Seattle Public Utilities

Genesee CSO Reduction Project

Genesee Area Alternatives Modeling Report – FINAL

May 2010

HDR

CH2MHILL

Genesee CSO Reduction Project

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FINAL

May 2010

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1.0 Executive Summary

The purpose of this report is to document the hydraulic modeling analysis that was performed to evaluate the individual engineering alternatives for combined sewer overflow (CSO) reduction in the Genesee Area. The report documents the modeling methodology, evaluation of alternative operating strategies, determination of the storage sizes needed, and the effectiveness of each alternative at reducing the number of CSOs.

The Base Model used in the alternatives analysis was the model calibrated in 2009 by CH2M HILL. The model was developed in InfoWorks CS version 9.5 by MWH Soft (formerly Wallingford Software) and calibrated to the flow monitoring conducted in the Genesee Area from January 2008 through January 2009. Model verification runs were completed with storms from September 2009 through March 2010.

The purpose of performing hydraulic modeling of the Genesee Area alternatives was to size CSO control alternatives (i.e., storage, conveyance, and capacity increases of pump stations and pipelines) designed to reduce the CSO frequency to an average of one event per year per outfall on a long-term average.

In order to support the alternatives screening process and conceptual engineering, Seattle Public Utilities (SPU) established boundary conditions for all proposed alternatives. The purpose of the boundary conditions is to evaluate the impact of a specific alternative at the SPU/King County system interface, which for the Genesee Area is the King County Rainier Avenue Pump Station.

The boundary conditions determined by SPU for the Genesee Area include the following conditions:

- For the King County Rainier Avenue Pump Station, do not exceed the firm capacity of 9.0 million gallons per day (MGD).
- Do not increase the frequency of overflows above the frequency predicted by the Base Model.
- The overflow rate (MGD) cannot increase beyond the capacity of the existing outfall.

In order to reduce the computer time needed to complete model simulations, 5-year simulations using rainfall data from August 2002-December 2007 were performed to predict whether the boundary conditions at King County facilities would be met and whether the proposed improvements would achieve control by reducing the predicted frequency of overflows to control levels. This analysis period was selected by examining the overflow statistics at Overflow Structure 41B in the Genesee Area for the long-term simulation.

From this process, 28 model runs were selected to test the impacts of incremental changes to the Base Model and develop overall alternatives. The Base Model was modified to reflect the proposed improvements for each alternative. Individual runs were performed to fully understand the impacts of each change to the model. Model adjustments were made to optimize facility sizing criteria and the design operating parameters. Once the analysis process was underway, some scenarios were eliminated based on results from the analysis. Of the initial 28 model runs identified, 19 were completed during the analysis of the preliminary alternatives. The results of the 19 completed model scenarios were sufficient to determine sizing and hydraulic feasibility of CSO control alternatives within the Genesee Area. The intent and the results of all model runs completed are presented in Table 1-1.

The next step of alternatives development will involve identifying which alternatives or combinations of alternatives will be further developed through preliminary engineering. Alternatives for preliminary engineering will be selected based on the results of the alternative modeling described in this report as well as non-modeling analysis, such as cost estimating, risk analysis, ease of operation, and social justice. A new phase of hydraulic modeling will take place for these selected solutions, and the goal will be to refine system design and to verify boundary conditions using 31-year simulations.

Specific analyses to be done in the next phase of alternative development include:

- The HydroBrake in Basin 40 in Run 1.0 was replaced in the model by a user-defined curve. Next refinements should include using a real-time controlled variable sluice gate.
- Reconfigure the size and control of the variable sluice gate used in the Run 3.0, Offline Storage for Basin 43.
- Refine the flow diversion structure used in Run 14.0, Combined Offline Storage for Basin 40 and Basin 41.
- Adjust the size and control of the variable sluice gate used in Run 21.0, Offline Storage in Basin 41 with Discharge to CSO Control Structure 38.

Table 1-1: Summary of Modeling Results by Model Run

Model Run	Model Run Goal	Results[a]
Run 1.0	Bring Basin 40 into control by removing and replacing the Q-H curve for the HydroBrake located in MH 059-490 with a less restrictive one.	0.82 MGD additional flow to Basin 41 (75% increase) Below benchmark[1] (6 overflows in 40)
Run 2.0	Bring Basin 43 into control by removing and replacing the Q-H curve for the HydroBrake located in MH 0060W-047 with a less restrictive one.	0.58 MGD additional flow to lake line (87% increase) Below benchmark (5 overflows in 43)
Run 3.0	Bring Basin 43 into control by modeling offline storage.	0.22 MG offline storage added Below benchmark (6 overflows in 43)
Run 4.0	Convey wet weather flows from Basin 43 to downstream runs.	Simulations completed only when Run 4.0 was coupled with other runs.
Run 5.0	Convey wet weather flows from Basin 41 and Basin 43 to downstream runs.	Simulations completed only when Run 5.0 was coupled with other runs.
Run 6.0	Bring Basin 41 into control by diverting flow from the lake line and storing it in an offline storage tank in Basin 42 to add capacity at Basin 41.	0.63 MG offline storage added Benchmark met (6 overflows in 41)
Run 7.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 38 along 43rd Avenue. Also provide enough storage to contain wet weather flows conveyed from Basin 43 (via Run 4.0 and Run 5.0).	0.70 MG offline storage added Below benchmark (6 overflows at 40, 4 overflows at 41)
Run 8.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 38 in Genesee Park. Also provide enough storage to contain wet weather flows conveyed from Basin 43 (via Run 4.0 and Run 5.0).	0.69 MG offline storage added Below benchmark (6 overflows at 40, 4 overflows at 41)
Run 9.0	Bring Basin 40 into control by modeling offline storage and removing and replacing the HydroBrake located in MH 059-490.	0.13 MG offline storage added Below benchmark (5 overflows in 40)
Run 10.1	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, and Basin 43 (via Run 4.0 and Run 5.0) to King County. Increase capacity of King County Rainier Avenue Pump Station to keep Basin 38 in control.	1.30 MGD additional flow through King County Rainier Avenue Pump Station (14% increase) Below benchmark (5 overflows in 41)

Table 1-1: Summary of Modeling Results by Alternative (Continued)

Model Run	Model Run Goal	Results[a]
Run 10.2	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, and Basin 43 (via Run 4.0 and Run 5.0) to King County. Model in-line storage in King County Hanford Street Trunk B to keep Basin 38 in control.	2.40 MG offline storage added Below benchmark (4 overflows in 41)
Run 12.0	Bring Basin 41 into control by modeling offline storage in the new parallel lake line. Also convey wet weather flows from Basin 40, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0) to the added offline storage.	2.90 MG offline storage added Below benchmark (2 overflows in 41)
Run 13.0	Bring Basin 40 into control by transferring flows to Basin 38. Bring Basin 41 into control by diverting flow from the lake line in Basin 42 to Basin 38.	0.34 MG of in-line storage added in Storage Facility 12 in Basin 38 Below benchmark s(0 overflows at 40, 4 overflows at 41)
Run 14.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 41.	0.43 MG of offline storage added Below benchmark (6 overflows at 40, 6 overflows at 41)
Run 15.0	Bring Basin 41 into control by modeling offline storage in the new parallel lake line. Also convey wet weather flows from Basin 40 and Basin 43 to the added offline storage (via Run 4.0 and Run 5.0).	0.83 MG of offline storage added Below benchmark (4 overflows in 41)
Run 16.1	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40 and Basin 41 (via Run 4.0 and Run 5.0) to King County. Increase capacity of King County Rainier Avenue Pump Station to keep Basin 38 in control.	0.8 MGD additional flow through King County Rainier Avenue Pump Station (9% increase) Below benchmark (4 overflows in 41)
Run 16.2	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40 and Basin 41 (via Run 4.0 and Run 5.0) to King County. Model in-line storage in King County Hanford Street Trunk B to keep Basin 38 in control.	1.6 MG of in-line storage added Below benchmark (4 overflows in 41)
Run 17.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 38 along 43rd Avenue. Also provide enough storage to contain flows from Basin 40, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0).	2.35 MG of offline storage added Benchmark met (7 overflows at 40, 4 overflows in 41)

Table 1-1: Summary of Modeling Results by Alternative (Continued)

Model Run	Model Run Goal	Results[a]
Run 18.1	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0) to King County. Increase capacity of King County Rainier Avenue Pump Station to keep Basin 38 in control.	3.82 MGD additional flow through King County Rainier Avenue Pump Station (43% increase) Below benchmark (4 overflows in 41)
Run 18.2	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0) to King County. Model in-line storage in King County Hanford Street Trunk B to keep Basin 38 in control.	7.00 MG of offline storage added Below benchmark (4 overflows in 41)
Run 19.0	Bring Basin 40 and Basin 41 into control by modeling an offline storage tunnel in Basin 42. Also store wet weather flows from Basin 43 (via Run 4.0) and Basin 44 from Henderson Area.	2.87 MG of offline storage added Below benchmark (0 overflows in 40, 3 overflows in 41)
Run 21.0	Bring Basin 41 into control by modeling offline storage in the new lake line in Basin 41. Transfer wet weather flows from Basin 40 and Basin 41 to Basin 38. Increase in-line storage in Basin 38.	0.22 MG of offline storage added 0.34 MG of in-line storage added Below benchmark (4 overflows in 41)

Notes:
[a] Benchmarks are discussed in Section 2.2. They refer to the allowable number of overflows at each outfall for the basin to be considered controlled.

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2.0 Introduction

The Genesee Area is a combined sewer basin located in southeast Seattle, southeast of Stan Sayres Park and north of Seward Park on Lake Washington. The 685-acre Genesee Area encompasses seven Basins: 37, 38, 40, 41, 42, 43, and 165. These basins are defined by the geographic limits of the sewer system that contributes combined sewer overflows (CSOs) to the National Pollutant Discharge Elimination System (NPDES) CSO outfalls (see Figure 2-1). Figure 2-2 is a schematic of the system showing the relative flow monitoring locations, CSO storage facilities, and outfalls.

The Genesee Area sewer system includes sanitary, storm, and combined collection systems. A portion of the Genesee Area has a fully separated sewer system, where sanitary sewage (sewage) and stormwater are conveyed using separate collection systems. Additionally there are some areas that have partially separated sewer systems, where stormwater from private property enters the sanitary sewer system while stormwater from roadways enters a separate stormwater system. The remaining area is comprised of a combined sewer system, where both sewage and stormwater are combined in the same system.

The Genesee Area sewer system includes the following key facilities:

- Pump Station 5: 3.1 MGD pump station located in Basin 38 that pumps flow from upstream Basin 40, Basin 41, Basin 42, Basin 43, and Basin 165 into the King County Hanford Street Trunk B.
- Pump Station 6: 0.95 MGD pump station located in Basin 165 that pumps flows from Basin 165 into the lake line.
- King County Rainier Avenue Pump Station: 9 MGD firm capacity pump station located downstream from Basin 37 and Basin 38 that pumps flows from all of the Genesee Area into the King County sewer system.
- Storage Facility 9: 55,000 gallon in-line storage pipe located in Basin 43 that flows into the lake line.
- Storage Facility 10: Two 17,000 gallon offline storage pipes located in Basin 42 that flow into the lake line.
- Storage Facility 11: 62,000 gallon in-line storage pipe located in Basin 40 that flows into Basin 41.
- Storage Facility 12: 384,000 gallon in-line storage pipe located in Basin 38 that flows into the King County Hanford Street Trunk B.
- Lake line: 5,000 feet of 15 to 21-inch-diameter pipe running along the Lake Washington Boulevard that collects flows from Basin 40, Basin 41, Basin 42, Basin 43, and Basin 165 and conveys them to Pump Station 5.
- King County Hanford Street Trunk B: 3,500 feet of 42-inch-diameter pipe running from Pump Station 5 to King County Rainier Avenue Pump Station. This trunk conveys flows from the entire Genesee Area to Rainier Avenue Pump Station.

Monitoring and model data for these outfalls have established that the overflow frequencies from Basin 40, Basin 41, and Basin 43 exceed one untreated discharge per year. SPU has established the Genesee Combined Sewer Overflow Reduction Project

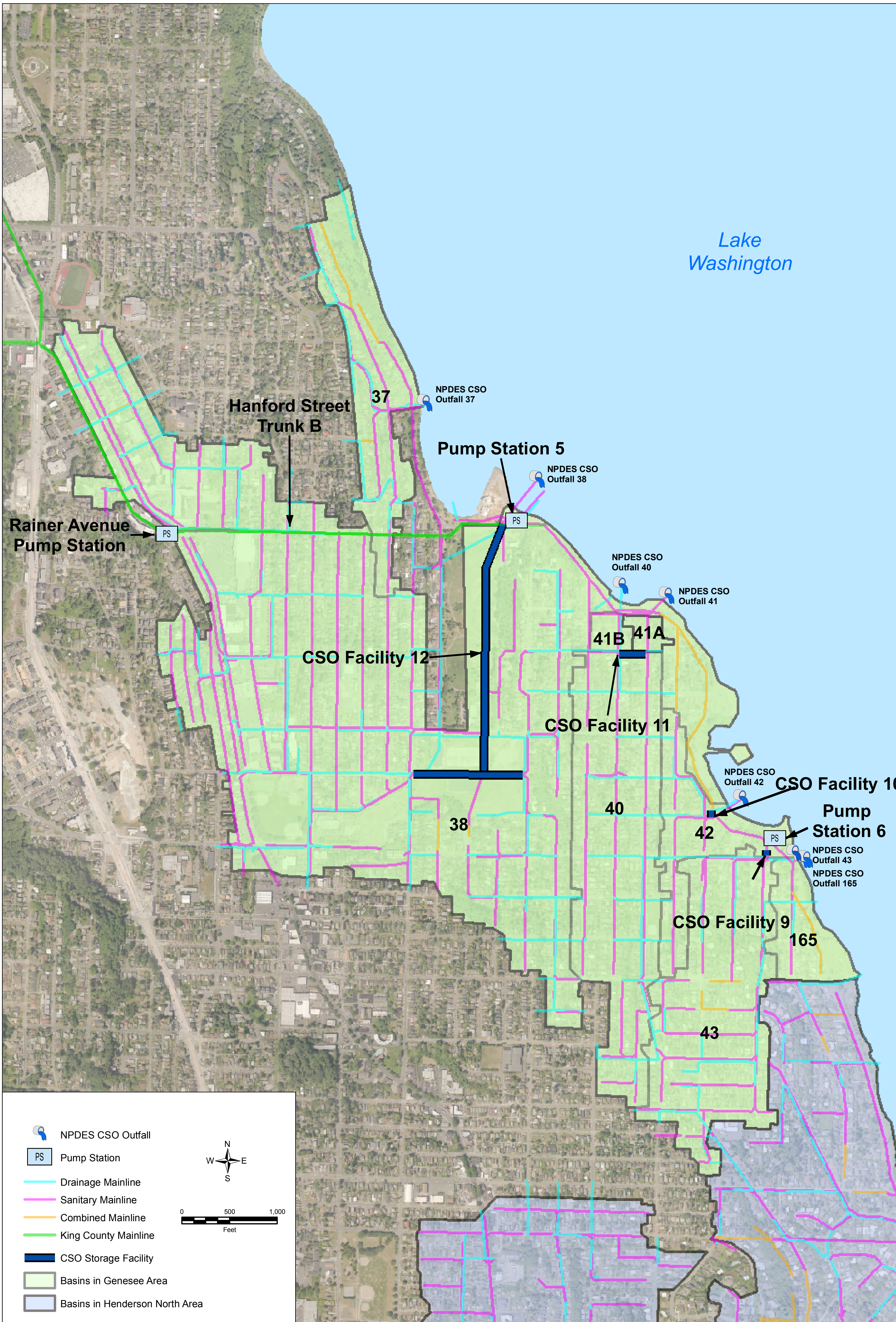
(Project) with the goal of developing and implementing CSO control improvements that will reduce the frequency of CSOs. The project goal is to reduce CSOs in the Genesee Area to a long-term average of no more than one overflow per year per outfall, per the following:

- **Revised Code of Washington (RCW)**
  - **RCW 90.48.480**: This law requires "the greatest reasonable reduction of combined sewer overflows."
- **Washington Administrative Code (WAC)**
  - **WAC 173-245-020 (22):** "The greatest reasonable reduction means control of each CSO in such a way that an average of one untreated discharge may occur per year."

The Project has identified and evaluated a number of CSO control alternatives. Hydrologic and hydraulic modeling of the Genesee combined sewer system was one of the evaluation techniques used to verify the viability of proposed improvements and to establish the sizing and design operation criteria for the proposed control facilities.

2.1 Purpose of Report

The purpose of this report is to document the modeling analysis that was performed to evaluate the individual engineering alternatives that have been developed to date. The report documents the modeling methodology, evaluation of alternative control strategies, determination of the additional storage sizes needed, and the effectiveness of each alternative at reducing CSOs. The results from this report will be used in the evaluation of alternatives for the Feasibility Analysis.



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GENESEE AREA

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FIGURE 2 - 1

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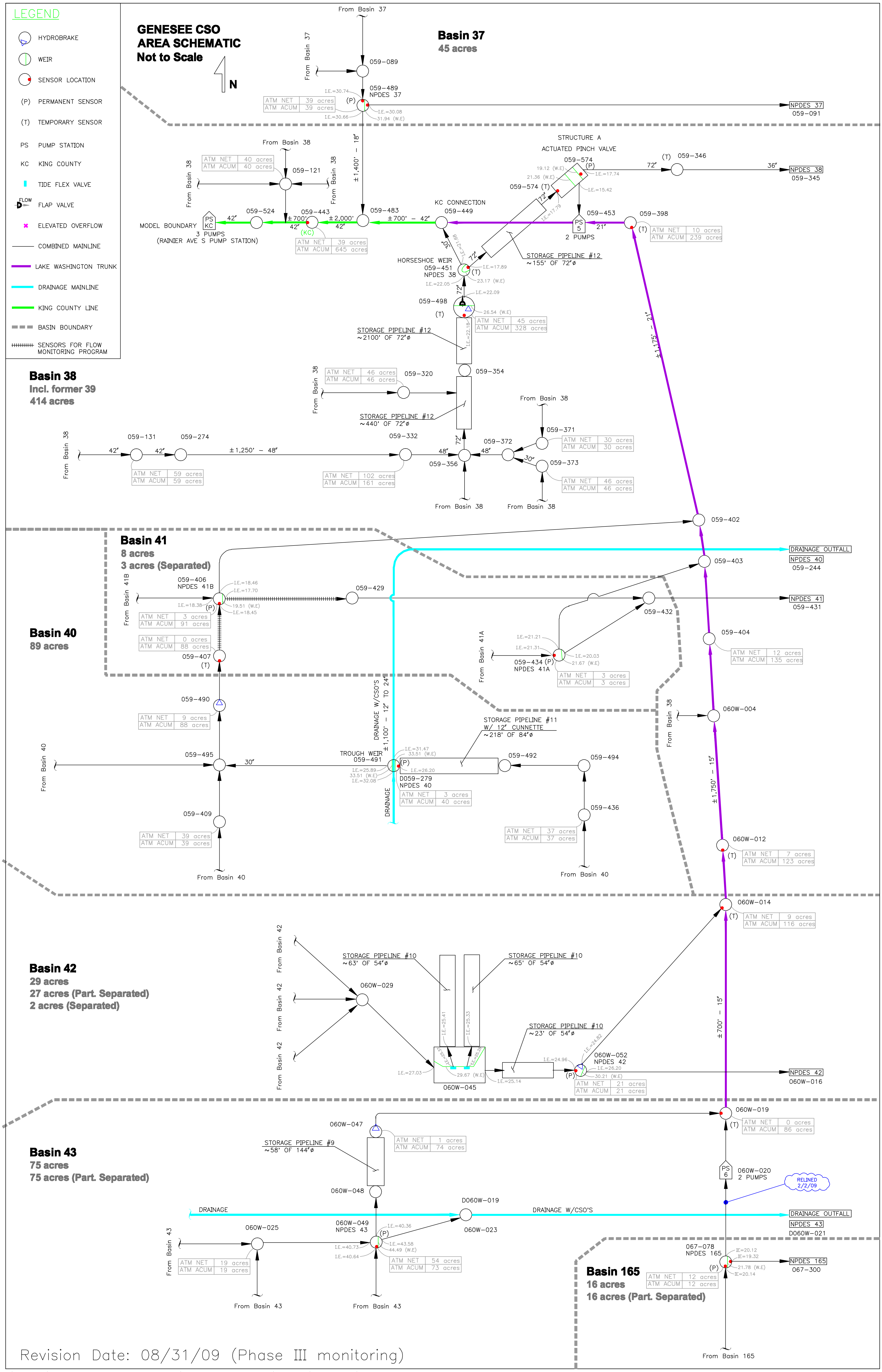

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Figure 2-2: Genesee Area Flow Schematic

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2.2 Terminology

Alternative – An alternative is a proposed modification to the system intended to bring the different CSO basins into control. These alternatives included such things as adding storage to detain excess flow until it could be handled by the system, or transferring flow from one area to other locations—either other SPU areas or King County facilities (i.e., the Rainier Avenue Pump Station or the Hanford Street Trunk B). Several different model runs were identified to evaluate the applicability of each alternative and the size facilities needed to bring the CSO basins into control.

Base Model – The Base Model represents the calibrated hydraulic model of the Genesee Area (as it existed in January 2010) used to predict the long-term frequency and CSO volumes at each of the NPDES CSO outfalls. These frequencies and volumes were established from a long-term model simulation using precipitation from January 1978 through June 2009.

Benchmark – The number of CSO events with volumes greater than the control volume at each overflow structure that occurred during the period from August 2002 through December 2007. This number was used to determine if the proposed modification brought the location under control. If the resulting total number of CSO events predicted by a model run is less than or equal to the benchmark, then that location is said to be in control.

Control volume – The control volume is defined as the volume of water that must be withheld (i.e., stored, treated, or otherwise managed) to control the basin or to reach an average of one CSO overflow per year. The control volume for each NPDES CSO outfall is predicted from the long-term model simulation of the Base Model using a 31-year continuous rainfall record from January 1978 through June 2009. The control volume at each of the outfalls is the CSO volume of the 32nd largest predicted CSO event. The basins with less than 32 predicted overflows events are assumed to be controlled.

HydroBrake - HydroBrakes are passive flow-control devices that use a vortex action to provide a near constant discharge for differential hydrostatic heads. HydroBrakes regulate the flow of combined sewage to downstream conveyance facilities and cause the excess flow to be diverted to storage or to an outfall. In the model, a HydroBrake is a link of zero length operating on a discharge-head (Q-H) relationship between two nodes. The vortex invert level determines when the control first becomes operational. The Q-H relationship was developed based on flow-monitoring data or the manufacturer's curve for each HydroBrake.

Link – A link is defined as a model element passing flow from one node to another. A link can represent a pump, gate, weir, orifice, sewer pipe, or force main.

Model run – A model run is an individual model analysis performed to evaluate the impact of a specific set of system changes and/or improvements to address a particular alternative.

Network – A model network is a collection of system elements (links, nodes, pumps, weirs, subcatchments, etc.) depicting the behavior of a sewer/drainage collection system. One network was defined for this analysis: the full basin network (Genesee Area), which consisted of Basin 37, Basin 38, Basin 40, Basin 41, Basin 42, Basin 43, and Basin 165. This model run network included the system modifications being evaluated to address a basin alternative.

Node – Nodes are model elements that represent structural elements like maintenance holes, storage, and outfalls. Nodes are points that contain information about node "X" and "Y" coordinates, ground and invert elevations, and dimensions.

Proportional integral differential (PID) controller – A PID controller represents a method of controlling a regulator to achieve a defined setpoint (e.g., level or flow target). A measurement sensor is placed at the point where the defined setpoint is to be maintained and the output from this sensor is used to control the operation of the regulator. The controller takes into account the rates of change of the measured variable and the regulator. In the model the controller is defined by three coefficients—proportional (K_p), integral (K_i) and differential (K_d)—that define how the controller behaves.

Pump – A pump is a type of link that passes flow between two nodes according to established rules that simulate the operation of a pump, ignoring the head difference between the nodes. A pump is typically defined by a flow-head (Q-H) curve or real-time control within the model. The upstream node of a pump is the storage type node representing a wet well.

Rainfall scaling factor – The rainfall scaling factor is the factor applied to the raw historical rainfall to account for model bias and changes in rainfall patterns anticipated to occur in the future. For this analysis a rainfall scaling factor of 1.088 was used. Refer to the South Genesee Combined Sewer Overflow Reduction Project: Hydrologic and Hydraulic Modeling Report for additional information regarding Rainfall scaling factor.

Real-time control (RTC) – RTC is a logical set of rules that control the operation of the hydraulic structures, such as a pump or a sluice gate, based on conditions in the system, such as depth or flow. RTC was incorporated into the alternative model to regulate the flow from CSO control structures based on operation depths in the downstream sewers.

Weir – A weir is a type of link that passes flow between two nodes according to a mathematical equation that simulates flow over a weir. The equation can be a standard (sharp-crested, broad-crested) or a user-defined weir equation.

2.3 Genesee Base Model

The Base Model used in the alternatives analysis was the model calibrated in November 2009 by CH2M HILL. The model was developed in InfoWorks CS version 9.5 and calibrated to the flow monitoring conducted in the Genesee Area from January 2008 through January 2009. Model verification runs were completed with storms from September 2009 through March 2010. Additional information on the Base Model and the calibration process is documented in the *South Genesee Combined Sewer Overflow Reduction Project: Hydrologic and Hydraulic Modeling Report* (CH2M HILL, 2010).

The existing combined sewer system defined in the model includes the drainage areas, sewer collection pipes, CSO control structures, overflow structures, pump stations, and NPDES CSO outfalls. The system features included in the model are as follows:

- Basin 37, Basin 38, Basin 40, Basin 41, Basin 42, Basin 43, and Basin 165
- NPDES CSO Outfalls 37, 38, 40, 41, 42, 43, and 165
- Genesee lake line that extends from Pump Station 6 at South Alaska Street north to Pump Station 5 at Stan Sayres Park along Lake Washington Boulevard
- SPU Pump Stations 5 and 6

- King County Rainier Avenue Pump Station
- King County Hanford Street Trunk B
- CSO Facilities 9, 10, 11, and 12 including HydroBrakes
- Overflow Structures 37, 38, 40, 41A, 41B, 43, and 165

Following the calibration of the model, base conditions including frequency of overflow events and control volumes for each of the outfalls were established by performing a 31-year (January 1978 through June 2009), long-term, continuous simulation and evaluating the predicted overflow events. For the development of the base conditions, a precipitation factor of 1.088 was applied to the 31 years of precipitation record to account for historical rainfall record uncertainty, model uncertainty, residual uncertainty, and climate change. The King County Rainier Avenue Pump Station was simulated with a capacity of 9 MGD consistent with the reported firm capacity. For each NPDES CSO outfall, the following were quantified:

- Number of CSO events – An inter-event period of 24 hours was applied consistent with the Washington Department of Ecology approach for establishing discrete CSO events.
- Control volume – The volume of water that must be withheld (i.e., stored, treated, or otherwise managed) to control the basin or to reach an average of one overflow per year.
- 31-year Volume – The cumulative volume, predicted by the model, discharged from an outfall for the 31-year rainfall time series.

The results of the Base Model simulation are provided in Table 2-1.

Table 2-1: Predicted CSO Frequency and Volume from 1978 through 2009

Overflow Structure	Total Number of CSOs	Annual CSO Frequency (events per year)	Control Volume (MG)	31-year CSO Volume (MG)
Overflow Structure 37	0	0.0	-	0.0
Overflow Structure 38	23	0.7	-	12.5
Overflow Structure 40	189	6.0	0.203	24.3
Overflow Structure 41	235	7.5	0.188	28.0
Overflow Structure 42	19	0.6	-	2.3
Overflow Structure 43	220	7.0	0.187	23.3
Overflow Structure 165[a]	35	1.1	0.006	0.6

Note: All statistics are based on following:

Control volume is based on a rainfall scaling factor of 1.088 over the entire Genesee Area.
King County Rainier Avenue Pump Station is limited to the reported firm capacity of 9.0 MGD.
The range of accuracy of the model was assumed to be 5,000 gallons.

[a] Overflow Structure 165 is believed to be controlled based on 2009 system improvements.

3.0 Genesee Area Alternatives Modeling

The purpose of performing hydraulic modeling of the Genesee Area alternatives was to size the proposed Genesee Area CSO control alternatives (i.e., storage, conveyance, capacities of pump stations and pipelines) to reduce CSO frequency to an average of one event per year per outfall. The Base Model, as shown in Figure 3-1, was the basis on which all alternatives were built, including the removal of the blockage (identified during model development) in the lake line downstream from CSO Control Structure 42. The alternatives had to meet the boundary conditions established by SPU as described in the section below. Also, the modeling approach included methods to reduce the time needed to perform individual model runs and a systematic approach to develop and analyze the alternatives.

3.1 Boundary Conditions

In order to support the alternatives screening process and conceptual engineering, SPU established boundary conditions for all proposed alternatives. The purpose of the boundary conditions is to evaluate the impact of a specific alternative at the SPU/King County system interface, which for Genesee is the King County Rainier Avenue Pump Station.

The boundary conditions determined by SPU for the Genesee Area include the following conditions:

- For the King County Rainier Avenue Pump Station, do not exceed the firm capacity of 9.0 MGD. For each alternative, the flow into the Rainier Avenue Pump Station was compared to the Base Model during the control volume event for Basin 41 (the December 14, 2006, event).
- Do not increase the frequency of overflows above the frequency predicted by the Base Model.
- The overflow rate (MGD) cannot increase beyond the capacity of the existing outfall.

3.2 Modeling Approach

This section describes the approach used to set up the various alternatives to be evaluated.

Five-year Simulations – In order to reduce the computer time needed to complete model simulations, 5-year simulations using rainfall data from August 2002-December 2007 were performed to predict if the boundary conditions at King County facilities would be met and if the proposed improvements would achieve control by reducing the predicted frequency of overflows to control levels. This analysis period was selected by examining the overflow statistics at Overflow Structure 41B in the Genesee Area for the long-term simulation.

At Overflow Structure 41B, the 5-year period from August 2002 – December 2007 contains 44 predicted CSO events. Six of the 42 events rank in the top 32 largest events by volume for the long-term rainfall record, as shown in Figure 3-2.

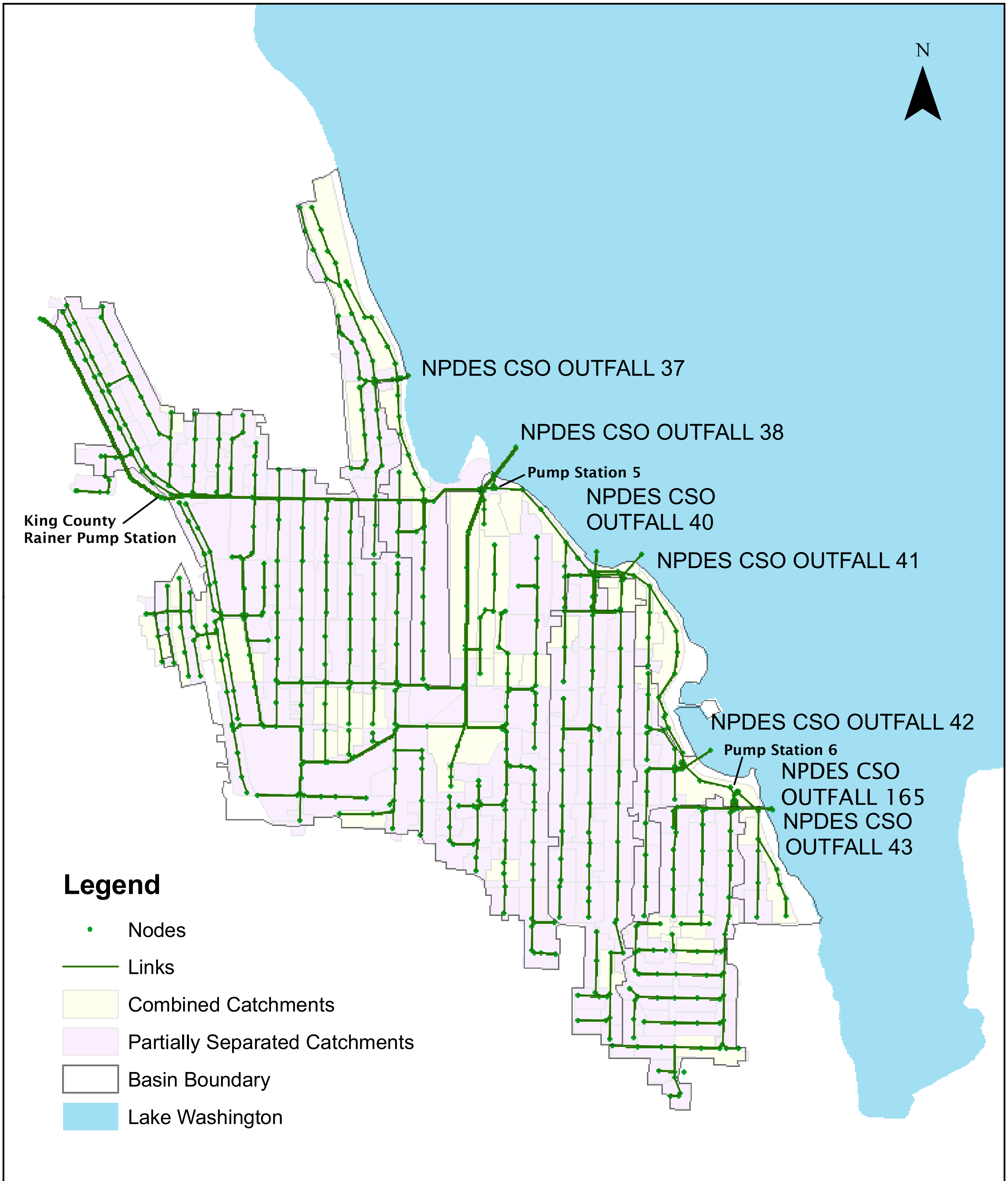

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FIGURE 3 - 1

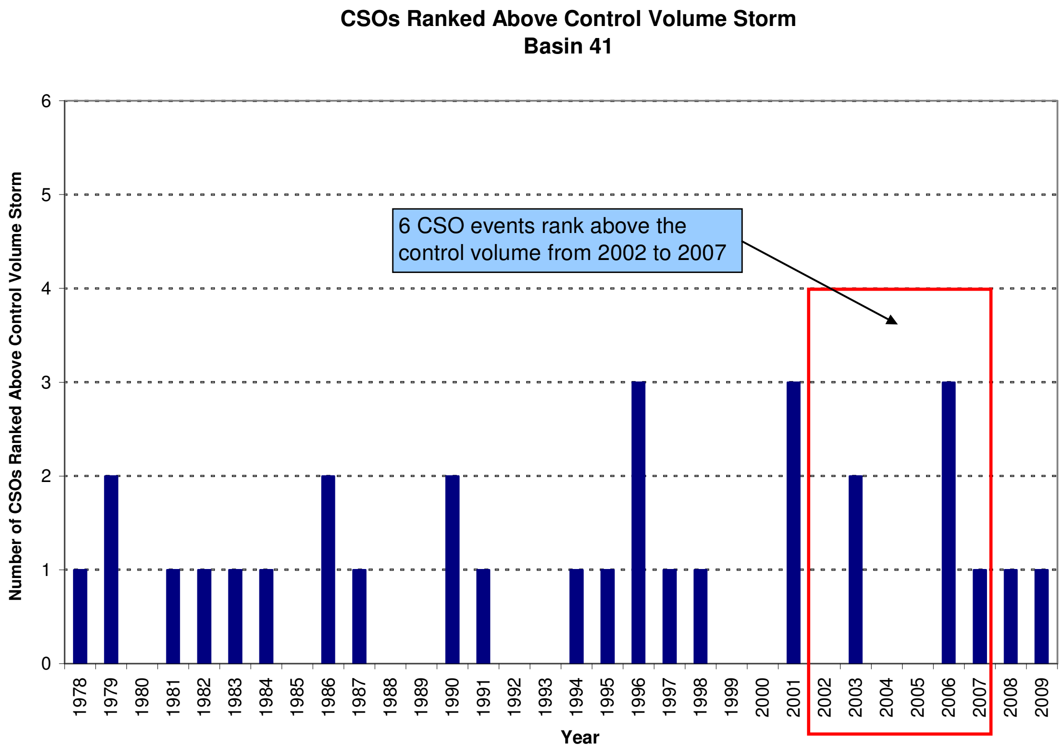


Figure 3-2: CSO Frequency for Overflow Structure 41B

Table 3-1 lists the predicted number of CSOs, CSO frequency, and CSO volume for the alternatives modeling duration from August 2002 through December 2007. The CSO frequency is slightly greater than the CSO frequency predicted by the 31-year long-term simulation at each of the overflow structures; however, this period provides a representative variation in storms and overflow events to be used in sizing CSO control structures in alternatives.

The statistics shown in Table 3-1 provided a benchmark for comparison of the results for each model run. For each model run, the number of CSO events was compared to the number of events greater than the control volume event, as shown in Table 3-1. If the number of CSO events for a model run at a particular overflow structure was less than or equal to the benchmark shown in Table 3-1, then that alternative is said to provide CSO control.

Figure 3-3 summarizes the alternatives modeling process.

Table 3-1: Predicted CSO Frequency and Volume from 2002 to 2007

Overflow Structure	Total Number of CSOs	Annual CSO Frequency (events per year)	CSO Volume (MG)	Number of Events ≥ Control Volume Event (Benchmark events per year)
Overflow Structure 37	0	0.0	0.00	0
Overflow Structure 38	5	1.0	5.40	5
Overflow Structure 40	34	6.8	6.28	7
Overflow Structure 41	42	8.4	6.80	6
Overflow Structure 42	4	0.8	0.94	4
Overflow Structure 43	36	7.2	5.23	7
Overflow Structure 165[a]	8	1.6	0.08	6

Note: All statistics are based on the following:

Control volume is based on a rainfall scaling factor of 1.088 over the entire Genesee Area.
King County Rainier Avenue Pump Station is limited to the reported firm capacity of 9.0 MGD.
The range of accuracy of the model was assumed to be 5,000 gallons.

[a] Overflow Structure 165 is believed to be controlled based on 2009 system improvements.

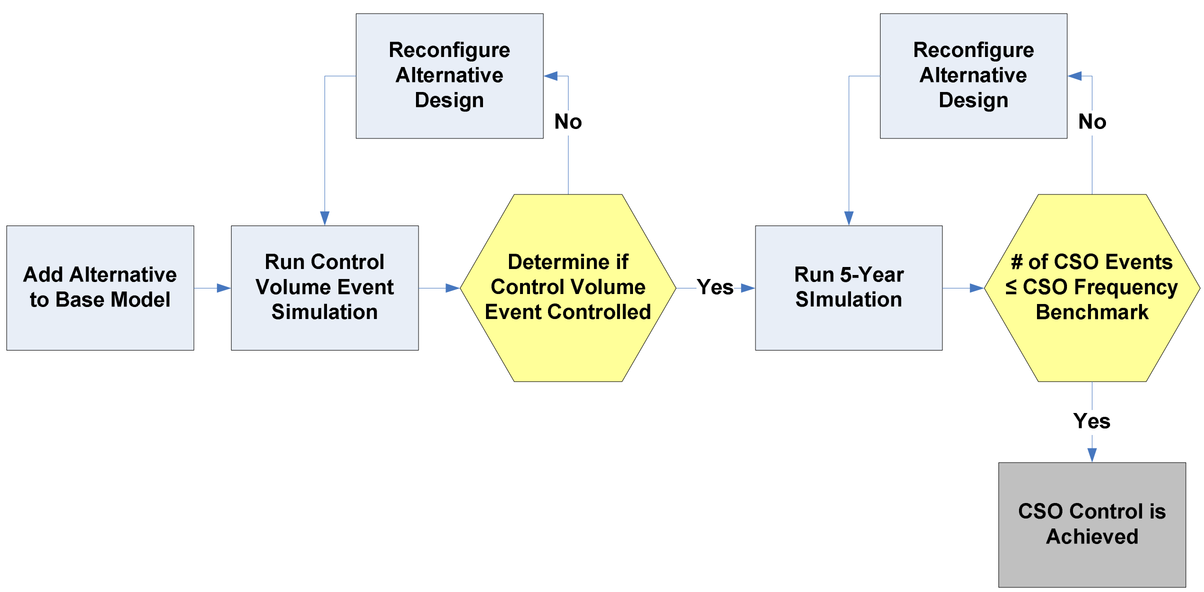


Figure 3-3: Alternatives Modeling Process Flowchart

Development of Alternatives – Alternatives for the Genesee Area were developed based on the following information:

- Understanding of the Genesee Area combined sewer system based on the Genesee Area Flow Monitoring Study from January 2008 – May 2009
- Historical CSO frequency of basins from 1998 – 2009
- CSO volumes observed during the Genesee Area Flow Monitoring Study from January 2008 – May 2009
    - Specifically, two rainfall events were assumed to produce roughly one-year CSO return frequencies: November 6, 2008, and January 7, 2009. Basins that did not have a CSO during these two events were assumed to be in control while developing alternatives.
- Understanding of the King County facilities located nearby, including the Rainier Avenue Pump Station and the Hanford B Trunk Sewer
- Results of the Base Model, which provided peak flow rates within the combined sewer system, peak flow rates over overflow structure weirs, and CSO volumes at NPDES outfalls

From this information, 28 model runs were identified to test the impacts of incremental changes to the Base Model and to develop overall alternatives. The Base Model was modified to reflect the proposed improvements for each run. Individual runs were performed so as to fully understand the impacts of each change to the model. Model adjustments were made to optimize facility sizing criteria and the design operating parameters. Schematics were developed to assist in conveying the concept of the proposed alternative. These schematics can be found in Appendix A.

Once the analysis process was underway, some model runs were eliminated because they were deemed to be unfeasible. Of the initial 28 model runs identified, 19 were completed during the analysis of the preliminary alternatives.

The results of the 19 model runs were sufficient for determining the sizing and hydraulic feasibility of the alternatives within the Genesee Area. Additional modeling will be performed to validate the results of the evaluation of preliminary alternatives using the 31-year rainfall record.

3.3 Modeling of Alternatives

Each of the CSO control alternatives was developed and then one or more model runs were performed to establish the control sizing (i.e., storage volume, conveyance diameter, and slope) for each of the alternatives. The following subsections are organized by the alternative description and further delineated into the model runs that comprised a given alternative. Table 3-2 displaces the names of the alternatives and the individual modeling runs they were incorporated into. Table 3-3 provides a "map" to where the different runs are discussed under each alternative. For example, Section 3.3.5, Offline Storage in Basin 38 along 43rd Avenue, contains the discussion on the runs performed that are related to sizing offline storage in Basin 38 (Runs 1.0, 2.0, 4.0, 5.0, and 7.0).

The intent and the results of all model runs completed are presented in Table 3-2. Detailed model run configurations and discussion are provided in subsections.

Table 3-2: Alternatives Names and Model Run ID

Alternative Name	Model Run #	Model Run Results
OFF-109-43	Run 3.0	Run 3.0: Offline Storage in Basin 43; Storage = 0.22 MG
RET-108-43	Run 2.0	Run 2.0: HydroBrake Replacement at MH 060W-047 (controls Basin 43)
CON-104-42	Run 4.0	Run 4.0: Wet Weather Conveyance from Basin 43
CON-104-42a	Run 12.0	Run 12.0: Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44 Diverted Flow
CON-104-42b	Run 17.0 Run 18.1 Run 18.2	Run 17.0: Offline Storage in Basin 38 including Henderson Basin 44 Run 18.1: Transfer to King County and Increase in King County Rainier Avenue Pump Station Capacity Run 18.2: Transfer to King County and In-Line Storage in Hanford Street Trunk B
CON-104-42c	Run 19.0	Run 19.0: Inter-Basin Transfer: Basin 41 to Basin 38, Offline Storage Tunnel
OFF-106-42	Run 6.0	Run 6.0: Offline Storage in Basin 42; Storage = 0.63 MG
CON-103-41	Run 5.0	Run 5.0: Wet Weather Conveyance from Basin 41
CON-103-41a	Run 15.0	Run 15.0: Offline Storage in Washington Boulevard; Storage = 0.83 MG
CON-103-41b	Run 12.0	Run 12.0: Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44 Diverted Flow
CON-103-41c	Run 7.0 Run 8.0 Run 10.1 Run 10.2	Run 7.0: Offline Storage in Basin 38 along 43rd Avenue Run 8.0: Offline Storage in Basin 38 in Genesee Park Run 10.1: Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity Run 10.2: Transfer to King County and In-Line Storage in King County Hanford Street Trunk B
CON-103-41d	Run 17.0 Run 18.1 Run 18.2	Run 17.0: Offline Storage in Basin 38 including Henderson Basin 44 Run 18.1: Transfer to King County and Increase in King County Rainier Avenue Pump Station Capacity Run 18.2: Transfer to King County and In-Line Storage in Hanford Street Trunk B
CON-103-41e	Run 21.0	Run 21.0: Offline Storage in Basin 41 with Pumped Conveyance to Storage Facility 12; Storage = 0.22 MG
IBT-100-41B to 38	Run 13.0	Run 13.0: Inter-basin transfer Basin 41 to Basin 38
IBT-101-41B to 38	Run 19.0	Run 19.0: Inter-Basin Transfer: Basin 41 to Basin 38, Offline Storage Tunnel
OFF-104-40	Run 9.0	Run 9.0: Offline Storage in Basin 40 and HydroBrake Replacement in MH 059-490 (Controls Basin 40)
RET-106-40	Run 1.0	Run 1.0: HydroBrake Replacement at MH 059-490 (controls Basin 40)
IN-101-38	Run 8.0	Run 8.0: Offline Storage in Basin 38 in Genesee Park; Storage = 0.69 MG

Alternative Name	Model Run #	Model Run Results
OFF-102-38	Run 7.0	Run 7.0: Offline Storage in Basin 38 along 43rd Avenue; Storage = 0.70 MG
OFF-102-38a	Run 17.0	Run 17.0: Offline Storage in Basin 38 including Henderson Basin 44; Storage = 2.35 MG
OFF-113-38	Run 14.0	Run 14.0: Combined Offline Storage for Basin 40 and 41; Storage = 0.43 MG
TKC-101-38	Run 10.1 Run 10.2 Run 18.1 Run 18.2	Run 10.1: Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity; 14% increase in flows to King County Run 10.2: Transfer to King County and In-Line Storage in King County Hanford Street Trunk B; Storage = 2.30 MG Run 18.1: Transfer to King County and Increase in King County Rainier Avenue Pump Station Capacity; 43% increase in flow at Pump Station Run 18.2: Transfer to King County and In-Line Storage in Hanford Street Trunk B; Storage = 7.00 MG
TKC-102-38	Run 18.1	Run 18.1: Transfer to King County and Increase in King County Rainier Avenue Pump Station Capacity; 43% increase in flow at Pump Station
TKC-103-38	Run 13.0 Run 21.0	Run 13.0: Inter-basin transfer Basin 41 to Basin 38; Storage = 0.34 MG Run 21.0: Offline Storage in Basin 41 with Pumped Conveyance to Storage Facility 12; Storage = 0.34 MG
TKC-104-38	Run 10.1 Run 10.2 Run 18.1 Run 18.2	Run 10.1: Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity Run 10.2: Transfer to King County and In-Line Storage in King County Hanford Street Trunk B; Run 18.1: Transfer to King County and Increase in King County Rainier Avenue Pump Station Capacity Run 18.2: Transfer to King County and In-Line Storage in Hanford Street Trunk B

Table 3-3: Modeling of Alternatives Subsections

Report Section	Alternative Description	Runs Included	Basins Controlled
3.3.1	Increased Conveyance in Basin 40	1.0	40
3.3.2	Increased Conveyance in Basin 43	2.0	43
3.3.3	Offline Storage in Basin 43	3.0	43
3.3.4	Offline Storage in Basin 40, Basin 42, and Basin 43	3.0, 6.0, 9.0	40, 41, 43
3.3.5	Offline Storage in Basin 38 along 43rd Avenue	1.0, 2.0, 4.0, 5.0, 7.0	40, 41, 43

Report Section	Alternative Description	Runs Included	Basins Controlled
3.3.6	Offline Storage in Basin 38 in Genesee Park	1.0, 2.0, 4.0, 5.0, 8.0	40, 41, 43
3.3.7	Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity	1.0, 2.0, 4.0, 5.0, 10.1	40, 41, 43
3.3.8	Transfer to King County and In-line Storage in King County Hanford Street Trunk B	1.0, 2.0, 4.0, 5.0, 10.2	40, 41, 43
3.3.9	Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44	1.0, 2.0, 4.0, 5.0, 12.0	40, 41, 43, 44
3.3.10	Inter-basin Transfer of Basin 41 to Basin 38	3.0, 13.0	40, 41, 43
3.3.11	Offline Storage for Basin 43 and Combined Offline Storage for Basin 40 and Basin 41	3.0, 14.0	40, 41, 43
3.3.12	Offline Storage in Lake Washington Boulevard	1.0, 2.0, 4.0, 5.0, 15.0	40, 41, 43
3.3.13	Transfer to King County, Offline Storage in Basin 43, and Increase in King County Rainier Avenue Pump Station Capacity	1.0, 3.0, 5.0, 16.1	40, 41, 43
3.3.14	Transfer to King County, Offline Storage in Basin 43, and In-line Storage in King County Hanford Street Trunk B	1.0, 3.0, 5.0, 16.2	40, 41, 43
3.3.15	Offline Storage in Basin 38 including Henderson Basin 44	1.0, 2.0, 4.0, 5.0, 17.0	40, 41, 43, 44
3.3.16	Transfer Basin 40, Basin 41, Basin 43, and Basin 44 to King County and Increase in King County Rainier Avenue Pump Station Capacity	1.0, 2.0, 4.0, 5.0, 18.1	40, 41, 43, 44
3.3.17	Transfer Basin 40, Basin 41, Basin 43, and Basin 44 to King County and In-line Storage in King County Hanford Street Trunk B	1.0, 2.0, 4.0, 5.0, 18.2	40, 41, 43, 44
3.3.18	Inter-basin Transfer: Basin 41 to Basin 38, Offline Storage in Tunnel	2.0, 4.0, 19.0	40, 41, 43, 44
3.3.19	Offline Storage in Basin 41 with Pumped Conveyance to Storage Facility 12	1.0, 3.0, 5.0, 21.0	40, 41, 43

In order to evaluate the increased peak flow rate at the King County facilities, the December 26, 2006, storm was used. This storm was ranked as the 45th largest storm event in Basin 40 in the Base Model 31-year simulation. This storm represented the highest ranked storm that occurred during the 5-year evaluation period from 2002 to 2007 that was ranked below the control storm event. By using this storm as a comparison to the Base Model results, it was possible to see the downstream impact of bringing basins into control.

