Technical Memorandum

To: BCWMC Technical Advisory Committee
From: Jen Koehler PE, Lulu Fang PE, and Stephanie Johnson PhD, PE
Subject: BCWMC XP-SWMM to PC-SWMM Model Conversion Summary
Date: November 05, 2026
Project: 23270051.62

At their meeting in April 2024, the Bassett Creek Watershed Management Commission (BCWMC) approved a Technical Advisory Committee (TAC) recommendation for a project to convert the BCWMC's hydrologic and hydraulic (H&H) model from XP-SWMM to PC-SWMM and to update the model with new information and recalibrate the model. At their May 2026 meeting, the Commission approved an updated scope and budget for the project and directed the Commission Engineer to begin work on Task 1 of project, converting the model from XP-SWMM to PC-SWMM.

1 Background

The BCWMC has been involved in several watershed wide modeling efforts over the past several decades. The original hydrologic and hydraulic models (HEC-1/HEC-2) of the Bassett Creek watershed were created in the 1970's with minor updates over the years.

In 2012, BCWMC completed its Phase 1 modeling effort, transitioning the existing HEC models for the watershed to XP-SWMM, while maintaining a similar watershed resolution; however, there were calibration challenges with this effort due to the coarse model resolution. In 2017, the BCWMC completed a Phase 2 modeling effort that incorporated additional details into the model that allowed for calibration to observed data at five locations throughout the watershed. The calibrated model was then used to evaluate NOAA Atlas 14 design storm events.

In 2018, BCWMC worked with Minnesota Department of Natural Resources (MnDNR) to update the Phase 2 XP-SWMM model by incorporating additional development and survey data. This model has gone through the FEMA review process and was used to develop the preliminary FEMA floodplain and floodway. The MnDNR is planning to utilize these models to finalize the FEMA mapping though the timeline to complete this effort is unknown.

Since completion of the FEMA update effort, BCWMC incorporated additional significant projects and developments completed between 2018 and 2021 into the XP-SWMM model based on data provided by the member communities and recently completed BCWMC CIP projects. BCWMC approved the updated model in August 2022, and it represents the current watershed model (2022 Model) used for regulatory purposes and project evaluation.

Due to upcoming changes in the available technical support and pricing structures for XP-SWMM, the BCWMC TAC recommended transitioning to a new modeling platform. PCSWMM was selected because of its similarity to XP-SWMM and use of the same EPA SWMM computational engine and affordability of licenses and usage in the region. The approved 2022 model served as the basis for the initial XP-SWMM to PCSWMM conversion described within this memorandum. The following sections document the model conversion process and results.

2 Conversion Process

The BCWMC's XP-SWMM model was developed in XP-SWMM Version 2014 SP1, and the conversion was completed using PCSWMM Version 7.7.3920, released in May 2025. This version of PCSWMM includes enhancements to the XP-SWMM import utility that improve the transfer of model components and attributes from one model platform to the other.

Due to the size and complexity of the BCWMC XP-SWMM model, the conversion process relied on both the built-in XP-SWMM import tool from PCSWMM and supplemental shapefile data to ensure that all hydraulic and hydrologic components were accurately transferred into the PCSWMM environment. This combined approach supported a more complete and reliable model conversion while preserving the original model structure and functionality.

The following sections detail assumptions and corrections for the conversion of the hydrology (watershed runoff) inputs as well as the hydraulics (storage and conveyance) inputs to the model.

2.1 Hydrology Input Conversion

The hydrologic response of the watershed as simulated within the XP-SWMM model was previously validated during the Phase 2 model calibration effort. As a result, all hydrologic parameters from the XP-SWMM model were transferred directly to the PCSWMM model without modification. These parameters include:

- Watershed area
- Slope
- Watershed width
- Directly connected impervious percentage
- Horton Infiltration inputs
    - Zero detention percentage
    - Depression storage for impervious and pervious surfaces
    - Roughness for impervious and pervious surfaces
    - Decay rate of infiltration
    - Max infiltration volume
- Runoff routing node;
    - XP-SWMM typically allowed for up to 5 different subcatchment inputs to be directed to a single runoff node. PCSWMM does not allow duplicate names when importing. There was one XPSWMM runoff node (BUE-088E) that was subdivided during one of the model updates and had two sub-catchments assigned in XP-SWMM; in PCSWMM it was combined as one subwatershed using the XP-SWMM inputs.

Maintaining the original hydrologic parameterization between the two modeling software programs ensures that differences between the XP-SWMM and PCSWMM results can be attributed primarily to differences in software implementation rather than changes to the calibrated watershed representation.

2.2 Hydraulic Input Conversion

Throughout the model conversion, we tried to maintain the hydraulic network and geometry, including storage and conveyance inputs, as much as possible. The following hydraulic input were transferred into PC-SWMM without any modifications:

- Hydraulic network connectivity and node-link relationships
- Node bottom invert, initial depth, and flow routing percentage.
- Storage node assignments and storage curve
- Regular conduit inverts, length, roughness, shape, size, and conduit factors (sediment depth, barrel number, inlet type, entrance and exit loss)
- Special conduit inverts, length, roughness, shape, size, and conduit factors (sediment depth, barrel number, inlet type, entrance and exit loss)
- Natural cross-section assignment along the creek, including inverts, length, geometry, roughness and channel overbank length
- Regular orifice and weir inputs
- User-defined and constant Inflows
- Tailwater and boundary conditions
- All available survey- and as-built-based hydraulic geometry

Maintaining these hydraulic inputs ensures that the converted PCSWMM model remains consistent with the original XP-SWMM model as much as possible, so that resulting differences primarily reflect differences in software implementation rather than changes to the underlying hydraulic representation.

The following hydraulic inputs required formatting or configuration adjustments to meet PCSWMM platform requirements while maintaining hydraulic behavior consistent with the original XP-SWMM model:

- User-defined weirs in XP-SWMM were converted to equivalent PCSWMM representations, including V-notch weirs, user-defined rating curves, or specially shaped transition structures, based on their original geometry and hydraulic function
- Outfall nodes were duplicated where necessary to comply with PCSWMM configuration requirements, while preserving the original tailwater conditions
- Connector links that had been added in XP-SWMM to overcome node connection limitations were removed, and the affected conduits were connected directly to the appropriate storage nodes in PCSWMM. This was applicable to how Medicine Lake was originally modeled in XP-SWMM due to the number of storm sewer inflows to the lake
- Pump curves were converted to Type IV pump curves in PCSWMM to replicate the static-head pump behavior represented in the original model. Pump station configurations and operational control logic were otherwise maintained without modification
- In the PCSWMM model simulations setting, a default surface area equivalent to a 48-inch-diameter manhole was assigned to all non-storage nodes. This approach is consistent with the default storage assumptions used in XP-SWMM
- Sealed nodes were reformatted by applying a 2,000-foot surcharge depth tolerance, providing a practical representation of the sealed-node functionality available in XP-SWMM

These adjustments were necessary to accommodate differences in model structure and software functionality between the two platforms while still preserving the hydraulic performance and intent of the original XP-SWMM model.

After the two steps above were completed, the PCSWMM model was run for the 500-year design event. This initial model run indicated water loss at a handful of non-storage nodes and generated a hydraulic routing error of 10%. To improve overall model stability, ensure complete volume capture, and enhance

overall model simulation performance, the following minor modifications were incorporated into the PCSWMM model as a next step:

- Minor storage volumes, equivalent to approximately a 48-inch-diameter manhole, were added to selected non-storage nodes where numerical instability resulted in water loss. These adjustments affected approximately 7% of all non-storage nodes and, in some cases, included minor increases to the original rim elevations.

- Additional minor storage was assigned to complex hydraulic structures with elevated instability potential, including but not limited to lift station locations and other major outlet structures.

- The lengths of selected overflow links representing overland flows were increased by 10-feet where steep slopes contributed to unstable hydraulic calculations.

- Approximately 4% of street overflow links were converted from 20-foot-bottom trapezoidal channels to 32-foot-wide street cross-sections to improve flow conveyance representation and ensure complete water capture.

- A data entry error in the original XP-SWMM model related to the MLS011OS weir length was corrected to reduce simulation instability at that location.

- The most downstream link along Plymouth Creek represents a short open channel connection from the most downstream wetland to Medicine Lake and was extended from 10 feet to 50 feet to improve hydraulic stability. Some of the channel storage is below the normal water level of Medicine Lake and the resulting increase in flood storage volume due to the channel extension is negligible relative to the overall storage volume of Medicine Lake. Ultimately, this minor change significantly improved stability at Medicine Lake and along Plymouth Creek and does not affect model results for the lake.

With these refinements, the PCSWMM model successfully achieves full water-volume capture and maintains acceptable continuity through the 500-year, 24-hour design storm event. It also demonstrates more stable and reliable hydraulic performance under the 100-year, 24-hour event.

3 Results Comparison

Similar to XP-SWMM, PCSWMM uses a two-layer modeling approach. The hydrologic layer generates runoff volumes and peak flows from subwatersheds, while the hydraulic layer routes runoff through municipal storm sewer systems, natural water bodies, and creek conveyance systems that are represented with cross sections. The model tracks water surface elevations (WSEs) at nodes and flow rates through links, producing hydrographs for both parameters.

Although XP-SWMM and PCSWMM are both based on the same EPA SWMM engine, differences in their computational approaches and model implementations can result in variations in simulated hydrologic and hydraulic responses.

3.1 Hydrology Output Comparison

As a first step, the hydrologic performance of the converted PCSWMM model was checked. As a best modeling practice, the target hydrologic continuity error should be 0%, indicating that no runoff volume is

artificially gained or lost during the simulation. The PCSWMM model meets this requirement using procedures described in Section 2.1.

Simulated results for a total of 1,193 subwatersheds were compared between the XP-SWMM and PCSWMM models. Table 3-1 summarizes the difference between the hydrologic results from XP-SWMM to PCSWMM, looking at the following:

- impervious runoff depth,
- pervious runoff depth,
- total runoff depth,
- total runoff volume, and
- peak flow rate

The data was summarized based on the % difference (e.g. % of hydrology nodes with less than 2% difference and % of nodes with greater than 5% difference). This data is also summarized in Figure 3-1,with a point representing each individual subwatershed in the models.

