HIGH LINE CANAL FEASIBILITY STUDY

FOR STORMWATER RUNOFF REDUCTION & TREATMENT

AUGUST 2014

PREPARED FOR: URBAN DRAINAGE & FLOOD CONTROL DISTRICT
DENVER WATER
CITY & COUNTY OF DENVER
AURORA WATER
ARAPAHOE COUNTY
DOUGLAS COUNTY

PREPARED BY: RESPEC CONSULTING & SERVICES
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August 25, 2014

Urban Drainage and Flood Control District
Mr. Ken MacKenzie, P.E., CFM
Master Planning Department Manager
2480 West 26th Avenue, Suite 156-B
Denver, Colorado 80211

Re: *High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment*

Dear Mr. MacKenzie and Project Sponsors:

RESPEC is pleased to submit this report, *High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment*. The intent of this report is to document the planning process from initiation through the conceptual design phase of the project. The High Line Canal is 66 miles long and runs through Douglas, Arapahoe, and Denver Counties, as well as through the cities of Littleton, Centennial, Greenwood Village, Cherry Hills Village, Denver, and Aurora. The project sponsors are the Urban Drainage and Flood Control District (UDFCD), Denver Water, Aurora Water, Douglas County, the City and County of Denver, and Arapahoe County. We appreciate the help received from project sponsors in making this project a successful venture.

The main objectives of this study are to determine the feasibility of repurposing the existing High Line Canal to collect and treat the stormwater runoff that currently taxes the capacity of existing storm sewer systems along the High Line Canal and to develop practical solutions that can be implemented through engineering analysis and coordination with the project sponsors and public. Detailed hydrologic and hydraulic analyses of the basins tributary to the High Line Canal were prepared to evaluate the feasibility of the concept. Project coordination meetings were held during the planning process to present the findings and possible solutions and to obtain comments from the project sponsors. Based on the results of our engineering analysis, field observations, and comments obtained, RESPEC developed a conceptual design of two reaches to convert the High Line Canal to a water quality facility. This conceptual design is detailed in this Feasibility Study.

The High Line Canal was divided into 52 individual design reaches. Each segment was evaluated to determine the amount of runoff that currently enters or could enter the canal, the storage volume available in the canal that could be used for water quality storage purposes, and the amount of storage needed to meet the water quality capture volume for the area tributary to the canal. The results of this analysis showed that there are canal reaches where there is excess capacity and reaches where the canal lacks adequate capacity to fully treat the existing and proposed canal inflows. In total, the segmentation of the canal allows the canal to temporarily store about 200 acre-feet of stormwater runoff, which represents about 68 percent of the needed storage volume to fully meet the water quality storage needs of the defined tributary area.

This amount of storage also provides the opportunity for additional infiltration of about 1,000 acre-feet of water in an average year that is then available for use by the existing trees and shrubs, thus assisting in preservation of the canal's recreational and aesthetic amenities. This can be accomplished with the addition of small control structures in the bottom of the canal that passively provide both the water quality and vegetation preservation benefits.

The estimated costs of the necessary facilities for the entire canal are around $36,000,000. This amount is much less, however, than the alternative of not using the canal, which is estimated to cost around $75,000,000 for water quality treatment alone. Thus, use of the canal can save several millions of dollars while preserving the trees that make the canal one of the most appealing recreational trails in the Denver metropolitan area.

RESPEC appreciates the opportunity to prepare the *High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment* for the UDFCD, Denver Water, Aurora Water, Douglas County, the City and County of Denver, and Arapahoe County. We look forward to the implementation of the facilities and concepts recommended in this study.

Sincerely,

RESPEC

Alan J. Leak, P.E.
Project Manager

COLORADO REGISTERED PROFESSIONAL ENGINEER 24167 8/25/14

Jessica Nolle, P.E.
Project Engineer

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EXECUTIVE SUMMARY

This Feasibility Study presents the development, analysis, and results of the Conceptual Design phase of the project titled *High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment*. This project is a jointly sponsored effort of the UDFCD, Denver Water, Aurora Water, Douglas County, the City and County of Denver, and Arapahoe County.

PROJECT GOALS

The purpose of the *High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment* project is to complete a Feasibility Study analyzing the practicability of retrofitting the Denver Water High Line Canal for stormwater treatment and runoff reduction and to develop a conceptual plan for accomplishing that goal. The conceptual plan will provide guidance to the project sponsors for future construction projects and development plans. The primary objectives of this study are as follows:

1. Develop a water quality hydrologic study of the area tributary to the stormwater inflow locations to the canal, including determining peak flow rates and annual volumes of runoff available to divert to the canal at each crossing for existing and future land-use conditions and determining the effect of upstream detention facilities on these peak flow rates and annual runoff volumes.
2. Prepare a hydraulic evaluation of each reach of the canal, including estimates of the annual volume lost to evaporation, seepage, and evapotranspiration, and an estimate of the volume of storage available for stormwater storage.
3. Develop a conceptual plan for integration of water quality facilities into the canal, including concepts for the type and configuration of bioretention facilities, strategies for maintaining the existing park aesthetic, plans for optimizing storage volume while minimizing problems associated with standing water, plans for diverting water into and discharging water out of each canal segment, estimates of vegetative consumptive use, and cost estimates for retrofitting storm sewer networks, construction of water quality facilities, and operation and maintenance.
4. Evaluate the conceptual plan to identify benefits, constraints, and solutions for plan implementation as well as the economic feasibility of the conceptual plan.

PLANNING PROCESS

A project advisory committee consisting of representatives from the project sponsors and stakeholders met periodically during the study process. Several progress meetings were held during this period. The project sponsors for this study are the UDFCD, Denver Water, Aurora Water, Douglas County, the City and County of Denver, and Arapahoe County. Project stakeholders include Aurora Parks & Open Space, South Suburban Parks and Recreation, Denver Parks, Southeast Metro Stormwater Authority (SEMSWA), and the cities of Centennial, Cherry Hills Village, Greenwood Village, and Littleton. The meetings were used primarily to exchange information and to discuss ideas and findings for the study.

Table ES-1 presents the project meeting participants and their affiliations.

Table ES-1
Project Meeting Participants

Participant Name	Organization
Ken MacKenzie	UDFCD
Shannon Carter	Arapahoe County Open Space
Mark Brown	Arapahoe County Public Works
Pat Schuler	Aurora Parks, Recreation & Open Space
Tracy Young	Aurora Parks, Recreation & Open Space
Lisa Darling	Aurora Water
Tom Ries	Aurora Water
Jeff Brasel	Centennial
Jay Goldie	Cherry Hills Village
Darren Mollendor	City and County of Denver Public Works
Sarah Anderson	City and County of Denver Public Works
Scott Gilmore	Denver Parks
Tom Roode	Denver Water
Garth Englund	Douglas County Engineering
Erik Nelson	Douglas County Engineering
Randy Burkhardt	Douglas County Parks
Suzanne Moore	Greenwood Village
David Flaig	Littleton
Alan Leak	RESPEC
Nathan Torrey	RESPEC
Lanae Raymond	SEMSWA
Paul Danley	SEMSWA
Will Singleton	Singleton Strategies
Brett Collins	South Suburban Parks and Recreation

PROJECT AREA DESCRIPTION

The High Line Canal is 66 miles long and passes through Douglas, Arapahoe, and Denver Counties, as well as through the cities of Littleton, Centennial, Greenwood Village, Cherry Hills Village, Denver, and Aurora. A vicinity map is provided in Figure ES-1 at the end of this section. The southern study area boundary is just south of the south limit of Chatfield Reservoir, near the inflow point of the South Platte River. The canal generally travels to the northeast from this location. The northern/eastern study area boundary is just west of First Creek, very near the boundary between the cities of Denver and Aurora in Denver County. Basins that drain to the High Line Canal have a total drainage area of approximately 26 square miles. Currently the High Line Canal is owned by Denver Water and is used to deliver water to 80 customers. Denver Water is investigating plans to cease its use of the canal in the future.

Multiple watersheds pass through the study area, generally from the southeast to the northwest, including, from south to north, Little Willow Creek, Willow Creek, Plum Creek, Spring Gulch, Marcy Gulch, Dad Clark Gulch, Lee Gulch, Big Dry Creek, Little Dry Creek, Greenwood Gulch, Blackmer Gulch, Goldsmith Gulch, Cherry Creek, Westerly Creek, West and East Toll Gate Creek, Sand Creek, and First Creek.

Existing land use within the study area varies, but the great majority of existing land use tributary to the canal is residential. Future land use will generally be an expansion of the existing land use. The majority of the soils belong to the Type C Hydrologic Soil Group with about a quarter of the soils being classified as Type B.

FEASIBILITY STUDY AND CONCEPTUAL DESIGN

The Feasibility Study and Conceptual Design process determined that it is indeed feasible to use the High Line Canal as a stormwater runoff water quality facility both from a physical hydraulic perspective and from a cost-savings perspective, especially if future water quality regulations require not only new and redevelopment but also existing development not currently treating stormwater runoff to retrofit their sites to provide treatment. An additional benefit not initially seen as a major component of a retrofit of the High Line Canal is that the proposed improvements would allow stormwater runoff to provide water to the extensive stand of existing trees along the canal that would otherwise be deprived of their historic source of water as Denver Water continues to reduce the use of the canal to transport water to its customers.

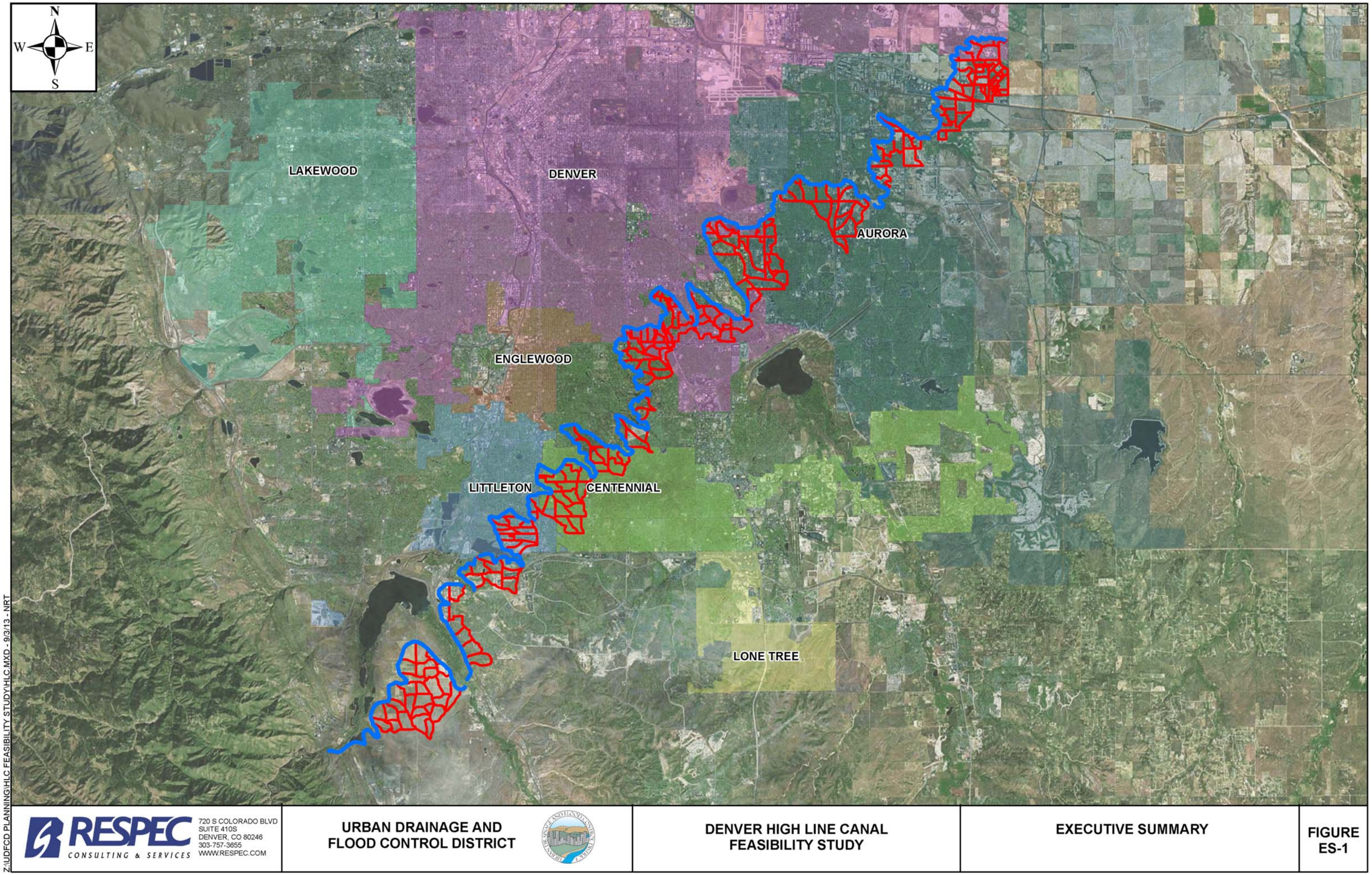
The following general considerations were accounted for during the development of the Feasibility Study and Conceptual Design:

- Allow the existing canal to be used to the fullest extent possible in terms of the volume available to store stormwater runoff and the amount of time the runoff can be stored in order to provide the most benefit from both a water quality standpoint and a vegetation maintenance standpoint.
- Provide trash and debris control at the inflow points into the canal.
- Provide or maintain access and facilities design that considers maintenance preferences of the local jurisdictions.
- Design facilities with the understanding that while the intent may be to treat the water quality capture volume, larger storms will need to be accommodated without undermining the integrity of the proposed facilities or cause a new flood risk to adjacent properties.
- Consider the aesthetics and potential health and safety concerns of the High Line Canal corridor from the perspective of the High Line Canal trail users and nearby residents.

Figures ES-2 through ES-4 show the length of the canal, the tributary areas draining to it, the water quality capture volume required for each of those tributary basins, and the volume the canal is capable of providing. These figures are located at the end of this section.

PRIORITY AND PHASING

Priority and phasing of the conceptual design should be determined by each local jurisdiction as it envisions either the need for water quality treatment of tributary development stormwater runoff or the benefit of stormwater runoff to be used to provide irrigation to the existing trees along the canal. Phasing may also depend on the timing of the termination of Denver Water's use of each reach of the canal to provide water to adjacent users. As a first phase, all jurisdictions should consider construction of only the control structures and associated outlet piping in any areas where stormwater flows currently enter a canal segment. Also as a first phase, consideration should be given to constructing forebays on existing inflow points to minimize the amount of trash and debris that currently enters the canal. Having these items as a first phase will be relatively inexpensive compared to constructing all the diversion storm sewer systems into the canal. In addition, these first phase items would provide experience on the operation and maintenance of the facilities before full implementation of the plan presented herein.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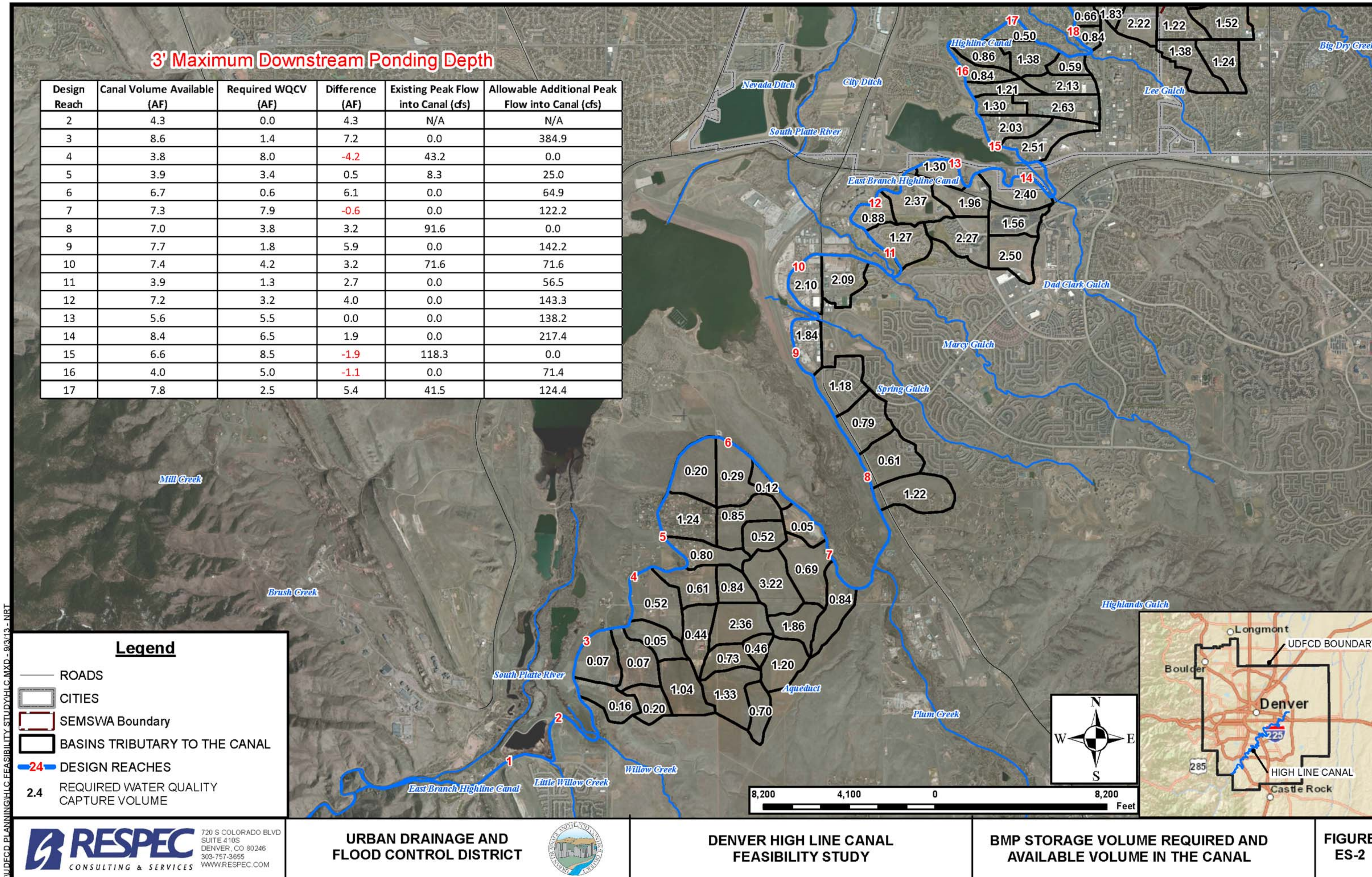
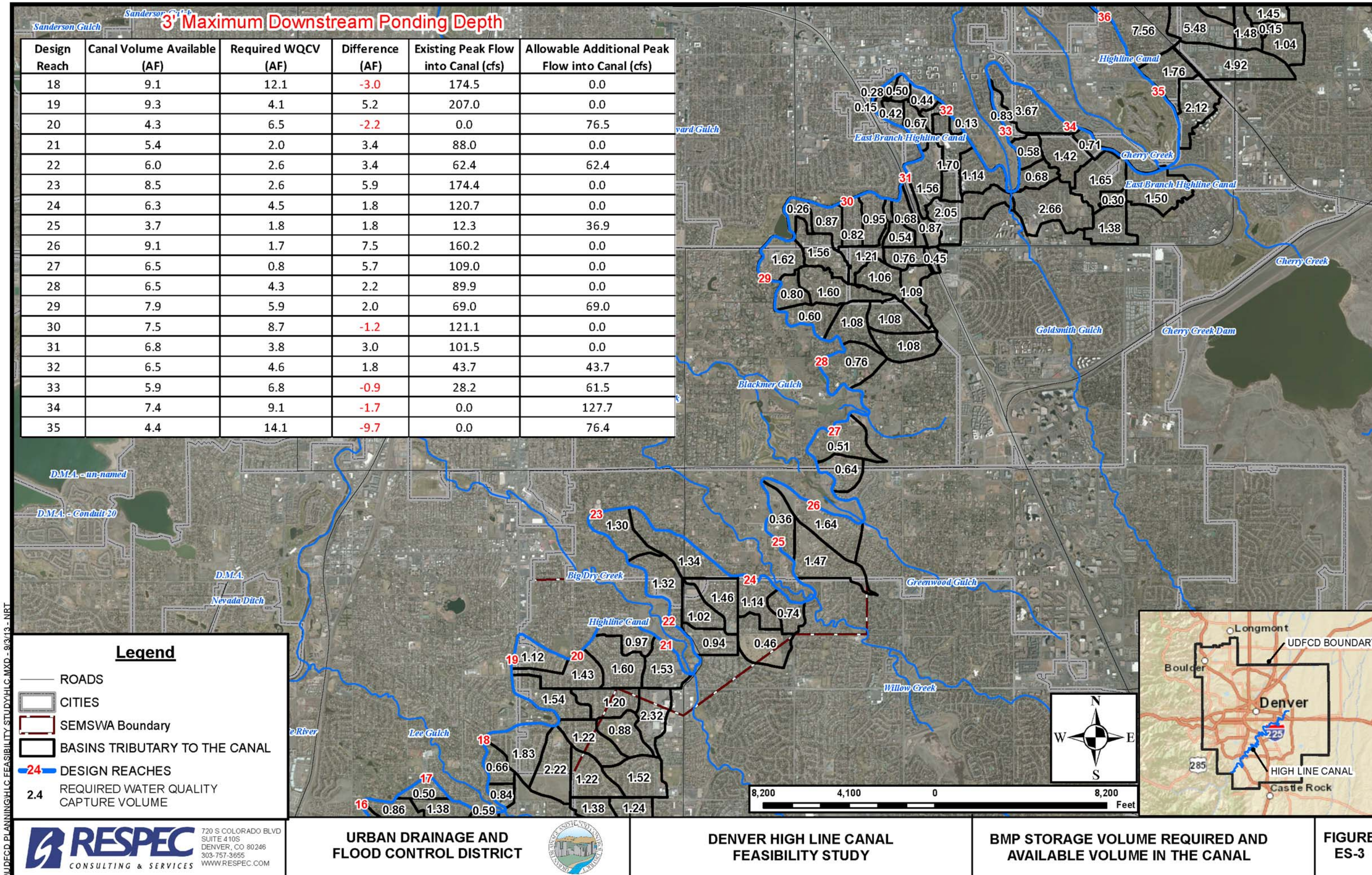
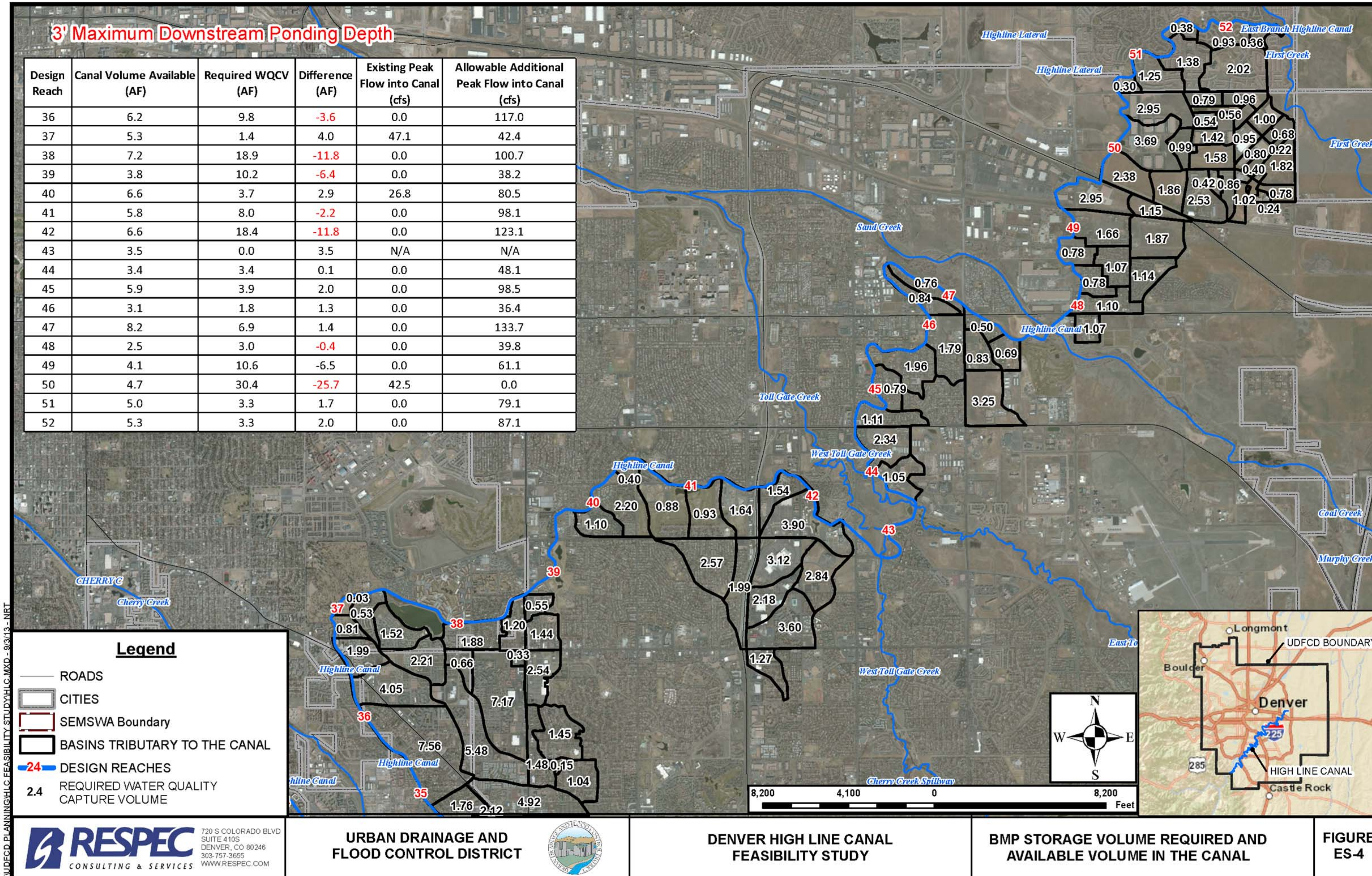
FLOOD CONTROL DISTRICT
DENVER HIGH LINE CANAL
FEASIBILITY STUDY
EXECUTIVE SUMMARY
FIGURE
ES-1



Design Reach	Canal Volume Available (AF)	Required WQCV (AF)	Difference (AF)	Existing Peak Flow into Canal (cfs)	Allowable Additional Peak Flow into Canal (cfs)
2	4.3	0.0	4.3	N/A	N/A
3	8.6	1.4	7.2	0.0	384.9
4	3.8	8.0	-4.2	43.2	0.0
5	3.9	3.4	0.5	8.3	25.0
6	6.7	0.6	6.1	0.0	64.9
7	7.3	7.9	-0.6	0.0	122.2
8	7.0	3.8	3.2	91.6	0.0
9	7.7	1.8	5.9	0.0	142.2
10	7.4	4.2	3.2	71.6	71.6
11	3.9	1.3	2.7	0.0	56.5
12	7.2	3.2	4.0	0.0	143.3
13	5.6	5.5	0.0	0.0	138.2
14	8.4	6.5	1.9	0.0	217.4
15	6.6	8.5	-1.9	118.3	0.0
16	4.0	5.0	-1.1	0.0	71.4
17	7.8	2.5	5.4	41.5	124.4



Design Reach	Canal Volume Available (AF)	Required WQCV (AF)	Difference (AF)	Existing Peak Flow into Canal (cfs)	Allowable Additional Peak Flow into Canal (cfs)
18	9.1	12.1	-3.0	174.5	0.0
19	9.3	4.1	5.2	207.0	0.0
20	4.3	6.5	-2.2	0.0	76.5
21	5.4	2.0	3.4	88.0	0.0
22	6.0	2.6	3.4	62.4	62.4
23	8.5	2.6	5.9	174.4	0.0
24	6.3	4.5	1.8	120.7	0.0
25	3.7	1.8	1.8	12.3	36.9
26	9.1	1.7	7.5	160.2	0.0
27	6.5	0.8	5.7	109.0	0.0
28	6.5	4.3	2.2	89.9	0.0
29	7.9	5.9	2.0	69.0	69.0
30	7.5	8.7	-1.2	121.1	0.0
31	6.8	3.8	3.0	101.5	0.0
32	6.5	4.6	1.8	43.7	43.7
33	5.9	6.8	-0.9	28.2	61.5
34	7.4	9.1	-1.7	0.0	127.7
35	4.4	14.1	-9.7	0.0	76.4



Design Reach	Canal Volume Available (AF)	Required WQCV (AF)	Difference (AF)	Existing Peak Flow into Canal (cfs)	Allowable Additional Peak Flow into Canal (cfs)
36	6.2	9.8	-3.6	0.0	117.0
37	5.3	1.4	4.0	47.1	42.4
38	7.2	18.9	-11.8	0.0	100.7
39	3.8	10.2	-6.4	0.0	38.2
40	6.6	3.7	2.9	26.8	80.5
41	5.8	8.0	-2.2	0.0	98.1
42	6.6	18.4	-11.8	0.0	123.1
43	3.5	0.0	3.5	N/A	N/A
44	3.4	3.4	0.1	0.0	48.1
45	5.9	3.9	2.0	0.0	98.5
46	3.1	1.8	1.3	0.0	36.4
47	8.2	6.9	1.4	0.0	133.7
48	2.5	3.0	-0.4	0.0	39.8
49	4.1	10.6	-6.5	0.0	61.1
50	4.7	30.4	-25.7	42.5	0.0
51	5.0	3.3	1.7	0.0	79.1
52	5.3	3.3	2.0	0.0	87.1

1.0 INTRODUCTION

This Feasibility Study presents the development, analysis, and results of the project titled *High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment*. This Feasibility Study consisted of an evaluation of the hydrology of the High Line Canal, an analysis of that hydrology as it pertains to water quality volumes, development of the canal's hydraulic characteristics, and the development of a hydraulic conceptual design to use the canal to maximize treatment of urban runoff while also preserving the existing vegetation within the canal.

1.1 AUTHORIZATION

The UDFCD contracted with RESPEC to investigate the feasibility of repurposing the Denver Water High Line Canal for stormwater treatment and runoff reduction per agreement number 13-08.04. The project sponsors were the UDFCD, Denver Water, Aurora Water, Douglas County, the City and County of Denver, and Arapahoe County. RESPEC received a Notice-To-Proceed on August 13, 2013 with the signing of the contract.

1.2 PROJECT PURPOSE AND GOALS

The High Line Canal Working Group, a group formed in part to work to enhance and protect the unique recreation experience along the High Line Canal, approached the UDFCD with the idea that the canal might be used as a drainage or flood control mechanism. While not ideally situated for flood control or drainage, the UDFCD recognized that the canal did have great potential to serve those two separate but interdependent functions. Using the canal as a water quality facility would not only provide treatment for a great deal of tributary area not currently being treated, it would also provide much needed irrigation water to the existing stand of trees along the canal in the process. This study has its origins in that idea.

The purpose of this study is to determine the feasibility of repurposing the existing High Line Canal to collect and treat stormwater runoff from areas draining to the High Line Canal and to develop practical solutions that can be implemented through engineering analysis and coordination with the project sponsors and public. The High Line Canal is currently owned and operated by Denver Water and, at its current usage rates for irrigation water deliveries, is an inefficient water delivery facility. Denver Water wishes to cease use of the canal for water delivery in the future and would like to examine options to repurpose the canal for use as a water quality facility for stormwater treatment. This report will assess existing facilities, evaluate the feasibility of using the canal for water quality treatment, and develop a conceptual plan for converting the canal to this use.

The following is the scope of work selected for this project:

- Coordinate and meet with project sponsors and other stakeholders to gather information and input.

- Gather and assemble available information on existing and planned drainage facilities, stormwater quality needs of sponsors and stakeholders, development plans for areas draining to the High Line Canal, existing drainage problems regarding crossings of the High Line Canal, and other applicable information.

- Develop base mapping of the High Line Canal, including existing headgate locations, existing users, existing stormwater inflow and outflow locations and facilities, locations of future stormwater crossings, and other applicable information.

- Develop a water quality hydrologic study of the area tributary to the stormwater inflow locations to the canal, including determining peak flow rates and annual volumes of runoff for the 2-year and 80th percentile runoff (90th percentile precipitation) events. Determine the quantity of runoff available to divert to the canal at each crossing for existing and future land-use conditions and determining the effect of upstream detention and water quality facilities on these peak flow rates and annual runoff volumes.

- Prepare a hydraulic evaluation of each reach of the canal, including estimates of the annual volume lost to evaporation, seepage, and evapotranspiration and an estimate of the volume of storage available for stormwater treatment.

- Develop a conceptual plan for integration of water quality facilities into the canal, including concepts for the type and configuration of bioretention facilities, strategies for maintaining the existing park aesthetic, plans for optimizing storage volume while minimizing problems associated with standing water, plans for diverting water into and discharging water out of each canal segment, estimates of vegetative consumptive use, and cost estimates for retrofitting storm sewer networks, construction of water quality facilities, and operation and maintenance.

- Evaluate the conceptual plan to identify benefits, constraints, and solutions for plan implementation as well as the economic feasibility of the conceptual plan, including infrastructure; environmental; operation and maintenance; legal, regulatory, and permitting; and public health and safety considerations.

- Develop a conceptual design, including a construction cost estimate for a pilot project downstream of Fairmount Cemetery, including retrofitting existing storm sewers to provide for inflow into and outflow out of the new water quality facility and the facilities and appurtenances necessary for water treatment.

1.3 PLANNING PROCESS

RESPEC, the project sponsors, and other stakeholders met periodically during the study process. The project sponsors for this study are the UDFCD, Denver Water, Aurora Water, Douglas County, the City and County of Denver, and Arapahoe County. Other project stakeholders include Aurora Parks & Open Space, South Suburban Parks and Recreation, Denver Parks, SEMSWA, and the cities of Centennial, Cherry Hills Village, Greenwood Village, and Littleton. Meetings consisted of a kickoff meeting and project progress meetings. Meeting minutes are included in Appendix A of this report. A brief description of each meeting is presented below:

- Meeting: Kickoff Meeting
  Date: September 5, 2013
  Time: 1:30 pm

Description: Project sponsors, stakeholders, and RESPEC met to kick off the study and discuss the project, project area, available data, goals, and priorities.

- Meeting: Progress Meeting No. 1
  Date: October 3, 2013
  Time: 1:30 pm

Description: Project sponsors and RESPEC met to discuss the progress of the project, development of the base mapping, and beginning the hydrologic analysis. Sediment and trash/debris control were discussed.

- Meeting: Progress Meeting No. 2
  Date: November 7, 2013
  Time: 1:30 pm

Description: Project sponsors, stakeholders, and RESPEC met to discuss project progress, including the hydrologic analysis and canal hydraulic characteristics. The meeting also included discussions regarding sediment inflows and inflow and diversion structures.

- Meeting: Progress Meeting No. 3
  Date: December 5, 2013
  Time: 1:30 pm

Description: Project sponsors, stakeholders, and RESPEC met to discuss project progress, including finalizing the hydrologic analysis and canal hydraulic characteristics. Base mapping and data collection are complete. Available storage volume versus required water quality volume, an infiltration analysis, and possible solutions to volume differences were discussed.

- Meeting: Progress Meeting No. 4
  Date: January 2, 2014
  Time: 1:30 pm

Description: Project sponsors, stakeholders, and RESPEC met to discuss project progress, including further discussions on the hydrologic analysis and canal hydraulic characteristics. Available storage volume versus required water quality volume, an infiltration analysis, and possible solutions to volume differences were further discussed as well as canal appurtenances that would be necessary.

- Meeting: Progress Meeting No. 5
  Date: February 6, 2014
  Time: 1:30 pm

Description: Project sponsors, stakeholders, and RESPEC met to discuss project progress, including finalizing the conceptual plan, the need for public presentations, and determining the location of the pilot project. Discussion also included criteria used to establish design reaches, inflow and discharge locations, and a conceptual outlet structure.

- Meeting: Progress Meeting No. 6
  Date: March 6, 2014
  Time: 1:30 pm

Description: Project sponsors, stakeholders, and RESPEC met to discuss project progress, including local sponsor comments received on the design reaches and criteria for locating the pilot project reach. Water rights concerns were discussed as well as water quality concerns and a cost/benefit analysis of the improvements.

- Meeting: Progress Meeting No. 7
  Date: June 5, 2014
  Time: 1:30 p m

Description: Project sponsors, stakeholders, and RESPEC met to discuss the project progress, including revisions to the design reaches, and the results of the development of the pilot project, including various issues that will need to be addressed for each of the reaches as they are converted to water quality treatment basins. The meeting included a discussion on potential water rights issues based upon information from the Colorado State Engineer's Office.

- Meeting: Progress Meeting No. 8
  Date: July 17, 2014
  Time: 1:30 p m

Description: Project sponsors and stakeholders provided comments on the Draft Feasibility Report. Written comments received on the Draft Feasibility Report after Progress Meeting No. 8 are also included in Appendix A. Additional editorial comments from project sponsors and stakeholders have not been included.

1.4 MAPPING AND SURVEYS

Topographic mapping and existing storm sewer infrastructure information for this study were provided by the various sponsors and stakeholders. The topographic mapping was developed in 2008 and has a contour interval of 2 feet. All topographic mapping is on the North American Vertical Datum 1988 (NAVD 88) and North American Datum 1983 (NAD 83), State Plane Colorado (North). Aerial photography, dated 2011, was also provided by UDFCD.

1.5 DATA COLLECTION

A portion of the data utilized in developing this study originated from other sources. Some of the hydrologic data for the study area, including subbasin data and Environmental Protection Agency Storm Water Management Model (EPA SWMM) routing, was originally established as part of one of several master planning documents referenced by this study. These include the City and County of Denver Storm Drainage Master Plan from June 2009; the Denver High Line Canal (Dad Clark Gulch to Mississippi Avenue) Major Drainageway Planning from June 2004; the Major Drainageway Plan for Westerly Creek (Upstream of the Westerly Creek Dam) from October 2013; the West Toll Gate Creek Watershed Baseline Hydrology Report Update from September 2011; and the Toll Gate Creek and East Toll Gate Creek (Downstream of Hampden) Baseline Hydrology Report from April 2012. Additional data was received from the project sponsors, including geographic information system (GIS) data, drainage reports and plans, as-built construction plans, and detention pond data between October 2013 and May 2014. Table 1-1 provides a summary of the data collected for the study.

Table 1-1
Data Collected for Study

Document Type	Description	Provided By
Aerial Image	Aerial Image	UDFCD
As-Built Drawings	As-Built Infrastructure	Douglas County, Aurora Water, City and County of Denver
GIS Shape Files	Parcels, Storm Infrastructure	Aurora Water, Denver, Denver Water, Douglas County, Greenwood Village, Littleton, SEMSWA
Reports and Plans	Drainage Reports, Construction Plans	Cherry Hills Village
Topographic Mapping	2-foot contour data	UDFCD

1.6 ACKNOWLEDGEMENTS

Development of the Feasibility Study required input from all project sponsors. Coordination and cooperation between project participants is crucial to successful project development. The following participants are acknowledged for their involvement and contribution to this report.

Project Sponsors:

Ken MacKenzie, UDFCD
Shannon Carter, Arapahoe County Open Space
Mark Brown, Arapahoe County Public Works
Lisa Darling, Aurora Water
Tom Ries, Aurora Water
Tom Roode, Denver Water
Sarah Anderson, City and County of Denver
Darren Mollendor, City and County of Denver
Garth Englund, Douglas County Engineering
Erik Nelson, Douglas County Engineering
Randy Burkhardt, Douglas County Parks

RESPEC Project Consultant Team:

Alan Leak, Project Manager
Nathan Torrey, Project Engineer
Jessica Nolle, Project Engineer

In addition to the project sponsor organizations, Table 1-2 provides a list of all the meeting participants that provided valuable feedback and support throughout the process of developing this study.

Table 1-2
Project Meeting Participants

Participant Name	Organization
Ken MacKenzie	UDFCD
Shannon Carter	Arapahoe County Open Space
Mark Brown	Arapahoe County Public Works
Pat Schuler	Aurora Parks, Recreation & Open Space
Tracy Young	Aurora Parks, Recreation & Open Space
Lisa Darling	Aurora Water
Tom Ries	Aurora Water
Jeff Brasel	City of Centennial
Jay Goldie	Cherry Hills Village
Darren Mollendor	City and County of Denver Public Works
Sarah Anderson	City and County of Denver Public Works
Scott Gilmore	Denver Parks
Tom Roode	Denver Water
Garth Englund	Douglas County Engineering
Erik Nelson	Douglas County Engineering
Randy Burkhardt	Douglas County Parks
Suzanne Moore	City of Greenwood Village
David Flaig	City of Littleton
Alan Leak	RESPEC
Nathan Torrey	RESPEC
Lanae Raymond	SEMSWA
Paul Danley	SEMSWA
Will Singleton	Singleton Strategies
Brett Collins	South Suburban Parks and Recreation

2.0 BACKGROUND INFORMATION

The High Line Canal has been in existence in the Denver metropolitan area for nearly 135 years. It has served both to transport irrigation water and to provide recreation activities for local residents. Water quality treatment requirements for stormwater runoff have existed on a federal, state, and municipal level for more than two decades. This section discusses the history of both the canal and water quality requirements to provide context for this Feasibility Study.

2.1 CREATION AND USE OF THE HIGH LINE CANAL

Construction of the High Line Canal began in 1879 and was completed in 1883. The Northern Colorado Irrigation Company built it as a gravity-flow transbasin water diversion to supply South Platte River water from Waterton Canyon to numerous agricultural and institutional users located on the plains south and east of Denver. However, the High Line Canal did not provide a reliable source of water to users along its 66 miles of length until it was sold to the Antero and Lost Park Reservoir Company in 1909. In 1916, the City of Denver purchased the Denver Union Water Company, which became the Denver Water Board, and the Denver Water Board acquired the High Line Canal in 1924. The High Line Canal is currently owned and operated by Denver Water.

In the 1970s, recreational use agreements were established between Denver Water and the various municipalities the High Line Canal passes through. As land use gradually transitioned from agricultural use to commercial and residential uses, the number of consumers of High Line Canal water was reduced. The canal currently still functions to deliver water to about 80 customers up to the Fairmount Cemetery but is primarily used as a recreational corridor.

The current capacity of the High Line Canal is approximately 600 cubic feet per second (cfs) at the headgate at a depth of about 6 feet, but in more recent years it has been running at an average depth of only about 3 feet. For the current customers, the High Line Canal is very inefficient. Only about 30 percent of the water put into the canal actually reaches the current water customers. Due to this inefficiency, combined with the reduced number of users, Denver Water is currently exploring the possibility of ceasing the use of the High Line Canal as a water delivery facility and using alternative water sources to supply the remaining customers.

The High Line Canal is one of the premier recreational corridors in the Denver metropolitan area, with a multiuse trail running adjacent to the canal for its entire length that provides local users a dense canopy of cottonwood trees under which they can ride bikes or horses, run, hike, and picnic. In an effort to protect this recreation experience for the entire Denver metropolitan area, the High Line Canal Working Group was formed in 2010. This Group is a collaborative organization that works to secure funding for and implement projects that will help enhance and protect the unique recreation experience along the High Line Canal. Their vision statement is that the "High Line Corridor be protected forever as an intimate treasure and continuous recreation experience along a historic, naturally scenic canal."

Some of the Group's goals and values are to identify and pursue open space properties near the High Line Canal that enhance conservation values; to preserve and enhance the overall trail experience; to preserve views and vistas; to preserve and enhance recreational opportunities for all citizens; and to preserve and enhance the historic canopy that defines the canal. The Group members and participating entities are as follows.

HIGH LINE CANAL WORKING GROUP

Members	Participating Entities
Arapahoe County	Adams County
City of Aurora	Arapahoe County Open Space and Trails Advisory Board
City of Centennial	Cherry Hills Land Preserve
City of Cherry Hills Village	Colorado Division of Wildlife
City and County of Denver	Colorado State Parks
Douglas County	Denver Parks and Recreation
City of Greenwood Village	Denver Water
Highlands Ranch Metropolitan District	High Line Canal Preservation Association
City of Littleton	Sand Creek Regional Greenway
South Suburban Park and Recreation District	South Metro Land Conservancy
	South Suburban Park Foundation
	The Trust for Public Land

As the use of the canal itself continues to transition away from being a water supply facility, the many other current and potential uses remain to be explored. The recreational use of the canal corridor is well-established and worthy of being maintained. The mechanism by which the aesthetic of the corridor can be maintained once the canal is no longer filled with irrigation water is currently under discussion. The feasibility of potential future use of the canal itself as a stormwater treatment and runoff reduction facility is being explored by this study. It is desirable to incorporate this use as part of the plan to help preserve and enhance the recreational use of the High Line Canal.

2.2 PAST STUDIES

A detailed hydrologic analysis was performed for the reach of the High Line Canal between Dad Clark Gulch and Mississippi Avenue, including delineation of the 100-year floodplain. This is the only previous hydrologic study that focused directly on the canal's flood conveyance capacity and on the inflows to and outflows from the canal during major storm events on the High Line Canal. Many other planning studies have been completed for the various drainageways that pass through the High Line Canal. Previous hydrologic studies within the study area that have been conducted include the following:

- *Denver High Line Canal (Dad Clark Gulch to Mississippi Avenue) Major Drainageway Planning, Phase B Preliminary Design*, June 2004, WRC Engineering, Inc.
- *Flood Hazard Area Delineation Marcy Gulch*, February 1983, Jack G. Raub Company
- *Major Drainageway Planning Sand Creek South Platte River to East Corporate Boundary of Aurora, Colorado, Development of Preliminary Plan – Phase B*, January 1984, Simons, Li & Associates, Inc.
- *Flood Hazard Area Delineation Spring Gulch*, December 1986, Jack G. Raub Company
- *Outfall Systems Planning Lower Dad Clark Gulch and DFA 0068*, February 1991, Centennial Engineering, Inc.
- *Major Drainageway Planning Granby and Sable Drainageways Phase B Preliminary Design*, March 1991, Kiowa Engineering Corporation
- *Major Drainageway Planning Sand Creek South Platte River to East Corporate Boundary of Aurora, Colorado, Development of Preliminary Plan – Phase B*, January 1984, Simons, Li & Associates, Inc.
- *Major Drainageway Planning of Denver High Line Canal and Little Dry Creek Watershed (Arapco) Phase A Alternatives Evaluation Report*, May 2003, WRC Engineering, Inc.
- *2003 Irondale Gulch Watershed Master Plan Implementation Hydrology Model Update*, July 2003, Boyle Engineering
- *Flood Hazard Area Delineation Plum Creek and East Plum Creek Douglas County, Colorado*, August 2004, Icon Engineering, Inc.
- *City and County of Denver Storm Drainage Master Plan*, June 2009, Matrix Design Group
- *Westerly Creek Drainageway Update (Downstream of Westerly Creek Dam), Major Drainageway Plan Conceptual Design Report*, July 2010, Kiowa Engineering Corporation
- *West Toll Gate Creek Watershed Baseline Hydrology Report Update*, September 2011, Enginuity Engineering Solutions, LLC and Michael Baker, Jr., Inc.
- *Toll Gate Creek and East Toll Gate Creek (Downstream of Hampden) Major Drainageway Plan Baseline Hydrology Report*, April 2012, J3 Engineering Consultants
- *High Line Canal Preservation and Enhancement Planning Study*, August 2012, Applied Design Services
- *Flood Hazard Area Delineation Sand Creek Colfax to Yale,* October 2012, Matrix Design Group
- *Major Drainageway Plan and FHAD for Westerly Creek (Upstream of the Westerly Creek Dam) Baseline Hydrology Report,* October 2013, CH2M Hill
- *Westerly Creek (Upstream of the Westerly Creek Dam) Major Drainageway Plan Baseline Hydrology Report,* November 2013, CH2M Hill

2.3 WATER QUALITY REQUIREMENTS

The Clean Water Act (CWA) is the primary federal law in the United States that governs water pollution. It was enacted in 1972 with one of its goals being to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources. CWA also introduced the National Pollutant Discharge Elimination System (NPDES), which is the permit system for regulating point sources of pollution. Point sources are point discharges from man-made conveyance facilities. Industrial, municipal, and other defined facilities must obtain NPDES permits if their discharges go directly to surface waters. Point sources include:

- Industrial facilities, such as manufacturing, mining, oil and gas extraction, and service industries,
- Municipal governments and other government facilities, such as military bases, and
- Some agricultural facilities, such as animal feedlots.

Polluted stormwater runoff is commonly transported through a Municipal Separate Storm Sewer System (MS4), which is a system of conveyances that is owned by a state, city, town, or other public entity that discharges stormwater into local waterbodies. Many public entities are now required to obtain an MS4 permit to operate their storm sewer systems. Several conditions are attached to the permit, among them being that the permittee must develop a program to reduce the amount and type of pollution generated that ends up in local waterbodies.

Local MS4 permits currently require new development and redevelopment projects to incorporate water quality treatment measures to treat the stormwater runoff from these projects prior to discharging it into local waterbodies. Types of water quality treatment facilities include water quality ponds, rain gardens, sand filters, and subgrade treatment vaults, to name a few. It is possible in the future that MS4 permits may require water quality treatment of stormwater runoff coming from existing development. This will likely be a difficult goal to meet in areas where development is fairly dense and there is little room to provide a retrofit water quality pond or treatment facility. The High Line Canal facility presents a rare opportunity to potentially provide that water quality treatment for areas that were developed prior to water quality facilities being part of a typical development landscape. Its use provides an opportunity to take credit for treatment in the canal against future redevelopment in the tributary watershed where there is insufficient room to construct above-ground treatment facilities.

3.0 TRIBUTARY AREA HYDROLOGIC ANALYSIS

3.1 OVERVIEW

A feasibility-level hydrologic analysis was performed for the areas draining to the High Line Canal to determine peak flow rates and volumes for existing and future development conditions. Peak flow rates were developed for this study for the 2-year precipitation event and for a water quality precipitation event. The water quality event modeled is the 80th percentile runoff event, a 2-hour design storm based on a 0.53-inch 1-hour point rainfall distributed temporally as a 0.61-inch 2-hour rainfall. Colorado Urban Hydrograph Procedure (CUHP) version 1.4.3 was used in conjunction with EPA SWMM version 5.0.022 to develop the peak flow rates and volumes for each event.

3.2 ANALYSIS

The High Line Canal traverses several major drainageway watersheds throughout the Denver metropolitan area. Many of these watersheds have been studied in detail by the UDFCD, and some are currently having their studies updated. Subbasin delineations and characteristics were taken from several of these major drainageway plans for use in this study. The following is a summary of the major drainageway plans referenced in this study:

- City and County of Denver Storm Drainage Master Plan, June 2009
- Denver High Line Canal (Dad Clark Gulch to Mississippi Avenue) Major Drainageway Planning Phase B Preliminary Design, June 2004
- Irondale Gulch Watershed Master Plan Implementation Hydrology Update, July 2003
- Major Drainageway Plan and FHAD for Westerly Creek (Upstream of the Westerly Creek Dam), Baseline Hydrology Report (Draft), October 2013
- Toll Gate Creek and East Toll Gate Creek (Downstream of Hampden), Major Drainageway Plan, Baseline Hydrology Report, April 2012
- West Toll Gate Creek Watershed, Baseline Hydrology Report Update, September 2011

Where areas included in the 2009 Denver Storm Drainage Master Plan overlapped with areas covered by the 2004 High Line Canal Major Drainageway Plan, precedence was given to the Denver Master Plan because it is more recent and has been updated with the more current storm sewer information.

The Denver Storm Drainage Master Plan and Denver High Line Canal Major Drainageway Plan were completed using the Urban Drainage Storm Water Management Model (UDSWM). UDSWM utilizes lengths and slopes of the elements as input. EPA SWMM adds the requirement for node elevations. Therefore, in order to convert the UDSWM model files to EPA SWMM, elevations were estimated for each node based on the study base topographic mapping.

The EPA SWMM routing for the Majestic Commerce Center, located just north of I-70, was taken directly from the Denver Storm Drainage Master Plan. The hydrologic analysis for the Majestic Commerce Center is included in the Irondale Gulch Watershed Master Plan Implementation Hydrology Model Update, dated July 2003. The Denver Storm Drainage Master Plan incorporated the hydrologic analysis from the 2003 Irondale Gulch study for the Majestic Commerce Center.

Because the 2003 Irondale Gulch hydrologic model that served as the basis for the Denver Storm Drainage Master Plan was subsequently found to be seriously flawed, the 2011 Irondale OSP should be used instead as the basis for design of improvements for all affected reaches of the High Line Canal.

A significant amount of land drains toward the High Line Canal. Most of this land area drains to one of the several major drainageways that cross the canal. For the purpose of this project, these lands were not considered to drain to the canal itself, as these major drainageways will continue to pass under or over the canal as they have historically. These major drainageways are First Creek, Sand Creek, East and West Toll Gate Creeks, Cherry Creek, Goldsmith Gulch, Blackmer Gulch, Greenwood Gulch, Little Dry Creek, Big Dry Creek, Lee Gulch, Dad Clark Gulch, Marcy Gulch, Spring Gulch, Willow Creek, and Little Willow Creek.

As a result, the subbasin areas considered treatable by the High Line Canal for water quality are generally those areas very near the canal itself and are not tributary to a major drainageway prior to entering the canal.

3.4 DESIGN RAINFALL

The 1-hour point design rainfalls for the study area were obtained using the UDFCD design spreadsheet, UD-Rain version 1.01. The UD-Rain software requires the user to select a predetermined location that best represents the project location. The Greenwood Village City Hall was chosen to be representative for this for this study. This study only utilized the 2-year event and the water quality event. The 2-year event one-hour point rainfall is 0.95 inches and the water quality event one-hour rainfall is 0.53 inches

CUHP version 1.4.3 was used to create a 2-hour design storm distribution with a 5-minute time interval for each storm frequency using the 1-hour point rainfall depths. All tributary basins within the study area are significantly less than 10 square miles, so area adjustment factors were not required. The rainfall distributions produced by CUHP are included in Appendix B.

3.5 SUBBASIN CHARACTERISTICS

The subbasin input parameters required for CUHP are subbasin identification number, drainage area, subbasin length, distance to subbasin centroid, subbasin slope, future development percent imperviousness, depression losses, and infiltration rates. Subbasin parameters were computed using ArcGIS or, where available, were obtained from the previously prepared master plans. A summary of the CUHP input parameters, the source of the data on subbasin characteristics, and the CUHP water quality output are included in Appendix B.

As a general rule, UDFCD recommends that individual subbasins average no more than 100 acres in size and no single subbasin shall exceed 130 acres. For the study area, 229 subbasins were delineated with an average size of 74 acres. Only 15 subbasins were larger than 130 acres, and only 6 of those were larger than 150 acres. The average subbasin slope was 2.2 percent. Only 16 subbasins had slopes greater than 4 percent. For the purposes of this Feasibility Study, these were all considered acceptable.

Soils information was obtained from the National Resources Conservation Service (NRCS) Web Soil Survey. Infiltration parameters were assigned to each hydrologic soil group as recommended in Table RO-7 of the Urban Storm Drainage Criteria Manual (USDCM). Composite infiltration parameters weighted by area were then determined for each subbasin. Depression losses were estimated as recommended in Table RO-6 of the USDCM. The directly connected impervious area level was set at zero.

3.6 HYDROGRAPH ROUTING

Hydrograph routing was performed in EPA SWMM version 5.0.022. Input includes nodes (junctions and dividers), conduits, storage units and outlets, and outfalls. The model input parameters for junctions include node identifier and invert elevation. Dividers also require overflow and diverted link identifier. Input required for conduits include conduit identifier, upstream and downstream node identifiers, shape, maximum depth, length, and roughness. Input required for storage units include storage unit identifier, invert elevation, maximum depth, and a stage-area relationship. Input required for storage outlets include outlet identifier, upstream and downstream node identifiers, and a stage-discharge relationship. Input required for outfalls include the outfall identifier and invert elevation.

4.0 WATER QUALITY HYDROLOGY

In the development of this Feasibility Study, there were discussions about which best management practices (BMP) model would be best suited for use in the retrofit of the High Line Canal. The mechanisms by which stormwater runoff can be treated in various BMP facilities include sedimentation, filtration, straining, adsorption/absorption, biological uptake, and hydrologic processes such as infiltration and evapotranspiration. The physical characteristics of the canal lend themselves most ideally to an extended detention basin, bioretention basin, or sand filter model. Filtration, sedimentation, straining, and adsorption/absorption are all likely to occur naturally once the canal is retrofitted. A hybrid of an extended detention basin and a bioretention basin was chosen as the model that would be followed in the course of this study.

A subbasin's Water Quality Capture Volume (WQCV) is based on the subbasin's area and imperviousness and on the desired drain time of the WQCV. Consultation with UDFCD resulted in the following method being selected to determine the WQCV.

The WQCV for this study is computed using the following equation:

$$WQCV = 0.22IT^{0.19}$$

Where:

WQCV = Water Quality Capture Volume (watershed inches)
T = Drain time (hours)
I = Imperviousness expressed as a decimal

The BMP storage volume needed to capture the entire WQCV is calculated using the following equation:

$$V = (WQCV/12)A$$

Where:

WQCV = Water Quality Capture Volume (watershed inches)
V = BMP storage volume to capture WQCV (acre-feet)
A = Watershed area (acres)

A drain time of 24 hours was used to calculate the WQCV although the basins themselves will be designed to drain in 72 hours. The 24-hour drain time was chosen for calculation purposes for two reasons. The first is that the goal of the project was to be able to capture and treat all the runoff from 80 percent of all runoff events (90 percent of all precipitation events). This is estimated to result in removal of between 80 percent and 90 percent of the annual total suspended solids (TSS) load. The second is that a 24-hour drain time is midway between the recommended drain time of a bioretention basin (12 hours) and an extended detention basin (40 hours), and the proposed High Line Canal facilities have characteristics of both types of facilities.

5.0 HIGH LINE CANAL REACH DESIGNATION & HYDRAULIC ANALYSIS

5.1 CANAL PHYSICAL CHARACTERISTICS

The High Line Canal drops approximately 132 feet over 66 miles, yielding an average channel slope of 2 feet per mile or 0.04 percent. The bottom width of the canal varies from approximately 9 to 10 feet at the most upstream and downstream ends of the canal to as much as 20 to 21 feet in some of the more central portions of the canal. Side slopes are generally steep and were assumed 2H:1V for the entire length of the canal.

5.2 WATER QUALITY CAPACITY REQUIREMENTS

The High Line Canal was divided into 52 individual design reaches. Initially the reaches were established to each be almost exactly 1 mile long. Although the canal typically has the capacity to hold up to about 6 feet of water before overtopping, a treatment depth of 3 feet was assumed at the downstream end of each reach as this is generally the recent historic depth of water in the canal. This assumption yields a depth of about 1 foot at the upstream end of the reach, assuming water is allowed to pond over the entire length of the reach. Reach boundaries were then adjusted to better distribute stormwater inflows and to coincide with the locations of existing storm sewers that could serve to pass water out of the canal.

If a design reach is segmented into two separate basins by constructing a berm at the midpoint of the reach, with the upstream segment draining to the downstream segment prior to discharging from the canal, the resulting two segments in that reach will be able to store significantly more water than if the mid-reach berm were not constructed. If the water is again allowed to pond to 3 feet at the downstream end of both segments within reach, 30 to 40 percent more water can be stored than with a single mile-long basin. A summary of the design reach characteristics, including reach length, tributary area, design WQCV, canal volume available, and design peak inflow rate, is included in Table 4-1. Assuming each of the 52 design reaches was a single continuous basin, 26 of the 52 would not have the capacity to treat the WQCV of the entire subbasin area draining to them. However, by using just one segmenting berm within each reach, the number of reaches that do not have the capacity to treat the WQCV of the entire subbasin area draining to them is reduced from 26 to 18. On a system-wide basis, segmenting reaches where possible provides an additional 81 acre-feet of storage volume that can be utilized to treat stormwater and provide irrigation to existing trees. Appendix C includes detailed mapping that shows reach and basin delineations as well as existing and proposed inflow locations and existing storm sewer infrastructure.

Table 4-1 - High Line Canal Feasibility Study Design Reach Results

Design Reach	Length (ft)	Segment Length (ft)	Tributary Area (ac)	Location	Required WQCV [1] (ac-ft)	Canal Volume Available (ac-ft)	Volume Difference (ac-ft)	CUHP Excess Precipitation (ac-ft)	Canal Segments	Gross Peak Flow Rate (cfs)	Imperviousness	% Difference	Design Peak Flow Rate (cfs)	Total Allowable Peak Flow Rate (cfs)	Existing Peak Flow Rate (cfs)	Allowable Additional Peak Rate (cfs)	Design Volume (ac-ft)	Allowable Volume (ac-ft)	Comments
1	5,867	2,934	0	Douglas County	0.00	4.91	4.91	0.00	2	0	N/A	N/A	N/A	N/A	N/A	N/A	0.00	4.91	No existing tributary area identified
2	4,944	2,472	0	Douglas County	0.00	4.32	4.32	0.00	2	0	N/A	N/A	N/A	N/A	N/A	N/A	0.00	4.32	No existing tributary area identified
3	7,121	3,561	447	Douglas County	1.43	8.61	7.18	0.81	2	17	10%	-0.74	64	385	0	385	1.43	8.61	
4	4,953	2,477	756	Douglas County	8.01	3.76	-4.25	6.80	2	75	32%	-19%	92	43	43	0	3.76	3.76	
5	4,399	2,200	374	Douglas County	3.42	3.95	0.53	2.28	2	21	27%	-27%	29	33	8	25	3.42	3.95	
6	8,594	4,297	272	Douglas County	0.61	6.75	6.13	0.11	2	1	7%	-84%	6	65	0	65	0.61	6.75	
7	6,395	3,198	587	Douglas County	7.86	7.30	-0.56	7.57	2	124	40%	-6%	132	122	0	122	7.30	7.30	
8	8,434	4,217	470	Douglas County	3.80	6.97	3.18	2.36	1	33	24%	-34%	50	92	92	0	3.80	6.97	Limit depth to not backup into siphon
9	5,734	2,867	73	Douglas County	1.84	7.71	5.87	2.07	2	42	75%	23%	34	142	0	142	1.84	7.71	
10	6,465	3,233	178	Douglas County	4.18	7.36	3.17	4.67	2	98	70%	20%	81	143	72	72	4.18	7.36	
11	2,432	1,216	100	Douglas County	1.27	3.93	2.67	1.16	2	17	38%	-9%	18	56	0	56	1.27	3.93	
12	4,969	2,485	167	Douglas County	3.24	7.20	3.95	3.50	2	73	58%	13%	65	143	0	143	3.24	7.20	
13	3,790	1,895	249	Douglas County	5.53	5.55	0.02	6.12	2	162	66%	18%	138	138	0	138	5.53	5.55	
14	6,419	3,210	266	Littleton/Douglas County	6.46	8.36	1.90	7.26	2	204	72%	21%	168	217	0	217	6.46	8.36	
15	4,949	2,475	316	Littleton	8.47	6.60	-1.87	9.65	2	190	80%	25%	152	118	118	0	6.60	6.60	
16	2,989	1,495	223	Littleton	5.05	3.98	-1.07	5.63	2	107	68%	19%	91	71	0	71	3.98	3.98	
17	7,089	3,545	153	Littleton	2.46	7.84	5.37	2.51	2	54	48%	4%	52	166	41	124	2.46	7.84	
18	7,801	3,901	763	Littleton/SEMSWA	12.14	9.14	-3.00	12.39	2	239	47%	3%	232	175	175	0	9.14	9.14	
19	8,575	4,288	256	SEMSWA/Littleton	4.08	9.27	5.18	4.15	2	94	48%	3%	91	207	207	0	4.08	9.27	
20	3,268	1,634	389	SEMSWA	6.49	4.30	-2.19	6.63	2	122	50%	5%	115	76	0	76	4.30	4.30	
21	4,604	2,302	118	SEMSWA	2.02	5.43	3.42	2.10	2	35	51%	7%	33	88	88	0	2.02	5.43	
22	5,580	2,790	182	SEMSWA	2.62	5.99	3.36	2.58	2	54	43%	-2%	55	125	62	62	2.62	5.99	
23	9,598	4,799	204	Greenwood Village	2.64	8.53	5.90	2.44	2	50	39%	-8%	54	174	174	0	2.64	8.53	
24	7,629	3,815	386	Greenwood Village/SEMSWA	4.48	6.27	1.79	4.08	2	74	35%	-14%	86	121	121	0	4.48	6.27	
25	6,787	3,394	201	Greenwood Village	1.83	3.67	1.84	1.38	1	18	27%	-27%	25	49	12	37	1.83	3.67	Limit depth to not backup into Big Dry Creek structure
26	9,057	4,529	164	Greenwood Village	1.66	9.13	7.47	1.27	2	23	30%	-22%	29	160	160	0	1.66	9.13	
27	6,740	3,370	132	Cherry Hills Village	0.83	6.49	5.67	0.48	2	7	19%	-47%	14	109	109	0	0.83	6.49	
28	7,278	3,639	386	Cherry Hills Village	4.29	6.46	2.17	3.73	2	50	33%	-16%	60	90	90	0	4.29	6.46	
29	9,160	4,580	347	Denver/Cherry Hills Village	5.89	7.88	1.99	6.08	2	110	51%	6%	103	138	69	69	5.89	7.88	
30	7,659	3,830	521	Denver	8.71	7.46	-1.25	8.97	2	149	50%	6%	141	121	121	0	7.46	7.46	Ponding under I-25, CDOT ROW
31	6,612	3,306	214	SEMSWA	3.80	6.76	2.96	3.98	2	62	53%	8%	57	101	101	0	3.80	6.76	
32	7,283	3,642	249	Denver	4.63	6.46	1.83	4.90	2	69	55%	10%	63	87	44	44	4.63	6.46	
33	7,012	3,506	396	Denver	6.79	5.93	-0.86	7.04	2	110	51%	7%	103	90	28	62	5.93	5.93	
34	10,243	5,122	450	SEMSWA/Denver	9.13	7.44	-1.69	9.86	2	179	60%	14%	157	128	0	128	7.44	7.44	
35	7,700	3,850	624	Denver	14.07	4.39	-9.68	15.60	1	290	67%	18%	245	76	0	76	4.39	4.39	Limit depth to not backup into Cherry Creek siphon
36	6,277	3,139	379	SEMSWA/Denver	9.82	6.18	-3.64	11.13	2	230	77%	24%	186	117	0	117	6.18	6.18	
37	5,137	2,569	98	Denver/SEMSWA	1.37	5.33	3.97	1.32	2	22	42%	-4%	23	90	47	42	1.37	5.33	
38	7,800	3,900	759	Denver	18.91	7.15	-11.76	21.33	2	326	74%	22%	266	101	0	101	7.15	7.15	
39	3,337	1,669	498	Aurora	10.18	3.76	-6.42	11.11	2	118	61%	15%	103	38	0	38	3.76	3.76	
40	6,433	3,217	201	Aurora	3.71	6.64	2.93	3.93	2	66	55%	10%	60	107	27	81	3.71	6.64	
41	6,224	3,112	584	Aurora	8.01	5.80	-2.21	7.70	2	129	41%	-5%	135	98	0	98	5.80	5.80	
42	6,914	3,457	707	Aurora	18.44	6.61	-11.84	20.92	2	427	78%	24%	344	123	0	123	6.61	6.61	
43	5,848	2,924	0	Aurora	0.00	3.48	3.48	0.00	1	0	N/A	N/A	N/A	N/A	N/A	N/A	0.00	3.48	2 siphons, East & West Toll Gate Creek; no trib. area
44	4,041	2,021	155	Aurora	3.38	3.45	0.06	3.71	2	55	65%	17%	47	48	0	48	3.38	3.45	
45	8,549	4,275	222	Aurora	3.85	5.88	2.03	4.02	2	69	52%	7%	65	99	0	99	3.85	5.88	
46	3,519	1,760	113	Aurora	1.79	3.08	1.29	1.81	2	22	47%	3%	21	36	0	36	1.79	3.08	
47	11,081	5,541	350	Aurora	6.87	8.22	1.35	7.37	2	126	59%	13%	112	134	0	134	6.87	8.22	
48	3,043	1,522	150	Aurora	2.95	2.53	-0.42	3.17	2	52	59%	13%	46	40	0	40	2.53	2.53	Piped under Colfax Ave.
49	6,227	3,114	533	Aurora	10.63	4.11	-6.52	11.44	2	180	59%	14%	158	61	0	61	4.11	4.11	
50	6,809	3,405	1,064	Aurora	30.40	4.73	-25.67	35.02	2	350	85%	28%	273	42	42	0	4.73	4.73	
51	6,670	3,335	209	Denver	3.30	5.02	1.72	3.34	2	53	47%	3%	52	79	0	79	3.30	5.02	
52	5,970	2,985	230	Denver	3.31	5.30	2.00	3.26	2	53	43%	-2%	54	87	0	87	3.31	5.30	
				Totals	**296.6**	**313.4**	**16.7**	**310.8**		**5229.1**			**4778.1**	**5353.0**			**201.8**	**313.4**	

[1] WQCV computed using UDFCD WQCV equation; $WQCV = 0.22I*T_d^{0.19}$ (T_d = drain time (24 hours), I = imperviousness, units in watershed inches), BMP Vol = (WQCV/12)*A (units in acre-feet)

5.3 LARGE STORM CAPACITY REQUIREMENTS

During the September 2013 flood events in the Denver metropolitan area and in previous years, the High Line Canal was inundated with stormwater runoff and flow within the canal overtopped the canal banks at several locations. Immediately prior to previous intense rainfall events that caused the flooding, the High Line Canal was carrying a base flow with a depth of approximately 3 feet. This is the approximate depth of flow that the canal has historically conveyed as an irrigation water delivery system in the last 20 or so years. Thus, when a storm event occurred while the canal was running, the capacity of the canal to carry stormwater runoff was limited to the surcharge area above the base canal flow. Similarly, one goal of this project is to allow the canal to carry stormwater runoff at levels that have been experienced in the recent past. Thus, the heights of the control structures have been limited to 3 feet in order to meet this constraint.

As an additional protection against canal bank overtopping, an emergency overflow facility should be considered by the designer during final design to minimize the potential negative effects of adding stormwater to the canal. Overflow facilities should be sized to remove the same flow rate from the canal as has been diverted into the canal for water quality treatment. The overflow facility could be located opposite either the inflow point into the canal segment or near the proposed outlet facility (if capacity exists) and at an elevation near the top of canal bank to avoid inadvertently discharging flows in excess of the water quality volume to allow the canal to continue conveying stormwater flows as it has historically.

