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Little Dry Creek, Tributary B, and Shaw Heights Tributary
DRAFT Major Drainageway Plan

November 2018

November 8, 2018

Mrs. Brooke Seymour, PE, CFM
Project Manager, Watershed Services
Urban Drainage and Flood Control District
2480 W. 26th Avenue, Suite 156B
Denver, CO 80211

Re: Little Dry Creek, Tributary B, and Shaw Heights Tributary Draft Major Drainageway Plan
Agreement No. 14-07.01
Olsson Project No. 014-1761

Dear Mrs. Seymour:

Olsson is pleased to submit the draft hydrology report for the Little Dry Creek, Tributary B, and Shaw Heights Tributary Draft Major Drainageway Plan. This report documents the baseline hydrology development process.

The hydrology report was prepared with the cooperation of UDFCD, Arvada, Westminster, and Adams County. The baseline hydrology will be used for the alternatives analysis and conceptual design.

We appreciate the opportunity to work with you on this project and look forward to working with you on the next phase of the project.

Sincerely,

Deb Ohlinger, PE, CFM
Project Manager

Amy M. Gabor, PE, CFM, LEED® AP
Project Engineer

Krystina Pacheco, EI
Assistant Engineer

CC: Brooke Seymour, Urban Drainage and Flood Control District
Russ Nelson, Adams County
Andrew Hawthorn, City of Westminster
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TABLE OF CONTENTS

EXECUTIVE SUMMARY 1
Purpose and Objective 1
Planning Process 1
Project Area Description 1
Alternatives Analysis 1
Master Plan 1
1.0 INTRODUCTION 1
1.1 Authorization 1
1.2 Purpose and Scope 1
1.3 Planning Process 1
1.4 Mapping and Surveys 1
1.5 Data Collection 1
1.6 Acknowledgements 2
2.0 STUDY AREA DESCRIPTION 3
2.1 Project Area 3
2.2 Land Use 5
2.3 Reach Description 5
2.4 Flood History 5
2.5 Environmental Assessment 6
3.0 HYDROLOGIC ANALYSES 7
3.1 Overview 7
3.2 Design Rainfall 7
3.3 Subwatershed Characteristics 8
3.4 Hydrograph Routing 8
3.5 Previous Studies 9
3.6 Results of Analysis 9
4.0 HYDRAULIC ANALYSIS 15
4.1 Evaluation of Existing Facilities 15
4.2 Flood Hazards 15
4.3 Previous Analysis 15
5.0 ALTERNATIVE ANALYSIS 16
5.1 Alternative Development Process 16
5.2 Criteria and Constraints 16
5.3 Alternative Categories 16
5.4 Alternative Hydraulics 16
5.5 Alternative Costs 16
5.6 Alternative Plans 16
5.7 Evaluation of Alternatives 16
5.8 Recommended Plan 16
6.0 CONCEPTUAL DESIGN 17
6.1 Plan Development Overview 17
6.2 Master Plan Description 17
6.3 Prioritization and Phasing 17
6.4 Water Quality Impacts 17
6.5 Operations and Maintenance 17
6.6 Environmental and Safety Assessment 17
7.0 REFERENCES 18

LIST OF APPENDICES

Appendix A – Project Correspondence
Meeting Minutes
Public Meeting Sign-in, Minutes, and Comments

Appendix B – Hydrologic Analysis
Figures B-1 through B-2B
Land Use Maps
Tables B-1 through B-5
EPA SWMM 5.1 Baseline Hydrology Input Parameters
EPA SWMM 5.1 Baseline Hydrology Output Parameters
Table B-6
Figure B-3

Appendix C – Hydraulic Analysis

Appendix D – Wetland and Riparian Inventory

Appendix E – Alternative Analysis

Appendix F – Conceptual Design Information

Appendix G – Master Plan Maps

Appendix H – Master Plan Profiles

LIST OF FIGURES

Figure 1 – Watershed Map 4
Figure 2A – Little Dry Creek Baseline Peak Discharge vs. Drainageway Station - Future Conditions 12
Figure 2B – Tributary B Baseline Peak Discharge vs. Drainageway Station - Future Conditions 13
Figure 2C – Shaw Heights Tributary Baseline Peak Discharge vs. Drainageway Station - Future Conditions 13

Appendix B – Hydrologic Analysis
Figure B-1 – Hydrology Map
Figures B-2A and B-2B – EPA SWMM Routing Schematic
Figure B-3 – Baseline Hydrographs

LIST OF TABLES

Table 1 – Data Collected 1
Table 2 – Project Participants 2
Table 3 – Land Uses and Corresponding Impervious Values 5
Table 4 – Major Structure Crossing Inventory 6
Table 5 – One-Hour Point Rainfall (inches) 7
Table 6 – Depth Reduction Factors for Design Rainfall Distributions 2-, 5-, and 10-Year Design Rainfall 7
Table 7 – Horton's Equation Parameters 8
Table 8A – Little Dry Creek Future Conditions Baseline Peak Flows and Runoff Volumes 10
Table 8B – Tributary B Future Conditions Baseline Peak Flows and Runoff Volumes 11
Table 8C – Shaw Heights Tributary Future Conditions Baseline Peak Flows and Runoff Volumes 11
Table 9 - Previous Studies Hydrology Comparison 14

Appendix B – Hydrologic Analysis
Table B-1 – Unadjusted Rainfall Distributions
Table B-2 – CUHP Input Parameters
Table B-3 – Detention Pond Stage-Storage and Stage-Discharge Information
Table B-4 – Tributary B Split Flow at Chase Drive
Table B-5 – Railroad Culvert Capacities
Table B-6 – Baseline Peak Flows and Runoff Volumes

ABBREVIATIONS INDEX

Arvada – City of Arvada
Ave - Avenue
Blvd - Boulevard
BMP – Best Management Practice
BNSF – Burlington Northern Santa Fe
CDOT – Colorado Department of Transportation
CMP – corrugated metal pipe
CUHP– Colorado Urban Hydrograph Procedure
D/S – downstream
E - East
EGL – energy grade line
EPA – Environmental Protection Agency
EURV – excess urban runoff volume
EX – existing
FEMA – Federal Emergency Management Agency
FHAD – Flood Hazard Area Delineation
FIRM – Flood Insurance Rate Map
FU – future
HSG – hydrologic soils group
I/Imp. – Imperviousness
LiDAR – light detection and ranging
MDP – Major Drainageway Plan
N - North
NOAA – National Oceanic and Atmospheric Administration
NRCS – Natural Resources Conservation Service
Olsson – Olsson Associates
Rd - Road
RCBC – reinforced concrete box culvert
RCP – reinforced concrete pipe
S - South
SEO – State Engineer's Office
SSP – smooth steel pipe
St - Street
SWMM – Storm Water Management Model
UDFCD – Urban Drainage and Flood Control District
U/S – upstream
USACE – United States Army Corps of Engineers
USDCM – Urban Storm Drainage Criteria Manual
W - West
Westminster – City of Westminster
WQCV – water quality capture volume
WSE – water surface elevation
% – percent
ac – acre
AF/ac-ft – acre-feet
cfs – cubic feet per second
ft or ' – foot/feet
in or " – inch/inches
mi – mile

EXECUTIVE SUMMARY

Purpose and Objective

Planning Process

Project Area Description

Alternatives Analysis

Master Plan

1.0 INTRODUCTION

1.1 Authorization

Olsson was retained to complete a Major Drainageway Plan (MDP) and Flood Hazard Area Delineation (FHAD) for Little Dry Creek, co-sponsored by Urban Drainage and Flood Control District (UDFCD), Adams County, City of Arvada (Arvada), and City of Westminster (Westminster). The Agreement Regarding Major Drainageway Plan and Flood Hazard Area Delineation for Little Dry Creek (Agreement No. 14-07.01) was executed on July 14, 2014.

1.2 Purpose and Scope

The purpose of this study was to update the hydrology, develop alternatives to alleviate potential flooding, and complete a conceptual design of the plan selected by the project sponsors. The information from this study provides guidance to project sponsors for future construction projects. The watershed is mostly developed and the MDP will be used to identify and rectify potential flooding hazards along Little Dry Creek. The only modification or amendment to the scope made by the project sponsors was to add Tributary B and Shaw Heights Tributary to the MDP.

The following tasks were completed as part of the major drainageway plan:

- Collected existing information, including the previous MDP and FHAD, development drainage studies, and drainage improvement as-built plans
- Solicited input from project sponsors
- Obtained base mapping, structure surveys, and GIS information from UDFCD, Adams County, Arvada, and Westminster
- Obtained future land use mapping from Westminster, Adams County, and Arvada
- Determined subwatershed boundaries and parameters in accordance with UDFCD criteria
- Developed existing and future (fully developed) conditions baseline hydrology using the Colorado Urban Hydrograph Procedure (CUHP) 2005, version 2.0.0 and the Environmental Protection Agency Stormwater Management Model (EPA SWMM), version 5.1.012
- Compared the hydrology with previous studies
- Completed a report

1.3 Planning Process

Hydrology of the Little Dry Creek watershed was completed for the *Flood Hazard Area Delineation: Little Dry Creek (ADCO),* prepared by Merrick and Company in June 1978 (1978 FHAD). The same hydrology was used in the *Major Drainageway Planning: Little Dry Creek (ADCO),* prepared by Merrick and Company in April 1979 (1979 MDP).

The 1979 MDP used the runoff block of SWMM, rather than CUHP. The baseline hydrology developed for this study represents an updated analysis using CUHP version 2.0.0 and EPA SWMM, version 5.1.012. Further information regarding the hydrologic modeling process is included in Section 3.0.

Multiple progress meetings were held since 2014 to discuss project status and areas of concern with the project sponsors. Meeting minutes and notes are included in Appendix A of this report.

UDFCD, Adams County, Arvada, and Westminster reviewed the draft baseline hydrology, draft alternatives analysis, and draft conceptual design and returned comments on XXX, XXX, and XXX, respectively. The comments were incorporated into this final report. A summary of the key review comments and responses is supplemented in the meeting minutes for the XXX, XXX, and XXX meetings, respectively, included in Appendix A.

1.4 Mapping and Surveys

UDFCD provided 2-foot (ft) interval 2008 LiDAR mapping for the entire Little Dry Creek watershed. The LiDAR mapping is referenced to the NAVD 88 vertical datum and the NAD 83 horizontal datum. The road crossing structures were surveyed by Accurate EngiSurv, LLC. UDFCD provided 2012 aerial photography. Adams County, Arvada, and Westminster provided GIS files of parcels, street centerlines, trails, zoning, and utilities in the watershed.

1.5 Data Collection

Many drainage studies and as-built plans were collected from UDFCD, Adams County, Arvada, and Westminster. The Adams County, Colorado and Incorporated Areas Flood Insurance Rate Maps (FIRMs) were obtained from the Federal Emergency Management Agency (FEMA). The main studies and plans that were reviewed in the preparation of this report are shown in Table 1. A list of all studies reviewed in the preparation of this report is shown in Section 8.

Table 1 – Data Collected

Title	Date	Author
Flood Hazard Area Delineation: Little Dry Creek (ADCO)	June 1978	Merrick and Company
Hydrology Report: Little Dry Creek at Federal Boulevard	October 21, 2010	Muller Engineering Company, Inc.
Kalcevik Gulch Draft Major Drainageway Plan	May 27, 2014	Enginuity Engineering Solutions
Little Dry Creek (ADCO): Channel Improvements Phase A-1	October 1993	Sellards & Grigg, Inc.
Little Dry Creek Drainage Improvements: Little Dry Creek Park – 60% Review	July 14, 2014	Muller Engineering Company, Inc. and Matrix Design Group, Inc.
Storm Water Design Memorandum for Downtown Westminster	December 2015	Drexel Barrel & Co.
Major Drainageway Planning: Little Dry Creek (ADCO)	April 1979	Merrick and Company
Master Drainage Report for Midtown at Clear Creek Preliminary Development Plan	June 10, 2014	Redland Consulting Group, Inc.
Rotary Park Detention Pond	January 1990	Sellards & Grigg, Inc.
Downtown Westminster: Westminster Mall Redevelopment Phase II Drainage Report	July 2014	Martin/Martin, Inc.
Storm Water Design Memorandum for Downtown Westminster: Westminster Mall Redevelopment	December 2015	Drexel Barrell & Co.
Segment B2-B4 Interim Drainage Report	April 2015	Ames/Granite Joint Venture

1.6 Acknowledgements

The MDP was prepared with the cooperation of UDFCD, Adams County, Arvada, and Westminster. The representatives who were involved with this study are listed in Table 2.

Table 2 – Project Participants

Name	Representing	Assignment
Brooke Seymour	UDFCD	Project Manager, Watershed Services
Shea Thomas	UDFCD	Watershed Services Manager
Russ Nelson	Adams County	Project Sponsor
Andrew Hawthorn	Westminster	Project Sponsor
Riley Pennington	Arvada	Project Sponsor
Deb Ohlinger	Olsson	Project Manager
Amy Gabor	Olsson	Project Engineer
Krystina Pacheco	Olsson	Assistant Engineer
Jason Messamer	Olsson	Assistant Engineer

2.0 STUDY AREA DESCRIPTION

2.1 Project Area

Watershed and Drainageway Description

The approximate 12.7 square mile Little Dry Creek watershed, Reuse number 5400, extends from Indiana Street to its confluence with Clear Creek, west of Pecos Street. The watershed is bound on the north by West 92nd Avenue and the south by West 62nd Avenue. The watershed extends through Adams County, Jefferson County, Arvada, and Westminster, see Figure 1. The watershed is approximately 8.7 miles long, 2.0 miles wide and generally slopes down to the southeast with slopes ranging from 0.5 to 4 percent (%). The lowest and highest watershed elevations are 5187 and 5738, respectively. The watershed is mostly developed.

Little Dry Creek consists of 9.1 miles of open channel, some concrete, and some vegetated, with defined low flow sections, storm sewer, wider natural channel sections, and ponds. Major tributaries include the 4.0 miles long Tributary B, 1.2 mile long Tributary C, and the 2.1 mile long Shaw Heights Tributary. The drainageway is discussed in more detail in Section 2.3.

Planned Construction

Floodplain modifications at the Midtown and Pomponio developments are currently underway. A CLOMR was completed as part of the project and will be included in the study. The City of Westminster is currently working on improvements along Little Dry Creek from north of 72nd Avenue to Lowell. The improvements include a Greenhouse expansion of 72nd Avenue and an administration building. The preliminary floodplain was used for design of these building to reduce the impacts of the floodplain.

Irrigation Ditches

Four irrigation ditches cross the Little Dry Creek watershed. Church Ditch crosses Little Dry Creek at Simms Street. The Farmer's Highline Canal and the Croke Canal run parallel to each other where they intersect Little Dry Creek upstream of Kipling Street. Allen Ditch crosses Shaw Heights Tributary at Circle Drive. The canals intercept some stormwater from adjacent residential neighborhoods. A spill structure is located on the Croke Canal at Little Dry Creek to separate the stormwater flows from irrigation flows. There are no structures located at the Farmer's Highline Canal.

Existing Regional Detention Ponds

Seven regional detention ponds are located in the Little Dry Creek watershed and were included in the baseline hydrology. Two detention ponds are owned by the City of Arvada: Lake Arbor and Pomona Lakes 2 and 3. Lake Arbor is located at the confluence of Tributary B and Tributary C, northwest of West 80th Avenue and North Harlan Street and consists of a permanent pool with capacity to detain flood storage in addition to the permanent pool. Pomona Lakes 2 and 3, which were combined into one pond, is located northwest of West 80th Avenue and Carr Drive and consists of a permanent pool with flood storage above the pool. Little Dry Creek parallels the south bank of Pomona Lakes 2 and 3. A small pipe diverts flow from Little Dry Creek into the pond and larger flows would overtop the pond spillway. Two additional detention ponds are located in Adams County: Rotary Parks Detention Pond and West 64th Avenue Detention Pond. Rotary Parks Detention Pond is located on Shaw Heights Tributary, southeast of US 36 and West 84th Avenue. The West 64th Avenue Detention Pond is located immediately upstream of the Clear Creek confluence and consists of a permanent pool with flood storage above the pool. Three detention ponds are located in Westminster: the Westminster mall detention pond, near W 88th Avenue and Sheridan Boulevard, Cable Pond, located south of the Westminster mall detention pond, and the Federal Boulevard detention pond.

Many private detention ponds and lakes, including Pond Lake, also known as Pomona Lake 1, are located in the watershed. Because the ponds are private, they were not included in the baseline hydrology.

Soils

Soil types were determined using the Natural Resources Conservation Service (NRCS) Web Soil Survey. The soils in the watershed consist primarily of hydrologic soils group (HSG) C, which are generally characterized by low infiltration rates, as defined by the NRCS. Patches of HSG A and B, which are generally characterized by high and moderate infiltration rates, respectively, are located primarily along the channel. Small patches of HSG D, soils with low infiltration rates, are also located in the watershed. The soils map is included on Figure B-1 in Appendix B.

~STANDLEY LAKE~

WADSWORTH BLVD

CABLE DETENTION POND

US 36

WESTMINSTER DETENTION POND

W 92ND AVE

~ADAMS COUNTY~

FARMER'S HIGHLINE CANAL

W 88TH AVE

W 86TH PKWY

TRIBUTARY B

ALLEN DITCH

ROTARY PARK DETENTION POND

SHAW HEIGHTS SPILL

CHASE DRIVE SPILL

LAKE ARBOR

TRIBUTARY C

POMONA LAKES 2 AND 3

CHURCH DITCH

INDIANA ST

ALKIRE ST

W 80TH AVE

SIMMS ST

LITTLE DRY CREEK - UPPER

CROKE CANAL

FARMER'S HIGHLINE CANAL

WEST 80TH PLACE SPILL

SHERIDAN BLVD

SHAW HEIGHTS TRIBUTARY

FEDERAL BLVD

LITTLE DRY CREEK - MIDDLE

FEDERAL BLVD DETENTION POND

US 36

KIPLING ST

W 72ND AVE

LITTLE DRY CREEK - LOWER

WADSWORTH BLVD

W 68TH AVE

LOWELL BLVD

W 64TH AVE

W 64TH AVE DETENTION POND

~JEFFERSON COUNTY~

CLEAR CREEK

LEGEND

- WATERSHED BOUNDARY
- LAKES / PONDS
- DRAINAGEWAY
- CANAL / DITCH
- COUNTY LINE
- CITY OF ARVADA
- CITY OF WESTMINSTER
- UNINCORPORATED ADAMS COUNTY
- UNINCORPORATED JEFFERSON COUNTY

N

1" = 3000'

0' 1500' 3000'

SCALE IN FEET

DWG: F:\Projects\014-176_WTRS\Preliminary_Plans\Hydrology\14-176_Watershed Map.dwg USER: agabor
DATE: Nov 08, 2018 4:59pm XREFS: 11x17 Border Existing Base Existing Boundaries Aerial_2012

TOPOGRAPHIC MAPPING METHOD:	LIDAR
TOPOGRAPHIC MAPPING BY:	MERRICK & COMPANY
HORIZONTAL/VERTICAL DATUM:	NAD 83/NAVD 88
CONTOUR INTERVAL:	2 FOOT
DATE FLOWN:	2008

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project no.:	014-1761
date:	08/2018

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT,
CITY OF WESTMINSTER, CITY OF ARVADA, AND ADAMS COUNTY

LITTLE DRY CREEK, TRIBUTARY B,
AND SHAW HEIGHTS TRIBUTARY
FLOOD HAZARD AREA DELINEATION

WATERSHED MAP

FIGURE
1
PAGE 4

2.2 Land Use

The watershed is almost completely developed. Future land use information was obtained from Adams County's, Arvada's, and Westminster's zoning maps. Westminster also provided existing land use information. Outside of Westminster, aerial imagery confirmation was used to determine the existing land use. The land use maps are included in Appendix B. The majority of the existing development and planned development in the watershed consists of residential land use. Pockets of commercial, office, industrial, and mixed-use developments are also present, primarily along the Wadsworth Boulevard, Sheridan Boulevard, 88th Avenue corridors, and near the downstream end of the watershed. The watershed also includes open space, parks and public community developments.

To determine appropriate percent imperviousness values, aerial imagery and UDFCD's Urban Storm Drainage Criteria Manual (USDCM) Table RO-3 were used. Several representative areas were evaluated in detail using aerial imagery to verify the percent imperviousness of the developed areas. It appears that the watershed typically developed at a higher density than was predicted in the 1979 MDP. The 1979 MDP had an overall future percent imperviousness of 32 percent (%), versus 49% for existing land use and 53% for future land use in this study. Because the watershed is mostly developed, only the future land use hydrology was developed.

The land use and imperviousness designations are shown on Figure B-1. The percent imperviousness designation by land use is shown in Table 3.

Table 3 – Land Uses and Corresponding Impervious Values

Land Use Plan	Land Use Designation from Corresponding Plan	Figure Designation	% Imp.
Varies	Undeveloped/Vacant	Undeveloped	2
Adams County	Parks and Open Space	Parks and Open Space	5
Arvada	Open Space and Parks		
Westminster	Public Parks		
Westminster	City Owned Open Space		
Westminster	Private Parks/ Open Space		
Arvada	Low Density Residential (1.5 units per 1 acre with open space requirements)	Residential Very Low Density	20
Westminster	Very Low Density Residential - R-1 (1 unit per acre) and R-2.5 (2.5 units per 1 acre)		
Westminster	Low Density Residential - R-3.5 (3.5 units per 1 acre)	Low Density Residential	40
Arvada	Public/ Quasi-Public	Public	50
Westminster	Public/ Quasi-Public		
Arvada	Suburban Residential (5 units per 1 acre)	Suburban Residential	55
Adams County	Urban Residential (residential 1 unit per acre or greater, and neighborhood commercial)	Urban Residential	60
Westminster	Medium Density Residential - R-5 (5 units per 1 acre) and R-8 (8 units per acre)	Medium Density Residential	65

Table 3 Continued - Land Uses and Corresponding Impervious Values

Land Use Plan	Land Use Designation from Corresponding Plan	Figure Designation	% Imp.
Arvada	Medium Density Residential (12 units per 1 acre)	Medium-High Density Residential	70
Westminster	High Density Residential - R-18 (18 units per 1 acre)	High Density Residential	80
Arvada	High Density Residential (24 units per 1 acre)		
Arvada	Mixed Use - Residential (mix of residential with 10%-40% non-residential)	Mixed Use Residential	80
Westminster	Flex/Light Industrial	Light Industrial	80
Adams County	Mixed Activity (offices, hotels, retail, high-density residential, indoor manufacturing, etc.)	Mixed Use Neighborhood	85
Arvada	Mixed Use (office, retail, light industrial, medium to high residential)		
Westminster	Traditional Mixed Use Neighborhood (mixed residential, office, retail, etc.)		
Westminster	Mixed Use (high density residential, office, retail, etc.)	High Density Mixed Use	90
Westminster	Mixed Use Center (high density residential, office, retail, etc.)		
Arvada	Industrial/ Office		
Adams County	Mixed Employment (offices, retail, indoor manufacturing, etc.)	Office/Commercial	95
Adams County	Commercial		
Arvada	Neighborhood/Community Commercial (retail and offices)		
Westminster	Office		
Westminster	Office/R&D High Intensity		
Westminster	Retail Commercial		
Westminster	Service Commercial		
Varies	Highway	Highway	100
Varies	Lakes	Lakes	100

2.3 Reach Description

This section, including Table 4, will be completed as part of the Alternatives Analysis.

2.4 Flood History

The FIRMs show a FEMA-designated Zone A floodplain on Little Dry Creek upstream of Lowell Boulevard, Tributary B downstream of Wadsworth Boulevard, Tributary C, and Shaw Heights Tributary. The FIRMs show a FEMA-designated Zone AE floodplain on Little Dry Creek downstream of Lowell Boulevard and on Tributary B upstream of Wadsworth Boulevard. The FEMA FIRM panels are included in Appendix C.

No reported flooding has occurred on Little Dry Creek or Tributary B. The only reported flooding to occur on Shaw Heights Tributary was due to a clogged pipe.

2.5 Environmental Assessment

This section will be completed as part of the Alternatives Analysis.

3.0 HYDROLOGIC ANALYSES

3.1 Overview

Existing infrastructure, future land use peak discharges for the 2-, 5-, 10-, 25-, 50-, 100-year, and 500-year return period storms were analyzed using CUHP 2005, version 2.0.0, to generate hydrographs for each subwatershed. Hydrographs for the subwatersheds were routed using EPA SWMM, version 5.1.012, to determine peak discharge rates at select design points. The updated EPA SWMM results were compared to the previous study to determine whether calibration was necessary. The hydrology comparison is detailed in Section 3.6 and shown in Table 9.

UDFCD's Detention Volume Estimating Workbook, version 2.34 and UDFCD's Culvert Hydraulics Workbook, version 3.02, were used to develop stage-storage and stage-discharge information for Pomona Lakes 2 and 3, Arbor Lake, Rotary Parks Detention Pond, the West 64th Avenue Detention Pond. The LiDAR data was used to estimate the stage-storage for all four detention ponds. The Pomona Lakes 2 and 3, Arbor Lake, and Cable Pond outlet structures were surveyed to determine the stage-discharge. The *Rotary Park Detention Pond* plans, prepared by Sellards & Grigg, Inc. in January 1990 and the *Little Dry Creek (ADCO): Phase A-1* plans, prepared by Sellards and Grigg, Inc. in October 1993 were used to determine the storage-discharge information for the Rotary Parks Detention Pond and the West 64th Avenue Detention Pond, respectively. The Federal Boulevard detention pond as-built stage-storage and stage-discharge information was obtained from Muller Engineering Company, Inc. The Westminster Mall detention pond stage-storage and stage-discharge information, and the Cable Pond stage-storage information was obtained from the *Downtown Westminster: Westminster Mall Redevelopment Phase II Drainage Report*, prepared by Martin/Martin, Inc. in July, 2014.

The hydrology for the adjacent Kalcevik Gulch watershed was updated in 2014 by Enginuity Engineering Solutions. The study identified a flow split into the Little Dry Creek watershed. The report states that "[a]ll drainage area to the west of Federal Boulevard reach the loop ramp at Highway 36 and Federal Boulevard. The loop ramp consists of a small water quality pond that discharges to a 30-inch pipe under the highway, removing flows from the Kalcevik Gulch watershed. Flows not able to be conveyed in the pipe system travel east along Highway 36 to Pecos Street. Some portion of these overland flows could be removed by roadside inlets and storm drains in Highway 36, however these pipes are all under 48 inches in size and were not accounted for in this hydrologic model." In addition, the Colorado Department of Transportation (CDOT) is currently designing a parallel 30-inch RCP at this location. The capacity of the two 30-inch pipes, 58 cfs, was added to the Little Dry Creek watershed at Design Point 111.

3.2 Design Rainfall

The one-hour and 6-hour rainfall depths from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 were input into CUHP 2005 to model the watershed hydrology for each storm event and are shown in Table 5. Area adjustments were used for the 2-, 5-, and 10-year storm events with tributary drainage basins greater than 5 square miles. Area correction values are included in Table 6. No area adjustment factors were necessary for the 25-, 50-, 100-, and 500-year storm events.

Table 5 - One-Hour Point Rainfall (inches)

Duration	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
1-Hour	0.809	1.09	1.34	1.72	2.04	2.38	3.28
6-Hour	1.23	1.63	1.99	2.53	2.98	3.47	4.72

Table 6 - Depth Reduction Factors for Design Rainfall Distributions 2-, 5-, and 10-Year Design Rainfall

Time (minutes)	Correction Factor by Watershed Area in Square Miles		
	2	5	10
5	1	1	1
10	1	1	1
15	1	0.97	0.94
20	1	0.86	0.75
25	1	0.86	0.75
30	1	0.89	0.75
35	1	0.97	0.94
40	1	0.97	0.94
45	1	1	1
50	1	1	1
55	1	1	1
60	1	1	1
65	1	1	1
70	1	1	1
75	1	1	1
80	1	1	1
85	1	1	1
90	1	1	1
95	1	1	1
100	1	1	1
105	1	1	1
110	1	1	1
115	1	1	1
120	1	1	1

3.3 Subwatershed Characteristics

A summary of the CUHP 2005 model parameters can be found in Table B-2 in Appendix B. LiDAR mapping, structure survey information, as-built drawings, and drainage studies were used to determine input parameters.

Subwatershed Delineation

The overall watershed boundary was delineated using LiDAR mapping and adjacent watershed boundaries. The following studies that were reviewed to determine the overall watershed boundary include: the 1979 MDP, 2012 Big Dry Creek MDP, 2008 Hidden Lake-Bates Lake MDP, 2014 Kalcevik Gulch MDP, 2004 Ralston Creek-Leyden Creek FHAD, and the 2014 Master Drainage Report for Midtown at Clear Creek Preliminary Development Plan.

The overall Little Dry Creek watershed was divided into 98 subwatersheds that were delineated based on the LiDAR mapping UDFCD provided (Section 1.4), various drainage studies, and site observations. Subwatershed boundaries reflect the major storm event conditions. The subwatersheds range in size from 16.0 acres to 159.9 acres, with an average subwatershed size of 82.6 acres. Subwatershed size was generally held to a maximum of 130 acres, with a few exceptions where the subwatershed could not easily be broken into smaller subwatersheds without resulting in very long and narrow subwatersheds, or subwatersheds with elongated tails. Pursuant to UDFCD policy, Church Ditch, Farmer's Highline Canal, Croke Canal, and Allen Ditch were assumed to be at full capacity for the baseline hydrology. The subwatersheds are shown on Figure B-1 in Appendix B.

Length, Distance to Centroid, Slope

The LiDAR data and structure survey information were used to determine subwatershed flow path lengths, distance to centroid values, and slopes. Subwatersheds were generally delineated to avoid shapes with elongated tails and very narrow and long shapes. To check these two scenarios, the following equations were used:

r = Length to Centroid / Total Length (if $0.1 \leq r < 0.3$, the subwatershed may have an elongated tail)
r = Length^2 / Area (if $r > 4$, the subwatershed may be very narrow and long)

If the r value of a subwatershed indicated that it may have an elongated tail, or be very narrow and long, it was checked. Many of the subwatersheds in question did not have an elongated tail and were not long and narrow in shape. The questionable r values were generally a result of the nature of the urbanized watershed. Flow paths were generally delineated following streets, which is a much longer path than just going across the subwatershed. The majority of subwatersheds with questionable r values had reasonable unit discharges, as compared to similar subwatersheds.

Several subwatersheds were delineated as longer, narrower subwatersheds. The subwatersheds could not be further divided without resulting in even narrower subwatersheds. The unit discharges of these subwatersheds were compared to similar subwatersheds and the Cp values were adjusted as needed to provide similar unit discharges.

Slopes were estimated using the weighted slope equation from the CUHP manual.

$$S = ((L_1 s_1^{0.24} + \ldots + L_n s_n^{0.24}) / (L_1 + \ldots + L_n))^{4.17}$$

As-built drawings and drainage reports were used to verify slopes, where applicable.

Watershed Imperviousness

Subwatershed imperviousness was determined using aerial imagery and land use maps. Because the watershed is almost fully developed, only the future imperviousness was used in the hydrology. A detailed description of the subwatershed imperviousness determination is included in Section 2.2.

Depression Losses

Depression losses were determined using Table 6-6 in the USDCM. A weighted average was used for the depression losses in each subbasin, based on land use designation. A pervious depression loss of 0.35 inches, which represents lawns and grass, was used for the developed portions of the watershed, and a value of 0.4, which represents open fields, was used for open space. An average of an impervious depression loss of 0.05, which represents sloped roofs, and 0.1, which represents large paved areas, was used for residential areas. A value of 0.1, which represents flat roofs and large paved areas, was used for open space, agricultural, commercial, office, and industrial areas.

Infiltration

Initial and final infiltration rates and Horton's decay rate were determined using Table 6-7 in the USDCM and are shown in Table 7. A weighted average of soil type was used to determine subwatershed rates. The hydrologic soil groups are shown on Figure B-1, in Appendix B.

Table 7 - Horton's Equation Parameters

NRCS Hydrologic Soil Group	Infiltration (inches per hour)		Decay Coefficient
	Initial	Final	
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018
D	3.0	0.5	0.0018

3.4 Hydrograph Routing

The parameters for the EPA SWMM model conveyance elements were determined using the LiDAR data, structure survey information, as-built drawings, and drainage reports. As described in Section 3.1, an inflow of 58 cfs from the adjacent Kalcevik Gulch watershed was incorporated into the EPA SWMM model at Design Point 111.

As-built drawings and drainage reports were used to verify channel slopes, where applicable. Because there are several drops along Little Dry Creek and design points are not located at each drop, the drops were modeled in EPA SWMM as one large drop at the downstream end of the conveyance element so that the slope reflected the actual channel slope. The drop height was calculated as the excess fall in a given reach, using the actual channel slope.

Channel geometry was determined using the mapping provided by the sponsors and as-built information for verification. For flows that are conveyed via streets, the street sections were models as trapezoidal sections with a 5-foot depth, 1-foot bottom width, and 20-foot horizontal to 1-foot vertical (20:1) side slopes. Overflow elements were added where they were needed to convey the full future 100-year storm event to ensure no inadvertent detention was being modeled at these locations. The underground storm

sewer system was not modeled, with the exception of where Little Dry Creek is conveyed in a storm sewer across West 80th Avenue and the parking lot to the south.

The Manning's n values for street sections and pipe were increased 25 percent in accordance with the USDCM. Street section Manning's n values were set at 0.016, or 0.02 in the model. Concrete pipe Manning's n values were set at 0.015, or 0.01875 in the model. Corrugated metal pipe Manning's n values were set at 0.024, or 0.03 in the model. Channel section Manning's n values ranged from 0.04375 to 0.075 in the model.

Pursuant to UDFCD's policy to recognize only regional, publicly-owned facilities, private detention ponds and inadvertent detention areas were not modeled. Seven detention ponds were included in the baseline hydrology: Pomona Lakes 2 and 3, Arbor Lake, Rotary Parks Detention Pond, the West 64th Avenue Detention Pond, the Westminster Mall Detention Pond, Cable Pond, and the Federal Boulevard Detention Pond. Design information for Pomona Lakes 2 and 3, and Arbor Lake could not be found, so information for the stage-storage was developed using the LiDAR mapping and the stage-discharge information was developed using the structure survey data provided by UDFCD. Outlet structure information for Cable Pond was also based on structure survey data provided by UDFCD. The information was input into UDFCD's Detention Volume Estimating Workbook and Culvert Hydraulics Workbook to develop stage-storage and stage-discharge information that was then input into the EPA SWMM model. The Rotary Parks Detention Pond and West 64th Avenue Detention Pond stage-storage and stage-discharge information was calculated using the design documents completed by Sellards and Grigg, Inc. The Federal Boulevard detention pond stage-storage and stage-discharge information was obtained from the as-built documents completed by Muller Engineering Company, Inc. and Matrix Design Group, Inc. The Westminster Mall detention pond stage-storage and stage-discharge information and Cable Pond stage-storage information was obtained from the *Downtown Westminster - Westminster Mall Redevelopment Phase II Drainage Report*, prepared by Martin/Martin, Inc. in July 2014. A summary of the detention pond stage-storage-discharge information can be found in Table B-3 in Appendix B.

