Draft Master Drainage Report:

I-70 East Corridor Project

September 29, 2015

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1. Introduction

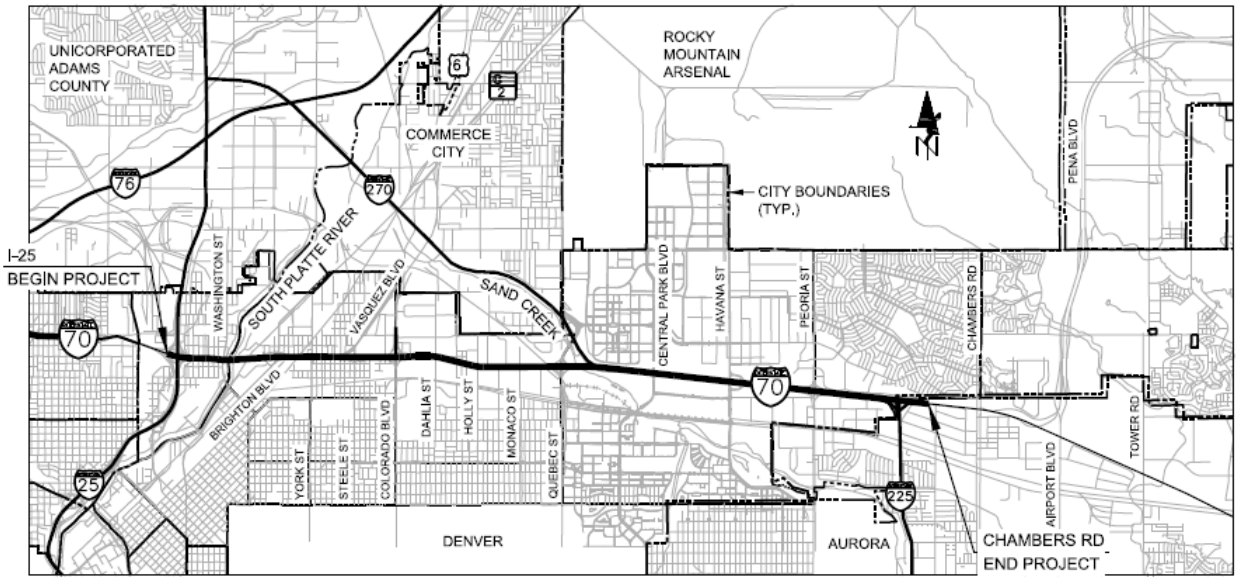
1.1. Project Background

This report discusses the preliminary design for the drainage and water quality improvements for I-70 East between I-25 and Chambers Road. As design progresses, additional detailed reports will be prepared by the Developer as discussed in Schedule 10, Section 8 of the Procurement Documents. The Procurement Documents and design/analysis were developed in conjunction with the Final Environmental Impact Statement (Final EIS), which is projected to be completed by January 2016. It is anticipated that the Record of Decision (ROD) will be in place by July 2016.

1.2. Locations of Improvements

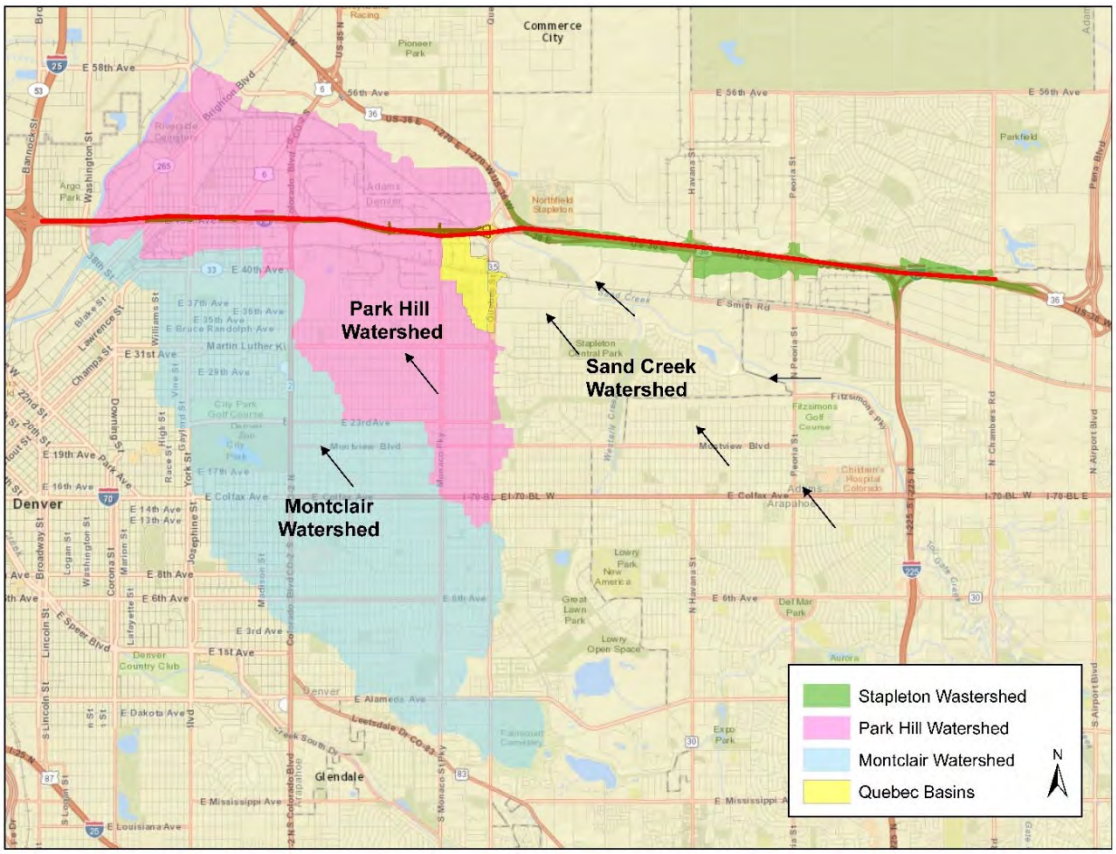
The I-70 East project includes construction along 11.7 miles of the I-70 corridor from I-25 to Chambers Road. The I-70 East proposed improvements fall within multiple city and county jurisdictions, including the City of Denver, the City of Commerce City, and the City of Aurora, as well as Denver County and Adams County. **Figure 1-1**, below, is a Vicinity Map showing the overall limits of the project.

Figure 1-1 Vicinity Map



The I-70 East project is impacted by four major drainage watersheds. **Figure 1-2,** below, shows each of the major watersheds in relation to I-70 East. A discussion of each watershed is included below.

Figure 1-2 Major Basin Map



Montclair Basin: The Montclair Basin impacts I-70 East between York Street and Brighton Boulevard. The Montclair Basin is the largest tributary area impacting I-70 East and was the focal point of the Multi-Agency Technical Team (MATT), which analyzed the flow impacting I-70 East from the Montclair Basin. The *Memorandum for I-70 Partial Cover Lowered Montclair Drainage Basin Hydrologic Analysis (Enginuity, 2014a)* documents the flow impacting I-70 East.

Park Hill Basin: The Park Hill Basin impacts I-70 East between Colorado Boulevard and Monaco Street. The Park Hill Basin is the second largest tributary area impacting I-70 East and was the second focal point of the MATT, which analyzed the flow impacting I-70 East from the Park Hill Basin. The *Memorandum for I-70 Partial Cover Lowered Park Hill Drainage Basin Hydrologic Analysis (Enginuity, 2014b)* documents the flow impacting I-70 East.

Sand Creek: Sand Creek crosses under I-70 East to the east of Quebec Street. The majority of the Sand Creek Watershed is illustrated in the Stapleton Basins discussed below. There is a Federal Emergency Management Agency (FEMA) Special Flood Hazard Area (SFHA) associated with Sand Creek. The FEMA Flood Insurance Rate Map (FIRM) is included in **Section 2.7**.

Stapleton Basins: The Stapleton Watershed impacting I-70 is separated into three areas according to the City and County of Denver Storm Drainage Master Plan (Denver, 2014). Three of these areas are Stapleton, Stapleton North, and Stapleton East, which are shown on **Figure 1-3**, **Figure 1-4**, and **Figure 1-5**, below.

Figure 1-3 Stapleton Basin (from City and County of Denver Storm Drainage Master Plan)

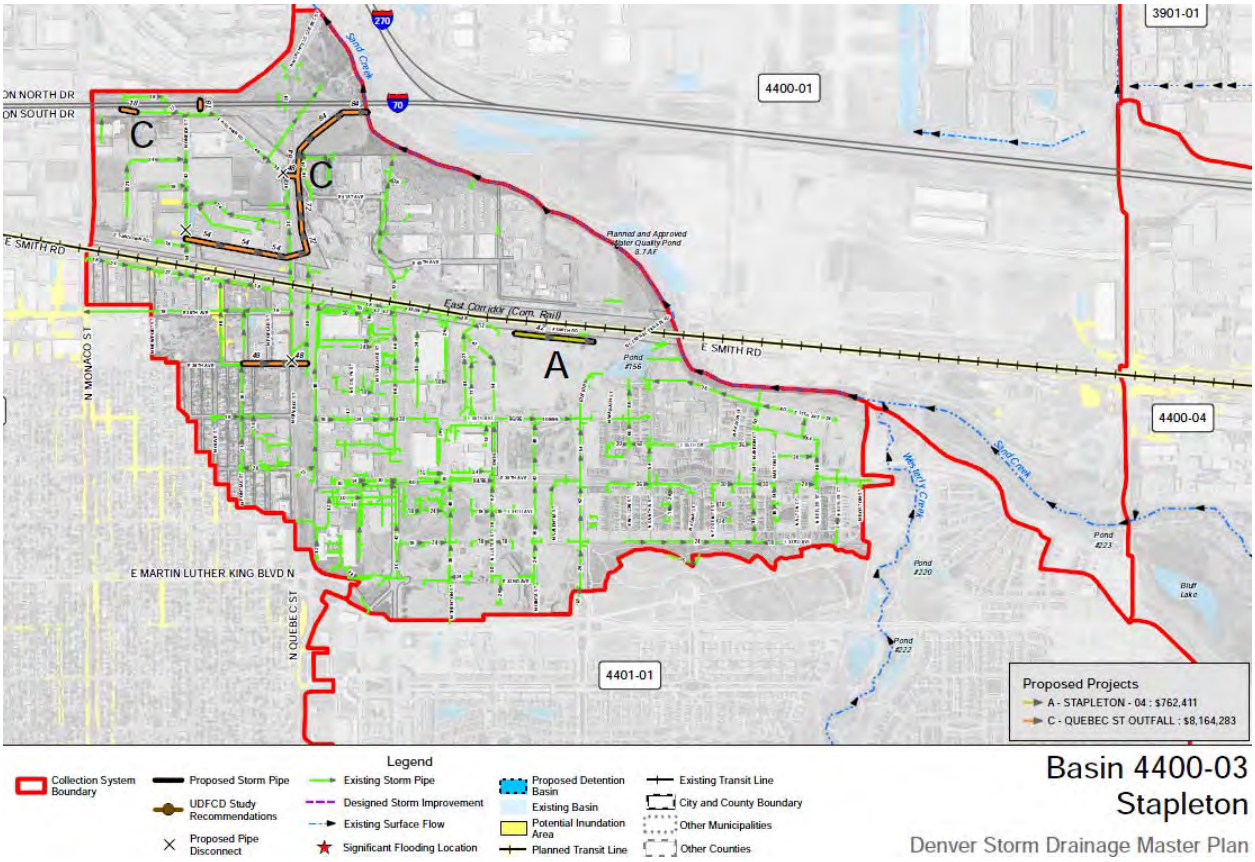


Figure 1-4 Stapleton North Basin (from City and County of Denver Storm Drainage Master Plan)

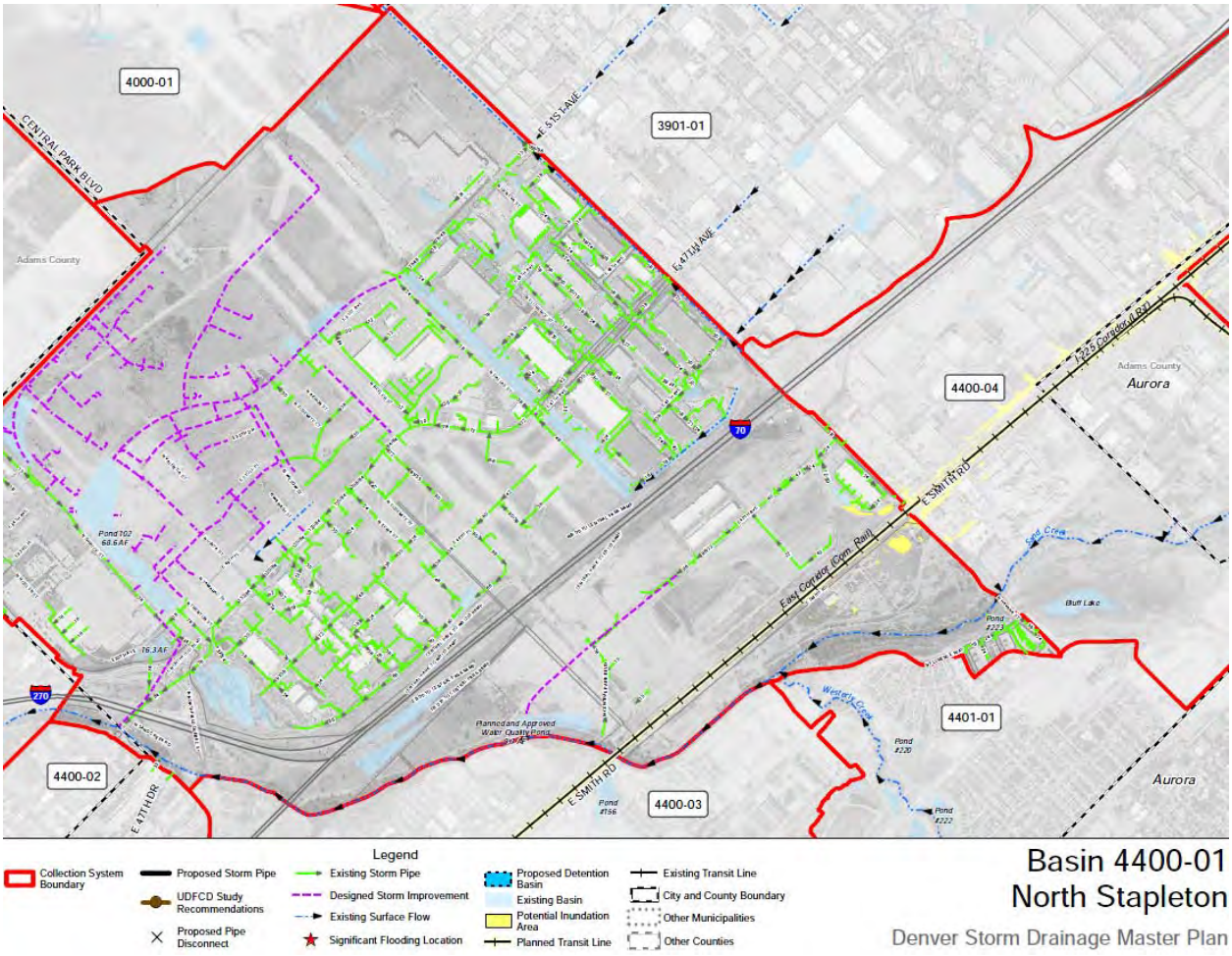
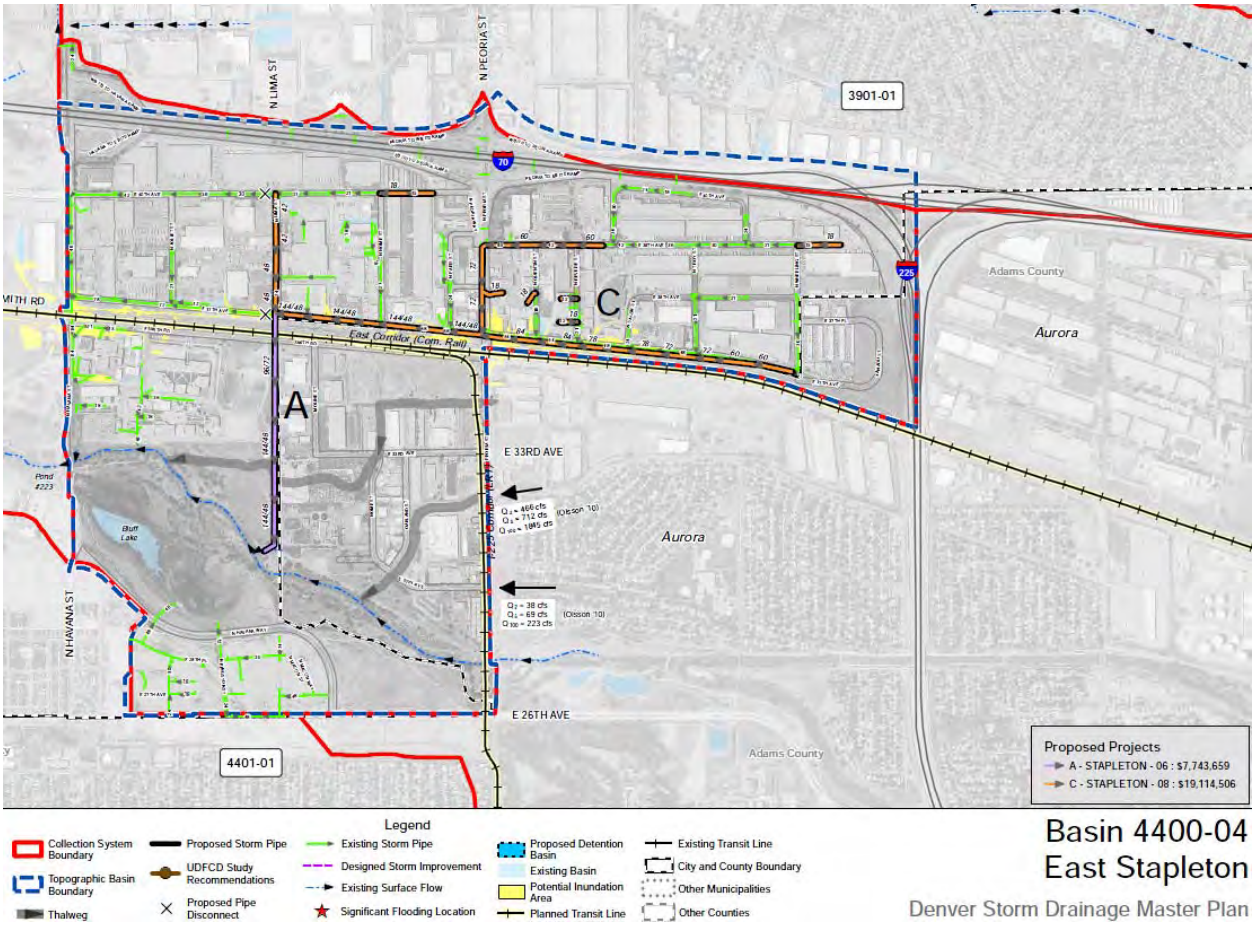


Figure 1-5 Stapleton East Basin (from City and County of Denver Storm Drainage Master Plan)



1.3. Description of Improvements

A conceptual overview of the proposed roadway and drainage improvements is described below.

- The improvements to I-70 East between I-25 and Brighton Boulevard will consist of restriping, which substantially reduces the shoulder of I-70. The catch basins required to meet spread criteria will need to be incorporated by the Developer in the final drainage design and are not included in the base design.
- I-70 East between Brighton Boulevard and Colorado Boulevard will be designed to ultimate build out. This section is referred to as the Partial Cover Lowered (PCL) section, which lowers the grade of I-70 approximately 42 feet below existing grade. An extensive offsite drainage system is proposed to protect the lowered section from the large offsite flows from the Montclair Basin and the Park Hill Basin (impacting the Colorado Boulevard interchange). The proposed system includes seven flood control detention basins and approximately 6,000 feet of larger-diameter conduit (concrete box culvert [CBC] and reinforced concrete pipe [RCP]). The hydrologic and hydraulic design and analysis developed for the Offsite Outfall System are discussed in **Section 2**.
- To drain the PCL section of I-70 East, an Onsite Outfall System is proposed to drain the proposed low point. The hydrologic and hydraulic design and analysis developed for the Onsite Outfall System are discussed in **Section 2**.

- From Colorado Boulevard to Sand Creek (east of Quebec Street), I-70 East will be designed to ultimate build out. The proposed drainage improvements follow existing flow patterns and consist of the required storm drains and catch basins needed to meet spread criteria. The proposed drainage improvements also include removing and replacing the existing cross drains. The drainage design for this sections is discussed in **Section 2**.
- From Sand Creek (east of Quebec Street) to the I-225 interchange, I-70 East will be widened to incorporate managed lanes. The proposed drainage improvements follow existing flow patterns and mostly drain to roadside ditches, but a few areas do require storm drains and catch basins to meet spread criteria. Several existing crossings will be removed and replaced within this section. The drainage design for this sections is discussed in **Section 2**.
- The section of I-70 East from I-225 to Chambers Road will consist mostly of restriping the drainage improvements to include roadside swales and removing and replacing existing drainage crossings. The drainage design for this section is discussed in **Section 2**.

A detailed discussion of the proposed drainage improvements for Outfall Systems and cross drains is provided in **Section 2**. **Section 3** discusses proposed drainage improvements for onsite roadway drainage. In general, the following design objectives are utilized:

- Effectively and efficiently collect and convey stormwater away from the roadway surface.
- Capture stormwater in Extended Detention Basins (EDBs) to control peak outflows and provide water quality treatment. Water quality design will be conducted on a project level, which is based on banking of treated impervious areas. The water quality design and analysis can be found in the Draft Master Water Quality Report included in Schedule 29, Procurement Reference Documents.
- Propose facilities that are consistent with the drainage master plans for local jurisdictions.

1.3.1. Existing Drainage Facilities

Existing water quality ponds were built during the I-70/Central Park Boulevard Interchange project, completed in 2012. The I-70 East improvements will have minimal impact on these ponds and do not depend on them to meet the water quality criteria.

Currently, the Havana Street interchange is being redesigned. It is anticipated that this interchange will be completed before the I-70 East project begins construction. There are two existing ponds located in the northeast and southeast infield areas that will be redesigned with the I-70 East project to include water quality ponds. Both the north and south ponds will be graded to maintain the existing volume.

1.4. Conceptual Plans

Conceptual drainage plans have been developed and are provided in Schedule 29, Reference Documents.

1.5. Discussion of Drainage Investigation

The drainage conditions have been investigated using aerial images and survey, land survey, review of as-built drawings, review of drainage reports, and site field investigations. Coordination between the Colorado Department of Transportation (CDOT) and local agencies to discuss the existing and proposed drainage system has begun, but will need to continue through final design.

2. Cross Drainage, Drainageways, and Irrigation Ditch Crossings

2.1. Location and General Discussion

This section discusses the major crossings and lateral drainageways proposed with the I-70 East roadway improvements.

- Sand Creek crosses under I-70 East through an existing bridge. No improvements are proposed to the Sand Creek Bridge, since this bridge was widened recently and can incorporate the proposed widening of I-70 East. The widening of I-70 East and ramps in this area will affect the Sand Creek floodplain, which will be discussed in **Section 2.7**.
- The Sand Creek overflow, which is located to the south of the proposed I-270 flyover, will be channelized and narrowed to fit within CDOT right of way (ROW). The floodplain impacts will be discussed in **Section 2.7**.
- The proposed Offsite Outfall System is located to the south of I-70 East within the proposed alignment of 46th Avenue and McFarlane Drive. The Offsite Outfall System begins to the east of the historic Market/Lead Railroad low point (near York Street) and conveys flow to the west to discharge into the South Platte River. A series of six flood control detention basins are proposed to attenuate and capture the large offsite flows impacting I-70 East. The proposed ponds are:
    - Brighton West Flood Control Pond (Station 2000+00)
    - Brighton East Flood Control Pond (Station 2012+00)
    - York East Flood Control Pond (Station 2028+00)
    - Steele West Flood Control Pond (Station 2050+00)
    - Steele East Flood Control Pond (Station 2055+00)
    - Steele North Flood Control Pond (Station 2055+00)

  At the Brighton West detention basin, the proposed Offsite Outfall System drains to the southwest within McFarland Drive, bisects the parking lot of the Denver Coliseum, enters the north section of Globeville Landing Park, and discharges into the South Platte River.
- The proposed Onsite Outfall System begins at the proposed low point of the PCL section of I-70 East and conveys the trench flow to the north along Claude Court and Race Street, where it discharges into the proposed onsite pond located on the south edge of the Riverside Cemetery just north of Brighton Boulevard. The proposed north pond outlets into the South Platte River via a stormwater pump station.
- Large flows from the Park Hill Watershed drain northwest through the Safeway Distribution Center, impacting the I-70 East and Colorado Boulevard intersection. Two detention basins (Colorado North and Colorado South) are proposed.
    - Colorado North Flood Control Pond (Station 2080+00)
    - Colorado South Flood Control Pond (Station 2080+00)

  A culvert is located under I-70 East connecting the north and south basins. A 20-foot x 5-foot storm drain system is located in Stapleton Drive to the north of the Safeway Distribution Center. This will protect the east end of the lowered section of I-70 East from the Park Hill Watershed flows.
- The Section of I-70 east of Quebec Street to Chambers Road consists of many storm drains and culverts that will be removed and replaced.

Table 2-1, below, is a summary of the drainage crossings included in the I-70 East project.

Table 2-1 Summary of Major Drainage Crossings

Crossing	Existing Structure	Proposed Structure	Comment
Sta 2005+00	N/A	24” RCP	
Sta 2023+25	N/A	10’ x 3’ CBC	
Sta 2027+40	N/A	72” RCP	
Sta 2027+60	N/A	42” RCP	
Sta 2080+55	24” RCP	72” RCP	
Sta 2084+50	N/A	20’ x 5’ CBC	
Sta 2085+15	N/A	36” RCP	
Sta 2118+00	108” RCP	108” RCP	
Sta 2118+90	N/A	30” RCP	Remove and replace
Sta 2128+00	72” RCP	72” RCP	
Sta 2142+60	N/A	30” RCP	Remove and replace
Sta 2171+00	N/A	30” RCP	
Sta 2185+80	N/A	42” RCP	
Sta 2186+00	N/A	48” RCP	
Sta 2238+50	24” into 30” RCP	24” into 30” RCP	
Sta 2256+15	36” RCP	36” RCP	Remove and replace
Sta 2288+00	N/A	Bridge for Swale	Remove and replace
Sta 2303+50	24” RCP	24” RCP	
Sta 2312+35	18” RCP	18” RCP	Remove and replace
Sta 2336+25	24” RCP	24” RCP	Remove and replace
Sta 2379+50	N/A	4 x 2 RCBC	Remove and replace
Sta 2408+15	24” into 36” RCP	24” into 36” RCP	Remove and replace
Sta 2444+40	30” x 19” RCP	30” x 19” HERCP	

2.2. Hydrology and Design Flow Development

The flow draining to I-70 East was calculated using the Colorado Urban Hydrograph Procedure (CUHP2005) software that was developed by the Urban Drainage and Flood Control District (UDFCD) and routed using Environmental Protection Agency (EPA) SWMM5. The offsite drainage basin maps are included in **Appendix D**. The proposed facilities conveying offsite flow are designed for the 100-year event.

Table 2-2, below, is a summary of the major offsite design points that were used to design the proposed Offsite Outfall System discussed above in Section 2.1. The design points are shown on the offsite drainage basin maps included in **Appendix D**.

Table 2-2 Design Points

Design Point	Location	SWMM Node	Q100-Year (CFS)
1	Outlet to South Platte River	Outfall_South_Platte	2197
2	Brighton West Pond	pond7A	2247
3	Brighton East Pond	pond7	2444
4	York East Pond	pond6	361
5	Steele West Pond	SV-WEST	365
6	Steele East Pond	SV-EAST	790
7	Inflow from Montclair Basin (Monroe St and 39th Ave)	COM_I-70_1	330
8	Inflow from Park Hill (Golf Course)	311	1395
9	Inflow from Park Hill (Forest St and Smith Rd)	625	1771
10	Colorado South Pond	I-70RC1	1661
11	Colorado Blvd and E 48 Ave	I-70RC2	2101
12	Quebec North Pond	774	255
13	Central Park Outlet	D170	160
14	Havana North#2 Pond	NE_Havana_Pond	35
15	Havana South Pond	SE_Havana_Pond	61
16	Peoria St North	IG130	42

2.3. Information Sources

The studies noted below were reviewed or referenced to develop the offsite flow draining to I-70 East. In addition, the as-built drawings for the existing I-70 East corridor were reviewed.

- *Memorandum for I-70 Partial Cover Lowered Montclair Drainage Basin Hydrologic Analysis (Enginuity, 2014a).* This memorandum was created through the MATT to develop the current offsite flow draining to I-70 from the Montclair Basin. The total flow impacting I-70 without removing flow conveyed in existing drainage facilities was referenced from this memorandum and used to design the Offsite Outfall System to protect the proposed lowered section of I-70.
- *The High Street Outfall and 40th Avenue Storm Sewer System, South Platte River to Blake Street, Final Design Report (WHPacific, 2012).* The drainage facility designed in this report is currently designed and ready for construction. The proposed High Street outfall is located in the Globeville Landing Park. Globeville Landing Park is located on a reclaimed landfill. The geotechnical and structural design to stabilize the storm drain using a compaction grouting method was reviewed and a similar method will be incorporated in the I-70 Outfall System design by the Developer.
- *Memorandum for I-70 Partial Cover Lowered Park Hill Drainage Basin Hydrologic Analysis (Enginuity, 2014b).* Park Hill hydrology analyzed through the MATT was referenced for the offsite flows impacting the proposed Colorado Boulevard and I-70 interchange improvements. No formal report was submitted for this data and the current hydrologic/hydraulic models and figures were received via email from Enginuity.
- *Central Park Boulevard Interchange.* Flow paths and proposed facilities were referenced and incorporated into the I-70 East drainage design.
- *Havana Street Design Build.* A conceptual design of the Havana Street interchange was reviewed and incorporated into the I-70 East drainage design.

- *Baranmor Ditch Watershed Outfall System Plan* (Olsson Associates 2009). The OSP was revised and conceptual hydrology and flow paths were incorporated into the hydrology for the area to the east of I-225.

2.4. Agency Coordination

Coordination with various agencies was conducted. Meetings with local agencies and cities were held to discuss existing drainage features, areas of concern, proposed improvements, and maintenance responsibilities. These agencies include the City and County of Denver, UDFCD, and the Farmers Reservoir and Irrigation Company (FRICO).

2.5. Description of Structural Design

All crossings along the corridor are proposed to be CDOT standard pipe or box culverts and storm drains. Refer to **Table 2-3**, below.

