

FLOODPLAINS AND DRAINAGE ASSESSMENT  
TECHNICAL REPORT

FOR THE

6<sup>TH</sup> AVENUE PARKWAY EXTENSION  
ENVIRONMENTAL ASSESSMENT

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## TABLE OF CONTENTS

	<u>Page</u>
<b>1. Introduction</b>	<b>1</b>
1.1 Proposed Action	1
1.2 No Action Alternative	3
<b>2. Affected Environment</b>	<b>4</b>
2.1 General Drainage Information	4
2.2 Related Plans and Policies	4
2.2.1 Policies	5
2.3 Description of Existing Conditions	5
2.4 Known Future Conditions/Issues	10
<b>3. Impact Evaluation</b>	<b>13</b>
3.1 Methodology for Impact Evaluation	13
3.1.1 Drainage and Water Quality	13
3.1.2 Floodplain	13
3.2 No Action Alternative	13
3.2.1 Drainage and Water Quality	13
3.2.2 Floodplains	13
3.3 Proposed Action	14
3.3.1 Drainage and Water Quality	14
3.3.2 On-Site (Roadway) Runoff	15
3.3.3 Off-Site Runoff	16
3.4 Floodplains	18
3.5 Potential Permits	18
<b>4. Mitigation</b>	<b>20</b>
4.1 Drainage and Water Quality	20
4.2 Floodplains	20
<b>5. References</b>	<b>22</b>

## APPENDICES

- APPENDIX A – RESOURCE IMPACT TABLE
- APPENDIX B – RESOURCE MITIGATION TABLE

## LIST OF FIGURES

	<u>Page</u>
Figure 1	Proposed Action and Study Area ----- 3
Figure 2	Hydrologic Soil Group ----- 7
Figure 3	Hydrologic Soil Group (cont.) ----- 8
Figure 4	Hydrologic Soil Group (cont.) ----- 9
Figure 5	Conceptual Drainage (1 of 2) ----- 11
Figure 6	Conceptual Drainage (2 of 2) ----- 12
Figure 7	Sand Creek/Coal Creek/Murphy Creek Floodplain Limits in Project Study Area ----- 19

## LIST OF TABLES

	<u>Page</u>
Table 1	2012 FHAD 100-year flows ----- 6
Table 2	On-site Runoff – Permanent Water Quality and Detention Locations ----- 16
Table 3	Off-site Runoff Summary ----- 17

## LIST OF ACRONYMS

AFB.....	Air Force Base
BFE.....	Base Flood Elevation
BMP.....	Best Management Practice
CDPS.....	Colorado Discharge Permit System
CFS .....	Cubic Feet per Second
CLOMR.....	Conditional Letter of Map Revision
CWA .....	Clean Water Act
CPW .....	Colorado Parks and Wildlife
E-470 .....	E-470 Tollway
EA.....	Environmental Assessment
FEMA.....	Federal Emergency Management Agency
FHAD.....	Flood Hazard Area Delineation
FHU .....	Felsburg Holt & Ullevig
FIRM.....	Flood Insurance Rate Map
FIS.....	Flood Insurance Study
HSG.....	Hydrologic Soil Group
LOMR .....	Letter of Map Revision
MDP.....	Major Drainage Plan
MS4 .....	Municipal Separate Storm Sewer System
NRCS .....	Natural Resources Conservation Service
OSP.....	Outfall Systems Plan
PROS .....	Parks Recreation and Open Space
RCBC .....	Reinforced Concrete Box Culvert
RCP.....	Reinforced Concrete Pipe
ROW.....	Right-of-Way
SF.....	Square Feet
SH 30 .....	State Highway 30
SWMP .....	Stormwater Management Plan
UDFCD .....	Urban Drainage and Flood Control District
WQCD .....	Water Quality Control Division

## 1. INTRODUCTION

This technical report has been prepared in support of the 6<sup>th</sup> Avenue Parkway Extension Environmental Assessment (EA) extending 6<sup>th</sup> Avenue from State Highway 30 (SH 30) to the E-470 Tollway (E-470). This technical report evaluates the effects of the Proposed Action Alternative and the No Action Alternative with respect to water resources, floodplains, and drainage.

### 1.1 Proposed Action

The Proposed Action would extend the 6<sup>th</sup> Avenue Parkway for approximately 2 miles along a new alignment, connecting existing 6<sup>th</sup> Avenue/SH 30 to the west with the existing 6<sup>th</sup> Avenue Parkway at E-470 to the east. This would close a gap in the existing major arterial street system, reducing out of direction travel and improving the efficiency and reliability of the transportation system. The Proposed Action would be a six-lane arterial roadway with a raised median and sidewalks.

Six initial alternatives were developed and screened through three screening levels to identify the Proposed Action. The alternatives screening is summarized in **Appendix A1 Alternatives Technical Report** of the EA. Details of the Proposed Action are presented in **Appendix A2 Conceptual Design Plans** of the EA.

The Proposed Action is shown on **Figure 1**. Major elements of the Proposed Action are identified by number from west to east on **Figure 1**, and include the following:

**Element 1. Tie into existing 6<sup>th</sup> Avenue/SH 30:** 6<sup>th</sup> Avenue/SH 30 is an existing two-lane arterial. At the western end of the Proposed Action, a signalized “thru-tee” type intersection would be constructed connecting the Proposed Action roadway to existing 6<sup>th</sup> Avenue/SH 30. This new signalized intersection would include bypass lanes for the eastbound SH 30 through movement or a thru-tee signalized intersection with bypass lanes for both the eastbound SH 30 through movement. The tie-in would be an urban curb and gutter section with three 12-foot travel lanes in each direction to connect to future 6-lane section to the west. A 10-foot sidewalk would be located on both the north and south sides of the roadway.

**Element 2. Triple Creek Trail realignment and connections:** A portion of the existing Triple Creek Trail would be realigned and would pass beneath the Proposed Action roadway which would be on a bridge at this location (see Element 3 in **Figure 1**). The Triple Creek Trail would be connected to 6<sup>th</sup> Avenue via a spur trail to the sidewalk constructed along the south side of the new roadway. The Triple Creek Trail is a 10-foot wide soft surface trail that serves equestrians, bicyclists and pedestrians. The realigned portion would match the existing width and surface. A 10-foot sidewalk on both sides of the bridge (Element 3) would provide connections to the trail. The southern terminus of the trail is currently at the Coal Creek Arena, and further extension to the south is planned by the City of Aurora.

**Element 3. Roadway bridge over Sand Creek:** Immediately east of the new intersection with existing 6<sup>th</sup> Avenue/SH 30 (Element 1 in **Figure 1**), the roadway would be elevated onto a six-lane bridge crossing over Sand Creek and its associated floodplain/floodway, and over the Triple Creek Trail. The bridge length and profile would be set to minimize impacts to Sand Creek, while still providing a minimum 10-foot vertical clearance over the Triple Creek Trail. The bridge would have a median and sidewalks. The bridge would be approximately 680 feet in length with 5 variable length spans supported on four piers. The bridge would be

designed to be compatible with the surrounding environment and to allow wildlife connectivity along Sand Creek and the Triple Creek Trail.

