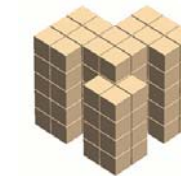


# DENVER STORM DRAINAGE MASTER PLAN

PROJECT CE21130

April 2005

Prepared for:  
**The City and County of Denver**  
**Department of Public Works**



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**1.0 BACKGROUND**

**1.1 Introduction**

This publication is formulated in compliance with Section 56-110 Master Drainage Plan, Division 4 Storm Drainage of the revised Municipal Code of the City & County of Denver, dated August 1, 1982. Additionally, the document incorporates the practices and principles of Volumes I and II of the Urban Drainage and Flood Control District (UDFCD) *Drainage Criteria Manual* and City & County of Denver *Storm Drainage Design and Technical Manual*.

The 1989 *Storm Drainage Master Plan* continues to serve as the framework for management of stormwater programs and implementation of capital improvements within the City. This update has been prepared to augment the 1989 document with new information available via geographic information systems (GIS), land use master plans, and Public Works Department stormwater section. This update process includes all of the City & County of Denver and provides a detailed evaluation of hydrologic conditions and conceptual-level design of drainage improvements within the following basins:

ID	OUTFALL	NAME/LOCATION	AREA (mi <sup>2</sup> )	COMPOSITE IMPERVIOUSNESS
0058-01	South Platte River	Prairie Gateway	1.59	24.95%
0059-01	South Platte River	Globeville - Utah Junction	3.67	52.01%
0060-01	South Platte River	I-70 & Colorado Boulevard	1.91	71.55%
0060-02	South Platte River	I-70 & York	1.47	71.84%
0061-01	South Platte River	27th & Federal	2.23	63.27%
0061-02	South Platte River	Highland	2.99	55.84%
0062-01	South Platte River	Lower Platte Valley	2.73	77.51%
0063-01	South Platte River	Central Platte Valley	2.10	83.24%
0064-01	South Platte River	1st & Federal	0.50	74.43%
0064-02	South Platte River	Valverde	2.66	69.23%
0065-01	South Platte River	Ruby Hill	1.25	70.17%
0065-02	South Platte River	Dartmouth	0.76	86.84%
0067-01	South Platte River	College View	1.29	23.80%
0067-02	South Platte River	West Belleview	4.21	50.73%
0067-03	No Outfall	Marston Lake	1.06	98.72%
3501-01	Second Creek	West Fork Second Creek	3.44	39.91%
3700-01	First Creek	Pena Corridor	2.24	30.59%
3700-02	First Creek	Green Valley Ranch	2.14	66.16%
3700-03	First Creek	Dogwood & Blue Grama Tribs.	2.64	54.07%
3702-01	First Creek	Tributary "T"	1.40	77.46%
3900-01	Irondale Gulch	Stapleton East Section 10	0.22	46.10%
3900-02	Irondale Gulch	East Montbello	1.91	39.96%
3900-03	Irondale Gulch	Parkfield	2.96	54.39%
3900-04	Irondale Gulch	Majestic Commerce Center	1.81	75.24%
3901-01	Irondale Gulch	West Montbello	3.31	62.45%
3901-02	Irondale Gulch	Gateway	0.97	63.56%
4000-01	Rocky Mountain Arsenal	Stapleton West Section 10	0.77	29.07%
4300-03	Clear Creek	North of I-70	1.79	58.22%

ID	OUTFALL	NAME/LOCATION	AREA (mi <sup>2</sup> )	COMPOSITE IMPERVIOUSNESS
4309-01	Clear Creek	Berkeley Lake	1.83	55.08%
4400-01	Sand Creek	North Stapleton	3.78	65.85%
4400-02	Sand Creek	Quebec Corridor	4.43	65.44%
4400-03	Sand Creek	Stapleton	1.49	74.69%
4400-04	Sand Creek	East Stapleton	2.77	74.10%
4401-01	Westerly Creek	South Stapleton	3.03	50.63%
4401-02	Westerly Creek	11th Avenue to Montview	2.83	62.62%
4401-03	Westerly Creek	Lowry	3.51	40.55%
4401-04	Westerly Creek	South of Alameda	2.85	64.56%
4500-01	Montclair	City Park	4.30	54.35%
4500-02	South Platte	36th & Downing	1.74	65.21%
4500-03	Montclair	Park Hill - Colfax Avenue	1.51	59.68%
4500-04	Montclair	Park Hill - 6th Avenue	3.69	54.36%
4600-01	Cherry Creek	Central Business District	2.17	83.23%
4600-02	Cherry Creek	Cherry Creek Mall	4.55	57.71%
4600-03	Cherry Creek	Upper Cherry Creek	5.60	68.81%
4600-04	Cherry Creek	Cherry Creek Reservoir	5.77	53.37%
4601-01	Goldsmith Gulch	Lower Goldsmith Gulch	3.92	64.31%
4601-02	Goldsmith Gulch	Middle Goldsmith Gulch	1.34	58.95%
4700-01	Sloan Lake	West Colfax Avenue	1.59	65.03%
4800-01	Lakewood Gulch	12th & Federal	1.17	59.56%
4801-01	Dry Gulch	12th & Sheridan	0.39	62.00%
4900-01	Weir Gulch	West 6th Avenue	2.30	58.31%
5000-01	I-25 & South Platte	West Washington Park	1.24	71.72%
5000-02	I-25	University & Mexico North	2.82	39.94%
5000-03	Florida	University & Mexico South	2.29	59.35%
5100-01	Sanderson Gulch	West Florida Avenue	5.57	54.59%
5200-01	Harvard Gulch	Harvard Gulch Lower Basin	0.83	61.13%
5200-02	Harvard Gulch	Harvard Gulch Middle Basin	2.76	48.47%
5200-03	Harvard Gulch	Harvard Gulch Upper Basin	3.86	48.24%
5300-01	West Harvard Gulch	West Yale Avenue	1.44	57.09%
5401-01	Greenwood Gulch	South Monaco Parkway	0.16	83.67%
5500-01	Bear Creek	Fort Logan	3.12	52.81%
5500-02	Bear Creek	Upper Bear Creek	1.84	45.45%
5500-03	Bear Creek	Academy Park Tributary	0.60	62.66%
5500-04	Bear Creek	Marston Lake North	2.24	46.01%
5500-05	Bear Creek	Pinehurst Tributary	0.72	41.57%
5501-01	Bear Creek	Henry's Lake	1.35	35.03%
5901-01	Dutch Creek	Coon Creek	3.10	53.21%

**TOTAL 156.52**

DIA Drainage Basins				
3300	Third Creek	Third Creek	16.32	40.06%
3500	Second Creek	Second Creek	8.01	30.35%
8056	Barr Lake	Barr Lake	3.85	7.81%
8100	Box Elder Creek	Box Elder Creek	20.47	24.22%
8150	Box Elder Creek	Box Elder Creek	18.52	37.69%
8151	Box Elder Creek	Box Elder Creek	12.06	23.29%

**TOTAL 79.23**

## 1.2 Executive Summary

At the direction of the Denver City Council, subsequent updates to the document will be performed for the drainage basins within the City to enable a 5-year planning cycle to be maintained. Consequently, the plan will be subject to regular modifications and holders of the plan are therefore cautioned to contact the Wastewater Management Division of the City & County of Denver to be certain that the most currently available information is obtained.

Urban stormwater management within the City & County of Denver has increasingly become a critical infrastructure element as major improvement programs and asset re-development efforts are implemented across the city. The following Master Plan updates and refines the 1989 *Storm Drainage Master Plan* to reflect significant changes in land use densities and stormwater management methodologies. Recent completion of the Denver Land Use and Transportation (LUT) study resulted in the formulation of *Blueprint Denver: An Integrated Land Use and Transportation Plan*, which ostensibly prepares the City for continued urbanization and redevelopment. Also, the City has implemented a myriad of stormwater management programs to comply with the Municipal NPDES permit, including inventorying the stormwater systems and construction of local and regional Best Management Practices (BMP's). One of the major goals of this updated plan is the integration of these documents and programs into a comprehensive Public Works management program.

### *Adaptive Urban Stormwater Management*

Traditionally drainage in the Denver Metropolitan Area has been managed with a combination of overland flow conveyance elements (e.g. roads, sewers, and channels) and regional detention facilities. As the City & County of Denver continues to densify, land values have increased resulting in higher easement and right-of-way costs for open channels. Also, parks and other open space areas continue to be improved to provide a more active and urban setting that limits the availability of storage for stormwater detention. Consequently, this master plan update generally utilizes storm sewer pipes to convey stormwater runoff to the major drainageways. The City should continue to evaluate redevelopment areas for land acquisition for detention facilities to reduce the peak flows the conveyance system must accommodate and improve the "Level of Service" provided by drainage infrastructure.

### *Current System Deficiencies*

At this juncture, the study has found that the capacity of the drainage system within a majority of the City & County of Denver correlates to between a 1 and 5 year system. Runoff generated from larger storm events is temporarily stored in streets and ultimately conveyed via the combination of roads and storm sewers when capacity becomes available. Complaints records maintained by the City since 1990 indicate that annually there are a number of storms that result in limited flooding and property damage. The records do not show serious chronic flood hazards, but instead reveal a more regular pattern of problems related to maintenance and nuisance flows.

Initial hydrologic models show that the storage which exists within the City street provides important flood flow attenuation and, as a result, it will be important to phase improvements from downstream to upstream to avoid eliminating storage that would increase peak discharges upon existing systems below. The models also show that two distinct drainage basins exist: 1) basins delineated by storm sewer catchments for minor storm conveyance designs, and 2) overland flow

basins that relate to larger storm events when mapping of potential inundation areas is appropriate to measure the risk of flooding posed by flooding streets or shallow non-regulatory floodplains. Because the minor storm system in many areas diverts flow from natural drainageways or contravenes topography, "split flow conditions" exist, whereby flow in pipes does not follow surface flow patterns.

### *Approaches to Providing an Upgraded Drainage System*

The following criteria are used to evaluate storm drainage improvements:

- Maximize level of public safety and property protection
- Ensure compatibility with *Blueprint Denver*
- Ensure compatibility with current land uses and needs
- Reduce permit requirements and the need for review of waiver requests
- Minimize negative environmental impacts such as 404 Permitting, NPDES Permitting, and other Clean Water Acts implications
- Maximize opportunities for water quality enhancement
- Minimize life cycle costs
- Support and be compatible with current capital improvement program for drainage and other Public Works programs
- Encourage and enable development participation
- Provide flexibility in phasing
- Minimize drainage impacts to transportation facilities, especially intersections, and high capacity roadway systems
- Minimize construction impacts to already developed properties
- Provide multi-means and multi-use facilities to the maximum extent possible, and
- Provide a document that is rational and likely to foster public and political support for drainage improvements.

Cost effective implementation of a City-wide 100-year drainage system is not practical because of the significant capital cost of retrofit construction and limited annualized flood hazard reduction. Consequently, a phased program is recommended that prioritizes improvements to address current hazards while improving the minor storm system.

Currently, it is the policy of Denver to require the design of drainage systems in accordance with the "Level of Service" goal of fully conveying, *at a minimum*, the minor or initial storm event within pipes or channels. "Minor" or "initial" storm is defined by the Denver Drainage Criteria as a 2-year storm event for residential properties and the 5-year storm event for commercial and industrial districts. Further, it is Denver's policy that storm sewers shall be designed to convey the minor storm flood peaks while flowing at 80% of the full pipe capacity.

This Master Plan identifies capital improvements based upon the hydrologic modeling and the "Level of Service" goal. In many cases, meeting this goal requires upsizing an existing pipe by one or two pipe sizes. This master plan shows the capital improvement as a basis for evaluating, prioritizing and designing capital improvements. It is not intended in all cases to recommend removing the existing pipe and replacement with a larger pipe. *Value engineering* (beyond the scope of this master plan) will evaluate the condition of the existing pipe, potentially propose a parallel

pipe, determine whether additional flow can be carried in the street, identify a new outfall and/or accept existing conditions where the cost/benefit ratio is less than one.

The proposed capital improvements, in general, are shown as complete replacement with a round pipe with conveyance capacity for the appropriate level of service based upon existing land use. Conflicting utilities and other constraints will necessitate drainage infrastructure equivalents such as box culverts or open channels. Also, the assumed slope of the proposed pipe is either the same as an existing pipe or at 0.50%. Shallower slopes, determined during preliminary design, may necessitate larger pipes/box culverts.

Denver's drainage criteria require all storm pipes to be reinforced concrete pipe (RCP). Many of the existing drain pipes were constructed with brick or other materials. Evaluating the condition of existing pipes is beyond the scope of this project, and replacement is based upon capacity rather than material or age. Denver maintenance forces will need to compile a separate inventory of capital improvements based upon pipe degradation.

All existing collector storm pipes must be 18-inch diameter or larger according to Denver Drainage Criteria. (15-inch pipe is allowed only if no more than one inlet is connected to the pipe.) All storm pipes less than 18-inch diameter and longer than 100-feet (assumed to represent collector pipes rather than laterals) have been queried in the GIS and shown in this capital improvement program as replacement with new 18-inch RCP.

### 1.3 Goals of the Storm Drainage Master Plan

#### 1.3.1 Management Interviews

To provide direction to the planning process and capitalize on the extensive experience and knowledge of staff, selected members of the City Public Works and Planning Departments were interviewed. The following questions were posed to these stakeholders:

#### What are the Primary Drainage Issues confronting the City?

- The existing City drainage system does not meet current drainage criteria, whereby the initial storm (2-year recurrence for residential areas and 5-year recurrence for commercial/industrial areas) cannot be fully conveyed within pipes or dedicated drainage channels. In other words, the current drainage system is generally undersized except for the major drainageways, which have been improved over the years (e.g. South Platte River, Goldsmith Gulch, Harvard Gulch),
- It is impractical to upsize the system on a City-wide basis to provide for a 100-year drainage system,
- The master plan needs to understand the implications of redevelopment. Major projects such as Stapleton or Lowry benefited from scale economies and private-sector developer investments to construct new improvements to outfall to major drainageways. Smaller redevelopment projects such as those within North Cherry Creek basin or lower downtown lack the financing and cohesion to build regional drainage systems, and

- Because the existing drainage system does not strictly satisfy 100-year standards, City staff must review waiver requests on a regular basis and need a decision-making tool for evaluating the reasonableness of proposals.

#### What Are the Goals for the Master Plan Update Process?

- Create optimal value with the master plan to capitalize on available revenues from the drainage enterprise fund while providing the greatest reduction in flood hazards,
- Ensure that facilities are designed to be maintainable, and that a commensurate budget for on-going maintenance is anticipated and provided for,
- Encourage the use of multi-purpose facilities such as incorporating linear parks within riparian corridors and co-locating detention facilities within other municipally owned properties or parks,
- Provide a framework document that informs developers of potential drainage deficiencies within project areas so that property values reflect the risk of flooding or level of capital investment required to address stormwater management issues,
- Provide a "toolbox" for reviewing development proposals (including waiver requests when appropriate), including access to background information used in the plan and hydrologic models that may be modified by staff as more specific development proposals are made within each, and
- Provide a framework for continued urbanization of the City & County of Denver and implementation of the concepts and tenets of *Blueprint Denver: An Integrated Land Use and Transportation Plan*.

#### What Threats or Obstacles Would Prevent Denver From Obtaining This Goal?

- The relatively short timeframe and broad expanse of the study area poses a major challenge to evaluation of the basins in a street-by-street detail. Hydrologic modeling should be developed in sufficient detail to support the conceptual design and sizing of infrastructure. There should not be an effort to develop new technology or precisely define urban floodplains.
- Because the City has limited enterprise funds for construction of new facilities, a 100-year system will likely be unachievable in most drainage basins. The plan needs to establish a rationale for appropriation of funds based upon current drainage criteria.

#### What is an Appropriate Measure for Success of the Update Process?

- Completion of the Master Plan with enough detail to validate or justify modification of the City's current CIP,
- Establishment of a framework for screening options and supporting a preferred plan for implementation, and
- Creation of a document that is usable and provides for continued update by the City's GIS and annual storm drainage master plan update process.

**What Are the Strengths and Weaknesses of the Existing 1989 Storm Drain Master Plan? Should Any Elements or Components be Retained in the 2003 Update?**

- The greatest strength of the 1989 plan is the comprehensive format in which the information has been compiled. The document is a useful tool for managers to plan and monitor stormwater programs across the City,
- The document is successfully linked with current bond programs and City-wide capital improvement programs, but
- A major weakness is found in the lack of accessible technical detail, including hydrologic models and other essential information to understand the basis for the master plan. Much of the information is assumed to be a compilation of anecdotal information, and
- The final document should retain the scale of documents within the 1989 study but include a more detailed description of hydrology and presentation of an electronic database for GIS and hydrologic models.

#### **1.4 Objectives of the Storm Drainage Master Plan**

##### ***1.4.1 Criteria for Screening Evaluation***

In order to identify potential solutions and to screen alternatives for selection of a preferred approach, technical working groups were challenged with establishing specific goals and objectives against which alternatives could be measured for achievement. The proposed alternative matrix showing the achievement (high, moderate, and low) is shown in the table on the following page.



**CITY AND COUNTY OF DENVER STORM DRAINAGE MASTER PLAN UPDATE**

*Alternatives Ranking Matrix*

ALTERNATIVE	OBJECTIVES												
	Safety	Land Use			Environmental	Capital Budgeting				Infrastructure	Economic	Political	
	Maximizes Level of Property Protection or Public Safety	Compatibility with BluePrint Denver	Compatibility with Current Land Uses	Reduces Permit Requirements	Minimizes Negative Environmental Impacts	Minimizes Construction Costs	Supports Current Capital Improvement Program	Enables Developer Participation	Provides Flexibility in Phasing	Minimizes Drainage Impacts on Transportation	Provides Multi-Purpose Benefits	High Benefit Cost Ratio	Galvanizes Public Support
1. No Action: Maintain Existing Condition	Low	Low	Moderate	High	High	High	Low	Low	High	Low	Low	Moderate	Moderate
2. Enlarged/Stabilized Open Channels	High	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate
3. Replace/Enlarge Ex. Storm Sewers	High	High	Moderate	Moderate	High	Low	High	Moderate	Moderate	High	Low	Low	Moderate
4. Construct New Storm Sewers	High	High	Moderate	Moderate	Moderate	Low	Moderate	High	Moderate	High	Low	Low	Moderate
5. Enlarge Existing Regional Detention	High	Moderate	Low	Moderate	Moderate	Moderate	Low	Moderate	High	Moderate	High	High	Moderate
6. Construct New Regional Detention	High	Moderate	Low	Moderate	Low	Moderate	Low	Low	High	Moderate	High	High	Low
7. Enlarged Bridges or Culverts	High	High	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	High	Low	Moderate	Moderate
8. Improve Intersections	Moderate	High	High	High	High	Moderate	High	Low	Moderate	High	Low	Moderate	Moderate
9. On-Site/Rooftop/Underground Detention	Low	Moderate	Moderate	High	Moderate	Moderate	Low	High	High	Low	Low	High	Moderate
10. Acquire/Control Flood Prone Property	High	Low	Low	High	Moderate	High	Low	Low	High	Low	Moderate	High	Low
11. Floodproofing	Moderate	Low	High	Moderate	High	High	Low	High	High	Low	Low	High	Moderate
12. Obtain Flood Insurance	Moderate	Moderate	High	Moderate	High	High	Low	High	High	Low	Low	High	Low

Key: High Achievement   
 Moderate Achievement   
 Low Achievement

## 1.5 Plan Formulation

### 1.5.1 Geology

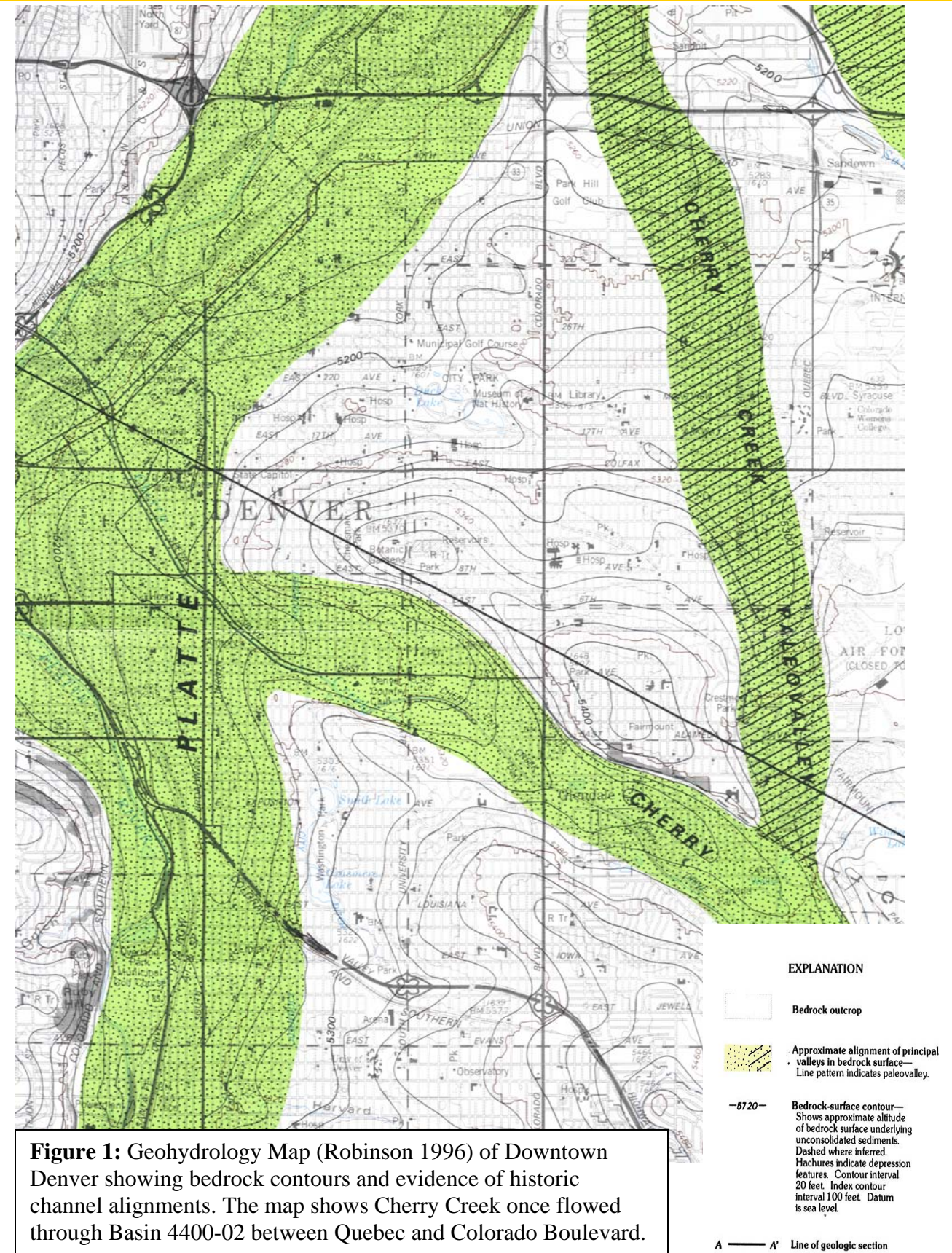
The City of Denver is built across the deepest part of the asymmetrical Denver basin, which was formed and filled during late Cretaceous and early Tertiary periods. Deep wells have not been drilled into the pre-Cambrian metamorphic rocks in this part of the basin, but seismic data reveals that this formation lies about 13,000 feet beneath the surface. The sandstone, shale, limestone, and other sedimentary rocks that occur between the basement formations and the surface, range in age from Pennsylvanian to Paleocene. Many small faults probably are present in these sediments, although very little is known about the formations below the Denver area. Most outcrops of bedrock in Denver consist of the Denver formation of Paleocene Age, although the Arapahoe Formation of Cretaceous Age outcrops in the low areas near the South Platte River. These two formations are similar in lithology and were deposited as a result of alluvial action, torrential floods, and dilation in quiet lakes. Overlying the bedrock surface at most places is a relatively thin covering of unconsolidated surficial materials composed of boulders, cobbles, gravel, sand, silt and clay. The surficial alluvial material making up the floodplain and terraces of the South Platte River is predominantly sand and gravel with some silt and clay beds. Figure 1 illustrates the bedrock topography for the downtown area of the South Platte River, Cherry Creek, and Sand Creek addressed in this Phase I update. This map identifies a paleo-channel alignment of Cherry Creek primarily through what now has been defined as Basin 4400-02.

### 1.5.2 Climate

The Lower South Platte drainage area experiences a climate commonly known as a semi-arid continental type. The area is characterized as a zone of transition from a plains to a foothills climate. The area has cold, dry winters and cool, relatively dry summers. Typically, there are low precipitation rates and humidity, pronounced variations in diurnal and seasonal temperatures, and periods of high winds.

Average annual temperature is around 49° with a recorded high in 1939 of 104° and a low of -30° recorded in 1936. Diurnal fluctuations usually range from 26 to 29° for most months; however, around July daily fluctuations can be as much as 31°. A wide average range in daily temperatures is typical of the high plains. Extremely hot weather in summer or extremely cold weather in winter generally does not last long and is followed by more moderate temperatures.

Annual precipitation averages about 14.2 inches. More than two-thirds of the precipitation falls from April to September, which is the average annual growing season. On average, Denver experiences about 75 storm events annually. Of these 75 events, about 46 on an average annual basis produce less than 0.1 inch of precipitation. About 22 of the remaining 29 runoff-producing average annual events total between 0.1 inches and 0.5 inches of precipitation. Typically, Denver experiences only 7 large storm events (greater than a 0.5 inches) annually. These significant storm events are characterized by short duration, high-intensity rain showers that overwhelm the existing drainage system for several hours.



**Figure 1:** Geohydrology Map (Robinson 1996) of Downtown Denver showing bedrock contours and evidence of historic channel alignments. The map shows Cherry Creek once flowed through Basin 4400-02 between Quebec and Colorado Boulevard.

The driest months are December through January. Average annual snowfall at Denver is about 59 inches. Humidity averages about 39% during the day and 62% during the night. Humidity is slightly higher in winter than in summer. The sun shines approximately 69% of the possible sunlight hours annually.

Wind speed averages about 5.9 mph, and upslope winds predominate from the south and west. An average wind speed is not adequate to describe conditions in the area. Low wind conditions have been experienced and often contribute to air pollution problems. High velocity winds often destroy trees, crops, and structures, and winds in excess of 90 mph have been recorded.

### 1.5.3 Topography

The South Platte River Drainage Basin can be divided into a plains region and a mountain region. The plains exhibit a trellis drainage pattern; streams flowing in alluvial channels. The mountain regions are characterized by a dendritic drainage pattern.

The Lower South Platte drainage area topography represents flat to gentle undulating plains with elevations ranging from 5,650 feet in the southeast to 4,950 feet in the floodplain of the South Platte River. Drainage from the west flows easterly from the foothills into tributaries of the South Platte River. On the east side of the South Platte River in the Denver area, major drainage flows lead from southeast to northwest by way of Cherry Creek, Sand Creek, Westerly Creek, Goldsmith Gulch, Harvard Gulch, Dutch Creek, Lilley Gulch, and Coon Creek.

### 1.5.4 Flood History

The City & County of Denver and surrounding metropolitan areas lie within the watershed of the South Platte River. The drainage area above Denver comprises approximately 3,800 square miles. Existing development within the floodplain is essentially industrial and has taken place in areas previously devoted to gardening and farming. Residential areas within the historic floodplain include Globeville, Valverde and scattered smaller developmental areas.

Numerous flood control and mitigation measures have been implemented throughout the years to reduce the flood hazards. In 1901 Mayor Speer suggested constructing walls along Cherry Creek, the first ordinance was passed in 1908, and construction was completed in November 1915. A Cherry Creek Flood Commission was appointed in 1912 and recommended a dam with reservoir capacity of 12,000 acre-feet. However, the Castlewood Dam built on Cherry Creek in 1890 failed in August 1933. After the 1933 flood, City officials decided to build a flood control dam at Kenwood. Also during this time, W.P.A. workers straightened and riprapped the Cherry Creek banks. In 1950, the U.S. Army Corps of Engineers completed Cherry Creek Dam 1,000 feet upstream from Kenwood Dam.

In June 1965, the South Platte River flooded Denver. Following the flood, several steps were taken to mitigate the effects of flooding from such an event. Congressional support was sought to build Chatfield Dam as a flood control structure. The Mayor of Denver constituted a South Platte River Development study group to develop a plan for the Platte River Valley that would incorporate various flood control measures. Several private groups in the community organized themselves to provide support for the planning effort. The preliminary report for Chatfield Dam was issued in December of 1965 and construction was completed in 1973.

The following is a summary of the major flood events in the Denver metro area:

**May-June 1844** – The earliest flood for which circumstantial evidence is available occurred in 1844, at which time the bottomlands in the vicinity of Denver were covered in water from bluff to bluff.

**May 19-20, 1864** - Heavy rain over the upper basin of Cherry Creek caused 19 deaths along Cherry Creek and the South Platte River in Denver. The flood from May 18 combined with this flood and covered the lower sections of the city with 1 to 5 feet of water. The flood washed out several bridges and swept large buildings off their foundations. Property damage from the flood was estimated at approximately one million dollars.

**July 14, 1912** – A thunderstorm with heavy rain in the late afternoon combined with a similar storm south of the city to produce widespread flooding on Cherry Creek in downtown Denver and resulted in two deaths. The flooding in Denver was the worst since 1864 and covered approximately 3 square miles of lower downtown. Bridges along Cherry Creek were washed out and water lapped at the floor of the Broadway Bridge over the South Platte. The floodwater caused great damage to the sewerage system, parkways, bridges and to residences and commercial warehouses near Cherry Creek. Flood damage was estimated at several million dollars.

**May 21, 1914** – A severe thunderstorm produced heavy rainfall of 0.83 inches in 15 minutes. Flooding caused considerable damage to bottomlands in eastern and southern parts of Denver.

**June 2-7, 1921** – During April the snowfall had been unusually heavy, approximately three times its normal depth for that month. Rainfall measurements in the foothills ranged from 3 to 5.5 inches from June 2 through 7. The South Platte River in the canyon reached a stage of 9 feet and washed out the tracks of the Colorado and Southern Railroad. The bottomlands in the valley below Denver were flooded, with the overflow being as much as 4 miles wide near Sterling. The overflow reportedly stretched the 43 miles from the mouth of the canyon to Denver.

**August 2-3, 1933** – 3 to 9 inches of rain in 9 hours caused Castlewood Dam on Cherry Creek to fail. Seven people died in Denver. Damage was estimated at 1 million dollars.

**May 1942** – Heavy rains caused extensive damages along the South Platte River. The high water destroyed five bridges including those at West Evans and West Mississippi.

**August 2-3, 1951** – Almost 3½ inches of rain fell on the Denver Metro area.

**July 9, 1953** – Heavy rains caused an estimated 2 million dollars damage from flooded stores and basements across metro Denver. The floodwaters reached a depth of 3 feet on streets in some sections of the city, damaging streets and automobiles. The heavy rainfall at Lowry Air Force Base totaled 3.9 inches.

**July 30-August 3, 1956** – Up to 12 inches of rain fell in five days in the Denver area and on the western slope, causing \$5 million in damage.

**June 16, 1965** -- Black Wednesday, the day Denver was hit by the worst natural disaster in the city's history. After a cloudburst that dumped 15 inches of water on mountain slopes southwest of Denver, a devastating flood struck 20 counties, including Denver along the South Platte River. Twenty-five people were killed, and property damage was estimated at more than \$500 million. Since that time, Chatfield and Bear Creek Dams have been constructed greatly reducing the flood threat to Denver from precipitation over major sub-drainage basins.

**July 23, 1965** – Heavy rains in Aurora washed out earthen bridges over Sand Creek. Several highways were washed out to the east and southeast of Denver.

**July 24, 1965** – Heavy rain fell over all of the Denver and Aurora areas, causing some flooding of roads, streets, and bridges.

**July 7, 1967** – A storm caused flood damage in southwest and south Denver. Unofficial reports indicated rainfall of 2 inches in 30 minutes and more than 3 inches total from the storm. Streets and buildings were flooded by the heavy runoff. Hail in some areas contributed to flooding by blocking storm drains. Water reached a depth of 5 feet in the street. Police rescued numerous stranded motorists. In southwest metro Denver, 100 to 150 homes were flooded, and there was one fatality.

**May 4-12, 1969** – Heavy rains caused flooding on the South Platte River in Denver.

**June 8, 1969** – Heavy rain flooded streets and underpasses throughout metro Denver. The heaviest amounts of rain fell in south Denver and Englewood, where unofficial totals of 5 to 6 inches were reported. Mud, debris, and hail carried by the heavy runoff clogged drains and increased the amount of flooding. Approximately 40 cars and a large truck were inundated at an underpass on I-25, and several more were inundated or buried in mud in other areas. A large number of basements were flooded and streets and highways were heavily damaged in some areas.

**June 11, 1970** – Over 3 inches of heavy rain flooded streets and underpasses throughout metro Denver.

**May 5-18, 1973** - Prolonged rains of up to 6 inches on May 5th and 6th in the South Platte Basin, along with melting of a large snow pack, produced major flooding during the next two weeks along Clear Creek, Sand Creek, and the South Platte River in the Denver metro area. One person died and damages were estimated at around 120 million dollars.

**July 20, 1975** – Heavy rains caused flash flooding across metro Denver, resulting in the closing of several streets and damage to numerous homes and businesses.

**June 13, 1984** – One of the worst hailstorms ever experienced in metro Denver occurred. Torrential rains with as much as 4.75 inches in Lakewood clogged drains and caused widespread damage from flooding. There was one fatality.

**May 16-17, 1995** – Significant moisture and upslope flow caused flooding across metro Denver. Moderate to heavy rains which began on the evening of the 16<sup>th</sup> developed in the foothills and spread eastward over metro Denver throughout the night. After the spring floodwaters receded, the CWCB and the Colorado Office of Emergency Management reported 15 flood-related deaths statewide and damage estimates approached \$20 million.

**June 4, 1995** - The heaviest measured rainfall was from a gauge operated by the Pinehurst Golf and Country Club located in southwest Denver where a reported 3.2 inches fell in less than one hour. Residential flooding and storm drainage problems were reported along a small south-bank tributary to Bear Creek. The June 4<sup>th</sup> storm also caused flood problems in other parts of Denver, Englewood and Sheridan. This single thunderstorm produced the highest peak flows for the year along lower Bear Creek and the South Platte River through Denver.

**July 19, 1997** - At approximately 4:00 p.m., a severe thunderstorm in NE Denver and NW Aurora produced 3.83 inches of rain in less than an hour, exceeding the official Denver one-hour record of 2.2 inches set on August 13, 1921. This storm was accompanied by copious amounts of hail with stone diameters reaching 1.25 inches. Westerly Creek, a tributary to Sand Creek that enters the old Stapleton International Airport property from the south, flowed out of its banks and nearly overtopped Montview Boulevard. The Montview culverts are designed to safely pass a 10-year flood, a project completed by Denver, Aurora and UDFCD in 1980.

**July 27, 1997** - Between 3:00 and 4:00 p.m., Goldsmith Gulch in Denver was hit by heavy rains with 1.66 inches falling at the Denver Tech Center (DTC). Downstream floodwaters approached 10-year levels causing the recently completed side-channel detention facility near Iliff Avenue to function. This flood control facility, constructed by Denver and UDFCD in 1996 was credited with preventing damages downstream. Local residents were pleased with its performance. A minor glitch did occur, however, when the pump that drains the facility failed to start. Denver Wastewater Management Division officials corrected the problem the next day.

The Eastman Avenue ALERT gage peaked at 4 p.m. at a depth of 7.4 feet with an estimated discharge of 1670 cfs, exceeding its prior record of 1470 cfs (8/2/91). The Temple Pond gage at the DTC had a maximum water depth of 8.2 feet and a peak outflow of 470 cfs.



*Iliff Stormwater Detention Basin on Goldsmith Gulch*

**July 28, 1997** - Some significant flooding occurred in Denver with Goldsmith Gulch being hit hard for the second consecutive day, exceeding the prior day's peak at Eastman Avenue by one foot and setting a new record of 2040 cfs at 6:30 p.m. Upstream at Temple Pond, Goldsmith floodwaters pooled to a depth of 9.5 feet releasing 500 cfs. Downstream of Eastman at Yale Avenue the peak flow was estimated at 1850 cfs and classified as a 10-year event. According to the Goldsmith Gulch design hydrology model, the discharge at Eastman approached the 50-year mark. As with the

previous day's storm, the Iliff detention facility and improved channel reaches performed as designed, preventing significant damages. By 9:00 p.m., Goldsmith Gulch floodwaters had combined with Cherry Creek flows causing the Market Street gage in lower downtown Denver to measure its new record peak of 3200 cfs. The Cherry Creek gage at Steele Street also set a new record at 2350 cfs. Heavy rains in other parts of Denver and Aurora caused localized flooding of many roads, parking lots and basements.



*Goldsmith Gulch downstream of Yale Avenue on July 28, 1997.*

**July 29, 1997** - Late evening rainfall on July 28 caused the Sand Creek ALERT gage to measure a new record flow of 4200 cfs at 2:47 a.m. (see July 19 discussion). At Sand Creek Park near its crossing with I-225, the pedestrian trail crossing was overtopped by 4.4 feet, and the discharge was estimated at 3480 cfs, another ALERT gage record. A parking lot flooded at Quebec St. and Leetsdale Drive in Denver to the point that a car was found floating in it.

**August 11, 1997** - Hail depths of up to 2 feet, driving rains and high winds caused an estimated \$150-million in damage in Lakewood and Denver. A rainfall amount of 1 inch in 10-minutes was measured by the Cherry Creek gage in downtown Denver, and after the hail melted, the total measured precipitation exceeded 2 inches. Cherry Creek flowed wall-to-wall at a depth of approximately 5 feet and a peak discharge of 2640 cfs. This was the second highest measurement for Cherry Creek for the year, exceeded only by the July 28 event.

**September 4, 1997** - Cherry Creek flowed wall-to-wall. Five rain gages had alarmed (1 inch in less than 1-hour) by 9:45 p.m. The locations and amounts were accurately reported to the public at the start of the 10 p.m. broadcast.

**July 24, 1998** - Heavy rains that occurred during the evening caused problems in Denver with flooded basements, stranded drivers and downed power lines. A forecaster for the NWS measured 3 inches in 30 minutes at his home near W. 38th Avenue and Federal Boulevard. The railroad viaduct near 38th and Fox (Basin 0061-01) trapped motorists in water 4 to 5 feet deep. This notorious flood area has been less of a problem in recent years due to drainage improvements completed by Denver and UDFCD, but this storm clearly exceeded the design rainfall amounts.

**July 30, 1998** - Denver streets flooded, zodiac boats were needed for rescues at "Lake Logan" (Logan Street underpass of I-25) and a kayaker was rescued from the South Platte at Santa Fe.

**July 31, 1998** - A flash flood watch was issued by the NWS shortly after 2 p.m. for the entire Front Range from Colorado Springs to Fort Collins. In Denver, street flooding damaged private property in the vicinity of Evans Avenue and Lipan Street.

**April 29-May 1, 1999** - On April 30 and May 1, the NWS issued flood watches for the South Platte River and other large Denver area streams. Gradual rises in river stage were observed due to relatively high rainfall accumulations over the prior week. Englewood Dam recorded a record high water depth of 16.2 feet on April 30. Spillway flows begin at a depth of 40 feet. Flood control improvements to this District-owned, normally dry detention dam were completed in 1976.

**July 31, 1999** - Martin Luther King Boulevard in the Park Hill area of Denver was barricaded due to flooding between Colorado Boulevard and Quebec Street. However, this measure did not stop six motorists from driving into the flooded area and stalling. Sand Creek recorded its annual peak while the Havana Park detention facility in the Westerly Creek basin overflowed into neighborhood streets. Thunderstorm rain in Denver and Aurora exceeded one inch at 8 gaging stations with 1.69 inches occurring at Horseshoe Park in Aurora.

**August 10, 1999** - In the Denver area, more than 3 inches were reported to have fallen in less than an hour. The highest ALERT rain measurement was 2.52 inches, near I-225 and Sand Creek in Aurora. In addition to the wind and rain, hail and lightning caused problems for many areas including DIA.

**August 17, 2000** - Denver Fire Fighter, Bob Crump, died in the line of duty after rescuing a woman from floodwaters in the vicinity of E. 49th Avenue and Colorado Boulevard (Basin 0060-01) Mr. Crump lost his life after being pulled into a submerged open 36 inches storm sewer. The storm at this location was estimated to be a 75-year event.

The flooding that was realized this day was somewhat unexpected. Morning analysis indicated minimum flood potential, but weather conditions changed substantially by mid-afternoon. Within 10 to 15 minutes, heavy rainfall was occurring over northern Douglas County and the Littleton area. By 4 p.m., the NWS had issued an urban and small stream flood advisory for this storm and at 4:37 p.m. the advisory was upgraded to a flash flood warning for a large portion of the Denver metropolitan area.

**May 3-5, 2001** - Three days of steady upslope rain saturated soils along the Front Range. Rainfall amounts totaled 2 to 3 inches over much of Denver causing some minor street flooding while larger streams like Cherry Creek and the South Platte River rose above normal. Two reservoirs monitored by the ALERT system recorded their annual peaks on May 5.

**June 20, 2001** - At 7:20 p.m., heavy rain and damaging hail struck DIA causing major damage. Between 40 and 50 mobile homes were also damaged in the Watkins area.

**July 8, 2001** - Serious street and stream flooding hit Denver between 4 and 6 p.m. The storms were accompanied by high winds and small hail. Flash flooding was observed on Harvard Gulch, Goldsmith Gulch, Cherry Creek, the South Platte River, and along I-25 where the infamous "Lake Logan" (Logan St./I-25 underpass) once again stopped traffic. The Harvard Gulch at Jackson Street rain gage measured the heaviest rainfall of 0.67 inches in 5 minutes and 2.48 inches in an hour.



Goldsmith Gulch upstream of Mexico Avenue on July 8, 2001.

**July 23, 2001** - A highly localized storm impacted rush hour traffic around the Denver Tech Center. Hail, wind and rainfall amounts exceeding 1.2 inches in 30 minutes slowed travel on I-25 and I-225. Funnel clouds were also reported. The South Platte River gage at Union Avenue recorded its record flow for the year.

**August 5, 2002** - A heavy thunderstorm near DIA set a record high water level for the 2-year-old ALERT stream gage on Third Creek. The rain gage at that station measured 2.36 inches and prompted the NWS to issue a flash flood warning. Most of the metro area received less than an inch of rain while two gages in the Bear Creek basin measured over an inch.

**September 13, 2002** - Once again the I-25/Logan Street underpass was inundated by stormwater - this time disrupting traffic for over 3 hours during evening rush hour. A number of motorists were rescued from their vehicles. Rainfall totals 1.06 inches to 1.18 inches were measured near the I-25 corridor between the Denver Tech Center and Broadway. The Transportation Expansion Project (T-REX) construction will vastly improve this historic drainage problem.

**August 18, 2004** - It was a deluge that produced standing water across the entire region and an average of 1.62 inches of precipitation fell on Denver. The South Platte River swelled to 10,000 cfs from 300 cfs earlier in the day. The Denver Fire Department responded to nearly 180 calls between 4:30 and 6:30 pm Wednesday, 10 times the normal volume. Many of those were for water rescues. City and State crews used snowplows to clear water from some clogged drains in Denver. About 5 inches fell on the Denver Zoo. A car was swept over a 6-foot embankment about 1:00 am. Two lanes of northbound I-25 at West Alameda Avenue were closed under 8 inches of standing water. The two worst flooding spots were I-25 at Alameda and I-70 in the area of Vasquez, Steele and York streets.

### 1.5.5 Existing Conditions

See Appendix Notebooks for Hydrologic Models. Existing drainage conditions have been evaluated through field reconnaissance, research of complaint records, and detailed hydrologic modeling using the Colorado Urban Hydrograph Procedure (CUHP) and Urban Drainage Stormwater Management Model (UD-SWMM) software developed by UDFCD. Modeling of the fully urbanized basins found

within the City & County of Denver poses a significant challenge because of the high degree of impervious area and complex basin routing inherent in the system. To ensure that a reasonable model was developed to simulate these conditions, there has been extensive coordination among the consultant team, City & County of Denver staff, and UDFCD. The participation of this team of experts has resulted in the development of sophisticated models which are linked with GIS-based capital budgeting tools. This approach will enable the models to be incorporated in subsequent versions of CUHP and UDSWM, including the incorporation of future GIS advancements and graphical user interfaces (GUI).

### Parameters for Stormwater Runoff

Volume 1 of the UDFCD Storm Drainage Criteria Manual provides the basis for input data for CUHP. In order to more accurately simulate the potential for runoff under future conditions, the Denver GIS database has been used to evaluate existing land uses and densities within commercial and residential areas. These have been compared with the permitted densities (and corresponding imperviousness) for current zoning and have been overlain with *Blueprint Denver* to ensure that a reasonable upper limit is used. Generally, the imperviousness for residential areas was set at 52%, commercial/retail from 80 to 90% and industrial 90 to 95%.

One-hour rainfall depths for the CUHP model have been obtained from Volume 1 for the following current periods:

- 2-year = 0.95 inches
- 5-year = 1.34 inches
- 100-year = 2.57 inches

### Evaluation of Split Flow Conditions

Hydrologic modeling of drainage conditions within Denver is further complicated by split flow conditions where the direction of storm sewers contravenes the surface gradient. The storm sewer system generally has 1-year capacity under current conditions and 2 to 5-year capacity with proposed improvement conditions. Delineation of the basins is important to ensure proper sizing of proposed improvements and also to evaluate overland flood flow conditions. As a result two models have been developed: 1) a low flow model for the minor storm event and 2) a split flow model which extracts the low flow and accounts for transbasin diversions of flow to enable mapping of hazard areas under 100-year storm event conditions. Potential ponding areas are shown as shaded zones on the full-size proposed improvement maps (see Technical Appendices or GIS database) to facilitate planning staff review of development applications and to advise potential landowners or developers of inherent localized flood hazards.

### 1.5.6 Future Development

The Denver Storm Drainage Master Plan is one of several documents that will feed information into the City's Comprehensive Plan. *Blueprint Denver* is another essential framework document that both identifies major transportation network improvements and establishes the basis for future land use planning. To assist with future planning, "Areas of Change" and "Areas of Stability" have been delineated in *Blueprint Denver*. The Areas of Change Map is included with the mapping for reference to show the potential for changing hydrology and highlight the areas where capital investment in infrastructure is expected.

## 2.0 MAJOR DRAINAGEWAYS

### 2.1 South Platte River (Basin 0000)

The South Platte River is the largest receiving waterway in the Denver Metropolitan area and flows from south to north along the I-25 corridor through the City & County of Denver. Within the city limits of Denver, the South Platte River meanders along a path some 11.7 miles in length from West Dartmouth Avenue to Franklin Street. The drainage basin covers approximately 4,850 square miles extending from the Continental Divide in the Rocky Mountain Front Range to the high plains and foothills of eastern Colorado. The mountainous portion of this basin is generally unsuited for dense development, while the foothills and high plains areas are actively being developed. The intense urbanization in the metropolitan area consists primarily of residential and commercial areas and some industrial regions along the river valley.

The South Platte River flood potential is mitigated by Chatfield Reservoir (constructed in 1973) located on the South Platte River, along with Cherry Creek Reservoir (constructed 1950) and Bear Creek Reservoir (constructed 1977) located on major tributaries. Short duration flooding will continue to occur from extremely heavy precipitation in those areas below the dam-sites. Peak 100-year flows of the South Platte vary from 5,000 cfs near Chatfield to 38,000 cfs at the confluence with Sand Creek. Normal discharges in the South Platte River are generally about 100 cfs, but approach about 1,000 cfs during the spring runoff period. Average daily flows are highly affected by treated effluent discharges from Metro Wastewater.

### 2.2 Third Creek (Basin 3300)

Third Creek is an east bank tributary of the South Platte River and is located northeast of Downtown Denver. Third Creek flows through Denver International Airport and is experiencing development in the drainage basin. Third Creek drains approximately 31 square miles of area to the South Platte River. The basin is about 14 miles long and 3.2 miles wide at its widest point. The drainage basin ranges in elevation from 4,960 feet at the South Platte River to 5,485 at the basin divide. Third Creek has a natural irregular channel section above the O'Brian Canal, and a small, poorly defined channel section between the O'Brian Canal and the South Platte River. Third Creek is crossed by Highway 85, I-76, the Union Pacific and Burlington Northern Railroads, and the O'Brian Canal, Fulton Ditch, McCann Ditch, and the Burlington Ditch.

### 2.3 Second Creek (Basin 3500)

Second Creek drains about 27 square miles of area to the South Platte River. The basin is about 15 miles long and 3.4 miles wide at its widest point. The drainage basin ranges in elevation from 4,990 at the South Platte River to 5,650 feet at the basin divide. Second Creek has a natural irregular channel section in the upper reaches above the O'Brian Canal. The Second Creek Basin is crossed by US Hwy 85, U-76, the Union Pacific and Burlington Northern Railroads, the O'Brian Canal, Fulton Ditch and the Burlington Ditch. Second Creek has a natural irregular channel section above the O'Brian Canal and a small, poorly defined channel section between the O'Brian Canal and the South Platte River. Existing development within the Second Creek basin is mainly agricultural, with

irrigated farmland located in the South Platte River Valley and dryland farming and pasture in the upstream areas.

The southern land area of the Second Creek drainage basin within the Denver city limits drains via a tributary known as the *West Fork of Second Creek*. This tributary drains about 3 square miles of area to Second Creek. The Highline Canal terminates at the West Fork. The sustained unused flow in the Highline Canal is wasted to the West Fork downstream of 64<sup>th</sup> Avenue, and the flows have eroded the channel on the West Fork. At Tower Road the West Fork channel is about 15 feet deep with vertical and very steep, unstable banks. The confluence of Second Creek and the West Fork of Second Creek is a wide, relatively flat area supporting a stand of cottonwood trees. Some wetland areas are present in the upper reaches of the West Fork, but, as the channel has eroded, the channel banks have become incised and support only a narrow band of wetland or riparian vegetation. The floodplain is contained within the channel except at road crossings, where overtopping will occur. The banks are unstable and some lateral channel migration may occur during large flows.

### 2.4 First Creek (Basin 3700)

The First Creek basin drains an area of 47.2 square miles. The headwaters of First Creek are located in Arapahoe County, south of I-70 and east of E-470. Runoff from the basin flows in a northwesterly direction. First Creek crosses Pena Boulevard just north of 56<sup>th</sup> Avenue and then flows through the northeastern portion of the Rocky Mountain Arsenal. First Creek is an east bank tributary to the South Platte River, and outfalls at approximately 128<sup>th</sup> Avenue. The basin shape is long and narrow, approximately 26 miles long and 2 to 4 miles wide. The average stream slope above Rocky Mountain Arsenal is about 31 feet per mile, and flattens to about 23 feet per mile below Rocky Mountain Arsenal.

The upper reaches of First Creek are primarily undeveloped irrigated cropland with wide swales and channels for drainageways. Toward the center of the basin, First Creek bisects Green Valley Ranch, which consists of medium density, single-family residences. First Creek then enters Rocky Mountain Arsenal with a more incised, low flow channel and wider floodplain areas.

The lower First Creek basin is located downstream from 56<sup>th</sup> Avenue and Pena Boulevard and continues to the South Platte River. The lower First Creek basin consists of irrigated farmland with pockets of light industrial and residential properties. Conveyance within the lower First Creek drainage consists of broad undefined channels with little or no defined thalweg. Between US-85 and Brighton Boulevard, the channel is incised with a well-defined thalweg. The O'Brian Canal and the Burlington Ditch which intercept runoff in First Creek cross the reach of First Creek below Rocky Mountain Arsenal.

### 2.5 Irondale Gulch (Basin 3900)

Irondale Gulch, which contains approximately 26.7 square miles, lies immediately southwest of First Creek and drains the general area from near the intersection of I-70 and Picadilly Road and the Adams County line, through the Montbello area, the Arsenal and Commerce City with an eventual outfall to the South Platte River at approximately East 96<sup>th</sup> Avenue. The southwest boundary of the basin is primarily the north side of I-70 until reaching the former Stapleton International Airport,

where the basin boundary lies just west of Havana Street. This basin is long and narrow, with a total length of 28 miles to the South Platte River and 1½ to 2 miles wide. The average slope of the basin is about 26 feet per mile, which remains fairly constant throughout the drainageway. The drainageways through the Arsenal contain several lakes and detention areas. The drainage below the Arsenal is primarily storm sewer or roadside ditches, with capacity for only minor floods.

### **2.6 Clear Creek (Basin 4300)**

Clear Creek is a west bank tributary to the South Platte River, and has its source in the Rocky Mountains west of Denver. Flowing in a generally easterly direction from the Continental Divide, Clear Creek enters the high plains in Golden. Within this lower reach, Clear Creek passes through unincorporated areas of Adams and Jefferson Counties, and the cities of Denver, Arvada, Wheat Ridge and Golden. Clear Creek crosses the northwest corner of Denver for a distance of 0.2 miles in the vicinity of 52<sup>nd</sup> Avenue and Gray Street.

The drainage area at the mouth is 575 square miles, of which 400 square miles are in the mountain region above Golden. There are 11 major reservoirs in the lower Clear Creek basin, three of which are on-stream and provide some residual flood control effects downstream from each site. Ralston Reservoir was built in 1938 by Denver and receives water from Ralston and South Boulder Creeks. Although Ralston Reservoir is not operated for flood control purposes, there are approximately 2,400 acre-feet of storage available. Maple Grove Reservoir is located on Lena Gulch at West 27th Avenue and has approximately 452 acre-feet of available storage. Leyden Lake is an irrigation water storage reservoir on Leyden Creek upstream from Indiana Street, and has approximately 550 acre-feet of uncontrolled storage.

### **2.7 Sand Creek (Basin 4400)**

Sand Creek is an east bank plains tributary of the South Platte River. The Sand Creek basin lies in north-central Colorado, to the east and northeast of Denver's Central Business District. The Sand Creek basin encompasses an area of 189 square miles. The basin is long and narrow, with a length of 32 miles and an average width of 6 miles. Portions of Elbert, Douglas, Arapahoe, Denver and Adams Counties are included in the drainage area. Sand Creek originates at the confluence of Coal Creek and Murphy Creek. Sand Creek joins the South Platte River in the vicinity of I-270 in Commerce City, north of Denver city limits. The reach of Sand Creek within Denver is located along I-70 near the Stapleton Redevelopment area. Principle tributaries of Sand Creek are Toll Gate Creek and Westerly Creek.

### **2.8 Westerly Creek (Basin 4401)**

The Westerly Creek tributary area consists of approximately 18 square miles of highly developed area from the low rolling divide between Cherry Creek and West Toll Gate Creek to the confluence with Sand Creek. The basin is about 8.5 miles long, 3 miles wide at its widest point. The crescent shaped area drains in a northwest-to-north direction with an average slope of 0.9 percent.

Development in the Westerly Creek drainage basin is at a state of full development consisting of townhouses, condominiums, apartments, single family homes, motels, large shopping complexes,

streets, parking areas and highways. This development and the basin slope contribute to the rapid response time for storm runoff and increased stormwater runoff.

The upper reaches of Westerly Creek begin in the City of Aurora. Runoff of peak events is captured in Westerly Creek Dam, built in 1989 on the former Lowry Air Force Base at Alameda and Havana. Westerly Creek fully contains the 500-year flood event and outlets via a 48" pipe. Flows from the Lowry Redevelopment area enter Westerly Creek and then are detained in Kelly Road Dam at 11<sup>th</sup> Avenue. The channel and culverts from Kelly Road Dam to Montview at the Stapleton Redevelopment area have been improved to the 10-year storm design. The Westerly Creek channel through the Stapleton site has been improved to 100-year capacity. All storm outfalls to Westerly Creek within the Stapleton site have regional water quality treatment at the end of pipe.

### **2.9 Cherry Creek (Basin 4600)**

The Cherry Creek tributary area consists of 410 square miles of which 385 square miles drain into Cherry Creek Reservoir. The dam is designed to release a maximum of 5,000 cfs to the lower Cherry Creek channel, which has a current capacity of between 4,000 and 11,000 cfs.

The lower Cherry Creek basin covers 25.2 square miles, with Goldsmith Gulch contributing 7.7 square miles of the total area. The lower channel of Cherry Creek flows 11.5 miles from the reservoir to the South Platte River confluence in the vicinity of Speer Boulevard.

The lower channel has been improved to contain the 100-year storm from 1<sup>st</sup> Avenue to the confluence. These improvements generally consist of cleaning, shaping, and landscaping the channel bottom.

### **2.10 Goldsmith Gulch (Basin 4601)**

The Goldsmith Gulch basin encompasses an area of 7.8 square miles from Arapahoe Road northwest to the confluence with Cherry Creek. Through Denver, the tributary area is primarily urbanized or in the process of development from a mix of commercial and residential construction. Many channel improvements have been completed along Goldsmith Gulch to reduce the potential of flood damage. The channel has been stabilized and regional parks have been constructed in the floodplain. Detention facilities have also been constructed along the channel at Bible Park, Wallace Park, Rosamond Park and at Iliff and Monaco. Channel slopes are generally mild with several newer drop structures along the reach.

The Highline Canal bisects Goldsmith Gulch at East Cornell Avenue. Goldsmith Gulch passes underneath the Highline Canal and East Cornell Avenue through a concrete box culvert.

The upper portion of Goldsmith Gulch includes the TREX construction site. New storm sewer and detention facilities drain the I-225 and I-25 interchange to Goldsmith Gulch.



**2.11 Sloan Lake (Basin 4700)**

The Sloan Lake drainage basin flows eastward from a high point near 26<sup>th</sup> Avenue and Garrison Street in Lakewood and outfalls into the South Platte River near Colfax Avenue and Invesco Field. The drainage basin lies within Denver's jurisdiction east of Sheridan Boulevard and is bounded by West 32<sup>nd</sup> Avenue on the north, Colfax Avenue on the south, Garrison Street on the west, and the South Platte River on the east. The basin totals almost 5.5 square miles within Denver, Lakewood, Edgewater, and Wheatridge. Since the basin is fully developed and heavily urbanized, the major drainageways are not clearly identifiable. Most of the historic drainage channels have either been filled in or built over to the point of obliteration.

The most prominent geographic feature within the basin is Sloan Lake. The lake, which occupies 176.5 acres of a 290-acre Denver park, has been and continues to be a valuable recreational resource for the metropolitan area. In addition to its scenic and recreational significance, the lake provides the important function of regulating and controlling downstream flows that otherwise would be allowed to run uninhibited through West Denver. The lake reduces peak flow rates from about 2,904 cfs to 166 cfs during the 100-year event.

**2.12 Lakewood Gulch (Basin 4800)**

Lakewood Gulch is a major drainageway that originates in Lakewood and flows easterly toward the South Platte River between 6<sup>th</sup> Avenue and Colfax Avenue. The Lakewood Gulch basin consists of approximately 16 square miles beginning in the foothills and extending easterly 10 miles to the South Platte River in the vicinity of Colfax Avenue. The tributary area is essentially fully developed in Denver and in the eastern portion of Lakewood. The basin is also developed in the western portion of Lakewood and Jefferson County.

**2.13 Dry Gulch (Basin 4801)**

The Dry Gulch basin consists of approximately 3.7 square miles lying predominantly in Lakewood. Dry Gulch is tributary to Lakewood Gulch in the vicinity of 10th Avenue and Perry Street in Denver, and extends westward a length of 5.7 miles along the general alignment of Colfax Avenue to Simms Street. The basin is essentially fully developed, with commercial establishments along Colfax Avenue and residential development comprising the remainder of the basin.

**2.14 Weir Gulch (Basin 4900)**

Weir Gulch meanders eastward from Green Mountain Village for approximately 8.3 miles to the confluence with the South Platte River in the vicinity of West 9th Avenue. The basin which comprises some 7.2 square miles is fully urbanized in Denver and mostly developed west of Sheridan Boulevard in Lakewood.

There are two drainageways tributary to Weir Gulch within the City of Denver. The 1<sup>st</sup> Avenue tributary to Weir Gulch is located just north of 1<sup>st</sup> Avenue and flows in an easterly direction. The drainage basin is bounded by 6<sup>th</sup> Avenue on the north, West Alameda Avenue on the south, Raleigh

Street on the east, and Wadsworth Boulevard on the west. This tributary of the Weir Gulch system is approximately 2 miles long and about 0.8 mile wide, with an average slope of 1.5 percent.

The Dakota Avenue Tributary to Weir Gulch lies within Denver's jurisdiction east of Sheridan Boulevard and is located just south of Dakota Avenue flowing in an easterly direction. It is bounded by West Alameda Avenue on the north, West Alaska Avenue on the south, Sheridan Boulevard on the west, and Xavier Street on the east. This tributary is about ¼-miles wide and has an average slope of 1½ percent.

Strip parks have been developed by the Denver Parks and Recreation Department from 1<sup>st</sup> Avenue to Alameda Avenue along the gulch. This development consists mainly of grassed channels and the installation of asphalt bike paths. Barnum Park is located on either side of 6<sup>th</sup> Avenue on the west side of Federal Boulevard. Barnum Lake, located south of 6<sup>th</sup> Avenue has been improved to contain the 100-year storm within the Weir Gulch channel. The open park area north of 6<sup>th</sup> Avenue, known as the Federal Boulevard Detention Reservoir, is designed to reduce the 25-year flow to a 10-year flow or less. The lower Weir Gulch channel from Federal to the South Platte River outfall has capacity for the 10-year storm.

**2.15 Sanderson Gulch (Basin 5100)**

Sanderson Gulch flows 8.63 miles in an easterly direction from South Union Boulevard above Smith Reservoir to the South Platte River in the vicinity of West Florida Avenue. This drainage basin, which encompasses approximately 9 square miles, is fully developed in Denver and is being rapidly urbanized west of Sheridan Boulevard. The entire basin's drainage area extends west to the top of Green Mountain, and channel slopes are generally mild.

Green belts and parks have been located along the Sanderson Gulch floodplain. Drainageway improvements have been constructed to contain the 100-year event within open channels; however, culverts were designed for the 10-year frequency discharge.

**2.16 Harvard Gulch (Basin 5200)**

Harvard Gulch flows west through the southern part of Denver for a length of 5.6 miles to reach its confluence with the South Platte River at Wesley Avenue. The total drainage basin area is approximately 7.4 square miles. The Highline Canal meanders through the southeast portion of the basin and does intercept storm flow. Single-family residences primarily urbanize the basin. Commercial development is generally located along Colorado Boulevard, Broadway and Santa Fe Drive. The residential portion of the basin is very dense with small lots having an estimated 52 percent average imperviousness.

The Harvard Gulch Flood Control project, completed in 1966, was designed for the 10-year flood and included an underground box culvert from Logan Street to the South Platte River. A grass-lined open channel was designed through Harvard Gulch Park, which also serves as an inlet to a detention pond in the park.

Highway I-25 and the TREX construction project bisect the upper portion of Harvard Gulch. Drainage improvements for TREX through the Holly Hills area include several detention/water quality basins as well as a new storm sewer system. The TREX storm sewer is connected to Denver's existing storm sewer system at two locations along the west side of I-25: 1) the TREX storm sewer system to the south outfalls to the Highline Canal, and 2) the storm sewer system to the north outfalls to the existing 36-inch storm sewer within Yale Avenue.

### **2.17 West Harvard Gulch (Basin 5300)**

West Harvard Gulch flows east 2.8 miles through Denver to its confluence with the South Platte River in the vicinity of Yale Avenue. The total area of the drainage basin is approximately 1.4 square miles. The average width of the basin is 0.66 mile, and the channel slopes range from 1.3 to 2.4 percent. The basin elevations range from approximately 5,525 feet to 5,250 feet.

The West Harvard Gulch Basin is primarily in residential development. Commercial areas are situated along Federal Boulevard, and a light industrial park is located in the Basin's lower reaches. Loretto Heights College sits on the ridge that forms the southern boundary of the basin.

In the West Harvard Gulch Basin, the main drainageway was piped in an underground conduit that extended from just above the Colorado and Southern Railroad to Zuni Street. This reach has been restored and an improved grass lined and concrete trickle channel carries the flood events. Channel slopes within this reach are stabilized with grouted sloping boulder drops.

During the 100-year flood event, most of the flood flow will be contained in the channel. At the confluence of the South Platte River, the main channel flows through an 84" diameter concrete pipe. This pipe has inadequate capacity to carry the 100-year flow resulting in shallow flooding around the Arapahoe Power Plant. Some ponding and overtopping will occur at Zuni, Clay and Decatur Street crossings during the 100-year flood event.

### **2.18 Bear Creek (Basin 5500)**

Bear Creek generally flows eastward from its headwaters at Mount Evans through the towns of Evergreen and Morrison until it reaches the metropolitan area of Denver where it is tributary to the South Platte. The drainage basin is approximately 36 miles long and has an average width of about 9 miles. This encompasses approximately 261 square miles of drainage area. Elevations in the basin range from approximately 14,260 feet at Mount Evans to 5,260 feet at the mouth. Turkey Creek, a major tributary, drains about 52 square miles and enters into Bear Creek approximately 2 miles downstream of Morrison. A majority of the basin is in the mountains, with the remainder draining the foothills and high plains region. The drainage basin area inside the Denver's city limits is about 12 miles in size.

The completion of Bear Creek Dam just downstream of Morrison has a great effect on the peak discharges of the 8.2-mile Bear Creek reach below the Dam. The Dam acts as a flood control reservoir that intercepts flows from areas in the upper and middle parts of the basin. At the Bear Creek Dam, peak flows from the 100-year event have been reduced from 30,000 cubic feet per second (cfs) to approximately 1,000 cfs through storage in the reservoir.

### **2.19 Marston Lake North (Basin 5501)**

The Marston Lake drainage basin consists of approximately 2.1 square miles of limited developed area, in the southwest corner of Denver. Various areas within the basin are subject to flooding which could increase in severity and frequency with continued urbanization of the basin without drainageway improvements. The basin originates approximately ½ mile west of Kipling Street between Belleview and Quincy Avenues, and extends approximately 4.4 miles in a northeasterly direction to its confluence with Bear Creek. Continued development in these areas, planned for mostly residential with some light commercial business, is expected to increase runoff rates.

Marston Lake is owned and operated by the Denver Water Board and serves as a major link in the water supply system for Denver and much of the metropolitan area. The Lake acts as a sump and is isolated from receiving or discharging stormwater.

The drainage basin traverses various jurisdictions and ownerships including Jefferson County, Denver, Denver Water Board, Marston Water Treatment Plant grounds, Pinehurst Country Club Golf Course, and United States Government properties to the south of Fort Logan National Cemetery.

Improvements to the drainageway have been accomplished by the Denver Water and by the Urban Drainage and Flood Control District. The north side of the Marston Lake Dam was reconstructed to allow room for an open channel, which, along with an improvement done by the Urban Drainage and Flood Control District provides improved 100-year capacity channel from Old Wadsworth Boulevard to West Quincy Avenue.

### 3.0 CAPITAL IMPROVEMENTS PROGRAM

#### 3.1 Cost Modeling

Development of cost estimates is an important component of the master planning process. Costs have been compiled to assist in the evaluation of drainage alternatives and to provide for systematic capital budgeting for future improvement programs. Bid data has been obtained from the City & County of Denver for the period 1999 to 2003 and statistically analyzed to derive regression equations that reflect typical construction practices within the City & County of Denver. A detailed tabulation of all unit costs and a listing by project is shown in the **GIS Appendix** and linked to the GIS database for project cost analysis. General unit costs (in 2003 dollars) are summarized below:

- Storm Sewer (66 in. and smaller): \$ 3.00 per inch diameter per lineal foot
- Storm Sewer (72 in. – 96 in.): \$ 4.35 per inch diameter per lineal foot
- Storm Sewer (96 in – 120 in.): \$ 4.35 to \$6.50 per inch per lineal foot
- Elliptical Storm Sewer  
1½ times the equivalent round pipe
- Jack and Bore Pipe: \$ 20.00 per inch diameter foot
- Box Culverts: \$ 600 per cy concrete, plus \$0.70 per lb. steel
- Headwalls: \$ 600 per cy concrete
- Manholes: \$ 2,175 - \$9,600 each Type C, B and P  
Tabulated in GIS, averaging 280 feet between manholes
- Inlets: \$ 2,500 for typical 6-foot Type 14 curb opening  
Up to \$5,860 each for larger inlets  
Assumed four inlets constructed per manhole
- Inlet laterals: Assumed 20 feet of 18" RCP per inlet
- Easements: \$ 2.00 - \$4.00 per sq. ft. (tax assessor's data)
- Acquisition: \$ 4.00 - \$8.00 per sq. ft. (tax assessor's data)
- Stormwater Detention Retrofit: \$ 40,000 per acre-foot (south of I-70)
- Stormwater Detention New: \$ 20,000 per acre-foot (Stapleton and north of I-70)
- Asphalt Patch (assumed 8-ft wider than the pipe diameter): \$ 4.00 per sy-in (\$72.73/ton) for assumed 9-inch full depth section
- Dry Utility Administration Cost: 5% of sub-total construction costs
- Wet Utility Relocation Cost: \$2,000 per crossing for sanitary sewer avoidance  
\$1,000 to \$20,000 for relocation of water, depending upon size

Indirect costs and contingency have been expressed as a percentage of direct construction costs. These include the following:

- |  |            |
|--|------------|
| • Traffic control:   | 3%         |
| • Mobilization/Demobilization:   | 10%        |
| • Engineering:   | 15%        |
| • Materials Management (limited environmental remediation and disposal): | 5%         |
| • Contract Administration/Construction Management:                       | 10%        |
| • Contingency:   | <u>25%</u> |
| INDIRECT COST TOTAL  | 68%        |

#### 3.2 Summary of Capital Costs

##### Cost by Project

A summary of costs for all basins and all projects within those basins is presented on the following pages, sorted first by basin, and then sorted by project. Costs are tabulated through automated GIS electronic master planning routines and are based upon unit prices developed in 2003. In some cases the automated costing may not match exactly hand calculated project costs shown in the individual Appendix Project Notebooks. However, great care has been taken to ensure these differences are within 5% or less.

In some cases, multiple alternatives are proposed which have been designated in the Basin ID. There is not sufficient information at this time to select a preferred alternative, so all alternatives have been shown for comparison.

This Drainage Master Plan does not distinguish between *Developer* cost and *City* cost. In particular, capital improvements have been shown for new developing areas (i.e., Stapleton), although their funding will certainly be borne by different entities and budgets than for retro-fit improvements of existing development.

##### Cost by Basin

For purposes of developing an overall drainage infrastructure capital improvement cost for the entire City & County of Denver, costs are summarized below by basin. In some cases, several different alternatives are shown for basins, usually based upon conveyance only, detention, or conveyance plus detention. The following table was compiled by selecting the least cost alternative; however, due to external factors such as land acquisition, a preferred alternative cannot be selected at this time. The total project cost to upgrade the City's storm drainage infrastructure to meet minimum current drainage criteria for the entire City is estimated to be about \$1,054 M in 2003 dollars.

