Seattle Public Utilities

Henderson CSO Reduction Project

Henderson Area Alternatives Modeling Report – FINAL

May 2010

HDR

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May 2010

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1.0 Executive Summary

The purpose of this report is to document the modeling analysis that was performed to evaluate the engineering alternatives that have been for Combined Sewer Overflow (CSO) reduction in the Henderson 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 Combined Sewer Overflows (CSOs).

The Base Model used in the alternative 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 Henderson Area from January 2008 through May 2009.

The purpose of performing hydraulic modeling of the Henderson Area alternatives was to size Henderson Area CSO control alternatives (i.e., storage conveyance capacity of pump stations and pipelines) to reduce CSO frequency to one event per year per outfall. Additional information regarding the alternatives can be found in Henderson and Genesee CSO Reduction Projects Options Report (August 2009).

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 interfaces. The two locations where the Henderson Area enters the King County system are the Henderson Pump Station and Henderson Trunk.

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

1. For the King County Henderson Pump Station:
    - Do not exceed the firm capacity of 16.9 MGD.
    - Do not increase the frequency of overflows above the frequency predicted by the Base Model.
2. For the King County Henderson Trunk, estimate the threshold maximum flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the Base Model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the Base Model.
3. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.

A total of 30 model runs were identified 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 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. Once the analysis process was underway, some runs were eliminated based on results from the analysis. Of the initial 30 runs identified, 20 runs were completed during the analysis of the preliminary alternatives. The results of the 20 completed model runs were sufficient for determining sizing and hydraulic feasibility of CSO control alternatives within the Henderson Area. The 10 model runs that were not completed were determined by the team to be unnecessary because results the 20 completed model runs provided sufficient information for the

alternatives development. 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 runs or combination of runs will be further developed. A new phase of hydraulic modeling will take place for these selected solutions. This next phase of modeling will involve evaluating the individual selected runs or combination of runs using the full Henderson network and the full 31-year rainfall record. The goal of these new runs will be to refine system design and verify that the boundary conditions are met.

Table 1-1: Model Run Summary Results

Model Run	Model Run Goal	Results
Run 1.0	Identify additional flow sent to the Henderson Pump Station by removing the existing HydroBrake in Basin 49	Maximum flow to King County = 4.0 MGD (Base Model maximum flow = 2.4 MGD) Below Benchmark (4 overflows)
Run 2.0	Identify additional flow sent to the Henderson Pump Station by replacing existing HydroBrake in Basin 49 with a modulating gate	Maximum flow to King County = 3.8 MGD (Base Model maximum flow = 2.4 MGD) Below Benchmark (7 overflows)
Run 4.0	Identify additional flow sent to Henderson Pump Station by removing the existing HydroBrake in Basin 171	Maximum flow to King County = 2.3 MGD (Base Model maximum flow = 0.8 MGD) Flooding occurs downstream due to pipeline capacity limitations. Below Benchmark (7 overflows)
Run 7.0	Generate hydrograph of flow to send to Genesee to control Basin 44	Hydrograph of flow to send to Genesee was generated from the results from Run 13.0
Run 8.0	Identify additional flow to Henderson Trunk by upsizing piping downstream of 47B	Maximum flow to King County = 12.3 MGD (Base Model maximum flow = 3.7 MGD) Below Benchmark (1 overflow at 47B; 5 overflows at 171)
Run 9.0	Identify additional flow to Henderson Trunk by removing existing HydroBrake in Basin 171 and upsizing piping downstream of 47B	Maximum flow to Henderson Trunk = 12.3 MGD (Base Model maximum flow = 3.7 MGD) Maximum flow to Henderson Pump Station = 2.4 MGD (Base Model maximum flow = 0.8 MGD) Below Benchmark (0 overflows at 47B; 2 overflows at 171)
Run 10.0	Identify additional storage needed to control Basin 44	44 Storage = 2.40 MG

Model Run	Model Run Goal	Results
Run 13.0	Identify combined storage in Basin 45 to control Basin 44 and Basin 45, and additional storage needed to control Basin 46	Reduce maximum pump rate at Pump Station 10 to 1.8 MG Basin 45 Storage = 2.60 MG Basin 46 Storage = 0.35 MG
Run 14.0	Identify additional storage needed to control Basin 47B/Basin 171	Basin 47B/Basin 171 Storage = 0.26 MG
Run 16.0	Identify additional storage needed to control Basin 49	Basin 49 Storage = 0.32 MG
Run 17.0	Replace existing HydroBrake in Basin 49 with modulating gate that limits flow to King County to current peak. Identify additional storage needed to control Basin 49	Basin 49 Storage = 0.10 MG
Run 18.0	Identify additional storage needed to control Basin 46	Basin 46 Storage = 0.35 MG
Run 19.0	Identify additional flow to Henderson Trunk from Basin 47C if existing orifice plate is removed	Maximum flow to Henderson Trunk = 19.5 MGD (Base Model maximum flow = 12.0 MGD)
Run 20.0	Identify Pump Station 9 capacity needed to control Basin 46	Maximum Pump Rate = 3.9 MGD (Base Model maximum pump rate = 3.2 MGD)

Model Run	Model Run Goal	Results
Run 22.0	Identify additional flow to Henderson Pump Station by removing existing HydroBrake in Basin 171 and upsizing downstream piping	Maximum flow to King County = 4.7 MGD (Base Model maximum flow = 0.8 MGD) Downstream pipe increased from 12" to 18" Below Benchmark (5 overflows)
Run 23.0	Identify additional flow to Henderson Pump Station by replacing existing HydroBrake in Basin 171 with modulating gate	Maximum flow to King County = 2.3 MGD (Base Model maximum flow = 0.8 MGD)
Run 24.0	Identify length of upsized pipe needed downstream of Basin 47B and additional flow sent to the Henderson Trunk by removing orifice at Basin 47B	Length of pipe = 1,415 ft Maximum flow to Henderson Trunk = 5.3 MGD (Base Model maximum flow = 3.7 MGD)
Run 26.0	Identify additional storage needed to control Basin 44, Basin 45 and Basin 46	Reduce maximum pump rate at Pump Station 10 to 1.8 MG Basin 44 Storage = 2.40 MG; Basin 45 Storage = 0.20 MG; Basin 46 Storage = 0.35 MG
Run 27.0	Determine if Basin 47C can be controlled by raising weir in the CSO overflow structure by 1 foot	Maximum flow to Henderson Trunk = 13.5 MGD (Base Model maximum flow = 12.0 MGD) Below Benchmark (5 overflows)
Run 28.0	Identify additional flow sent to the Henderson Pump Station by replacing existing HydroBrake in Basin 49 with a modulating gate	Maximum flow to King County = 3.6 MGD (Base Model maximum flow = 2.4 MGD)

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2.0 Introduction

The Henderson Area is located in southeast Seattle on Lake Washington and shown in Figure 2-1. The Henderson Area is approximately 1,700 acres and encompasses seven Basins: 44, 45, 46, 47, 48, 49, and 171. The Henderson Area is defined by the limits of the sewer system that contributes flows to common King County system connections. The common connections to the King County system for the Henderson Area are the Henderson Trunk and Henderson Pump Station.

The Henderson Area is divided into eight basins. 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.

The Henderson Area sewer systems include sanitary, storm and combined collection systems. A portion of the Henderson Area has fully separated sewer systems, 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.

Under wet weather conditions, flows are a combination of sewage and stormwater from all three types of systems including groundwater infiltration through separated sewers. When flows exceed the capacity of the system, excess combined sewage flows into a control structure where it is discharged directly into the receiving water body through a permitted outfall. This discharge is known as a CSO. The discharge point is called an NPDES CSO Outfall.

Seattle Public Utilities (SPU) has established the Henderson 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 Henderson Area to a long-term average of no more than one overflow per year per outfall

Hydrologic and hydraulic modeling of the Henderson Area collection system was one of the evaluation techniques used to verify the viability of proposed improvements and to establish the sizing and design operating 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 proposed to date. 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 results from this report will be used in the evaluation of alternatives for the Feasibility Analysis.

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 the Henderson Basin to other locations either other SPU basins (i.e., Genesee) or to

King County facilities (i.e., the Henderson Pump Station or the Henderson Trunk). Several different model runs were identified to evaluate the applicability of each alternative and size facilities needed to bring the CSO basins into control.

Base Model – The Base Model represents the calibrated hydraulic model of the Henderson Area (as it existed in January 2010) used to predict the long-term frequency and overflow volumes at each of the 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 determined 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 outfall is determined from the long-term model simulation of the Base Model. The control volume at each of the outfalls is the overflow 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 manufacture's curve for each HydroBrake.

Links – 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 and force main.

Model Run – 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 (e.g., links, nodes, pumps, weirs, subcatchments, etc.) depicting the behavior of a sewer/drainage collection system. Three main networks were defined for this analysis: the full basin network (Henderson), a network representing the northern portion of the Henderson basin containing Basin 44, Basin 45, Basin 46 and Basin 47N (HEN_N) and a network representing the southern portion of the Henderson basin containing Basin 47S, Basin 49 and Basin 171 (HEN_S). Additionally, a separate version of a model run network was created from one of the main networks for each model run that was performed. These model run networks included the system modifications being evaluated to address a basin alternative.

Nodes – 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.

Pumps – 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 1.093 was used.

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.

Weirs – 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 Henderson Base Model

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 depths and flows from the flow monitoring conducted in the Henderson Area from January 2008 through May 2009. Additional information on the Base Model and the calibration process is documented in the *Henderson Combined Sewer Overflow Reduction Project – Henderson Hydrological and Hydraulic Modeling Report* (CH2M HILL, 2010).

The existing combined sewer system is defined in the model and includes the drainage areas, sewer collection pipes, CSO control structures, CSO overflow structures, pump stations and NPDES CSO outfalls. A summary of the modeled collection system is as follows (also see Figure 2-1):

- Basin 44, Basin 45, Basin 46, Basin 47N, Basin 47S, Basin 48, Basin 49 and Basin 171
- NPDES CSO Outfalls 44, 45, 46, 47, 48, 49 and 171
- Henderson Lake line, which extends from Seward Park to the King County Henderson Pump Station
- Pump Station 9, Pump Station 10 and Pump Station 80
- CSO Control Structures 4, 5, 7, and 8 including HydroBrakes or orifices
- CSO Overflow Structures 44A, 44B, 45A, 45B, 46, 47B, 47C, 47D, 47E, 49, and 171

- King County Henderson Trunk, including basin tributary to the trunk that is not part of the Henderson Area
- Henderson Pump station and Henderson Force Mains

The calibrated model was used to establish the Base Model (see Terminology). A precipitation scaling factor of 1.093 was applied to the 31-years of precipitation record to account for historical rainfall record uncertainty, model uncertainty, residual uncertainty, and climate change.

The base conditions established by the 31-year continuous simulation included evaluation of the predicted CSO events in terms of volume, frequency, and maximum flow at each of the CSO overflow structures. The Henderson Pump Station was simulated with a firm capacity of 16.9 MGD consistent with the boundary conditions. For each outfall the following were quantified:

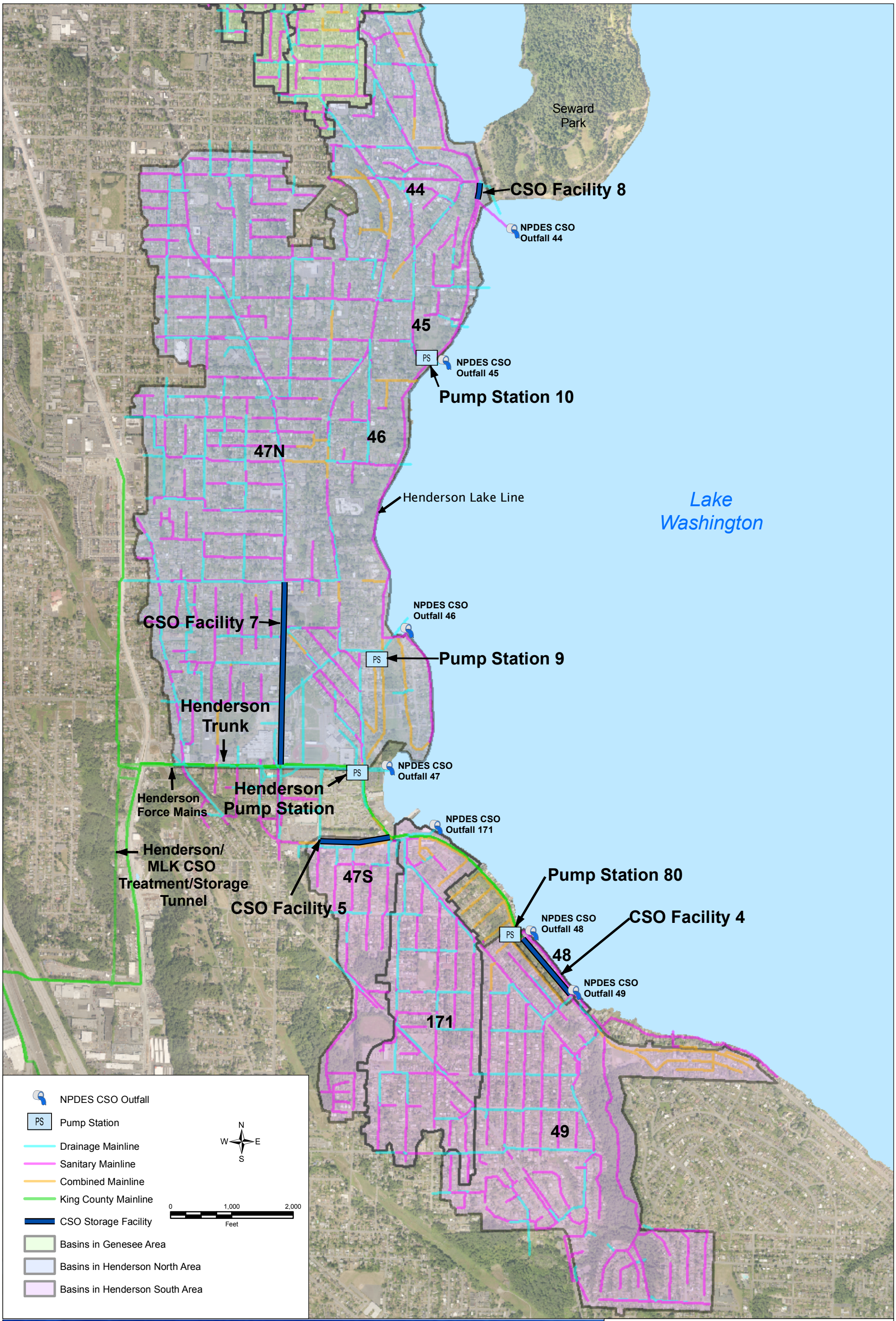
- Number of CSO events – an inter-event period of 24 hours was applied consistent with the Ecology approach for establishing discrete CSO events.
- Control Volume – the volume of water that must be held (i.e., stored, treated, or otherwise managed) to meet the requirement of one untreated discharge per outfall 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: Base Conditions Established from 1/1978 through 6/2009

Overflow Structure	Number of CSOs (No.)	Annual CSO Frequency (events per year)	Control Volume (MG)[1]	31-year CSO Volume (MG)
Overflow Structure 44A	415	13.0	2.07	282.6
Overflow Structure 44B	125	3.9	0.07	8.6
Overflow Structure 45A	168	5.3	0.13	26.8
Overflow Structure 45B	107	3.3	0.05	6.3
Overflow Structure 46	205	6.4	0.26	29.6
Overflow Structure 47B	119	3.7	0.11	16.5
Overflow Structure 47C	62	1.9	0.15	38.4
Overflow Structure 49	51	1.6	0.16	24.2
Overflow Structure 171	128	4.0	0.15	21.2

Notes:
1. Control volume is based on a rainfall scaling factor of 1.093 over the entire Henderson Area.
2. Henderson Pump Station is limited to the reported firm capacity of 16.9 MGD
3. The range of accuracy of the model was assumed to be 10,000 gallons.
4. The model predicted no overflows at Overflow Structure 47D, Overflow Structure 47E and NPDES CSO Outfall 48.



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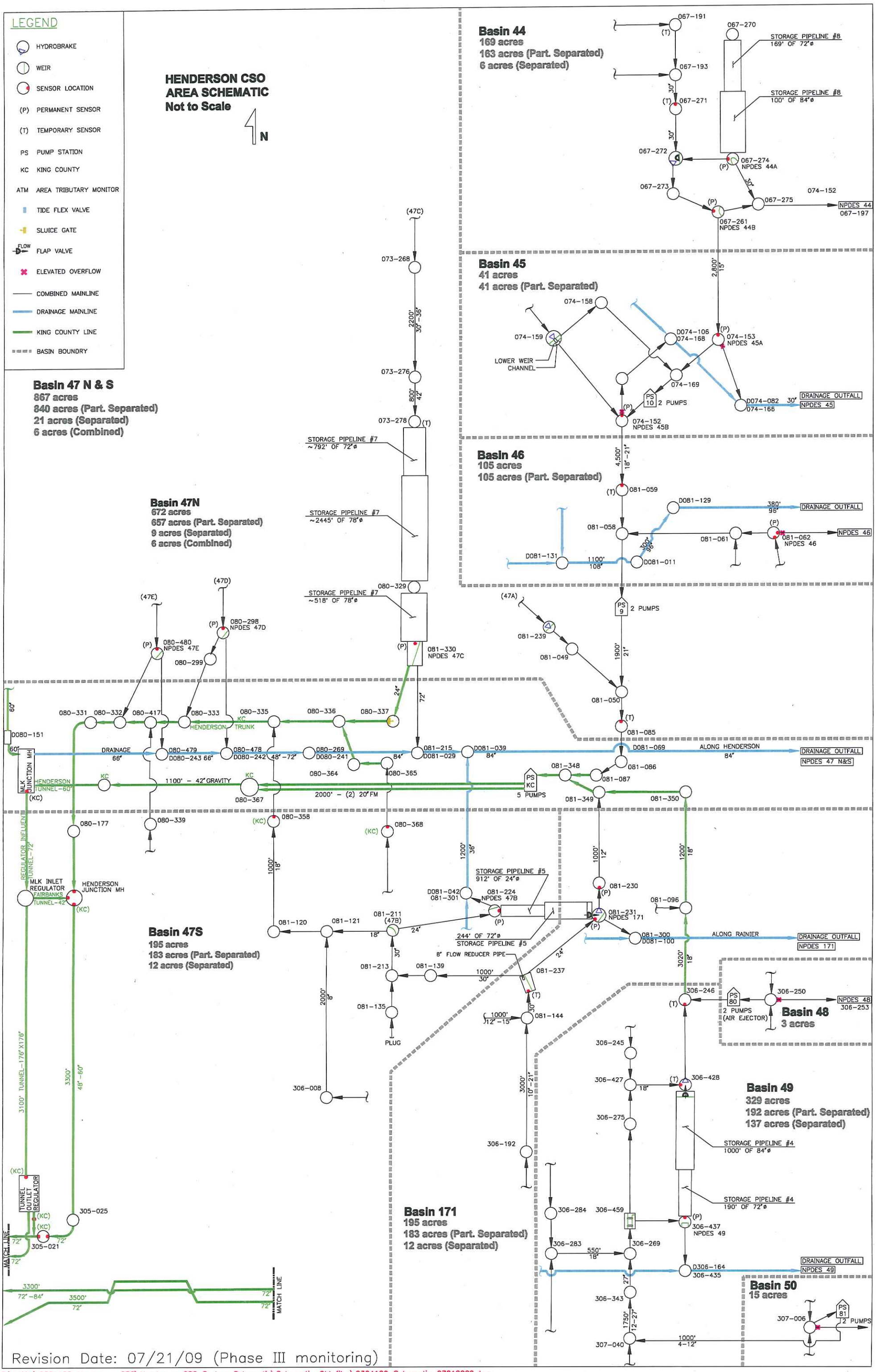

Figure 2-2: Henderson Area Flow Monitoring Schematic

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3.0 Henderson Area Alternatives Modeling

The purpose of performing hydraulic modeling of the Henderson Area alternatives was to size Henderson Area CSO control alternatives (i.e., additional storage, conveyance capacity of pump stations and pipelines) to reduce CSO frequency to one event per year per outfall. The alternatives had to meet the boundary conditions established by SPU as described in the section below. A systematic approach was deployed during this analysis that incorporated a model run time reduction to simulate these alternatives more efficiently.

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 establishing the boundary conditions is to evaluate the impact of a specific alternative at the SPU/King County system interfaces. The two locations where the Henderson Area enters the King County system are the Henderson Pump Station and Henderson Trunk.

The boundary conditions determined by SPU for the Henderson Area are described below:

1. For the King County Henderson Pump Station:
   - Do not exceed the firm capacity of 16.9 MGD.
   - Do not increase the frequency of overflows above the frequency predicted by the Base Model.
2. For the King County Henderson Trunk, estimate the threshold maximum flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the Base Model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the Base Model.
3. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.

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 model simulation times, five-year simulations, using rainfall data from August 2002-December 2007, were performed to determine if the boundary conditions at King County facilities were met and the improvements achieved control by reducing the predicted frequency of overflows to control levels. This period was selected by examining the overflow statistics at Overflow Structure 44A in the Henderson Basin for the long-term simulation. The same five year period was adopted for the Genesee alternative analysis for consistency.

At Overflow Structure 44A, the 5-year period from August 2002 through December 2007 contains 78 predicted CSO events. Seven of the 78 events rank in the top 40 largest events by volume for the long-term rainfall record, as shown in Figure 3-2. This modeling period provides CSO events with a large enough CSO volume for evaluating CSO control alternatives because there are events approximately the size of the control volume.

Table 3-1 contains the predicted number of CSOs, CSO frequency and CSO volume for the 5-year alternatives modeling duration. The CSO frequency is slightly greater than the

CSO frequency predicted by the long term simulations 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 alternatives.

The statistics shown in

Table 3-1 provided a benchmark with which to compare the results of each model run. The alternatives modeling process followed is summarized in the following bullets and by the flowchart in Figure 3-1.

- The alternative was constructed into the Base Model and simulation was run.
- The results of the run were compared against the results of the Base Model to determine if the number of CSO events was less than or equal to the CSO frequency benchmark.
- If the number of CSOs was less than or equal to the CSO frequency benchmark then the alternative was considered to provide adequate CSO control. If the number of CSOs was greater than the CSO frequency benchmark than the alternative was reconfigured and the process restarted.

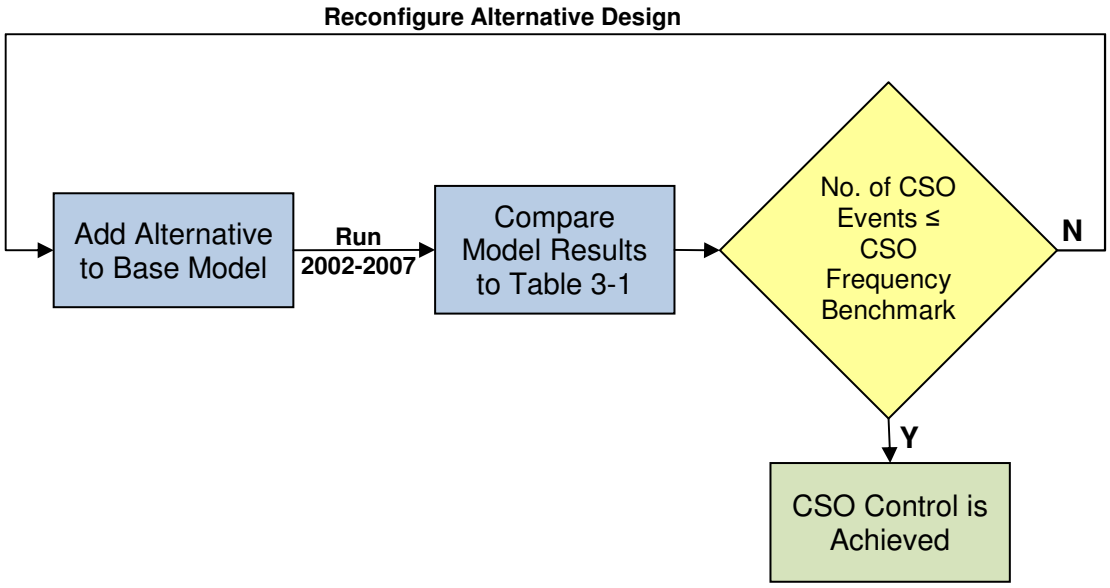

Figure 3-1: Alternatives Modeling Process Flowchart

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

Overflow Structure	Number of CSOs	Annual CSO Frequency (events per year)	CSO Volume[1] (MG)	Number of Events ≥ Control Volume Event (Benchmark Events per year)
Overflow Structure 44A	78	15.6	53.4	6
Overflow Structure 44B	24	4.8	1.85	6
Overflow Structure 45A	28	5.6	3.30	7
Overflow Structure 45B	22	4.4	1.34	6
Overflow Structure 46	34	6.8	5.98	6
Overflow Structure 47B	24	4.8	5.07	9
Overflow Structure 47C	9	1.8	13.3	5
Overflow Structure 49	19	3.8	7.81	10
Overflow Structure 171	28	5.6	6.36	9

Notes:
1. Statistics are based on a rainfall scaling factor of 1.093 over the entire Henderson Area.
2. Henderson Pump Station is limited to the reported firm capacity of 16.9 MGD
3. The range of accuracy of the model was assumed to be 10,000 gallons.
4. The model predicted no overflows at Overflow Structure 47D, Overflow Structure 47E and NPDES CSO Outfall 48.

Model Division into North and South Henderson – The Base Model was modified such that the boundary of the northern portion of the Henderson Area, including Basin 44, Basin 45, Basin 46 and Basin 47N, was separated from the southern portion of the Henderson Area, including Basin 47S, Basin 49 and Basin 171. The northern portion of the Henderson Area was represented by a model network labeled as "HEN_N" and the southern portion of the Henderson Area was represented by a model network labeled as "HEN_S". The purpose for splitting the model into HEN_N and HEN_S was to decrease the model run time by running only the portion of the Henderson Area, which contained the outfall of interest. HEN_N and HEN_S are shown in Figure 3-3 and Figure 3-4, respectively.

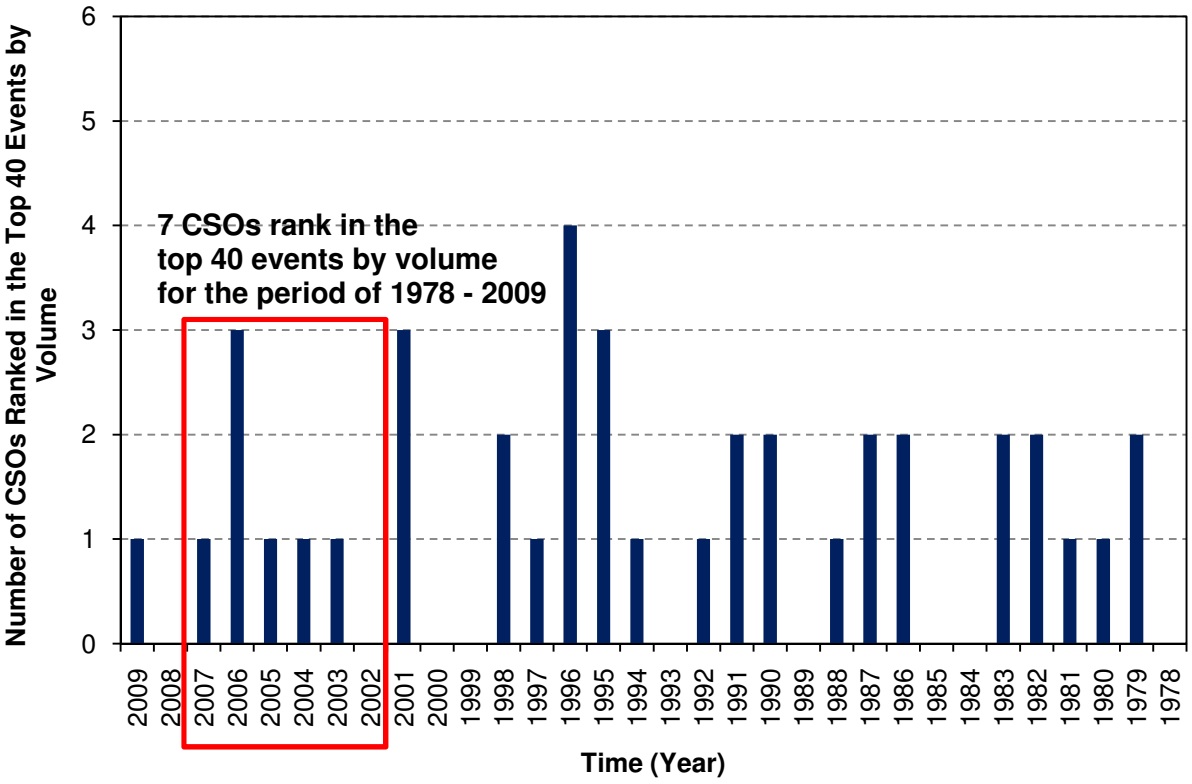

Figure 3-2: CSO Frequency for Overflow Structure 44A

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

- Understanding of the Henderson Area combined sewer system based on the Henderson Area Flow Monitoring Study from January 2008 – May 2009.
- Historical CSO frequency of Basins from 1998 – 2009.
- CSO volumes observed during the Henderson 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 including the Henderson Pump Station, Henderson Trunk, Henderson/MLK CSO Storage and Treatment Tunnel.
- Results of the Base Model – The Base Model results provided maximum flow rates within the combined sewer system, maximum flow rates at overflow structure weirs and overflow volumes at NPDES outfalls.

A total of 30 model runs were identified 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 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. Once the analysis process was underway, some runs were eliminated based on results from the analysis. Of the initial 30 runs identified, 20 runs were completed during the analysis of the preliminary alternatives.

The results of the 20 completed model runs were sufficient for determining sizing and hydraulic feasibility of CSO control alternatives within the Henderson Area. Additional modeling will be performed to validate the results of the preliminary alternatives using the long term rainfall record, complete Henderson Model (i.e., HEN_N and HEN_S combined) and complete Area Alternatives following the preferred alternatives selection.

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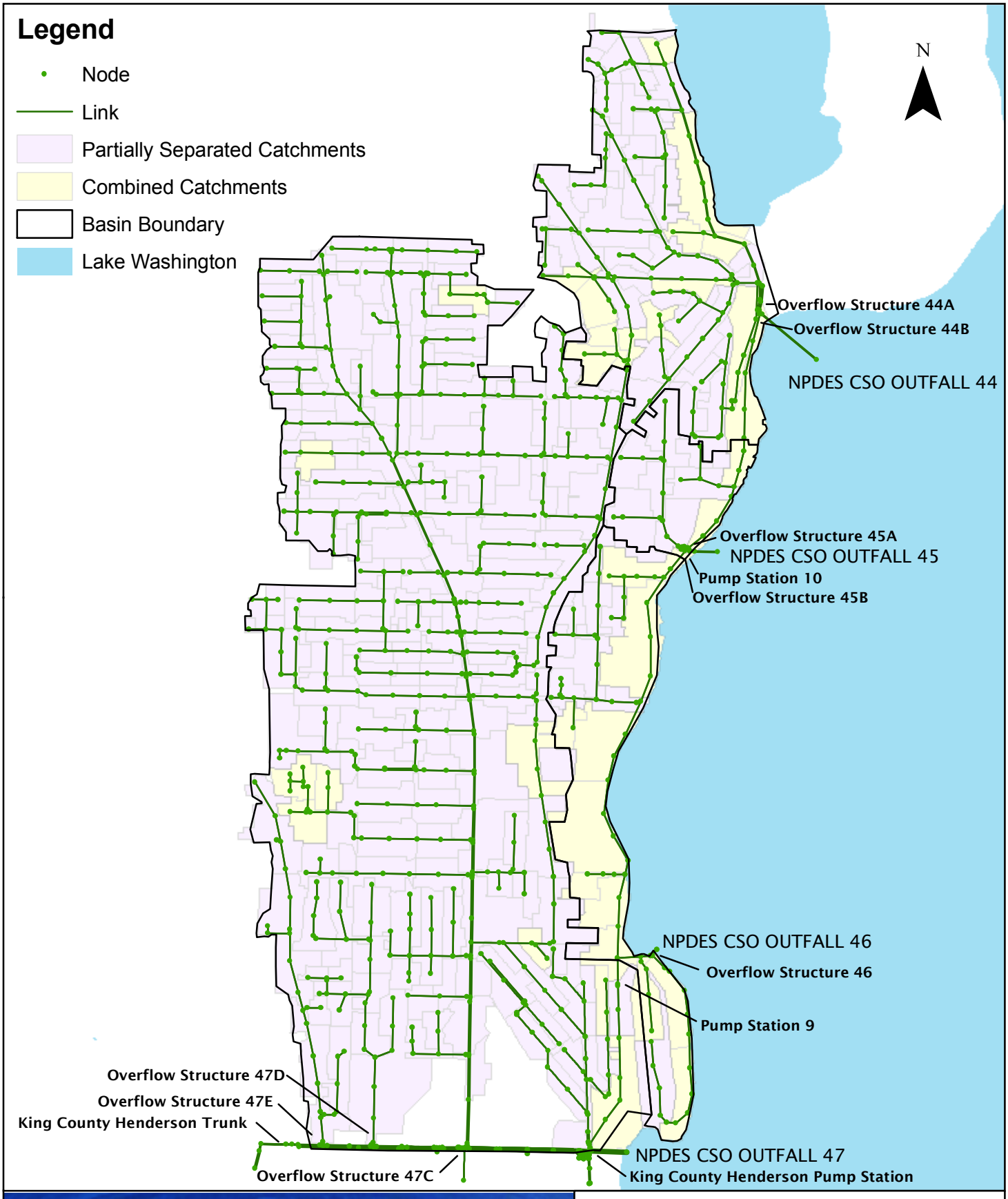

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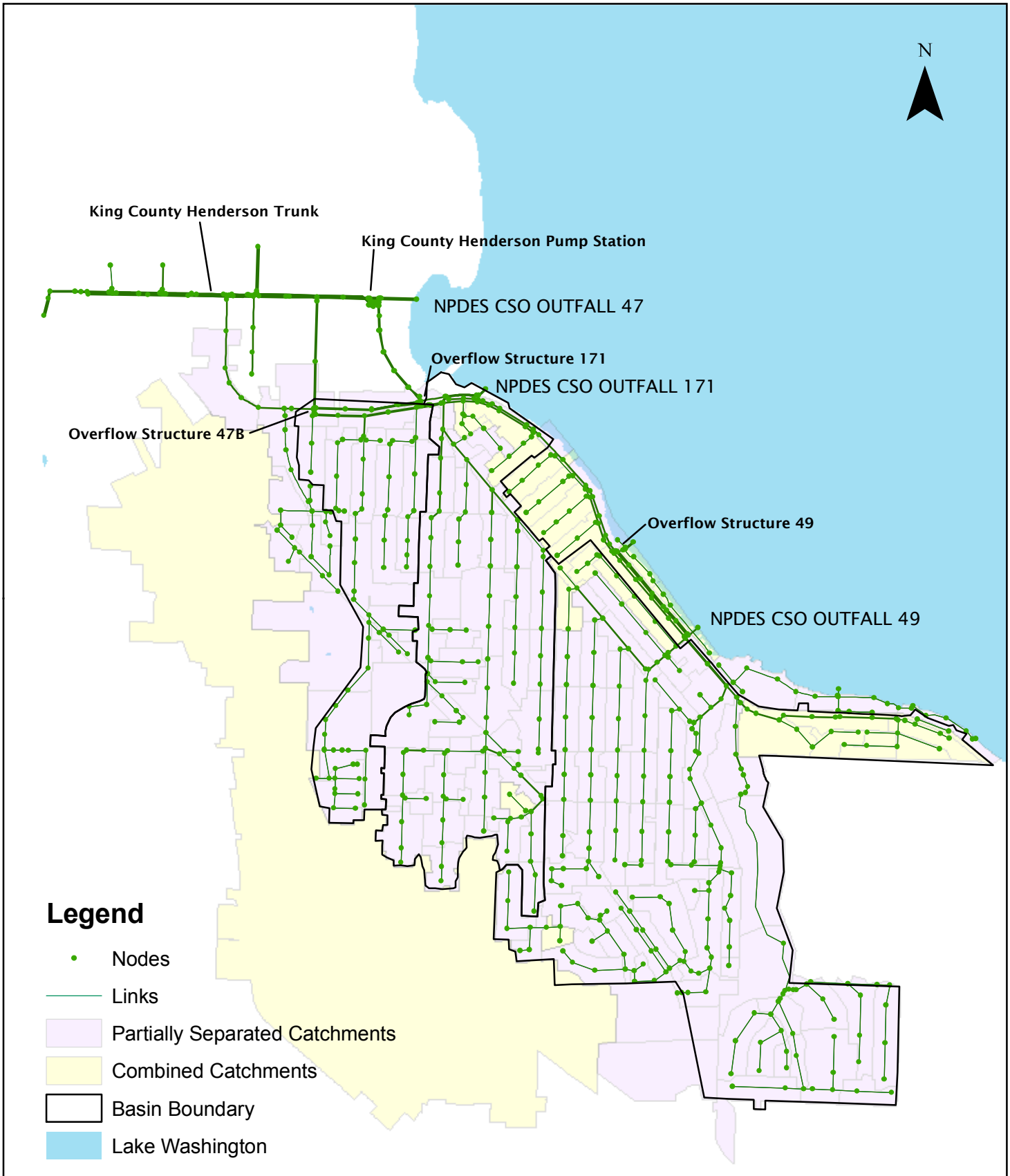
Henderson Area Alternatives
Modeling Report

HEN_N Network

MAY 2010

FIGURE 3 - 3



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Henderson Area Alternatives
Modeling Report

HEN_S Network

MAY 2010 | **FIGURE 3 - 4**

3.3 Modeling of Alternatives

For each of the CSO control alternatives identified 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 control alternatives and further delineated into the model runs corresponding to the given alternative. Table 3-2 provides a summary and reference under Section 3.3 to the different runs under each alternative. For example, Section 3.3.1 contains the discussion on the runs performed that are related to sizing offline storage in Basin 44. Details on the modifications made for each model run to the base network (HEN_N, HEN_S or the full Henderson network) are described in the Model Tracker in Appendix A.