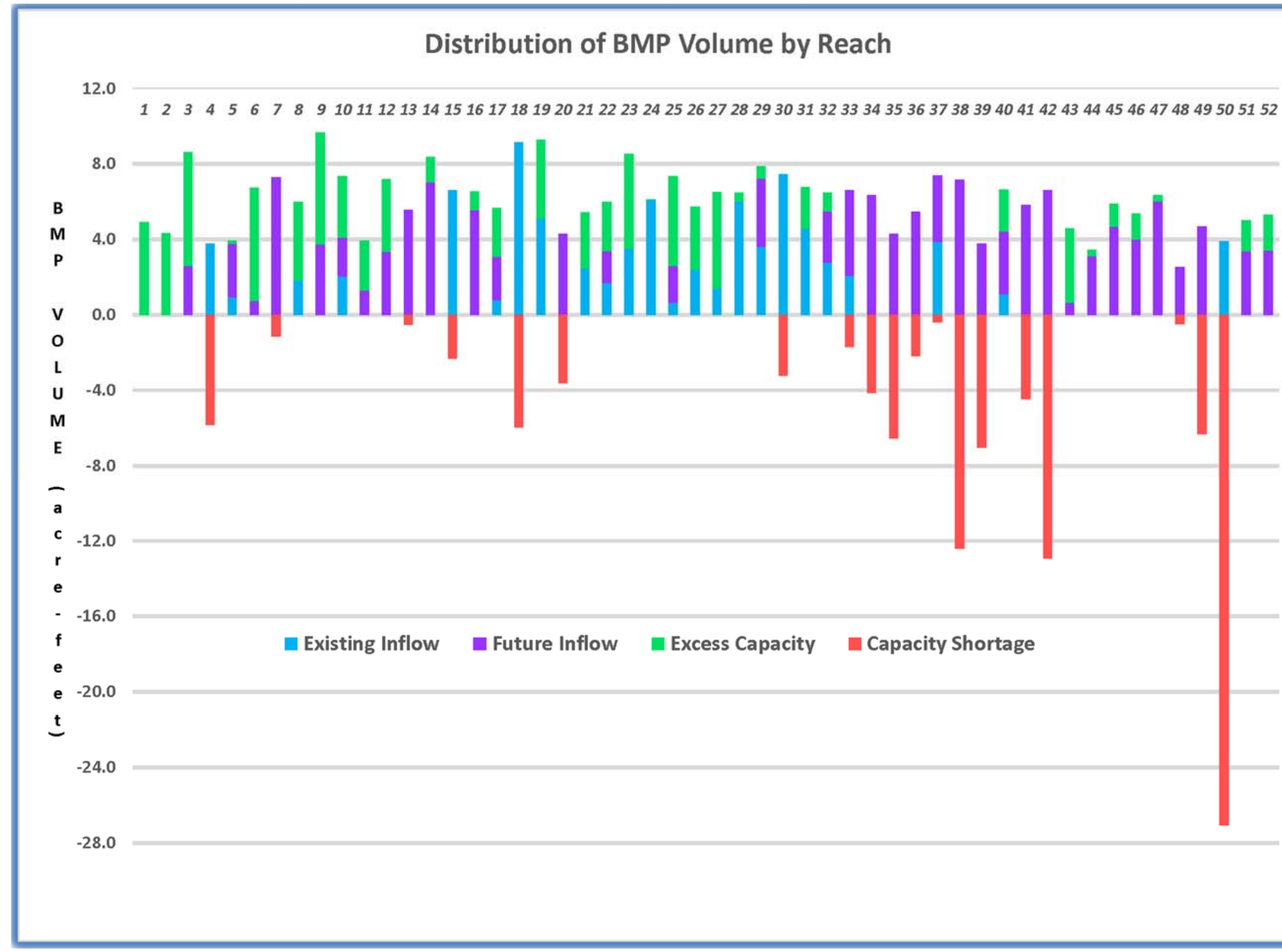
6.0 WATER QUALITY FACILITY DESIGN CONSIDERATIONS

There are several design components involved in diverting stormwater runoff into the High Line Canal, storing it for up to 72 hours to provide water quality treatment, and then discharging it downstream of the canal into the same watershed in which it was generated. Each of these components has its own set of design considerations and alternatives, which are discussed in the following sections.

6.1 DIVERSIONS INTO THE CANAL

There are currently multiple surface inflows into the canal, such as sheet flow and drainage pans, as well as several enclosed storm sewers that discharge into the canal, the majority of them draining small areas. In fact, over 20 percent of the watersheds that drain towards the canal actually drain directly into the canal. Figure 6-1 is a reach-by-reach graphic of the the existing stormwater inflow into the canal and the capacity of each reach to accept additional stormwater inflows. The reaches shown in red are those that do not have sufficient capacity to treat the entire WQCV of the tributary area draining to them.

Figure 6-1 – Existing and Future Canal Inflow Volumes



The full potential to retrofit the High Line Canal as a water quality facility will not be realized unless some stormwater flow is diverted into the canal from those existing storm sewers that currently pass under the canal. Within any given reach of the canal, there could be more storm sewers crossing the canal than there is volume in the canal to store the water quality capture volume of all the basins they drain.

The water quality capture volume for any given subbasin is separate from the total runoff volume actually produced by EPA SWMM when evaluating the water quality event, which for this study is a 2-hour design storm based on a 0.53-inch 1-hour point rainfall distributed temporally as a 0.61-inch 2-hour rainfall. This is because the water quality control volume calculation is based upon analysis of many storm events, whereas the runoff modelling used to determine peak flow rates is based upon a single representative storm event. Therefore, the water quality event runoff volumes calculated by EPA SWMM are not equal to the calculated WQCV, nor are the values for excess precipitation calculated by the CUHP model on a basin-by-basin basis. The CUHP and EPA SWMM input and output files are included in Appendix B.

The reason an EPA SWMM model is used at all in this study is to determine the peak flow rates that will need to be diverted into the canal from the various storm sewers that currently pass under the canal. However, these peak flow rates are meaningless if the volumes they produce cannot be correlated to the water quality control volume. Because the WQCV is not equal to the CUHP excess precipitation or to the EPA SWMM runoff volume, an analysis was completed to determine diversion flow rates for developing a correlation relationship between basin imperviousness, CUHP excess precipitation, and the calculated WQCV for each of the basins within the project area. That relationship is shown in the Figure 6-2 and is represented by the following equation having an R^2 value of 0.9924:

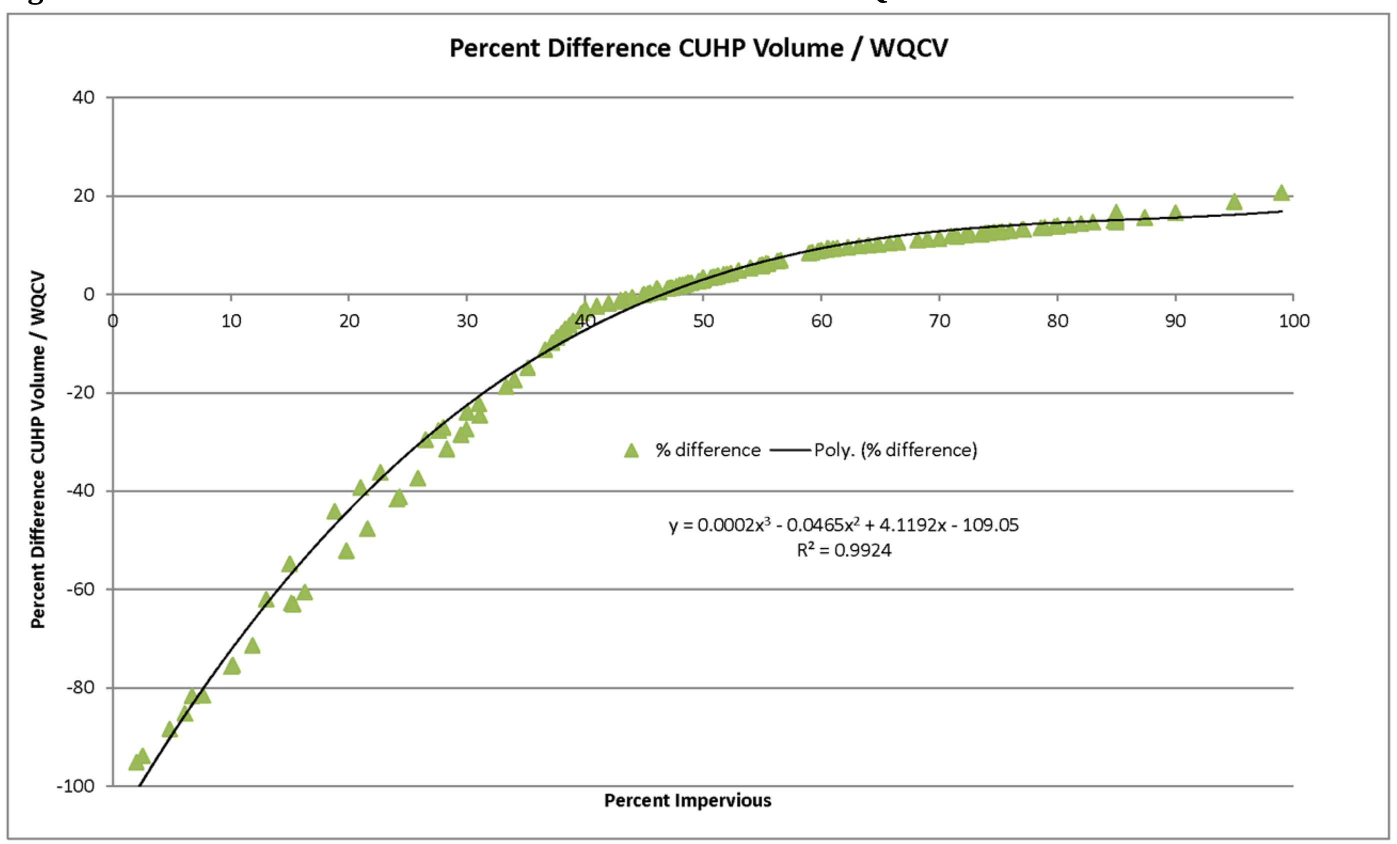
Percent difference = $0.0002I^3 - 0.0465I^2 + 4.1192I - 109.05$ (expressed as a decimal)

Where:

Percent difference = (CUHP excess precipitation in acre-feet – WQCV in acre-feet)/ WQCV in acre-feet)

I = Imperviousness expressed as a percentage

Figure 6-2 – Percent Difference Between CUHP Volume and WQCV



The calculated percent difference, which is based only on basin imperviousness, can now be used to adjust the total peak runoff calculated by the EPA SWMM model for each design reach that has sufficient capacity to store the calculated WQCV. This relationship gives reasonable results for tributary areas with between 20 and 100 percent imperviousness. However, for tributary areas with less than 20 percent imperviousness, the inflow rate should be reviewed and confirmed or revised as part of the final design. An example of the use of this equation is as follows: reach 5 takes runoff from basins WQ125 through WQ128. These basins have a WQCV of 3.42 acre-feet, a CUHP excess precipitation of 2.28 acre-feet, and a composite imperviousness of 27 percent. There is 3.95 acre-feet of available storage in reach 5, so capacity is not a problem.

In the case of reach 5, basins WQ128 and WQ127 drain to the canal via outfall node WQ126, whereas basin WQ125 drains directly to the canal. The peak discharge to reach 5 is therefore the sum of the peak inflow at EPA SWMM outfall node WQ126 and junction node WQ125. Discharges from WQ127 and WQ128 are contained in the value for WQ126. The peak discharges can be summed without regard to timing since the 72-hour drain time of each reach negates any effects of the differences in inflow timing.

The sum of the EPA SWMM model peak discharges into reach 5 is 21 cfs, but this represents a CUHP excess precipitation volume of only 2.28 acre-feet, whereas the desired WQCV is 3.42 acre-feet. The design peak discharge into reach 5 needs to be larger than the peak discharge from a 0.53-inch storm event in order to fill the desired storage volume of 3.95 acre-feet.

The percent difference is calculated to be -27 percent using the formula above. The gross peak flow rate of 21 cfs should be adjusted by dividing it by 1 plus the percent difference, or 0.73, which in this case would yield a design peak discharge of 29 cfs. Additionally, because reach 5 has an excess capacity of 0.5 acre-feet, this flow rate should be further adjusted upward to yield additional water that could be used to irrigate existing trees along the canal. The 3.95 acre-feet of storage is 15 percent higher than the 3.42 acre-feet required by the WQCV. The design peak flow should be adjusted upward 15 percent to 33 cfs to account for this.

Similarly, if the CUHP excess precipitation for basins draining to a reach is higher than the calculated WQCV, the design peak EPA SWMM flow rate is adjusted downward by dividing it by 1 plus the percent difference, with the percent difference being a positive value in that case. In the event the canal does not have enough capacity to store the WQCV, the peak EPA SWMM flow rates will need to be adjusted in a similar fashion to ensure that the design reaches do not overtop during the water quality event.

An integral part of the design of the diversion structures for any reach of the canal will be to determine which storm sewer crossings should be diverted and which should be left unmodified. To determine which storm sewer crossings should be diverted, a qualitative list of costs and benefits should be completed for each existing crossing. It will be very difficult and costly to divert flows from storm sewers that cross deeply below the canal or remain at an invert elevation below the canal invert elevations for a considerable distance upstream of the canal. Depending on additional existing infrastructure in the immediate vicinity of the storm sewers, it may prove ill-advised to divert flows in this scenario. On the other hand, if a reach has only one storm sewer crossing and it carries drainage from a large basin, it may prove worthwhile to pursue a diversion even under difficult circumstances, especially if there are large trees along that reach of the canal that will have a difficult time surviving once irrigation water is removed from the canal.

Determining which crossings to divert will also need to consider the land area, use, and associated water quality capture volume of the subbasin each crossing pipe drains. It will also be important to evaluate all the crossings within each reach as a singular unit, as opposed to only evaluating each crossing as a stand-alone facility. The subbasin areas that already contribute storm drainage to the canal must also be considered as part of the reach unit, as some reaches already receive a significant amount of stormwater inflow. This will ensure that the total volume of water flowing into the reach from multiple subbasins during a storm event will both optimize the use of the canal and not overtop the reach's downstream control structure during a water quality event.

Finally, there are several locations where a storm sewer crosses the canal very close to a reach boundary. In scenarios where there is an option to divert flow into one of two reaches, the choice will often be determined by which reach has more available capacity and water rights ramifications if the flow would be diverted into another watershed.

6.2 DIVERSION STRUCTURES

Diversion structures need to be designed following several criteria. There are two main goals for each diversion structure. The first is to divert all storm flows up to and including the water quality event peak flow rate entirely into the canal for treatment, provided space is available. The second is to limit the amount of flow that is diverted into the canal for all events larger than the water quality event.

One general concept diversion structure design consists of installing a new manhole or vault at the proposed diversion location. The storm sewer from which flow is being diverted will maintain its existing invert elevation; however, the diversion pipe will be placed at an elevation lower than the existing storm sewer invert at an elevation that the peak water quality flow rate is entirely diverted to the canal. The flow rate in the diversion pipe can then be controlled by adjusting the pipe slope such that the pipe reaches full flow capacity at the design flow rate. Creative benching of the diversion manhole or vault invert can aid the transition of the water quality peak flow rate into the diversion pipe.

Diversion structures also limit the flow of additional water into the diversion pipe above the design flow rate and storage capacity of the canal reach. The available storage in a canal reach may be less than the WQCV. The total runoff volume from the water quality event may be higher than the calculated WQCV. The goal when designing each reach should be to fill the canal to the indicated depth at the downstream end of each segment (typically 3 feet) without overtopping the downstream control structure. The water quality event flow should be diverted into the canal from as many different basins within the reach as possible as long as capacity is available, regardless of the calculated WQCV. Due to capacity constraints, this may require that a water quality event point rainfall of less than 0.53 inches be used if the total volume of runoff produced by EPA SWMM is greater than the capacity of the reach. The diversion structure should be designed for the peak flow resulting from that lesser point rainfall. This methodology will help to ensure transbasin diversions are avoided.

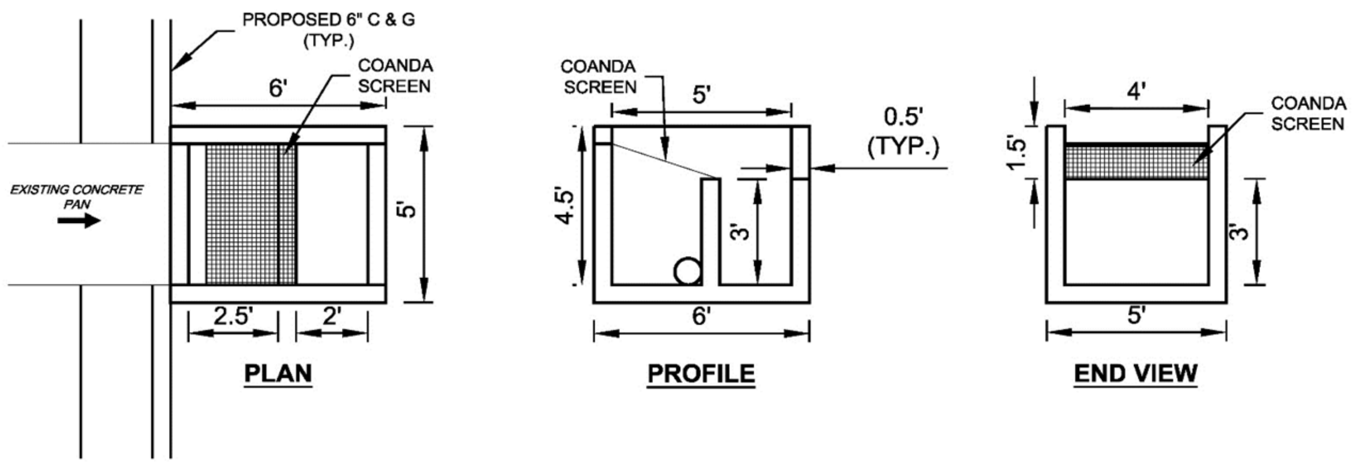
6.3 FOREBAYS

Natural debris, such as leaves, twigs, and branches; man-made trash, such as plastic containers, food wrappers, and newspapers; and sediment loads, including sands and fine particles, are all conveyed by stormwater and ultimately end up being discharged where the stormwater is discharged. To prevent trash and debris from being dispersed throughout the length of the High Line Canal, forebays ultimately should be provided at all existing and new stormwater inflow points into the canal. Forebays will collect and store incoming trash and debris and provide singular points of maintenance in lieu of having to remove trash and debris along the entire length of the canal.

The shape and location of the forebays will need to be specific to local site parameters, including the elevation, size, and type of the incoming stormwater conveyance; the existing land use; the availability of maintenance access and the type of maintenance preferred; the physical space available; and the size of existing or potential easements within which to construct the forebay. There are at least three structural scenarios for inflow points into the canal that will each have various possible forebay configurations. One scenario is concentrated surface flows that discharge to the top of the canal banks, including drainage pans and curb and gutter sections. The second two scenarios are enclosed storm sewers that will discharge to the canal at either the canal invert or somewhere higher up on the canal bank. The vertical location of the incoming pipe will often be determined by the configuration of existing storm sewer infrastructure with respect to the location and invert of the canal. Generally speaking, a higher discharge location offers more options.

The UDFCD has a calculation method used to determine forebay sizes for extended detention basins. These basins typically require a larger forebay to minimize the amount of sediment that is carried in the storage area of the basin. In contrast, the High Line Canal has for years carried stormwater runoff with little impact from inflowing sediment. The use of the UDFCD equations would result in the need to place forebays directly into the canal, which would defeat the purpose of keeping trash and debris out of the canal. Therefore, the forebays considered for this project are smaller in size and are directed towards preventing trash and debris from entering the canal.

Figure 6-3 – Forebay Option for Concentrated Surface Flows



Where a curb and gutter section directs surface flow to a discharge point on the side of the canal, these surface flows could be collected in an inlet box structure with a sump below the outlet pipe to collect trash and debris. The floor of the sump and the walls of the structure below the outlet pipe should be perforated and the structure backfilled with course aggregate to encourage the sump area to drain. Figure 6-3 shows a schematic of this concept. As an alternative to this in-ground structure, a surface forebay that can utilize a street sweeper for cleaning should be evaluated.

For forebays that serve incoming storm sewer pipes, there are several general concept options that have historically been used. The first is an underground vault that has a sump built in to collect trash and debris. These vaults can be traditional curb or area inlets that have been modified to serve as inflow forebays on larger vaults or proprietary devices. The advantage to vaults with sumps is that they can be innocuous and will allow for grades around the site to remain mostly unchanged. Another advantage is that access will be provided at the top of the channel bank so maintenance can be conducted with the use of a vacuum truck. The disadvantage is that it is not clear when maintenance is necessary by simply driving by. Where space is at a premium, underground forebays may be the only option available to the local entities wishing to provide them at the inflow points. Where sediment load is anticipated to be low, it may be possible for a vault concept forebay to have a fairly long maintenance interval.

A typical option often used at storm sewer inflow points into extended detention ponds is an open concept forebay. The storm sewer pipe discharges near the invert of the pond directly into a large rectangular concrete basin with sidewalls at a height of 6 to 12 inches to contain trash and debris. This kind of forebay may have baffles immediately downstream of the pipe outfall to slow and disperse flow. An open concept forebay requires a great deal of space. There are two options for this. The pipe could discharge at the canal toe of slope, in which case the forebay would extend across nearly the entire width of the channel. This option would limit canal side slope grading and impacts to adjacent properties. The other option is to push the discharge point back from the canal toe of slope. This would require cutting into the canal banks with headwalls and wingwalls to place the forebay somewhat offset from the main canal invert.

The advantages and disadvantages of the open concept forebay are essentially the mirror of those of the vault option with one additional disadvantage. The need for maintenance is more readily visible; however, more space is required and maintenance access may prove more difficult depending on the specific location of the open forebay. The additional disadvantage is that for those forebays that extend significantly into the main channel, stormwater flows moving along the length of the canal may dislodge any trash or debris that have accumulated in the forebay, essentially negating their purpose.

The project sponsors and stakeholders have differing levels of maintenance capabilities and preferences. Therefore, a single method to keep trash and debris out of the canal is not proposed. Rather, each entity should determine the method of trash and debris collection and disposal that is most appropriate for their jurisdiction.

6.4 CONTROL STRUCTURES

Control structures are designed to be located near the midpoints of those canal reaches for which dividing the reach into two segments would provide much needed additional water quality treatment volume. This will apply to the majority of the design reaches of the canal. The exact location of the control structure within each reach will ultimately be determined by the need to balance the location of inflow points and the water quality volume they are anticipated to contribute with the resulting reach segment volumes the control structure location will yield.

For example, control structures ideally will be placed at the exact midpoint of each canal reach, providing two identical treatment volume segments for that reach. However, if a reach has only one inflow point in the upstream half of the reach and four inflow points in the downstream half of the reach, for example, the location of the control structure may be moved slightly downstream of the midpoint in order to collect a second inflow point, especially if the volume expected from the most upstream of these four inflow points is significant. This will allow for more water quality treatment for the downstream subbasins and will maximize the use of the available treatment volume in the upstream segment.

The design concept for the control structures is presented in schematic form in Figures 6-4 and 6-5. Control structure sites would consist of a 3-foot-high earthen berm spanning the width of the canal. The berm will have a top width of 4 feet and 3:1 side slopes surfaced with buried soil riprap on the upstream side. Within the berm will be the control structure itself, an orifice plate, and a trash rack mounted on the upstream side of a concrete box with upstream wingwalls and manhole or CDOT Type C grate access from the top of the berm. An 18-inch perforation in the control structure's downstream wall will allow water to pass from the control structure to the downstream segment. The downstream side of the structure is designed as a vertical drop structure. This is intended to reduce the footprint of the structure while protecting the canal from failure when overtopping of the structure occurs during larger storm events. This type of control structure is common in canals and should add to the historic nature of the canal infrastructure. The apron downstream of the vertical drop should be designed for the stormwater flow capacity of the canal at each structure, considering both flow rate and backwater effects.

The orifice plate on each control structure will need to be designed to drain the upstream segment of the reach within 72 hours. Hydraulic routing will be required as part of the design. If stand-alone software such as EPA SWMM is used to perform the routing, the stage-storage curve should use elevation increments of 0.25 feet or less due to the minimal degree of relief provided by each reach segment. A time step no greater than 5 minutes should be used. Discharge calculations or the stage-discharge curve used to route flow through the control structure will need to account for the presence of backwater in the downstream segment of the reach until the water depth at the upstream end of the downstream segment reaches zero.

The proposed standard orifice plate design is two circular orifices, one below the other. The lower orifice will have its centroid at the invert of the canal. The centroid of the upper orifice will be located at a depth of half the berm height, or 1.5 feet for the standard control structure. The area of the upper orifice will be 1.41 (√2) times the area of the lower orifice so that at the start of the drain time, when the water depth is 3 feet, each orifice will pass the same amount of flow. A micropool should be provided upstream of the orifice plate.

Figure 6-4 – Control Structure Plan

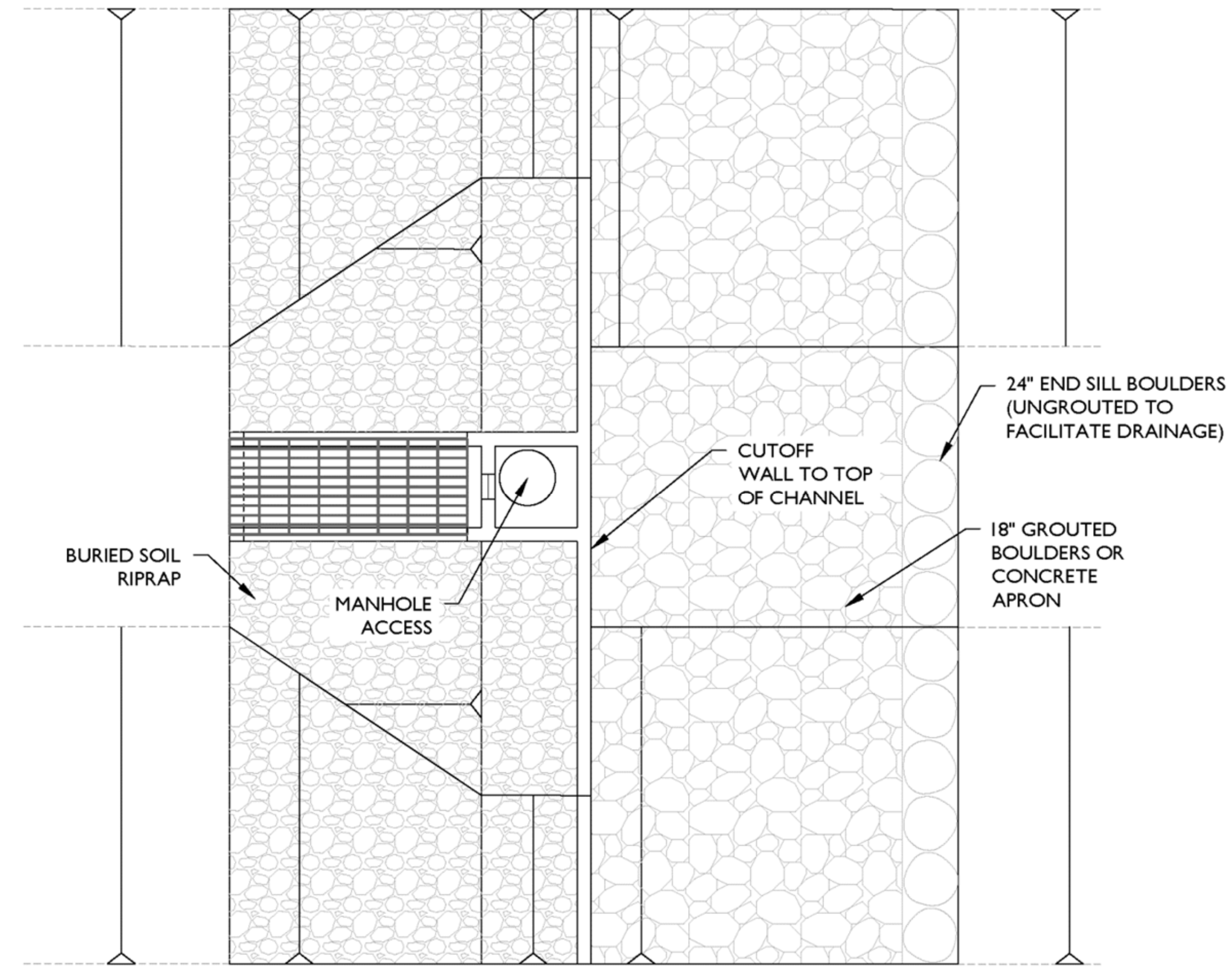
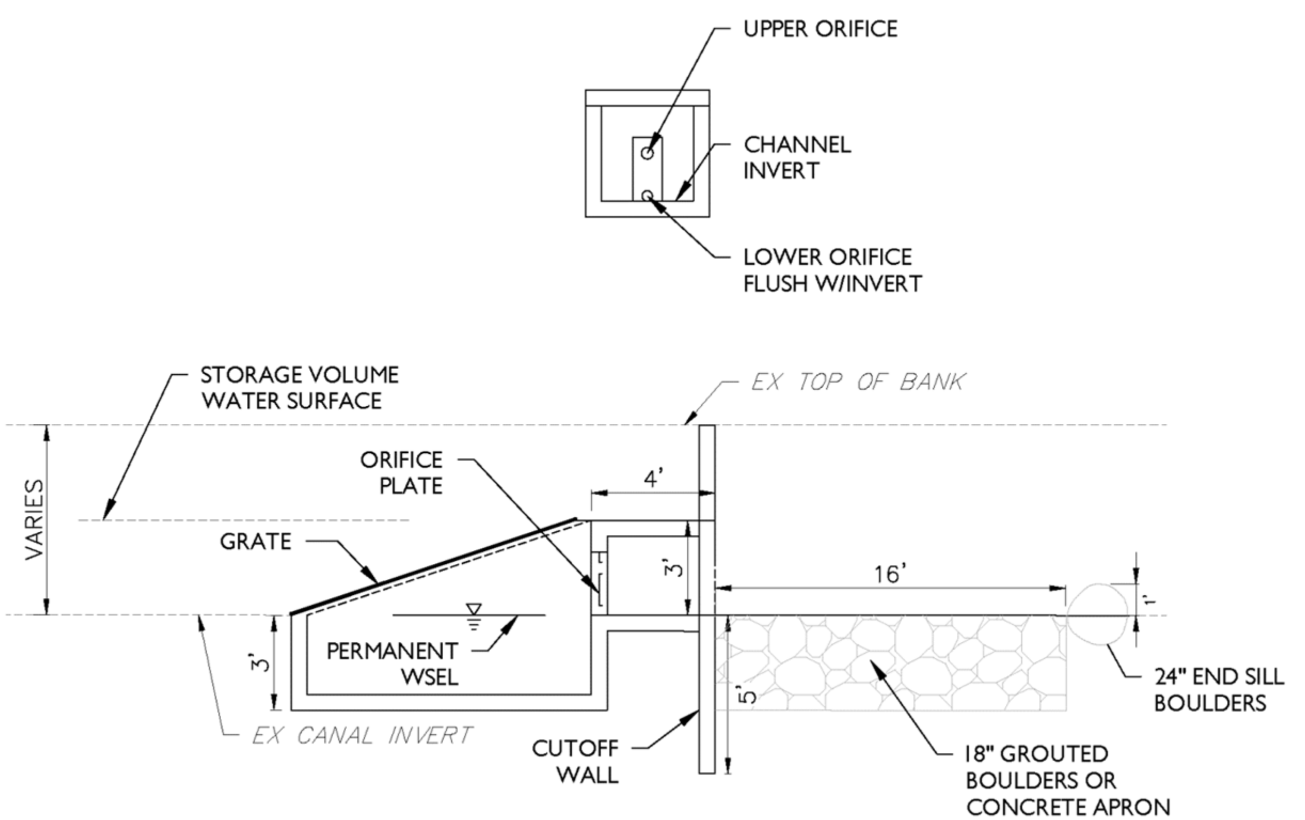


Figure 6-5 – Control Structure Section



6.5 OUTLET STRUCTURES

Outlet structure sites will look very similar to control structure sites in that they will consist of the same 3-foot-high earthen berm with 4-foot top width and 3:1 side slopes surfaced with buried soil riprap on the upstream side. The upstream side of the control structure itself will also look very similar to that of the control structure in that there will be a trash rack mounted on wingwalls, a micropool, and an orifice plate. The most prominent difference will be that instead of a pipe discharging into the canal downstream of the berm, the discharge pipe will exit the canal via the side of the control structure. Discharges from the canal would then be to downstream drainage systems, whether this means discharging into an enclosed storm system or into one of the several drainageways crossing the canal. In either case, water will ultimately be discharged to the same drainageway it would be discharging to without using the High Line Canal as a water quality facility.

The orifice plate on each outlet structure will need to be designed to drain the downstream segment of the reach within 72 hours. Because the upstream segment ultimately also drains to the downstream segment, the orifice plate on the outlet structure will be sized somewhat larger than the orifice plate on the control structure. A reach-wide hydraulic routing will be required to account for the upstream segment contributing inflow into the downstream segment. The same routing parameters required for control structures will apply to the reach-wide routing with the goal being to have both segments drain simultaneously.

The proposed standard orifice plate design is the same for the outlet structure as for the control structure. It is proposed to consist of two circular orifices, one below the other. The lower orifice will have its centroid at the invert of the canal. The centroid of the upper orifice will be located at a depth of half the berm height, or 1.5 feet for the standard control structure. The area of the upper orifice will be 1.41 ($\sqrt{2}$) times the area of the lower orifice so that at the start of the drain time, when the water depth is 3 feet, each orifice will pass the same amount of flow. A micropool should be provided upstream of the orifice plate. A schematic of the design is shown below in Figures 6-6 and 6-7.

Figure 6-6 – Outlet Structure Plan

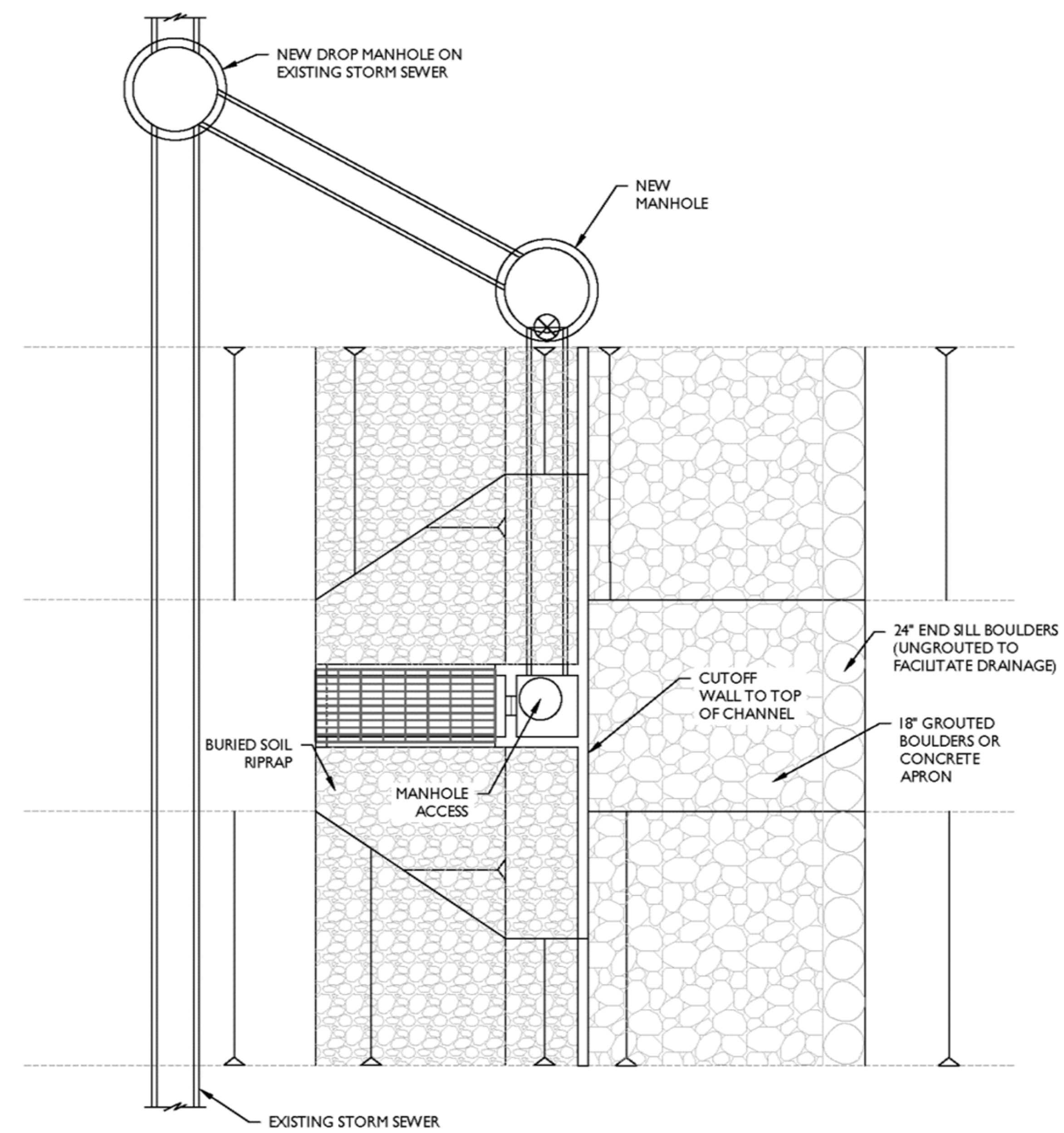
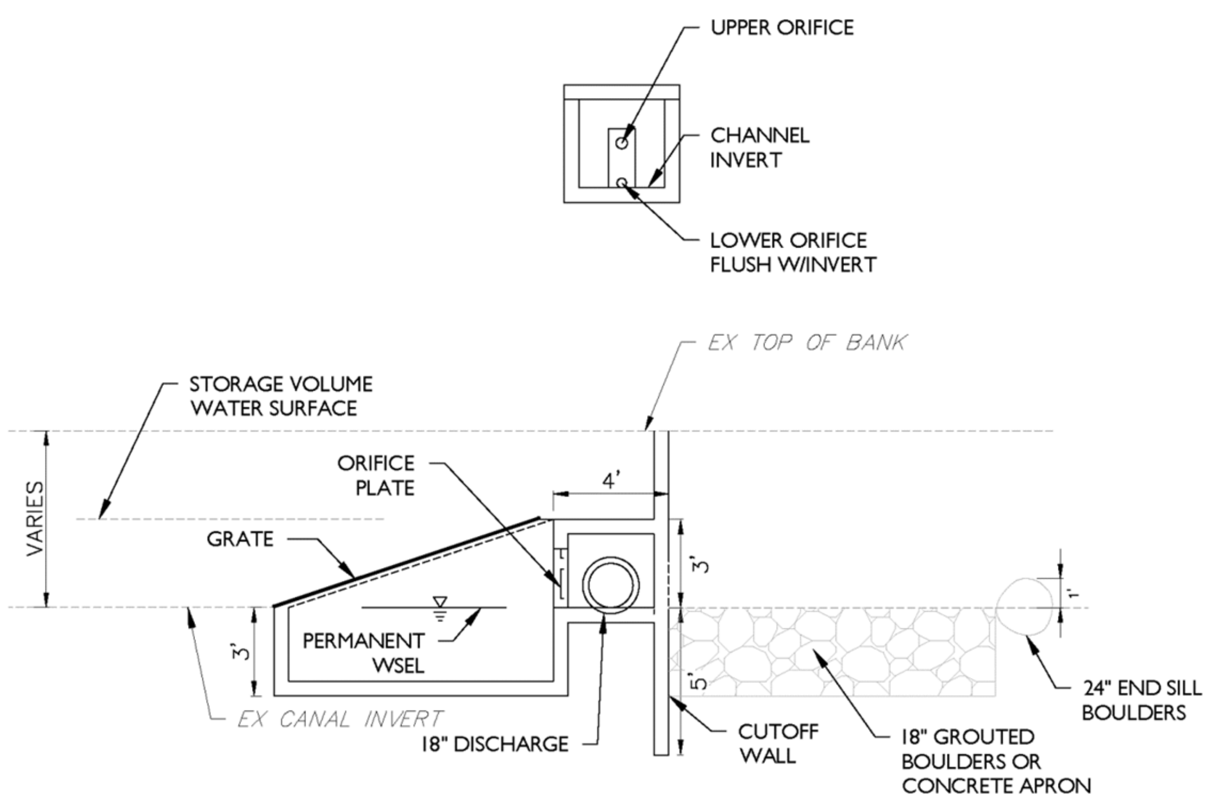


Figure 6-7 – Outlet Structure Section



6.6 CONNECTIONS TO EXISTING INFRASTRUCTURE

Connections to existing infrastructure to return the treated water to the storm sewer system will typically involve construction of a new manhole or replacement of an existing manhole to merge the two systems. An analysis may be completed to determine existing stormwater flow rates already being carried by the storm sewer to which each reach will discharge. However, as the design reaches are being designed to drain very slowly over 72 hours, it is highly unlikely that canal discharges coming from the newly constructed water quality facilities will overwhelm the systems into which they discharge.

7.0 PILOT PROJECT

As part of this Feasibility Study, a conceptual design and construction cost estimate for a pilot project was developed. The conceptual design includes a proposed retrofit of portions of the existing storm sewer system to include stormwater diversions into the canal, control structures between segments, and outlet structures to pass water into the downstream watershed.

7.1 PURPOSE

The pilot project is intended to provide a specific case study on how a proposed retrofit of the High Line Canal might be physically realized given the various constraints that will be encountered along the majority of the length of the canal, including limited existing easement and right-of-way, existing utilities, and locations of existing storm sewer infrastructure. More importantly, the pilot project will provide a better estimate of the cost of the water quality retrofit that can then be used to estimate the costs for retrofit of the entire canal.

7.2 LOCATION

The pilot project includes two non-contiguous 1-mile reaches of the High Line Canal. The first area, reach 38, begins just downstream of the Fairmont Cemetery in the City and County of Denver. Its upstream boundary is South Valentia Street and its downstream boundary and outlet structure is located at South Havana Street. The second pilot project is reach 40, which begins at East Alameda Avenue and extends downstream to Peoria Street. One reason these locations were chosen is that Denver Water does not currently run water downstream of the Fairmount Cemetery on a regular basis. Another reason these reaches were chosen is that they are located in two separate municipalities, the City and County of Denver and the City of Aurora. This will give the two cities the opportunity to see specifically how a retrofit of the High Line Canal for water quality might serve their communities.

7.3 RESULTS

Presented in Appendix D are the conceptual design drawings for the pilot reaches. As-constructed drawings were provided for most of the storm sewer systems in the two pilot reaches. Specific benchmarks and datums to tie the drawings to the base topographic mapping were not available. Therefore, the elevations of the storm sewer systems were adjusted to the topographic mapping datum using comparable street elevations and other locations where the drawings could be reasonably compared within the accuracy of the 2-foot contour mapping. One of the most important findings from the pilot study is that, for these two areas, the existing storm sewer systems are fairly deep, making it difficult to divert water from the existing storm sewers at an elevation that will drain to the canal. For the reach 38 area, diversions into the water quality outfall storm sewers are located well south of the canal on South Dayton and South Valentia Streets. In addition, the storm sewer on East Kentucky Avenue is also too deep, thus requiring an additional water quality outfall to collect runoff draining to East Kentucky Avenue. Since the canal in reach 38 doesn't have capacity to treat all the tributary area, the needed water quality flow was divided among four water quality outfalls. The water quality outfall locations and their design flow rates are as follows:

South Valentia Street water quality outfall system – 11 cfs

Lakeshore Drive water quality outfall system – 47 cfs

East Kentucky Avenue water quality outfall system – 11 cfs

South Dayton Street water quality outfall system – 32 cfs

The total peak water quality flow rate is 101 cfs. With the deeper depth of the storm sewer systems in this area, forebays for this area will need to be either buried vaults or need to be located at each of the individual storm sewer inlets before they discharge to the storm sewer system. The outlet structure can easily be tied into the existing storm sewer in South Havana Street.

In reach 40, again the existing storm sewer systems are fairly deep. In fact, part of the tributary area in this reach drains to a private pond that drains under the High Line Canal and cannot be physically directed into the canal without pumping. There are also several multi-family housing developments that currently drain directly into the canal. This area can contribute uncontrolled debris and trash into the canal and thus small forebays are suggested at the discharge points of these areas into the canal. This will require construction of a curb and gutter to concentrate the overland flow to a specific point at the forebays. The outlet structure can easily be tied into the storm sewer in South Peoria Street.

The costs of the facilities for each reach also varied substantially. This was primarily because a substantial portion of reach 40 cannot be diverted into the canal due the construction of a pond that collects runoff from a large portion of the watershed area and diverts the runoff under the canal. Therefore, for purposes of this study, the more extensive costs from reach 38 were used as a baseline against which the costs of the remaining reaches are determined.

The conclusion from the pilot study is that it is feasible to divert a water quality flow into the canal by new storm sewers dedicated to water quality or by diversions from existing storm sewer systems. However, the extent and cost of the infrastructure to accomplish this is more extensive than one may have thought prior to completing the pilot study and well exceeds the costs of just installing the control facilities in the canal. There will still be obstacles that the pilot study did not find (e.g. existing utilities, etc.) that will need to be examined in more detail prior to committing to construction of the projects.

8.0 COSTS

8.1 COST ESTIMATING PROCESS

Two separate cost estimates were prepared for this Feasibility Study. First, an estimate of costs was prepared for the proposed retrofit of the High Line Canal for the water quality purposes described in this Feasibility Study. This estimate of costs included the costs of the in-canal control and outlet structures as well as the outfall storm sewers and forebays needed to direct stormwater runoff into the canal. This estimate of costs does not include a value for the land underlying the High Line Canal as it is undetermined what the value of this property is as related to the stormwater quality use.

A second cost estimate was prepared assuming the canal could not be used for water quality treatment and thus an alternative method of obtaining water quality treatment for the subject watersheds would need to be implemented at some future point in time. The following sections describe the procedure used for these two cost estimates.

8.2 COSTS FOR IN-CANAL WATER QUALITY TREATMENT

The estimated costs for the in-canal water quality treatment were developed using a procedure that followed the logical differences between the 52 reaches in this study. First, the estimated costs for the facilities examined for the two pilot reaches were determined. These costs included three separate features: the control and outlet structures, the water quality outfall storm sewers, and the forebays. These facilities were estimated separately to simplify the application of these costs to the remaining reaches of the canal. In addition, the average slope and design inflow rates for the pilot reaches were determined. Next, a method was developed to relate these costs to the remaining canal reaches. The pilot study showed that the length of the water quality outfall storm sewers is related to the average slope of the watershed. Where the watershed slope is relatively flat, longer water quality outfall storm sewers are needed to collect and convey the water quality flows into the canal. Where steeper watershed conditions exist, these water quality outfall storm sewers will be much shorter since a greater elevation drop exists in a shorter distance. In addition, the sizes of the water quality outfall storm sewers are dependent on the rate of flow needed to be collected for delivery to the canal. Also, whereas most of the flow in the pilot reaches will need to be collected by water quality outfall storm sewers, other watersheds currently have significant amounts of stormwater runoff that discharges to the canal without the need for any additional conveyance facilities. All of these considerations were applied in the cost estimating process.

The estimated cost of the control and outlet facilities were allocated equally to the remaining reaches since all reaches will have an outlet facility and most will have a control facility. For the water quality outfall storm sewers, the pilot reach cost estimates were first prorated to the other reaches by ratio of the design inflow rate for the pilot reaches to the design inflow rate for the remaining reaches. This prorated cost was further prorated based upon the average watershed slope as compared to the watershed slope of the pilot reaches. A final proration was applied to this figure to account for the percent of the watershed that currently drains directly to the canal. The costs of the forebays were prorated only based upon design flow, assuming that forebays are desirable at all inflow points to the canal. These figures were then combined to determine the estimated cost for each of the reaches of the canal. UDFCD's master planning cost workbook, UD-MP COST Version 2.2, was used for estimating the total costs of the pilot reaches, which include construction costs with a contingency as well as legal, administration, and engineering costs. A CCI value of 2014 was used. The resulting estimated costs for the addition of water quality to the High Line Canal are presented by reach and by jurisdiction in Table 8-1. Also included in this table are the estimated operations and maintenance costs for these facilities. These costs do not include costs for maintenance of the High Line Canal trail and facilities as it was assumed that this cost is or will be addressed in the recreational aspects of the canal.

8.3 COSTS FOR ALTERNATIVE WATER QUALITY TREATMENT

The estimated costs of the alternative water quality facilities were estimated using UDFCD's BMP-REALCOST spreadsheet program, assuming the installation of extended detention basins as a comparable method of treatment. This spreadsheet uses a slightly different methodology to determine the WQCV but the overall results are comparable to the results obtained in this study. The alternative cost estimate includes land costs since the construction of new extended detention basins will likely require the acquisition of existing developed property for their installation. The estimated land costs may be low considering very few properties exist that are not already developed. This estimate does not include any storm sewers that may be needed to direct flow to the extended detention basins. The estimated cost of the alternative facilities is $75,452,000. It should be noted that the need for water quality treatment of runoff from all the tributary watersheds is not currently required and may or may not be required in the future. Thus, it may be inappropriate to compare this cost to the cost of the facilities proposed in this project. However, consideration should be given to the fact that the potential to convert the canal may or may not exist in the future, depending on the plans and desires of Denver Water for future use of the canal and canal easements and rights-of-way. In addition, the ongoing reduction in water deliveries to the canal continues to stress the existing vegetation and trees. Water has not run for many years in some areas of the canal, and the benefit of preservation of vegetation and trees may be reduced in these areas. The benefits of enhancement of water quality are, however, still substantial in those areas.

Table 8-1 - High Line Canal Feasibility Study - Costs Summary by Reach

Design Reach	Design Flow Rate	Jurisdiction	Total Capital Cost - Control and Outfall Structures	Total Capital Cost - WQ Outfall Systems	Grand Total Capital Cost	Total Annual O&M Cost
1	0	Douglas County	$0	$0	$0	$0
2	0	Douglas County	$0	$0	$0	$0
3	64	Douglas County	$177,000	$220,238	$397,238	$18,357
4	43	Douglas County	$177,000	$149,412	$326,412	$15,905
5	29	Douglas County	$177,000	$99,733	$276,733	$14,185
6	6	Douglas County	$177,000	$20,312	$197,312	$11,435
7	122	Douglas County	$177,000	$422,248	$599,248	$25,352
8	50	Douglas County	$177,000	$172,264	$349,264	$16,696
9	34	Douglas County	$177,000	$198,568	$375,568	$14,783
10	81	Douglas County	$177,000	$606,188	$783,188	$20,469
11	18	Douglas County	$177,000	$174,580	$351,580	$12,909
12	65	Douglas County	$177,000	$388,325	$565,325	$18,459
13	138	Douglas County	$177,000	$1,274,447	$1,451,447	$27,192
14	168	Littleton/Douglas County	$177,000	$2,757,417	$2,934,417	$30,830
15	118	Littleton	$177,000	$408,625	$585,625	$24,880
16	71	Littleton	$177,000	$705,242	$882,242	$19,272
17	52	Littleton	$177,000	$276,222	$453,222	$16,969
18	175	Littleton/SEMSWA	$177,000	$602,972	$779,972	$31,609
19	91	SEMSWA/Littleton	$177,000	$315,246	$492,246	$21,647
20	76	SEMSWA	$177,000	$885,840	$1,062,840	$19,879
21	33	SEMSWA	$177,000	$112,937	$289,937	$14,642
22	55	SEMSWA	$177,000	$347,382	$524,382	$17,277
23	54	Greenwood Village	$177,000	$186,170	$363,170	$17,178
24	86	Greenwood Village/SEMSWA	$177,000	$298,030	$475,030	$21,051
25	25	Greenwood Village	$177,000	$139,602	$316,602	$13,668
26	29	Greenwood Village	$177,000	$100,723	$277,723	$14,219
27	14	Cherry Hills Village	$177,000	$47,881	$224,881	$12,390
28	60	Cherry Hills Village	$177,000	$206,011	$383,011	$17,865
29	103	Denver/Cherry Hills Village	$177,000	$684,802	$861,802	$23,074
30	121	Denver	$177,000	$418,346	$595,346	$25,216
31	57	SEMSWA	$177,000	$197,203	$374,203	$17,560
32	63	Denver	$177,000	$489,704	$666,704	$18,218
33	90	Denver	$177,000	$504,020	$681,020	$21,464
34	128	SEMSWA/Denver	$177,000	$942,680	$1,119,680	$26,003
35	76	Denver	$177,000	$547,826	$724,826	$19,869
36	117	SEMSWA/Denver	$177,000	$784,349	$961,349	$24,721
37	23	Denver/SEMSWA	$177,000	$263,749	$440,749	$13,475
38	101	Denver	$177,000	$1,517,321	$1,694,321	$22,777
39	38	Aurora	$177,000	$658,561	$835,561	$15,300
40	60	Aurora	$177,000	$770,860	$947,860	$17,905
41	98	Aurora	$177,000	$951,938	$1,128,938	$22,466
42	123	Aurora	$177,000	$1,089,191	$1,266,191	$25,456
43	N/A	Aurora	$177,000	$0	$177,000	$10,732
44	47	Aurora	$177,000	$508,411	$685,411	$16,378
45	65	Aurora	$177,000	$821,178	$998,178	$18,450
46	21	Aurora	$177,000	$220,755	$397,755	$13,265
47	112	Aurora	$177,000	$953,847	$1,130,847	$24,099
48	40	Aurora	$177,000	$598,983	$775,983	$15,490
49	61	Aurora	$177,000	$1,167,937	$1,344,937	$18,045
50	42	Aurora	$177,000	$201,845	$378,845	$15,810
51	52	Denver	$177,000	$623,213	$800,213	$16,957
52	54	Denver	$177,000	$850,405	$1,027,405	$17,232
		Totals	**$8,850,000**	**$26,883,737**	**$35,733,737**	**$949,081**

Costs Summary by Jurisdiction

Jurisdiction	Total Capital Cost - Control and Outfall Structures	Total Capital Cost - WQ Outfall Systems	Grand Total Capital Cost	Total Annual O&M Cost
Douglas County	$2,035,500	$5,105,022	$7,140,522	$211,158
Littleton	$796,500	$3,227,906	$4,024,406	$103,163
SEMSWA	$1,239,000	$3,146,876	$4,385,876	$138,611
Greenwood Village	$619,500	$575,511	$1,195,011	$55,591
Cherry Hills Village	$442,500	$596,292	$1,038,792	$41,791
Denver	$1,593,000	$6,288,625	$7,881,625	$185,371
Aurora	$2,124,000	$7,943,506	$10,067,506	$213,396
Totals	**$8,850,000**	**$26,883,737**	**$35,733,737**	**$949,081**

9.0 ADDITIONAL CONSIDERATIONS

In addition to the technical hydrologic and hydraulic considerations accounted for in the design of the conceptual water quality facilities, several legal, regulatory, and operational factors were considered as well. These are described in the following sections.

9.1 WATER RIGHTS

In the development of the conceptual hydraulic design of the proposed canal outlet structures, care was taken to ensure that the water quality volume stored by each canal reach would be released downstream within the 72-hour time frame as designated by the State Engineer in his "Administrative Approach for Storm Water Management," dated May 21, 2011. The high potential for infiltration of stormwater during this storage time frame was disregarded in order to provide a factor of safety for each reach's drain time. Additionally, during the development of reach locations, it was ensured that the runoff flowing into the canal at one location would eventually be discharged into the same watershed in order to prevent unauthorized transfers of water from one watershed to another. The State Engineer's current policy also requires that the water be stored in such a manner as to minimize consumption from vegetation. Currently, there are many locations where stormwater enters the canal and has done so for many, many years. Thus, the only change from current conditions is that the canal would be expected to be wet about 100 more days a year than currently exists. This increased frequency could cause a slight increase in vegetation growth and thus a slight chance of additional consumption of water. If one were to consider the worst case scenario that these 100 days of additional inundation would create an additional 100 days of evapotranspiration, we would estimate that this additional water consumption could be in the range of around 150 acre-feet per year. Such a use would require an augmentation plan be obtained through the Colorado Division 1 Water Court. For the purposes of this study, we have included the cost of obtaining water rights and a water augmentation plan at around $2,500,000. There has been recent discussion in the water rights community regarding the need for an augmentation plan whenever detention is used, whether for flood control or water quality due to potential changes in the timing of the flow of storm water. This issue and a final quantification of potential increase in water consumption with the installation of water quality facilities should be reviewed carefully prior to moving forward with construction. The project sponsors would be well-advised to obtain an expert engineering opinion and legal opinion on the water rights issue.

9.2 RIGHT-OF-WAY

While Denver Water has physical ownership of the land occupied by the High Line Canal in several locations, there are many locations in which use of the High Line Canal by Denver Water is by easement only. Some of those easements may not be absolute but may be for use of the canal to transport decreed irrigation water only. Once that use ceases, it is possible that the easement will be void and new easements for the repurposed High Line Canal will have to be obtained from adjacent landowners. The status of right-of-way and easement requirements varies along the length of the canal and local jurisdictions will have to address this issue during the detailed design stage of each reach.

9.3 OPERATIONS AND MAINTENANCE ACCESS

Denver Water currently provides operations and maintenance support to the length of the canal. In the future, it is anticipated that operations and maintenance personnel from each local jurisdiction will be required to access the inflow forebays, segmenting berms, and outlet structures and berms to conduct inspections and to provide maintenance, including removing debris and trash from these facilities. In many areas, this access may be along the High Line Canal trail. However, where inflow points occur on the side of the canal opposite the trail, additional access will be required. Maintenance access should be considered during the detailed design phase of each reach and maintenance personnel should be consulted in that effort.

9.4 PRESERVATION OF VEGETATION

During the development of this Feasibility Study and conceptual plan, it was discussed whether or not the infiltration capacity of the High Line Canal invert should be considered and how much time should be allowed for any given treatment reach to drain. The State Engineer has set a policy of a maximum allowable drain time of 72 hours, but water quality benefits could possibly be realized in less time than the maximum allowable. Ultimately, it was the need to provide irrigation water to the existing trees, in addition to the need for water quality treatment, that lead to the use of a 72-hour drain time. It is likely that the drain time will be less than this because of infiltration losses that were not considered, but from a hydraulic design perspective, the segmenting and outlet structures were designed to drain in 72 hours. This drain time is expected to provide about 100 additional days during which the canal bottom will be wet after storm events compared to not using the canal as a water quality facility.

The average annual amount of precipitation in the Denver metropolitan area is about 15 to 16 inches per year and ranges from about 10 inches in a very dry year to 20 inches in a very wet year. This precipitation is generated in about 40 to 50 storm events per year. The proposed water quality facilities are intended to capture about 85 percent of these storm events. This represents about 4,000 acre-feet of runoff per year from the 26 square miles of area tributary to the canal considered in this study. Runoff from these events generates an average of 5 to 6 inches of captureable runoff per year. Based upon the proposed reach segmentation plan, we estimate that the amount of runoff that would be temporarily stored and potentially available to the trees would average about 2,900 acre-feet per year. Of this amount, analysis of the historic seepage rate over the entire canal results in an estimated average infiltration of about 1,000 acre-feet per year. If this amount of water were to be provided by a non-potable water source (such as existing non-potable water systems of Denver Water and City of Aurora, for example), the estimated value of this water is around $31,000,000 and does not include the infrastructure necessary to deliver the non-potable water to the canal. However, the non-potable water can and would be delivered on a schedule matching the vegetation water needs whereas the timing of stormwater cannot be controlled.

Maintenance of the extensive growth of cottonwood trees will absolutely require supplemental irrigation if the canal is not used as a stormwater treatment facility and may require some degree of supplemental irrigation even if the canal is used as a stormwater treatment facility. The canal bottom is anticipated to be wet after storm events for an additional 100 days a year once the improvements are completed.

9.5 HEALTH AND SAFETY

The existing High Line Canal trail is heavily used by Denver metropolitan residents and passes through multiple residential areas over the course of its 66-mile length. For many years, there has been a general concern about ponding water for an extended period of time due to the possibility that doing so may provide habitat for mosquitoes. The current condition of the High Line Canal where Denver Water is no longer running water is not one of a strictly uniform channel bottom that always drains dry within a few hours after a storm. Instead, small pools are created that can remain for days at a time. The current risk these pools pose is unclear, but the proposed plan would not likely markedly increase that risk above what it is now or be any more detrimental than any other water quality facility that ponds water for up to 72 hours. This issue is one that will need to be addressed on a reach-by-reach basis by the local jurisdiction to weigh the benefits of using the canal as a water quality facility that will also provide much needed water to vegetation versus installing water quality facilities elsewhere and providing separate irrigation facilities.

9.6 CONSIDERATIONS FOR IMPLEMENTATION

The following items should be evaluated as part of the implementation of the plan and transfer of ownership from Denver Water to the ultimate organization or jurisdiction that will be constructing and maintaining these water quality facilities:

1. A phasing plan should be agreed upon with the participating jurisdictions.
2. A system-wide analysis of safety issues along the canal should be prepared in concert with the recreational use plan defining present and future issues that might be created by the new water quality features. How these safety issues can be mitigated should be part of the analysis.
3. A geotechnical study and evaluation of the canal for infiltration and stability should be conducted in cooperation with Denver Water to identify potential future areas of concern for instability and infiltration.
4. A vegetation maintenance plan should be prepared with recommendations for maintaining existing vegetation and for new plantings that may be desired as part of the canal conversion process. A public engagement process should be considered to inform and gain input and support from the public for the project.
5. Plans for dealing with potential illicit discharges, including plans for how any offenses will be enforced within the new infrastructure facility, should be considered.
6. Plans for 404 permitting of the facilities will need be addressed that consider any new rules that may be promulgated prior to implementation. If the facilities are constructed and financed by a new authority or agency, consideration should be given to how costs will be assessed for new development and re-development as compared to costs that may be appropriately assessed on existing development.
7. A portion of the canal has been previously studied to determine the extent and location of overflows that are expected to occur during larger storm events. The entire canal should be studied to identify and re-verify its response to large storm events with the proposed water quality facilities in place. Emergency overflow needs to be considered and directed appropriately to protect life and property. A plan should be prepared to identify the method and location for removal and disposal of materials collected in the forebays.
8. A spill response plan should be prepared to identify the issues and responsibilities associated with potential spills of hazardous materials and pollutants entering the canal and how those spills will be addressed to minimize and protect groundwater, especially in areas of high canal infiltration rates.
9. As additional master planning studies are conducted in the future, the results of those studies should be used to update and refine the hydrologic analysis and flow rates to be used for design of the water quality diversion rates and volumes presented in this plan.

9.7 ORGANIZATIONAL REQUIREMENTS

The canal is currently owned and operated by Denver Water. There are also still a significant number of customers that are provided irrigation water via the High Line Canal. Retrofitting any design reach will require coordination with Denver Water to manage the timing of construction and easement and/or ownership concerns. Denver Water is a willing partner in this endeavor but will have concerns over the specifics of any actual construction that will take place. It is critical that Denver Water be contacted prior to any design work being completed on any reaches so that they may voice any concerns that they have in any particular reach. Once the decision has been made to use the canal for water quality treatment, Denver Water and the local jurisdictions should consider what would be the best management organization for future operation and maintenance of the canal.

10.0 RESULTS AND CONCLUSIONS

In the course of this study, through review of existing infrastructure and mapping, and from conversations with local sponsors, it appears that retrofitting the High Line Canal to provide water quality treatment is a feasible endeavor. Potential challenges that should be anticipated have been included in this report, but ultimately retrofitting the canal as discussed herein will provide many benefits for much less expenditure of capital than would providing those same benefits through other means.

If the High Line Canal is not repurposed to provide water quality treatment for stormwater runoff and to provide a water supply for existing vegetation, alternative infrastructure will be required to meet these needs. The more immediate and irrefutable need will be to prevent the loss of the existing stand of cottonwood trees along the length of the High Line Canal. Irrigation infrastructure and the cost of water will present a substantial cost to local entities as will acquisition of lands and the construction of infrastructure required to construct alternative water quality facilities.

Every design reach of the High Line Canal that has the capacity to treat the full design WQCV of the area draining to it is expected to remove 80 percent to 90 percent of the annual TSS load coming from that tributary area. 31 design reaches can treat the full WQCV while another 18 design reaches can treat some portion of the WQCV of their tributary basins. The total storage deficit for those 18 reaches is 95 acre-feet.

The WQCV of all the tributary basins to the canal is approximately 297 acre-feet. Even with the deficit of 95 acre-feet, the canal is able to treat 202 acre-feet of stormwater runoff for every precipitation event equal to or greater than the WQCV-sized event. If this volume of runoff were to be treated in a separate facility, an extraordinary amount of land would be required, some of it in already fairly densely developed areas. One has only to look at aerial photography of some of the tributary basins to be hard-pressed to find space to convert to water quality treatment. That exercise makes the benefit of using the canal as a water quality facility very clear.

10.1 PROPOSED REACHES

After multiple iterations and in consultation with the local jurisdictions, the High Line Canal was divided into 52 individual design reaches. While each design reach may have multiple points of inflow into the canal, each reach is correlated with only one distinct discharge point from the canal to the downstream watershed. A reach may consist of a single length of unobstructed canal or it may be further subdivided into two segments separated by a segmenting berm at a location somewhere near the middle of the design reach. In these cases, the upstream segment will discharge to the downstream segment prior to discharging from the High Line Canal at the reach discharge point.

All but four design reaches are anticipated to be divided into two segments with the segmenting berm placed midway in the reach length and downstream ponding depths of 3 feet. Three of the reaches that will not be segmented contain siphon structures into which water cannot be backed up. These are reaches 8, 25, and 35. The downstream ponding depth in reaches 8 and 35 will still be 3 feet, but the downstream ponding depth in reach 25 will be limited to approximately 2.7 feet.

Reaches 1, 2, and 43 have little to no tributary area and will not be utilized at all for water quality treatment.

10.2 OTHER PROJECT BENEFITS

There are additional benefits of using the High Line Canal for water quality treatment. These are as follows:

- The canal can be readily used to meet water quality requirements for linear transportation projects.
- The cost of the proposed facilities may provide the most cost-effective method to maintain the natural and recreational environment of the canal.
- The proposed facilities will provide a significant reduction in the rate of storm flows below the canal during more frequent storm events where storm sewers are proposed to be diverted into the canal. The cumulative amount of these flow reductions is estimated to approach 3300 cfs for the entire tributary watershed area. The value of this reduction was not quantified but should be considered in the sizing and need for downstream storm sewer additions or improvements.
- The volume of stormwater discharged to downstream-receiving streams will be reduced by up to 1,000 acre-feet. This will provide a significant reduction in pollutants reaching these downstream-receiving streams.

10.3 TIMING, PHASING, AND PRIORITY OF CONSTRUCTION

With the goal of using the High Line Canal as a water quality facility to treat stormwater runoff, construction of water quality facilities within any portion of any jurisdiction may generally proceed independently of the others. The repurposed High Line Canal will be divided into multiple reaches that are somewhat autonomous from each other. During a storm event, stormwater diversion structures will divert the water quality capture volume, or some portion of it, into the reaches of the canal that have been retrofitted. This volume will be stored for up to 72 hours before being fully discharged from the High Line Canal downstream into to the same watershed in which it was generated. Due to the limitations inherent in design of diversion structures, it is expected that that volumes of water slightly larger than the water quality capture volume will enter the retrofitted High Line Canal segments during larger storm events. Any inflow volumes in excess of the capacity of the retrofitted High Line Canal segments will need to be provided for by including a revetted overflow path at each of the segmenting berms that are constructed as part of the retrofit.

There currently existing several stormwater inflow points into the High Line Canal, and these existing inflows have historically been accommodated. Several additional stormwater inflows will also be constructed as part of the proposed retrofit. It is not anticipated that these additional inflow points will present a problem hydraulically, provided that diversion structures are appropriately designed. Care should be taken to design a diversion that will produce a water quality event inflow hydrograph that will yield no more volume than that which the retrofitted canal segment can accommodate.

Diversion structures and retrofitted canal segments should be evaluated in conjunction using EPA SWMM routing for up to the 100-year event to approximate the rate of overtopping of each segmenting berm to ensure adequate freeboard and revetment is provided.

Priority and phasing of the conceptual design should be determined by each local jurisdiction as it envisions either the need for water quality treatment of tributary development stormwater runoff or the benefit of stormwater runoff to be used to provide irrigation to the existing trees along the canal. Phasing may also depend on the timing of the termination of Denver Water's use of each reach of the canal to provide water to adjacent users. As a first phase, all jurisdictions should consider construction of only the control structures and associated outlet piping in any areas where stormwater flows currently enter a canal segment. Also as a first phase, consideration should be given to constructing forebays on existing inflow points to minimize the amount of trash and debris that currently enters the canal. Having these items as a first phase will be relatively inexpensive compared to constructing all the diversion storm sewer systems into the canal. In addition, these first phase items would provide experience on the operation and maintenance of the facilities before full implementation of the plan presented herein.

With the goal of using the High Line Canal as a means by which to provide irrigation in the form of stormwater to the extensive stand of vegetation that came into existence solely because of the use of the canal as an irrigation water transport mechanism, the timing of construction may be more critical. Once

Denver Water ceases to run water in the High Line Canal, it is unknown how long much of the vegetation along the canal will be able to survive without some form of supplemental water.

Regardless of the timing of Denver Water ceasing its use of the canal, the retrofit of those reaches of the canal still in use may begin with some additional modifications. There are a few options that may be utilized. The diversion structure may be designed with an interim modification that will release a lesser volume of water that will correspond to the volume available in the canal that is in excess of what Denver Water is using. Alternately, the diversion structure may be fitted with a gate to prevent diversions during the time of the year Denver Water is using the canal. During any months that Denver Water is not using the canal, the gate may be fully opened. Similarly, the downstream outlet structure will need to be fitted with an interim modification or a gate so that only the amount of stormwater added to the canal is allowed to exit the canal. Any design of water quality facilities for an interim condition must be approved by Denver Water.

APPENDIX A – Meeting Minutes Review Comments

RESPEC
WATER & NATURAL RESOURCES

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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
KICKOFF MEETING – SEPTEMBER 5, 2013

1:30 P.M. – 3:00 P.M.
UDFCD Board Room

Attendees

- Ken MacKenzie, UDFCD
- Mark Brown, Arapahoe County Public Works
- Pat Schuler, Aurora Parks and Open Space
- Tracy Young, Aurora Water
- Tom Ries, Aurora Water
- Jay Goldie, Cherry Hills Village
- Darren Mollendor, Denver
- Scott Gilmore, Denver Parks
- Tom Roode, Denver Water
- Garth Englund, Douglas County
- Erik Nelson, Douglas County
- Randy Burkhardt, Douglas County
- David Flaig, Littleton
- Alan Leak, RESPEC
- Nathan Torrey, RESPEC
- Lanae Raymond, SEMSWA
- Paul Danley, SEMSWA
- Brett Collins, South Suburban Parks and Recreation

Introduction

Ken MacKenzie opened the meeting with a brief presentation on the High Line Canal and the possibility of repurposing it for stormwater treatment. The presentation included a history of the canal, example stormwater treatment facilities (rain gardens) in the Denver area, summary of the High Line Canal working group, and a potential pilot project for the canal.

Alan Leak followed with a presentation summarizing the overall scope for the master plan project and project schedule. The project scope consists of the following:

- Project Coordination
- Study Mapping
- Water Quality Hydrology
- Canal Water Quality Hydraulic Characteristics
- Conceptual Plan Development
- Conceptual Plan Evaluation
- Pilot Project Preliminary Design

The project deliverables will include a written report, feasibility drawings compatible with ArcView GIS format, and a technical appendix. Preliminary design drawings will also be prepared for a pilot project located downstream of Fairmont Cemetery. The project has a 300 day schedule (10 months).

The project will generally follow this schedule:

- Month 1 – Study Mapping
- Months 2, 3, and 4 – Water Quality Hydrology and Hydraulic Characteristics
- Months 5, 6, and 7 – Conceptual Design Development
- Months 8, 9, and 10 – Conceptual Plan Evaluation and Pilot Project Preliminary Design

The meeting continued with introductions of the project sponsors and stakeholders. Each stakeholder then had the opportunity to express their overall goals for the study, as follows:

Denver Water (Tom Roode) – The High Line Canal is a water delivery facility. It is very inefficient, 70% of the canal flow does not make it to the customer. There has been an increased recreational use along the canal trail system. Denver Water was interested in adding stormwater to the canal and approached UDFCD. With this study, Denver Water would like to investigate the viability of repurposing the canal for stormwater treatment from a technical standpoint; is it physically possible from an engineering standpoint.