### SUMMARY OF PROJECT COSTS BY BASIN

ID	OUTFALL	NAME/LOCATION	CIP COST (2003 Dollars)
0058-01	South Platte River	Prairie Gateway	\$1,800,099
0059-01	South Platte River	Globeville - Utah Junction	\$8,001,091
0060-01	South Platte River	I-70 & Colorado Boulevard	\$31,244,812
0060-02	South Platte River	I-70 & York	\$21,845,216
0061-01	South Platte River	27th & Federal	\$38,898,861
0061-02	South Platte River	Highland	\$54,218,473
0062-01	South Platte River	Lower Platte Valley	\$55,254,536
0063-01	South Platte River	Central Platte Valley	\$27,359,420
0064-01	South Platte River	1st & Federal	\$7,188,037
0064-02	South Platte River	Valverde	\$20,098,628
0065-01	South Platte River	Ruby Hill	\$8,757,581
0065-02	South Platte River	Dartmouth	\$256,663
0067-01	South Platte River	College View	\$5,891,113
0067-02	South Platte River	West Belleview	\$1,578,468
0067-03	No Outfall	Marston Lake	\$0
3501-01	Second Creek	West Fork Second Creek	\$24,424,942
3700-01	First Creek	Pena Corridor	\$12,286,855
3700-02	First Creek	Green Valley Ranch	\$0
3700-03	First Creek	Dogwood & Blue Grama Tribs.	\$12,999,563
3702-01	First Creek	Tributary "T"	\$2,650,939
3900-01	Irondale Gulch	Stapleton East Section 10	\$329,280
3900-02	Irondale Gulch	East Montbello	\$1,488,486
3900-03	Irondale Gulch	Parkfield	\$5,636,592
3900-04	Irondale Gulch	Majestic Commerce Center	\$7,772,739
3901-01	Irondale Gulch	West Montbello	\$12,949,445
3901-02	Irondale Gulch	Gateway	\$0
4000-01	Rocky Mountain Arsenal	Stapleton West Section 10	\$1,713,600
4300-03	Clear Creek	North of I-70	\$4,612,184
4309-01	Clear Creek	Berkeley Lake	\$0
4400-01	Sand Creek	North Stapleton	\$46,633,050
4400-02	Sand Creek	Quebec Corridor	\$55,022,918
4400-03	Sand Creek	Stapleton	\$13,067,973
4400-04	Sand Creek	East Stapleton	\$19,607,749

ID	OUTFALL	NAME/LOCATION	CIP COST (2003 Dollars)
4401-01	Westerly Creek	South Stapleton	\$14,957,964
4401-02	Westerly Creek	11th Avenue to Montview	\$3,343,018
4401-03	Westerly Creek	Lowry	\$0
4401-04	Westerly Creek	South of Alameda	\$8,839,980
4500-01	Montclair	City Park	\$78,564,203
4500-02	South Platte	36th & Downing	incl. in 0062-01
4500-03	Montclair	Park Hill - Colfax Avenue	\$24,673,365
4500-04	Montclair	Park Hill - 6th Avenue	\$56,388,966
4600-01	Cherry Creek	Central Business District	\$33,678,387
4600-02	Cherry Creek	Cherry Creek Mall	\$37,639,979
4600-03	Cherry Creek	Upper Cherry Creek	\$29,609,758
4600-04	Cherry Creek	Cherry Creek Reservoir	\$14,854,512
4601-01	Goldsmith Gulch	Lower Goldsmith Gulch	\$6,930,213
4601-02	Goldsmith Gulch	Middle Goldsmith Gulch	\$0
4700-01	Sloan Lake	West Colfax Avenue	\$8,022,685
4800-01	Lakewood Gulch	12th & Federal	\$3,327,009
4801-01	Dry Gulch	12th & Sheridan	\$699,578
4900-01	Weir Gulch	West 6th Avenue	\$2,993,951
5000-01	I-25 & South Platte	West Washington Park	\$14,437,123
5000-02	I-25	University & Mexico North	\$14,810,454
5000-03	Florida	University & Mexico South	\$16,267,290
5100-01	Sanderson Gulch	West Florida Avenue	\$36,303,896
5200-01	Harvard Gulch	Harvard Gulch Lower Basin	\$40,560,765
5200-02	Harvard Gulch	Harvard Gulch Middle Basin	\$39,319,486
5200-03	Harvard Gulch	Harvard Gulch Upper Basin	\$39,954,989
5300-01	West Harvard Gulch	West Yale Avenue	\$4,443,596
5401-01	Greenwood Gulch	South Monaco Parkway	\$0
5500-01	Bear Creek	Fort Logan	\$8,618,701
5500-02	Bear Creek	Upper Bear Creek	\$6,910,558
5500-03	Bear Creek	Academy Park Tributary	\$0
5500-04	Bear Creek	Marston Lake North	\$2,015,158
5500-05	Bear Creek	Pinehurst Tributary	\$1,199,136
5501-01	Bear Creek	Henry's Lake	\$1,142,400
5901-01	Dutch Creek	Coon Creek	\$0
<b>TOTAL</b>			<b>\$1,054,096,433</b>

STATEMENT OF PROBABLE COSTS IN 2003 DOLLARS

PROJECT			HARD COSTS							INDIRECT COSTS							TOTALS		
BASIN	ID	PROJECT	PIPE	MANHOLE	INLETS	ASPHALT PATCH	DRY UTILITY RELOCATE	WET UTILITY RELOCATE	DETENTION	TOTAL CONSTRUCTION COSTS	TRAFFIC CONTROL (3%)	MOBILIZATION (10%)	DESIGN & ENGINEERING (15%)	MATERIALS MANAGEMENT (5%)	ADMINISTRATIVE (10%)	CONTINGENCY (25%)	EASEMENT/ACQUISITION	TOTAL	TOTAL BY BASIN
0058-01	A	E 56TH AVE IMPROVEMENTS	\$447,696	\$41,526	\$143,200	\$191,280	\$41,785	\$12,000		\$877,487	\$26,325	\$87,749	\$131,623	\$43,874	\$87,749	\$219,372		\$1,474,179	
0058-01	B	PRAIRIE GATEWAY DETENTION - 01			\$0				\$18,000	\$18,000	\$540	\$1,800	\$2,700	\$900	\$1,800	\$4,500		\$30,240	
0058-01	C	PRAIRIE GATEWAY DETENTION - 02			\$0				\$176,000	\$176,000	\$5,280	\$17,600	\$26,400	\$8,800	\$17,600	\$44,000		\$295,680	\$1,800,099
0059-01	A	OUTFALL 1000 AT PECOS	\$91,368	\$49,520	\$0		\$13,065	\$120,405		\$274,358	\$8,231	\$27,436	\$41,154	\$13,718	\$27,436	\$68,590		\$460,923	
0059-01	B	OUTFALL 400 AT 47TH AND LOGAN	\$1,080	\$9,000	\$0		\$754	\$4,990		\$15,824	\$475	\$1,582	\$2,374	\$791	\$1,582	\$3,956		\$26,584	
0059-01	C	OUTFALL 500/600 AT 49TH AND ARGO PARK	\$608,636	\$94,300	\$0		\$52,946	\$355,992		\$1,111,874	\$33,356	\$111,187	\$166,781	\$55,594	\$111,187	\$277,968	\$23,958	\$1,891,905	
0059-01	D	OUTFALL 700 AT 53RD AND FRANKLIN	\$965,300	\$3,900	\$0	\$83,968	\$52,658		\$1,770,055	\$2,875,881	\$86,276	\$287,588	\$431,382	\$143,794	\$287,588	\$718,970	\$790,200	\$5,621,679	\$8,001,091
0060-01	A	100-YEAR CHANNEL	\$2,524,200		\$0		\$129,660	\$69,000		\$2,722,860	\$81,686	\$272,286	\$408,429	\$136,143	\$272,286	\$680,715		\$4,574,405	\$4,574,405
0060-01	ALT1	A 50TH AND COLORADO IMPROVEMENTS	\$2,085,977	\$95,550	\$186,160	\$225,646	\$130,917	\$25,000		\$2,749,250	\$82,478	\$274,925	\$412,388	\$137,462	\$274,925	\$687,312		\$4,618,740	
0060-01	ALT1	B 48TH AVE INTERCEPTOR	\$2,486,092	\$92,850	\$200,480	\$362,022	\$159,772	\$54,000		\$3,355,216	\$100,656	\$335,522	\$503,282	\$167,761	\$335,522	\$838,804		\$5,636,763	
0060-01	ALT1	C 50TH AVE INTERCEPTOR	\$329,130	\$54,350	\$114,560	\$110,234	\$31,014	\$12,000		\$651,288	\$19,539	\$65,129	\$97,693	\$32,564	\$65,129	\$162,822		\$1,094,164	
0060-01	ALT1	D 54TH ST OUTFALL	\$2,815,212	\$44,100	\$85,920	\$253,660	\$161,345	\$28,000		\$3,388,237	\$101,647	\$338,824	\$508,236	\$169,412	\$338,824	\$847,059		\$5,692,239	
0060-01	ALT1	E COLUMBINE AND YORK UPGRADES	\$521,082	\$95,550	\$186,160	\$202,922	\$52,286	\$40,000		\$1,098,000	\$32,940	\$109,800	\$164,700	\$54,900	\$109,800	\$274,500		\$1,844,640	
0060-01	ALT1	F MILWAUKEE ST IMPROVEMENTS	\$61,200	\$5,800	\$28,640	\$34,000	\$6,482			\$136,122	\$4,084	\$13,612	\$20,418	\$6,806	\$13,612	\$34,030		\$228,684	
0060-01	ALT1	G MILWAUKEE ST OUTFALL	\$203,898	\$23,400	\$71,600	\$43,338	\$17,312	\$4,000		\$363,548	\$10,906	\$36,355	\$54,532	\$18,177	\$36,355	\$90,887		\$610,760	
0060-01	ALT1	H RIVERSIDE INTERCEPTOR			\$0		\$300	\$6,000		\$6,300	\$189	\$630	\$945	\$315	\$630	\$1,575		\$10,584	
0060-01	ALT1	I RIVERSIDE OUTFALL	\$725,493	\$36,750	\$71,600	\$109,446	\$47,464	\$6,000		\$996,753	\$29,903	\$99,675	\$149,513	\$49,838	\$99,675	\$249,188		\$1,674,545	
0060-01	ALT1	J STEELE ST IMPROVEMENTS	\$86,310	\$8,700	\$42,960	\$43,158	\$9,956	\$18,000		\$209,084	\$6,273	\$20,908	\$31,363	\$10,454	\$20,908	\$52,271		\$351,261	
0060-01	ALT1	K UPPER DAHLIA ST OUTFALL	\$733,040	\$44,100	\$85,920	\$115,940	\$49,450	\$10,000		\$1,038,450	\$31,154	\$103,845	\$155,768	\$51,922	\$103,845	\$259,612		\$1,744,596	
0060-01	ALT1	L N COLORADO BLVD IMPROVEMENTS	\$154,386	\$48,825	\$300,720	\$108,642	\$31,279	\$13,000		\$656,852	\$19,706	\$65,685	\$98,528	\$32,843	\$65,685	\$164,213		\$1,103,512	\$24,610,488
0060-01	ALT2	A 48TH AND COLORADO DETENTION	\$67,077	\$22,050	\$42,960	\$14,590	\$7,634	\$6,000	\$180,000	\$340,311	\$10,209	\$34,031	\$51,047	\$17,016	\$34,031	\$85,078	\$1,036,800	\$1,608,523	
0060-01	ALT2	B 48TH AVE INTERCEPTOR	\$1,756,522	\$83,175	\$171,840	\$311,654	\$118,860	\$54,000		\$2,496,051	\$74,882	\$249,605	\$374,408	\$124,803	\$249,605	\$624,013		\$4,193,367	
0060-01	ALT2	C 50TH AVE INTERCEPTOR	\$325,890	\$54,350	\$114,560	\$109,298	\$30,805	\$12,000		\$646,903	\$19,407	\$64,690	\$97,035	\$32,345	\$64,690	\$161,726		\$1,086,796	
0060-01	ALT2	D 54TH ST OUTFALL	\$1,101,767	\$22,050	\$42,960	\$177,172	\$68,197	\$20,000		\$1,432,146	\$42,964	\$143,215	\$214,822	\$71,607	\$143,215	\$358,036		\$2,406,005	
0060-01	ALT2	E COLUMBINE AND YORK UPGRADES	\$521,082	\$95,550	\$186,160	\$202,922	\$52,286	\$40,000		\$1,098,000	\$32,940	\$109,800	\$164,700	\$54,900	\$109,800	\$274,500		\$1,844,640	
0060-01	ALT2	F MILWAUKEE ST IMPROVEMENTS	\$61,200	\$5,800	\$28,640	\$34,000	\$6,482			\$136,122	\$4,084	\$13,612	\$20,418	\$6,806	\$13,612	\$34,030		\$228,684	
0060-01	ALT2	G MILWAUKEE ST OUTFALL	\$264,918	\$23,400	\$71,600	\$40,166	\$20,204	\$4,000		\$424,288	\$12,729	\$42,429	\$63,643	\$21,214	\$42,429	\$106,072		\$712,804	
0060-01	ALT2	H RIVERSIDE INTERCEPTOR			\$0		\$300	\$6,000		\$6,300	\$189	\$630	\$945	\$315	\$630	\$1,575		\$10,584	
0060-01	ALT2	I RIVERSIDE OUTFALL	\$658,338	\$36,750	\$71,600	\$112,636	\$44,266	\$6,000		\$929,590	\$27,888	\$92,959	\$139,438	\$46,480	\$92,959	\$232,398		\$1,561,712	
0060-01	ALT2	J STEELE ST IMPROVEMENTS	\$86,310	\$8,700	\$42,960	\$43,158	\$9,956	\$18,000		\$209,084	\$6,273	\$20,908	\$31,363	\$10,454	\$20,908	\$52,271		\$351,261	
0060-01	ALT2	K UPPER DAHLIA ST OUTFALL	\$790,424	\$44,100	\$85,920	\$127,614	\$52,903	\$10,000		\$1,110,961	\$33,329	\$111,096	\$166,644	\$55,548	\$111,096	\$277,740		\$1,866,414	
0060-01	ALT2	L PARK HILL DETENTION			\$0				\$720,000	\$720,000	\$21,600	\$72,000	\$108,000	\$36,000	\$72,000	\$180,000	\$1,079,028	\$2,288,628	
0060-01	ALT2	M N COLORADO BLVD IMPROVEMENTS	\$154,386	\$48,825	\$300,720	\$108,642	\$31,279	\$13,000		\$656,852	\$19,706	\$65,685	\$98,528	\$32,843	\$65,685	\$164,213		\$1,103,512	\$19,262,930
0060-01	ALT3	A 48TH AND COLORADO DETENTION	\$67,077	\$22,050	\$42,960	\$14,590	\$7,634	\$6,000	\$180,000	\$340,311	\$10,209	\$34,031	\$51,047	\$17,016	\$34,031	\$85,078	\$1,036,800	\$1,608,523	
0060-01	ALT3	B 48TH AVE INTERCEPTOR	\$1,733,361	\$85,500	\$186,160	\$306,222	\$118,162	\$52,000		\$2,481,405	\$74,442	\$248,140	\$372,211	\$124,070	\$248,140	\$620,351		\$4,168,759	
0060-01	ALT3	C 50TH AVE INTERCEPTOR	\$325,890	\$54,350	\$114,560	\$109,298	\$30,805	\$12,000		\$646,903	\$19,407	\$64,690	\$97,035	\$32,345	\$64,690	\$161,726		\$1,086,796	
0060-01	ALT3	D 54TH ST OUTFALL			\$0		\$1,000	\$20,000		\$21,000	\$630	\$2,100	\$3,150	\$1,050	\$2,100	\$5,250		\$35,280	
0060-01	ALT3	E COLUMBINE AND YORK UPGRADES	\$521,082	\$95,550	\$186,160	\$202,922	\$52,286	\$40,000		\$1,098,000	\$32,940	\$109,800	\$164,700	\$54,900	\$109,800	\$274,500		\$1,844,640	
0060-01	ALT3	F MILWAUKEE ST IMPROVEMENTS	\$61,200	\$5,800	\$28,640	\$34,000	\$6,482			\$136,122	\$4,084	\$13,612	\$20,418	\$6,806	\$13,612	\$34,030		\$228,684	
0060-01	ALT3	G MILWAUKEE ST OUTFALL			\$0		\$200	\$4,000		\$4,200	\$126	\$420	\$630	\$210	\$420	\$1,050		\$7,056	
0060-01	ALT3	H RIVERSIDE INTERCEPTOR			\$0		\$300	\$6,000		\$6,300	\$189	\$630	\$945	\$315	\$630	\$1,575		\$10,584	
0060-01	ALT3	I RIVERSIDE OUTFALL	\$727,935	\$36,750	\$71,600	\$109,330	\$47,581	\$6,000		\$999,196	\$29,976	\$99,920	\$149,879	\$49,960	\$99,920	\$249,799		\$1,678,650	
0060-01	ALT3	J STEELE ST IMPROVEMENTS	\$86,310	\$8,700	\$42,960	\$43,158	\$9,956	\$18,000		\$209,084	\$6,273	\$20,908	\$31,363	\$10,454	\$20,908	\$52,271		\$351,261	
0060-01	ALT3	K UPPER DAHLIA ST OUTFALL	\$764,008	\$44,100	\$85,920	\$120,838	\$51,243	\$10,000		\$1,076,109	\$32,283	\$107,611	\$161,416	\$53,805	\$107,611	\$269,027		\$1,807,862	
0060-01	ALT3	L 41ST AVE OUTFALL PHASE I	\$1,452,360	\$36,750	\$71,600	\$123,760	\$86,224	\$40,000		\$1,810,694	\$54,321	\$181,069	\$271,604	\$90,535	\$181,069	\$452,674		\$3,041,966	
0060-01	ALT3	M PARK HILL DETENTION			\$0				\$2,840,000	\$2,840,000	\$85,200	\$284,000	\$426,000	\$142,000	\$284,000	\$710,000	\$2,359,516	\$7,130,716	
0060-01	ALT3	N N COLORADO BLVD IMPROVEMENTS	\$154,386	\$48,825	\$300,720	\$108,642	\$31,279	\$13,000		\$656,852	\$19,706	\$65,685	\$98,528	\$32,843	\$65,685	\$164,213		\$1,103,512	
0060-01	ALT3	O COMMERCE CITY OUTFALL	\$3,114,771	\$104,250	\$229,120	\$218,822	\$183,348		\$400,000	\$4,250,311	\$127,509	\$425,031	\$637,547	\$212,516	\$425,031	\$1,062,578		\$7,140,523	\$31,244,812
0060-02	A	E 45TH AVE	\$1,167,324	\$175,650	\$615,760	\$473,740	\$128,624	\$140,000		\$2,701,098	\$81,033	\$270,110	\$405,165	\$135,055	\$270,110	\$675,274		\$4,537,845	
0060-02	B	N BRIGHTON BLVD OUTFALL	\$3,502,081	\$206,767	\$429,600	\$511,576	\$237,001	\$90,000		\$4,977,025	\$149,311	\$497,702	\$746,554	\$248,851	\$497,702	\$1,244,256	\$145,965	\$8,507,366	
0060-02	C	N RACE ST OUTFALL	\$2,032,467	\$210,200	\$544,160	\$549,190	\$173,001	\$124,000		\$3,633,018	\$108,991	\$363,302	\$544,953	\$181,651	\$363,302	\$908,254		\$6,103,471	
0060-02	D	NATIONAL WESTERN IMPROVEMENTS	\$655,074	\$123,820	\$429,600	\$263,154	\$76,432	\$57,000		\$1,605,080	\$48,152	\$160,508	\$240,762	\$80,254	\$160,508	\$401,270		\$2,696,534	\$21,845,216
0061-01	ALT1	A 19TH AND 23RD AVENUE OUTFALLS	\$785,382	\$52,100	\$195,2														

STATEMENT OF PROBABLE COSTS IN 2003 DOLLARS

PROJECT			HARD COSTS							INDIRECT COSTS							TOTALS		
BASIN	ID	PROJECT	PIPE	MANHOLE	INLETS	ASPHALT PATCH	DRY UTILITY RELOCATE	WET UTILITY RELOCATE	DETENTION	TOTAL CONSTRUCTION COSTS	TRAFFIC CONTROL (3%)	MOBILIZATION (10%)	DESIGN & ENGINEERING (15%)	MATERIALS MANAGEMENT (5%)	ADMIN-ISTRATIVE (10%)	CONTINGENCY (25%)	EASEMENT/ ACQUISITION	TOTAL	TOTAL BY BASIN
0061-01	ALT3	A 19TH AND 23RD AVENUE OUTFALLS	\$785,382	\$62,100	\$195,200	\$93,790	\$58,424	\$32,000		\$1,226,896	\$36,807	\$122,690	\$184,034	\$61,345	\$122,690	\$306,724		\$2,061,186	
0061-01	ALT3	B 20TH AVENUE COLLECTION SYSTEM	\$764,406	\$144,925	\$539,760	\$350,310	\$98,070	\$162,000		\$2,059,471	\$61,784	\$205,947	\$308,921	\$102,974	\$205,947	\$514,868		\$3,459,912	
0061-01	ALT3	C 20TH AVENUE OUTFALL	\$1,659,924	\$156,000	\$453,840	\$376,300	\$138,303	\$120,000		\$2,904,367	\$87,131	\$290,437	\$435,655	\$145,218	\$290,437	\$726,092		\$4,879,337	
0061-01	ALT3	D 24TH AVENUE COLLECTION SYSTEM	\$1,281,942	\$186,125	\$1,054,640	\$644,486	\$171,260	\$258,000		\$3,596,453	\$107,894	\$359,645	\$539,468	\$179,823	\$359,645	\$899,113		\$6,042,041	
0061-01	ALT3	E 29TH AVENUE COLLECTION SYSTEM	\$2,136,900	\$243,750	\$725,040	\$700,328	\$202,601	\$246,000		\$4,254,619	\$127,639	\$425,462	\$638,193	\$212,731	\$425,462	\$1,063,655		\$7,147,761	
0061-01	ALT3	F CENTRAL ST COLLECTION AND OUTFALL	\$1,178,172	\$142,550	\$604,320	\$325,564	\$120,330	\$156,000		\$2,526,936	\$75,808	\$252,694	\$379,040	\$126,347	\$252,694	\$631,734		\$4,245,253	
0061-01	ALT3	G 29TH AVE AND ZUNI COLLECTION	\$1,165,734	\$183,175	\$801,280	\$539,638	\$146,991	\$250,000		\$3,086,818	\$92,605	\$308,682	\$463,023	\$154,341	\$308,682	\$771,704		\$5,185,855	
0061-01	ALT3	H ZUNI STREET OUTFALL	\$2,231,608	\$183,250	\$426,080	\$401,328	\$168,763	\$133,000		\$3,544,029	\$106,321	\$354,403	\$531,604	\$177,201	\$354,403	\$886,007		\$5,953,968	\$38,975,313
0061-02	ALT1	A 34TH/35TH AVENUE COLLECTION SYSTEM	\$1,237,554	\$177,625	\$556,720	\$532,610	\$136,275	\$221,000		\$2,861,784	\$85,854	\$286,178	\$429,268	\$143,089	\$286,178	\$715,446		\$4,807,797	
0061-02	ALT1	B 38TH AVE AND SOUTH INCA ST OUTFALLS	\$1,866,186	\$86,350	\$170,960	\$171,106	\$118,430	\$74,000		\$2,487,032	\$74,611	\$248,703	\$373,055	\$124,352	\$248,703	\$621,758		\$4,178,214	
0061-02	ALT1	C 40TH AVE AND FEDERAL COLLECTION	\$2,308,452	\$221,675	\$1,178,240	\$796,268	\$238,832	\$272,000		\$5,015,467	\$150,464	\$501,547	\$752,320	\$250,773	\$501,547	\$1,253,867		\$8,425,985	
0061-02	ALT1	D 42ND AVE AND FEDERAL COLLECTION	\$827,478	\$109,875	\$700,160	\$395,366	\$107,944	\$126,000		\$2,266,823	\$68,005	\$226,682	\$340,023	\$113,341	\$226,682	\$566,706		\$3,808,262	
0061-02	ALT1	E 46TH AVENUE COLLECTION SYSTEM	\$1,166,022	\$188,975	\$856,800	\$519,126	\$145,996	\$189,000		\$3,065,919	\$91,978	\$306,592	\$459,888	\$153,296	\$306,592	\$766,480		\$5,150,745	
0061-02	ALT1	F 47TH AVENUE COLLECTION SYSTEM	\$1,261,093	\$200,750	\$744,880	\$427,838	\$137,028	\$106,000		\$2,877,589	\$86,328	\$287,759	\$431,638	\$143,879	\$287,759	\$719,397		\$4,834,349	
0061-02	ALT1	G CHAFFEE PARK INTERCEPTOR	\$1,476,792	\$267,550	\$768,880	\$569,976	\$165,510	\$227,000		\$3,475,708	\$104,271	\$347,571	\$521,356	\$173,785	\$347,571	\$868,927		\$5,839,189	
0061-02	ALT1	H FOX STREET OUTFALL	\$1,667,510	\$99,300	\$198,720	\$215,286	\$110,441	\$28,000		\$2,319,257	\$69,578	\$231,926	\$347,889	\$115,963	\$231,926	\$579,814		\$3,896,353	
0061-02	ALT1	I LOWER 38TH AVE COLLECTION SYSTEM	\$2,365,599	\$115,375	\$513,760	\$507,872	\$182,630	\$150,000		\$3,835,236	\$115,057	\$383,524	\$575,285	\$191,762	\$383,524	\$958,809		\$6,443,197	
0061-02	ALT1	J LOWER INCA ST COLLECTION UPGRADES	\$1,608,895	\$113,725	\$560,480	\$427,044	\$143,007	\$150,000		\$3,003,151	\$90,095	\$300,315	\$450,473	\$150,158	\$300,315	\$750,788		\$5,045,295	
0061-02	ALT1	K UPPER 38TH AVENUE COLLECTION	\$1,358,514	\$219,750	\$791,360	\$531,074	\$154,235	\$184,000		\$3,238,933	\$97,168	\$323,893	\$485,840	\$161,947	\$323,893	\$809,733		\$5,441,407	\$57,870,793
0061-02	ALT2	A 34TH/35TH AVENUE COLLECTION	\$1,268,118	\$177,600	\$596,160	\$536,166	\$139,852	\$219,000		\$2,936,896	\$88,107	\$293,690	\$440,534	\$146,845	\$293,690	\$734,224		\$4,933,986	
0061-02	ALT2	B 37TH AVENUE COLLECTION SYSTEM	\$1,032,750	\$150,500	\$592,640	\$426,974	\$117,443	\$146,000		\$2,466,307	\$73,989	\$246,631	\$369,946	\$123,315	\$246,631	\$616,577		\$4,143,396	
0061-02	ALT2	C 38TH AVENUE COLLECTION SYSTEM	\$1,079,334	\$111,450	\$315,040	\$402,710	\$103,227	\$156,000		\$2,167,761	\$65,033	\$216,776	\$325,164	\$108,388	\$216,776	\$541,940		\$3,641,838	
0061-02	ALT2	D 40TH AVE AND FEDERAL COLLECTION	\$1,158,354	\$144,300	\$909,680	\$517,890	\$145,211	\$174,000		\$3,049,435	\$91,483	\$304,944	\$457,415	\$152,472	\$304,944	\$762,359		\$5,123,052	
0061-02	ALT2	E 40TH AVENUE COLLECTION SYSTEM	\$1,374,337	\$93,650	\$368,800	\$311,874	\$112,633	\$104,000		\$2,365,294	\$70,959	\$236,529	\$354,794	\$118,265	\$236,529	\$591,324		\$3,973,694	
0061-02	ALT2	F 42ND AVE AND FEDERAL COLLECTION	\$831,168	\$108,700	\$712,720	\$397,376	\$108,998	\$130,000		\$2,288,962	\$68,669	\$228,896	\$343,344	\$114,448	\$228,896	\$572,240		\$3,845,455	
0061-02	ALT2	G CHAFFEE PARK COLLECTION SYSTEM	\$1,630,458	\$280,500	\$1,253,360	\$750,826	\$210,007	\$285,000		\$4,410,151	\$132,305	\$441,015	\$661,523	\$220,508	\$441,015	\$1,102,538		\$7,409,055	
0061-02	ALT2	H CIANCIO AND CHAFFEE PARK DETENTION	\$587,646	\$149,725	\$384,880	\$246,734	\$72,449	\$80,000	\$1,396,994	\$2,918,428	\$87,553	\$291,843	\$437,764	\$145,921	\$291,843	\$729,607		\$4,902,959	
0061-02	ALT2	I FOX ST OUTFALL SYSTEM UPGRADES	\$1,482,919	\$172,800	\$341,920	\$234,338	\$113,799	\$44,000		\$2,389,776	\$71,693	\$238,978	\$358,466	\$119,489	\$238,978	\$597,444		\$4,014,824	
0061-02	ALT2	J LOWER INCA ST COLLECTION UPGRADES	\$1,015,884	\$68,275	\$405,600	\$313,836	\$95,880	\$114,000		\$2,013,475	\$60,404	\$201,348	\$302,021	\$100,674	\$201,348	\$503,369		\$3,382,639	
0061-02	ALT2	K SOUTH INCA STREET OUTFALL	\$2,131,144	\$129,900	\$356,240	\$336,432	\$153,086	\$108,000		\$3,214,802	\$96,444	\$321,480	\$482,220	\$160,740	\$321,480	\$803,700		\$5,400,866	
0061-02	ALT2	L UPPER INCA ST COLLECTION UPGRADES	\$859,273	\$163,050	\$536,240	\$307,354	\$97,696	\$88,000		\$2,051,613	\$61,548	\$205,161	\$307,742	\$102,581	\$205,161	\$512,903		\$3,446,709	\$54,218,473
0061-02	ALT3	A 34TH/35TH AVENUE COLLECTION SYSTEM	\$1,236,834	\$170,650	\$513,760	\$532,498	\$133,537	\$217,000		\$2,804,279	\$84,128	\$280,428	\$420,642	\$140,214	\$280,428	\$701,070		\$4,711,189	
0061-02	ALT3	B 40TH AVE AND FEDERAL COLLECTION	\$1,150,308	\$153,000	\$992,960	\$517,028	\$149,365	\$174,000		\$3,136,661	\$94,100	\$313,666	\$470,499	\$156,833	\$313,666	\$784,165		\$5,269,590	
0061-02	ALT3	C 40TH AVENUE AND LIPAN INTERCEPTOR	\$490,086	\$89,750	\$282,880	\$222,646	\$58,668	\$88,000		\$1,232,030	\$36,961	\$123,203	\$184,804	\$61,602	\$123,203	\$308,008		\$2,069,811	
0061-02	ALT3	D 42ND AVE AND FEDERAL COLLECTION	\$828,594	\$109,875	\$700,160	\$395,970	\$108,230	\$130,000		\$2,272,829	\$68,185	\$227,283	\$340,924	\$113,641	\$227,283	\$568,207		\$3,818,352	
0061-02	ALT3	E CHAFFEE PARK COLLECTION & DETENTION	\$1,743,930	\$288,625	\$1,170,960	\$797,066	\$214,979	\$299,000	\$680,999	\$5,195,559	\$155,867	\$519,556	\$779,334	\$259,778	\$519,556	\$1,298,890		\$8,728,540	
0061-02	ALT3	F GALAPAGO STREET AND S INCA OUTFALL	\$1,921,885	\$205,300	\$469,040	\$314,248	\$150,524	\$100,000		\$3,160,997	\$94,830	\$316,100	\$474,150	\$158,050	\$316,100	\$790,249		\$5,310,476	
0061-02	ALT3	G LOWER 38TH AVENUE COLLECTION	\$4,083,735	\$250,650	\$728,560	\$702,568	\$298,976	\$214,000		\$6,278,489	\$188,355	\$627,849	\$941,773	\$313,924	\$627,849	\$1,569,622		\$10,547,861	
0061-02	ALT3	H LOWER INCA ST COLLECTION UPGRADES	\$1,015,884	\$68,275	\$405,600	\$313,836	\$95,880	\$114,000		\$2,013,475	\$60,404	\$201,348	\$302,021	\$100,674	\$201,348	\$503,369		\$3,382,639	
0061-02	ALT3	I QUIVAS STREET INTERCEPTOR	\$1,158,144	\$97,125	\$410,000	\$279,240	\$102,125	\$98,000		\$2,144,634	\$64,339	\$214,463	\$321,695	\$107,232	\$214,463	\$536,158		\$3,602,984	
0061-02	ALT3	J UPPER 38TH AVENUE COLLECTION	\$1,007,298	\$151,275	\$648,160	\$422,674	\$118,370	\$138,000		\$2,485,777	\$74,573	\$248,578	\$372,867	\$124,289	\$248,578	\$621,444		\$4,176,106	
0061-02	ALT3	K UPPER INCA ST COLLECTION UPGRADES	\$859,273	\$160,725	\$521,920	\$307,354	\$96,864	\$88,000		\$2,034,136	\$61,024	\$203,414	\$305,120	\$101,707	\$203,414	\$508,534		\$3,417,349	\$55,034,897
0062-01		A 31ST ST OUTFALL	\$8,512,661	\$749,553	\$2,062,080	\$1,786,778	\$683,254	\$554,000		\$14,348,326	\$430,450	\$1,434,833	\$2,152,249	\$717,416	\$1,434,833	\$3,587,082		\$24,105,189	
0062-01		B 27TH ST IMPROVEMENTS	\$4,717,324	\$250,925	\$544,160	\$993,310	\$341,236	\$319,000		\$7,165,955	\$214,979	\$716,596	\$1,074,893	\$358,298	\$716,596	\$1,791,489		\$12,038,860	
0062-01		C 36TH ST OUTFALL	\$1,582,416	\$50,404	\$71,600	\$166,056	\$95,524	\$40,000		\$2,006,000	\$60,180	\$200,600	\$300,900	\$100,300	\$200,600	\$501,500		\$3,370,800	
0062-01		D E 33RD AVE	\$919,584	\$135,375	\$730,320	\$518,560	\$130,542	\$307,000		\$2,741,381	\$82,241	\$274,138	\$411,207	\$137,069	\$274,138	\$685,345		\$4,605,519	
0062-01		E N MARION ST	\$586,098	\$85,550	\$358,000	\$282,786	\$70,472	\$97,000		\$1,479,906	\$44,397	\$147,991	\$221,986	\$73,995	\$147,991	\$369,976		\$2,486,242	
0062-01		F 20TH ST IMPROVEMENTS	\$1,255,770	\$58,800	\$114,560	\$150,280	\$80,620	\$33,000		\$1,693,030	\$50,791	\$169,303	\$253,954	\$84,652	\$169,303	\$423,258		\$2,844,291	
0062-01		G N GRANT ST IMPROVEMENTS	\$1,323,299	\$103,925	\$358,000	\$383,730	\$115,298	\$137,000		\$2,									

STATEMENT OF PROBABLE COSTS IN 2003 DOLLARS

PROJECT			HARD COSTS							INDIRECT COSTS							TOTALS		
BASIN	ID	PROJECT	PIPE	MANHOLE	INLETS	ASPHALT PATCH	DRY UTILITY RELOCATE	WET UTILITY RELOCATE	DETENTION	TOTAL CONSTRUCTION COSTS	TRAFFIC CONTROL (3%)	MOBILIZATION (10%)	DESIGN & ENGINEERING (15%)	MATERIALS MANAGEMENT (5%)	ADMINISTRATIVE (10%)	CONTINGENCY (25%)	EASEMENT/ACQUISITION	TOTAL	TOTAL BY BASIN
0065-02	A	S BRYANT ST IMPROVEMENTS	\$59,040	\$8,700	\$42,960	\$32,800	\$7,275	\$2,000		\$152,775	\$4,583	\$15,278	\$22,916	\$7,639	\$15,278	\$38,194		\$256,663	\$256,663
0067-01	A	S QUITMAN ST IMPROVEMENTS	\$396,666	\$84,900	\$243,440	\$175,274	\$49,864	\$97,000		\$1,047,144	\$31,414	\$104,714	\$157,072	\$52,357	\$104,714	\$261,786		\$1,759,201	\$1,759,201
0067-01	B	W UNION AVE IMPROVEMENTS	\$1,056,798	\$232,125	\$572,800	\$391,630	\$117,118	\$89,000		\$2,459,471	\$73,784	\$245,947	\$368,921	\$122,974	\$245,947	\$614,868		\$4,131,912	\$5,891,113
0067-02	A	W GRAND AVE IMPROVEMENTS	\$394,812	\$88,200	\$171,840	\$154,972	\$44,741	\$85,000		\$939,565	\$28,187	\$93,956	\$140,935	\$46,978	\$93,956	\$234,891		\$1,578,468	\$1,578,468
3501-01	A	HIGH POINTE DETENTION #102	\$1,865,679		\$0	\$71,352	\$96,852		\$1,900,000	\$3,933,883	\$118,016	\$393,388	\$590,082	\$196,694	\$393,388	\$983,471		\$6,608,922	
3501-01	B	INTERNATIONAL BUSINESS CENTER POND 'L'	\$423,600		\$0		\$21,180		\$30,000	\$474,780	\$14,243	\$47,478	\$71,217	\$23,739	\$47,478	\$118,695		\$797,630	
3501-01	C	SECOND CREEK GRADE CONTROL	\$7,710,142	\$1,500,000	\$0	\$28,336	\$461,924			\$9,700,402	\$291,012	\$970,040	\$1,455,060	\$485,020	\$970,040	\$2,425,100		\$16,296,674	
3501-01	D	E 64TH AVE IMPROVEMENTS	\$397,472		\$0	\$11,664	\$20,457			\$429,593	\$12,888	\$42,959	\$64,439	\$21,480	\$42,959	\$107,398		\$721,716	\$24,424,942
3700-01	A	BLUE GRAMMA DETENTION	\$989,184		\$0	\$9,792	\$49,949		\$5,384,000	\$6,432,925	\$192,988	\$643,292	\$964,939	\$321,646	\$643,292	\$1,608,231		\$10,807,313	
3700-01	B	DOGWOOD GULCH DETENTION	\$501,600		\$0		\$25,080		\$354,000	\$880,680	\$26,420	\$88,068	\$132,102	\$44,034	\$88,068	\$220,170		\$1,479,542	\$12,286,855
3700-03	A	POND 812 DETENTION			\$0				\$262,000	\$262,000	\$7,860	\$26,200	\$39,300	\$13,100	\$26,200	\$65,500		\$440,160	
3700-03	B	POND 815 DETENTION	\$778,000		\$0		\$38,900		\$782,000	\$1,598,900	\$47,967	\$159,890	\$239,835	\$79,945	\$159,890	\$399,725		\$2,686,152	
3700-03	C	PRIVATE DETENTION	\$564,900		\$0	\$5,312	\$28,511		\$8,000	\$606,723	\$18,202	\$60,672	\$91,008	\$30,336	\$60,672	\$151,681		\$1,019,294	
3700-03	D	POND 801 DETENTION			\$0				\$400,000	\$400,000	\$12,000	\$40,000	\$60,000	\$20,000	\$40,000	\$100,000		\$672,000	
3700-03	E	POND 802 DETENTION	\$690,600		\$0	\$9,984	\$35,029		\$646,000	\$1,381,613	\$41,448	\$138,161	\$207,242	\$69,081	\$138,161	\$345,403		\$2,321,109	
3700-03	F	POND 800 DETENTION			\$0		\$222,000		\$6,660	\$222,000	\$6,660	\$22,200	\$33,300	\$11,100	\$22,200	\$55,500		\$372,960	
3700-03	G	POND 816 DETENTION	\$1,143,800		\$0		\$57,190		\$1,032,000	\$2,232,990	\$66,990	\$223,299	\$334,948	\$111,650	\$223,299	\$558,248		\$3,751,424	
3700-03	H	POND 826 DETENTION	\$548,200		\$0		\$27,410		\$458,000	\$1,033,610	\$31,008	\$103,361	\$155,042	\$51,680	\$103,361	\$258,402		\$1,736,464	\$12,999,563
3702-01	A	N PICADILLY RD IMPROVEMENTS	\$1,502,800		\$0		\$75,140			\$1,577,940	\$47,338	\$157,794	\$236,691	\$78,897	\$157,794	\$394,485		\$2,650,939	\$2,650,939
3900-01	A	STAPLETON - 10			\$0				\$196,000	\$196,000	\$5,880	\$19,600	\$29,400	\$9,800	\$19,600	\$49,000		\$329,280	\$329,280
3900-02	A	E 53RD AVE IMPROVEMENTS	\$174,600	\$23,200	\$114,560	\$81,480	\$21,192	\$30,000		\$445,032	\$13,351	\$44,503	\$66,755	\$22,252	\$44,503	\$111,258		\$747,654	
3900-02	B	E MAXWELL PL IMPROVEMENTS	\$167,040	\$26,100	\$128,880	\$77,952	\$20,999	\$20,000		\$440,971	\$13,229	\$44,097	\$66,146	\$22,049	\$44,097	\$110,243		\$740,832	\$1,488,486
3900-03	A	SILVERADO 1 DETENTION			\$0				\$680,000	\$680,000	\$20,400	\$68,000	\$102,000	\$34,000	\$68,000	\$170,000		\$1,142,400	
3900-03	B	E 45TH AVE IMPROVEMENTS	\$1,421,800		\$0	\$33,024	\$72,741			\$1,527,565	\$45,827	\$152,756	\$229,135	\$76,378	\$152,756	\$381,891		\$2,566,308	
3900-03	C	N PENNA BLVD EAST IMPROVEMENTS	\$325,800		\$0		\$16,290			\$342,090	\$10,263	\$34,209	\$51,314	\$17,104	\$34,209	\$85,522		\$574,711	
3900-03	D	N PENNA BLVD WEST IMPROVEMENTS	\$758,985		\$0	\$8,120	\$38,355			\$805,460	\$24,164	\$80,546	\$120,819	\$40,273	\$80,546	\$201,365		\$1,353,173	\$5,636,592
3900-04	A	SILVERADO II DETENTION			\$0				\$1,560,000	\$1,560,000	\$46,800	\$156,000	\$234,000	\$78,000	\$156,000	\$390,000		\$2,620,800	
3900-04	B	E BOLLING DR IMPROVEMENTS	\$780,800		\$0		\$40,040	\$20,000		\$840,840	\$25,225	\$84,084	\$126,126	\$42,042	\$84,084	\$210,210		\$1,412,611	
3900-04	C	HIMALAYA RD OUTFALL	\$2,115,800		\$0		\$105,990	\$4,000		\$2,225,790	\$66,774	\$222,579	\$333,868	\$111,290	\$222,579	\$556,448		\$3,739,328	\$7,772,739
3901-01	A	18 IN. UPGRADES	\$103,302	\$27,900	\$171,840	\$72,694	\$19,687	\$18,000		\$413,423	\$12,403	\$41,342	\$62,013	\$20,671	\$41,342	\$103,356		\$694,550	
3901-01	B	E 45TH AVE IMPROVEMENTS	\$1,555,169	\$105,600	\$157,520	\$120,632	\$98,296	\$27,000		\$2,064,217	\$61,927	\$206,422	\$309,633	\$103,211	\$206,422	\$516,054		\$3,467,886	
3901-01	C	E 47TH AVE IMPROVEMENTS	\$972,086	\$232,550	\$486,880	\$299,704	\$103,211	\$73,000		\$2,167,431	\$65,023	\$216,743	\$325,115	\$108,372	\$216,743	\$541,858		\$3,641,285	
3901-01	D	E 53RD AVE IMPROVEMENTS	\$1,020,942	\$110,250	\$214,800	\$235,568	\$81,278	\$44,000		\$1,706,838	\$51,205	\$170,684	\$256,026	\$85,342	\$170,684	\$426,710		\$2,867,489	
3901-01	E	E ALBROOK DR IMPROVEMENTS	\$480,150	\$85,100	\$200,480	\$161,862	\$48,180	\$36,000		\$1,011,772	\$30,353	\$101,177	\$151,766	\$50,589	\$101,177	\$252,943		\$1,699,777	
3901-01	F	E ANDREWS DR IMPROVEMENTS	\$131,436	\$20,300	\$100,240	\$67,948	\$16,396	\$8,000		\$344,320	\$10,330	\$34,432	\$51,648	\$17,216	\$34,432	\$86,080		\$578,458	\$12,949,445
4000-01	A	STAPLETON - 10			\$0				\$582,000	\$582,000	\$17,460	\$58,200	\$87,300	\$29,100	\$58,200	\$145,500		\$977,760	
4000-01	B	STAPLETON - 11			\$0				\$438,000	\$438,000	\$13,140	\$43,800	\$65,700	\$21,900	\$43,800	\$109,500		\$735,840	\$1,713,600
4300-03	A	N FEDERAL BLVD OUTFALL	\$767,376	\$136,550	\$300,720	\$291,504	\$76,208	\$28,000		\$1,600,358	\$48,011	\$160,036	\$240,054	\$80,018	\$160,036	\$400,090		\$2,688,603	
4300-03	B	CLEAR CREEK OUTFALL	\$835,850	\$45,616	\$71,600	\$137,400	\$54,523			\$1,144,989	\$34,350	\$114,499	\$171,748	\$57,249	\$114,499	\$286,247		\$1,923,581	\$4,612,184
4400-01	A	STAPLETON - 01	\$3,088,944	\$171,582	\$315,040	\$300,320	\$193,994	\$4,000	\$560,000	\$4,633,880	\$139,016	\$463,388	\$695,082	\$231,694	\$463,388	\$1,158,470		\$7,784,918	
4400-01	B	STAPLETON - 02	\$15,627,702	\$88,200	\$171,840	\$808,944	\$835,034	\$4,000	\$2,300,000	\$19,835,720	\$595,072	\$1,983,572	\$2,975,358	\$991,786	\$1,983,572	\$4,958,930		\$33,324,010	
4400-01	C	STAPLETON - 03	\$2,326,470	\$71,776	\$128,880	\$219,510	\$137,532	\$4,000	\$400,000	\$3,288,168	\$98,645	\$328,817	\$493,225	\$164,408	\$328,817	\$822,042		\$5,524,122	\$46,633,050
4400-02 ALT1	A	20TH AVE IMPROVEMENTS	\$251,910	\$36,550	\$114,560	\$113,174	\$27,610	\$36,000		\$579,804	\$17,394	\$57,980	\$86,971	\$28,990	\$57,980	\$144,951		\$974,070	
4400-02 ALT1	B	35TH AVE IMPROVEMENTS	\$276,858	\$46,800	\$143,200	\$120,938	\$32,590	\$64,000		\$684,386	\$20,532	\$68,439	\$102,658	\$34,219	\$68,439	\$171,096		\$1,149,769	
4400-02 ALT1	D	38TH AVE INTERCEPTOR	\$1,479,508	\$84,150	\$229,120	\$306,452	\$109,362	\$88,000		\$2,296,592	\$68,898	\$229,659	\$344,489	\$114,830	\$229,659	\$574,148		\$3,858,275	
4400-02 ALT1	E	41ST AVE OUTFALL PHASE I	\$1,878,438	\$29,400	\$57,280	\$125,992	\$104,856	\$6,000		\$2,201,966	\$66,059	\$220,197	\$330,295	\$110,098	\$220,197	\$550,492		\$3,699,304	
4400-02 ALT1	F	41ST AVE OUTFALL PHASE II	\$2,474,612	\$134,625	\$272,080	\$315,872	\$163,359	\$70,000		\$3,430,548	\$102,916	\$343,055	\$514,582	\$171,527	\$343,055	\$857,637		\$5,763,320	
4400-02 ALT1	G	41ST AVE OUTFALL PHASE III	\$1,808,738	\$112,975	\$286,400	\$367,590	\$134,385	\$112,000		\$2,822,088	\$84,663	\$282,209	\$423,313	\$141,104	\$282,209	\$705,522		\$4,741,108	
4400-02 ALT1	H	41ST AVE OUTFALL PHASE IV	\$1,119,186	\$110,050	\$257,760	\$317,036	\$94,452	\$85,000		\$1,983,484	\$59,505	\$198,348	\$297,523	\$99,174	\$198,348	\$495,871		\$3,332,253	
4400-02 ALT1	I	41ST AVE OUTFALL PHASE V	\$298,980	\$45,450	\$114,560	\$128,900	\$31,294	\$38,000		\$657,184	\$19,716	\$65,718	\$98,578	\$32,859	\$65,718	\$164,296		\$1,104,069	
4400-02 ALT1	J	48TH AND FOREST INTERCEPTOR	\$338,667	\$51,450	\$100,240	\$96,034	\$29,920	\$12,000		\$628,311	\$18,849	\$62,831	\$94,247	\$31,416	\$62,831	\$157,078		\$1,055,563	
4400-02 ALT1	K	DAHLIA ST OUTFALL PHASE II	\$12,113,034	\$182,625	\$443,920	\$973,164	\$688,537	\$58,000		\$14,459,280	\$433,778	\$1,445,928	\$2,168,892	\$722,964	\$1,445,928	\$3,614,820		\$24,291,590	
4400-02 ALT1	L	EUODORA ST IMPROVEMENTS	\$431,370	\$79,100	\$214,800	\$18													

STATEMENT OF PROBABLE COSTS IN 2003 DOLLARS

PROJECT		HARD COSTS								INDIRECT COSTS							TOTALS		
BASIN	ID	PROJECT	PIPE	MANHOLE	INLETS	ASPHALT PATCH	DRY UTILITY RELOCATE	WET UTILITY RELOCATE	DETENTION	TOTAL CONSTRUCTION COSTS	TRAFFIC CONTROL (3%)	MOBILIZATION (10%)	DESIGN & ENGINEERING (15%)	MATERIALS MANAGEMENT (5%)	ADMINISTRATIVE (10%)	CONTINGENCY (25%)	EASEMENT/ACQUISITION	TOTAL	TOTAL BY BASIN
4400-02	ALT2	A 20TH AVE IMPROVEMENTS	\$251,910	\$36,550	\$114,560	\$113,174	\$27,610	\$36,000		\$579,804	\$17,394	\$57,980	\$86,971	\$28,990	\$57,980	\$144,951		\$974,070	
4400-02	ALT2	B 35TH AVE IMPROVEMENTS	\$276,858	\$46,800	\$143,200	\$120,938	\$32,590	\$64,000		\$684,386	\$20,532	\$68,439	\$102,658	\$34,219	\$68,439	\$171,096		\$1,149,769	
4400-02	ALT2	D 38TH AVE INTERCEPTOR	\$1,479,508	\$86,475	\$243,440	\$306,452	\$110,194	\$88,000		\$2,314,069	\$69,422	\$231,407	\$347,110	\$115,703	\$231,407	\$578,517		\$3,887,635	
4400-02	ALT2	F 41ST AVE OUTFALL PHASE II	\$2,500,034	\$134,625	\$272,080	\$317,544	\$164,914	\$74,000		\$3,463,197	\$103,896	\$346,320	\$519,480	\$173,160	\$346,320	\$865,799		\$5,818,172	
4400-02	ALT2	G 41ST AVE OUTFALL PHASE III	\$1,808,738	\$110,650	\$272,080	\$367,590	\$133,553	\$112,000		\$2,804,611	\$84,138	\$280,461	\$420,692	\$140,231	\$280,461	\$701,153		\$4,711,747	
4400-02	ALT2	H 41ST AVE OUTFALL PHASE IV	\$1,119,186	\$110,050	\$257,760	\$317,036	\$94,452	\$85,000		\$1,983,484	\$59,505	\$198,348	\$297,523	\$99,174	\$198,348	\$495,871		\$3,332,253	
4400-02	ALT2	I 41ST AVE OUTFALL PHASE V	\$298,980	\$45,450	\$114,560	\$128,900	\$31,294	\$38,000		\$657,184	\$19,716	\$65,718	\$98,578	\$32,859	\$65,718	\$164,296		\$1,104,069	
4400-02	ALT2	J 48TH AND FOREST INTERCEPTOR	\$859,850	\$58,800	\$114,560	\$134,776	\$59,199	\$16,000		\$1,243,185	\$37,296	\$124,318	\$186,478	\$62,159	\$124,318	\$310,796		\$2,088,550	
4400-02	ALT2	K DAHLIA ST OUTFALL PHASE II	\$13,556,735	\$226,725	\$529,840	\$1,067,314	\$772,331	\$66,000		\$16,218,945	\$486,568	\$1,621,894	\$2,432,842	\$810,947	\$1,621,894	\$4,054,736		\$27,247,826	
4400-02	ALT2	L EUDORA ST IMPROVEMENTS	\$431,370	\$79,100	\$214,800	\$184,570	\$48,042	\$51,000		\$1,008,882	\$30,266	\$100,888	\$151,332	\$50,444	\$100,888	\$252,220		\$1,694,920	
4400-02	ALT2	M FOREST ST IMPROVEMENTS	\$206,856	\$26,100	\$128,880	\$103,944	\$24,939	\$33,000		\$523,719	\$15,712	\$52,372	\$78,558	\$26,186	\$52,372	\$130,930		\$879,849	
4400-02	ALT2	N GLENCOE ST IMPROVEMENTS	\$579,906	\$64,400	\$186,160	\$233,490	\$56,448	\$65,000		\$1,185,404	\$35,562	\$118,540	\$177,811	\$59,270	\$118,540	\$296,351		\$1,991,478	
4400-02	ALT2	O IVY ST REMEDIAL DRAINAGE	\$128,844	\$20,500	\$57,280	\$57,676	\$14,215	\$20,000		\$298,515	\$8,955	\$29,852	\$44,777	\$14,926	\$29,852	\$74,629		\$501,506	
4400-02	ALT2	P LEYDEN ST IMPROVEMENTS	\$167,256	\$17,400	\$85,920	\$82,232	\$18,740	\$22,000		\$393,548	\$11,806	\$39,355	\$59,032	\$19,677	\$39,355	\$98,387		\$661,160	
4400-02	ALT2	Q LOCUST ST IMPROVEMENTS	\$215,064	\$23,400	\$71,600	\$98,392	\$21,373	\$19,000		\$448,829	\$13,465	\$44,883	\$67,324	\$22,441	\$44,883	\$112,207		\$754,032	
4400-02	ALT2	R MLK AND EUDORA INTERCEPTOR	\$786,240	\$86,450	\$229,120	\$274,336	\$73,557	\$95,000		\$1,544,703	\$46,341	\$154,470	\$231,705	\$77,235	\$154,470	\$386,176		\$2,595,100	
4400-02	ALT2	S MLK OUTFALL	\$715,698	\$109,875	\$315,040	\$289,602	\$76,811	\$106,000		\$1,613,026	\$48,391	\$161,303	\$241,954	\$80,651	\$161,303	\$403,256		\$2,709,884	
4400-02	ALT2	T MONACO ST OUTFALL	\$1,174,835	\$87,450	\$229,120	\$241,612	\$88,851	\$44,000		\$1,865,868	\$55,976	\$186,587	\$279,880	\$93,293	\$186,587	\$466,467		\$3,134,658	
4400-02	ALT2	U NEWPORT ST IMPROVEMENTS	\$328,140	\$55,900	\$171,840	\$133,580	\$36,473	\$40,000		\$765,933	\$22,978	\$76,593	\$114,890	\$38,297	\$76,593	\$191,483		\$1,286,767	
4400-02	ALT2	V SMITH ROAD INTERCEPTOR	\$270,522	\$51,450	\$100,240	\$94,858	\$27,154	\$26,000		\$570,224	\$17,107	\$57,022	\$85,534	\$28,511	\$57,022	\$142,556		\$957,976	
4400-02	ALT2	W UPPER DAHLIA ST OUTFALL	\$931,392	\$44,100	\$85,920	\$147,312	\$61,936	\$30,000		\$1,300,660	\$39,020	\$130,066	\$195,099	\$65,033	\$130,066	\$325,165		\$2,185,109	\$69,666,530
4400-02	ALT3	A 20TH AVE IMPROVEMENTS	\$251,910	\$36,550	\$114,560	\$113,174	\$27,610	\$36,000		\$579,804	\$17,394	\$57,980	\$86,971	\$28,990	\$57,980	\$144,951		\$974,070	
4400-02	ALT3	B 35TH AVE IMPROVEMENTS	\$276,858	\$46,800	\$143,200	\$120,938	\$32,590	\$64,000		\$684,386	\$20,532	\$68,439	\$102,658	\$34,219	\$68,439	\$171,096		\$1,149,769	
4400-02	ALT3	C 38TH AND GRAPE ST DETENTION	\$1,252,175	\$88,200	\$171,840	\$202,770	\$87,049	\$26,000	\$1,400,000	\$3,228,034	\$96,841	\$322,803	\$484,205	\$161,402	\$322,803	\$807,008	\$1,381,982	\$6,805,078	
4400-02	ALT3	D 38TH AVE INTERCEPTOR	\$1,457,556	\$93,825	\$257,760	\$302,980	\$111,206	\$112,000		\$2,335,327	\$70,060	\$233,533	\$350,299	\$116,766	\$233,533	\$583,832		\$3,923,350	
4400-02	ALT3	E 41ST AVE OUTFALL PHASE I	\$1,135,554	\$29,400	\$57,280	\$96,764	\$66,450	\$10,000		\$1,395,448	\$41,863	\$139,545	\$209,317	\$69,772	\$139,545	\$348,862		\$2,344,352	
4400-02	ALT3	F 41ST AVE OUTFALL PHASE II	\$4,187,690	\$105,225	\$214,800	\$425,056	\$250,839	\$84,000		\$5,267,610	\$158,028	\$526,761	\$790,142	\$263,380	\$526,761	\$1,316,902		\$8,849,584	
4400-02	ALT3	G 41ST AVE OUTFALL PHASE III	\$1,808,738	\$115,675	\$272,080	\$367,590	\$133,804	\$112,000		\$2,809,887	\$84,297	\$280,989	\$421,483	\$140,494	\$280,989	\$702,472		\$4,720,611	
4400-02	ALT3	H 41ST AVE OUTFALL PHASE IV	\$1,119,186	\$110,050	\$257,760	\$317,036	\$94,452	\$85,000		\$1,983,484	\$59,505	\$198,348	\$297,523	\$99,174	\$198,348	\$495,871		\$3,332,253	
4400-02	ALT3	I 41ST AVE OUTFALL PHASE V	\$298,980	\$45,450	\$114,560	\$128,900	\$31,294	\$38,000		\$657,184	\$19,716	\$65,718	\$98,578	\$32,859	\$65,718	\$164,296		\$1,104,069	
4400-02	ALT3	J 48TH AND FOREST INTERCEPTOR	\$859,850	\$51,450	\$100,240	\$99,456	\$31,091	\$12,000		\$1,243,185	\$37,296	\$124,318	\$186,478	\$62,159	\$124,318	\$310,796		\$2,088,550	
4400-02	ALT3	K DAHLIA ST OUTFALL PHASE II	\$567,622	\$50,325	\$186,160	\$121,858	\$46,398	\$2,000		\$974,363	\$29,231	\$97,436	\$146,154	\$48,718	\$97,436	\$243,591		\$1,636,929	
4400-02	ALT3	L EUDORA ST IMPROVEMENTS	\$431,370	\$76,200	\$200,480	\$184,570	\$47,181	\$51,000		\$990,801	\$29,724	\$99,080	\$148,620	\$49,540	\$99,080	\$247,700		\$1,664,545	
4400-02	ALT3	M FOREST ST IMPROVEMENTS	\$202,626	\$26,100	\$128,880	\$101,970	\$24,429	\$29,000		\$513,005	\$15,390	\$51,300	\$76,951	\$25,650	\$51,300	\$128,251		\$861,847	
4400-02	ALT3	N GLENCOE ST IMPROVEMENTS	\$579,906	\$64,400	\$186,160	\$233,490	\$56,448	\$65,000		\$1,185,404	\$35,562	\$118,540	\$177,811	\$59,270	\$118,540	\$296,351		\$1,991,478	
4400-02	ALT3	O IVY ST REMEDIAL DRAINAGE	\$128,844	\$20,500	\$57,280	\$57,676	\$14,215	\$20,000		\$298,515	\$8,955	\$29,852	\$44,777	\$14,926	\$29,852	\$74,629		\$501,506	
4400-02	ALT3	P LEYDEN ST IMPROVEMENTS	\$167,256	\$17,400	\$85,920	\$82,232	\$18,740	\$22,000		\$393,548	\$11,806	\$39,355	\$59,032	\$19,677	\$39,355	\$98,387		\$661,160	
4400-02	ALT3	Q LOCUST ST IMPROVEMENTS	\$215,064	\$23,400	\$71,600	\$98,392	\$21,373	\$19,000		\$448,829	\$13,465	\$44,883	\$67,324	\$22,441	\$44,883	\$112,207		\$754,032	
4400-02	ALT3	R MLK AND EUDORA INTERCEPTOR	\$786,240	\$86,450	\$229,120	\$274,336	\$73,557	\$95,000		\$1,544,703	\$46,341	\$154,470	\$231,705	\$77,235	\$154,470	\$386,176		\$2,595,100	
4400-02	ALT3	S MLK OUTFALL	\$715,698	\$109,875	\$315,040	\$289,602	\$76,811	\$106,000		\$1,613,026	\$48,391	\$161,303	\$241,954	\$80,651	\$161,303	\$403,256		\$2,709,884	
4400-02	ALT3	T MONACO ST OUTFALL	\$1,174,835	\$87,450	\$229,120	\$241,612	\$88,851	\$44,000		\$1,865,868	\$55,976	\$186,587	\$279,880	\$93,293	\$186,587	\$466,467		\$3,134,658	
4400-02	ALT3	U NEWPORT ST IMPROVEMENTS	\$328,140	\$55,900	\$171,840	\$133,580	\$36,473	\$40,000		\$765,933	\$22,978	\$76,593	\$114,890	\$38,297	\$76,593	\$191,483		\$1,286,767	
4400-02	ALT3	V SMITH ROAD INTERCEPTOR	\$215,280	\$36,750	\$71,600	\$77,808	\$20,972	\$18,000		\$440,410	\$13,212	\$44,041	\$66,062	\$22,020	\$44,041	\$110,102		\$739,888	
4400-02	ALT3	W UPPER DAHLIA ST OUTFALL	\$931,392	\$44,100	\$85,920	\$147,312	\$61,936	\$30,000		\$1,300,660	\$39,020	\$130,066	\$195,099	\$65,033	\$130,066	\$325,165		\$2,185,109	\$55,022,918
4400-03	A	STAPLETON - 04	\$2,358,610	\$181,822	\$329,360	\$491,214	\$174,000	\$119,000	\$400,000	\$4,054,006	\$121,620	\$405,401	\$608,101	\$202,700	\$405,401	\$1,013,502		\$6,810,731	
4400-03	B	STAPLETON - 05	\$952,408	\$109,965	\$300,720	\$310,762	\$84,093	\$8,000		\$1,765,948	\$52,978	\$176,595	\$264,892	\$88,297	\$176,595	\$441,487		\$2,966,792	
4400-03	C	QUEBEC ST OUTFALL	\$1,246,189	\$102,900	\$200,480	\$270,766	\$93,267	\$45,000		\$1,958,602	\$58,758	\$195,860	\$293,790	\$97,930	\$195,860	\$489,650		\$3,290,450	\$13,067,973
4400-04	A	STAPLETON - 06	\$2,424,777	\$61,450	\$100,240	\$235,440	\$141,495	\$8,000		\$2,971,402	\$89,142	\$297,140	\$445,710	\$148,570	\$297,140	\$742,850		\$4,991,954	
4400-04	B	STAPLETON - 07	\$1,749,594	\$126,100	\$315,040	\$415,116	\$130,292			\$2,736,142	\$82,084	\$273,614	\$410,421	\$136,807	\$273,614	\$684,036		\$4,596,718	
4400-04	C	STAPLETON - 08	\$4,129,610	\$211,275	\$558,480	\$718,384	\$283,987	\$62,000		\$5,963,736	\$178,912	\$596,374	\$894,560	\$298,187	\$596,374	\$1,490,934			



STATEMENT OF PROBABLE COSTS IN 2003 DOLLARS

PROJECT			HARD COSTS							INDIRECT COSTS						TOTALS			
BASIN	ID	PROJECT	PIPE	MANHOLE	INLETS	ASPHALT PATCH	DRY UTILITY RELOCATE	WET UTILITY RELOCATE	DETENTION	TOTAL CONSTRUCTION COSTS	TRAFFIC CONTROL (3%)	MOBILIZATION (10%)	DESIGN & ENGINEERING (15%)	MATERIALS MANAGEMENT (5%)	ADMINISTRATIVE (10%)	CONTINGENCY (25%)	EASEMENT/ACQUISITION	TOTAL	TOTAL BY BASIN
4500-03	A	16TH STREET SYSTEM	\$9,662,650	\$849,550	\$1,675,440	\$1,453,528	\$699,358	\$346,000		\$14,686,526	\$440,596	\$1,468,653	\$2,202,979	\$734,326	\$1,468,653	\$3,671,632		\$24,673,365	\$24,673,365
4500-04	A	HALE STREET SYSTEM	\$12,415,546	\$1,700,200	\$3,164,720	\$2,682,603	\$1,031,603	\$669,000		\$21,663,672	\$649,910	\$2,166,367	\$3,249,551	\$1,083,184	\$2,166,367	\$5,415,918		\$36,394,969	\$36,394,969
4500-04	B	JACKSON STREET SYSTEM	\$7,155,560	\$796,300	\$1,589,520	\$1,460,086	\$566,723	\$333,000		\$11,901,189	\$357,036	\$1,190,119	\$1,785,178	\$595,059	\$1,190,119	\$2,975,297		\$19,993,997	\$56,388,966
4600-01	A	STOUT ST OUTFALL EAST	\$1,748,056	\$186,275	\$830,560	\$536,912	\$176,140	\$221,000		\$3,698,943	\$110,968	\$369,894	\$554,841	\$184,947	\$369,894	\$924,736		\$6,214,223	
4600-01	B	CHERRY CREEK OUTFALLS	\$1,437,147	\$158,042	\$544,160	\$675,331	\$148,884	\$163,000		\$3,126,564	\$93,797	\$312,656	\$468,985	\$156,328	\$312,656	\$781,641		\$5,252,627	
4600-01	C	W 14TH AVE OUTFALL	\$473,292	\$64,106	\$143,200	\$174,604	\$45,760	\$60,000		\$960,962	\$28,829	\$96,096	\$144,144	\$48,048	\$96,096	\$240,240		\$1,614,415	
4600-01	D	W 8TH AVE OUTFALL	\$90,000	\$3,626	\$0	\$30,000	\$6,781	\$12,000		\$142,407	\$4,272	\$14,241	\$21,361	\$7,120	\$14,241	\$35,602		\$239,244	
4600-01	E	W 9TH AVE OUTFALL	\$535,410	\$79,660	\$286,400	\$262,402	\$63,794	\$112,000		\$1,339,666	\$40,190	\$133,967	\$200,950	\$66,983	\$133,967	\$334,916		\$2,250,639	
4600-01	F	WEST COLFAX AVE OUTFALL	\$1,755,171	\$170,641	\$572,800	\$617,180	\$172,240	\$329,000		\$3,617,032	\$108,511	\$361,703	\$542,555	\$180,852	\$361,703	\$904,258		\$6,076,614	
4600-01	G	CURTIS ST OUTFALL	\$1,322,154	\$208,956	\$873,520	\$644,730	\$163,218	\$215,000		\$3,427,578	\$102,827	\$342,758	\$514,137	\$171,379	\$342,758	\$856,894		\$5,758,331	
4600-01	H	N BANNOCK ST IMPROVEMENTS	\$285,012	\$34,875	\$214,800	\$165,140	\$38,341	\$67,000		\$805,168	\$24,155	\$80,517	\$120,775	\$40,258	\$80,517	\$201,292		\$1,352,682	
4600-01	I	N SPEER BLVD IMPROVEMENTS	\$63,612	\$18,600	\$114,560	\$44,764	\$12,677	\$12,000		\$266,213	\$7,986	\$26,621	\$39,932	\$13,311	\$26,621	\$66,553		\$447,237	
4600-01	J	W 13TH AVE OUTFALL	\$1,624,040	\$105,122	\$272,080	\$384,118	\$126,768	\$150,000		\$2,662,128	\$79,864	\$266,213	\$399,319	\$133,106	\$266,213	\$665,532		\$4,472,375	\$33,678,387
4600-01 100 YEAR	A	100 YEAR SYSTEM	\$8,870,831	\$257,250	\$501,200	\$1,087,386	\$547,583	\$235,000		\$11,499,250	\$344,978	\$1,149,925	\$1,724,888	\$574,962	\$1,149,925	\$2,874,812		\$19,318,740	\$19,318,740
4600-02	A	DOWNING ST OUTFALL	\$1,136,196	\$138,419	\$644,400	\$554,372	\$134,969	\$226,000		\$2,834,356	\$85,031	\$283,436	\$425,153	\$141,718	\$283,436	\$708,589		\$4,761,719	
4600-02	B	LA FAYETTE ST OUTFALL	\$632,475	\$104,275	\$315,040	\$268,419	\$71,510	\$110,000		\$1,501,719	\$45,052	\$150,172	\$225,258	\$75,086	\$150,172	\$375,430		\$2,522,889	
4600-02	C	E 5TH AVE OUTFALL	\$1,252,404	\$214,001	\$758,960	\$579,444	\$149,790	\$191,000		\$3,145,599	\$94,368	\$314,560	\$471,840	\$157,280	\$314,560	\$786,400		\$5,284,607	
4600-02	D	E 6TH AVE OUTFALL	\$27,540	\$5,106	\$0	\$7,956	\$2,030			\$42,632	\$1,279	\$4,263	\$6,395	\$2,132	\$4,263	\$10,658		\$71,622	
4600-02	E	E CEDAR AVE	\$160,614	\$27,300	\$157,520	\$106,070	\$23,975	\$28,000		\$503,479	\$15,104	\$50,348	\$75,522	\$25,174	\$50,348	\$125,870		\$845,845	
4600-02	F	STEELE ST OUTFALL	\$1,817,035	\$66,150	\$128,880	\$194,488	\$111,728	\$28,000		\$2,346,281	\$70,388	\$234,628	\$351,942	\$117,314	\$234,628	\$586,570		\$3,941,751	
4600-02	G	S BONNIE BRAE BLVD	\$915,426	\$145,325	\$529,840	\$421,682	\$108,914	\$166,000		\$2,287,187	\$68,616	\$228,719	\$343,078	\$114,359	\$228,719	\$571,797		\$3,842,475	
4600-02	H	COLORADO BLVD	\$854,362	\$81,675	\$286,400	\$263,688	\$78,006	\$74,000		\$1,638,131	\$49,144	\$163,813	\$245,720	\$81,907	\$163,813	\$409,533		\$2,752,061	
4600-02	I	N UNIVERSITY BLVD OUTFALL	\$794,376	\$89,044	\$358,000	\$320,136	\$82,478	\$88,000		\$1,732,034	\$51,961	\$173,203	\$259,805	\$86,602	\$173,203	\$433,008	\$62,960	\$2,972,776	
4600-02	J	5TH AVE IMPROVEMENTS	\$514,440	\$92,875	\$286,400	\$226,984	\$60,735	\$94,000		\$1,275,434	\$38,263	\$127,543	\$191,315	\$63,772	\$127,543	\$318,858		\$2,142,728	
4600-02	K	BAYAUD OUTFALL	\$1,532,418	\$192,601	\$830,560	\$729,106	\$176,284	\$241,000		\$3,701,969	\$111,059	\$370,197	\$555,295	\$185,098	\$370,197	\$925,492		\$6,219,307	
4600-02	L	18 IN. UPGRADES	\$369,306	\$81,375	\$501,200	\$259,882	\$64,688	\$82,000		\$1,358,451	\$40,754	\$135,845	\$203,768	\$67,923	\$135,845	\$339,613		\$2,282,199	\$37,639,979
4600-02 100 YEAR	A	CHERRY CREEK	\$3,911,856	\$124,950	\$243,440	\$442,004	\$240,512	\$88,000		\$5,050,762	\$151,523	\$505,076	\$757,614	\$252,538	\$505,076	\$1,262,690		\$8,485,279	
4600-02 100 YEAR	B	STEELE ST	\$1,591,854	\$73,500	\$143,200	\$274,560	\$106,056	\$38,000		\$2,227,170	\$66,815	\$222,717	\$334,076	\$111,358	\$222,717	\$556,792		\$3,741,645	\$12,226,924
4600-03	A	E EXPOSITION AVE OUTFALL	\$3,582,239	\$282,275	\$1,031,040	\$1,129,142	\$317,435	\$324,000		\$6,666,131	\$199,984	\$666,613	\$999,920	\$333,307	\$666,613	\$1,666,533		\$11,199,101	
4600-03	B	S FOREST ST OUTFALL	\$628,326	\$79,850	\$257,760	\$204,878	\$61,941	\$68,000		\$1,300,755	\$39,023	\$130,076	\$195,113	\$65,038	\$130,076	\$325,189		\$2,185,270	
4600-03	C	S HOLLY ST OUTFALL	\$262,782	\$39,363	\$186,160	\$153,038	\$34,167	\$42,000		\$717,510	\$21,525	\$71,751	\$107,626	\$35,876	\$71,751	\$179,378		\$1,205,417	
4600-03	D	S HONEY WAY OUTFALL	\$56,052	\$13,950	\$85,920	\$39,444	\$9,768			\$205,134	\$6,154	\$20,513	\$30,770	\$10,257	\$20,513	\$51,284		\$344,625	
4600-03	E	E FLORIDA AVE OUTFALL	\$2,439,614	\$92,850	\$200,480	\$382,128	\$158,304	\$51,000		\$3,324,376	\$99,731	\$332,438	\$498,656	\$166,219	\$332,438	\$831,094		\$5,584,952	
4600-03	F	S ONEIDA ST OUTFALL	\$40,095	\$11,600	\$57,280	\$20,295	\$6,764	\$6,000		\$142,034	\$4,261	\$14,203	\$21,305	\$7,102	\$14,203	\$35,508		\$238,616	
4600-03	G	S VALE DR OUTFALL	\$111,204	\$17,060	\$85,920	\$68,932	\$15,256	\$22,000		\$320,372	\$9,611	\$32,037	\$48,056	\$16,019	\$32,037	\$80,093	\$13,192	\$551,417	
4600-03	H	JEWELL AVE OUTFALL	\$345,438	\$26,372	\$100,240	\$150,030	\$32,204	\$22,000		\$676,284	\$20,289	\$67,628	\$101,443	\$33,814	\$67,628	\$169,071		\$1,136,157	
4600-03	I	S NIAGARA ST OUTFALL	\$3,129,303	\$88,800	\$257,760	\$522,476	\$203,067	\$63,000		\$4,264,406	\$127,932	\$426,441	\$639,661	\$213,220	\$426,441	\$1,066,102		\$7,164,203	\$29,609,758
4600-04	A	18 IN. UPGRADES	\$206,766	\$62,775	\$386,640	\$145,502	\$41,084	\$20,000		\$862,767	\$25,883	\$86,277	\$129,415	\$43,138	\$86,277	\$215,692		\$1,449,449	
4600-04	B	E CORNELL AVE OUTFALL	\$2,185,015	\$117,600	\$229,120	\$237,780	\$139,676	\$24,000		\$2,933,191	\$87,996	\$293,319	\$439,979	\$146,660	\$293,319	\$733,298		\$4,927,762	
4600-04	C	N IRVING AVE OUTFALL	\$2,544,627	\$132,300	\$257,760	\$291,522	\$164,610	\$66,000		\$3,456,819	\$103,705	\$345,682	\$518,523	\$172,841	\$345,682	\$864,205		\$5,807,457	
4600-04	D	S KENTON ST OUTFALL	\$1,068,149	\$88,200	\$171,840	\$177,328	\$75,676	\$8,000		\$1,589,193	\$47,676	\$158,919	\$238,379	\$79,460	\$158,919	\$397,298		\$2,669,844	\$14,854,512
4601-01	A	18 IN. UPGRADES	\$354,942	\$67,425	\$415,280	\$249,774	\$56,871	\$50,000		\$1,194,292	\$35,829	\$119,429	\$179,144	\$59,715	\$119,429	\$298,573		\$2,006,411	
4601-01	B	E ILIFF AVE IMPROVEMENTS	\$658,026	\$110,050	\$257,760	\$234,714	\$64,428	\$28,000		\$1,352,978	\$40,589	\$135,298	\$202,947	\$67,649	\$135,298	\$338,244		\$2,273,003	
4601-01	C	S MONACA PKWY IMPROVEMENTS	\$318,366	\$66,150	\$128,880	\$117,518	\$33,346	\$36,000		\$700,260	\$21,008	\$70,026	\$105,039	\$35,013	\$70,026	\$175,065		\$1,176,437	
4601-01	D	S TAMARAC DR IMPROVEMENTS	\$353,520	\$71,750	\$200,480	\$151,056	\$41,790	\$59,000		\$877,596	\$26,328	\$87,760	\$131,639	\$43,880	\$87,760	\$219,399		\$1,474,362	\$6,930,213
4700-01	A	N STUART ST OUTFALL	\$21,924	\$4,650	\$28,640	\$15,428	\$3,932	\$8,000		\$82,574	\$2,477	\$8,257	\$12,386	\$4,129	\$8,257	\$20,644		\$138,724	
4700-01	B	N WOLFE ST OUTFALL	\$25,866	\$4,650	\$28,640	\$18,202	\$4,468	\$12,000		\$93,826	\$2,815	\$9,383	\$14,074	\$4,691	\$9,383	\$23,456		\$157,628	
4700-01	C	W 15TH AVE IMPROVEMENTS	\$1,086,109	\$112,600	\$315,040	\$300,056	\$95,990	\$106,000		\$2,015,795	\$60,474	\$201,580	\$302,369	\$100,790	\$201,580	\$503,949		\$3,386,537	
4700-01	D	W COLFAX AVE IMPROVEMENTS	\$1,294,686	\$110,250	\$214,800	\$272,988	\$97,036	\$48,000		\$2,037,760	\$61,133	\$203,776	\$305,664	\$101,888	\$203,776	\$509,440		\$3,423,437	
4700-01	E	W LAKESHORE DR IMPROVEMENTS	\$181,872	\$31,925	\$171,840	\$109,840	\$25,974	\$24,000		\$545,451	\$16,364	\$54,545	\$81,818	\$27,273	\$54,545	\$136,363		\$916,359	\$8,022,68