Section 3.3 discusses the modeling approach to each of the Genesee Area alternatives. The organization of each alternative is as follows:

- Section 3.3.X: Alternative overview (purpose, basins controlled, current status, and runs included in alternative)
- Section 3.3.X.X: Model run details (purpose, changes to Base Model configuration, results, other findings)

On several occasions the same model run was used in multiple alternatives. In these cases, the details of the model run are discussed in the first alternative that the model run is used in and referenced thereafter.

Plan view figures are frequently used to visually explain the modifications made to the Base Model. Figure 3-4 provides a key for using these plan views.

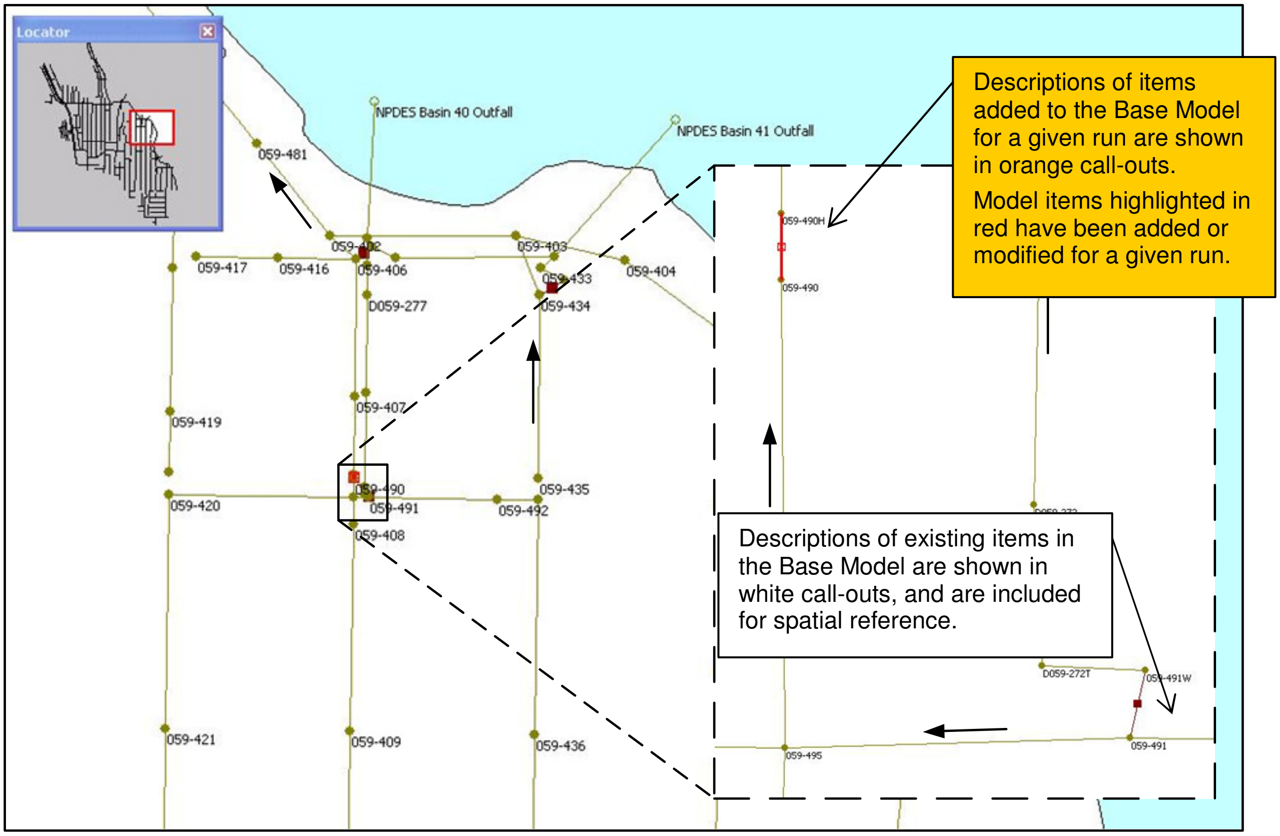


Figure 3-4: Plan View Key

Table 3-4 provides a high-level summary of the results of each model run. Table 3-5 provides a high-level summary of the results of each alternative. Individual descriptions of the area alternatives and model runs are presented in subsections 3.3.1 through 3.3.19.

Table 3-4: Summary of Modeling Results by Run

Model Run	Model Run Goal	Results[a]
Run 1.0	Bring Basin 40 into control by removing and replacing the Q-H curve for the HydroBrake located in MH 059-490 with a less restrictive one.	0.82 MGD additional flow to Basin 41 (75% increase) Below benchmark (6 overflows in 40)
Run 2.0	Bring Basin 43 into control by removing and replacing the Q-H curve for the HydroBrake located in MH 0060W-047 with a less restrictive one.	0.58 MGD additional flow to lake line (87% increase) Below benchmark (5 overflows in 43)
Run 3.0	Bring Basin 43 into control by modeling offline storage.	0.22 MG offline storage added Below benchmark (6 overflows in 43)
Run 4.0	Convey wet weather flows from Basin 43 to downstream runs.	Simulations completed only when Run 4.0 was coupled with other runs.
Run 5.0	Convey wet weather flows from Basin 41 and Basin 43 to downstream runs.	Simulations completed only when Run 5.0 was coupled with other runs.
Run 6.0	Bring Basin 41 into control by diverting flow from the lake line and storing it in an offline storage tank in Basin 42 to add capacity at Basin 41.	0.63 MG offline storage added Benchmark met (6 overflows in 41)
Run 7.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 38 along 43rd Avenue. Also provide enough storage to contain wet weather flows conveyed from Basin 43 (via Run 4.0 and Run 5.0).	0.70 MG offline storage added Below benchmark (6 overflows at 40, 4 overflows at 41)
Run 8.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 38 in Genesee Park. Also provide enough storage to contain wet weather flows conveyed from Basin 43 (via Run 4.0 and Run 5.0).	0.69 MG offline storage added Below benchmark (6 overflows at 40, 4 overflows at 41)
Run 9.0	Bring Basin 40 into control by modeling offline storage and removing and replacing the HydroBrake located in MH 059-490.	0.13 MG offline storage added Below benchmark (5 overflows in 40)
Run 10.1	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, and Basin 43 (via Run 4.0 and Run 5.0) to King County. Increase capacity of King County Rainier Avenue Pump Station to keep Basin 38 in control.	1.30 MGD additional flow through King County Rainier Avenue Pump Station (14% increase) Below benchmark (5 overflows in 41)

Table 3-4: Summary of Modeling Results by Run (Continued)

Model Run	Model Run Goal	Results
Run 10.2	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, and Basin 43 (via Run 4.0 and Run 5.0) to King County. Model in-line storage in King County Hanford Street Trunk B to keep Basin 38 in control.	2.40 MG offline storage added Below benchmark (4 overflows in 41)
Run 12.0	Bring Basin 41 into control by modeling offline storage in the new parallel lake line. Also convey wet weather flows from Basin 40, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0) to the added offline storage.	2.90 MG offline storage added Below benchmark (2 overflows in 41)
Run 13.0	Bring Basin 40 into control by transferring flows to Basin 38. Bring Basin 41 into control by diverting flow from the lake line in Basin 42 to Basin 38.	0.34 MG of in-line storage added in Storage Facility 12 in Basin 38 Below benchmarks (0 overflows at 40, 4 overflows at 41)
Run 14.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 41.	0.43 MG of offline storage added Below benchmarks (5 overflows at 40, 6 overflows at 41
Run 15.0	Bring Basin 41 into control by modeling offline storage in the new parallel lake line. Also convey wet weather flows from Basin 40 and Basin 43 to the added offline storage (via Run 4.0 and Run 5.0).	0.83 MG of offline storage added Below benchmark (4 overflows in 41)
Run 16.1	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40 and Basin 41 (via Run 4.0 and Run 5.0) to King County. Increase capacity of King County Rainier Avenue Pump Station to keep Basin 38 in control.	0.8 MGD additional flow through King County Rainier Avenue Pump Station (9% increase) Below benchmark (4 overflows in 41)
Run 16.2	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40 and Basin 41 (via Run 4.0 and Run 5.0) to King County. Model in-line storage in King County Hanford Street Trunk B to keep Basin 38 in control.	1.6 MG of in-line storage added Below benchmark (4 overflows in 41)
Run 17.0	Bring Basin 40 and Basin 41 into control by modeling offline storage in Basin 38 along 43rd Avenue. Also provide enough storage to contain flows from Basin 40, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0).	2.35 MG of offline storage added Benchmark met (7 overflows at 40, 4 overflows in 41)

Table 3-4: Summary of Modeling Results by Run (Continued)

Model Run	Model Run Goal	Results
Run 18.1	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0) to King County. Increase capacity of King County Rainier Avenue Pump Station to keep Basin 38 in control.	3.82 MGD additional flow through King County Rainier Avenue Pump Station (43% increase) Below benchmark (4 overflows in 41)
Run 18.2	Bring Basin 41 into control by conveying wet weather flows collected from Basin 40, Basin 41, Basin 43, and Basin 44 (via Run 4.0 and Run 5.0) to King County. Model in-line storage in King County Hanford Street Trunk B to keep Basin 38 in control.	7.00 MG of offline storage added Below benchmark (4 overflows in 41)
Run 19.0	Bring Basin 40 and Basin 41 into control by modeling an offline storage tunnel in Basin 42. Also store wet weather flows from Basin 43 (via Run 4.0) and Basin 44 from Henderson Area.	2.87 MG of offline storage added Below benchmark (0 overflows in 40, 3 overflows in 41)
Run 21.0	Bring Basin 41 into control by modeling offline storage in the new lake line in Basin 41. Transfer wet weather flows from Basin 40 and Basin 41 to Basin 38. Increase in-line storage in Basin 38.	0.22 MG of offline storage added 0.34 MG of in-line storage added Below benchmark (4 overflows in 41)

[a] Benchmarks are discussed in Section 2.2. They refer to the allowable number of overflows at each outfall for the basin to be considered controlled.

Table 3-5: Summary of Modeling Results by Alternative

Alternative Name (Runs Included)	Basins Controlled	Results	
		Added Storage Volume (MG)	Change in Peak Flow to Downstream
Increased Conveyance in Basin 40 (1.0)	40	-	0.82 MGD additional flow to Basin 41 (75% increase)
Increased Conveyance in Basin 43 (2.0)	43	-	0.58 MGD additional flow to lake line (87% increase)
Offline Storage in Basin 43 (3.0)	43	0.22	-
Offline Storage in Basin 40, Basin 42, and Basin 43 (3.0, 6.0, 9.0)	40, 41, 43	0.85	-
Offline Storage in Basin 38 along 43rd Avenue (1.0, 2.0, 4.0, 5.0, 7.0)	40, 41, 43	0.70	-
Offline Storage in Basin 38 in Genesee Park (1.0, 2.0, 4.0, 5.0, 8.0)	40, 41, 43	0.69	-
Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity (1.0, 2.0, 4.0, 5.0, 10.1)	40, 41, 43	-	1.30 MGD additional flow through King County Rainier Avenue Pump Station (20% increase)
Transfer to King County and In-line Storage in King County Hanford Street Trunk B (1.0, 2.0, 4.0, 5.0, 10.2)	40, 41, 43	2.30	-
Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44 (1.0, 2.0, 4.0, 5.0, 12.0)	40, 41, 43, 44	2.90	-
Inter-basin Transfer of Basin 41 to Basin 38 (3.0, 13.0)	40, 41, 43	0.52	-
Offline Storage for Basin 43 and Combined Offline Storage for Basin 40 and Basin 41 (3.0, 14.0)	40, 41, 43	0.65	-
Offline Storage in Lake Washington Boulevard (1.0, 2.0, 4.0, 5.0, 15.0)	40, 41, 43	0.83	-

Table 3-5: Summary of Modeling Results by Alternative (Continued)

Alternative Name (Runs Included)	Basins Controlled	Results	
		Added Storage Volume (MG)	Change in Peak Flow to Downstream
Transfer to King County, Offline Storage in Basin 43, and Increase in King County Rainier Avenue Pump Station Capacity (1.0, 3.0, 5.0, 16.1)	40, 41, 43	-	0.8 MGD additional flow through King County Rainier Avenue Pump Station (9% increase)
Transfer to King County, Offline Storage in Basin 43, and In-line Storage in King County Hanford Street Trunk B (1.0, 3.0, 5.0, 16.2)	40, 41, 43	1.82	-
Offline Storage in Basin 38 including Henderson Basin 44 (1.0, 2.0, 4.0, 5.0, 17.0)	40, 41, 43, 44	2.35	
Transfer Basin 40, Basin 41, Basin 43, and Basin 44 to King County and Increase in King County Rainier Avenue Pump Station Capacity (1.0, 2.0, 4.0, 5.0, 18.1)	40, 41, 43, 44	-	3.82 MGD additional flow through King County Rainier Avenue Pump Station (43% increase)
Transfer Basin 40, Basin 41, Basin 43, and Basin 44 to King County and In-line Storage in King County Hanford Street Trunk B (1.0, 2.0, 4.0, 5.0, 18.2)	40, 41, 43, 44	7.00	-
Inter-basin Transfer: Basin 41 to Basin 38, Offline Storage in Tunnel (2.0, 4.0, 19.0)	40, 41, 43, 44	2.87	-
Offline Storage in Basin 41 with Pumped Conveyance to Storage Facility 12 (1.0, 3.0, 5.0, 21.0)	40, 41, 43	0.44	-

3.3.1 Increased Conveyance in Basin 40

The purpose of this alternative is to bring Basin 40 into control by increasing the capacity of the conveyance system in Basin 40. Currently, flows from Basin 40 go through Storage Facility 11, which has a capacity of 58,000 gallons and is controlled by a HydroBrake located in MH 059-490. The HydroBrake limits the discharge from Basin 40 to approximately 1.1 MGD. Flows exceeding the HydroBrake capacity are stored in Storage Facility 11; once the storage capacity has been exceeded, flow overtops the weir located in Overflow Structure 40. During the Genesee Basin Flow Monitoring Study (January 2008 – May 2009), the HydroBrake was observed to restrict flow when the downstream system had available capacity. In order to reduce CSO frequency at NPDES CSO Outfall 40, the conveyance from Storage Facility 11 to Basin 41 was increased using model Run 1.0: HydroBrake Replacement at MH 059-490.

3.3.1.1 Run 1.0: HydroBrake Replacement at MH 059-490

The purpose of Run 1.0 is to identify a control strategy that conveys more flow to the downstream system and uses available downstream capacity prior to storing flows in Storage Facility 11.

As seen in Figure 3-5, to accomplish this control strategy, the existing Q-H curve for the HydroBrake located in MH 059-490 was replaced with a less restrictive Q-H curve that allows 1.92 MGD of flow through the basin. This flow brought Basin 40 into control and was arrived at by completing several control storm simulations modeling various Q-H curves with flows ranging from 1.5 to 2.1 MGD. Table 3-6 compares the resulting CSO volume at NPDES CSO Outfall 40 with the various Q-H curves modeled. The final Q-H curve is highlighted in blue.

Figure 3-6 shows the Q-H curves of the Base Model HydroBrake and the final Q-H curve needed to bring Basin 40 into control.

Table 3-6: Comparison of Basin 40 Q-H Curve Peak Flow to Basin 40 CSO Volume

Peak Flow in Q-H Curve (MGD)	CSO Volume at NPDES CSO Outfall 40 (MG)
1.1 [a]	0.20
1.5	0.05
1.8	0.01
1.92	0.00
2.1	0.00
[a] From existing Basin 40 HydroBrake Q-H curve	

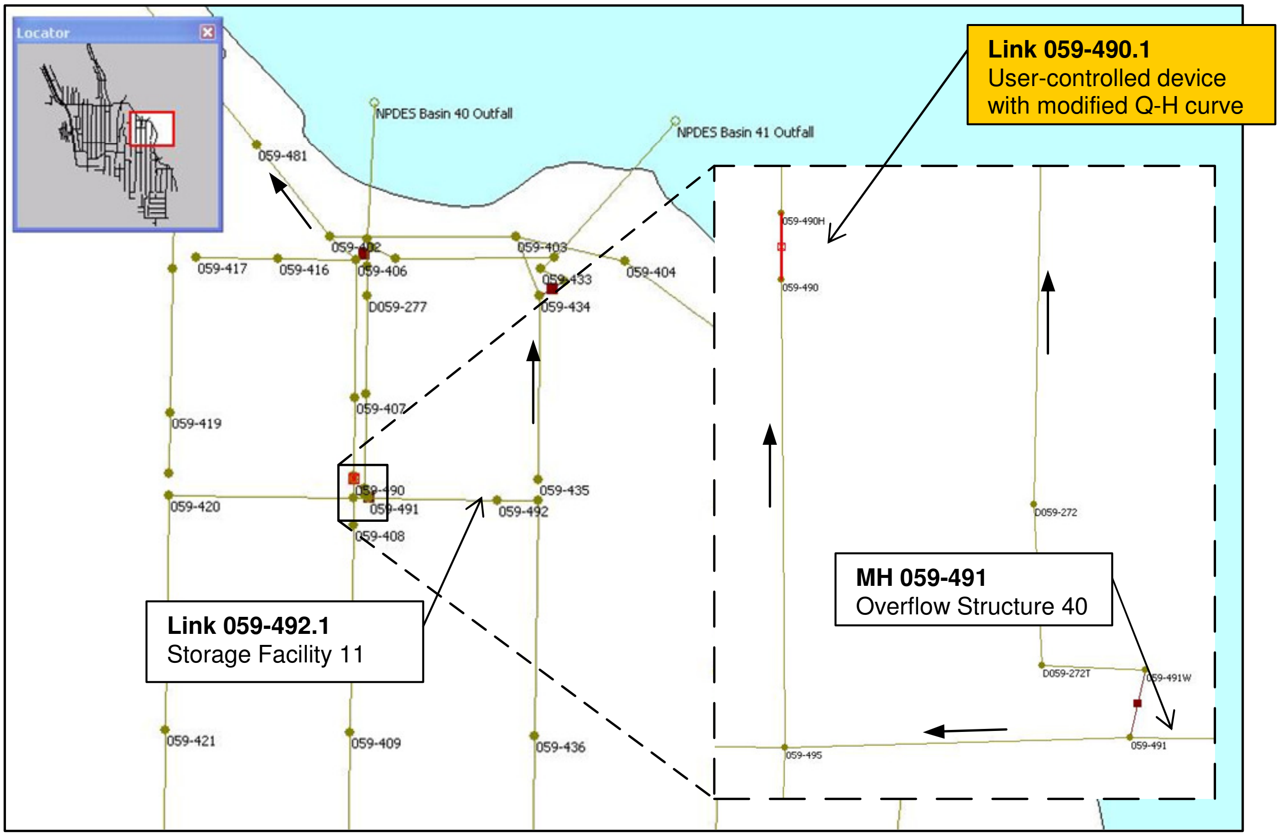


Figure 3-5: Base Model Modifications for Run 1.0

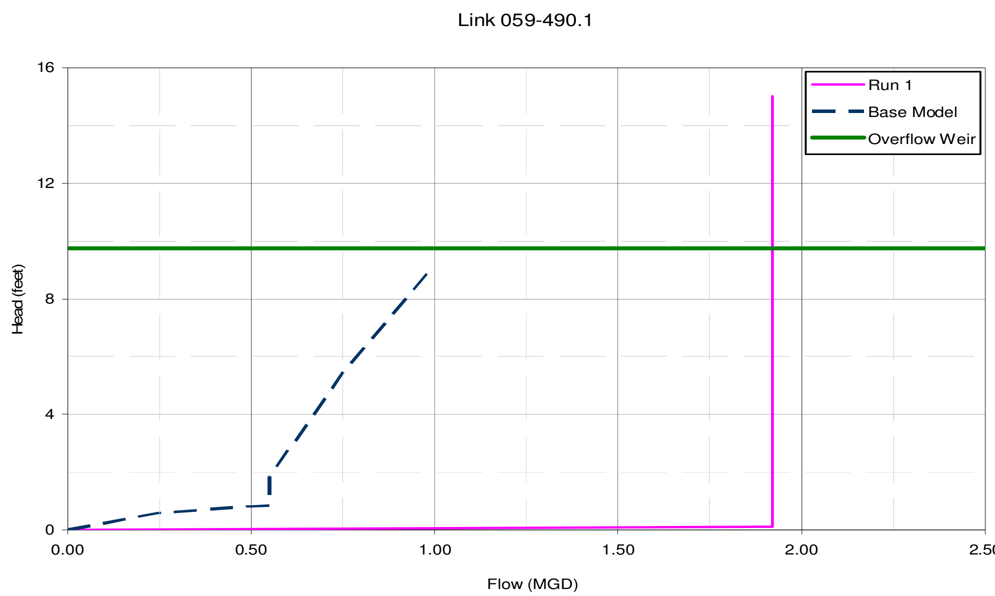


Figure 3-6: Comparison of Base Model and Run 1.0 Q-H Curves

Results from the 5-year simulation for Run 1.0 showed that overflows in Basin 40 were reduced from 34 events to 6 events. These results were below the benchmark of 7 events for Basin 40; therefore, replacing the HydroBrake with a flow-limiting device sufficiently reduces CSOs in Basin 40. Table 3-7 shows the CSO frequency and volume reduction for Basin 40 for the 5-year period.

Table 3-7: CSO Results Comparison between Base Model and Run 1.0

	Base Model	Run 1.0
NPDES CSO Outfall	40	40
No. of CSO Events	34	6
CSO Volume (MG)	6.28	1.45

The results of the run showed an increase in peak flow to downstream Basin 41 of approximately 0.82 MGD (from 1.1 MGD to 1.92 MGD, a 75 percent increase), as shown in Figure 3-7 for the 52nd-ranked storm in Basin 40, which occurred on 12/26/2006. The focus of Run 1.0 was to develop a control strategy for Basin 40 by increasing the flow out of the basin; however, this strategy increased the frequency and volume of CSOs in Basin 41 and the volume of CSOs in Basin 38. This increase in CSO frequency and volume at downstream basins was attenuated by other runs with which Run 1.0 was coupled. Figure 3-8 depicts the increases in these basins, as well as the decreases in Basin 40.

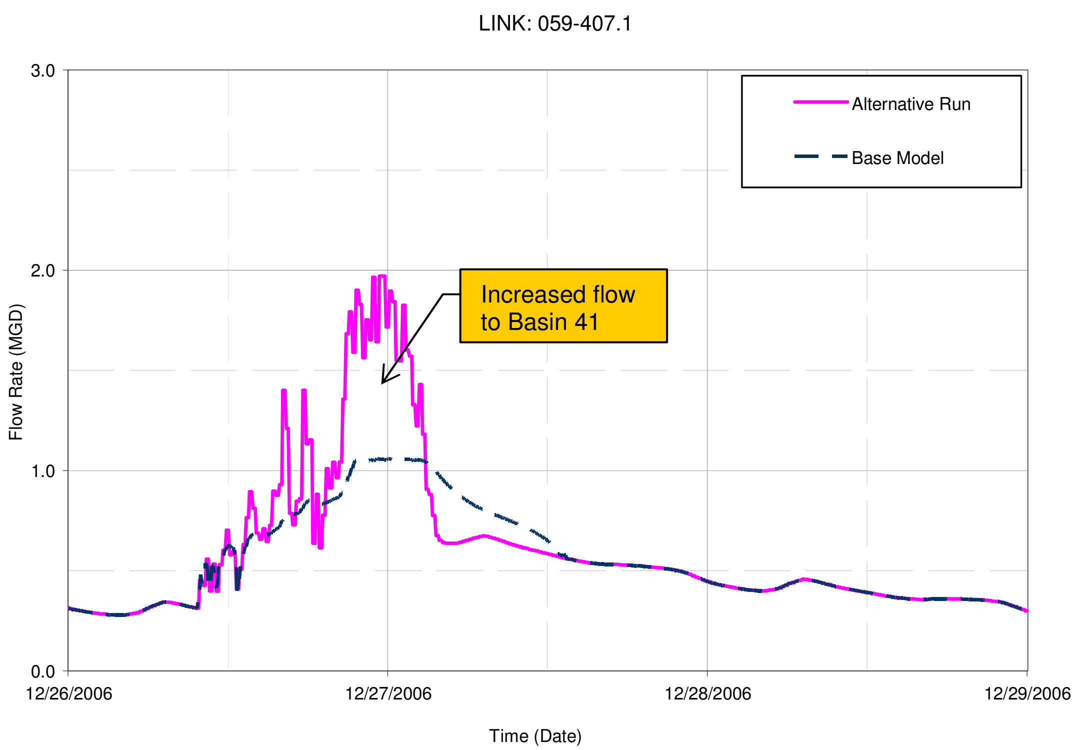
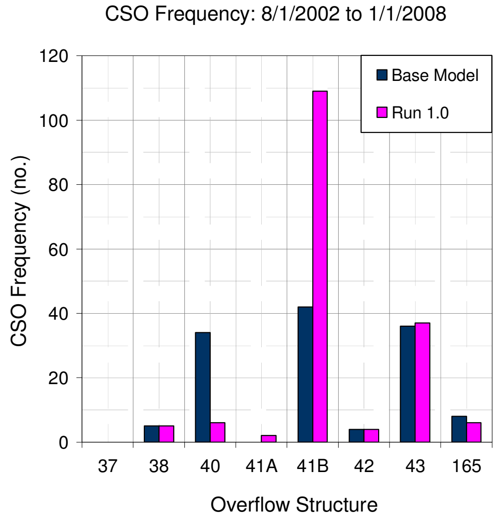


Figure 3-7: Comparison of Flow to Basin 41 for Base Model and Run 1.0



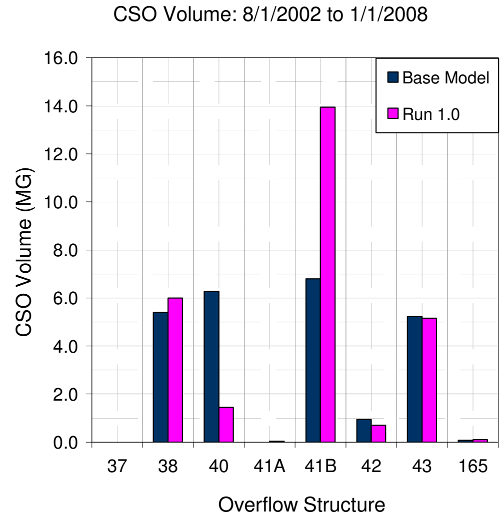


Figure 3-8: Comparison of Base Model and Run 1.0 CSO Frequency and Volume

3.3.2 Increased Conveyance in Basin 43

The purpose of this alternative is to bring Basin 43 into control by increasing the capacity of the conveyance system in Basin 43. Currently, flows from Basin 43 go through Storage Facility 9, which has a capacity of 70,000 gallons and is controlled by a HydroBrake located in MH 060W-047. The HydroBrake limits the discharge from the basin to approximately 0.67 MGD. Flows exceeding the HydroBrake capacity are stored in Storage Facility 9; once the storage capacity has been exceeded, flow overtops the weir located in Overflow Structure 43. During the Genesee Basin Flow Monitoring Study (January 2008 – May 2009), the HydroBrake was observed to have several Q-H curves, and the more restrictive curve was used in the Base Model and subsequent alternatives modeling. In addition, the HydroBrake was observed to restrict flow when the downstream system had available capacity. In order to reduce the CSO frequency at NPDES CSO Outfall 43, the conveyance from Storage Facility 9 to the lake line was increased using model Run 2.0: HydroBrake Replacement at MH 060W-047.

3.3.2.1 Run 2.0: HydroBrake Replacement at MH 060W-047

The purpose of Run 2.0 is to identify a control strategy that conveys more flow to the downstream system and uses the available downstream conveyance system capacity prior to storing flows in Storage Facility 9.

As seen in Figure 3-9, to accomplish this control strategy, the existing Q-H curve for the HydroBrake located in MH 060W-047 was replaced with a less restrictive Q-H curve that allows 1.25 MGD of flow through the basin. This flow brought Basin 43 into control and was arrived at by completing several control storm simulations modeling various Q-H curves with flows ranging from 0.9 to 1.28 MGD. Table 3-8 compares the resulting CSO volumes at NPDES CSO Outfall 43 with the various Q-H curves modeled. The final Q-H curve is highlighted in blue.

Figure 3-10 shows the Q-H curves of the Base Model HydroBrake and the final Q-H curve needed to bring Basin 43 into control.

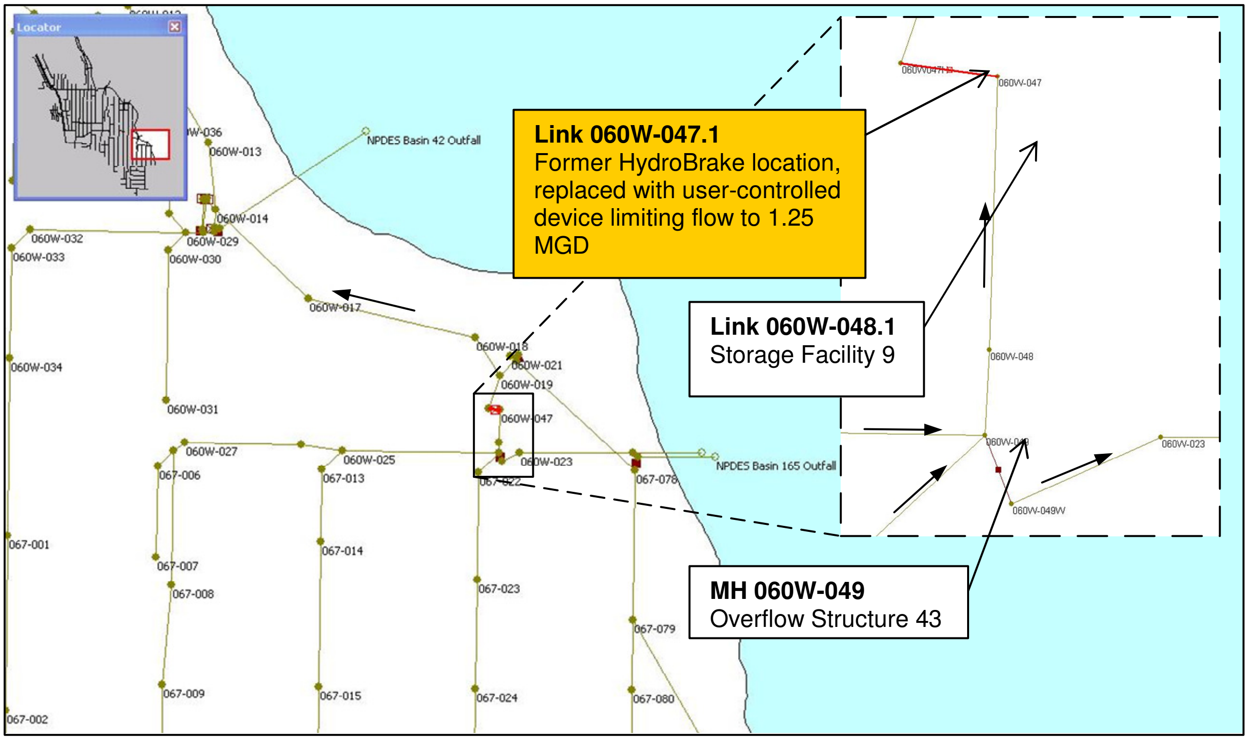


Figure 3-9: Base Model Modifications for Run 2.0

Table 3-8: Comparison of Basin 43 Q-H Curve Peak Flow to Basin 43 CSO Volume

Peak Flow in Q-H Curve (MGD)	CSO Volume at NPDES CSO Outfall 43 (MG)
0.67 [a]	0.187
1.04	0.023
1.10	0.017
1.25	0.000
1.30	0.000

[a] From existing Basin 43 HydroBrake Q-H curve

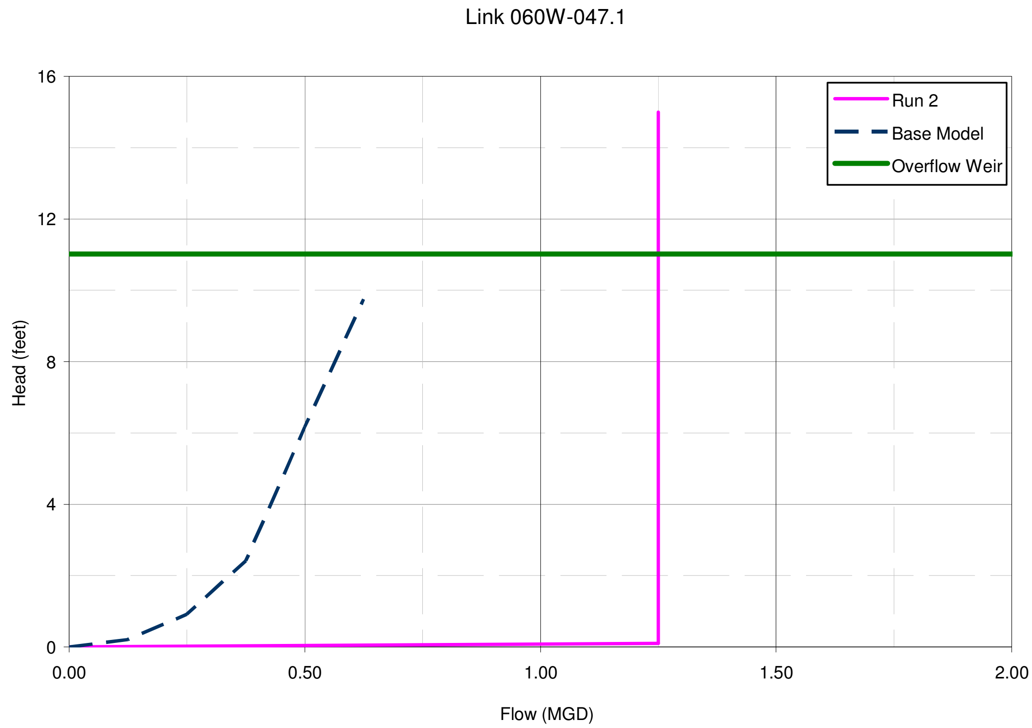


Figure 3-10: Comparison of Base Model and Run 2.0 Q-H Curves

Results from the Run 2.0 simulation showed that overflows in Basin 43 were reduced from 36 events to 5 events. These results were below the benchmark of 7 events for Basin 43; therefore, replacing the HydroBrake with a flow-limiting device sufficiently reduces CSOs in Basin 43. Table 3-9 shows the CSO frequency and volume reduction for Basin 43 for the 5-year period.

Table 3-9: CSO Results Comparison between Base Model and Run 2.0

	Base Model	Run 2.0
NPDES CSO Outfall	43	43
No. of CSO Events	36	5
CSO Volume (MG)	5.23	1.52

Results also indicated surface flooding at MH 060W-012 due to the increased conveyance through Basin 43. Figure 3-11 shows the hydraulic profile during the October 20, 2003, storm, which was the 4th-ranked storm in the Base Model 31-year simulation. This surface flooding will be conveyed by Run 5.0, which was coupled with Run 2.0 in other alternatives and consisted of wet weather conveyance from Basin 43.

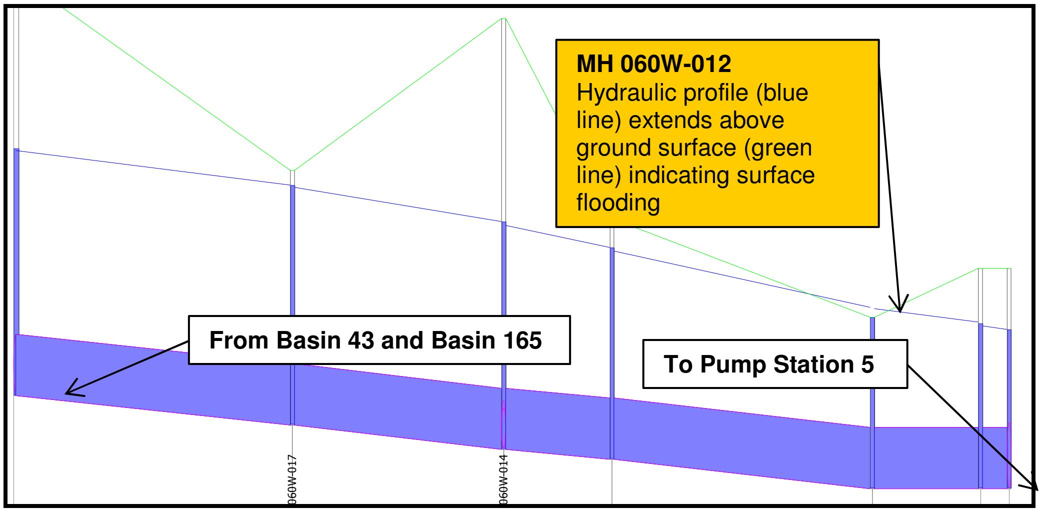


Figure 3-11: Hydraulic Profile Showing Surface Flooding at MH 060W-012

The results of the run also showed an increase in peak flow to the downstream lake line of approximately 0.58 MGD (from 0.67 MGD to 1.25 MGD, an 87 percent increase), as shown in Figure 3-12 for the 40th-ranked storm in Basin 43, which occurred on 12/26/2006. The focus of Run 2.0 was to develop a control strategy for Basin 43 by increasing the allowable flow out of the basin; however, this strategy increased the frequency and volume of CSOs in Basin 41 and the volume of CSOs in Basin 38. This increase in CSO frequency and volume at downstream basins was attenuated by other runs to which Run 2.0 was coupled. Figure 3-13 depicts the increases in these basins, as well as the decreases in Basin 43.

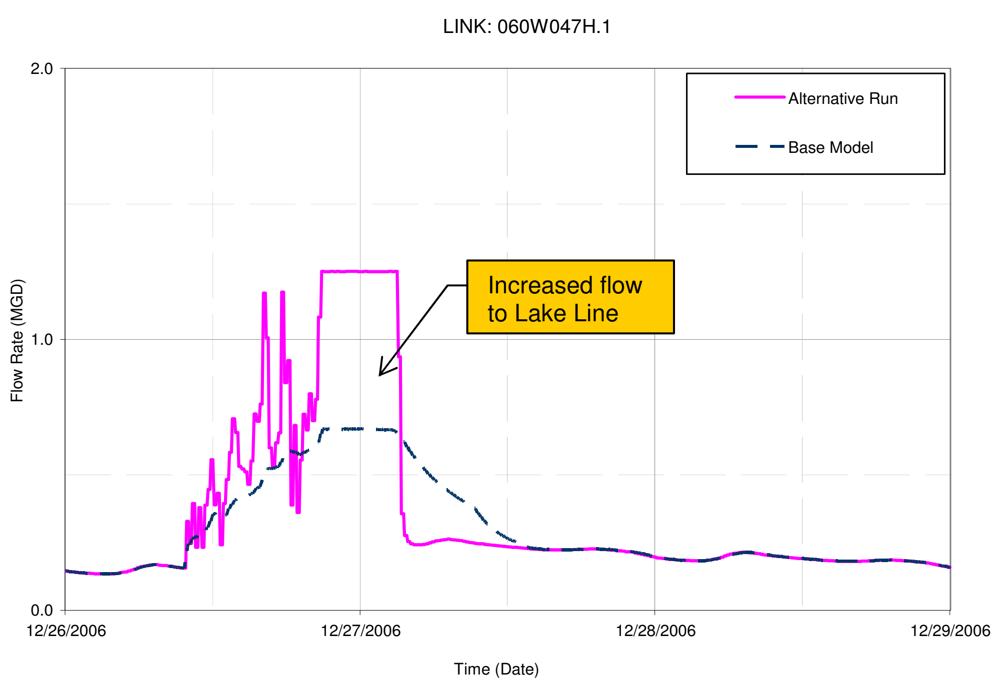


Figure 3-12: Comparison of Flow to the Lake Line for Base Model and Run 2.0

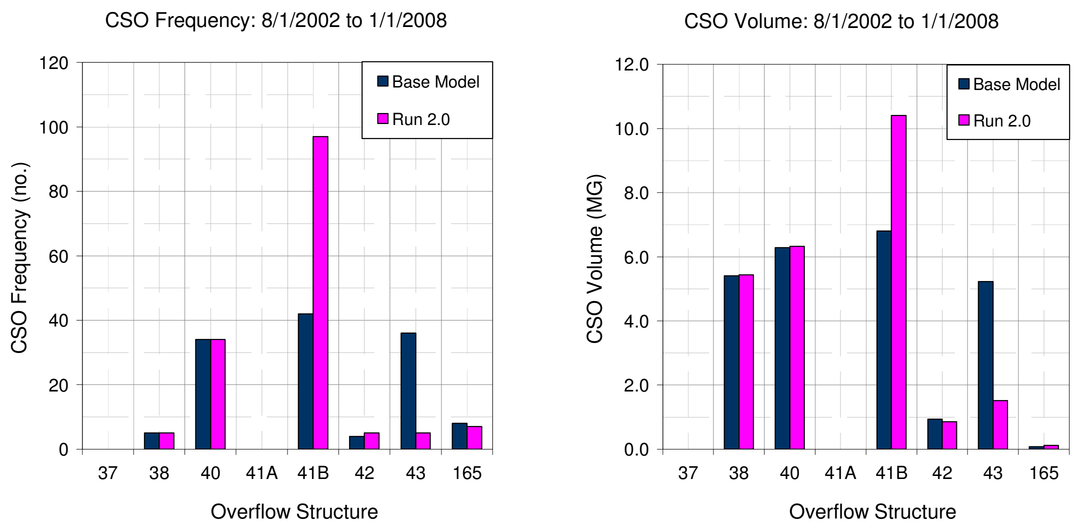


Figure 3-13: Comparison of Base Model and Run 2.0 CSO Frequency and Volume

3.3.3 Offline Storage in Basin 43

The purpose of this alternative is to bring Basin 43 into control by modeling offline storage in Basin 43. Currently, flows from Basin 43 go through Storage Facility 9, which has a capacity of 70,000 gallons and is controlled by a HydroBrake located in MH 060W-047. The HydroBrake limits the discharge from the basin to approximately 0.67 MGD. Flows exceeding the HydroBrake capacity are stored in Storage Facility 9; once the storage capacity is exceeded, excess flows overtop the weir in Overflow Structure 43. In order to reduce the CSO frequency at NPDES CSO Outfall 43, a new 216,000-gallon offline storage facility was modeled adjacent to the existing in-line Storage Facility 9 in Run 3.0: Offline Storage in Basin 43.

3.3.3.1 Run 3.0: Offline Storage in Basin 43

The purpose of Run 3.0 is to add sufficient offline storage in Basin 43 to bring it into control. The Genesee network was modified as described below and shown in Figure 3-14.

A 6-foot-wide storage diversion weir was modeled to divert wet weather flows into the storage pipes. This weir is located in MH 060W-048 and set at an elevation of 43.98 feet NAVD88, which is 6 inches below the elevation of the crest of the weir at Overflow Structure 43 in MH 060W-048.

Three 48-foot-long, 144-inch-diameter storage pipes were added to the east of Storage Facility 9 (link 060W-048.1). The storage pipes provide a storage volume of 115,000 gallons. The storage conveyance pipes and maintenance holes provide an additional 101,000 gallons of storage for a total of 216,000 gallons of additional storage.

The storage volume was predicted by completing several control volume event simulations with varying storage volumes. As shown in Table 3-10, a storage volume equal to the control volume of 187,000 gallons was used initially. This simulation showed an overflow at Basin 43, indicating that because the crest of the storage diversion weir was 6 inches below the elevation of the weir crest in Overflow Structure 43, the storage volume needed to be slightly larger than the control volume. A subsequent run showed that a storage volume of 216,000 gallons was sufficient to control the control volume event. A 5-year simulation was completed, as discussed below, and confirmed the storage volume.