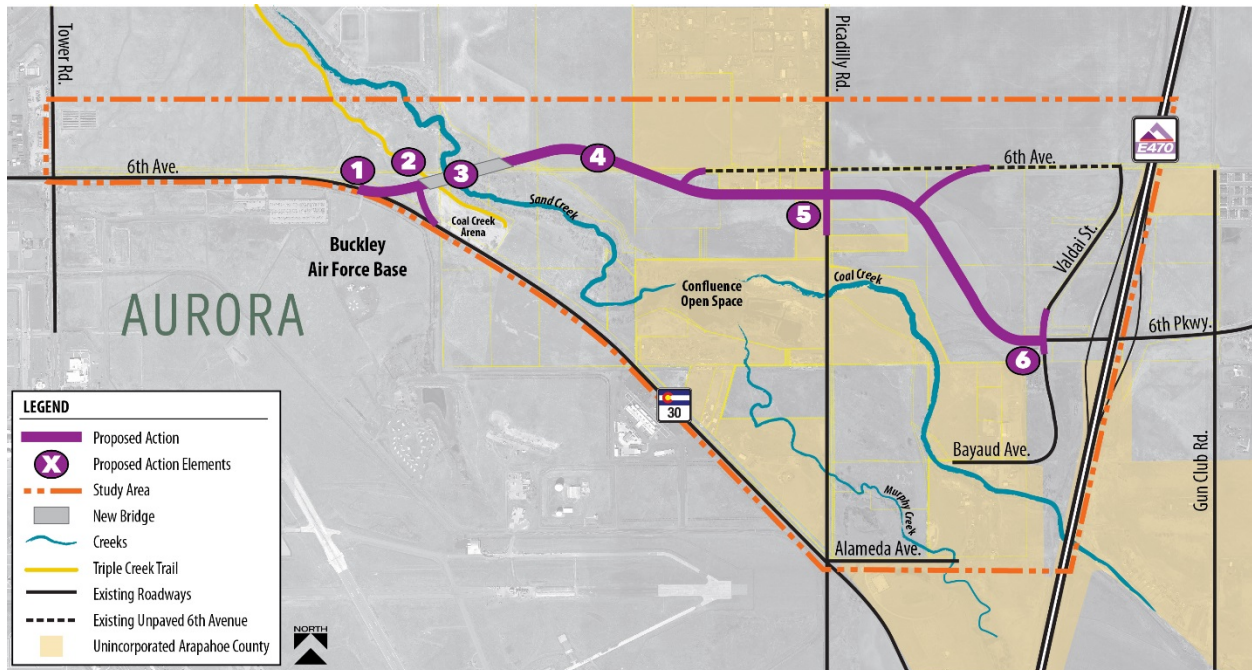
**Element 4. 6<sup>th</sup> Avenue Parkway arterial roadway:** The 6<sup>th</sup> Avenue Parkway extension would consist of a 144-foot wide, six-lane arterial roadway (three lanes in each direction) with a raised vegetated median. There would be curb and gutter and 10-foot wide sidewalks on the north and south sides of the roadway. The Proposed Action would provide two new access connections from the Proposed Action to two existing portions of 6<sup>th</sup> Avenue. One of these connections would provide access to the existing residences along unpaved 6<sup>th</sup> Avenue, west of Picadilly Road. The second connection would extend northeast from the Proposed Action to unpaved 6<sup>th</sup> Avenue to areas planned for development east of Picadilly Road.

**Element 5. Intersection with Picadilly Road:** The Proposed Action roadway would cross Picadilly Road, which is an existing north-south road. A signalized intersection would be constructed at this location. Picadilly Road is currently two lanes, but the City of Aurora anticipates that expansion to six lanes would occur in the future as a different project. Therefore, the intersection would be configured such that future expansion of Picadilly Road to six lanes can be accommodated and is not precluded.

**Element 6. Tie into existing 6<sup>th</sup> Avenue Parkway at E-470:** On its eastern end, the Proposed Action roadway would tie into the existing E-470 interchange, which currently truncates at this location, forming a connection with the existing 6<sup>th</sup> Parkway to the east of the interchange. The intersection tie-in at Valdai Street and 6<sup>th</sup> Avenue Parkway would be signalized. This connection would allow access from the west via the Proposed Action to the E-470 interchange and to the existing 6<sup>th</sup> Avenue Parkway extending to the east of E-470.

In addition to these transportation elements, the Proposed Action would include permanent roadway stormwater drainage with water quality features for roadway runoff and accommodate offsite stormwater flows. Details of drainage and water quality features are presented in this technical report.

Figure 1 Proposed Action and Study Area



Note: Numbers in graphic correspond with text above.

### 1.2 No Action Alternative

If the Proposed Action is not selected for implementation, there would be no improvements made to 6<sup>th</sup> Avenue beyond the existing and committed transportation system. The No Action Alternative was carried forward as a baseline comparison for environmental analysis purposes.

## 2. AFFECTED ENVIRONMENT

Merrick & Company, as a sub-consultant to FHU, provided drainage design support for the overall project Scope of Services.

### 2.1 General Drainage Information

Roadway improvements typically impact existing drainage conditions. This primarily includes impacts to natural drainageways due to the physical location of the roadway, increased stormwater runoff, and increased sediment loads. Roadway drainage improvements shall be designed to minimize these impacts and impacts to adjacent properties, and to comply with local, state and federal drainage and floodplain requirements. Typical roadway drainage improvements include: bridges, culverts, storm sewers, outfalls to existing drainageways, detention and/or water quality facilities.

The study area includes Sand, Coal and Murphy Creeks, which are large natural drainageways. The proposed roadway will cross Sand Creek and several small tributaries to Sand and Coal Creeks.

### 2.2 Related Plans and Policies

Information was gathered from various sources provided by the City of Aurora and Urban Drainage and Flood Control District (UDFCD). Resources used include:

- Sand Creek Flood Hazard Area Delineation (2012 FHAD) (Matrix Design Group, Inc. 2013)
- Sand Creek Major Drainageway Plan (MDP) (Colfax to Yale) (Matrix Design Group, Inc. 2013)
- Sand Creek (I-225 to E-470) Right Bank Tributaries Outfall Systems Plan (OSP) Conceptual Design Report (Draft) (Merrick & Company, 2015)
- Effective Flood Insurance Rate Maps (FIRM) for the study area (FEMA, 2010)
- City of Aurora Storm Drainage Design and Technical Criteria (City of Aurora, 2010)
- UDFCD Urban Storm Drainage Criteria Manuals

These studies were used in assessing the drainage for the study area to determine culvert, drainageway, and storm sewer system design.

Floodplain information for the three drainageways in the study area (Coal Creek, Murphy Creek, and Sand Creek) is shown on FIRMs 08005C01282K and 08005C0201K, effective December 17, 2010. The creeks are also discussed in the Flood Insurance Study (FIS) for Arapahoe County, Colorado and Incorporated Areas, effective December 17, 2010. There are no Letters of Map Revision (LOMRs) that have been issued in the study area for these creeks since the FIRM and FIS effective date. The FIS information and floodplains delineated on the FIRMs are based on two studies; the FHAD for Sand Creek (UDFCD, March 1977) and the FHAD for Piney Creek, Cottonwood Creek, Lone Tree Creek, and Murphy Creek, (Gingery Associates, Inc., October 1975). These FHADs are being referenced for information only to show the source data for the published FEMA information. The 2012 Sand Creek FHAD was



used for the existing and proposed floodplain analysis because it is more current information that has been accepted by UDFCD and the City of Aurora.

### 2.2.1 Policies

Executive Order 11988 – Floodplain Management (U.S. Department of Transportation [DOT] Order 5650.2; 23 C.F.R. 650, Subpart A) directs all federal agencies to avoid to the extent practicable and feasible all short-term and long-term adverse impacts associated with floodplain modification. Also, they are to avoid direct and indirect support of development within the 100-year floodplain whenever there is a reasonable alternative available. Projects that encroach upon 100-year floodplains must be supported with additional specific information.

Executive Order 13690 – Establishing a Federal Flood Risk Management Standard was issued January 30, 2015. This applies to projects where Federal funds are used to build structures in and around floodplains to ensure those structures are resilient, safer, and long-lasting.

The U.S. DOT Order 5650.2, titled “Floodplain Management and Protection”, prescribes policies and procedures for ensuring that proper consideration is given to the avoidance and mitigation of adverse floodplain impacts in agency actions, planning programs and budget requests.

The Flood Disaster Protection Act (42 U.S.C. 4001-4128; DOT Order 5650.2, 23 C.F.R. 650 Subpart A; and 23 C.F.R. 771) is to identify flood-prone areas and provide insurance. The Act requires purchase of insurance for buildings in special flood-hazard areas. The Act is applicable to any federally assisted acquisition or construction project in an area identified as having special flood hazards. Projects should avoid construction in, or develop a design to be consistent with FEMA identified flood-hazard areas.

The City of Aurora participates in the National Flood Insurance Program administered by FEMA. In conjunction with this program, the City regulates development and construction activities within floodplains. FEMA requires revision of the FIRM for any construction or development within the floodway that results in a change in regulatory base flood elevations (BFEs), or a change in floodplain boundaries. When an increase is anticipated by a proposed project, a Conditional Letter of Map Revision (CLOMR) must be obtained from FEMA before construction is initiated. After the project is completed a LOMR must be obtained from FEMA to finish the revision of the FIRM. A LOMR is only required when there is a decrease in BFE or floodplain boundaries.

In order to participate in the National Flood Insurance Program and thereby allow citizens to acquire federal flood insurance, the City of Aurora has adopted these same floodplain management requirements as part of their floodplain ordinances. The Floodplain Administrator must issue a floodplain development permit for any construction within the floodplain.