South Suburban Parks and Recreation (Brett Collins) – Water for the trees along the High Line Canal is the number one priority. Canal use in the past has allowed for the growth of large stands of trees along the canal. The canal trail is currently seen as a green space corridor. With canal diversions coming to an end, the existing trees along the canal likely will not survive.

For existing and future development, often times it is easier to discharge stormwater runoff to the canal than it is the major drainageway or creek.

Littleton (David Flaig) – The High Line Canal is a 66 miles linear park, and the trees are an important aspect of that park. If the trees die, this is a failure. Are stormwater diversions enough to keep the trees alive?

Aurora Water (Tracy Young, Tom Ries) – The High Line Canal in Aurora looks very different from more established areas due to the lack of water. The City Council is looking at ways to add trees along the canal. New canal improvements must be maintained; trash and debris removal, mosquitos, etc.

Arapahoe County (Mark Brown) – It will be exciting to see the results of this study in the future.

Douglas County (Garth Englund) – Does adding water quality make it more difficult to develop? Will it cost more to develop than if we had not done this study (i.e. more storm sewer required)?

City/County of Denver (Darren Mollendor) – This study meets Denver's green infrastructure sustainability goals. Will it be part of the MS4 permit? Could this type of project be used for water quality exchanges, i.e. road projects, infill, etc.

SEMSWA (Paul Danley) – This project will have a significant drainage benefit and will open numerous possibilities.

SEMSWA (Lanae Raymond) – Thank you Denver for moving this study forward on a regional basis. Canal could provide flood protection. Within the Four Square mile area, several existing retention ponds are creating an increase in groundwater.

Cherry Hills Village (Jay Goldie) – Within Cherry Hills Village, most of the stormwater drains to the canal. The City has a pilot project to irrigate 1000' of canal and plant additional trees this year. Currently, new single family developments/redevelopments can't drain runoff from increased impervious areas to the canal. Large lot residential properties may not create enough stormwater runoff to support existing canal vegetation, specifically trees.

Douglas County (Erik Nelson) – Regional water quality within the canal should be encouraged. It may be easier to maintain the canal than current facilities. His experience is that most rain gardens require minimal maintenance, with the exception of trash removal.

Progress meetings will be held the first Thursday of each month at 1:30 p.m. at UDFCD.

Meeting was adjourned at 3:30 P.M.

Minutes Developed By: Nathan R. Torrey, RESPEC

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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
PROGRESS MEETING – OCTOBER 3, 2013

1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees

- Ken MacKenzie, UDFCD
- Shannon Carter, Arapahoe Co Open Space
- Mark Brown, Arapahoe County Public Works
- Lisa Darling, Aurora Water
- Tracy Young, Aurora Water
- Tom Ries, Aurora Water
- Jay Goldie, Cherry Hills Village
- Scott Gilmore, Denver Parks
- Tom Roode, Denver Water
- Garth Englund, Douglas County
- Randy Burkhardt, Douglas County
- Suzanne Moore, Greenwood Village
- David Flaig, Littleton
- Alan Leak, RESPEC
- Nathan Torrey, RESPEC
- Paul Danley, SEMSWA
- Brett Collins, South Suburban Parks and Recreation

Introduction

Alan Leak opened the meeting with a brief summary of the project progress to date and schedule. The project is one month in and the main effort at this point is developing the study base mapping and beginning the hydrologic analysis.

Nathan Torrey summarized the data received to date and that still needed.

Nathan also summarized the ongoing hydrologic analysis. The analysis will develop peak flow rates and volumes for existing and future land use conditions for the water quality event (80^{th} percentile event, 0.6" storm event) and 2-year event. Subwatershed data from existing and ongoing master plans will assist in the hydrologic analysis, particularly subbasin delineation and characteristics. For the area covered by the original WRC master plan, the original data will be compared to revised data and modified where necessary. The final hydrology product will be one complete CUHP/SWMM model for flows to the High Line Canal. There is no need to model/route flows in the canal itself.

Alan presented some of the Water Quality Capture Volume (WQCV) requirements and constraints. A plot was presented showing the required canal length per acre of tributary area versus imperviousness. It was explained that there may not be enough canal miles to treat all of the tributary areas.

Inflow Types and Maintenance

Alan presented some of the sediment and debris control issues associated with the study. The main stormwater inflow types to the canal are piped (storm sewer) inflows, rundowns, and channels. There are several methods in sediment and debris control, depending on the inflow type, including:

- Underground vaults/proprietary facilities
- Surface forebays before the canal
- Surface forebays in the canal
- Individual inlet controls

Inflow rate, type, and available space may limit what control options are available. Do the project sponsors/stakeholders have a preference when it comes to the type of sediment/debris control measures used? The following are comments on this question:

Ken – Sediment will take care of itself in the canal, trash is another matter completely. UDFCD and Denver are working on an end of pipe control sock. Ken provided a few pictures and examples of the sock. Socks will be very heavy during maintenance activities.

Denver Water – Typical practice is to run a surge of water in the canal to flush trash/debris to designated wasteways.

SEMSWA – The preference would be surface trash/debris forebays before the canal. A distant second is inlet trash racks.

Underground vaults have confined space issues and are not a preferred solution.

Los Angeles is putting in controls at all inlets to meet trash TMDLs.

It's preferable to prevent the trash from getting in to the system. If not, it will have to be removed at the outlet.

Trash control at the inlet is preferred; however it becomes a streets maintenance issue. These areas may be in a special district or HOA controlled.

Trash removal is a benefit to drive more development around those spaces.

Access into the canal will be an issue for in-canal trash/debris collection. There will be a need for good and easy access to the bottom of the canal for routine maintenance. Vac trucks are often used for maintenance and should be accounted for in the design. The High Line Canal trail should not be used for maintenance access if other access can be built into the design.

Ultimately, it may be a jurisdictional issue as to what department pays for trash/debris removal associated with these facilities. Estimated maintenance costs will be included in the study.

Rain Gardens and Vegetation

Once the rain gardens are established in the canal, trees will grow in the canal and infill over time. It will be very interesting to see how vegetation responds in the canal. Over time, the canal will most likely have a different look than today. The existing 100-foot right-of-way could be completely converted.

The current rain garden criteria is to pond to a maximum depth of 1-foot. The ponding depth is limited so as to not drown the vegetation, less time under water. Look at possibly using deeper depths. The preference would be to treat more stormwater runoff if space is available in the canal.

Ken – The main treatment method of a rain garden is infiltration, not biological uptake. It has been UDFCD experience that trees create high infiltration rates. Once the canal rain gardens are established, they will not have to be cleaned out or replaced in the future.

We may want to provide examples of what the HLC will look like in 10, 20, 30, 50+ years.

Other Options

Suzanne Moore (Greenwood Village) – Are there any options to break down the canal banks and restore the historic (pre-canal) drainage patterns? The City of Greenwood Village is bisected by the canal and new developments or redevelopments have difficulty meeting the current stormwater criteria. At some locations it is impossible to discharge stormwater runoff to Little Dry Creek because the canal stands in the way.

Ken has had discussions with the State Engineers Office regarding the viability of this project from a water rights standpoint. Currently, it is our understanding that piped flows that are diverted to the canal, and treated, must be returned to a piped system. This does not include surface inflows. However, this study should not be limited to this constraint, the rules may change in the future.

Meeting was adjourned at 3:30 P.M.

Minutes Developed By: ______________________
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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
PROGRESS MEETING – NOVEMBER 7, 2013

1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees

- Ken MacKenzie, UDFCD
- Shannon Carter, Arapahoe Co Open Space
- Mark Brown, Arapahoe County Public Works
- Tracy Young, Aurora Water
- Darren Mollendor, Denver
- Tom Roode, Denver Water
- Garth Englund, Douglas County
- Randy Burkhardt, Douglas County
- Erik Nelson, Douglas County
- Suzanne Moore, Greenwood Village
- David Flaig, Littleton
- Alan Leak, RESPEC
- Nathan Torrey, RESPEC
- Paul Danley, SEMSWA
- Brett Collins, South Suburban Parks and Recreation

Introduction

Alan Leak opened the meeting with a brief summary of the project progress to date and schedule. The project is approximately three months in and the main effort at this point is developing the water quality hydrologic analysis and canal hydraulic characteristics. Accumulation of data and development of the base mapping is mostly complete.

Alan provided an overview of the hydrologic analysis. Peak flow rates and volumes will be developed for existing and future development conditions. The Water Quality Capture Volume (WQCV) is based on the new UDFCD (9/24/13) WQCV equations. Peak flow rates will be developed for the water quality precipitation event (80th percentile event, 0.6" one hour point precipitation) and the 2-year storm event. CUHP and EPA SWMM will be used to develop peak flow rates.

Detention ponds that provide only 100-year detention will have little effect on the water quality event which is the focus of this study. Therefore, it is proposed that these 100-year only detention ponds not be included in the hydrologic analysis. It is also proposed that water quality detention ponds be reviewed and included in the analysis if needed to make an individual water quality facility feasible. This will be looked at on a case-by-case basis.

Denver – Denver has tributary areas for public/private water quality ponds.

Alan provided further discussion on inflow sediment and debris control facilities as well as inflow and diversion structures. Typical inflows that require debris/trash control are storm sewer outfalls, rundowns, and open channels.

Several types of sediment and debris control measures are available, but based on discussions with the project sponsors and participants, the general preference is to use surface forebays before the canal if space is available. Additional, less favorable options, include forebays in the canal, control at each individual inlet, and pipe socks on outlets.

Alan provided further discussion on inflow control and diversion structures. They are designed to direct up to the Water Quality Capture Volume (WQCV) into the canal and minimize additional flows into the canal during precipitation events larger than the WQCV. These types of controls typically work best for storm sewer inflows. It is more difficult to control flows into the canal from rundowns and small channels because flows from these facilities currently drain to the canal. If inflows are not controlled, the canal must be designed to accommodate flows larger than the WQCV. Examples of typical storm sewer diversion structures were also provided.

Greenwood Village – Stormwater runoff naturally goes into the canal and discharges further downstream at a control gate.

Nathan Torrey provided a summary of the progress to date of the water quality hydrologic analysis. Figures were provided showing the tributary area to the canal as well as existing storm sewer outfalls into the canal and potential canal discharge locations.

In general, there is more WQCV than can be treated in the canal at an average depth of one foot. Allowing a deeper ponding depth increases the amount of runoff that can be treated.

Draft final results will be provided at the next meeting to be held December 5, 2013.

Meeting was adjourned at 3:30 P.M.

Minutes Developed By: ____________________
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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
PROGRESS MEETING – DECEMBER 5, 2013

1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees

- Ken MacKenzie, UDFCD
- Shannon Carter, Arapahoe Co Open Space
- Mark Brown, Arapahoe County Public Works
- Lisa Darling, Aurora Water
- Tracy Young, Aurora Water
- Mary Price, Denver Water
- Sarah Anderson, Denver
- Randy Burkhardt, Douglas County
- Suzanne Moore, Greenwood Village
- David Flaig, Littleton
- Alan Leak, RESPEC
- Nathan Torrey, RESPEC
- Paul Danley, SEMSWA

Introduction

Alan Leak opened the meeting with a brief summary of the project progress to date and schedule. The project is approximately four months in and the main effort at this point is finalizing the water quality hydrologic analysis and canal hydraulic characteristics. Accumulation of data and development of the base mapping is complete, unless unforeseen needs arise.

Water Quality Hydrologic Analysis

Nathan Torrey provided a summary of the draft results from the water quality hydrologic analysis. The Water Quality Capture Volume (WQCV) was calculated for the tributary areas to the canal based on the updated equation provided in a memo from UDFCD dated September 24, 2013. The required BMP storage volume was calculated from the WQCV.

The available storage volume within the canal was computed using the best available information; aerial photography, topographic mapping, cross section data from previous master plans, etc. The UDFCD criteria for bioretention facilities recommends a maximum ponding depth of 1 foot. The volume of the canal was computed on a reach-by-reach basis using a measured cross section of the canal over an average depth of 1 foot.

For ease of analysis, the canal was broken into 1-mile long reaches based on mile markers. More detailed reaches will be developed later in the study and will be based on specific inflow/outflow locations.

Tables were provided with the figures that summarized the available storage volume within the canal versus the required BMP volume tributary to that specific reach. A cumulative total was also provided for the entire length of the canal.
In general, the canal does not have enough storage volume to treat the required BMP volume based on an average ponding depth of 1 foot.

The analysis was repeated assuming an average ponding depth of 2 feet. At this depth, many more of the canal reaches have adequate capacity to handle the required BMP volume. However, several of the tributary areas are still too large to be treated entirely by the canal. For the entire length of the canal, the total BMP volume required is approximately 300 acre-feet. The storage volume available in the canal, at an average depth of 2 feet, is 270 acre-feet (120 acre-feet at a depth of 1 foot). It was agreed that for the purposes of this study, an average ponding depth of 2 feet is to be used for conceptual design of bioretention facilities.

Infiltration Analysis

Seepage measurements were performed by Denver Water from 1997 to 2007. Flow measurements were taken at the upstream and downstream ends of 16 specific reaches to determine the amount of flow lost over each reach. These results were used as the basis of this infiltration analysis. In general, the result of the infiltration analysis showed that the canal does not have the seepage capacity to handle the total BMP volume required. Over the entire length of the canal, only 26% of the required infiltration volume is able to be met.

Summary of Results

The required BMP volume exceeds the capacity of the canal assuming an average ponding depth of 1 foot.

In general, the canal lacks the infiltration capacity to handle the computed BMP volume. For areas that lack infiltration capacity, release excess volume over an extended period, 24 - 40 hrs.

Comments

Longer stormwater holding times will be good for the existing trees.

Vegetation in the bottom of the canal will determine itself over time based on depth and frequency of inundation.

Each entity will need to determine for itself whether a developer would be allowed to use the canal to meet a development's water quality requirements.

Residential properties (Greenwood Village) located downstream of the canal have sumps that run continuously when the canal is running. Designs may need to include a consideration for underdrains on the downstream side of the canal in these areas.

Solutions

- Decrease the amount of watershed area and/or volume proposed to drain to the canal.
- Increase the average ponding depth in the canal.
- Increase the infiltrative capacity of the canal through underdrains and/or canal bottom and bank modifications.
- Develop a hybrid water quality BMP design for the canal.
- Account for upstream water quality facilities

Meeting was adjourned at 3:30 P.M.

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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
PROGRESS MEETING – JANUARY 2, 2014

1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees

- Ken MacKenzie, UDFCD
- Holly Piza, UDFCD
- Mark Brown, Arapahoe County Public Works
- Tracy Young, Aurora Parks
- Jay Goldie, Cherry Hills Village
- Darren Mollendor, Denver
- Emmanuel Padilla
- Tom Roode, Denver Water
- Garth Englund, Douglas County
- Randy Burkhardt, Douglas County
- Suzanne Moore, Greenwood Village
- Alan Leak, RESPEC
- Nathan Torrey, RESPEC
- Jessie Nolle, RESPEC
- Paul Danley, SEMSWA

Introduction

Alan Leak opened the meeting with a brief summary of the project progress to date and schedule. The project is approximately five months in and the main effort at this point is finalizing the canal hydraulic characteristics and beginning the conceptual plan development phase of the project. Accumulation of data and development of the base mapping is complete, unless unforeseen needs arise.

Summary of Volume/Seepage Results

Alan provided a summary of the volume/seepage results to date. In general the BMP volume required exceeds the volumetric capacity of the canal at an average depth of 1 foot. The BMP volume is calculated based on the WQCV for the tributary areas to the canal. Additional capacity is available in the canal if deeper ponding depths are feasible. RESPEC recommends using an average ponding depth of 2 feet.

In general, the canal also lacks the capacity to infiltrate the BMP volume required.

Some possible solutions to these deficiencies include; decreasing the amount of tributary area, and corresponding BMP volume proposed, draining to the canal, increase the infiltrative capacity of the canal through underdrains and/or canal bottom/bank modifications, or develop a hybrid water quality facility for the canal.

Alan summarized current BMP design concepts used by UDFCD and a potential hybrid design for the canal.

Infiltration Capacity – Canal Segmenting Efficiencies

Alan provided a summary of the canal design reach and segmenting concepts. A design reach will have one outlet structure. A design reach can be broken into segments by placing a berm and control structure within the design reach. Segmenting a design reach into two or more segments increases the average ponding depth and infiltration. Limitations for segmenting include; inflow points are required in each segment, additional cost associated with each segment berm and control structure, and additional maintenance requirements.

BMP Initial Design Results

Alan presented an initial design for six segments in Douglas County. The six reaches were used as an example to show how the remainder of the canal would be broken into design reaches. The BMP design concept is as follows:

- Locate inflows in the upper segment of the design reach
- Control diversion of the water quality event to minimize risk of overloading the BMP facility
- Reduce the height of the ponding depth/control structure as needed to allow unimpeded flow of stormwater for larger storm events.
- Consider the benefits of a micropool for maintaining outlet structure capacity
- Consider limitations of existing canal structures on reach locations and segmenting

Meeting was adjourned at 3:30 P.M.

Minutes Developed By: Nathan R. Torrey, RESPEC

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High Line Canal Feasibility Study
Meeting Minutes
Progress Meeting – February 6, 2014

1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees

- Shea Thomas, UDFCD
- Holly Piza, UDFCD
- Mark Brown, Arapahoe County Public Works
- Tracy Young, Aurora Parks
- Darren Mollendor, Denver
- Sarah Anderson, Denver
- Tom Roode, Denver Water
- Garth Englund, Douglas County
- Randy Burkhardt, Douglas County
- David Flaig, Littleton
- Alan Leak, RESPEC
- Nathan Torrey, RESPEC
- Paul Danley, SEMSWA
- Stacey Thompson, SEMSWA

Introduction

Nate Torrey opened the meeting with a brief summary of the project progress to date and schedule. The project is approximately six months in and the main effort at this point is development of the conceptual plan. Accumulation of data and development of the base mapping is complete, unless unforeseen needs arise. There are two public presentations associated with this project. We will need to determine when, where, and with whom these will take place. Also, we will need to determine the reach for the pilot project. It would be preferable for the pilot study reach to have more detailed mapping (1-ft contours) as well as a detailed survey, or as-built drawings, of the existing storm sewer and other utilities.

Water Quality BMP Design Criteria

Nate provided a summary of the design criteria used in development of the design reaches and segments. The following is a summary of the design criteria used:

- Maximize the available canal volume, volume estimates based on the following:
  - Canal slope of 0.04%
  - Estimated bottom width for each mile of canal
  - 2:1 side slopes
- Maximum ponding depth of 3 feet
- 72 Hour drain time
  - Maximum allowed by the State Engineer
- Updated WQCV Equation
  - $WQCV = 0.23T^{0.17}I^{a}$ (units in watershed inches)
  - T (drain time) = 24 hours for calculation

Water Quality BMP Preliminary Results

Nate provided a summary of the preliminary design results. The canal was broken into design reaches varying in length from approximately 3/4 mile to 1-1/2 miles. Each design reach includes several inflow locations and one discharge location and outlet structure at the downstream end of the reach.

Inflow and discharge locations are primarily located at existing storm sewer crossings. Discharge locations are also located at major drainageways. Note that open channel flow cannot be diverted into the canal for this project, per discussions with the State Engineer, only piped flow.

The BMP volume required is computed using the following relationship:

- BMP Volume = (WQCV/12) x A (units in acre-feet)

The results presented in the table included the location of the design reach, BMP volume required, canal volume available, and the difference between the two.

Nate also summarized the concept of segmenting the design reaches to maximize the canal volume and infiltration rate. Multiple segments can be created within a design reach by locating a berm and control structure within the canal. A maximum ponding depth of 3' can be achieved at each segment berm, which results in more volume and infiltration than just one control structure per reach. The limitations for segmenting reaches is that inflow points are required for each reach, added cost for additional structures, and additional maintenance access is required.

Each design reach was reviewed in Google Earth. KMZ files were created of the reach alignments, potential inflow/discharge locations, and storm sewer pipes. The KMZ files will be posted to the project dropbox for the sponsors to review. RESPEC requested that the sponsors review the design reaches and have any comments back to us by February 23, 2014.

Typical Details – Outlet Structure and Segment Berm

RESPEC provided preliminary details of a typical outlet structure and segment berm. A typical outlet structure will consist of an earthen berm reinforced with buried soil riprap, a concrete outlet structure within the berm, cutoff wall extending to the top of the berm, orifice plate to control the release of water, a discharge pipe from the outlet structure to the tie-in point with an existing storm sewer outside the canal, and manholes outside the canal to accommodate the bend/junction of new and existing pipe. A segment berm structure will be very similar to an outlet structure but without the discharge pipe to the outside of the canal.

Coming Up

The next month of work will include a review of water rights issues with the proposed design, development of cost estimates of the facilities, maintenance access requirements, and development of the draft report.

Meeting was adjourned at 3:30 P.M.

Minutes Developed By: ______________________

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HIGH LINE CANAL FEASIBILITY STUDY

Summary of comments received on design reaches

Douglas County

1. For Reach 2, Little Willow Creek enters directly into the Canal at this point, so it doesn't look like treatment would work in this section. You need to go into the Willow Creek basin and treat.

2. For Reaches 13, 14, 15 you need to sell to City of Englewood since they control McLellen Reservoir. In the past they discouraged any water into the reservoir even historic or treated.

City of Littleton

1. W. Mineral Ave. – Littleton has in UDFCD Design and Construction program 5 year Capital Improvement Plan a 2014 project to begin design of stream stabilization on Jackass Gulch. This proposed outlet for High Line Canal water quality planning effort will need to be coordinated with design.

2. S. Windermere St. – The proposed Canal discharge would be to an existing 18" inverted siphon storm sewer under the Canal, which presently discharges to an open roadside ditch. I fear the Canal discharge will create a wetland environment in the existing ditch, which may not be appropriate in front of a single family residence and church, as shown on the enclosed map. If extension of the storm sewer to connect to an existing storm sewer at W. Geddes Ave./Rangeview Dr. could be included as part of the Canal water quality improvements, this discharge might be considered.

3. Lee Gulch – The proposed discharge location is the area locally referred to as Horseshoe Park. The adjacent neighborhood has a very strong interest in any activity in this natural open space. The master planning effort is strongly encouraged to do public outreach efforts to get local resident buy in to any activity in this area.

SEMSWA

1. A discharge point is shown at Orchard Road where Reach 22 connects to Reach 23. This is possible in the future, but currently there is no storm sewer system in Orchard Road in that area (storm sewer is shown on your map incorrectly). A future storm sewer project is being discussed with the City of Centennial as part of a road widening project.

2. At this same location where the canal crosses Orchard Road, there is an existing inflow culvert from the Orchard Road gutter flowline into the canal on the north side. This is on the northeast corner of the canal crossing at Orchard Road. Inflows could also easily enter the canal from the south gutter flowline of Orchard Road. These are surface flows that accumulate all the way from the University intersection (no storm sewer collection). A plate across the curb opening on the south side of the canal crossing currently prevents this flow from entering the canal.

3. After review of the Littles Creek Major Drainageway Plan dated July 2012, there is an existing inflow point that may not be accounted for in the design reaches. The MDP reach descriptions indicate that a 60" RCP outfalls just upstream of the HLC, where the pipe flows combine with street flows and discharge into the HLC. This existing inflow point is located at the reach line between Reaches 18 and 19.

4. Arapahoe County, UDFCD and SEMSWA are participating in the Iliff Avenue Corridor Study (Quebec – Parker), which is being prepared by David Evans & Associates with Ayres Associates completing the stormwater analysis. The Corridor Study will include an update to the 1985 Four Square Mile Area OSP specific to Basin 7, the Parker/Iliff Outfall System. During the stormwater discussions and water quality evaluation, UDFCD indicated that for planning purposes, the High Line Canal could be utilized to provide WQCV for the contributing area east of the HLC. This inflow location is not currently identified on the design reaches, and would be located at the reach line between Reaches 35 and 36.

UDFCD

Provide an inflow location at Iliff Avenue

Greenwood Village

1. Reach 23 - This community exists in a "horseshoe" that doesn't have anywhere else to drain except into the canal. Thus limiting the amount of flow that goes into the canal to not overwhelm the system wouldn't be feasible. However perhaps the weirs in the canal can limit what stays in and what continues on down the system. Not sure how that would work. The proposed discharge for this segment is the storm sewer along University which is a CDOT system, and thus would take some coordination. Also this segment includes a ridge down the middle for which the south side would typically go to Big Dry Creek that is south and west of the canal and the north half would go to Little Dry Creek which is where the proposed outlet into the CDOT storm sewer outfalls into. Thus we may be breaking water right rules, however you would know best.

2. Reach 24 - Looks good. No Comments

3. Reach 25 - The storm sewer input indicated directly north of Orchard Rd actually goes under the canal. If you follow this storm line to the origin, that is a private EDB for that development to the northeast. So that basin shown is actually smaller than shown due to it all going to the EDB, under the canal and into Little Dry Creek. The basin to the north (near the "25" marker) still goes into the canal. Potential discharge point is into the other private EDB for this same development however showing it to go there is okay for this level of detail.

4. Reach 26 - The storm sewer inflow indicated at the south "26" actually goes under the canal and into the private EDB (mentioned above), thus that drainage basin is smaller. Greenwood Gulch that is halfway through this "horseshoe" actually goes into the canal and then dumps back out around where the north "25" is shown.

South Suburban Parks and Recreation

We are ok with the reaches and inflow/discharge areas as long as they don't negatively affect the trail or park amenities, which it doesn't appear they will.

Arapahoe County
No comments at this time

Cherry Hills Village
No comments at this time

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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
PROGRESS MEETING – MARCH 6, 2014

1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees

- Shea Thomas, UDFCD
- Holly Piza, UDFCD
- Mark Brown, Arapahoe County Public Works
- Tracy Young, Aurora Parks
- Darren Mollendor, Denver
- Sarah Anderson, Denver
- Tom Roode, Denver Water
- Garth Englund, Douglas County
- Randy Burkhardt, Douglas County
- David Flaig, Littleton
- Alan Leak, RESPEC
- Nathan Torrey, RESPEC
- Paul Danley, SEMSWA
- Stacey Thompson, SEMSWA

Introduction

Alan Leak opened the meeting with a brief summary of the project progress to date and schedule. The project is approximately seven months in and the main effort at this point is review of design reach issues from the project stakeholders and selection of a pilot reach(s).

Comments Received on the Design Reaches

A summary of the comments received on the design reaches was provided to the meeting attendees. Nate led discussion of each of the stakeholder's comments and how these are to be incorporated into the project. The following is a summary of the design criteria used:

- Maximize the available canal volume, volume estimates based on the following:
  - Canal slope of 0.04%
  - Estimated bottom width for each mile of canal
  - 2:1 side slopes
- Maximum ponding depth of 3 feet
- 72 Hour drain time
  - Maximum allowed by the State Engineer
- Updated WQCV Equation
  - $WQCV = 0.23T^{0.17}I^{a}$ (units in watershed inches)
  - T (drain time) = 24 hours for calculation

Pilot Reach Selection

Discussion was held with the stakeholders on the possible locations and characteristics of a pilot study reach or reaches. Two reaches that are preferred by the project sponsors are Reach 38 (Denver) and Reach 40 (Aurora). There are storm sewer improvements under construction in Dayton Street (Reach 38 area). Other options include looking at a reach between Wellshire Golf Course and Fairmont Cemetery. Ken requested that Denver and Aurora confirm the use of Reaches 38 and 40 as the preferred pilot study reaches by the end of next week (March 14th).

Additional items for consideration in the design of the water quality facilities include:

- Accommodation of base flows
- Add a manhole upstream of the discharge point into the canal for dry weather flow and water quality monitoring

Water Rights / Water Quality Discussion

Alan discussed the State Engineers' current policy on stormwater detention facilities and that RESPEC will be working with Denver Water on what water, if any, will be needed to replace depletions caused by this project.

Alan discussed the water quality benefits expected from this project and the use of WQ-COSM in the evaluation of storm events which are currently or will be diverted into the canal.

Benefits / Costs Analysis

Items to include in the benefits / costs analysis were discussed. Alan explained that part of the benefits of the project are not quantifiable in the terms of dollars and thus will be discussed as qualitative benefits of the project. These include enhancement of the recreational experience, preservation of habitat, and preservation of trees. It was noted that the project will identify the estimated amount of additional water which may become available for use by trees and vegetation from infiltration of stormwater in the canal.

Coming Up

The next months of work will concentrate on conceptual design of the pilot reach facilities. Alan will coordinate with Denver and Aurora to obtain as-constructed drawings of storm sewers in and crossing the High Line Canal in Reaches 38 and 40.

Meeting was adjourned at 3:15 P.M.

Minutes Developed By: ______________
Nathan R. Torrey, RESPEC

RESPEC
WATER & NATURAL RESOURCES
720 South Colorado Blvd., Suite 410S
Denver, Colorado 80246
Phone (303) 757-3655
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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
PROGRESS MEETING – JUNE 5, 2014
1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees
- Ken MacKenzie, UDFCD
- Josh Garcia (for Shannon Carter), Arapahoe County Open Space
- Mark Brown, Arapahoe County Public Works
- Lisa Darling, Aurora Water
- Darren Mollendor, Denver
- Sarah Anderson, Denver
- Barry Schoger (for Tom Roode), Denver Water
- Garth Englund, Douglas County
- Randy Burkhardt, Douglas County
- David Flaig, Littleton
- Alan Leak, RESPEC
- Jessie Nolle, RESPEC
- Melissa Reese-Thacker (for Brett Collins), South Suburban Parks & Rec
- Bob Lindgren, Denver Water

Introduction
Alan Leak opened the meeting with a brief summary of the project progress to date and schedule. The main effort at this point is completion of the draft feasibility report and conceptual design of the pilot reach. Also in progress is finalization of the evaluation of the canal water quality hydraulic characteristics such as estimated capacity versus estimated need. Deliverables in the next month will include the written feasibility report, drawings, and a technical appendix.

Design Reaches Updates
Approximately nine reaches were adjusted to address potential water rights issues related to trans-basin transfers and to address sponsors' comments. Alan also discussed a bar graph showing the distribution of WQCV between existing and future inflows by reach. The graph illustrated that in many of the middle reaches (e.g. 18 through 33) a significant amount of runoff already discharges to the canal. Attendees expressed an interest in seeing the graph also designate watershed and jurisdictional boundaries. The sum of the WQCV for all the basins tributary to the canal is approximately 300 acre-feet. About 80 acre-feet of that volume can be utilized by water already draining to the canal. There is capacity in the canal for using an additional 140 acre-feet of that capacity that may be achieved by redirecting stormwater runoff into the canal, although limitations such as topography and the configuration of existing storm sewer infrastructure may reduce this amount.

Pilot Reach Results
Reaches 38 and 40 were chosen as pilot reaches. A more detailed evaluation of these pilot reaches resulted in the identification of several constraints that may be encountered and decisions that will need to be made specific to each design reach during the detailed design phase of that reach. A major constraint is that existing storm sewer infrastructure may be too deep for too long a distance upstream of the canal to divert water easily into the canal. This may result in higher costs to direct piped stormwater into the canal.

One major question that will need to be addressed include whether or not to put a forebay at every single point inflow or whether some inflow points, specifically the smaller existing ones, can continue operating as they have been. For larger inflows, the design of the forebay will need to consider space available, maintenance access, and cost. Forebays may vary from jurisdiction to jurisdiction based on preferred maintenance practices.

Another question is whether the canal can be used for water quality treatment while the canal is still carrying irrigation flows. After discussion it was determined the improvements would be designed where possible to accommodate this scenario. However, gates will need to be added at each WQ outlet from the canal to the downstream watershed so that they may be closed while the canal is delivering irrigation water.

Water Quality Concerns
Although the total capacity in the canal is greater than the calculated WQCV for the total area draining to the canal, the effective available capacity is only about 71% of total available capacity due to having capacity where it's not needed and needing capacity where it is not available (i.e. a reach by reach basis). Even so, an average of 2900 acre-feet per year of water can be temporarily stored in the canal.

Miscellaneous Discussions
Denver Water staff noted that homeowners downstream of the canal experience standing water in their yards when canal is running for several weeks. It was noted that this will not be the case once the canal is repurposed for water quality, that water will be gone within 72 hours after a storm. Denver Water staff also noted that while vegetation in the canal is expected to change over time, they prefer an absence of vegetation in the bottom of the canal. A 72-hour drain time will provide about 100 additional days that the canal bottom will be wet after storm events. Infiltration is estimated to be about 1000 acre-feet per year.

Water Rights Issues
Meeting participants discussed the potential for any form of regional detention, including for water quality purposes, to require a water right/augmentation plan in light of the recent communications from the State Engineers Office. Meeting participants are hopeful that issues may be resolved through legislation. In the interim, water rights impacts to repurposing the High Line Canal will be based upon the State Engineer's *Administrative Approach for Stormwater Management* dated May 21, 2011. An augmentation plan may ultimately be required.

Coming Up

The draft report will be submittal in the next 2-3 weeks. Comments from local sponsors will be critical in the development of the final conceptual design report. Next meeting is scheduled for July 10, 2014 (after the meeting, the meeting date was moved to July 17, 2014). The VIP group will meet July 30th at City and County of Denver building.

Meeting was adjourned at 3:15 P.M.

Minutes Developed By: Jessie Nolle, RESPEC

RESPEC WATER & NATURAL RESOURCES

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Denver, Colorado 80246
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HIGH LINE CANAL FEASIBILITY STUDY
MEETING MINUTES
PROGRESS MEETING – JULY 17, 2014

1:30 P.M. – 3:30 P.M.
UDFCD Board Room

Attendees

- Ken MacKenzie, UDFCD
- Shannon Carter, Arap. County Open Space
- Jay Henke, Denver Parks
- Suzanne Moore, Greenwood Village
- Tom Roode, Denver Water
- Garth Englund, Douglas County
- Randy Burkhardt, Douglas County
- Stacey Thompson, SEMSWA
- Alan Leak, RESPEC
- Jessie Nolle, RESPEC
- Brett Collins, South Suburban Parks & Rec
- Bob Deeds, Littleton

Introduction

Alan Leak opened the meeting by stating that the meeting was intended to be an open forum to discuss everyone's comments, suggestions, and questions based on everyone's preliminary review of the draft feasibility report. Specifically, he suggested that comments could come in the form of items that were not included in the report but should be added; items that needed additional clarification; items for which further discussion is suggested; and finally, discussion on the overall content, presentation, and clarity of the draft document. The floor was then opened for comment and discussion.

Comments and Discussion

Provide additional discussion and recommendations on phasing. Is there a prioritization of certain reaches? Are there any reaches that should not be used? Potentially consider easement issues, whether irrigation water is still running, locations where treatment may be better handled offsite. Sections 9.1, 9.4, and 10.0 may be good places to include additional discussion. (Shannon)

Denver Water would prefer a north-to-south sequencing since water is currently not running at the north end of the canal.

Provide additional information on where the costs for augmentation come from. Alan stated that the assumption was $20,000 per acre-foot of consumptive use to buy senior water rights to account for annual average evaporation. 125 acre-feet per year was the calculated average annual evaporation for a total of $2.5Million.

Provide a comparative cost of using potable water for tree irrigation in lieu of stormwater, possibly in Section 9.4.

Provide language concerning cost distribution assumptions and potential exceptions.

The scenario was posed that exempting development of less than 1 acre from water quality requirements may drive developers to keep their developments to less than 1 acre.

Littleton has several existing water quality ponds; therefore, the canal in these areas may not need to be used to provide water quality. Alan responded that this is a good point; however, discharging stormwater into the canal would still provide irrigation water for the trees.

Provide additional discussion and analysis regarding alternative water quality facilities costs including assumptions and exceptions. Some of the values in the report may be high.

Consider a pumped alternative.

A future continuous simulation of storm events could help verify the proper diversion pipe size.

Provide additional text in 9.3 to include operations and maintenance costs for forebays and trash pickup. Provide a comparative analysis for costs to maintain retrofit inlets used as forebays versus in-stream forebays and be specific about where costs come from.

Provide an analysis and discussion of existing tree population including a lifecycle analysis. Alan stated that the study scope is use of the HLC as a water quality facility. Providing irrigation water to existing trees is an ancillary benefit. Reference will be made to the HLC Working Group study to address this concern.

Quantify how much water could be put into the canal and define this in terms of how many storms will be fully treated each year (e.g. 22 of 29 annual storms are fully treated).

Given that water will be in the canal 100 more days a year, how many problems is this anticipated to cause. What are the issues and risks of doing this? Canal may end up looking like bio swales.

With a 72-hour drain time, standing water may be an issue. Some re-grading and/or addition of French drains may be needed to avoid causing long-term ponding. This should be looked at on a reach-by-reach basis.

Ketring Lake is filled by water delivered by the canal. Littleton still needs this water, or an alternative source. Tom expanded that Denver Water is assessing potential alternative sources of water to current customers. Once the canal is retrofit in these reaches, storm events may provide enough water to replace what the canal currently provides. Analysis will need to occur.

The maps included in the report are hard to read. Add street names and City boundaries. Make inflow points more visible.

Add the graph showing extent of existing inflow volume from surface discharges. Where surface discharges already are capable of filling the canal, perhaps these areas get priority for retrofit since capital costs will be less (i.e. inflow infrastructure will not be required).

How do we determine who gets to put water into the canal when a canal reach does not have sufficient capacity to serve everyone? Should it be fee-based, first-come-first-served? Alan responded that this will be determined by each individual jurisdiction or a new overall canal management group.

It is more likely that point discharge limits will be implemented than it will be to require water quality measures be implemented for existing development.

Expand discussion of use of canal for water quality while Denver Water uses it for delivery.

Another way to look at the alternative of not using the canal is to estimate the percent redevelopment of the watershed over 100 years and how much water quality will be needed for that area.

Possibly include text to discuss effectiveness of regional versus individual water quality measures.

<u>Coming Up</u>
All comments are due by Monday, July 28.

The VIP group will meet Wednesday, July 30 at City and County of Denver building.

Final report and deliverables will be submitted Friday, August 22.

Meeting was adjourned at 3:15 P.M.

Minutes Developed By: Jessie Nolle, RESPEC

City of Aurora

AURORA WATER

Water Department
Administration
Phone: 303-739-7370
Fax: 303-739-7491

July 30, 2014

Ken McKenzie
Urban Drainage and Flood Control District
2480 W. 26th Avenue, Suite 156-B
Denver, Colorado 80211

Dear Ken,

On behalf of the Aurora Water and Parks, Recreation and Open Space (PROS) Departments, we offer the following comments regarding the draft High Line Canal Feasibility Study.

Comments - General

While much of the Study was very well mapped and documented, and the technical drawings were adequate for review, many of the assumptions made as a basis of the Study were broad and unsubstantiated. The focus of the Study was the repurposing of the High Line Canal for stormwater quality improvements and runoff reductions. However, many of the conclusions reached were based upon a presumption that current stormwater regulations would *definitively* change, and that existing stormwater systems would be inadequate in the future to meet these new requirements. We believe that Aurora's developed stormwater system meets or exceeds all current and anticipated MS4 regulations without retrofit. Based on that fact, the conclusion must be reached that a stormwater system repurposing the High Line Canal is simply not necessary, and perhaps an imprudent use of taxpayer funds.

Comments – Specific

1. Generally, cost information needs to be described in far greater depth. For example, in the draft, there is an estimate for future maintenance costs of the reaches in Aurora and other municipalities, but no basis or information on where these estimate were derived. This is one example of where costs (and resource use) could be significant due to the increase in structures that require more intensive maintenance and the increase in the length of stormwater channel requiring maintenance.
2. There was insufficient discussion on the presumption of operations, maintenance and owner responsibilities.
3. Repurposing land costs were not included, nor was there discussion of easement cost and feasibility of acquisition.
4. There is no discussion about evaluating the canal's current condition and what rehabilitation would be required to ensure that the canal's banks are stable. Directing flows to the canal during large events would expose weaknesses similar to those that were identified in September 2013. For example, the plan shows a typical water depth of three (3) feet, but it is anticipated that once the canal is connected to the stormwater system this water surface elevation could be significantly deeper during a large rainfall event.
5. The pilot project conceptual designs were inadequate to assess future actions. Also, upon development of an actual pilot project onsite, water runs by Denver Water would no longer be feasible for continued tree health in Aurora.

6. Additional considerations and analysis must be completed in the following areas:
    - Condition of existing stormwater systems;
    - Water rights filings and requirements;
    - Current State regulations of regional stormwater project systems;
    - Assessment of stormwater regulatory changes anticipated, including timing;
    - Permitting requirement changes and costs; and
    - Water quality detail by both segment and receiving body.

Aurora appreciates the opportunity to work with other High Line Canal stakeholders, but has reached a general conclusion, barring additional evaluation, that the water quality improvements achieved through repurposing of the Canal are not required at this time. While not the focus of the Study but certainly of interest to many is the current condition of the trees along the canal, the benefits and impacts of the repurposing on the health of that canopy, the costs to trim/improve the current vegetation and future tree/water maintenance costs. If the goal is to preserve the recreational experience historically enjoyed by many along the High Line Canal, there are likely more efficient and cost-effective means to do so. Aurora recommends that the High Line Canal Management Team and Working Groups reconvene and determine possible strategies moving forward.

Thank you for your coordination and efforts on the Study, and we look forward to working with you to determine the very best future for the High Line Canal.

Sincerely,

Marshall P. Brown
Director

cc: Tom Barrett, Director City of Aurora, PROS

Ken MacKenzie

From: Ken MacKenzie
Sent: Tuesday, September 02, 2014 10:47 AM
To: Ken MacKenzie
Subject: FW: Draft Feasibility Report Denver Comments

From: Mollendor, Darren M. - WMD [mailto:Darren.Mollendor@denvergov.org]
Sent: Tuesday, July 29, 2014 11:40 AM
To: Ken MacKenzie
Cc: Anderson, Sarah E - PWWMD Wastewater Management
Subject: RE: Draft Feasibility Report

Denver only has a few concerns regarding the study and the 30% design:

The 30% design needs to add reference to evaluate in-channel flood flows and potential flood flow bypass when required to prevent spilling or overtopping (Alan has a pretty good idea of what I am talking about). For projects that are moving forward additional field survey and hydraulic modeling (CUHP/SWWM/ Flow 2D) correlating predictive flow to existing street and storm conveyance capacity for the 100 year event will be required. Neither item noted were part of the this scope but worthy of narrative cautionary note in sections 5.3, 6.1, 6.5, 6.6 and may require additional design for an intermediate flood flow bypass structures based on actual field conditions.) We may also want to note that the additional analysis and design may also improve the historic overtopping and spill areas leading to safer communities and reduces potential property loss.

This concept is reflected in Section 11.2 paragraph 3 but may be expanded upon...

Darren Mollendor, PE
PW Wastewater

1

DOUGLAS COUNTY
COLORADO
Department of Public Works Engineering
www.douglas.co.us
Engineering Services

September 1, 2014

Ken MacKenzie
Project Engineer
Urban Drainage and Flood Control District
2480 W. 26th Avenue, Suite 156-B
Denver, CO 80211

Re: Highline Canal Feasibility Study Comments

Dear Mr. MacKenzie,

Thank you for letting us be a part of the Highline Canal feasibility working group. The Highline Canal Feasibility Study by RESPEC Consulting is a reasonable beginning to the process of defining the practicability of using the canal for stormwater reduction and treatment. The County is interested in receiving the plan for the next phase of this important project.

The next phase of implementing the pilot project will be important to further define the feasibility of this project and hopefully will provide some answers to the many issues brought up by the present study.

We have some comments on what the next phase should include, which are listed below:

Design:

1. A Phasing Plan is required to identify the prioritization of the improvements along the canal.
2. A system wide analysis of safety issues along the canal is needed along with methods for mitigating these safety issues that can be used independent of city or county.
3. A detailed geotechnical study and evaluation of the ditch for infiltration and stability is needed reach by reach. As a start this should be done for the pilot project.
4. Further evaluation of flood control should be studied to ensure the base flows allow for surcharges required to convey storm events within capacity limits. Emergency overflow needs to be considered and directed appropriately to protect life and property. We assume this will require a district or public agency to obtain some Drainage easements.

Operation:

1. A detailed maintenance and construction plan needs to be developed, along with an economic study to determine how a special district could be organized and financed.

2. Improvements should account for the canal during times of extreme stress, like drought or heavy runoff periods. Some additional scenario testing would be beneficial in defining how to operate the canal in times such as these.

3. Forebay maintenance - Vactor truck resources are typically limited; this is a costly way to dispose of contents, and should be considered the only removal method. Any other options will need to be carefully considered and developed. The plan for the disposal of this material is a very significant maintenance cost and needs further definition.

4. A vegetation maintenance plan should be prepared which should include recommendations for the existing vegetation and for new plantings that are more drought resistant.

Public Outreach and Finance:

1. A plan for how the public outreach process will be organized needs to be developed and agreed to by all parties.

2. A public engagement process to inform, gain input and support from the public needs to begin soon.

3. These potential improvements offer a regional water quality option for new and future developments, how will the financial costs of these improvements be assessed to the existing and future developments? A process needs to be defined and should be consistent for the length of the canal.

4. The County prefers a district be formed to build, maintain and fund the canal. An economic feasibility study is required so that this special district can be defined.

Regulatory:

1. How will the Proposed Rule Docket ID No. EPA–HQ– OW–2011–0880 - Definitions of "Waters of the United States" under the *Clean Water Act* impact this feasibility study and the potential improvement and maintenance operations - both economically and operationally?

2. The Canal has been reported with a 70% infiltration rate and a historical groundwater surcharge. In addition, the proposed use of a bio retention hybrid basin is being considered with a water quality volume calculated at 24 hour storage with an actual release rate of 72 hours. The introduction of storm water from MS4's will potentially add constituents that have never been in the canal before. How will impacted groundwater be protected in accordance with regulations?

3. Water rights need additional analysis in the next phase. The pilot project should be used to

define this issue in more depth with the State Engineering Office. We disagree that each municipality should be responsible for defining this legal issue! We need a plan consistent for the whole length of the canal.

4. Plans for dealing with potential illicit discharges, including plans for how any offenses will be enforced within the new infrastructure facility, is required.

Douglas County is looking forward to the next phase of this project. Please keep us informed of future steps. If you have any questions or need further clarification on our comments, feel free to contact me at 303-660-7479.

Sincerely,

Garth W. Englund Jr. P.E.

Special Projects Engineer

APPENDIX B – Hydrologic & Hydraulic Analysis

CUHP Input Hydrology Parameters

Subcatchment Name	Original Name	Source	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Percent Imperviousness
WQ110	DC1	New	0.125149	0.290781	0.579639	0.015969	4.15	0.0018	0.58	6.09
WQ111	DC2	New	0.158605	0.282113	0.56322	0.022568	4.02	0.0018	0.57	2
WQ112	DC3	New	0.156041	0.339548	0.693868	0.125908	3.54	0.0018	0.54	2
WQ113	DC3	New	0.093857	0.193944	0.488003	0.175914	3.65	0.0018	0.54	10.16
WQ114	DC4	New	0.115463	0.294925	0.661553	0.136806	3.79	0.0018	0.55	2.01
WQ115	DC4	New	0.175051	0.276274	0.70196	0.027553	3.00	0.0018	0.50	27.59
WQ116	DC5	New	0.205031	0.343694	0.756787	0.018372	4.50	0.0018	0.60	11.82
WQ117	DC6	New	0.144382	0.19848	0.471802	0.017386	4.50	0.0018	0.60	19.77
WQ118	DC6	New	0.098682	0.284106	0.542736	0.024717	4.50	0.0018	0.60	39.72
WQ119	DC6	New	0.137058	0.266614	0.701046	0.020751	3.94	0.0018	0.56	15.11
WQ120	DC6	New	0.174324	0.261647	0.608799	0.034008	4.37	0.0018	0.59	63.19
WQ121	DC6	New	0.096813	0.178405	0.455674	0.037839	3.68	0.0018	0.55	35.14
WQ122	DC6	New	0.049523	0.119128	0.304236	0.038185	3.43	0.0018	0.53	43.43
WQ123	DC6	New	0.186315	0.324736	0.668101	0.036689	3.05	0.0018	0.50	33.31
WQ124	DC6	New	0.089568	0.250282	0.567459	0.033711	3.01	0.0018	0.50	36.6
WQ125	DC8	New	0.126382	0.205558	0.608948	0.030814	4.50	0.0018	0.60	29.49
WQ126	DC11	New	0.193268	0.27756	0.732997	0.016138	4.50	0.0018	0.60	29.94
WQ127	DC11	New	0.16385	0.200159	0.492091	0.023898	4.50	0.0018	0.60	24.29
WQ128	DC11	New	0.101081	0.212817	0.408889	0.012479	4.57	0.0016	0.66	24.08
WQ129	DC11	New	0.189797	0.329504	0.637562	0.007778	4.50	0.0018	0.60	4.81
WQ130	DC11	New	0.178077	0.268082	0.452932	0.020092	4.50	0.0018	0.60	7.62
WQ131	DC11	New	0.057478	0.237341	0.393112	0.032172	4.61	0.0016	0.69	10.04
WQ132	DC10	New	0.088133	0.257826	0.657645	0.025424	4.85	0.0010	0.88	2.53
WQ133	DC10	New	0.198224	0.382976	0.699044	0.027808	4.60	0.0016	0.68	16.28
WQ134	DC10	New	0.20799	0.203683	0.501339	0.031183	4.54	0.0017	0.63	72.24
WQ135	DC9	New	0.121076	0.272986	0.558707	0.027874	4.42	0.0018	0.59	71.48
WQ136	DC9	New	0.150328	0.253075	0.756406	0.042254	3.31	0.0018	0.52	37.22
WQ137	DC12	New	0.150747	0.391293	0.738451	0.053693	4.56	0.0017	0.65	25.84
WQ138	DC13	New	0.200602	0.262737	0.532728	0.065515	4.96	0.0008	0.97	28.3
WQ139	DC14	New	0.186035	0.375694	0.786858	0.009177	4.99	0.0007	0.99	15.28
WQ140	DC15	New	0.170382	0.214647	0.548338	0.057668	4.97	0.0008	0.98	21.59
WQ141	DC15	New	0.176585	0.313081	0.636242	0.029707	5.00	0.0007	1.00	31.09
WQ142	DC16	New	0.113667	0.367833	0.601417	0.020145	5.00	0.0007	1.00	75.29
WQ143	DC17	New	0.121963	0.368481	0.632445	0.012327	5.00	0.0007	1.00	80
WQ144	DC18	New	0.156298	0.200436	0.608513	0.019468	4.97	0.0008	0.98	62.26
WQ145	DC19	New	0.156935	0.339547	0.63979	0.030137	4.70	0.0014	0.76	37.64
WQ146	DC20	New	0.08053	0.184447	0.412923	0.034452	4.51	0.0018	0.61	50.85
WQ147	DC20	New	0.179732	0.350466	0.701302	0.024667	4.45	0.0014	0.72	61.34
WQ148	DC22	New	0.075762	0.144743	0.39202	0.020253	3.00	0.0018	0.50	79.74
WQ149	DC22	New	0.133987	0.133327	0.371343	0.050336	3.41	0.0018	0.53	68.17
WQ150	DC21	New	0.178741	0.228447	0.483228	0.034559	3.30	0.0018	0.52	59.22
WQ151	DC24	New	0.149866	0.070344	0.5663	0.021223	3.09	0.0018	0.51	74.55
WQ152	DC23	New	0.120435	0.127086	0.365062	0.025561	3.02	0.0018	0.50	60.5
WQ153	DC23	New	0.145718	0.202451	0.457414	0.033857	3.00	0.0018	0.50	80

CUHP Input Hydrology Parameters

Subcatchment Name	Original Name	Source	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Percent Imperviousness
WQ210	303	WRC	0.146191	0.284	0.672	0.021	3.00	0.0018	0.50	80
WQ211	307	WRC	0.11792	0.341	0.72	0.017	3.00	0.0018	0.50	80
WQ212	305	WRC	0.075923	0.237	0.587	0.02	3.00	0.0018	0.50	80
WQ213	304	WRC	0.153345	0.53	0.966	0.015	3.00	0.0018	0.50	80
WQ214	308	WRC	0.073449	0.417	0.795	0.017	3.00	0.0018	0.50	77
WQ215	353	WRC	0.10453	0.17	0.455	0.006	3.00	0.0018	0.50	95
WQ216	306	WRC	0.076998	0.17	0.53	0.023	3.00	0.0018	0.50	51
WQ217	351	WRC	0.09291	0.189	0.455	0.017	3.00	0.0018	0.50	43
WQ218	356	WRC	0.054471	0.152	0.218	0.02	3.00	0.0018	0.50	43
WQ219	352	WRC	0.125662	0.284	0.492	0.026	3.00	0.0018	0.50	51
WQ220	355	WRC	0.058164	0.076	0.294	0.04	3.00	0.0018	0.50	47
WQ221	354	WRC	0.04104	0.104	0.246	0.052	3.00	0.0018	0.50	95
WQ222	357	WRC	0.072071	0.104	0.265	0.048	3.00	0.0018	0.50	43
WQ223	408	WRC	0.181188	0.189	0.625	0.028	3.00	0.0018	0.50	47
WQ224	405	WRC	0.175314	0.398	0.663	0.026	3.00	0.0018	0.50	59
WQ225	406	WRC	0.138555	0.284	0.36	0.034	3.00	0.0018	0.50	41
WQ226	404	WRC	0.138368	0.417	0.606	0.023	3.00	0.0018	0.50	41
WQ227	403	WRC	0.161448	0.313	0.644	0.021	3.00	0.0018	0.50	44
WQ228	402	WRC	0.149913	0.284	0.663	0.019	3.00	0.0018	0.50	43
WQ229	401	WRC	0.134696	0.303	0.663	0.023	3.00	0.0018	0.50	43
WQ230	407	WRC	0.149372	0.161	0.322	0.038	3.00	0.0018	0.50	48
WQ231	453	WRC	0.106104	0.208	0.341	0.011	3.00	0.0018	0.50	49
WQ232	454	WRC	0.144876	0.189	0.417	0.014	3.00	0.0018	0.50	46
WQ233	455	WRC	0.173533	0.265	0.701	0.011	3.00	0.0018	0.50	43
WQ234	456	WRC	0.129814	0.114	0.303	0.025	3.00	0.0018	0.50	43
WQ235	451	WRC	0.131672	0.227	0.625	0.02	3.00	0.0018	0.50	82
WQ236	452	WRC	0.120966	0.17	0.436	0.026	3.00	0.0018	0.50	34
WQ237	140	WRC	0.102806	0.076	0.549	0.002	3.00	0.0018	0.50	44
WQ238	138	WRC	0.132273	0.398	0.549	0.016	3.00	0.0018	0.50	54
WQ239	136	WRC	0.101836	0.189	0.559	0.023	3.00	0.0018	0.50	43
WQ240	137	WRC	0.10346	0.133	0.436	0.033	3.00	0.0018	0.50	46
WQ241	141	WRC	0.158336	0.133	0.322	0.018	3.00	0.0018	0.50	39
WQ242	142	WRC	0.138118	0.189	0.473	0.017	3.00	0.0018	0.50	44
WQ243	520	WRC	0.201387	0.152	0.341	0.028	3.00	0.0018	0.50	31
WQ244	521	WRC	0.12877	0.322	0.379	0.023	3.00	0.0018	0.50	53
WQ245	522	WRC	0.126774	0.246	0.606	0.02	3.00	0.0018	0.50	42
WQ246	536	WRC	0.164358	0.284	0.587	0.028	3.00	0.0018	0.50	13
WQ247	523	WRC	0.082541	0.152	0.341	0.014	3.00	0.0018	0.50	42
WQ248	524	WRC	0.20147	0.208	0.833	0.009	3.00	0.0018	0.50	34
WQ249	525	WRC	0.113055	0.133	0.492	0.021	3.00	0.0018	0.50	15
WQ250	610	WRC	0.208714	0.114	0.549	0.028	3.00	0.0018	0.50	30
WQ257	636	WRC	0.095403	0.095	0.492	0.021	3.00	0.0018	0.50	31
WQ258	621	WRC	0.15789	0.114	0.568	0.025	3.00	0.0018	0.50	15
WQ259	625	WRC	0.167655	0.227	0.53	0.029	3.00	0.0018	0.50	21

CUHP Input Hydrology Parameters

Subcatchment Name	Original Name	Source	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Percent Imperviousness
WQ260	628	WRC	0.125544	0.189	0.568	0.037	3.00	0.0018	0.50	40
WQ261	626	WRC	0.131965	0.379	0.682	0.031	3.00	0.0018	0.50	38
WQ262	627	WRC	0.128651	0.284	0.72	0.029	3.00	0.0018	0.50	39
WQ263	629	WRC	0.099873	0.076	0.417	0.041	3.00	0.0018	0.50	28
WQ310	5200-03-430	Denver	0.071964	0.095	0.275	0.021	3.00	0.0018	0.50	52
WQ311	5200-03-440	Denver	0.162129	0.218	1.022	0.016	3.00	0.0018	0.50	46
WQ312	5200-03-420	Denver	0.12362	0.227	0.407	0.025	3.00	0.0018	0.50	61
WQ313	5200-03-410	Denver	0.134808	0.331	0.814	0.026	3.00	0.0018	0.50	54
WQ314	5200-03-771	Denver	0.052753	0.114	0.417	0.014	3.00	0.0018	0.50	22.66
WQ315	5200-03-772	Denver	0.084591	0.156	0.422	0.04	3.00	0.0018	0.50	48
WQ316	5200-03-780	Denver	0.079917	0.17	0.417	0.037	3.00	0.0018	0.50	48
WQ317	5200-03-790	Denver	0.092617	0.265	0.616	0.02	3.00	0.0018	0.50	48
WQ318	5200-03-800	Denver	0.093144	0.388	1.013	0.019	3.00	0.0018	0.50	60.64
WQ319	5200-03-810	Denver	0.102545	0.256	0.521	0.02	3.00	0.0018	0.50	48
WQ320	5200-03-832	Denver	0.06644	0.212	0.543	0.032	3.00	0.0018	0.50	48
WQ321	5200-03-831	Denver	0.05259	0.143	0.362	0.03	3.00	0.0018	0.50	48
WQ322	5200-03-820	Denver	0.068775	0.161	0.43	0.028	3.00	0.0018	0.50	51.72
WQ323	5200-03-821	Denver	0.028601	0.231	0.398	0.015	3.00	0.0018	0.50	74.14
WQ324	5200-03-840	Denver	0.091493	0.265	0.502	0.023	3.00	0.0018	0.50	55.5
WQ325	5200-03-881	Denver	0.062294	0.538	0.711	0.027	3.00	0.0018	0.50	64.78
WQ326	5200-03-880	Denver	0.146177	0.473	0.758	0.017	3.00	0.0018	0.50	49.64
WQ327	5200-03-870	Denver	0.062317	0.095	0.364	0.006	3.00	0.0018	0.50	50
WQ328	5200-03-871	Denver	0.039313	0.18	0.36	0.015	3.00	0.0018	0.50	50
WQ329	5200-03-872	Denver	0.013811	0.104	0.237	0.026	3.00	0.0018	0.50	50
WQ330	5000-02-401	Denver	0.021754	0.33	0.37	0.0129	3.00	0.0018	0.50	60.5
WQ331	4601-01-610	Denver	0.031344	0.3352	0.7629	0.0119	3.00	0.0018	0.50	73.54
WQ332	4601-01-580	Denver	0.042518	0.2587	0.4314	0.007	3.00	0.0018	0.50	48
WQ333	4601-01-570	Denver	0.027679	0.2629	0.4223	0.0108	3.00	0.0018	0.50	48
WQ334	4601-01-510	Denver	0.029523	0.232	0.3138	0.0157	3.00	0.0018	0.50	48
WQ335	4601-01-520	Denver	0.012887	0.2	0.2729	0.0069	3.00	0.0018	0.50	46.1
WQ336	4601-01-460	Denver	0.120093	0.5186	0.81	0.0131	3.00	0.0018	0.50	65.78
WQ337	4601-01-470	Denver	0.114852	0.3013	0.4324	0.0105	3.00	0.0018	0.50	46.24
WQ338	4601-01-440	Denver	0.190418	0.6932	1.082	0.0178	3.00	0.0018	0.50	50.03
WQ339	4601-01-450	Denver	0.244443	0.5674	0.8856	0.0231	3.00	0.0018	0.50	50.65
WQ340	4601-01-480	Denver	0.069241	0.2951	0.3896	0.0408	3.00	0.0018	0.50	45.5
WQ341	4601-01-490	Denver	0.060373	0.1464	0.4117	0.0198	3.00	0.0018	0.50	44.95
WQ342	4601-01-555	Denver	0.054605	0.3955	0.6589	0.0279	3.00	0.0018	0.50	71
WQ343	4600-03-140	Denver	0.21088	0.5	0.9999	0.01	3.00	0.0018	0.50	81
WQ344	4600-04-150	Denver	0.137133	0.1598	0.6748	0.018	3.00	0.0018	0.50	48.28
WQ345	4600-04-160	Denver	0.0412	0.2811	0.5498	0.006	3.00	0.0018	0.50	80
WQ346	4600-04-140	Denver	0.166152	0.3074	0.7051	0.02	3.00	0.0018	0.50	46.18
WQ347	4600-04-135	Denver	0.0301	0.2178	0.3447	0.031	3.00	0.0018	0.50	46.28
WQ348	4600-04-130	Denver	0.117494	0.2765	0.517	0.026	3.00	0.0018	0.50	54.88
WQ349	4600-04-180	Denver	0.180488	0.2576	0.4184	0.019	3.00	0.0018	0.50	38.68

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CUHP Input Hydrology Parameters

Subcatchment Name	Original Name	Source	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Percent Imperviousness
WQ350	4600-04-360	Denver	0.152122	0.3593	0.953	0.018	3.00	0.0018	0.50	64.82
WQ351	4600-04-370	Denver	0.13665	0.1403	0.4568	0.035	3.00	0.0018	0.50	60
WQ352	4600-04-390	Denver	0.254742	0.6019	1.2025	0.006	3.00	0.0018	0.50	90
WQ353	4600-03-010	Denver	0.503171	0.5	0.9999	0.01	3.00	0.0018	0.50	70
WQ354	4600-03-030	Denver	0.227193	0.3598	0.8523	0.01	3.00	0.0018	0.50	83
WQ355	4600-03-040	Denver	0.113229	0.1799	0.4261	0.011	3.00	0.0018	0.50	82
WQ356	4600-03-041	Denver	0.049374	0.2273	0.5114	0.032	3.00	0.0018	0.50	76
WQ357	4500-04-010	Denver	0.021288	0.4924	0.8617	0.014	3.00	0.0018	0.50	6.7
WQ358	4401-04-462	Denver	0.08234	0.2936	0.549	0.004	3.00	0.0018	0.50	30.02
WQ359	4401-04-410	Denver	0.093054	0.2273	0.549	0.002	3.00	0.0018	0.50	89.4
WQ360	4401-04-463	Denver	0.118699	0.464	0.644	0.005	3.00	0.0018	0.50	59.72
WQ361	4401-04-411	Denver	0.149371	0.4072	0.634	0.004	3.00	0.0018	0.50	69
WQ362	4401-04-412	Denver	0.345151	0.7292	1.591	0.009	3.00	0.0018	0.50	74
WQ363	4401-04-431	Denver	0.1315	0.2936	0.511	0.004	3.00	0.0018	0.50	66.5
WQ364	4401-04-432	Denver	0.0587	0.1705	0.426	0.011	3.00	0.0018	0.50	52
WQ365	4401-04-433	Denver	0.381989	0.7386	1.212	0.012	3.00	0.0018	0.50	87.4
WQ366	4401-04-045	Denver	0.087468	0.3456	0.392	0.004	3.00	0.0018	0.50	63.99
WQ367	4401-04-046	Denver	0.095548	0.216	0.536	0.01	3.00	0.0018	0.50	70
WQ368	4401-04-041	Denver	0.01747	0.1	0.203	0.001	3.00	0.0018	0.50	87.4
WQ369	4401-04-073	Denver	0.124531	0.297	0.686	0.004	3.00	0.0018	0.50	95
WQ370	4401-04-012	Denver	0.108015	0.477	0.805	0.021	3.00	0.0018	0.50	64
WQ371	4401-04-264	Denver	0.164734	0.312	0.606	0.005	3.00	0.0018	0.50	41
WQ372	4401-04-014	Denver	0.017046	0.0966	0.242	0.006	3.00	0.0018	0.50	41
WQ373	4401-04-013	Denver	0.117859	0.347	0.642	0.009	3.00	0.0018	0.50	41
WQ374	19	WesterlyCreek	0.045609	0.281	0.742	0.007	3.00	0.0018	0.50	56.56
WQ410	WC1	New	0.09358	0.197076	0.46054	0.015514	3.00	0.0018	0.50	55
WQ411	WC1	New	0.186266	0.54214	0.920184	0.011539	3.00	0.0018	0.50	55
WQ412	WC1	New	0.034142	0.095758	0.19864	0.014602	3.00	0.0018	0.50	55
WQ413	LT11	WestTollGate	0.217679	0.242	0.494	0.22	3.00	0.0018	0.50	18.8
WQ414	LT12	WestTollGate	0.1642	0.241	0.508	0.022	3.00	0.0018	0.50	26.5
WQ415	LT10	WestTollGate	0.21805	0.242	0.578	0.028	3.18	0.0018	0.51	54.8
WQ416	LT8	WestTollGate	0.147137	0.174	0.434	0.026	3.00	0.0018	0.50	52
WQ417	LT7	WestTollGate	0.164882	0.449	0.805	0.018	4.19	0.0018	0.58	56.3
WQ418	LT2	WestTollGate	0.098643	0.066	0.326	0.024	3.00	0.0018	0.50	72.6
WQ419	LW35	WestTollGate	0.242377	0.407	0.678	0.017	3.00	0.0018	0.50	75
WQ420	LW33	WestTollGate	0.171005	0.645	0.803	0.026	3.00	0.0018	0.50	85
WQ421	LW34	WestTollGate	0.168233	0.449	0.648	0.029	3.00	0.0018	0.50	78.6
WQ422	LW32	WestTollGate	0.119664	0.458	0.763	0.026	3.00	0.0018	0.50	84.8
WQ423	LW31	WestTollGate	0.224578	0.423	0.705	0.025	3.05	0.0018	0.50	74.7
WQ424	LW30	WestTollGate	0.080225	0.142	0.466	0.015	4.50	0.0018	0.61	73.9
WQ510	EG4	EastTollGate	0.100585	0.3879	0.86	0.0057	3.15	0.0018	0.51	48.52
WQ511	EG2	EastTollGate	0.141064	0.4453	0.99	0.0107	3.00	0.0018	0.50	77.15
WQ512	GD20	EastTollGate	0.100476	0.192	0.53	0.0123	3.00	0.0018	0.50	51.25
WQ513	GD22	EastTollGate	0.081267	0.1475	0.19	0.004	3.00	0.0018	0.50	45.34

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CUHP Input Hydrology Parameters

Subcatchment Name	Original Name	Source	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Percent Imperviousness
WQ514	SD14	EastTollGate	0.164763	0.5328	0.92	0.0237	3.00	0.0018	0.50	55.33
WQ515	SD12	EastTollGate	0.176785	0.5733	0.98	0.0111	3.00	0.0018	0.50	47.17
WQ516	SD10	EastTollGate	0.075089	0.5733	0.98	0.0111	3.00	0.0018	0.50	52.34
WQ517	SC1	New	0.070957	0.163155	0.370732	0.01092	4.46	0.0018	0.60	50
WQ518	SC2	New	0.05139	0.149192	0.306389	0.023545	3.00	0.0018	0.50	45
WQ519	SA2	EastTollGate	0.0858	0.3928	0.65	0.009	3.00	0.0018	0.50	45
WQ520	SA4	EastTollGate	0.191646	0.3159	0.74	0.0089	3.00	0.0018	0.50	78.93
WQ521	SC3	New	0.071633	0.178602	0.352531	0.028907	3.00	0.0018	0.50	45
WQ610	SC4	New	0.05866	0.22515	0.382929	0.003714	4.54	0.0017	0.63	85
WQ611	SC5	New	0.103041	0.358812	0.693295	0.00449	4.50	0.0018	0.60	50
WQ612	SC6	New	0.07272	0.119349	0.347895	0.009753	4.50	0.0018	0.60	50
WQ613	SC7	New	0.072897	0.142743	0.346014	0.00621	4.50	0.0018	0.60	50
WQ614	SC7	New	0.155084	0.251808	0.659999	0.009509	4.50	0.0018	0.60	50
WQ615	SC7	New	0.099383	0.209042	0.589869	0.004608	4.50	0.0018	0.60	50
WQ616	SC7	New	0.174045	0.33802	0.596116	0.014149	4.43	0.0018	0.60	50
WQ617	SC7	New	0.106447	0.198065	0.482771	0.019307	4.50	0.0018	0.60	50
WQ618	SC8	New	0.161581	0.289614	0.66415	0.011794	3.79	0.0018	0.55	85
WQ619	SC8	New	0.063342	0.240315	0.539686	0.011572	3.18	0.0018	0.51	85
WQ620	SC9	New	0.130398	0.293058	0.621951	0.010332	3.00	0.0018	0.50	85
WQ621	SC9	New	0.101734	0.206621	0.465498	0.013242	3.00	0.0018	0.50	85
WQ622	SC9	New	0.138826	0.428923	0.73768	0.009926	3.00	0.0018	0.50	85
WQ623	SC9	New	0.20223	0.249614	0.731896	0.012598	3.51	0.0018	0.53	85
WQ710	3900-04-125	Denver	0.161828	0.2841	0.6061	0.0081	3.00	0.0018	0.50	85
WQ711	3900-04-124	Denver	0.026565	0.0947	0.44	0.0026	3.00	0.0018	0.50	99
WQ712	3900-04-120	Denver	0.043307	0.23	0.32	0.0094	3.00	0.0018	0.50	85
WQ713	3900-04-118	Denver	0.052799	0.24	0.45	0.005	3.00	0.0018	0.50	85
WQ714	3900-04-117	Denver	0.025341	0.0663	0.1326	0.0059	3.00	0.0018	0.50	85
WQ715	3900-04-123	Denver	0.029779	0.02	0.0947	0.01	3.00	0.0018	0.50	85
WQ716	3900-04-119	Denver	0.077641	0.15	0.44	0.0051	3.00	0.0018	0.50	85
WQ717	3900-04-121	Denver	0.053995	0.1	0.45	0.011	3.00	0.0018	0.50	85
WQ718	3900-04-122	Denver	0.004049	0.035	0.07	0.013	3.00	0.0018	0.50	85
WQ719	3900-04-112	Denver	0.05502	0.1326	0.17	0.02	3.00	0.0018	0.50	85
WQ720	3900-04-113	Denver	0.051962	0.16	0.27	0.0069	3.00	0.0018	0.50	85
WQ721	3900-04-116	Denver	0.086871	0.31	0.43	0.0053	3.00	0.0018	0.50	85
WQ722	3900-04-115	Denver	0.023191	0.0663	0.1136	0.01	3.00	0.0018	0.50	85
WQ723	3900-04-114	Denver	0.047409	0.18	0.44	0.0163	3.00	0.0018	0.50	85
WQ724	3900-04-109	Denver	0.037072	0.23	0.34	0.061	3.00	0.0018	0.50	85
WQ725	3900-04-111	Denver	0.012183	0.0663	0.0947	0.005	3.00	0.0018	0.50	85
WQ726	3900-04-110	Denver	0.04381	0.0568	0.1894	0.015	3.00	0.0018	0.50	85
WQ727	3900-04-108	Denver	0.021714	0.12	0.27	0.0076	3.00	0.0018	0.50	85
WQ728	3900-04-106	Denver	0.013033	0.02	0.0663	0.05	3.00	0.0018	0.50	85
WQ729	3900-04-103	Denver	0.099975	0.27	0.41	0.0056	3.00	0.0018	0.50	85
WQ730	3900-04-107	Denver	0.007647	0.02	0.0757	0.05	3.00	0.0018	0.50	85
WQ731	3900-04-104	Denver	0.055993	0.22	0.47	0.0141	3.00	0.0018	0.50	85