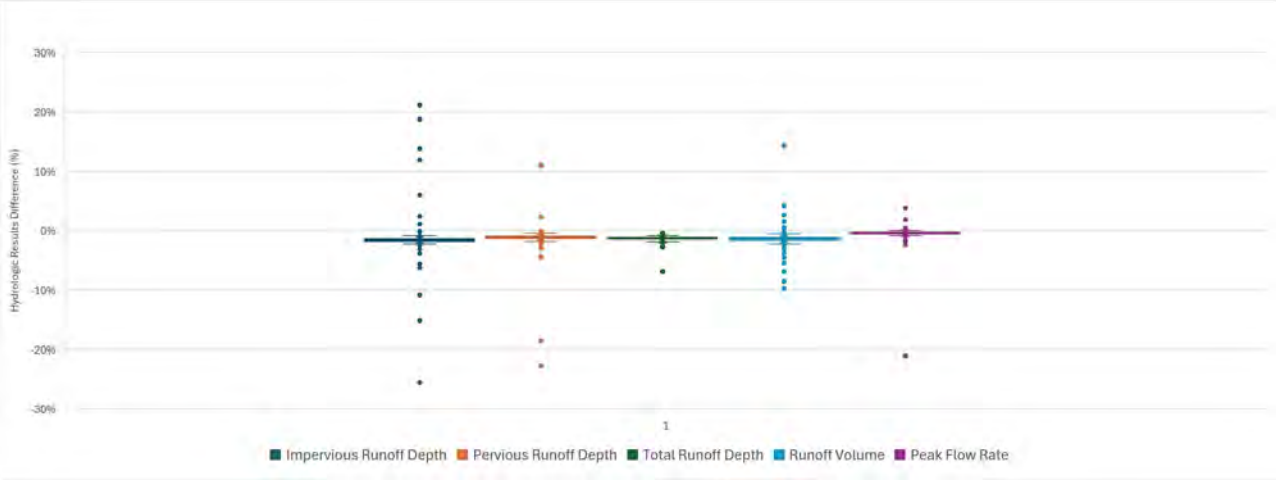
Overall, the hydrologic results are highly consistent. As shown in Figure 3-1, PCSWMM generally produces slightly greater runoff depths from impervious areas and slightly lower runoff depths from pervious areas when compared to XP-SWMM. Despite these minor differences, approximately 98% of subwatersheds generate total runoff depths that are comparable between the two models (within 2%). In addition, more than 90% of subwatersheds produce nearly identical total runoff volumes. Agreement in peak runoff flow rates is even stronger.

We reviewed subwatersheds exhibiting larger differences in impervious, pervious, or total runoff depth in detail. Most of these subwatersheds are small, highly impervious subwatersheds whose drainage areas and runoff volumes represent a relatively small portion of the overall watershed area. As a result, the cumulative difference in total runoff volume between the two models is less than 2%, indicating overall agreement in hydrologic performance.

Table 3-1 XP-SWMM to PCSWMM Hydrologic Node Results Comparison Summary

% Difference between XP-SWMM and PCSWMM	% of Subwatershed Nodes - Impervious Runoff Depth	% of Subwatershed Nodes - Pervious Runoff Depth	% of Subwatershed Nodes - Total Runoff Depth	% of Subwatershed Nodes – Total Runoff Volume	% of Subwatershed Nodes - Peak Flow Rate
Under 2%	92.53%	98.32%	98.41%	91.69%	99.75%
Above 5%	1.26%	0.25%	0.08%	0.92%	0.08%

Figure 3-1 Runoff Results Difference Comparison



3.2 Hydraulic Output Comparison

As a next step, the hydraulic performance of the converted PCSWMM model was checked. The accepted standard for hydraulic routing continuity error is typically less than 2%. The original XP-SWMM model produced a hydraulic routing error of 0.8% for the 100-year, 24-hour design storm.

As part of the model conversion process, the original hydraulic configuration of the BCWMC's XP-SWMM model was preserved to the greatest extent possible, meaning we made minimal changes to the inputs for the conveyance and storage parameters. The BCWMC's XP-SWMM model was developed using the best available data at the time of its development, including survey and as-built information and was also reviewed and approved through the FEMA mapping update process with the MnDNR.

The initial PCSWMM model (immediately following conversion), without any adjustments, resulted in a hydraulic routing error exceeding 40%. The corrective actions described in Section 2.2 substantially reduced this routing error to 1.2%, which is within accepted modeling standards and comparable to the original XP-SWMM model hydraulic performance.

The converted PCSWMM model contains a total of 4,268 hydraulic nodes, classified as junctions, storage, or outfall nodes. Junction nodes (2,886) are generally equivalent to the non-storage nodes used in the XP-SWMM model, where negligible storage is represented. The 1,367 storage nodes in the PCSWMM model can be further categorized into two groups. A total of 1,119 storage nodes were assigned individual storage curves as converted from XP-SWMM, representing actual storage characteristics derived from LiDAR data and available construction and as-built drawings. The remaining storage nodes were junctions which had volume "lost" during the initial PCSWMM model runs for the 500-year event. To capture the "lost" volume, we assigned minimal storage volumes, and raised their rim elevation slightly, to improve numerical stability and capture water during model simulations. The PCSWMM model has 15 outfall nodes where flow can leave the system, similar to the original XP-SWMM.

This approach preserves the hydraulic storage representation of the original XP-SWMM model while maintaining stable model performance in PCSWMM.

3.2.1 Comparison of Water Surface Elevations

The maximum water surface elevation (MWSE) differences between the XP-SWMM and PCSWMM models for the 100-year, 24-hour storm event were evaluated at all 4,267 nodes. A summary of the results is provided in Table 3-2. Individual results of the water surface elevation differences are also included in Figure 3-2 through Figure 3-6.

When running models in different versions of the same software or in completely different software packages, some differences in the hydraulic results are expected. To evaluate the results, a few benchmarks were picked. The lowest threshold is applied to differences in MWSE less than 0.2 feet. Our modeling experience has shown that running the same model in a newer version of XP-SWMM, can result in changes in the MWSE on the order of 0.1 to 0.2 feet. Additionally, a difference of 0.2 feet within the accuracy of the available LiDAR used to develop the models and inundation mapping. Additionally, the City of Minneapolis has been converting many of their models from XP-SWMM to PCSWMM and have been using a difference of 0.5 feet as another threshold to evaluate the conversion process so that the majority of results fall below threshold. Additional difference thresholds of 1, 2, and 5 feet were selected for flood risk assessment considerations and to help focus investigation into specific areas during the model transition process.

The comparison indicates strong agreement between the two models. More than 88% of all nodes have MWSE differences of 0.5 feet or less, while more than 80% of storage nodes are within 0.2 feet. In general, storage nodes exhibit more stable hydraulic behavior and produce results that more closely match those from the XP-SWMM model.

A detailed review of nodes with the largest MWSE differences (e.g. greater than 5 feet) found that these locations are primarily associated with sealed nodes. XP-SWMM includes a sealing option that restricts surcharging behavior, whereas PCSWMM does not provide an equivalent feature. In the PCSWMM model, these conditions are represented by allowing additional surcharging depth above the node. As a result, larger MWSE differences at these locations are expected and reflect differences in software functionality rather than inaccuracies in the model conversion.

Sealed nodes are commonly used in simulating lift stations and deep tunnel systems. Although we see highest differences in the sealed nodes representing lift station structure itself, the upstream storage node related to the lift station are typically within 0.2 feet of difference.

The other sealed nodes in XP-SWMM represent pipe transitions, often found in deep tunnels and storm sewer points which do not have surface access. The WSE differences at these locations are within 10 feet.

Table 3-2 XP-SWMM to PCSMWMM 100-year, 24-hour MWSEL Results Comparison Summary

MWSE Difference (feet)	<0.2	<0.5	<1.0	<2.0	>5.0
Percentage of all nodes	74.3%	88.2%	94.1%	97.5%	0.1%
Percentage of all storage nodes	84.3%	94.9%	97.9%	99.6%	0.0%
Percentage of non-storage nodes	70.8%	85.8%	92.8%	96.8%	0.1%

Municipal Boundary
BCWMC Jurisdictional Boundary
Ponds and Wetlands
Trunk System Storage
Trunk System
Stormsewer Network Modeled
Subwatershed Boundaries

Storage Node MWSE Difference

Difference (ft)

- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2

Non-Storage Node MWSE Difference

Difference (ft)

- <-5
- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2
- <5
- >5

N

0 2,000 4,000

Feet

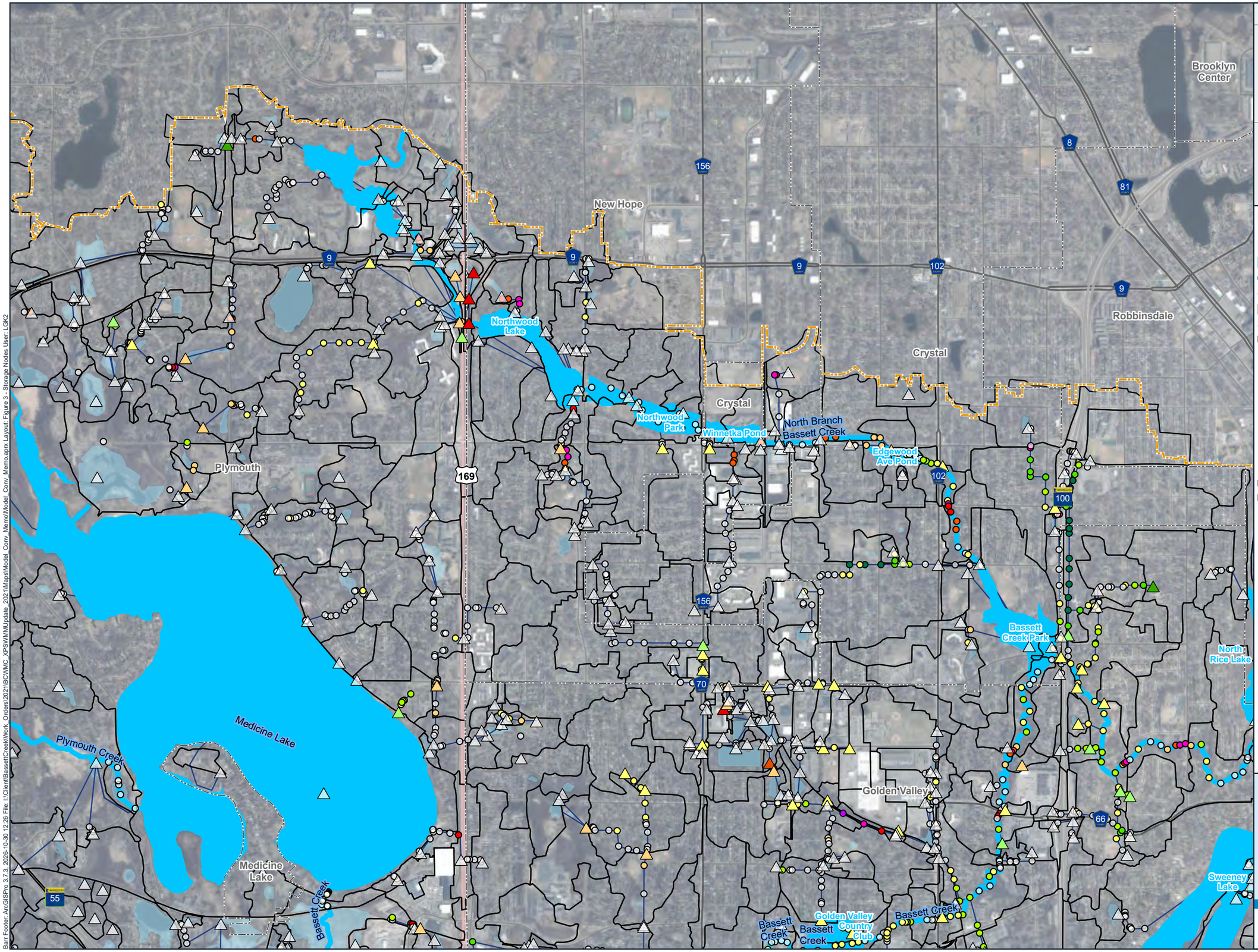
NODE DIFFERENCES IN 100-YEAR PEAK ELEVATIONS

Bassett Creek Valley

FIGURE 3-2
MAP 1/5

BARR

Barr Footer: ArcGISPro 3.7.3, 2026-10-30 12:26 File: I:\Client\BassettCreek\Work_Orders\2021\BCWMC_XPSWMMUpdate_2021\Maps\Model_Conv_Memo\Model_Conv_Memo.aprx Layout: Figure 3 - Storage Nodes User: LGK2