Table 3-3 provides a summary of model results performed under alternatives modeling. Modeling goals and corresponding results for the 20 model runs are summarized. As noted earlier, some of the model runs originally planned were not performed because the alternative was shown to be ineffective. Detailed model run configuration and discussion of each alternative are provided in subsections that follow.

In order to evaluate the increased maximum flow rate at the King County facilities, the rainfall event of December 2nd through December 6th, 2007 was used. This event is the largest event in the long term rainfall record. The Base Model simulations showed that the event produced the largest combined system response.

Table 3-2: Modeling of Alternatives Subsections

Report Section	Alternative Description	Runs Included
3.3.1	Offline Storage in Basin 44	Run 10.0
3.3.2	Offline Storage for Basin 44 and Basin 45	Run 13.0
3.3.3	Offline Storage in Basin 46	Run 18.0
3.3.4	Transfer Basin 44 to Basin 165 (Genesee)	Run 7.0
3.3.5	Transfer Basin 46 to the King County Henderson Pump Station	Run 20.0
3.3.6	Transfer Basin 47N to the King County Henderson Trunk	Run 19.0
3.3.7	Offline Storage in Basin 49	Run 16.0; Run 17.0
3.3.8	Offline Storage in Basin 47S and Basin 171	Run 14.0; Run 23.0
3.3.9	Transfer Basin 49 to the King County Henderson Pump Station	Run 1.0; Run 2.0; Run 28.0
3.3.10	Transfer Basin 171 to the King County Henderson Pump Station	Run 4.0; Run 22.0
3.3.11	Transfer Basin 47S to the King County Henderson Trunk	Run 8.0; Run 9.0; Run 24.0
3.3.12	Distributed Offline Storage (Basins 44, 45, 46)	Run 26.0
3.3.13	Overflow Structure 47C Retrofit	Run 27.0

Table 3-3: Model Run Summary Results

Model Run	Model Run Goal	Results
Run 1.0	Identify additional flow sent to the Henderson Pump Station by removing the existing HydroBrake in Basin 49	Maximum flow to King County = 4.0 MGD (Base Model maximum flow = 2.4 MGD) Below Benchmark (4 overflows)
Run 2.0	Identify additional flow sent to the Henderson Pump Station by replacing existing HydroBrake in Basin 49 with a modulating gate	Maximum flow to King County = 3.8 MGD (Base Model maximum flow = 2.4 MGD) Below Benchmark (7 overflows)
Run 4.0	Identify additional flow sent to Henderson Pump Station by removing the existing HydroBrake in Basin 171	Maximum flow to King County = 2.3 MGD (Base Model maximum flow = 0.8 MGD) Flooding occurs downstream due to pipeline capacity limitations. Below Benchmark (7 overflows)
Run 7.0	Generate hydrograph of flow to send to Genesee to control Basin 44	Hydrograph of flow to send to Genesee was generated from the results from Run 13.0
Run 8.0	Identify additional flow to Henderson Trunk by upsizing piping downstream of 47B	Maximum flow to King County = 12.3 MGD (Base Model maximum flow = 3.7 MGD) Below Benchmark (1 overflow at 47B; 5 overflows at 171)
Run 9.0	Identify additional flow to Henderson Trunk by removing existing HydroBrake in Basin 171 and upsizing piping downstream of 47B	Maximum flow to Henderson Trunk = 12.3 MGD (Base Model maximum flow = 3.7 MGD) Maximum flow to Henderson Pump Station = 2.4 MGD (Base Model maximum flow = 0.8 MGD) Below Benchmark (0 overflows at 47B; 2 overflows at 171)

Model Run	Model Run Goal	Results
Run 10.0	Identify additional storage needed to control Basin 44	44 Storage = 2.40 MG
Run 13.0	Identify combined storage in Basin 45 to control Basin 44 and Basin 45, and additional storage needed to control Basin 46	Reduce maximum pump rate at Pump Station 10 to 1.8 MG Basin 45 Storage = 2.60 MG Basin 46 Storage = 0.35 MG
Run 14.0	Identify additional storage needed to control Basin 47B/Basin 171	Basin 47B/Basin 171 Storage = 0.26 MG
Run 16.0	Identify additional storage needed to control Basin 49	Basin 49 Storage = 0.32 MG
Run 17.0	Replace existing HydroBrake in Basin 49 with modulating gate that limits flow to King County to current peak. Identify additional storage needed to control Basin 49	Basin 49 Storage = 0.10 MG
Run 18.0	Identify additional storage needed to control Basin 46	Basin 46 Storage = 0.35 MG
Run 19.0	Identify additional flow to Henderson Trunk from Basin 47C if existing orifice plate is removed	Maximum flow to Henderson Trunk = 19.5 MGD (Base Model maximum flow = 12.0 MGD)

Model Run	Model Run Goal	Results
Run 20.0	Identify Pump Station 9 capacity needed to control Basin 46	Maximum Pump Rate = 3.9 MGD (Base Model maximum pump rate = 3.2 MGD)
Run 22.0	Identify additional flow to Henderson Pump Station by removing existing HydroBrake in Basin 171 and upsizing downstream piping	Maximum flow to King County = 4.7 MGD (Base Model maximum flow = 0.8 MGD) Downstream pipe increased from 12" to 18" Below Benchmark (5 overflows)
Run 23.0	Identify additional flow to Henderson Pump Station by replacing existing HydroBrake in Basin 171 with modulating gate	Maximum flow to King County = 2.3 MGD (Base Model maximum flow = 0.8 MGD)
Run 24.0	Identify length of upsized pipe needed downstream of Basin 47B and additional flow sent to the Henderson Trunk by removing orifice at Basin 47B	Length of pipe = 1,415 ft Maximum flow to Henderson Trunk = 5.3 MGD (Base Model maximum flow = 3.7 MGD)
Run 26.0	Identify additional storage needed to control Basin 44, Basin 45 and Basin 46	Reduce maximum pump rate at Pump Station 10 to 1.8 MG Basin 44 Storage = 2.40 MG; Basin 45 Storage = 0.20 MG; Basin 46 Storage = 0.35 MG
Run 27.0	Determine if Basin 47C can be controlled by raising weir in the CSO overflow structure by 1 foot	Maximum flow to Henderson Trunk = 13.5 MGD (Base Model maximum flow = 12.0 MGD) Below Benchmark (5 overflows)
Run 28.0	Identify additional flow sent to the Henderson Pump Station by replacing existing HydroBrake in Basin 49 with a modulating gate	Maximum flow to King County = 3.6 MGD (Base Model maximum flow = 2.4 MGD)

3.3.1 Offline Storage in Basin 44

The control volume for Basin 44 is 2.14 MG based on the Base Model results (the combined CSO control volume at Overflow Structure 44A and Overflow Structure 44B). The existing storage volume of Storage Facility 8 (located within Seward Park) is approximately 65,000 gallons. The existing storage volume does not provide enough CSO control for Basin 44; therefore, additional storage or conveyance capacity is needed. Flow from Basin 44 is conveyed through the Henderson lake line to Pump Station 10 located in Basin 45.

3.3.1.1 Run 10.0: Offline Storage in Basin 44

The purpose of Run 10.0 was to determine the storage volume needed to meet the control volume for Basin 44. The HEN_N network was modified through the following steps and as shown in Figure 3-5.

- The HydroBrake located at node 067-272 (Overflow Structure 44A) was removed and replaced with a motor operated gate. The motor operated gate modulates to control the level in node 067-261 (Overflow Structure 44B) to a depth of 15 inches. The pipe exiting Overflow Structure 44B is 15-inch-diameter; therefore, this level setting maintains flow to the crown of the pipe and below the overflow weir.
- A weir was added to the north end of existing Storage Facility 8. The weir height is approximately 1.5 ft less than the overflow weir height in Overflow Structure 44A, which conveys flow to NPDES CSO Outfall 44.
- A storage node was connected to the new weir. The volume of the storage node was varied to determine the volume of storage needed in Basin 44 to adequately reduce CSOs.
- The storage node was "emptied" by pumping flow back into the system. The storage began to empty at a rate of 700 gpm at 10 ft of head when the level at NODE 067-271 drops below the crest of the transfer weir to Storage Facility 8.

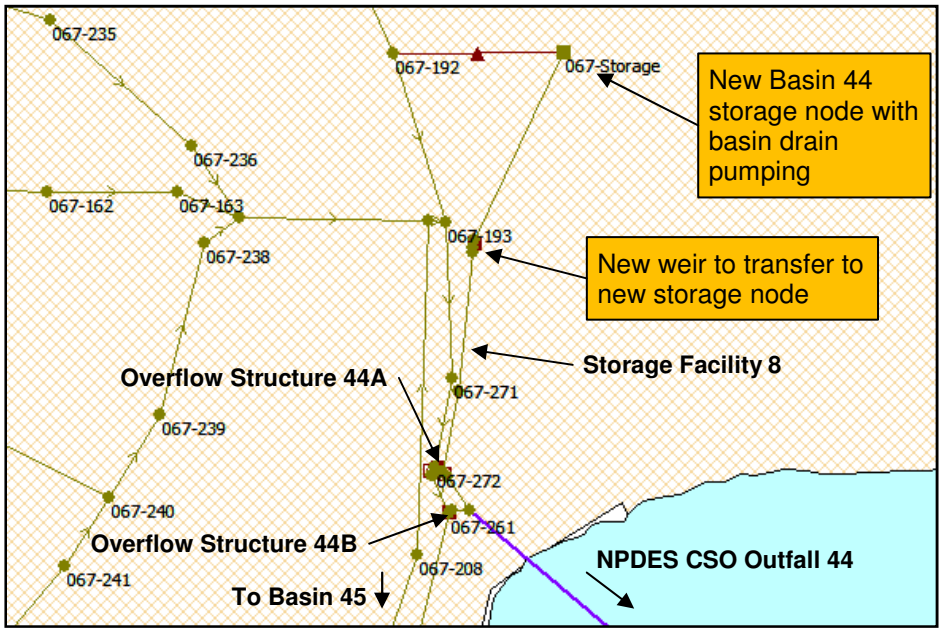

Figure 3-5: Model Modifications for Run 10.0 in Basin 44

Initially, it was assumed that both Basin 44 and Basin 45 could be controlled by providing adequate storage in Basin 44. However, based on the preliminary results of Run 10.0 which evaluated different sizes for the storage node, this assumption could not be validated. Therefore, the storage was sized to control Basin 44 only.

Table 3-4 shows the relationship between CSO events at Basin 44 and Basin 45 for varying storage sizes. Run 10.0 identified an additional storage volume of 2.3 MG necessary to bring Basin 44 into control (See

Table 3-1 for benchmark values). Table 3-4 shows that, for this model configuration, changes in the storage volume at Basin 44 had little impact on CSO frequency at Basin 45. The storage volume that meets the CSO frequency benchmark is highlighted in blue.

Table 3-4: Basin 44 Additional Storage Volume Needed

Additional Storage Volume (MG)	CSO Events at NPDES CSO Outfall 44 (No.)	CSO Volume at NPDES CSO Outfall 44 (MG)	CSO Events at NPDES CSO Outfall 45 (No.)	CSO Volume at NPDES CSO Outfall 45 (MG)
0	78	55.2	28	4.6
2.1	7	14.5	23	3.1
2.2	7	12.9	22	3.1
2.3	6	12.3	23	3.1
2.4	5	11.7	23	3.1
2.7	5	10.4	23	3.1

3.3.2 Offline Storage for Basin 44 and Basin 45

Flow from Basin 44 is conveyed through the Henderson lake line to Basin 45. Basin 44 and Basin 45 flow combines just south of Pump Station 10. The control volume for Basin 44 is 2.14 MG and the control volume for Basin 45 is 0.18 MG. An alternative to providing storage in Basin 44 for the flows generated in Basin 44 is to pump the flows into Basin 45, then provide a common storage for both Basin 44 and Basin 45.

3.3.2.1 Run 13.0: Common Storage for Basin 44 and Basin 45

Run 13.0 was developed to provide storage for Basin 44 in Basin 45 by providing a pump station in the vicinity of Storage Facility 8 and conveying flows to a storage near existing Pump Station 10. The HEN_N network was modified through the following steps and as shown in Figure 3-6 and Figure 3-7:

- A weir was added to the north end of existing Storage Facility 8. The weir height is approximately 1.5 ft less than the overflow weir height in Overflow Structure 44A, which conveys flow to NPDES CSO Outfall 44.

- A new storage node was added in Basin 45.
- A new pump station in Basin 44 was added. This new pump station was controlled based on the level in the new storage node in Basin 45. Pump was on when the depth at 45_Storage was less than 25 ft; pump was off when the depth at 45_Storage was greater than 30 ft. The new pump station is set up to pump 5.3 MGD at 8 ft of water head.
- A storage drain valve was added and controlled based on level in node 074-152 (located in the Henderson lake line).
  - Open Valve at a rate of 0.25 ft/100s when depth at node 074-152 was less than 19.3 inches.
  - Close Valve at a rate of 0.25 ft/100s when depth at node 074-152 was greater than 19.3 inches.
- Reduced maximum pump rate through Pump Station 10.

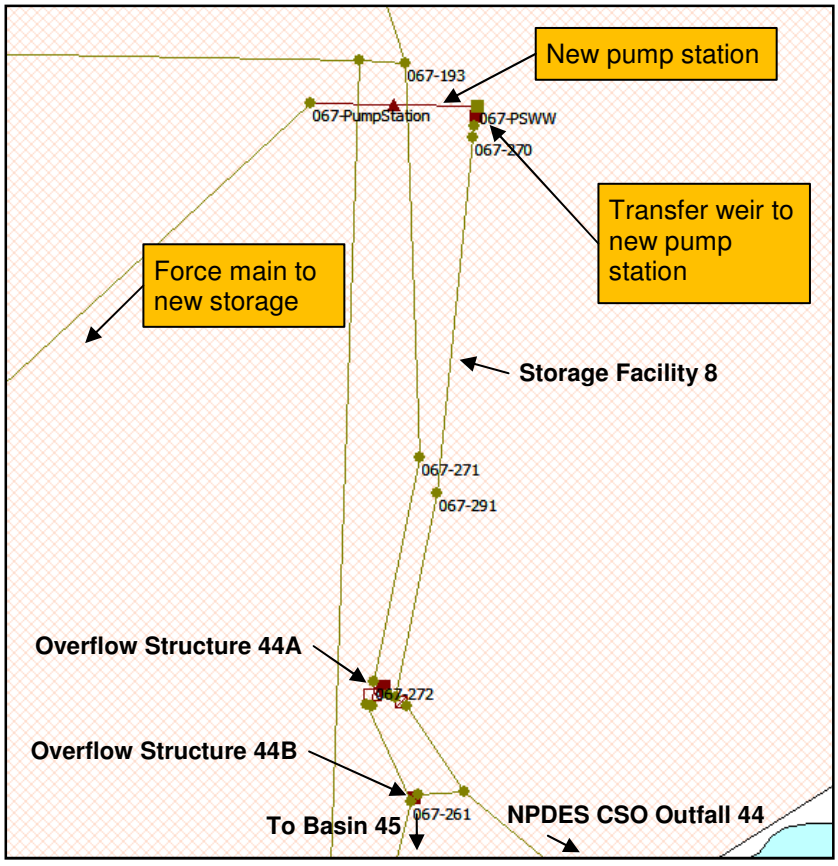

Figure 3-6: Model Configuration for Run 13.0 in Basin 44

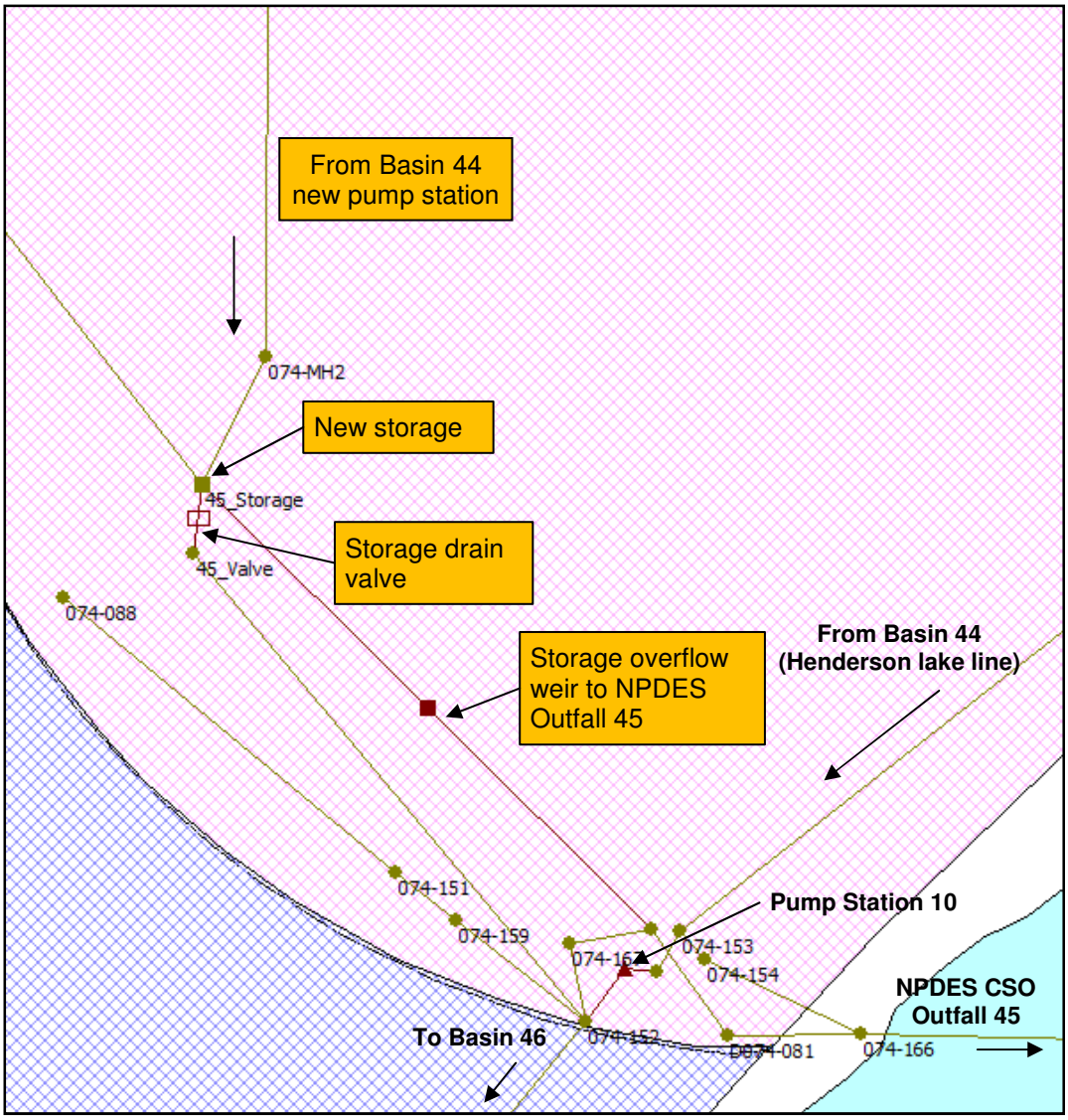

Figure 3-7: Model Configuration for Run 13.0 in Basin 45

The pumping rate needed for the new pump station that transfers flow from Basin 44 to Basin 45 is dependent on the buffering volume available in the wet well. Further analysis should be done to refine the relationship between the wet well size and the pump rate for the pump station as this alternative moves forward.

The modeling analysis of Basin 45 showed that overflows were occurring at Overflow Structure 45B due to capacity limitations in the Henderson lake line downstream of Pump Station 10. In order to control the overflows at Overflow Structure 45B it was necessary to reduce the maximum flow rate at Pump Station 10 from 2.6 MGD to 1.8 MGD.

The results of Run 13.0 show that a storage volume of approximately 2.6 MG is needed to control both Basin 44 and Basin 45. The number of CSO events at Overflow Structure 44 was reduced to 6 events, meeting the benchmark of 6 events. The number of events at Overflow Structures 45A and 45B were reduced to 2 events and 4 events, respectively. These events combined to produce a total of 5 events at Overflow Structure 45. These results exceeded the benchmarks of 7 events and 6 events identified for Overflow

Structures 45A and 45B, respectively. Table 3-5 summarizes the reduction in CSO volume that resulted from the additional storage and other changes made to the network that were evaluated in this run.

Table 3-5: CSO Results Comparison between Base Model and Run 13.0

	Base Model Results		Run 13.0 (2.6 MG of additional storage)	
	NPDES Outfall 44	NPDES Outfall 45	NPDES Outfall 44	NPDES Outfall 45
CSO Events (No.)	78	28	6	5
CSO Volume (MG)	55.2	4.6	11.5	1.2

3.3.3 Offline Storage in Basin 46

Flow from Basin 45 is conveyed through the Henderson lake line to Basin 46. Flows from Basin 44, Basin 45 and Basin 46 are conveyed to the King County Henderson Pump Station by Pump Station 9. The control volume for Basin 46 is approximately 0.26 MG. There is no existing storage located in Basin 46.

3.3.3.1 Run 18.0: Offline Storage in Basin 46

Run 18.0 was performed to determine the storage volume needed to control Basin 46. The HEN_N network was modified by adding a storage node (46_Storage) upstream of Pump Station 9, as shown in Figure 3-8. The storage node had a base elevation at 10.5 ft NAVD88 and a top elevation at 18.5 ft NAVD88. The top of the storage node was set equal to the crest of weir at Overflow Structure 46. To drain the storage a sluice gate was used; the sluice gate is set to close when the flow depth upstream of the storage reaches 18 inches and open when the depth decreases back to 10 inches.

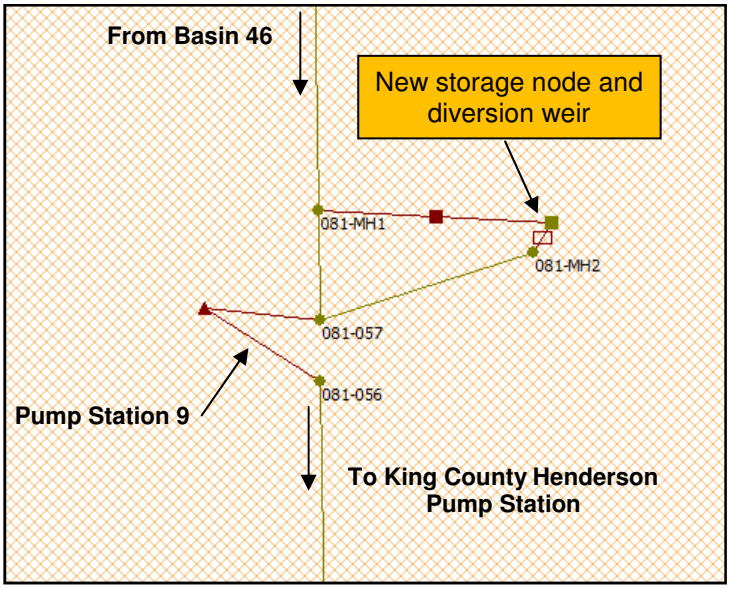

Figure 3-8: Model Configuration for Run 18.0 in Basin 46

Table 3-6 shows the relationship between the storage volume and the number of CSO events in Basin 46 for the model configuration in Run 18.0. The storage volume needed to control Basin 46 is approximately 350,000 gallons. The resulting 5 overflow events exceed the benchmark of 6 events for this location.

Table 3-6: Basin 46 Additional Storage Volume Needed

Storage Volume (gallons)	CSO Events at NPDES CSO Outfall 46 (No.)	CSO Volume at NPDES CSO Outfall 46 (MG)
0	34	5.98
200,000	9	2.87
300,000	7	2.28
350,000	5	2.11

The additional storage volume determined is slightly larger than the predicted Control Volume of 260,000 gallons. A review of the modeling results show that flow from the Pump Station 9 wet well (represented by node 081-057) is backing up through the drain valve and into storage during some wet weather events. Further model refinement could be done to minimize the impacts of this phenomenon and possibly reduce the amount of storage needed to bring this basin into control.

3.3.4 Transfer Basin 44 to Basin 165 (Genesee)

An inter-basin transfer from Basin 44 to Genesee Area Basin 165 was evaluated in Run 7.0. Currently, flow from Basin 44 is conveyed by gravity south to Basin 45; this inter-basin transfer would convey flows north into the Genesee Area.

3.3.4.1 Run 7.0: Inter-basin transfer from Basin 44 to Basin 165

This run was performed to control CSOs in Basin 44 by sending excess flow, totaling the additional storage volume of 2.4 MG (determined in Run 10.0, See section 3.3.1.1), to the Genesee Area at node 060W-108. The HEN_N model network was modified as described below and shown in Figure 3-9:

- A weir was added to the north end of existing Storage Facility 8. The weir height is approximately 1.5 ft less than the overflow weir height in Overflow Structure 44A, which conveys flow to NPDES CSO Outfall 44.
- A new transfer pump station and force main was added to transfer flows to Genesee. This pump station was controlled to only allow 2.4 MG to be transferred for each wet weather event. Once 2.4 MG was pumped the pumps were turned off. The new pump station is set up to pump 5.3 MGD at 8 ft of water head.

Once Run 7.0 was completed a hydrograph of the transferred flow was generated for use in the Genesee Area model.

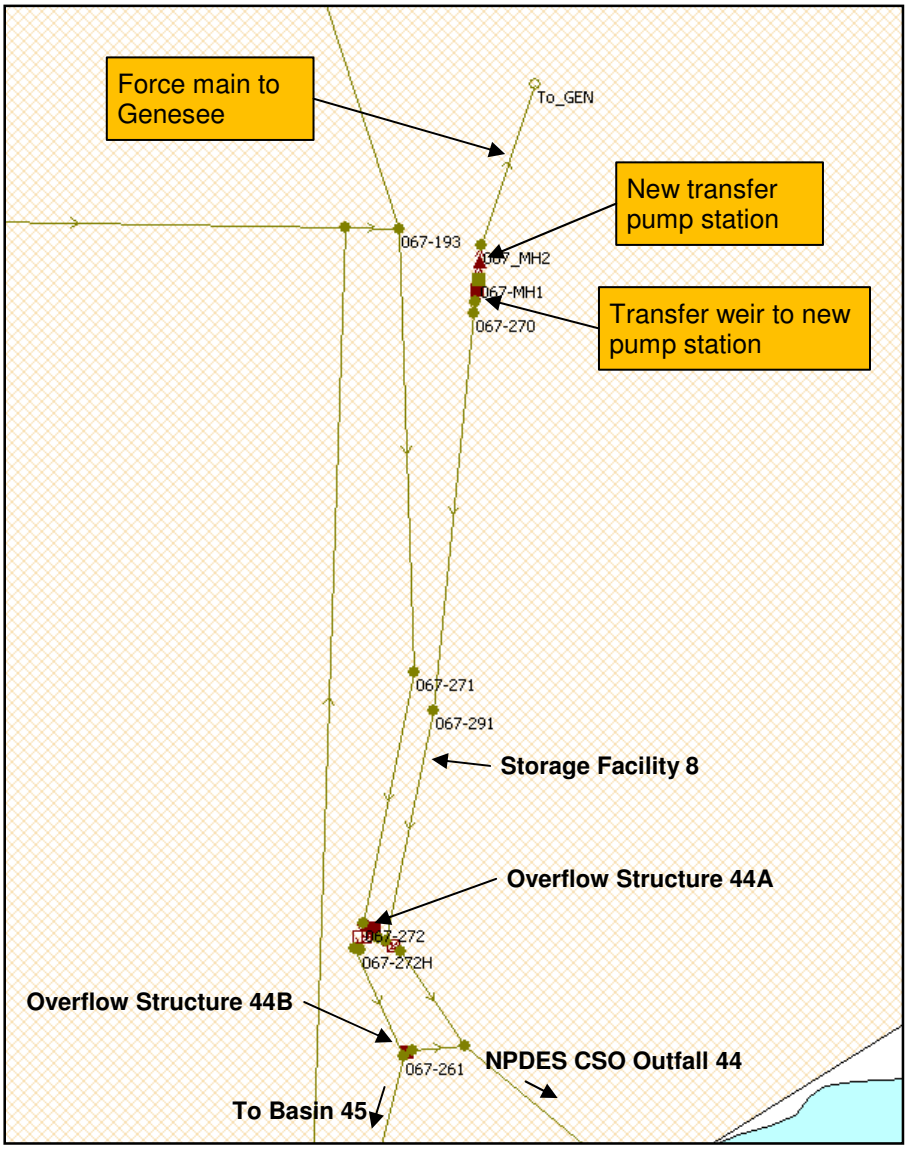

Figure 3-9: Model Configuration for Run 7.0 in Basin 44

The RTC settings needed for the transfer pump in this run proved to be challenging. While the controls could be set to turn the pump off once 2.4 MG was pumped, this was not possible without the Genesee Area hydraulic model network which would reset the transfer volume counter to have the system ready for the next wet weather event. For this reason it was determined that the operation of the pump station developed in Run 13.0 (See Section 3.3.2.1) would closely mimic the intent of the pump station for this run. Therefore, the pumped flow hydrograph from Run 13.0 was used in the Genesee Area model to evaluate the impacts on that system from the additional flows from the Henderson Area.

3.3.5 Transfer Basin 46 to King County Henderson Pump Station

Flow comes to Basin 46 from Basin 44 and Basin 45 through the Henderson lake line. Flows from Basin 44, Basin 45 and Basin 46 are then conveyed to the King County Henderson Pump Station by Pump Station 9. Run 20.0 evaluated improvements needed

to Pump Station 9 to control Basin 46. These improvements will result in sending additional flow to the King County Henderson Pump Station.

3.3.5.1 Run 20.0: Increase the Capacity of Pump Station 9

The purpose of Run 20.0 was to determine if increasing the capacity at Pump Station 9, and fully utilizing the capacity of the downstream pipeline, would meet the overflow benchmark for Basin 46 of 6 events. Figure 3-10 shows how the HEN_N model network was modified. Pump Station 9 maximum pump rate was increased to pump a maximum of 4.15 MGD at 9.0 ft of water head.

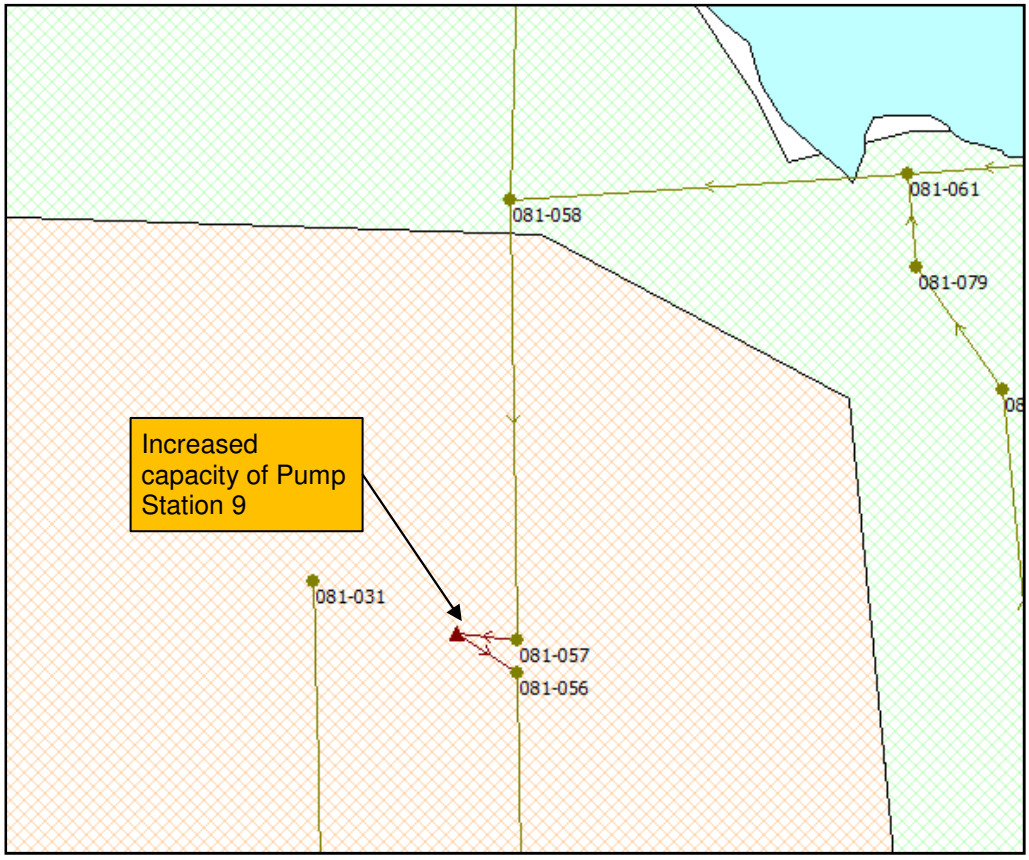

Figure 3-10: Model Configuration for Run 20.0 in Basin 46

Figure 3-11 shows that the results of the Base Model run indicate that the downstream pipeline is not fully utilized for the current configuration of Pump Station 9. In the Base Model, Pump Station 9 produced a maximum flow of 3.2 MGD.

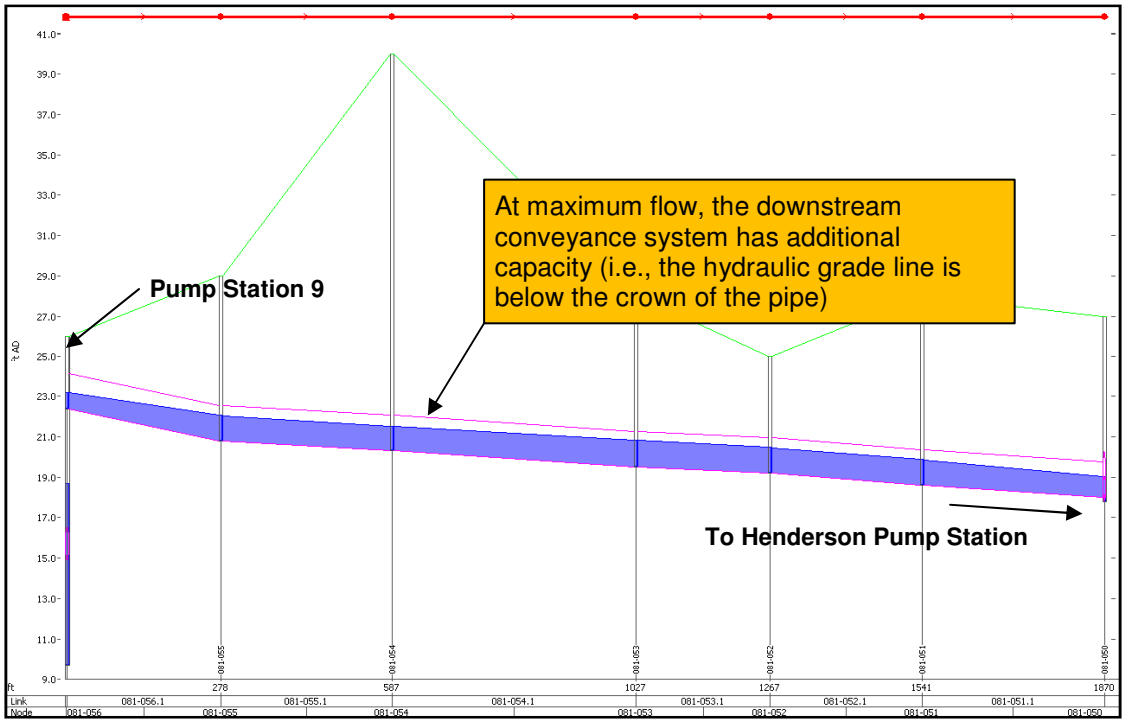

Figure 3-11: Maximum Hydraulic Profile to the Henderson Pump Station (Base Model)

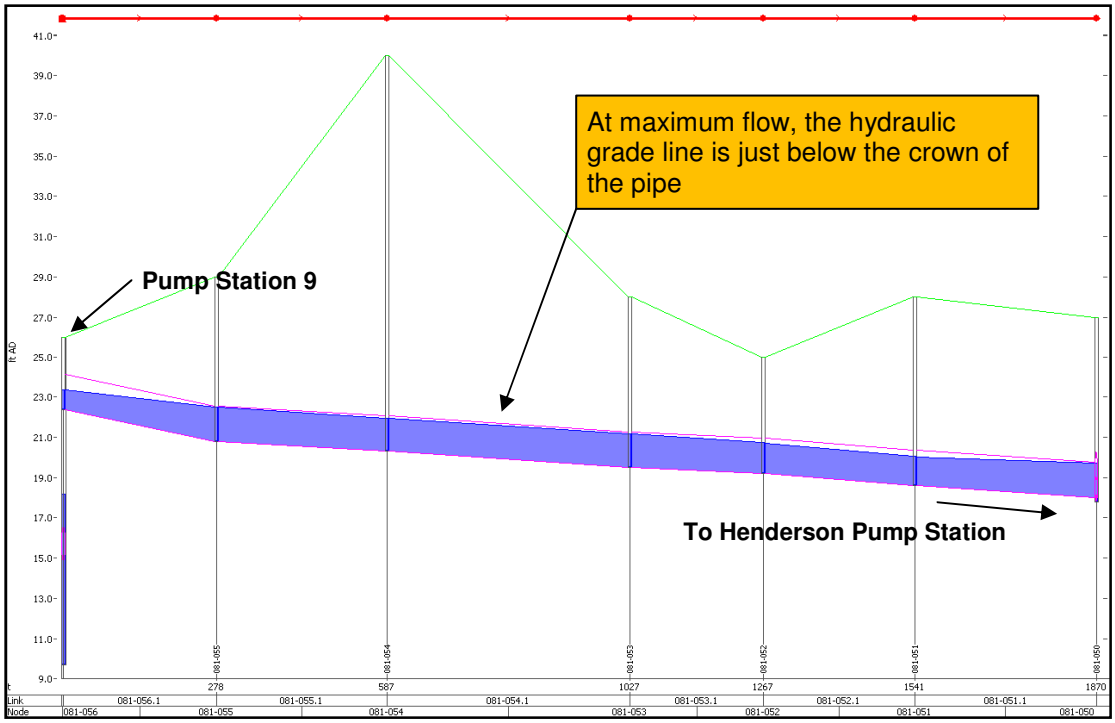

Figure 3-12: Maximum Hydraulic Profile to the Henderson Pump Station (Run 20.0)

With the increased pump rate in Run 20.0 the downstream pipeline becomes fully utilized (Figure 3-12). The maximum pump rate through the pump station increases to 3.9 MGD. Thus,

flow to the Henderson Pump Station is increased by 0.7 MGD. Figure 3-13 shows the increase in flow from the Base Model and Run 20.0 for the largest wet weather event of December 2007.