A split flow occurs on Tributary B at Chase Drive. Flow will first pass through the existing culverts under the road. When the culvert capacity is exceeded, water will overtop the road and flow to the south and down Chase Drive to the east. To determine how much water will flow to the south as opposed to the east, a cross section was cut and the percentage of flow in each section was determined to be 84% to the east and 16% to the south.

The BNSF railroad culvert crossings were surveyed. Rather than inputting each separate culvert into the EPA SWMM model, the full-flow culvert capacities were estimated using Manning's n equation:
$Q = (0.49/n)AR^{2/3}s^{1/2}$

Q = discharge (cfs)
n = roughness coefficient
A = area of cross section (ft^2)
R = hydraulic radius=Area/Wetted Perimeter (ft)
s = channel bottom slope (ft/ft)

A cutoff flow equal to the value of the full-flow culvert capacity was then added to the EPA SWMM model at the majority of the culvert locations. Once the full-flow capacity is reached, water will flow along the BNSF railroad tracks to the next culvert crossing. The culvert capacity calculations are shown in Table B-5, in Appendix B.

The EPA SWMM 5.1 input parameters and 100-year future conditions output are included in Appendix B. EPA SWMM 5.1 model elements, including subwatersheds, design points and conveyance elements are shown in Figure B-1 and a schematic of the model is shown in Figures B-2A and B-2B in Appendix B.

3.5 Previous Studies

Two previous studies of the Little Dry Creek watershed have been completed. The 1978 FHAD and 1979 MDP were completed prior to the majority of development in the western portion of the watershed. The drainageway and road crossing structures were designed and built to the design flows shown in the 1979 study. A detailed peak flow comparison is included in Section 3.6.

3.6 Results of Analysis

The baseline peak discharges and volumes for the 2-, 5-, 10-, 25-, 50-, 100-year, and 500-year storm events for all of the EPA SWMM 5.1 design points can be found in Table B-6 in Appendix B. A summary of key peak flows and runoff volumes are listed in Tables 8A through 8C and the peak discharge versus channel station are shown in Figures 2A through 2C. Select SWMM generated hydrographs are included in Appendix B as Figure B-3.

Table 8A - Little Dry Creek Future Conditions Baseline Peak Flows and Runoff Volumes

Design Point	Downstream Conveyance Element	Location	Total Drainage Area (acres)	Total Drainage Area (mi^2)	Length (feet)	Peak Flows (cfs)						Runoff Volumes (acre-feet)					
						Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
101	---	Clear Creek Confluence	8099	12.7	0	818	1,291	1,733	3,451	4,572	6,358	287	393	497	908	1,135	1,396
301	501	W. 64th Avenue Detention Pond	8099	12.7	0	876	1,303	1,754	3,464	4,580	6,377	328	436	540	951	1,178	1,436
102	202	D/S BNSF Railroad	7975	12.5	2,322	871	1,299	1,747	3,453	4,570	6,359	325	430	534	939	1,163	1,418
103T	203T	U/S BNSF Railroad	7918	12.4	2,322	867	1,296	1,742	3,445	4,558	6,339	325	427	531	933	1,154	1,409
106T	206T	D/S BNSF Railroad	7619	11.9	5,180	845	1,284	1,714	3,389	4,493	6,245	319	417	516	902	1,117	1,360
106	206	Federal Boulevard	7619	11.9	6,025	845	1,284	1,714	3,389	4,493	6,246	319	417	516	905	1,120	1,363
306	506	Federal Boulevard Detention Pond	7619	11.9	6,025	903	1,372	1,868	4,618	6,216	8,123	319	417	516	905	1,120	1,363
108	208	Grove Street	7522	11.8	6,714	890	1,354	1,846	4,588	6,175	8,078	316	414	509	893	1,105	1,344
109T	209T		7441	11.6	7,752	884	1,345	1,837	4,567	6,144	8,036	313	411	506	887	1,099	1,335
112	212	Lowell Boulevard	7178	11.2	9,280	791	1,238	1,723	4,387	5,920	7,774	191	284	377	743	945	1,175
117T	217T		6668	10.4	11,632	732	1,159	1,621	4,143	5,568	7,323	177	264	350	690	881	1,093
117	217	W. 72nd Avenue	6668	10.4	11,791	732	1,159	1,621	4,128	5,530	7,272	177	264	350	687	875	1,083
118T	218T		6577	10.3	12,247	722	1,146	1,604	4,096	5,471	7,204	175	260	344	678	862	1,068
119	219	Winona Court	6500	10.2	13,708	714	1,136	1,590	4,077	5,452	7,185	173	257	341	675	859	1,065
120	220	W. 76th Avenue/Shaw Heights Tributary Confluence	6425	10.0	16,157	708	1,127	1,580	4,044	5,433	7,141	172	255	338	666	850	1,053
138	238	Sheridan Boulevard	5083	7.9	16,605	582	934	1,404	3,066	4,047	5,194	143	212	293	519	666	826
140T	242T		4872	7.6	18,089	556	900	1,354	2,964	3,912	5,005	137	202	280	497	638	792
142	242	Tributary B Confluence	4636	7.2	18,575	518	840	1,266	2,806	3,711	4,726	128	190	264	470	605	749
160	260	N. Harlan Street	2985	4.7	19,745	494	822	1,239	2,315	3,137	3,947	86	133	187	295	384	476
162	262	Marshall Street	2843	4.4	21,364	466	786	1,186	2,236	3,030	3,824	81	126	177	280	365	451
163T	263T		2742	4.3	22,465	444	761	1,148	2,175	2,958	3,728	78	121	170	270	350	436
165	265	Pierce Street	2554	4.0	22,680	404	704	1,067	2,041	2,727	3,426	72	111	157	250	325	405
166	266	Webster Way	2497	3.9	23,926	395	689	1,045	2,007	2,812	3,450	70	108	153	244	319	396
167	267	Wadsworth Boulevard	2413	3.8	25,522	381	664	1,007	1,985	2,648	3,505	66	103	146	234	306	381
171	271	Target parking lot	2081	3.3	26,659	340	588	888	1,627	2,329	2,957	59	91	128	201	262	328
174	274	W. 80th Avenue	1833	2.9	27,186	305	523	787	1,455	1,921	2,571	50	78	110	175	224	284
175T	275T	D/S Pomona Lakes 2&3	1365	2.1	29,228	229	394	593	1,093	1,443	1,928	37	58	82	129	166	210
180	280	Club Crest Drive	1290	2.0	30,995	229	394	592	1,092	1,442	1,926	36	55	79	125	159	202
181T	281T		1222	1.9	31,504	222	380	570	1,055	1,391	1,851	33	52	74	117	150	191
182	282	Hoyt Way	1178	1.8	31,999	218	374	558	1,029	1,354	1,800	33	51	72	114	146	184
183	283	Kipling Street	1094	1.7	34,106	209	356	530	978	1,284	1,700	30	47	67	106	136	172
185	285	Kline Street	865	1.4	34,815	168	285	425	790	1,035	1,360	23	36	52	83	106	134
186	286	Farmer's Highline Canal and Croke Canal	785	1.2	36,643	161	272	403	746	972	1,266	22	34	48	76	97	123
189	289	Simms Street	553	0.9	40,378	146	233	338	612	791	1,019	17	27	37	56	72	89
193	293	Union Circle	371	0.6	42,101	98	161	233	417	537	690	12	18	25	38	48	60
194	294	Ward Road	350	0.5	42,723	94	153	221	394	507	651	11	17	24	36	45	57
195	295	W. 85th Avenue	250	0.4	43,588	69	111	159	280	360	460	8	12	17	26	33	41
196	296	Alkire Street	205	0.3	45,655	59	95	135	234	300	381	7	10	14	21	27	33
197	297	Beech Street and 86th Parkway	113	0.2	46,669	44	66	90	145	182	227	4	6	8	12	15	19
198	298	Five Parks Drive	97	0.2	47,916	42	63	85	133	167	205	4	5	7	11	13	16

Table 8B - Tributary B Future Conditions Baseline Peak Flows and Runoff Volumes

Design Point	Downstream Conveyance Element	Location	Total Drainage Area (acres)	Total Drainage Area (mi^2)	Length (feet)	Peak Flows (cfs)						Runoff Volumes (acre-feet)					
						Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
143	243	W. 80th Avenue	1616	2.5	1,290	166	252	348	554	703	870	56	84	115	172	217	270
144	244	D/S Lake Arbor	1573	2.5	2,625	165	248	334	503	626	740	54	81	109	159	199	245
344	544	Lake Arbor	1573	2.5	2,625	317	509	715	1,209	1,561	2,053	54	81	109	159	199	245
145	245	Chase Drive	1081	1.7	4,631	246	399	567	982	1,270	1,664	39	58	79	118	148	183
146	246	Lamar Drive	1026	1.6	5,492	236	383	544	943	1,219	1,595	37	56	75	112	140	174
147	247	Otis Drive	866	1.4	7,725	212	340	481	836	1,076	1,401	32	47	64	95	119	147
149	249	Wadsworth Boulevard	620	1.0	11,363	170	267	375	647	828	1,062	22	33	44	67	84	104
151	251	Dover Street	428	0.7	14,667	148	226	312	513	649	816	15	22	30	45	57	71
153T	253T		240	0.4	16,145	88	136	188	305	387	486	8	12	17	26	32	40
154	254	W. 86th Place	152	0.2	18,189	50	75	103	173	222	285	6	8	11	17	21	26
155	255	Kipling Street	56	0.1	20,451	21	33	47	77	98	122	2	3	4	6	7	9

Table 8C - Shaw Heights Tributary Future Conditions Baseline Peak Flows and Runoff Volumes

Design Point	Downstream Conveyance Element	Location	Total Drainage Area (acres)	Total Drainage Area (mi^2)	Length (feet)	Peak Flows (cfs)						Runoff Volumes (acre-feet)					
						Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
122T	222T	W. 78th Avenue	1216	1.9	2,217	279	383	515	975	1,293	1,918	47	69	93	136	169	209
123T	223T		1153	1.8	3,130	266	360	498	937	1,243	1,840	46	67	89	130	162	199
123	223	W. 80th Avenue	1094	1.7	3,952	256	345	480	901	1,196	1,773	44	65	86	125	156	191
125T	225T	D/S BNSF Railroad	1009	1.6	6,116	204	301	435	836	1,108	1,643	40	58	78	113	141	174
127	227	D/S Rotary Parks Detention Pond	557	0.9	7,436	86	151	224	410	604	902	18	27	37	57	72	90
327	527	Rotary Parks Detention Pond	557	0.9	7,436	244	367	502	804	1,015	1,264	18	27	37	57	72	90
130	230	Circle Drive/Shaw Boulevard	312	0.5	9,711	193	279	370	553	689	849	12	17	23	34	43	52
132	232	Shaw Boulevard/Lowell Boulevard	118	0.2	11,092	130	180	223	304	368	447	7	9	12	16	19	23

Figure 2A
Little Dry Creek
Baseline Peak Discharge vs. Drainageway Station - Future Conditions

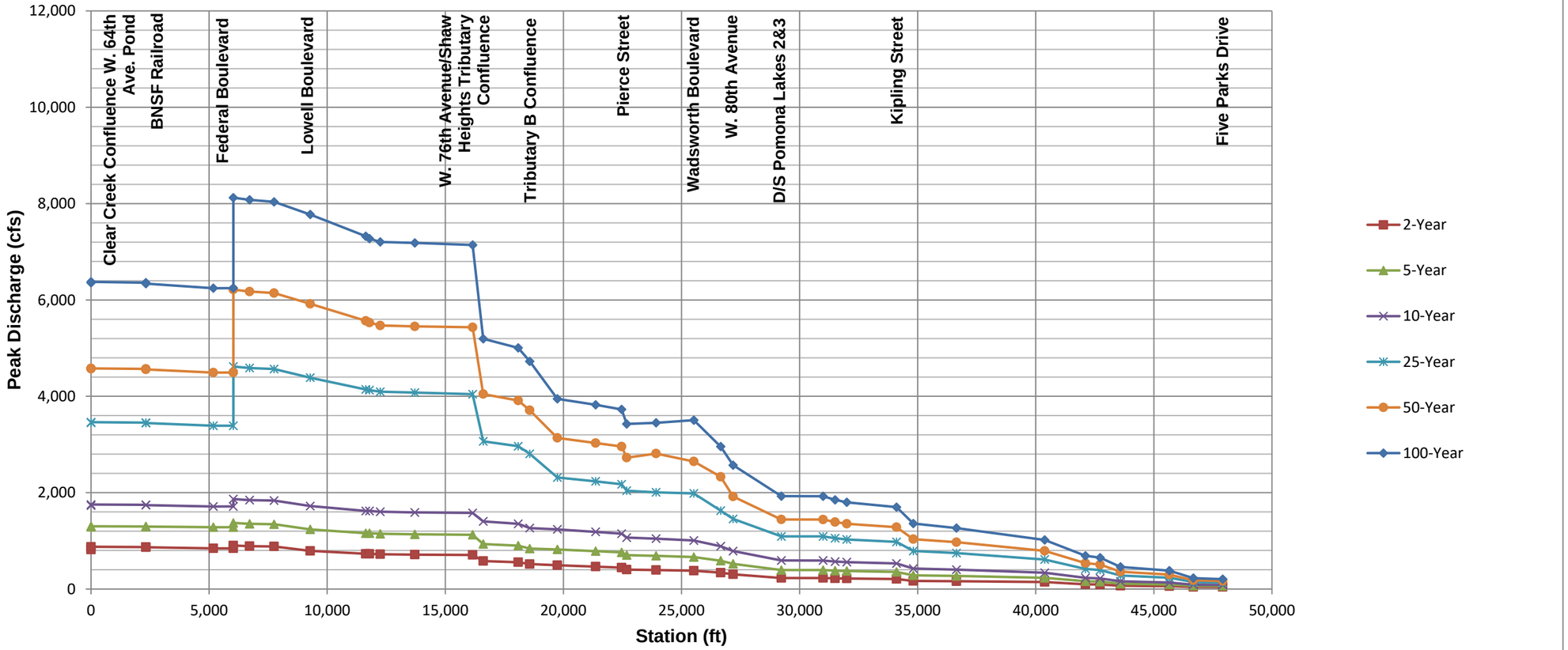


Figure 2B
Tributary B
Baseline Peak Discharge vs. Drainageway Station - Future Conditions

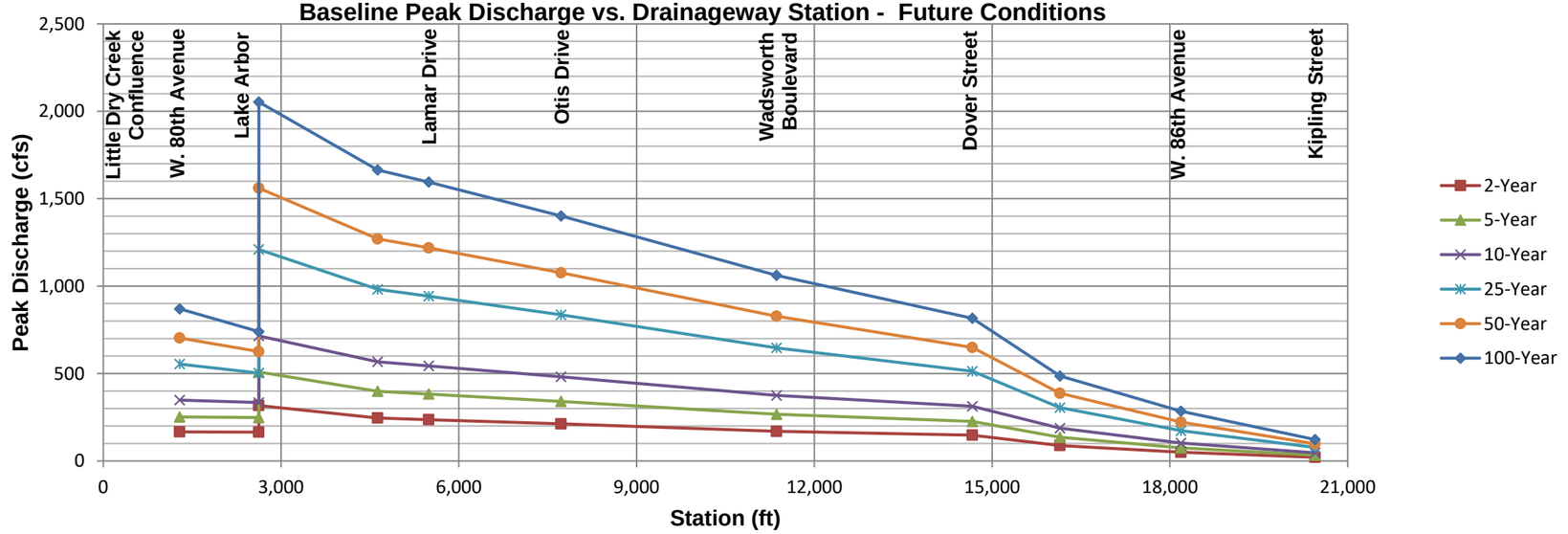
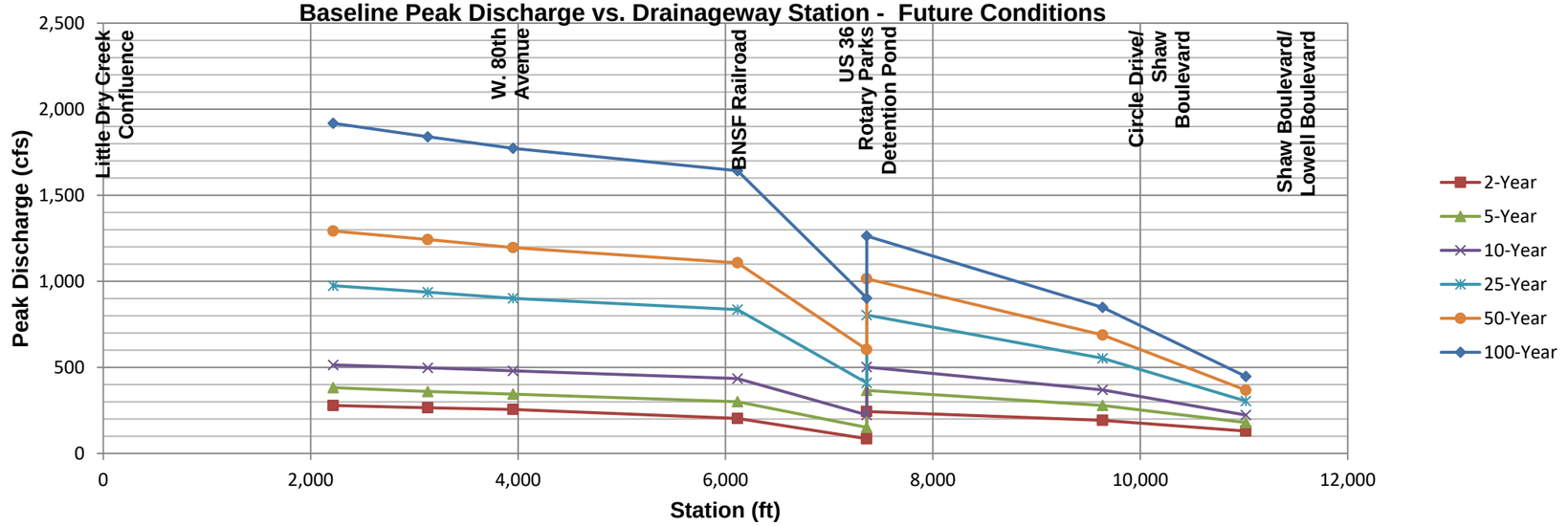


Figure 2C
Shaw Heights Tributary
Baseline Peak Discharge vs. Drainageway Station - Future Conditions



The peak flows are much higher, with an average increase of 82% on Little Dry Creek, 58% on Tributary B, and 10% on Shaw Heights Tributary, in this study as compared to the 1978 FHAD peak flows, to which the drainageway improvements have been designed and built. The differences in peak flow can be attributed to additional detention ponds being modeled, detention ponds being modeled differently, higher percent imperviousness, different soil parameters, and different modeling policies. The 1978 FHAD had an overall unit discharge, which includes detention, of 0.6 cfs per acre on Little Dry Creek, 0.3 cfs per acre on Tributary B, and 1.3 cfs per acre on Shaw Heights Tributary. This study has an overall average unit discharge, which includes detention, of 0.8 cfs per acre on Little Dry Creek, 0.5 cfs per acre on Tributary B, and 1.6 cfs per acre on Shaw Heights Tributary. The comparison process is summarized below.

- The 1978 FHAD included only Pomona Lakes 2 and 3, Rotary Parks Detention Pond, and Lake Arbor. The 1978 FHAD included Pomona Lakes 2 and 3 as an on-line detention pond. In reality, a 24-inch pipe diverts flows from Little Dry Creek into the pond. The 24-inch pipe could not be located and is likely buried. The capacity of the pipe is negligible and was not included in the baseline hydrology. It was also noted that the 1978 FHAD outflow of the Rotary Parks Detention Pond and Pomona Lakes 2 and 3 ponds was greater than the last point given in the input file, which resulted in the 1978 model extrapolating results.

- The 100-year one-hour rainfall depth used in the 1978 FHAD was 2.44 inches, as opposed to 2.38 inches used in this study.

- The 1979 study was completed prior to the majority of the development in the watershed and the assumed land use densities used in the 1979 studies were lower than what was actually constructed in the watershed. The 1978 FHAD watershed had an average watershed imperviousness of 32.4% as compared to the average future watershed imperviousness of 52.6% used in this study, a 60% increase.

- The 1979 study used a decay rate of 0 and an average infiltration rate of 0.65 inches per hour, as compared to this study's average values of 0.0018 for the decay rate, 3.10 inches per hour for the initial infiltration rate, and 0.52 inches per hour for the final infiltration rate. In addition, the 1979 study used a maximum depression storage on impervious surfaces of 0.1 inches, as compared to this study's average of 0.08 inches per hour.

- The 1978 FHAD routed flows for 748 acres down the Farmer's Highline Canal at a 0.02% slope to the Little Dry Creek diversion structure. The current policy is to assume that canals are flowing full. No berms are present to redirect flows, so if the canals are full, water would sheet flow across the canal to the northeast.

UDFCD underwent a calibration effort of CUHP. Hydrology for the Little Dry Creek watershed was developed prior to the calibration effort and was evaluated as a part of the effort. As part of the evaluation, the model differences listed above were adjusted in a separate model and it was found that the peak flows still could not be reconciled. The 1978 FHAD peak flow differences are likely due to the study using the SWMM Runoff Block. The peak flows developed in the updated model are more representative of the runoff from a fully developed watershed than those in the 1978 FHAD model. The hydrology herein is based on the resulting models from the calibration effort; and therefore, calibrating the peak flows to the 1978 FHAD was not completed.

Table 9 – Previous Studies Hydrology Reconciliation

Location	Design Point	1978 FHAD Peak Flow (cfs)	2018 MDP Peak Flow (cfs)	% Diff. (B to A)
		A	B	
Little Dry Creek				
Confluence	101	4,580	6,358	39%
64th Ave	102	4,600	6,359	38%
Federal Blvd (Pond Outflow)	106	4,640	6,246	35%
Federal Blvd (Pond Inflow)	306	4,640	8,123	75%
Lowell Blvd	112	4,100	7,774	90%
Raleigh and 72nd Ave	117	4,240	7,272	72%
Winona Ct	119	4,350	7,185	65%
76th Ave	120	4,460	7,141	60%
Sheridan Blvd	138	2,700	5,194	92%
Harlan St	160	2,020	3,947	95%
Marshall St	162	1,730	3,824	121%
Pierce St	165	1,550	3,426	121%
Webster St	166	1,390	3,450	148%
Wadsworth Blvd	167	1,120	3,505	213%
80th Ave and Pomona	174	1,040	2,571	147%
Club Crest Dr	180	1,380	1,926	40%
Hoyt Way	182	1,360	1,800	32%
Kipling St	183	1,310	1,700	30%
Alkire St	196	260	381	46%
Average				82%
Tributary B				
Lake Arbor Outlet	144	460	740	61%
Lake Abor Inlet	344	1,000	2,053	105%
Chase Dr.	145	1,010	1,664	65%
Lamar Dr.	146	1,010	1,595	58%
Otis Dr.	147	1,030	1,401	36%
Wadsworth Blvd.	149	850	1,062	25%
Average				58%
Shaw Heights Tributary				
80th Avenue	123	1,740	1,773	2%
D/S Rotary Parks Pond	127	810	902	11%
Rotary Parks Pond	327	1,020	1,264	24%
Circle Drive	130	830	849	2%
Average				10%

4.0 HYDRAULIC ANALYSIS

4.1 Evaluation of Existing Facilities

4.2 Flood Hazards

4.3 Previous Analysis

5.0 ALTERNATIVE ANALYSIS

5.1 Alternative Development Process

5.2 Criteria and Constraints

5.3 Alternative Categories

5.4 Alternative Hydraulics

5.5 Alternative Costs

5.6 Alternative Plans

5.7 Evaluation of Alternatives

5.8 Recommended Plan

6.0 CONCEPTUAL DESIGN

6.1 Plan Development Overview

6.2 Master Plan Description

6.3 Prioritization and Phasing

6.4 Water Quality Impacts

6.5 Operations and Maintenance

6.6 Environmental and Safety Assessment

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APPENDIX A

PROJECT CORRESPONDENCE

MEETING MINUTES

KICKOFF MEETING MINUTES

Little Dry Creek MDP and FHAD
Monday, July 21, 2014
1:00 pm at Urban Drainage and Flood Control District

Attendees:

Name	Company	E-mail
Shea Thomas	Urban Drainage and Flood Control District (UDFCD)	sthomas@udfcd.org
Brik Zivkovich	UDFCD	bzivkovich@udfcd.org
Anna Sparks	Adams County	ASparks@adcogov.org
Chris Sveum	City of Arvada (Arvada)	csveum@arvada.org
Andrew Hawthorn	City of Westminster (Westminster)	ahawthor@cityofwestminster.us
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Amy Gabor	Olsson Associates	agabor@olssonassociates.com
Jason Messamer	Olsson Associates	jmessamer@olssonassociates.com

Discussion Items:

The meeting was held to discuss the start of the project, determine known issues and problem areas, and identify other stakeholders that should be involved in the project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Introduction
   a) Other stakeholders will be contacted during the alternatives analysis phase of the project.

2) Project goals
   a) Main areas of concern and observed problems were discussed.
      i. Darren Bradshaw worked on a steep bank channel repair project following the September floods that included ungrouted boulders upstream of Kipling.
      ii. A bank stabilization project between Hoyt and Pomona Drive was completed prior to the September floods. Some areas were damaged during the floods.
      iii. The Rocky Mountain Arsenal to Rocky Flats trail includes a connection in the watershed. Chris will check with Harry to find out whether any trail layouts are available.
      iv. The floodplain is a Zone A in Arvada and will be updated to a Zone AE with this project.
      v. The Little Dry Creek transformation project to lower the floodplain is located between the BNSF crossing and Lowell. Shea will send Olsson the 90% Muller drawings. The project applied for a certificate of no rise.
      vi. Westminster would like to evaluate alternatives to remove the concrete channel north of 72nd Avenue.
      vii. The culverts under Federal will need to be extended when CDOT widens the road.
      viii. Olsson should contact Greg Labrie, PE, CFM at Adams County regarding floodplain modifications proposed by the Midtown development. Shea will also check for any reports.
      ix. Westminster will send plans for the 72nd Avenue bridge replacement project.

3) Needed information
   a) Shea will coordinate the structure surveys.
   b) Most GIS layers have been obtained by Olsson. Arvada will send any storm sewer, water, or sanitary sewer GIS files.
   c) Adams County, Arvada, and Westminster will send Olsson any development and highway drainage reports they have in the watershed.

4) Hydrology
   a) Olsson will compare overall watershed boundary to surrounding studies. Shea will send Olsson the Leyden Creek, Big Dry Creek, Hidden Lake, and Kalcevik Gulch overall watershed boundaries.
   b) Olsson will use EPA SWMM 5.1.006 and CUHP 1.4.3.
   c) Baseline hydrology calibration will be discussed at the next meeting. Typically, if peak flow differences are greater than 10% (prior to updating rainfall, detention, and percent imperviousness), the model would be calibrated to the older model results.
   d) Peak flow increases are anticipated.
   e) Regional detention ponds to be included in the baseline hydrology were discussed. Adams County, Arvada, and Westminster will send Olsson any storage-discharge information they have. If no information can be found, Shea will include the pond outlets in the structure surveys and the LiDAR data will be used for the stage-storage.
      i. Pomona Lakes 2 and 3 are owned by Arvada and will be included.
      ii. Lake Arbor is owned by Arvada and will be included.
      iii. Shea will determine whether the lake upstream of the Clear Creek confluence should be included.
      iv. Upstream development lakes do not appear to be regional ponds and will not be included.
      v. Anna will determine whether Midtown lake should be included.
      vi. The proposed Westminster pond at Federal Boulevard will be included in the baseline hydrology.

5) Floodplain
   a) The floodplain will be delineated for Little Dry Creek. Shea will determine whether Tributary B should also be included in the FHAD. Westminster would like for Tributary B to be included in the master plan. If possible, Arvada would like to remove the Zone A floodplain designation on Tributary B. If that is not possible, Arvada would like to update the floodplain to Zone AE.
   b) At a minimum, the floodplain extents should extend to the existing floodplain limits. The floodplain may be extended if the one square mile tributary area is located farther upstream than the current limits.
   c) HEC-RAS version 4.1.0 will be used to evaluate the floodplain.

6) Schedule to follow agreement
   a) Draft hydrology due September 17, 2014.
   b) Shea is finalizing the funding for the project.

7) Meeting schedule

a) The next progress meeting will be held in approximately 5 to 6 weeks to discuss progress on the baseline hydrology.

8) Other
   a) Alternatives and conceptual design of improvements on Tributary B will be added to the scope.

Action Items:

- UDFCD
  - Send Olsson watershed boundaries of surrounding studies - *Completed*
  - Provide Olsson with the 2013 aerial
  - Send Olsson instructions for creating interactive hydrology maps
  - Coordinate structure surveys
  - Look into maintenance eligibility of the lake upstream of the Clear Creek confluence
  - Send 90% design plans for project from Lowell to Federal – *Completed*
  - Send Olsson Midtown plans and drainage studies
  - Determine whether Tributary B should be added to the FHAD
- Adams County
  - Determine whether the Midtown lake should be included in baseline hydrology and send any storage-discharge information to Olsson
  - Send Olsson Midtown plans and drainage studies
  - Send Olsson any other relevant drainage studies in the watershed
- Arvada
  - Send Olsson any storage-discharge information for Pomona Lakes 2 and 3 and Lake Arbor
  - Send Olsson any other relevant drainage studies in the watershed
  - Send Olsson utility GIS files (i.e. storm, water, and sanitary)
  - Determine whether any trail layouts for the Rocky Mountain Arsenal to Rocky Flats trail are available
- Westminster
  - Send Olsson any relevant drainage studies in the watershed
  - Send Olsson plans for the 72nd Avenue bridge project
- Olsson
  - Send fee estimate for adding Tributary B alternatives and conceptual design
  - Contact Greg Labrie, PE, CFM at Adams County regarding floodplain modifications proposed by the Midtown development.
  - Schedule next progress meeting

Please contact Olsson at 303-237-2072 if there are any changes or questions with these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Amy Gabor
cc: Attendees, File

PROGRESS MEETING MINUTES

Little Dry Creek MDP and FHAD
Monday, August 25, 2014
2:00 pm at Urban Drainage and Flood Control District

Attendees:

Name	Company	E-mail
Shea Thomas	Urban Drainage and Flood Control District (UDFCD)	sthomas@udfcd.org
Brik Zivkovich	UDFCD	bzivkovich@udfcd.org
Anna Sparks	Adams County	ASparks@adcogov.org
Chris Sveum	City of Arvada (Arvada)	csveum@arvada.org
Andrew Hawthorn	City of Westminster (Westminster)	ahawthor@cityofwestminster.us
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Amy Gabor	Olsson Associates	agabor@olssonassociates.com
Jason Messamer	Olsson Associates	jmessamer@olssonassociates.com

Discussion Items:

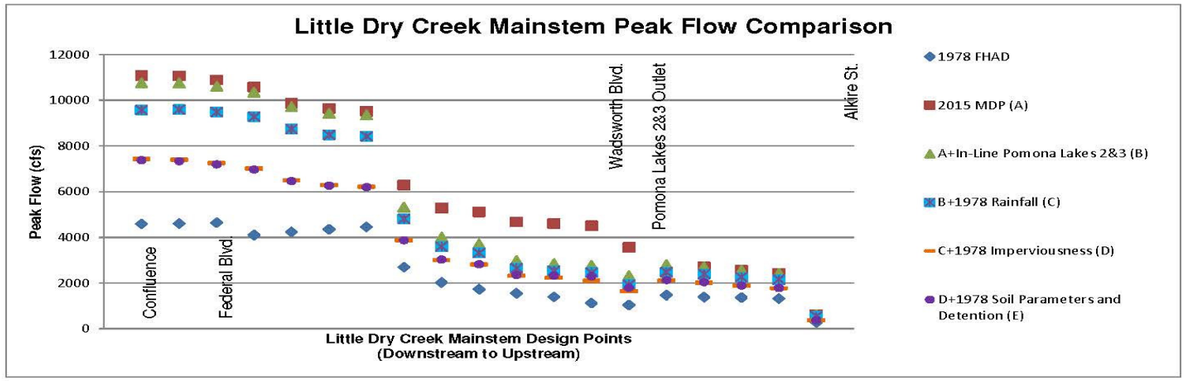
The meeting was held to discuss the progress of the project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

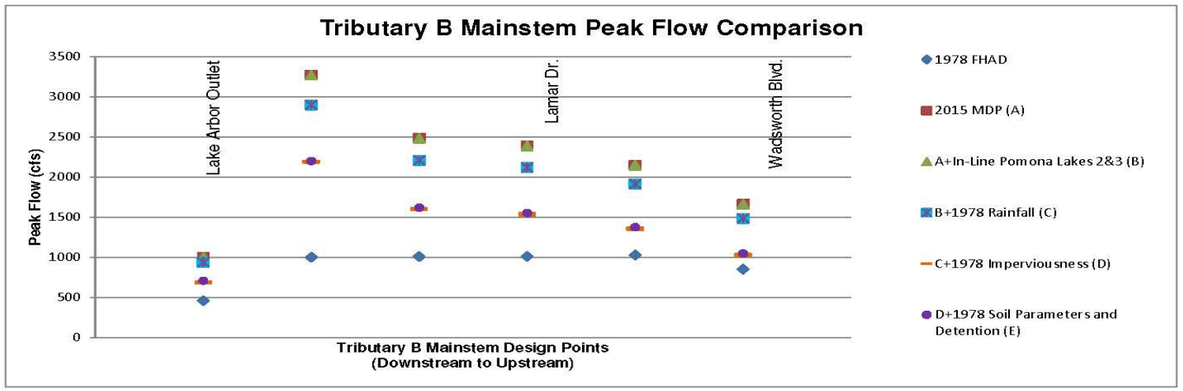
1) Olsson will contact Adams County, Arvada, and Westminster for permission to use their logos on the report.