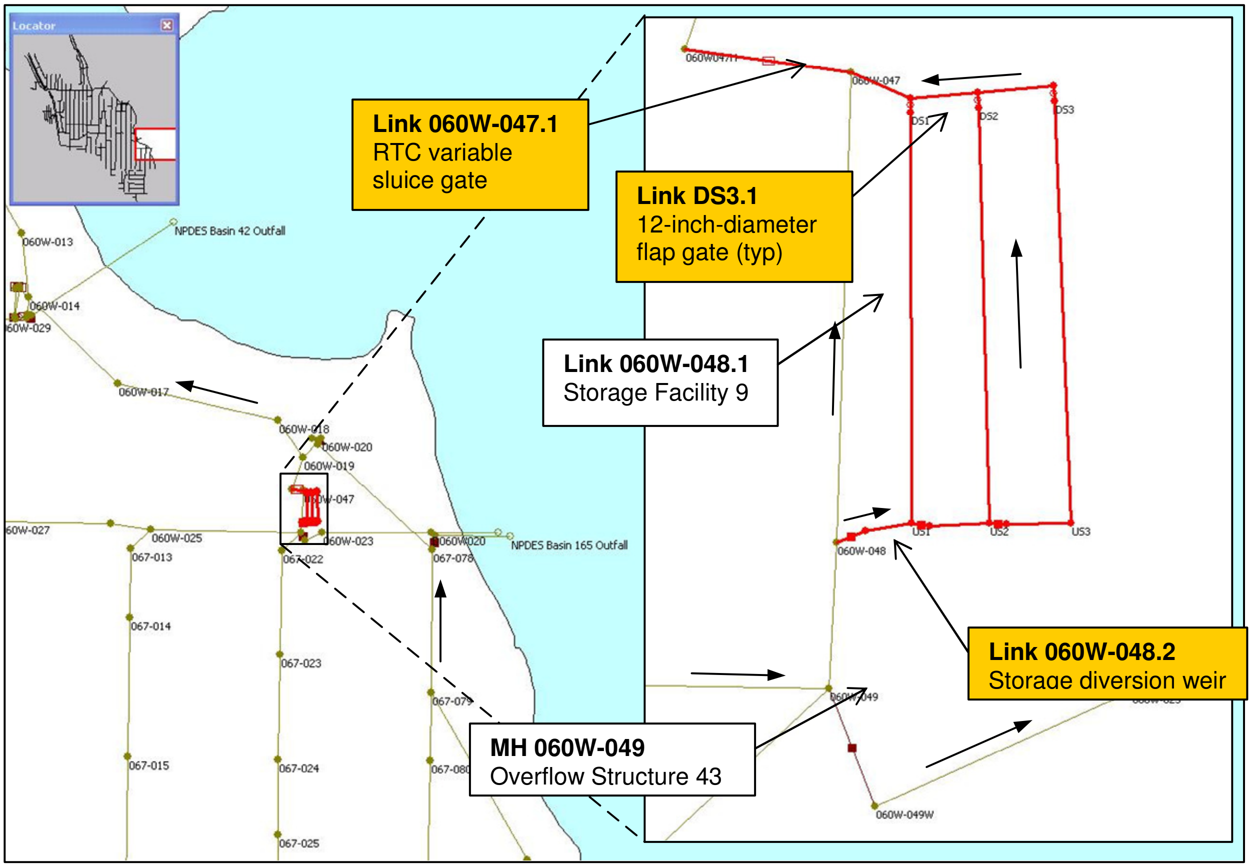


Figure 3-14: Base Model Modifications for Run 3.0

Table 3-10: Comparison of Offline Storage Volume and Basin 43 CSO Volume

Additional Offline Storage Volume (MG)	CSO Volume at NPDES CSO Outfall 43 (MG)
0.00	0.187
0.19 [a]	0.023
0.22	0.000

[a] Equal to Basin 43 control volume of 187,000 gallons.

Flow from the storage pipes is drained by a 12-inch-wide RTC variable sluice gate. The variable sluice gate RTC is set to mimic the existing HydroBrake Q-H curve. The existing HydroBrake Q-H curve is shown in Figure 3-6 in Section 3.3.2.1. While the Base Model HydroBrake Q-H curve represents the best approximation of the existing HydroBrake performance, actual performance of the HydroBrake has varied significantly. Replacing the HydroBrake with a variable sluice gate will result in more predictable and reliable flow conditions in Basin 43.

Results from the simulation for Run 3.0 showed that overflows at Basin 43 were reduced from 36 events to 6 events. These results were below the benchmark of 7 events for Basin 43; therefore, modeling an additional 216,000 gallons of offline storage sufficiently reduces CSOs at NPDES CSO Outfall 43. Table 3-11 shows the CSO frequency and volume reduction for Basin 43 for the 5-year period.

Table 3-11: CSO Results Comparison between Base Model and Run 3.0

	Base Model	Run 3.0
NPDES CSO Outfall	43	43
No. of CSO Events	36	6
CSO Volume (MG)	5.23	2.13

Figure 3-15 below compares Run 3.0 and the Base Model CSO volumes and frequencies across all basins in the Genesee Area. The slight increase in CSO volume and frequency at Overflow Structure 41B is due to the removal of the lake line blockage between the Base Model and Run 3.0 simulations, and not due to modifications made during Run 3.0.

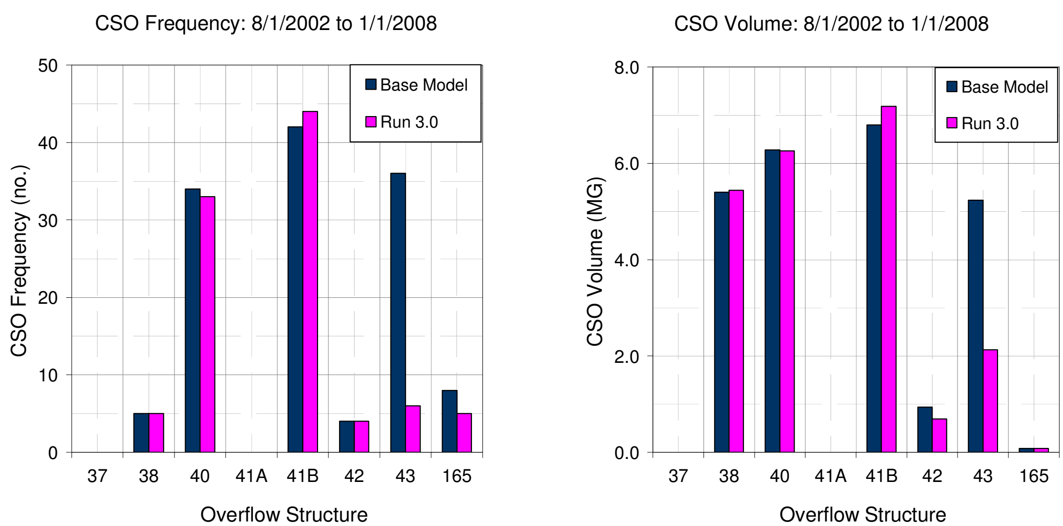


Figure 3-15: Comparison of Base Model and Run 3.0 CSO Frequency and Volume

3.3.4 Offline Storage in Basin 40, Basin 42, and Basin 43

The purpose of this alternative is to bring Basin 40, Basin 41, and Basin 43 into control. Currently these basins have a combined control volume of approximately 578,000 gallons. To bring these basins into control, their CSO frequencies were reduced through the following three runs:

- Run 3.0: Offline storage in Basin 43. See section 3.3.3.1 for details.
- Run 9.0: Offline storage in Basin 40 and HydroBrake replacement in MH 059-490.
- Run 6.0: Offline storage in Basin 42.

3.3.4.1 Run 9.0: Offline Storage in Basin 40 and HydroBrake Replacement in MH 059-490

The purpose of this run is to bring Basin 40 into control by modeling offline storage in Basin 40 and increasing the conveyance system capacity. Currently, flows from Basin 40 go through Storage Facility 11, which has a capacity of 58,000 gallons and is controlled by a HydroBrake located in MH 059-490. The HydroBrake limits the discharge from Basin 40 to approximately 1.1 MGD. Flows exceeding the HydroBrake capacity are stored in Storage Facility 11; once the storage capacity has been exceeded, flow overtops the weir located in Overflow Structure 40. During the Genesee Basin Flow Monitoring Study (January 2008 – May 2009), the HydroBrake was observed to restrict flow when the downstream system had available capacity. In order to reduce CSO frequency at NPDES CSO Outfall 40, additional offline storage was modeled parallel to Storage Facility 11, and the HydroBrake in Basin 40 was removed and replaced.

As seen in Figure 3-16, to model the additional offline storage, 300 feet of 120-inch-diameter pipe was added to the Base Model parallel to the existing storage pipe in Basin 40, along with a 10-foot-wide flow diversion weir and 24-inch-diameter flap gate. The flow diversion weir, located at MH 059-495, is set at an elevation of 33.25 feet NAVD88, or 3 inches below the elevation of the weir crest in Overflow Structure 40. The storage pipe provides 128,000 gallons of additional storage, which is equivalent to 63 percent of the Basin 40 control volume. The storage pipe is sized based on the available space in the street right-of-way (ROW). Flow is stored in this new storage tank after the existing storage is filled, using the new flow control device that replaced the HydroBrake in MH 059-490.

To address the remaining 37 percent of the control volume for Basin 40, the HydroBrake in MH 059-490 was removed and replaced with a new user-controlled device and corresponding Q-H curve. Similar to the Q-H curve developed for Run 1.0, the new Q-H curve limits the flow out of Basin 40 in order to control the basin. The final Q-H curve limits the flow out of Basin 40 to 1.1 MGD, and was predicted as shown in Figure 3-17 using the control storm event. Figure 3-18 compares the Q-H curves of the Base Model and Run 9.0.

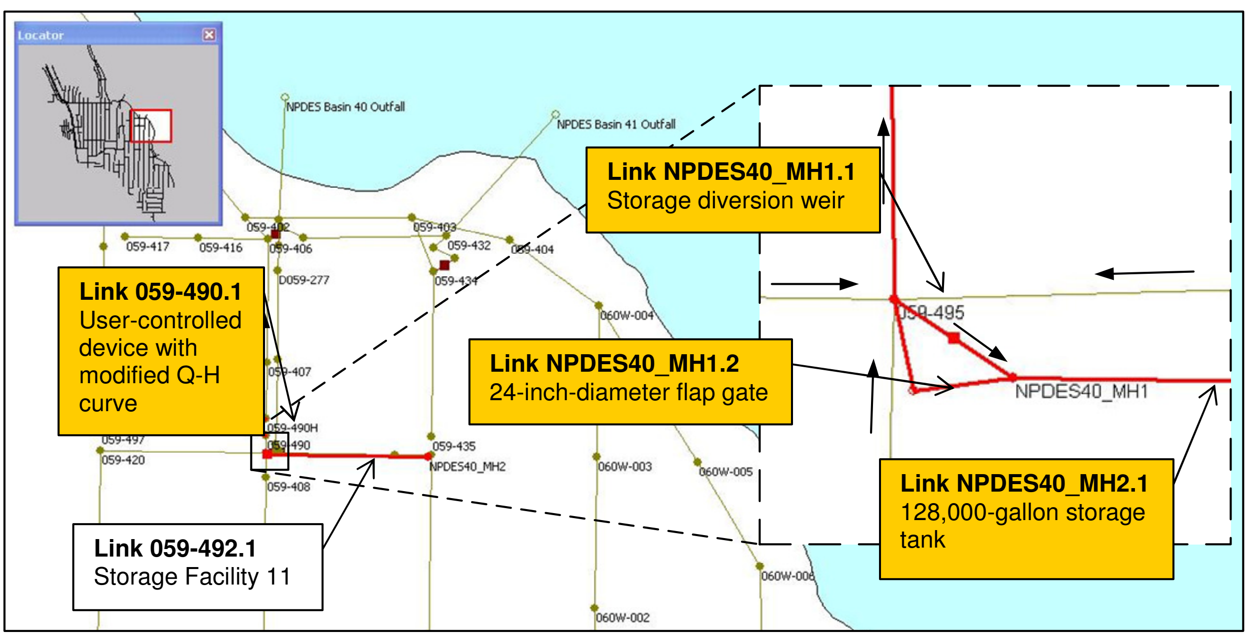


Figure 3-16: Base Model Modifications for Run 9.0

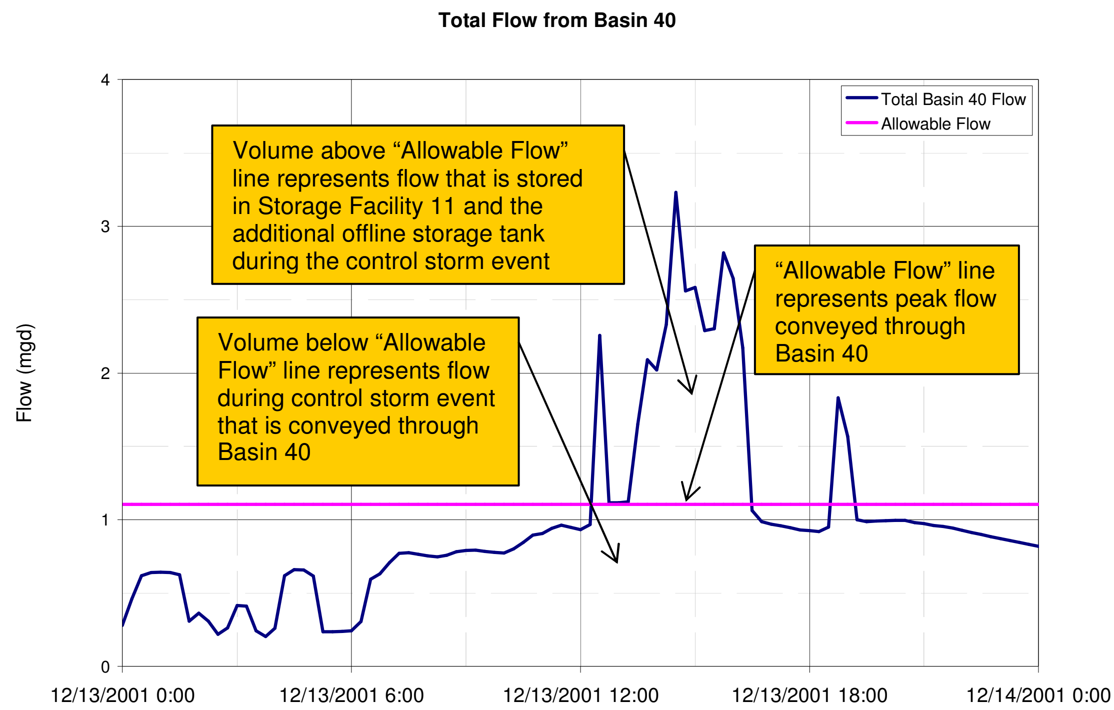


Figure 3-17: Calculation for Peak Flow for Q-H Curve in Basin 40

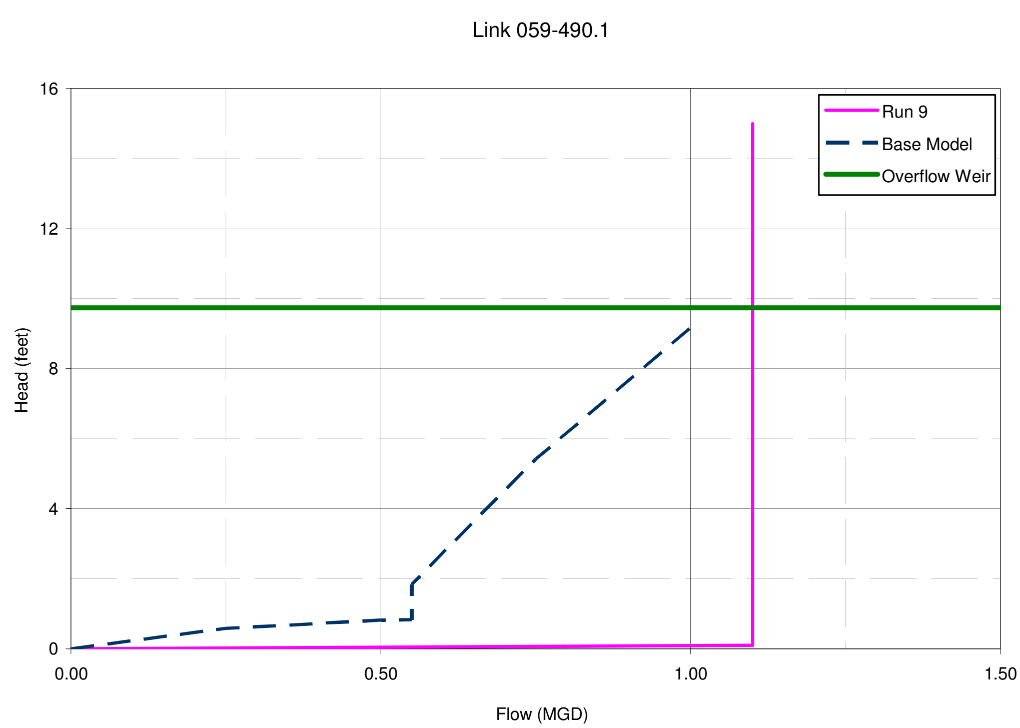


Figure 3-18: Comparison of Base Model and Run 9.0 Q-H Curves

Results from the simulation for Run 9.0 indicated that overflows at Basin 40 were reduced from 34 events to 5 events. These results were below the benchmark of 7 events for Basin 40; therefore, adding offline storage and replacing the HydroBrake with a flow limiting device sufficiently reduces CSOs in Basin 40. The CSO frequency and volume reduction for Basin 40 are shown in Table 3-12 for the 5-year period.

Table 3-12: CSO Results Comparison between Base Model and Run 9.0

	Base Model	Run 9.0
NPDES CSO Outfall	40	40
No. of CSO Events	34	5
CSO Volume (MG)	6.28	3.08

The results of Run 9.0 show an increase in peak flow to Basin 41 of approximately 0.10 MGD (increase from 1.0 MGD to 1.10 MGD) for the 52nd ranked storm on 12/26/2006, as shown in Figure 3-19. This increased flow to Basin 41 increased the CSO frequency and volume in the basin, as seen in Figure 3-20. The increase was attenuated by using Run 6.0, described in the following section.

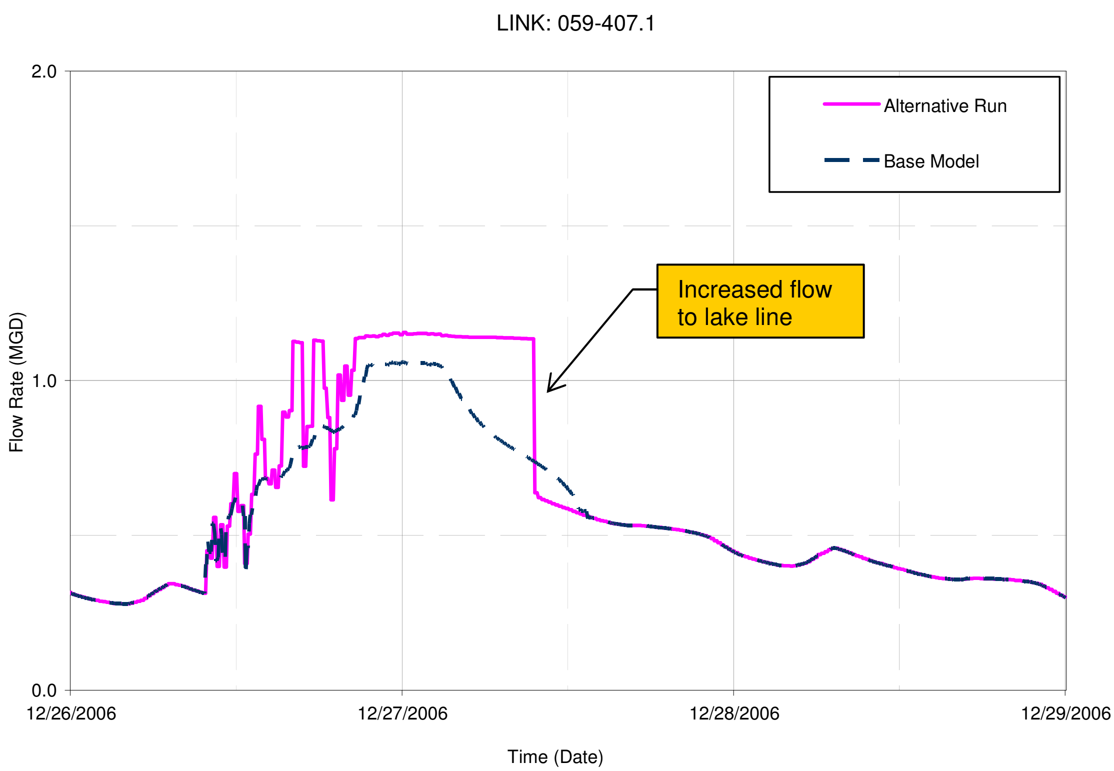


Figure 3-19: Comparison of Flow to Basin 41 for Base Model and Run 9.0

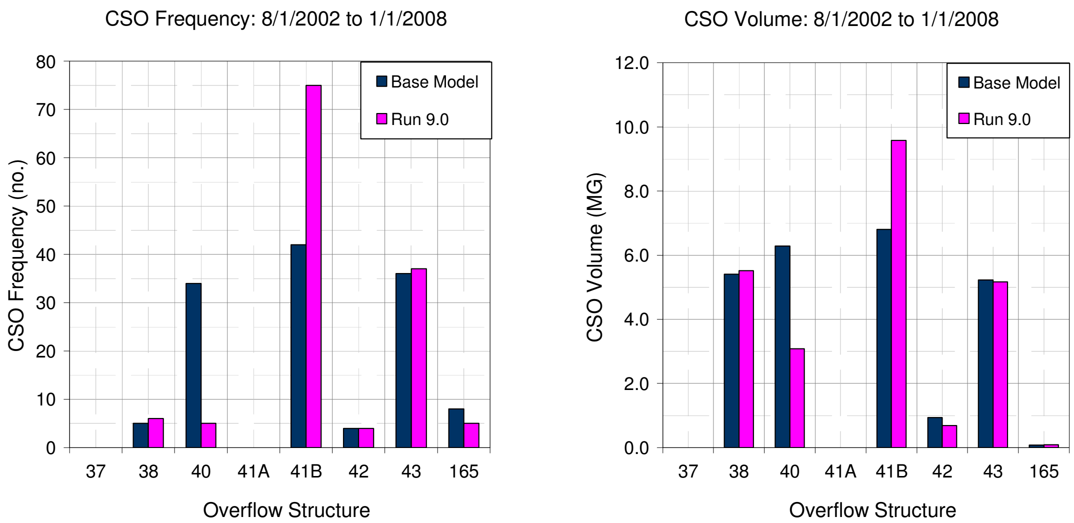


Figure 3-20: Comparison of Base Model and Run 9.0 CSO Frequency and Volume

3.3.4.2 Run 6.0: Offline Storage in Basin 42

The purpose of Run 6.0 is to bring Basin 41 into control given the upstream conditions provided by Run 3.0 in Basin 43 and Run 9.0 in Basin 40. Prior to Run 9.0, Basin 41 was already uncontrolled in the Base Model, and modifications made during Run 9.0 increased the CSO frequency at Basin 41. Run 6.0 compensates for the increased flow from Basin 40, as well as the existing overflows at Basin 41, by diverting and storing flows in the lake line at MH 060W-007.

Wet weather flows are diverted from the lake line into a 630,000 gallon offline storage tank through a new flow diversion structure upstream from MH 060W-007. This flow diversion structure consists of a user-controlled device that limits flow into Basin 41 to 0.71 MGD, and a 10-foot-wide storage diversion weir set at an elevation that corresponds with the depth of flow at 0.71 MGD. Restricting the flow in the lake line at MH 060W-007 to 0.71 MGD increases the available capacity in the lake line at Basin 41 sufficiently to bring the basin into control.

The size of the storage tank was predicted by completing an interim simulation for Run 6.0 that included the lake line diversion structure and user-controlled device described above diverting flow to an outfall, instead of an offline storage tank. A control volume event simulation was completed, and the results showed that, if only 0.71 MGD of flow was allowed to travel downstream, the volume of flow diverted out of the lake line was 0.63 MG. Subsequently, a storage tank was modeled with a volume of 0.63 MG. A 5-year simulation was completed to verify that it provided sufficient volume to avoid upstream surface flooding and did not cause an increase in overflows at Basin 42.

Two 0.3-MGD pumps are used to drain the storage tank back into the lake line downstream from MH 060W-007. The pumps are controlled based on the flow in link 060W-007.1, which is downstream from MH 060W-007. Both pumps shut off when the storage tank is fully drained, or when the flow in link 060W-007.1 exceeded 0.71 MGD.

Figure 3-21 shows the modifications to the Base Model configuration.

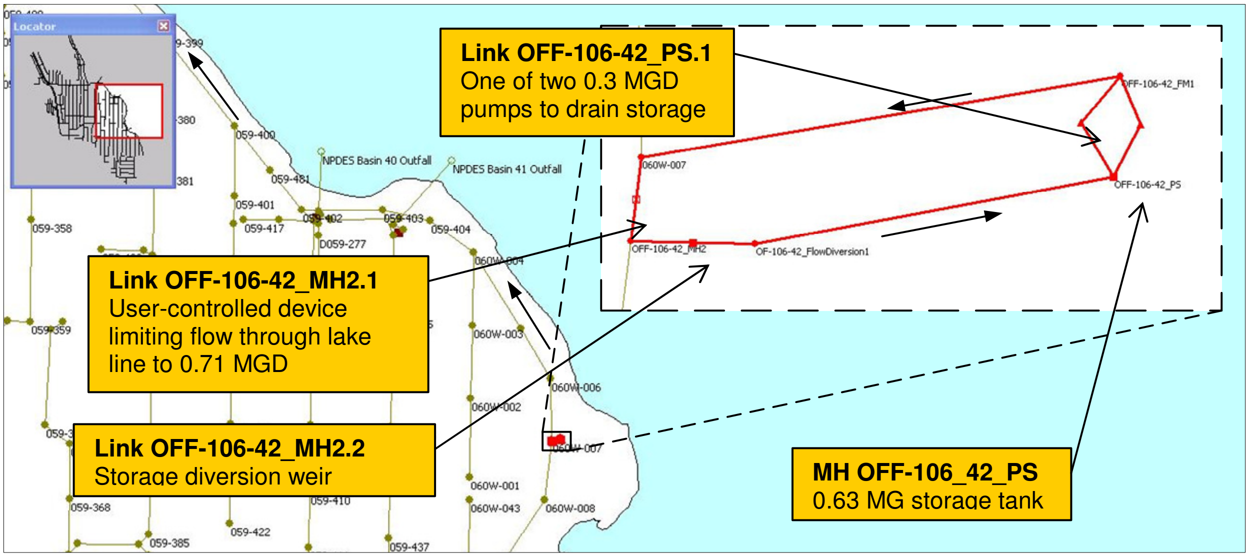


Figure 3-21: Base Model Modifications for Run 6.0

Results from the simulation for Run 6.0 indicated that overflows at Basin 41 were reduced from 42 events to 6 events. These results were below the benchmark of 6 events for Basin 41; therefore, diverting and storing 670,000 gallons of flow in the lake line sufficiently reduces CSOs at NPDES CSO Outfall 41B. Table 3-13 shows the CSO frequency and volume reduction for Basin 41 for the 5-year period. Figure 3-22 shows the results of a 5-year simulation combining all of the runs in this alternative (Runs 3.0, 6.0, and 9.0).

Table 3-13: CSO Results Comparison between Base Model and Run 6.0

	Base Model	Run 6.0
NPDES CSO Outfall	41	41
No. of CSO Events	42	6
CSO Volume (MG)	6.80	1.16

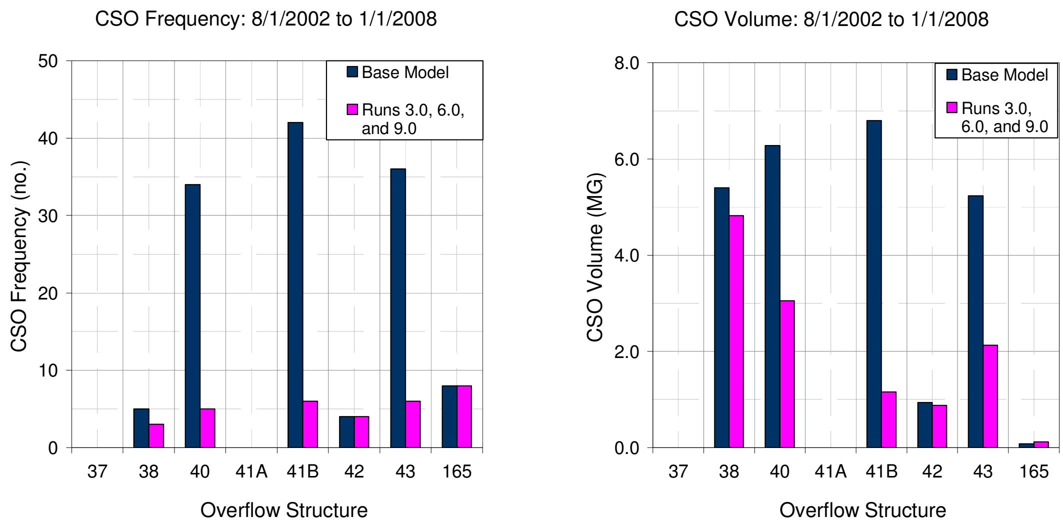


Figure 3-22: Comparison of Base Model and Simulation Containing Runs 3.0, 6.0, and 9.0 CSO Frequency and Volume

3.3.5 Offline Storage in Basin 38 along 43rd Avenue

The purpose of this alternative is to solve the Base Model control volume for Basin 40, Basin 41, and Basin 43 by modeling an offline storage pipe along 43rd Avenue in Basin 38, and conveyance in upstream basins in order to convey flows from Basin 40, Basin 41, and Basin 43 into the new storage pipe. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is approximately 578,000 gallons. The CSOs in Basin 40, Basin 41, and Basin 43 were reduced by using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. This run is described below.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. This run is described below.
- Run 7.0: Offline storage pipe in Basin 38 along 43rd Avenue and conveyance from the terminus of Run 5.0 to the new storage pipe. This run is described below.

3.3.5.1 Run 4.0: Wet Weather Conveyance from Basin 43

The purpose of Run 4.0 is to convey the increased flows, due to the HydroBrake replacement in Run 2.0, into a new wet weather lake line to reduce downstream surface flooding at MH 060W-012, and increased CSO volumes and frequencies at downstream Basin 38 Basin and 41.

Run 4.0 is also used to convey flows from Basin 44 in the Henderson Area in some alternatives. Flow from Basin 44 enters the Genesee Area in MH CON-104-42_MH11, located at the upstream (southern) end of the new lake line.

As Figure 3-23 shows, Run 4.0 consists of the upstream section of a new lake line parallel to the existing lake line in the right-of-way (ROW) of Lake Washington Boulevard. Approximately 3,500 feet of new 24-inch-diameter pipe was modeled from Basin 43 to the vicinity of Basin 41. The weir crest in the wet weather diversion structure located immediately downstream from MH 060W-018 is set at an elevation of 25.83 feet NAVD88, which is 6 inches above the invert elevation of the incoming pipe. This weir is set at this elevation to avoid surface flooding at MH 060W-012 downstream and to divert sufficient flow into storage for other runs that use the components of Run 4.0. The terminus of Run 4.0 is near MH 059-402 in Basin 41.

Run 4.0 is not a stand-alone alternative. No simulations were completed using only the components of Run 4.0.

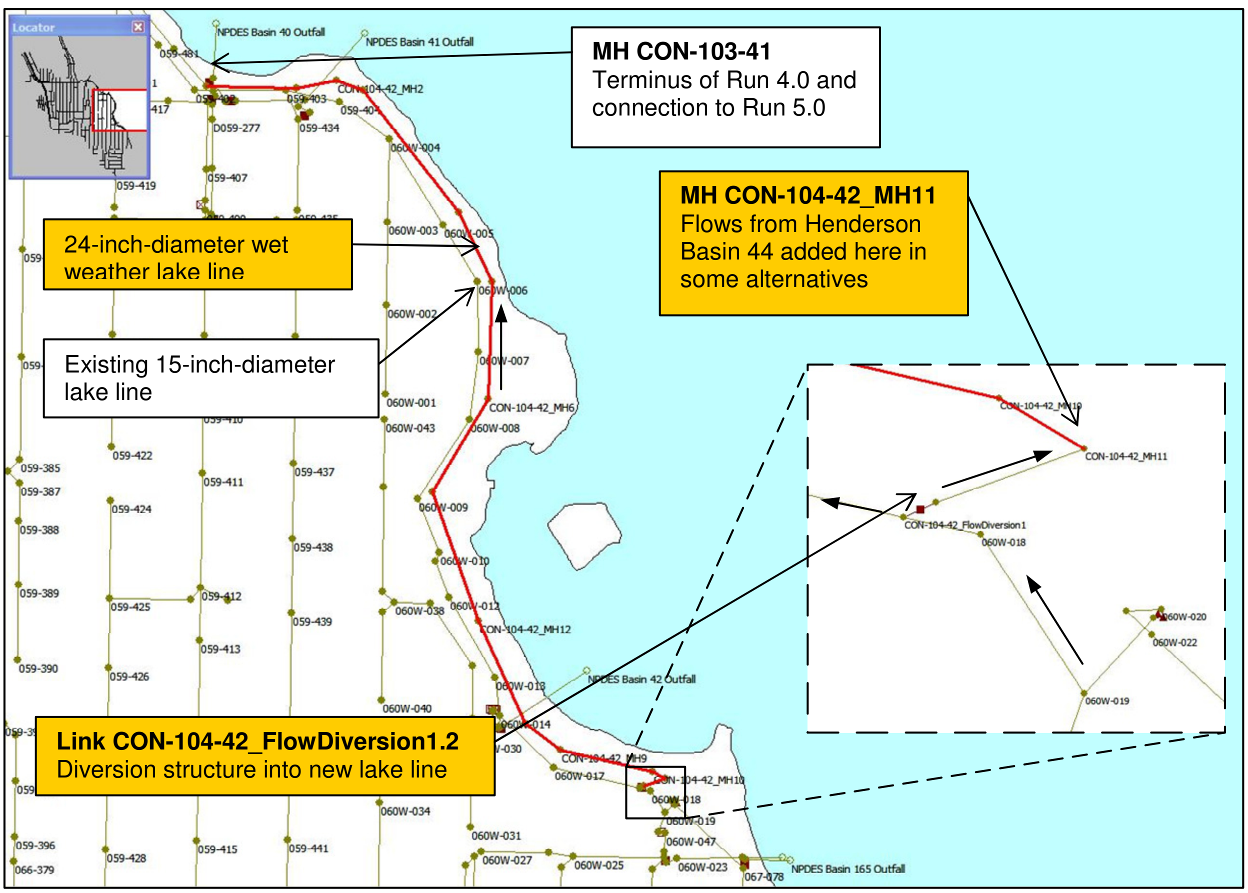


Figure 3-23: Base Model Modifications for Run 4.0

3.3.5.2 Run 5.0: Wet Weather Conveyance from Basin 41

The purpose of Run 5.0 is to convey the following flows:

- Wet weather flows from Basin 40 and Basin 41
- Flows conveyed from Basin 43 by the new conveyance pipe in Run 4.0

As Figure 3-24 shows, Run 5.0 consists of the downstream (northern) section of the new lake line parallel to the existing lake line in the Lake Washington Boulevard. It includes approximately 1,500 feet of 24-inch-diameter pipe and runs from the terminus of Run 4.0, near MH 059-402, to the vicinity of Pump Station 5. From there, Run 5.0 connects to other runs that convey the flows to either a new storage facility or to King County.

Flows from Basin 41 enter the new lake line through a storage diversion structure, seen as link 059-406.1 in Figure 3-24 below. A new overflow structure was modeled immediately downstream from the storage diversion structure. The weir crest elevation at the overflow structure is set at 19.51 feet NAVD88, matching the height of the current overflow weir in Basin 41.

A new overflow structure was also modeled by connecting the upstream end of Run 5.0 to a new maintenance hole downstream from MH D059-245 in NPDES CSO Outfall 40. The elevation of this weir crest is set to 19.51 feet NAVD88 to match the weir crest elevation in Overflow Structure 41. This additional overflow structure for Basin 40 was needed to provide sufficient capacity for large CSO events. Overflow Structure 41B was limited to a capacity of 1.8 MGD, which was frequently exceeded by peak flows in the new lake line.

Run 5.0 was not a stand-alone alternative. No simulations were completed using only the components of Run 5.0.

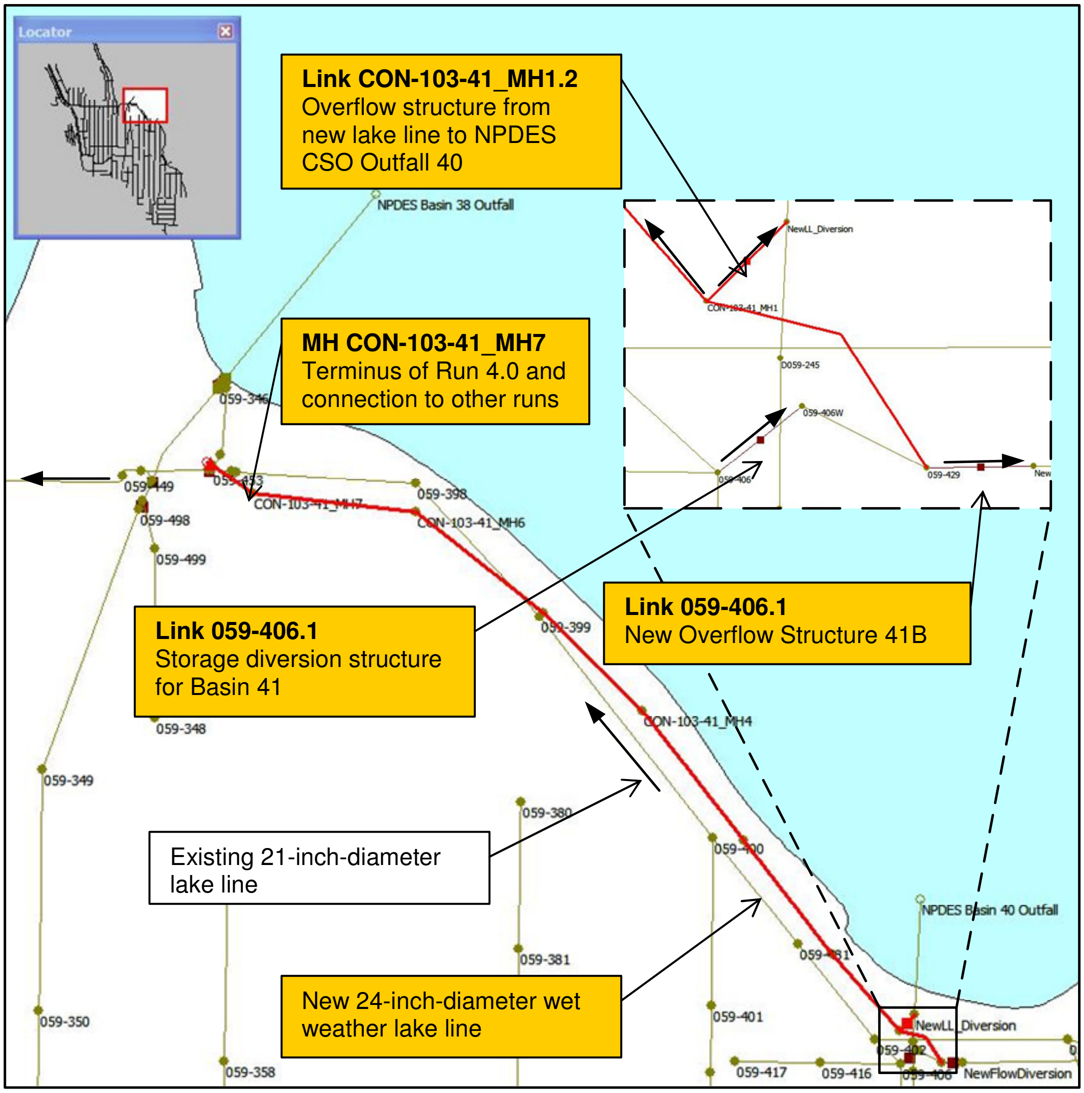


Figure 3-24: Base Model Modifications for Run 5.0

3.3.5.3 Run 7.0: Offline Storage in Basin 38 along 43rd Avenue

The purpose of Run 7.0 is to provide offline storage for flows conveyed from Run 5.0, and to bring Basin 40 and Basin 41 into compliance.

As Figure 3-25 shows, Run 7.0 conveys flows from the terminus of Run 5.0, near MH 059-455 adjacent to Pump Station 5, through approximately 1,100 feet of 24-inch-diameter pipe to a new offline storage pipe located in the 43rd Avenue ROW in Basin 38. The 144-inch-diameter storage pipe is 790 feet long and provides 0.70 MG of storage. Once the storage is full, flows overtop the weirs located in Overflow Structure 40 and Overflow Structure 41B, as described in Section 3.3.5.2 for Run 5.0.

The storage volume was predicted by completing a control storm event simulation with the components of Runs 1.0, 2.0, 4.0, 5.0, and 7.0 discharging to an outfall, instead of a storage pipe. The resulting volume of flow discharged during the control storm event was 0.70 MG. A subsequent 5-year simulation confirmed that a storage volume of 0.70 MG is sufficient to bring Basin 40 and Basin 41 into control.

The storage pipe is drained by three 0.72-MGD pumps that pump flow out of the pipe as downstream capacity becomes available.

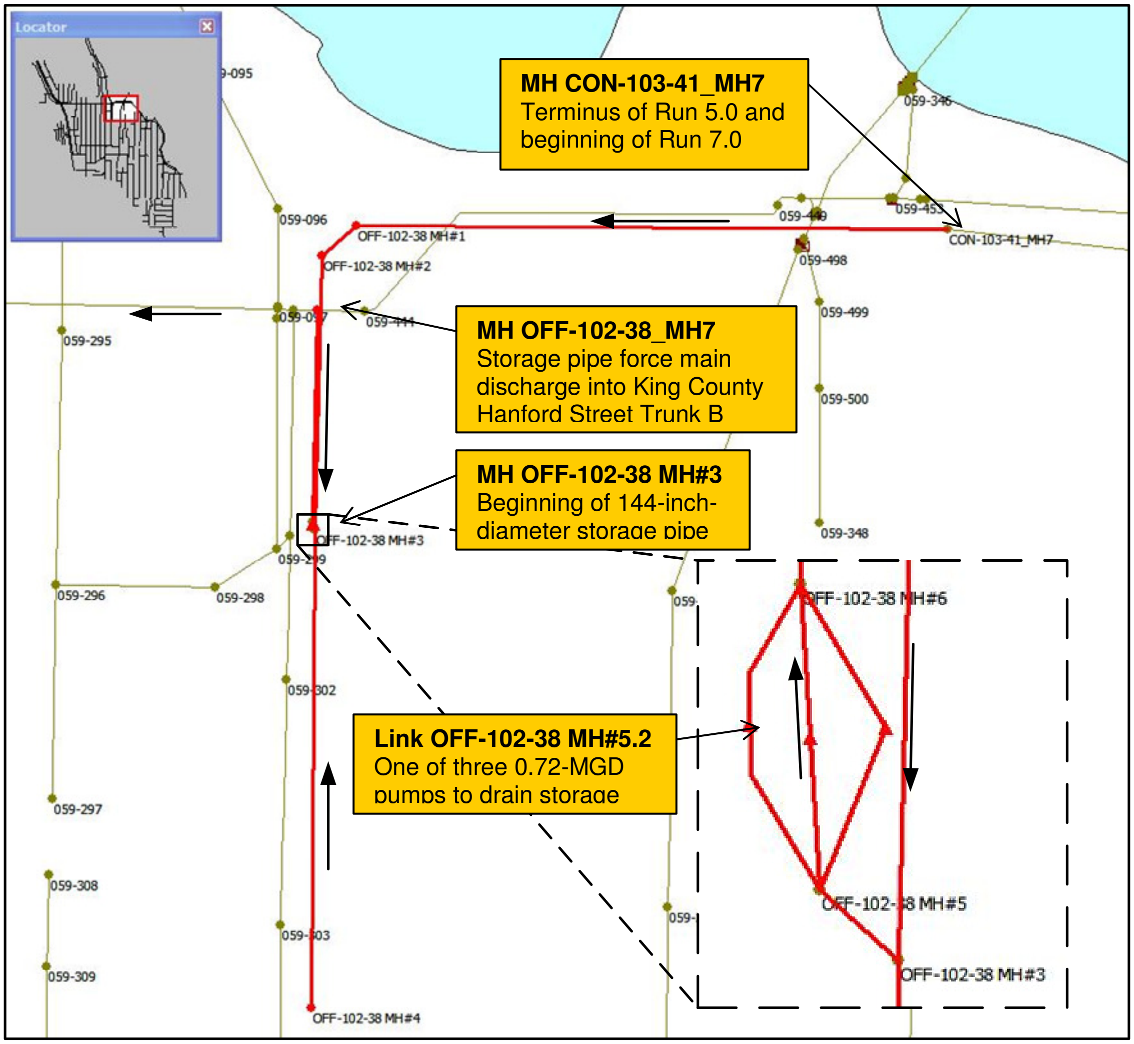


Figure 3-25: Base Model Modifications for Run 7.0

Results from the Run 7.0 simulation indicated that overflows at Basin 40 were reduced from 34 events to 6 events. Overflows at Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 7 events for Basin 40 and 6 events for Basin 41; therefore, modeling the offline storage pipe sufficiently reduces CSOs in Basin 40 and Basin 41. Table 3-14 shows the CSO frequency and volume reduction for Basin 40 and Basin 41 for the 5-year period.

Table 3-14: CSO Results Comparison between Base Model and Run 7.0

	Base Model		Run 7.0	
NPDES CSO Outfall	40	41B	40	41B
No. of CSO Events	34	42	6	4
CSO Volume (MG)	6.28	6.80	5.24	2.18

Although Run 7.0 includes the upstream conditions given by Run 1.0, the resulting CSO volume at NPDES CSO Outfall 40 is 3.56 MG larger for Run 7.0 than it is for Run 1.0. The cause of this discrepancy is the new overflow structure connecting the new parallel lake line to NPDES CSO Outfall 40 in Run 5.0, described in Section 3.3.5.2. However, Basin 40 is controlled in both Run 1.0 and Run 7.0, as indicated by the frequency of CSOs.

Figure 3-26 shows the results for a simulation containing Runs 1.0, 2.0, 4.0, 5.0, and 7.0 for all basins in the Genesee Area.

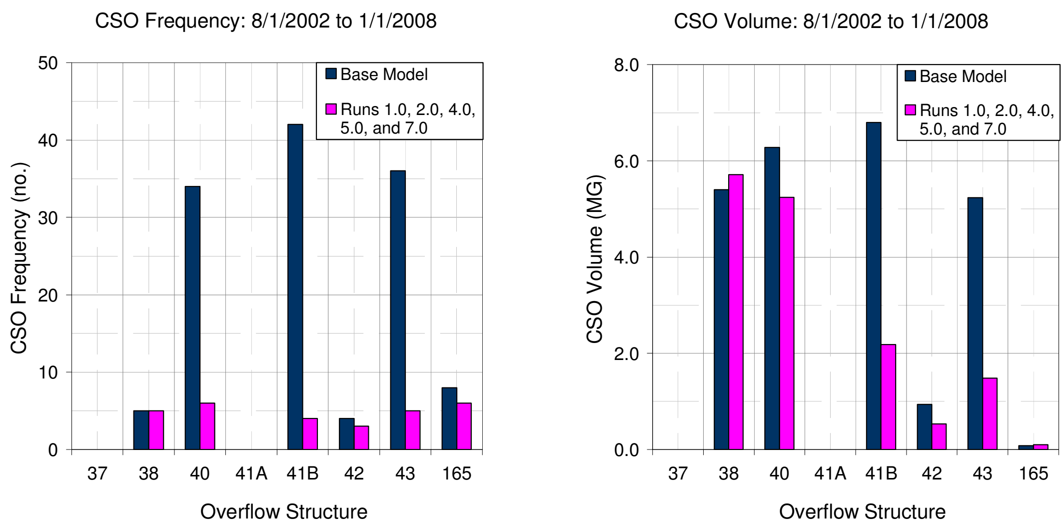


Figure 3-26: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 7.0 CSO Frequency and Volume

3.3.6 Offline Storage in Basin 38 in Genesee Park

The purpose of this alternative is to solve the Base Model control volume for Basin 40, Basin 41, and Basin 43 by modeling an offline storage pipe in Basin 38, and conveyance in upstream basins in order to convey flows from Basin 40, Basin 41, and Basin 43 into the new storage pipe. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. CSOs in Basin 40, Basin 41, and Basin 43 were reduced by using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 8.0: Offline storage pipe in Basin 38 in Genesee Park and conveyance from the terminus of Run 5.0 to the new storage pipe. This run is described below.