The results of Run 20.0 show that the number of overflow events at NPDES CSO Outfall 46 was reduced from 34 events to 6 events, matching the benchmark established for this location. CSO volume is decreased from 6.0 MG to 0.8 MG

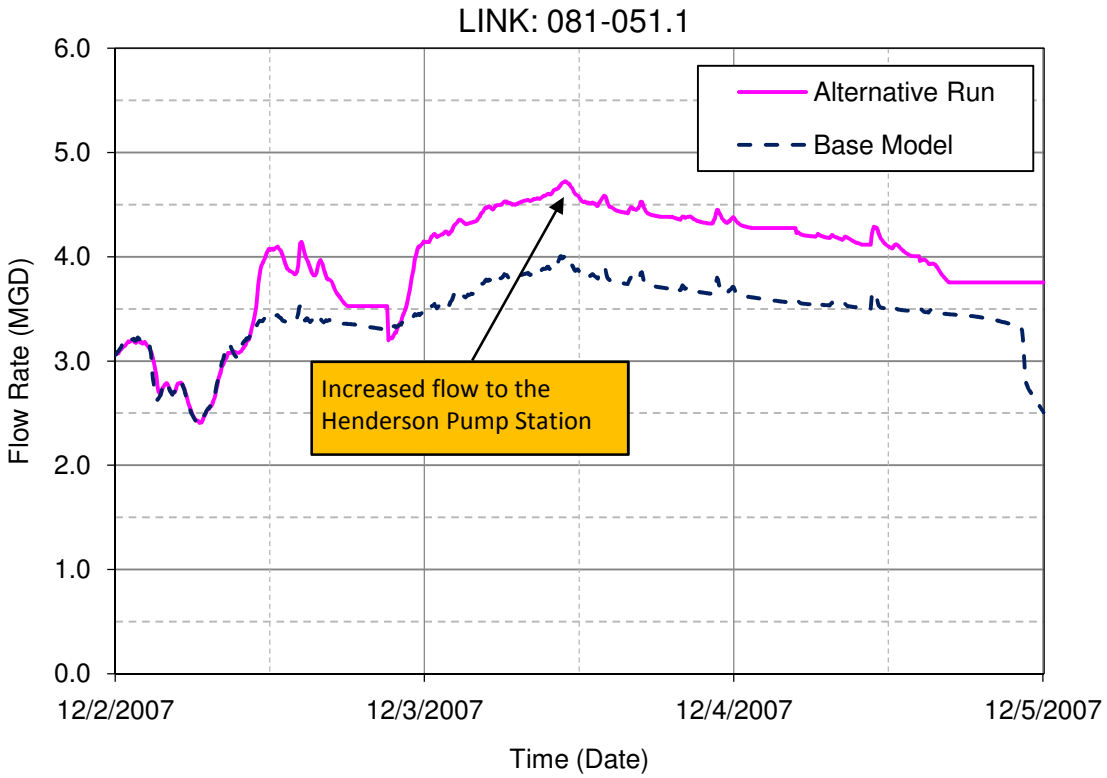

Figure 3-13: Comparison of Maximum flow Rates to the Henderson Pump Station from Basin 46 between the Base Model and Run 20.0

3.3.6 Transfer Basin 47N to King County Henderson Trunk

The control volume for Basin 47N is approximately 150,000 gallons. Based on the results of the Base Model, all CSOs in Basin 47N occur at Overflow Structure 47C. No CSOs are predicted at Overflow Structure 47D or Overflow Structure 47E. Storage Facility 7, located upstream of Overflow Structure 47C, has approximately 320,000 gallons of storage volume; however, this storage appears to be insufficient based on the Base Model results. Flow transfer into Storage Facility 7 is controlled by an orifice plate located on the outlet of Overflow Structure 47C.

3.3.6.1 Run 19.0: Removing the Orifice Plate at Overflow Structure 47C

The purpose of Run 19.0 was to determine the increased flow to the King County Henderson Trunk as a result of removing the orifice. The Base Model predicted maximum flow to the Henderson Trunk is approximately 12.0 MGD. By removing the orifice located at node 080-337 (see Figure 3-14), the flow from Basin 47N to the King County Henderson Trunk is increased. The predicted maximum flow rate to the King County

Henderson Trunk by removing the orifice is approximately 19.5 MGD (See Figure 3-15). The increase of the maximum flow to King County is approximately 7.5 MGD. The number of CSOs decreased from 9 events in the Base Model to 2 events with the orifice removed, below the benchmark of 5 events established for this basin.

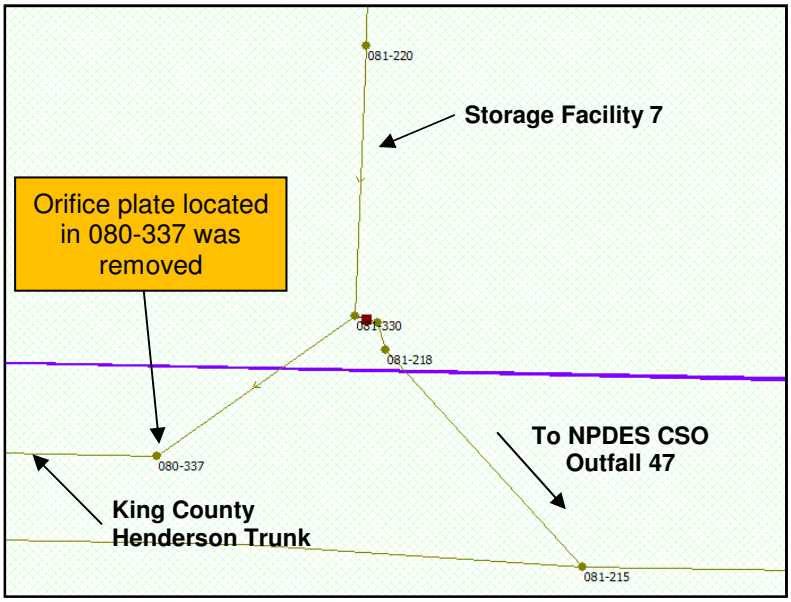

Figure 3-14: Model Configuration for Run 19.0 in Basin 47C

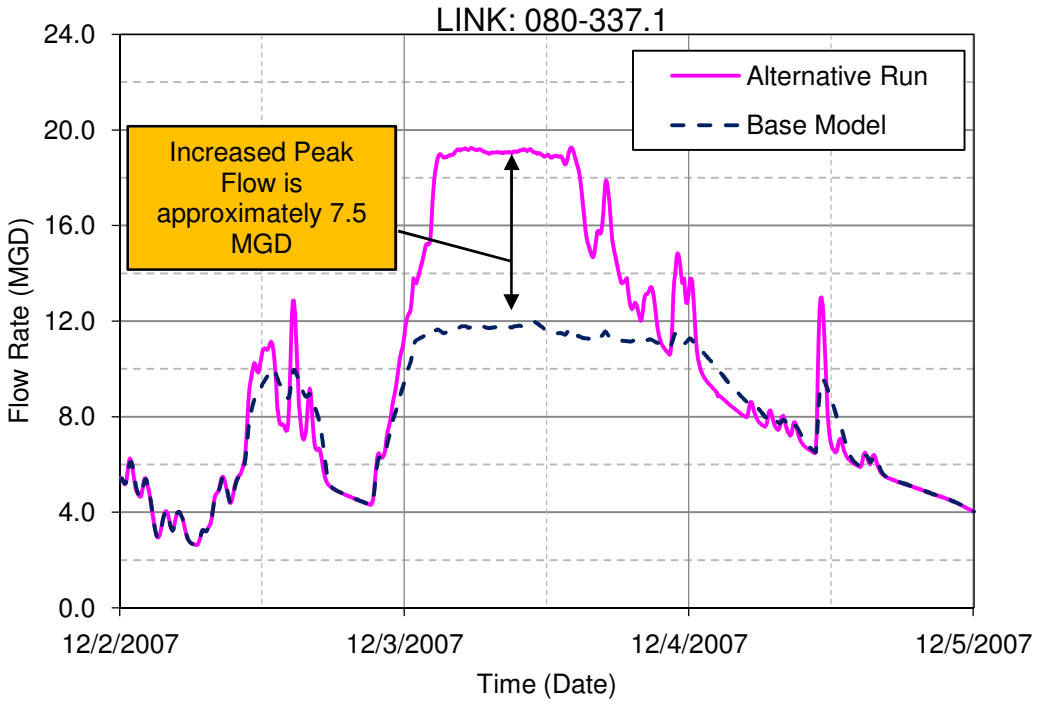

Figure 3-15: Comparison of the Maximum Flow Rates to the Henderson Trunk from Basin 47N between the Base Model and Run 19.0

3.3.7 Offline Storage in Basin 49

Flows from Basin 49 are conveyed to the King County Henderson Pump Station through a HydroBrake located in node 306-428. The HydroBrake limits the maximum flow from Basin 49 to approximately 2.4 MGD. The existing storage, Storage Facility 4, is located just upstream of the HydroBrake and has a volume of approximately 320,000 gallons. In order to reduce CSO frequency at NPDES Outfall 49, additional storage was evaluated. Based on the results of the Base Model, the control volume for Basin 49 is approximately 160,000 gallons. Two runs were performed to determine the additional storage volume needed to control Basin 49:

- Run 16.0: Offline Storage Volume for Basin 49 with HydroBrake.
- Run 17.0: Offline Storage Volume for Basins 49 with Modulating Gate.

3.3.7.1 Run 16.0: Offline Storage Volume for Basin 49 with HydroBrake

The HEN_S network was modified by adding a storage node (306-MH1) connected to node 306-429. The storage node had a base elevation at 27.8 ft NAVD88 and a top elevation at 36.61 ft NAVD88 (see Figure 3-16). The top of the storage node was set equal to the crest of the weir at Overflow Structure 49. The link definition between 306-MH1 and 306-429 includes the following parameters:

- Length = 20 ft
- Diameter = 36 inches
- Inverts: 28.7 ft NAVD88 (upstream) and 28.8 ft NAVD88 (downstream).

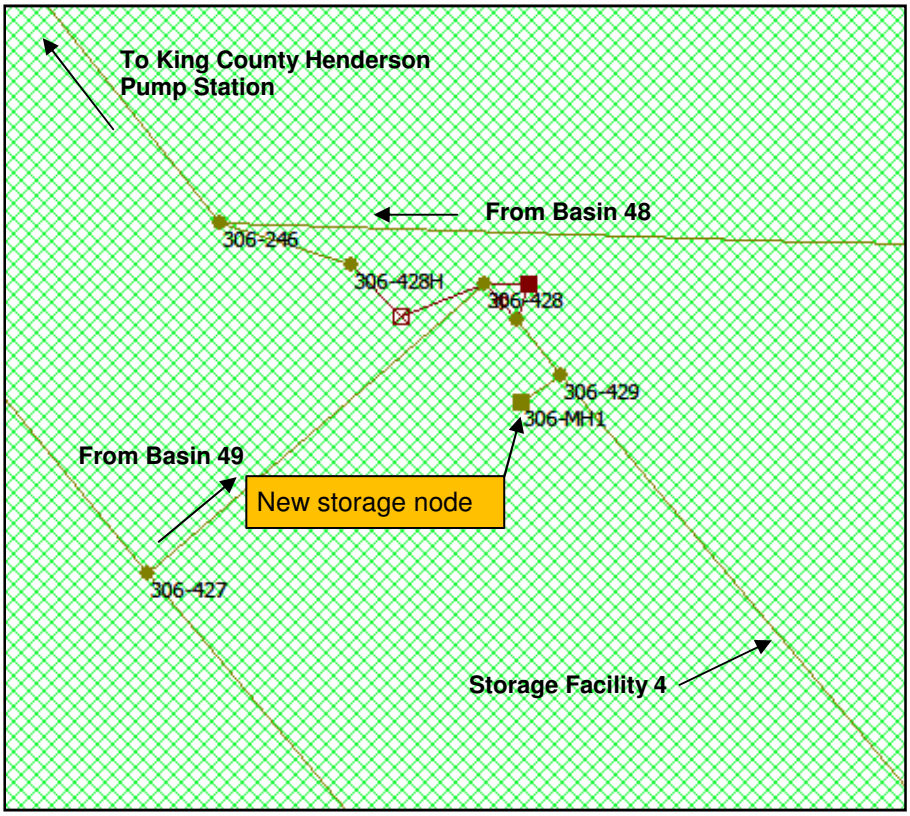

Figure 3-16: Model Configuration for Run 16.0 in Basin 49

The storage volume needed for Basin 49 was determined by varying the volume of the storage node until the benchmark conditions were met. Under these model runs, the HydroBrake was not removed and continued to discharge a maximum flow rate of approximately 2.4 MGD.

Table 3-7: Basin 49 Additional Storage Volume Needed (Run 16.0)

Additional Storage Volume (gallons)	CSO Events at NPDES CSO Outfall 49 (No.)	CSO Volume at NPDES CSO Outfall 49 (MG)
0	19	7.81
250,000	11	5.68
280,000	11	5.50
290,000	10	5.42
300,000	10	5.35
310,000	10	5.29

Based on the results of Run 16.0, the minimum, additional storage volume needed to control CSOs in Basin 49 is approximately 290,000 as shown in Table 3-7. The additional storage volume needed is approximately twice the control volume for Basin 49 due to the release of flow from the flap gate located in CSO Control Structure 49 (node 306-428). The flap gate limits the flow rate from Storage Facility 4 back into the combined system. Because the flap gate limits the release of flow, Basin 49 is not able to recover quickly enough to handle back-to-back storms. Back-to-back rainfall events are a contributing factor to the additional storage volume needed for Basin 49.

Additional modeling could be performed to increase the discharge from the flap gate in order to possibly decrease the additional storage volume needed to control Basin 49.

3.3.7.2 Run 17.0: Offline Storage Volume for Basins 49 with Modulating Gate

Run 17.0 is a variation of Run 16.0. For Run 17.0 the HydroBrake was replaced with a modulating gate that was set to maintain the current maximum flow to King County. Figure 3-17 shows the model configuration for this run. As with Run 16.0, the purpose of this run is to determine additional storage needed to meet the benchmark established for Basin 49. The HEN_S network was modified by adding a storage node (306-MH1) connected to node 306-429. The storage node had a base elevation at 28.8 ft NAVD88 and a top elevation at 36.6 ft NAVD88 (see Figure 3-17). The top of the storage node was set equal to the crest of the weir at Overflow Structure 49. The link definition between 306-MH1 and 306-429 includes the following parameters:

- Length = 20 ft
- Diameter = 36 inches
- Inverts: 28.7 ft NAVD88 (upstream) and 28.8 ft NAVD88 (downstream).

The modulating gate was set to limit flow to the King County system to a peak of 2.4 MGD. A PID controller was implemented to control the operation of the gate; the PID controller used the following coefficients to "smooth" the gate response:

- K_p = -2.25
- K_i = 0
- K_d = 1.0

Also the gate speeds were set with a positive (opening) speed of 0.25 ft/s and a negative (closing) speed of 5.0 ft/s.

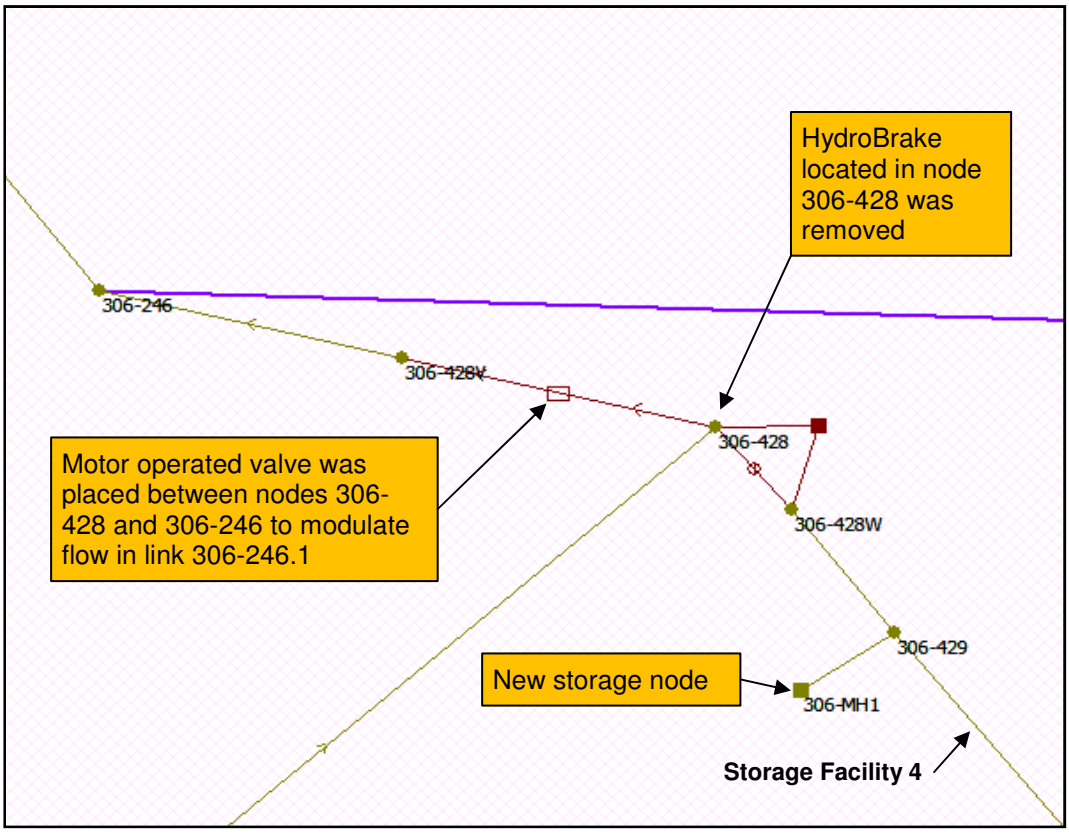

Figure 3-17: Model Configuration for Run 17.0 in Basin 49

The storage volume needed for Basin 49 was determined by varying the volume of the storage node until the benchmark conditions and boundary conditions were met. Results of the analysis are shown in Table 3-8. Table 3-8 shows that an additional storage of 100,000 gallons will meet the benchmark of 10 events for Basin 49.

Table 3-8: Basin 49 Additional Storage Volume Needed (Run 17.0)

Additional Storage Volume (gallons)	CSO Events at NPDES CSO Outfall 49 (No.)	CSO Volume at NPDES CSO 49 (MG)
0	19	7.81
100,000	10	5.55
150,000	8	5.06
200,000	6	4.69

3.3.8 Offline Storage in Basin 47S and Basin 171

Flows from Basin 47S and Basin 171 enter a common storage, Storage Facility 5, during wet weather events (See Figure 2-2 for the Henderson Area Flow Schematic). Storage Facility 5 is emptied by conveying flow through a HydroBrake located in MH 081-231. The HydroBrake limits the discharge from Storage Facility 5 to approximately 0.9 MGD. If the discharge to the King County Henderson Pump Station cannot be increased, additional storage for these basins is needed. The existing storage volume of Storage Facility 5 is approximately 70,000 gallons. Based on the results of the Base Model, the control volume for Basin 47S and Basin 171 is approximately 260,000 gallons. Two runs were performed to determine the additional storage volume needed to control Basin 47S and Basin 171:

- Run 14.0: Offline Storage Volume for Basin 47S and Basin 171 with HydroBrake.
- Run 23.0: Offline Storage Volume for Basins 47S and Basin 171 with Modulating Gate.

3.3.8.1 Run 14.0: Offline Storage Volume for Basin 47S and Basin 171 with HydroBrake

The HEN_S network was modified by adding a storage node (081-Storage1) adjacent to node 081-MH1, as shown in Figure 3-18. The storage node had a base elevation at 29.1 ft NAVD88 and a top elevation at 32.19 ft NAVD88. The top of the storage node was set equal to the crest of the weir at Overflow Structure 171. The link definition between 081-Storage1 and 081-MH1 includes the following parameters:

- Length = 20 ft
- Diameter = 15 inches
- Inverts: 29.0 ft NAVD88 (upstream) and 29.1 ft NAVD88 (downstream).

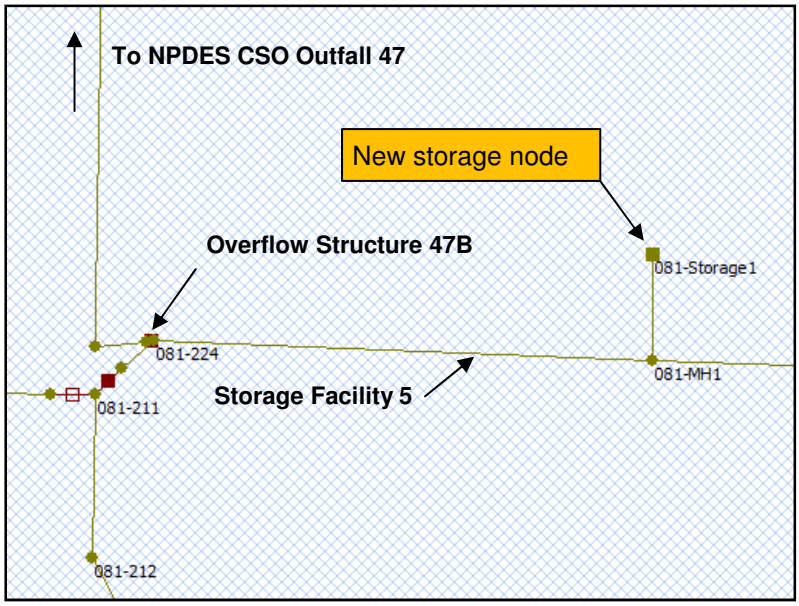

Figure 3-18: Model Configuration for Run 14.0 in Basin 47S

The storage volume needed for Basin 47S and Basin 171 was determined by varying the volume of the storage node until the benchmark conditions and boundary conditions were met. Under these model runs, the HydroBrake was not removed and continued to discharge a maximum flow rate of approximately 0.9 MGD. Table 3-9 shows the relationship between the additional storage volume and CSOs at Overflow Structure 47B and Overflow Structure 171. The additional storage volume needed for Basin 47S and Basin 171 is approximately 230,000 gallons. Results from this run meet the benchmarks of 9 events established for both Basin 47B and Basin 171.

Table 3-9: Basin 47S/Basin 171 Additional Storage Volume Needed (Run 14.0)

Additional Storage Volume (gallons)	NPDES CSO Outfall Structure 47B		NPSES CSO Outfall 171	
	CSO Events (No.)	CSO Volume (MG)	CSO Events (No.)	CSO Volume (MG)
0	24	5.07	28	6.36
210,000	10	3.62	10	4.51
220,000	9	3.59	10	4.49
230,000	9	3.53	9	4.41
240,000	9	3.48	9	4.36
250,000	9	3.46	9	4.35

3.3.8.2 Run 23.0: Offline Storage Volume for Basin 47S and Basin 171 with Modulating Gate

The HEN_S network was modified by adding a storage node (081-Storage1) adjacent to node 081-MH1, as shown in Figure 3-18 under 3.3.8.1.

The HydroBrake located in node 081-231 was removed and replaced with a 12-inch sluice gate. To control the sluice gate, an RTC group was created. The RTC was set to control the level at node 081-231H to a depth of 10. The purpose for modulating the flow depth at 10-inches is to maintain the hydraulic grade line below the crown of the 12-inch pipe. A PID controller was implemented to control the operation of the gate; the PID controller used the following coefficients to "smooth" the gate response:

- K_p = -0.25
- K_i = 0
- K_d = 1.0

The results of Run 23.0 show that the maximum flow to the King County Henderson Pump Station increases from 0.9 MGD to 2.3 MGD. The downstream pipe is fully utilized with the hydraulic grade line remains below the crown of the 12-inch pipe downstream. The storage volume needed in combination with this gate is approximately 100,000 gallons. This is smaller than the storage volume determined in Run 14.0 using the existing the HydroBrake. The storage volume was reduced because the sluice gate is allowing more flow to go to the Henderson Pump Station.

3.3.9 Transfer Basin 49 to King County Henderson Pump Station

As described in Section 3.3.7, flows from Basin 49 are conveyed to the King County Henderson Pump Station through a HydroBrake. The HydroBrake limits the maximum flow from Basin 49 to approximately 2.4 MGD. In order to reduce CSO frequency at NPDES Outfall 49, the following three runs evaluated increasing the discharge to King County Henderson Pump Station from Basin 49:

- Run 1.0: Removing the HydroBrake at node 306-428.
- Run 2.0: Removing the HydroBrake at node 306-428 and controlling discharge using a modulating gate.
- Run 28.0: Determine the minimum additional flow to the Henderson Pump Station needed to achieve control.

3.3.9.1 Run 1.0: Removing the HydroBrake at MH 306-428

The HEN_S network was modified by removing link 306-428H.1 and node 306-428H, and connecting link 306-428.1 from node 306-428 to node 306-246 as shown in Figure 3-19. The chamber floor of node 306-428 was modified from 28.42 ft NAVD88 to 28.45 ft NAVD88 to match the newly connected pipe inverts.

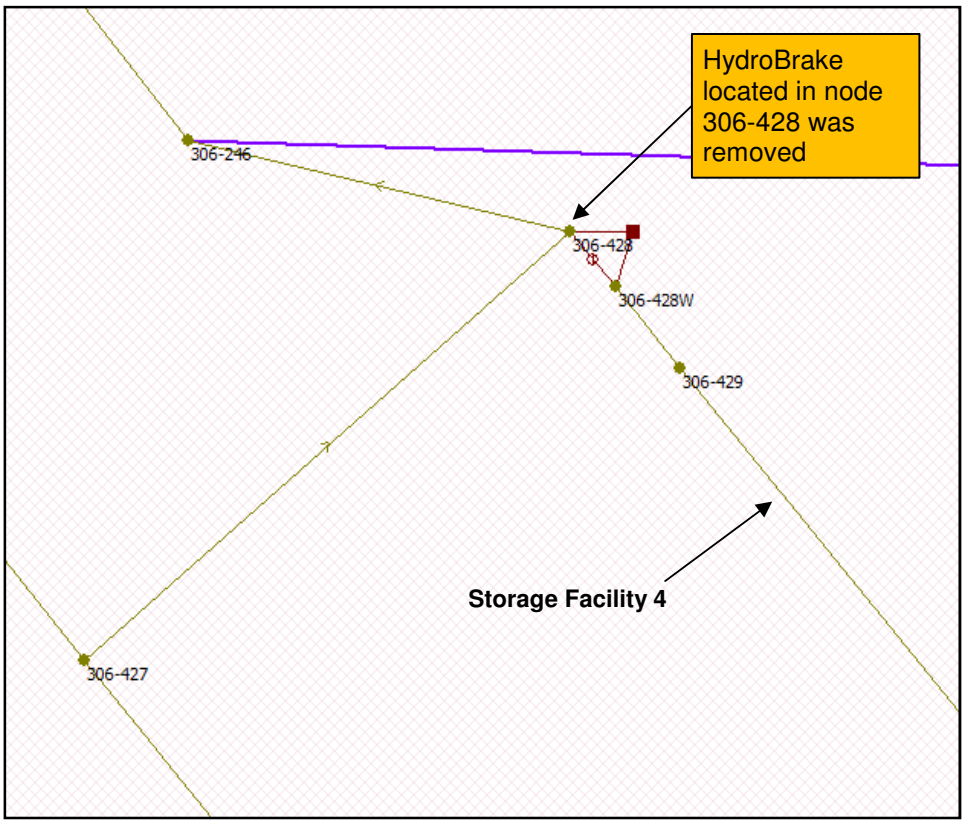

Figure 3-19: Model Configuration for Run 1.0 in Basin 49

The results of Run 1.0 show an increase in maximum flow to the Henderson Pump Station of approximately 1.5 MGD (increase from 2.4 MGD to 3.9 MGD) as shown in Figure 3-20. The increase in maximum flow caused a sharp increase in the hydraulic grade line above the crown of the pipe within the 18-inch diameter Henderson Interceptor from node 306-246 to node 081-349 (located just upstream of the Henderson Pump Station), as shown in Figure 3-21. The Base Model shows that at the maximum condition the hydraulic grade line remains below the crown of the pipe. The increase in the hydraulic grade line could cause sewers directly connected to the interceptor to surcharge and back up into adjacent homes. Side sewer information is not a part of the model network; therefore the impact to side sewers is unknown.

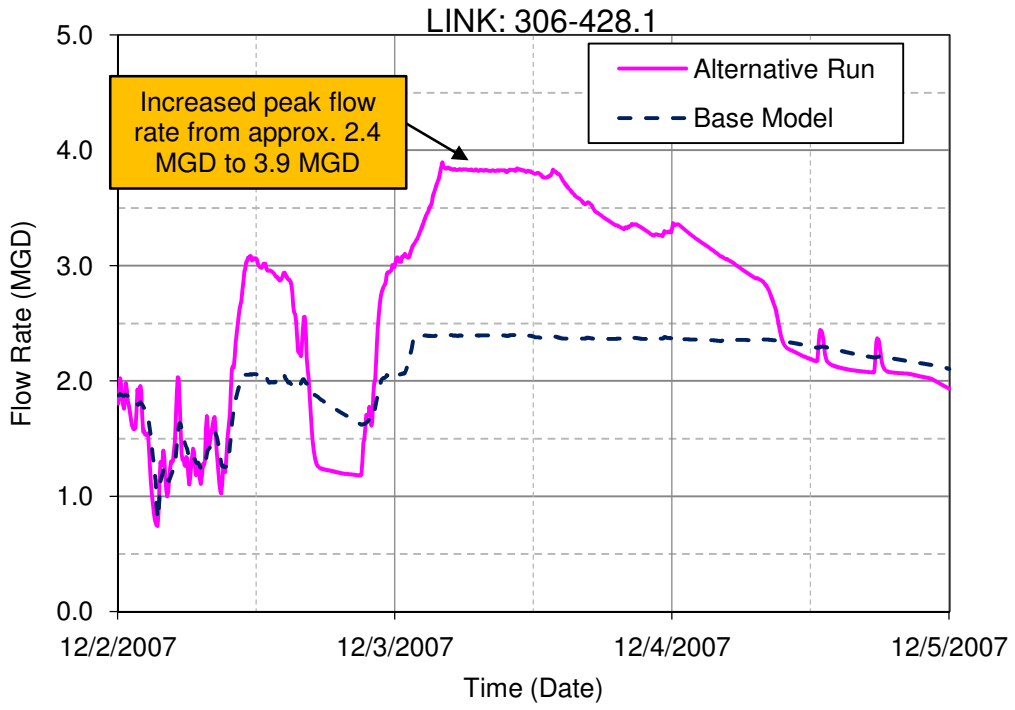

Figure 3-20: Comparison of Maximum F low Rates to the Henderson Pump Station from Basin 49 between the Base Model and Run 1.0

For this run, the number of CSOs at Overflow Structure 49 was reduced from 19 events to 4 events, below the benchmark of 10 events for NPDES CSO Outfall 49. Total CSO volume is decreased as shown in Table 3-13.

Table 3-10: CSO Results Comparison between Base Model and Run 1.0

	Base Model	Run 1.0
	NPDES Outfall 49	NPDES Outfall 49
CSO Events	19	4
CSO Volume	7.81 MG	1.75 MG

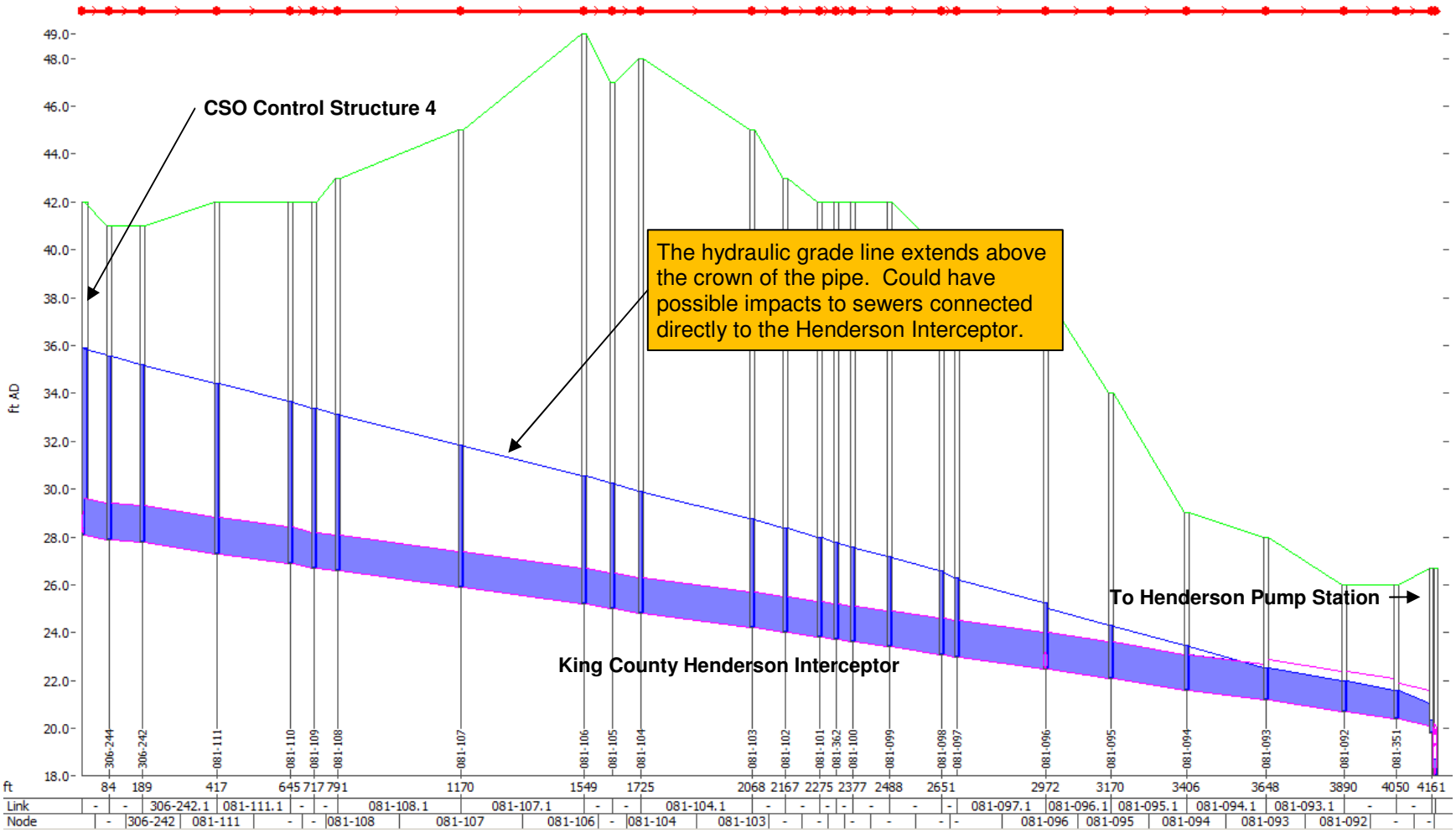

Figure 3-21: Maximum Hydraulic Profile from CSO Control Structure 4 to MH 081-349 (Run 1.0)

3.3.9.2 Run 2.0: Removing the HydroBrake at Node 306-428 and Controlling Discharge Using a Modulating Gate

The HEN_S network was modified through the following steps:

- The HydroBrake was removed and replaced by a sluice gate.
- The inverts around node 306-428 to match recent survey data.

To control the sluice gate, an RTC group was created. The RTC was set to control the level at the upstream end of link 306-246.1 to a depth of 16 inches in the 18-inch diameter interceptor. A PID controller was implemented to control the operation of the gate; the PID controller used the following coefficients to "smooth" the gate response:

- K_p = -1.0
- K_i = 0
- K_d = 1.0.

