Master Plan
Hydrology and Hydraulics Report

US 6 Bridges Design Build Project
BR 0061-083
Sub Account No. 18838 (CN)
Denver, Colorado

Prepared for
Colorado Department of Transportation

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1.0 INTRODUCTION

This Master Plan Hydrology and Hydraulics Report presents the drainage concepts, hydrologic, hydraulic analysis and design calculations for planned bridge and ultimate highway improvements of US 6 from Knox Court to the Burlington Northern Santa Fe (BNSF) Railroad bridge to be constructed as a design build project. This report is prepared in accordance with the Colorado Department of Transportation (CDOT) *Drainage Design Manual (DDM)*, the City and County of Denver (CCD) *Storm Drainage Design & Technical Criteria Manual (SDDTCM)*, the Urban Drainage Flood Control District (UDFCD) *Urban Storm Drainage Criteria Manual (USDCM)*, and standard engineering practices.

Permanent best management practices for stormwater quality treatment are presented in a separate report titled Master Plan Water Quality Report. Hydraulic and floodplain analysis for the bridge over the South Platte River is presented in a separate report titled Preliminary Bridge Hydraulics Report.

1.1 Location of Improvements

The overall project area, shown in Figure 1, is located in the south halves of Sections 4 and 5 and the north halves of Sections 8 and 9, Township 4 South, Range 68 West of the Sixth Principal Meridian in the City and County of Denver, Colorado. The project will include highway improvements along US 6 from approximately Knox Court to the BNSF Bridge east of Interstate 25 (I-25); along I-25 from approximately 700 feet north of the US 6 interchange to 1300 feet south of the interchange; along Federal Boulevard from 5th Avenue to 7th Avenue; along 5th Avenue from Federal Boulevard to Decatur Street; and reconstruction of Barnum Park East.

The project area is surrounded by portions of P.T. Barnums Subdivision, Moore's Addition, Ellerman's Addition, Burns City View Addition, Burns Boulevard Addition, Weir Addition, Fletcher's West Side Subdivision, and Middaugh's Addition to Denver.

The Flood Insurance Rate Map (FIRM) for Denver County, Colorado, panel number FM0800460182G, dated November 17, 2005, shows that the project is partially located in Zone X (shaded), designating special flood hazard areas of the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance (base flood) sheet flow flooding with average depths of less than 1 foot, areas of base flood stream flooding with a contributing drainage area of less than 1 square mile, or areas protected from the base flood by levees. The subject site is also partially located in Zone AE, designating special flood hazard areas of inundation by the 1-percent-annual-chance flood. The FIRM panel is included in Appendix A.

The project is located in existing and proposed CDOT and CCD Right-of-Way, as well as property owned by CDOT and CCD. The receiving water for the project is the South Platte River, which flows from south to north through the project area.

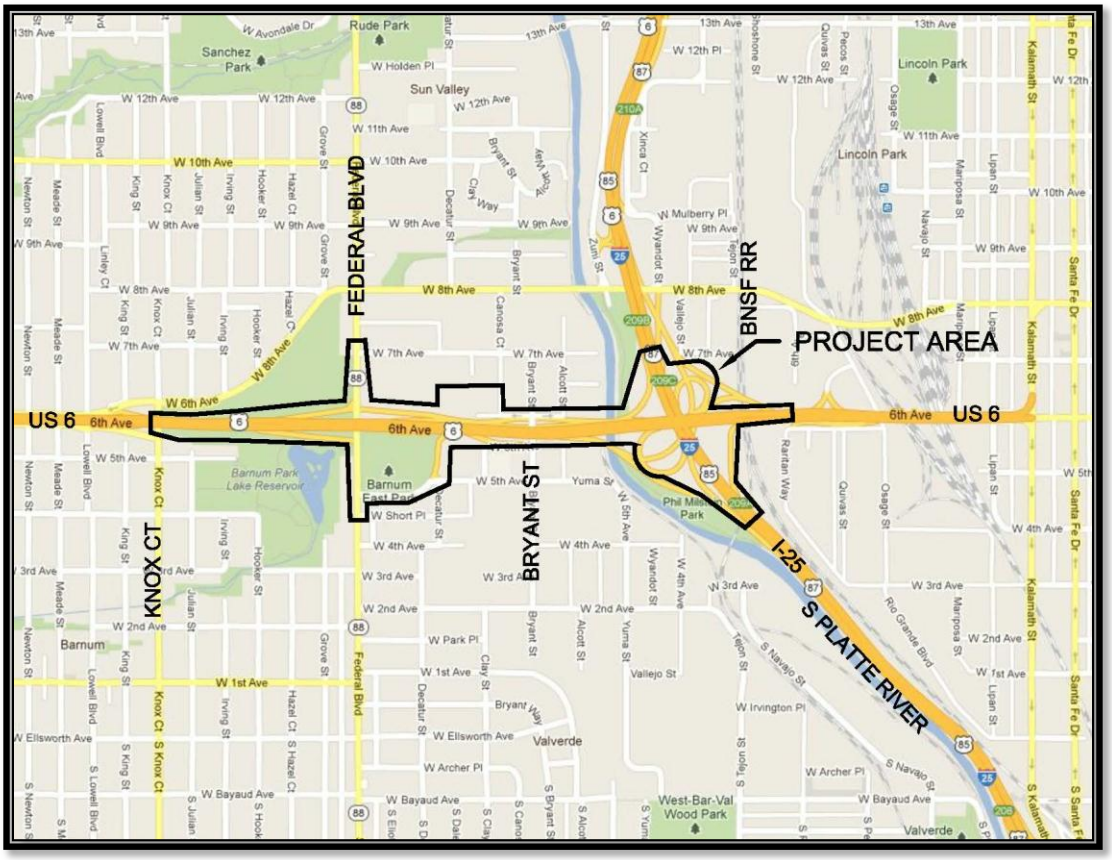

Figure 1: Vicinity Map

1.2 Description of Improvements

The planned highway improvements consist of replacing the bridges at Federal Boulevard, Bryant Street, the South Platte River, I-25, and the BNSF Railroad, and associated highway and ramp improvements. Barnum Park East, located at the southeast corner of the Federal Boulevard/US 6 Interchange, will also be reconstructed with the project.

1.3 Previous Studies

The *Valley Highway – Logan to 6th Avenue Environmental Impact Statement* (EIS) dated February 2005 and *Record of Decision for the I-25 Valley Highway Logan to US 6* (ROD) dated June 2007 evaluated the potential floodplain impacts and identified conceptual drainage improvements for the Valley Highway, which included US 6 from I-25 on the east to Federal Boulevard on the west. The EIS and ROD were prepared in accordance with the National Environmental Policy Act (NEPA) provisions and corresponding regulations and guidelines of the Council on Environmental Quality and the Federal Highway Administration (FHWA).

The project is located within the Weir Gulch (4900-01), 1st and Federal (0064-02), and Central Platte Valley (0063-01) basins identified in the City and County of Denver Storm Drainage Master Plan (updated June 2010). Several reports have studied the project area including:

- *Major Drainageway Planning Sanderson Gulch/ Weir Gulch*, Frasier & Gingery, August 1972
- *Major Drainageway Planning, South Platte River, Chatfield Dam to Baseline Road, Phase* B, Wright Water Engineers, November 1985
- South Platte River Hydrologic Study: Chatfield Dam to Sand Creek, Merrick & Company, 1983
- Flood Hazard Area Delineation, South Platte River, Denver Metropolitan Area, Sand Creek to Oxford Ave, Wright Water Engineers September 1985
- *City & County of Denver Storm Drainage Master Plan*, Matrix Design Group, Revised June 2010
- *Final Drainage Report for Federal Boulevard/US 6 Interchange Improvements, Project No. IM 088A024,* Olsson Associates, January 7, 2011

2.0 CROSS DRAINAGE, DRAINAGEWAY, AND IRRIGATION DITCH CROSSINGS

2.1 Location and General Discussion

Weir Gulch runs from the southwest to the northeast near the west end of the project area, between Knox Court and Federal Boulevard. Weir Gulch flows through Barnum Lake, located at the southwest corner of Federal Boulevard and US 6, then under US 6 before continuing north. A (2)8'x6' culvert and a parallel 66" RCP in a 96" tunnel liner sleeve connects Barnum Lake at the southwest corner of Federal Blvd and US 6 to Weir Gulch.

In addition to the Weir Gulch culvert, an 18" pipe runs under US 6 from the north side of Barnum Lake to the outlet of the Weir Gulch culvert. This outlet pipe has slide gates and is used to release water for water quality and water level control. The pipe cannot be abandoned. If the highway improvements impact the pipe, proposed changes must be approved by CCD.

Multiple cross drains connect the low points between the ramps associated with the I-25/US 6 interchange. These cross drains are sized to handle the 100-year storm event, and are a part of the interchange pond system. See Figures 13, 14, 17, and 18 in Appendix C for plan views. See Section 3.3.2.6 I-25 System for more details.

Included in the Denver Stormwater Master Plan is a 90" outfall, which is proposed to run under I-25 at approximately 7th Avenue and outfall on the east bank of the South Platte River. Although the 90" outfall is not part of the US 6 project, its profile shall be considered in the design of any I-25 modifications.

There are no major existing irrigation facilities in the project area.

2.2 Hydrology and Design Flow Development

Hydrology and design flows for Weir Gulch were developed in the *Major Drainageway Planning Sanderson Gulch/ Weir Gulch*. It is not anticipated that the highway improvements will impact the culvert under US 6. However, the 2009 Bridge Inspection Report for the culvert indicates there are areas of spalling and exposed reinforcing steel in the double 8 foot by 6 foot pipe. The Contractor will be required to refer to Section 15 of the Technical Requirements to determine appropriate repairs to the culvert. If it is determined that any modifications are needed to the culvert, approvals from UDFCD and CCD will be required.

Hydrology and design flows have been developed for the I-25 ramp cross drains and are included in Appendix A.

2.3 Agency Coordination

Approvals from UDFCD, CCD, Federal Emergency Management Agency (FEMA) and the U.S. Army Corps of Engineers will be needed for the US 6 bridge over the South Platte River.

If the 18" RCP outlet pipe from Barnum Lake is impacted, proposed modifications must be approved by CCD.

2.4 Hydraulic Design

Refer to the US 6 Bridges Design Build Project Preliminary Bridge Hydraulics Report for discussion of hydraulic design requirements for the US 6 bridge over the South Platte River, and the scour analysis and floodplain impacts.

2.5 Irrigation Ditch Crossings

No irrigation ditch crossings exist within the project limits.

3.0 HIGHWAY DRAINAGE SYSTEMS

3.1 Drainage Basin Delineations and Characterization

3.1.1 Existing Basins

The study area includes commercial, industrial, park, and residential land uses. The topography in the site vicinity generally slopes to the South Platte River, with slopes ranging from 0.3 to 15 percent. The existing ground cover in areas of new pavement is primarily grass. The SCS Soil Survey does not have data for the project area. It was therefore assumed that the drainage area soils belong to the Hydrologic Soils Group C, soil that is poorly drained and has a moderately high runoff potential.

In existing conditions, runoff from Vrain Street to Bryant Street flows east in US 6 via gutters and storm drains. A low point between Federal Boulevard and Bryant Street prevents flows from continuing east and directs stormwater down the ramp to Bryant Street and into the storm drain system in US 6 and in Bryant Street. A high point in the profile of US 6 at Bryant Street directs runoff east of Bryant Street into a storm drain system which outfalls into the South Platte River. East of the South Platte River, runoff from US 6 generally flows west and is conveyed to the South Platte River via an existing storm drain system. Multiple storm drain outfalls exist on both sides of the river near the existing US 6 Bridge over the South Platte River. In general, existing storm drains are undersized per current criteria.

Runoff from US 6 east of the BNSF railroad bridge flows east to the project limits in existing conditions.

Refer to the *Final Drainage Report for Federal Boulevard/US 6 Interchange Improvements* by Olsson Associates for discussion of existing drainage patterns of Federal Boulevard and 6th Avenue.

3.1.2 Proposed Basins

Subwatersheds were delineated to determine water quality, 10-, 50-, and 100-year flows from the highway right-of-way within the project limits and the tributary non-project areas. Base mapping from the project survey provided by CDOT, 2' contours from the CCD GIS database, and proposed roadway grading were used to delineate the sub-watersheds shown on Figures 5 through 18 (see Appendix C).

Approximately 60 acres of non-project area (from Vrain Street to Knox Court) flows east into the project area. It is proposed that 100-year flows from the project and non-project tributary area west of Weir Gulch be discharged to the Gulch to reduce the flows to the sump in US 6 that is located between Federal Boulevard and Bryant Street and the sumps located in the ramps on the west side of Federal Boulevard. Discharging to the Gulch would reduce the size of the outfall storm drain from the sump to the South Plate River. Water quality flows would be diverted to the US 6 water quality pond. See Section 3.2 for further discussion of hydrology for the off-site portion to the west of the project area.

The preliminary proposed roadway designs include multiple low points on US 6 between Federal Boulevard and Bryant Street. Runoff from US 6 east of Weir Gulch and west of the crest over Bryant Street will flow to and collect in these low points (design points 20, 30, 40, 42, 50, and 71). The on-ramp to westbound US 6 from Federal Boulevard and the off-ramp to Federal from eastbound US 6 also have sump locations on the ramps (design points 6 and 60).

Runoff from the ramp from eastbound US 6 to southbound I-25 (F-16-OE) flows to an existing low point near the South Platte River. This low point is within project limits and the existing inlet may need to be modified.

Runoff from US 6 between Bryant Street and the east abutment of the bridge over I-25 flows to a low point on US 6 near the east abutment of the bridge over the South Platte River. Runoff from US 6 east of the bridge over I-25 and west of the crest near the BNSF bridge is intercepted and conveyed to the 6th Avenue Interchange Water Quality Pond. Runoff from US 6 east of the BNSF bridge flows to the east project limits.

Runoff from I-25 Ramps "A," "B," "C," and "D" collects in low points at each respective ramp. The flyovers (F-16-OG and F-16-OL) at the I-25/US 6 Interchange also contribute storm runoff to Pond B in the center of Ramp "B" and the low point in the center of Ramp "C" via deck drains.

Refer to the *Final Drainage Report for Federal Boulevard/US 6 Interchange Improvements* by Olsson Associates for hydrology of Federal Boulevard and 6th Avenue.

See Appendix A for Rational Method Calculations and Appendix C for the Basin Maps.

3.2 Hydrology and Design Flow Development

The Rational Method model was used to estimate the peak runoff rates for the water quality storm. This method is defined as:

$Q = CIA$

where: Q = Peak discharge in cubic feet per second (cfs)

C = Runoff coefficient

I = Rainfall intensity in inches per hour

A = Drainage area in acres

The 10-, 50- and 100- year storm frequencies were used to evaluate the proposed improvements with one-hour point rainfall values of 1.55-, 2.25- and 2.57- inches, respectively, to calculate the rainfall intensities. Values were obtained from Table 5.1 in the SDDTCM. A Water Quality storm event was also evaluated, with a one-hour point rainfall value of 0.6 inches. Water Quality storm event hydrology and drainage design is presented in the US 6 Bridges Design Build Project Master Plan Water Quality Report.

The time of concentration is required to select the appropriate rainfall intensity. The time of concentration was calculated using equations from Section 2.4 of the Runoff chapter of the USDCM. The resultant time found using these equations is compared to the time of concentration for urbanized basins, which is also calculated using an equation from Section 2.4. The lesser of the two times is used to determine the rainfall intensity, with a minimum allowable time of concentration equal to five minutes. Runoff coefficients were determined using the percent imperviousness, NRCS hydrologic soil group, and Table RO-3 from the USDCM. Equation 5.1 from the SDDTCM was used to determine the rainfall intensities for each sub-basin. Manning's equation for full pipe flow was used to calculate pipe flow velocities and travel times. Figure 7.2 from the DDM was used to calculate overland flow travel times for the street flow. Hydrologic calculations are included with this report in Appendix A.

The flow from the off-site tributary area west of Weir Gulch along US 6 consists of two systems. The "north system" consists of runoff from areas north of the US 6 median, including runoff generated in the westbound lanes, and discharges to Weir Gulch at design point 251. The "south system" consists of runoff from areas south of the US 6 median, including runoff generated in the eastbound lanes, and discharges to Weir Gulch at design point 254. Flows from the low point at Perry Street (design point 273) are collected in an existing storm drain system and join the north and south systems just east of Knox Court. The existing storm drain from the sump is under sized. The analysis assumes that the pipe could be up sized in the future.

For the 10-year analysis it was assumed that the existing storm drain system intercepts the flow from basins OS-30 and OS-32 at design point 276 and conveys it to the north system. For the 100-year analysis it was assumed that the flow split at this design point with one-half the flow going to the north and south systems. This was accomplished by maintaining the Time of Concentration and 100-year rainfall intensity to calculate an equivalent CA that would contribute flow to each system.

3.3 Hydraulic Analysis

3.3.1 Hydraulic Criteria

Criteria 13 from the DDM were used for spread widths, gutter depths, and inlet and storm drain design for US 6, I-25, and associated ramps. Based on discussions with the CDOT Hydraulics Unit it was decided that the minor storm event for drainage facility design on US 6 and I-25

should be the 10-year storm event. Required design frequencies and spread widths are summarized in Table 1.

Table 1: Design Frequency and Spread Width

Location	Design Frequency	Design Spread Width
US 6 and I-25	10-year	Shoulder
US 6 and I-25 - sumps	50-year	Shoulder
US 6 and I-25 - continuous grade and sumps	100-year	Shoulder + 4 feet
Ramps - continuous grade	10-year	Shoulder
Ramps - sumps	50-year	Shoulder + 3 feet

Concrete median barriers are proposed throughout the project which will result in water accumulating against the barriers during major storms. Opening slots in the barriers can provide some relief but tend to clog, causing ponding and possible highway closures. Instead, inlets were sized in accordance with the criteria presented in Table 1 should be used.

Inlets at sump locations will need to be designed with the consideration that concrete barriers will prevent cross flows. Flanking inlets are recommended to minimize the possibility of clogged sump inlets flooding the highway.

3.3.2 Proposed Storm Drain System

Six storm drain systems are proposed for the ultimate US 6 highway configuration. The West US 6 System and the West Federal System discharge to Weir Gulch. The US 6 – Federal to Bryant System and the South Platte River System discharge to the South Platte River. The Ramp “D” System will outlet to the US 6 Interchange Quality Pond, and then discharge to the South Platte River. The I-25 System converges at the Ramp “A” Pond, and is pumped to the South Platte River.

Proposed storm drain trunk lines for the proposed storm drain systems are shown on the basin maps in Appendix C. Between Knox Court and Bryant Street trunk lines were analyzed using Hydraflow Storm Sewers Extension for AutoCAD Civil 3D. Flows were entered manually, based on the Rational Method calculations. The proposed storm drains were sized to carry the 10-year flows, with the exception that all pipes downstream of sump inlets within CDOT jurisdictions and the proposed pipes west of Weir Gulch were sized to carry the 100-year flows. See Appendix B for the storm drain analysis results.

Only the proposed storm drain trunk lines were modeled. Additional inlets and laterals will be needed to comply with the spread width and gutter flow depth criteria.

3.3.2.1 West US 6 System

The West US 6 System extends from Knox Court to the Weir Gulch box culvert under US 6. Off-site drainage from Vrain Street to Knox Court flows into the project area at the west extent in the

form of both street and pipe flow. The existing storm drain system which runs down the center of US 6 is intercepted at Manhole 2172C, and the storm drain system from West 8th Avenue which merges from the north with the existing US 6 System is intercepted at Manhole 401C. These flows are directed east in a proposed storm drain main which runs along the north shoulder of US 6. A parallel system will run along the drainage swale on south side of US 6. 100-year flows will be intercepted and discharged into the Weir Gulch culvert, in order to reduce the flows which would collect in the sump locations on the ramps on the west side of Federal Boulevard and at the sump between Federal Boulevard and Bryant Street. Both of the storm drain lines, on the north and south sides of US 6, will tie into the existing (2) 8'x6' RCBC. A 45 degree tie-in angle is recommended in order to direct flows downstream and reduce degradation of the inner wall of the box culvert. Water quality flows will be diverted at Manholes 411R and 308R to the US 6 Water Quality Pond. The invert elevations of the water quality diversions must be equal to or higher than the 100-year hydraulic grade line of the box culvert, in order to prevent Weir Gulch flows from back flowing into the water quality pipes and into the US 6 Water Quality Pond.

3.3.2.2 West Federal System

The West Federal System collects runoff from the west half of Federal Boulevard within the project limits and drains to Weir Gulch to reduce flow to the sump on US 6 between Federal Boulevard and Bryant Street. It consists of two portions. The north portion collects runoff from the west half of Federal Boulevard between 7th Avenue and the crest over US 6, runs down the on-ramp to westbound US 6 from Federal Boulevard, and ties in to the Weir Gulch 66" RCP under US 6. Manhole 111C1 will divert the water quality flows to Manhole 111C2 (the US 6 – Federal to Bryant System) and the major and minor storm event flows will continue to Weir Gulch. Inlet 414L on the ramp is in a sump location and will need to be designed accordingly.

The south portion of the West Federal System collects runoff from West 5th Avenue, the west half of Federal Boulevard between the crest over US 6 and 5th Avenue, and the US 6 eastbound off-ramp to Federal Boulevard. The system runs north under the Federal Boulevard roadway, then west along the drainage swale parallel to the ramp, where it ties into the Weir Gulch 66" RCP under US 6. Inlet 311R on the ramp is in a sump location in the drainage swale, and will need to be designed accordingly. Manhole 107C will divert the water quality flows to Manhole 4990C (the US 6 – Federal to Bryant System), and the major and minor storm event flows will continue to Weir Gulch.

3.3.2.3 US 6 - Federal to Bryant System

The US 6 - Federal to Bryant System collects runoff on US 6 from the Weir Gulch culvert to the crest over Bryant Street, from the east half of Federal Boulevard from W 7th Avenue to W 5th Avenue, from a portion of W 5th Avenue from Federal to N Decatur Street, and from Barnum Park East. Runoff from Federal Boulevard is collected at Inlet 106R, and is conveyed to the east down the southeast Federal ramp. Water quality flows from the south portion of the West Federal System join this storm drain system at Manhole 4990C. Runoff from 5th Avenue and Barnum Park East tie in to this storm drain main at Manhole 4998C. Runoff from the ramp to Bryant and the sump at inlet 5000R is collected at Manhole 500C. Runoff from US 6 near Bryant Street as well as the flyover ramp is collected and conveyed to Manhole 2504C. This line picks up runoff from the westbound lanes before tying into Manhole 6000C. Another branch of this system collects 100-year runoff at the low points between Federal Boulevard and Bryant Street (Inlets 2994R, 2693R, and 2193R), as well as the diverted water quality flows from the West US

6 System. At Manhole 5997C, this branch ties into the storm drain line which collects runoff from Federal Boulevard between 7th Avenue and US 6, as well as from the US 6 westbound ramp to Federal.

Manhole 6000C ties together all the branches of the US 6 – Federal to Bryant System. This manhole structure will have a water quality diversion to the US 6 Water Quality Pond on the north side of the highway west of North Canosa Court. The US 6 Water Quality Pond will provide water quality for Federal Boulevard and US 6 west of Bryant Street. Refer to the US 6 Bridges Design Build Project Master Plan Water Quality Report for further discussion on water quality.

From Manhole 6000C, the minor and major storm events will flow east in the storm outfall to the South Platte River. Outflow from the US 6 Water Quality Pond will tie into the storm outfall at Manhole 6006C. Backflow into the US 6 Water Quality Pond through the pond outfall storm drain is possible during large storm events, and the water quality outlet structure will need to have an overflow weir to release backflow waters. From Manhole 6006C to the South Platte River, the average ground slope is 0.3%. Near the river, a Metro Wastewater brick sanitary sewer main runs north-south, and the storm outfall will need to be placed above it. The clearance between the sanitary main and the storm outfall will be increased because the brick sanitary main will be replaced with RCP, within the South Platte River bridge abutment impact limits, as part of this project. Due to the flat slope and clearance requirements, a wide and shallow RCBC is recommended between structures 6006T and the outfall. Two 7'x2' RCBC will be needed to convey a 100-year storm event outfall flow of 165.7 cfs, with the constraints of maintaining a minimum ground cover of 1 foot and a 6" clearance above the sanitary sewer main. Structure 6006T will be a special structure to transition from a 54" RCP to (2)7'x2' RCBC, matching inverts. A grouted boulder rundown will be needed at the outfall to protect the bank of the river.

3.3.2.4 South Platte River System

The South Platte River System collects runoff from US 6 between the crest over Bryant Street and the east abutment of the I-25 collector/distributor tunnel under US 6. The west portion of this system is a series of inlets at the west abutment of the bridge over the South Platte River. Inlet 1014R will collect flows from Inlets 7014L and 2014R, and an outfall pipe will be placed through the bridge abutment to outfall at the South Platte River. Alternatively, this system could be tied in to the US 6 – Federal to Bryant Street outfall at Manhole 7014L2. In either case, a drop manhole or inlet will be needed to bring the flows from the elevated highway down to the river. A grouted boulder rundown will be needed at the outfall to protect the bank of the river.

The east portion of the South Platte River System collects runoff at the low point on US 6 along the east abutment of the bridge over the South Platte River. Inlets 2018R and 1017R are in sump locations, and additional inlets will be needed to intercept the 100-year storm event runoff. Manholes 1017C and 7018C will be drop manholes in order to bring the stormwater down to the South Platte River. This system will outfall on the north (downstream) side of the bridge. A grouted boulder rundown will be needed at the outfall to protect the bank of the river.

3.3.2.5 Ramp "D" System

The Ramp "D" System collects runoff on US 6 from the east abutment of the I-25 collector/distributor tunnel under US 6 to the crest over the BNSF Bridge, as well as from I-25

from the US 6 bridge to the crest over the BNSF bridge to the south. A cross drain will be placed under Ramp "D" to facilitate drainage of the low point between the new and old ramps. Inlet 11012C intercepts runoff from I-25 before flows reach the end of the drainage ditch between I-25 and the collector/distributor lanes. A cross drain will be placed at this location (Structure 9011L to 9011C), to collect drainage from the roadside ditch. The ditch will not extend under US 6, so all flows reaching this design point will need to be intercepted. Three inlets (9027R, 1024R, and 2024R) will collect runoff from US 6, and will outlet to the low point between US 6, I-25, and Ramp "D." Structure 9010C will collect runoff from the low point, and flows will be conveyed to the 6th Avenue Interchange Water Quality Pond, located between I-25 and Ramp "C". An outlet structure will allow the minor and major storm events to flow directly to the South Platte River. A grouted boulder rundown will be needed at the outfall to protect the bank of the river. This pond will provide water quality for a portion of US 6, I-25 and Ramp "D." Refer to the US 6 Bridges Design Build Project Master Plan Water Quality Report for the discussion on water quality.

3.3.2.6 I-25 System

The I-25 System collects runoff from I-25 between 8th Avenue and US 6, the southbound I-25 to westbound US 6 ramp (Ramp "A"), the northbound I-25 to westbound US 6 ramp (Ramp "B"), and the southbound I-25 to eastbound US 6 ramp (Ramp "C"). This system picks up runoff from the low point on I-25 and conveys the flows through a series of ponds to a pump station located in Pond A, which lies between the South Platte River and Ramp "A". The pump station will discharge to the South Platte River.

In the proposed roadway design, the low point of I-25 is at elevation 5202.41, located at the east edge of the southbound lanes, near the north side of the US 6 Bridge over I-25. Gravity drainage of I-25 is not possible due to the water surface elevations of the South Platte River. High flows in the South Platte River are influenced by releases from Chatfield Reservoir. Releases from the reservoir and resulting high water surface elevations on the river can occur at any time, therefore an outfall from I-25 to the river that is set too low could result in a clear day flooding of I-25.

The 100-year water surface elevation on the river is approximately 5205.25 at the outfall from Pond A. During high river flows, a gravity drainage system would back up water onto the interstate. Flooding at the low point would inundate three of the four northbound lanes and all five southbound lanes. Water surface elevations of the South Platte River were obtained from the approved Letter of Map Revision (LOMR), Case No. 12-08-0474P, completed by Matrix Design Group in May 2012 and approved in July 2012, and are presented in Table 2.

Due to the roadway design low point elevation being lower than the 100-year water surface elevation of the river, a gravity drainage system is not possible. A pump station is proposed to drain the I-25 interchange. A series of interconnected ponds is proposed for the areas around Ramps A and B. The combined volume of these ponds was calculated using Equation 13.1 from the *SDDTCM*. The pump station is proposed to pump the stored volume in less than 8 hours. See Appendix B for pond design calculations.

Table 2: South Platte River Water Surface Elevations

South Platte River Station	Water Surface Elevations (feet)			
	5 YR*	10 YR	50 YR	100 YR
10432	5196.08	5198.79	5202.86	5204.71
Pond A Outfall (interpolated)	*5196.34*	*5199.10*	*5203.34*	*5205.25*
11014	5197.00	5199.84	5204.24	5206.13
11110	US 6 Bridge over the South Platte River			
11204	5198.05	5201.11	5204.75	5207.58

*5 year frequency flows have been estimated by extrapolating 10-, 50-, and 100-year flows from the FIS.

The low point on I-25, at design point 102 (104), will drain to the east and outfall in Pond B, located within Ramp "B." Flows from Pond B are conveyed to Pond A, located on the west side of Ramp "A," via a 42" RCP cross drain. The area between Ramp "A" and I-25 and the area inside Ramp "C" will be graded to low points, and flows from these low points will be conveyed to Pond A. The required volume for the areas tributary to Ramps A, B, and C is 8.0 acre-feet. With the grading shown on the basin maps (see Appendix C), 9.5 acre-feet of volume is provided at elevation 5201.41, giving a 1-foot freeboard below the low point of I-25. The cross drain connecting Ponds A and B allows water to flow freely between the two ponds, and allows the design volume to be satisfied within the two ponds. The bottom of Pond B is at elevation 5193.73, and the bottom of Pond A is at elevation 5190.65. The grading of Pond B and the low point in Ramp "C" must not disturb the footings of the flyover ramps.

Pond A will have a gravity drain placed above the normal low flow elevation of the river. This pipe should have a flap gate to prevent high flows in the South Platte River from entering the pond system. The invert is proposed at elevation 5197.0. The gravity drain will allow a portion of the stored volume, from elevation 5201.4 to 5197.0, to drain without pumping if the flows in the river are low. A pump station will discharge to a separate, parallel pipe with the outlet invert placed above the 100-year water surface elevation of the South Platte River. This pump station discharge line will drain into a gravity line, which will discharge downstream of the trail along the river. A grouted boulder rundown will be needed at the outfall to protect the bank of the river. An emergency spillway will be graded in at elevation 5207.00, which is approximately one foot above the 100-year water surface elevation of the river. The difference between the emergency spillway and the gravity drain is 9.25 feet. If this difference is greater than 10 feet, the pond embankment would be considered a jurisdictional dam.

The groundwater elevation in the vicinity of Pond A is approximately 5193.6, as measured on January 4, 2012. The bottom of the pond is three feet below groundwater; therefore the ponds will need a lining or other preventative measure to keep groundwater from seeping into the pond. Cutoff walls will be needed for the outfall and connecting pipes to prevent water from seeping along the pipes.

3.3.3 Pavement, Median, and Roadside Drainage

The proposed drainage swale alongside US 6 eastbound, west of Federal Boulevard, has a capacity of approximately 23 cfs, assuming a slope of 3.8% and a flow depth of 1 foot. Inlets will need to be placed in this swale to intercept the 100-year flow to discharge into Weir Gulch at an

interval which prevents the spread width from exceeding CDOT criteria. See Appendix B for swale capacity calculations.

3.4 Design Coordination

3.4.1 Adjacent Segments

The EIS delineated a basin on I-25 to the south of this project, designated the "3rd Avenue Basin," located on I-25 between the I-25 Bridge over the BNSF railroad and the I-25 & Alameda project. It proposed that the water quality flows from the 3rd Avenue basin be conveyed to the 6th Avenue Interchange Water Quality Pond. The 3rd Avenue Basin improvements will be constructed by others. However, the 6th Avenue Interchange Water Quality Pond will need to be sized to include the water quality capture volume for the 3rd Avenue basin.

3.4.2 Agency Coordination

CCD will review and approve all storm drain improvements located in City and County of Denver right-of-way.

UDFCD will review and approve all storm drain outfalls to the South Platte River

Appendix A

Hydrology – US 6 West of Weir Gulch

Hydrology – US 6 from Federal to Bryant

Hydrology – I-25 and US 6 from Bryant to BNSF

Precipitation Data

FEMA Maps

PROPOSED COMPOSITE RUNOFF COEFFICIENTS

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359
DATE: 7/6/2012
CALCULATED BY: JM/MO
CHECKED BY: DPK
FILE NAME: Rational West System - Proposed.xls

			IMPERVIOUSNESS					SOIL TYPE			RUNOFF COEFF.				
DESIGN BASIN	DESIGN POINT	TOTAL AREA (AC)	PAVED AREA (AC) 100	ROOF AREA (AC) 90	GRASS AREA (AC) 0	GRAVEL AREA (AC) 40	% I	Percent of Total Area A	Percent of Total Area B	Percent of Total Area C/D	C_2	C_5	C_{10}	C_{50}	C_{100}
WB6-6	251	0.72	0.72	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-7	252	0.42	0.42	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-8	253	0.66	0.66	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB6-4	254	0.42	0.35	0.00	0.07	0.00	82.40	0.0	0.0	100.0	0.62	0.65	0.69	0.75	0.76
EB6-5	255	0.74	0.64	0.00	0.10	0.00	86.57	0.0	0.0	100.0	0.68	0.70	0.73	0.79	0.80
EB6-6	256	0.68	0.58	0.00	0.10	0.00	84.75	0.0	0.0	100.0	0.65	0.68	0.71	0.77	0.78
OS-1	257	0.83	0.00	0.00	0.83	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
OS-11	258	4.57	1.18	0.19	3.20	0.00	29.56	0.0	0.0	100.0	0.22	0.30	0.38	0.52	0.57
OS-12	259	3.28	0.71	0.20	2.37	0.00	27.22	0.0	0.0	100.0	0.21	0.29	0.37	0.52	0.56
OS-13	260	0.54	0.48	0.00	0.06	0.00	89.56	0.0	0.0	100.0	0.72	0.74	0.77	0.82	0.83
OS-14	261	1.16	0.18	0.11	0.87	0.00	24.18	0.0	0.0	100.0	0.19	0.28	0.36	0.51	0.56
OS-15	262	0.47	0.00	0.00	0.47	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
OS-16	263	0.78	0.00	0.00	0.78	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
OS-17	264	0.53	0.53	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
OS-18	265	0.87	0.00	0.00	0.87	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
OS-20	266	12.65	6.03	1.77	4.66	0.00	60.25	0.0	0.0	100.0	0.41	0.46	0.51	0.61	0.63
OS-21	267	1.87	1.18	0.00	0.69	0.00	63.10	0.0	0.0	100.0	0.43	0.48	0.53	0.62	0.64
OS-22	268	2.95	1.70	0.09	1.16	0.00	60.45	0.0	0.0	100.0	0.41	0.46	0.51	0.61	0.63
OS-23	269	2.47	0.88	0.45	1.14	0.00	52.09	0.0	0.0	100.0	0.35	0.41	0.47	0.58	0.61
OS-24	270	0.37	0.37	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
OS-25	271	0.61	0.61	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
OS-26	272	9.87	3.65	1.77	4.46	0.00	53.06	0.0	0.0	100.0	0.36	0.41	0.47	0.58	0.61
OS-27	273	5.04	5.04	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
OS-28	274	4.67	2.08	0.74	1.86	0.00	58.70	0.0	0.0	100.0	0.40	0.45	0.50	0.60	0.63
OS-29	275	2.11	1.05	0.30	0.76	0.00	62.77	0.0	0.0	100.0	0.43	0.48	0.53	0.62	0.64
OS-30	276	1.76	0.87	0.25	0.64	0.00	62.23	0.0	0.0	100.0	0.42	0.47	0.52	0.62	0.64
OS-31	277	1.49	1.49	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
OS-32	278	0.63	0.43	0.06	0.15	0.00	76.02	0.0	0.0	100.0	0.55	0.59	0.62	0.70	0.71

STANDARD FORM SF-2
PROPOSED TIME OF CONCENTRATION

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: JM/MO
CHECKED BY: DPK

DATE: 7/6/2012

Manning N = 0.015

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt					Tc CHECK (URBANIZED BASINS)			FINAL	Remarks	Structure Notes
BASIN ID	AREA (AC)	C5	L (FT)	S (%)	Ti (MIN)	D (IN)	L (FT)	S (%)	VEL. (FPS)	Tt (MIN)	COMP Tc (MIN)	TOTAL LENGTH (FT)	MIN.Tc (MIN)	Tc (MIN)		
OS-32	0.63	0.59	75	1.00	1.8		620	1.00	2.0	5.2	6.9	695		6.9	GUTTER	To Inlet 3651 (MT 09)
OS-31	1.49	0.90	75	1.00	0.7		230	1.00	2.0	1.9					GUTTER	To Inlets 4103, 4104 (MT 15)
						15	45	1.00	4.6	0.2					PIPE	To Inlets 4067, 4086 (MT 14)
						15	475	1.00	4.6	1.7	4.5	825		5.0	PIPE	To Manhole
OS-30	1.76	0.47	75	0.88	2.2		875	0.88	1.9	7.8	10.0	950	15.3	10.0	GUTTER	To Inlet 4107, 3957 (MT 32)
OS-29	2.11	0.48	75	1.02	2.1		530	1.07	2.1	4.3					GUTTER	To Inlet 4065 (MT 4)
						15	350	1.07	4.7	1.2					PIPE	To Inlet 4064 (MT 34)
						15	310	1.21	5.0	1.0					PIPE	To Inlet 3839 (MT 36)
						18	80	1.01	5.2	0.3	8.9	1,345		8.9	PIPE	To edge of subbasin
OS-28	4.67	0.45	75	1.30	2.0		290	0.20	0.9	5.4					GUTTER	To Inlet 3672 (MT 60)
						18	298	0.61	4.0	1.2					PIPE	To Inlet 3678 (MT 61)
						18	304	0.63	4.1	1.2					PIPE	To Inlet 3681 (MT 70)
						18	304	0.49	3.6	1.4	11.3	1,271	17.1	11.3	PIPE	To Inlet 3682 (MT 76)
OS-27	5.04	0.90	75	0.66	0.8		520	0.90	1.9	4.6					GUTTER	To Inlet 4106, 3956 (MT 2)
						15	40	1.00	4.6	0.1					PIPE	To Manhole
						15	296	1.14	4.9	1.0					PIPE	To Manhole near 4064, 4107 (MT 34, MT 32)
						15	355	1.67	5.9	1.0					PIPE	To Manhole near 4063, 4108 (MT 38, MT 40)
						15	298	5.30	10.5	0.5					PIPE	To Manhole near 4062 (Mt45)
						15	325	2.38	7.0	0.8	8.8	1,909		8.8	PIPE	To Manhole near 4114
OS-26	9.87	0.41	75	0.70	2.6		360	1.00	2.0	3.0					GUTTER	To Inlet 3834 (MT 43)
						18	297	1.18	5.6	0.9					PIPE	To Inlet 3829 (MT 52)
						21	304	0.79	5.1	1.0					PIPE	To Inlet 3753 (MT 62)
						21	309	0.65	4.6	1.1					PIPE	To Inlet 3751 (MT 68)
						21	321	0.63	4.5	1.2	9.8	1,666		9.8	PIPE	To MH 4014 (MT 74)
OS-25	0.61	0.90	75	0.50	0.9		375	0.86	1.9	3.4	4.2	450		5.0	GUTTER	To Inlet 4116, 3958 (MT 78)
OS-24	0.37	0.90	75	0.50	0.9		325	0.86	1.9	2.9	3.8	400		5.0	GUTTER	To Inlet 4012 (MT 79)
OS-23	2.47	0.41	75	0.70	2.7		293	0.92	1.9	2.5					GUTTER	To Inlet 3747 (MT 73)
						24	321	0.67	5.1	1.0	6.3	689		6.3	PIPE	To MH 4013 (MT 80)
OS-22	2.95	0.46	50	2.30	1.4		550	3.70	3.8	2.4					GUTTER	To Inlet 4117, 4118, 4119 (MT 89)
						15	40	1.42	5.4	0.1					PIPE	To Inlet 4085, MH 4084 (MT 90)
						24	180	3.86	12.3	0.2	4.1	820		5.0	PIPE	To edge of subbasin
OS-21	1.87	0.48	50	2.30	1.3		710	3.70	3.8	3.1	4.4	760		5.0	GUTTER	To edge of subbasin
OS-20	12.65	0.46	75	0.70	2.5		610	1.50	2.4	4.2					GUTTER	To Inlet 3738 (MT 85)
						15	73	1.00	4.6	0.3					PIPE	To MH near 3740 (MT 86)
						24	318	1.37	7.3	0.7					PIPE	To 3733 (MT 101)
						24	384	1.85	8.5	0.8	8.4	1,460		8.4	PIPE	To Inlet 3901 (MT 107)
OS-18	0.87	0.15	25	5.0	1.1		80	16.9	2.9	0.5					GRASS	
							340	4.0	4.0	1.4	3.0	445		5.0	GUTTER	To 402L
OS-17	0.53	0.90	50	6.0	0.3		375	4.0	4.0	1.6	1.9	425		5.0	GUTTER	To 402L
OS-16	0.78	0.15	20	20.0	0.6		80	31.0	3.9	0.3					GRASS	
							395	3.9	3.9	1.7	2.6	495		5.0	GUTTER	To 406L
OS-15	0.47	0.15	50	17.0	1.0		350	9.0	2.1	2.8					GRASS	
							120	3.8	3.9	0.5	4.3	520		5.0	GUTTER	To 408L
OS-14	1.16	0.28	20	6.8	0.8		75	1.0	2.0	0.6					GUTTER	
							270	7.6	1.9	2.3					GRASS	

STANDARD FORM SF-2
PROPOSED TIME OF CONCENTRATION

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: JM/MO
CHECKED BY: DPK

DATE: 7/6/2012

Manning N = 0.015

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt					Tc CHECK (URBANIZED BASINS)			FINAL	Remarks	Structure Notes
BASIN ID	AREA (AC)	C5	L (FT)	S (%)	Ti (MIN)	D (IN)	L (FT)	S (%)	VEL. (FPS)	Tt (MIN)	COMP Tc (MIN)	TOTAL LENGTH (FT)	MIN.Tc (MIN)	Tc (MIN)		
							190	4.1	3.0	1.0	4.8	555		5.0	SWALE	To 2673R
OS-13	0.54	0.74	50	4.4	0.6		165	4.0	4.0	0.7					PAVED	
							80	4.6	3.2	0.4	1.7	295		5.0	SWALE	To 2673R
OS-12	3.28	0.29	45	1.0	2.1		635	1.3	2.3	4.6					GUTTER	
							265	8.6	2.1	2.2					GRASS	
							45	33.3	4.0	0.2					GRASS	
							320	4.0	3.0	1.8	10.9	1,310	17.3	10.9	SWALE	To 2677R
OS-11	4.57	0.30	40	2.6	1.5		830	2.6	3.2	4.3					GUTTER	
							215	10.5	2.3	1.6					GRASS	
							45	33.3	4.0	0.2					GRASS	
							205	4.2	3.1	1.1	8.6	1,335		8.6	SWALE	To 302R
OS-1	0.83	0.15	75	16.0	1.3		380	10.0	2.2	2.9					GRASS	
							250	3.0	3.5	1.2	5.4	705		5.4	GUTTER	To 305R
WB6-6	0.72	0.90	50	4.5	0.3		515	4.0	4.0	2.1	2.5	565		5.0	GUTTER	To 411L
WB6-7	0.42	0.90	50	4.5	0.3		350	4.0	4.0	1.5	1.8	400		5.0	GUTTER	To 408L
WB6-8	0.66	0.90	50	5.0	0.3		470	3.9	3.9	2.0	2.3	520		5.0	GUTTER	To 406L
EB6-4	0.42	0.65	50	4.5	0.8		150	4.5	4.2	0.6					PAVED	
							265	4.0	3.0	1.5	2.8	465		5.0	SWALE	To 305R
EB6-5	0.74	0.70	50	4.5	0.7		120	4.5	4.2	0.5					GUTTER	
							365	4.2	3.1	2.0	3.1	535		5.0	SWALE	To 302R
EB6-6	0.68	0.68	50	4.5	0.7		105	4.5	4.2	0.4					GUTTER	
							380	4.0	3.0	2.1	3.2	535		5.0	SWALE	To 2677R

NOTES: $Ti=0.395*(1.1-C5)*L^{0.5})/(S^{0.33})$ Tt=L/60V (V From Fig. 7.2, CDOT DDM, Pipe V calculated seperately) Tc Check= 10+L/180

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES CALCULATED BY: JM P_1 = 0.6 inches Table 5.1, Denver Criteria manual, 2006 DATE: 7/6/2012

PROJECT NUMBER: 011-2359 CHECKED BY: DPK 0.015 Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME				
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef. (C_2)	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)	Tt (min)	Remarks	Structure Notes
	278		OS-32	0.63	0.55	6.9	0.35	1.85	0.6														
																	1.00	15	71	4.6	0.3	Tt from DP278 to DP277	To Manhole
OS-31-32	277		OS-31	1.49	0.89	5.0	1.32	2.04	2.7	7.2	1.67	1.83	3.0									Flows Offsite for WQ Event Tt from DP277 to DP279	Inlet 4066 (MT 12) believed to drain north
	275		OS-29	2.11	0.43	8.9	0.90	1.70	1.5							1.5	1.01	18	230	5.2	0.7	9.9 cfs max in pipe at DP275	To Inlet 3834 (MT 43)
																	1.18	18	297	5.6	0.9		To Inlet 3829 (MT 52)
																	0.79	21	304	5.1	1.0		To Inlet 3753 (MT 62)
																	0.65	21	309	4.6	1.1		To Inlet 3751 (MT 68)
																	0.63	21	321	4.5	1.2		To MH 4014 (MT 74)
OS-26-29	272		OS-26	9.87	0.36	9.8	3.53	1.63	5.8	13.8	4.43	1.41	6.3						1461		4.9	Tt from DP275 to DP272 (in pipes)	
	274		OS-28	4.67	0.40	11.3	1.85	1.54	2.9													7.4 cfs max at DP274	
OS-26-28-29	272									13.8	6.29	1.41	8.9			2.9	1.39	18	120	6.1	0.3	Tt from DP274 to DP272 (in pipes)	To MH 4014 (MT 74)
OS-23-26-28-29	269		OS-23	2.47	0.35	6.3	0.87	1.91	1.7	14.8	7.15	1.37	9.8			8.9	0.67	24	290	5.1	0.9	18.5 cfs max in pipe at DP272 Tt from DP272 to DP269 (in pipes)	To MH 4013 (MT 80)
	271		OS-25	0.61	0.89	5.0	0.54	2.04	1.1														
OS-23-25-26-28-29	269									14.8	7.70	1.37	10.6			1.1	1.00	15	100	4.6	0.4	Tt from DP271 to DP 269	To MH 4013 (MT 80)
	270		OS-24	0.37	0.89	5.0	0.33	2.04	0.7														
OS-23-24-25-26-28-29	269									14.8	8.02	1.37	11.0			0.7	1.00	15	12	4.6	0.0	Tt from DP270 to DP 269	To MH 4013 (MT 80)
																11.0	1.02	24	156	6.3	0.4	19.8 cfs max in pipe at DP269	
																	1.34	24	210	7.2	0.5		To MH near 3740 (MT 86)
																	1.37	24	318	7.3	0.7		To 3733 (MT 101)
																	1.85	24	384	8.5	0.8		To MH 3904 (MT 106)
																			1068		2.4	Tt from DP269 to DP266 (in pipes)	
OS-20-23-24-25-26-28-29	266		OS-20	12.65	0.41	8.4	5.17	1.74	9.0	17.2	13.19	1.28	16.8			16.8	1.66	24	45	8.0	0.1	42.2 cfs max at DP266 in pipes	To MH 3905 (MT 109)
																	13.2	30	108	26.3	0.1	Note: n=0.013	To 401C
																			153		0.2	Tt from DP266 to 401C (in pipes)	
	276		OS-30	1.76	0.42	10.0	0.75	1.62	1.2							1.2	1.00	15	43	4.6	0.2		To MH
																	1.67	15	355	5.9	1.0		To MH near 4108, 4063 (MT 40, MT 38)
																	5.30	15	298	10.5	0.5		To MH near 4109, 4062 (MT 47, MT 45)
																	2.38	15	325	7.0	0.8		To MH near 4058, 4059 (MT 54)
																			1021		2.4	TT from DP276 to DP273 (in pipes)	
OS-27-30	273		OS-27	5.04	0.89	8.8	4.47	1.71	7.6	12.4	5.21	1.48	7.7			7.7	0.38	24	422	3.8	1.8	14.0 cfs max in pipe at DP267	To MH near 4054, 4115 (MT 65, MT 67)
																	0.44	24	1108.6	4.1	4.5	Note: n=0.013	To MH near 4012, 4116, 3958 (MT 79, MT 78)
																	0.5	24	206	4.4	0.8	Note: Existing pipes convey WQ flow	To MH 4084 (MT 90)
																	3.86	24	445	12.3	0.6		To 2172C
	268		OS-22	2.95	0.41	5.0	1.21	2.04	2.5										2182		7.7	TT from DP273 to 2172C	
		2172C								20.1	6.42	1.18	7.6			0.00	3.86	24	245	12.3	0.3	Tt from DP268 to 2172C	To 2172C
		401C								20.2	19.61	1.17	23.0			7.6	2.77	24	67	10.4	0.1	Tt from 2172C to 401C	To 401C
	267		OS-21	1.87	0.43	5.0	0.81	2.04	1.6							23.0	2.63	36	85	13.3	0.1	Tt from 401C to 402L	To 402L
	265	402L	OS-18	0.87	0.04	5.0	0.03	2.04	0.1					3.7	1.6				500	3.8	2.2	Tt from DP267 to 402L	To 402L
OS-20 to OS-32 OS-17,OS-18	264	402L	OS-17	0.53	0.89	5.0	0.47	2.04	1.0	20.3	20.92	1.17	24.5									**OS-20 to OS-32 Routed to WB lanes**	To 402L
	263	406L	OS-16	0.78	0.04	5.0	0.03	2.04	0.1							24.5	4.00	36	398	16.4	0.4	Qmax= 115.6 cfs Tt from 402L to 406L	To 406L
OS-20 to OS-32 OS-16-17-18,WB6-8	253	406L	WB6-8	0.66	0.89	5.0	0.58	2.04	1.2	20.7	21.54	1.16	25.0										
	262	408L	OS-15	0.47	0.04	5.0	0.02	2.04	0.0							25.0	4.00	36	232	16.4	0.2	Qmax= 115.6 cfs Tt from 406L to 408L	To 408L
OS-20 to OS-32, OS-15-16-17-18, WB6-7,WB6-8	252	408L	WB6-7	0.42	0.89	5.0	0.37	2.04	0.8	20.9	21.93	1.15	25.3									Qmax= 126.5 cfs	

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES CALCULATED BY: JM P_1 = 0.6 inches Table 5.1, Denver Criteria manual, 2006 DATE: 7/6/2012

PROJECT NUMBER: 011-2359 CHECKED BY: DPK 0.015 Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME				
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef. (C_2)	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)	Tt (min)	**Remarks**	**Structure Notes**
OS-20 to OS-32, OS-15-16-17-18, WB6-7,WB6-8		411R								21.2	21.93	1.14	**25.1**			25.3	4.79	36	297	17.9	0.3	Tt from 408L to 411R	To 411R
																25.3	2.50	24	26	9.9	0.0	**End of West Bound System** Tt from 411R to 2182C	To 2182C
	261	300R	OS-14	1.16	0.19	5.0	0.22	2.04	0.5														
OS-13-14	260	300R	OS-13	0.54	0.72	5.0	0.39	2.04	0.8	5.0	0.61	2.04	1.2										
	259	304R	OS-12	3.28	0.21	10.9	0.69	1.57	1.1							1.2	4.05	24	380	12.6	0.5	Qmax= 39.5 cfs Tt from 300R to 304R	To 304R
OS-12-13-14, EB6-6	256	304R	EB6-6	0.68	0.65	5.0	0.44	2.04	0.9	10.9	1.74	1.57	2.7										
	258	307R	OS-11	4.57	0.22	8.6	1.02	1.72	1.7							2.7	4.49	36	358	17.3	0.3	Qmax= 122.5 cfs Tt from 304R to 307R	To 307R
OS-11-12-13-14 EB6-5-6	255	307R	EB6-5	0.74	0.68	5.0	0.50	2.04	1.0	11.2	3.26	1.55	5.0										
OS-11-12-13-14 EB6-5-6		308R								11.3	3.26	1.54	5.0			5.0	2.67	36	59	13.4	0.1	Qmax= 94.5 cfs Tt from 307R to 308R	To 308R
		2182C								21.3	25.19	1.14	**28.8**			5.0	2.48	18	241	8.1	0.5	**End of East Bound System** Tt from 308R to 2182C	To 2182C
ALL BASINS		2183C								21.3	25.19	1.14	**28.7**			28.8	5.00	24	66	14.0	0.1	**Connection of WB to EB** Tt from 2182C to 2183C	To 2183C
																						Water Quality flow to US 6 Water Quality Pond	**To US 6 WQ Pond**

Note: Analysis uses velocities for pipes assuming a flow-full condition and may underestimate the Tc slightly.