2.6. Hydraulic Design

2.6.1. Offsite Outfall System (South Platte River to Colorado Boulevard)

For the proposed lowered section of I-70 between Brighton Boulevard and Colorado Boulevard, the Offsite Outfall System was divided into three sections. The first section is from York Street to the South Platte River, the second section is from York Street to Colorado Boulevard, and the third section is at the Colorado Boulevard and I-70 interchange. Below is a conceptual summary of how the Offsite Outfall System will work in the proposed condition. It should be noted that all three sections of the Offsite Outfall System are required to protect the lowered section of I-70 from flooding in the 100-year event. The hydrologic basins and flow paths are shown on the Basin Maps included in **Appendix D.**

The purpose of the Offsite Outfall System is to capture and convey the large urban overflows draining north to I-70 East from the Montclair Basin to the south (shown on the drainage maps included in **Appendix D**) and the local flows from the east. The Montclair Basin flows impacting I-70 are referenced from the *Memorandum for I-70 Partial Cover Lowered Montclair Drainage Basin Hydrologic Analysis* (Enginuity, 2014a). The results of the memorandum show 4,655 cubic feet per second (cfs) draining to I-70 between York Street and the South Platte River. It is important to note that the 4,655 cfs does not take into account the flow leaving the system through the existing 120-inch brick storm drain and the High Street Outfall (8-foot x 12-foot CBC) that is currently designed and will be built before the I-70 East project is in place. A minor flow split takes place at York Street, where approximately 201 cfs from the Montclair Basin drains north on York Street to I-70. **Table 2-3**, below, summarizes the flow diverted through the 120-inch brick pipe and the High Street Outfall. The majority of the flow from the Montclair Basin drains to the northwest through the Union Pacific Railroad (UPRR) yard to I-70. The flow split locations and existing facilities are shown on the Basin Maps included in **Appendix D** and calculations are included in **Appendix A**.

Table 2-3 Montclair Basin Flow Summary

Flow Description	100-Year Flow (cfs)
Total Montclair Basin Flow	4,655
120” Brick Pipe—Diverted to South Platte River	959
High Street Outfall (8’ x12’ CBC)—Diverted to South Platte River	1,364
*York Street—Flow draining north on York Street to Pond 6	201
*Montclair Basin—Flow draining to I-70 near the UPRR crossing	2,131

*Note: *Items summarizing the Montclair Basin flow draining to I-70*

The local sub-basins (I-70 1 through 4) are located in the Park Hill Master Basin. A CUHP2005 and SWMM5 model was developed to calculate the 100-year flow produced from the four local sub-basins. The majority of the flow is conveyed to the west along East 45th Avenue, where an existing storm drain is located. The flow drains west and discharges into the proposed York East Pond at York Street and I-70. The proposed basins, pond locations, and flow split locations are shown on the Basin Maps included in **Appendix D**.

The major design points of the proposed Offsite Outfall System are discussed below. These design points begin upstream of the Market/Lead Railroad low point moving west (downstream), where the system outlets into the South Platte River.

- The upstream end of the Offsite Outfall System starts to the east of the Market/Lead Railroad low point with an 18-inch RCP that is located within 46th Avenue and conveys flow into two proposed detention basins located at the intersection of Steele Street. The proposed detention basins are Steele East Pond (20 acre-feet) and Steele West Pond (9.4 acre-feet). The outlet of the Steele West pond is a 78-inch RCP that is upsized to an 84-inch RCP. The flow drains to the 72-inch RCP bridge at York Street and continues to the north past I-70 East. The remaining flow that does not drain north into the 72-inch RCP bridge drains to the south to the York East Pond.

  The proposed design takes into account the flow conveyed through the existing 54-inch RCP to 60-inch RCP storm drain facility located in East 45th Avenue, which drains into the York East Pond. Local drainage will be captured through this section of the Offsite Outfall System, which is located south of I-70 within the Park Hill Watershed and accounts for the additional flow from the Montclair Watershed draining to the Market/Lead Railroad low point (Node 641, 330 cfs).

- The York East Pond is located to the east of York Street and to the south of I-70. The York East Pond has two primary functions: (1) to capture the flow draining north on York Street from the south (Montclair Basin), and (2) to split flow draining to the north in the existing 72-inch RCP utilizing existing storm drain capacity.

  During final design of the project, design of a drop inlet system and depressed curb will be required from the Developer to capture this flow. The flow from the local sub-basins described above is conveyed west in an existing 60-inch RCP located in East 45th Avenue and then will be diverted into the York East Pond. The proposed storm drain located in East 46th Avenue will drain into the York East Pond, as well.

  Because of the proposed lowered section, the existing 72-inch RCP will be removed and replaced with a bridge structure for the pipe to span the proposed lowered section of I-70 East and to redirect the remaining flow draining to the west in the proposed Offsite Outfall System.

  The York East Pond is approximately 1.23 acre-feet in volume and for the 100-year event, 361 cfs drains to the pond. The water surface elevation in the pond for the 100-year event is 5,185.3 feet and it will have two feet of freeboard. The overflow path will be designed (in the final stage) so it drains west through the rail yard and does not drain toward I-70. The total depth of the pond is six feet and the depth of water is five feet. The pond was analyzed in SWMM5 using the orifice function in the software to calculate the water surface elevation and the flow discharging from the pond to the north and west. The outlet structure of the pond will need to be designed in greater detail by the Developer. A digital copy of the SWMM5 model is included in Schedule 29 of the reference documents.

- The drainage facility between the York East Pond and the Brighton East Pond is a 7-foot x 6-foot CBC and is located in the proposed alignment of East 46th Avenue to the north of the existing Nestlé Purina PetCare facility. The proposed 7-foot x 6-foot CBC will cross under the existing and proposed UPRR improvements and continue west to the Brighton West Pond. Drop inlets will be placed to capture and track drainage of offsite urban overflow from the Montclair Basin. The proposed 7-foot x 6-foot CBC was modeled using SWMM5 and a digital copy is included in Schedule 29 of the reference documents.

- The main purpose of the proposed Brighton East Pond and Brighton West Pond is to capture the Montclair Basin flow that drains to the northwest through the UPRR yard prior to the urban overflow reaching the lowered section of I-70 East. The ponds also will provide detention storage and attenuation of the peak flow. Brighton East Pond is located between the UPRR to the east and Brighton Boulevard to the west. Brighton West Pond is located between Brighton Boulevard to the east and the Denver Coliseum to the west. The two ponds are connected with a dual 20-foot x 6-foot CBC under Brighton Boulevard.

  Brighton East Pond is approximately 22.10 acre-feet in volume and for the 100-year event, 2,460 cfs drains to the pond from the Montclair Basin and local drainage, as discussed above. The water surface elevation in the Brighton East Pond for the 100-year event is 5,176.35. The total depth of the Brighton East Pond is 11.76 feet.

  Brighton West Pond is approximately 23.51 acre-feet in volume and for the 100-year event, 2,274 cfs drains to the pond, which includes discharge from the Brighton East Pond. The water surface elevation in the Brighton West Pond for the 100-year event is 5,174.08 feet. The total depth of the Brighton West Pond is 9.86 feet.

  The Brighton East Pond and Brighton West Pond were modeled using SWMM5 and a digital copy is included in Schedule 29 of the reference documents. The outlet structures of each pond will need to be designed in greater detail by the Developer.

- The proposed storm drain that drains the Brighton East Pond and Brighton West Pond is located in McFarland Drive. The Offsite Outfall System is located to the south of the Denver Coliseum and flows through the Denver Coliseum parking lot, continuing into Globeville Landing Park, where it discharges into the South Platte River through a boulder drop structure. The proposed storm drain is designed to cross one foot above the existing 78-inch brick and 77-inch brick sanitary sewer lines located in the Globeville Landing Park. To clear the existing sewer lines, the Offsite Outfall System is designed at a 0.2 percent longitudinal slope. Globeville Landing Park and portions of the Denver Coliseum parking lot are located on a pre-existing landfill. To accommodate the unknown foundation conditions, the proposed Offsite Outfall System will be constructed on a compacted grout foundation similar to the High Street Outfall.

  The Offsite Outfall System is approximately 2,592 feet. The storm drain starts as a dual 18-foot x 6-foot CBC east of the Denver Coliseum and increases to a dual 20-foot x 6-foot CBC to the west of the Coliseum into Globeville Landing Park. Due to limited clearance over the existing sanitary sewer, a culvert system with a thinner slab thickness is necessary. The 11-foot x 6-foot CBC has a thinner bottom and top slab thickness, so the Offsite Outfall System will transition to a four-cell system (three 11-foot x 6-foot CBCs and one 12-foot x 6-foot CBC) through the park. The existing 78-inch brick and 77-inch brick sanitary sewer lines will be encased in concrete at the proposed crossings. The Offsite Outfall System is designed to convey the 100-year event flow of 2,260 cfs. The Offsite Outfall System was modeled using SWMM5 and a digital copy is included in Schedule 29 of the reference documents.

2.6.2. Colorado Boulevard Interchange

The Colorado Boulevard interchange drainage improvements consist of two detention basins that are located in the southeast and northeast quadrants of the Colorado Boulevard and I-70 interchange Colorado South Pond and Colorado North Pond. These detention basins discharge to the north into a City and County of Denver existing storm drain.

The flow conveyed in the existing 10-foot x 4-foot CBC in Smith Road (constructed as part of the Eagle PPP) will be diverted and drained into the proposed Colorado South Pond.

The Colorado South Pond and Colorado North Pond are connected by a 72-inch RCP under I-70. The majority of flow draining to the Colorado Boulevard interchange is from the Park Hill Basin (Enginuity, 2014b. The proposed Colorado Boulevard detention basins will reduce the flow draining to the north of I-70 from a historic rate of 2,175 cfs (Park Hill Node JUNCT_341) to approximately 2,101 cfs. The flow draining to the north of I-70 East will follow the existing flow pattern.

A 20-foot x 5-foot CBC is proposed at Stapleton Drive to the north of the existing Safeway Distribution Center. The purpose of this CBC is to convey the Park Hill Watershed flow to the north into the Colorado North Pond, protecting the lowered section of I-70 and preventing an adverse impact on the Safeway Distribution Center. It should be noted that a flow split was analysed with SWMM5 that shows the flows draining to the north in Dahlia Street under I-70 East and the flow draining to the west in Stapleton Drive is conveyed in the proposed 20-foot x 5-foot CBC. The flow split calculations are included in **Appendix A**. The Colorado Boulevard drainage system was modelled in SWMM5 and a digital copy is included in Schedule 29 of the reference documents.

The I-70 East improvements remove existing water quality ponds that the Safeway Distribution Center depends on. It will be the responsibility of the Developer to coordinate with Safeway and incorporate the ponds into the final I-70 East design.

2.6.3. Sand Creek West Outfall

Currently, there is a storm sewer system along Stapleton Drive South that receives runoff from I-70 East between Monaco Street and Quebec Street. These flows are piped southeasterly in Airlawn Road, where they combine with another storm sewer system collecting runoff from residential and industrial lots. The tributary watershed is more than 200 acres in size and is piped northeasterly in a 48-inch RCP at 1.77 percent toward its outfall at Sand Creek. Since the pipe capacity is significantly less than the 100-year design flow, the system's capacity was evaluated as the flow in the aforementioned 48-inch RCP. The proposed design collects the I-70 East runoff in a separate system and directs this flow to a water quality pond (Quebec North Pond) in the northeast gore area for the I-70 and Quebec Street interchange. This flow combines with the reconstructed 48-inch RCP and outfalls at Sand Creek, similar to the existing condition. This drainage system was modelled in SWMM5 and a digital copy is included in Schedule 29 of the reference documents.

2.6.4. Sand Creek to Havana Street

The preliminary Central Park Boulevard SWMM model was used to analyze the design associated with the recently constructed Central Park Boulevard configuration. Offsite flows from the east (to Peña Boulevard) and from the south (Stapleton Filing No. 7) are included in the model. The Havana Street gore area ponds are regraded with the I-70 East project to accommodate water quality treatment and are reflected in the Stage-Storage for the SWMM model. Additionally, the western basin (Basin 62) has increased due to the I-270 flyover alignment and grading. The additional imperviousness associated with the I-70 East improvements was added to the basins along I-70 to reflect the improvements. This drainage system was modeled in SWMM5 and a digital copy is included in Schedule 29 of the reference documents.

2.6.5. Havana Street to I-225

There are several existing issues with the area near the interchange at I-225 and I-70 East.

- The I-225 infield areas do not have an outlet.
- The low point to the west of I-225 and south of I-70 has an outlet pipe with minimal capacity and minimal cover. This cover will be reduced by the proposed and future widening of I-70.
- The outlet pipe mentioned above currently contributes to a pond at East 42nd Avenue and Crown Boulevard. When this pond is full, the water surface elevation is higher than the low point of I-70, so the system backs up into I-70.

I-225 at I-70 was analyzed as part of the Baranmor Ditch Watershed Outfall Systems Plan. The two outfalls to I-225 are combined in this model and the associated hydrograph was input into the I-70 East SWMM5 model. The design-build team should confirm adequate capacity is provided in South Abilene Street as it continues southerly from East 39th Avenue to ensure it does not overtop into the I-225 and I-70 interchange. An 18-inch RCP outfall was added to the northwest corner of the I-225 infield area to provide an outlet that is not provided in the existing condition. This pipe outfalls to a ditch south of I-70. Runoff continues to the

existing low point approximately 1,200 feet west of I-225. It is then piped northerly to the existing storm sewer system in East 42nd Avenue and then westerly to the pond at Crown Boulevard and East 42nd Avenue. A future storm system is proposed in East 42nd Avenue that parallels the existing storm system. This drainage system was modeled in SWMM5 and a digital copy is included in Schedule 29 of the reference documents.

2.6.6. Onsite Outfall System

This section provides an overview of the Onsite Outfall System, which includes the storm drain necessary to drain the proposed lowered section of I-70. The area draining to the low point of the PCL in I-70 East is approximately 42 acres. The onsite sub-basins are shown on the Basin Maps included in **Appendix D.** The Onsite Outfall System required to drain the lowered section of I-70 includes a 72-inch RCP and is designed to convey the 100-year flow of 128 cfs from onsite basins. Two sections of the storm drain under the lowered section in I-70 will be a 10-foot x 3-foot CBC due to the minimal cover and storm drain slope. The elevation of the Onsite Outfall System is approximately 42 feet below existing grade and therefore, is expected to be constructed by tunneling. The storm drain alignment is located to the north along Claude Court, then west on 49th Avenue, north on Race Street, and then discharges into the South Platte River. The total length of the proposed storm drain is 4,883 feet. A proposed detention pond is located near the outlet of the storm drain to the south of the historic Riverside Cemetery. The proposed pond provides detention and water quality opportunities. The Onsite Outfall System alignment is shown on Basin Maps included in **Appendix D.**

The proposed 72-inch RCP discharges into the proposed Onsite North Pond. A proposed pump station will drain the Onsite North Pond and convey the flow to the South Platte River upstream of the intake to the Burlington irrigation ditch. This Onsite Outfall System was modeled in SWMM5 and a digital copy is included in Schedule 29 of the reference documents. It should be noted that the water surface elevation used for the Onsite North Pond is based on the water surface elevation in South Platte River and minimum flow released from the pond via gravity flow to ensure the lowered section in I-70 East is not adversely impacted.

A pump station is proposed to convey 10 cfs (4,500 gpm) from the outlet of the Onsite North Pond, located northwest of Race Court and Brighton Boulevard. Runoff will be conveyed from the invert of the pond to the pump station by a 24" RCP storm drain. The pump station comprises of an inlet structure, wet well, outlet structure and above grade engine and control building. The inlet 11-feet x 40- feet x 30 feet inlet structure includes a trash rack to prevent pump fouling, an access hatch to facilitate cleaning, and a weir to direct runoff evenly to the wet well. The 20-feet x 40-feet x 27-feet wet well houses 3 duty pumps and 1 standby pump. The duty pumps are submersibles that each have the capacity to convey 1,500 gpm at 20-feet total dynamic head. The duty pump lifts approximately 20-feet of discharge piping and fittings which connect to the adjacent 10-feet x 40-feet x 7-feet outlet structure. The standby pump is a vertical axial flow pump which conveys 4,500 gpm at 20-feet total dynamic head. The standby pump system includes a vertical shaft that discharges runoff to the outlet structure and connects the submerged propeller to the right angle gear above. The building footprint is 34-feet x 40-feet x 14-feet with CMU walls and a mansard style roof which houses the natural gas (or diesel) engine, right angle gear, control equipment and cabinets, an overhead crane system, trash removal and equipment maintenance access hatches, and other appurtenant equipment and storage space. From the outlet structure, runoff will be conveyed to the South Platte River by a proposed 24-inch RCP gravity storm drain.

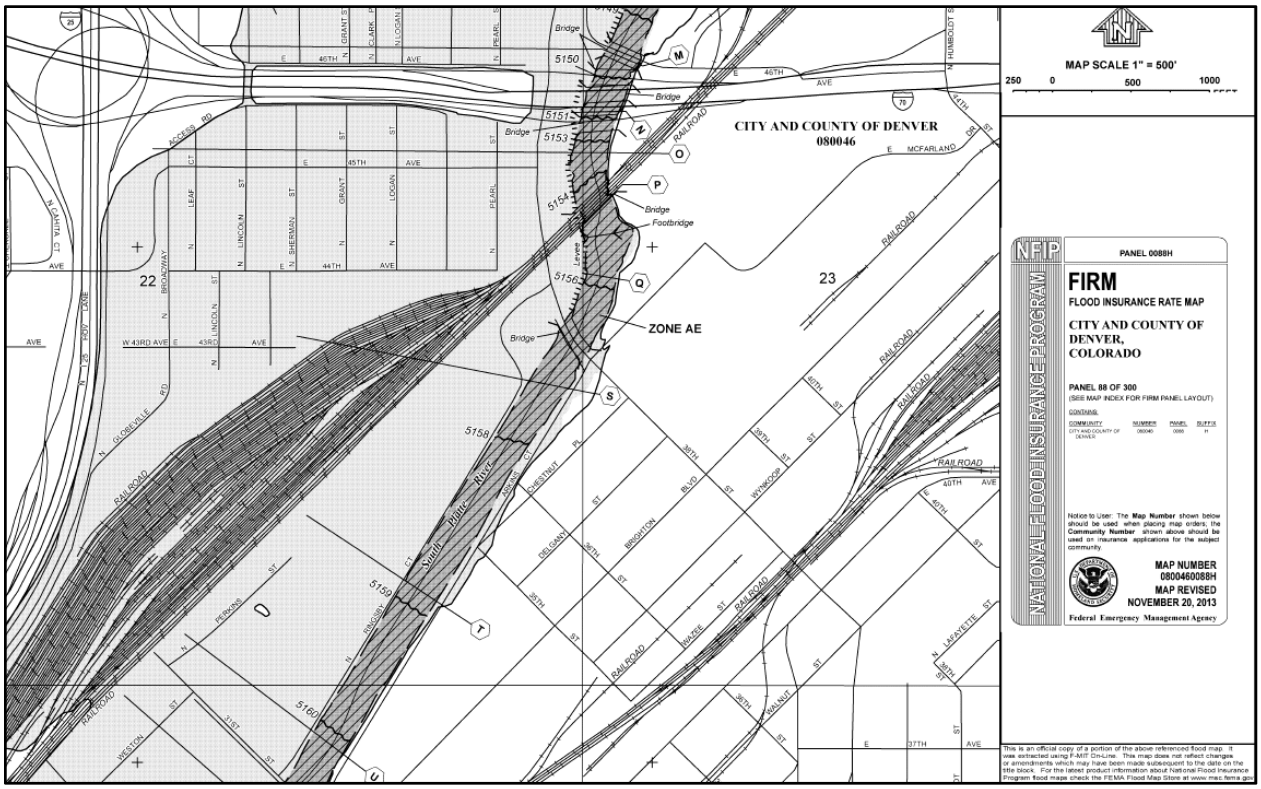
2.7. Drainageways and Floodplains

2.7.1. South Platte River Floodplain

FEMA FIRM panel 080046088H designates the South Platte River as a FEMA Flood Zone AE and is defined at the river crossing. A FEMA Flood Zone AE is defined as an area located within the 100-year floodplain with calculated Base Flood Elevations (BFEs). **Appendix B** includes the FIRM panel for the South Platte River crossing. The BFEs for the two outfall locations discharging into the South Platte River were referenced from the Flood Insurance Study (FIS) for the City and County of Denver, Colorado, Volume 1, revised in November 2013. These BFEs were used as tailwater boundary conditions for the proposed onsite

and offsite storm drains. The necessary reference material is included in **Appendix E. Figure 2-1**, below, shows the Sand Creek Flood Zones.

Figure 2-1 South Platte River FIRMette



2.7.2. Sand Creek Floodplain

FEMA FIRM panel 0800460094H designates multiple FEMA flood zones for the Sand Creek, including Zone A, Zone AO, and Zone AE. A FEMA flood Zone A is defined as an area located within the 100-year floodplain without calculated BFEs. A FEMA flood Zone AO is defined as an area located within the 100-year floodplain where shallow flooding (one to three feet deep) will occur. A FEMA flood Zone AE is defined as an area located within the 100-year floodplain with calculated BFEs. **Figure 2-2**, below, shows the Sand Creek Flood Zones.

Figure 2-2 Sand Creek FIRMette

2.8. Scour Analysis

Analysis of erosion and scour at bridges and swales will be performed per HEC-14 and HEC-18 criteria by the Developer. The countermeasures for scour will be designed per HEC-23 by the Developer.

2.9. Bank Stabilization

Erosion, scour analysis, and outlet protection will be designed in accordance with CDOT, UDFCD, and Federal Highway Administration (FHWA) standards.

3. Roadway Drainage Systems

3.1. General Discussion

The proposed roadway drainage systems for collections and conveyance of stormwater will be a significant improvement over the existing roadway drainage system. The proposed roadway drainage improvements include inlets, pipes, roadside ditches, water quality ponds, and flood control detention basins.

3.2. Drainage Basin Delineations and Characterizations

Existing basins were not evaluated. Due to the nature of the project, the existing roadway and drainage system will be completely replaced; therefore, existing basins are obsolete. Proposed basins were delineated within the ROW limits for the ultimate configuration from Brighton Boulevard to Quebec Street. For the section of I-70 East to the east of Quebec Street, the design is based on the proposed widening and not ultimate configuration.

3.3. Hydrology and Design Flow Development

The drainage basins were delineated based on the roadway design. The Rational Method was used to calculate the peak flow. The hydrologic parameters used in the Rational Method are rainfall data, C-value, and time of concentration (Tc). Runoff computations have been prepared for the10-year minor storm and the 100-year major storm frequencies. A single rainfall distribution was used for the hydrologic analysis and was developed based on the criteria stated in Chapter 4 of the Urban Storm Drainage Criteria Manual. The rainfall distribution is presented in Schedule 12, Section 8 of the procurement documents.

3.4. Pavement, Median, and Roadside Drainage

Bentleys Inroads Storm and Sanitary model software was used to calculate the proposed pipe flow, Hydraulic Grade Line (HGL), and catch basins. The Inroads Storm and Sanitary model is included in the reference material in Schedule 29 of the Procurement Documents.

3.4.1. Inlet/Catch Basin Spacing Design

Schedule 10, Section 8 of the Procurement Documents states that the minor storm will be the 10-year storm event and the major storm will be the 100-year storm event. **Table 3-1**, below, is a summary of the spread criteria used for I-70 East. The spread criteria also are presented in Schedule 10, Section 8 of the Procurement Documents. The spread criteria for side streets are located out of CDOT ROW and will follow the local agencies' criteria.

Table 3-1 Spread Criteria

Road Classification		Design Frequency	Allowable Spread into Travel Lane
I-70 Mainline		10 year	0 feet
		100 year	4 feet
I-70 Mainline Entrance/Exit Ramps and CDOT Roadways	< or = 45 mph	10 year	3 feet
	< or = 45 mph	100 year	Half of adjacent travel lane
	> 45 mph	10 year	0 feet
	> 45 mph	100 year	4 feet
Local Agency Roadway		Local Agency Criteria	

3.4.2. Storm Drain Design

The necessary storm drain network recommends draining the proposed improvements included with I-70 East. The Bentleys Inroads Storm and Sanitary model software was used to calculate the proposed pipe flow, HGL, and catch basins. The Inroads Storm and Sanitary model is included in the reference material in Schedule 29 of the Procurement Documents. In many locations, proposed storm drain systems tie into existing storm drain systems. **Table 3-2**, below, includes a summary of the proposed connections that will be the responsibility of the Developer to coordinate with the local agencies.

Table 3-2 Storm Drain Connection Summary

Location	Station	Tie-in: Prop. to Existing (PE) or Existing to Prop. (EP)	Connection	Upstream Pipe	Downstream Pipe
Brighton Blvd: Outfall to proposed drainage pond (Brighton West)	2003+00, 208' RT	EP	Manhole	18" RCP	18" RCP
Brighton Blvd: intersection with E 47th Ave	2005+85, 670' LT	PE	Manhole	18" RCP, 21" RCP, 12" PVC	21" RCP
Brighton Blvd: intersectoin with E 47th Ave	2006+20, 670' LT	PE	Manhole	18" RCP, 21" RCP, 15" RCP	21" RCP
Race St: intersection with E 47th Ave	2015+20, 600' LT	PE	Junction	54" RCP, 78" RCP	72" RCP
York St: intersection with 46th Ave N	2026+40, 150' LT	PE	Junction	72" RCP	72" RCP
York St: intersection with 47th Ave	2026+00, 580' LT	PE	Manhole	18" RCP	78" RCP
York St: intersection with E 45th Ave, drains to proposed drainage pond (York East)	2027+50, 520' RT	EP	Manhole	60" RCP	60" RCP
Steele St: intersection with E 45th Ave	2052+40, 520' RT	PE	Manhole	54" RCP, 18" RCP, 18" RCP	54" RCP
Steele St: intersection with E 45th Ave	2052+85, 520' RT	PE	Manhole	18" RCP, 18" RCP	60" RCP
Steele St: intersection with E 45th Ave	2053+20, 500' RT	PE	Manhole	24" RCP, 48" RCP, 60" RCP	48" RCP
Steele St: intersection with E 45th Ave	2053+75, 500' RT	PE	Manhole	18" RCP, 18" RCP	48" RCP
Velasquez Blvd: 240' NE of intersection with E 47th Ave	2055+80, 730' LT	EP	Manhole	10" RCP, unk.	18" RCP
Velasquez Blvd: Drains to proposed drainage pond (Steele North)	2055+80, 430' LT	EP	Manhole	3 x RCP, unknown size	18" RCP
Adams St: intersection with E 45th Ave	2056+40, 500' RT	EP	Manhole	48" RCP, 15" RCP	18" RCP (48" RCP DS pipe to be capped)

Location	Station	Tie-in: Prop. to Existing (PE) or Existing to Prop. (EP)	Connection	Upstream Pipe	Downstream Pipe
E 45th Ave: between Adams St & Cook St	2057+50, 500' RT	PE	Manhole	24" RCP, 24" RCP, 48" RCP	48" RCP
Colorado Blvd: 1100' N of north ramp intersection	2079+65, 1165' LT	PE	Manhole	72" RCP, 24" RCP	72" RCP
I-70 WB	2090+10, 170' LT	PE	Manhole	30" RCP, 24" RCP, 18" RCP	48" RCP
I-70 EB: Proposed drainage – drains Safeway	2088+25, 140' RT	EP	Junction	27" RCP	20' x 5' CBC
I-70 EB: Proposed drainage – drains Safeway	2090+55, 130' RT	EP	Junction	Unk.	20' x 5' CBC
I-70 EB: Proposed drainage – drains Safeway	2094+00, 140' RT	EP	Junction	24" RCP	16' x 5' CBC
I-70 EB: Proposed drainage – drains Safeway	2098+00, 120' RT	EP	Junction	15" RCP	12' x 4' CBC
I-70 EB: Proposed drainage – drains Safeway	2098+60, 125' RT	EP	Junction	Unk.	18" RCP
I-70 EB: Stapleton Drive S	2114+10, 125' RT	EP	Inlet	N/A	18" RCP
Forest St: intersection with Stapleton Dr S	2118+15, 180' RT	PE	Inlet	N/A	36" RCP
Forest St: intersection with Stapleton Dr S	2118+40, 180' RT	EP	Manhole	36" RCP, 18" RCP	24" RCP
Forest St: intersection with Stapleton Dr S	2118+55, 180' RT	PE	Inlet	N/A	18" RCP
Forest St: intersection with Stapleton Dr N	2117+60, 165' LT	PE	Manhole	24" RCP, 18" RCP, 108" RCP	108" RCP
Grape St: intersectoin with Stapleton Dr N	2124+45, 140' LT	PE	Manhole	24" RCP, 72" RCP	72" RCP
Stapleton Dr S: 500' E of intersection with Grape St	2128+50, 150' RT	EP	Manhole	Unk., 18" RCP, 48" RCP	72" RCP
Holly St: 360' N of intersection with Stapleton Drive N	2131+30, 480' LT	PE	Inlet	N/A	24" RCP

Location	Station	Tie-in: Prop. to Existing (PE) or Existing to Prop. (EP)	Connection	Upstream Pipe	Downstream Pipe
Monaco St: intersection with Stapleton Drive S	2158+00, 145’ RT	PE	Manhole	18” RCP	36” RCP
Stapleton Dr S: 800’ E of intersection with Monaco St	2164+85, 135’ RT	EP	N/A	12” VCP, 36” RCP	42” RCP
Airlawn Rd: intersection with Stapleton Dr S	2175+30, 185’ RT	PE	Manhole	18” RCP, 48” RCP	48” RCP
Quebec St WB exit ramp: 200’ N of WB I-70	2187+90, 160’ LT	PE	Inlet	48” RCP, 48” RCP	54” RCP
I-270 EB Connector: 65’ N of WB I-70	2200+10, 135’ LT	PE	Inlet	N/A	24” CMP
I-270 EB Connector: 215’ S of EB I-70	2206+40, 240’ RT	PE	Inlet	N/A	24” CMP

3.4.3. Roadside Ditch and Channel Design

The majority of I-70 East to the east of Quebec Street drains to a road side ditch or swale. A digital copy of the swale calculations are included in Schedule 29 of the Procurement Documents.

To the south of the proposed I-270 flyover, the Sand Creek overflow channel is narrowed from its existing geometry. A preliminary HEC-RAS model for the proposed design of the channel is included with the reference material in Schedule 29 of the Procurement Documents.

3.4.4. Detention Pond Design

The proposed 13 detention basin locations and functions are summarized below in **Table 3-3**. The ponds are designed in accordance with CDOT and UDFCD criteria. All detention basins and flood control measures are designed for the 100-year storm event and are modeled in EPA SWMM5.