Figure 3-22 shows the model configuration for Run 2.0.

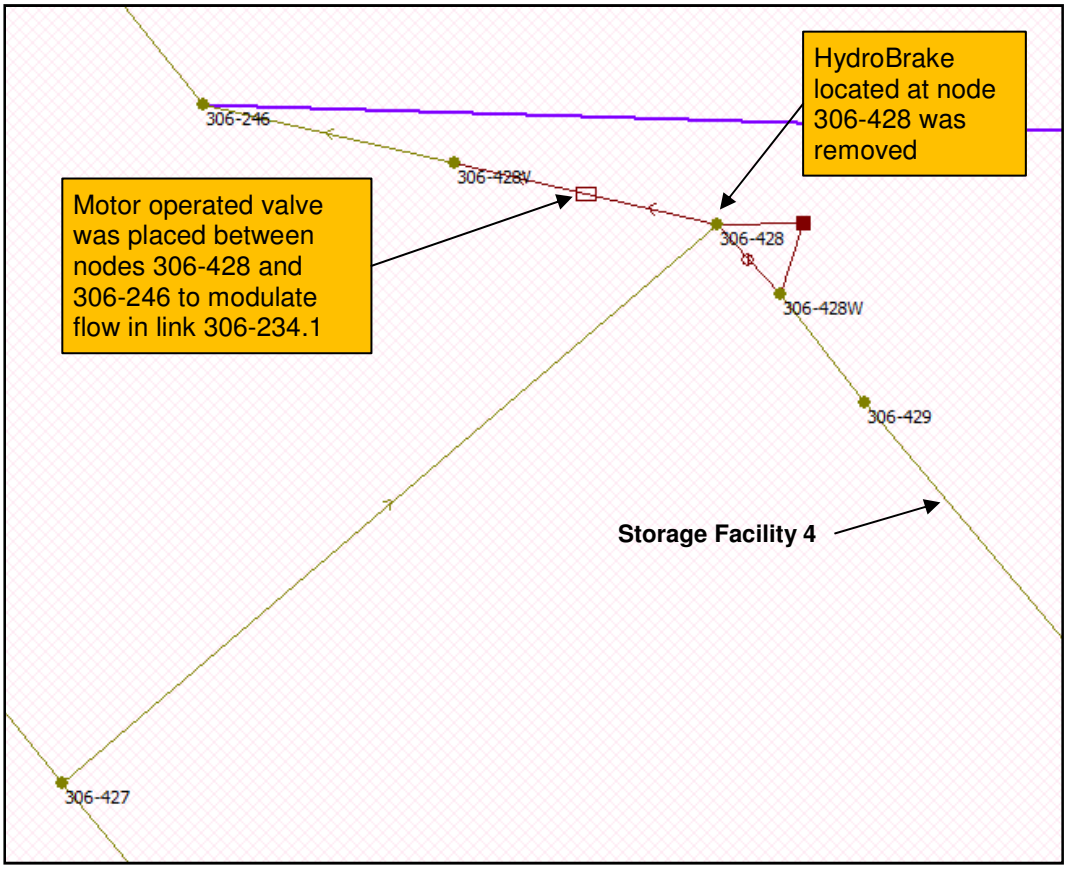

Figure 3-22: Model Configuration for Run 2.0 in Basin 49

The results of Run 2.0 show an increase in the maximum flow to the King County Henderson Pump Station of approximately 0.5 MGD (increase from 2.4 MGD to 2.9 MGD) as shown in Figure 3-23. In contrast to Run 1.0, the sluice gate is modulated to control the depth of flow to 16 inches so that the hydraulic grade line would remain at or below the crown of the existing 18-inch-diameter interceptor. The team assumed that as long as

the flow remains below the crown of the existing interceptor, side sewer connections will not become surcharged and flow will not back-up into adjacent homes. This assumption should be confirmed by field investigations.

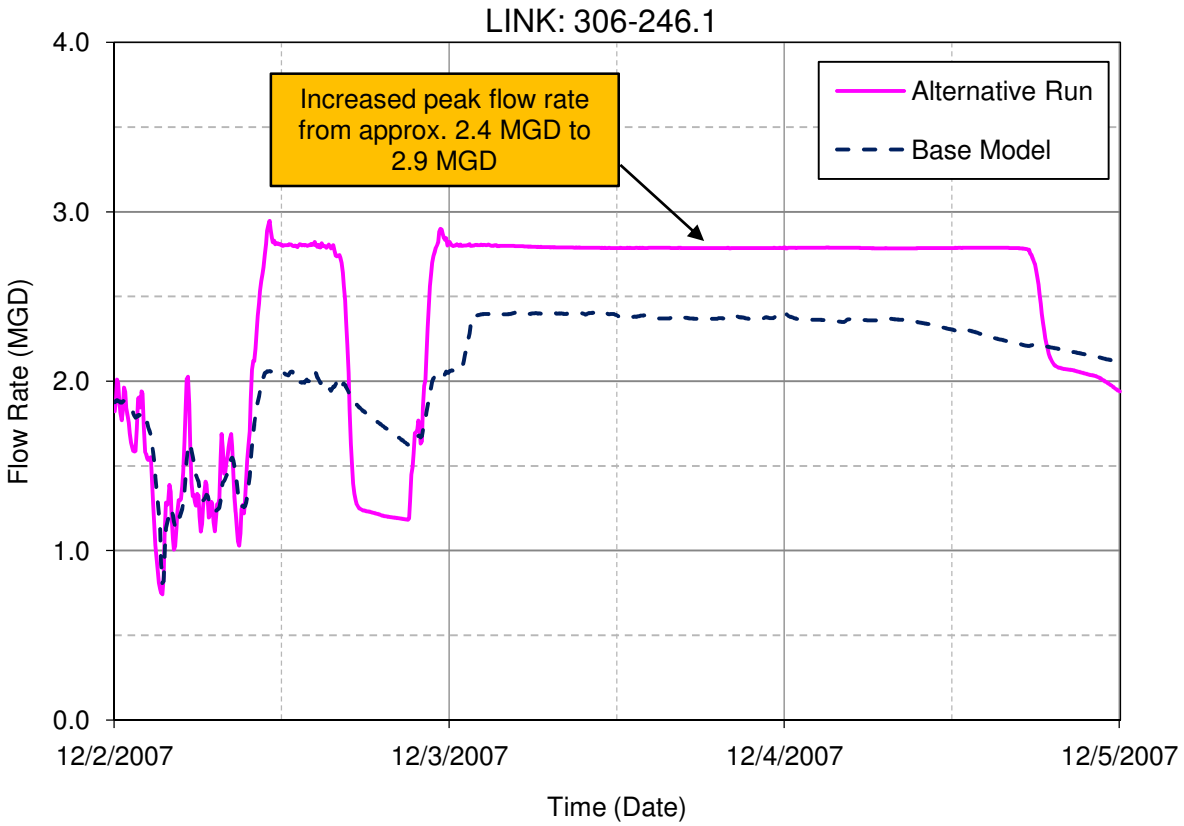

Figure 3-23: Comparison of Maximum flow Rates to the Henderson Pump Station from Basin 49 between the Base Model and Run 2.0

For this run, the number of CSOs at Overflow Structure 49 is reduced from 19 events to 7 events, below the benchmark of 10 events for NPDES CSO Outfall 49. Total CSO volume is decreased as shown in Table 3-11.

Table 3-11: CSO Results Comparison at NPDES Outfall 49 between Base Model and Run 2.0

	Base Model	Run 2.0 Results
CSO Events (No.)	19	7
CSO Volume (MG)	7.81	3.50

3.3.9.3 Run 28.0: Removing the HydroBrake at Node 306-428 and Controlling Discharge using a Modulating Gate

The RTC setup from Run 2.0 was adjusted to determine the depth set point needed to achieve the benchmark level of 10 overflows at NPDES CSO Outfall 49. The network setup was unchanged from Run 2.0 besides the depth set point at the upstream end of link 306-246.1. Table 3-12 shows the number of CSOs predicted as the depth set point is changed. A set point of 12.5 inches, at link 306-246.1, produces 10 overflows at NPDES CSO Outfall 49. The flow rate to the Henderson Pump Station was increased by 0.2 MGD, from approximately 2.4 MGD in the Base Model to approximately 2.6 MGD for a depth set point of 12.5 inches.

Table 3-12: Depth Set Point Variations for Run 28.0

Depth Set Point at 306-246.1 (Inches)	CSO Frequency at NPDES CSO Outfall 49 (Events)
Operation with existing HydroBrake	19
18	7
14	7
13.2	9
12.5	10
12.0	11

3.3.10 Transfer Basin 171 to King County Henderson Pump Station

Flows from Basin 47S and Basin 171 enter a common storage, Storage Facility 5, during wet weather events (See Figure 2-2 for the Henderson Area Flow Schematic). Storage Facility 5 is emptied by conveying flow through a HydroBrake located in node 081-231. The HydroBrake limits the discharge from Storage Facility 5 to approximately 0.8 MGD. In order to reduce CSO frequency at NPDES Outfall 47 and NPDES Outfall 171, the discharge from Storage Facility 5 was increased to the King County Henderson Pump Station using two runs:

- Run 4.0: Removing the HydroBrake at node 081-231.
- Run 22.0: Removing the HydroBrake at node 081-231 and increasing downstream conveyance.

3.3.10.1 Run 4.0: Removing the HydroBrake at MH 081-231

The HEN_S network was modified by removing link 081-231H.1 and node 081-231H, and reconnecting link 081-231.1 from node 081-231 to node 081-230 as shown in Figure 3-24. The inverts for link 081-231.1 were adjusted to make the upstream invert equal to 24.53 ft

NAVD88 and downstream invert 24.2 ft NAVD88, matching the inverts of the adjacent nodes.

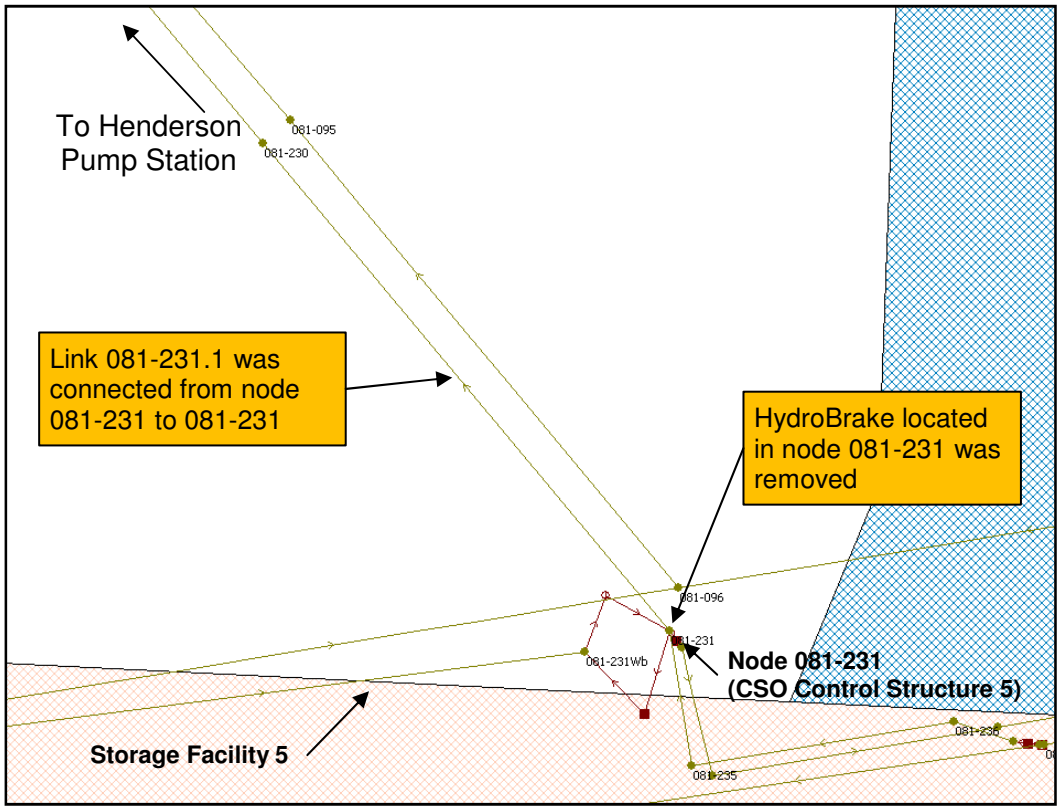

Figure 3-24: Model Configuration for Run 4.0 in Basin 171

The results of Run 4.0 show an increase in maximum flow to the Henderson Pump Station of approximately 1.5 MGD (increase from 0.8 MGD to 2.3 MGD) as shown in Figure 3-25. The increase in maximum flow caused the hydraulic grade line within the 12-inch diameter conveyance line from MH 081-231 to MH 081-349 (located just upstream of the Henderson Pump Station) to sharply increase. The hydraulic grade line is shown to extend above the rim of MH 081-229 in Figure 3-26. The 12-inch pipe does not have sufficient capacity to convey the increased flow to the Henderson Pump Station; therefore this alternative could cause side-sewer backups and surface flooding as predicted by the model.

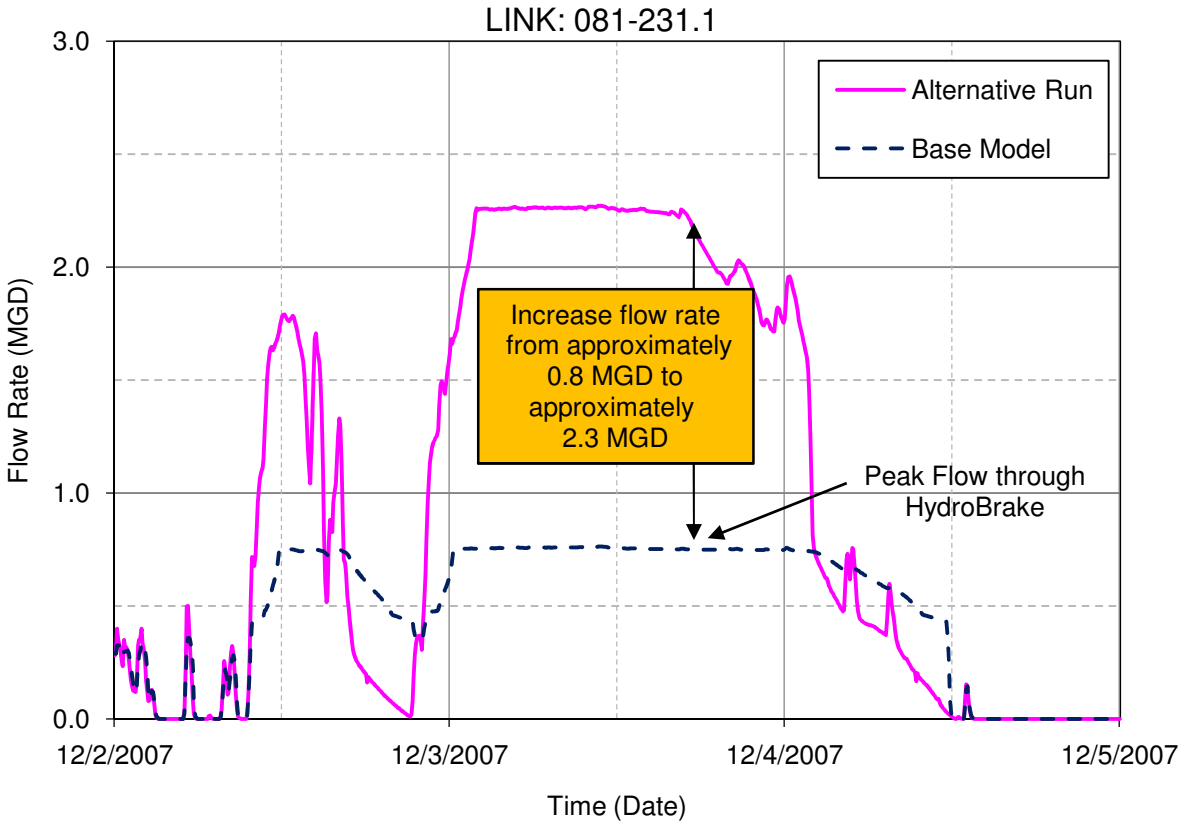

Figure 3-25: Comparison of Maximum Flow Rates to the Henderson Pump Station from Node 081-231 between the Base Model and Run 4.0

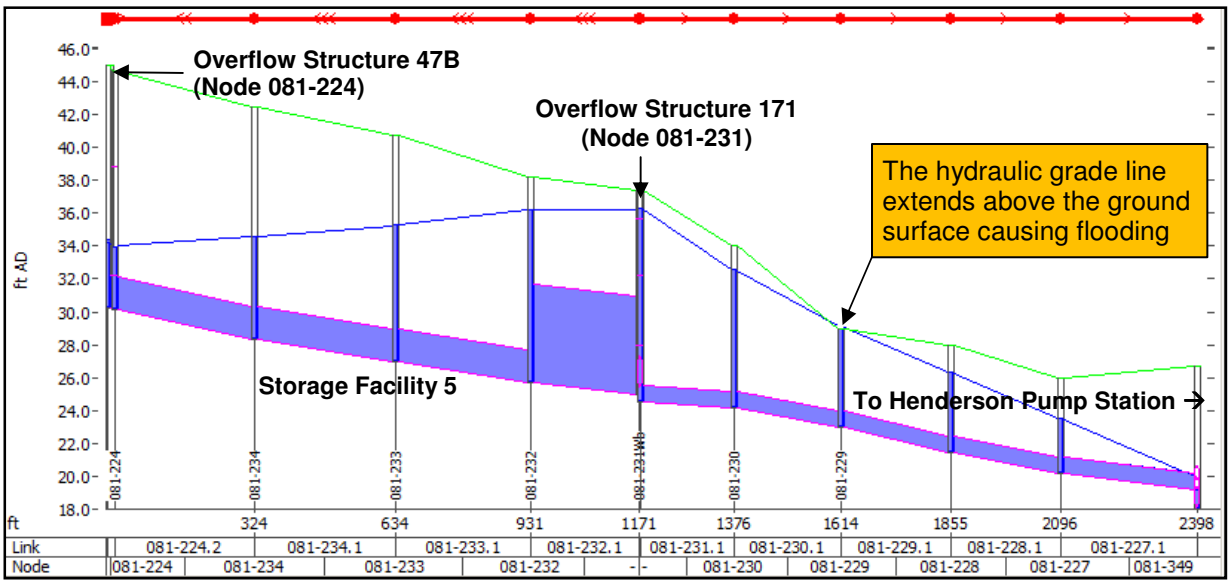

Figure 3-26: Maximum Hydraulic Profile from Overflow Structure 47B to Node 081-349 (Run 4.0)

For this run, the number of CSOs at Overflow Structure 171 was reduced from 28 events to 8 events, below the benchmark of 9 events. Therefore, removing the HydroBrake sufficiently reduces CSOs at NPDES Outfall 171. Likewise, the result of this run reduces the number of CSOs at Overflow Structure 47B from 24 events to 7 events, below the benchmark of 9 events for this location. CSO volume is decreased as shown in Table 3-13. The CSO volume that leaves the system through MH 081-229 has not been quantified in these results.

Table 3-13: CSO Results Comparison between Base Model and Run 4.0

	Base Model		Run 4.0	
	NPDES Outfall 171	NPDES Outfall 47B	NPDES Outfall 171	NPDES Outfall 47B
CSO Events (No.)	28	24	8	7
CSO Volume (MG)	6.36	5.07	1.91	2.19

3.3.10.2 Run 22.0: Removing the HydroBrake at Node 081-231 and Increasing Conveyance to the Henderson Pump Station

The HEN_S network was modified by removing link 081-231H.1 and node 081-231H, and reconnecting link 081-231.1 from node 081-231 to node 081-230 as shown in Figure 3-27. The inverts for link 081-231.1 were modified to make the upstream invert equal to 24.53 ft NAVD88 and downstream invert 24.2 ft NAVD88, matching the chamber floors of the adjacent nodes. This pipe remains 12-inch-diameter.

The HEN_S network was further modified by increasing the diameter of links between nodes 081-230 and 081-349 from 12-inch-diameter to 18-inch-diameter. In order to maintain the existing pipe crown elevations, the invert of each link was dropped by 6-inches, the difference between the two pipe diameters. The invert at link 081-330.1 (furthest upstream link) was changed to 23.7 ft NAVD88 and the invert of link 081-227.1 (furthest downstream link) was changed to 18.7 ft NAVD88. Figure 3-27 shows the modification made to the HEN_S network.

The results of Run 22.0 show an increase in maximum flow to the Henderson Pump Station of approximately 3.4 MGD (increase from 0.8 MGD to 4.2 MGD) as shown in Figure 3-28. Unlike in Run 4.0, the hydraulic grade line in Run 22.0 remains below the crown of the interceptor to the Henderson Pump Station. The 12-inch diameter pipe (link 081-231.1) from MH 081-231 acts as an orifice. This orifice causes the flow rate to the Henderson Pump Station to be limited to the capacity of the pipe and the hydraulic grade line to be limited by the overflow weir in MH 081-231. As shown in Figure 3-29, Storage Facility 5 is fully utilized during the maximum condition.

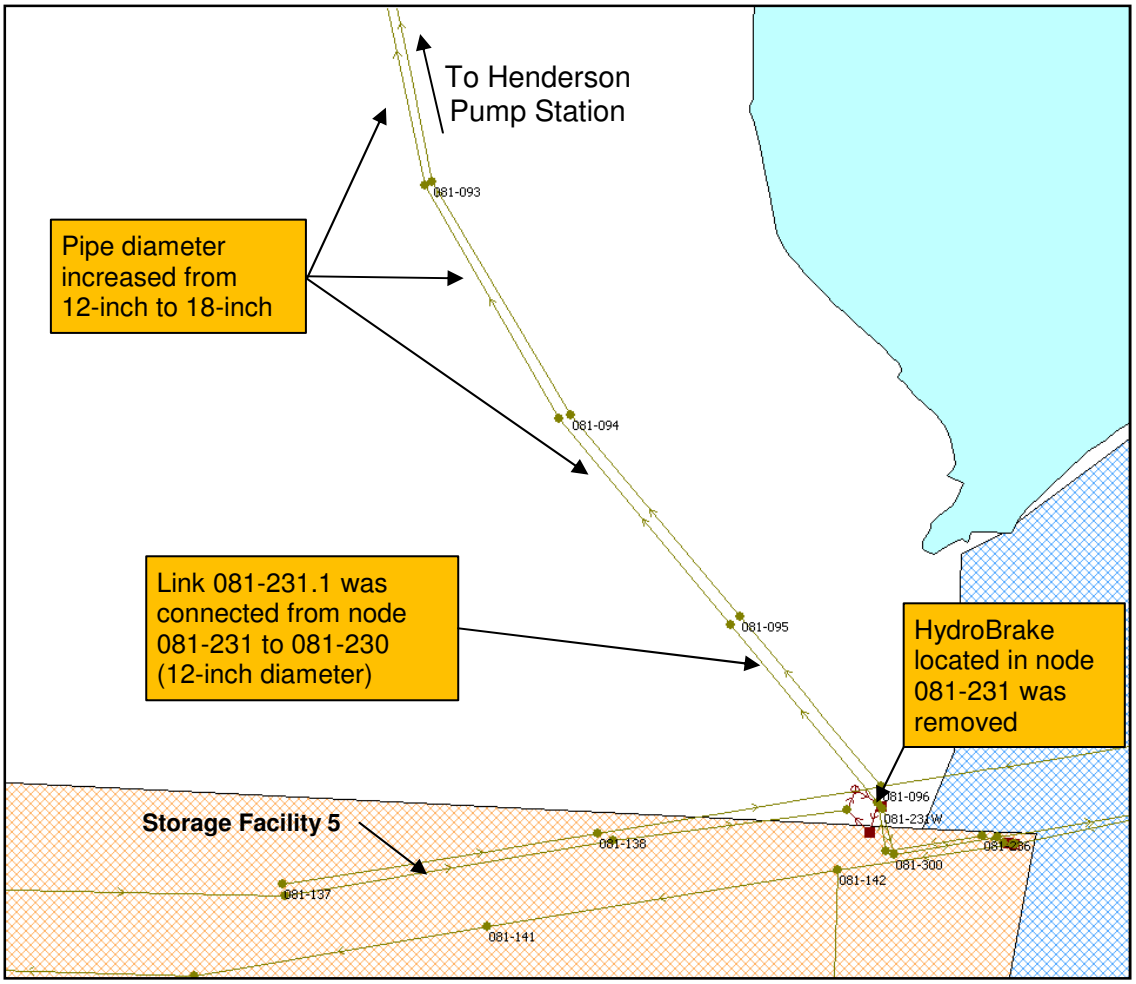

Figure 3-27: Model Configuration for Run 22.0 in Basin 171

For Run 22.0, the number of CSOs at Overflow Structure 171 was reduced from 28 events to 5 events, below the benchmark of 9 events for this location. Likewise, during this run the number of CSOs at Overflow Structure 47B was reduced from 24 events to 5 events, below the benchmark of 9 events for this location. The results from this run show that CSOs are reduced to both NPDES Outfall 171 and NPDES Outfall 47. CSO volume is decreased as shown in Table 3-14.

Table 3-14: CSO Results Comparison between Base Model and Run 22.0

	Base Model Results		Run 22.0 Results	
	NPDES Outfall 171	NPDES Outfall 47B	NPDES Outfall 171	NPDES Outfall 47B
CSO Events (No.)	28	24	5	5
CSO Volume (MG)	6.36	5.07	0.53	0.85

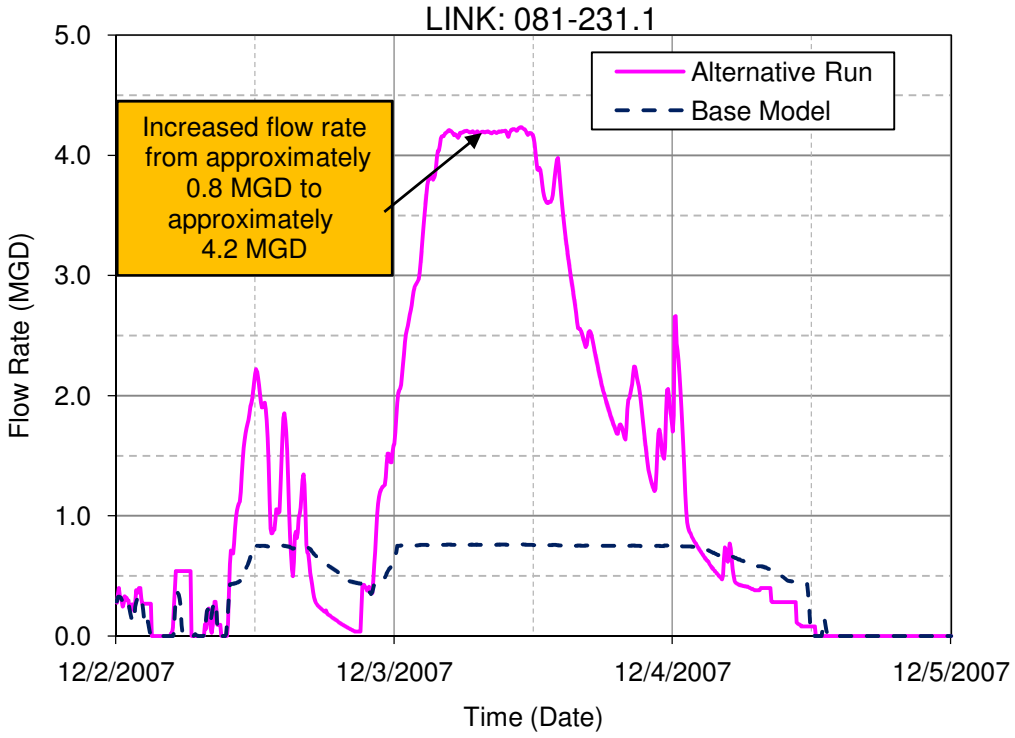

Figure 3-28: Comparison of Maximum Flow Rates to the Henderson Pump Station from Node 081-231 between Base Model and Run 22.0

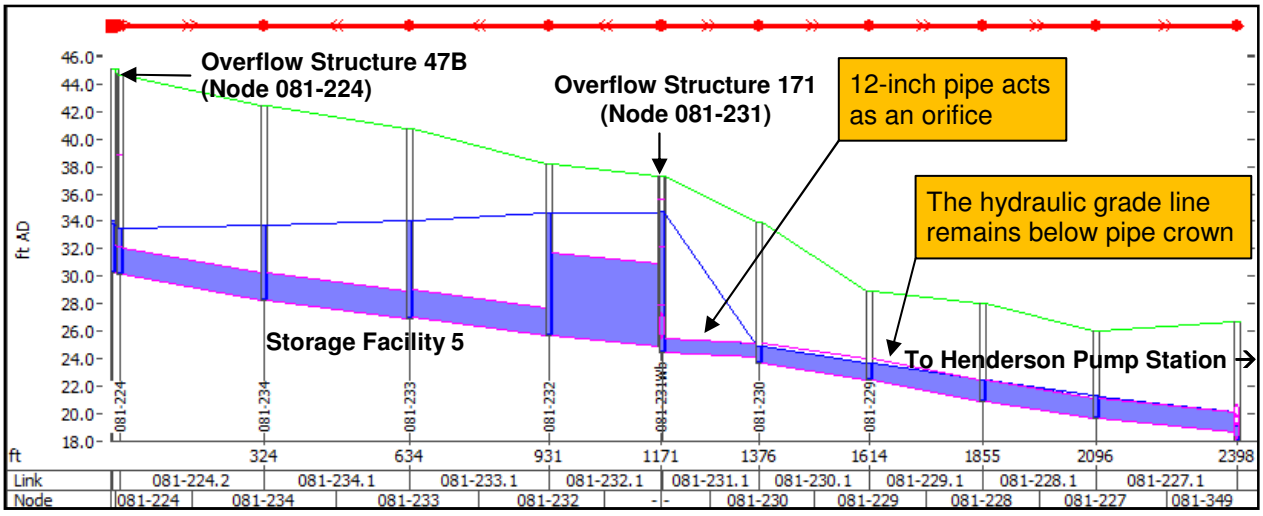

Figure 3-29: Maximum Hydraulic Profile from Overflow Structure 47B to MH 081-349 (Run 22.0)

3.3.11 Transfer Basin 47S to King County Henderson Trunk

Basin 47S receives flow from Basin 171 from the east through a short section of 8-inch pipe just downstream of the high-flow weir located at node 081-211. This orifice causes flow to back up in the system overtopping the high-flow weir and entering the west end of Storage Facility 5 (a shared facility with Basin 171). Flow that does not enter the storage facility continues through an 18-inch pipeline to the Henderson Trunk. The following three runs were identified to quantify the impacts of sending additional flow to the Henderson Trunk:

- Run 8.0: Remove orifice and increase downstream pipeline diameter.
- Run 9.0: Remove orifice and HydroBrake and increase downstream pipeline diameter.
- Run 24.0: Remove orifice and HydroBrake and increase a portion of downstream pipeline diameter.

3.3.11.1 Run 8.0: Remove Orifice and Increase Downstream Pipeline Diameter

Run 8.0 estimates the additional flow that could be transferred to the King County Henderson Trunk by increasing the conveyance capacity between the high-flow diversion weir at the 47B overflow structure, node 081-211, and the Henderson Trunk, node 080-355. Currently the connecting pipe is 18-inches in diameter. The pipe size was increased to 30-inches for a total length of approximately 2,040 feet. The following changes were made to the HEN_S model network and are shown in Figure 3-20:

- The orifice in Basin 47S was removed.
- Increased the pipe diameter for pipes between node 081-211 and the Henderson Trunk from 18-inches to 30-inches. The inverts for these new pipes were dropped to match crowns of the existing pipes.

Figure 3-30 shows the hydraulic profile at maximum flow conditions of the enlarged pipeline between the 47B structure and the Henderson Trunk. The conveyance pipeline experiences fewer surcharges than in the Base Model. Maximum flow to the Henderson Trunk has increased to 8.3 MGD (Figure 3-32).

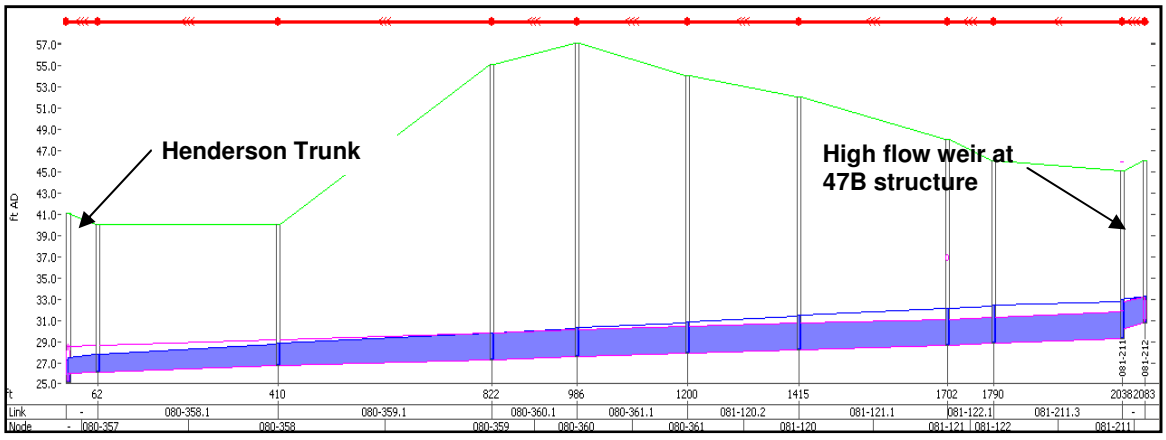

Figure 3-30: Maximum Hydraulic Profile of Pipeline from 47B to Henderson Trunk (Run 8.0)

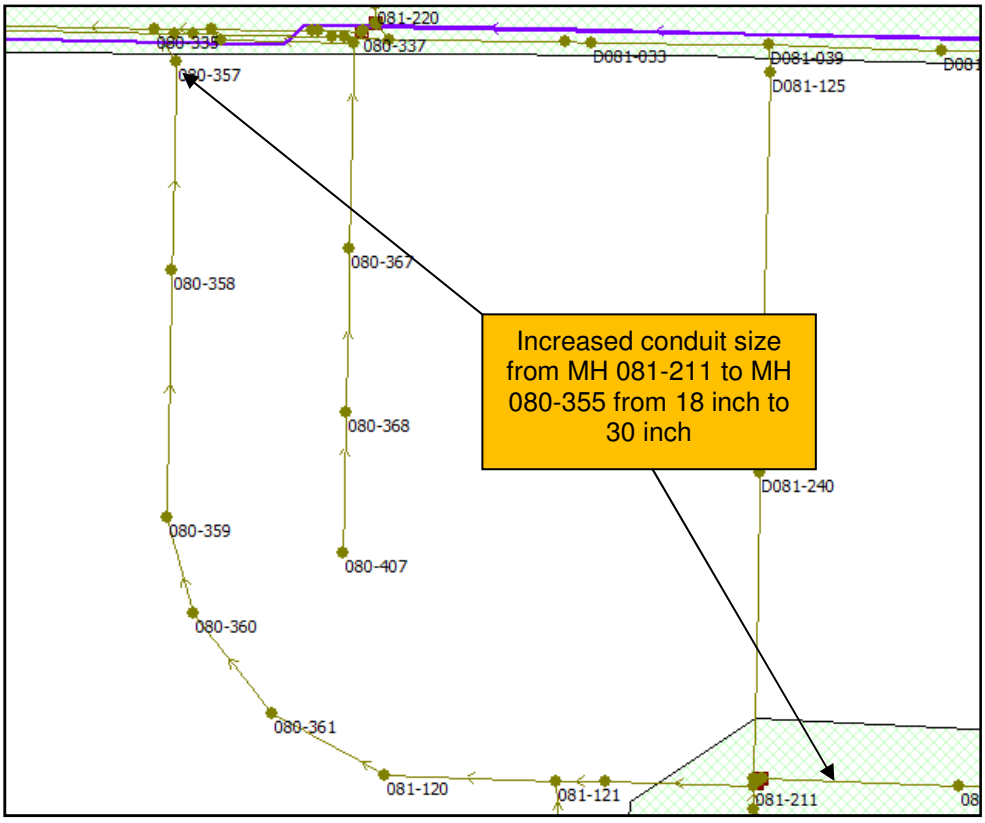

Figure 3-31: Model Configuration for Run 8.0 in Basin 47S

Results from Run 8.0 show a reduction in CSO events at 47B from 24 events to 1 event, below the benchmark of 9 events. The CSO volume decreased from 5.07 MG to 0.08 MG. The number of events at 171 also decreased, from 28 events to 5 events. This also exceeded the benchmark of 9 events established for this location. The volume of overflow at 171 decreased from 6.36 MG to 0.87 MG. These results are summarized in Table 3-15.