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 10-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: JM/MO
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006
0.015 Manning N

DATE: 7/6/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)	Tt (min)	Remarks *Pipe flow assumed to be full flow conditions	Structure Notes
	275		OS-29	2.11	0.53	8.9	1.11	4.38	4.9							4.9	1.01	18	230	5.2	0.7	9.9 cfs max in pipe at DP275	To Inlet 3834 (MT 43)
																	1.18	18	297	5.6	0.9		To Inlet 3829 (MT 52)
																	0.79	21	304	5.1	1.0		To Inlet 3753 (MT 62)
																	0.65	21	309	4.6	1.1		To Inlet 3751 (MT 68)
																	0.63	21	321	4.5	1.2		To MH 4014 (MT 74)
																			1461		4.9	Tt from DP275 to DP272 (in pipes)	
OS-26-29	272		OS-26	9.87	0.47	9.8	4.66	4.22	19.7	13.8	5.77	3.65	21.1									16.1 cfs max in pipe at DP272	No capacity to accept flow from DP274
														0.66	5.0	16.1			310	1.6	3.2	Tt from DP272 to DP269 (surface)	
OS-23-26-29	269		OS-23	2.47	0.47	6.3	1.15	4.94	5.7	17.0	6.92	3.31	22.9	Strt Cap = 12.5 cfs								19.8 cfs max in pipe at DP269	No capacity to accept flow from DP270 or DP271
														1.32	3.1	19.8			1083	2.3	7.9	Tt from DP269 to 266 (surface)	
OS-20-23-26-29	266		OS-20	12.65	0.51	8.4	6.45	4.48	28.9	24.9	13.38	2.71	36.2			36.2	1.66	24	45	8.0	0.1	42.2 cfs max at DP266 from pipes	To MH 3905 (MT 109)
																	13.2	30	108	26.3	0.1	Note: n=0.013	To 401C
																			153		0.2	Tt from DP266 to 401C (in pipes)	
	278		OS-32	0.63	0.62	6.9	0.39	4.78	1.9														
														0.88	1.9				1000	1.9	8.9	Tt from DP278 to DP276 (surface)	
OS-30-32	276		OS-30	1.76	0.52	10.0	0.92	4.19	3.9	15.9	1.31	3.43	4.5			4.5	1.00	15	43	4.6	0.2		To MH
																	1.67	15	355	5.9	1.0		To MH near 4108, 4063 (MT 40, MT 38)
																	5.30	15	298	10.5	0.5		To MH near 4109, 4062 (MT 47, MT 45)
																	2.38	15	325	7.0	0.8		To MH near 4058, 4059 (MT 54)
																			1021		2.4	TT from DP276 to DP273 (in pipes)	
	277		OS-31	1.49	0.92	5.0	1.36	5.26	7.2					0.88	7.2				1017	1.9	9.1	5.6 cfs max in pipe at DP277	
														3.31	7.2				905	3.6	4.2	Assumed no runoff diverted north	
																			1922		13.2	Tt from DP277 to DP273 (surface)	
OS-27-30-31-32	273		OS-27	5.04	0.92	8.8	4.62	4.41	20.3	18.3	7.29	3.20	23.3			23.3	0.38	36	422	5.0	1.4	14.0 cfs current max in	To MH near 4054, 4115 (MT 65, MT 67)
																	0.44	36	1108.6	5.4	3.4	24" pipe at DP273	To MH near 4012, 4116, 3958 (MT 79, MT 78)
																	0.5	36	206	5.8	0.6	Ponding at DP273 likely (sump)	To MH 4084 (MT 90)
																	3.86	36	445	16.1	0.5	See Note A at bottom of sheet.	To 2172C
																			2182		5.9	TT from DP273 to 2172C	
OS-27-30-31-32		2172C								24.1	7.29	2.76	20.1										
																20.1	2.77	24	67	10.4	0.1	Tt from 2172C to 401C	To 401C
OS-20-23-26-27-29-30-31-32		401C								25.1	20.67	2.70	55.7										
																55.7	2.63	36	85	13.3	0.1	Tt from 401C to 402L	To 402L
	270		OS-24	0.37	0.92	5.0	0.34	5.26	1.8					See Note B at bottom of sheet.								Pipe at DP269 is full	
														3.61	1.8				730	3.8	3.2	Tt from DP270 to DP267 (surface)	
OS-21-24	267		OS-21	1.87	0.53	5.0	0.99	5.26	5.2	8.2	1.33	4.51	6.0	See Note B at bottom of sheet.									
														3.7	6.0				500	3.8	2.2	Tt from DP267 to 402L	To 402L
	265	402L	OS-18	0.87	0.25	5.0	0.22	5.26	1.1														
																							To 402L
OS-17-18-20-21-23-24-26-27-29-30-31-32	264	402L	OS-17	0.53	0.92	5.0	0.49	5.26	2.6	25.2	22.70	2.69	61.0									Qmax= 115.6 cfs	
																61.0	4.00	36	398	16.4	0.4	Tt from 402L to 406L	To 406L
	263	406L	OS-16	0.78	0.25	5.0	0.19	5.26	1.0														
OS-16-17-18-20-21-23-24-26-27-29-30-31 32, WB6-8	253	406L	WB6-8	0.66	0.92	5.0	0.60	5.26	3.2	25.6	23.49	2.67	62.6									Qmax= 115.6 cfs	
																62.6	4.00	36	232	16.4	0.2	Tt from 406L to 408L	To 408L
	262	408L	OS-15	0.47	0.25	5.0	0.12	5.26	0.6														
OS-15-16-17-18-20-21-23-24-26-27-29-30 31-32, WB6-7, WB6-8	252	408L	WB6-7	0.42	0.92	5.0	0.38	5.26	2.0	25.8	24.00	2.65	63.6									Qmax= 126.5 cfs	
																63.6	4.79	36	296	17.9	0.3	Tt from 408L to 411R	To 409R
		411R								26.1	24.00	2.64	63.2									Qmax= 117.3 cfs	WQ Diversion
																63.6	4.12	36	64	16.6	0.1	Tt from 411R to 411C	To 411C
	251	411L	WB6-6	0.72	0.92	5.0	0.66	5.26	3.5														
OS-15-16-17-18-20-21-23-24-26-27-29-30 31-32, WB6-6-7-8	251	411C	Total pipe flow at Outfall to Weir Gulch from North System							26.2	24.65	2.63	64.9			3.5	0.50	18	43	3.6	0.2	Tt from 411L to 411C	To 411C
																64.9	3.81	48	19	19.3	0.0	**OUTFALL TO WEIR GULCH**	To Weir Gulch
	274		OS-28	4.67	0.50	11.3	2.34	3.99	9.3													Pipe at DP272 is full	
														0.66	9.3				330	1.6	3.4	Tt from DP274 to DP271 (surface)	
OS-25-28	271		OS-25	0.61	0.92	5.0	0.56	5.26	2.9	14.7	2.90	3.55	10.3	See Note B at bottom of sheet.								Pipe at DP269 is full	

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 10-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: JM/MO
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006
0.015 Manning N

DATE: 7/6/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			Remarks *Pipe flow assumed to be full flow conditions	Structure Notes
			Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)	Tt (min)		
OS-22-25-28	268		OS-22	2.95	0.51	5.0	1.51	5.26	7.9	18.0	4.41	3.22	14.2	3.61	10.3				750	3.8	3.3	Tt from DP271 to DP266 (surface)	
														See Note B at bottom of sheet.									
	261	300R	OS-14	1.16	0.36	5.0	0.42	5.26	2.2					4.05	14.2				430	4.0	1.8	Tt from DP266 to 300R	To 300R
OS-13-14-22-25-28	260	300R	OS-13	0.54	0.77	5.0	0.41	5.26	2.2	19.8	5.24	3.06	16.1										
																16.1	4.05	24	380	12.6	0.5	Qmax= 39.5 cfs Tt from 300R to 304R	To 304R
	259	304R	OS-12	3.28	0.37	10.9	1.22	4.05	4.9														
OS-12-13-14-22-25-28, EB6-6	256	304R	EB6-6	0.68	0.71	5.0	0.48	5.26	2.5	20.3	6.94	3.02	21.0										
																21.0	4.49	36	358	17.3	0.3	Qmax= 122.5 cfs Tt from 304R to 307R	To 307R
	258	307R	OS-11	4.57	0.38	8.6	1.73	4.44	7.7														
OS-11-12-13-14-22-25-28, EB6-5, EB6-6	255	307R	EB6-5	0.74	0.73	5.0	0.54	5.26	2.8	20.7	9.21	3.00	27.6										
																27.6	2.67	36	59	13.4	0.1	Qmax= 94.5 cfs Tt from 307R to 308R	To 308R
		308R								20.7	9.21	2.99	27.6										
OS-1-11-12-13-14-22-25-28,	257	310R	OS-1	0.83	0.25	5.4	0.21	5.16	1.1							27.6	3.00	36	201	14.2	0.2	Qmax= 100.1 cfs Tt from 308R to 310R	WQ Diversion To 310R
OS-1-11-12-13-14-22-25-28, EB6-4-5-6	254	310R	EB6-4	0.42	0.69	5.0	0.29	5.26	1.5	21.0	9.71	2.97	28.9										
	254		Total pipe flow at Outfall to Weir Gulch from South System										28.9										
																						OUTFALL TO WEIR GULCH	To Weir Gulch

Notes:
A. Assumes undersized pipe at DP273 could be increased from 24" to 36" in the future to eliminate the sump condition.
B. Assumes existing inlets in basin OS-24, OS-25, OS-21, and OS-22 main stem cannot accept all flow (pipe capacity in main line > inlet capacity) necessitating overland flow travel times.

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: JM
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006
0.015 Manning N

DATE: 7/6/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt	Remarks *Pipe flow velocity calculated for full-flow pipe conditions	Structure Notes
	275		OS-29	2.11	0.64	8.9	1.36	7.26	9.9							9.9	1.01	18	230	5.2	0.7	9.9 cfs max in pipe at DP275	To Inlet 3834 (MT 43)
																	1.18	18	297	5.6	0.9		To Inlet 3829 (MT 52)
																	0.79	21	304	5.1	1.0		To Inlet 3753 (MT 62)
																	0.65	21	309	4.6	1.1		To Inlet 3751 (MT 68)
																	0.63	21	321	4.5	1.2		To MH 4014 (MT 74)
																			1461		4.9	Tt from DP275 to DP272 (in pipes)	
OS-26-29	272		OS-26	9.87	0.61	9.8	6.03	7.00	42.2	13.8	7.38	6.06	44.7									16.1 cfs max in pipe at DP272	No capacity to accept flow from DP274
														0.66	28.6	16.1			310	1.6	3.2	Tt from DP272 to DP269 (surface)	
OS-23-26-29	269		OS-23	2.47	0.61	6.3	1.50	8.18	12.3	17.0	8.89	5.49	48.8	**Strt Cap = 12.5 cfs**								19.8 cfs max in pipe at DP269	
																						Split Flow Location	No capacity to accept flow from DP270 or DP271
OS-23-26-29	269		Pipe Flow and Street Frontage Road Equivalent CA= 5.89							17.0	5.89	5.49	32.3	**Strt Cap = 12.5 cfs**								19.8 cfs max in pipe at DP269	
														1.32	12.5	19.8			1083	2.3	7.9	Tt from DP269 to 266 (surface)	
OS-23-26-29	269		Spill onto WB HWY6 Ramp near King St, Equivalent CA= 3							17.0	3.00	5.49	16.5										
														1.73	16.5				175	2.6	1.1		
														4.50	16.5				560	4.2	2.2		
																			1818		3.3	Tt from DP269 to DP267 (surface)	
Street and Pipe Flow from DP269, OS-20	266		OS-20	12.65	0.63	8.4	8.02	7.43	59.6	24.9	13.91	4.49	62.4										
														20.2 cfs		42.2	1.6	24	45	7.9	0.1	42.2 cfs max from pipes at DP266	To MH 3905 (MT 109)
																	13.2	30	108	26.3	0.1	Excess flow travels out of watershed to	To 401C
																			153		0.2	Tt from DP266 to 401C (in pipes)	
	278		OS-32	0.63	0.71	6.9	0.45	7.93	3.6														
														0.88	3.6				1000	1.9	8.9	Tt from DP278 to DP276 (surface)	
OS-30-32	276		OS-30	1.76	0.64	10.0	1.13	6.95	7.8	15.9	1.58	5.68	9.0			4.5	1.00	15	43	4.6	0.2	Split Flow Location	To MH
																	1.67	15	355	5.9	1.0		To MH near 4108, 4063 (MT 40, MT 38)
OS-30-32	276		10-yr Flow in Pipe to North System, Equivalent CA= 0.79							15.9	0.79	5.68	4.5				5.30	15	298	10.5	0.5		To MH near 4109, 4062 (MT 47, MT 45)
																	2.38	15	325	7.0	0.8		To MH near 4058, 4059 (MT 54)
OS-30-32	276		Remainder Street Flows to South System, Equivalent CA= 0.79							15.9	0.79	5.68	4.5						1021		2.4	TT from DP276 to DP273 (in pipes)	
	277		OS-31	1.49	0.96	5.0	1.42	8.72	12.4					0.88	12.4				1017	1.9	9.1	5.6 cfs max in pipe at DP277	
														3.31	12.4				905	3.6	4.2		
																			1922		13.2	Tt from DP277 to DP273 (surface)	
Pipe Flow from DP276, OS-27-31	273		OS-27	5.04	0.96	8.8	4.82	7.31	35.2	18.3	7.03	5.30	37.3			37.3	0.38	36	422	5.0	1.4	14.0 cfs current max in	To MH near 4054, 4115 (MT 65, MT 67)
																	0.44	36	1108.6	5.4	3.4	24" pipe at DP273	To MH near 4012, 4116, 3958 (MT 79, MT 78)
																	0.5	36	206	5.8	0.6	Ponding at DP273 likely (sump)	To MH 4084 (MT 90)
																	3.86	36	445	16.1	0.5	See Note A at bottom of sheet.	To 2172C
																			2182		5.9	TT from DP273 to 2172C	
Pipe Flow from DP276, OS-27-31		2172C								24.1	7.03	4.57	37.3										
Pipe Flow from DP276, Pipe Flow from DP266,										Add 42.2 CFS for pipe flow from DP 266						37.3	2.77	24	67	10.4	0.1	Tt from 2172C to 401C	To 401C
OS-27-31		401C								25.1	7.03	4.47	73.6									42.2 cfs added from North System	
																73.6	2.63	36	85	13.3	0.1	Tt from 401C to 402L	To 402L
	270		OS-24	0.37	0.96	5.0	0.35	8.72	3.1					See Note B at bottom of sheet.								Pipe at DP269 is full	
Ramp Spill from DP269,														3.61	3.1				730	3.8	3.2	Tt from DP270 to DP267 (surface)	
OS-21-24	267		OS-21	1.87	0.64	5.0	1.21	8.72	10.5	20.4	4.56	5.01	22.8	See Note B at bottom of sheet.									
														3.7	22.8				500	3.8	2.2	Tt from DP267 to 402L	To 402L
	265	402L	OS-18	0.87	0.50	5.0	0.43	8.72	3.8														
Pipe Flow from DP276, Ramp spill from DP269,										Add 42.2 CFS for pipe flow from DP 266													
Pipe flow from DP266,																							
OS-17-18-21-24-27-31	264	402L	OS-17	0.53	0.96	5.0	0.51	8.72	4.4	25.2	12.53	4.46	98.1			Includes 42.2 cfs from DP266						Qmax= 115.6 cfs	
																98.1	4.00	36	398	16.4	0.4	Tt from 402L to 406L	To 406L
	263	406L	OS-16	0.78	0.50	5.0	0.39	8.72	3.4														
Pipe Flow from DP276, Ramp spill from DP269,										Add 42.2 CFS for pipe flow from DP 266													
Pipe flow from DP266,																							
OS-16-17-18-21-24-27-31, WB6-8	253	406L	WB6-8	0.66	0.96	5.0	0.63	8.72	5.5	25.6	13.55	4.42	102.1			Includes 42.2 cfs from DP266						Qmax= 115.6 cfs	
																102.1	4.00	36	232	16.4	0.2	Tt from 406L to 408L	To 408L
	262	408L	OS-15	0.47	0.50	5.0	0.23	8.72	2.0														
Pipe Flow from DP276, Ramp spill from DP269,										Add 42.2 CFS for pipe flow from DP 266													
Pipe flow from DP266, OS-15-16-17-18-21-24-																							
27-31, WB6-7-8	252	408L	WB6-7	0.42	0.96	5.0	0.40	8.72	3.5	25.8	14.19	4.40	104.6			Includes 42.2 cfs from DP266						Qmax= 126.5 cfs	
										Add 42.2 CFS for pipe flow from DP 266						104.6	4.79	36	296	17.9	0.3	Tt from 408L to 411R	To 411R
		411R								26.1	14.19	4.37	104.2										WQ Diversion

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: JM
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006
0.015 Manning N

DATE: 7/6/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt	Remarks *Pipe flow velocity calculated for full-flow pipe conditions	Structure Notes
	251	411L	WB6-6	0.72	0.96	5.0	0.69	8.72	6.0							104.6	4.12	36	64	16.6	0.1	Tt from 411R to 411C	To 411C
Pipe Flow from DP276, Ramp spill from DP269, Pipe flow from DP266, OS-15-16-17-18-21-24-27-31, WB6-6-7-8		411C	Total pipe flow at Outfall to Weir Gulch from North System							26.2	14.87	4.36	107.1			6.0	0.50	18	43	3.6	0.2	Tt from 411L to 411C	To 411C
																107.1	3.81	48	19	19.3	0.0	**OUTFALL TO WEIR GULCH** Includes 42.2 cfs from DP266	To Weir Gulch
Street Flow from DP276, OS-28	274		OS-28	4.67	0.63	11.3	2.93	6.61	19.4	11.3	3.72	6.61	24.6										
Street Flow from DP276, OS-25-28	271		OS-25	0.61	0.96	5.0	0.58	8.72	5.1	14.7	4.31	5.88	25.3	0.66	19.4				330	1.6	3.4	Pipe at DP272 is full Tt from DP274 to DP271 (surface)	
Street Flow from DP276, OS-22-25-28	268		OS-22	2.95	0.63	5.0	1.87	8.72	16.3	17.9	6.18	5.35	33.1	See Note B at bottom of sheet. 3.61	25.3				720	3.8	3.2	Pipe at DP269 is full Tt from DP271 to DP268 (surface)	
	261	300R	OS-14	1.16	0.56	5.0	0.65	8.72	5.7					See Note B at bottom of sheet. 4.05	33.1				460	4.0	1.9	Tt from DP266 to 300R	To 300R
Street Flow from DP276, OS-13-14-22-25-28	260	300R	OS-13	0.54	0.83	5.0	0.45	8.72	3.9	19.8	7.27	5.08	37.0										
	259	304R	OS-12	3.28	0.56	10.9	1.85	6.72	12.4							37.0	4.05	24	380	12.6	0.5	Qmax= 39.5 cfs Tt from 300R to 304R	To 304R
Street Flow from DP276, OS-12-13-14-22-25-28, EB6-6	256	304R	EB6-6	0.68	0.78	5.0	0.53	8.72	4.6	20.3	9.65	5.01	48.4										
	258	307R	OS-11	4.57	0.57	8.6	2.59	7.36	19.1							48.4	4.49	36	358	17.3	0.3	Qmax= 122.5 cfs Tt from 304R to 307R	To 307R
Street Flow from DP276, OS-11-12-13-14-22-25-28, EB6-5-6	255	307R	EB6-5	0.74	0.80	5.0	0.59	8.72	5.1	20.7	12.83	4.97	63.8										
Street Flow from DP276, OS-11-12-13-14-22-25-28, EB6-5-6		308R								20.7	12.83	4.96	63.7			63.8	2.67	36	59	13.4	0.1	Qmax= 94.5 cfs Tt from 307R to 308R	To 308R
	257	310R	OS-1	0.83	0.50	5.4	0.41	8.55	3.5							63.8	3.00	36	201	14.2	0.2	Qmax= 100.1 cfs Tt from 308R to 310R	WQ Diversion To 310R
Street Flow from DP276, OS-1-11-12-13-14- 22-25-28, EB6-4-5-6	254	310R	EB6-4	0.42	0.76	5.0	0.32	8.72	2.8	21.0	13.57	4.93	66.9										
	254		Total pipe flow at Outfall to Weir Gulch from South System										66.9			66.9	3.00	36	14	14.2	0.0	Qmax= 100.1 cfs Tt from 310R to 310R (outfall)	To Weir Gulch
																						OUTFALL TO WEIR GULCH	

Notes:

A. Assumes undersized pipe at DP273 could be increased from 24" to 36" in the future to eliminate the sump condition.
B. Assumes existing inlets in basin OS-24, OS-25, OS-21, and OS-22 main stem cannot accept all flow (pipe capacity in main line > inlet capacity) necessitating overland flow travel times.

PROPOSED COMPOSITE RUNOFF COEFFICIENTS

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359
DATE: 7/6/2012
CALCULATED BY: MEO
CHECKED BY: DPK
FILE NAME: Rational 6th & Fed System - Proposed.xls

			IMPERVIOUSNESS					SOIL TYPE			RUNOFF COEFF.				
DESIGN BASIN	DESIGN POINT	TOTAL AREA (AC)	PAVED AREA (AC) 100	ROOF AREA (AC) 90	GRASS AREA (AC) 0	GRAVEL AREA (AC) 40	% I	Percent of Total Area A	Percent of Total Area B	Percent of Total Area C/D	C_2	C_5	C_{10}	C_{50}	C_{100}
SW1	1	0.73	0.73	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
SW2	3	0.61	0.34	0.00	0.27	0.00	56.18	0.0	0.0	100.0	0.38	0.43	0.49	0.59	0.62
SW3	5	0.97	0.48	0.00	0.49	0.00	49.50	0.0	0.0	100.0	0.33	0.40	0.46	0.57	0.60
SW4	6	0.38	0.18	0.00	0.20	0.00	47.23	0.0	0.0	100.0	0.32	0.38	0.45	0.56	0.60
SE1	7	0.84	0.82	0.00	0.02	0.00	97.63	0.0	0.0	100.0	0.84	0.86	0.88	0.92	0.92
SE2	8	1.41	1.41	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
SR	9	0.34	0.34	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WQ1	10	2.25	0.00	0.00	2.25	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
WQ3	11	0.41	0.00	0.00	0.41	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
WB1	20	2.49	2.49	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB2	21	0.70	0.70	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB3	22	1.03	1.03	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB3A	23	0.07	0.07	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB4	24	1.05	1.05	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB5	25	0.65	0.65	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB5A	26	0.07	0.07	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6	27	0.26	0.26	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WBF1	28	0.48	0.48	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-5	29	0.28	0.28	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB1	30	0.47	0.47	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB2	31	1.60	1.60	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
CD1	40	3.31	3.31	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
CD2	41	1.13	1.13	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
CD3	42	0.69	0.69	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
CD4	43	0.45	0.45	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
FR	50	0.69	0.69	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
NW1	60	0.95	0.95	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
NF1	61	0.23	0.23	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
NF2	62	0.29	0.28	0.00	0.01	0.00	96.51	0.0	0.0	100.0	0.83	0.84	0.86	0.91	0.91
NF3	63	0.36	0.27	0.00	0.09	0.00	75.62	0.0	0.0	100.0	0.55	0.58	0.62	0.70	0.71
NF4	64	0.40	0.26	0.00	0.14	0.00	65.62	0.0	0.0	100.0	0.45	0.50	0.54	0.64	0.66
NF5	65	0.25	0.25	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
NF6	66	1.11	0.78	0.19	0.14	0.00	85.73	0.0	0.0	100.0	0.67	0.69	0.72	0.78	0.79
NF7	67	0.54	0.46	0.07	0.00	0.00	97.95	0.0	0.0	100.0	0.85	0.86	0.88	0.93	0.93
NF8	68	1.02	0.87	0.06	0.09	0.00	90.56	0.0	0.0	100.0	0.73	0.75	0.78	0.83	0.84
NF9	69	0.32	0.28	0.04	0.00	0.00	98.76	0.0	0.0	100.0	0.86	0.88	0.90	0.94	0.94
NF10	70	0.17	0.17	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
NE	71	1.41	1.29	0.12	0.00	0.00	99.15	0.0	0.0	100.0	0.87	0.88	0.90	0.94	0.94
BPE1	80	1.83	1.34	0.00	0.49	0.00	73.10	0.0	0.0	100.0	0.52	0.56	0.60	0.68	0.70
BPE2	81	6.83	0.45	0.00	5.44	0.93	12.09	0.0	0.0	100.0	0.12	0.22	0.31	0.48	0.54
5TH1	90	1.12	0.78	0.00	0.34	0.00	69.64	0.0	0.0	100.0	0.49	0.53	0.57	0.66	0.68
5TH2	91	0.96	0.25	0.20	0.23	0.27	57.17	0.0	0.0	100.0	0.39	0.44	0.49	0.60	0.62
5TH3	92	0.47	0.18	0.00	0.30	0.00	37.07	0.0	0.0	100.0	0.26	0.34	0.41	0.54	0.58
5TH4	93	1.49	0.19	0.20	0.97	0.13	28.27	0.0	0.0	100.0	0.22	0.30	0.37	0.52	0.57
5TH5	94	1.32	0.28	0.10	0.92	0.03	28.27	0.0	0.0	100.0	0.22	0.30	0.37	0.52	0.57
5TH6	95	0.24	0.16	0.00	0.08	0.00	65.22	0.0	0.0	100.0	0.45	0.49	0.54	0.63	0.65
5TH7	96	0.10	0.10	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
OS-7	2	0.61	0.34	0.23	0.04	0.00	89.33	0.0	0.0	100.0	0.72	0.74	0.76	0.82	0.83
OS-8	4	0.10	0.04	0.00	0.06	0.00	40.00	0.0	0.0	100.0	0.28	0.35	0.42	0.55	0.58
OS-10	97	0.49	0.35	0.00	0.00	0.14	82.69	0.0	0.0	100.0	0.63	0.66	0.69	0.75	0.77

STANDARD FORM SF-2
PROPOSED TIME OF CONCENTRATION

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK/DO

DATE: 7/6/2012

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN ID	AREA (AC)	C5	L (FT)	S (%)	Ti (MIN)	L (FT)	S (%)	VEL. (FPS)	Tt (MIN)	COMP Tc (MIN)	TOTAL LENGTH (FT)	MIN.Tc (MIN)	Tc (MIN)	
SW1	0.73	0.90	50	1.4	0.5	350	1.50	2.4	2.4	2.9	400		5.0	GUTTER
OS-7	0.61	0.74	20	1.0	0.6	410	2.4	3.1	2.2	2.8	430		5.0	GUTTER
SW2	0.61	0.43	30	8.0	0.7	125	3.0	2.6	0.8					SWALE
						170	0.5	1.4	2.0	3.5	325		5.0	GUTTER
OS-8	0.10	0.35	30	10.0	0.8	60	7.0	4.0	0.3					SWALE
						65	0.5	1.4	0.8	1.8	155		5.0	GUTTER
SW3	0.97	0.40	60	2.0	1.7	150	1.0	2.0	1.3					GUTTER
						345	0.5	1.1	5.4	8.4	555		8.4	SWALE
SW4	0.38	0.38	60	3.5	1.5	130	1.5	1.8	1.2	2.6	190		5.0	SWALE
SE1	0.84	0.86	60	2.6	0.5	350	1.3	2.3	2.6	3.1	410		5.0	GUTTER
SE2	1.41	0.90	60	2.0	0.5	1,540	3.3	3.6	7.1	7.6	1,600		7.6	GUTTER
SR	0.34	0.90	60	4.8	0.4	250	2.5	3.2	1.3	1.7	310		5.0	GUTTER
WQ1	2.25	0.15	50	10.0	1.2	550	3.8	3.9	2.4	3.6	600		5.0	GUTTER
WQ3	0.41	0.15	10	25.0	0.4	40	25.0	3.5	0.2	0.6	50		5.0	GRASS
WB1	2.49	0.90	50	4.5	0.3	1,175	2.5	3.2	6.2	6.5	1,225		6.5	GUTTER
WB2	0.70	0.90	50	0.8	0.6	290	0.5	1.4	3.4	4.0	340		5.0	GUTTER
WB3	1.03	0.90	50	2.0	0.5	225	0.5	1.4	2.7	3.1	275		5.0	GUTTER
WB3A	0.07	0.90	50	2.0	0.5	60	0.5	1.4	0.7	1.2	110		5.0	GUTTER
WB4	1.05	0.90	50	2.0	0.5	385	0.8	1.8	3.6	4.0	435		5.0	GUTTER
WB5	0.65	0.90	50	2.0	0.5	505	4.5	4.2	2.0	2.4	555		5.0	GUTTER
WB5A	0.07	0.90	50	2.2	0.4	50	1.6	2.5	0.3	0.8	100		5.0	GUTTER
WB6	0.26	0.90	50	2.0	0.5	380	3.7	3.8	1.6	2.1	430		5.0	GUTTER
WBF1	0.48	0.90	50	6.0	0.3	685	1.2	2.2	5.2	5.5	735		5.5	GUTTER
WB6-5	0.28	0.90	50	4.4	0.3	260	4.7	4.3	1.0	1.3	310		5.0	GUTTER
EB1	0.47	0.90	50	3.5	0.4	425	1.2	2.2	3.3	3.7	475		5.0	GUTTER
EB2	1.60	0.90	50	3.6	0.4	1,355	0.6	1.5	14.8	15.2	1,405	17.8	10.0	GUTTER
CD1	3.31	0.90	50	4.5	0.3	1,245	2.7	3.3	6.3	6.6	1,295		6.6	GUTTER
CD2	1.13	0.90	50	2.6	0.4	760	1.0	2.0	6.5	6.9	810		6.9	GUTTER
CD3	0.69	0.90	50	0.3	0.8	380	0.9	1.9	3.3	4.2	430		5.0	GUTTER
CD4	0.45	0.90	50	0.9	0.6	330	1.2	2.2	2.5	3.1	380		5.0	GUTTER

STANDARD FORM SF-2
PROPOSED TIME OF CONCENTRATION

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK/DO

DATE: 7/6/2012

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN ID	AREA (AC)	C5	L (FT)	S (%)	Ti (MIN)	L (FT)	S (%)	VEL. (FPS)	Tt (MIN)	COMP Tc (MIN)	TOTAL LENGTH (FT)	MIN.Tc (MIN)	Tc (MIN)	
FR	0.69	0.90	40	2.4	0.4	890	2.3	3.0	4.9	5.3	930		5.3	GUTTER
NW1	0.95	0.90	60	2.0	0.5	600	1.0	2.0	5.0	5.5	660		5.5	GUTTER
NF1	0.23	0.90	100	3.6	0.5	140	1.8	2.7	0.9	1.4	240		5.0	GUTTER
NF2	0.29	0.84	50	2.9	0.5	175	1.4	2.4	1.2	1.7	225		5.0	GUTTER
NF3	0.36	0.58	65	2.1	1.3	160	0.1	0.6	4.2	5.5	225		5.5	GUTTER
NF4	0.40	0.50	55	1.3	1.6	160	0.4	1.3	2.1	3.7	215		5.0	GUTTER
NF5	0.25	0.90	50	3.3	0.4	170	2.5	3.2	0.9	1.3	220		5.0	GUTTER
NF6	1.11	0.69	50	0.4	1.5	260	1.4	2.4	1.8	3.4	310		5.0	PAVED
NF7	0.54	0.86	50	0.8	0.7	210	1.3	2.3	1.5	2.2	260		5.0	PAVED
NF8	1.02	0.75	50	1.1	0.9	275	1.9	2.8	1.7	2.6	325		5.0	PAVED
NF9	0.32	0.88	40	2.5	0.4	195	1.4	2.4	1.4	1.8	235		5.0	GUTTER
NF10	0.17	0.90	50	1.3	0.5	80	0.4	1.3	1.1	1.6	130		5.0	GUTTER
NE	1.41	0.88	60	2.0	0.5	930	2.6	3.2	4.8	5.4	990		5.4	GUTTER
BPE1	1.83	0.56	35	2.0	1.0	770	3.2	3.6	3.6	4.6	805		5.0	PAVED
BPE2	6.83	0.22	100	2.0	2.8	345	1.3	0.8	7.2		445			GRASS
						575	4.6	3.2	3.0	12.9	1,020	15.7	10.0	SWALE
5TH1	1.12	0.53	50	1.8	1.3	400	3.1	3.5	1.9	3.2	450		5.0	GUTTER
5TH2	0.96	0.44	50	2.4	1.4	385	2.9	3.4	1.9	3.3	435		5.0	GUTTER
5TH3	0.47	0.34	70	4.6	1.5	245	5.0	4.5	0.9	2.4	315		5.0	GUTTER
5TH4	1.49	0.30	90	2.1	2.4	220	3.2	1.3	2.9		310			GRASS
						295	4.6	4.3	1.1	6.4	605		6.4	GUTTER
5TH5	1.32	0.30	65	4.8	1.5	260	8.2	2.0	2.2		325			GRASS
						50	1.9	2.8	0.3	4.0	375		5.0	GUTTER
5TH6	0.24	0.49	50	4.8	1.0	255	4.4	4.2	1.0	2.0	305		5.0	GUTTER
5TH7	0.10	0.90	50	5.5	0.3	150	4.4	4.2	0.6	0.9	200		5.0	GUTTER
OS-10	0.49	0.66	45	2.3	0.9	960	3.2	3.6	4.5	5.4	1,005		5.4	PAVED

NOTES: $Ti=0.395*(1.1-C5)*L^{0.5})/(S^{0.33})$ Tt=L/60V (V From Fig. 7.2, CDOT DDM) Tc Check= 10+L/180

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY STORM

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 0.6 inches — Table 3.1, Ch 3, Vol 3, USDCM, 2011 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef. (C_2)	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	90		5TH1	1.12	0.49	5.0	0.55	2.04	1.1													
	91		5TH2	0.96	0.39	5.0	0.37	2.04	0.8					4.98	1.1				260	4.4	1.0	Tt from 205L to 208L
5TH1, 5TH3	92	208L	5TH3	0.47	0.26	5.0	0.12	2.04	0.3	6.0	0.67	1.94	1.3	4.40	0.8				300	4.2	1.2	Tt from 205R to 208R
5TH2, 5TH4	93	208R	5TH4	1.49	0.22	6.4	0.32	1.89	0.6	6.4	0.69	1.89	1.3			1.3	1.00	18	22.81	5.2	0.1	Qmax=9.1cfs Tt from 208L to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	1.36	1.89	2.6			1.3	1.00	18	22.23	5.2	0.1	Qmax=9.1cfs Tt from 208R to 208C
	97		OS-10	0.49	0.63	5.4	0.30	2.00	0.6							2.6	4.43	18	160.74	10.8	0.2	Qmax=19.16cfs Tt from 208C to 210C1
5TH5, OS-10	94	811L	5TH5	1.32	0.22	5.0	0.28	2.04	0.6	5.8	0.59	1.95	1.1	1.60	0.6				70	2.5	0.5	Tt from OS-10 to 811L
5TH5, OS-10		811C								5.9	0.59	1.94	1.1			1.1	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 811L to 811C
	95	211L	5TH6	0.24	0.45	5.0	0.11	2.04	0.2							1.1	0.50	18	82.17	3.6	0.4	Qmax=6.44cfs Tt from 811C to 210C1
	96	211R	5TH7	0.10	0.89	5.0	0.09	2.04	0.2							0.2	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 211L to 211C
5TH6, 5TH7		211C								5.1	0.20	2.03	0.4			0.2	1.00	18	15.79	5.2	0.1	Qmax=9.1cfs Tt from 211R to 211C
5TH1-7, OS-10		210C1								6.7	2.15	1.87	4.0			0.4	0.50	18	125.53	3.6	0.6	Qmax=6.44cfs Tt from 211C to 210C1
	80	210L	BPE1	1.83	0.52	5.0	0.95	2.04	1.9							4.0	0.50	24	172.1	4.4	0.6	Qmax=13.86cfs Tt from 210C1 to 210C2
5TH1-7, OS-10, BPE1		210C2								7.4	3.10	1.81	5.6			1.9	10.00	18	35.27	16.3	0.0	Qmax=28.79cfs Tt from 210L to 210C2
	81		BPE2	6.83	0.12	10.0	0.84	1.62	1.4							5.6	0.50	36	263.51	5.8	0.8	Qmax=40.87cfs Tt from 210C2 to 4998C
																1.4	2.00	24	Approx; Stub-out 100	8.8	0.2	Qmax=27.73cfs Tt from BPE2 to 4998C
	1	906L	SW1	0.73	0.89	5.0	0.65	2.04	1.3							1.3	1.00	18	24.42	5.2	0.1	Qmax=9.1cfs Tt from 906L to 906C
	3	906R	SW2	0.61	0.38	5.0	0.23	2.04	0.5							0.5	1.87	18	12.28	7.0	0.0	Qmax=12.45cfs Tt from 906R to 906C
SW1, SW2		906C								5.1	0.88	2.03	1.8			1.8	0.50	18	73.41	3.6	0.3	Qmax=6.44cfs Tt from 906C to 105C
SW1, SW2		105C								5.4	0.88	1.99	1.8			1.8	0.50	18	192.91	3.6	0.9	Qmax=6.44cfs Tt from 105C to 107C
SW1, SW2		107C								6.3	0.88	1.91	1.7			1.7	0.50	18	142.9	3.6	0.7	Qmax=6.44cfs Tt from 107C to 4990C
	7	106R	SE1	0.84	0.84	5.0	0.71	2.04	1.5							1.5	1.00	18	15.26	5.2	0.0	Qmax=9.1cfs Tt from 106R to 106C1

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY STORM

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PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 0.6 inches — Table 3.1, Ch 3, Vol 3, USDCM, 2011 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef. (C_2)	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
		106C1								5.0	0.71	2.03	1.4									
																1.4	0.50	18	94.36	3.6	0.4	Qmax=6.44cfs Tt from 106C1 to 106C2
		106C2								5.5	0.71	1.99	1.4									
																1.4	0.50	18	119.97	3.6	0.5	Qmax=6.44cfs Tt from 106C2 to 4990C
SW1, SW2, SE1		4990C								7.0	1.59	1.85	2.9									
																2.9	0.50	24	366.16	4.4	1.4	Qmax=13.86cfs Tt from 4990C to 4994C
SW1, SW2, SE1		4994C								8.3	1.59	1.74	2.8									
																2.8	4.12	24	377.7	12.7	0.5	Qmax=39.8cfs Tt from 4994C to 4998C
SE1, 5TH1-7 OS-10, BPE1, BPE2		4998C								10.2	5.54	1.61	8.9									
																8.9	0.50	42	231.89	6.4	0.6	Qmax=61.66cfs Tt from 4998C to 500C
	8	502R	SE2	1.41	0.89	7.6	1.25	1.80	2.2													
																2.2	0.50	18	20.34	3.6	0.1	Qmax=6.44cfs Tt from 502R to 502C
		502C								7.7	1.25	1.79	2.2									
																2.2	0.50	18	189.62	3.6	0.9	Qmax=6.44cfs Tt from 502C to 500C
	42	5000R	CD3	0.69	0.89	5.0	0.62	2.04	1.3													
																1.3	1.21	18	20.43	5.7	0.1	Qmax=10.01cfs Tt from 5000R to 500C
SE1, SE2, 5TH1-7, CD3 OS-10, BPE1, BPE2		500C								10.8	7.40	1.57	11.6									
																11.6	0.50	48	JACKED 284.99	7.0	0.7	Qmax=88.03cfs Tt from 500C to 6000C
	26	2507L2	WB5A	0.07	0.89	5.0	0.06	2.04	0.1													
																0.1	0.50	18	64.61	3.6	0.3	Qmax=6.44cfs Tt from 2507L2 to 2507L
	43	3007L	CD4	0.45	0.89	5.0	0.40	2.04	0.8													
																0.8	0.50	18	123.56	3.6	0.6	Qmax=6.44cfs Tt from 3007L to 2507L
WB5A, CD4, WB3A	23	2507L	WB3A	0.07	0.89	5.0	0.06	2.04	0.1	5.6	0.52	1.98	1.0									
																1.0	0.50	18	248.4	3.6	1.1	Qmax=6.44cfs Tt from 2507L to 2504C
	50	4004R	FR	0.69	0.89	5.3	0.61	2.01	1.2													
																1.2	0.50	18	118.15	3.6	0.5	Qmax=6.44cfs Tt from 4004R to 2504C
WB5A, CD4, WB3A FR		2504C								6.7	1.13	1.87	2.1									
																2.1	0.50	24	314.16	4.4	1.2	Qmax=13.86cfs Tt from 2504C to 2501C
		2501C								7.9	1.13	1.77	2.0									
																2.0	0.50	24	56.01	4.4	0.2	Qmax=13.86cfs Tt from 2501C to 2501L
WB5A, CD4, WB3A FR, WB5	25	2501L	WB5	0.65	0.89	5.0	0.58	2.04	1.2	8.1	1.71	1.76	3.0									
																3.0	0.50	24	74.93	4.4	0.3	Qmax=13.86cfs Tt from 2501L to 6000C
WEST BASINS	251	2183C	WQ FLOWS FROM WEST BASIN (SEE WEST SYSTEM ROUTING)							21.3	25.19	1.14	28.7									
																28.7	4.40	36	87.58	17.2	0.1	Qmax=121.25cfs Tt from 2183C to 2184C
WEST BASINS SW1-3,NF1-4,NW1		2184C								21.4	25.19	1.14	28.7									
																28.7	0.50	36	378.08	5.8	1.1	Qmax=40.87cfs Tt from 2184C to 2188C
WEST BASINS SW1-3,NF1-4,NW1		2188C								22.5	25.19	1.11	27.9									
																27.9	1.60	36	302.74	10.3	0.5	Qmax=73.12cfs Tt from 2188C to 2190C
WEST BASINS SW1-3,NF1-4,NW1		2190C								23.0	25.19	1.09	27.6									
																27.6	2.98	36	62.35	14.1	0.1	Qmax=99.79cfs Tt from 2190C to 2190R
WEST BASINS SW1-3,NF1-4,NW1		2190R								23.1	25.19	1.09	27.5									
																27.5	1.57	36	270.59	10.2	0.4	Qmax=72.43cfs Tt from 2190R to 2193R