Municipal Boundary
BCWMC Jurisdictional Boundary
Ponds and Wetlands
Trunk System Storage
Trunk System
Stormsewer Network Modeled
Subwatershed Boundaries

Storage Node MWSE Difference

Difference (ft)

- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2

Non-Storage Node MWSE Difference

Difference (ft)

- <-5
- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2
- <5
- >5

N

0 2,000 4,000

Feet

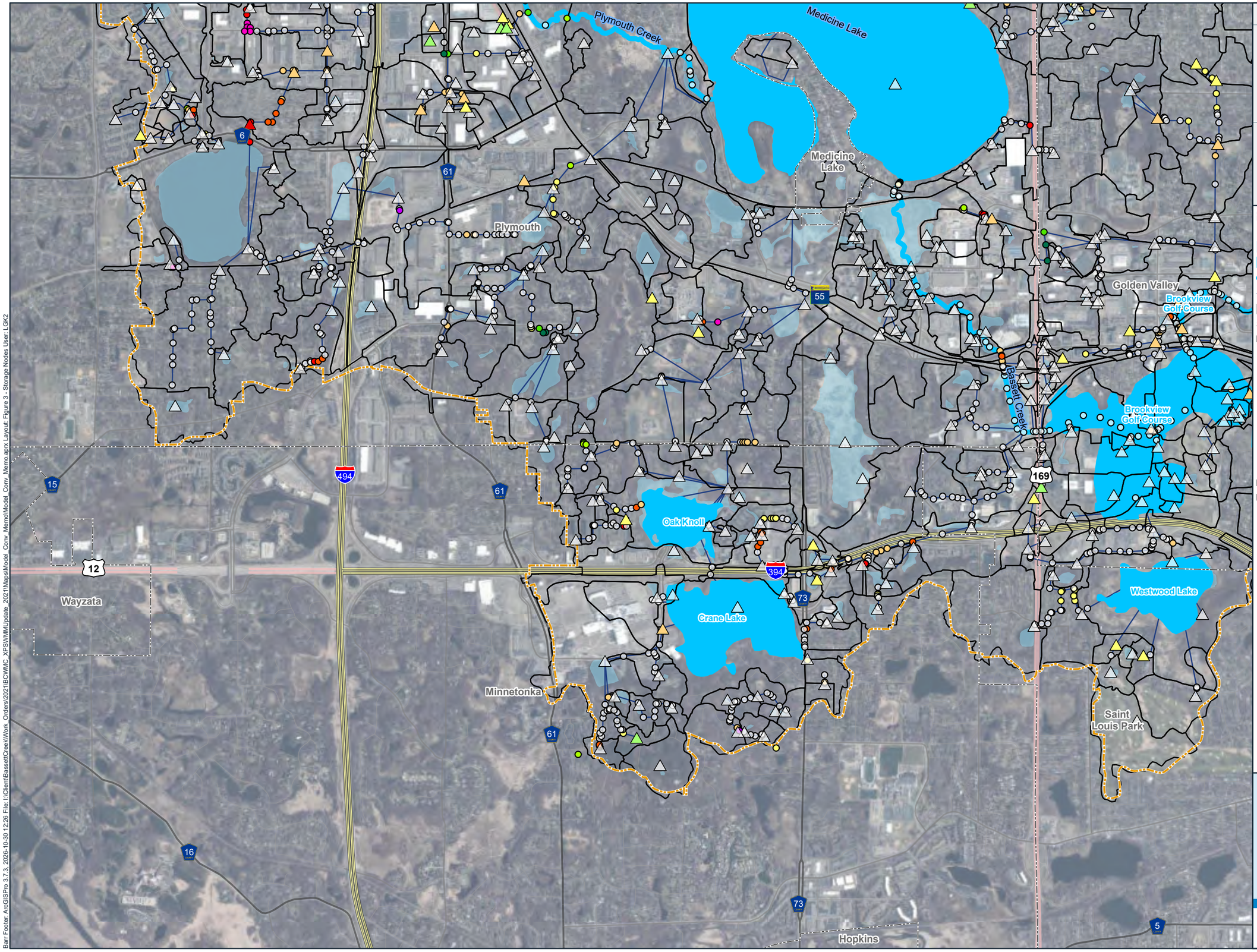
NODE DIFFERENCES IN 100-YEAR PEAK ELEVATIONS

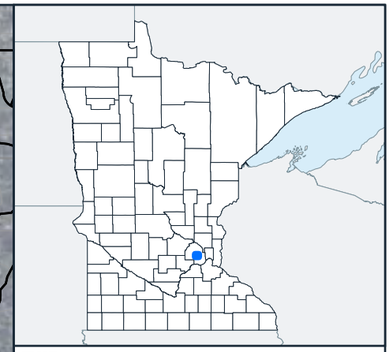
Bassett Creek Valley

FIGURE 3-2
MAP 2/5

BARR

Barr Footer: ArcGISPro 3.7.3, 2026-10-30 12:26 File: I:\Client\BassettCreek\Work Orders\2021\BCWMC_XPSWMM\Update_2021\Maps\Model Conv. Memo\Model Conv. Memo.aprx Layout: Figure 3 - Storage Nodes User: LGK2





Municipal Boundary
BCWMC Jurisdictional Boundary
Ponds and Wetlands
Trunk System Storage
Trunk System
Stormsewer Network Modeled
Subwatershed Boundaries

Storage Node MWSE Difference

Difference (ft)

- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2

Non-Storage Node MWSE Difference

Difference (ft)

- <-5
- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2
- <5
- >5

0 2,000 4,000

Feet

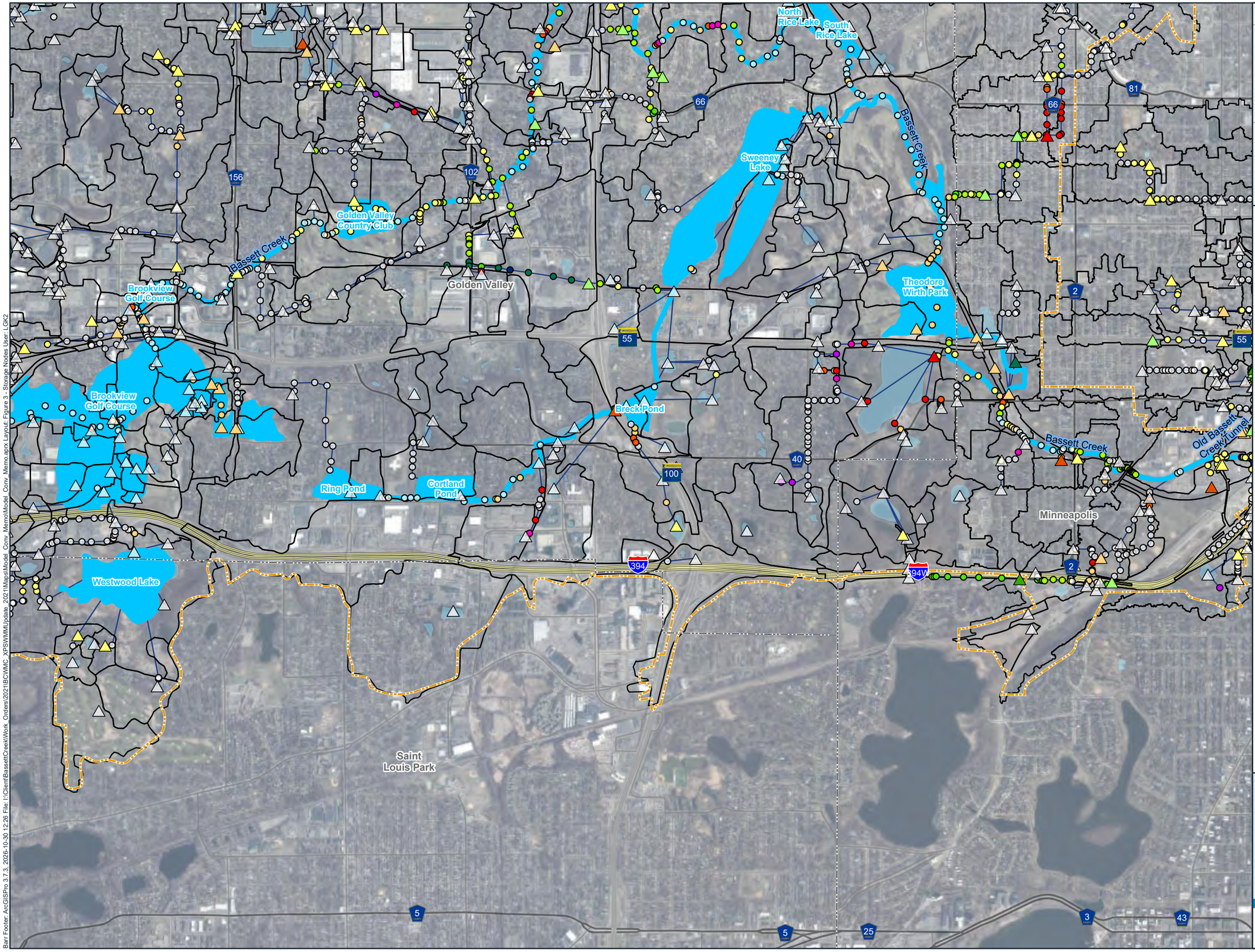
NODE DIFFERENCES IN 100-YEAR PEAK ELEVATIONS

Bassett Creek Valley

FIGURE 3-2
MAP 3/5

BARR

Barr Footer: ArcGISPro 3.7.3, 2026-10-30 12:26 File: I:\Client\BassettCreek\Work_Orders\2021\BCWMC_XPSWMMUpdate_2021\Maps\Model_Conv_Memo\Model_Conv_Memo.aprx Layout: Figure 3 - Storage Nodes User: LGK2