STATEMENT OF PROBABLE COSTS IN 2003 DOLLARS

PROJECT			HARD COSTS								INDIRECT COSTS						TOTALS		
BASIN	ID	PROJECT	PIPE	MANHOLE	INLETS	ASPHALT PATCH	DRY UTILITY RELOCATE	WET UTILITY RELOCATE	DETENTION	TOTAL CONSTRUCTION COSTS	TRAFFIC CONTROL (3%)	MOBILIZATION (10%)	DESIGN & ENGINEERING (15%)	MATERIALS MANAGEMENT (5%)	ADMINISTRATIVE (10%)	CONTINGENCY (25%)	EASEMENT/ACQUISITION	TOTAL	TOTAL BY BASIN
5000-03	A	FLORIDA AVE. OUTFALL	\$6,452,826	\$351,050	\$874,440	\$1,082,461	\$441,720	\$73,632		\$9,276,129	\$278,284	\$927,613	\$1,391,419	\$463,806	\$927,613	\$2,319,032		\$15,583,896	
5000-03	B	SUB-BASIN 600 IMPROVEMENTS	\$138,834	\$20,500	\$69,400	\$23,218	\$13,848	\$25,000		\$290,800	\$8,724	\$29,080	\$43,620	\$14,540	\$29,080	\$72,700		\$488,544	
5000-03	C	SUB-BASIN 700 IMPROVEMENTS	\$52,920	\$20,300	\$0	\$37,240	\$5,523			\$115,983	\$3,479	\$11,598	\$17,397	\$5,799	\$11,598	\$28,996		\$194,850	\$16,267,290
5100-01	A	18 IN. UPGRADES	\$350,352	\$109,275	\$673,040	\$246,544	\$71,661	\$54,000		\$1,504,872	\$45,146	\$150,487	\$225,731	\$75,244	\$150,487	\$376,218		\$2,528,185	
5100-01	B	S CARLAN ST OUTFALL	\$387,432	\$58,250	\$200,480	\$171,912	\$43,704	\$56,000		\$917,778	\$27,533	\$91,778	\$137,667	\$45,889	\$91,778	\$229,444		\$1,541,867	
5100-01	C	S DECATUR ST OUTFALL	\$384,588	\$77,750	\$186,160	\$170,732	\$43,962	\$60,000		\$923,192	\$27,696	\$92,319	\$138,479	\$46,160	\$92,319	\$230,798		\$1,550,963	
5100-01	D	S FEDERAL BLVD OUTFALL	\$509,724	\$77,750	\$186,160	\$184,892	\$50,426	\$50,000		\$1,058,952	\$31,769	\$105,895	\$158,843	\$52,948	\$105,895	\$264,738		\$1,779,040	
5100-01	E	S NAVAJO ST OUTFALL	\$2,936,329	\$264,400	\$558,480	\$671,874	\$230,004	\$169,000		\$4,830,087	\$144,903	\$483,009	\$724,513	\$241,504	\$483,009	\$1,207,522		\$8,114,547	
5100-01	F	S QUITMAN ST IMPROVEMENTS	\$119,808	\$23,200	\$114,560	\$66,560	\$17,706	\$30,000		\$371,834	\$11,155	\$37,183	\$55,775	\$18,592	\$37,183	\$92,958		\$624,680	
5100-01	G	S TEJON ST OUTFALL	\$182,376	\$36,750	\$71,600	\$65,064	\$18,290	\$10,000		\$384,080	\$11,522	\$38,408	\$57,612	\$19,204	\$38,408	\$96,020		\$645,254	
5100-01	H	S TENNYSON ST IMPROVEMENTS	\$2,842,120	\$196,100	\$572,800	\$540,792	\$215,091	\$150,000		\$4,516,903	\$135,507	\$451,690	\$677,535	\$225,845	\$451,690	\$1,129,226		\$7,588,396	
5100-01	I	S UTIKA OUTFALL	\$847,467	\$64,400	\$186,160	\$190,570	\$66,430	\$40,000		\$1,395,027	\$41,851	\$139,503	\$209,254	\$69,751	\$139,503	\$348,757		\$2,343,646	
5100-01	J	S VRAIN ST OUTFALL	\$464,796	\$77,150	\$315,040	\$234,844	\$57,092	\$50,000		\$1,198,922	\$35,968	\$119,892	\$179,838	\$59,946	\$119,892	\$299,730		\$2,014,188	
5100-01	K	S XAVIER ST OUTFALL	\$183,924	\$36,550	\$114,560	\$90,964	\$22,800	\$30,000		\$478,798	\$14,364	\$47,880	\$71,820	\$23,940	\$47,880	\$119,700		\$804,382	
5100-01	L	W JEWELL AVE IMPROVEMENTS	\$1,092,348	\$227,475	\$472,560	\$374,412	\$115,740	\$148,000		\$2,430,535	\$72,916	\$243,054	\$364,580	\$121,527	\$243,054	\$607,634		\$4,083,300	
5100-01	M	W KENTUCKY AVE IMPROVEMENTS	\$777,528	\$132,300	\$257,760	\$278,776	\$76,118	\$76,000		\$1,598,482	\$47,954	\$159,848	\$239,772	\$79,924	\$159,848	\$399,620		\$2,685,448	\$36,303,896
5100-01 100 YEAR	A	100 YEAR SYSTEM	\$3,188,090	\$124,950	\$243,440	\$656,316	\$217,340	\$134,000		\$4,564,136	\$136,924	\$456,414	\$684,620	\$228,207	\$456,414	\$1,141,034		\$7,667,749	
5100-01 100 YEAR	B	S NAVAJO ST OUTFALL	\$3,759,097	\$161,700	\$315,040	\$584,446	\$248,164	\$143,000		\$5,211,447	\$156,343	\$521,145	\$781,717	\$260,572	\$521,145	\$1,302,862		\$8,755,231	
5100-01 100 YEAR	C	W ARIZONA AVE OUTFALL	\$1,182,104	\$36,750	\$71,600	\$180,992	\$75,772	\$44,000		\$1,591,218	\$47,737	\$159,122	\$238,683	\$79,561	\$159,122	\$397,804		\$2,673,247	\$19,096,227
5200-01 ALT1	A	ASBURY OUTFALL	\$3,369,234	\$163,150	\$343,680	\$241,390	\$208,773	\$58,000		\$4,384,227	\$131,527	\$438,423	\$657,634	\$219,211	\$438,423	\$1,096,057		\$7,365,502	
5200-01 ALT1	B	BROADWAY TRIBUTARY (S OF EVANS)	\$435,066	\$96,050	\$243,440	\$147,662	\$48,108	\$40,000		\$1,010,266	\$30,308	\$101,027	\$151,540	\$50,513	\$101,027	\$252,566		\$1,697,247	
5200-01 ALT1	C	BROADWAY TRIBUTARY (S OF HARVARD)	\$70,848	\$11,600	\$57,280	\$28,864	\$8,430			\$177,022	\$5,311	\$17,702	\$26,553	\$8,851	\$17,702	\$44,256		\$297,397	
5200-01 ALT1	D	BROADWAY TRIBUTARY (S OF ILIFF)	\$41,040	\$8,700	\$42,960	\$19,152	\$5,593			\$117,445	\$3,523	\$11,744	\$17,617	\$5,872	\$11,744	\$29,361		\$197,306	
5200-01 ALT1	E	BROADWAY TRIBUTARY (S OF WESLEY)	\$41,220	\$8,700	\$42,960	\$19,236	\$5,706	\$2,000		\$119,822	\$3,595	\$11,982	\$17,973	\$5,991	\$11,982	\$29,956		\$201,301	
5200-01 ALT1	F	DELAWARE TRIBUTARY (S OF EVANS)	\$212,004	\$53,500	\$143,200	\$78,468	\$25,159	\$16,000		\$528,331	\$15,850	\$52,833	\$79,250	\$26,417	\$52,833	\$132,083		\$887,597	
5200-01 ALT1	G	DELAWARE TRIBUTARY (S OF HARVARD)	\$140,472	\$45,500	\$114,560	\$57,208	\$18,487	\$12,000		\$388,227	\$11,647	\$38,823	\$58,234	\$19,411	\$38,823	\$97,057		\$652,222	
5200-01 ALT1	H	DELAWARE TRIBUTARY (S OF WESLEY)	\$38,070	\$8,700	\$42,960	\$17,766	\$5,475	\$2,000		\$114,971	\$3,449	\$11,497	\$17,246	\$5,749	\$11,497	\$28,743		\$193,152	
5200-01 ALT1	I	EVANS OUTFALL	\$1,078,956	\$66,150	\$128,880	\$76,036	\$69,001	\$30,000		\$1,449,023	\$43,471	\$144,902	\$217,353	\$72,451	\$144,902	\$362,256		\$2,434,358	
5200-01 ALT1	J	EVANS TRIBUTARY (EAST OF BROADWAY)	\$879,984	\$171,550	\$429,600	\$225,971	\$90,755	\$108,000		\$1,905,860	\$57,176	\$190,586	\$285,879	\$95,293	\$190,586	\$476,465		\$3,201,845	
5200-01 ALT1	K	GALAPAGO TRIBUTARY (S OF EVANS)	\$109,512	\$17,400	\$85,920	\$44,616	\$13,072	\$4,000		\$274,520	\$8,236	\$27,452	\$41,178	\$13,726	\$27,452	\$68,630		\$461,194	
5200-01 ALT1	L	GALAPAGO TRIBUTARY (S OF HARVARD)	\$245,160	\$8,700	\$42,960		\$14,841			\$311,661	\$9,350	\$31,166	\$46,749	\$15,583	\$31,166	\$77,915		\$523,590	
5200-01 ALT1	M	GALAPAGO TRIBUTARY (S OF WESLEY)	\$39,510	\$8,700	\$42,960	\$18,438	\$5,480			\$115,088	\$3,453	\$11,509	\$17,263	\$5,754	\$11,509	\$28,772		\$193,348	
5200-01 ALT1	N	SUPPLEMENTAL MAJOR CONDUIT IN HARVARD	\$8,828,610	\$53,700	\$100,240	\$310,720	\$467,064	\$48,000		\$9,808,334	\$294,250	\$980,833	\$1,471,250	\$490,417	\$980,833	\$2,452,084		\$16,478,001	
5200-01 ALT1	O	SUPPLEMENTAL MAJOR CONDUIT IN ILIFF	\$9,236,605	\$92,700	\$171,840	\$330,560	\$493,785	\$44,000		\$10,369,490	\$311,085	\$1,036,949	\$1,555,424	\$518,474	\$1,036,949	\$2,592,372		\$17,420,743	\$52,204,803
5200-01 ALT2	A	ASBURY OUTFALL	\$3,369,234	\$163,150	\$343,680	\$241,390	\$208,773	\$58,000		\$4,384,227	\$131,527	\$438,423	\$657,634	\$219,211	\$438,423	\$1,096,057		\$7,365,502	
5200-01 ALT2	B	BROADWAY TRIBUTARY (S OF EVANS)	\$539,244	\$116,550	\$300,720	\$192,044	\$59,428	\$40,000		\$1,247,986	\$37,440	\$124,799	\$187,198	\$62,399	\$124,799	\$311,996		\$2,096,617	
5200-01 ALT2	C	BROADWAY TRIBUTARY (S OF HARVARD)	\$70,848	\$11,600	\$57,280	\$28,864	\$8,430			\$177,022	\$5,311	\$17,702	\$26,553	\$8,851	\$17,702	\$44,256		\$297,397	
5200-01 ALT2	D	BROADWAY TRIBUTARY (S OF WESLEY)	\$41,220	\$8,700	\$42,960	\$19,236	\$5,706	\$2,000		\$119,822	\$3,595	\$11,982	\$17,973	\$5,991	\$11,982	\$29,956		\$201,301	
5200-01 ALT2	E	DELAWARE TRIBUTARY (S OF EVANS)	\$316,116	\$68,900	\$186,160	\$118,484	\$35,283	\$16,000		\$740,943	\$22,228	\$74,094	\$111,141	\$37,047	\$74,094	\$185,236		\$1,244,783	
5200-01 ALT2	F	DELAWARE TRIBUTARY (S OF HARVARD)	\$140,472	\$45,500	\$114,560	\$57,208	\$18,487	\$12,000		\$388,227	\$11,647	\$38,823	\$58,234	\$19,411	\$38,823	\$97,057		\$652,222	
5200-01 ALT2	G	DELAWARE TRIBUTARY (S OF WESLEY)	\$38,070	\$8,700	\$42,960	\$17,766	\$5,475	\$2,000		\$114,971	\$3,449	\$11,497	\$17,246	\$5,749	\$11,497	\$28,743		\$193,152	
5200-01 ALT2	H	EVANS OUTFALL	\$1,078,956	\$66,150	\$128,880	\$76,036	\$69,001	\$30,000		\$1,449,023	\$43,471	\$144,902	\$217,353	\$72,451	\$144,902	\$362,256		\$2,434,358	
5200-01 ALT2	I	EVANS TRIBUTARY (EAST OF BROADWAY)	\$879,984	\$180,450	\$429,600	\$225,971	\$91,200	\$108,000		\$1,915,205	\$57,456	\$191,520	\$287,281	\$95,760	\$191,520	\$478,801		\$3,217,543	
5200-01 ALT2	J	GALAPAGO TRIBUTARY (S OF EVANS)	\$141,264	\$20,300	\$100,240	\$57,552	\$16,168	\$4,000		\$339,524	\$10,186	\$33,952	\$50,929	\$16,976	\$33,952	\$84,881		\$570,400	
5200-01 ALT2	K	GALAPAGO TRIBUTARY (S OF HARVARD)	\$245,160	\$8,700	\$42,960		\$14,841			\$311,661	\$9,350	\$31,166	\$46,749	\$15,583	\$31,166	\$77,915		\$523,590	
5200-01 ALT2	L	GALAPAGO TRIBUTARY (S OF WESLEY)	\$39,510	\$8,700	\$42,960	\$18,438	\$5,480			\$115,088	\$3,453	\$11,509	\$17,263	\$5,754	\$11,509	\$28,772		\$193,348	
5200-01 ALT2	M	ROSEDALE PARK DETENTION	\$177,840	\$14,700	\$28,640	\$18,240	\$11,971		\$3,199,995	\$3,451,386	\$103,542	\$345,139	\$517,708	\$172,569	\$345,139	\$862,846		\$5,798,329	
5200-01 ALT2	N	SUPPLEMENTAL MAJOR CONDUIT IN HARVARD	\$8,445,000	\$61,050	\$114,560	\$274,560	\$447,058	\$46,000		\$9,388,228	\$281,647	\$938,823	\$1,408,234	\$469,411	\$938,823	\$2,347,057		\$15,772,223	\$40,560,765
5200-02	A	COLUMBINE OUTFALL	\$16,848	\$5,800	\$28,640	\$9,360	\$3,132	\$2,000		\$65,780	\$1,973	\$6,578	\$9,867	\$3,289	\$6,578	\$16,445		\$110,510	
5200-02	B	CORNELL TRIB (FLOWS TO ENGLEWOOD)	\$58,590	\$11,600	\$57,280	\$27,342	\$8,241	\$10,000		\$173,053	\$5,192	\$17,305	\$25,958	\$8,653	\$17,305	\$43,263		\$290,729	
5200-02	C	DARTMOUTH TRIB (FLOWS TO ENGLEWOOD)	\$46,350	\$8,700	\$42,960	\$21,630	\$5,982			\$125,622	\$3,769	\$12,562	\$18,843	\$6,281	\$12,562	\$31,406</			

STATEMENT OF PROBABLE COSTS IN 2003 DOLLARS

Table with columns: PROJECT (BASIN, ID, PROJECT), HARD COSTS (PIPE, MANHOLE, INLETS, ASPHALT PATCH, DRY UTILITY RELOCATE, WET UTILITY RELOCATE, DETENTION, TOTAL CONSTRUCTION COSTS), INDIRECT COSTS (TRAFFIC CONTROL, MOBILIZATION, DESIGN & ENGINEERING, MATERIALS MANAGEMENT, ADMINISTRATIVE, CONTINGENCY, EASEMENT/ACQUISITION), TOTALS (TOTAL, TOTAL BY BASIN). Rows list various projects like AMHERST OUTFALL, BIRCH OUTFALL, CLAYTON OUTFALL, etc.

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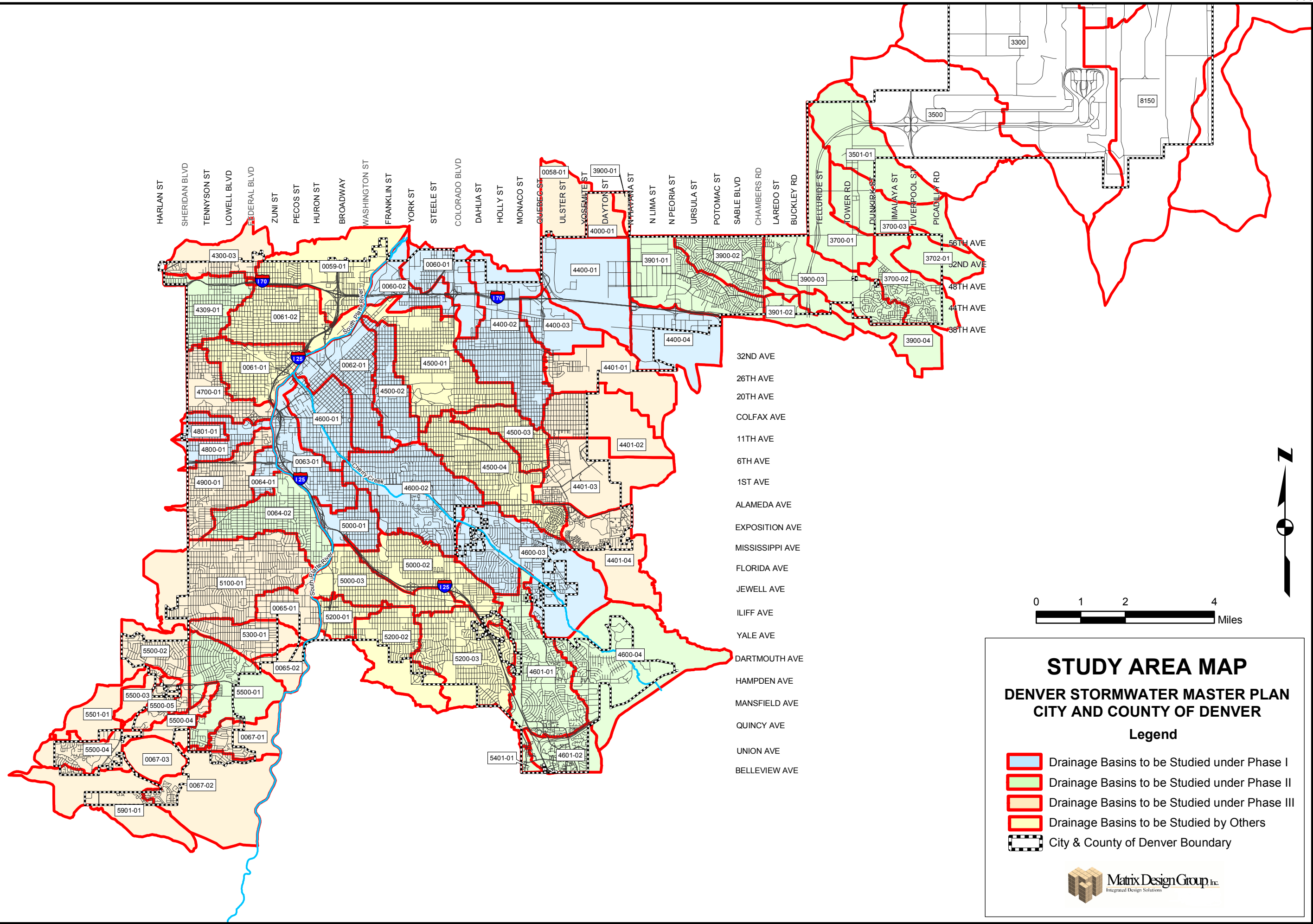
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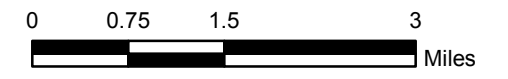
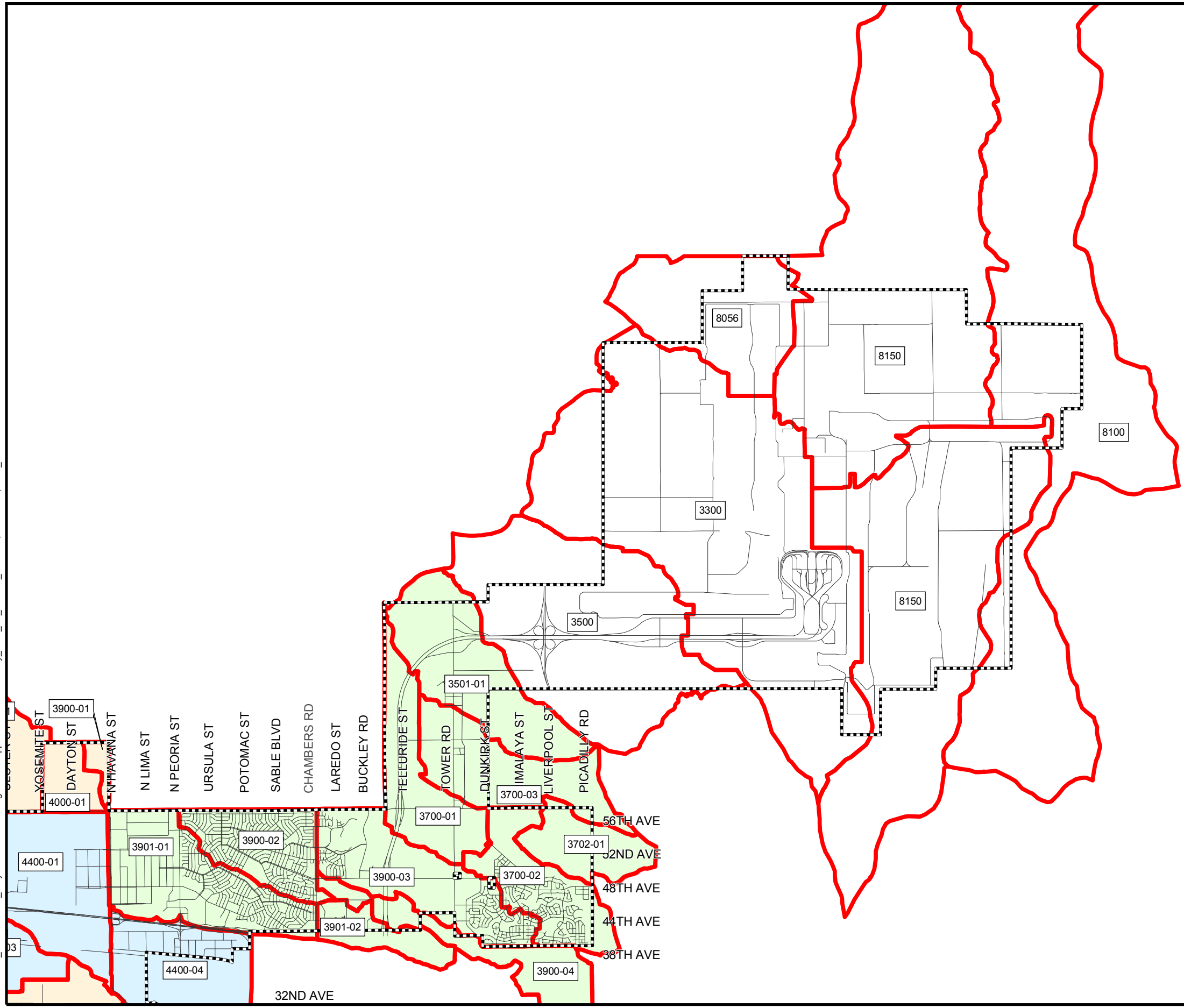
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### STUDY AREA MAP

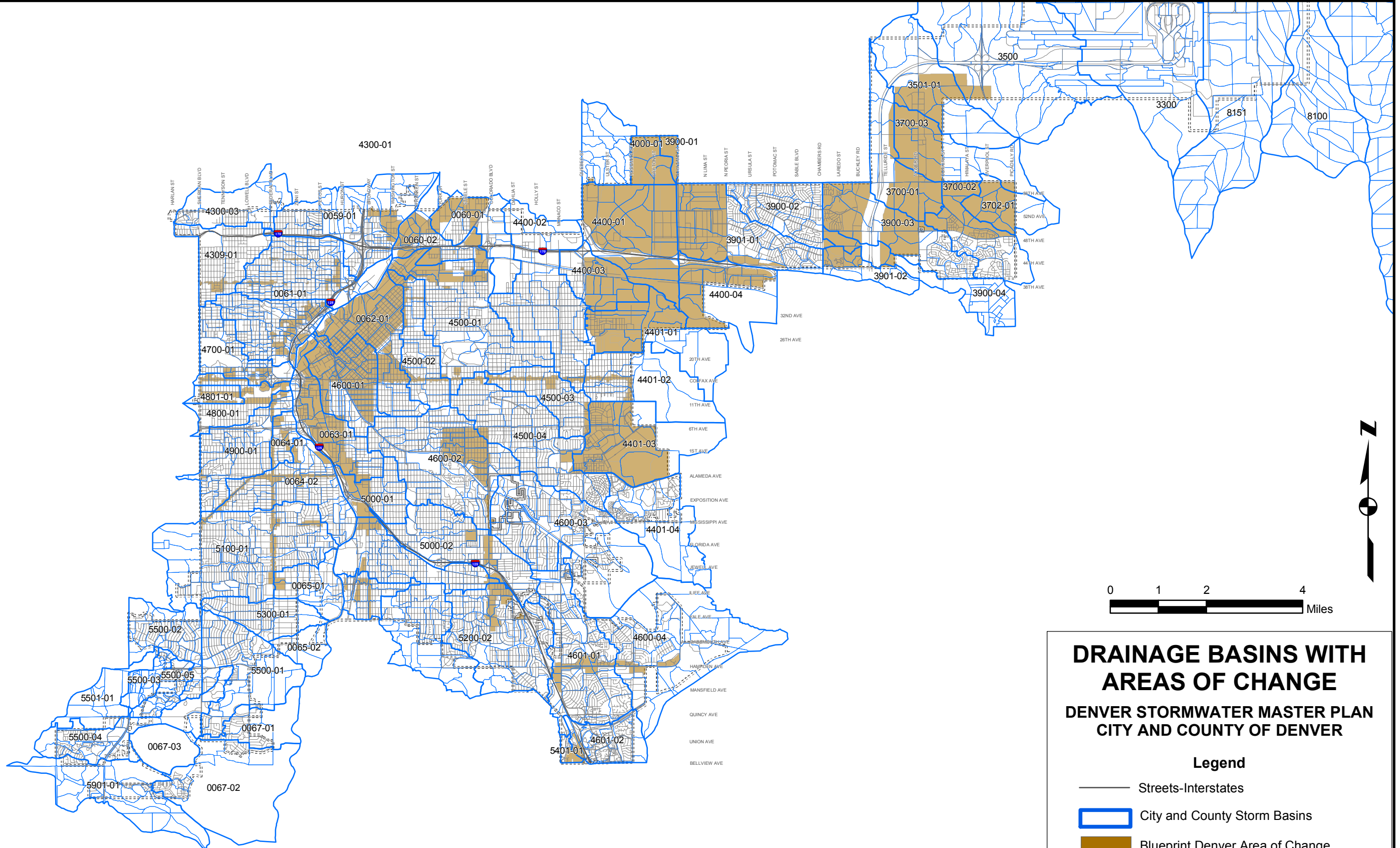
#### DENVER STORMWATER MASTER PLAN CITY AND COUNTY OF DENVER

**Legend**

- Drainage Basins to be Studied under Phase I
- Drainage Basins to be Studied under Phase II
- Drainage Basins to be Studied under Phase III
- Drainage Basins to be Studied by Others
- City & County of Denver Boundary



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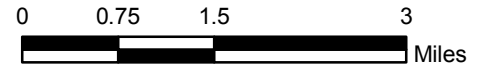
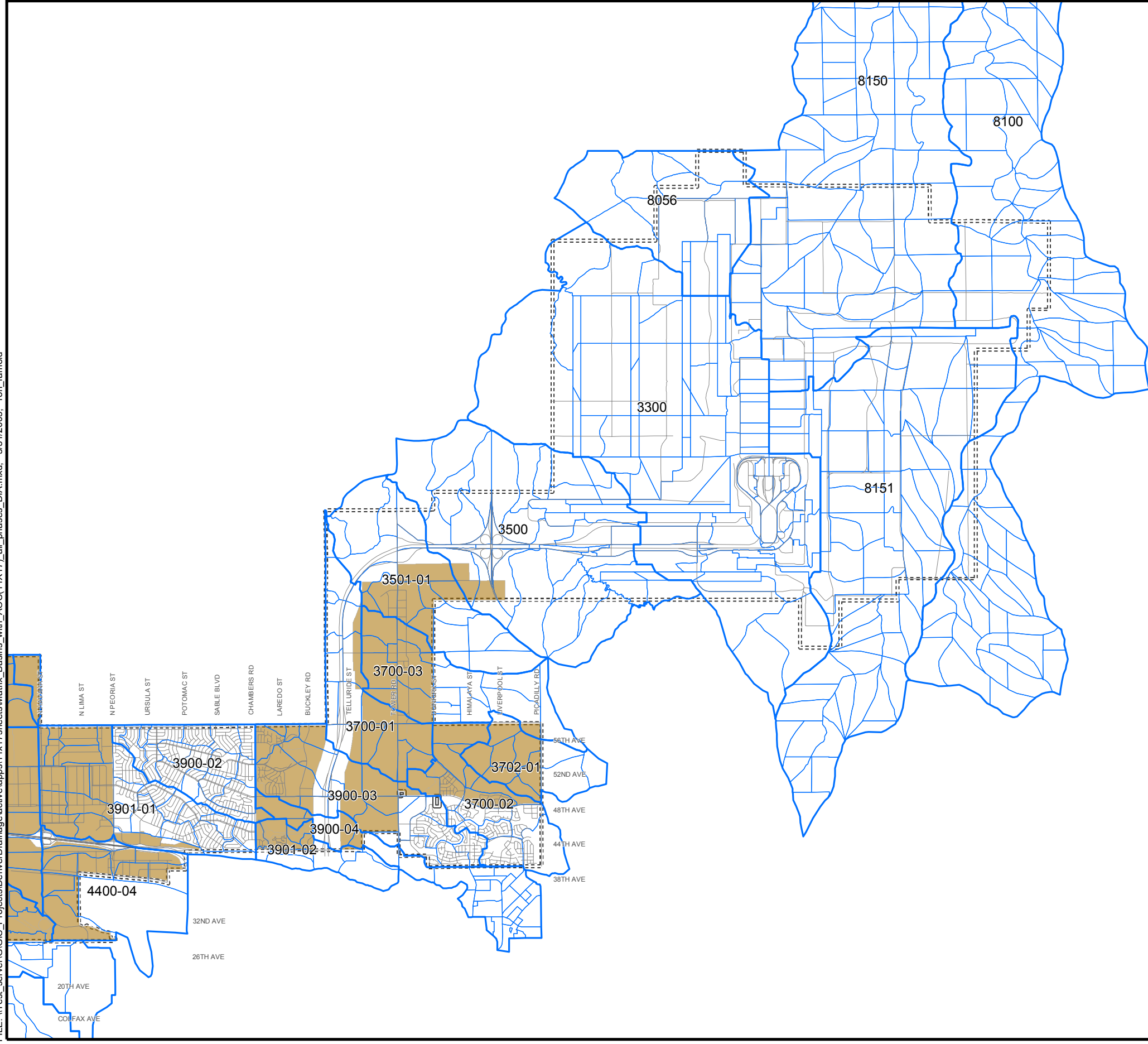
**DRAINAGE BASINS WITH AREAS OF CHANGE**  
**DENVER STORMWATER MASTER PLAN**  
**CITY AND COUNTY OF DENVER**

**Legend**

- Streets-Interstates
- City and County Storm Basins
- Blueprint Denver Area of Change



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**DRAINAGE BASINS WITH AREAS OF CHANGE - DIA**  
**DENVER STORMWATER MASTER PLAN**  
**CITY AND COUNTY OF DENVER**

**Legend**

-  Streets-Interstates
-  City and County Storm Basins
-  Blueprint Denver Area of Change

 **Matrix Design Group, Inc.**  
 Integrated Design Solutions

## Basin: 0058-01 (Prairie Gateway)

### Existing Basin Description:

This basin is a tributary to the South Platte River and is located in Denver and Adams Counties north of Stapleton. The basin consists of about 1,017 acres and is mostly undeveloped, except for Denver Water's Pump Station and the U.S. Postal Service's Bulk Mail Center located in the northeast corner of 56<sup>th</sup> Avenue and Quebec Street. Topography within the basin is characterized by generally flat terrain defined by alluvial and stabilized eolian sand deposits. The landscape is scattered with natural depressions which capture, store, and encourage infiltration of stormwater runoff.

The basin was loosely defined in the 1989 Master Plan and included a portion of north Stapleton (south of 56<sup>th</sup>), as well as the Postal Facility and Adams County (north of 56<sup>th</sup>). Basin 4400-01 includes all area south of 56<sup>th</sup> Avenue in accordance with the approved Drainage Master Plan for the Stapleton Redevelopment site, dated March 2001. Therefore, the remainder of this basin lies north of 56<sup>th</sup> Avenue.

Although most of the land in this basin is within Adams County, it is included in this Denver study for the approximately 70-acre Denver Water Pump Station and Postal Facility. The surrounding area was previously part of the Rocky Mountain Arsenal, but has been cleaned and transferred to the U.S. Fish and Wildlife Service, which in-turn has transferred the land to Commerce City. This land is known as the "Prairie Gateway."

The site was studied in detail by the Urban Drainage & Flood Control District, Adams County and Commerce City in a report titled, "*Prairie Gateway Outfall Systems Planning Alternative Evaluation Report*," dated August 2002. The report concluded that the 100-year storm could be retained on the site rather than upsizing the storm sewer outfalls through Commerce City to the South Platte River. There are many existing natural depressions on the site that can contain the 100-year rainfall event. In addition, the US Postal Facility contains existing 100-year retention ponds. The Prairie Gateway report identifies the maximum available storage as 10.7 acre-feet for the 30-acre parking lot, and 29.6 acre-feet for the 31.7-acre Bulk Mail Facility.

### Identified Drainage Problems/Deficiencies:

The undeveloped portion (Commerce City) of the site can retain the 100-year event in natural depressions. The developed portion (Denver) of the site includes 100-year capacity retention ponds.

In general, there are no trunk storm pipes within this basin. The storm pipes west of Quebec that could convey site runoff directly to the South Platte River through Commerce City are relatively small, and reportedly were built in the 1970's and can only convey less than the 2-year event.

### Potential Improvements:

100-year retention facilities will be constructed commensurate with development for this basin, or will utilize existing natural depression storage along with forebay water quality ponds to preserve the infiltration capacity of the depressions. Upsizing outfalls through Commerce City to the South Platte River have been determined to be infeasible.

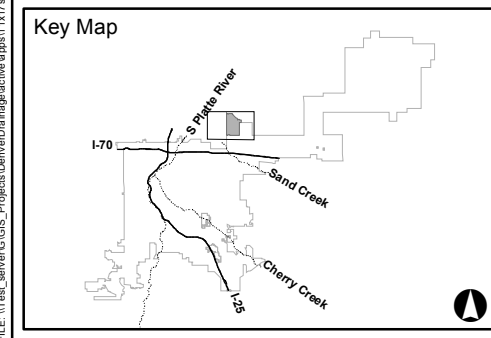
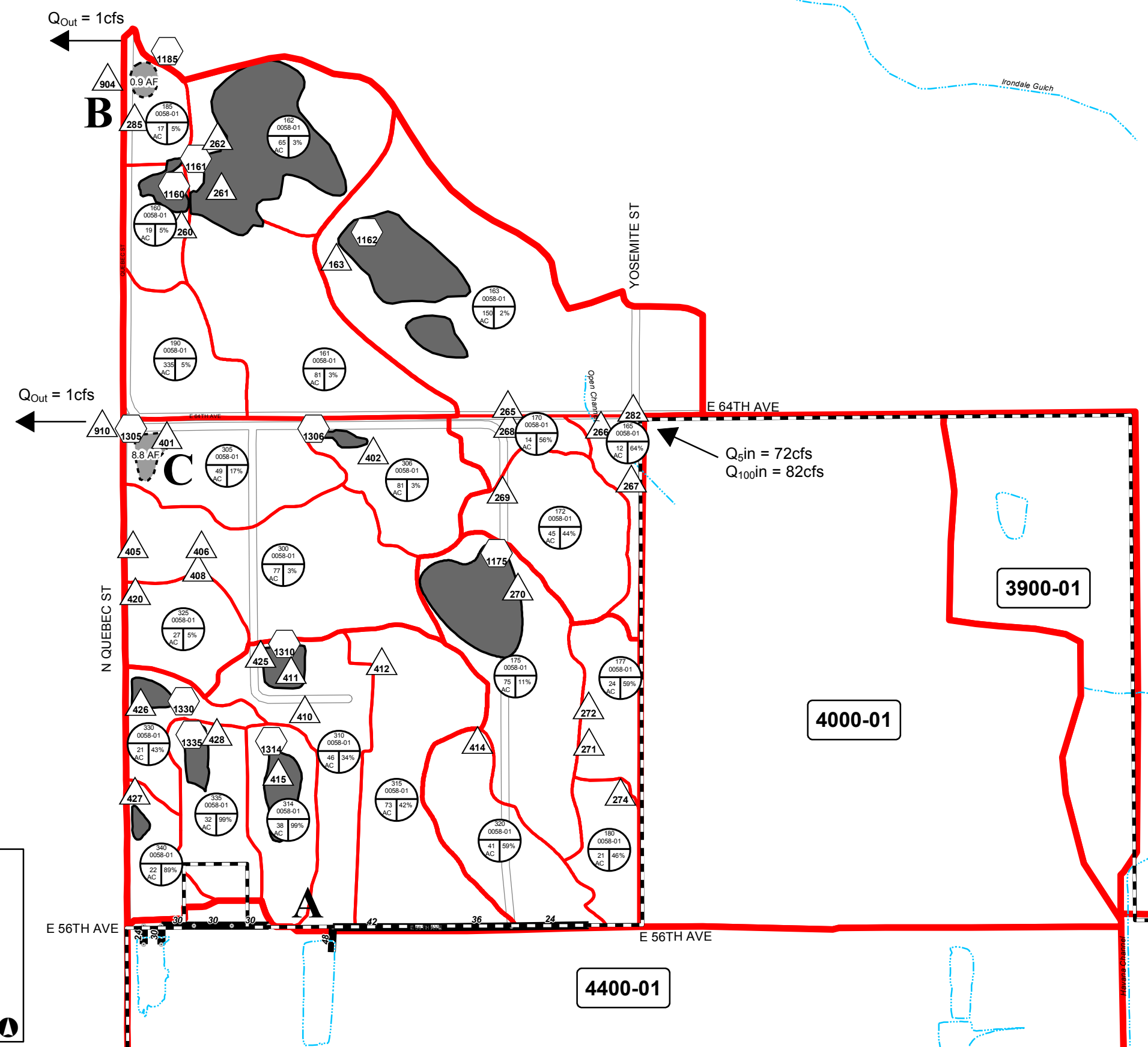
With the redevelopment of the Prairie Gateway site for the Kroenke Sports Soccer Stadium, Quebec Street and 56<sup>th</sup> Avenue will be reconstructed. This will improve the land values at the 56<sup>th</sup> & Quebec intersection where a retention pond is located which is currently primarily serving a Denver Maintenance Facility. About half of the Denver Water Pump Station site north of 56<sup>th</sup> drains to this retention pond in the southeast corner of the intersection. Either the Denver Water site can continue to drain to this pond also, or alternatively, a new retention pond could be constructed to the east of the existing Maintenance Facility.

### Developed Conditions Hydrology:

#### BASIN 0058-01

Design Point	Tributary Area (acres)	Peak Discharge		
		2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
163	150.5	28	45	186
260	19.1	1	1	15
261	80.8	1	1	32
262	449.8	1	1	13
265	234.0	50	81	223
266	12.0	8	13	49
267	na	8	11	29
268	222.0	42	68	175
269	208.0	31	49	124
270	162.6	42	67	221
271	45.5	35	56	145
272	24.3	28	42	97
274	21.2	15	24	63
285	600.3	0	1	12
401	49.4	7	11	39
402	36.4	0	1	23
405	336.7	3	4	61
406	76.9	1	2	42
408	232.8	0	0	0
410	45.6	7	11	47
411	118.7	29	46	151
412	73.1	26	41	116
414	41.9	24	38	99
415	38.4	61	99	209
420	27.0	2	3	21
425	114.1	47	85	224
426	43.7	33	54	137
427	22.5	21	33	89
428	70.4	49	77	169
904	600.3	0	0	0
910	386.1	0	0	0
1160	52.6	0	0	0
1161	583.2	0	0	0
1162	384.5	0	0	0
1175	162.6	0	0	0
1185	600.3	0	0	0
1305	386.1	0	0	0
1306	36.4	0	0	21
1310	232.8	0	0	0
1314	38.4	14	20	46
1330	43.7	0	33	119

Proposed Projects	
A	E 56th Ave Improvements
B	Prairie Gateway Detention - 01
C	Prairie Gateway Detention - 02



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0058-01 (Prairie Gateway)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

**Matrix Design Group, Inc.**  
Integrated Design Solutions

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## Basin 0059-01 (Globeville -Utah Junction)

### Existing System Description:

This basin consists of 2420 acres (3.78 square miles) and is mostly built-out. I – 25 traverses the middle of the basin and I – 70 traverses the southern portion of the basin. The I – 25/I – 70 interchange is within this basin. *Blueprint Denver* shows much of the industrial area northeast of the I – 25/I – 70 interchange as “Areas of Change.” Approximately the northern third of the basin is within Adams County.

The basin drainage is predominately west to east, with eight major outfalls to the South Platte River. A ninth outfall exists at 58<sup>th</sup> Avenue, in Adams County. Rennick railroad yard, west of I – 25, intercepts a significant amount of the basin drainage from the west and diverts the discharge to the south. I – 25 also is a barrier to the runoff due to the limited crossing capacity and elevated design. The outfall systems south of approximately 47<sup>th</sup> Avenue have capacity for the major storm (not including the railroad yard diversion). The capacities of the outfall systems north of approximately 47<sup>th</sup> Avenue vary from less than the 5-year flood event to approximately a 25-year event.

Constraints to drainage infrastructure in this basin include:

- Crossing the railroad yards west of I – 25
- Crossing I – 25
- Multiple large Metro sewers just west of the South Platte River
- The South Platte River west bank levee

### Drainage Deficiencies:

The existing drainage system has limited capacity at several locations north of approximately 47<sup>th</sup> Avenue, at I – 25, and at the South Platte River levee. The interior drainage system between 47<sup>th</sup> Avenue and the Corporate Limit to the north is less than a 5-year capacity. The lack of capacity of the outfall system through the levee to the South Platte River results in the accumulation of runoff landward of the levee.

### Potential Ponding Areas:

I – 25 creates a ponding area at West 52<sup>nd</sup> Avenue and Bannock Street. The BNSF Railroad creates ponding areas at approximately Logan Street and East 49<sup>th</sup> Avenue, and also north of East 51<sup>st</sup> Avenue. The overland flow landward of the South Platte River levee accumulates at Heron Pond, which has approximately a 25-year capacity to the River prior to overtopping.

### Proposed Capital Improvements:

The following drainage improvements have been proposed to increase the level of service to a minimum of 5-year capacity and increase the capacity through the South Platte River levee. Increasing the capacity through the levee will reduce the flooding landward of the levee.

Project A: East 47<sup>th</sup> Avenue Inlets at Logan Street (Outfall 400) involves adding additional inlets to the existing outfall to assure optimization of the system.

Project B: East 48<sup>th</sup> Avenue Outfall (Outfall 500/600) includes a new 48” RCP and a new 98” by 63” HERCP from the railroad spur to the South Platte River along the north side of the BNSF Railroad, a box culvert beneath the railroad spur for the major storm, and increased detention storage west of the railroad spur between Argo Park and East 49<sup>th</sup> Avenue. The new 98” by 63” HERCP will replace an existing 87” by 63” CMP. The new 48” RCP will drain the low flows from the increased detention. The box culvert will convey the 100-year flood beneath the railroad spur without inundating the homes currently within the floodplain west of the spur.

Project C: Heron Pond Expansion and Outfall (Outfall 700) includes expanding the existing pond and replacing an existing 48” RCP outfall with a box culvert to Franklin Street, and adding an additional 48” RCP from Franklin Street to the South Platte River. Additionally, permanent easements are needed for existing detention ponds on railroad property at approximately East 52<sup>nd</sup> Avenue, just east of Logan Street.

Project D: West 52<sup>nd</sup> Avenue and Pecos Street Storm Sewer (Outfall 1000) includes upsizing a portion of the existing storm sewer, adding inlets, and replacing existing inlets and storm sewer pipe from West 52<sup>nd</sup> Avenue and Pecos Street to West 51<sup>st</sup> Avenue and Pecos Street.

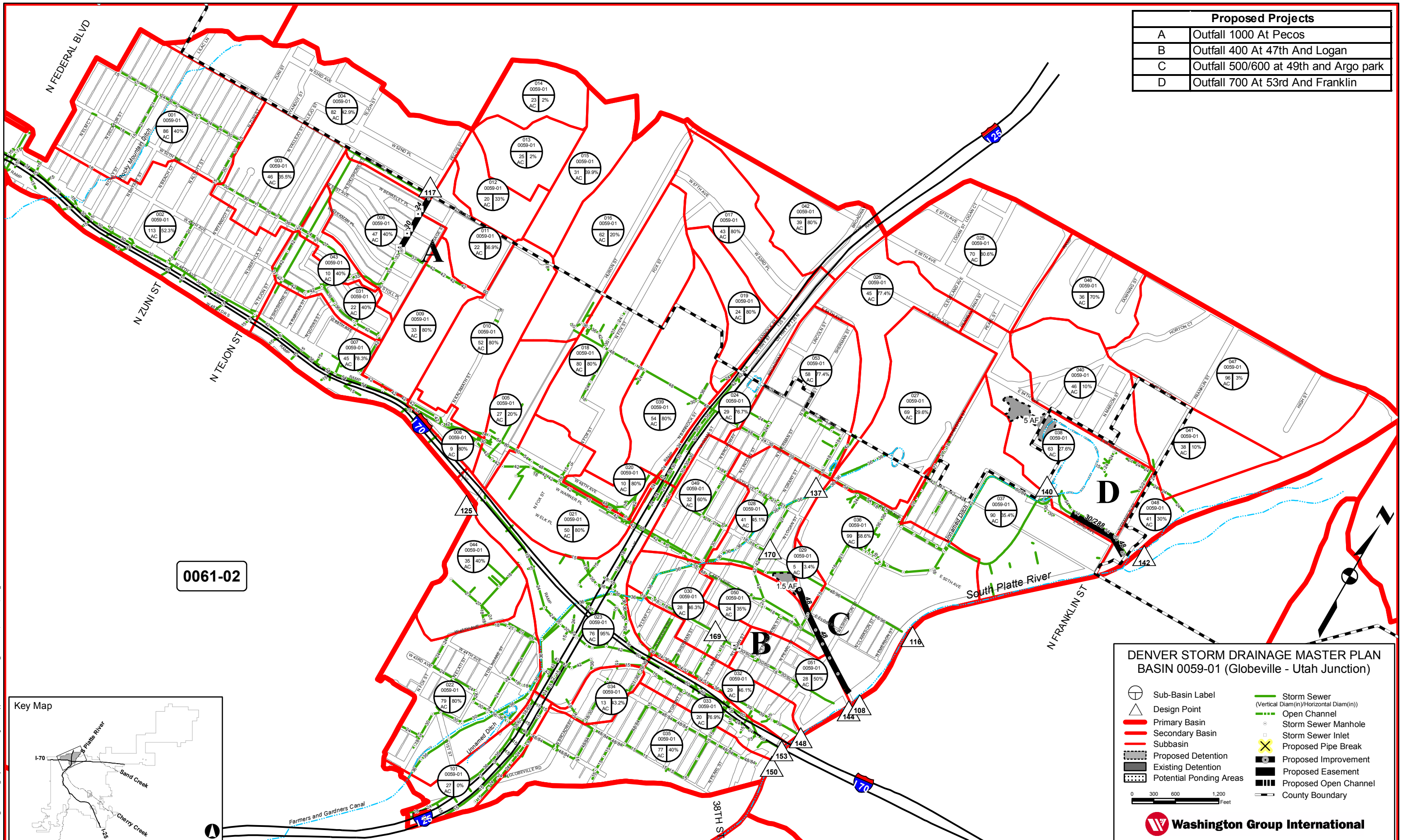
### Hydrology:

The following table summarizes existing conditions hydrology:

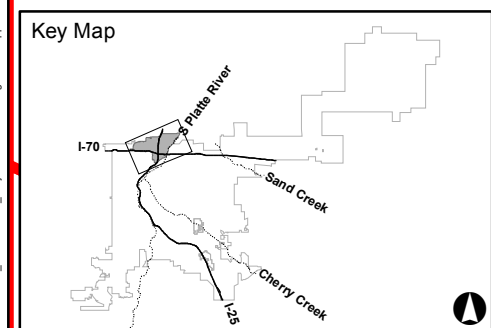
### BASIN 0059-01

Design Point	Contributing Basins	Tributary Area  (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
150	22, 35, 44	198	49	74	204
153	23, 33	93	81	107	152
148	32, 34	43	18	35	93
169	30	30	16	31	88
144	30, 51	57	29	55	134
170	1-3, 7-8, 20-21, 28, 31, 49	466	24	47	308
108	1-3, 7-8, 20-21, 28, 31, 49, 50	492	102	115	115
116	1-3, 7-8, 20-21, 28-29, 31, 49	474	70	72	79
137	14-15, 17-19, 24, 26, 39, 42, 53	459	161	193	201
140	14-15, 17-19, 24, 26-27, 36-39, 42, 53	772	180	278	827
142	14-15, 17-19, 24-27, 36-39, 42, 53	845	43	68	122
117	4	87	16	52	196
125	1, 3-6, 8-13, 16, 31, 43	579	93	182	615

Proposed Projects	
A	Outfall 1000 At Pecos
B	Outfall 400 At 47th And Logan
C	Outfall 500/600 at 49th and Argo park
D	Outfall 700 At 53rd And Franklin



0061-02



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0059-01 (Globeville - Utah Junction)**

Sub-Basin Label	Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
Design Point	Open Channel
Primary Basin	Storm Sewer Manhole
Secondary Basin	Storm Sewer Inlet
Subbasin	Proposed Pipe Break
Proposed Detention	Proposed Improvement
Existing Detention	Proposed Easement
Potential Ponding Areas	Proposed Open Channel
	County Boundary

0 300 600 1,200 Feet

**Washington Group International**

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## Basin 0060-01 (I-70 & Colorado Boulevard)

### Existing System Description:

This basin includes a mix of industrial and residential land uses, and consists of 1,745 acres (2.73 square miles). It is fully built-out with older neighborhood residential in the upper reaches and commercial in the lower reaches. *Blueprint Denver* shows the region downstream (northwest) of Vasquez Boulevard as an “Area of Change”. The upper reaches of Basin 0060-01 are shown as “Areas of Stability”. All drainage from this basin outfalls to the South Platte River.

### Drainage Deficiencies:

The existing drainage system has capacity to convey less than the 1-year storm event to the outfall. Rainfall runoff in excess of the storm drain capacity has a history of ponding in the sump and flat areas. Major drainage problems have been experienced along the Smith Road corridor and along Vasquez Boulevard near Sand Creek. Specific drainage deficiencies include:

- The existing Union Pacific Railroad (UPRR) right-of-way creates a major barrier for surface flow and causes broad flooding of the Swansea Park area.
- Improved conveyance (storm sewer) is needed in York Street above Brighton Boulevard and in the industrial zones above Vasquez Boulevard.

### Potential Ponding Areas:

An extensive area of potential ponding has been identified within Basins 0060-01 and 4400-02, related primarily to ponding behind railroad tracks, I-70, and other sumps in the lower portions of each basin. A total of 716 structures with a structure value (excluding land value) of \$120.6M (per 2003 Denver Assessors’ records) lie within the 501-acre zone most severely impacted by the flooding. Annualized flood damage costs are estimated to be \$1.3M and \$2.1M for 5-year and 100-year return periods, respectively.

### Proposed Capital Improvements:

Drainage improvements in these basins should be viewed primarily to achieve the minimum performance objectives for residential and commercial areas (2- and 5-year system capacities) established for the Denver stormwater program, primarily due to the high cost of retrofitting new storm sewer in existing streets.

Proposed capital improvements include:

- Construction of storm sewers in local roads shown to improve interception of minor storm event runoff and conveyance within neighborhoods.
- Construction of storm sewers in East 54<sup>th</sup> Avenue, York Street and Columbine Street from the UPRR right-of-way to Brighton Boulevard
- Installation of an outfall sewer within Brighton Boulevard and the Riverside Cemetery to the South Platte River
- Installation of storm sewers within York Street and Columbine Street.
- Installation of channels or storm sewers along Vasquez Boulevard, East 46<sup>th</sup> Avenue, and North Monroe Street.

Although these basins have generally not been identified by *Blueprint Denver* as areas of significant change, corridor studies are now being initiated for this segment of I-70 that will evaluate the need for highway and commuter rail improvements, and identify related transit-oriented development (TOD) opportunities within Basins 0060-01 and 0044-02. Re-development of land within these basins would generally require a 100-year drainage system and improvement of highway and rail drainage facilities for a 50-year conveyance system. It is assumed that additional locations for stormwater detention or related conveyance improvements would be planned and constructed as part of the improvement programs associated with any enhanced land use.

### Alternatives Analysis for Combined Capital Improvements for Basins 0060-01 & 4400-02:

Stormwater improvements for Basins 0060-01 and 4400-02 are linked because of the “split flow condition” (from Basin 4400 to 0060) that exists along Smith Road and availability of storage volume in Basin 0060-01. Three alternatives have been evaluated that combine improvements for these basins as described below.

**Alternative 1 (Direct Conveyance):** Construction of a storm sewer to divert flows from Basin 4400-02 to 0060-01 is proposed to minimize the size of downstream conveyance facilities within Basin 4400-02. This would require installation of a storm sewer along North Eudora Street and Elm Street to intercept and route runoff to a new system crossing Smith Road and I-70.

An outfall sewer would be constructed within Dahlia Street from Smith Road to 48<sup>th</sup> Avenue, and along 48<sup>th</sup> Avenue to Colorado Boulevard. A parallel sewer would be constructed along Colorado Boulevard, 50<sup>th</sup> Avenue, and Vasquez Boulevard to augment the capacity of recently installed storm sewers. A separate system would be constructed from 52<sup>nd</sup> Avenue to Cook Street to 54<sup>th</sup> Avenue for an outfall to Sand Creek.

**Alternative 2 (Limited Detention):** Alternative 2 would incorporate additional detention within Basin 0060-01 to minimize the cost of outfall system construction. Vacant property at the southeast corner of 48<sup>th</sup> Avenue & Colorado Boulevard would be acquired to enable construction of a 9 acre-foot detention facility. This would attenuate discharges and result in the elimination of improvements from 48<sup>th</sup> Avenue and 53<sup>rd</sup> Avenue and significant reduction in storm sewer sizes from 53<sup>rd</sup> Avenue to Sand Creek (as described in Alternative 1 above.)

In order to minimize the size of downstream conveyance facilities, a diversion structure would be installed at Smith Road and Dahlia Street to provide for off-line, peak flow attenuation within an existing sump area at the Park Hill Golf Course. The sump would be excavated, re-vegetated, and integrated within to golf course layout to provide 18 acre-feet of flood storage.

**Alternative 3 (Detention):** This alternative maintains the improvements described in Alternative 2 above and links with the expansion of detention volumes within the Park Hill Golf Course to 71 acre-feet to enable the downsizing of outfall systems within Basin 4400-02. This would fully utilize recently installed infrastructure, and obviate the need for additional improvements from 50<sup>th</sup> Avenue to Sand Creek within the 4400-02 basin.

### Cost Analysis (Basins 0060-01 and 4400-02 Combined):

Costs for Alternatives 1, 2, and 3 are shown below. These costs include the combined system improvements for Basins 0060-01 and 4400-02 because of the divided flow hydrologic conditions and joint use of detention within the Park Hill Golf Course (which is within Basin 0006-01 and provides benefits to Basin 4400-02.)

<u>Alternative</u>	<u>Construction Costs</u>
1	\$93.0M
2	\$88.0M
3	\$79.3M

### Economic Analysis:

Alternative 3 (Detention) represents the **least cost solution** for the combined improvement program for Basins 0060-01 and 4400-02. Therefore, it is recommended that further discussions with the operators of the Park Hill Golf Course, Denver Police Department, Dahlia Square and Denver Department of Asset occur to pursue regional detention facilities in these basins.



**Existing Hydrology:**

**BASIN 0060-01 EXISTING CONDITIONS**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
311	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,310,500	2324	160	661	3771
321	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,310,320,500	2426	169	246	1973
330	330	31	44	65	134
341	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,310,320,330,340,500	2525	283	414	2092
351	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,500	2645	407	610	2197
371	370	84	107	161	351
381	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,310,380,500,510,520,530	2887	239	629	2409
391	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,390,500	2839	581	802	2339
411	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,390,410,500	2894	550	786	2296
431	420,430	166	130	218	555

**BASIN 0060-01 ALTERNATIVE 2**

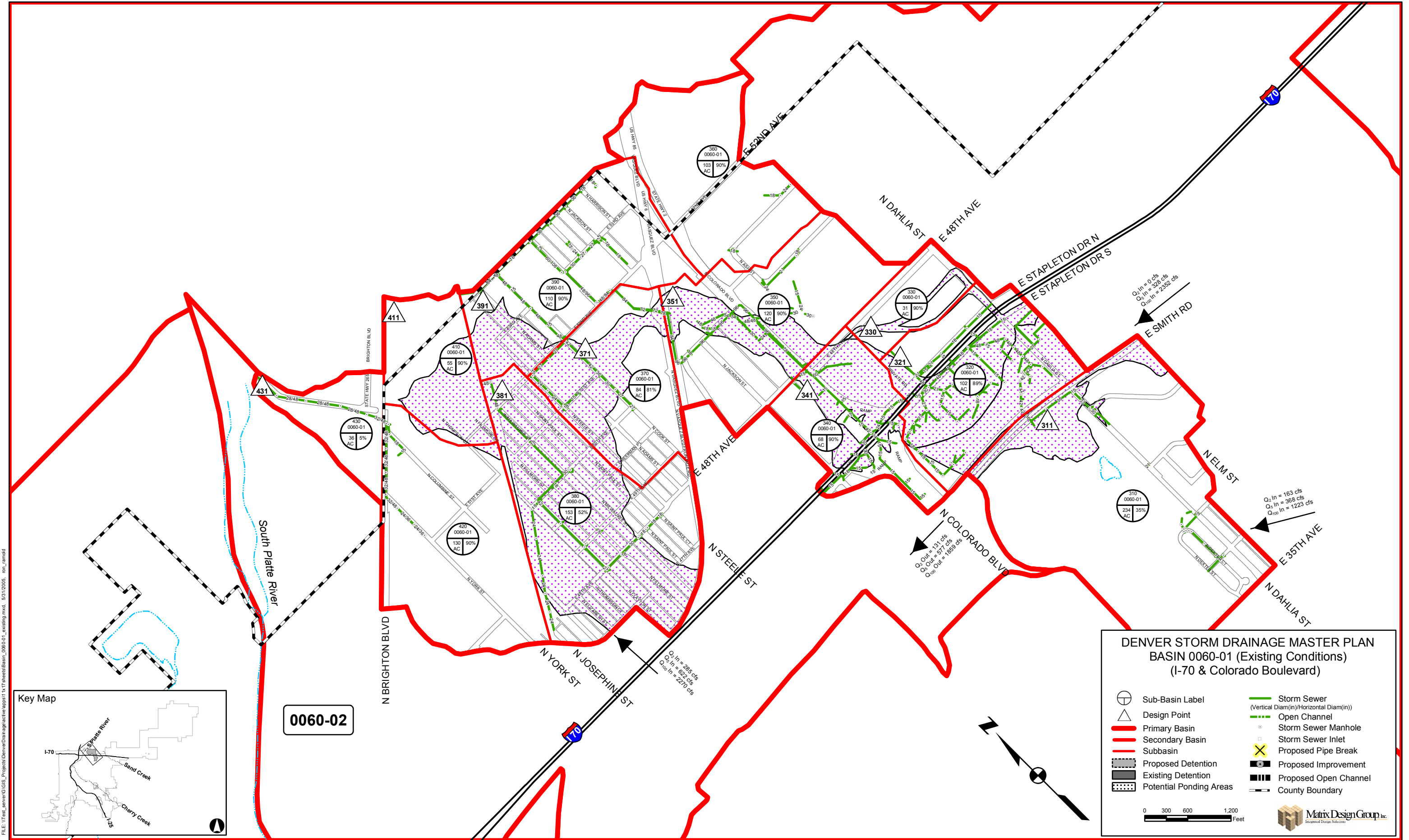
Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
310	90,100,130,135,310,500	759	246	471	1454
320	10,20,30,50,60,70,75,80,110,120,150,160,320	1609	169	246	509
330	90,100,130,135,310,330,500	790	213	250	370
342	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,500	2467	273	310	777
350	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,500	2587	320	433	1015
360	360	103	170	248	509
370	370	84	107	161	351
375	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,500	2671	359	556	1221
380	10,20,30,50,60,70,75,80,110,120,150,160,380,510,520,530	2070	90	163	1050
390	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,390,500	2781	492	708	1560
410	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,390,410,500	2836	462	708	1618
420	420	130	203	295	607
430	420,430	166	130	218	555

**BASIN 0060-01 ALTERNATIVE 1**

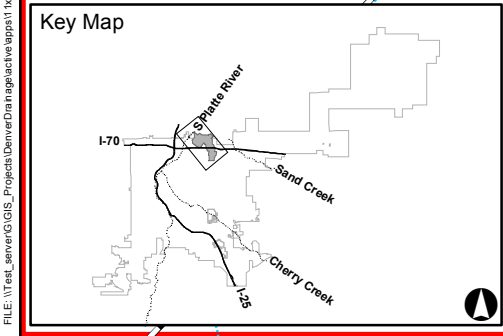
Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
310	90,100,130,135,310,500	759	246	471	1454
320	10,20,30,50,60,70,75,80,110,120,150,160,320	1609	169	246	509
330	90,100,130,135,310,330,500	790	252	475	658
340	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,500	2467	348	602	1357
350	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,500	2587	462	737	1605
360	360	103	170	248	509
370	370	84	107	161	351
375	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,500	2671	538	809	1788
380	10,20,30,50,60,70,75,80,110,120,150,160,380,510,520,530	2070	90	163	1081
390	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,390,500	2781	635	921	2141
410	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,390,410,500	2836	610	923	2149
420	420	130	203	295	607
430	420,430	166	130	218	555

**BASIN 0060-01 ALTERNATIVE 3**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
311	10,20,30,50,80,90,100,120,130,135,150,310,500	1669	193	260	1686
320	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,500	2368	169	246	851
330	10,20,30,50,80,90,100,120,130,135,150,310,330,500	1700	194	262	327
342	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,500	2467	245	334	1212
350	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,500	2587	266	361	1141
360	360	103	170	248	509
370	370	84	107	161	351
375	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,500	2671	332	482	1137
380	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,380,500,510,520,530	2829	90	163	1294
390	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,375,500	2781	487	696	1463
410	10,20,30,50,60,70,75,80,90,100,110,120,130,135,150,160,310,320,330,340,350,370,375,410,500	2836	429	649	1536
420	420	130	203	295	607
430	420,430	166	130	218	555



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0060-02

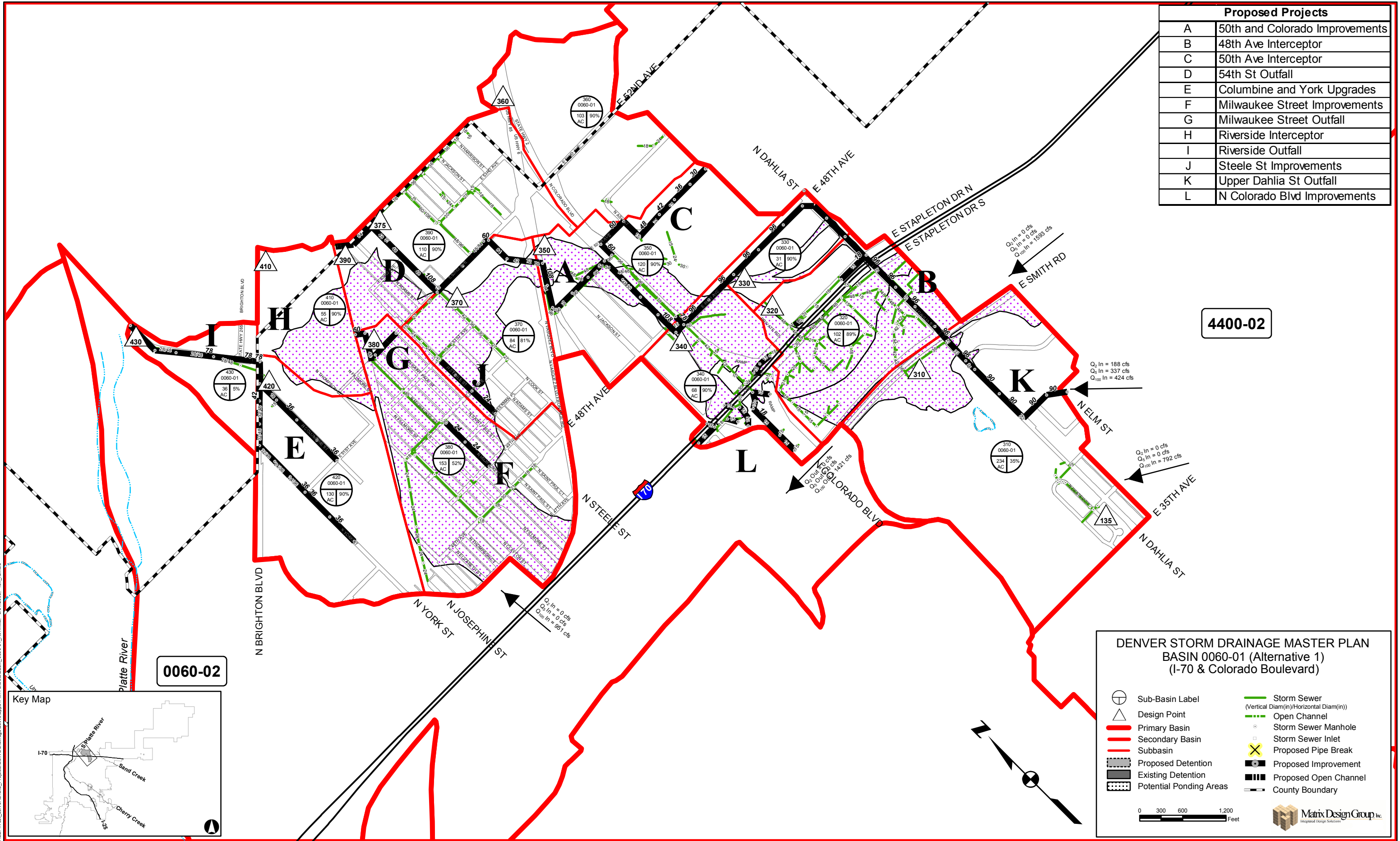
**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0060-01 (Existing Conditions)  
(I-70 & Colorado Boulevard)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

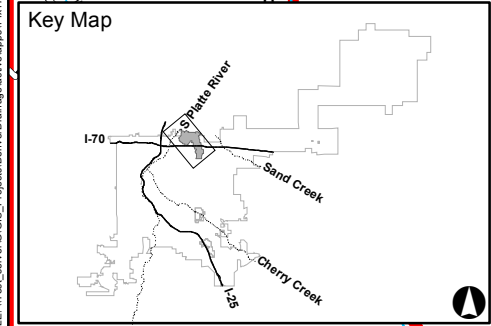
Matrix Design Group, Inc.  
Innovative Design Solutions

Proposed Projects	
A	50th and Colorado Improvements
B	48th Ave Interceptor
C	50th Ave Interceptor
D	54th St Outfall
E	Columbine and York Upgrades
F	Milwaukee Street Improvements
G	Milwaukee Street Outfall
H	Riverside Interceptor
I	Riverside Outfall
J	Steele St Improvements
K	Upper Dahlia St Outfall
L	N Colorado Blvd Improvements



4400-02

0060-02



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0060-01 (Alternative 1)  
(I-70 & Colorado Boulevard)**

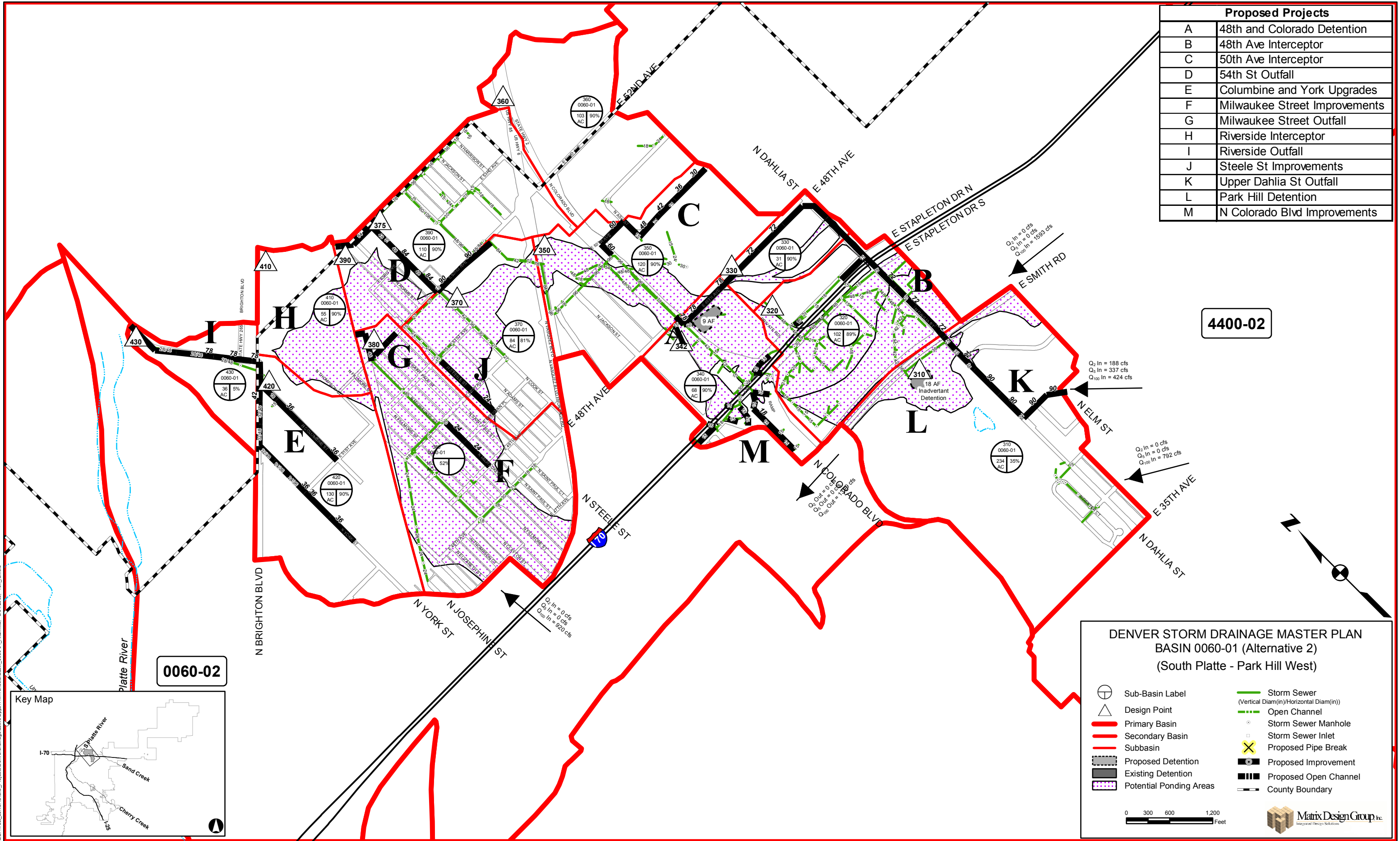
	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Integrated Design Solutions

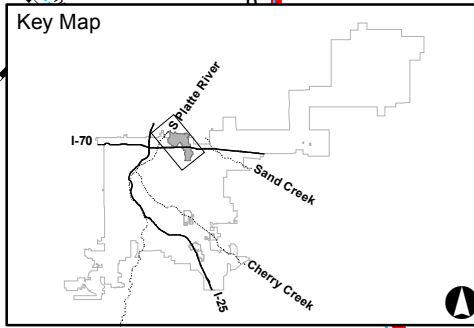
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Proposed Projects	
A	48th and Colorado Detention
B	48th Ave Interceptor
C	50th Ave Interceptor
D	54th St Outfall
E	Columbine and York Upgrades
F	Milwaukee Street Improvements
G	Milwaukee Street Outfall
H	Riverside Interceptor
I	Riverside Outfall
J	Steele St Improvements
K	Upper Dahlia St Outfall
L	Park Hill Detention
M	N Colorado Blvd Improvements



4400-02

0060-02



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0060-01 (Alternative 2)  
(South Platte - Park Hill West)**

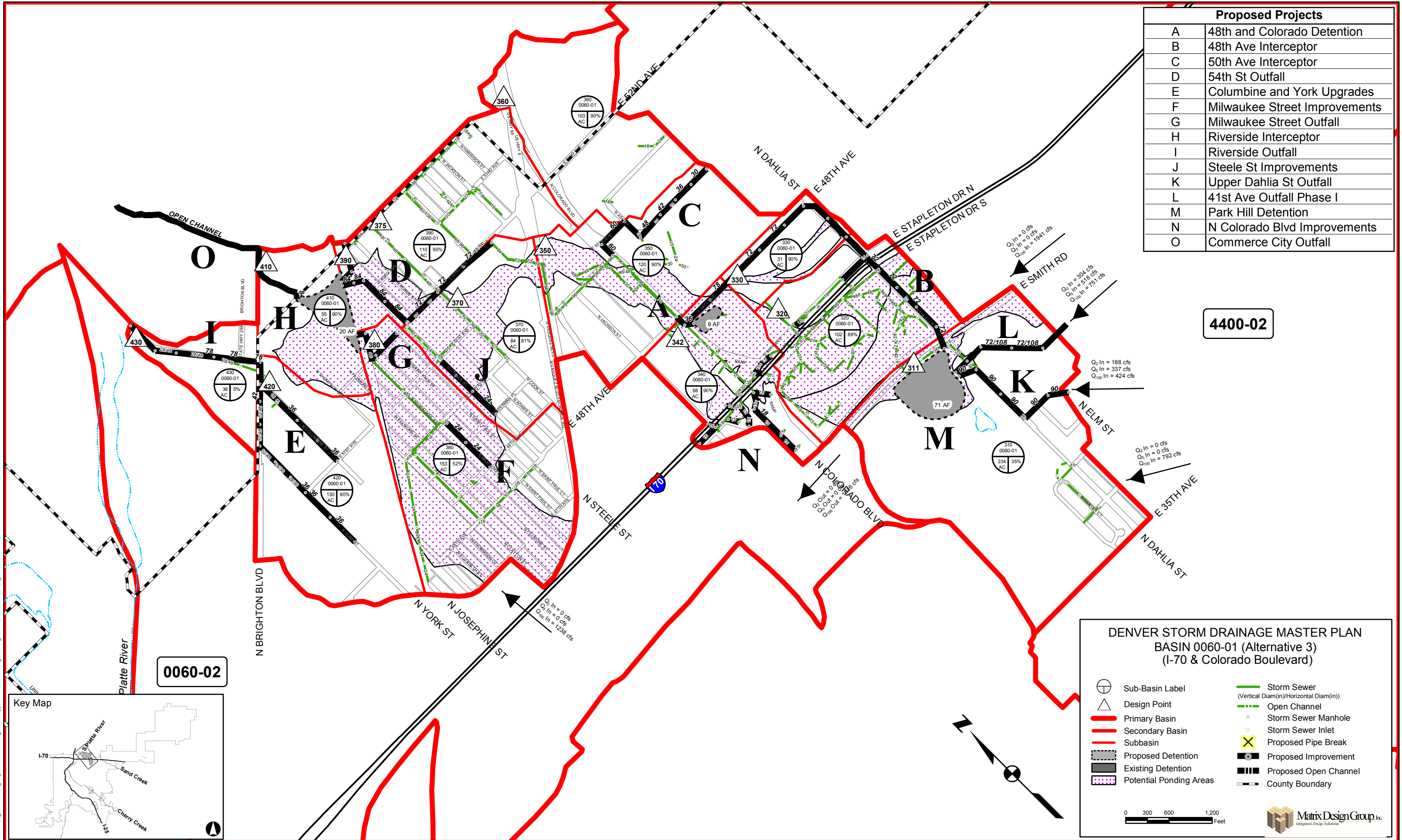
	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1200 Feet

Matrix Design Group, Inc.