The City of Aurora has a Phase I Municipal Separate Stormwater Sewer System (MS4) Permit. This permit was issued by Colorado Department of Health and Environment (CDPHE) water quality control division (WQCD), as is required by the Clean Water Act. The study area will comply with this MS4 permit and their regulatory-based conditions. The Colorado Department of Transportation (CDOT) also has an MS4 Permit. The portions of this project impacting CDOT right-of-way will comply with CDOT's MS4 permit.

### 2.3 *Description of Existing Conditions*

The study area is located entirely within the 186.76 square mile Sand Creek watershed. The Sand Creek watershed is made up of several smaller or sub-watersheds that include Coal

Creek, Senac Creek which includes Aurora Reservoir, Murphy Creek, Toll Gate Creek and Sand Creek itself. The study area is located near the beginning of Sand Creek just downstream of the Murphy Creek and Coal Creek confluence where Sand Creek originates. The study area includes jurisdictional areas of both the City of Aurora and unincorporated Arapahoe County.

Topography within the study area generally slopes to the southwest with slopes ranging 0 to 4 percent along Sand Creek and 3:1 side slope to 2 percent slopes outside of the channel. Land use of surrounding areas near the study area mainly consists of rural land, but includes some commercial, industrial, and sparse residential areas.

Soil types, as defined by the Natural Resources Conservation Service (NRCS), within the Sand Creek watershed consist primarily of hydrologic soil group (HSG) A and B. Surrounding areas consist of HSG A and B and smaller areas of HSG C and D. **Figures 2 through 4** illustrate the HSGs found within the project limits.

Coal Creek flows from east to west in the study area. Murphy Creek flows from south to north and flows into Coal Creek in the study area. Downstream of the Coal Creek/Murphy Creek confluence, Sand Creek is formed and flows from the southeast to the northwest through and out of the study area. All three creeks have FEMA regulated floodplains defined with Zones AE, X, and floodways. **Table 1** gives the effective and 2012 FHAD 100-year flows for each drainageway. The effective floodplain information did not account for a change in flow in Sand Creek after the Coal Creek/Murphy Creek confluence. This is corrected in the 2012 FHAD.

**Table 1** 2012 FHAD 100-year flows

Drainageway	Effective Q100	2012 FHAD Q100
Coal Creek (upstream of Murphy Creek)	18,400 cfs	13,400 cfs
Murphy Creek	4,450 cfs	5,912 cfs
Sand Creek	18,400 cfs	19,312 cfs

The Murphy Creek/Coal Creek confluence that forms Sand Creek results in a large and interconnected floodplain within the study area. The confluence is comprised of several large ponds located within the middle of the study area that are the result of aggregate mining operations in the past. The Sand Creek floodplain and floodway is very wide at approximately 1200 feet and 800 feet wide, respectively. Coal Creek and Murphy Creek share a wide floodplain and floodway at approximately 1400 feet and 1000 feet respectively. The 2012 FHAD shows similar conditions with the Sand Creek floodplain and floodway at approximately 1300 feet and 900 feet wide respectively and the Murphy/Coal Creek floodplain and floodway at approximately 1500 feet 900 feet wide, respectively.

Sand Creek's water quality is influenced by storm water discharges from the upstream watershed, including some high density residential and commercial developments. Most of the existing storm drainage systems near the study area have no form of water quality treatment prior to their passing into an adjacent drainageway, with the exception of Buckley Air Force Base (AFB). Runoff from Buckley AFB is collected in an on-site lake which provides some water quality benefit, although this lake will be removed in the future. The watershed as a whole collects storm waters and passes them through the study area with minor water quality treatment from existing vegetation.

Figure 2 Hydrologic Soil Group

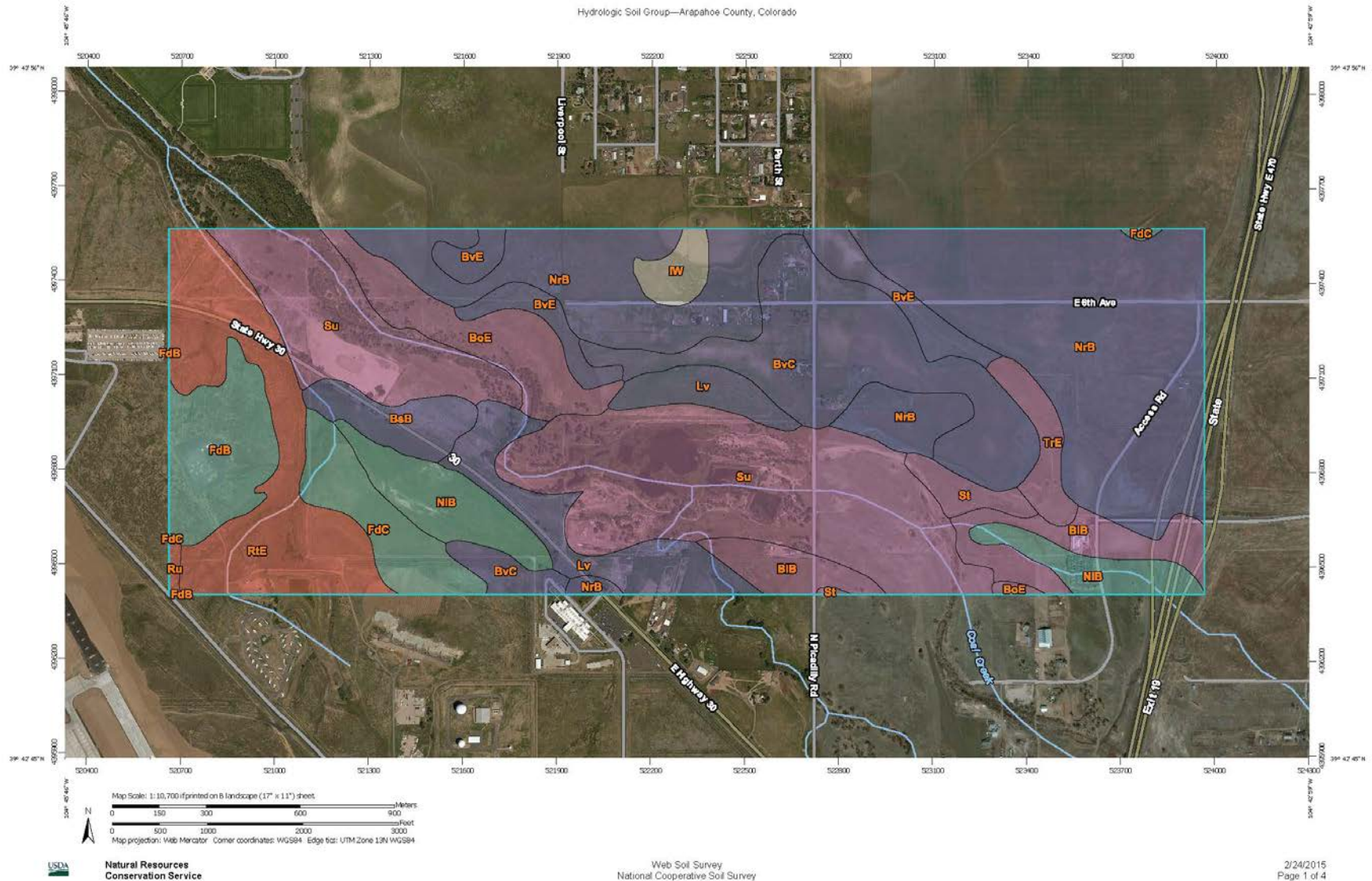


Figure 3 Hydrologic Soil Group (cont.)