CUHP Input Hydrology Parameters

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WQ732	3900-04-105	Denver	0.001584	0.03	0.06	0.01	3.00	0.0018	0.50	85
WQ733	3900-04-101	Denver	0.013228	0.0284	0.0947	0.01	3.00	0.0018	0.50	85
WQ744	3900-04-102	Denver	0.042739	0.1	0.23	0.0117	3.00	0.0018	0.50	85
WQ745	3900-03-061	Denver	0.028324	0.23	0.64	0.0111	3.00	0.0018	0.50	48.71
WQ746	3900-03-063	Denver	0.121865	0.189	0.379	0.009	3.00	0.0018	0.50	47.73
WQ747	3900-03-062	Denver	0.1396	0.265	0.625	0.0094	3.00	0.0018	0.50	46.1
WQ748	3700-02-059	Denver	0.037213	0.1547	0.3201	0.0053	3.00	0.0018	0.50	47.19
WQ749	3700-02-061	Denver	0.091361	0.2701	0.44	0.0069	3.00	0.0018	0.50	47.37
WQ750	3700-02-062	Denver	0.224139	0.2424	0.5398	0.014	3.00	0.0018	0.50	41.97
WQ751	3700-02-063	Denver	0.04379	0.1515	0.7386	0.009	3.00	0.0018	0.50	38.31

CUHP Water Quality Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ110		0.184	0.234	42.3	9.10	22.0	6.43	15.2	89	290,746	0.00	1,051	45.0	0	1,051	0.00
WQ111		0.182	0.258	34.0	8.24	17.7	5.82	13.7	140	368,471	0.00	144	40.0	0	143	0.00
WQ112		0.183	0.258	27.4	6.92	14.2	4.89	11.5	171	362,514	0.00	141	35.0	0	141	0.00
WQ113		0.186	0.212	20.2	4.78	10.5	3.38	8.0	139	218,049	0.01	2,195	35.0	1	2,180	0.01
WQ114		0.201	0.246	28.2	6.82	14.6	4.82	11.4	123	268,244	0.00	106	35.0	0	106	0.00
WQ115		0.119	0.260	23.1	6.12	12.0	4.33	10.2	227	406,678	0.08	32,625	35.0	9	32,664	0.08
WQ116		0.141	0.233	38.8	8.43	20.2	5.96	14.0	159	476,328	0.01	6,489	40.0	1	6,484	0.01
WQ117		0.139	0.223	24.7	5.74	12.8	4.05	9.6	175	335,428	0.04	12,784	35.0	3	12,767	0.04
WQ118		0.127	0.330	17.8	6.02	9.3	4.26	10.0	166	229,258	0.15	35,269	35.0	11	35,082	0.18
WQ119		0.149	0.214	37.0	7.59	19.2	5.36	12.6	111	318,413	0.02	7,198	40.0	1	7,193	0.02
WQ120		0.093	0.540	7.6	2.65	3.9	1.77	7.7	692	404,990	0.28	113,089	30.0	59	106,640	0.53
WQ121		0.132	0.287	14.3	4.64	7.4	3.28	7.7	204	224,916	0.12	27,081	30.0	11	27,003	0.17
WQ122		0.154	0.331	9.7	3.40	5.0	2.27	6.6	153	115,052	0.17	19,907	30.0	10	19,793	0.30
WQ123		0.110	0.301	18.2	5.71	9.5	4.03	9.5	307	432,847	0.11	47,145	35.0	15	46,927	0.13
WQ124		0.134	0.295	18.8	5.76	9.8	4.07	9.6	143	208,084	0.13	27,180	35.0	9	27,067	0.15
WQ125		0.129	0.258	19.9	5.45	10.4	3.85	9.1	190	293,611	0.08	24,898	35.0	8	24,796	0.09
WQ126		0.113	0.278	23.8	6.58	12.4	4.65	11.0	243	449,000	0.09	39,246	35.0	11	39,229	0.09
WQ127		0.126	0.242	19.7	5.16	10.2	3.65	8.6	250	380,656	0.06	21,900	35.0	7	21,744	0.06
WQ128		0.147	0.225	27.2	6.20	14.2	4.38	10.3	111	234,831	0.06	13,278	35.0	3	13,251	0.05
WQ129		0.165	0.254	46.2	10.51	24.0	7.43	17.5	123	440,936	0.00	995	45.0	0	994	0.00
WQ130		0.160	0.241	28.9	6.86	15.1	4.85	11.4	185	413,708	0.01	2,342	40.0	1	2,343	0.00
WQ131		0.217	0.197	37.8	7.22	19.7	5.10	12.0	46	133,533	0.01	1,313	40.0	0	1,313	0.01
WQ132		0.217	0.234	44.7	9.54	23.2	6.74	15.9	59	204,751	0.00	128	45.0	0	128	0.00
WQ133		0.131	0.228	33.9	7.43	17.6	5.25	12.4	175	460,514	0.03	11,901	40.0	3	11,884	0.02
WQ134		0.085	0.597	5.1	1.79	2.7	1.20	6.4	1,218	483,202	0.33	157,334	30.0	94	156,177	0.71
WQ135		0.101	0.547	8.3	2.89	4.3	1.93	8.3	440	281,284	0.32	90,475	30.0	47	87,142	0.61
WQ136		0.113	0.325	15.8	5.45	8.2	3.85	9.1	285	349,242	0.14	47,177	30.0	17	47,036	0.18
WQ137		0.127	0.246	27.0	6.60	14.0	4.66	11.0	168	350,215	0.07	22,802	35.0	6	22,766	0.06
WQ138		0.113	0.270	14.8	4.56	7.7	3.22	7.6	408	466,039	0.08	36,395	30.0	14	36,292	0.11
WQ139		0.136	0.224	48.6	9.88	25.3	6.98	16.5	115	432,197	0.02	9,840	45.0	2	9,830	0.01
WQ140		0.129	0.234	18.3	4.80	9.5	3.39	8.0	279	395,831	0.05	17,991	30.0	6	17,894	0.05
WQ141		0.114	0.282	20.4	5.92	10.6	4.18	9.9	260	410,242	0.09	38,666	35.0	12	38,651	0.10
WQ142		0.101	0.556	10.5	3.69	5.5	2.47	10.0	324	264,071	0.34	90,205	30.0	42	89,990	0.57
WQ143		0.097	0.576	11.2	3.94	5.8	2.63	10.8	325	283,344	0.37	103,885	35.0	46	104,122	0.59
WQ144		0.097	0.527	8.1	2.84	4.2	1.90	8.0	579	363,112	0.27	99,698	30.0	51	95,231	0.51
WQ145		0.112	0.332	17.6	5.97	9.1	4.22	10.0	268	364,591	0.14	50,368	35.0	17	50,070	0.16
WQ146		0.127	0.411	9.4	3.30	4.9	2.21	7.5	256	187,087	0.21	39,622	30.0	19	38,712	0.37
WQ147		0.093	0.533	10.2	3.57	5.3	2.38	9.4	529	417,553	0.27	112,722	30.0	54	112,292	0.47
WQ148		0.112	0.536	6.3	2.21	3.3	1.48	6.8	359	176,010	0.37	64,287	30.0	36	61,548	0.74
WQ149		0.099	0.542	4.1	1.45	2.2	0.97	5.4	970	311,279	0.30	94,802	25.0	84	118,981	0.99
WQ150		0.095	0.520	6.6	2.32	3.5	1.55	6.9	808	415,251	0.26	107,437	30.0	59	103,828	0.52
WQ151		0.093	0.576	4.1	1.42	2.1	0.95	5.5	1,109	348,169	0.34	117,576	25.0	104	147,695	1.09
WQ152		0.106	0.498	5.5	1.93	2.9	1.29	6.0	654	279,795	0.27	74,360	25.0	48	79,747	0.62
WQ153		0.092	0.592	5.2	1.83	2.7	1.22	6.5	837	338,532	0.37	124,118	30.0	73	122,280	0.79
WQ210		0.092	0.592	8.3	2.90	4.3	1.94	8.8	530	339,631	0.37	124,521	30.0	66	121,594	0.71
WQ211		0.098	0.573	10.8	3.80	5.6	2.54	10.5	326	273,952	0.37	100,441	35.0	45	100,634	0.60
WQ212		0.112	0.537	9.7	3.40	5.1	2.28	9.2	234	176,384	0.37	64,669	30.0	32	64,288	0.65
WQ213		0.090	0.596	14.1	4.93	7.3	3.30	13.3	326	356,251	0.37	130,615	35.0	53	131,303	0.54
WQ214		0.115	0.526	16.0	5.61	8.3	3.75	13.3	138	170,637	0.35	59,831	35.0	22	60,027	0.47

CUHP Water Quality Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ215		0.097	0.597	7.6	2.65	3.9	1.77	8.3	413	242,844	0.45	110,357	30.0	59	105,296	0.89
WQ216		0.129	0.410	11.5	4.01	6.0	2.68	8.5	202	178,882	0.21	38,030	30.0	17	37,705	0.34
WQ217		0.127	0.359	13.6	4.74	7.0	3.17	8.7	206	215,849	0.17	36,880	30.0	15	36,852	0.25
WQ218		0.150	0.332	10.5	3.69	5.5	2.47	7.0	155	126,547	0.17	21,622	30.0	10	21,284	0.28
WQ219		0.110	0.441	11.0	3.84	5.7	2.57	8.7	344	291,938	0.21	62,065	30.0	28	61,480	0.35
WQ220		0.143	0.366	6.4	2.25	3.3	1.50	5.5	272	135,127	0.19	25,855	25.0	16	27,109	0.43
WQ221		0.129	0.519	4.1	1.43	2.1	0.96	5.2	302	95,344	0.45	43,328	25.0	40	54,742	1.51
WQ222		0.137	0.346	6.9	2.41	3.6	1.61	5.5	314	167,435	0.17	28,608	25.0	17	29,506	0.36
WQ223		0.101	0.434	9.2	3.23	4.8	2.16	7.6	590	420,936	0.19	80,541	30.0	39	78,189	0.34
WQ224		0.095	0.518	10.9	3.83	5.7	2.56	9.7	481	407,289	0.26	104,857	30.0	47	104,413	0.42
WQ225		0.113	0.361	11.1	3.88	5.8	2.60	7.6	375	321,891	0.16	51,797	30.0	23	51,265	0.26
WQ226		0.113	0.360	18.8	6.59	9.8	4.40	11.2	221	321,457	0.16	51,727	35.0	17	51,753	0.19
WQ227		0.106	0.401	14.6	5.10	7.6	3.41	10.0	333	375,076	0.18	65,979	35.0	25	65,412	0.24
WQ228		0.109	0.386	15.4	5.40	8.0	3.61	10.1	292	348,278	0.17	59,507	35.0	21	59,022	0.22
WQ229		0.113	0.380	16.0	5.59	8.3	3.74	10.3	253	312,926	0.17	53,467	35.0	19	52,980	0.22
WQ230		0.106	0.430	6.2	2.15	3.2	1.44	5.9	728	347,021	0.20	68,217	25.0	42	71,832	0.44
WQ231		0.118	0.416	11.0	3.85	5.7	2.58	8.4	289	246,501	0.20	49,761	30.0	23	49,271	0.33
WQ232		0.109	0.412	10.2	3.57	5.3	2.39	7.9	426	336,576	0.19	62,652	30.0	29	61,811	0.32
WQ233		0.105	0.395	16.3	5.72	8.5	3.82	10.8	319	403,152	0.17	68,883	35.0	24	68,468	0.22
WQ234		0.114	0.378	6.8	2.39	3.6	1.60	5.8	570	301,584	0.17	51,529	25.0	30	53,415	0.36
WQ235		0.094	0.589	7.5	2.62	3.9	1.75	8.1	528	305,900	0.38	115,448	30.0	62	109,496	0.73
WQ236		0.125	0.287	14.0	4.60	7.3	3.25	7.7	258	281,028	0.11	31,749	30.0	12	31,679	0.16
WQ237		0.122	0.375	14.8	5.18	7.7	3.46	9.6	208	238,839	0.18	42,014	30.0	16	41,792	0.24
WQ238		0.107	0.465	14.0	4.90	7.3	3.28	10.8	283	307,297	0.23	70,387	35.0	27	69,593	0.32
WQ239		0.123	0.364	13.3	4.67	6.9	3.12	8.7	229	236,585	0.17	40,423	30.0	16	40,378	0.25
WQ240		0.121	0.391	8.4	2.93	4.3	1.96	6.7	371	240,358	0.19	44,742	30.0	23	44,954	0.35
WQ241		0.110	0.346	8.6	3.01	4.5	2.01	6.3	552	367,846	0.15	54,556	30.0	28	55,137	0.28
WQ242		0.112	0.392	11.1	3.90	5.8	2.61	8.1	372	320,876	0.18	56,445	30.0	25	55,911	0.29
WQ243		0.110	0.287	10.2	3.58	5.3	2.40	6.3	590	467,862	0.10	45,369	30.0	21	44,843	0.16
WQ244		0.108	0.456	10.0	3.51	5.2	2.35	8.4	385	299,158	0.22	66,867	30.0	32	65,850	0.39
WQ245		0.116	0.366	15.2	5.32	7.9	3.56	9.6	250	294,521	0.17	48,851	30.0	18	48,613	0.22
WQ246		0.146	0.222	30.9	6.76	16.1	4.78	11.3	160	381,837	0.02	7,594	40.0	2	7,597	0.02
WQ247		0.132	0.343	12.2	4.26	6.3	2.84	7.8	204	191,759	0.17	31,806	30.0	14	31,587	0.26
WQ248		0.107	0.310	21.5	6.63	11.2	4.68	11.0	281	468,055	0.11	52,878	35.0	16	52,902	0.12
WQ249		0.159	0.208	24.4	5.40	12.7	3.82	9.0	139	262,649	0.03	7,162	40.0	2	7,152	0.03
WQ250		0.110	0.282	11.4	3.97	5.9	2.80	6.6	549	484,884	0.09	44,518	30.0	19	43,515	0.14
WQ257		0.139	0.256	14.7	4.40	7.7	3.11	7.3	194	221,640	0.10	21,493	30.0	8	21,411	0.13
WQ258		0.143	0.219	20.0	4.86	10.4	3.43	8.1	237	366,810	0.03	10,003	35.0	3	9,926	0.03
WQ259		0.130	0.232	22.3	5.48	11.6	3.87	9.1	225	389,496	0.05	19,978	35.0	6	19,940	0.06
WQ260		0.117	0.346	12.0	4.21	6.3	2.82	7.8	313	291,664	0.16	45,504	30.0	20	45,129	0.24
WQ261		0.117	0.327	20.3	6.58	10.5	4.65	11.0	195	306,581	0.14	43,168	35.0	13	43,148	0.16
WQ262		0.117	0.336	17.9	6.11	9.3	4.32	10.2	216	298,882	0.15	44,328	35.0	14	44,131	0.18
WQ263		0.141	0.241	11.3	3.59	5.9	2.53	6.0	266	232,025	0.08	19,063	30.0	8	18,736	0.13
WQ310		0.131	0.412	6.5	2.28	3.4	1.53	5.9	331	167,187	0.22	36,452	25.0	21	37,604	0.46
WQ311		0.105	0.419	15.4	5.40	8.0	3.61	10.8	315	376,658	0.19	70,114	35.0	25	69,590	0.25
WQ312		0.105	0.502	7.6	2.65	3.9	1.77	7.4	489	287,194	0.27	77,043	30.0	40	73,842	0.51
WQ313		0.106	0.466	13.7	4.78	7.1	3.20	10.7	296	313,186	0.23	71,735	35.0	28	70,962	0.33
WQ314		0.183	0.199	27.8	5.75	14.5	4.07	9.6	57	122,556	0.06	7,133	40.0	2	7,113	0.06
WQ315		0.127	0.394	8.9	3.10	4.6	2.07	7.0	287	196,522	0.20	38,632	30.0	19	38,175	0.36

CUHP Water Quality Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ316		0.129	0.391	9.6	3.36	5.0	2.25	7.3	250	185,663	0.20	36,498	30.0	17	35,813	0.34
WQ317		0.124	0.400	15.5	5.43	8.1	3.63	10.4	179	215,168	0.20	42,298	35.0	15	41,913	0.26
WQ318		0.115	0.479	18.6	6.50	9.7	4.35	13.9	150	216,392	0.27	57,661	35.0	19	57,527	0.32
WQ319		0.120	0.406	13.4	4.70	7.0	3.14	9.5	229	238,233	0.20	46,832	30.0	19	46,616	0.28
WQ320		0.137	0.380	13.7	4.78	7.1	3.19	9.1	146	154,353	0.20	30,343	30.0	12	30,264	0.28
WQ321		0.147	0.367	10.5	3.68	5.5	2.46	7.4	150	122,177	0.20	24,018	30.0	11	23,730	0.33
WQ322		0.133	0.407	10.0	3.50	5.2	2.34	7.7	207	159,778	0.22	34,593	30.0	16	34,113	0.37
WQ323		0.156	0.449	14.2	4.96	7.4	3.32	10.6	61	66,446	0.34	22,296	35.0	9	22,055	0.46
WQ324		0.119	0.449	11.6	4.08	6.1	2.73	9.2	236	212,557	0.24	50,470	30.0	22	50,208	0.38
WQ325		0.128	0.470	19.1	6.68	9.9	4.47	14.0	98	144,721	0.29	41,574	35.0	13	41,515	0.34
WQ326		0.106	0.441	18.4	6.42	9.5	4.29	12.9	239	339,598	0.21	69,713	35.0	23	69,639	0.25
WQ327		0.138	0.390	11.3	3.94	5.9	2.63	8.1	166	144,775	0.21	29,999	30.0	13	29,729	0.34
WQ328		0.159	0.364	15.1	5.28	7.9	3.53	9.5	78	91,332	0.21	18,925	30.0	7	18,843	0.28
WQ329		0.220	0.311	13.5	4.71	7.0	3.15	7.9	31	32,086	0.21	6,648	30.0	3	6,611	0.30
WQ330		0.181	0.385	22.8	7.97	11.8	5.33	13.7	29	50,539	0.27	13,432	35.0	4	13,400	0.27
WQ331		0.152	0.453	23.6	8.26	12.3	5.53	16.2	40	72,818	0.33	24,205	40.0	7	24,187	0.34
WQ332		0.157	0.356	23.8	8.00	12.4	5.65	13.3	54	98,778	0.20	19,418	35.0	5	19,331	0.20
WQ333		0.180	0.334	26.0	8.17	13.5	5.78	13.6	32	64,304	0.20	12,641	40.0	3	12,634	0.18
WQ334		0.176	0.337	18.9	6.38	9.8	4.51	10.6	47	68,588	0.20	13,483	35.0	4	13,464	0.23
WQ335		0.230	0.287	30.7	8.27	16.0	5.85	13.8	13	29,939	0.19	5,589	40.0	1	5,582	0.16
WQ336		0.104	0.523	17.3	6.07	9.0	4.06	14.1	208	279,000	0.29	81,565	35.0	28	81,303	0.37
WQ337		0.117	0.399	15.4	5.38	8.0	3.60	10.4	224	266,824	0.19	50,000	35.0	18	49,559	0.25
WQ338		0.098	0.462	22.7	7.95	11.8	5.31	15.9	252	442,379	0.21	91,736	40.0	27	91,641	0.22
WQ339		0.090	0.484	15.5	5.42	8.0	3.62	12.1	474	567,890	0.21	119,657	35.0	45	120,005	0.29
WQ340		0.137	0.365	13.4	4.71	7.0	3.15	8.8	154	160,861	0.18	29,529	30.0	12	29,500	0.27
WQ341		0.144	0.353	12.7	4.44	6.6	2.97	8.2	143	140,259	0.18	25,351	30.0	11	25,335	0.28
WQ342		0.129	0.484	15.5	5.42	8.0	3.62	12.1	106	126,858	0.32	40,488	35.0	15	40,604	0.44
WQ343		0.081	0.629	13.1	4.60	6.8	3.08	13.1	481	489,916	0.37	182,254	35.0	77	183,062	0.57
WQ344		0.109	0.426	10.8	3.78	5.6	2.53	8.4	381	318,587	0.20	63,098	30.0	29	62,389	0.33
WQ345		0.136	0.490	18.1	6.33	9.4	4.23	13.8	68	95,716	0.37	35,093	35.0	12	35,009	0.45
WQ346		0.104	0.422	14.2	4.97	7.4	3.33	10.2	351	386,004	0.19	72,213	35.0	27	71,576	0.26
WQ347		0.177	0.327	16.8	5.73	8.8	4.05	9.5	54	69,928	0.19	13,118	30.0	4	13,035	0.23
WQ348		0.110	0.462	10.6	3.70	5.5	2.47	8.7	334	272,962	0.23	63,862	30.0	30	63,096	0.40
WQ349		0.106	0.350	12.6	4.42	6.6	2.95	8.1	429	419,310	0.15	61,173	30.0	26	61,096	0.22
WQ350		0.097	0.537	13.2	4.63	6.9	3.10	11.6	345	353,410	0.29	101,596	35.0	42	100,918	0.43
WQ351		0.102	0.504	5.7	1.99	3.0	1.33	6.2	720	317,465	0.26	83,581	25.0	51	87,234	0.58
WQ352		0.075	0.671	15.3	5.35	8.0	3.58	15.6	500	591,817	0.42	249,802	40.0	92	247,203	0.56
WQ353		0.081	0.670	12.3	4.29	6.4	2.87	13.0	1,231	1,168,967	0.31	367,034	35.0	160	366,410	0.50
WQ354		0.079	0.642	9.9	3.46	5.1	2.31	10.6	690	527,815	0.38	202,055	35.0	97	203,899	0.67
WQ355		0.098	0.575	6.9	2.41	3.6	1.61	7.6	493	263,054	0.38	99,277	30.0	53	93,281	0.74
WQ356		0.130	0.492	10.1	3.53	5.2	2.36	8.9	147	114,706	0.35	39,613	30.0	19	39,200	0.60
WQ357		0.315	0.178	153.4	22.42	79.8	15.84	37.4	4	49,456	0.00	245	100.0	0	245	0.00
WQ358		0.147	0.245	44.0	9.77	22.9	6.91	16.3	56	191,292	0.09	17,582	45.0	3	17,576	0.06
WQ360		0.107	0.492	20.4	7.13	10.6	4.77	15.3	175	275,762	0.26	72,150	40.0	22	71,996	0.29
WQ361		0.095	0.555	15.8	5.54	8.2	3.70	13.7	283	347,019	0.31	107,168	35.0	40	107,154	0.41
WQ362		0.080	0.651	19.1	6.67	9.9	4.46	18.4	543	801,855	0.33	268,469	40.0	89	268,302	0.40
WQ363		0.100	0.533	13.4	4.67	6.9	3.12	11.6	295	305,501	0.30	90,432	35.0	37	89,984	0.44
WQ364		0.139	0.400	13.7	4.79	7.1	3.20	9.5	129	136,372	0.22	29,733	30.0	12	29,589	0.31
WQ365		0.076	0.707	13.7	4.81	7.1	3.22	14.9	834	887,437	0.41	361,061	35.0	142	358,468	0.58

CUHP Water Quality Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ366		0.115	0.491	15.9	5.55	8.3	3.71	12.5	165	203,206	0.28	57,563	35.0	21	57,704	0.38
WQ367		0.109	0.523	10.5	3.67	5.5	2.46	9.5	273	221,977	0.31	69,697	30.0	33	69,280	0.53
WQ368		0.172	0.445	14.7	5.14	7.6	3.43	10.9	36	40,586	0.41	16,513	35.0	6	16,344	0.55
WQ369		0.092	0.613	12.3	4.30	6.4	2.87	12.1	304	289,310	0.45	131,473	35.0	57	131,457	0.71
WQ370		0.108	0.507	15.9	5.58	8.3	3.73	12.8	203	250,940	0.28	71,098	35.0	26	71,355	0.38
WQ371		0.107	0.370	21.8	7.63	11.3	5.10	12.8	227	382,710	0.16	61,584	35.0	18	61,528	0.17
WQ372		0.217	0.263	21.7	5.89	11.3	4.16	9.8	24	39,601	0.16	6,372	35.0	2	6,369	0.17
WQ373		0.119	0.352	23.9	7.96	12.4	5.62	13.3	148	273,810	0.16	44,060	35.0	12	43,866	0.16
WQ374		0.147	0.410	26.0	9.09	13.5	6.07	16.1	53	105,959	0.24	25,795	40.0	7	25,750	0.23
WQ410		0.118	0.448	10.6	3.73	5.5	2.49	8.6	264	217,405	0.23	51,010	30.0	24	50,397	0.39
WQ411		0.096	0.496	18.9	6.60	9.8	4.42	14.5	296	432,733	0.23	101,534	35.0	33	101,131	0.27
WQ412		0.162	0.385	8.1	2.84	4.2	1.90	6.5	126	79,319	0.23	18,611	30.0	10	18,840	0.45
WQ413		0.124	0.235	12.8	3.81	6.6	2.69	6.3	511	505,712	0.04	21,371	30.0	9	20,993	0.07
WQ414		0.123	0.252	20.9	5.54	10.9	3.92	9.2	236	381,469	0.08	28,671	35.0	9	28,612	0.09
WQ415		0.091	0.507	7.7	2.71	4.0	1.81	7.5	846	506,574	0.23	118,291	30.0	61	112,535	0.44
WQ416		0.105	0.459	7.4	2.60	3.9	1.74	6.9	594	341,829	0.22	74,530	30.0	40	73,948	0.43
WQ417		0.099	0.496	15.0	5.25	7.8	3.51	12.0	330	383,054	0.24	92,685	35.0	36	93,036	0.34
WQ418		0.107	0.535	3.6	1.27	1.9	0.85	5.0	816	229,167	0.33	75,049	25.0	75	97,022	1.19
WQ419		0.080	0.621	8.6	3.02	4.5	2.02	9.4	842	563,090	0.34	191,488	30.0	101	190,362	0.65
WQ420		0.086	0.620	11.3	3.97	5.9	2.65	11.5	453	397,279	0.39	156,407	35.0	70	156,292	0.64
WQ421		0.088	0.600	8.9	3.12	4.6	2.08	9.3	567	390,839	0.36	140,369	30.0	72	139,302	0.67
WQ422		0.096	0.588	11.1	3.87	5.8	2.59	10.8	324	278,003	0.39	109,145	35.0	49	109,496	0.64
WQ423		0.082	0.613	8.5	2.97	4.4	1.99	9.2	793	521,740	0.34	176,602	30.0	94	174,838	0.65
WQ424		0.113	0.523	7.5	2.64	3.9	1.77	7.6	319	186,379	0.33	62,304	30.0	33	59,173	0.63
WQ510		0.120	0.409	28.1	9.83	14.6	6.57	17.2	107	233,679	0.20	46,578	40.0	12	46,443	0.18
WQ511		0.094	0.580	15.2	5.31	7.9	3.55	13.8	279	327,720	0.35	115,171	35.0	44	115,019	0.48
WQ512		0.118	0.428	12.4	4.35	6.5	2.91	9.3	243	233,426	0.21	49,942	30.0	21	49,847	0.33
WQ513		0.131	0.372	11.1	3.89	5.8	2.60	7.8	219	188,799	0.18	34,502	30.0	16	34,143	0.30
WQ514		0.099	0.489	16.6	5.79	8.6	3.87	12.9	299	382,777	0.24	90,522	35.0	33	90,909	0.31
WQ515		0.102	0.434	24.5	8.58	12.7	5.73	16.1	216	410,707	0.19	78,949	40.0	22	78,943	0.19
WQ516		0.129	0.417	32.3	11.31	16.8	7.56	19.7	70	174,447	0.22	38,359	45.0	9	38,351	0.18
WQ517		0.133	0.398	12.0	4.20	6.2	2.81	8.6	177	164,847	0.21	34,158	30.0	15	34,008	0.33
WQ518		0.151	0.345	11.5	4.01	6.0	2.68	7.6	135	119,389	0.18	21,610	30.0	10	21,361	0.29
WQ519		0.129	0.373	26.0	8.95	13.5	6.33	14.9	99	199,331	0.18	36,079	40.0	9	36,088	0.17
WQ520		0.085	0.613	10.0	3.50	5.2	2.34	10.3	575	445,232	0.36	160,689	30.0	76	161,731	0.62
WQ521		0.136	0.363	10.9	3.82	5.7	2.55	7.6	197	166,418	0.18	30,122	30.0	14	29,810	0.30
WQ610		0.119	0.528	12.5	4.38	6.5	2.93	11.0	141	136,279	0.39	53,652	35.0	22	53,387	0.60
WQ611		0.118	0.421	24.7	8.64	12.8	5.78	15.8	125	239,385	0.21	49,603	40.0	14	49,585	0.21
WQ612		0.132	0.399	10.2	3.57	5.3	2.38	7.7	214	168,943	0.21	35,006	30.0	16	34,562	0.35
WQ613		0.132	0.400	12.3	4.31	6.4	2.88	8.8	177	169,354	0.21	35,092	30.0	15	35,036	0.32
WQ614		0.104	0.448	14.1	4.93	7.3	3.29	10.6	330	360,291	0.21	74,655	35.0	29	73,883	0.29
WQ615		0.119	0.419	17.8	6.24	9.3	4.17	12.0	167	230,887	0.21	47,842	35.0	16	47,934	0.26
WQ616		0.100	0.455	13.3	4.66	6.9	3.12	10.3	392	404,341	0.21	83,783	35.0	33	83,052	0.30
WQ617		0.117	0.423	10.8	3.79	5.6	2.53	8.4	295	247,298	0.21	51,242	30.0	23	50,671	0.34
WQ618		0.087	0.615	8.7	3.06	4.5	2.04	9.4	555	375,385	0.39	147,788	30.0	77	146,921	0.75
WQ619		0.117	0.534	11.2	3.91	5.8	2.62	10.1	170	147,156	0.39	57,935	30.0	26	57,931	0.63
WQ620		0.093	0.596	9.7	3.40	5.0	2.27	9.9	403	302,941	0.39	119,267	30.0	58	120,003	0.70
WQ621		0.101	0.574	7.5	2.64	3.9	1.76	8.0	405	236,348	0.39	93,049	30.0	49	87,958	0.76
WQ622		0.091	0.601	12.4	4.34	6.4	2.90	12.0	336	322,521	0.39	126,975	35.0	55	126,855	0.61

CUHP Water Quality Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ623		0.081	0.636	7.6	2.65	3.9	1.77	8.7	802	469,821	0.39	184,967	30.0	102	179,071	0.79
WQ710		0.087	0.615	9.1	3.17	4.7	2.12	9.6	536	375,959	0.39	148,014	30.0	76	148,272	0.73
WQ711		0.146	0.491	12.7	4.43	6.6	2.96	10.5	63	61,716	0.48	29,677	35.0	12	29,540	0.72
WQ712		0.131	0.505	10.7	3.73	5.5	2.50	9.4	122	100,611	0.39	39,610	30.0	18	39,344	0.66
WQ713		0.123	0.520	13.6	4.77	7.1	3.19	11.6	116	122,663	0.39	48,292	35.0	19	48,116	0.57
WQ714		0.155	0.466	5.5	1.93	2.9	1.29	5.8	138	58,872	0.39	23,178	25.0	16	25,501	0.97
WQ715		0.147	0.477	2.2	0.75	1.1	0.50	3.8	415	69,183	0.39	27,237	25.0	25	29,234	1.29
WQ716		0.109	0.551	9.0	3.14	4.7	2.10	8.8	260	180,376	0.39	71,013	30.0	36	69,679	0.73
WQ717		0.122	0.522	7.3	2.56	3.8	1.71	7.4	221	125,441	0.39	49,386	30.0	26	47,188	0.76
WQ718		0.273	0.354	5.7	2.01	3.0	1.34	5.1	21	9,407	0.39	3,703	25.0	3	4,054	0.99
WQ719		0.122	0.523	4.5	1.58	2.3	1.06	5.5	366	127,822	0.39	50,323	25.0	41	60,515	1.17
WQ720		0.124	0.519	8.2	2.86	4.3	1.91	7.9	191	120,718	0.39	47,526	30.0	24	45,438	0.73
WQ721		0.106	0.560	11.8	4.13	6.1	2.76	11.0	221	201,819	0.39	79,455	35.0	34	79,288	0.62
WQ722		0.159	0.460	4.7	1.64	2.4	1.10	5.3	148	53,877	0.39	21,211	25.0	17	25,285	1.17
WQ723		0.127	0.512	9.3	3.25	4.8	2.17	8.6	153	110,141	0.39	43,362	30.0	22	42,505	0.71
WQ724		0.138	0.493	7.5	2.63	3.9	1.76	7.3	148	86,126	0.39	33,907	30.0	18	32,721	0.75
WQ725		0.194	0.417	6.8	2.39	3.5	1.60	6.1	54	28,304	0.39	11,143	30.0	6	11,501	0.81
WQ726		0.131	0.506	3.8	1.32	2.0	0.88	4.9	349	101,779	0.39	40,070	25.0	39	50,848	1.39
WQ727		0.162	0.455	10.4	3.64	5.4	2.43	8.6	63	50,446	0.39	19,860	30.0	9	19,596	0.67
WQ728		0.190	0.422	1.8	0.63	0.9	0.42	3.5	217	30,278	0.39	11,920	25.0	10	11,081	1.14
WQ729		0.101	0.572	10.0	3.50	5.2	2.34	9.8	300	232,262	0.39	91,441	30.0	44	91,651	0.69
WQ730		0.224	0.389	2.5	0.86	1.3	0.57	3.7	93	17,766	0.39	6,994	25.0	6	7,010	1.18
WQ731		0.121	0.525	10.1	3.54	5.3	2.37	9.3	166	130,083	0.39	51,213	30.0	24	50,955	0.68
WQ732		0.366	0.307	8.1	2.84	4.2	1.90	5.7	6	3,680	0.39	1,449	30.0	1	1,470	0.75
WQ733		0.189	0.423	3.7	1.30	1.9	0.87	4.5	107	30,731	0.39	12,099	25.0	11	14,199	1.32
WQ744		0.132	0.504	5.8	2.04	3.0	1.36	6.3	220	99,291	0.39	39,091	30.0	23	40,175	0.84
WQ745		0.178	0.339	28.8	9.01	15.0	6.36	15.0	29	65,802	0.20	13,182	40.0	3	13,161	0.18
WQ746		0.114	0.415	11.2	3.93	5.8	2.63	8.5	326	283,117	0.20	55,253	30.0	25	54,755	0.32
WQ747		0.110	0.410	16.3	5.69	8.5	3.80	11.0	258	324,319	0.19	60,538	35.0	22	60,267	0.24
WQ748		0.165	0.344	18.7	6.43	9.7	4.54	10.7	60	86,453	0.19	16,628	35.0	5	16,602	0.23
WQ749		0.124	0.394	17.6	6.15	9.1	4.11	11.4	156	212,250	0.19	41,022	35.0	14	41,054	0.24
WQ750		0.097	0.398	12.0	4.20	6.2	2.81	8.6	561	520,720	0.17	86,291	30.0	37	85,884	0.26
WQ751		0.165	0.280	29.9	7.92	15.6	5.60	13.2	44	101,733	0.14	14,559	40.0	3	14,545	0.12

CUHP 2-Year Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ110		0.182	0.231	42.2	9.00	22.0	6.36	15.0	89	290,746	0.04	10,636	45.0	3	10,624	0.03
WQ111		0.181	0.257	34.0	8.21	17.7	5.80	13.7	140	368,471	0.01	4,327	40.0	1	4,319	0.01
WQ112		0.182	0.256	27.4	6.89	14.2	4.87	11.5	171	362,514	0.01	4,556	40.0	2	4,554	0.02
WQ113		0.182	0.208	20.0	4.70	10.4	3.32	7.8	141	218,049	0.07	14,727	35.0	6	14,614	0.10
WQ114		0.200	0.245	28.2	6.80	14.6	4.80	11.3	123	268,244	0.01	3,269	40.0	1	3,270	0.02
WQ115		0.117	0.269	22.0	6.04	11.4	4.27	10.1	239	406,678	0.23	93,174	35.0	32	93,155	0.29
WQ116		0.138	0.230	38.4	8.30	20.0	5.87	13.8	160	476,328	0.07	35,360	40.0	9	35,338	0.07
WQ117		0.137	0.226	24.2	5.69	12.6	4.02	9.5	179	335,428	0.14	47,378	35.0	16	47,346	0.18
WQ118		0.126	0.337	17.4	6.00	9.1	4.24	10.0	170	229,258	0.34	77,556	35.0	28	77,055	0.45
WQ119		0.147	0.215	36.3	7.51	18.9	5.31	12.5	113	318,413	0.11	33,696	40.0	9	33,682	0.10
WQ120		0.093	0.543	7.5	2.62	3.9	1.75	7.7	697	404,990	0.57	231,299	30.0	123	218,193	1.10
WQ121		0.131	0.296	13.7	4.61	7.1	3.26	7.7	212	224,916	0.30	66,446	30.0	30	66,343	0.48
WQ122		0.153	0.340	9.4	3.29	4.9	2.20	6.6	158	115,052	0.38	43,975	30.0	23	43,689	0.73
WQ123		0.109	0.313	17.3	5.65	9.0	3.99	9.4	323	432,847	0.28	123,227	35.0	47	122,542	0.39
WQ124		0.132	0.307	17.9	5.72	9.3	4.04	9.5	150	208,084	0.32	66,315	35.0	24	66,026	0.42
WQ125		0.128	0.263	19.4	5.42	10.1	3.83	9.0	195	293,611	0.23	67,611	35.0	25	67,230	0.31
WQ126		0.112	0.283	23.2	6.54	12.0	4.62	10.9	250	449,000	0.23	105,349	35.0	35	105,452	0.28
WQ127		0.125	0.246	19.2	5.13	10.0	3.62	8.5	256	380,656	0.18	69,077	35.0	26	68,576	0.25
WQ128		0.146	0.226	26.9	6.17	14.0	4.36	10.3	113	234,831	0.17	40,189	35.0	12	40,098	0.19
WQ129		0.164	0.252	46.2	10.44	24.0	7.38	17.4	123	440,936	0.03	11,982	45.0	3	11,974	0.02
WQ130		0.158	0.239	28.9	6.79	15.0	4.80	11.3	185	413,708	0.04	18,370	40.0	6	18,377	0.06
WQ131		0.216	0.196	37.7	7.19	19.6	5.08	12.0	46	133,533	0.05	7,010	40.0	2	7,010	0.05
WQ132		0.217	0.234	44.7	9.54	23.2	6.74	15.9	59	204,751	0.01	1,128	40.0	0	1,128	0.01
WQ133		0.131	0.228	33.7	7.41	17.5	5.23	12.3	176	460,514	0.10	46,384	40.0	13	46,331	0.10
WQ134		0.085	0.598	5.1	1.79	2.7	1.19	6.4	1,223	483,202	0.66	317,556	30.0	188	315,490	1.41
WQ135		0.100	0.549	8.2	2.87	4.3	1.92	8.3	442	281,284	0.65	183,472	30.0	97	176,610	1.26
WQ136		0.112	0.337	15.1	5.29	7.9	3.54	9.0	298	349,242	0.32	112,164	30.0	46	111,866	0.48
WQ137		0.127	0.248	26.5	6.57	13.8	4.64	10.9	170	350,215	0.19	66,046	35.0	20	65,897	0.21
WQ138		0.113	0.270	14.8	4.56	7.7	3.22	7.6	408	466,039	0.16	76,384	30.0	32	76,168	0.25
WQ139		0.136	0.224	48.6	9.88	25.3	6.98	16.5	115	432,197	0.05	22,180	45.0	4	22,159	0.03
WQ140		0.129	0.234	18.3	4.80	9.5	3.39	8.0	279	395,831	0.10	40,462	30.0	15	40,244	0.14
WQ141		0.114	0.282	20.4	5.92	10.6	4.18	9.9	260	410,242	0.19	76,282	35.0	24	76,253	0.21
WQ142		0.101	0.556	10.5	3.69	5.5	2.47	10.0	324	264,071	0.67	175,617	30.0	83	175,198	1.14
WQ143		0.097	0.576	11.2	3.94	5.8	2.63	10.8	325	283,344	0.71	202,249	30.0	90	202,711	1.15
WQ144		0.097	0.527	8.1	2.84	4.2	1.90	8.0	579	363,112	0.53	194,098	30.0	100	185,402	1.00
WQ145		0.112	0.332	17.6	5.97	9.1	4.22	10.0	268	364,591	0.29	107,452	35.0	39	106,817	0.38
WQ146		0.126	0.415	9.3	3.26	4.8	2.18	7.4	259	187,087	0.45	83,439	30.0	42	81,242	0.82
WQ147		0.093	0.533	10.2	3.56	5.3	2.38	9.4	529	417,553	0.54	225,334	30.0	109	224,481	0.95
WQ148		0.112	0.538	6.3	2.20	3.3	1.47	6.8	362	176,010	0.74	130,630	30.0	73	125,065	1.51
WQ149		0.099	0.546	4.1	1.44	2.1	0.96	5.4	980	311,279	0.62	194,470	25.0	172	245,100	2.01
WQ150		0.094	0.526	6.5	2.29	3.4	1.53	6.9	820	415,251	0.54	223,641	30.0	127	215,382	1.11
WQ151		0.093	0.579	4.0	1.41	2.1	0.94	5.5	1,118	348,169	0.69	240,274	25.0	213	302,982	2.22
WQ152		0.106	0.503	5.4	1.90	2.8	1.27	6.0	664	279,795	0.55	154,884	25.0	103	166,960	1.33
WQ153		0.091	0.594	5.2	1.82	2.7	1.21	6.4	842	338,532	0.74	252,121	30.0	148	248,804	1.58
WQ210		0.091	0.594	8.2	2.88	4.3	1.92	8.8	533	339,631	0.74	252,940	30.0	137	246,631	1.47
WQ211		0.098	0.575	10.8	3.77	5.6	2.52	10.4	328	273,952	0.74	204,025	30.0	96	204,353	1.27
WQ212		0.112	0.539	9.7	3.38	5.0	2.26	9.2	236	176,384	0.74	131,362	30.0	66	130,520	1.37
WQ213		0.090	0.599	14.0	4.90	7.3	3.28	13.2	329	356,251	0.74	265,318	35.0	111	266,840	1.13
WQ214		0.114	0.528	15.9	5.56	8.3	3.72	13.2	139	170,637	0.72	122,015	35.0	47	122,382	1.01

CUHP 2-Year Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ215		0.097	0.597	7.6	2.65	3.9	1.77	8.3	414	242,844	0.90	217,726	30.0	118	207,716	1.76
WQ216		0.128	0.417	11.2	3.91	5.8	2.62	8.5	207	178,882	0.46	82,361	30.0	39	81,612	0.80
WQ217		0.126	0.371	13.0	4.56	6.8	3.05	8.7	214	215,849	0.38	82,685	30.0	37	82,647	0.62
WQ218		0.149	0.343	10.1	3.55	5.3	2.37	6.9	161	126,547	0.38	48,476	30.0	24	47,953	0.70
WQ219		0.110	0.449	10.7	3.74	5.6	2.50	8.6	353	291,938	0.46	134,414	30.0	66	132,895	0.82
WQ220		0.142	0.374	6.2	2.18	3.2	1.46	5.5	280	135,127	0.42	56,967	25.0	37	60,587	1.00
WQ221		0.129	0.519	4.1	1.43	2.1	0.95	5.2	302	95,344	0.90	85,483	25.0	76	108,052	2.91
WQ222		0.136	0.358	6.6	2.31	3.4	1.55	5.5	327	167,435	0.38	64,140	25.0	40	66,358	0.87
WQ223		0.100	0.444	8.9	3.13	4.7	2.09	7.6	608	420,936	0.42	177,458	30.0	93	171,408	0.80
WQ224		0.095	0.524	10.8	3.76	5.6	2.52	9.7	489	407,289	0.54	219,539	30.0	105	218,475	0.93
WQ225		0.112	0.374	10.6	3.72	5.5	2.49	7.6	391	321,891	0.36	117,154	30.0	58	115,738	0.66
WQ226		0.113	0.374	18.0	6.31	9.4	4.22	11.1	230	321,457	0.36	116,996	35.0	43	117,091	0.49
WQ227		0.106	0.412	14.1	4.93	7.3	3.29	9.9	344	375,076	0.39	147,278	35.0	61	146,149	0.59
WQ228		0.109	0.399	14.8	5.19	7.7	3.47	10.1	303	348,278	0.38	133,415	35.0	54	132,310	0.56
WQ229		0.112	0.393	15.3	5.37	8.0	3.59	10.2	263	312,926	0.38	119,873	35.0	47	118,859	0.55
WQ230		0.106	0.439	6.0	2.09	3.1	1.40	5.9	749	347,021	0.43	149,658	25.0	97	159,518	1.02
WQ231		0.117	0.424	10.7	3.75	5.6	2.51	8.3	297	246,501	0.44	108,701	30.0	53	107,331	0.78
WQ232		0.108	0.422	9.9	3.46	5.1	2.31	7.8	440	336,576	0.41	138,641	30.0	71	136,520	0.76
WQ233		0.104	0.408	15.7	5.50	8.2	3.68	10.7	331	403,152	0.38	154,436	35.0	61	153,216	0.55
WQ234		0.114	0.391	6.6	2.30	3.4	1.54	5.8	592	301,584	0.38	115,528	30.0	72	119,363	0.86
WQ235		0.094	0.590	7.4	2.61	3.9	1.74	8.1	531	305,900	0.76	233,883	30.0	127	221,627	1.50
WQ236		0.123	0.299	13.3	4.56	6.9	3.22	7.6	272	281,028	0.29	82,137	30.0	38	81,853	0.49
WQ237		0.121	0.385	14.3	5.01	7.4	3.35	9.6	216	238,839	0.39	93,783	30.0	38	93,250	0.58
WQ238		0.106	0.472	13.7	4.80	7.1	3.21	10.8	289	307,297	0.49	150,485	35.0	63	148,825	0.74
WQ239		0.123	0.377	12.8	4.49	6.7	3.00	8.7	238	236,585	0.38	90,629	30.0	41	90,624	0.62
WQ240		0.120	0.401	8.1	2.84	4.2	1.90	6.7	383	240,358	0.41	99,008	30.0	56	99,630	0.84
WQ241		0.109	0.359	8.2	2.88	4.3	1.93	6.3	577	367,846	0.34	126,495	30.0	73	128,577	0.72
WQ242		0.111	0.403	10.8	3.77	5.6	2.52	8.0	385	320,876	0.39	125,996	30.0	62	124,385	0.70
WQ243		0.108	0.298	9.7	3.40	5.0	2.27	6.2	623	467,862	0.26	122,693	30.0	69	121,817	0.54
WQ244		0.108	0.464	9.8	3.43	5.1	2.29	8.3	394	299,158	0.48	143,572	30.0	73	141,261	0.88
WQ245		0.115	0.380	14.6	5.10	7.6	3.41	9.6	261	294,521	0.37	110,004	30.0	45	109,324	0.55
WQ246		0.142	0.220	30.3	6.61	15.7	4.67	11.0	163	381,837	0.10	37,227	40.0	11	37,232	0.11
WQ247		0.131	0.356	11.6	4.08	6.1	2.73	7.8	213	191,759	0.37	71,622	30.0	34	70,881	0.64
WQ248		0.105	0.322	20.4	6.56	10.6	4.64	10.9	296	468,055	0.29	136,801	35.0	48	136,721	0.37
WQ249		0.156	0.210	23.8	5.33	12.4	3.76	8.9	143	262,649	0.11	30,107	35.0	11	30,062	0.15
WQ250		0.108	0.292	10.8	3.79	5.6	2.53	6.5	579	484,884	0.25	122,378	30.0	65	120,358	0.49
WQ257		0.136	0.266	13.9	4.35	7.3	3.08	7.3	205	221,640	0.26	58,123	30.0	27	57,873	0.43
WQ258		0.140	0.220	19.4	4.79	10.1	3.39	8.0	244	366,810	0.11	42,046	35.0	17	41,743	0.17
WQ259		0.128	0.237	21.4	5.40	11.1	3.81	9.0	235	389,496	0.17	65,364	35.0	24	65,170	0.22
WQ260		0.117	0.358	11.5	4.04	6.0	2.70	7.8	327	291,664	0.35	103,376	30.0	50	102,337	0.62
WQ261		0.116	0.339	19.3	6.53	10.0	4.62	10.9	205	306,581	0.33	102,216	35.0	36	102,094	0.43
WQ262		0.116	0.348	17.1	5.98	8.9	4.00	10.1	226	298,882	0.34	102,780	35.0	38	102,042	0.47
WQ263		0.139	0.250	10.7	3.55	5.6	2.51	5.9	280	232,025	0.23	54,070	30.0	29	53,119	0.46
WQ310		0.130	0.419	6.4	2.23	3.3	1.49	5.9	339	167,187	0.47	78,604	25.0	48	81,554	1.05
WQ311		0.104	0.429	15.0	5.24	7.8	3.50	10.7	325	376,658	0.41	155,152	35.0	62	153,607	0.60
WQ312		0.105	0.507	7.5	2.61	3.9	1.75	7.3	497	287,194	0.56	160,441	30.0	87	153,893	1.10
WQ313		0.106	0.474	13.4	4.68	7.0	3.13	10.6	302	313,186	0.49	153,369	35.0	65	151,741	0.75
WQ314		0.180	0.204	26.6	5.67	13.8	4.01	9.5	60	122,556	0.18	22,419	35.0	7	22,361	0.21
WQ315		0.126	0.403	8.6	3.01	4.5	2.01	6.9	295	196,522	0.43	84,753	30.0	46	84,074	0.85

CUHP 2-Year Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ316		0.128	0.400	9.3	3.26	4.8	2.18	7.3	257	185,663	0.43	80,070	30.0	41	78,179	0.81
WQ317		0.123	0.409	15.1	5.28	7.8	3.53	10.4	184	215,168	0.43	92,794	35.0	37	91,935	0.62
WQ318		0.114	0.484	18.3	6.40	9.5	4.28	13.8	153	216,392	0.56	120,135	35.0	42	119,835	0.71
WQ319		0.119	0.415	13.1	4.57	6.8	3.05	9.4	236	238,233	0.43	102,741	30.0	45	102,376	0.68
WQ320		0.136	0.389	13.3	4.64	6.9	3.10	9.1	150	154,353	0.43	66,567	30.0	29	66,376	0.68
WQ321		0.146	0.375	10.2	3.58	5.3	2.39	7.4	154	122,177	0.43	52,691	30.0	26	52,075	0.78
WQ322		0.132	0.415	9.8	3.41	5.1	2.28	7.7	212	159,778	0.47	74,685	30.0	38	73,448	0.86
WQ323		0.155	0.451	14.0	4.92	7.3	3.29	10.6	61	66,446	0.69	45,639	35.0	18	45,162	0.99
WQ324		0.118	0.456	11.4	3.99	5.9	2.67	9.2	241	212,557	0.50	107,221	30.0	50	106,571	0.85
WQ325		0.127	0.474	18.8	6.60	9.8	4.41	13.9	99	144,721	0.60	86,152	35.0	30	86,015	0.74
WQ326		0.105	0.450	17.9	6.25	9.3	4.18	12.8	245	339,598	0.45	151,869	35.0	56	152,074	0.60
WQ327		0.137	0.398	11.0	3.84	5.7	2.57	8.1	170	144,775	0.45	65,251	30.0	31	64,559	0.79
WQ328		0.158	0.371	14.7	5.15	7.6	3.44	9.5	80	91,332	0.45	41,164	30.0	16	40,959	0.66
WQ329		0.219	0.317	13.1	4.59	6.8	3.07	7.8	32	32,086	0.45	14,461	30.0	6	14,384	0.72
WQ330		0.180	0.389	22.4	7.85	11.7	5.25	13.7	29	50,539	0.55	27,990	35.0	9	27,907	0.61
WQ331		0.151	0.455	23.4	8.19	12.2	5.48	16.1	40	72,818	0.68	49,586	40.0	15	49,544	0.74
WQ332		0.156	0.364	23.1	7.95	12.0	5.62	13.3	55	98,778	0.43	42,599	35.0	13	42,481	0.48
WQ333		0.178	0.341	25.3	8.13	13.2	5.74	13.5	33	64,304	0.43	27,732	35.0	8	27,698	0.44
WQ334		0.175	0.344	18.3	6.35	9.5	4.49	10.6	48	68,588	0.43	29,580	35.0	10	29,518	0.55
WQ335		0.228	0.294	29.8	8.22	15.5	5.81	13.7	13	29,939	0.41	12,361	40.0	3	12,346	0.38
WQ336		0.103	0.527	17.1	5.99	8.9	4.00	14.0	211	279,000	0.61	168,803	35.0	62	168,221	0.81
WQ337		0.116	0.409	14.9	5.22	7.8	3.49	10.3	231	266,824	0.41	110,528	35.0	44	109,457	0.60
WQ338		0.097	0.471	22.1	7.74	11.5	5.18	15.8	258	442,379	0.45	199,512	40.0	64	199,309	0.52
WQ339		0.089	0.493	15.1	5.28	7.8	3.53	12.0	486	567,890	0.46	259,535	35.0	107	260,513	0.68
WQ340		0.136	0.374	13.0	4.56	6.8	3.05	8.7	159	160,861	0.41	65,485	30.0	29	65,451	0.65
WQ341		0.143	0.362	12.3	4.29	6.4	2.87	8.2	148	140,259	0.40	56,355	30.0	26	56,209	0.67
WQ342		0.129	0.487	15.3	5.36	8.0	3.59	12.1	107	126,858	0.66	83,222	35.0	33	83,497	0.94
WQ343		0.081	0.631	13.1	4.57	6.8	3.06	13.1	484	489,916	0.75	369,717	35.0	161	371,167	1.19
WQ344		0.108	0.436	10.5	3.68	5.5	2.46	8.4	391	318,587	0.43	138,261	30.0	68	136,245	0.78
WQ345		0.135	0.491	18.0	6.29	9.3	4.21	13.8	69	95,716	0.74	71,284	35.0	25	71,146	0.96
WQ346		0.103	0.432	13.8	4.82	7.2	3.22	10.1	362	386,004	0.41	159,672	35.0	67	158,228	0.63
WQ347		0.175	0.335	16.3	5.70	8.5	4.03	9.5	55	69,928	0.41	28,994	30.0	11	28,844	0.57
WQ348		0.110	0.469	10.3	3.62	5.4	2.42	8.7	341	272,962	0.50	136,028	30.0	67	134,386	0.89
WQ349		0.105	0.363	12.1	4.22	6.3	2.82	8.1	449	419,310	0.34	142,783	30.0	68	142,028	0.59
WQ350		0.096	0.542	13.1	4.57	6.8	3.06	11.6	350	353,410	0.60	210,521	35.0	90	208,559	0.93
WQ351		0.102	0.510	5.6	1.96	2.9	1.31	6.2	732	317,465	0.55	174,288	25.0	109	182,894	1.25
WQ352		0.075	0.672	15.3	5.34	7.9	3.57	15.6	501	591,817	0.84	499,755	40.0	188	494,460	1.15
WQ353		0.081	0.675	12.1	4.25	6.3	2.84	13.0	1,244	1,168,967	0.65	755,416	35.0	344	754,443	1.07
WQ354		0.079	0.644	9.8	3.44	5.1	2.30	10.6	694	527,815	0.77	408,796	30.0	202	412,887	1.39
WQ355		0.098	0.577	6.9	2.40	3.6	1.60	7.6	496	263,054	0.76	201,124	30.0	109	188,852	1.51
WQ356		0.130	0.495	10.0	3.50	5.2	2.34	8.8	148	114,706	0.71	80,889	30.0	40	80,016	1.27
WQ357		0.308	0.175	152.7	21.99	79.4	15.54	36.6	4	49,456	0.05	2,349	80.0	0	2,349	0.01
WQ358		0.144	0.254	41.6	9.64	21.7	6.81	16.1	59	191,292	0.25	48,317	45.0	10	48,288	0.19
WQ360		0.107	0.498	20.1	7.02	10.4	4.69	15.3	178	275,762	0.55	150,622	40.0	50	150,295	0.65
WQ361		0.095	0.558	15.7	5.48	8.1	3.66	13.7	286	347,019	0.64	220,857	35.0	86	220,842	0.90
WQ362		0.079	0.654	18.9	6.61	9.8	4.42	18.3	548	801,855	0.69	549,658	40.0	192	549,643	0.87
WQ363		0.100	0.538	13.2	4.62	6.9	3.09	11.6	299	305,501	0.61	186,979	35.0	80	185,558	0.95
WQ364		0.138	0.407	13.4	4.67	6.9	3.13	9.4	132	136,372	0.47	64,116	30.0	27	63,828	0.72
WQ365		0.075	0.708	13.7	4.79	7.1	3.20	14.9	837	887,437	0.82	726,265	35.0	298	721,387	1.22

CUHP 2-Year Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ366		0.115	0.495	15.7	5.48	8.1	3.66	12.4	168	203,206	0.59	119,408	35.0	47	119,739	0.84
WQ367		0.109	0.526	10.4	3.63	5.4	2.43	9.5	276	221,977	0.65	143,447	30.0	70	142,657	1.14
WQ368		0.172	0.446	14.6	5.12	7.6	3.42	10.8	36	40,586	0.82	33,215	35.0	13	32,851	1.14
WQ369		0.091	0.613	12.3	4.29	6.4	2.87	12.1	305	289,310	0.90	259,387	35.0	114	259,337	1.42
WQ370		0.107	0.511	15.7	5.51	8.2	3.68	12.8	206	250,940	0.59	147,482	35.0	58	147,940	0.84
WQ371		0.107	0.384	20.9	7.31	10.9	4.89	12.8	237	382,710	0.36	139,290	35.0	47	139,232	0.44
WQ372		0.215	0.273	20.8	5.86	10.8	4.14	9.8	25	39,601	0.36	14,413	35.0	5	14,403	0.44
WQ373		0.118	0.365	22.9	7.91	11.9	5.59	13.2	155	273,810	0.36	99,655	35.0	31	99,417	0.41
WQ374		0.146	0.416	25.5	8.91	13.2	5.96	16.1	54	105,959	0.51	54,556	40.0	16	54,500	0.53
WQ410		0.118	0.454	10.4	3.65	5.4	2.44	8.6	269	217,405	0.50	108,598	30.0	53	107,151	0.89
WQ411		0.095	0.504	18.5	6.47	9.6	4.32	14.4	302	432,733	0.50	216,159	35.0	75	215,117	0.63
WQ412		0.161	0.391	7.9	2.78	4.1	1.86	6.5	129	79,319	0.50	39,621	30.0	22	40,129	1.02
WQ413		0.121	0.239	12.3	3.76	6.4	2.66	6.3	530	505,712	0.15	74,863	30.0	40	72,902	0.29
WQ414		0.121	0.261	19.8	5.47	10.3	3.86	9.1	249	381,469	0.22	83,440	35.0	31	83,061	0.29
WQ415		0.091	0.514	7.6	2.65	3.9	1.77	7.5	863	506,574	0.50	251,067	30.0	136	239,171	0.98
WQ416		0.104	0.467	7.3	2.54	3.8	1.70	6.8	609	341,829	0.47	160,713	30.0	92	159,517	0.98
WQ417		0.098	0.500	14.8	5.18	7.7	3.47	12.0	334	383,054	0.50	192,868	35.0	79	193,543	0.75
WQ418		0.106	0.538	3.6	1.26	1.9	0.84	5.0	824	229,167	0.67	153,936	25.0	151	199,940	2.39
WQ419		0.080	0.624	8.6	3.00	4.5	2.01	9.3	849	563,090	0.70	391,533	30.0	212	389,262	1.37
WQ420		0.085	0.622	11.3	3.95	5.9	2.64	11.5	455	397,279	0.79	315,605	35.0	144	315,566	1.31
WQ421		0.088	0.603	8.8	3.09	4.6	2.07	9.3	571	390,839	0.73	285,656	30.0	152	283,368	1.41
WQ422		0.096	0.589	11.0	3.86	5.7	2.58	10.8	326	278,003	0.79	220,296	35.0	101	221,038	1.32
WQ423		0.082	0.616	8.4	2.95	4.4	1.97	9.1	800	521,740	0.69	361,128	30.0	196	357,308	1.37
WQ424		0.113	0.524	7.5	2.63	3.9	1.76	7.5	320	186,379	0.68	125,916	30.0	67	119,622	1.30
WQ510		0.119	0.417	27.3	9.57	14.2	6.40	17.1	110	233,679	0.43	101,504	40.0	28	101,179	0.43
WQ511		0.093	0.583	15.1	5.27	7.8	3.53	13.7	281	327,720	0.72	234,825	35.0	94	234,590	1.04
WQ512		0.117	0.436	12.1	4.24	6.3	2.84	9.3	249	233,426	0.46	108,041	30.0	49	107,703	0.76
WQ513		0.130	0.382	10.8	3.77	5.6	2.52	7.8	226	188,799	0.41	76,568	30.0	38	75,685	0.72
WQ514		0.099	0.497	16.2	5.68	8.4	3.79	12.8	305	382,777	0.50	192,447	35.0	75	193,269	0.71
WQ515		0.101	0.444	23.8	8.33	12.4	5.57	16.0	223	410,707	0.42	173,821	40.0	53	173,680	0.47
WQ516		0.128	0.424	31.6	11.04	16.4	7.38	19.6	71	174,447	0.47	82,596	45.0	20	82,553	0.42
WQ517		0.132	0.402	11.8	4.15	6.2	2.77	8.6	180	164,847	0.44	72,345	30.0	33	71,912	0.73
WQ518		0.150	0.354	11.1	3.88	5.8	2.59	7.5	139	119,389	0.40	48,028	30.0	23	47,546	0.71
WQ519		0.128	0.382	25.2	8.82	13.1	5.89	14.8	102	199,331	0.40	80,186	40.0	23	80,155	0.42
WQ520		0.084	0.616	9.9	3.47	5.2	2.32	10.3	579	445,232	0.73	326,866	30.0	162	329,308	1.32
WQ521		0.135	0.372	10.6	3.70	5.5	2.47	7.5	203	166,418	0.40	66,946	30.0	33	66,124	0.72
WQ610		0.119	0.529	12.5	4.37	6.5	2.92	10.9	141	136,279	0.79	107,140	35.0	46	106,632	1.21
WQ611		0.118	0.425	24.4	8.52	12.7	5.70	15.8	127	239,385	0.44	105,002	40.0	31	104,967	0.47
WQ612		0.131	0.404	10.0	3.52	5.2	2.35	7.7	217	168,943	0.44	74,104	30.0	37	73,114	0.79
WQ613		0.131	0.404	12.2	4.26	6.3	2.85	8.8	180	169,354	0.44	74,284	30.0	34	74,074	0.72
WQ614		0.104	0.452	13.9	4.86	7.2	3.25	10.5	335	360,291	0.44	158,035	35.0	65	156,430	0.66
WQ615		0.119	0.423	17.6	6.15	9.1	4.11	12.0	170	230,887	0.44	101,274	35.0	37	101,483	0.59
WQ616		0.100	0.460	13.1	4.59	6.8	3.07	10.2	398	404,341	0.44	177,537	35.0	76	176,167	0.68
WQ617		0.117	0.427	10.7	3.74	5.6	2.50	8.3	299	247,298	0.44	108,472	30.0	53	107,083	0.77
WQ618		0.087	0.616	8.7	3.05	4.5	2.04	9.4	557	375,385	0.79	296,696	30.0	159	294,864	1.53
WQ619		0.116	0.536	11.1	3.90	5.8	2.60	10.1	171	147,156	0.79	116,752	30.0	54	116,733	1.33
WQ620		0.093	0.597	9.7	3.38	5.0	2.26	9.9	405	302,941	0.79	240,661	30.0	122	242,180	1.46
WQ621		0.100	0.575	7.5	2.63	3.9	1.76	8.0	407	236,348	0.79	187,759	30.0	101	177,349	1.54
WQ622		0.091	0.603	12.3	4.32	6.4	2.89	12.0	337	322,521	0.79	256,216	35.0	113	255,919	1.27

CUHP 2-Year Event Output

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.4.3

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
WQ623		0.081	0.637	7.5	2.64	3.9	1.76	8.7	805	469,821	0.79	371,917	30.0	208	359,799	1.61
WQ710		0.087	0.617	9.0	3.16	4.7	2.11	9.6	538	375,959	0.79	298,668	30.0	157	298,969	1.52
WQ711		0.146	0.491	12.7	4.43	6.6	2.96	10.5	63	61,716	0.94	57,928	30.0	24	57,662	1.42
WQ712		0.131	0.506	10.6	3.71	5.5	2.48	9.4	122	100,611	0.79	79,927	30.0	38	79,376	1.38
WQ713		0.123	0.521	13.6	4.74	7.0	3.17	11.5	117	122,663	0.79	97,445	35.0	40	97,014	1.19
WQ714		0.154	0.467	5.5	1.92	2.8	1.28	5.8	139	58,872	0.79	46,769	25.0	32	51,547	2.00
WQ715		0.147	0.478	2.1	0.75	1.1	0.50	3.8	417	69,183	0.79	54,960	25.0	47	58,904	2.46
WQ716		0.109	0.552	8.9	3.12	4.6	2.09	8.8	261	180,376	0.79	143,293	30.0	75	140,583	1.51
WQ717		0.122	0.523	7.3	2.55	3.8	1.71	7.4	222	125,441	0.79	99,653	30.0	53	95,229	1.54
WQ718		0.273	0.355	5.7	2.00	3.0	1.33	5.1	21	9,407	0.79	7,473	25.0	5	8,192	2.02
WQ719		0.121	0.525	4.5	1.57	2.3	1.05	5.5	367	127,822	0.79	101,544	25.0	83	122,397	2.37
WQ720		0.124	0.520	8.1	2.85	4.2	1.90	7.9	191	120,718	0.79	95,900	30.0	50	91,602	1.50
WQ721		0.105	0.562	11.8	4.12	6.1	2.75	11.0	222	201,819	0.79	160,328	35.0	71	159,992	1.27
WQ722		0.159	0.461	4.7	1.63	2.4	1.09	5.3	149	53,877	0.79	42,801	25.0	35	51,128	2.36
WQ723		0.127	0.513	9.2	3.23	4.8	2.16	8.6	154	110,141	0.79	87,498	30.0	45	85,696	1.47
WQ724		0.137	0.494	7.5	2.62	3.9	1.75	7.2	148	86,126	0.79	68,420	30.0	36	66,053	1.54
WQ725		0.194	0.418	6.8	2.38	3.5	1.59	6.1	54	28,304	0.79	22,485	25.0	13	23,204	1.67
WQ726		0.130	0.507	3.7	1.31	1.9	0.88	4.9	351	101,779	0.79	80,855	25.0	77	102,658	2.73
WQ727		0.162	0.456	10.3	3.62	5.4	2.42	8.5	63	50,446	0.79	40,075	30.0	19	39,537	1.39
WQ728		0.190	0.423	1.8	0.63	0.9	0.42	3.5	218	30,278	0.79	24,054	25.0	18	22,388	2.18
WQ729		0.101	0.574	10.0	3.48	5.2	2.33	9.8	301	232,262	0.79	184,513	30.0	92	184,999	1.44
WQ730		0.224	0.390	2.4	0.86	1.3	0.57	3.7	94	17,766	0.79	14,113	25.0	11	14,127	2.28
WQ731		0.121	0.526	10.1	3.53	5.2	2.36	9.3	167	130,083	0.79	103,340	30.0	51	102,829	1.42
WQ732		0.365	0.308	8.1	2.82	4.2	1.89	5.7	6	3,680	0.79	2,923	25.0	2	2,968	1.53
WQ733		0.189	0.424	3.7	1.29	1.9	0.86	4.5	108	30,731	0.79	24,413	25.0	22	28,714	2.57
WQ744		0.131	0.505	5.8	2.03	3.0	1.36	6.2	221	99,291	0.79	78,879	25.0	48	81,167	1.75
WQ745		0.176	0.346	28.0	8.96	14.6	6.33	14.9	30	65,802	0.44	28,832	40.0	8	28,821	0.42
WQ746		0.113	0.424	10.9	3.82	5.7	2.55	8.4	335	283,117	0.43	121,357	30.0	59	120,092	0.76
WQ747		0.109	0.420	15.8	5.51	8.2	3.69	11.0	266	324,319	0.41	133,905	35.0	53	133,155	0.59
WQ748		0.163	0.351	18.1	6.34	9.4	4.24	10.7	62	86,453	0.42	36,606	35.0	13	36,603	0.55
WQ749		0.124	0.403	17.1	5.97	8.9	3.99	11.3	161	212,250	0.43	90,240	35.0	34	90,193	0.58
WQ750		0.096	0.413	11.5	4.02	6.0	2.69	8.6	585	520,720	0.37	194,341	30.0	93	192,773	0.65
WQ751		0.163	0.290	28.6	7.87	14.8	5.56	13.1	46	101,733	0.34	34,248	40.0	9	34,243	0.33

CUHP 2-Year Rainfall Distribution

Comment	2yr Event		
1Hr Depth	0.95		
Return Period	2	Years	
Time	Depth	CurveValue	
0:05	0.019		0.02
0:10	0.038		0.04
0:15	0.08		0.084
0:20	0.152		0.16
0:25	0.238		0.25
0:30	0.133		0.14
0:35	0.06		0.063
0:40	0.048		0.05
0:45	0.029		0.03
0:50	0.029		0.03
0:55	0.029		0.03
1:00	0.029		0.03
1:05	0.029		0.03
1:10	0.019		0.02
1:15	0.019		0.02
1:20	0.019		0.02
1:25	0.019		0.02
1:30	0.019		0.02
1:35	0.019		0.02
1:40	0.019		0.02
1:45	0.019		0.02
1:50	0.019		0.02
1:55	0.01		0.01
2:00	0.01		0.01
2:05	0		

CUHP Water Quality Event Rainfall Distribution

Comment	Water Quality Event		
1Hr Depth	0.53		
Return Period	2	Years	
Time	Depth	CurveValue	
0:05	0.011		0.02
0:10	0.021		0.04
0:15	0.045		0.084
0:20	0.085		0.16
0:25	0.133		0.25
0:30	0.074		0.14
0:35	0.033		0.063
0:40	0.027		0.05
0:45	0.016		0.03
0:50	0.016		0.03
0:55	0.016		0.03
1:00	0.016		0.03
1:05	0.016		0.03
1:10	0.011		0.02
1:15	0.011		0.02
1:20	0.011		0.02
1:25	0.011		0.02
1:30	0.011		0.02
1:35	0.011		0.02
1:40	0.011		0.02
1:45	0.011		0.02
1:50	0.011		0.02
1:55	0.005		0.01
2:00	0.005		0.01
2:05	0		