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY STORM

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PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 0.6 inches — Table 3.1, Ch 3, Vol 3, USDCM, 2011 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef. (C_2)	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	40	2994R	CD1	3.31	0.89	6.6	2.93	1.88	5.5													
CD1,CD2	41	2994R	CD2	1.13	0.89	6.9	1.00	1.86	1.9	6.9	3.93	1.86	7.3			7.3	0.50	36	72.2	5.8	0.2	Qmax=40.87cfs Tt from 2994R to 2693R
	30	2693R	EB1	0.47	0.89	5.0	0.42	2.04	0.9													
CD1,CD2,EB1,EB2	31	2693R	EB2	1.60	0.89	10.0	1.41	1.62	2.3	10.0	5.76	1.62	9.4			9.4	0.50	36	65.13	5.8	0.2	Qmax=40.87cfs Tt from 2693R to 2193R
	29		WB6-5	0.28	0.89	5.0	0.25	2.04	0.5													
WB6-5, WB1	20	2193R	WB1	2.49	0.89	6.5	2.21	1.89	4.2					2.50					1000	3.1	5.3	Tt from WB6-5 to WB1
CD1-2,EB1-2,WB1-2,WB6-5 WEST,SW1-3,NF1-4,NW1	21	2193R	WB2	0.70	0.89	5.0	0.62	2.04	1.3	23.5	34.03	1.08	36.8									
CD1-2,EB1-2,WB1-2,WB6-5 WEST,SW1-3,NF1-4,NW1		2197C								24.4	34.03	1.06	36.1			36.8	0.50	54	400.71	7.6	0.9	Qmax=120.51cfs Tt from 2193R to 2197C
CD1-2,EB1-2,WB1-3,WB6-5 WEST,SW1-3,NF1-4,NW1	22	2197L	WB3	1.03	0.89	5.0	0.91	2.04	1.9	24.5	34.94	1.06	37.0			36.1	0.50	54	39.92	7.6	0.1	Qmax=120.51cfs Tt from 2197C to 2197L
																37.0	0.50	54	78.69	7.6	0.2	Qmax=120.51cfs Tt from 2197L to 5997C
	64	117L	NF4	0.40	0.45	5.0	0.18	2.04	0.4													
NF4		117C								5.0	0.18	2.03	0.4			0.4	1.00	18	11.44	5.2	0.0	Qmax=9.1cfs Tt from 117L to 117C
	63	115L	NF3	0.36	0.55	5.5	0.19	1.98	0.4							0.4	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 117C to 115C
NF3-NF4		115C								5.8	0.38	1.95	0.7			0.4	3.45	18	13.68	9.6	0.0	Qmax=16.91cfs Tt from 115L to 115C
	62	113L	NF2	0.29	0.83	5.0	0.24	2.04	0.5							0.7	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 115C to 113C1
NF2-NF4		113C1								6.6	0.61	1.88	1.2			0.5	3.18	18	14.96	9.2	0.0	Qmax=16.23cfs Tt from 113L to 113C1
	61	112L	NF1	0.23	0.89	5.0	0.20	2.04	0.4							1.2	0.50	18	133.14	3.6	0.6	Qmax=6.44cfs Tt from 113C1 to 112C1
NF1-NF4		112C1								7.2	0.81	1.83	1.5			0.4	11.38	18	15.23	17.4	0.0	Qmax=30.71cfs Tt from 112L to 112C1
NF1-NF4		111C1								7.7	0.81	1.79	1.5			1.5	0.50	18	108.46	3.6	0.5	Qmax=6.44cfs Tt from 112C1 to 111C1
																1.5	0.51	18	378.03	3.7	1.7	Qmax=6.5cfs Tt from 111C1 to 111C2
	69	116R2	NF9	0.32	0.86	5.0	0.28	2.04	0.6							0.6	1.00	18	83.41	5.2	0.3	Qmax=9.1cfs Tt from 116R2 to 116C
	68	116R1	NF8	1.02	0.73	5.0	0.75	2.04	1.5							1.5	1.00	18	17.59	5.2	0.1	Qmax=9.1cfs Tt from 116R1 to 116C
NF9, NF8		116C								5.3	1.02	2.01	2.1			2.1	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 116C to 114C

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY STORM

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PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 0.6 inches — Table 3.1, Ch 3, Vol 3, USDCM, 2011 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef. (C_2)	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	67	114R	NF7	0.54	0.85	5.0	0.46	2.04	0.9													
NF9, NF8, NF7		114C								5.7	1.48	1.96	2.9			0.9	3.00	18	16.56	8.9	0.0	Qmax=15.77cfs Tt from 114R to 114C
	66	113R	NF6	1.11	0.67	5.0	0.74	2.04	1.5							2.9	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 114C to 113C2
NF9, NF8, NF7, NF6		113C2								6.2	2.22	1.92	4.3			1.5	6.30	18	16.07	12.9	0.0	Qmax=22.85cfs Tt from 113R To 113C2
	65	112R	NF5	0.25	0.89	5.0	0.22	2.04	0.4							4.3	0.50	36	133.61	5.8	0.4	Qmax=40.87cfs Tt from 113C2 to 112C2
NF9, NF8, NF7 NF6, NF5		112C2								6.6	2.44	1.88	4.6			0.4	5.40	18	14.4	12.0	0.0	Qmax=21.16cfs Tt from 112R to 112C2
NF1-9		111C2								9.4	3.26	1.66	5.4			4.6	0.50	36	115.29	5.8	0.3	Qmax=40.87cfs Tt from 112C2 to 111C2
NF1-9		5994C								9.9	3.26	1.63	5.3			5.4	1.81	36	350.19	11.0	0.5	Qmax=77.77cfs Tt from 111C2 to 5994C
	71	5997L	NE	1.41	0.87	5.4	1.23	2.00	2.5							5.3	4.13	24	370.15	12.7	0.5	Qmax=39.84cfs Tt from 5994C to 5997C
NE, WB4	24	5997L	WB4	1.05	0.89	5.0	0.93	2.04	1.9	5.4	2.16	2.00	4.3			4.3	0.50	36	16.72	5.8	0.0	Qmax=40.87cfs Tt from 5997L to 5997C
W, SW1-3,NF1-9,NW1 CD1-3,EB1-2,WB1-4,NE		5997C								24.7	40.36	1.05	42.5			42.5	0.91	54	322.47	10.2	0.5	Qmax=162.58cfs Tt from 5997C to 6000C
W,SW1-3,NF1-9,NW1,BP CD1-3,EB1-2,WB1-5,NE,5TH		6000C								25.2	49.47	1.04	51.5			51.5	7.91	24	17.54	17.6	0.0	Qmax=55.14cfs Tt from 6000L to 6000C
W, SW1-3,NF1-9,NW1,BP CD1-3,EB1-2,WB1-5,NE,5TH		6000L	WATER QUALITY OUTLET TO POND							25.2	49.47	1.04	51.5									
	27	6004L	WB6	0.26	0.89	5.0	0.23	2.04	0.5													
		6004C								5.1	0.23	2.03	0.5			0.5	0.50	18	13.76	3.6	0.1	Qmax=6.44cfs Tt from 6004L to 6004C
		6006T								5.2	0.23	2.01	0.5			0.5	2.74	54	143.28	17.7	0.1	Qmax=282.11cfs Tt from 6004C to 6006T
	28	6007L	WBF1	0.48	0.89	5.5	0.42	1.99	0.8	5.5	0.65	1.99	1.3			0.5	0.30	72	104.19	7.1	0.2	Qmax=201.04cfs Tt from 6006T to 6007L
		300C	OUTFALL TO SOUTH PLATTE RIVER							7.4	0.65	1.81	1.2			1.3	0.30	72	813.21	7.1	1.9	Qmax=201.04cfs Tt from 6007L to 300C
	5	312R	SW3	0.97	0.33	8.4	0.33	1.73	0.6													
	6	311R-D	SW4	0.38	0.32	5.0	0.12	2.04	0.2	8.8	0.45	1.70	0.8			0.6	0.75	24	150	5.4	0.5	Qmax=16.98cfs Tt from 312R to 311R-D
Untreated To Weir Gulch		311R														0.8	1.00	24	22.21	6.2	0.1	Qmax=19.61cfs Tt from 311R-D to 311R
	60	414L	NW1	0.95	0.89	5.5	0.84	1.98	1.7													
		414C								5.6	0.84	1.98	1.7			1.7	0.50	24	17.66	4.4	0.1	Qmax=13.86cfs Tt from 414L to 414C
																1.7	0.50	24	152.08	4.4	0.6	Qmax=13.86cfs Tt from 414C to 412C-D

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY STORM

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 0.6 inches — Table 3.1, Ch 3, Vol 3, USDCM, 2011 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			Remarks *Pipe flow assumed to be full flow conditions
			Area Desig.	Area (Ac)	Runnoff Coef. (C_2)	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	
		412C-D								6.1	0.84	1.92	1.6									Qmax=0cfs
Untreated To Weir Gulch		412C								6.2	0.84	1.92	1.6			1.6	2.75	24	22.19	10.3	0.0	Tt from 412C-D to 412C
Flows Offsite	9		SR	0.34	0.89	5.0	0.30	2.04	0.6													
Flows to Barnum Lake	2		OS-7	0.61	0.72	5.0	0.44	2.04	0.9													
Flows to Barnum Lake	4		OS-8	0.10	0.28	5.0	0.03	2.04	0.1													
Water Quality Pond	10		WQ1	2.25	0.04	5.0	0.09	2.04	0.2													
Flows Offsite	11		WQ3	0.41	0.04	5.0	0.02	2.04	0.0													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 10-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK/DO

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006
n = 0.015 Manning's n

DATE: 7/6/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt	Remarks *Pipe flow assumed to be full flow conditions
	1	906L	SW1	0.73	0.92	5.0	0.67	5.26	3.5							3.5	1.00	18	24.42	5.2	0.1	Qmax=9.1cfs Tt from 906L to 906C
	3	906R	SW2	0.61	0.49	5.0	0.30	5.26	1.6							1.6	1.87	18	12.28	7.0	0.0	Qmax=12.45cfs Tt from 906R to 906C
SW1, SW2		906C								5.1	0.97	5.24	5.1			5.1	0.50	18	73.41	3.6	0.3	Qmax=6.44cfs Tt from 906C to 105C
SW1, SW2		105C								5.4	0.97	5.15	5.0			5.0	0.50	18	192.91	3.6	0.9	Qmax=6.44cfs Tt from 105C to 107C
SW1, SW2		107C								6.3	0.97	4.93	4.8			4.8	0.88	18	386.09	4.8	1.3	Qmax=8.54cfs Tt from 107C to 312R
SW1, SW2, SW3	5	312R	SW3	0.97	0.46	8.4	0.44	4.48	2.0	8.4	1.41	4.48	6.3			6.3	0.75	24	149.88	5.4	0.5	Qmax=16.98cfs Tt from 312R to 311R-D
SW1, SW2, SW3, SW4	6	311R	SW4	0.38	0.45	5.0	0.17	5.26	0.9	8.8	1.58	4.39	7.0			7.0	1.00	24	22.21	6.2	0.1	Qmax=16.98cfs Tt from 311R-D to 311R
SW1, SW2, SW3, SW4		311T	10-YR DISCHARGE TO WEIR GULCH							8.9	1.58	4.38	6.9									
	90		5TH1	1.12	0.57	5.0	0.64	5.26	3.4													
	91		5TH2	0.96	0.49	5.0	0.47	5.26	2.5					4.98	3.4				260	4.4	1.0	Tt from 205L to 208L
5TH1, 5TH3	92	208L	5TH3	0.47	0.41	5.0	0.19	5.26	1.0	6.0	0.83	5.00	4.2	4.40	2.5				300	4.2	1.2	Tt from 205R to 208R
5TH2, 5TH4	93	208R	5TH4	1.49	0.37	6.4	0.56	4.89	2.7	6.4	1.03	4.89	5.0			4.2	1.00	18	22.81	5.2	0.1	Qmax=9.1cfs Tt from 208L to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	1.86	4.88	9.1			5.0	1.00	18	22.23	5.2	0.1	Qmax=9.1cfs Tt from 208R to 208C
	97		OS-10	0.49	0.69	5.4	0.33	5.16	1.7							9.1	4.43	18	160.74	10.8	0.2	Qmax=19.16cfs Tt from 208C to 210C1
5TH5, OS-10	94	811L	5TH5	1.32	0.37	5.0	0.50	5.26	2.6	5.8	0.83	5.04	4.2	1.60	1.7				70	2.5	0.5	Tt from OS-10 to 811L
5TH5, OS-10		811C								5.9	0.83	5.02	4.2			4.2	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 811L to 811C
	95	211L	5TH6	0.24	0.54	5.0	0.13	5.26	0.7							4.2	0.50	18	82.17	3.6	0.4	Qmax=6.44cfs Tt from 811C to 210C1
	96	211R	5TH7	0.10	0.92	5.0	0.09	5.26	0.5							0.7	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 211L to 211C
5TH6, 5TH7		211C								5.1	0.22	5.23	1.2			0.5	1.00	18	15.79	5.2	0.1	Qmax=9.1cfs Tt from 211R to 211C
5TH1-7, OS-10		210C1								6.7	2.91	4.82	14.0			1.2	0.50	18	125.53	3.6	0.6	Qmax=6.44cfs Tt from 211C to 210C1
	80	210L	BPE1	1.83	0.60	5.0	1.10	5.26	5.8							14.0	0.50	24	172.1	4.4	0.6	Qmax=13.86cfs Tt from 210C1 to 210C2
5TH1-7, OS-10, BPE1		210C2								7.4	4.01	4.68	18.8			5.8	10.00	18	35.27	16.3	0.0	Qmax=28.79cfs Tt from 210L to 210C2
	81		BPE2	6.83	0.31	10.0	2.13	4.19	8.9							18.8	0.50	36	263.51	5.8	0.8	Qmax=40.87cfs Tt from 210C2 to 4998C
																8.9	2.00	24	Approx; Stub-out 100	8.8	0.2	Qmax=27.73cfs Tt from BPE2 to 4998C

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 10-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK/DO

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006
n = 0.015 Manning's n

DATE: 7/6/2012

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	7	106R	SE1	0.84	0.88	5.0	0.74	5.26	3.9							3.9	1.00	18	15.26	5.2	0.0	Qmax=9.1cfs Tt from 106R to 106C1
		106C1								5.0	0.74	5.24	3.9			3.9	0.50	18	94.36	3.6	0.4	Qmax=6.44cfs Tt from 106C1 to 106C2
		106C2								5.5	0.74	5.13	3.8			3.8	2.92	18	119.97	8.8	0.2	Qmax=15.56cfs Tt from 106C2 to 4990C
		4990C								5.7	0.74	5.07	3.8			3.8	0.50	24	366.16	4.4	1.4	Qmax=13.86cfs Tt from 4990C to 4994C
		4994C								7.1	0.74	4.74	3.5			3.5	4.12	24	377.7	12.7	0.5	Qmax=39.8cfs Tt from 4994C to 4998C
SE1, 5TH1-7 OS-10, BPE1, BPE2		4998C								10.2	6.88	4.16	28.6			28.6	0.50	42	231.89	6.4	0.6	Qmax=61.66cfs Tt from 4998C to 500C
	8	502R	SE2	1.41	0.92	7.6	1.29	4.64	6.0							6.0	0.50	18	20.34	3.6	0.1	Qmax=6.44cfs Tt from 502R to 502C
		502C								7.7	1.29	4.63	6.0			6.0	0.50	18	189.62	3.6	0.9	Qmax=6.44cfs Tt from 502C to 500C
	42	5000R	CD3	0.69	0.92	5.0	0.64	5.26	3.3							3.3	1.21	18	20.43	5.7	0.1	Qmax=10.01cfs Tt from 5000R to 500C
SE1, SE2, 5TH1-7, CD3 OS-10, BPE1, BPE2		500C								10.8	8.81	4.07	35.8			35.8	0.50	48	JACKED 284.99	7.0	0.7	Qmax=88.03cfs Tt from 500C to 6000C
	26	2507L2	WB5A	0.07	0.92	5.0	0.06	5.26	0.3							0.3	0.50	18	64.61	3.6	0.3	Qmax=6.44cfs Tt from 2507L2 to 2507L
	43	3007L	CD4	0.45	0.92	5.0	0.42	5.26	2.2							2.2	0.50	18	123.56	3.6	0.6	Qmax=6.44cfs Tt from 3007L to 2507L
WB5A, CD4, WB3A	23	2507L	WB3A	0.07	0.92	5.0	0.06	5.26	0.3	5.6	0.54	5.11	2.8			2.8	0.50	18	248.4	3.6	1.1	Qmax=6.44cfs Tt from 2507L to 2504C
	50	4004R	FR	0.69	0.92	5.3	0.63	5.19	3.3							3.3	0.50	18	118.15	3.6	0.5	Qmax=6.44cfs Tt from 4004R to 2504C
WB5A, CD4, WB3A FR		2504C								6.7	1.17	4.83	5.7			5.7	0.50	24	314.16	4.4	1.2	Qmax=13.86cfs Tt from 2504C to 2501C
		2501C								7.9	1.17	4.58	5.4			5.4	0.50	24	56.01	4.4	0.2	Qmax=13.86cfs Tt from 2501C to 2501L
WB5A, CD4, WB3A FR, WB5	25	2501L	WB5	0.65	0.92	5.0	0.60	5.26	3.1	8.1	1.77	4.54	8.0			8.0	0.50	24	74.93	4.4	0.3	Qmax=13.86cfs Tt from 2501L to 6000C
			WATER QUALITY FLOWS FROM DIVERSION AT WEIR GULCH ADDED TO STORM DRAIN SYSTEM AT DP 21										28.7									
	40	2994R	CD1	3.31	0.92	6.6	3.03	4.85	14.7													
CD1, CD2	41	2994R	CD2	1.13	0.92	6.9	1.03	4.79	4.9	6.9	4.07	4.79	19.5									Qmax=40.87cfs

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 10-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK/DO

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006
n = 0.015 Manning's n

DATE: 7/6/2012

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	30	2693R	EB1	0.47	0.92	5.0	0.43	5.26	2.3							19.5	0.50	36	72.2	5.8	0.2	Tt from 2994R to 2693R
CD1-2, EB1-2	31	2693R	EB2	1.60	0.92	10.0	1.46	4.19	6.1	10.0	5.96	4.19	25.0									
	29		WB6-5	0.28	0.92	5.0	0.26	5.26	1.4							25.0	0.50	42	65.13	6.41	0.2	Qmax=61.66cfs Tt from 2693R to 2193R
WB6-5, WB1	20	2193R	WB1	2.49	0.92	6.5	2.28	4.88	11.1	6.5	2.54	4.88	12.4	2.50						3.1	0.0	Tt from WB6-5 to WB1
CD1-2, EB1-2 WB1-2, WB6-5	21	2193R	WB2	0.70	0.92	5.0	0.64	5.26	3.4	10.2	9.14	4.17	+WQ 66.8			66.8	0.50	54	400.71	7.6	0.9	Qmax=120.51cfs Tt from 2193R to 2197C
CD1-2, EB1-2 WB1-2, WB6-5		2197C								11.1	9.14	4.03	+WQ 65.5			65.5	0.50	54	39.92	7.6	0.1	Qmax=120.51cfs Tt from 2197C to 2197L
CD1-2, EB1-2 WB1-3, WB6-5	22	2197L	WB3	1.03	0.92	5.0	0.94	5.26	5.0	11.1	10.08	4.01	+WQ 69.2			69.2	0.50	54	78.69	7.6	0.2	Qmax=120.51cfs Tt from 2197L to 5997C
	69	116R2	NF9	0.32	0.90	5.0	0.29	5.26	1.5							1.5	1.00	18	83.41	5.2	0.3	Qmax=9.1cfs Tt from 116R2 to 116C
	68	116R1	NF8	1.02	0.78	5.0	0.79	5.26	4.2							4.2	1.00	18	17.59	5.2	0.1	Qmax=9.1cfs Tt from 116R1 to 116C
NF9, NF8		116C								5.3	1.08	5.18	5.6			5.6	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 116C to 114C
	67	114R	NF7	0.54	0.88	5.0	0.48	5.26	2.5							2.5	3.00	18	16.56	8.9	0.0	Qmax=15.77cfs Tt from 114R to 114C
NF9, NF8, NF7		114C								5.7	1.56	5.06	7.9			7.9	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 114C to 113C2
	66	113R	NF6	1.11	0.72	5.0	0.80	5.26	4.2							4.2	6.30	18	16.07	12.9	0.0	Qmax=22.85cfs Tt from 113R To 113C2
NF9, NF8, NF7, NF6		113C2								6.2	2.36	4.95	11.7			11.7	0.50	36	133.61	5.8	0.4	Qmax=40.87cfs Tt from 113C2 to 112C2
	65	112R	NF5	0.25	0.92	5.0	0.23	5.26	1.2							1.2	5.40	18	14.4	12.0	0.0	Qmax=21.16cfs Tt from 112R to 112C2
NF9, NF8, NF7 NF6, NF5		112C2								6.6	2.59	4.86	12.6			12.6	0.50	36	115.29	5.8	0.3	Qmax=40.87cfs Tt from 112C2 to 111C2
NF9, NF8, NF7 NF6, NF5		111C2								6.9	2.59	4.78	12.4			12.4	1.81	36	350.19	11.0	0.5	Qmax=77.77cfs Tt from 111C2 to 5994C
NF9, NF8, NF7 NF6, NF5		5994C								7.4	2.59	4.67	12.1			12.1	4.13	36	370.15	16.6	0.4	Qmax=117.47cfs Tt from 5994C to 5997C
	71	5997L	NE	1.41	0.90	5.4	1.28	5.16	6.6													
NE, WB4	24	5997L	WB4	1.05	0.92	5.0	0.96	5.26	5.0	5.4	2.24	5.16	11.5									
NE, NF5-9, WB1-4 CD1-2, EB1-2,WB6-5		5997C								11.3	15.65	3.99	+WQ 91.2			11.5	0.50	36	16.72	5.8	0.0	Qmax=40.87cfs Tt from 5997L to 5997C
			WATER QUALITY FLOWS DIVERTED TO US 6 POND										51.5			91.2	0.91	54	322.47	10.2	0.5	Qmax=162.58cfs Tt from 5997C to 6000C

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 10-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 1.55 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-5,NE,WB6-5		6000C								11.8	25.49	3.91	-WQ 77.0			77.0	1.25	54	381.92	12.0	0.5	Qmax=190.55cfs Tt from 6000C to 6004C
	27	6004L	WB6	0.26	0.92	5.0	0.23	5.26	1.2							1.2	0.50	18	13.76	3.6	0.1	Qmax=6.44cfs Tt from 6004L to 6004C
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-6,NE		6004C								12.4	25.72	3.84	-WQ 76.0			76.0	2.74	54	143.28	17.7	0.1	Qmax=282.11cfs Tt from 6004C to 6006C
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-6,NE,WB6-5		6006C								12.5	25.72	3.82	-WQ 75.5			75.5	0.30	72	435.44	7.1	1.0	Qmax=201.04cfs Tt from 6006C to 305C
	28	305C	WBF1	0.48	0.92	5.5	0.44	5.13	2.2	13.5	26.16	3.69	-WQ 73.8			73.8	0.30	72	481.95	7.1	1.1	Qmax=201.04cfs Tt from 305C to 300C
NF5-9,BP,5TH,CD1-3,WB6-5 FR,EB1-2,WB1-6,NE,WBF1		300C	10-YR DISCHARGE TO THE SOUTH PLATTE RIVER							14.7	26.16	3.56	-WQ 70.3									
	64	117L	NF4	0.40	0.54	5.0	0.22	5.26	1.1							1.1	1.00	18	11.44	5.2	0.0	Qmax=9.1cfs Tt from 117L to 117C
NF4		117C								5.0	0.22	5.25	1.1			1.1	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 117C to 115C
	63	115L	NF3	0.36	0.62	5.5	0.22	5.12	1.1							1.1	3.45	18	13.68	9.6	0.0	Qmax=16.91cfs Tt from 115L to 115C
NF3-NF4		115C								5.8	0.44	5.05	2.2			2.2	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 115C to 113C1
	62	113L	NF2	0.29	0.86	5.0	0.25	5.26	1.3							1.3	3.18	18	14.96	9.2	0.0	Qmax=16.23cfs Tt from 113L to 113C1
NF2-NF4		113C1								6.6	0.69	4.86	3.3			3.3	0.50	18	133.14	3.6	0.6	Qmax=6.44cfs Tt from 113C1 to 112C1
	61	112L	NF1	0.23	0.92	5.0	0.21	5.26	1.1							1.1	11.38	18	15.23	17.4	0.0	Qmax=30.71cfs Tt from 112L to 112C1
NF1-NF4		112C1								7.2	0.89	4.73	4.2			4.2	0.50	18	108.46	3.6	0.5	Qmax=6.44cfs Tt from 112C1 to 111C1
NF1-NF4		111C1								7.7	0.89	4.62	4.1			4.1	0.51	18	378.03	3.7	1.7	Qmax=6.5cfs Tt from 111C1 to 414C
	60	414L	NW1	0.95	0.92	5.5	0.87	5.12	4.5							4.5	0.50	24	17.66	4.4	0.1	Qmax=13.86cfs Tt from 414L to 414C
NF1-NF4, NW1		414C								9.4	1.77	4.30	7.6			7.6	0.50	24	152.08	4.4	0.6	Qmax=13.86cfs Tt from 414C to 412C-D
NF1-NF4, NW1		412C-D								10.0	1.77	4.20	7.4			7.4	2.75	24	22.19	10.3	0.0	Qmax=32.51cfs Tt from 412C-D to 412C
NF1-NF4, NW1		412C	10-YR DISCHARGE TO WEIR GULCH							10.0	1.77	4.19	7.4									
Flows Offsite	9		SR	0.34	0.92	5.0	0.31	5.26	1.6													
Flows to Barnum Lake	2		OS-7	0.61	0.76	5.0	0.47	5.26	2.5													
Flows to Barnum Lake	4		OS-8	0.10	0.42	5.0	0.04	5.26	0.2													
Water Quality Pond	10		WQ1	2.25	0.25	5.0	0.56	5.26	3.0													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 10-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 1.55 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
Flows Offsite	11		WQ3	0.41	0.25	5.0	0.10	5.26	0.5													

NOTE: PIPES BETWEEN INLETS 2193R AND 6000C INCLUDE WATER QUALITY FLOWS FROM THE DIVERSION AT WEIR GULCH, AS NOTED BY "+WQ". THE FLOW DIVERTED AT 6000L TO THE US 6 POND IS THEN SUBTRACTED FROM THE FLOWS BETWEEN INLETS 6000L AND THE OUTFALL TO THE SOUTH PLATTE RIVER, AS NOTED BY "-WQ".

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	1	906L	SW1	0.73	0.96	5.0	0.70	7.63	5.3													
																5.3	1.00	18	24.42	5.2	0.1	Qmax=9.1cfs Tt from 906L to 906C
	3	906R	SW2	0.61	0.59	5.0	0.36	7.63	2.8													
																2.8	1.87	18	12.28	7.0	0.0	Qmax=12.45cfs Tt from 906R to 906C
SW1, SW2		906C								5.1	1.06	7.60	8.1									
																8.1	0.50	18	73.41	3.6	0.3	Qmax=6.44cfs Tt from 906C to 105C
SW1, SW2		105C								5.4	1.06	7.47	7.9									
																7.9	0.50	18	192.91	3.6	0.9	Qmax=6.44cfs Tt from 105C to 107C
SW1, SW2		107C								6.3	1.06	7.15	7.6									
																7.6	0.88	18	386.09	4.8	1.3	Qmax=8.54cfs Tt from 107C to 312R
SW1, SW2, SW3	5	312R	SW3	0.97	0.57	8.4	0.56	6.50	3.6	8.4	1.62	6.50	10.5									
																10.5	0.75	24	149.88	5.4	0.5	Qmax=16.98cfs Tt from 312R to 311R-D
SW1, SW2, SW3, SW4	6	SUMP 311R	SW4	0.38	0.56	5.0	0.22	7.63	1.6	8.8	1.83	6.38	11.7									
																11.7	1.00	24	22.21	6.2	0.1	Qmax=19.61cfs Tt from 311R-D to 311R
SW1, SW2, SW3, SW4		311T	50-YR DISCHARGE TO WEIR GULCH							8.9	1.83	6.36	11.7									
	90		5TH1	1.12	0.66	5.0	0.74	7.63	5.6													
														4.98	5.6				260	4.4	1.0	Tt from 205L to 208L
	91		5TH2	0.96	0.60	5.0	0.57	7.63	4.4													
														4.40	4.4				300	4.2	1.2	Tt from 205R to 208R
5TH1, 5TH3	92	208L	5TH3	0.47	0.54	5.0	0.26	7.63	2.0	6.0	0.99	7.26	7.2									
																7.2	1.00	18	22.81	5.2	0.1	Qmax=9.1cfs Tt from 208L to 208C
5TH2, 5TH4	93	208R	5TH4	1.49	0.52	6.4	0.78	7.10	5.5	6.4	1.35	7.10	9.6									
																9.6	1.00	18	22.23	5.2	0.1	Qmax=9.1cfs Tt from 208R to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	2.34	7.08	16.6									
																16.6	4.43	18	160.74	10.8	0.2	Qmax=19.16cfs Tt from 208C to 210C1
	97		OS-10	0.49	0.75	5.4	0.37	7.49	2.7													
														1.60	2.7				70	2.5	0.5	Tt from OS-10 to 811L
5TH5, OS-10	94	SUMP 811L	5TH5	1.32	0.52	5.0	0.69	7.63	5.3	5.8	1.06	7.31	7.7									
																7.7	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 811L to 811C
5TH5, OS-10		811C								5.9	1.06	7.28	7.7									
																7.7	0.50	18	82.17	3.6	0.4	Qmax=6.44cfs Tt from 811C to 210C1
	95	211L	5TH6	0.24	0.63	5.0	0.15	7.63	1.2													
																1.2	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 211L to 211C
	96	211R	5TH7	0.10	0.96	5.0	0.09	7.63	0.7													
																0.7	1.00	18	15.79	5.2	0.1	Qmax=9.1cfs Tt from 211R to 211C
5TH6, 5TH7		211C								5.1	0.25	7.60	1.9									
																1.9	0.50	18	125.53	3.6	0.6	Qmax=6.44cfs Tt from 211C to 210C1
5TH1-7, OS-10		210C1								6.7	3.65	7.00	25.5									
																25.5	0.50	24	172.1	4.4	0.6	Qmax=13.86cfs Tt from 210C1 to 210C2
	80	210L	BPE1	1.83	0.68	5.0	1.24	7.63	9.5													
																9.5	10.00	18	35.27	16.3	0.0	Qmax=28.79cfs Tt from 210L to 210C2
5TH1-7, OS-10, BPE1		210C2								7.4	4.89	6.79	33.2									
																33.2	0.50	36	263.51	5.8	0.8	Qmax=40.87cfs Tt from 210C2 to 4998C
	81		BPE2	6.83	0.48	10.0	3.30	6.09	20.1													
																20.1	2.00	24	Approx; Stub-out 100	8.8	0.2	Qmax=27.73cfs Tt from BPE2 to 4998C

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	7	SUMP 106R	SE1	0.84	0.92	5.0	0.78	7.63	5.9							5.9	1.00	18	15.26	5.2	0.0	Qmax=9.1cfs Tt from 106R to 106C1
		106C1								5.0	0.78	7.61	5.9			5.9	0.50	18	94.36	3.6	0.4	Qmax=6.44cfs Tt from 106C1 to 106C2
		106C2								5.5	0.78	7.44	5.8			5.8	2.92	18	119.97	8.8	0.2	Qmax=15.56cfs Tt from 106C2 to 4990C
		4990C								5.7	0.78	7.36	5.7			5.7	0.50	24	366.16	4.4	1.4	Qmax=13.86cfs Tt from 4990C to 4994C
		4994C								7.1	0.78	6.89	5.4			5.4	4.12	24	377.7	12.7	0.5	Qmax=39.8cfs Tt from 4994C to 4998C
SE1, 5TH1-7 OS-10, BPE1, BPE2		4998C								10.2	8.97	6.04	54.2			54.2	0.50	42	231.89	6.4	0.6	Qmax=61.66cfs Tt from 4998C to 500C
	8	502R	SE2	1.41	0.96	7.6	1.34	6.74	9.1							9.1	0.50	18	20.34	3.6	0.1	Qmax=6.44cfs Tt from 502R to 502C
		502C								7.7	1.34	6.71	9.0			9.0	0.50	18	189.62	3.6	0.9	Qmax=6.44cfs Tt from 502C to 500C
	42	SUMP 5000R	CD3	0.69	0.96	5.0	0.66	7.63	5.1							5.1	1.21	18	20.43	5.7	0.1	Qmax=10.01cfs Tt from 5000R to 500C
SE1, SE2, 5TH1-7, CD3 OS-10, BPE1, BPE2		500C								10.8	10.98	5.90	64.8			64.8	0.50	48	JACKED 284.99	7.0	0.7	Qmax=88.03cfs Tt from 500C to 6000C
	26	2507L2	WB5A	0.07	0.96	5.0	0.07	7.63	0.5							0.5	0.50	18	64.61	3.6	0.3	Qmax=6.44cfs Tt from 2507L2 to 2507L
	43	3007L	CD4	0.45	0.96	5.0	0.43	7.63	3.3							3.3	0.50	18	123.56	3.6	0.6	Qmax=6.44cfs Tt from 3007L to 2507L
WB5A, CD4, WB3A	23	2507L	WB3A	0.07	0.96	5.0	0.06	7.63	0.5	5.6	0.57	7.41	4.2			4.2	0.50	18	248.4	3.6	1.1	Qmax=6.44cfs Tt from 2507L to 2504C
	50	SUMP 4004R	FR	0.69	0.96	5.3	0.66	7.53	5.0							5.0	0.50	18	118.15	3.6	0.5	Qmax=6.44cfs Tt from 4004R to 2504C
WB5A, CD4, WB3A FR		2504C								6.7	1.22	7.01	8.6			8.6	0.50	24	314.16	4.4	1.2	Qmax=13.86cfs Tt from 2504C to 2501C
		2501C								7.9	1.22	6.65	8.1			8.1	0.50	24	56.01	4.4	0.2	Qmax=13.86cfs Tt from 2501C to 2501L
WB5A, CD4, WB3A FR, WB5	25	2501L	WB5	0.65	0.96	5.0	0.63	7.63	4.8	8.1	1.85	6.58	12.2			12.2	0.50	24	74.93	4.4	0.3	Qmax=13.86cfs Tt from 2501L to 6000C
			WATER QUALITY FLOWS FROM DIVERSION AT WEIR GULCH ADDED TO STORM DRAIN SYSTEM AT DP 21										28.7									
	40	SUMP 2994R	CD1	3.31	0.96	6.6	3.17	7.04	22.3													
CD1, CD2	41	SUMP 2994R	CD2	1.13	0.96	6.9	1.08	6.96	7.5	6.9	4.24	6.96	29.5									Qmax=40.87cfs

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	30	SUMP 2693R	EB1	0.47	0.96	5.0	0.45	7.63	3.4							29.5	0.50	36	72.2	5.8	0.2	Tt from 2994R to 2693R
CD1-2, EB1-2	31	SUMP 2693R	EB2	1.60	0.96	10.0	1.53	6.09	9.3	10.0	6.22	6.09	37.9									
	29		WB6-5	0.28	0.96	5.0	0.27	7.63	2.1							37.9	0.50	42	65.13	6.4	0.2	Qmax=61.66cfs Tt from 2693R to 2193R
WB6-5, WB1	20	SUMP 2193R	WB1	2.49	0.96	6.5	2.38	7.08	16.8	6.5	2.65	7.08	18.7	2.50						3.1	0.0	Tt from WB6-5 to WB1
CD1-2, EB1-2 WB1-2, WB6-5	21	SUMP 2193R	WB2	0.70	0.96	5.0	0.67	7.63	5.1	10.2	9.54	6.05	+WQ 86.4									
CD1-2, EB1-2 WB1-2, WB6-5		2197C								11.1	9.54	5.85	+WQ 84.5			86.4	0.50	54	400.71	7.6	0.9	Qmax=120.51cfs Tt from 2193R to 2197C
CD1-2, EB1-2 WB1-3, WB6-5	22	2197L	WB3	1.03	0.96	5.0	0.98	7.63	7.5	11.1	10.53	5.83	+WQ 90.1			84.5	0.50	54	39.92	7.6	0.1	Qmax=120.51cfs Tt from 2197C to 2197L
																90.1	0.50	54	78.69	7.6	0.2	Qmax=120.51cfs Tt from 2197L to 5997C
	69	SUMP 116R2	NF9	0.32	0.94	5.0	0.30	7.63	2.3													
	68	SUMP 116R1	NF8	1.02	0.83	5.0	0.85	7.63	6.5							2.3	1.00	18	83.41	5.2	0.3	Qmax=9.1cfs Tt from 116R2 to 116C
NF9, NF8		116C								5.3	1.15	7.53	8.7			6.5	1.00	18	17.59	5.2	0.1	Qmax=9.1cfs Tt from 116R1 to 116C
	67	114R	NF7	0.54	0.93	5.0	0.50	7.63	3.8							8.7	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 116C to 114C
NF9, NF8, NF7		114C								5.7	1.65	7.35	12.1			3.8	3.00	18	16.56	8.9	0.0	Qmax=15.77cfs Tt from 114R to 114C
	66	113R	NF6	1.11	0.78	5.0	0.87	7.63	6.7							12.1	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 114C to 113C2
NF9, NF8, NF7, NF6		113C2								6.2	2.52	7.19	18.1			6.7	6.30	18	16.07	12.9	0.0	Qmax=22.85cfs Tt from 113R To 113C2
	65	112R	NF5	0.25	0.96	5.0	0.24	7.63	1.8							18.1	0.50	36	133.61	5.8	0.4	Qmax=40.87cfs Tt from 113C2 to 112C2
NF9, NF8, NF7 NF6, NF5		112C2								6.6	2.76	7.05	19.5			1.8	5.40	18	14.4	12.0	0.0	Qmax=21.16cfs Tt from 112R to 112C2
NF9, NF8, NF7 NF6, NF5		111C2								6.9	2.76	6.95	19.2			19.5	0.50	36	115.29	5.8	0.3	Qmax=40.87cfs Tt from 112C2 to 111C2
NF9, NF8, NF7 NF6, NF5		5994C								7.4	2.76	6.78	18.7			19.2	1.81	36	350.19	11.0	0.5	Qmax=77.77cfs Tt from 111C2 to 5994C
	71	SUMP 5997L	NE	1.41	0.94	5.4	1.34	7.49	10.0							18.7	4.13	36	370.15	16.6	0.4	Qmax=117.47cfs Tt from 5994C to 5997C
NE, WB4	24	SUMP 5997L	WB4	1.05	0.96	5.0	1.00	7.63	7.6	5.4	2.34	7.49	17.5									
NE, NF5-9, WB1-4 CD1-2, EB1-2,WB6-5		5997C								11.3	16.40	5.79	+WQ 123.7			17.5	0.50	36	16.72	5.8	0.0	Qmax=40.87cfs Tt from 5997L to 5997C
			WATER QUALITY FLOWS DIVERTED TO US 6 POND										51.5			123.7	0.91	54	322.47	10.2	0.5	Qmax=162.58cfs Tt from 5997C to 6000C

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt	Remarks *Pipe flow assumed to be full flow conditions
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-5,NE,WB6-5		6000C								11.8	28.45	5.68	-WQ 138.8			138.8	1.25	54	381.92	12.0	0.5	Qmax=190.55cfs Tt from 6000C to 6004C
	27	6004L	WB6	0.26	0.96	5.0	0.24	7.63	1.9							1.9	0.50	18	13.76	3.6	0.1	Qmax=6.44cfs Tt from 6004L to 6004C
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-6,NE		6004C								12.4	28.69	5.57	-WQ 137.2			137.2	2.74	54	143.28	17.7	0.1	Qmax=282.11cfs Tt from 6004C to 6006C
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-6,NE,WB6-5		6006C								12.5	28.69	5.55	-WQ 136.4			136.4	0.30	72	435.44	7.1	1.0	Qmax=201.04cfs Tt from 6006C to 305C
	28	305C	WBF1	0.48	0.96	5.5	0.46	7.45	3.4	13.5	29.15	5.36	-WQ 133.4			133.4	0.30	72	481.95	7.1	1.1	Qmax=201.04cfs Tt from 305C to 300C
NF5-9,BP,5TH,CD1-3,WB6-5 FR,EB1-2,WB1-6,NE,WBF1		300C	50-YR DISCHARGE TO THE SOUTH PLATTE RIVER							14.7	29.15	5.16	-WQ 127.8									
	64	117L	NF4	0.40	0.64	5.0	0.25	7.63	1.9							1.9	1.00	18	11.44	5.2	0.0	Qmax=9.1cfs Tt from 117L to 117C
NF4		117C								5.0	0.25	7.62	1.9			1.9	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 117C to 115C
	63	115L	NF3	0.36	0.70	5.5	0.25	7.43	1.8							1.8	3.45	18	13.68	9.6	0.0	Qmax=16.91cfs Tt from 115L to 115C
NF3-NF4		115C								5.8	0.50	7.32	3.7			3.7	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 115C to 113C1
	62	113L	NF2	0.29	0.91	5.0	0.26	7.63	2.0							2.0	3.18	18	14.96	9.2	0.0	Qmax=16.23cfs Tt from 113L to 113C1
NF2-NF4		113C1								6.6	0.76	7.06	5.4			5.4	0.50	18	133.14	3.6	0.6	Qmax=6.44cfs Tt from 113C1 to 112C1
	61	112L	NF1	0.23	0.96	5.0	0.22	7.63	1.7							1.7	11.38	18	15.23	17.4	0.0	Qmax=30.71cfs Tt from 112L to 112C1
NF1-NF4		112C1								7.2	0.98	6.86	6.7			6.7	0.50	18	108.46	3.6	0.5	Qmax=6.44cfs Tt from 112C1 to 111C1
NF1-NF4		111C1								7.7	0.98	6.71	6.6			6.6	0.51	18	378.03	3.7	1.7	Qmax=6.5cfs Tt from 111C1 to 414C
	60	SUMP 414L	NW1	0.95	0.96	5.5	0.91	7.44	6.8							6.8	0.50	24	17.66	4.4	0.1	Qmax=13.86cfs Tt from 414L to 414C
NF1-NF4, NW1		414C								9.4	1.89	6.24	11.8			11.8	0.50	24	152.08	4.4	0.6	Qmax=13.86cfs Tt from 414C to 412C-D
NF1-NF4, NW1		412C-D								10.0	1.89	6.10	11.5			11.5	2.75	24	22.19	10.3	0.0	Qmax=32.51cfs Tt from 412C-D to 412C
NF1-NF4, NW1		412C	50-YR DISCHARGE TO WEIR GULCH							10.0	1.89	6.09	11.5									
Flows Offsite	9		SR	0.34	0.96	5.0	0.33	7.63	2.5													
Flows to Barnum Lake	2		OS-7	0.61	0.82	5.0	0.50	7.63	3.8													
Flows to Barnum Lake	4		OS-8	0.10	0.55	5.0	0.05	7.63	0.4													
Water Quality Pond	10		WQ1	2.25	0.44	5.0	0.99	7.63	7.6													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 50-YEAR (FOR SUMP INLETS ONLY)

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.25 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
Flows Offsite	11		WQ3	0.41	0.44	5.0	0.18	7.63	1.4													

NOTE: PIPES BETWEEN INLETS 2193R AND 6000C INCLUDE WATER QUALITY FLOWS FROM THE DIVERSION AT WEIR GULCH, AS NOTED BY "+WQ". THE FLOW DIVERTED AT 6000L TO THE US 6 POND IS THEN SUBTRACTED FROM THE FLOWS BETWEEN INLETS 6000L AND THE OUTFALL TO THE SOUTH PLATTE RIVER, AS NOTED BY "-WQ".