Hydrologic Soil Group—Arapahoe County, Colorado

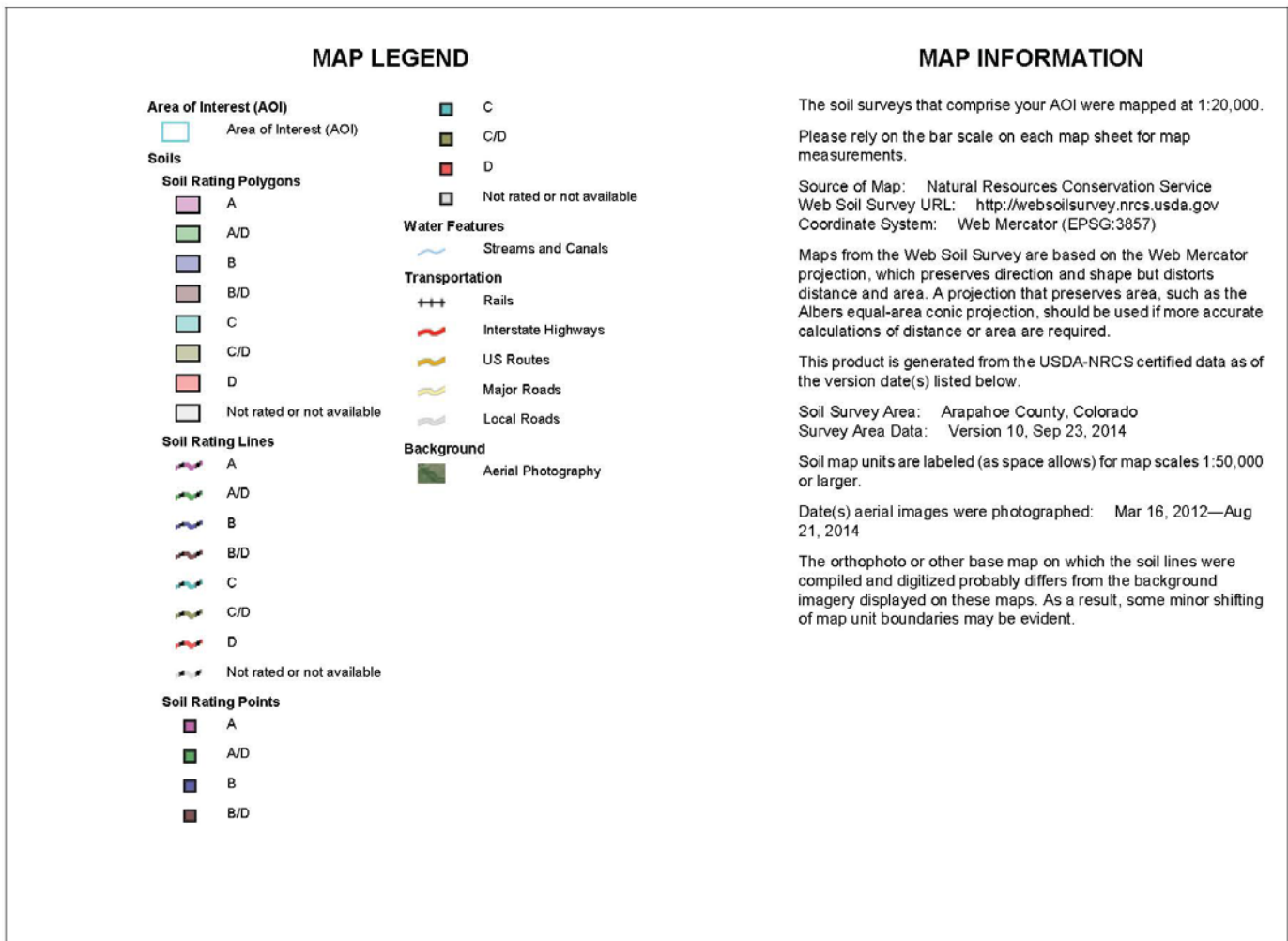


Figure 4 Hydrologic Soil Group (cont.)

Hydrologic Soil Group—Arapahoe County, Colorado

### Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Arapahoe County, Colorado (CO005)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BIB	Bijou sandy loam, 0 to 3 percent slopes	A	40.5	4.3%
BoE	Blakeland loamy sand, 1 to 20 percent slopes	A	37.9	4.0%
BsB	Bresser sandy loam, terrace, 0 to 3 percent slopes	B	19.2	2.0%
BvC	Bresser-Truckton sandy loams, 3 to 5 percent slopes	B	96.6	10.2%
BvE	Bresser-Truckton sandy loams, 5 to 20 percent slopes	B	32.0	3.4%
FdB	Fondis silt loam, 1 to 3 percent slopes	C	38.6	4.1%
FdC	Fondis silt loam, 3 to 5 percent slopes	C	30.8	3.2%
IW	Intermittent Water		9.7	1.0%
Lv	Loamy alluvial land	B	52.6	5.5%
NIB	Nunn loam, 1 to 3 percent slopes	C	44.6	4.7%
NrB	Nunn-Bresser-Ascalon complex, 0 to 3 percent slopes	B	244.2	25.7%
RtE	Renohill-Little-Thedalund complex, 9 to 30 percent slopes	D	81.5	8.6%
Ru	Rock outcrop	D	1.4	0.2%
St	Sand pits	A	9.6	1.0%
Su	Sandy alluvial land	A	198.1	20.8%
TrE	Truckton loamy sand, 5 to 20 percent slopes	A	13.9	1.5%
<b>Totals for Area of Interest</b>			<b>951.4</b>	<b>100.0%</b>

The Colorado Water Quality Control Commission has classified Sand Creek as follows:

- **Aquatic Life Warm 2** – Waters that are not capable of sustaining a wide variety of warm water biota, including sensitive species, due to physical habitat, water flows, or levels, or abundance and diversity of species.
- **Recreation E** – Waters are those in which primary contact uses are known.
- **Agriculture** – Surface water that is suitable or intended to be suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.

Colorado Water Quality Control Commission Regulation #93 defines the portion of Sand Creek within the Study Area as Segment COSPUS16a (mainstem of Sand Creek from the confluence of Murphy and Coal Creek to the confluence with Toll Gate Creek). This entire reach is on the CDPHE 303d Sensitive Waters List for Selenium and *Escherichia coli* (*E. coli*), neither of which are caused by roadway runoff. The Murphy Creek and Coal Creek tributaries are not on the CDPHE 303d Sensitive Waters List.

Sand Creek functions essentially as a stormwater conveyance system and provides very limited habitat for warm water fish. Sand Creek does provide habitat for some aquatic life such as frogs and lizards and also supports urban wildlife such as ducks, migratory birds, deer, and fox.

#### 2.4 *Known Future Conditions/Issues*

Future conditions within the study area that could occur are described in the *Sand Creek (I-225 to E-470) Right Bank Tributaries Outfall Systems Plan (OSP) Conceptual Design Report (Draft)*, recently completed for the City of Aurora and UDFCD by Merrick & Company in October 2015. Future improvements include detention facilities that will reduce the peak flowrates and enhance water quality within each tributary watershed and Sand Creek, as well as storm sewers and open channels to convey detained runoff to Sand and Coal Creeks. These future improvements are further discussed in this report and are shown on **Figure 5** and **Figure 6**. This includes the engineer's recommended plan as described in Section 6 of the OSP Alternatives Evaluation Report, plus updates to this plan that have occurred since the Alternatives Evaluation Report was published in July 2015.

Runoff from Buckley AFB is currently collected in an on-site lake that provides detention. This lake will be removed in the future, which will increase runoff to the study area. For the purposes of this study, it is assumed to be removed.

The 2012 FHAD is currently being reviewed by FEMA and is expected to be adopted to update the Sand Creek floodplain delineation, although this may still be several years away. The FEMA published floodplain information for Sand Creek, Coal Creek, and Murphy Creek will be used as a starting point for consideration of these drainageways; however, the 2012 FHAD information will be used as more accurate and more up to date information for conceptual and preliminary design of alternatives in the study area.