3.3.6.1 Run 8.0: Offline Storage in Basin 38 in Genesee Park

The purpose of Run 8.0 is to provide offline storage for flows conveyed from Run 5.0, and to bring Basin 40 and Basin 41 into compliance.

As Figure 3-27 shows, Run 8.0 conveys flows from the terminus of Run 5.0, near MH 059-455 adjacent to Pump Station 5, through approximately 200 feet of 24-inch-diameter pipe to a new offline storage pipe located in Genesee Park in Basin 38. The 96-inch-diameter storage pipe is 1,780 feet long and provided 0.69 MG of storage. Once the storage is full, flows overtops the weirs located in Overflow Structure 40 and Overflow Structure 41B, as described in Section 3.3.5.2 for Run 5.0.

The storage volume was predicted by completing a control storm event simulation with the components of Runs 1.0, 2.0, 4.0, 5.0, and 7.0 discharging to an outfall, instead of a storage pipe. The resulting volume of flow discharged during the control storm event was 0.69 MG. A subsequent 5-year simulation confirmed that a storage volume of 0.69 MG is sufficient to bring Basin 40 and Basin 41 into control.

The storage pipe is drained by three 0.72-MGD pumps that pump flow out of the pipe as downstream capacity became available.

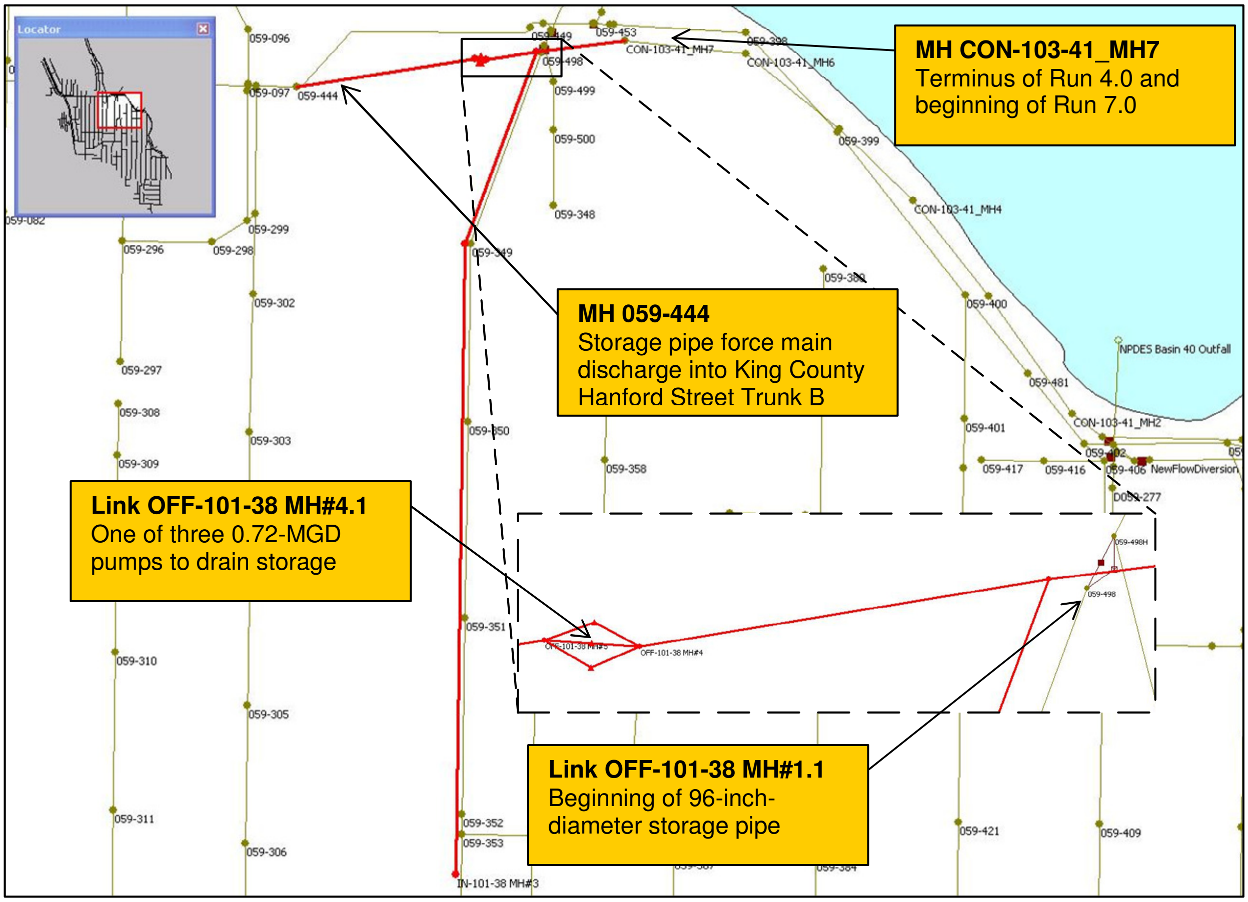


Figure 3-27: Base Model Modifications for Run 8.0

Results from the Run 8.0 5-year simulation indicated that overflows at Basin 40 were reduced from 34 events to 6 events. Overflows at Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 7 events for Basin 40 and 6 events for Basin 41; therefore, modeling the offline storage pipe sufficiently reduces CSOs in Basin 40 and Basin 41. Table 3-15 shows the CSO frequency and volume reduction for Basin 40 and Basin 41 for the 5-year period.

Table 3-15: CSO Results Comparison between Base Model and Run 8.0

	Base Model		Run 8.0	
NPDES CSO Outfall	40	41B	40	41B
No.of CSO Events	34	42	6	4
CSO Volume (MG)	6.28	6.80	4.78	2.14

Although Run 8.0 includes the upstream conditions given by Run 1.0, the resulting CSO volume at NPDES CSO Outfall 40 is 3.10 MG larger for Run 8.0 than it is for Run 1.0. The cause of this discrepancy is the new overflow structure connecting the new parallel lake line to NPDES CSO Outfall 40 in Run 5.0, described in Section 3.3.5.2.

Figure 3-28 summarizes the results of a simulation containing Runs 1.0, 2.0, 4.0, 5.0, and 8.0 for the Genesee Area basins.

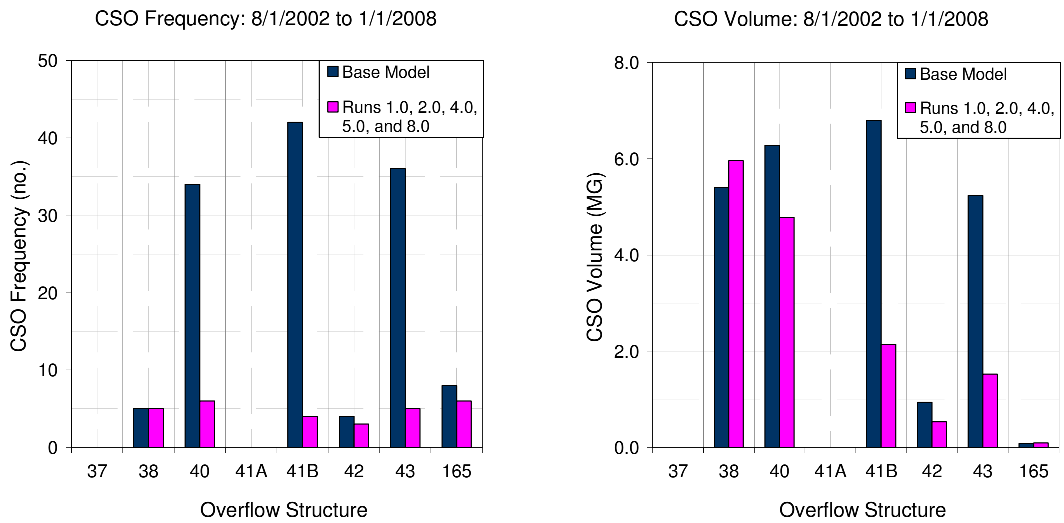


Figure 3-28: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 8.0 CSO Frequency and Volume

3.3.7 Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity

The purpose of this alternative is to bring Basin 40, Basin 41, and Basin 43 into control by increasing the conveyance to King County. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. The overflows in Basin 40, Basin 41, and Basin 43 were reduced by using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 10.1: Wet weather flow conveyance from terminus of Run 5.0 to King County, and increased capacity of Rainier Avenue Pump Station. This run is described below.

3.3.7.1 Run 10.1: Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity

The purpose of this run is the following:

- Bring Basin 40 into control by conveying flows collected from Basin 40, Basin 41, and Basin 43 from the terminus of Run 5.0 near Pump Station 5 to the King County Hanford Street Trunk B via a new pump station adjacent to existing Pump Station 5.

- Increase the capacity of King County's Rainier Avenue Pump Station to maintain existing conditions in the Hanford Street Trunk B.

The Base Model was modified by adding two 0.58-MGD pumps in a station adjacent to Pump Station 5, as seen in Figure 3-29. When flows entering the new pump station exceed the pump station capacity, flow backs up along the new conveyance pipe until they discharge from NPDES CSO Outfall 41. The pump station is sized to bring Basin 41 into control. Flows from the new pump station are pumped through a 130-foot-long, 10-inch-diameter force main and discharge into a new maintenance hole between MH 059-450 and MH 059-499. Operation of the two pumps is controlled based on the wet well level.

Run 10.1 also changed the discharge location of Pump Station 5, which is modified to pump around the existing hydraulic constriction at MH 059-450 due to the King County grit chamber, and discharge at the same point as the new pump station discharge.

Two modifications were made to the HydroBrake chamber located in MH 059-498. First, the HydroBrake was replaced with a 12-inch-wide RTC variable sluice gate to avoid increased overflows at Overflow Structure 38 due to the increased flow to King County. The gate is modulated to maintain a water level at 0.1 foot below the crest of the horseshoe weir in downstream MH 059-451. Flows that overtop the horseshoe weir flow into Overflow Structure 38, where they are either pumped through Pump Station 5 or discharge out of NPDES CSO Outfall 38, depending on conditions in the Pump Station.

The HydroBrake chamber in MH 059-498 was also modified with a new 6-foot-wide bypass weir to avoid surface flooding at MH 059-498 during large storm events. The crest of the weir is set at an elevation 28.52 feet NAVD88, to correspond with the crown of the 72-inch-diameter pipe in Storage Facility 12. Flows over the new bypass weir enter a 54-foot-long, 24-inch-diameter pipe and reach the Hanford Street Trunk B at MH 059-449.

Despite the modifications at MH 059-498, interim simulations indicated an increase in backups at the King County Rainier Pump Station, as seen by the increase in CSO frequency and volume at Overflow Structure 38. In order to avoid increased backups behind Rainier Pump Station, and to avoid increased CSO conditions at Overflow Structure 38, the capacity of King County's Rainier Avenue Pump Station was increased from 9.0 MGD to 10.3 MGD, a 14 percent increase. This pump station capacity was predicted iteratively by completing simulations with capacities at Rainier Pump Station varying from 9.0 MGD to 11.0 MGD.

Figure 3-29 shows the modifications to the model configuration.

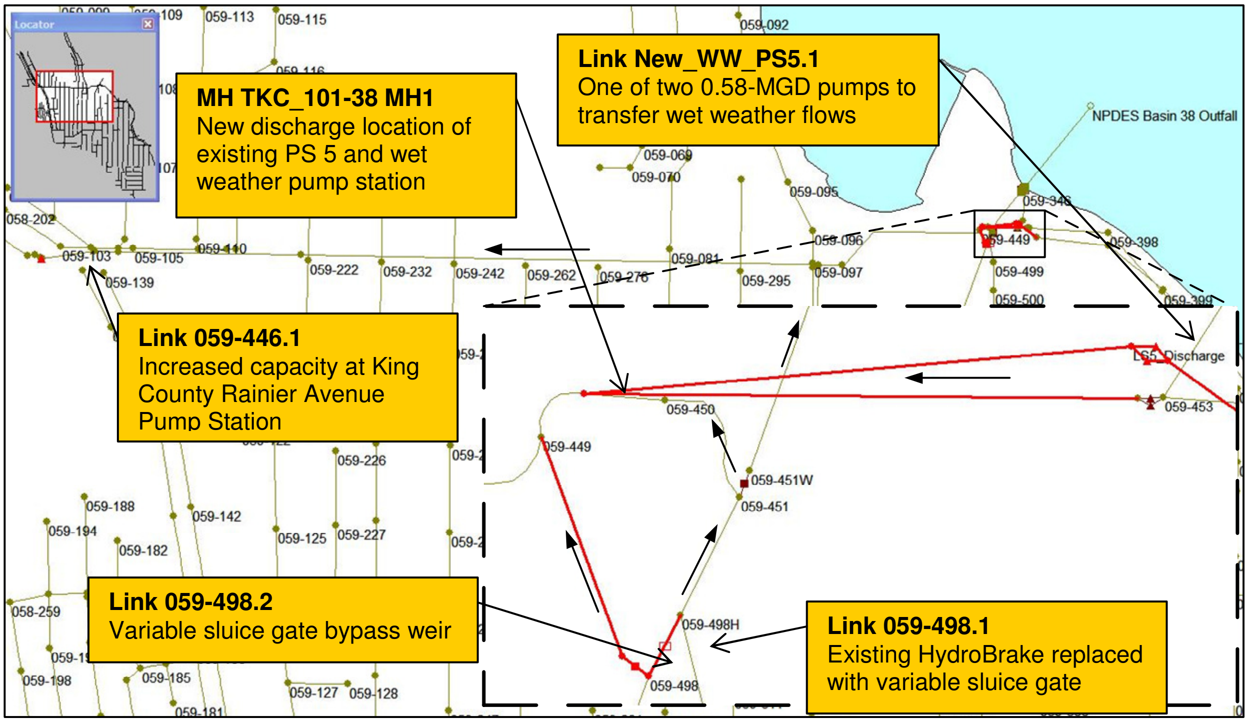


Figure 3-29: Base Model Modifications for Run 10.1

Results from the 5-year simulation for Run 10.1 showed that CSOs at Basin 41 were reduced from 42 events to 5 events. These results were below the benchmark of 6 events for Basin 41; therefore, Run 10.1 sufficiently reduces CSOs in Basin 41. The CSO frequency and volume reduction for Basin 41 are shown in Table 3-16.

Table 3-16: CSO Results Comparison between Base Model and Run 10.1

	Base Model		Run 10.1	
NPDES CSO Outfall	38	41B	38	41B
No. of CSO Events	5	42	5	5
CSO Volume (MG)	5.40	6.80	5.39	3.48

The results of Run 10.1 showed an increase in peak flow to King County of approximately 1.0 MGD for the 52nd ranked storm on 12/26/2006, as shown in Figure 3-30. The results of Run 10.1 are summarized in Figure 3-31 from a simulation containing Runs 1.0, 2.0, 4.0, 5.0, and 10.1.

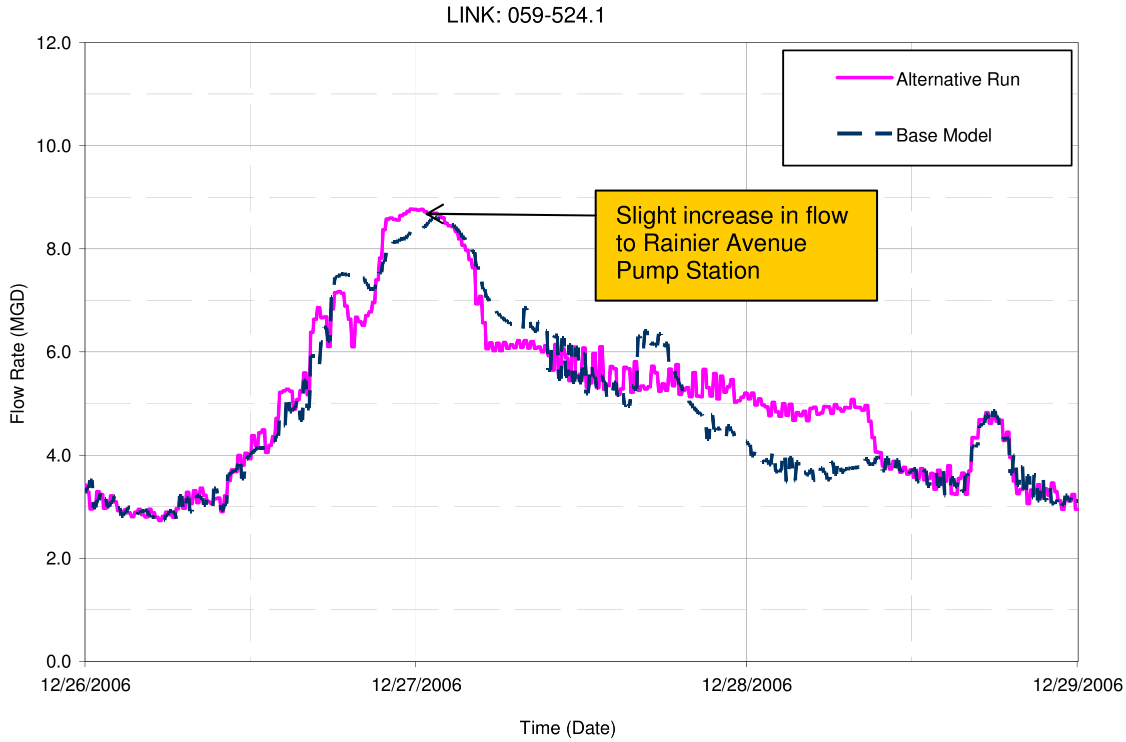
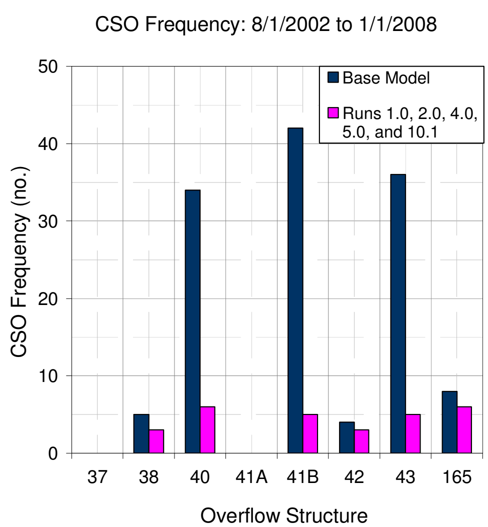


Figure 3-30: Comparison of Base Model and Run 10.1 Flow to Rainier Avenue Pump Station



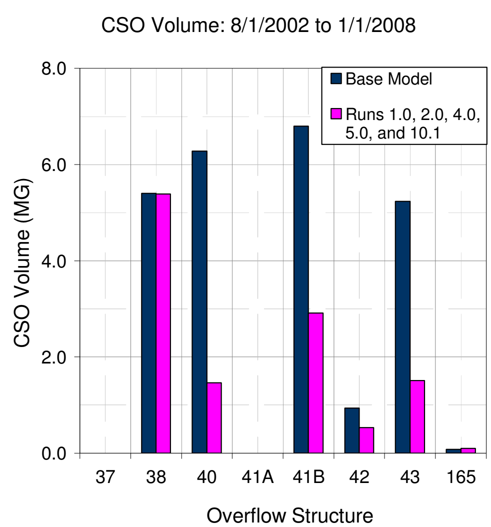


Figure 3-31: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 10.1 CSO Frequency and Volume

3.3.8 Transfer to King County and In-line Storage in King County Hanford Street Trunk B

The purpose of this alternative is to bring Basin 40, Basin 41, and Basin 43 into control by conveying the wet weather flows from them to King County. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. The overflows in Basin 40, Basin 41, and Basin 43 were reduced by using the following five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 10.2: Wet weather flow conveyance from terminus of Run 5.0 to King County, and new in-line storage in the Hanford Street Trunk B. This run is described below.

3.3.8.1 Run 10.2: Transfer to King County and In-Line Storage in King County Hanford Street Trunk B

Run 10.2 is similar to Run 10.1, described in Section 3.3.7.1, with the exception of how the increase in CSO volume and frequency at Overflow Structure 38 is managed. Run 10.1 increases the capacity at King County's Rainier Avenue Pump Station, while Run 10.2 provides in-line storage at MH 059-449 in King County Hanford Street Trunk B. The following is a summary of other changes between Run 10.2 and the Base Model:

- Two new 0.58-MGD pumps to convey flow from the terminus of Run 5.0 to King County, sized to bring Basin 41 into control.
- New discharge location for Pump Station 5 to avoid hydraulic constriction in MH 059-450.
- Replacement of the HydroBrake in MH 059-498 with an RTC variable sluice gate that is controlled based on the depth of flow at the horseshoe weir in MH 059-451.
- New HydroBrake bypass structure to avoid surface flooding at MH 059-498.

As shown in Figure 3-32, a new 2.4 MG in-line storage tank at MH 059-449 was modeled to store flows and to prevent an increase in the CSO volume and frequency at Overflow Structure 38. The tank is filled as flows to King County exceed the capacity of the 42-inch-diameter Hanford Street Trunk B. The storage tank has a footprint of 94,000 square feet and a depth of 3.3 feet. The tank floor matches the invert elevation of the pipe outlet (19.9 feet NAVD88), and the tank cover elevation matches the crest of the horseshoe weir in MH 059-498 (23.17 feet NAVD88). While the dimensions of the storage tank are not feasible for implementation, the purpose of this run is to predict the necessary storage volume. The tank is drained by gravity as capacity became available downstream. The storage volume was predicted by completing several simulations with storage volumes ranging from 0.5 MG to 2.5 MG, the results of which are shown in Table 3-17 below. The simulations were from 1/1/2007 to 1/1/2008, and the results from NPDES CSO Outfall 38 were compared to the Base Model results for the same simulation. The storage volume was varied until the CSO volume for the given storage volume matched the Base Model results. The selected storage volume is highlighted in blue.

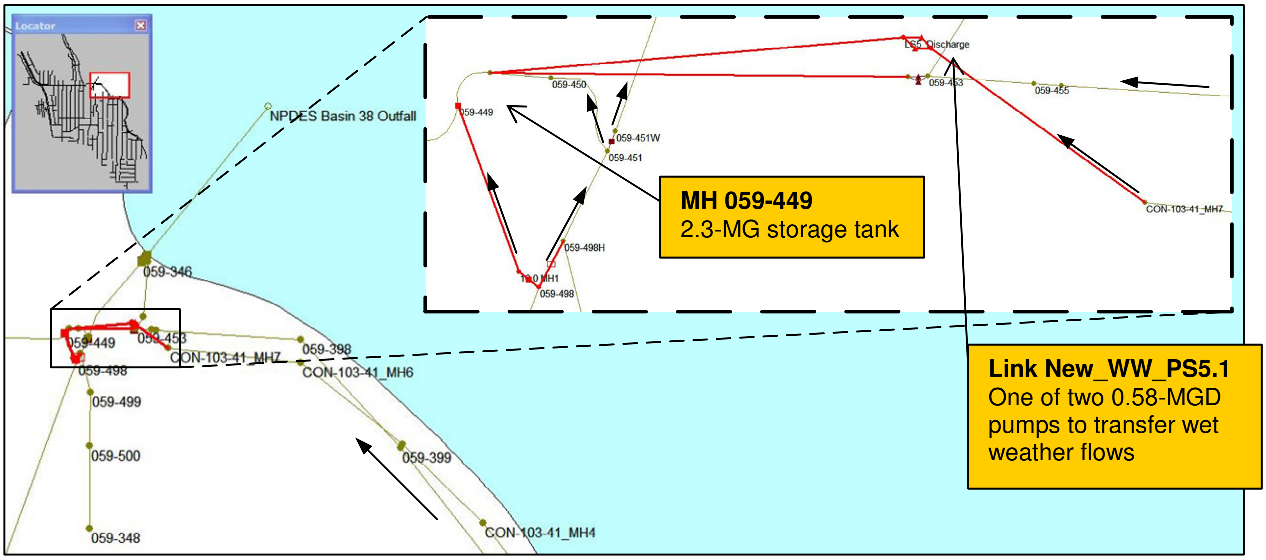


Figure 3-32: Base Model Modifications for Run 10.2

Table 3-17: Comparison of Storage Volume to CSO Volume at NPDES CSO Outfall 38

Storage Volume (MG)	CSO Volume at NPDES CSO Outfall 38 (MG)
0.0 [a]	2.84
2.0	2.97
2.3	2.95
2.4	2.84
2.5	2.73
[a] From Base Model	

Results from the simulation for Run 10.2 indicated that CSOs in Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 6 events for Basin 41; therefore, Run 10.2 sufficiently reduces CSOs in Basin 41. The CSO frequency and volume reduction for Basin 41 is shown in Table 3-18 for the 5-year period.

Table 3-18: CSO Results Comparison between Base Model and Run 10.2

	Base Model		Run 10.2	
NPDES CSO Outfall	38	41B	38	41B
No. of CSO Events	5	42	2	4
CSO Volume (MG)	5.40	6.80	5.35	2.67

The results of the Run 10.2 showed no increase in peak flow to King County for the 52nd-ranked storm on 12/26/2006, as shown in Figure 3-33. The results of Run 10.2 are summarized in Figure 3-34 from a simulation containing Runs 1.0, 2.0, 4.0, 5.0, and 10.2.

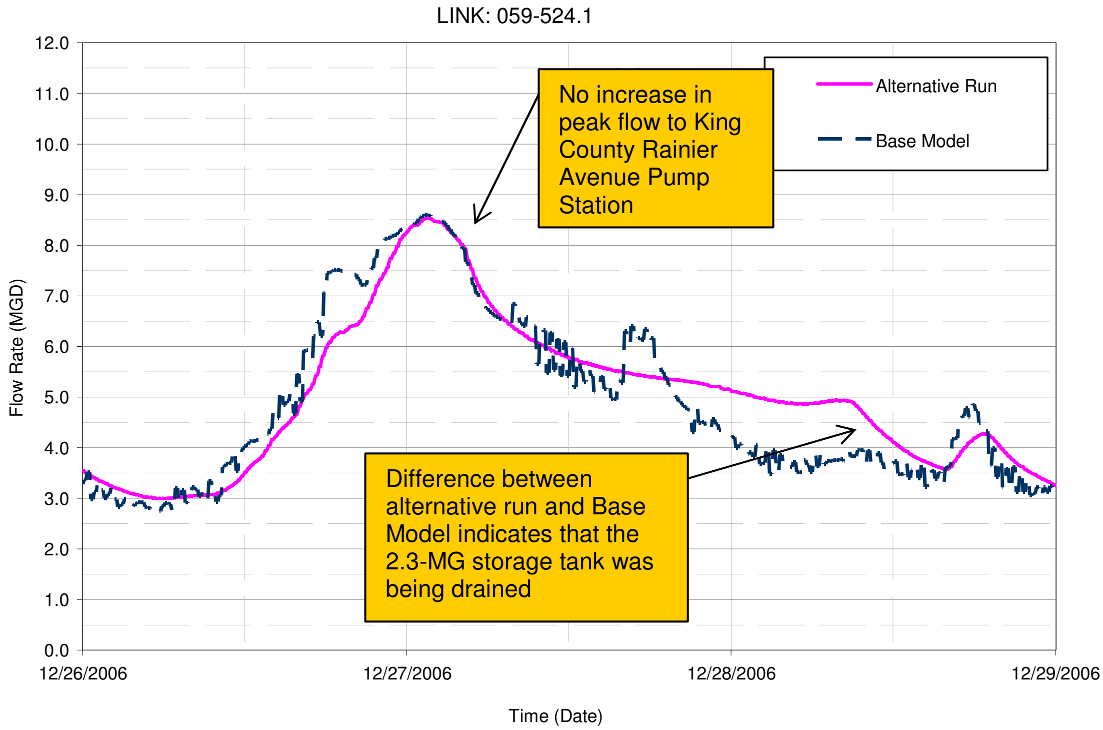


Figure 3-33: Comparison of Base Model and Run 10.2 Flow to King County Rainier Avenue Pump Station

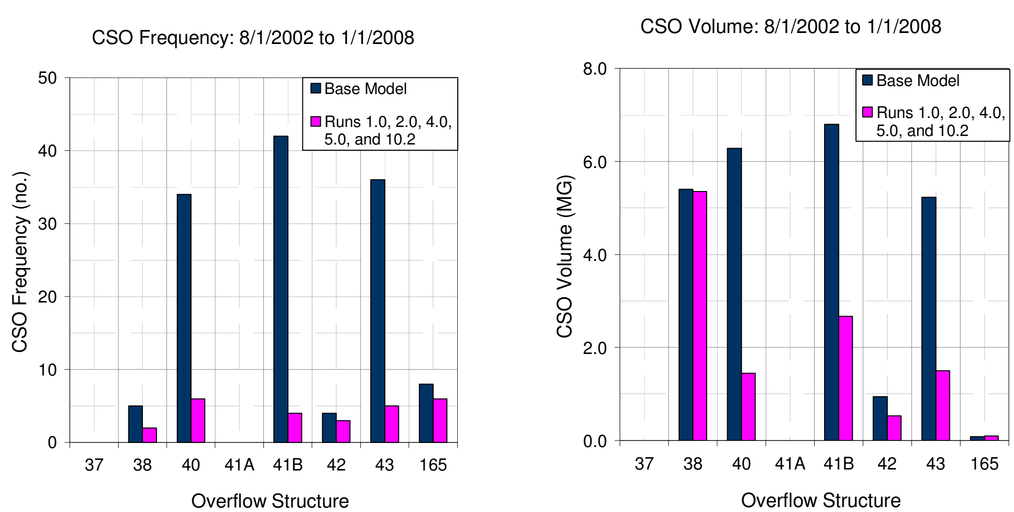


Figure 3-34: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 10.2 CSO Frequency and Volume

3.3.9 Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44

The purpose of this alternative is to bring Basin 40, Basin 41, Basin 43, and Basin 44 into control by adding offline storage along the new parallel lake line from Run 4.0 and Run 5.0. Currently, the combined control volume for Basin 40, Basin 41, Basin 43, and Basin 44 is 2.8 MG. The overflows in Basin 40, Basin 41, Basin 43, and Basin 44 were reduced by using the following five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 12.0: Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44 Diverted Flow. This run is described below.

3.3.9.1 Run 12.0: Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44 Diverted Flow

The purpose of this run is to provide sufficient storage to bring Basin 41 into control, and to provide sufficient storage to store flows from Basin 40, Basin 43, and Basin 44. Flows from Basin 40 are conveyed to storage by Run 1.0. Flows from Basin 43 and Basin 44 are conveyed to storage by Run 5.0.

As seen in Figure 3-35, the diameter of the parallel lake line from Run 4.0 and Run 5.0 was increased from 24 inches to 144 inches from the downstream end of Run 5.0 (near the vicinity of Pump Station 5) 3,150 feet upstream to MHCON-104-42_MH6. The parallel lake line was modeled so that the crown of the storage pipe was below the Overflow Structure 41B weir crest elevation of 19.51 feet NAVD88. The pipe upstream from the 144-inch-diameter storage pipe was increased from a 24-inch-diameter pipe to a 36-inch-diameter pipe from the upstream end of the 144-inch-diameter pipe to the diversion weir from the existing lake line at the upstream end of Run 4.0. The above adjustments resulted in 2.9 MG of offline storage.

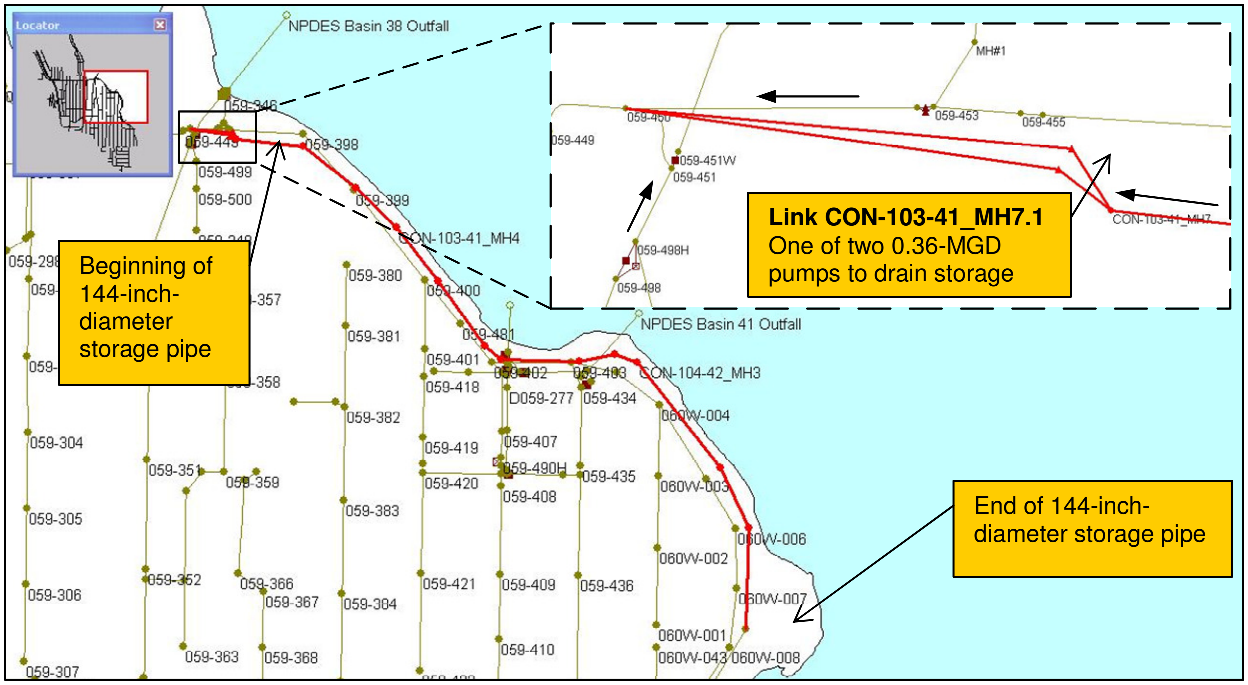


Figure 3-35: Base Model Modifications for Run 12.0

The offline storage pipe is drained with two fixed-speed pumps, each with a capacity of 0.36 MGD. The control for the pumps is based on the available capacity in the downstream system. If additional capacity is available in the system (Hanford Street Trunk B), the lead and lag pumps draining the storage pipe are activated. The level at the upstream end of the King County Hanford Street Trunk B near the grit chamber in MH 059-499 was used to activate the drainage pumps.

The model was used to find the balance among pump rates that could sufficiently drain the storage pipe, control for the pumps, and provide the volume of storage needed to control NPDES CSO Outfall 41 without increasing the CSOs at NPDES CSO Outfall 38. The level at the horseshoe weir (MH 059-451) was initially used to control the drainage pumps; however, the maximum level at this location is 0.77 foot (from invert to the weir crest elevation). The pump controls were only successful when the level in the downstream Hanford Street Trunk B was used.

Results from the simulation for Run 12.0 indicated that CSOs in Basin 41 were reduced from 42 events to 2 events. These results were below the benchmark of 6 events for Basin 41; therefore, Run 12.0 sufficiently reduces CSOs in Basin 41. The CSO frequency and volume reduction for Basin 41 is shown in Table 3-19 for the 5-year period.

Table 3-19: CSO Results Comparison between Base Model and Run 12.0

	Base Model		Run 12.0	
NPDES CSO Outfall	38	41	38	41
No. of CSO Events	5	42	5	2
CSO Volume (MG)	5.40	6.8	6.24	1.53

The number of CSOs at NPDES CSO Outfall 38 was equal to the Base Model condition of five CSOs, but total volume discharged during the 5-year run increased from 5.40 to 6.24 MG. The increase in CSO volume is due to the increase of flow into Hanford Street Trunk B. Figure 3-36 compares the flows into the Rainier Avenue Pump Station, showing the increase during the December 2006 control volume event.

The results of Run 12.0 are summarized in Figure 3-37 from a simulation containing Runs 1.0, 2.0, 4.0, 5.0, and 10.2.

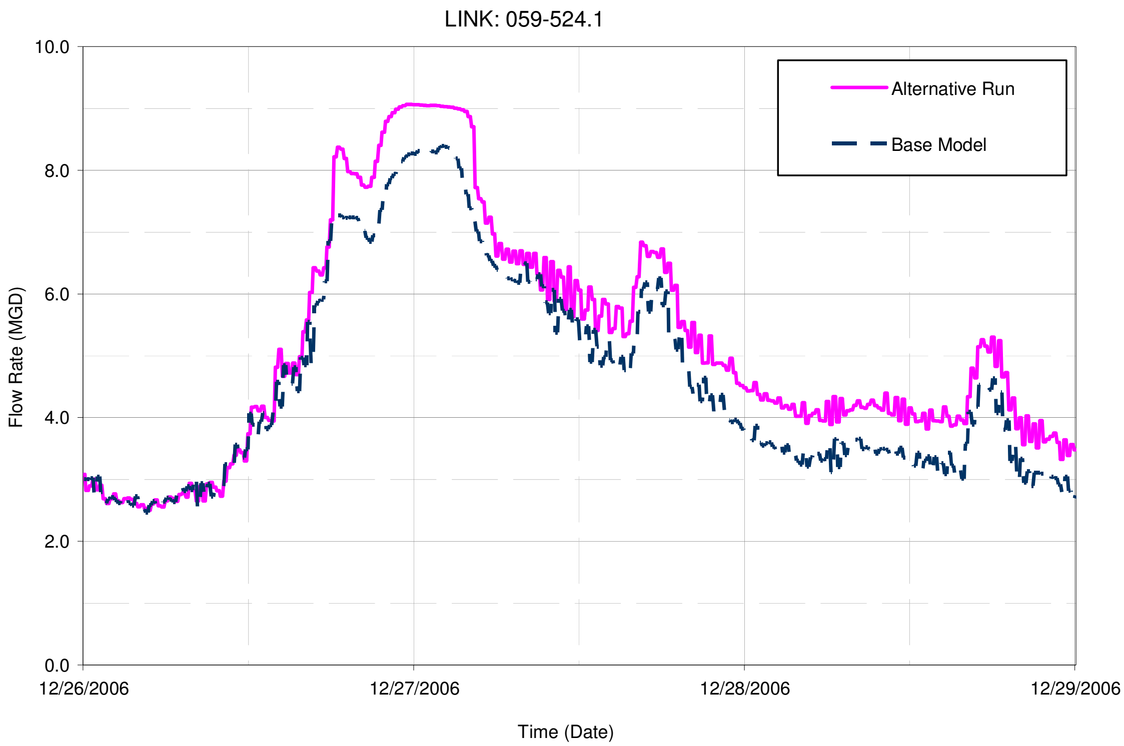


Figure 3-36: Comparison of Run 12.0 and Base Model Flow into Rainier Avenue Pump Station

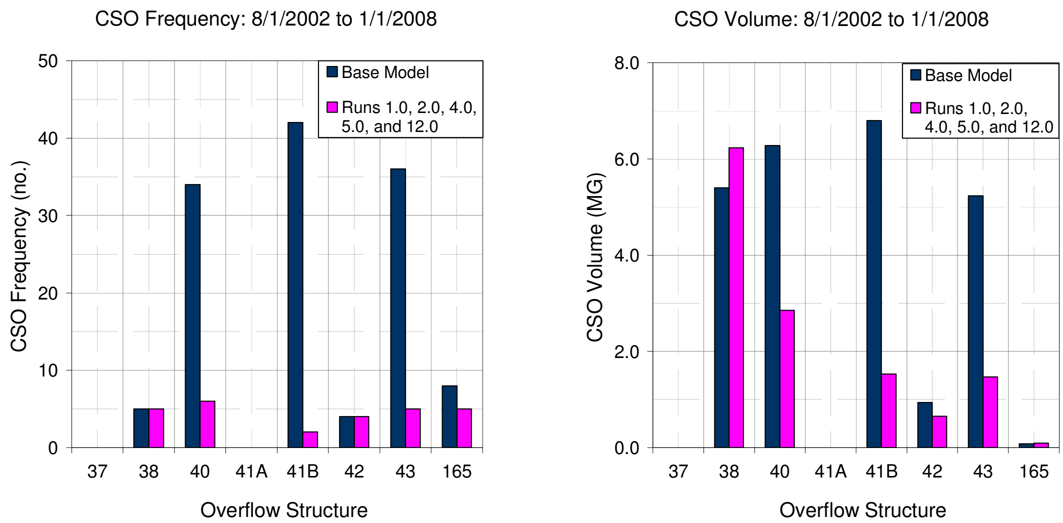


Figure 3-37: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 12.0 CSO Frequency and Volume

3.3.10 Inter-basin Transfer of Basin 41 to Basin 38

The purpose of this alternative is to bring Basin 40, Basin 41, and Basin 43 into control by transferring flows from Basin 41 to Basin 38 and adding offline storage in Basin 43. Currently, the combined control volume for Basin 40, Basin 41, Basin 43, and Basin 44 is 578,000 gallons. The overflows in Basin 40, Basin 41, and Basin 43 were reduced by using the following model runs:

- Run 3.0: Offline storage in Basin 43. See Section 3.3.3.1 for details.
- Run 13.0: Inter-basin transfer of Basin 41 to Basin 38. This run is described below.

3.3.10.1 Run 13.0: Inter-basin transfer of Basin 41 to Basin 38

The purpose of Run 13.0 is to bring Basin 40 and Basin 41 into control. To control Basin 41, flows from the lake line were diverted into a new pump station located near MH 060W-007 at the parking lot to the east of Adams Street and Lake Washington Boulevard. Flow from the new pump station was then pumped into the upstream end of CSO Facility 12 in Genesee Park. By diverting this flow, the capacity in the lake line in Basin 41 increased sufficiently to bring Basin 41 into control.

To control Basin 40, approximately 80 percent of the basin area which previously flowed through the Overflow Structure 40 in the Base Model was also diverted into the new pump station and conveyed into the Genesee Park in-line storage pipe.

To incorporate the above, the Base Model was modified by the following changes:

- 1,000 feet of 12-inch-diameter pipe was added to intercept flow previously conveyed to Basin 40 through MHs 060W-001, 059-437, and 059-410. A 50-foot segment between this new 12-inch-diameter pipe and MH 059-384 was increased from an 8-inch to a 12-inch-diameter pipe.

- 1,700 feet of 12-inch-diameter force main was used to convey flow from the new pump station to MH 059-384.
- A diversion weir was modeled in the lake line with a weir crest elevation of 22.35 feet NAVD88, 4 inches above the invert of the 15-inch-diameter lake line. The elevation was based on conveying dry weather flow down the existing lake line, but diverting wet weather flow into the new pump station. This diversion of flow was needed in order to control CSOs at Overflow Structure 41B.
- A new pump station was modeled near MH 060W-007 at the parking lot to the east of Adams Street and Lake Washington Boulevard. The pump station has two pumps, each with a capacity of 2 MGD.
- The bypass weir at Overflow Control Structure 38 was raised from the Base Model elevation of 26.55 to 28.43 feet NAVD88 in order to increase the effective in-line storage in Storage Facility 12 by 0.34 MG (a 92 percent increase).

The above modifications are shown in Figure 3-38.

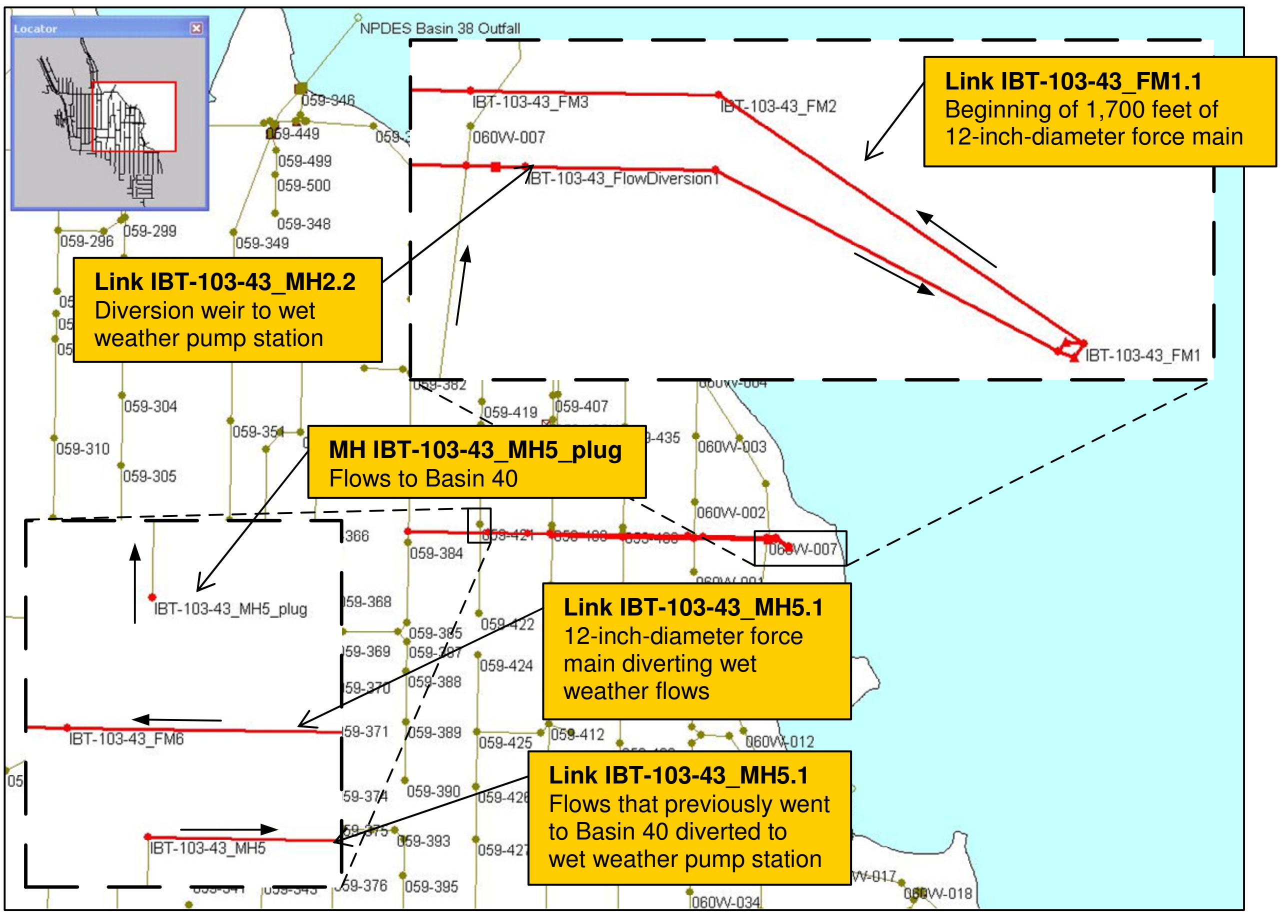


Figure 3-38: Base Model Modifications for Run 13.0

Results from the simulation for Run 13.0 indicated that overflows at Basin 40 were reduced from 34 events to 0 events, and overflows at Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 7 events for Basin 40 and 6 events for Basin 41; therefore, transferring flows from the lake line to Basin 38 sufficiently reduces CSOs in Basin 40 and Basin 41. The CSO frequency and volume reduction for Basin 40 and Basin 41 are shown in Table 3-20 for the 5-year period. Figure 3-39 compares the CSO frequency and volume at all basins in the Genesee Area for combined simulation of Run 3.0 and Run 13.0.

The number of CSOs at Overflow Structure 38 was increased from 5 in the Base Model to 6 CSOs. The model predicted that the smallest CSO volume (resulting from the sixth-ranked storm) was less than 9,000 gallons. As a result, Run 13.0 needs some additional refinement, possibly during preliminary engineering. These additional changes may include adjusting the configuration of the new pump station, additional changes to use the in-line storage in Genesee Park more efficiently, and adjusting the RTC control approach used in the run.

Table 3-20: CSO Results Comparison between Base Model and Run 13.0

	Base Model			Run 13.0		
NPDES CSO Outfall	38	40	41	38	40	41
No. of CSO Events	5	34	42	6	0	4
CSO Volume (MG)	5.40	6.28	6.8	9.48	0	0.81

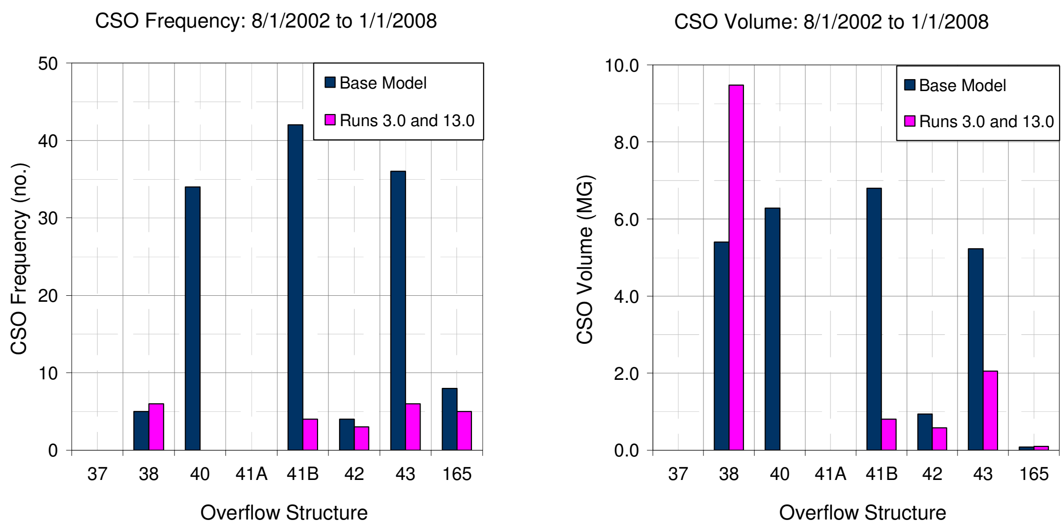


Figure 3-39: Comparison of Base Model and Simulation Containing Runs 3.0 and 13.0 CSO Frequency and Volume

3.3.11 Offline Storage for Basin 43 and Combined Offline Storage for Basin 40 and Basin 41

The purpose of this alternative is to bring Basin 40, Basin 41, and Basin 43 into control by modeling offline storage in Basin 43 and a combined offline storage tank for Basin 40 and 41 in Basin 41. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. CSOs in Basin 40, Basin 41, and Basin 43 were reduced by using two model runs:

- Run 3.0: Offline storage in Basin 43. See Section 3.3.3.1 for details.
- Run 14.0: Combined Offline Storage for Basin 40 and Basin 41. This run is described below.

3.3.11.1 Run 14.0: Combined Offline Storage for Basin 40 and 41

The purpose of Run 14.0 is to bring Basin 40 and Basin 41 into control by adding offline storage in Basin 41.

A 430,000-gallon offline storage tank was modeled to the east of Overflow Control Structure 41B at MH 059-406 to store wet weather flows from Basin 40 and Basin 41. The combined control volume for Basin 40 and Basin 41 is 391,000 gallons. The storage volume to control Basin 40 and Basin 41 is 39,000 gallons larger than the combined control volume for Basin 40 and Basin 41 because the control volume events for Basin 40 and Basin 41 do not occur at the same time. Thus, the storage tank is sized for the storm that had the largest combined CSO volume from Basin 40 and Basin 41. Table 3-21 compares the combined CSO volumes for Basin 40 and Basin 41 for their respective control volume events.

Table 3-21: Sizing of Storage Tank Based on Control Volume Events

	Basin 40	Basin 41
Control Volume Event	12/13/2001	11/21/1980
Basin 40 CSO Volume (MG)	0.203	0.219
Basin 41 CSO Volume (MG)	0.223	0.188
Total CSO Volume (MG)	0.426	0.407

Flows from Basin 40 are diverted into the storage tank with a new 20-foot-wide storage diversion weir at MH 059-495, directly upstream from the existing HydroBrake in MH 059-490. This weir crest is set at an elevation of 33.25 feet NAVD88, which is 3 inches below the elevation of the weir crest in Overflow Structure 40. A wide weir is needed to allow a large amount of flow over the weir with a small head, in order to keep the hydraulic profile from backing up over the overflow weir upstream at MH 059-495.

Flows from Basin 41 enter the offline storage tank from a storage diversion weir located in MH 059-406, as seen in Figure 3-40. This weir crest is set at an elevation of 19.51 feet NAVD88 to match the elevation of the weir in Overflow Structure 41B.

Once the offline storage tank is full, flow is diverted out of NPDES CSO Outfalls 40 and 41. Flow enters NPDES CSO Outfall 41 from Overflow Structure 41B, located in MH 059-406W. Flows enter NPDES CSO Outfall 40 from two locations:

- The existing Control Structure 40 located in MH 059-491. Weir crest elevation is 19.51 feet NAVD88.
- An additional Control Structure 40 located in MH OFF-113-38_MH4, which connected the offline storage tank to NPDES CSO Outfall 40 at MH D059-278. Weir crest elevation is 19.51 feet NAVD88.

These two overflow structures are needed to provide sufficient CSO flow capacity for the storage tank to overflow during large storm events. The capacity of NPDES CSO Outfall 41 is 1.8 MGD, which is frequently smaller than the flow diverted into storage when storage is full. Adding the overflow structure into NPDES CSO Outfall 40 increases the CSO flow capacity to nearly 30 MGD, providing sufficient capacity.

Changes to the Base Model for Run 14.0 are shown in Figure 3-40.

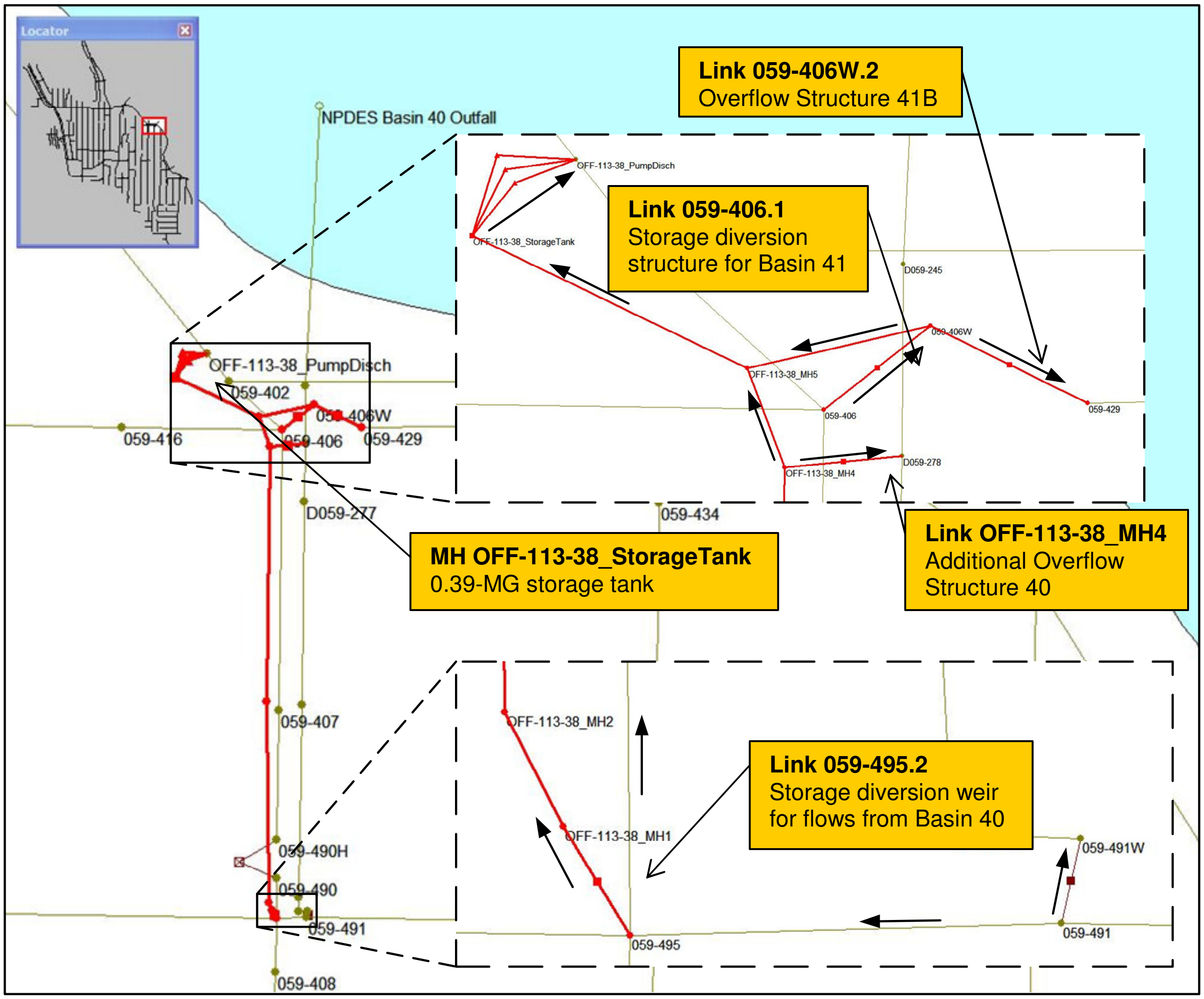


Figure 3-40: Base Model Modifications for Run 14.0

Results from the simulation for Run 14.0 indicated that overflows at Basin 40 were reduced from 34 events to 5 events, and overflows at Basin 41 were reduced from 42 events to 6 events. These results were below or met the benchmark of 7 events for Basin 40 and 6 events for Basin 41; therefore, modeling 430,000 gallons of offline storage sufficiently reduces CSOs in Basin 40 and Basin 41. The CSO frequency and volume reduction for Basin 40 and Basin 41 are shown in Table 3-22 for the 5-year period. Figure 3-41 compares the CSO frequency and volume at all basins in the Genesee Area for a simulation including Runs 3.0 and 14.0.

Table 3-22: CSO Results Comparison between Base Model and Run 14.0

	Base Model		Run 14.0	
NPDES CSO Outfall	40	41B	40	41B
No. of CSO Events	34	42	6	6
CSO Volume (MG)	6.28	6.80	4.44	3.48

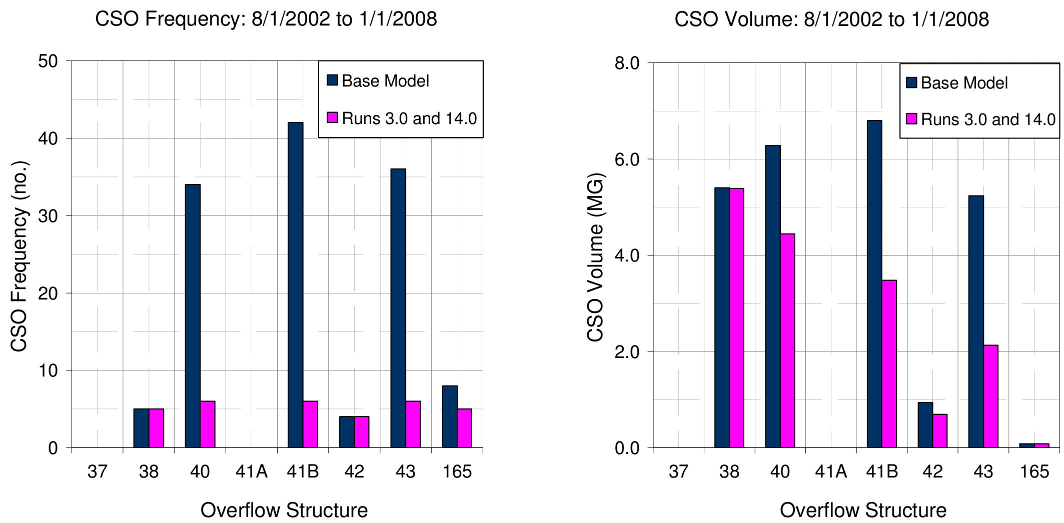


Figure 3-41: Comparison of Base Model and Simulation Containing Runs 3.0 and 14.0 CSO Frequency and Volume

3.3.12 Offline Storage in Lake Washington Boulevard

The purpose of this alternative is to bring Basin 40, Basin 41, and Basin 43 into control by adding offline storage in Lake Washington Boulevard. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. The overflows in Basin 40, Basin 41, and Basin 43 were reduced by using the following five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details.
- Run 15.0: Offline storage in Lake Washington Boulevard. This run is described below.

3.3.12.1 Run 15.0: Offline Storage in Washington Boulevard

The purpose of Run 15.0 is to bring Basin 41 into control by adding offline storage in the Lake Washington Boulevard, and to provide sufficient storage to store flows from Basin 40 and Basin 43. Flows from Basin 40 are conveyed to storage by Run 1.0. Flows from Basin 43 are conveyed to storage by Runs 4.0 and 5.0.

To model the offline storage pipe, the diameter of the pipe used in Run 5.0 was increased from a 24-inch-diameter pipe to a 120-inch-diameter pipe. The pipe alignment and slope used in Run 5.0 are also used in Run 15.0; however, the offline storage pipe was deepened such that the crown of the pipe is below the weir crest elevation in Overflow Structure 41B of

19.51 feet NAVD88. The length of the offline storage pipe is 1,250 feet, and it provides 0.83 MG of storage.

The offline storage pipe is drained by two fixed-speed pumps, each rated at 0.36 MGD. Control for these pumps is based on the level in the Pump Station 5 wet well. As the level in Pump Station 5 wet well decreased after a storm, the offline drainage pumps are activated.

The above modifications are shown in Figure 3-42.

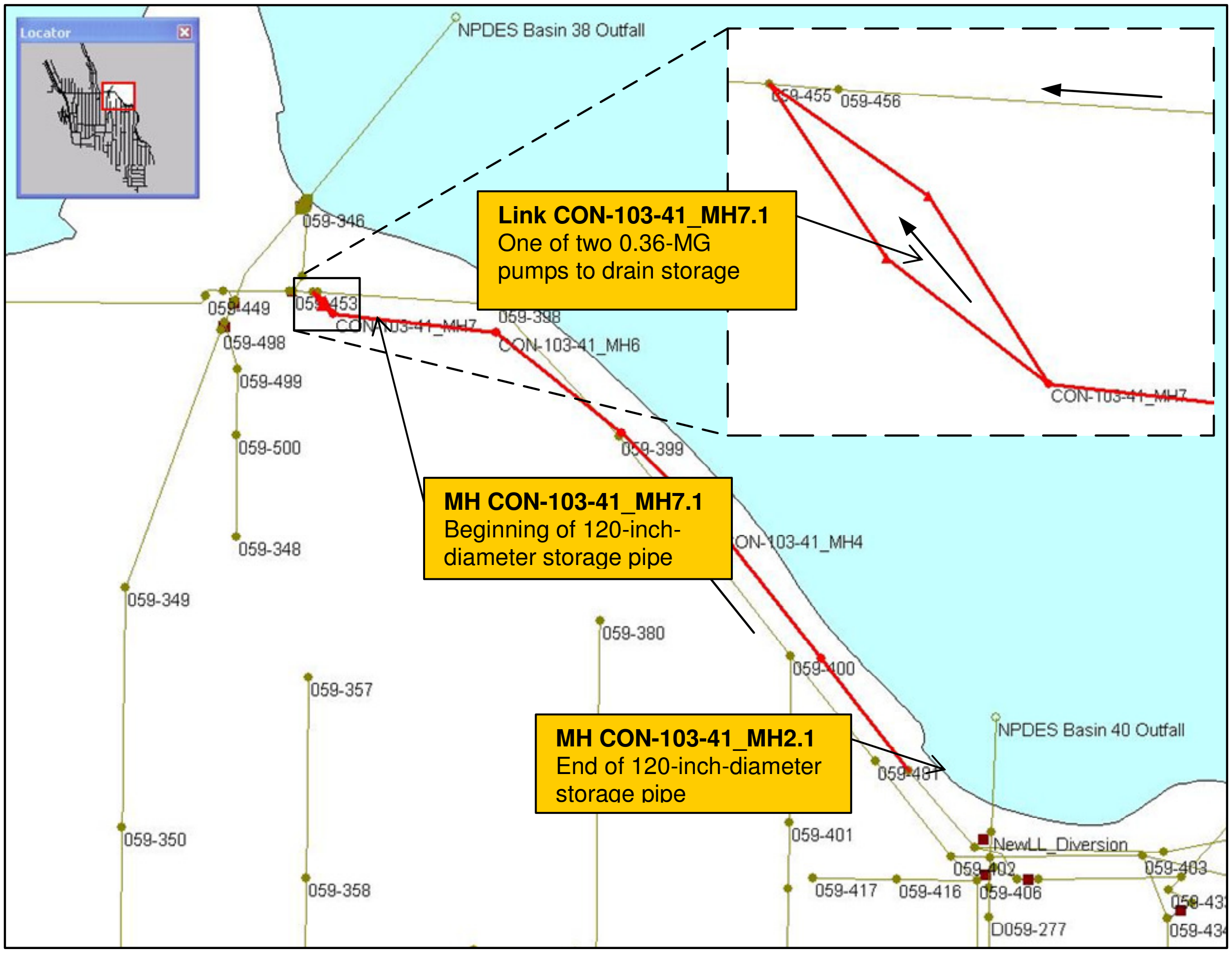


Figure 3-42: Base Model Modifications for Run 15.0

Results from the simulation for Run 15.0 indicated that CSOs in Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 6 events for Basin 41; therefore, adding 0.83 MG of offline storage in Run 15.0 sufficiently reduces CSOs in Basin 41. The CSO frequency and volume reduction for Basin 41 is shown in Table 3-23 for the 5-year period.

Figure 3-43 shows the results of a simulation containing Runs 1.0, 2.0, 4.0, 5.0, and 15.0 for all basins in the Genesee Area.

Table 3-23: CSO Results Comparison between Base Model and Run 15.0

	Base Model		Run 15.0	
NPDES CSO Outfall	38	41	38	41
No. of CSO Events	5	42	5	4
CSO Volume (MG)	5.40	6.8	6.03	3.01

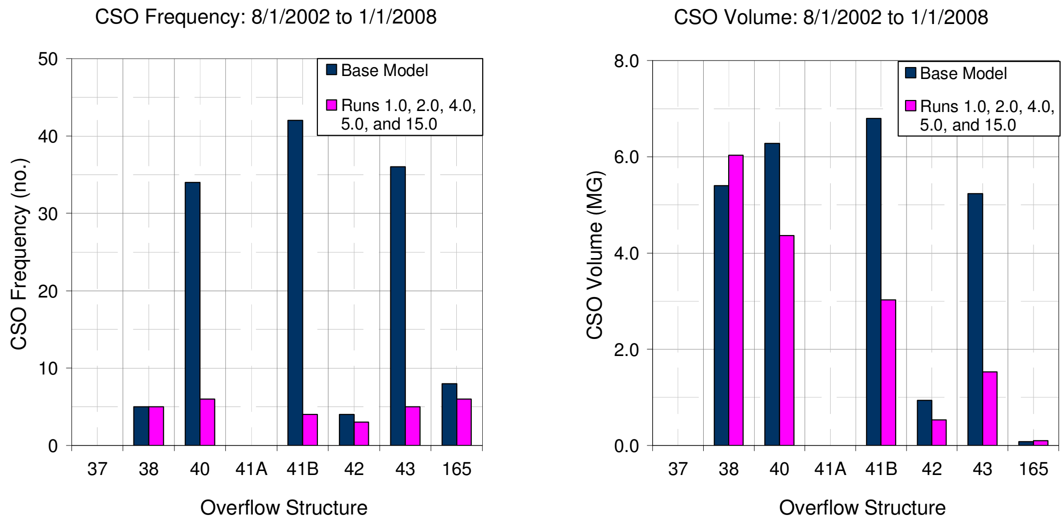


Figure 3-43: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 15.0 CSO Frequency and Volume

3.3.13 Transfer to King County, Offline Storage in Basin 43, and Increase in King County Rainier Avenue Pump Station Capacity

The purpose of this alternative is to control Basin 40 and Basin 41 by increasing the conveyance to King County and control Basin 43 by modeling offline storage in Basin 43. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. The overflows in Basin 40, Basin 41, and Basin 43 were reduced using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 3.0: Offline storage in Basin 43. See Section 3.3.3.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 16.1: Wet weather flow conveyance from terminus of Run 5.0 to King County and increased capacity of Rainier Avenue Pump Station. This run is described below.

3.3.13.1 Run 16.1: Transfer to King County and Increase Capacity of Rainier Avenue Pump Station

The purpose of Run 16.1 is to bring Basin 41 into control by transferring flows from Basin 40, Basin 41, and Basin 43 to King County. Run 16.1 is similar to Run 10.1 (described in Section 3.3.7.1) with the exceptions of the capacity of the new pump station located next to Pump Station 5 and the capacity of King County's Rainier Avenue Pump Station. These differences are caused by different upstream conditions for Run 16.1 and Run 10.1. Run 16.1 includes offline storage in Basin 43 (Run 3.0), while Run 10.1 includes increased conveyance in Basin 43 (Run 2.0). The following is a summary of the changes between Run 16.1 and the Base Model:

- Two new 0.33-MGD pumps to convey flow from the terminus of Run 5.0 to the Hanford Street Trunk B, sized to bring Basin 41 into control
- New discharge location for Pump Station 5 to avoid hydraulic constriction in MH 059-450
- Replacement of the HydroBrake in MH 059-498 with an RTC variable sluice gate controlled based on the combined sewage level at the horseshoe weir in MH 059-451
- New HydroBrake bypass structure to avoid surface flooding at MH 059-498

The overflow frequency and volume at Overflow Structure 38 increased despite the modifications at MH 059-498. In order to maintain existing overflow conditions at Overflow Structure 38, the capacity of King County Rainier Avenue Pump Station was increased from 9.0 MGD to 9.8 MGD, an increase of 9 percent.

Figure 3-44 shows the modifications to the model configuration.

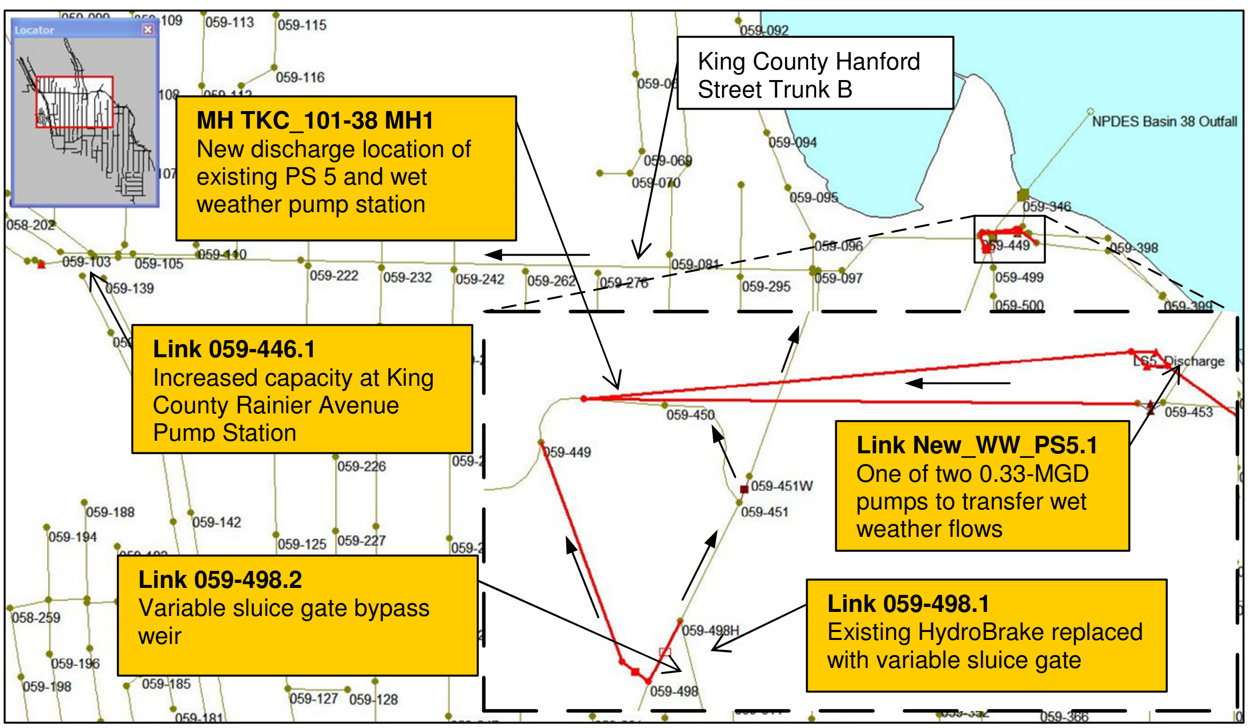


Figure 3-44: Base Model Modifications for Run 16.1

Results from the 5-year simulation for Run 16.1 indicated that overflows at Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 6 events for Basin 41; therefore, Run 16.1 sufficiently reduces CSOs at Overflow Structure 41B. The CSO frequency and volume reduction for Basin 41 are shown in Table 3-24 for the 5-year period. The results of Run 16.1 are summarized in Figure 3-45. The CSO volumes and frequencies shown are from a simulation that includes Runs 1.0, 3.0, 4.0, 5.0, and 16.1.

Table 3-24: CSO Results Comparison between Base Model and Run 16.1

	Base Model		Run 10.1	
NPDES CSO Outfall	38	41B	38	41B
No. of CSO Events	5	42	3	4
CSO Volume (MG)	5.40	6.80	5.45	3.09

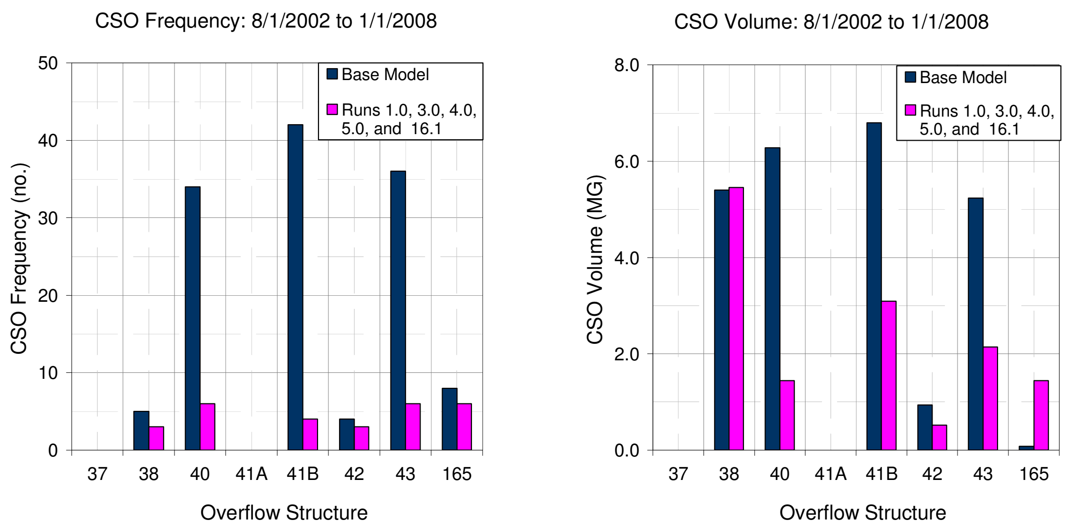


Figure 3-45: Comparison of Base Model and Simulation Containing Runs 1.0, 3.0, 4.0, 5.0, and 16.1 CSO Frequency and Volume

3.3.14 Transfer to King County, Offline Storage in Basin 43, and In-line Storage in King County Hanford Street Trunk B

The purpose of this alternative is to bring Basin 40 and Basin 41 into control by conveying them to King County, and to bring Basin 43 into control by modeling offline storage in Basin 43. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. The overflows in Basin 40, Basin 41, and Basin 43 were reduced by using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 3.0: Offline storage in Basin 43. See Section 3.3.3.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.

- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 16.2: Wet weather flow conveyance from terminus of Run 5.0 to King County, and increased capacity of Rainier Avenue Pump Station. This run is described below.

3.3.14.1 Run 16.2: Transfer to King County and In-Line Storage in King County Hanford Street Trunk B

The purpose of Run 16.2 is to bring Basin 41 into control by transferring flows from Basin 40 and Basin 41 to King County. Run 16.2 and Run 16.1 (described in Section 3.3.13.1) are the same with the exception of how the increase in CSO volume and frequency at Overflow Structure 38 is managed. Run 16.1 increases the capacity at King County Rainier Avenue Pump Station while Run 16.2 provides in-line storage at MH 059-449. The following is a summary of changes between Run 16.2 and the Base Model:

- Two new 0.33-MGD pumps to convey flow from the terminus of Run 5.0 to King County
- New discharge location for Pump Station 5 to avoid hydraulic constriction in MH 059-450
- Replacement of the HydroBrake in MH 059-498 with an RTC variable sluice gate controlled based on the combined sewage level at the horseshoe weir in MH 059-451
- New HydroBrake bypass structure to avoid surface flooding at MH 059-498

In addition, the Base Model was modified with a 1.6-MG in-line storage tank at MH 059-449 to prevent an increase in the CSO volume and frequency at Overflow Structure 38. The tank is filled as flows to King County exceed the capacity of the 42-inch-diameter Hanford Street Trunk B. The storage tank has a footprint of 65,000 square feet, and a depth of 3.3 feet. The tank floor matches the invert elevation of the outgoing pipe (19.9 feet NAVD88), and the tank cover elevation matches the crest of the horseshoe weir in MH 059-498 (23.17 feet NAVD88). While the dimensions of the storage tank are not feasible for implementation, this run is intended to predict the required storage volume. The tank is drained by gravity as conveyance capacity became available downstream.

Figure 3-46 shows the Run 16.2 modifications to the model configuration.

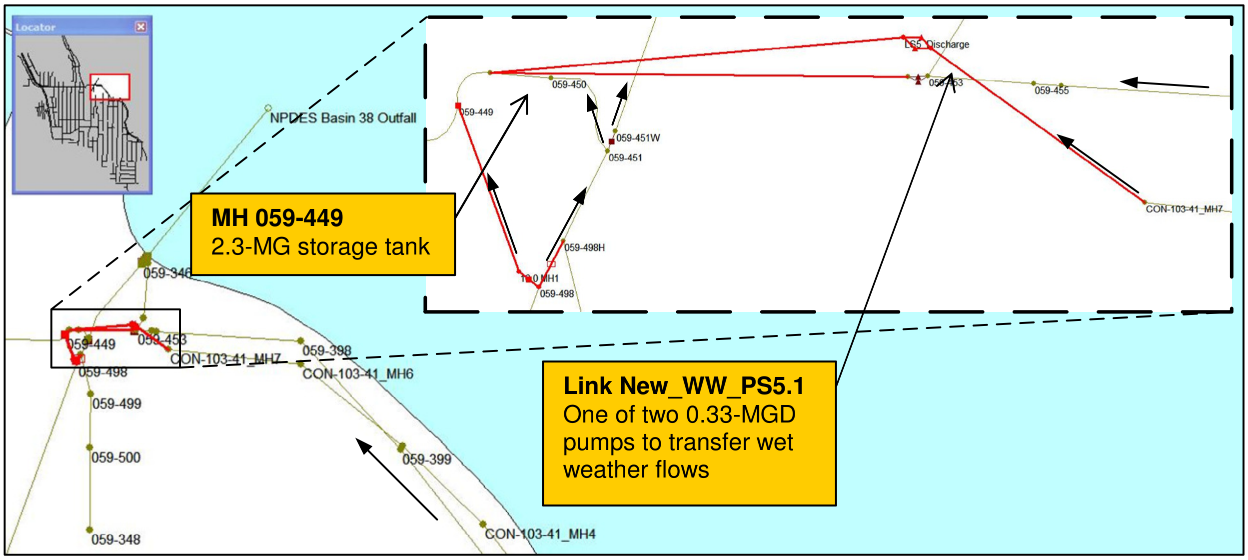


Figure 3-46: Base Model Modifications for Run 16.2

Results from the 5-year simulation for Run 16.2 showed that CSOs at Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 6 events for Basin 41; therefore, Run 16.2 sufficiently reduces CSOs at Overflow Structure 41B. The CSO frequency and volume reduction for Basin 41 is shown in Table 3-25 for the 5-year period.

The results of the Run 16.2 showed an increase in peak flow to King County of approximately 0.6 MGD for the 52nd-ranked storm on 12/26/2006, as shown in Figure 3-47.

The results of a simulation including Runs 1.0, 3.0, 4.0, 5.0, and 16.2 are summarized in Figure 3-48.

Table 3-25: CSO Results Comparison between Base Model and Run 16.2

	Base Model		Run 16.2	
NPDES CSO Outfall	38	41B	38	41B
No. of CSO Events	5	42	3	4
CSO Volume (MG)	5.40	6.80	5.09	3.07

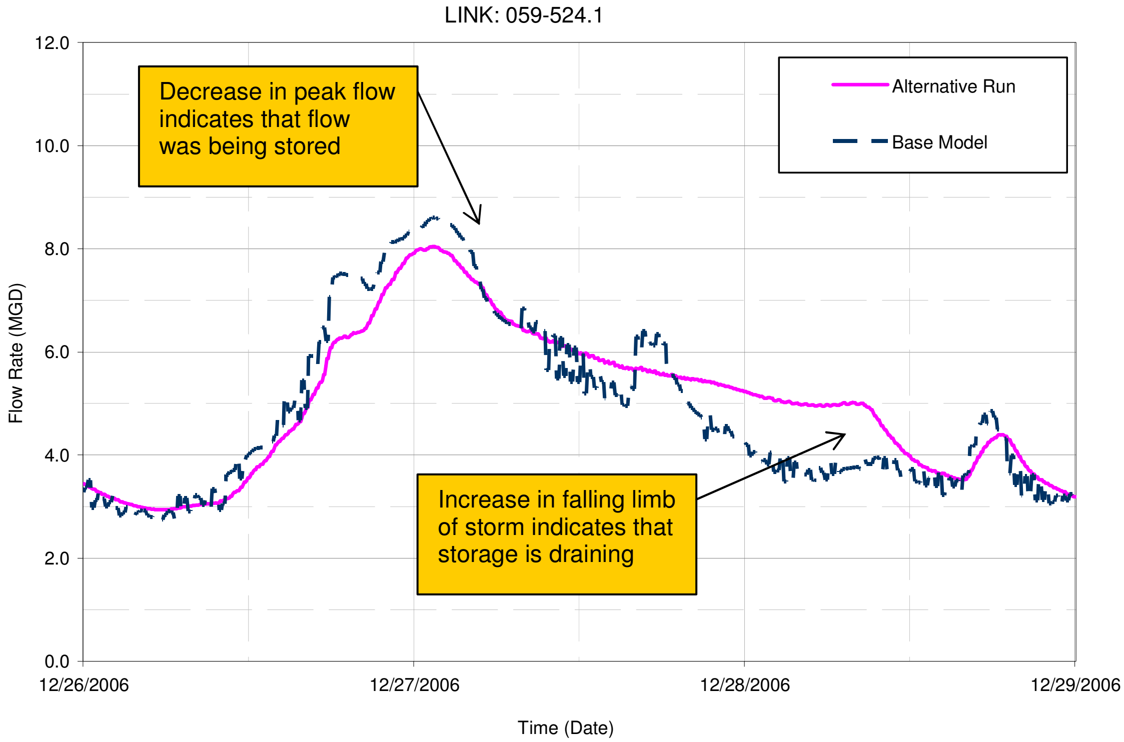


Figure 3-47: Comparison of Run 16.2 and Base Model Flow into Rainier Avenue Pump Station

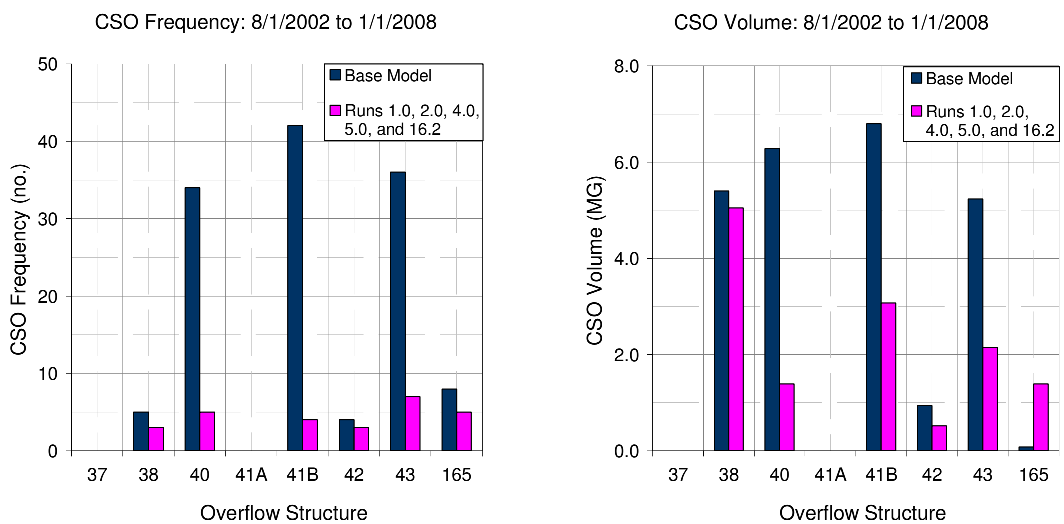


Figure 3-48: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 16.2 CSO Frequency and Volume

3.3.15 Offline Storage in Basin 38 including Henderson Basin 44

The purpose of this alternative is to bring Basin 40, Basin 41, Basin 43, and Basin 44 into control by modeling an offline storage pipe in Basin 38, and to convey flow from Basin 40, Basin 41, Basin 43, and Basin 44 into the storage pipe. Currently, the combined control volume for Basin 40, Basin 41, Basin 43, and Basin 44 is 2.8 MG. CSO frequency was reduced by using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.5.5.2 for details on this run.
- Run 17.0: Offline storage in Basin 38 including Henderson Basin 44. This run is described below.

3.3.15.1 Run 17.0: Offline Storage in Basin 38 including Henderson Basin 44

The purpose of Run 17.0 was to provide offline storage for flows conveyed from Run 5.0, and to bring Basin 40 and Basin 41 into compliance.

As Figure 3-49 shows, Run 17.0 conveys flows from the terminus of Run 5.0, near MH 059-455 adjacent to Pump Station 5, through approximately 1,100 feet of 24-inch-diameter pipe to a new offline storage pipe located in the 43rd Avenue ROW in Basin 38. The 144-inch-diameter storage pipe is 2,525 feet long and provides 2.35 MG of storage. Once the storage is full, flows overtop the weirs located in Overflow Structure 40 and Overflow Structure 41B, as described in Section 3.5.5.2 for Run 5.0.

The storage volume was predicted by completing a control storm event simulation with the components of Runs 1.0, 2.0, 4.0, 5.0, and 17.0 discharging to an outfall instead of a storage pipe. The resulting volume of flow discharged during the control storm event was 2.35 MG. A subsequent 5-year simulation confirmed that a storage volume of 2.35 MG is sufficient to bring Basin 40 and Basin 41 into control. The storage volume is 250,000 gallons smaller than the sum of the control volumes for Basin 40, Basin 41, Basin 43, and Basin 44 because the control volume events do not occur at the same event.

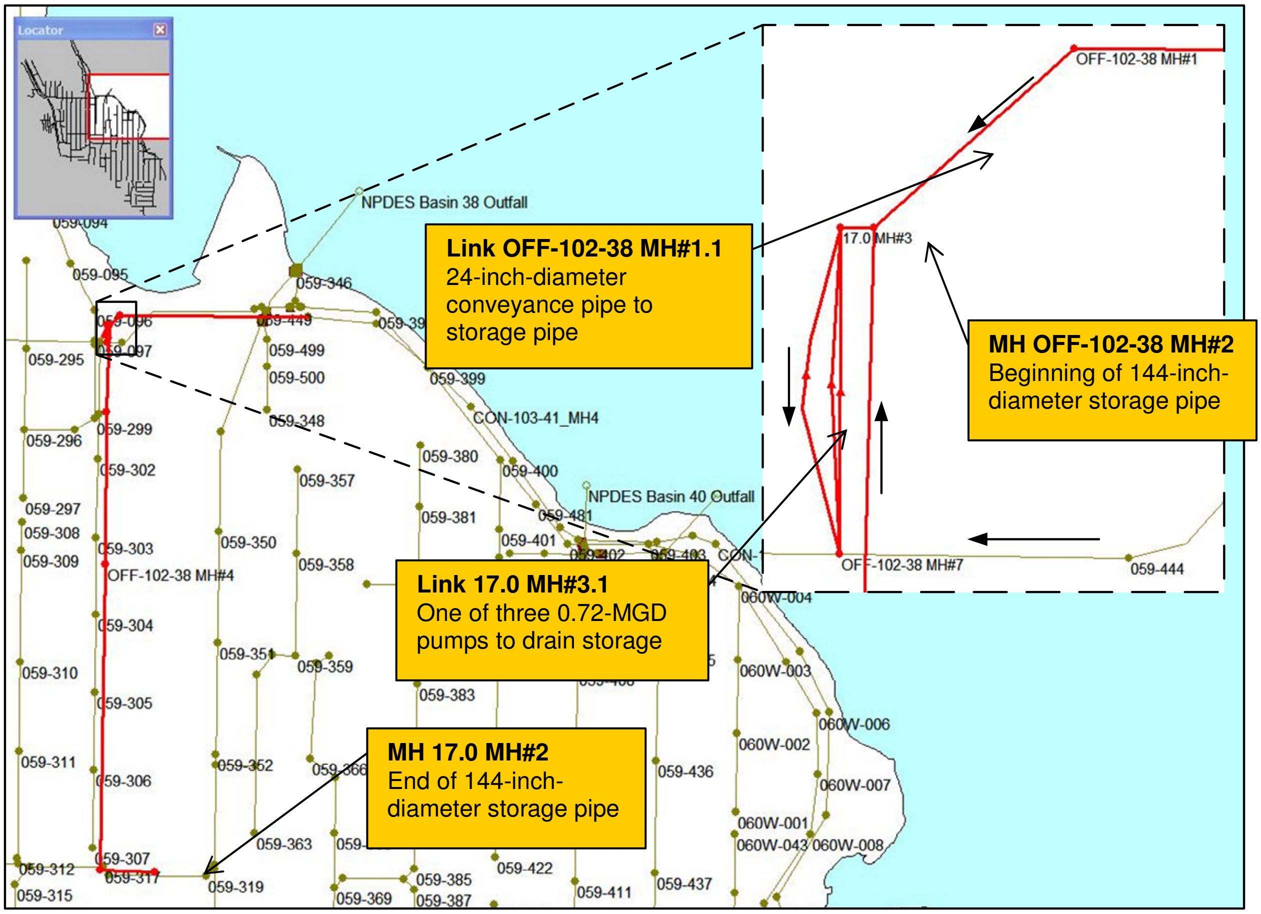


Figure 3-49: Base Model Modifications for Run 17.0

Results from the 5-year simulation for Run 17.0 indicated that overflows at Basin 40 were reduced from 34 events to 7 events. Overflows at Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 7 events for Basin 40 and 6 events for Basin 41; therefore, modeling the offline storage pipe sufficiently reduces CSOs at NPDES CSO Outfalls 40 and 41. The CSO frequency and volume reduction for Basin 40 and Basin 41 are shown in Table 3-26 for the 5-year period. The results for all basins in the Genesee Area of a simulation containing Runs 1.0, 2.0, 4.0, 5.0, and 17.0 are shown in Figure 3-50.

Table 3-26: CSO Results Comparison between Base Model and Run 17.0

	Base Model		Run 17.0	
NPDES CSO Outfall	40	41B	40	41B
No. of CSO Events	34	42	7	4
CSO Volume (MG)	6.28	6.80	5.24	2.18

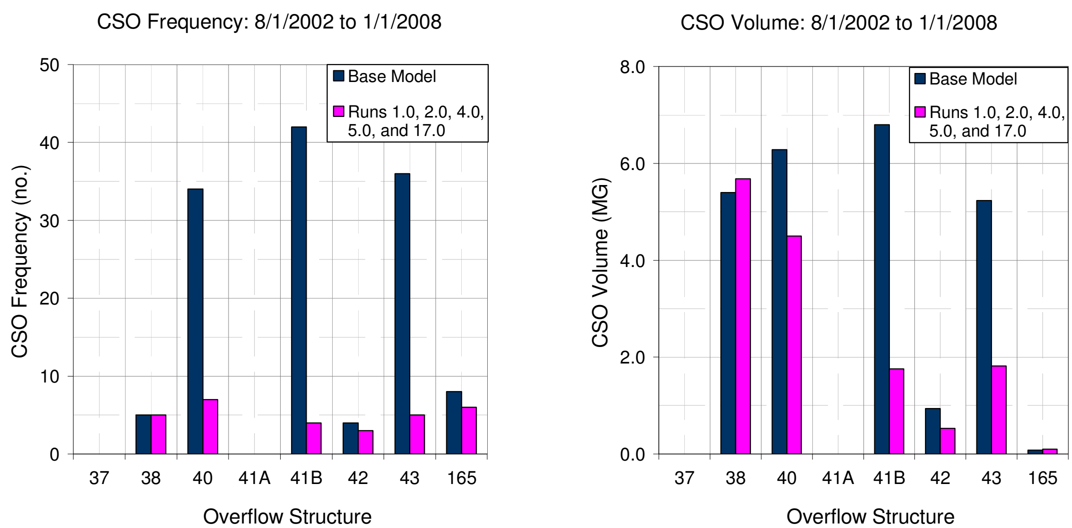


Figure 3-50: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 17.0 CSO Frequency and Volume

3.3.16 Transfer Basin 40, Basin 41, Basin 43, and Basin 44 to King County and Increase in King County Rainier Avenue Pump Station Capacity

The purpose of this alternative is to bring Basin 40, Basin 41, Basin 43, and Basin 44 into control by conveying wet weather flows to King County. Currently, the combined control volume for Basin 40, Basin 41, Basin 43, and Basin 44 is 2.8 MG. The overflows in Basin 40, Basin 41, Basin 43, and Basin 44 were reduced by using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 18.1: Wet weather flow conveyance from terminus of Run 5.0 to King County, and increased capacity of Rainier Avenue Pump Station. This run is described below.

3.3.16.1 Run 18.1: Transfer to King County and Increase in King County Rainier Avenue Pump Station Capacity

The purpose of Run 18.1 is to bring Basin 41 into control by transferring flows from Basin 40, Basin 41, Basin 43, and Basin 44 to King County. Run 18.1 is similar to Run 10.1 (described in Section 3.3.8.1) with the exceptions of the capacity of the new pump station located next to Pump Station 5 and the capacity of King County's Rainier Avenue Pump Station. These differences are caused by Run 18.1 including flow from Basin 44 in the Henderson Area, while Run 10.1 does not. The following is a summary of the changes between Run 18.1 and the Base Model:

- Two new 3.1-MGD pumps to convey flow from the terminus of Run 5.0 to the Hanford Street Trunk B, sized to bring Basin 41 into control
- New discharge location for Pump Station 5 to avoid hydraulic constriction in MH 059-450
- Replacement of the HydroBrake in MH 059-498 with an RTC variable sluice gate controlled based on the combined sewage level at the horseshoe weir in MH 059-451
- New HydroBrake bypass structure to avoid surface flooding at MH 059-498

The overflow frequency and volume at Overflow Structure 38 increased despite the modifications at MH 059-498. In order to maintain existing overflow conditions at Overflow Structure 38, the capacity of King County Rainier Avenue Pump Station was increased from 9.0 MGD to 12.82 MGD, an increase of 43 percent.