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR ROUTED

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	1	906L	SW1	0.73	0.96	5.0	0.70	8.72	6.1													
																6.1	1.00	18	24.42	5.2	0.1	Qmax=9.1cfs Tt from 906L to 906C
	3	906R	SW2	0.61	0.62	5.0	0.38	8.72	3.3													
																3.3	1.87	18	12.28	7.0	0.0	Qmax=12.45cfs Tt from 906R to 906C
SW1, SW2		906C								5.1	1.08	8.68	9.4									
																9.4	0.50	18	73.41	3.6	0.3	Qmax=6.44cfs Tt from 906C to 105C
SW1, SW2		105C								5.4	1.08	8.53	9.2									
																9.2	0.50	18	192.91	3.6	0.9	Qmax=6.44cfs Tt from 105C to 107C
SW1, SW2		107C								6.3	1.08	8.17	8.8									
																8.8	0.88	18	386.09	4.8	1.3	Qmax=8.54cfs Tt from 107C to 312R
SW1, SW2, SW3	5	312R	SW3	0.97	0.60	8.4	0.59	7.43	4.4	8.4	1.66	7.43	12.4									
																12.4	0.75	24	149.88	5.4	0.5	Qmax=16.98cfs Tt from 312R to 311R-D
SW1, SW2, SW3, SW4	6	SUMP 311R	SW4	0.38	0.60	5.0	0.23	8.72	2.0	8.8	1.89	7.28	13.8									
																13.8	1.00	24	22.21	6.2	0.1	Qmax=19.61cfs Tt from 311R-D to 311R
SW1, SW2, SW3, SW4		311T	100-YR DISCHARGE TO WEIR GULCH							8.9	1.89	7.27	13.7									
	90		5TH1	1.12	0.68	5.0	0.76	8.72	6.6													
														4.98	6.6				260	4.4	1.0	Tt from 205L to 208L
	91		5TH2	0.96	0.62	5.0	0.60	8.72	5.2													
														4.40	5.2				300	4.2	1.2	Tt from 205R to 208R
5TH1, 5TH3	92	208L	5TH3	0.47	0.58	5.0	0.27	8.72	2.4	6.0	1.03	8.30	8.6									
																8.6	1.00	18	22.81	5.2	0.1	Qmax=9.1cfs Tt from 208L to 208C
5TH2, 5TH4	93	208R	5TH4	1.49	0.57	6.4	0.84	8.12	6.8	6.4	1.44	8.12	11.7									
																11.7	1.00	18	22.23	5.2	0.1	Qmax=9.1cfs Tt from 208R to 208C
5TH1, 5TH2 5TH3, 5TH4		208C								6.5	2.47	8.09	20.0									
																20.0	4.43	18	160.74	10.8	0.2	Qmax=19.16cfs Tt from 208C to 210C1
	97		OS-10	0.49	0.77	5.4	0.37	8.55	3.2													
														1.60	3.2				70	2.5	0.5	Tt from OS-10 to 811L
5TH5, OS-10	94	SUMP 811L	5TH5	1.32	0.57	5.0	0.75	8.72	6.5	5.8	1.12	8.36	9.3									
																9.3	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 811L to 811C
5TH5, OS-10		811C								5.9	1.12	8.32	9.3									
																9.3	0.50	18	82.17	3.6	0.4	Qmax=6.44cfs Tt from 811C to 210C1
	95	211L	5TH6	0.24	0.65	5.0	0.16	8.72	1.4													
																1.4	1.00	18	28.29	5.2	0.1	Qmax=9.1cfs Tt from 211L to 211C
	96	211R	5TH7	0.10	0.96	5.0	0.09	8.72	0.8													
																0.8	1.00	18	15.79	5.2	0.1	Qmax=9.1cfs Tt from 211R to 211C
5TH6, 5TH7		211C								5.1	0.25	8.68	2.2									
																2.2	0.50	18	125.53	3.6	0.6	Qmax=6.44cfs Tt from 211C to 210C1
5TH1-7, OS-10		210C1								6.7	3.84	7.99	30.7									
																30.7	0.50	24	172.1	4.4	0.6	Qmax=13.86cfs Tt from 210C1 to 210C2
	80	210L	BPE1	1.83	0.70	5.0	1.27	8.72	11.1													
																11.1	10.00	18	35.27	16.3	0.0	Qmax=28.79cfs Tt from 210L to 210C2
5TH1-7, OS-10, BPE1		210C2								7.4	5.11	7.76	39.7									
																39.7	0.50	36	263.51	5.8	0.8	Qmax=40.87cfs Tt from 210C2 to 4998C
	81		BPE2	6.83	0.54	10.0	3.66	6.95	25.5										Approx; Stub-out			
																25.5	2.00	24	100	8.8	0.2	Qmax=27.73cfs Tt from BPE2 to 4998C

OLSSON ASSOCIATES

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR ROUTED

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK/DO

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006
n = 0.015 Manning's n

DATE: 7/6/2012

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	7	SUMP 106R	SE1	0.84	0.92	5.0	0.78	8.72	6.8							6.8	1.00	18	15.26	5.2	0.0	Qmax=9.1cfs Tt from 106R to 106C1
		106C1								5.0	0.78	8.69	6.8			6.8	0.50	18	94.36	3.6	0.4	Qmax=6.44cfs Tt from 106C1 to 106C2
		106C2								5.5	0.78	8.50	6.6			6.6	2.92	18	119.97	8.8	0.2	Qmax=15.56cfs Tt from 106C2 to 4990C
		4990C								5.7	0.78	8.41	6.6			6.6	0.50	24	366.16	4.4	1.4	Qmax=13.86cfs Tt from 4990C to 4994C
		4994C								7.1	0.78	7.87	6.1			6.1	4.12	24	377.7	12.7	0.5	Qmax=39.8cfs Tt from 4994C to 4998C
SE1, 5TH1-7 OS-10, BPE1, BPE2		4998C								10.2	9.56	6.90	65.9			65.9	0.50	42	231.89	6.4	0.6	Qmax=61.66cfs Tt from 4998C to 500C
	8	502R	SE2	1.41	0.96	7.6	1.34	7.70	10.4							10.4	0.50	18	20.34	3.6	0.1	Qmax=6.44cfs Tt from 502R to 502C
		502C								7.7	1.34	7.67	10.3			10.3	0.50	18	189.62	3.6	0.9	Qmax=6.44cfs Tt from 502C to 500C
	42	SUMP 5000R	CD3	0.69	0.96	5.0	0.66	8.72	5.8							5.8	1.21	18	20.43	5.7	0.1	Qmax=10.01cfs Tt from 5000R to 500C
SE1, SE2, 5TH1-7, CD3 OS-10, BPE1, BPE2		500C								10.8	11.56	6.74	78.0			78.0	0.50	48	JACKED 284.99	7.0	0.7	Qmax=88.03cfs Tt from 500C to 6000C
	26	2507L2	WB5A	0.07	0.96	5.0	0.07	8.72	0.6							0.6	0.50	18	64.61	3.6	0.3	Qmax=6.44cfs Tt from 2507L2 to 2507L
	43	3007L	CD4	0.45	0.96	5.0	0.43	8.72	3.8							3.8	0.50	18	123.56	3.6	0.6	Qmax=6.44cfs Tt from 3007L to 2507L
WB5A, CD4, WB3A	23	2507L	WB3A	0.07	0.96	5.0	0.06	8.72	0.6	5.6	0.57	8.47	4.8			4.8	0.50	18	248.4	3.6	1.1	Qmax=6.44cfs Tt from 2507L to 2504C
	50	SUMP 4004R	FR	0.69	0.96	5.3	0.66	8.60	5.7							5.7	0.50	18	118.15	3.6	0.5	Qmax=6.44cfs Tt from 4004R to 2504C
WB5A, CD4, WB3A FR		2504C								6.7	1.22	8.01	9.8			9.8	0.50	24	314.16	4.4	1.2	Qmax=13.86cfs Tt from 2504C to 2501C
		2501C								7.9	1.22	7.59	9.3			9.3	0.50	24	56.01	4.4	0.2	Qmax=13.86cfs Tt from 2501C to 2501L
WB5A, CD4, WB3A FR, WB5	25	2501L	WB5	0.65	0.96	5.0	0.63	8.72	5.5	8.1	1.85	7.52	13.9			13.9	0.50	24	74.93	4.4	0.3	Qmax=13.86cfs Tt from 2501L to 6000C
			WATER QUALITY FLOWS FROM DIVERSION AT WEIR GULCH ADDED TO STORM DRAIN SYSTEM AT DP 21										28.7									
	40	SUMP 2994R	CD1	3.31	0.96	6.6	3.17	8.04	25.5													
CD1, CD2	41	SUMP 2994R	CD2	1.13	0.96	6.9	1.08	7.95	8.6	6.9	4.24	7.95	33.7									Qmax=40.87cfs

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR ROUTED

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
	30	SUMP 2693R	EB1	0.47	0.96	5.0	0.45	8.72	3.9							33.7	0.50	36	72.2	5.8	0.2	Tt from 2994R to 2693R
CD1-2, EB1-2	31	SUMP 2693R	EB2	1.60	0.96	10.0	1.53	6.95	10.6	10.0	6.22	6.95	43.2									Qmax=61.66cfs
	29		WB6-5	0.28	0.96	5.0	0.27	8.72	2.4							43.2	0.50	42	65.13	6.4	0.2	Tt from 2693R to 2193R
WB6-5, WB1	20	SUMP 2193R	WB1	2.49	0.96	6.5	2.38	8.08	19.2	6.5	2.65	8.08	21.4	2.50						3.1	0.0	Tt from WB6-5 to WB1
CD1-2, EB1-2 WB1-2, WB6-5	21	SUMP 2193R	WB2	0.70	0.96	5.0	0.67	8.72	5.9	10.2	9.54	6.91	+WQ 94.6									Qmax=120.51cfs
CD1-2, EB1-2 WB1-2, WB6-5		2197C								11.1	9.54	6.68	+WQ 92.4			94.6	0.50	54	400.71	7.6	0.9	Tt from 2193R to 2197C
CD1-2, EB1-2 WB1-3, WB6-5	22	2197L	WB3	1.03	0.96	5.0	0.98	8.72	8.6	11.1	10.53	6.66	+WQ 98.8									Qmax=120.51cfs
																92.4	0.50	54	39.92	7.6	0.1	Tt from 2197C to 2197L
																98.8	0.50	54	78.69	7.6	0.2	Qmax=120.51cfs Tt from 2197L to 5997C
	69	SUMP 116R2	NF9	0.32	0.94	5.0	0.30	8.72	2.6													
	68	SUMP 116R1	NF8	1.02	0.84	5.0	0.85	8.72	7.4							2.6	1.00	18	83.41	5.2	0.3	Qmax=9.1cfs Tt from 116R2 to 116C
NF9, NF8		116C								5.3	1.16	8.60	9.9			7.4	1.00	18	17.59	5.2	0.1	Qmax=9.1cfs Tt from 116R1 to 116C
	67	114R	NF7	0.54	0.93	5.0	0.50	8.72	4.3							9.9	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 116C to 114C
NF9, NF8, NF7		114C								5.7	1.66	8.40	13.9			4.3	3.00	18	16.56	8.9	0.0	Qmax=15.77cfs Tt from 114R to 114C
	66	113R	NF6	1.11	0.79	5.0	0.88	8.72	7.7							13.9	0.50	24	122.21	4.4	0.5	Qmax=13.86cfs Tt from 114C to 113C2
NF9, NF8, NF7, NF6		113C2								6.2	2.54	8.21	20.8			7.7	6.30	18	16.07	12.9	0.0	Qmax=22.85cfs Tt from 113R To 113C2
	65	112R	NF5	0.25	0.96	5.0	0.24	8.72	2.1							20.8	0.50	36	133.61	5.8	0.4	Qmax=40.87cfs Tt from 113C2 to 112C2
NF9, NF8, NF7 NF6, NF5		112C2								6.6	2.78	8.06	22.4			2.1	5.40	18	14.4	12.0	0.0	Qmax=21.16cfs Tt from 112R to 112C2
NF9, NF8, NF7 NF6, NF5		111C2								6.9	2.78	7.93	22.0			22.4	0.50	36	115.29	5.8	0.3	Qmax=40.87cfs Tt from 112C2 to 111C2
NF9, NF8, NF7 NF6, NF5		5994C								7.4	2.78	7.74	21.5			22.0	1.81	36	350.19	11.0	0.5	Qmax=77.77cfs Tt from 111C2 to 5994C
	71	SUMP 5997L	NE	1.41	0.94	5.4	1.34	8.56	11.4							21.5	4.13	36	370.15	16.6	0.4	Qmax=117.47cfs Tt from 5994C to 5997C
NE, WB4	24	SUMP 5997L	WB4	1.05	0.96	5.0	1.00	8.72	8.7	5.4	2.34	8.56	20.0									
NE, NF5-9, WB1-4 CD1-2, EB1-2,WB6-5		5997C								11.3	16.42	6.61	+WQ 137.3			20.0	0.50	36	16.72	5.8	0.0	Qmax=40.87cfs Tt from 5997L to 5997C
			WATER QUALITY FLOWS DIVERTED TO US 6 POND										51.5			137.3	0.91	54	322.47	10.2	0.5	Qmax=162.58cfs Tt from 5997C to 6000C

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR ROUTED

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt	Remarks *Pipe flow assumed to be full flow conditions
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-5,NE,WB6-5		6000C								11.8	29.05	6.49	-WQ 165.7			165.7	1.25	54	381.92	12.0	0.5	Qmax=190.55cfs Tt from 6000C to 6004C
	27	6004L	WB6	0.26	0.96	5.0	0.24	8.72	2.1							2.1	0.50	18	13.76	3.6	0.1	Qmax=6.44cfs Tt from 6004L to 6004C
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-6,NE		6004C								12.4	29.29	6.37	-WQ 163.8			163.8	2.74	54	143.28	17.7	0.1	Qmax=282.11cfs Tt from 6004C to 6006C
NF5-9,BP,5TH,CD1-3 FR,EB1-2,WB1-6,NE,WB6-5		6006C								12.5	29.29	6.34	-WQ 162.9			162.9	0.30	equivalent 72	435.44	7.1	1.0	Qmax=201.04cfs Tt from 6006C to 305C
	28	305C	WBF1	0.48	0.96	5.5	0.46	8.51	3.9	13.5	29.75	6.12	-WQ 159.3			159.3	0.30	equivalent 72	481.95	7.1	1.1	Qmax=201.04cfs Tt from 305C to 300C
NF5-9,BP,5TH,CD1-3,WB6-5 FR,EB1-2,WB1-6,NE,WBF1		300C	100-YR DISCHARGE TO THE SOUTH PLATTE RIVER							14.7	29.75	5.90	-WQ 152.7									
	64	117L	NF4	0.40	0.66	5.0	0.26	8.72	2.3							2.3	1.00	18	11.44	5.2	0.0	Qmax=9.1cfs Tt from 117L to 117C
NF4		117C								5.0	0.26	8.70	2.3			2.3	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 117C to 115C
	63	115L	NF3	0.36	0.71	5.5	0.25	8.49	2.1							2.1	3.45	18	13.68	9.6	0.0	Qmax=16.91cfs Tt from 115L to 115C
NF3-NF4		115C								5.8	0.52	8.37	4.3			4.3	0.50	18	167.73	3.6	0.8	Qmax=6.44cfs Tt from 115C to 113C1
	62	113L	NF2	0.29	0.91	5.0	0.26	8.72	2.3							2.3	3.18	18	14.96	9.2	0.0	Qmax=16.23cfs Tt from 113L to 113C1
NF2-NF4		113C1								6.6	0.78	8.06	6.3			6.3	0.50	18	133.14	3.6	0.6	Qmax=6.44cfs Tt from 113C1 to 112C1
	61	112L	NF1	0.23	0.96	5.0	0.22	8.72	1.9							1.9	11.38	18	15.23	17.4	0.0	Qmax=30.71cfs Tt from 112L to 112C1
NF1-NF4		112C1								7.2	0.99	7.83	7.8			7.8	0.50	18	108.46	3.6	0.5	Qmax=6.44cfs Tt from 112C1 to 111C1
NF1-NF4		111C1								7.7	0.99	7.66	7.6			7.6	0.51	18	378.03	3.7	1.7	Qmax=6.5cfs Tt from 111C1 to 414C
	60	SUMP 414L	NW1	0.95	0.96	5.5	0.91	8.50	7.7							7.7	0.50	24	17.66	4.4	0.1	Qmax=13.86cfs Tt from 414L to 414C
NF1-NF4, NW1		414C								9.4	1.90	7.12	13.6			13.6	0.50	24	152.08	4.4	0.6	Qmax=13.86cfs Tt from 414C to 412C-D
NF1-NF4, NW1		412C-D								10.0	1.90	6.96	13.3			13.3	2.75	24	22.19	10.3	0.0	Qmax=32.51cfs Tt from 412C-D to 412C
NF1-NF4, NW1		412C	100-YR DISCHARGE TO WEIR GULCH							10.0	1.90	6.95	13.2									
Flows Offsite	9		SR	0.34	0.96	5.0	0.33	8.72	2.8													
Flows to Barnum Lake	2		OS-7	0.61	0.83	5.0	0.50	8.72	4.4													
Flows to Barnum Lake	4		OS-8	0.10	0.58	5.0	0.06	8.72	0.5													
Water Quality Pond	10		WQ1	2.25	0.50	5.0	1.13	8.72	9.8													

STANDARD FORM SF-3
PROPOSED STORM DRAINAGE

DESIGN STORM: 100-YEAR ROUTED

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 7/6/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK/DO — n = 0.015 — Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt	**Remarks** *Pipe flow assumed to be full flow conditions
Flows Offsite	11		WQ3	0.41	0.50	5.0	0.20	8.72	1.8													

PROPOSED COMPOSITE RUNOFF COEFFICIENTS

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359
DATE: 8/15/2012
CALCULATED BY: MEO
CHECKED BY: DPK
FILE NAME: Rational East System - Proposed.xls

			IMPERVIOUSNESS					SOIL TYPE			RUNOFF COEFF.				
DESIGN BASIN	DESIGN POINT	TOTAL AREA (AC)	PAVED AREA (AC) 100	ROOF AREA (AC) 90	GRASS AREA (AC) 0	GRAVEL AREA (AC) 40	% I	Percent of Total Area A	Percent of Total Area B	Percent of Total Area C/D	C_2	C_5	C_{10}	C_{50}	C_{100}
VHW1	101	1.20	0.06	0.00	1.13	0.00	5.19	0.0	0.0	100.0	0.08	0.18	0.28	0.46	0.52
VHW2	102	1.38	1.38	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
VHW3	103	4.05	0.46	0.00	3.59	0.00	11.32	0.0	0.0	100.0	0.12	0.22	0.31	0.48	0.53
VHW4	104	1.09	1.09	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
VHW5	105	3.02	0.45	0.00	2.58	0.00	14.74	0.0	0.0	100.0	0.14	0.24	0.32	0.49	0.54
VHW6	106	2.86	0.45	0.00	2.41	0.00	15.66	0.0	0.0	100.0	0.15	0.24	0.33	0.49	0.54
VHW7	107	1.39	1.39	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
VHW8	108	0.37	0.00	0.00	0.37	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
VHE1	110	2.78	0.62	0.00	2.16	0.00	22.34	0.0	0.0	100.0	0.18	0.27	0.35	0.51	0.56
VHE2	111	2.40	1.31	0.00	1.09	0.00	54.45	0.0	0.0	100.0	0.37	0.42	0.48	0.59	0.61
VHE3	112	1.76	1.76	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
VHE4	113	2.66	1.01	0.00	1.65	0.00	37.96	0.0	0.0	100.0	0.27	0.34	0.41	0.54	0.58
VHE5	114	1.84	1.23	0.00	0.61	0.00	66.75	0.0	0.0	100.0	0.46	0.50	0.55	0.64	0.66
VHE6	115	0.80	0.00	0.00	0.80	0.00	0.00	0.0	0.0	100.0	0.04	0.15	0.25	0.44	0.50
VHE7	116	0.97	0.97	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
3RD	117	17.19	17.19	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB6-1a	120	0.46	0.46	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB6-1b	121	0.68	0.68	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB6-2a	122	0.43	0.43	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB6-2b	123	0.16	0.16	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB6-3a	130	0.39	0.39	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EB6-3b	131	1.11	1.11	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-1a	140	0.52	0.52	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-1b	141	0.56	0.56	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-2a	142	0.15	0.15	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-2b	143	0.69	0.69	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-2c	144	0.15	0.15	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-3a	150	0.51	0.51	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-3b	151	1.14	1.14	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-4a	152	0.36	0.36	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
WB6-4b	153	0.84	0.84	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
EBR1	160	1.13	1.13	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
BNSF-1	180	0.93	0.93	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
BNSF-2	181	0.78	0.78	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
BNSF-3	182	0.11	0.11	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
BNSF-4	183	0.16	0.16	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
RE-1	200	0.60	0.60	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
RE-2	201	0.44	0.44	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
RG-1	202	0.61	0.61	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
RG-2	203	0.11	0.11	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96
OS-20	117	1.30	1.30	0.00	0.00	0.00	100.00	0.0	0.0	100.0	0.89	0.90	0.92	0.96	0.96

STANDARD FORM SF-2
EXISTING TIME OF CONCENTRATION

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK

DATE: 8/15/2012

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN ID	AREA (AC)	C5	L (FT)	S (%)	Ti (MIN)	L (FT)	S (%)	VEL. (FPS)	Tt (MIN)	COMP Tc (MIN)	TOTAL LENGTH (FT)	MIN.Tc (MIN)	Tc (MIN)	
VHW1	1.20	0.18	65	25.0	1.0	180	2.0	2.1	1.4					SWALE
						85	2.0	1.0	1.4					GRASS
						25	0.5	1.4	0.3	4.1	355		5.0	GUTTER
VHW2	1.38	0.90	50	2.0	0.5	830	2.5	3.2	4.4	4.8	880		5.0	GUTTER
VHW3	4.05	0.22	60	20.0	1.0	425	0.9	1.4	5.0					SWALE
						35	33.3	8.7	0.1					SWALE
						170	2.0	1.0	2.9					GRASS
						100	0.5	1.4	1.2	10.1	790	14.4	10.1	GUTTER
VHW4	1.09	0.90	60	6.3	0.3	575	2.8	3.3	2.9	3.2	635		5.0	GUTTER
VHW5	3.02	0.24	30	7.0	1.0	370	2.4	2.3	2.7	3.6	400		5.0	SWALE
VHW6	2.86	0.24	25	2.0	1.4	200	1.8	2.7	1.2					PAVED
						620	5.1	3.4	3.1	5.6	845		5.6	SWALE
VHW7	1.39	0.90	60	2.0	0.5	875	3.8	3.9	3.8	4.3	935		5.0	GUTTER
VHW8	0.37	0.15	10	16.0	0.5	20	33.0	4.0	0.1	0.6	30		5.0	GRASS
VHE1	2.78	0.27	25	4.0	1.0	177	21.0	3.2	0.9					GRASS
						190	0.5	1.4	2.2	4.2	392		5.0	GUTTER
VHE2	2.40	0.42	50	3.1	1.3	155	5.0	4.5	0.6					PAVED
						525	3.5	2.8	3.1	5.0	730		5.0	SWALE
VHE3	1.76	0.90	60	4.3	0.4	310	1.3	2.3	2.3	2.7	370		5.0	GUTTER
VHE4	2.66	0.34	60	5.9	1.3	140	4.3	4.1	0.6					PAVED
						350	5.0	3.4	1.7	3.6	550		5.0	SWALE
VHE5	1.84	0.50	45	2.6	1.2	450	2.6	3.2	2.3					GUTTER
						165	3.0	2.6	1.1	4.5	660		5.0	SWALE
VHE6	0.80	0.15	60	2.6	2.1	840	4.0	4.0	3.5	5.6	900		5.6	GUTTER
VHE7	0.97	0.90	60	6.5	0.3	400	3.6	3.8	1.8	2.1	460		5.0	GUTTER

STANDARD FORM SF-2
EXISTING TIME OF CONCENTRATION

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK

DATE: 8/15/2012

SUB-BASIN DATA			INITIAL/OVERLAND Ti			TRAVEL TIME Tt				Tc CHECK (URBANIZED BASINS)			FINAL	Remarks
BASIN ID	AREA (AC)	C5	L (FT)	S (%)	Ti (MIN)	L (FT)	S (%)	VEL. (FPS)	Tt (MIN)	COMP Tc (MIN)	TOTAL LENGTH (FT)	MIN.Tc (MIN)	Tc (MIN)	
EB6-1a	0.46	0.90	60	2.0	0.5	360	2.1	2.9	2.1	2.6	420		5.0	GUTTER
EB6-1b	0.68	0.90	60	3.6	0.4	490	2.3	3.0	2.7	3.1	550		5.0	GUTTER
EB6-2a	0.43	0.90	60	2.4	0.5	300	0.7	1.7	3.0	3.5	360		5.0	GUTTER
EB6-2b	0.16	0.90	60	1.2	0.6	100	1.6	2.5	0.7	1.3	160		5.0	GUTTER
EB6-3a	0.39	0.90	60	4.0	0.4	300	0.9	1.9	2.6	3.0	360		5.0	GUTTER
EB6-3b	1.11	0.90	60	3.6	0.4	725	1.4	2.4	5.1	5.5	785		5.5	GUTTER
WB6-1a	0.52	0.90	60	2.0	0.5	450	2.0	2.8	2.7	3.1	510		5.0	GUTTER
WB6-1b	0.56	0.90	60	3.5	0.4	605	2.0	2.8	3.6	4.0	665		5.0	GUTTER
WB6-2a	0.15	0.90	60	3.4	0.4	150	2.9	3.4	0.7	1.2	210		5.0	GUTTER
WB6-2b	0.69	0.90	60	3.5	0.4	595	2.2	3.0	3.3	3.8	655		5.0	GUTTER
WB6-2c	0.15	0.90	50	2.2	0.4	65	0.2	0.9	1.2	1.7	115		5.0	GUTTER
WB6-3a	0.51	0.90	60	3.0	0.4	280	0.7	1.7	2.8	3.2	340		5.0	GUTTER
WB6-3b	1.14	0.90	60	3.0	0.4	720	1.4	2.4	5.1	5.5	780		5.5	GUTTER
WB6-4a	0.36	0.90	50	3.3	0.4	300	0.7	1.7	3.0	3.4	350		5.0	GUTTER
WB6-4b	0.84	0.90	50	3.0	0.4	715	1.4	2.4	5.0	5.4	765		5.4	GUTTER
EBR1	1.13	0.90	60	3.6	0.4	690	2.9	3.4	3.4	3.8	750		5.0	GUTTER
BNSF-1	0.93	0.90	60	2.0	0.5	590	3.5	3.7	2.6	3.1	650		5.0	GUTTER
BNSF-2	0.78	0.90	60	2.0	0.5	595	3.6	3.8	2.6	3.1	655		5.0	GUTTER
BNSF-3	0.11	0.90	60	5.9	0.3	105	5.3	4.6	0.4	0.7	165		5.0	GUTTER
BNSF-4	0.16	0.90	60	5.9	0.3	135	5.9	4.9	0.5	0.8	195		5.0	GUTTER
OS-20	1.30	0.90	60	2.0	0.5	540	1.0	2.0	4.5	5.0	600		5.0	GUTTER

NOTES: $Ti=0.395*(1.1-C5)*L^{0.5})/(S^{0.33})$ Tt=L/60V (V From Fig. 7.2, CDOT DDM) Tc Check= 10+L/180

OLSSON ASSOCIATES

STANDARD FORM SF-3
EXISTING STORM DRAINAGE

DESIGN STORM: P=0.6" WATER QUALITY

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES CALCULATED BY: MEO P_1 = 0.6 inches Table 5.1, Denver Criteria manual, 2006 DATE: 8/15/2012

PROJECT NUMBER: 011-2359 CHECKED BY: DPK n = 0.015 WATER QUALITY STORM

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef. (C_2	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt (Min)	**Remarks** *Pipe flow assumed to be full flow conditions
	140	9025R	WB6-1a	0.52	0.89	5.0	0.46	2.04	0.9													
																0.9	0.50	18	44.7	3.6	0.2	Tt from 9025R to 2524L max Q= 6.44 cfs
	142	2524L	WB6-2a	0.15	0.89	5.0	0.14	2.04	0.3	5.2	0.59	2.01	1.2									
																1.2	0.50	18	118.1	3.6	0.5	Tt from 2524L to 2525R max Q= 6.44 cfs
	120	2525R	EB6-1a	0.46	0.89	5.0	0.41	2.04	0.8	5.7	1.00	1.96	2.0									
																2.0	2.00	18	130.0	7.3	0.3	Tt from 2525R to 9011R max Q= 12.87 cfs
	107	11012C	VHW7	1.39	0.89	5.0	1.23	2.04	2.5													
																2.5	5.60	18	114.2	12.2	0.2	Tt from 11012C to 11013R max Q= 21.54 cfs
		11013R								5.2	1.23	2.02	2.5									
																2.5	1.50	18	65.3	6.3	0.2	Tt from 11013R to 9009R max Q= 11.15 cfs
	114	10003R	VHE5	1.84	0.46	5.0	0.85	2.04	1.7													
																1.7	0.50	24	284.8	4.4	1.1	Tt from 10003R to 10003L max Q= 0 cfs
	116	9011L	VHE7	0.97	0.89	5.0	0.86	2.04	1.7													
																1.7	1.00	18	69.1	5.2	0.2	Tt from 9011L to 9011C max Q= 9.1 cfs
	113		VHE4	2.66	0.27	5.0	0.71	2.04	1.4													
		9010C	TOTAL INFLOW TO RAMP "D" LOW POINT							6.1	4.66	1.93	9.0									
																9.0	0.33	42	318.4	5.2	1.0	Tt from 9010C to 11012L max Q= 0 cfs
	106	8004L	VHW6	2.86	0.15	5.6	0.42	1.97	0.8	7.1	5.07	1.84	9.3									
			TOTAL INFLOW TO I-25 WQ POND							7.1	5.07	1.84	9.3									

STANDARD FORM SF-3
EXISTING STORM DRAINAGE

DESIGN STORM: 10-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006
n = 0.015 Manning's n

DATE: 8/15/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt (Min)	Remarks *Pipe flow assumed to be full flow conditions
	151	7014L	WB6-3b	1.14	0.92	5.5	1.04	5.12	5.4													
	131	2514R	EB6-3b	1.11	0.92	5.5	1.02	5.12	5.2							5.4	0.50	24	62.2	4.4	0.2	Tt from 7014L to 2514L max Q= 13.86 cfs
WB6-3b EB6-3b, WB6-4b	153	2514L	WB6-4b	0.84	0.92	5.4	0.77	5.14	4.0	5.7	2.84	5.06	14.4			5.2	4.25	18	50.5	10.6	0.1	Tt from 2514R to 2514L max Q= 18.77 cfs
		2515L	10-YR DISCHARGE TO S PLATTE RIVER							5.8	2.84	5.05	14.3			14.4	1.00	36	27.1	8.2	0.1	Tt from 2514L to 2515L max Q= 57.81 cfs
	122	2018R	EB6-2a	0.43	0.92	5.0	0.40	5.26	2.1													
	123	2018R	EB6-2b	0.16	0.92	5.0	0.14	5.26	0.7	5.0	0.54	5.26	2.8									
EB6-2a, EB6-2b		2017C								5.4	0.54	5.16	2.8			2.8	0.50	18	79.0	3.6	0.4	Tt from 2018R to 2017C max Q= 6.44 cfs
EB6-2a,b,3a	130	2017R	EB6-3a	0.39	0.92	5.0	0.35	5.26	1.9	5.6	0.89	5.10	4.5			2.8	0.50	18	52.9	3.6	0.2	Tt from 2017C to 2017R max Q= 6.44 cfs
	143	2519L	WB6-2b	0.69	0.92	5.0	0.63	5.26	3.3							4.5	0.50	24	50.5	4.4	0.2	Tt from 2017R to 2517L max Q= 13.86 cfs
WB6-2b,c	144	2518L	WB6-2c	0.15	0.92	5.0	0.14	5.26	0.7	5.2	0.77	5.19	4.0			3.3	1.25	18	79.9	5.8	0.2	Tt from 2519L to 2518L max Q= 10.18 cfs
EB6-2a,b,3a WB6-2b,c,4a	152	2517L	WB6-4a	0.36	0.92	5.0	0.33	5.26	1.7	5.8	1.99	5.05	10.0			4.0	1.00	18	45.3	5.2	0.1	Tt from 2518L to 2517L max Q= 9.1 cfs
EB6-2a,b,3a WB6-2b,c,3a,4a	150	7017L	WB6-3a	0.51	0.92	5.0	0.47	5.26	2.4	6.0	2.45	5.01	12.3			10.0	1.00	24	62.3	6.2	0.2	Tf from 2517L to 7017L max Q= 19.61 cfs
	141	7018R	WB6-1b	0.56	0.92	5.0	0.51	5.26	2.7							12.3	1.00	24	36.6	6.2	0.1	Tt from 7017L to 7017C max Q= 19.61 cfs
EB6-2a,b,3a WB6-1b,2b,c,3a,4a		7017C								6.1	2.97	4.98	14.8			2.7	1.25	18	51.3	5.8	0.1	Tt from 7018R to 7017C max Q= 10.18 cfs
EB6-2a,b,3a WB6-1b,2b,c,3a,4a		7018C								6.1	2.97	4.98	14.8			14.8	13.98	24	41.6	23.3	0.0	Tt from 7017C to 7018C max Q= 73.31 cfs
EB6-2a,b,3a WB6-1b,2b,c,3a,4a		7016C	10-YR DISCHARGE TO S PLATTE RIVER							6.2	2.97	4.95	14.7			14.8	4.81	24	95.6	13.7	0.1	Tt from 7018C to 7016C max Q= 43 cfs
	140	9025R	WB6-1a	0.52	0.92	5.0	0.47	5.26	2.5													
WB6-1a, 2a	142	2524L	WB6-2a	0.15	0.92	5.0	0.14	5.26	0.7	5.2	0.61	5.20	3.2			2.5	0.50	18	44.7	3.6	0.2	Tt from 9025R to 2524L max Q= 6.44 cfs
WB6-1a, 2a, EB6-1a	120	2525R	EB6-1a	0.46	0.92	5.0	0.43	5.26	2.2	5.7	1.04	5.06	5.3			3.2	0.50	18	118.1	3.6	0.5	Tt from 2524L to 2525R max Q= 6.44 cfs
	107	11012C	VHW7	1.39	0.92	5.0	1.27	5.26	6.7							5.3	2.00	18	130.0	7.3	0.3	Tt from 2525R to 9011R max Q= 12.87 cfs
		11012L								5.2	1.27	5.21	6.6			6.7	5.60	18	114.2	12.2	0.2	Tt from 11012C to 11012L max Q= 21.54 cfs
	114	10003R	VHE5	1.84	0.55	5.0	1.02	5.26	5.3							6.6	1.50	18	65.3	6.3	0.2	Tt from 11012L to 9009R max Q= 11.15 cfs
	116	9011L	VHE7	0.97	0.92	5.0	0.89	5.26	4.7							5.3	0.50	24	284.8	4.4	1.1	Tt from 10003R to 10003L max Q= 13.86 cfs
																						Tt from 9011L to 9011C

OLSSON ASSOCIATES

STANDARD FORM SF-3
EXISTING STORM DRAINAGE

DESIGN STORM: 10-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006
n = 0.015 Manning's n

DATE: 8/15/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt (Min)	Remarks *Pipe flow assumed to be full flow conditions
	113		VHE4	2.66	0.41	5.0	1.09	5.26	5.7							4.7	1.00	18	69.1	5.2	0.2	max Q= 9.1 cfs
WB6-1a, 2a, EB6-1a VHW7, VHE4, 5, 7		9010C	INFLOW TO RAMP "D" LOW POINT							6.1	5.30	4.98	26.4									
WB6-1a, 2a, EB6-1a VHW6, 7, VHE4, 5, 7	106	8004L	VHW6	2.86	0.33	5.6	0.94	5.09	4.8	7.1	6.24	4.74	29.6			26.4	0.33	42	318.4	5.2	1.0	Tt from 9010C to 11012L max Q= 50.09 cfs
. .			10-YR DISCHARGE FROM I-25 WQ POND TO S PLATTE RIVER							7.9	6.24	4.58	28.6			29.6	0.50	42	303.4	6.4	0.8	Tt from 8005L to 8002R max Q= 61.66 cfs
	117		OS-20	1.30	0.92	5.0	1.19	5.26	6.3													
	102	11019C	VHW2	1.38	0.92	5.0	1.27	5.26	6.7					2.50	6.3				730.0	3.1	3.9	Tt from OS-20 to 11019C
OS-20,VHW2, VHW4	104	11019C	VHW4	1.09	0.92	5.0	1.00	5.26	5.3	8.9	3.46	4.39	15.2			15.2	0.50	36	79.8	5.8	0.2	Tt from 11019C to 11019R max Q= 40.87 cfs
	111	11019R	VHE2	2.40	0.48	5.0	1.15	5.26	6.0													
VHW2, VHW4, OS-20 VHE2, VHE3	112	11019R	VHE3	1.76	0.92	5.0	1.61	5.26	8.5	9.1	6.23	4.35	27.1			27.1	0.50	42	111.8	6.4	0.3	Tt from 11019R to 9014R max Q= 61.66 cfs
		9014R	INFLOW FROM I-25 TO RAMP "B" POND							9.4	6.23	4.30	26.8									
	110	9016R	VHE1	2.78	0.35	5.0	0.98	5.26	5.2													
		9016R	TOTAL INFLOW TO RAMP "B" POND							9.4	7.21	4.30	31.0			31.0	0.50	42	674.5	6.4	1.8	Tt from 9016R to 7022L max Q= 61.66 cfs
	121		EB6-1b	0.68	0.92	5.0	0.62	5.26	3.3													
EB6-1b, VHW5	105	8001R	VHW5	3.02	0.32	5.0	0.98	5.26	5.1	5.2	1.60	5.20	8.3	33.00	3.3				150.0	11.5	0.2	Tt from DP121 to 8001R
EB6-1b, VHW5		8001R	TOTAL INFLOW TO RAMP "C" LOW POINT										8.3			8.3	0.50	36	317.3	5.8	0.9	Tt from 8001R to 11019L max Q= 40.87 cfs
	101	11019L	VHW1	1.20	0.28	5.0	0.33	5.26	1.8	6.1	1.93	4.97	9.6									
			TOTAL INFLOW TO RAMP "A" LOW POINT										9.6			9.6	0.65	36	314.0	6.6	0.8	Tt from 11019L to 7020C max Q= 46.6 cfs
EB6-1b, OS-20 VHW1-5,VHE1-3	103	7021C	VHW3	4.05	0.31	10.1	1.25	4.18	5.2	11.1	10.38	4.01	41.7									
EB6-1b, OS-20 VHW1-5,VHE1-3			TOTAL INFLOW TO RAMP "A" POND										41.7									
	180		BNSF-1	0.93	0.92	5.0	0.85	5.26	4.5													
BNSF-1,3	182		BNSF-3	0.11	0.92	5.0	0.10	5.26	0.5	5.0	0.95	5.26	5.0									
	181		BNSF-2	0.78	0.92	5.0	0.72	5.26	3.8													

OLSSON ASSOCIATES

STANDARD FORM SF-3
EXISTING STORM DRAINAGE

DESIGN STORM: 10-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES CALCULATED BY: MEO P_1 = 1.55 inches Table 5.1, Denver Criteria manual, 2006 DATE: 8/15/2012

PROJECT NUMBER: 011-2359 CHECKED BY: DPK n = 0.015 Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt (Min)	**Remarks** *Pipe flow assumed to be full flow conditions
BNSF-2,4	183		BNSF-4	0.16	0.92	5.0	0.14	5.26	0.8	5.0	0.86	5.26	4.5									
	160		EBR1	1.13	0.92	5.0	1.04	5.26	5.5													
GRASS BUFFER	115		VHE6	0.80	0.25	5.6	0.20	5.09	1.0													
GRASS BUFFER	108		VHW8	0.37	0.25	5.0	0.09	5.26	0.5													

STANDARD FORM SF-3
EXISTING STORM DRAINAGE

DESIGN STORM: 100-YEAR

PROJECT NAME: US 6 BRIDGES
PROJECT NUMBER: 011-2359

CALCULATED BY: MEO
CHECKED BY: DPK

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011
P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006
n = 0.015 Manning's n

DATE: 8/15/2012

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt (Min)	Remarks *Pipe flow assumed to be full flow conditions
	151	7014L	WB6-3b	1.14	0.96	5.5	1.09	8.49	9.3													
	131	2514R	EB6-3b	1.11	0.96	5.5	1.07	8.49	9.0							9.3	0.50	24	62.2	4.4	0.2	Tt from 7014L to 2514L max Q= 13.86 cfs
WB6-3b EB6-3b, WB6-4b	153	2514L	WB6-4b	0.84	0.96	5.4	0.81	8.52	6.9	5.7	2.96	8.39	24.9			9.0	4.25	18	50.5	10.6	0.1	Tt from 2514R to 2514L max Q= 18.77 cfs
		2515L	100-YR DISCHARGE TO S PLATTE RIVER							5.8	2.96	8.37	24.8			24.9	1.00	36	27.1	8.2	0.1	Tt from 2514L to 2515L max Q= 57.81 cfs
	122	2018R	EB6-2a	0.43	0.96	5.0	0.41	8.72	3.6													
	123	2018R	EB6-2b	0.16	0.96	5.0	0.15	8.72	1.3	5.0	0.56	8.72	4.9									
EB6-2a, EB6-2b		2017C								5.4	0.56	8.56	4.8			4.9	0.50	18	79.0	3.6	0.4	Tt from 2018R to 2017C max Q= 6.44 cfs
EB6-2a,b,3a	130	2017R	EB6-3a	0.39	0.96	5.0	0.37	8.72	3.2	5.6	0.93	8.45	7.9			4.8	0.50	18	52.9	3.6	0.2	Tt from 2017C to 2017R max Q= 6.44 cfs
	143	2519L	WB6-2b	0.69	0.96	5.0	0.66	8.72	5.8							7.9	0.50	24	50.5	4.4	0.2	Tt from 2017R to 2517L max Q= 13.86 cfs
WB6-2b,c	144	2518L	WB6-2c	0.15	0.96	5.0	0.14	8.72	1.2	5.2	0.80	8.61	6.9			5.8	1.25	18	79.9	5.8	0.2	Tt from 2519L to 2518L max Q= 10.18 cfs
EB6-2a,b,3a WB6-2b,c,4a	152	2517L	WB6-4a	0.36	0.96	5.0	0.34	8.72	3.0	5.8	2.07	8.37	17.4			6.9	1.00	18	45.3	5.2	0.1	Tt from 2518L to 2517L max Q= 9.1 cfs
EB6-2a,b,3a WB6-2b,c,4a		7017L	Assume WB6-3a bypasses inlet to Pond A							6.0	2.07	8.30	17.2			17.4	1.00	24	62.3	6.2	0.2	Tf from 2517L to 7017L max Q= 19.61 cfs
	141	7018R	WB6-1b	0.56	0.96	5.0	0.54	8.72	4.7							17.2	1.00	24	36.6	6.2	0.1	Tt from 7017L to 7017C max Q= 19.61 cfs
EB6-2a,b,3a WB6-1b,2b,c,4a		7017C								6.1	2.61	8.26	21.6			4.7	1.25	18	51.3	5.8	0.1	Tt from 7018R to 7017C max Q= 10.18 cfs
EB6-2a,b,3a WB6-1b,2b,c,4a		7018C								6.1	2.61	8.25	21.5			21.6	13.98	24	41.6	23.3	0.0	Tt from 7017C to 7018C max Q= 73.31 cfs
EB6-2a,b,3a WB6-1b,2b,c,4a		7016C	100-YR DISCHARGE TO S PLATTE RIVER							6.2	2.61	8.20	21.4			21.5	4.81	24	95.6	13.7	0.1	Tt from 7018C to 7016C max Q= 43 cfs
	140	9025R	WB6-1a	0.52	0.96	5.0	0.49	8.72	4.3													
WB6-1a, 2a	142	2524L	WB6-2a	0.15	0.96	5.0	0.15	8.72	1.3	5.2	0.64	8.62	5.5			4.3	0.50	18	44.7	3.6	0.2	Tt from 9025R to 2524L max Q= 6.44 cfs
WB6-1a, 2a, EB6-1a	120	2525R	EB6-1a	0.46	0.96	5.0	0.44	8.72	3.9	5.7	1.08	8.39	9.1			5.5	0.50	18	118.1	3.6	0.5	Tt from 2524L to 2525R max Q= 6.44 cfs
	107	11012C	VHW7	1.39	0.96	5.0	1.32	8.72	11.5							9.1	2.00	18	130.0	7.3	0.3	Tt from 2525R to 9011R max Q= 12.87 cfs
		11012L								5.2	1.32	8.65	11.5			11.5	5.60	18	114.2	12.2	0.2	Tt from 11012C to 11012L max Q= 21.54 cfs
	114	10003R	VHE5	1.84	0.66	5.0	1.22	8.72	10.6							11.5	1.50	18	65.3	6.3	0.2	Tt from 11012L to 9009R max Q= 11.15 cfs
	116	9011L	VHE7	0.97	0.96	5.0	0.93	8.72	8.1							10.6	0.50	24	284.8	4.4	1.1	Tt from 10003R to 10003L max Q= 13.86 cfs
																						Tt from 9011L to 9011C

OLSSON ASSOCIATES

STANDARD FORM SF-3
EXISTING STORM DRAINAGE

DESIGN STORM: 100-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES — CALCULATED BY: MEO — P_1 = 2.57 inches — Table 5.1, Denver Criteria manual, 2006 — DATE: 8/15/2012

PROJECT NUMBER: 011-2359 — CHECKED BY: DPK — n = 0.015 — Manning's n

Tributary Sub-basins	Design Pt.	Structure ID	DIRECT RUNOFF Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	TOTAL RUNOFF Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	STREET Slope (%)	St. Flow (cfs)	PIPE Design Flow (cfs)	Slope(%)	Pipe Size (in)	TRAVEL TIME Length (ft)	Velocity (fps)*	Tt (Min)	Remarks *Pipe flow assumed to be full flow conditions
	113	9010C	VHE4	2.66	0.58	5.0	1.54	8.72	13.4							8.1	1.00	18	69.1	5.2	0.2	max Q= 9.1 cfs
WB6-1a, 2a, EB6-1a VHW7, VHE4, 5, 7		9010C	INFLOW TO RAMP "D" LOW POINT							6.1	6.10	8.26	50.3									
WB6-1a, 2a, EB6-1a VHW6, 7, VHE4, 5, 7	106	8004L	VHW6	2.86	0.54	5.6	1.56	8.43	13.1	7.1	7.66	7.87	60.2			50.3	0.33	42	318.4	5.2	1.0	Tt from 9010C to 11012L max Q= 50.09 cfs
			100-YR DISCHARGE FROM I-25 WQ POND TO S PLATTE RIVER							7.9	7.66	7.59	58.1			60.2	0.50	42	303.4	6.4	0.8	Tt from 8004L to 8002R max Q= 61.66 cfs
	117		OS-20	1.30	0.96	5.0	1.24	8.72	10.8													
	102	11019C	VHW2	1.38	0.96	5.0	1.32	8.72	11.5					2.50	10.8				730.0	3.1	3.9	Tt from OS-20 to 11019C
OS-20,VHW2, VHW4	104	11019C	VHW4	1.09	0.96	5.0	1.04	8.72	9.1	8.9	3.61	7.28	26.3									
	111	11019R	VHE2	2.40	0.61	5.0	1.48	8.72	12.9							26.3	0.50	36	79.84	5.8	0.2	Tt from 11019C to 11019R max Q= 40.87 cfs
VHW2, VHW4, OS-20 VHE2, VHE3	112	11019R	VHE3	1.76	0.96	5.0	1.68	8.72	14.7	9.1	6.77	7.21	48.8									
		9014R	INFLOW FROM I-25 TO RAMP "B" POND							9.4	6.77	7.13	48.3			48.8	0.50	42	111.75	6.4	0.3	Tt from 11019R to 9014R max Q= 61.66 cfs
	110	9016R	VHE1	2.78	0.56	5.0	1.55	8.72	13.5													
		9016R	TOTAL INFLOW TO RAMP "B" POND							9.4	8.32	7.13	59.3									
	121		EB6-1b	0.68	0.96	5.0	0.65	8.72	5.6							59.3	0.50	42	674.5	6.4	1.8	Tt from 9016R to 7022L max Q= 61.66 cfs
EB6-1b, VHW5	105	8001R	VHW5	3.02	0.54	5.0	1.64	8.72	14.3	5.2	2.28	8.62	19.7	33.00	5.6				150.0	11.5	0.2	Tt from DP121 to 8001R
EB6-1b, VHW5		8001R	TOTAL INFLOW TO RAMP "C" LOW POINT										19.7			19.7	0.50	36	317.3	5.8	0.9	Tt from 8001R to 11019L max Q= 40.87 cfs
	101	11019L	VHW1	1.20	0.52	5.0	0.62	8.72	5.4	6.1	2.90	8.23	23.9									
			TOTAL INFLOW TO RAMP "A" LOW POINT										23.9			23.9	0.65	36	314.0	6.6	0.8	Tt from 11019L to 7020C max Q= 46.6 cfs
WB6-1b,3a	150		WB6-3a	0.51	0.96	5.0	0.49	8.72	4.2													
EB6-1b,WB6-1b,3a VHW1-5, VHE1-3 ,OS-20	103	7020C	VHW3	4.05	0.53	10.1	2.17	6.93	15.0	11.1	13.87	6.66	92.3	7.70	4.2				375.0	5.5	1.1	Tc from WB6-3a to 7021C
EB6-1b,WB6-1b,3a VHW1-5, VHE1-3, OS-20			TOTAL INFLOW TO RAMP "A" POND										92.3									
	180		BNSF-1	0.93	0.96	5.0	0.89	8.72	7.8													

OLSSON ASSOCIATES

STANDARD FORM SF-3
EXISTING STORM DRAINAGE

DESIGN STORM: 100-YEAR

$I=(28.5\ P_1)/(10+T_c)^{0.786}$ Eq. RA-3, USDCM Vol 1, 2011

PROJECT NAME: US 6 BRIDGES CALCULATED BY: MEO P_1 = 2.57 inches Table 5.1, Denver Criteria manual, 2006 DATE: 8/15/2012

PROJECT NUMBER: 011-2359 CHECKED BY: DPK n = 0.015 Manning's n

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
Tributary Sub-basins	Design Pt.	Structure ID	Area Desig.	Area (Ac)	Runnoff Coef.	Tc (Min)	C*A	I (In/Hr)	Q (cfs)	Tc (Min)	Sum of C*A's	I (In/Hr)	Q (cfs)	Slope (%)	St. Flow (cfs)	Design Flow (cfs)	Slope(%)	Pipe Size (in)	Length (ft)	Velocity (fps)*	Tt (Min)	**Remarks** *Pipe flow assumed to be full flow conditions
BNSF-1,3	182		BNSF-3	0.11	0.96	5.0	0.11	8.72	0.9	5.0	1.00	8.72	8.7									
	181		BNSF-2	0.78	0.96	5.0	0.75	8.72	6.5													
BNSF-2,4	183		BNSF-4	0.16	0.96	5.0	0.15	8.72	1.3	5.0	0.90	8.72	7.8									
	160		EBR1	1.13	0.96	5.0	1.08	8.72	9.4													
GRASS BUFFER	115		VHE6	0.80	0.50	5.6	0.40	8.44	3.4													
GRASS BUFFER	108		VHW8	0.37	0.50	5.0	0.18	8.72	1.6													

5.0 RAINFALL

5.1 Introduction

The design rainfall data to be used to complete hydrologic analyses described in the RUNOFF chapter of these DENVER CRITERIA are presented in this section. More specifically, this chapter provides: 1) point precipitation values for Denver, 2) information on the Colorado Urban Hydrograph Procedure (CUHP), and 3) an intensity-duration-frequency table for use with the Rational Method. All hydrological analyses within Denver shall use the rainfall data presented herein for calculating storm runoff. There may be cases where the designer needs to consider events more extreme than the 100-year storm (e.g., for public safety).

The design storms and intensity-frequency-duration tables for Denver were developed using the rainfall data and procedures presented in the DISTRICT MANUAL and are presented herein for convenience.