2) Needed information
   a) Structure surveys, including pond and railroad information, are underway. Shea will provide the survey information when it is complete.
   b) Andrew will send Olsson the 72nd Avenue plans.
   c) Chris will send Olsson the as-builts for the Little Dry Creek pipe under W. 80th Avenue.
   d) Shea will initiate the contact with Muller Engineering to obtain the stage-storage-discharge information and CAD files for the designed Federal Blvd. pond.

3) Hydrology process
   a) 12.5 square mile watershed broken into 98 subwatersheds – 16 acres to 160 acres, average 82 acres
   b) Used Westminster existing land use maps for existing conditions, used aerial for existing conditions outside of Westminster. Several areas in Westminster showed a higher density land use for existing than future conditions. Olsson will use the higher land use for the study.
   c) Existing percent imperviousness = 49.3%, future = 52.3%. Because the percent impervious values are so close, only a future conditions model will be included in the study.
   d) As-builts were used to verify slopes and channel shapes in SWMM.
   e) Aerial and site observations were used to determine Manning's n values plus 25%, per UDFCD criteria.
   f) Many elements were undersized in the initial SWMM model. To prevent the model from storing water, the depth of the SWMM elements was increased. More realistic overflow sections will be added, which should decrease the flows.
   g) The following detention ponds will be included in the model:
      i) Pomona Lakes 2 and 3
         (1) The dam between the pond and the channel is a jurisdictional dam registered with the State. The 1979 MDP included this pond as an in-line pond. In reality, there is a small diversion pipe that goes into the pond. Water can also spill out of the channel over the pond spillway. Olsson will check for as-builts of the pond diversion and will let Shea know if survey is needed.
      ii) Lake Arbor
      iii) W. 64th Avenue detention pond
      iv) Designed Federal Blvd. detention pond
      v) Rotary Parks Pond, upstream of US36 south of W. 84th Avenue. Olsson will check for as-builts of the pond and will let Shea know if survey is needed. Andrew noted that the pond appears to work well during large storms, but that the downstream system is undersized and that 2 to 3 feet of water in the downstream apartment parking lot have been reported.

4) Hydrology calibration
   a) 1979 MDP
      i) Used Runoff Block of SWMM, not CUHP
      ii) 100-year one-hour point rainfall of 2.44 inches distributed over 2 hours
      iii) Future percent imperviousness = 32.4%
      iv) Decay rate = 0, infiltration rate average of minimum and maximum – varies from 0.13 to 0.90, average=0.65
      v) Maximum depression storage on impervious = 0.1
      vi) Pomona Lakes 2 and 3 modeled as in-line detention pond
   b) This MDP
      i) 100-year one-hour point rainfall of 2.66 inches distributed over 2 hours
      ii) Future percent imperviousness = 52.3%
      iii) Decay rate, initial infiltration, and final infiltration varies based on UDFCD table – average 0.0018, 3.10, and 0.52, respectively
      iv) Maximum depression storage on impervious varies, but mostly 0.05 (sloped roofs)
      v) Pomona Lakes 2 and 3 initially modeled as off-line detention pond, but will be changed to an off-line detention pond with a diversion off of the channel.
      vi) For calibration purposes, the designed Federal Blvd. detention pond and the W. 64th Avenue detention pond were not included in the initial model, since they were not included in the 1979 model.
   c) Calibration
      i) Using the same detention storage-discharge, rainfall, percent imperviousness, and soil parameters yields average 55% (51% using unit discharge) increase in flows along Little Dry Creek and 57% (19% unit discharge) increase in flows along Tributary B





ii) The majority of the watershed contains hydrologic soil group (HSG) type C soils. According to the UDFCD manual, a historic unit discharge rate for HSG C soils would be 1.00 cfs/acre. The weighted average historic unit discharge rate of all soils at the confluence would be 0.98 cfs/acre.
   (1) The 2015 MDP model (model A on the graphs) was modified to reflect historic conditions. All detention was removed from the model and a 2% imperviousness and 0.4 maximum depression storage on pervious surfaces was used for all subwatersheds.
      (a) The historic unit discharge rate on Little Dry Creek varied from 0.89 to 1.13 (higher values upstream, lower values downstream), with an average of 1.03 cfs/acre.
      (b) The historic unit discharge rate on Tributary B varied from 0.95 to 1.06 (higher values upstream, lower values downstream), with an, average 0.99 cfs/acre.
   (2) The 2015 MDP model appears to be acceptable based on the historic model results.

iii) The 1979 model included several areas with a 0.02% slope. After the meeting, Olsson investigated these areas and found that the 1979 model routed flows on the west side of the canals in the canals up to the Little Dry Creek diversion. The 2015 MDP assumes the canals are full, which routes water across the canal generally to the northeast at a much steeper slope. Re-routing the calibration model D design points to the same point and using a 0.02% slope results in a 43% increase in flows.

iv) No reported flooding along the concrete section of Little Dry Creek has been reported. Olsson noted that the canals likely intercepted flows during actual storm events and inadvertent detention occurred behind the railroad tracks.

v) Olsson will look at gage data on Little Dry Creek. Andrew noted the last big flood was in 2011.

vi) Following the meeting, Olsson converted the Marston Lake North Drainageway model to EPA SWMM 5.1 to compare changes from EPA SWMM 5.0. The flows changed between -0.34 cfs to 0.41 cfs. Based on these results, it appears that using EPA SWMM 5.1 versus 5.0 has little effect on the peak flows.

vii) Olsson will investigate the flow differences more and will send the completed model to UDFCD for further investigation.

viii) The hydrology will be completed without calibration.

5) Floodplain
   a) Olsson will wait to begin the floodplain modeling until a final decision on the hydrology is made, since that will affect the cross section extents in the HEC-RAS model.
   b) Add Tributary B and possibly Shaw Heights Tributary – Olsson will submit a fee

6) Schedule to follow agreement
   a) Draft hydrology due September 17, 2014
   b) Funding status – Adams County will present the Page Gulch Amendment to the Board which, if approved, will in turn release funding for this study.

7) Reach descriptions and environmental assessment sections of the report will be completed during the Alternatives phase. The number of reaches will be minimized.

8) Other
   a) Shaw Heights Tributary will be added to the MDP. Depending on the floodplain changes, it might also be added to the FHAD. Olsson will submit a fee.

Action Items:

- UDFCD
  - Provide Olsson with the 2013 aerial
  - Coordinate structure surveys
  - Initiate contact with Muller Engineering for Federal Blvd. pond
  - Send Olsson update information on Kalcevik Gulch watershed - *Completed*
- Arvada
  - Send Olsson as-builts for W. 80th Ave. pipe - *Completed*
- Westminster
  - Send Olsson plans for the 72nd Avenue bridge project
- Olsson
  - Send fee estimate for adding Tributary B and Shaw Heights Tributary alternatives, conceptual design, and FHAD
  - Investigate flow differences from 1979 MDP
  - Send final model to UDFCD

Please contact Olsson at 303-237-2072, or agabor@olssonassociates.com, if there are any changes or questions with these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Amy Gabor
cc: Attendees, File

PROGRESS MEETING MINUTES

Little Dry Creek MDP and FHAD
Wednesday October 29, 2014
10:00 am at Urban Drainage and Flood Control District

Attendees:

Name	Company	E-mail
Ken MacKenzie	Urban Drainage and Flood Control District (UDFCD)	kmackenzie@udfcd.org
David Skuodas	UDFCD	dskuodas@udfcd.org
Shea Thomas	UDFCD	sthomas@udfcd.org
Brik Zivkovich	UDFCD	bzivkovich@udfcd.org
Mathew Emmens	Adams County	MEmmens@adcogov.org
Anna Sparks	Adams County	ASparks@adcogov.org
Chris Sveum	City of Arvada (Arvada)	csveum@arvada.org
John Burke	City of Westminster (Westminster)	jburke@cityofwestminster.us
Andrew Hawthorn	Westminster	ahawthor@cityofwestminster.us
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Amy Gabor	Olsson Associates	agabor@olssonassociates.com
Jason Messamer	Olsson Associates	jmessamer@olssonassociates.com

Discussion Items:

The meeting was held to discuss the progress of the project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) The hydrology calibration process was discussed. Hydrology model differences are shown in Table 1. A full description of the hydrologic calibration process is included in the report. The following items document additional discussions not included in the report.

   - The three main explainable causes of the increased flows were that for the 1978 FHAD, detention at Pomona 2 & 3 was modeled as an inline pond whereas it does not currently function as an inline pond, the rainfall was 2.44 inches versus an updated rainfall of 2.66 inches, and the percent imperviousness 32.4% versus an updated 50%.

   - The 1978 FHAD rainfall of 2.44” is within the 90% confidence bands. Because 2.44” is just as statically correct as 2.66”, using the 1978 rainfall of 2.44” could be justified.

   - A stream gage is located on Little Dry Creek at 72nd Avenue. Using 31 years of data, the estimated 100-year peak flows are significantly lower than the 1978 FHAD and the 2015 MDP. However, the watershed has been developing over the last 31 years, so the data would be skewed. The gage would reflect actual conditions, including private detention ponds and the four canals that flow through the watershed. The canals would likely have a larger effect on smaller storms than the larger storms, since they may intercept the entire upstream runoff.

   - Only the parameters shown in Table 1 were adjusted to determine the duplicate effective model. The 2015 SWMM model parameters and routing, other than detention and canal re-routing, and 2015 CUHP subwatershed areas, lengths, lengths to centroid, and slopes were not updated to reflect the 1978 FHAD. A large portion of the upper watershed was undeveloped in 1978. Per policy, the 1978 FHAD accounted for future land use, but other parameters were not adjusted to account for development, including lengths, slopes, and channel sections. The undeveloped subwatershed parameters and channel sections could vary significantly from the developed subwatershed parameters in the 2015 MDP model. Roughly approximating no detention in the 1978 FHAD results in a future land use unit discharge of 0.70 cfs/acre. Prior to any model calibration, Olsson will complete a true duplicate effective model, using all of the 1978 FHAD parameters to verify the percent difference due solely to changes in models.

   - It was noted that the peak flows have the same timing at Federal and Sheridan Boulevards. Olsson will investigate.

Table 1 – Hydrology Summary

Parameter	1978 FHAD	2015 Duplicate Effective	2015 MDP	2015 Historic
Rainfall	2.44 in	2.44 in	2.66 in	2.66 in
Percent imperviousness	Avg. 32.4%	32.4%	Avg. 52.6%	2%
Maximum depression storage on pervious	0.35 in	0.35 in	Varies – mostly 0.35 in	0.4 in
Maximum depression storage on impervious	0.1 in	0.1 in	Varies - mostly 0.05 in	Varies – mostly 0.05 in
Initial rate	Varies – mostly 0.65 in/hr	0.65 in/hr	Varies – mostly 3.00 in/hr	Varies – mostly 3.00 in/hr
Decay coefficient (1/second)	0	~0	Varies – mostly 0.0018	Varies – mostly 0.0018
Final rate	Varies – mostly 0.65 in/hr	0.65 in/hr	Varies – mostly 0.5 in/hr	Varies – mostly 0.5 in/hr
Detention	Lake Arbor, Rotary Parks Pond, Pomona Lakes 2&3 (on-line)	Lake Arbor, Rotary Parks Pond, Pomona Lakes 2&3 (on-line)	Lake Arbor, Rotary Parks Pond, Pomona Lakes 2&3 (off-line), W. 64th Ave. pond, designed Federal Blvd. pond	None
Tributary B Lake Arbor Inlet Q100 (cfs)	1,000	1,914	2,802	1,345 (0.85 cfs/ac)
Tributary B Lake Arbor Outlet Q100 (cfs)	460	644	978	1,345 (0.85 cfs/ac)
Shaw Heights Tributary at 80th Avenue Q100 (cfs)	1,740	1,951	2,896	1,320 (1.21 cfs/ac)
Little Dry Creek at Federal Q100 (cfs)	4,640	6,821	10,798	7,161 (0.94 cfs/ac)
Little Dry Creek at Clear Creek Q100 (cfs)	4,580	6,990	5,481	7,347 (0.91 cfs/ac)

- During the MDP process, slowing down the peak flows on one or more tributaries will be evaluated, since multiple tributaries hit at essentially the same time.

2) The following hydrology comments were not discussed in the meeting, but are documented in the minutes as a response to the comments.

- UDFCD (Page 7) – CUHP 1.4.3 was used for the hydrology. Version 1.4.4 was released after the hydrology was completed.
- Adams County/UDFCD (Page 10) – Olsson will coordinate with Adams County to get the GIS file for unincorporated Adams County that was annexed into Westminster.
- Adams County (Page 20) – The canal routing is at 0.02%, or 0.0002 ft/ft in 1978 FHAD.
- UDFCD (Page 35) – Olsson will adjust the text so that entire area is on one figure.
- UDFCD (Page 36) – This area is currently undeveloped. The 85% imperviousness came from Westminster's "Mixed Use Neighborhood" future land use designation.
- Westminster – Pomona Lake 1 was not included in the hydrology. A total of 445 cfs reaches the pond. Inclusion of this pond can be investigated in the alternatives analysis.
- Westminster – The hydraulic model has not been completed.
- Federal Blvd designed pond and RTD
    - Federal Blvd storage-discharge was extrapolated for higher elevations. In reality, water will overtop the tracks and flow east, rather than only being released through the outlet structure unless the flows or design change.
    - Current RTD project has higher flows than this MDP for new crossings:

Approximately 7 crossings convey 1,554 cfs under embankment to Little Dry Creek in 100-yr event. MDP has 1,270 cfs including 58 cfs inflow from Kalcevik Gulch at US 36.

- Shaw Heights Tributary flow: Historic model – 1.41 cfs/ac. Olsson will look into calibrating the flow on this tributary.
    - If reduce Cp value by 20% to match target historic discharge, the resulting flows decreased by 230 cfs at the downstream end of Shaw Heights Tributary, 50 cfs on Little Dry Creek at 76th Avenue, 115 cfs at Federal Boulevard, and 10 cfs at the downstream end of Little Dry Creek.

3) Additional information needed for final hydrology

- Area downstream of Rotary Park Pond
    - US 36 construction – final plans? Site visit to verify is 66" culvert is still under US 36
- Shaw Heights Tributary structure surveys.

4) Amendment for Tributary B and Shaw Heights Tributary submitted

5) Funding status – Adams County will present the Page Gulch Amendment to the Board which, if approved, will in turn release funding for this study.

6) Schedule – Olsson will wait for the remaining funding to be release prior to finalizing the hydrology and proceeding with the hydraulic model. The schedule will then follow the agreement.

Action Items:

- UDFCD
    - Coordinate Shaw Heights Tributary structure surveys
- Adams County
    - Send Olsson GIS file for unincorporated Adams County that was annexed into Westminster
- Olsson
    - Acquire US 36 plans for recent construction
    - Complete duplicate effective model, after additional funding has been released
    - Send final model to UDFCD

Please contact Olsson at 303-237-2072 or agabor@olssonassociates.com if there are any changes or questions with these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Amy Gabor
cc: Attendees, File

PROGRESS MEETING MINUTES

Little Dry Creek MDP and FHAD
Wednesday March 4, 2015
3:00 pm at Urban Drainage and Flood Control District

Attendees:

Name	Company	E-mail
Shea Thomas	Urban Drainage and Flood Control District (UDFCD)	sthomas@udfcd.org
Mathew Emmens	Adams County	MEmmens@adcogov.org
Anna Sparks	Adams County	ASparks@adcogov.org
Chris Sveum	City of Arvada (Arvada)	csveum@arvada.org
Andrew Hawthorn	City of Westminster (Westminster)	ahawthor@cityofwestminster.us
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Amy Gabor	Olsson Associates	agabor@olssonassociates.com
Jason Messamer	Olsson Associates	jmessamer@olssonassociates.com

Discussion Items:

The meeting was held to discuss the progress of the project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Shea presented a summary of the hydrology calibration process to date. UDFCD will be conducting a review of their hydrology this year and changes to their procedures and/or models may result.

2) Olsson will wait for UDFCD's direction to complete the calibration process. It was decided at the meeting that if this study moves forward, the following items will be completed:

   - Olsson completed a four subbasin model upstream of West 72nd Avenue to better represent the original CUHP model calibration during its development. Olsson will calibrate this model to the 1978 FHAD and then update the parameters to the 2015 MDP. The overall 98 subbasin model will then be calibrated to the calibrated four subbasin model with the 2015 parameters.

   - Olsson will finalize the hydrology report with the above calibration process.

   - Olsson will complete the hydraulic model and submit a rough cut floodplain. The alternatives analysis will not be completed until the project sponsors have reviewed the preliminary floodplain.

Please contact Olsson at 303-237-2072 or agabor@olssonassociates.com if there are any changes or questions with these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Amy Gabor
cc: Attendees, File

PROGRESS MEETING MINUTES

Little Dry Creek MDP and FHAD
Wednesday April 15, 2015
2:00 pm at Urban Drainage and Flood Control District

Attendees:

Name	Company	E-mail
Shea Thomas	Urban Drainage and Flood Control District (UDFCD)	sthomas@udfcd.org
Ken MacKenzie	UDFCD	kam@udfcd.org
Dave Skuodas	UDFCD	dskuodas@udfcd.org
Commissioner Charles Tedesco	Adams County	ctedesco@adcogov.org
Matthew Emmens	Adams County	MEmmens@adcogov.org
Anna Sparks	Adams County	ASparks@adcogov.org
Chris Sveum	City of Arvada (Arvada)	csveum@arvada.org
Andrew Hawthorn	City of Westminster (Westminster)	ahawthor@cityofwestminster.us
John Burke	City of Westminster	jburke@cityofwestminster.us
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Jason Messamer	Olsson Associates	jmessamer@olssonassociates.com

Discussion Items:

The meeting was held to discuss the progress of the project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Olsson presented the preliminary results of the HEC-RAS hydraulic model developed for Little Dry Creek and provided a status update of the work completed for the project. Two preliminary floodplains were delineated for Little Dry Creek, one using the regulatory FHAD flows and the second using the calibrated CUHP flows developed during the hydrology phase of this project.

2) Construction activities in lower Little Dry Creek were discussed. An RTD CLOMR was submitted for construction activities downstream of the project at Federal Boulevard. The bridge at 72nd Avenue is being replaced. Olsson will obtain plans and hydraulic models for these projects and run the new flows resulting from the project at Federal Boulevard through the RTD model to determine a preliminary floodplain. The models will be incorporated into the overall hydraulic model. If the RTD CLOMR does not extend to the confluence with Clear Creek Olsson will add that portion of Adams County to the hydraulic model along Little Dry Creek.

3) The FHAD will include Tributary B, Tributary C, and Shaw Heights Tributary. Revised flows will be used downstream of Federal Boulevard based on the project CLOMR.

4) Options for moving forward were discussed and are as follows:

   A. Proceed with the FHAD and MDP using the existing (effective) hydrology.

   B. Proceed with the FHAD upstream of Lowell Boulevard using the existing (effective) hydrology and put the MDP on hold until the UDFCD recalibration of CUHP project is complete.

   C. Proceed with the FHAD upstream of Lowell Boulevard using the existing (effective) hydrology and cancel the MDP. If needed, prepare an MDP amendment with recommendations for the portion downstream of Federal Boulevard.

Please contact Olsson at 303-237-2072 or jmessamer@olssonassociates.com with changes or questions regarding these meeting minutes. The minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Jason Messamer
cc: Attendees, Amy Gabor, File

FHAD MEETING MINUTES

Little Dry Creek MDP and DFHAD
Monday January 4, 2016
1:30 pm at Urban Drainage

Attendees:

Name	Company	E-mail
Shea Thomas	Urban Drainage and Flood Control District (UDFCD)	sthomas@udfcd.org
David Mallory	UDFCD	dmallory@udfcd.org
Terri Fead	UDFCD	tfead@udfcd.org
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Amy Gabor	Olsson	agabor@olssonassociates.com
Jason Messamer	Olsson	jmessamer@olssonassociates.com

Discussion Items:

The meeting was held to discuss comments from the first FHAD submittal. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Discussion of Flows

   a) Little Dry Creek and Tributary B

      i) Flow changes in Little Dry Creek and Tributary B for the 100-year event will be reduced to match the number of design points from the 1978 FHAD hydrology and will not include interpolated flows published in Table 4 of the 1978 FHAD.

      ii) LOMR case no. 01-08-179P, effective 02/14/2002, (2002 LOMR) flows will be used for Little Dry Creek for the 100-year event at the Shaw Heights tributary confluence.

   b) Shaw Heights

      i) Only the 10-year and 100-year flows are available for Shaw Heights. Dummy flows will be used for the other storm events so that all the flows and plans are contained in one file.

      ii) The 1985 Shaw Heights Tributary to Little Dry Creek MDP flows were used for improvements in the watershed and for LOMRs that became effective after the 1978 FHAD was published. The upper end of the tributary is currently undeveloped farmland. The MDP flows assume that a new regional detention pond will be required at the upper end of the tributary if the land use changes.

      iii) The 2002 LOMR and as-constructed documents on Shaw Heights tributary show flows that include updated stage/storage information for the Rotary Parks detention pond and detention at the former Westminster Mall site is also included. Hydrology models and/or design reports are not available to verify the detention assumptions. The published 2002 LOMR flows and design flows shown on the as-constructed documents have been used.

      iv) LOMR case no. 03-08-0044P, effective 01/20/2003, (2003 LOMR) includes existing conditions flows and proposed flows upstream and downstream of West 80th Ave on Shaw Heights tributary. The proposed flows from the 2003 LOMR will be used and match the 2002 LOMR, 1985 MDP, and as-constructed documents.

      v) Shea will contact Westminster to determine whether there are design documents available for the mall redevelopment that is currently underway.

      vi) CDOT altered a portion of the Shaw Heights tributary and Olsson obtained a design memorandum showing flows for the reach that has been altered. Olsson will provide contact information to David Mallory so that he can check on the status of a potential LOMR that should be filed with the improvements.

   c) Other flow comments

      i) Flows will be added to the hydrology description that was submitted with the FHAD to make it easier to understand what is changing from reach to reach on Shaw Heights tributary. This information, including discharge profiles, will be incorporated into the FHAD report. Noting that particular flows have been used as the regulatory/effective flows will be helpful for justification of their use. Notes will also be added to the FHAD maps to make it easier to track flow changes.

      ii) The FHAD report will not need to follow the standard report outline since new hydrology was not developed. Rather, a summarized explanation of the flows and their source documents will be included.

2) HEC-RAS Model Comments

   a) General comments

      i) Upstream and downstream cross sections at skewed crossings will not be changed in orientation to be perpendicular for Little Dry Creek since Olsson has accounted for the impact of skewed crossings.

      ii) All relevant crossings were modified to include survey data, photos, as-builts, etc.

      iii) Ineffective areas on the downstream side of crossings will be adjusted if the crossing is not overtopped to prevent an overestimation of the flow conveyance.

      iv) Highly inundated pedestrian bridges do not necessarily need increased contraction and expansion coefficients. Olsson will adjust on a case-by-case basis.

      v) The overland flow path will be used as the centerline if it differs from the low-flow or piped-flow centerline.

      vi) Bank stations will be revised and varied Manning's n values will be used when needed.

vii) Floodway transitions will be altered to show smoother transitions. The preferred method is to keep the HEC-RAS model results as they are, but modify the mapped lines within the allowable tolerance to produce a smoother line.

b) Specific locations

i) A separate analysis is required for the improved/tapered inlets. UDFCD requested that a rating curve be developed separately from the HEC-RAS model and that resulting known water surfaces be used in the HEC-RAS model. The analysis will look at the face, throat, and outlet control conditions for the culverts.

ii) The stream alignment in the golf course will be adjusted to follow the floodplain channel and not the small overflow swales.

iii) Ineffective areas adjacent to the Shaw Heights concrete channel that are lower than the water surface elevation will be mapped as floodplain if they are hydraulically connected or have the potential for local ponding.

iv) Shaw Heights 12'x8' RCBC and "Monster inlet" (48" culvert upstream) – The main concern is an outlet control situation of the RCBC. Olsson will update the analysis to determine the hydraulic control of the structure.

3) Schedule – Olsson will proceed with incorporation of review comments that can be completed at this time. Some of the action items involve additional information requests. Once Olsson has received additional information, Olsson will contact Shea to determine the schedule for the next FHAD submittal.

Action Items

Olsson
- Olsson will provide a contact to David Mallory for the consultant who completed the CDOT work at Highway 36 along Shaw Heights and potential LOMR.
- Olsson will send the 1991 design report and 2002 LOMR on Little Dry Creek at the Shaw Heights tributary confluence to UDFCD. The 1991 design report is embedded in the 2002 LOMR PDF.

Shea Thomas
- Contact Westminster for information regarding the mall redevelopment

Please contact Olsson at 303-237-2072 or jmessamer@olssonassociates.com with changes or questions regarding these meeting minutes. The minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Jason Messamer
cc: Attendees, File

RE-STARTED KICKOFF MEETING MINUTES

Little Dry Creek MDP and FHAD
Monday December 4, 2017
10:00 am at Urban Drainage

Attendees:

Name	Company	E-mail
Shea Thomas	Urban Drainage and Flood Control District (UDFCD)	sthomas@udfcd.org
Brooke Seymour	UDFCD	bseymour@udfcd.org
Anna Sparks	Adams County	asparks@adcogov.org
Allison Rice	Adams County	arice@adcogov.org
Riley Pennington	City of Arvada	rpennington@arvada.org
Andrew Hawthorn	City of Westminster	ahawthor@CityofWestminster.us
Nicole Ankeney	City of Westminster	nankeney@CityofWestminster.us
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Amy Gabor	Olsson	agabor@olssonassociates.com
Krystina Pacheco	Olsson	kpacheco@olssonassociates.com

Discussion Items:

The meeting was held to discuss the startup of the Little Dry Creek (LDC) FHAD and MDP. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Requested information and status

   a) As-built pond stage-storage-discharge information, as-built topography, as-built HEC-RAS model for the Federal Project – Shea checking with Dave Skuodas

   b) LOMR information for RTD project downstream of Federal – Enginuity completed the CLOMR for this project. A LOMR was not completed since the as-built project will be included as part of this FHAD. It was noted that the 0.5-foot floodway had caused problems in this area.

   c) Westminster Mall detention pond – provided by Seth Plas

   d) Any new culverts RTD installed – Design plans were shared by Muller in 2015. Olsson will coordinate with Alana Bales for the as-built plans.

   e) CDOT as-builts for Shaw Heights – Olsson will coordinate with Ryan Sorenson and Scott Leiker for the as-built plans.

   f) 72nd and Raleigh bridge as-builts – As-builts have been received.

   g) Floodplain modifications at the Midtown and Pomponio developments are currently underway. A CLOMR was completed as part of the project and will be included in this study.

   h) Rocky Mountain Arsenal to Rocky Flats trail includes a connection in the watershed.

   i) City of Westminster confirmed Phase 1 of the trail project has been completed, It follows the original Little Dry Creek trail to Stanley Lake and, therefore, will have no impact on the floodplain.

2) FHAD

   a) Rough estimate of the 100-year floodplain was provided at the meeting. This floodplain used previously-estimated flows and will change with the updated hydrology.

   b) City of Westminster is working on improvements along Little Dry Creek from north of 72nd to Lowell. The improvements include a Greenhouse expansion south of 72nd Ave and an administration building. The preliminary floodplain was used for design of these buildings to reduce the impacts to the floodplain.

   c) Olsson will update the draft floodplain delineation south of 72nd Avenue for the City of Westminster after completion of the updated hydrology to give them an idea of floodplain limits for their upcoming projects.

   d) Olsson will incorporate the large inlet and storm drain system upstream of Rotary Park Detention Pond into the HEC-RAS model. The project was designed to eliminate the 100-year floodplain through the neighborhood. Olsson will check inlet capacities to verify that the 100-year flow is intercepted.

   e) The floodplain in Arvada will be updated from a Zone A to a zone AE with this project.

3) Problem Areas and Potential Alternatives

   a) Steep banks are present upstream of Kipling.

   b) A bank stabilization project between Hoyt and Pomona Drive is being completed.

   c) Olsson will review Matrix Design Group's master plan south of 72nd.

   d) City of Westminster is looking at an accessible ramp at 72nd and Raleigh.

   e) A sanitary sewer interceptor project is currently in progress. The sewer runs mainly along the south side of Little Dry Creek from Lowell to 72nd Ave. The sewer crosses the creek at Wolfram Park. The City of Westminster will send plans for the project. The alternatives analysis will be coordinated with these plans to avoid any conflicts.

   f) City of Westminster would like Olsson to evaluate a 100-year storm drain system at the upstream end of Shaw Heights Tributary.

   g) Alternatives to remove the houses from the floodplain at Rotary Park will be evaluated.

   h) City of Westminster is interested in alternatives to reduce the floodplain south of Highway 36th and any improvements to help the Westminster station.

   i) Water quality and detention alternatives will be investigated. Westminster will send a GIS layer of parcels owned by the City.

   j) Westminster open space at 75th Ave and Sheridan Ave. has the potential for detention.

k) Olsson will evaluate improvements to increase the detention in Lake Arbor and create online detention at Pomona Lakes No. 2.

l) Adams County prefers natural channels where possible and has existing trails along Little Dry Creek.

m) RTD proposed a floodwall to eliminate flooding across the tracks. They might have conceded that flooding will occur. Adams County expressed some concern with utilizing a floodwall.

n) Olsson will evaluate whether flows from the downtown redevelopment area adversely affect the area north of West 81st Place and west of the railroad.

4) Schedule

a) Updated hydrology report will be provided to the District by 1/12/2018. FHAD and MDP shall follow typical schedule as outlined in the contract thereafter.

Action Items

Olsson
- Coordinate with Alana Bales for LOMR information for RTD project downstream of Federal
- Coordinate with Ryan Sorenson and Scott Leiker for the CDOT as-built plans
- Create a rough floodplain boundary with updated flows for the use of City of Westminster upcoming projects.

UDFCD
- Provide as-built pond stage-storage-discharge information, as-built topography, and as-built HEC-RAS model for the Federal project.

Adams County
- Send Olsson information regarding Midtown and Pomponio developments.

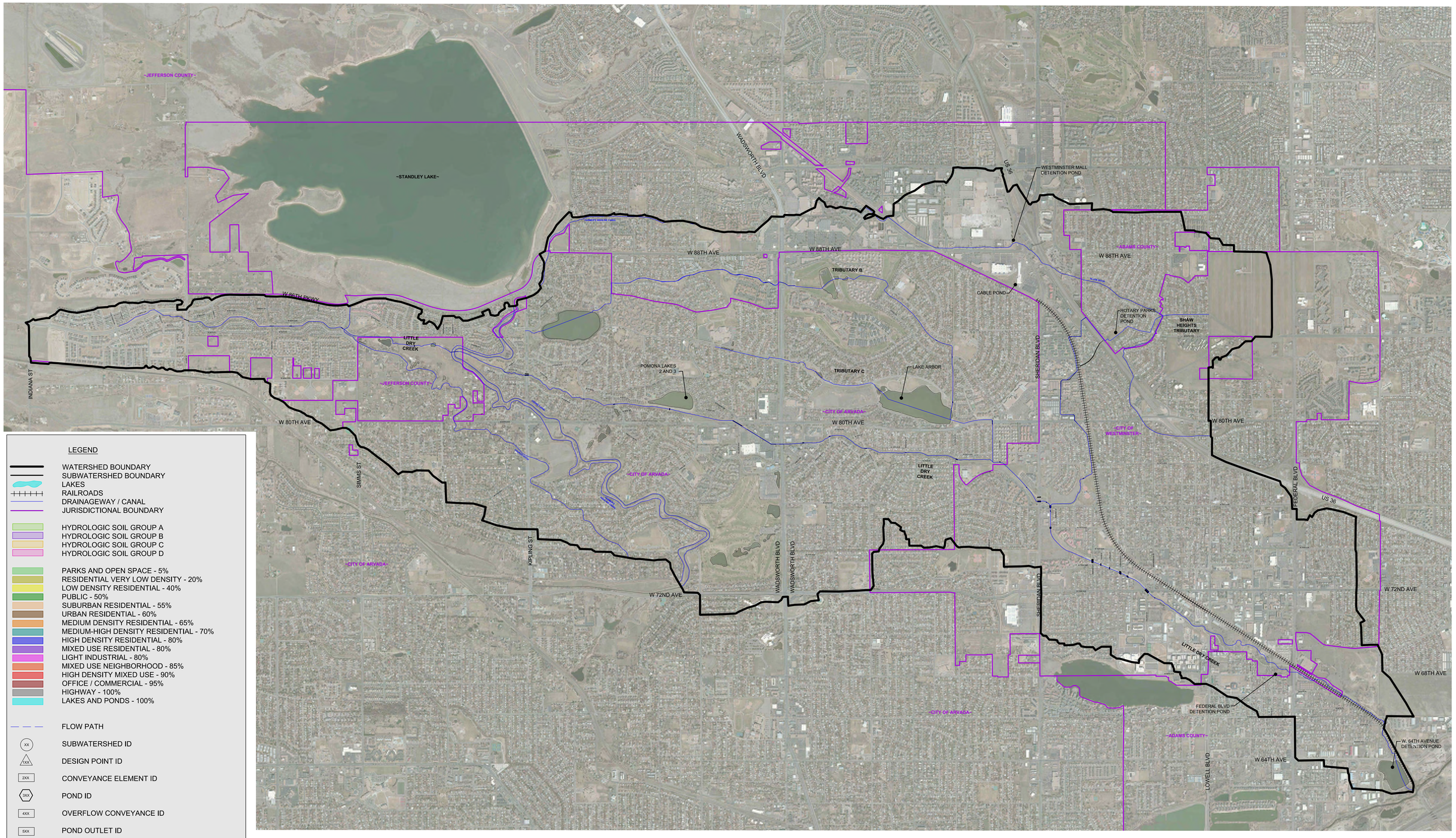
City of Westminster
- Provide the following information:
  - Plans for sanitary sewer interceptor project along Little Dry Creek - *completed*
  - As-builts for inlet and storm drain at Shaw Blvd. along Shaw Heights - *completed*
  - Shapefile of parcel information
  - 72nd Avenue Bridge as-builts - *completed*
  - Westminster Station Park conceptual plans - *completed*

Please contact Olsson at 303-237-2072 or agabor@olssonassociates.com with changes or questions regarding these meeting minutes. The minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Krystina Pacheco
cc: Attendees, File

APPENDIX B

HYDROLOGIC ANALYSIS



LEGEND

- WATERSHED BOUNDARY
- SUBWATERSHED BOUNDARY
- LAKES
- RAILROADS
- DRAINAGEWAY / CANAL
- JURISDICTIONAL BOUNDARY

- HYDROLOGIC SOIL GROUP A
- HYDROLOGIC SOIL GROUP B
- HYDROLOGIC SOIL GROUP C
- HYDROLOGIC SOIL GROUP D

- PARKS AND OPEN SPACE - 5%
- RESIDENTIAL VERY LOW DENSITY - 20%
- LOW DENSITY RESIDENTIAL - 40%
- PUBLIC - 50%
- SUBURBAN RESIDENTIAL - 55%
- URBAN RESIDENTIAL - 60%
- MEDIUM DENSITY RESIDENTIAL - 65%
- MEDIUM-HIGH DENSITY RESIDENTIAL - 70%
- HIGH DENSITY RESIDENTIAL - 80%
- MIXED USE RESIDENTIAL - 80%
- LIGHT INDUSTRIAL - 80%
- MIXED USE NEIGHBORHOOD - 85%
- HIGH DENSITY MIXED USE - 90%
- OFFICE / COMMERCIAL - 95%
- HIGHWAY - 100%
- LAKES AND PONDS - 100%

- FLOW PATH
- XX — SUBWATERSHED ID
- !XX — DESIGN POINT ID
- 2XX — CONVEYANCE ELEMENT ID
- 3XX — POND ID
- 4XX — OVERFLOW CONVEYANCE ID
- 5XX — POND OUTLET ID
- XX / XX — SUBWATERSHED ID, FUTURE PERCENT IMPERVIOUS, SUBWATERSHED ACREAGE

NOTE: DUMMY ELEMENTS ARE NOT SHOWN FOR CLARITY.