EDBs were designed in accordance with CDOT and UDFCD criteria. EDBs were designed with 4:1 side slopes, a 10-foot-wide berm around the perimeter, 10:1 maintenance access down to pond bottom, a six-foot trickle channel (0.5 percent minimum slope), micropool, and forebay. This level of preliminary design was required to determine the necessary footprint of the ponds and to facilitate the necessary property acquisition for these permanent best management practice (BMP) features. The outlet structures have not been designed and will require further analysis by the Concessionaire.

Table 3-3 Summary Water Quality and Detention Ponds

Design Location	Station	Facility Type
Brighton West	2000+00	Flood Control Pond
Brighton East	2012+00	Flood Control Pond
York East	2028+00	Flood Control Pond
Steele West	2050+00	Flood Control Pond
Steele East	2055+00	Flood Control Pond
Steele North	2055+00	Flood Control Pond
Colorado North	2080+00	Flood Control Pond
Colorado South	2080+00	Flood Control Pond
Quebec North	2185+00	Water Quality Pond
Havana North#1	2292+00	Water Quality Pond
Havana North#2	2292+00	Detention Pond
Havana South	2292+00	Water Quality and Detention Pond
Onsite North	Race Court and Brighton Boulevard	Water Quality and Detention Pond

4. Permanent Stormwater Quality Facilities

4.1. Assumptions and Methodologies

There are limited water quality treatment facilities within the project limits. New or improved water quality treatment facilities are needed to treat runoff from the increased impervious area that will be created by this project. New ROW will be required for the flood control pond at the outfall of the PCL section. The other Permanent Water Quality Treatment Facilities (PWQTFs) will be within existing ROW. The recommended PWQTFs will adhere to CDOT's Municipal Separate Storm Sewer System (MS4) permit.

This section of I-70 located between Brighton Boulevard and Chambers Road currently does not have the water quality treatment facilities necessary to treat the runoff from the increased impervious area from this project. See **Table 4-1**, below, for changes to impervious area and the resultant Water Quality Capture Volume (WQCV) needed to treat. For more details, see the Draft Master Water Quality Report included in Schedule 29 of the Procurement Documents.

Table 4-1 Summary of Impervious Area

Changes to Impervious Area and WQCV from I-70 Improvements								
	Impervious Area (acres)			90% of Δ Area (acre)		Water Quality Capture Volume (acre-ft)		
Drains to	Existing	Proposed	Ultimate	Proposed	Ultimate	Proposed	Ultimate	Total
South Platte Directly	53.6	84.2	84.2	27.6	0.0	1.4	0.0	1.4
Sand Creek (fr. West)	36.9	67.1	67.4	27.2	0.3	1.4	0.0	1.4
Sand Creek (fr. East)	74.9	85.9	110.8	10.0	22.4	0.5	1.1	1.6
Irondale Gulch	55.6	59.1	72.4	3.1	12.0	0.2	0.6	0.8

The method of treatment will be provided with EDBs. The permanent BMP facilities are summarized in **Table 3-3** in the previous section.

4.2. Hydrology and Hydraulics

On January 8, 2015, the Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division issued a statement regarding required water quality treatment. A meeting was held on January 30, 2015, for clarification of water quality treatment requirements under CDOT's MS4. Per this meeting:

- WQCV Standard: The WQCV generated by 90% of the new impervious area would be calculated using the UDFCD method.
- Pollutant Removal Standard: The Control Measure must remove 80% of the Total Suspended Solids (TSS).
- Infiltration Standard: The infiltration Control Measure must capture and infiltrate 70% of the WQCV.

This project is divided into three segments for water quality treatment based on where the drainage will outfall. See **Table 4-2**, below, for segment descriptions.

Table 4-2 Stream Segments

Segment ID	Stream	I-70 East Segment	Pollutant
COSPUS14_0600	South Platte River	Segment 1	Arsenic, *Escherichia Coli*
COSPUS16A_00	Sand Creek	Segment 2	*Escherichia Coli*, Selenium
Tributary to the South Platte River	Irondale Gulch	Segment 3	Ammonia, Un-ionized Cadmium, *Escherichia Coli*, Nitrate/Nitrite (Nitrite + Nitrate as N)* (*for discharge to the South Platte River)

To satisfy CDOT's permit requirements, WQCV will have to be treated within the project limits. Each outfall is designated for a Section 303(d) listed stream; therefore, water quality treatment must occur within the drainage basin, since no equivalencies will be allowed outside of the basin to each Section 303(d) impaired stream.

5. References

1. BNSF Railway-Union Pacific Railroad, *Guidelines for Railroad Grade Separation Projects*, 2007.
2. CCD 2010, CE00024 Park Hill Storm Phase IV /51st and St Paul Sanitary Drainage Narrative. May 2010.
3. CCD 2014, City and County of Denver Storm Drainage Master Plan, September 2014
4. Colorado Department of Transportation, I-70 East Final Environmental Impact Statement.
5. Colorado Department of Transportation, Drainage Design Manual, 2004.
6. David Evans and Associates 2011, Final – Hydraulic Design Report for I-70 Over Sand Creek, March 2011
7. Enginuity, 2014a, *I-70 PCL Montclair Drainage Basin Hydrologic Analysis*, February 2014.
8. Enginuity, 2014b, *I-70 PCL Park Hill Drainage Basin Hydrologic Analysis*, Email.
9. Environmental Protection Agency, *Storm Water Management Model User's Manual Version 5.0*, 2010
10. FEMA 2013, Flood Insurance Study, City and County of Denver, Colorado volume 1 and 2 (020045V001B), November 2013
11. Natural Resources Conservation Service Online Soil Survey, *Colorado*, 2012
12. Olsson Associates 2009, Baranmor Ditch Watershed outfall System Plan. October 2009
13. U.S. Department of Transportation, Federal Highway Administration, *Hydraulic Design Series No. 5, Hydraulic Design of Highway Culverts,* 1998
14. Urban Drainage and Flood Control District, *Urban Storm Drainage, Criteria Manual, Volume 3*, 2010.
15. Urban Drainage and Flood Control District, *CUHP 2005 User Manual, Criteria Version 1.4.0*, 2013.
16. SHE 2015, Brighton Boulevard Preliminary Design: 44th Street to Race Court
17. State of Colorado, *Dam Safety Manual*, January 2002
18. TSH 2015, Final Drainage Report For I-70 Over Havana Street Design-Build, May 2015
19. WHPacific, 2012, *High Street Outfall and 40th Avenue Storm Sewer System, S. Platte River to Blake Street Final Design Report,* April 2013
20. Wilson & Company 2010, Final Drainage Report for Central Park Boulevard Interchange with I-70, May 2010.

Appendix

A. Hydrologic Calculations

B. Hydraulics

C. Permanent Stormwater Quality Facilities

D. Basin Maps

E. Reference Materials

A. Hydrologic Calculations

A.1 CUHP Summary Table

A.2 CUHP

A.2.a Onsite Outfall

A.2.b I-70 East Offsite

A.2.c I-70 East of Sand Creek

A.3 Flow Split

A.3.a York Street Split

A.3.b Dahlia Street Split

A.4 Soils Map

A.1 CUHP Summary Table

System	CUHP File	CUHP interface
Onsite Outfall	PCL.xlsm	PCL-out.txt
Steele-Vasquez_to_South_Platte	I-70East_offsite_133_1.xlsm	I-70East_SV.txt
Park Hill without Golf Course pond	4400-02-100.chi	ParkHill_WO_GolfCourseBypass.txt
Park Hill - Colorado Ponds	I-70East_offsite_133_1.xlsm	I-70East_SV.txt
Southwest Quebec	I70_East_of_Sand_Creek_Cuhp133_1.xlsm	I70_East-East_of_Sand_Creek-100_Year.txt
Havana through Central Park Blvd	I70_East_of_Sand_Creek_Cuhp133_1.xlsm	I70_East-East_of_Sand_Creek-100_Year.txt

4400-02-100.chi is not included. This is the Park Hill CUHP file from Multi-Agency Technical Team/Denver Master Plan, which was not modified for the I-70 East drainage analyses.

A.2 CUHP

A.2.a Onsite Outfall

CUHP Input for Partially Covered Lower Region

Summary of CUHP Input Parameters (Version 1.3.3)

							Storage		Parameters			DCIA Level and Fractions			
Catchment Name/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
PCL-1	100_YEAR _ONSITE	0.049	0.595	1.140	0.015	100.0	0.35	0.10	3.00	0.50	0.0018	0.00	1.00	0.40	100.00
PCL-2	100_YEAR _ONSITE	0.017	0.223	0.390	0.015	100.0	0.35	0.10	3.00	0.50	0.0018	0.00	1.00	0.40	100.00

CUHP Output for Partially Covered Lower Region

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.3.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph		
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)
PCL-1		0.121	0.539	23.9	8.36	12.4	5.59	19.0	61	113,409	2.76	313,046	45.0	91	312,770
PCL-2		0.168	0.461	14.5	5.06	7.5	3.38	11.0	35	39,532	2.76	109,120	40.0	41	108,137

A.2 CUHP

A.2.b I-70 East Offsite

CUHP Input for Steele/Vasquez to Dahlia

Summary of CUHP Input Parameters (Version 1.3.3)

							Depression		Horton's Infiltration			DCIA Level and Fractions			
Catchment Name/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
1-70_1	100_YEAR	0.132	0.358	0.627	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12
1-70_2A	100_YEAR	0.037	0.207	0.405	0.010	53.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.87	0.24	51.62
1-70_2B	100_YEAR	0.059	0.211	0.436	0.010	53.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.87	0.24	51.62
1-70_3A	100_YEAR	0.089	0.301	0.602	0.008	51.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.86	0.23	49.59
1-70_3B	100_YEAR	0.027	0.233	0.442	0.008	51.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.86	0.23	49.59
1-70_4	100_YEAR	0.180	0.373	0.766	0.004	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12
I-70RC6	100_YEAR	0.069	0.228	0.471	0.016	68.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.29	66.89
I-70RC7	100_YEAR	0.082	0.309	0.597	0.003	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12
I-70RC1	100_YEAR	0.111	0.194	1.097	0.002	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12
I-70RC5	100_YEAR	0.017	0.253	0.474	0.012	100.0	0.35	0.10	3.00	0.50	0.0018	0.00	1.00	0.40	100.00
I-70RC3	100_YEAR	0.021	0.273	0.418	0.006	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12
I-70RC4	100_YEAR	0.019	0.158	0.317	0.011	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12
I-70RC2	100_YEAR	0.104	0.347	0.691	0.007	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12
NE_SV	100_YEAR	0.029	0.130	0.289	0.016	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.12

CUHP Output for Steele/Vasquez to Dahlia

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.3.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph		
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)
1-70_1		0.094	0.587	11.1	3.87	5.7	2.59	10.8	359	307,023	2.52	773,968	35.0	353	776,466
1-70_2A		0.158	0.388	17.7	6.19	9.2	4.14	11.3	63	85,712	2.20	188,712	40.0	72	188,870
1-70_2B		0.137	0.417	14.9	5.22	7.8	3.49	10.5	119	137,603	2.20	302,960	40.0	124	299,967
1-70_3A		0.121	0.431	18.8	6.57	9.8	4.39	12.9	143	207,831	2.18	452,719	40.0	168	451,996
1-70_3B		0.175	0.361	24.7	8.34	12.8	5.89	13.9	33	63,558	2.18	138,449	45.0	42	138,169
1-70_4		0.086	0.614	13.3	4.66	6.9	3.11	13.0	405	417,646	2.52	1,052,837	40.0	456	1,059,207
I-70RC6		0.121	0.495	10.6	3.70	5.5	2.48	9.2	194	159,225	2.38	378,698	35.0	187	375,545
I-70RC7		0.109	0.546	16.5	5.78	8.6	3.86	14.0	150	191,241	2.52	482,096	40.0	182	481,047
I-70RC1		0.099	0.572	16.4	5.75	8.6	3.85	14.5	203	257,961	2.52	650,290	40.0	243	646,389
I-70RC5		0.167	0.461	17.7	6.21	9.2	4.15	13.0	29	39,968	2.76	110,325	40.0	39	110,477
I-70RC3		0.166	0.445	20.8	7.28	10.8	4.87	14.4	30	48,778	2.52	122,963	40.0	40	122,601
I-70RC4		0.172	0.438	13.0	4.55	6.8	3.04	9.8	43	43,811	2.52	110,442	35.0	47	109,906
I-70RC2		0.101	0.566	14.1	4.94	7.3	3.30	12.7	220	241,023	2.52	607,590	40.0	254	612,017
NE_SV		0.150	0.468	8.3	2.91	4.3	1.95	7.5	106	68,421	2.52	172,481	35.0	87	165,806

A.2 CUHP

A.2.c I-70 East of Sand Creek

CUHP Input for Regions East of Sand Creek

Summary of CUHP Input Parameters (Version 1.3.3)

							Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
10	100YR	0.057	0.560	1.400	0.008	65.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	63.84
20	100YR	0.101	0.650	1.300	0.010	65.5	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	64.35
21	100YR	0.005	0.071	0.100	0.019	59.2	0.35	0.10	4.50	0.60	0.0018	0.00	0.90	0.27	57.98
30	100YR	0.298	0.457	0.915	0.011	55.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.88	0.25	53.65
40	100YR	0.029	0.305	0.564	0.005	38.5	0.35	0.10	4.50	0.60	0.0018	0.00	0.77	0.20	36.87
41	100YR	0.006	0.055	0.113	0.015	15.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.30	0.12	13.36
42	100YR	0.005	0.080	0.201	0.014	75.4	0.35	0.10	4.50	0.60	0.0018	0.00	0.93	0.32	74.36
43	100YR	0.002	0.046	0.100	0.012	35.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.70	0.19	33.20
50a	100YR	0.016	0.116	0.241	0.008	31.7	0.35	0.10	4.50	0.60	0.0018	0.00	0.63	0.18	29.77
50b	100YR	0.009	0.038	0.120	0.007	48.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.84	0.22	46.51
53	100YR	0.003	0.019	0.083	0.015	72.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.92	0.31	70.97
60	100YR	0.048	0.468	0.660	0.007	36.1	0.35	0.10	4.50	0.60	0.0018	0.00	0.72	0.19	34.31
61a	100YR	0.011	0.084	0.143	0.005	54.6	0.35	0.10	4.50	0.60	0.0018	0.00	0.87	0.25	53.29
61b	100YR	0.004	0.043	0.073	0.031	37.8	0.35	0.10	4.50	0.60	0.0018	0.00	0.76	0.19	36.10
62	100YR	0.028	0.050	0.238	0.008	42.4	0.35	0.10	4.50	0.60	0.0018	0.00	0.81	0.21	40.85
63	100YR	0.004	0.058	0.155	0.012	64.8	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.28	63.60
65a	100YR	0.003	0.094	0.172	0.012	66.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	64.88
65b	100YR	0.005	0.092	0.231	0.010	20.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.40	0.13	18.19
66	100YR	0.011	0.100	0.180	0.004	52.6	0.35	0.10	4.50	0.60	0.0018	0.00	0.86	0.24	51.25
68	100YR	0.004	0.041	0.112	0.014	73.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.93	0.31	71.96
70	100YR	0.007	0.060	0.118	0.005	48.8	0.35	0.10	4.50	0.60	0.0018	0.00	0.84	0.23	47.37
72	100YR	0.021	0.214	0.510	0.004	31.3	0.35	0.10	4.50	0.60	0.0018	0.00	0.63	0.17	29.37
73	100YR	0.002	0.059	0.085	0.016	45.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.83	0.22	43.50
74	100YR	0.011	0.338	0.602	0.007	40.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.80	0.20	38.48
75	100YR	0.005	0.055	0.110	0.026	30.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.60	0.17	28.07
77	100YR	0.002	0.027	0.070	0.035	40.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.80	0.20	38.48
78	100YR	0.006	0.029	0.099	0.011	30.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.60	0.17	28.07
80	100YR	0.109	0.443	0.885	0.008	90.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.96	0.37	89.41
90	100YR	0.010	0.177	0.328	0.006	50.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.85	0.23	48.56
225A	100YR	0.008	0.249	0.149	0.003	54.6	0.35	0.10	4.50	0.60	0.0018	0.00	0.87	0.25	53.28
225B	100YR	0.020	0.280	0.126	0.017	50.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.85	0.23	48.60
225C	100YR	0.281	0.861	0.404	0.004	73.5	0.35	0.10	4.50	0.60	0.0018	0.00	0.93	0.31	72.43
225D	100YR	0.401	1.066	0.473	0.005	85.4	0.35	0.10	4.50	0.60	0.0018	0.00	0.95	0.35	84.62
225E	100YR	0.024	0.744	0.387	0.006	65.9	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	64.75

CUHP Input for Regions East of Sand Creek

Summary of CUHP Input Parameters (Version 1.3.3)

							Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
225F	100YR	0.021	0.239	0.131	0.010	65.9	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	64.75
225G	100YR	0.014	0.181	0.081	0.023	35.1	0.35	0.10	4.50	0.60	0.0018	0.00	0.70	0.19	33.32
225H	100YR	0.012	0.199	0.066	0.005	66.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.29	64.80
225I	100YR	0.007	0.161	0.054	0.009	51.6	0.35	0.10	4.50	0.60	0.0018	0.00	0.86	0.24	50.14
225J	100YR	0.013	0.369	0.185	0.007	51.6	0.35	0.10	4.50	0.60	0.0018	0.00	0.86	0.24	50.14
225K	100YR	0.008	0.252	0.126	0.006	96.8	0.35	0.10	4.50	0.60	0.0018	0.00	0.99	0.39	96.55
IG010	100YR	0.016	0.295	0.128	0.008	29.4	0.35	0.10	4.50	0.60	0.0018	0.00	0.59	0.17	27.42
IG020	100YR	0.006	0.220	0.098	0.015	21.7	0.35	0.10	4.50	0.60	0.0018	0.00	0.43	0.14	19.88
IG030	100YR	0.010	0.317	0.132	0.005	64.3	0.35	0.10	4.50	0.60	0.0018	0.00	0.91	0.28	63.16
IG040	100YR	0.023	0.214	0.071	0.016	73.1	0.35	0.10	4.50	0.60	0.0018	0.00	0.93	0.31	72.10
IG050	100YR	0.068	0.473	0.126	0.003	86.8	0.35	0.10	4.50	0.60	0.0018	0.00	0.95	0.36	86.14
IG060	100YR	0.007	0.208	0.092	0.019	36.4	0.35	0.10	4.50	0.60	0.0018	0.00	0.73	0.19	34.64
IG065	100YR	0.013	0.197	0.089	0.026	29.4	0.35	0.10	4.50	0.60	0.0018	0.00	0.59	0.17	27.44
IG070	100YR	0.014	0.406	0.214	0.005	55.6	0.35	0.10	4.50	0.60	0.0018	0.00	0.88	0.25	54.23
IG080	100YR	0.008	0.212	0.103	0.031	38.7	0.35	0.10	4.50	0.60	0.0018	0.00	0.77	0.20	37.09
IG090	100YR	0.008	0.253	0.124	0.002	86.7	0.35	0.10	4.50	0.60	0.0018	0.00	0.95	0.36	86.00
IG100	100YR	0.010	0.167	0.067	0.008	81.5	0.35	0.10	4.50	0.60	0.0018	0.00	0.94	0.34	80.61
IG110	100YR	0.006	0.194	0.049	0.017	78.7	0.35	0.10	4.50	0.60	0.0018	0.00	0.94	0.33	77.80
IG120	100YR	0.006	0.242	0.133	0.009	79.2	0.35	0.10	4.50	0.60	0.0018	0.00	0.94	0.33	78.27
IG130	100YR	0.011	0.215	0.102	0.022	88.9	0.35	0.10	4.50	0.60	0.0018	0.00	0.96	0.37	88.28
IG200	100YR	0.008	0.191	0.087	0.033	51.3	0.35	0.10	4.50	0.60	0.0018	0.00	0.86	0.24	49.86
IG210	100YR	0.007	0.184	0.058	0.013	50.5	0.35	0.10	4.50	0.60	0.0018	0.00	0.85	0.23	49.06
IG220	100YR	0.009	0.272	0.144	0.010	81.9	0.35	0.10	4.50	0.60	0.0018	0.00	0.94	0.34	81.11
11	100YR	0.015	0.050	0.100	0.011	40.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.80	0.20	38.48
SC010	100YR	0.029	0.231	0.423	0.005	67.9	0.35	0.10	4.50	0.60	0.0018	0.00	0.92	0.29	66.81
SC020	100YR	0.009	0.083	0.189	0.017	52.4	0.35	0.10	4.50	0.60	0.0018	0.00	0.86	0.24	50.98
SC030	100YR	0.008	0.041	0.152	0.024	45.1	0.35	0.10	4.50	0.60	0.0018	0.00	0.83	0.22	43.57
SC040	100YR	0.029	0.211	0.478	0.008	51.3	0.35	0.10	4.50	0.60	0.0018	0.00	0.86	0.24	49.87
SC700	100YR	0.293	1.171	0.574	0.006	72.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.31	71.42
SC705	100YR	0.055	0.743	0.372	0.008	92.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.97	0.38	91.64
SC710	100YR	0.015	0.251	0.116	0.026	100.0	0.35	0.10	3.00	0.50	0.0018	0.00	1.00	0.40	100.00
SC720	100YR	0.020	0.332	0.134	0.021	53.2	0.35	0.10	3.00	0.50	0.0018	0.00	0.87	0.24	51.81
SC730	100YR	0.008	0.135	0.073	0.049	37.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.74	0.19	35.29

CUHP Output for Regions East of Sand Creek

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.3.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph		
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)
10		0.130	0.471	36.7	12.85	19.1	8.59	24.6	47	132,422	2.25	297,354	55.0	70	296,980
20		0.109	0.515	27.6	9.64	14.3	6.45	20.7	110	234,643	2.25	528,482	50.0	151	528,428
21		0.284	0.310	10.4	3.63	5.4	2.43	6.6	14	11,616	2.17	25,181	35.0	12	24,897
30		0.087	0.545	14.5	5.06	7.5	3.38	12.6	619	692,314	2.11	1,460,669	40.0	646	1,469,418
40		0.184	0.281	47.1	11.67	24.5	8.25	19.5	18	67,373	1.89	127,199	55.0	26	127,122
41		0.382	0.136	31.5	4.78	16.4	3.38	8.0	6	13,939	1.58	22,032	45.0	6	21,966
42		0.264	0.351	13.6	4.75	7.1	3.17	8.6	11	11,616	2.39	27,707	35.0	12	27,689
43		0.433	0.170	26.0	4.90	13.5	3.46	8.2	2	4,646	1.84	8,557	40.0	3	8,534
50a		0.234	0.213	29.4	6.31	15.3	4.46	10.5	16	37,171	1.80	66,817	45.0	19	66,822
50b		0.252	0.292	10.0	3.50	5.2	2.34	6.2	27	20,909	2.01	42,121	35.0	22	41,742
53		0.314	0.318	5.7	2.00	3.0	1.34	4.8	16	6,970	2.34	16,309	30.0	11	17,577
60		0.160	0.283	49.8	12.30	25.9	8.69	20.5	29	111,514	1.86	206,937	55.0	41	206,984
61a		0.228	0.331	13.8	4.83	7.2	3.23	8.3	24	25,555	2.10	53,793	35.0	24	53,649
61b		0.342	0.204	11.4	3.28	5.9	2.32	5.5	11	9,293	1.88	17,455	35.0	9	17,093
62		0.182	0.312	10.4	3.63	5.4	2.43	6.6	82	66,022	1.94	128,055	35.0	67	126,586
63		0.297	0.315	13.3	4.65	6.9	3.11	7.9	9	9,293	2.24	20,838	35.0	9	20,716
65a		0.322	0.305	19.8	6.13	10.3	4.33	10.2	5	6,970	2.26	15,746	40.0	5	15,710
65b		0.379	0.140	60.2	7.99	31.3	5.65	13.3	2	11,616	1.65	19,116	55.0	3	19,104
66		0.231	0.322	18.3	6.04	9.5	4.27	10.1	18	25,555	2.08	53,096	40.0	19	52,906
68		0.286	0.334	8.4	2.95	4.4	1.97	6.1	14	9,293	2.35	21,867	35.0	12	22,198
70		0.271	0.285	14.8	4.73	7.7	3.34	7.9	14	16,262	2.03	32,946	35.0	14	32,861
72		0.215	0.220	59.7	11.58	31.0	8.18	19.3	11	48,787	1.79	87,440	60.0	15	87,434
73		0.408	0.221	18.4	4.62	9.6	3.26	7.7	3	4,646	1.97	9,175	35.0	3	9,126
74		0.247	0.254	69.8	15.12	36.3	10.68	25.2	5	25,555	1.91	48,761	65.0	7	48,743
75		0.340	0.172	19.2	4.03	10.0	2.85	6.7	8	11,616	1.78	20,624	35.0	8	20,516
77		0.419	0.197	11.0	3.16	5.7	2.23	5.3	5	4,646	1.91	8,866	35.0	4	8,679
78		0.321	0.176	15.2	3.56	7.9	2.51	5.9	12	13,939	1.78	24,748	35.0	11	24,564
80		0.097	0.593	15.5	5.44	8.1	3.64	14.3	210	253,229	2.59	655,230	40.0	251	651,591
90		0.241	0.306	32.1	9.05	16.7	6.40	15.1	9	23,232	2.04	47,435	45.0	12	47,359
225A		0.254	0.314	31.4	9.07	16.3	6.41	15.1	7	18,067	2.10	38,029	45.0	10	37,934
225B		0.196	0.338	14.5	5.07	7.5	3.39	8.8	41	45,474	2.04	92,869	35.0	40	92,499
225C		0.079	0.634	13.7	4.79	7.1	3.20	13.6	616	652,861	2.36	1,540,301	40.0	666	1,542,951
225D		0.076	0.709	12.7	4.44	6.6	2.97	14.0	947	930,561	2.52	2,347,950	40.0	1,025	2,338,029
225E		0.169	0.417	35.1	12.29	18.3	8.21	21.2	21	56,462	2.26	127,472	50.0	31	127,485

CUHP Output for Regions East of Sand Creek

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 1.3.3)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph		
Catchment Name/ID	User Comment for Catchment	Ct	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)
225F		0.176	0.408	11.7	4.10	6.1	2.74	8.6	54	49,072	2.26	110,787	35.0	52	110,077
225G		0.237	0.229	15.8	4.28	8.2	3.02	7.1	27	32,529	1.84	59,955	35.0	26	59,755
225H		0.211	0.374	11.8	4.13	6.1	2.76	8.2	30	27,360	2.26	61,786	35.0	29	61,337
225I		0.264	0.298	13.0	4.48	6.8	3.16	7.5	17	16,805	2.06	34,666	35.0	16	34,479
225J		0.221	0.325	29.2	8.79	15.2	6.21	14.7	13	29,891	2.06	61,660	45.0	17	61,531
225K		0.213	0.408	15.9	5.58	8.3	3.73	10.8	15	18,588	2.68	49,850	40.0	18	49,513
IG010		0.240	0.201	37.4	7.27	19.5	5.14	12.1	13	36,471	1.77	64,446	45.0	15	64,435
IG020		0.360	0.147	50.3	7.16	26.2	5.06	11.9	3	12,897	1.67	21,514	50.0	4	21,509
IG030		0.225	0.360	22.3	7.67	11.6	5.42	12.8	13	22,975	2.24	51,384	40.0	17	51,314
IG040		0.166	0.435	6.5	2.27	3.4	1.52	6.1	106	53,475	2.35	125,931	30.0	75	129,257
IG050		0.113	0.546	10.3	3.59	5.3	2.40	9.7	199	158,186	2.54	402,357	35.0	194	401,398
IG060		0.290	0.214	24.6	5.54	12.8	3.92	9.2	9	16,359	1.86	30,425	40.0	10	30,375
IG065		0.252	0.196	20.8	4.63	10.8	3.27	7.7	19	31,125	1.77	55,006	40.0	20	54,679
IG070		0.212	0.345	31.6	9.89	16.4	6.99	16.5	13	31,649	2.12	67,019	45.0	17	66,926
IG080		0.275	0.233	20.3	5.13	10.6	3.63	8.6	12	18,500	1.89	34,979	40.0	12	34,813
IG090		0.217	0.398	20.9	7.33	10.9	4.90	13.2	12	19,264	2.54	48,962	40.0	16	48,889
IG100		0.208	0.402	8.9	3.12	4.6	2.09	7.1	34	23,483	2.47	57,988	35.0	29	56,943
IG110		0.252	0.363	9.3	3.25	4.8	2.17	6.8	18	12,984	2.43	31,570	35.0	16	31,236
IG120		0.242	0.371	18.0	6.30	9.4	4.21	11.0	11	14,792	2.44	36,060	40.0	13	36,084
IG130		0.199	0.417	9.0	3.13	4.7	2.10	7.3	36	24,818	2.57	63,840	35.0	31	62,061
IG200		0.259	0.300	12.9	4.47	6.7	3.16	7.4	18	18,034	2.06	37,135	35.0	17	36,908
IG210		0.266	0.293	13.5	4.54	7.0	3.21	7.6	16	16,680	2.05	34,168	35.0	15	34,078
IG220		0.213	0.397	15.9	5.55	8.3	3.71	10.6	17	21,447	2.48	53,104	40.0	20	52,619
11		0.224	0.266	9.2	3.21	4.8	2.14	5.6	49	34,848	1.91	66,492	35.0	37	65,786
SC010		0.159	0.434	19.7	6.89	10.2	4.61	13.4	44	66,607	2.28	152,190	40.0	53	152,074
SC020		0.247	0.311	13.5	4.73	7.0	3.34	7.9	20	20,565	2.07	42,656	35.0	19	42,630
SC030		0.264	0.273	9.7	3.38	5.0	2.26	5.9	25	18,947	1.98	37,431	35.0	20	36,954
SC040		0.172	0.366	23.3	8.06	12.1	5.70	13.4	37	67,601	2.06	139,206	40.0	45	138,687
SC700		0.080	0.635	16.8	5.89	8.8	3.94	16.2	521	679,906	2.40	1,630,994	45.0	619	1,624,940
SC705		0.119	0.538	17.7	6.20	9.2	4.14	14.7	93	127,471	2.63	335,599	40.0	117	333,165
SC710		0.176	0.450	8.0	2.80	4.2	1.87	7.1	55	33,991	2.73	92,705	35.0	45	90,624
SC720		0.191	0.355	14.4	5.04	7.5	3.37	9.1	42	46,455	2.17	100,897	35.0	43	100,528
SC730		0.277	0.222	13.2	3.75	6.9	2.65	6.2	18	18,675	1.98	37,030	35.0	17	36,480

A.3 Flow Split

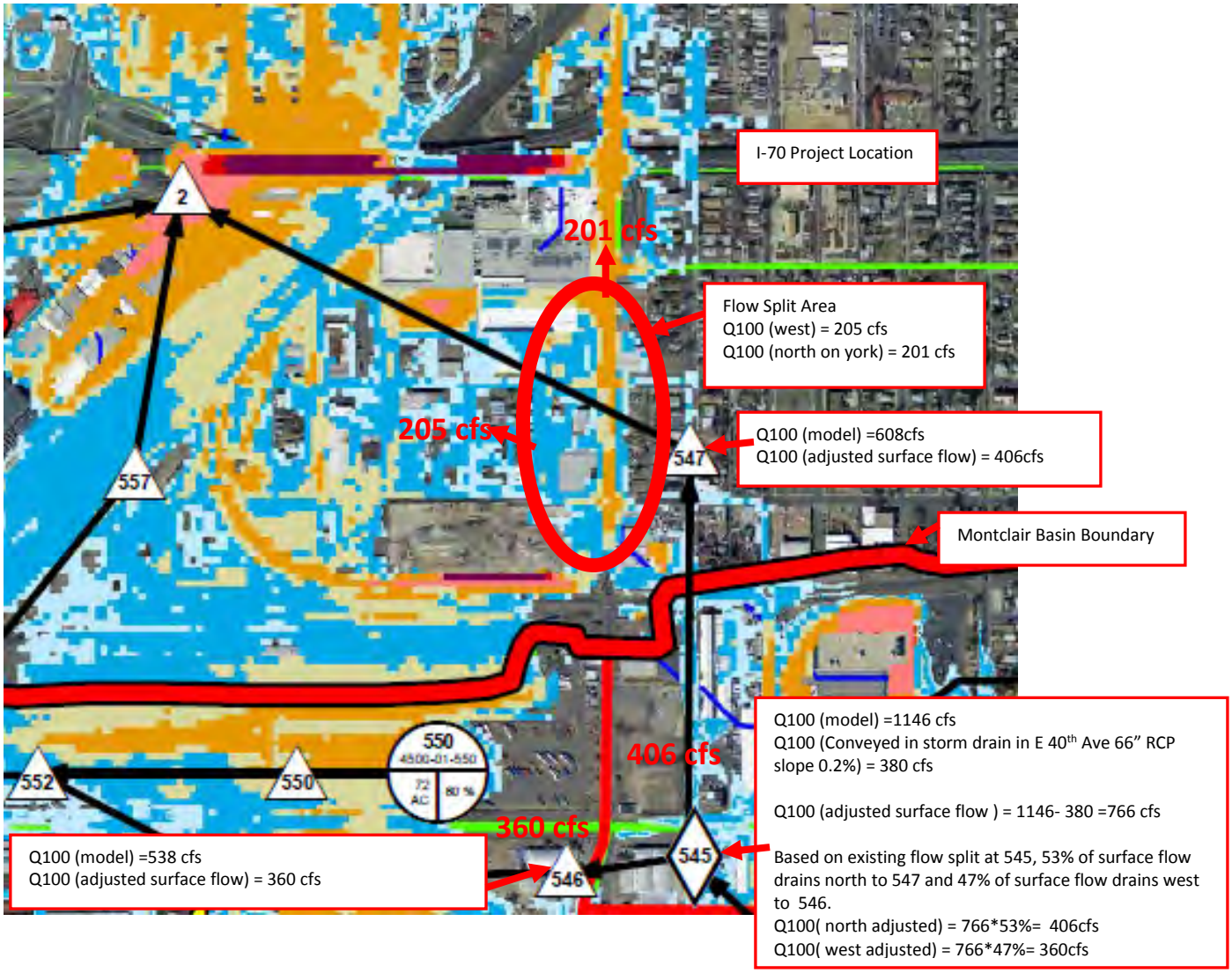
A.3.a York Street Split

Montclair Basin Flow Summary

Flow Description	100-Year Flow (cfs)
Total Montclair Basin Flow	4,655
120” Brick Pipe—Diverted to South Platte River	959
High Street Outfall (8’ x12’ CBC)—Diverted to South Platte River	1,364
***York Street—Flow draining north on York Street to Pond 6**	**201**

Flow split: Between 43rd Avenue and I-70 on York Street

The below snap shot is from the FLO-2D analysis developed by Enginuity for the Montclair Basin (*Memorandum for I-70 Partial Cover Lowered Montclair Drainage Basin Hydrologic Analysis* (Enginuity, 2014a). The snap shot below shows the 100 year flows draining to York Street. The flow split calculation takes into account the 380 cfs conveyed in the existing 66" RCP storm drain in 40th Avenue. Based on a flow master cross section of York Street it is concluded that **201 cfs** is conveyed to the north in York Steet and the remaining **205 cfs** will drain to the west.