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Proposed Projects	
A	48th and Colorado Detention
B	48th Ave Interceptor
C	50th Ave Interceptor
D	54th St Outfall
E	Columbine and York Upgrades
F	Milwaukee Street Improvements
G	Milwaukee Street Outfall
H	Riverside Interceptor
I	Riverside Outfall
J	Steele St Improvements
K	Upper Dahlia St Outfall
L	41st Ave Outfall Phase I
M	Park Hill Detention
N	N Colorado Blvd Improvements
O	Commerce City Outfall



4400-02

0060-02

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0060-01 (Alternative 3)  
(I-70 & Colorado Boulevard)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

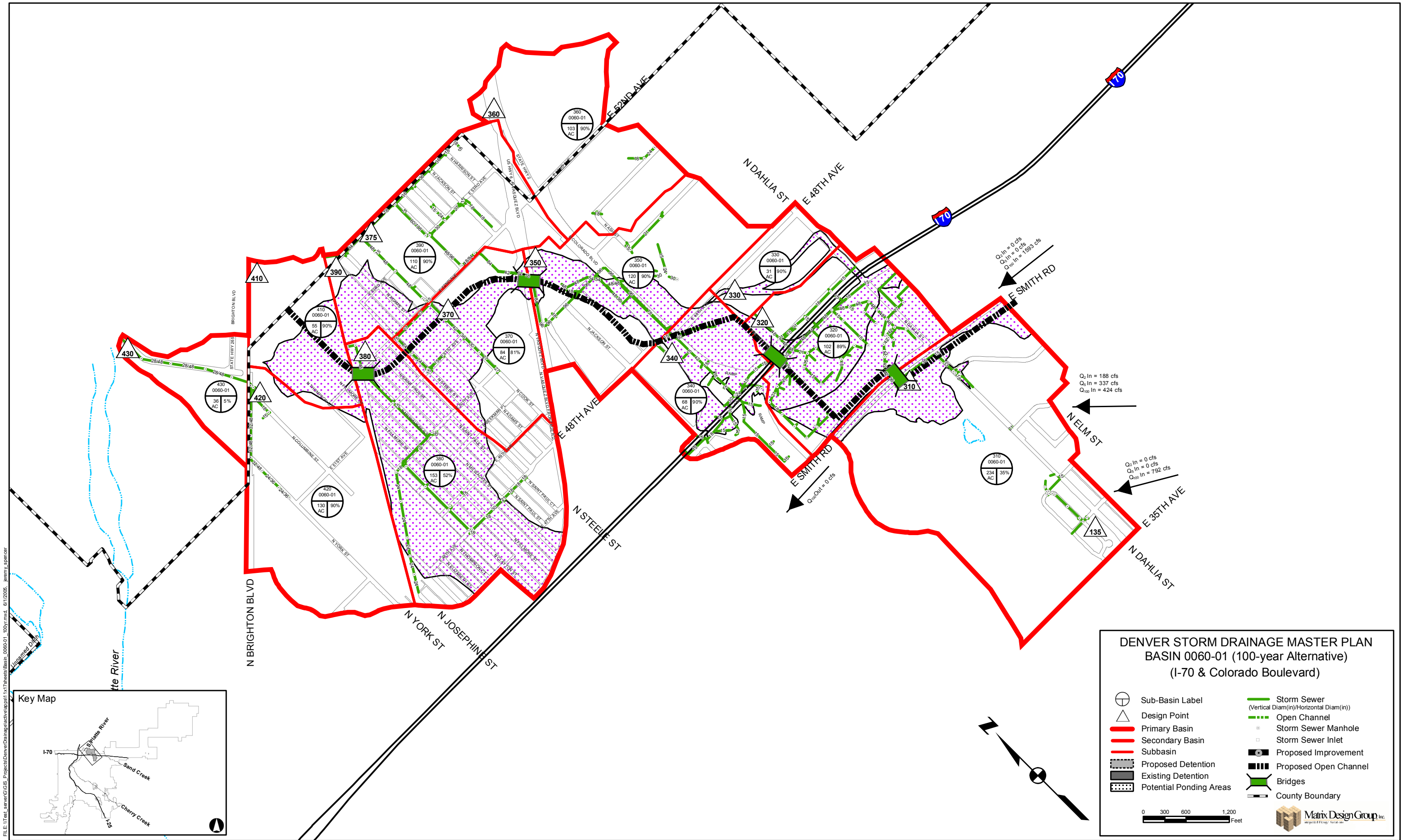
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## **Basin 0060-01 (I-70 & Colorado Boulevard) (Alternative 100-Year System)**

### **Alternative 100-Year System:**

Ponding is predicted to start at Smith Road from an estimated 100-year flow of 3,771cfs for the 2,324 tributary acres. The proposed 5-year system to reduce ponding in the area is estimated to be \$48.8M (Projects A,B G,K,L and M Basin 0060-01, and Projects C,D,E,F,G,H,I,M and V Basin 4400-02). A 100-year drainage outfall of the magnitude to eliminate the ponding would require construction of an open channel (estimated Right-of-Way of 115 feet wide). The proposed channel alignment, as shown on the facing map, follows the predicted thalweg of overland flow. Property acquisition is necessary to retro-fit the large channel into the developed site and is estimated to be \$10M. Construction cost of the 100-year channel outfall is estimated to be at least \$10M, plus an additional \$20M for four bridge structures at major roadway crossings (Smith Road, I-70, Vasquez Blvd, and the Union Pacific Railroad). Total cost of the 100-year system is predicted to be roughly \$88M due to the long length of drainage infrastructure required.



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**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 0060-01 (100-year Alternative)**  
**(I-70 & Colorado Boulevard)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Improvement
	Proposed Detention		Proposed Open Channel
	Existing Detention		Bridges
	Potential Ponding Areas		County Boundary

## Basin 0060-02 (I-70 & York)

### Existing System Description:

This basin consists of 936 acres (1.46 square miles) and is fully built-out with older neighborhood residential in the upper reaches and industrial in the lower reaches. The National Western Stock Show grounds are located within this drainage basin. *Blueprint Denver* shows the industrial portions of the basin as “Areas of Change”. Only the residential neighborhoods are shown as “Areas of Stability”. All drainage from this basin outfalls to the South Platte River.

Intercepted stormwater is discharged to the South Platte River via at least 12 storm drainage outfalls. However, the only major (larger than 48inch) outfall exists at Race Court just upstream of the Burlington Ditch headgate. This outfall (Design Point 1541) drains 580 tributary areas discharging via a 78-inch pipe and parallel 42-inch pipe which have a total capacity of about 410 cfs. Following the criteria of an 80% full flow pipe, the existing system has less than a 2-year level of service, whereas current criteria requires a 5-year level of service for commercial/industrial areas.

Constraints to drainage infrastructure in this basin include:

- Crossing a major rail switching yard west of Blake Street
- Crossing I-70
- Crossing a railroad next to Brighton Boulevard
- An elevated section of the Metro Sewer creating a wall barrier for drainage

### Drainage Deficiencies:

The existing drainage system will pond water beyond a 2-year storm event, and certainly more ponding will occur in a 100-year event.

### Proposed Capital Improvements:

Four major storm drain projects have been proposed in this basin to increase the level of service from a 2-year capacity to a 5-year capacity.

Project A: East 45<sup>th</sup> Avenue includes an extension of the lateral network south of I-70. Currently, stormwater is collected in 45<sup>th</sup> Avenue. These improvements extend the storm drains into 44<sup>th</sup> and 43<sup>rd</sup> Avenues, and upsize the crossing under I-70 from an existing 66-inch to a 96-inch pipe.

Project B: North Brighton Boulevard Outfall involves construction of a new outfall at a new location. There is not easy or obvious new outfall route to the South Platte River; access is either restricted by I-70 or the Stock Show complex. To maximize the use of the existing pipe network, a new 102-inch outfall has been proposed through the National Western Stock Show grounds to the South Platte River. Negotiations are needed to obtain an easement for a new drainage outfall in this area, if the existing outfall is to remain without replacement. Other minor outfall pipes also need to be upsized to improve the level of service in the area.

Project C: North Race Street Outfall involves upsizing existing storm pipe north of I-70. The railroad is a major barrier for constructing new pipe in this area. There are few roadway crossings of the railroad in the area. The 89-acre area (sub-basin 020) northeast of Vasquez Boulevard and I-70 is currently drained by an 18-inch pipe under I-70. The proposed pipe follows a new alignment in 48<sup>th</sup> Avenue to avoid construction in the I-70 corridor.

Project D: National Western Improvements involve enlarging existing storm drain outfalls near I-70. Specifically, a 30-inch outfall south of I-70 (Design Point 110) is upsized to a 48-inch pipe. A 24-inch outfall north of I-70 (Design Point 100) is upsized to a 48-inch pipe. A 30-inch outfall north of I-70 (Design Point

90) is upsized to a 54-inch pipe. Preliminary design may consider parallel pipes for this project rather than complete replacement.

### Potential Ponding:

The study shows areas around the National Western Stock Show complex as subject to potential ponding during major storm events. These areas are located along the South Platte River Valley and at localized areas and sumps. Redevelopment of the site would warrant drainage improvements here.

A second area of potential ponding in this basin is the result of overflow from Basins 4400-02 and 0060-01. Runoff from these basins enters Basin 0060-02 along Smith Road and crosses I-70 near Fillmore and Milwaukee Streets, and flows overland back into Basin 0060-01. Alternative drainage improvements in these adjacent basins may reduce the threat of potential ponding in this area.

Another area of potential ponding (not shown on the map) is the result of overland flow from the Montclair Basins (4500). Runoff in excess of the pipe capacity may enter this basin south of I-70 near 40<sup>th</sup> Street. Further study of the Montclair Basin may add shaded areas of potential ponding in the southern reaches of Basin 0060-02.

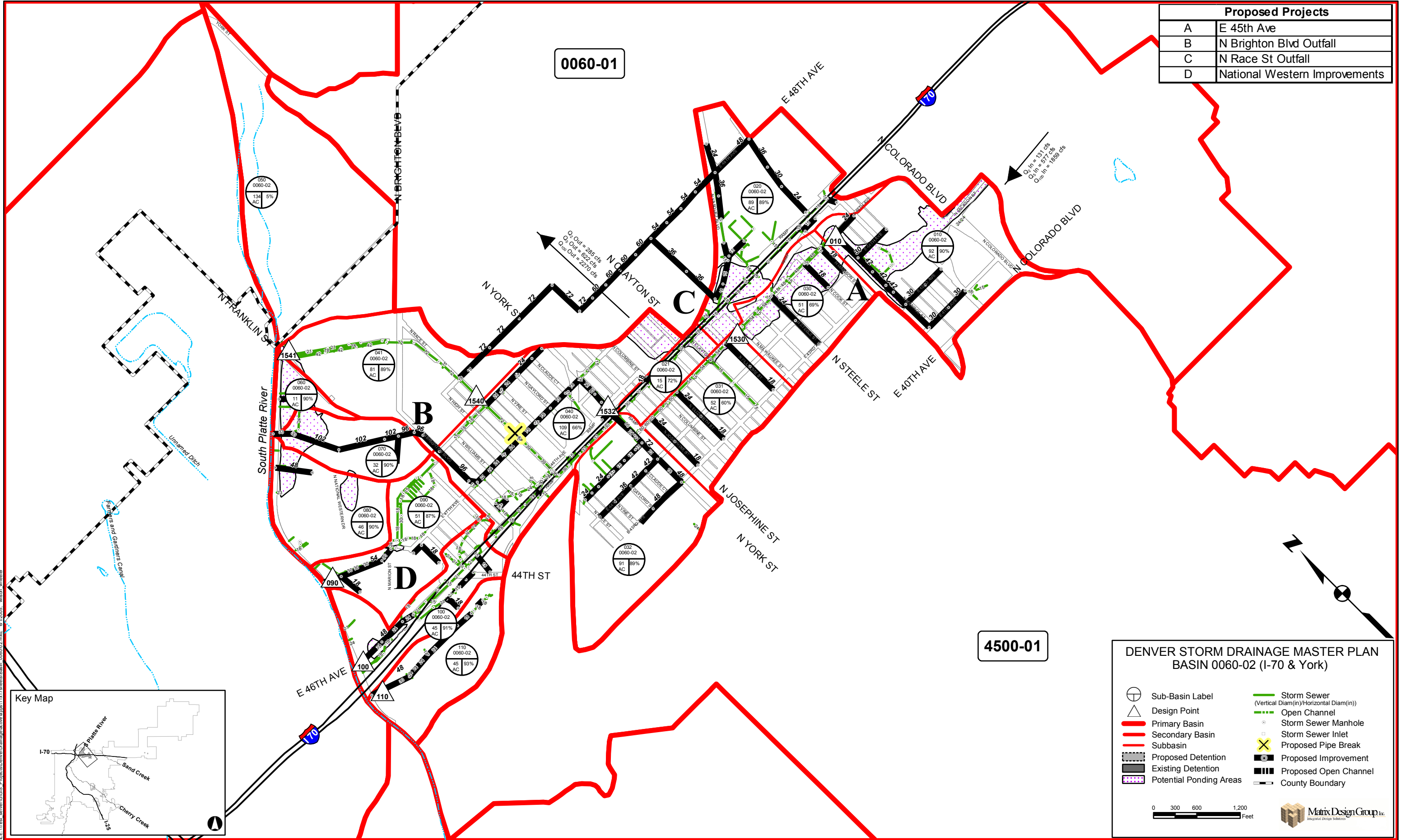
### Existing Hydrology:

The following table summarizes existing conditions hydrology:

#### BASIN 0060-02

<u>Design Point</u>	<u>Contributing Basins</u>	<u>Tributary Area</u> (acres)	<u>Peak Discharge</u>		
			<u>2-Year</u> (cfs)	<u>5-Year</u> (cfs)	<u>100-Year</u> (cfs)
10	10	92	154	221	456
90	90	51	80	117	245
100	100	44	71	103	212
110	110	38	64	91	185
1530	10,30	143	174	267	611
1532	10,20,30,31,21,32	390	385	603	1452
1540	10,20,30,31,21,32,40	499	383	610	1616
1541	10,20,30,31,21,32,40,41	580	381	612	1664



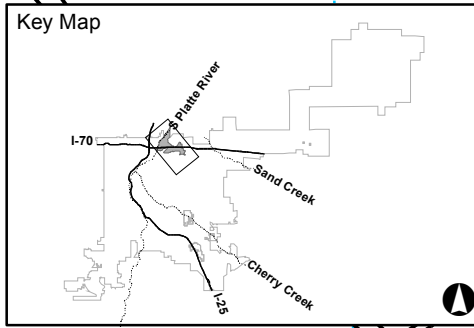


0060-01

4500-01

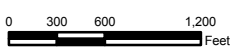
Proposed Projects	
A	E 45th Ave
B	N Brighton Blvd Outfall
C	N Race St Outfall
D	National Western Improvements

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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0060-02 (I-70 & York)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



## Basin 0061-01 (27<sup>th</sup> and Federal Basin)

### Existing System Description:

The 27<sup>th</sup> and Federal basin is located in northwest Denver. The approximate boundaries of the basin are W. 19<sup>th</sup> Avenue on the south (Mile High Stadium), W. 34<sup>th</sup> Avenue on the north, the South Platte River to the east and a varying edge on the west primarily extending to N. Newton Street, with some portions extending as far west as N. Wolff Street. The basin is comprised of approximately 1424 acres (2.23 sq mi) of fully developed area. The basin generally drains from west to east and has multiple outfalls into the South Platte River.

The basin is composed of a variety of land uses including residential, parks, commercial and industrial land uses. Much of the basin is residential with commercial areas primarily located along Federal Boulevard and the I-25 corridor.

**Blueprint Denver** shows the area within ½ mile of I-25, bounded on the east by I-25, W. 20<sup>th</sup> Avenue on the South, W. 33<sup>rd</sup> Avenue on the North as an area subject to change. The remainder (over three-quarters of the basin) is shown as being an “Area of Stability”.

All drainage from this basin outfalls to the South Platte River. Intercepted stormwater is discharged in over 9 separate storm drainage outfalls which cross under I-25, ultimately discharging into the South Platte. Some of the more major outfalls include:

- 50-inch pipe at W. 20<sup>th</sup> Avenue and N. Bryant Street
- 48-inch x 72” pipe at W. 25<sup>th</sup> Avenue and W. Byron Place
- 5ftx8ft box culvert at Central Street and 19<sup>th</sup> Street

### Drainage Deficiencies:

In general, much of the existing system is undersized and does not adequately convey the 2-year or 5-year design flows. Storm drain infrastructure in this basin has undersized outfalls, incomplete networks of storm drain laterals and is primarily composed of brick and clay pipe systems which do not meet Denver Wastewater’s criteria for size and/or material. Much of the system was previously a part of a combined sewer system which has since been separated from the sanitary component.

The 27<sup>th</sup> and Federal basin lies on a relatively steep area on the side of the South Platte River Valley. As a result, water tends to move quickly through the basin and generally does not produce areas of severe ponding. However, there are two major flow paths within the overall basin that do see shallow overland flooding. This shallow flooding is primarily contained in the streets when a storm event exceeds the storm drain capacity.

The two major flow paths are generally described as follows:

- Beginning near the intersection of N. King Street and W. 27<sup>th</sup> Avenue, traveling south along 27<sup>th</sup>. Traveling east down W. 24<sup>th</sup> Avenue and W. 23<sup>rd</sup> Avenue across Federal Boulevard and then northeast toward Mile High Stadium.
- Beginning near N. Irving Street and Speer Boulevard, traveling along Speer Boulevard to I-25.

### Proposed Capital Improvements:

Drainage improvements in this basin are primarily recommended to achieve the minimum performance objectives as described in Denver Wastewater’s Drainage Criteria; 2-year and 5-year systems for residential and commercial areas respectively. To meet these requirements, most of the existing storm drain network will need to be replaced. These improvements can be phased in smaller projects following the completion of the major project components. Proposed capital improvements include:

- Construction of storm drains in local roads shown to improve interception of minor storm event runoff and conveyance within neighborhoods.
- Installation of four new outfalls under I-25 at N. Bryant Street and 19<sup>th</sup> Avenue; at N. Bryant Street and W. 20<sup>th</sup> Avenue; at W. 23<sup>rd</sup> Avenue and N. Alcott Street; and at N. Zuni St. and W. Byron Place;
- Installation of major storm drain interceptors connecting to the I-25 outfalls.

### Alternatives Analysis:

**Alternative 1 (Direct Conveyance):** The direct conveyance alternative seeks to intercept all 2-year and 5-year design flows within the basin. Four outfalls would require substantial upgrades. In addition, upstream interception systems would need to be upgraded and/or reconstructed to meet the minimum conveyance capacity required by the drainage criteria.

**Alternative 2 (Detention):** This alternative seeks to maximize storage facilities within the basin, thereby reducing the size of downstream pipe facilities. All detention was modeled as offline, allowing nuisance flows to bypass the facilities. Facilities would see stormwater once per year.

Two storage ponds would be created at Viking Park with storage volumes of 6.9 acre-feet (west) and 3.1 acre-feet (east). One storage pond would be created at the athletic facilities of North High School with a total storage volume of 1.7 acre-feet. The facilities at these two locations ultimately reduce the size of the downstream storm drain system and outfall under I-25 at W. Byron Place and N. Zuni St.

### Cost Analysis:

Costs for Alternatives 1 and 2 are shown below.

<u>Alternative</u>	<u>Construction Costs</u>
1	\$35.0M
2	\$35.5M

### Economic Analysis:

Alternative 1 (Conveyance) represents the **least cost solution** for the improvement program for Basin 0061-01.

**Basin 0061-01 EXISTING CONDITIONS**

<u>Design Point</u> Minor Event Model	<u>Contributing Basins</u> Minor Event Model	<u>Tributary Area</u> Minor Event Model (acres)	<u>Peak Discharge</u>		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
50	10,20,30,40,50,120	360.2	198	227	326
185	110,120,130,140,150,160,170,180	329.3	148	278	826
200	195,200,210	136.0	119	194	395
230	110,120,130,140,150,160,170,180,190,195,200,210,220,230	617.1	351	532	1339

**Basin 0061-01 ALTERNATIVE 1 : Conveyance**

<u>Design Point</u> Minor Event Model	<u>Contributing Basins</u> Minor Event Model	<u>Tributary Area</u> Minor Event Model (acres)	<u>Peak Discharge</u>	
			2-Year (cfs)	5-Year (cfs)
160	10,20,30,40,50,60,65,70,80,90,100,110,120,130,140,150,160	447.9	303	476
470	200,210,220,230,240,250,260,270,280,290,300,310,320,330,340,350,360,370,380,390,400,410,420,430,440,450,460,470	562	411	687
430	200,210,220,230,240,250,260,270,280,290,300,310,320,350,360,370,380,390,400,410,420,430	444.6	304	515
320	200,210,220,230,240,250,260,270,280,290,300,310,320	291.3	183	309
40	10,20,30,40	149.8	95	157

**Basin 0061-01 ALTERNATIVE 2 : Detention**

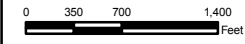
<u>Design Point</u> Minor Event Model	<u>Contributing Basins</u> Minor Event Model	<u>Tributary Area</u> Minor Event Model (acres)	<u>Peak Discharge</u>	
			2-Year (cfs)	5-Year (cfs)
470	200,210,220,230,240,250,260,270,280,290,300,310,320,330,340,350,360,370,380,390,400,410,420,430,440,450,460,470	562	315	449
160	10,20,30,40,50,60,65,70,80,90,100,110,120,130,140,150,160	447.9	303	476
430	200,210,220,230,240,250,260,270,280,290,300,310,320,350,360,370,380,390,400,410,420,430	444.6	181	241
320	200,210,220,230,240,250,260,270,280,290,300,310,320	291.3	107	142
40	10,20,30,40	149.8	95	157

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### DENVER STORM DRAINAGE MASTER PLAN BASIN 0061-01 (Existing) (27th & Federal)

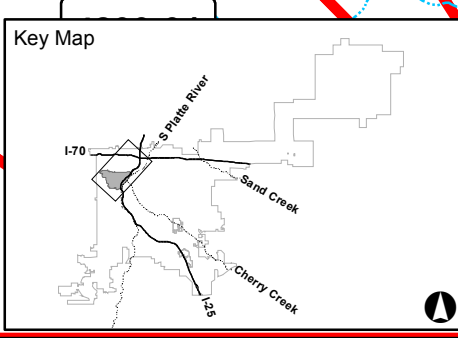
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	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary



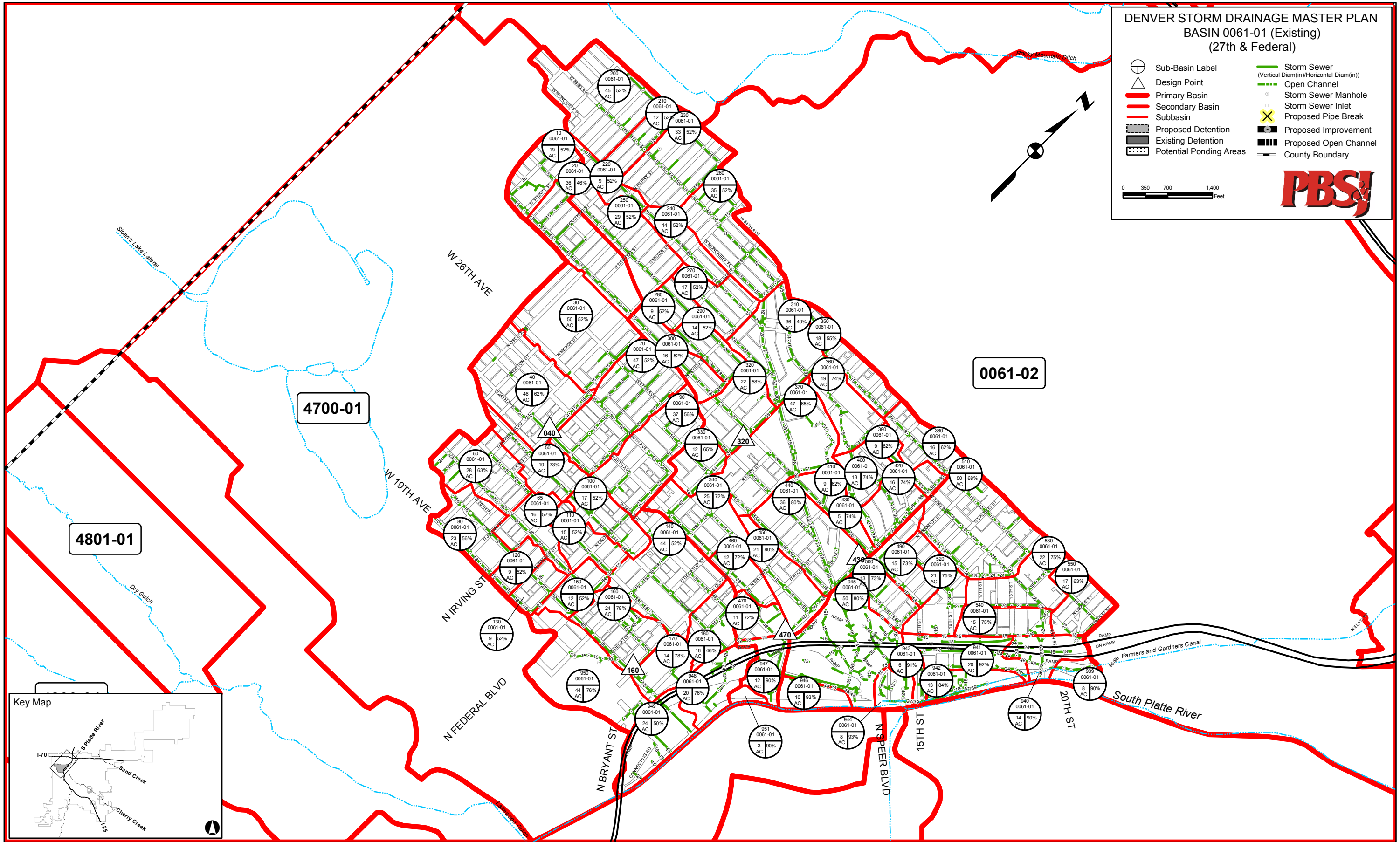
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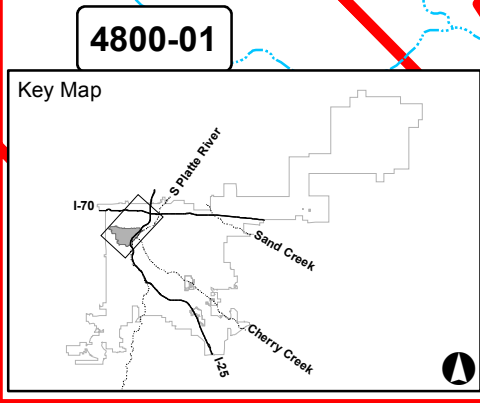
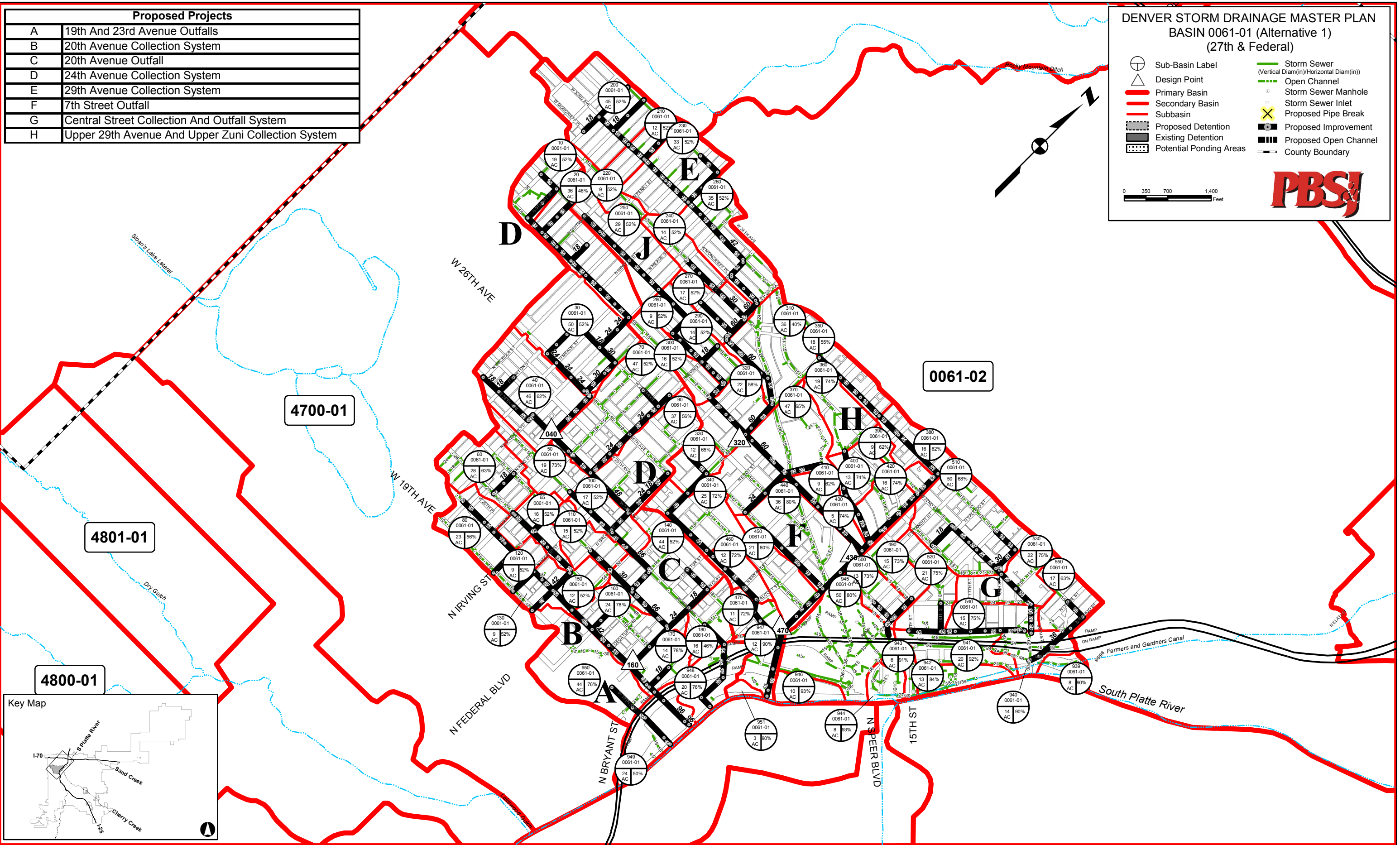


Proposed Projects	
A	19th And 23rd Avenue Outfalls
B	20th Avenue Collection System
C	20th Avenue Outfall
D	24th Avenue Collection System
E	29th Avenue Collection System
F	7th Street Outfall
G	Central Street Collection And Outfall System
H	Upper 29th Avenue And Upper Zuni Collection System

**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 0061-01 (Alternative 1)**  
**(27th & Federal)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet



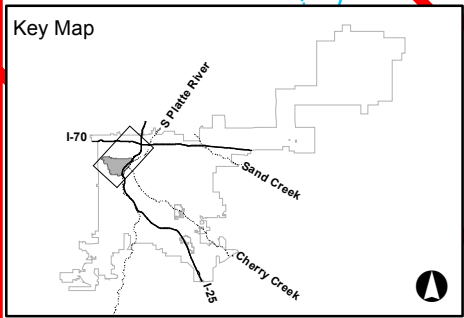
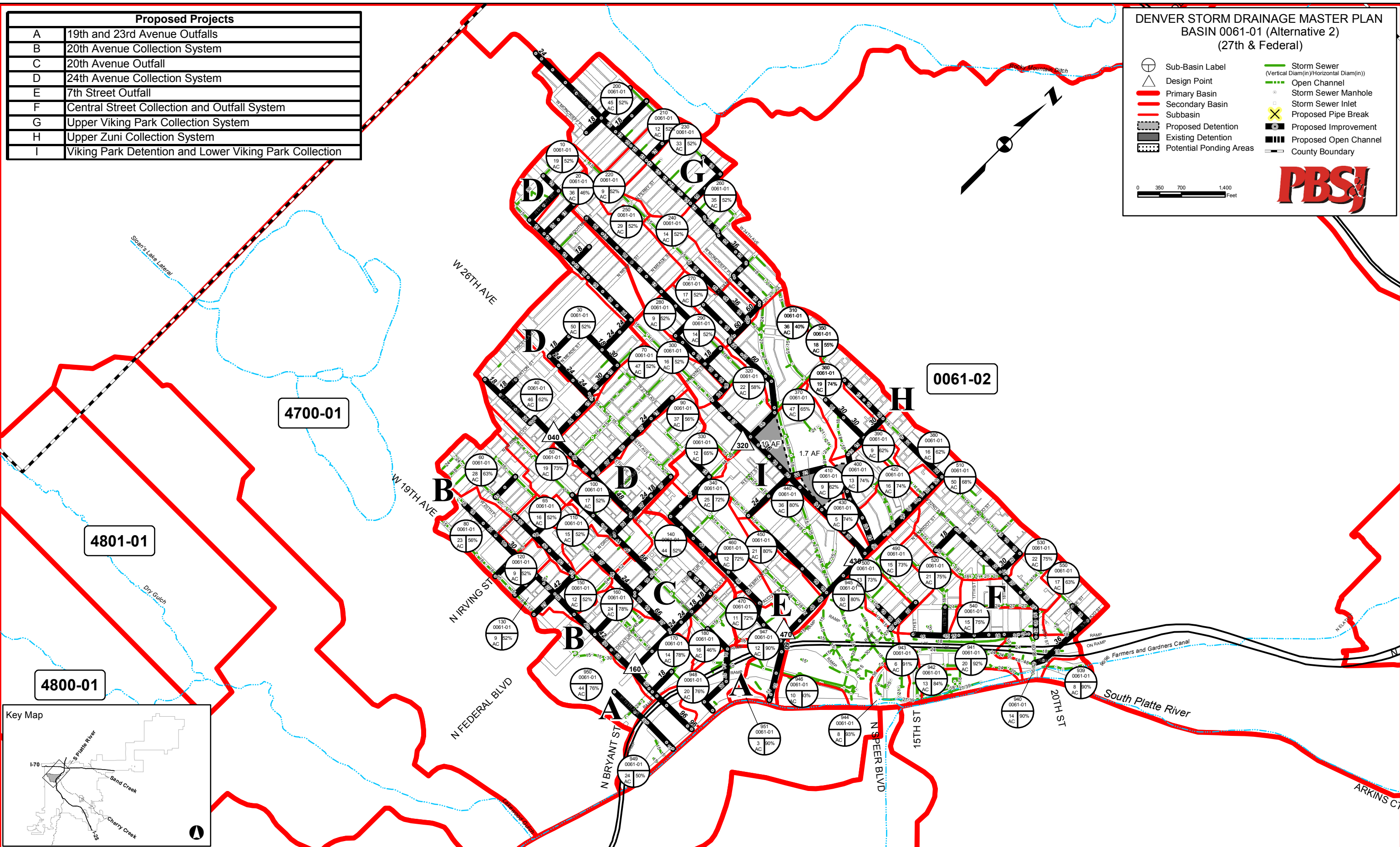
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Proposed Projects	
A	19th and 23rd Avenue Outfalls
B	20th Avenue Collection System
C	20th Avenue Outfall
D	24th Avenue Collection System
E	7th Street Outfall
F	Central Street Collection and Outfall System
G	Upper Viking Park Collection System
H	Upper Zuni Collection System
I	Viking Park Detention and Lower Viking Park Collection

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0061-01 (Alternative 2)  
(27th & Federal)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1400 Feet



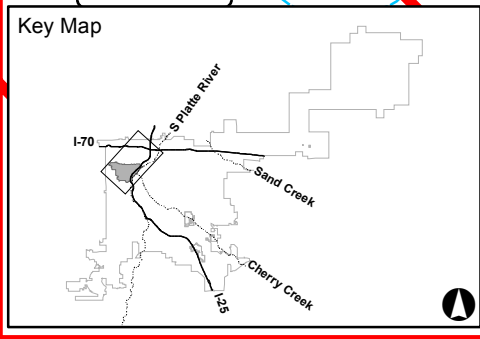
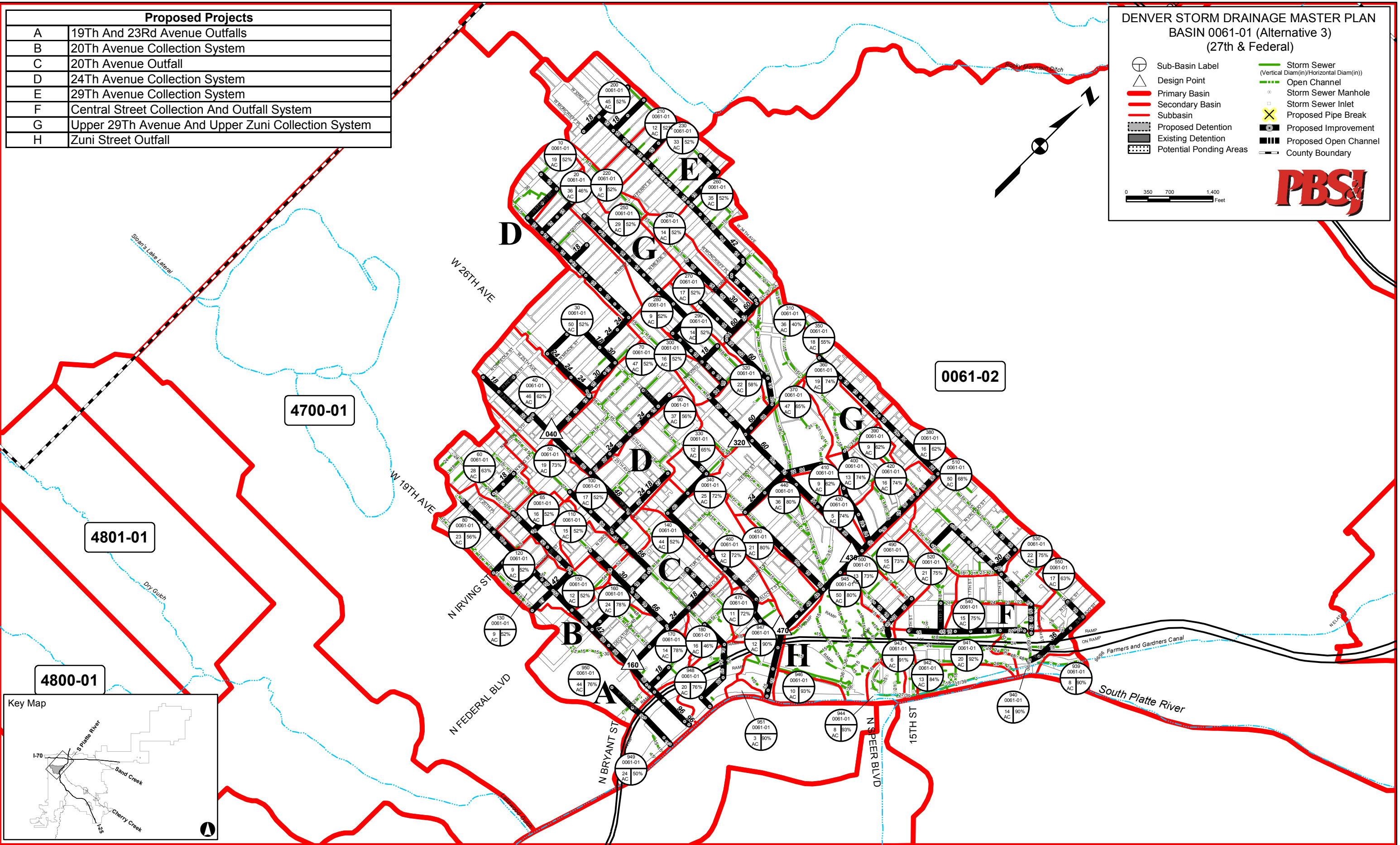
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Proposed Projects	
A	19Th And 23Rd Avenue Outfalls
B	20Th Avenue Collection System
C	20Th Avenue Outfall
D	24Th Avenue Collection System
E	29Th Avenue Collection System
F	Central Street Collection And Outfall System
G	Upper 29Th Avenue And Upper Zuni Collection System
H	Zuni Street Outfall

**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 0061-01 (Alternative 3)**  
**(27th & Federal)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet



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## Basin 0061-02 (Highland Basin)

### Existing System Description:

The Highland basin is located in northwest Denver. The approximate boundaries of the basin are W. 34<sup>th</sup> Avenue to the south, I-70 on the north, the South Platte River to the east and a varying edge on the west extending as far west as N. Berry Street. The basin is comprised of approximately 1915 acres (3.0 square miles) of fully developed area. The basin generally drains from west to east and has multiple outfalls into the South Platte River.

The basin is composed of a variety of land uses including residential, parks, commercial and industrial land uses. Much of the basin is residential with commercial areas primarily located along Federal Boulevard, W. 38<sup>th</sup> Avenue, and the I-25 corridor. Many areas have mixed commercial/retail space on street corners with gas stations, convenience stores and other neighborhood retail outlets. The northeast corner of the basin is composed of industrial and warehouse uses. This area is generally bounded by I-70 (north) and W. 44<sup>th</sup> Ave (south) and N. Pecos Street (west) and the Rennick Railyard (east).

*Blueprint Denver* shows areas subject to change in the vicinity of W. 38<sup>th</sup> Avenue, just west of Federal Boulevard, N. Inca Street, north of W. 38<sup>th</sup> Avenue, and W. 44<sup>th</sup> Avenue, just east of Federal Boulevard. The remainder of the basin is shown as being an “Area of Stability”.

All drainage from this basin outfalls to the South Platte River. Intercepted stormwater is discharged in over 5 separate storm drainage outfalls which cross under I-25, ultimately discharging into the South Platte. Some of the more major outfalls include:

- 8x8 box culvert and 4 x 7 box culvert at W. 34<sup>th</sup> Avenue and N Lipan Street
- 60-inch x 84-inch pipe at W 38<sup>th</sup> Avenue and I-25
- 24-inch storm pipe crossing under I-25 at N Inca Street draining a small local basin just west of I-25
- A 36-inch and a 30-inch storm drain crossing under I-25 just north of the Park Avenue overpass, draining a small local basin on the west side of I-25

### Drainage Deficiencies:

Storm drain infrastructure in this basin has undersized outfalls, incomplete networks of storm drain laterals and is primarily composed of brick and clay pipe systems which do not meet Denver Wastewater’s criteria for size and/or material. Much of the system was previously a part of a combined sewer system which has since been separated from the sanitary component.

The Highland Basin lies on a relatively steep area on the side of the South Platte River Valley. As a result, water tends to move quickly through the basin and generally does not produce areas of severe ponding. However, there are three major flow paths within the overall basin that do see shallow overland flooding. This shallow flooding is primarily contained in the streets when a storm event exceeds the storm drain capacity. The three major flow paths are generally described as follows:

- Beginning at the intersection of N. Irving Street and W. 37<sup>th</sup> Avenue, traveling east along W. 37<sup>th</sup> Ave, across Federal Boulevard. Continuing east on W. 37<sup>th</sup> Ave. and W. 38<sup>th</sup> Avenue and finally south down N. Lipan Street to I-25.
- Beginning at the intersection of N. Clay Street and W. 41<sup>st</sup> Avenue, traveling southeast, ultimately reaching 38<sup>th</sup> Avenue and the low point under the Rennick Railyard.
- Beginning at the intersection of N. Zuni Street and W. 44<sup>th</sup> Avenue, traveling east down W. 44<sup>th</sup> Avenue across Chaffee Park, then north east towards the intersection of N. Jason Street and W. 47<sup>th</sup> Avenue to the Rennick Railyard.

In general, much of the existing system is undersized and does not adequately convey the 2-year or 5-year design flows. The recently installed system along N. Inca Street was designed for the 2-3/4 year event and was constructed of concrete pipe, however, the design frequency identified in this study indicates the need for a 5-year system, therefore this system is undersized as well.

### Proposed Capital Improvements:

Drainage improvements in this basin are primarily recommended to achieve the minimum performance objectives as described in Denver Wastewater’s Drainage Criteria; 2-year and 5-year systems for residential and commercial areas respectively. To meet these requirements, most of the existing storm drain network will need to be replaced. These improvements can be phased in smaller projects following the completion of the major project components. Proposed capital improvements include:

- Construction of storm drains in local roads shown to improve interception of minor storm event runoff and conveyance within neighborhoods.
- Installation of new outfalls under I-25 at W. 34<sup>th</sup> Avenue and N. Lipan Street; and Park Avenue and I-25.
- Installation of major storm drain interceptors connecting to the I-25 outfalls.

### Alternatives Analysis:

**Alternative 1 (Direct Conveyance):** The direct conveyance alternative seeks to intercept all 2-year and 5-year design flows within the basin. Three outfalls would require substantial upgrades. In addition, upstream interception systems would need to be upgraded and/or reconstructed to meet the minimum conveyance capacity required by the drainage criteria.

**Alternative 2 (Detention):** This alternative seeks to maximize storage facilities within the basin, thereby reducing the size of downstream pipe facilities. All detention was modeled as offline, allowing nuisance flows to bypass the facilities. In general, the facilities would see stormwater once per year.

For the area draining to the outfall at N. Lipan Street and W. 34<sup>th</sup> Avenue, two upstream ponds are proposed. A 17.9 acre-feet detention facility would be constructed at Ciancio Park and a 10.8 acre-feet facility would be created at Chaffee Park. These facilities work in combination to reduce the size of the downstream outfall. It is anticipated that construction of a facility at Ciancio Park would require substantial reconstruction of existing recreation and playing field facilities. If a pond is not feasible at Ciancio Park, Alternative 3 could be considered.

**Alternative 3 (Detention at Chaffee Park Only) :** This alternative proposes creation of a 11.0 acre-feet detention facility at Chaffee Park only. This facility would capture storm runoff to the northwest of Chaffee Park, alleviating some of the capacity problems in the existing Inca Street System.

### Cost Analysis:

Costs for Alternatives 1, 2 and 3 are shown below.

<u>Alternative</u>	<u>Construction Costs</u>
1	\$52.9M
2	\$50.5M
3	\$48.9M

### Economic Analysis:

Alternative 3 (Detention at Chaffee Park Only) represents the **least cost solution** for the improvement program for Basin 0061-02. Therefore, it is recommended that further discussions with the Denver Parks and Denver Public Schools occur to pursue this detention facility.

**Basin 0061-02 EXISTING CONDITIONS**

Design Point Minor Event Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
400	350,360,370,380,390,400	209.3	119	218	636
430	350,360,370,380,390,400,410,430,480,490,500,510,520,530,540,550,560	868.3	445	822	2473
440	350,360,370,380,390,400,410,420,430,440,480,490,500,510,520,530,540,550,560,570	1053.7	446	545	846
530	480,490,500,510,520,530	351.5	211	396	1120
650	580,590,600,610,620,630,640,650,660	390	267	411	992
710	350,360,370,380,390,400,410,430,480,490,500,510,520,530,540,550,560,570,580,590,600,610,620,630,640,650,660,670,680,690,700,710	459.7	355	919	3337
1575	350,360,370,380,390,400,410,430,480,490,500,510,520,530,540,550,560,570	922.9	367	367	367

**Basin 0061-02 ALTERNATIVE 1 : Conveyance**

Design Point Minor Event Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge	
			2-Year (cfs)	5-Year (cfs)
900	600,610,620,630,640,650,660,670,680,690,700,710,720,730,740,750,760,770,780,790,800,810,820,830,840,850,860,870,880,890,900	1054	642	1142
931	910,911,912,913,914,915,916,917,918,919,920,921,922,923,924,925,926,928,929,930,931	460.3	286	492
890	600,610,620,630,640,650,660,670,680,690,700,710,740,750,760,780,790,810,820,830,850,860,870,880,890	849.5	524	929
921	910,911,912,913,914,915,916,917,918,919,920,921	323.5	222	370
810	650,740,810	105.6	71	130
850	600,610,620,630,640,660,670,680,690,700,710,750,760,780,790,820,830,850	642.6	396	716
750	600,610,660,670,680,690,750	338.4	218	381
790	620,630,640,700,710,760,780,790	158.8	109	195

**Basin 0061-02 ALTERNATIVE 2 : Detention**

Design Point Minor Event Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge	
			2-Year (cfs)	5-Year (cfs)
900	600,610,620,630,640,650,660,670,680,690,700,710,720,730,740,750,760,770,780,790,800,810,820,830,840,850,860,870,880,890,900,910,916,917	1178.6	384	625
931	911,912,913,914,915,918,919,920,921,922,923,924,925,926,928,929,930,931	335.6	205	376
890	600,610,620,630,640,650,660,670,680,690,700,710,740,750,760,780,790,810,820,830,850,860,870,880,890,910,916,917	974.1	264	421
921	911,912,913,914,915,918,919,920,921	198.8	136	244
811	650,740,810,910,916,917	230.3	31	40
850	620,630,640,700,710,760,780,790,830,850	250.7	156	285
750	600,610,660,670,680,690,750	338.4	218	381
790	620,630,640,700,710,760,780,790	158.8	109	195

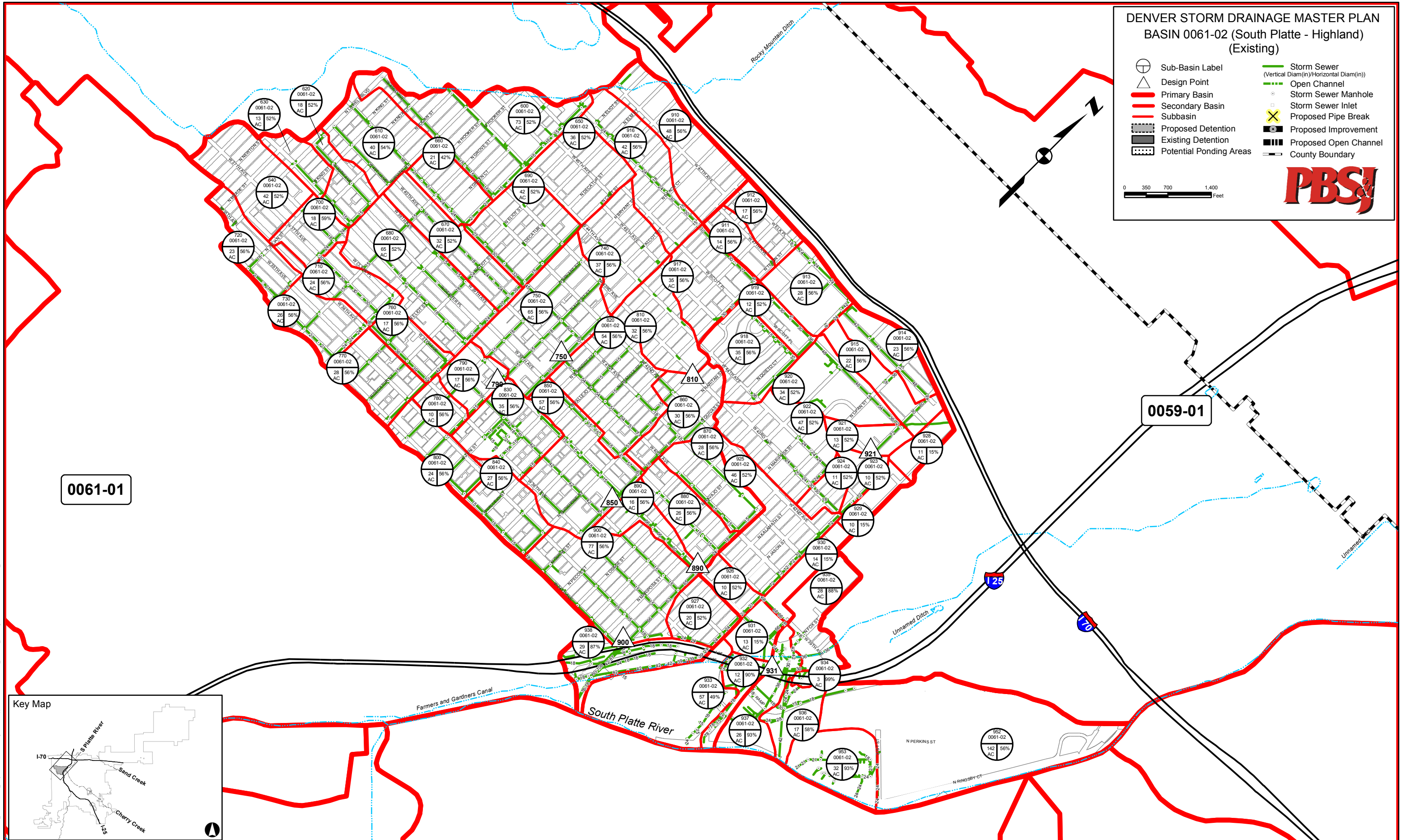
**Basin 0061-02 ALTERNATIVE 3 : Detention at Chaffee Park Only**

Design Point Minor Event Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge	
			2-Year (cfs)	5-Year (cfs)
900	600,610,620,630,640,650,660,670,680,690,700,710,720,730,740,750,760,770,780,790,800,810,820,830,840,850,860,870,880,890,900,910,916,917	1178.6	606	1027
931	911,912,913,914,915,918,919,920,921,922,923,924,925,926,928,929,930,931	335.7	205	383
890	600,610,620,630,640,650,660,670,680,690,700,710,740,750,760,780,790,810,820,830,850,860,870,880,890,910,916,917	974.2	486	816
921	911,912,913,914,915,918,919,920,921	198.8	134	245
810	650,740,810,910,916,917	230.3	27	41
850	600,610,620,630,640,650,660,670,680,690,700,710,740,750,760,780,790,810,820,830,850,910,916,917	872.9	425	717
750	600,610,660,670,680,690,750	338.4	218	381
790	620,630,640,700,710,760,780,790	158.8	109	195

### DENVER STORM DRAINAGE MASTER PLAN BASIN 0061-02 (South Platte - Highland) (Existing)

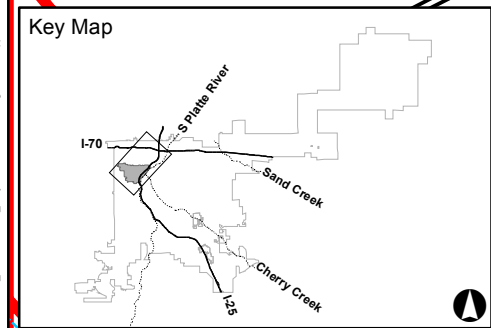
- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary

0 350 700 1,400 Feet



0061-01

0059-01



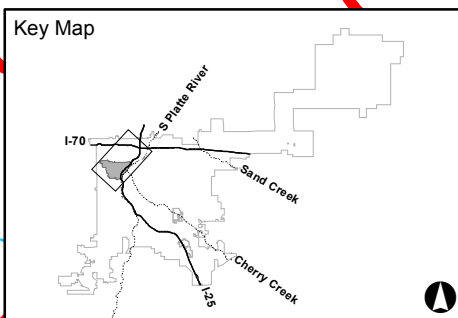
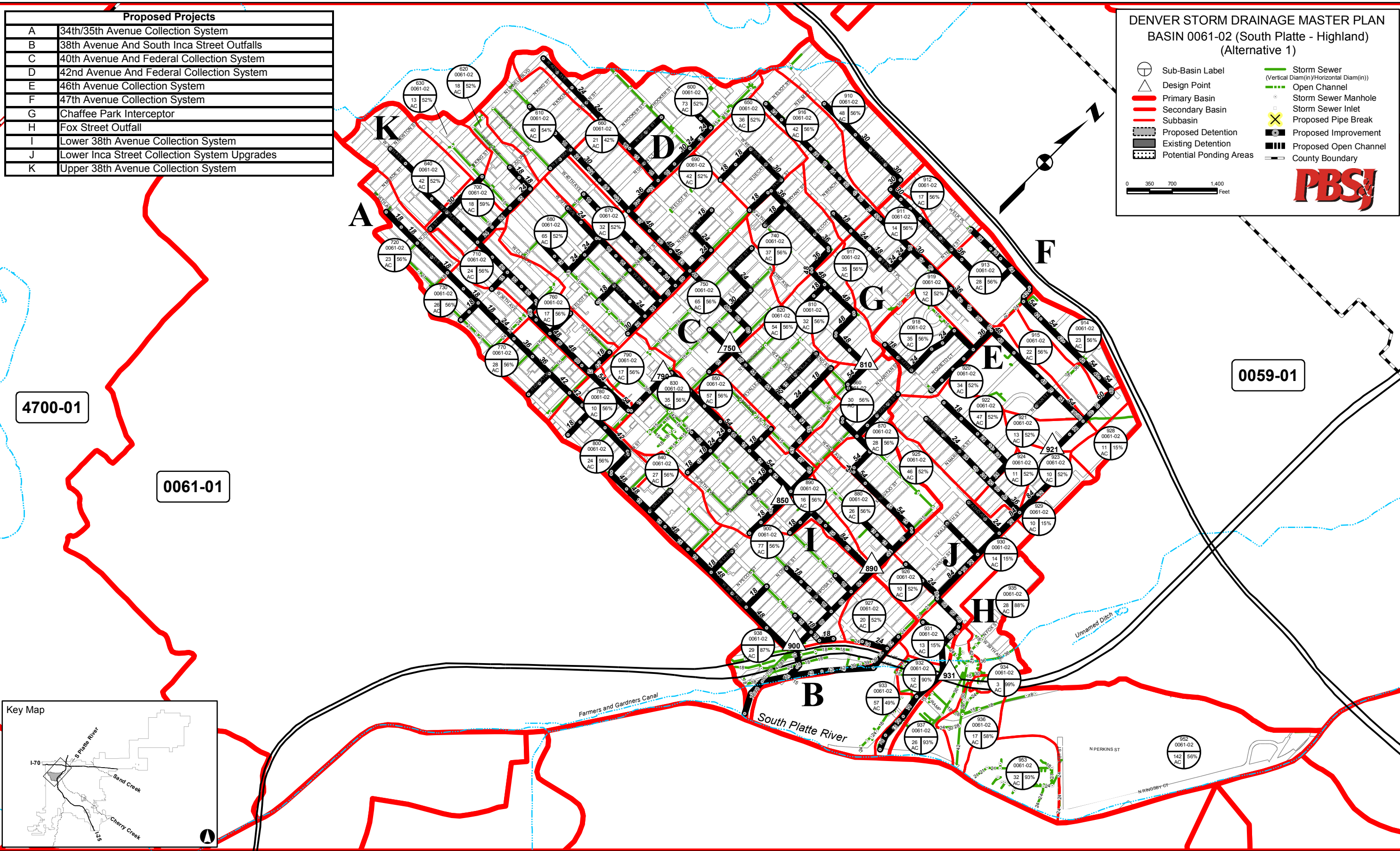
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Proposed Projects	
A	34th/35th Avenue Collection System
B	38th Avenue And South Inca Street Outfalls
C	40th Avenue And Federal Collection System
D	42nd Avenue And Federal Collection System
E	46th Avenue Collection System
F	47th Avenue Collection System
G	Chaffee Park Interceptor
H	Fox Street Outfall
I	Lower 38th Avenue Collection System
J	Lower Inca Street Collection System Upgrades
K	Upper 38th Avenue Collection System

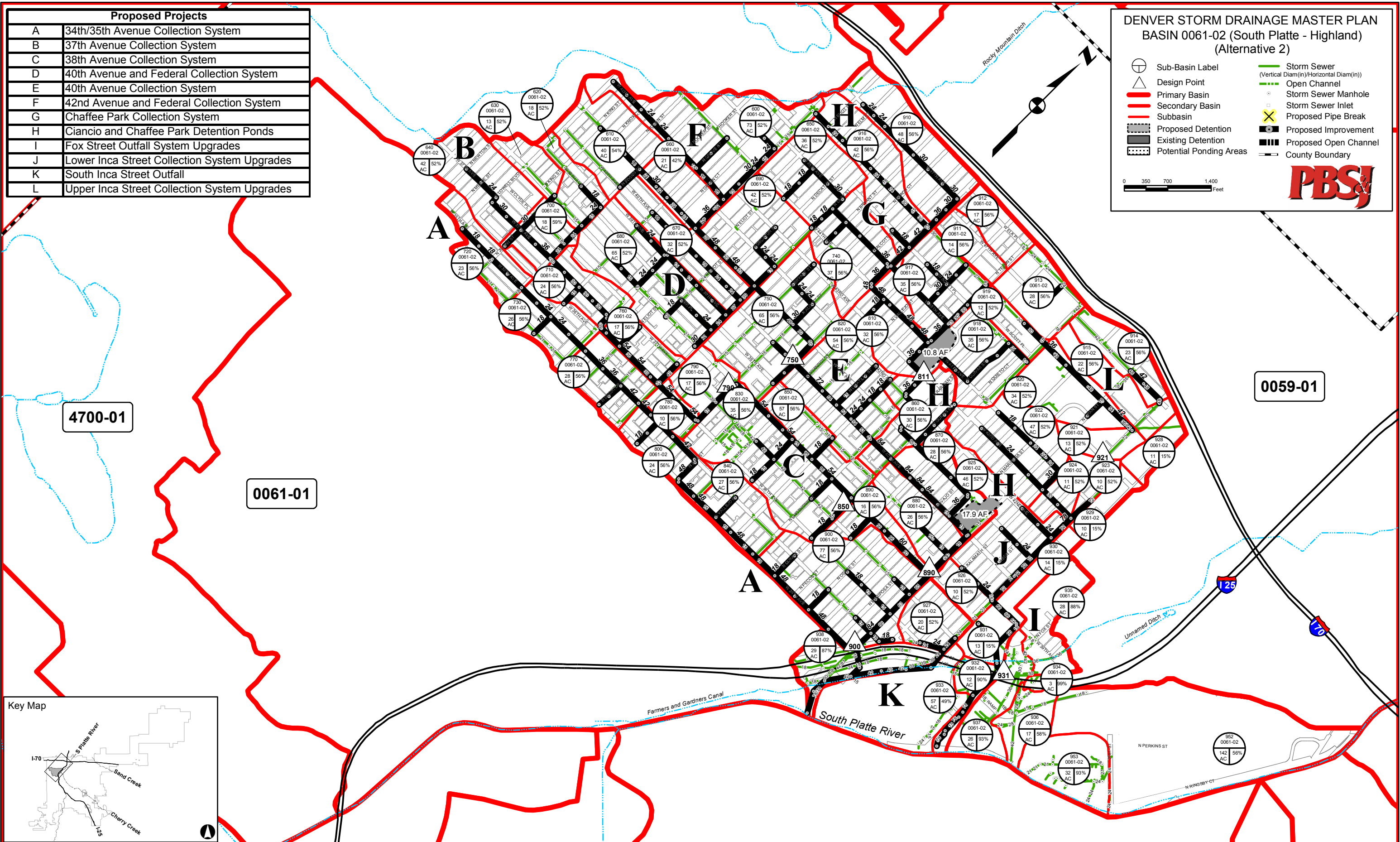
**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 0061-02 (South Platte - Highland)**  
**(Alternative 1)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary

0 350 700 1,400 Feet



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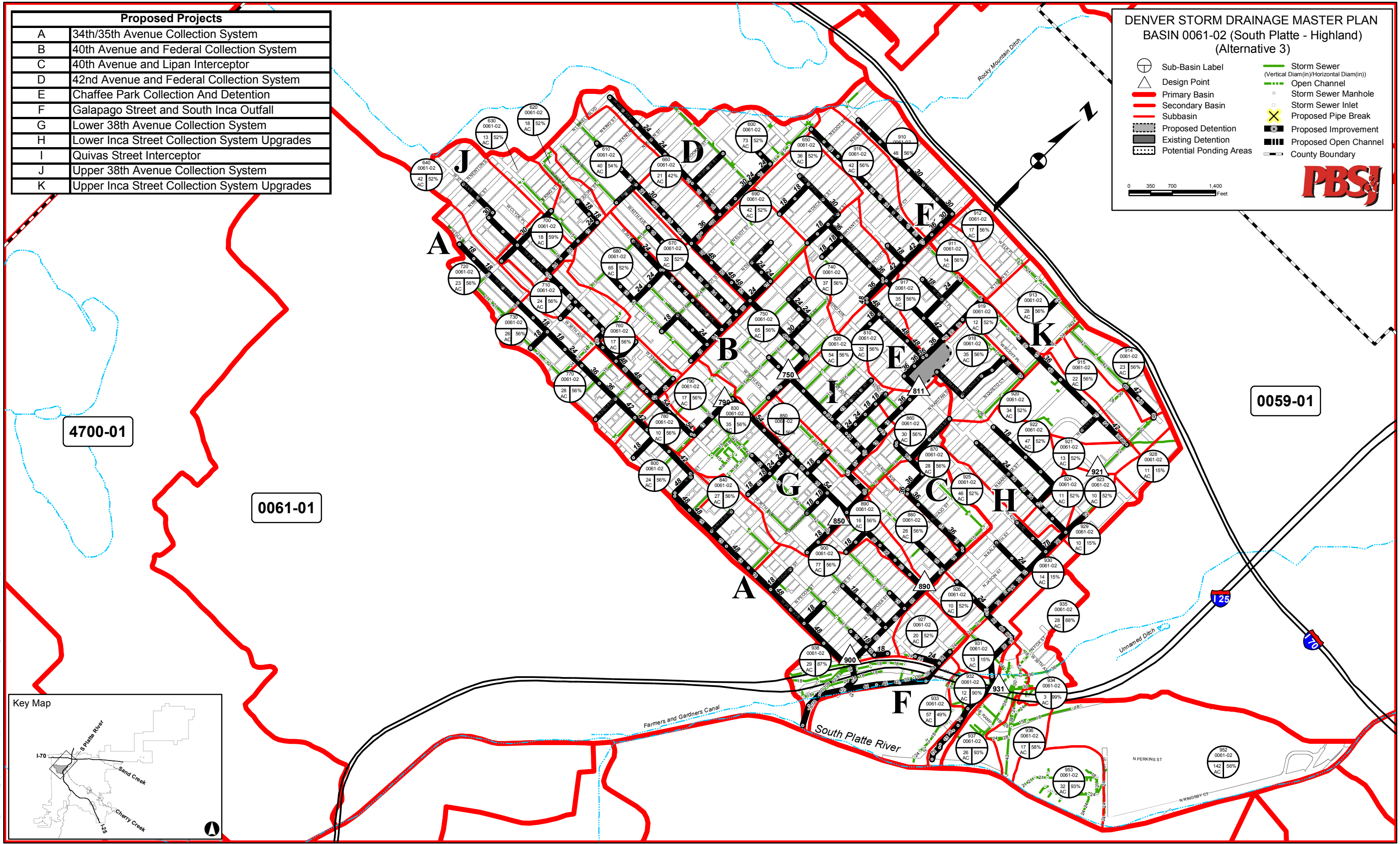
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Proposed Projects	
A	34th/35th Avenue Collection System
B	40th Avenue and Federal Collection System
C	40th Avenue and Lipan Interceptor
D	42nd Avenue and Federal Collection System
E	Chaffee Park Collection And Detention
F	Galapago Street and South Inca Outfall
G	Lower 38th Avenue Collection System
H	Lower Inca Street Collection System Upgrades
I	Quivas Street Interceptor
J	Upper 38th Avenue Collection System
K	Upper Inca Street Collection System Upgrades

**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 0061-02 (South Platte - Highland)**  
**(Alternative 3)**

	Sub-Basin Label		Storm Sewer
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

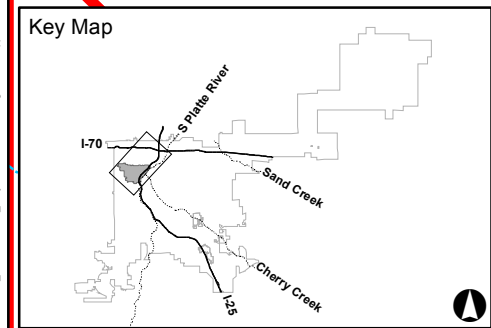
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0061-01

0059-01



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## Basin 0062-01/4500-02 (Lower Platte Valley)

### Existing System Description:

This basin includes a mix of industrial, commercial and residential land uses, and includes 2,858 tributary acres (4.47 square miles). The basin is fully built-out with older neighborhood residential in the upper reaches and commercial in the lower reaches. This basin includes Lower Downtown, Coors Field, rail yards, and a number of existing residential neighborhoods. It is characterized by terrace topography in the upper portions of the basin and near flat outfalls near the South Platte River. This condition results in inadvertent detention near the basin headwaters and surcharge of storm sewers in lower reaches.

Currently, most of the drainage (nearly 80% of the basin) outfalls through one 81-inch storm pipe at 36<sup>th</sup> Street. Design Point 1560 shows that 2,260 acres are tributary to this one outfall. This pipe has approximately 475 cfs capacity, but the hydrology indicates the flow will be 1,215 cfs in a 2-year event, and 1,957 cfs in a 5-year event (design flow). There are opportunities for regional water quality treatment off the existing 81-inch pipe near the South Platte outfall since it currently can convey a ½-inch rainfall (WQCV) over such a large developed basin area.

### Drainage Deficiencies:

The existing drainage system has less than a 1-year capacity. Rainfall runoff in excess of the storm drain capacity has a history of ponding in the sump and flat areas. Many of the existing storm drains surcharge out the manholes during large storm events. Major drainage problems have been experienced in this basin, particularly north of Coors Field.

Split flow conditions exist in the basin, whereby storm runoff is exported and imported out and into this basin. During a major storm event, runoff will flow west over Grant Street into basin 4600-01. Flow in excess of pipe capacity will then overtop Market Street and re-enter this basin.

### Proposed Capital Improvements:

This basin requires improvements primarily to the outfall since the lateral network is currently extensive in this basin. The outfall should have 5-year capacity, whereas the lateral network through the residential areas should have a 2-year capacity.

The existing 81-inch outfall is undersized, and additional outfalls are needed to relieve the burden on the existing pipe. Constructing two new outfalls in this basin will reduce the tributary area of the existing outfall. Five major drainage projects are proposed for this basin as described below:

**Project A: 31<sup>st</sup> Street Outfall** includes a completely new 120-inch outfall in 31<sup>st</sup> Street. This proposed storm drain will continue up the basin in Downing Street and branch into new laterals around Children’s Hospital. The existing pipe will be cut and plugged to provide additional capacity in the downstream system where the new pipe crosses the existing storm pipe. Work on this project should begin at the outfall and extend upward to improve the level of drainage service in the basin.

**Project B: 27<sup>th</sup> Street Improvements** includes maximizing the use of the newly constructed 108-inch pipe in 29<sup>th</sup> Street for the Coors Field Parking Lot. Currently, the tributary area to the pipe is only 81 acres. The outfall will extend up 27<sup>th</sup> Street and then Washington Street and Clarkson Street with a 96-inch pipe transitioning down to smaller pipe up into the basin.

**Project C: 36<sup>th</sup> Street Outfall** includes replacing the existing outfall from an 81-inch pipe to a 108-inch pipe. Efforts were made to preserve this pipe by sending more stormwater to new outfalls, however, this became impractical, and the existing outfall must be replaced or a parallel pipe constructed.

**Project D: East 33<sup>rd</sup> Avenue** includes balancing out the remainder of the basin tributary to the existing outfall. A new 42-inch pipe at 33<sup>rd</sup> and Humboldt Street will disconnect the existing pipe and convey runoff to the large 81-inch pipe in Downing.

**Project E: North Marion Street** includes balancing out the remainder of the basin tributary to the existing 36<sup>th</sup> Street outfall. A new 48-inch pipe in Marion between 25<sup>th</sup> and 30<sup>th</sup> Avenues will collect six laterals and convey runoff to the large 81-inch pipe in Downing. Marion was selected as an appropriate alignment due to the apparent absence of existing utilities in the street corridor.

**Project F: 20<sup>th</sup> Street Improvements** include replacing the existing 72-inch pipe in 20<sup>th</sup> Street with a new 9’ x 4’ concrete box culvert. This proposed storm drain will continue into Wynkoop Street and improve drainage conditions around Union Station. Additionally, the existing 72-inch storm drain constructed for the *Lincoln at Prospect Park* development can be extended across the railroad tracks to collect major event flows along the north side of Coors Field.

**Project G: N. Grant Street Improvements** Cost effective drainage improvements utilize the existing system and re-route drainage via a new outfall, thereby reducing the burden on the existing outfall. Capturing runoff above the Central Business District at 13<sup>th</sup> & Grant and routing it via a new 78-inch outfall in 13<sup>th</sup> Avenue to Cherry Creek will benefit this basin and downtown. This project is continued in Basin 4600-01.

**Project H: E. 12<sup>th</sup> Ave Improvements** include replacing existing small pipes with 18-inch diameter pipes to meet current drainage criteria, improve collection/conveyance and reduce maintenance problems.