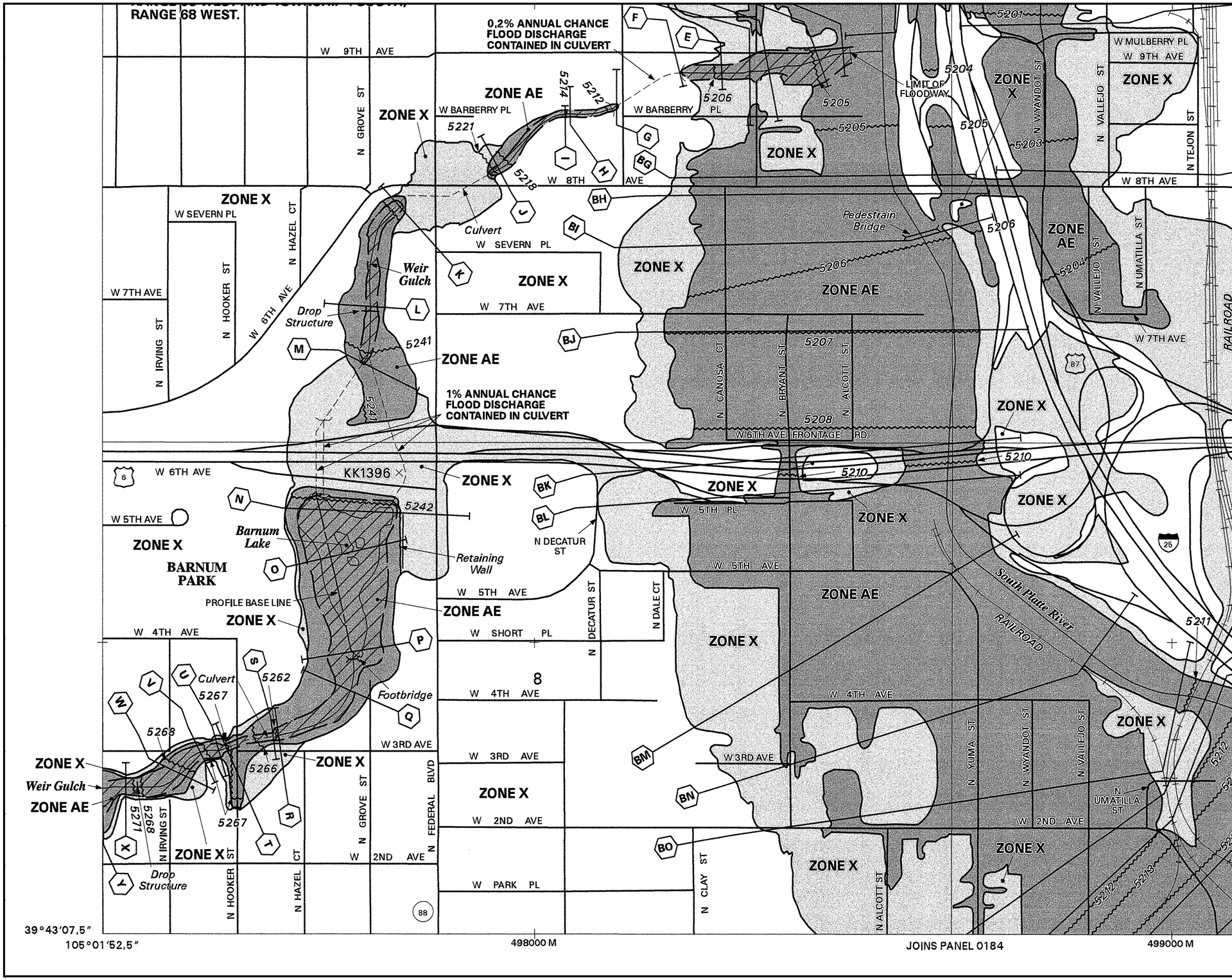
5.2 Rainfall Depth-Duration-Frequency Values

A review of the isopluvial maps presented in the *Precipitation-Frequency Atlas of the Western United States, Volume III-Colorado* (National Oceanic and Atmospheric Administration [NOAA] Atlas) shows that all of Denver can be included in one rainfall zone. The precipitation values for various return periods and duration storms were found to have minimal variation.

The 1-hour point rainfall is necessary for use with both the Rational Method and CUHP and is also the basis for deriving durations less than one hour. For watersheds greater than 10 square miles, the 3-hour rainfall depth is required, and for watersheds 20 square miles and larger, the 6-hour rainfall depth is required for use with CUHP. One-hour point rainfall values are summarized in Table 5.1. To obtain durations less than 1 hour, the factors in Table 5.2 are applied to the 1-hour point rainfall.

Table 5.1. One-hour Point Rainfall Depths

Return Period	One-hour Point Rainfall (inches)
2-Year	0.95
5-Year	1.34
10-Year	1.55
50-Year	2.25
100-Year	2.57
Date: July, 1992 Revised:	Reference: Wastewater Management Division, 1987, as determined based on NOAA Atlas 2, Volume IIII.



National Flood Insurance Program at (800) 638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0182G

FIRM

FLOOD INSURANCE RATE MAP

CITY AND COUNTY OF DENVER, COLORADO

PANEL 182 OF 300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DENVER, CITY AND COUNTY OF	080046	0182	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 0800460182G

MAP REVISED: NOVEMBER 17, 2005

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix B

Hydraulic Grade Line Calculations

FlowMaster and UD-Channel Calculations

Pond Stage Storage and Calculations

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	48	64.90	5243.40	5245.78	2.38	7.81	8.32	1.07	5246.86	0.462	21.210	5244.25	5246.63	2.38**	7.80	8.32	1.08	5247.71	0.462	0.462	n/a	0.47	0.51
2	42	63.60	5244.75	5246.63	1.88	5.27	12.06	2.26	5248.89	1.252	64.420	5247.91	5250.35	2.44**	7.17	8.87	1.22	5251.58	0.575	0.914	n/a	0.15	n/a
3	42	63.60	5248.11	5250.35	2.24	6.51	9.77	1.48	5251.84	0.728	296.430	5262.02	5264.46	2.44**	7.17	8.87	1.22	5265.69	0.575	0.652	n/a	0.15	n/a
4	36	62.60	5262.52	5264.46	1.94	4.84	12.93	2.60	5267.06	1.558	231.530	5271.78	5274.30	2.52**	6.34	9.87	1.51	5275.82	0.844	1.201	n/a	0.15	0.23
5	36	61.00	5271.98	5274.30	2.32	5.87	10.39	1.68	5275.98	0.937	397.510	5287.90	5290.39	2.49**	6.27	9.73	1.47	5291.86	0.819	0.878	n/a	0.15	n/a
6	36	55.70	5288.03	5290.39	2.36	5.96	9.34	1.36	5291.75	0.756	84.880	5290.26	5292.64	2.38**	6.01	9.27	1.33	5293.97	0.743	0.749	n/a	1.00	1.33
7	24	36.20	5297.32	5298.25	0.93*	1.43	25.33	9.97	5308.22	13.199	106.740	5311.41	5314.57	2.00	3.14	11.52	2.06	5316.63	2.562	7.880	8.411	1.00	2.06
8	24	23.30	5291.18	5292.64	1.46	2.45	9.49	1.40	5294.04	1.365	66.990	5293.04	5294.76	1.72**	2.87	8.11	1.02	5295.78	0.983	1.174	n/a	1.00	n/a

Project File: West System - North 10yr.stm | Number of lines: 8 | Run Date: 7/9/2012

Notes: * Normal depth assumed.; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

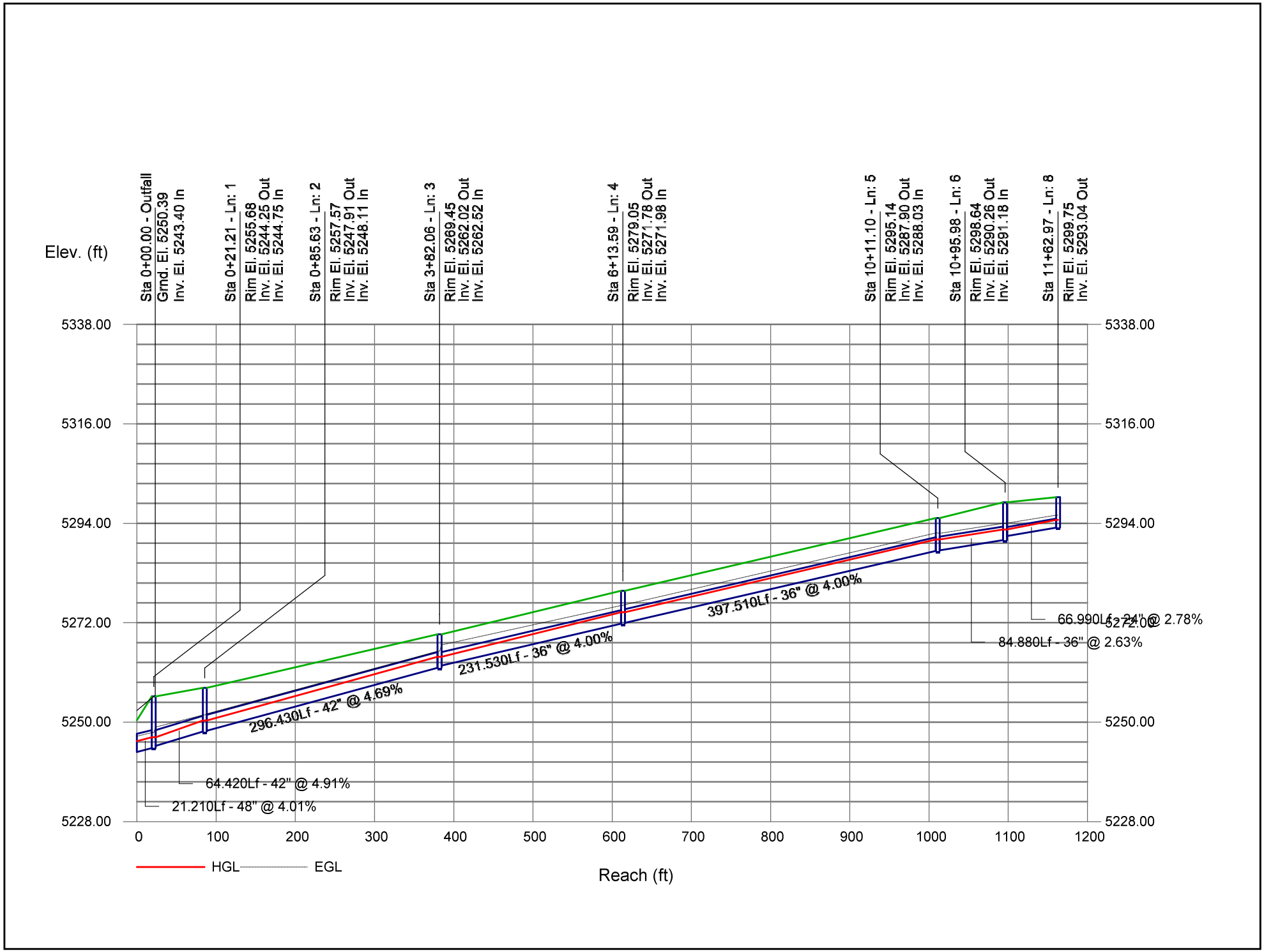
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: West System - North 10yr.stm



Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	48	107.1	5243.40	5246.46	3.06	10.32	10.38	1.67	5248.14	0.639	21.210	5244.25	5247.31	3.06**	10.32	10.38	1.67	5248.99	0.639	0.639	n/a	0.47	0.79
2	42	104.6	5244.75	5247.31	2.56	7.54	13.87	2.99	5250.30	1.379	64.420	5247.91	5251.04	3.13**	9.07	11.54	2.07	5253.10	0.958	1.168	n/a	0.15	0.31
3	42	104.6	5248.11	5251.04	2.93	8.59	12.18	2.30	5253.34	1.045	296.430	5262.02	5265.15	3.13**	9.07	11.54	2.07	5267.21	0.958	1.001	n/a	0.15	0.31
4	36	102.1	5262.52	5265.15	2.63	6.56	15.57	3.77	5268.91	2.122	231.530	5271.78	5274.69	2.91**	7.00	14.58	3.31	5277.99	2.059	2.091	n/a	0.15	0.50
5	36	98.10	5271.98	5274.69	2.71	6.71	14.62	3.32	5278.01	1.901	397.510	5287.90	5290.79	2.89**	6.99	14.04	3.06	5293.86	1.892	1.897	n/a	0.15	n/a
6	36	79.50	5288.03	5290.79	2.76	6.81	11.68	2.12	5292.91	1.233	84.880	5290.26	5293.03	2.77**	6.82	11.66	2.11	5295.14	1.232	1.232	n/a	1.00	n/a
7	24	42.20	5297.32	5298.34	1.02*	1.60	26.33	10.77	5309.11	13.192	106.740	5311.41	5315.20	2.00	3.14	13.43	2.81	5318.01	3.481	8.337	8.899	1.00	2.81
8	24	37.30	5291.18	5293.03	1.85	3.03	12.30	2.35	5295.38	2.356	66.990	5293.04	5294.98	1.94**	3.11	11.98	2.23	5297.21	2.393	2.374	n/a	1.00	2.23

Project File: West System - North 100yr.stm | Number of lines: 8 | Run Date: 7/9/2012

Notes: * Normal depth assumed.; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

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Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

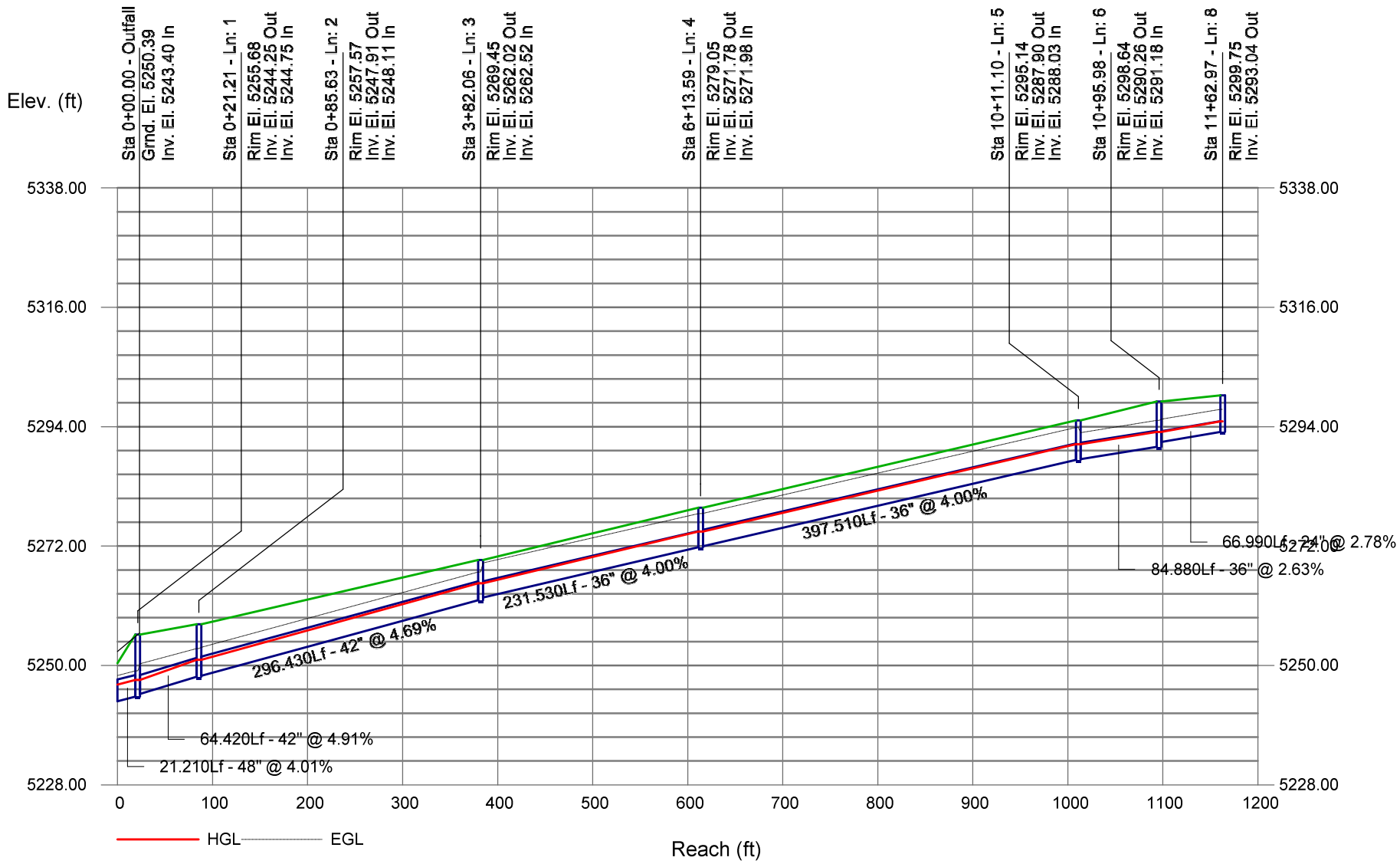
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: West System - North 100yr.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2011 Plan

Project File: West System-South 10 yr.stm	Number of lines: 4	Date: 5/30/2012

Storm Sewers v8.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	9.917	-175.073	MH	29.30	0.00	0.00	0.0	5247.35	0.50	5247.40	36	Cir	0.013	0.15	5252.71	PIPE - (50)
2	1	260.697	0.000	MH	27.60	0.00	0.00	0.0	5247.59	3.48	5256.65	36	Cir	0.013	0.15	5263.38	PIPE - (49)
3	2	360.580	-4.371	MH	21.00	0.00	0.00	0.0	5256.77	4.14	5271.71	36	Cir	0.013	0.15	5278.13	PIPE - (48)
4	3	379.144	0.040	MH	16.10	0.00	0.00	0.0	5272.63	4.07	5288.07	24	Cir	0.013	1.00	5293.42	PIPE - (47)

Project File: West System-South 10 yr.stm | Number of lines: 4 | Date: 5/30/2012

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	PIPE - (50)	29.30	36	Cir	9.917	5247.35	5247.40	0.502	5249.08	5249.14	0.11	5249.25	End	Manhole
2	PIPE - (49)	27.60	36	Cir	260.697	5247.59	5256.65	3.475	5249.25	5258.32	n/a	5258.32	1	Manhole
3	PIPE - (48)	21.00	36	Cir	360.580	5256.77	5271.71	4.143	5258.32	5273.17	n/a	5273.17 j	2	Manhole
4	PIPE - (47)	16.10	24	Cir	379.144	5272.63	5288.07	4.072	5273.45	5289.49	n/a	5289.49	3	Manhole

Project File: West System-South 10 yr.stm | Number of lines: 4 | Run Date: 5/30/2012

NOTES: Return period = 10 Yrs. ; j - Line contains hyd. jump.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	36	29.30	5247.35	5249.08	1.73	4.21	6.96	0.75	5249.83	0.488	9.917	5247.40	5249.14	1.74	4.25	6.89	0.74	5249.88	0.475	0.481	0.048	0.15	0.11
2	36	27.60	5247.59	5249.25	1.66	4.02	6.87	0.73	5249.99	0.488	260.697	5256.65	5258.32	1.67**	4.06	6.80	0.72	5259.04	0.476	0.482	n/a	0.15	n/a
3	36	21.00	5256.77	5258.32	1.55	3.70	5.68	0.50	5258.83	0.352	360.580	5271.71	5273.17 j	1.46**	3.42	6.15	0.59	5273.76	0.434	0.393	n/a	0.15	n/a
4	24	16.10	5272.63	5273.45	0.82*	1.21	13.26	2.73	5276.18	4.064	379.144	5288.07	5289.49	1.42**	2.39	6.74	0.71	5290.20	0.695	2.380	n/a	1.00	n/a

Project File: West System-South 10 yr.stm | Number of lines: 4 | Run Date: 5/30/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

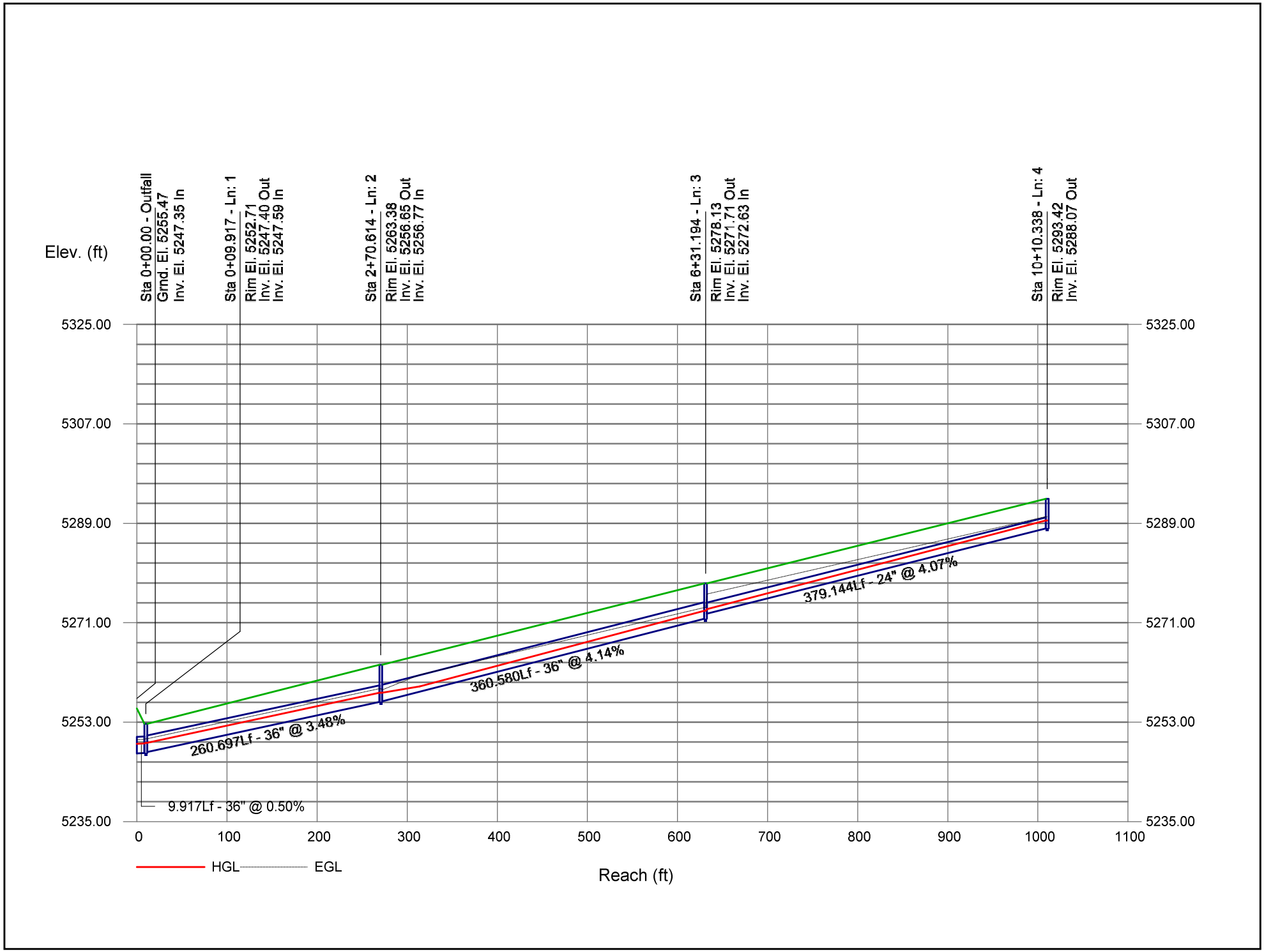
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: West System-South 10 yr.stm



Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	36	66.90	5247.18	5249.80	2.62	6.55	10.21	1.62	5251.42	0.913	14.370	5247.54	5250.16	2.62**	6.55	10.21	1.62	5251.78	0.913	0.913	n/a	0.73	n/a
2	36	63.80	5247.74	5250.16	2.42	6.11	10.44	1.69	5251.86	0.942	200.740	5253.76	5256.31	2.55**	6.40	9.98	1.55	5257.85	0.864	0.903	n/a	0.15	n/a
3	36	63.80	5253.96	5256.31	2.35	5.93	10.76	1.80	5258.11	1.003	59.300	5255.54	5258.09	2.55**	6.40	9.98	1.55	5259.63	0.864	0.934	n/a	0.15	n/a
4	36	48.40	5255.74	5258.09	2.35	5.93	8.16	1.04	5259.12	0.577	358.000	5271.63	5273.85 j	2.22**	5.60	8.64	1.16	5275.01	0.655	0.616	n/a	0.15	n/a
5	24	37.00	5272.63	5274.00	1.37*	2.29	16.18	4.07	5278.07	4.074	379.140	5288.07	5290.01	1.94**	3.11	11.89	2.20	5292.21	2.352	3.213	n/a	1.00	n/a

Project File: West System - South 100yr.stm | Number of lines: 5 | Run Date: 7/9/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

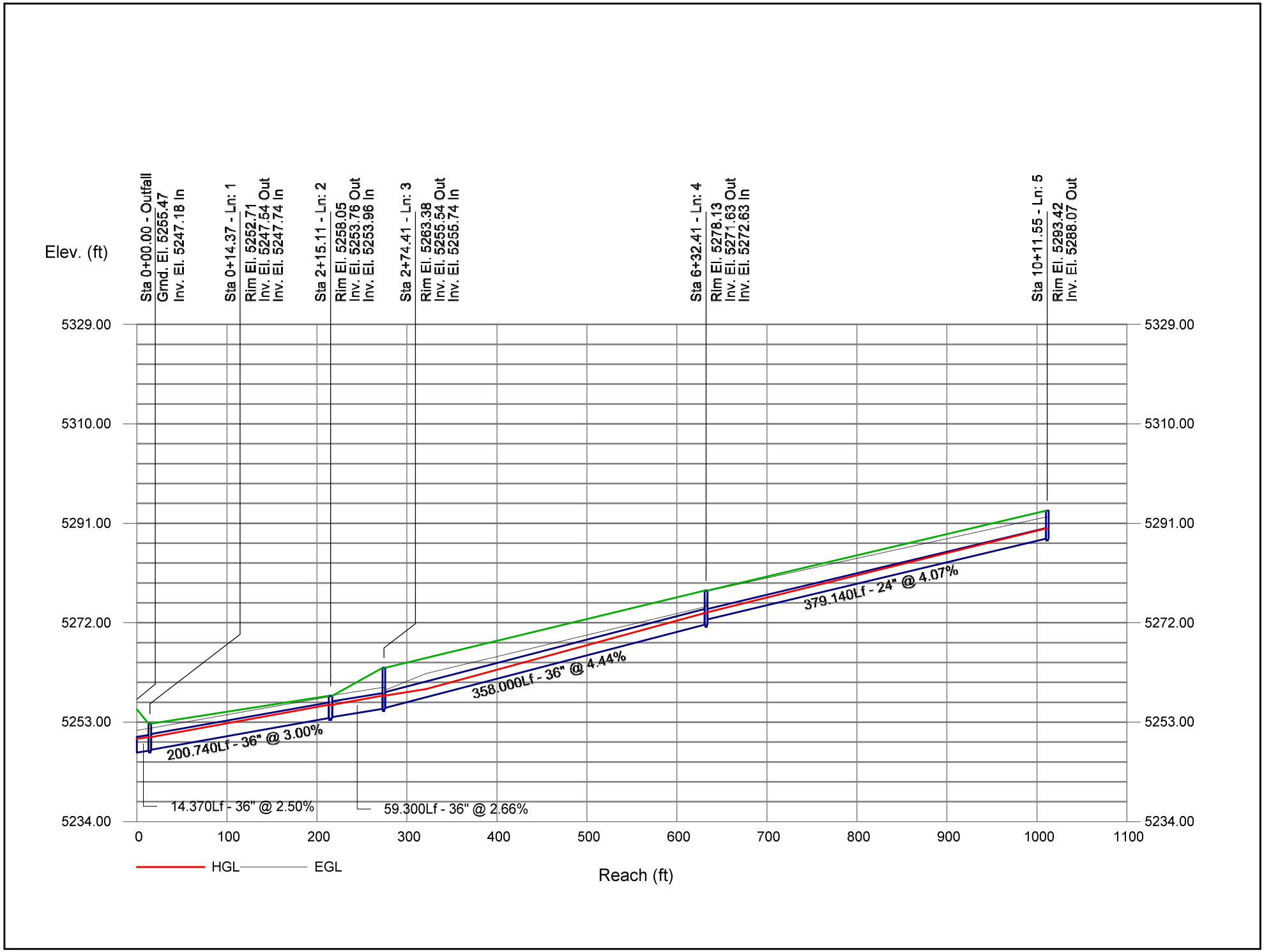
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: West System - South 100yr.stm



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	412C-D to 412C	7.60	24	Cir	22.189	5240.73	5241.34	2.748	5241.71	5242.32	n/a	5242.32 j	End	Manhole
2	414C to 412C-D	7.60	24	Cir	152.082	5241.54	5242.30	0.500	5242.47	5243.28	0.39	5243.28	1	Manhole
3	111C1 to 414C	4.20	18	Cir	383.510	5242.80	5244.72	0.501	5243.57	5245.50	n/a	5245.50	2	Manhole
4	112C1 to 111C1	4.20	18	Cir	107.695	5244.92	5245.46	0.501	5245.69	5246.25	0.31	5246.56	3	Manhole
5	113C1 to 112C1	3.30	18	Cir	133.310	5245.66	5246.33	0.503	5246.56	5247.02	n/a	5247.02 j	4	Manhole
6	115C to 113C1	2.20	18	Cir	167.732	5246.53	5247.37	0.501	5247.07	5247.94	n/a	5247.94	5	Manhole
7	117C to 115C	1.10	18	Cir	167.732	5247.57	5248.41	0.501	5247.94	5248.81	0.13	5248.81	6	Manhole
8	117L to 117C	1.10	18	Cir	11.443	5248.61	5248.72	0.964	5248.93	5249.14	0.12	5249.25	7	Manhole
9	115L to 115C	1.10	18	Cir	13.680	5247.59	5248.06	3.437	5247.94	5248.46	0.13	5248.46	6	Manhole
10	414L to 414C	4.50	24	Cir	17.663	5247.11	5247.20	0.511	5247.80	5247.96	0.27	5248.22	2	Manhole
11	113L to 113C1	1.30	18	Cir	14.957	5247.25	5247.73	3.209	5247.51	5248.35	0.06	5248.40	5	Manhole
12	112L to 112C1	1.10	18	Cir	18.243	5247.14	5248.87	9.483	5247.32	5249.38	0.07	5249.45	4	Manhole

6th & Fed- NW Fed 10yr | Number of lines: 12 | Run Date: 6/6/2012

NOTES: Return period = 10 Yrs. ; j - Line contains hyd. jump.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	7.60	5240.73	5241.71	0.98	1.53	4.96	0.38	5242.09	0.412	22.189	5241.34	5242.32 j	0.98**	1.52	4.99	0.39	5242.70	0.418	0.415	n/a	0.65	0.25
2	24	7.60	5241.54	5242.47	0.93*	1.43	5.33	0.44	5242.91	0.499	152.082	5242.30	5243.28	0.98**	1.52	4.99	0.39	5243.66	0.418	0.458	n/a	1.00	0.39
3	18	4.20	5242.80	5243.57	0.77*	0.91	4.60	0.33	5243.90	0.501	383.510	5244.72	5245.50	0.78**	0.93	4.51	0.32	5245.82	0.473	0.487	n/a	1.00	n/a
4	18	4.20	5244.92	5245.69	0.77*	0.91	4.60	0.33	5246.02	0.501	107.695	5245.46	5246.25	0.79**	0.94	4.48	0.31	5246.56	0.466	0.483	0.521	1.00	0.31
5	18	3.30	5245.66	5246.56	0.90	1.10	2.99	0.14	5246.70	0.188	133.310	5246.33	5247.02 j	0.69**	0.80	4.13	0.27	5247.29	0.441	0.315	n/a	1.00	n/a
6	18	2.20	5246.53	5247.07	0.54*	0.57	3.88	0.23	5247.30	0.500	167.732	5247.37	5247.94	0.57**	0.61	3.60	0.20	5248.14	0.408	0.454	n/a	1.00	n/a
7	18	1.10	5247.57	5247.94	0.37*	0.34	3.19	0.16	5248.10	0.501	167.732	5248.41	5248.81	0.40**	0.38	2.90	0.13	5248.94	0.385	0.443	n/a	1.00	0.13
8	18	1.10	5248.61	5248.93	0.32*	0.27	4.03	0.25	5249.18	0.965	11.443	5248.72	5249.14	0.42	0.40	2.74	0.12	5249.25	0.328	0.647	0.074	1.00	0.12
9	18	1.10	5247.59	5247.94	0.35	0.31	3.57	0.20	5248.13	0.685	13.680	5248.06	5248.46	0.40**	0.38	2.90	0.13	5248.59	0.385	0.535	n/a	1.00	0.13
10	24	4.50	5247.11	5247.80	0.69*	0.96	4.67	0.34	5248.14	0.510	17.663	5247.20	5247.96	0.76**	1.09	4.14	0.27	5248.22	0.366	0.438	0.077	1.00	0.27
11	18	1.30	5247.25	5247.51	0.26*	0.20	6.46	0.65	5248.16	3.209	14.957	5247.73	5248.35	0.62	0.69	1.90	0.06	5248.40	0.104	1.656	0.248	1.00	0.06
12	18	1.10	5247.14	5247.32	0.18*	0.12	8.97	1.25	5248.57	9.418	18.243	5248.87	5249.38	0.51	0.53	2.09	0.07	5249.45	0.154	4.786	0.873	1.00	0.07

6th & Fed- NW Fed 10yr | Number of lines: 12 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

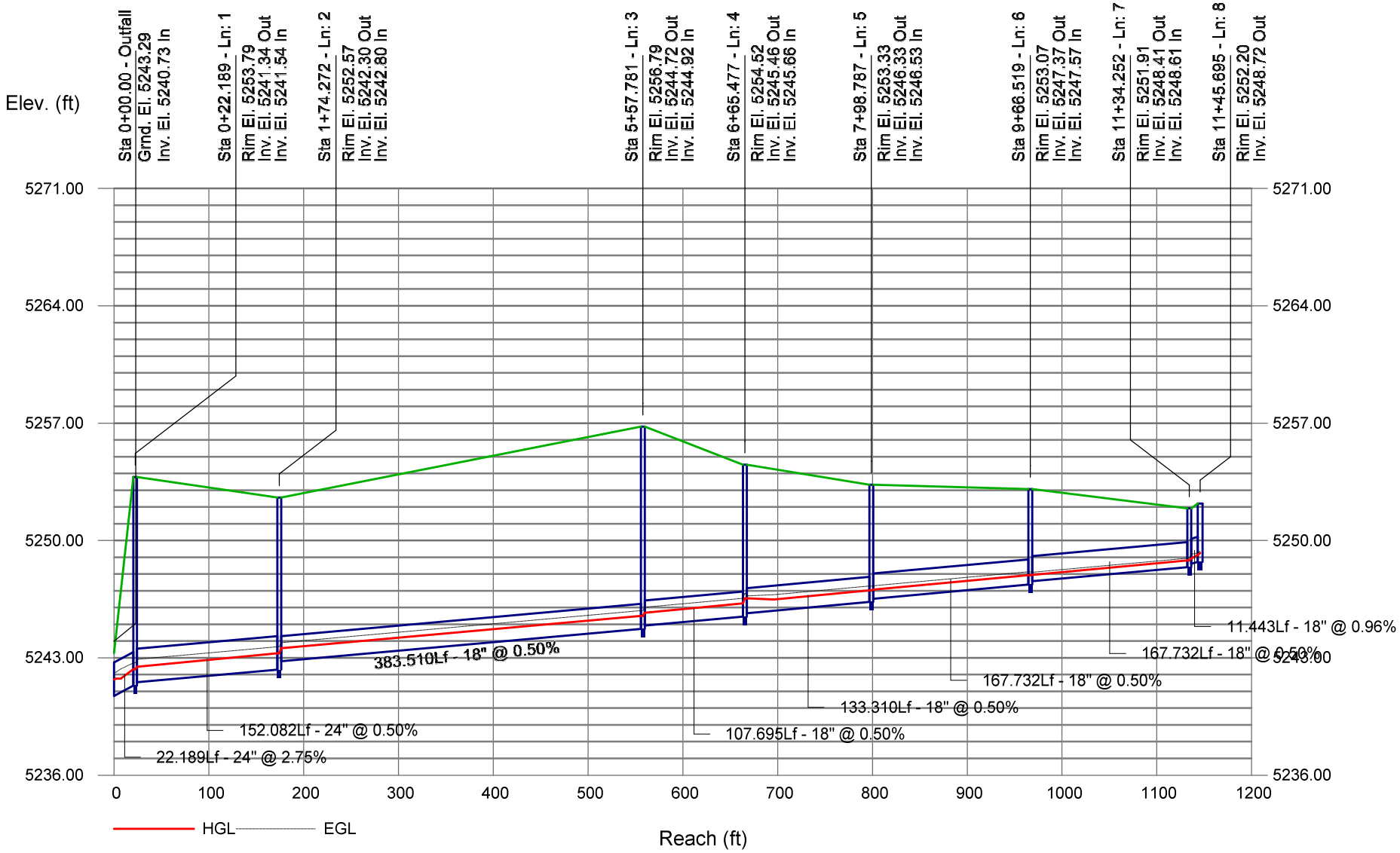
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: 6th & Fed NW Federal 10yr.stm



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	412C-D to 412C	11.80	24	Cir	22.189	5240.73	5241.34	2.748	5241.95	5242.56	0.35	5242.56	End	Manhole
2	414C to 412C-D	11.80	24	Cir	152.082	5241.54	5242.30	0.500	5242.75	5243.52	0.54	5244.06	1	Manhole
3	111C1 to 414C	6.70	18	Cir	383.510	5242.80	5244.72	0.501	5244.06	5245.71	n/a	5245.71	2	Manhole
4	112C1 to 111C1	6.70	18	Cir	107.695	5244.92	5245.46	0.501	5245.97	5246.50	0.40	5246.91	3	Manhole
5	113C1 to 112C1	5.40	18	Cir	133.310	5245.66	5246.33	0.503	5246.91	5247.22	n/a	5247.60 j	4	Manhole
6	115C to 113C1	3.70	18	Cir	167.732	5246.53	5247.37	0.501	5247.60	5248.10	n/a	5248.10 j	5	Manhole
7	117C to 115C	1.90	18	Cir	167.732	5247.57	5248.41	0.501	5248.10	5248.94	n/a	5248.94 j	6	Manhole
8	117L to 117C	1.90	18	Cir	11.443	5248.61	5248.72	0.964	5249.03	5249.31	0.14	5249.44	7	Manhole
9	115L to 115C	1.80	18	Cir	13.680	5247.59	5248.06	3.437	5248.10	5248.57	n/a	5248.57 j	6	Manhole
10	414L to 414C	6.80	24	Cir	17.663	5247.11	5247.20	0.511	5247.98	5248.13	0.35	5248.48	2	Manhole
11	113L to 113C1	2.00	18	Cir	14.957	5247.25	5247.73	3.209	5247.60	5248.27	0.19	5248.46	5	Manhole
12	112L to 112C1	1.70	18	Cir	18.243	5247.14	5248.87	9.483	5247.37	5249.82	0.03	5249.85	4	Manhole

6th & Fed- NW Fed 50yr | Number of lines: 12 | Run Date: 6/6/2012

NOTES: Return period = 50 Yrs. ; j - Line contains hyd. jump.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	11.80	5240.73	5241.95	1.22	2.00	5.90	0.54	5242.49	0.493	22.189	5241.34	5242.56	1.22**	2.00	5.90	0.54	5243.10	0.493	0.493	n/a	0.65	0.35
2	24	11.80	5241.54	5242.75	1.21*	1.99	5.93	0.55	5243.30	0.499	152.082	5242.30	5243.52	1.22**	2.01	5.87	0.54	5244.06	0.487	0.493	0.750	1.00	0.54
3	18	6.70	5242.80	5244.06	1.26	1.58	4.24	0.28	5244.34	0.334	383.510	5244.72	5245.71	0.99**	1.23	5.43	0.46	5246.17	0.584	0.459	n/a	1.00	n/a
4	18	6.70	5244.92	5245.97	1.04*	1.31	5.10	0.40	5246.37	0.501	107.695	5245.46	5246.50	1.04	1.31	5.10	0.40	5246.91	0.502	0.502	0.540	1.00	0.40
5	18	5.40	5245.66	5246.91	1.25	1.57	3.44	0.18	5247.09	0.219	133.310	5246.33	5247.22 j	0.89**	1.09	4.94	0.38	5247.60	0.515	0.367	0.490	1.00	0.38
6	18	3.70	5246.53	5247.60	1.07	1.35	2.74	0.12	5247.72	0.144	167.732	5247.37	5248.10 j	0.73**	0.86	4.30	0.29	5248.39	0.455	0.299	n/a	1.00	0.29
7	18	1.90	5247.57	5248.10	0.53	0.57	3.36	0.18	5248.28	0.377	167.732	5248.41	5248.94 j	0.53**	0.55	3.44	0.18	5249.12	0.400	0.389	n/a	1.00	n/a
8	18	1.90	5248.61	5249.03	0.42*	0.40	4.71	0.34	5249.37	0.961	11.443	5248.72	5249.31	0.59	0.64	2.96	0.14	5249.44	0.265	0.613	0.070	1.00	0.14
9	18	1.80	5247.59	5248.10	0.51	0.54	3.36	0.18	5248.28	0.390	13.680	5248.06	5248.57 j	0.51**	0.53	3.38	0.18	5248.75	0.398	0.394	n/a	1.00	0.18
10	24	6.80	5247.11	5247.98	0.87*	1.30	5.22	0.42	5248.40	0.511	17.663	5247.20	5248.13	0.93**	1.43	4.76	0.35	5248.48	0.398	0.454	0.080	1.00	0.35
11	18	2.00	5247.25	5247.60	0.35	0.31	6.38	0.63	5248.23	2.166	14.957	5247.73	5248.27	0.54**	0.58	3.46	0.19	5248.46	0.393	1.280	0.191	1.00	0.19
12	18	1.70	5247.14	5247.37	0.23*	0.17	10.22	1.62	5248.99	9.440	18.243	5248.87	5249.82	0.95	1.18	1.44	0.03	5249.85	0.042	4.741	0.865	1.00	0.03

6th & Fed- NW Fed 50yr | Number of lines: 12 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

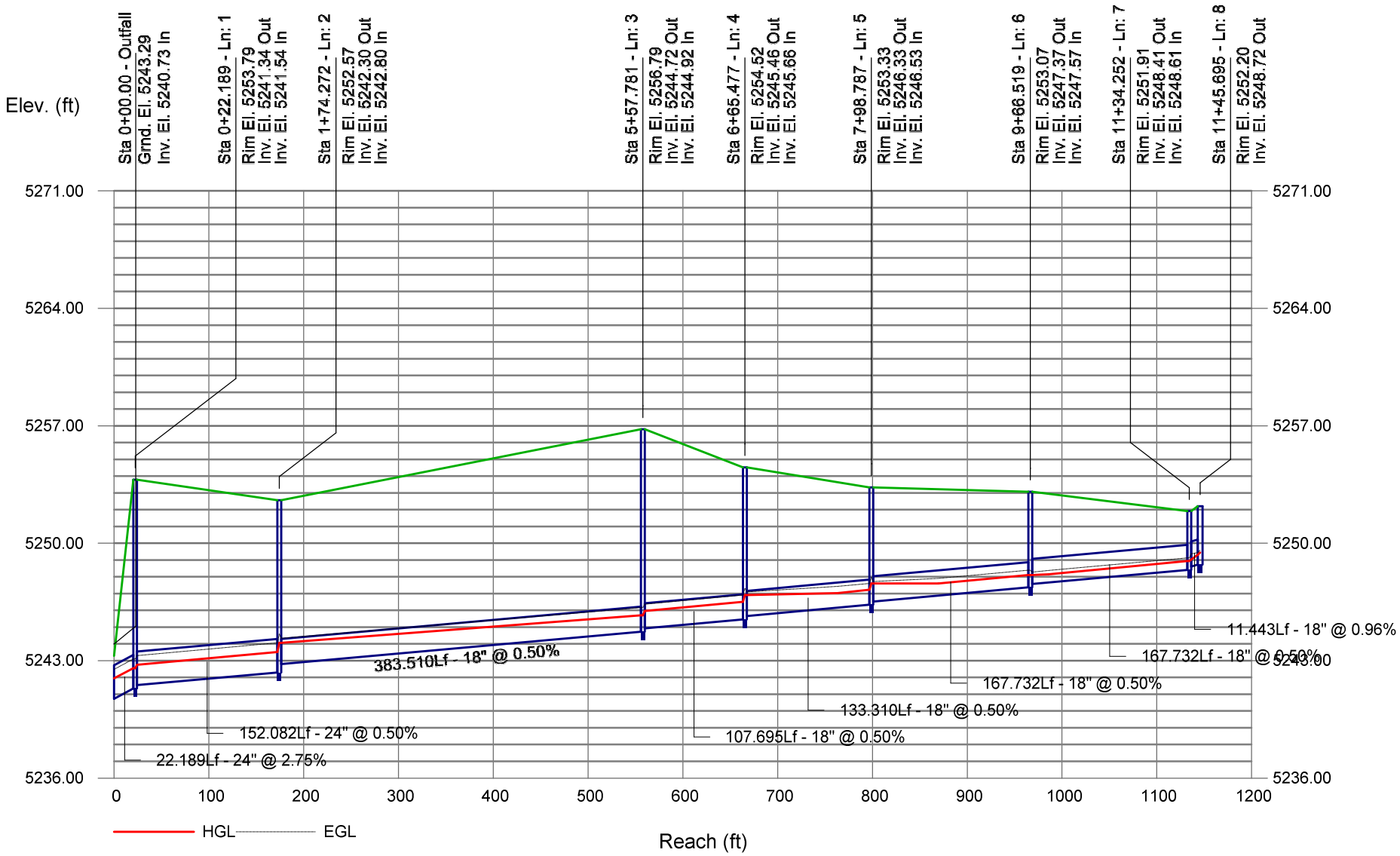
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: 6th & Fed NW Federal 50yr.stm



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	412C-D to 412C	13.50	24	Cir	22.189	5240.73	5241.34	2.748	5242.03	5242.64	n/a	5242.64	End	Manhole
2	414C to 412C-D	13.50	24	Cir	152.082	5241.54	5242.30	0.500	5242.87	5243.63	0.58	5244.21	1	Manhole
3	111C1 to 414C	7.80	18	Cir	383.510	5242.80	5244.72	0.501	5244.21	5245.88	0.44	5246.32	2	Manhole
4	112C1 to 111C1	7.80	18	Cir	107.695	5244.92	5245.46	0.501	5246.32	5246.73	0.37	5247.10	3	Manhole
5	113C1 to 112C1	6.30	18	Cir	133.310	5245.66	5246.33	0.503	5247.10	5247.42	0.33	5247.75	4	Manhole
6	115C to 113C1	4.30	18	Cir	167.732	5246.53	5247.37	0.501	5247.75	5248.16	n/a	5248.16 j	5	Manhole
7	117C to 115C	2.30	18	Cir	167.732	5247.57	5248.41	0.501	5248.16	5248.99	n/a	5248.99 j	6	Manhole
8	117L to 117C	2.30	18	Cir	11.443	5248.61	5248.72	0.964	5249.07	5249.38	0.15	5249.53	7	Manhole
9	115L to 115C	2.10	18	Cir	13.680	5247.59	5248.06	3.437	5248.16	5248.61	n/a	5248.61 j	6	Manhole
10	414L to 414C	7.70	24	Cir	17.663	5247.11	5247.20	0.511	5248.04	5248.19	0.39	5248.57	2	Manhole
11	113L to 113C1	2.30	18	Cir	14.957	5247.25	5247.73	3.209	5247.75	5248.31	0.21	5248.31	5	Manhole
12	112L to 112C1	1.90	18	Cir	18.243	5247.14	5248.87	9.483	5247.38	5249.96	0.03	5249.99	4	Manhole