INTERACTIVE FIGURES (SELECT FROM BELOW)

SOILS MAP

FUTURE LAND USE MAP

SUBWATERSHED BOUNDARIES MAP

BASELINE HYDROLOGY SWMM ROUTING MAP

N

1" = 1000'

0 500' 1000'

SCALE IN FEET

TURN AERIAL ON OR OFF

TOPOGRAPHIC MAPPING METHOD: LIDAR
TOPOGRAPHIC MAPPING BY: MERRICK & COMPANY
HORIZONTAL/VERTICAL DATUM: NAD 83/NAVD 88
CONTOUR INTERVAL: 2 FOOT
DATE FLOWN: 2008

OLSSON ASSOCIATES
1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

designed by: AG
drawn by: KP
checked by: DO/DK
project no.: 014-1761
date: 11/2018

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT,
CITY OF WESTMINSTER, CITY OF ARVADA, AND ADAMS COUNTY

LITTLE DRY CREEK, TRIBUTARY B,
AND SHAW HEIGHTS TRIBUTARY
FLOOD HAZARD AREA DELINEATION

HYDROLOGY MAP

FIGURE
B-1

SHEET 1 of 1

DWG: F:\Projects\014-1761_WRS\Preliminary_Plans\Hydrology\14-1761_Hydrology Map.dwg USER: agabor
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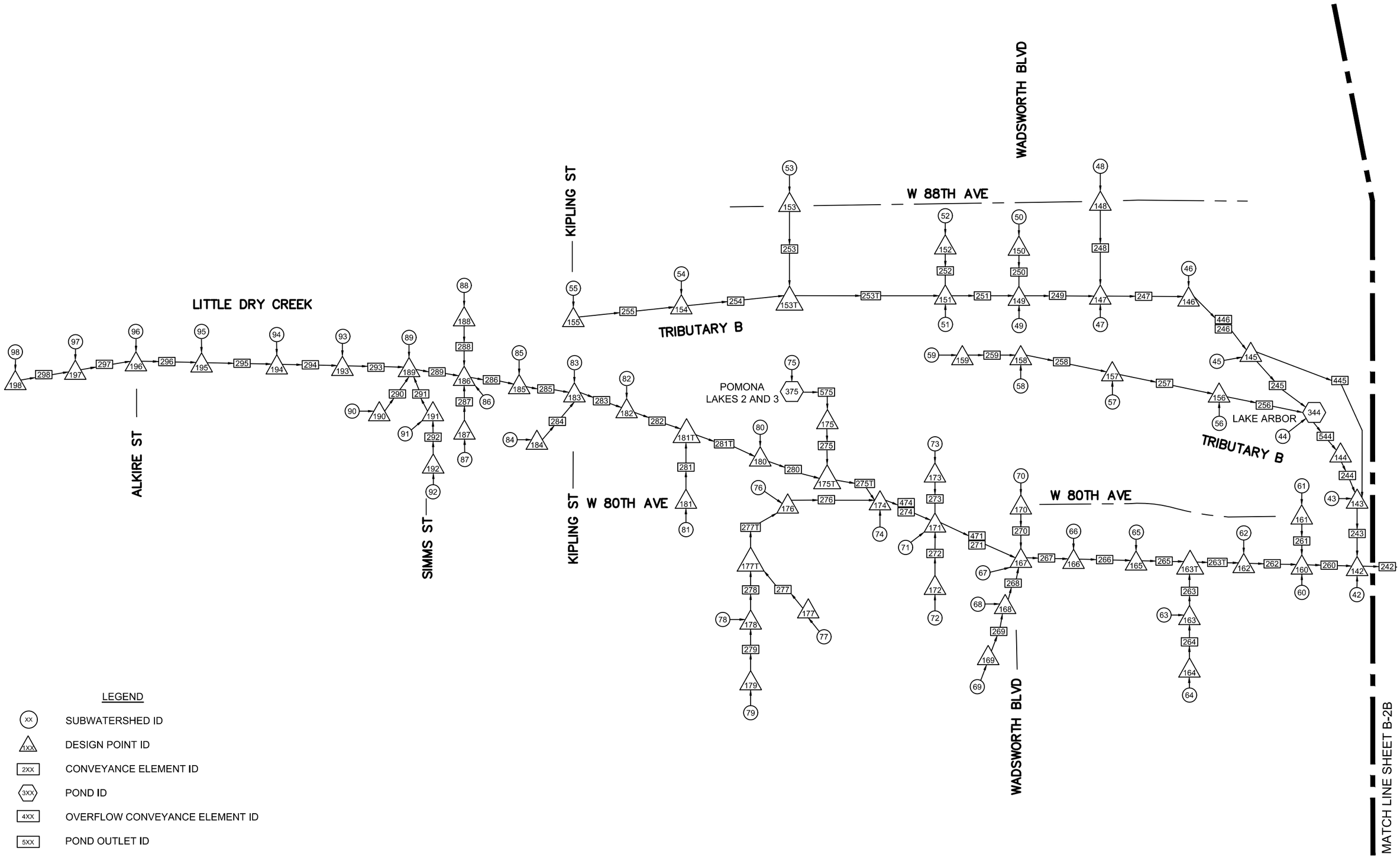

LEGEND

- XX — SUBWATERSHED ID
- 1XX — DESIGN POINT ID
- 2XX — CONVEYANCE ELEMENT ID
- 3XX — POND ID
- 4XX — OVERFLOW CONVEYANCE ELEMENT ID
- 5XX — POND OUTLET ID

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TOPOGRAPHIC MAPPING BY: MERRICK & COMPANY
HORIZONTAL/VERTICAL DATUM: NAD 83/NAVD 88
CONTOUR INTERVAL: 2 FOOT
DATE FLOWN: 2008

OLSSON ASSOCIATES
1525 Raleigh Street
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Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

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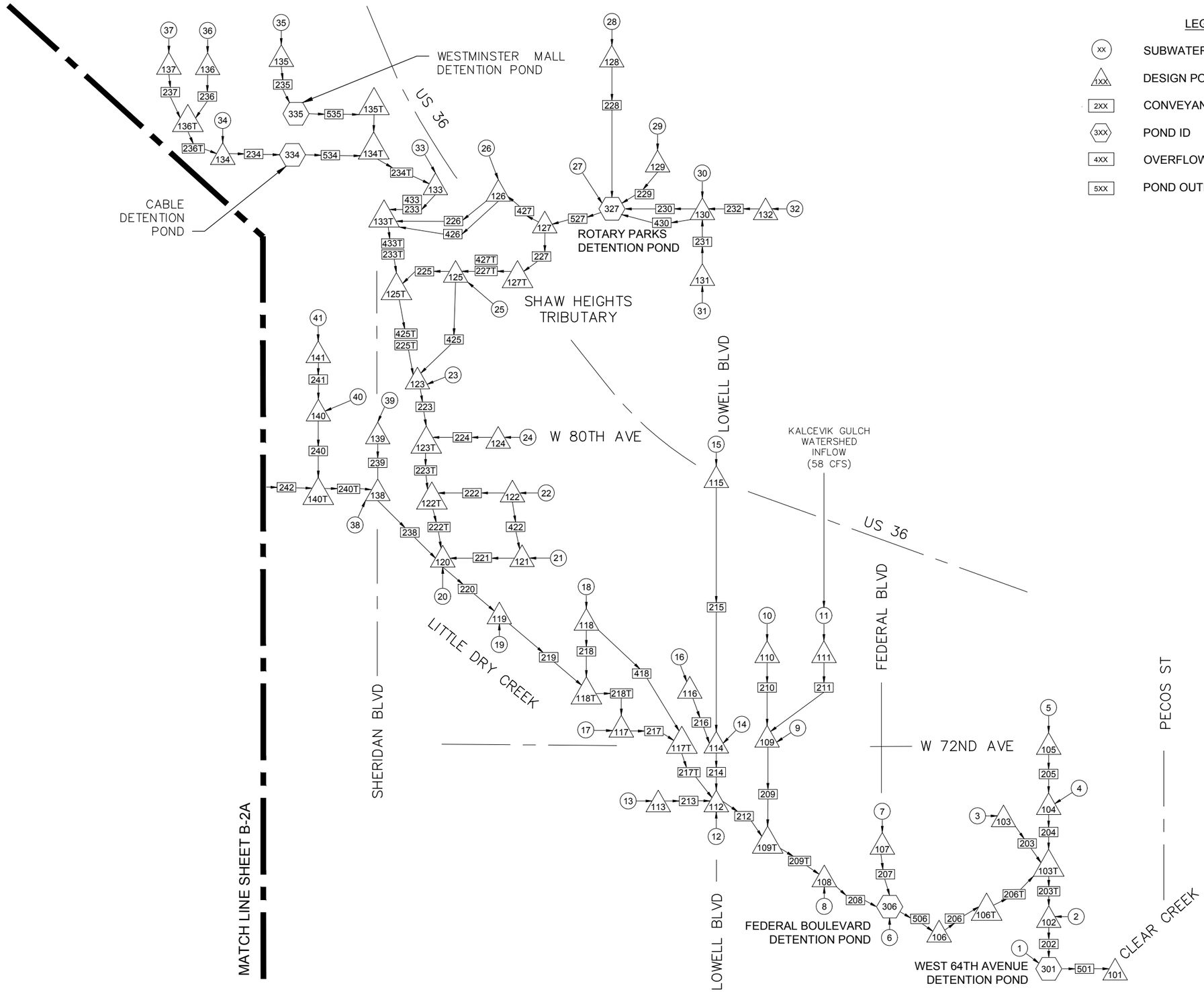
drawn by: KP
checked by: DO/DK
project no.: 014-1761
date: 08/2018

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT,
CITY OF WESTMINSTER, CITY OF ARVADA, AND ADAMS COUNTY

LITTLE DRY CREEK, TRIBUTARY B,
AND SHAW HEIGHTS TRIBUTARY
FLOOD HAZARD AREA DELINEATION

EPA SWMM 5.1
ROUTING SCHEMATIC

FIGURE
B-2A
SHEET 1 of 2



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TOPOGRAPHIC MAPPING BY:	MERRICK & COMPANY
HORIZONTAL/VERTICAL DATUM:	NAD 83/NAVD 88
CONTOUR INTERVAL:	2 FOOT
DATE FLOWN:	2008

OLSSON ASSOCIATES
1525 Raleigh Street
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TEL 303.237.2072
FAX 303.237.2659

designed by:	AG
drawn by:	KP
checked by:	DO/DK
project no.:	014-1761
date:	08/2018

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT,
CITY OF WESTMINSTER, CITY OF ARVADA, AND ADAMS COUNTY

LITTLE DRY CREEK, TRIBUTARY B,
AND SHAW HEIGHTS TRIBUTARY
FLOOD HAZARD AREA DELINEATION

EPA SWMM 5.1
ROUTING SCHEMATIC

FIGURE
B-2B
SHEET 2 of 2

LAND USE MAPS

Figure 7

Future Land Use

SEE INSET MAP FOR EASTERN ADAMS COUNTY

WELD COUNTY

CITY AND COUNTY OF BROOMFIELD

Lochbuie

Brighton

Agricultural Tourism Study Area

Westminster

Thornton

Northglenn

Westminster

Federal Heights

Commerce City

Arvada

Commerce City

Rocky Mountain Arsenal National Wildlife Refuge

CITY AND COUNTY OF DENVER

Denver International Airport

Peña

Front Range Airport

Aurora

Bennett

Strasburg

ARAPAHOE COUNTY

Western Adams County

0 1 2 4 6 8 Miles

Imagine ADAMS COUNTY

Map Date: October 2012
Map Created By: Clarion Associates
Data Source: Adams County GIS

Adams County Planning and Development Department
4430 South Adams County Parkway 1st Floor, Suite W2000A
Brighton, CO 80601
720.523.6800

ADAMS COUNTY COLORADO

Legend

- Adams County Boundary
- Adjacent County
- Water Body
- Existing Parks and Open Space
- Rail
- Future FasTracks Station
- DIA Noise Impact Area
- Front Range Noise Impact Area

Future Land Use

Residential
- Urban Residential
- Estate Residential

Mixed Use
- Mixed Use Neighborhood
- Activity Center
- Mixed Use Employment

Commercial/Industrial
- Commercial
- Industrial

Other
- Agriculture
- DIA Reserve
- Parks and Open Space
- Public
- Municipal Area

Special Overlays
- Agricultural Tourism Study Area
- Natural Resource Conservation

WELD COUNTY

MORGAN COUNTY

WASHINGTON COUNTY

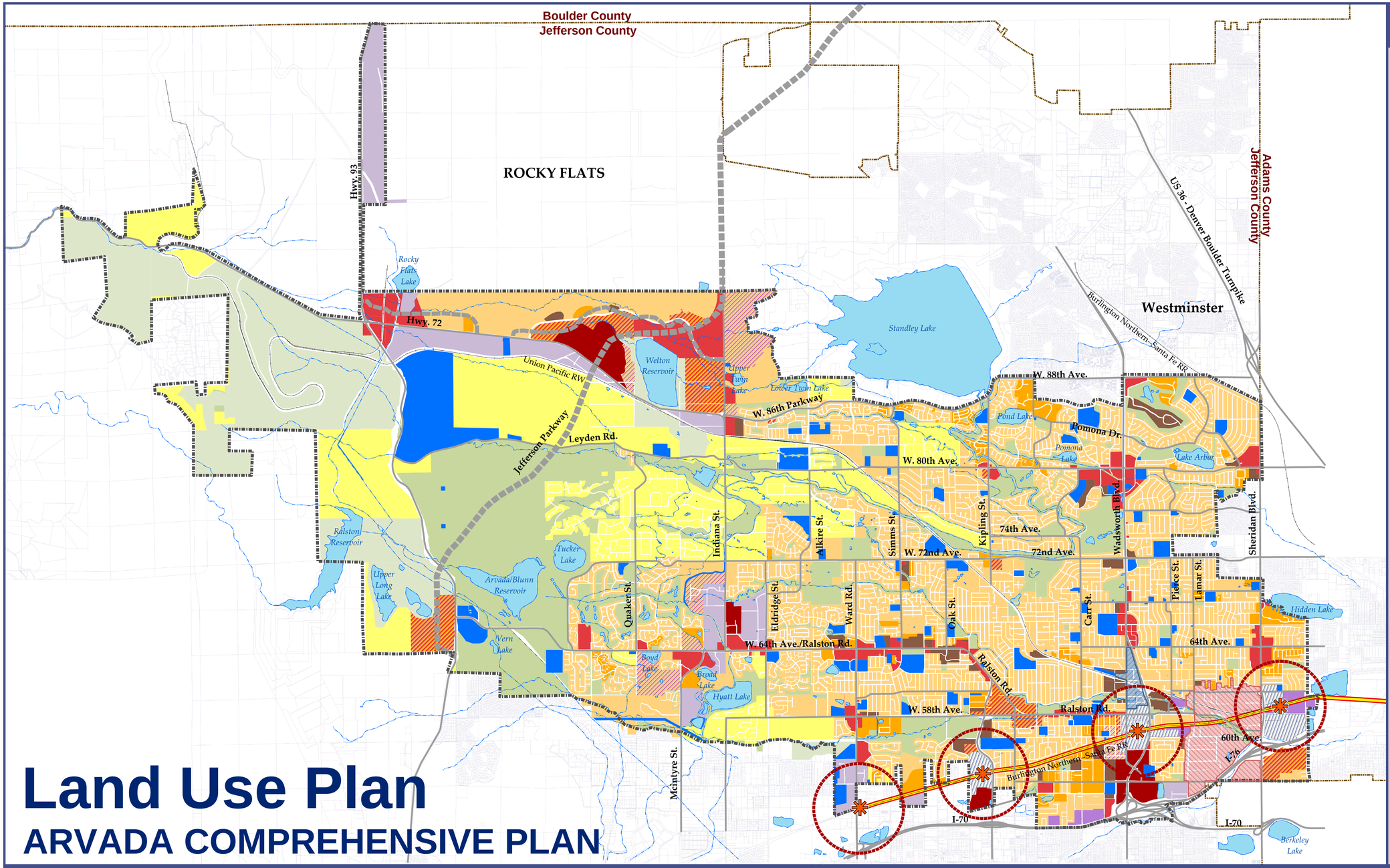
Bennett

Strasburg

ARAPAHOE COUNTY

0 5 10 20 Miles

Eastern Adams County



Land Use Plan

ARVADA COMPREHENSIVE PLAN

CITY OF ARVADA

LAND USE PLAN

Legend

- Planning Area Boundary
- County Boundaries
- Railroads
- Waterways
- Lakes and Ponds

Land Use Categories

- Low Density Residential
- Suburban Residential
- Medium Density Residential
- High Density Residential
- Industrial
- Industrial/Office
- Neighborhood/Community Commercial
- Large Format Commercial
- Mixed-Use: Residential Emphasis
- Mixed-Use
- Open Space and Parks
- Public Land (Not Owned by City)
- Public/Quasi-Public
- Clear Creek/I-76 Community Plan Area (refer to that plan for land uses)
- Transit Station Framework Plan
- Wadsworth Neighborhood Plan

Transportation

- Major Streets (Existing)
- Major Streets (Future)
- Jefferson Parkway (Future- Preferred Alignment))
- Gold Line (Future)
- Gold Line Station Area (Future)
- Transit-Oriented Develoment Influence Areas

0 0.25 0.5 0.75 1 Mi.

North

FIGURE 3

June 16, 2008

LOW DENSITY RESIDENTIAL (WITH CLUSTER OPTION)
Primary Uses: Single-family residences, duplexes, patio homes, townhomes, and condominiums.
Density: (see chart)

Gross Density (du/ac)	Open Space Min.
Up to 0.65 du/ac.	20%
Up to 1.2 du/ac.	50%
Up to 1.5 du/ac.	70%

SUBURBAN RESIDENTIAL
Primary Uses: Single-family residences, duplexes, and attached residences.
Density: Up to 5 dwelling units per acre.

MEDIUM DENSITY RESIDENTIAL
Primary Uses: Medium Density Residential includes a broader variety of residential types, including single-family residences, duplexes, patio homes, townhomes, and condominiums.
Density: Up to 12 dwelling units per acre.

HIGH DENSITY RESIDENTIAL
Primary Uses: High Density Residential is appropriate for multi-family residential apartments and condominiums and similar higher-density residential types.
Density: Minimum of 12 dwelling units per acre and up to 24 dwelling units per acre. For High Density Residential within Transit-Oriented Development (TOD) Influence Areas, a minimum density of 20 dwelling units per acre.

MIXED-USE
Primary Uses: The Mixed-Use category is intended to promote a wide range of land uses, including retail, office, light industrial, live-work, and medium and higher density residential. No more than 80% of site or building should be devoted to a single use.
Density/Intensity: Minimum density of 7 dwelling units per acre. For residential portions of Mixed-Use development within Transit-Oriented Development (TOD) Influence Areas, the City will target a minimum density of 20 dwelling units per acre.

MIXED-USE: RESIDENTIAL EMPHASIS
Primary Uses: A range of residential housing types, such as single-family residences, duplexes, patio homes, townhomes, apartments, condominiums, and live-work units, should be built on a majority of any site within this category. Between ten (10) and forty (40) percent of the site area should be allocated to non-residential uses that are related to the neighborhood.
Density/Intensity: Minimum density of 7 dwelling units per acre should be provided. For residential portions of Mixed-Use Residential within Transit-Oriented Development (TOD) Influence Areas, the City will target a minimum density of 20 dwelling units per acre.

INDUSTRIAL
Primary Uses: This category encompasses Arvada's heavier industrial areas and generally provides a location where less restrictive regulations apply.

INDUSTRIAL/OFFICE
Primary Uses: This category allows office and industrial uses with minimal impact on surrounding uses. The intent is a business park environment.

NEIGHBORHOOD & COMMUNITY COMMERCIAL
Primary Uses: General retail and office to serve neighborhoods and the community.

LARGE FORMAT COMMERCIAL
Primary Uses: The Large Format Commercial category is designed to provide a location for more intense retail that will serve the broader community or region. It may include, but is not limited to, general retail and office, "Big Box" retail centers, and regional malls.

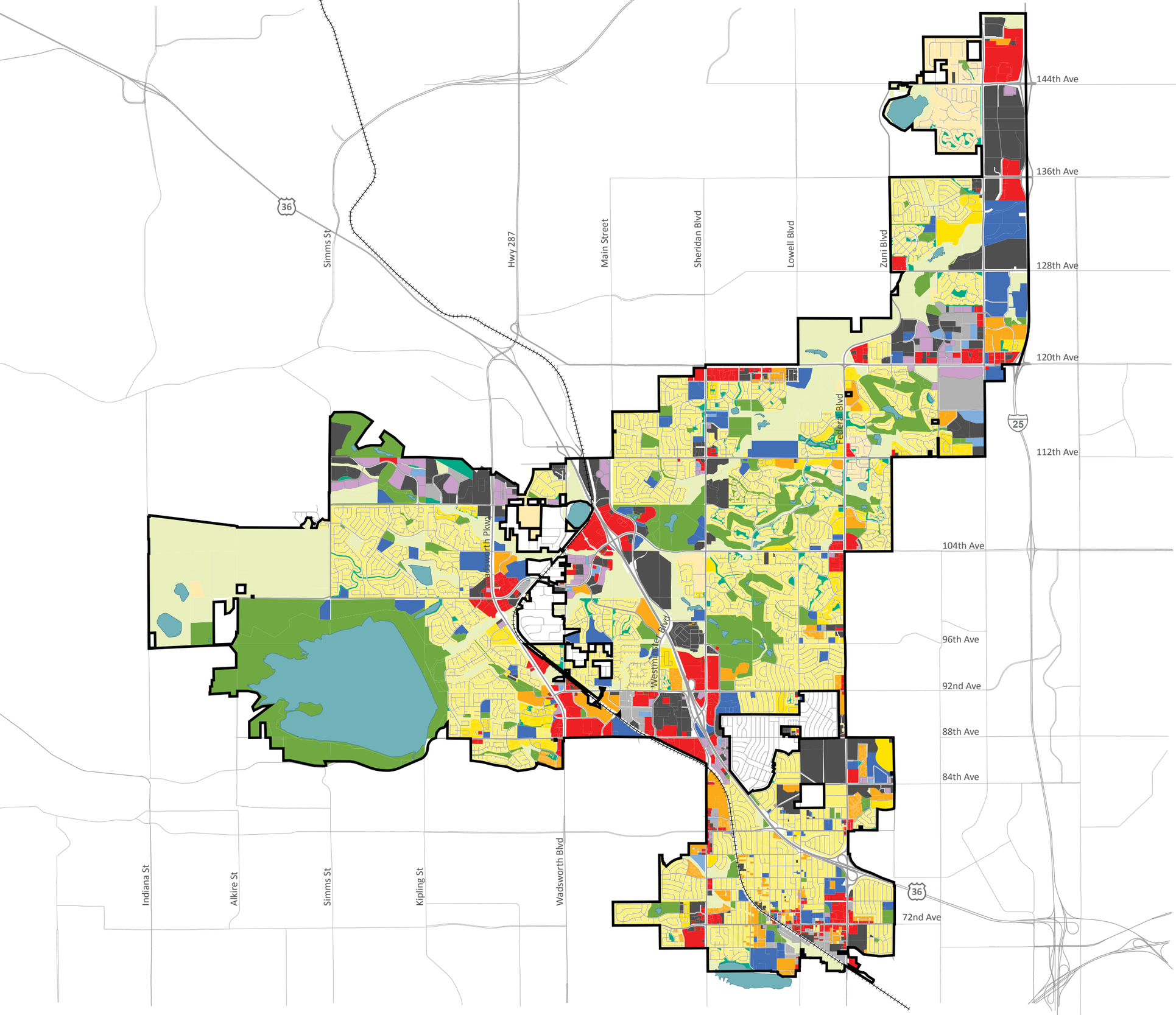
OPEN SPACE AND PARKS
Primary Uses: Public and private open space, public and private parks, and golf courses.

PUBLIC AND QUASI-PUBLIC
Primary Uses: Uses related to community services, such as fire stations, schools, libraries, community centers, hospitals, city buildings, utilities, cemeteries, and places of worship.

City of Westminster Landuse Map
Figure 2-1: Existing Land Use 2013

Legend

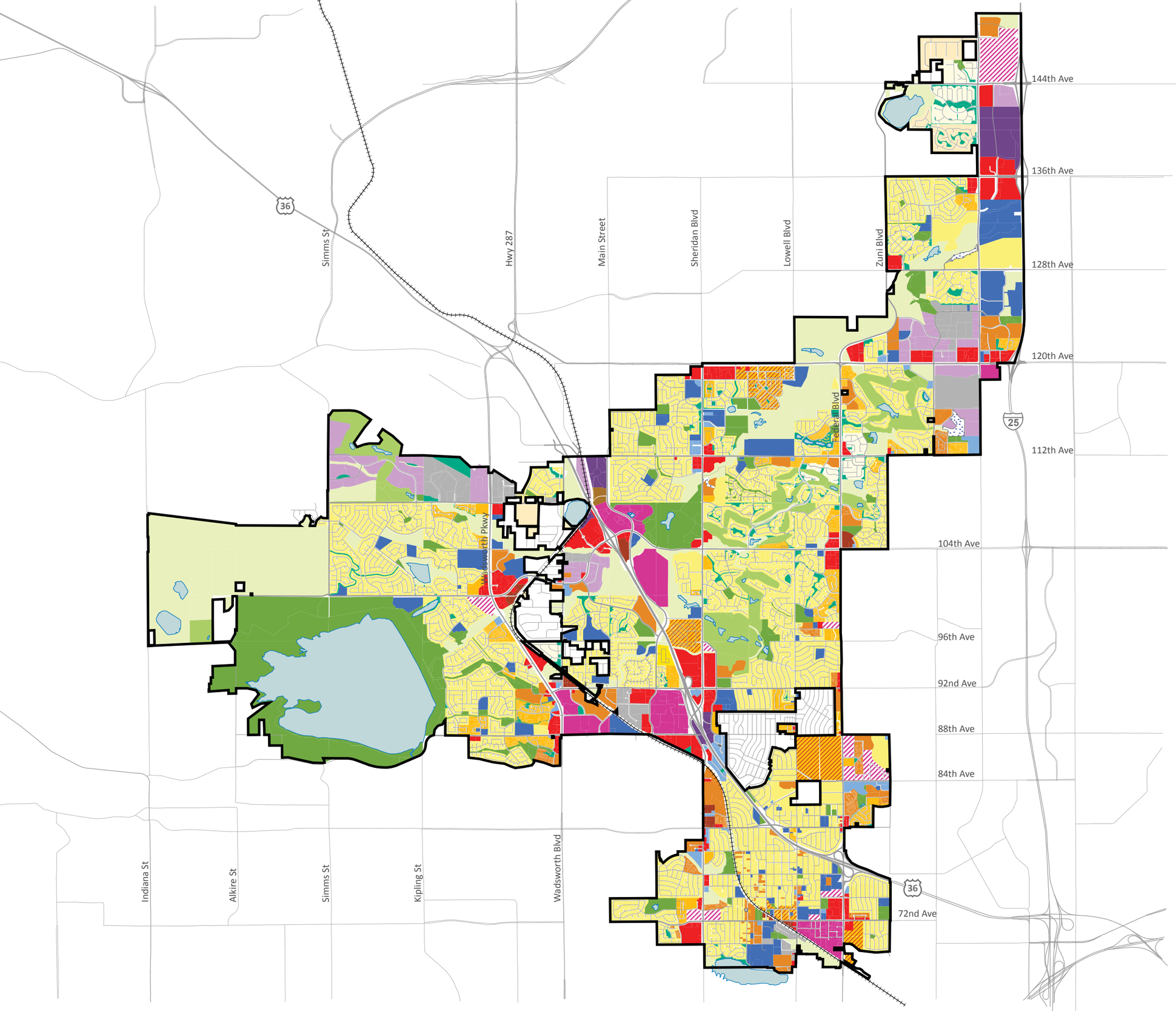
- Very Low Density Residential (R-1, R-2.5)
- Low Density Residential (R-3.5)
- Medium Density Residential (R-5, R-8)
- High Density Residential (R-18)
- Retail Commercial
- Office
- Light Industrial
- Park and Golf Courses
- Private Park/Private Open Space
- City Owned Open Space
- Public/Quasi Public
- Vacant
- City Limits
- Rail Corridor



0 0.5 1.0 2.0
Miles

City of Westminster Landuse Map

Figure 2-2: Land Use Diagram - Future



Legend

- Residential R-1
- Residential R-2.5
- Residential R-3.5
- Residential R-5
- Residential R-8
- Residential R-18
- Residential R-36
- Traditional Mixed Use Neighborhood Devt.
- Mixed Use
- Mixed Use Center
- Retail Commercial
- Service Commercial
- Office
- Office/R&D Low Intensity
- Office/R&D High Intensity
- Flex/Light Industrial
- Public/Quasi-Public
- Public Parks
- City Owned Open Space
- Golf Courses
- Private Parks/Open Space
- Major Creek Corridor on Non-Public Land
- City Limits
- Water

0 0.5 1.0 2.0

Miles

Table B-1 - Unadjusted Rainfall Distributions

1Hr Depth	0.81	
Return Period	2	Years
Time	Depth	CurveValue
0:05	0.016	0.020
0:10	0.032	0.040
0:15	0.068	0.084
0:20	0.129	0.160
0:25	0.202	0.250
0:30	0.113	0.140
0:35	0.051	0.063
0:40	0.040	0.050
0:45	0.024	0.030
0:50	0.024	0.030
0:55	0.024	0.030
1:00	0.024	0.030
1:05	0.024	0.030
1:10	0.016	0.020
1:15	0.016	0.020
1:20	0.016	0.020
1:25	0.016	0.020
1:30	0.016	0.020
1:35	0.016	0.020
1:40	0.016	0.020
1:45	0.016	0.020
1:50	0.016	0.020
1:55	0.008	0.010
2:00	0.008	0.010

1Hr Depth	1.09	
Return Period	5	Years
Time	Depth	CurveValue
0:05	0.022	0.020
0:10	0.040	0.037
0:15	0.095	0.087
0:20	0.167	0.153
0:25	0.273	0.250
0:30	0.142	0.130
0:35	0.063	0.058
0:40	0.048	0.044
0:45	0.039	0.036
0:50	0.039	0.036
0:55	0.033	0.030
1:00	0.033	0.030
1:05	0.033	0.030
1:10	0.033	0.030
1:15	0.027	0.025
1:20	0.024	0.022
1:25	0.024	0.022
1:30	0.024	0.022
1:35	0.024	0.022
1:40	0.016	0.015
1:45	0.016	0.015
1:50	0.016	0.015
1:55	0.016	0.015
2:00	0.014	0.013

1Hr Depth	1.34	
Return Period	10	Years
Time	Depth	CurveValue
0:05	0.027	0.020
0:10	0.050	0.037
0:15	0.110	0.082
0:20	0.201	0.150
0:25	0.335	0.250
0:30	0.161	0.120
0:35	0.075	0.056
0:40	0.058	0.043
0:45	0.051	0.038
0:50	0.043	0.032
0:55	0.043	0.032
1:00	0.043	0.032
1:05	0.043	0.032
1:10	0.043	0.032
1:15	0.043	0.032
1:20	0.034	0.025
1:25	0.025	0.019
1:30	0.025	0.019
1:35	0.025	0.019
1:40	0.025	0.019
1:45	0.025	0.019
1:50	0.025	0.019
1:55	0.023	0.017
2:00	0.017	0.013

1Hr Depth	1.72	
Return Period	25	Years
Time	Depth	CurveValue
0:05	0.022	0.013
0:10	0.060	0.035
0:15	0.086	0.050
0:20	0.138	0.080
0:25	0.258	0.150
0:30	0.430	0.250
0:35	0.206	0.120
0:40	0.138	0.080
0:45	0.086	0.050
0:50	0.086	0.050
0:55	0.055	0.032
1:00	0.055	0.032
1:05	0.055	0.032
1:10	0.041	0.024
1:15	0.041	0.024
1:20	0.031	0.018
1:25	0.031	0.018
1:30	0.024	0.014
1:35	0.024	0.014
1:40	0.024	0.014
1:45	0.024	0.014
1:50	0.024	0.014
1:55	0.024	0.014
2:00	0.024	0.014

1Hr Depth	2.04	
Return Period	50	Years
Time	Depth	CurveValue
0:05	0.027	0.013
0:10	0.071	0.035
0:15	0.102	0.050
0:20	0.163	0.080
0:25	0.306	0.150
0:30	0.510	0.250
0:35	0.245	0.120
0:40	0.163	0.080
0:45	0.102	0.050
0:50	0.102	0.050
0:55	0.065	0.032
1:00	0.065	0.032
1:05	0.065	0.032
1:10	0.049	0.024
1:15	0.049	0.024
1:20	0.037	0.018
1:25	0.037	0.018
1:30	0.029	0.014
1:35	0.029	0.014
1:40	0.029	0.014
1:45	0.029	0.014
1:50	0.029	0.014
1:55	0.029	0.014
2:00	0.029	0.014

1Hr Depth	2.38	
Return Period	100	Years
Time	Depth	CurveValue
0:05	0.024	0.010
0:10	0.071	0.030
0:15	0.109	0.046
0:20	0.190	0.080
0:25	0.333	0.140
0:30	0.595	0.250
0:35	0.333	0.140
0:40	0.190	0.080
0:45	0.148	0.062
0:50	0.119	0.050
0:55	0.095	0.040
1:00	0.095	0.040
1:05	0.095	0.040
1:10	0.048	0.020
1:15	0.048	0.020
1:20	0.029	0.012
1:25	0.029	0.012
1:30	0.029	0.012
1:35	0.029	0.012
1:40	0.029	0.012
1:45	0.029	0.012
1:50	0.029	0.012
1:55	0.029	0.012
2:00	0.029	0.012