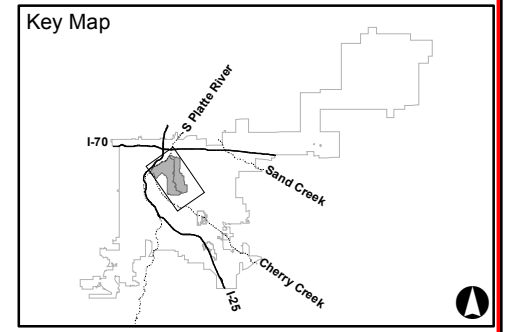
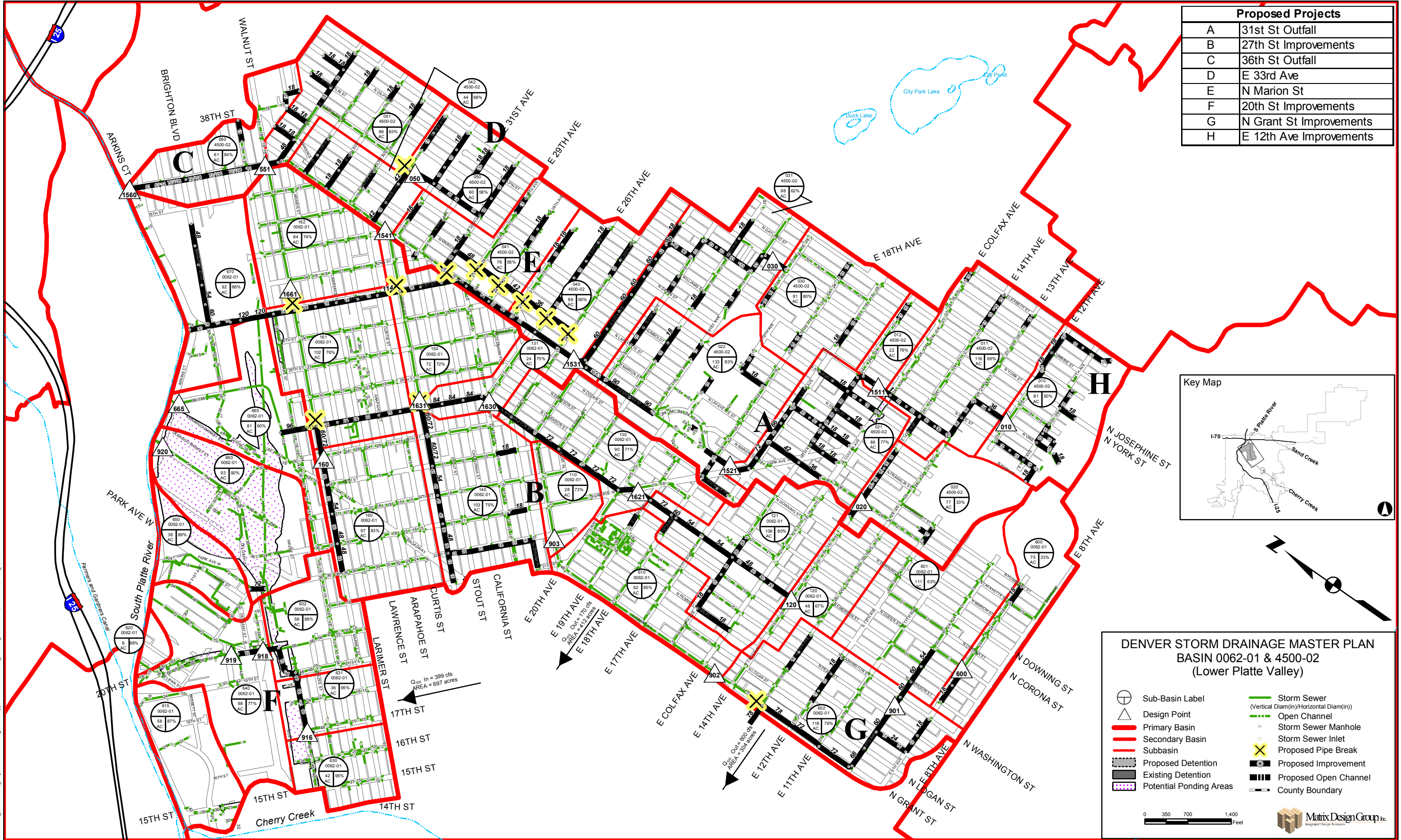
### BASIN 0062-01, 4500-02 Existing Hydrology:

Design Point Minor Event Model	Design Point Overland Flow Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge*		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	NA	10	79	67	125	NA
20	NA	20	77	38	87	NA
30	NA	30	80	117	176	NA
50	NA	50	60	53	92	NA
120	NA	120	47	55	90	NA
160	NA	160	93	141	209	NA
551	1550	10-51,110-162,600-610,800	2184	1198	1933	<b>4044</b>
600	NA	600	75	28	63	NA
665	1765	665	81	134	194	<b>1232</b>
901	NA	600,601	186	141	246	NA
902	100	600-602	304	218	341	<b>873</b>
903	1120	600-610	385	197	293	<b>586</b>
916	NA	600-610,80,81,90-92,100,101,125-127,630	757	72	102	NA
918	1281	600-610,80,81,90-92,100,101,125-127,630-632	849	206	298	<b>810</b>
919	1740	600-610,80,81,90-92,100,101,125-127,630-632,640	947	236	296	<b>475</b>
1511	10	10,11	195	173	295	<b>1053</b>
1521	NA	10-21	380	265	479	NA
1531	1530	10-31	691	505	753	<b>2307</b>
1541	1540	10-41,110-150,600-610	1715	976	1535	<b>3173</b>
1560	1560	10-60,110-162,600-610,800	2260	1215	1957	<b>4144</b>
1621	120	120121	155	192	282	<b>656</b>
1630	1660	110-130,600-610	660	415	642	<b>1195</b>
1631	1640	110-140,600-610	787	473	740	<b>1446</b>
1661	NA	160,161	195	223	321	NA

\* 100-year discharge in **bold** represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths.



Proposed Projects	
A	31st St Outfall
B	27th St Improvements
C	36th St Outfall
D	E 33rd Ave
E	N Marion St
F	20th St Improvements
G	N Grant St Improvements
H	E 12th Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0062-01 & 4500-02  
(Lower Platte Valley)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet

**Matrix Design Group, Inc.**  
Integrated Design Solutions

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## Basin 0063-01 (Central Platte Valley)

### Existing System Description:

This basin consists of a majority of the Central Platte Valley area of downtown Denver. This basin consists of 1,342 acres (2.10 square miles) and includes older neighborhood residential in the upper reaches east of the railroad tracks and Sante Fe, and commercial in the lower reaches. All drainage from this basin will outfall into the South Platte River. Intercepted stormwater is discharged via at least 32 storm drainage outfalls, which are comprised mainly of local storm drains from I-25 and adjacent properties. Some of the existing larger outfalls include:

- Bayaud Avenue outfall is 36-inch (54-inch upstream) with 351 tributary acres
- 3<sup>rd</sup> Avenue outfall is 54-inch with 104 tributary acres
- 6<sup>th</sup> Avenue outfall is 72-inch with 273 tributary acres
- 13<sup>th</sup> Avenue outfall is 42-inch with 119 tributary acres
- Colfax Avenue outfall is 36-inch with 53 tributary acres
- Elitch outfall is 48-inch with 44 tributary acres

The storm drain infrastructure consists of a random network of drains and laterals. Drainage from the basin is constrained by the elevation of the South Platte River and I-25, which generally reduces capacity and creates sump or surcharge conditions during major storm events. The reach adjacent to the South Platte River between 6<sup>th</sup> Avenue and Cherry Creek is in the 100-year floodplain, but Phase II South Platte channel improvements may remove these properties from riverine flooding.

### Drainage Deficiencies:

The existing drainage systems have capacities varying from a 1-year storm event to a 5-year storm event. Rainfall runoff in excess of the storm drain capacity has a history of ponding within the commercial and industrial areas against the railroad and I-25. Drainage problems have been experienced at Bayaud and Galapago where the railroad creates a sump and localized ponding (see “Potential Ponding” delineation). Flooding has occurred within Broadway, exacerbated by the roadway cross-section, which has steep side slopes and reduced conveyance capacity due to construction over an old trolley bed.

The basin delineation is based upon the storm drain network. The only split flow situation in this basin where the pipe flow contravenes the site topography is at the Elitches site. Runoff in excess of the 16’x4’ box culvert capacity at the Pepsi Center will flow from the Auraria Campus and the Pepsi Center area northwest into Six Flags Elitch Gardens.

### Proposed Capital Improvements:

Difficulties in constructing additional or replacement storm drains are the crossing of the railroad and I-25. *Blueprint Denver* shows the majority of the basin (commercial areas) subject to change. Only the residential neighborhood east of the railroad tracks between Alameda and 8<sup>th</sup> Avenue is shown as an “Areas of Stability”, a relatively small area of the overall basin.

Project A: West 13<sup>th</sup> Avenue Outfall includes replacing the existing 42-inch outfall with a new 66-inch pipe to provide a 5-year level of service. The enlargement of the existing system is carried up the storm drains along 13<sup>th</sup> Avenue. The 13<sup>th</sup> Avenue outfall is shown with a lateral extension of a 54-inch storm drain further into the sub-basin for connection by future redevelopment.

Project B: West 7<sup>th</sup> Avenue Outfall The relatively new 72-inch storm drain in 6<sup>th</sup> Avenue must be upsized to an 90-inch pipe to provide a minimum 5-year level of service. An existing constriction occurs where a 60-inch pipe with 0.61% slope connects downstream to a 42-inch and 48-inch pipe at 0.61%. This intermediate reach of pipe between Quivas and Tejon should be replaced with a larger pipe (78-inch for 5-year capacity).

Project C: West Bayaud Avenue The existing system has less than a 1-year event capacity (Design Point 1516 with 351 tributary acres). The Bayaud Avenue outfall consisting of a 54-inch pipe is proposed for replacement with an 84-inch pipe for a 5-year system. (Alternatively, a 100-year system to serve the sump at Galapago & Bayaud would require a 120-inch pipe outfall.) At Galapago, the proposed pipe jogs over to Ellsworth Avenue to preserve the existing trunk system upstream. Since flooding is known to occur in Broadway, the proposed storm system extends to Lincoln to provide additional storm conveyance in this area.

Project D: West Ellsworth Avenue A short 24-inch storm drain outfall in Ellsworth under I-25 should be replaced with a 54-inch pipe to provide 5-year capacity.

Project E: West Mulberry Place A new 48”x72” box culvert outfall is proposed in Mulberry Place. This 60 acre area is currently served by 15 and 18-inch outfalls. Redevelopment of the area will prompt the construction of a new outfall.

Project F: West 3<sup>rd</sup> Avenue Outfall A new 78-inch outfall will replace the existing 60-inch outfall in 3<sup>rd</sup> Avenue to achieve a 5-year level of service.

Project G: West Colfax Avenue Improvements 18-inch upgrades and replacement of an existing 36-inch pipe with a new 60-inch pipe is proposed in this general area.

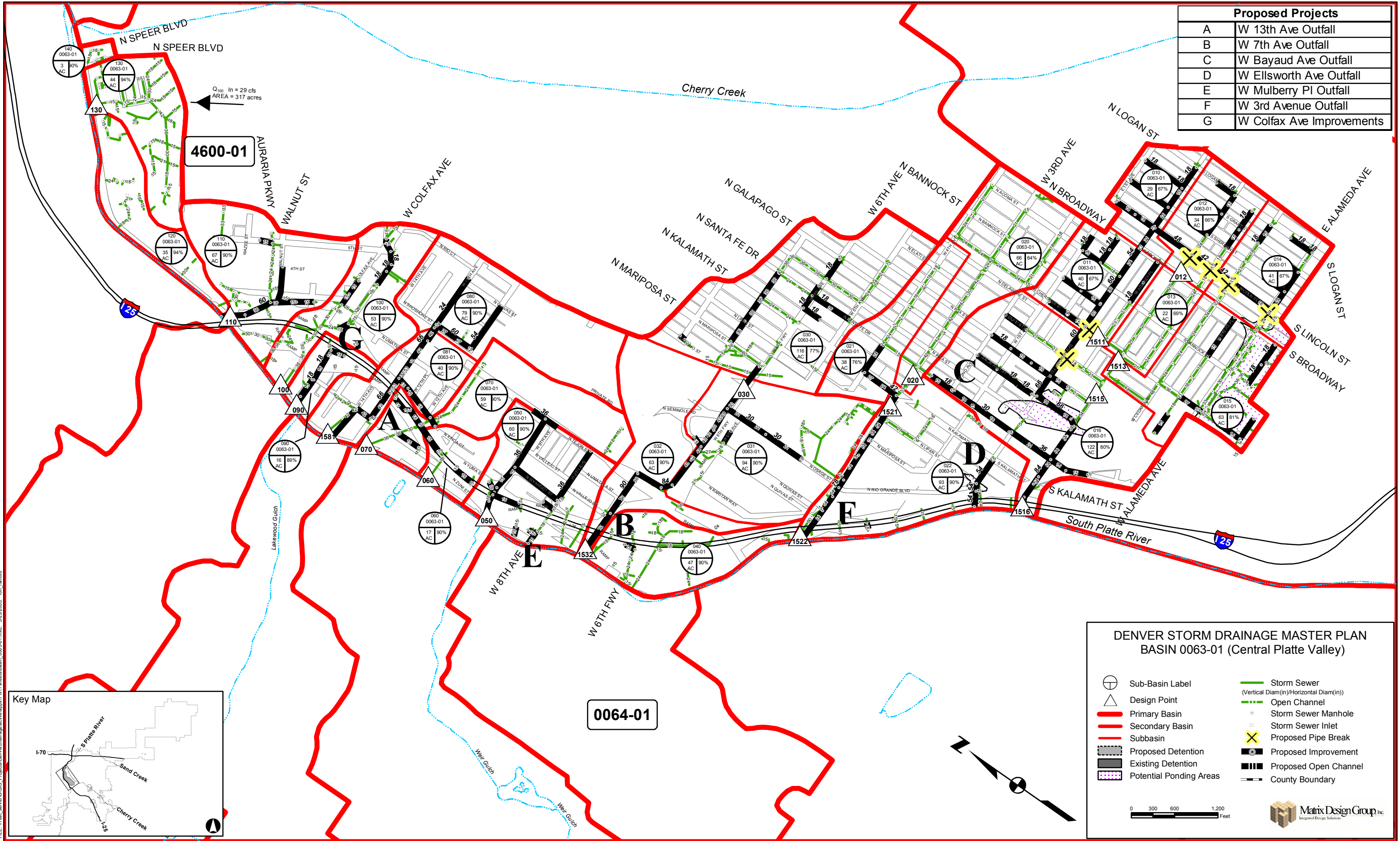
### Existing Hydrology:

#### BASIN 0063-01

Design Point Minor Event Model	Design Point Overland Flow Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge*		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
12		12	34	38	62	148
20		20	66	47	78	192
30		30	116	160	246	546
50		50	60	98	142	292
60		60	17	27	39	81
70		70	59	75	109	229
90		90	16	24	35	74
100		100	53	70	102	214
110		110	67	106	154	317
130	1070	130	44	74	106	<b>176</b>
1511		10,11	69	66	106	263
1513		10-13	125	115	190	477
1515		10-15	229	207	333	820
1516		10-16	351	276	431	1111
1521		20,21	104	89	143	338
1522		20-22	197	192	276	581
1532		30-32	273	299	391	922
1581		80,81	119	122	179	411

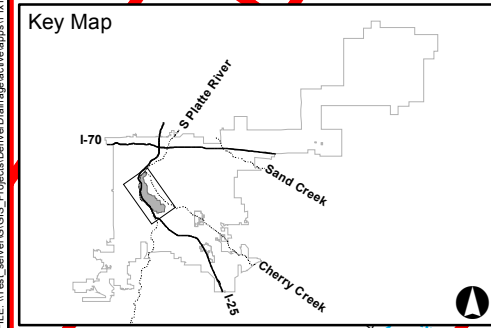
\* 100-year discharge in **bold** represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths.

Proposed Projects	
A	W 13th Ave Outfall
B	W 7th Ave Outfall
C	W Bayaud Ave Outfall
D	W Ellsworth Ave Outfall
E	W Mulberry Pl Outfall
F	W 3rd Avenue Outfall
G	W Colfax Ave Improvements



4600-01

0064-01



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## Basin 0064-01 (1<sup>st</sup> & Federal)

### Existing System Description:

This basin is tributary to Weir Gulch and the South Platte River by topography and pipe network. In general, this basin is located south of Weir Gulch. This basin consists of 610 acres (0.95 square miles) and includes residential in the upper reaches, and industrial/commercial in the lower reaches. Much of the industrial land is within the current South Platte River floodplain.

Intercepted stormwater is discharged in 8 storm drainage outfalls, which is comprised of two to Weir Gulch and 6 directly to the South Platte River. The outfalls include:

#### Weir Gulch

- Irving Street outfall is 38"x60" with 208 tributary acres
- Grove Street outfall is 42-inch with 78 tributary acres

#### South Platte River

- Yuma Street outfall is 24-inch for local drainage
- 5<sup>th</sup> Avenue outfall is 42-inch with 177 tributary acres
- 6<sup>th</sup> Avenue 42-inch outfall for 72 tributary acres
- 6<sup>th</sup> Avenue 15-inch outfall for local drainage
- 7<sup>th</sup> Avenue 36-inch outfall
- 8<sup>th</sup> Avenue 24-inch outfall

The storm drain infrastructure consists of a random network of drains and laterals in the low reaches and collectors in the residential reaches. The condition of the existing inlets is unknown at this time.

*Blueprint Denver* shows the Federal Boulevard subject to change along with some of the commercial/industrial area adjacent to the South Platte River. The residential neighborhoods are shown as "Areas of Stability" in *Blueprint Denver*.

### Drainage Deficiencies:

Significant portions of Basin 0064-01 are within the South Platte River regulatory floodplain, including sub-basins 10, 20, and 32.

The areas in the South Platte River floodplain have capacity for the 2-year storm event, although this area should have a 5-year level of service by land use criteria.

### Proposed Capital Improvements:

Proposed South Platte River channel improvements will remove much of the development in this basin from the regulatory floodplain. The lower reaches of Weir Gulch have been improved to convey drainage from the 100-year event and even includes 500-year capacity culverts.

No major drainage complaints have been reported in these basins outside the regulatory floodplains due to the relatively steep gradient toward the receiving drainageways and lack of sumps or flat areas. This basin generally meets Denver drainage criteria. The roads and drainage pipe convey the 2-year storm event in residential areas and 5-year storm event in the commercial/industrial areas.

Most of the capital improvements proposed in the 1989 Master Plan have been constructed. This area has been improved by construction of diversion facilities to Weir Gulch implemented since the 1989 plan.

A difficulty in constructing additional or replacement storm drain outfalls is presence of the Metro Sanitary Sewer along the west bank of the South Platte River. Otherwise, railroad tracks and the interstate are located on the opposite bank of the South Platte, and there are relatively few obstructions for new storm pipe in this basin. Proposed projects include:

Project A: West 3<sup>rd</sup> Avenue Outfall Storm drain laterals are extended further into the basin to reduce street flooding. Storm pipes smaller than 18" have been upgraded to 18" per current criteria.

Project B: West 8<sup>th</sup> Avenue Outfall A new 48-inch outfall is proposed in 8<sup>th</sup> Avenue.

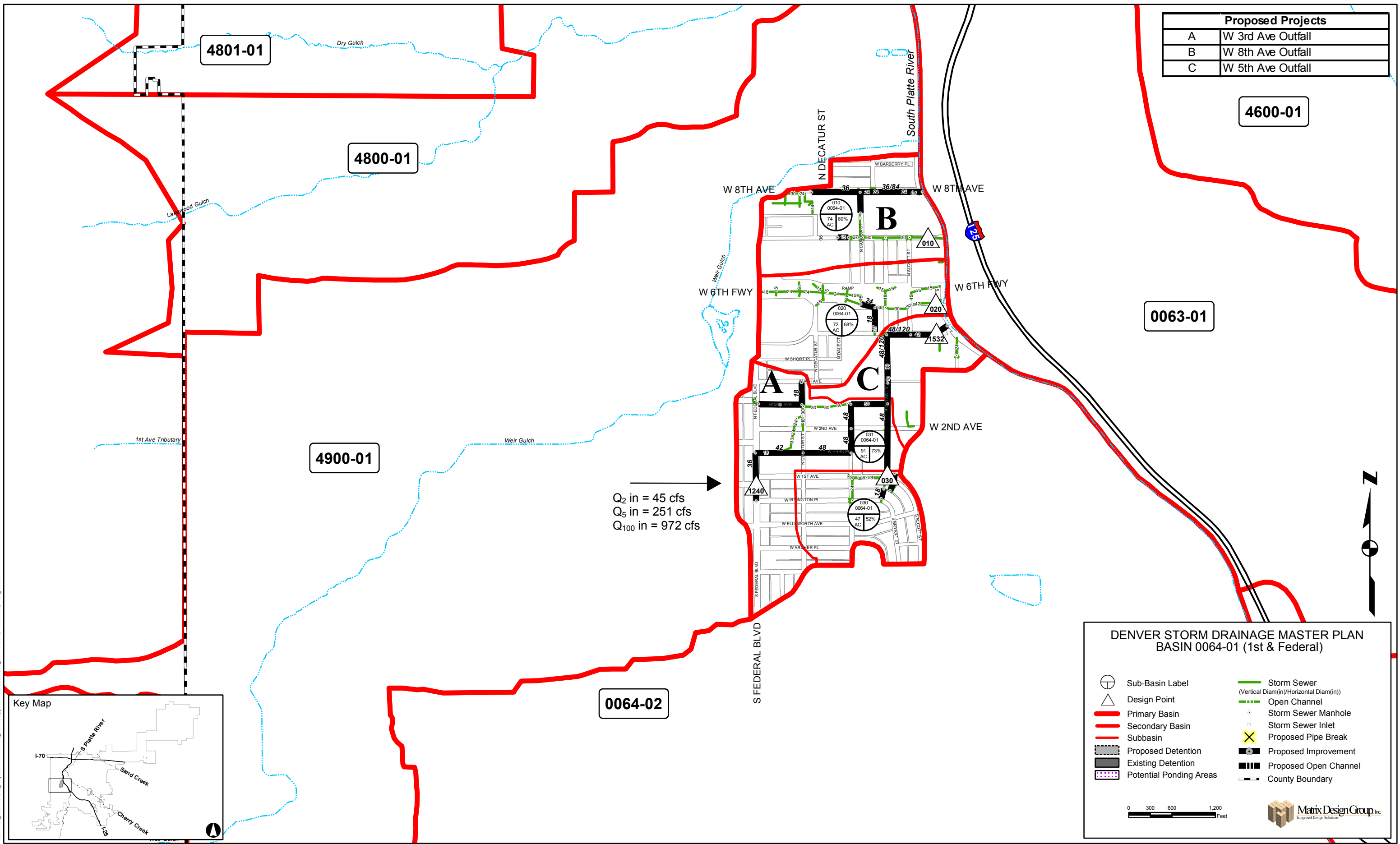
Project C: West 5<sup>th</sup> Avenue Outfall A new 72-inch outfall is proposed in 5<sup>th</sup> Avenue to better serve properties in the current South Platte River floodplain. All 12-inch and 15-inch collector storm drains do not meet current drainage criteria and have been proposed for replacement with 18-inch pipes.

### Existing Hydrology:

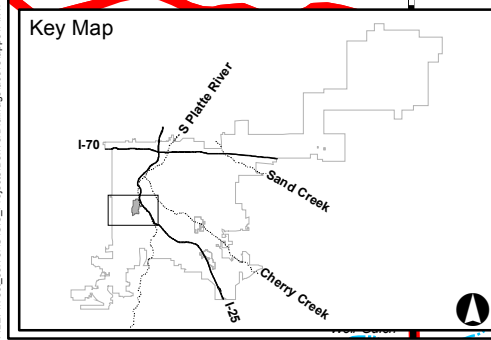
#### **BASIN 0064-01**

<u>Design Point</u>	<u>Contributing Basins</u>	<u>Tributary Area</u> (acres)	<u>Peak Discharge</u>		
			<u>2-Year</u> (cfs)	<u>5-Year</u> (cfs)	<u>100-Year</u> (cfs)
10	10	74	102	149	311
20	20	72	69	112	265
30	30	47	41	75	195
50	50	208	209	361	915
1240	split	split	45	251	972
1532	30,31,32,split	split	159	362	1374

Proposed Projects	
A	W 3rd Ave Outfall
B	W 8th Ave Outfall
C	W 5th Ave Outfall



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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0064-01 (1st & Federal)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

## Basin 0064-02 (Valverde)

### Existing System Description:

This basin drains to the South Platte River between 4<sup>th</sup> Avenue on the north and Sanderson Gulch on the south. The western boundary of the basin is Morrison Road. This basin consists of 1701 acres (2.66 square miles). Much of the upper basin is comprised of residential neighborhoods, while the lower portion is mostly commercial/industrial along the South Platte River. An existing detention basin is located in West-Bar-Val-Wood-Park. Improvements have been constructed along Mississippi Avenue since the 1989 plan, which drain to Sanderson Gulch. The improvements effectively remove the Huston Lake area from this basin when considering the minor storm events.

The storm drain infrastructure consists of a network of trunk lines and laterals including fifteen outfalls. Drainage from the basin is constrained by the South Platte River floodplain, which parallels the west side of the river throughout the basin and has minimal topographic relief.

**BluePrint Denver** shows Federal Boulevard, Alameda Avenue, and Morrison Road subject to change, along with some of the commercial/industrial areas adjacent to the South Platte River.

Currently, a significant portion of the drainage basin (55% of the tributary area) outfalls through one 54"x108" box culvert at Vallejo Street. Design point 1150 shows that 942 acres are tributary to this one outfall.

### Drainage Deficiencies:

The existing pipe system that outfalls into the South Platte along Vallejo Street is undersized. Generally, the lower portion of the system is located in the South Platte floodplain, which is relatively flat for drainage purposes. The 54"x108" box culvert is deficient due to the minimal 0.19% slope. The system can convey the 2-year event in some areas but not in others. A 5-year design criteria should be set for this industrial area.

The storm sewers around West-Bar-Val-Wood-Park along Bayaud Avenue, Yuma Street, Cedar Avenue, and Alcott Street are undersized.

The system in Dakota Avenue below Federal Boulevard will convey less than a one-year event. Storm drains below the commercial areas of Federal Boulevard should be sized for a 5-year event according to Denver's storm drainage criteria. Storm sewers are almost non-existent along Federal Boulevard, which is a major transportation arterial along west Denver.

Localized drainage problems occur in the industrial areas along the river mostly due to relatively flat grades. The areas north and south of Vanderbilt Park have been identified with these types of drainage problems as well as properties along S. Jason Street.

### Proposed Capital Improvements:

This basin requires improvements primarily to the outfall since the lateral network is currently extensive in this basin. The outfall should have 5-year capacity, whereas the lateral network through the residential areas should have a 2-year capacity.

**Project A: 18-Inch Upgrades** Upsizing various pipes to the City's 18-inch minimum diameter is proposed to meet current drainage criteria.

**Project B: S. Huron St. Outfall** A 36-inch outfall is proposed along Huron Street to serve commercial properties along the South Platte River in the southern portion of the basin.

**Project C: W. Alameda Ave. Outfall** A new 42"x120" box culvert is proposed along Alameda Avenue in conjunction with a new 42"x120" box culvert along Byers Drive to relieve the existing Vallejo Street system. The new pipes will receive a portion of the flow from the Alameda/Alcott intersection, while the remainder of the flow will be conveyed by the existing Vallejo Street outfall. Improvements are proposed in Alcott Street between Alameda and Virginia Avenues. The existing 66-inch pipe between Alameda and Dakota Avenues can be up-sized to an 84-inch pipe to convey the 5-year event. A new 60-inch pipe is proposed between Dakota and Virginia Avenues to connect the proposed Virginia Avenue line to the main system. The proposed 60-inch pipe along Virginia Avenue will relieve the existing system in Dakota Avenue by providing additional conveyance to serve sub-basins 50, 60, 70, and 90. The improvements extend west of Federal Boulevard and then along Federal Boulevard (or the alley west of Federal) to provide stormwater interception for Federal Boulevard.

**Project D: W. Arizona Ave. Outfall** A 48-inch outfall is proposed along Huron Street to serve commercial properties along the South Platte River in the southern portion of the basin.

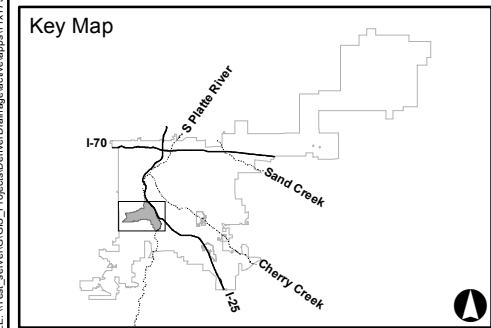
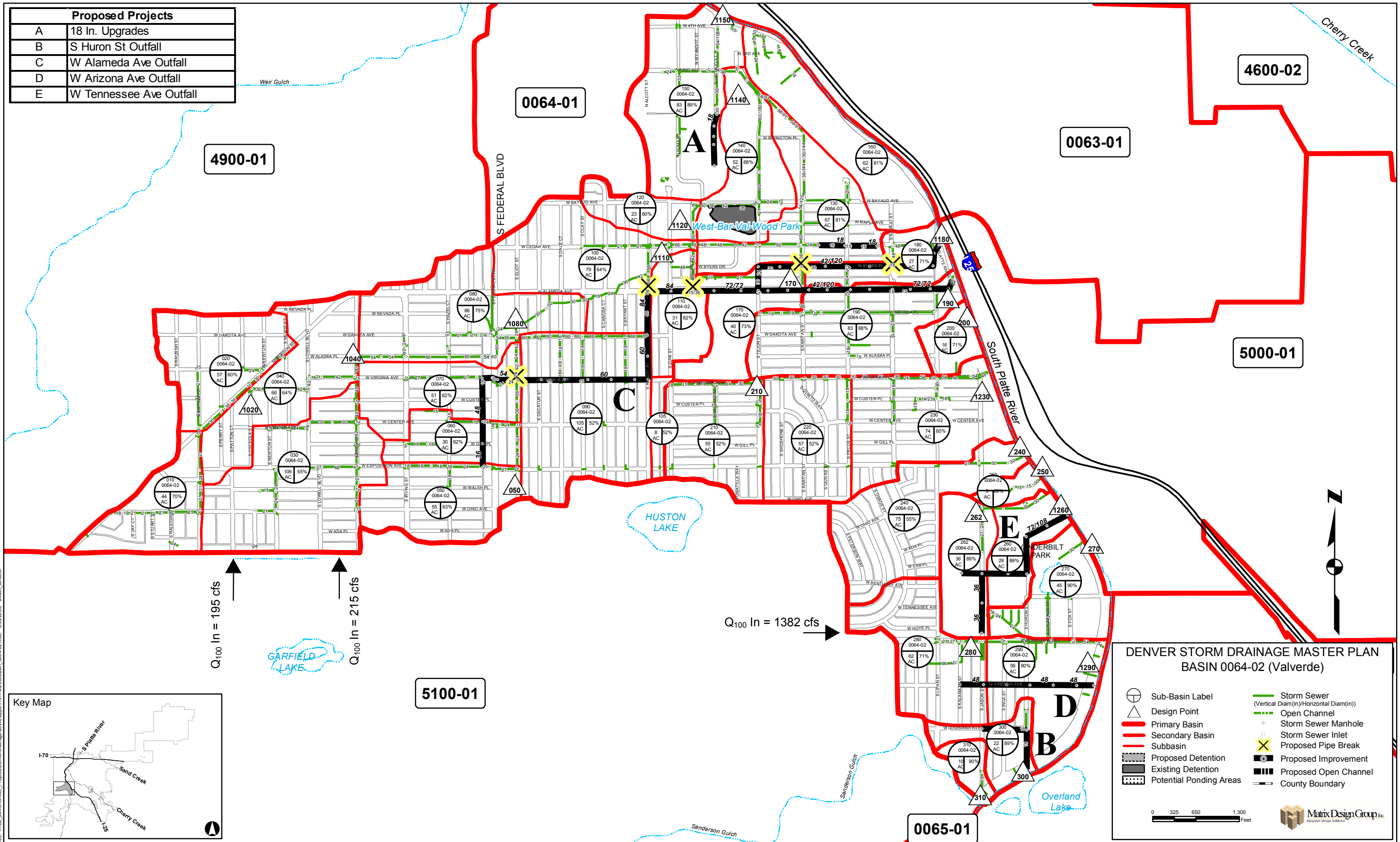
**Project E: W. Tennessee Ave. Outfall** A new 9'x6' outfall is proposed along Huron Street near Vanderbilt Park to reduce flooding along Jason Street and drain areas west of the railroad spur.

### Existing Hydrology:

#### **BASIN 0064-02**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
50	50	55	46	78	189
160	160	62	99	144	301
170	170	40	38	61	140
190	190	83	68	110	262
200	200	16	19	30	69
210	210	55	37	68	179
240	240	75	47	83	215
250	250	9	14	21	43
262	262	36	51	75	155
270	270	40	64	93	192
280	280	62	52	83	194
300	300	22	32	47	99
310	310	10	16	24	49
1020	10,20	101	87	135	339
1040	10,20,30,40	274	199	322	836
1080	10-80	495	364	536	1425
1090	10-90	600	391	614	1665
1110	10-110	718	441	708	1957
1120	10-120	740	450	729	2014
1124	10-120	740	233	612	1897
1140	10-140	859	282	631	2086
1150	10-150	942	309	662	2237
1180	170,180	67	47	73	157
1230	210,220,230	186	99	159	454
1260	260,262	65	80	120	263
1290	280,290	118	110	166	334

Proposed Projects	
A	18 In. Upgrades
B	S Huron St Outfall
C	W Alameda Ave Outfall
D	W Arizona Ave Outfall
E	W Tennessee Ave Outfall



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0064-02 (Valverde)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 325 650 1,300 Feet

Matrix Design Group Inc.  
Regional Design Solutions

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## Basin: 0065-01 (Ruby Hill)

### Existing System Description:

The Ruby Hill basin is bounded between Federal Boulevard and the South Platte River, and generally between Jewell Avenue and Iliff Avenue. Ruby Hill Park is located along the South Platte River in the northern portion of this basin, north of Jewell Avenue. A Power Plant is located in the southern portion of the basin along the South Platte River. Approximately 20% of the basin is located within the boundaries of Englewood (south of Evans, between Zuni and Pecos), and the remainder is in Denver.

Ruby Hill is approximately 1.25 square miles in size and is fully developed with residential properties in the upper reaches, and industrial properties in the lower reaches along the banks of the South Platte River. The basin is relatively steep with Evans Avenue generally being the low point (thalweg) of the drainage basin.

The Evans system outfalls via a 72" pipe to the South Platte River. Other outfalls in the basin include smaller pipes (less than 36") in Warren, Iliff and Wesley Avenues.

### Drainage Deficiencies:

The existing drainage system has capacity to convey less than the 5-year storm event within Evans Avenue and Jewell Avenue. Potential Ponding areas occur within basins 300, 310 and 320, in a commercial area, where the railroad embankment blocks the flow path to the South Platte River. The flat topography along the South Platte River makes it difficult to adequately drain the lower portion of this basin. Other problem areas include:

- Basins 220, 230, 240, 250 and 260, which drain an industrial/residential area, should be sized for the 5-year event. The 5-year flow rate is 432 cfs. The existing 36-inch storm sewer capacity cannot handle even the 2-year event of 262 cfs.

### Proposed Capital Improvements:

Drainage improvements in these basins should be viewed primarily to achieve the minimum objectives for residential and commercial areas (2- and 5-year system capacities) established for the City and County of Denver. Although this basin has not been identified by *Blueprint Denver* as a significant area of change, re-development of this area could provide an opportunity to construct the proposed facilities. Two existing detention basins exist within the upper portion of the basin. These facilities are small and no improvements to these facilities are proposed.

The proposed storm sewer improvements are summarized below:

**Project A: 18-inch Upgrades** Includes upsizing an existing 15-inch storm sewer to an 18-inch storm sewer. The lateral is located within the alley between Lipan Street and Jason Street.

**Project B: W. Evans Ave. Outfall** Upsize the existing storm sewer facility to a 5-year capacity within Evans Avenue to the existing detention pond at W. Pacific Place.

**Project C: W. Jewell Avenue Outfall** Construct a new 5-year storm sewer to collect and convey storm flows through the railroad embankment and around the commercial site along South Pecos Street and Evans Avenue.

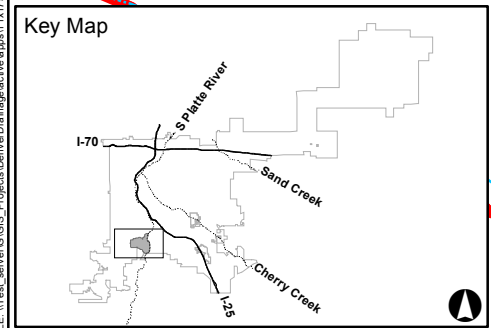
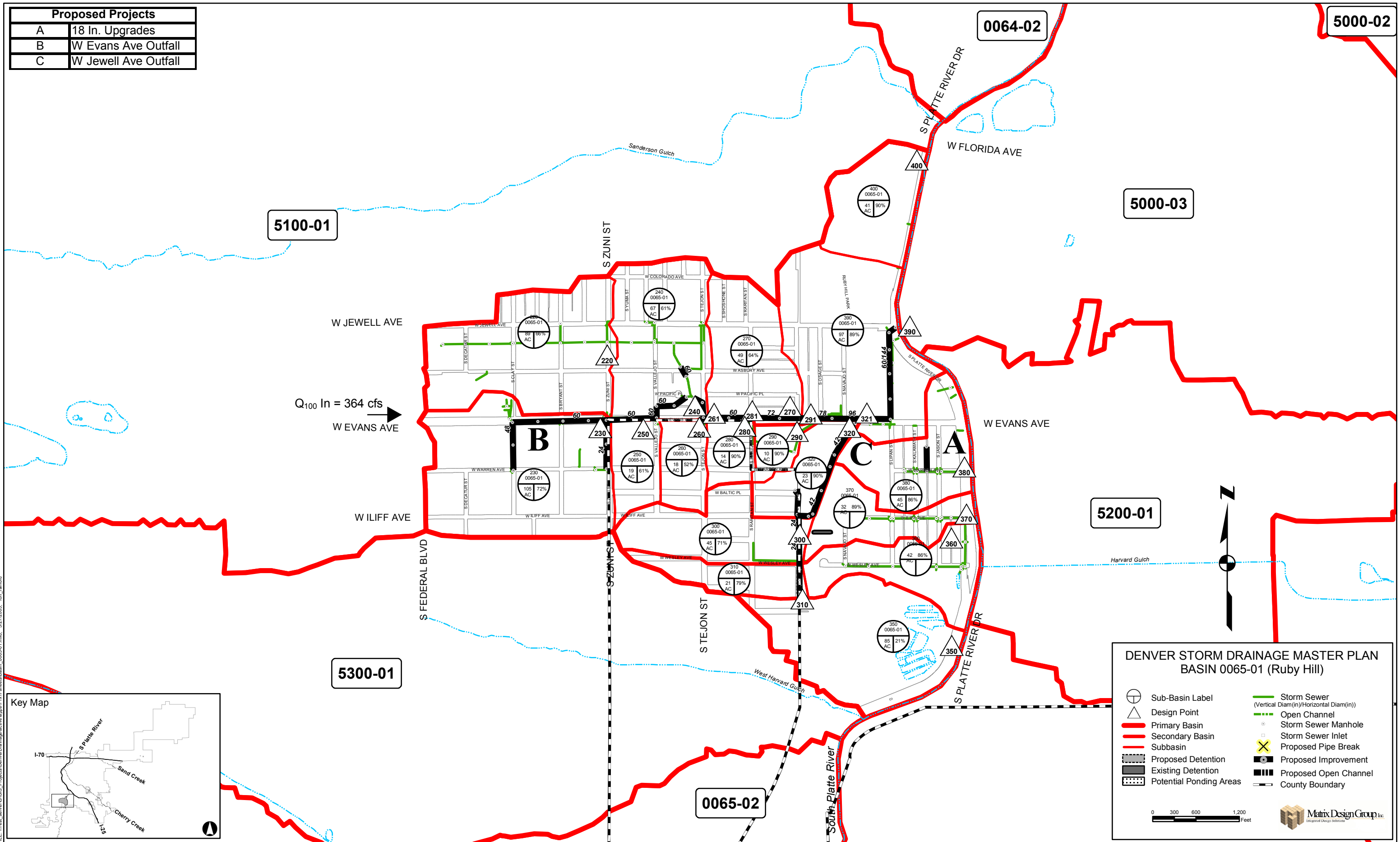
### Existing Hydrology:

#### BASIN 0065-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
220	220	89	80	131	315
230	230	105	135	214	489
240	240	67	50	85	211
250	230,250	124	140	226	533
260	260	18	14	25	66
261	220,230,240,250,260	403	262	432	1017
270	270	49	42	70	169
280	280	14	22	32	67
281	261,280	417	276	448	1058
290	290	10	15	21	45
291	270,281,290	476	329	518	1246
300	300	45	50	80	186
310	310	23	32	48	106
320	320	21	33	48	100
321	291,320	497	341	565	1310
350	350	85	22	65	228
360	360	42	72	109	229
370	300,310,360,370	501	158	243	528
380	380	45	54	79	171
390	321,390	142	382	584	1556
400	400	41	66	96	197



Proposed Projects	
A	18 In. Upgrades
B	W Evans Ave Outfall
C	W Jewell Ave Outfall



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0065-01 (Ruby Hill)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Integral Design Solutions

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## Basin: 0065-02 (Dartmouth)

### Existing System Description:

The Dartmouth Basin borders West Harvard Gulch directly to the south.

The Dartmouth basin is bounded between Federal Boulevard and the South Platte River, and generally between Amherst Avenue and Hampden Avenue. Most of the basin is located within the boundaries of Englewood, and only about 30% of the basin is in Denver. Denver's portion includes the upper steep reaches between Federal and Zuni, and an industrial complex located along the banks of the South Platte River.

Dartmouth Basin is approximately 0.76 square miles in size and is fully developed with residential properties in the upper reaches, and industrial properties in the lower reaches along the banks of the South Platte River. Land use mix in the basin is about 1/3 residential and 2/3 commercial and industrial. The basin is relatively steep with Dartmouth Avenue generally being the low point (thalweg) of the drainage basin.

No outfall pipes in this basin are shown in the Denver GIS database. However, we expect there is a system in Dartmouth and other smaller localized outfalls.

### Drainage Deficiencies:

Currently this basin drains east to Englewood's storm sewer system along Dartmouth which then drains back to Denver's storm sewer system before entering the South Platte River. The 5-year flow rate is 465 cfs. The existing 72-inch storm sewer capacity is sufficient to drain this basin.

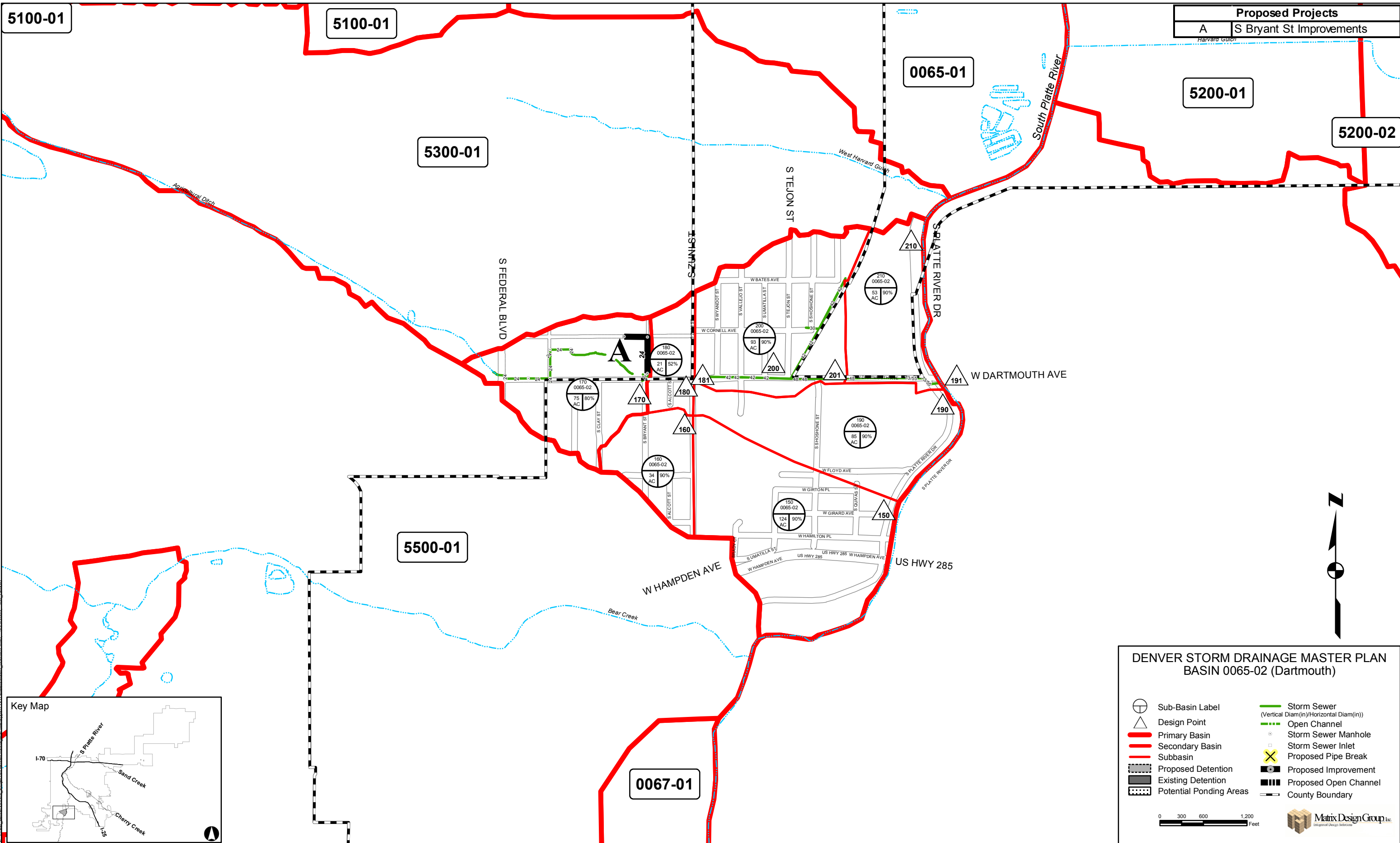
### Proposed Capital Improvements:

Project A: S. Bryant Street Improvement Only a small improvement is recommended along South Bryant Street from Dartmouth Avenue to and along West Cornell Avenue. A 24-inch, 2-year capacity storm sewer is proposed.

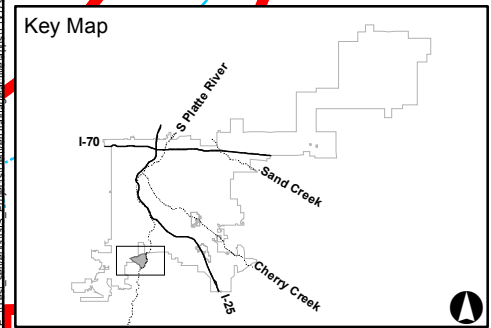
### Existing Hydrology:

#### BASIN 0065-02

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
150	150	122	203	293	602
160	160	34	54	79	162
170	170	75	108	163	355
180	180	21	17	32	82
181	160,170,180	130	180	258	596
190	190	85	105	152	320
191	160,170,180,190,200	308	405	550	1243
200	200	93	153	221	453
201	160,170,180,190,200	401	318	425	935
210	210	54	65	95	201



Proposed Projects	
A	S Bryant St Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0065-02 (Dartmouth)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Engineering Design Solutions



## Basin: 0067-01 (College View)

### Existing System Description:

The College View basin has a total drainage area of approximately 1.5 square miles. This basin flows east through Denver and Littleton to its confluence with the South Platte River. The lower portion is outside the City and County of Denver and was not studied. The basin is currently fully developed with the exception of a few scattered vacant lots including residential, commercial and industrial areas.

### Drainage Deficiencies:

The entire storm sewer within the College View basin is adequately sized for the 2-year storm event. However, the storm sewer system should have 5-year capacity due to the commercial areas through the neighborhood. Much of the residential area along West Quincy Avenue does not have any storm sewer system and would benefit from a new lateral.

### Proposed Capital Improvements:

Two major storm drain projects have been proposed in this basin to increase the level of service from a 2-year capacity to a 5-year capacity.

Project A: S. Quitman Street Improvements A new 24-inch to 42-inch storm sewer from Quincy and Lowell to Quitman Street is proposed. A 30-inch lateral will be extended down S. Newton Street.

Project B: West Union Avenue Improvements The existing storm sewer system along West Union Avenue does not meet the minimum required performance objectives for a 5-year storm sewer. Upsizing the existing storm sewer system will satisfy this requirement.

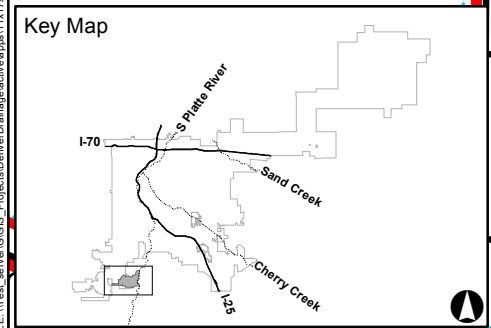
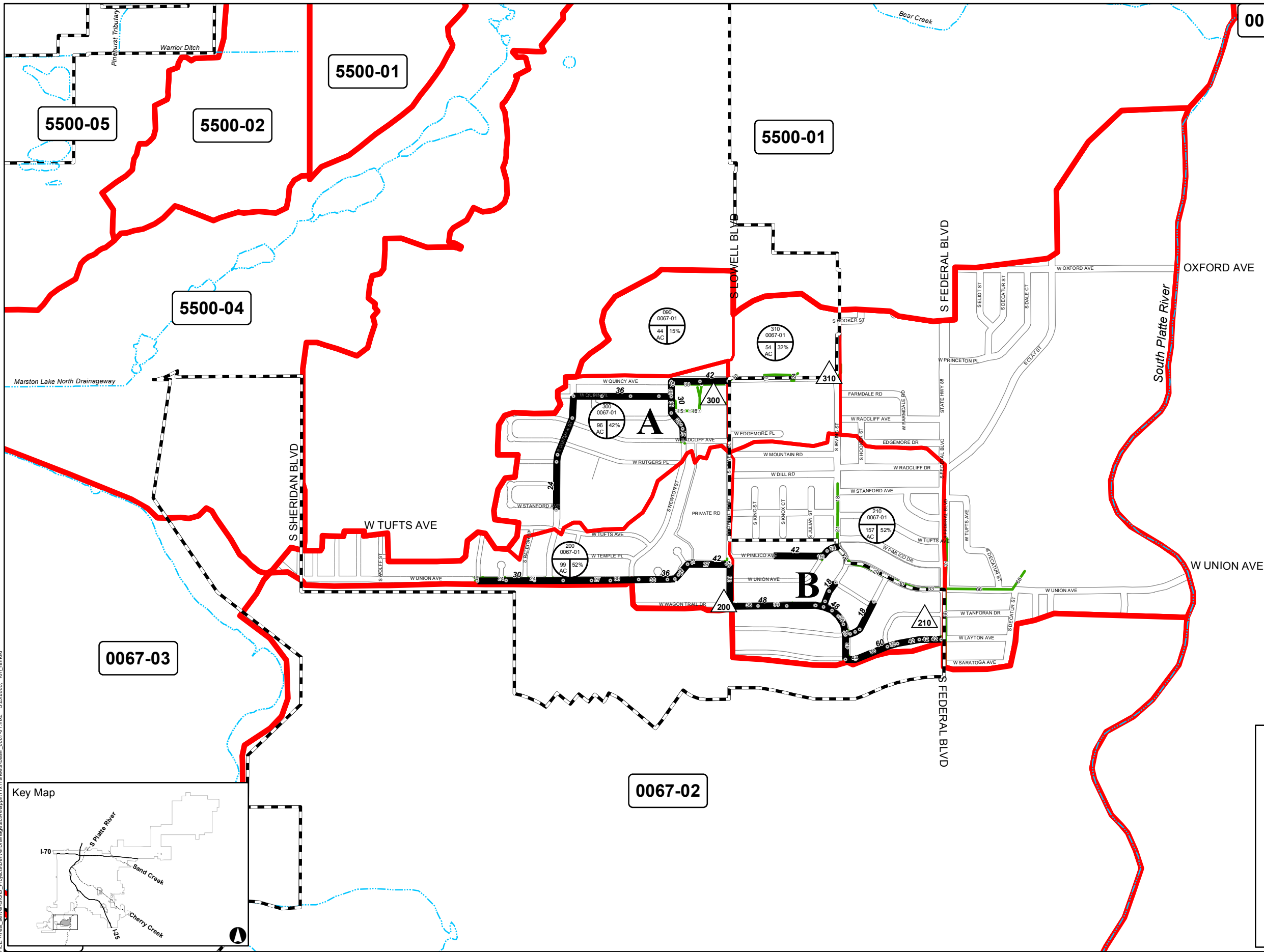
Difficulties in constructing a new outfall system for this basin would include coordination with downstream municipalities at the two outfall locations, Lowell Boulevard and Federal Boulevard. Agreements should be in place before any designs are considered.

### Existing Hydrology:

#### BASIN 0067-01, 0067-02

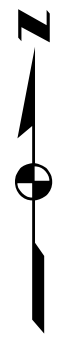
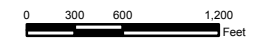
Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
20	5,10,20	764	768	1148	2534
30	30	23	12	26	76
40	30,40	51	30	58	158
50	50	116	110	181	433
60	60	43	29	53	139
70	70	100	93	167	430
80	70,80	252	191	355	943
90	70,80,90	362	245	467	1308
200	200	99	55	100	267
210	200,210	256	166	306	779
300	300	96	45	91	260

0065-02 Proposed Projects	
A	S Quitman St Improvements
B	W Union Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0067-01 (College View)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin: 0067-02 (West Belleview)

### Existing System Description:

The Fort Logan basin has a total drainage area of approximately 5.5 square miles. This basin flows east through Denver and Littleton to its confluence with the South Platte River. The lower portion of this basin is outside the City and County of Denver and was not studied. The upper portion of the Fort Logan basin includes Marston Reservoir. The basin is currently fully developed with the exception of a few scattered vacant lots including residential, commercial and industrial areas.

### Drainage Deficiencies:

The existing development in these basins is relatively new. Grant Ranch within basin 0067-02 has been fully developed and the storm sewer appears to be adequate in this area. The drainage basins to the north along W. Belleview Avenue and within basin 0067-02 have no existing storm sewer in Denver's GIS database.

### Proposed Capital Improvements:

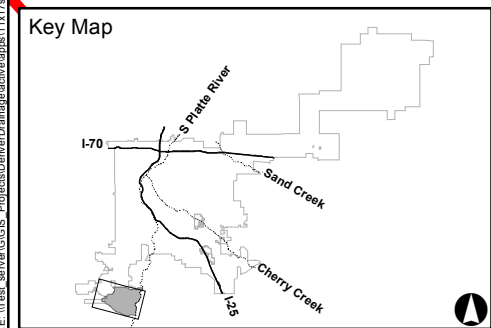
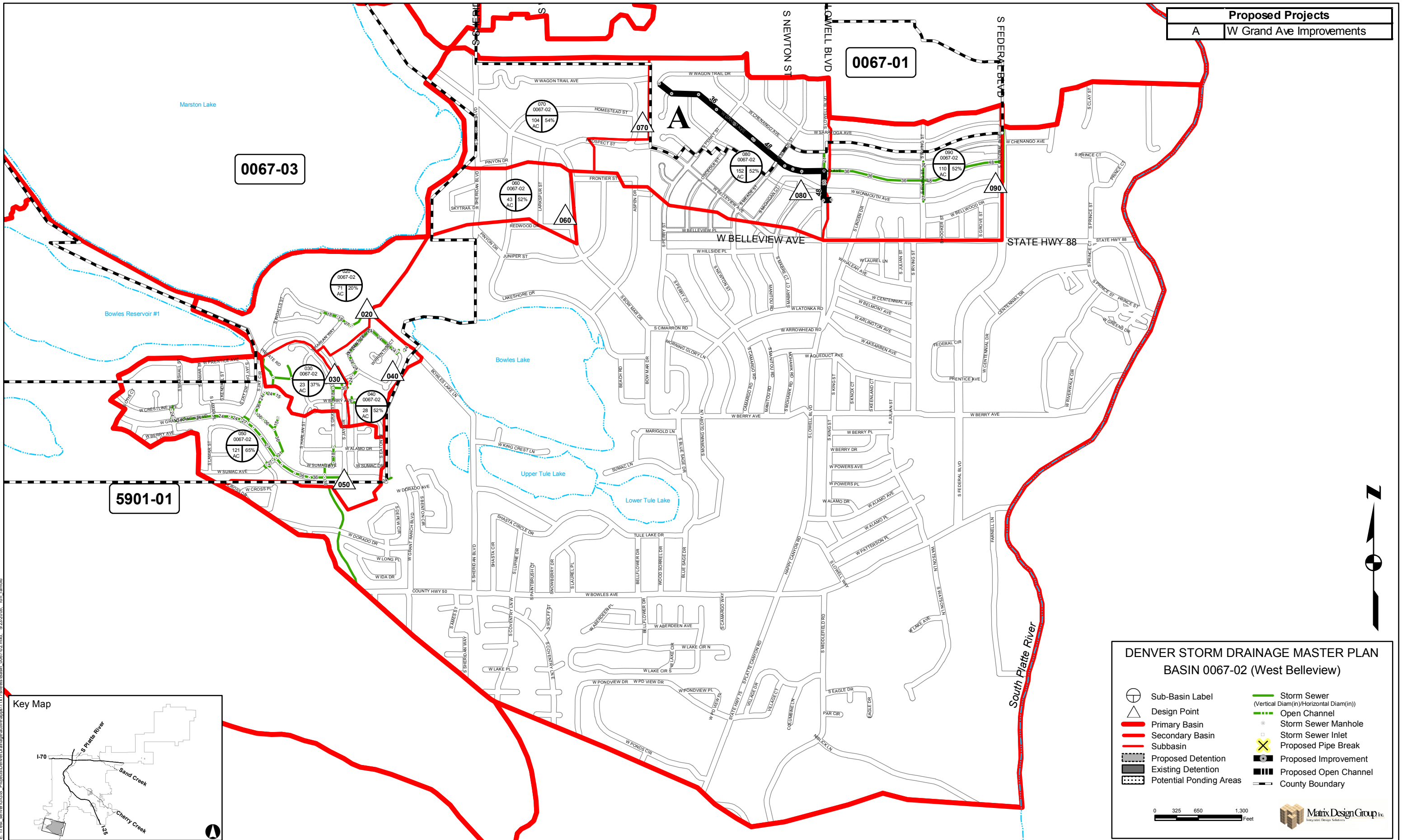
Project A: W. Grand Avenue Improvements The existing residential neighborhood along Wagon Trail Drive currently does not have any storm sewer. A 2-year capacity storm sewer system is proposed along Wagon Trail Avenue and will connect to Englewood's storm sewer system at Lowell and West Grand Avenue.

### Existing Hydrology:

#### BASIN 0067-01, 0067-02

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
20	5,10,20	764	768	1148	2534
30	30	23	12	26	76
40	30,40	51	30	58	158
50	50	116	110	181	433
60	60	43	29	53	139
70	70	100	93	167	430
80	70,80	252	191	355	943
90	70,80,90	362	245	467	1308
200	200	99	55	100	267
210	200,210	256	166	306	779
300	300	96	45	91	260

Proposed Projects	
A	W Grand Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 0067-02 (West Belleview)**

Sub-Basin Label	Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
Design Point	Open Channel
Primary Basin	Storm Sewer Manhole
Secondary Basin	Storm Sewer Inlet
Subbasin	Proposed Pipe Break
Proposed Detention	Proposed Improvement
Existing Detention	Proposed Open Channel
Potential Ponding Areas	County Boundary

0 325 650 1,300 Feet

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## Basin: 0067-03 (Marston Lake)

### Existing System Description:

The Marston Lake basin has a total drainage area of approximately 1.1 square miles. This basin is within Denver and has no outlet. A 12-foot high berm surrounds the reservoir and keeps any storm water from leaving. A small portion of Marston Reservoir does include a small residential area with no outlet.

### Drainage Deficiencies:

No drainage deficiencies are identified at this time.

### Proposed Capital Improvements:

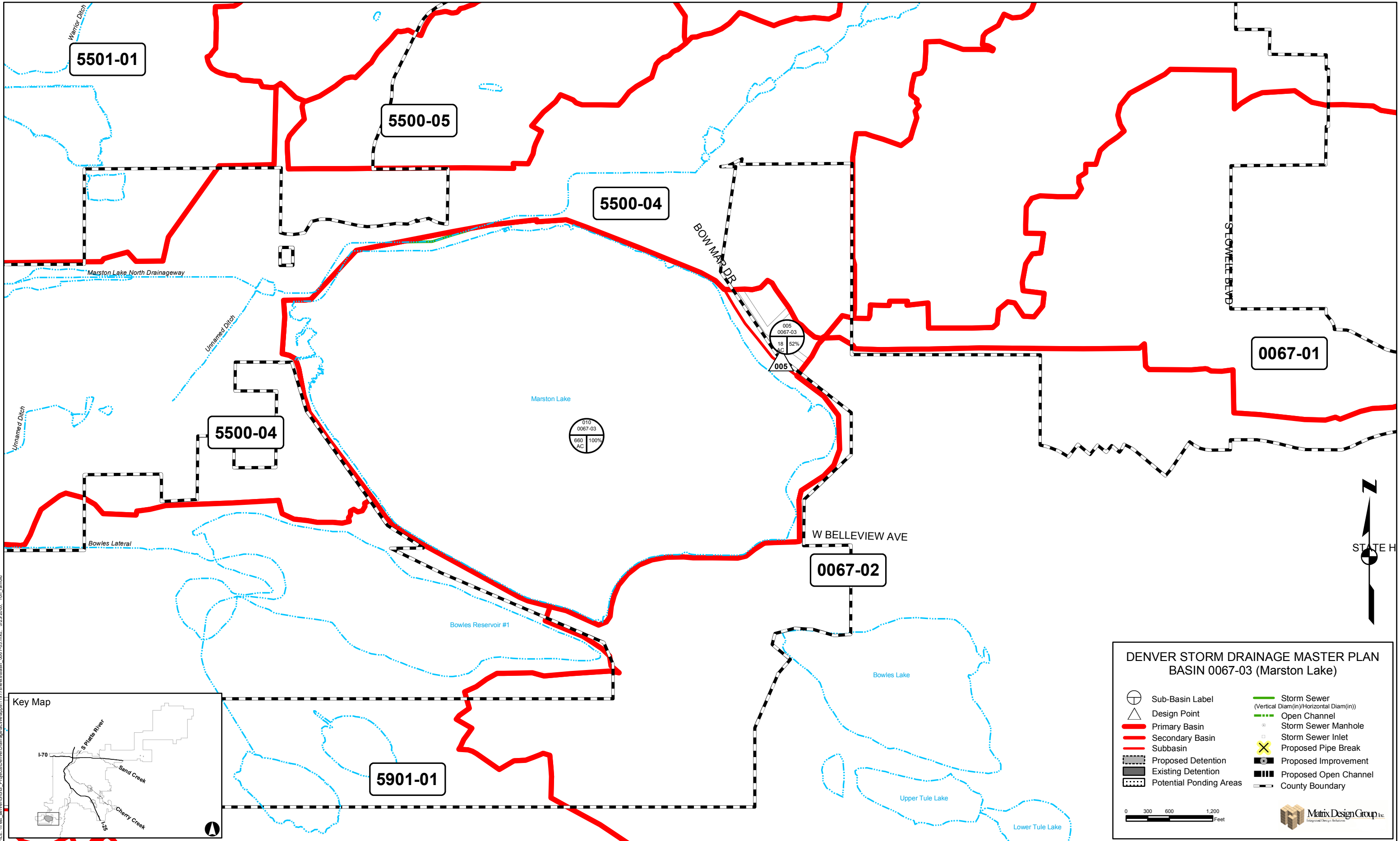
No improvements are proposed.

### BASIN 0067-03

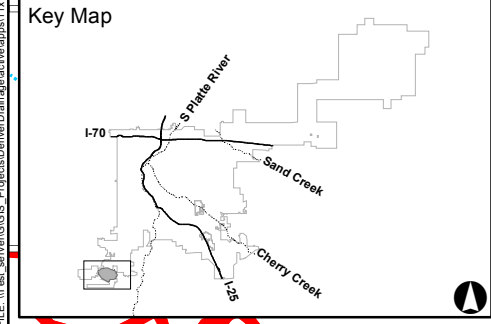
<u>Design Point</u>	<u>Contributing Basins</u>	<u>Tributary Area</u> <i>(acres)</i>	<u>Peak Discharge</u>		
			<u>2-Year</u> <i>(cfs)</i>	<u>5-Year</u> <i>(cfs)</i>	<u>100-Year</u> <i>(cfs)</i>
5	5	23	19	35	91
10	5,10	670	833	1202	2487

### Existing Hydrology:





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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0067-03 (Marston Lake)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Integrated Design Solutions

## Basin 3501-01 (West Fork Second Creek)

### Existing System Description:

The West Fork of Second Creek is located along the southern boundary of DIA within the City and County of Denver and drains about 3 square miles of area to the main branch of Second Creek. West Fork Second Creek flows across Pena Boulevard at the 90° bend and continues in a northwesterly direction, eventually outfalling to the South Platte River. There is limited existing development within the West Fork Second Creek basin. The land is mainly agricultural, with dryland farming and pasture in the upper reaches.

The Highline Canal terminates at the West Fork. The sustained unused flow in the Highline Canal is wasted to the West Fork downstream of 64<sup>th</sup> Avenue, and the flows have eroded the channel on the West Fork. At Tower Road the West Fork channel is about 15 feet deep with vertical and very steep, unstable banks. The confluence of Second Creek and the West Fork of Second Creek is a wide, relatively flat area supporting a stand of cottonwood trees. Some wetland areas are present in the upper reaches of the West Fork, but, as the channel has eroded, the channel banks have become incised and support only a narrow band of wetland or riparian vegetation. The floodplain is contained within the channel except at road crossings, where overtopping will occur. The banks are unstable and some lateral channel migration may occur during large flows.

### Identified Drainage Problems/Deficiencies:

West Fork Second Creek is largely undeveloped, and drainage is primarily via open channels and swales. There are few storm drain pipe systems within the basin. Since there is little development, the system currently functions without ponding or drainage problems, except for channel erosion which will be exacerbated by further development.

### Proposed Capital Improvements:

The drainage basin is currently mostly undeveloped with a low imperviousness of about 5%. The *Second Creek and Direct Flow Area 0053 Outfall Planning Study, Preliminary Design* completed by Urban Drainage & Flood Control District in May 1990, assumes the upper reaches of the basin will be developed with an average 70% imperviousness. The OSP calls for channel stabilization measures by constructing a series of drop structures along the channel. These improvements will be constructed commensurate with development.

The Pena Boulevard Transportation Corridor includes land extending 250 feet from centerline for a future light rail line. Therefore, existing and proposed detention ponds are not immediately adjacent to Pena Boulevard.

Two regional detention facilities are currently proposed in the basin, along with multiple, smaller detention facilities serving future developments.

### Project A: High Pointe Pond #102

The 95 acre-foot “High Pointe Pond #102” located east of Tower Road and north of 72<sup>nd</sup> Avenue was master planned to reduce flows to historic conditions in the West Fork Second Creek. Originally, this pond was planned further downstream, adjacent to Pena Boulevard; however 404 permitting required a bridge rather than a culvert under Pena. Open channel improvements will be required to serve as conveyance from future development areas into the West Fork of Second Creek. These improvements will be required as development occurs to adequately convey flows to the culvert upstream of 72<sup>nd</sup> Avenue on the West Fork of Second Creek.

### Project B: Pond ‘L’

This small Pond ‘L’ near Pena Boulevard will be constructed during development of the land, within the Denver International Business Center, to maintain historic flows in the drainageway.

### Project C: Wetland Channel Improvements

Channel stabilization is required on about 18,000 lineal feet of the West Fork Second Creek. The channel will be graded from steep unstable banks to a channel with sloped overbanks and with a top width of about 40 to 45 feet. An estimated 35 drop structures are also proposed to stabilize the channel by shallowing the existing grade.

### Project D: E. 64<sup>th</sup> Avenue Improvements

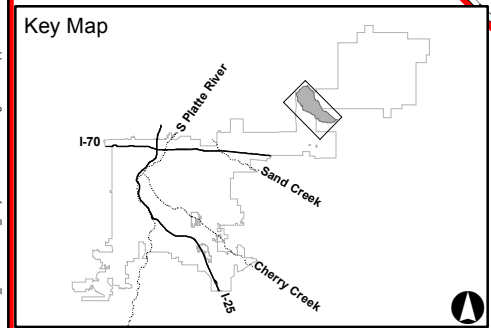
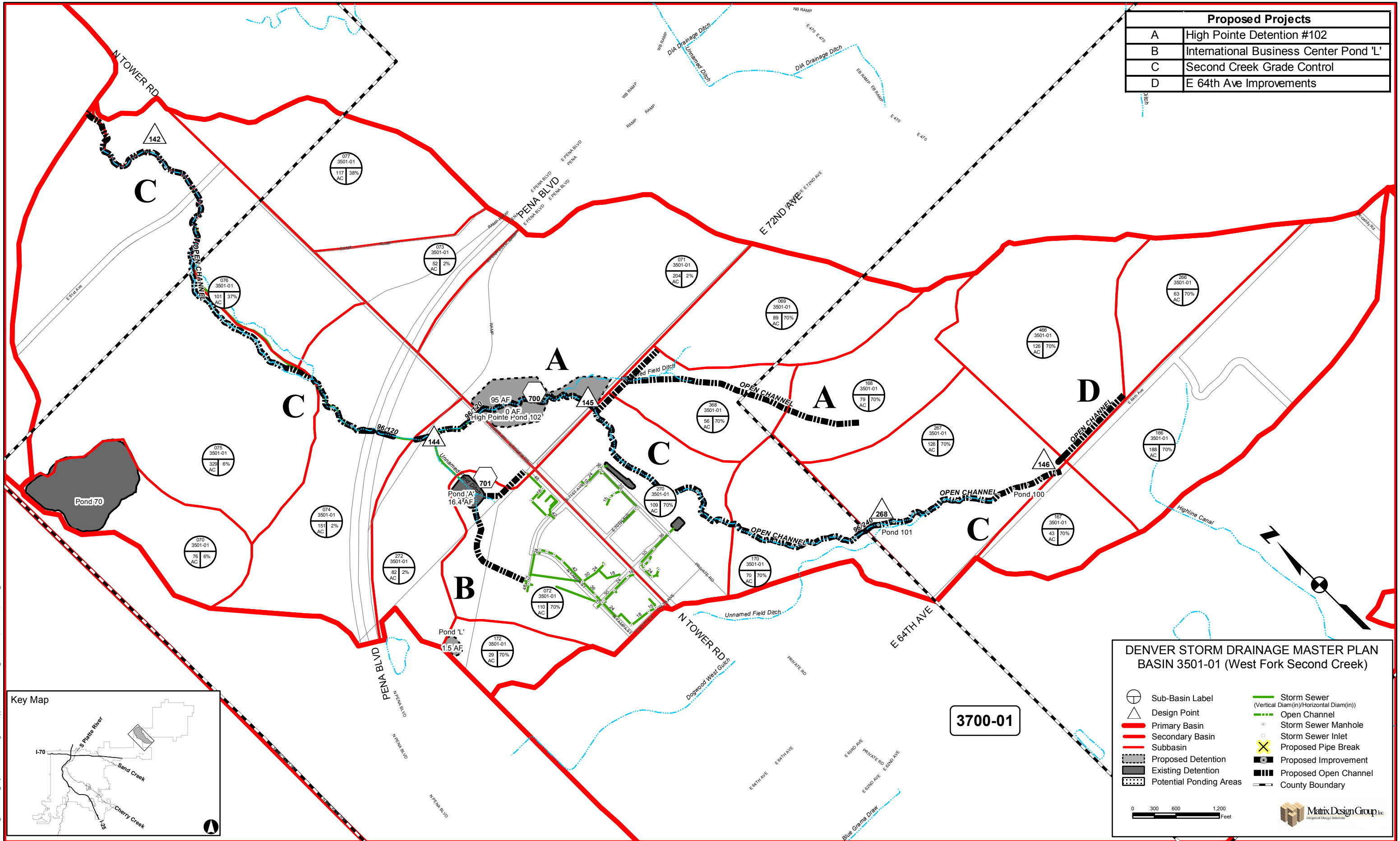
Open channel improvements will be required to serve as conveyance from future development areas into the West Fork of Second Creek. These improvements will be required as development occurs to adequately convey flows to Pond 100.

### Developed Conditions Hydrology:

#### BASIN 3501-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
142	69,71,72,73,74,75,76,77,166,167,168,170,172,266,267,270,272,368,466	2124	234	428	1636
144	69,71,72,166,167,168,170,172,266,267,270,272,368,466	1374	231	389	1208
145	69,71,166,167,168,170,266,267,270,368,466	1153	354	636	2210
146	166,167,266,466	420	392	613	1510
268	166,167,266,267,466	546	358	585	1614
700	69,71,166,167,168,170,266,267,270,368,466	1153	212	358	1077
701	72	110	15	24	100

Proposed Projects	
A	High Pointe Detention #102
B	International Business Center Pond 'L'
C	Second Creek Grade Control
D	E 64th Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3501-01 (West Fork Second Creek)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1200 Feet

**3700-01**

Matrix Design Group Inc.  
Integral Design Solutions

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## Basin 3700-01 (First Creek – Pena Corridor)

### Existing Basin Description:

The First Creek drainage basin is located south of DIA and crosses Pena Boulevard just north of 56<sup>th</sup> Avenue. West of Pena Boulevard, First Creek flows through the southeastern portion of the Rocky Mountain Arsenal. First Creek enters Rocky Mountain Arsenal with an incised, low flow channel and wide floodplain.

Basin 3700-01 is entirely within the City & County of Denver and has been defined as the area within the wide Pena Boulevard corridor that will not experience further development. However, a portion of this basin extends upstream to the outlet of the regional Green Valley Ranch Golf Course detention pond. This basin is 2.24 square miles and will include future development. General imperviousness is 8% along Pena Boulevard, and about 65% further upstream on First Creek.