Figure 5 Conceptual Drainage (1 of 2)

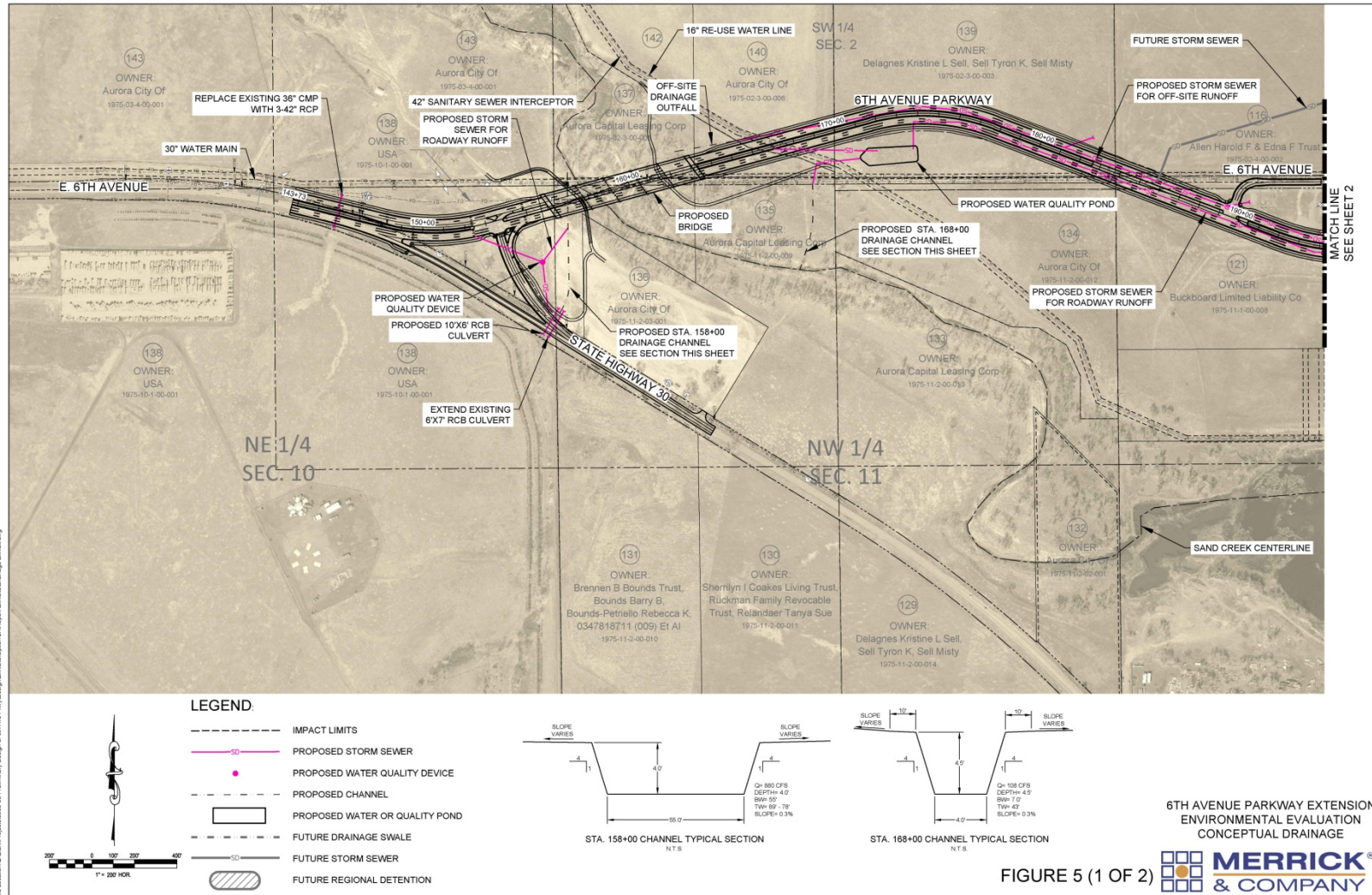
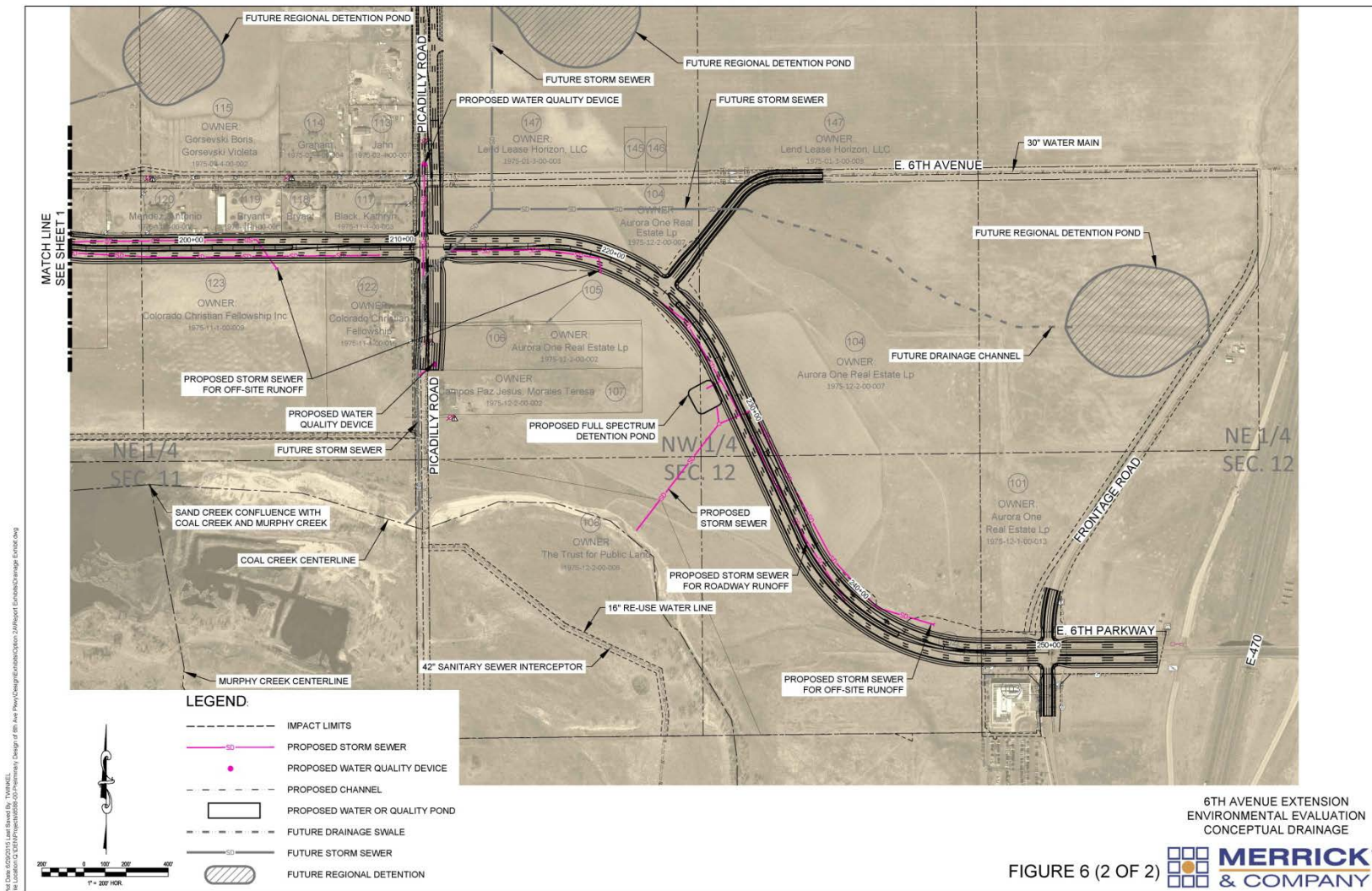


Figure 6 Conceptual Drainage (2 of 2)





## 3. IMPACT EVALUATION

### 3.1 *Methodology for Impact Evaluation*

#### 3.1.1 Drainage and Water Quality

The Proposed Action will impact the existing drainage patterns. These impacts were evaluated through a review of the previous studies and criteria described in **Section 2.1**, as well as numerous discussions with staff from the City of Aurora Public Works, Water, and Parks, Recreation & Open Space Departments. The 2012 FHAD and the 2015 OSP Alternatives Evaluation Report are the basis for design flowrates used in the analysis for off-site runoff.

The increase in impervious area as a result of the project can be a discriminating factor for the analysis of alternatives. As the size of impervious drainage area increases in the study area, the stormwater runoff that enters Sand Creek will also increase. The greater amount of stormwater runoff – directly related to the impervious area – the larger the Best Management Practice (BMP) (e.g., water quality detention pond) must be to capture the runoff. Right-of-Way (ROW) acquisition is necessary to adequately provide enough area for a BMP at some discharge points. Therefore, the greater amount of impervious area could indirectly affect ROW acquisition necessary to follow the applicable MS4 permits. To minimize ROW impacts, undevelopable remainders were used where possible. These impacts were evaluated through a review City of Aurora criteria, as well numerous discussions with staff from the City of Aurora Public Works, Water, and Parks Recreation and Open Space (PROS) Departments.

#### 3.1.2 Floodplain

HEC-RAS was used to evaluate the impacts to the floodplain due to the Proposed Action. The HEC-RAS model that was used to develop the 2012 FHAD was obtained from UDFCD and used as a base for the existing conditions in the study area. This model was then updated with LiDAR contour information from 2014 to create a more recent existing conditions model. The Proposed Action was then modeled by adding a bridge at the crossing with Sand Creek. Using this methodology, the proposed condition of the Proposed Action could be compared with the existing conditions model to determine the impacts.