Municipal Boundary
BCWMC Jurisdictional Boundary
Ponds and Wetlands
Trunk System Storage
Trunk System
Stormsewer Network Modeled
Old Tunnel
Tunnel
Subwatershed Boundaries

Storage Node MWSE Difference

Difference (ft)

- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2

Non-Storage Node MWSE Difference

Difference (ft)

- <-5
- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2
- <5
- >5

0 2,000 4,000
Feet

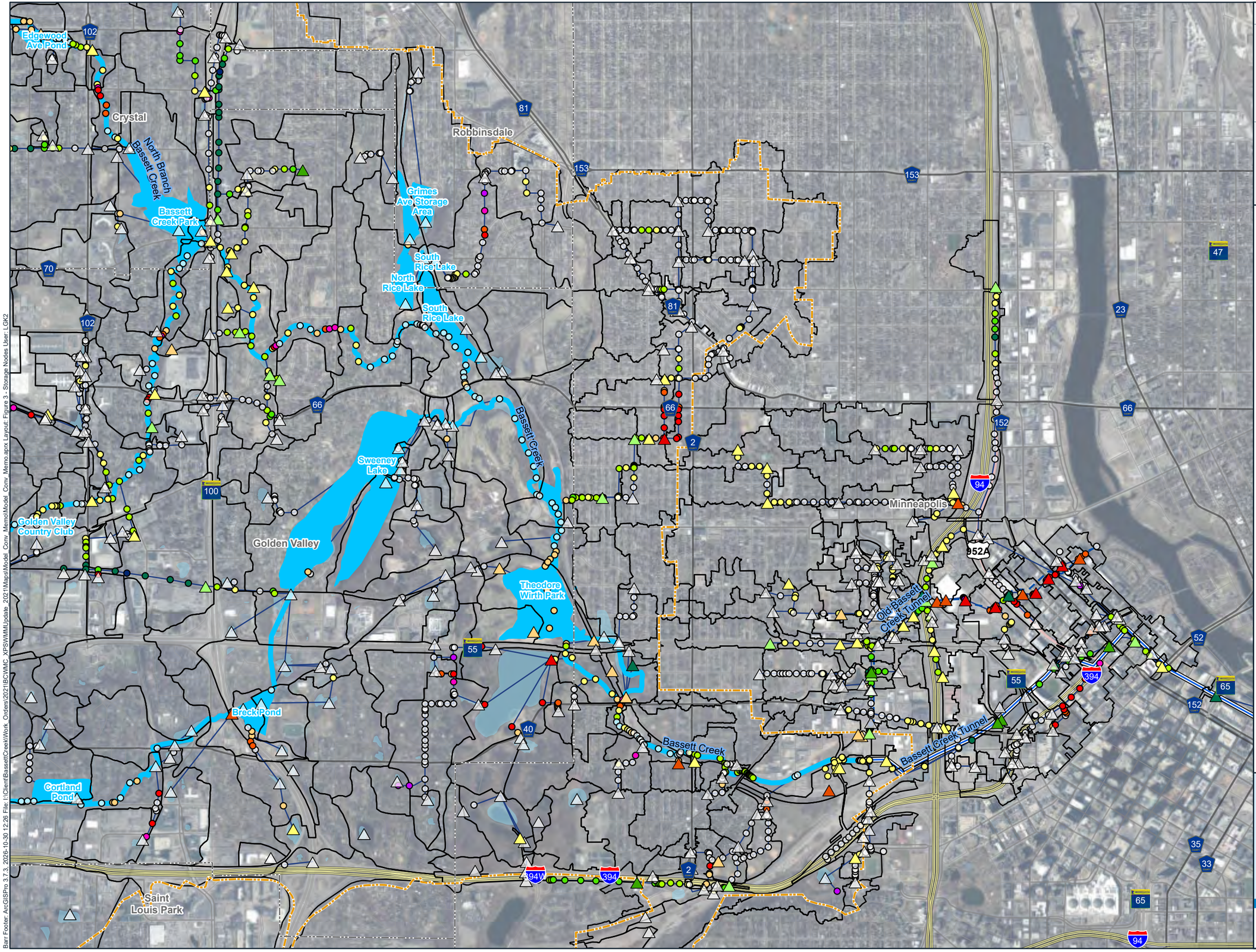
NODE DIFFERENCES IN 100-YEAR PEAK ELEVATIONS

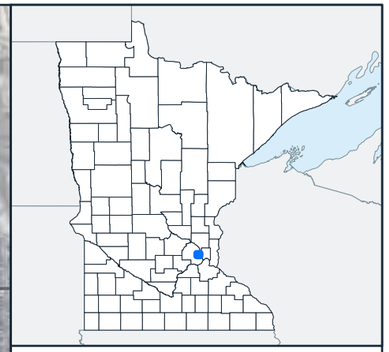
Bassett Creek Valley

FIGURE 3-2
MAP 4/5

BARR

Barr Footer: ArcGISPro 3.7.3, 2026-10-30 12:26 File: I:\Client\BassettCreek\Work_Orders\2021\BCWMC_XPSWMMUpdate_2021\Maps\Model_Conv_Memo\Model_Conv_Memo.aprx Layout: Figure 3 - Storage Nodes User: LGK2





- Municipal Boundary
- BCWMC Jurisdictional Boundary
- Ponds and Wetlands
- Trunk System Storage
- Trunk System
- Stormsewer Network Modeled
- Old Tunnel
- Tunnel
- Subwatershed Boundaries

Storage Node MWSE Difference

Difference (ft)

- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2

Non-Storage Node MWSE Difference

Difference (ft)

- <-5
- <-2
- <-1
- <-0.5
- <-0.2
- <0.2
- <0.5
- <1
- <2
- <5
- >5

0 2,000 4,000

Feet

NODE DIFFERENCES IN 100-YEAR PEAK ELEVATIONS

Bassett Creek Valley

FIGURE 3-2
MAP 5/5

BARR

Barr Footer: ArcGISPro 3.7.3, 2026-10-30 12:26, File: I:\Client\BassettCreek\Work_Orders\2021\BCWMC_XPSWMMUpdate_2021\Maps\Model_Conv_Memo\Model_Conv_Memo.aprx Layout: Figure 3 - Storage Nodes User: LGK2

In addition to evaluating the overall hydraulic performance of all notes, we also reviewed the model performance along the Bassett Creek trunk system separately from the upstream contributing watershed areas. As defined by the district, the BCWMC trunk system includes 490 nodes, representing lakes, major wetlands, inundation areas, creek reaches, culverts, and the associated upstream and downstream hydraulic structures on the water bodies and water courses the BCWMC has jurisdiction over.

As summarized in Table 3-3, the BCWMC trunk system exhibits slightly greater differences between the XP-SWMM and PCSWMM models than the watershed-wide comparison. Nevertheless, model agreement remains strong, with more than 85% of trunk system nodes showing maximum water surface elevation (MWSE) differences of 0.5 feet or less.

The 35 storage nodes within the BCWMC trunk system, which primarily represent larger lakes and wetlands, perform even better than the overall storage node population. This is likely because larger water bodies are less sensitive to minor differences in hydraulic computations between the two modeling platforms.

For non-storage nodes on the BCMWC trunk system that often represent connections between channel cross sections, cross-sections and culvert crossings, or storm sewer conveyance downstream of trunk system water bodies, nearly 85% of results are within 0.5 feet of the XP-SWMM results. This demonstrates that the PCSWMM model closely replicates the hydraulic behavior of the XP-SWMM model along the Bassett Creek corridor and its associated conveyance features.

Table 3-3 100-year, 24-hour MWSE Results Comparison Summary for BCWMC Trunk Nodes

MWSE Difference (feet)	<0.2	<0.5	<1.0	<2.0	>5.0
Percentage of all BCWMC trunk nodes	63.4%	85.5%	96.3%	99.0%	0.0%
Percentage of all storage BCWMC trunk nodes (e.g. Lake and Inundation areas)	91.2%	97.1%	100.0%	100.0%	0.0%
Percentage of non-storage BCWMC trunk nodes (e.g. cross-sections, culverts)	61.3%	84.6%	96.0%	98.9%	0.0%

3.2.2 Comparison of Flows

We compared the differences between peak flow rates simulated within the two models for all 6,774 links, estimating the percent difference. Of these, 621 links are located within the Bassett Creek trunk system, which includes natural channel cross-sections along the creeks and major culvert structures. A summary of the flow difference comparison is provided in Table 3-4.

Compared to node water surface elevations, link peak flow rates exhibit greater variability between the two modeling platforms. In general, the trunkline links show slightly lower agreement than the model as a whole. This is primarily attributable to the larger number of box culverts, arch culverts, and other non-circular conveyance structures within the BCWMC trunk system. PCSWMM and XP-SWMM apply different numerical approaches when representing flow through non-circular conduits, which can result in differences in simulated peak flows.

Despite this variability, the observed differences are within the expected range for a model conversion of this complexity and are consistent with known differences in hydraulic computations between the two software platforms. Overall, the results indicate that the PCSWMM model provides a comparable representation of hydraulic performance throughout both the trunkline system and the broader watershed network.

Table 3-4 Link Flow Rate 100-year, 24-hour Results Comparison Summary

Flow Rate Difference (%)	<5%	<10%	<20%	<50%	>100%
Percentage of all links	60.1%	72.8%	81.9%	89.1%	7.6%
Percentage of links along BCWMC trunk system	35.1%	65.9%	80.3%	90.0%	6.6%

3.2.3 Summary Along the BCMWC Trunk System

To further evaluate model performance, the 100-year, 24-hour MWSEs and peak flow rates at key locations along the Bassett trunk system were compared between the XP-SWMM and PCSWMM models. This comparison follows the format of Table 2-9 in the BCWMC Regulations and is presented as Table 3-5 in this memo. The numbers in red in the “PCSWMM – XPSWMM Difference” column highlight locations where the WSE difference is higher than 0.5 ft, and flow difference is higher than 100 cfs.