WEIR CALCULATION

Project: Flow Split Calculation: Flow draining West between E 43rd Ave and I-70

WEIR Equation $Q = C*L*H^{3/2}$

H = Head above weir crest	0.4	ft
C = Weir Coefficient	3.0	
L = Horizontal length of weir	278	ft
Q = Flow	205	cfs

Worksheet for York street Flow split

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.87700	%
Normal Depth	1.00	ft

Section Definitions

Station (ft)	Elevation (ft)
0+000	1.00
0+000	0.00
0+002	0.17
0+020	0.37
0+039	0.15
0+040	0.00
0+040	1.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+000, 1.00)	(0+002, 0.17)	0.013
(0+002, 0.17)	(0+039, 0.15)	0.017
(0+039, 0.15)	(0+040, 1.00)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge		200.71	ft³/s
Elevation Range	0.00 to 1.00 ft		
Flow Area		29.96	ft²
Wetted Perimeter		42.02	ft

Worksheet for York street Flow split

Results

Hydraulic Radius		0.71	ft
Top Width		40.00	ft
Normal Depth		1.00	ft
Critical Depth		1.17	ft
Critical Slope		0.00444	ft/ft
Velocity		6.70	ft/s
Velocity Head		0.70	ft
Specific Energy		1.70	ft
Froude Number		1.37	
Flow Type	Supercritical		

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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	1.17	ft
Channel Slope	0.87700	%
Critical Slope	0.00444	ft/ft

Flow Split (Existing Storm Drain Diverted Out Flow)

Worksheet for Existing 120" Brick Pipe

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.39000	%
Normal Depth	9.60	ft
Diameter	10.00	ft

Results

Discharge	958.87	ft^3/s
Flow Area	77.49	ft^2
Wetted Perimeter	27.39	ft
Hydraulic Radius	2.83	ft
Top Width	3.92	ft
Critical Depth	7.46	ft
Percent Full	96.0	%
Critical Slope	0.00544	ft/ft
Velocity	12.37	ft/s
Velocity Head	2.38	ft
Specific Energy	11.98	ft
Froude Number	0.49	
Maximum Discharge	962.75	ft^3/s
Discharge Full	894.99	ft^3/s
Slope Full	0.00448	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	96.00	%
Downstream Velocity	Infinity	ft/s

Worksheet for Existing 120" Brick Pipe

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	9.60	ft
Critical Depth	7.46	ft
Channel Slope	0.39000	%
Critical Slope	0.00544	ft/ft

Cross Section for Existing 120" Brick Pipe

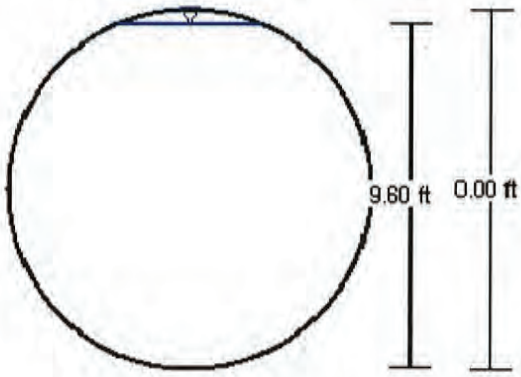
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.39000	%
Normal Depth	9.60	ft
Diameter	10.00	ft
Discharge	958.87	ft³/s

Cross Section Image



V: 1
H: 1

Worksheet for Existing High Street (8'x12' CBC) Q 100

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.30000	%
Normal Depth	7.99	ft
Height	8.00	ft
Bottom Width	12.00	ft

Results

Discharge	1364.35	ft^3/s
Flow Area	95.88	ft^2
Wetted Perimeter	27.98	ft
Hydraulic Radius	3.43	ft
Top Width	12.00	ft
Critical Depth	7.38	ft
Percent Full	99.9	%
Critical Slope	0.00368	ft/ft
Velocity	14.23	ft/s
Velocity Head	3.15	ft
Specific Energy	11.14	ft
Froude Number	0.89	
Discharge Full	1077.35	ft^3/s
Slope Full	0.00187	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	99.88	%
Downstream Velocity	Infinity	ft/s

Worksheet for Existing High Street (8'x12' CBC) Q 100

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	7.99	ft
Critical Depth	7.38	ft
Channel Slope	0.30000	%
Critical Slope	0.00368	ft/ft

Cross Section for Existing High Street (8'x12' CBC) Q 100

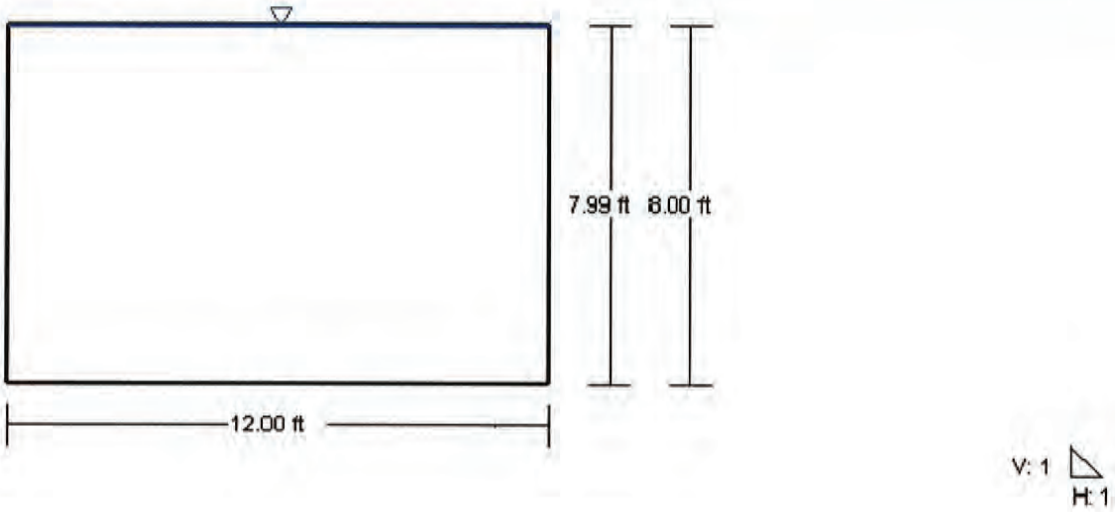
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.30000	%
Normal Depth	7.99	ft
Height	8.00	ft
Bottom Width	12.00	ft
Discharge	1364.35	ft³/s

Cross Section Image



Worksheet for Existing 72" RCP at York St Capacity Calculation

Calculation showing the capacity that is conveyed in the existing 72" RCP that will be conveyed over the lowered section of I-70 in the proposed storm drain structure

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.52000	%
Normal Depth	5.65	ft
Diameter	6.00	ft

Results

Discharge	328.47	ft³/s
Flow Area	27.61	ft²
Wetted Perimeter	15.92	ft
Hydraulic Radius	1.73	ft
Top Width	2.81	ft
Critical Depth	4.93	ft
Percent Full	94.2	%
Critical Slope	0.00598	ft/ft
Velocity	11.90	ft/s
Velocity Head	2.20	ft
Specific Energy	7.85	ft
Froude Number	0.67	
Maximum Discharge	328.50	ft³/s
Discharge Full	305.38	ft³/s
Slope Full	0.00602	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	94.17	%
Downstream Velocity	Infinity	ft/s

Worksheet for Existing 72" RCP at York St Capacity Calculation

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	5.65	ft
Critical Depth	4.93	ft
Channel Slope	0.52000	%
Critical Slope	0.00598	ft/ft

Cross Section for Existing 72" RCP at York St Capacity Calculation

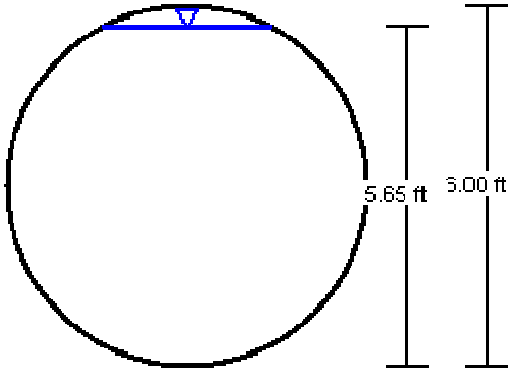
Project Description

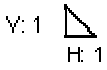
Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.52000	%
Normal Depth	5.65	ft
Diameter	6.00	ft
Discharge	328.47	ft³/s

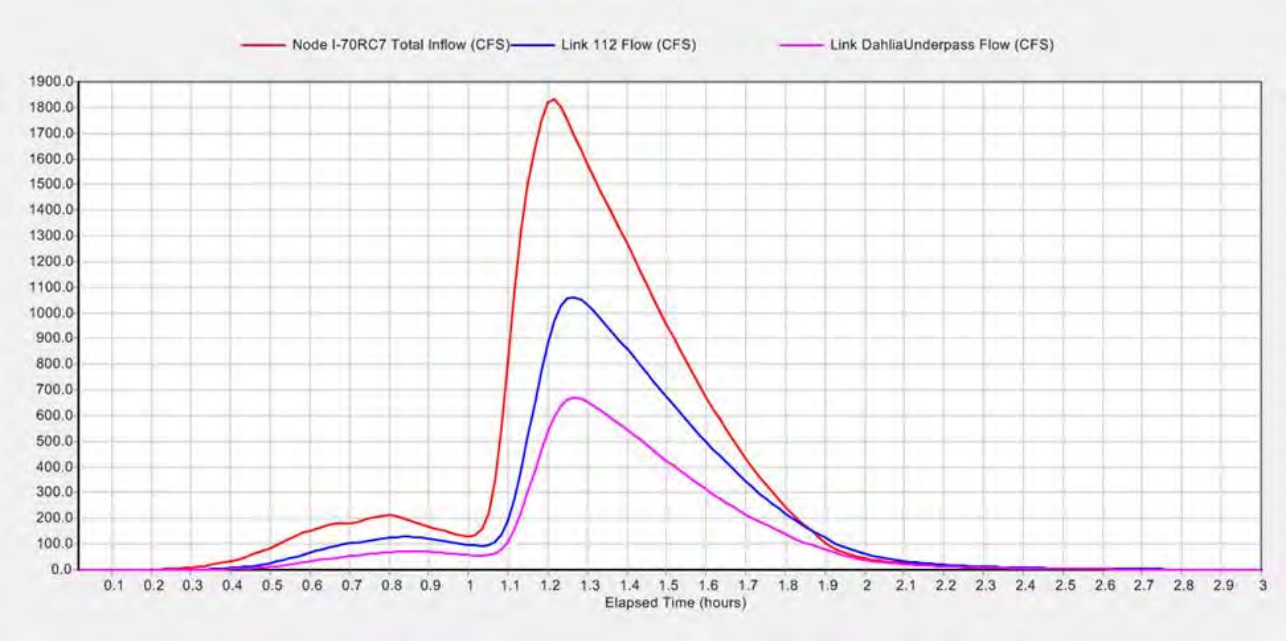
Cross Section Image





A.3 Flow Split

A.3.b Dahlia Street Split



Node I-70RC7 = Total flow to Dahlia Street and Stapleton Drive South

Link 112 = Stapleton Drive South flow to the west

Link Dahlia Underpass = flow under I-70 in Dahlia Street

A small sump is located just west of the intersection, so flow in excess of the minor street capacity will pond up and split to the north and west. SWMM5 was utilized to evaluate the diverted flow to each direction as shown above.

A.4 Soils Map

ADAMS COUNTY

CITY AND COUNTY OF DENVER

CITY AND COUNTY OF DENVER

ADAMS COUNTY

ADAMS COUNTY

ARAPAHOE COUNTY

Soils Map

COLORADO Department of Transportation

ATKINS

Legend

Project Basins

Soils

- A
- B
- C/D
- City of Denver Unknown Assume C/D
- Water

N

0 2,500 5,000 10,000 Feet

B. Hydraulics

B.1 CUHP-SWMM Summary Table

B.2 Swale Summary Table

B.3 South Platte HEC-RAS

B.4 Pump Design

B.1 CUHP-SWMM Summary Table

CUHP interface	SWMM File	
PCL-out.txt	PCL_Pump.ini	Dynamic Wave
I-70East_SV.txt	Steele-Vasquez_to_South_Platte.inp	Dynamic Wave
ParkHill_WO_GolfCourseBypass.txt	Park_Hill_No_Golf.inp	Kinematic Wave
I-70East_SV.txt	PH_ColoradoPonds.inp	Dynamic Wave
I70_East-East_of_Sand_Creek-100_Year.txt	SW_Quebec.inp	Dynamic Wave
I70_East-East_of_Sand_Creek-100_Year.txt	CPB_SWMM.inp	Dynamic Wave

B.2 Swale Summary Table

Triangular Channel (SWALES_East_I70.fm8) Report

Label	Notes	Discharge (ft³/s)	Channel Slope (ft/ft)	Roughness Coefficient	Normal Depth (ft)	Left Side Slope (ft/ft (H:V))	Right Side Slope (ft/ft (H:V))	Flow Area (ft²)	Top Width (ft)	Velocity (ft/s)	Froude Number
DP62 - North of 270 SB Ramp	EXISTING_Sta 2204+00, 100' RT to Sta 2224+00, 300' RT	50.00	0.006	0.035	0.97	3.00	50.00	24.75	51.22	2.02	0.51
DP66 - North CPB EB Ramp	Sta 2214+90, 70' RT to Sta 2219+00, 80'RT	19.00	0.006	0.035	1.38	4.00	4.00	7.57	11.00	2.51	0.53
DP70 - South CPB WB Ramp	Sta 2222+00, 70' LT to Sta 2228+80, 90' LT	14.00	0.010	0.035	1.25	3.00	3.00	4.68	7.49	2.99	0.67
DP77 - North I270 SB Exit	Sta 2223+80, 350' RT to Sta 2225+70, 360' RT	5.00	0.005	0.035	0.97	3.00	3.00	2.80	5.80	1.78	0.45
DP68 - North I270 EB Ramp	Sta 2232+40, 120' RT to Sta 2238+30, 70' RT	12.00	0.006	0.035	1.30	3.00	3.00	5.04	7.78	2.38	0.52
DP50b - North I270 NB Exit East	EXISTING_Sta 2234+30, 230' LT to Sta 2238+00, 180' LT	22.00	0.003	0.035	0.93	33.33	3.00	15.79	33.87	1.39	0.36
DP136 - North I270 NB Exit West	EXISTING_Sta 2238+00, 180' LT to Sta Sta 2241+10, 140' LT	40.00	0.003	0.035	1.17	33.33	3.00	24.73	42.39	1.62	0.37
DP53 - South I270 NB Exit West	Sta 2238+40, 80' LT to Sta 2242+80, 70' LT	12.00	0.020	0.035	1.03	3.00	3.00	3.21	6.21	3.74	0.92
DP68 - North I270 SB Exit West	Sta 2238+30, 70' RT to Sta 2240+50, 70' RT	81.00	0.005	0.035	2.75	3.00	3.00	22.62	16.48	3.58	0.54
SE Gore - West	EXISTING_Sta 2244+00, 110' RT to Sta 2253+60, 130' RT	111.00	0.005	0.035	1.21	35.00	35.00	51.59	84.98	2.15	0.49
NE Gore - West	Sta 2244+00, 120' LT to Sta 2258+20, 90' LT	47.00	0.003	0.035	1.01	60.00	3.00	31.98	63.48	1.47	0.36
Link120 - North I70 Under CPB West	Sta 2241+10, 140' LT to Sta 2244+00, 120' LT	35.00	0.005	0.035	2.00	3.00	3.00	12.06	12.03	2.90	0.51
Link118 - South CPB WB Exit West	Sta 2244+00, 140' LT to Sta 2254+40, 90' LT	35.00	0.005	0.035	2.00	3.00	3.00	12.06	12.03	2.90	0.51
Link117 - South CPB WB Exit West	Sta 2258+20, 90' LT to Sta 2263+40, 80' LT	35.00	0.015	0.035	1.63	3.00	3.00	7.99	9.79	4.38	0.86
D148 - North CPB EB Exit West	Sta 2253+60, 130' RT to Sta 2257+70, 90' RT	84.00	0.005	0.035	2.78	3.00	3.00	23.25	16.70	3.61	0.54
DP60 - South CPB EB Exit West	Sta 2253+80, 220' RT to Sta 2281+70, 130' RT	78.00	0.005	0.035	1.11	3.00	60.00	38.61	69.75	2.02	0.48
DP114 - NorthI70 Havana to Peoria West	Sta 2265+70, 120' LT to Sta 2281+00, 110' LT	41.00	0.005	0.035	2.13	3.00	3.00	13.57	12.76	3.02	0.52
Link55 - UPRR Underpass	EXISTING_Sta 2287+40, 190' LT to Sta 2290+00, 240' RT	34.00	0.005	0.035	1.25	10.00	10.00	15.57	24.95	2.18	0.49
SC030 - North Peoria EB Exit East	Sta 2334+60, 110' RT to Sta 2337+30, 130' RT	19.00	0.016	0.035	0.58	12.00	35.00	8.04	27.49	2.36	0.77
SC025 - North Peoria EB Exit West	EXISTING_Sta 2337+30, 130' RT to Sta 2343+60, 160' RT	20.00	0.004	0.035	1.69	3.00	3.00	8.62	10.17	2.32	0.44
IG220 - North Peoria WB Entrance West	Sta 2336+20, 120' LT to Sta 2337+60, 220' LT	45.00	0.009	0.035	1.86	4.00	3.00	12.06	12.99	3.73	0.68
IG210 - South Peoria WB Entrance West	EXISTING_Sta 2336+10, 180' LT to 2343+10, 230' LT	27.00	0.012	0.035	0.76	4.00	34.00	11.06	29.00	2.44	0.70
IG200 - South Peoria WB Exit West	EXISTING_Sta 2344+40, 230' LT to Sta 2354+00, 80' LT	17.00	0.045	0.035	0.42	30.00	30.00	5.33	25.29	3.19	1.22
SC020 - North Peoria EB Entrance West	Sta 2348+00, 160' RT to Sta 2354+00, 100' RT	19.00	0.024	0.035	0.64	15.00	15.00	6.17	19.25	3.08	0.96
225K - I70 Peoria to I225 East	EXISTING_Sta 2361+10, 150' RT to Sta 2373+10, 110' RT	18.00	0.006	0.035	1.51	3.00	3.00	6.84	9.06	2.63	0.53
225J - I70 Peoria to I225 West	Sta 2373+10, 110' RT to Sta 2399+30, 2100' RT	17.00	0.005	0.035	1.53	3.00	3.00	7.01	9.17	2.42	0.49
IG080 - South I225 Flyover West	EXISTING_Sta 2386+30, 150' LT to Sta 2398+10, 240' LT	12.00	0.004	0.035	1.32	4.00	3.00	6.06	9.21	1.98	0.43
IG070 - South I225 Flyover West	EXISTING_Sta 2388+50, 90' LT to Sta 2395+40, 80' LT	28.00	0.004	0.035	1.81	4.00	3.00	11.45	12.66	2.44	0.45
225E - I225 Infiled West	Sta 2399+00, 90' RT to Sta 2412+80, 70' RT	31.00	0.005	0.035	1.92	3.00	3.00	11.01	11.49	2.82	0.51

Triangular Channel (SWALES_East_I70.fm8) Report

Label	Notes	Discharge (ft³/s)	Channel Slope (ft/ft)	Roughness Coefficient	Normal Depth (ft)	Left Side Slope (ft/ft (H:V))	Right Side Slope (ft/ft (H:V))	Flow Area (ft²)	Top Width (ft)	Velocity (ft/s)	Froude Number
20 - South I70 West	Sta 2300+00, 110' RT to Sta 2338+00, 110' RT	151.00	0.010	0.035	3.05	3.00	3.00	27.83	18.27	5.43	0.78
10 - North I70 West	Sta 2300+00, 110' LT to Sta 2338+00, 110' LT	70.00	0.003	0.035	2.86	3.00	3.00	24.56	17.17	2.85	0.42

Worksheet for IG090 - South I225 Flyover East

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00400	ft/ft
Discharge	16.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00.0	2.00
0+09.0	0.50
0+09.5	0.50
0+09.5	0.00
0+15.5	0.00
0+15.5	0.50
0+16.0	0.50
0+20.0	1.83
0+20.0	2.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient

Worksheet for IG090 - South I225 Flyover East

Input Data

Start Station	Ending Station	Roughness Coefficient
(0+00.0, 2.00)	(0+09.0, 0.50)	0.035
(0+09.0, 0.50)	(0+16.0, 0.50)	0.013
(0+16.0, 0.50)	(0+20.0, 2.00)	0.035

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth		0.81	ft
Elevation Range	0.00 to 2.00 ft		
Flow Area		5.60	ft²
Wetted Perimeter		10.87	ft
Hydraulic Radius		0.52	ft
Top Width		9.79	ft
Normal Depth		0.81	ft
Critical Depth		0.64	ft
Critical Slope		0.00969	ft/ft
Velocity		2.86	ft/s

Worksheet for IG090 - South I225 Flyover East

Results

Velocity Head		0.13	ft
Specific Energy		0.94	ft
Froude Number		0.67	
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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.81	ft
Critical Depth	0.64	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00969	ft/ft

Messages

Notes

Sta 2379+40, 100' LT to Sta 2386+30, 150' LT

Cross Section for IG090 - South I225 Flyover East

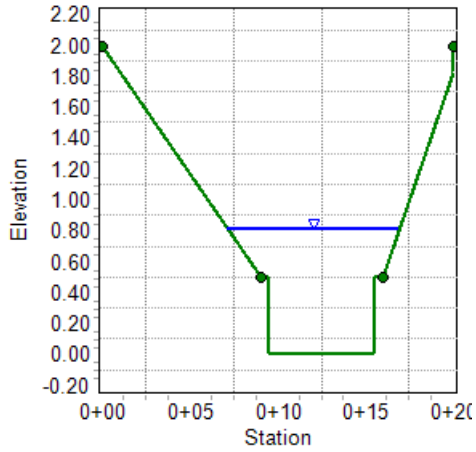
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00400	ft/ft
Normal Depth	0.81	ft
Discharge	16.00	ft³/s

Cross Section Image



Worksheet for IG070 - South I225 Flyover East

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00500	ft/ft
Discharge	16.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00.0	2.00
0+09.0	0.50
0+09.5	0.50
0+09.5	0.00
0+15.5	0.00
0+15.5	0.50
0+16.0	0.50
0+20.0	1.83
0+20.0	2.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient

Worksheet for IG070 - South I225 Flyover East

Input Data

Start Station	Ending Station	Roughness Coefficient
(0+00.0, 2.00)	(0+09.0, 0.50)	0.035
(0+09.0, 0.50)	(0+16.0, 0.50)	0.013
(0+16.0, 0.50)	(0+20.0, 2.00)	0.035

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.74	ft
Elevation Range	0.00 to 2.00 ft	
Flow Area	4.93	ft²
Wetted Perimeter	10.21	ft
Hydraulic Radius	0.48	ft
Top Width	9.15	ft
Normal Depth	0.74	ft
Critical Depth	0.63	ft
Critical Slope	0.00861	ft/ft
Velocity	3.24	ft/s

Worksheet for IG070 - South I225 Flyover East

Results

Velocity Head		0.16	ft
Specific Energy		0.90	ft
Froude Number		0.78	
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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.74	ft
Critical Depth	0.63	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00861	ft/ft

Messages

Notes

Sta 2395+40, 80' LT to Sta 2408+20, 90' LT

Cross Section for IG070 - South I225 Flyover East

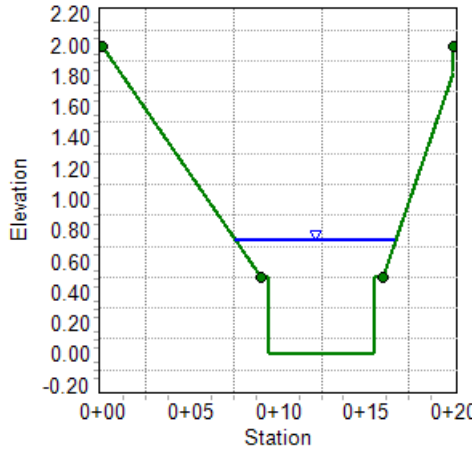
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	0.74	ft
Discharge	16.00	ft³/s

Cross Section Image



Worksheet for IG060 - South I225 Flyover West

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00500	ft/ft
Discharge	10.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00.0	2.00
0+09.0	0.50
0+09.5	0.50
0+09.5	0.00
0+15.5	0.00
0+15.5	0.50
0+16.0	0.50
0+20.0	1.83
0+20.0	2.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient

Worksheet for IG060 - South I225 Flyover West

Input Data

Start Station	Ending Station	Roughness Coefficient
(0+00.0, 2.00)	(0+09.0, 0.50)	0.035
(0+09.0, 0.50)	(0+16.0, 0.50)	0.013
(0+16.0, 0.50)	(0+20.0, 2.00)	0.035

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth		0.41	ft
Elevation Range	0.00 to 2.00 ft		
Flow Area		2.45	ft²
Wetted Perimeter		6.82	ft
Hydraulic Radius		0.36	ft
Top Width		6.00	ft
Normal Depth		0.41	ft
Critical Depth		0.44	ft
Critical Slope		0.00388	ft/ft
Velocity		4.09	ft/s

Worksheet for IG060 - South I225 Flyover West

Results

Velocity Head		0.26	ft
Specific Energy		0.67	ft
Froude Number		1.13	
Flow Type	Supercritical		

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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.41	ft
Critical Depth	0.44	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00388	ft/ft

Messages

Notes

Sta 2408+20, 90' LT to Sta 2419+30, 70' LT

Cross Section for IG060 - South I225 Flyover West

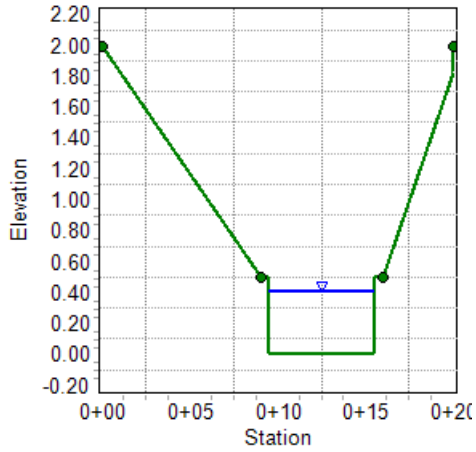
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	0.41	ft
Discharge	10.00	ft³/s

Cross Section Image



B.3 South Platte HEC-RAS

The Interstate 270 fly-over ramp was modeled in the Effective Sand Creek LOMR's Overflow1 Reach to show the effects from the improvements. The existing and proposed conditions models are provided in the following files and are shown in the subsequent profiles, tables, and sections:

Existing Conditions (Effective LOMR model)

SC_post.prj

SC_post.p01

SC_post.go1

SC_post.f01

Proposed Conditions (I-270 ramp improvements)

SC_post.prj

SC_post.p02

SC_post.go3

SC_post.f01

STUDY AREA

ZONE AE

ZONE A

ZONE AO
(DEPTH 2')

ZONE AE

ZONE A

ZONE A

ZONE AE

PROFILE BASE LINE

PROFILE BASE LINE

Sand Creek Overflow

Sand Creek

Bridge

Footbridge

Bridge

Bridge

Bridge

5233
5234
5235
5238
5241
5243
5244
5245
5246
5248
5249
5250
5252
5257
5258
5260
5262
5264
5265
5266
5267

21

535

270

35

290

KK1538

KK1539

KK1291

CITY AND

CENTRAL PARK BLVD

RAILROAD

RAILROAD

E 41ST AVE

E 40TH AVE

E SMITH RD

E 38TH AVE

E 36TH AVE

N QUEBEC ST

QUEBEC ST

ROSLYN ST

SYRACUSE ST

ULSTER ST

N XANTHIA ST

MAP SCALE 1" = 500'

250 0 500 1000

FEET

METERS

PANEL 0094H

FIRM

FLOOD INSURANCE RATE MAP

CITY AND COUNTY OF DENVER, COLORADO

PANEL 94 OF 300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

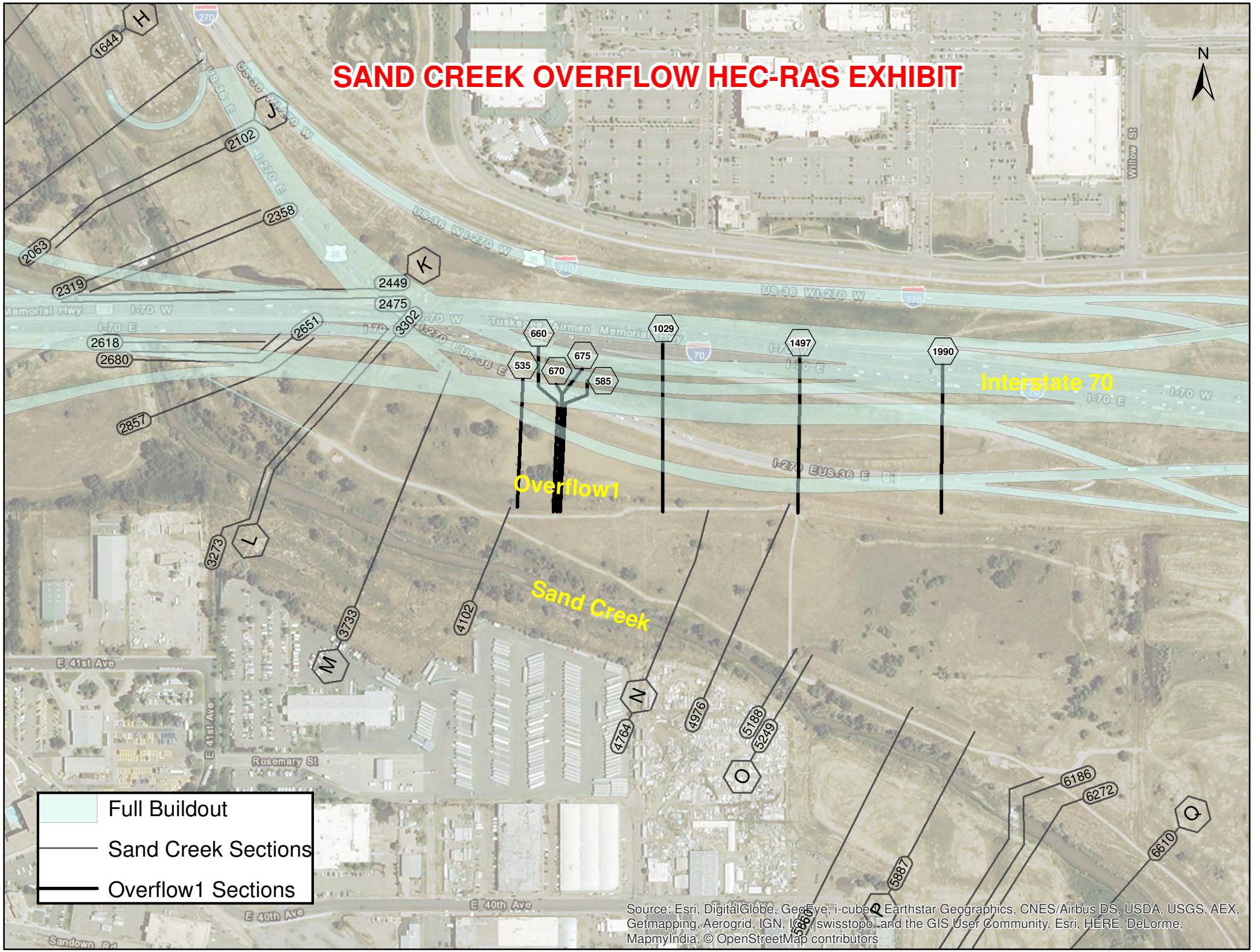
COMMUNITY	NUMBER	PANEL	SUFFIX
CITY AND COUNTY OF DENVER	080046	0094	H

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
0800460094H
MAP REVISED
NOVEMBER 20, 2013

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM


SAND CREEK OVERFLOW HEC-RAS EXHIBIT
N
H
J
K
L
M
N
O
P
Q
1644
2102
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2319
2449
2475
2651
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535
670
585
1029
1497
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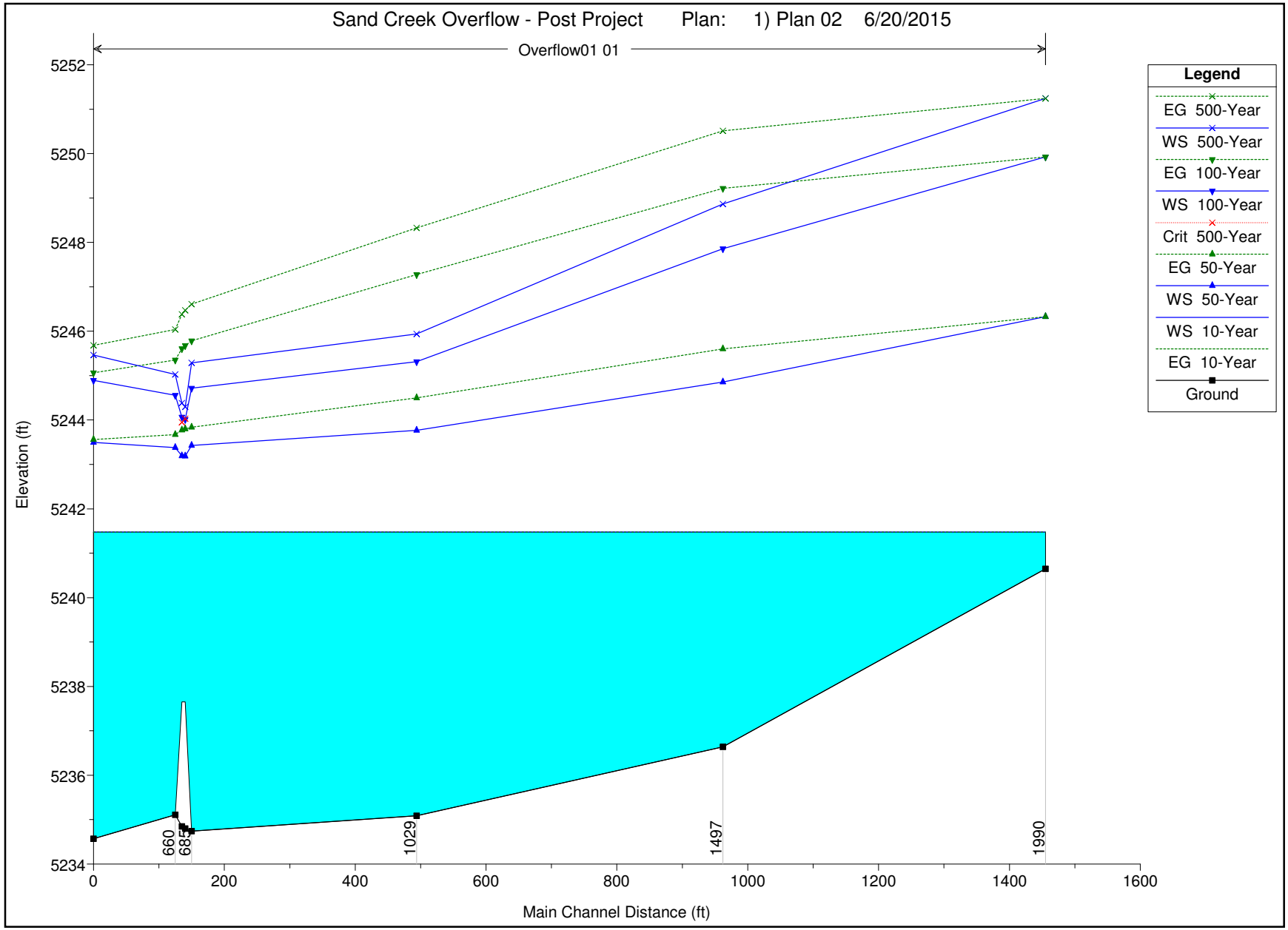
4976
5188
5249
5887
6186
6272
6610
Interstate 70
Overflow1
Sand Creek
US-36 E
US-36 W I-270 W
I-70 E
I-70 W
I-270 E US-36 E
E 41st Ave
E 40th Ave
Rosemary St
Sandown Rd
Willow St
Full Buildout
Sand Creek Sections
Overflow1 Sections
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors

Existing Conditions Profile

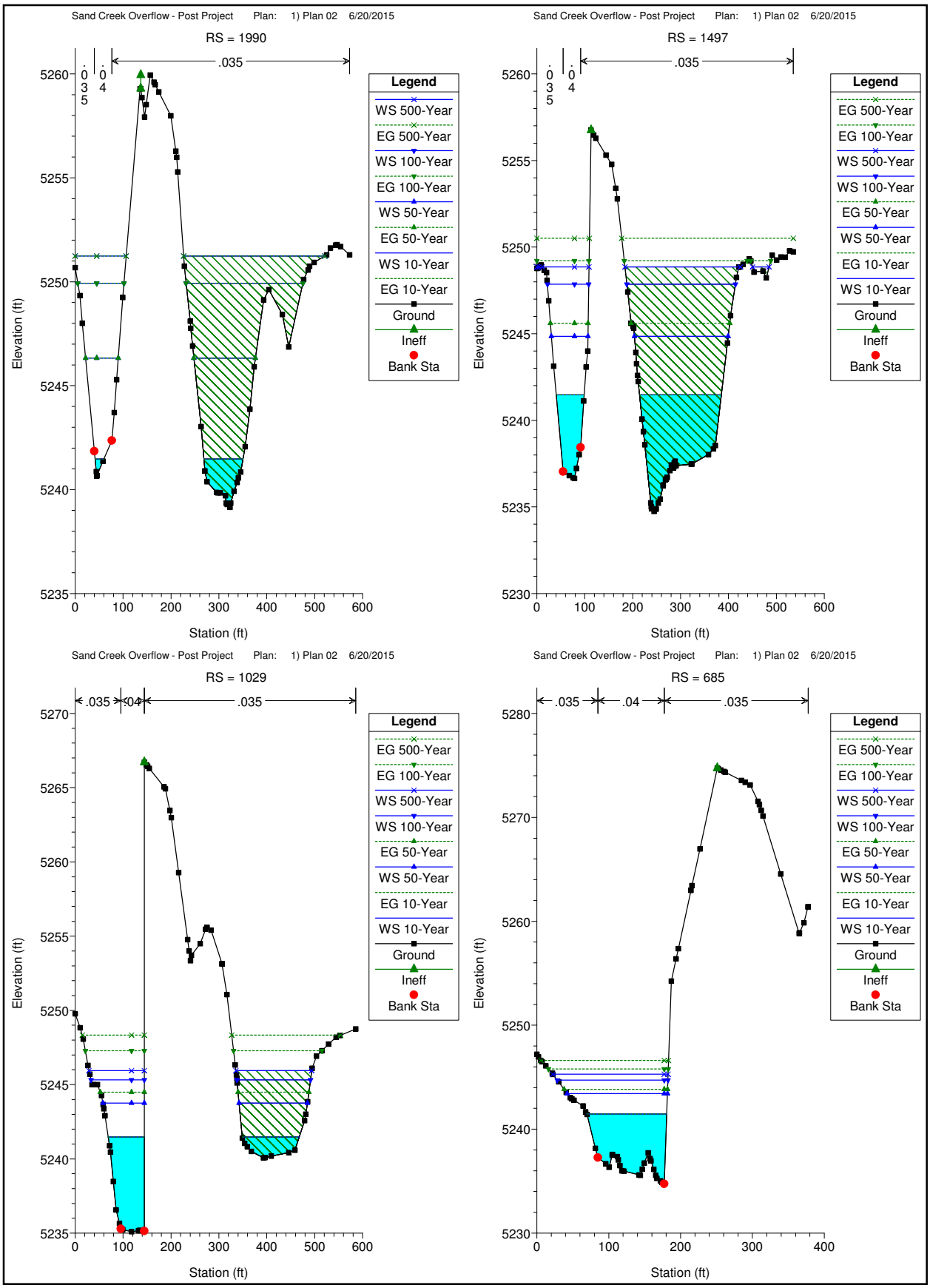


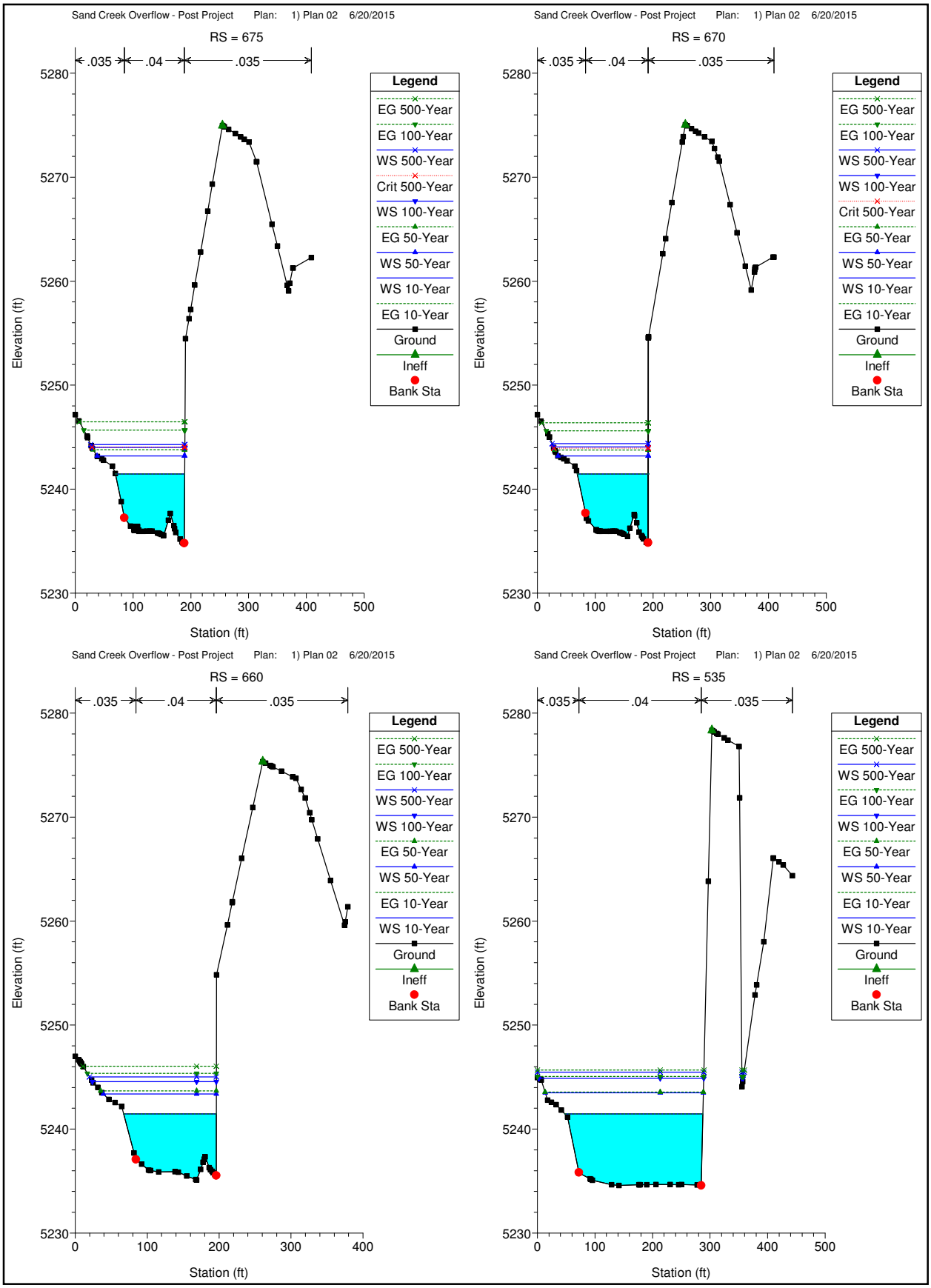
Existing Conditions Table

HEC-RAS Plan: Plan 02 River: Overflow01 Reach: 01

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
01	1990	10-Year	0.01	5240.65	5241.47		5241.47	0.000000	0.00	7.57	99.99	0.00
01	1990	50-Year	0.01	5240.65	5246.33		5246.33	0.000000	0.00	245.84	196.71	0.00
01	1990	100-Year	0.01	5240.65	5249.93		5249.93	0.000000	0.00	537.86	339.73	0.00
01	1990	500-Year	0.01	5240.65	5251.24		5251.24	0.000000	0.00	672.40	400.86	0.00
01	1497	10-Year	0.01	5236.64	5241.47		5241.47	0.000000	0.00	204.20	229.05	0.00
01	1497	50-Year	2892.84	5236.64	5244.86		5245.60	0.002650	7.49	434.22	271.99	0.47
01	1497	100-Year	6095.52	5236.64	5247.86		5249.21	0.003213	10.25	678.45	312.91	0.55
01	1497	500-Year	7467.10	5236.64	5248.86		5250.51	0.003576	11.48	768.50	378.66	0.59
01	1029	10-Year	0.01	5235.09	5241.47		5241.47	0.000000	0.00	404.04	194.64	0.00
01	1029	50-Year	3948.16	5235.09	5243.77		5244.50	0.002167	7.26	590.02	229.51	0.44
01	1029	100-Year	7770.45	5235.09	5245.32		5247.28	0.004864	12.15	737.73	265.19	0.67
01	1029	500-Year	9405.40	5235.09	5245.94		5248.33	0.005539	13.49	808.38	273.93	0.72
01	685	10-Year	0.01	5234.74	5241.47		5241.47	0.000000	0.00	559.40	111.26	0.00
01	685	50-Year	3948.16	5234.74	5243.42		5243.84	0.001382	5.30	800.73	139.55	0.34
01	685	100-Year	7770.45	5234.74	5244.72		5245.78	0.002949	8.61	990.17	153.91	0.51
01	685	500-Year	9405.40	5234.74	5245.29		5246.61	0.003397	9.63	1079.93	160.56	0.55
01	675	10-Year	0.01	5237.65	5241.47		5241.47	0.000000	0.00	428.33	119.76	0.00
01	675	50-Year	3948.16	5237.65	5243.18		5243.80	0.003074	6.44	652.68	151.65	0.48
01	675	100-Year	7770.45	5237.65	5244.02		5245.68	0.007035	10.70	782.64	160.83	0.75
01	675	500-Year	9405.40	5237.65	5244.30	5244.03	5246.47	0.008728	12.27	828.35	163.10	0.84
01	670	10-Year	0.01	5237.65	5241.47		5241.47	0.000000	0.00	440.86	122.71	0.00
01	670	50-Year	3948.16	5237.65	5243.19		5243.77	0.002881	6.24	670.11	155.80	0.47
01	670	100-Year	7770.45	5237.65	5244.07		5245.61	0.006425	10.28	810.34	164.11	0.72
01	670	500-Year	9405.40	5237.65	5244.38	5243.95	5246.38	0.007830	11.72	862.70	166.35	0.80
01	660	10-Year	0.01	5235.11	5241.47		5241.47	0.000000	0.00	674.35	128.72	0.00
01	660	50-Year	3948.16	5235.11	5243.38		5243.67	0.000951	4.43	940.81	157.14	0.28
01	660	100-Year	7770.45	5235.11	5244.56		5245.35	0.002163	7.35	1135.08	172.32	0.44
01	660	500-Year	9405.40	5235.11	5245.03		5246.04	0.002596	8.34	1217.10	176.31	0.48
01	535	10-Year	0.01	5234.57	5241.47		5241.47	0.000000	0.00	1496.40	240.37	0.00
01	535	50-Year	3948.16	5234.57	5243.50		5243.56	0.000168	2.04	2021.56	274.79	0.12
01	535	100-Year	7770.45	5234.57	5244.89		5245.06	0.000381	3.39	2411.62	288.92	0.19
01	535	500-Year	9405.40	5234.57	5245.47		5245.68	0.000456	3.85	2577.01	293.02	0.21

Existing Conditions Sections

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EG 100-Year
WS 500-Year
Crit 500-Year
WS 100-Year
EG 50-Year
WS 50-Year
WS 10-Year
EG 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Sand Creek Overflow - Post Project Plan: 1) Plan 02 6/20/2015
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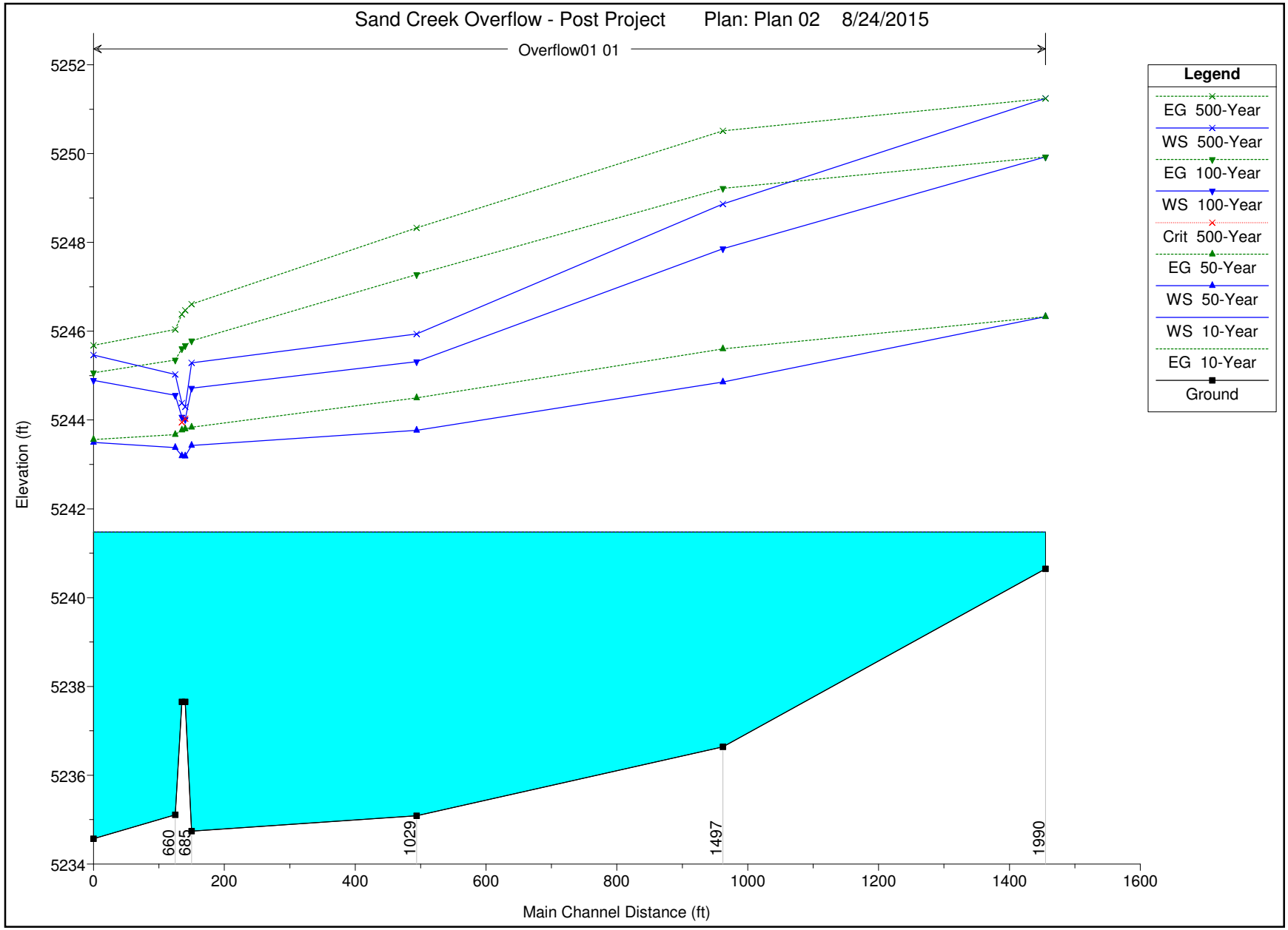
RS = 660
Sand Creek Overflow - Post Project Plan: 1) Plan 02 6/20/2015
RS = 535