SWMM Input

```
[TITLE]
High Line Canal Feasibility Study
RESPEC

[OPTIONS]
FLOW_UNITS       CFS
INFILTRATION     HORTON
FLOW_ROUTING     KINWAVE
START_DATE       01/01/2014
START_TIME       00:00:00
REPORT_START_DATE  01/01/2014
REPORT_START_TIME  00:00:00
END_DATE         01/01/2014
END_TIME         12:00:00
SWEEP_START      01/01
SWEEP_END        12/31
DRY_DAYS         0
REPORT_STEP      00:15:00
WET_STEP         00:05:00
DRY_STEP         01:00:00
ROUTING_STEP     0:00:30
ALLOW_PONDING    NO
INERTIAL_DAMPING  PARTIAL
VARIABLE_STEP    0.75
LENGTHENING_STEP  0
MIN_SURFAREA     0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE  NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS     DEPTH
MIN_SLOPE        0

[FILES]
USE INFLOWS "Z:\UDFCD PLANNING\HLC Master Plan\Hydrology\CUHP\SWMM_WQ.txt"

[EVAPORATION]
;;Type      Parameters
;;---------- ----------
CONSTANT    0.0
DRY_ONLY    NO

[JUNCTIONS]
;;          Invert   Max.    Init.   Surcharge  Ponded
;;Name      Elev.    Depth   Depth   Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
7160        5446     0       0       0          0
7170        5446.4   0       0       0          0
7171        5446     0       0       0          0
7200        5451.5   0       0       0          0
7201        5447.6   0       0       0          0
7202        5446.8   0       0       0          0
7203        5440.8   0       0       0          0
7210        5460     0       0       0          0
7211        5458.9   0       0       0          0
7222        5451.9   0       0       0          0
7260        5458.4   0       0       0          0
7261        5456.6   0       0       0          0
```

1

SWMM Input

WQ110	0	0	0	0	0
WQ111	0	0	0	0	0
WQ113	5574.0	0	0	0	0
WQ115	5605.7	0	0	0	0
WQ116	0	0	0	0	0
WQ118	5595.9	0	0	0	0
WQ119	5575.7	0	0	0	0
WQ120	5585.6	0	0	0	0
WQ121	5611.5	0	0	0	0
WQ122	5641.4	0	0	0	0
WQ123	5635.8	0	0	0	0
WQ124	5677.6	0	0	0	0
WQ125	0	0	0	0	0
WQ127	5565.4	0	0	0	0
WQ128	5569.2	0	0	0	0
WQ129	0	0	0	0	0
WQ130	0	0	0	0	0
WQ131	0	0	0	0	0
WQ132	0	0	0	0	0
WQ134	5600.0	0	0	0	0
WQ135	5610.0	0	0	0	0
WQ136	5641.1	0	0	0	0
WQ137	0	0	0	0	0
WQ138	0	0	0	0	0
WQ139	0	0	0	0	0
WQ140	0	0	0	0	0
WQ141	0	0	0	0	0
WQ142	0	0	0	0	0
WQ143	0	0	0	0	0
WQ144	0	0	0	0	0
WQ145	0	0	0	0	0
WQ146	0	0	0	0	0
WQ147	0	0	0	0	0
WQ148	0	0	0	0	0
WQ150	5579.2	0	0	0	0
WQ152	5579.8	0	0	0	0
WQ153	5616.5	0	0	0	0
WQ210	0	0	0	0	0
WQ211	0	0	0	0	0
WQ213	5563.6	0	0	0	0
WQ215	5585.5	0	0	0	0
WQ216	0	0	0	0	0
WQ217	0	0	0	0	0
WQ218	0	0	0	0	0
WQ219	0	0	0	0	0
WQ220	0	0	0	0	0
WQ221	0	0	0	0	0
WQ222	0	0	0	0	0
WQ223	0	0	0	0	0
WQ224	5505.6	0	0	0	0
WQ226	5530	0	0	0	0
WQ227	5564	0	0	0	0
WQ228	5599.4	0	0	0	0
WQ229	5599.3	0	0	0	0
WQ230	0	0	0	0	0
WQ231	0	0	0	0	0
WQ232	0	0	0	0	0

2

SWMM Input

WQ236	5551.7	0	0	0	0
WQ237	0	0	0	0	0
WQ238	0	0	0	0	0
WQ239	0	0	0	0	0
WQ240	0	0	0	0	0
WQ241	0	0	0	0	0
WQ242	0	0	0	0	0
WQ243	0	0	0	0	0
WQ244	0	0	0	0	0
WQ246	5538.2	0	0	0	0
WQ247	0	0	0	0	0
WQ248	0	0	0	0	0
WQ249	0	0	0	0	0
WQ250	0	0	0	0	0
WQ257	0	0	0	0	0
WQ258	0	0	0	0	0
WQ259	0	0	0	0	0
WQ261	5530.1	0	0	0	0
WQ262	5530	0	0	0	0
WQ263	0	0	0	0	0
WQ311	5508.1	0	0	0	0
WQ312	0	0	0	0	0
WQ313	0	0	0	0	0
WQ314	0	0	0	0	0
WQ315	0	0	0	0	0
WQ316	0	0	0	0	0
WQ317	0	0	0	0	0
WQ319	5548.7	0	0	0	0
WQ323	5546.8	0	0	0	0
WQ325	0	0	0	0	0
WQ326	0	0	0	0	0
WQ327	0	0	0	0	0
WQ328	0	0	0	0	0
WQ329	0	0	0	0	0
WQ330	0	0	0	0	0
WQ331	0	0	0	0	0
WQ332	0	0	0	0	0
WQ333	0	0	0	0	0
WQ334	0	0	0	0	0
WQ335	0	0	0	0	0
WQ336	0	0	0	0	0
WQ337	0	0	0	0	0
WQ338	0	0	0	0	0
WQ339	0	0	0	0	0
WQ340	0	0	0	0	0
WQ341	0	0	0	0	0
WQ342	0	0	0	0	0
WQ343	0	0	0	0	0
WQ344	0	0	0	0	0
WQ345	0	0	0	0	0
WQ346	0	0	0	0	0
WQ347	0	0	0	0	0
WQ348	0	0	0	0	0
WQ349	0	0	0	0	0
WQ350	0	0	0	0	0
WQ351	0	0	0	0	0
WQ352	0	0	0	0	0

3

SWMM Input

WQ353	0	0	0	0	0
WQ354	0	0	0	0	0
WQ355	0	0	0	0	0
WQ356	0	0	0	0	0
WQ357	0	0	0	0	0
WQ358	0	0	0	0	0
WQ360	0	0	0	0	0
WQ364	5475.0	0	0	0	0
WQ367	5463.0	0	0	0	0
WQ368	5484.6	0	0	0	0
WQ369	5484.5	0	0	0	0
WQ370	5505.0	0	0	0	0
WQ371	5506.1	0	0	0	0
WQ372	5561.7	0	0	0	0
WQ373	5570.9	0	0	0	0
WQ374	0	0	0	0	0
WQ410	0	0	0	0	0
WQ411	0	0	0	0	0
WQ412	0	0	0	0	0
WQ413	5461.2	0	0	0	0
WQ415	5513.2	0	0	0	0
WQ417	5518.5	0	0	0	0
WQ418	0	0	0	0	0
WQ420	5458	0	0	0	0
WQ421	5458.1	0	0	0	0
WQ422	5478.4	0	0	0	0
WQ423	5509.0	0	0	0	0
WQ424	5582.0	0	0	0	0
WQ510	0	0	0	0	0
WQ511	0	0	0	0	0
WQ512	0	0	0	0	0
WQ513	0	0	0	0	0
WQ514	0	0	0	0	0
WQ515	0	0	0	0	0
WQ516	0	0	0	0	0
WQ517	0	0	0	0	0
WQ519	5460.1	0	0	0	0
WQ521	0	0	0	0	0
WQ610	0	0	0	0	0
WQ611	0	0	0	0	0
WQ612	0	0	0	0	0
WQ613	5433.3	0	0	0	0
WQ615	5440.9	0	0	0	0
WQ617	5447.8	0	0	0	0
WQ619	5455.6	0	0	0	0
WQ623	0	0	0	0	0
WQ710	0	0	0	0	0
WQ712	5440.1	0	0	0	0
WQ713	5440.1	0	0	0	0
WQ714	5440.1	0	0	0	0
WQ715	5440.1	0	0	0	0
WQ716	5446.4	0	0	0	0
WQ717	5446.8	0	0	0	0
WQ718	5446.9	0	0	0	0
WQ719	5456.6	0	0	0	0
WQ720	5456.5	0	0	0	0
WQ721	5470	0	0	0	0

4

SWMM Input

WQ722	5475.4	0	0	0	0
WQ723	5475.5	0	0	0	0
WQ724	5460.1	0	0	0	0
WQ725	5460.0	0	0	0	0
WQ726	5458.5	0	0	0	0
WQ727	5472.5	0	0	0	0
WQ728	5472.7	0	0	0	0
WQ729	5461.0	0	0	0	0
WQ730	5472.7	0	0	0	0
WQ731	5470.0	0	0	0	0
WQ732	5470.0	0	0	0	0
WQ733	5460.1	0	0	0	0
WQ745	0	0	0	0	0
WQ747	5424.1	0	0	0	0
WQ748	0	0	0	0	0
WQ750	5433.4	0	0	0	0
WQ751	0	0	0	0	0

[OUTFALLS]

;;	Invert	Outfall	Stage/Table	Tide
;;Name	Elev.	Type	Time Series	Gate
;;--------------	----------	----------	----------------	----
WQ112	5183.8	FREE		NO
WQ114	5144.8	FREE		NO
WQ117	5542.4	FREE		NO
WQ126	5538.6	FREE		NO
WQ133	5528.6	FREE		NO
WQ149	5516.5	FREE		NO
WQ151	5514.1	FREE		NO
WQ212	5527.3	FREE		NO
WQ214	5512.5	FREE		NO
WQ225	5505.5	FREE		NO
WQ233	5505.6	FREE		NO
WQ245	5499.1	FREE		NO
WQ260	5482.6	FREE		NO
WQ310	5480.7	FREE		NO
WQ318	5484.4	FREE		NO
WQ320	5479.7	FREE		NO
WQ361	5480.6	FREE		NO
WQ363	5466.1	FREE		NO
WQ366	5462.9	FREE		NO
WQ414	5461.1	FREE		NO
WQ416	5459.1	FREE		NO
WQ419	5452.1	FREE		NO
WQ518	5438.1	FREE		NO
WQ614	5433.2	FREE		NO
WQ618	5433.0	FREE		NO
WQ620	5427.0	FREE		NO
WQ711	5439.9	FREE		NO
WQ746	5424.0	FREE		NO
WQ749	5423.6	FREE		NO

[DIVIDERS]

;;	Invert	Diverted	Divider					
;;Name	Elev.	Link	Type	Parameters				
;;--------------	----------	----------------	----------	----------				
WQ234	5543.1	234_OVERFLOW	OVERFLOW	0	0	0	0	

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SWMM Input

```
WQ235   5547.7  235_OVERFLOW  OVERFLOW 0   0   0   0
WQ321   5493.0  321_OVERFLOW  OVERFLOW 0   0   0   0
WQ322   5519.5  322_OVERFLOW  OVERFLOW 0   0   0   0
WQ324   5557.8  324_OVERFLOW  OVERFLOW 0   0   0   0
WQ362   5490.5  362_OVERFLOW  OVERFLOW 0   0   0   0
WQ365   5474.9  365_OVERFLOW  OVERFLOW 0   0   0   0
WQ520   5466.5  520_OVERFLOW  OVERFLOW 0   0   0   0
WQ616   5454.8  616_OVERFLOW  OVERFLOW 0   0   0   0
WQ621   5452.6  621_OVERFLOW  OVERFLOW 0   0   0   0
WQ622   5477.2  622_OVERFLOW  OVERFLOW 0   0   0   0
WQ744   5469.9  744_OVERFLOW  OVERFLOW 0   0   0   0

[STORAGE]
;;          Invert  Max.   Init.  Storage  Curve            Ponded  Evap.
;;Name      Elev.   Depth  Depth  Curve    Params           Area    Frac.  Infiltration Parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -----------------------
STO711   5440    100  0   FUNCTIONAL 0   0   43560  0   0
STO714   5440.2  10   0   FUNCTIONAL 0   0   43560  0   0
STO715   5440.2  10   0   FUNCTIONAL 0   0   43560  0   0
STO719   5456.7  10   0   FUNCTIONAL 0   0   43560  0   0
STO722   5475.5  10   0   FUNCTIONAL 0   0   43560  0   0
STO725   5460.1  0    0   FUNCTIONAL 0   0   43560  0   0
STO726   5458.6  10   0   FUNCTIONAL 0   0   43560  0   0
STO727   5472.6  10   0   FUNCTIONAL 0   0   43560  0   0
STO733   5460.2  10   0   FUNCTIONAL 0   0   43560  0   0

[CONDUITS]
;;       Inlet      Outlet          Manning  Inlet   Outlet  Init.   Max.
;;Name   Node       Node     Length  N       Offset  Offset  Flow    Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
113     WQ113     WQ112     3036   .035   0   0   0   0
115     WQ115     WQ114     2935   .035   0   0   0   0
118     WQ118     WQ117     1786   .035   0   0   0   0
119     WQ119     WQ117     2255   .035   0   0   0   0
120     WQ120     WQ117     2276   .035   0   0   0   0
121     WQ121     WQ120     1992   .035   0   0   0   0
122     WQ122     WQ120     2276   .035   0   0   0   0
123     WQ123     WQ121     1237   .035   0   0   0   0
124     WQ124     WQ123     1537   .035   0   0   0   0
127     WQ127     WQ126     2548   .035   0   0   0   0
128     WQ128     WQ127     1560   .035   0   0   0   0
134     WQ134     WQ133     2133   .035   0   0   0   0
135     WQ135     WQ133     3105   .035   0   0   0   0
136     WQ136     WQ135     1831   .035   0   0   0   0
150     WQ150     WQ149     1930   .013   0   0   0   0
152     WQ152     WQ151     1930   .013   0   0   0   0
153     WQ153     WQ152     1775   .013   0   0   0   0
213     WQ213     WQ212     1900   .013   0   0   0   0
215     WQ215     WQ214     4200   .013   0   0   0   0
224     WQ224     WQ225     1      0.01   0   0   0   0
226     WQ226     WQ225     1300   .013   0   0   0   0
227     WQ227     WQ226     2400   .013   0   0   0   0
228     WQ228     WQ229     1      0.01   0   0   0   0
229     WQ229     WQ226     3400   .013   0   0   0   0
234     WQ234     WQ233     3550   .013   0   0   0   0
234_OVERFLOW  WQ234     WQ233     3550   .035   0   0   0   0
235     WQ235     WQ234     820    .013   0   0   0   0
```

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SWMM Input

```
235_OVERFLOW  WQ235     WQ234     820    .035   0   0   0   0
236     WQ236     WQ234     1200   .013   0   0   0   0
246     WQ246     WQ245     2700   .013   0   0   0   0
261     WQ261     WQ262     1      0.01   0   0   0   0
262     WQ262     WQ260     2000   .062   0   0   0   0
311     WQ311     WQ310     864    .02    0   0   0   0
319     WQ319     WQ318     3081   .013   0   0   0   0
321     WQ321     WQ320     1140   .013   0   0   0   0
321_OVERFLOW  WQ321     WQ320     1140   .035   0   0   0   0
322     WQ322     WQ321     1100   .013   0   0   0   0
322_OVERFLOW  WQ322     WQ321     1100   .035   0   0   0   0
323     WQ323     WQ322     1410   .013   0   0   0   0
324     WQ324     WQ322     1124   .013   0   0   0   0
324_OVERFLOW  WQ324     WQ322     1124   .035   0   0   0   0
340     WQ720     7200      1000   .035   0   0   0   0
362     WQ362     WQ361     2500   .013   0   0   0   0
362_OVERFLOW  WQ362     WQ361     2500   .035   0   0   0   0
364     WQ364     WQ365     1      0.01   0   0   0   0
365     WQ365     WQ363     1300   .013   0   0   0   0
365_OVERFLOW  WQ365     WQ363     1300   .035   0   0   0   0
367     WQ367     WQ366     1      0.01   0   0   0   0
368     WQ368     WQ369     1      0.01   0   0   0   0
369     WQ369     WQ366     2600   .02    0   0   0   0
370     WQ370     WQ369     2600   .02    0   0   0   0
371     WQ371     WQ370     600    .02    0   0   0   0
372     WQ372     WQ370     2700   .02    0   0   0   0
373     WQ373     WQ372     800    .02    0   0   0   0
413     WQ413     WQ414     1      0.01   0   0   0   0
415     WQ415     WQ414     2550   0.01   0   0   0   0
417     WQ417     WQ416     2295   .013   0   0   0   0
420     WQ420     WQ419     1020   .013   0   0   0   0
421     WQ421     WQ420     1      0.01   0   0   0   0
422     WQ422     WQ420     1420   .013   0   0   0   0
423     WQ423     WQ422     1330   0.01   0   0   0   0
424     WQ424     WQ423     3360   0.01   0   0   0   0
450     7210      7211      80     .015   0   0   0   0
460     7211      7222      1400   .02    0   0   0   0
475     7222      7200      80     .015   0   0   0   0
519     WQ519     WQ518     1166   .013   0   0   0   0
520     WQ520     WQ519     2635   .013   0   0   0   0
520_OVERFLOW  WQ520     WQ519     2635   .035   0   0   0   0
613     WQ613     WQ614     1      0.01   0   0   0   0
615     WQ615     WQ613     1769   .013   0   0   0   0
616     WQ616     WQ614     2754   .013   0   0   0   0
616_OVERFLOW  WQ616     WQ614     2754   .035   0   0   0   0
617     WQ617     WQ615     2252   .013   0   0   0   0
619     WQ619     WQ618     2635   .035   0   0   0   0
621     WQ621     WQ620     2168   .013   0   0   0   0
621_OVERFLOW  WQ621     WQ620     2168   .035   0   0   0   0
622     WQ622     WQ621     1714   .013   0   0   0   0
622_OVERFLOW  WQ622     WQ621     1714   .035   0   0   0   0
712     WQ712     STO711    1      0.01   0   0   0   0
713     WQ713     STO711    1      0.01   0   0   0   0
714     WQ714     STO711    1      0.01   0   0   0   0
715     WQ715     STO711    1      0.01   0   0   0   0
716     WQ716     7160      80     .015   0   0   0   0
717     WQ717     7170      80     .015   0   0   0   0
```

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SWMM Input

```
718      WQ718    WQ717    1     0.01  0   0   0   0
719      WQ719    WQ720    80    .015  0   0   0   0
721      WQ721    7210     2000  .035  0   0   0   0
722      WQ722    7210     1700  .015  0   0   0   0
723      WQ723    WQ722    1     0.01  0   0   0   0
724      WQ724    WQ725    1     0.01  0   0   0   0
725      WQ725    WQ726    1400  .015  0   0   0   0
726      WQ726    7260     80    .015  0   0   0   0
727      WQ727    WQ725    2800  .015  0   0   0   0
728      WQ728    STO727   1     0.01  0   0   0   0
729      WQ729    WQ725    500   .035  0   0   0   0
730      WQ730    STO727   1     0.01  0   0   0   0
731      WQ731    WQ744    1     0.01  0   0   0   0
732      WQ732    WQ744    1     0.01  0   0   0   0
733      WQ733    WQ725    1     0.01  0   0   0   0
744      WQ744    WQ729    300   .015  0   0   0   0
747      WQ747    WQ746    1     0.01  0   0   0   0
750      WQ750    WQ749    1439  .013  0   0   0   0
7160     7160     STO711   1200  .035  0   0   0   0
7170     7170     7171     80    .015  0   0   0   0
7171     7171     STO711   1200  .015  0   0   0   0
7200     7200     7201     80    .015  0   0   0   0
7201     7201     7202     80    .015  0   0   0   0
7202     7202     7203     600   .035  0   0   0   0
7203     7203     STO711   80    .02   0   0   0   0
7260     7260     7261     1800  .035  0   0   0   0
7261     7261     WQ720    80    .015  0   0   0   0
744_OVERFLOW  WQ744    WQ729    300   .035  0   0   0   0

[OUTLETS]
;;       Inlet    Outlet    Outflow  Outlet         Qcoeff/             Flap
;;Name   Node     Node      Height   Type           QTable              Qexpon  Gate
;;-------------- ---------------- ---------------- ---------- --------------- ---------------- ---------- ----
OUT711   STO711   WQ711     0        TABULAR/DEPTH  RATING_CURVE_711           NO
OUT714   STO714   WQ714     0        TABULAR/DEPTH  RATING_CURVE_714           NO
OUT715   STO715   WQ715     0        TABULAR/DEPTH  RATING_CURVE_715           NO
OUT719   STO719   WQ719     0        TABULAR/DEPTH  RATING_CURVE_719           NO
OUT722   STO722   WQ722     0        TABULAR/DEPTH  RATING_CURVE_722           NO
OUT725   STO725   WQ725     0        TABULAR/DEPTH  RATING_CURVE_725           NO
OUT726   STO726   WQ726     0        TABULAR/DEPTH  RATING_CURVE_726           NO
OUT727   STO727   WQ727     0        TABULAR/DEPTH  RATING_CURVE_727           NO
OUT733   STO733   WQ733     0        TABULAR/DEPTH  RATING_CURVE_733           NO

[XSECTIONS]
;;Link   Shape        Geom1     Geom2   Geom3   Geom4   Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
113      TRAPEZOIDAL  5         20      4       4       1
115      TRAPEZOIDAL  5         20      4       4       1
118      TRAPEZOIDAL  5         20      4       4       1
119      TRAPEZOIDAL  5         20      4       4       1
120      TRAPEZOIDAL  5         20      4       4       1
121      TRAPEZOIDAL  5         20      4       4       1
122      TRAPEZOIDAL  5         20      4       4       1
123      TRAPEZOIDAL  5         20      4       4       1
124      TRAPEZOIDAL  5         20      4       4       1
127      TRAPEZOIDAL  5         20      4       4       1
128      TRAPEZOIDAL  5         20      4       4       1
```

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SWMM Input

```
134      TRAPEZOIDAL  5     20    4     4     1
135      TRAPEZOIDAL  5     20    4     4     1
136      TRAPEZOIDAL  5     20    4     4     1
150      CIRCULAR  5.5     0     0     0     1
152      CIRCULAR  9.0     0     0     0     1
153      CIRCULAR  7.5     0     0     0     1
213      CIRCULAR  4.5     0     0     0     1
215      CIRCULAR  3.5     0     0     0     1
224      DUMMY     0       0     0     0     1
226      CIRCULAR  5       0     0     0     1
227      CIRCULAR  5       0     0     0     1
228      DUMMY     0       0     0     0     1
229      CIRCULAR  5       0     0     0     1
234      CIRCULAR  4       0     0     0     1
234_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
235      CIRCULAR  3       0     0     0     1
235_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
236      CIRCULAR  3       0     0     0     1
246      CIRCULAR  1.5     0     0     0     1
261      DUMMY     0       0     0     0     1
262      TRAPEZOIDAL  8     15    9     6     1
311      TRAPEZOIDAL  20    195   20    20    1
319      CIRCULAR  2.5     0     0     0     1
321      CIRCULAR  1.75    0     0     0     1
321_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
322      CIRCULAR  1.75    0     0     0     1
322_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
323      CIRCULAR  1.75    0     0     0     1
324      CIRCULAR  1.75    0     0     0     1
324_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
340      TRAPEZOIDAL  5     10    4     4     1
362      CIRCULAR  4       0     0     0     1
362_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
364      DUMMY     0       0     0     0     1
365      CIRCULAR  4.5     0     0     0     1
365_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
367      DUMMY     0       0     0     0     1
368      DUMMY     0       0     0     0     1
369      TRAPEZOIDAL  20    1     20    20    1
370      TRAPEZOIDAL  20    1     20    20    1
371      TRAPEZOIDAL  20    1     20    20    1
372      TRAPEZOIDAL  20    1     20    20    1
373      TRAPEZOIDAL  20    1     20    20    1
413      DUMMY     0       0     0     0     1
415      IRREGULAR   LowerTollTrib   0     0     0     1
417      CIRCULAR  2.75    0     0     0     1
420      CIRCULAR  10      0     0     0     1
421      DUMMY     0       0     0     0     1
422      CIRCULAR  8       0     0     0     1
423      IRREGULAR   AuroraMall   0     0     0     1
424      IRREGULAR   AuroraMall   0     0     0     1
450      CIRCULAR  8       0     0     0     1
460      TRAPEZOIDAL  5     10    4     4     1
475      CIRCULAR  8       0     0     0     1
519      CIRCULAR  5.5     0     0     0     1
520      CIRCULAR  5       0     0     0     1
520_OVERFLOW   TRAPEZOIDAL 20    1     20    20    1
```

9

SWMM Input

```
613         DUMMY       0       0     0     0     1
615         CIRCULAR    4       0     0     0     1
616         CIRCULAR    2       0     0     0     1
616_OVERFLOW   TRAPEZOIDAL 20      1     20    20    1
617         CIRCULAR    36      0     0     0     1
619         TRAPEZOIDAL 5       10    4     4     1
621         CIRCULAR    2       0     0     0     1
621_OVERFLOW   TRAPEZOIDAL 20      1     20    20    1
622         CIRCULAR    1.75    0     0     0     1
622_OVERFLOW   TRAPEZOIDAL 20      1     20    20    1
712         DUMMY       0       0     0     0     1
713         DUMMY       0       0     0     0     1
714         DUMMY       0       0     0     0     1
715         DUMMY       0       0     0     0     1
716         CIRCULAR    5       0     0     0     1
717         CIRCULAR    6.18    0     0     0     1
718         DUMMY       0       0     0     0     1
719         CIRCULAR    2.656   0     0     0     1
721         TRAPEZOIDAL 5       10    4     4     1
722         TRAPEZOIDAL 1       24    .02   .02   1
723         DUMMY       0       0     0     0     1
724         DUMMY       0       0     0     0     1
725         CIRCULAR    10      0     0     0     1
726         CIRCULAR    12      0     0     0     1
727         TRAPEZOIDAL 1.5     24    .02   .02   1
728         DUMMY       0       0     0     0     1
729         TRAPEZOIDAL 5       10    4     4     1
730         DUMMY       0       0     0     0     1
731         DUMMY       0       0     0     0     1
732         DUMMY       0       0     0     0     1
733         DUMMY       0       0     0     0     1
744         TRAPEZOIDAL 1       24    .02   .02   1
747         DUMMY       0       0     0     0     1
750         CIRCULAR    4       0     0     0     1
7160        TRAPEZOIDAL 5       10    4     4     1
7170        CIRCULAR    4.5     0     0     0     1
7171        TRAPEZOIDAL 1       24    .02   .02   1
7200        CIRCULAR    10      0     0     0     1
7201        CIRCULAR    10      0     0     0     1
7202        TRAPEZOIDAL 5       12    4     4     1
7203        CIRCULAR    8       0     0     0     1
7260        TRAPEZOIDAL 4.5     10    4     4     1
7261        CIRCULAR    12      0     0     0     1
744_OVERFLOW   TRAPEZOIDAL 20      1     20    20    1

[TRANSECTS]

NC 0.087   0.087   0.079
X1 LowerTollTrib   6    1500   1536   0.0   0.0   0.0   0.0   0.0
GR 100   1000   90   1500   86   1516   86   1520   90   1536
GR 100   2036

NC .078   .078   .071
X1 AuroraMall   6   1000   1050   0.0   0.0   0.0   0.0   0.0
GR 110   900   100   1000   95   1020   95   1030   100   1050
GR 110   1150
```

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SWMM Input

```
[LOSSES]
;;Link      Inlet     Outlet    Average   Flap Gate
;;-------------- ---------- ---------- ---------- ----------

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
RATING_CURVE_711 Rating     0     0
RATING_CURVE_711            1     20
RATING_CURVE_711            10    100
RATING_CURVE_711            30    320
RATING_CURVE_711            60    400
RATING_CURVE_711            85    465

RATING_CURVE_714 Rating     0     0
RATING_CURVE_714            1     5
RATING_CURVE_714            2     13

RATING_CURVE_715 Rating     0     0
RATING_CURVE_715            1.2   8.4
RATING_CURVE_715            2.8   17.8

RATING_CURVE_719 Rating     0     0
RATING_CURVE_719            2     8
RATING_CURVE_719            6     39.2

RATING_CURVE_722 Rating     0     0
RATING_CURVE_722            1.2   5.4
RATING_CURVE_722            2.65  16.8

RATING_CURVE_726 Rating     0     0
RATING_CURVE_726            1.5   5
RATING_CURVE_726            3.8   24.3

RATING_CURVE_727 Rating     0     0
RATING_CURVE_727            0.5   1
RATING_CURVE_727            1     5.8

RATING_CURVE_733 Rating     0     0
RATING_CURVE_733            0.5   3
RATING_CURVE_733            1     6.784

RATING_CURVE_725 Rating     0     0
RATING_CURVE_725            0.5   1.5
RATING_CURVE_725            1     7

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -385.000 -1400.000 8085.000 29400.000
```

11

SWMM Input

Units None

[COORDINATES]

;;Node	X-Coord	Y-Coord
;;--------------	------------------	------------------
7160	2000.000	25750.000
7170	1521.871	25655.651
7171	1749.554	25817.731
7200	2800.000	26000.000
7201	2600.000	26000.000
7202	2400.000	26000.000
7203	2200.000	26000.000
7210	3443.676	25500.000
7211	3238.933	25665.014
7222	3042.906	25817.849
7260	3666.000	26000.000
7261	3333.000	26000.000
WQ110	8000.000	0.000
WQ111	9000.000	0.000
WQ113	2000.000	0.000
WQ115	2000.000	1000.000
WQ116	8000.000	1000.000
WQ118	1700.000	2500.000
WQ119	1700.000	1500.000
WQ120	2000.000	2000.000
WQ121	3000.000	2000.000
WQ122	2700.000	2500.000
WQ123	4000.000	2000.000
WQ124	4700.000	2500.000
WQ125	8000.000	2000.000
WQ127	2000.000	3000.000
WQ128	2700.000	3500.000
WQ129	8000.000	3000.000
WQ130	9000.000	3000.000
WQ131	10000.000	3000.000
WQ132	11000.000	3000.000
WQ134	1700.000	4500.000
WQ135	2000.000	4000.000
WQ136	2700.000	4500.000
WQ137	8000.000	4000.000
WQ138	9000.000	4000.000
WQ139	10000.000	4000.000
WQ140	11000.000	4000.000
WQ141	12000.000	4000.000
WQ142	13000.000	4000.000
WQ143	8000.000	5000.000
WQ144	9000.000	5000.000
WQ145	10000.000	5000.000
WQ146	11000.000	5000.000
WQ147	12000.000	5000.000
WQ148	13000.000	5000.000
WQ150	2000.000	5000.000
WQ152	2000.000	6000.000
WQ153	2700.000	6500.000
WQ210	8000.000	6000.000
WQ211	9000.000	6000.000
WQ213	2000.000	7000.000

12

SWMM Input

WQ215	2000.000	8000.000
WQ216	8000.000	8000.000
WQ217	9000.000	8000.000
WQ218	10000.000	8000.000
WQ219	11000.000	8000.000
WQ220	8000.000	9000.000
WQ221	9000.000	9000.000
WQ222	10000.000	9000.000
WQ223	11000.000	9000.000
WQ224	1700.000	8500.000
WQ226	2000.000	9000.000
WQ227	2700.000	9500.000
WQ228	3700.000	8500.000
WQ229	3000.000	9000.000
WQ230	8000.000	10000.000
WQ231	9000.000	10000.000
WQ232	10000.000	10000.000
WQ236	3000.000	10000.000
WQ237	8000.000	11000.000
WQ238	9000.000	11000.000
WQ239	10000.000	11000.000
WQ240	11000.000	11000.000
WQ241	12000.000	11000.000
WQ242	13000.000	11000.000
WQ243	14000.000	11000.000
WQ244	15000.000	11000.000
WQ246	2000.000	11000.000
WQ247	8000.000	12000.000
WQ248	9000.000	12000.000
WQ249	10000.000	12000.000
WQ250	11000.000	12000.000
WQ257	12000.000	12000.000
WQ258	13000.000	12000.000
WQ259	14000.000	12000.000
WQ261	3000.000	12000.000
WQ262	2000.000	12000.000
WQ263	8000.000	13000.000
WQ311	2000.000	13000.000
WQ312	8000.000	14000.000
WQ313	9000.000	14000.000
WQ314	10000.000	14000.000
WQ315	11000.000	14000.000
WQ316	12000.000	14000.000
WQ317	13000.000	14000.000
WQ319	2000.000	14000.000
WQ323	3700.000	15500.000
WQ325	8000.000	15000.000
WQ326	9000.000	15000.000
WQ327	10000.000	15000.000
WQ328	11000.000	15000.000
WQ329	12000.000	15000.000
WQ330	13000.000	15000.000
WQ331	14000.000	15000.000
WQ332	15000.000	15000.000
WQ333	16000.000	15000.000
WQ334	17000.000	15000.000
WQ335	18000.000	15000.000

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SWMM Input

WQ336	19000.000	15000.000
WQ337	20000.000	15000.000
WQ338	21000.000	15000.000
WQ339	22000.000	15000.000
WQ340	23000.000	15000.000
WQ341	24000.000	15000.000
WQ342	8000.000	16000.000
WQ343	9000.000	16000.000
WQ344	10000.000	16000.000
WQ345	11000.000	16000.000
WQ346	12000.000	16000.000
WQ347	13000.000	16000.000
WQ348	14000.000	16000.000
WQ349	15000.000	16000.000
WQ350	16000.000	16000.000
WQ351	17000.000	16000.000
WQ352	18000.000	16000.000
WQ353	19000.000	16000.000
WQ354	20000.000	16000.000
WQ355	21000.000	16000.000
WQ356	22000.000	16000.000
WQ357	23000.000	16000.000
WQ358	24000.000	16000.000
WQ360	8000.000	17000.000
WQ364	2700.000	16500.000
WQ367	1700.000	18500.000
WQ368	2700.000	17500.000
WQ369	2000.000	18000.000
WQ370	3000.000	18000.000
WQ371	3700.000	18500.000
WQ372	4000.000	18000.000
WQ373	4700.000	17500.000
WQ374	8000.000	18000.000
WQ410	9000.000	18000.000
WQ411	10000.000	18000.000
WQ412	11000.000	18000.000
WQ413	1700.000	19500.000
WQ415	2000.000	19000.000
WQ417	2000.000	20000.000
WQ418	8000.000	20000.000
WQ420	2000.000	21000.000
WQ421	2700.000	21500.000
WQ422	3000.000	21000.000
WQ423	4000.000	21000.000
WQ424	4700.000	21500.000
WQ510	8000.000	21000.000
WQ511	9000.000	21000.000
WQ512	10000.000	21000.000
WQ513	11000.000	21000.000
WQ514	8000.000	22000.000
WQ515	9000.000	22000.000
WQ516	10000.000	22000.000
WQ517	11000.000	22000.000
WQ519	2000.000	22000.000
WQ521	8000.000	23000.000
WQ610	9000.000	23000.000
WQ611	10000.000	23000.000

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SWMM Input

WQ612	11000.000	23000.000
WQ613	2000.000	22500.000
WQ615	3000.000	22500.000
WQ617	4000.000	22500.000
WQ619	2000.000	24000.000
WQ623	8000.000	24000.000
WQ710	9000.000	24000.000
WQ712	1300.000	26500.000
WQ713	2000.000	26500.000
WQ714	2309.539	26215.249
WQ715	2333.408	25755.765
WQ716	2000.000	25500.000
WQ717	1300.000	25500.000
WQ718	1529.589	25343.069
WQ719	3311.332	26218.451
WQ720	3000.000	26000.000
WQ721	3763.977	25500.000
WQ722	3686.796	25308.337
WQ723	4000.000	25308.337
WQ724	5700.000	26500.000
WQ725	5000.000	26000.000
WQ726	4000.000	26000.000
WQ727	5297.510	25798.615
WQ728	6300.000	25100.000
WQ729	6000.000	26000.000
WQ730	6300.000	25500.000
WQ731	7700.000	25800.000
WQ732	7700.000	26200.000
WQ733	5000.000	25500.000
WQ745	8000.000	28000.000
WQ747	2000.000	27000.000
WQ748	9000.000	28000.000
WQ750	2000.000	28000.000
WQ751	10000.000	28000.000
WQ112	1000.000	0.000
WQ114	1000.000	1000.000
WQ117	1000.000	2000.000
WQ126	1000.000	3000.000
WQ133	1000.000	4000.000
WQ149	1000.000	5000.000
WQ151	1000.000	6000.000
WQ212	1000.000	7000.000
WQ214	1000.000	8000.000
WQ225	1000.000	9000.000
WQ233	1000.000	10000.000
WQ245	1000.000	11000.000
WQ260	1000.000	12000.000
WQ310	1000.000	13000.000
WQ318	1000.000	14000.000
WQ320	1000.000	15000.000
WQ361	1000.000	16000.000
WQ363	1000.000	17000.000
WQ366	1000.000	18000.000
WQ414	1000.000	19000.000
WQ416	1000.000	20000.000
WQ419	1000.000	21000.000
WQ518	1000.000	22000.000

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SWMM Input

WQ614	1000.000	23000.000
WQ618	1000.000	24000.000
WQ620	1000.000	25000.000
WQ711	1000.000	26000.000
WQ746	1000.000	27000.000
WQ749	1000.000	28000.000
WQ234	2000.000	10000.000
WQ235	2700.000	10500.000
WQ321	2000.000	15000.000
WQ322	3000.000	15000.000
WQ324	3700.000	14500.000
WQ362	2000.000	16000.000
WQ365	2000.000	17000.000
WQ520	3000.000	22000.000
WQ616	2000.000	23500.000
WQ621	2000.000	25000.000
WQ622	3000.000	25000.000
WQ744	7000.000	26000.000
STO711	2000.000	26000.000
STO714	2700.000	26500.000
STO715	2700.000	25500.000
STO719	3700.000	26500.000
STO722	4076.559	25000.000
STO725	5000.000	26500.000
STO726	4700.000	26500.000
STO727	5700.000	25500.000
STO733	5000.000	25000.000

[VERTICES]

;;Link	X-Coord	Y-Coord
234_OVERFLOW	1503.770	9856.195
235_OVERFLOW	2475.801	10166.926
321_OVERFLOW	1485.938	14816.874
322_OVERFLOW	2514.966	14829.224
324_OVERFLOW	3465.832	14884.163
362_OVERFLOW	1500.708	15780.091
365_OVERFLOW	1513.386	16807.026
520_OVERFLOW	2512.864	21807.998
616_OVERFLOW	1595.609	23074.068
621_OVERFLOW	1511.635	24798.766
622_OVERFLOW	2525.783	24798.766
744_OVERFLOW	6537.158	25793.535

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SWMM Water Quality Event Output

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
------------------------------------------------------------

High Line Canal Feasibility Study
RESPEC
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ JAN-01-2014 00:00:00
Ending Date .............. JAN-01-2014 12:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Routing Time Step ........ 30.00 sec

**************************        Volume     Volume
Flow Routing Continuity        acre-feet   10^6 gal
**************************     ---------  ---------
Dry Weather Inflow .......         0.000      0.000
Wet Weather Inflow .......         0.000      0.000
Groundwater Inflow .......         0.000      0.000
RDII Inflow ..............         0.000      0.000
External Inflow ..........       188.863     61.544
External Outflow .........       190.665     62.131
Internal Outflow .........         0.183      0.059
Storage Losses ...........         0.000      0.000
Initial Stored Volume ....         0.000      0.000
Final Stored Volume ......         0.327      0.106
Continuity Error (%) .....        -1.224