### Identified Drainage Problems/Deficiencies:

The Pena Boulevard corridor is a wide area for the new roadway and contains sites planned for regional detention before outfalling into the Rocky Mountain Arsenal. The basin is actively being developed in accordance with current drainage criteria, which is the 100-year storm event. Therefore, no existing deficiencies have been identified.

### Proposed Capital Improvements:

Urban Drainage & Flood Control District prepared drainage master plans prior to development of the basin and has required incorporation of regional water quality and detention into land planning. All development in the First Creek drainage basin must detain and treat water quality on-site or in regional ponds since runoff will flow into the Rocky Mountain Arsenal. The Arsenal has strict agreements for the quantity and quality of stormwater runoff into the federal property.

Two regional detention facilities are planned for within this basin, within the Pena Boulevard corridor.

#### Project A: Dogwood Gulch Detention Pond

This 17.7 acre-foot detention pond will sit to the east of Pena Boulevard, at the outfall of Dogwood Gulch to the Pena Boulevard corridor. A 250' setback from the centerline of Pena is planned to reserve room for the future light rail/commuter train corridor. This detention pond will meter flows out to an open channel to the south, which will be routed through the planned Blue Grama Draw detention pond before outfalling to First Creek immediately upstream of Pena.

#### Project B: Blue Grama Draw Detention Pond

A 269 acre-foot detention pond is planned at the outfall of Blue Grama Draw into the Pena Boulevard corridor. A 250' setback from the centerline of Pena is planned to reserve room for the future light rail/commuter train corridor. This pond will serve to detain flows from upstream development areas, and to provide historical releases into First Creek before it enters the Rocky Mountain Arsenal. This pond will also receive diverted flows from the main channel of First Creek, to detain flows of the main channel before releasing them back to the creek upstream of Pena Boulevard.

### Master Plan Agreements:

Many documents and agreements have been compiled for the First Creek Drainage Basin which specifies 100-year discharges and storage volumes. Therefore, nothing in this master plan shall take precedence over those agreements or specified discharges. This study was completed for the purposes of analyzing initial storm flows for the 2- and 5-year events. Agreement 99-03.11, dated January 25, 2001, states the following for the Dogwood Gulch Detention Pond (#813) and the Blue Grama Draw Pond (#305):

Master Plan Design Parameters				
ID No.	Peak Inflow (cfs)	Peak Outflow (cfs)	Volume (AF)	Jurisdiction
305	2027	1929	269	Denver
813	213	83	18	Denver

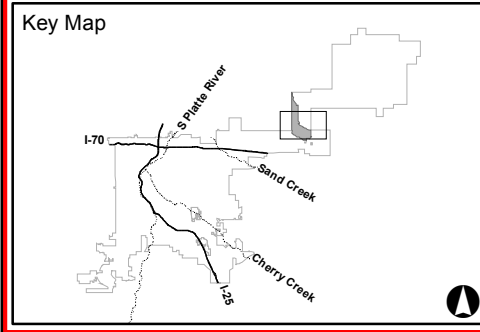
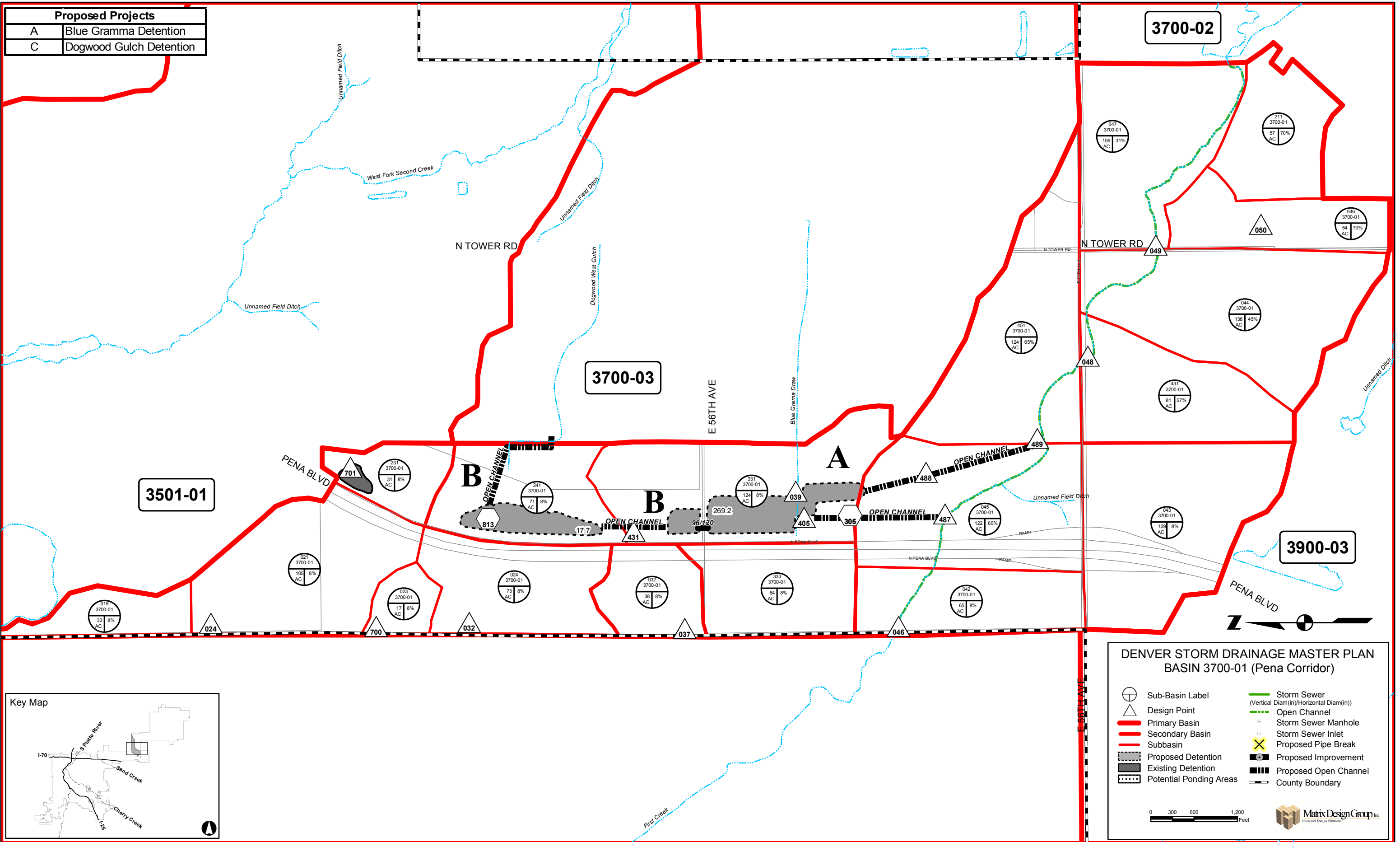
### Developed Conditions Hydrology:

The following table is provided for 2- and 5-year discharges. 100-year flows shown only for comparison purposes. Refer to agreements and Urban Drainage & Flood Control District master plans for specific discharges.

#### BASIN 3700-01

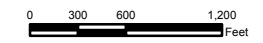
Design Point	Tributary Area (acres)	Peak Discharge		
		2-year (cfs)	5-year (cfs)	100-year (cfs)
24	184.6	71	110	327
32	57.6	2	3	57
37	64	2	4	64
39	1709.9	94	137	915
46	19378.9	684	1627	4381
48	16926.9	1111	1638	4181
49	16690.1	1107	1630	4172
50	54.1	40	58	275
405	2028.7	560	881	1898
431	318.7	23	30	106
487	19122	681	1727	1877
488	0	453	721	1644
489	17048.5	1112	1643	4184
700	17.5	0	2	-
701	31	1	3	-

Proposed Projects	
A	Blue Gramma Detention
C	Dogwood Gulch Detention



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3700-01 (Pena Corridor)**

- |  |                         |  |  |
|--|-------------------------|--|--|
|  | Sub-Basin Label         |  | Storm Sewer<br>(Vertical Diam(in)/Horizontal Diam(in)) |
|  | Design Point            |  | Open Channel   |
|  | Primary Basin           |  | Storm Sewer Manhole                                    |
|  | Secondary Basin         |  | Storm Sewer Inlet                                      |
|  | Subbasin                |  | Proposed Pipe Break                                    |
|  | Proposed Detention      |  | Proposed Improvement                                   |
|  | Existing Detention      |  | Proposed Open Channel                                  |
|  | Potential Ponding Areas |  | County Boundary  |



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## Basin 3700-02 (First Creek – Green Valley Ranch)

### Existing Basin Description:

Basin 3700-02 is primarily within the City & County of Denver, but includes some area within Adams County. The basin includes area within Denver that is tributary to the regional Green Valley Ranch Golf Course Detention Pond, also known as the “Himalaya Pond”. This basin is being developed by Green Valley Ranch and includes 2.14 square miles. First Creek runs through this basin, and bisects Green Valley Ranch, which consists of medium density, single-family residences. General imperviousness has been master planned as 70%; however, actual imperviousness is likely lower.

### Identified Drainage Problems/Deficiencies:

The basin is actively being developed in accordance with current drainage criteria, which is the 100-year storm event. Therefore, no existing deficiencies have been identified.

### Proposed Capital Improvements:

Urban Drainage & Flood Control District prepared drainage master plans prior to development of the basin and has required incorporation of regional water quality and detention into land planning. All development in the First Creek drainage basin must detain and treat water quality on-site or in regional ponds since runoff will flow into the Rocky Mountain Arsenal. The Arsenal has strict agreements for the quantity and quality of stormwater runoff into the federal property.

There are no further planned improvements for the basin, beyond the capital construction required for the Green Valley Ranch development.

### Master Plan Agreements:

Many documents and agreements have been compiled for the First Creek Drainage Basin which specifies 100-year discharges and storage volumes. Therefore, nothing in this master plan shall take precedence over those agreements or specified discharges. This study was completed for the purposes of analyzing initial storm flows for the 2- and 5-year events. Agreement 99-03.11, dated January 25, 2001, states the following for the “Green Valley Ranch Golf Course Pond” or the “Himalaya Pond” (#808):

Master Plan Design Parameters				
ID No.	Peak Inflow (cfs)	Peak Outflow (cfs)	Volume (AF)	Jurisdiction
808	4857	4306	263	Denver

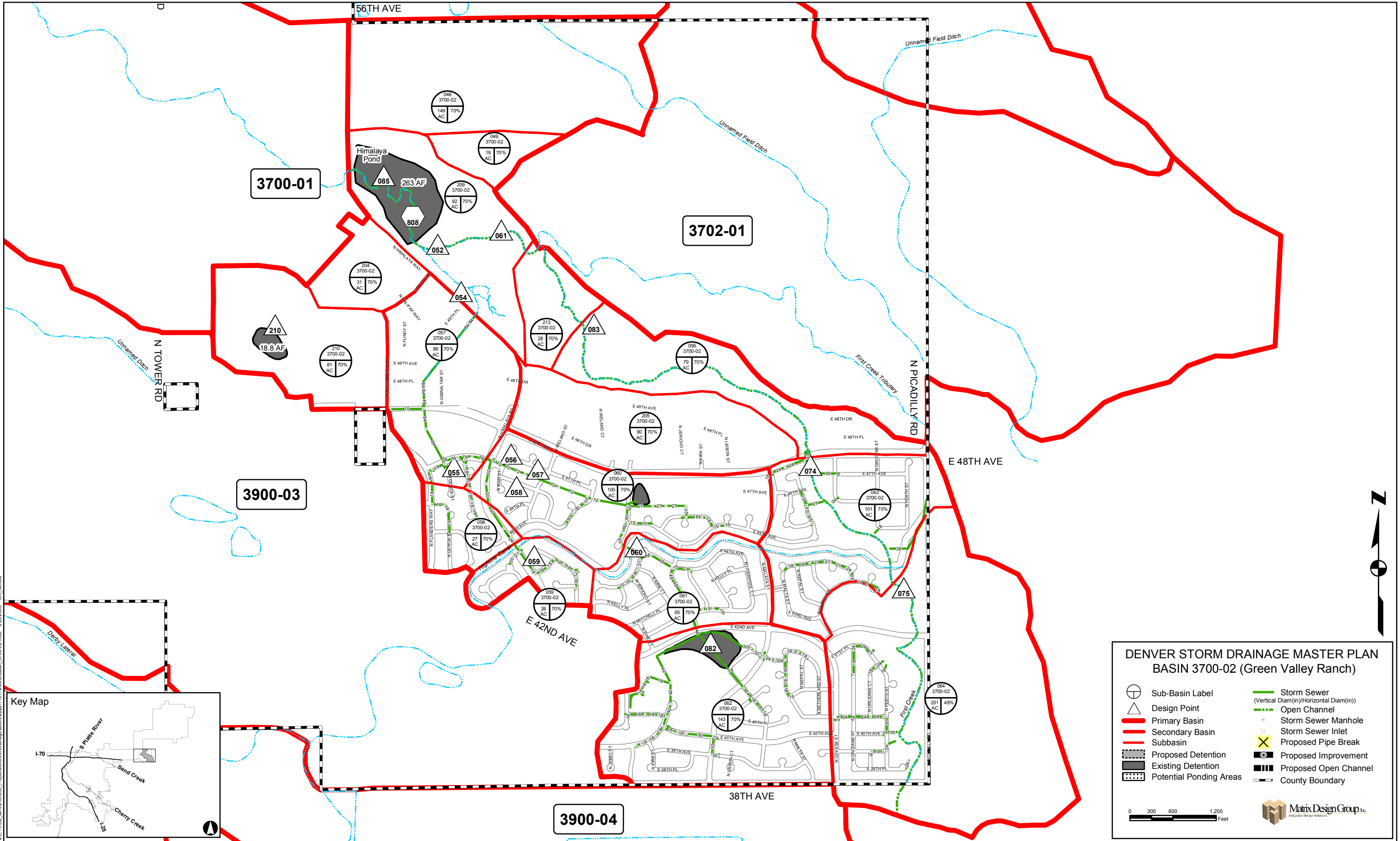
However, the pond was constructed with 369 acre-feet of storage, rather than the 263 acre-feet per the agreement.

### Developed Conditions Hydrology:

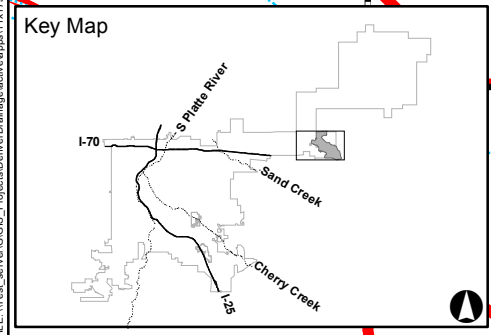
The following table is provided for 2- and 5-year discharges. 100-year flows shown only for comparison purposes. Refer to agreements and Urban Drainage & Flood Control District master plans for specific discharges.

### BASIN 3700-02

Design Point	Tributary Area (acres)	Peak Discharge		
		2-year (cfs)	5-year (cfs)	100-year (cfs)
52	16182.3	1153	1640	4880
54	445	257	375	1155
55	356.4	210	313	978
56	311.6	184	276	868
57	286	167	254	802
58	25.6	27	39	97
59	25.6	26	38	92
60	185.6	145	213	568
61	15737.3	1130	1613	4818
74	9636.9	480	771	3255
75	9536	479	783	3377
76	9273.6	469	797	3575
82	121.6	119	172	431
83	9805.4	481	748	3080
85	16473.4	1149	1652	4873
210	81	63	91	-
703	9833.7	480	747	-



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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3700-02 (Green Valley Ranch)**

Sub-Basin Label	Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
Design Point	Open Channel
Primary Basin	Storm Sewer Manhole
Secondary Basin	Storm Sewer Inlet
Subbasin	Proposed Pipe Break
Proposed Detention	Proposed Improvement
Existing Detention	Proposed Open Channel
Potential Ponding Areas	County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Integrated Design Solutions

## Basin 3700-03 (First Creek – Dogwood & Blue Grama Tribs.)

### Existing Basin Description:

Basin 3700-03 is located within the City & County of Denver and Adams County. This basin has been defined as the area draining to the Dogwood Gulch Tributary and the Blue Grama Draw Tributary. This basin is 2.64 square miles and is actively being developed. The subdivisions of “Denver International Business Center”, “HighPointe”, “SingleTree at DIA” are within this drainage basin. General imperviousness, at full development, will be around 65%.

### Identified Drainage Problems/Deficiencies:

The basin is actively being developed in accordance with current drainage criteria, which is the 100-year storm event. Therefore, no existing deficiencies have been identified.

### Proposed Capital Improvements:

Urban Drainage & Flood Control District prepared drainage master plans prior to development of the basin and has required incorporation of regional water quality and detention into land planning. All development in the First Creek drainage basin must detain and treat water quality on-site or in regional ponds since runoff will flow into the Rocky Mountain Arsenal. The Arsenal has strict agreements for the quantity and quality of stormwater runoff into the federal property.

Multiple detention ponds are planned throughout the basin in conjunction with development, both on Dogwood Gulch and Blue Grama Draw.

#### Project A: Dogwood Gulch Pond 812

This 13.1 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the east of the Pena Boulevard corridor, between 66<sup>th</sup> and 68<sup>th</sup> Avenues. This pond will serve to regulate increased flows from the development back into Dogwood Gulch as it enters the Pena corridor.

#### Project B: Blue Grama Draw Pond 815

This 39.1 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the east of the Pena Boulevard corridor, between 60<sup>th</sup> and 64<sup>th</sup> Avenues. This pond will serve to regulate increased flows from the development back into Blue Grama Draw as it enters the Pena corridor.

#### Project C: Blue Grama Draw Pond 801

This 37.4 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the east of Himalaya Road, and north of 60<sup>th</sup> Avenue. This pond will serve to regulate increased flows from the development back into Blue Grama Draw before crossing Himalaya Road.

#### Project D: Blue Grama Draw Pond 802

This 32.3 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the east of Tower Road, between 60<sup>th</sup> and 64<sup>th</sup> Avenues. This pond will serve to regulate increased flows from the development back into Blue Grama Draw before crossing Tower Road.

#### Project E: Dogwood Gulch Pond 800

This 11.1 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the east of Tower Road, near the alignment of 66<sup>th</sup> Avenue. This pond will serve to regulate increased flows from the development back into Dogwood Gulch before crossing Tower Road.

#### Project F: Blue Grama Draw Pond 816

This 40.0 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the north of 60<sup>th</sup> Avenue and to the west of the Highline Canal in Adams County. This pond will serve to regulate increased flows from the development back into Blue Grama Draw.

#### Project G: Blue Grama Draw Pond 826

This 22.9 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the south of 60<sup>th</sup> Avenue, on both sides of Argonne Street. This pond will serve to regulate increased flows from the development back into Blue Grama Draw. Currently only a portion of this pond is constructed, as only a portion of the tributary area is developed.

### Open Channel Improvements

Generally, this basin requires a series of open channel improvements associated with each detention pond to serve as conveyance channels for both Dogwood Gulch and Blue Grama Draw. These open channel improvements, and associated culvert crossings, will be required as development occurs.

### Master Plan Agreements:

Many documents and agreements have been compiled for the First Creek Drainage Basin which specifies 100-year discharges and storage volumes. Therefore, nothing in this master plan shall take precedence over those agreements or specified discharges. This study was completed for the purposes of analyzing initial storm flows for the 2- and 5-year events. Agreement 99-03.11, dated January 25, 2001, states the following:

Master Plan Design Parameters				
ID No.	Peak Inflow (cfs)	Peak Outflow (cfs)	Volume (AF)	Jurisdiction
800	419	120	11	Denver
801	1226	655	37	Aurora
802	982	920	33	Denver
812	444	216	13	Denver
815	1095	999	39	Denver
816	864	438	40	Aurora
826	589	180	23	Denver

### Developed Conditions Hydrology:

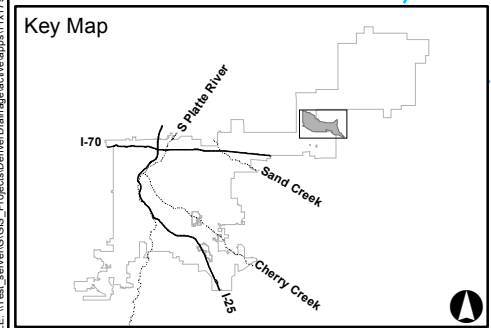
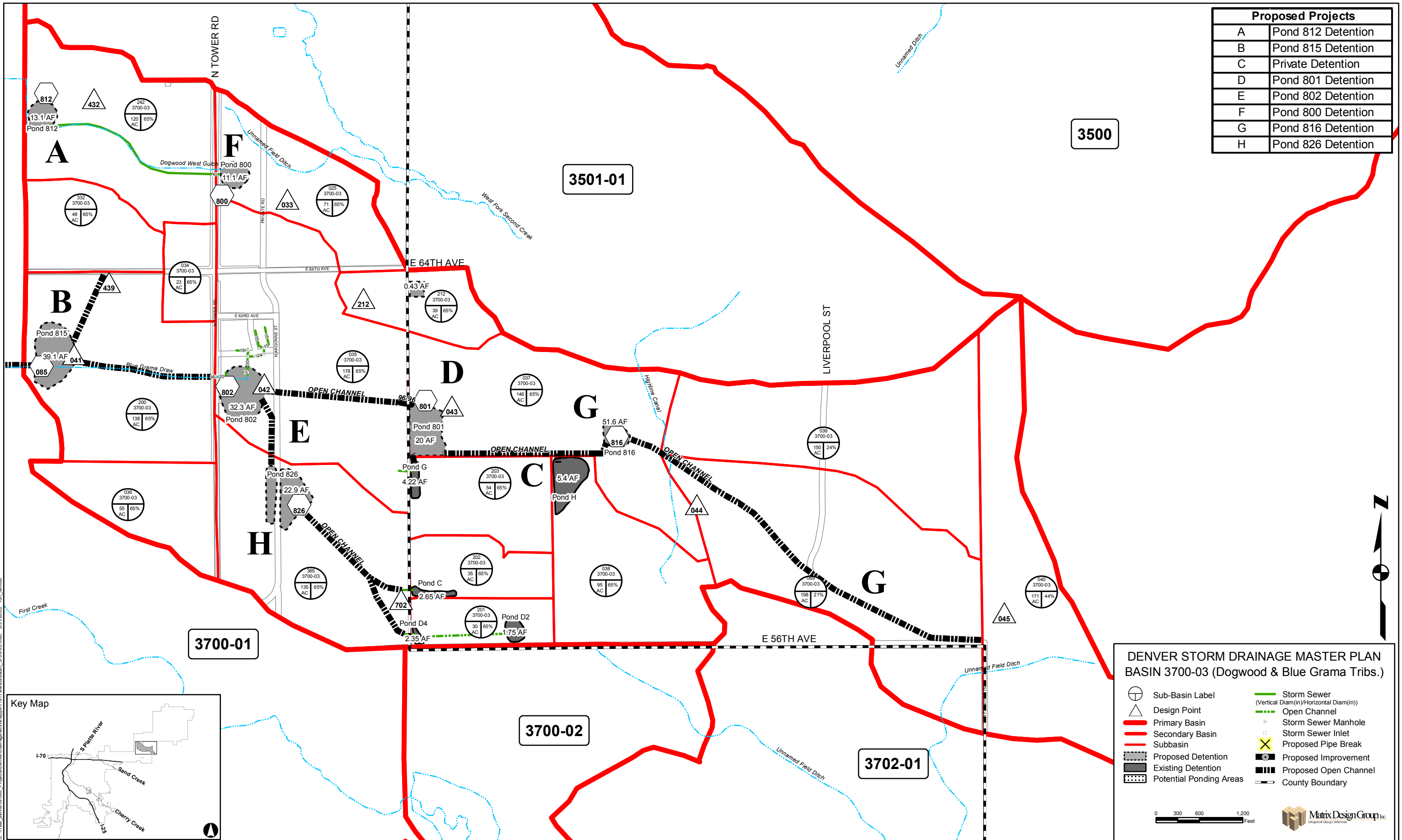
The following table is provided for 2- and 5-year discharges. 100-year flows shown only for comparison purposes. Refer to agreements and Urban Drainage & Flood Control District master plans for specific discharges.

#### BASIN 3700-03

Design Point	Tributary Area (acres)	Peak Discharge		
		2-year (cfs)	5-year (cfs)	100-year (cfs)
33	96	80	119	306
41	1585.7	174	265	848
42	1322.4	217	326	763
43	811.3	151	226	912
44	549.6	74	134	690
45	217.6	90	142	500
212	39.2	28	42	-
432	216.3	102	152	330
439	70.4	57	85	83
702	65.6	48	72	-



Proposed Projects	
A	Pond 812 Detention
B	Pond 815 Detention
C	Private Detention
D	Pond 801 Detention
E	Pond 802 Detention
F	Pond 800 Detention
G	Pond 816 Detention
H	Pond 826 Detention



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3700-03 (Dogwood & Blue Grama Tribs.)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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## Basin 3702-01 (First Creek – Tributary “T”)

### Existing Basin Description:

Basin 3702-01 is defined as the portion of Denver draining to the channel known as Tributary “T”. This basin is also includes land in Adams County. The basin area is 1.40 square miles and will include future development and the Green Valley Ranch Golf Course. General imperviousness is about 70%.

This tributary extends further upstream beyond the limits of this basin into Adams County. The upper reaches of Tributary “T” basin have been master planned for development under the direction of Urban Drainage & Flood Control District by Wright Water Engineers in 1990, Turner, Collie & Braden in 2000, Mueller Engineering in 2003. In addition, development engineers have also studied the basin and include Martin & Martin in 1998, Vestal Engineering in 2004, and Stantec in 2005. There are also other development engineers that have also completed studies of the basin.

### Identified Drainage Problems/Deficiencies:

The basin is actively being developed in accordance with current drainage criteria, which is the 100-year storm event. Therefore, no existing deficiencies have been identified.

### Proposed Capital Improvements:

Urban Drainage & Flood Control District prepared drainage master plans prior to development of the basin and has required incorporation of regional water quality and detention into land planning. All development in the First Creek drainage basin must detain and treat water quality on-site or in regional ponds since runoff will flow into the Rocky Mountain Arsenal. The Arsenal has strict agreements for the quantity and quality of stormwater runoff into the federal property.

Two open channel improvement projects will be required to serve the development in this basin, and will be constructed as part of those developments.

### Project A: N Picadilly Rd Improvements

Open channels or underground pipes will be required to convey the increased flows from the residential development surrounding the Green Valley Ranch Golf Course to Tributary ‘T’ of First Creek. Open channels will also be required to convey the increased flows east of Picadilly Road and outside of the CCD boundaries. These open channels will serve to convey flows to Tributary ‘T’ of First Creek.

### Master Plan Agreements:

Many documents and agreements have been compiled for the First Creek Drainage Basin which specifies 100-year discharges and storage volumes. Therefore, nothing in this master plan shall take precedence over those agreements or specified discharges. This study was completed for the purposes of analyzing initial storm flows for the 2- and 5-year events.

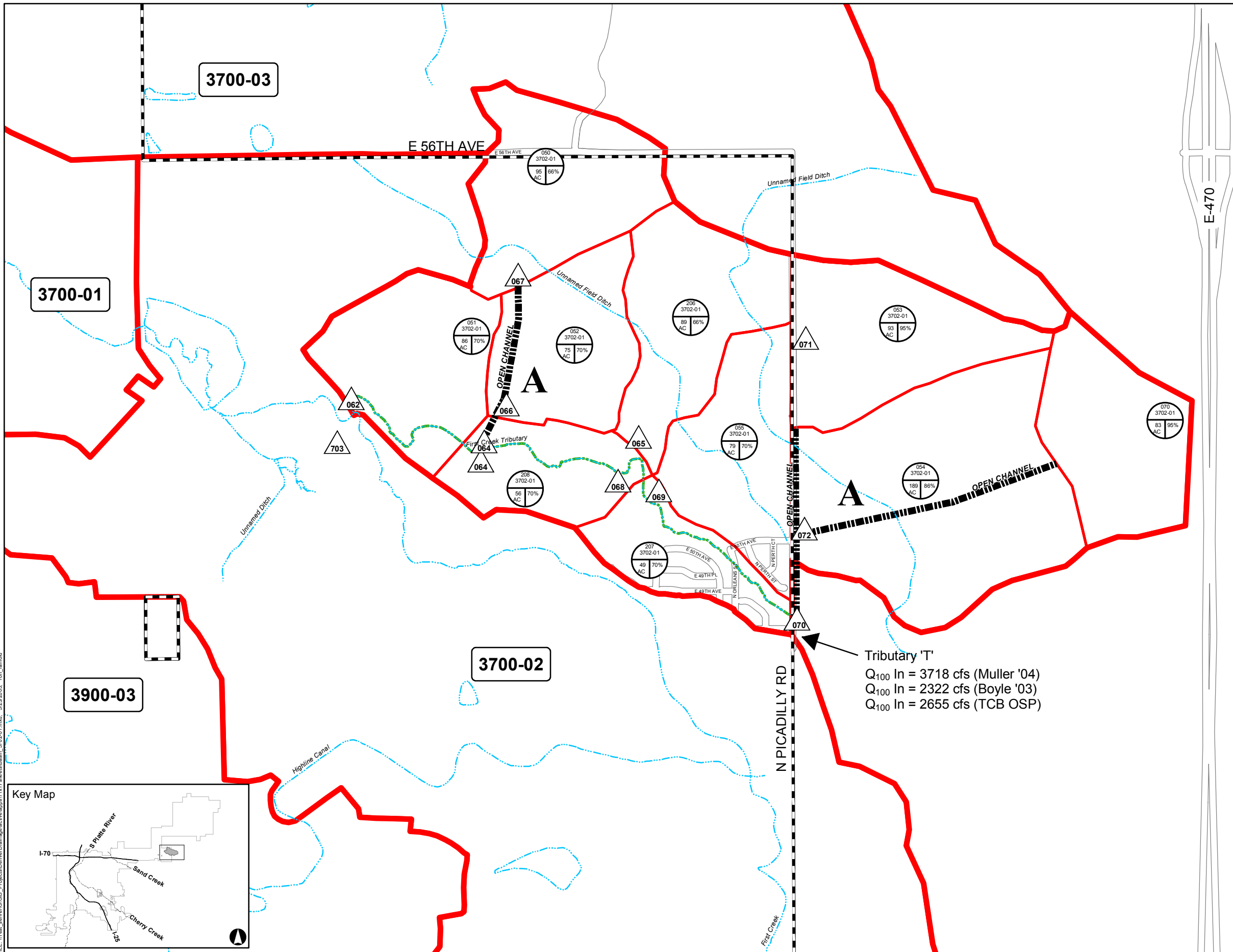
### Developed Conditions Hydrology:

The following table is provided for 2- and 5-year discharges. 100-year flows shown only for comparison purposes. Refer to agreements and Urban Drainage & Flood Control District master plans for specific discharges.

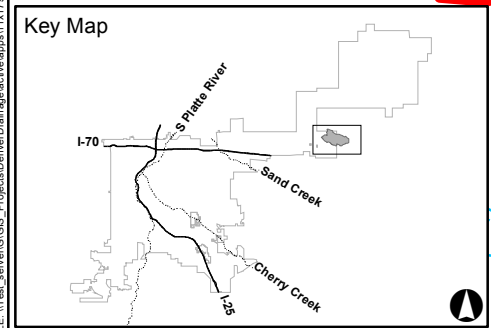
### BASIN 3702-01

Design Point	Tributary Area (acres)	Peak Discharge		
		2-year (cfs)	5-year (cfs)	100-year (cfs)
62	5903.5	701	1089	3051
64	5817.3	694	1089	2911
65	89.3	63	93	593
66	170.7	137	199	2726
67	95.2	83	123	452
68	5591	675	1071	3232
69	79.4	63	92	969
70	5372.8	815	1256	2655
71	83.2	115	157	312
72	349.4	395	568	917

Proposed Projects	
A	N Picadilly Rd Improvements



Tributary 'T'  
 $Q_{100} In = 3718$  cfs (Muller '04)  
 $Q_{100} In = 2322$  cfs (Boyle '03)  
 $Q_{100} In = 2655$  cfs (TCB OSP)



**DENVER STORM DRAINAGE MASTER PLAN  
 BASIN 3702-01 (Tributary "T")**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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## Basin: 3900-01 (Irondale Gulch – Stapleton East Section 10)

### Existing Basin Description:

This basin is located within Section 10 of the former airport, Stapleton Redevelopment site (City & County of Denver) and partially within the Rocky Mountain Arsenal (Adams County). The basin is a tributary to Irondale Gulch, which is tributary to the South Platte River. The basin consists of about 140 acres and is currently undeveloped, except for former runways and storage of crushed concrete. The basin was similarly defined in the 1989 Denver Drainage Master Plan, but included more land within the Arsenal north of Irondale Gulch in Adams County. Topography within the basin is characterized by generally flat terrain. Discharge from this basin flows to the north (downstream) into the Rocky Mountain Arsenal.

Irondale Gulch does not have an improved channel to the South Platte River, and therefore runoff in the basin is controlled by detention and retention ponds. There are also limitations to discharges into the Arsenal. The redevelopment of Stapleton will include detention to control runoff.

### Identified Drainage Problems/Deficiencies:

In general, there are currently no trunk storm pipes within this basin. Depressions between the runways have captured stormwater runoff and directed it via overland flow into Irondale Gulch.

Discharges from this basin into the Rocky Mountain Arsenal must be limited to historic conditions. The previous study for this basin was the 1995 *Stapleton Area Outfall Systems Plan* (OSP) by Urban Drainage & Flood Control District and McLaughlin Water Engineers, which set the discharge for existing and developed conditions as shown.

### Potential Improvements:

The Stapleton Development Master Plan includes a detention pond, which will be constructed in this basin at the Denver boarder commensurate with development, to limit discharges to historic conditions. Proposed detention pond (Pond #176) is at the boarder of the Rocky Mountain Arsenal. This pond is estimated to be about 10 acre-feet and will release into the Arsenal at the defined historic rates.

### Developed Conditions Hydrology:

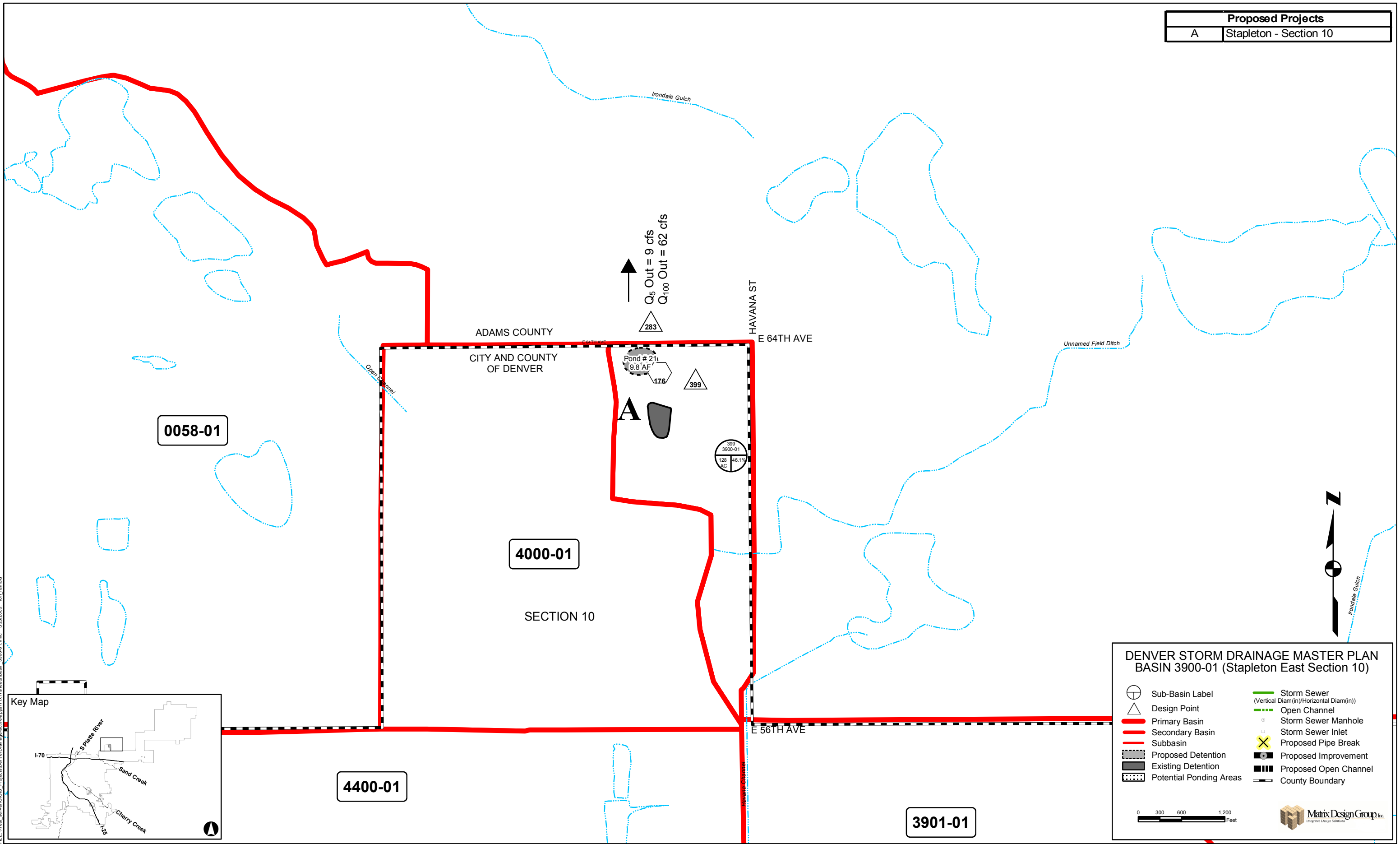
#### Basin 3900-01

Allowable Discharges from Denver to the Rocky Mountain Arsenal	Design Point	Peak Discharge				
		2-Year (cfs)	5-Year (cfs)	10-Year (cfs)	50-Year (cfs)	100-Year (cfs)
OSP Existing Conditions	210*	3	5	7	50	94
OSP Developed Conditions	270*	9	9	11	29	62
Stapleton Master Plan	283**	16	22	25	53	65

\*Reference: Urban Drainage & Flood Control District, "Stormwater Outfall Systems Plan - Stapleton Area," July 1995.

\*\*Reference: BRW, Inc. "Stapleton Infrastructure Master Plan - Section 5," March 2001.

Proposed Projects	
A	Stapleton - Section 10



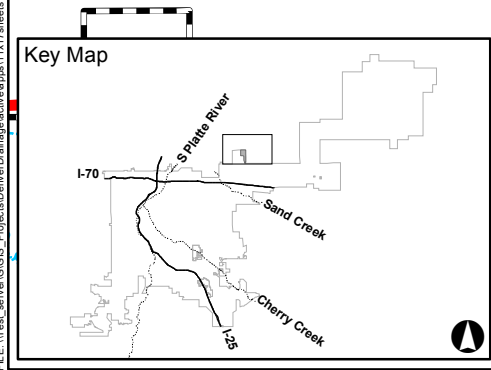
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SECTION 10

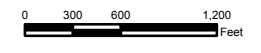
4400-01

3901-01



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3900-01 (Stapleton East Section 10)**

- |  |                         |  |  |
|--|-------------------------|--|--|
|  | Sub-Basin Label         |  | Storm Sewer<br>(Vertical Diam(in)/Horizontal Diam(in)) |
|  | Design Point            |  | Open Channel   |
|  | Primary Basin           |  | Storm Sewer Manhole                                    |
|  | Secondary Basin         |  | Storm Sewer Inlet                                      |
|  | Subbasin                |  | Proposed Pipe Break                                    |
|  | Proposed Detention      |  | Proposed Improvement                                   |
|  | Existing Detention      |  | Proposed Open Channel                                  |
|  | Potential Ponding Areas |  | County Boundary  |



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## Basin 3900-02 (Irondale Gulch – East Montbello)

### Existing Basin Description:

This basin is located fully within the Montbello neighborhood in the City and County of Denver. The boundaries of this basin are 56<sup>th</sup> Avenue to the north, Chambers Road to the east, the northern boundary of Basin 3901-01 to the south, and Peoria Street to the west. The basin consists of about 1,220 acres and is fully developed with residential neighborhoods. Low flows are conveyed in open channels and pipe systems, while higher flows are conveyed overland through the streets. Topography is characterized by generally flat terrain and there are no large, regional detention facilities internally within the basin. Discharge from the basin flows generally northerly through a series of concrete channels and pipes until crossing under 56<sup>th</sup> Avenue. A regional detention facility, known as the “Havana Pond” or “Southgate Pond” is located on the Rocky Mountain Arsenal property north of 56<sup>th</sup> Avenue. Beyond that pond, flows also enter Ladora Lake and Lake Mary on the Arsenal property. Very little flow is discharged to Irondale Gulch from Lake Mary, except in large events.

This basin currently has 7 storm pipes which cross north under 56<sup>th</sup> Avenue. East of Peoria Street is a storm pipe running along Revere Street discharging flows under 56<sup>th</sup> Avenue at design point 40. There are other minor storm pipes under 56<sup>th</sup> Avenue to each side of design point 40, but all flows from the contributing area within Basin 3900-02 were modeled to enter the RMA at design point 40. Further east of design point 40 is design point 51. Flow is collected in a storm pipe system and discharged to an open channel along Uvalda Street. Those flows are conveyed under 56<sup>th</sup> Avenue to the RMA. Other pipe systems discharge at design points 48 and 49 into a ditch on the north side of 56<sup>th</sup> Avenue. Basin 3900-04 flows into Basin 3900-02. Upstream runoff, attenuated in the Chambers I pond, flows into Basin 3900-02 at Chambers Rd and 48<sup>th</sup> Ave.

### Identified Drainage Problems/Deficiencies:

This drainage basin is essentially fully developed with single-family residential properties. By Denver criteria, the initial storm is a 2-year event for residential areas. The “Irondale Gulch Stormwater Outfall Systems Plan and Preliminary Design Report,” dated May 1990 by Wright Water Engineers states, “The Montbello area currently suffers from a lack of adequate capacity for major floods. The existing channels have the capacity of around the 5- to 10-year flood.”

The concrete trapezoidal channels and storm pipe systems that are currently in place apparently had a design goal to convey the 10-year flow. However, due to changes that occurred during construction, some systems are oversized, while others are undersized. Specifically, the concrete trapezoidal channel in 53<sup>rd</sup> Avenue was likely planned to extend further east past Chambers. However, as-built conditions direct all stormwater east of Chambers easterly into Parkfield Pond.

### Potential Improvements:

The 1990 study was completed to upgrade all facilities within the Montbello Area to 100-year capacity. The greatest constraint was the undersized road crossings over the open channels. By reconstructing these crossings, major conveyance facilities would be able to convey larger storm events. In areas where additional capacity is required, the 1990 study proposed replacing the sloping walls with vertical concrete walls to establish a rectangular concrete channel within the right-of-way of the existing channel. However, the recommended improvements have not been constructed. A recommendation was also made in the 1990 study to change the bottoms of the existing concrete channels to wetlands for water quality benefits. However, these changes have not been implemented.

There has been greater emphasis on detention to reduce flows to the capacity of existing systems. As upstream development has occurred, detention has been required to keep the flood peaks from increasing above existing levels.

### Project A: E 53<sup>rd</sup> Ave Improvements and Project B: E Maxwell Pl Improvements:

The 1990 Urban Drainage & Flood Control District study focused on major drainageway conveyance. Improvements needed beyond those evaluated in the previous study are additional storm drain laterals. These laterals are suggested to reduce flows in streets during minor events and reduce ponding and cross street flow.

### Master Plan Agreements:

Many documents and agreements have been compiled for the Irondale Gulch Drainage Basin which specifies 100-year discharges and storage volumes. Therefore, nothing in this master plan shall take precedence over those agreements or specified discharges. This study was completed for the purposes of analyzing initial storm flows for the 2- and 5-year events.

### Existing Hydrology:

Design Point	Contributing Basins	Tributary Area (Ac.)	2-Year (cfs) <sup>(1)</sup>	5-Year (cfs) <sup>(1)</sup>	100-Year (cfs) <sup>(2)</sup>
40	D181, D197, D199	131	<b>48</b>	73	293
48	D49, B41	2,128	<b>58</b>	129	285
49	D50, B43	2,054	<b>58</b>	130	275
50	D552, B42	1,957	<b>58</b>	131	141
51	D52, D165, B33	4,051	<b>302</b>	476	1,547
52	D53, D54	1,847	<b>253</b>	401	1,232
53	D219, B44	289	<b>95</b>	151	500
54	D232, B48	1,559	<b>158</b>	251	738
55	D231, B45	151	<b>55</b>	86	306
56	D62, D190	1,346	<b>95</b>	148	440
57	D515	1,069	<b>72</b>	90	180
62	D217, B46	1,260	<b>74</b>	115	181
165	D48	2,128	<b>58</b>	129	269
181	B98	75	<b>26</b>	40	
190	B47	86	<b>23</b>	35	
197	B97	32	<b>12</b>	18	
199	B99	24	<b>11</b>	16	
217	D57, B134	1,194	<b>72</b>	84	
219	D55, B130	216	<b>76</b>	120	
231	B131	62	<b>24</b>	37	
232	D233, B132	1,493	<b>140</b>	221	
233	D56, B133	1,405	<b>116</b>	179	

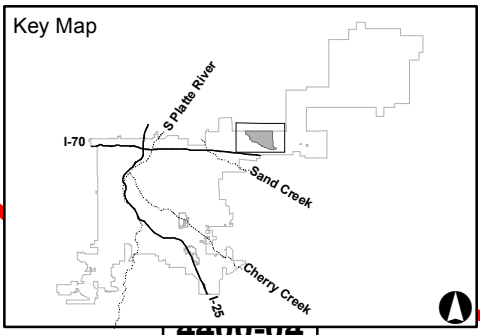
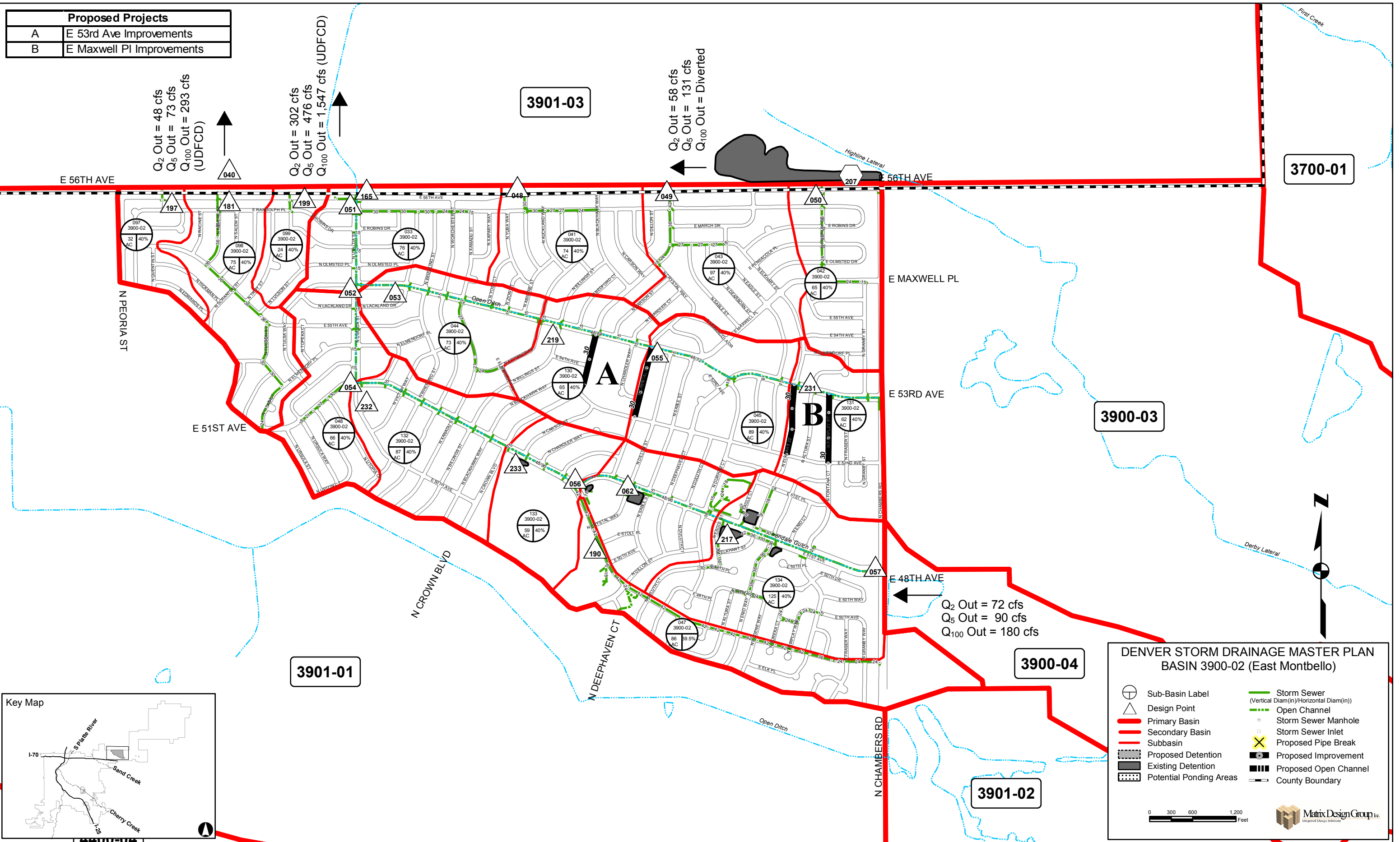
Numbers in bold are used for CIP sizing for residential land use.

D = Design Point, B = sub Basin

(1) Q<sub>2 and 5</sub> results are based on a restudy of the basin for this Master Plan.

(2) Q<sub>100</sub> results are based on 2003 model, approved by UDFCD.

Proposed Projects	
A	E 53rd Ave Improvements
B	E Maxwell PI Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3900-02 (East Montbello)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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## Basin 3900-03 (Irondale Gulch - Parkfield)

### Existing Basin Description:

This basin contains the **Tower Outfall Lateral** and the **Highline Lateral** and is located through three neighborhoods in the City and County of Denver: **Parkfield, Denver Connection, and Green Valley Ranch**. The boundaries of this basin are 56<sup>th</sup> Avenue and the southern boundary of the First Creek basin to the north, the middle of the Green Valley Ranch neighborhood to the east, the northern boundary of Basin 3900-04 and 38<sup>th</sup> Avenue to the south, and Chambers Road to the west. The basin consists of about 1,892 acres and is partially developed with residential neighborhoods, with plans for commercial and residential developments in the near future. Low flows are conveyed through storm pipes and open channels to regional detention facilities including Parkfield Lake, Parkfield II Lake, Highline Pond, Silverado I Pond and two Green Valley Ranch detention facilities. High flows are conveyed through some of the storm pipe system and overland through the streets to the detention areas. Topography is characterized by generally flat terrain with runoff discharge flowing generally to the northwest toward Parkfield II Lake.

### Identified Drainage Problems/Deficiencies:

The information provided for use in the current models indicates that the Highline pond exceeds the allowable surface acreage according to an internal memo between Denver, Aurora, and Denver International Airport (DIA) which sets the maximum pond acreage to 7.6 acres. After discussions with members of the Urban Drainage and Flood Control District, it is understood that the pond was constructed to meet the original requirements of 7.6 acres. As-constructed information has not yet been provided to update the model and determine if the discharge also meets requirements.

The channel downstream of the Highline Pond, to the west of Pena Boulevard, will need to be monitored to determine how the channel is being impacted by erosion from pond discharges.

### Potential Improvements:

Areas at the upstream end (Green Valley Ranch) and the downstream end (Parkfield) of this drainage basin have already been developed and there are plans for development for the areas in between. The existing drainage pipe systems are generally sufficient in size to convey the design flows. It is recommended that outfall systems from the ponds within this drainage basin are monitored to observe potential erosion impacts to downstream channels.

#### Project A: Silverado I Detention

This proposed 34 acre-foot detention pond will be constructed as development occurs. It will be located immediately to the east of the Pena Boulevard corridor, adjacent to 48<sup>th</sup> Avenue. This pond will serve to regulate increased flows from development as it enters the Pena corridor.

#### Project B: East 45<sup>th</sup> Avenue Improvements

An open channel or underground pipe will be needed during development of the site to convey flows from Green Valley Ranch toward Parkfield. This channel should be designed for the 100-year event.

#### Project C: N Pena Blvd East Improvements

An open channel or underground pipe will be needed during development of the area to direct flows into the existing Highline Detention Pond. This channel should be designed for the 100-year event.

#### Project D: N Pena Blvd West Improvements

An open channel or underground pipe will be needed during development of the area to convey flows from the Highline and Silverado I Detention Ponds toward Parkfield Development. This channel should be stabilized and designed for the 100-year event.

### Developed Conditions Hydrology:

Design Point	Contributing Basins	Tributary Area (Ac.)	2-Year (cfs) <sup>(1)</sup>	5-Year (cfs) <sup>(1)</sup>	100-Year (cfs) <sup>(2)</sup>
65	D70, D71	1,129	217	329	<b>715</b>
66	D65, B502	1,299	233	354	<b>866</b>
67	D603, D703, B503	373	279	410	<b>873</b>
68	D167, D168, B504	1,892	89	140	<b>531</b>
70	D182, B506, B806, B906	719	111	177	<b>776</b>
71	D183, B505	410	239	396	<b>1,075</b>
72	D1228, B263	119	105	157	<b>432</b>
73	D75, D77, B60	461	128	189	<b>452</b>
75	B61	90	43	68	
76	D73	461	123	184	<b>447</b>
77	B62, B64	294	53	86	<b>276</b>
78	B62	89	40	63	
79	B63	78	41	61	
80	B500	86	68	100	<b>187</b>
81	D78, D79	167	80	124	
166	D66	1,299	226	347	<b>851</b>
167	D67, D166	1,672	299	451	<b>1,296</b>
168	D180, B510	133	68	105	<b>296</b>
172	D72, D1230	180	194	272	<b>686</b>
176	D76, D706	494	95	148	<b>471</b>
180	D80, B501	113	70	105	<b>280</b>
182	D176, B509	603	110	172	
183	D172, B508	289	188	286	
550	D68	1,957	107	168	<b>531</b>
563	B163	63	33	52	<b>176</b>
603	B603	20	53	75	<b>247</b>
703	B703	59	41	60	<b>168</b>
706	B706	34	47	69	<b>203</b>
1228	B363	25	38	55	
1230	B606	61	92	133	

Numbers in bold are used for CIP sizing for new land use development.

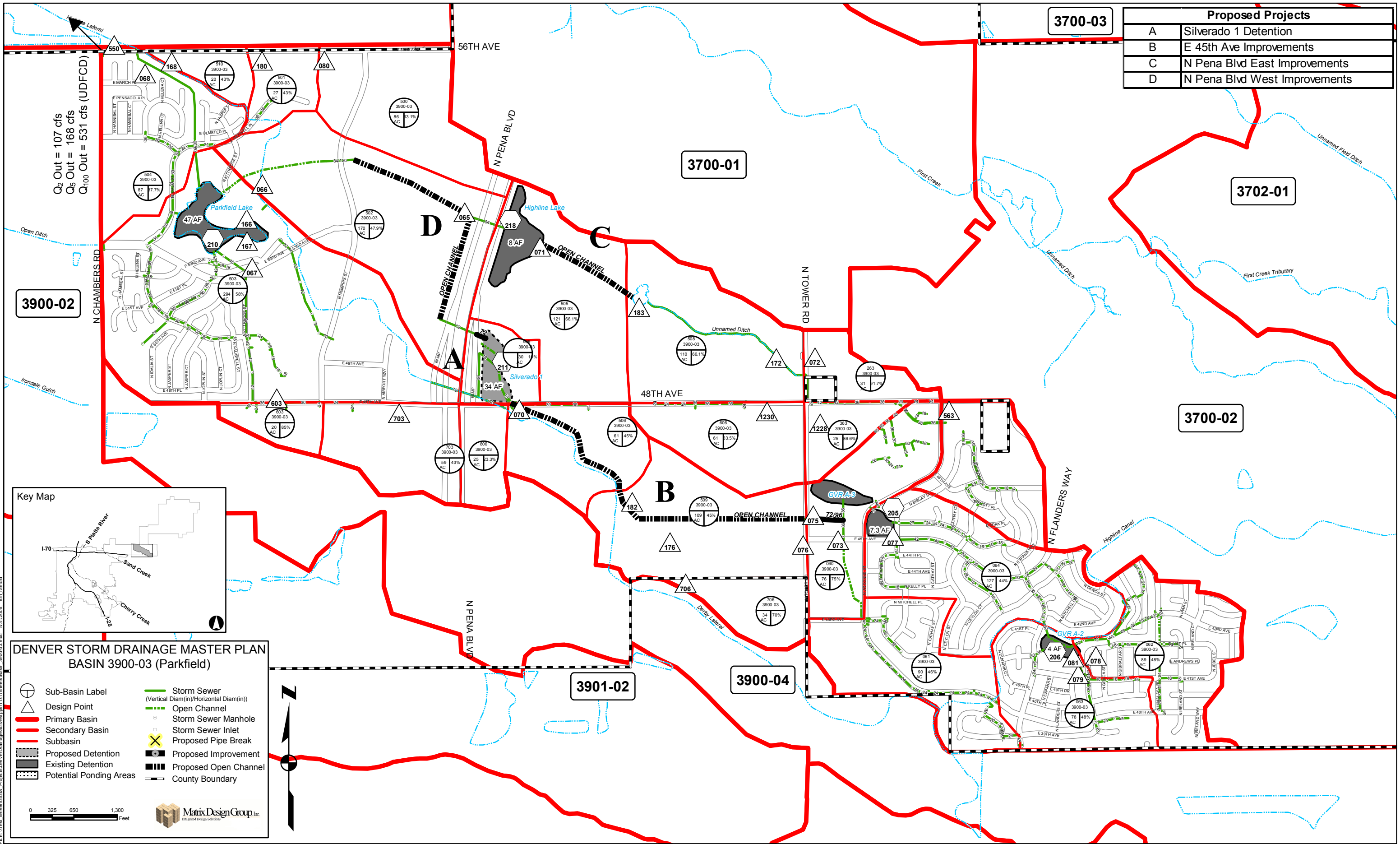
D = Design Point, B = sub Basin

(1) Q<sub>2 and 5</sub> results are based on a restudy of the basin for this Master Plan.

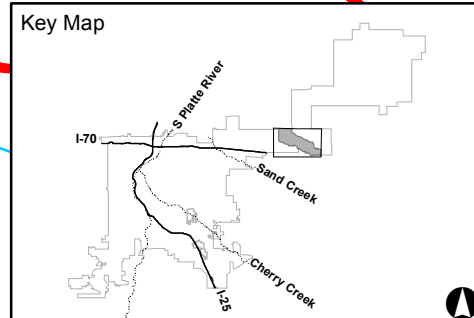
(2) Q<sub>100</sub> results are based on 2003 model, approved by UDFCD.



Proposed Projects	
A	Silverado 1 Detention
B	E 45th Ave Improvements
C	N Pena Blvd East Improvements
D	N Pena Blvd West Improvements

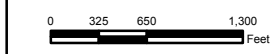


Q<sub>2</sub> Out = 107 cfs  
 Q<sub>5</sub> Out = 168 cfs  
 Q<sub>100</sub> Out = 531 cfs (UDFCD)



**DENVER STORM DRAINAGE MASTER PLAN  
 BASIN 3900-03 (Parkfield)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin 3900-04 (Irondale Gulch – Majestic Commerce Center)

### Existing Basin Description:

This basin contains the **Bolling Drive Tributary** and is located in the City and County of Denver and the City of Aurora. The boundaries of this basin are the southern boundary of Basin 3900-03 to the north, Picadilly Road to the east, the northern boundary of Basin 3901-02 and Union Pacific Realty Company to the south and Chambers Road to the west. The basin consists of about 1,157 acres and is mostly undeveloped with plans for residential, commercial and industrial developments in the near future. The future subdivisions along the Bolling Drive Tributary include Denver Connection, Gateway Park and Majestic Commercenter. This tributary also passes through the Pena Boulevard right-of-way. Low flows are currently conveyed through open channels to regional detention facilities including Chambers I Pond, Silverado II Pond, and the two Majestic Commercenter ponds. High flows are conveyed through the same open channels to the detention areas. Topography is characterized by generally flat terrain with flows discharging generally to the northwest toward the Chambers I pond.

Runoff from the City of Aurora flows into the City and County of Denver near design point 352. A Gateway Park residential development will be constructed upstream of this design point within the City of Aurora. Runoff from the Majestic Commercenter will flow through the Gateway Park development.

### Identified Drainage Problems/Deficiencies:

The Majestic Commercenter development hydrologic model has been adopted for this study without revision. In 2003, Boyle Engineering created an updated model for UDFCD based on information provided by the City of Aurora. That model information was adopted unchanged at the direction of Aurora, although the mapping was poor. The information was transcribed into Denver’s GIS without edits. It was noted that during the current model update, certain basin areas and model routing from the original information provided by the City of Aurora could be remodeled to more accurately match the proposed conditions. It is recommended that the Majestic Commercenter area be reviewed again to more accurately represent the flows entering the City and County of Denver.

### Potential Improvements:

Storm drain improvements will be constructed commensurate with development to meet current drainage criteria of 100-year systems.

#### Project A: N Pena Blvd Detention – 01 (Silverado II Detention)

These proposed 78 acre-foot detention ponds each side of Pena will be constructed as development occurs. It will be located immediately to the west of the Pena Boulevard corridor, between 40<sup>th</sup> and 48<sup>th</sup> Avenues. These ponds will serve to regulate flows from Aurora into Denver.

#### Project B: N Pena Blvd Detention – 02 (Silverado II Detention)

These proposed 78 acre-foot detention ponds each side of Pena will be constructed as development occurs. It will be located immediately to the east of the Pena Boulevard corridor, between 40<sup>th</sup> and 48<sup>th</sup> Avenues. These ponds will serve to regulate flows from Aurora into Denver.

#### Project C: E Bolling Dr Improvements

An open channel or underground pipe will be needed during development of the area to direct flows from the Silverado II Ponds to the existing Chambers I Detention Pond. This channel should be designed for the 100-year event.

#### Project D: Himalaya Rd Outfall

An open channel or underground pipe will be needed during development of the area to convey flows from Aurora’s Majestic Commercenter to the Silverado II Detention Ponds and into Denver. This channel should be stabilized and designed for the 100-year event.

### Master Plan Agreements:

Many documents and agreements have been compiled for the Irondale Gulch Drainage Basin which specifies 100-year discharges and storage volumes. Therefore, nothing in this master plan shall take precedence over those agreements or specified discharges. This study was completed for the purposes of analyzing initial storm flows for the 2- and 5-year events.

Agreement 93-04.05, dated April 16, 1995 specifies cost sharing agreements, land use, and the 100-year discharges and storage volumes for Irondale Gulch. In Basin 3900-04, the Majestic Commercenter Ponds (Aurora Business Center Ponds), and Silverado II Ponds are regulated by this agreement as follows:

Master Plan Design Parameters				
ID No.	Peak Inflow (cfs)	Peak Outflow (cfs)	Detention Volume (AF)	Jurisdiction
Aurora Business Center	N/A	393	17	Aurora
Silverado II	863	244	65	Denver

### Developed Conditions Hydrology:

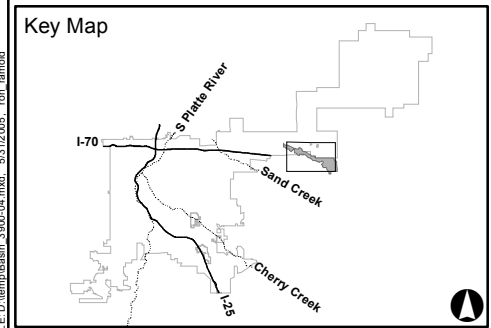
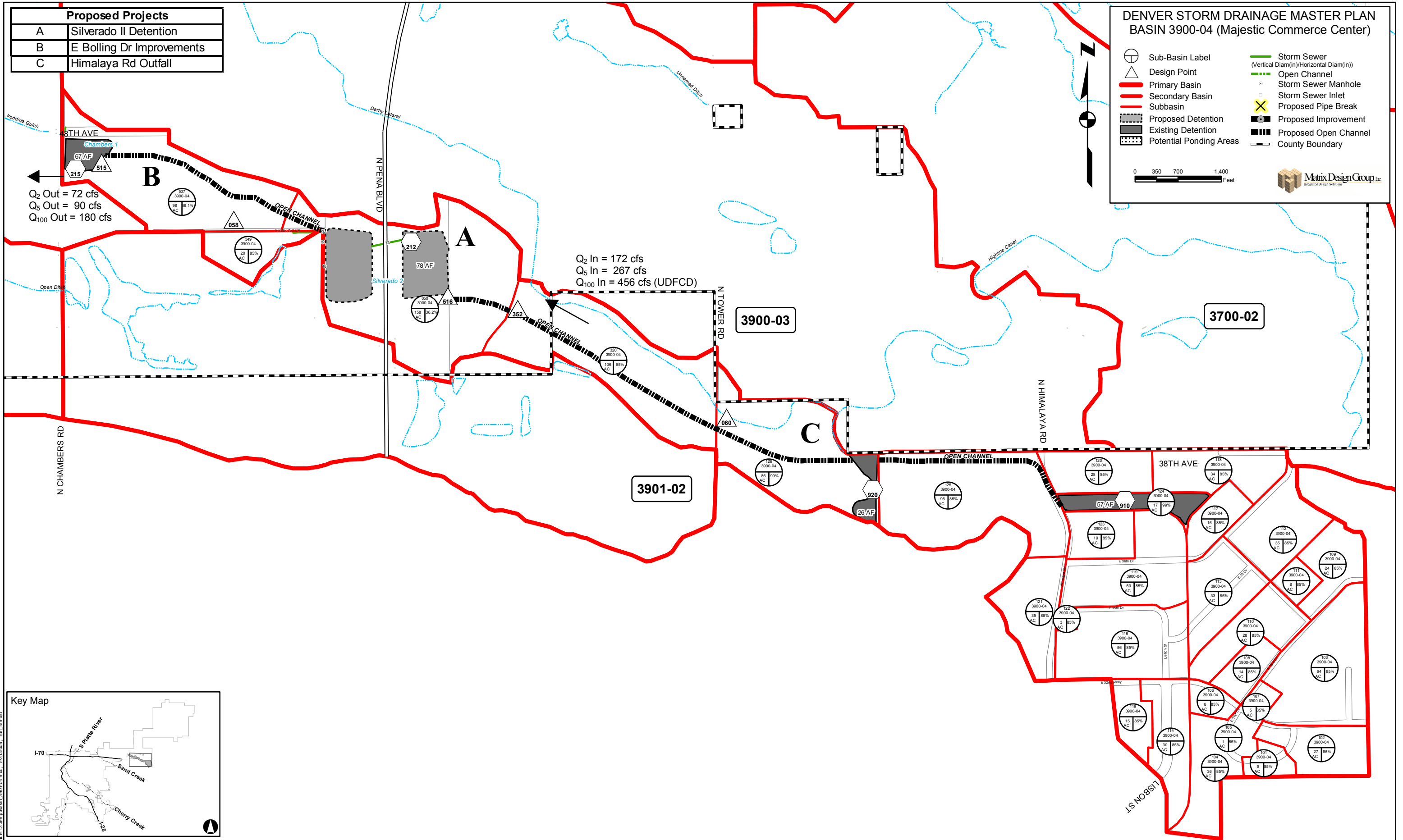
IRONDALE GULCH					
BASIN HYDROLOGY					
Design Point	Contributing Basins	Tributary Area (Ac.)	2-Year (cfs) <sup>(1)</sup>	5-Year (cfs) <sup>(1)</sup>	100-Year (cfs) <sup>(2)</sup>
58	D516, D358	971	114	163	<b>255</b>
60	B101, B102, B103, B104, B105, B106, B107, B108, B109, B110, B111, B112, B113, B114, B115, B116, B117, B118, B119, B120, B121, B122, B123, B124, B125, B126	687	171	261	<b>438</b>
352	D60, B320	793	172	267	<b>456</b>
515	D58, B507	1,069	113	162	<b>296</b>
516	D352, B50	951	170	272	<b>462</b>

Numbers in bold are used for CIP sizing for residential land use.

D = Design Point, B = sub Basin

(1) Q<sub>2 and 5</sub> results are based on a restudy of the basin for this Master Plan.

(2) Q<sub>100</sub> results are based on 2003 model, approved by UDFCD.



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## Basin 3901-01 (Irondale Gulch – West Montbello)

### Existing Basin Description:

This basin is located mostly within the City and County of Denver. The boundaries of this basin are 56<sup>th</sup> Avenue and the southern boundary of Basin 3900-02 to the north, Havana Street to the west, I-70 to the south and Chambers Road to the East. The basin consists of about 2,117 acres and is mostly developed with industrial warehouses in the western portion of the basin and residential neighborhoods in the eastern portion of the basin. Low flows are conveyed within a pipe and channel system, while higher flows are conveyed overland through channels and streets. Topography is characterized by generally flat terrain, and there are no regional detention facilities within the basin. Discharge from the basin flows generally to the east and north.

This basin discharges to the Rocky Mountain Arsenal (RMA) at two points along 56<sup>th</sup> Avenue. Beginning at the western end near N. Havana Street, runoff from Basin 3901-01 is collected in an open channel along the west side of N. Havana Street, crosses 56<sup>th</sup> Avenue and flows under N. Havana Street to the Havana Detention Pond. The design point for this flow to the RMA is 74. Just to the east of design point 74 is design point 11 where flows from Basin 3901-01 are collected in a storm pipe system and are conveyed under 56<sup>th</sup> Avenue, and discharged into an open channel to the Havana Detention Pond.

### Identified Drainage Problems/Deficiencies:

This drainage basin is essentially fully developed with single-family residential properties and commercial/industrial properties. By Denver criteria, the initial storm is a 2-year event for residential areas, and 5-year for commercial/industrial. The “Irondale Gulch Stormwater Outfall Systems Plan and Preliminary Design Report,” dated May 1990 by Wright Water Engineers states, “The Montbello area currently suffers from a lack of adequate capacity for major floods. The existing channels have the capacity of around the 5- to 10-year flood.” In general, the concrete trapezoidal channels can convey flows except for a few areas.

### Potential Improvements:

The 1990 study was completed to upgrade all facilities within the Montbello Area to 100-year capacity. The greatest constraint was the undersized road crossings over the open channels. By reconstructing these crossings, major conveyance facilities would be able to convey larger storm events.

#### Project A: 18 Inch Upgrades

Pipes smaller than 18” are allowed only if they are less than 75 feet and only convey flows from one inlet. These upgrades meet current criteria and provide improved maintenance.

#### Project B: E 45<sup>th</sup> Ave Improvements

This is an example where the open channel and road crossings cannot convey the developed 5-year flows. The channel can be reconstructed with vertical walls and the road crossings can be expanded. The existing box culvert is also not adequate to convey 5-year flows while 80% full.

#### Project C: E 47<sup>th</sup> Ave Improvements

The road crossings cannot convey the developed 5-year flows. The existing box culvert is also not adequate to convey 5-year flows while 80% full. Additional laterals should be constructed to reduce street flow.

#### Project D: E 53<sup>rd</sup> Ave Improvements

The existing 78” pipe is not adequate to convey 5-year flows while 80% full and must be replaced with a 90” equivalent. The UDFCD outfall system plan assumed some of this flow would be conveyed to the Havana Lateral, but actually discharges to the RMA, therefore, this study found higher flows to this outfall.

#### Project E: E Albroom Dr Improvements

Existing storm pipe must be upsized to convey runoff to the concrete trapezoidal channels.

#### Project F: E Andrews Dr Improvements

Additional storm laterals should be constructed to reduce runoff in the street during minor storm events.

### Existing Hydrology:

Design Point	Contributing Basins	Tributary Area (Ac.)	2-Year (cfs) <sup>(1)</sup>	5-Year (cfs) <sup>(1)</sup>	100-Year (cfs) <sup>(2)</sup>
2	D23, B96	251	195	<b>293</b>	
4	D36	79	<b>28</b>	43	
11	D185, B85	424	383	<b>568</b>	572
15	B13	107	<b>34</b>	52	182
16	D17, D18	2,288	725	<b>1040</b>	2,532
17	D191, B90	1,705	378	<b>516</b>	1,294
18	D19	583	349	<b>557</b>	1,362
19	D20, D21	583	486	<b>736</b>	1,520
20	D124, B93	239	206	<b>309</b>	713
21	D2, B95	344	292	<b>438</b>	807
23	B18	139	<b>77</b>	118	194
24	B17	59	<b>25</b>	38	138
25	D26, B16	1,414	<b>257</b>	404	1,145
26	D27, D28	1,336	<b>242</b>	379	1,150
27	D235, B21	1,134	<b>186</b>	284	746
28	D4, B19	202	<b>58</b>	95	417
29	D30, D31	927	<b>127</b>	189	502
30	D237, B23	769	<b>45</b>	77	277
31	D238, B22	158	<b>83</b>	119	261
36	B20	79	<b>31</b>	47	289
74	D16, B10, B29(100-yr)	2,331	623	<b>925</b>	2,701
124	D24, B94	165	140	<b>206</b>	
185	D186, D187	403	396	<b>585</b>	
186	D188, B86	139	175	<b>261</b>	
187	D189, B87	264	221	<b>329</b>	
188	B88	100	153	<b>222</b>	
189	D15, B89	171	116	<b>171</b>	
191	D192, B91	1,622	365	<b>485</b>	
192	D25, B92	1,528	317	<b>455</b>	
235	D236, B135	1,067	<b>176</b>	262	
236	D29, B136	997	<b>152</b>	223	
237	D315, B137	707	<b>38</b>	72	
238	D239, B138	66	<b>56</b>	82	
239	B139	39	45	<b>66</b>	
315	D435	638	<b>35</b>	66	220

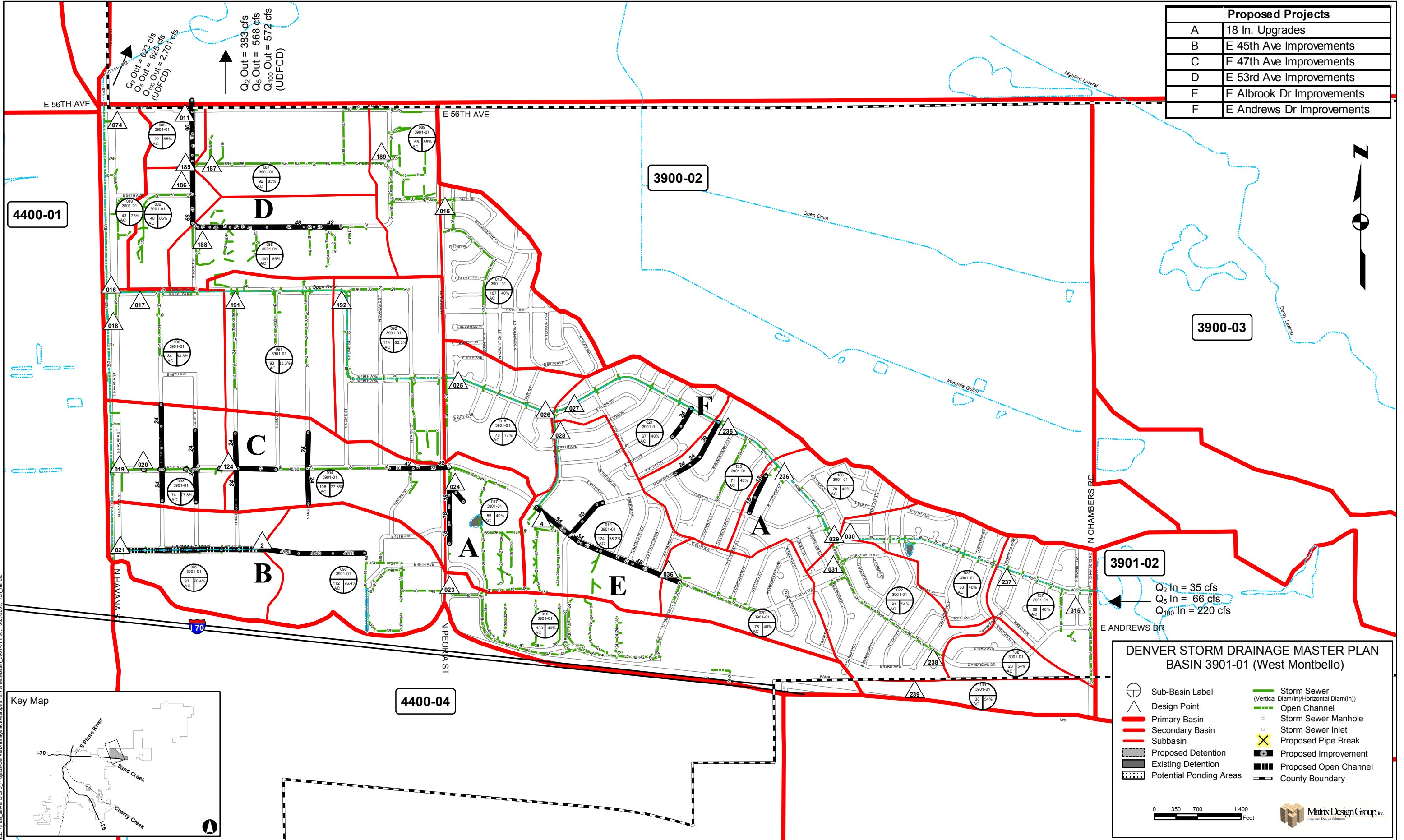
Numbers in bold are used for CIP sizing for residential land use.