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

	Base Model		Run 22.0	
	NPDES Outfall 171	NPDES Outfall 47B	NPDES Outfall 171	NPDES Outfall 47B
CSO Events (No.)	28	24	5	1
CSO Volume (MG)	6.36	5.07	0.87	0.08

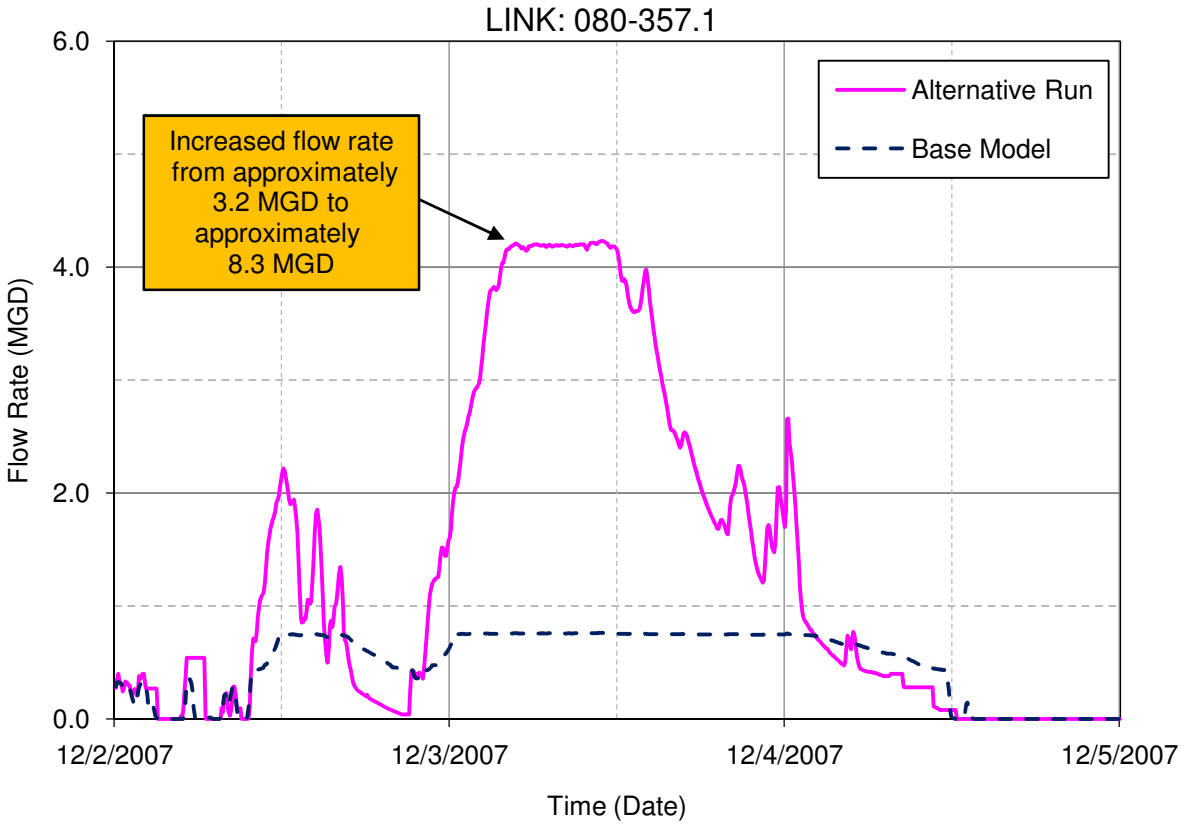

Figure 3-32: Comparison of Maximum Flow Rates to Henderson Trunk between the Base Model and Run 8.0

3.3.11.2 Run 9.0: Remove Orifice and HydroBrake and Increase Downstream Pipeline Diameter

Run 9.0 estimates the additional flow to the King County Henderson Trunk by removing the HydroBrake at node 081-231 and increasing the conveyance capacity between the high-flow diversion weir at the 47B overflow structure, node 081-211, and the Henderson Trunk, node 080-355. Currently the pipe is 18-inches in diameter. The pipe size was increased to 30-inches for a total length of approximately 2,040 feet. The following changes were made to the HEN_S model network and are shown in Figure 3-33:

- The orifice in Basin 47S and the HydroBrake in Basin 171 were removed.
- Increased the pipe diameter for pipes between node 081-211 and the Henderson Trunk from 18-inches to 30-inches. The inverts for these new pipes were dropped to match crowns of the existing pipes.

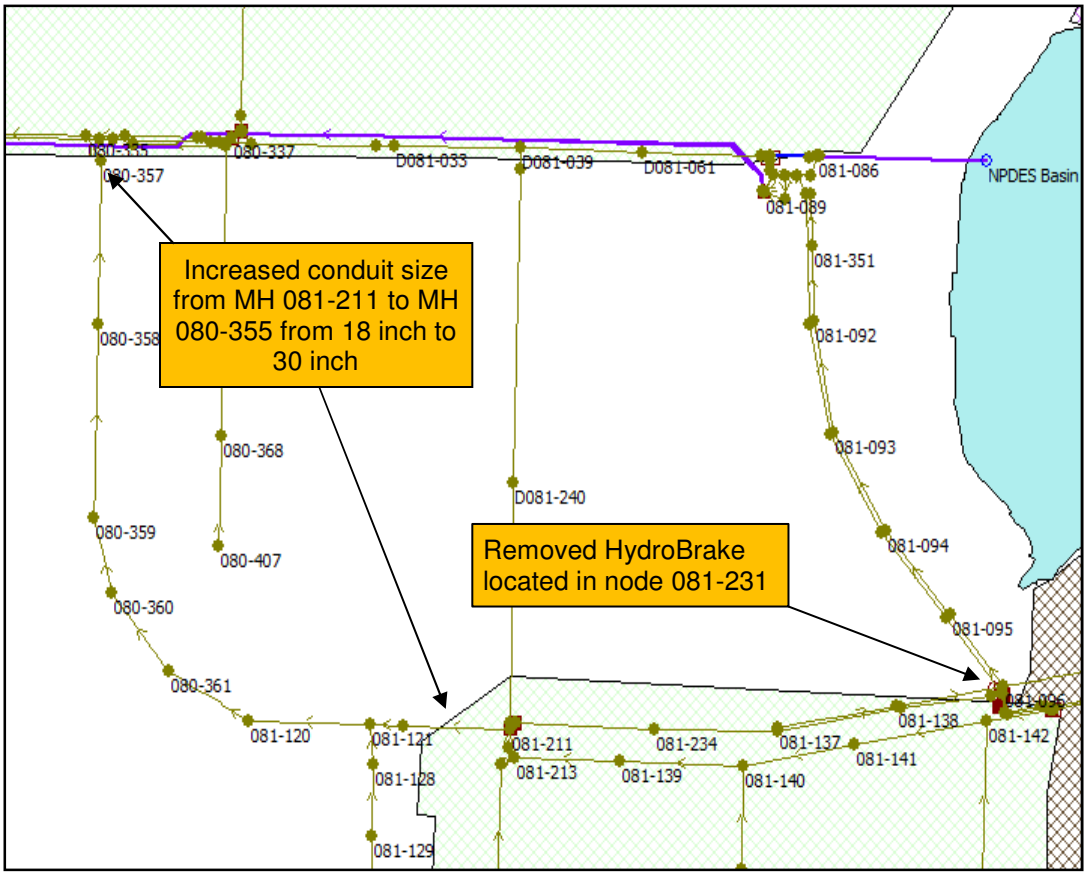

Figure 3-33: Model Configuration for Run 9.0 in Basin 47S

As with the results from Run 8.0, the maximum flow condition hydraulic profile for the pipeline to the Henderson Trunk shows improved capacity with the increase in pipe size (Figure 3-34). Maximum flow to the Henderson Trunk increased to 7.9 MGD (from a base flow condition of 3.7 MGD). The increase is shown graphically in Figure 3-35.

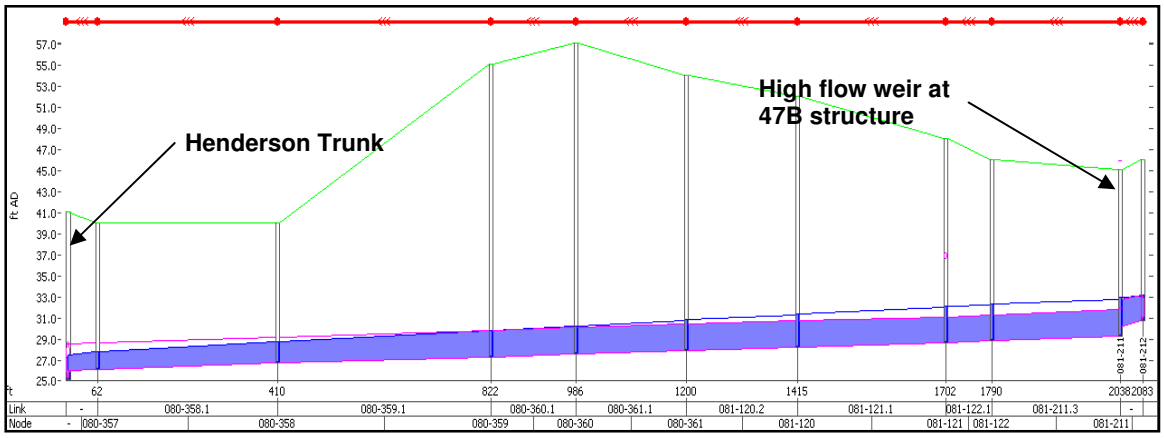

Figure 3-34: Maximum Hydraulic Profile of Pipeline from 47B to Henderson Trunk (Run 9.0)

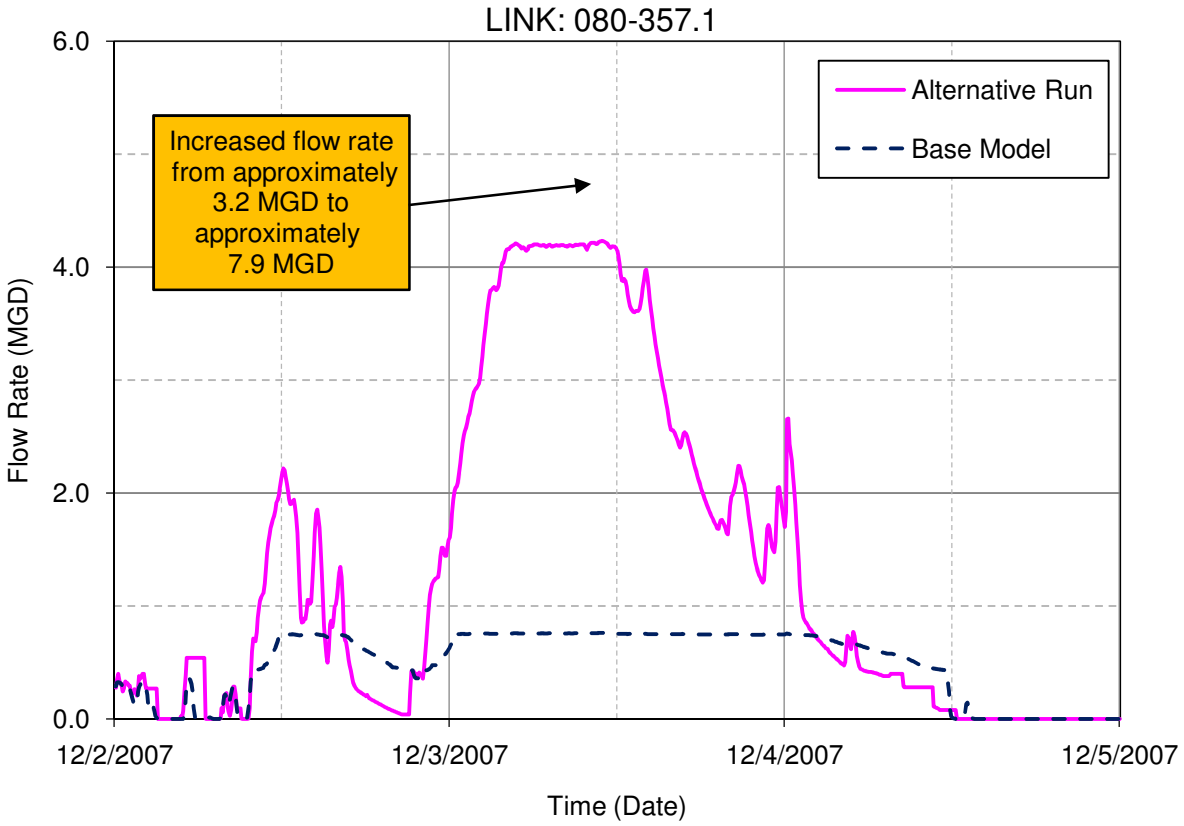

Figure 3-35: Comparison of Maximum Flow Rates to Henderson Trunk between the Base Model and Run 9.0

Removing the HydroBrake at MH 081-231 causes flooding problems as shown in the results of Run 4.0 and described in Section 3.3.10. The resulting hydraulic profile is shown in Figure 3-36.

As with Run 4.0, the results for Run 9.0 show that the maximum flow to the King County Pump Station increased from 0.9 MGD to about 2.4 MGD. This increase in the hydraulic grade line is shown in Figure 3-36.

Results from Run 9.0 show an elimination of CSO events at 47B, below the benchmark of 9 events. The number of events at 171 decreased, from 28 events to 2 events. This also exceeded the benchmark of 9 events established for this location. The volume of overflow at 171 decreased from 6.36 MG to 0.87 MG. These results are summarized in Table 3-16. The CSO volume that leaves the system through MH 081-229 has not been quantified in these results.

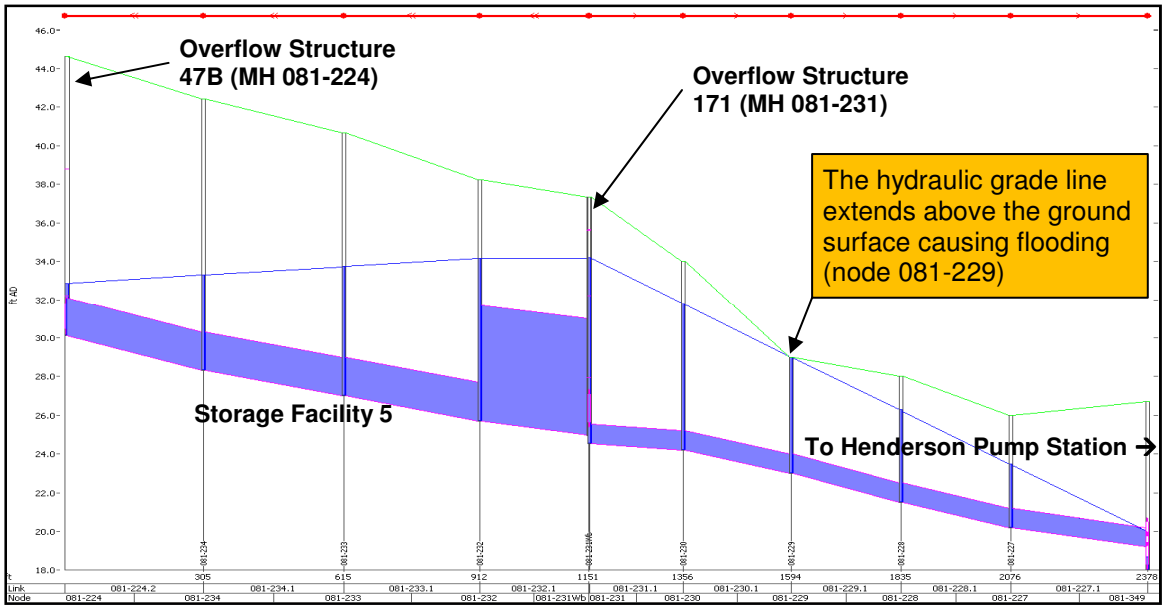

Figure 3-36: Maximum Hydraulic Profile from Overflow Structure 47B to MH 081-349 (Run 9.0)

Table 3-16: CSO Results Comparison between Base Model and Run 9.0

	Base Model Results		Run 22.0 Results	
	NPDES Outfall 171	NPDES Outfall 47B	NPDES Outfall 171	NPDES Outfall 47B
CSO Events (No.)	28	24	2	0
CSO Volume (MG)	6.36	5.07	0.21	0.00

3.3.11.3 Run 24.0: Remove Orifice and HydroBrake and Increase a Portion of Downstream Pipeline Diameter

Run 24.0 is a further refinement of Run 8.0. This run estimates the additional flow to the King County Henderson Trunk resulting from increase of the conveyance capacity of a portion of the pipeline between the high flow diversion weir at the 47B overflow structure, MH 081-211 and the Henderson Trunk, MH 080-355. The pipe size was increased section by section starting from the connection point to the Henderson Trunk and moving upstream. The model was run to determine the minimum length of pipe with increase diameter needed to meet the benchmark of 9 CSO events for both Basin 47B and Basin 171. The following changes were made to the HEN_S model network and are shown in Figure 3-37:

- The orifice in Basin 47S was removed.
- Increased the pipe diameter for pipes between node 081-120 and the Henderson Trunk from 18-inches to 30-inches. The inverts for these new pipes were dropped to match crowns of the existing pipes.

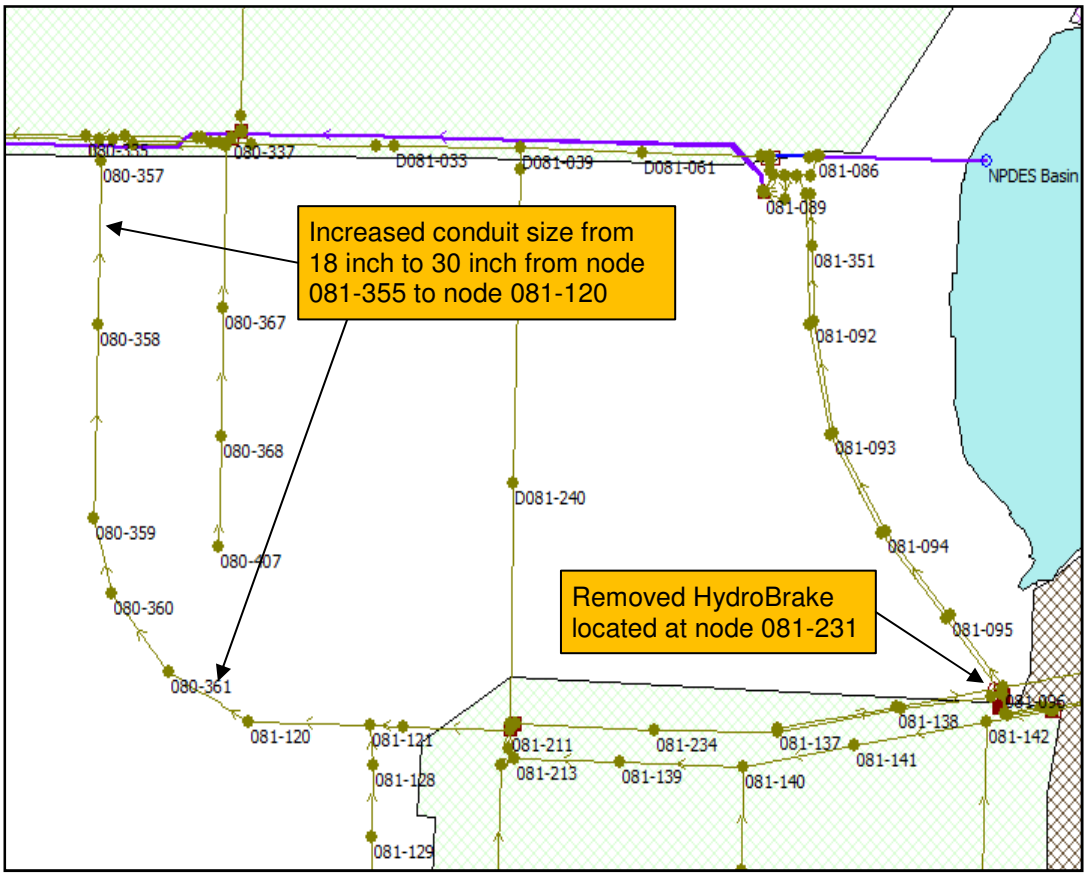

Figure 3-37: Model Configuration for Run 24.0 in Basin 47B

Results for Run 24.0 show that increasing the pipe diameter from node 080-355 to node 081-121, a length of about 1,415 feet, will bring both Basin 47B and Basin 171 into compliance. The maximum flow hydraulic profile is shown in Figure 3-38. Flows to the Henderson Trunk were increased by 1.2 MGD, from 3.2 MGD to 5.0 MGD. Figure 3-39 shows a hydrograph comparing results from the Base Model and Run 24.0.

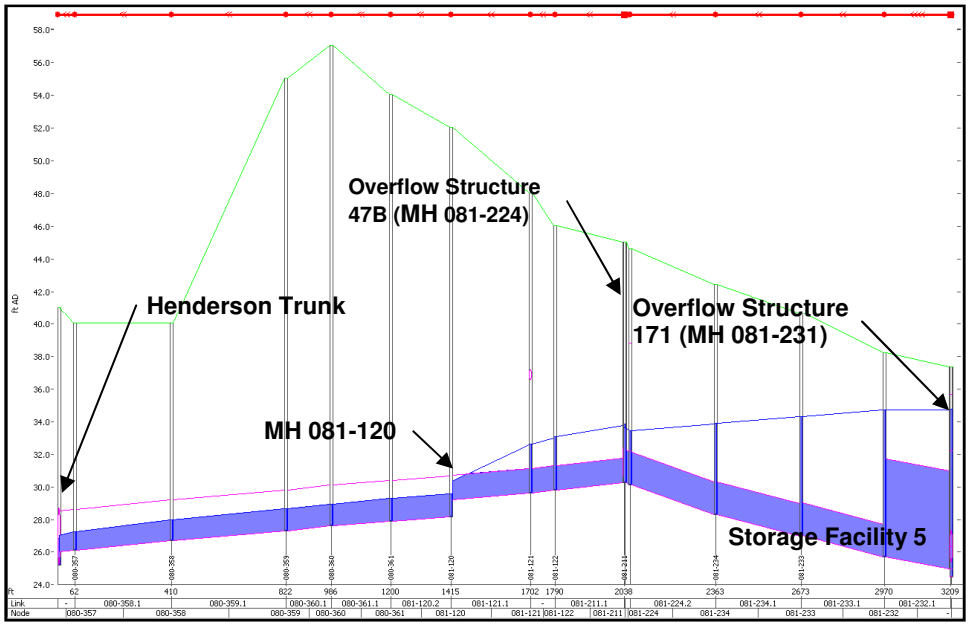

Figure 3-38: Maximum Hydraulic Profile from Overflow Structure 171 to MH 080-355 (Run 24.0)

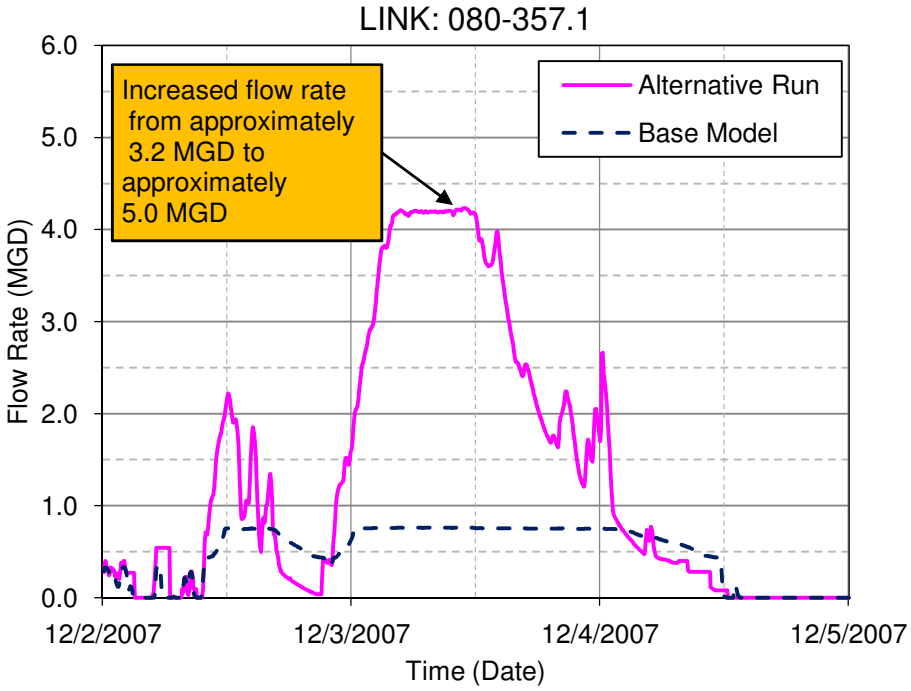

Figure 3-39: Comparison of Maximum Flow Rates to Henderson Trunk between the Base Model and Run 24.0

Run 24.0 resulted in 9 overflow events at 47B and 9 events at 171. This meets the benchmark of 9 events at each location. Table 3-18 summarizes the comparison of results between the Base Model and Run 24.0.

Table 3-17: CSO Results Comparison between Base Model and Run 24.0

	Base Model		Run 24.0	
	NPDES Outfall 171	NPDES Outfall 47B	NPDES Outfall 171	NPDES Outfall 47B
CSO Events (No.)	28	24	9	9
CSO Volume (MG)	6.36	5.07	2.28	1.45

3.3.12 Distributed Offline Storage (Basins 44, 45 and 46)

Basin 44, Basin 45 and Basin 46 are hydraulically linked through the Henderson Lake line. All three basins are considered to be uncontrolled. As discussed in Run 10.0, it was assumed that Basin 45 could be brought into control by providing storage in Basin 44 and Basin 46. This assumption was found to be inadequate; therefore, additional storage was needed in Basin 45. Run 26.0 was used to determine the volume of storage needed in Basin 45, in combination with the results of Run 10.0 and Run 18.0.

3.3.12.1 Run 26.0: Distributed Offline Storage for Basin 44, Basin 45 and Basin 46

The HEN_N network was modified by including the model configurations for Run 10.0 and Run 18.0 (see Figure 3-5 and Figure 3-8). In the Base Model, there is no existing storage in Basin 45; therefore storage for Basin 45 was provided as shown in Figure 3-40.

The storage drain valve is controlled by the depth in node 074-152, located just downstream of Pump Station 10. When the valve closes, flow from Basin 45 is stored in storage node 45_Storage until there is capacity downstream or until the storage fills and overflows to NPDES CSO Outfall 45. Specifically, the gate closes when the level at node 074-152 is greater than 25 ft NAVD88 and opens when the level at node 074-152 is less than 25 ft NAVD88.

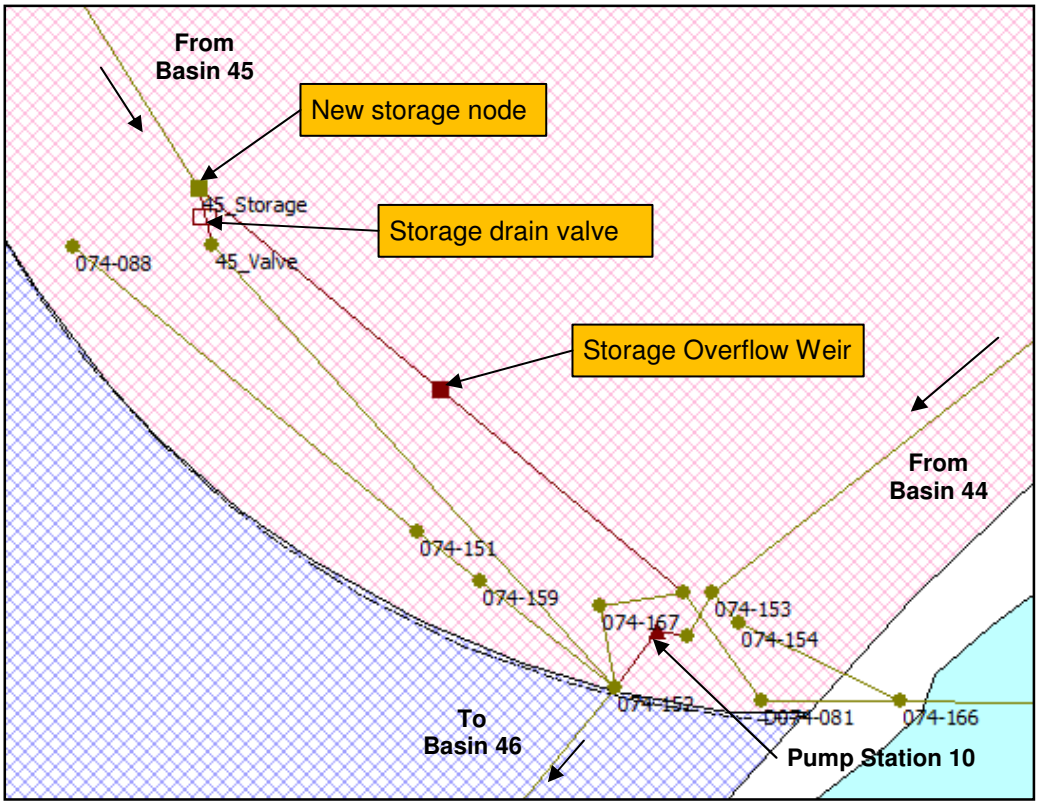

Figure 3-40: Model Configuration for Run 26.0 in Basin 45

Due to the complexity of this model run, the storage volume was determined in steps. The following steps describe the process used to determine the storage volume needed in Basin 45, in combination with storage in Basin 44 and Basin 46.

1. The storage volume in Basin 44, determined in Run 10.0, was reduced from 2.4 MG to 2.2 MG. The control volume for Basin 44 is 2.14 MG
2. The storage volume at Basin 45 was modeled as being equal to the control volume, 0.18 MG.
    - This storage volume produced 30 CSOs at Overflow Structure 45B and 0 CSOs at overflow structure 45A. CSOs were occurring at 45B due to the limited Henderson Lake line capacity between Basin 45 and Basin 46. Pump Station 10 and flow contributions from Basin 46 caused the Henderson Lake line to back up and overflow at Overflow Structure 45B.
3. In order to reduce the number of CSOs occurring at Overflow Structure 45B, the maximum flow rate from Pump Station 10 was reduced from 2.6 MGD to 1.8 MGD.
    - Because the maximum flow rate was reduced at Pump Station 10, the storage volume at Basin 44 was increased from 2.2 MG to 2.4 MG. Similarly, the storage volume at Basin 45 was increased from 0.18 MG to 0.20 MG.
4. The storage volume at Basin 46 was determined during Run 18.0 to be 0.35 MG. This storage was added to the model.

Table 3-18 shows the CSO frequency and volumes at Basin 44, Basin 45 and Basin 46 based on the model configuration for Run 26.0 and modifications made to Pump Station 10. The results of Run 26.0 meet the benchmark conditions for Basin 44, Basin 45 and Basin 46.

Table 3-18: CSO Results Comparison between Base Model and Run 26.0

Structure	Base Model		Run 26.0	
	CSO Events (No.)	CSO Volume (MG)	CSO Events (No.)	CSO Volume (MG)
Overflow Structure 44A	78	53.44	6	12.42
Overflow Structure 44B	24	1.85	0	0.00
Overflow Structure 45A	28	3.30	2	0.22
Overflow Structure 45B	22	1.34	4	1.21
Overflow Structure 46	34	5.98	5	2.09

Notes:

1. Additional storage volume at Basin 44 equals 2.4 MG.
2. Storage volume at Basin 45 equals 0.20 MG.
3. Storage volume at Basin 46 equals 0.35 MG.
4. Pump Station 10 maximum flow reduced from 2.4 MGD to 1.8 MGD due to the limited capacity of the Henderson lake line between Overflow Structure 45B and Pump Station 9.

3.3.13 Overflow Structure 47C Retrofit

The control volume for Basin 47N is approximately 150,000 gallons. Based on the result of the Base Model, all CSOs in Basin 47N occur at Overflow Structure 47C because no CSOs are predicted at Overflow Structure 47D or Overflow Structure 47E. Based on flow monitoring data and as-builts of the existing structure, it was observed that the existing storage capacity is not fully utilized. This was supported by the results of the Base Model run. Storage Facility 7 has approximately 320,000 gallons of storage based on the existing weir height.

3.3.13.1 Run 27.0: Overflow Structure 47C Retrofit

Run 27.0 was performed to optimize Storage Facility 7 to control Basin 47N. The weir located in MH 081-330 (Overflow Structure 47C) was raised by 1-foot to optimize Storage Facility 7. Figure 3-41 describes the modifications made to the Base Model to raise the weir.

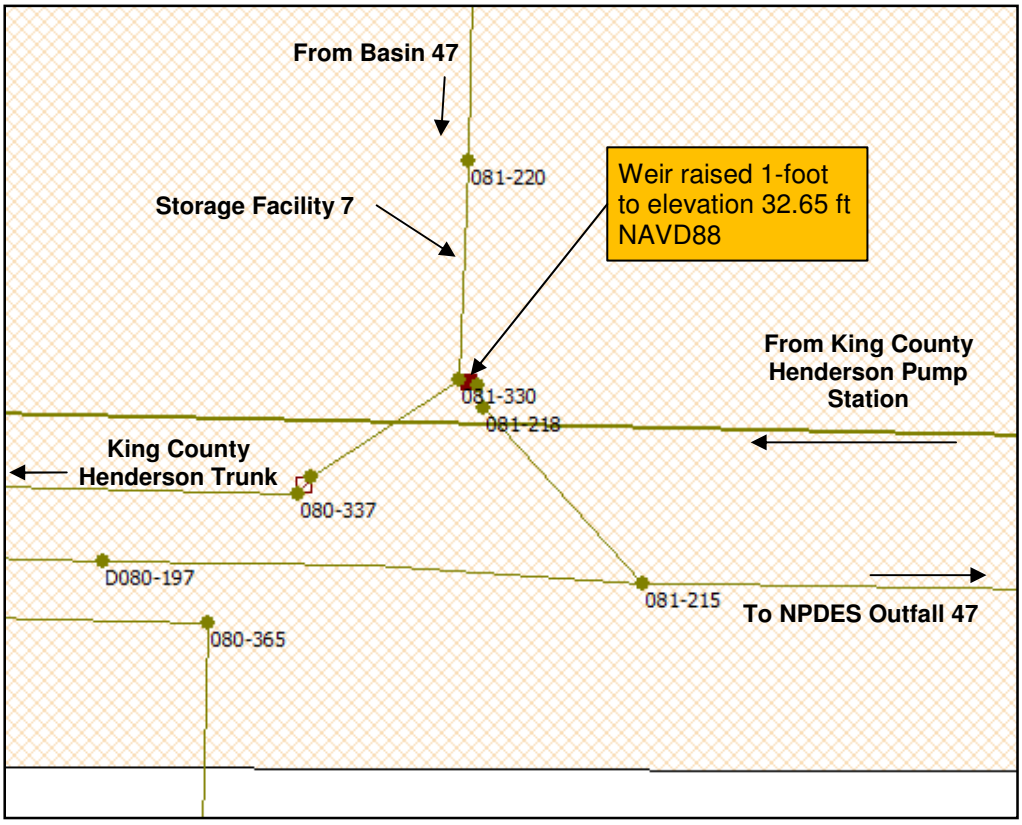

Figure 3-41: Model Configuration for Run 27.0 in Basin 47C

Raising the weir located in MH 081-220 by 1-foot reduced the number of overflows from 9 events to 5 events. This reduction is CSO events meets the benchmark for this structure and controls Basin 47N. The increased weir height does not indicate any surface flooding as shown in the hydraulic profile in Figure 3-42. However, the impact of the increased hydraulic grade line on side sewers connected directly to Storage Facility 7 and side sewers connected to adjacent sewers cannot be determined from the model.

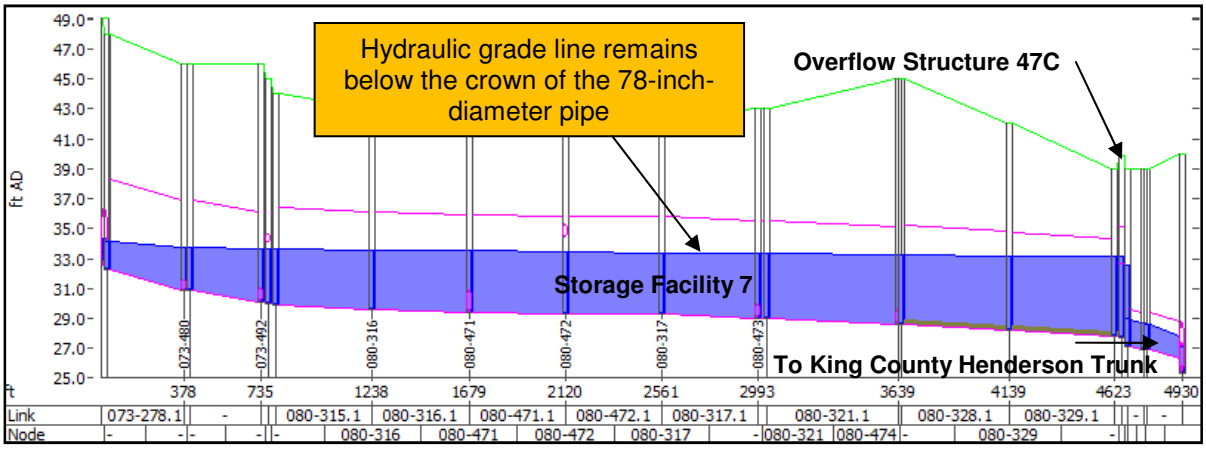

Figure 3-42: Maximum Hydraulic Profile of Storage Facility 7 for Run 27.0

4.0 Conclusion

The results from the hydraulic modeling runs described in this report provide information to proceed with the next phase of selecting and sizing alternatives to control CSOs within the Henderson Area. All runs evaluated in this phase met or exceeded the event benchmarks established for CSO control at each NPDES CSO Outfall.

The boundary condition on alternative design criteria was summarized in Section 3.1. The alternatives were checked to determine if they met the established criteria. All alternatives evaluated were able to meet Boundary Condition 3 and bring uncontrolled basins into control without increasing the overflow frequency of basins already in control.