6th & Fed- NW Fed 100yr | Number of lines: 12 | Run Date: 6/6/2012

NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	13.50	5240.73	5242.03	1.30	2.16	6.24	0.61	5242.64	0.529	22.189	5241.34	5242.64	1.30**	2.16	6.24	0.60	5243.25	0.529	0.529	n/a	0.65	n/a
2	24	13.50	5241.54	5242.87	1.33*	2.22	6.09	0.58	5243.45	0.499	152.082	5242.30	5243.63	1.33	2.22	6.09	0.58	5244.21	0.498	0.499	0.758	1.00	0.58
3	18	7.80	5242.80	5244.21	1.41	1.72	4.53	0.32	5244.52	0.406	383.510	5244.72	5245.88	1.16	1.46	5.33	0.44	5246.32	0.530	0.468	1.795	1.00	0.44
4	18	7.80	5244.92	5246.32	1.40	1.72	4.55	0.32	5246.64	0.406	107.695	5245.46	5246.73	1.27	1.59	4.90	0.37	5247.10	0.447	0.427	0.460	1.00	0.37
5	18	6.30	5245.66	5247.10	1.44	1.74	3.61	0.20	5247.30	0.267	133.310	5246.33	5247.42	1.09	1.38	4.58	0.33	5247.75	0.397	0.332	0.443	1.00	0.33
6	18	4.30	5246.53	5247.75	1.22	1.53	2.80	0.12	5247.87	0.146	167.732	5247.37	5248.16 j	0.79**	0.95	4.55	0.32	5248.48	0.477	0.311	n/a	1.00	0.32
7	18	2.30	5247.57	5248.16	0.59	0.65	3.55	0.20	5248.36	0.379	167.732	5248.41	5248.99 j	0.58**	0.63	3.66	0.21	5249.20	0.411	0.395	n/a	1.00	0.21
8	18	2.30	5248.61	5249.07	0.46*	0.46	4.97	0.38	5249.46	0.964	11.443	5248.72	5249.38	0.66	0.75	3.07	0.15	5249.53	0.255	0.609	0.070	1.00	0.15
9	18	2.10	5247.59	5248.16	0.57	0.62	3.39	0.18	5248.34	0.358	13.680	5248.06	5248.61 j	0.55**	0.59	3.55	0.20	5248.81	0.405	0.382	n/a	1.00	0.20
10	24	7.70	5247.11	5248.04	0.93*	1.43	5.39	0.45	5248.49	0.511	17.663	5247.20	5248.19	0.99**	1.55	4.98	0.39	5248.57	0.412	0.461	0.081	1.00	0.39
11	18	2.30	5247.25	5247.75	0.50	0.51	4.51	0.32	5248.06	0.733	14.957	5247.73	5248.31	0.58**	0.63	3.66	0.21	5248.52	0.411	0.572	n/a	1.00	0.21
12	18	1.90	5247.14	5247.38	0.24*	0.18	10.58	1.74	5249.12	9.485	18.243	5248.87	5249.96	1.09	1.37	1.38	0.03	5249.99	0.036	4.761	0.868	1.00	0.03

6th & Fed- NW Fed 100yr | Number of lines: 12 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

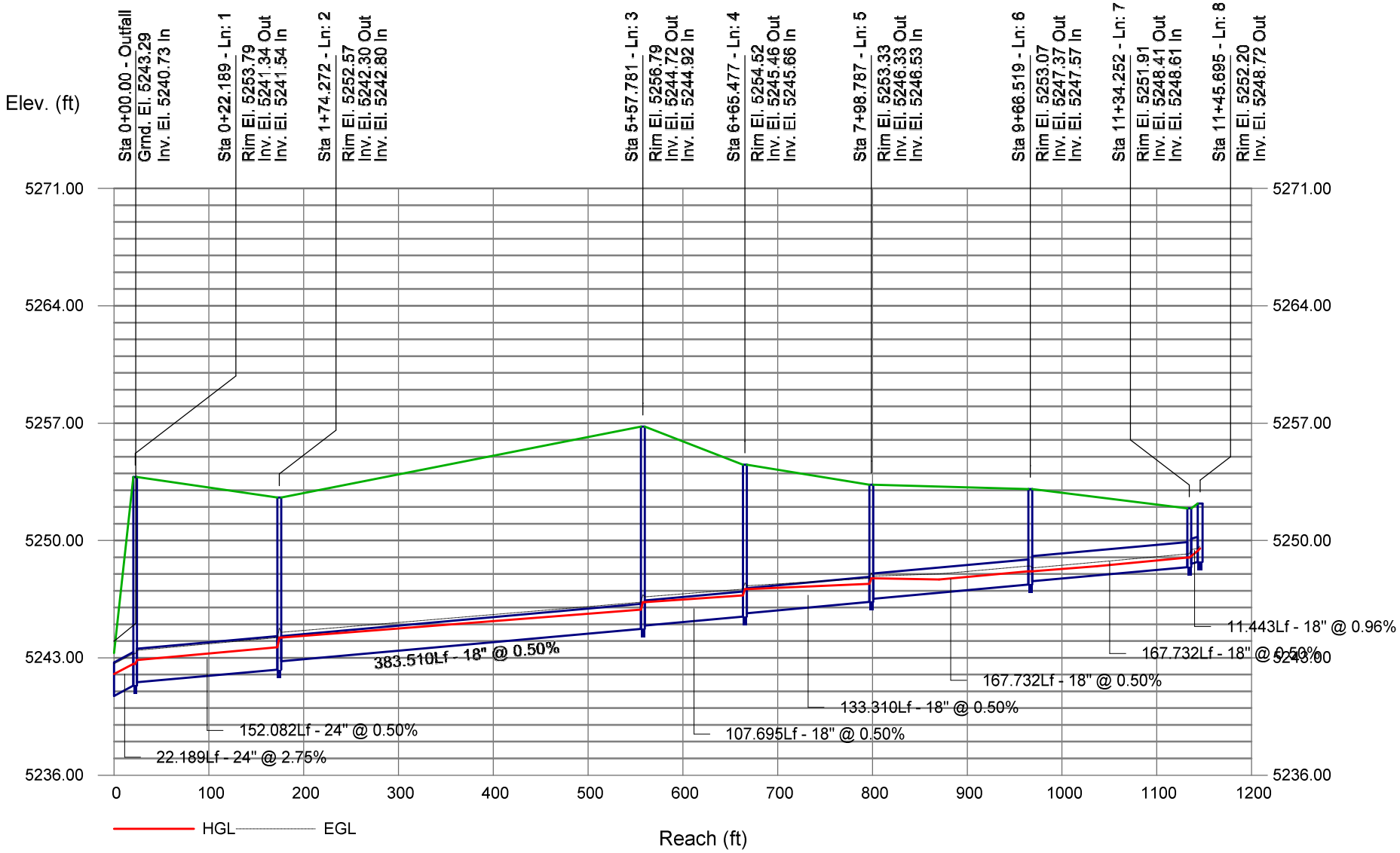
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: 6th & Fed NW Federal 100yr.stm



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	306R-D to 306R	7.40	24	Cir	22.029	5242.90	5243.09	0.862	5243.86	5244.05	n/a	5244.05	End	Manhole
2	307R to 306R-D	7.40	24	Cir	149.564	5243.29	5244.41	0.749	5244.14	5245.37	n/a	5245.37	1	Manhole
3	107C to 307R	5.10	18	Cir	388.099	5244.91	5248.79	1.000	5245.65	5249.65	n/a	5249.65	2	Manhole
4	105C to 107C	5.10	18	Cir	180.847	5249.96	5250.86	0.498	5250.88	5251.77	0.32	5252.09	3	Manhole
5	906C to 105C	5.10	18	Cir	73.409	5251.06	5251.43	0.504	5252.09	5252.32	0.34	5252.66	4	Manhole
6	906R to 906C	1.60	18	Cir	12.278	5251.63	5251.86	1.873	5252.66	5252.64	0.05	5252.69	5	Manhole
7	906L to 906C	3.50	18	Cir	24.423	5251.63	5251.87	0.984	5252.66	5252.59	0.27	5252.86	5	Manhole

6th & Fed- SW Federal 10yr | Number of lines: 7 | Run Date: 6/6/2012

NOTES: Return period = 2 Yrs.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	7.40	5242.90	5243.86	0.96	1.50	4.94	0.38	5244.24	0.487	22.029	5243.09	5244.05	0.96**	1.50	4.94	0.38	5244.43	0.486	0.486	n/a	0.50	n/a
2	24	7.40	5243.29	5244.14	0.85*	1.28	5.80	0.52	5244.67	0.749	149.564	5244.41	5245.37	0.96**	1.50	4.94	0.38	5245.75	0.486	0.617	n/a	0.15	n/a
3	18	5.10	5244.91	5245.65	0.74*	0.86	5.90	0.54	5246.19	1.000	388.099	5248.79	5249.65	0.86**	1.05	4.85	0.37	5250.02	0.598	0.799	n/a	1.00	n/a
4	18	5.10	5249.96	5250.88	0.92*	1.13	4.52	0.32	5251.19	0.497	180.847	5250.86	5251.77	0.91	1.13	4.53	0.32	5252.09	0.499	0.498	0.901	1.00	0.32
5	18	5.10	5251.06	5252.09	1.03	1.30	3.94	0.24	5252.33	0.352	73.409	5251.43	5252.32	0.89	1.09	4.66	0.34	5252.66	0.538	0.445	0.327	1.00	0.34
6	18	1.60	5251.63	5252.66	1.03	1.29	1.24	0.02	5252.68	0.035	12.278	5251.86	5252.64	0.78	0.93	1.71	0.05	5252.69	0.080	0.057	0.007	1.00	0.05
7	18	3.50	5251.63	5252.66	1.03	1.29	2.71	0.11	5252.77	0.167	24.423	5251.87	5252.59	0.72**	0.84	4.19	0.27	5252.86	0.516	0.342	0.083	1.00	0.27

6th & Fed- SW Federal 10yr | Number of lines: 7 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

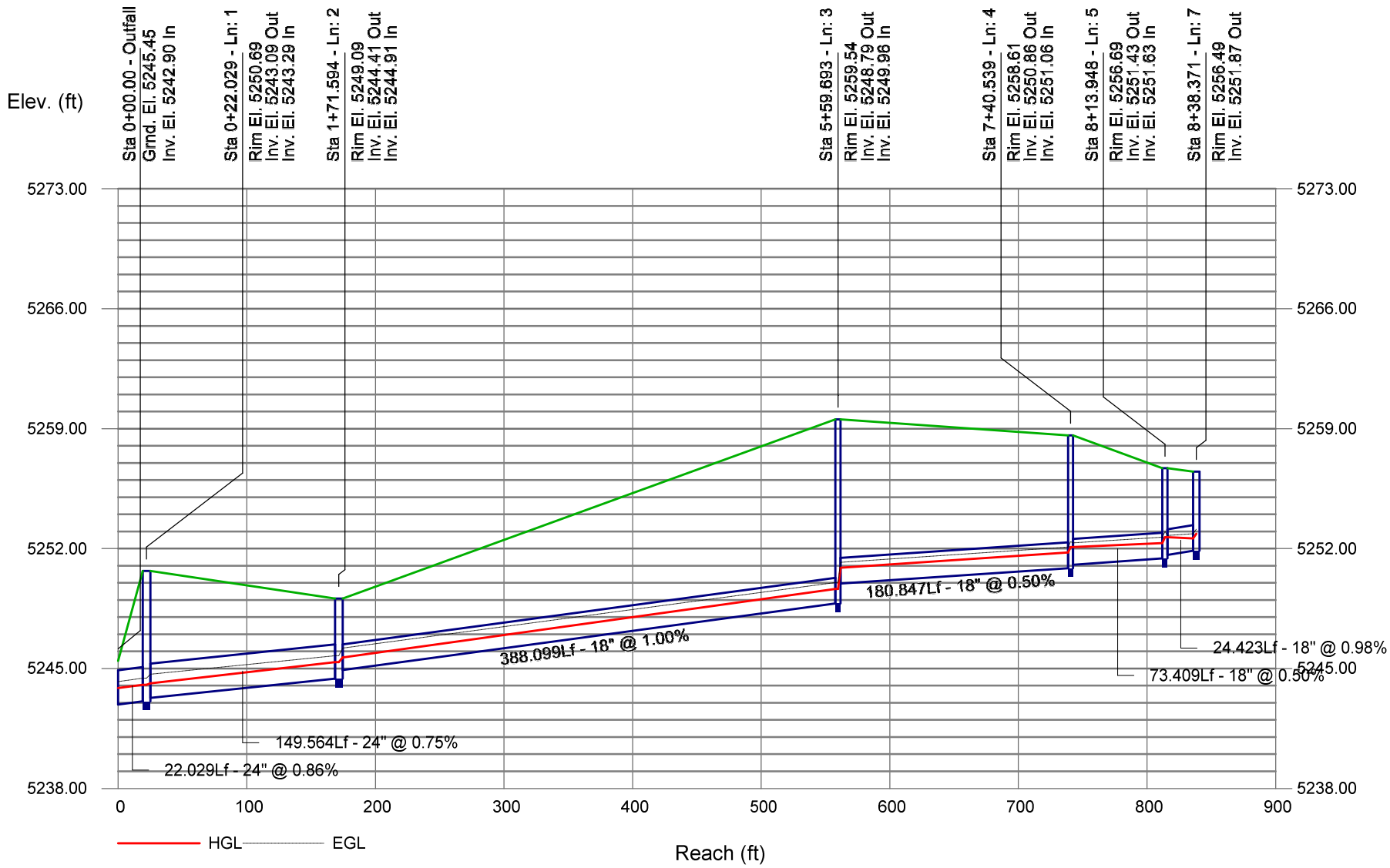
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: 6th & Fed SW Federal 10yr.stm



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	306R-D to 306R	12.60	24	Cir	22.029	5242.90	5243.09	0.862	5244.16	5244.35	0.29	5244.35	End	Manhole
2	307R to 306R-D	12.60	24	Cir	149.564	5243.29	5244.41	0.749	5244.46	5245.67	0.09	5245.67	1	Manhole
3	107C to 307R	8.10	18	Cir	388.099	5244.91	5248.79	1.000	5245.90	5249.88	0.54	5249.88	2	Manhole
4	105C to 107C	8.10	18	Cir	180.847	5249.96	5250.86	0.498	5251.46*	5252.54*	0.33	5252.86	3	Manhole
5	906C to 105C	8.10	18	Cir	73.409	5251.06	5251.43	0.504	5252.86*	5253.30*	0.33	5253.63	4	Manhole
6	906R to 906C	2.80	18	Cir	12.278	5251.63	5251.86	1.873	5253.63*	5253.64*	0.04	5253.67	5	Manhole
7	906L to 906C	5.30	18	Cir	24.423	5251.63	5251.87	0.984	5253.63*	5253.69*	0.14	5253.83	5	Manhole

6th & Fed- SW Federal 50yr | Number of lines: 7 | Run Date: 6/6/2012

NOTES: Return period = 2 Yrs. ; *Surcharged (HGL above crown).

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	12.60	5242.90	5244.16	1.26	2.08	6.06	0.57	5244.73	0.598	22.029	5243.09	5244.35	1.26**	2.08	6.06	0.57	5244.92	0.598	0.598	n/a	0.50	0.29
2	24	12.60	5243.29	5244.46	1.17*	1.90	6.62	0.68	5245.14	0.749	149.564	5244.41	5245.67	1.26**	2.08	6.06	0.57	5246.24	0.598	0.673	n/a	0.15	0.09
3	18	8.10	5244.91	5245.90	0.99*	1.24	6.56	0.67	5246.57	0.999	388.099	5248.79	5249.88	1.09**	1.37	5.91	0.54	5250.42	0.778	0.889	n/a	1.00	0.54
4	18	8.10	5249.96	5251.46	1.50*	1.77	4.58	0.33	5251.79	0.595	180.847	5250.86	5252.54	1.50	1.77	4.58	0.33	5252.86	0.595	0.595	1.076	1.00	0.33
5	18	8.10	5251.06	5252.86	1.50	1.77	4.58	0.33	5253.19	0.595	73.409	5251.43	5253.30	1.50	1.77	4.58	0.33	5253.63	0.595	0.595	0.437	1.00	0.33
6	18	2.80	5251.63	5253.63	1.50	1.77	1.58	0.04	5253.67	0.071	12.278	5251.86	5253.64	1.50	1.77	1.58	0.04	5253.67	0.071	0.071	0.009	1.00	0.04
7	18	5.30	5251.63	5253.63	1.50	1.77	3.00	0.14	5253.77	0.255	24.423	5251.87	5253.69	1.50	1.77	3.00	0.14	5253.83	0.255	0.255	0.062	1.00	0.14

6th & Fed- SW Federal 50yr | Number of lines: 7 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

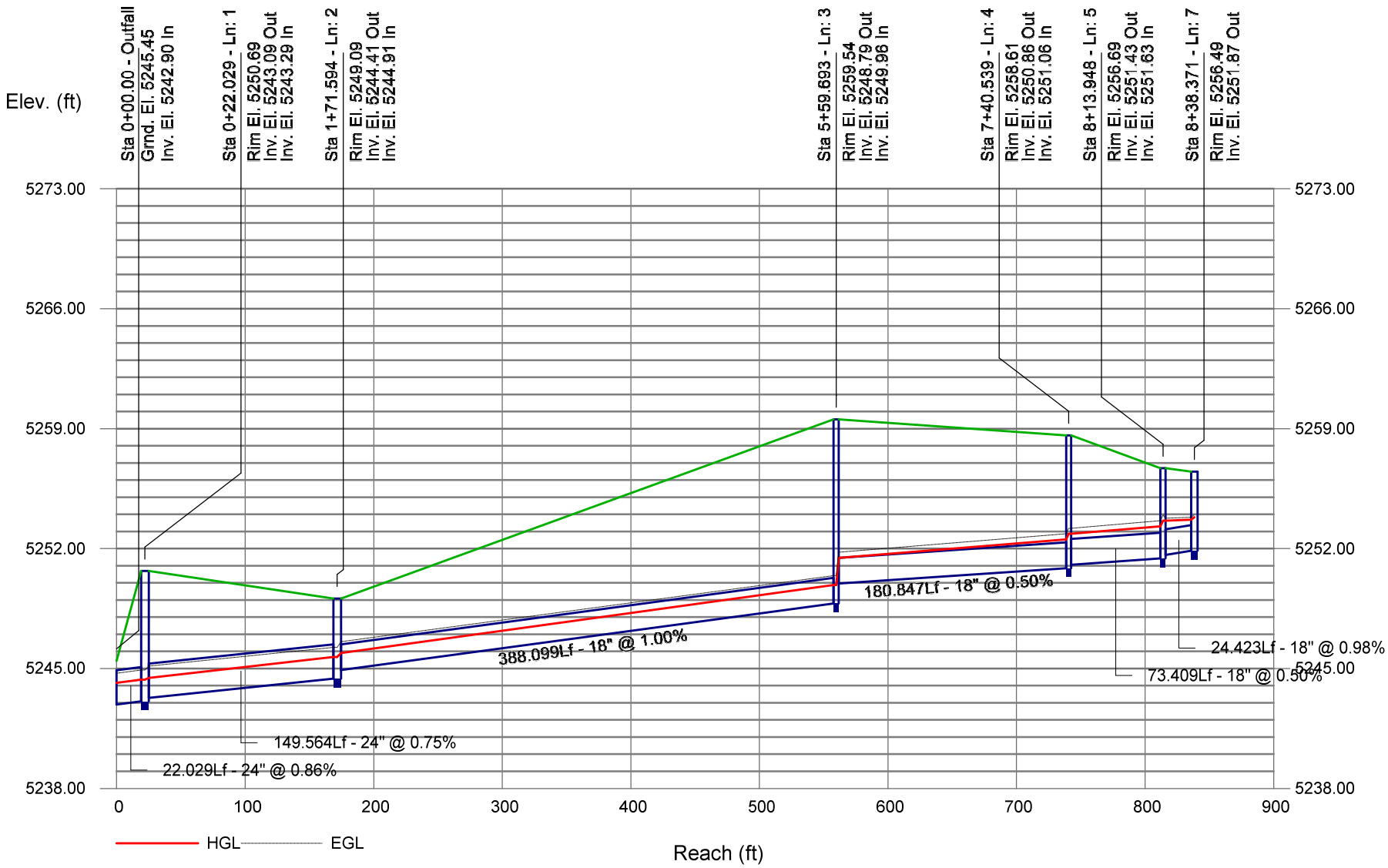
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: 6th & Fed SW Federal 50yr.stm



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	306R-D to 306R	14.80	24	Cir	22.029	5242.90	5243.09	0.862	5244.26	5244.46	0.33	5244.78	End	Manhole
2	307R to 306R-D	14.80	24	Cir	149.564	5243.29	5244.41	0.749	5244.78	5245.77	0.10	5245.77	1	Manhole
3	107C to 307R	9.40	18	Cir	388.099	5244.91	5248.79	1.000	5246.02	5249.96	0.63	5249.96	2	Manhole
4	105C to 107C	9.40	18	Cir	180.847	5249.96	5250.86	0.498	5251.46*	5252.91*	0.44	5253.35	3	Manhole
5	906C to 105C	9.40	18	Cir	73.409	5251.06	5251.43	0.504	5253.35*	5253.94*	0.44	5254.38	4	Manhole
6	906R to 906C	3.30	18	Cir	12.278	5251.63	5251.86	1.873	5254.38*	5254.39*	0.05	5254.44	5	Manhole
7	906L to 906C	6.10	18	Cir	24.423	5251.63	5251.87	0.984	5254.38*	5254.46*	0.19	5254.65	5	Manhole

6th & Fed- SW Federal 100yr | Number of lines: 7 | Run Date: 6/6/2012

NOTES: Return period = 2 Yrs. ; *Surcharged (HGL above crown).

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	14.80	5242.90	5244.26	1.36	2.28	6.49	0.66	5244.92	0.656	22.029	5243.09	5244.46	1.37**	2.29	6.47	0.65	5245.11	0.650	0.653	0.144	0.50	0.33
2	24	14.80	5243.29	5244.78	1.49	2.51	5.89	0.54	5245.32	0.521	149.564	5244.41	5245.77	1.36**	2.28	6.49	0.66	5246.43	0.657	0.589	n/a	0.15	0.10
3	18	9.40	5244.91	5246.02	1.11*	1.40	6.72	0.70	5246.72	0.999	388.099	5248.79	5249.96	1.17**	1.48	6.35	0.63	5250.59	0.883	0.941	n/a	1.00	0.63
4	18	9.40	5249.96	5251.46	1.50*	1.77	5.32	0.44	5251.90	0.802	180.847	5250.86	5252.91	1.50	1.77	5.32	0.44	5253.35	0.801	0.801	1.449	1.00	0.44
5	18	9.40	5251.06	5253.35	1.50	1.77	5.32	0.44	5253.79	0.802	73.409	5251.43	5253.94	1.50	1.77	5.32	0.44	5254.38	0.801	0.801	0.588	1.00	0.44
6	18	3.30	5251.63	5254.38	1.50	1.77	1.87	0.05	5254.43	0.099	12.278	5251.86	5254.39	1.50	1.77	1.87	0.05	5254.44	0.099	0.099	0.012	1.00	0.05
7	18	6.10	5251.63	5254.38	1.50	1.77	3.45	0.19	5254.56	0.338	24.423	5251.87	5254.46	1.50	1.77	3.45	0.19	5254.65	0.337	0.338	0.082	1.00	0.19

6th & Fed- SW Federal 100yr | Number of lines: 7 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

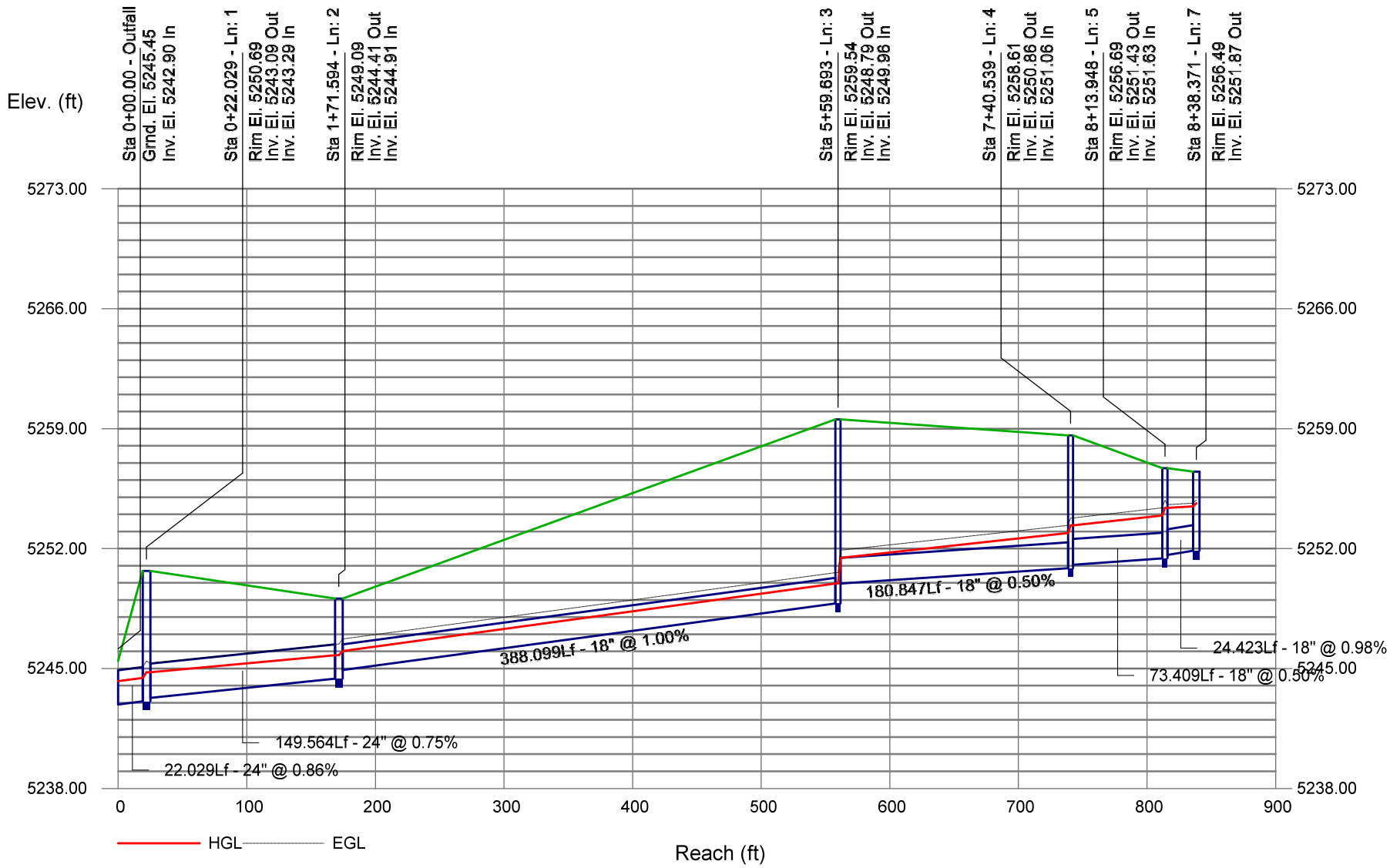
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: 6th & Fed SW Federal 100yr.stm



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	6000C to 6000L	51.70	24	Cir	17.541	5208.23	5209.61	7.867	5210.21	5211.59	n/a	5211.59	End	Manhole
2	5997C to 6000C	44.00	54	Cir	322.470	5210.31	5213.23	0.905	5211.80	5215.13	0.74	5215.13	1	Manhole
3	2197L to 5997C	39.50	54	Cir	78.687	5213.23	5213.63	0.508	5215.13	5215.43	n/a	5215.43	2	Manhole
4	2197C to 2197L	38.60	54	Cir	39.918	5213.82	5214.02	0.502	5215.44	5215.84	0.64	5216.48	3	Manhole
5	2193R to 2197C	39.50	54	Cir	400.706	5214.22	5216.22	0.499	5216.48	5218.02	n/a	5218.02 j	4	Manhole
6	2190R to 2193R	32.10	36	Cir	270.590	5218.95	5222.17	1.190	5220.35	5223.98	n/a	5223.98	5	Manhole
7	2190C to 2190R	32.10	36	Cir	62.346	5222.36	5224.22	2.984	5223.98	5226.03	n/a	5226.03	6	Manhole
8	2188C to 2190C	32.10	36	Cir	302.737	5224.42	5229.25	1.595	5226.03	5231.06	n/a	5231.06	7	Manhole
9	2184C to 2188C	32.10	36	Cir	378.080	5229.45	5231.34	0.500	5231.27	5233.15	n/a	5233.96 j	8	Manhole
10	2183C to 2184C	28.90	36	Cir	87.576	5231.54	5235.40	4.407	5233.96	5237.11	n/a	5237.11 j	9	Manhole
11	411C-D to 2183C	25.00	24	Cir	26.950	5241.92	5242.46	2.004	5243.25*	5244.67*	0.98	5245.66	10	Manhole
12	408L to 411C-D	24.20	48	Cir	360.853	5243.83	5261.52	4.902	5245.66	5262.98	n/a	5262.98 j	11	Manhole
13	406L to 408L	24.20	36	Cir	231.532	5262.40	5272.09	4.185	5263.26	5273.66	n/a	5273.66	12	Manhole
14	402L to 406L	23.70	36	Cir	397.495	5272.27	5287.90	3.932	5273.66	5289.45	0.10	5289.45	13	Manhole
15	401C to 402L	23.10	36	Cir	84.877	5288.03	5290.26	2.627	5289.45	5291.79	n/a	5291.79	14	Manhole
16	3905 MT 109 to 401C	17.00	24	Cir	106.738	5297.32	5311.41	13.201	5297.94	5312.87	0.74	5312.87	15	Manhole
17	2172C to 401C	7.40	24	Cir	66.988	5291.18	5293.04	2.776	5291.79	5294.00	n/a	5294.00	15	Manhole
18	305R-D to 2183C	5.60	18	Cir	208.668	5245.86	5246.90	0.498	5246.83	5247.88	0.33	5248.21	10	Manhole
19	302R to 305R-D	5.00	36	Cir	260.697	5247.59	5256.65	3.475	5248.21	5257.36	0.04	5257.36	18	Manhole
20	2677R to 302R	2.80	36	Cir	360.580	5256.77	5271.71	4.143	5257.36	5272.24	n/a	5272.24 j	19	Manhole
21	2673R to 2677R	1.20	24	Cir	379.144	5272.63	5288.07	4.072	5272.85	5288.46	0.12	5288.46	20	Manhole
22	500C to 6000C	10.30	48	Cir	284.986	5212.42	5213.85	0.502	5213.28	5214.80	n/a	5214.80	1	Manhole
23	4998C to 500C	7.50	42	Cir	231.891	5214.35	5215.50	0.496	5215.12	5216.34	n/a	5216.34	22	Manhole
24	4994C to 4998C	1.50	24	Cir	377.703	5230.41	5248.87	4.887	5230.65	5249.30	n/a	5249.30	23	Manhole

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

NOTES: Return period = 2 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
25	4990C to 4994C	1.50	24	Cir	366.155	5249.07	5250.90	0.500	5249.48	5251.33	n/a	5251.33	24	Manhole
26	106C2 to 4990C	1.50	18	Cir	119.971	5251.40	5252.00	0.500	5251.86	5252.47	0.07	5252.54	25	Manhole
27	106C1 to 106C2	1.50	18	Cir	94.361	5252.18	5252.65	0.498	5252.64	5253.12	0.16	5253.28	26	Manhole
28	106R to 106C1	1.50	18	Cir	15.259	5252.85	5253.00	0.982	5253.28	5253.47	n/a	5253.47	27	Manhole
29	306R-D to 2184C	2.40	18	Cir	219.689	5241.49	5242.59	0.501	5242.08	5243.19	0.21	5243.40	9	Manhole
30	307R to 306R-D	2.40	24	Cir	149.564	5243.29	5244.41	0.749	5243.76	5244.96	0.03	5244.96	29	Manhole
31	107C to 307R	1.80	18	Cir	388.099	5244.91	5248.79	1.000	5245.33	5249.30	0.18	5249.30	30	Manhole
32	105C to 107C	1.80	18	Cir	180.847	5249.96	5250.86	0.498	5250.46	5251.38	0.17	5251.55	31	Manhole
33	906C to 105C	1.80	18	Cir	73.409	5251.06	5251.43	0.504	5251.56	5251.95	0.17	5252.12	32	Manhole
34	906R to 906C	0.50	18	Cir	12.278	5251.63	5251.86	1.873	5252.12	5252.13	n/a	5252.21 j	33	Manhole
35	906L to 906C	1.30	18	Cir	24.423	5251.63	5251.87	0.984	5252.12	5252.31	n/a	5252.31 j	33	Manhole
36	411L to 411C-D	2.10	18	Cir	17.626	5250.52	5250.61	0.510	5251.06	5251.17	0.19	5251.36	11	Manhole
37	412C-D to 2184C	2.80	18	Cir	31.447	5240.68	5240.84	0.508	5241.32	5241.48	0.23	5241.72	9	Manhole
38	414C to 412C-D	2.80	24	Cir	152.082	5241.54	5242.30	0.500	5242.11	5242.89	0.20	5242.89	37	Manhole
39	111C1 to 414C	1.50	18	Cir	383.510	5242.80	5244.72	0.501	5243.26	5245.19	n/a	5245.19	38	Manhole
40	112C1 to 111C1	1.50	18	Cir	107.695	5244.92	5245.46	0.501	5245.38	5245.93	0.16	5246.09	39	Manhole
41	113C1 to 112C1	1.20	18	Cir	133.310	5245.66	5246.33	0.503	5246.09	5246.75	n/a	5246.75 j	40	Manhole
42	115C to 113C1	0.70	18	Cir	167.732	5246.53	5247.37	0.501	5246.84	5247.69	n/a	5247.69	41	Manhole
43	117C to 115C	0.40	18	Cir	167.732	5247.57	5248.41	0.501	5247.81	5248.65	n/a	5248.65	42	Manhole
44	117L to 117C	0.40	18	Cir	11.443	5248.61	5248.72	0.964	5248.81	5248.96	0.07	5249.04	43	Manhole
45	5994C to 5997C	4.60	24	Cir	370.149	5221.50	5236.80	4.133	5221.93	5237.56	0.04	5237.56	2	Manhole
46	111C2 to 5994C	4.60	24	Cir	350.186	5237.00	5244.31	2.087	5237.56	5245.07	0.27	5245.07	45	Manhole
47	112C2 to 111C2	4.60	24	Cir	115.018	5244.52	5245.09	0.495	5245.26	5245.85	0.27	5246.13	46	Manhole
48	112R to 112C2	0.40	18	Cir	11.110	5248.27	5249.05	7.019	5248.40	5249.29	n/a	5249.29	47	Manhole

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

NOTES: Return period = 2 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
49	113C2 to 112C2	4.30	24	Cir	133.810	5245.29	5245.96	0.501	5246.13	5246.69	n/a	5246.69 j	47	Manhole
50	114C to 113C2	2.90	24	Cir	122.213	5246.16	5246.77	0.499	5246.74	5247.37	n/a	5247.37	49	Manhole
51	116C to 114C	2.10	18	Cir	122.213	5247.27	5247.88	0.499	5247.82	5248.44	0.19	5248.63	50	Manhole
52	116R1 to 116C	1.50	18	Cir	17.593	5248.08	5248.26	1.021	5248.63	5248.73	n/a	5248.73 j	51	Manhole
53	116R2 to 116C	0.60	18	Cir	83.405	5248.08	5248.91	0.995	5248.63	5249.21	n/a	5249.21 j	51	Manhole
54	115L to 115C	0.40	18	Cir	13.680	5247.59	5248.06	3.437	5247.74	5248.30	n/a	5248.30	42	Manhole
55	114R to 114C	0.90	18	Cir	16.558	5247.46	5247.96	3.020	5247.69	5248.33	0.11	5248.44	50	Manhole
56	414L to 414C	1.70	24	Cir	17.663	5247.11	5247.20	0.511	5247.55	5247.67	0.15	5247.81	38	Manhole
57	113L to 113C1	0.50	18	Cir	14.957	5247.25	5247.73	3.209	5247.42	5248.00	0.08	5248.00	41	Manhole
58	112L to 112C1	0.40	18	Cir	18.243	5247.14	5248.87	9.483	5247.26	5249.11	n/a	5249.11	40	Manhole
59	113R to 113C2	1.50	18	Cir	16.068	5246.66	5247.67	6.284	5246.90	5248.37	0.05	5248.43	49	Manhole
60	210C2 to 4998C	5.70	36	Cir	263.506	5216.00	5217.32	0.501	5216.70	5218.08	0.25	5218.08	23	Manhole
61	210C1 to 210C2	4.00	24	Cir	172.098	5218.32	5219.18	0.500	5219.00	5219.89	0.25	5219.89	60	Manhole
62	208C to 210C1	2.60	18	Cir	160.738	5225.88	5233.00	4.430	5226.23	5233.62	n/a	5233.62	61	Manhole
63	208R to 208C	1.30	18	Cir	22.227	5233.31	5233.53	0.989	5233.67	5233.97	0.14	5234.11	62	Manhole
64	208L to 208C	1.30	18	Cir	22.812	5233.20	5233.43	1.008	5233.62	5233.87	n/a	5233.87	62	Manhole
65	5000R to 500C	1.30	18	Cir	20.433	5227.98	5228.22	1.176	5228.32	5228.66	0.14	5228.80	22	Manhole
66	2501L to 6000C	2.90	24	Cir	74.927	5222.10	5222.47	0.494	5222.68	5223.08	0.20	5223.28	1	Manhole
67	2501C to 2501L	2.00	24	Cir	56.005	5222.67	5222.95	0.500	5223.28	5223.45	0.16	5223.45	66	Manhole
68	2504C to 2501C	2.00	24	Cir	257.622	5223.15	5224.44	0.501	5223.63	5224.94	0.16	5224.94	67	Manhole
69	4004R to 2504C	1.20	18	Cir	117.795	5227.55	5228.14	0.501	5227.96	5228.56	0.14	5228.70	68	Manhole
70	2507L to 2504C	0.90	18	Cir	304.941	5224.94	5226.45	0.495	5225.29	5226.81	0.12	5226.81	68	Manhole
71	2507L2 to 2507L	0.10	18	Cir	64.612	5226.90	5227.22	0.496	5227.02	5227.34	n/a	5227.38 j	70	Manhole
72	3007L to 2507L	0.80	18	Cir	123.559	5226.65	5227.27	0.502	5226.98	5227.62	0.11	5227.72	70	Manhole

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

NOTES: Return period = 2 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
73	500R to 500C	0.10	18	Cir	21.174	5224.71	5224.81	0.473	5224.83	5224.93	n/a	5224.97 j	22	Manhole
74	811C to 210C1	1.10	18	Cir	82.171	5223.40	5223.81	0.499	5223.79	5224.21	0.13	5224.34	61	Manhole
75	811R to 811C	0.10	18	Cir	12.304	5224.01	5224.13	0.976	5224.34	5224.34	0.01	5224.35	74	Manhole
76	811L to 811C	1.10	18	Cir	28.293	5224.01	5224.29	0.991	5224.34	5224.69	0.13	5224.69	74	Manhole
77	210L to 210C2	1.90	18	Cir	35.266	5223.90	5227.43	10.010	5224.14	5227.96	n/a	5227.96	60	Manhole
78	5997L to 5997C	4.30	36	Cir	16.718	5220.27	5220.35	0.479	5220.89	5221.02	0.21	5221.23	2	Manhole
79	211C to 210C1	0.40	18	Cir	125.531	5219.68	5220.31	0.502	5219.92	5220.55	0.07	5220.63	61	Manhole
80	211R to 211C	0.20	18	Cir	15.789	5220.81	5220.97	1.014	5220.95	5221.14	0.05	5221.19	79	Manhole
81	211L to 211C	0.20	18	Cir	28.295	5220.51	5220.79	0.991	5220.65	5220.96	0.05	5220.96	79	Manhole
82	2693R to 2193R	8.80	36	Cir	65.126	5217.72	5218.05	0.506	5218.60	5219.00	0.05	5219.05	5	Manhole
83	2994R to 2693R	6.60	36	Cir	72.203	5218.25	5218.61	0.498	5219.05	5219.43	n/a	5219.43	82	Manhole
84	502C to 500C	2.30	18	Cir	189.619	5216.25	5217.20	0.501	5216.82	5217.78	0.20	5217.99	22	Manhole
85	502R to 502C	2.30	18	Cir	20.335	5217.40	5217.50	0.492	5217.99	5218.08	0.20	5218.29	84	Manhole

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

NOTES: Return period = 2 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	51.70	5208.23	5210.21	1.98	3.14	16.48	4.22	5214.44	4.845	17.541	5209.61	5211.59	1.98**	3.14	16.48	4.22	5215.81	4.847	4.846	n/a	1.00	n/a
2	54	44.00	5210.31	5211.80	1.49*	4.58	9.61	1.44	5213.23	0.904	322.470	5213.23	5215.13	1.90**	6.40	6.88	0.74	5215.87	0.360	0.632	n/a	1.00	0.74
3	54	39.50	5213.23	5215.13	1.90	6.40	6.18	0.59	5215.73	0.290	78.687	5213.63	5215.43	1.80**	5.95	6.64	0.68	5216.12	0.353	0.322	n/a	0.15	n/a
4	54	38.60	5213.82	5215.44	1.62*	5.16	7.49	0.87	5216.31	0.501	39.918	5214.02	5215.84	1.82	6.01	6.42	0.64	5216.48	0.329	0.415	0.166	1.00	0.64
5	54	39.50	5214.22	5216.48	2.26	7.98	4.95	0.38	5216.86	0.160	400.706	5216.22	5218.02 j	1.80**	5.95	6.64	0.68	5218.71	0.353	0.256	n/a	1.00	n/a
6	36	32.10	5218.95	5220.35	1.40*	3.22	9.97	1.54	5221.89	1.188	270.590	5222.17	5223.98	1.81**	4.45	7.22	0.81	5224.79	0.508	0.848	n/a	1.00	n/a
7	36	32.10	5222.36	5223.98	1.62	3.88	8.27	1.06	5225.04	0.723	62.346	5224.22	5226.03	1.81**	4.45	7.22	0.81	5226.84	0.508	0.616	n/a	1.00	n/a
8	36	32.10	5224.42	5226.03	1.61	3.85	8.33	1.08	5227.11	0.738	302.737	5229.25	5231.06	1.81**	4.45	7.22	0.81	5231.87	0.508	0.623	n/a	0.15	n/a
9	36	32.10	5229.45	5231.27	1.82*	4.47	7.17	0.80	5232.07	0.500	378.080	5231.34	5233.15 j	1.81**	4.47	7.19	0.80	5233.96	0.502	0.501	1.893	1.00	0.80
10	36	28.90	5231.54	5233.96	2.42	6.10	4.74	0.35	5234.31	0.194	87.576	5235.40	5237.11 j	1.71**	4.17	6.93	0.75	5237.86	0.485	0.339	n/a	1.00	n/a
11	24	25.00	5241.92	5243.25	1.33*	2.22	11.27	1.97	5245.22	2.002	26.950	5242.46	5244.67	2.00	3.14	7.96	0.98	5245.66	1.222	1.612	0.434	1.00	0.98
12	48	24.20	5243.83	5245.66	1.83	5.60	4.32	0.29	5245.95	0.155	360.853	5261.52	5262.98 j	1.46**	4.13	5.86	0.53	5263.51	0.355	0.255	n/a	0.15	0.08
13	36	24.20	5262.40	5263.26	0.86*	1.66	14.55	3.29	5266.55	4.174	231.532	5272.09	5273.66	1.57**	3.74	6.47	0.65	5274.31	0.454	2.314	n/a	0.15	n/a
14	36	23.70	5272.27	5273.66	1.39	3.20	7.41	0.85	5274.51	0.661	397.495	5287.90	5289.45	1.55**	3.69	6.42	0.64	5290.09	0.451	0.556	n/a	0.15	0.10
15	36	23.10	5288.03	5289.45	1.42	3.30	7.00	0.76	5290.21	0.577	84.877	5290.26	5291.79	1.53**	3.63	6.36	0.63	5292.42	0.447	0.512	n/a	1.00	n/a
16	24	17.00	5297.32	5297.94	0.62*	0.83	20.60	6.60	5304.54	13.172	106.738	5311.41	5312.87	1.46**	2.46	6.92	0.74	5313.61	0.724	6.948	n/a	1.00	0.74
17	24	7.40	5291.18	5291.79	0.61	0.81	9.10	1.29	5293.08	2.597	66.988	5293.04	5294.00	0.96**	1.50	4.94	0.38	5294.38	0.486	1.542	n/a	1.00	n/a
18	18	5.60	5245.86	5246.83	0.97*	1.21	4.61	0.33	5247.17	0.498	208.668	5246.90	5247.88	0.98	1.22	4.60	0.33	5248.21	0.496	0.497	1.037	1.00	0.33
19	36	5.00	5247.59	5248.21	0.61	1.04	4.80	0.36	5248.56	0.665	260.697	5256.65	5257.36	0.71**	1.29	3.89	0.24	5257.60	0.367	0.516	n/a	0.15	0.04
20	36	2.80	5256.77	5257.36	0.59	0.99	2.83	0.12	5257.49	0.242	360.580	5271.71	5272.24 j	0.53**	0.85	3.29	0.17	5272.41	0.371	0.306	n/a	0.15	n/a
21	24	1.20	5272.63	5272.85	0.22*	0.19	6.25	0.61	5273.46	4.083	379.144	5288.07	5288.46	0.39**	0.43	2.80	0.12	5288.58	0.416	2.250	n/a	1.00	0.12

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
22	48	10.30	5212.42	5213.28	0.86*	1.98	5.19	0.42	5213.70	0.500	284.986	5213.85	5214.80	0.95**	2.28	4.51	0.32	5215.12	0.337	0.419	n/a	1.00	n/a
23	42	7.50	5214.35	5215.12	0.77*	1.57	4.78	0.36	5215.48	0.495	231.891	5215.50	5216.34	0.84**	1.77	4.23	0.28	5216.62	0.351	0.423	n/a	1.00	n/a
24	24	1.50	5230.41	5230.65	0.24*	0.21	7.10	0.78	5231.43	4.849	377.703	5248.87	5249.30	0.43**	0.50	2.99	0.14	5249.44	0.414	2.631	n/a	0.15	n/a
25	24	1.50	5249.07	5249.48	0.41*	0.47	3.19	0.16	5249.64	0.499	366.155	5250.90	5251.33	0.43**	0.50	2.99	0.14	5251.47	0.414	0.456	n/a	0.92	n/a
26	18	1.50	5251.40	5251.86	0.46*	0.46	3.29	0.17	5252.03	0.499	119.971	5252.00	5252.47	0.47**	0.47	3.16	0.16	5252.63	0.447	0.473	0.567	0.46	0.07
27	18	1.50	5252.18	5252.64	0.46*	0.46	3.28	0.17	5252.81	0.497	94.361	5252.65	5253.12	0.47**	0.47	3.16	0.16	5253.28	0.447	0.472	0.445	1.00	0.16
28	18	1.50	5252.85	5253.28	0.43	0.41	3.63	0.20	5253.48	0.657	15.259	5253.00	5253.47	0.47**	0.47	3.19	0.16	5253.63	0.459	0.558	n/a	1.00	n/a
29	18	2.40	5241.49	5242.08	0.59*	0.64	3.75	0.22	5242.30	0.500	219.689	5242.59	5243.19	0.60**	0.65	3.68	0.21	5243.40	0.474	0.487	1.071	1.00	0.21
30	24	2.40	5243.29	5243.76	0.47*	0.57	4.22	0.28	5244.04	0.748	149.564	5244.41	5244.96	0.55**	0.70	3.43	0.18	5245.14	0.416	0.582	n/a	0.15	0.03
31	18	1.80	5244.91	5245.33	0.42*	0.41	4.44	0.31	5245.64	0.999	388.099	5248.79	5249.30	0.51**	0.53	3.38	0.18	5249.48	0.467	0.733	n/a	1.00	0.18
32	18	1.80	5249.96	5250.46	0.50*	0.52	3.45	0.19	5250.65	0.496	180.847	5250.86	5251.38	0.52**	0.54	3.35	0.17	5251.55	0.455	0.476	0.860	1.00	0.17
33	18	1.80	5251.06	5251.56	0.50*	0.52	3.47	0.19	5251.75	0.504	73.409	5251.43	5251.95	0.52**	0.54	3.35	0.17	5252.12	0.455	0.479	0.352	1.00	0.17
34	18	0.50	5251.63	5252.12	0.49	0.50	1.00	0.02	5252.14	0.043	12.278	5251.86	5252.13 j	0.27**	0.22	2.28	0.08	5252.21	0.435	0.239	0.029	1.00	0.08
35	18	1.30	5251.63	5252.12	0.49	0.50	2.59	0.10	5252.23	0.288	24.423	5251.87	5252.31 j	0.44**	0.43	3.05	0.15	5252.45	0.455	0.371	n/a	1.00	n/a
36	18	2.10	5250.52	5251.06	0.54*	0.58	3.63	0.21	5251.27	0.508	17.626	5250.61	5251.17	0.56**	0.60	3.52	0.19	5251.36	0.464	0.486	0.086	1.00	0.19
37	18	2.80	5240.68	5241.32	0.64*	0.71	3.93	0.24	5241.56	0.508	31.447	5240.84	5241.48	0.64**	0.72	3.87	0.23	5241.72	0.489	0.498	0.157	1.00	0.23
38	24	2.80	5241.54	5242.11	0.57*	0.73	3.83	0.23	5242.33	0.500	152.082	5242.30	5242.89	0.59**	0.78	3.59	0.20	5243.09	0.419	0.460	n/a	1.00	0.20
39	18	1.50	5242.80	5243.26	0.46*	0.46	3.29	0.17	5243.43	0.499	383.510	5244.72	5245.19	0.47**	0.47	3.19	0.16	5245.35	0.459	0.479	n/a	1.00	n/a
40	18	1.50	5244.92	5245.38	0.46*	0.46	3.29	0.17	5245.55	0.501	107.695	5245.46	5245.93	0.47**	0.47	3.16	0.16	5246.09	0.447	0.474	0.510	1.00	0.16
41	18	1.20	5245.66	5246.09	0.43	0.41	2.90	0.13	5246.22	0.420	133.310	5246.33	5246.75 j	0.42**	0.40	2.98	0.14	5246.89	0.453	0.437	n/a	1.00	n/a
42	18	0.70	5246.53	5246.84	0.31*	0.27	2.64	0.11	5246.95	0.498	167.732	5247.37	5247.69	0.32**	0.28	2.54	0.10	5247.79	0.450	0.474	n/a	1.00	n/a