D = Design Point, B = sub Basin

(1) Q2 and 5 results are based on a restudy of the basin for this Master Plan.

(2) Q100 results are based on 2003 model, approved by UDFCD.

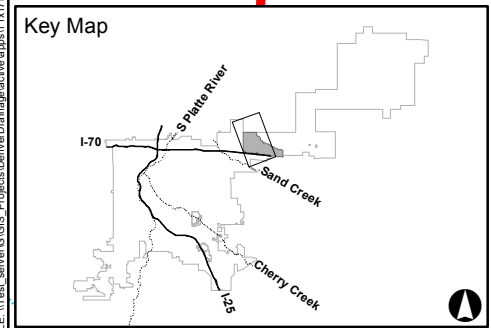
Proposed Projects	
A	18 In. Upgrades
B	E 45th Ave Improvements
C	E 47th Ave Improvements
D	E 53rd Ave Improvements
E	E Albrook Dr Improvements
F	E Andrews Dr Improvements



$Q_2$  Out = 622 cfs  
 $Q_5$  Out = 925 cfs  
 $Q_{100}$  Out = 2,701 cfs  
 (UDFCD)

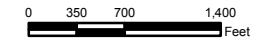
$Q_2$  Out = 383 cfs  
 $Q_5$  Out = 568 cfs  
 $Q_{100}$  Out = 572 cfs  
 (UDFCD)

$Q_2$  In = 35 cfs  
 $Q_5$  In = 66 cfs  
 $Q_{100}$  In = 220 cfs



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3901-01 (West Montbello)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin 3901-02 (Irondale Gulch – Gateway)

### Existing Basin Description:

This basin contains the Montbello Tributary and is located in the City and County of Denver and Aurora. The boundaries of this basin are the southern boundary of Basin 3900-04 to the north, Tower Road to the east, Chambers Road to the west, and I-70 to the south. The basin consists of about 621 acres and is partially developed with the Gateway Park development and Union Pacific Realty. This tributary also passes through the Pena Boulevard right-of-way. Low flows are currently conveyed through storm pipes and open channels to regional detention facilities including the three Chambers II ponds, and the three Upland ponds. High flows are conveyed through open channels and through the streets to the detention areas. Topography is characterized by generally flat terrain with flows discharging generally to the west and northwest toward the three Chambers II ponds.

Drainage from the City of Aurora crosses a boundary into the City and County of Denver within this drainage basin at design points 437 and 431.

### Identified Drainage Problems/Deficiencies:

This is a newly developed basin and drainage infrastructure has been designed for the 100-year event. Therefore, no existing drainage deficiencies have been identified.

### Potential Improvements:

Necessary drainage capital improvements will be constructed by the developer to current drainage criteria.

Agreement 93-04.05, dated April 16, 1995 specifies cost sharing agreements, land use, and the 100-year discharges and storage volumes for Irondale Gulch. In Basin 3901-02, the Upland Detention Ponds, and Chambers II Pond are regulated by this agreement as follows:

Master Plan Design Parameters				
ID No.	Peak Inflow (cfs)	Peak Outflow (cfs)	Detention Volume (AF)	Jurisdiction
Upland Detention Pond	948	56	42	Aurora UP Realty
Chambers II	663	219	32	Denver UP Realty

### Developed Conditions Hydrology:

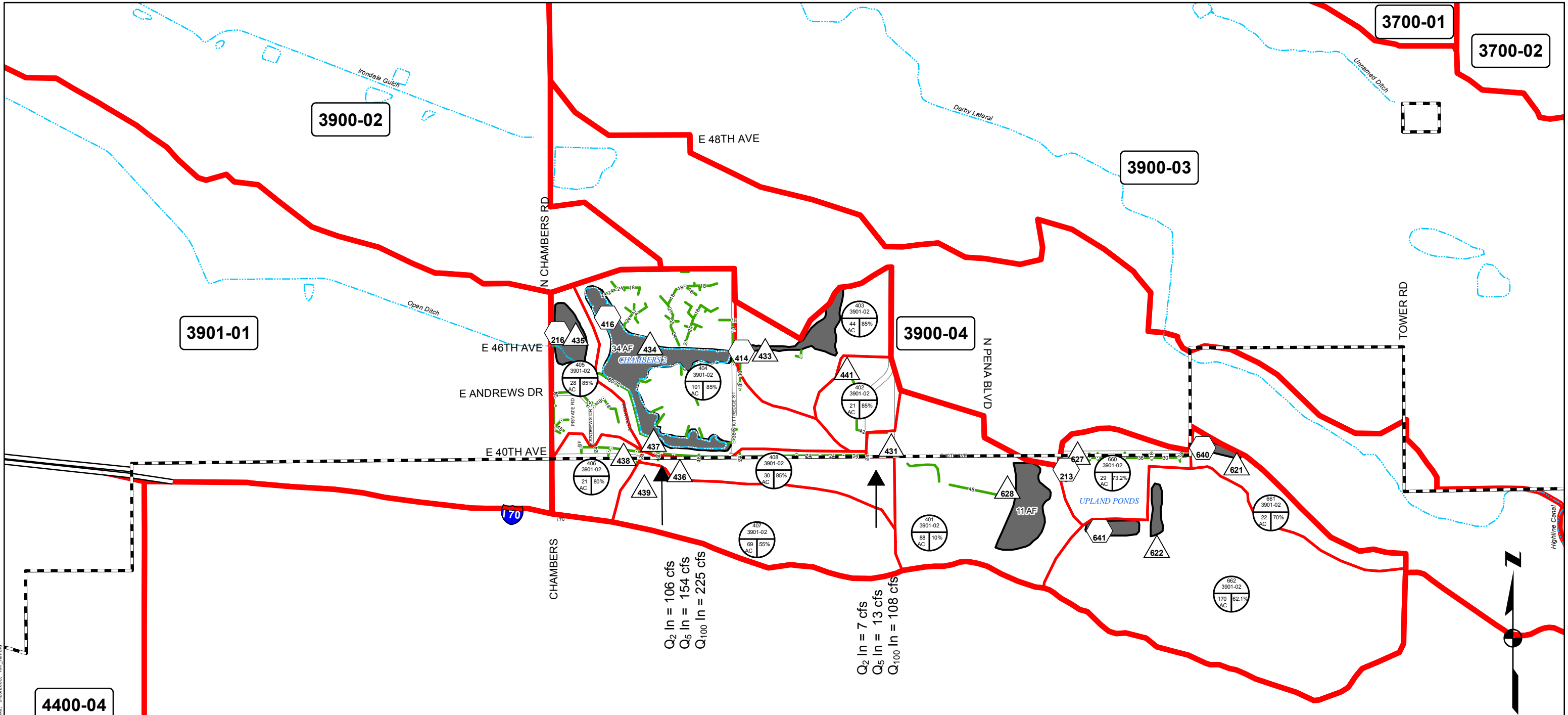
IRONDALE GULCH					
BASIN HYDROLOGY					
Design Point	Contributing Basins	Tributary Area (Ac.)	2-Year (cfs) <sup>(1)</sup>	5-Year (cfs) <sup>(1)</sup>	100-Year (cfs) <sup>(2)</sup>
431	D628, B401	326	7	13	<b>108</b>
433	D441, B403	390	95	139	<b>291</b>
434	D433, B404	491	158	231	<b>440</b>
435	D434, D437, B405	638	140	210	<b>310</b>
436	B408	30	44	64	<b>174</b>
437	D436, D438, D439	119	106	154	<b>225</b>
438	B406	21	28	40	<b>63</b>
439	B407	69	41	61	<b>119</b>
441	D431, B402	346	30	45	<b>117</b>
621	B661	22	24	36	<b>143</b>
622	B662	170	184	268	<b>605</b>
627	D621, D622, B660	238	73	106	<b>517</b>
628	D627	238	7	13	<b>92</b>

Numbers in bold are used for CIP sizing for residential land use.

D = Design Point, B = sub Basin

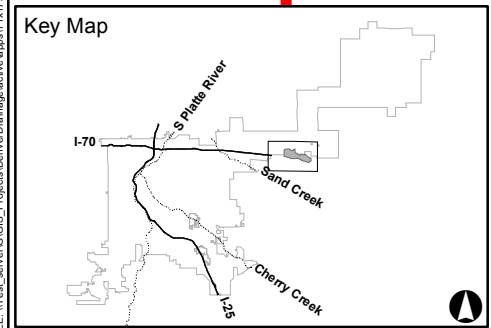
(1) Q2 and 5 results are based on a restudy of the basin for this Master Plan.

(2) Q100 results are based on 2003 model, approved by UDFCD.



Q<sub>2</sub> In = 106 cfs  
 Q<sub>5</sub> In = 154 cfs  
 Q<sub>100</sub> In = 225 cfs

Q<sub>2</sub> In = 7 cfs  
 Q<sub>5</sub> In = 13 cfs  
 Q<sub>100</sub> In = 108 cfs



### DENVER STORM DRAINAGE MASTER PLAN BASIN 3901-02 (Gateway)

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1200 Feet

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 Regional Design Solutions

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## Basin: 4000-01 (Stapleton West Section 10)

### Existing Basin Description:

This basin known as *Section 10* on the Stapleton site is a tributary to the South Platte River, and is located entirely in the City & County of Denver. The basin consists of about 498 acres and is currently undeveloped, except for former runways and storage of crushed concrete. Topography within the basin is characterized by generally flat terrain. The surrounding area to the north (downstream) of the site is the Rocky Mountain Arsenal.

The basin was loosely defined in the 1989 Denver Drainage Master Plan and included a portion of north Stapleton (south of 56<sup>th</sup>), as well as Adams County (west of Section 10). Basin 4400-01 includes all area south of 56<sup>th</sup> Avenue in accordance with the approved Drainage Master Plan for the Stapleton Redevelopment site, dated March 2001. Therefore, the remainder of this basin lies north of 56<sup>th</sup> Avenue and south of 64<sup>th</sup> Avenue.

### Identified Drainage Problems/Deficiencies:

In general, there are currently no trunk storm pipes within this basin. Depressions between the runways captured stormwater runoff.

Discharges from this basin into the Rocky Mountain Arsenal must be limited to historic conditions. The previous study for this basin was the 1995 *Stapleton Area Outfall Systems Plan* (OSP) by Urban Drainage & Flood Control District and McLaughlin Water Engineers, which set the following discharge for existing and developed conditions:

### Basin 4000-01

Allowable Discharges from Denver to the Rocky Mountain Arsenal	Design Point	Peak Discharge				
		2-Year (cfs)	5-Year (cfs)	10-Year (cfs)	50-Year (cfs)	100-Year (cfs)
OSP Existing Conditions	10*	8	11	12	24	29
OSP Developed Conditions	272*	72	72	72	76	82
Stapleton Master Plan	282**	8	10	10	11	11

\*Reference: Urban Drainage & Flood Control District, "Stormwater Outfall Systems Plan - Stapleton Area," July 1995.

\*\*Reference: BRW, Inc. "Stapleton Infrastructure Master Plan - Section 5," March 2001.

### Potential Improvements:

100-year retention facilities will be constructed commensurate with development for this basin. Establishing new outfalls through the Rocky Mountain Arsenal would violate previous agreements.

The latest proposed land plan calls for more development than previously included in the "Green Book" and OSP. Accordingly, a zero discharge lake (Pond ZD) is proposed to fully store runoff from the 100-year, 24-hour storm. This retention pond will receive runoff from 187.5 acres and must store approximately 22 acre-feet of runoff in a 100-year event.

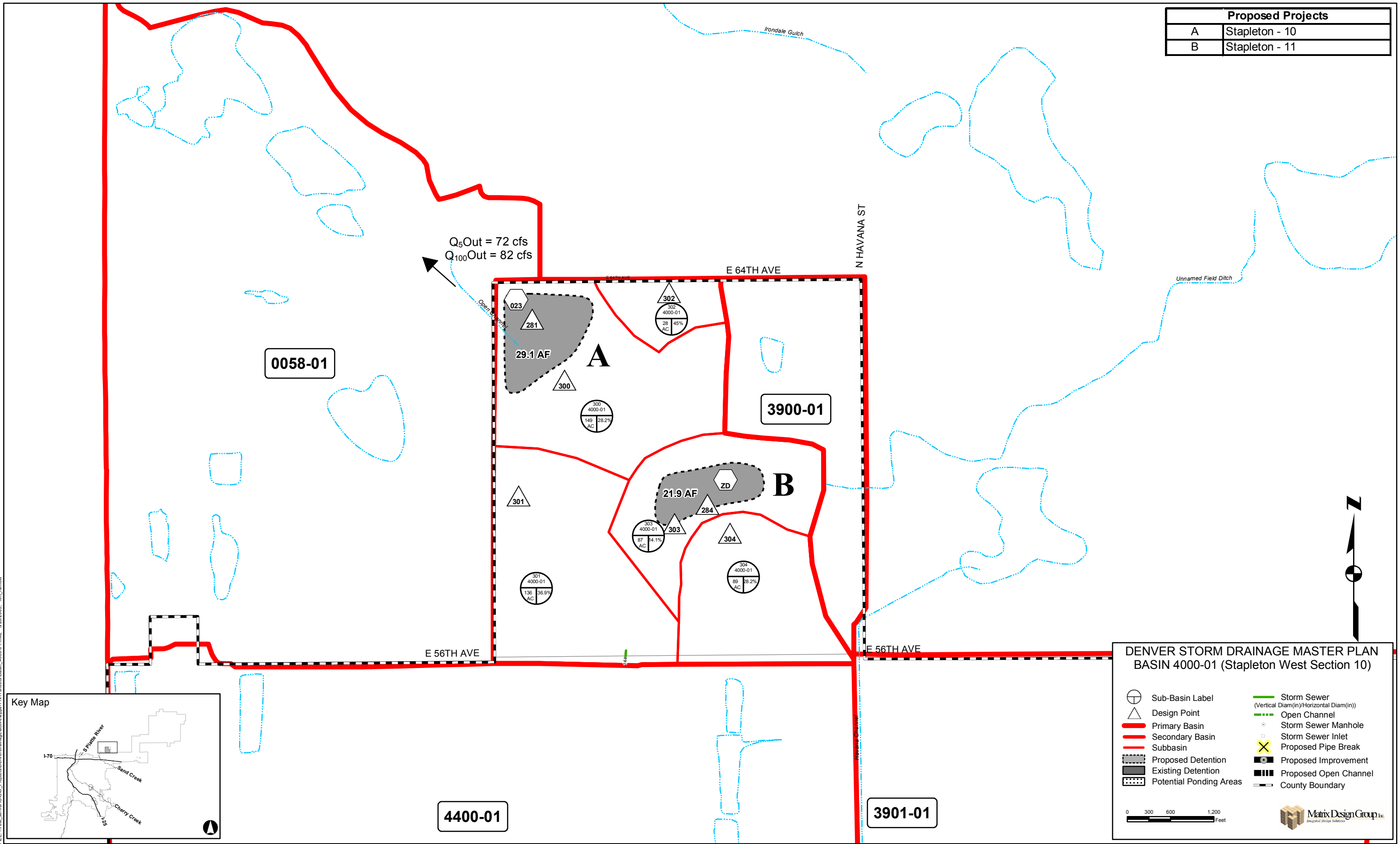
A second retention pond (Pond #23) is proposed in the northwest corner of Section 10 to control releases into the Rocky Mountain Arsenal. This pond is estimated to be about 29 acre-feet and will release at the defined historic rates.

### Developed Conditions Hydrology:

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
303	303	87.2	10	23	192
304	304	100.3	61	92	287
284	303, 304	187.5	71	115	479
300	300	148.2	33	63	272
301	301	133.6	43	71	265
302	302	28.5	14	22	69
281	300, 301, 302	310.3	74	129	550
282	300, 301, 302, 303, 304	497.8	8	10	11



Proposed Projects	
A	Stapleton - 10
B	Stapleton - 11



0058-01

3900-01

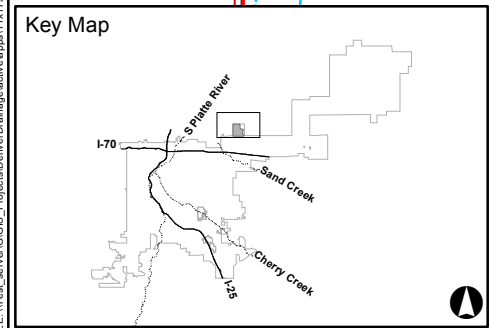
4400-01

3901-01

Q<sub>5</sub>Out = 72 cfs  
Q<sub>100</sub>Out = 82 cfs

023  
281  
29.1 AF  
A

302  
303  
21.9 AF  
B  
ZD



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4000-01 (Stapleton West Section 10)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Integrated Design Solutions

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## Basin: 4300-03 (Clear Creek – North of I-70)

### Existing System Description:

This basin drains to Clear Creek and is generally bound by Regis Boulevard on the south, Clear Creek on the north and west, and Alcott Street on the east. A 60” RCP drains into the basin from the south from basin 4309-01 (Berkeley Lake) and continues through Willis Case Golf Course and then along Sheridan Boulevard to Clear Creek. The southern half of the basin is located within the City of Denver and drains to an existing 36-inch system in 52<sup>nd</sup> Avenue. The northern half is outside of the City and drains to the north into Clear Creek. The majority of the basin is residential, but also includes Regis University and Willis Case Golf Course.

### Drainage Deficiencies:

The 12-inch pipe in Federal, which continues to its outfall in Arvada, is undersized.

The majority of trunk drainage systems in the residential portions of this basin are adequately sized for a 2-year event.

### Proposed Capital Improvements:

#### Project A: N. Federal Blvd. Outfall

Replacing the 12-inch pipe in Federal with a 24- to 30-inch line within Denver’s jurisdiction will provide a 5-year level of service. Extending the system to the north into Arvada and the outfall at Clear Creek will require a 42-inch line to be coordinated with the City of Arvada.

#### Project B: Clear Creek Outfall

The storm drain outfall in Sheridan Boulevard will be upsized to better convey flows to Clear Creek.

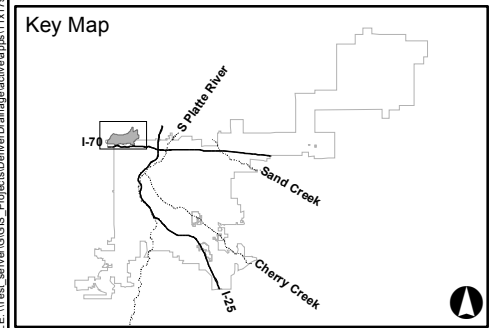
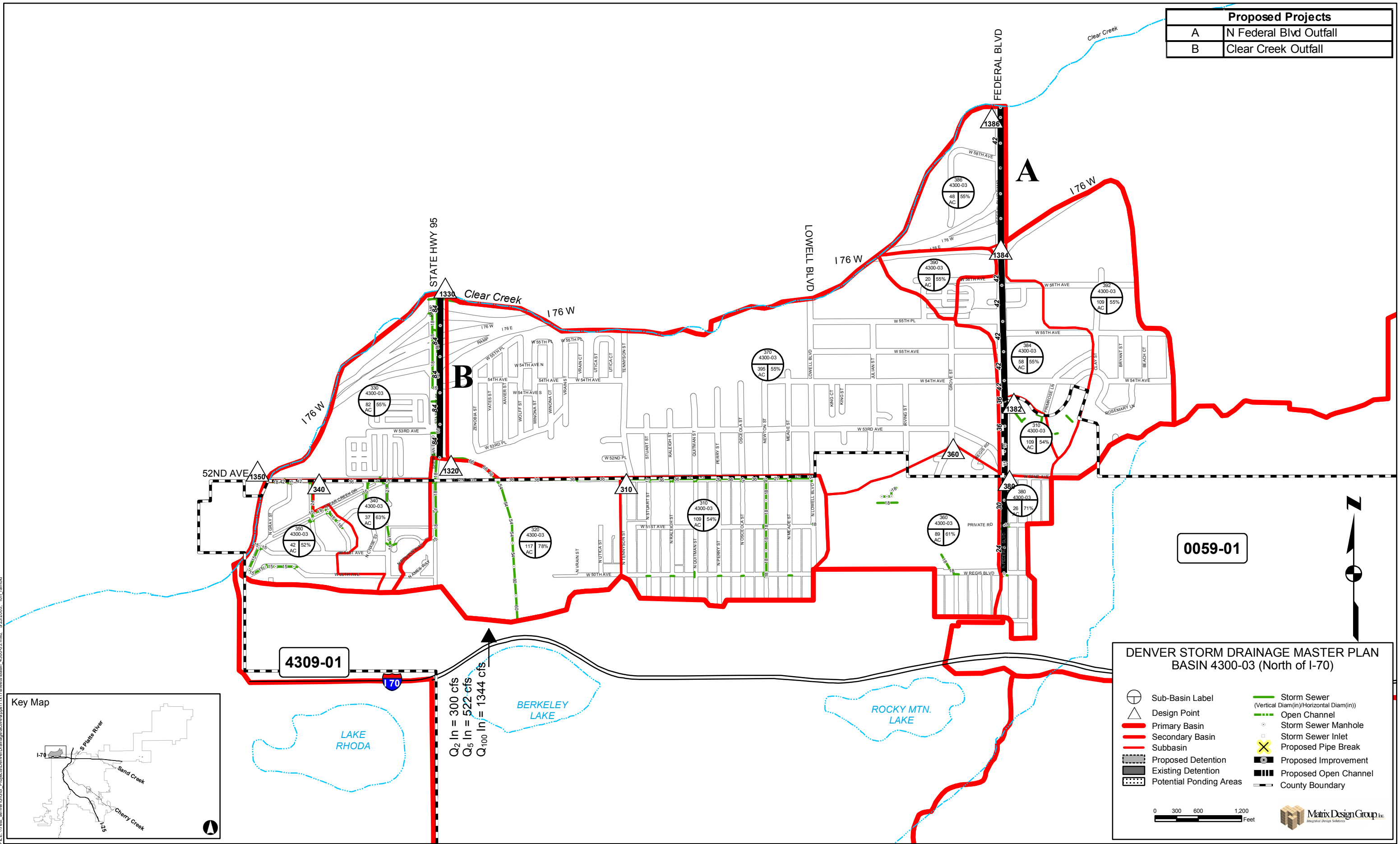
### Existing Hydrology:

The City of Denver has recently (2005) revised the 2003 *Rocky Mountain Ditch Outfall Systems Planning Study* (OSP). Results from the new study have been incorporated into this Master Plan. The following hydrologic results are derived from models developed for the the Denver Master Plan for areas north of I-70, while the 2005 OSP re-study model was used for areas south of I-70.

### BASIN 4300-03

<u>Design Point</u>	<u>Contributing Basins</u>	<u>Tributary Area</u> (acres)	<u>Peak Discharge</u>		
			<u>2-Year</u> (cfs)	<u>5-Year</u> (cfs)	<u>100-Year</u> (cfs)
310	310	109	83	149	382
340	340	37	35	59	145
360	360	89	77	130	319
380	380	26	26	41	97
1190	Berkeley Lake	1035	318	566	1488
1320	Berkeley Lake, 310, 320	1261	388	693	1937
1330	Berkeley Lake, 310, 320, 330	1343	391	701	2018
1350	340, 350	79	58	101	270
1382	380, 382	43	37	63	156
1384	380, 382, 384	101	71	125	331
1386	380, 382, 384, 386	149	82	151	438

Proposed Projects	
A	N Federal Blvd Outfall
B	Clear Creek Outfall



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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4300-03 (North of I-70)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1200 Feet

Matrix Design Group Inc.  
Integrated Design Solutions

## Basin: 4309-01 (Berkeley Lake)

### Existing System Description:

This basin drains to Clear Creek and is generally bound by Sheridan Boulevard on the west, Regis Boulevard on the north, 35<sup>th</sup> Avenue on the South, and the Rocky Mountain Ditch on the east. Approximately half of the basin drains to the intersection of Sheridan Boulevard and I-70, while the other half drains to the Tennyson Street and I-70 intersection. Runoff from these two intersections is conveyed via large storm sewer systems around Berkeley Lake and to the north across I-70. Currently, storm pipes carry water around Berkeley Lake and do not discharge directly into the lake. Proposed improvements originally recommended in the 2003 *Rocky Mountain Ditch Outfall Systems Planning Study* (OSP) included a new 60" RCP that would discharge into the lake and alleviate the Sheridan Boulevard and I-70 system. However, the 2003 OSP was re-studied by the City of Denver in 2005, and the proposed 60" RCP was determined to be unnecessary because the existing system was found to be adequate. It should be noted that the lake was not constructed as a detention facility, but inadvertent detention does occur.

### Drainage Deficiencies:

The 2005 OSP re-study found the existing drainage system to be adequate basin-wide.

### Proposed Capital Improvements:

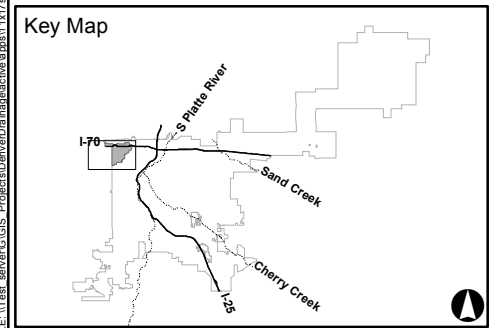
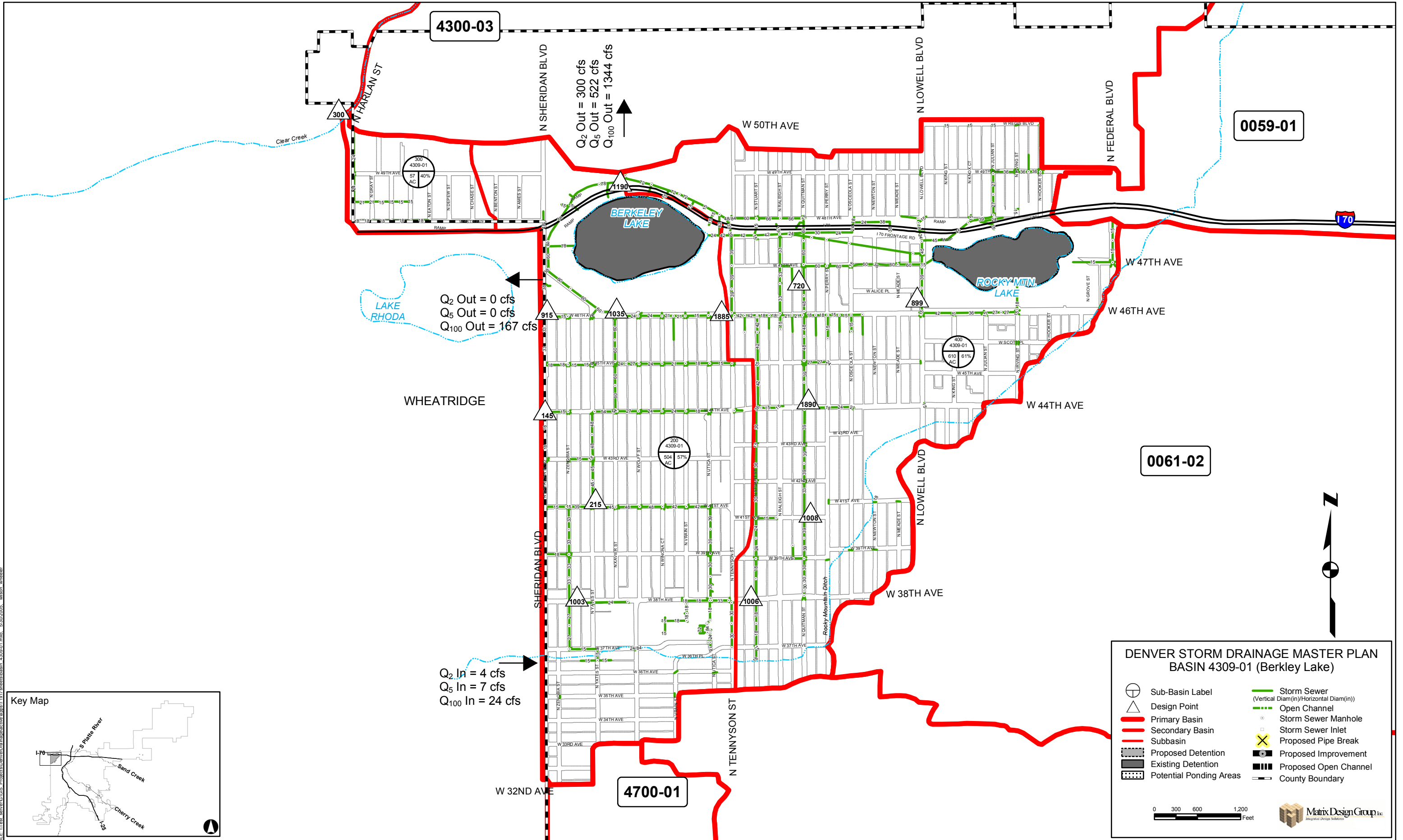
Based upon the OSP re-study, there are no capital improvements proposed in this basin.

### Existing Hydrology:

The 2003 OSP has been re-studied by the City of Denver (2005). Results from the new study have been incorporated into this Master Plan and are summarized in the following table.

### BASIN 4309-01

<u>Design Point</u>	<u>Peak Discharge</u>				
	<u>2-Year</u> <i>(cfs)</i>	<u>5-Year</u> <i>(cfs)</i>	<u>10-Year</u> <i>(cfs)</i>	<u>25-Year</u> <i>(cfs)</i>	<u>100-Year</u> <i>(cfs)</i>
145	13	19	24	49	115
215	65	108	132	205	259
284	17	28	35	58	73
720	58	87	94	116	129
899	32	44	44	44	44
915	26	63	110	341	629
1003	22	35	43	73	107
1006	9	15	19	33	66
1008	25	42	52	95	167
1013	31	58	78	160	297
1035	120	195	212	274	344
1037	149	235	278	511	800
1885	42	74	96	147	222
1890	51	74	78	89	105



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4309-01 (Berkley Lake)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1200 Feet

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## Basin 4400-01 (North Stapleton)

### Existing System Description:

This basin consists of 3,183 acres (4.97 square miles) will be nearly completely re-built with the redevelopment of Stapleton. *Blueprint Denver* shows the entire basin within the City & County of Denver subject to change. The portion of this basin within Adams County does not receive or contribute drainage from or to Denver, and therefore has generally been ignored for this study. All drainage from this basin will outfall to Sand Creek.

Drainage currently is generally contained within informal sump/retention areas within the former runways. Currently, drainage for areas north of I-70 flows to the north into the Rocky Mountain Arsenal. Drainage from the I-70 corridor and south of I-70 flows into Sand Creek.

### Drainage Deficiencies:

The Sand Creek floodplain significantly encumbers the site between Sand Creek and I-70. FEMA Flood Insurance Rate Maps (FIRM) for the Stapleton site shows large floodplain areas resulting from Sand Creek breaching levees along the river edge. I-70 is also shown as being inundated during a 100-year flood event in Sand Creek. The Sand Creek floodplain will eventually become more confined via implementation of the Sand Creek Master Plan channel improvements.

Currently, there is only one formal major outfall that exists – the CDOT storm pipe for the I-70 corridor. Drainage from the I-70 corridor flows in a storm pipe system parallel to I-70 into Sand Creek.

Very little drainage infrastructure exists today in this undeveloped basin, except for the Catellus site west of and adjacent to Havana. Since no major outfall exists today for the area, 100-year retention has been constructed. Water is metered out through small storm drains to allow the ponds to dry between storms.

### Proposed Capital Improvements:

There have been a number of previous studies that have established the framework for management of stormwater at the site, including the *Outfall Systems Plan-Stapleton Area* (OSP), prepared by the City & County of Denver and the Urban Drainage & Flood Control District in 1995, and the *Stapleton Sitewide Infrastructure Master Plan* prepared by Turner, Collie and Braden in 1996. The most current document is the *Infrastructure Master Plan* prepared by BRW, Inc in December 2000 and approved by Denver Wastewater in April 2001. The BRW Master Drainage Plan was prepared to evaluate infrastructure needed to support redevelopment of the former Stapleton International Airport into the variety of uses envisioned in the previous Forest City Stapleton Preliminary Concept Plan.

The northern portion of Stapleton, which currently consists of open land containing multiple runways, offers greater potential for development, and will require more extensive earthwork and land forming in order to create the environment envisioned in the *Green Book* and the densities proposed in the Concept Plan. The plan retains the *Green Book* concept of establishing a major drainageway called the “North Stapleton Outfall Channel”. This major drainageway receives almost all runoff generated on the North Stapleton site. It is proposed to be a large channel, where multiple uses of the drainage corridor are envisioned. An important consideration in the development of the Stapleton Master Drainage Plan is the integration of active land uses such as parks, ballfields, and sport complex facilities, together with passive land uses such as prairie parks, linear parks and trails, and undisturbed natural open space.

North of I-70, detention ponds are sized per the criteria used in the OSP: the 100-year storm event defines the quantity detention. An allowable release rate of 0.85 cfs per acre is allowed north of I-70 (Type “A” soils, SCS classification). The ponds are sized to store the 100-year hydrograph without overtopping, and an emergency spillway will be provided to accommodate events exceeding the 100-year storm event.

Only three outfall locations are designated for this basin north of Sand Creek, and are defined by the projects listed below:

**Project A: Stapleton – 01** Much of the site is intended to drain through the proposed North Stapleton Channel, which will extend from 56<sup>th</sup> Avenue southwest to a large detention pond (No. 26) at approximately Quebec and I-270. Discharges from that detention facility will be directed west under I-270 to Sand Creek. This detention pond receives nearly all drainage from the basin defined by I-70 on the south, Havana Street on the east, 56<sup>th</sup> Avenue on the north, and almost to Quebec on the west. Seventeen sub-basins containing a total of 1,580 acres contribute flow to this outfall location.

**Project B: Stapleton – 02** Significant development is underway along Havana Street, by Catellus (Stapleton Business Center), and King Soopers. The OSP recommends the 320 acres of impervious area will require the need for construction of “Pond 26,” a large detention pond at I-70/I-270/Quebec Street with about 120 acre-feet of storage volume. However, Catellus has currently constructed about 100 acre-feet of retention volume, and is seeking a slow-release outfall to reduce stagnant ponding. This retention volume potentially could be revised to provide detention, and thus reduce the size of pond 26 by about 35 acre-feet. This scenario requires the approval of UDFCD and DWMD as well as the property owners.

**Project C: Stapleton – 03** South of I-70 and north of Sand Creek, the area is envisioned to discharge to Sand Creek to the west through a singular outfall point from sub-basin 160, although final grading may render a second outfall location as a reasonable alternative. This south central area is comprised of seven sub-basins draining a total of 386 acres. Regional water quality treatment is proposed at the outfalls.

### Existing Hydrology:

#### BASIN 4400-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
226	226	174	194	273	615
263	160	41	34	48	121
264	161, 162	256	201	288	598
268	212	213	243	342	759
277	230, 231, 232	272	74	118	448
279	200-232	1539	161	247	657



## Basin 4400-02 (Quebec Corridor)

### Existing System Description:

This basin includes a mix of industrial and residential land uses to the west of Stapleton along Quebec. It consists of 3,206 acres (4.61 square miles) and is fully built-out with older neighborhood residential in the upper reaches and commercial in the lower reaches. *Blueprint Denver* shows the entire basin as an “Areas of Stability”, inferring that Basin 4400-02 is not an area of future land use change. All drainage from this basin outfalls to Sand Creek or the South Platte River.

### Drainage Deficiencies:

The existing drainage system has capacity to convey less than the 1-year storm event to the outfall. Rainfall runoff in excess of the storm drain capacity has a history of ponding in the sump and flat areas. Major drainage problems have been experienced in the sump area near Smith Road and Grape Street. More shallow ponding also occurs on adjacent flat commercial properties because of water being built up behind the railroad and I-70. Specific deficiencies include:

- Local drainage conveyance problems exist in Basin 70 between Forest Street and Grape Street.
- Drainage to the south of Smith Road requires improved conveyance via Dahlia Street; the lack of an adequate outfall causes ponding of up to 4 feet in depth and creation of an urban floodplain along Stapleton Boulevard.

An extensive area of flood hazards have been identified within Basins 0060-01 and 4400-02, related primarily to ponding behind railroad tracks, I-70, and other sumps in the lower portions of each basin. A total of 716 structures with a total property value of \$120.6M (per 2003 Denver assessors’ records) lie within the 501-acre zone most severely impacted by the flooding. Annualized flood damage costs are estimated to be \$1.3M and \$2.M for 5-year and 100-year return periods, respectively. Drainage improvements in these basins should be viewed on the basis of achieving the minimum performance objectives for residential and commercial areas established for the Denver stormwater program due to the high cost of retrofitting new storm sewer in existing streets.

### Proposed Capital Improvements:

Drainage improvements in these basins should be viewed primarily to achieve the minimum performance objectives for residential and commercial areas (2- and 5-year system capacities) established for the Denver stormwater program.

Although these basins have not been identified by *Blueprint Denver* as areas of significant change, corridor studies are now being initiated for this segment of I-70 that will evaluate the need for highway and commuter rail improvements and identify related transit-oriented development (TOD) opportunities. Re-development of land within these basins would generally require a 100-year drainage system and improvement of highway and rail drainage facilities for a 50-year conveyance system. It is assumed that additional locations for stormwater detention or related conveyance improvements would be planned and constructed as part of the improvement programs associated with any enhanced use within the area.

### Alternatives Analysis for Proposed Capital Improvements:

Stormwater improvements for Basins 4400-02 and 0060-01 are inextricably linked because of the “split flow” condition (from Basin 4400 to 0060) that exists along Smith Road and availability of storage volume in Basin 0060-01. Multiple detention pond locations are possible within existing city parks (Park Hill Golf Course, Skyland, and MLK) and a parcel recently acquired by the City of Denver for a new Police Department complex. Three alternatives have been evaluated that combine improvements for these basins as described below. The corresponding improvements for each alternative within the 0060-01 are presented in that respective section of this study.

**Alternative 1(Conveyance):** Alternative 1 includes construction of a parallel North Dahlia Street outfall from Sand Creek to East 48<sup>th</sup> Avenue. Additionally, a spine outfall would be constructed along North Forest Street with sizes graduating from an 8’x10’ RCBC storm sewer to an 8’x20’ RCBC. A manifold storm sewer system would be constructed along 38<sup>th</sup> Avenue from Eldora Street with sizes ranging from 24-inch to an 8’ x 14’ RCBC. The local storm sewer would be improved as shown to extend to East 17<sup>th</sup> Parkway.

Construction of a storm sewer which diverts flows from Basin 4400-02 to 0060-01 is proposed to minimize the size of downstream conveyance facilities. This would require installation of a storm sewer along North Eudora Street and Elm Street to intercept and route runoff to a new system crossing Smith Road and I-70.

**Alternative 2(Limited Detention):** Alternative 2 includes all the components as described above for Alternative 1 and is linked to Alternative 2 for the 0060-01 basin. Additionally, a diversion structure would be installed at Smith Road and Dahlia Street to provide for off-line peak flow attenuation within an existing sump area within the Park Hill Golf Course. The sump would be excavated, re-vegetated, and integrated with the golf course to provide 18 acre-feet of flood storage. The outfall from Park Hill would be constructed as described for Alternative 1 for the 0060-01 basins.

**Alternative 3(Detention):** This alternative provides additional detention storage to downsize outfall systems, fully utilize recently installed infrastructure, and obviate the need for additional improvements from East 50<sup>th</sup> Avenue to Sand Creek. Detention would be provided at or proximate two locations: 1) Park Hill Golf Course and 2) 38<sup>th</sup> Avenue and North Grape Street near or within a proposed City & County of Denver police station site. The Park Hill Golf Course detention would require expansion to 71 acre-feet (requiring approximately 15 acres of inundation area.) The 38<sup>th</sup> and Grape detention facility would accommodate 18 acre-feet for off-line flow attenuation. This concept has been screened with Denver Police Department and is considered to be potentially viable. If this approach is not acceptable to the City, another site with at least 2.5 acres of land near Grape Street between 38<sup>th</sup> Avenue and Smith Road should be acquired. The benefit of this approach is realized by the reduction of sizes for storm sewers along Dahlia from Smith Road to 50<sup>th</sup> Avenue and avoidance of additional improvements to Sand Creek.

### Economic Analysis:

Alternative 3 (Detention) represents the **least cost solution** for the combined improvement program for Basins 0060-01 and 4400-02 (see Basin 0060-01). Therefore, it is recommended that further discussions with the operators of the Park Hill Golf Course, Denver Police Department, Dahlia Square and Denver Department of Asset occur to pursue regional detention facilities in these basins.

### Alternative 100-Year System:

Ponding is predicted to start at Smith Road from an estimated 100-year flow of 3,771cfs for the 2,324 tributary acres. The proposed 5-year system to reduce ponding in the area is estimated to be \$48.8M (Projects A,B G,K,L and M Basin 0060-01, and Projects C,D,E,F,G,H,I,M and V Basin 4400-02). A 100-year drainage system of the magnitude to eliminate the ponding would require property acquisition for detention or an open channel (assumed ROW of 115 feet wide). Property acquisition is estimated to be roughly \$10M, and construction costs for a 100-year system would be at least \$88M.



**BASIN 4400-02 EXISTING CONDITIONS**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
11	10	50	45	75	180
21	10,20	225	169	292	740
31	10,20,30	418	214	384	1085
51	10,20,30,50	526	239	439	1294
71	70	131	125	225	575
72	60,70	230	157	281	759
76	60,70,75	338	180	330	969
81	10,20,30,50,80	691	252	478	1516
91	90,500	314	92	191	626
101	90,100,500	469	171	327	1001
131	90,100,130,135,500	583	245	450	1305
151	10,20,30,50,60,75,80,90,100,110,120,130,135,150,500	2003	674	997	2965
161	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,500	2090	737	1125	3135
191	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,180,190,500	2277	581	695	1105
200	200	159	265	382	784
211	200,210,230	337	357	536	1203
221	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,180,190,220,500	2412	927	1202	1961
231	200,230	250	281	424	950
241	200,210,230,240	475	218	361	986
251	10,20,30,50,60,75,80,90,100,110,120,130,135,150,160,180,190,220,250,500	2520	948	1256	2004

**BASIN 4400-02 ALTERNATIVE 1**

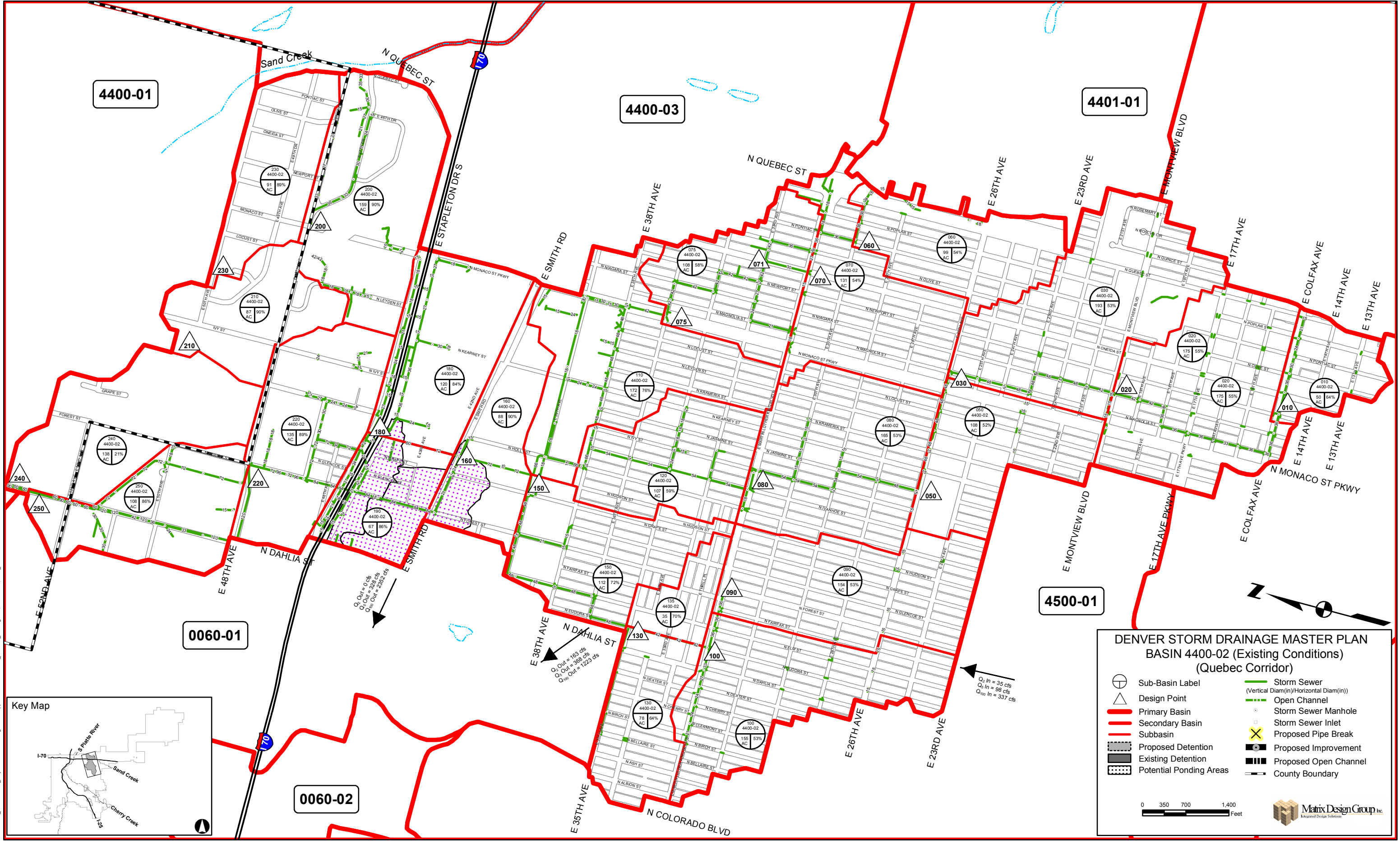
Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	50	45	75	180
20	10,20	225	172	298	742
30	10,20,30	418	219	388	1086
50	10,20,30,50	526	244	444	1296
60	60	99	71	127	329
70	70	131	125	225	575
71	60,70	230	161	283	758
75	60,70,75	338	184	332	969
80	10,20,30,50,80	691	258	484	1517
90	90,500	314	85	152	527
100	90,100,500	469	168	309	912
130	90,100,130,135,500	583	244	438	1230
150	10,20,30,50,60,70,75,80,110,120,150	1420	648	986	2890
160	160	87	118	170	357
180	160,180,190	274	240	354	764
200	200	159	265	382	784
210	200,210,230	337	359	537	1203
220	10,20,30,50,60,70,75,80,110,120,150,160,180,190,220	1829	1019	1590	2590
230	200,230	250	284	425	949
240	200,210,230,240	475	222	364	988
250	10,20,30,50,60,70,75,80,110,120,150,160,180,190,220,250	1937	1072	1613	2684

**BASIN 4400-02 ALTERNATIVE 2**

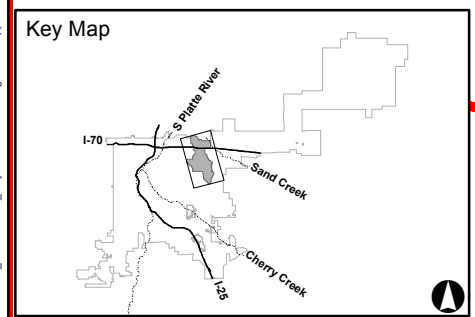
Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	50	45	75	180
20	10,20	225	172	298	742
30	10,20,30	418	219	388	1086
50	10,20,30,50	526	244	444	1296
60	60	99	71	127	329
70	70	131	125	225	575
71	60,70	230	161	283	758
75	60,70,75	338	184	332	969
80	10,20,30,50,80	691	258	484	1517
90	90,500	314	85	152	527
100	90,100,500	469	168	309	912
130	90,100,130,135,500	583	244	438	1230
150	10,20,30,50,60,70,75,80,110,120,150	1420	648	986	2890
160	160	87	118	170	357
180	160,180,190	274	240	354	764
200	200	159	265	382	784
210	200,210,230	337	359	537	1203
220	10,20,30,50,60,70,75,80,110,120,150,160,180,190,220	1829	1019	1590	2590
230	200,230	250	284	425	949
240	200,210,230,240	475	222	364	988
250	10,20,30,50,60,70,75,80,110,120,150,160,180,190,220,250	1937	1072	1613	2684

**BASIN 4400-02 ALTERNATIVE 3**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	50	45	75	180
20	10,20	225	172	298	742
30	10,20,30	418	219	388	1086
50	10,20,30,50	526	244	444	1296
60	60	99	71	127	329
70	70	131	125	225	575
71	60,70	230	161	283	758
75	60,70,75	338	184	332	969
80	10,20,30,50,80	691	258	484	1517
90	90,500	314	85	152	527
100	90,100,500	469	168	309	912
130	90,100,130,135,500	583	244	438	1230
152	10,20,30,50,60,70,75,80,110,120	1308	134	235	2395
160	10,20,30,50,60,70,75,80,110,120,160	1395	157	268	2413
190	180,190	187	240	354	764
200	200	159	265	382	784
210	200,210,230	337	359	537	1203
220	10,20,30,50,60,70,75,80,110,120,160,180,190,220	1717	478	666	1565
230	200,230	250	284	425	949
240	200,210,230,240	475	222	364	988
250	10,20,30,50,60,70,75,80,110,120,160,180,190,220,250	1825	559	808	1831



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**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 4400-02 (Existing Conditions)**  
**(Quebec Corridor)**

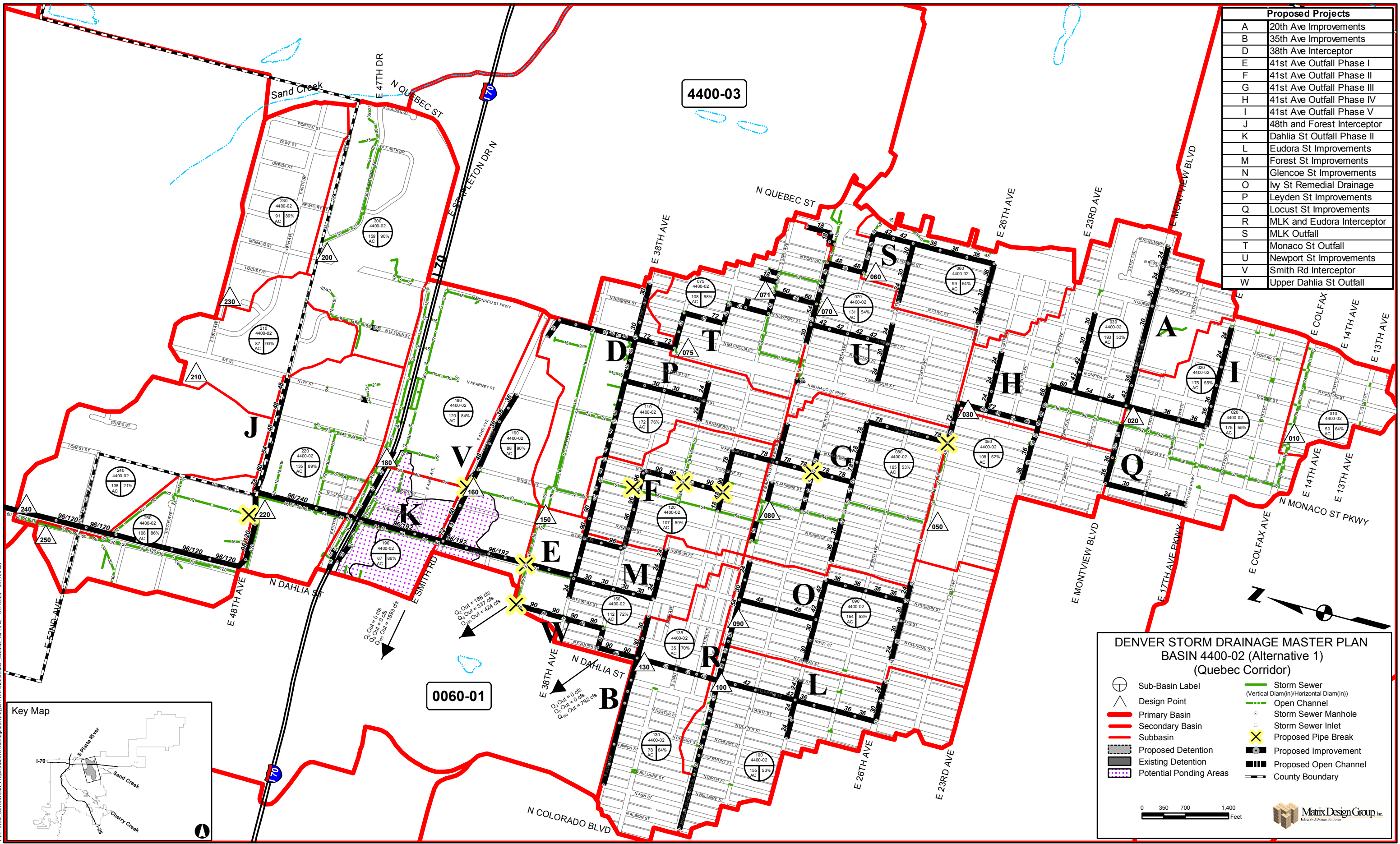
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	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

$Q_{10} \text{ In} = 35 \text{ cfs}$   
 $Q_{5} \text{ In} = 98 \text{ cfs}$   
 $Q_{100} \text{ In} = 337 \text{ cfs}$

0 350 700 1,400 Feet

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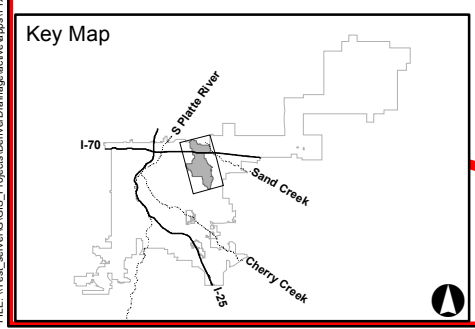
Proposed Projects	
A	20th Ave Improvements
B	35th Ave Improvements
D	38th Ave Interceptor
E	41st Ave Outfall Phase I
F	41st Ave Outfall Phase II
G	41st Ave Outfall Phase III
H	41st Ave Outfall Phase IV
I	41st Ave Outfall Phase V
J	48th and Forest Interceptor
K	Dahlia St Outfall Phase II
L	Eudora St Improvements
M	Forest St Improvements
N	Glencoe St Improvements
O	Ivy St Remedial Drainage
P	Leyden St Improvements
Q	Locust St Improvements
R	MLK and Eudora Interceptor
S	MLK Outfall
T	Monaco St Outfall
U	Newport St Improvements
V	Smith Rd Interceptor
W	Upper Dahlia St Outfall



4400-03

0060-01

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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4400-02 (Alternative 1)  
(Quebec Corridor)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

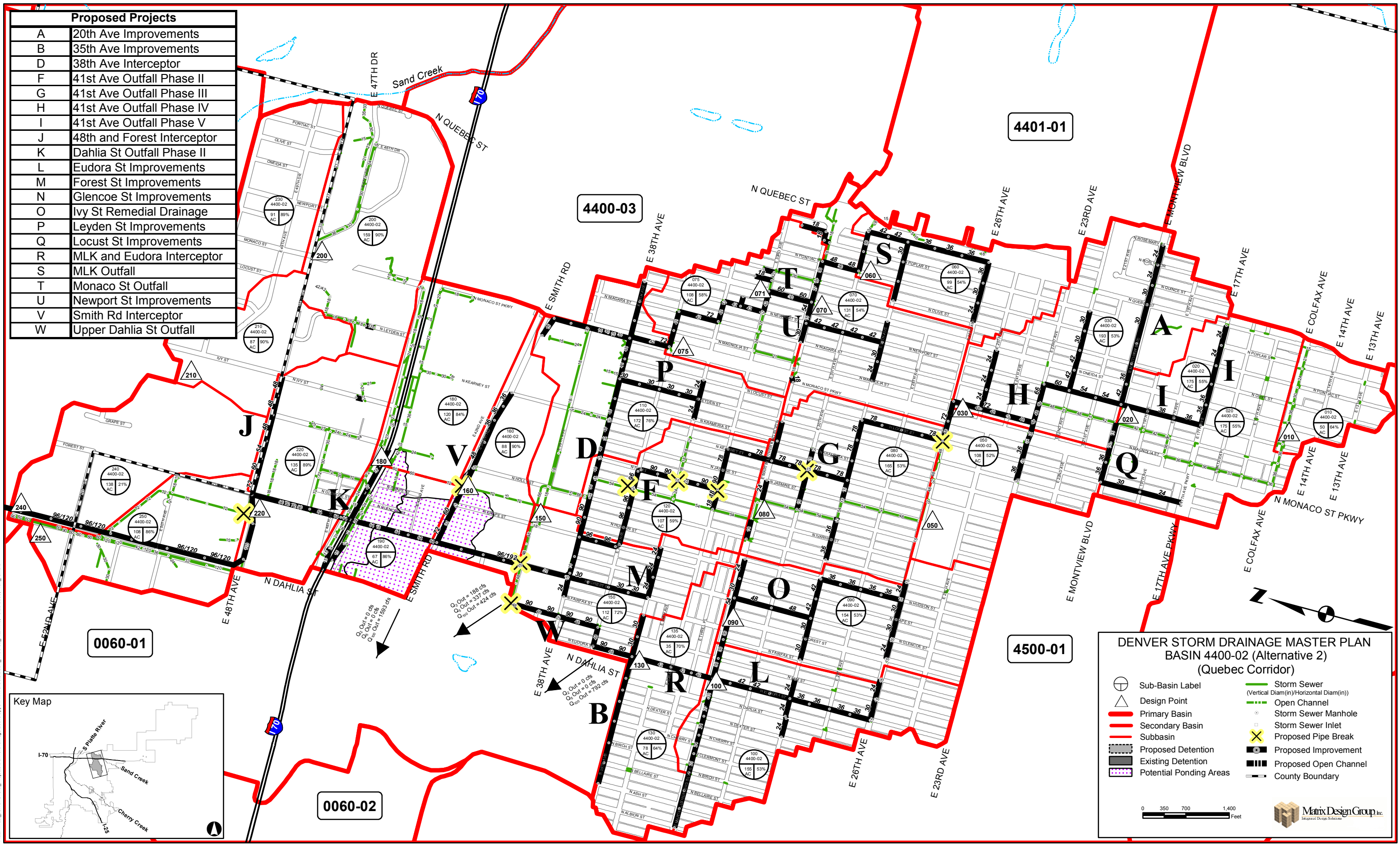
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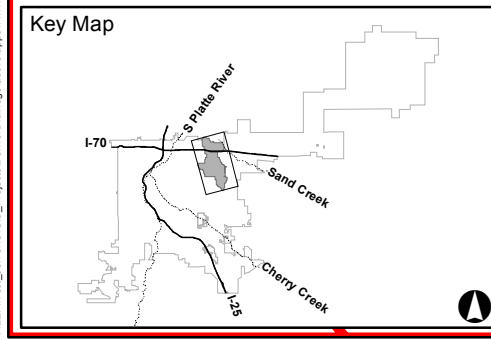
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Q<sub>100</sub> Out = 0 cfs  
Q<sub>50</sub> Out = 0 cfs  
Q<sub>25</sub> Out = 792 cfs

Proposed Projects	
A	20th Ave Improvements
B	35th Ave Improvements
D	38th Ave Interceptor
F	41st Ave Outfall Phase II
G	41st Ave Outfall Phase III
H	41st Ave Outfall Phase IV
I	41st Ave Outfall Phase V
J	48th and Forest Interceptor
K	Dahlia St Outfall Phase II
L	Eudora St Improvements
M	Forest St Improvements
N	Glencoe St Improvements
O	Ivy St Remedial Drainage
P	Leyden St Improvements
Q	Locust St Improvements
R	MLK and Eudora Interceptor
S	MLK Outfall
T	Monaco St Outfall
U	Newport St Improvements
V	Smith Rd Interceptor
W	Upper Dahlia St Outfall



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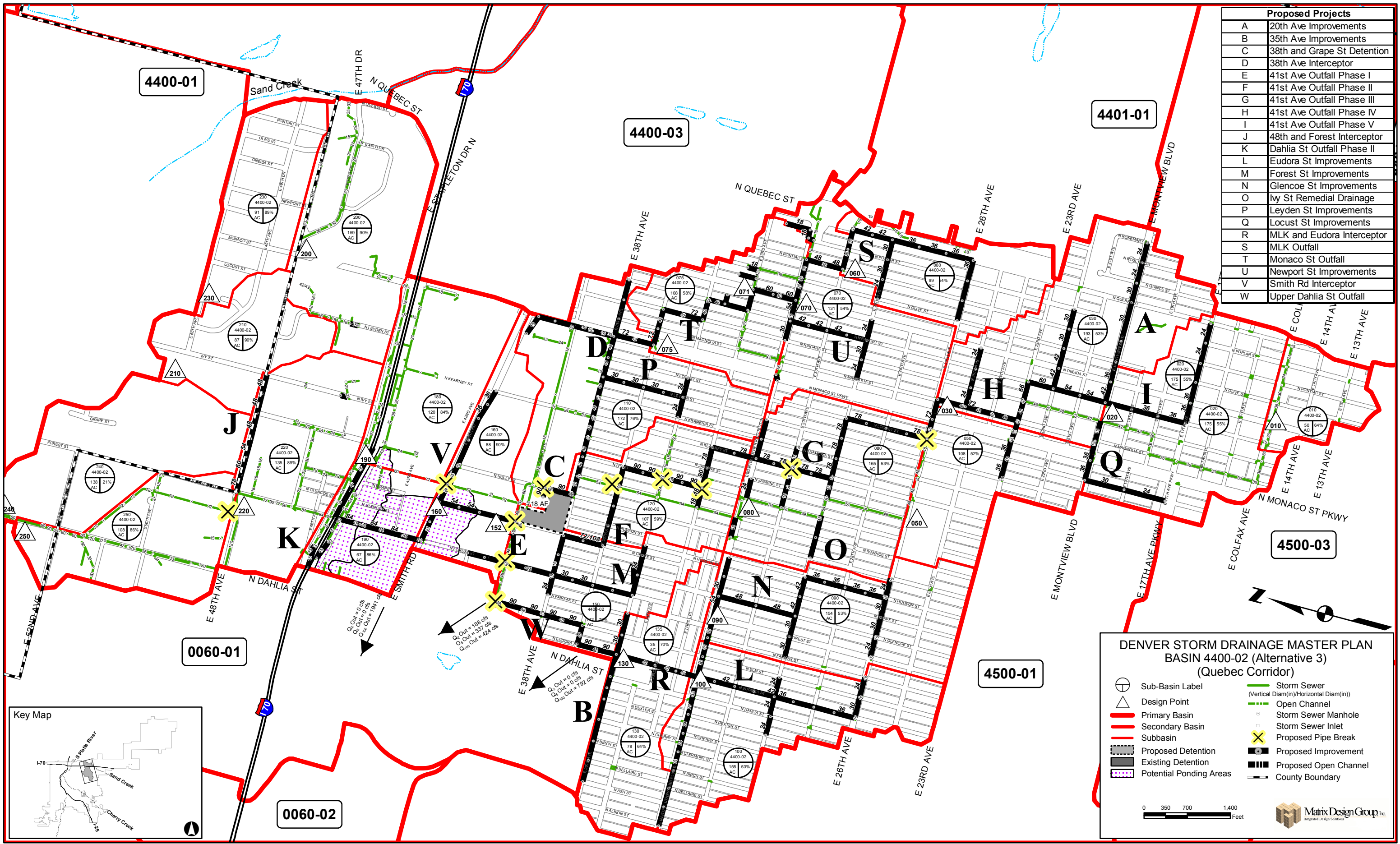
**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4400-02 (Alternative 2)  
(Quebec Corridor)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

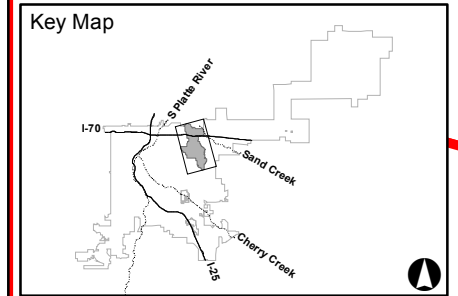
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Integrated Design Solutions

Proposed Projects	
A	20th Ave Improvements
B	35th Ave Improvements
C	38th and Grape St Detention
D	38th Ave Interceptor
E	41st Ave Outfall Phase I
F	41st Ave Outfall Phase II
G	41st Ave Outfall Phase III
H	41st Ave Outfall Phase IV
I	41st Ave Outfall Phase V
J	48th and Forest Interceptor
K	Dahlia St Outfall Phase II
L	Eudora St Improvements
M	Forest St Improvements
N	Glencoe St Improvements
O	Ivy St Remedial Drainage
P	Leyden St Improvements
Q	Locust St Improvements
R	MLK and Eudora Interceptor
S	MLK Outfall
T	Monaco St Outfall
U	Newport St Improvements
V	Smith Rd Interceptor
W	Upper Dahlia St Outfall



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**DENVER STORM DRAINAGE MASTER PLAN**  
**Basin 4400-02 (Alternative 3)**  
**(Quebec Corridor)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1400 Feet

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 Integrated Design Solutions

## Basin 4400-03 (Stapleton)

### Existing System Description:

This basin consists of 1,016 acres (1.59 square miles) and is being, or will be, nearly completely re-built with the redevelopment of Stapleton. *Blueprint Denver* shows the portion of the basin on the Stapleton site within the City & County of Denver subject to change. All drainage from this basin will outfall to Sand Creek.

### Drainage Deficiencies:

Drainage currently is conveyed through a random network of storm drains. These pipes will be upsized and replaced commensurate with redevelopment.

### Proposed Capital Improvements:

There have been a number of previous studies that have established the framework for management of stormwater at the site, including the *Outfall Systems Plan-Stapleton Area* (OSP), prepared by the City & County of Denver and the Urban Drainage & Flood Control District in 1995, and the *Stapleton Sitewide Infrastructure Master Plan* prepared by Turner, Collie and Braden in 1996. The most current document is the *Infrastructure Master Plan* prepared by BRW, Inc in December 2000 and approved by Denver Wastewater in April 2001. The BRW Master Drainage Plan was prepared to evaluate infrastructure needed to support redevelopment of the former Stapleton International Airport into the variety of uses envisioned in the previous Forest City Stapleton Preliminary Concept Plan.

South of I-70, the requirement for quantity detention has been waived. The waiver was granted by DWMD via a letter dated June 2, 2000. Formerly, 10-year detention was required for the Stapleton site south of I-70; however, with the waiver only water quality detention is required, provided that the full 100-year storm is conveyed directly to the receiving major drainageway without impact to downstream properties. Therefore, all new Stapleton drainage systems are designed for 100-year capacity.

For design purposes, Type ‘B’ soils are assumed for the Stapleton site south of Sand Creek. This classification affects infiltration rates and detention release rates.

There are two outfalls into Sand Creek, located between Westerly Creek and Quebec Street/I-70.

Project A: Stapleton – 04 Sub-basins 060 and 061 with 134 tributary acres will be conveyed to a proposed regional water quality pond via a proposed 72-inch storm drain.

Project B: Stapleton – 05 Filing No.1 was recently constructed and involves a Regional Retail Center and related utility infrastructure to support approximately 1 million square feet of commercial retail and office development. The Filing No. 1 site is generally bound on the south by 35<sup>th</sup> Avenue, on the east by Trenton Street, on the west by Quebec Street and on the north by Smith Road. The majority of this area was at one time a system of parking lots, concrete runways and buildings located on the west portion of the Stapleton site. The historic drainage patterns flowed northerly to a 72-inch storm sewer in Syracuse Street crossing Smith Road and the UPRR railroad tracks, outfalling to Sand Creek. This 72-inch outfall system served a 345-acre basin, with approximately 280 acres being comprised by the former airport south of Smith Road. Two major runoff basins (Basin 091 and 092) for the Filing No. 1 site drain to the 72-inch storm sewer. Because the storm sewer does not have adequate capacity to convey fully developed 100-year runoff from the 345-acre basin, an allocation of the available capacity has been reviewed with DWMD whereby Filing No.1 discharges would be limited to 285 cfs. Discharges in excess of this amount must then be attenuated with detention facilities or conveyed by a supplemental storm sewer outfall system.

Flows from Filing No.1 will be reduced by a combination of on-site detention and a trans-basin diversion of stormwater easterly to the proposed regional outfall system discharging at Smith Road and Sand Creek (near RK Mechanical). The trans-basin diversion will redirect stormwater south of 35<sup>th</sup> Avenue (Basins 065, 066, 067) to ostensibly reduce the tributary area to the 72-inch Syracuse outfall. An existing 54-inch storm sewer in Syracuse St will capture runoff from Basins 065, 066 and 067. The existing line will be extended with a 66/72-inch sewer in Trenton Street collecting a portion of runoff from Basin 063. This storm sewer is proposed to connect to an existing east-west 72-inch storm sewer south of Smith Road to be re-used. A new 36/48-inch storm sewer in Martin Luther King Boulevard and Uinta Street will serve basin 064. This line will be extended down Uinta with a 60-inch sewer to collect local drainage from 062 and 064. The ultimate outfall for Basins 062 and 064 is an 8’x5’ RCBC. These outfalls will be combined in the regional water quality pond near Smith Road and Sand Creek (Pond 156).

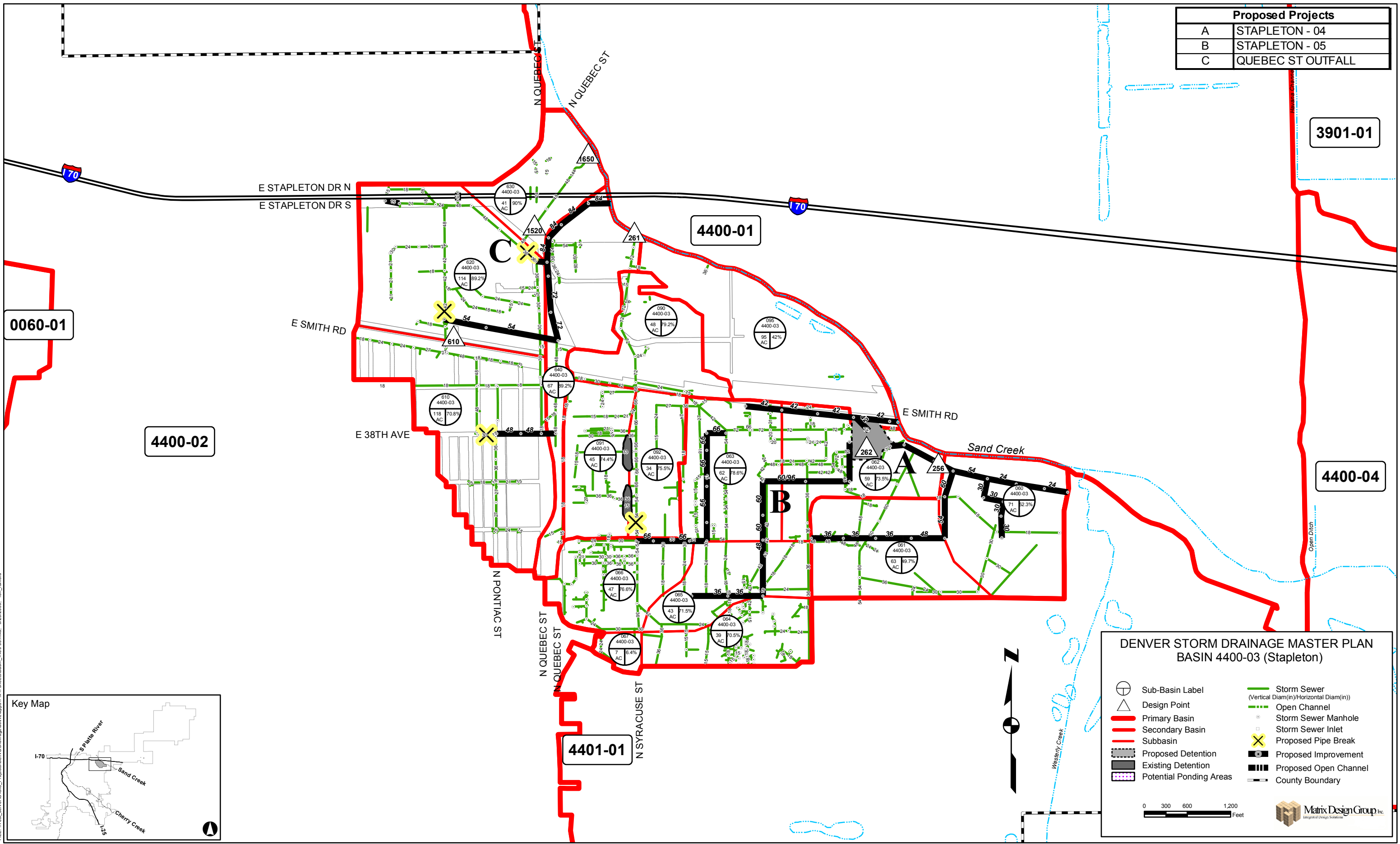
Project C: Quebec Street Outfall A new 84-inch outfall is proposed between I-70 and Smith Road east of Quebec. Additionally, a new 48-inch pipe is proposed to divert runoff from North Pontiac Street to the existing 48-inch pipe in Quebec Street, which will reduce the burden on the existing 54-inch crossing under I-70 near North Oneida Street. This new storm drain will be constructed commensurate with the reconstruction of Quebec Street.