For the runs that were performed that impacted flow to either the King County Henderson Pump Station or King County Henderson Trunk the increase in maximum flow was quantified. However, due to the process of dividing the overall Henderson Basin model into two separate networks, HEN_N and HEN_S, it was not possible to verify that Boundary Conditions 1 and 2 were met. As these different alternatives move forward, additional modeling will be performed on the full basin network to confirm these conditions are satisfied.

Results from all the model runs described in this report are summarized in Table 3-3.

5.0 Next Steps

The next step of alternatives development will involve identifying which runs or combination of runs will be further developed. A new phase of hydraulic modeling will take place for these selected solutions. This next phase of modeling will involve evaluating the individual selected runs or combination of runs using the full Henderson network and the full 31-year rainfall record. The goal of these new runs will be to refine system design and verify that the boundary conditions are met.

Specific analysis to be in the next phase of alternative development includes:

- Refine how Basin 49 storage is modeled to further optimize the size (improve discharge from flap gate).
- Refine transfer pump station wet well/pump rate combination for Run 13.0, common storage for Basin 44 and Basin 45.
- Refine how storage is modeled for Basin 46.

6.0 References

Henderson Combined Sewer Overflow Reduction Project – Henderson Hydrological and Hydraulic Modeling Report (CH2M HILL, 2010)

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Appendix A – Model Tracker

Henderson and Genesee CSO Reduction Projects
Henderson Area Model Tracker

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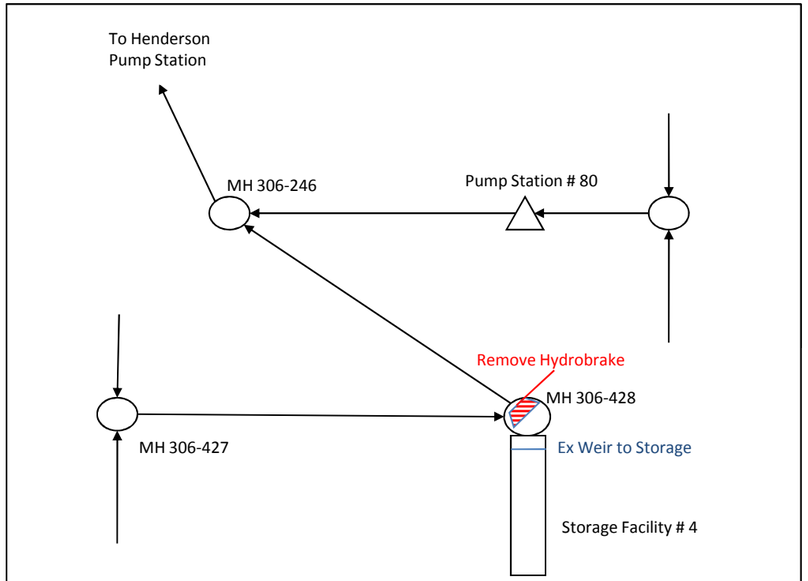
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
1.0	TKC-6-49	Remove the hydrobrake located in MH 306-428. Run the model to determine if removing the hydrobrake alone will reduce CSOs at NPDES 49. Quantify the increase in flowrate to the KC Henderson Pump Station. Quantify the reduction in overflows and overflow volume. Quantify the reduction in the Control Volume.	The purpose of this run is to determine if the existing conveyance capacity in the KC interceptor downstream of MH 306-246 can be increased to reduce overflows at NPDES 49.	12/30	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **1.0_Hen_S_Remove_49HB_2010.01.05**	**Modeling Performed By:** **Lisa Tamura** **Date:** **1/5/2010** **CSO Results** Basin 49 # of Overflows: **4** Overflow Volume Reduction: **6.06 MG** Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	1.0 Initial network build (changes from base Hen S): - Deleted node 306-428H - Deleted link 360-428H.1 (hydrobrake) - Reconnected link 306-428.1 to nodes 306-428 and 360-246 - Modified chamber floor at node 306-428 from 28.417 to 28.450 to match pipe inverts. **RESULTS:** Removal of hydrobrake increased the maximum flow in the KC line from 2.4 MGD to 3.9 MGD (link 306-428.1) . The model shows that the KC line is surcharged for a majority of distance from the Basin 49 storage structure to the Henderson PS. Flows to the Henderson PS from Basin 49 (link 081-350.1) increased from 2.5 MGD to 4.0 MGD.

Henderson and Genesee CSO Reduction Projects
Henderson Area Model Tracker

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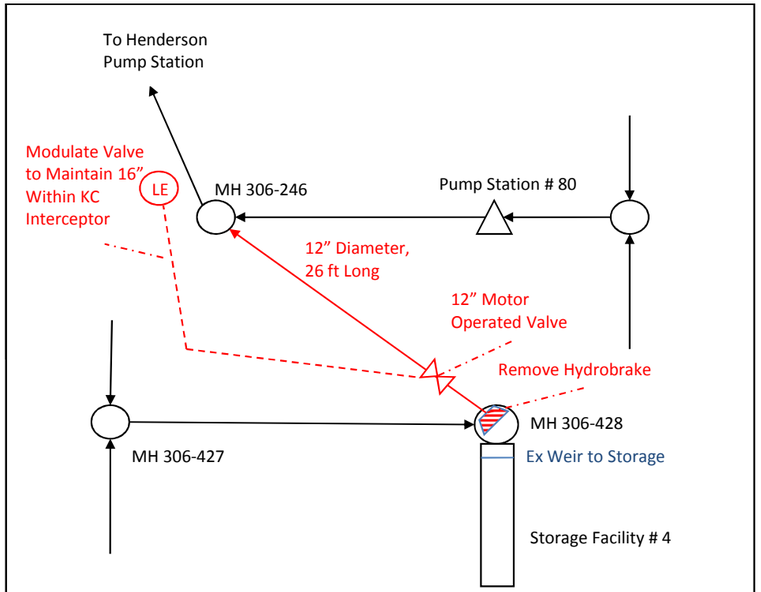
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details

2.0	TKC-6-49	Remove the hydrobrake located in MH 306-428.
		
		Place a motor-operated valve between MH 306-428 and MH 306-246. The valve should be controlled based on the level in the KC Interceptor downstream of MH 306-246. Modulate the valve to close completely when the interceptor contains 16" of depth. Quantify the increased discharge to the KC Henderson Pump Station. Quantify the reduction in overflows and overflow volume. Quantify the reduction in the Control Volume
			The purpose of this run is to determine if the existing conveyance capacity in the KC interceptor downstream of MH 306-246 can be increased to reduce overflows at NPDES 49. The gate is to provide the ability to regulate flows into the KC interceptor.	12/30	Network Built: **Y**
					Simulation Built: **Y**
					
					Statistical Results
					Model Run Complete: **Y**
					CSO Report Complete: **Y**
					
					File Management
					Network Archived:
					Results Archived:
					
					File Path:
					
					Results Path:
					
					SIM ID:
					
					Run Title:
					2.1_Hen_S_Remove_49HB_Add_valve_2010.01.08
						Modeling Performed By:
						Lisa Tamura
						Date:
						1/12/2009
						CSO Results
						Basin 49
						# of Overflows: **7**
						Overflow Volume Reduction: **4.31 MG**
						Control Volume Reduction:
						Available Capacity:
						Reserve Capacity:
						
						Boundary Conditions
						
						Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.**
						Boundary Condition 2 Met: **Y**
						Boundary Condition 3 Met: **Y**
							2.0 Initial network build (changes from base Hen S):
							- Renamed node 306-428H to 306-428V
							- Renamed link from 306-428H.1 to 360-428V.1 (pipe downstream from hydrobrake now downstream of valve).
							- Deleted link 306-428H.1 (hydrobrake)
							- Added sluice gate link (306-428.1)
							- Pipe information for 306-428V.1: Diameter = 12"; Length = 26 ft
							
							2.1 Adjusted inverts around MH 306-428 to match survey data
							- Added RTC group "2.1 RTC 49 Valve"
							- RTC Control:
							  - Set point at upstream end of 306-246.1
							  - Maximum depth set at 16 inches
							  - PID Controller timestep = 100 s
							  - PID controller: Proportional = -1.0; Integral = 0; Differential = 1.0
							
							RESULTS:
							# CSO events = 7 (allowed 10)
							Volume = 3.50 MG
							Max. Flow to KC (at link 081-350.1) = 2.9 MGD (up from 2.4 MGD)

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General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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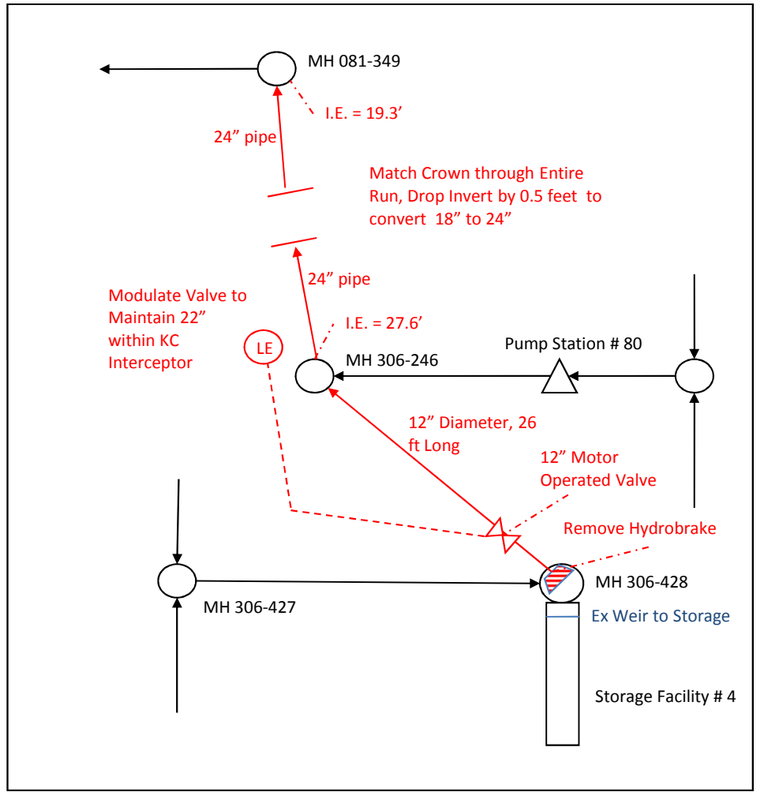
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
3.0	TM 6649	Remove the hydrobrake located in MH 306-428. Place a motor-operated valve between MH 306-428 and MH 306-246. The Gate should be controlled based on the level in the KC interceptor downstream of MH 306-246. Modulate valve to maintain 22" within KC interceptor. Increase the KC Interceptor from MH 306-428 to MH 081-349 from 18-inch diameter to 24-inch diameter. Match Crown of existing pipe. Quantify the increased flowrate to the KC Henderson Pump Station. Quantify the reduction in overflows and overflow volume. Quantify the reduction in the Control Volume.	The purpose of this run is to determine if the existing conveyance capacity in the KC interceptor downstream of MH 306-246 can be increased to reduce overflows at NPDES 49. The gate is to provide the ability to regulate flows into the increased KC interceptor. The flow to the Henderson Pump Station will be increased under this scenario.	12/30	Network Built: **Y** Simulation Built: **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Date:** **CSO Results** Basin 49 # of Overflows: Overflow Volume Reduction: Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	3.0 Initial network build (changes from base Hen S): - Started from network from Run 2.0 - Increased diameter of pipes: - From 081-092.1 to 081-246.1 from 18" to 24" - All inverts for above listed pipes dropped by 0.5 feet - Added RTC Group "3.0 RTC 49 Valve" - RTC Control: - Set point at upstream end of 306-246.1 - Maximum depth set at 22 inches - PID Controller timestep = 100 s - PID controller: Proportional = -0.875; Integral = 0; Differential = 120

ON HOLD

Results of Run 1.0 and Run 2.0 demonstrate the max. flow needed to bring Basin 49 into compliance. This model run is not necessary at this time.

Henderson and Genesee CSO Reduction Projects
Henderson Area Model Tracker

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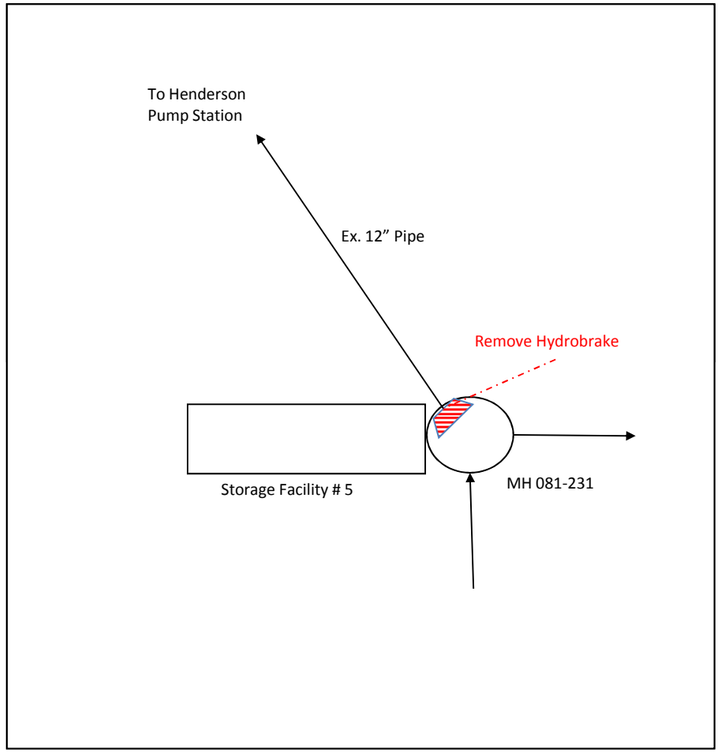
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
4.0	TKC-4-171	Remove the hydrobrake located in MH 081-231. Run the model to determine if removing the hydrobrake alone will provide a solution. Quantify the increased flowrate into the KC Henderson Pump Station. Quantify the increased flow to the Henderson Pump Station. Quantify the reduction in overflows and overflow volume. Quantify the reduction in the Control Volume. This network will later be combined with Storage in Basin 47S under Run 15.0	The purpose of this run is to determine if the existing conveyance capacity in the SPU pipe downstream of MH 081-231 can be increased to reduce overflows at NPDES 171 and NPDES 47.	1/5	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **4.0_HEN_S_Remove_171HB_2009.12.30**	**Modeling Performed By:** Steven Drangsholt **Date:** 12/30/2009 **CSO Results** Basin 47S # of Overflows: **7** Overflow Volume Reduction: **2.88 MG** Control Volume Reduction: Basin 171 # of Overflows: **8** Overflow Volume Reduction: **4.45 MG** Control Volume Reduction: Available Capacity: **N/A** Reserve Capacity: **Cannot Determine** **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	Hydrobrake was removed at 081-231 by removing node 081-231.H and link 081-231.H then link 081-231.1 was connected to node 081-230. The link definition for 081-231.1 is as follows: • 12-inch diameter • Upstream invert: 24.53 • Downstream Invert: 24.2 **Results:** The results show an increase in the HGL above the surface at node 081-229; this occurs 8 times in the 5 year period. Then 12 inch pipe appears to create the restriction, which causes the HGL to increase so dramatically. Max depth at link 081-231.1 increases from approximately 0.7ft to approximately 6 ft. Increased peak flowrate to KC is approximately 1.5 MGD (2.3 MGD minus 0.8 MGD) Removing the HB alone may cause flooding downstream of MH 081-231; this alternative is not adequate for reducing CSOs. Quantities in RESULTS box do not include flood frequency or volume. - # Overflow events 47S = 7; Volume = 2.19 MG - # Overflow events 171 = 8; Volume = 1.91 MG

Henderson and Genesee CSO Reduction Projects
Henderson Area Model Tracker

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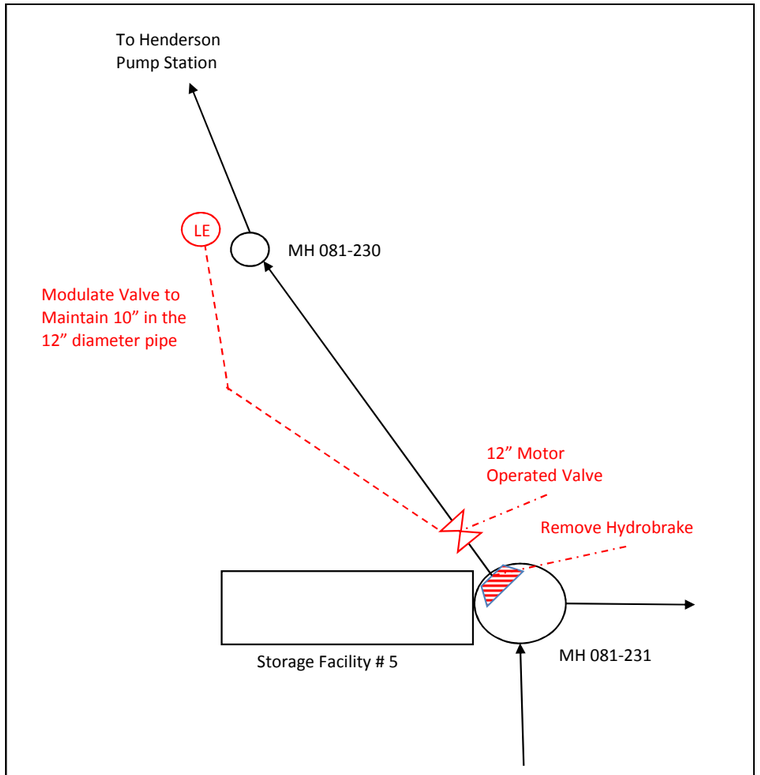
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
5.0	TKC-4-171	Remove the hydrobrake located in MH 081-231. Place a motor-operated valve between MH 081-231 and MH 081-330. The valve should be controlled based on the level in the SPU Pipe downstream of MH 081-330. Modulate the valve to close completely when the pipe is near full. Quantify the increased discharge to the KC Henderson Pump Station.	The purpose of this run is to determine if the existing conveyance capacity in the SPU pipe downstream of MH 081-231 can be increased to reduce overflows at NPDES 171 and NPDES 47. The gate will provide the ability to regulate flows into the KC Henderson Pump Station.	1/5	Network Built: Simulation Built: **Statisitical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SMP ID: Run Title:	**Modeling Performed By:** **Date:** **CSO Results** Basin 47S # of Overflows: Overflow Volume Reduction: Control Volume Reduction: Basin 171 # of Overflows: Overflow Volume Reduction: Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	*Describe how elements contained in the description were modeled. In particular, gates and pumps with controllers. Provide screenshots demonstrating the network set up. Provide graphs showing operation of modeled elements and validation of the boundary conditions. This documentation will occur in a Word file containing the same file name as the Network. The CSO Overflow Stats report will be contained in an excel file containing the same file name as the Run Title The information in the Results box can be modified if CSO results are not necessary.*

Removed

Results of Run 22.0 demonstrate the max flow needed to bring Basin 171 and Basin 47S into compliance. This model run is not necessary at this time and will be performed in conjuction with storage in Run 23.0.

Henderson and Genesee CSO Reduction Projects
Henderson Area Model Tracker

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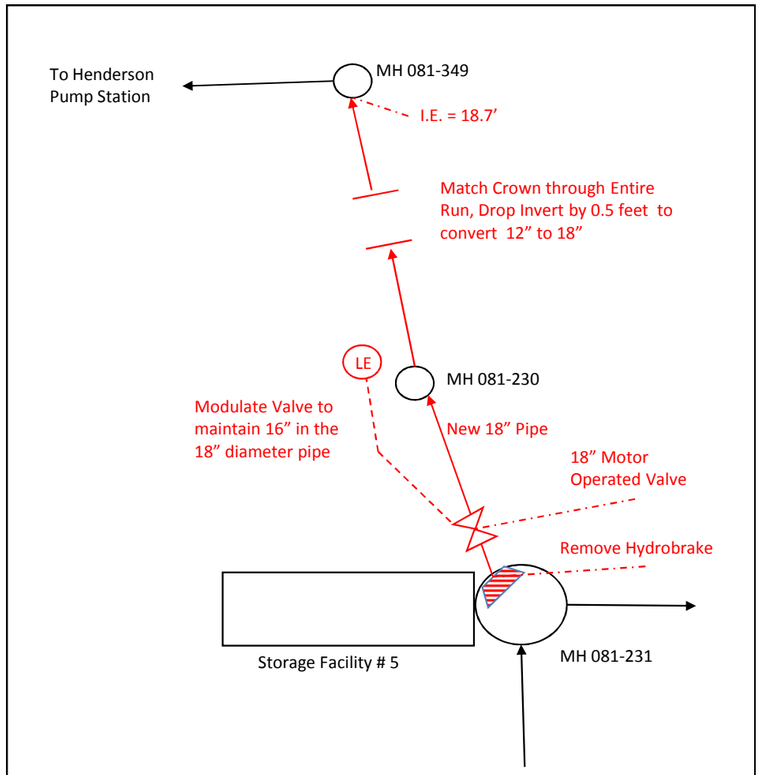
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
6.0	TKC-4-171	Remove the hydrobrake located in MH 081-231. Place a motor-operated valve between MH 081-231 and MH 081-230. The valve should be controlled based on the level in the SPU pipe downstream of MH 081-230. Modulate the valve to maintain 16" in the 18" diameter pipe. Quantify the increased discharge to the KC Henderson Pump Station. Increase the SPU Interceptor from MH 081-231 to MH 081-349 from 12-inch diameter to 18-inch diameter. Quantify the increased flowrate to the KC Henderson Pump Station. Quantify the reduction in overflows and overflow volume. Quantify the reduction in the Control Volume.	The purpose of this run is to determine if by increasing the existing conveyance capacity in the SPU pipe downstream of MH 081-231 overflows at NPDES 171 and NPDES 47 can be reduced and the boundary conditions met. The gate is to provide the ability to regulate flows into the KC Henderson Pump Station.	4/1/2010	Network Built: Simulation Built: **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Date:** **CSO Results** Basin 47S # of Overflows: Overflow Volume Reduction: Control Volume Reduction: Basin 171 # of Overflows: Overflow Volume Reduction: Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	*Describe how elements contained in the description were modeled. In particular, gates and pumps with controllers. Provide screenshots demonstrating the network set up. Provide graphs showing operation of modeled elements and validation of the boundary conditions. This documentation will occur in a Word file containing the same file name as the Network. The CSO Overflow Stats report will be contained in an excel file containing the same file name as the Run Title The information in the Results box can be modified if CSO results are not necessary.*

Removed

Results of Run 22.0 demonstrate the max. flow needed to bring Basin 171 and Basin 47S into compliance. This model run is not necessary.

Henderson and Genesee CSO Reduction Projects
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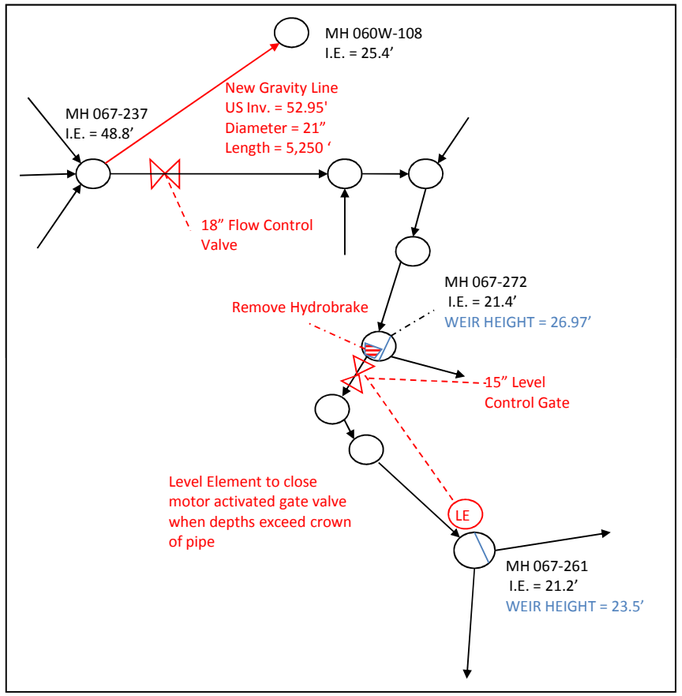
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
7.0	IBT-2-44 to 165	Remove the hydrobrake located at MH 067-272. At MH 067-237, add a motor-operated valve on the pipe headed east. The valve should be controlled by the level in the pipe downstream of MH 067-261. Modulate the valve to close completely when the pipe is near full. Place a 21" pipe from MH 067-237 to MH 060W-108. Quantify the increased discharge to the Genesee Area. Details for this pipe are shown on the schematic.	The purpose of this run is to determine if by transferring flows from Basin 44 (Henderson) to Basin 165 (Genesee) the CSOs at Basin 44 and 45 can be reduced.	1/6	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Lisa Tamura** **Date: 1/18/2009** **CSO Results** <u>Basin 44</u> # of Overflows: Overflow Volume Reduction: <u>Basin 45</u> # of Overflows: Overflow Volume Reduction: <u>Basin 46</u> # of Overflows: Overflow Volume Reduction: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	7.0 Initial network build (changes from base Hen N): - Added nodes 067-237V, To_Genesee - Added link 067-237.2 (overflow pipe to Genesee) as 24" pipe with US Inv = 52.95 (highest crown of incoming pipes); DS Inv = 25.4 (invert at MH 060W-108) - Added orifice link 067-237.3 – Flow control setting to be determined - Reconnected link 067-237V.1 to US MH 067-237V (instead of 067-237) - Deleted hydrobrake link 067-272.1 - Added sluice link 067-272.1. Positive gate speed = 0.25 ft/s; Negative gate speed = 1.5 ft/s - Added PID controller to limit flow depth to 15 inches (crown of pipe downstream of 44B - 067-261.1). Initial settings: P = -0.5; I = 0.0; D = 10 7.1 Added flow control setting to orifice 067-237.3. Varied setting to evaluate results. 7.2 Set orifice to very small flow setting (0.01 MGD) to simulate all flow being diverted to Genesee. **<u>RESULTS 2002-2008 (preliminary):</u>** - Gate modulates such that depth downstream of 44B does not exceed 15 inches (crown of pipe). - Flow setting at orifice set to 0.01 MGD (all flow from Juneau diverted to Genesee). - Overflow pipe to Genesee 30 inches in diameter - **44A: # of overflows = 15**; Vol. of overflow = 8.07 MG - 44B: # of overflows = 0; Vol. of overflow = 0 MG - 45A: # of overflows = 17; Vol. of overflow = 1.88 MG - 45B: # of overflows = 16; Vol. of overflow = 1.14 MG - 46: # of overflows = 26; Vol. of overflow = 5.09 MG - 47C: # of overflow = 9; Vol. of overflow = 13.30 MG

General Assumptions

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- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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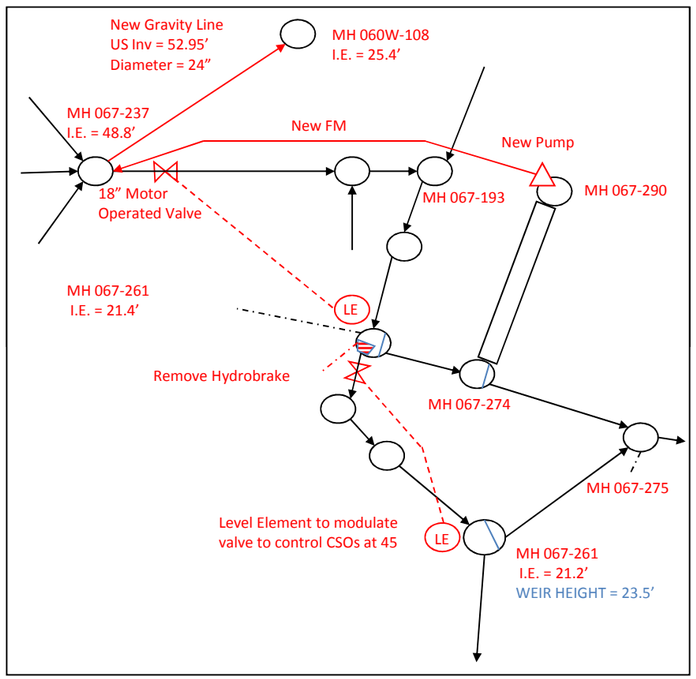

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
7.3	IBT-2-44 to 165	Remove the hydrobrake located at MH 067-272. At MH 067-237, add a motor-operated valve on the pipe headed east. The valve should be controlled by the level in the pipe downstream of MH 067-261. Modulate the valve to close completely when the pipe is near full. Place a 21" pipe from MH 067-237 to MH 060W-108. Quantify the increased discharge to the Genesee Area. Details for this pipe are shown on the schematic.	The purpose of this run is to determine if by transferring flows from Basin 44 (Henderson) to Basin 165 (Genesee) the CSOs at Basin 44 and 45 can be reduced.	1/6	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **7.4_Hen_N_Transfer_to_Genesee_+FCV-Pump_2010.01.29**	**Modeling Performed By:** **Lisa Tamura** **Date: 1/30/2009** **CSO Results** Basin 44 # of Overflows: **6 / 0 (44A / 44B)** Overflow Volume Reduction: **51.0 MG / 1.85 MG (44A / 44B)** Basin 45 # of Overflows: **5 / 6 (45A / 45B)** Overflow Volume Reduction: **2.51 MG / 0.75 MG (45A / 45B)** Basin 46 # of Overflows: **16** Overflow Volume Reduction: **2.96 MG** **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	7.3 Initial network build (changes from Run 7.0) - Flow control valve at Juneau converted to gate. - Gate open when HGL at node 067-272 < 24 ft AD - Gate closed when HGL at node 067-272 > 26 ft AD - Added pump at end of 44 Storage to pump flow to node 067-237 - Pump on when HGL in storage 22.2 ft AD (invert of upper end of storage pipe) - Pump off when storage is empty 7.4 Modulate gate to control overflows at 45 - Modulating gate at node 067-272 controlled to 0.55 ft **RESULTS - Run 7.3 (Control only 44)** Pump rate out of 44 storage = 1.2 MGD - # Overflows 44A = 6 (no overflows at 44B); Volume = 3.08 MG - # Overflows 45A = 18: Volume = 1.82 MG - # Overflows 45B = 15; Volume = 1.07 MG - # Overflows 46 = 33; Volume = 5.55 MG - # Overflows 47C = 9; Volume 13.28 MG **RESULTS - Run 7.4 (Control 44 & 45)** Pump rate out of 44 storage = 2.0 MGD - # Overflows 44A = 6 (no overflows at 44B); Volume = 2.40 MG - # Overflows 45A = 5: Volume = 0.79 MG - # Overflows 45B = 6; Volume = 0.59 MG - # Overflows 46 = 16; Volume = 3.02 MG - # Overflows 47C = 9; Volume 13.28 MG Time series for Genesee genereted from this run resulted in excessive volumes. **TIME SERES FOR GENESEE DERIVED FROM PUMPED FLOW IN RUN 13.0**

Henderson and Genesee CSO Reduction Projects
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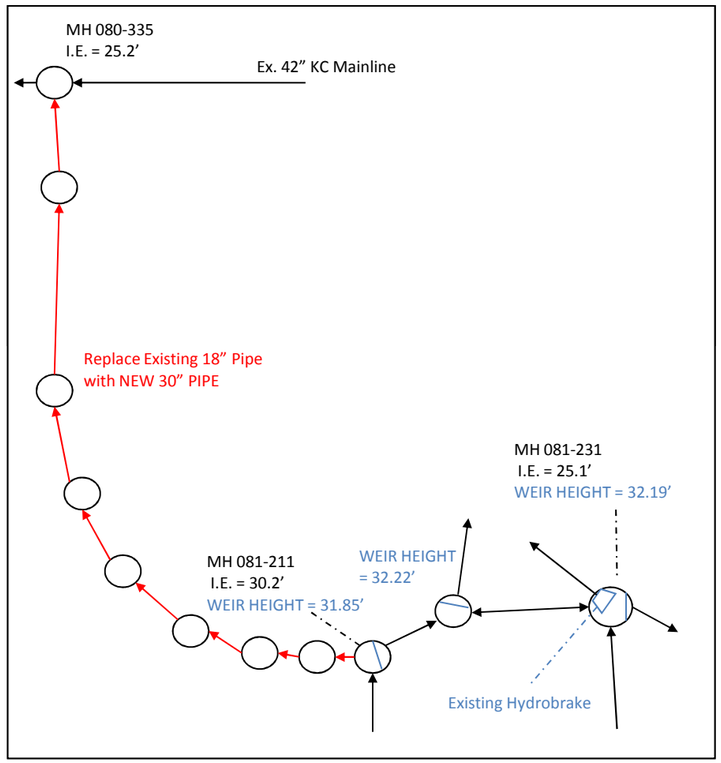
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
8.0	TKC-7-47S	Increase the conduit size from MH 081-211 to MH 080-335 from an 18-inch pipe to a 30-inch pipe. Match crown of the existing pipe. Quantify the increased peak flow to the Henderson trunk.	The purpose of this run is to determine if by increasing the existing conveyance capacity from Basin 47B and 171, overflows at both outfalls can be reduced to meet requirements.	1/6	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **8.1_Hen_S_Upsize_Ex_18in_to_30in_47S_2010.01.05**	**Modeling Performed By:** **Lisa Tamura** **Date: 1/5/2010** **CSO Results** Basin 47S # of Overflows: **1** Overflow Volume Reduction: **4.99 MG** Control Volume Reduction: Basin 171 # of Overflows: **5** Overflow Volume Reduction: **5.49 MG** Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 3 Met: **Y**	8.0 Initial network build (changes from base Hen S): - Deleted 081-211.1 (orifice) - Deleted node 081-211O - Renamed link 081-211O.2 to 081-211.3 (connected between node 081-211 and node 081-122) - Changed diameter for links 081-211.3, 081-122.1, 081-121.1, 080-361.1, 080-360.1, 080-359.1, 080-358.1 and 080-357.1 to 30 in from 18 in - Changed diameter for link 081.120.2 to 30 in from 17.6 in - Subtracted 0.5 ft from inverts (both US & DS) for links 081-211.1, 081-122.1, 081-120.2, 080-361.1, 080-360.1, 080-359.1, 080-358.1, 080-357.1 8.1 Adjusted inverts so crowns match for upsized pipes: - Subtracted 0.5 ft from inverts (both US & DS) for links 081-211.1, 081-122.1, 081-120.2, 080-361.1, 080-360.1, 080-359.1, 080-358.1, 080-357.1 **RESULTS:** Increasing pipe size enabled more flow to enter the Henderson Trunk from Basin 47S. Overflows events at both 47B and 171 were reduced as more flow is diverted to the Henderson Trunk and away from storage. Peak flows (Dec. 3-4, 2007) into the Henderson Trunk from 47S increased from 3.2 MGD to 8.3 MGD (link 080-357.1).

Henderson and Genesee CSO Reduction Projects
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General Assumptions

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- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
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     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
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Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
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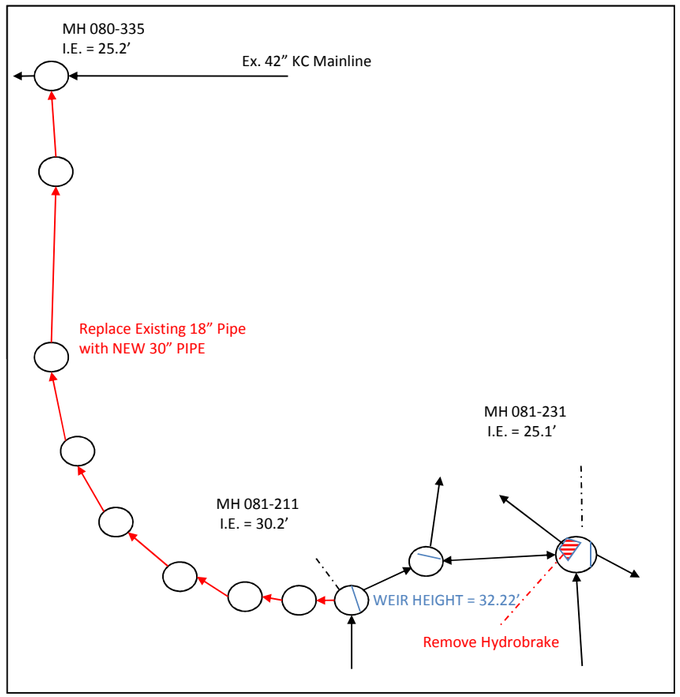

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
9.0	TKC-7-47S	Increase the conduit size from MH 081-211 to MH 080-335 from an 18-inch pipe to a 30-inch pipe. Match crown of the existing pipe. Remove the hydrobrake located in MH 081-231. Quantify the increased peak flowrate to the Henderson Pump Station (from this Basin only). Quantify the increased peak flow to the Henderson trunk.	The purpose of this run is to determine if by increasing the existing conveyance capacity from Basin 47B and 171 and removing the hydrobrake in Storage Facility #5, overflows at both outfalls can be reduced to meet requirements.	1/7	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **9.1_Hen_S_Upsize_Ex_18in_to_30in_Remove_171HB_2010.01.0**5	**Modeling Performed By:** **Lisa Tamura** **Date: 1/5/2010** **CSO Results** Basin 47S # of Overflows: **0** Overflow Volume Reduction: **5.07 MG** Control Volume Reduction: Basin 171 # of Overflows: **2** Overflow Volume Reduction: **6.15 MG** Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 2 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 3 Met: **Y**	9.0 Initial network build (changes from base Hen S): - Deleted 081-211.1 (orifice) - Deleted node 081-211O - Renamed link 081-211O.2 to 081-211.3 (connected between node 081-211 and node 081-122) - Deleted 081-231.1 (Hydrobrake) - Deleted node 081-231H - Renamed link 081-231H.1 to 081-231.1 (connected between node 081-231 and node 081-230) - Changed diameter for links 081-211.3, 081-122.1, 081-121.1, 080-361.1, 080-360.1, 080-359.1, 080-358.1 and 080-357.1 to 30 in from 18 in - Changed diameter for link 081.120.2 to 30 in from 17.6 in - Subtracted 0.5 ft from inverts (both US & DS) for links 081-211.1, 081-122.1, 081-120.2, 080-361.1, 080-360.1, 080-359.1, 080-358.1, 080-357.1 9.1 Adjusted inverts so crowns match for upsized pipes: - Subtracted 0.5 ft from inverts (both US & DS) for links 081-211.1, 081-122.1, 081-120.2, 080-361.1, 080-360.1, 080-359.1, 080-358.1, 080-357.1 **RESULTS:** Increasing pipe size enabled more flow to enter the Henderson Trunk from Basin 47S. Overflows events at both 47B and 171 were reduced as more flow is diverted to the Henderson Trunk and away from storage. Peak flows (Dec 3-4, 2007) into the Henderson Trunk from 47S increased from 3.2 MGD to 7.9 MGD. Peak flows to the Henderson Pump Station from Basin 171 increased from 0.88 MGD to 2.41 MGD. However, pipe is surcharged above crown.