### 3.2 *No Action Alternative*

#### 3.2.1 Drainage and Water Quality

The No Action Alternative would not impact existing drainage patterns as no changes would result if no improvements are made. However, future drainage improvements (unrelated to the Proposed Action) are planned that would impact the existing drainage patterns. These include the removal of the Buckley AFB detention pond and the proposed improvements described in the *2015 OSP Alternatives Evaluation Report*. Future development in the surrounding area would also impact existing drainage patterns by increasing runoff and constructing the drainage infrastructure needed to support the development.

#### 3.2.2 Floodplains

For the No Action Alternative, impacts to the floodplain are likely to be minimal by the year 2035. The only potential impacts would be due to natural changes due to flooding, low flow channel migration, and erosion. These might result in minor changes to the floodplain limits, but would not be quantifiable at this level of analysis.

### 3.3 Proposed Action

#### 3.3.1 Drainage and Water Quality

The Proposed Action would change the existing conditions within the study area by altering existing drainage patterns, increasing runoff, and constructing new drainage improvements. The existing Sand Creek and Coal Creek channels and the aggregate ponds that comprise the confluence would not be impacted by the Proposed Action, except in the vicinity of the proposed Sand Creek Bridge. Minor impacts would occur where proposed drainageways and storm sewers outfall into the main channels.

A five-span bridge would be constructed over Sand Creek that would impact the Sand Creek floodplain and floodway. The existing Triple Creek Trail would be realigned to pass under the western most span of the proposed bridge and tie back into its existing alignment within the Coal Creek Arena. The trail was set at a minimum elevation of 5474.50 feet to remain above the 10-year storm event in Sand Creek. This elevation is based on the proposed condition with the five-span bridge over Sand Creek.

The *2015 OSP Alternatives Evaluation Report* includes future improvements, such as storm sewer and upstream detention that significantly change the existing drainage patterns in the study area and reduce the future flowrates included with the 2012 FHAD. Since development in and around the study area is imminent, these proposed improvements would likely be funded and constructed prior to or at the same time as the Proposed Action. Therefore, the City of Aurora has decided to assume, for the purposes of this study, that these proposed improvements are in place at the time of implementation of the Proposed Action.

Existing off-site runoff would be conveyed through storm sewer, culverts, and drainage channels directly to Sand and Coal Creeks, or to the future drainage improvements included with the 2015 OSP improvements. Roadway runoff would be conveyed through storm sewer to water quality facilities and/or detention ponds, and discharged to Sand and Coal Creeks or to the future drainage improvements included with the 2015 OSP improvements. Water quality facilities would decrease the load of sediment and pollution produced by the roadway before discharging to Sand and Coal Creeks via storm sewers and constructed drainage channels.

The Proposed Action includes water quality/detention ponds, drainage channel outfalls to Sand Creek, and storm sewer outfalls to Sand and Coal Creeks. The locations of these ponds and outfalls were selected to minimize impacts to wetlands, conservation easements and existing utilities. The final design process will be closely coordinated with staff from the Aurora PROS Department so that the proposed drainage improvements support future trail locations and blend in well with the surrounding natural areas.

The following detailed information and **Figure 5** and **Figure 6** summarize the conceptual drainage associated with the Proposed Action.

### 3.3.2 On-Site (Roadway) Runoff

Roadway runoff was calculated per City of Aurora criteria for the Proposed Action. Roadway runoff would be collected in inlets and conveyed through storm sewer to water quality and/or detention facilities, and discharged to Sand and Coal Creeks via storm sewer or open channels. The following is a brief description of the proposed roadway drainage system, and **Table 2** provides a summary of water quality and detention facilities. The City of Aurora is committed to maintaining the proposed permanent water quality and detention facilities. Refer to **Figure 5** and **Figure 6** for roadway stationing.

**Station 143+73 to Station 159+33:** Runoff from the Proposed Action would drain to the roadway sump at Station 152+09, where it will be collected in inlets and conveyed to a proprietary water quality device located in the area southeast of the proposed thru-tee intersection. There is approximately 31 cubic feet per second (cfs) of roadway runoff draining to this sump during the 100-year storm event. Runoff from the south leg of the proposed thru-tee intersection would drain south toward SH 30, where it would be collected in inlets and conveyed to the same proprietary water quality device. There is approximately 6 cfs of roadway runoff draining to this location during the 100-year storm event. The proprietary water quality device would discharge east to a proposed open channel that discharges directly to Sand Creek. A proprietary device is preferred for this area because the drainage area is not large enough to warrant a water quality pond and available ROW is limited. Roadway detention is not required since the area is adjacent to Sand Creek and would not discharge across private property.

**Station 159+33 to Station 211:** Runoff from the Proposed Action would be collected by inlets and conveyed by storm sewer towards the roadway sump at Station 168+03, where it would discharge to a water quality pond located south of the roadway near station 170+00. The water quality pond would be constructed on a remnant parcel previously acquired by the City of Aurora on the south side of the proposed roadway. Total roadway runoff of 108 cfs for the 100-year event would be collected at the water quality pond and would discharge to Sand Creek via storm sewer and open channel. The storm sewer outfall from the water quality pond would cross over the existing 30-inch water main and 16-inch water re-use pipe; however, just the existing 16-inch water re-use pipe would need to be lowered. Once the storm sewer crosses over these pipes, an open channel would convey the runoff to Sand Creek. Roadway detention is not required since the area is adjacent to Sand Creek and would not discharge across private property.

**Station 211+00 to Station 221+14 & Picadilly Road:** Roadway runoff from the Proposed Action, including Picadilly Road, would be collected and conveyed via storm sewer within the ROW to the future storm sewer outfall to Coal Creek described in the *2015 Sand Creek Right Bank Tributaries OSP Alternatives Evaluation Report*. Roadway water quality would be provided for 6<sup>th</sup> Avenue Parkway runoff and for Picadilly Road runoff for both the north and south legs of the intersection. Roadway detention is not required since it is a small amount of runoff, is adjacent to Coal Creek, and would not be discharged across private property. The storm sewer system would be designed to accommodate the future expansion of Picadilly Road.

**Station 221+14 to Station 250+20:** Runoff from the Proposed Action would be collected by inlets and conveyed by storm sewer towards the roadway sump at Station 229+29, where it would discharge to a full spectrum detention pond located west of and adjacent to the

roadway. Total roadway runoff of 26 cfs for the 100-year event would be collected at the full spectrum detention pond and would discharge to Coal Creek via storm sewer. Full spectrum detention provides detention for both flood attenuation and water quality purposes. Roadway detention is required because the tributary area is greater than five acres and the runoff will need to cross private property.

**Table 2 On-site Runoff – Permanent Water Quality and Detention Locations**

STATION	Perm. Water Quality	Water Quality Comments	Detention	Detention Comments
STA. 152+09	Yes	Proprietary Device for Roadway STA 143+73 to 159+33; discharges via storm sewer and open channel to Sand Creek. Also includes new SH 30 connection. A proprietary device is preferred because the drainage area is not large enough to warrant a water quality pond and available ROW is limited.	No	Detention is not required since roadway runoff would not discharge across private property.
STA. 170+00	Yes	Water quality pond for STA 159+33 to 211; discharges via storm sewer and channel to Sand Creek.	No	Detention is not required since roadway runoff would not discharge across private property.
STA. 211+00 (Picadilly Rd.)	Yes	Two Proprietary Devices for 6 <sup>th</sup> Avenue Parkway & Picadilly Rd. runoff; discharges via storm sewer to Coal Creek. A proprietary device is preferred because the drainage area is not large enough to warrant a water quality pond and available ROW is limited.	No	Detention is not required since roadway runoff would not discharge across private property.
STA. 229+29	Yes	Full Spectrum detention for Roadway STA 221+14 to 250+20; discharges via storm sewer to Coal Creek.	Yes	Detention is required since the tributary area is greater than 5 acres and runoff will discharge across private property.

### 3.3.3 Off-Site Runoff

The Proposed Action would change the drainage patterns in the study area for runoff flowing toward Sand and Coal Creeks. Drainage improvements are necessary to redirect off-site runoff through or around the Proposed Action without adverse impacts to adjacent properties. The following is a brief description of the proposed drainage system to accommodate off-site runoff, followed by a more detailed summary in **Table 3**. Refer to **Figure 5** and **Figure 6** for roadway stationing.