********************************
Highest Flow Instability Indexes
********************************
Link 7200 (2)

*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.07
******************
```

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SWMM Water Quality Event Output

Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min
7160	JUNCTION	0.06	1.62	5447.62	0	00:30
7170	JUNCTION	0.06	1.48	5447.88	0	00:30
7171	JUNCTION	0.06	1.48	5447.48	0	00:30
7200	JUNCTION	0.31	1.65	5453.15	0	00:55
7201	JUNCTION	0.41	2.04	5449.64	0	00:51
7202	JUNCTION	0.41	2.04	5448.84	0	00:51
7203	JUNCTION	0.50	2.55	5443.35	0	00:53
7210	JUNCTION	0.17	1.29	5461.29	0	00:55
7211	JUNCTION	0.17	1.27	5460.17	0	00:56
7222	JUNCTION	0.22	1.54	5453.44	0	00:46
7260	JUNCTION	0.45	2.85	5461.25	0	00:38
7261	JUNCTION	0.48	2.53	5459.13	0	00:50
WQ110	JUNCTION	0.00	0.00	0.00	0	00:00
WQ111	JUNCTION	0.00	0.00	0.00	0	00:00
WQ113	JUNCTION	0.00	0.02	5574.02	0	00:35
WQ115	JUNCTION	0.00	0.12	5605.82	0	00:35
WQ116	JUNCTION	0.00	0.00	0.00	0	00:00
WQ118	JUNCTION	0.01	0.21	5596.11	0	00:35
WQ119	JUNCTION	0.00	0.08	5575.78	0	00:40
WQ120	JUNCTION	0.05	0.67	5586.27	0	00:35
WQ121	JUNCTION	0.03	0.47	5611.97	0	00:41
WQ122	JUNCTION	0.01	0.20	5641.60	0	00:30
WQ123	JUNCTION	0.02	0.35	5636.15	0	00:38
WQ124	JUNCTION	0.01	0.19	5677.79	0	00:35
WQ125	JUNCTION	0.00	0.00	0.00	0	00:00
WQ127	JUNCTION	0.03	0.28	5565.68	0	00:55
WQ128	JUNCTION	0.01	0.21	5569.41	0	00:35
WQ129	JUNCTION	0.00	0.00	0.00	0	00:00
WQ130	JUNCTION	0.00	0.00	0.00	0	00:00
WQ131	JUNCTION	0.00	0.00	0.00	0	00:00
WQ132	JUNCTION	0.00	0.00	0.00	0	00:00
WQ134	JUNCTION	0.02	0.72	5600.72	0	00:30
WQ135	JUNCTION	0.03	0.55	5610.55	0	00:33
WQ136	JUNCTION	0.01	0.32	5641.42	0	00:30
WQ137	JUNCTION	0.00	0.00	0.00	0	00:00
WQ138	JUNCTION	0.00	0.00	0.00	0	00:00
WQ139	JUNCTION	0.00	0.00	0.00	0	00:00
WQ140	JUNCTION	0.00	0.00	0.00	0	00:00
WQ141	JUNCTION	0.00	0.00	0.00	0	00:00
WQ142	JUNCTION	0.00	0.00	0.00	0	00:00
WQ143	JUNCTION	0.00	0.00	0.00	0	00:00
WQ144	JUNCTION	0.00	0.00	0.00	0	00:00
WQ145	JUNCTION	0.00	0.00	0.00	0	00:00
WQ146	JUNCTION	0.00	0.00	0.00	0	00:00
WQ147	JUNCTION	0.00	0.00	0.00	0	00:00
WQ148	JUNCTION	0.00	0.00	0.00	0	00:00
WQ150	JUNCTION	0.04	1.16	5580.36	0	00:30
WQ152	JUNCTION	0.06	1.38	5581.18	0	00:30
WQ153	JUNCTION	0.05	1.32	5617.82	0	00:30
WQ210	JUNCTION	0.00	0.00	0.00	0	00:00

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SWMM Water Quality Event Output

WQ211	JUNCTION	0.00	0.00	0.00	0	00:00
WQ213	JUNCTION	0.05	1.34	5564.94	0	00:35
WQ215	JUNCTION	0.06	1.64	5587.14	0	00:30
WQ216	JUNCTION	0.00	0.00	0.00	0	00:00
WQ217	JUNCTION	0.00	0.00	0.00	0	00:00
WQ218	JUNCTION	0.00	0.00	0.00	0	00:00
WQ219	JUNCTION	0.00	0.00	0.00	0	00:00
WQ220	JUNCTION	0.00	0.00	0.00	0	00:00
WQ221	JUNCTION	0.00	0.00	0.00	0	00:00
WQ222	JUNCTION	0.00	0.00	0.00	0	00:00
WQ223	JUNCTION	0.00	0.00	0.00	0	00:00
WQ224	JUNCTION	0.00	0.00	5505.60	0	00:00
WQ226	JUNCTION	0.08	1.61	5531.61	0	00:36
WQ227	JUNCTION	0.04	0.95	5564.95	0	00:35
WQ228	JUNCTION	0.00	0.00	5599.40	0	00:00
WQ229	JUNCTION	0.05	1.11	5600.41	0	00:35
WQ230	JUNCTION	0.00	0.00	0.00	0	00:00
WQ231	JUNCTION	0.00	0.00	0.00	0	00:00
WQ232	JUNCTION	0.00	0.00	0.00	0	00:00
WQ236	JUNCTION	0.04	0.96	5552.66	0	00:30
WQ237	JUNCTION	0.00	0.00	0.00	0	00:00
WQ238	JUNCTION	0.00	0.00	0.00	0	00:00
WQ239	JUNCTION	0.00	0.00	0.00	0	00:00
WQ240	JUNCTION	0.00	0.00	0.00	0	00:00
WQ241	JUNCTION	0.00	0.00	0.00	0	00:00
WQ242	JUNCTION	0.00	0.00	0.00	0	00:00
WQ243	JUNCTION	0.00	0.00	0.00	0	00:00
WQ244	JUNCTION	0.00	0.00	0.00	0	00:00
WQ246	JUNCTION	0.02	0.39	5538.59	0	00:40
WQ247	JUNCTION	0.00	0.00	0.00	0	00:00
WQ248	JUNCTION	0.00	0.00	0.00	0	00:00
WQ249	JUNCTION	0.00	0.00	0.00	0	00:00
WQ250	JUNCTION	0.00	0.00	0.00	0	00:00
WQ257	JUNCTION	0.00	0.00	0.00	0	00:00
WQ258	JUNCTION	0.00	0.00	0.00	0	00:00
WQ259	JUNCTION	0.00	0.00	0.00	0	00:00
WQ261	JUNCTION	0.00	0.00	5530.10	0	00:00
WQ262	JUNCTION	0.03	0.61	5530.61	0	00:35
WQ263	JUNCTION	0.00	0.00	0.00	0	00:00
WQ311	JUNCTION	0.00	0.06	5508.16	0	00:35
WQ312	JUNCTION	0.00	0.00	0.00	0	00:00
WQ313	JUNCTION	0.00	0.00	0.00	0	00:00
WQ314	JUNCTION	0.00	0.00	0.00	0	00:00
WQ315	JUNCTION	0.00	0.00	0.00	0	00:00
WQ316	JUNCTION	0.00	0.00	0.00	0	00:00
WQ317	JUNCTION	0.00	0.00	0.00	0	00:00
WQ319	JUNCTION	0.04	0.96	5549.66	0	00:30
WQ323	JUNCTION	0.03	0.75	5547.55	0	00:35
WQ325	JUNCTION	0.00	0.00	0.00	0	00:00
WQ326	JUNCTION	0.00	0.00	0.00	0	00:00
WQ327	JUNCTION	0.00	0.00	0.00	0	00:00
WQ328	JUNCTION	0.00	0.00	0.00	0	00:00
WQ329	JUNCTION	0.00	0.00	0.00	0	00:00
WQ330	JUNCTION	0.00	0.00	0.00	0	00:00
WQ331	JUNCTION	0.00	0.00	0.00	0	00:00
WQ332	JUNCTION	0.00	0.00	0.00	0	00:00
WQ333	JUNCTION	0.00	0.00	0.00	0	00:00

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SWMM Water Quality Event Output

WQ334	JUNCTION	0.00	0.00	0.00	0	00:00
WQ335	JUNCTION	0.00	0.00	0.00	0	00:00
WQ336	JUNCTION	0.00	0.00	0.00	0	00:00
WQ337	JUNCTION	0.00	0.00	0.00	0	00:00
WQ338	JUNCTION	0.00	0.00	0.00	0	00:00
WQ339	JUNCTION	0.00	0.00	0.00	0	00:00
WQ340	JUNCTION	0.00	0.00	0.00	0	00:00
WQ341	JUNCTION	0.00	0.00	0.00	0	00:00
WQ342	JUNCTION	0.00	0.00	0.00	0	00:00
WQ343	JUNCTION	0.00	0.00	0.00	0	00:00
WQ344	JUNCTION	0.00	0.00	0.00	0	00:00
WQ345	JUNCTION	0.00	0.00	0.00	0	00:00
WQ346	JUNCTION	0.00	0.00	0.00	0	00:00
WQ347	JUNCTION	0.00	0.00	0.00	0	00:00
WQ348	JUNCTION	0.00	0.00	0.00	0	00:00
WQ349	JUNCTION	0.00	0.00	0.00	0	00:00
WQ350	JUNCTION	0.00	0.00	0.00	0	00:00
WQ351	JUNCTION	0.00	0.00	0.00	0	00:00
WQ352	JUNCTION	0.00	0.00	0.00	0	00:00
WQ353	JUNCTION	0.00	0.00	0.00	0	00:00
WQ354	JUNCTION	0.00	0.00	0.00	0	00:00
WQ355	JUNCTION	0.00	0.00	0.00	0	00:00
WQ356	JUNCTION	0.00	0.00	0.00	0	00:00
WQ357	JUNCTION	0.00	0.00	0.00	0	00:00
WQ358	JUNCTION	0.00	0.00	0.00	0	00:00
WQ360	JUNCTION	0.00	0.00	0.00	0	00:00
WQ364	JUNCTION	0.00	0.00	5475.00	0	00:00
WQ367	JUNCTION	0.00	0.00	5463.00	0	00:00
WQ368	JUNCTION	0.00	0.00	5484.60	0	00:00
WQ369	JUNCTION	0.08	0.98	5485.48	0	00:44
WQ370	JUNCTION	0.05	0.80	5505.80	0	00:41
WQ371	JUNCTION	0.03	0.72	5506.82	0	00:35
WQ372	JUNCTION	0.02	0.47	5562.17	0	00:55
WQ373	JUNCTION	0.02	0.43	5571.33	0	00:35
WQ374	JUNCTION	0.00	0.00	0.00	0	00:00
WQ410	JUNCTION	0.00	0.00	0.00	0	00:00
WQ411	JUNCTION	0.00	0.00	0.00	0	00:00
WQ412	JUNCTION	0.00	0.00	0.00	0	00:00
WQ413	JUNCTION	0.00	0.00	5461.20	0	00:00
WQ415	JUNCTION	0.07	1.86	5515.06	0	00:30
WQ417	JUNCTION	0.05	1.24	5519.74	0	00:35
WQ418	JUNCTION	0.00	0.00	0.00	0	00:00
WQ420	JUNCTION	0.22	3.12	5461.12	0	00:35
WQ421	JUNCTION	0.00	0.00	5458.10	0	00:00
WQ422	JUNCTION	0.15	1.92	5480.32	0	00:36
WQ423	JUNCTION	0.11	1.67	5510.67	0	00:33
WQ424	JUNCTION	0.03	0.94	5582.94	0	00:30
WQ510	JUNCTION	0.00	0.00	0.00	0	00:00
WQ511	JUNCTION	0.00	0.00	0.00	0	00:00
WQ512	JUNCTION	0.00	0.00	0.00	0	00:00
WQ513	JUNCTION	0.00	0.00	0.00	0	00:00
WQ514	JUNCTION	0.00	0.00	0.00	0	00:00
WQ515	JUNCTION	0.00	0.00	0.00	0	00:00
WQ516	JUNCTION	0.00	0.00	0.00	0	00:00
WQ517	JUNCTION	0.00	0.00	0.00	0	00:00
WQ519	JUNCTION	0.14	2.70	5462.80	0	00:38
WQ521	JUNCTION	0.00	0.00	0.00	0	00:00

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SWMM Water Quality Event Output

WQ610	JUNCTION	0.00	0.00	0.00	0	00:00
WQ611	JUNCTION	0.00	0.00	0.00	0	00:00
WQ612	JUNCTION	0.00	0.00	0.00	0	00:00
WQ613	JUNCTION	0.10	1.71	5435.01	0	00:41
WQ615	JUNCTION	0.10	1.72	5442.62	0	00:37
WQ617	JUNCTION	0.03	0.80	5448.60	0	00:30
WQ619	JUNCTION	0.03	0.72	5456.32	0	00:30
WQ623	JUNCTION	0.00	0.00	0.00	0	00:00
WQ710	JUNCTION	0.00	0.00	0.00	0	00:00
WQ712	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ713	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ714	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ715	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ716	JUNCTION	0.06	1.62	5448.02	0	00:30
WQ717	JUNCTION	0.05	1.33	5448.13	0	00:30
WQ718	JUNCTION	0.00	0.00	5446.90	0	00:00
WQ719	JUNCTION	0.41	0.87	5457.47	0	00:55
WQ720	JUNCTION	0.51	2.53	5459.03	0	00:50
WQ721	JUNCTION	0.04	0.99	5470.99	0	00:35
WQ722	JUNCTION	0.03	0.25	5475.65	0	00:30
WQ723	JUNCTION	0.00	0.00	5475.50	0	00:00
WQ724	JUNCTION	0.00	0.00	5460.10	0	00:00
WQ725	JUNCTION	0.40	3.21	5463.21	0	00:33
WQ726	JUNCTION	0.46	3.13	5461.63	0	00:37
WQ727	JUNCTION	0.03	0.06	5472.56	0	00:56
WQ728	JUNCTION	0.00	0.00	5472.70	0	00:00
WQ729	JUNCTION	0.08	2.09	5463.09	0	00:30
WQ730	JUNCTION	0.00	0.00	5472.70	0	00:00
WQ731	JUNCTION	0.00	0.00	5470.00	0	00:00
WQ732	JUNCTION	0.00	0.00	5470.00	0	00:00
WQ733	JUNCTION	0.00	0.00	5460.10	0	00:00
WQ745	JUNCTION	0.00	0.00	0.00	0	00:00
WQ747	JUNCTION	0.00	0.00	5424.10	0	00:00
WQ748	JUNCTION	0.00	0.00	0.00	0	00:00
WQ750	JUNCTION	0.06	1.54	5434.94	0	00:30
WQ751	JUNCTION	0.00	0.00	0.00	0	00:00
WQ112	OUTFALL	0.00	0.03	5183.83	0	00:55
WQ114	OUTFALL	0.01	0.16	5144.96	0	00:55
WQ117	OUTFALL	0.06	0.65	5543.05	0	00:43
WQ126	OUTFALL	0.03	0.21	5538.81	0	00:58
WQ133	OUTFALL	0.04	0.70	5529.30	0	00:32
WQ149	OUTFALL	0.05	1.15	5517.65	0	00:31
WQ151	OUTFALL	0.06	1.38	5515.48	0	00:31
WQ212	OUTFALL	0.06	1.32	5528.62	0	00:37
WQ214	OUTFALL	0.07	1.55	5514.05	0	00:35
WQ225	OUTFALL	0.08	1.60	5507.10	0	00:38
WQ233	OUTFALL	0.11	2.28	5507.88	0	00:38
WQ245	OUTFALL	0.02	0.50	5499.60	0	00:55
WQ260	OUTFALL	0.04	0.74	5483.34	0	00:55
WQ310	OUTFALL	0.00	0.07	5480.77	0	00:55
WQ318	OUTFALL	0.05	0.95	5485.35	0	00:36
WQ320	OUTFALL	0.10	1.75	5481.45	0	00:25
WQ361	OUTFALL	0.14	4.00	5484.60	0	00:55
WQ363	OUTFALL	0.14	3.46	5469.56	0	00:40
WQ366	OUTFALL	0.09	1.02	5463.92	0	00:55
WQ414	OUTFALL	0.11	1.68	5462.78	0	00:40
WQ416	OUTFALL	0.06	1.23	5460.33	0	00:37

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SWMM Water Quality Event Output

WQ419	OUTFALL	0.22	3.11	5455.21	0 00:36
WQ518	OUTFALL	0.08	1.57	5439.67	0 00:39
WQ614	OUTFALL	0.11	2.00	5435.20	0 00:32
WQ618	OUTFALL	0.04	0.75	5433.75	0 00:55
WQ620	OUTFALL	0.14	2.00	5429.00	0 00:26
WQ711	OUTFALL	0.00	0.00	5439.90	0 00:00
WQ746	OUTFALL	0.00	0.00	5424.00	0 00:00
WQ749	OUTFALL	0.07	1.52	5425.12	0 00:33
WQ234	DIVIDER	0.11	3.00	5546.10	0 00:31
WQ235	DIVIDER	0.10	3.00	5550.70	0 00:27
WQ321	DIVIDER	0.10	1.75	5494.75	0 00:23
WQ322	DIVIDER	0.09	1.75	5521.25	0 00:25
WQ324	DIVIDER	0.04	1.14	5558.94	0 00:30
WQ362	DIVIDER	0.11	3.22	5493.72	0 00:40
WQ365	DIVIDER	0.13	3.49	5478.39	0 00:35
WQ520	DIVIDER	0.11	2.77	5469.27	0 00:30
WQ616	DIVIDER	0.09	2.00	5456.80	0 00:26
WQ621	DIVIDER	0.13	2.00	5454.60	0 00:23
WQ622	DIVIDER	0.08	1.75	5478.95	0 00:24
WQ744	DIVIDER	0.01	0.28	5470.18	0 00:30
STO711	STORAGE	1.03	6.12	5446.12	0 01:16
STO714	STORAGE	0.08	0.35	5440.55	0 00:55
STO715	STORAGE	0.07	0.38	5440.58	0 00:55
STO719	STORAGE	0.24	0.86	5457.56	0 00:55
STO722	STORAGE	0.09	0.35	5475.85	0 00:55
STO725	STORAGE	0.00	0.00	5460.10	0 00:00
STO726	STORAGE	0.24	0.74	5459.34	0 00:55
STO727	STORAGE	0.25	0.55	5473.15	0 00:56
STO733	STORAGE	0.04	0.19	5460.39	0 00:55

****
Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
7160	JUNCTION	0.00	36.15	0 00:30	0.000	0.344
7170	JUNCTION	0.00	28.23	0 00:30	0.000	0.261
7171	JUNCTION	0.00	28.23	0 00:30	0.000	0.260
7200	JUNCTION	0.00	131.27	0 00:51	0.000	2.955
7201	JUNCTION	0.00	131.20	0 00:51	0.000	2.952
7202	JUNCTION	0.00	131.22	0 00:51	0.000	2.950
7203	JUNCTION	0.00	130.79	0 00:53	0.000	2.949
7210	JUNCTION	0.00	52.05	0 00:55	0.000	0.738
7211	JUNCTION	0.00	50.67	0 00:56	0.000	0.738
7222	JUNCTION	0.00	45.20	0 00:46	0.000	0.745
7260	JUNCTION	0.00	102.04	0 00:38	0.000	1.566
7261	JUNCTION	0.00	80.43	0 00:50	0.000	1.674
WQ110	JUNCTION	0.19	0.19	0 00:45	0.002	0.002
WQ111	JUNCTION	0.03	0.03	0 00:40	0.000	0.000
WQ113	JUNCTION	0.65	0.65	0 00:35	0.008	0.008
WQ115	JUNCTION	9.43	9.43	0 00:35	0.117	0.117
WQ116	JUNCTION	1.24	1.24	0 00:40	0.015	0.015
WQ118	JUNCTION	11.48	11.48	0 00:35	0.142	0.142

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SWMM Water Quality Event Output

WQ119	JUNCTION	1.43	1.43	0 00:40	0.018	0.018
WQ120	JUNCTION	58.91	62.30	0 00:35	0.540	1.092
WQ121	JUNCTION	10.51	28.67	0 00:41	0.121	0.427
WQ122	JUNCTION	9.53	9.53	0 00:30	0.099	0.099
WQ123	JUNCTION	15.00	21.45	0 00:38	0.188	0.301
WQ124	JUNCTION	8.58	8.58	0 00:35	0.107	0.107
WQ125	JUNCTION	7.56	7.56	0 00:35	0.095	0.095
WQ127	JUNCTION	6.62	6.82	0 00:35	0.084	0.137
WQ128	JUNCTION	3.27	3.27	0 00:35	0.042	0.042
WQ129	JUNCTION	0.17	0.17	0 00:45	0.002	0.002
WQ130	JUNCTION	0.55	0.55	0 00:40	0.007	0.007
WQ131	JUNCTION	0.25	0.25	0 00:40	0.003	0.003
WQ132	JUNCTION	0.02	0.02	0 00:45	0.000	0.000
WQ134	JUNCTION	93.91	93.91	0 00:30	0.814	0.814
WQ135	JUNCTION	47.21	52.27	0 00:33	0.436	0.650
WQ136	JUNCTION	16.99	16.99	0 00:30	0.202	0.202
WQ137	JUNCTION	5.66	5.66	0 00:35	0.072	0.072
WQ138	JUNCTION	13.84	13.84	0 00:30	0.161	0.161
WQ139	JUNCTION	1.58	1.58	0 00:45	0.019	0.019
WQ140	JUNCTION	5.75	5.75	0 00:30	0.072	0.072
WQ141	JUNCTION	11.76	11.76	0 00:35	0.146	0.146
WQ142	JUNCTION	41.61	41.61	0 00:30	0.431	0.431
WQ143	JUNCTION	46.27	46.27	0 00:35	0.487	0.487
WQ144	JUNCTION	51.47	51.47	0 00:30	0.478	0.478
WQ145	JUNCTION	16.52	16.52	0 00:35	0.204	0.204
WQ146	JUNCTION	19.11	19.11	0 00:30	0.193	0.193
WQ147	JUNCTION	53.59	53.59	0 00:30	0.543	0.543
WQ148	JUNCTION	35.88	35.88	0 00:30	0.317	0.317
WQ150	JUNCTION	59.34	59.34	0 00:30	0.533	0.533
WQ152	JUNCTION	47.86	117.76	0 00:30	0.417	1.049
WQ153	JUNCTION	73.27	73.27	0 00:30	0.637	0.637
WQ210	JUNCTION	66.31	66.31	0 00:30	0.606	0.606
WQ211	JUNCTION	45.43	45.43	0 00:35	0.476	0.476
WQ213	JUNCTION	52.57	52.57	0 00:35	0.558	0.558
WQ215	JUNCTION	59.41	59.41	0 00:30	0.530	0.530
WQ216	JUNCTION	16.91	16.91	0 00:30	0.180	0.180
WQ217	JUNCTION	14.80	14.80	0 00:30	0.167	0.167
WQ218	JUNCTION	9.81	9.81	0 00:30	0.105	0.105
WQ219	JUNCTION	28.28	28.28	0 00:30	0.295	0.295
WQ220	JUNCTION	16.06	16.06	0 00:25	0.141	0.141
WQ221	JUNCTION	39.58	39.58	0 00:25	0.290	0.290
WQ222	JUNCTION	16.72	16.72	0 00:25	0.153	0.153
WQ223	JUNCTION	39.32	39.32	0 00:30	0.390	0.390
WQ224	JUNCTION	47.43	47.43	0 00:30	0.497	0.497
WQ226	JUNCTION	16.89	79.88	0 00:36	0.203	0.962
WQ227	JUNCTION	24.53	24.53	0 00:35	0.286	0.286
WQ228	JUNCTION	21.34	21.34	0 00:35	0.252	0.252
WQ229	JUNCTION	18.79	40.13	0 00:35	0.224	0.476
WQ230	JUNCTION	42.07	42.07	0 00:25	0.374	0.374
WQ231	JUNCTION	22.61	22.61	0 00:30	0.237	0.237
WQ232	JUNCTION	29.47	29.47	0 00:30	0.303	0.303
WQ236	JUNCTION	12.41	12.41	0 00:30	0.143	0.143
WQ237	JUNCTION	15.59	15.59	0 00:30	0.183	0.183
WQ238	JUNCTION	27.12	27.12	0 00:35	0.305	0.305
WQ239	JUNCTION	16.39	16.39	0 00:30	0.184	0.184
WQ240	JUNCTION	23.23	23.23	0 00:30	0.228	0.228
WQ241	JUNCTION	27.98	27.98	0 00:30	0.280	0.280

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SWMM Water Quality Event Output

WQ242	JUNCTION	25.44	25.44	0 00:30	0.269	0.269
WQ243	JUNCTION	20.54	20.54	0 00:30	0.225	0.225
WQ244	JUNCTION	31.86	31.86	0 00:30	0.322	0.322
WQ246	JUNCTION	1.90	1.90	0 00:40	0.023	0.023
WQ247	JUNCTION	13.64	13.64	0 00:30	0.149	0.149
WQ248	JUNCTION	15.68	15.68	0 00:35	0.193	0.193
WQ249	JUNCTION	2.13	2.13	0 00:40	0.026	0.026
WQ250	JUNCTION	18.87	18.87	0 00:30	0.213	0.213
WQ257	JUNCTION	7.99	7.99	0 00:30	0.096	0.096
WQ258	JUNCTION	3.36	3.36	0 00:35	0.041	0.041
WQ259	JUNCTION	6.23	6.23	0 00:35	0.076	0.076
WQ261	JUNCTION	13.31	13.31	0 00:35	0.163	0.163
WQ262	JUNCTION	14.46	27.77	0 00:35	0.178	0.340
WQ263	JUNCTION	8.35	8.35	0 00:30	0.093	0.093
WQ311	JUNCTION	25.48	25.48	0 00:35	0.295	0.295
WQ312	JUNCTION	40.42	40.42	0 00:30	0.375	0.375
WQ313	JUNCTION	28.07	28.07	0 00:35	0.315	0.315
WQ314	JUNCTION	1.87	1.87	0 00:40	0.023	0.023
WQ315	JUNCTION	19.36	19.36	0 00:30	0.192	0.192
WQ316	JUNCTION	17.42	17.42	0 00:30	0.178	0.178
WQ317	JUNCTION	15.18	15.18	0 00:35	0.178	0.178
WQ319	JUNCTION	18.60	18.60	0 00:30	0.211	0.211
WQ323	JUNCTION	8.51	8.51	0 00:35	0.097	0.097
WQ325	JUNCTION	13.40	13.40	0 00:35	0.155	0.155
WQ326	JUNCTION	23.46	23.46	0 00:35	0.269	0.269
WQ327	JUNCTION	13.46	13.46	0 00:30	0.143	0.143
WQ328	JUNCTION	6.95	6.95	0 00:30	0.082	0.082
WQ329	JUNCTION	2.68	2.68	0 00:30	0.030	0.030
WQ330	JUNCTION	3.82	3.82	0 00:35	0.046	0.046
WQ331	JUNCTION	6.86	6.86	0 00:40	0.078	0.078
WQ332	JUNCTION	5.33	5.33	0 00:35	0.065	0.065
WQ333	JUNCTION	3.23	3.23	0 00:40	0.040	0.040
WQ334	JUNCTION	4.33	4.33	0 00:35	0.053	0.053
WQ335	JUNCTION	1.28	1.28	0 00:40	0.016	0.016
WQ336	JUNCTION	28.11	28.11	0 00:35	0.316	0.316
WQ337	JUNCTION	18.03	18.03	0 00:35	0.212	0.212
WQ338	JUNCTION	26.69	26.69	0 00:40	0.304	0.304
WQ339	JUNCTION	45.15	45.15	0 00:35	0.502	0.502
WQ340	JUNCTION	11.90	11.90	0 00:30	0.134	0.134
WQ341	JUNCTION	10.64	10.64	0 00:30	0.118	0.118
WQ342	JUNCTION	15.27	15.27	0 00:35	0.170	0.170
WQ343	JUNCTION	76.61	76.61	0 00:35	0.796	0.796
WQ344	JUNCTION	28.95	28.95	0 00:30	0.301	0.301
WQ345	JUNCTION	11.81	11.81	0 00:35	0.134	0.134
WQ346	JUNCTION	27.36	27.36	0 00:35	0.315	0.315
WQ347	JUNCTION	4.46	4.46	0 00:30	0.054	0.054
WQ348	JUNCTION	29.72	29.72	0 00:30	0.306	0.306
WQ349	JUNCTION	25.74	25.74	0 00:30	0.284	0.284
WQ350	JUNCTION	41.50	41.50	0 00:35	0.448	0.448
WQ351	JUNCTION	50.70	50.70	0 00:25	0.455	0.455
WQ352	JUNCTION	92.05	92.05	0 00:40	0.975	0.975
WQ353	JUNCTION	160.27	160.27	0 00:35	1.625	1.625
WQ354	JUNCTION	96.77	96.77	0 00:35	0.979	0.979
WQ355	JUNCTION	53.34	53.34	0 00:30	0.474	0.474
WQ356	JUNCTION	18.92	18.92	0 00:30	0.191	0.191
WQ357	JUNCTION	0.01	0.01	0 00:55	0.000	0.000
WQ358	JUNCTION	3.15	3.15	0 00:45	0.037	0.037

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SWMM Water Quality Event Output

WQ360	JUNCTION	22.38	22.38	0 00:40	0.255	0.255
WQ364	JUNCTION	11.66	11.66	0 00:30	0.133	0.133
WQ367	JUNCTION	32.50	32.50	0 00:30	0.334	0.334
WQ368	JUNCTION	6.19	6.19	0 00:35	0.071	0.071
WQ369	JUNCTION	56.85	86.03	0 00:44	0.591	1.368
WQ370	JUNCTION	26.44	50.33	0 00:41	0.292	0.689
WQ371	JUNCTION	18.24	18.24	0 00:35	0.220	0.220
WQ372	JUNCTION	1.86	15.67	0 00:55	0.023	0.171
WQ373	JUNCTION	12.05	12.05	0 00:35	0.148	0.148
WQ374	JUNCTION	6.81	6.81	0 00:40	0.080	0.080
WQ410	JUNCTION	23.62	23.62	0 00:30	0.244	0.244
WQ411	JUNCTION	32.59	32.59	0 00:35	0.376	0.376
WQ412	JUNCTION	9.83	9.83	0 00:30	0.096	0.096
WQ413	JUNCTION	9.24	9.24	0 00:30	0.105	0.105
WQ415	JUNCTION	61.38	61.38	0 00:30	0.570	0.570
WQ417	JUNCTION	35.63	35.63	0 00:35	0.394	0.394
WQ418	JUNCTION	75.34	75.34	0 00:25	0.517	0.517
WQ420	JUNCTION	69.73	266.17	0 00:35	0.723	3.157
WQ421	JUNCTION	72.49	72.49	0 00:30	0.687	0.687
WQ422	JUNCTION	49.11	138.31	0 00:36	0.513	1.756
WQ423	JUNCTION	93.66	96.48	0 00:33	0.866	1.226
WQ424	JUNCTION	32.58	32.58	0 00:30	0.300	0.300
WQ510	JUNCTION	11.60	11.60	0 00:40	0.135	0.135
WQ511	JUNCTION	43.77	43.77	0 00:35	0.472	0.472
WQ512	JUNCTION	20.95	20.95	0 00:30	0.231	0.231
WQ513	JUNCTION	15.51	15.51	0 00:30	0.165	0.165
WQ514	JUNCTION	32.81	32.81	0 00:35	0.367	0.367
WQ515	JUNCTION	21.77	21.77	0 00:40	0.251	0.251
WQ516	JUNCTION	8.65	8.65	0 00:45	0.098	0.098
WQ517	JUNCTION	14.78	14.78	0 00:30	0.160	0.160
WQ519	JUNCTION	9.41	82.23	0 00:38	0.114	0.902
WQ521	JUNCTION	13.64	13.64	0 00:30	0.145	0.145
WQ610	JUNCTION	22.37	22.37	0 00:35	0.242	0.242
WQ611	JUNCTION	13.57	13.57	0 00:40	0.158	0.158
WQ612	JUNCTION	16.44	16.44	0 00:30	0.170	0.170
WQ613	JUNCTION	14.92	47.09	0 00:39	0.163	0.605
WQ615	JUNCTION	16.40	36.17	0 00:37	0.190	0.443
WQ617	JUNCTION	23.48	23.48	0 00:30	0.245	0.245
WQ619	JUNCTION	25.56	25.56	0 00:30	0.273	0.273
WQ623	JUNCTION	102.34	102.34	0 00:30	0.899	0.899
WQ710	JUNCTION	75.77	75.77	0 00:30	0.727	0.727
WQ712	JUNCTION	18.30	18.30	0 00:30	0.189	0.189
WQ713	JUNCTION	19.40	19.40	0 00:35	0.211	0.211
WQ714	JUNCTION	0.00	1.75	0 00:55	0.000	0.132
WQ715	JUNCTION	0.00	2.65	0 00:55	0.000	0.156
WQ716	JUNCTION	36.25	36.25	0 00:30	0.345	0.345
WQ717	JUNCTION	26.18	28.44	0 00:30	0.240	0.261
WQ718	JUNCTION	2.57	2.57	0 00:25	0.021	0.021
WQ719	JUNCTION	0.00	3.43	0 00:55	0.000	0.312
WQ720	JUNCTION	24.42	90.94	0 00:49	0.228	2.212
WQ721	JUNCTION	34.39	34.39	0 00:35	0.366	0.366
WQ722	JUNCTION	0.00	22.53	0 00:30	0.000	0.341
WQ723	JUNCTION	21.60	21.60	0 00:30	0.210	0.210
WQ724	JUNCTION	17.91	17.91	0 00:30	0.166	0.166
WQ725	JUNCTION	0.00	104.62	0 00:33	0.000	1.315
WQ726	JUNCTION	0.00	102.06	0 00:37	0.000	1.569
WQ727	JUNCTION	0.00	1.49	0 00:56	0.000	0.164

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SWMM Water Quality Event Output

WQ728	JUNCTION	9.54	9.54	0 00:25	0.059	0.059
WQ729	JUNCTION	43.85	91.71	0 00:30	0.443	0.907
WQ730	JUNCTION	5.80	5.80	0 00:25	0.038	0.038
WQ731	JUNCTION	24.47	24.47	0 00:30	0.247	0.247
WQ732	JUNCTION	0.76	0.76	0 00:30	0.008	0.008
WQ733	JUNCTION	0.00	1.14	0 00:55	0.000	0.075
WQ745	JUNCTION	3.18	3.18	0 00:40	0.039	0.039
WQ747	JUNCTION	21.58	21.58	0 00:35	0.251	0.251
WQ748	JUNCTION	5.38	5.38	0 00:35	0.065	0.065
WQ750	JUNCTION	37.38	37.38	0 00:30	0.404	0.404
WQ751	JUNCTION	3.39	3.39	0 00:40	0.042	0.042
WQ112	OUTFALL	0.03	0.95	0 00:55	0.000	0.011
WQ114	OUTFALL	0.03	15.64	0 00:55	0.000	0.124
WQ117	OUTFALL	3.39	73.35	0 00:43	0.043	1.334
WQ126	OUTFALL	10.79	13.43	0 00:48	0.135	0.290
WQ133	OUTFALL	2.51	118.08	0 00:35	0.032	1.555
WQ149	OUTFALL	84.47	126.43	0 00:27	0.629	1.161
WQ151	OUTFALL	104.44	203.88	0 00:27	0.781	1.826
WQ212	OUTFALL	31.64	78.35	0 00:36	0.313	0.868
WQ214	OUTFALL	22.14	75.74	0 00:35	0.244	0.778
WQ225	OUTFALL	23.28	143.27	0 00:35	0.248	1.703
WQ233	OUTFALL	24.26	113.89	0 00:38	0.285	1.280
WQ245	OUTFALL	17.79	18.51	0 00:35	0.210	0.233
WQ260	OUTFALL	19.62	39.43	0 00:55	0.214	0.578
WQ310	OUTFALL	21.41	36.90	0 00:36	0.195	0.493
WQ318	OUTFALL	18.99	36.91	0 00:36	0.218	0.429
WQ320	OUTFALL	12.03	58.43	0 00:42	0.136	0.780
WQ361	OUTFALL	39.65	118.06	0 00:43	0.434	1.344
WQ363	OUTFALL	36.78	185.49	0 00:37	0.398	2.018
WQ366	OUTFALL	21.45	111.55	0 00:48	0.238	1.964
WQ414	OUTFALL	8.95	63.18	0 00:40	0.110	0.840
WQ416	OUTFALL	40.23	65.99	0 00:32	0.378	0.771
WQ419	OUTFALL	100.71	351.27	0 00:35	0.940	4.085
WQ518	OUTFALL	9.53	89.07	0 00:39	0.102	1.002
WQ614	OUTFALL	28.60	98.54	0 00:39	0.325	1.353
WQ618	OUTFALL	77.21	81.08	0 00:35	0.725	1.025
WQ620	OUTFALL	58.28	106.05	0 00:41	0.582	1.678
WQ711	OUTFALL	0.00	65.53	0 01:16	0.000	4.377
WQ746	OUTFALL	24.85	44.87	0 00:30	0.262	0.513
WQ749	OUTFALL	14.05	49.80	0 00:34	0.165	0.570
WQ234	DIVIDER	29.74	94.15	0 00:30	0.277	0.989
WQ235	DIVIDER	61.71	61.71	0 00:30	0.552	0.552
WQ321	DIVIDER	11.06	51.61	0 00:37	0.116	0.626
WQ322	DIVIDER	16.39	45.19	0 00:31	0.168	0.501
WQ324	DIVIDER	22.11	22.11	0 00:30	0.237	0.237
WQ362	DIVIDER	88.89	88.89	0 00:40	0.916	0.916
WQ365	DIVIDER	141.64	153.06	0 00:35	1.486	1.619
WQ520	DIVIDER	76.06	76.06	0 00:30	0.778	0.778
WQ616	DIVIDER	33.19	33.19	0 00:35	0.373	0.373
WQ621	DIVIDER	49.23	77.08	0 00:37	0.444	1.034
WQ622	DIVIDER	54.51	54.51	0 00:35	0.570	0.570
WQ744	DIVIDER	23.10	48.32	0 00:30	0.209	0.464
STO711	STORAGE	12.19	186.52	0 00:50	0.134	4.391
STO714	STORAGE	15.76	15.76	0 00:25	0.133	0.133
STO715	STORAGE	24.53	24.53	0 00:25	0.157	0.157
STO719	STORAGE	41.19	41.19	0 00:25	0.319	0.319
STO722	STORAGE	17.34	17.34	0 00:25	0.133	0.133

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SWMM Water Quality Event Output

STO725	STORAGE	6.33	6.33	0 00:30	0.059	0.059
STO726	STORAGE	38.92	38.92	0 00:25	0.270	0.270
STO727	STORAGE	9.31	21.36	0 00:25	0.095	0.192
STO733	STORAGE	11.14	11.14	0 00:25	0.076	0.076

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Node Surcharge Summary

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Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
WQ110	JUNCTION	12.01	0.000	0.000
WQ111	JUNCTION	12.01	0.000	0.000
WQ116	JUNCTION	12.01	0.000	0.000
WQ125	JUNCTION	12.01	0.000	0.000
WQ129	JUNCTION	12.01	0.000	0.000
WQ130	JUNCTION	12.01	0.000	0.000
WQ131	JUNCTION	12.01	0.000	0.000
WQ132	JUNCTION	12.01	0.000	0.000
WQ137	JUNCTION	12.01	0.000	0.000
WQ138	JUNCTION	12.01	0.000	0.000
WQ139	JUNCTION	12.01	0.000	0.000
WQ140	JUNCTION	12.01	0.000	0.000
WQ141	JUNCTION	12.01	0.000	0.000
WQ142	JUNCTION	12.01	0.000	0.000
WQ143	JUNCTION	12.01	0.000	0.000
WQ144	JUNCTION	12.01	0.000	0.000
WQ145	JUNCTION	12.01	0.000	0.000
WQ146	JUNCTION	12.01	0.000	0.000
WQ147	JUNCTION	12.01	0.000	0.000
WQ148	JUNCTION	12.01	0.000	0.000
WQ210	JUNCTION	12.01	0.000	0.000
WQ211	JUNCTION	12.01	0.000	0.000
WQ216	JUNCTION	12.01	0.000	0.000
WQ217	JUNCTION	12.01	0.000	0.000
WQ218	JUNCTION	12.01	0.000	0.000
WQ219	JUNCTION	12.01	0.000	0.000
WQ220	JUNCTION	12.01	0.000	0.000
WQ221	JUNCTION	12.01	0.000	0.000
WQ222	JUNCTION	12.01	0.000	0.000
WQ223	JUNCTION	12.01	0.000	0.000
WQ224	JUNCTION	12.01	0.000	0.000
WQ228	JUNCTION	12.01	0.000	0.000
WQ230	JUNCTION	12.01	0.000	0.000
WQ231	JUNCTION	12.01	0.000	0.000
WQ232	JUNCTION	12.01	0.000	0.000
WQ237	JUNCTION	12.01	0.000	0.000
WQ238	JUNCTION	12.01	0.000	0.000
WQ239	JUNCTION	12.01	0.000	0.000
WQ240	JUNCTION	12.01	0.000	0.000
WQ241	JUNCTION	12.01	0.000	0.000
WQ242	JUNCTION	12.01	0.000	0.000
WQ243	JUNCTION	12.01	0.000	0.000
WQ244	JUNCTION	12.01	0.000	0.000

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SWMM Water Quality Event Output

WQ247	JUNCTION	12.01	0.000	0.000
WQ248	JUNCTION	12.01	0.000	0.000
WQ249	JUNCTION	12.01	0.000	0.000
WQ250	JUNCTION	12.01	0.000	0.000
WQ257	JUNCTION	12.01	0.000	0.000
WQ258	JUNCTION	12.01	0.000	0.000
WQ259	JUNCTION	12.01	0.000	0.000
WQ261	JUNCTION	12.01	0.000	0.000
WQ263	JUNCTION	12.01	0.000	0.000
WQ312	JUNCTION	12.01	0.000	0.000
WQ313	JUNCTION	12.01	0.000	0.000
WQ314	JUNCTION	12.01	0.000	0.000
WQ315	JUNCTION	12.01	0.000	0.000
WQ316	JUNCTION	12.01	0.000	0.000
WQ317	JUNCTION	12.01	0.000	0.000
WQ325	JUNCTION	12.01	0.000	0.000
WQ326	JUNCTION	12.01	0.000	0.000
WQ327	JUNCTION	12.01	0.000	0.000
WQ328	JUNCTION	12.01	0.000	0.000
WQ329	JUNCTION	12.01	0.000	0.000
WQ330	JUNCTION	12.01	0.000	0.000
WQ331	JUNCTION	12.01	0.000	0.000
WQ332	JUNCTION	12.01	0.000	0.000
WQ333	JUNCTION	12.01	0.000	0.000
WQ334	JUNCTION	12.01	0.000	0.000
WQ335	JUNCTION	12.01	0.000	0.000
WQ336	JUNCTION	12.01	0.000	0.000
WQ337	JUNCTION	12.01	0.000	0.000
WQ338	JUNCTION	12.01	0.000	0.000
WQ339	JUNCTION	12.01	0.000	0.000
WQ340	JUNCTION	12.01	0.000	0.000
WQ341	JUNCTION	12.01	0.000	0.000
WQ342	JUNCTION	12.01	0.000	0.000
WQ343	JUNCTION	12.01	0.000	0.000
WQ344	JUNCTION	12.01	0.000	0.000
WQ345	JUNCTION	12.01	0.000	0.000
WQ346	JUNCTION	12.01	0.000	0.000
WQ347	JUNCTION	12.01	0.000	0.000
WQ348	JUNCTION	12.01	0.000	0.000
WQ349	JUNCTION	12.01	0.000	0.000
WQ350	JUNCTION	12.01	0.000	0.000
WQ351	JUNCTION	12.01	0.000	0.000
WQ352	JUNCTION	12.01	0.000	0.000
WQ353	JUNCTION	12.01	0.000	0.000
WQ354	JUNCTION	12.01	0.000	0.000
WQ355	JUNCTION	12.01	0.000	0.000
WQ356	JUNCTION	12.01	0.000	0.000
WQ357	JUNCTION	12.01	0.000	0.000
WQ358	JUNCTION	12.01	0.000	0.000
WQ360	JUNCTION	12.01	0.000	0.000
WQ364	JUNCTION	12.01	0.000	0.000
WQ367	JUNCTION	12.01	0.000	0.000
WQ368	JUNCTION	12.01	0.000	0.000
WQ374	JUNCTION	12.01	0.000	0.000
WQ410	JUNCTION	12.01	0.000	0.000
WQ411	JUNCTION	12.01	0.000	0.000
WQ412	JUNCTION	12.01	0.000	0.000

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SWMM Water Quality Event Output

WQ413	JUNCTION	12.01	0.000	0.000
WQ418	JUNCTION	12.01	0.000	0.000
WQ421	JUNCTION	12.01	0.000	0.000
WQ510	JUNCTION	12.01	0.000	0.000
WQ511	JUNCTION	12.01	0.000	0.000
WQ512	JUNCTION	12.01	0.000	0.000
WQ513	JUNCTION	12.01	0.000	0.000
WQ514	JUNCTION	12.01	0.000	0.000
WQ515	JUNCTION	12.01	0.000	0.000
WQ516	JUNCTION	12.01	0.000	0.000
WQ517	JUNCTION	12.01	0.000	0.000
WQ521	JUNCTION	12.01	0.000	0.000
WQ610	JUNCTION	12.01	0.000	0.000
WQ611	JUNCTION	12.01	0.000	0.000
WQ612	JUNCTION	12.01	0.000	0.000
WQ623	JUNCTION	12.01	0.000	0.000
WQ710	JUNCTION	12.01	0.000	0.000
WQ712	JUNCTION	12.01	0.000	0.000
WQ713	JUNCTION	12.01	0.000	0.000
WQ714	JUNCTION	12.01	0.000	0.000
WQ715	JUNCTION	12.01	0.000	0.000
WQ718	JUNCTION	12.01	0.000	0.000
WQ723	JUNCTION	12.01	0.000	0.000