Proposed Conditions Profile

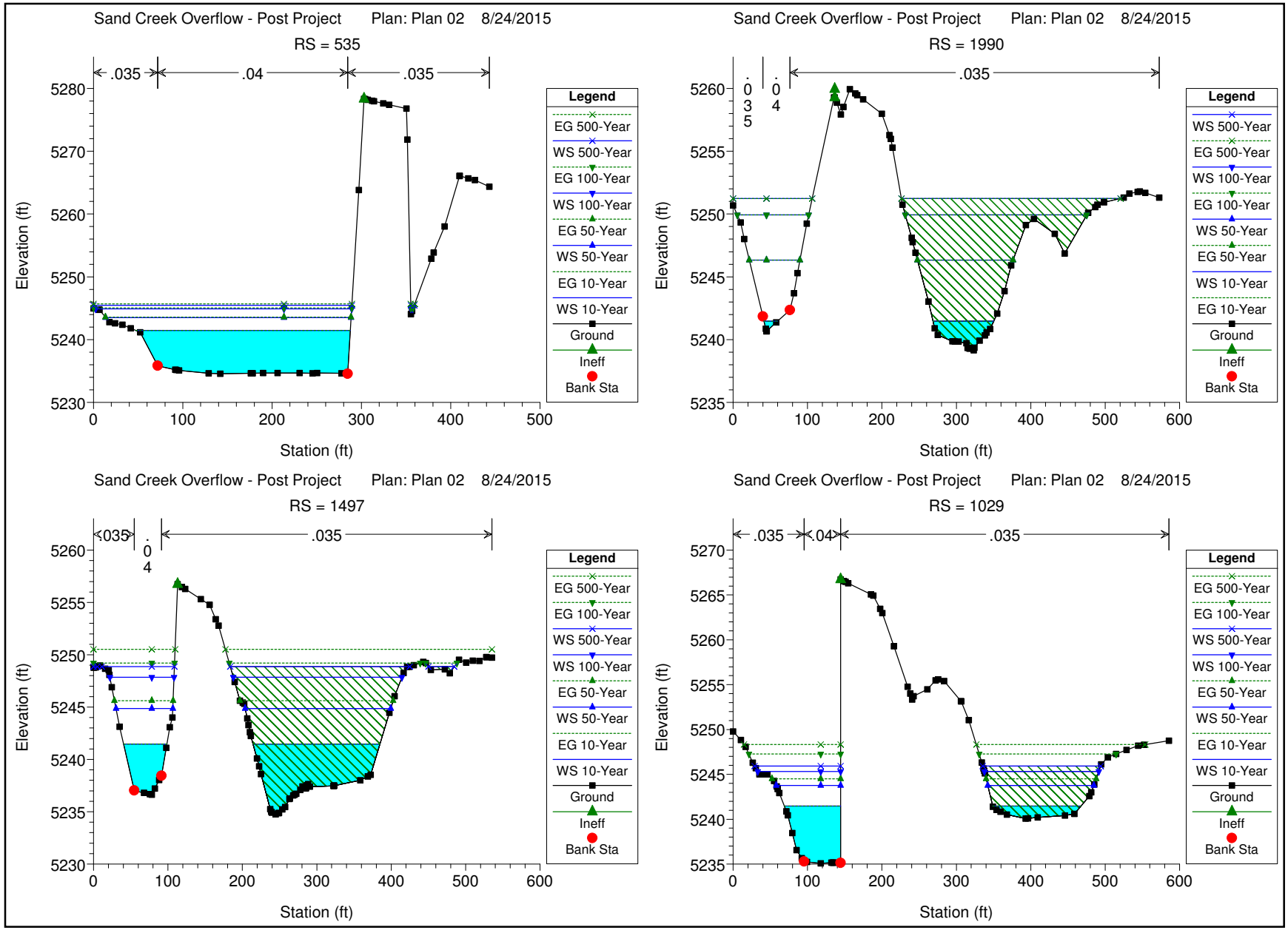


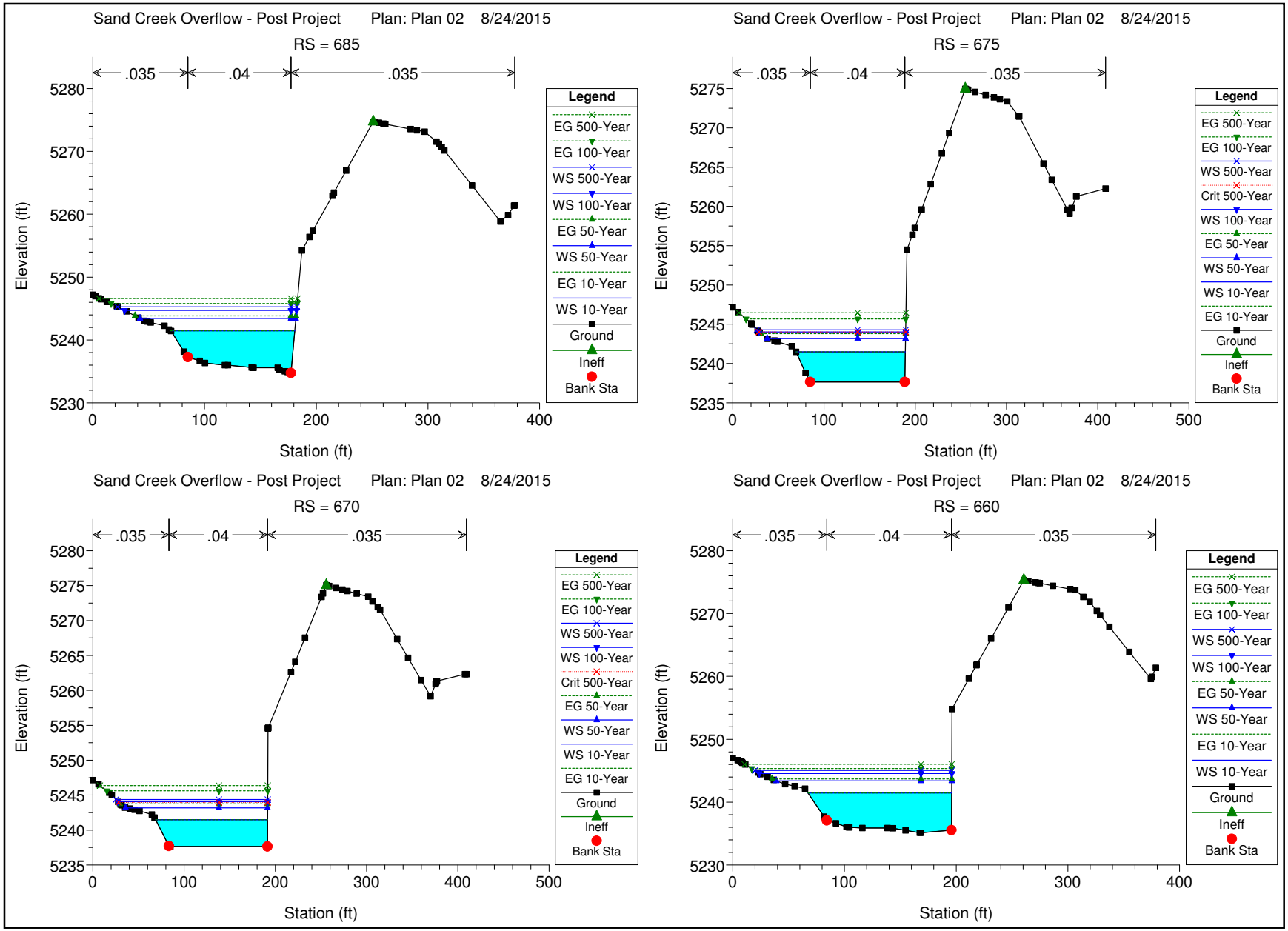
Proposed Conditions Table

HEC-RAS Plan: Plan 02 River: Overflow01 Reach: 01

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
01	1990	10-Year	0.01	5240.65	5241.47		5241.47	0.000000	0.00	7.57	99.99	0.00
01	1990	50-Year	0.01	5240.65	5246.33		5246.33	0.000000	0.00	245.84	196.71	0.00
01	1990	100-Year	0.01	5240.65	5249.93		5249.93	0.000000	0.00	537.86	339.73	0.00
01	1990	500-Year	0.01	5240.65	5251.24		5251.24	0.000000	0.00	672.40	400.86	0.00
01	1497	10-Year	0.01	5236.64	5241.47		5241.47	0.000000	0.00	204.20	229.05	0.00
01	1497	50-Year	2892.84	5236.64	5244.86		5245.60	0.002650	7.49	434.22	271.99	0.47
01	1497	100-Year	6095.52	5236.64	5247.86		5249.21	0.003213	10.25	678.45	312.91	0.55
01	1497	500-Year	7467.10	5236.64	5248.86		5250.51	0.003576	11.48	768.50	378.66	0.59
01	1029	10-Year	0.01	5235.09	5241.47		5241.47	0.000000	0.00	404.04	194.64	0.00
01	1029	50-Year	3948.16	5235.09	5243.77		5244.50	0.002167	7.26	590.02	229.51	0.44
01	1029	100-Year	7770.45	5235.09	5245.32		5247.28	0.004864	12.15	737.73	265.19	0.67
01	1029	500-Year	9405.40	5235.09	5245.94		5248.33	0.005539	13.49	808.38	273.93	0.72
01	685	10-Year	0.01	5234.74	5241.47		5241.47	0.000000	0.00	559.40	111.26	0.00
01	685	50-Year	3948.16	5234.74	5243.42		5243.84	0.001382	5.30	800.73	139.55	0.34
01	685	100-Year	7770.45	5234.74	5244.72		5245.78	0.002949	8.61	990.17	153.91	0.51
01	685	500-Year	9405.40	5234.74	5245.29		5246.61	0.003397	9.63	1079.93	160.56	0.55
01	675	10-Year	0.01	5237.65	5241.47		5241.47	0.000000	0.00	428.33	119.76	0.00
01	675	50-Year	3948.16	5237.65	5243.18		5243.80	0.003074	6.44	652.68	151.65	0.48
01	675	100-Year	7770.45	5237.65	5244.02		5245.68	0.007035	10.70	782.64	160.83	0.75
01	675	500-Year	9405.40	5237.65	5244.30	5244.03	5246.47	0.008728	12.27	828.35	163.10	0.84
01	670	10-Year	0.01	5237.65	5241.47		5241.47	0.000000	0.00	440.86	122.71	0.00
01	670	50-Year	3948.16	5237.65	5243.19		5243.77	0.002881	6.24	670.11	155.80	0.47
01	670	100-Year	7770.45	5237.65	5244.07		5245.61	0.006425	10.28	810.34	164.11	0.72
01	670	500-Year	9405.40	5237.65	5244.38	5243.95	5246.38	0.007830	11.72	862.70	166.35	0.80
01	660	10-Year	0.01	5235.11	5241.47		5241.47	0.000000	0.00	674.35	128.72	0.00
01	660	50-Year	3948.16	5235.11	5243.38		5243.67	0.000951	4.43	940.81	157.14	0.28
01	660	100-Year	7770.45	5235.11	5244.56		5245.35	0.002163	7.35	1135.08	172.32	0.44
01	660	500-Year	9405.40	5235.11	5245.03		5246.04	0.002596	8.34	1217.10	176.31	0.48
01	535	10-Year	0.01	5234.57	5241.47		5241.47	0.000000	0.00	1496.40	240.37	0.00
01	535	50-Year	3948.16	5234.57	5243.50		5243.56	0.000168	2.04	2021.56	274.79	0.12
01	535	100-Year	7770.45	5234.57	5244.89		5245.06	0.000381	3.39	2411.62	288.92	0.19
01	535	500-Year	9405.40	5234.57	5245.47		5245.68	0.000456	3.85	2577.01	293.02	0.21

Proposed Conditions Sections




Sand Creek Overflow - Post Project Plan: Plan 02 8/24/2015
RS = 685
.035
.04
.035
Elevation (ft)
Station (ft)
Legend
EG 500-Year
EG 100-Year
WS 500-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 10-Year
WS 10-Year
Ground
Ineff
Bank Sta
Sand Creek Overflow - Post Project Plan: Plan 02 8/24/2015
RS = 675
.035
.04
.035
Elevation (ft)
Station (ft)
Legend
EG 500-Year
EG 100-Year
WS 500-Year
Crit 500-Year
WS 100-Year
EG 50-Year
WS 50-Year
WS 10-Year
EG 10-Year
Ground
Ineff
Bank Sta
Sand Creek Overflow - Post Project Plan: Plan 02 8/24/2015
RS = 670
.035
.04
.035
Elevation (ft)
Station (ft)
Legend
EG 500-Year
EG 100-Year
WS 500-Year
WS 100-Year
Crit 500-Year
EG 50-Year
WS 50-Year
WS 10-Year
EG 10-Year
Ground
Ineff
Bank Sta
Sand Creek Overflow - Post Project Plan: Plan 02 8/24/2015
RS = 660
.035
.04
.035
Elevation (ft)
Station (ft)
Legend
EG 500-Year
EG 100-Year
WS 500-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 10-Year
WS 10-Year
Ground
Ineff
Bank Sta

B.4 Pump Design

Pipe Headloss, Static Head, Total Dynamic Head & Horse Power
I-70 North Detention Basin Pump Station

Pump System Requirements and Friction Loss Factor					
Flow		**Number of Pumps**	**Flow per Pump**	**C Factor**	
4,500 gpm	10.0 cfs	3	1500.00	120	

Pipe Velocities		
Pipe Diameter	**Velocity (Suction)**	**Velocity in Discharge Pipes (1,500gpm ea)**
6.0 in	N/A (SUBMERSIBLE PUMPS)	17.0 fps
8.0 in	N/A (SUBMERSIBLE PUMPS)	9.6 fps
10.0 in	N/A (SUBMERSIBLE PUMPS)	6.1 fps

Friction Head Loss (h_f)[1]

Force Main (As-built Ref)	**Diameter**	**Area**	**Length**	**Velocity**	**C**	**$h_{friction}$**
Suction Pipe	6.0 in	0.20 sqft	0 ft	N/A	120	0.0 ft
Suction Pipe	8.0 in	0.35 sqft	0 ft	N/A	120	0.0 ft
Dischrage Pipe	6.0 in	0.20 sqft	0 ft	17.0 fps	120	0.0 ft
Dischrage Pipe	8.0 in	0.35 sqft	0 ft	9.6 fps	120	0.0 ft
Dischrage Pipe	**10.0 in**	0.55 sqft	20 ft	6.1 fps	120	0.3 ft
Dischrage Pipe	12.0 in	0.79 sqft	0 ft	N/A	120	0.0 ft
Dischrage Pipe	14.0 in	1.07 sqft	0 ft	N/A	120	0.0 ft
					Total h_f	0.3 ft

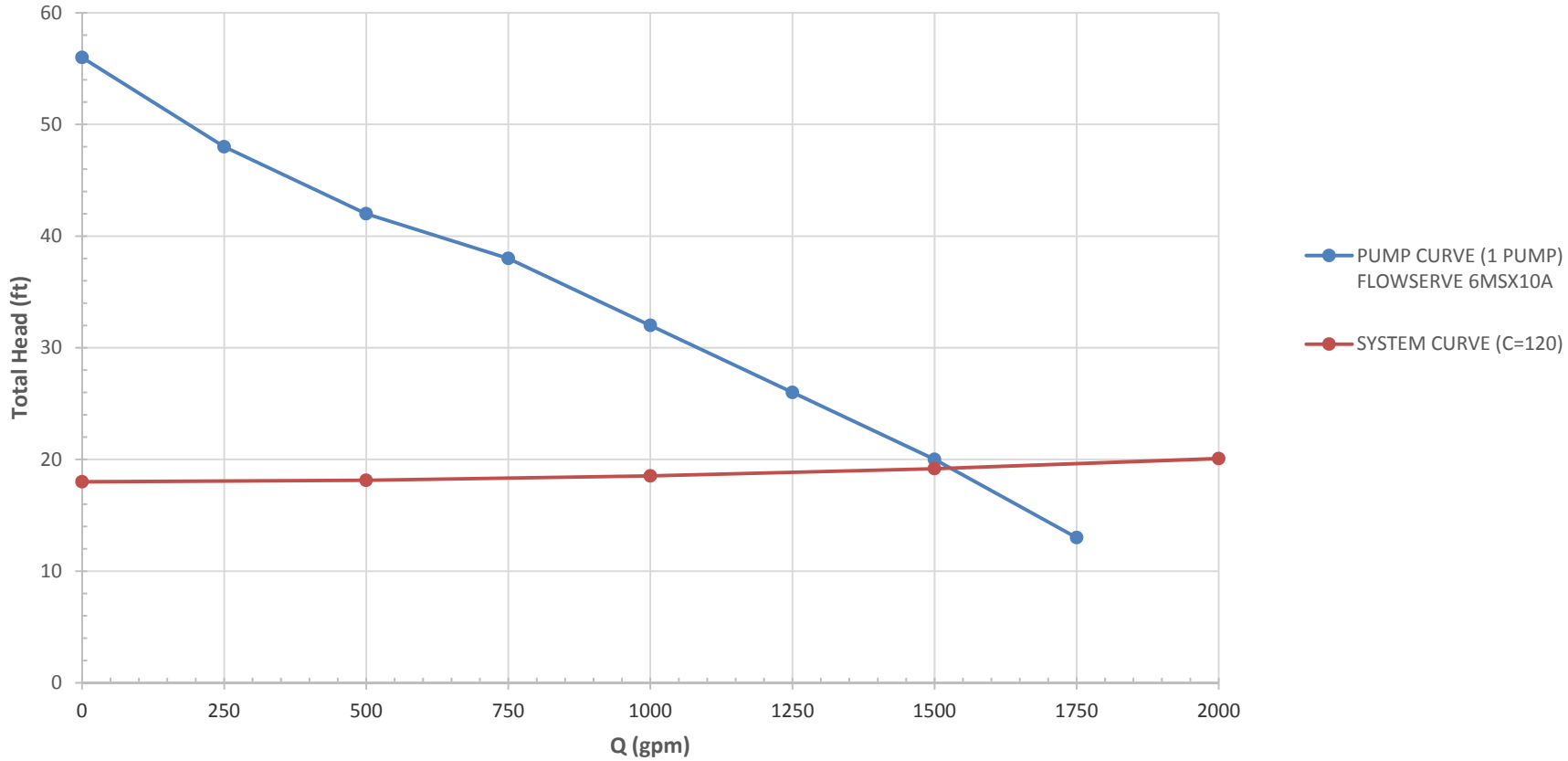
Minor Head Loss (h_m)

Device	**Loss Coefficient (K)**	**Quantity**				
		10 in Suction	**12 in. Suction**	**8 in. Discharge**	**10 in. Discharge**	**12 in. Discharge**
90° Bend	0.40	0	0	0	2	0
60° Bend	0.35	0	0	0	0	0
45° Bend	0.30	0	0	0	0	0
22.5° Bend	0.10	0	0	0	0	0
Tee (Straight Through)	0.60	0	0	0	0	0
Tee (Branch)	1.00	0	0	0	0	0
Increaser (6"x10")	0.40	0	0	0	0	0
Increaser (8"x12")	0.30	0	0	0	0	0
Reducer (10"x8")	0.30	0	0	0	0	0
Reducer (12"x10")	0.20	0	0	0	0	0
Meter	0.50	0	0	0	0	0
Check Valve	2.50	0	0	0	0	0
Gate Valve	0.15	0	0	0	0	0
Pipe Entrance	0.50	0	0	0	0	0
Pipe Exit	1.00	0	0	0	1	0
Total K		0.00	0.00	0.00	1.80	0.00
Minor Head Loss		0.0 ft	0.0 ft	0.0 ft	2.6 ft	0.0 ft
					Total h_m	2.6 ft

Constant Level Elevation	5130.0 ft
Discharge Centerline Elevation	5148.0 ft
Static Head	18.0 ft
Total Dynamic Head[1]	20.9 ft
Efficiency	65%
Total Horse Power	37 hp
Horse Power per pump	12 hp

Notes:
1. Total Dynamic Head calculated using the Hazen-Williams formula and in accordance with the CDOT Drainage Design Manual.

I-70 NORTH PUMP STATION
CONCEPTUAL SYSTEM HEAD AND PUMP CURVE

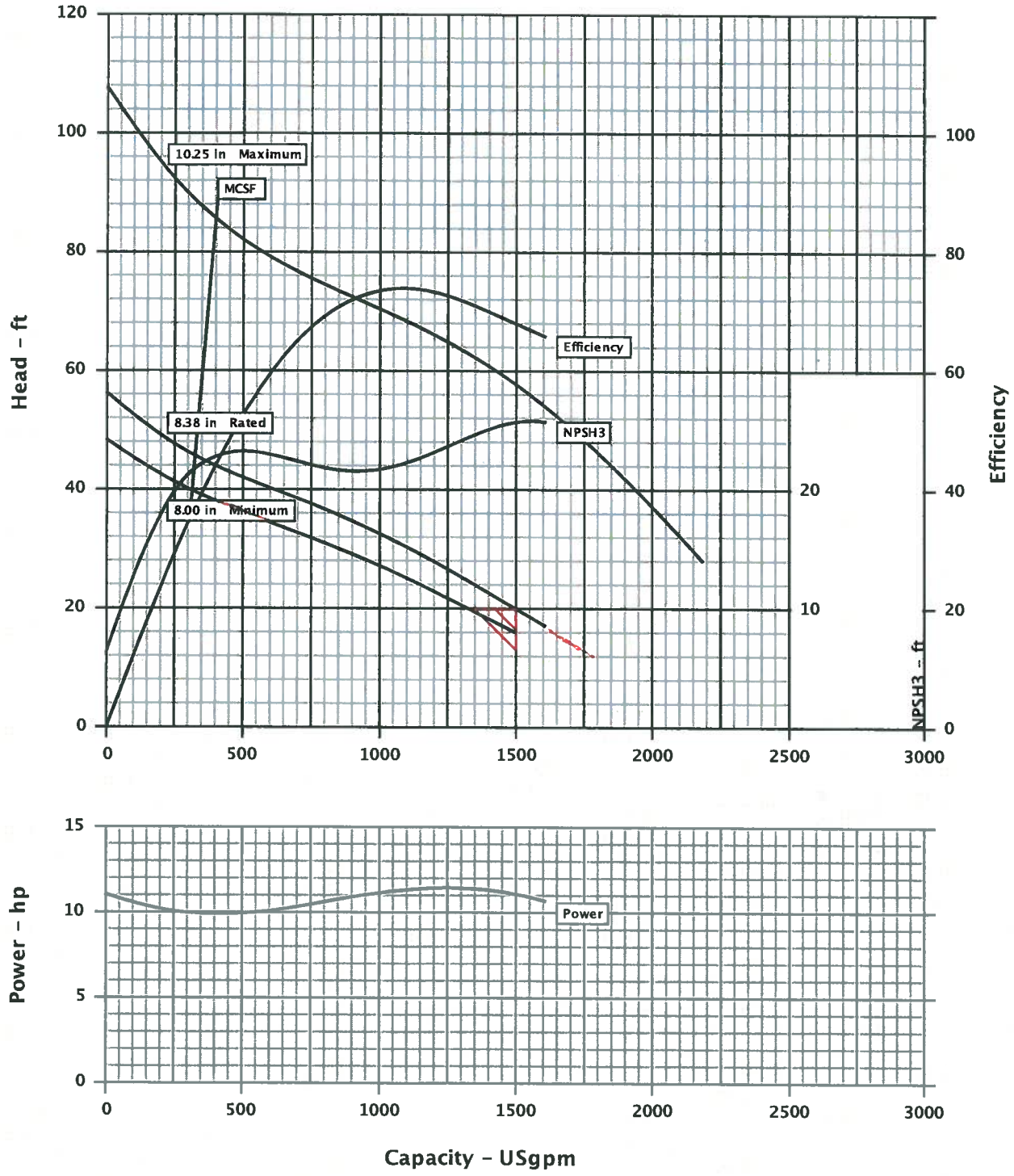


FLOWSERVE

Pump size & type	: 6MSX10A
Based on curve no.	: 89123376B
Number of stages	: 1

Customer	: Cortech Engineering	Capacity	: 1500.0 USgpm
Item number	: ATKINS	Head	: 20.00 ft
Service	:	Specific gravity	: 1.000
Flowserve reference	: 366720149	Pump speed	: 1760 rpm
Date	: May 1, 2015	Test tolerance	: Hydraulic Institute Level A

CURVES ARE APPROXIMATE. PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS: CAPACITY, HEAD, AND EFFICIENCY.



FLOWSERVE

Hydraulic Datasheet

Customer	: Cortech Engineering	Pump / Stages	: 6MSX10A	/ 1
Customer reference	:	Based on curve no.	: 89123376B	
Item number	: ATKINS	Flowserve reference	: 366720149	
Service	:	Date	: May 1, 2015	

Operating Conditions

Capacity	: 1500.0 USgpm
Water capacity (CQ=1.00)	: -
Normal capacity	: -
Total developed head	: 20.00 ft
Water head (CH=1.00)	: -
NPSH available (NPSHa)	: Ample
NPSHa less NPSH margin	: -
Maximum suction pressure	: 0.0 psig

Liquid

Liquid type	: Other		
Temperature / Spec. Gravity	: 68 F	/	1.000
Solid Size - Actual / Limit	: -	/	3.00 in
Viscosity / Vapor pressure	: 1.00 cSt	/	-

Materials / Specification

Material column code	: STD
Pump specification	: HI Standards

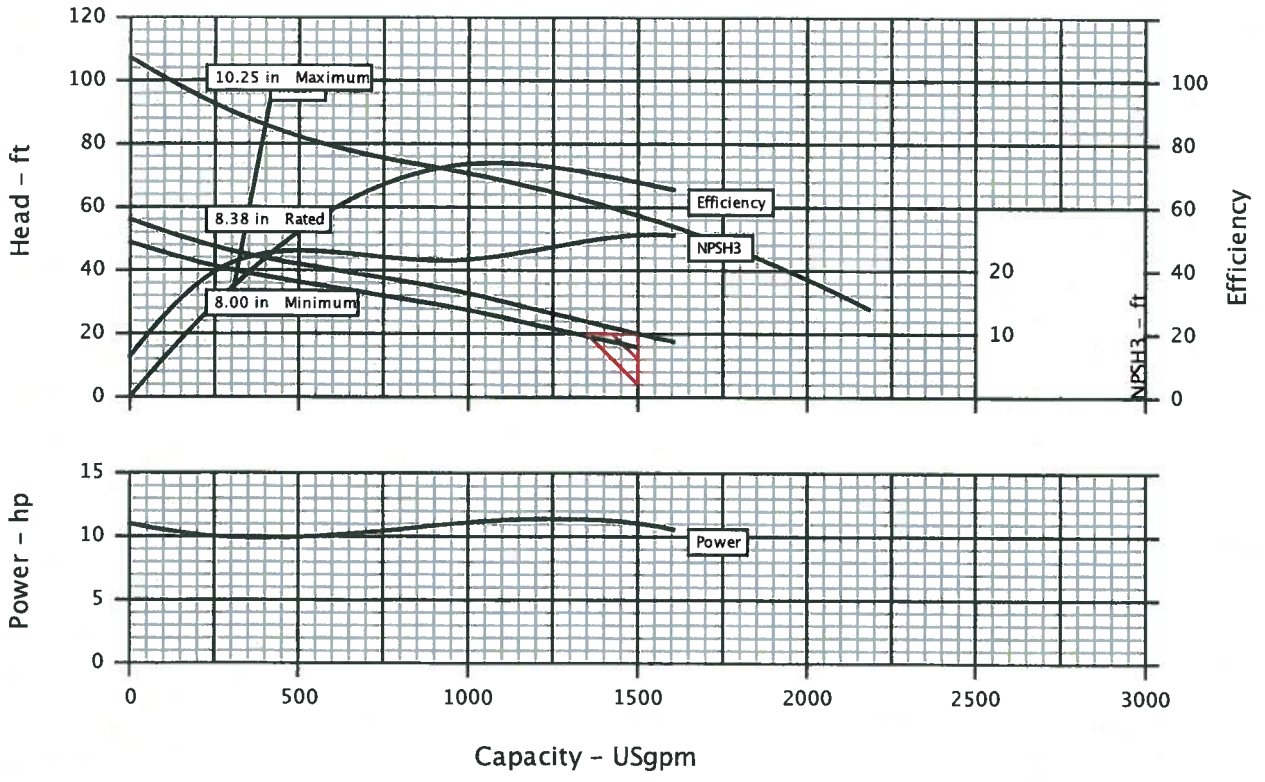
Other Requirements

Hydraulic selection : No specification
Construction : No specification
Test tolerance : Hydraulic Institute Level A
Driver Sizing : Max Power (SO to EOC) w/o SF

Performance

Hydraulic power	: 7.58 hp	Impeller diameter	
Pump speed	: 1760 rpm	Rated	: 8.38 in
Pump overall efficiency (CE=1.00)	: 68.0 %	Maximum	: 10.25 in
		Minimum	: 8.00 in
NPSH required (NPSH3)	: 26.0 ft	Suction specific speed	: 6400 US units
Rated power	: 11.1 hp	Minimum continuous flow	: 323.8 USgpm
Maximum power	: 11.5 hp	Maximum head @ rated dia	: 56.22 ft
Driver power	: 15.0 hp / 11.2 kW	Flow at BEP	: 1074.6 USgpm
Casing working pressure	: 24.3 psig	Flow as % of BEP	: 139.6 %
(based on shut off @ cut dia/rated SG)		Efficiency at normal flow	: -
Maximum allowable	: 49.0 psig	Impeller dia ratio (rated/max)	: 81.7 %
Hydrostatic test pressure	: 74.0 psig	Head rise to shut off	: 181.1 %
Est. rated seal chamb. press.	: -	Total head ratio (rated/max)	: 34.5 %

CURVES ARE APPROXIMATE, PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS; CAPACITY, HEAD, AND EFFICIENCY.



FLOWSERVE

Construction Datasheet

Customer	: Cortech Engineering		Pump / Stages	: 6MSX10A	/ 1
Customer reference	:		Based on curve no.	: 89123376B	
Item number	: ATKINS		Flowserve reference	: 366720149	
Service	:		Date	: May 1, 2015	

Construction

Nozzles	Size	Rating	Face	Pos'n
Suction	5.62"	125#	FF	Bottom
Discharge	6"	125#	FF	Side

Casing mounting	: Vertical
Casing split	: Axial
Impeller type	: Closed; Double Vane
Bearing type (radial)	: Single Row
Bearing number (radial)	: Refer
Bearing type (thrust)	: DR Ang. Contact
Bearing number (thrust)	: Refer
Bearing lubrication	: Grease
Rotation (view from cplg)	: CW per Hyd. Institute

Materials

Casing	: Cast Iron
Impeller	: Cast iron
Case wear ring	: 400 Series Hard SS
Impeller wear ring	: CA15 SS
Inducer	: N/A
Shaft	: 400 Series St Stl
Sleeve	: N/A

Baseplate, Coupling and Guard

Baseplate type	: N/A
Baseplate material	: N/A
Coupling manufacturer	: N/A
Coupling size	:
Coupling / Shaft guard	: N/A

Weights (Approx.)

Bareshaft pump(nett)	: 1150.0 lb
Baseplate(nett)	: -
Driver(nett)	: -
Shipping gross weight/vol.	: 1170.0 lb / REFER

Testing

Hydrostatic test	: None
Performance test	: Non witnessed
NPSH test	: None

Paint and Package

Pump paint	: Powder Coat Epoxy
Base grout surface prep	: N/A
Shipment type	: Domestic

Driver Information

Manufacturer	: Flowserve
Power	: 15.0 hp / 11.2 kW
Service factor (req'st / act)	: 1.15 / -
Speed	: 1800
Orientation / Mounting	: Vertical / Other
Driver Type	: Submersible
Frame-size / material	: /
Enclosure	: Submersible
Hazardous area class	: None
Explosion 'T' rating	: None
Volts / Phase / Hz	: 460 V / 3 / 60 Hz
Amps-full load/locked rotor	: - / -
Motor starting	: Direct on line (DOL)
Insulation	: H
Temperature rise	: 95 C
Bearings	: Other
Lubrication	: Grease
Motor mounted by	: Flowserve

Sound Pressure (dBA @ 1.0 m)

Driver, expected	: -
Pump & driver, estimated	: -

Seal Information

Arrangement	: Double Mechanical
Size	: As Required
Manufacturer / Type	: John Crane / As Required
Material code (Man'f/API)	: N/A / N/A
Internal neck bushing	: N/A

Gland

Gland material	: N/A
Flush	: N/A
Vent	: N/A
Drain	: N/A
Auxiliary seal device	: N/A

Piping

Seal flush plan	: None
Seal flush construction	: Other
Seal flush material	: Other
Aux seal flush plan	: Other
Aux seal flush construction	: Other
Aux seal flush material	: Other

Notes

3" Solids Size (minimum)

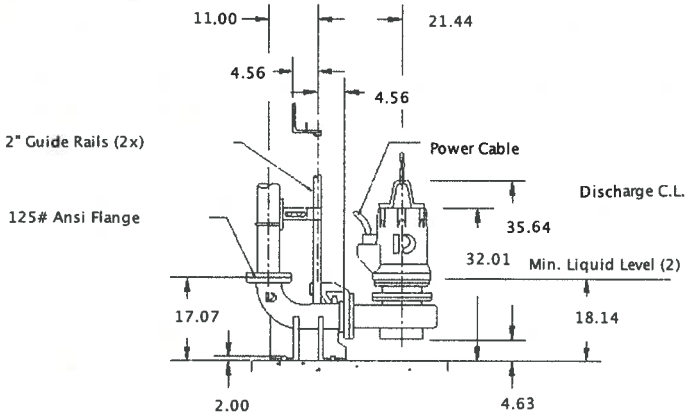
Motor meets EPACT Efficiencies

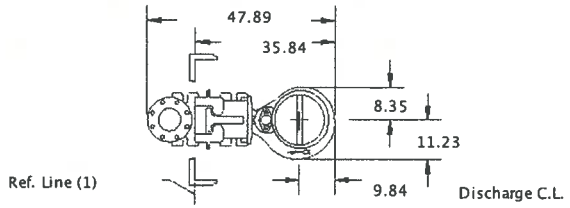
Class H Motor Insulation Std.