Figure 3-51 shows the model configuration modifications.

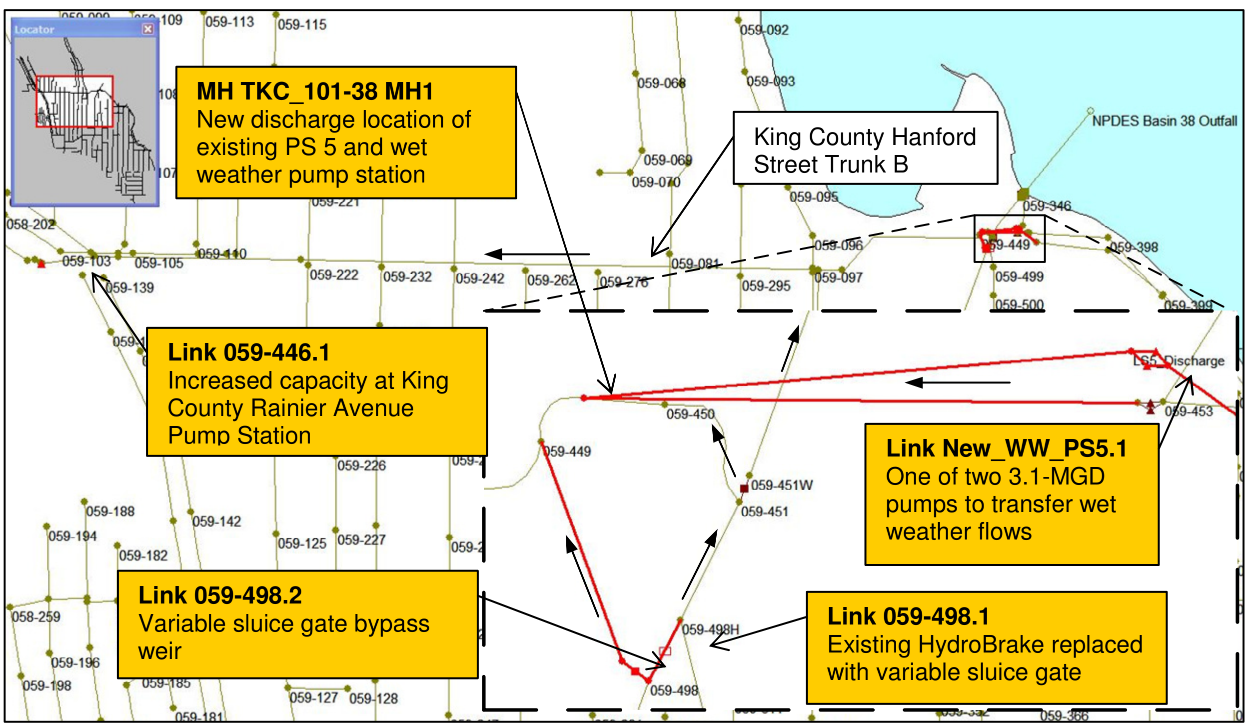


Figure 3-51: Base Model Modifications for Run 18.1

Results from the 5-year simulation for Run 18.1 showed that CSOs at Basin 41 were reduced from 42 events to 4 events. These results met the benchmark of 6 events for Basin

41B; therefore, Run 18.1 sufficiently reduces CSOs at Overflow Structure 41B. The CSO frequency and volume reduction for Basin 41 is shown in Table 3-27 for the 5-year period. The results of Run 18.1 are summarized in Figure 3-52, which is from a simulation that included Runs 1.0, 2.0, 4.0, 5.0, and 18.1.

Table 3-27: SO Results Comparison between Base Model and Run 18.1

	Base Model		Run 18.1	
NPDES CSO Outfall	38	41B	38	41B
No. of CSO Events	5	42	5	4
CSO Volume (MG)	5.40	6.80	5.39	3.48

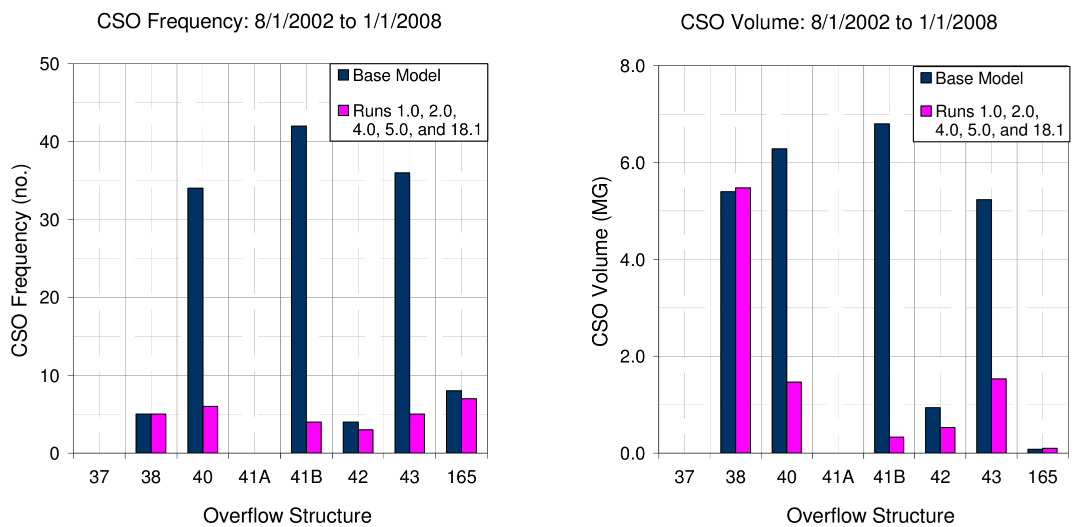


Figure 3-52: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 18.1 CSO Frequency and Volume

3.3.17 Transfer Basin 40, Basin 41, Basin 43, and Basin 44 to King County and In-line Storage in King County Hanford Street Trunk B

The purpose of this alternative is to bring Basin 40, Basin 41, Basin 43, and Basin 44 into control by conveying additional flow to King County. Currently, the combined control volume for Basin 40, Basin 41, Basin 43, and Basin 44 is 2.8 MG. The overflows in Basin 40, Basin 41, Basin 43, and Basin 44 were reduced by using five model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to the vicinity of Basin 41. See Section 3.3.5.1 for details on this run.

- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details on this run.
- Run 18.2: Wet weather flow conveyance from terminus of Run 5.0 to King County, and new in-line storage in the Hanford Street Trunk B. This run is described below.

3.3.17.1 Run 18.2: Transfer to King County and In-Line Storage in Hanford Street Trunk B

The purpose of Run 18.2 is to bring Basin 41 into control by transferring flows from Basin 40, Basin 41, Basin 43, and Basin 44 to King County. Run 18.2 is the same as Run 18.1 (described in Section 3.3.16.1) with the exception of how the increase in CSO volume and frequency at Overflow Structure 38 is managed. Run 18.1 increases the capacity of King County's Rainier Avenue Pump Station, while Run 18.2 provides in-line storage at MH 059-449. The following is a summary of other changes between Run 18.2 and the Base Model:

- Two new 3.1-MGD pumps to convey flow from the terminus of Run 5.0 to King County, sized to bring Basin 41 into control
- New discharge location for Pump Station 5 force main to avoid hydraulic constriction at MH 059-450
- Replacement of the HydroBrake in MH 059-498 with an RTC variable sluice gate that is controlled based on the combined sewage level at the horseshoe weir in MH 059-451
- New HydroBrake bypass structure to avoid surface flooding at MH 059-498

A 7.0-MG in-line storage tank at MH 059-449 was modeled to store flows to prevent an increase in the CSO volume and frequency at Overflow Structure 38. The tank fills as flow to King County exceeds the capacity of the 42-inch-diameter Hanford Street Trunk B. The storage tank has a footprint of 286,000 square feet and a depth of 3.3 feet. The tank floor matches the invert elevation of the pipe outlet (19.9 feet NAVD88), and the tank cover elevation matches the crest of the horseshoe weir in MH 059-498 (23.17 feet NAVD88). While the dimensions of the storage tank are not feasible for implementation, the purpose of this run was to predict the necessary storage volume. The tank would be drained by gravity as capacity becomes available downstream.

Figure 3-53 shows the modifications to the model configuration.

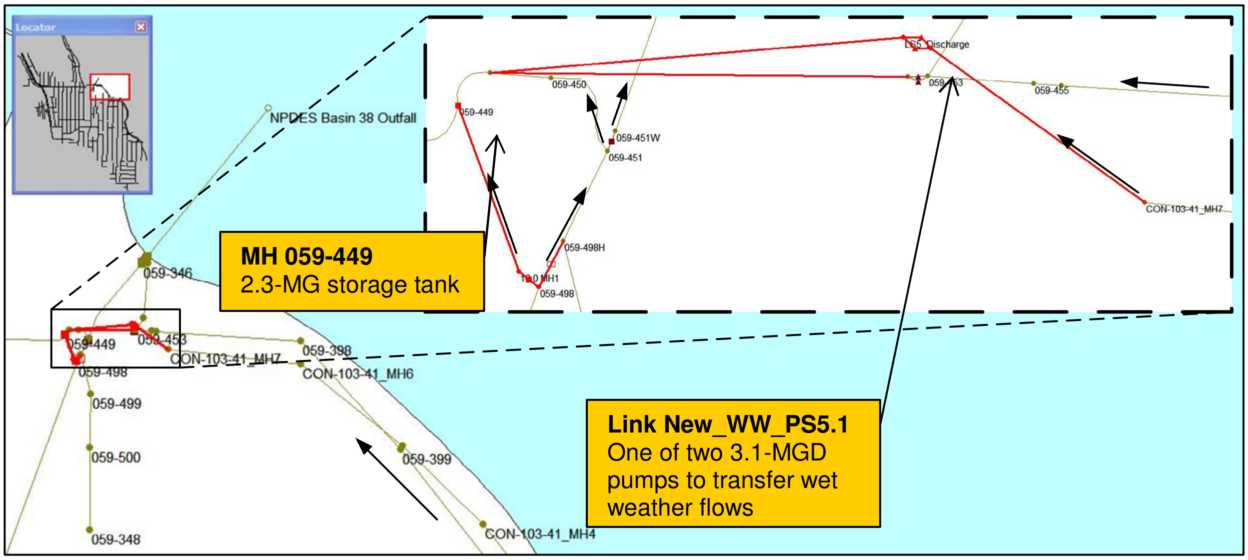
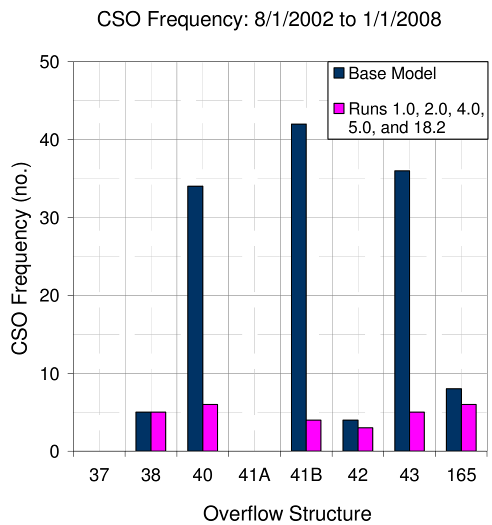


Figure 3-53: Base Model Modifications for Run 18.2

Results from the 5-year simulation for Run 18.2 showed that CSOs at Basin 41 were reduced from 42 events to 2 events. These results were below the benchmark of 6 events for Basin 41B; therefore, Run 18.2 sufficiently reduces CSOs at Overflow Structure 41B. The CSO frequency and volume reduction for Basin 41 is shown in Table 3-28 for the 5-year period. The results for all basins in the Genesee Area for a simulation that included Run 1.0, 2.0, 4.0, 5.0, and 18.2 are shown in Figure 3-54.

Table 3-28: CSO Results Comparison between Base Model and Run 18.2

	Base Model		Run 18.2	
NPDES CSO Outfall	38	41B	38	41B
No. of CSO Events	5	42	2	4
CSO Volume (MG)	5.40	6.80	3.95	0.21



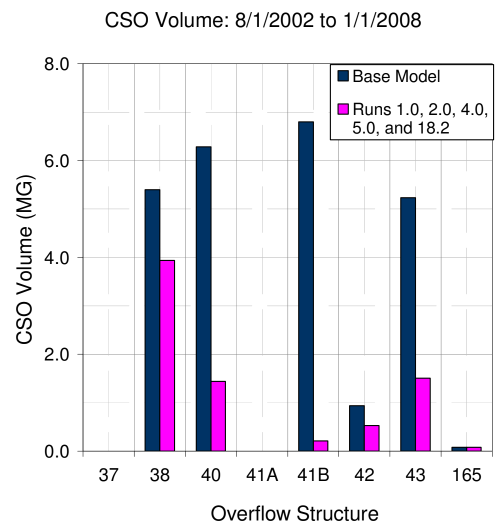


Figure 3-54: Comparison of Base Model and Simulation Containing Runs 1.0, 2.0, 4.0, 5.0, and 18.2 CSO Frequency and Volume

3.3.18 Inter-basin Transfer: Basin 41 to Basin 38, Offline Storage in Tunnel

The purpose of this alternative is to bring Basin 40, Basin 41, Basin 43, and Basin 44 into control by modeling an offline storage tunnel. Currently, the combined control volume for Basin 40, Basin 41, Basin 43, and Basin 44 is 2.9 MG. The overflows in Basin 40, Basin 41, Basin 43, and Basin 44 were reduced by using the following three model runs:

- Run 2.0: HydroBrake replacement in Basin 43 at MH 060W-047. See Section 3.3.2.1 for details on this run.
- Run 4.0: Wet weather flow conveyance from Basin 43 to Basin 41. See Section 3.3.5.1 for details on this run.
- Run 19.0: Inter-basin Transfer: Basin 41 to Basin 38, Offline Storage in Tunnel. This run is described below.

3.3.18.1 Run 19.0: Inter-basin Transfer: Basin 41 to Basin 38, Offline Storage Tunnel

The purpose of Run 19.0 was the following:

- Bring Basin 40 into control by diverting flow to the storage tunnel
- Bring Basin 41 into control by decreasing flows through the lake line
- Store wet weather flows from Basin 43 and Basin 44
- Replace the HydroBrake in MH 059-498 to maximize use of Storage Facility 12 in Basin 38

The Base Model was modified by adding a 168-inch-diameter, 2,350-foot-long storage tunnel that provided a storage volume of 2.87 MG. The storage tunnel is drained by a 2.4-MGD pump station that pumps flow into CSO Facility 12 as capacity becomes available.

A new user-controlled device was added at MH 060W-007 to limit flow to the lake line to 1.21 MGD, bringing downstream Basin 41 into control. When the incoming flow at MH

060W-007 exceeds 1.21 MGD, flow is diverted into the storage tunnel by a new 10-foot-wide weir.

In addition to Basin 41 flows, wet weather flows from Basins 40, 43, and 44 are stored in the offline storage tunnel. To collect flows from Basin 40, a 12-inch-diameter pipe was modeled to convey flow from approximately 80 percent of the area of Basin 40 east to MH 060W-007. Flows from Basins 43 and 44 are collected and conveyed by the components of Run 4.0 to the storage tunnel, as described in Section 3.3.5.1.

Lastly, the HydroBrake at MH 059-498 was replaced with a 12-inch-wide RTC variable sluice gate to avoid increased overflows at Overflow Structure 38. The gate is modulated to maintain a water level at 0.1 foot below the crest of the horseshoe weir in downstream MH 059-451.

Figure 3-55 shows the modifications to the model configuration.

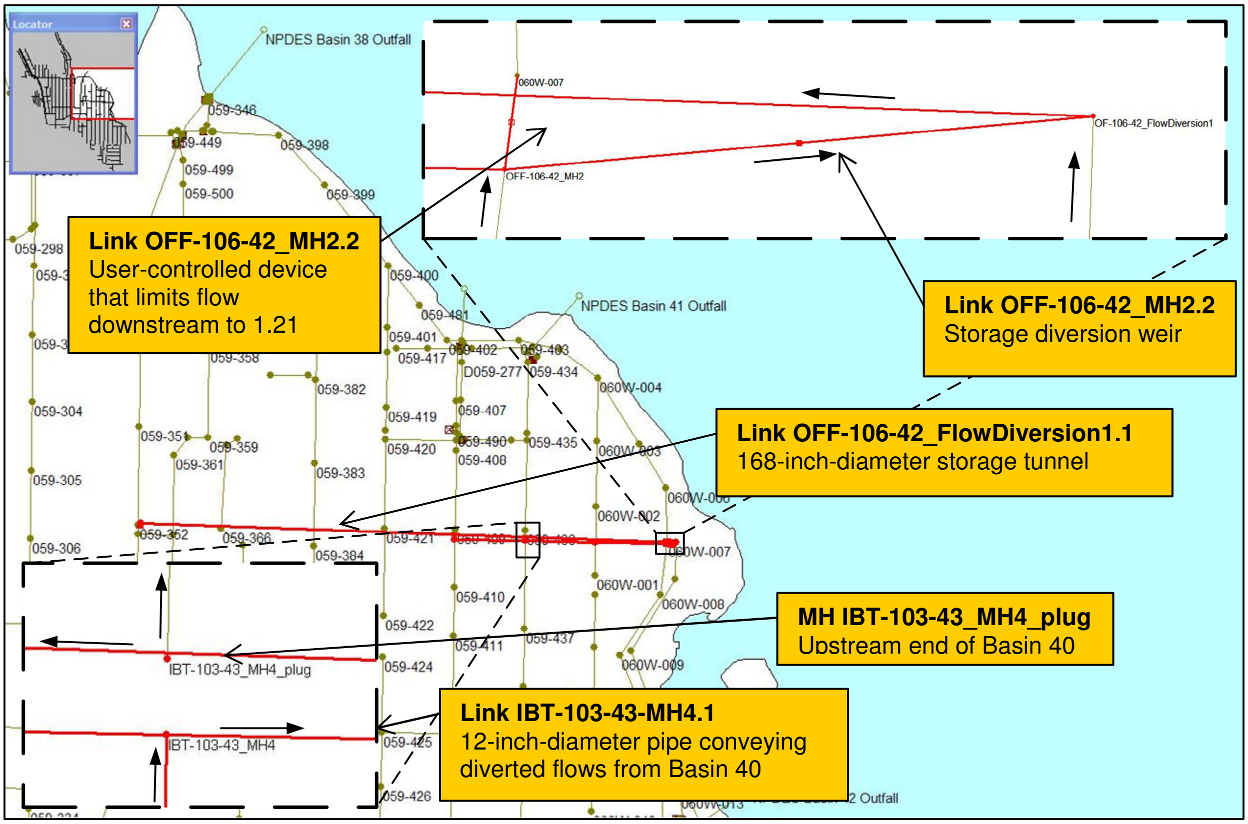


Figure 3-55: Base Model Modifications for Run 19.0

Results from the 5-year simulation for Run 19.0 showed that CSOs in Basin 40 were reduced from 34 events to zero events. CSOs in Basin 41 were reduced from 42 events to 3 events. These results were below the benchmark of 7 events for Basin 40 and 6 events for Basin 41; therefore, adding a 2.87 MG offline storage tunnel and diverting flows to it sufficiently reduces CSOs in Basin 40 and Basin 41 to bring them into control. Table 3-29 shows the CSO frequency and volume reductions for Basin 40 and Basin 41.

Table 3-29: CSO Results Comparison between Base Model and Run 19.0

	Base Model		Run 19.0	
NPDES CSO Outfall	40	41B	40	41B
No. of CSO Events	34	42	0	3
CSO Volume (MG)	6.28	6.80	0	0.45

The results of Run 19.0 showed a decrease in peak flow to King County of approximately 1.4 MGD for the 52nd-ranked storm on 12/26/2006, as shown in Figure 3-56. The results of a simulation containing Runs 2.0, 4.0, and 19.0 for all basins in the Genesee Area are shown in Figure 3-57.

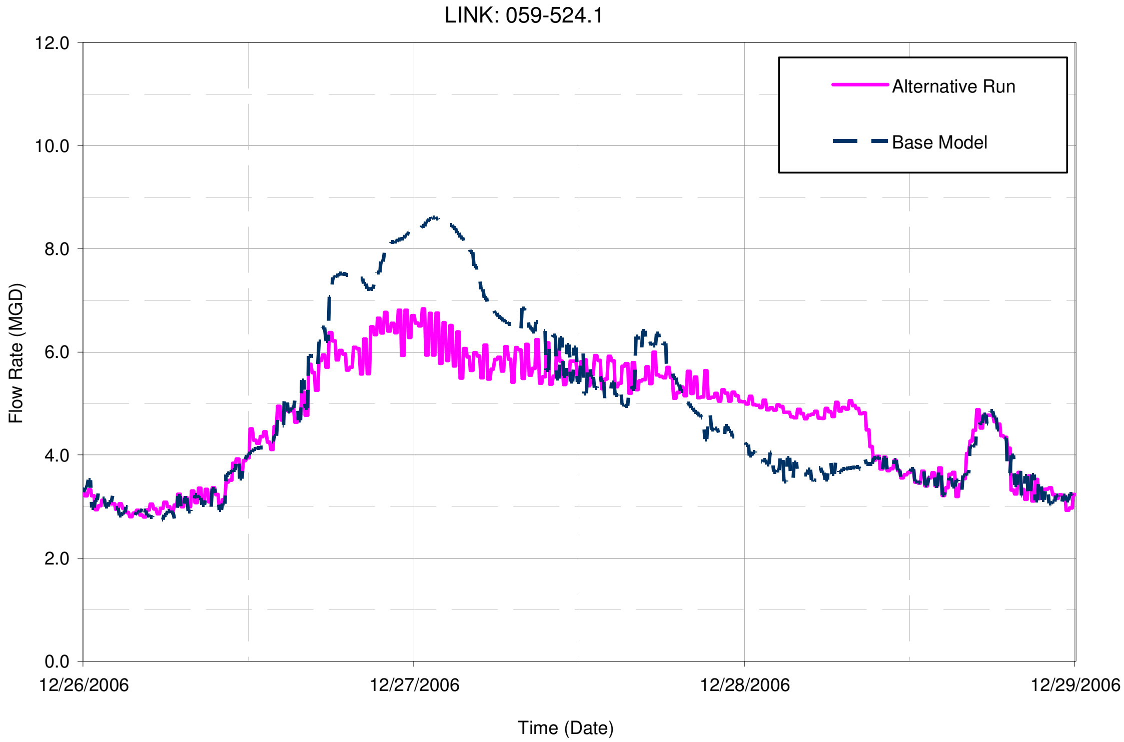


Figure 3-56: Comparison of Flows into Rainier Avenue Pump Station for Run 19.0 and Base Model

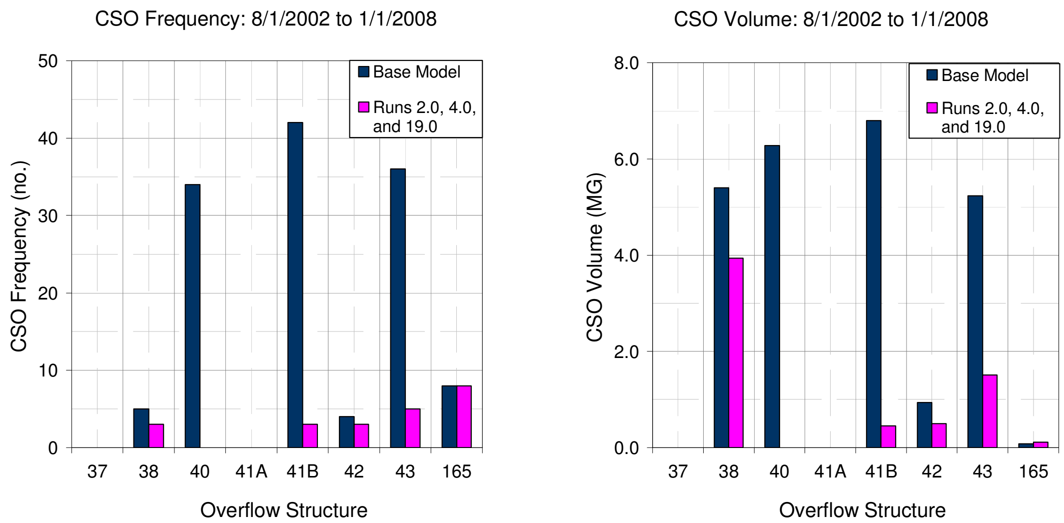


Figure 3-57: Comparison of Base Model and Simulation Containing Runs 2.0, 4.0, and 19.0 CSO Frequency and Volume

3.3.19 Offline Storage in Basin 41 with Pumped Conveyance to Storage Facility 12

The purpose of this alternative is to bring Basin 40 and Basin 41 into control by adding offline storage along the Lake Washington Boulevard and conveying flow to Storage Facility 12 in Basin 38, and to bring Basin 43 into control by adding offline storage in Basin 43. Currently, the combined control volume for Basin 40, Basin 41, and Basin 43 is 578,000 gallons. The overflows in Basin 40, Basin 41, and Basin 43 were reduced by using the following four model runs:

- Run 1.0: HydroBrake replacement in Basin 40 at MH 059-490. See Section 3.3.1.1 for details on this run.
- Run 3.0: Offline storage in Basin 43 at MH 060W-047. See Section 3.3.3.1 for details on this run.
- Run 5.0: Wet weather flow conveyance from terminus of Run 4.0 to the vicinity of Pump Station 5. See Section 3.3.5.2 for details.
- Run 21.0: Offline storage in Basin 41 with Discharge to CSO Control Structure 38. This run is described below.

3.3.19.1 Run 21.0: Offline Storage in Basin 41 with Pumped Conveyance to Storage Facility 12

The purpose of Run 21.0 is to bring Basin 40 and Basin 41 into control by adding offline storage in the new parallel lake line and conveying flow to King County.

The first phase of implementing Run 21.0 in the model was to predict the size of the offline storage pipe using the pipe alignment and profile from Run 5.0. To drain the offline storage pipe, pumps were modeled with the pumps discharging to the upstream side of the CSO Control Structure 38. Modeling iterations targeted the needed diameter and the rate of the pumps to empty the offline storage pipe. The offline storage pipe diameter was iteratively increased from 36 inches to 84 inches while pump discharge rates were decreased from 0.8

MGD to 0.05 MGD, rates less than the diverted flow into the offline storage pipe. The challenge was to control Overflow Structure 41B without increasing the frequency of CSOs at NPDES CSO Outfall 38, directly downstream from the Genesee Park in-line storage pipe, above the Base Model conditions.

In the first phase, Overflow Structure 41B was nearly controlled by implementing the above approach, but NPDES CSO Outfall 38 exceeded allowable frequency. The second phase targeted increasing the effective existing storage in CSO Facility 12. The analysis of the modeling results yielded the following adjustments to the modeled system:

- The existing weir crest elevation at CSO Control Structure 38 is 26.6 feet NAVD88. The invert elevation of the HydroBrake chamber and bypass weir in CSO Control Structure 38 is 22.4 feet NAVD88. The diameter of CSO Facility 12 is 72 inches. As a result of the bypass weir crest elevation being approximately 4 feet above the invert, the maximum hydraulic profile cannot exceed 26.6 feet NAVD88 and CSO Facility 12 cannot fill completely. To address this, the bypass weir was removed at CSO Control Structure 38, allowing the hydraulic profile to equal or exceed the crown of the CSO Facility 12 in-line pipe.
- To prevent surface flooding at Overflow Control Structure 38, a new bypass structure was modeled in one pipe segment upstream, at MH 059-349. The bypass weir crest elevation is set to 28.77 feet NAVD88, which is 18 inches below the ground surface elevation at CSO Control Structure 38 (MH 059-451). Flow is diverted from CSO Facility 12 to the King County Hanford Street Trunk B downstream from the grit chamber at MH 059-449.
- The HydroBrake at Overflow Control Structure 38 was replaced with an RTC variable sluice gate. Results from the model showed that the HydroBrake was not restricting sufficient flow, and therefore CSO Facility 12 could not be fully used. The sluice gate was initially a 6-foot by 6-foot gate, but eventually decreased to a 2-foot by 2-foot gate. Control for the gate operation was based on the level at the horseshoe weir at MH 059-451. An elevation setpoint of 22.4 feet NAVD88 deep was eventually successful in controlling NPDES CSO Outfall 38.

Figure 3-58 shows the changes to the system for Run 21.0.

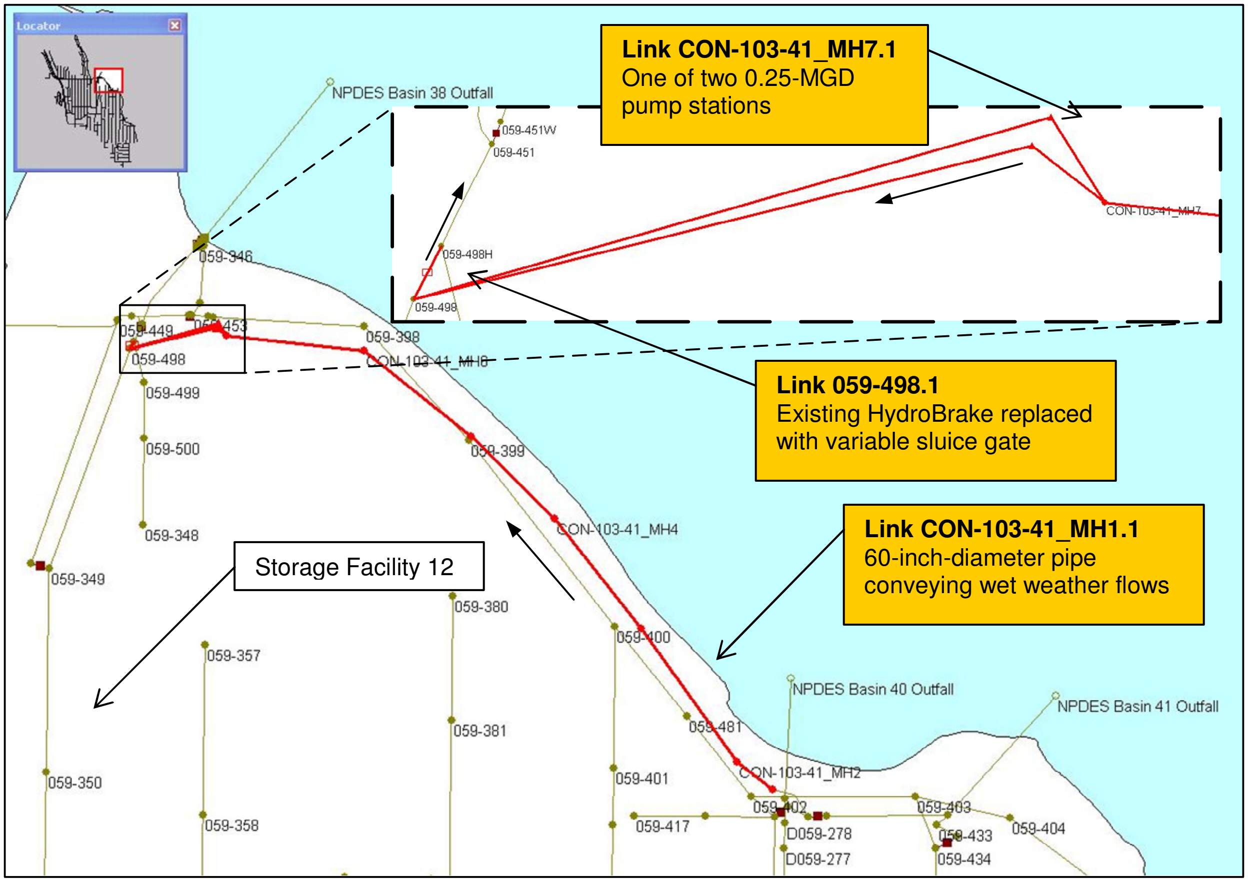


Figure 3-58: Base Model Modifications for Run 21.0

Implementing the above modifications at CSO Facility 12 enabled the new offline storage diameters and pump discharge rates to be refined from the first phase. The final modifications to the Base Model system were the following:

- New 60-inch-diameter in-line storage pipe from downstream of Overflow Structure 41B to a new pump station draining the storage pipe, providing 0.22 MG of storage.
- New pump station using two pumps, each with a pump rate of 0.25 MGD.
- New bypass structure diverting peak flows from the existing Storage Facility 12 to the Hanford Street Trunk B with a weir elevation of 28.87 feet, adding 0.34 MG of in-line storage in Storage Facility 12.
- The HydroBrake at CSO Control Structure 38 (MH 059-451) was replaced with a variable sluice gate and the bypass weir was removed.

To assess the potential for surface or basement flooding by modifying the existing CSO Storage Facility 12, the hydraulic profile during the control volume event was reviewed. As shown in Figure 3-59, the hydraulic profile resulting from the modifications listed above does not indicate an increase in risk of surface or basement flooding in the vicinity of the in-line storage pipe.

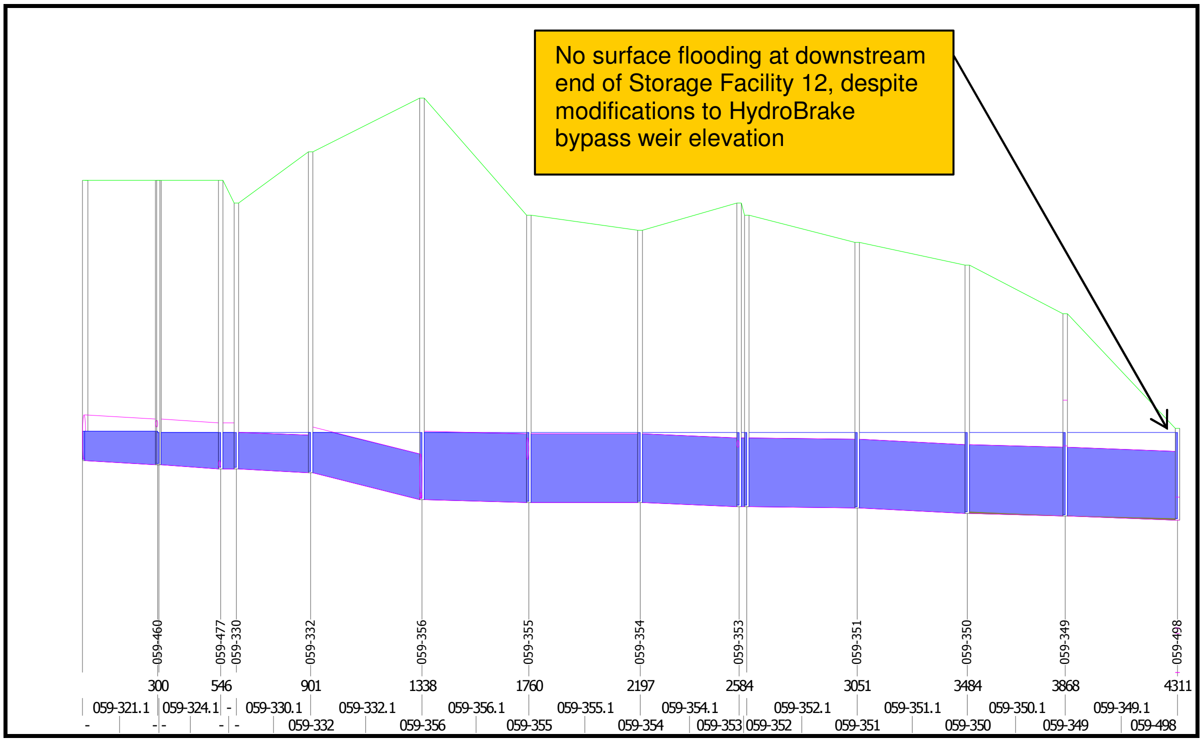


Figure 3-59: Hydraulic Profile of CSO Facility 12 from Overflow Control Structure 38 Upstream to MH 059-321

Results from the 5-year simulation for Run 21.0 showed that CSOs in Basin 41 were reduced from 42 events to 4 events. These results were below the benchmark of 6 events for Basin 41; therefore, adding offline storage and conveyance sufficiently reduces CSOs in Basin 41 to bring it into control. Table 3-30 below shows the CSO frequency and volume reductions for Basin 40 and Basin 41.

Table 3-30: CSO Results Comparison between Base Model and Run 21.0

	Base Model		Run 21.0	
NPDES CSO Outfall	38	41	38	41
No. of CSO Events	5	42	5	4
CSO Volume (MG)	5.40	6.8	7.86	3.52

The number of CSOs at Overflow Structure 38 was equal to the Base Model of 5 CSOs, but volume was increased from 5.4 MG to 7.9 MG. The increase in CSO volume is due to the increase of flow into Hanford Street Trunk B. Figure 3-60 compares the flow into the Rainier Avenue Pump Station showing the increase during the December 2006 control volume event.

The results of a simulation containing Runs 1.0, 3.0, 5.0 and 21.0 for all basins in the Genesee Area are shown in Figure 3-61.

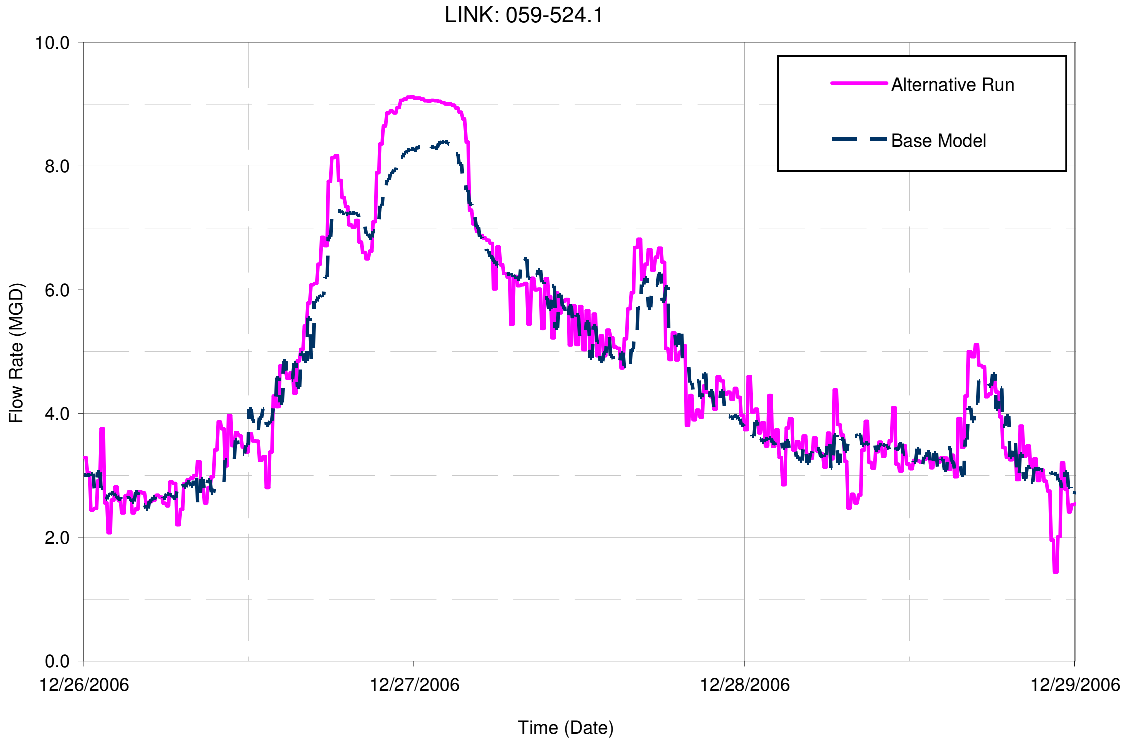
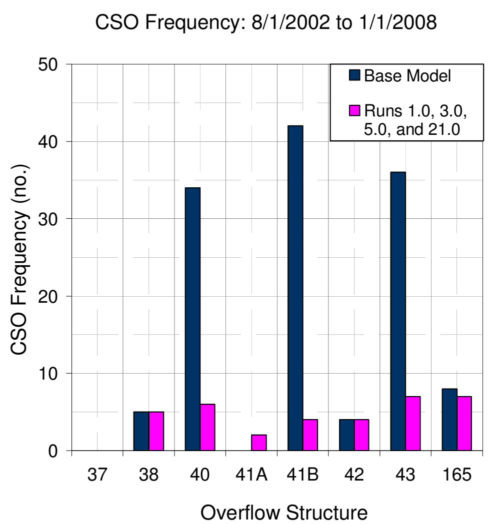


Figure 3-60: Comparison of Flows into Rainier Avenue Pump Station for Run 21.0 and Base Model



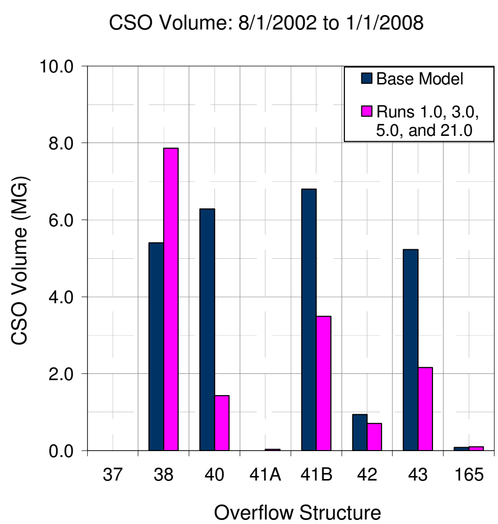


Figure 3-61: Comparison of Base Model and Simulation Containing Runs 1.0, 3.0, 5.0, and 21.0 CSO Frequency and Volume

4.0 Conclusions

Table 4-1 summarizes the results of each modeled alternative. The purpose of each alternative was to bring the targeted basin(s) into control based on CSO frequency. As such, the alternative was considered successful when the CSO frequency was less than or equal to the CSO benchmark. All alternatives were able to bring the targeted basins into control. Table 4-1 summarizes the remaining CSO volume and CSO volume reduction for each alternative.

As simulations were completed for each alternative, the results were compared to the two established boundary conditions:

- For the King County Rainier Avenue Pump Station, do not exceed the firm capacity of 9.0 MGD.
- Do not increase the frequency of overflows above the frequency predicted by the Base Model.

The majority of alternatives met both boundary conditions during the 5-year simulation period. Those alternatives that violated either of the boundary conditions are discussed below. Violations were typically due to intentional increases in capacity at the King County Rainier Avenue Pump Station, or small increases in CSO frequency at controlled basins.

- Increased Conveyance in Basin 43 (Run 2.0): This alternative increased the number of CSOs in Basin 42 from 4 events to 5. This alternative was not a stand-alone alternative and was not intended to meet both boundary conditions when evaluated by itself. When this alternative is combined with other alternatives, such as Offline Storage in Basin 38 along 43rd Avenue, both boundary conditions are met.
- Transfer to King County and Increase King County Rainier Avenue Pump Station Capacity (Runs 1.0, 2.0, 4.0, 5.0, and 10.1): This alternative increased the capacity of the Rainier Avenue Pump Station by 14 percent. The purpose of this alternative was to predict how much the capacity at the pump station needed to be increased to keep Basin 38 in control. As such, it was not intended to meet the boundary condition at the Rainier Avenue Pump Station.
- Inter-basin Transfer of Basin 41 to Basin 38 (Runs 3.0 and 13.0): This alternative increased the number of CSOs in Basin 38 from 5 events to 6. The smallest CSO during the alternative 5-year simulation had a volume of 9,000 gallons. It was concluded by the modeling team after review of the model results that the volume of the smallest overflow is below the accuracy of the model analysis and further analysis was not warrented.
- Transfer to King County, Offline Storage in Basin 43, and Increase in King County Rainier Avenue Pump Station Capacity (Runs 1.0, 3.0, 4.0, 5.0, and 16.1): This alternative increased the capacity of the Rainier Avenue Pump Station by 9 percent, violating the boundary conditions. The purpose of this alternative was to predict how much the capacity at the pump station needed to be increased to keep Basin 38 in control. As such, it was not intended to meet the boundary condition at the Rainier Avenue Pump Station.
- Transfer Basin 40, Basin 41, Basin 43, and Basin 44 to King County and Increase in King County Rainier Avenue Pump Station Capacity (Runs 1.0, 2.0, 4.0, 5.0, and 18.1): This alternative increased the capacity of the Rainier Avenue Pump Station by 43 percent, violating the boundary conditions. The purpose of this alternative was to

predict how much the capacity at the pump station needed to be increased to keep Basin 38 in control. As such, it was not intended to meet the boundary condition at the Rainier Avenue Pump Station.

- Transfer Basins 40, 41B, 43, and 44 to King County and In-line Storage in King County Hanford Street Trunk B (Runs 1.0, 2.0, 4.0, 5.0, and 18.2): Results from this alternative indicated a 3.5 percent increase in flow through the King County Rainier Avenue Pump Station. The increase was due to the conveyance of Basin 44 from Henderson through the Genesee Area. The large amount of flow contributed from Basin 44 caused the pump station to operate higher up on its Q-H curve, resulting in a higher peak flow rate.

Table 4-1: Summary of CSO Volume Reduction for Evaluated Alternatives

Alternative Name	Runs Included	Basins Controlled	Basin 40		Basin 41		Basin 43		Basin 44	
			Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction	Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction	Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction	Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction
Increased Conveyance in Basin 40	1.0	40	0.37	94%	-	-	-	-	-	-
Increased Conveyance in Basin 43	2.0	43	-	-	-	-	1.52	71%	-	-
Offline Storage in Basin 43	3.0	43	-	-	-	-	2.13	59%	-	-
Offline Storage in Basin 40, Basin 42, and Basin 43	3.0, 6.0, 9.0	40, 41, 43	3.05	51%	1.16	83%	2.13	59%	-	-
Offline Storage in Basin 38 along 43rd Avenue	1.0, 2.0, 4.0, 5.0, 7.0	40, 41, 43	5.24	17%	2.18	68%	1.48	72%	-	-
Offline Storage in Basin 38 in Genesee Park	1.0, 2.0, 4.0, 5.0, 8.0	40, 41, 43	4.78	24%	2.14	69%	1.52	71%	-	-
Transfer to King County with an Increase to King County Rainier Avenue Pump Station Capacity	1.0, 2.0, 4.0, 5.0, 10.1	40, 41, 43	1.46	77%	2.91	57%	1.51	71%	-	-
Transfer to King County and In-line Storage in King County Hanford Street Trunk B	1.0, 2.0, 4.0, 5.0, 10.2	40, 41, 43	1.44	77%	2.67	61%	1.5	71%	-	-
Offline Storage in Basins 40, 41, and 42 with Henderson Basin 44	1.0, 2.0, 4.0, 5.0, 12.0	40, 41, 43, 44	2.85	55%	1.53	78%	1.47	72%	11.5	79%
Inter-basin Transfer of Basin 41 to Basin 38	3.0, 13.0	40, 41, 43	0.00	100%	0.80	88%	2.05	61%	-	-
Offline Storage for Basin 43 and Combined Offline Storage for Basins 40 and 41	3.0, 14.0	40, 41, 43	4.44	29%	3.48	49%		100%	-	-

Table 4-1: Summary of CSO Volume Reduction for Evaluated Alternatives (Continued)

Alternative Name	Runs Included	Basins Controlled	Basin 40		Basin 41		Basin 43		Basin 44	
			Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction	Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction	Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction	Alternative CSO Volume (MG)	Alternative CSO Volume % Reduction
Offline Storage in Lake Washington Boulevard	1.0, 2.0, 4.0, 5.0, 15.0	40, 41, 43	4.37	30%	3.01	56%	1.53	71%	11.5	79%
Transfer to King County, Offline Storage in Basin 43, and Increase in King County Rainier Avenue Pump Station Capacity	1.0, 3.0, 5.0, 16.1	40, 41, 43	1.44	77%	3.09	55%	2.14	59%	-	-
Transfer to King County, Offline Storage in Basin 43, and In-line Storage in King County Hanford Street Trunk B	1.0, 3.0, 5.0, 16.2	40, 41, 43	1.39	78%	3.07	55%	2.15	59%	-	-
Offline Storage in Basin 38 including Basin 44 from Henderson	1.0, 2.0, 4.0, 5.0, 17.0	40, 41, 43, 44	4.48	29%	1.76	74%	1.82	65%	11.5	79%
Transfer Basins 40, 41, 43, and 44 to King County and Increase in King County Rainier Avenue Pump Station Capacity	1.0, 2.0, 4.0, 5.0, 18.1	40, 41, 43, 44	1.47	77%	0.33	95%	1.53	71%	11.5	79%
Transfer Basins 40, 41B, 43, and 44 to King County and In-line Storage in King County Hanford Street Trunk B	1.0, 2.0, 4.0, 5.0, 18.2	40, 41, 43, 44	1.44	77%	0.21	97%	1.51	71%	11.5	79%
Inter-basin Transfer: Basin 41 to Basin 38, Offline Storage in Tunnel	2.0, 4.0, 19.0	40, 41, 43, 44	0.00	100%	0.45	93%	1.51	71%	11.5	79%
Offline Storage in Basin 41 with Pumped Conveyance to Storage Facility 12	1.0, 3.0, 5.0, 21.0	40, 41, 43	1.43	77%	3.49	49%	2.16	59%	-	

5.0 Next Steps

The next step of alternatives development will involve identifying which alternatives or combinations of alternatives will be further developed through preliminary engineering. The selection of alternatives going through preliminary engineering is based on the results of the alternative modeling described in this report, as well as non-modeling analysis, such as cost estimating, risk analysis, ease of operation, and social justice. A new phase of hydraulic modeling will take place for these selected solutions, and the goal will be to refine system design and to verify boundary conditions.