Table 3 Off-site Runoff Summary

LOCATION/ STATION	Q(100) cfs	Design Flowrate Source	Proposed Improvements
SH 30 – STA 146+00	168	2012 FHAD	Replace Ex. 36" CMP with 3 – 42" RCPs Attach sidewalk on south side and use drop inlet to stay within ex. ROW.
SH 30 – South of STA 157	880	2012 FHAD	Extend Ex. 6'x7' RCBC; add new 10'x6' RCBC. Culverts would discharge via a proposed channel to Sand Creek at the proposed bridge. A box culvert below the proposed 6 <sup>th</sup> Avenue bridge would be needed to accommodate the realigned Triple Creek Trail.
STA 165+50 to STA 204+00			Proposed storm sewer for off-site runoff. Discharges to Sand Creek at the east abutment of the proposed bridge.
STA 182+00	112	2015 OSP	
STA 190+00	9	2015 OSP (0.88 cfs/ac × 10.5 ac)	
STA 204+00	5	2015 OSP (0.88 cfs/ac × 5.5 ac)	
STA 212+50	632	2015 OSP	Future 8'x6' RCBC
STA 220+00	3	2015 OSP (1.18 cfs/ac × 2.45 ac)	Proposed storm sewer for off-site runoff. Discharges to future 8'x6' RCBC.
STA 223+00 – Connection to Existing East 6 <sup>th</sup> Avenue	293	2015 OSP	Future 6'x6' RCBC
STA 229+29	25	2015 OSP (1.18 cfs/ac × 21.5 ac)	Proposed storm sewer for off-site runoff. Discharges to Coal Creek through the proposed full spectrum detention outfall storm sewer at STA 229+29.
STA 241+00	2	2015 OSP (1.18 cfs/ac × 1.9 ac)	Proposed storm sewer for off-site runoff. Discharges to Coal Creek through the proposed full spectrum detention outfall storm sewer at STA 229+29.

Off-site runoff would be conveyed through storm sewer, culverts, and drainage channels directly to Sand and Coal Creeks.

- Peak flowrates for off-site drainage basins were taken from the 2012 FHAD (future conditions) and the *Sand Creek (I-225 to E-470) Right Bank Tributaries OSP Alternatives Evaluation Report*, July 2015. When flowrates were not provided, they were calculated based on the drainage area and the flowrate/area ratio taken from the 2012 FHAD or 2015 OSP, as appropriate.

- Existing culverts would be extended, replaced and/or augmented with additional culverts at the following locations: existing SH 30 at 6<sup>th</sup> Avenue Parkway extension STA 146+00, and existing SH 30 south of 6<sup>th</sup> Avenue Parkway STA 157+00.
- Proposed storm sewer would collect off-site runoff reaching the Proposed Action between Stations 182+00 to 204+00 and convey it to Sand Creek near the east abutment of the proposed bridge.
- Proposed storm sewer would collect off-site runoff reaching the Proposed Action between Stations 229+29 and 241+00 and convey it to Coal Creek through the proposed full spectrum detention pond outfall storm sewer at Station 229+29. Further analysis during preliminary design would determine if this section of roadway needs a combined storm sewer for both roadway and off-site runoff, or two separate systems.
- Off-site runoff draining west towards Picadilly Road would not be addressed by the Proposed Action. Storm sewer proposed by the *2015 OSP Alternatives Evaluation Report* would collect off-site runoff reaching Picadilly Road and would convey it south to Coal Creek.

### 3.4 Floodplains

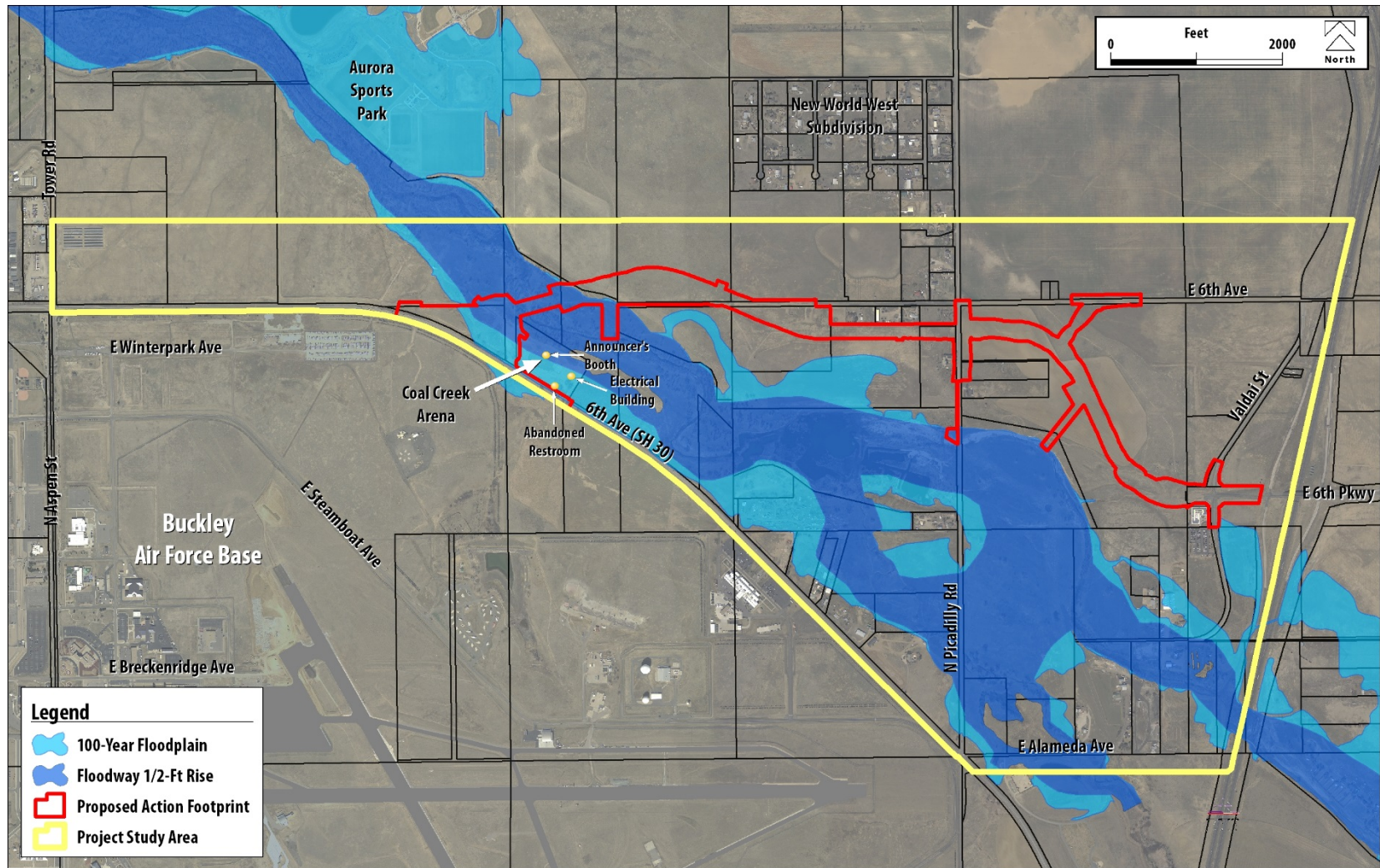
The Proposed Action would impact the Sand Creek floodplain; however, the crossing is far enough north that it would not impact the Murphy Creek or Coal Creek floodplain. Impacts to the Sand Creek floodplain include a maximum rise in the water surface elevation of approximately 1.2 feet and changes to the floodplain and floodway delineation due to the rise in the water surface elevation and due to grading in the floodplain/floodway for the Proposed Action. These impacts would occur on City of Aurora property and the Buckley AFB property. It is unlikely that any other property would be impacted by these changes to the floodplain/floodway.

There are three structures located at the Coal Creek Arena, which is owned by the City of Aurora that would also be adversely affected by the changes in the floodplain/floodway. All three of these structures are currently in the floodplain, and one is currently in the floodway. One structure is the main electrical building for the arena, one structure is an abandoned restroom facility that now contains a holding tank for well water and distributes non-potable water to the Coal Creek Arena and the third building is the announcer's booth which is elevated above the ground and served by electricity. The announcer's booth is currently in the floodway. Refer to **Figure 7** for the floodplain information.

### 3.5 Potential Permits

The Proposed Action would require a CLOMR issued from FEMA prior to construction because it would cause a rise in the floodway water surface elevations. After the CLOMR is issued, a floodplain development permit would be needed from the City of Aurora before construction in the floodplain or floodway can begin.