35 Feet of Cable included

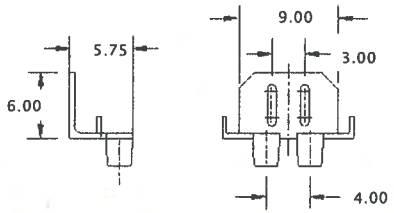
O-Rings Buna-N

Viton Cable Entry Material

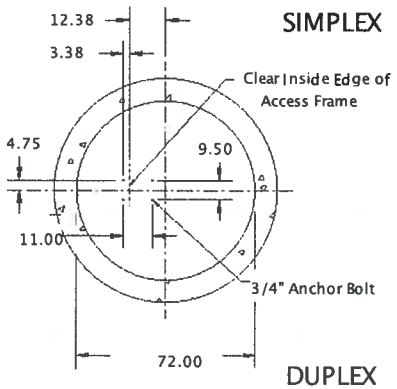


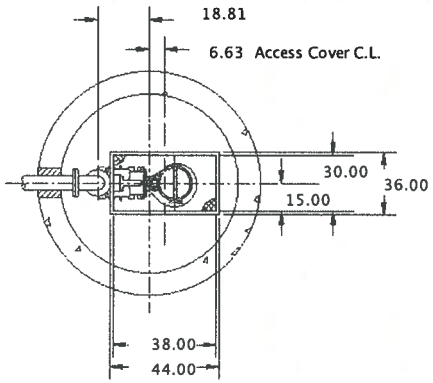


UPPER GUIDE BRACKET



SIMPLEX





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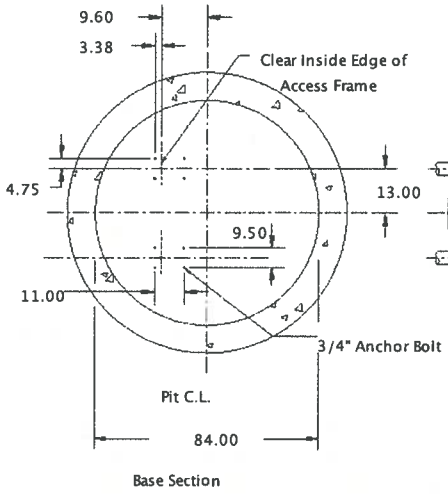
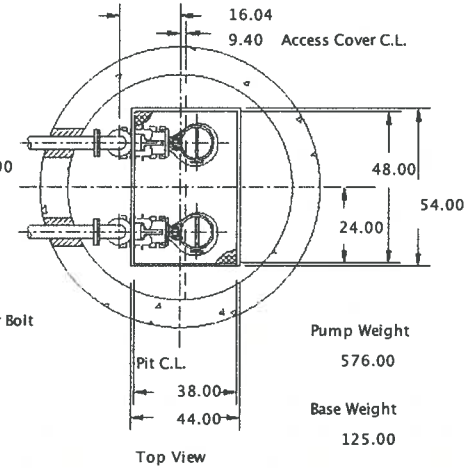


Base Section



Top View

Pump Weight
576.00

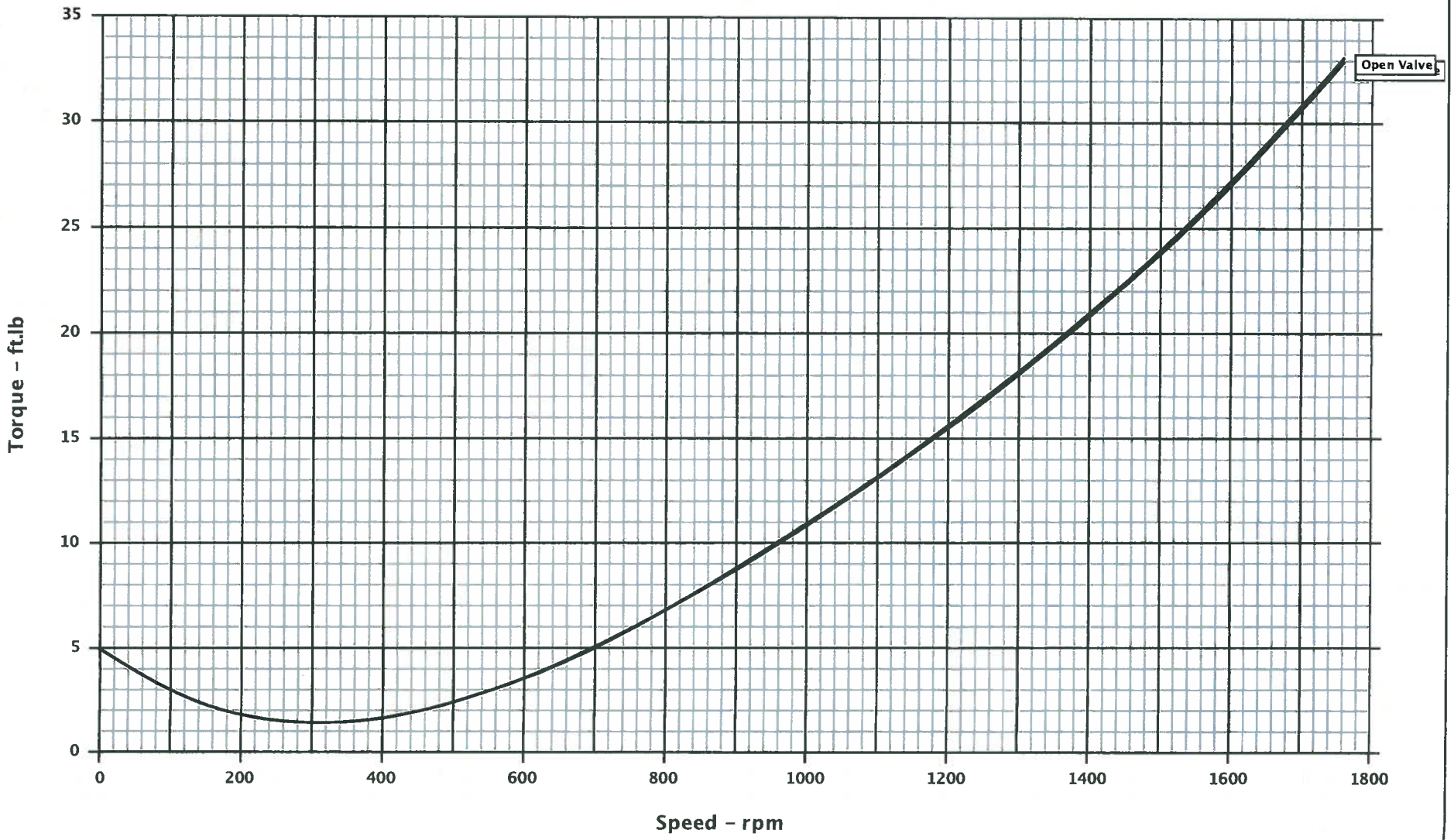
Base Weight
125.00

Notes:
(1)Indicates Inside Edge of Access Frame
(2)Min. Liquid Level For Cont. Operation

All dimensions are in inches unless otherwise specified

Customer	: Cortech Engineering	Pump size & type	: 6MSX10A	Drawing number	: -
Item number	: ATKINS	Pump speed / Stages	: 1760 rpm / 1	Date	: May 1, 2015
Service	:	Flow / Head	: 1500.0 USgpm / 20.00 ft	Certified by / Date :	: -
Customer PO #	: -	Driver power / Frame	: 15.0 hp / 11.2 kW /	Seal type	: As Required
Flowserve reference	: 366720149	Volts / Phase / Hz	: 460 / 3 / 60	Seal flush plan	: None

Customer	: Cortech Engineering			Pump size & type	: 6MSX10A
Item number	: ATKINS			Based on curve no.	: 89123376B
Service	:			Number of stages	: 1
Flowserve reference	: 366720149				
Date	: May 1, 2015				
		Capacity	: 1500.0 USgpm	Specific gravity	: 1.000
		Head	: 20.00 ft	Pump speed	: 1760 rpm



FLOWSERVE

Additional Details

Customer	: Cortech Engineering	Pump / Stages	: 6MSX10A / 1
Customer reference	:	Based on curve no.	: 89123376B
Item number	: ATKINS	Flowserve reference	: 366720149
Service	:	Date	: May 1, 2015

Duty Conditions

Quantity of pumps	: 3
Liquid description	:
Liquid type	: Other
Frequency	: 60 Hz
Flammable	: No
Toxic	: No
H2S	: N
Rated flow	: 1,500.0 USgpm
Rated head	: 20.00 ft
NPSHa	: Ample ft
Viscosity	: 1.00 cSt
Specific gravity	: 1.000
Maximum suction pressure	: 0.0 psig
Rated suction pressure	: 0.0 psig
Temperature	: 68 F
Vapor pressure	: 0.00 psia
Altitude	: 0.00 ft
Pump length strategy used	: -
Requested pump material	: STD
Selected pump material	: STD

Performance

Hydraulic power	: 7.58 hp
Overall Efficiency	: 68.0 %
NPSH3 @ impeller	: 26.0 ft
Rated power	: 11.1 hp
Maximum power	: 11.5 hp
Motor rating	: 15.0 hp / 11.2 kW
Suction specific speed	: 6,400 Nss
MCSF	: 323.8 USgpm
Rated impeller diameter	: 8.38 in
Maximum impeller diameter	: 10.25 in
Minimum impeller diameter	: 8.00 in
Maximum head	: 56.22 ft
Flow at BEP	: 1,074.6 USgpm
Flow as % of BEP	: 139.6 %
Rated/max diameter	: 81.7 %
Head rise to shut off	: 181.1 %
Rated/max head	: 34.5 %
Visc. capacity correction factor (CQ)	: 1.00
Visc. Head Correction Factor (CH)	: 1.00
Visc. Eff. Correction Factor (CE)	: 1.00

Selection

Pump type	: MSX Wet	Business unit	: Taneytown
Speed	: 1760 rpm	Selection	: Acceptable
Pump reference	: 25		

Working Pressure Limits

Casing assembly MRWP	: 24.3 psig
Suction region MRWP	: 0.0 psig
Discharge region MRWP	: N/A
Casing Assembly MAWP	: 49.0 psig
Suction region MAWP	: 50.0 psig
Discharge Region MAWP	: 49.0 psig

Actual Pressure Values

Casing pressure (based on shut off @ cut dia/rated SG)	: 24.3 psig
Allowed discharge	: 49.0 psig
Allowed suction	: 50.0 psig
Seal chamber pressure	: 0.0 psig
Maximum discharge pressure	: N/A
Maximum suction pressure	: 0.0 psig
Casing design	: Wet Pit (Rail Mounted)
Discharge flange rating	: N/A
Suction flange rating	: N/A

Hydrostatic Test Pressures

Casing hydrotest pressure	: 74.0 psig	Suction region hydrotest pressure	: 74.0 psig
Discharge region hydrotest pressure	: 74.0 psig		

Performance Corrections and Factors

Mechanical Seal / Packing	: N/A	Bearing configuration	: N/A
Auxiliary seal	: N/A	Back wear ring supply	: N/A
Clearances	: N/A	Solid size	: 0.00 in
Shaft configuration	: N/A	Solid size limit	: 3.00 in
Orifice plate diameter	: 0.00 in	Torque rating (max power)	: 0.65 hp/100 rpm
Energy density	: 0 hp/min	Torque rating (rated power)	: 0.63 hp/100 rpm
dN (API 7th) / dmN (API 8th)	: 0.00 ft/s	Torque limit	: 2.00 hp/100 rpm

FLOWSERVE

Additional Details

Customer	: Cortech Engineering	Pump / Stages	: 6MSX10A	/ 1
Customer reference	:	Based on curve no.	: 89123376B	
Item number	: ATKINS	Flowserve reference	: 366720149	
Service	:	Date	: May 1, 2015	

Shaft Deflection and Bearing Life

Shaft deflection (rated)	: -	Radial bearing life (shut off)	: -
Shaft deflection limit (rated)	: -	Radial bearing life limit (shut off)	: -
Shaft deflection (shut off)	: -	Thrust bearing life (rated)	: 0 h
Shaft deflection limit (shut off)	: -	Thrust bearing life limit (rated)	: 0 h
Radial bearing life (rated)	: -	Thrust bearing life (shut off)	: 0 h
Radial bearing life limit (rated)	: -	Thrust bearing life limit (shut off)	: 0 h

User Messages

FLOWSERVE

Pricing Sheet / Scope of Supply

Customer:	Cortech Engineering	Pump / Stg:	6MSX10A/1
Cust / Proj Ref:		Curve Number:	89123376B
Item Number:	ATKINS	FLS # / Reference:	366720149 /
Service:		Date:	May 1, 2015

Qty	Description	Average Unit Price	Extended Price
3	6MSX10A FPD - STD Wet Pit Pump - Rail Mountable Design Motor Size (15.0 hp 1800 RPM) Standard Motor Enclosure; No Approvals NOT SUPPLIED - Terminal Board Three-Phase 460 volts 60 Hz Frame 12 NOT SUPPLIED - Motor Winding RTD's NOT SUPPLIED - Lower Bearing RTD NOT SUPPLIED - Upper Bearing RTD 35 ft Power/Control Cable (Standard) Standard Cable Configuration Qty 1 Cable (1 Power/Control) Cable Grips (includes rqd qty PER PUMP) Stator Housing Material - Cast Iron Pump Casing Material - Cast Iron Casing Wear Ring - 400 Series Hard'nd SS Impeller Material - Cast Iron Impeller Wear Ring - CA15 Hardened SS Shaft Material - 400 Series SS Pump O-ring - BUNA N Cable Entry Grommet - Neoprene Lower Seal-Silicn/Silicn - BUNA N Elast Upper Seal-Carbon/Ceramic - BUNA N Elast Casing Exterior Coating - Epoxy Stator Hsg Ext Coating - Epoxy Slotted Discharge Flanges (ANSI/ISO) 2 inch Double Rail Hardware Cast Iron Double Rail Discharge Base 6"x6" Non-increasing dischrg base elbow Duct Iron Slide Bracket - 2" Double Rail Ductile Iron Dbl Rail Upper Guide Brkt WALL Mount Ductile Iron Intrm Guide Brkt		

Feature quantities match pump quantity unless otherwise noted.

Prices may be subject to exchange rate fluctuations. Proposal is valid for 60 days.

Customer:	Cortech Engineering	Pump / Stg:	6MSX10A/1
Cust / Proj Ref:		Curve Number:	89123376B
Item Number:	ATKINS	FLS # / Reference:	366720149 /
Service:		Date:	May 1, 2015

Qty	Description	Average Unit Price	Extended Price
	NOT SUPPLIED - Rail Pipe 30' SS Lifting Cable Assy Grab Link Assembly SS Grab Link (Equal to Flygt Grip Eye) 3 Ft of SS Chain (Included w/ Grab Link) 50Ft Nylon Guide Rope (Incl w/Grab Link) NOT SUPPLIED - Adjustable Portable Hoist Standard Moisture Probe Supplied Moisture Probe RELAY NON-Witnessed FACTORY Performance Test No Curve Approval required NOT SUPPLIED - Variable Speed Testing NOT SUPPLIED - Vibration Testing NOT SUPPLIED - Casing Hydrostatic Test Basic FACTORY Inspect & Operational Test O&M Manual - English NOT SUPPLIED - Spare Parts Flowserve's Standard Packaging FOB Factory - Freight Prepaid & ADD		
3	Driver (Price incl'd above - Ignore "0" price)		

Customer Comments

Shipment (after receipt of order and full release to manufacture) is 11 working weeks.

Feature quantities match pump quantity unless otherwise noted.

Prices may be subject to exchange rate fluctuations. Proposal is valid for 60 days.

FLOWSERVE

Price Make Up

Customer:	Cortech Engineering	Pump / Stg:	6MSX10A/1
Cust / Proj Ref:		Curve Number:	89123376B
Item Number:	ATKINS	FLS # / Reference:	366720149 /
Service:		Date:	May 1, 2015

Qty	Description	Ship	Unit List	C*	Mult	Net	Exch	Net
3	6MSX10A FPD - STD	ADD 6	USD 11888		1.000	35664	1.000	USD 35664
	Wet Pit Pump - Rail Mountable Design							
	\Horsepower rated motor							
	Motor Size (15.0 hp 1800 RPM)							
	Standard Motor Enclosure; No Approvals		STD					
	NOT SUPPLIED - Terminal Board		STD					
	Three-Phase							
	460 volts 60 Hz		N/C					
	Frame 12							
	\Series 1							
	\QTY 3 Motor Klixon thermostats included		STD					
	NOT SUPPLIED - Motor Winding RTD's		STD					
	NOT SUPPLIED - Lower Bearing RTD		STD					
	NOT SUPPLIED - Upper Bearing RTD		STD					
	\NO Motor RTD's Supplied		STD					
	35 ft Power/Control Cable (Standard)		STD					
	Standard Cable Configuration							
	Qty 1 Cable (1 Power/Control)		STD					
3	Cable Grips (includes rqd qty PER PUMP)		USD 227		1.000	681	1.000	USD 681
	\NOT SUPPLIED - Float Switch Bracket		STD					
	Stator Housing Material - Cast Iron		STD					
	Pump Casing Material - Cast Iron		STD					
3	Casing Wear Ring - 400 Series Hard'nd SS	CO6 4	USD 647		1.000	1941	1.000	USD 1941
	Impeller Material - Cast Iron		STD					
3	Impeller Wear Ring - CA15 Hardened SS	CO6 4	USD 527		1.000	1581	1.000	USD 1581
	Shaft Material - 400 Series SS		STD					
	\Options For "Std" Material Selection							
	Pump O-ring - BUNA N		STD					
	\Options For "Std" Material Selection							
	Cable Entry Grommet - Neoprene		STD					
	\Options For "Std" Material Selection							
	Lower Seal-Silicn/Silicn - BUNA N Elast		STD					

* - S = special; M = Multiplier Change; R = Refer Feature; A = Alliance Multiplier; F = Freight; E = Export Boxing

* - % = % of total price minus any other % prices; %P = % of total price minus motor and any other % prices; %T = % of total price

Prices may be subject to exchange rate fluctuations. Proposal is valid for 60 days.

Customer:	Cortech Engineering	Pump / Stg:	6MSX10A/1
Cust / Proj Ref:		Curve Number:	89123376B
Item Number:	ATKINS	FLS # / Reference:	366720149 /
Service:		Date:	May 1, 2015

Qty	Description	Ship	Unit List	C*	Mult	Net	Exch	Net
	\Options For "Std" Material Selection							
	Upper Seal-Carbon/Ceramic - BUNA N Elast		STD					
	Casing Exterior Coating - Epoxy		STD					
	Stator Hsg Ext Coating - Epoxy		STD					
	Slotted Discharge Flanges (ANSI/ISO)		STD					
	2 inch Double Rail Hardware							
	Cast Iron Double Rail Discharge Base							
	\Discharge Base w/ NON-increasing elbow							
3	6"x6" Non-increasing dischrg base elbow		USD 1266		1.000	3798	1.000	USD 3798
3	Duct Iron Slide Bracket - 2" Double Rail		USD 754		1.000	2262	1.000	USD 2262
3	Ductile Iron Dbl Rail Upper Guide Brkt		USD 162		1.000	486	1.000	USD 486
3	WALL Mount Ductile Iron Intrm Guide Brkt		USD 339		1.000	1017	1.000	USD 1017
	\READ NOTE!!!!							
	NOT SUPPLIED - Rail Pipe		STD					
	\NOT SUPPLIED - Transportable Stand							
3	30' SS Lifting Cable Assy		USD 361		1.000	1083	1.000	USD 1083
3	Grab Link Assembly		USD 459		1.000	1377	1.000	USD 1377
	SS Grab Link (Equal to Flygt Grip Eye)							
	3 Ft of SS Chain (Included w/ Grab Link)							
	50Ft Nylon Guide Rope (Incl w/Grab Link)							
	NOT SUPPLIED - Adjustable Portable Hoist		STD					
	\NOT SUPPLIED - Cap/Relays f/ Single Phs							
	Standard Moisture Probe Supplied		STD					
3	Moisture Probe RELAY	ADD 0	USD 525		1.000	1575	1.000	USD 1575
	\NOT SUPPLIED - Access Cover		STD					
	\Add Add'l Accessories Here As Specials							
3	NON-Witnessed FACTORY Performance Test	ADD 1	USD 1047		1.000	3141	1.000	USD 3141
	No Curve Approval required		STD					
	NOT SUPPLIED - Variable Speed Testing		STD					
	NOT SUPPLIED - Vibration Testing		STD					
	NOT SUPPLIED - Casing Hydrostatic Test		STD					
	Basic FACTORY Inspect & Operational Test		STD					
	O&M Manual - English		STD					
	NOT SUPPLIED - Spare Parts							
	\NOT SUPPLIED - Start-up Supervision		STD					
	\NO COMMISSION INCLUDED		STD					
	Flowserve's Standard Packaging		STD					
	FOB Factory - Freight Prepaid & ADD		STD					

SUB TOTAL: USD 54606

* - S = special; M = Multiplier Change; R = Refer Feature; A = Alliance Multiplier; F = Freight; E = Export Boxing

* - % = % of total price minus any other % prices; %P = % of total price minus motor and any other % prices; %T = % of total price

Prices may be subject to exchange rate fluctuations. Proposal is valid for 60 days.

Customer:	Cortech Engineering	Pump / Stg:	6MSX10A/1
Cust / Proj Ref:		Curve Number:	89123376B
Item Number:	ATKINS	FLS # / Reference:	366720149 /
Service:		Date:	May 1, 2015

Qty	Description	Ship	Unit List	C*	Mult	Net	Exch	Net
	(Price incl'd above - Ignore "0" price)							

TOTAL: USD 54606

Customer Comments

Shipment (after receipt of order and full release to manufacture) is 11 working weeks.

* - S = special; M = Multiplier Change; R = Refer Feature; A = Alliance Multiplier; F = Freight; E = Export Boxing

* - % = % of total price minus any other % prices; %P = % of total price minus motor and any other % prices; %T = % of total price

Prices may be subject to exchange rate fluctuations. Proposal is valid for 60 days.

C. Permanent Stormwater Quality Facilities

C.1 EDB Calculations

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: South Platte Directly - "Onsite" Pond located north of Brighton Blvd. and Race Ct.

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 100.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 1.000
C) Contributing Watershed Area	Area = 27.600 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: (●) Water Quality Capture Volume (WQCV) ( ) Excess Urban Runoff Volume (EURV)
F) Design Volume (1.2 WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area * 1.2)$)	V_{DESIGN} = 1.380 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))$)	$V_{DESIGN\ OTHER}$ = ____ ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$ = ____ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One: ( ) A ( ) B ( ) C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = (0.1878i - 0.0104) * Area$ For HSG B: $EURV_B = (0.1178i - 0.0042) * Area$ For HSG C/D: $EURV_{C/D} = (0.1043i - 0.0031) * Area$	EURV = ____ ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: South Platte Directly - "Onsite" Pond located north of Brighton Blvd. and Race Ct.

5. Forebay		
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.035	ac-ft
B) Actual Forebay Volume	V_F = 40.000	ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 30.0	in
D) Forebay Discharge		
i) Undetained 100-year Peak Discharge	Q_{100} = 128.00	cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 2.56	cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir	
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P =	in
G) Rectangular Notch Width	Calculated W_N = 8.3	in
6. Trickle Channel		
A) Type of Trickle Channel	Choose One: ◉ Concrete ○ Soft Bottom	
F) Slope of Trickle Channel	S = 0.0050	ft / ft
7. Micropool and Outlet Structure		
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5	ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 65	sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate ○ Other (Describe):	
D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E.	H = 2.50	feet
E) Volume to Drain Over Prescribed Time	WQCV = 1.150	ac-ft
F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours)	t_D = 40	hours
G) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 2.46	square inches
H) Orifice Dimensions: i) Circular Orifice Diameter or	$D_{orifice}$ = 1 - 3 / 4	inches
ii) Width of 2" High Rectangular Orifice	$W_{orifice}$ =	inches
I) Number of Columns	n_c = 1	number
J) Actual Design Outlet Area per Row (A_o)	A_o = 2.41	square inches
K) Number of Rows (nr)	n_r = 7	number
L) Total Outlet Area (A_{ot})	A_{ot} = 18.0	square inches
M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV})	H_{WQCV} =	feet
N) Ensure Minimum 40 Hour Drain Time for WQCV	$T_{D\ WQCV}$ =	hours

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: South Platte Directly - "Onsite" Pond located north of Brighton Blvd. and Race Ct.

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)
D_{IS} = 30.0 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)
V_{IS} = 150.3 cu ft

C) Initial Surcharge Provided Above Micropool
V_s = 162.5 cu ft

9. Trash Rack

A) Type of Water Quality Orifice Used
Choose One
- ○ Circular (up to 1-1/4" diameter)
- ◉ Circular (greater than 1-1/4" diameter) OR Rectangular (2" high)

B) Water Quality Screen Open Area: $A_t = Aot * 38.5*(e^{-0.095D})$
A_t = 588 square inches

C) For 1-1/4"", or Smaller, Circular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen and Concrete Opening ($W_{opening}$)
$W_{opening}$ = inches

ii) Height of Water Quality Screen (H_{TR})
H_{TR} = inches

iii) Type of Screen, Describe if "Other"
Choose One
- ○ S.S. Well Screen with 60% Open Area*
- ○ Other (Describe):

D) For Circular Opening (greater than 1-1/4" diameter) OR 2" High Rectangular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen Opening ($W_{opening}$)
$W_{opening}$ = 1.2 ft

ii) Height of Water Quality Screen (H_{TR})
H_{TR} = 4.8 ft

iii) Type of Screen, Describe if "Other"
Choose One
- ◉ Aluminum Amico-Klemp SR Series (or equal)
- ○ Other (Describe):

v) Cross-bar Spacing
2.0 inches

vi) Minimum Bearing Bar Size
1-1/4 inch x 3/16 inch

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: South Platte Directly - "Onsite" Pond located north of Brighton Blvd. and Race Ct.

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Overflow will overtop pond to surrounding, vegetated area.
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z_E = _____ ft / ft
	Choose One
11. Vegetation	○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	Annual, local maintenance with vacuum trucks.

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the West - Northeast Gore I-70 and Quebec Interchange

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 100.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 1.000

C) Contributing Watershed Area — Area = 27.500 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One

- (●) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (1.2 WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area * 1.2)$) — V_{DESIGN} = 1.375 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))$) — $V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ____ ac-ft

I) Predominant Watershed NRCS Soil Group

Choose One

- ( ) A
- ( ) B
- ( ) C / D

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = (0.1878i - 0.0104) * Area$
For HSG B: $EURV_B = (0.1178i - 0.0042) * Area$
For HSG C/D: $EURV_{C/D} = (0.1043i - 0.0031) * Area$

EURV = ____ ac-f t

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.5 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations: Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the West - Northeast Gore I-70 and Quebec Interchange

5. Forebay		
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.034	ac-ft
B) Actual Forebay Volume	V_F = 0.040	ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 18.0	in
D) Forebay Discharge		
i) Undetained 100-year Peak Discharge	Q_{100} = 52.07	cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 1.04	cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir	
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P =	in
G) Rectangular Notch Width	Calculated W_N = 5.6	in
6. Trickle Channel		
A) Type of Trickle Channel	Choose One: ◉ Concrete ○ Soft Bottom	
F) Slope of Trickle Channel	S = 0.0050	ft / ft
7. Micropool and Outlet Structure		
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5	ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 60	sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate ○ Other (Describe):	
D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E.	H = 6.00	feet
E) Volume to Drain Over Prescribed Time	WQCV = 1.146	ac-ft
F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours)	t_D = 40	hours
G) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 1.53	square inches
H) Orifice Dimensions: i) Circular Orifice Diameter or	$D_{orifice}$ = 1 - 3 / 8	inches
ii) Width of 2" High Rectangular Orifice	$W_{orifice}$ =	inches
I) Number of Columns	n_c = 1	number
J) Actual Design Outlet Area per Row (A_o)	A_o = 1.48	square inches
K) Number of Rows (nr)	n_r = 18	number
L) Total Outlet Area (A_{ot})	A_{ot} = 26.7	square inches
M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV})	H_{WQCV} =	feet
N) Ensure Minimum 40 Hour Drain Time for WQCV	$T_{D\ WQCV}$ =	hours

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the West - Northeast Gore I-70 and Quebec Interchange

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches): D_{IS} = 30.0 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV): V_{IS} = 149.7 cu ft

C) Initial Surcharge Provided Above Micropool: V_s = 150.0 cu ft

9. Trash Rack

A) Type of Water Quality Orifice Used

Choose One
- ○ Circular (up to 1-1/4" diameter)
- ◉ Circular (greater than 1-1/4" diameter) OR Rectangular (2" high)

B) Water Quality Screen Open Area: $A_t = Aot * 38.5*(e^{-0.095D})$: A_t = 903 square inches

C) For 1-1/4"", or Smaller, Circular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen and Concrete Opening ($W_{opening}$): $W_{opening}$ = inches

ii) Height of Water Quality Screen (H_{TR}): H_{TR} = inches

iii) Type of Screen, Describe if "Other"

Choose One
- ○ S.S. Well Screen with 60% Open Area*
- ○ Other (Describe):

D) For Circular Opening (greater than 1-1/4" diameter) OR 2" High Rectangular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen Opening ($W_{opening}$): $W_{opening}$ = 1.1 ft

ii) Height of Water Quality Screen (H_{TR}): H_{TR} = 8.3 ft

iii) Type of Screen, Describe if "Other"

Choose One
- ◉ Aluminum Amico-Klemp SR Series (or equal)
- ○ Other (Describe):

v) Cross-bar Spacing: 2.0 inches

vi) Minimum Bearing Bar Size: 2-1/4 inch x 3/16 inch

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the West - Northeast Gore I-70 and Quebec Interchange

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Overflow will overtop roadway.
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z_E = _____ ft / ft
	Choose One
11. Vegetation	○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Annual, local maintenance with vacuum trucks.

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the East - Southeast Gore I-70 and Havana Street Interchange

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 100.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 1.000

C) Contributing Watershed Area — Area = 32.400 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One

- (•) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (1.2 WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area * 1.2)$) — V_{DESIGN} = 1.620 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))$) — $V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ____ ac-ft

I) Predominant Watershed NRCS Soil Group

Choose One

- ( ) A
- ( ) B
- ( ) C / D

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = (0.1878i - 0.0104) * Area$
For HSG B: $EURV_B = (0.1178i - 0.0042) * Area$
For HSG C/D: $EURV_{C/D} = (0.1043i - 0.0031) * Area$
EURV = ____ ac-ft

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.1 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 3.00 ft / ft
DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations: Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the East - Southeast Gore I-70 and Havana Street Interchange

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV) — V_{FMIN} = 0.041 ac-ft

B) Actual Forebay Volume — V_F = 0.050 ac-ft

C) Forebay Depth (D_F = 30 inch maximum) — D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 128.00 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 2.56 cfs

E) Forebay Discharge Design — Choose One: ○ Berm With Pipe; ◉ Wall with Rect. Notch; ○ Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 8.6 in

6. Trickle Channel

A) Type of Trickle Channel — Choose One: ◉ Concrete; ○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 75 sq ft

C) Outlet Type — Choose One: ◉ Orifice Plate; ○ Other (Describe):

D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E. — H = 2.50 feet

E) Volume to Drain Over Prescribed Time — WQCV = 1.350 ac-ft

F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours) — t_D = 40 hours

G) Recommended Maximum Outlet Area per Row, (A_o) — A_o = 2.84 square inches

H) Orifice Dimensions:
i) Circular Orifice Diameter or — $D_{orifice}$ = 1 - 7 / 8 inches
ii) Width of 2" High Rectangular Orifice — $W_{orifice}$ = inches

I) Number of Columns — n_c = 1 number

J) Actual Design Outlet Area per Row (A_o) — A_o = 2.76 square inches

K) Number of Rows (nr) — n_r = 7 number

L) Total Outlet Area (A_{ot}) — A_{ot} = 20.7 square inches

M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV}) — H_{WQCV} = feet

N) Ensure Minimum 40 Hour Drain Time for WQCV — $T_{D\ WQCV}$ = hours

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the East - Southeast Gore I-70 and Havana Street Interchange

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = 30.0 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = 176.4 cu ft

C) Initial Surcharge Provided Above Micropool — V_s = 187.5 cu ft

9. Trash Rack

A) Type of Water Quality Orifice Used

Choose One
- ○ Circular (up to 1-1/4" diameter)
- ◉ Circular (greater than 1-1/4" diameter) OR Rectangular (2" high)

B) Water Quality Screen Open Area: $A_t = Aot * 38.5*(e^{-0.095D})$ — A_t = 667 square inches

C) For 1-1/4"", or Smaller, Circular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen and Concrete Opening ($W_{opening}$) — $W_{opening}$ = inches

ii) Height of Water Quality Screen (H_{TR}) — H_{TR} = inches

iii) Type of Screen, Describe if "Other"

Choose One
- ○ S.S. Well Screen with 60% Open Area*
- ○ Other (Describe):

D) For Circular Opening (greater than 1-1/4" diameter) OR 2" High Rectangular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen Opening ($W_{opening}$) — $W_{opening}$ = 1.4 ft

ii) Height of Water Quality Screen (H_{TR}) — H_{TR} = 4.8 ft

iii) Type of Screen, Describe if "Other"

Choose One
- ◉ Aluminum Amico-Klemp SR Series (or equal)
- ○ Other (Describe):

v) Cross-bar Spacing — 2.0 inches

vi) Minimum Bearing Bar Size — 1-1/4 inch x 3/16 inch

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Sand Creek from the East - Southeast Gore I-70 and Havana Street Interchange

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Overflow will overtop to Havana.
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z_E = _____ ft / ft
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Annual, local maintenance with vacuum trucks.