Table B-2 - CUHP Input Parameters

Basin	Area	Area	Area	Length to Centroid	Length to Centroid	Length	Length	Weighted Slope	Future Imperviousness	Maximum Depression Storage on Pervious	Maximum Depression Storage on Impervious	Initial Infiltration Rate (fi)	Horton's Decay Rate (a)	Final Infiltration Rate (fo)
	ft^2	acres	mi^2	ft	mi	ft	mi	ft/ft	%	in	in	in/hr	1/second	in/hr
1	5402379	124	0.1938	2458	0.4656	4916	0.9311	0.0101	68.88	0.35	0.09	3.90	0.0013	0.72
2	2487757	57	0.0892	2118	0.4011	3796	0.7190	0.0113	68.45	0.35	0.08	3.91	0.0013	0.73
3	5120351	118	0.1837	1900	0.3599	8249	1.5622	0.0176	43.87	0.35	0.08	3.25	0.0017	0.56
4	3485564	80	0.1250	3051	0.5778	4856	0.9196	0.0096	59.84	0.35	0.09	3.00	0.0018	0.50
5	4442438	102	0.1594	1958	0.3707	3790	0.7178	0.0155	51.40	0.35	0.08	3.00	0.0018	0.50
6	1956261	45	0.0702	753	0.1427	2451	0.4642	0.0239	58.18	0.35	0.08	3.50	0.0015	0.62
7	2253205	52	0.0808	1478	0.2799	2641	0.5002	0.0182	90.92	0.35	0.1	3.00	0.0018	0.50
8	3518779	81	0.1262	1175	0.2226	2888	0.5470	0.0163	42.50	0.37	0.07	4.00	0.0012	0.75
9	1550420	36	0.0556	593	0.1123	1799	0.3407	0.0170	92.19	0.35	0.1	3.46	0.0015	0.61
10	5042780	116	0.1809	2150	0.4072	4495	0.8514	0.0226	48.25	0.35	0.08	3.00	0.0018	0.50
11	4878006	112	0.1750	2278	0.4314	4641	0.8789	0.0170	67.51	0.35	0.09	3.00	0.0018	0.50
12	6962194	160	0.2497	1834	0.3473	3921	0.7426	0.0096	60.70	0.35	0.09	3.08	0.0018	0.52
13	3444230	79	0.1235	1726	0.3269	3954	0.7489	0.0101	39.38	0.35	0.07	3.00	0.0018	0.50
14	4775609	110	0.1713	3369	0.6381	6868	1.3008	0.0261	52.44	0.35	0.07	3.02	0.0018	0.51
15	2665764	61	0.0956	1740	0.3295	2757	0.5222	0.0478	44.60	0.35	0.07	3.91	0.0013	0.73
16	4380017	101	0.1571	3440	0.6515	6377	1.2077	0.0266	49.44	0.35	0.07	3.08	0.0018	0.52
17	3936666	90	0.1412	1069	0.2025	3633	0.6881	0.0125	57.19	0.35	0.08	3.20	0.0018	0.51
18	3382639	78	0.1213	1449	0.2745	3505	0.6638	0.0241	44.81	0.35	0.07	3.00	0.0018	0.50
19	3236393	74	0.1161	1147	0.2172	2738	0.5185	0.0076	43.92	0.35	0.07	3.58	0.0018	0.54
20	4489813	103	0.1610	2369	0.4486	4551	0.8620	0.0114	38.60	0.35	0.07	3.07	0.0018	0.50
21	1025850	24	0.0368	772	0.1461	1738	0.3291	0.0270	48.56	0.35	0.07	3.00	0.0018	0.50
22	2747038	63	0.0985	1484	0.2810	3244	0.6143	0.0360	38.57	0.35	0.07	3.08	0.0018	0.52
23	3689748	85	0.1324	1600	0.3029	4492	0.8508	0.0133	83.24	0.35	0.09	3.00	0.0018	0.50
24	2559156	59	0.0918	2832	0.5364	3607	0.6832	0.0207	39.74	0.35	0.07	3.28	0.0016	0.57
25	1594506	37	0.0572	645	0.1222	2569	0.4866	0.0244	42.58	0.35	0.07	3.00	0.0018	0.50
26	5526928	127	0.1983	1601	0.3032	5888	1.1152	0.0194	72.68	0.35	0.09	3.09	0.0018	0.52
27	5447350	125	0.1954	1338	0.2535	4819	0.9126	0.0169	39.95	0.35	0.07	3.00	0.0018	0.50
28	4216117	97	0.1512	1809	0.3426	4459	0.8444	0.0132	43.84	0.35	0.07	3.00	0.0018	0.50
29	1005508	23	0.0361	1307	0.2476	2327	0.4407	0.0333	40.49	0.35	0.07	3.83	0.0013	0.71
30	5280078	121	0.1894	2257	0.4274	4269	0.8085	0.0192	41.75	0.35	0.07	3.00	0.0018	0.50
31	3182569	73	0.1142	650	0.1231	3035	0.5749	0.0309	45.44	0.35	0.07	3.20	0.0017	0.55
32	5137372	118	0.1843	1197	0.2267	2784	0.5272	0.0188	84.90	0.35	0.07	3.00	0.0018	0.50
33	2624948	60	0.0942	2223	0.4210	4257	0.8062	0.0185	92.45	0.35	0.1	3.00	0.0018	0.50
34	1884789	43	0.0676	864	0.1636	2778	0.5261	0.0078	86.23	0.35	0.1	3.00	0.0018	0.50
35	3308988	76	0.1187	1557	0.2950	3721	0.7047	0.0070	86.37	0.35	0.1	3.00	0.0018	0.50
36	3217266	74	0.1154	999	0.1892	2641	0.5003	0.0100	91.81	0.35	0.1	3.00	0.0018	0.50
37	1527635	35	0.0548	1265	0.2396	2186	0.4141	0.0092	79.24	0.35	0.1	3.00	0.0018	0.50
38	6744774	155	0.2419	1747	0.3309	4316	0.8173	0.0238	43.28	0.35	0.07	3.07	0.0018	0.50
39	2448242	56	0.0878	1625	0.3077	3293	0.6238	0.0140	77.84	0.35	0.09	3.23	0.0018	0.52
40	5272125	121	0.1891	3325	0.6298	7362	1.3944	0.0099	67.67	0.35	0.07	3.00	0.0018	0.50
41	4992859	115	0.1791	2792	0.5287	4684	0.8872	0.0120	54.38	0.35	0.07	3.00	0.0018	0.50
42	1536133	35	0.0551	663	0.1256	1972	0.3734	0.0202	50.79	0.35	0.07	3.31	0.0018	0.52
43	1878887	43	0.0674	1428	0.2704	2610	0.4943	0.0072	57.47	0.35	0.07	3.00	0.0018	0.50
44	4874699	112	0.1749	1527	0.2892	3257	0.6168	0.0139	59.74	0.35	0.07	3.00	0.0018	0.50
45	2426398	56	0.0870	1954	0.3702	3876	0.7342	0.0105	54.05	0.35	0.07	3.00	0.0018	0.50
46	6966712	160	0.2499	2177	0.4124	5652		0.0150	52.41	0.35	0.07	3.00	0.0018	0.50
47	6167582	142	0.2212	1789	0.3388	4216	0.7984	0.0142	44.11	0.35	0.07	3.00	0.0018	0.50
48	4551849	104	0.1633	2475	0.4688	4549	0.8616	0.0111	80.91	0.35	0.09	3.00	0.0018	0.50
49	2717595	62	0.0975	3608	0.6834	4631	0.8772	0.0097	45.70	0.35	0.07	3.00	0.0018	0.50
50	5616794	129	0.2015	2320	0.4394	5203	0.9854	0.0138	56.61	0.35	0.09	3.00	0.0018	0.50
51	3339222	77	0.1198	704	0.1334	3288	0.6227	0.0079	50.83	0.35	0.07	3.00	0.0018	0.50
52	4843029	111	0.1737	3858	0.7306	5194	0.9838	0.0085	56.48	0.35	0.07	3.00	0.0018	0.50
53	3833071	88	0.1375	718	0.1359	2793	0.5289	0.0137	47.30	0.35	0.07	3.00	0.0018	0.50
54	4192866	96	0.1504	2347	0.4445	3080	0.5834	0.0198	59.33	0.35	0.07	3.00	0.0018	0.50
55	2443381	56	0.0876	1203	0.2278	2570	0.4868	0.0135	47.96	0.35	0.07	3.00	0.0018	0.50

Table B-2 - CUHP Input Parameters

Basin	Area	Area	Area	Length to Centroid	Length to Centroid	Length	Length	Weighted Slope	Future Imperviousness	Maximum Depression Storage on Pervious	Maximum Depression Storage on Impervious	Initial Infiltration Rate (fi)	Horton's Decay Rate (a)	Final Infiltration Rate (fo)
	ft^2	acres	mi^2	ft	mi	ft	mi	ft/ft	%	in	in	in/hr	1/second	in/hr
56	5737140	132	0.2058	2444	0.4630	5049	0.9563	0.0118	38.10	0.35	0.07	3.00	0.0018	0.50
57	2233148	51	0.0801	1597	0.3025	3018	0.5716	0.0166	46.62	0.35	0.07	3.00	0.0018	0.50
58	5022707	115	0.1802	1630	0.3087	3154	0.5973	0.0127	52.19	0.35	0.07	3.00	0.0018	0.50
59	3560183	82	0.1277	1545	0.2926	4155	0.7869	0.0137	46.68	0.35	0.07	3.00	0.0018	0.50
60	5072264	116	0.1819	2203	0.4172	4104	0.7773	0.0188	53.60	0.35	0.07	3.03	0.0018	0.50
61	1123438	26	0.0403	1048	0.1985	2341	0.4434	0.0209	51.18	0.35	0.07	3.46	0.0018	0.53
62	4405012	101	0.1580	1706	0.3231	5519	1.0452	0.0197	50.86	0.35	0.07	3.13	0.0018	0.51
63	4582148	105	0.1644	1797	0.3404	3764	0.7129	0.0202	52.33	0.35	0.07	3.00	0.0018	0.50
64	3606572	83	0.1294	2495	0.4725	3958	0.7496	0.0339	53.60	0.35	0.07	3.00	0.0018	0.50
65	2453599	56	0.0880	1598	0.3026	3508	0.6645	0.0261	55.00	0.35	0.07	3.16	0.0018	0.51
66	3662492	84	0.1314	1466	0.2777	4381	0.8297	0.0263	71.66	0.35	0.09	3.20	0.0018	0.51
67	5068149	116	0.1818	2206	0.4179	4669	0.8843	0.0300	35.83	0.35	0.09	3.02	0.0018	0.50
68	5505260	126	0.1975	2414	0.4573	5152	0.9757	0.0107	30.72	0.35	0.07	3.00	0.0018	0.50
69	2492471	57	0.0894	705	0.1336	3446	0.6526	0.0186	31.60	0.35	0.07	3.00	0.0018	0.50
70	1400554	32	0.0502	996	0.1887	2423	0.4588	0.0208	88.29	0.35	0.1	3.25	0.0018	0.52
71	4041870	93	0.1450	2051	0.3884	3703	0.7014	0.0274	70.73	0.35	0.09	3.01	0.0018	0.50
72	3923518	90	0.1407	1299	0.2461	4820	0.9129	0.0207	38.30	0.35	0.07	3.00	0.0018	0.50
73	2835940	65	0.1017	1188	0.2250	3130	0.5929	0.0266	52.52	0.35	0.07	3.02	0.0018	0.50
74	1608151	37	0.0577	2942	0.5573	4095	0.7755	0.0068	38.11	0.35	0.07	3.00	0.0018	0.50
75	3259109	75	0.1169	1532	0.2902	2662	0.5042	0.0079	57.81	0.35	0.07	3.00	0.0018	0.50
76	5596806	128	0.2008	2394	0.4534	4782	0.9057	0.0212	46.09	0.35	0.07	3.00	0.0018	0.50
77	4541923	104	0.1629	1998	0.3785	4873	0.9229	0.0158	44.31	0.35	0.07	3.00	0.0018	0.50
78	3922455	90	0.1407	2123	0.4020	4813	0.9115	0.0250	29.81	0.38	0.07	3.00	0.0018	0.50
79	4728363	109	0.1696	1374	0.2603	3763	0.7128	0.0125	54.29	0.35	0.07	3.00	0.0018	0.50
80	2944059	68	0.1056	943	0.1787	2289	0.4334	0.0226	54.58	0.35	0.07	3.00	0.0018	0.50
81	1954896	45	0.0701	1233	0.2335	2634	0.4989	0.0333	25.26	0.4	0.07	3.00	0.0018	0.50
82	3648108	84	0.1309	1194	0.2261	3250	0.6155	0.0221	42.00	0.35	0.07	3.00	0.0018	0.50
83	5805476	133	0.2082	1332	0.2522	4401	0.8334	0.0281	51.04	0.35	0.07	3.00	0.0018	0.50
84	4179945	96	0.1499	1435	0.2717	4363	0.8263	0.0151	48.16	0.35	0.07	3.00	0.0018	0.50
85	3480762	80	0.1249	791	0.1498	3117	0.5903	0.0235	30.21	0.35	0.07	3.00	0.0018	0.50
86	2220191	51	0.0796	1439	0.2726	3379	0.6400	0.0349	19.94	0.35	0.07	3.00	0.0018	0.50
87	4567853	105	0.1638	2578	0.4883	4495	0.8513	0.0272	21.05	0.35	0.07	3.00	0.0018	0.50
88	3306205	76	0.1186	2376	0.4501	3867	0.7324	0.0149	43.54	0.35	0.07	3.00	0.0018	0.50
89	1976616	45	0.0709	958	0.1815	2789	0.5281	0.0182	52.84	0.35	0.07	3.00	0.0018	0.50
90	1369993	31	0.0491	984	0.1864	2083	0.3945	0.0244	55.00	0.35	0.07	3.00	0.0018	0.50
91	1844037	42	0.0661	1271	0.2407	2258	0.4277	0.0231	54.98	0.35	0.07	3.00	0.0018	0.50
92	2718035	62	0.0975	1278	0.2420	3041	0.5759	0.0127	37.03	0.35	0.07	3.00	0.0018	0.50
93	936728	22	0.0336	536	0.1015	1409	0.2669	0.0205	50.99	0.35	0.07	3.00	0.0018	0.50
94	4360286	100	0.1564	1487	0.2816	3790	0.7178	0.0184	52.28	0.35	0.07	3.00	0.0018	0.50
95	1941169	45	0.0696	1249	0.2366	2320	0.4393	0.0202	49.20	0.35	0.07	3.00	0.0018	0.50
96	4031386	93	0.1446	1514	0.2868	4232	0.8015	0.0139	42.61	0.35	0.07	3.00	0.0018	0.50
97	696747	16	0.0250	752	0.1424	1817	0.3441	0.0154	38.88	0.35	0.07	3.00	0.0018	0.50
98	4208689	97	0.1510	1893	0.3585	4591	0.8695	0.0125	58.63	0.35	0.07	3.00	0.0018	0.50

Notes:
1. Weighted Slope Calc. - $S = (L1*S1^{0.24}+\ldots+Ln*Sn^{0.24})/\text{Total L})^{4.17}$ - CUHP Manual
2. If S>.04, then adjust S based on Figure B-9 (see CUHP Manual)
3. UDFCD Manual: Table RO-6: Impervious depression storage = paved and flat roofs = 0 .1 and sloped roofs = 0.05. Pervious lawn/grass = 0.35, open fields/wooded = 0.4
4. UDFCD Manual - Runoff Section 3.0 - Table RO-7: HSG A - fi = 5, fo=1, a=0.0007; HSG B - fi = 4.5, fo = 0.6, a = .0018; HSG C - fi = 3.0, fo = 0.5, a = .0018; HSG D - fi = 3.0, fo = 0.5, a = .0018

Table B-3 - Detention Pond Stage-Storage and Stage-Discharge Information

Design Point 301 - West 64th Avenue Detention Pond[1]

Elevation	Depth (ft)	Area (SF)	Storage (AF)	(2) 24" Outlet Pipes				Spillway Discharge (cfs)	Spillway Overflow Discharge (cfs)	Total Spillway Discharge (cfs)	Total Discharge (cfs)	Notes
				Vertical Orifice Discharge (cfs)	Culvert Inlet Discharge (cfs)	Culvert Outlet Discharge (cfs)	Controlling Discharge (cfs)					
5186.6	0	484999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Culvert invert
5188	1.4	508015	15.96	18.01	14.60	16.35	14.60	0.00	0.00	0.00	14.60	
5190	3.4	540894	40.04	47.65	45.00	29.21	29.21	0.00	0.00	0.00	29.21	
5190.1	3.5	543014	41.28	48.63	46.20	29.85	29.85	0.00	0.00	0.00	29.85	Spillway crest
5192	5.4	583308	65.85	64.52	63.20	41.24	41.24	1,045.92	0.00	1045.92	1087.16	
5194	7.4	708500	95.50	77.81	76.60	50.52	50.52	3,308.82	0.00	3308.82	3359.34	Spillway overflow
5196	9.4	834419	130.92	89.14	87.80	58.32	58.32	6,529.62	6292.28	12821.90	12880.22	
5198	11.4	983226	172.65	99.19	97.60	65.21	65.21	10,671.92	25034.51	35706.43	35771.64	

[1]Stage-storage and stage-discharge information was developed using LiDAR topography and as-builts from the *"Little Dry Creek (ADCO) Channel Improvements: Phase A-1"* plans, prepared by Sellards & Grigg, Inc. in January 1994. Elevations from the plans were raised by 4.1 feet to adjust for a datum difference. The datum difference was calculated based on the West 64th culvert outlet invert and verified with the detention pond spillway elevation. Information was input into UDFCD's, Detention Volume Estimating Worksheet, Version 2.34 and UDFCD's Culvert Hydraulics Worksheet, Version 3.02.

Design Point 306 - Federal Boulevard Detention Pond[1]

Stage-Area		
Elevation	Depth (ft)	Area (SF)
5231	0	0
5231.1	0.1	0
5232	1	6551
5233	2	14018
5234	3	20650
5235	4	125679
5236	5	151876
5237	6	180468
5238	7	218720
5239	8	248094
5240	9	276410
5241	10	314191
5242	11	356223
5243	12	396616
5244	13	448746
5245	14	501483
5246	15	547002
5247	16	592071
5248	17	655602
5249	18	726395
5250	19	815547
5251	20	900715
5252	21	978197
5253	22	1075391
5254	23	1149036
5255	24	1206435
5256	25	1273937
5257	26	1442883
5258	27	1522384
5259	28	1600568
5260	29	1676310
5261	30	1774094

[1]Stage-storage and stage-discharge information was was provided by Muller Engineering Company, Inc. for the Federal Boulevard detention pond.

Stage-Discharge		
Elevation	Depth (ft)	Total Discharge (cfs)
5231.00	0.00	0.00
5232.15	1.15	48.82
5232.79	1.79	96.68
5233.31	2.31	144.78
5233.77	2.77	192.77
5234.19	3.19	240.73
5234.57	3.57	288.14
5234.93	3.93	335.67
5235.28	4.28	383.41
5235.60	4.60	429.94
5235.92	4.92	477.89
5236.22	5.22	524.35
5236.51	5.51	571.31
5236.80	5.80	618.96
5237.07	6.07	664.96
5237.34	6.34	711.91
5237.61	6.61	759.35
5237.87	6.87	805.85
5238.12	7.12	851.62
5238.37	7.37	898.02
5238.62	7.62	945.10
5238.86	7.86	991.19
5239.10	8.10	1037.27
5239.34	8.34	1083.77
5239.57	8.57	1129.42
5239.80	8.80	1175.12
5240.03	9.03	1220.91
5240.26	9.26	1267.15
5240.49	9.49	1313.54
5240.71	9.71	1358.84
5240.93	9.93	1404.10
5241.15	10.15	1449.29
5241.37	10.37	1494.63
5241.59	10.59	1540.43
5241.81	10.81	1586.21
5242.03	11.03	1631.76
5242.24	11.24	1676.13
5242.45	11.45	1720.00
5242.66	11.66	1763.65
5242.87	11.87	1807.23
5243.08	12.08	1850.69
5243.29	12.29	1896.24
5243.51	12.51	1942.07
5243.74	12.74	1988.15
5243.96	12.96	2032.82
5244.19	13.19	2078.63
5244.42	13.42	2124.55
5244.64	13.64	2169.16
5244.87	13.87	2214.84
5245.09	14.09	2259.70
5245.32	14.32	2305.98
5245.55	14.55	2351.67
5245.77	14.77	2396.18
5246.00	15.00	2442.96
5246.23	15.23	2488.60
5246.45	15.45	2534.00
5246.68	15.68	2579.69
5246.90	15.90	2623.95
5247.12	16.12	2669.00
5247.35	16.35	2715.24
5247.57	16.57	2759.58

Stage-Discharge		
Elevation	Depth (ft)	Total Discharge (cfs)
5247.80	16.80	2805.66
5248.02	17.02	2850.69
5248.25	17.25	2896.70
5248.56	17.56	2961.08
5248.88	17.88	3025.91
5249.16	18.16	3083.65
5249.42	18.42	3135.77
5249.68	18.68	3188.31
5249.95	18.95	3242.62
5250.22	19.22	3296.89
5250.50	19.50	3352.57
5250.78	19.78	3409.80
5251.06	20.06	3466.65
5251.35	20.35	3526.21
5251.64	20.64	3585.06
5251.94	20.94	3646.51
5252.21	21.21	3707.07
5252.36	21.36	3763.49
5252.49	21.49	3819.44
5252.60	21.60	3873.33
5252.71	21.71	3928.56
5252.81	21.81	3983.79
5252.91	21.91	4036.78
5253.00	22.00	4085.55
5253.09	22.09	4134.56
5253.17	22.17	4182.97
5253.25	22.25	4231.71
5253.33	22.33	4280.17
5253.41	22.41	4329.64
5253.49	22.49	4378.52
5253.57	22.57	4427.62
5253.64	22.64	4476.70
5253.71	22.71	4526.05
5253.78	22.78	4575.55
5253.85	22.85	4624.73
5253.92	22.92	4674.44
5253.99	22.99	4724.94
5254.06	23.06	4774.70
5254.12	23.12	4823.64
5254.19	23.19	4873.89
5254.25	23.25	4923.68
5254.32	23.32	4974.67
5254.38	23.38	5024.46
5254.44	23.44	5074.02
5254.50	23.50	5123.80
5254.57	23.57	5174.49
5254.63	23.63	5224.23
5254.69	23.69	5274.63
5254.74	23.74	5323.88
5254.80	23.80	5374.24
5254.86	23.86	5424.59
5254.92	23.92	5475.02
5254.98	23.98	5526.21
5255.03	24.03	5575.35
5255.09	24.09	5626.19
5255.15	24.15	5677.27
5255.20	24.20	5727.16
5255.26	24.26	5778.17
5255.31	24.31	5828.02
5255.36	24.36	5878.26

Stage-Discharge		
Elevation	Depth (ft)	Total Discharge (cfs)
5255.42	24.42	5929.36
5255.47	24.47	5979.19
5255.53	24.53	6030.71
5255.58	24.58	6080.86
5255.63	24.63	6130.98
5255.68	24.68	6181.58
5255.73	24.73	6231.31
5255.79	24.79	6283.16
5255.84	24.84	6333.99
5255.89	24.89	6384.58
5255.94	24.94	6435.14
5255.99	24.99	6485.89
5256.04	25.04	6536.43
5256.09	25.09	6587.11
5256.14	25.14	6637.66
5256.19	25.19	6688.27
5256.24	25.24	6735.76
5256.29	25.29	6781.26
5256.33	25.33	6839.15
5256.38	25.38	6890.40
5256.43	25.43	6941.52
5256.48	25.48	6992.64
5256.53	25.53	7043.65
5256.57	25.57	7093.59
5256.62	25.62	7144.39
5256.67	25.67	7195.59
5256.71	25.71	7245.29
5256.76	25.76	7296.83
5256.81	25.81	7348.55
5256.85	25.85	7398.32
5256.90	25.90	7449.11
5256.94	25.94	7499.52
5256.99	25.99	7550.76
5257.04	26.04	7601.55
5257.08	26.08	7651.40
5257.13	26.13	7702.32
5257.17	26.17	7752.04
5257.22	26.22	7802.89
5257.26	26.26	7852.75
5257.30	26.30	7902.47
5257.35	26.35	7953.21
5257.39	26.39	8003.11
5257.44	26.44	8053.84
5257.48	26.48	8103.71
5257.52	26.52	8153.45
5257.57	26.57	8204.28
5257.61	26.61	8254.05
5257.65	26.65	8304.29
5257.70	26.70	8355.58
5257.74	26.74	8405.35
5257.78	26.78	8455.15
5257.82	26.82	8504.88
5257.87	26.87	8556.00
5257.91	26.91	8606.48
5257.95	26.95	8656.18
5257.99	26.99	8706.03
5258.04	27.04	8756.90
5258.08	27.08	8807.43
5258.12	27.12	8857.26
5258.16	27.16	8907.09

Stage-Discharge		
Elevation	Depth (ft)	Total Discharge (cfs)
5258.20	27.20	8957.72
5258.24	27.24	9007.55
5258.28	27.28	9057.31
5258.32	27.32	9107.63
5258.37	27.37	9158.82
5258.41	27.41	9209.29
5258.45	27.45	9259.37
5258.49	27.49	9309.07
5258.53	27.53	9359.14
5258.57	27.57	9409.50
5258.61	27.61	9459.58
5258.65	27.65	9509.99
5258.69	27.69	9559.98
5258.73	27.73	9610.49
5258.77	27.77	9660.39
5258.81	27.81	9710.97
5258.85	27.85	9760.78
5258.89	27.89	9811.53
5258.93	27.93	9862.06
5258.97	27.97	9911.88
5259.00	28.00	9961.50
5259.04	28.04	10011.41
5259.08	28.08	10061.84
5259.12	28.12	10111.83
5259.16	28.16	10162.17
5259.20	28.20	10212.87
5259.24	28.24	10262.98
5259.28	28.28	10313.42
5259.31	28.31	10363.03
5259.35	28.35	10413.19
5259.39	28.39	10463.32
5259.43	28.43	10513.97
5259.47	28.47	10564.23
5259.50	28.50	10613.44
5259.54	28.54	10664.09
5259.58	28.58	10714.43
5259.62	28.62	10764.35
5259.66	28.66	10815.05
5259.69	28.69	10864.82
5259.73	28.73	10915.25
5259.77	28.77	10965.06
5259.81	28.81	11015.71
5259.84	28.84	11065.50
5259.88	28.88	11116.11
5259.92	28.92	11166.59
5259.95	28.95	11215.68
5259.99	28.99	11266.14
5260.03	29.03	11316.74
5260.06	29.06	11366.52
5260.10	29.10	11417.14
5260.14	29.14	11466.94
5260.17	29.17	11516.47
5260.21	29.21	11567.13
5260.25	29.25	11617.89
5260.28	29.28	11667.53
5260.32	29.32	11718.09
5260.36	29.36	11768.82
5260.39	29.39	11817.94
5260.43	29.43	11868.16
5260.46	29.46	11917.86

Table B-3 - Detention Pond Stage-Storage and Stage-Discharge Information

Design Point 327 - Rotary Parks Detention Pond[1]

Elevation	Depth (ft)	Area (SF)	Storage (AF)	36" Outlet Pipe				Spillway Discharge (cfs)	Spillway Overflow Discharge (cfs)	Total Spillway Discharge (cfs)	Total Discharge (cfs)	Notes
				Vertical Orifice Discharge (cfs)	Culvert Inlet Discharge (cfs)	Culvert Outlet Discharge (cfs)	Controlling Discharge (cfs)					
5396.78	0	0	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	Culvert invert
5398	1.22	5990	0.08	10.99	7.9	25.98	7.90	0.00	0.00	0.00	7.90	
5400	3.22	34832	1.02	45.38	38.7	39.55	38.70	0.00	0.00	0.00	38.70	
5402	5.22	70097	3.43	66.74	63.4	58.67	58.67	0.00	0.00	0.00	58.67	
5403.7	6.92	95674	6.66	80.56	78.4	71.20	71.20	0.00	0.00	0.00	71.20	Spillway crest
5404	7.22	100187	7.34	82.76	80.7	73.19	73.19	3.94	0.00	3.94	77.13	
5406	9.22	128298	12.58	96.14	94.6	85.26	85.26	83.71	0.00	83.71	168.97	
5408	11.22	146311	18.89	107.88	106.2	95.81	95.81	214.00	0.00	214.00	309.81	
5410	13.22	164796	26.03	118.46	116.6	105.32	105.32	379.51	0.00	379.51	484.83	
5412	15.22	186447	34.09	128.17	126.1	114.06	114.06	573.89	698.01	1271.90	1385.95	Spillway overflow
5414	17.22	205556	43.09	137.19	135.0	122.13	122.13	793.35	4778.31	5571.66	5693.79	

1Stage-storage and stage-discharge information was developed using LiDAR topography and as-builts from the *Rotary Park Detention Pond* plans, prepared by Sellards & Grigg, Inc. in January 1990. Elevations from the plans were raised by 3.09 feet to adjust for a datum difference. Information was input into UDFCD's Detention Volume Estimating Worksheet, Version 2.34 and UDFCD's Culvert Hydraulics Worksheet, Version 3.02. The culvert inlet and outlet calulations were based on the CMP, since it has less capacity than the RCP.

Design Point 334 - Cable Pond[1]

Elevation	Depth (ft)	Area (SF)	Storage (AF)	18-Inch RCP Discharge (cfs)	Outlet Box Discharge (cfs)	Outlet Pipe Discharge (cfs)	Spillway Discharge (cfs)	Total Discharge (cfs)
5414.32	0	0	0.00	0.00	0	0.00	0.00	0.00
5414.5	0.18	0	0.00	0.00	0	0.62	0.00	0.00
5415	0.68	24.63	0.00	0.60	0	4.57	0.00	0.60
5416	1.68	1619.44	0.02	5.91	0	17.76	0.00	5.91
5417	2.68	16093.3	0.22	10.70	0	35.78	0.00	10.70
5418	3.68	30564.5	0.76	13.76	0	51.09	0.00	13.76
5419	4.68	40840.6	1.58	16.25	0	61.70	0.00	16.25
5420	5.68	49460.9	2.61	18.41	0	70.74	0.00	18.41
5421	6.68	55882.5	3.82	20.34	5.42	78.75	0.00	25.76
5422	7.68	61290.4	5.17	22.11	39.07	86.02	0.00	61.18
5423	8.68	65967	6.63	23.74	51.97	92.72	0.48	76.19
5424	9.68	73995	8.24	25.27	62.25	98.97	610.42	697.94
5425	10.68	80527	10.01	26.70	71.06	104.84	2056.19	2153.95
5426	11.68	86152	11.92	28.07	78.89	110.40	4395.64	4502.60

[1]Stage-storage information was developed using the *Downstream Westminster: Westminster Mall Redevlopment Phase II Drainage Report* . Stage-discharge information was developed using structure survey information input into UDFCD's Detention Volume Estimating Worksheet, Version 2.34.

Design Point 335 - Westminster Mall Pond[1]

Elevation	Depth (ft)	Area (SF)	Elevation	Depth (ft)	Total Discharge (cfs)
5444.44	0	0	5444.44	0	0
5445	0.56	25223	5447.23	2.79	1.1
5446	1.56	43464	5448.6	4.16	2
5447	2.56	59237	5449.16	4.72	2.3
5448	3.56	68670	5449.69	5.25	5.8
5449	4.56	68670	5450.15	5.71	23.7
5450	5.56	73576	5450.72	6.28	56.5
5451	6.56	78590	5451.07	6.63	74.1
5452	7.56	83705	5451.53	7.09	78.44
5453	8.56	88920	5453	8.56	425.6

[1]Stage-storage and stage-discharge information was developed using the *Downstream Westminster: Westminster Mall Redevlopment Phase II Drainage Report* .

Design Point 344 - Lake Arbor[1]

Elevation	Depth (ft)	Area (SF)	Storage (AF)	Channel Outlet Discharge (cfs)	Total Discharge (cfs)	Notes
5377.31	0	1624803	0.00	0.00	0.00	Channel invert
5378	0.69	1700947	26.34	173.00	173.00	
5380	2.69	1921655	109.50	644.43	644.43	
5381	3.69	2076976	155.40	805.69	805.69	
5382	4.69	2232298	204.87	1660.61	1660.61	In road
5384	6.69	2791446	320.19	5794.10	5794.10	In road

[1]Stage-storage and stage-discharge information was developed using LiDAR topography and structure survey information input into UDFCD's Detention Volume Estimating Worksheet, Version 2.34 and UDFCD's Culvert Hydraulics Worksheet, Version 3.02.

Design Point 375 - Pomona Lakes 2 and 3[1]

Elevation	Depth (ft)	Area (SF)	Storage (AF)	36" Outlet Pipe				Spillway Discharge (cfs)	Total Discharge (cfs)	Notes
				Vertical Orifice Discharge (cfs)	Culvert Inlet Discharge (cfs)	Culvert Outlet Discharge (cfs)	Controlling Discharge (cfs)			
5453.35	0	398882	0	0	0	0	0.00	0	0.00	Culvert invert
5454	0.65	417823	6.09	4.27	2.50	49.26	2.50	0.00	2.50	
5456	2.65	476103	26.62	35.18	30.20	64.08	30.20	0.00	30.20	
5457.77	4.42	498556	46.42	59.13	55.20	82.36	55.20	0.00	55.20	Spillway crest
5458	4.65	501473	49.06	61.41	57.80	84.70	57.80	15.12	72.92	
5460	6.65	526920	72.67	78.53	76.50	102.63	76.50	516.42	592.92	
5462	8.65	560874	97.64	92.52	91.20	117.87	91.20	1505.77	1596.97	

[1]Stage-storage and stage-discharge information was developed using LiDAR topography and structure survey information input into UDFCD's Detention Volume Estimating Worksheet, Version 2.34 and UDFCD's Culvert Hydraulics Worksheet, Version 3.02.

Table B-4 - Tributary B Split Flow at Chase Drive

Total Flow	Culvert Flow	Total Overflow	Overflow to South	Overflow to East
cfs	cfs	cfs	cfs	cfs
0	0	0	0	0
297	297	0	0	0
1000	326	674	566	108
2350	350	2000	1680	320
3200	359	2841	2386	454

Table B-5 - Railroad Culvert Capacities

Design Point	Type	Diameter (in)	Number of Pipes	n	Slope (ft/ft)	Pipe Capacity (cfs)	Future Conditions Peak Flows (cfs)						Notes
							Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	
133	RCP	66	1	0.013	0.014	400	58	95	137	299	397	509	Three pipes have capacity to convey Q100
133	CMP	36	1	0.024	0.020	52	58	95	137	299	397	509	Three pipes have capacity to convey Q100
133	RCP	18	1	0.013	0.015	13	58	95	137	299	397	509	Three pipes have capacity to convey Q100
125	CMP	48	2			268	90	157	181	199	213	231	Capacity based on culvert inlet and outlet capacties at elevation where the overflow channel and the culvert capacities equal the total flow
122	CMP	48	1	0.024	0.030	136	17	28	42	75	97	123	
118	RCP	18	1	0.013	0.040	21	27	43	62	105	134	168	
109	RCBC	96x96	2			2323	190	252	316	460	558	674	Capacity from RTD plans. Designed pipe will replace existing
107	RCP/SSP	48	2			295	47	65	81	112	135	161	Capacity from RTD plans. Designed pipe will replace existing

Capacity first exceeded

Note: Capacities of culverts were calculated using Manning's Equation.