Overall, the direct conversion from XP-SWMM to PCSWMM as outlined above produced highly comparable results. The largest differences are generally associated with complex hydraulic features, including outlet structures with combined weir and orifice controls, lift stations, non-standard conduit shapes, abrupt transitions between natural channels and culverts, and deep tunnel systems. These differences are consistent with the distinct computational approaches used by the two software platforms to represent specialized hydraulic conditions.

The comparison also indicates that PCSWMM performs particularly well for larger storage features, such as lakes and major wetlands, which are more critical for inundation mapping and flood risk assessment. In addition, the model closely reproduces hydraulic conditions throughout the Bassett Creek trunk system,

with strong agreement in both water surface elevations and flow rates at key regulatory and assessment locations.

The comparison results demonstrate that the PCSWMM model provides reliable results and is considered an interim model that will serve as a good starting point for the upcoming future tasks that include the incorporation of new data and project updates, re-calibration, and flood risk evaluation using Atlas 15.

Table 3-5 Summary of Atlas 14 100-year, 24-hour Results Comparison Summary

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
BASSETT CREEK MAIN STEM (Creek Distance Upstream of Mississippi River)											
Tunnel Inlet	8,000	807.3	1,220	810.9	1,380	809.8	1,276	809.6	1,221	-0.2	-57
Van White Memorial Blvd (DS)	---	---	---	811.0	1,400	809.8	1,275	809.7	1,214	-0.2	-62
Van White Memorial Blvd (US)	---	---	---	811.0	1,530	809.8	1,409	809.7	1,312	-0.2	-97
Irving Avenue Bridge (DS)	9,800	808.6	1,135	811.2	1,380	809.9	1,276	809.7	1,221	-0.2	-57
Irving Avenue Bridge (US)	---	809.3	1,135	811.3	1,380	809.9	1,395	809.7	1,295	-0.2	-99
Cedar Lake Rd (DS)	---	---	---	812.9	1,380	812.9	1,395	811.8	1,344	-1.1	-51
Cedar Lake Rd (Bridge)	10,900	812.9	945	813.3	1,380	813.1	1,395	812.4	1,358	-0.8	-37
MN&S RR Bridge (Downstream)	---	---	---	813.7	1,370	813.7	1,395	812.9	1,358	-0.9	-37
MN&S RR Bridge	11,600	814.8	945	814.5	1,370	813.8	1,394	812.9	1,749	-0.9	357
Penn Ave Culvert & Bridge (DS)	12,410	814.9	705	814.5	1,370	812.9	1,393	813.4	1,296	0.5	-97
Penn Ave Culvert & Bridge (US)	---	815.2	705	814.5	1,370	814.8	1,393	814.9	1,297	0.1	-97
BN RR Bridge (DS)	---	---	---	814.4	1,370	814.7	1,393	814.9	1,297	0.2	-97
BN RR Bridge	12,670	815.3	705	815.6	1,370	814.8	1,393	814.9	1,297	0.2	-96
MN&S RR Bridge (DS)	13,930	816.2	465	815.8	1,370	815.8	1,391	815.6	1,306	-0.2	-85
MN&S RR Bridge (US)	---	816.4	465	---	---	815.9	1,391	816.2	1,307	0.3	-84
Fruen Mill Dam (DS)	14,150	816.5	510	817.2	1,370	817.0	1,391	816.8	1,349	-0.2	-42
Fruen Mill Dam (US)	---	818.2	510	819.8	1,370	819.8	1,391	819.6	1,294	-0.2	-97
Glenwood Ave (DS)	---	---	---	822.1	1,370	821.8	1,391	822.4	1,748	0.6	357
Glenwood Ave	14,855	820.3	680	822.2	1,290	821.8	1,300	822.9	2,094	1.1	792
Hwy 55 (DS)	16,500	821.7	680	823.4	1,190	823.2	1,204	822.7	1,125	-0.5	-79
Hwy 55 (US)	---	826.2	680	826.5	1,500	826.5	1,507	826.7	1,629	0.2	122
Golf Cart Bridge	---	826.2	680	826.6	1,520	826.5	1,538	826.8	1,629	0.2	91
MN&S RR Bridge (DS)	---	---	---	826.6	1,520	826.5	1,538	826.8	1,629	0.2	91

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
MN&S RR Bridge	18,700	826.2	945	826.6	1,520	826.6	1,541	826.8	1,629	0.2	89
Plymouth Ave Bridge	19,500	826.2	680	826.7	1,550	826.6	1,583	826.8	1,678	0.2	95
Wirth Parkway (DS)	20,480	826.2	1,570	826.7	1,450	826.6	1,475	826.8	1,522	0.2	48
Wirth Parkway (US) Bridge	---	826.5	1,570	826.8	1,460	826.8	1,478	826.9	1,521	0.0	43
Confluence w/ Sweeney Lake Branch	22,000	827.2	----	827.2	1,460	827.3	1,483	827.4	1,530	0.1	47
Golden Valley Road (DS)	23,800	827.4	790	828.2	1,350	828.3	1,364	828.3	1,416	0.0	53
Golden Valley Road (US)	23,800	830.2	680	833.8	1,340	833.7	1,361	833.9	1,411	0.2	51
Dresden Lane (DS)	25,900	830.5	680	834.1	1,340	834.0	1,353	834.1	1,409	0.1	58
Dresden Lane (US)	---	831.6	680	834.1	1,350	834.0	1,357	834.1	1,440	0.1	83
Bassett Creek Drive (DS)	---	832.2	665	834.4	1,290	834.3	1,310	834.3	1,397	0.0	88
Bassett Creek Drive (US)	---	832.9	665	837.0	1,300	837.0	1,312	837.0	1,397	0.0	86
Noble Lane (DS)	29,200	839.7	660	838.7	1,320	839.0	1,337	839.3	1,435	0.3	89
Noble Lane (US)	---	839.7	660	839.7	1,300	840.0	1,318	842.5	3,299	2.5	1,940
Regent Avenue (DS)	30,800	---	660	843.0	1,300	843.0	1,319	843.0	1,402	0.0	83
Regent Avenue (US)	---	842.1	660	843.7	1,280	843.7	1,291	846.7	4,939	3.0	3,650
Minnaqua Avenue	31,650	842.7	---	844.0	1,260	844.0	1,274	843.5	1,400	-0.5	127
Highway 100 (DS)	34,020	843.4	770	844.8	1,300	844.8	1,314	844.6	1,373	-0.2	60
Highway 100 (US)	34,020	849.2	610	851.2	1,040	850.9	963	851.0	1,012	0.1	49
DS Confluence N. Branch	34,400	849.2	495	851.2	1,040	850.9	963	851.0	581	0.1	-381
DS Confluence N. Branch (US)						850.9	810	851.0	839	0.1	29
Westbrook Road (DS)	37,000	857.3	940	859.0	870	858.9	822	859.4	947	0.6	124
Westbrook Road (US)	---	858.3	940	860.0	870	860.1	795	863.6	902	3.5	107
Duluth Street (DS)	38,400	861.5	850	861.9	850	861.8	795	861.8	887	0.0	92
Duluth Street (US)	---	862.0	850	862.6	830	862.5	780	863.9	2,353	1.5	1,576
St. Croix Avenue (DS)	39,800	863.2	850	864.5	830	864.3	783	864.4	868	0.1	84

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
St. Croix Avenue (US)	---	864.3	850	864.7	800	864.6	746	864.6	812	0.0	66
MN&S RR (DS)	41,660	869.7	760	870.3	700	870.2	647	869.5	706	-0.6	59
MN&S RR (US)	---	869.7	760	870.5	690	870.3	636	869.9	690	-0.4	54
Douglas Drive (DS)	42,130	870.4	670	871.0	700	870.8	637	870.5	690	-0.4	53
Douglas Drive (US)	---	871.2	670	871.8	690	871.6	631	871.7	681	0.1	50
Florida Avenue (DS)	42,820	871.8	670	872.6	690	872.5	632	872.0	681	-0.5	49
Florida Avenue (US)	---	872.5	670	873.0	690	872.9	633	872.7	681	-0.2	48
Hampshire Ave (DS)	43,410	872.7	630	873.4	690	873.2	635	872.9	682	-0.3	48
Hampshire Ave (US)	---	873.2	630	874.0	670	873.8	604	873.8	646	0.0	42
GV Country Club (DS)	44,320	874.6	365	876.1	660	875.8	595	875.9	642	-0.1	45
GV Country Club (US)	---	878.6	405	880.6	650	880.6	573	881.1	600	0.5	26
Pennsylvania Avenue (DS)	46,500	879.5	380	881.6	650	881.4	573	881.2	600	-0.2	26
Pennsylvania Avenue (US)	---	880.7	375	882.9	550	882.5	475	882.6	493	0.1	18
C&NW RR (DS)	47,200	881.9	375	884.1	560	883.5	492	883.2	505	-0.3	12
C&NW RR (US)	---	883.1	375	885.0	450	884.8	372	884.6	383	-0.1	12
Winnetka Ave (DS)	48,000	883.5	360	885.1	440	884.8	360	884.7	367	-0.1	8
Winnetka Ave (US)	---	883.7	360	885.3	430	885.0	358	884.9	365	-0.1	8
Wisconsin Ave (DS)	49,750	884.9	360	886.0	430	885.3	356	885.3	363	0.0	7
Wisconsin Ave (US)	50,100	888.2	340	887.6	370	888.0	289	888.1	312	0.2	24
Golden Valley Road (DS)	---	888.2	290	887.7	340	888.1	314	888.2	341	0.1	27
Golden Valley Road (US)	---	888.2	290	887.7	340	888.2	310	888.2	419	0.0	107
Westbound Hwy 55 (DS)	51,250	888.2	290	887.7	340	888.3	328	888.2	352	-0.1	24
Eastbound Hwy 55 (US)	---	888.3	290	887.8	410	888.1	-424	888.3	460	0.1	884
Boone Ave (DS)	---	888.4	280	887.9	320	888.1	304	888.3	337	0.2	33
Boone Ave (US)	---	888.5	280	887.9	220	888.2	227	888.5	280	0.3	53