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Irondale Gulch - Northeast Gore of I-70 and Havana Interchange

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 100.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 1.000

C) Contributing Watershed Area — Area = 14.300 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One

- (●) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (1.2 WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area * 1.2)$) — V_{DESIGN} = 0.715 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ____ ac-ft

Choose One

I) Predominant Watershed NRCS Soil Group

- ( ) A
- ( ) B
- ( ) C / D

J) Excess Urban Runoff Volume (EURV) Design Volume — EURV = ____ ac-f t
For HSG A: $EURV_A = (0.1878i - 0.0104) * Area$
For HSG B: $EURV_B = (0.1178i - 0.0042) * Area$
For HSG C/D: $EURV_{C/D} = (0.1043i - 0.0031) * Area$

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 8.9 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 3.00 ft / ft
DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations: Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Irondale Gulch - Northeast Gore of I-70 and Havana Interchange

5. Forebay		
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.018	ac-ft
B) Actual Forebay Volume	V_F = 0.020	ac-ft
C) Forebay Depth (D_F = 18 inch maximum)	D_F = 18.0	in
D) Forebay Discharge		
i) Undetained 100-year Peak Discharge	Q_{100} = 19.18	cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 0.38	cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir	(flow too small for berm w/ pipe)
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P =	in
G) Rectangular Notch Width	Calculated W_N = 4.4	in
6. Trickle Channel		
A) Type of Trickle Channel	Choose One: ◉ Concrete ○ Soft Bottom	
F) Slope of Trickle Channel	S = 0.0050	ft / ft
7. Micropool and Outlet Structure		
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5	ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 35	sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate ○ Other (Describe):	
D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E.	H = 2.10	feet
E) Volume to Drain Over Prescribed Time	WQCV = 0.596	ac-ft
F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours)	t_D = 40	hours
G) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 1.51	square inches
H) Orifice Dimensions: i) Circular Orifice Diameter or	$D_{orifice}$ = 1 - 3 / 8	inches
ii) Width of 2" High Rectangular Orifice	$W_{orifice}$ =	inches
I) Number of Columns	n_c = 1	number
J) Actual Design Outlet Area per Row (A_o)	A_o = 1.48	square inches
K) Number of Rows (nr)	n_r = 6	number
L) Total Outlet Area (A_{ot})	A_{ot} = 9.4	square inches
M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV})	H_{WQCV} =	feet
N) Ensure Minimum 40 Hour Drain Time for WQCV	$T_{D\ WQCV}$ =	hours

Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Irondale Gulch - Northeast Gore of I-70 and Havana Interchange

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)
D_{IS} = 30.0 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)
V_{IS} = 77.9 cu ft

C) Initial Surcharge Provided Above Micropool
V_s = 87.5 cu ft

9. Trash Rack

A) Type of Water Quality Orifice Used
Choose One
- ○ Circular (up to 1-1/4" diameter)
- ◉ Circular (greater than 1-1/4" diameter) OR Rectangular (2" high)

B) Water Quality Screen Open Area: $A_t = Aot * 38.5*(e^{-0.095D})$
A_t = 316 square inches

C) For 1-1/4"", or Smaller, Circular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen and Concrete Opening ($W_{opening}$)
$W_{opening}$ = inches

ii) Height of Water Quality Screen (H_{TR})
H_{TR} = inches

iii) Type of Screen, Describe if "Other"
Choose One
- ○ S.S. Well Screen with 60% Open Area*
- ○ Other (Describe):

D) For Circular Opening (greater than 1-1/4" diameter) OR 2" High Rectangular Opening (See Fact Sheet T-12):

i) Width of Water Quality Screen Opening ($W_{opening}$)
$W_{opening}$ = 1.0 ft

ii) Height of Water Quality Screen (H_{TR})
H_{TR} = 4.4 ft

iii) Type of Screen, Describe if "Other"
Choose One
- ◉ Aluminum Amico-Klemp SR Series (or equal)
- ○ Other (Describe):

v) Cross-bar Spacing
2.0 inches

vi) Minimum Bearing Bar Size
1-1/4 inch x 3/16 inch

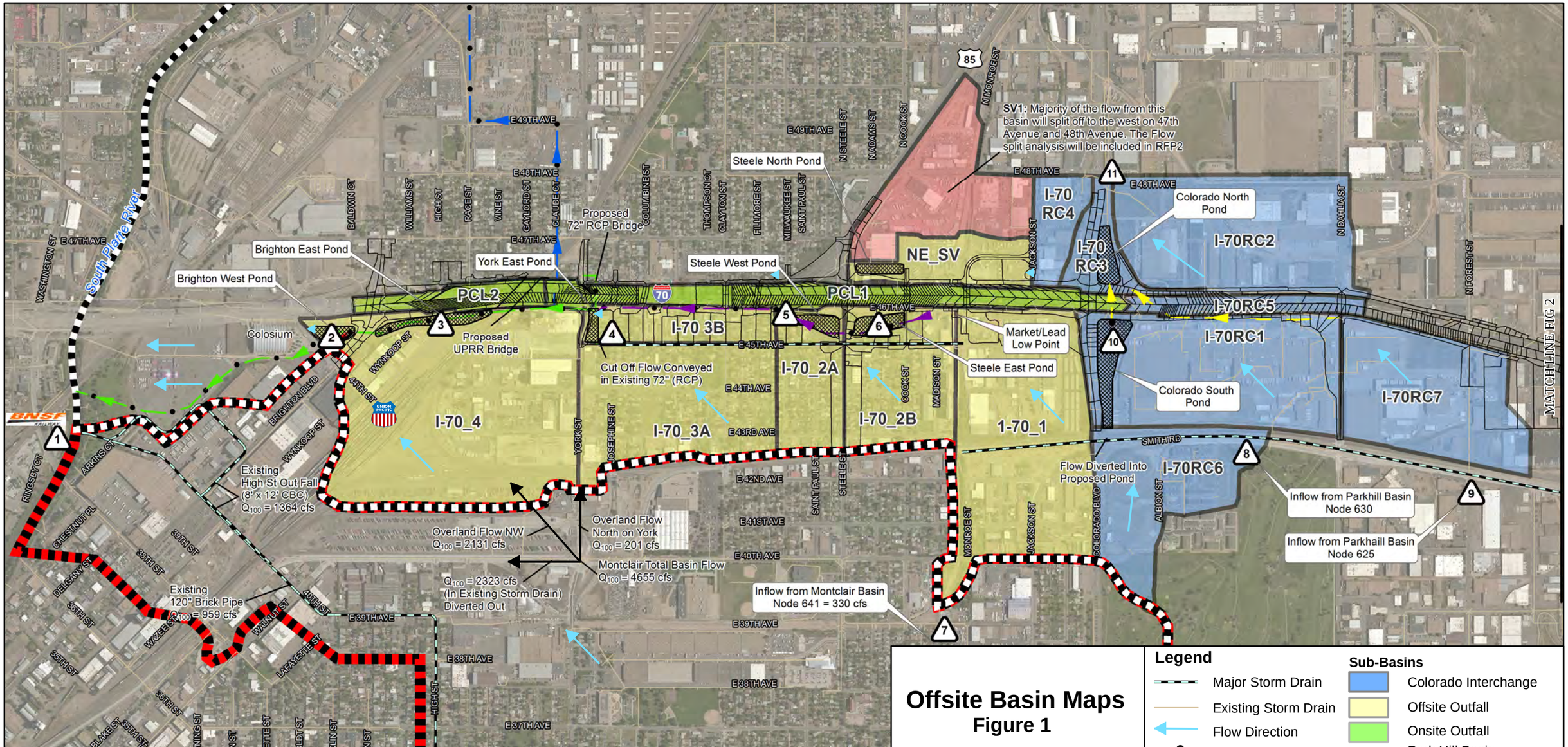
Design Procedure Form: Extended Detention Basin (EDB)

Designer: MNJ
Company: Atkins
Date: August 27, 2015
Project: I-70 East
Location: Irondale Gulch - Northeast Gore of I-70 and Havana Interchange

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Overflow will overtop to Havana.
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z_E = _____ ft / ft
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Annual maintenance by local municipalities with vacuum trucks.

Notes:

D. Basin Maps



Catchment Name/ID	Area (ac)	Percent Imperv.	Peak (cfs)
1-70_1	84.579	80.0	359
1-70_2A	23.612	53.0	63
1-70_2B	37.907	53.0	119
1-70_3A	57.254	51.0	143
1-70_3B	17.509	51.0	33
1-70_4	115.054	80.0	405
I-70RC6	43.864	68.0	194
I-70RC7	52.683	80.0	150
I-70RC1	71.063	80.0	203
I-70RC5	11.011	100.0	29
I-70RC3	13.437	80.0	30
I-70RC4	12.069	80.0	43
I-70RC2	66.397	80.0	220
NE_SV	18.849	80.0	106

Design Point	SWMM_Node	Q100-Year (CFS)
1	Outfall_South_Platte	2197
2	pond7A	2247
3	pond7	2444
4	pond6	361
5	SV-WEST	365
6	SV-EAST	790
7	COM_I-70_1	330
8	311	1395
9	625	1771
10	I-70RC1	1661
11	I-70RC2	2101

Notes
*Areas where the onsite roadway basins overlap the offsite basins was done for drop inlet design and the area was not double counted.

Offsite Basin Maps
Figure 1

COLORADO Department of Transportation

ATKINS

Legend

- Major Storm Drain
- Existing Storm Drain
- Flow Direction
- Design Point
- Proposed Ponds

Sub-Basins

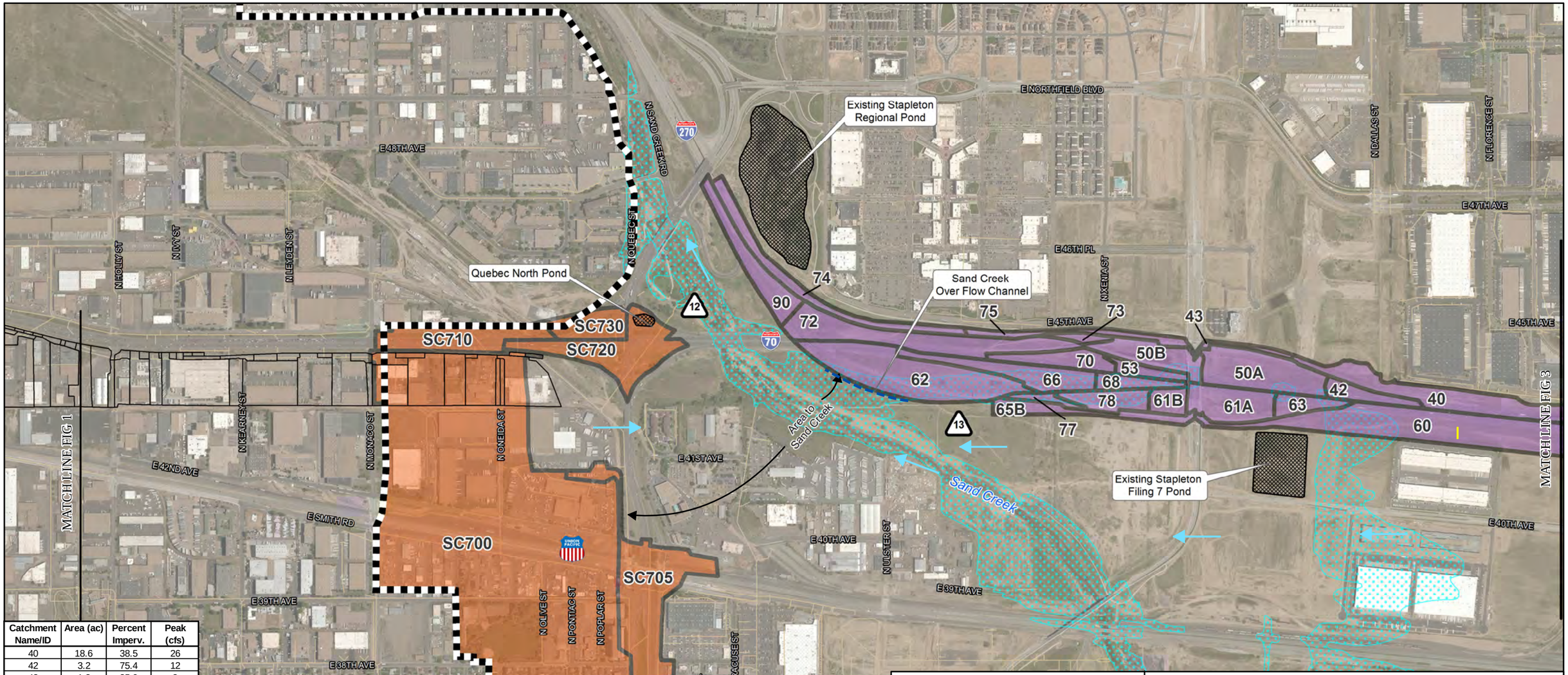
- Colorado Interchange
- Offsite Outfall
- Onsite Outfall
- Park Hill Basin (Referenced)
- Montclair Basin (Referenced)
- *Onsite Roadway Sub-Basins (Analyzed With Rational Method)

Proposed Drainage Improvements

- Offsite Outfall Drainage System (South Platte - York)
- Drainage Facilities (York - Colorado)
- Colorado Interchange Drainage System
- Onsite Drainage System

N

0 1,000 2,000 3,000 Feet



Catchment Name/ID	Area (ac)	Percent Imperv.	Peak (cfs)
40	18.6	38.5	26
42	3.2	75.4	12
43	1.3	35.0	3
50a	10.2	31.7	19
50b	5.8	48.0	22
53	1.9	72.0	11
60	30.7	36.1	41
61a	7.0	54.6	24
61b	2.6	37.8	9
62	18.2	42.4	67
65a	1.9	66.0	5
65b	3.2	20.0	3
66	7.0	52.6	19
68	2.6	73.0	12
70	4.5	48.8	14
72	13.4	31.3	15
73	1.3	45.0	3
74	7.0	40.0	7
75	3.2	30.0	8
77	1.3	40.0	4
78	3.8	30.0	11
90	6.4	50.0	12
SC700	187.3	72.5	619
SC705	35.1	92.1	117
SC710	9.4	100.0	45
SC720	12.8	53.2	43
SC730	5.1	37.0	17

Design Point	SWMM_Node	Q100-Year (CFS)
12	774	255
13	D170	160

Notes
*Areas where the onsite roadway basins overlap the offsite basins was done for drop inlet design and the area was not double counted.

Offsite Basin Maps
Figure 2

COLORADO Department of Transportation

ATKINS

Legend

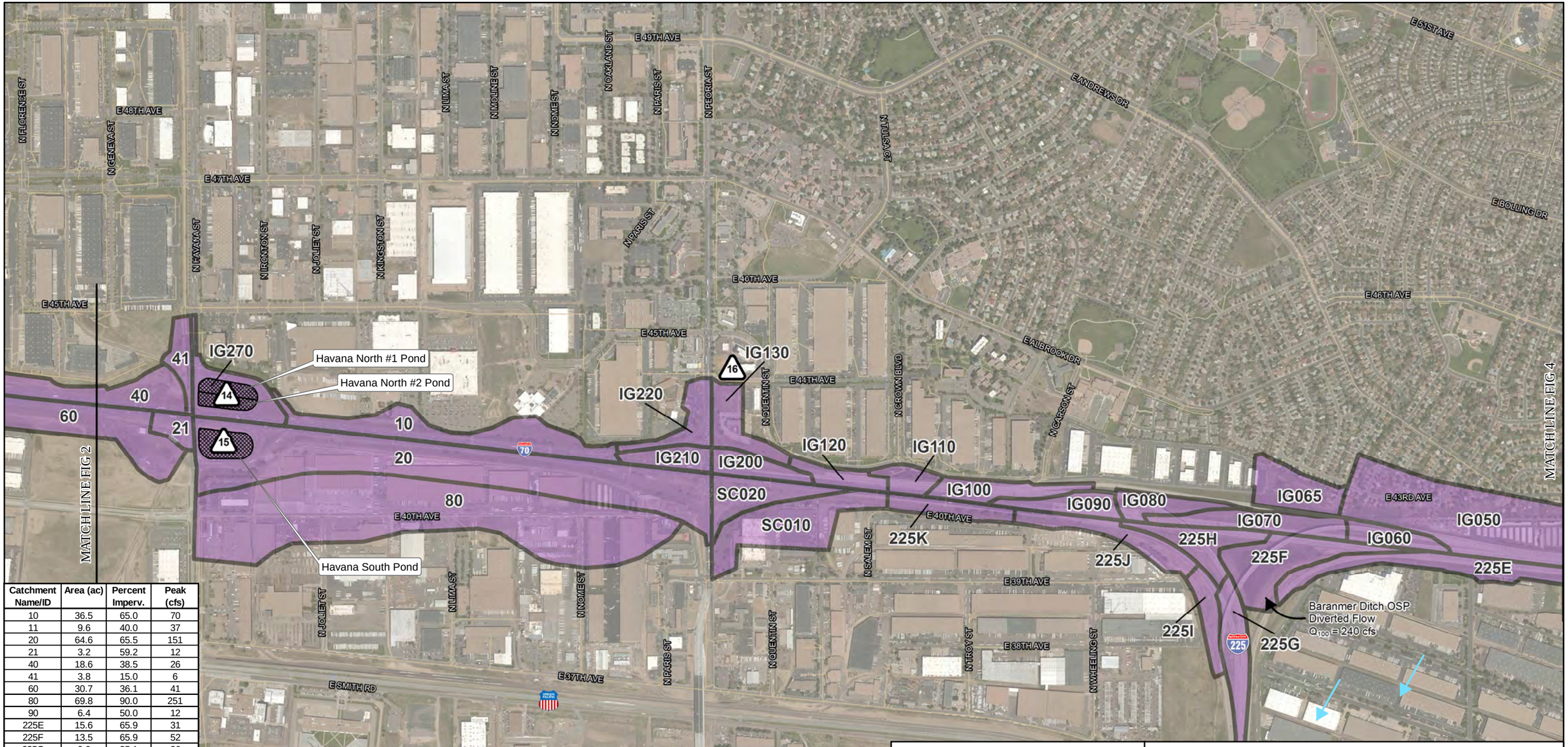
- Existing Storm Drain
- Flow Direction
- Design Point
- Proposed Ponds
- Effective Floodplain

Sub-Basins

- SW Quebec Basin
- Sand Creek to Chambers (Stapleton North & East)
- Park Hill Basin (Referenced)
- *Onsite Roadway Sub-Basins (Analyzed With Rational Method)

N

0 1,000 2,000 3,000 Feet



Catchment Name/ID	Area (ac)	Percent Imperv.	Peak (cfs)
10	36.5	65.0	70
11	9.6	40.0	37
20	64.6	65.5	151
21	3.2	59.2	12
40	18.6	38.5	26
41	3.8	15.0	6
60	30.7	36.1	41
80	69.8	90.0	251
90	6.4	50.0	12
225E	15.6	65.9	31
225F	13.5	65.9	52
225G	9.0	35.1	26
225H	7.5	66.0	29
225I	4.6	51.6	16
225J	8.2	51.6	17
225K	5.1	96.8	18
IG050	43.6	86.8	194
IG060	4.5	36.4	10
IG070	8.7	55.6	17
IG080	5.1	38.7	12
IG090	5.3	86.7	16
IG100	6.5	81.5	29
IG110	3.6	78.7	16
IG120	4.1	79.2	13
IG130	6.8	88.9	31
IG200	5.0	51.3	17
IG210	4.6	50.5	15
IG220	5.9	81.9	20
SC010	18.3	67.9	53
SC020	5.7	52.4	19

Design Point	SWMM_Node	Q100-Year
14	NE_Havana_Pond	35
15	SE_Havana_Pond	61
16	IG130	42

Offsite Basin Maps
Figure 3

COLORADO
Department of Transportation

ATKINS

Legend

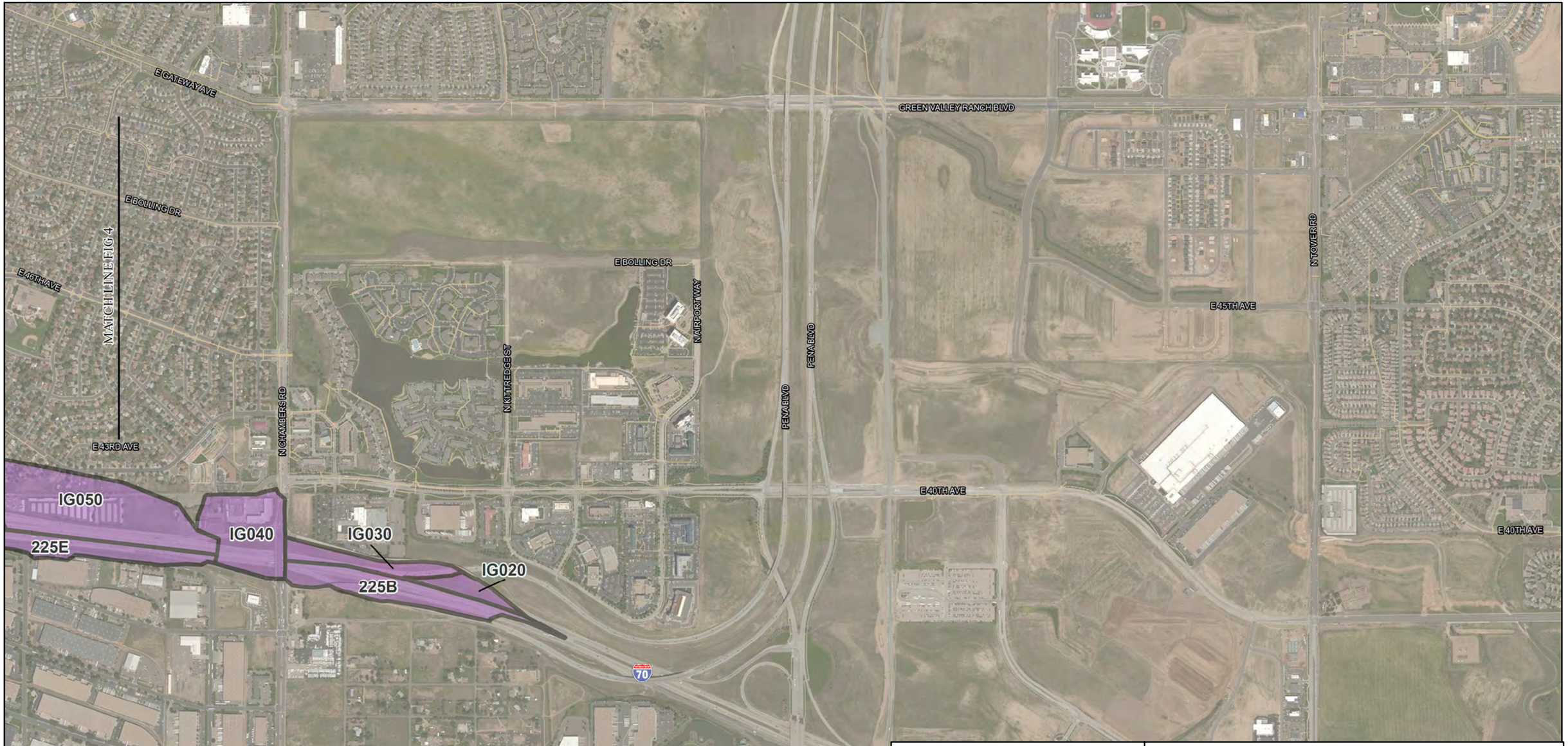
- Existing Storm Drain
- Flow Direction
- Design Point
- Proposed Ponds

Sub-Basins

- Sand Creek to Chambers (Stapleton North & East)

N

0 1,000 2,000 3,000 Feet



Catchment Name/ID	Area (ac)	Percent Imperv.	Peak (cfs)
IG020	3.6	21.7	4
IG030	6.3	64.3	17
IG040	14.7	73.1	75
IG050	43.6	86.8	194
225B	12.5	50.0	40
225E	15.6	65.9	31

Offsite Basin Maps
Figure 4

COLORADO Department of Transportation

ATKINS

Legend

Existing Storm Drain

Sub-Basins

Sand Creek to Chambers (Stapleton North & East)

N

0 1,000 2,000 3,000 Feet

Catchment Name/ID	Area (ac)	Percent Imperv.	Peak (cfs)
PCL1	31.360	100	91
PCL1	10.880	100	41

Onsite Basin Map
Figure 5

COLORADO Department of Transportation

ATKINS

Legend

- Roadway Improvements
- Existing Storm Drain
- Flow Direction
- Onsite Outfall
- Proposed Ponds

Proposed Drainage Improvements

- Offsite Outfall Drainage System (South Platte - York)
- Drainage Facilities (York - Colorado)
- Colorado Interchange Drainage System
- Onsite Drainage System

N

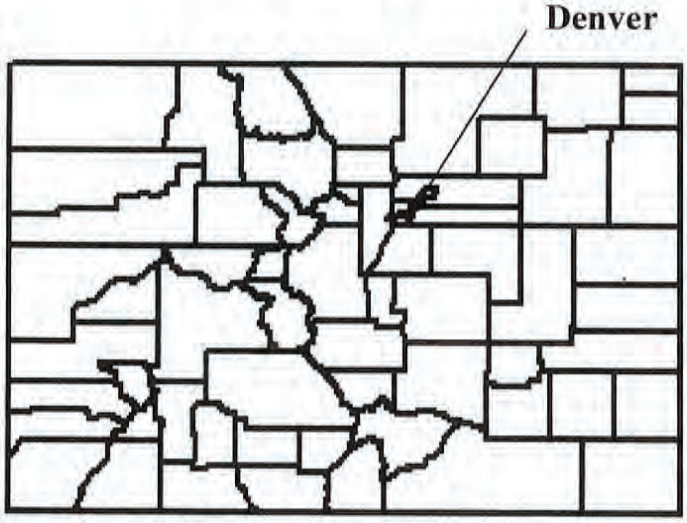
0 500 1,000 1,500 2,000 Feet

E. Reference Materials

FLOOD INSURANCE STUDY

CITY AND COUNTY OF DENVER, COLORADO

VOLUME 1 OF 2

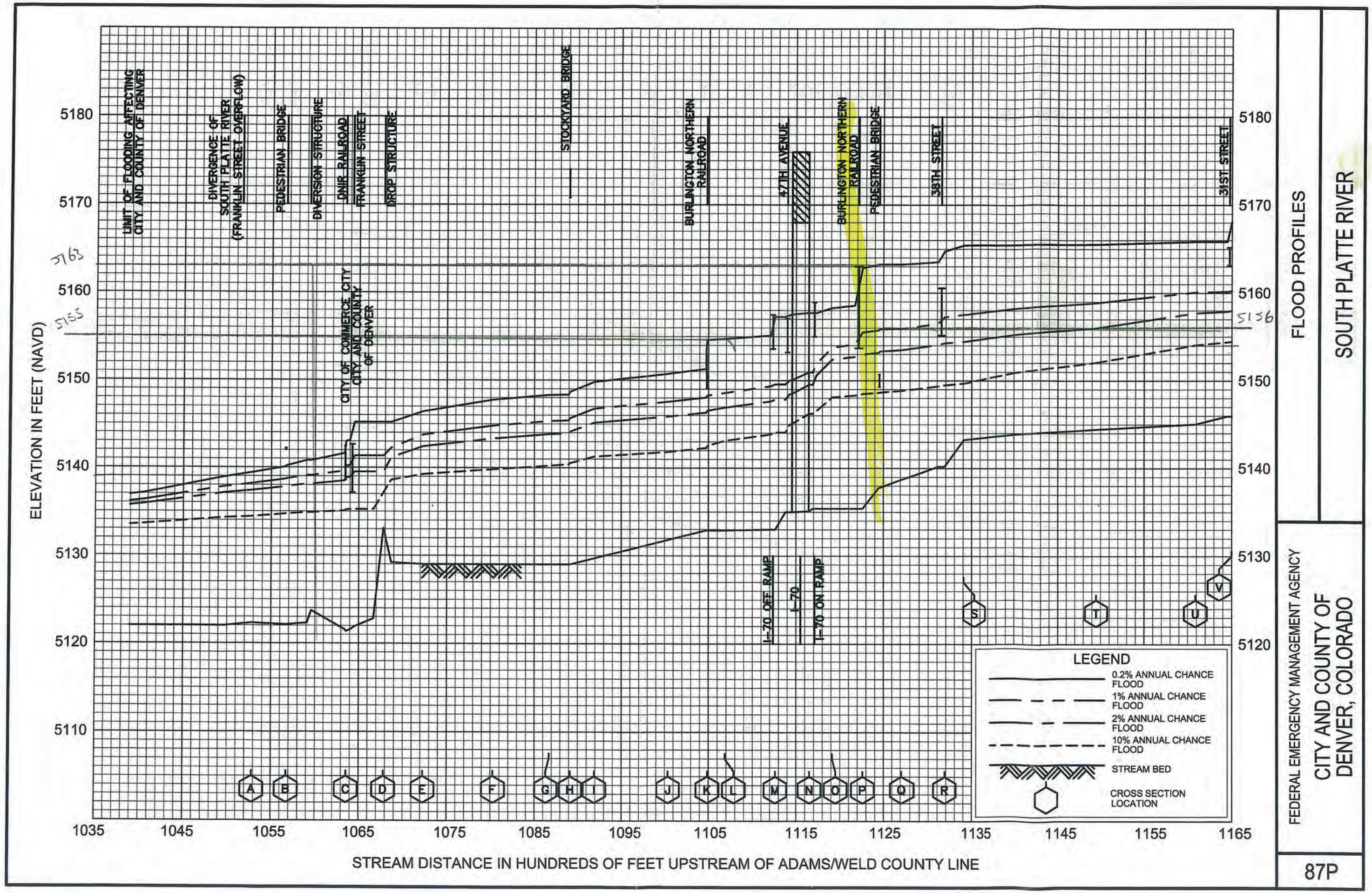


REVISED: NOVEMBER 20, 2013

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER

080046V001B



FLOOD PROFILES

SOUTH PLATTE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF DENVER, COLORADO

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