WQ724	JUNCTION	12.01	0.000	0.000
WQ728	JUNCTION	12.01	0.000	0.000
WQ730	JUNCTION	12.01	0.000	0.000
WQ731	JUNCTION	12.01	0.000	0.000
WQ732	JUNCTION	12.01	0.000	0.000
WQ733	JUNCTION	12.01	0.000	0.000
WQ745	JUNCTION	12.01	0.000	0.000
WQ747	JUNCTION	12.01	0.000	0.000
WQ748	JUNCTION	12.01	0.000	0.000
WQ751	JUNCTION	12.01	0.000	0.000
STO714	STORAGE	12.01	0.350	9.650
STO715	STORAGE	12.01	0.379	9.621
STO719	STORAGE	12.01	0.859	9.141
STO722	STORAGE	12.01	0.353	9.647
STO725	STORAGE	12.01	0.000	0.000
STO726	STORAGE	12.01	0.741	9.259
STO727	STORAGE	12.01	0.552	9.448
STO733	STORAGE	12.01	0.190	9.810

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Node Flooding Summary

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Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CFS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 gal	Maximum Ponded Volume 1000 ft3
STO725	0.68	6.32	0 00:30	0.059	0.000

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Storage Volume Summary

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SWMM Water Quality Event Output

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Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
STO711	44.970	1	0	266.731	6	0 01:15	65.53
STO714	3.560	1	0	15.247	4	0 00:55	1.75
STO715	3.002	1	0	16.500	4	0 00:55	2.65
STO719	10.488	2	0	37.437	9	0 00:55	3.43
STO722	3.934	1	0	15.413	4	0 00:55	1.59
STO725	0.000	0	0	0.000	0	0 00:00	0.00
STO726	10.456	2	0	32.304	7	0 00:55	2.47
STO727	10.802	2	0	24.072	6	0 00:55	1.49
STO733	1.692	0	0	8.285	2	0 00:55	1.14

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Outfall Loading Summary

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Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
WQ112	31.58	0.11	0.95	0.011
WQ114	30.67	1.25	15.64	0.124
WQ117	97.92	4.21	73.35	1.334
WQ126	97.92	0.91	13.43	0.290
WQ133	92.85	5.18	118.08	1.555
WQ149	15.82	22.69	126.43	1.161
WQ151	19.15	29.48	203.88	1.826
WQ212	17.42	15.41	78.35	0.868
WQ214	31.37	7.67	75.74	0.778
WQ225	33.52	15.71	143.27	1.703
WQ233	35.67	11.09	113.89	1.280
WQ245	20.47	3.52	18.51	0.233
WQ260	49.27	3.63	39.43	0.578
WQ310	8.33	18.29	36.90	0.493
WQ318	22.35	5.94	36.91	0.429
WQ320	20.96	11.50	58.43	0.780
WQ361	32.27	12.88	118.06	1.344
WQ363	17.35	35.97	185.49	2.018
WQ366	20.61	29.47	111.55	1.964
WQ414	27.62	9.40	63.18	0.840
WQ416	17.49	13.64	65.99	0.771
WQ419	70.85	17.83	351.27	4.085
WQ518	43.79	7.07	89.07	1.002
WQ614	34.21	12.23	98.54	1.353
WQ618	94.52	3.35	81.08	1.025
WQ620	26.58	19.52	106.05	1.678
WQ711	97.85	13.83	65.53	4.377
WQ746	5.55	28.55	44.87	0.513
WQ749	18.11	9.73	49.80	0.570
System	39.04	370.07	2304.38	34.977

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Link Flow Summary

SWMM Water Quality Event Output

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Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
113	CONDUIT	0.95	0 00:55	3.03	0.00	0.00
115	CONDUIT	15.64	0 00:55	9.80	0.00	0.02
118	CONDUIT	16.35	0 00:55	6.01	0.01	0.04
119	CONDUIT	2.16	0 00:55	2.18	0.00	0.01
120	CONDUIT	59.60	0 00:43	4.39	0.02	0.13
121	CONDUIT	27.73	0 00:55	3.13	0.01	0.09
122	CONDUIT	8.85	0 00:55	4.44	0.00	0.03
123	CONDUIT	21.05	0 00:43	3.26	0.01	0.07
124	CONDUIT	12.55	0 00:55	5.26	0.00	0.03
127	CONDUIT	6.69	0 00:58	1.84	0.00	0.04
128	CONDUIT	5.06	0 00:55	1.77	0.01	0.03
134	CONDUIT	89.35	0 00:32	8.65	0.03	0.14
135	CONDUIT	45.78	0 00:42	4.72	0.02	0.10
136	CONDUIT	21.75	0 00:55	5.65	0.01	0.06
150	CONDUIT	58.05	0 00:31	32.58	0.10	0.21
152	CONDUIT	117.68	0 00:31	19.32	0.05	0.15
153	CONDUIT	73.16	0 00:30	27.61	0.07	0.17
213	CONDUIT	51.19	0 00:37	33.86	0.19	0.29
215	CONDUIT	53.68	0 00:35	28.89	0.40	0.44
224	DUMMY	47.43	0 00:30			
226	CONDUIT	79.63	0 00:38	14.83	0.22	0.32
227	CONDUIT	24.10	0 00:37	25.38	0.08	0.19
228	DUMMY	21.34	0 00:35			
229	CONDUIT	40.65	0 00:55	33.78	0.11	0.22
234	CONDUIT	91.26	0 00:38	14.87	0.62	0.56
234_OVERFLOW	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
235	CONDUIT	53.96	0 00:37	17.24	1.08	1.00
235_OVERFLOW	CONDUIT	8.37	0 00:36	4.98	0.00	0.02
236	CONDUIT	12.01	0 00:33	16.20	0.21	0.31
246	CONDUIT	3.05	0 00:55	15.67	0.24	0.26
261	DUMMY	13.31	0 00:35			
262	CONDUIT	39.43	0 00:55	5.96	0.01	0.07
311	CONDUIT	30.83	0 00:55	4.49	0.00	0.00
319	CONDUIT	18.09	0 00:36	27.30	0.31	0.38
321	CONDUIT	18.03	0 00:58	10.54	1.05	1.00
321_OVERFLOW	CONDUIT	32.38	0 00:43	8.31	0.00	0.04
322	CONDUIT	26.58	0 00:50	14.64	1.08	1.00
322_OVERFLOW	CONDUIT	18.50	0 00:38	8.32	0.00	0.03
323	CONDUIT	8.44	0 00:36	21.47	0.38	0.43
324	CONDUIT	21.80	0 00:32	30.07	0.75	0.64
324_OVERFLOW	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
340	CONDUIT	90.62	0 00:55	3.50	0.10	0.33
362	CONDUIT	90.39	0 00:55	19.31	1.00	0.77
362_OVERFLOW	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
364	DUMMY	11.66	0 00:30			
365	CONDUIT	151.76	0 00:40	27.30	0.94	0.77
365_OVERFLOW	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
367	DUMMY	32.50	0 00:30			
368	DUMMY	6.19	0 00:35			
369	CONDUIT	96.14	0 00:55	5.50	0.00	0.05
370	CONDUIT	50.66	0 00:55	6.60	0.00	0.04

SWMM Water Quality Event Output

371	CONDUIT	23.55	0	00:55	6.62	0.00	0.04
372	CONDUIT	14.72	0	00:58	10.24	0.00	0.02
373	CONDUIT	15.67	0	00:55	11.51	0.00	0.02
413	DUMMY	9.24	0	00:30			
415	CHANNEL	46.81	0	00:40	7.30	0.00	0.12
417	CONDUIT	34.85	0	00:37	34.49	0.41	0.45
420	CONDUIT	264.73	0	00:36	12.72	0.21	0.31
421	DUMMY	72.49	0	00:30			
422	CONDUIT	137.31	0	00:38	14.93	0.13	0.24
423	CHANNEL	93.28	0	00:38	3.86	0.00	0.11
424	CHANNEL	25.86	0	00:55	5.15	0.00	0.05
450	CONDUIT	50.67	0	00:56	10.14	0.05	0.16
460	CONDUIT	45.20	0	00:46	4.48	0.03	0.17
475	CONDUIT	45.20	0	00:46	6.69	0.08	0.19
519	CONDUIT	81.97	0	00:39	14.71	0.18	0.29
520	CONDUIT	72.93	0	00:38	16.31	0.57	0.53
520_OVERFLOW	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
613	DUMMY	47.09	0	00:39			
615	CONDUIT	35.63	0	00:41	7.34	0.38	0.43
616	CONDUIT	21.67	0	00:31	17.11	1.08	1.00
616_OVERFLOW	CONDUIT	10.83	0	00:48	6.04	0.00	0.02
617	CONDUIT	20.53	0	00:38	10.08	0.00	0.02
619	CONDUIT	27.62	0	00:55	6.36	0.02	0.12
621	CONDUIT	26.37	0	00:59	11.08	1.07	1.00
621_OVERFLOW	CONDUIT	48.74	0	00:57	10.48	0.00	0.04
622	CONDUIT	20.04	0	00:27	21.06	1.06	1.00
622_OVERFLOW	CONDUIT	29.12	0	00:43	9.10	0.00	0.04
712	DUMMY	18.30	0	00:30			
713	DUMMY	19.40	0	00:35			
714	DUMMY	1.75	0	00:55			
715	DUMMY	2.65	0	00:55			
716	CONDUIT	36.15	0	00:30	10.45	0.23	0.32
717	CONDUIT	28.23	0	00:30	9.21	0.10	0.21
718	DUMMY	2.57	0	00:25			
719	CONDUIT	3.43	0	00:56	2.17	0.23	0.33
721	CONDUIT	37.27	0	00:55	5.99	0.04	0.18
722	CONDUIT	20.33	0	00:37	4.99	0.09	0.23
723	DUMMY	21.60	0	00:30			
724	DUMMY	17.91	0	00:30			
725	CONDUIT	99.95	0	00:37	4.93	0.21	0.31
726	CONDUIT	102.04	0	00:38	4.96	0.12	0.24
727	CONDUIT	1.05	0	01:27	0.90	0.00	0.03
728	DUMMY	9.54	0	00:25			
729	CONDUIT	87.93	0	00:33	3.32	0.15	0.41
730	DUMMY	5.80	0	00:25			
731	DUMMY	24.47	0	00:30			
732	DUMMY	0.76	0	00:30			
733	DUMMY	1.14	0	00:55			
744	CONDUIT	48.01	0	00:30	9.13	0.12	0.28
747	DUMMY	21.58	0	00:35			
750	CONDUIT	36.15	0	00:33	20.14	0.30	0.38
7160	CONDUIT	31.91	0	00:37	4.78	0.03	0.19
7170	CONDUIT	28.23	0	00:30	6.19	0.23	0.33
7171	CONDUIT	26.11	0	00:34	4.32	0.16	0.33
7200	CONDUIT	131.20	0	00:51	19.92	0.04	0.14
7201	CONDUIT	131.22	0	00:51	11.38	0.09	0.20
7202	CONDUIT	130.79	0	00:53	4.71	0.09	0.31

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SWMM Water Quality Event Output

7203	CONDUIT	130.82	0	00:53	9.47	0.22	0.32
7260	CONDUIT	80.43	0	00:50	2.43	0.25	0.50
7261	CONDUIT	80.25	0	00:50	4.63	0.10	0.21
744_OVERFLOW	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
OUT711	DUMMY	65.53	0	01:16			
OUT714	DUMMY	1.75	0	00:55			
OUT715	DUMMY	2.65	0	00:55			
OUT719	DUMMY	3.43	0	00:55			
OUT722	DUMMY	1.59	0	00:55			
OUT725	DUMMY	0.00	0	00:00			
OUT726	DUMMY	2.47	0	00:55			
OUT727	DUMMY	1.49	0	00:56			
OUT733	DUMMY	1.14	0	00:55			

****
Conduit Surcharge Summary
****

	--------- Hours Full --------			Hours Above Full	Hours Capacity
Conduit	Both Ends	Upstream	Dnstream	Normal Flow	Limited
224	0.01	0.01	0.01	12.01	0.01
228	0.01	0.01	0.01	12.01	0.01
235	0.08	0.14	0.10	0.05	0.14
261	0.01	0.01	0.01	12.01	0.01
321	0.53	0.56	0.54	0.56	0.56
322	0.37	0.40	0.38	0.41	0.40
362	0.01	0.01	0.01	0.01	0.01
364	0.01	0.01	0.01	12.01	0.01
367	0.01	0.01	0.01	12.01	0.01
368	0.01	0.01	0.01	12.01	0.01
413	0.01	0.01	0.01	12.01	0.01
421	0.01	0.01	0.01	12.01	0.01
613	0.01	0.01	0.01	12.01	0.01
616	0.28	0.38	0.32	0.10	0.38
621	0.53	0.57	0.54	0.03	0.57
622	0.47	0.52	0.47	0.48	0.52
712	0.01	0.01	0.01	12.01	0.01
713	0.01	0.01	0.01	12.01	0.01
714	0.01	0.01	0.01	12.01	0.01
715	0.01	0.01	0.01	12.01	0.01
718	0.01	0.01	0.01	12.01	0.01
723	0.01	0.01	0.01	12.01	0.01
724	0.01	0.01	0.01	12.01	0.01
728	0.01	0.01	0.01	12.01	0.01
730	0.01	0.01	0.01	12.01	0.01
731	0.01	0.01	0.01	12.01	0.01
732	0.01	0.01	0.01	12.01	0.01
733	0.01	0.01	0.01	12.01	0.01
747	0.01	0.01	0.01	12.01	0.01

Analysis begun on: Mon Jun 16 17:36:04 2014
Analysis ended on: Mon Jun 16 17:36:04 2014
Total elapsed time: < 1 sec

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SWMM 2-Year Event Output

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)

High Line Canal Feasibility Study
RESPEC

****

NOTE: The summary statistics displayed in this report are based on results found at every computational time step, not just on results from each reporting time step.

****

****
Analysis Options
****

Flow Units .... CFS
Process Models:
Rainfall/Runoff .... NO
Snowmelt .... NO
Groundwater .... NO
Flow Routing .... YES
Ponding Allowed .... NO
Water Quality .... NO
Flow Routing Method ...... KINWAVE
Starting Date JAN-01-2014 00:00:00
Ending Date JAN-01-2014 12:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Routing Time Step .... 30.00 sec

Flow Routing Continuity	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	663.586	216.239
External Outflow	667.813	217.617
Internal Outflow	0.000	0.000
Storage Losses	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.692	0.225
Continuity Error (%)	-0.741	

****
Highest Flow Instability Indexes
****

Link 475 (2)
Link 422 (1)
Link 420 (1)
Link 7203 (1)
Link 7260 (1)

****
Routing Time Step Summary
****

Minimum Time Step : 30.00 sec
Average Time Step : 30.00 sec

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SWMM 2-Year Event Output

Maximum Time Step : 30.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 1.14

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min
7160	JUNCTION	0.18	2.40	5448.40	0	00:30
7170	JUNCTION	0.16	2.19	5448.59	0	00:30
7171	JUNCTION	0.16	2.19	5448.19	0	00:30
7200	JUNCTION	0.56	2.48	5453.98	0	00:48
7201	JUNCTION	0.72	3.09	5450.69	0	00:46
7202	JUNCTION	0.72	3.09	5449.89	0	00:47
7203	JUNCTION	0.88	4.01	5444.81	0	00:48
7210	JUNCTION	0.32	1.79	5461.79	0	00:39
7211	JUNCTION	0.31	1.79	5460.69	0	00:39
7222	JUNCTION	0.40	2.30	5454.20	0	00:42
7260	JUNCTION	0.82	4.20	5462.60	0	00:35
7261	JUNCTION	0.85	3.82	5460.42	0	00:45
WQ110	JUNCTION	0.00	0.00	0.00	0	00:00
WQ111	JUNCTION	0.00	0.00	0.00	0	00:00
WQ113	JUNCTION	0.01	0.10	5574.10	0	00:35
WQ115	JUNCTION	0.02	0.24	5605.94	0	00:35
WQ116	JUNCTION	0.00	0.00	0.00	0	00:00
WQ118	JUNCTION	0.03	0.37	5596.27	0	00:35
WQ119	JUNCTION	0.03	0.23	5575.93	0	00:40
WQ120	JUNCTION	0.13	1.22	5586.82	0	00:37
WQ121	JUNCTION	0.09	0.93	5612.43	0	00:37
WQ122	JUNCTION	0.02	0.35	5641.75	0	00:30
WQ123	JUNCTION	0.07	0.70	5636.50	0	00:35
WQ124	JUNCTION	0.03	0.34	5677.94	0	00:35
WQ125	JUNCTION	0.00	0.00	0.00	0	00:00
WQ127	JUNCTION	0.07	0.51	5565.91	0	00:40
WQ128	JUNCTION	0.05	0.47	5569.67	0	00:35
WQ129	JUNCTION	0.00	0.00	0.00	0	00:00
WQ130	JUNCTION	0.00	0.00	0.00	0	00:00
WQ131	JUNCTION	0.00	0.00	0.00	0	00:00
WQ132	JUNCTION	0.00	0.00	0.00	0	00:00
WQ134	JUNCTION	0.07	1.07	5601.07	0	00:30
WQ135	JUNCTION	0.08	0.90	5610.90	0	00:33
WQ136	JUNCTION	0.05	0.58	5641.68	0	00:30
WQ137	JUNCTION	0.00	0.00	0.00	0	00:00
WQ138	JUNCTION	0.00	0.00	0.00	0	00:00
WQ139	JUNCTION	0.00	0.00	0.00	0	00:00
WQ140	JUNCTION	0.00	0.00	0.00	0	00:00
WQ141	JUNCTION	0.00	0.00	0.00	0	00:00
WQ142	JUNCTION	0.00	0.00	0.00	0	00:00
WQ143	JUNCTION	0.00	0.00	0.00	0	00:00
WQ144	JUNCTION	0.00	0.00	0.00	0	00:00
WQ145	JUNCTION	0.00	0.00	0.00	0	00:00
WQ146	JUNCTION	0.00	0.00	0.00	0	00:00
WQ147	JUNCTION	0.00	0.00	0.00	0	00:00

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SWMM 2-Year Event Output

WQ148	JUNCTION	0.00	0.00	0.00	0	00:00
WQ150	JUNCTION	0.13	1.71	5580.91	0	00:30
WQ152	JUNCTION	0.15	1.99	5581.79	0	00:28
WQ153	JUNCTION	0.14	1.85	5618.35	0	00:30
WQ210	JUNCTION	0.00	0.00	0.00	0	00:00
WQ211	JUNCTION	0.00	0.00	0.00	0	00:00
WQ213	JUNCTION	0.18	2.00	5565.60	0	00:35
WQ215	JUNCTION	0.17	2.57	5588.07	0	00:30
WQ216	JUNCTION	0.00	0.00	0.00	0	00:00
WQ217	JUNCTION	0.00	0.00	0.00	0	00:00
WQ218	JUNCTION	0.00	0.00	0.00	0	00:00
WQ219	JUNCTION	0.00	0.00	0.00	0	00:00
WQ220	JUNCTION	0.00	0.00	0.00	0	00:00
WQ221	JUNCTION	0.00	0.00	0.00	0	00:00
WQ222	JUNCTION	0.00	0.00	0.00	0	00:00
WQ223	JUNCTION	0.00	0.00	0.00	0	00:00
WQ224	JUNCTION	0.00	0.00	5505.60	0	00:00
WQ226	JUNCTION	0.26	2.70	5532.70	0	00:36
WQ227	JUNCTION	0.14	1.50	5565.50	0	00:35
WQ228	JUNCTION	0.00	0.00	5599.40	0	00:00
WQ229	JUNCTION	0.17	1.78	5601.08	0	00:35
WQ230	JUNCTION	0.00	0.00	0.00	0	00:00
WQ231	JUNCTION	0.00	0.00	0.00	0	00:00
WQ232	JUNCTION	0.00	0.00	0.00	0	00:00
WQ236	JUNCTION	0.15	1.81	5553.51	0	00:30
WQ237	JUNCTION	0.00	0.00	0.00	0	00:00
WQ238	JUNCTION	0.00	0.00	0.00	0	00:00
WQ239	JUNCTION	0.00	0.00	0.00	0	00:00
WQ240	JUNCTION	0.00	0.00	0.00	0	00:00
WQ241	JUNCTION	0.00	0.00	0.00	0	00:00
WQ242	JUNCTION	0.00	0.00	0.00	0	00:00
WQ243	JUNCTION	0.00	0.00	0.00	0	00:00
WQ244	JUNCTION	0.00	0.00	0.00	0	00:00
WQ246	JUNCTION	0.12	1.11	5539.31	0	00:40
WQ247	JUNCTION	0.00	0.00	0.00	0	00:00
WQ248	JUNCTION	0.00	0.00	0.00	0	00:00
WQ249	JUNCTION	0.00	0.00	0.00	0	00:00
WQ250	JUNCTION	0.00	0.00	0.00	0	00:00
WQ257	JUNCTION	0.00	0.00	0.00	0	00:00
WQ258	JUNCTION	0.00	0.00	0.00	0	00:00
WQ259	JUNCTION	0.00	0.00	0.00	0	00:00
WQ261	JUNCTION	0.00	0.00	5530.10	0	00:00
WQ262	JUNCTION	0.10	1.05	5531.05	0	00:35
WQ263	JUNCTION	0.00	0.00	0.00	0	00:00
WQ311	JUNCTION	0.01	0.11	5508.21	0	00:35
WQ312	JUNCTION	0.00	0.00	0.00	0	00:00
WQ313	JUNCTION	0.00	0.00	0.00	0	00:00
WQ314	JUNCTION	0.00	0.00	0.00	0	00:00
WQ315	JUNCTION	0.00	0.00	0.00	0	00:00
WQ316	JUNCTION	0.00	0.00	0.00	0	00:00
WQ317	JUNCTION	0.00	0.00	0.00	0	00:00
WQ319	JUNCTION	0.14	1.62	5550.32	0	00:30
WQ323	JUNCTION	0.11	1.21	5548.01	0	00:35
WQ325	JUNCTION	0.00	0.00	0.00	0	00:00
WQ326	JUNCTION	0.00	0.00	0.00	0	00:00
WQ327	JUNCTION	0.00	0.00	0.00	0	00:00
WQ328	JUNCTION	0.00	0.00	0.00	0	00:00

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SWMM 2-Year Event Output

WQ329	JUNCTION	0.00	0.00	0.00	0	00:00
WQ330	JUNCTION	0.00	0.00	0.00	0	00:00
WQ331	JUNCTION	0.00	0.00	0.00	0	00:00
WQ332	JUNCTION	0.00	0.00	0.00	0	00:00
WQ333	JUNCTION	0.00	0.00	0.00	0	00:00
WQ334	JUNCTION	0.00	0.00	0.00	0	00:00
WQ335	JUNCTION	0.00	0.00	0.00	0	00:00
WQ336	JUNCTION	0.00	0.00	0.00	0	00:00
WQ337	JUNCTION	0.00	0.00	0.00	0	00:00
WQ338	JUNCTION	0.00	0.00	0.00	0	00:00
WQ339	JUNCTION	0.00	0.00	0.00	0	00:00
WQ340	JUNCTION	0.00	0.00	0.00	0	00:00
WQ341	JUNCTION	0.00	0.00	0.00	0	00:00
WQ342	JUNCTION	0.00	0.00	0.00	0	00:00
WQ343	JUNCTION	0.00	0.00	0.00	0	00:00
WQ344	JUNCTION	0.00	0.00	0.00	0	00:00
WQ345	JUNCTION	0.00	0.00	0.00	0	00:00
WQ346	JUNCTION	0.00	0.00	0.00	0	00:00
WQ347	JUNCTION	0.00	0.00	0.00	0	00:00
WQ348	JUNCTION	0.00	0.00	0.00	0	00:00
WQ349	JUNCTION	0.00	0.00	0.00	0	00:00
WQ350	JUNCTION	0.00	0.00	0.00	0	00:00
WQ351	JUNCTION	0.00	0.00	0.00	0	00:00
WQ352	JUNCTION	0.00	0.00	0.00	0	00:00
WQ353	JUNCTION	0.00	0.00	0.00	0	00:00
WQ354	JUNCTION	0.00	0.00	0.00	0	00:00
WQ355	JUNCTION	0.00	0.00	0.00	0	00:00
WQ356	JUNCTION	0.00	0.00	0.00	0	00:00
WQ357	JUNCTION	0.00	0.00	0.00	0	00:00
WQ358	JUNCTION	0.00	0.00	0.00	0	00:00
WQ360	JUNCTION	0.00	0.00	0.00	0	00:00
WQ364	JUNCTION	0.00	0.00	5475.00	0	00:00
WQ367	JUNCTION	0.00	0.00	5463.00	0	00:00
WQ368	JUNCTION	0.00	0.00	5484.60	0	00:00
WQ369	JUNCTION	0.20	1.36	5485.86	0	00:43
WQ370	JUNCTION	0.15	1.15	5506.15	0	00:40
WQ371	JUNCTION	0.13	1.03	5507.13	0	00:35
WQ372	JUNCTION	0.08	0.62	5562.32	0	00:38
WQ373	JUNCTION	0.08	0.62	5571.52	0	00:35
WQ374	JUNCTION	0.00	0.00	0.00	0	00:00
WQ410	JUNCTION	0.00	0.00	0.00	0	00:00
WQ411	JUNCTION	0.00	0.00	0.00	0	00:00
WQ412	JUNCTION	0.00	0.00	0.00	0	00:00
WQ413	JUNCTION	0.00	0.00	5461.20	0	00:00
WQ415	JUNCTION	0.21	2.65	5515.85	0	00:30
WQ417	JUNCTION	0.18	2.09	5520.59	0	00:35
WQ418	JUNCTION	0.00	0.00	0.00	0	00:00
WQ420	JUNCTION	0.48	4.76	5462.76	0	00:35
WQ421	JUNCTION	0.00	0.00	5458.10	0	00:00
WQ422	JUNCTION	0.31	2.88	5481.28	0	00:35
WQ423	JUNCTION	0.24	2.46	5511.46	0	00:33
WQ424	JUNCTION	0.10	1.39	5583.39	0	00:30
WQ510	JUNCTION	0.00	0.00	0.00	0	00:00
WQ511	JUNCTION	0.00	0.00	0.00	0	00:00
WQ512	JUNCTION	0.00	0.00	0.00	0	00:00
WQ513	JUNCTION	0.00	0.00	0.00	0	00:00
WQ514	JUNCTION	0.00	0.00	0.00	0	00:00

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SWMM 2-Year Event Output

WQ515	JUNCTION	0.00	0.00	0.00	0	00:00
WQ516	JUNCTION	0.00	0.00	0.00	0	00:00
WQ517	JUNCTION	0.00	0.00	0.00	0	00:00
WQ519	JUNCTION	0.37	5.00	5465.10	0	00:39
WQ521	JUNCTION	0.00	0.00	0.00	0	00:00
WQ610	JUNCTION	0.00	0.00	0.00	0	00:00
WQ611	JUNCTION	0.00	0.00	0.00	0	00:00
WQ612	JUNCTION	0.00	0.00	0.00	0	00:00
WQ613	JUNCTION	0.27	2.94	5436.24	0	00:39
WQ615	JUNCTION	0.27	2.98	5443.88	0	00:36
WQ617	JUNCTION	0.10	1.16	5448.96	0	00:30
WQ619	JUNCTION	0.09	1.09	5456.69	0	00:30
WQ623	JUNCTION	0.00	0.00	0.00	0	00:00
WQ710	JUNCTION	0.00	0.00	0.00	0	00:00
WQ712	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ713	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ714	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ715	JUNCTION	0.00	0.00	5440.10	0	00:00
WQ716	JUNCTION	0.18	2.41	5448.81	0	00:30
WQ717	JUNCTION	0.15	1.90	5448.70	0	00:30
WQ718	JUNCTION	0.00	0.00	5446.90	0	00:00
WQ719	JUNCTION	0.70	1.34	5457.94	0	01:19
WQ720	JUNCTION	0.89	3.82	5460.32	0	00:46
WQ721	JUNCTION	0.12	1.45	5471.45	0	00:35
WQ722	JUNCTION	0.06	0.39	5475.79	0	00:30
WQ723	JUNCTION	0.00	0.00	5475.50	0	00:00
WQ724	JUNCTION	0.00	0.00	5460.10	0	00:00
WQ725	JUNCTION	0.76	4.82	5464.82	0	00:32
WQ726	JUNCTION	0.84	4.72	5463.22	0	00:35
WQ727	JUNCTION	0.06	0.14	5472.64	0	00:46
WQ728	JUNCTION	0.00	0.00	5472.70	0	00:00
WQ729	JUNCTION	0.24	2.98	5463.98	0	00:30
WQ730	JUNCTION	0.00	0.00	5472.70	0	00:00
WQ731	JUNCTION	0.00	0.00	5470.00	0	00:00
WQ732	JUNCTION	0.00	0.00	5470.00	0	00:00
WQ733	JUNCTION	0.00	0.00	5460.10	0	00:00
WQ745	JUNCTION	0.00	0.00	0.00	0	00:00
WQ747	JUNCTION	0.00	0.00	5424.10	0	00:00
WQ748	JUNCTION	0.00	0.00	0.00	0	00:00
WQ750	JUNCTION	0.21	2.66	5436.06	0	00:30
WQ751	JUNCTION	0.00	0.00	0.00	0	00:00
WQ112	OUTFALL	0.01	0.09	5183.89	0	00:46
WQ114	OUTFALL	0.02	0.24	5145.04	0	00:41
WQ117	OUTFALL	0.14	1.20	5543.60	0	00:41
WQ126	OUTFALL	0.07	0.49	5539.09	0	00:53
WQ133	OUTFALL	0.10	1.07	5529.67	0	00:31
WQ149	OUTFALL	0.13	1.70	5518.20	0	00:30
WQ151	OUTFALL	0.15	1.99	5516.09	0	00:29
WQ212	OUTFALL	0.19	1.99	5529.29	0	00:36
WQ214	OUTFALL	0.18	2.43	5514.93	0	00:33
WQ225	OUTFALL	0.26	2.69	5508.19	0	00:37
WQ233	OUTFALL	0.31	4.00	5509.60	0	00:32
WQ245	OUTFALL	0.12	1.09	5500.19	0	00:43
WQ260	OUTFALL	0.11	1.00	5483.60	0	00:42
WQ310	OUTFALL	0.01	0.11	5480.81	0	00:37
WQ318	OUTFALL	0.14	1.60	5486.00	0	00:36
WQ320	OUTFALL	0.27	1.75	5481.45	0	00:21

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SWMM 2-Year Event Output

WQ361	OUTFALL	0.48	4.00	5484.60	0	00:34
WQ363	OUTFALL	0.45	4.50	5470.60	0	00:29
WQ366	OUTFALL	0.21	1.35	5464.25	0	00:49
WQ414	OUTFALL	0.24	2.45	5463.55	0	00:39
WQ416	OUTFALL	0.18	2.06	5461.16	0	00:36
WQ419	OUTFALL	0.48	4.75	5456.85	0	00:35
WQ518	OUTFALL	0.24	2.40	5440.50	0	00:43
WQ614	OUTFALL	0.26	2.00	5435.20	0	00:25
WQ618	OUTFALL	0.10	0.99	5433.99	0	00:41
WQ620	OUTFALL	0.34	2.00	5429.00	0	00:21
WQ711	OUTFALL	0.00	0.00	5439.90	0	00:00
WQ746	OUTFALL	0.00	0.00	5424.00	0	00:00
WQ749	OUTFALL	0.21	2.62	5426.22	0	00:32
WQ234	DIVIDER	0.30	4.00	5547.10	0	00:26
WQ235	DIVIDER	0.26	3.00	5550.70	0	00:21
WQ321	DIVIDER	0.27	1.75	5494.75	0	00:19
WQ322	DIVIDER	0.22	1.75	5521.25	0	00:20
WQ324	DIVIDER	0.15	1.75	5559.55	0	00:24
WQ362	DIVIDER	0.47	4.00	5494.50	0	00:29
WQ365	DIVIDER	0.44	4.50	5479.40	0	00:27
WQ520	DIVIDER	0.34	5.00	5471.50	0	00:27
WQ616	DIVIDER	0.24	2.00	5456.80	0	00:21
WQ621	DIVIDER	0.33	2.00	5454.60	0	00:18
WQ622	DIVIDER	0.25	1.75	5478.95	0	00:20
WQ744	DIVIDER	0.03	0.43	5470.33	0	00:30
STO711	STORAGE	3.70	15.10	5455.10	0	01:23
STO714	STORAGE	0.24	0.75	5440.95	0	01:11
STO715	STORAGE	0.19	0.79	5440.99	0	01:05
STO719	STORAGE	0.69	1.88	5458.58	0	01:19
STO722	STORAGE	0.26	0.77	5476.27	0	01:13
STO725	STORAGE	0.17	0.39	5460.49	0	01:54
STO726	STORAGE	0.66	1.64	5460.24	0	01:50
STO727	STORAGE	0.45	1.10	5473.70	0	01:10
STO733	STORAGE	0.11	0.40	5460.60	0	01:07

****
Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
7160	JUNCTION	0.00	74.36	0	00:30	0.000	1.051
7170	JUNCTION	0.00	57.62	0	00:30	0.000	0.773
7171	JUNCTION	0.00	57.37	0	00:30	0.000	0.772
7200	JUNCTION	0.00	297.95	0	00:46	0.000	8.871
7201	JUNCTION	0.00	297.67	0	00:46	0.000	8.868
7202	JUNCTION	0.00	297.75	0	00:47	0.000	8.865
7203	JUNCTION	0.00	296.98	0	00:48	0.000	8.861
7210	JUNCTION	0.00	102.01	0	00:39	0.000	2.248
7211	JUNCTION	0.00	102.00	0	00:39	0.000	2.247
7222	JUNCTION	0.00	100.02	0	00:42	0.000	2.255
7260	JUNCTION	0.00	216.35	0	00:35	0.000	4.899
7261	JUNCTION	0.00	181.12	0	00:45	0.000	5.048
WQ110	JUNCTION	2.73	2.73	0	00:45	0.079	0.079

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SWMM 2-Year Event Output

WQ111	JUNCTION	1.39	1.39	0 00:40	0.032	0.032
WQ113	JUNCTION	6.26	6.26	0 00:35	0.109	0.109
WQ115	JUNCTION	32.44	32.44	0 00:35	0.697	0.697
WQ116	JUNCTION	9.34	9.34	0 00:40	0.264	0.264
WQ118	JUNCTION	28.13	28.13	0 00:35	0.576	0.576
WQ119	JUNCTION	8.84	8.84	0 00:40	0.252	0.252
WQ120	JUNCTION	122.97	178.10	0 00:37	1.632	3.909
WQ121	JUNCTION	30.00	91.84	0 00:37	0.496	1.919
WQ122	JUNCTION	23.21	23.21	0 00:30	0.327	0.327
WQ123	JUNCTION	46.96	68.26	0 00:35	0.917	1.416
WQ124	JUNCTION	24.19	24.19	0 00:35	0.494	0.494
WQ125	JUNCTION	24.77	24.77	0 00:35	0.503	0.503
WQ127	JUNCTION	26.23	29.42	0 00:40	0.513	0.832
WQ128	JUNCTION	12.48	12.48	0 00:35	0.300	0.300
WQ129	JUNCTION	2.94	2.94	0 00:45	0.090	0.090
WQ130	JUNCTION	6.40	6.40	0 00:40	0.137	0.137
WQ131	JUNCTION	1.93	1.93	0 00:40	0.052	0.052
WQ132	JUNCTION	0.30	0.30	0 00:40	0.008	0.008
WQ134	JUNCTION	188.16	188.16	0 00:30	2.360	2.360
WQ135	JUNCTION	97.32	123.85	0 00:33	1.321	2.171
WQ136	JUNCTION	46.15	46.15	0 00:30	0.837	0.837
WQ137	JUNCTION	20.40	20.40	0 00:35	0.493	0.493
WQ138	JUNCTION	31.54	31.54	0 00:30	0.570	0.570
WQ139	JUNCTION	3.96	3.96	0 00:45	0.166	0.166
WQ140	JUNCTION	14.78	14.78	0 00:30	0.301	0.301
WQ141	JUNCTION	23.85	23.85	0 00:35	0.570	0.570
WQ142	JUNCTION	83.26	83.26	0 00:30	1.310	1.310
WQ143	JUNCTION	90.08	90.08	0 00:30	1.516	1.516
WQ144	JUNCTION	99.80	99.80	0 00:30	1.387	1.387
WQ145	JUNCTION	38.57	38.57	0 00:35	0.799	0.799
WQ146	JUNCTION	42.38	42.38	0 00:30	0.608	0.608
WQ147	JUNCTION	109.13	109.13	0 00:30	1.679	1.679
WQ148	JUNCTION	73.07	73.07	0 00:30	0.935	0.935
WQ150	JUNCTION	127.03	127.03	0 00:30	1.611	1.611
WQ152	JUNCTION	102.55	246.80	0 00:28	1.249	3.105
WQ153	JUNCTION	147.58	147.58	0 00:30	1.861	1.861
WQ210	JUNCTION	137.32	137.32	0 00:30	1.845	1.845
WQ211	JUNCTION	95.54	95.54	0 00:30	1.529	1.529
WQ213	JUNCTION	111.16	111.16	0 00:35	1.996	1.996
WQ215	JUNCTION	117.64	117.64	0 00:30	1.554	1.554
WQ216	JUNCTION	39.33	39.33	0 00:30	0.610	0.610
WQ217	JUNCTION	36.74	36.74	0 00:30	0.618	0.618
WQ218	JUNCTION	24.44	24.44	0 00:30	0.359	0.359
WQ219	JUNCTION	65.58	65.58	0 00:30	0.994	0.994
WQ220	JUNCTION	37.32	37.32	0 00:25	0.453	0.453
WQ221	JUNCTION	76.45	76.45	0 00:25	0.808	0.808
WQ222	JUNCTION	40.05	40.05	0 00:25	0.496	0.496
WQ223	JUNCTION	92.81	92.81	0 00:30	1.282	1.282
WQ224	JUNCTION	104.87	104.87	0 00:30	1.634	1.634
WQ226	JUNCTION	43.03	202.97	0 00:36	0.876	3.832
WQ227	JUNCTION	61.02	61.02	0 00:35	1.093	1.093
WQ228	JUNCTION	53.66	53.66	0 00:35	0.990	0.990
WQ229	JUNCTION	47.23	100.90	0 00:35	0.889	1.879
WQ230	JUNCTION	97.31	97.31	0 00:25	1.193	1.193
WQ231	JUNCTION	53.15	53.15	0 00:30	0.803	0.803
WQ232	JUNCTION	70.56	70.56	0 00:30	1.021	1.021
WQ236	JUNCTION	38.08	38.08	0 00:30	0.612	0.612

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SWMM 2-Year Event Output

WQ237	JUNCTION	38.47	38.47	0 00:30	0.698	0.698
WQ238	JUNCTION	62.71	62.71	0 00:35	1.113	1.113
WQ239	JUNCTION	40.65	40.65	0 00:30	0.678	0.678
WQ240	JUNCTION	55.90	55.90	0 00:30	0.745	0.745
WQ241	JUNCTION	73.19	73.19	0 00:30	0.962	0.962
WQ242	JUNCTION	61.94	61.94	0 00:30	0.930	0.930
WQ243	JUNCTION	69.05	69.05	0 00:30	0.911	0.911
WQ244	JUNCTION	72.60	72.60	0 00:30	1.057	1.057
WQ246	JUNCTION	11.28	11.28	0 00:40	0.278	0.278
WQ247	JUNCTION	34.05	34.05	0 00:30	0.530	0.530
WQ248	JUNCTION	47.95	47.95	0 00:35	1.023	1.023
WQ249	JUNCTION	10.77	10.77	0 00:35	0.225	0.225
WQ250	JUNCTION	64.80	64.80	0 00:30	0.900	0.900
WQ257	JUNCTION	26.55	26.55	0 00:30	0.433	0.433
WQ258	JUNCTION	16.89	16.89	0 00:35	0.312	0.312
WQ259	JUNCTION	23.91	23.91	0 00:35	0.487	0.487
WQ261	JUNCTION	36.25	36.25	0 00:35	0.764	0.764
WQ262	JUNCTION	38.32	74.56	0 00:35	0.763	1.527
WQ263	JUNCTION	29.22	29.22	0 00:30	0.397	0.397
WQ311	JUNCTION	62.13	62.13	0 00:35	1.149	1.149
WQ312	JUNCTION	87.02	87.02	0 00:30	1.151	1.151
WQ313	JUNCTION	64.84	64.84	0 00:35	1.135	1.135
WQ314	JUNCTION	6.94	6.94	0 00:35	0.167	0.167
WQ315	JUNCTION	45.90	45.90	0 00:30	0.629	0.629
WQ316	JUNCTION	41.25	41.25	0 00:30	0.585	0.585
WQ317	JUNCTION	36.65	36.65	0 00:35	0.688	0.688
WQ319	JUNCTION	44.51	44.51	0 00:30	0.766	0.766
WQ323	JUNCTION	18.15	18.15	0 00:35	0.338	0.338
WQ325	JUNCTION	29.67	29.67	0 00:35	0.643	0.643
WQ326	JUNCTION	56.06	56.06	0 00:35	1.138	1.138
WQ327	JUNCTION	31.49	31.49	0 00:30	0.483	0.483
WQ328	JUNCTION	16.49	16.49	0 00:30	0.306	0.306
WQ329	JUNCTION	6.35	6.35	0 00:30	0.108	0.108
WQ330	JUNCTION	8.55	8.55	0 00:35	0.209	0.209
WQ331	JUNCTION	14.77	14.77	0 00:40	0.371	0.371
WQ332	JUNCTION	13.01	13.01	0 00:35	0.318	0.318
WQ333	JUNCTION	7.87	7.87	0 00:35	0.207	0.207
WQ334	JUNCTION	10.43	10.43	0 00:35	0.221	0.221
WQ335	JUNCTION	3.15	3.15	0 00:40	0.092	0.092
WQ336	JUNCTION	61.92	61.92	0 00:35	1.258	1.258
WQ337	JUNCTION	44.08	44.08	0 00:35	0.819	0.819
WQ338	JUNCTION	63.51	63.51	0 00:40	1.491	1.491
WQ339	JUNCTION	106.59	106.59	0 00:35	1.949	1.949
WQ340	JUNCTION	28.97	28.97	0 00:30	0.490	0.490
WQ341	JUNCTION	25.96	25.96	0 00:30	0.420	0.420
WQ342	JUNCTION	32.93	32.93	0 00:35	0.625	0.625
WQ343	JUNCTION	161.13	161.13	0 00:35	2.776	2.776
WQ344	JUNCTION	68.28	68.28	0 00:30	1.019	1.019
WQ345	JUNCTION	25.19	25.19	0 00:35	0.532	0.532
WQ346	JUNCTION	66.93	66.93	0 00:35	1.184	1.184
WQ347	JUNCTION	10.94	10.94	0 00:30	0.216	0.216
WQ348	JUNCTION	67.05	67.05	0 00:30	1.005	1.005
WQ349	JUNCTION	67.68	67.68	0 00:30	1.062	1.062
WQ350	JUNCTION	90.34	90.34	0 00:35	1.560	1.560
WQ351	JUNCTION	109.37	109.37	0 00:25	1.368	1.368
WQ352	JUNCTION	188.09	188.09	0 00:40	3.699	3.699
WQ353	JUNCTION	344.40	344.40	0 00:35	5.643	5.643

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SWMM 2-Year Event Output

WQ354	JUNCTION	202.05	202.05	0 00:30	3.088	3.088
WQ355	JUNCTION	109.12	109.12	0 00:30	1.413	1.413
WQ356	JUNCTION	39.99	39.99	0 00:30	0.599	0.599
WQ357	JUNCTION	0.19	0.19	0 01:20	0.018	0.018
WQ358	JUNCTION	10.19	10.19	0 00:45	0.361	0.361
WQ360	JUNCTION	49.76	49.76	0 00:40	1.124	1.124
WQ364	JUNCTION	27.22	27.22	0 00:30	0.477	0.477