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
43	18	0.40	5247.57	5247.81	0.24*	0.18	2.24	0.08	5247.88	0.502	167.732	5248.41	5248.65	0.24**	0.18	2.17	0.07	5248.73	0.460	0.481	n/a	1.00	n/a
44	18	0.40	5248.61	5248.81	0.20*	0.14	2.81	0.12	5248.94	0.958	11.443	5248.72	5248.96	0.24**	0.19	2.14	0.07	5249.04	0.439	0.698	0.080	1.00	0.07
45	24	4.60	5221.50	5221.93	0.43*	0.49	9.36	1.36	5223.29	4.135	370.149	5236.80	5237.56	0.76**	1.09	4.20	0.27	5237.83	0.441	2.288	n/a	0.15	0.04
46	24	4.60	5237.00	5237.56	0.56	0.72	6.40	0.64	5238.20	1.415	350.186	5244.31	5245.07	0.76**	1.09	4.20	0.27	5245.34	0.441	0.928	n/a	1.00	0.27
47	24	4.60	5244.52	5245.26	0.74*	1.05	4.38	0.30	5245.56	0.495	115.018	5245.09	5245.85	0.76**	1.10	4.17	0.27	5246.13	0.431	0.463	0.532	1.00	0.27
48	18	0.40	5248.27	5248.40	0.13*	0.07	5.62	0.49	5248.89	6.953	11.110	5249.05	5249.29	0.24**	0.18	2.17	0.07	5249.36	0.460	3.706	n/a	1.00	n/a
49	24	4.30	5245.29	5246.13	0.83	1.24	3.46	0.19	5246.31	0.273	133.810	5245.96	5246.69 j	0.73**	1.05	4.11	0.26	5246.96	0.437	0.355	n/a	1.00	n/a
50	24	2.90	5246.16	5246.74	0.58*	0.75	3.86	0.23	5246.97	0.497	122.213	5246.77	5247.37	0.60**	0.80	3.63	0.21	5247.58	0.420	0.459	n/a	1.00	n/a
51	18	2.10	5247.27	5247.82	0.55*	0.58	3.61	0.20	5248.02	0.500	122.213	5247.88	5248.44	0.56**	0.60	3.52	0.19	5248.63	0.464	0.482	0.589	1.00	0.19
52	18	1.50	5248.08	5248.63	0.55	0.59	2.56	0.10	5248.73	0.250	17.593	5248.26	5248.73 j	0.47**	0.47	3.19	0.16	5248.89	0.459	0.355	n/a	1.00	n/a
53	18	0.60	5248.08	5248.63	0.55	0.59	1.02	0.02	5248.65	0.040	83.405	5248.91	5249.21 j	0.30**	0.25	2.44	0.09	5249.30	0.452	0.246	n/a	1.00	0.09
54	18	0.40	5247.59	5247.74	0.15*	0.09	4.40	0.30	5248.04	3.434	13.680	5248.06	5248.30	0.24**	0.18	2.17	0.07	5248.38	0.460	1.947	n/a	1.00	n/a
55	18	0.90	5247.46	5247.69	0.23*	0.17	5.36	0.45	5248.13	3.023	16.558	5247.96	5248.33	0.37**	0.33	2.70	0.11	5248.44	0.434	1.729	0.286	1.00	0.11
56	24	1.70	5247.11	5247.55	0.44*	0.51	3.34	0.17	5247.72	0.511	17.663	5247.20	5247.67	0.47**	0.56	3.06	0.15	5247.81	0.399	0.455	0.080	1.00	0.15
57	18	0.50	5247.25	5247.42	0.17*	0.11	4.59	0.33	5247.75	3.200	14.957	5247.73	5248.00	0.27**	0.22	2.31	0.08	5248.08	0.455	1.827	n/a	1.00	0.08
58	18	0.40	5247.14	5247.26	0.12*	0.06	6.25	0.61	5247.87	9.440	18.243	5248.87	5249.11	0.24**	0.18	2.17	0.07	5249.19	0.460	4.950	n/a	1.00	n/a
59	18	1.50	5246.66	5246.90	0.24*	0.19	8.06	1.01	5247.92	6.275	16.068	5247.67	5248.37	0.70	0.81	1.84	0.05	5248.43	0.101	3.188	0.512	1.00	0.05
60	36	5.70	5216.00	5216.70	0.70*	1.26	4.51	0.32	5217.02	0.501	263.506	5217.32	5218.08	0.76**	1.41	4.04	0.25	5218.34	0.368	0.434	n/a	1.00	0.25
61	24	4.00	5218.32	5219.00	0.68*	0.95	4.23	0.28	5219.28	0.500	172.098	5219.18	5219.89	0.71**	1.00	4.02	0.25	5220.14	0.433	0.467	n/a	1.00	0.25
62	18	2.60	5225.88	5226.23	0.35*	0.31	8.38	1.09	5227.32	4.418	160.738	5233.00	5233.62	0.62**	0.68	3.81	0.23	5233.84	0.492	2.455	n/a	1.00	n/a
63	18	1.30	5233.31	5233.67	0.36*	0.32	4.03	0.25	5233.92	0.989	22.227	5233.53	5233.97	0.44**	0.43	3.02	0.14	5234.11	0.442	0.715	0.159	1.00	0.14

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
64	18	1.30	5233.20	5233.62	0.42	0.40	3.26	0.17	5233.78	0.548	22.812	5233.43	5233.87	0.44**	0.43	3.05	0.15	5234.01	0.455	0.501	n/a	1.00	n/a
65	18	1.30	5227.98	5228.32	0.34*	0.30	4.27	0.28	5228.61	1.169	20.433	5228.22	5228.66	0.44**	0.43	3.02	0.14	5228.80	0.442	0.805	0.165	1.00	0.14
66	24	2.90	5222.10	5222.68	0.58*	0.75	3.85	0.23	5222.91	0.494	74.927	5222.47	5223.08	0.61**	0.81	3.59	0.20	5223.28	0.408	0.451	0.338	0.98	0.20
67	24	2.00	5222.67	5223.28	0.60	0.80	2.49	0.10	5223.37	0.198	56.005	5222.95	5223.45	0.50**	0.62	3.25	0.16	5223.62	0.414	0.306	n/a	1.00	0.16
68	24	2.00	5223.15	5223.63	0.48*	0.58	3.47	0.19	5223.82	0.500	257.622	5224.44	5224.94	0.50**	0.62	3.25	0.16	5225.11	0.414	0.457	n/a	1.00	0.16
69	18	1.20	5227.55	5227.96	0.41*	0.39	3.09	0.15	5228.11	0.500	117.795	5228.14	5228.56	0.42**	0.41	2.95	0.14	5228.70	0.439	0.470	0.554	1.00	0.14
70	18	0.90	5224.94	5225.29	0.35*	0.32	2.83	0.12	5225.42	0.495	304.941	5226.45	5226.81	0.36**	0.33	2.74	0.12	5226.93	0.450	0.473	n/a	1.00	0.12
71	18	0.10	5226.90	5227.02	0.12*	0.07	1.47	0.03	5227.06	0.496	64.612	5227.22	5227.34 j	0.12**	0.07	1.46	0.03	5227.38	0.485	0.491	0.317	1.00	0.03
72	18	0.80	5226.65	5226.98	0.33*	0.29	2.75	0.12	5227.10	0.503	123.559	5227.27	5227.62	0.34**	0.31	2.61	0.11	5227.72	0.434	0.468	0.579	1.00	0.11
73	18	0.10	5224.71	5224.83	0.12*	0.07	1.45	0.03	5224.87	0.472	21.174	5224.81	5224.93 j	0.12**	0.07	1.46	0.03	5224.97	0.485	0.478	0.101	1.00	0.03
74	18	1.10	5223.40	5223.79	0.39*	0.37	3.01	0.14	5223.93	0.498	82.171	5223.81	5224.21	0.40**	0.38	2.87	0.13	5224.34	0.437	0.468	0.384	1.00	0.13
75	18	0.10	5224.01	5224.34	0.33	0.29	0.34	0.00	5224.34	0.008	12.304	5224.13	5224.34	0.21	0.15	0.66	0.01	5224.35	0.049	0.029	0.004	1.00	0.01
76	18	1.10	5224.01	5224.34	0.33	0.29	3.78	0.22	5224.56	0.951	28.293	5224.29	5224.69	0.40**	0.38	2.90	0.13	5224.82	0.452	0.701	n/a	1.00	0.13
77	18	1.90	5223.90	5224.14	0.24*	0.19	10.19	1.61	5225.76	9.986	35.266	5227.43	5227.96	0.53**	0.55	3.44	0.18	5228.14	0.470	5.228	n/a	1.00	n/a
78	36	4.30	5220.27	5220.89	0.62*	1.05	4.09	0.26	5221.15	0.478	16.718	5220.35	5221.02	0.67**	1.17	3.67	0.21	5221.23	0.353	0.416	0.069	1.00	0.21
79	18	0.40	5219.68	5219.92	0.24*	0.18	2.24	0.08	5220.00	0.502	125.531	5220.31	5220.55	0.24**	0.19	2.14	0.07	5220.63	0.439	0.470	0.590	1.00	0.07
80	18	0.20	5220.81	5220.95	0.14*	0.09	2.32	0.08	5221.04	1.002	15.789	5220.97	5221.14	0.17**	0.11	1.76	0.05	5221.19	0.457	0.730	0.115	1.00	0.05
81	18	0.20	5220.51	5220.65	0.14*	0.09	2.31	0.08	5220.74	0.988	28.295	5220.79	5220.96	0.17**	0.11	1.80	0.05	5221.01	0.484	0.736	n/a	1.00	0.05
82	36	8.80	5217.72	5218.60	0.88*	1.72	5.13	0.41	5219.00	0.505	65.126	5218.05	5219.00	0.95**	1.93	4.56	0.32	5219.33	0.365	0.435	0.283	0.16	0.05
83	36	6.60	5218.25	5219.05	0.80	1.52	4.33	0.29	5219.35	0.396	72.203	5218.61	5219.43	0.82**	1.56	4.22	0.28	5219.71	0.369	0.383	n/a	1.00	n/a
84	18	2.30	5216.25	5216.82	0.57*	0.62	3.71	0.21	5217.04	0.501	189.619	5217.20	5217.78	0.58**	0.63	3.63	0.20	5217.99	0.471	0.486	0.922	1.00	0.20

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
85	18	2.30	5217.40	5217.99	0.59	0.64	3.59	0.20	5218.19	0.458	20.335	5217.50	5218.08	0.58**	0.63	3.63	0.20	5218.29	0.471	0.465	0.094	1.00	0.20

6th & Federal Water Quality | Number of lines: 85 | Run Date: 6/6/2012

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Worksheet for 6'x2' RCBC

Project Description

Friction Method	Manning Formula
Solve For	Bottom Width

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00300	ft/ft
Normal Depth	1.97	ft
Height	2.00	ft
Discharge	83.00	ft^3/s

Results

Bottom Width	6.00	ft
Flow Area	11.81	ft^2
Wetted Perimeter	9.94	ft
Hydraulic Radius	1.19	ft
Top Width	6.00	ft
Critical Depth	1.81	ft
Percent Full	98.5	%
Critical Slope	0.00379	ft/ft
Velocity	7.03	ft/s
Velocity Head	0.77	ft
Specific Energy	2.74	ft
Froude Number	0.88	
Discharge Full	61.97	ft^3/s
Slope Full	0.00167	ft/ft
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	98.50	%
Downstream Velocity	Infinity	ft/s

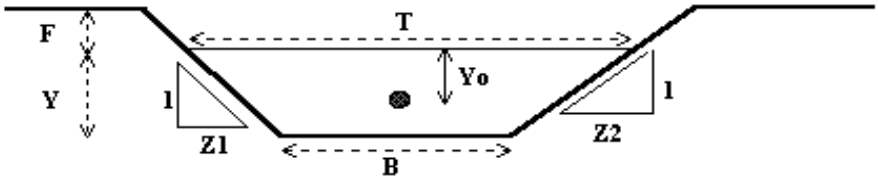
Worksheet for 6'x2' RCBC

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.97	ft
Critical Depth	1.81	ft
Channel Slope	0.00300	ft/ft
Critical Slope	0.00379	ft/ft

Normal Flow Analysis - Trapezoidal Channel

Project:	**US 6 Bridges**
Channel ID:	**US 6 EB Swale (West of Federal)**



Design Information (Input)			
Channel Invert Slope	So =	0.0380	ft/ft
Manning's n	n =	0.035	
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	6.00	ft/ft
Freeboard Height	F =	0.00	ft
Design Water Depth	Y =	**1.00**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**23.11**	cfs
Froude Number	**Fr =**	**1.28**	
Flow Velocity	**V =**	**5.14**	fps
Flow Area	A =	4.50	sq ft
Top Width	T =	9.00	ft
Wetted Perimeter	P =	9.25	ft
Hydraulic Radius	R =	0.49	ft
Hydraulic Depth	D =	0.50	ft
Specific Energy	Es =	1.41	ft
Centroid of Flow Area	Yo =	0.33	ft
Specific Force	Fs =	0.32	kip

WQ Pond Contribution - WEST US 6 BASINS

Detention Formula per UDFCD criteria:

$V = K_i A$

$K_{100} = (1.78I-0.002I^2-3.56)/1000$

$K_5 = (0.77I-2.65)/1000$

Basin	Area (Ac)	%I	A*%I
WB6-7	0.42	100.00	41.9
WB6-8	0.66	100.00	65.7
EB6-5	0.74	86.57	63.7
EB6-6	0.68	84.75	57.6
OS-11	4.57	29.56	135.1
OS-12	3.28	27.22	89.2
OS-13	0.54	89.56	48.4
OS-14	1.16	24.18	28.0
OS-15	0.47	0.00	0.0
OS-16	0.78	0.00	0.0
OS-17	0.53	100.00	53.0
OS-18	0.87	0.00	0.0
OS-20	12.65	60.25	762.2
OS-21	1.87	63.10	118.0
OS-22	2.95	60.45	178.3
OS-23	2.47	52.09	128.7
OS-24	0.37	100.00	37.0
OS-25	0.61	100.00	61.0
OS-26	9.87	53.06	523.7
OS-27	5.04	100.00	504.0
OS-28	4.67	58.70	274.1
OS-29	2.11	62.77	132.4
OS-30	1.76	62.23	109.5
	59.05	57.77	3412

WQ 2

Basin
OS-1
EB6-4
WB6-6
SW4
SW3
NW1

Where: V = volume of the 100-year or 5-year storm (acre-feet)

I = developed basin imperviousness (%) = 57.77 %

A = tributary area (acres) = 59.05 acres

K_{100}= 0.0926 K_5= 0.0418

V_{100}= 5.4683 ac-ft V_5= 2.4705 ac-ft

= 238,201 ft^3 = 107,615 ft^3

From Table SO-1 (UDFCDCriteria) for Type 'C' soils

5-Year Release Rate = 0.17 cfs/acre x 59.05 = 10.04

100-Year Release Rate = 1.00 cfs/acre x 59.05 = 59.0531778

Water Quality Capture Volume

Volume Formula per UDFCD (Volume 3)

$V_{WQCV}=(WQCV/12)*A*1.2$

$WQCV = 1.0*(0.91*I^3-1.19*I^2+0.78*I)$

Where: V_{WQCV} = storage volume

WQCV = watershed inches of runoff (Figure EDB-2) = 0.23 in

A = tributary area (acres)

1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

V_{WQCV}= 1.3518 ac-ft

= 58,885 ft^3 1766.55749 1413.2

Total Detention Pond Volume

100-yr & WQCV **5-yr & WQCV**

$V_{Total} = V_{100} + V_{WQCV}$ $V_{Total} = V_5 + V_{WQCV}$

V_{Total}= 6.8202 ac-ft V_{Total}= 3.8223 ac-ft

= 297,086 ft^3 = 166,500 ft^3

WQ Pond Contribution - US 6 POND (WQ3)

Detention Formula per UDFCD criteria:

$V = K_I A$

$K_{100} = (1.78I-0.002I^2-3.56)/1000$

$K_5 = (0.77I-2.65)/1000$

Basin	Area (Ac)	%I	A*%I
SW1	0.73	100.00	73.2
SW2	0.61	56.18	34.3
SE1	0.84	97.63	82.4
SE2	1.41	100.00	140.7
WQ1	2.25	0.00	0.0
WB1	2.49	100.00	248.9
WB2	0.70	100.00	70.4
WB3	1.03	100.00	102.8
WB3A	0.07	100.00	6.8
WB4	1.05	100.00	104.7
WB5	0.65	100.00	65.4
WB5A	0.07	100.00	6.9
WB6-5	0.28	100.00	28.2
EB1	0.47	100.00	47.2
EB2	1.60	100.00	159.6
CD1	3.31	100.00	331.2
CD2	1.13	100.00	112.6
CD3	0.69	100.00	69.5
CD4	0.45	100.00	45.5
FR	0.69	100.00	68.8
NF1	0.23	100.00	22.7
NF2	0.29	96.51	27.6
NF3	0.36	75.62	26.9
NF4	0.40	65.62	26.3
NF5	0.25	100.00	24.7
NF6	1.11	85.73	95.5
NF7	0.54	97.95	52.7
NF8	1.02	90.56	92.1
NF9	0.32	98.76	31.9
NE	1.41	99.15	140.3
BPE1	1.83	73.10	133.8
BPE2	6.83	12.09	82.5
5TH1	1.12	69.64	78.0
5TH2	0.96	57.17	54.6
5TH3	0.47	37.07	17.6
5TH4	1.49	28.27	42.2
5TH5	1.32	28.27	37.4
5TH6	0.24	65.22	15.8
5TH7	0.10	100.00	9.9
OS-10	0.49	82.69	40.1
WEST BASINS	59.05	57.77	3411.7
	100.35	62.41	6263

Where: V = volume of the 100-year or 5-year storm (acre-feet)
I = developed basin imperviousness (%) = 62.41 %
A = tributary area (acres) = 100.35 acres

K_{100}= 0.0997 K_5= 0.0454

V_{100}= 10.0092 ac-ft V_5= 4.5566 ac-ft

= 436,000 ft^3 = 198,485 ft^3

From Table SO-1 (UDFCDCriteria) for Type 'C' soils

5-Year Release Rate = 0.17 cfs/acre x 100.35 = 17.06

100-Year Release Rate = 1.00 cfs/acre x 100.35 = 100.352229

Water Quality Capture Volume

Volume Formula per UDFCD (Volume 3)

$V_{WQCV}=(WQCV/12)*A*1.2$

$WQCV = 1.0*(0.91*I^3-1.19*I^2+0.78*I)$

Where: V_{WQCV} = storage volume
WQCV = watershed inches of runoff (Figure EDB-2) = 0.24 in
A = tributary area (acres)
1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

V_{WQCV}= 2.4536 ac-ft

= 106,881 ft^3 3206.42029 2565.1

Total Detention Pond Volume

100-yr & WQCV **5-yr & WQCV**

$V_{Total} = V_{100} + V_{WQCV}$ $V_{Total} = V_5 + V_{WQCV}$

V_{Total}= 12.4628 ac-ft V_{Total}= 7.0102 ac-ft

= 542,880 ft^3 = 305,366 ft^3

OLSSON ASSOCIATES

WQ Pond Contribution - WQ12 - 6th Avenue Interchange Water Quality Pond

Detention Formula per UDFCD criteria:

$V = K_iA$

$K_{100} = (1.78I-0.002I^2-3.56)/1000$

$K_5 = (0.77I-2.65)/1000$

Basin	Area (Ac)	%I	A*%I				
WB6-1a	0.52	100.00	51.5				
WB6-2a	0.15	100.00	15.3				
EB6-1a	0.46	100.00	46.5				
VHE4	2.66	37.96	101.1				
VHE5	1.84	66.75	123.1				
VHE7	0.97	100.00	97.0				
VHW7	1.27	100.00	127.0				
VHW6	2.86	15.66	44.8				
RG-1	0.61	100.00	60.8	1.012	10.74	620.38	606.38
3RD	17.19	100.00	1719.0		11.35	58.78	667.18
	28.54	83.61	2386				

Where: V = volume of the 100-year or 5-year storm (acre-feet)

I = developed basin imperviousness (%) = 83.61 %

A = tributary area (acres) = 28.54 acres

K_{100}= 0.1313 K_5= 0.0617

V_{100}= 3.7468 ac-ft V_5= 1.7617 ac-ft

= 163,210 ft^3 = 76,741 ft^3

From Table SO-1 (UDFCDCriteria) for Type 'C' soils

5-Year Release Rate = 0.17 cfs/acre x 28.54 = 4.85

100-Year Release Rate = 1.00 cfs/acre x 28.54 = 28.5399516

Water Quality Capture Volume

Volume Formula per UDFCD (Volume 3)

V_{WQCV}=(WQCV/12)*A*1.2

$WQCV = 1.0*(0.91*I^3-1.19*I^2+0.78*I)$

Where: V_{WQCV} = storage volume

WQCV = watershed inches of runoff (Figure EDB-2) = 0.35 in

A = tributary area (acres)

1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

V_{WQCV}= 1.0050 ac-ft

= 43,778 ft^3 1313.35448 1050.7

Total Detention Pond Volume

100-yr & WQCV **5-yr & WQCV**

$V_{Total} = V_{100} + V_{WQCV}$ $V_{Total} = V_5 + V_{WQCV}$

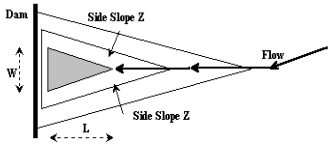
V_{Total}= 4.7518 ac-ft V_{Total}= 2.7667 ac-ft

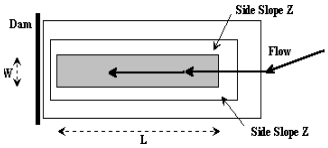
= 120,519 ft^3

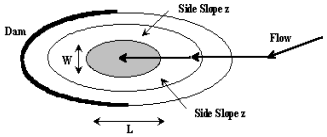
OLSSON ASSOCIATES

STAGE-STORAGE SIZING FOR POLYGONAL, ELLIPTICAL, OR IRREGULAR PONDS

Project: US 6 BRIDGES
Basin ID: US 6 Water Quality Pond







Design Information (Input):

Width of Pond Bottom, W =		ft
Length of Pond Bottom, L =		ft
Dam Side-slope (H:V), Z_d =		ft/ft

Check Pond Shape

Right Triangle		OR…
Isosceles Triangle		OR…
Rectangle		OR…
Circle / Ellipse		OR…
Irregular	X	(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':			acre-ft.
Storage Requirement from Sheet 'Hydrograph':			acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':			acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Stage ft (input)	Side Slope (H:V) ft/ft Below El.	Pond Width at Stage ft (output)	Pond Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	5203.00	(input)				0	0	0.000	0.000	
	5203.50		0.00	0.00		610	152	0.014	0.004	
	5204.00		0.00	0.00		3,666	1,221	0.084	0.028	
	5204.50		0.00	0.00		11,507	5,015	0.264	0.115	
	5205.00		0.00	0.00		18,318	12,471	0.421	0.286	
	5205.50		0.00	0.00		22,737	22,734	0.522	0.522	
	5206.00		0.00	0.00		26,783	35,114	0.615	0.806	
	5206.50		0.00	0.00		30,782	49,506	0.707	1.136	
	5207.00		0.00	0.00		34,819	65,906	0.799	1.513	
	5207.50		0.00	0.00		38,814	84,314	0.891	1.936	
	5208.00		0.00	0.00		42,575	104,662	0.977	2.403	
WQCV	5208.05		0.00	0.00		42,928	106,799	0.985	2.452	
	5208.50		0.00	0.00		46,106	126,832	1.058	2.912	
	5209.00		0.00	0.00		49,686	150,780	1.141	3.461	
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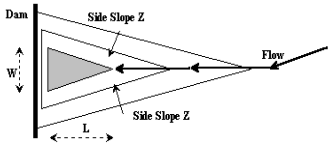
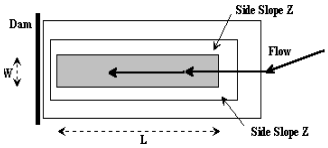
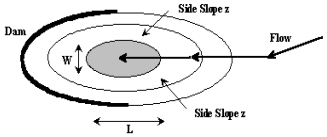
STAGE-STORAGE SIZING FOR POLYGONAL, ELLIPTICAL, OR IRREGULAR PONDS

Project: US 6 BRIDGES
Basin ID: 6th Avenue Interchange Water Quality Pond







Design Information (Input):

Width of Pond Bottom, W =		ft
Length of Pond Bottom, L =		ft
Dam Side-slope (H:V), Z_d =		ft/ft

Check Pond Shape

Right Triangle		OR…
Isosceles Triangle		OR…
Rectangle		OR…
Circle / Ellipse		OR…
Irregular	X	(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
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Storage Requirement from Sheet 'Full-Spectrum':			acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Stage ft (input)	Side Slope (H:V) ft/ft Below El. (input)	Pond Width at Stage ft (output)	Pond Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	5201.23					0	0	0.000	0.000	
	5201.50		0.00	0.00		339	46	0.008	0.001	
	5202.00		0.00	0.00		1,272	449	0.029	0.010	
	5202.50		0.00	0.00		3,581	1,662	0.082	0.038	
	5203.00		0.00	0.00		5,245	3,869	0.120	0.089	
	5203.50		0.00	0.00		6,293	6,753	0.144	0.155	
	5204.00		0.00	0.00		6,811	10,029	0.156	0.230	
	5204.50		0.00	0.00		7,350	13,570	0.169	0.312	
	5205.00		0.00	0.00		7,910	17,385	0.182	0.399	
	5205.50		0.00	0.00		8,491	21,485	0.195	0.493	
	5206.00		0.00	0.00		9,094	25,881	0.209	0.594	
	5206.50		0.00	0.00		9,718	30,584	0.223	0.702	
	5207.00		0.00	0.00		10,363	35,604	0.238	0.817	
	5207.50		0.00	0.00		11,030	40,953	0.253	0.940	
WQCV	5207.76		0.00	0.00		11,388	43,867	0.261	1.007	1.005 AF
	5208.00		0.00	0.00		11,718	46,640	0.269	1.071	
	5208.50		0.00	0.00		12,427	52,676	0.285	1.209	
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RETENTION VOLUMES

Description	100 YR BASIN AREA (AC)	% IMPER.	EFFECTIVE RAINFALL (R_{EFF})	RETENTION VOLUME REQUIRED (AC-FT)	RETENTION VOLUME PROVIDED (AC-FT)
Ramp A Area	5.8	17.9	2.08	1.5	7.2
Ramp B Area	11.4	71.4	3.58	5.1	2.1
Ramp C Area	4.3	40.1	2.70	1.5	0.0
Total	21.4			8.0	9.3

Effective Rainfall depth from Table 13.4, CCD Storm Drainage Design and Technical Criteria Manual

$V_r = 1.5 \times [(r_{eff} / 12) \times A]$

V_r = Volume of retention pond in acre-feet

r_{eff} = Effective rainfall (from Table 13.4) in inches

A = Area of development in acres

Table 13.4

% IMPER.	EFFECTIVE RAINFALL (R_{EFF})
15	2.00
20	2.14
25	2.28
30	2.42
35	2.56
40	2.70
45	2.84
50	2.98
55	3.12
60	3.26
65	3.40
70	3.54
75	3.68
80	3.82
85	3.96
90	4.10
95	4.24
99	4.35

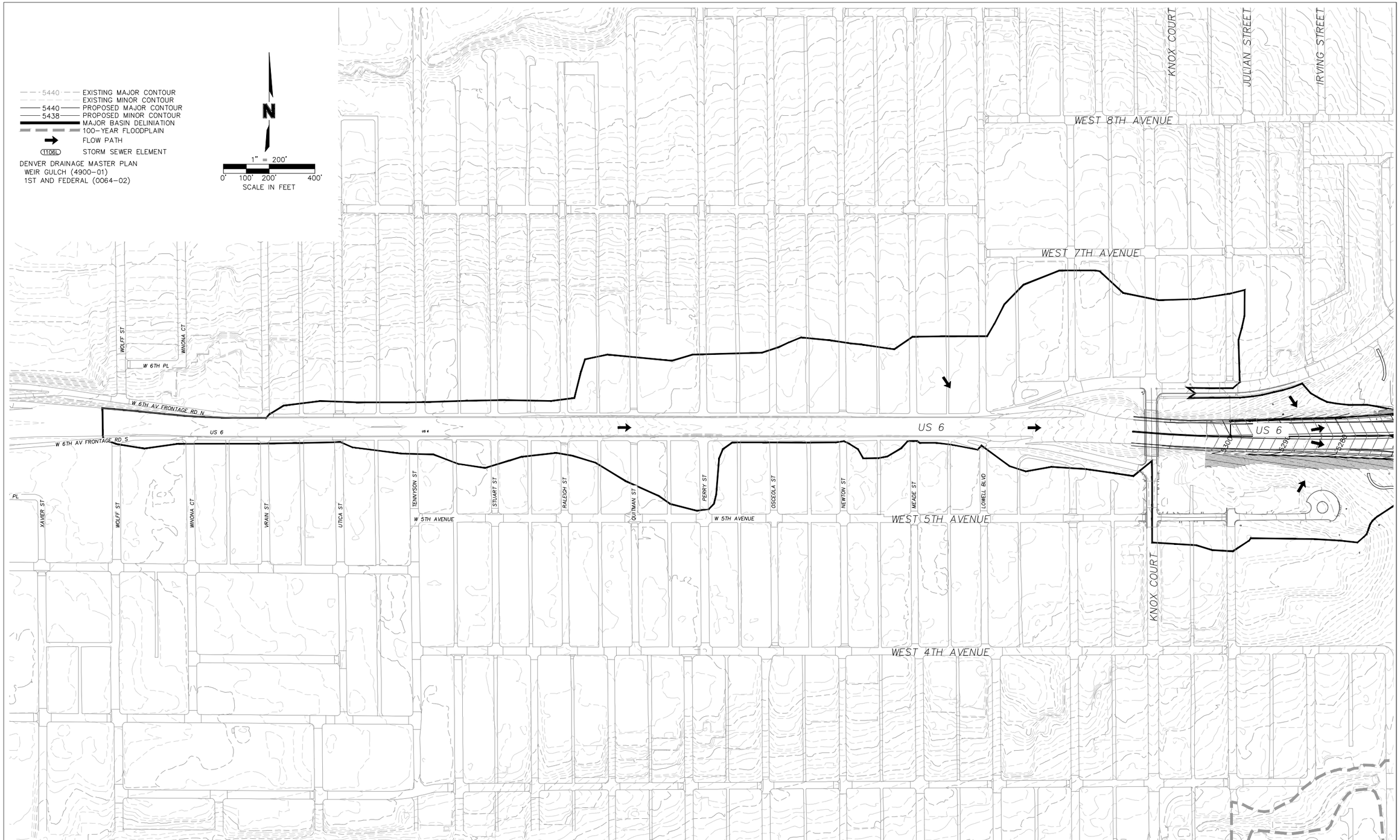
Ramp A Ponds			
Sub-basins	Area (Ac)	%I	A*%I
WB6-3a	0.51	100.00	50.8
VHW1	1.20	5.19	6.2
VHW3	4.05	11.32	45.9
Subtotal	5.75		102.82
I =	17.87	%	

Ramp B Pond			
Sub-basins	Area (Ac)	%I	A*%I
OS-20	1.30	100.00	130.2
VHW2	1.38	100.00	138.4
VHW4	1.21	100.00	120.9
VHE2	2.40	54.45	130.7
VHE3	1.76	100.00	176.2
RE-2	0.44	100.00	43.7
RG-2	0.11	100.00	11.2
VHE1	2.78	22.34	62.1
Subtotal	11.38		813.29
I =	71.44	%	

Ramp C Pond			
Sub-basins	Area (Ac)	%I	A*%I
EB6-1b	0.68	100.00	67.6
VHW5	3.02	14.74	44.5
RE-1	0.60	100.00	60.2
Subtotal	4.30		172.36
I =	40.09	%	

Appendix C

Drainage Basin Maps



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Last Modification Date: 08/14/2012	Initials: MEO		
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Index of Revisions			
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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

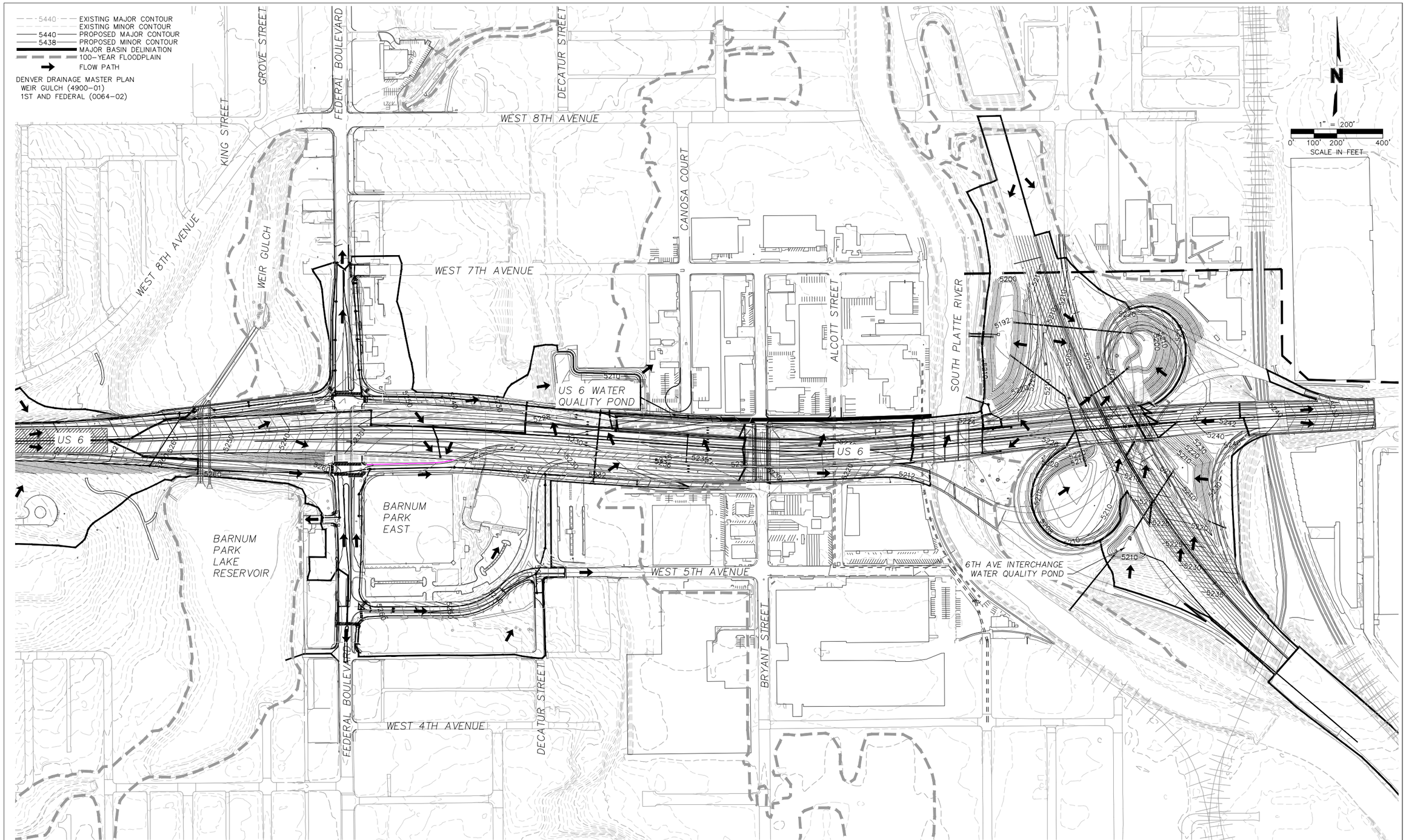
Colorado Department of Transportation
CDOT DEPARTMENT OF TRANSPORTATION
8833 South Wadsworth Court
Littleton, CO 80128
Phone: 303-972-9112 FAX: 303-972-9114
Region 6 TG

As Constructed
No Revisions:
Revised:
Void:

DRAINAGE AREA MAP

Designer:	MORLOFF		
Detailer:	MORLOFF		
Sheet Subset:	DRAINAGE	Subset Sheet::	3 of 18

18192/18202
Number
Code
Sheet Number 3



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Creation Date: 02/22/12	Initials: MEO	
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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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Region 6 TG

As Constructed
No Revisions:
Revised:
Void:

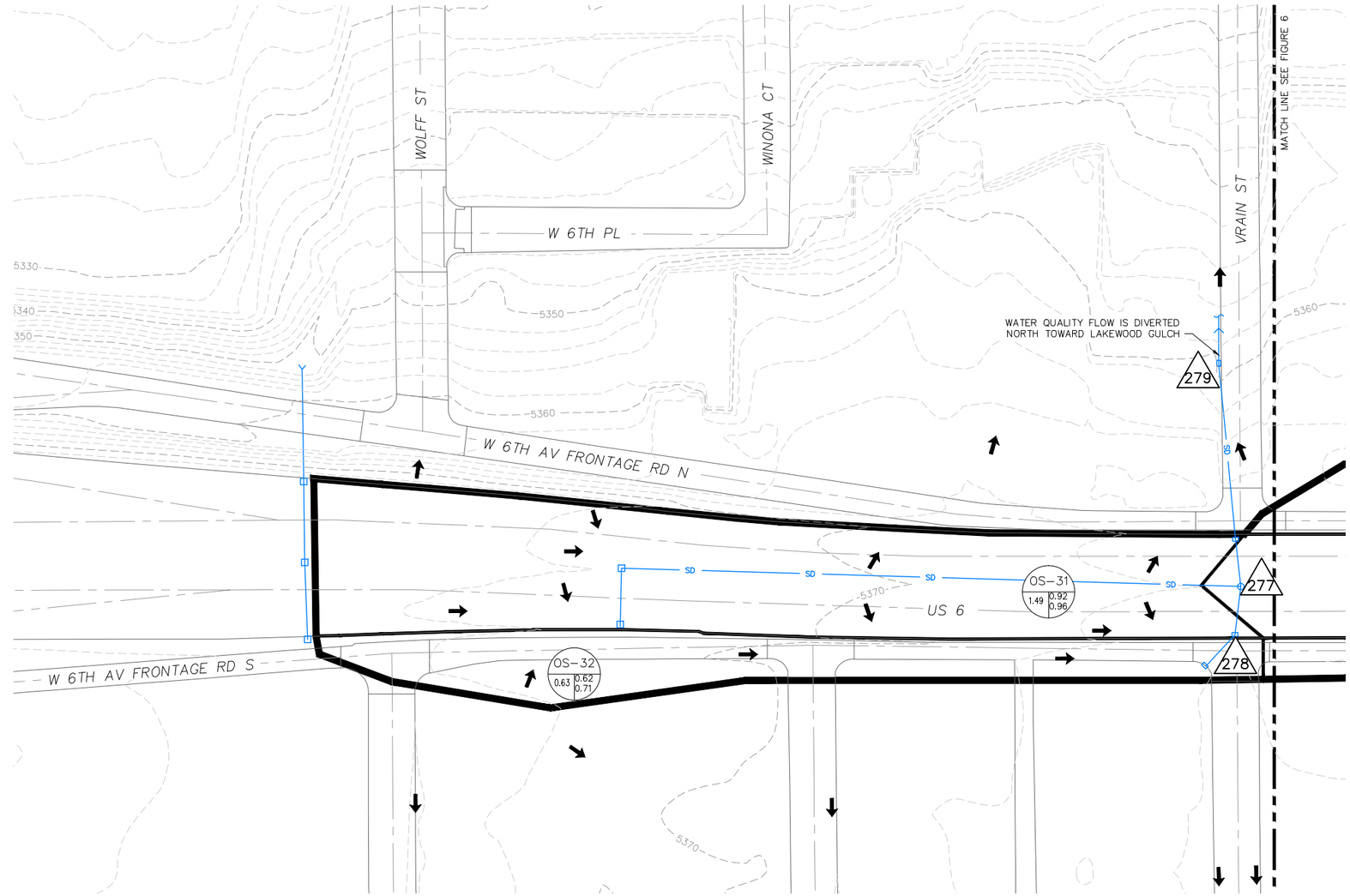
DRAINAGE AREA MAP

Designer:	MORLOFF		
Detailer:	MORLOFF		
Sheet Subset:	DRAINAGE	Subset Sheet::	4 of 18

18192/18202
Number
Code
Sheet Number 4

SUMMARY RUNOFF TABLE

DESIGN POINT/ STRUCTURE ID	CONTRIBUTING BASIN(S)	10-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)	COMMENTS
251	WB6-6	3.5	6.0	
252 (10-YR)	OS-15-16-17-18-20-21-23-24-26-27-29-30-31-32, WB6-7, WB6-8	63.6	-	
252 (100-YR)	PIPE FLOW FROM DP276, RAMP SPILL FROM DP269, PIPE FLOW FROM DP266, OS-15-16-17-18-21-24-27-31, WB6-7, WB6-8	-	104.6	
253 (10-YR)	OS-16-17-18-20-21-23-24-26-27-29-30-31-32, WB6-8	62.6	-	
253 (100-YR)	PIPE FLOW FROM DP276, RAMP SPILL FROM DP269, PIPE FLOW FROM DP266, OS-16-17-18-21-24-27-31, WB6-8	-	102.1	
254 (10-YR)	OS-1-11-12-13-14-22-25-28, EB6-4-5-6	28.9		OUTFALL TO WEIR GULCH
254 (100-YR)	STREET FLOW FROM DP276, OS-1-11-12-13-14-22-25-28, EB6-4-5-6	-	66.9	OUTFALL TO WEIR GULCH
255 (10-YR)	OS-11-12-13-14-22-25-28, EB6-5-6	27.6	-	
255 (100-YR)	STREET FLOW FROM DP276, OS-11-12-13-14-22-25-28, EB6-5-6	-	63.8	
256 (10-YR)	OS-12-13-14-22-25-28, EB6-6	21.0	-	
256 (100-YR)	STREET FLOW FROM DP 276, OS-12-13-14-22-25-28, EB6-6	-	48.4	
257	OS-1	1.1	3.5	
258	OS-11	7.7	19.1	
259	OS-12	4.9	12.4	
260 (10-YR)	OS-13-14-22-25-28	16.1	-	
260 (100-YR)	STREET FLOW FROM DP276, OS-13-14-22-25-28	-	37.0	
261	OS-14	2.2	5.7	
262	OS-15	0.6	2.0	
263	OS-16	1.0	3.4	
264 (10-YR)	OS-17-18-20-21-23-24-26-27-29-30-31-32	61.0	-	
264 (100-YR)	PIPE FLOW FROM DP276, RAMP SPILL FROM DP269, PIPE FLOW FROM DP266, OS-17-18-21-24-27- 31	-	98.1	
265	OS-18	1.1	3.8	
266 (10-YR)	OS-20-23-26-29	36.2	-	
266 (100-YR)	STREET AND PIPE FLOW FROM DP269, OS-20	-	62.4	PIPE CAPACITY = 42.2 CFS, EXCESS FLOW TRAVELS OUT OF WATERSHED
267 (10-YR)	OS-21-24	6.0	-	
267 (100-YR)	RAMP SPILL FROM DP269, OS-21-24	-	22.8	
268 (10-YR)	OS-22-25-28	14.2	-	
268 (100-YR)	STREET FLOW FROM DP276, OS-22-25-28		33.1	
269 (10-YR)	OS-23-26-29	22.9	-	
269 (100-YR TOT)	OS-23-26-29	-	48.8	TOTAL FLOW AT DESIGN POINT
269 (100-YR SPILL)	OS-23-26-30	-	16.5	SPILL ONTO HWY6 RAMP
269 (100-YR P,ST)	OS-23-26-31	-	32.3	PIPE AND STREET FLOW ALONG FRONTAGE RD
270	OS-24	1.8	3.1	
271 (10-YR)	OS-25-28	10.3	-	
271 (100-YR)	STREET FLOW FROM DP276, OS-25-28	-	25.3	
272	OS-26-29	21.1	44.7	
273 (10-YR)	OS-27-30-31-32	23.3	-	
273 (100-YR)	PIPE FLOW FROM DP 276OS-27-31	-	37.3	
274 (10-YR)	OS-28	9.3	-	
274 (100-YR)	STREET FLOW FROM DP276, OS-28	-	24.6	
275	OS-29	4.9	9.9	
276 (10-YR)	OS-30-32	4.5	9.1	
276 (100-YR TOT)	OS-30-32	-	9.0	TOTAL FLOW AT DESIGN POINT
276 (100-YR ST)	OS-30-32	-	4.5	STREET FLOW (SOUTH SYSTEM)
276 (100-YR P)	OS-30-32	-	4.5	PIPE FLOW (TO NORTH SYSTEM)
277	OS-31	7.2	12.4	
278	OS-32	1.9	3.6	
308R (10-YR)	OS-11-12-13-14-22-25-28, EB6-5-6	27.6	-	WQ DIVERSION
308R (100-YR)	STREET FLOW FROM DP276,OS-11-12-13-14-22-25-28, EB6-5-6	-	63.7	WQ DIVERSION
401C (10-YR)	OS-20-23-26-27-29-30-31-32	55.7	-	MAJOR JUNCTION
401C (100-YR)	PIPE FLOW FROM DP276, PIPE FLOW FROM DP266, OS-27-31	-	73.6	MAJOR JUNCTION
411C (10-YR)	OS-15-16-17-18-20-21-23-24-26-27-29-30-31-32, WB6-6-7-8	64.9	-	OUTFALL TO WEIR GULCH
411C (100-YR)	PIPE FLOW FROM DP276, RAMP SPILL FROM DP269, PIPE FLOW FROM DP266, OS-15-16-17-18-21-24-27-31, WB6-6-7-8	-	107.1	OUTFALL TO WEIR GULCH
411R (10-YR)	OS-15-16-17-18-20-21-23-24-26-27-29-30-31-32, WB6-7, WB6-8	63.2	-	WQ DIVERSION
411R (100-YR)	PIPE FLOW FROM DP276, RAMP SPILL FROM DP269, PIPE FLOW FROM DP266, OS-15-16-17-18-21-24-27-31, WB6-7-8	-	104.2	WQ DIVERSION



A = BASIN DESCRIPTION
B = AREA IN ACRES
C = COMPOSITE RUNOFF COEFFICIENTS (10-YR, 100-YR)
D = DESIGN POINT DESIGNATION

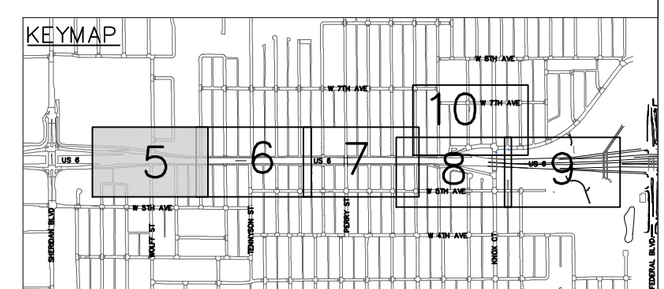
5440 EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
MAJOR BASIN DELINEATION
100-YEAR FLOODPLAIN
FLOW PATH
1106L STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
PROPOSED WATER QUALITY PIPE

DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900-01)
1ST AND FEDERAL (0064-02)

EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA

N

1" = 100'
0' 25' 50' 100'
SCALE IN FEET



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R-X	mm/dd/yy	XXXXX	XXX

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DRAINAGE AREA MAP

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18192/18202
Number
Code
Sheet Number 5

VRAIN ST
UTICA ST
TENNYSON ST
STUART ST
RALEIGH ST
W 5TH AVENUE
US 6
5360
279
278
277
276
275
OS-29
2.11 0.53 0.64
OS-30
1.76 0.52 0.64
Q_{10}=4.5 CFS
$Q_{100}-Q_{10}$=4.5 CFS
SD
MATCH LINE SEE FIGURE 5
MATCH LINE SEE FIGURE 7
N
1" = 100'
0' 25' 50' 100'
SCALE IN FEET

A = BASIN DESCRIPTION
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5440 EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
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100-YEAR FLOODPLAIN
FLOW PATH
1106L STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
PROPOSED WATER QUALITY PIPE

DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900-01)
1ST AND FEDERAL (0064-02)

EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA

KEYMAP
5 6 7 8 9 10
US 6
W 5TH AVE
W 7TH AVE
W 6TH AVE
SHERIDAN BLVD
WOLFF ST
TENNYSON ST
PERRY ST
NAUL CT
FEDERAL BLVD

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DRAINAGE AREA MAP

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Subset Sheet:: 6 of 18

18192/18202
Number
Code
Sheet Number 6

QUITMAN ST
PERRY ST
OSCEOLA ST
NEWTON ST
MEADE ST
OS-26 9.87 0.47 0.61
OS-27 5.04 0.92 0.96
OS-28 4.67 0.50 0.63
273
272
274
LOWPOINT
US 6
W 5TH AVENUE
MATCH LINE SEE FIGURE 6
MATCH LINE SEE FIGURE 8
N
1" = 100'
0' 25' 50' 100'
SCALE IN FEET

A = BASIN DESCRIPTION
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DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900-01)
1ST AND FEDERAL (0064-02)

EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA

KEYMAP
5 6 7 8 9 10
W 6TH AVE
W 7TH AVE
W 5TH AVE
W 4TH AVE
US 6
SHERIDAN BLVD
WOLFF ST
TENNYSON ST
PERRY ST
NEWTON CT
FEDERAL BLVD

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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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DRAINAGE AREA MAP

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Number
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MATCH LINE SEE FIGURE 10

MATCH LINE SEE FIGURE 7

MEADE ST

LOWELL BLVD

W 6TH AVENUE

16.5 CFS SPILLS DOWN RAMP

US 6

W 5TH AVENUE

KING ST

KNOX CT

MATCH LINE SEE FIGURE 9

OS-23 | 2.47 | 0.47 | 0.61

OS-24 | 0.37 | 0.92 | 0.96

OS-25 | 0.61 | 0.92 | 0.96

OS-21 | 1.87 | 0.53 | 0.64

OS-22 | 2.95 | 0.51 | 0.63

OS-18 | 0.87 | 0.25 | 0.50

OS-17 | 0.53 | 0.92 | 0.96

OS-13 | 0.54 | 0.77 | 0.83

OS-14 | 1.16 | 0.36 | 0.56

OS-12 | 3.28 | 0.37 | 0.56

272 269 270 271 274 267 268

5340 5338 5342 5344 5334 5330 5320 5328

SD

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DENVER DRAINAGE MASTER PLAN
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1ST AND FEDERAL (0064-02)

EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA

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1" = 100'
0' 25' 50' 100'
SCALE IN FEET

KEYMAP

5 6 7 8 9 10

W 8TH AVE W 7TH AVE W 6TH AVE W 5TH AVE W 4TH AVE US 6 SHERIDAN BLVD WOLFF ST TENNYSON ST PERRY ST KNOX CT FEDERAL BLVD

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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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LIMIT OF FUTURE US 6 RECONSTRUCTION

MATCH LINE SEE FIGURE 10

MATCH LINE SEE FIGURE 11

MATCH LINE SEE FIGURE 8

W 8TH AVENUE

W 5TH AVENUE

JULIAN ST

WEIR GULCH

~MOORE'S ADDITION~

US 6

BARNUM PARK LAKE RESERVOIR

TOTAL CAPACITY OF 42.2 CFS AT THESE TWO PIPES EXCESS FLOW TRAVELS ALONG W 6TH AVE/W 8TH AVE TO WEIR GULCH

CONNECT EXISTING PIPE TO NEW STORM DRAIN SYSTEM

24" TO REMAIN

DIVERT WATER QUALITY FLOW TO US 6 WATER QUALITY POND

INTERCEPT 100-YEAR FLOW WEST OF WEIR GULCH AND DISCHARGE TO GULCH.

EXISTING STORM DRAIN WITHIN LIMITS OF HIGHWAY RECONSTRUCTION TO BE REMOVED EXCEPT WHERE NOTED

Basin	A	B	C
OS-18	0.87	0.25	0.50
OS-17	0.53	0.92	0.96
OS-16	0.78	0.25	0.50
OS-15	0.47	0.25	0.50
OS-14	1.16	0.36	0.56
OS-13	0.54	0.77	0.83
OS-12	3.28	0.37	0.56
OS-11	4.57	0.38	0.57
OS-1	0.83	0.25	0.50
WB6-8	0.66	0.92	0.96
WB6-7	0.42	0.92	0.96
WB6-6	0.72	0.92	0.96
WB6-5	0.28	0.92	0.96
WB1	2.49	0.92	0.96
CD1	3.31	0.92	0.96
SW4	0.38	0.45	0.60
EB6-6	0.68	0.71	0.78
EB6-5	0.74	0.73	0.80
EB6-4	0.42	0.69	0.76

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EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
MAJOR BASIN DELINEATION
100-YEAR FLOODPLAIN
FLOW PATH
(1106) STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
PROPOSED WATER QUALITY PIPE

DENVER DRAINAGE MASTER PLAN
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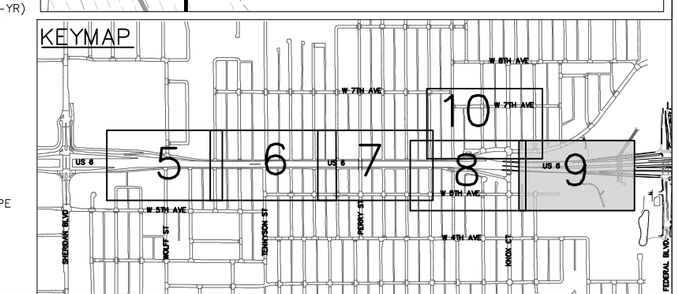
1" = 100'
0' 25' 50' 100'
SCALE IN FEET

KEYMAP



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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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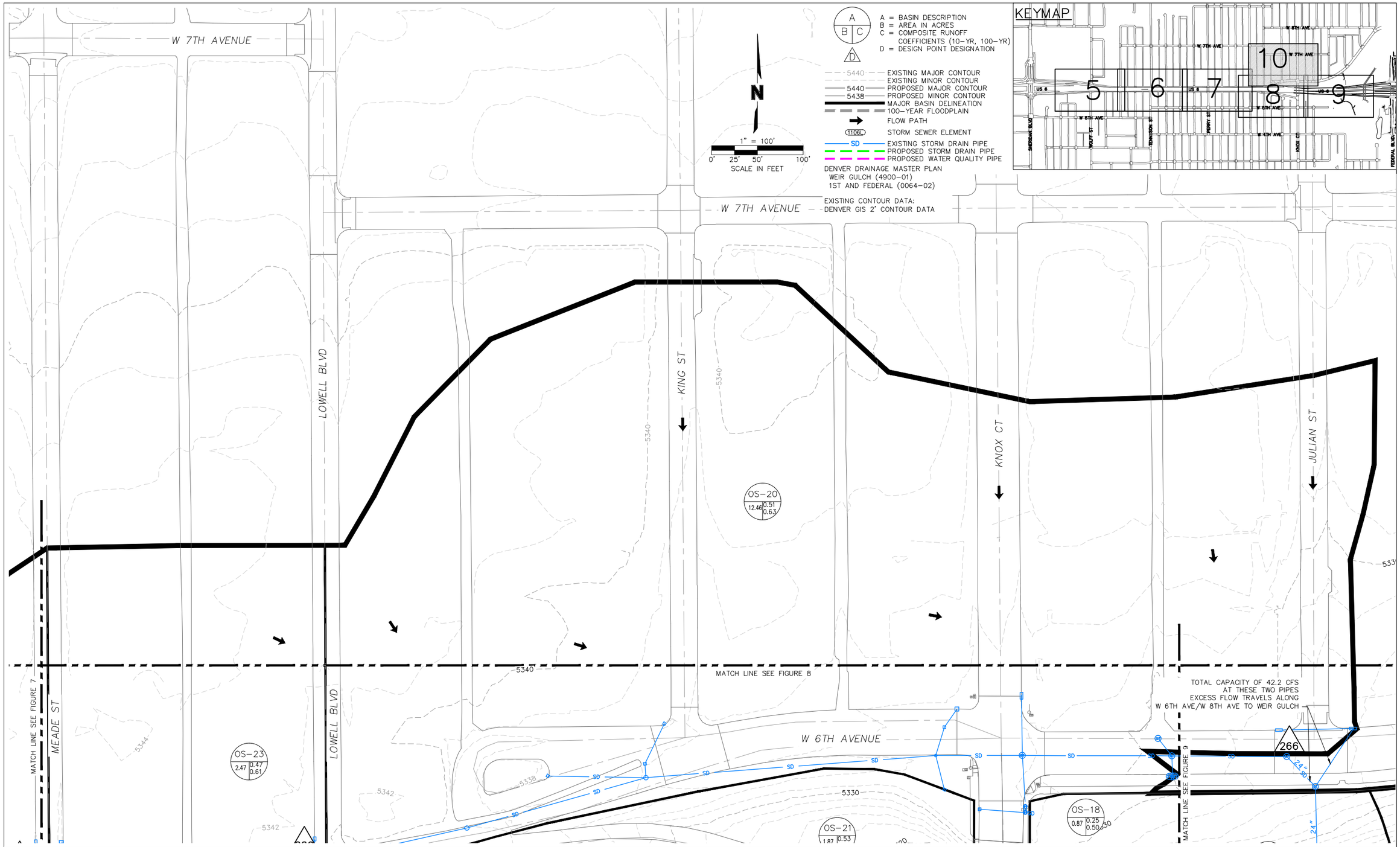

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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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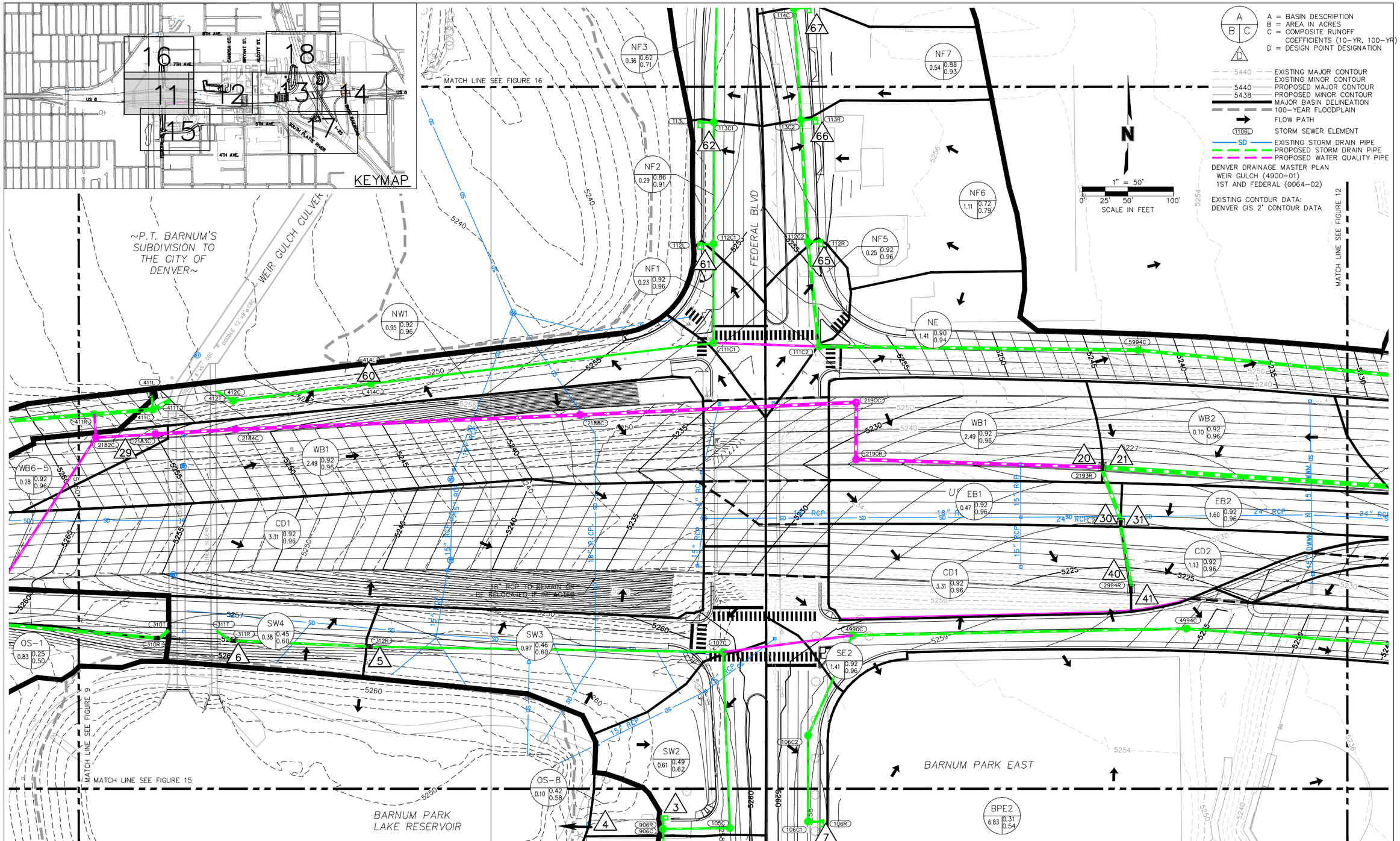
Number

Code

Sheet Number 10



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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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A = BASIN DESCRIPTION
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	WATER SURFACE ELEVATION (FEET)	VOLUME (ACRE-FT)	RELEASE RATE (CFS)
WATER QUALITY CAPTURE VOLUME	5208.05	2.45	*

*OUTLET WORKS WQCV ORIFICE PLATE DESIGNED TO RELEASE WQCV OVER 40 HOURS.

5440 EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
MAJOR BASIN DELINEATION
100-YEAR FLOODPLAIN
FLOW PATH
1106L STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
PROPOSED WATER QUALITY PIPE

DENVER DRAINAGE MASTER PLAN
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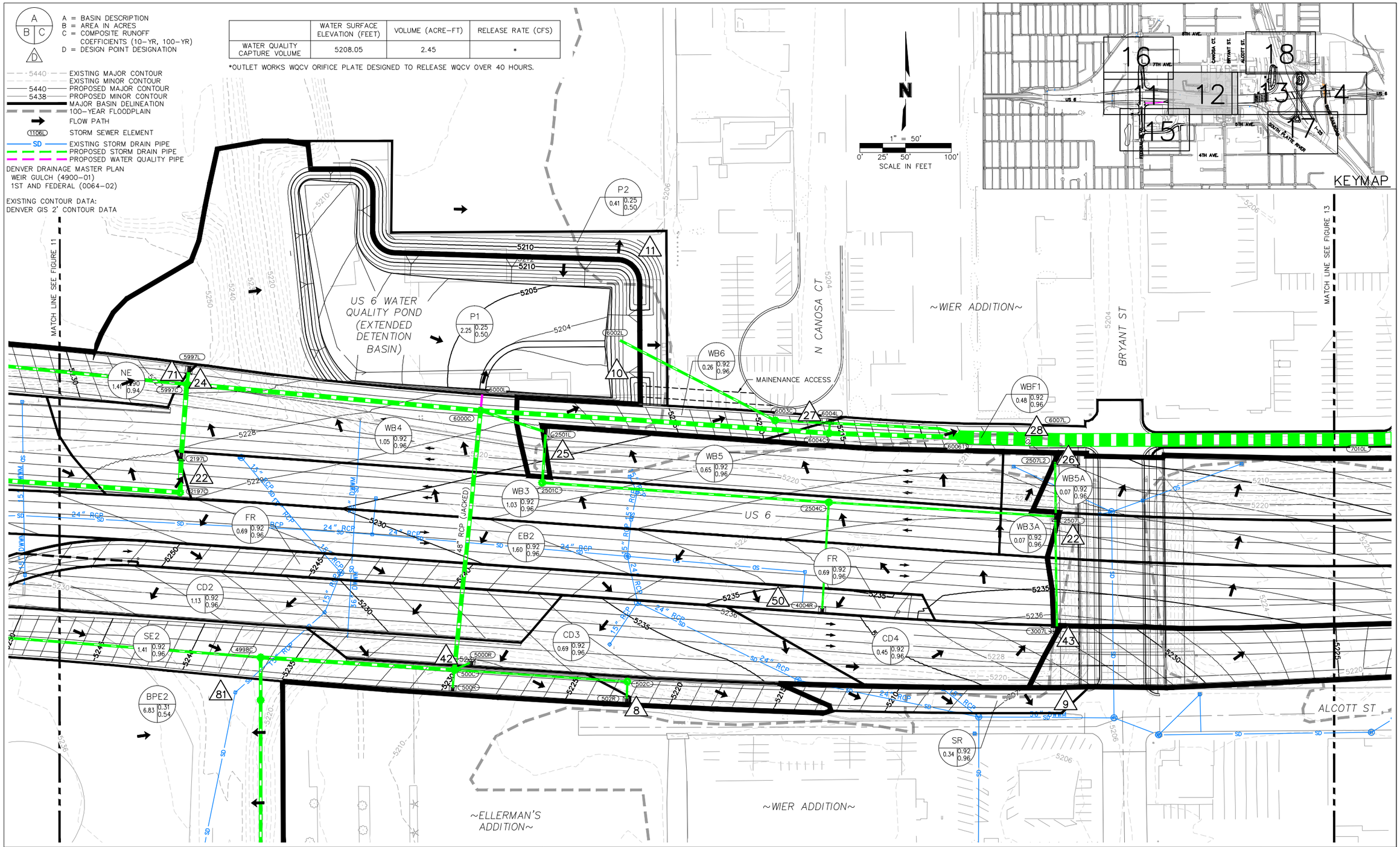
EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA



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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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DRAINAGE AREA MAP

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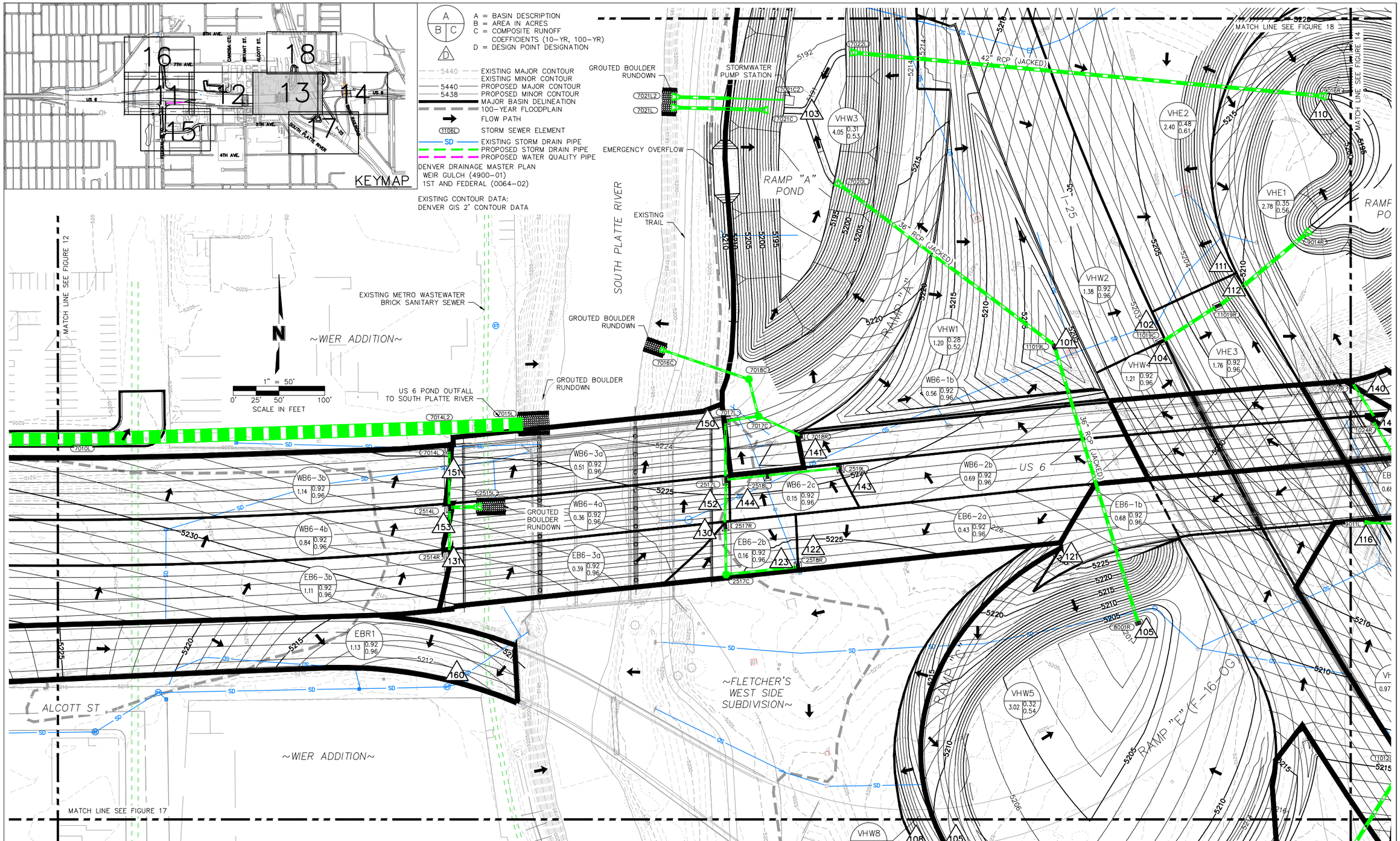

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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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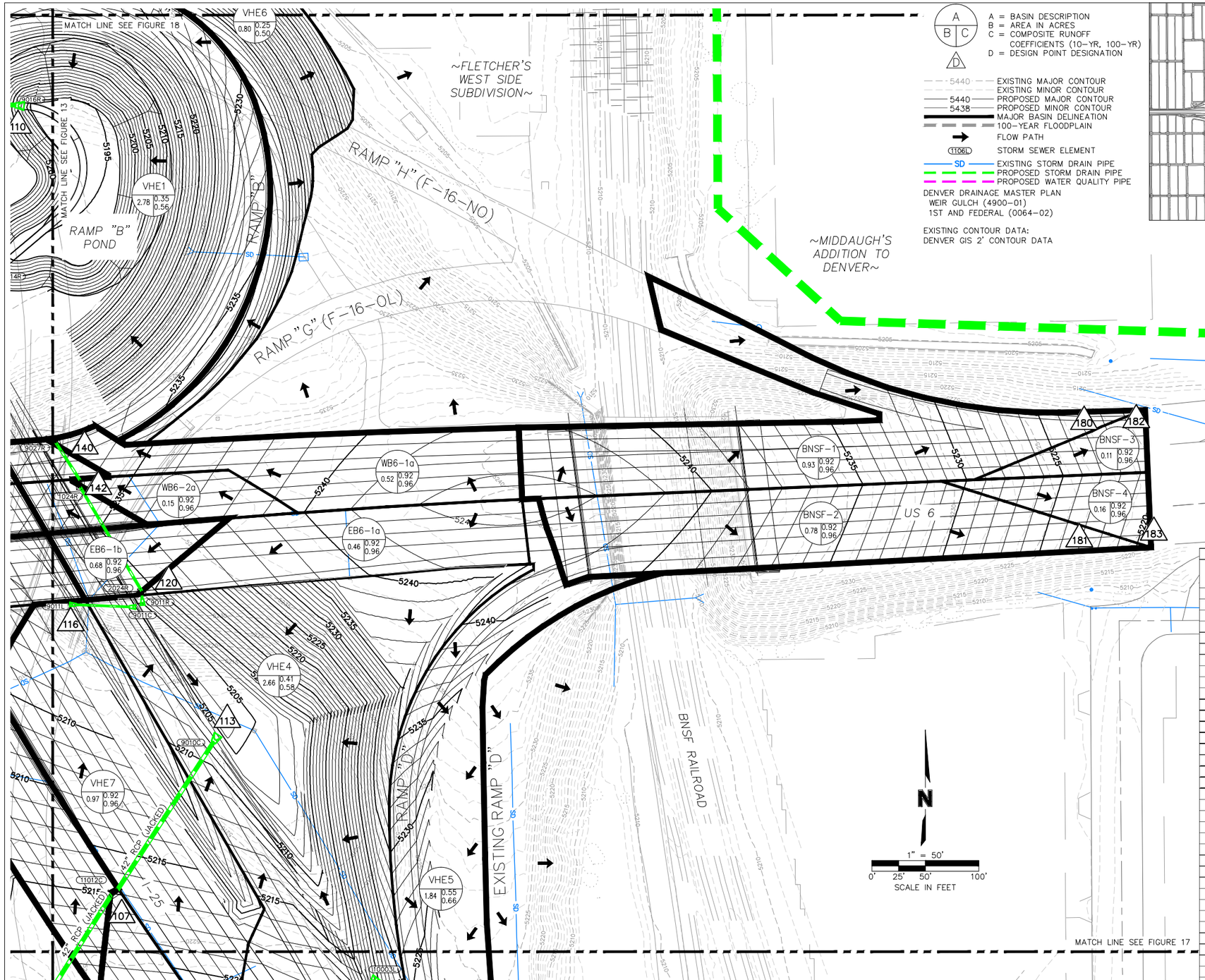

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EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
MAJOR BASIN DELINEATION
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FLOW PATH
1106L STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
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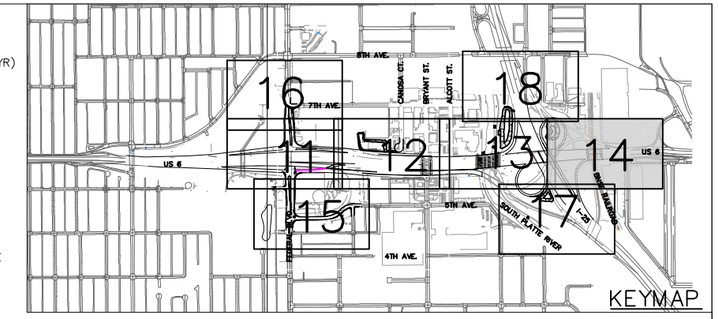
EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA



SUMMARY RUNOFF TABLE

DESIGN POINT/ STRUCTURE ID	CONTRIBUTING BASIN(S)	10-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)	COMMENTS
101	VHW1	9.6	23.9	
102	VHW2	6.7	11.5	
103	EB6-1b,WB6-1b,3a, VHW 1-5, VHE1-3 ,OS-20	41.7	92.3	
104	OS-20,VHW2, VHW4	15.2	26.3	
105	EB6-1b, VHW5	8.3	19.7	
106	WB6-1a, 2a, EB6-1a, VHW6, 7, VHE4, 5, 7	29.6	60.2	
107	VHW7	6.7	11.5	
108	VHW8	0.5	1.6	GRASS BUFFER
110	VHE1	5.2	13.5	
111	VHE2	6.0	12.9	
112	VHW2, VHW4, OS-20, VHE2, VHE3	27.1	48.8	
113	VHE4	5.7	13.4	
114	VHE5	5.3	10.6	
115	VHE6	1.0	3.4	GRASS BUFFER
116	VHE7	4.7	8.1	
117	OS-20	6.3	10.8	
120	WB6-1a, 2a, EB6-1a	5.3	9.1	
121	EB6-1b	3.3	5.6	
122	EB6-2a	2.1	3.6	
123	EB6-2b	2.8	4.9	
130	EB6-2a,b,3a	4.5	7.9	
131	EB6-3b	5.2	9.0	
140	WB6-1a	2.5	4.3	
141	WB6-1b	2.7	4.7	
142	WB6-1a, 2a	3.2	5.5	
143	WB6-2b	3.3	5.8	
144	WB6-2b,c	4.0	6.9	
150	WB6-1b,3a	12.3	4.2	
151	WB6-3b	5.4	9.3	
152	EB6-2a,b,3a, WB6-2b,c,4a	10.0	17.4	
153	WB6-3b, EB6-3b, WB6-4b	14.4	24.9	
160	EBR1	5.5	9.4	
180	BNSF-1	4.5	7.8	
181	BNSF-2	3.8	6.5	
182	BNSF-1,3	5.0	8.7	
183	BNSF-2,4	4.5	7.8	

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Acad Ver. 2011	Scale: 1"=50'	Units: FEET

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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

Colorado Department of Transportation
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Littleton, CO 80128
Phone: 303-972-9112 FAX: 303-972-9114
Region 6 TG

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DRAINAGE AREA MAP

Designer: MORLOFF
Detailer: MORLOFF
Sheet Subset: DRAINAGE Subset Sheet:: 14 of 18

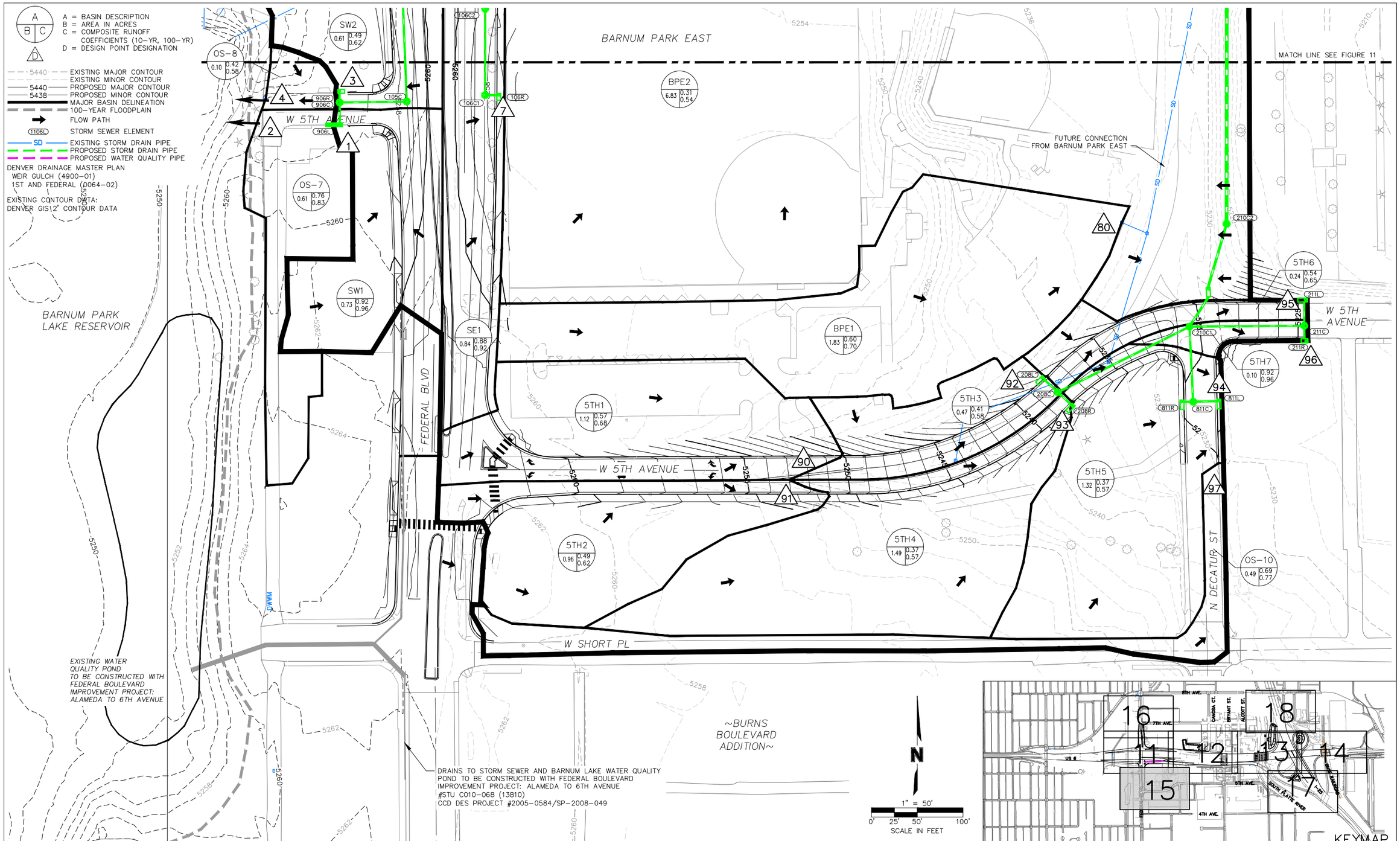
18192/18202
Number
Code
Sheet Number 14

A = BASIN DESCRIPTION
B = AREA IN ACRES
C = COMPOSITE RUNOFF COEFFICIENTS (10-YR, 100-YR)
D = DESIGN POINT DESIGNATION

5440 EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
MAJOR BASIN DELINEATION
100-YEAR FLOODPLAIN
FLOW PATH
106L STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
PROPOSED WATER QUALITY PIPE

DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900-01)
1ST AND FEDERAL (0064-02)

EXISTING CONTOUR DATA:
DENVER GIS\2' CONTOUR DATA



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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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Revised:
Void:

DRAINAGE AREA MAP

Designer:	MORLOFF		
Detailer:	MORLOFF		
Sheet Subset:	DRAINAGE	Subset Sheet::	15 of 18

18192/18202
Number
Code
Sheet Number 15

A = BASIN DESCRIPTION
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C = COMPOSITE RUNOFF COEFFICIENTS (10-YR, 100-YR)
D = DESIGN POINT DESIGNATION

5440 EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
5440 PROPOSED MAJOR CONTOUR
5438 PROPOSED MINOR CONTOUR
MAJOR BASIN DELINEATION
100-YEAR FLOODPLAIN
FLOW PATH
1106L STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
PROPOSED WATER QUALITY PIPE

N

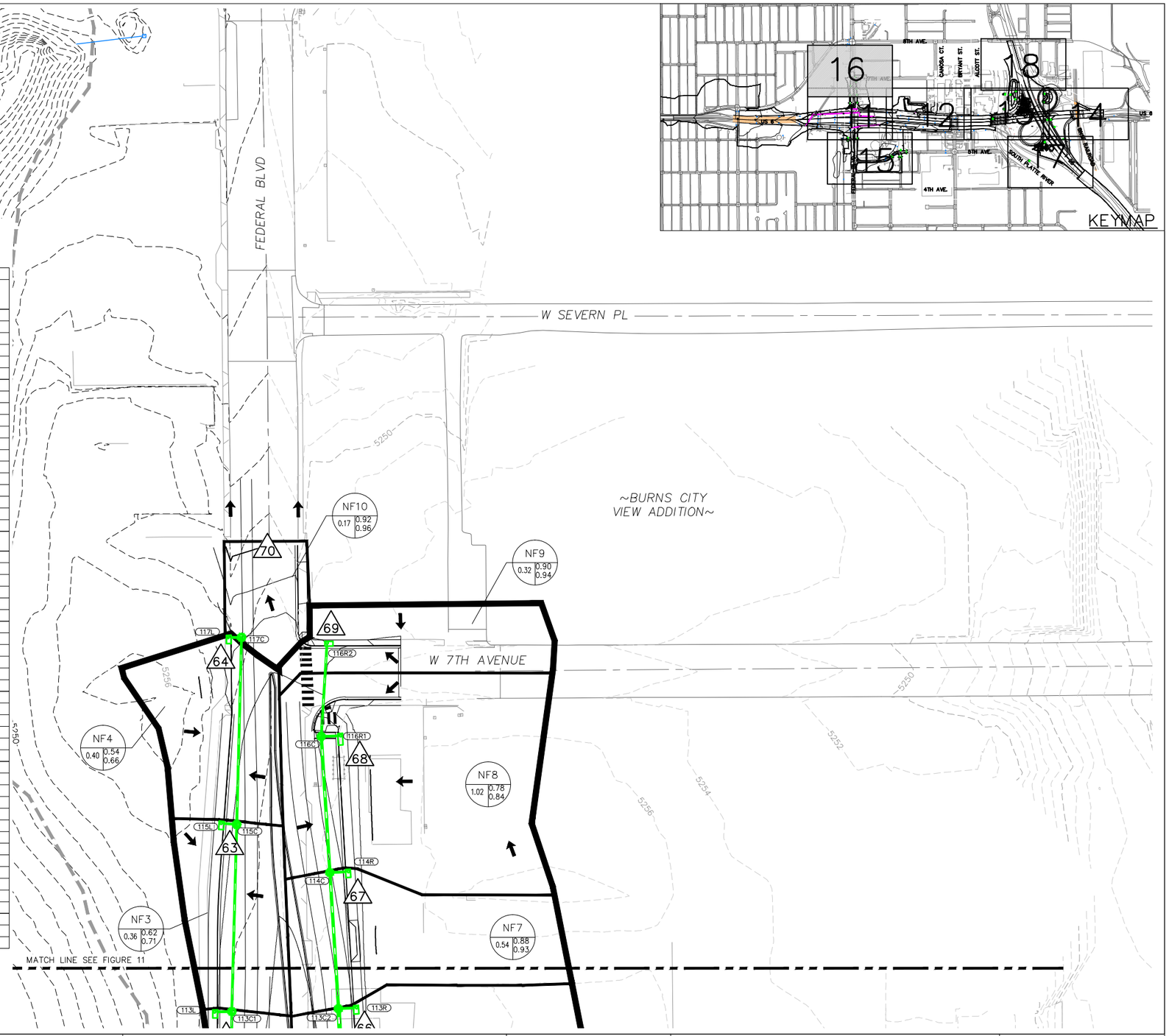
1" = 50'
0' 25' 50' 100'
SCALE IN FEET

DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900-01)
1ST AND FEDERAL (0064-02)

EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA

SUMMARY RUNOFF TABLE

DESIGN POINT/ STRUCTURE ID	CONTRIBUTING BASIN(S)	10-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)	COMMENTS
1	SW1	3.5	6.1	
2	-	2.5	4.4	FLOWS TO BARNUM LAKE
3	SW2	1.6	3.3	
4	-	0.2	0.5	FLOWS TO BARNUM LAKE
5	SW1, SW2, SW3	6.3	12.4	
6	SW1, SW2, SW3, SW4	7.0	13.8	SUMP
7	SE1	3.9	6.8	SUMP
8	SE2	6.0	10.4	
9	-	1.6	2.8	FLOWS OFFSITE
10	WQ1	3.0	9.8	WATER QUALITY POND
11	WQ3	0.5	1.8	FLOWS OFFSITE
20	WB6-5, WB1	12.4	21.4	SUMP
21	CD1-2, EB1-2, WB1-2, WB6-5	66.8	94.6	SUMP
22	CD1-2, EB1-2, WB1-3, WB6-5	69.2	98.8	
23	WB5A, CD4, WB3A	2.8	4.8	
24	NE, WB4	11.5	20.0	SUMP
25	WB5A, CD4, WB3A, FR, WB5	8.0	13.9	
26	WB5A	0.3	0.6	
27	WB6-5, WB1	1.2	2.1	
28	NF5-9,BP,5TH,CD1-3, FR,EB1-2,WB1-6,NE,WB6-5, WBF1	73.8	159.3	
29	WB6-5	1.4	2.4	
30	EB1	2.3	3.9	SUMP
31	CD1-2, EB1-2	25.0	43.2	SUMP
40	CD1	14.7	25.5	SUMP
41	CD1, CD2	19.5	33.7	SUMP
42	CD3	3.3	5.8	SUMP
43	CD4	2.2	3.8	
50	FR	3.3	5.7	SUMP
60	NW1	4.5	7.7	SUMP
61	NF1	1.1	1.9	
62	NF2	1.3	2.3	
63	NF3	1.1	2.1	
64	NF4	1.1	2.3	
65	NF5	1.2	2.1	
66	NF6	4.2	7.7	
67	NF7	2.5	4.3	
68	NF8	4.2	7.4	SUMP
69	NF9	1.5	2.6	SUMP
71	NE	6.6	11.4	SUMP
80	BPE1	5.8	11.1	
81	BPE2	8.9	25.5	
90	5TH1	3.4	6.6	
91	5TH2	2.5	5.2	
92	5TH1, 5TH3	4.2	8.6	
93	5TH2, 5TH4	5.0	11.7	
94	5TH5, OS-10	4.2	9.3	SUMP
95	5TH6	0.7	1.4	
96	5TH7	0.5	0.8	
97	OS-10	1.7	3.2	
6000C	NF5-9,BP,5TH,CD1-3, FR,EB1-2,WB1-5,NE,WB6-5	77.0	165.7	
500C	SE1, SE2, 5TH1-7, CD3, OS-10, BPE1, BPE2	35.8	78.0	
5997C	NE, NF5-9, WB1-4, CD1-2, EB1-2,WB6-5	91.2	137.3	
2193R	CD1-2, EB1-2, WB1-2, WB6-5	66.8	94.6	
OUTFALL	NF5-9,BP,5TH,CD1-3, FR,EB1-2,WB1-5,NE,WB6-5	75.5	162.9	



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DRAINAGE AREA MAP

Designer: MORLOFF
Detailer: MORLOFF
Sheet Subset: DRAINAGE Subset Sheet:: 16 of 18

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MATCH LINE SEE FIGURES 13 & 14

VHW8 0.37 0.25 0.50

108

105

VHW5 3.02 0.32 0.54

MAINTENANCE ACCESS ROAD

~FLETCHER'S WEST SIDE SUBDIVISION~

RAMP "F" (F-16-OE)

SOUTH PLATTE RIVER

GROUTED BOULDER RUNDOWN

8002R

106

8004L

C1101L

6TH AVENUE INTERCHANGE WATER QUALITY POND (EXTENDED DETENTION BASIN)

WATER QUALITY PIPE FROM 3RD AVENUE BASIN TO BE BUILT BY OTHERS

VHW6 2.86 0.33 0.54

RAMP "G" (F-16-OL)

VHW7 1.27 0.92 0.96

VHE4 2.66 0.41 0.58

I-25

EXISTING RAMP "D"

T10003L

T10003R

114

VHE5 1.84 0.55 0.66

~FLETCHER'S WEST SIDE SUBDIVISION~

BNSF RAILROAD

BNSF RAILROAD

BNSF RAILROAD

3RD 17.19 0.92 0.96

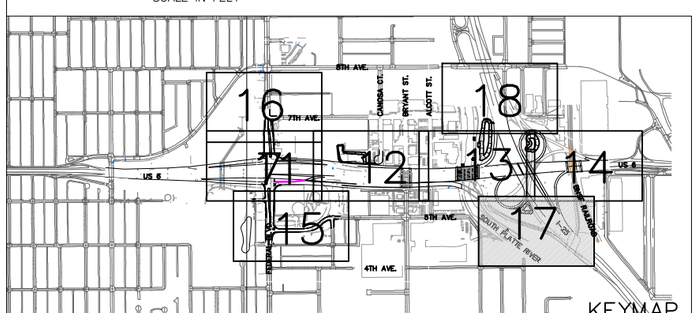
3RD AVENUE BASIN

N

1" = 50'

0' 25' 50' 100'

SCALE IN FEET



KEYMAP

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MAJOR BASIN DELINEATION
100-YEAR FLOODPLAIN
FLOW PATH
1106L STORM SEWER ELEMENT
SD EXISTING STORM DRAIN PIPE
PROPOSED STORM DRAIN PIPE
PROPOSED WATER QUALITY PIPE

DENVER DRAINAGE MASTER PLAN
WEIR GULCH (4900-01)
1ST AND FEDERAL (0064-02)

EXISTING CONTOUR DATA:
DENVER GIS 2' CONTOUR DATA

	WATER SURFACE ELEVATION (FEET)	VOLUME (ACRE-FT)	RELEASE RATE (CFS)
WATER QUALITY CAPTURE VOLUME	5207.76	1.01	*

*OUTLET WORKS WQCV ORIFICE PLATE DESIGNED TO RELEASE WQCV OVER 40 HOURS.

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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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DRAINAGE AREA MAP

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Detailer: MORLOFF
Sheet Subset: DRAINAGE
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DENVER DRAINAGE MASTER PLAN
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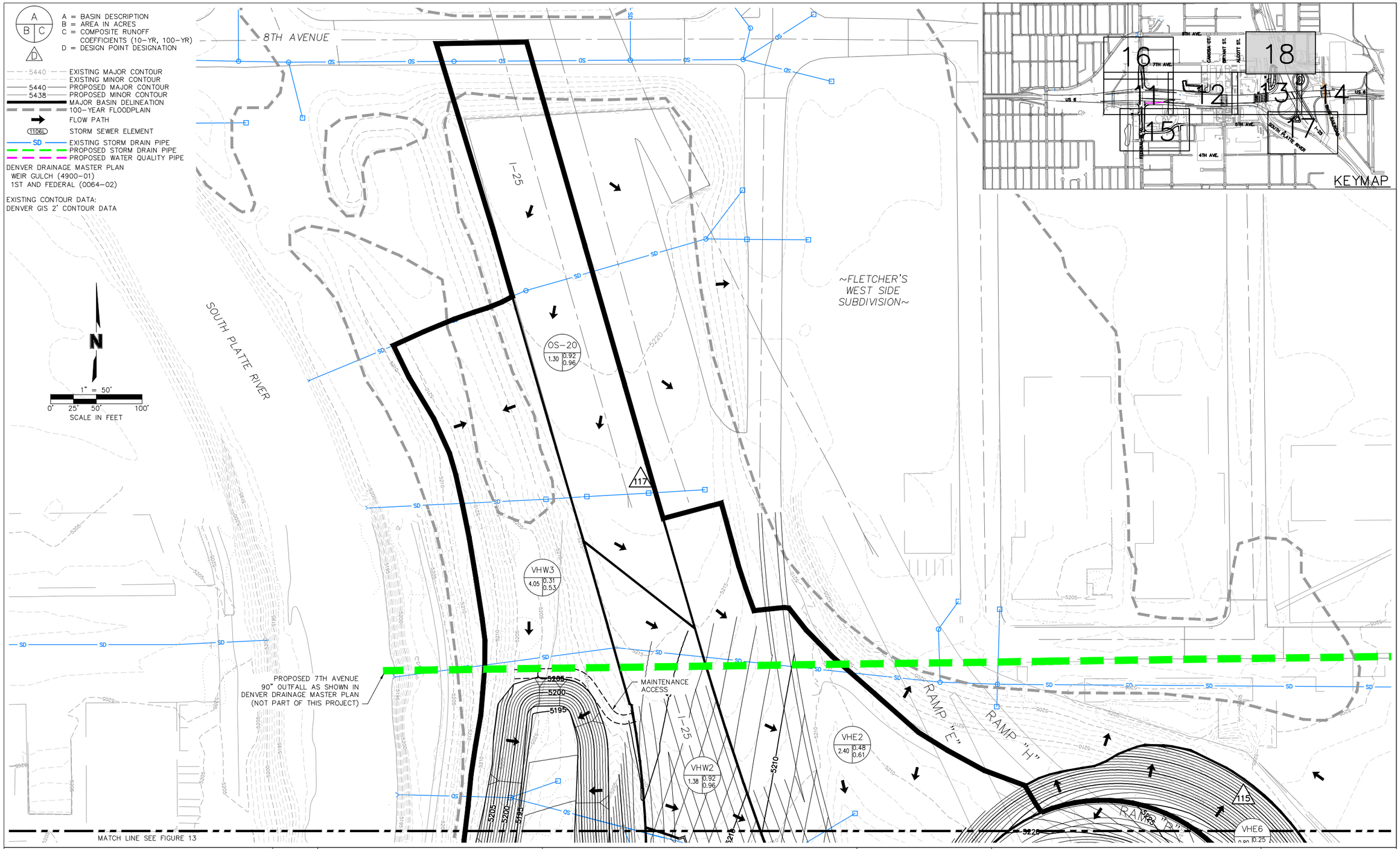

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R-X	mm/dd/yy	XXXXX	XXX
R-X	mm/dd/yy	XXXXX	XXX

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DRAINAGE AREA MAP

Designer: MORLOFF
Detailer: MORLOFF
Sheet Subset: DRAINAGE Subset Sheet:: 18 of 18

18192/18202
Number
Code
Sheet Number 18