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
Hwy 169 (DS)	56,500	888.6	255	888.3	300	888.4	301	888.5	361	0.1	60
Hwy 169 (US)	---	888.7	250	888.4	240	888.5	238	888.6	292	0.1	54
Hwy 55 Ramp (DS)	58,300	888.7	235	888.4	220	888.5	228	888.6	264	0.1	36
Hwy 55 Ramp (US)	---	888.7	235	888.4	220	888.5	228	888.7	264	0.2	36
Hwy 55 Eastbound (DS)	58,500	888.7	235	888.4	220	888.5	228	888.7	264	0.2	36
Hwy 55 Eastbound (US)	---	888.7	235	888.4	220	888.5	228	888.7	275	0.2	47
Hwy 55 Westbound (DS)	---	888.7	235	888.4	220	888.5	228	888.7	275	0.2	47
Hwy 55 Westbound (US)	---	889.0	235	888.4	220	888.5	228	888.8	370	0.2	142
Hwy 169 ramp to W 55 (DS)	58,750	889.0	235	888.4	220	888.6	228	888.9	370	0.3	142
Hwy 169 ramp to W 55 (US)	---	889.0	235	888.5	220	888.6	228	889.3	516	0.6	288
Hwy 55 N Frontage Rd (DS)	58,850	889.2	235	888.5	220	888.6	228	889.2	516	0.5	288
Hwy 55 N Frontage Rd (US)	---	889.2	235	888.5	220	888.6	228	888.9	284	0.2	56
Pedestrian Bridge near Cub Foods	---	---	---	888.7	220	888.9	229	888.9	268	0.0	39
10th Ave (DS)	---	889.2	---	889.0	220	889.2	227	889.1	265	-0.1	38
10th Ave (US)	---	889.2	---	889.2	220	889.3	227	889.3	265	0.0	38
C&NW RR Bridge (DS)	63,450	889.2	200	889.2	220	889.3	227	889.3	265	0.0	38
C&NW RR Bridge (US)	---	889.6	200	889.2	220	889.4	228	889.6	399	0.2	171
South Shore Drive (DS)	63,800	889.6	190	889.3	220	889.5	228	889.6	277	0.1	49
South Shore Drive (US)	---	890.5	190	889.4	220	889.5	228	889.6	277	0.1	49
Medicine Lake Weir (DS)	63,960	890.5	190	889.4	220	889.5	228	889.6	277	0.1	49
Inundation Areas											
Theodore Wirth Park (Area upstream of Highway 55 Control Structure)	---	826.2	---	826.5	---	826.5	---	826.7	---	0.2	---
South Rice Pond	---	831.7	---	834.3	---	834.2	---	834.2	---	0.0	---
North Rice Pond	---	838.2	---	836.4	---	836.6	---	836.6	---	0.0	---

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
Grimes Avenue Pond	---	838.2	---	836.4	---	836.7	---	836.7	---	0.0	---
Golden Valley Country Club	---	878.6	---	880.6	---	880.6	---	881.1	---	0.5	---
Brookview Golf Course	---	888.3	---	887.8	---	888.1	---	888.3	---	0.1	---
Westwood Lake	---	889.2	---	890.0	---	889.9	---	890.0	---	0.1	---
Medicine Lake	---	890.5	---	890.4	---	890.4	---	890.2	---	-0.2	---
NORTH BRANCH (Creek Distance Above Confluence with Main Stem)											
Hwy 100 Control (US)	---	849.2	610	851.2	1,040	850.9	963	851.0	1,012	0.1	49
Confluence w/Main Stem	---	849.2	---	851.2	1740.0	850.9	963	851.0	1,012	0.1	49
Confluence w/Main Stem (US)	---	849.2	---	851.2	1740	850.9	368	851.0	1,952	0.1	1,578
29th Avenue (DS)	200	849.2	1515	851.2	1740.0	850.9	319	851.0	1,897	0.1	1,572
29th Avenue (US)	---	849.7	1515	851.2	1290	850.9	1588	851.0	1,331	0.1	-258
Bassett Creek Park Pond						850.9	1588	851.0	1,331	0.1	-258
32nd Avenue (DS)	2,600	849.8	1175	851.2	1290	850.9	1588	851.0	1,331	0.1	-258
32nd Avenue (US)	---	854.2	1175	852.7	560	852.7	598	852.5	559	-0.2	-36
Brunswick Avenue (DS)	3,000	854.9	1175	852.7	560.0	852.7	598	852.5	559	-0.2	-36
Brunswick Avenue (US)	---	856.1	1175	856.7	510	856.8	559	856.5	518	-0.4	-37
34th Culvert (DS)	4,200	863.0	700	861.5	520	861.6	565	863.4	531	1.8	-30
34th Culvert (US)	---	866.3	430	867.2	500	868.0	560	871.0	2,211	2.9	1,681
Apartment Drive Crossing (DS)	---	---	---	868.3	570	869.0	778	869.5	556	0.4	-216
Apartment Drive Crossing (US)	---	---	---	869.6	580	870.6	834	870.3	614	-0.3	-211
Douglas Drive (DS)	5,250	870.2	670	869.6	580	870.6	834	870.3	614	-0.3	-211
Douglas Drive (US)	---	870.3	670	870.5	380	870.6	437	870.4	418	-0.3	-15
Edgewood Emb (DS)	5,600	870.9	430	871.0	380	871.4	437	870.4	418	-1.0	-15
Edgewood Emb (US)	---	878.4	340	880.4	340	880.5	395	880.5	378	-0.1	-13
Georgia Avenue (DS)	6,250	878.4	305	880.4	460	880.5	455	880.5	393	-0.1	-59

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
Georgia Avenue (US)	---	878.6	305	880.8	520	880.8	506	881.0	290	0.2	-218
36th & Hampshire (DS)	6,800	878.6	260	880.8	480	880.8	---	881.0	---	0.2	---
36th & Hampshire (US)	6,980	879.2	260	881.3	280	881.5	363	881.7	307	0.2	-58
Louisiana Ave. (DS) (Street Elevation Approx. 882.4)	8,000	881.2	---	883.3	490	883.3	485	883.2	488	-0.1	147
Maryland Ave. (Street Elevation Approx. 885.7)	8,500	---	---	886.0	260	886.5	321	886.5	318	0.0	74
Oregon Ave. (Street Elevation Approx. 885.4)	9,000	---	---	888.5	90	888.3	97	888.4	117	0.0	24
MN & S RR (Street Elevation Approx. 889.1)	9,300	---	---	889.6	90.0	889.9	97	890.0	117	0.2	24
East Winnetka Pond Inlet (Control Structure)	9,500	888.2	---	890.9	100	890.2	169	890.3	167	0.1	-2
Service Road (West Winnetka Pond- DS)	---	---	---	890.9	190	890.2	169	890.3	167	0.1	-2
Service Road (West Winnetka Pond- US)	10,000	888.2	---	891.1	190	890.5	169	890.6	167	0.1	-2
Winnetka Ave. (DS)	10,600	888.2	---	891.1	220	890.5	-240	890.6	259	0.1	499
Winnetka Ave. (US)	---	889.2	---	891.3	270	891.2	-311	891.2	316	0.0	628
Boone Ave. (DS)	13,500	889.5	---	891.4	730	891.2	731	891.2	627	0.1	-104
Boone Ave. (US)	---	889.7	---	891.4	270	891.2	328	891.2	253	0.1	-74
Northwood Pond	---	889.7	---	891.4	270	891.2	328	891.2	253	0.1	-74
TH 169 (DS)	16,850	889.7	---	893.0	270	891.8	328	893.1	253	1.3	-74
TH 169(US)	---	890.7	---	893.1	750	892.9	328	893.1	253	0.2	-74
Rockford Road (DS)	18,350	890.7	---	893.1	750	892.9	328	893.1	253	0.2	-74
Rockford Road (US)	---	898.7	---	897.2	---	897.1	---	897.2	---	0.2	---
Inundation Areas											
Bassett Creek Park	---	849.7	---	851.2	---	850.9	---	851.0	---	0.1	47
Edgewood Avenue Pond	---	878.4	---	880.4	---	880.5	---	880.5	---	0.1	52
Winnetka Pond (DS of Winnetka Avenue)	---	888.2	---	890.9	---	890.2	---	890.3	---	0.1	2
Northwood Park	---	889.5	---	891.3	---	891.2	---	891.2	---	0.1	-21
Northwood Pond	---	889.7	---	891.4	---	891.2	---	891.2	---	0.1	-21

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
SWEENEY LAKE BRANCH (Creek Distance Upstream of Confluence with Main Stem)											
Confluence w/Main Stem	---	827.2	---	827.2	1,460	827.3	1,483	827.4	1,530	0.1	1
Confluence w/Main Stem	---	827.2	---	827.2	170	828.0	1,361	828.0	1,412	0.1	213
Courage Center Downstream Crossing (DS)	700	827.2	---	827.2	170	827.3	171	827.4	172	0.1	213
Courage Center Downstream Crossing (US)	---	829.2	---	828.0	170	828.0	193	828.0	172	0.1	213
Courage Center Upstream Crossing (DS)	---	--	---	828.0	170	828.0	193	828.0	172	0.1	15
Courage Center Upstream Crossing (US)	---	---	---	830.6	170	830.6	171	830.7	172	0.4	-64
Courage Center & Hidden Lakes Parkway (DS)	900	829.2	---	830.6	170	830.6	171	830.7	172	-0.2	-303
Courage Center & Hidden Lakes Parkway (US)	---	831.2	---	831.9	170	831.8	171	832.0	377	-0.1	-17
Precast Concrete Dam (DS)	1,700	831.7	---	831.9	170	831.8	171	832.0	377	-0.1	4
Sweeney Lake	---	831.7	---	831.9	170	831.8	171	832.0	377	0.0	2
Union Pacific RR (DS)	6,800	831.7	---	831.9	400	831.8	395	832.0	410	0.0	2
Union Pacific RR (US)	---	835.8	311	836.3	480	836.0	474	836.4	410	0.0	23
Hwy 55 (DS)	8,150	835.8	680	836.8	860	836.6	834	836.4	532	0.9	12
Hwy 55 (US)	---	836.9	680	838.4	310	838.3	297	838.2	279	0.9	12
MN & S RR (DS)	9,000	836.9	233	838.4	260	838.3	250	838.2	254	0.1	12
MN & S RR (US)	---	839.5	233	841.7	260	841.3	251	841.3	254	0.1	---
Breck Pond & Control Structure (US)	9,580	839.9	296	842.5	270	842.4	251	842.5	254	0.1	108
TH 100 (DS) (Breck Pond)	10,400	839.9	298	842.5	440	842.4	472	842.5	496	0.1	108
TH 100 (US)	---	845.4	298	851.0	500	846.8	486	847.8	498	0.1	---
Turners Crossroad (DS)	---					846.8	486	847.8	498	0.1	72
Turners Crossroad (US)	10,950	854.9	241	857.2	430	857.1	416	857.1	429	0.1	-2
Glenwood Pond A	---	854.9	---	857.2	---	857.1	---	857.1	---	0.1	---
MN & S RR (DS)	11,550	854.9	233	857.2	440	857.1	185	857.1	156	0.1	45
MN & S RR (US)	---	855.0	233	857.2	440	857.1	185	857.2	156	0.1	41

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
Glenwood Pond B	---	855.0	---	857.2	---	857.1	---	857.2	---	0.1	72
Glenwood Ave (DS)	---	855.0	84	857.2	100	857.1	115	857.2	190	0.0	0
Glenwood Ave (US)	---	855.0	84	857.2	100	857.1	100	857.2	98	0.0	9
Duck Pond	---	855.0	---	857.2	---	857.1	---	857.2	---	0.0	-42
MN & S RR (DS)	---	855.0	233	857.2	560	857.1	567	857.2	615	0.0	---
MN & S RR (US)	---	858.9	233	859.4	300	859.3	360	859.4	404	0.1	47
Ravine Storage Area	---	858.9	---	859.4	90	859.3	115	859.4	190	0.1	52
Courtlawn Pond	---	873.1	---	873.6	120	873.6	113	873.6	113	0.1	2
East Ring Pond	---	879.0	---	879.4	180	879.4	181	879.4	190	0.1	-21
78” RCP Equalizer	18,800	---	---	879.4	480	879.4	476	879.4	434	0.1	-21
West Ring Pond	---	879.0	---	879.4	---	879.4	---	879.4	---	0.1	2
Ravine Storage Area Overflow											
Glenwood Pond B	---	855.0	---	857.2	---	857.1	---	857.2	---	0.1	---
MN & S RR (DS)	---	855.0	---	857.2	---	857.1	---	857.2	---	0.1	---
MN & S RR (US)	---	857.3	---	858.9	---	858.9	---	859.1	---	0.2	---
Storage Area	---	857.3	---	858.9	---	858.9	---	859.1	---	0.2	---
Glenwood Ave (DS)	---	857.3	---	858.9	---	858.9	---	859.1	---	0.2	---
Glenwood Ave (US)	---	858.9	---	859.4	---	859.3	---	859.4	---	0.1	---
Ravine Storage Area	---	858.9	---	859.4	---	859.3	---	859.4	---	0.1	---
Inundation Areas											
Sweeney Lake	---	831.7	---	831.9	---	831.8	---	832.0	---	0.1	---
Twin Lake	---	831.7	---	831.9	---	831.8	---	832.0	---	0.1	---
Breck Pond	---	839.9	---	842.5	---	842.4	---	842.5	---	0.0	---
Courtlawn Pond	---	873.1	---	873.6	---	873.6	---	873.6	---	0.0	---
East Ring Pond	---	879.0	---	879.4	---	879.4	---	879.4	---	0.0	---

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
West Ring Pond	---	879.0	---	879.4	---	879.4	---	879.4	---	0.0	---
Medicine Lake	---	---	---	879.4	---	890.4	760	890.2	733	-0.2	-27
Pedestrian Crossing (DS)	---	---	---	890.4	---	890.4	---	890.2	---	-0.2	---
Pedestrian Crossing (US)	---	---	---	890.4	690	890.4	754	890.3	733	-0.2	-21
Pedestrian Crossing (DS)	---				---	890.5	---	890.3	---	-0.2	---
Pedestrian Crossing (US)	---				---	890.5	---	890.3	---	-0.2	---
West Medicine Lake Drive (DS)	10,450	890.5	---	890.7	690	890.6	---	890.4	---	-0.2	---
West Medicine Lake Drive (US)	---	891.7	---	893.6	690	893.6	809	893.6	727	0.0	-82
Fish Barrier (DS)	---	---	---	916.1	240	916.2	275	915.9	354	-0.3	80
Fish Barrier (US)	---	---	---	923.0	240	923.0	275	923.1	281	0.0	7
26th Avenue N. (DS)	16,500	925.2	---	924.5	240	924.9	275	924.8	281	-0.1	7
26th Avenue N. (US)	---	925.7	---	925.1	240	925.6	275	925.6	281	0.0	7
28th Avenue N. Dike (DS)	---	928.2	---	930.0	240	930.2	275	930.4	281	0.2	7
28th Avenue N. Dike (US)	---	931.0	---	932.3	270	932.3	288	932.3	293	-0.1	6
County Road 61 (DS)	---	931.0	---	932.3	270	932.3	288	932.3	293	-0.1	6
County Road 61 (US)	---	931.4	---	934.1	240	934.2	275	934.4	281	0.2	6
Xenium Lane (DS)	20,850	931.4	---	934.1	440	934.2	472	934.4	492	0.2	20
Xenium Lane (US)	---	931.7	---	934.5	460	934.6	473	934.8	503	0.2	30
Crowne Plaza Downstream Crossing (DS)	---	---	---	934.5	460	934.6	473	934.8	329	0.2	-145
Crowne Plaza Downstream Crossing (US)	---	---	---	937.6	440	935.2	451	935.4	453	0.2	2
Crowne Plaza Upstream Crossing (DS)	---	---	---	937.7	440	935.3	451	935.5	453	0.2	2
Crowne Plaza Upstream Crossing (US)	---	---	---	938.0	440	936.1	482	936.3	478	0.2	-4
I-494 (DS)	22,500	935.2	---	938.1	440	936.5	482	936.3	478	-0.2	-4

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
I-494 (US)	---	938.7	---	938.9	410	937.7	456	937.9	467	0.1	11
Annapolis (DS)	---	---	---	941.9	280	942.0	325	942.0	345	0.0	20
Annapolis (US)	---	---	---	942.8	280	943.0	324	943.1	344	0.1	20
Fernbrook Lane (DS)	25,000	947.2	---	946.7	280	947.4	324	948.3	344	0.9	20
Fernbrook Lane (US)	---	948.2	---	946.8	280	947.7	324	948.6	344	0.8	19
Central Park Pond Outlet Structure (DS)	---	949.2	---	949.8	280	950.2	325	950.3	344	0.1	19
Central Park Pond Outlet Structure (US)	---	953.2	---	955.0	690	954.8	716	954.7	767	0.0	51
37th Avenue	28,900	956.2	---	955.1	690	954.7	716	954.7	767	0.0	51
37th Avenue (US)						954.9	497	954.9	517	0.0	21
County Road 9	30,450	959.2	---	955.3	390	954.9	453	954.9	311	0.0	-142
County Road 9(US)						958.5	404	958.2	422	-0.2	18
Vicksburg Lane (DS)	31,300	961.2	---	963.0	380	963.1	396	963.0	419	-0.1	23
Vicksburg Lane (US)	---	962.2	---	963.7	280	963.8	296	963.8	335	0.0	39
Pedestrian Crossing/ 41st Street Extension (DS)	---	---	---	966.8	200	966.0	206	965.8	213	-0.2	7
Pedestrian Crossing/ 41st Street Extension (US)	---	---	---	967.6	140	966.9	155	966.7	165	-0.2	10
Yuma Lane (DS)	---	---	---	967.9	140	967.7	155	967.3	165	-0.4	10
Yuma Lane (US)	---	---	---	970.3	110	968.4	104	968.3	117	-0.1	13
Dunkirk Lane (DS)	---	979.2	---	978.1	140	978.3	142	978.2	150	-0.1	8
Dunkirk Lane (US)	34,450	982.2	---	983.0	140	983.0	145	983.0	154	-0.1	9
Field Crossing (DS)	---	---	---	983.1	100	983.2	100	983.1	123	-0.1	23
Field Crossing (US)	---	---	---	983.1	110	983.2	101	983.1	138	-0.1	37
T.H. 55 (DS)	38,300	982.2	---	983.1	100	983.2	98	983.1	101	-0.1	2
T.H. 55 (US)	---	982.7	---	984.0	---	984.0	---	984.0	---	-0.1	---
Inundation Areas											
Xenium Lane	---	931.7	---	934.5	---	934.6	---	934.8	---	0.2	---

Location	Creek Distance, See Reach Reference (feet)	BCWMC Historic Flood Profiles[1]		Phase 2 XPSWMM Model[5]		2022 XPSWMM Model		PCSWMM Model		PCSWMM-XPSWMM Difference	
		Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate	Flood Elevation	Flow Rate
		(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)	(NAVD88 feet)	(cfs)
Central Park Pond	---	952.2	---	955.0	---	954.8	---	954.7	---	0.0	---
Turtle Lake	---	964.2	---	967.0	---	967.0	---	967.0	---	0.0	---
Rockford Road	---	968.2	---	968.5	---	968.4	---	968.3	---	0.0	---
Dunkirk Lane	---	982.2	---	983.0	---	983.0	---	983.0	---	-0.1	---
Oak Knoll Pond	---	917.3	---	918.6	---	918.7	---	918.6	---	0.0	---
Crane Lake	---	920.7	---	920.2	---	920.2	---	920.2	---	0.0	---

[1] Values as listed in table of the original BCWMC 2015 Watershed Management Plan (reflecting Hennepin County FIS – revised December 23, 2002), prior to July 2017 that included updates to Table 2-9. The 2015 values were presented in NGVD29 and have been updated to NAVD88 (NAVD88=NGVD29+0.18ft).

[2] Multiple inflows to node. The reported peak inflow reflects the sum of all inflow peaks.

[3] Barr surveyed outlet of Westwood Lake and found the outlet ditch has filled with sediment to elevation 887.6ft. The outlet pipe invert elevation (historical normal water level) is at 886.18ft

[4] As-built survey November 27,2012

[5] Turtle Lake Feasibility Study, November 10, 2011

[6] Revised results based on Phase 2 model and July 2017 update to Table 2-9

[7] Based on July 2020 model with MNDNR and Plymouth comments incorporated and submitted to MnDNR; Has not been officially approved

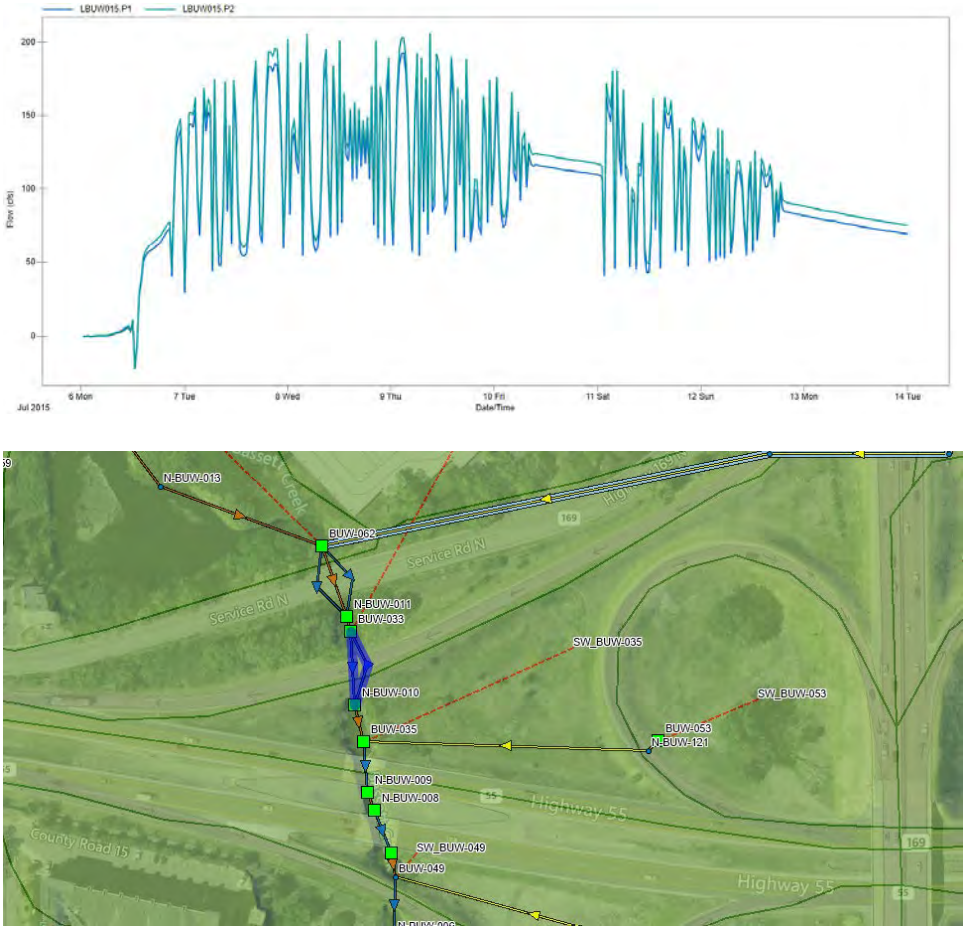
4 Result Instabilities Discussion

Those model nodes exhibiting larger differences in simulated MWSEs, as identified in Table 3-4 were investigated in further detail. That review indicated that these differences are typically associated with links experiencing highly unstable flow conditions. Investigation into the causes of these instabilities show they are often tied to locations where there is an abrupt change in conveyance geometry that creates complex hydraulic conditions and increases the potential for numerical instability during routing simulations, especially over short distances.

For example, one such location occurs at the western Highway 55 crossing downstream of Medicine Lake, where a 50-foot wide natural channel transitions into two 8-foot-high by 10-foot-wide box culverts before expanding into a wider 70-foot natural channel downstream. This abrupt change results in an unstable flow hydrograph as shown in Figure 4-1. As a result, localized differences in flow rates and water surface elevations between XP-SWMM and PCSWMM are expected at this location.

These differences are primarily attributable to the way the two modeling platforms handle rapidly varying flow conditions, transitions between open channels and culverts, and associated hydraulic losses, rather than to differences in the underlying hydraulic network representation.

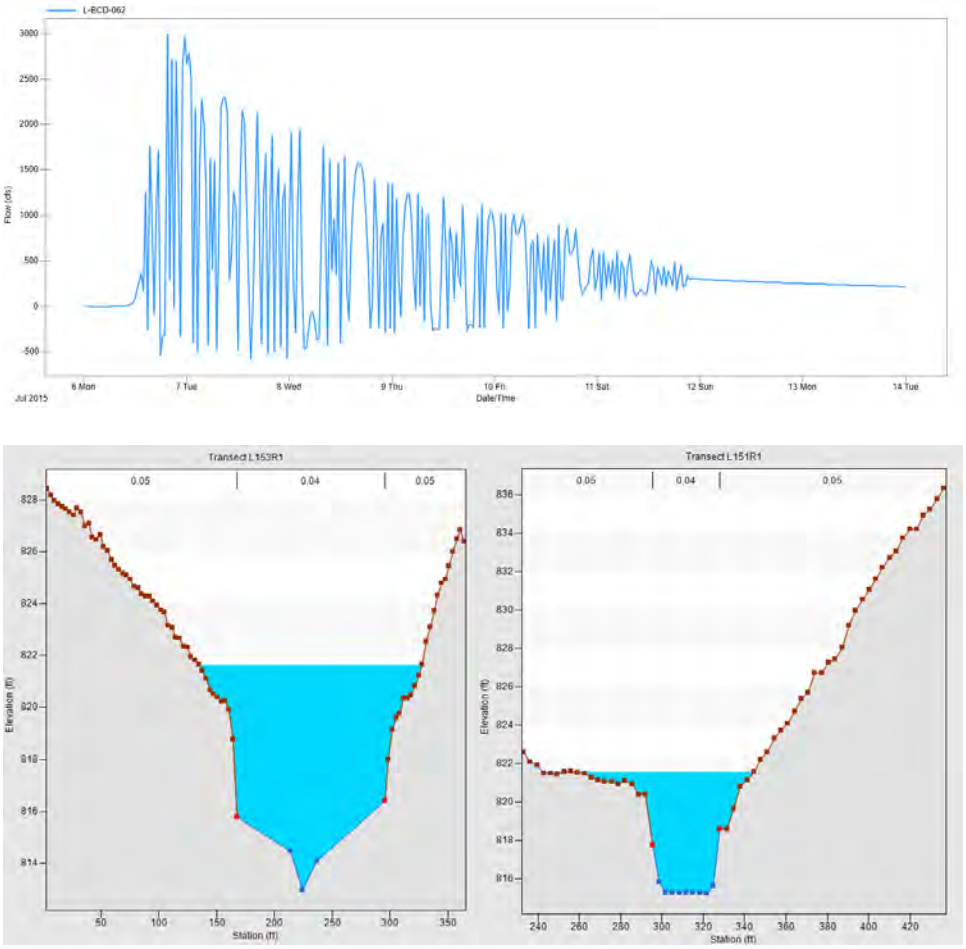
Figure 4-1 Example of an Unstable Flow Hydrograph at an Abrupt Channel to Culvert Transition



Similar flow instabilities were observed in other creek reaches where flow transitions from wider cross-sections to narrower channels, particularly in locations where channel segments are relatively short and convey high flow rates. These abrupt changes in hydraulic geometry can create rapidly varying flow conditions that are challenging for numerical routing algorithms.

Another representative example of this flow instability is observed at the Glenwood Avenue crossing along the main stem, shown in Figure 4-2. At this location, flow travels through the wider natural channel sections within Wirth Lake Park before constricting beneath the Glenwood Avenue bridge, where the channel cross-sections are significantly narrower. The combination of a sharp reduction in conveyance capacity, short transition lengths, and high flow rates contributes to localized hydraulic instabilities and increases the potential for differences between the XP-SWMM and PCSWMM simulation results.

Figure 4-2 Flow Hydrograph at a typical unstable Creek cross-section



As part of the initial conversion from XP-SWMM to PCSWMM, the choice was made to not make modifications to the model geometry and physical parameters within the models to best allow for 1:1 comparison. However, based on internal consultations with Barr staff experienced in multiple conversions of models from XP-SWMM to PCSWMM and through follow-up discussions with CHI (the

software provider of PCSWMM), several geometric conditions were identified as primary contributors to hydraulic instability in the PCSWMM model:

- **Short natural channel segments:** As part of the original conversion from the HEC-2 model, cross-sections used to represent bridge and culvert contraction, and expansion losses were carried forward into the XP-SWMM and then PCSWMM models. Unlike HEC-2, SWMM does not explicitly utilize these short transition reaches to simulate contraction and expansion effects. Numerical instability is often exacerbated when these short segments also contain adverse slopes (e.g. downstream inverts in a channel are higher than the upstream inverts).
- **Abrupt transitions from wide to narrow conveyance features:** Instability is frequently observed where flow moves from a wider conveyance element into a significantly narrower one, including natural channel cross-sections, culverts, weirs, orifices, and combinations thereof. XP-SWMM automatically reduces the computational time step when solution tolerances are exceeded, whereas PCSWMM generally maintains the assigned time step and seeks to balance the governing equations within that interval. Although the PCSWMM model was configured with a substantially smaller time step than the original XP-SWMM model, complex hydraulic transitions can still create localized instability.
- **Wider overflow weirs:** Fortunately, relatively few overflow structures in the original XP-SWMM model were represented as wide weirs. However, previous modeling experience suggests that replacing these features with appropriately defined natural channel cross-sections can improve numerical stability while providing a more realistic representation of the actual overflow flow path.
- **Steep links**: A handful of overflow links in the original XP-SWMM model were intentionally shortened to avoid double-counting storage volume. This approach can accidentally create artificially steep slopes, which may contribute to instability during hydraulic routing. These locations represent opportunities for refinement in future model updates.

Hydraulic instability tends to increase as the volume of water conveyed through the system increases. As a result, the 500-year, 24-hour storm simulation produced a hydraulic routing error of approximately 3.5%, whereas the 10-year, 24-hour storm simulation achieved a substantially lower routing error of approximately 0.5%.

These differences are primarily attributable to the way the two modeling platforms handle rapidly varying flow conditions rather than differences in the underlying hydraulic network representation. As a result, the observed instabilities and larger MWSE discrepancies are generally confined to localized areas associated with complex hydraulic transitions. They do not significantly affect regional hydraulic performance, watershed-scale flood elevations, or the overall conclusions derived from the model results.

5 Next Steps

As mentioned, this interim PCSWMM model generally produces reliable and defensible results and provides a good foundation for the upcoming model updates to be completed in subsequent tasks of this project. The next phase of work for the project will focus on updating the PCSWMM model to incorporate significant capital improvement projects and other significant changes in the watershed as implemented between 2021 and 2026. Additionally, the latest 2022 LiDAR dataset will be leveraged to generate new storage curves in areas where there were known changes in surface storage from the original 2011 LiDAR.

During the model update process, we expect to address many of the instability issues identified during the model conversion process. Planned model refinement tasks include:

- **Improving floodplain representation along the creek corridor.** Incorporation of recent project data and updated topography will increase resolution within floodplain areas that are currently represented by wide natural channel cross-sections. This will help reduce abrupt transitions between wide and narrow conveyance features and improve hydraulic stability.

- **Simplifying short channel segments at crossings.** Creek reaches with very short segments, particularly those associated with bridges and culverts, will be reviewed and consolidated where appropriate to reduce numerical instability while preserving hydraulic functionality.

- **Replacing wide-weir overflow representations with LiDAR based geometry.** Wide-weir overflow structures will be converted to natural channel cross-sections developed from the 2022 LiDAR data. Associated conduit lengths and slopes will be revised as needed to better represent actual flow paths and improve model stability.

These refinements are expected to further reduce routing errors, represent a more up to date condition of the district, and help set the model as a dependable baseline for the future tasks including recalibration of the model and evaluation of Atlas 15 events. As we move through subsequent tasks, we will continue to build on the comparisons summarized in the memo above to continue to track improvements in the model hydraulic performance.