Figure 7 Sand Creek/Coal Creek/Murphy Creek Floodplain Limits in Project Study Area



114046-01 - Floodplains\_FHAD\_8x11

## 4. MITIGATION

### 4.1 *Drainage and Water Quality*

A Stormwater Management Plan (SWMP) will be required by the Aurora and CDOT MS4 permits for construction activities on this project. Erosion and sediment control during construction of the project will be incorporated into a SWMP and will follow the City of Aurora Rules and Regulations Regarding Stormwater Discharges Associated with Construction Activities, latest edition. Prior to the start of construction, the project is required to obtain a Colorado Discharge Permit System (CDPS) Stormwater Construction Permit from CDPHE and a City of Aurora Stormwater Permit.

After the construction is completed and the re-established vegetative cover is adequate as determined by the City of Aurora SWMP inspector, the temporary erosion control measures can be removed. The site's final stabilization measures will continue to control pollutants being passed into the drainage. The native grass along the roadway perimeter will slow down stormwater flows and encourage evapo-transpiration. Soil riprap will be used at outfall locations to protect the channel from erosion without causing permanent impacts to jurisdictional waters and wetlands. All culvert outlets will have riprap erosion protection. The City of Aurora will continue to make use of street sweeping and other routine maintenance programs to decrease sedimentation of the adjacent waterways. They will continue to modify their maintenance operations as newer technology becomes available in order to lessen the impacts of the Proposed Action on the environment.

Permanent water quality facilities will be provided throughout the roadway corridor to treat roadway runoff to minimize the load of sediment and pollution discharged to Sand and Coal Creeks. The locations of these facilities (ponds or proprietary devices) were selected to minimize impacts to wetlands, conservation easements and existing utilities. The final design process will be closely coordinated with staff from the Aurora Water and CDOT Departments so that the proposed drainage improvements support future trail locations, blend in well with the surrounding natural areas, and are assessable for maintenance. The City of Aurora is committed to maintaining the proposed permanent water quality facilities.

### 4.2 *Floodplains*

Mitigation for the rise in the water surface elevation will be investigated in a few ways. First, an approved CLOMR from FEMA and a floodplain development permit from the City of Aurora will allow the construction of the Proposed Action with the rise so long as it can be shown that affected property owners have been notified and no structures are adversely affected by a rise.

Because there are structures that will be adversely affected by the rise in the water surface elevation, mitigation measures at those structures will be required. This may be accomplished by providing channel improvements and other grading operations in the floodplain and floodway to eliminate the rise, however, this may be difficult to achieve, and cannot be determined until final design.

Another mitigation option is to address the structures themselves, and remove them from the floodplain/floodway or flood proof them. This could be accomplished by moving the structures outside of the floodplain limits, or placing the structures on fill so they are located higher than the base flood elevations. Flood proofing would involve improving the structures to ensure flood proofing to one-foot elevation above the BFEs. The flood proofing will need to address any



electrical and mechanical equipment located in the buildings. A CLOMR may not be issued until the mitigation has been completed at the affected structures.

## 5. REFERENCES

- City of Aurora. 2010. City of Aurora Storm Drainage Design and Technical Criteria, City of Aurora, October.
- City of Aurora. 2010. Rules and Regulations Regarding Stormwater Discharges Associated with Construction Activities. November.
- Colorado Water Quality Control Commission (CWQCC). 2013. Regulation #38 Stream Classification and Water Quality Standards.
- CWQCC. Regulation #93. 2016.
- Federal Emergency Management Agency (FEMA). 2010. Flood Insurance Rate Maps 08005C01282K and 08005C0201K. December 17, 2010.
- Gingery Associates, Inc. 1975. Flood Hazard Area Delineation for Piney Creek, Cottonwood Creek, Lone Tree Creek, and Murphy Creek. October.
- Matrix Design Group, Inc. 2012. Sand Creek Flood Hazard Area Delineation (Colfax to Yale), October.
- Matrix Design Group, Inc. 2013. Sand Creek Major Drainageway Plan (Colfax to Yale), August.
- Merrick & Company. 2015. Sand Creek (I-225 to E-470) Right Bank Tributaries Outfall Systems Plan Conceptual Design Report (Draft), October, 2015.
- Urban Drainage and Flood Control (UDFCD). Urban Storm Drainage Criteria Manual, Vols. 1-3.
- UDFCD. 1977. Flood Hazard Area Delineation for Sand Creek. March.

## Appendix A Resource Impact Table

Resource	Context	No Action Alternative	Proposed Action
<p>Floodplains, Drainage and Water Quality</p>	<p>The study area is located within the Sand Creek watershed, and includes the confluence of Coal Creek and Murphy Creek which are tributaries with Sand Creek. Within the study area, the Sand Creek 100-year floodplain and floodway are approximately 1200 feet and 800 feet wide, respectively. Given the presence in the floodplain and floodway, the area has a one percent chance in any year of flooding to the level that is shown on the 100-year floodplain maps. Historically, major floods in the study area have occurred 10 times in the past 120 years. Sand Creek flows northwest from the study area. Colorado Water Quality Control Commission Regulation #93 defines the portion of Sand Creek within the Study Area as Segment COSPUS16a (mainstem of Sand Creek from the confluence of Murphy and Coal Creek to the confluence with Toll Gate Creek). This entire reach is on the Department of Public Health and Environment (CDPHE) 303d Sensitive Waters List for Selenium and Escherichia coli (E. coli), neither of which are caused by roadway runoff. The Murphy Creek and Coal Creek tributaries are not on the CDPHE 303d Sensitive Waters List.</p>	<p>Would not affect floodplains and drainage. Would result in no impacts to existing structures at the Coal Creek Arena. Would result in natural changes to floodplains and drainages due to flooding, low flow channel migration, and erosion resulting in minor changes to floodplain limits.</p>	<p>Would impact existing drainage patterns, and increase runoff due to an increase in impervious surface area.</p> <p>Would adversely impact three existing structures at the Coal Creek Arena due to change in floodplain and maximum rise in surface water elevation by 1.2 feet. Impact to the Sand Creek floodplain and floodway would include:</p> <ul style="list-style-type: none"> <li>■ A maximum rise in the water surface elevation of approximately by 1.2 feet and changes to the floodplain and floodway delineation due to the rise in the water surface elevation and due to grading in the floodplain/floodway.</li> <li>■ Additional point discharges causing erosion.</li> <li>■ Impacts to jurisdictional waters</li> <li>■ Release of sediment into the drainageway</li> </ul>

## Appendix B Resource Mitigation Table

Mitigation Category	Proposed Action Impact	Mitigation Commitments for the 6 <sup>th</sup> Avenue Parkway Extension Project	Responsible Branch	Timing/Phase that Mitigation will be Implemented
Floodplains	Increase in the floodplain base flood elevations	Submit a CLOMR to FEMA to notify them of the rise in the floodway. Part of the CLOMR package will include proof of notifications to affected property owners and that buildings that would have been adversely impacted by the rise in the water surface elevations have been mitigated.	City of Aurora	Design
Floodplains	Floodplain impacts to three structures at Coal Creek Arena	The main electrical building and the abandoned restroom building will be consolidated to a single building that will be constructed near the existing water well with a finished floor elevation one foot above the proposed 100-year floodplain elevation. The announcer's booth stilts will be reinforced to improve the integrity of the structure and protect it from increased flooding hazards caused by floating debris.	City of Aurora	Design and Construction
Drainage and Water Quality	Increased sediment from the proposed roadway construction process	A SWMP will be required by the MS4 permit for construction activities and will follow the City of Aurora Rules and Regulations Regarding Stormwater Discharges Associated with Construction Activities, latest edition. For the area impacting CDOT's ROW, the SWMP will comply with CDOT's MS4 permit.	City of Aurora; CDOT	Design and Construction
Drainage and Water Quality	Increased runoff from the proposed roadway	Permanent water quality BMPs will be provided and maintained to treat roadway runoff prior to release to the drainageways.	City of Aurora; CDOT	Design and Construction
Drainage and Water Quality	Additional point discharges causing erosion	All culvert outlets will have permanent riprap erosion protection.	City of Aurora	Design and Construction
Drainage and Water Quality	Impacts to jurisdictional waters	City of Aurora will use street sweeping and other routine maintenance programs to decrease sedimentation of the adjacent waterways. They will modify their maintenance operations as newer technology becomes available.	City of Aurora	Design and Construction