Table 5-1 summarizes refinements that could be made to each model run to optimize the results. In addition to the refinements described in Table 5-1, specific analyses to be included in the next phase of alternative development include 31-year simulations to confirm the results of the 5-year simulations for the preferred alternatives.

6.0 References

CH2M HILL. 2010. *South Genesee Combined Sewer Overflow Reduction Project – Genesee Hydrologic and Hydraulic Modeling Report.*

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Table 5-1: Model Refinements for Detailed Modeling

Run	Basins Controlled	Benchmark CSO Frequency	Run 5-Year CSO Frequency	Possible Model Run Refinements
Run 1.0	40	7	6	- Replace user-controlled device with variable sluice gate - Basin 40 slightly over-controlled, refine flow control - Adjust control strategy to eliminate CSO ranked below control volume storm (current run shows CSO for storm ranked no. 84)
Run 2.0	43	7	5	- Replace user-controlled device with variable sluice gate - Basin 40 slightly over-controlled, refine flow control
Run 3.0	43	7	6	- Reduce variable sluice gate width to allow more realistic opening heights. Current run heights are maintained at around 1 inch
Run 4.0	N/A	N/A	N/A	- Refine height of storage diversion weir to reduce storage volume required for other runs
Run 5.0	N/A	N/A	N/A	- Consider other connections to for the additional Overflow Structure 40, and further evaluate the feasibility of making this connection
Run 6.0	41	6	6	- Refine RTC scenario on pumps to drain storage, possible to optimize use of downstream capacity to drain tank faster
Run 7.0	41	6	4	- Refine RTC scenario on pumps to drain storage as capacity becomes available downstream in Hanford Street Trunk B. Could significantly reduce storage size if King County line is used first - Refinement in Run 4.0 would reduce storage size
Run 8.0	41	6	4	- Refine RTC scenario on pumps to drain storage as capacity becomes available downstream in Hanford Street Trunk B. Could significantly reduce storage size if King County line is used first - Refinement in Run 4.0 would reduce storage size
Run 9.0	40	7	5	- Basin 40 slightly over-controlled, refine flow control - Replace user-controlled device with variable sluice gate
Run 10.1	41	6	5	- Basin 41 slightly over-controlled, refine new pump station capacity - Re-adjust Rainier Pump Station capacity so that NPDES CSO Outfall 38 matches base model frequency instead of volume

Table 5-1: Model Refinements for Detailed Modeling (Continued)

Run	Basins Controlled	Benchmark CSO Frequency	Run CSO Frequency	Possible Model Run Refinements
Run 10.2	41	6	4	- Basin 41 slightly over-controlled, refine new pump station capacity - Re-adjust Rainier Pump Station capacity so that NPDES CSO Outfall 38 matches base model frequency instead of volume
Run 12.0	41	6	2	- Basin 41 is over-controlled; consider refining storage volume
Run 13.0	40, 41	7, 6	0, 4	- Refine RTC to drain CSO Facility 12 based on available capacity in Hanford Street Trunk B - Refine wet well and pump rates wet weather pump station - Zero CSOs from Basin 40, consider decommissioning NPDES CSO Outfall 40
Run 14.0	40, 41	7, 6	6, 6	- Basin 40 slightly over-controlled, refine flow diversion structure
Run 15.0	41	6	4	- Slope and inverts of 24-inch-diameter line upstream from the 12-foot-diameter offline storage tank need to be revised - Refining the RTC of the drainage pumps could result in a decreased offline storage volume
Run 16.1	41	6	4	- Basin 41 slightly over-controlled, refine new pump station capacity - Re-adjust Rainier Pump Station capacity so that NPDES CSO Outfall 38 matches base model frequency instead of volume
Run 16.2	41	6	4	- Basin 41 slightly over-controlled, refine new pump station capacity - Re-adjust Rainier Pump Station capacity so that NPDES CSO Outfall 38 matches base model frequency instead of volume
Run 17.0	40, 41	7, 6	7, 4	- Refine RTC scenario on pumps to drain storage as capacity becomes available downstream in Hanford Street Trunk B. Could reduce storage size if storage in King County line used first
Run 18.1	41	6	4	- Basin 41 slightly over-controlled, refine new pump station capacity - Re-adjust Rainier Pump Station capacity so that NPDES CSO Outfall 38 matches base model frequency instead of volume
Run 18.2	41	6	4	- Basin 41 slightly over-controlled, refine new pump station capacity - Re-adjust Rainier Pump Station capacity so that NPDES CSO Outfall 38 matches base model frequency instead of volume
Run 19.0	40, 41	7, 6	0, 3	- Refine RTC scenario on pumps to drain storage as capacity becomes available in downstream Basin 38, could optimize storage use
Run 21.0	40, 41	7, 6	6, 4	- Basin 41 is over-controlled; consider refining storage volume

Appendix A – Model Tracker

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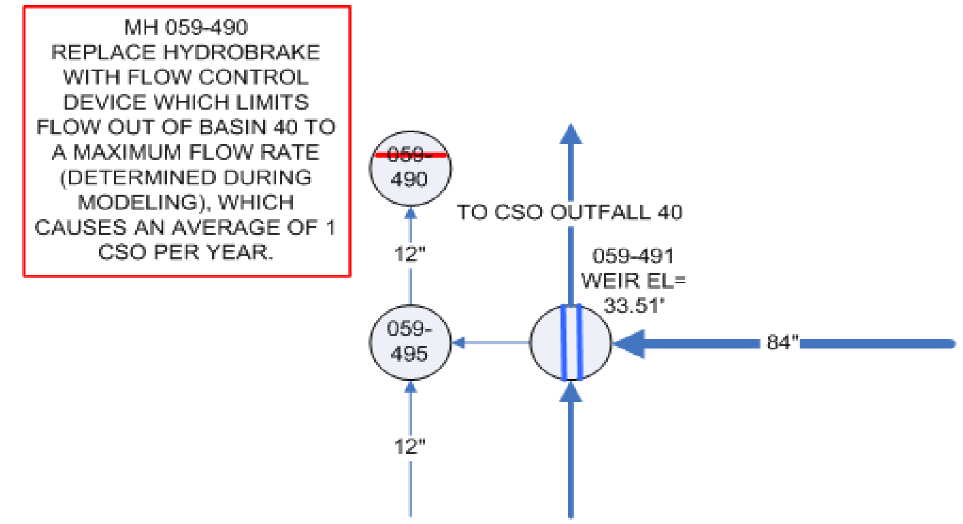
General Assumptions

- Unless otherwise stated each alternative needs to reduce the number of CSOs at each outfall to 1 untreated discharge per year of the duration of the simulation.
- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
- Run Title will have the following format: Model Run#_NetworkName_Description_ModelRunDate (yyyy_mm_dd)
  - For example, 6_Genesee_LakeLineImprovements_2009-10-30



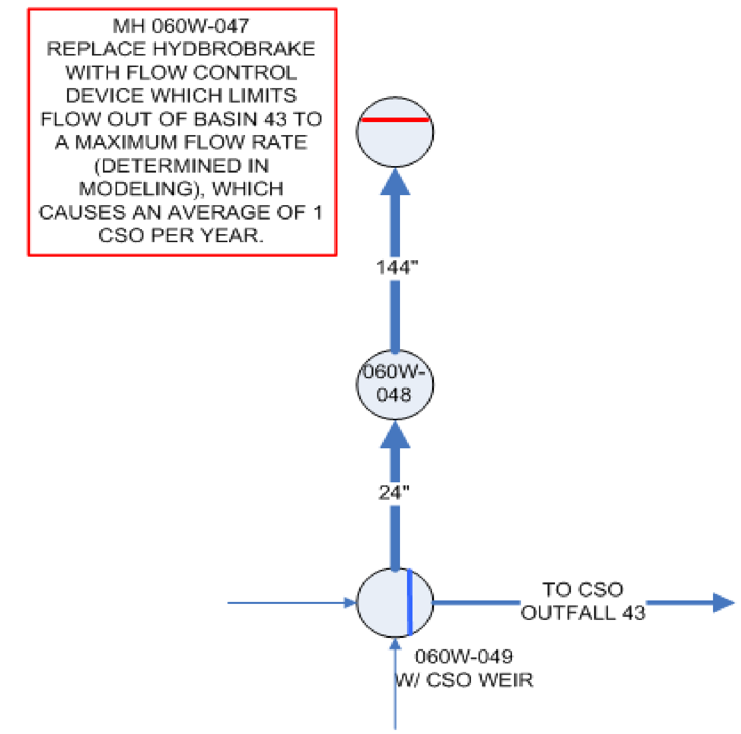
Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
1.0	RET-105-40	Remove the existing hydrobrake and replace it with a flow control device that limits the flow out of basin 40 to a maximum flow rate (determined during modeling), which causes an average of 1 overflow per year. This alternative does not contain any new storage, and CSOs are conveyed downstream, which will result in an increase in CSO volumes downstream. ☑ Schematic Provided ☐ Hydrographs Requested	The purpose is to eliminate overflows in this basin by allowing storm flow to continue downstream. This alternative will not be used as a stand alone alternative, as it will increase CSO volumes and frequencies downstream. It will be incorporated into runs 4, 5, 7, 8, 10, 12, 13, 15, 16, 17, 18, 19, and 21.	11/20/2009	☑ Network Built ☑ Simulation Built **Statistical Results** ☑ Model Run Complete ☑ CSO Stats Report Complete **File Management** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title: 1.1_RET-105-40_FINAL 1.2_RET-105-40_FINAL	**Modeling Performed By: Santtu Winter** **Date: 11/19/2009** **CSO Results (MG)** Basin 40 <u># of Overflows</u>: 6 <u>Overflow Volume Reduction</u>: 4.83 mg (77%) <u>Control Volume Reduction</u>: 0.20 mg (100%) **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☐ Boundary Condition 2 Met	For this alternative, the boundary condition of no increase in overflows at other basins was ignored. This alternative will not be a stand alone alternative, but will be coupled with other alternatives. Model Construction: - 1.1: Hydrobrake at 40 removed and replaced with a straight pipe. - 1.2: Hydrobrake replaced with a flow control device which limits the flow out of basin 40 to 1.92 mgd, which was determined during modeling, as described below. Control Strom Results: 1.1: N/A, run only evaluated with 5 year simulation. 1.2: Maximum flow rate allowable out of basin 40 adjusted until the control storm (12/13/2001) was just controlled. This resulting flow was 1.92 mgd. 5-Year Results: 1.1: All overflows at 40 eliminated, increases in overflow volume and frequency at 41B and 38. 1.2: 6 overflows in basin 40, all but one of which were ranked above the control volume storm. One storm was ranked #84, and had a high peak flow which caused the overflow. These results indicate that basin 40 is in control during the 5 year period, but may overflow during smaller storms ranked below the control volume event. This alternative resulte decrease of 4.83 mg at basin 40, indicating that overall this alternative results in a net increase of CSO volume from Genesee.

General Assumptions

- Unless otherwise stated each alternative needs to reduce the number of CSOs at each outfall to 1 untreated discharge per year of the duration of the simulation.
- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
- Run Title will have the following format: Model Run#_NetworkName_Description_ModelRunDate (yyyy_mm_dd)
  - For example, 6_Genesee_LakeLineImprovements_2009-10-30



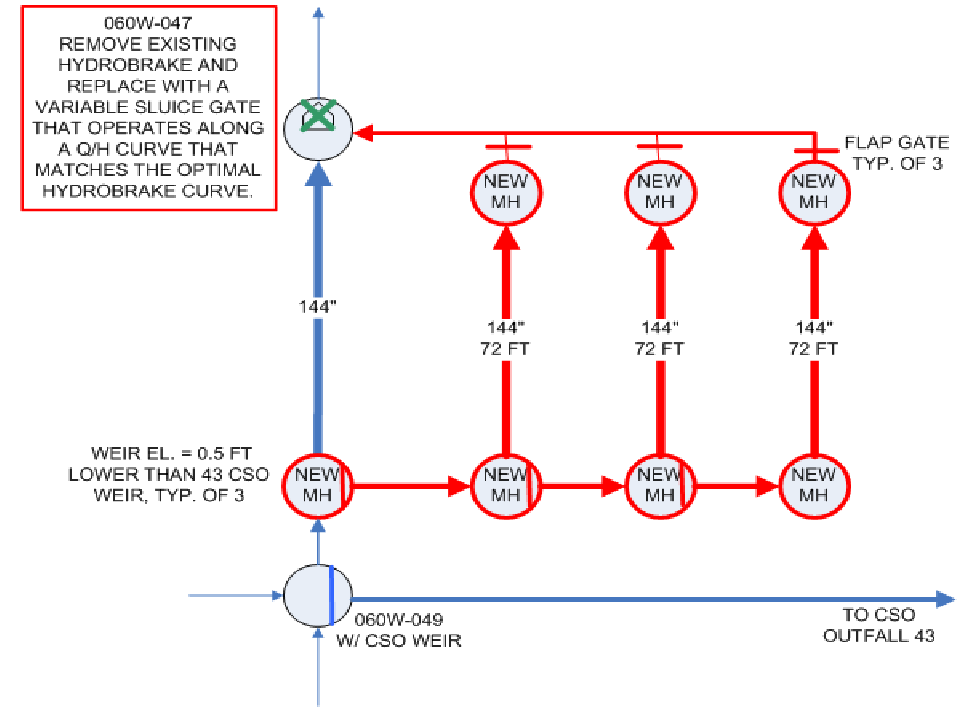
Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
2.0	RET-108-43	Remove the existing hydrobrake and replace it with a flow control device that limits the flow out of basin 43 to a maximum flow rate (determined during modeling), which causes an average of 1 overflow per year. This alternative does not contain any new storage, and CSOs are conveyed downstream, which will result in an increase in CSO volumes downstream. ☑ Schematic Provided ☐ Hydrographs Requested	The purpose is to eliminate overflows in this basin by allowing storm flow to continue downstream. This alternative will not be used as a stand alone alternative, as it will increase CSO volumes and frequencies downstream. It will be incorporated into runs 4, 5, 7, 8, 10, 12, 15, 18, 19.	11/20/2009	☑ Network Built ☑ Simulation Built **Statistical Results** ☑ Model Run Complete ☑ CSO Stats Report Complete **File Management** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title: 2.1_RET-108-43_FINAL 2.2_RET-108-43_FINAL	**Modeling Performed By: D.O'L** **Date: 11/22/2009** **CSO Results** Basin 43 # of Overflows: 5 Overflow Volume Reduction: 3.71 mg (71%) Control Volume Reduction: 0.187 mg (100%) **Boundary Conditions** ☑ Boundary Condition 1 Met ☐ Boundary Condition 2 Met *Provide validation using hydrographs*	For this alternative, the boundary condition of no increase in overflows at other basins was ignored. This alternative will not be a stand alone alternative, but will be coupled with other alternatives. Model Construction: - 2.1: Hydrobrake at 43 removed and replaced with a straight pipe. - 2.2: Hydrobrake replaced with a flow control device which limits the flow out of basin 43 to 1.25 mgd. This flow rate was determined during modeling, as described below. Control Strom Results: 2.1: N/A, run only evaluated with 5 year simulation. 2.2: Maximum flow rate allowable out of basin 40 adjusted until the control storm (11/27/1996) was just controlled. This resulting flow was 1.25 mgd. 5-Year Results: 2.1: All overflows at 43 eliminated, increases in overflow volume and frequency at 41B and 38. Significant surface flooding also occurred out of MH 060W-012 2.2: 5 overflows in basin 43, all of which were ranked above the control volume storm. Surface flooding was observed at MH 060W-012, however it will be resolved when run 2.2 is coupled with runs 4.0 and 5.0 (new lake line conveyance). The overflow volume at 43 was reduced by 3.7 mg, while the overflow volume at 41B was increased by 3.6 mg, resulting in no net decrease in CSO volume in the Genesee basin.

General Assumptions

- Unless otherwise stated each alternative needs to reduce the number of CSOs at each outfall to 1 untreated discharge per year of the duration of the simulation.
- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
- Run Title will have the following format: Model Run#_NetworkName_Description_ModelRunDate (yyyy_mm_dd)
  – For example, 6_Genesee_LakeLineImprovements_2009-10-30



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
3.0	OFF-109-43	Place new storage next to the existing storage in Basin 43 with a total volume equal to the control volume of basin 43 (0.203 mg). Place (3) 72 foot long 12' dia. parallel pipes on the east side of the existing storage facility. Place a new node (or modify the existing node) where the existing 24" pipe becomes 12' dia. and set up a weir 6" lower than overflow weir. Have this weir direct flow east to another node connected to the first new storage pipe. Once this storage pipe is full, it will overflow into the next storage pipe, and so on until all three of the new storage pipes are full. The end of each tank should have a flap valve and tie in to a common manifold before the lake line. See drawing. ☑ Schematic Provided ☐ Hydrographs Requested	The purpose is to bring basin 43 into compliance by building additional storage volume equal to the control volume (0.187 mg).	11/23/2009	☑ Network Built ☑ Simulation Built ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title: 3.1_OFF-109-43_FINAL 3.2_OFF-109-43_FINAL	**Modeling Performed By: Santtu Winter** **Date: 11/30/2009** **CSO Results (in MG)** Basin 43 # of Overflows: 6 Overflow Volume Reduction: 3.08 mg (59 %) Control Volume Reduction: 0.187 mg (100%) **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: 3 parallel pipes (144 inches in diameter, 48 feet long), set of storage overflow weirs set 6 inches below the elevation of the overflow weir upstream at NPDES 43. Nodes were inserted between links, and specifically, large 12 ft diameter nodes were created at the upstream and downstream end of the storage pipes. To account for this additional storage, the schematic storage pipe length of 72 ft was decreased by 24 ft. The crown of each storage pipe was set 12" above the storage weir. Total storage provided is 216,000 gallons. The tanks were drained via one of two scenarios, summarized below: Tank drainage scenario 1 (3.1): Maintain existing hydrobrake to drain all four tanks (one existing tank and three new tanks). Tank drainage scenario 2 (3.2): Replace existing hydrobrake with a variable sluice gate and drain all four tanks via the gate RTC, which operates in such a way to maintain the existing hydrobrake QH curve characteristics, thus keeping both downstream overflows at the same volume, the control storm overflow into storage at 43 the same volume as the baseline CSO, and avoids surface flooding. 5-Year Results: Results for 3.1 and 3.2 indicated that overflows at 43 were reduced to 6 overflows, each of which were ranked above the control storm. 3.2 resulted in 132,000 gallons of surface flooding out of MH 060W-012. The baseline run with the blockage removed resulted in 139,000 gallons out of the same MH, indicating that this alternative slightly reduces the amount of surface flooding.

General Assumptions

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- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
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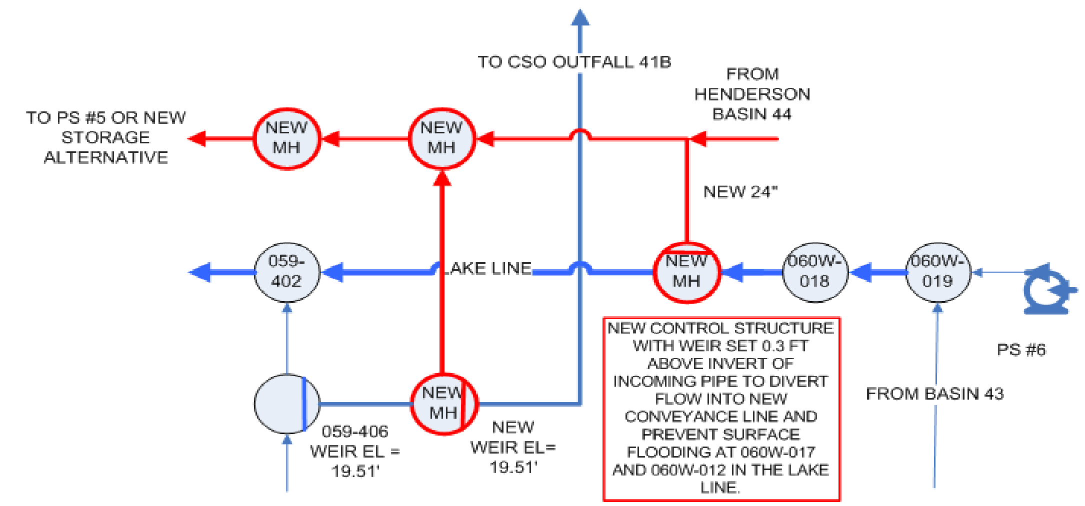

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
4.0	CON-104-42	Place 3,500 ft of new 24"conveyance line at a slope of 0.15% in Lake Washington Blvd to convey overflows from basin 43 to run 5.0 (new conveyance to storage or to King County). This alternative may also need to convey flows from Henderson Basin 44. Couple this alternative with Model run 5.0. Place an new diversion structure to the northwest of 060W-018. ☑ Schematic Provided ☐ Hydrographs Requested	The purpose is to convey the increased flows from Model run 2.2 into a new lake line to prevent downstream impacts at Basin 42. This alternative will also be used to off-load some flows currently going through the existing lake line during the wet weather season. This run is just a conveyance improvement, as such no modeling runs are necessary. This run is included in the model tracker to provide a description of what this run consists of.	11/23/2009	☑ Network Built ☐ Simulation Built **Statistical Results** ☐ Model Run Complete ☐ CSO Stats Report Complete ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title:	Modeling Performed By: D.O'L. Date: 12/15/2009 CSO Results Basin N/A # of Overflows: N/A Overflow Volume Reduction: N/A Control Volume Reduction: N/A ***Boundary Conditions*** *Provide validation using hydrographs* ☐ Boundary Condition 1 Met ☐ Boundary Condition 2 Met	This run is conveyance only and will be combined with several other runs. For modeling details, see results from runs 7, 8, 10, 12, 15, 16, 17, 18, and 19.

General Assumptions

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- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
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Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

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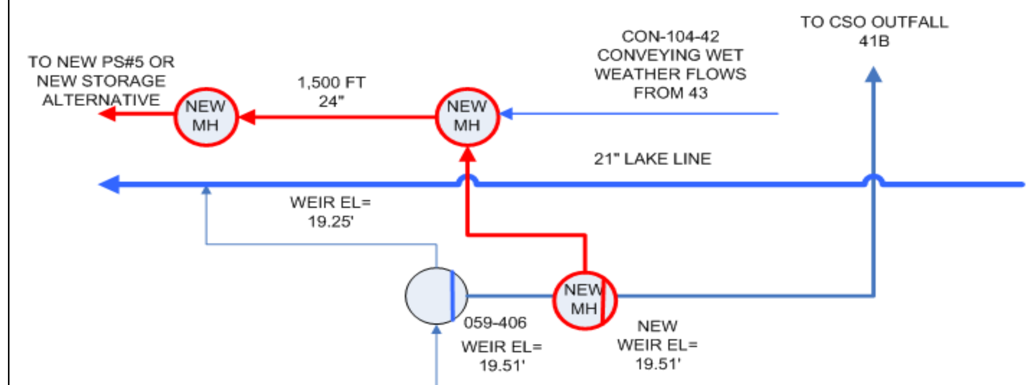
  - For example, 6_Genesee_LakeLineImprovements_2009-10-30



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
5.0	CON-103-41	Place 1,500 ft of new 24" conveyance pipe at a slope of approximately 0.1% in Lake Washington Blvd. This alternative builds a parallel lake line near Manhole 059-406 (41B overflow) and picks up flow that would normally overflow using a new structure that will saddle the existing overflow pipe. This new structure will direct flow into the new lake line. An overflow weir will also be in the structure to maintain the current maximum hydraulic gradeline. ☑ Schematic Provided ☐ Hydrographs Requested	The purpose is to convey the increased flows from Model run 1.0 and/or increased flows from model run 2.0 into a new lake line to prevent downstream impacts at 41B.This run is just a conveyance improvement no modeling runs are necessary.	11/23/2009	☑ Network Built ☐ Simulation Built **Statistical Results** ☐ Model Run Complete ☐ CSO Stats Report Complete ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title:	Modeling Performed By: D.O'L. Date: 12/15/2009 CSO Results Basin N/A # of Overflows: N/A Overflow Volume Reduction: N/A Control Volume Reduction: N/A ***Boundary Conditions*** *Provide validation using hydrographs* ☐ Boundary Condition 1 Met ☐ Boundary Condition 2 Met	Control structure added the directs flow first down existing Lake Line, then secondly, down the new 24-inch pipe to a new LS 5. This run is conveyance only and will be combined with several other runs. For modeling details, see results from runs 7, 8, 13, and 15.

General Assumptions

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  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

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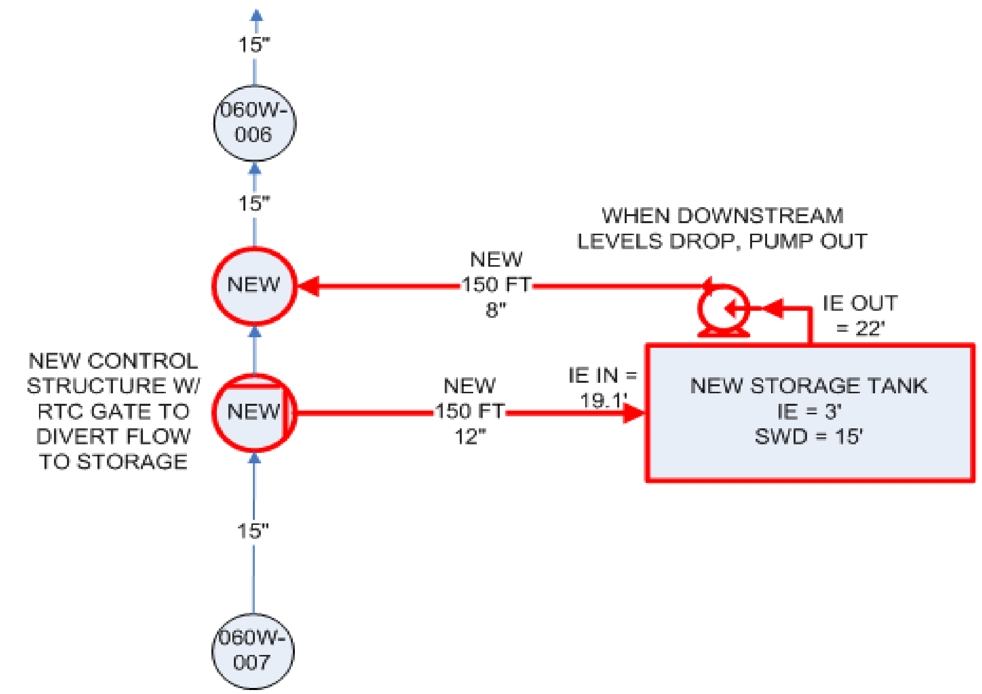

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
6.0	OFF-106-42	Provide new storage in Parks parking lot at South Adams Street and Lake Washington Boulevard, near MH 060W-007. Wet weather flows would be diverted by gravity from the lake line to a new storage tank via a new flow control structure with an RTC controlled gate. Once downstream levels subside, flow would be pumped out of the storage tank at 200 gpm to the lake line. See schematic. This alternative is coupled with runs 3.2 and 9.0, which are storage at basin 43 and 40, respectively. ☑ Schematic Provided ☐ Hydrographs Requested	The purpose of this alternative is to store increased flows and prevent downstream impacts at 41B.	12/16/2009	☑ Network Built ☑ Simulation Built ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title: 6.0_OFF-106-42_FINAL	**Modeling Performed By: Santtu Winter** **Date: 1/27/2010** **CSO Results** Basin 40 / 41B / 43 # of Overflows: 5 / 6 / 6 Overflow Volume Reduction: 3.2 / 5.6 / 3.1 mg Control Volume Reduction: 0.2 / 0.19 / 0.19 mg **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: - Lake line diversion structure at MH 060W-007, which diverts flow into a storage tank at the eastern end of Adams St. This tank decreases flows in the lake line, allowing 41B to become controlled. A pump station with a capacity of 0.6 mgd was set up to drain the storage tanks once the storm had passed. Flow was diverted into the storage tank by constructing a flow control device that allowed a maximum flow of 0.71 mgd to pass through. The flow rate of 0.71 mgd was determined during modeling, as described below. Flows above 0.71 mgd were diverted into storage. The height of the diversion weir was determined by calculating the flow depth corresponding to a flow rate of 0.71 mgd in a 15" diameter pipe at a slope of 0.171% and a Manning's N value of 0.013. - New 300 foot long, 10 foot diameter storage pipe was constructed parallel to the existing storage pipe in basin 40, along with a new flow diversion weir and drainage flap gate. This tank was not big enough to store the control volume event at basin 40, so the outflow from the basin was adjusted such that basin 40 came into compliance. The existing hydrobrake was converted into a flow control device that allows a maximum of 1.1 mgd of flow through - New storage in basin 43 that is equal in volume to the control volume. For details see run 3.2. Control Storm Results: NPDES 40: Maximum flow out of basin 40 was adjusted to cause the control storm (12/13/2001) to just be controlled. Maximum flow allowable out of basin 40 was 1.10 mgd. The volume of the new storage tank is 0.128 mg. NPDES 41B: Maximum flow allowable through the lake line at 060W-007 was determined to be 0.71 mgd. This flow rate resulted in the control storm (11/21/1980) at basin 41B to be just controlled. Flows in excess of 0.71 mgd were diverted into a storage tank that was sized to be 0.63 mg. The tank was sized based on the volume of flow that was diverted into storage during the control storm. NPDES 43: See run 3.2 for details. 5-Year Results: 40, 41B, and 43 are controlled. Basin 40 had 5 overflows, basin 41B had 6 overflows, and 43 had 6. The lowest ranked overflow for each basin was #23, #30, and #23 respectively. In the baseline run, the lowest ranked overflow above the control storm during the 5-year period was #28, #30, and #24 for basins 40, 41B, and 43 respectively. This indicates that basin 40 appears to be slightly over-controlled, while basins 41B and 43 are appropriately controlled.

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Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
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Overflow Structure 165	35	0	0	6	0.10	6

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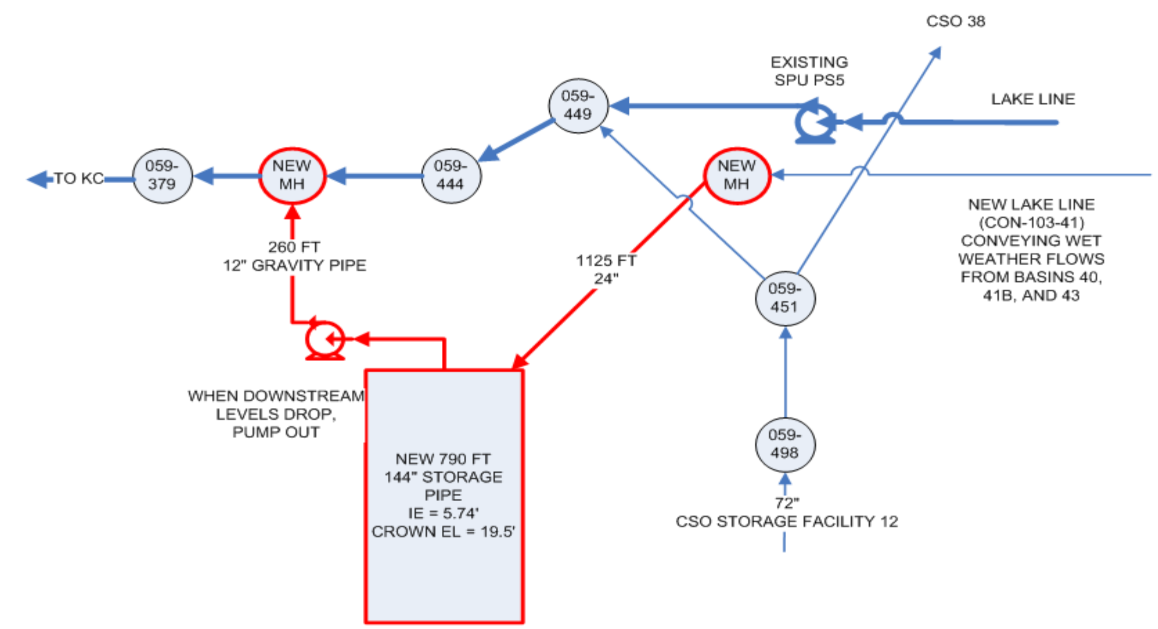

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
7.0	OFF-102-38	Storage built in ROW to handle all of the Genesee Basins that are not currently controlled. Storage will start at volume of 0.60 MG. Model to confirm if this is large enough. The storage pipe will be connected to model runs 4 and 5 (new lake line) and flows will be pumped out into the King County trunk at a new MH just downstream of existing MH 059-444. Model Construction: This alternative combines alternatives 1.2, 2.0, 4.0, and 5.0. This run incorporates all the components of ***Alternative ROW 5*** . ☑ Schematic Provided ☐ Hydrographs Requested	The purpose of this alternative is to eliminate overflows in Basins 40, 41B, and 43 by building sufficient storage in the right of way of 43rd Ave in Basin 38.	12/20/2009	☑ Network Built ☑ Simulation Built ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title: 7.0_OFF-102-38_FINAL	**Modeling Performed By: Santtu Winter** **Date: 1/10/2010** **CSO Results** Basin 40, 41A, 43 \# of Overflows: 6 / 4 / 5 Overflow Volume Reduction: 1.27 / 4.71 / 3.41 mg Control Volume Reduction: 0.203 / 0.188 / 0.187 mg **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: This alternative includes runs 1.2, 2.2, 4.0, and 5.0. 1,125 ft of new gravity conveyance was constructed from the terminus of alternative 4.0 near PS5 to the new storage pipe along 43rd Ave at a slope of 0.57%. A 12' diameter storage pipe was constructed with a volume of 0.67 mg (790 ft in length) at a slope of 0.22%. In order to avoid a crossing with the 96" stormwater pipe that intersects 43rd Ave, the beginning of the new storage pipe is located approximately 375 ft south of the intersection of 43rd Ave and Lake Washington Blvd. The relief point for the storage pipe is through the existing outfall at 41B, and a new connection made to the overflow at NPDES 40. This new connection was needed to allow the storage tank to overflow sufficiently quickly to avoid increased CSO volumes at 38 and 41A. 5-year Results: Basins 40, 41B, and 43 were all brought into compliance. Other Findings: It was determined that, in order to meet the boundary condition that overflow volumes at other controlled basins in Genesee do not increase, an additional overflow connection needed to be made into NPDES 40. Without this connection, the storage tank was not abl During control storm simulations, it was observed that the height of the storage diversion weir in basin 43 had a large impact on the total amount of flow that was diverted into storage. Control storm simulations indicated a difference in total storage volume required ranging from 0.56 mg to 0.78 mg. The final weir height was selected which resulted in a required storage volume of 0.67 mg, which matches the storage size that was used for cost estimating purposes.

General Assumptions

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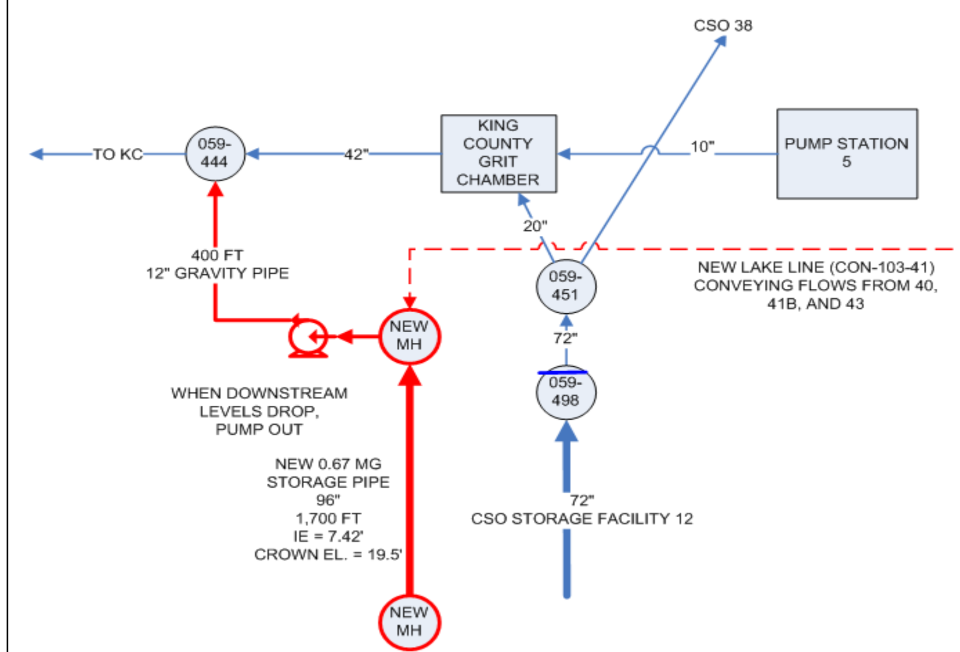

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
8.0	IN-101-38	Storage built in Genesee park to handle all of the Genesee Basins that are not currently controled. Storage will start at volume of 0.60 MG. Model to confirm if this is large enough. The storage pipe will be connected to Model runs 4 and 5 (new lakeline) and to the exsiting inline storage tank. After the storm event flows will be pumped out and into the King County trunk at MH 059-444. Model Construction: This alternative combines alternatives 1.2, 2.0, 4.0, and 5.0. This run incorporates all the components of ***Alternative ROW 5.*** ☑ Schematic Provided ☐ Hydrographs Requested	To elminiate overflows in Basins 40,41b, and 43 by building storage in Basin 38.	12/21/2009	☑ Network Built ☑ Simulation Built ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title: 8.0_IN-101-38_FINAL	**Modeling Performed By: Santtu Winter** **Date: 2/1/2010** **CSO Results** Basin 40 / 41B / 43 \# of Overflows: 6 / 4 / 5 Overflow Volume Reduction mg (%): 1.0 (24%) / 4.66 (69%) / 3.71 (71%) Control Volume Reduction mg (%): 0.203 (100%) / 0.188 (100%) / 0.187 (100%) **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: This alternative includes runs 1.2, 2.2, 4.0, and 5.0. 200 ft of new gravity conveyance was constructed from the terminus of alternative 4.0 near PS5 to the new storage pipe in Genesee Park at a slop eof 1.8%. An 8' diameter storage pipe was constructed with a volume of 0.67 MG (1,780 ft in length) at a slope of 0.2%. The relief point for the storage pipe is through the existing outfall at 41B, and a new connection made to the overflow at NPDES 40. This new connection was needed to allow the storage tank to overflow sufficiently quickly to avoid increased CSO volumes at 38 and 41A. 5-year Results: Basins 40, 41B, and 43 are all brought into compliance. Other Findings: During control storm simulations, it was observed that the height of the storage diversion weir in basin 43 had a large impact on the total amount of flow that was diverted into storage. Control storm simulations indicated a difference in total storage volume required ranging from 0.56 mg to 0.78 mg. The final weir height was selected which resulted in a required storage volume of 0.67 mg. During control storm simulations, it was observed that the height of the storage diversion weir in basin 43 had a large impact on the total amount of flow that was diverted into storage. Control storm simulations indicated a difference in total storage volume required ranging from 0.56 mg to 0.78 mg. The final weir height was selected which resulted in a required storage volume of 0.67 mg, which matches the storage size that was used for cost estimating purposes.

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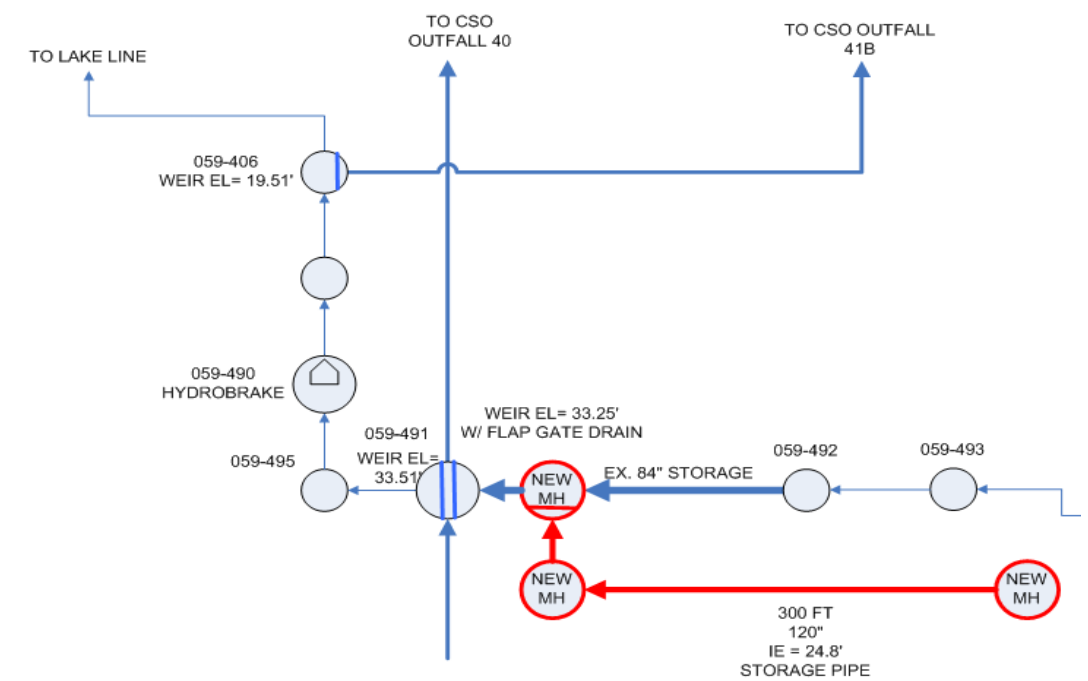

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
9.0	OFF-104-40	This alternative would construct additional storage adjacent to the existing storage in basin 40. New storage would be 10 feet in diameter and 300 feet long. It is likely that this is not enough storage to bring the basin into compliance. If the storage does not bring the basin into compliance, the hydrobrake at 059-490 will be replaced with a flow control device that limits the flow out of basin 40 to a maximum flow rate that brings the basin into compliance (similar to run 1.2). Modeling will determine the size of storage, and the maximum flow allowable out of basin 40 to bring the basin into compliance. ☑ Schematic Provided ☐ Hydrographs Requested	Modeling intent is to see what impact more storage in basin 40 would have on basin 41B.		☑ Network Built ☑ Simulation Built ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title: 9.0_OFF-104-40_FINAL	**Modeling Performed By: Santtu Winter** **Date: 2/5/2010** **CSO Results** Basin 40 # of Overflows: 5 Overflow Volume Reduction: 3.2 mg Control Volume Reduction: 0.203 mg **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: New 270 foot long, 10 foot diameter storage pipe was constructed parallel to the existing storage pipe in basin 40, along with a new flow diversion weir and drainage flap gate. The new storage tank provided 0.128 mg of additional storage, which is equivalent to 63% of the control volume at basin 40 (0.203 mg). To bring 40 into compliance, the maximum flow out of the basin was limited to 1.1 mgd, based on the modeling described below. Control Storm Results: NPDES 40: Results indicated that the maximum flow allowable out of basin 40 was 1.10 mgd. This resulted in the control storm just being controlled. The storage volume of 0.128 mg by itself brought the basin to an approximate CSO frequency of 1.5 overflows per year. NPDES 41B: Overflows at 41B increased significantly - 79% based on frequency, and 41% based on volume. This indicates that this alternative needs to be coupled with either storage at 41B or conveyance to new storage downstream or to King County. This run is similar to run 1.2, except that run 9 provides additional storage, whereas run 1.2 does not. Results from 1.2 indicated an increase in overflows at 41B - 160% in terms of frequency and 105% in 5-Year Results: Five year results confirmed that the control scenario resulted in basins 40 to come into compliance. Basin 40 had 5 overflows, with the lowest ranked overflow at #23. In the baseline run, the lowest ranked overflow above the control storm during the 5-year period was #28.