Henderson and Genesee CSO Reduction Projects
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General Assumptions

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     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
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Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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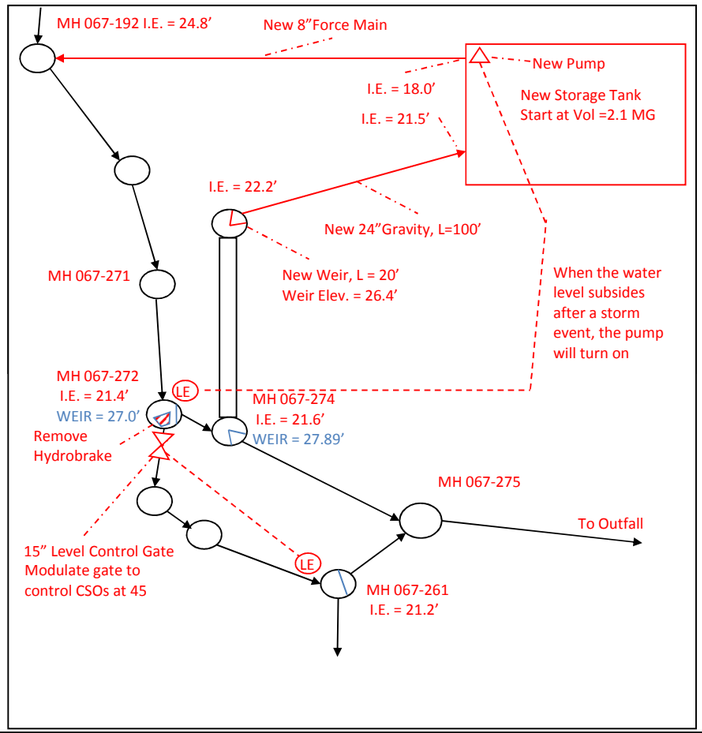

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
10.0	OFF-2-44	Determine the storage volume required to bring both Basin 44 and Basin 45 into compliance. A detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a volume of 2.1 MG. Increase storage in 0.1 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/7	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y (44 storage only)** CSO Report Complete: **Y (44 storage only)** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **10.0_Hen_N_44_Storage_2010.02.10**	**Modeling Performed By:** **Lisa Tamura** **Date: 2/10/2010** **CSO Results** Basin 44 # of Overflows: **6** Overflow Volume Reduction: **43.0 MG** Basin 45 # of Overflows: **18 / 14 (45A / 45B)** Overflow Volume Reduction: Basin 46 # of Overflows: **32** Overflow Volume Reduction: **Only Basin 44 brought into compliance** **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	10.0 Initial network build (created from base Hen N): - Added nodes 067-MH1, 067-Storage (new storage tank with depth of 10' – area variable) - Added links 067-MH1.1 (Diameter = 24"; Length = 100'; DS Invert = 21.5), 067-290.2 (new weir) - Added links 067-Storage.1, 067-Storage.2, 067-Storage.3 (pumps to empty new storage tank) - Redefined link 067-272.1 from hydrobrake to modulating sluice gate 10.1 Modulate gate downstream to control overflows at 45. Increase storage at 44. 10.0a Single pump to drain 44 Storage; adjusted RTC controls. **RESULTS - Run 10.0 -** Level controled to 15.0 inches - Volume needed to only control Basin = 2.3 MG - # Overflows @ 44A = 6 (no overflows at 44B); Volume = 12.25 MG - # Overflows @ 45A = 18; Volume = 1.74 MG - # Overflows @ 45B = 14; Volume = 1.02 MG - **# Overflows @ 46 = 32; Volume = 5.48 MG** - # Overflows @ 47C = 7; Volume = 13.43 **RESULTS - Run 10.1 (Preliminary):** - Last run with storage at 3.5 MG; Level controled to 6.6 inches - # Overflows @ 44A = 20 (no overflows at 44B); Volume = 50.21 MG - # Overflows @ 45A = 5; Volume = 0.77 MG - # Overflows @ 45B = 6; Volume = 0.57 MG - # Overflows @ 46 = 15; Volume = 2.92 MG - # Overflows @ 47C = 7; Volume = 13.43 Combined storage sizing impacted by limitations at 45 (PS 10 and basin flows being re-routed upstream of PS 10)

Henderson and Genesee CSO Reduction Projects
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     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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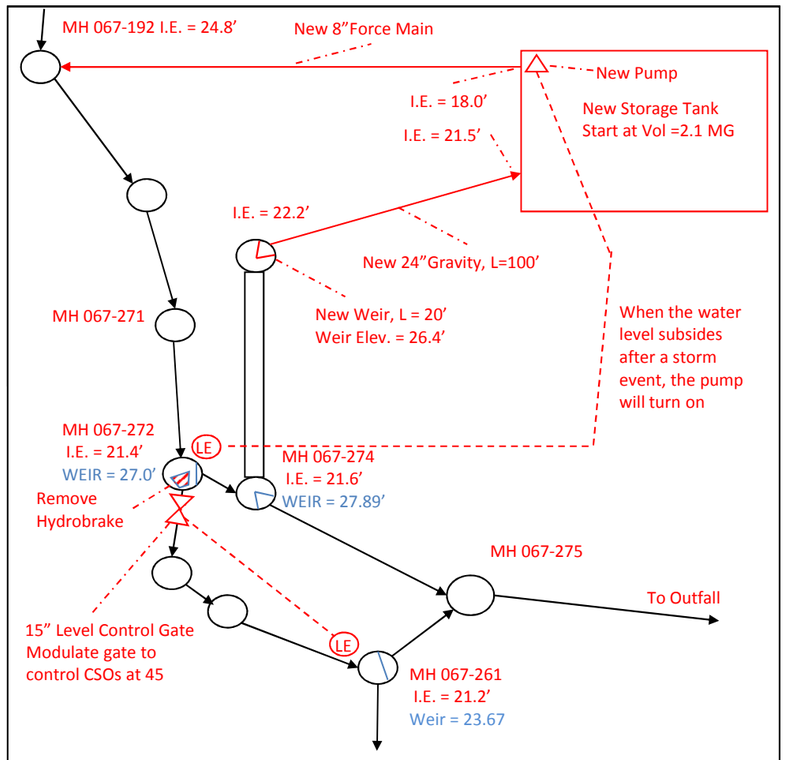

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
11.0	OFF-2-44	Determine the storage volume required to bring Basin 44, Basin 45 and Basin 46 into compliance. Update detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a storage volume of previous size. Increase storage in 0.1 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/12	Network Built: **Y** Simulation Built: **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Date:** **CSO Results** Basin 44 # of Overflows: Overflow Volume Reduction: Basin 45 # of Overflows: Overflow Volume Reduction: Basin 46 # of Overflows: Overflow Volume Reduction: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	*Describe how elements contained in the description were modeled. In particular, gates and pumps with controllers. Provide screenshots demonstrating the network set up. Provide graphs showing operation of modeled elements and validation of the boundary conditions. This documentation will occur in a Word file containing the same file name as the Network. The CSO Overflow Stats report will be contained in an excel file containing the same file name as the Run Title The information in the Results box can be modified if CSO results are not necessary.*

Removed

Results of Run 10.0 demonstrate that distributed storage needed to bring three basins into compliance.

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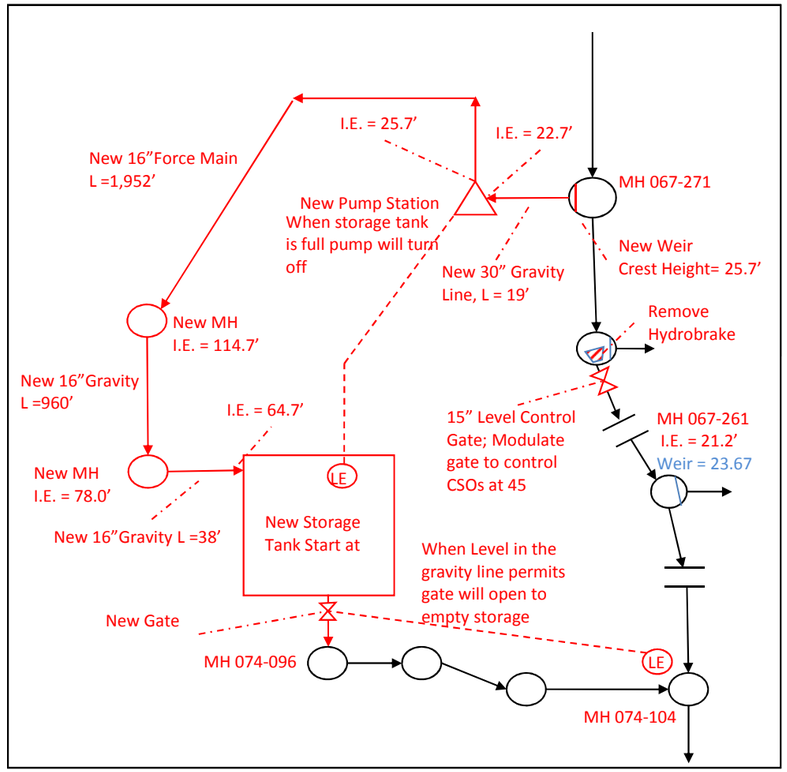

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
12.0	CON-1-44 and OFF-3-45	Determine the storage volume required to bring both Basin 44 and Basin 45 into compliance. A detailed schematic has been provided including MH to remove pipes to be removed and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a volume of 2.1 MG. Increase storage in 0.1 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/12	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Lisa Tamura** **Date: 2/3/2010** **CSO Results** Basin 44 # of Overflows: Overflow Volume Reduction: Basin 45 # of Overflows: Overflow Volume Reduction: Basin 46 # of Overflows: Overflow Volume Reduction: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	12.0 Initial network build (created from base Hen N): - Added nodes 067-271PS, 067-271W, 074-MH1, 074-MH2, 45_Storage - Added links 067-271PS.1, 074-MH1.1, 074-MH2.1, 067-271W.2 (new pump station), 45_Storage.1 (storage pump), 067-271.2 (new weir) - Added RTC Group "12.0 Pump Controls" - Pump Station (067-271W.2) - Pump on when depth at storage (45_Storage) less than 25 ft - Pump off when depth at storage (45_Storage) greater than 30 ft - Storage Pump (45_Storage.1) - Pump on when depth at upstream end of 074-104.1 less than 12 inches - Pump off when depth at upstream end of 074-104.1 greater than 12 inches

Removed

Similar to Run 13.0. Run 26.0 shows storage must discharge downstream of PS 10.

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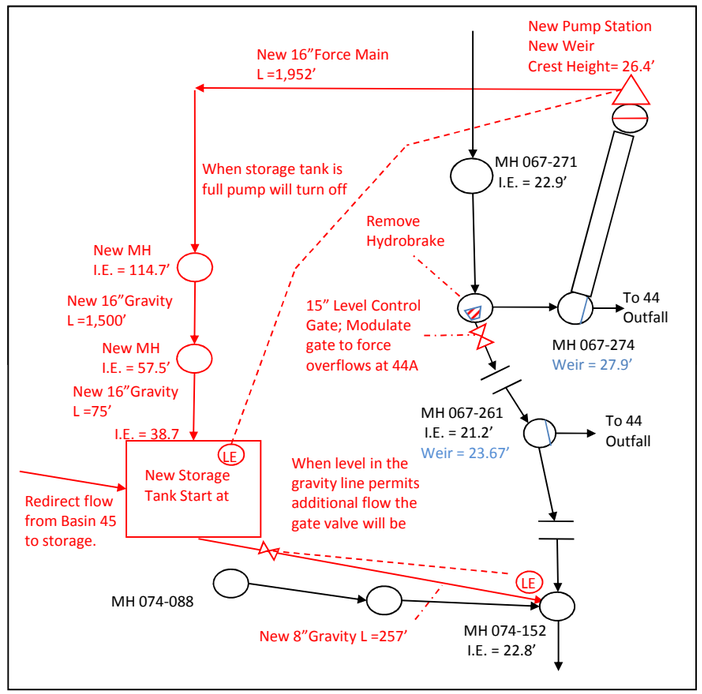
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
13.0	CON-1-44 and OFF-3-45	Determine the storage volume required to bring Basin 44 and Basin 45 into compliance. A detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a storage volume of previous size. Increase storage in 0.1 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/12	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **13.0_Hen_N_44-45_Storage_2010.02.17**	**Modeling Performed By:** **Lisa Tamura** **Date: 2/17/2010** **CSO Results** Basin 44 # of Overflows: **6** Overflow Volume Reduction: **43.77 MG** Basin 45 # of Overflows: **5** Overflow Volume Reduction: **3.48 MG** **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	13.0 Initial network build (created from base Hen N): - Added nodes 067-PSWW (new storage facility with volume of 0.1 MG), 067-PumpStation, 067-290.2 (weir), 074-MH1, 074-MH2, 45_Valve, 45_Storage (new storage facility 20 ft deep – variable area), 45_Storage.2 (overflow weir) - Deleted nodes 074-158, 074-159H, 074-159W - Adjusted invert at 074-159 to 24.2 ft (was 24.257 ft) - Added conduits 067-PumpStation.1, 067-PSWW.1 (new pump to transfer flow from 44 to 45), 074-159.2, 074-MH1.1, 074-MH2.1, 45_Valve.1, 45_Storage.1 (drain for storage tank in 45) - Deleted conduits 074-158.1, 074-159H.2, 074-159W.1, 074-159.1 (Hydrobrake), 074-159.3 (weir), 074-159H.3 (weir) - Replaced Hydrobrake at 067-272.1 with sluice gate - Reduced capacity of PS10 (074-156.1) **RESULTS:** - Modulating gate in 44 set to control depth at 44B to 15 inches - Wet well in 44 = 0.10 MG; Max pump rate = 5.3 MGD - PS10 max pump rate = 1.8 MGD - 44 transfer pumps limited to 2.4 MG (pumps turn off when tank at 45 reaches 2.4 MG) - Storage tank at 45 volume = 2.6 MG - # Overflows 44A = 6 (Vol = 11.48 MG); no overflows at 44B - # Overflows 45A = 2 (Vol = 0.22 MG) - # Overflows 45B = 4 (Vol = 0.88 MG) - # Overflows 45 = 5 (Vol = 1.16 MG) - # Overflows 46 = 30 (Vol = 5.89 MG) - # Overflows 47C = 7 (Vol = 13.43 MG)

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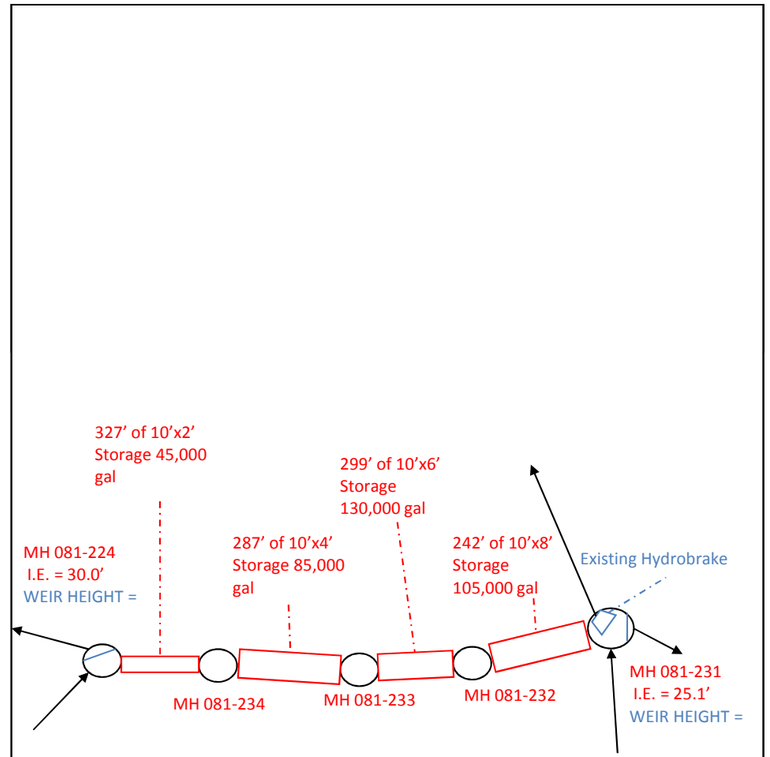
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
14.0	OFF-9-47S	Determine the storage volume required to bring both Basin 47S and Basin 171 into compliance while keeping the existing hydrobrake in MH 081-231 in place. A detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a storage volume of .20 MG. Increase storage in 0.05 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/11	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **14.0_Hen_S_Size_Storage_47B_and_171**	**Modeling Performed By:** **Paige Igoe** **Date: 2/3/2010** **CSO Results** Basin 47S # of Overflows: **9** Overflow Volume Reduction: **1.54 MG** Basin 171 # of Overflows: **9** Overflow Volume Reduction: **1.95 MG** Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	**MODEL BUILD:** 14.0 Initial network build (start with Base Hen S). **Schematic above was simplified. Individual pipes were not upsized, rather a storage node was added and simulations were conducted to size appropriately. --Added a storage node named '081-Storage 1'. Connect to Manhole 081-MH1. --Conduit added to connect new storage node with existing manhole. Conduit named '081-MH1.1'. --Conduit is 20 feet in length, 15 inches diameter, upstream invert 29 feet and downstream invert 29.1 feet. --Conduit definition - upstream node: 081-MH1 and downstream node: 081-Storage1. --Enter the bottom and top elevation of tank and plan area of tank in sq ft. --Storage node: top level set to match weir 081-231.3 (32.19 ft) and bottom is the same as the adjacent manhole bottom (081-MH1). **RESULTS:** --Conducted several runs and several sizes meet crtieria of allowing 9 events at outfal 171 and outfall 47B. --Smallest size to meet criteria: 230,000 gallons (Vol 47B = 3.53 MG; Vol 171 = 4.41 MG)

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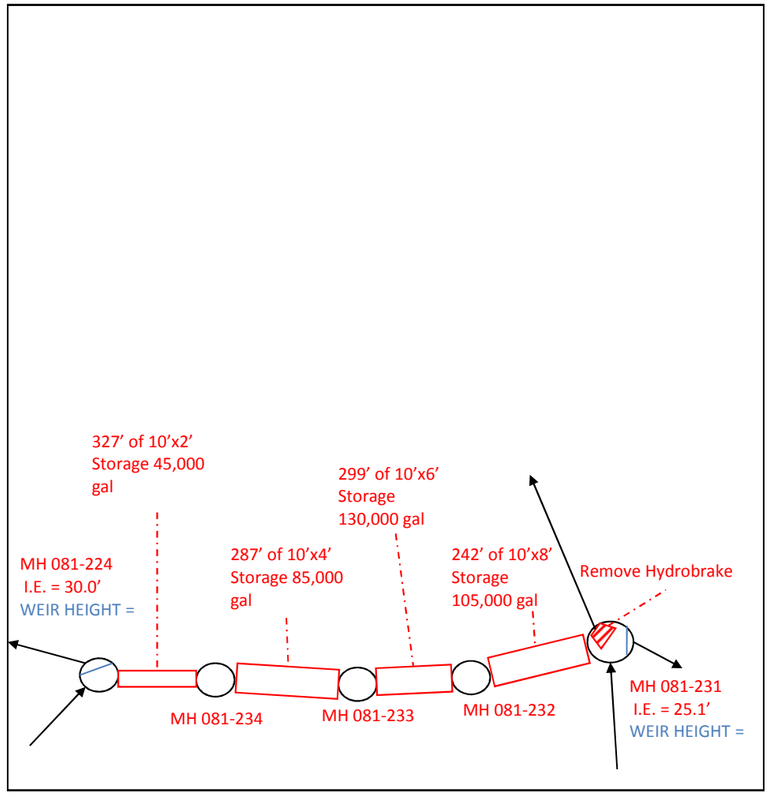
General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (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 44A	416	2.07	8.16	78	53.5	6
Overflow Structure 44B	123	0.07	0.87	23	2.06	7
Overflow Structure 45A	169	0.13	1.77	28	3.38	6
Overflow Structure 45B	107	0.05	0.60	20	1.44	7
Overflow Structure 46	206	0.26	1.33	16	6.03	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	120	0.11	1.90	10	5.14	8
Overflow Structure 171	127	0.15	2.40	27	6.40	8
Overflow Structure 49	50	0.18	2.40	18	7.88	11

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
15.0	OFF-9-47S and TKC-4-171	Determine the storage volume required to bring both Basin 47S and Basin 171 into compliance with removing the existing hydrobrake in MH 081-231. A detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a storage volume of 0.20 MG. Increase/decrease storage volume in 0.05 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/11	Network Built: Simulation Built: **Statisitical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Date:** **CSO Results** Basin 47S # of Overflows: Overflow Volume Reduction: Basin 171 # of Overflows: Overflow Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	*Describe how elements contained in the description were modeled. In particular, gates and pumps with controllers. Provide screenshots demonstrating the network set up. Provide graphs showing operation of modeled elements and validation of the boundary conditions. This documentation will occur in a Word file containing the same file name as the Network. The CSO Overflow Stats report will be contained in an excel file containing the same file name as the Run Title The information in the Results box can be modified if CSO results are not necessary.*

Removed

Removing the hydrobrake without replacing some kind of control device will cause surcharge in the 12-inch pipe downstream. Runs 14.0 and 23.0 cover the conditions

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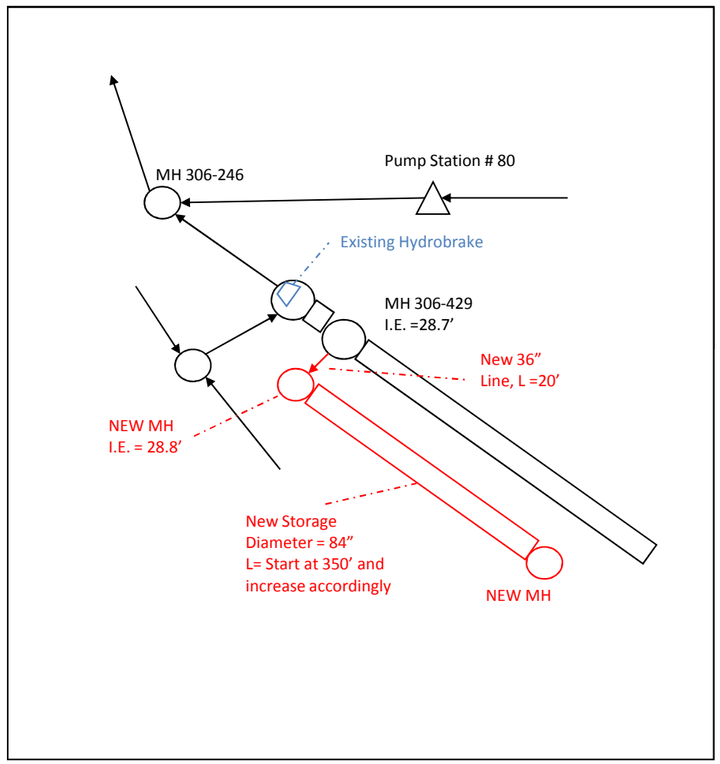
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd



Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
16.0	OFF-6-49	Determine the storage volume required to bring Basin 49 into compliance while keeping the existing hydrobrake in MH 306-428 in place. A detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a storage volume of .15 MG. Increase/decrease storage volume in 0.025 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/15	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **16.1_Hen_S_Size_Storage_49**	**Modeling Performed By:** **Paige Igoe** **Date: 2/3/2020** **CSO Results** Basin 49 # of Overflows: **10** Overflow Volume Reduction: **2.39 MG** Control Volume Reduction: **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	**MODEL BUILD:** 16.1 Initial network build (start with Base Hen S). **Schematic above was simplified. A new pipe was not added for additional storage, rather a storage node was added and simulations were conducted to size appropriately. --Added a storage node named '306-MH1'. Connect to Manhole 306-429. --Conduit added to connect new storage node with existing manhole. Conduit named '306-429.2'. --Conduit is 20 feet in length, 36 inches diameter, upstream invert 28.7 feet and downstream invert 28.7 feet. --Conduit definition - upstream node: 306-429 and downstream node: 306-MH1. --Enter the bottom and top elevation of tank and plan area of tank in sq ft. --Storage node: top level set to match weir 306.437.2 (36.61 ft) and bottom is same as the adjacent manhole bottom (306-429). **RESULTS:** --Conducted several runs and several sizes meet crtieria of allowing 10 events at outfall 49. --Smallest size to meet criteria: 290,000 gallons (CSO volume = 5.42 MG)

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General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
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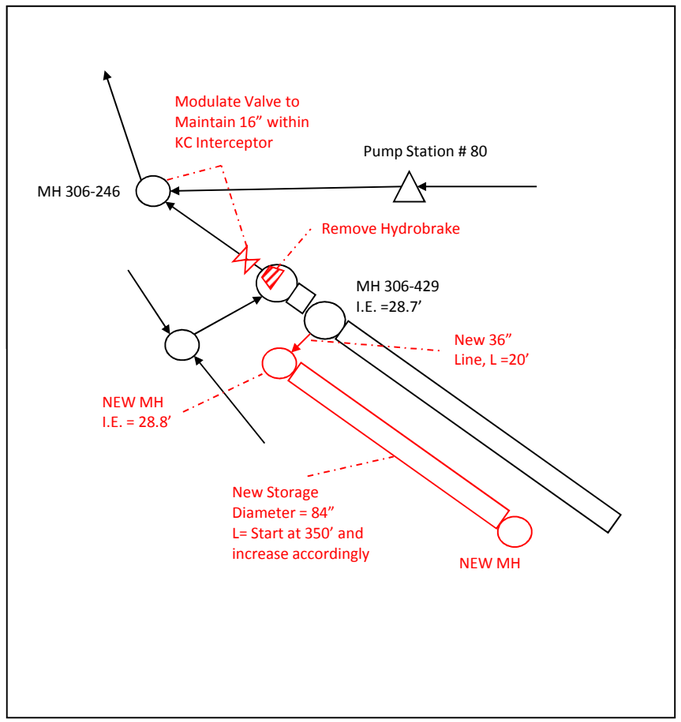

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
17.0	OFF-6-49 and TKC-6-49	Determine the storage volume required to bring Basin 49 into compliance. Remove the hydrobrake located in MH 306-428. Place a motor-operated valve between MH 306-428 and MH 306-246. The Gate should be controlled based on the level in the KC Interceptor downstream of MH 306-246. Modulate the valve to match current peak flows. Use Gate from Run 2.0 Storage volume should be increased as required to reduce overflows. Begin the storage volume determined in Run 16.0. Increase/decrease storage volume in 0.025 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/15	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **17.0_Hen_S_Remove_49HB_Add_Valve+Storage_2010.02.24**	**Modeling Performed By:** **Lisa Tamura** **Date: 2/24/2010** **CSO Results** Basin 49 # of Overflows: **10** Overflow Volume Reduction: **2.26 MG** Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	**MODEL BUILD:** 17.0 Initial network build (changes from base Hen S): - Added nodes 306-428V, 306-MH1 - Deleted nodes 306-428H - Modified invert of node 306-428 to 28.32 (from 28.417) - Added conduits 306-428V.1, 306-429.2 - Deleted conduits 306-428H.1 - Modified DS invert of 306-427.1 to 28.32 (from 28.59) - Converted 306-428.1 HydroBrake to sluice gate - Added RTC Control, "17.0 Flow Control to KC": - PID controller: P = -2.25; I = 0; D = 1 - Gate modulates to maintain maximum flow of 2.4 MGD in 306-246.1 (peak flow in base model **RESULTS:** - Flow to KC controled to not exceed 2.4 MGD (current peak) - Additional storage of 0.10 MG

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  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

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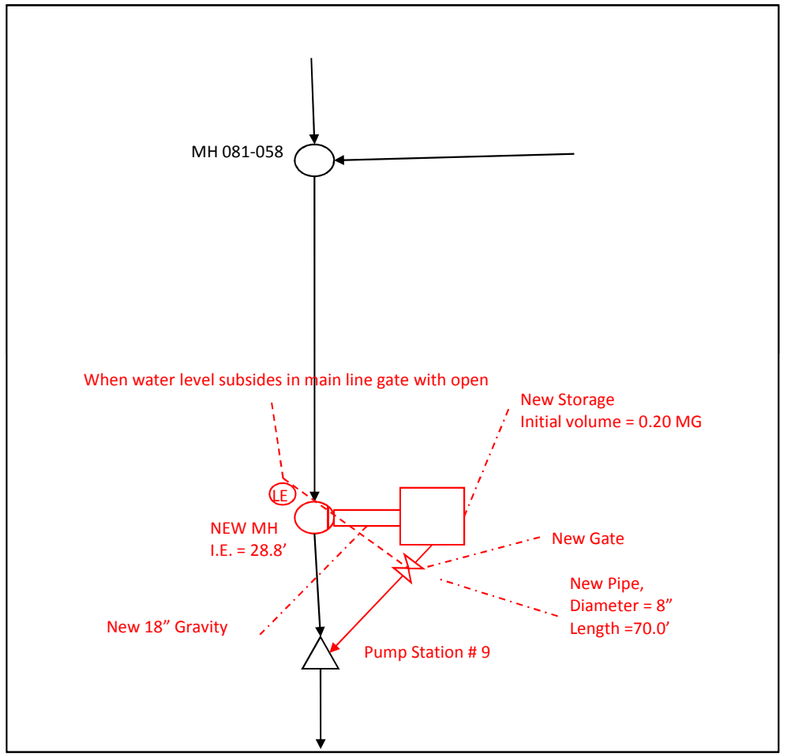

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
18.0	OFF-4-46	Determine the storage volume required to bring Basin 46 into compliance. A detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a storage volume of 0.2 MG. Increase/decrease storage volume in 0.05 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/18	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **18.0_Hen_N_46_Storage_2010.02.05**	**Modeling Performed By:** **Lisa Tamura** **Date: 2/6/2010** **CSO Results** Basin 46 # of Overflows: **5** Overflow Volume Reduction: **3.87** **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson North portion only.** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	18.0 Initial network build (created from base Hen N): - Added node 46_Storage (new storage), MH1, MH2 - Added links MH1.2, MH2.1, 46_Storage.1 (new sluice gate/control valve), MH1.1 (new weir) - Added RTC Group "18.0 Storage in 46" - Gate open below depth of 10 inches at upstream end of MH1.2 - Gate closes above depth of 18 inches at upstream end of MH1.2 - Gate closes at speed of 0.125 ft/100s - Gate opens at speed of 0.25 ft/100s - Tank has invert at 10.5 ft and top at 18.5 (just above the weir elevation). This sets cross-sectional area for tank volume calculation. Initially assumed tank volume = 0.2 MG. **RESULTS** - Storage at 46 sized to 0.35 MG - # CSO Events at 46 = 5 events - Volume of overflow = 2.11 MG

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- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. Alternatives that bring uncontrolled basins into control shall not increase the overflow frequency of basins already in control.
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Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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Overflow Structure 47B	119	0.11	1.90	24	5.07	9
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Overflow Structure 49	51	0.16	2.50	19	7.81	10

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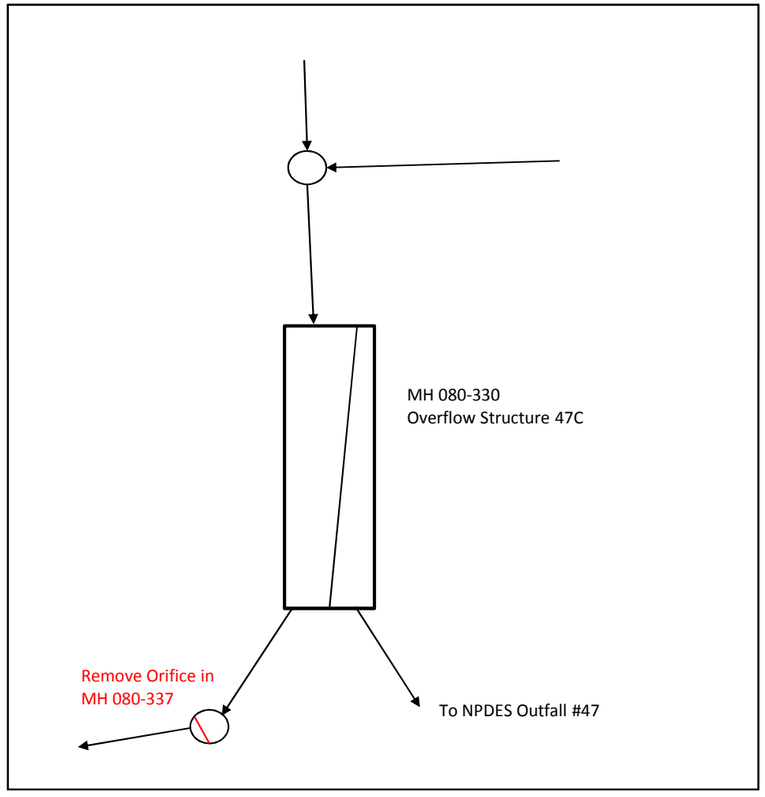

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
19.0	TKC-5-47N	Determine the increased flow into the Henderson Trunk from Basin 47N if the orifice plate is removed. Does the increased flow cause additional overflows for the County? Does removal of the orifice plate reduce overflows at overflow structure 47C?	The purpose of this run is to reduce overflows at overflow structure 47C and quantified the increase in peak flow rate to the Henderson Trunk.	1/18	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **19.1_Henderson_Remove_Orifice_at_47C_2010.01.06**	**Modeling Performed By:** **Lisa Tamura** **Date:** **1/6/2010** **CSO Results** Basin 47 # of Overflows: **2** Overflow Volume Reduction: **10.8 MG** Increased Peak Flow to KC: **7.5 MGD** **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: Boundary Condition 3 Met: **Y**	19.0 Initial network build (created from base Hen N): - Deleted link 080-337O.1 (orifice) - Deleted node 080-337O - Reconnected link 080.330.1 at downstream end to node 080-337 19.1 Set up run using full basin (both Henderson North and Henderson South) **RESULTS:** Removing the orifice plate allowed increased flows into the Henderson Trunk. Peak flows increased from 12.0 MGD to 19.5 MGD. Peak depths upstream of the orifice decreased from 4.5 ft to 3.4 ft, while peak depths downstream of the orifice location increased from 1.7 ft to 3.1 ft (the downstream pipe is 30" in diameter). With orifice plate removed Henderson Trunk is fully utilized during peak conditions but does not surcharge. Increase in depth in the Henderson Trunk does not impact 47D or 47E (i.e., cause overflows at those locations).

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  1. For the King County Henderson Pump Station:
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     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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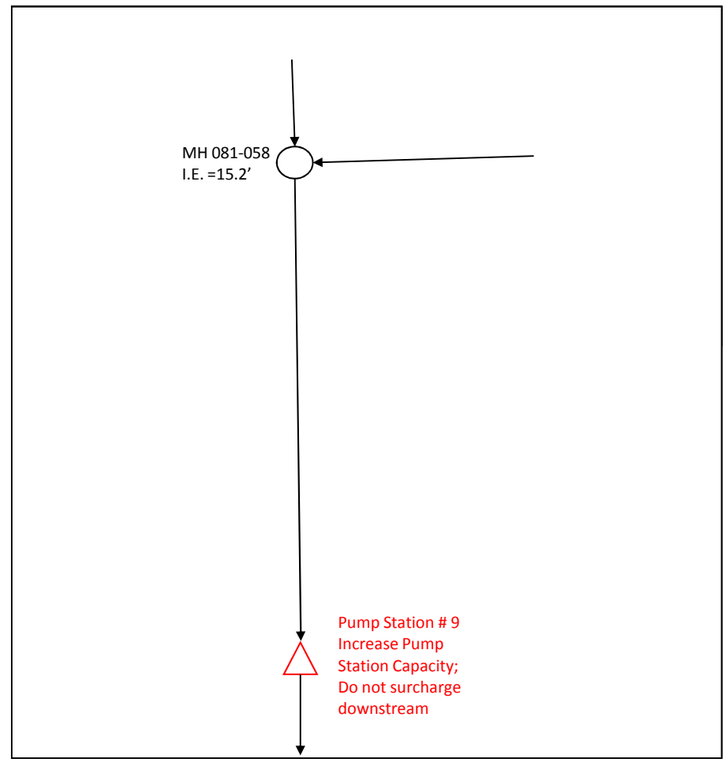

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details

20.0	TKC-2-46	Determine the increased pump station capacity at Pump Station 9 needed to reduce overflows at Basin 46. Flow from the pump station should maximize the downstream gravity pipe to the KC Henderson Pump Station; however, do not surcharge gravity pipe above the crown.
		