EPA SWMM 5.1 INPUT PARAMETERS

```
[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/02/2005
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:05:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         0:00:01

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.557
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[FILES]
;;Interfacing Files
USE INFLOWS "F:\Projects\014-1761\Data\1 HYDROLOGY\Baseline\CUHP - v. 2.0.0\Output\6_Fut_100yr_0mi^2_.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
198              5669.5     0          0          0          0
197              5658       0          0          0          0
195              5621.5     0          0          0          0
194              5611.3     0          0          0          0
193              5601.9     0          0          0          0
192              5640       0          0          0          0
191              5596       0          0          0          0
190              5610       0          0          0          0
189              5586       0          0          0          0
186              5536.7     0          0          0          0
185              5518.4     0          0          0          0
184              5606       0          0          0          0
183              5507.56    0          0          0          0
182              5484.86    0          0          0          0
181              5518.5     0          0          0          0
181T             5477.5     0          0          0          0
180              5470.5     0          0          0          0
179              5603       0          0          0          0
178              5498       0          0          0          0
177              5515.5     0          0          0          0
177T             5464       0          0          0          0
175T             5450.46    0          0          0          0
```



```
172              5502       0          0          0          0
169              5518       0          0          0          0
168              5464       0          0          0          0
167              5399.28    0          0          0          0
166              5386.65    0          0          0          0
165              5373.11    0          0          0          0
164              5443       0          0          0          0
163              5412       0          0          0          0
163T             5369       0          0          0          0
162              5358.35    0          0          0          0
160              5343.62    0          0          0          0
159              5467.5     0          0          0          0
158              5442       0          0          0          0
157              5420       0          0          0          0
156              5378       0          0          0          0
155              5526       0          0          0          0
154              5518       0          0          0          0
153              5502       0          0          0          0
153T             5490       0          0          0          0
151              5485.1     0          0          0          0
149              5452.7     0          0          0          0
148              5434       0          0          0          0
147              5410.15    0          0          0          0
143              5362       0          0          0          0
142              5332.82    0          0          0          0
141              5374       0          0          0          0
140              5364       0          0          0          0
140T             5331.69    0          0          0          0
138              5318.41    0          0          0          0
137              5446       0          0          0          0
136              5450       0          0          0          0
136T             5441       0          0          0          0
135              5446       0          0          0          0
134T             5414       0          0          0          0
132              5471.5     0          0          0          0
131              5446       0          0          0          0
129              5440       0          0          0          0
128              5471       0          0          0          0
124              5367.5     0          0          0          0
123              5348       0          0          0          0
122T             5334       0          0          0          0
121              5336       0          0          0          0
120              5304.13    0          0          0          0
119              5284.8     0          0          0          0
118T             5275       0          0          0          0
117              5273.1     0          0          0          0
116              5292       0          0          0          0
115              5403       0          0          0          0
114              5284       0          0          0          0
113              5287       0          0          0          0
112              5254.7     0          0          0          0
111              5298       0          0          0          0
110              5298       0          0          0          0
106T             5228.56    0          0          0          0
104              5244.5     0          0          0          0
102              5204.1     0          0          0          0
196              5647.4     0          0          0          0
103              5204.12    0          0          0          0
109T             5240.3     0          0          0          0
139              5320       0          0          0          0
161              5344       0          0          0          0
170              5402       0          0          0          0
173              5414       0          0          0          0
187              5538.1     0          0          0          0
188              5538.1     0          0          0          0
150              5454       0          0          0          0
152              5486       0          0          0          0
176              5455       0          0          0          0
144              5377.31    0          0          0          0
175              5453       0          0          0          0
123T             5344       0          0          0          0
105              5354       0          0          0          0
103T             5204.11    0          0          0          0
108              5235       0          0          0          0
106              5231.07    0          0          0          0
```

```
117T            5272       0          0          0          0
109             5261.83    0          0          0          0
107             5247.12    0          0          0          0
135T            5444.44    0          0          0          0
134             5414.32    0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
101             5186.6     FREE                        NO

[DIVIDERS]
;;Name           Elevation  Diverted Link    Type       Parameters
;;-------------- ---------- ---------------- ---------- ----------
174             5420.3     474              OVERFLOW   0          0          0          0
171             5413.8     471              OVERFLOW   0          0          0          0
127T            5396.76    427T             OVERFLOW   0          0          0          0
125             5379.17    425              CUTOFF     268        0          0          0          0

;Capacity of 18" RCP pipe only
118             5304.94    418              CUTOFF     21         0          0          0          0

125T            5377       425T             OVERFLOW   0          0          0          0
146             5390.6     446              OVERFLOW   0          0          0          0
145             5383       445              TABULAR    145_Split       0          0          0          0

133T            5385.93    433T             OVERFLOW   0          0          0          0
122             5339.92    422              CUTOFF     136        0          0          0          0

130             5429.83    430              OVERFLOW   0          0          0          0
127             5396.78    427              OVERFLOW   0          0          0          0
126             5400       426              OVERFLOW   0          0          0          0
133             5390       433              OVERFLOW   0          0          0          0

[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Name/Params            N/A      Fevap
Psi      Ksat     IMD
;;-------------- -------- ---------- ---------- ---------- ---------------------------- -------- --------
        -------- --------
;Pomona Lakes 2 and 3
375             5453.35  8.65       0          TABULAR    Pomona_Lakes                 0        0
;Lake Arbor
344             5377.31  6.69       0          TABULAR    Lake_Arbor                   0        0
;Rotary Parks Detention Pond
327             5396.78  17.22      0          TABULAR    Rotary_Parks                 0        0
;West 64th Ave Detention Pond
301             5186.6   11.4       0          TABULAR    64th_Pond                    0        0
;Matches storage curve bottom from Muller
306             5231     29.46      0          TABULAR    Federal_Pond                 0        0
;Westminster Pond
335             5444.44  8.56       0          TABULAR    WestminsterEastPond          0        0
334             5414.32  11.68      0          TABULAR    334Stage-Area                0        0

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow
MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ----------
----------
;Half of link is dense vegetation, other half is lake
202             102              301              2322       0.05       0          7.75       0          0

203             103              103T             400        0.01       0          0          0          0

203T            103T             102              400        0.01       0          0          0          0

204             104              103T             1507       0.04375    0          16         0          0

205             105              104              4056       0.02       0          0          0          0

206             106              106T             845.1      .05        0          0          0          0

206T            106T             103T             2858       .05        0          10.16      0          0

207             107              306              470.9      0.05625    0          0          0          0
```



```
208             108              306              688.5      0.04375    0          1.66       0          0

209             109              109T             725.7      0.013      0          2.7        0          0

209T            109T             108              1038.5     0.04375    0          0          0          0

210             110              109              1316.6     0.02       0          0          0          0

211             111              109              1402.4     0.02       0          0          0          0

212             112              109T             1527.9     0.04375    0          9.97       0          0

;Majority of link is street
213             113              112              2906.8     0.02       0          0          0          0

214             114              112              621.5      0.02       0          10         0          0

215             115              114              4935.7     0.02       0          0          0          0

216             116              114              782.7      0.02       0          0          0          0

217             117              117T             159.3      0.04375    0          0.38       0          0

217T            117T             112              2351.8     0.04375    0          6.72       0          0

218             118              118T             504        0.05625    0          0          0          0

218T            118T             117              455.4      0.01875    0          .53        0          0

219             119              118T             1461.4     0.01875    0          5.42       0          0

220             120              119              2448.6     0.04375    0          7.09       0          0

221             121              120              1559.3     0.02       0          12         0          0

;Pipe enlarged to allow cutoff flow in from
;seperate alanysis
222             122              122T             88.43      0.03       0          3.24       0          0

;design channel starts in middle of link
222T            122T             120              2217.5     0.04375    0          14.13      0          0

223             123              123T             822        0.05625    0          0          0          0

223T            123T             122T             912.4      0.05625    0          2.1        0          0

224             124              123T             489        0.04375    0          0          0          0

;(x2) 48" CMPs, cutoff value applied at divider
225             125              125T             74.1       0.03       0          1.5        0          0

;Majority of this segment is in an underground pipe.
;Dimensions unknown.
225T            125T             123              2164.3     0.01875    0          5.4        0          0

226             126              133T             1079.7     0.013      0          0          0          0

227T            127T             125              1246       0.013      0          2.8        0          0

227             127              127T             1          0.011      0          0          0          0

228             128              327              2988.5     0.02       0          0          0          0

229             129              327              783        0.02       0          22         0          0

430             130              327              2274.6     0.02       9.75       13.36      0          0

231             131              130              503.9      0.02       0          9.75       0          0

232             132              130              1381.5     0.02       0          9.75       0          0

;KMZ says 72" RCP, 36" CMP, 18" RCP
233             133              133T             152.4      0.013      0          0.07       0          0

233T            133T             125T             926.9      0.05625    0          4          0          0
```

234T	134T	133	1578.4	0.05625	0	0	0	0
235T	135T	134T	2257.9	0.02	0	0	0	0
236	136	136T	182.7	0.02	0	0	0	0
236T	136T	134	2353.6	0.04375	0	13.68	0	0
237	137	136T	389.8	0.02	0	0	0	0
238	138	120	448.9	0.04375	0	12.04	0	0
239	139	138	400	0.01	0	0	0	0
240	140	140T	1417.8	0.02	0	6.08	0	0

;low fow channel ignored, flat area on right bank
;included in bottomw width

240T	140T	138	1483.2	0.04375	0	2.9	0	0
241	141	140	877.6	0.02	0	0	0	0
242	142	140T	486	0.04375	0	0	0	0
243	143	142	1289.6	0.04375	0	7.26	0	0
244	144	143	1335.5	0.04375	0	0	0	0
245	145	344	2006.2	0.04375	0	0	0	0
246	146	145	861	0.05625	0	4.16	0	0
247	147	146	2232.7	0.075	0	10.62	0	0
248	148	147	1417.9	0.04375	0	0	0	0
249	149	147	3638.3	0.04375	0	0	0	0
250	150	149	400	0.01	0	0	0	0
251	151	149	3303.5	0.05625	0	23.15	0	0
252	152	151	400	0.01	0	0	0	0
253	153	153T	1085.3	0.02	0	0	0	0
253T	153T	151	1478	0.04375	0	0.76	0	0
254	154	153T	2043.6	0.04375	0	12	0	0
255	155	154	2262.9	0.015	0	0	0	0
256	156	344	400	0.01	0	0	0	0
257	157	156	2333	0.02	0	0	0	0
258	158	157	1548.4	0.05625	0	14	0	0
259	159	158	2149.6	0.02	0	0	0	0
260	160	142	1170.4	0.04375	0	7.87	0	0
261	161	160	400	0.01	0	0	0	0
262	162	160	1619.2	0.04375	0	10.68	0	0
263	163	163T	1880.5	0.02	0	8	0	0
263T	163T	162	1101.2	0.04375	0	7.9	0	0
264	164	163	1549.9	0.02	0	0	0	0
265	165	163T	214.3	0.04375	0	3.57	0	0

266	166	165	1245.8	0.04375	0	10.43	0	0
267	167	166	1596.7	0.05625	0	0	0	0

;Channel that ends as street flow. Used channel manning n
;but cross section typical of street.

268	168	167	2640.2	0.04375	0	22.48	0	0
269	169	168	2087.3	0.04375	18.5	0	0	0
270	170	167	400	0.01	0	0	0	0

;GIS shows smaller pipe segments than at inlet

271	171	167	1136.7	0.01875	0	3.15	0	0
272	172	171	2962.7	0.02	0	12.2	0	0
273	173	171	400	0.01	0	0	0	0
274	174	171	527.4	0.01875	0	0	0	0
275	175	175T	400	0.01	0	0	0	0
275T	175T	174	2041.2	0.05625	0	16.4	0	0
276	176	174	1265	0.05625	0	15.7	0	0
277	177	177T	2259	0.05625	0	1.8	0	0
277T	177T	176	853.3	0.02	0	0	0	0
278	178	177T	1952	0.02	0	0	0	0
279	179	178	3306.7	0.075	0	0	0	0
280	180	175T	1767.9	0.05625	0	2	0	0
281	181	181T	901.94	0.02	0	4.9	0	0
281T	181T	180	508.9	0.04375	0	4.46	0	0
282	182	181T	494.5	0.04375	0	4.89	0	0
283	183	182	2107.5	0.04375	0	12.16	0	0
284	184	183	3385.7	0.04375	0	11	0	0
285	185	183	708.7	0.075	0	0	0	0
286	186	185	1828.42	0.04375	0	11.1	0	0
287	187	186	400	0.01	0	0	0	0
288	188	186	400	0.01	0	0	0	0
289	189	186	3734.2	0.05625	0	0	0	0
290	190	189	1330.1	0.02	0	5.4	0	0
291	191	189	399.7	0.02	0	5.4	0	0
292	192	191	1461.3	0.02	0	0	0	0
293	193	189	1723.6	0.0438	0	0.49	0	0
294	194	193	622.1	0.0438	0	5.2	0	0
295	195	194	864.5	0.0438	0	4.4	0	0
296	196	195	2067.3	0.0438	0	4.92	0	0
297	197	196	1013.6	0.0438	0	5.03	0	0
298	198	197	1247.3	0.0438	0	4.64	0	0

418	118	117T	1078	0.02	0	16	0	0
422	122	121	1301	0.04365	5	0	0	0
425	125	123	1726	0.04375	0	0	0	0
425T	125T	123	2143	0.02	4	8	0	0

;grass lined channel was replace by an 8-foot wide by 5-foot tall concrete lined U channel

427	127	126	899	0.013	7.22	0	0	0

;Pipes shown in GIS layer

427T	127T	125	1246	0.075	0	0	0	0
433T	133T	125T	926.9	0.02	6	10	0	0
445	145	143	2612	.02	7	7	0	0
446	146	145	946	0.02	5.4	5	0	0
471	171	167	1217.4	0.02	12.2	20.72	0	0
474	174	171	527.4	0.02	9.7	14.2	0	0
230	130	327	1731	.01875	12.17	6.12	0	0
426	126	133T	1079.7	0.02	4	10	0	0
235	135	335	1	0.01	0	0	0	0
234	134	334	1	0.01	0	0	0	0
433	133	133T	1	0.01	0	0	0	0

[OUTLETS]

;;Name	From Node	To Node	Offset	Type	QTable/Qcoeff	Qexpon	Gated
575	375	175	0	TABULAR/DEPTH	Pomona_Lake_Out		NO
544	344	144	0	TABULAR/DEPTH	Lake_Arbor_Out		NO
527	327	127	0	TABULAR/DEPTH	Rotary_Parks_Out		NO
501	301	101	0	TABULAR/DEPTH	64th_Pond_Out		NO
506	306	106	0	TABULAR/DEPTH	Federal_Pond_Out		NO

;Westminster Pond Outlet

535	335	135T	0	TABULAR/DEPTH	WestminsterDischarge		NO
534	334	134T	0	TABULAR/DEPTH	534Stage-Discharge		NO

[XSECTIONS]

;;Link	Shape	Geom1	Geom2	Geom3	Geom4	Barrels	Culvert
202	TRAPEZOIDAL	16	25	4	4	1	
203	DUMMY	0	0	0	0	1	
203T	DUMMY	0	0	0	0	1	
204	TRAPEZOIDAL	3	10	20	20	1	
205	TRAPEZOIDAL	5	1	20	20	1	
206	TRAPEZOIDAL	16	40	4	4	1	
206T	IRREGULAR	206T	0	0	0	1	
207	TRAPEZOIDAL	4	4	4	4	1	
208	TRAPEZOIDAL	15	30	5	5	1	
209	RECT_CLOSED	8	8	0	0	2	
209T	IRREGULAR	As-builtTypSection	0	0	0	1	
210	TRAPEZOIDAL	5	1	20	20	1	
211	TRAPEZOIDAL	5	1	20	20	1	
212	TRAPEZOIDAL	16	20	6	5	1	
213	TRAPEZOIDAL	5	1	20	20	1	
214	TRAPEZOIDAL	5	1	20	20	1	

215	TRAPEZOIDAL	5	1	20	20	1
216	TRAPEZOIDAL	5	1	20	20	1
217	IRREGULAR	217	0	0	0	1
217T	IRREGULAR	217	0	0	0	1
218	TRAPEZOIDAL	2	8	4	10	1
218T	IRREGULAR	219	0	0	0	1
219	IRREGULAR	219	0	0	0	1
220	IRREGULAR	220	0	0	0	1
221	TRAPEZOIDAL	5	1	20	20	1
222	DUMMY	0	0	0	0	1
222T	TRAPEZOIDAL	13	5	4	4	1
223	TRAPEZOIDAL	12.5	8	2.5	2.5	1
223T	TRAPEZOIDAL	12	8	2.5	2.5	1
224	TRAPEZOIDAL	3	15	5	10	1
225	DUMMY	0	0	0	0	1
225T	CIRCULAR	8	0	0	0	1
226	CIRCULAR	5.5	0	0	0	1
227T	CIRCULAR	3.5	0	0	0	1
227	CIRCULAR	3.5	0	0	0	1
228	TRAPEZOIDAL	5	1	20	20	1
229	TRAPEZOIDAL	5	1	20	20	1
430	TRAPEZOIDAL	5	1	20	20	1
231	TRAPEZOIDAL	5	1	20	20	1
232	TRAPEZOIDAL	5	1	20	20	1
233	CIRCULAR	6	0	0	0	1
233T	TRAPEZOIDAL	6	5	2	2	1
234T	TRAPEZOIDAL	8	5	3	3	1
235T	TRAPEZOIDAL	5	1	20	20	1
236	TRAPEZOIDAL	5	1	20	20	1
236T	TRAPEZOIDAL	4	5	5	10	1
237	TRAPEZOIDAL	5	1	20	20	1
238	IRREGULAR	238	0	0	0	1
239	DUMMY	0	0	0	0	1
240	TRAPEZOIDAL	5	1	20	20	1
240T	TRAPEZOIDAL	8	60	7	6	1
241	TRAPEZOIDAL	5	1	20	20	1
242	TRAPEZOIDAL	11	8	7	30	1
243	IRREGULAR	243	0	0	0	1
244	IRREGULAR	244	0	0	0	1
245	TRAPEZOIDAL	10	20	4	4	1
246	IRREGULAR	246	0	0	0	1
247	IRREGULAR	247	0	0	0	1
248	TRAPEZOIDAL	4	8	5	5	1
249	TRAPEZOIDAL	4	100	20	20	1
250	DUMMY	0	0	0	0	1
251	TRAPEZOIDAL	9	8	4	4	1
252	DUMMY	0	0	0	0	1
253	TRAPEZOIDAL	5	1	20	20	1
253T	IRREGULAR	253T	0	0	0	1
254	IRREGULAR	253T	0	0	0	1
255	RECT_OPEN	1	600	0	0	1
256	DUMMY	0	0	0	0	1
257	TRAPEZOIDAL	5	1	20	20	1
258	TRAPEZOIDAL	6	12	4	4	1
259	TRAPEZOIDAL	5	1	20	20	1
260	IRREGULAR	Maint_Typ	0	0	0	1
261	DUMMY	0	0	0	0	1
262	IRREGULAR	Maint_Typ	0	0	0	1
263	TRAPEZOIDAL	5	1	20	20	1
263T	IRREGULAR	Maint_Typ	0	0	0	1
264	TRAPEZOIDAL	5	1	20	20	1
265	IRREGULAR	Maint_Typ	0	0	0	1
266	IRREGULAR	Maint_Typ	0	0	0	1
267	IRREGULAR	Maint_Typ	0	0	0	1
268	TRAPEZOIDAL	5	1	20	20	1
269	TRAPEZOIDAL	5	100	20	20	1
270	DUMMY	0	0	0	0	1
271	RECT_CLOSED	6	10	0	0	2
272	TRAPEZOIDAL	5	1	20	20	1
273	DUMMY	0	0	0	0	1
274	RECT_CLOSED	6	10	0	0	2
275	DUMMY	0	0	0	0	1
275T	TRAPEZOIDAL	12	7	3	4	1
276	TRAPEZOIDAL	10	7	3	4	1
277	TRAPEZOIDAL	6	10	5	5	1

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277T            TRAPEZOIDAL  5              1          20         20         1
278             TRAPEZOIDAL  5              1          20         20         1
279             TRAPEZOIDAL  5              40         5          5          1
280             TRAPEZOIDAL  12             7          3          4          1
281             TRAPEZOIDAL  5              1          20         20         1
281T            TRAPEZOIDAL  10.5           6          3          3          1
282             TRAPEZOIDAL  12             6          3          3          1
283             TRAPEZOIDAL  10             7.5        3          3          1
284             TRAPEZOIDAL  5              10         3          3          1
285             TRAPEZOIDAL  10             50         4          4          1
286             IRREGULAR    286            0          0          0          1
287             DUMMY        0              0          0          0          1
288             DUMMY        0              0          0          0          1
289             TRAPEZOIDAL  12             15         10         10         1
290             TRAPEZOIDAL  5              1          20         20         1
291             TRAPEZOIDAL  5              1          20         20         1
292             TRAPEZOIDAL  5              1          20         20         1
293             IRREGULAR    LakeCrest      0          0          0          1
294             IRREGULAR    LakeCrest      0          0          0          1
295             IRREGULAR    LakeCrest      0          0          0          1
296             IRREGULAR    LakeCrest      0          0          0          1
297             TRAPEZOIDAL  6              180        4          4          1
298             IRREGULAR    AboveBeech     0          0          0          1
418             TRAPEZOIDAL  5              1          20         20         1
422             TRAPEZOIDAL  3              10         4          4          1
425             TRAPEZOIDAL  3.5            20         10         5          1
425T            TRAPEZOIDAL  5              1          20         20         1
427             IRREGULAR    CDOTChannel    0          0          0          1
427T            TRAPEZOIDAL  4.5            20         10         10         1
433T            TRAPEZOIDAL  5              1          20         20         1
445             TRAPEZOIDAL  5              1          20         20         1
446             TRAPEZOIDAL  5              1          20         20         1
471             TRAPEZOIDAL  5              1          20         20         1
474             TRAPEZOIDAL  5              1          20         20         1
230             CIRCULAR     3.5            0          0          0          1
426             TRAPEZOIDAL  5              1          20         20         1
235             DUMMY        0              0          0          0          1
234             DUMMY        0              0          0          0          1
433             DUMMY        0              0          0          0          1

[TRANSECTS]
;;Transect Data in HEC-2 format
;
;Wetland in low flow
NC 0.0438   0.0438   0.05
X1 AboveBeech        6        23.9     30.1     0.0      0.0      0        0        0
GR 6.5      0        0.5      23.9     0        24       0        30       0.5      30.1
GR 6.5      54
;
;Concrete low flow
NC 0.0438   0.01875  0.0438
X1 LakeCrest         8        24       26       0.0      0.0      0        0        0
GR 6.67     0        5.67     4        0.67     24       0        24.01    0        25.99
GR 0.67     26       5.67     46       6.67     50
;
NC 0.04375  0.04375  0.04375
X1 286               6        40       88       0.0      0.0      0        0        0
GR 8        0        4        40       0        60       0        68       4        88
GR 8        128
;
;Design Plans upper section
NC 0.04375  0.04375  0.05625
X1 280               8        35       42       0.0      0.0      0        0        0
GR 10       0        3        35       2        37       0        37.01    0        39.99
GR 2        40       3        42       10       77
;
;Based on as-builts
NC 0.04375  0.04375  0.01875
X1 253T              7        32       37       0.0      0.0      0        0        0
GR 8.75     0        0.75     32       0.25     32.01    0        34.5     0.25     36.99
GR 0.75     37       8.75     69
;
;From design plans
NC 0.04375  0.04375  0.01875
X1 238               8        48       57       0.0      0.0      0        0        0
```



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GR 15       0        5        40       1        48       0        50       0        55
GR 1        57       5        65       15       105
;
NC 0.04375  0.04375  0.01875
X1 244               6        16       28       0.0      0.0      0        0        0
GR 10       0        2        16       0        20       0        24       2        28
GR 10       44
;
;Concrete low flow, estimated side slopes
NC 0.04375  0.04375  0.01875
X1 243               6        10       22       0.0      0.0      0.0      0.0      0.0
GR 6        0        2        10       0        14       0        18       2        22
GR 6        32
;
;Typical from Vance to Trib B conf
NC 0.04375  0.04375  0.01875
X1 Maint_Typ         8        32       45       0.0      0.0      0.0      0.0      0.0
GR 14       -80      10       0        2        32       0        36       0        41
GR 2        45       10       77       14       157
;
;From design plans
NC 0.04375  0.04375  0.02
X1 220               8        132      147      0.0      0.0      0.0      0.0      0.0
GR 10       0        4        32       2        132      0        136      0        143
GR 2        147      2.4      167      10       197.4
;
;See page 5 design plans
;Some segments have vertical walls, some have sloped walls
;above 9' portion
NC 0.01875  0.01875  0.01875
X1 219               10       25.25    34.25    0.0      0.0      0.0      0.0      0.0
GR 14.77    0        9.77     0        1.77     12       1.5      25.25    0        26.75
GR 0        32.75    1.5      34.25    1.77     47.5     9.77     59.5     14.77    59.5
;
;Low flow from design plans
NC 0.04375  0.04375  0.04375
X1 217               8        40       54       0.0      0.0      0.0      0.0      0.0
GR 14       -8       2        40       0        44       0        50       2        54
GR 8        184      12       200      14       208
;
;From Adco Ph C designs
NC 0.05625  0.05625  0.04375
X1 Lowell_to_Federal  6        100      140      0.0      0.0      0.0      0.0      0.0
GR 6        0        4        100      0        116      0        124      4        140
GR 6        240
;
;ICON plans
NC 0.05625  0.05625  0.04375
X1 UpstreamFederal   6        100      144      0.0      0.0      0.0      0.0      0.0
GR 6        0        4        100      0        116      0        128      4        144
GR 6        244
;
NC 0.05625  0.05625  0.075
X1 246               8        15       30       0.0      0.0      0.0      0.0      0.0
GR 10       -8       8        0        3        15       0        21       0        24
GR 3        30       8        50       10       58
;
NC 0.05625  0.075    0.05625
X1 247               6        12       46       0.0      0.0      0.0      0.0      0.0
GR 11       -12      5        12       0        27       0        31       5        46
GR 11       70
;
NC .05      .05      .05
X1 206T              9        150      214      0.0      0.0      0.0      0.0      0.0
GR 14       -150     10       0        6        150      0        174      0        190
GR 6        214      10       254      12       274      14       294
;
NC 0.045    0.045    0.035
X1 As-builtTypSection  8        54       73       0.0      0.0      0.0      0.0      0.0
GR 5252     -8       5250     0        5236.5   54       5235     58.5     5235     68.5
GR 5236.5   73       5250     127      5252     135
;
NC 0.004375 0.04375  0.013
X1 CDOTChannel       6        20       28       0.0      0.0      0.0      0.0      0.0
GR 12       0        7        20       0        20.1     0        27.9     7        28
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GR 12       48

[INFLOWS]
;;Node           Constituent      Time Series      Type     Mfactor  Sfactor  Baseline Pattern
;;-------------- ---------------- ---------------- -------- -------- -------- -------- --------
111              FLOW             ""               FLOW     1.0      1.0      58

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
;Split at node 145
145_Split        Diversion  0          0
145_Split                   297        0
145_Split                   1000       108
145_Split                   2350       320
145_Split                   3200       454
;
;Total discharge out of lake
Pomona_Lake_Out  Rating     0          0.00
Pomona_Lake_Out             0.65       2.50
Pomona_Lake_Out             2.65       30.20
Pomona_Lake_Out             4.42       55.20
Pomona_Lake_Out             4.65       72.92
Pomona_Lake_Out             6.65       592.92
Pomona_Lake_Out             8.65       1596.97
;
;Total discharge out of lake
Lake_Arbor_Out   Rating     0          0.00
Lake_Arbor_Out              0.69       173.00
Lake_Arbor_Out              2.69       644.43
Lake_Arbor_Out              3.69       805.69
Lake_Arbor_Out              4.69       1660.61
Lake_Arbor_Out              6.69       5794.10
;
Rotary_Parks_Out Rating     0          0.00
Rotary_Parks_Out            1.22       7.90
Rotary_Parks_Out            3.22       38.70
Rotary_Parks_Out            5.22       58.67
Rotary_Parks_Out            6.92       71.20
Rotary_Parks_Out            7.22       77.13
Rotary_Parks_Out            9.22       168.97
Rotary_Parks_Out            11.22      309.81
Rotary_Parks_Out            13.22      484.83
Rotary_Parks_Out            15.22      1385.95
Rotary_Parks_Out            17.22      5693.79
;
64th_Pond_Out    Rating     0          0.00
64th_Pond_Out               1.4        14.60
64th_Pond_Out               3.4        29.21
64th_Pond_Out               3.5        29.85
64th_Pond_Out               5.4        1087.16
64th_Pond_Out               7.4        3359.34
64th_Pond_Out               9.4        12880.22
64th_Pond_Out               11.4       35771.64
;
;From Muller Spreadsheet
Federal_Pond_Out Rating     0.00       0.00
Federal_Pond_Out            1.15       48.82
Federal_Pond_Out            1.79       96.68
Federal_Pond_Out            2.31       144.78
Federal_Pond_Out            2.77       192.77
Federal_Pond_Out            3.19       240.73
Federal_Pond_Out            3.57       288.14
Federal_Pond_Out            3.93       335.67
Federal_Pond_Out            4.28       383.41
Federal_Pond_Out            4.60       429.94
Federal_Pond_Out            4.92       477.89
Federal_Pond_Out            5.22       524.35
Federal_Pond_Out            5.51       571.31
Federal_Pond_Out            5.80       618.96
Federal_Pond_Out            6.07       664.96
Federal_Pond_Out            6.34       711.91
Federal_Pond_Out            6.61       759.35
Federal_Pond_Out            6.87       805.85
Federal_Pond_Out            7.12       851.62
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Federal_Pond_Out            7.37       898.02
Federal_Pond_Out            7.62       945.10
Federal_Pond_Out            7.86       991.19
Federal_Pond_Out            8.10       1037.27
Federal_Pond_Out            8.34       1083.77
Federal_Pond_Out            8.57       1129.42
Federal_Pond_Out            8.80       1175.12
Federal_Pond_Out            9.03       1220.91
Federal_Pond_Out            9.26       1267.15
Federal_Pond_Out            9.49       1313.54
Federal_Pond_Out            9.71       1358.84
Federal_Pond_Out            9.93       1404.10
Federal_Pond_Out            10.15      1449.29
Federal_Pond_Out            10.37      1494.63
Federal_Pond_Out            10.59      1540.43
Federal_Pond_Out            10.81      1586.21
Federal_Pond_Out            11.03      1631.76
Federal_Pond_Out            11.24      1676.13
Federal_Pond_Out            11.45      1720.00
Federal_Pond_Out            11.66      1763.65
Federal_Pond_Out            11.87      1807.23
Federal_Pond_Out            12.08      1850.69
Federal_Pond_Out            12.29      1896.24
Federal_Pond_Out            12.51      1942.07
Federal_Pond_Out            12.74      1988.15
Federal_Pond_Out            12.96      2032.82
Federal_Pond_Out            13.19      2078.63
Federal_Pond_Out            13.42      2124.55
Federal_Pond_Out            13.64      2169.16
Federal_Pond_Out            13.87      2214.84
Federal_Pond_Out            14.09      2259.70
Federal_Pond_Out            14.32      2305.98
Federal_Pond_Out            14.55      2351.67
Federal_Pond_Out            14.77      2396.18
Federal_Pond_Out            15.00      2442.96
Federal_Pond_Out            15.23      2488.60
Federal_Pond_Out            15.45      2534.00
Federal_Pond_Out            15.68      2579.69
Federal_Pond_Out            15.90      2623.95
Federal_Pond_Out            16.12      2669.00
Federal_Pond_Out            16.35      2715.24
Federal_Pond_Out            16.57      2759.58
Federal_Pond_Out            16.80      2805.66
Federal_Pond_Out            17.02      2850.69
Federal_Pond_Out            17.25      2896.70
Federal_Pond_Out            17.56      2961.08
Federal_Pond_Out            17.88      3025.91
Federal_Pond_Out            18.16      3083.65
Federal_Pond_Out            18.42      3135.77
Federal_Pond_Out            18.68      3188.31
Federal_Pond_Out            18.95      3242.62
Federal_Pond_Out            19.22      3296.89
Federal_Pond_Out            19.50      3352.57
Federal_Pond_Out            19.78      3409.80
Federal_Pond_Out            20.06      3466.65
Federal_Pond_Out            20.35      3526.21
Federal_Pond_Out            20.64      3585.06
Federal_Pond_Out            20.94      3646.51
Federal_Pond_Out            21.21      3707.07
Federal_Pond_Out            21.36      3763.49
Federal_Pond_Out            21.49      3819.44
Federal_Pond_Out            21.60      3873.33
Federal_Pond_Out            21.71      3928.56
Federal_Pond_Out            21.81      3983.79
Federal_Pond_Out            21.91      4036.78
Federal_Pond_Out            22.00      4085.55
Federal_Pond_Out            22.09      4134.56
Federal_Pond_Out            22.17      4182.97
Federal_Pond_Out            22.25      4231.71
Federal_Pond_Out            22.33      4280.17
Federal_Pond_Out            22.41      4329.64
Federal_Pond_Out            22.49      4378.52
Federal_Pond_Out            22.57      4427.62
Federal_Pond_Out            22.64      4476.70
Federal_Pond_Out            22.71      4526.05
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Federal_Pond_Out          22.78     4575.55
Federal_Pond_Out          22.85     4624.73
Federal_Pond_Out          22.92     4674.44
Federal_Pond_Out          22.99     4724.94
Federal_Pond_Out          23.06     4774.70
Federal_Pond_Out          23.12     4823.64
Federal_Pond_Out          23.19     4873.89
Federal_Pond_Out          23.25     4923.68
Federal_Pond_Out          23.32     4974.67
Federal_Pond_Out          23.38     5024.46
Federal_Pond_Out          23.44     5074.02
Federal_Pond_Out          23.50     5123.80
Federal_Pond_Out          23.57     5174.49
Federal_Pond_Out          23.63     5224.23
Federal_Pond_Out          23.69     5274.63
Federal_Pond_Out          23.74     5323.88
Federal_Pond_Out          23.80     5374.24
Federal_Pond_Out          23.86     5424.59
Federal_Pond_Out          23.92     5475.02
Federal_Pond_Out          23.98     5526.21
Federal_Pond_Out          24.03     5575.35
Federal_Pond_Out          24.09     5626.19
Federal_Pond_Out          24.15     5677.27
Federal_Pond_Out          24.20     5727.16
Federal_Pond_Out          24.26     5778.17
Federal_Pond_Out          24.31     5828.02
Federal_Pond_Out          24.36     5878.26
Federal_Pond_Out          24.42     5929.36
Federal_Pond_Out          24.47     5979.19
Federal_Pond_Out          24.53     6030.71
Federal_Pond_Out          24.58     6080.86
Federal_Pond_Out          24.63     6130.98
Federal_Pond_Out          24.68     6181.58
Federal_Pond_Out          24.73     6231.31
Federal_Pond_Out          24.79     6283.16
Federal_Pond_Out          24.84     6333.99
Federal_Pond_Out          24.89     6384.58
Federal_Pond_Out          24.94     6435.14
Federal_Pond_Out          24.99     6485.89
Federal_Pond_Out          25.04     6536.43
Federal_Pond_Out          25.09     6587.11
Federal_Pond_Out          25.14     6637.66
Federal_Pond_Out          25.19     6688.27
Federal_Pond_Out          25.24     6735.76
Federal_Pond_Out          25.29     6781.26
Federal_Pond_Out          25.33     6839.15
Federal_Pond_Out          25.38     6890.40
Federal_Pond_Out          25.43     6941.52
Federal_Pond_Out          25.48     6992.64
Federal_Pond_Out          25.53     7043.65
Federal_Pond_Out          25.57     7093.59
Federal_Pond_Out          25.62     7144.39
Federal_Pond_Out          25.67     7195.59
Federal_Pond_Out          25.71     7245.29
Federal_Pond_Out          25.76     7296.83
Federal_Pond_Out          25.81     7348.55
Federal_Pond_Out          25.85     7398.32
Federal_Pond_Out          25.90     7449.11
Federal_Pond_Out          25.94     7499.52
Federal_Pond_Out          25.99     7550.76
Federal_Pond_Out          26.04     7601.55
Federal_Pond_Out          26.08     7651.40
Federal_Pond_Out          26.13     7702.32
Federal_Pond_Out          26.17     7752.04
Federal_Pond_Out          26.22     7802.89
Federal_Pond_Out          26.26     7852.75
Federal_Pond_Out          26.30     7902.47
Federal_Pond_Out          26.35     7953.21
Federal_Pond_Out          26.39     8003.11
Federal_Pond_Out          26.44     8053.84
Federal_Pond_Out          26.48     8103.71
Federal_Pond_Out          26.52     8153.45
Federal_Pond_Out          26.57     8204.28
Federal_Pond_Out          26.61     8254.05
Federal_Pond_Out          26.65     8304.29
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Federal_Pond_Out          26.70     8355.58
Federal_Pond_Out          26.74     8405.35
Federal_Pond_Out          26.78     8455.15
Federal_Pond_Out          26.82     8504.88
Federal_Pond_Out          26.87     8556.00
Federal_Pond_Out          26.91     8606.48
Federal_Pond_Out          26.95     8656.18
Federal_Pond_Out          26.99     8706.03
Federal_Pond_Out          27.04     8756.90
Federal_Pond_Out          27.08     8807.43
Federal_Pond_Out          27.12     8857.26
Federal_Pond_Out          27.16     8907.09
Federal_Pond_Out          27.20     8957.72
Federal_Pond_Out          27.24     9007.55
Federal_Pond_Out          27.28     9057.31
Federal_Pond_Out          27.32     9107.63
Federal_Pond_Out          27.37     9158.82
Federal_Pond_Out          27.41     9209.29
Federal_Pond_Out          27.45     9259.37
Federal_Pond_Out          27.49     9309.07
Federal_Pond_Out          27.53     9359.14
Federal_Pond_Out          27.57     9409.50
Federal_Pond_Out          27.61     9459.58
Federal_Pond_Out          27.65     9509.99
Federal_Pond_Out          27.69     9559.98
Federal_Pond_Out          27.73     9610.49
Federal_Pond_Out          27.77     9660.39
Federal_Pond_Out          27.81     9710.97
Federal_Pond_Out          27.85     9760.78
Federal_Pond_Out          27.89     9811.53
Federal_Pond_Out          27.93     9862.06
Federal_Pond_Out          27.97     9911.88
Federal_Pond_Out          28.00     9961.50
Federal_Pond_Out          28.04     10011.41
Federal_Pond_Out          28.08     10061.84
Federal_Pond_Out          28.12     10111.83
Federal_Pond_Out          28.16     10162.17
Federal_Pond_Out          28.20     10212.87
Federal_Pond_Out          28.24     10262.98
Federal_Pond_Out          28.28     10313.42
Federal_Pond_Out          28.31     10363.03
Federal_Pond_Out          28.35     10413.19
Federal_Pond_Out          28.39     10463.32
Federal_Pond_Out          28.43     10513.97
Federal_Pond_Out          28.47     10564.23
Federal_Pond_Out          28.50     10613.44
Federal_Pond_Out          28.54     10664.09
Federal_Pond_Out          28.58     10714.43
Federal_Pond_Out          28.62     10764.35
Federal_Pond_Out          28.66     10815.05
Federal_Pond_Out          28.69     10864.82
Federal_Pond_Out          28.73     10915.25
Federal_Pond_Out          28.77     10965.06
Federal_Pond_Out          28.81     11015.71
Federal_Pond_Out          28.84     11065.50
Federal_Pond_Out          28.88     11116.11
Federal_Pond_Out          28.92     11166.59
Federal_Pond_Out          28.95     11215.68
Federal_Pond_Out          28.99     11266.14
Federal_Pond_Out          29.03     11316.74
Federal_Pond_Out          29.06     11366.52
Federal_Pond_Out          29.10     11417.14
Federal_Pond_Out          29.14     11466.94
Federal_Pond_Out          29.17     11516.47
Federal_Pond_Out          29.21     11567.13
Federal_Pond_Out          29.25     11617.89
Federal_Pond_Out          29.28     11667.53
Federal_Pond_Out          29.32     11718.09
Federal_Pond_Out          29.36     11768.82
Federal_Pond_Out          29.39     11817.94
Federal_Pond_Out          29.43     11868.16
Federal_Pond_Out          29.46     11917.86
;
;see Westminster Pond Discharge Calcs.xlsx
WestminsterDischarge Rating     0          0
```

```
WestminsterDischarge           2.79      1.1
WestminsterDischarge           4.16      2
WestminsterDischarge           4.72      2.3
WestminsterDischarge           5.25      5.8
WestminsterDischarge           5.71      23.7
WestminsterDischarge           6.28      56.5
WestminsterDischarge           6.63      74.1
WestminsterDischarge           7.09      78.44
WestminsterDischarge           8.56      425.6
;
;Calculated using survey
534Stage-Discharge Rating     0         0.00
534Stage-Discharge            0.18      0.00
534Stage-Discharge            0.68      0.60
534Stage-Discharge            1.68      5.91
534Stage-Discharge            2.68      10.70
534Stage-Discharge            3.68      13.76
534Stage-Discharge            4.68      16.25
534Stage-Discharge            5.68      18.41
534Stage-Discharge            6.68      25.76
534Stage-Discharge            7.68      61.18
534Stage-Discharge            8.68      76.19
534Stage-Discharge            9.68      697.94
534Stage-Discharge            10.68     2153.95
534Stage-Discharge            11.68     4502.60
;
Pomona_Lakes     Storage    0         398882.0827
Pomona_Lakes                0.65      417823
Pomona_Lakes                2.65      476103
Pomona_Lakes                4.42      498556
Pomona_Lakes                4.65      501473
Pomona_Lakes                6.65      526920
Pomona_Lakes                8.65      560874
;
Lake_Arbor       Storage    0         1624803
Lake_Arbor                  0.69      1700947
Lake_Arbor                  2.69      1921655
Lake_Arbor                  3.69      2076976
Lake_Arbor                  4.69      2232298
Lake_Arbor                  6.69      2791446
;
Rotary_Parks     Storage    0         0
Rotary_Parks                1.22      5990
Rotary_Parks                3.22      34832
Rotary_Parks                5.22      70097
Rotary_Parks                6.92      95674
Rotary_Parks                7.22      100187
Rotary_Parks                9.22      128298
Rotary_Parks                11.22     146311
Rotary_Parks                13.22     164796
Rotary_Parks                15.22     186447
Rotary_Parks                17.22     205556
;
64th_Pond        Storage    0         484999
64th_Pond                   1.4       508015
64th_Pond                   3.4       540894
64th_Pond                   3.5       543014
64th_Pond                   5.4       583308
64th_Pond                   7.4       708500
64th_Pond                   9.4       834419
64th_Pond                   11.4      983226
;
;From Muller Spreadsheet, assumed ft2
Federal_Pond     Storage    0         0
Federal_Pond                1         6551
Federal_Pond                2         14018
Federal_Pond                3         20650
Federal_Pond                4         125679
Federal_Pond                5         151876
Federal_Pond                6         180468
Federal_Pond                7         218720
Federal_Pond                8         248094
Federal_Pond                9         276410
Federal_Pond                10        314191
Federal_Pond                11        356223
```



```
Federal_Pond                12        396616
Federal_Pond                13        448746
Federal_Pond                14        501483
Federal_Pond                15        547002
Federal_Pond                16        592071
Federal_Pond                17        655602
Federal_Pond                18        726395
Federal_Pond                19        815547
Federal_Pond                20        900715
Federal_Pond                21        978197
Federal_Pond                22        1075391
Federal_Pond                23        1149036
Federal_Pond                24        1206435
Federal_Pond                25        1273937
Federal_Pond                26        1442883
Federal_Pond                27        1522384
Federal_Pond                28        1600568
Federal_Pond                29        1676310
Federal_Pond                30        1774094
;
WestminsterEastPond Storage    0         0
WestminsterEastPond            0.56      25222.8829
WestminsterEastPond            1.56      43463.9886
WestminsterEastPond            2.56      59236.9718
WestminsterEastPond            3.56      68669.7114
WestminsterEastPond            4.56      68669.7114
WestminsterEastPond            5.56      73576.0053
WestminsterEastPond            6.56      78590.2312
WestminsterEastPond            7.56      83704.9929
WestminsterEastPond            8.56      88920.2906
;
;From Westminster Mall Redevelopment Phase II Drainage Report
334Stage-Area    Storage    0         0
334Stage-Area               0.18      0
334Stage-Area               0.68      24.63
334Stage-Area               1.68      1619.44
334Stage-Area               2.68      16093.29
334Stage-Area               3.68      30564.51
334Stage-Area               4.68      40840.55
334Stage-Area               5.68      49460.9
334Stage-Area               6.68      55882.52
334Stage-Area               7.68      61290.366
334Stage-Area               8.68      65967
334Stage-Area               9.68      73995
334Stage-Area               10.68     80527
334Stage-Area               11.68     86152

[REPORT]
;;Reporting Options
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2727.273 0.000 12727.273 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
198              -1495.478          6634.806
197              -1087.175          6814.940
195              -120.457           6727.875
194              140.737            6631.804
193              353.896            6637.808
192              1062.422           6028.356
191              966.351            6502.708
190              609.085            6487.697
189              921.317            6622.797
186              2101.561           6352.072
185              2673.371           6149.661
```