WQ367	JUNCTION	69.90	69.90	0 00:30	1.067	1.067
WQ368	JUNCTION	12.76	12.76	0 00:35	0.246	0.246
WQ369	JUNCTION	113.51	204.01	0 00:43	1.940	5.213
WQ370	JUNCTION	58.16	126.15	0 00:40	1.107	3.004
WQ371	JUNCTION	46.70	46.70	0 00:35	1.041	1.041
WQ372	JUNCTION	4.75	34.95	0 00:38	0.108	0.850
WQ373	JUNCTION	31.08	31.08	0 00:35	0.744	0.744
WQ374	JUNCTION	15.56	15.56	0 00:40	0.408	0.408
WQ410	JUNCTION	53.26	53.26	0 00:30	0.801	0.801
WQ411	JUNCTION	75.44	75.44	0 00:35	1.609	1.609
WQ412	JUNCTION	22.18	22.18	0 00:30	0.300	0.300
WQ413	JUNCTION	39.81	39.81	0 00:30	0.545	0.545
WQ415	JUNCTION	136.32	136.32	0 00:30	1.789	1.789
WQ417	JUNCTION	78.79	78.79	0 00:35	1.448	1.448
WQ418	JUNCTION	150.97	150.97	0 00:25	1.496	1.496
WQ420	JUNCTION	143.75	576.89	0 00:35	2.360	9.781
WQ421	JUNCTION	151.71	151.71	0 00:30	2.120	2.120
WQ422	JUNCTION	100.83	303.45	0 00:35	1.653	5.313
WQ423	JUNCTION	196.43	211.46	0 00:33	2.673	3.642
WQ424	JUNCTION	66.85	66.85	0 00:30	0.895	0.895
WQ510	JUNCTION	27.89	27.89	0 00:40	0.757	0.757
WQ511	JUNCTION	93.57	93.57	0 00:35	1.755	1.755
WQ512	JUNCTION	48.91	48.91	0 00:30	0.806	0.806
WQ513	JUNCTION	37.56	37.56	0 00:30	0.566	0.566
WQ514	JUNCTION	75.23	75.23	0 00:35	1.446	1.446
WQ515	JUNCTION	52.98	52.98	0 00:40	1.299	1.299
WQ516	JUNCTION	20.26	20.26	0 00:45	0.617	0.617
WQ517	JUNCTION	33.32	33.32	0 00:30	0.538	0.538
WQ519	JUNCTION	23.28	183.22	0 00:42	0.600	3.293
WQ521	JUNCTION	33.13	33.13	0 00:30	0.495	0.495
WQ610	JUNCTION	45.59	45.59	0 00:35	0.798	0.798
WQ611	JUNCTION	31.04	31.04	0 00:40	0.785	0.785
WQ612	JUNCTION	36.87	36.87	0 00:30	0.547	0.547
WQ613	JUNCTION	33.65	111.54	0 00:37	0.554	2.120
WQ615	JUNCTION	37.47	85.15	0 00:36	0.759	1.569
WQ617	JUNCTION	52.59	52.59	0 00:30	0.801	0.801
WQ619	JUNCTION	53.87	53.87	0 00:30	0.873	0.873
WQ623	JUNCTION	208.12	208.12	0 00:30	2.691	2.691
WQ710	JUNCTION	157.49	157.49	0 00:30	2.236	2.236
WQ712	JUNCTION	38.30	38.30	0 00:30	0.594	0.594
WQ713	JUNCTION	40.22	40.22	0 00:35	0.726	0.726
WQ714	JUNCTION	0.00	3.77	0 01:11	0.000	0.382
WQ715	JUNCTION	0.00	5.50	0 01:05	0.000	0.440
WQ716	JUNCTION	74.80	74.80	0 00:30	1.052	1.052
WQ717	JUNCTION	53.33	57.84	0 00:30	0.712	0.774
WQ718	JUNCTION	5.24	5.24	0 00:25	0.061	0.061
WQ719	JUNCTION	0.00	7.54	0 01:19	0.000	0.893
WQ720	JUNCTION	49.99	207.27	0 00:45	0.685	6.623
WQ721	JUNCTION	70.86	70.86	0 00:35	1.197	1.197
WQ722	JUNCTION	0.00	46.74	0 00:30	0.000	1.017

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SWMM 2-Year Event Output

WQ723	JUNCTION	44.61	44.61	0 00:30	0.641	0.641
WQ724	JUNCTION	36.50	36.50	0 00:30	0.494	0.494
WQ725	JUNCTION	0.00	220.05	0 00:32	0.000	4.181
WQ726	JUNCTION	0.00	216.39	0 00:35	0.000	4.903
WQ727	JUNCTION	0.00	5.80	0 00:46	0.000	0.523
WQ728	JUNCTION	18.17	18.17	0 00:25	0.167	0.167
WQ729	JUNCTION	91.85	189.52	0 00:30	1.384	2.783
WQ730	JUNCTION	11.15	11.15	0 00:25	0.106	0.106
WQ731	JUNCTION	51.02	51.02	0 00:30	0.769	0.769
WQ732	JUNCTION	1.56	1.56	0 00:25	0.022	0.022
WQ733	JUNCTION	0.00	2.41	0 01:07	0.000	0.214
WQ745	JUNCTION	7.68	7.68	0 00:40	0.216	0.216
WQ747	JUNCTION	52.64	52.64	0 00:35	0.996	0.996
WQ748	JUNCTION	13.11	13.11	0 00:35	0.274	0.274
WQ750	JUNCTION	92.84	92.84	0 00:30	1.442	1.442
WQ751	JUNCTION	9.16	9.16	0 00:40	0.256	0.256
WQ112	OUTFALL	1.67	6.71	0 00:45	0.034	0.150
WQ114	OUTFALL	1.18	32.02	0 00:41	0.024	0.729
WQ117	OUTFALL	16.34	219.24	0 00:41	0.354	5.140
WQ126	OUTFALL	35.04	53.69	0 00:45	0.789	1.650
WQ133	OUTFALL	13.13	275.84	0 00:34	0.347	4.934
WQ149	OUTFALL	171.94	270.74	0 00:26	1.833	3.440
WQ151	OUTFALL	212.51	435.73	0 00:27	2.266	5.361
WQ212	OUTFALL	66.37	166.56	0 00:35	0.976	2.964
WQ214	OUTFALL	47.28	155.09	0 00:34	0.915	2.469
WQ225	OUTFALL	58.31	351.97	0 00:35	0.866	6.324
WQ233	OUTFALL	60.65	247.49	0 00:42	1.146	4.506
WQ245	OUTFALL	44.67	53.21	0 00:35	0.818	1.096
WQ260	OUTFALL	49.58	101.86	0 00:39	0.765	2.320
WQ310	OUTFALL	48.34	94.25	0 00:32	0.610	1.759
WQ318	OUTFALL	42.41	86.04	0 00:35	0.896	1.661
WQ320	OUTFALL	28.80	135.86	0 00:40	0.496	2.611
WQ361	OUTFALL	86.40	216.32	0 00:50	1.652	5.965
WQ363	OUTFALL	79.76	370.20	0 00:42	1.388	7.337
WQ366	OUTFALL	47.14	263.94	0 00:46	0.896	7.204
WQ414	OUTFALL	30.74	170.82	0 00:38	0.621	3.017
WQ416	OUTFALL	91.86	151.78	0 00:31	1.193	2.638
WQ419	OUTFALL	211.82	761.12	0 00:35	2.912	12.673
WQ518	OUTFALL	23.22	198.17	0 00:39	0.356	3.641
WQ614	OUTFALL	65.34	220.66	0 00:39	1.170	4.705
WQ618	OUTFALL	158.52	174.76	0 00:34	2.206	3.110
WQ620	OUTFALL	121.97	234.37	0 00:40	1.812	5.171
WQ711	OUTFALL	0.00	156.11	0 01:23	0.000	13.238
WQ746	OUTFALL	58.98	107.94	0 00:30	0.898	1.894
WQ749	OUTFALL	34.04	123.35	0 00:33	0.675	2.114
WQ234	DIVIDER	71.74	207.50	0 00:32	0.893	3.186
WQ235	DIVIDER	126.66	126.66	0 00:30	1.658	1.658
WQ321	DIVIDER	26.26	116.27	0 00:37	0.390	2.093
WQ322	DIVIDER	37.73	97.38	0 00:34	0.549	1.690
WQ324	DIVIDER	50.03	50.03	0 00:30	0.797	0.797
WQ362	DIVIDER	191.79	191.79	0 00:40	4.111	4.111
WQ365	DIVIDER	298.34	325.02	0 00:35	5.396	5.873
WQ520	DIVIDER	161.94	161.94	0 00:30	2.463	2.463
WQ616	DIVIDER	75.84	75.84	0 00:35	1.318	1.318
WQ621	DIVIDER	100.51	168.85	0 00:36	1.327	3.277
WQ622	DIVIDER	112.77	112.77	0 00:35	1.914	1.914
WQ744	DIVIDER	47.92	98.66	0 00:30	0.607	1.398

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SWMM 2-Year Event Output

STO711	STORAGE	24.10	433.10	0 00:45	0.431	13.270
STO714	STORAGE	32.46	32.46	0 00:25	0.386	0.386
STO715	STORAGE	46.95	46.95	0 00:25	0.441	0.441
STO719	STORAGE	83.33	83.33	0 00:25	0.916	0.916
STO722	STORAGE	34.99	34.99	0 00:25	0.382	0.382
STO725	STORAGE	12.99	12.99	0 00:25	0.174	0.174
STO726	STORAGE	76.52	76.52	0 00:25	0.768	0.768
STO727	STORAGE	19.33	43.34	0 00:25	0.296	0.569
STO733	STORAGE	21.79	21.79	0 00:25	0.215	0.215

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Node Surcharge Summary
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Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
WQ110	JUNCTION	12.01	0.000	0.000
WQ111	JUNCTION	12.01	0.000	0.000
WQ116	JUNCTION	12.01	0.000	0.000
WQ125	JUNCTION	12.01	0.000	0.000
WQ129	JUNCTION	12.01	0.000	0.000
WQ130	JUNCTION	12.01	0.000	0.000
WQ131	JUNCTION	12.01	0.000	0.000
WQ132	JUNCTION	12.01	0.000	0.000
WQ137	JUNCTION	12.01	0.000	0.000
WQ138	JUNCTION	12.01	0.000	0.000
WQ139	JUNCTION	12.01	0.000	0.000
WQ140	JUNCTION	12.01	0.000	0.000
WQ141	JUNCTION	12.01	0.000	0.000
WQ142	JUNCTION	12.01	0.000	0.000
WQ143	JUNCTION	12.01	0.000	0.000
WQ144	JUNCTION	12.01	0.000	0.000
WQ145	JUNCTION	12.01	0.000	0.000
WQ146	JUNCTION	12.01	0.000	0.000
WQ147	JUNCTION	12.01	0.000	0.000
WQ148	JUNCTION	12.01	0.000	0.000
WQ210	JUNCTION	12.01	0.000	0.000
WQ211	JUNCTION	12.01	0.000	0.000
WQ216	JUNCTION	12.01	0.000	0.000
WQ217	JUNCTION	12.01	0.000	0.000
WQ218	JUNCTION	12.01	0.000	0.000
WQ219	JUNCTION	12.01	0.000	0.000
WQ220	JUNCTION	12.01	0.000	0.000
WQ221	JUNCTION	12.01	0.000	0.000
WQ222	JUNCTION	12.01	0.000	0.000
WQ223	JUNCTION	12.01	0.000	0.000
WQ224	JUNCTION	12.01	0.000	0.000
WQ228	JUNCTION	12.01	0.000	0.000
WQ230	JUNCTION	12.01	0.000	0.000
WQ231	JUNCTION	12.01	0.000	0.000
WQ232	JUNCTION	12.01	0.000	0.000
WQ237	JUNCTION	12.01	0.000	0.000
WQ238	JUNCTION	12.01	0.000	0.000
WQ239	JUNCTION	12.01	0.000	0.000

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SWMM 2-Year Event Output

WQ240	JUNCTION	12.01	0.000	0.000
WQ241	JUNCTION	12.01	0.000	0.000
WQ242	JUNCTION	12.01	0.000	0.000
WQ243	JUNCTION	12.01	0.000	0.000
WQ244	JUNCTION	12.01	0.000	0.000
WQ247	JUNCTION	12.01	0.000	0.000
WQ248	JUNCTION	12.01	0.000	0.000
WQ249	JUNCTION	12.01	0.000	0.000
WQ250	JUNCTION	12.01	0.000	0.000
WQ257	JUNCTION	12.01	0.000	0.000
WQ258	JUNCTION	12.01	0.000	0.000
WQ259	JUNCTION	12.01	0.000	0.000
WQ261	JUNCTION	12.01	0.000	0.000
WQ263	JUNCTION	12.01	0.000	0.000
WQ312	JUNCTION	12.01	0.000	0.000
WQ313	JUNCTION	12.01	0.000	0.000
WQ314	JUNCTION	12.01	0.000	0.000
WQ315	JUNCTION	12.01	0.000	0.000
WQ316	JUNCTION	12.01	0.000	0.000
WQ317	JUNCTION	12.01	0.000	0.000
WQ325	JUNCTION	12.01	0.000	0.000
WQ326	JUNCTION	12.01	0.000	0.000
WQ327	JUNCTION	12.01	0.000	0.000
WQ328	JUNCTION	12.01	0.000	0.000
WQ329	JUNCTION	12.01	0.000	0.000
WQ330	JUNCTION	12.01	0.000	0.000
WQ331	JUNCTION	12.01	0.000	0.000
WQ332	JUNCTION	12.01	0.000	0.000
WQ333	JUNCTION	12.01	0.000	0.000
WQ334	JUNCTION	12.01	0.000	0.000
WQ335	JUNCTION	12.01	0.000	0.000
WQ336	JUNCTION	12.01	0.000	0.000
WQ337	JUNCTION	12.01	0.000	0.000
WQ338	JUNCTION	12.01	0.000	0.000
WQ339	JUNCTION	12.01	0.000	0.000
WQ340	JUNCTION	12.01	0.000	0.000
WQ341	JUNCTION	12.01	0.000	0.000
WQ342	JUNCTION	12.01	0.000	0.000
WQ343	JUNCTION	12.01	0.000	0.000
WQ344	JUNCTION	12.01	0.000	0.000
WQ345	JUNCTION	12.01	0.000	0.000
WQ346	JUNCTION	12.01	0.000	0.000
WQ347	JUNCTION	12.01	0.000	0.000
WQ348	JUNCTION	12.01	0.000	0.000
WQ349	JUNCTION	12.01	0.000	0.000
WQ350	JUNCTION	12.01	0.000	0.000
WQ351	JUNCTION	12.01	0.000	0.000
WQ352	JUNCTION	12.01	0.000	0.000
WQ353	JUNCTION	12.01	0.000	0.000
WQ354	JUNCTION	12.01	0.000	0.000
WQ355	JUNCTION	12.01	0.000	0.000
WQ356	JUNCTION	12.01	0.000	0.000
WQ357	JUNCTION	12.01	0.000	0.000
WQ358	JUNCTION	12.01	0.000	0.000
WQ360	JUNCTION	12.01	0.000	0.000
WQ364	JUNCTION	12.01	0.000	0.000
WQ367	JUNCTION	12.01	0.000	0.000

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SWMM 2-Year Event Output

WQ368	JUNCTION	12.01	0.000	0.000
WQ374	JUNCTION	12.01	0.000	0.000
WQ410	JUNCTION	12.01	0.000	0.000
WQ411	JUNCTION	12.01	0.000	0.000
WQ412	JUNCTION	12.01	0.000	0.000
WQ413	JUNCTION	12.01	0.000	0.000
WQ418	JUNCTION	12.01	0.000	0.000
WQ421	JUNCTION	12.01	0.000	0.000
WQ510	JUNCTION	12.01	0.000	0.000
WQ511	JUNCTION	12.01	0.000	0.000
WQ512	JUNCTION	12.01	0.000	0.000
WQ513	JUNCTION	12.01	0.000	0.000
WQ514	JUNCTION	12.01	0.000	0.000
WQ515	JUNCTION	12.01	0.000	0.000
WQ516	JUNCTION	12.01	0.000	0.000
WQ517	JUNCTION	12.01	0.000	0.000
WQ521	JUNCTION	12.01	0.000	0.000
WQ610	JUNCTION	12.01	0.000	0.000
WQ611	JUNCTION	12.01	0.000	0.000
WQ612	JUNCTION	12.01	0.000	0.000
WQ623	JUNCTION	12.01	0.000	0.000
WQ710	JUNCTION	12.01	0.000	0.000
WQ712	JUNCTION	12.01	0.000	0.000
WQ713	JUNCTION	12.01	0.000	0.000
WQ714	JUNCTION	12.01	0.000	0.000
WQ715	JUNCTION	12.01	0.000	0.000
WQ718	JUNCTION	12.01	0.000	0.000
WQ723	JUNCTION	12.01	0.000	0.000
WQ724	JUNCTION	12.01	0.000	0.000
WQ728	JUNCTION	12.01	0.000	0.000
WQ730	JUNCTION	12.01	0.000	0.000
WQ731	JUNCTION	12.01	0.000	0.000
WQ732	JUNCTION	12.01	0.000	0.000
WQ733	JUNCTION	12.01	0.000	0.000
WQ745	JUNCTION	12.01	0.000	0.000
WQ747	JUNCTION	12.01	0.000	0.000
WQ748	JUNCTION	12.01	0.000	0.000
WQ751	JUNCTION	12.01	0.000	0.000
STO711	STORAGE	2.48	7.100	84.900
STO714	STORAGE	12.01	0.753	9.247
STO715	STORAGE	12.01	0.786	9.214
STO719	STORAGE	12.01	1.885	8.115
STO722	STORAGE	12.01	0.767	9.233
STO725	STORAGE	12.01	0.391	9.609
STO726	STORAGE	12.01	1.635	8.365
STO727	STORAGE	12.01	1.101	8.899
STO733	STORAGE	12.01	0.401	9.599

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Node Flooding Summary

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No nodes were flooded.

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Storage Volume Summary

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SWMM 2-Year Event Output

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
STO711	161.246	4	0	657.807	15	0 01:22	156.11
STO714	10.270	2	0	32.810	8	0 01:11	3.77
STO715	8.444	2	0	34.237	8	0 01:05	5.50
STO719	30.032	7	0	82.102	19	0 01:19	7.54
STO722	11.256	3	0	33.394	8	0 01:12	3.45
STO725	7.308	2	0	17.015	4	0 01:53	1.17
STO726	28.818	7	0	71.232	16	0 01:50	6.13
STO727	19.529	4	0	47.970	11	0 01:10	5.80
STO733	4.796	1	0	17.479	4	0 01:07	2.41

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Outfall Loading Summary

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Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
WQ112	44.90	1.03	6.71	0.150
WQ114	46.22	4.88	32.02	0.729
WQ117	98.61	16.12	219.24	5.140
WQ126	98.61	5.17	53.69	1.650
WQ133	98.61	15.47	275.84	4.934
WQ149	27.41	38.81	270.74	3.440
WQ151	30.40	54.54	435.73	5.361
WQ212	32.20	28.47	166.56	2.964
WQ214	42.75	17.86	155.09	2.469
WQ225	47.74	40.96	351.97	6.324
WQ233	48.85	28.53	247.49	4.506
WQ245	40.18	8.44	53.21	1.096
WQ260	63.15	11.36	101.86	2.320
WQ310	21.44	25.37	94.25	1.759
WQ318	35.74	14.37	86.04	1.661
WQ320	35.46	22.77	135.86	2.611
WQ361	48.44	38.08	216.32	5.965
WQ363	32.48	69.86	370.20	7.337
WQ366	34.84	63.95	263.94	7.204
WQ414	38.03	24.53	170.82	3.017
WQ416	32.41	25.18	151.78	2.638
WQ419	80.92	48.44	761.12	12.673
WQ518	55.73	20.21	198.17	3.641
WQ614	46.43	31.34	220.66	4.705
WQ618	98.61	9.75	174.76	3.110
WQ620	39.00	41.00	234.37	5.171
WQ711	98.54	41.54	156.11	13.238
WQ746	22.83	25.66	107.94	1.894
WQ749	31.44	20.79	123.35	2.114
System	50.76	794.50	5147.69	119.823

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Link Flow Summary

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SWMM 2-Year Event Output

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
113	CONDUIT	5.25	0	00:46	3.16	0.00	0.02
115	CONDUIT	30.86	0	00:41	6.40	0.00	0.05
118	CONDUIT	26.81	0	00:39	3.62	0.01	0.07
119	CONDUIT	7.52	0	00:57	1.82	0.00	0.04
120	CONDUIT	173.91	0	00:41	6.01	0.07	0.24
121	CONDUIT	87.90	0	00:43	4.23	0.04	0.18
122	CONDUIT	19.09	0	00:38	3.18	0.01	0.06
123	CONDUIT	67.19	0	00:39	4.34	0.03	0.14
124	CONDUIT	23.23	0	00:39	3.32	0.01	0.07
127	CONDUIT	27.46	0	00:53	2.66	0.01	0.10
128	CONDUIT	9.98	0	00:54	1.17	0.01	0.08
134	CONDUIT	187.34	0	00:31	7.63	0.05	0.21
135	CONDUIT	115.81	0	00:39	5.97	0.04	0.17
136	CONDUIT	43.18	0	00:38	3.63	0.02	0.11
150	CONDUIT	125.06	0	00:30	20.34	0.21	0.31
152	CONDUIT	246.54	0	00:29	23.86	0.11	0.22
153	CONDUIT	148.39	0	00:30	17.76	0.13	0.25
213	CONDUIT	109.35	0	00:36	16.25	0.40	0.44
215	CONDUIT	109.52	0	00:33	16.40	0.83	0.69
224	DUMMY	104.87	0	00:30			
226	CONDUIT	202.41	0	00:37	18.83	0.57	0.54
227	CONDUIT	60.51	0	00:36	12.43	0.20	0.30
228	DUMMY	53.66	0	00:35			
229	CONDUIT	100.25	0	00:36	16.34	0.27	0.35
234	CONDUIT	159.74	0	00:44	15.14	1.08	1.00
234_OVERFLOW	CONDUIT	50.00	0	00:42	10.21	0.00	0.04
235	CONDUIT	53.97	0	00:45	8.63	1.08	1.00
235_OVERFLOW	CONDUIT	64.94	0	00:35	7.14	0.00	0.06
236	CONDUIT	37.06	0	00:32	8.59	0.66	0.59
246	CONDUIT	11.10	0	00:43	8.29	0.88	0.72
261	DUMMY	36.25	0	00:35			
262	CONDUIT	67.87	0	00:42	3.20	0.01	0.12
311	CONDUIT	61.06	0	00:37	2.97	0.00	0.01
319	CONDUIT	43.93	0	00:36	13.60	0.74	0.64
321	CONDUIT	18.43	0	01:32	8.40	1.08	1.00
321_OVERFLOW	CONDUIT	96.57	0	00:41	4.99	0.00	0.06
322	CONDUIT	26.52	0	01:06	12.15	1.08	1.00
322_OVERFLOW	CONDUIT	71.69	0	00:38	7.88	0.00	0.05
323	CONDUIT	18.13	0	00:36	10.40	0.82	0.69
324	CONDUIT	31.56	0	00:45	14.53	1.08	1.00
324_OVERFLOW	CONDUIT	18.57	0	00:36	9.87	0.00	0.03
340	CONDUIT	204.95	0	00:48	4.22	0.22	0.50
362	CONDUIT	97.76	0	01:11	8.75	1.08	1.00
362_OVERFLOW	CONDUIT	75.44	0	00:55	7.26	0.00	0.06
364	DUMMY	27.22	0	00:30			
365	CONDUIT	173.94	0	00:56	12.16	1.08	1.00
365_OVERFLOW	CONDUIT	145.83	0	00:42	9.43	0.00	0.08
367	DUMMY	69.90	0	00:30			
368	DUMMY	12.76	0	00:35			
369	CONDUIT	198.87	0	00:49	5.47	0.00	0.07
370	CONDUIT	119.66	0	00:48	5.29	0.00	0.06
371	CONDUIT	45.25	0	00:40	2.11	0.00	0.05
372	CONDUIT	33.02	0	00:47	4.96	0.00	0.03

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SWMM 2-Year Event Output

373	CONDUIT	30.47	0	00:38	3.77	0.00	0.03
413	DUMMY	39.81	0	00:30			
415	CHANNEL	111.62	0	00:39	4.05	0.00	0.17
417	CONDUIT	77.44	0	00:36	16.47	0.91	0.75
420	CONDUIT	574.83	0	00:35	15.71	0.46	0.47
421	DUMMY	151.71	0	00:30			
422	CONDUIT	302.28	0	00:37	18.65	0.28	0.36
423	CHANNEL	207.77	0	00:37	4.49	0.01	0.16
424	CHANNEL	49.20	0	00:43	3.56	0.00	0.07
450	CONDUIT	102.00	0	00:39	12.12	0.11	0.22
460	CONDUIT	100.02	0	00:42	5.20	0.06	0.26
475	CONDUIT	100.02	0	00:42	8.40	0.18	0.29
519	CONDUIT	181.31	0	00:43	18.37	0.39	0.44
520	CONDUIT	138.68	0	00:42	8.42	1.08	0.95
520_OVERFLOW	CONDUIT	28.01	0	00:39	5.11	0.00	0.04
613	DUMMY	111.54	0	00:37			
615	CONDUIT	83.89	0	00:39	8.71	0.89	0.73
616	CONDUIT	21.65	0	01:10	8.05	1.08	1.00
616_OVERFLOW	CONDUIT	42.46	0	00:46	7.33	0.00	0.05
617	CONDUIT	48.51	0	00:36	5.44	0.00	0.03
619	CONDUIT	45.69	0	00:41	3.63	0.04	0.20
621	CONDUIT	26.57	0	01:59	9.64	1.08	1.00
621_OVERFLOW	CONDUIT	133.17	0	00:44	5.81	0.00	0.07
622	CONDUIT	20.45	0	01:23	9.43	1.08	1.00
622_OVERFLOW	CONDUIT	84.21	0	00:40	6.86	0.00	0.05
712	DUMMY	38.30	0	00:30			
713	DUMMY	40.22	0	00:35			
714	DUMMY	3.77	0	01:11			
715	DUMMY	5.50	0	01:05			
716	CONDUIT	74.36	0	00:30	8.00	0.47	0.48
717	CONDUIT	57.62	0	00:30	7.36	0.21	0.31
718	DUMMY	5.24	0	00:25			
719	CONDUIT	7.54	0	01:20	2.68	0.51	0.51
721	CONDUIT	63.29	0	00:41	3.25	0.07	0.27
722	CONDUIT	43.58	0	00:35	4.96	0.20	0.38
723	DUMMY	44.61	0	00:30			
724	DUMMY	36.50	0	00:30			
725	CONDUIT	212.03	0	00:35	5.99	0.45	0.47
726	CONDUIT	216.35	0	00:35	6.14	0.26	0.35
727	CONDUIT	5.89	0	02:09	1.82	0.02	0.09
728	DUMMY	18.17	0	00:25			
729	CONDUIT	184.13	0	00:32	2.92	0.32	0.59
730	DUMMY	11.15	0	00:25			
731	DUMMY	51.02	0	00:30			
732	DUMMY	1.56	0	00:25			
733	DUMMY	2.41	0	01:07			
744	CONDUIT	97.97	0	00:30	9.54	0.25	0.43
747	DUMMY	52.64	0	00:35			
750	CONDUIT	90.57	0	00:32	10.56	0.76	0.65
7160	CONDUIT	68.16	0	00:36	3.26	0.07	0.28
7170	CONDUIT	57.37	0	00:30	7.49	0.48	0.49
7171	CONDUIT	55.48	0	00:32	4.52	0.35	0.52
7200	CONDUIT	297.67	0	00:46	25.35	0.09	0.21
7201	CONDUIT	297.75	0	00:47	14.40	0.21	0.31
7202	CONDUIT	296.98	0	00:48	5.87	0.21	0.47
7203	CONDUIT	297.30	0	00:48	11.80	0.50	0.50
7260	CONDUIT	181.12	0	00:45	2.51	0.56	0.75

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SWMM 2-Year Event Output

7261	CONDUIT	181.09	0	00:46	5.84	0.22	0.32
744_OVERFLOW	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
OUT711	DUMMY	156.11	0	01:23			
OUT714	DUMMY	3.77	0	01:11			
OUT715	DUMMY	5.50	0	01:05			
OUT719	DUMMY	7.54	0	01:19			
OUT722	DUMMY	3.45	0	01:13			
OUT725	DUMMY	1.17	0	01:54			
OUT726	DUMMY	6.13	0	01:50			
OUT727	DUMMY	5.80	0	00:46			
OUT733	DUMMY	2.41	0	01:07			

****

Conduit Surcharge Summary

****

Conduit	--------- Hours Full ------- Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
224	0.01	0.01	0.01	12.01	0.01
228	0.01	0.01	0.01	12.01	0.01
234	0.17	0.27	0.19	0.28	0.27
235	0.35	0.38	0.37	0.03	0.38
261	0.01	0.01	0.01	12.01	0.01
321	1.15	1.18	1.17	1.23	1.18
322	0.72	0.75	0.73	0.77	0.75
324	0.31	0.34	0.32	0.04	0.34
362	0.55	0.63	0.58	0.09	0.63
364	0.01	0.01	0.01	12.01	0.01
365	0.42	0.46	0.44	0.48	0.46
367	0.01	0.01	0.01	12.01	0.01
368	0.01	0.01	0.01	12.01	0.01
413	0.01	0.01	0.01	12.01	0.01
421	0.01	0.01	0.01	12.01	0.01
520	0.01	0.19	0.04	0.20	0.19
613	0.01	0.01	0.01	12.01	0.01
616	0.68	0.76	0.72	0.07	0.76
621	1.58	1.63	1.62	0.05	1.63
622	0.97	1.01	0.98	1.06	1.01
712	0.01	0.01	0.01	12.01	0.01
713	0.01	0.01	0.01	12.01	0.01
714	0.01	0.01	0.01	12.01	0.01
715	0.01	0.01	0.01	12.01	0.01
718	0.01	0.01	0.01	12.01	0.01
723	0.01	0.01	0.01	12.01	0.01
724	0.01	0.01	0.01	12.01	0.01
728	0.01	0.01	0.01	12.01	0.01
730	0.01	0.01	0.01	12.01	0.01
731	0.01	0.01	0.01	12.01	0.01
732	0.01	0.01	0.01	12.01	0.01
733	0.01	0.01	0.01	12.01	0.01
747	0.01	0.01	0.01	12.01	0.01

Analysis begun on: Wed Feb 19 10:49:09 2014

Analysis ended on: Wed Feb 19 10:49:09 2014

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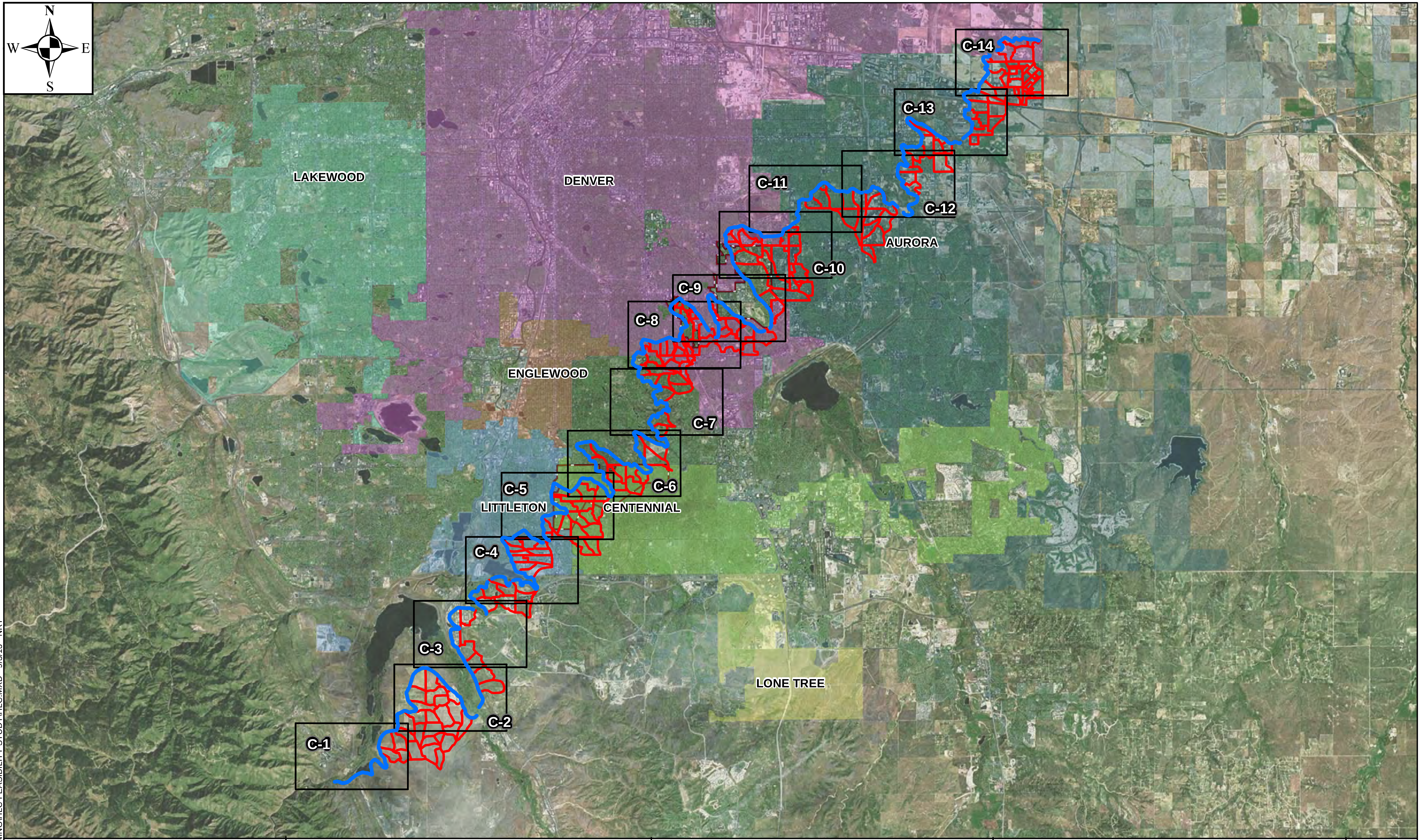
Canal Bottom Width by Mile Marker

Downstream Mile Marker	County	Bottom Width (ft)
2	Douglas	10
3	Douglas	10
4	Douglas	18
5	Douglas	8
6	Douglas	10
7	Douglas	11
8	Douglas	16
9	Douglas	16
10	Douglas	21
11	Douglas	19
12	Douglas	15
13	Douglas	16
14	Douglas	20
15	Douglas	19
16	Douglas	19
17	Arapahoe	18
18	Arapahoe	16
19	Arapahoe	16
20	Arapahoe	17
21	Arapahoe	18
22	Arapahoe	17
23	Arapahoe	16
24	Arapahoe	14
25	Arapahoe	15
26	Arapahoe	14
27	Arapahoe	14
28	Arapahoe	14
29	Arapahoe	11
30	Arapahoe	12
31	Arapahoe	12
32	Arapahoe	16
33	Arapahoe	13
34	Arapahoe	12
35	Arapahoe	12
36	Arapahoe	13
37	Arapahoe	12
38	Arapahoe	14
39	Arapahoe	14
40	Arapahoe	14
41	Arapahoe	12
42	Arapahoe	11
43	Arapahoe	12
44	Arapahoe	11
45	Arapahoe	11
46	Arapahoe	13

Downstream Mile Marker	County	Bottom Width (ft)
47	Arapahoe	13
48	Arapahoe	13
49	Arapahoe	13
50	Arapahoe	14
51	Arapahoe	13
52	Arapahoe	14
53	Arapahoe	12
54	Arapahoe	13
55	Arapahoe	9
56	Arapahoe	8
57	Arapahoe	6
58	Arapahoe	9
59	Arapahoe	9
60	Arapahoe	12
61	Arapahoe	8
62	Arapahoe	7
63	Arapahoe	8
64	Arapahoe	10
65	Arapahoe	9
66	Arapahoe	11

APPENDIX C – Feasibility Study Maps



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RESPEC CONSULTING & SERVICES 720 S COLORADO BLVD SUITE 410S DENVER, CO 80246 303-757-3655 WWW.RESPEC.COM	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	DENVER HIGH LINE CANAL FEASIBILITY STUDY	APPENDIX C	KEY MAP

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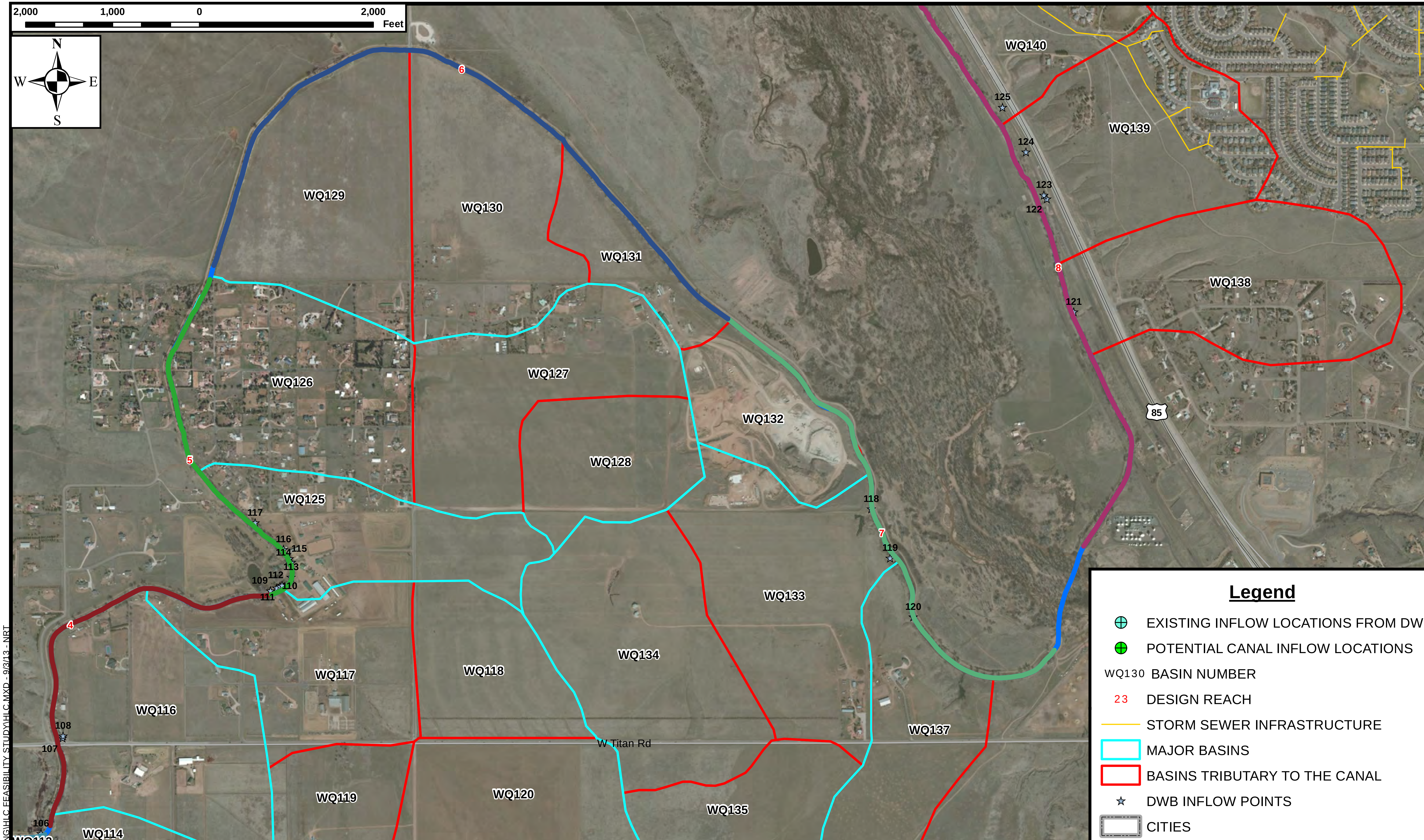
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-1



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DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-2

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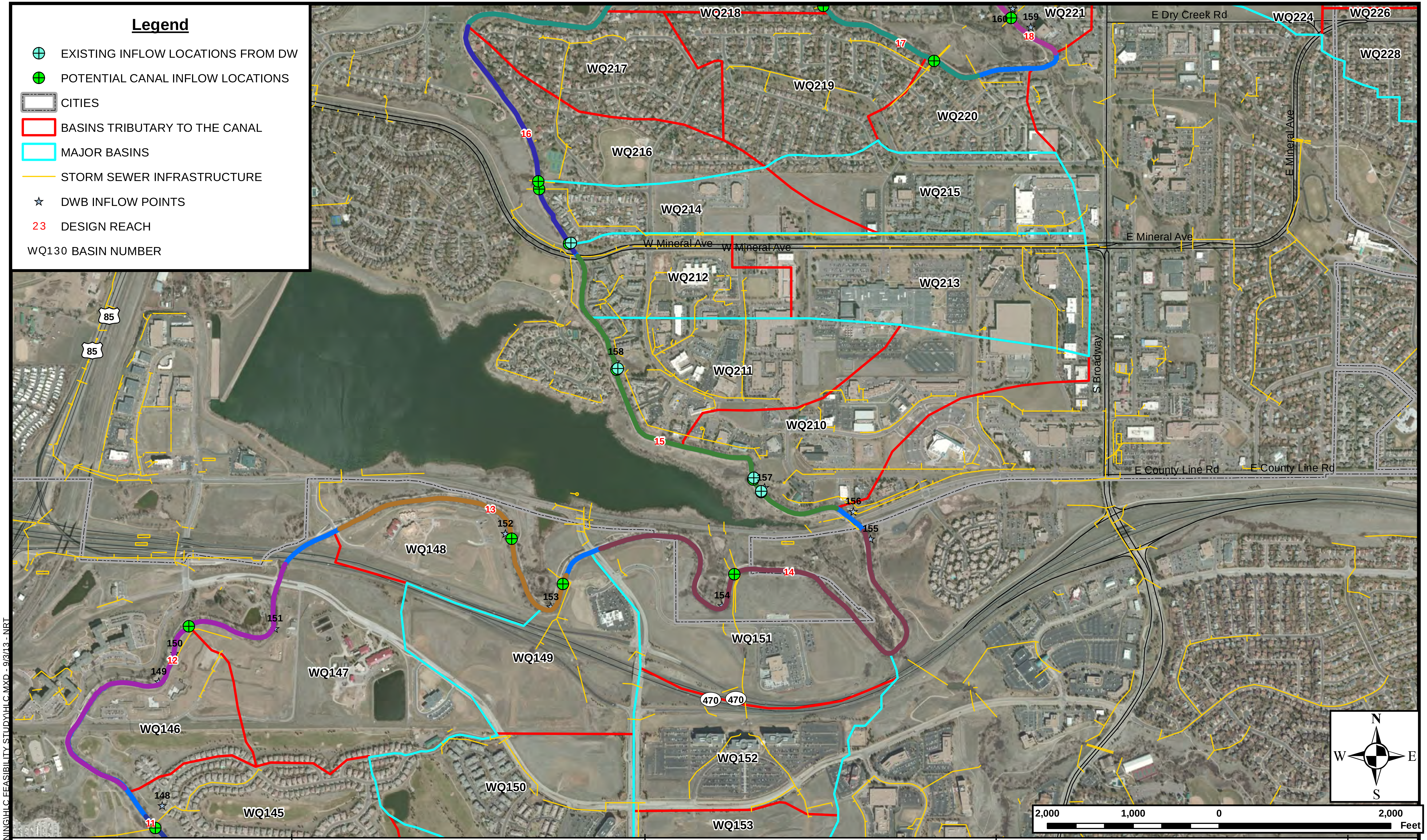
DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-3

Z:\UDFCD PLANNING\HLC FEASIBILITY STUDY\HLC.MXD - 9/3/13 - NRT



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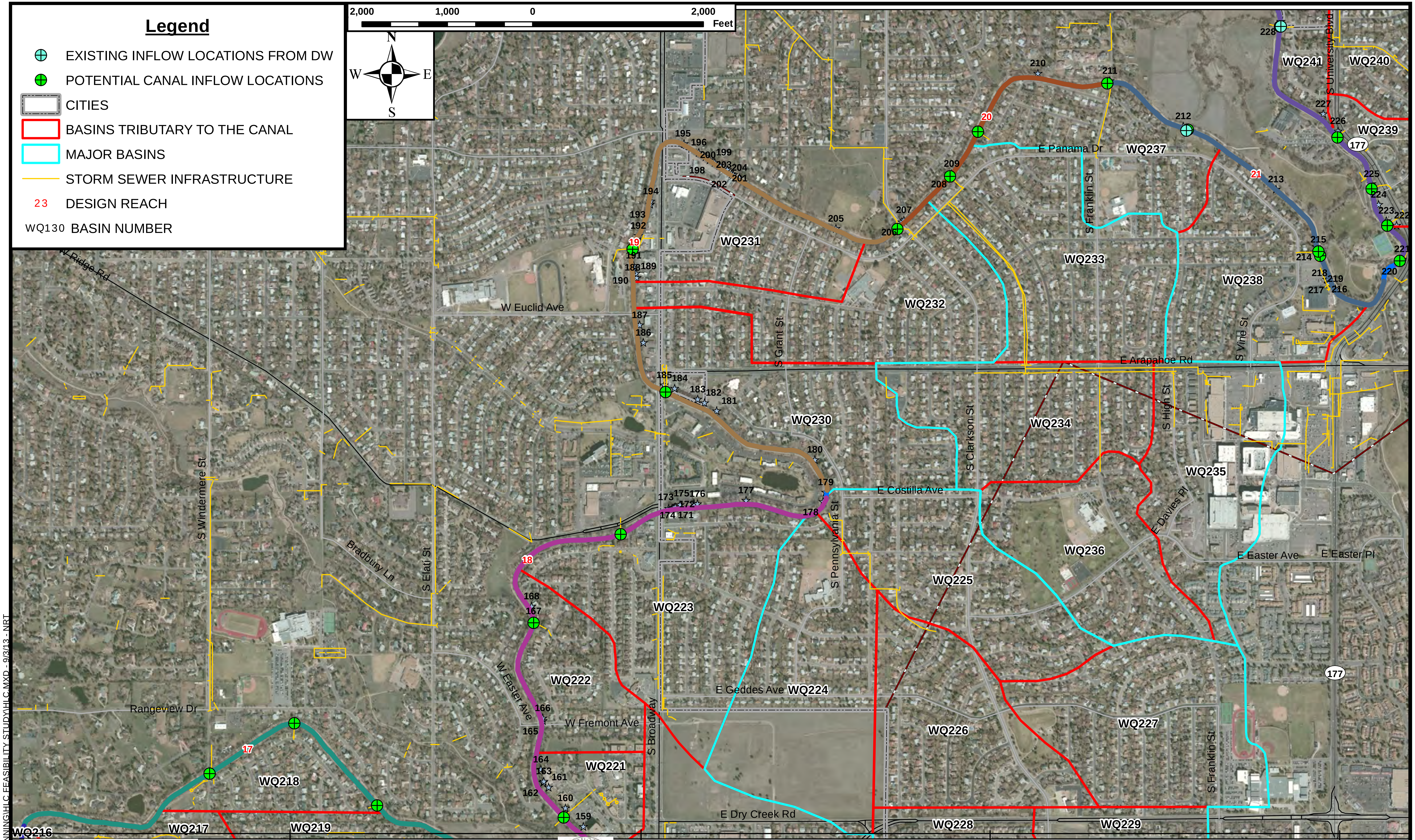
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-4



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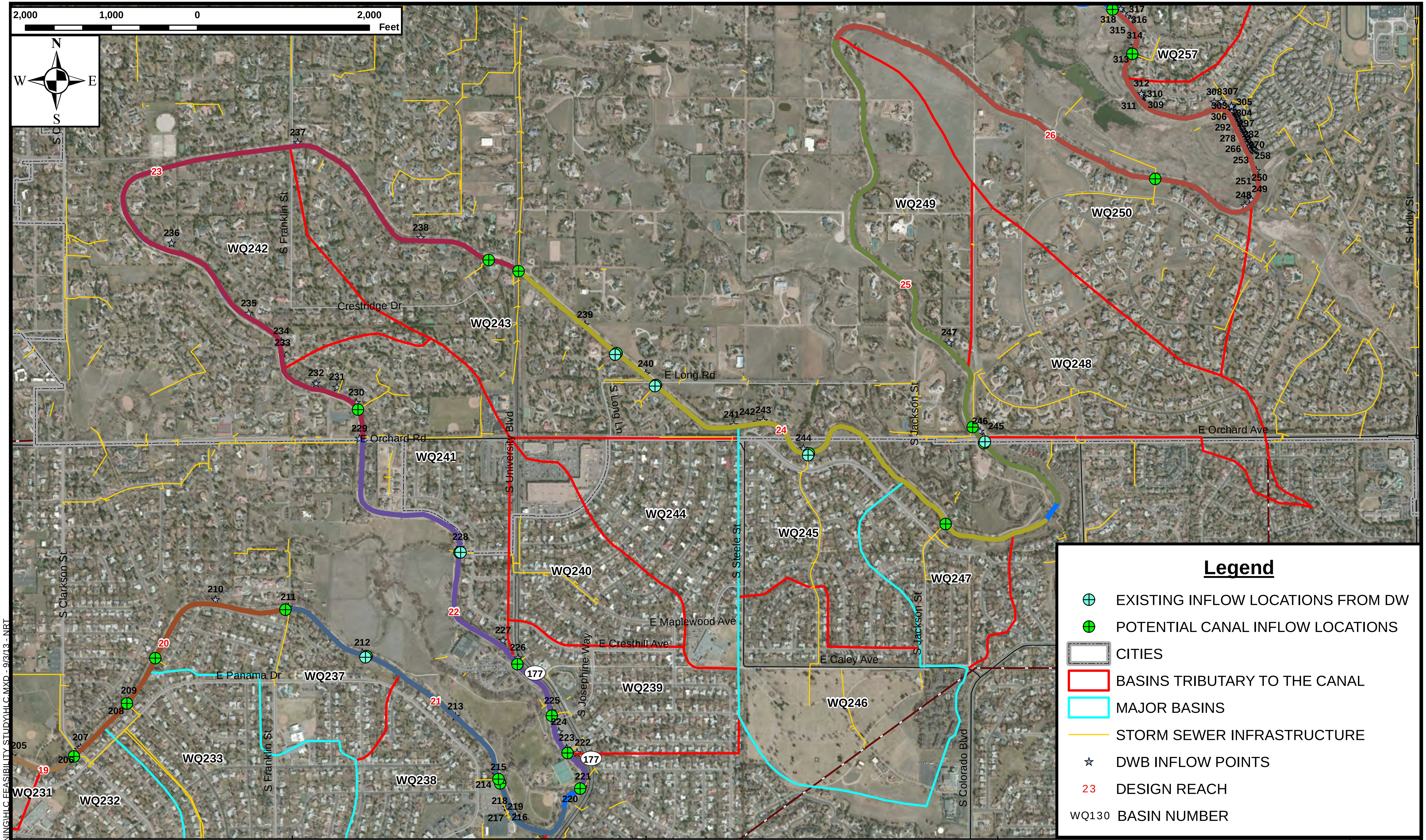
DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-5



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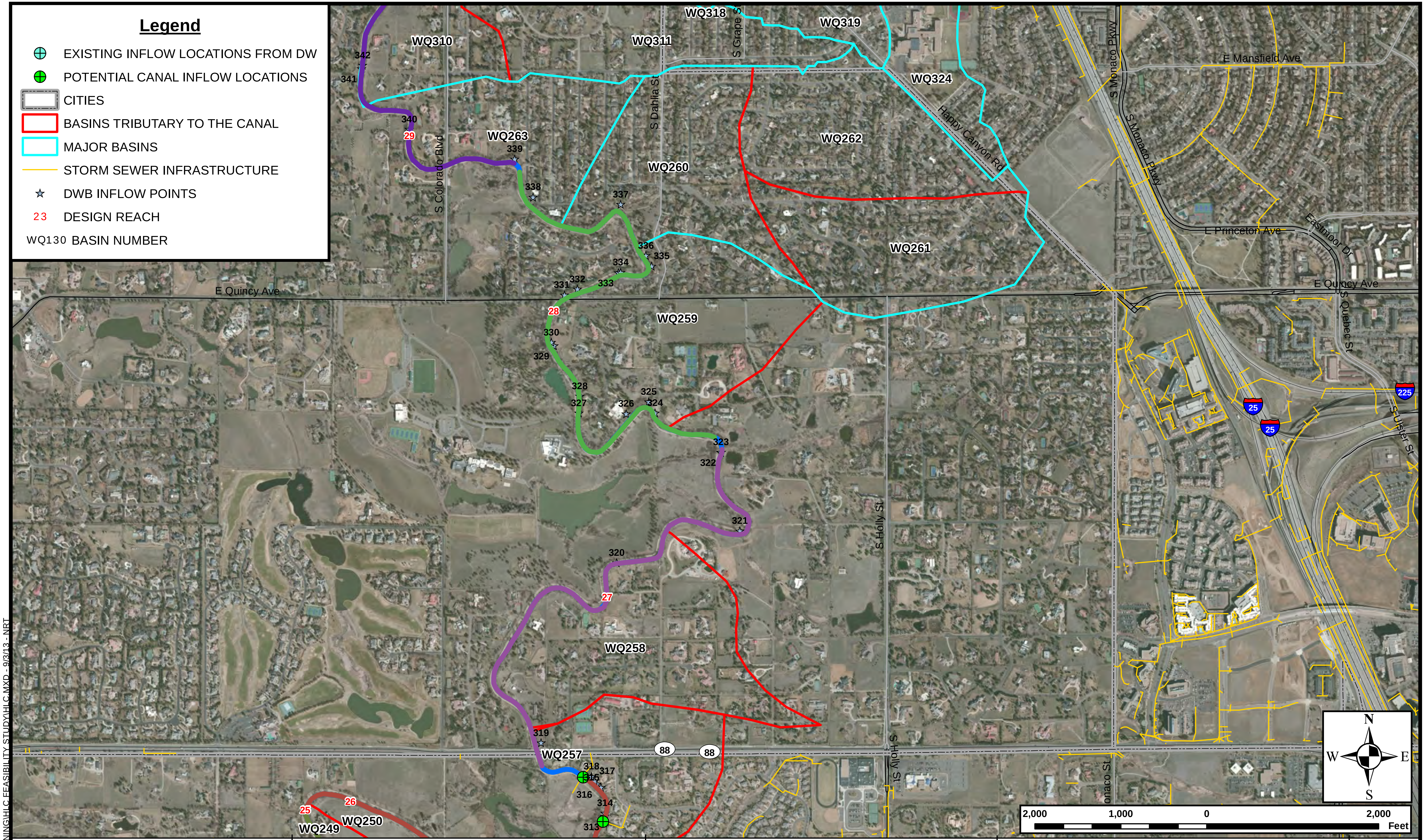
DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-6



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DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-7

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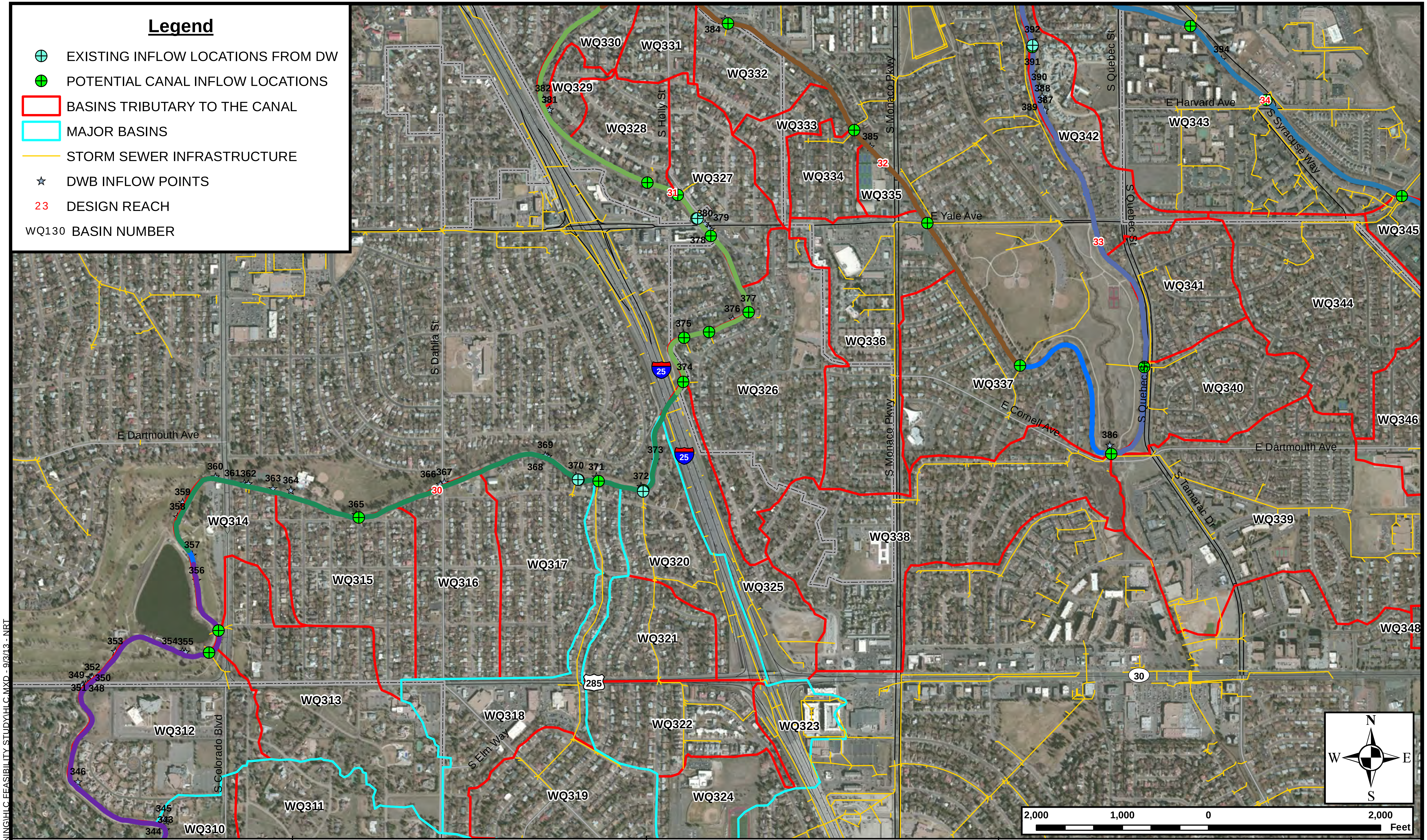

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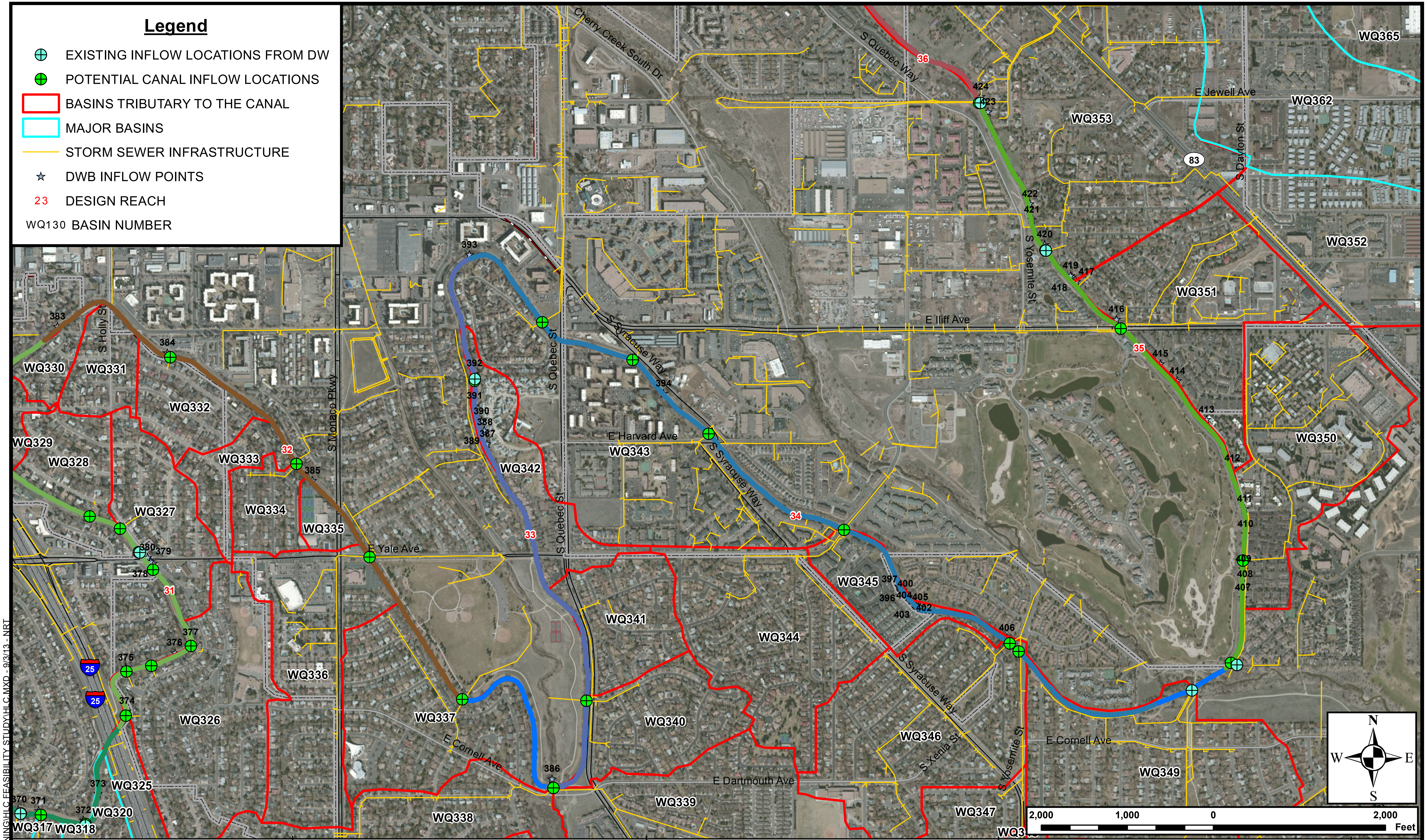
DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-8



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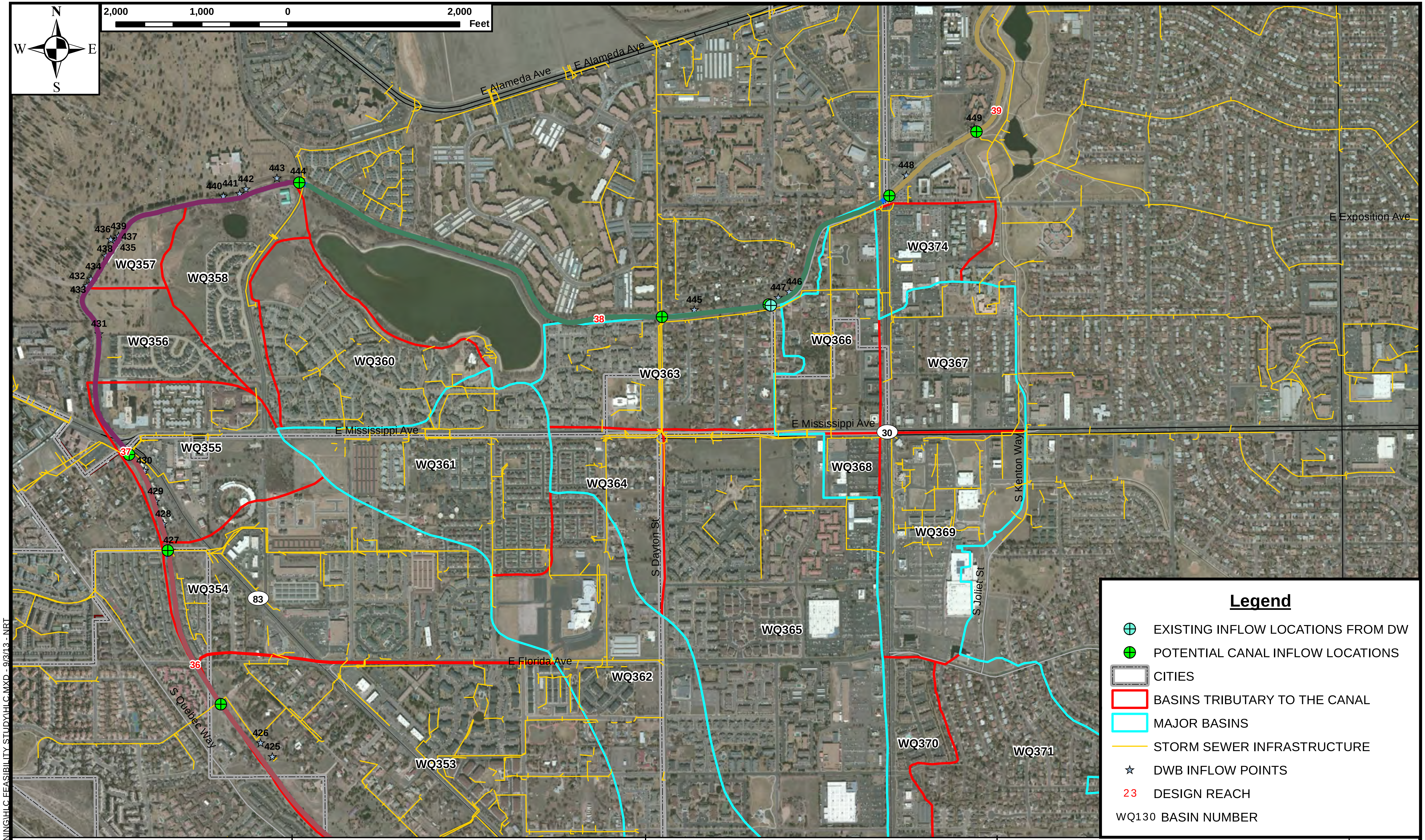
DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-9



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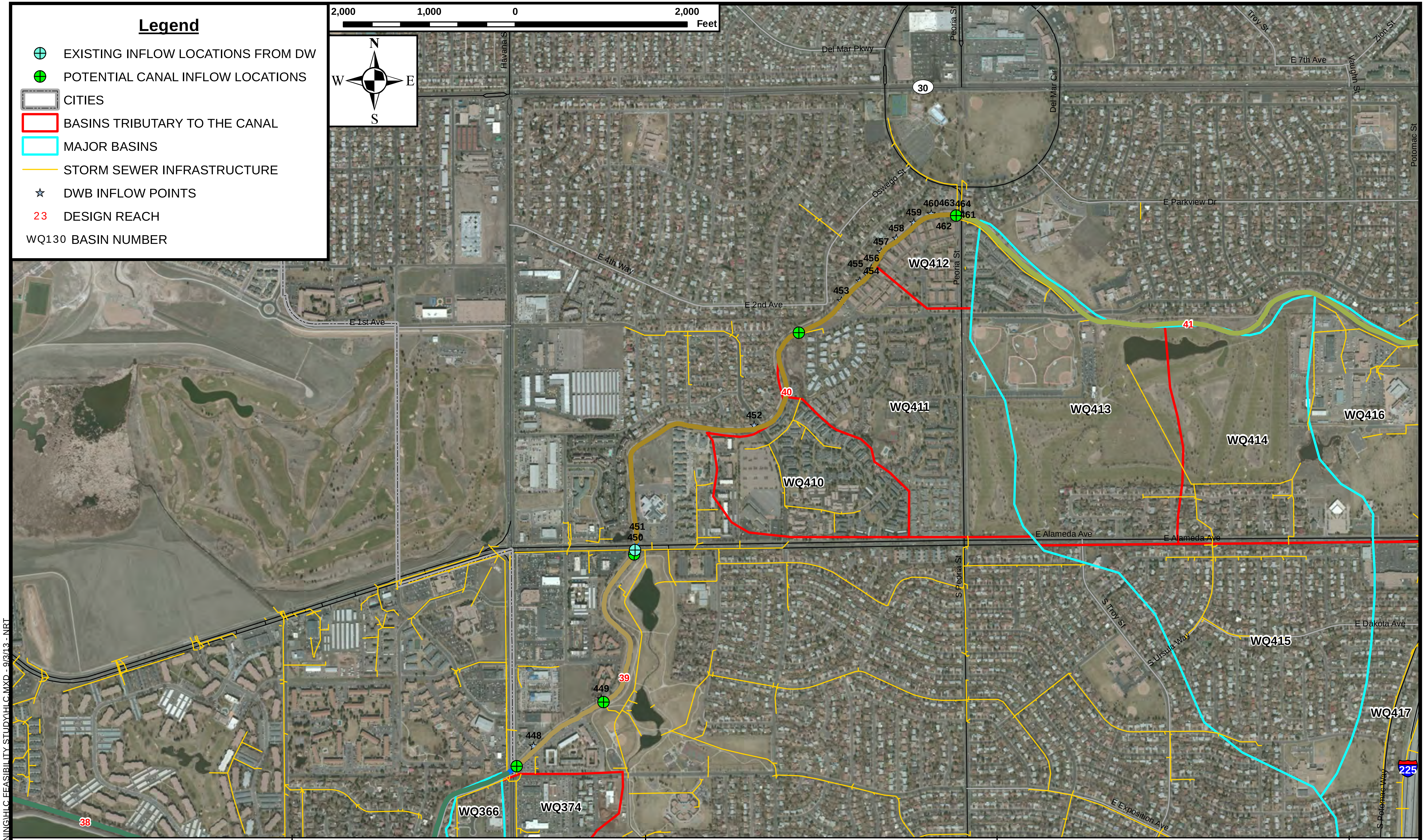
DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-10



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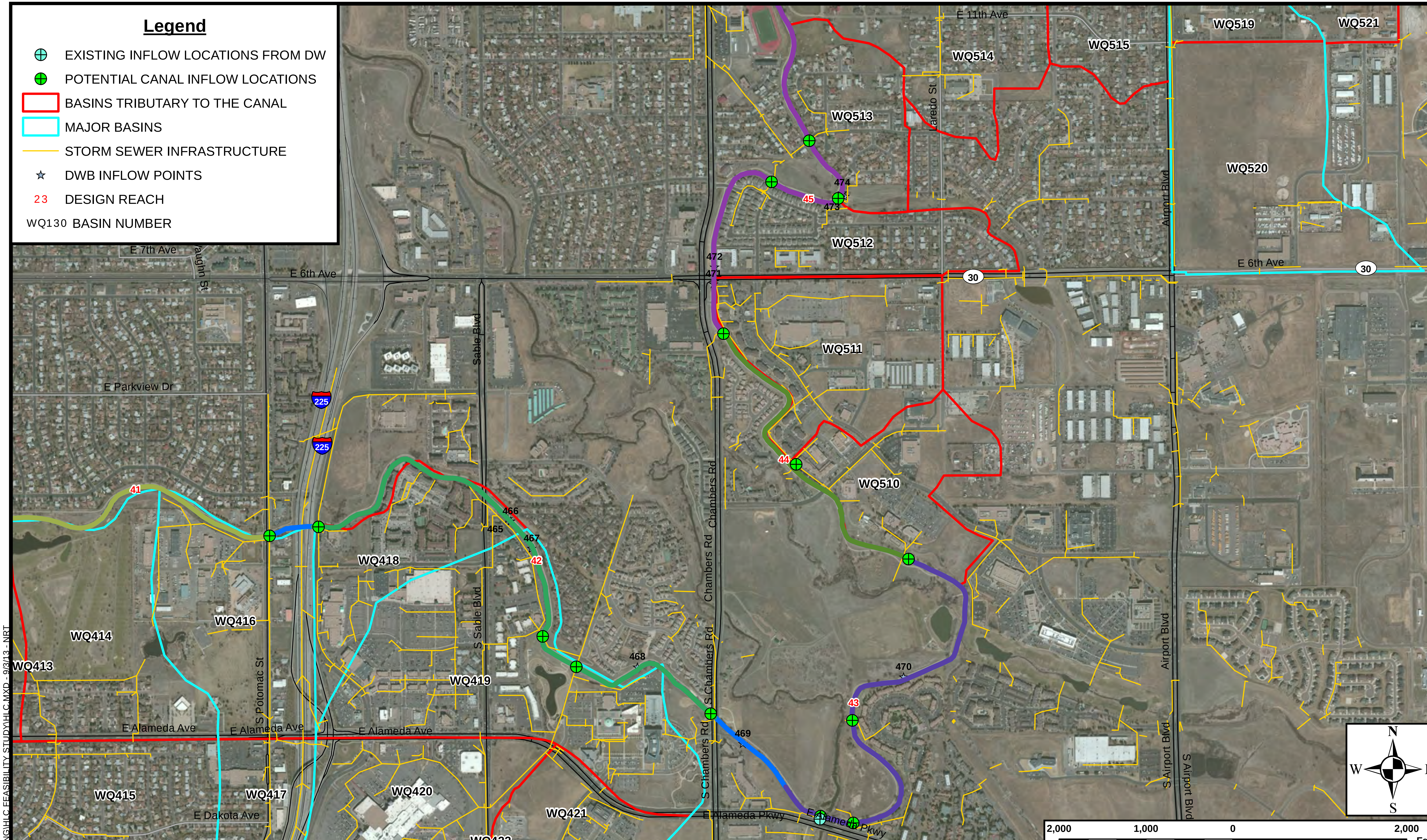
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-11



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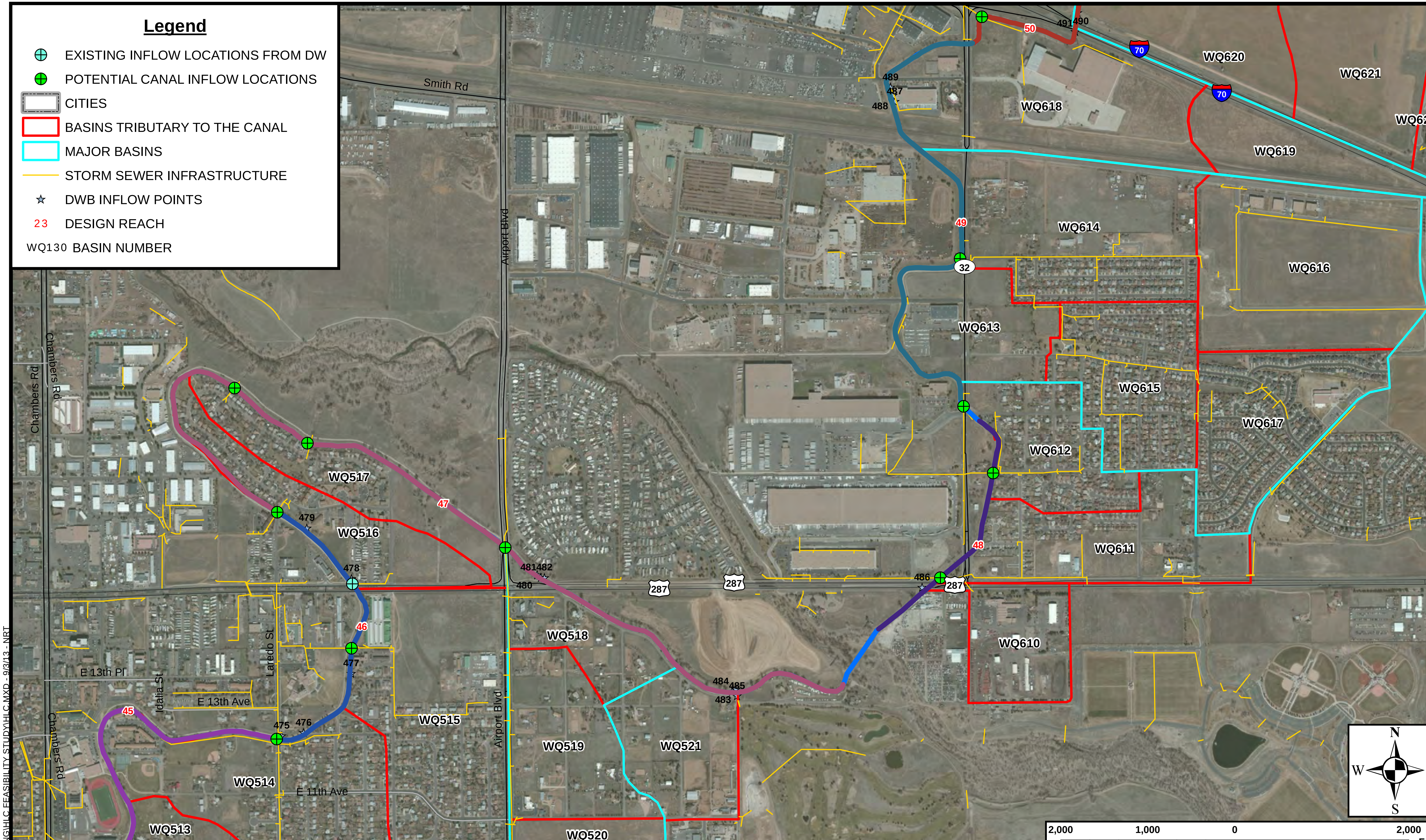
DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-12



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DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

FIGURE C-13

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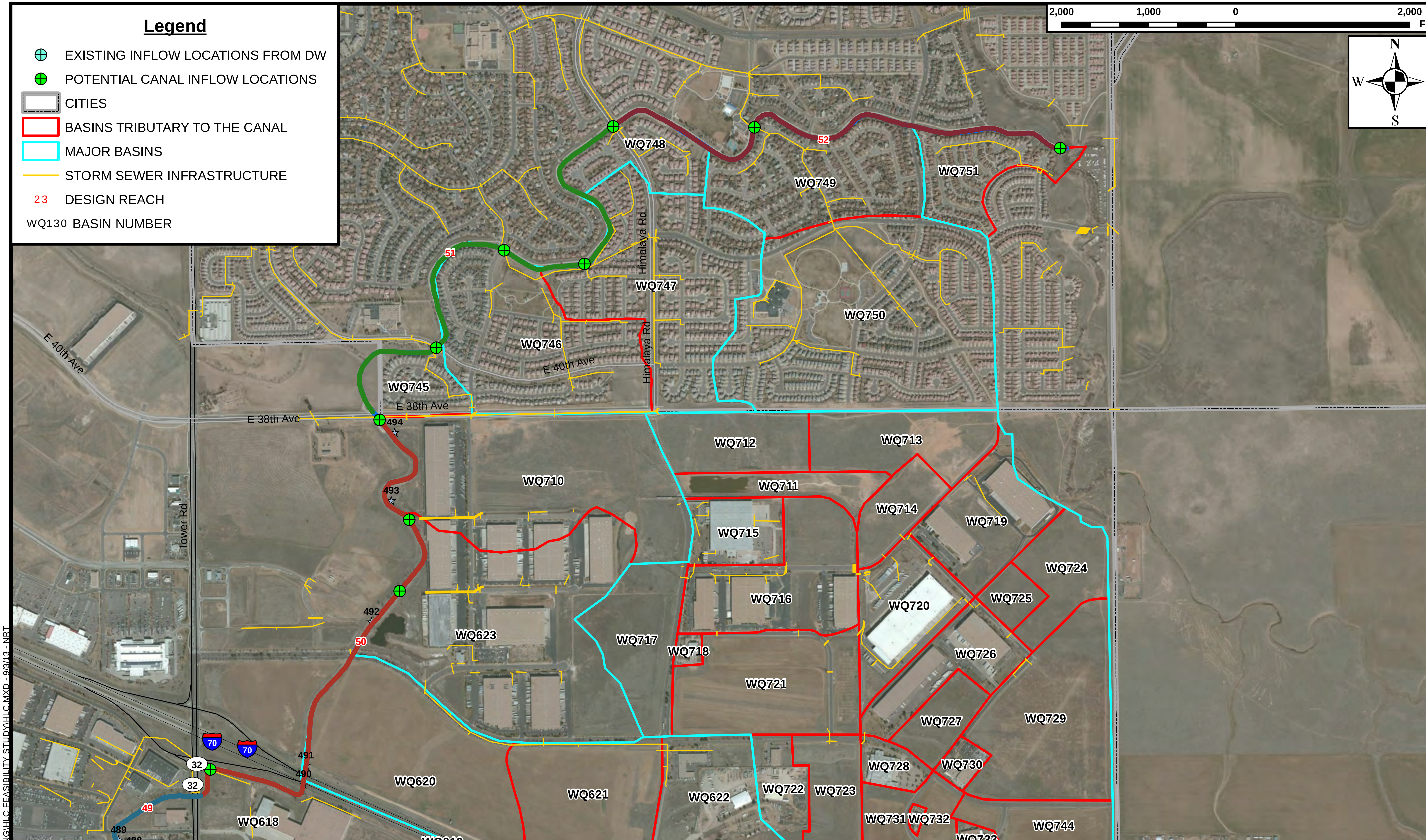

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DENVER HIGH LINE CANAL FEASIBILITY STUDY

REACH & BASIN DELINEATIONS WITH INFLOW LOCATIONS

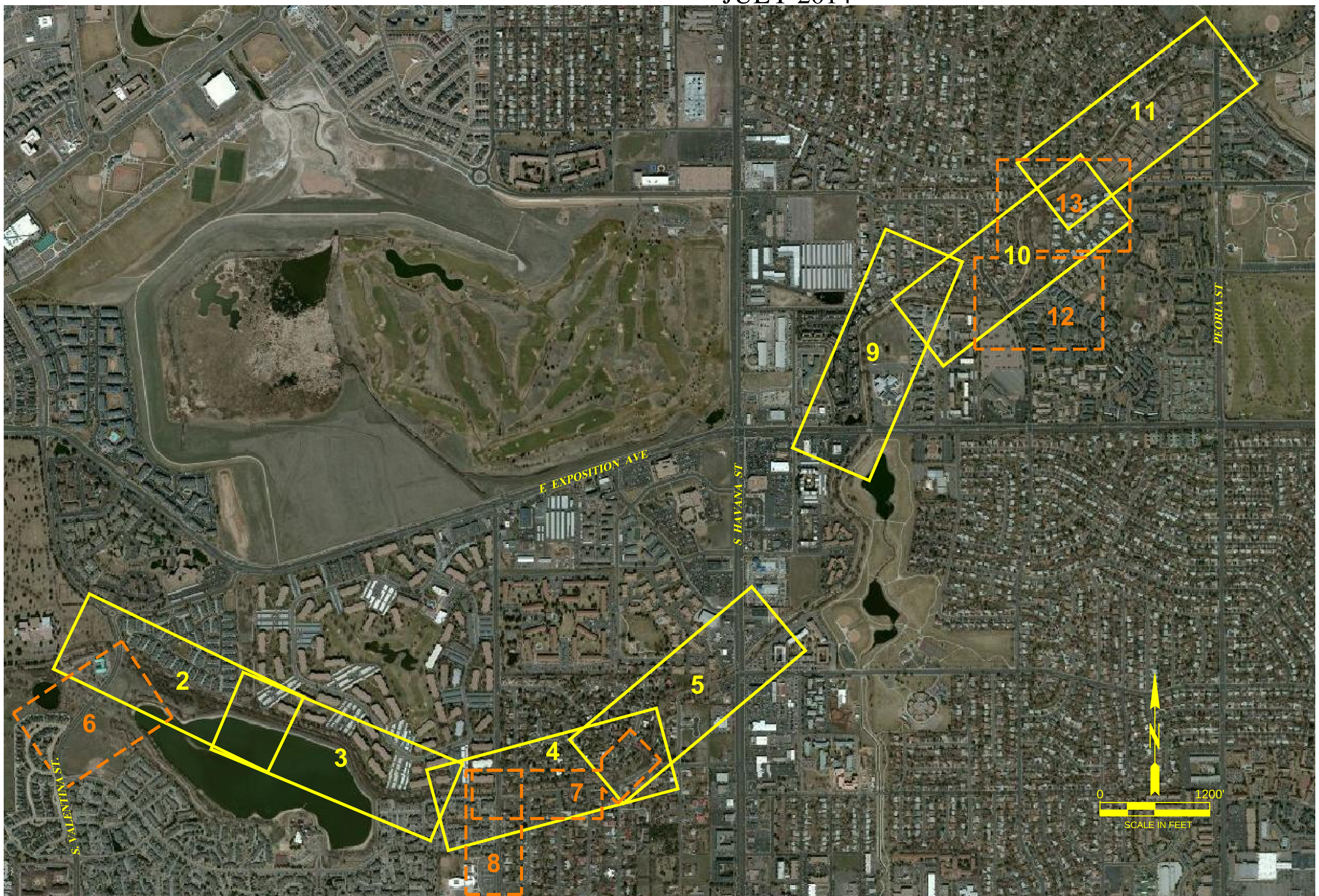
FIGURE C-14

APPENDIX D – Pilot Reach Conceptual Design Drawings

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

HIGH LINE CANAL
FEASIBILITY STUDY FOR STORM WATER
RUNOFF REDUCTION AND TREATMENT
CONCEPTUAL DESIGN - REACH 38 & 40

JULY 2014



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3	PLAN AND PROFILE
4	PLAN AND PROFILE
5	PLAN AND PROFILE
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11	PLAN AND PROFILE
12	MOLINE STREET WQ OUTFALL
13	1ST & NEWARK WQ OUTFALL
14	REACH 40 FOREBAYS
15	DETAILS

NAME: Z:\UDFCD PLANNING\HLC MASTER PLAN\CAD\SHEETS\02310_S_COVER.DWG
PLOT DATE: July 2, 2014 5:47 PM, BY: TODD M. NELSON

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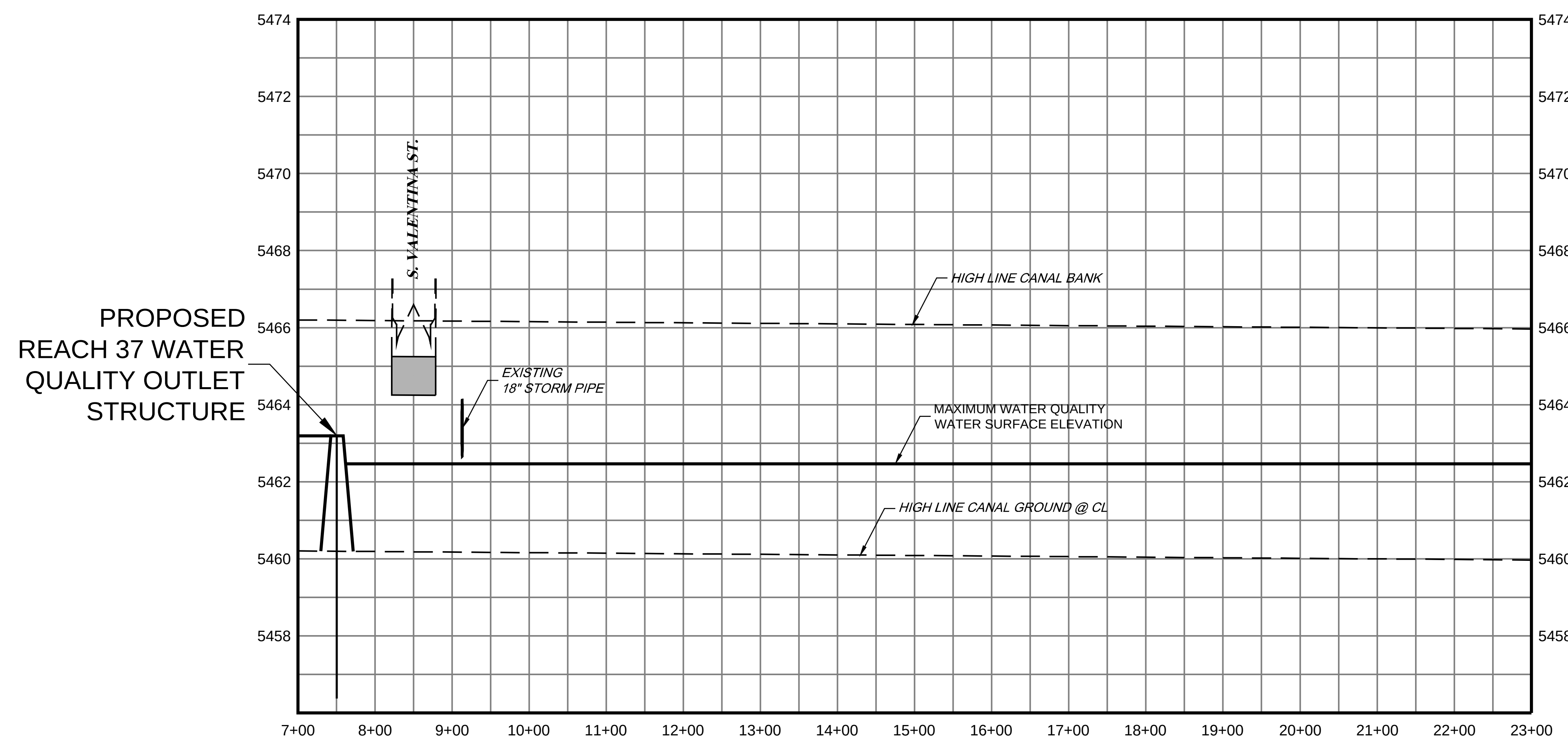
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

HIGH LINE CANAL WQ FEASIBILITY STUDY

COVER SHEET

SHEET NUMBER:
1
SHEET 1

REACH 37 | REACH 38



NAME: Z:\UDFCD PLANNING\HLC MASTER PLAN\CAD\SHEETS\02310_S_PLPR_REACH38.DWG
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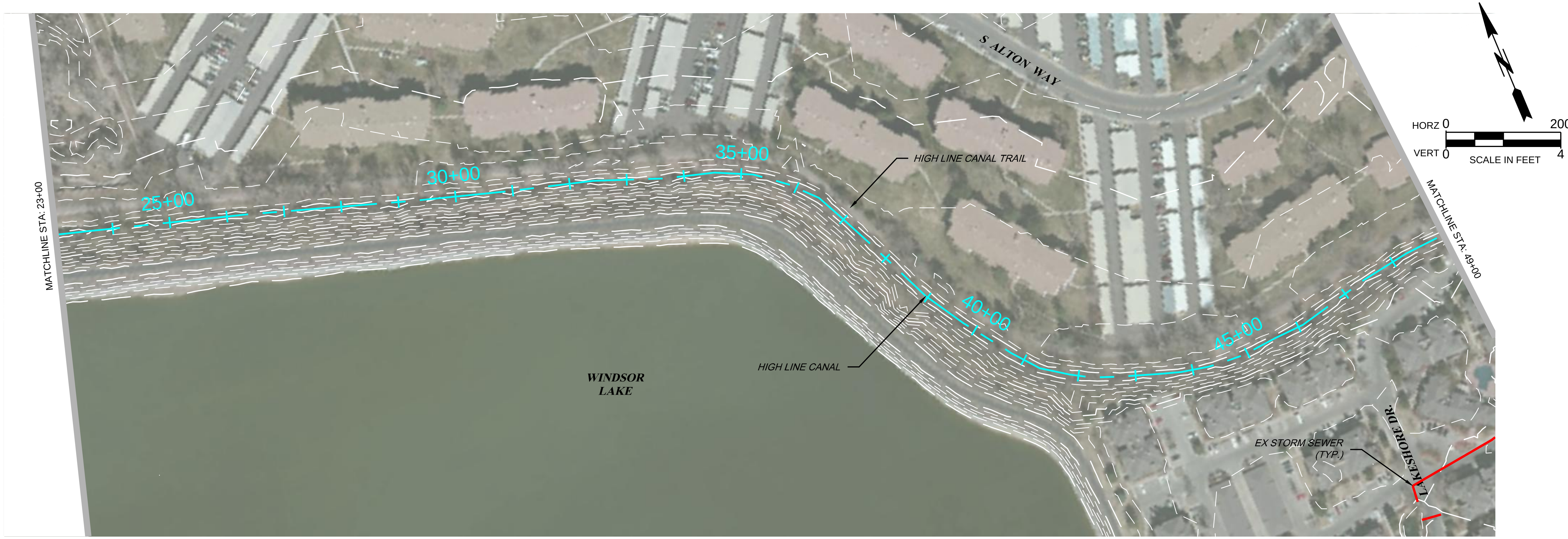
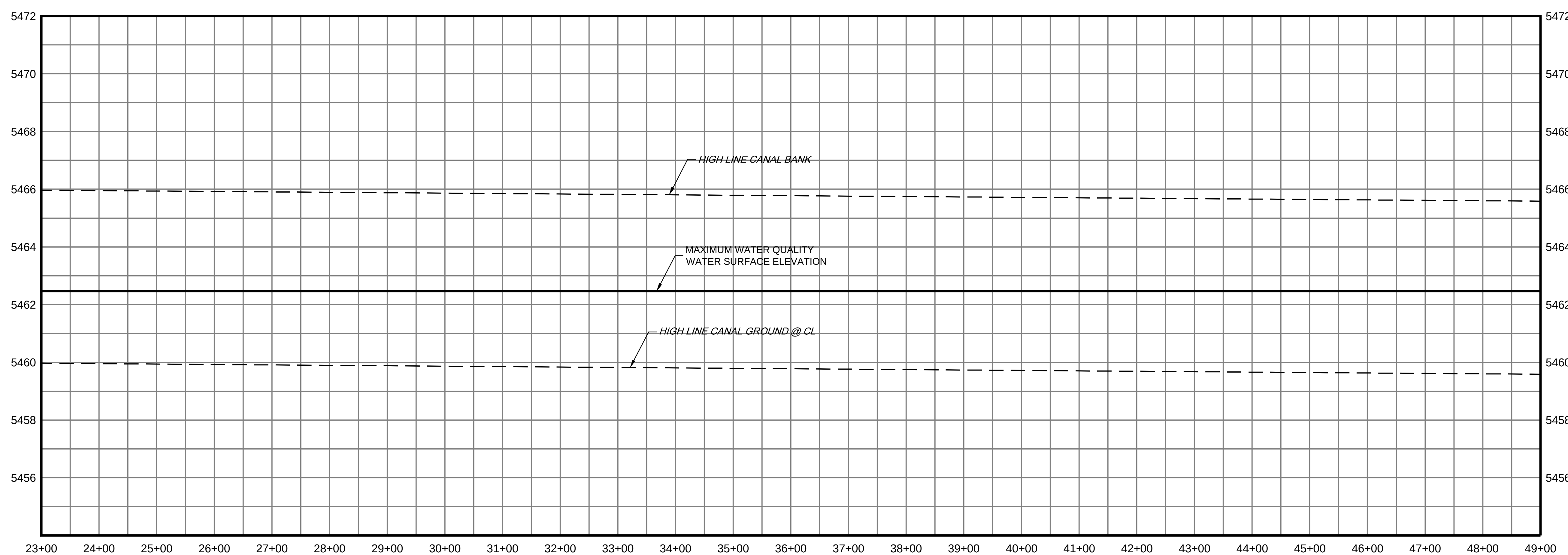
REACH 38
PLAN AND PROFILE

SHEET NUMBER:
2
SHEET 2



REACH 38



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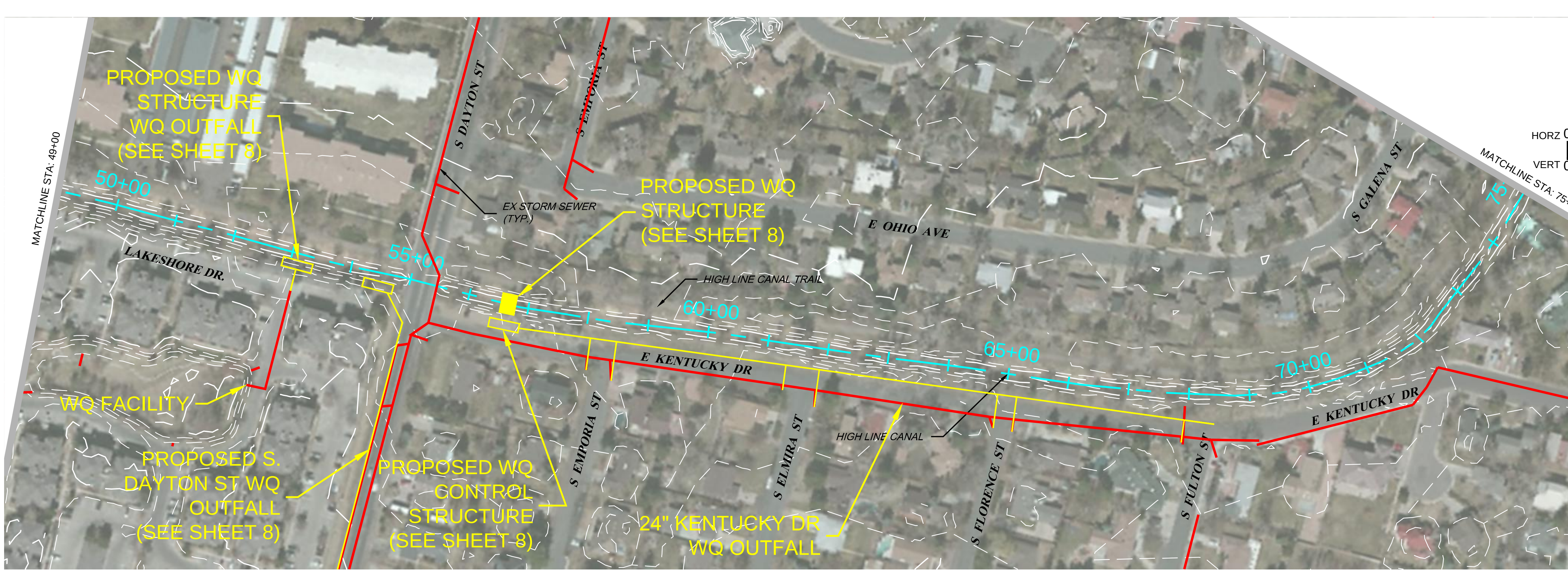
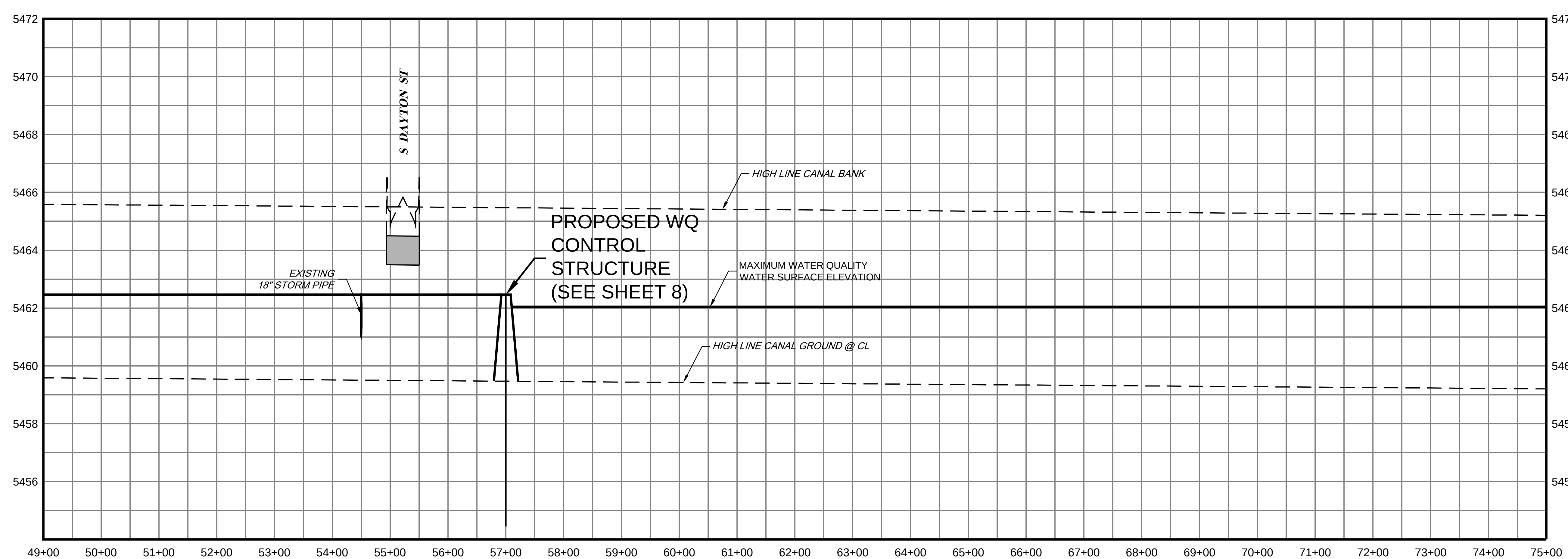
REACH 38
PLAN AND PROFILE

SHEET NUMBER:
3
SHEET 3



REACH 38



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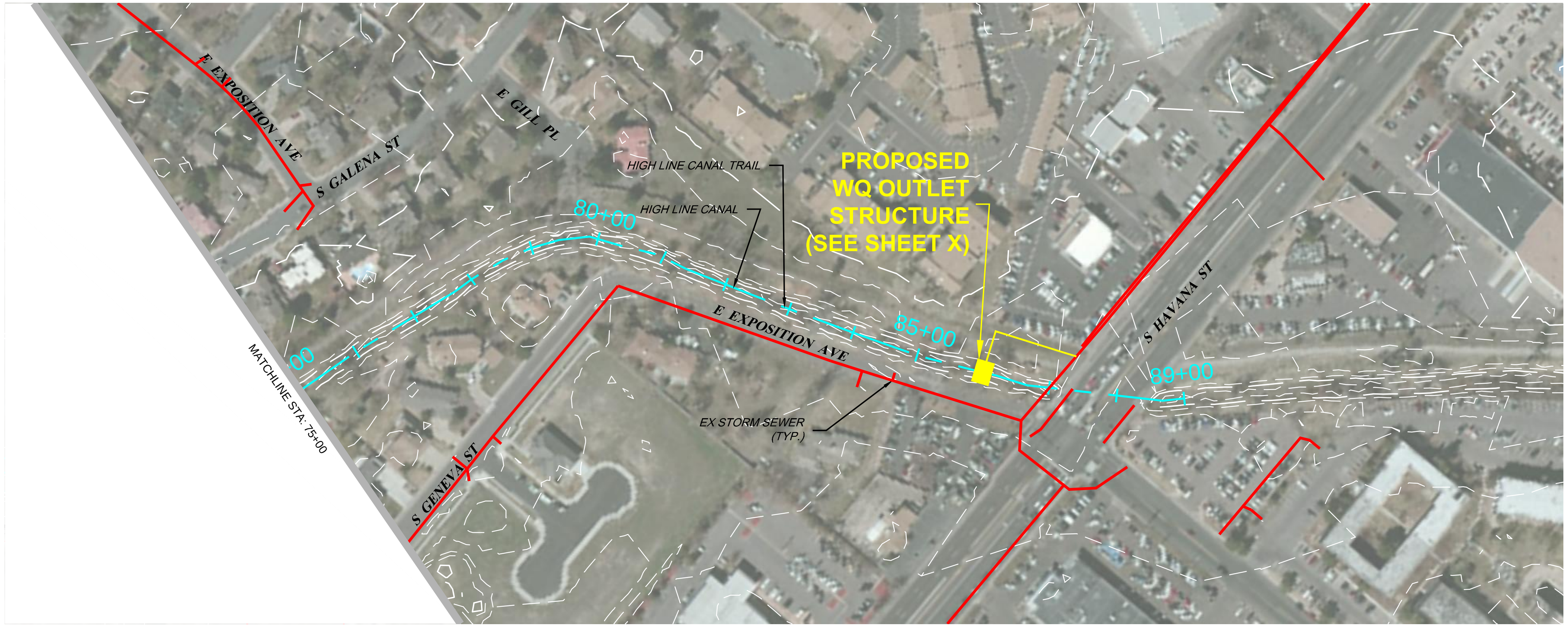
REACH 38
PLAN AND PROFILE

SHEET NUMBER:
4
SHEET 4



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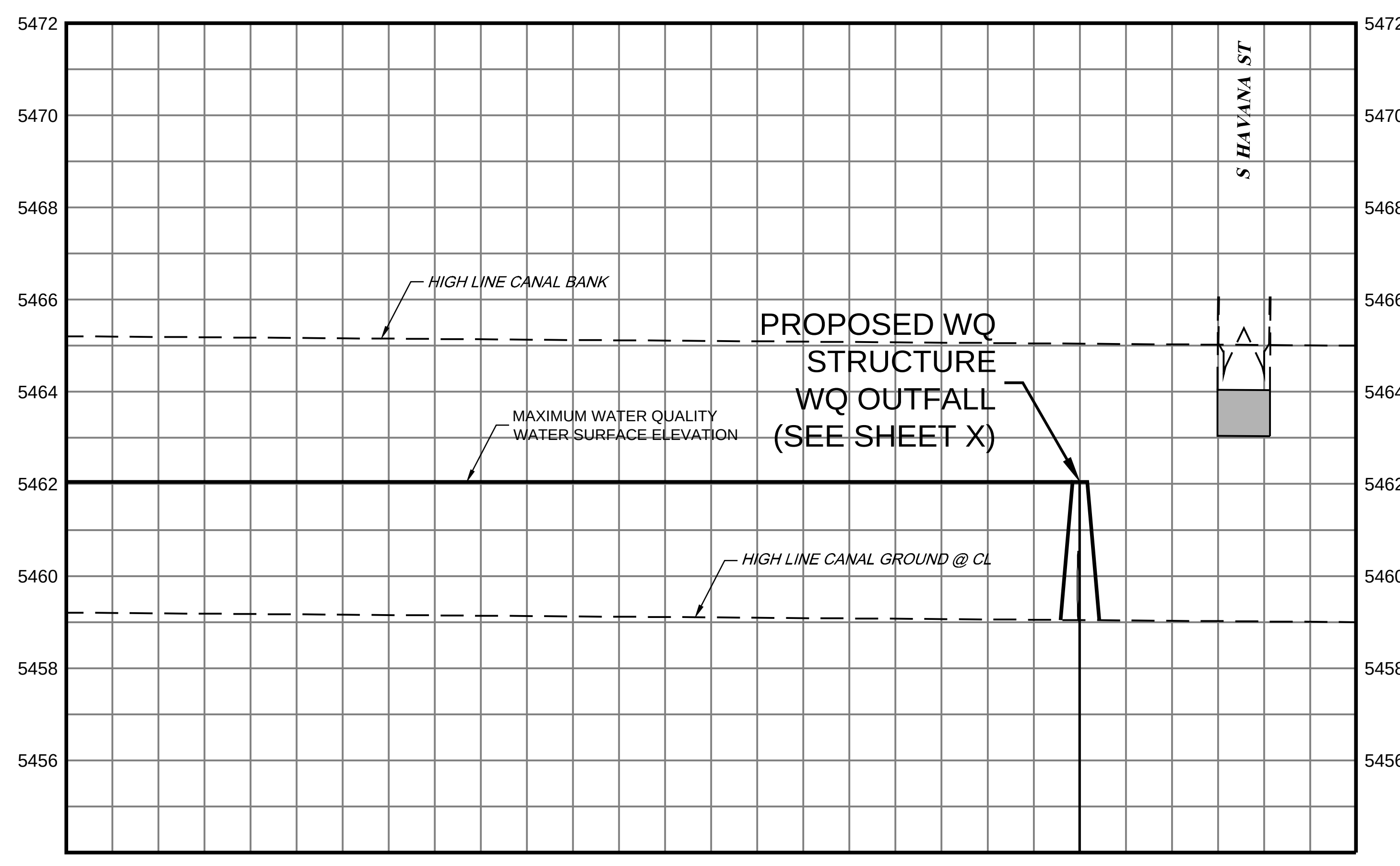
SCALE IN FEET

REACH 38

REACH 39



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REACH 38 PLAN AND PROFILE

SHEET NUMBER:
5
SHEET 5

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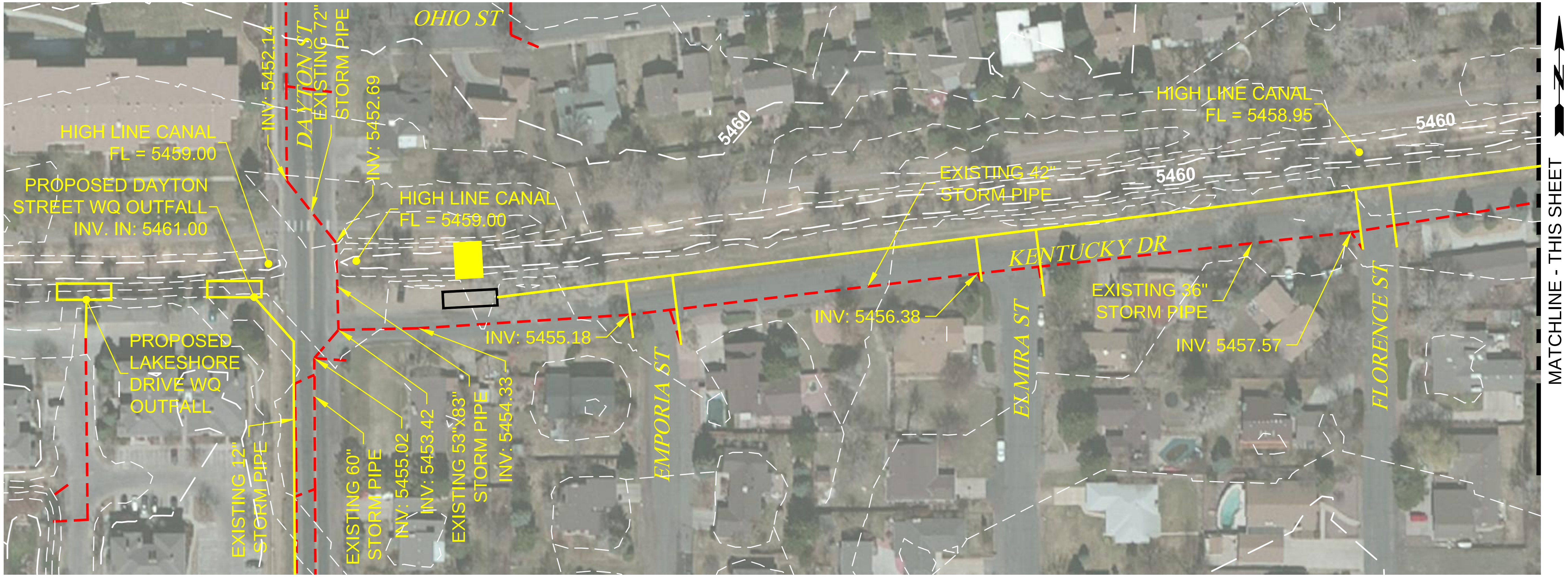
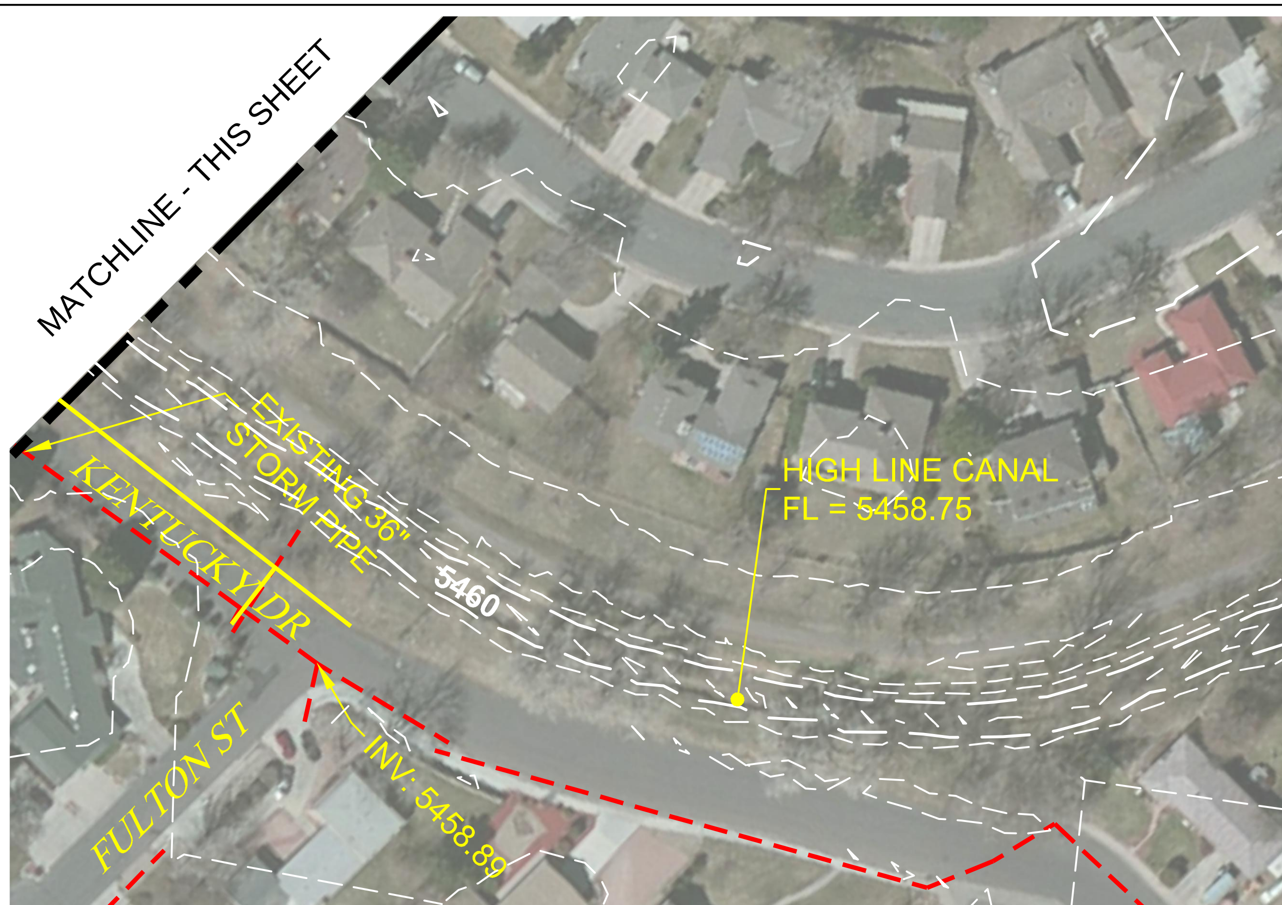
HIGH LINE CANAL WQ FEASIBILITY STUDY

VALENTIA STREET WQ OUTFALL

SHEET NUMBER:
6
SHEET 6





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SCALE IN FEET

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HIGH LINE CANAL WQ FEASIBILITY STUDY

EAST KENTUCKY WQ OUTFALL

SHEET NUMBER:
7
SHEET 7

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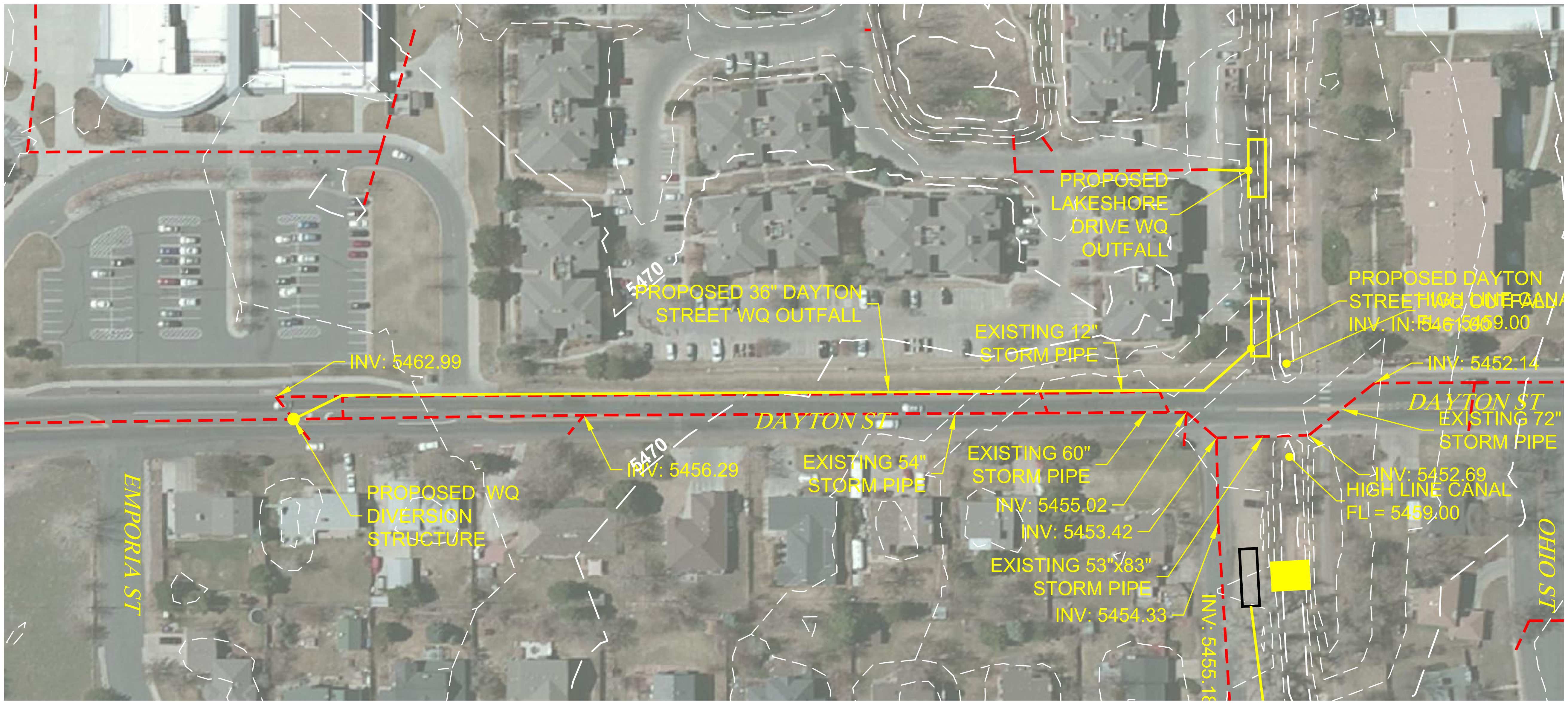

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SCALE IN FEET

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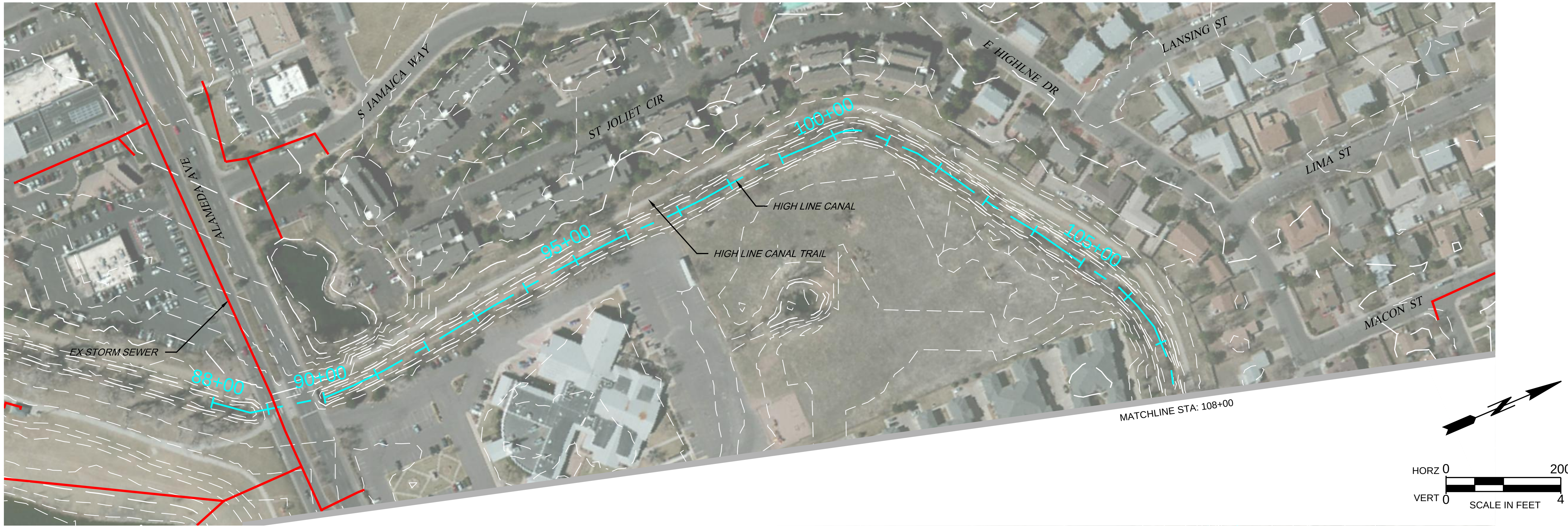
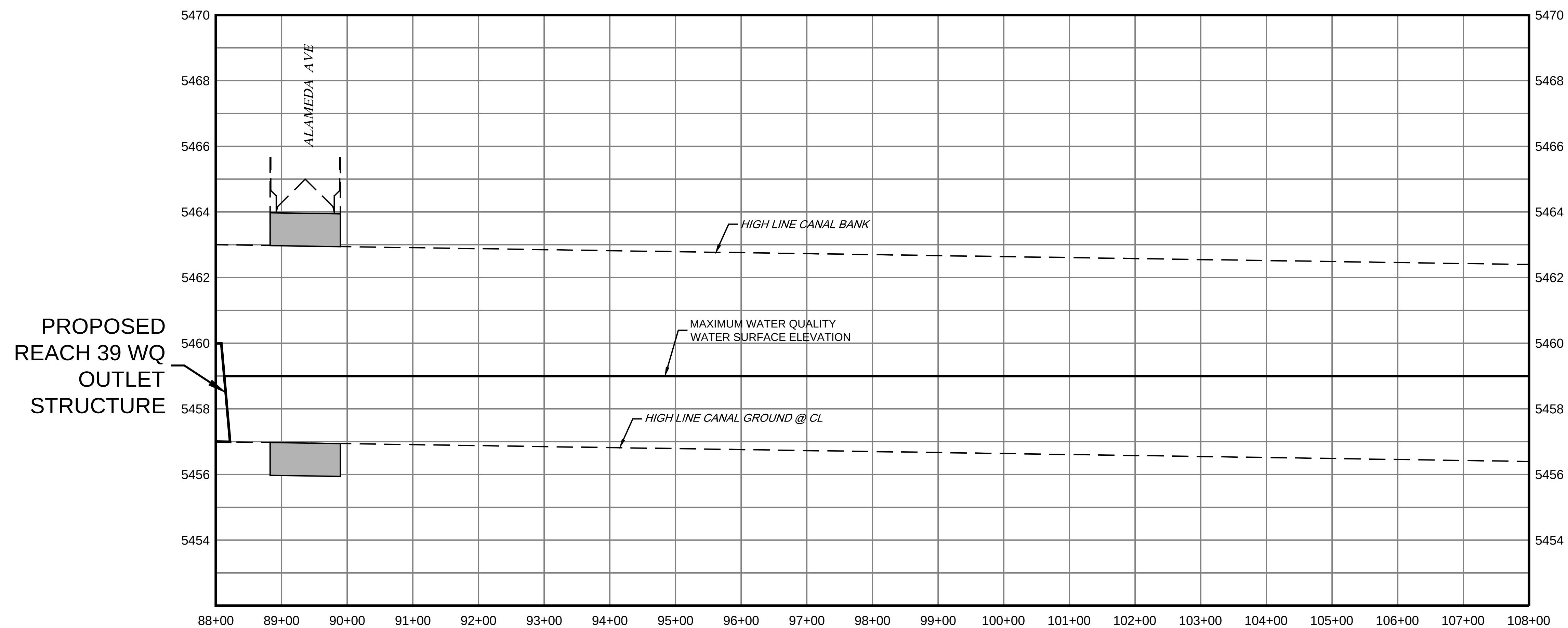
HIGH LINE CANAL WQ FEASIBILITY STUDY

SOUTH DAYTON STREET WQ OUTFALL

SHEET NUMBER:
8
SHEET 8



REACH 39 — REACH 40



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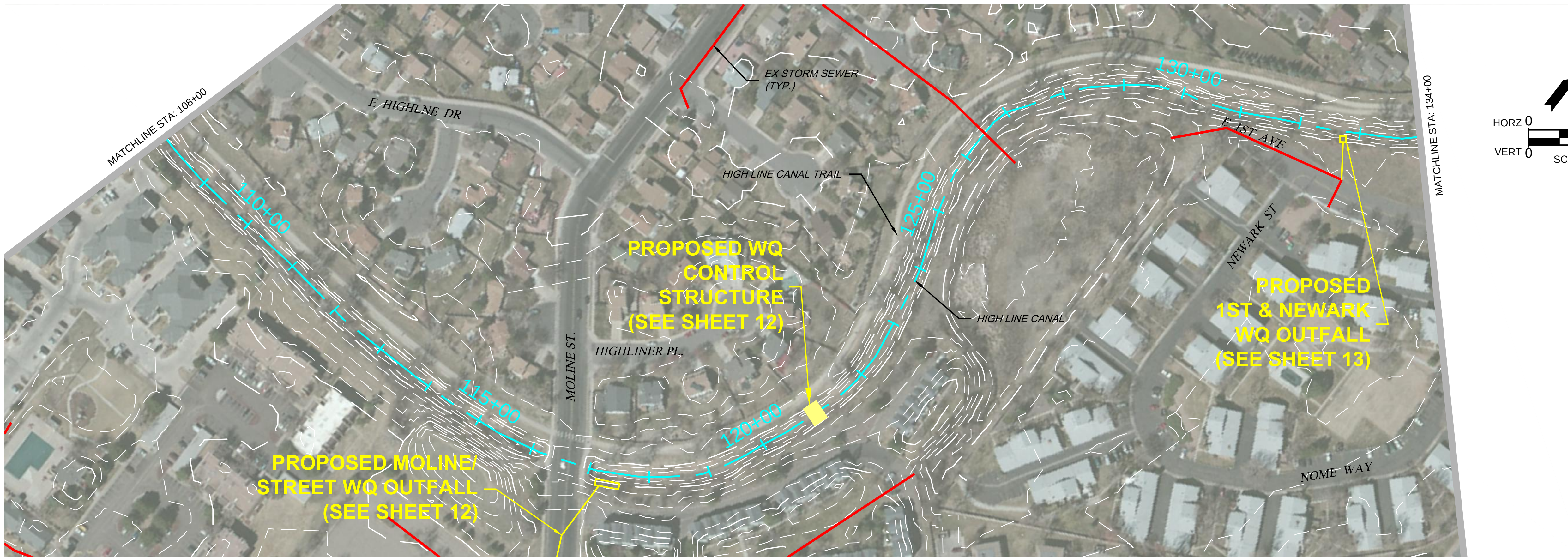
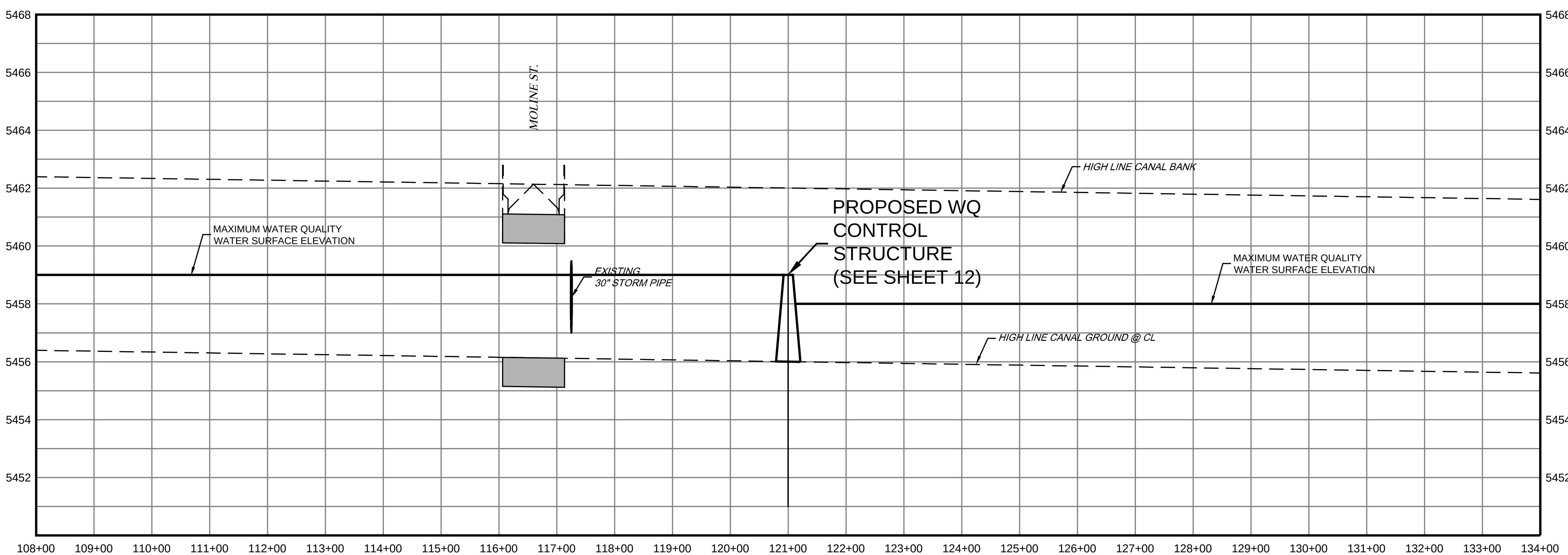
HIGH LINE CANAL WQ FEASIBILITY STUDY

REACH 40
PLAN AND PROFILE

SHEET NUMBER:
9
SHEET 9



REACH 40



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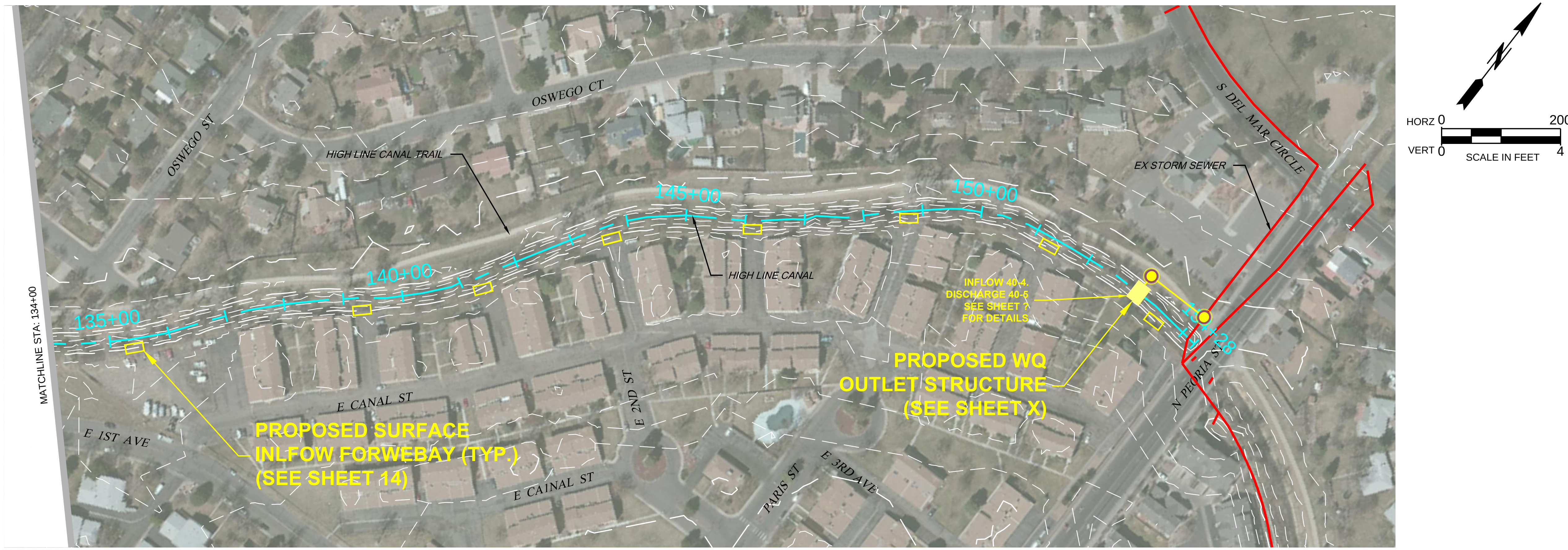
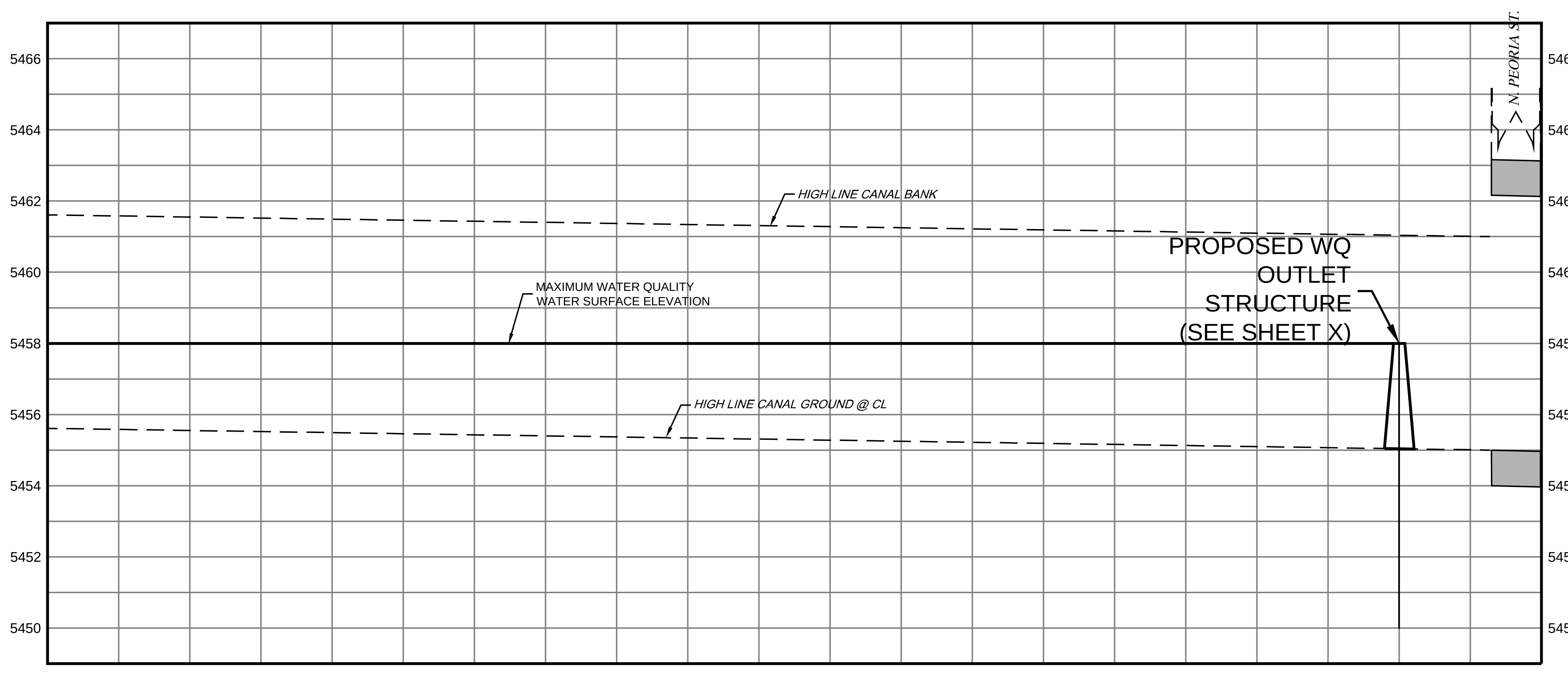
HIGH LINE CANAL WQ FEASIBILITY STUDY

REACH 40 PLAN AND PROFILE

SHEET NUMBER:
10
SHEET 10



REACH 40 | REACH 41



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REACH 40
PLAN AND PROFILE

SHEET NUMBER:
11
SHEET 11

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HIGH LINE CANAL WQ FEASIBILITY STUDY

MOLINE STREET WQ OUTFALL

SHEET NUMBER:
12
SHEET 12

NAME: Z:\UDFCD PLANNING\HLC MASTER PLAN\CAD\SHEETS\02310_S_DRAIN PLAN.DWG
PLOT DATE: July 2, 2014 5:49 PM, BY: TODD M. NELSON

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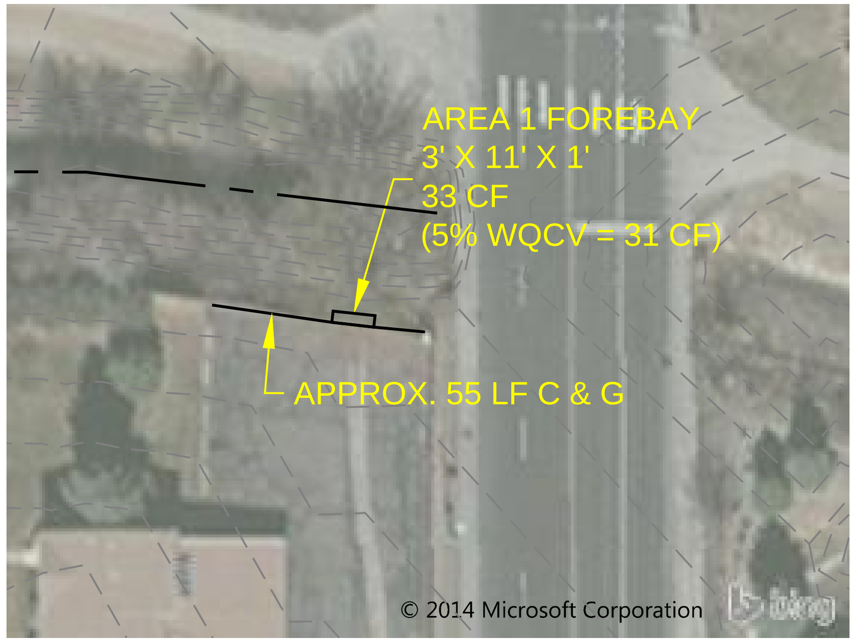
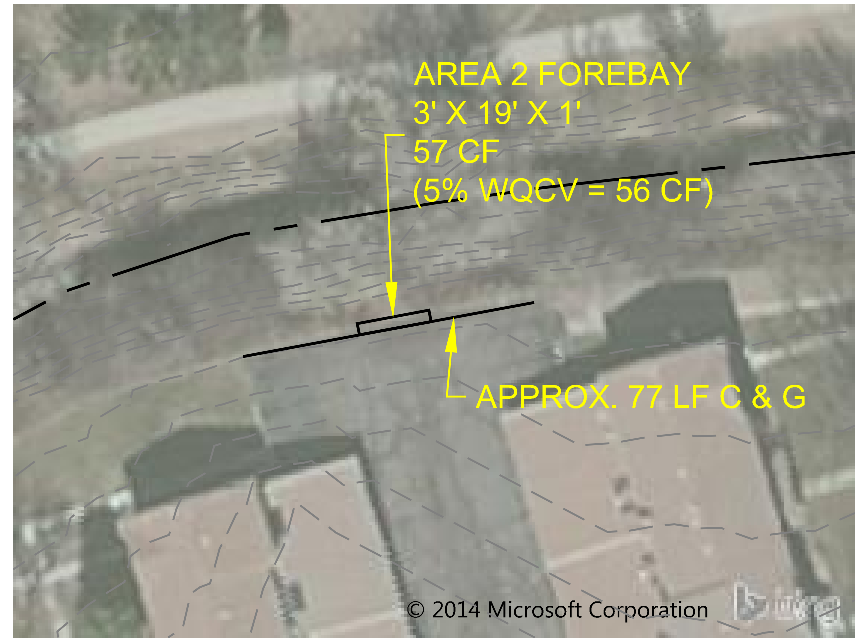
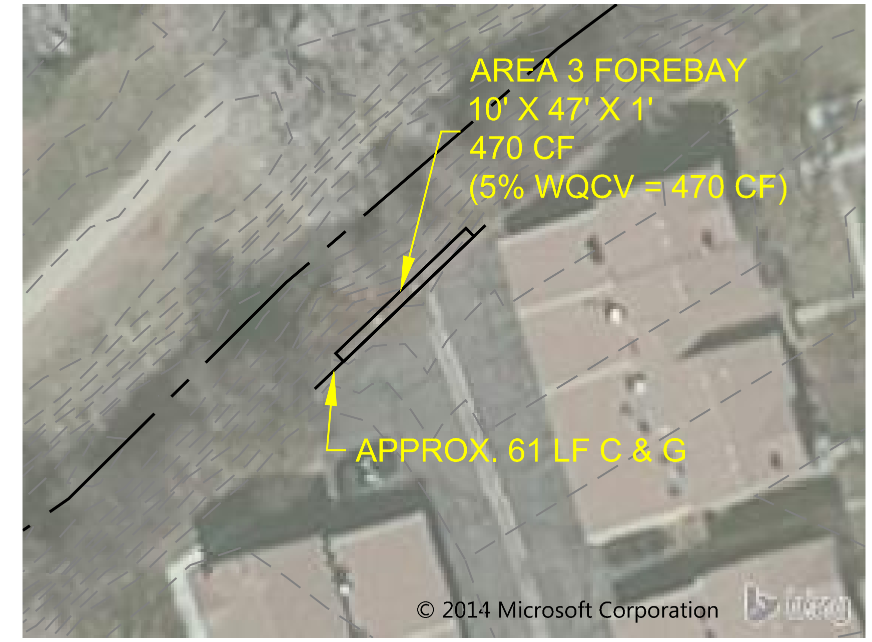
HIGH LINE CANAL WQ FEASIBILITY STUDY

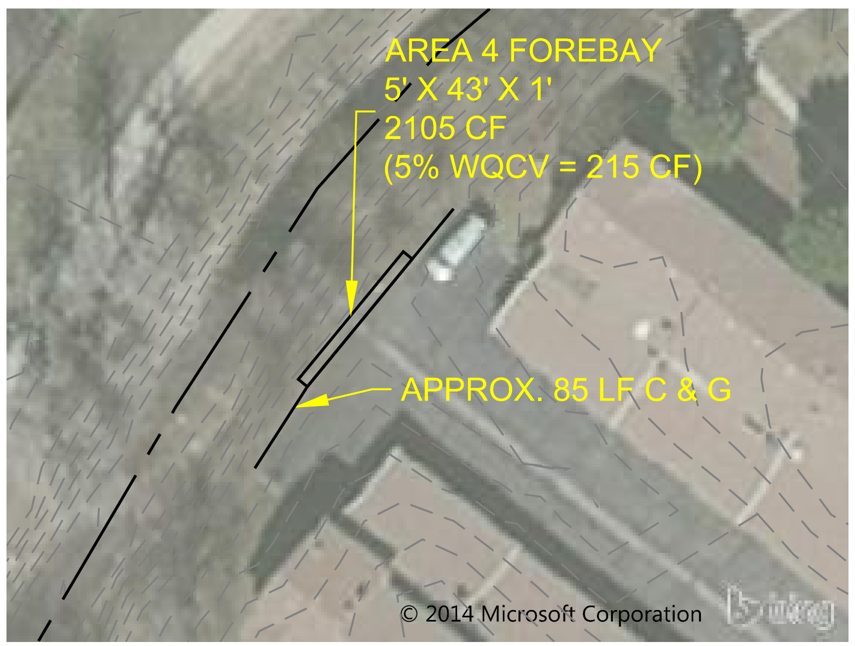
1ST & NEWARK WQ OUTFALL

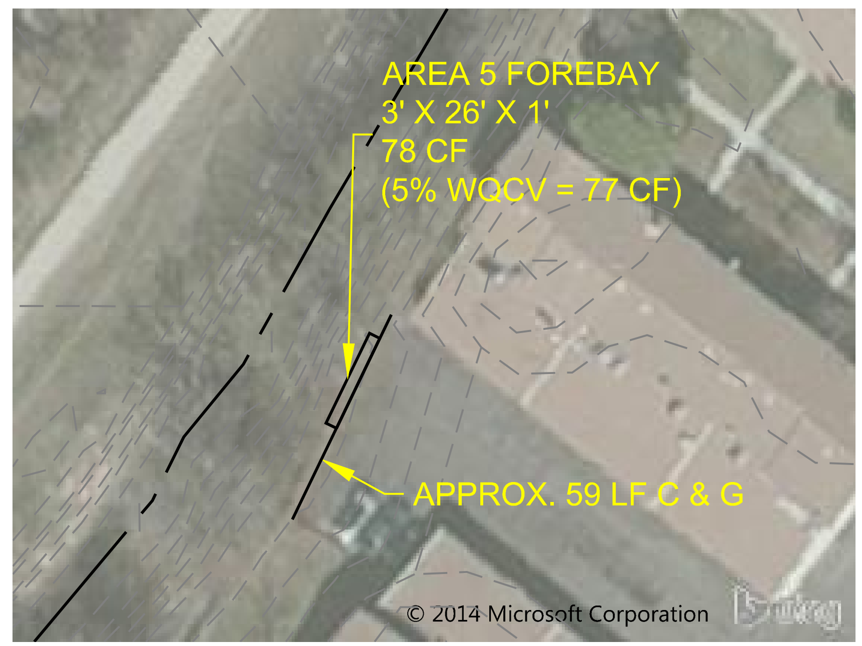
SHEET NUMBER:
13
SHEET 13

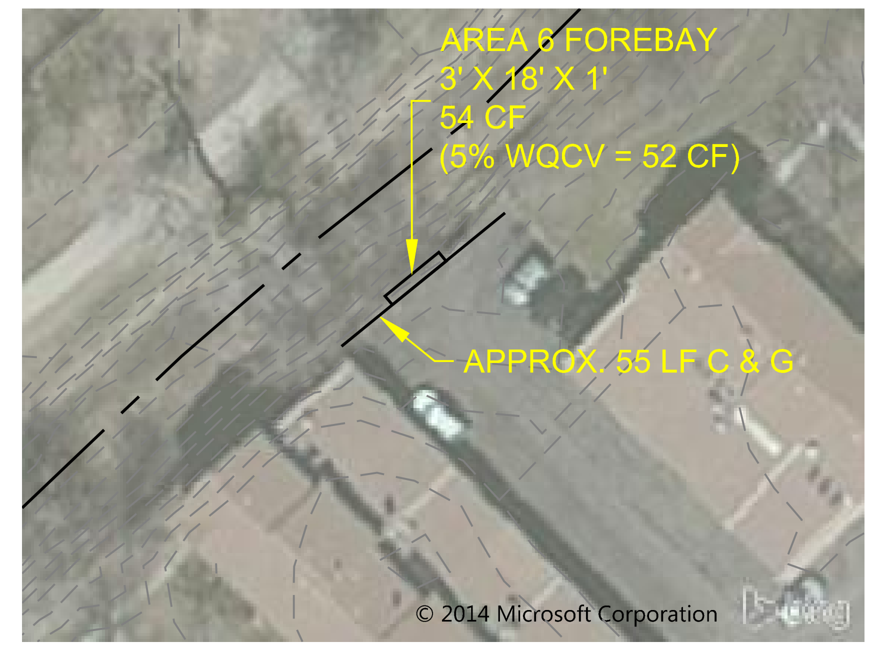


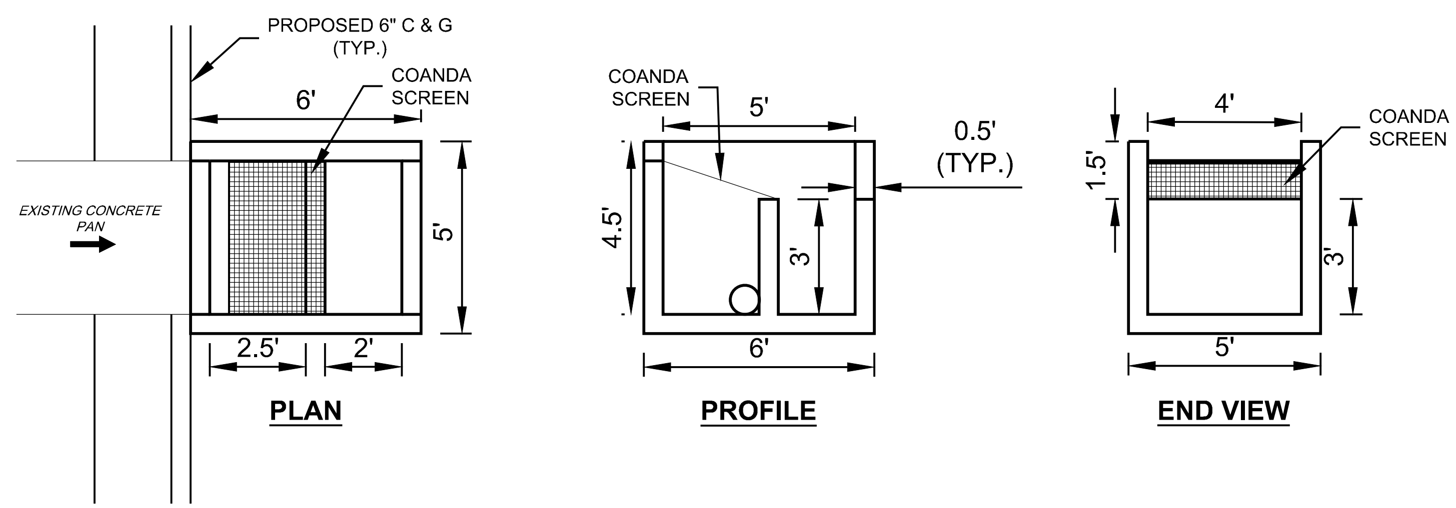












TRASH SEPARATOR DETAIL

SCALE: 1" = 5'

0 50
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HIGH LINE CANAL WQ FEASIBILITY STUDY

REACH 40 FOREBAYS

SHEET NUMBER:
14
SHEET 14

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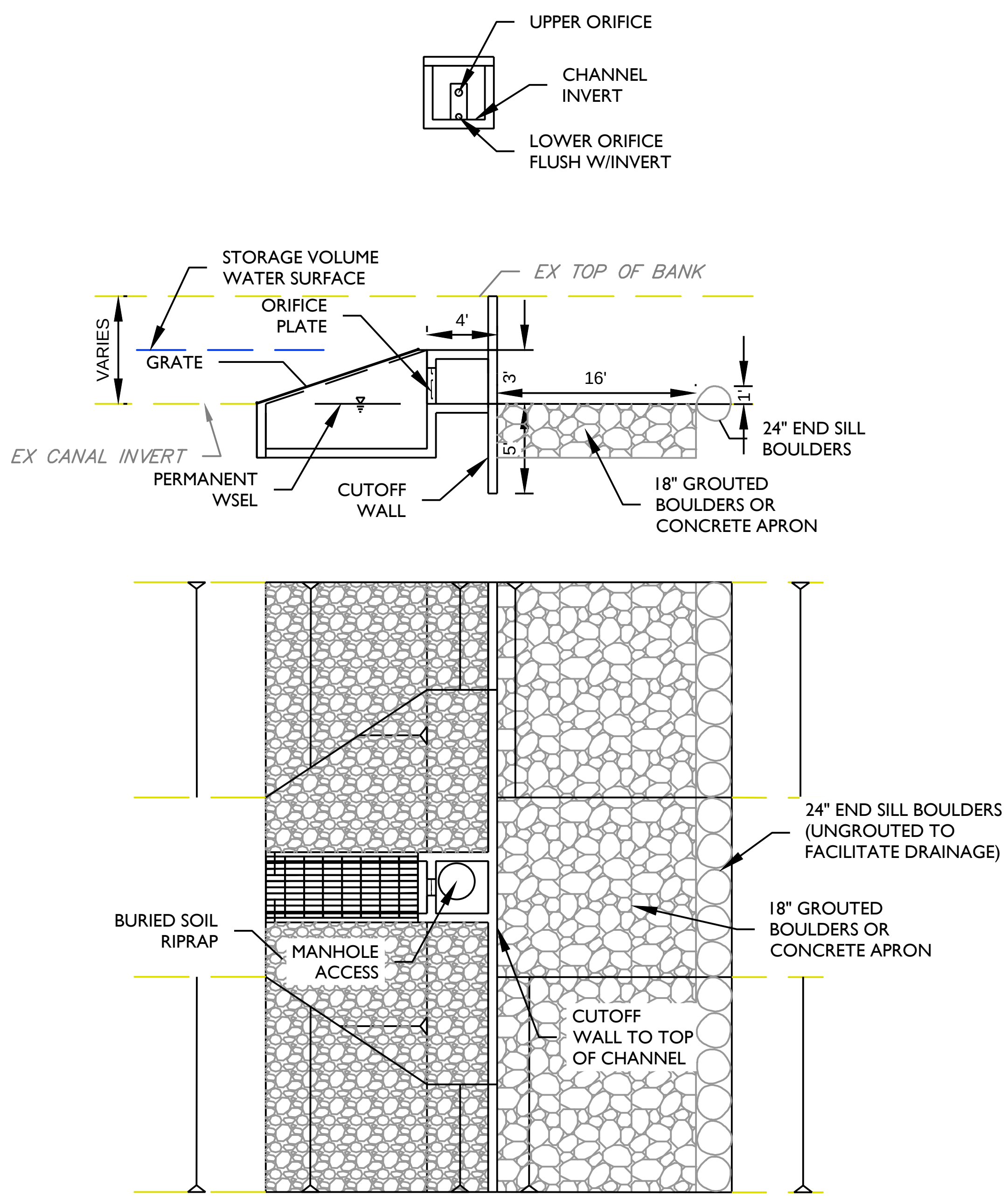
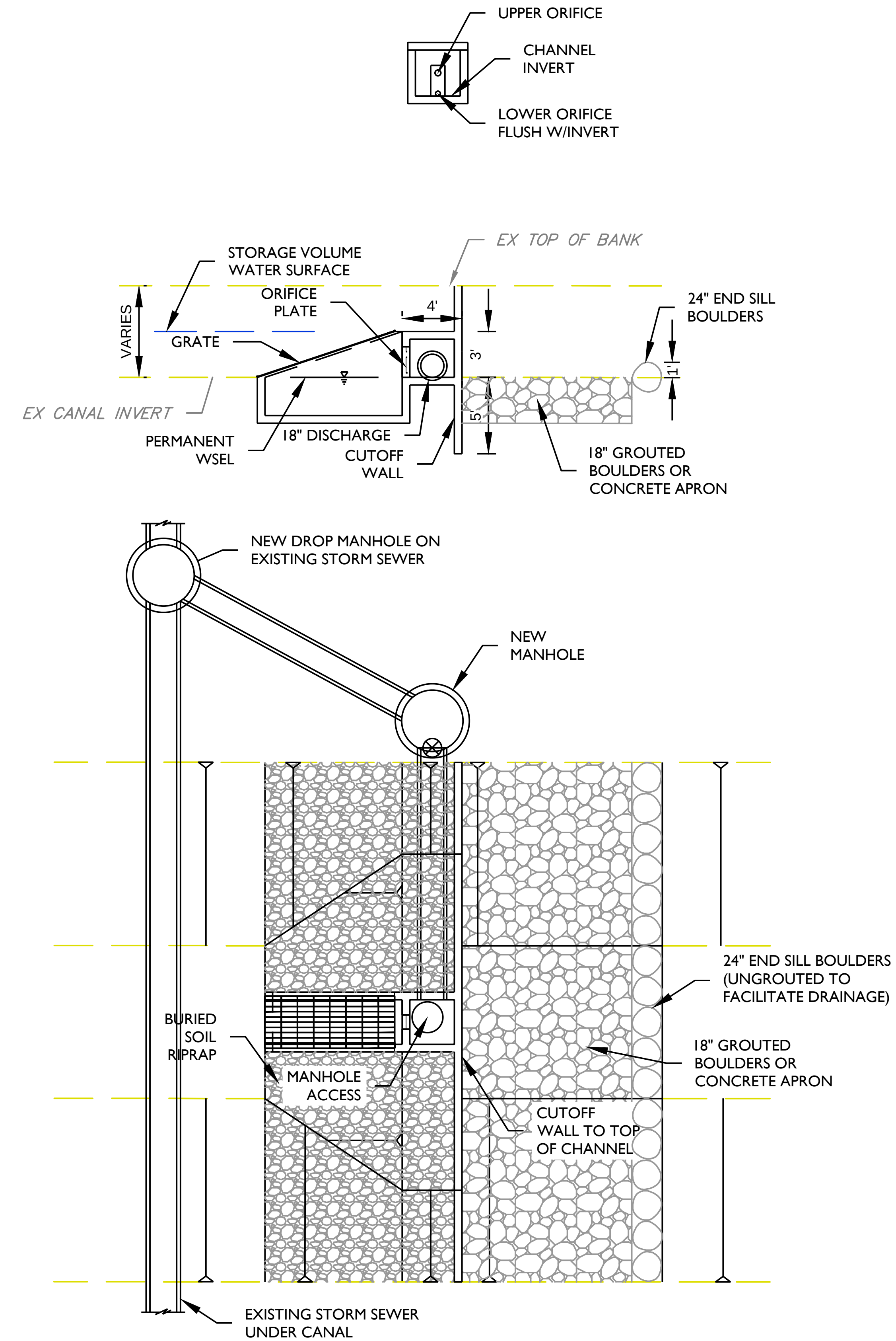


WATER QUALITY CONTROL STRUCTURE

N.T.S.



WATER QUALITY OUTFALL STRUCTURE

N.T.S.

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DETAILS

SHEET NUMBER:
15
SHEET 15

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PLOT DATE: August 19, 2014 1:40 PM, BY: JESSICA NOLLE