		Start with an increased peak capacity of 1.5 MGD.
		
		Quantify the increased flow to HPS. Does the increased flow cause increased CSOs at the HPS?
			The purpose of this run is to determine the additional capacity needed at Pump Station 9 necessary to meet project requirements.	1/15	Network Built: **Y**
					Simulation Built: **Y**
					
					Statistical Results
					Model Run Complete: **Y**
					CSO Report Complete: **Y**
					
					File Management
					Network Archived:
					Results Archived:
					
					File Path:
					
					Results Path:
					
					SIM ID:
					
					Run Title:
					20.1_Hen_N_Increase_PS9_Capacity_2010.02.27
						Modeling Performed By:
						Lisa Tamura
						Date:
						2/27/2010
						CSO Results
						Overflow Structure 45B
						# of Overflows: **16**
						Overflow Volume Reduction: **0.22 MG**
						Basin 46
						# of Overflows: **6**
						Overflow Volume Reduction: **5.14 MG**
						Reserve Capacity:
						Boundary Conditions
						
						Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson North portion only.**
						
						Boundary Condition 2 Met: **Y**
						
						Boundary Condition 3 Met: **Y**
							MODEL BUILD:
							20.0 Initial network build (created from base Hen N):
							- Created new pump curve for PS9 (element 081-057.1) to maximize downstream pipe utilization, "PS9 Revised QH Curve"
							
							20.1 Adjusted pump rate to meet criteria
							
							RESULTS (Run 20.1):
							Max Pump rate increased to 3.9 MGD (from 3.2 MGD)
							# Overflows at 46 = 6
							Volume = 0.84 MG
							Flow Rate at 081-051.1 = 4.7 MGD (increase of 0.70 MGD over base)

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General Assumptions

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  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
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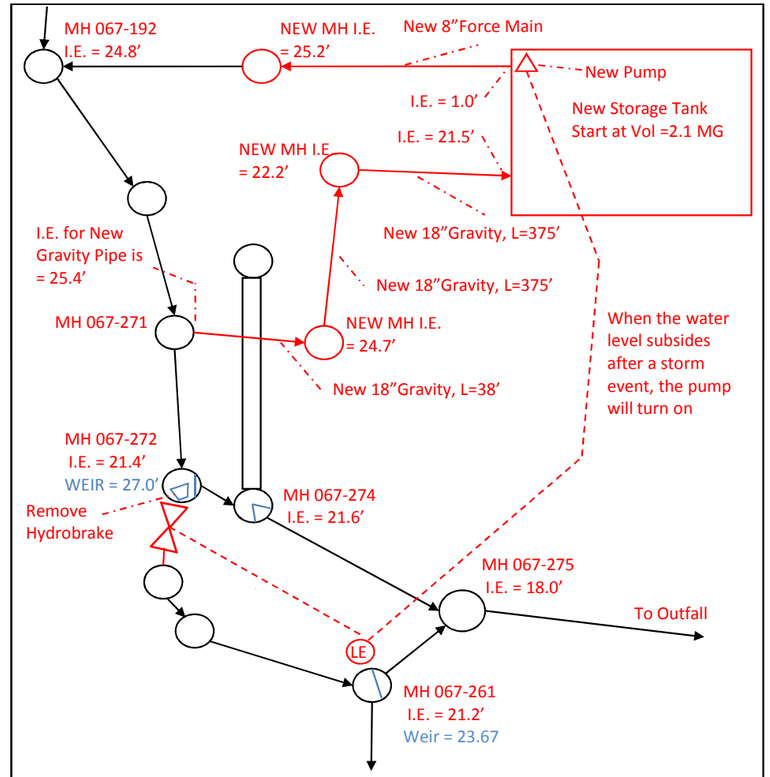

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
21.0	OFF-2-44	Determine the storage volume required to bring both Basin 44 and Basin 45 into compliance. A detailed schematic has been provided including MHs to remove, pipes to be removed, and new invert elevations. Storage volume should be increased as required to reduce overflows. Begin with a volume of 2.1 MG. Increase storage in 0.1 MG increments. Remove the hydrobrake and replace with a motor operated gate that is controlled based on level in 067-261. Gate should modulate to maximize flow downstream; close Gate completely at a WSL of 23.3.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/12	Network Built: Simulation Built: **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Date:** **CSO Results** Basin 44 # of Overflows: Overflow Volume Reduction: Basin 45 # of Overflows: Overflow Volume Reduction: Basin 46 # of Overflows: Overflow Volume Reduction: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	*Describe how elements contained in the description were modeled. In particular, gates and pumps with controllers. Provide screenshots demonstrating the network set up. Provide graphs showing operation of modeled elements and validation of the boundary conditions. This documentation will occur in a Word file containing the same file name as the Network. The CSO Overflow Stats report will be contained in an excel file containing the same file name as the Run Title The information in the Results box can be modified if CSO results are not necessary.*

Removed

System configuration essentially same as Run 10.0.

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     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
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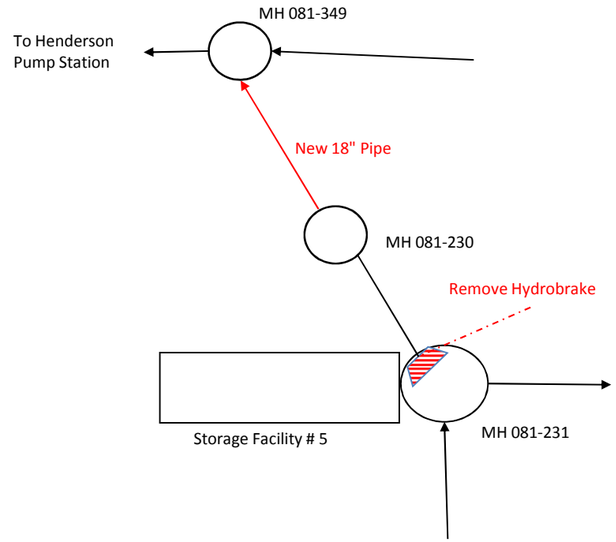

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
22.0	TKC-4-171	Remove the hydrobrake located in MH 081-231 and increased the pipe diameter downstream to 18-inch. Quantify the increased flowrate into the KC Henderson Pump Station. Quantify the increased flow to the Henderson Pump Station. Quantify the reduction in overflows and overflow volume. Quantify the reduction in the Control Volume. Begin with the same Network as Run 4.0.	The purpose of this run is to determine if by increasing the existing conveyance capacity in the SPU pipe downstream of MH 081-231 overflows can be reduced at NPDES 171 and NPDES 47.	1/5	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **22.0_Hen_S_Remove_171HBwNewPipe_2009.12.31**	**Modeling Performed By:** Steven Drangsholt **Date:** 12/31/2009 **CSO Results** Basin 47S # of Overflows: **5** Overflow Volume Reduction: **4.22 MG** Control Volume Reduction: Basin 171 # of Overflows: **5** Overflow Volume Reduction: **5.83 MG** Control Volume Reduction: Available Capacity: Reserve Capacity: **Cannot Determine** **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	Hydrobrake was removed at 081-231 by removing node 081-231.H and link 081-231.H and connecting link 081-231.1 to node 081-230. Link definition: 12-inch diameter, Upstream invert: 24.53, Downstream Invert: 24.2. Pipe diameter was increased from node 081-230 to node 081-349 from 12-inch to 18-inch, inverts were dropped by 6-inches so that crown of existing pipe was matched. Link 081-330.1 Upstream invert: 23.7 Link 081-227.1 downstream invert: 18.7. **Results:** Peak Flow in Link 081-231.1 was increased from approximately 0.8 MGD to approximately 4.2 MGD. HGL remained below the crown of the 18-inch pipe downstream of 081-330. Surface flooded did not occur along the pipeline as in Run 4.0. Overflows at NPDES 171 were decreased from 27 events to 5 events (Vol = 0.85 MG). Overflows at NPDES 47B were decreased from 10 events to 5 events (Vol = 0.53 MG). To Determine Control Volume Reduction, Reserve Capacity and Boundary Condition 1, the 32 year simulation should be run.

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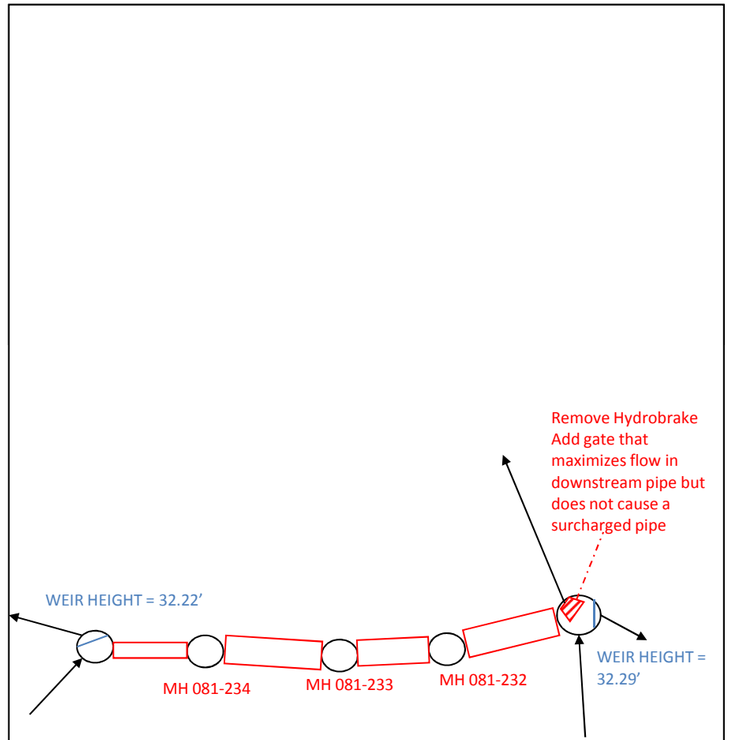

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
23.0	OFF-9-47S and TKC-4-171	Determine the storage volume required to bring both Basin 47S and Basin 171 into compliance with removing the existing hydrobrake in MH 081-231. Add a gate that will maximize flow into the 12-inch pipe downstream; however, the 12-inch pipe should not be surcharged. Storage volume should be increased as required to reduce overflows. Begin with a storage volume of .20 MG. Increase/decrease storage volume in 0.05 MG increments.	The purpose of this run is to determine the storage volume necessary to meet project requirements.	1/19	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: Needs refinement CSO Report Complete: Y **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **23.0_Hen_S_Remove_47_and_171_HB_Add Gate2**	**Modeling Performed By: Paige Igoe** **CSO Results** Basin 47S # of Overflows: **9** Overflow Volume Reduction: **1.74 MG** Basin 171 # of Overflows: **9** Overflow Volume Reduction: **2.44 MG** Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	**Model Build:** 23.0 Initial network build (changes from run 14.1): - Deleted link 081-231.1 (hydrobrake) - Added sluice gate link (081-231.1) - Downstream pipe - 081-231H.1. Pipe information for 081-231H.1: Diameter = 12"; Length = 205 ft Invert of Sluice gate is 24.53 ft. Preliminary Results: Started with storage of 260,000 gallons in place from Run 14.1. Reduced timestep and adjust PID controller coefficients to improve gate operations. Gate set to modulate depth of 10 inches (0.83 ft) in downstream pipe. Volume adjusted to meet criteria. - Volume = 100,000 gallons - # of CSO Events 47S = 9; Volume = 3.01 MG - # of CSO Events 171 = 9; Volume = 3.50 MG Max flow on DS side of gate (link 081-231H.1) = 2.25 MGD (increased from 0.9 MGD). Downstream pipe at maximum capacity (full to crown).

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- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

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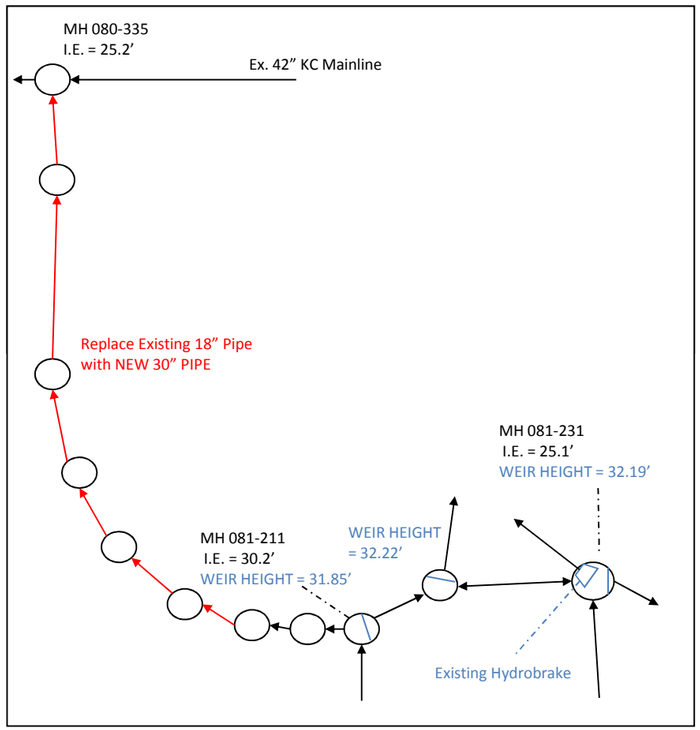

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
24.0	TKC-7-47S	Increase the conduit size from MH 081-122 to MH 080-335 from an 18-inch pipe to a 30-inch pipe. Match crown of the existing pipe. Quantify the increased peak flow to the Henderson trunk. Adjust the length of the 18-inch pipe accordingly to meet frequency requirements at Basin 47B and 171.	The purpose of this run is to determine if by increasing the existing conveyance capacity from Basin 47B and 171, overflows at both outfalls can be reduced to meet requirements.	1/19	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **24.1_Hen_S_Increase_Pipe_Size_DS_of_47B_2010.02.23**	**Modeling Performed By:** **Lisa Tamura** **Date: 2/23/2010** **CSO Results** Basin 47S # of Overflows: 9 Overflow Volume Reduction: **3.62 MG** Control Volume Reduction: Basin 171 # of Overflows: **9** Overflow Volume Reduction: **4.08 MG** Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	**MODEL BUILD:** 24.0 Initial network build (changes from Hen S): - Increased diameter of pipe from 18" to 30" working upstream from conduit 080-357.1 - Adjusted inverts so new pipes match crown of existing pipes (no change in slope) 24.1 Increased diameter of pipe 081-120.2 from 17.6" to 30". Adjusted inverte to match crown of existing pipe. **RESULTS:** - Increased pipe size to 30" downstream of MH 080-361 (last flow input point in model) - Length of pipe affected = 1,415 ft - # Overflows at 47B = 9; Volume = 1.45 MG - # Overflows at 171 = 9; Volume = 2.28 MG - Peak flow to King County Henderson Trunk (Dec 3-4, 2007) increased from 3.2 MGD to 5.0 MGD

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General Assumptions

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  1. For the King County Henderson Pump Station:
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     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
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Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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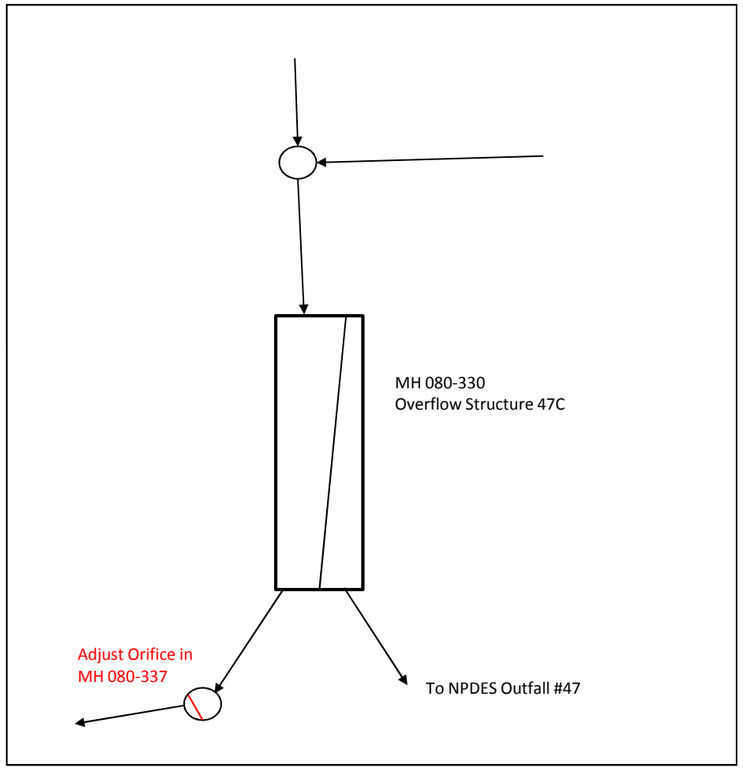

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
25.0	TKC-5-47N	Adjust orifice plate on the discharge of Overflow Structure 47C accordingly to meet performance requirements. Determine the increased flow into the Henderson Trunk from Basin 47N. Does the increased flow cause additional overflows for the County?	The purpose of this run is to reduce overflows at overflow structure 47C and quantified the increase in peak flow rate to the Henderson Trunk.	1/19	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: **Y** CSO Report Complete: **Y** **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **25.0_Henderson_Control_47C_2010.03.01 25_Henderson_Control_47C-Set gate position_2010.03.01**	**Modeling Performed By:** **Lisa Tamura** **Date:** **3/1/2010** **CSO Results** Basin 47C # of Overflows: **4** Overflow Volume Reduction: **9.2 MG (with set gate position)** Increased Peak Flow to KC: **5.2 MGD (with set gate position)** **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: Boundary Condition 3 Met: **Y**	**MODEL BUILD:** 25.0 Initial network build (changes from Henderson): - Renamed node 080-337O to 080-337G - Changed link 080-337G.1 from orifice to sluice gate - Added RTC control, "25.0 RTC 47C Control" - PID Controls: P = -1; I = 0; D = 1 - Adjust gate position based on depth at upstream end of 081-337.2 **RESULTS - Modulate Gate:** - Control depth to 2.1 ft - # Events at 47C = 4; Volume = 4.87 MG - Flow to Henderson Trunk increased from 12.0 MGD to 17.1 MGD **RESULTS - Set Gate Position:** - Control depth to 1.8 ft - # Events at 47C = 4; Volume = 4.08 MG - Flow to Henderson Trunk increased from 12.0 MGD to 17.2 MGD

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Only modifications in Basin 45 Shown
(Modifications in 44 similar to those shown for Run 10.0; Modifications in 46 similar to those shown for Run 18.0)

General Assumptions

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  1. For the King County Henderson Pump Station:
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Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
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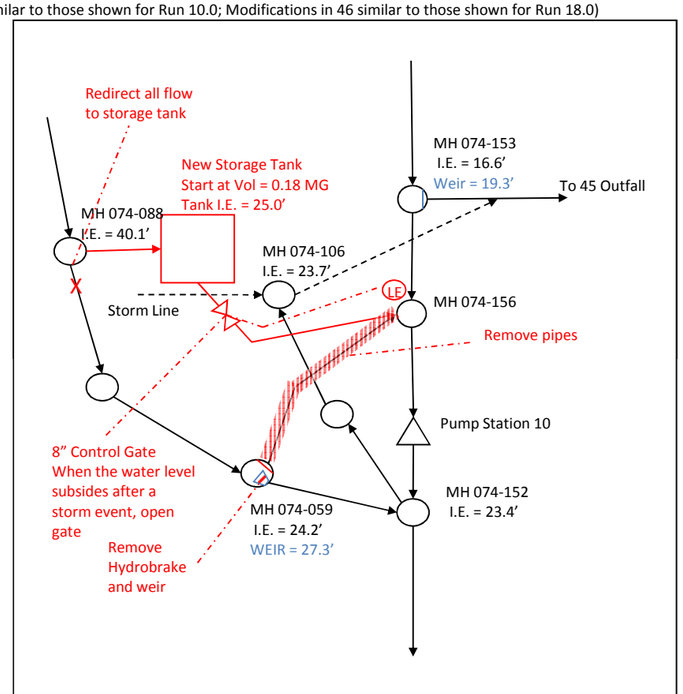

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details

26.0		Determine storage size necessary to bring Basins 44 and 45 into compliance.
		
		Storage structures will be put in both Basin 44 and Basin 45. Initial size for 44 will be 2.1 MG. Initial size for 45 will be 0.18 MG.
		
		At 44, remove hydrobrake and replace with modulating gate to control depths downstream of 44B to no greater than 15" (crown of pipeline). Add weir at end of existing storage to new storage facility. Pump will empty new storage back into the system.
		
		At 45, divert flow into MH074-088 into new storage facility. Add pipeline from storage to upstream of PS 10. Storage will empty by gravity. Add control valve at downstream end of storage to close when depths at 074-153 (45A) approach the overflow pipe invert.
		
		At 46, add new storage facility (based on results from Run 18.0). Storage will empty by gravity. Add control valve at downstream end of storage to close when depths in Lake Line upstream of PS 9 subside.
			The purpose of this run is to size separte storage facilities in both 44, 45 and 46 to meet the overflow criteria.	2/5	Network Built: **Y**
					Simulation Built: **Y**
					
					Statistical Results
					Model Run Complete: **Y**
					CSO Report Complete: **Y**
					
					File Management
					Network Archived:
					Results Archived:
					
					File Path:
					
					Results Path:
					
					SIM ID:
					
					Run Title:
					26.1_Hen_N_Distribued_Storage_2010.02.09
						Modeling Performed By:
						Lisa Tamura
						Date: 2/10/2010
						
						CSO Results
						<u>Basin 44</u>
						# of Overflows: **6**
						Overflow Volume Reduction: **42.83 MG**
						
						<u>Basin 45</u>
						# of Overflows: **4**
						Overflow Volume Reduction: **3.95 MG**
						
						<u>Basin 46</u>
						# of Overflows: **5**
						Overflow Volume Reduction: **3.89 MG**
						
						Boundary Conditions
						
						Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson North portion only.**
						
						Boundary Condition 2 Met: **Y**
						
						Boundary Condition 3 Met: **Y**
							- Added nodes 067-MH1, 067-Storage (new storage tank with depth of 10' – area variable), 45_Storage (new storage tank with depth of 20' – area variable), 45_Valve
							- Added links 067-MH1.2 (Diameter = 24"; Length = 100'; DS Invert = 21.5), 067-290.2 (new weir), 079_159.2, 45_Valve.1
							- Added links 067-Storage.1 (pump to empty new 44 storage tank; max pump rate 1.0 MGD), 45_Storage.1 (sluice gate to empty 45 storage)
							- Removed 074-158, 074-159H, 074-159W
							- Redefined link 067-272.1 from hydrobrake to modulating sluice gate
							- Changed floor elevation of node 074-159 to 24.2 ft (was 24.257 ft)
							- Removed links 074-158.1, 074-159H.2, 074-159W.1, 074-159.3 (weir), 074-159H.3 (weir)
							- Reconnected 074-087.1 DS MH now 45_Storage (was 074-088)
							- Added RTC Group "26.0 Distributed Storage Controls"
							  - 44 storage pump (067-Storage.1):
							  - PumpOn: Level at 067-261 < 22.4 ft
							  - PumpOff: Level at 067-261 > 22.4 ft
							  - 45 sluice gate (45_Storage.1): modulate to maintain level at 19.0 ft at 074-153
							
							<u>RESULTS:</u>
							- 44 Storage = 2.4 MG; Overflow volume = 12.42 MG
							- 45 Storage = 0.20 MG
							  - Overflow volume 45A = 0.22 MG
							  - Overflow volume 45B = 1.21 MG
							- 46 Storage = 0.35 MG; Overflow volume = 2.09 MG
							- PS 10 maximum flow rate reduced to 1.8 MG (from 2.6 MG)

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     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
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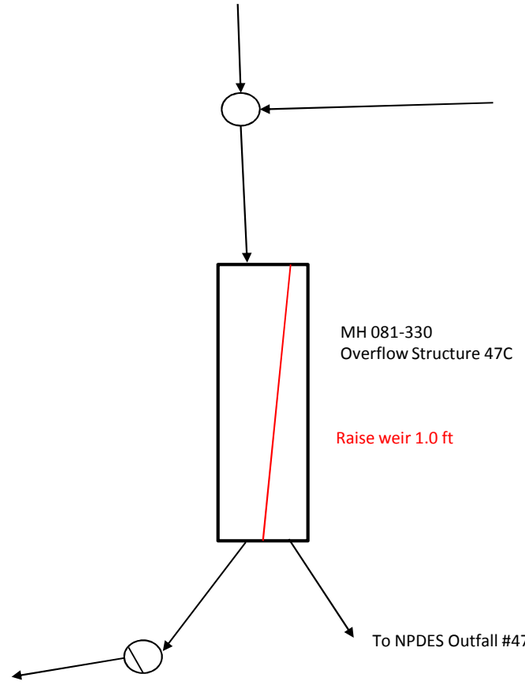

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
27.0		Determine the impacts of raising the weir at 47C by 1 ft.	The purpose of this run is to determine if by raising the weir at 47C the basin will be brought into compliance.	2/15	Network Built: Y Simulation Built: Y **Statistical Results** Model Run Complete: Y CSO Report Complete: Y **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: 27.0_Hen_N_Raise_Weir_1ft_at_47C_2010.02.06	**Modeling Performed By:** **Paige Igoe** **Date: 2/6/2010** **CSO Results** Basin 47 # of Overflows: **5** Overflow Volume Reduction: **4.55 MG** Increased Peak Flow to KC: **1.5 MGD** **Boundary Conditions** Boundary Condition 1 Met: **Y** Boundary Condition 2 Met: **Need to run with entire Henderson model. This run was completed on the Henderson North portion only.** Boundary Condition 3 Met: **Y**	**Model Build:** Weir is in MH 081-330 Raise weir height 1 ft from 31.65 ft to 32.65 ft. **Results:** Outfall 47C 081-218.1 5 Events at Outfall 47C with change in weir height (in compliance). Volume of overflow = 8.75 MG

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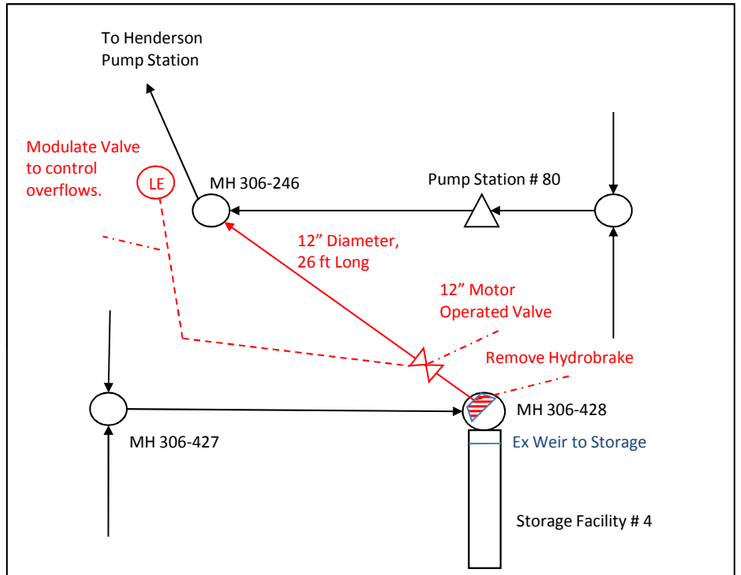

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
28.0	TKC-6-49	Remove the hydrobrake located in MH 306-428. Place a motor-operated valve between MH 306-428 and MH 306-246. The valve should be controlled based on the level in the KC Interceptor downstream of MH 306-246. Determine the setting to control overflows at this location. Quantify the increased discharge to the KC Henderson Pump Station. Quantify the reduction in overflows and overflow volume. Quantify the reduction in the Control Volume.	The purpose of this run is to determine if the existing conveyance capacity in the KC interceptor downstream of MH 306-246 can be increased to reduce overflows at NPDES 49. The gate is to provide the ability to regulate flows into the KC interceptor.	2/8	Network Built: Y Simulation Built: Y **Statistical Results** Model Run Complete: Some refinement needed CSO Report Complete: Y **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: 28.0_Hen_S_ Remove_49B_Add_Valve_Vary_ Depth_Control_2010.02.24	**Modeling Performed By:** **Paige Igoe** **Date:** **2/24/2010** **CSO Results** Basin 49 # of Overflows: **10** Overflow Volume Reduction: **2.27 MG** Control Volume Reduction: Available Capacity: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: **Need to run with entire Henderson model. This run was completed on the Henderson South portion only.** Boundary Condition 2 Met: **Y** Boundary Condition 3 Met: **Y**	Model Build: No storage added. Used network named '2.1 Remove 49B_Add_Valve'. Used RTC control from Run 2.0 to start. Needs refinement to lessen chatter. Change depth control in downstream pipe to 12 inches. Preliminary Results: Try RTC with depth control at 14 inches (1.17 ft) and Outfall 49 has 7 events. Try 13.2 inches (1.1 ft) and Outfall 49 has 9 events. Try 12.5 inches (1.04 ft) and Outfall 49 has 10 events (in compliance). Volume = 5.54 MG Try 12.0 inches (1 ft) and Outfall 49 has 11 events. Flow to KC (with gate setting at 12.5 inches) = 2.62 MGD (link 081-350.1)

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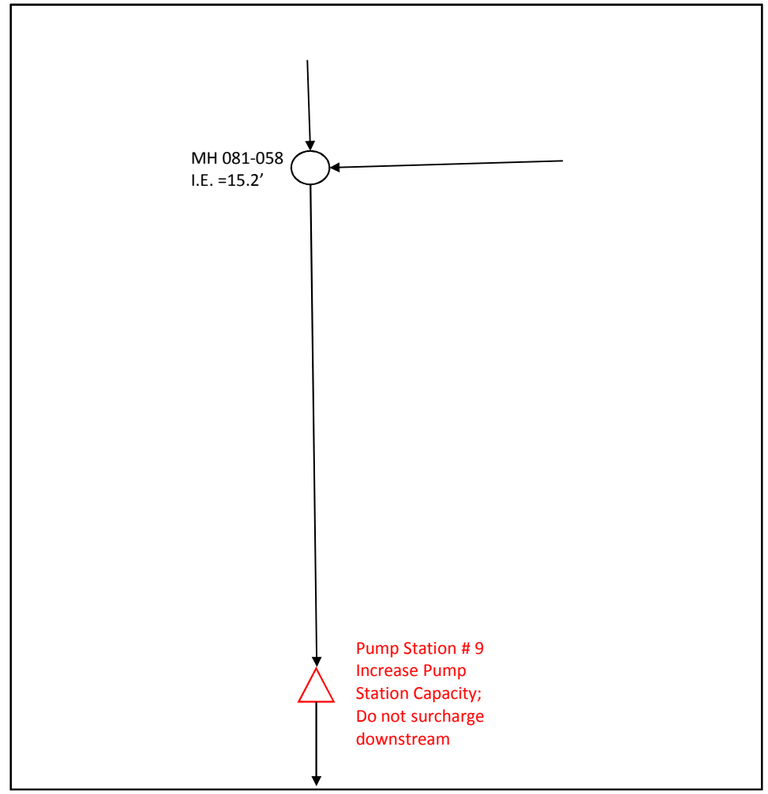

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
29.0	TKC-2-46	Determine the increased pump station capacity at Pump Station 9 needed to reduce overflows at Basin 46. Flow from the pump station should maximize the downstream capacity/pipe to the KC Henderson Pump Station. Increase downstream pipe size to convey maximum flow to HPS. Start with an increased peak capacity of 1.5 MGD. Quantify the increased flow to HPS. Does the increased flow cause increased CSOs at the HPS?	The purpose of this run is to determine the additional capacity needed at Pump Station 9 and downstream pipeline improvemetns necessary to meet project requirements.	2/25	Network Built: Simulation Built: **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title:	**Modeling Performed By:** **Date:** **CSO Results** Overflow Structure 45B # of Overflows: Overflow Volume Reduction: Basin 46 # of Overflows: Overflow Volume Reduction: Reserve Capacity: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	*Describe how elements contained in the description were modeled. In particular, gates and pumps with controllers. Provide screenshots demonstrating the network set up. Provide graphs showing operation of modeled elements and validation of the boundary conditions. This documentation will occur in a Word file containing the same file name as the Network. The CSO Overflow Stats report will be contained in an excel file containing the same file name as the Run Title The information in the Results box can be modified if CSO results are not necessary.*

Removed

Results from Run 20.0 show that increasing capacity of PS 9 brings basin into compliance.

General Assumptions

- Alternatives need to reduce the number of CSOs at each Outfall to 1 untreated discharge per year for the duration of the simulation.
- Alternatives will meet Boundary Conditions at the respective King County Facilities. The Boundary Conditions are as follows:
  1. For the King County Henderson Pump Station:
     - Do not exceed the firm capacity of 16.9 MGD. The "available capacity" is the difference between the base model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station firm capacity.
     - Do not increase the frequency of overflows above the frequency predicted by the base model.
     - Determine the "reserve capacity" of the Henderson Pump Station which is the difference between the alternative model peak flow for the largest wet weather event (assumed to be the Dec 3, 2007 storm event) and the pump station peak capacity; this "reserve capacity" may be considered later, if applicable., in negotiations with King County.
  2. For the King County Henderson Trunk, estimate the threshhold peak flow where, below that flow, overflows will not occur at a frequency above the frequency predicted by the base model and, above that flow rate, backwater would occur and cause overflows above the number predicted by the base model.
  3. 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:

Overflow Structure	Overflow Frequency 32 Year Simulation (Events)	Control Volume (MG)	Control Flowrate (MGD)	Overflow Frequency 8/02 – 12/07 Simulation (Events)	Overflow Volume 8/02 – 12/07 Simulation (MG)	Number of Events ≥ Control Volume Event (Events)
Overflow Structure 44A	415	2.07	8.16	78	53.4	6
Overflow Structure 44B	125	0.07	0.79	24	1.85	6
Overflow Structure 45A	168	0.13	1.80	28	3.30	7
Overflow Structure 45B	107	0.05	0.56	22	1.34	6
Overflow Structure 46	205	0.26	1.33	34	5.98	6
Overflow Structure 47C	62	0.15	5.40	9	13.3	5
Overflow Structure 47B	119	0.11	1.90	24	5.07	9
Overflow Structure 171	128	0.15	2.30	28	6.36	9
Overflow Structure 49	51	0.16	2.50	19	7.81	10

- The model Run Period for the conceptual alternatives evaluation is August 1, 2002 – December 31, 2007
- Run Title will have the following format: ModelRun#_NetworkName_Description_ModelRunDate. Format for Model Run Date is yyyy_mm_dd

Model Run #	Alternative Names	Description	Purpose	Due Date	Status	Results	Modeling Details
30.0		Increase the capacity of the Lake Line between 45 and 46. Determine the pipe size needed in the Lake Line meet criteria for basins 45 and 46. Remove HydroBrakes at 44 and 45 & resize pump stations 10 and 9 to move flow downstream. Increase pipe size from 44B overflow structure to Henderson Pump Station to accommodate flow. Match crowns of existing pipe. Size Pump Station 9 to limit overflows at 46 to meet criteria.	The purpose of this run is to determine the impacts of increasing the pipe size of the Lake Line and identify the additional flow to King County Henderson Pump Station needed to bring the system into compliance.	2/25	Network Built: **Y** Simulation Built: **Y** **Statistical Results** Model Run Complete: CSO Report Complete: **File Management** Network Archived: Results Archived: File Path: Results Path: SIM ID: Run Title: **30.1_Hen_N_Increase_Lake_Line_Capacity_2010.02.22**	**Modeling Performed By:** **Lisa Tamura** **Date:** **CSO Results (Run 30.1)** Overflow Structure 44A / 44B # of Overflows: Overflow Volume Reduction: Overflow Structure 45A / 45B # of Overflows: Overflow Volume Reduction: Basin 46 # of Overflows: Overflow Volume Reduction: **Boundary Conditions** Boundary Condition 1 Met: Boundary Condition 2 Met: Boundary Condition 3 Met:	30.0 Initial network build (changes from base Hen N): - Pipe sizes increased on Lake Line from Structure 44B to Pump Station 9 (PS9). Start with conduit 067-261.1 end at conduit 081-058.1. - Inverts of pipes lowered to match crowns of existing pipes and to maintain slope. 30.1 Remove HydroBrakes & Increase PS capacity - Removed nodes 067-272H, 074-158, 074-159H, 074-159W - Removed conduits 067-272H.1, 074-158.1, 074-159H.2, 074-159W.1, 074-159.3 (weir), 074-159H.3 (weir) - Reconnected conduits 067-272H.1, 074-159.1 - Increased pump capacity at Pump Stations 10 and 9 **RUN 30.0 RESULTS (only increase Lake Line pipe size):** - # Overflows at 44A = 68 (Volume = 47.14 MG); No overflows at 44B - # Overflows at 45A = 5 (Volume = 1.26 MG); No overflows at 45B - # Overflows at 46 = 31 (Volume = 13.87 MG) - # Overflows at 47C = 9 (Volume = 13.31 MG) - Criteria met at 45. Number of events (and volume) reduced at 44A but not controled. Volume of overflow increased at 46. - Increase in CSO volume at 46 due to the fact that PS 9 cannot keep up with increased flow. - Flow to KC remains the same as base (about 6.2 MGD). **RUN 30.1 RESULTS (remove HBs, increase pump capacity & increase pipe size)**: