piping to north primary basins – Top of grating	
12	1:59 PM	105.3	2.81										At gate just upstream of piping to south primary basins – Top of grating	
15	1:54 PM	105.6	6.36										At Primary Basin No. 1 launder – Top of concrete	
18	1:57 PM	105.0	6.60										At Primary Basin No. 3 launder – Top of support	
19	1:58 PM	105.1	3.93										Primary Basin No. 1 bridge – Top of grating	
20	1:58 PM	105.1	3.96										Primary Basin No. 3 bridge – Top of grating	
21	2:00 PM	105.2	2.8										At grating just east of Mechanical Building East (north) – Top of grating	
22	2:00 PM	105.2	2.84										At grating just east of Mechanical Building East (south) – Top of grating	
23	2:02 PM	105.1	1.25										Primary effluent channel upstream of aeration splitter weir gates – Top of grating	
27	2:02 PM	105.1	1.62										Upstream of Contact Basin No. 1 Parshall Flume (north) – Top of grating	
28	2:01 PM	105.2	1.58										Upstream of Contact Basin No. 3 Parshall Flume (south) – Top of grating	
29	2:03 PM	105.1	3.57										West end of Contact Basin No. 1 as shown – Top of concrete	
30	2:03 PM	105.1	6.09										West end of Reaeration Basin No. 1 as shown – Top of concrete	
31	2:01 PM	105.1	3.60										West end of Contact Basin No. 3 as shown – Top of concrete	
32	2:02 PM	105.1	6.30										West end of Reaeration Basin No. 3 as shown – Top of concrete	
35	2:34 PM	107.9	7.45										West end of Mixed Liquor Channel adjacent to Contact Basin No. 2 – Top of grating	
36	2:37 PM	107.8	7.52										West end of Mixed Liquor Channel adjacent to Contact Basin No. 4 – Top of grating	
41	2:36 PM	107.7	2.53										At Final Basin No. 1 launder – Top of concrete	
44	2:38 PM	108.5	2.58										At Final Basin No. 5 launder – Top of concrete	
45	2:42 PM	107.3	3.99										Final Basin No. 1 bridge – Top of grating	
46	2:40 PM	107.3	3.97										Final Basin No. 5 bridge – Top of grating	
47	2:41 PM	108.3	3.00										Secondary effluent channel (north) – Top of grating	
48	2:41 PM	108.3	3.01										Secondary effluent channel (south) – Top of grating	
49	2:42 PM	107.3	3.35										South plant secondary effluent and north plant bypass channel – Top of grating	
50	2:45 PM	107.4	2.95										Just upstream of gate to Chlorine Contact Basin No. 1 – Top of angle	
51	2:43 PM	108.0	2.95										Just upstream of gate to Chlorine Contact Basin No. 2 – Top of angle	
52	2:45 PM	107.4	3.54										Upstream of Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete	
53	2:44 PM	107.6	4.84										At bridge over Chlorine Contact Basin No. 1 Parshall Flume – Top of concrete	
54	2:44 PM	107.6	4.84										Upstream of Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete	
55	2:43 PM	108.0	3.52										At bridge over Chlorine Contact Basin No. 2 Parshall Flume – Top of concrete	
56	2:48 PM	107.5	1.84										At Primary Basin No. 3 – primary effluent diversion box to GBF South – Top of concrete	

GBF South Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: 09/10/19

Recorded by: CNM/JB

	Measurement #1				Measurement #2				Measurement #3			Measurement #4				
		Influent Flow		Depth to Water		Influent Flow		Depth to Water		Influent Flow	Depth to Water		Influent Flow	Depth to Water		
Survey Point	Time	GB	SP	(ft)	Time	GB	SP	(ft)	Time	(MGD)	(ft)	Time	(MGD)	(ft)	Description	Comments/Observations
57	12:06 PM	85.3	11.4	2.37	3:02 PM	73.4	10.0	2.40							Upstream end of Aeration Basin No. 2 – Top of concrete	
58	12:08 PM	84.9	11.3	3.27	3:03 PM	74.2	10.0	3.33							Downstream end of Aeration Basin No. 2 – Top of concrete	
59	12:10 PM	83.6	11.3	6.46	3:03 PM	74.2	10.0	6.54							Channel just south of Mechanical Building – Top of grating	
60	12:10 PM	83.6	11.3	6.46	3:04 PM	74.3	9.9	6.54							Channel just north of Electrical Building – Top of grating	
61	12:12 PM	82.0	11.1	6.38	3:04 PM	74.3	9.9	6.38							Secondary Clarifier No. 1 bridge – Top of support	
62	12:12 PM	82.0	11.1	6.48	3:05 PM	73.3	9.9	6.50							Secondary Clarifier No. 2 bridge – Top of support	
64	12:15 PM	82.3	11.0	6.02	3:08 PM	74.5	9.9	6.07							At Secondary Clarifier No. 1 launder – Top of concrete	
66	12:18 PM	81.0	11.0	6.16	3:09 PM	73.6	9.9	6.17							At Secondary Clarifier No. 2 launder – Top of concrete	

GBF South Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: 09/11/19

Recorded by: CNM/JB

	Measurement #1				Measurement #2			Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow GB	Influent Flow SP	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Description	Comments/Observations
57	1:41 PM	107.3	11.1	2.39										Upstream end of Aeration Basin No. 2 – Top of concrete	
58	1:42 PM	107.3	11.1	3.23										Downstream end of Aeration Basin No. 2 – Top of concrete	
59	1:43 PM	107.2	11.1	6.50										Channel just south of Mechanical Building – Top of grating	
60	1:43 PM	107.2	11.1	6.50										Channel just north of Electrical Building – Top of grating	
61	1:44 PM	107.6	11.1	6.36										Secondary Clarifier No. 1 bridge – Top of support	
62	1:44 PM	107.6	11.1	6.49										Secondary Clarifier No. 2 bridge – Top of support	
64	1:46 PM	107.7	11.1	6.04										At Secondary Clarifier No. 1 launder – Top of concrete	
66	1:48 PM	107.5	11.1	6.14										At Secondary Clarifier No. 2 launder – Top of concrete	

DPF Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: 09/10/19

Recorded by: CNM/JB

	Measurement #1				Measurement #2				Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow (MGD)	Effluent flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Effluent flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Description	Comments/Observations
1	9:27 AM	25.9	18.4	3.68	1:13 PM	19.2	18.9	4.12							Approach to Preliminary Treatment Unit bypass weir – Top of grating	
3	9:28 AM	25.9	18.4	4.68	1:13 PM	19.2	18.9	4.73							North Preliminary Treatment Unit bridge – Top of grating	
5	9:30 AM	24.6	18.2	2.22	1:14 PM	19.4	18.7	2.78							At North Preliminary Treatment Unit launder – Top of concrete	
6	9:29 AM	25.2	18.2	4.70	1:13 PM	19.2	18.9	4.75							South Preliminary Treatment Unit bridge – Top of grating	
9	9:32 AM	25.0	19.0	2.93	1:12 PM	19.2	18.8	3.51							Downstream of Preliminary Treatment Unit bypass gate – Top of grating	
10	9:33 AM	25.4	19.3	4.59	1:12 PM	19.2	18.8	5.04							North Anoxic Basin influent channel – Top of grating	
11	9:34 AM	25.0	19.7	4.58	1:12 PM	19.2	18.8	5.09							South Anoxic Basin influent channel – Top of grating	
14	9:34 AM	25.0	19.7	2.15	1:11 PM	19.2	18.8	2.66							Upstream end of north Anoxic Basin – Top of concrete	
15	9:36 AM	25.0	20.4	2.18	1:16 PM	19.6	19.3	2.70							Upstream end of south Anoxic Basin – Top of concrete	
22	9:35 AM	25.0	20.4	2.61	1:10 PM	19.2	18.7	3.14							North Aeration Basin – Top of concrete	
23	9:37 AM	24.4	20.9	2.64	1:17 PM	19.6	19.5	3.16							South Aeration Basin – Top of concrete	
26	9:38 AM	25.7	21.2	2.98	1:20 PM	19.2	19.5	3.7							North Aeration Basin effluent channel – Top of grating	
27	9:38 AM	25.7	21.2	3.00	1:20 PM	19.2	19.5	3.77							South Aeration Basin effluent channel – Top of grating	
28	9:39 AM	24.3	21.4	5.14	1:20 PM	19.2	19.5	5.16							North Intermediate Clarifier bridge – Top of grating	
29	9:41 AM	24.2	21.6	5.08	1:19 PM	19.2	19.5	5.09							South Intermediate Clarifier bridge – Top of grating	
32	9:40 AM	24.2	21.4	6.06	1:21 PM	19.2	19.5	6.39							At North Intermediate Clarifier launder – Top of grating	
35	9:41 AM	24.2	21.6	5.78	1:19 PM	19.2	19.5	6.16							At South Intermediate Clarifier launder – Top of grating	Slight level drop after convergence of clarifier flows
36	9:44 AM	24.7	21.6	2.42	1:23 PM	19.4	19.6	2.86							Splitter Box T-20 – Top of grating	
42	9:46 AM	25.2	21.7	4.32	1:25 PM	19.4	19.7	4.46							At north gate just upstream of piping to final clarifiers – Top of grating	9:46 reading: 2 finals online, filling 3rd. CW at 60% open. 13:25 reading: 2 finals online.
43	9:49 AM	24.7	22.0	3.79	1:27 PM	19.3	19.6	3.80							North Final Clarifier bridge – Top of steel	
46	9:50 AM	24.9	21.9	5.33	1:27 PM	19.3	19.6	5.44							North Final Clarifier launder (from bridge) – Top of steel	
47	9:50 AM	24.9	21.9	5.24	1:28 PM	19.3	19.8	5.35							CS T-29 – Top of grating	
48	9:56 AM	24.6	21.7	2.57	1:30 PM	18.9	19.9	2.64							CS T-31 – Top of grating	No bypass flow
52	9:57 AM	23.2	21.9	1.51	1:31 PM	19.1	19.7	1.63							T-51 – Top of concrete	
55	9:58 AM	24.3	21.9	2.83	1:31 PM	19.1	19.7	2.99							Channel on west side of UV Disinfection Building as shown – Top of grating	
57	9:59 AM	23.7	21.7	5.00	1:34 PM	19.3	19.8	5.17							Final Effluent Flume – Top of concrete	
59	10:00 AM	23.6	21.8	5.34	1:33 PM	19.3	19.8	5.32							CS T-53 – Top of grating	

DPF Plant Hydraulic Evaluation - Field Point High Flow Measurements

Date: 09/11/19

Recorded by: CNM/JB

	Measurement #1				Measurement #2			Measurement #3			Measurement #4				
Survey Point	Time	Influent Flow (MGD)	Effluent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Time	Influent Flow (MGD)	Depth to Water (ft)	Description	Comments/Observations
1	11:45 AM	23.9	21.7	3.61										Approach to Preliminary Treatment Unit bypass weir – Top of grating	
3	11:46 AM	22.6	21.9	4.68										North Preliminary Treatment Unit bridge – Top of grating	
5	11:48 AM	19.4	22.2	2.12										At North Preliminary Treatment Unit launder – Top of concrete	
6	11:47 AM	27.7	22.1	4.67										South Preliminary Treatment Unit bridge – Top of grating	
9	11:45 AM	23.9	21.7	2.82										Downstream of Preliminary Treatment Unit bypass gate – Top of grating	
10	11:49 AM	28.9	22.4	4.49										North Anoxic Basin influent channel – Top of grating	
11	11:49 AM	28.9	22.4	4.44										South Anoxic Basin influent channel – Top of grating	
14	11:50 AM	35.5	22.7	2.04										Upstream end of north Anoxic Basin – Top of concrete	
15	11:52 AM	32.9	23.3	2.03										Upstream end of south Anoxic Basin – Top of concrete	
22	11:51 AM	34.6	23.1	2.53										North Aeration Basin – Top of concrete	
23	11:52 AM	32.9	23.3	2.53										South Aeration Basin – Top of concrete	
26	11:54 AM	34.8	23.8	2.92										North Aeration Basin effluent channel – Top of grating	
27	11:54 AM	34.8	23.8	2.94										South Aeration Basin effluent channel – Top of grating	
28	11:55 AM	34.7	23.8	5.13										North Intermediate Clarifier bridge – Top of grating	
29	11:53 AM	31.7	23.4	5.07										South Intermediate Clarifier bridge – Top of grating	
32	11:55 AM	34.7	23.8	6.00										At North Intermediate Clarifier launder – Top of grating	
35	11:54 AM	34.8	23.8	5.74										At South Intermediate Clarifier launder – Top of grating	Slight level drop after convergence of clarifier flows
36	12:02 AM	35.5	22.2	2.22										Splitter Box T-20 – Top of grating	
42	12:02 PM	35.5	22.2	4.82										At north gate just upstream of piping to final clarifiers – Top of grating	2 finals online, filling 3rd. CW at 60% open.
43	12:03 PM	35.5	21.2	3.80										North Final Clarifier bridge – Top of steel	
46	12:03 PM	35.5	21.2	5.59										North Final Clarifier launder (from bridge) – Top of steel	
47	12:04 PM	35.3	20.1	5.58										CS T-29 – Top of grating	
48	12:08 PM	35.4	18.8	2.86										CS T-31 – Top of grating	No bypass flow
52	12:10 PM	35.6	18.9	1.65										T-51 – Top of concrete	
55	12:10 PM	35.6	18.9	3.06										Channel on west side of UV Disinfection Building as shown – Top of grating	
57	12:12 PM	35.5	18.7	5.21										Final Effluent Flume – Top of concrete	
59	12:11 PM	35.7	18.7	5.12										CS T-53 – Top of grating	

Appendix D

Measured vs Modeled Water Surface Elevation Tables

Measured vs Modeled Water Surface Elevation Tables

GBF North – 9/10 Calibration

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
55 Downstream of Effluent Parshall Flume	103.82	103.67	0.15
54 Downstream of Chlorine Contact Tanks	105.05	105	0.05
51 End of Final Effluent Channel	105.47	105.29	0.18
48 Secondary Effluent Channel (mid-way)	105.55	105.5	0.05
44 Final Basin Effluent Trough	105.68	105.46	0.22
46 Final Basin	106.78	106.77	0.01
36 Re-aeration Effluent Channel	108.64	108.34	0.30
32 Re-aeration Basin	110.45	110.43	0.02
31 Contact Basin	111.09	111.14	-0.05
28 Contact Basin Splitter Parshall Flume	113.24	113.24	0.00
22 Primary Basin Effluent Channel	113.76	113.81	-0.05
18 Primary Basin Effluent Trough	114.08	114.06	0.02
20 Primary Basin	114.45	114.35	0.10
12 Primary Basin Influent Channel	116.16	116.07	0.09
8 Primary Influent Parshall Flume*	116.46	116.91	-0.45
6 Headworks	117.81	117.49	0.32

*Donohue recommends additional investigation at this element. Headloss measured is unable to be predicted by the model.

GBF North – 9/10 Validation

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
55 Downstream of Effluent Parshall Flume	103.70	103.45	0.25
54 Downstream of Chlorine Contact Tanks	104.74	104.67	0.07
51 End of Final Effluent Channel	105.11	104.89	0.22
48 Secondary Effluent Channel (mid-way)	105.17	105.05	0.12
44 Final Basin Effluent Trough	105.30	105.39	-0.09
46 Final Basin	106.78	106.75	0.03
36 Re-aeration Effluent Channel*	108.54	108.13	0.41
32 Re-aeration Basin	110.39	110.29	0.10
31 Contact Basin	111.06	111.01	0.05
28 Contact Basin Splitter Parshall Flume	112.96	112.84	0.12
22 Primary Basin Effluent Channel	113.46	113.25	0.21
18 Primary Basin Effluent Trough	113.76	113.5	0.26
20 Primary Basin	114.44	114.35	0.09
12 Primary Basin Influent Channel	115.71	115.72	-0.01
8 Primary Influent Parshall Flume*	116.03	116.6	-0.57
6 Headworks*	117.17	116.76	0.41

*Donohue recommends additional investigation at this element. Headloss measured is unable to be predicted by the model.

GBF North – 9/11 Validation

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
55 Downstream of Effluent Parshall Flume	103.98	103.96	0.02
54 Downstream of Chlorine Contact Tanks	105.31	105.24	0.07
51 End of Final Effluent Channel	105.94	105.65	0.29
48 Secondary Effluent Channel (mid-way)	106.02	105.93	0.09
44 Final Basin Effluent Trough	106.14	106.25	-0.11
46 Final Basin	106.79	106.81	-0.02
36 Re-aeration Effluent Channel	108.78	109.06	-0.28
32 Re-aeration Basin	110.40	110.18	0.22
31 Contact Basin	111.07	110.89	0.18
28 Contact Basin Splitter Parshall Flume	113.00	112.93	0.07
22 Primary Basin Effluent Channel	113.55	113.67	-0.12
18 Primary Basin Effluent Trough	114.07	114.37	-0.30
20 Primary Basin	114.47	114.5	-0.03
12 Primary Basin Influent Channel	116.63	116.3	0.33
8 Primary Influent Parshall Flume	116.84	117.05	-0.21
6 Headworks*	117.91	117.44	0.47

*Donohue recommends additional investigation at this element. Headloss measured is unable to be predicted by the model.

GBF South – 9/10 Calibration

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
64 Secondary Clarifier Effluent Trough	101.60	101.52	0.08
61 Secondary Clarifier Water Surface	103.08	102.94	0.14
60 ML Channel	103.31	103.44	-0.13
58 Downstream end of Aeration Basin	107.21	107.28	-0.07
57 Upstream end of Aeration Basin	108.03	108.17	-0.14

GBF South – 9/10 Validation

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
64 Secondary Clarifier Effluent Trough	101.52	101.47	0.05
61 Secondary Clarifier Water Surface	103.08	102.94	0.13
60 ML Channel	103.26	103.36	-0.10
58 Downstream end of Aeration Basin	107.20	107.22	-0.02
57 Upstream end of Aeration Basin	108.01	108.14	-0.13

GBF South – 9/11 Validation

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
64 Secondary Clarifier Effluent Trough	101.59	101.50	0.09
61 Secondary Clarifier Water Surface	103.08	102.96	0.12
60 ML Channel	103.30	103.40	-0.10
58 Downstream end of Aeration Basin	107.21	107.32	-0.11
57 Upstream end of Aeration Basin	108.03	108.15	-0.12

DPF – 9/10 Calibration

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
59 T-53 Control Structure	584.11	583.86	0.25
57 T-52 and Channel to Flume	585.40	585.53	-0.13
55 Switchback Channel	587.40	587.69	-0.29
52 T-51 Control Structure	588.82	589.01	-0.19
48 Gravity Filters	598.68	598.83	-0.15
47 T-29 Control Structure	598.86	599.09	-0.23
46 Final Clarifier Effluent Trough	599.44	599.67	-0.23
43 Final Clarifier Water Surface	600.86	600.90	-0.04
42 Second Stage Aeration Bypass Channel Gate	601.67	601.97	-0.30
36 T-20 Control Structure	603.99	603.88	0.11
33 Intermediate Clarifier Effluent Trough	604.84	605.06	-0.22
29 Intermediate Clarifier Water Surface	605.98	605.96	0.02
27 Intermediate Clarifiers Splitter Box	607.52	607.79	-0.27
23 Contact Tanks	607.89	608.20	-0.31
15 Stabilization Tank	608.39	608.66	-0.27
11 Stablization Basin Influent Channel	608.50	608.80	-0.30
5 PTU Effluent Trough	609.28	609.54	-0.26
3 PTU Water Surface	609.54	609.71	-0.17
1 Channel Upstream of PTU Bypass	610.53	610.69	-0.16

DPF – 9/10 Validation

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
59 T-53 Control Structure	584.01	583.88	0.13
57 T-52 and Channel to Flume	585.28	585.36	-0.08
55 Switchback Channel	587.27	587.53	-0.26
52 T-51 Control Structure	588.74	588.89	-0.15
48 Gravity Filters	598.58	598.76	-0.18
47 T-29 Control Structure	598.74	598.98	-0.24
46 Final Clarifier Effluent Trough	599.41	599.56	-0.15
43 Final Clarifier Water Surface	600.85	600.89	-0.04
42 Second Stage Aeration Bypass Channel Gate	601.50	601.83	-0.32
36 T-20 Control Structure	603.64	603.44	0.20
33 Intermediate Clarifier Effluent Trough	604.35	604.68	-0.33
29 Intermediate Clarifier Water Surface	605.96	605.95	0.01
27 Intermediate Clarifiers Splitter Box	607.11	607.02	0.09
23 Contact Tanks	607.61	607.68	-0.07
15 Stabilization Tank	607.84	608.14	-0.30
11 Stablization Basin Influent Channel	608.01	608.29	-0.28
5 PTU Effluent Trough	608.76	608.98	-0.22
3 PTU Water Surface	609.53	609.66	-0.13
1 Channel Upstream of PTU Bypass	610.34	610.25	0.11

DPF – 9/11 Validation

ELEMENT	MODELED SURFACE WATER ELEVATIONS (FT)	FIELD MEASURED WATER SURFACE ELEVATIONS (FT)	DIFFERENCE
59 T-53 Control Structure	584.20	584.08	0.12
57 T-52 and Channel to Flume	585.51	585.32	0.19
55 Switchback Channel	587.53	587.46	0.06
52 T-51 Control Structure	588.88	588.87	0.02
48 Gravity Filters	598.76	598.54	0.22
47 T-29 Control Structure	598.97	598.75	0.22
46 Final Clarifier Effluent Trough	599.47	599.41	0.07
43 Final Clarifier Water Surface	600.86	600.89	-0.03
42 Second Stage Aeration Bypass Channel Gate	601.63	601.47	0.17
36 T-20 Control Structure	604.21	604.08	0.13
33 Intermediate Clarifier Effluent Trough	605.37	605.10	0.27
29 Intermediate Clarifier Water Surface	606.00	605.97	0.03
27 Intermediate Clarifiers Splitter Box	608.14	607.85	0.29
23 Contact Tanks	608.42	608.31	0.11
15 Stabilization Tank	608.70	608.81	-0.11
11 Stablization Basin Influent Channel	608.81	608.94	-0.13
5 PTU Effluent Trough	609.83	609.64	0.19
3 PTU Water Surface	609.83	609.71	0.12
1 Channel Upstream of PTU Bypass	611.07	610.76	0.31