184	1995.295	5653.755
183	2890.963	6109.179
182	3518.436	5861.226
181	3508.315	5587.971
181T	3680.364	5815.683
180	3842.293	5795.442
179	2930.083	4978.034
178	3796.402	5535.936
177	4024.277	4938.746
177T	4454.490	5569.331
175T	4446.632	5722.558
172	4745.227	4897.492
169	4974.025	4114.257
168	5571.137	4488.717
167	5628.049	5358.313
166	6168.248	5440.047
165	6552.829	5318.601
164	6613.552	4200.281
163	6588.251	4746.790
163T	6638.853	5313.540
162	6998.132	5273.058
160	7534.521	5202.214
159	4951.160	6421.781
158	5650.186	6283.043
157	6117.093	6066.932
156	6821.455	5842.817
155	2892.284	6576.406
154	3629.957	6780.298
153	3973.594	7428.625
153T	4083.557	7133.098
151	4566.940	7144.552
149	5655.122	7121.643
148	6990.723	7451.534
147	6761.632	7007.098
143	7934.027	5626.706
142	7936.695	5165.135
141	7928.691	5797.460
140	8104.781	5613.366
140T	8091.441	5114.442
138	8402.631	4747.804
137	7322.990	7481.011
136	7441.249	7484.123
136T	7447.473	7409.433
135	8209.928	7521.468
134T	8458.893	6889.719
132	10295.010	6766.417
131	9762.848	6561.021
129	9345.831	6318.280
128	8922.591	7435.510
124	8951.562	5615.409
123	8798.676	5682.122
122T	8996.037	5140.073
121	9101.668	4706.433
120	8550.194	4695.014
119	9018.275	4111.569
118T	9465.814	3897.529
117	9585.342	3797.458
116	10035.660	3697.388
115	10277.498	5242.923
114	10274.718	3555.621
113	9282.351	3316.563
112	10266.379	3336.021
111	10727.816	3766.881
110	10586.049	3783.560
106T	11225.389	2905.162
104	12176.060	2813.430
102	12145.483	2335.315
196	-765.936	6703.858
103	12129.854	2381.639
109T	10630.036	3092.148
139	8410.516	4820.484
161	7506.949	5253.882
170	5610.507	5424.614
173	5284.671	5603.971
187	2038.261	6343.942

188	2075.034	6422.741
150	5611.820	7192.350
152	4527.038	7190.783
176	4731.575	5570.147
144	7531.849	5609.840
175	4447.079	5774.128
123T	8959.136	5445.257
105	12000.741	3109.850
103T	12141.084	2351.494
108	10935.715	2945.202
106	11125.182	2906.657
117T	9649.975	3754.491
109	10624.965	3341.581
107	11100.247	3049.570
135T	8284.630	7401.204
134	8209.101	7014.083
101	12490.171	1643.160
174	5142.044	5616.478
171	5289.377	5524.149
127T	9073.320	6416.391
125	8897.694	6212.469
118	9460.254	4103.230
125T	8838.565	6190.685
146	7316.033	6487.061
145	7499.305	6308.370
133T	8754.539	6497.599
122	9043.293	5153.972
130	9784.632	6753.968
127	9061.987	6447.483
126	8898.790	6499.980
133	8782.548	6578.512
375	4448.537	5864.513
344	7380.234	5663.333
327	9093.754	6461.434
301	12469.770	1649.009
306	11104.577	2906.686
335	8264.884	7459.209
334	8260.045	6988.611

[VERTICES]

;;Link	X-Coord	Y-Coord
202	12139.924	2221.346
202	12267.792	1998.966
202	12392.880	1670.957
204	12126.025	2538.236
205	12004.259	2946.276
205	12157.280	2940.999
206T	11375.495	2813.430
206T	11472.786	2835.668
206T	11764.659	2624.408
206T	12098.228	2393.690
210	10622.186	3591.758
213	10038.440	3352.700
217T	9955.048	3538.943
220	8579.076	4345.067
220	8765.319	4197.741
222T	8996.037	5026.104
222T	8890.407	4984.408
222T	8815.354	4756.469
223	8837.592	5618.188
225T	8668.028	6029.590
225T	8670.808	5682.122
227T	9024.125	6317.669
228	8816.781	7323.476
228	8779.436	6937.580
430	9663.262	6514.340
235T	8358.679	7179.057
246	7501.596	6420.625
249	6344.686	7142.261
251	5031.994	7243.062
251	5421.449	7146.843
253	3975.885	7201.825
254	3824.684	6892.552
254	3824.684	7114.771

257	6351.880	5992.227
257	6642.696	6024.244
258	5890.309	6243.023
258	5927.662	6173.654
263	6636.572	4914.598
263	6707.416	5041.105
263	6606.210	5253.636
266	6332.956	5456.047
272	4883.577	5147.990
272	4909.424	5333.767
272	5014.429	5514.699
275T	4948.195	5632.627
276	4737.682	5621.223
276	5034.146	5611.230
277	4253.548	5201.300
277	4271.318	5359.615
277T	4522.274	5569.592
277T	4677.723	5570.147
278	3890.070	5577.701
279	3172.807	4952.519
279	3534.669	5180.299
280	4059.693	5789.326
281T	3749.255	5783.456
283	2985.087	6099.731
283	3157.958	5968.113
283	3311.184	5942.575
283	3425.122	5863.998
284	2144.306	5608.620
284	2342.714	5681.305
284	2511.656	5716.665
284	2763.105	5871.856
284	2829.896	6007.402
286	2218.955	6361.002
286	2525.408	6213.668
289	1052.076	6527.979
289	1446.929	6520.121
289	1478.360	6453.330
289	1792.671	6423.864
289	1910.537	6453.330
290	609.085	6547.742
290	741.694	6557.446
290	828.248	6556.748
291	927.322	6559.751
292	1071.429	6319.572
292	1050.413	6436.659
293	501.005	6634.806
293	585.067	6694.851
293	726.172	6673.835
293	798.226	6607.786
295	-15.379	6694.851
295	35.659	6628.802
296	-594.809	6682.842
296	-507.745	6619.795
296	-381.651	6643.813
296	-276.573	6733.880
297	-925.055	6742.887
298	-1261.304	6754.895
418	9626.509	4101.352
425T	8704.290	6029.411
425T	8705.518	5723.566
427T	8952.742	6362.283
433T	8750.334	6304.456
445	7731.350	6184.111
446	7284.279	6376.320
471	5483.673	5494.099
474	5239.431	5613.126
230	9637.663	6552.391
230	9112.978	6462.886
230	9112.978	6462.886
426	8894.387	6493.678
426	8760.733	6492.659
433	8782.016	6548.553
575	4517.998	5816.008
544	7431.258	5593.357
506	11114.579	2894.183


```
[PROFILES]
;;Name           Links
;;-------------- ----------
"DWY B           " 255 254 253T 251 249
"DWY B           " 247 246 245 544 244
"DWY B           " 243
"                " 217 217T 212 209T 208
"                " 506 206 206T 203T
```

EPA SWMM 5.1 100-YEAR FUTURE CONDITIONS OUTPUT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------

WARNING 08: elevation drop exceeds length for Conduit 235
WARNING 04: minimum elevation drop used for Conduit 234
WARNING 08: elevation drop exceeds length for Conduit 433
WARNING 10: crest elevation raised to downstream invert for regulator Link 506

***********************************************************
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
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ 01/01/2005 00:00:00
Ending Date .............. 01/02/2005 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 1.00 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 ..........      1435.293       467.712
External Outflow .........      1395.008       454.584
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......        56.717        18.482
Continuity Error (%) .....        -1.145


*********************************
Highest Flow Instability Indexes
*********************************
Link 534 (11)
Link 234T (10)
Link 233 (9)
Link 233T (7)
Link 225T (2)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     1.00 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00


******************
Node Depth Summary
```



```
******************

-------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
Node                 Type           Feet     Feet     Feet  days hr:min        Feet
-------------------------------------------------------------------------------
198                  JUNCTION       0.22     3.42  5672.92     0  00:40        3.42
197                  JUNCTION       4.87     8.04  5666.04     0  00:46        8.03
195                  JUNCTION       5.29     8.87  5630.37     0  00:54        8.87
194                  JUNCTION       4.84     8.91  5620.21     0  00:54        8.91
193                  JUNCTION       5.69    10.27  5612.17     0  00:53       10.26
192                  JUNCTION       0.06     0.83  5640.83     0  00:45        0.83
191                  JUNCTION       0.09     1.28  5597.28     0  00:41        1.27
190                  JUNCTION       0.05     0.86  5610.86     0  00:35        0.86
189                  JUNCTION       5.49     6.68  5592.68     0  00:42        6.67
186                  JUNCTION       0.57     6.45  5543.15     0  01:01        6.44
185                  JUNCTION      11.68    17.53  5535.93     0  01:07       17.52
184                  JUNCTION       0.10     1.92  5607.92     0  00:40        1.92
183                  JUNCTION      11.11    12.88  5520.44     0  00:48       12.87
182                  JUNCTION      12.91    20.33  5505.19     0  01:09       20.33
181                  JUNCTION       0.05     0.64  5519.14     0  00:45        0.64
181T                 JUNCTION       5.72    13.50  5491.00     0  01:09       13.49
180                  JUNCTION       5.30    13.17  5483.67     0  01:09       13.17
179                  JUNCTION       0.07     1.40  5604.40     0  00:40        1.40
178                  JUNCTION       0.14     1.46  5499.46     0  00:50        1.46
177                  JUNCTION       0.13     1.99  5517.49     0  00:45        1.99
177T                 JUNCTION       1.93     3.76  5467.76     0  00:51        3.76
175T                 JUNCTION       2.78     9.91  5460.37     0  01:12        9.90
172                  JUNCTION       0.07     1.01  5503.01     0  00:40        1.01
169                  JUNCTION      18.52    18.83  5536.83     0  00:40       18.83
168                  JUNCTION       0.17     1.75  5465.75     0  00:51        1.75
167                  JUNCTION      22.66    24.21  5423.49     0  01:01       24.21
166                  JUNCTION       1.27    10.66  5397.31     0  01:02       10.50
165                  JUNCTION      11.70    20.93  5394.04     0  01:17       20.91
164                  JUNCTION       0.07     1.09  5444.09     0  00:40        1.09
163                  JUNCTION       0.10     1.54  5413.54     0  00:41        1.53
163T                 JUNCTION       8.34    14.16  5383.16     0  01:05       14.14
162                  JUNCTION       9.22    18.91  5377.26     0  01:08       18.89
160                  JUNCTION      12.02    21.81  5365.43     0  01:13       21.80
159                  JUNCTION       0.08     1.15  5468.65     0  00:40        1.15
158                  JUNCTION       0.24     4.12  5446.12     0  00:42        4.11
157                  JUNCTION      14.25    18.08  5438.08     0  00:49       18.08
156                  JUNCTION       0.13     1.65  5379.65     0  00:51        1.64
155                  JUNCTION       0.01     0.13  5526.13     0  00:40        0.13
154                  JUNCTION       0.29     3.21  5521.21     0  00:49        3.21
153                  JUNCTION       0.07     1.40  5503.40     0  00:35        1.40
153T                 JUNCTION      12.28    15.21  5505.21     0  00:53       15.21
151                  JUNCTION       1.23     6.84  5491.94     0  00:48        6.83
149                  JUNCTION      23.74    29.76  5482.46     0  01:03       29.76
148                  JUNCTION       0.14     2.32  5436.32     0  00:40        2.32
147                  JUNCTION       0.99     9.13  5419.28     0  01:07        9.11
143                  JUNCTION       7.09     8.39  5370.39     0  01:19        8.39
142                  JUNCTION       9.32    19.20  5352.02     0  01:16       19.19
141                  JUNCTION       0.10     1.30  5375.30     0  00:45        1.30
140                  JUNCTION       0.12     1.58  5365.58     0  00:45        1.58
140T                 JUNCTION       6.21     7.69  5339.38     0  01:25        7.69
138                  JUNCTION       4.00    12.02  5330.43     0  01:20       12.02
137                  JUNCTION       0.06     0.91  5446.91     0  00:40        0.91
136                  JUNCTION       0.06     1.06  5451.06     0  00:35        1.06
136T                 JUNCTION       0.18     3.23  5444.23     0  00:35        3.22
135                  JUNCTION       0.00     0.00  5446.00     0  00:00        0.00
134T                 JUNCTION       0.59     4.09  5418.09     0  00:50        4.08
132                  JUNCTION       0.08     1.51  5473.01     0  00:35        1.51
131                  JUNCTION       0.06     1.27  5447.27     0  00:35        1.27
129                  JUNCTION       0.04     0.55  5440.55     0  00:40        0.55
128                  JUNCTION       0.08     1.04  5472.04     0  00:45        1.04
124                  JUNCTION       0.06     0.74  5368.24     0  00:50        0.74
123                  JUNCTION       8.37    13.40  5361.40     0  00:48       13.40
122T                 JUNCTION       3.83    10.90  5344.90     0  01:09       10.89
121                  JUNCTION       0.04     0.77  5336.77     0  00:35        0.77
120                  JUNCTION      15.37    24.06  5328.19     0  01:21       24.05
119                  JUNCTION       8.70    15.25  5300.05     0  01:21       15.24
118T                 JUNCTION       7.38    16.27  5291.27     0  01:22       16.26
117                  JUNCTION       2.67    11.39  5284.49     0  01:23       11.38
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6_Fut_100yr_0mi^2_

116	JUNCTION	0.09	1.25	5293.25	0	00:45	1.25
115	JUNCTION	0.06	0.92	5403.92	0	00:40	0.92
114	JUNCTION	0.11	1.49	5285.49	0	00:46	1.49
113	JUNCTION	0.09	1.06	5288.06	0	00:45	1.06
112	JUNCTION	10.81	17.38	5272.08	0	01:26	17.37
111	JUNCTION	0.70	1.32	5299.32	0	00:40	1.32
110	JUNCTION	0.08	1.16	5299.16	0	00:40	1.15
106T	JUNCTION	3.07	11.68	5240.24	0	02:00	11.68
104	JUNCTION	0.13	1.76	5246.26	0	00:48	1.76
102	JUNCTION	2.87	12.13	5216.23	0	02:06	12.12
196	JUNCTION	5.07	5.68	5653.08	0	00:53	5.68
103	JUNCTION	0.00	0.00	5204.12	0	00:00	0.00
109T	JUNCTION	12.11	22.74	5263.04	0	01:28	22.72
139	JUNCTION	0.00	0.00	5320.00	0	00:00	0.00
161	JUNCTION	0.00	0.00	5344.00	0	00:00	0.00
170	JUNCTION	0.00	0.00	5402.00	0	00:00	0.00
173	JUNCTION	0.00	0.00	5414.00	0	00:00	0.00
187	JUNCTION	0.00	0.00	5538.10	0	00:00	0.00
188	JUNCTION	0.00	0.00	5538.10	0	00:00	0.00
150	JUNCTION	0.00	0.00	5454.00	0	00:00	0.00
152	JUNCTION	0.00	0.00	5486.00	0	00:00	0.00
176	JUNCTION	0.38	4.90	5459.90	0	00:52	4.89
144	JUNCTION	1.06	3.99	5381.30	0	02:11	3.99
175	JUNCTION	0.00	0.00	5453.00	0	00:00	0.00
123T	JUNCTION	1.18	9.80	5353.80	0	01:07	9.76
105	JUNCTION	0.07	1.12	5355.12	0	00:40	1.12
103T	JUNCTION	16.58	21.32	5225.43	0	02:07	21.31
108	JUNCTION	2.94	13.17	5248.17	0	01:29	13.16
106	JUNCTION	2.56	11.68	5242.75	0	01:58	11.68
117T	JUNCTION	16.05	17.06	5289.06	0	00:41	17.05
109	JUNCTION	0.72	1.92	5263.75	0	00:41	1.91
107	JUNCTION	0.12	2.20	5249.32	0	00:35	2.20
135T	JUNCTION	0.24	0.85	5445.29	0	01:23	0.85
134	JUNCTION	13.88	16.78	5431.10	0	00:45	16.78
101	OUTFALL	0.00	0.00	5186.60	0	00:00	0.00
174	DIVIDER	17.52	25.02	5445.32	0	01:16	25.01
171	DIVIDER	14.29	17.05	5430.85	0	01:14	17.05
127T	DIVIDER	0.51	3.50	5400.26	0	00:36	3.50
125	DIVIDER	3.31	6.30	5385.47	0	00:38	6.30
118	DIVIDER	0.06	1.06	5306.00	0	00:40	1.06
125T	DIVIDER	10.11	12.71	5389.71	0	01:03	12.70
146	DIVIDER	11.63	19.71	5410.31	0	01:13	19.71
145	DIVIDER	7.56	14.16	5397.16	0	01:00	14.16
133T	DIVIDER	10.06	12.05	5397.98	0	01:02	12.04
122	DIVIDER	5.00	5.00	5344.92	0	00:00	5.00
130	DIVIDER	12.46	15.67	5445.50	0	00:20	15.67
127	DIVIDER	7.48	13.88	5410.66	0	01:00	13.87
126	DIVIDER	4.07	6.66	5406.66	0	01:01	6.62
133	DIVIDER	0.61	4.02	5394.02	0	00:55	4.02
375	STORAGE	0.73	1.21	5454.56	0	02:12	1.21
344	STORAGE	0.52	3.28	5380.59	0	02:11	3.28
327	STORAGE	1.59	14.15	5410.93	0	01:00	14.14
301	STORAGE	4.14	8.03	5194.63	0	02:13	8.03
306	STORAGE	4.77	24.82	5255.82	0	01:58	24.81
335	STORAGE	4.09	6.89	5451.33	0	01:23	6.89
334	STORAGE	1.50	9.20	5423.52	0	00:50	9.20

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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	Flow Balance Error Percent
198	JUNCTION	204.93	204.93	0 00:40	5.36	5.36	0.000
197	JUNCTION	26.66	227.09	0 00:46	0.784	6.15	0.000
195	JUNCTION	99.39	459.58	0 00:53	2.33	13.2	0.000
194	JUNCTION	240.13	650.53	0 00:52	5.34	18.6	-0.000
193	JUNCTION	60.01	690.23	0 00:52	1.12	19.7	0.000
192	JUNCTION	106.17	106.17	0 00:45	3.03	3.03	0.000
191	JUNCTION	102.22	202.97	0 00:41	2.29	5.32	0.000

190	JUNCTION	78.64	78.64	0	00:35	1.7	1.7	0.000
189	JUNCTION	106.76	1018.74	0	00:52	2.42	29.1	0.000
186	JUNCTION	63.14	1265.96	0	01:01	2.2	40.1	0.000
185	JUNCTION	162.02	1359.75	0	01:05	3.7	43.8	0.000
184	JUNCTION	203.12	203.12	0	00:40	5	5	0.000
183	JUNCTION	350.59	1699.56	0	01:05	7.04	55.9	0.000
182	JUNCTION	187.81	1799.90	0	01:08	4.19	60.1	0.000
181	JUNCTION	63.31	63.31	0	00:45	1.97	1.97	0.000
181T	JUNCTION	0.00	1851.47	0	01:08	0	62.1	0.000
180	JUNCTION	205.88	1925.52	0	01:08	3.64	65.7	0.000
179	JUNCTION	265.25	265.25	0	00:40	5.87	5.87	0.000
178	JUNCTION	116.99	355.49	0	00:50	4.12	10.1	0.000
177	JUNCTION	185.95	185.95	0	00:45	5.32	5.32	0.000
177T	JUNCTION	0.00	534.02	0	00:53	0	15.4	0.000
175T	JUNCTION	0.00	1927.87	0	01:12	0	68.4	0.000
172	JUNCTION	164.19	164.19	0	00:40	4.41	4.41	0.000
169	JUNCTION	104.80	104.80	0	00:40	2.67	2.67	0.000
168	JUNCTION	151.60	250.41	0	00:51	5.89	8.61	0.000
167	JUNCTION	198.53	3505.49	0	01:01	5.6	124	0.000
166	JUNCTION	235.89	3450.21	0	01:02	4.96	129	0.000
165	JUNCTION	124.39	3425.92	0	01:04	3.04	132	0.000
164	JUNCTION	177.63	177.63	0	00:40	4.46	4.46	0.000
163	JUNCTION	247.85	417.68	0	00:41	5.62	10.1	0.000
163T	JUNCTION	0.00	3728.06	0	01:05	0	142	0.000
162	JUNCTION	205.27	3824.23	0	01:08	5.33	147	0.000
160	JUNCTION	261.05	3947.43	0	01:12	6.28	155	0.000
159	JUNCTION	155.59	155.59	0	00:40	4.23	4.23	0.000
158	JUNCTION	280.57	416.50	0	00:42	6.16	10.4	0.000
157	JUNCTION	94.95	498.70	0	00:48	2.64	13.1	0.000
156	JUNCTION	194.19	687.90	0	00:51	6.44	19.5	0.000
155	JUNCTION	122.31	122.31	0	00:40	2.92	2.92	0.000
154	JUNCTION	234.47	284.56	0	00:49	5.36	8.5	0.000
153	JUNCTION	251.07	251.07	0	00:35	4.56	4.56	0.000
153T	JUNCTION	0.00	486.16	0	00:45	0	13.1	0.000
151	JUNCTION	189.18	816.22	0	00:48	4.05	23.2	0.000
149	JUNCTION	118.70	1061.57	0	01:00	3.2	33.9	-0.000
148	JUNCTION	254.56	254.56	0	00:40	6.52	6.52	0.000
147	JUNCTION	288.23	1401.13	0	01:07	7.2	48	0.000
143	JUNCTION	83.57	869.84	0	01:39	2.37	87.9	-0.000
142	JUNCTION	96.25	4725.61	0	01:24	1.84	244	0.000
141	JUNCTION	212.90	212.90	0	00:45	6.21	6.21	0.000
140	JUNCTION	238.73	449.58	0	00:45	7.07	13.3	0.000
140T	JUNCTION	0.00	5004.76	0	01:19	0	258	0.000
138	JUNCTION	345.43	5194.36	0	01:20	7.82	269	0.000
137	JUNCTION	88.31	88.31	0	00:40	2.15	2.15	0.000
136	JUNCTION	260.43	260.43	0	00:35	4.83	4.83	0.000
136T	JUNCTION	0.00	345.66	0	00:35	0	6.98	-0.000
135	JUNCTION	198.26	198.26	0	00:40	4.85	4.85	0.000
134T	JUNCTION	0.00	398.91	0	00:50	0	13.7	0.000
132	JUNCTION	447.37	447.37	0	00:35	7.43	7.43	0.000
131	JUNCTION	212.32	212.32	0	00:35	3.62	3.62	0.000
129	JUNCTION	35.00	35.00	0	00:40	1.02	1.02	0.000
128	JUNCTION	172.41	172.41	0	00:45	4.92	4.92	0.000
124	JUNCTION	79.09	79.09	0	00:50	2.79	2.79	0.000
123	JUNCTION	229.01	1772.89	0	01:05	5.34	62.1	0.000
122T	JUNCTION	0.00	1918.40	0	01:08	0	68	0.000
121	JUNCTION	57.51	57.51	0	00:35	1.22	1.22	0.000
120	JUNCTION	149.53	7140.58	0	01:18	5.05	343	0.000
119	JUNCTION	148.43	7184.55	0	01:21	3.69	347	0.000
118T	JUNCTION	0.00	7204.03	0	01:22	0	348	0.000
117	JUNCTION	230.44	7272.10	0	01:22	4.91	353	0.000
116	JUNCTION	182.45	182.45	0	00:45	5.23	5.23	0.000
115	JUNCTION	123.40	123.40	0	00:40	2.77	2.77	0.000
114	JUNCTION	210.58	500.25	0	00:46	5.86	13.9	0.000
113	JUNCTION	122.69	122.69	0	00:45	3.9	3.9	0.000
112	JUNCTION	398.37	7774.24	0	01:25	8.89	383	0.000
111	JUNCTION	329.70	329.70	0	00:40	44	44	0.000
110	JUNCTION	240.96	240.96	0	00:40	6.03	6.03	0.000
106T	JUNCTION	0.00	6244.69	0	02:00	0	443	0.000
104	JUNCTION	129.93	340.13	0	00:48	4.45	9.89	0.000
102	JUNCTION	108.51	6358.57	0	02:06	3.16	462	0.000
196	JUNCTION	171.57	380.89	0	00:50	4.67	10.9	0.000
103	JUNCTION	181.95	181.95	0	00:45	5.76	5.76	0.000
109T	JUNCTION	0.00	8036.43	0	01:27	0	435	-0.000
139	JUNCTION	142.04	142.04	0	00:40	3.43	3.43	0.000

			6_Fut_100yr_0mi^2_					
161	JUNCTION	52.75	52.75	0	00:40	1.35	1.35	0.000
170	JUNCTION	101.01	101.01	0	00:35	2.06	2.06	0.000
173	JUNCTION	164.00	164.00	0	00:35	3.47	3.47	0.000
187	JUNCTION	119.20	119.20	0	00:50	4.57	4.57	0.000
188	JUNCTION	121.38	121.38	0	00:45	3.85	3.85	0.000
150	JUNCTION	261.57	261.57	0	00:45	7.05	7.05	0.000
152	JUNCTION	172.41	172.41	0	00:50	6.1	6.1	0.000
176	JUNCTION	245.52	756.33	0	00:52	6.63	22.1	0.000
144	JUNCTION	0.00	739.71	0	02:11	0	79.8	0.000
175	JUNCTION	0.00	10.20	0	02:12	0	2.7	0.000
123T	JUNCTION	0.00	1840.07	0	01:07	0	64.9	0.000
105	JUNCTION	219.25	219.25	0	00:40	5.41	5.41	0.000
103T	JUNCTION	0.00	6339.07	0	02:07	0	459	0.000
108	JUNCTION	157.47	8078.39	0	01:28	3.5	438	0.000
106	JUNCTION	0.00	6246.12	0	01:58	0	444	0.000
117T	JUNCTION	0.00	7322.76	0	01:22	0	356	0.000
109	JUNCTION	134.66	673.86	0	00:41	2.27	52.2	0.000
107	JUNCTION	161.01	161.01	0	00:35	3.37	3.37	0.000
135T	JUNCTION	0.00	76.59	0	01:23	0	3.94	0.000
134	JUNCTION	126.05	424.24	0	00:44	2.75	9.82	0.000
101	OUTFALL	0.00	6357.52	0	02:13	0	455	0.000
174	DIVIDER	54.21	2570.67	0	01:13	1.81	92.4	0.000
171	DIVIDER	252.80	2956.99	0	01:01	5.46	107	0.000
127T	DIVIDER	0.00	181.22	0	02:30	0	13.6	0.000
125	DIVIDER	85.32	231.26	0	00:50	1.83	15.5	0.000
118	DIVIDER	167.74	167.74	0	00:40	3.96	3.96	0.000
125T	DIVIDER	0.00	1642.94	0	01:02	0	56.6	0.000
146	DIVIDER	324.09	1595.22	0	01:11	8.57	56.6	0.000
145	DIVIDER	95.31	1664.09	0	01:13	3.01	59.7	0.000
133T	DIVIDER	0.00	1424.08	0	01:01	0	41.1	0.000
122	DIVIDER	122.82	122.82	0	00:40	3.06	3.06	0.000
130	DIVIDER	221.98	848.73	0	00:36	6.08	17.1	0.000
127	DIVIDER	0.00	902.46	0	01:00	0	29.3	0.000
126	DIVIDER	342.01	954.22	0	01:00	7.53	23.3	0.000
133	DIVIDER	152.42	509.46	0	00:54	3.97	17.7	0.000
375	STORAGE	172.00	172.00	0	00:40	4.14	4.14	-0.000
344	STORAGE	297.21	2052.84	0	01:13	6.23	79.8	-0.000
327	STORAGE	249.71	1263.68	0	00:41	6.19	29.3	0.003
301	STORAGE	257.45	6376.83	0	02:10	6.87	468	-0.000
306	STORAGE	129.30	8123.07	0	01:29	2.37	444	0.001
335	STORAGE	0.00	198.26	0	00:40	0	4.85	-0.000
334	STORAGE	0.00	424.24	0	00:44	0	9.82	0.001

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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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Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
375	300.460	7	0	0	502.069	12	0 02:12	10.20
344	904.381	6	0	0	5932.504	43	0 02:11	739.71
327	100.761	5	0	0	1291.292	69	0 01:00	902.46
301	2182.867	29	0	0	4618.737	61	0 02:13	6357.52
306	1105.881	6	0	0	12311.263	64	0 01:58	6246.12
335	195.606	36	0	0	399.077	74	0 01:23	76.59
334	35.326	7	0	0	324.024	62	0 00:50	398.46

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Outfall Loading Summary
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	Flow	Avg	Max	Total

Outfall Node	Freq Pcnt	Flow CFS	6_Fut_100yr_0mi^2_ Flow CFS	Volume 10^6 gal
101	99.32	708.17	6357.52	454.551
System	99.32	708.17	6357.52	454.551

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Link Flow Summary
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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
202	CONDUIT	6349.61	0 02:10	7.16	0.53	0.76
203	DUMMY	181.95	0 00:45			
203T	DUMMY	6339.07	0 02:07			
204	CONDUIT	337.03	0 00:53	4.33	0.27	0.58
205	CONDUIT	210.36	0 00:48	8.51	0.02	0.22
206	CONDUIT	6244.69	0 02:00	6.17	0.51	0.73
206T	CHANNEL	6214.01	0 02:07	5.34	0.44	0.80
207	CONDUIT	159.70	0 00:36	5.74	0.24	0.55
208	CONDUIT	8076.76	0 01:30	7.36	0.62	0.81
209	CONDUIT	673.73	0 00:41	21.92	0.18	0.24
209T	CHANNEL	8034.27	0 01:29	10.21	0.54	0.77
210	CONDUIT	238.74	0 00:42	8.67	0.02	0.23
211	CONDUIT	327.07	0 00:41	9.16	0.03	0.26
212	CONDUIT	7763.94	0 01:28	6.76	0.58	0.80
213	CONDUIT	119.14	0 00:54	5.25	0.02	0.21
214	CONDUIT	500.12	0 00:47	10.88	0.04	0.30
215	CONDUIT	113.64	0 00:50	7.14	0.01	0.18
216	CONDUIT	181.40	0 00:46	5.58	0.03	0.25
217	CHANNEL	7272.02	0 01:23	7.02	0.47	0.76
217T	CHANNEL	7302.45	0 01:26	7.04	0.47	0.76
218	CONDUIT	21.15	0 01:53	3.53	0.07	0.26
218T	CHANNEL	7203.90	0 01:23	15.59	0.55	0.74
219	CHANNEL	7183.03	0 01:22	15.56	0.54	0.73
220	CHANNEL	7119.31	0 01:21	8.28	0.62	0.82
221	CONDUIT	55.86	0 00:41	4.58	0.01	0.15
222	DUMMY	122.82	0 00:40			
222T	CONDUIT	1902.71	0 01:12	7.23	0.25	0.58
223	CONDUIT	1770.13	0 01:07	5.58	0.56	0.78
223T	CONDUIT	1837.91	0 01:09	6.98	0.48	0.73
224	CONDUIT	79.08	0 00:50	5.20	0.06	0.25
225	DUMMY	231.26	0 00:50			
225T	CONDUIT	714.56	0 00:46	15.61	1.08	1.00
226	CONDUIT	414.79	0 00:44	19.10	1.08	1.00
227T	CONDUIT	118.61	0 02:56	13.58	1.08	1.00
227	CONDUIT	181.22	0 02:30	19.96	1.08	1.00
228	CONDUIT	169.50	0 00:49	7.73	0.02	0.21
229	CONDUIT	34.86	0 00:43	5.33	0.00	0.11
430	CONDUIT	728.86	0 00:41	13.33	0.09	0.41
231	CONDUIT	210.29	0 00:36	6.29	0.03	0.25
232	CONDUIT	442.29	0 00:36	9.55	0.04	0.30
233	CONDUIT	509.46	0 00:54	26.58	0.74	0.64
233T	CONDUIT	427.13	0 00:35	4.24	1.00	1.00
234T	CONDUIT	384.64	0 00:55	5.67	0.20	0.50
235T	CONDUIT	76.50	0 01:30	5.09	0.01	0.17
236	CONDUIT	259.98	0 00:35	10.99	0.02	0.21
236T	CONDUIT	312.35	0 00:45	3.77	0.53	0.77
237	CONDUIT	88.37	0 00:40	5.07	0.01	0.18
238	CHANNEL	5194.16	0 01:21	11.61	0.58	0.80
239	DUMMY	142.04	0 00:40			
240	CONDUIT	448.14	0 00:48	8.74	0.05	0.32
240T	CONDUIT	5002.22	0 01:22	7.74	0.64	0.80
241	CONDUIT	211.88	0 00:46	6.04	0.03	0.26
242	CONDUIT	4725.34	0 01:25	4.09	0.39	0.70
243	CHANNEL	869.82	0 01:40	18.16	0.40	0.65
244	CHANNEL	739.70	0 02:13	15.50	0.15	0.40
245	CONDUIT	1442.29	0 01:18	4.72	0.41	0.66
246	CHANNEL	1299.93	0 01:00	4.30	1.00	1.00
247	CHANNEL	1386.81	0 01:13	4.71	0.61	0.82

					6_Fut_100yr_0mi^2_		
248	CONDUIT	250.24	0	00:43	5.63	0.29	0.57
249	CONDUIT	1032.79	0	01:11	4.64	0.20	0.42
250	DUMMY	261.57	0	00:45			
251	CONDUIT	754.32	0	01:03	3.51	0.48	0.73
252	DUMMY	172.41	0	00:50			
253	CONDUIT	245.65	0	00:37	6.24	0.03	0.28
253T	CHANNEL	483.04	0	00:50	4.96	0.27	0.58
254	CHANNEL	283.61	0	00:53	7.31	0.09	0.37
255	CONDUIT	99.46	0	01:00	1.52	0.03	0.12
256	DUMMY	687.90	0	00:51			
257	CONDUIT	495.87	0	00:51	8.92	0.05	0.33
258	CONDUIT	407.89	0	00:49	3.60	0.43	0.68
259	CONDUIT	153.12	0	00:47	5.72	0.02	0.23
260	CHANNEL	3931.18	0	01:16	8.52	0.56	0.81
261	DUMMY	52.75	0	00:40			
262	CHANNEL	3772.70	0	01:13	8.56	0.53	0.79
263	CONDUIT	414.69	0	00:44	8.64	0.04	0.31
263T	CHANNEL	3682.10	0	01:08	8.42	0.52	0.79
264	CONDUIT	175.23	0	00:43	7.14	0.02	0.22
265	CHANNEL	3423.48	0	01:05	8.31	0.48	0.76
266	CHANNEL	3356.26	0	01:17	8.56	0.48	0.75
267	CHANNEL	3312.58	0	01:02	14.48	0.26	0.57
268	CONDUIT	242.41	0	01:01	4.02	0.06	0.35
269	CONDUIT	98.91	0	00:51	2.93	0.01	0.06
270	DUMMY	101.01	0	00:35			
271	CONDUIT	1784.13	0	00:49	16.63	1.23	1.00
272	CONDUIT	161.43	0	00:47	7.74	0.01	0.20
273	DUMMY	164.00	0	00:35			
274	CONDUIT	1980.37	0	01:00	18.36	1.23	1.00
275	DUMMY	10.20	0	02:12			
275T	CONDUIT	1920.12	0	01:16	6.06	0.44	0.72
276	CONDUIT	754.53	0	00:55	6.41	0.18	0.49
277	CONDUIT	181.37	0	00:51	4.73	0.09	0.33
277T	CONDUIT	533.59	0	00:54	7.39	0.07	0.38
278	CONDUIT	353.67	0	00:53	8.08	0.04	0.29
279	CONDUIT	238.89	0	00:51	4.03	0.09	0.26
280	CONDUIT	1921.41	0	01:12	7.04	0.36	0.66
281	CONDUIT	63.12	0	00:46	7.14	0.00	0.13
281T	CONDUIT	1851.11	0	01:09	6.62	0.63	0.83
282	CONDUIT	1799.55	0	01:09	6.58	0.44	0.72
283	CONDUIT	1693.18	0	01:09	6.54	0.62	0.82
284	CONDUIT	194.84	0	00:48	6.78	0.14	0.37
285	CONDUIT	1358.87	0	01:07	5.26	0.17	0.39
286	CHANNEL	1255.23	0	01:07	4.45	0.54	0.80
287	DUMMY	119.20	0	00:50			
288	DUMMY	121.38	0	00:45			
289	CONDUIT	987.09	0	01:02	5.28	0.06	0.31
290	CONDUIT	77.29	0	00:41	5.12	0.01	0.17
291	CONDUIT	202.89	0	00:42	5.99	0.03	0.26
292	CONDUIT	106.12	0	00:46	7.33	0.01	0.17
293	CHANNEL	688.49	0	00:55	8.41	0.41	0.74
294	CHANNEL	650.28	0	00:53	7.45	0.45	0.76
295	CHANNEL	459.15	0	00:54	6.76	0.32	0.68
296	CHANNEL	378.69	0	00:54	7.49	0.21	0.59
297	CONDUIT	221.58	0	00:53	1.89	0.02	0.11
298	CHANNEL	200.95	0	00:46	3.74	0.20	0.52
418	CONDUIT	145.23	0	00:41	9.68	0.02	0.21
422	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
425	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
425T	CONDUIT	974.55	0	01:06	17.43	0.13	0.46
427	CHANNEL	734.02	0	01:01	13.98	0.18	0.55
427T	CONDUIT	62.40	0	02:35	3.62	0.05	0.23
433T	CONDUIT	994.93	0	01:03	11.13	0.20	0.54
445	CONDUIT	209.77	0	01:19	10.57	0.03	0.28
446	CONDUIT	293.88	0	01:13	15.65	0.05	0.31
471	CONDUIT	1594.84	0	01:01	15.72	0.33	0.63
474	CONDUIT	964.64	0	01:14	12.15	0.23	0.57
230	CONDUIT	113.46	0	00:22	13.02	1.08	1.00
426	CONDUIT	568.65	0	01:02	13.82	0.09	0.41
235	DUMMY	198.26	0	00:40			
234	DUMMY	424.24	0	00:44			
433	DUMMY	0.00	0	00:00			
575	DUMMY	10.20	0	02:12			
544	DUMMY	739.71	0	02:11			
527	DUMMY	902.46	0	01:00			

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501	DUMMY	6357.52	0	02:13
506	DUMMY	6246.12	0	01:58
535	DUMMY	76.59	0	01:23
534	DUMMY	398.46	0	00:50

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Conduit Surcharge Summary
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Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
225T	1.21	1.21	1.21	1.23	1.21
226	0.84	0.84	0.84	0.86	0.84
227T	2.31	2.31	2.31	2.33	2.31
227	1.91	1.91	1.91	1.91	1.91
233T	1.34	1.34	1.34	1.31	1.34
246	0.54	0.54	0.54	0.52	0.54
271	1.15	1.15	1.15	1.16	1.15
274	0.91	0.91	0.91	0.92	0.91
230	1.45	1.45	1.45	1.48	1.45

Analysis begun on: Fri Nov 09 11:29:15 2018
Analysis ended on: Fri Nov 09 11:29:27 2018
Total elapsed time: 00:00:12

Table B-6 - Baseline Peak Flows and Runoff Volumes

Design Point	Drainage Area[1] (acres)	Area Adjustment?	Future Condtions Peak Flow (cfs)							Future Condtions Runoff Volume (acre-feet)						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
101	8099	YES	818	1291	1733	3451	4572	6358	10420	287	393	497	908	1135	1396	2038
301	8099	YES	876	1303	1754	3464	4580	6377	10446	328	436	540	951	1178	1436	2081
102	7975	YES	871	1299	1747	3453	4570	6359	10398	325	430	534	939	1163	1418	2050
103T	7918	YES	867	1296	1742	3445	4558	6339	10361	325	427	531	933	1154	1409	2035
103	118	NO	28	43	62	111	143	182	274	3	5	7	11	14	18	27
104	182	NO	62	95	131	215	272	340	501	6	10	13	19	24	30	45
105	102	NO	40	61	86	140	176	219	323	3	5	7	10	13	17	25
106T	7619	YES	845	1284	1714	3389	4493	6245	10172	319	417	516	902	1117	1360	1964
106	7619	YES	845	1284	1714	3389	4493	6246	10174	319	417	516	905	1120	1363	1967
306	7619	YES	903	1372	1868	4618	6216	8123	12436	319	417	516	905	1120	1363	1967
107	52	NO	47	65	81	112	135	161	226	3	4	5	7	9	10	15
108	7522	YES	890	1354	1846	4588	6175	8078	12351	316	414	509	893	1105	1344	1940
109T	7441	YES	884	1345	1837	4567	6144	8036	12270	313	411	506	887	1099	1335	1924
109	263	NO	190	252	316	460	558	674	952	125	130	135	145	152	160	181
110	116	NO	41	65	92	152	193	241	357	3	5	7	12	15	19	28
111	112	NO	120	148	176	238	280	330	449	120	122	124	128	131	135	144
112	7178	YES	791	1238	1723	4387	5920	7774	11859	191	284	377	743	945	1175	1743
113	79	NO	17	29	42	75	96	123	184	2	3	4	7	9	12	18
114	271	NO	85	130	180	309	395	500	749	8	13	17	27	34	43	64
115	61	NO	20	29	39	73	96	123	189	2	2	3	5	6	9	13
116	101	NO	32	49	69	115	145	182	269	3	5	7	10	13	16	24
117T	6668	YES	732	1159	1621	4143	5568	7323	11104	177	264	350	690	881	1093	1620
117	6668	YES	732	1159	1621	4128	5530	7272	11012	177	264	350	687	875	1083	1605
118T	6577	YES	722	1146	1604	4096	5471	7204	10904	175	260	344	678	862	1068	1584
118	78	NO	27	43	62	105	134	168	249	2	3	5	8	10	12	18
119	6500	YES	714	1136	1590	4077	5452	7185	10884	173	257	341	675	859	1065	1580
120	6425	YES	708	1127	1580	4044	5433	7141	10790	172	255	338	666	850	1053	1562
121	24	NO	10	16	23	36	46	58	118	1	1	2	2	3	4	7
122T	1216	NO	279	383	515	975	1293	1918	3284	47	69	93	136	169	209	306
122	63	NO	17	28	42	75	97	123	185	1	2	3	6	7	9	14
123T	1153	NO	266	360	498	937	1243	1840	3155	46	67	89	130	162	199	293
123	1094	NO	256	345	480	901	1196	1773	3051	44	65	86	125	156	191	280
124	59	NO	11	17	26	47	61	79	120	1	2	3	5	7	9	13
125T	1009	NO	204	301	435	836	1108	1643	2844	40	58	78	113	141	174	256
125	594	NO	90	157	181	199	213	231	273	19	29	37	42	45	48	53
126	127	NO	83	118	152	351	581	954	1788	6	9	14	34	51	72	123
127	557	NO	86	151	224	410	604	902	1579	18	27	37	57	72	90	134
327	557	NO	244	367	502	804	1015	1264	1862	18	27	37	57	72	90	134
127T	557	NO	86	151	181	181	181	181	181	18	27	34	38	41	42	44
128	97	NO	27	43	62	107	136	172	256	3	4	6	9	12	15	23
129	23	NO	5	8	10	20	27	35	54	1	1	1	2	2	3	5
130	312	NO	193	279	370	553	689	849	1232	12	17	23	34	43	52	77
131	73	NO	35	54	79	130	167	212	316	2	3	4	7	9	11	17
132	118	NO	130	180	223	304	368	447	627	7	9	12	16	19	23	32
133T	415	NO	136	189	257	644	909	1424	2592	21	29	41	71	96	126	202
133	288	NO	58	95	137	299	397	509	770	15	21	27	37	45	54	78
134	152	NO	111	155	196	287	351	424	605	9	12	16	21	25	30	43
134T	228	NO	42	67	103	239	314	399	593	11	16	21	28	35	42	61
334	152	NO	111	155	196	287	351	424	605	9	12	16	21	25	30	43
135	76	NO	55	76	95	136	165	198	279	4	6	8	10	13	15	21
335	76	NO	55	76	95	136	165	198	279	4	6	8	10	13	15	21
135T	76	NO	2	3	14	40	60	77	176	2	3	5	8	10	12	18
136T	109	NO	100	138	172	238	288	346	486	6	9	11	15	18	21	30
136	74	NO	78	107	132	180	217	260	364	4	6	8	10	13	15	21
137	35	NO	23	33	42	60	73	88	125	2	3	3	5	5	7	9
138	5083	YES	582	934	1404	3066	4047	5194	7951	143	212	293	519	666	826	1228

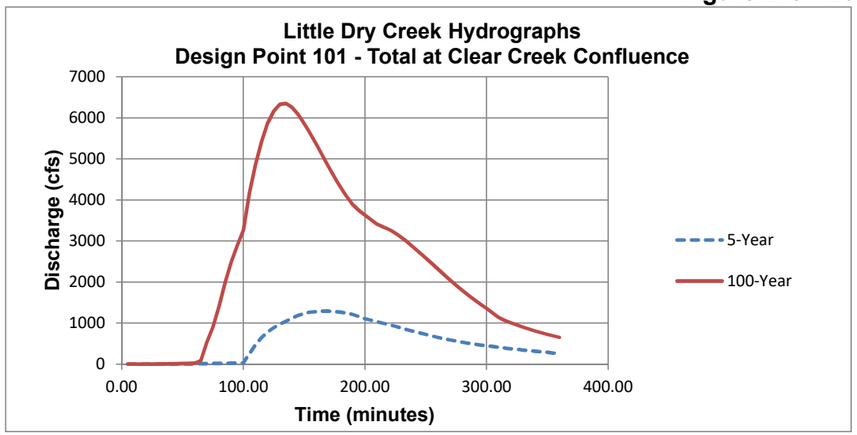
Table B-6 - Baseline Peak Flows and Runoff Volumes

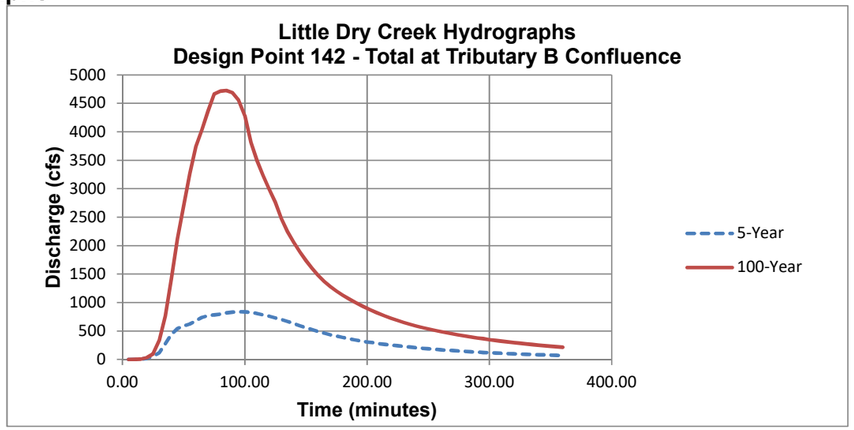
Design Point	Drainage Area[1] (acres)	Area Adjustment?	Future Condtions Peak Flow (cfs)							Future Condtions Runoff Volume (acre-feet)						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
139	56	NO	36	51	65	96	117	142	202	3	4	5	7	9	11	15
140T	4872	YES	556	900	1354	2964	3912	5005	7690	137	202	280	497	638	792	1175
140	236	NO	95	140	186	292	364	450	651	9	14	18	27	33	41	60
141	115	NO	40	61	84	136	171	213	312	4	6	8	12	15	19	28
142	4636	YES	518	840	1266	2806	3711	4726	7286	128	190	264	470	605	749	1117
143	1616	NO	166	252	348	554	703	870	1632	56	84	115	172	217	270	399
144	1573	NO	165	248	334	503	626	740	1432	54	81	109	159	199	245	359
344	1573	NO	317	509	715	1209	1561	2053	3154	54	81	109	159	199	245	359
145	1081	NO	246	399	567	982	1270	1664	2547	39	58	79	118	148	183	270
146	1026	NO	236	383	544	943	1219	1595	2439	37	56	75	112	140	174	256
147	866	NO	212	340	481	836	1076	1401	2129	32	47	64	95	119	147	217
148	104	NO	67	95	119	173	211	255	361	5	8	10	14	17	20	29
149	620	NO	170	267	375	647	828	1062	1604	22	33	44	67	84	104	154
150	129	NO	51	77	105	168	211	262	382	5	7	9	14	17	22	32
151	428	NO	148	226	312	513	649	816	1216	15	22	30	45	57	71	106
152	111	NO	33	50	68	110	138	172	252	4	6	8	12	15	19	28
153T	240	NO	88	136	188	305	387	486	730	8	12	17	26	32	40	59
153	88	NO	43	68	98	157	200	251	371	3	4	6	9	11	14	21
154	152	NO	50	75	103	173	222	285	433	6	8	11	17	21	26	38
155	56	NO	21	33	47	77	98	122	181	2	3	4	6	7	9	13
156	380	NO	104	168	242	422	541	688	1031	11	17	24	37	48	60	90
157	248	NO	81	128	182	310	395	499	743	8	12	16	25	32	40	60
158	197	NO	71	112	157	261	332	417	618	6	9	13	20	25	32	48
159	82	NO	26	41	59	98	125	156	231	2	4	5	8	10	13	19
160	2985	NO	494	822	1239	2315	3137	3947	6097	86	133	187	295	384	476	709
161	26	NO	10	14	20	34	42	53	78	1	1	2	3	3	4	6
162	2843	NO	466	786	1186	2236	3030	3824	5896	81	126	177	280	365	451	672
163T	2742	NO	444	761	1148	2175	2958	3728	5729	78	121	170	270	350	436	648
163	188	NO	77	119	164	266	336	418	615	6	10	13	20	25	31	46
164	83	NO	34	52	71	114	143	178	261	3	4	6	9	11	14	20
165	2554	NO	404	704	1067	2041	2727	3426	5361	72	111	157	250	325	405	605
166	2497	NO	395	689	1045	2007	2812	3450	5272	70	108	153	244	319	396	589
167	2413	NO	381	664	1007	1985	2648	3505	5121	66	103	146	234	306	381	568
168	184	NO	25	46	75	146	192	250	385	3	6	9	15	20	26	41
169	57	NO	12	22	34	63	82	105	160	1	2	3	5	6	8	13
170	32	NO	29	40	50	69	84	101	142	2	3	3	4	5	6	9
171	2081	NO	340	588	888	1627	2329	2957	4489	59	91	128	201	262	328	491
172	90	NO	23	38	57	101	130	164	247	2	3	5	8	11	14	21
173	65	NO	31	48	66	104	132	164	242	2	3	4	7	9	11	16
174	1833	NO	305	523	787	1455	1921	2571	4006	50	78	110	175	224	284	427
175T	1365	NO	229	394	593	1093	1443	1928	3004	37	58	82	129	166	210	316
175	75	NO	1	2	2	5	7	10	17	2	2	3	5	6	8	14
375	75	NO	35	52	71	111	139	172	251	3	4	6	8	10	13	19
176	431	NO	106	174	256	458	590	756	1143	12	19	27	42	54	68	102
177T	303	NO	76	124	182	324	418	534	806	8	13	19	29	37	47	72
177	104	NO	29	47	67	115	147	186	276	3	4	6	10	13	16	25
178	199	NO	51	82	120	215	278	355	537	6	8	12	19	24	31	47
179	109	NO	51	78	106	170	214	265	388	4	6	8	12	14	18	27
180	1290	NO	229	394	592	1092	1442	1926	2999	36	55	79	125	159	202	304
181T	1222	NO	222	380	570	1055	1391	1851	2872	33	52	74	117	150	191	287
181	45	NO	6	10	17	36	48	63	98	1	1	2	3	5	6	10
182	1178	NO	218	374	558	1029	1354	1800	2789	33	51	72	114	146	184	278
183	1094	NO	209	356	530	978	1284	1700	2621	30	47	67	106	136	172	258
184	96	NO	35	55	78	128	163	203	300	3	4	6	10	12	15	23
185	865	NO	168	285	425	790	1035	1360	2092	23	36	52	83	106	134	203
186	785	NO	161	272	403	746	972	1266	1937	22	34	48	76	97	123	185

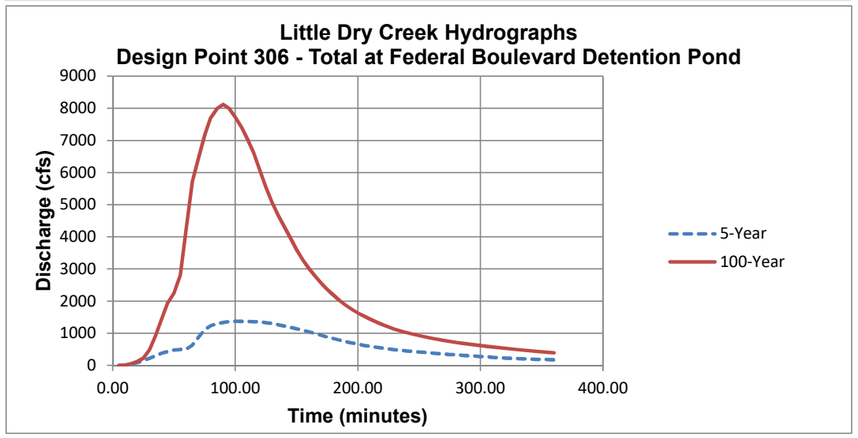
Table B-6 - Baseline Peak Flows and Runoff Volumes

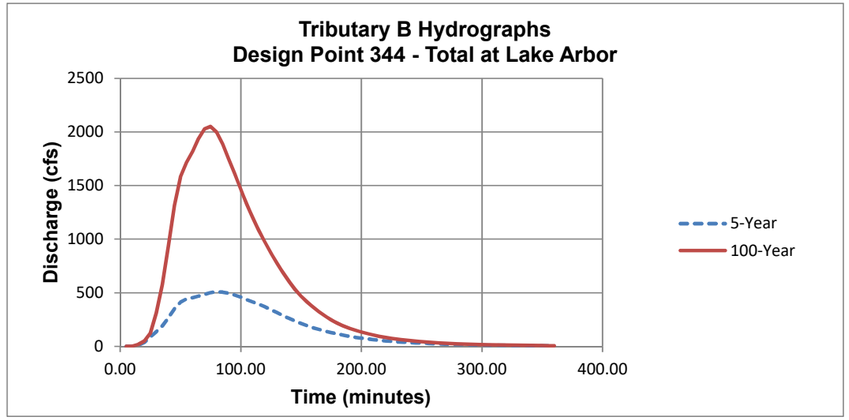
Design Point	Drainage Area[1] (acres)	Area Adjustment?	Future Condtions Peak Flow (cfs)							Future Condtions Runoff Volume (acre-feet)						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
187	105	NO	9	19	33	68	91	119	185	1	2	4	8	10	14	22
188	76	NO	19	30	43	75	96	121	181	2	3	5	7	9	12	18
189	553	NO	146	233	338	612	791	1019	1547	17	27	37	56	72	89	133
190	31	NO	16	24	32	50	63	79	115	1	2	2	3	4	5	8
191	105	NO	32	52	74	126	161	203	303	3	4	6	10	13	16	25
192	62	NO	14	24	36	65	84	106	160	1	2	3	6	7	9	14
193	371	NO	98	161	233	417	537	690	1045	12	18	25	38	48	60	90
194	350	NO	94	153	221	394	507	651	983	11	17	24	36	45	57	85
195	250	NO	69	111	159	280	360	460	691	8	12	17	26	33	41	60
196	205	NO	59	95	135	234	300	381	570	7	10	14	21	27	33	50
197	113	NO	44	66	90	145	182	227	333	4	6	8	12	15	19	28
198	97	NO	42	63	85	133	167	205	299	4	5	7	11	13	16	24

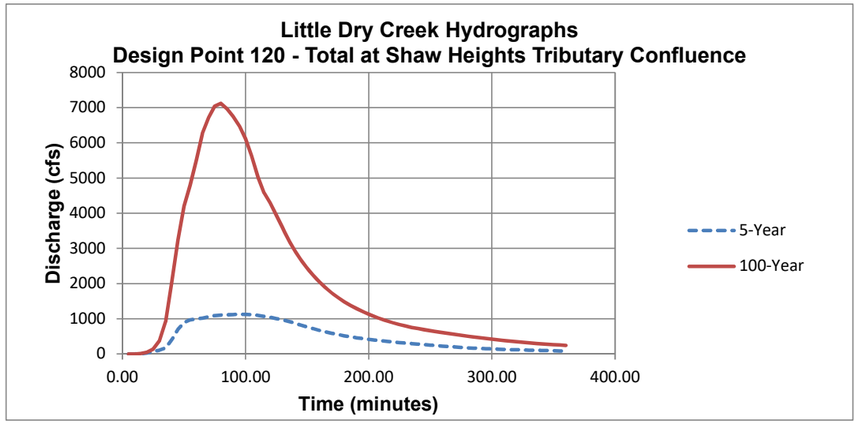
Figure B-3 - Baseline Hydrographs

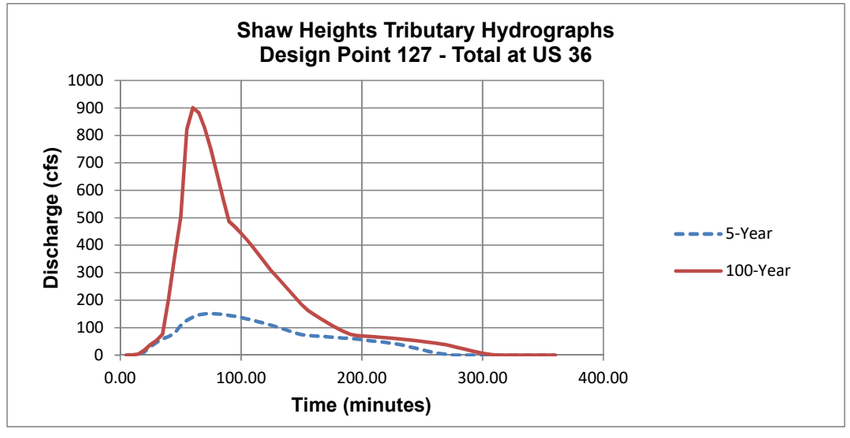












APPENDIX C

HYDRAULIC ANALYSIS

APPENDIX D

WETLAND AND RIPARIAN INVENTORY

APPENDIX E

ALTERNATIVES ANALYSIS

APPENDIX F

CONCEPTUAL DESIGN INFORMATION

APPENDIX G

MASTER PLAN MAPS

CLICK HERE TO VIEW FULL-SIZE MAPS

CLICK HERE TO VIEW PRESET 11X17 PRINTABLE MAPS

APPENDIX H

MASTER PLAN PROFILES

CLICK HERE TO VIEW FULL-SIZE PROFILES

CLICK HERE TO VIEW PRESET 11X17 PRINTABLE PROFIES