General Assumptions

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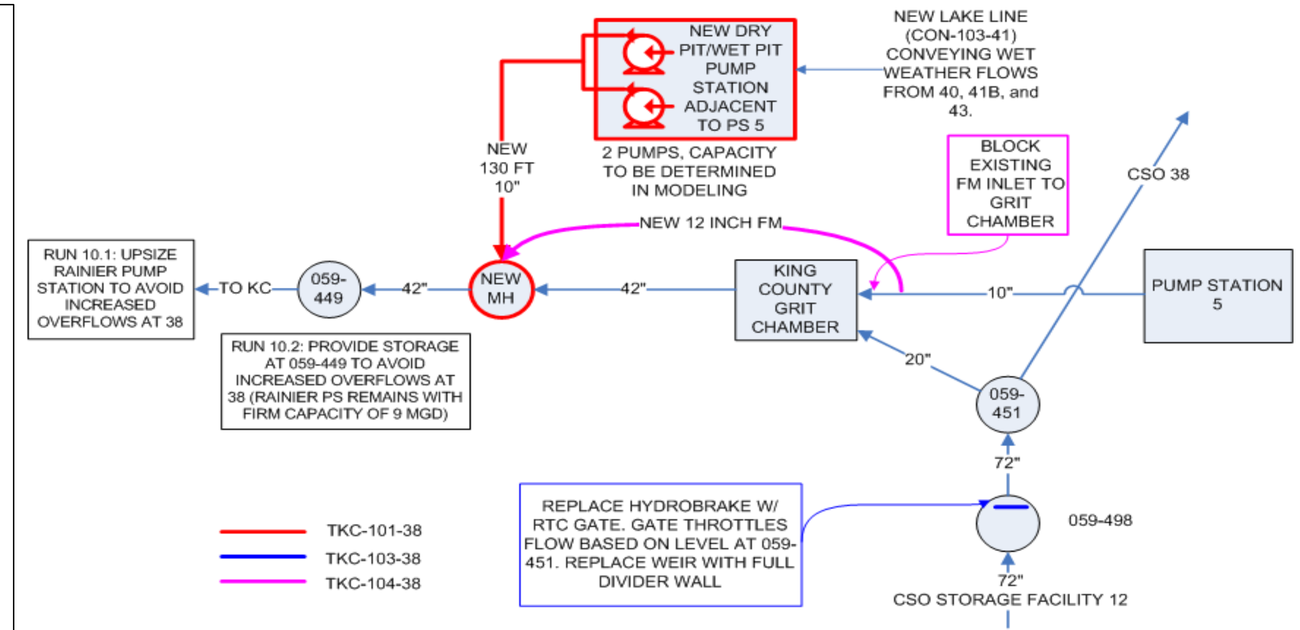
- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
- Run Title will have the following format: Model Run#_NetworkName_Description_ModelRunDate (yyyy_mm_dd)
  - For example, 6_Genesee_LakeLineImprovements_2009-10-30



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
10.0	TKC-101-38 TKC-103-38 TKC-104-38	TKC 101-38 consists of constructing a new pump station adjacent to PS #5. This pump station would receive flow from the new lake line (CON-103-41) and have 2 pumps at a capacity to be determined during modeling. The pumps would operate in a lead/lag mode. The force main would discharge downstream of the King County grit chamber. TKC 103-38 replaces the hydrobrake with a slide gate operated with RTCs in 056-498. Modulate the gate based on the level at MH 059-450 to avoid increased overflows at NPDES 38. Allow flow to back up in to CSO Storage Facility 12 only if the downstream conveyance line is full. TKC 104-38 replaces the existing Pump Station #5 force main with a new line (same diameter) that bypasses the King County grit chamber. See schematics. Modeling will need to determine the following: - What capacity is needed at the new pump station to bring NPDES 41B into compliance? - 10.1: What capacity is needed at the Rainier PS to handle this additional flow and keep overflows at NPDES 38 at baseline conditions? - 10.2: What storage volume would be needed to handle this additional flow and keep overflows at NPDES 38 at baseline conditions if the firm capacity of Rainier remains at the current flow rate of 9 mgd. ☑ Schematic Provided ☑ Hydrographs Requested Model Construction: This alternative combines alternatives 1.0, 2.0, 4.0, and 5.0. This run incorporates all the components of ***Alternative ROW 24.***	These changes reduce the chokepoint currently experienced at Pump Station 5. They are needed to maintain reliability and reduce pressure on downstream conveyance.	11/23/2009	☑ Network Built ☑ Simulation Built **Statistical Results** ☑ Model Run Complete ☑ CSO Stats Report Complete ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title: 10.1_FINAL 10.2_FINAL	**Modeling Performed By: Santtu Winter** **Date: 2/15/2010** **CSO Results** **10.1** Basin 40 / 41B / 43 # of Overflows: 6 / 5 / 5 Overflow Volume Reduction: 4.8 / 3.9 / 3.7 mg Control Volume Reduction: 0.20 / 0.19 / 0.19 mg **10.2** Basin 40 / 41B / 43 # of Overflows: 7 / 4 / 5 Overflow Volume Reduction: 4.9 / 4.1 / 3.7 mg Control Volume Reduction: 0.20 / 0.19 / 0.19 mg **Boundary Conditions** *Provide validation using hydrographs* ☐ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: This run is a combination of runs 1.2, 2.2, 4, and 5. The following is a brief summary of those runs: - 38: Hydrobrake removed and replaced with a variable sluice gate. The hydrobrake bypass weir was also removed. These changes are unique to this alternative, and are not based on another run. - 40: Controlled by replacing the hydrobrake with a flow control device which limits the flow coming out of the basin (run 1.2). - 41B: Controlled by the new parallel lake line (runs 4 and 5), which collects wet weather flows from basin 40, 41B, and 43. - 43: Controlled by replacing the hydrobrake with a flow control device which limits the flow coming out of the basin (run 2.2). In addition to the changes noted above, the new lake line conveyance from run 4 and 5 was modified to pump flows into the Charleston Street Trunk one MH downstream of the grit chamber. The existing PS#5 was also modified to pump around the grit chamber, in order to eliminate the hydraulic constriction at that location. Two sub-alternatives were evaluated in run: 10.1: All flows from the new lake line are conveyed into the Hanford Trunk B, and conveyed through the Rainier pump station, which is sized so that the additional flow from the new lake line does not cause additional overflows at basin 38. 10.2: Increases in CSO volume at 38 were kept at baseline conditions by building a storage tank in Hanford Trunk B. 5 Year Results: Initial runs consisted of determining the optimal pump capacity at the new conveyance pump station that caused overflows at 41B. It was determined that a capacity of 1.16 mgd resulted in 4 overflows at 41B. Basins 40 and 43 were also brought into compliance. The following are the results for the two sub-alternatives: 10.1: Rainier Pump Station was upsized to 10.3 mgd to avoid an increase of CSOs at 38. 10.2: Storage was built with a volume of 2.4 mg to avoid an increase of CSOs at 38.

General Assumptions

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  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
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Overflow Structure 38	23	0.0	0.0	5	5.40	5
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Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
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Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
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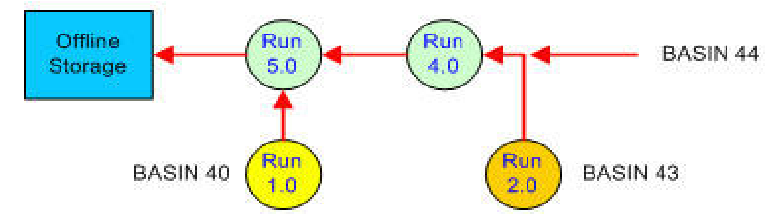

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
12.0	ROW 17n+44A	Off-line storage for Basins 40, 41B, 42, and 43 in new parallel lake line, coupled with alternatives 1.0, 2.0, 4.0, 5.0, and Basin 44 time series. Modeling to determine length of pipe needed to controll all basins in Genesee and Henderson basin 44. [ ] Schematic Provided [ ] Hydrographs Requested	The purpose is to determine the amount of strorage needed to bring Genesee and Henderson 44 into compliance.	12/23/2009	[x] Network Built [x] Simulation Built [x] Model Run Complete [x] CSO Stats Report Complete **Statistical Results** [ ] Archived Results [ ] Archived Network **File Management** File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By: DOL** **Date:** **CSO Results** Basin 40 / 41 / 43 __# of Overflows__: 6 / 4 / 5 __Overflow Volume Reduction__: 1.04 / 4.62 / 3.75 MG __Control Volume Reduction__: 0.203 / 0.188 / 0.187 MG **Boundary Conditions** *Provide validation using hydrographs* [ ] Boundary Condition 1 Met [ ] Boundary Condition 2 Met	The new parallel lake line from runs 4 and 5 was increased to a diameter of 12 feet from the bottom terminus of Run 5 3,150 ft upstream to MHCON-104-42_MH6. The new parallel lake line was lowered in order for the crown of the storage pipe to be below the Overflow Structure 41B weir elevation of 19.511 ft to maximize the effective storage volume. The pipe upstream of the 12-ft storage pipe was increased to 36-inch-diameter to the diversion weir from the existing lake line. The above adjustments resulted in 2.9 million gallons (MG) of offline storage. The offline storage pipe is drained with two fixed-speed pumps, each with a capacity of 0.36 million gallons per day (mgd). Control for the pumps is based on available capacity in the downstream system. As capacity exists in the system, the lead and lag pumps draining the storage pipe are activated. To accomplish this, the level at the upstream end of the King County Hanford Street Trunk B near the grit chamber in MH 059-499 was used to activate the drainage pumps. The model was used to find the balance among pump rates that could sufficiently drain the pipe storage, control for the pumps, and provide the volume of storage needed to control NPDES CSO Outfall 41 without increasing the CSOs at NPDES CSO Outfall 38. The level at the horseshoe weir (MH 059-451) was initially used to control the drainage pumps; however, the maximum level at this location is 0.77 foot (from invert to weir elevation). The pump controls were only successfully when the level in the downstream Hanford Street Trunk B was used.

Henderson and Genesee CSO Reduction Projects
Genesee Area Model Tracker

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General Assumptions

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  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
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Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
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Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
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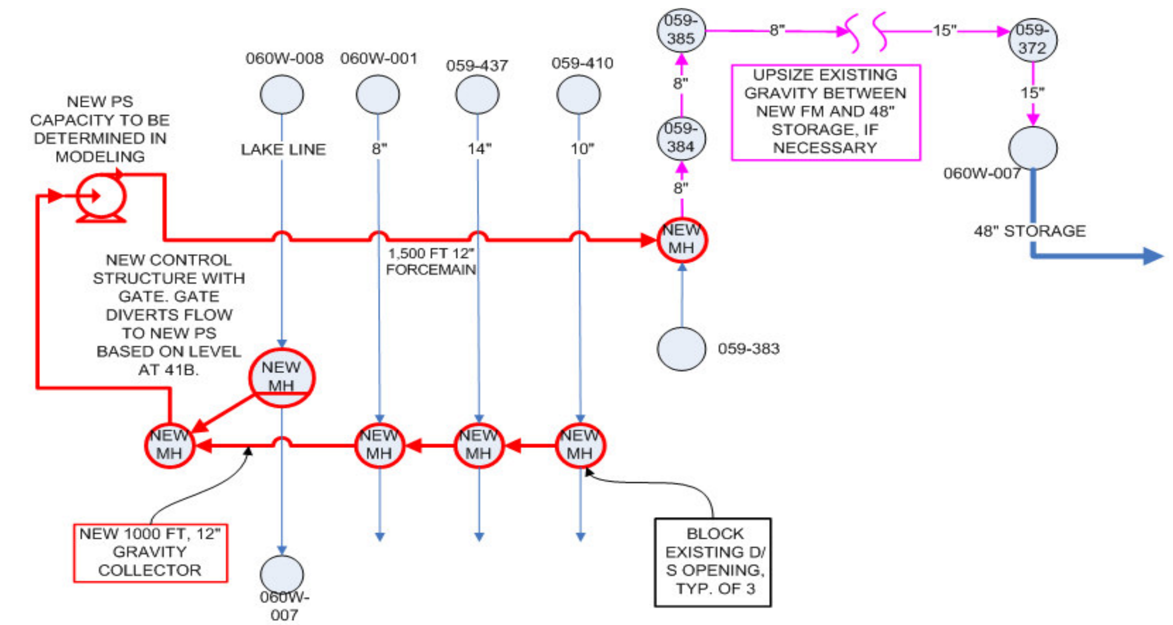

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
13.0	IBT-100-41 to 38	New pump station near MH 060W-007, at the parking lot to the east of Adams St. and Lake Washington Blvd., that pumps flows to Genesee park to off load peak flows from the lake line. This will avoid surcharged conditions in the lake line that cause overflows at 41B, effectively bringing 41B into compliance. Approximately 80% of the flow in basin 40 will also be diverted into this new pump station, bringing basin 40 into compliance. Specifically, flow through MHs 060W-001, 059-437, and 059-410 in basin 40 will be diverted into a new 1,000 foot long, 12 inch diameter gravity pipe that flows east to the new pump station. The capacity of this pump station will be determined during modeling. See schematic for details. Basin 43 is brought into compliance by adding new storage (components from run 3.2). Model Construction: This alternative combines alternatives 1.0 and 3.0. This run incorporates all the components of ***Alternative ROW 40*** . ☐ Schematic Provided ☐ Hydrographs Requested	To transfer flows to Basin 38 storage. To eliminate surcharging in the existing lake line and bring basin 41b into compliance.	12/23/2009	☑ Network Built ☑ Simulation Built ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By: DOL** **Date: 2/1/2010** **CSO Results** Basin 40 / 41B / 43 \# of Overflows: 0 / 4 / 6 Overflow Volume Reduction: 6.3 / 6.0 / 3.2 mg Control Volume Reduction: 0.203 / 0.188 / 0.187 mg **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: A new pump station and diversion structure was constructed in the parking lot area just east of Adams St. and Lake Washington Blvd, which picks up flows along the lake line and from 80% of basin 40. The diverted flows from 40 are diverted into a new 12" pipe and flow into the new pump station. This pump station pumps flows from the lake line and 40 into the existing 72" storage pipe in basin 38. 5 Year Results: Results indicated that this alternative controlled basins 40, 41B, and 43. Overflows at 40 were entirely eliminated, allowing the decommissioning of the outfall. 41B was reduced to 4 overflows over the 5 year period, bringing it into compliance. Interim runs indicated an increase in CSO volumes and frequency at basin 38, caused by the pumping of flows from the lake line and 40. These increases were eliminated by reducing the pump rate at the new pump station and removing the hydrobrake bypass weir at 38. Final capacity of the new pump station was two pumps at 2 mgd (4 mgd capacity total).

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  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
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- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
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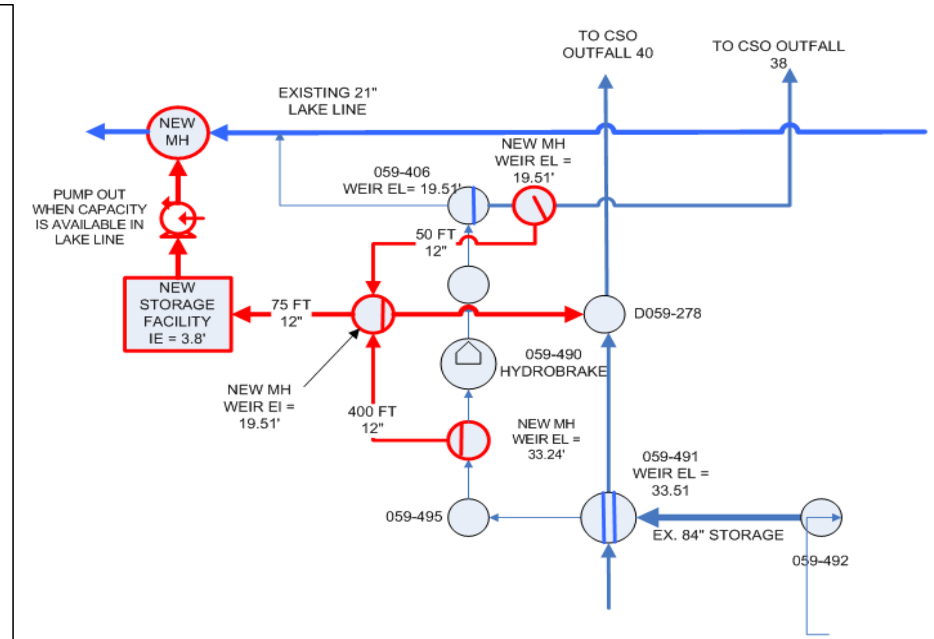

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
14.0	OFF-113-38	Provide offline storage for Basin 40, 41B, and provide lake line relief by offloading wet weather flows. This alternative would install a new control structure between 059-490 and 059-495 with a weir set at 33.25' (3" lower than the Basin 40 overflow weir). Another new control structure would be installed between 059-406 and 059-402 with a weir set to 19.25' (3" lower than basin 41b overflow). Flow that overtops these weirs would go northwest to new storage facility located in a parks parking lot. Flow would be pumped out of this storage facility in such away so that it would not impact the capacity of PS#5. ☑ Schematic Provided ☐ Hydrographs Requested	This Alternative will bring Basin 40 and 41B into compliance. **Model runs need to determine the size of the storage facility.**	12/23/2009	☑ Network Built ☑ Simulation Built **Statistical Results** ☑ Model Run Complete ☑ CSO Stats Report Complete **File Management** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title: 14.0_OFF-113-38_FINAL	**Modeling Performed By: Santtu Winter** **Date: 1/30/2010** **CSO Results** Basin 40 / 41B # of Overflows: 6 / 6 Overflow Volume Reduction: 1.8 / 3.3 mg Control Volume Reduction: 0.203 / 0.19 mg **Boundary Conditions** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model construction: A flow diversion structure was constructed for both NPDES 40 and 41B to divert flow into the new offline storage tank. At NPDES 41B, the diversion was placed immediately downstream of the existing NPDES 41B overflow weir, to divert would-be overflows to storage. Flow at NPDES 40 is diverted one manhole downstream of the existing overflow structure via a new 20 ft long weir, and one manhole upstream of the existing hydrobrake. The weir elevation at the NPDES 40 storage diversion weir was determined by running NPDES 40 control storm simulations with differing weir elevations to narrow in on the elevation that resulted in the control storm being just controlled. The storage tank overflows out of NPDES 41B and a new connection made to the overflow pipe for NPDES 40. This new connection was needed in order to allow enough capacity for the storage tank to overflow during large storm events without increasing the CSO volume at NPDES 38 and 41A. 5-Year Simulation Results: A sensitivity analysis was completed to determine what storage volume was needed to control 40 and 41B. Runs were completed with varying storage volumes, and it was determined that a volume of 0.426 MG is sufficient to control 40 and 41B. However, results indicated that basin 40 overflowed 6 times during the 5 year period, all of which were ranked above the control volume storm. Key Problems Encountered: - Interim runs completed before the connection was made between NPDES 41B and 40 resulted in an increase in CSO volume at 38 and at 41A. This was caused by not enough flow being able to get out of the overflow pipe at 41B, resulting in a backwater condition that caused higher surcharge levels in the lake line compared to the baseline run. This resulted in a higher head on the weir at NPDES 38 and 41A, resulting in higher overflow volumes. The first attempt to solve this problem was to increase the size of the storage tank to see how large of a tank was needed to return CSO volumes at 38 and 41A to baseline conditions. Results from those simulation indicated that an excessively large tank of upwards of 2 mg in size would be needed. Following this attempt, a test run was completed that allowed the overflow weir at 41B to overflow as a free discharge under all conditions. This test run resulted in a slight decrease in overflow volumes at 38 and 41A when compared to the baseline conditions, thus confirming that the problem was due to the inability of flow to get out of the system. - Interim runs also showed overflows at 40 during low-ranked, high peak flow, summer storms. These were eliminated by increasing the length of the storage diversion weir from 6 ft to 20 ft.

General Assumptions

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  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
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Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
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Overflow Structure 165	35	0	0	6	0.10	6

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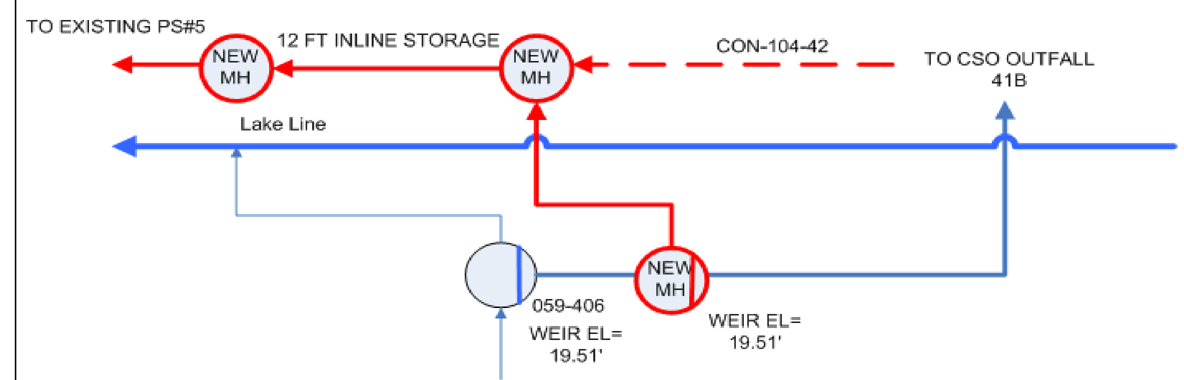

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
15.0	ROW 44	Previously Run 11.0. Construct new lake line using runs 4.0 and 5.0. Create sufficient 12 foot diameter in line storage in the northern section of the new lake line to control basins 40, 41B, and 43. Modeling will confirm the total length required. Flows will be pumped out of storage at the northern end into MH 059-455, which is directly upstream of PS5. Model Construction: This alternative combines alternatives 1.2, 2.0, 4.0, and 5.0. This run incorporates all the components of ***Alternative ROW 44*** . ☐ Schematic Provided ☐ Hydrographs Requested	The purpose is to determine the amount of inline storage need in model run 5.0. Use the existing developed model components and add a storage node at the appropriate point to determine the volume need to bring Basin 41b into compliance. Take that storage volume and upsize the 5.0 pipe to accommodate the volume and rerun.	12/23/2009	☑ Network Built ☑ Simulation Built ☐ Model Run Complete ☐ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network **File Management** File Path: Results Path: SIM ID: Run Title:	Modeling Performed By: D.O'L. Date: 2/1/2010 CSO Results Basin 40 / 41B / 43 # of Overflows: Overflow Volume Reduction: Control Volume Reduction: ***Boundary Conditions*** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☐ Boundary Condition 2 Met	Model Construction: This alternative includes runs 1.2, 2.2, 4.0, and 5.0. The last 1,150' of the new lake line conveyance was converted into a 10' diameter storage pipe, resulting in a storage volume of 0.67 mg. When conditions indicated capacity in the existing lake line, flows from the storage pipe were pumped back into the existing lake line just upstream of PS5. The relief point for the storage pipe is through the existing outfall at 41B, and a new connection made to the overflow at NPDES 40. This new connection was needed to allow the storage tank to overflow sufficiently quickly to avoid increased CSO volumes at 38 and 41A. 5-year Results: Results are expected to be identical to the 5 year simulation results from run 7.0, due to the similarities between the construction of the runs. The only difference between the two runs is the location of the storage tank. Refer to results from run 7.0. A 5 year simulation will be completed as soon as possible for run 8.0. Other Findings: During control storm simulations, it was observed that the height of the storage diversion weir in basin 43 had a large impact on the total amount of flow that was diverted into storage. Control storm simulations indicated a difference in total storage volume required ranging from 0.56 mg to 0.78 mg. The final weir height was selected which resulted in a required storage volume of 0.67 mg.

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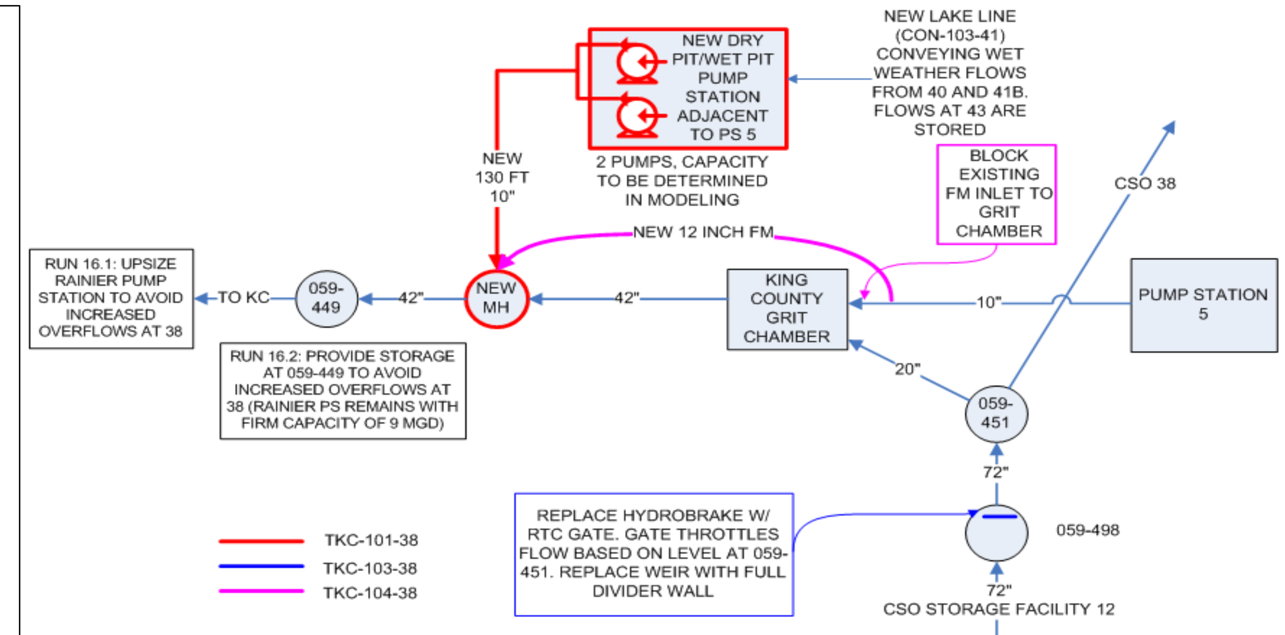
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
- Run Title will have the following format: Model Run#_NetworkName_Description_ModelRunDate (yyyy_mm_dd)
  - For example, 6_Genesee_LakeLineImprovements_2009-10-30



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
16.0		TKC 101-38 consists of constructing a new pump station adjacent to PS #5. This pump station would receive flow from the new lake line (CON-103-41) and have 2 pumps at a capacity to be determined during modeling. The pumps would operate in a lead/lag mode. The force main would discharge downstream of the King County grit chamber. TKC 103-38 replaces the hydrobrake with a slide gate operated with RTCs in 056-498. Modulate the gate based on the level at MH 059-450 to avoid increased overflows at NPDES 38. Allow flow to back up in to CSO Storage Facility 12 only if the downstream conveyance line is full. TKC 104-38 replaces the existing Pump Station #5 force main with a new line (same diameter) that bypasses the King County grit chamber. This run is identical to run 10.0, except that run 16.0 contains storage at basin 43. See schematic. Modeling will need to determine the following: - What capacity is needed at the new pump station to bring NPDES 41B into compliance? - 16.1: What capacity is needed at the Rainier PS to handle this additional flow and keep overflows at NPDES 38 at baseline conditions? - 16.2: What storage volume would be needed to handle this additional flow and keep overflows at NPDES 38 at baseline conditions if the firm capacity of Rainier remains at the current flow rate of 9 mgd. ☐ Schematic Provided ☐ Hydrographs Requested	These changes reduce the chokepoint currently experienced at Pump Station 5. They are needed to maintain reliability and reduce pressure on downstream conveyance.		☑ Network Built ☑ Simulation Built **File Management** ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title: 16.1_FINAL 16.2_FINAL	Modeling Performed By: Santtu Winter Date: 2/15/2010 CSO Results 16.1 Basin 40 / 41B / 43 # of Overflows: 6 / 4 / 6 Overflow Volume Reduction: 4.8 / 3.9 / 3.7 mg Control Volume Reduction: 0.20 / 0.19 / 0.19 mg 16.2 Basin 40 / 41B / 43 # of Overflows: 7 / 4 / 5 Overflow Volume Reduction: 4.9 / 4.1 / 3.7 mg Control Volume Reduction: 0.20 / 0.19 / 0.19 mg ***Boundary Conditions*** *Provide validation using hydrographs* ☐ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: This run is a combination of runs 1.2, 3.2, 4, and 5. The following is a brief summary of those runs: - 38: Hydrobrake removed and replaced with a variable sluice gate. The hydrobrake bypass weir was also removed. These changes are unique to this alternative, and are not based on another run. - 40: Controlled by replacing the hydrobrake with a flow control device which limits the flow coming out of the basin (run 1.2). - 41B: Controlled by the new parallel lake line (runs 4 and 5), which collects wet weather flows from basin 40, 41B, and 43. - 43: Controlled by placing new storage with a volume equal to the control volume (run 3.2). In addition to the changes noted above, the new lake line conveyance from run 4 and 5 was modified to pump flows into the Charleston Street Trunk one MH downstream of the grit chamber. The existing PS#5 was also modified to pump around the grit chamber, in order to eliminate the hydraulic constriction at that location. Two sub-alternatives were evaluated in run: 16.1: All flows from the new lake line are conveyed into the Hanford Trunk B, and conveyed through the Rainier pump station, which is sized so that the additional flow from the new lake line does not cause additional overflows at basin 38. 16.2: Increases in CSO volume at 38 were kept at baseline conditions by building a storage tank in Hanford Trunk B. 5 Year Results: Initial runs consisted of determining the optimal pump capacity at the new conveyance pump station that caused overflows at 41B. It was determined that a capacity of 0.66 mgd resulted in 4 overflows at 41B. Basins 40 and 43 were also brought into compliance. The following are the results for the two sub-alternatives: 16.1: Rainier Pump Station was upsized to 10.3 mgd to avoid an increase of CSOs at 38. 16.2: Storage was built with a volume of 2.4 mg to avoid an increase of CSOs at 38.

General Assumptions

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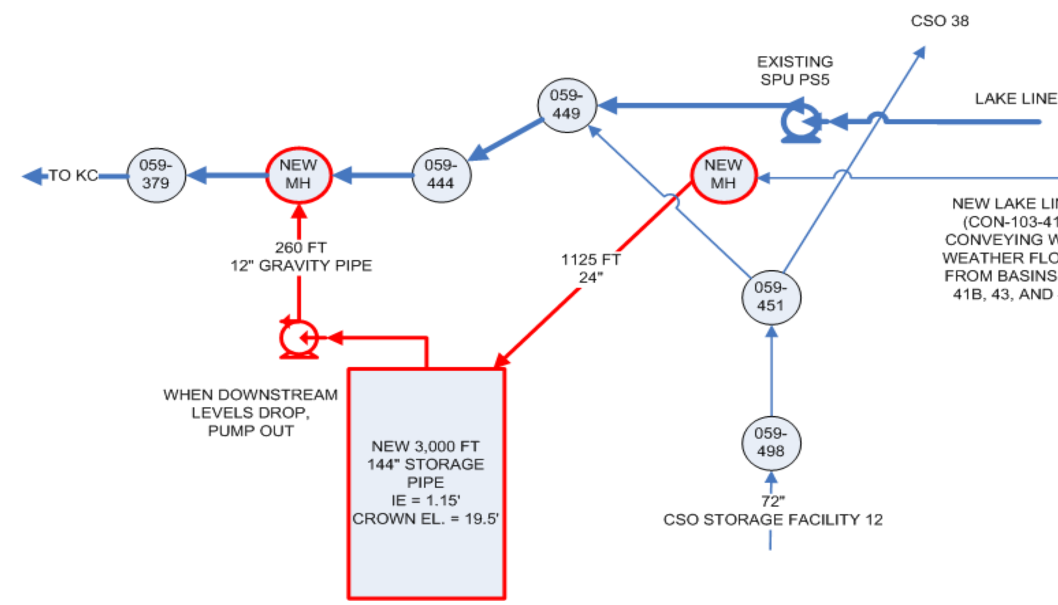
- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
- Run Title will have the following format: Model Run#_NetworkName_Description_ModelRunDate (yyyy_mm_dd)
  - For example, 6_Genesee_LakeLineImprovements_2009-10-30



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
17.0		Storage built in ROW to handle all of the Genesee Basins that are not currently controlled, as well as basin 44 from Henderson. Storage will start with a 3,000 foot long 12 foot diameter pipe, with a volume of 2.5 mg. Model to confirm if this is large enough. The storage pipe will be connected to model runs 4 and 5 (new lake line) and flows will be pumped out into the King County trunk at a new MH just downstream of existing MH 059-444. Model Construction: This alternative combines alternatives 1.2, 2.0, 4.0, and 5.0, and will include the Henderson time series as an inflow at the southern most MH of run 4.0. Flows from Henderson will enter ☐ Schematic Provided ☐ Hydrographs Requested	The purpose of this alternative is to eliminate overflows in Basins 40, 41B, 43, and 44 by building sufficient storage in the right of way of 43rd Ave in Basin 38.		☑ Network Built ☑ Simulation Built **File Management** ☐ Model Run Complete ☐ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title:	Modeling Performed By: Santtu Winter Date: 2/22/2010 CSO Results Basin 40 / 41B / 43 # of Overflows: 7 / 4 / 5 Overflow Volume Reduction: 1.8 / 5.0 / 3.4 mg Control Volume Reduction: 0.20 / 0.19 / 0.19 mg ***Boundary Conditions*** *Provide validation using hydrographs* ☐ Boundary Condition 1 Met ☐ Boundary Condition 2 Met	Model Construction: This alternative includes runs 1.2, 2.2, 4.0, and 5.0. x,xxx ft of new gravity conveyance was constructed from the terminus of alternative 4.0 near PS5 to the new storage pipe along 43rd Ave at a slope of 0.57%. A 12' diameter storage pipe was constructed with a volume of 2.14 mg (2,531 ft in length) at a slope of 0.xx%. The relief point for the storage pipe is through the existing outfall at 41B, and a new connection made to the overflow at NPDES 40. This new connection was needed to allow the storage tank to overflow sufficiently quickly to avoid increased CSO volumes at 38 and 41A. 5-year Results: Basins 40, 41B, and 43 were all brought into compliance. Results showed unusual behavior at Other Findings: It was determined that, in order to meet the boundary condition that overflow frequencies at other controlled basins in Genesee do not increase, an additional overflow connection needed to be made into NPDES 40. Without this connection, the storage tank was not able to overflow quickly enough, resulting in an increase of CSO volume and frequency at 38. During control storm simulations, it was observed that the height of the storage diversion weir in basin 43 had a large impact on the total amount of flow that was diverted into storage. Control storm simulations indicated a difference in total storage volume required ranging from 0.56 mg to 0.78 mg. The final weir height was selected which resulted in a required storage volume of 0.67 mg, which matches the storage size that was used for cost estimating purposes.

General Assumptions

- Unless otherwise stated each alternative needs to reduce the number of CSOs at each outfall to 1 untreated discharge per year of the duration of the simulation.
- Alternatives need to meet the Boundary Conditions within the SPU network and at King County Facilities. The Boundary Conditions are as follows:
  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
- Run Title will have the following format: Model Run#_NetworkName_Description_ModelRunDate (yyyy_mm_dd)
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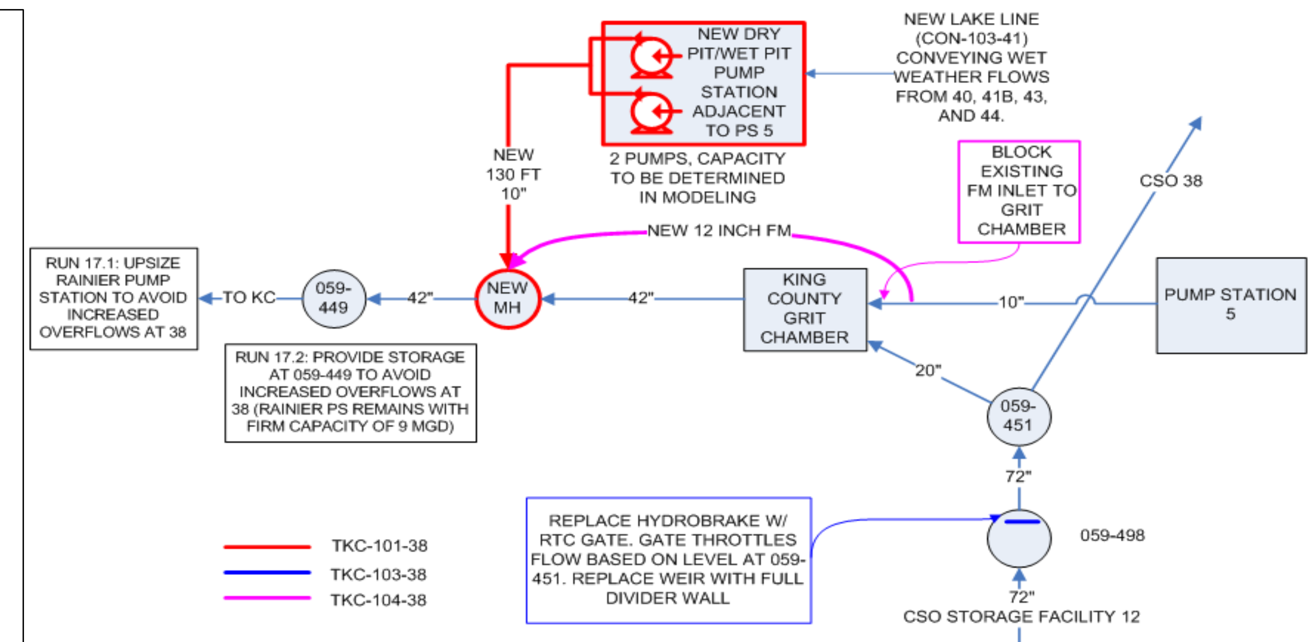

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
18.0	☐ Schematic Provided ☐ Hydrographs Requested	Transfer to King County via new pump station pumping flows from new parallel lake line into Charleston Street Trunk, existing pump station 5 pumps around existing King County grit chamber. Coupled with runs 1.0, 2.0, 4.0, 5.0, and Henderson basin 44 TS.	The purpose of this run is to reduce overflows at 40, 41B, 43, and 44 by increasing the capacity of the lake line by building a new parallel one to convey wet weather flows, effectively transferring flows to King County.		☑ Network Built ☑ Simulation Built **File Management** ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title:	Modeling Performed By: Santtu Winter Date: 2/23/2010 CSO Results 18.1 Basin 40 / 41B / 43 # of Overflows: 6 / 4 / 5 Overflow Volume Reduction: 4.8 / 6.5 / 3.7 mg Control Volume Reduction: 0.20 / 0.19 / 0.19 mg 18.2 Basin 40 / 41B / 43 # of Overflows: 6 / 4 / 5 Overflow Volume Reduction: 4.9 / 6.6 / 3.7 mg Control Volume Reduction: 0.20 / 0.19 / 0.19 mg ***Boundary Conditions*** *Provide validation using hydrographs* ☐ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: This run is a combination of runs 1.2, 2.2, 4, and 5. This run also includes flows from basin 44 in Henderson. The following is a brief summary of changes to each basin: - 38: Hydrobrake removed and replaced with a variable sluice gate that controls the level at 059-451 (horseshoe weir) to avoid flow over the weir into Structure A. The hydrobrake bypass weir was also removed. These changes are not based on another run. - 40: Controlled by replacing the hydrobrake with a flow control device which limits the flow coming out of the basin to 1.92 mgd (run 1.2). - 41B: Controlled by the new parallel lake line (runs 4 and 5), which collects wet weather flows from basin 40, 41B, and 43. - 43: Controlled by replacing the hydrobrake with a flow control device which limits the flow coming out of the basin to 1.25 mgd (run 2.2). - 44: Flows from Henderson are introduced to the southern-most end of the new parallel lake line at the new MH CON-104-42_MH11. In addition to the changes noted above, the new lake line conveyance from run 4 and 5 was modified to pump flows into the Charleston Street Trunk one MH downstream of the grit chamber. The existing PS#5 was also modified to pump around the grit Two sub-alternatives were evaluated in run: 18.1: All flows from the new lake line are conveyed into the Hanford Trunk B, and conveyed through the Rainier pump station, which is sized so that the additional flow from the new lake line does not cause additional overflows at basin 38. 18.2: Increases in CSO volume at 38 were kept at baseline conditions by building a storage tank in Hanford Trunk B. 5 Year Results: Initial runs consisted of determining the optimal pump capacity at the new conveyance pump station that caused overflows at 41B. It was determined that a capacity of 6.2 mgd resulted in 4 overflows at 41B. Basins 40 and 43 were also brought into compliance. The following are the results for the two sub-alternatives: 18.1: Rainier Pump Station was upsized to 12.82 mgd to avoid an increase of CSOs at 38.

General Assumptions

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  1. Flow at the Rainier Avenue Pump Station will not exceed the firm capacity of the pump station (9 mgd) nor increase the frequency of overflows above the frequency predicted by the base model.
  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
Overflow Structure 37				0	0	0
Overflow Structure 38	23	0.0	0.0	5	5.40	5
Overflow Structure 40	189	0.20	2.15	34	6.28	7
Overflow Structure 41A	0	0.0	0.0	0	0	0
Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

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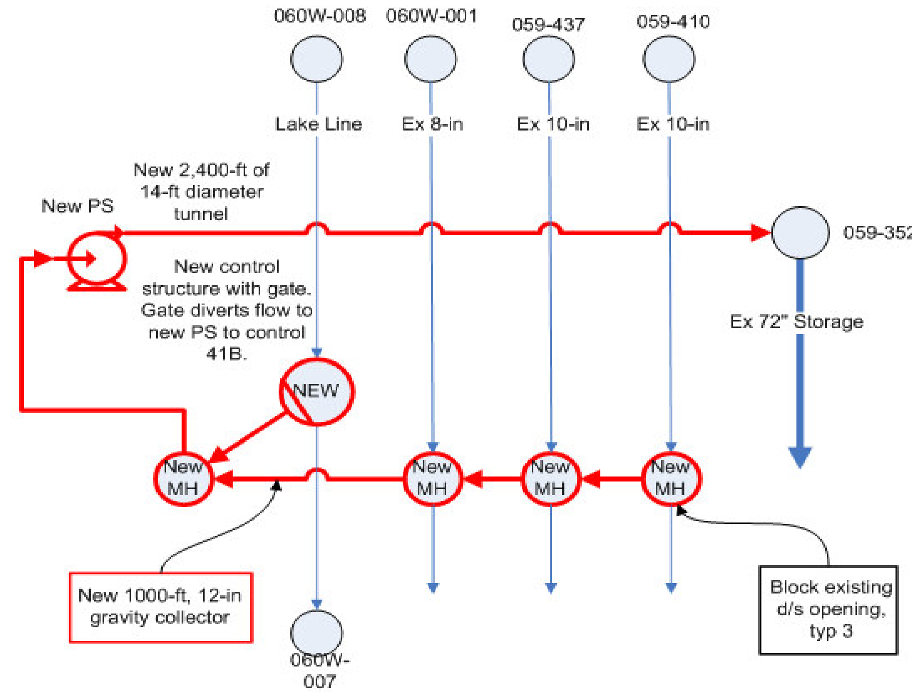

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
19.0	Row 17N + 41	New storage tunnel conveying flows to Genesee Park coupled with runs 1.0, 2.0, 4.0 (partial) and Henderson basin 44 TS. ☐ Schematic Provided ☐ Hydrographs Requested	The purpose of this run is to reduce overflows at 40, 41B, 43, and 44 by building a new storage tunnel with sufficient volume to control all basins.		☑ Network Built ☑ Simulation Built **File Management** ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title: 19.0_ROW17N+44_5yr_FINAL	Modeling Performed By: Santtu Winter Date: 2/25/2010 CSO Results Basin 40 / 41 / 43 # of Overflows: 0 / 3 / 5 Overflow Volume Reduction: 6.28 / 6.35 / 3.72 MG Control Volume Reduction: 0.203 / 0.188 / 0.187 MG ***Boundary Conditions*** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☑ Boundary Condition 2 Met	Model Construction: This run is designed to control basins 40, 41B, 43, and 44 from the Henderson basin. Using run 13.0 as a template, a new 14 ft diameter tunnel was constructed from the flow diversion structure at MH 060W-007, heading east 2,300 ft, ending at the storage pipe in Genesee Park where stored flow is pumped into basin 38. Total storage volume for the tunnel is 2.73 mg. Basin 41B is controlled by limiting flows through the lake line upstream of 41B at the flow diversion structure at 060W-007. The majority of flows from basin 40 are diverted to the tunnel, controlling basin 40. Basin 43 is controlled by using run 2.0, which maximizes existing storage and conveys the rest of the control volume storm. 5-Year Results: Results indicated that basins 40, 41, 43, and 44 were brought into control. CSOs at Basin 40 were entirely eliminated from the 5-year simulation period.

Henderson and Genesee CSO Reduction Projects DRAFT
Genesee Area Model Tracker

General Assumptions

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  2. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
- Alternatives performance will be compared to the Base Model. Performance of the Base Model includes (using 5,000 gallon threshold):

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flow (MGD)	Overflow Frequency 8/02 - 12/07 Simulation (Events)	Overflow Volume 8/02 - 12/07 Simulation (MG)	Number of Events Larger than Control Volume (Events)
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Overflow Structure 41B	235	0.19	1.33	42	6.80	6
Overflow Structure 42	19	0.0	0.0	4	0.94	4
Overflow Structure 43	220	0.19	2.16	36	5.23	7
Overflow Structure 165	35	0	0	6	0.10	6

- The model run period for the conceptual alternative evaluation is August 1, 2002 - December 31, 2007.
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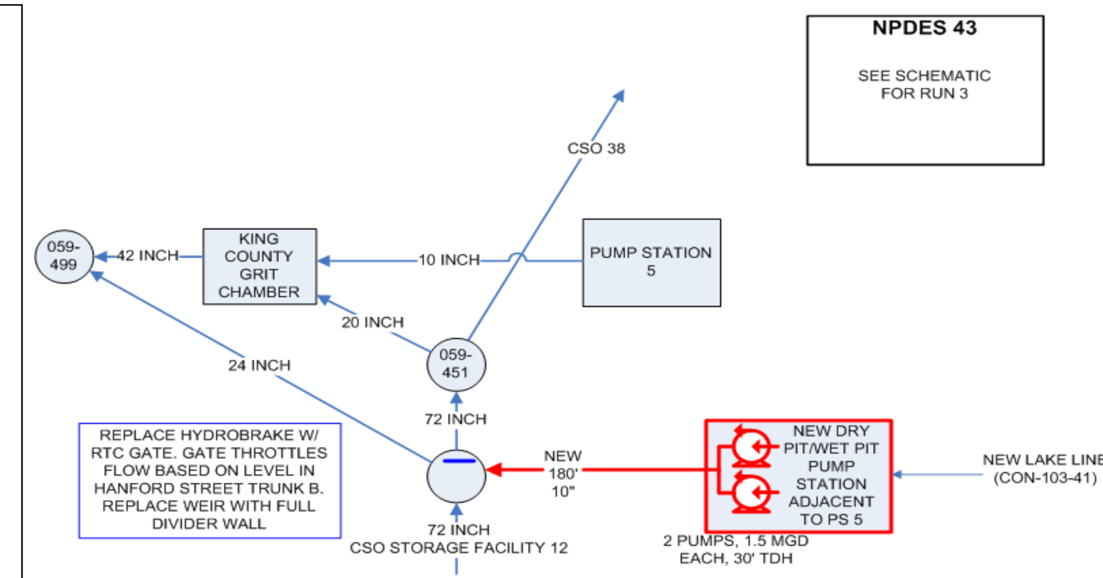

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
21.0		New conveyance that pumps to existing storage in Genesee Park. Coupled with runs 1.0, 3.0, and 5.0. ☐ Schematic Provided ☐ Hydrographs Requested	Determine the size of the new Lake Line, size of pumps draining the new lake line, and bypass weir elevations.		☑ Network Built ☑ Simulation Built **File Management** ☑ Model Run Complete ☑ CSO Stats Report Complete **Statistical Results** ☐ Archived Results ☐ Archived Network File Path: Results Path: SIM ID: Run Title:	Modeling Performed By: D.O'L Date: 2/18/2010 CSO Results Basin 38 / 40 / 41A / 41B / 43 # of Overflows: 5 / 6 / 2 / 4 / 7 Overflow Volume Reduction: -2.5 / 4.9 / -0.03 / 3.3 / 3.1 mg Control Volume Reduction: -- / 0.20 / -- / 0.19 / 0.19 mg ***Boundary Conditions*** *Provide validation using hydrographs* ☑ Boundary Condition 1 Met ☐ Boundary Condition 2 Met	Model Construction:This run consisted of the following: A new lake line was inserted from 41B overflow weir to a new lift station; new lift station draining the new lake line discharging to upstream of the hydrobrake in 38, and a bypass structure from the existing Genesee storage to the Hanford Trunk B. Bypass weirs were adjusted maximizing the existing available storage in Genesee Park. General iteration was to increase the size of the new lake line until 41B was controlled then adjusting the pump rate of the draining pumps so as not to increase the frequency at 38. As iterations were performed, 41B could be controlled, however, decreasing the pumps had no impact on 38. A bypass structure was inserted in model one maintenance hole upstream of the 38 hydrobrake location. The weir was set 18-inches below the surface flooding level at the lowest point (38 hydrobrake)--aweir elevation of 28.87. Modeling team concluded that the 38 hydrobrake was not restrictive enough and the Genesee Park storage could not be fully used. Only after implementing RTC instead of the hydrobrake at 38, could 38 and 41B be controlled. Final simulations yielded the fo