### Existing Hydrology:

#### BASIN 4400-03

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
256	60,61	117	81	140	391
261	90,91,92	127	66	163	464
262	60-67	285	293	461	1016
610	610	118	148	238	550
1520	610,620	232	276	432	989
1650	610,620,630	273	306	495	1164

Proposed Projects	
A	STAPLETON - 04
B	STAPLETON - 05
C	QUEBEC ST OUTFALL



0060-01

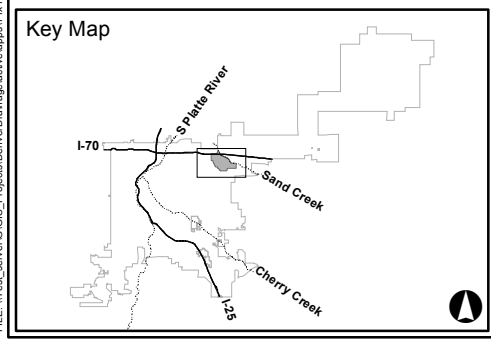
4400-02

4400-01

3901-01

4400-04

4401-01



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4400-03 (Stapleton)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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## Basin 4400-04 (East Stapleton)

### Existing System Description:

This basin consists of 1,806 acres (2.82 square miles). A portion of this basin is within Aurora. The Denver portion (Stapleton site and north of Sand Creek and south of I-70) is subject to change according to *Blueprint Denver*. The Stapleton redevelopment site is scheduled to be completely re-built by the developer, Forest City.

All drainage from this basin will outfall into Sand Creek. The area south of Sand Creek within Denver was undeveloped, so no storm drain system was warranted. The area north of Sand Creek south of I-70 was divided by the railroad tracks and Smith Road. The area north of Smith Road drains to an existing 84-inch outfall at Havana Street. The area south of Smith Road drains to open channels in Aurora and directly to Sand Creek. Currently, there are only three known outfalls into Sand Creek within this basin:

- 72-inch from Aurora from the south through the Stapleton site
- 84-inch in Havana from the north, collecting drainage along Smith Road and Havana
- Open channel in Aurora from the north

Type B soils are assumed south of Sand Creek for hydrologic calculations and detention design.

### Drainage Deficiencies:

Drainage on the Stapleton site is currently informal with few storm drains, relying upon infiltration, evaporation and sheet flow to drain the site to Sand Creek. A 72-inch storm drain from Aurora currently flows north through the Stapleton site and discharges to Bluff Lake. This 72-inch pipe can convey only runoff up to the 5-year event. The 100-year flow will split out of this basin by flowing in an open channel constructed along the southern Stapleton boundary at 26<sup>th</sup> Avenue, and discharging into Westerly Creek.

Drainage from the jail and other commercial/industrial properties between Smith Road and I-70 is conveyed to Sand Creek in the 84-inch pipe. This pipe has approximate capacity for the 2-year discharge. Runoff in excess of a 2-year event will back-up against Smith Road and the railroad tracks.

Drainage from the I-70 corridor flows in a storm pipe system parallel to I-70 into Sand Creek.

### Proposed Capital Improvements:

The framework for stormwater management at the Stapleton site has been set by the *Outfall Systems Plan-Stapleton Area* (OSP), prepared by the City & County of Denver and the Urban Drainage & Flood Control District in 1995. The most current document is the *Infrastructure Master Plan* prepared by BRW, Inc in December 2000 and approved by Denver Wastewater in April 2001. The BRW Master Drainage Plan was prepared to evaluate infrastructure needed to support redevelopment of the former Stapleton International Airport. Redevelopment will include drainage infrastructure to convey the full 100-year storm to Sand Creek. In addition, regional water quality treatment will be provided in accordance with Urban Drainage & Flood Control District Volume 3.

Project A: Stapleton – 06 To achieve a 5-year system for the commercial area north of Smith Road, and to preserve the existing storm drain in the area, a new outfall is proposed along the Denver County line at Lima Street. This new 12' x 4' box culvert will provide the additional outfall capacity for the 579-acre site to be protected from ponding up to a 5-year event.

Project B: Stapleton – 07 Discussions with Denver Parks Department indicated that they have interest in the development of Bluff Lake (in the southeastern portion of the Stapleton site) for limited use as a water quality pond. This lake was formerly fed by Sand Creek via an irrigation-style channel, but this water supply is no longer active. Management plans for Bluff Lake propose to enhance its use as a public amenity and to

encourage wetlands restoration. Therefore, additional water supply is desired for the structure. Proposed grading plans for the Stapleton site direct stormwater flows to Bluff Lake to enhance its water volume. A new 7' x 5' box culvert is proposed to discharge into Bluff Lake for regional water quality treatment. Storm drainage pipes in this area will be constructed commensurate with development.

Project C: Stapleton – 08 This project connects to Project A and extends the lateral network further into the basin. Existing 48- and 54-inch laterals will be upsized to 72- and 90-inch pipes, respectively to provide a 5-year level of service

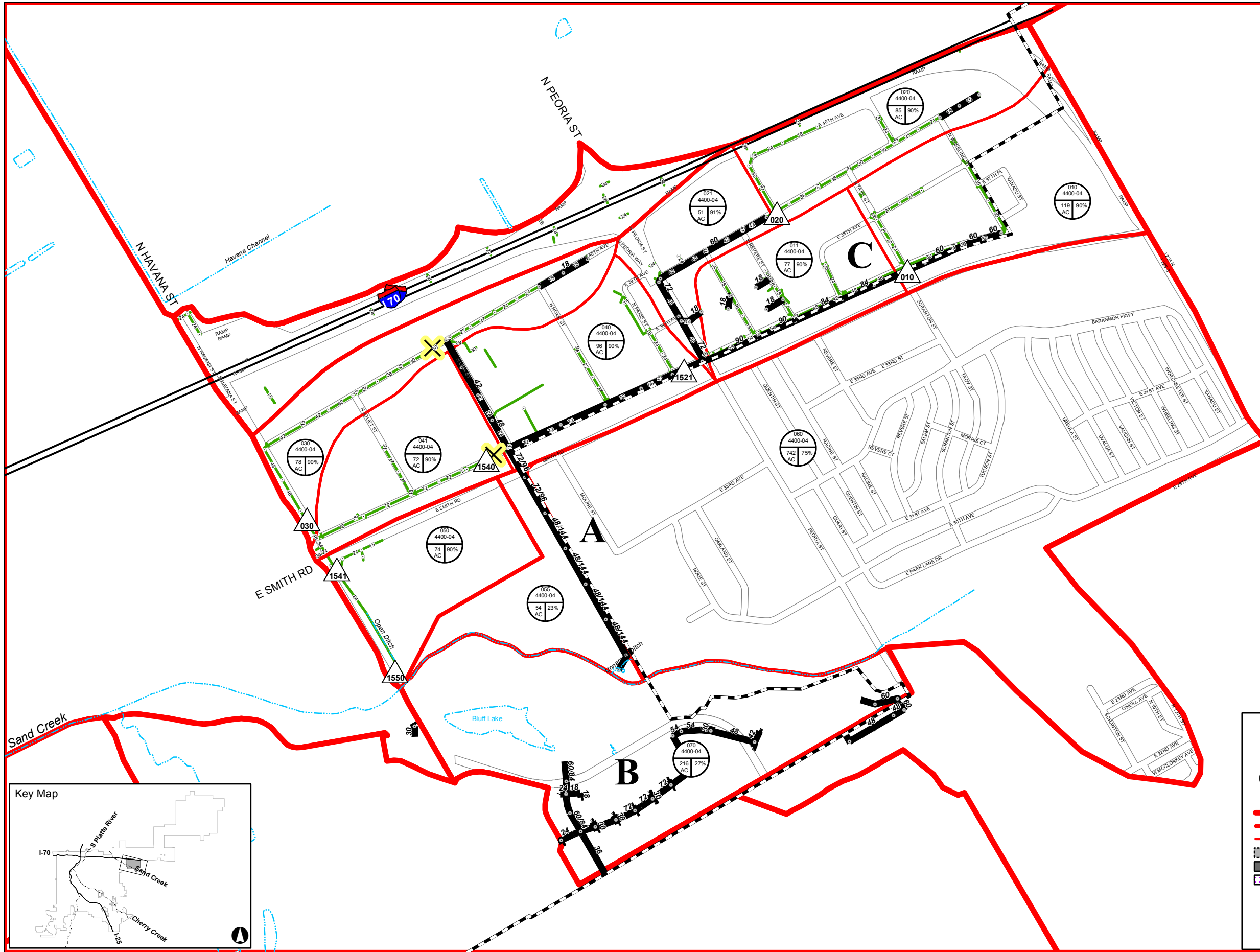
### Existing Hydrology:

#### BASIN 4400-04

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	119	197	285	585
20	20	85	108	157	329
30	30	78	76	110	236
1521	10-21	332	358	522	1164
1540	10-21,40	429	363	541	1313
1541	10-41	579	452	675	1661
1550	10-50	653	507	756	1863



Proposed Projects	
A	STAPLETON - 06
B	STAPLETON - 07
C	STAPLETON - 08

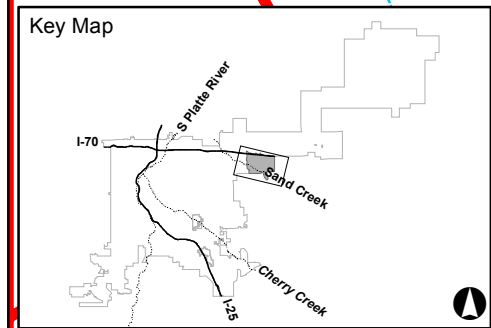


**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4400-04 (East Stapleton)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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Integrated Design Solutions



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## Basin: 4401-01 (Westerly Creek – South Stapleton)

### Existing System Description:

This basin drains to Westerly Creek and is generally bound by Quebec Street on the west, Montview Boulevard on the south, Peoria Street on the east and Sand Creek/Martin Luther King Boulevard on the north. The portion of this basin in Denver is located within the Stapleton Redevelopment property, with the exception of the southeast portion of the basin located in Aurora. The basin size is 3.03 square miles. Most of the basin is comprised of residential neighborhoods, with commercial/retail areas located near the arterial roadways.

The portion of the basin in Stapleton was reconstructed between years 2000 to 2005 with 100-year conveyance systems. Each outfall includes a regional water quality pond before discharging into Westerly Creek. Water quality ponds are located on the west bank at 23<sup>rd</sup> Avenue, 26<sup>th</sup> Avenue, 29<sup>th</sup> Avenue, Martin Luther King Boulevard and 33<sup>rd</sup> Avenue. Water quality ponds are located on the east bank at 29<sup>th</sup> Avenue and Martin Luther King Boulevard. A regional detention basin capturing runoff from 181 acres is located within the “East-West Linear Park” at Stapleton, located along 26<sup>th</sup> Avenue at Central Park Boulevard.

The portion of the basin in Aurora has historically drained to Bluff Lake via a 72” storm drain. However, this has capacity for only the 5-year storm event, and flows in excess of the capacity have historically been trapped against the former runways and been directed in an open channel along 26<sup>th</sup> Avenue to Westerly Creek. The 26<sup>th</sup> Avenue channel was studied as a part of Stapleton Planning Area 4 and will be improved to adequately convey the full 100-year storm to Westerly Creek.

### Drainage Deficiencies:

All drainage problems within Denver are being accounted for in the redevelopment of Stapleton. Overflow from Aurora’s system is following the historic path and is being directed to Westerly Creek in an improved channel along 26<sup>th</sup> Avenue.

### Proposed Capital Improvements:

#### Project A: Stapleton 09

This project includes capital improvements by the developer for 100-year storm systems throughout out the Stapleton development.

Basin Identification Correlation between Map 4401-01 and existing Stapleton studies:

Basin Identification	
Map 4401-01	Stapleton IMP
100	030
101	010
102	031, 032, 033
110	040, 041, 042
120	051, 052, 053
130	050
140	130

Basin Identification	
Map 4401-01	PA4 Attachment B
150	120 & 141 series
151	121 series
152	122 series

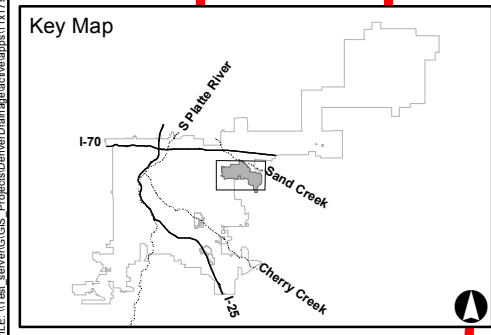
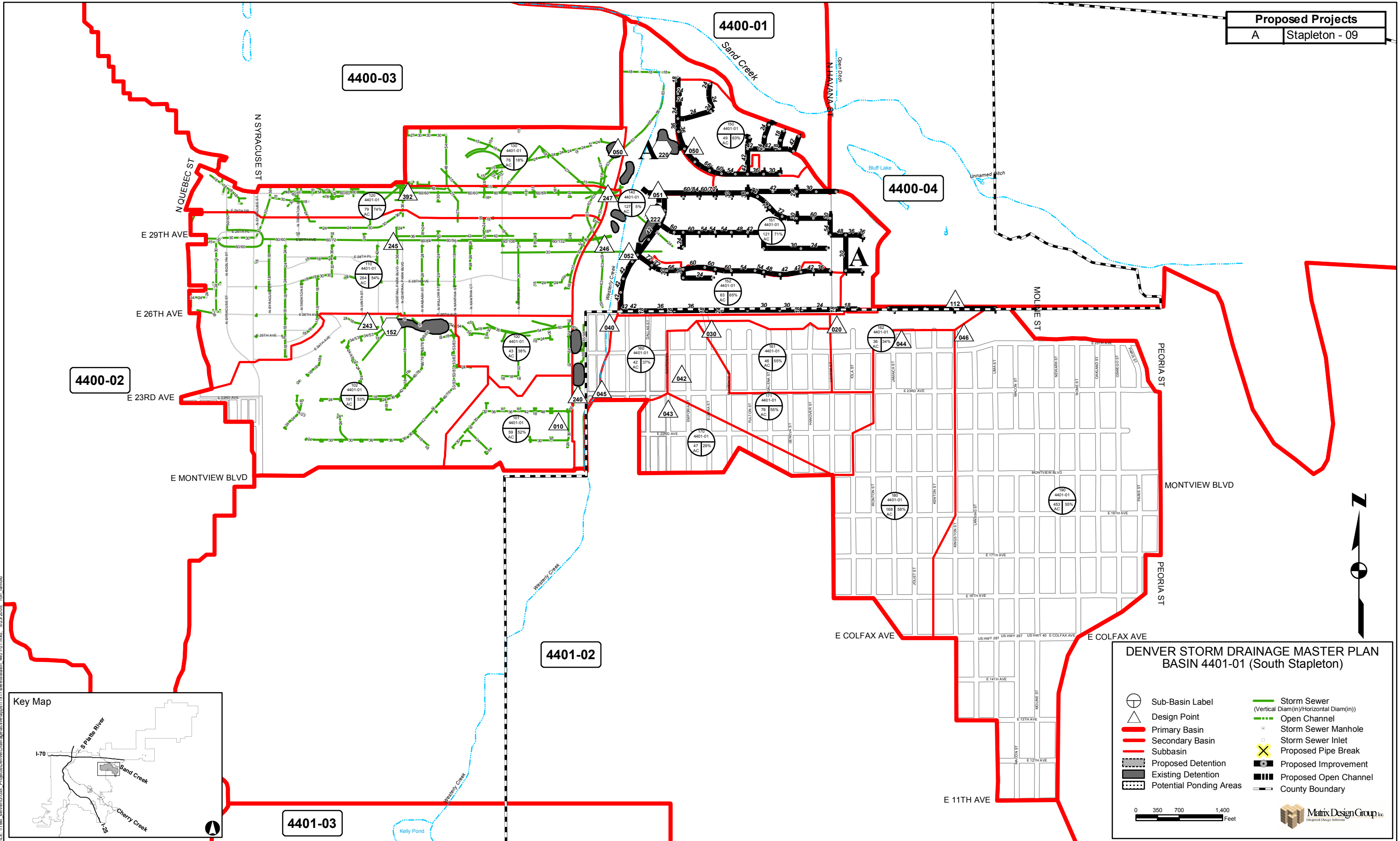
Basin Identification	
Map 4401-01	PA4
160	8
161	9
162	7
170	12
171	10
180	11
190	13

### Existing Hydrology:

### HYDROLOGIC SUMMARY TABLE: BASIN 4401-01

Design Point	Tributary Area (acres)	Peak Discharge		
		2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	59	39	67	187
20	715			1687
30	740			1744
40	856			1839
42				282
43				183
44				1656
45				160
46				1295
50	85	10	25	109
50		147	219	504
51		144	213	487
52		133	205	513
112				288
152	181	41		132
240	59	16	41	158
243	181	118		529
245	160	114	193	530
246	266	146	262	808
247	152	64	112	314
353		40		133
392	40	39	60	116

Proposed Projects  
A Stapleton - 09



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4401-01 (South Stapleton)**

Sub-Basin Label	Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
Design Point	Open Channel
Primary Basin	Storm Sewer Manhole
Secondary Basin	Storm Sewer Inlet
Subbasin	Proposed Pipe Break
Proposed Detention	Proposed Improvement
Existing Detention	Proposed Open Channel
Potential Ponding Areas	County Boundary

0 350 700 1,400 Feet

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Integrating Design Solutions

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## Basin: 4401-02 (Westerly Creek – 11<sup>th</sup> Avenue to Montview)

### Existing System Description:

This basin drains to Westerly Creek and is generally bound by Quebec Street on the west, Montview Boulevard on the north, Peoria Street on the east and 11<sup>th</sup> Avenue on the south. The basin is located between the Stapleton Redevelopment property and the Lowry Redevelopment property. The west portion of the basin is in Denver and the east portion is in Aurora, with Westerly Creek running south to north down the center of the basin. The basin is comprised of residential neighborhoods with commercial/retail areas located near the arterial roadways.

There are several existing storm sewer systems in roadways that discharge in three locations directly to Westerly Creek. A 15” pipe in Richthofen Place with an existing capacity of 7 cfs drains 123 acres with a 5-year runoff of 86 cfs. A 48” pipe in 13<sup>th</sup> Avenue with an existing capacity of 80 cfs will drain a 116 acre area with a proposed 5-year runoff of 149 cfs. A 60” pipe in Montview Boulevard with an existing capacity of 138 cfs drains 290 acres with a 5-year runoff of 244 cfs.

Three new storm sewers designed by Denver will eliminate some existing deficiencies. The proposed systems include 16<sup>th</sup> Avenue from Willow Street to Yosemite Street, Uinta Street from Colfax Avenue to 13<sup>th</sup> Avenue, and 12<sup>th</sup> Avenue from Wabash Street to Westerly Creek.

### Drainage Deficiencies:

- The 15” pipe draining Basin 210 has a capacity of 4 cfs, while the 2-year flow to the pipe is 122 cfs.
- The 60” pipe draining Basins 260 and 261 has a capacity of 138 cfs, while the 2-year flow is 185 cfs.

### Proposed Capital Improvements:

This basin requires improvements primarily to the outfalls since the lateral network is currently sufficient with the new pipes designed by Denver.

Project A: E. Colfax Ave Outfall Colfax Avenue is a major transportation corridor through the basin with few existing storm drainage facilities. An improvement is required at the outfall to Westerly Creek to convey localized storm runoff.

Project B: E. 17<sup>th</sup> Ave Outfall The combined flows of Basins 260 and 261 exceed the allowable capacity of the 60” pipe in Montview Boulevard. A new 60” outfall in 17<sup>th</sup> Avenue from Uinta Street to Westerly Creek will drain 131 acres from Basins 261 and 260. The 2-year flow from the new drainage area will be 98 cfs, with the capacity of a 60” pipe at 0.5% of 185 cfs.

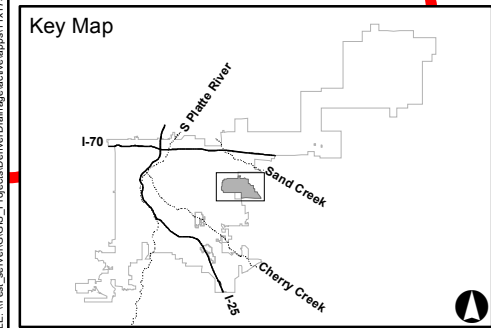
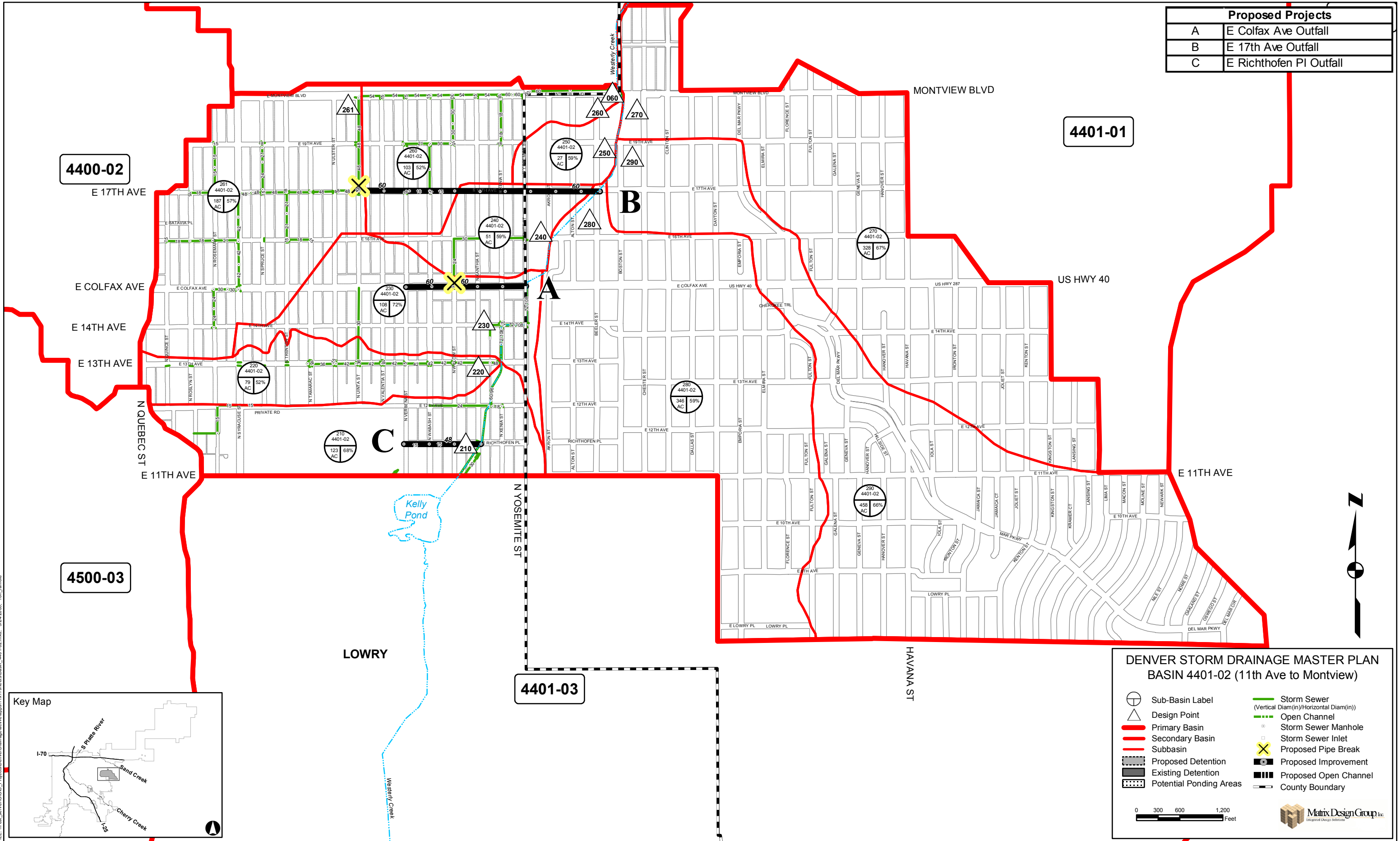
Project C: E. Richthofen Pl. Outfall The 15” outfall in Richthofen Place needs to be improved to convey a 2-year flow of 122 cfs. Upsizing the pipe to 48” from Verbena Street to Westerly Creek will provide a capacity of 121 cfs at a slope of 0.7%.

### Existing Hydrology:

**HYDROLOGIC SUMMARY TABLE: BASIN 4401-02**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
60	261, 260	290	185	320	796
61	261	187	128	216	538
210	210	123	122	197	465
220	220	79	48	87	230
230	230	108	120	191	440
240	240	51	60	104	252
250	250	27	32	56	137
260	260	103	57	104	277
261	261	187	140	244	622
270	270	328	215	349	850
280	280	346	244	418	1057
290	290	458	486	798	1884

Proposed Projects	
A	E Colfax Ave Outfall
B	E 17th Ave Outfall
C	E Richthofen PI Outfall



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4401-02 (11th Ave to Montview)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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Engineering Design Solutions

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## Basin: 4401-03 (Westerly Creek - Lowry)

### Existing System Description:

This basin drains to Westerly Creek and is generally bound by Quebec Street on the west, 11<sup>th</sup> Avenue on the north, Dayton Street/Havana Street/Peoria Street on the east and Alameda Avenue on the south. The basin is entirely within the Lowry Redevelopment property, except for one offsite subbasin to the east. The majority of the basin is in Denver; a small portion of the northeast corner of Lowry and the offsite subbasin are in Aurora.

Westerly Creek runs from south to north down the center of the basin. Westerly Creek Dam Pond (500-year detention capacity) is located in the southeast corner of the basin and Kelly Road Dam (100-year detention capacity) is located in the north. The basin is comprised of a mix of residential neighborhoods, commercial areas, golf course and open space.

The redevelopment of Lowry included 100-year capacity storm drains. The hydrology for this basin was studied in detail in a report titled "Lowry Master Drainage Plan" (December 1998) to design 100-year capacity systems.

The discharge from Westerly Creek Dam is a 48" RCP storm drain. An open channel of Westerly Creek exists between Westerly Creek Dam and Kelly Road Dam to capture and convey local runoff. Most Lowry storm drains outfall to Westerly Creek north of the 6<sup>th</sup> Avenue alignment.

Regional water quality treatment occurs within Westerly Creek Dam and Kelly Road Dam.

### Drainage Deficiencies:

All drainage problems were accounted for in the redevelopment of Lowry per the Lowry Master Drainage Plan (December 1998).

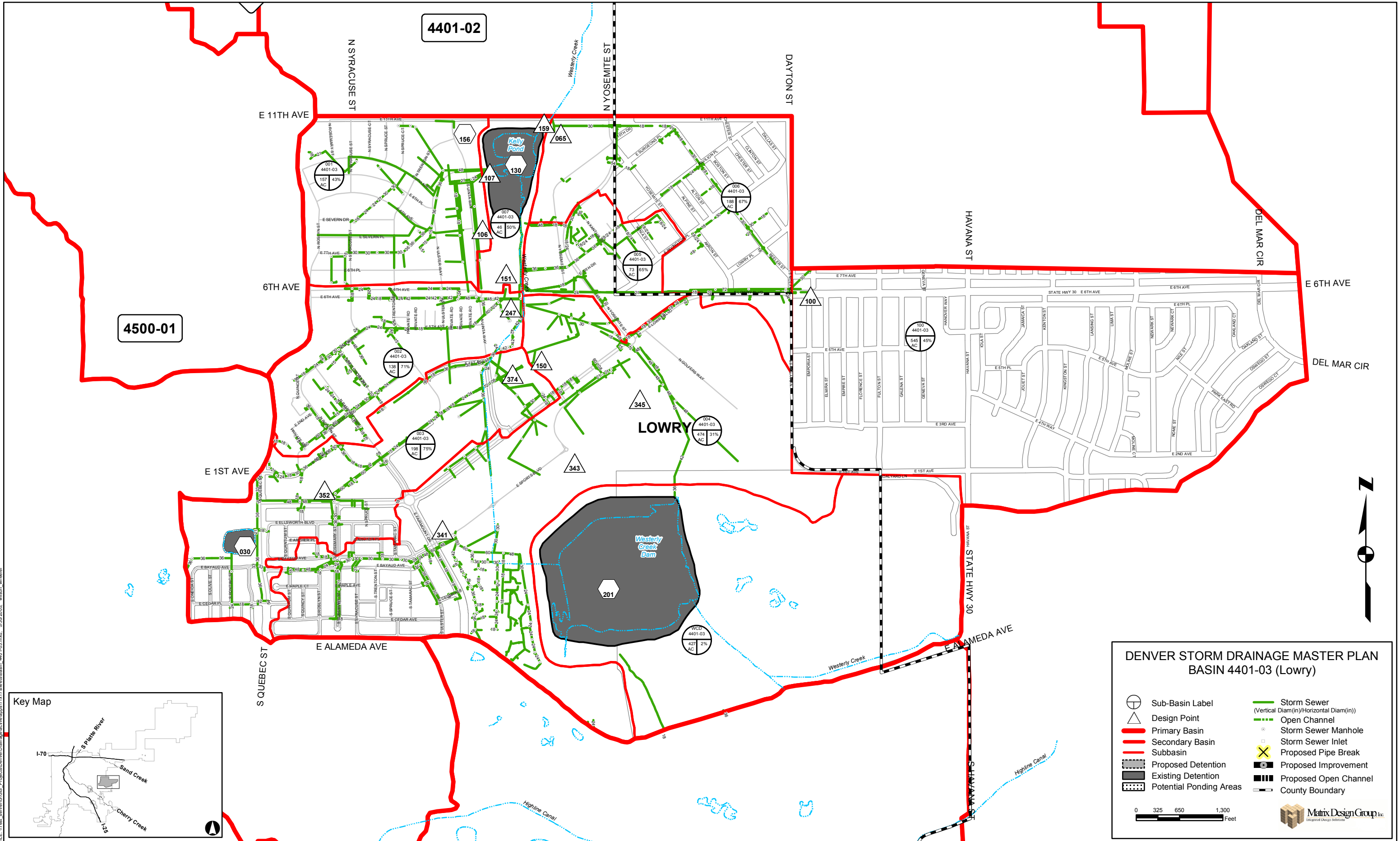
### Proposed Capital Improvements:

No capital improvements are proposed for this basin. The developer is providing 100-year storm systems throughout out the Lowry development.

### Existing Hydrology:

**HYDROLOGIC SUMMARY TABLE: BASIN 4401-03**

Design Point / Flow Element	Tributary Area (acres)	Peak Discharge		
		2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
001	157			
002	138			
003	198			
004	474			
005	73			
006	188			
007	46			
WCD	427			
30	64		16	20
100	506		397	1118
106	71		89	103
107	60		71	98
130	1569		80	98
150	638		462	1265
151	1366		950	2198
156	24		9	113
159	1788		320	733
201			48	48
202			48	48
247	98		168	377
341	160		167	450
343	243		230	568
345	436		332	909
352	95		53	134
374	180		217	488



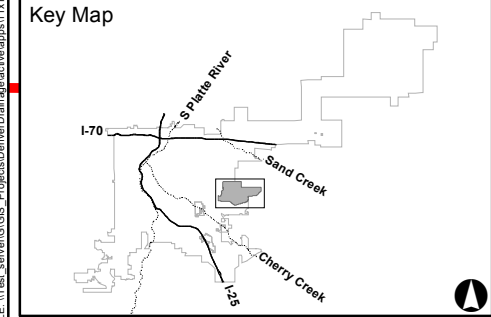
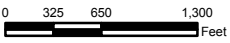
4500-01

4401-02

LOWRY

DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4401-03 (Lowry)

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin: 4401-04 (Westerly Creek – South of Alameda)

### Existing System Description:

This basin drains to Westerly Creek and is generally bound by Alameda Avenue on the north, Havana Street on the east and Evans Avenue on the south. The basin is located south of the Lowry Redevelopment property. The northern portion of the basin is in Denver and the remainder is located in Aurora but drains into Denver. The Highline Canal runs west to east across the northern portion of the basin. The basin is comprised of a mix of residential neighborhoods with commercial/retail areas located near the arterial roadways.

The two major existing storm sewer trunk systems are located in Havana Street and Dayton Street, draining a majority of the basin to the Westerly Creek Dam Pond. There are several additional pipes crossing Alameda conveying flows from the south to the Westerly Creek Dam Pond area. Basin 470 drains directly to the Highline Canal. Basins 410, 411 and 412 drain via storm sewer to the privately-owned Windsor Lake, which then discharges into the Highline Canal.

### Drainage Deficiencies:

- The 54” storm pipe draining Basins 410, 411 and 412 has the capacity to convey approximately 108 cfs, while the 2-year and 5-year flows are 260 cfs and 422 cfs, respectively.
- The 72” storm sewer in Dayton Street has the capacity to convey approximately 255 cfs, while the 2-year and 5-year design flows for the system are 378 cfs and 548 cfs, respectively.
- Ponding occurs at the intersection of Mississippi and Havana.
- The 66” storm sewer in Havana Street has the capacity to convey approximately 238 cfs, while the 2-year and 5-year design flows for the system are 276 cfs and 397 cfs, respectively.
- The 24” storm sewer draining Basins 461, 462, and 463 has the capacity to convey approximately 15 cfs, while the 2-year and 5-year flows are 131 cfs and 233 cfs, respectively.

### Proposed Capital Improvements:

This basin requires improvements primarily to the outfalls since the lateral network is currently adequate.

**Project A: S. Alton St. Improvements** The 54” outfall near Mississippi and Alton needs to be improved to convey a 5-year flow of 422 cfs. Adding a new 78” pipe in Alton from Mississippi south and connecting the existing system from Aurora to this new pipe will help alleviate the flows from the existing 54” line. The existing 54” line would continue to convey flows from 64 acres, with a 5-year flow of 85 cfs. The new 78” line will convey flows from the remaining 253 acres, most of which is in Aurora. The outfall at the intersection of the old and new pipes will need to be upsized to 84”. Adding a large regional detention pond in Aurora would greatly help reduce the flows and pipe sizes needed in Denver.

**Project B: East Mississippi Detention** The 72” outfall in Dayton Street needs to be improved to convey a 5-year flow of 504 cfs in the reach upstream of the Highline Canal and 548 cfs in the reach downstream of the canal. One option would be to increase the pipe size to 90” from Mississippi to the outfall. Another option (shown on the adjacent page) is to provide detention at the vacant lot in the southeast corner of Mississippi and Dayton. This parcel is located within Aurora.

**Project C: S. Havana St. Outfall** The 66” outfall in Havana Street needs to be improved to convey a 5-year flow of 397 cfs. In addition, frequent ponding occurs at the intersection of Mississippi and Havana. Increasing the existing pipe to a 84” pipe and extending it up Havana to Mississippi would provide 5-year conveyance and alleviate the flooding at the Mississippi and Havana intersection.

**Project D: S. Valentia St. Improvements** Upsizing the existing 24” storm sewer to a 48” line is proposed to convey the 2-year event.

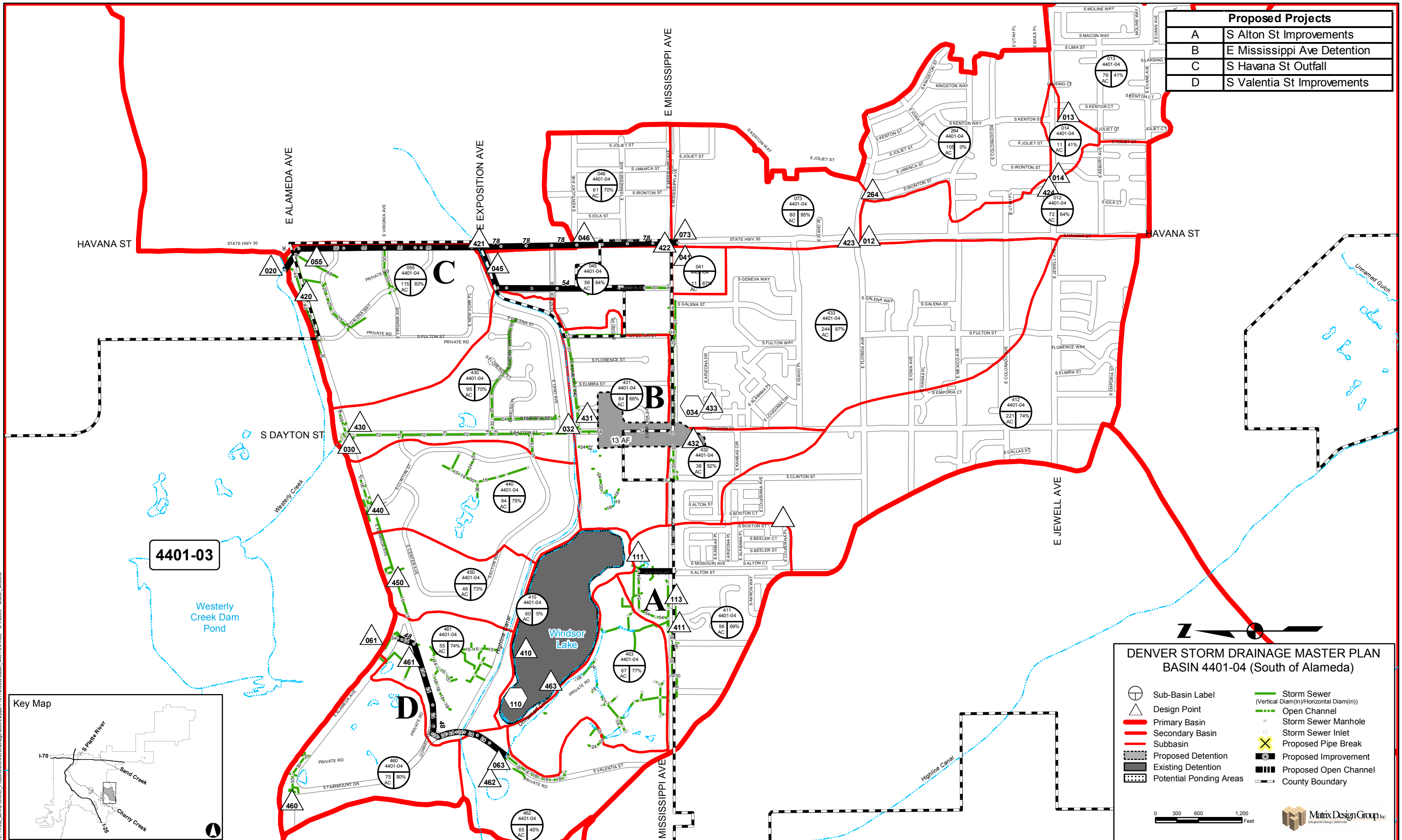
### Existing Hydrology:

HYDROLOGIC SUMMARY TABLE: BASIN 4401-04

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	412, 411, 410	377	262	436	1072
11	412, 411	317	260	422	1008
112	412, 411	317	260	422	1008
113	412, 411	317	276	433	1018
20	422, 421, 420	497	359	536	1193
21	422	291	228	345	791
30	433, 432, 431, 430	503	482	694	1774
31	433, 432, 431	386	378	548	1379
32	433, 432, 431	386	407	629	1429
33	433, 432	298	337	504	1106
34	433, 432	298	347	521	1134
61	463, 462, 461	187	131	223	611
62	463, 462	132	92	164	427
63	463, 462	132	111	186	455
12	12	67	59	90	240
13	13	83	21	35	163
14	14	11	4	7	32
41	41	12	15	22	56
45	45	63	50	78	220
46	46	58	36	58	198
55	55	105	21	34	166
73	73	72	115	164	330
264	264	105	25	43	201
410	410	60	2	14	65
411	411	96	96	154	361
412	412	221	194	303	700
420	12, 13, 14, 41, 45, 46, 55, 73, 264	576	276	397	1297
421	12, 13, 14, 41, 45, 46, 73, 264	471	275	425	1158
422	12, 13, 14, 41, 73, 264	350	208	316	912
423	12, 13, 14, 264	266	101	164	611
424	13, 14	94	24	41	193
425	12, 13, 14, 41, 45, 46, 73, 264	471	255	363	1131
430	430	117	118	189	441
431	431	88	95	155	368
432	432	38	35	64	165
433	433	260	319	470	998
440	440	94	97	151	344
450	450	46	62	97	219
460	460	75	107	161	351
461	461	55	108	170	387
462	462	65	37	72	199
463	463	67	74	114	256
470	470	51	56	94	225



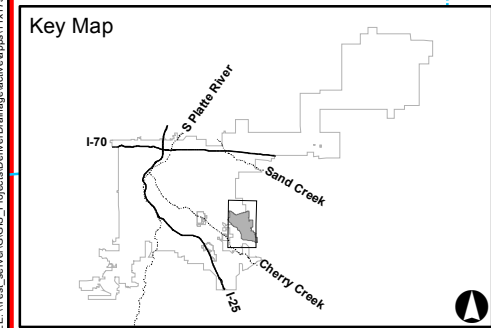
Proposed Projects	
A	S Alton St Improvements
B	E Mississippi Ave Detention
C	S Havana St Outfall
D	S Valentia St Improvements



4401-03

Westerly Creek Dam Pond

Windsor Lake



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4401-04 (South of Alameda)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Engineering Design Solutions

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## Basins: 4500-01, -03, -04 (Montclair)

### Existing System Description:

The Montclair Basin contains a total land area of approximately 6,079 acres and includes planning basins 4500-01, 03, and 04. The upstream basin limit of the fully-developed basin is located at the southeast at the Fairmont Cemetery located near the intersection of South Quebec Street and East Alameda Avenue. Land use varies within the basin from primarily residential in the upper reaches to commercial and industrial in the lower reaches. City Park, an approximately 320 acre urban park that contains the Denver Zoological Gardens, the Denver Museum of Nature & Science, and the City Park Golf Course, is located near the center of the planning basin. Storm water runoff flows northwest through the basin in an extensive system of existing storm sewer pipes. Surcharged flows are conveyed overland via the network of City streets. The basin discharges to the South Platte River through a main outfall, an 10' x 10' (120" x 120") reinforced concrete box culvert, located in Globeville Park, approximately 500 feet northeast of the intersection of 38<sup>th</sup> and Arkins Streets. A second smaller outfall (24-inch) pipe discharges to the South Platte River near 38<sup>th</sup> Street.

The planning area was sub-divided into 57 subbasins having an average size of 106.6 acres. The delineations were developed to reflect minor storm event conditions and were based on two-foot contour interval mapping and the network of existing storm drain systems as presented on the City and County of Denver's GIS database. Several field visits were made to revise and/or confirm subbasin delineations. A UDSWM routing network was developed to simulate hydraulic conditions within the basin. The network contains 47 conveyance elements representing all existing pipes having a diameter of 24 inches or greater.

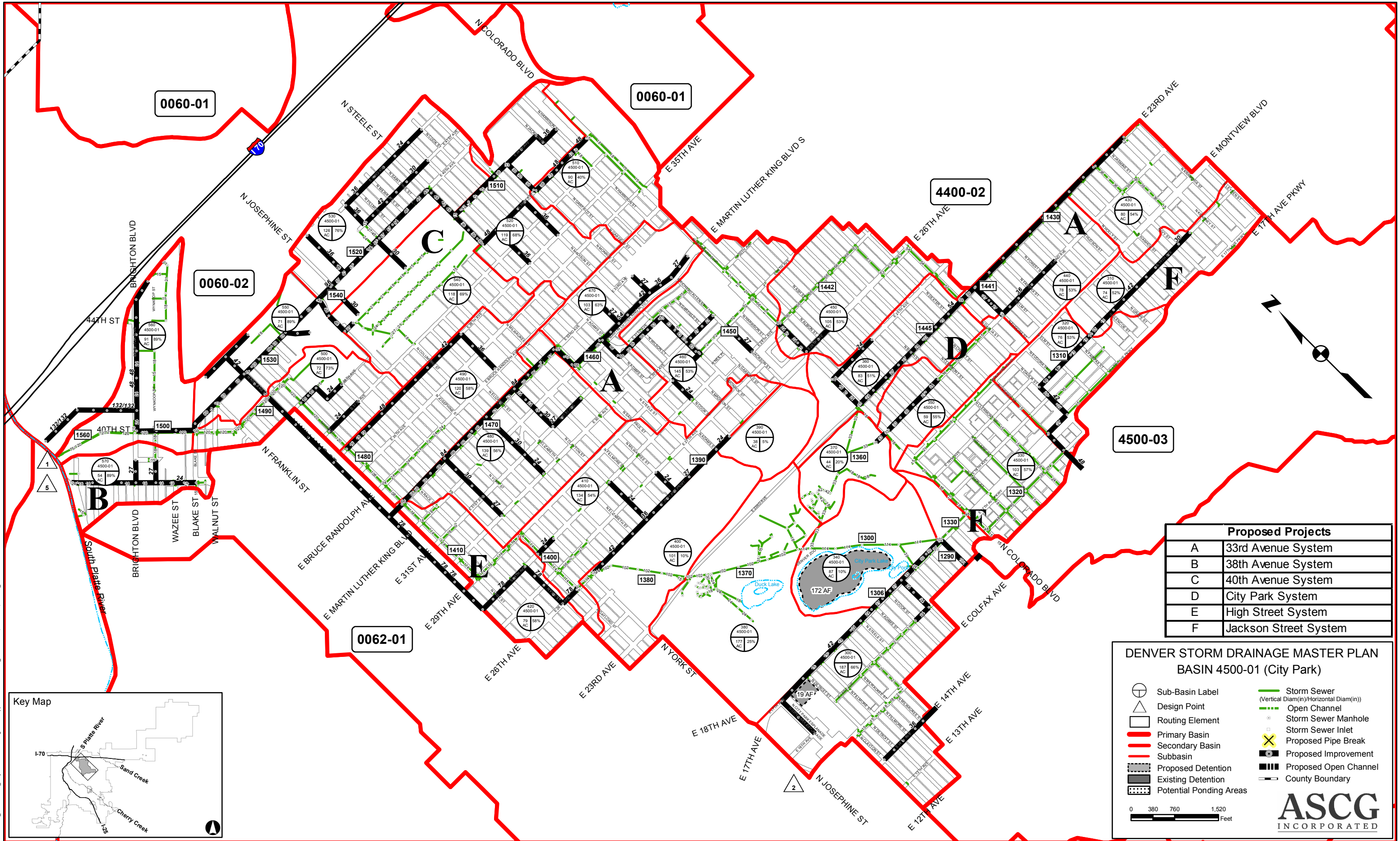
The model network contains one detention element to simulate the existing storm water detention facility in Crestmoor Park, located northwest of South Monaco Parkway and East Alameda Avenue. The network also contains three conveyance elements with diversions representing split flow conditions. Two of the diversions represent split flow conditions within the basin, one located near the intersection of 23<sup>rd</sup> Avenue and Dahlia Street, the second located at the intersection of East 12<sup>th</sup> Avenue and North Colorado Boulevard. The third diversion simulates flow entering the Montclair Basin at East Colfax Avenue and North Elizabeth Street from planning basin 4500-04. Flow only enters the Montclair Basin from this diversion when the existing storm drain system capacity is exceeded.

### MONTCLAIR BASINS 4500-01,4500-03, 4500-04 EXISTING CONDITIONS

Routing Element	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-year (cfs)	5-year (cfs)	100-year (cfs)
1020	10,20	229	5	43	251
1030	10-30	392	93	184	592
1035	10-40	505	21	27	666
1050	50	101	70	135	390
1070	10-70	706	131	234	824
1090	10-90	856	205	372	1097
1100	10-100	943	218	404	1250
1110	10-130	1349	454	824	2506
1120	120	130	97	162	477
1130	120,130	270	191	184	960
1150	10-150	1531	515	948	2884
1160	10-160	1626	530	973	3061
1180	180	154	126	239	621

Routing Element	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-year (cfs)	5-year (cfs)	100-year (cfs)
1190	180,190	252	206	374	1031
1195	10-200, split	2047	764	1365	4177
1198	10-200 and split from 1195	split	346	939	3729
1200	10-200	2047	391	391	391
1210	10-210	2187	462	541	862
1230	230	148	105	195	556
1240	230,240	300	200	374	1094
1250	230-250	436	212	414	1272
1260	230-260	608	285	533	1678
1270	230-270	768	334	627	1989
1280	230-280	869	324	615	2020
1290	10-290	3328	1213	2201	7003
1300	10-330	3827	1377	2504	7974
1305	305, split	61	51	88	217
1306	305 (split from 1305)	61	0	13	120
1310	310	74	29	57	173
1320	310,320	150	61	117	361
1330	310-330	253	131	237	659
1360	350,360 and split from 1441	142	73	144	539
1370	10-370 and split from 1441	4100	1435	2662	8766
1380	10-380 and split from 1441	4277	1443	2738	9046
1390	390	38	1	12	69
1400	10-400 and split from 1441	4416	1425	2745	9196
1410	10-410 and split from 1441	4549	1401	2721	9232
1430	430	80	53	95	223
1441	430,440, split	158	104	189	455
1442	430,440 minus 1441 split	158	81	103	151
1445	split from 1441	split	0	30	235
1450	430-450 minus 1441 split	263	128	191	378
1460	430-460 minus 1441 split	408	193	327	801
1470	430-470 minus 1441 split	511	224	375	1009
1480	10-480	5280	1606	3088	10338
1490	10-490	5398	1558	2996	10217
1500	10-550	5995	1742	3324	11277
1510	510	90	37	69	220
1520	510,520	209	118	192	548
1530	510-540	453	278	451	1233
1540	540	118	138	221	519
1560	10-560	6085	1751	3369	11463
1	10-560	6086	1751	3369	11463
2	305 split to 4500-02 near East High School	61	51	63	63
5	570	56	71	104	219

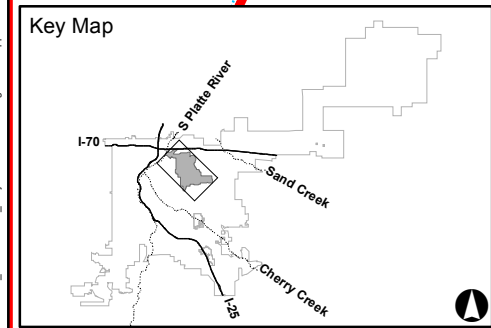
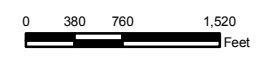
The attached maps represent the "Detention with Conveyance" alternative.



Proposed Projects	
A	33rd Avenue System
B	38th Avenue System
C	40th Avenue System
D	City Park System
E	High Street System
F	Jackson Street System

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4500-01 (City Park)**

- |   |                         |     |  |
|---|-------------------------|-----|--|
| ⊕ | Sub-Basin Label         | —   | Storm Sewer<br>(Vertical Diam(in)/Horizontal Diam(in)) |
| △ | Design Point            | --- | Open Channel   |
| □ | Routing Element         | ○   | Storm Sewer Manhole                                    |
| ▬ | Primary Basin           | □   | Storm Sewer Inlet                                      |
| ▬ | Secondary Basin         | ✕   | Proposed Pipe Break                                    |
| ▬ | Subbasin                | ▬   | Proposed Improvement                                   |
| ▬ | Proposed Detention      | ▬   | Proposed Open Channel                                  |
| ▬ | Existing Detention      | ▬   | County Boundary  |
| ▬ | Potential Ponding Areas |     |  |



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## Basins: 4500-01, -03, -04 (Montclair) continued

### Drainage Deficiencies:

Approximately 140,860 feet of existing storm sewer pipes were identified as deficient, with the majority having less than 50 percent of the required design capacity. On average, existing pipe systems located within the Montclair Basin provide a conveyance capacity of approximately 15% of the 100-year event when flowing at 80% capacity. This means that the existing Montclair Basin storm drain system has the ability to convey (at 80% capacity) storm water runoff resulting from a storm slightly larger than the one year event (approximately the 1.4 year event).

In addition, numerous areas within the Montclair Basin do not contain a storm sewer pipe network. These areas currently rely on the streets to convey storm water runoff to the nearest inlet and pipe system. Section 3.0 Drainage Policy of the City's DSDDTC states that local and collector streets can convey storm water runoff up to 6-inches of depth at the cross pans or gutters during the minor event. Areas were identified within the Montclair Basin that likely exceeds the allowable minor event street capacity. Approximately 2,490 acres of land within the Montclair Basin are estimated to exceed the allowable street conveyance capacity during the minor event and require storm drain systems.

Numerous sump areas exist within the basin, and several flooding incidents have been documented by CCD. Most notably, the Coca Cola bottling plant located near the intersection of N. Race Street and 38<sup>th</sup> Avenue has reported frequent flooding at their facility. Also, frequent street flooding is reported along east 17<sup>th</sup> Avenue, on the south side of City Park.

### Proposed Capital Improvements:

Two project alternatives were developed to mitigate system deficiencies. One alternative, named Conveyance Only, routes storm water through the basin in a network of pipes. The second alternative, named Conveyance with Detention, manages storm water runoff within the basin using a combination of pipes and detention storage in City Park.

City and County of Denver design criteria states that storm drain systems should adequately convey storm water runoff from the design event when flowing at 80% capacity. The design event for pipe systems serving residential areas is the 2-year storm and for commercial and industrial areas it is the 5-year storm.

The two project alternatives were developed by creating a network of pipes, that when constructed, will provide adequate conveyance capacity within the entire basin when flowing at 80% capacity. The majority of the proposed system improvements in both alternatives consists of replacement pipes. Both alternatives, however, include additional lateral pipes to service currently unsewered areas. The Conveyance with Detention Alternative includes one segment of additional parallel pipe along Williams Street.

### Alternative 1: Conveyance Only Alternative

The Montclair Basin Conveyance Only Alternative includes approximately 223,680 feet (42.4 miles) of storm sewer pipes/box culverts, 884 manholes, 3536 inlets, and 70,720 feet (13.4 miles) of inlet lateral pipes. The alternative includes the following seven project areas:

#### 38<sup>th</sup> Street

The 38<sup>th</sup> Street project is the smallest of the Montclair Basin projects with only approximately 56 acres of contributing land. The project is located at the South Platte River just west of the major basin outfall and is hydrologically disconnected from the rest of the Montclair Basin. Proposed improvements include a trunk line located along 38<sup>th</sup> Street and two small laterals to service currently unsewered commercial areas. The project includes 15 manholes, 60 inlets with 1,200 feet of inlet lateral pipes, and 2,906 feet of storm sewer main line ranging in size from 24-inch diameter to 54-inch diameter reinforced concrete pipe.

#### High Street

The High Street Project contains the existing major outfall system for the Montclair Basin. The project contains subbasins 410, 420, 490, 500, 560, and a small portion of 550 for a total of approximately 515 acres of contributing land. The project is comprised of commercial/industrial lands in the lower reaches and residential areas in the upper reaches. The primary upgrade within the project is a proposed 10' x 20' (120" x 240") box culvert outfall to the South Platte River aligned along the north side of the Pepsi Bottling Plant. The main trunk line would then extend upstream along Brighton Boulevard then along 40<sup>th</sup> Street to a crossing under the Union Pacific Railroad yard. The trunk line would continue east to High Street, where it would head south, replacing the existing undersized sewer in High Street. The project includes 109 manholes, 436 inlets with 8,720 feet of inlet lateral pipes, and 27,197 feet of storm sewer main lines ranging in size from 24-inch diameter to 10' x 20' (120" x 240") reinforced concrete box culvert.

#### 40<sup>th</sup> Avenue

The 40<sup>th</sup> Avenue project is located at the downstream end of the project basin and includes subbasins 510, 520, 530, 540, and a portion of 550. The upstream portion of the project begins near the intersection of 38<sup>th</sup> Avenue and Colorado Boulevard and extends downstream to the storm sewer trunk line located at the intersection of High Street and 40<sup>th</sup> Avenue. Approximately 506 acres of primarily commercial and industrial land are included within the project bounds. The major upgrade within the project is a proposed 8' x 9' (96" x 108") reinforced concrete box culvert to replace the existing 69-inch storm drain located along 40<sup>th</sup> Avenue. The project includes 89 manholes, 356 inlets with 7,120 feet of inlet lateral pipes, and 21,685 feet of storm sewer main lines ranging in size from 24-inch diameter to 8' x 9' (96" x 108") box culverts.

#### 33<sup>rd</sup> Street

The 33<sup>rd</sup> Avenue project is located just north of City Park and includes land tributary to Martin Luther King Drive and 33<sup>rd</sup> Street. This project contains approximately 650 acres of primarily residential land and includes subbasins 430 – 480. Primary upgrades within the basin include a replacement trunk line along 33<sup>rd</sup> Avenue that begins at High Street and extends up the basin along Martin Luther King Drive, 31<sup>st</sup> Avenue, and Monroe Street, as well as nine lateral lines to service unsewered residential areas. The project includes 120 manholes, 480 inlets with 9,600 feet of inlet lateral pipes, and 31,081 feet of storm sewer main lines ranging in size from 24-inch diameter to 8' x 9' (96" x 108") reinforced concrete box culvert.

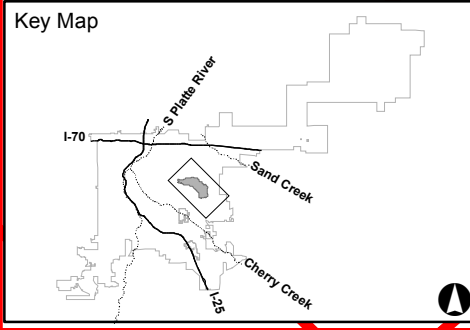
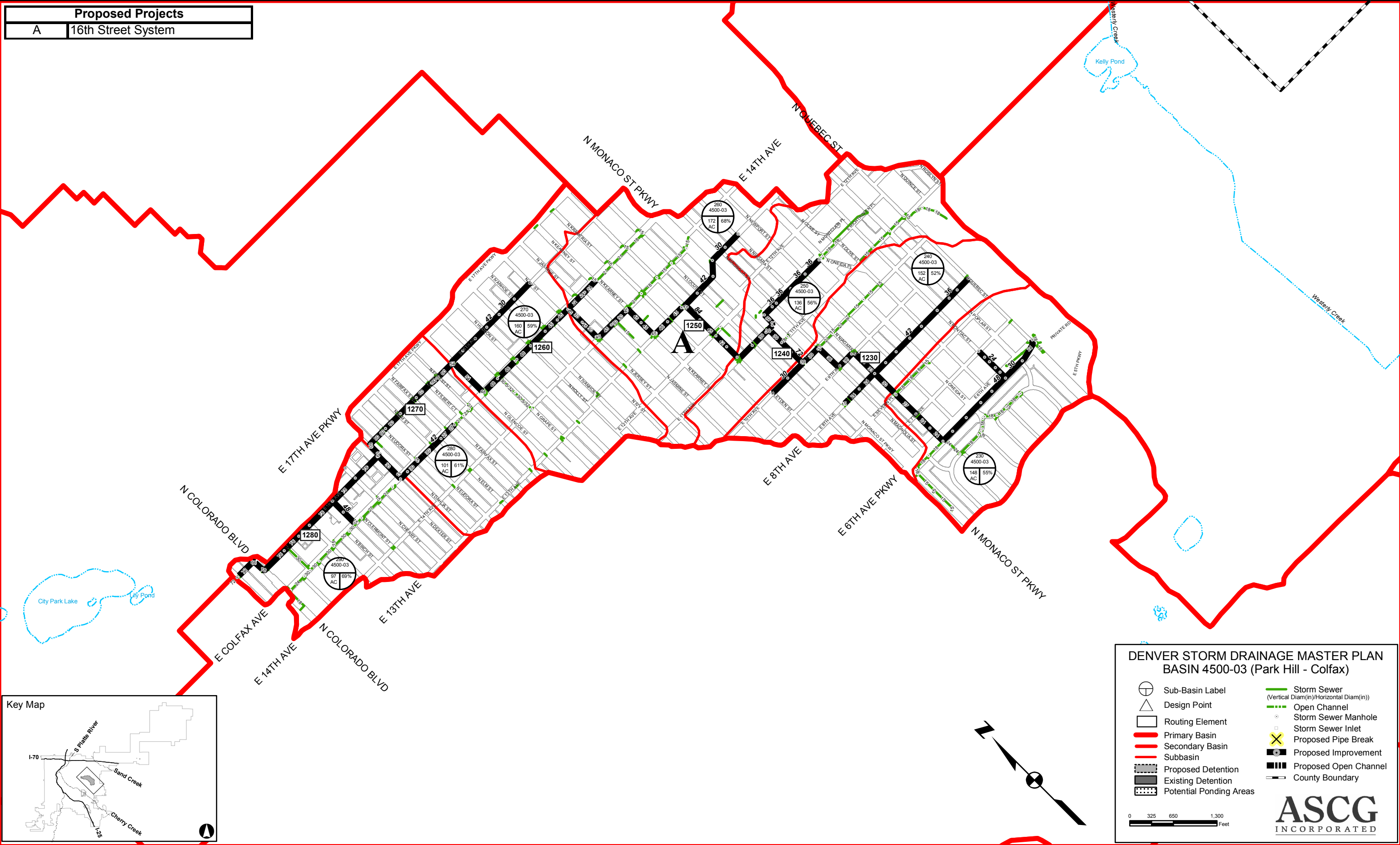
#### City Park

This centrally located project contains City Park and residential areas located just east of the park. Subbasins 340 – 400 contribute storm water runoff from a total of approximately 590 acres of land. The project includes an 8' x 18' (96" x 216") box culvert trunk line through City Park to convey peak flows from upstream basin areas. Upgrades include 59 manholes, 236 inlets with 4,720 feet of inlet lateral pipes, and 15,298 feet of storm sewer main lines ranging in size from 24-inch diameter to 10' x 19' (120" x 228") reinforced concrete box culvert.

#### Jackson Street

The Jackson Street project is located south of City Park and includes land tributary to the existing Colorado Boulevard/Jackson Street storm drain trunk line. A portion of the project is located east of City Park along 19<sup>th</sup> Street. Approximately 1120 acres of land contributes storm water runoff within the project including subbasins 180 – 220 and 300 – 330. The majority of land within the project bounds is residential, although commercial districts and a hospital complex are located along Colorado Boulevard. Primary upgrades within the basin include a replacement trunk line along Colorado Boulevard/Jackson Street and several lateral drain lines to service currently unsewered residential areas. The project includes 156 manholes, 624 inlets with 12,480 feet of inlet lateral pipes, and 39,329 feet of storm sewer main lines ranging in size from 24-inch diameter to 9' x 19' (108" x 228") reinforced concrete box culvert.

Proposed Projects	
A	16th Street System



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4500-03 (Park Hill - Colfax)**

	Sub-Basin Label		Storm Sewer
	Design Point		Open Channel
	Routing Element		Storm Sewer Manhole
	Primary Basin		Storm Sewer Inlet
	Secondary Basin		Proposed Pipe Break
	Subbasin		Proposed Improvement
	Proposed Detention		Proposed Open Channel
	Existing Detention		County Boundary
	Potential Ponding Areas		

0 325 650 1,300 Feet

**ASCG**  
INCORPORATED

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## Basins: 4500-01, -03, -04 (Montclair) continued

### 16<sup>th</sup> Street

The 16<sup>th</sup> Street project is located in the southeast portion of the Montclair Basin and collects storm water runoff in a trunk line that runs along 16<sup>th</sup> Avenue and ends at Harrison Street near the southeast corner of City Park. This project contains approximately 970 acres of primarily residential land but includes commercial lands located along Colfax Boulevard. Subbasins within the project include 230 – 290. The primary upgrade within the project is a replacement trunk line located along 16<sup>th</sup> Avenue and extending up through the project, and five lateral lines to service currently unsewered areas. The project includes 114 manholes, 456 inlets with 9,120 feet of inlet lateral pipes, and 27,632 feet of storm sewer main lines ranging in size from 24-inch diameter to 9' x 9' (108" x 108") reinforced concrete box culvert.

### Hale Street

The Hale Street Project is the largest of the Montclair Basin projects with approximately 1680 acres of contributing area. The project is located at the upstream or southern end of the Montclair Basin and contains commercial lands in the lower reaches along Hale Street, with the remainder being residential areas. Subbasins 10 – 170 are included within the project. The project includes an extensive network of proposed pipe systems, including an 8' x 12' (96" x 144") box culvert that begins at Hale Street and Colorado Boulevard and extends upstream along Hale Street. Upgrades include 222 manholes, 888 inlets with 17,760 feet of inlet lateral pipes, and 52,861 feet of storm sewer main lines ranging in size from 24-inch diameter to 8' x 12' (96" x 144") reinforced concrete box culvert.

### **Alternative 2: Conveyance with Detention Alternative**

The Montclair Basin Conveyance with Detention Alternative includes approximately 172 acre-feet of detention storage in City Park's Ferril Lake, approximately 19 acre-feet of detention storage in the City Park soccer fields, approximately 203,423 feet (38.5 miles) of storm sewer pipes/box culverts, 839 manholes, 3356 inlets, and 67,120 feet (12.7 miles) of inlet lateral pipes. The following presents a summary of the proposed improvements located within the seven project areas. The project limits are essentially the same between the two alternatives and therefore the following description does not repeat the geographical and land use characteristics of the projects.

### 38<sup>th</sup> Street

The 38<sup>th</sup> Street Project is identical between the two project alternatives. Proposed improvements include a trunk line located along 38<sup>th</sup> Street and two small laterals to service currently unsewered commercial areas. The project includes 15 manholes, 60 inlets with 1,200 feet of inlet lateral pipes, and 2,906 feet of storm sewer main lines ranging in size from 24-inch diameter to 54-inch diameter reinforced concrete pipe.

### High Street

The High Street Project contains the existing major outfall system for the Montclair Basin located along High Street. The primary upgrade within the project is a proposed 11' x 11' (132" x 132") box culvert outfall to the South Platte River that would be aligned along the north side of the Pepsi Bottling Plant. The main trunk line would then extend upstream along Brighton Boulevard then along 40<sup>th</sup> Street to a crossing under the Union and Pacific Railroad yard. The trunk line would continue east to Williams Street, where it would head south, parallel to the existing trunk line located in High Street. A parallel line was selected over direct replacement for this alternative because of the reduced peak flows resulting from the detention storage in City Park (the existing line in High Street provides a greater portion of the design flow in this alternative than in the Conveyance Only Alternative). The project includes 108 manholes, 432 inlets with 8,640 feet of inlet lateral pipes, and 25,893 feet of storm sewer main lines ranging in size from 24-inch diameter to 11' x 11' (132" x 132") reinforced concrete box culvert.

### 40<sup>th</sup> Avenue

The 40<sup>th</sup> Avenue Project is essentially the same as presented in Alternative 1 with only minor differences in improvement quantities caused by the trunk line configurations between the two alternatives. The major upgrade within the project is a proposed 8' x 9' (96" x 108") reinforced concrete box culvert to replace the existing 69-inch storm drain located along 40<sup>th</sup> Avenue. The project includes 91 manholes, 364 inlets with 7,280 feet of inlet lateral pipes, and 22,006 feet of storm sewer main lines ranging in size from 24-inch diameter to 8' x 9' (96" x 108") box culverts.

### 33<sup>rd</sup> Street

Primary upgrades within the project basin include a replacement trunk line along 33<sup>rd</sup> Avenue that begins at Williams Street and extends up the basin along Martin Luther King Drive, 31<sup>st</sup> Avenue, and Monroe Street, as well as nine lateral lines to service unsewered residential areas. Improvements under this alternative are less extensive than under the Conveyance Only Alternative. The proposed trunk line located along 23<sup>rd</sup> Avenue in the City Park Project intercepts peak flows from subbasins 430 and 440 and conveys the flow to the City Park Soccer Field detention storage facility. This diversion eliminates the need to replace a portion of the existing trunk line system that extends in a southeasterly direction from 29<sup>th</sup> and Monroe Street to 23<sup>rd</sup> Avenue and Dahlia Street. The project includes 103 manholes, 412 inlets with 8,240 feet of inlet lateral pipes, and 25,082 feet of storm sewer main lines ranging in size from 24-inch diameter to 8' x 9' (96" x 108") reinforced concrete box culvert.

### City Park

The Conveyance with Detention Alternative modifies City Park to provide a combined detention storage volume of approximately 191 acre-feet. Storage is to be provided in two locations within the Park; approximately 172 acre-feet of detention storage in City Park's Ferril Lake and an additional 19 acre-feet of storage in ball fields located near the northeast corner of the Park. The reduction in peak flows resulting from the detention storage under this alternative eliminates the need to upgrade the existing Denver Zoo trunk line. The project also includes a proposed trunk line located along 23<sup>rd</sup> Avenue to intercept peak flows from subbasins 430 and 440 located in the 33<sup>rd</sup> Avenue Project. Upgrades include a total of 191 acre-feet of storage in City Park, 25 manholes, 100 inlets with 2,000 feet of inlet lateral pipes, and 6,219 feet of storm sewer main lines ranging in size from 24-inch diameter to 9' x 19' (108" x 228") RCBC.

### Jackson Street

The Jackson Street Project is essentially the same as presented in Alternative 1 with only minor differences in improvement quantities caused by the trunk line configurations between the two alternatives. Primary upgrades within the basin include a replacement trunk line along Colorado Boulevard/Jackson Street and several new laterals to service currently unsewered residential areas. The project includes 161 manholes, 644 inlets with 12,880 feet of inlet lateral pipes, and 40,664 feet of storm sewer main lines ranging in size from 24-inch diameter to 8' x 20' (96" x 240") reinforced concrete box culvert.

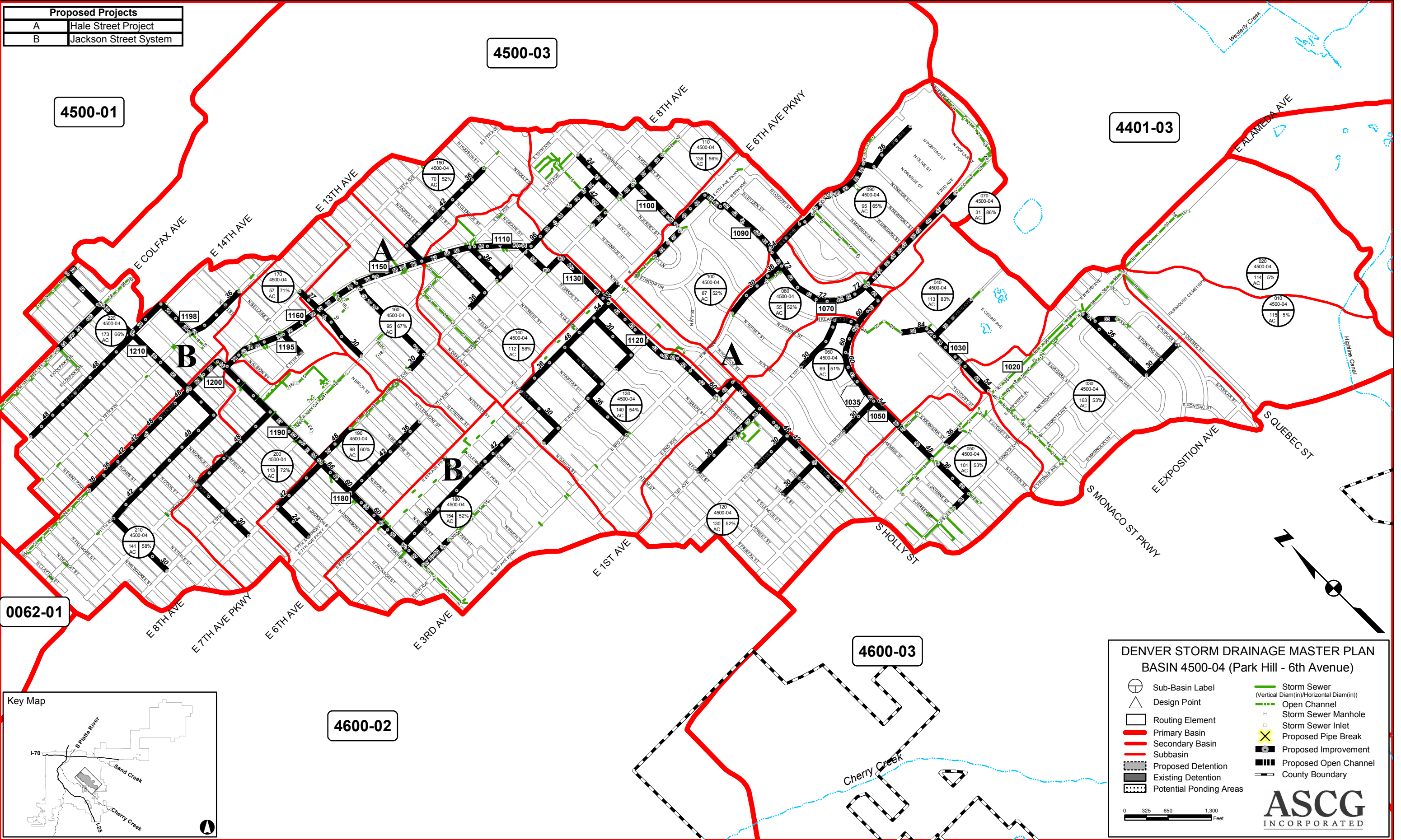
### 16<sup>th</sup> Street

The 16<sup>th</sup> Street Project is identical between the two project alternatives. The primary upgrade within the project is a replacement trunk line located along 16<sup>th</sup> Avenue and extending up through the project, and five lateral lines to service currently unsewered areas. The project includes 114 manholes, 456 inlets with 9,120 feet of inlet lateral pipes, and 27,632 feet of storm sewer main lines ranging in size from 24-inch diameter to 9' x 9' (108" x 108") reinforced concrete box culvert.

### Hale Street

The Hale Street Project is identical between the two project alternatives. The project includes an extensive network of proposed pipe systems, including an 8' x 12' (96" x 144") box culvert trunk line that begins at Hale Street and Colorado Boulevard and extends upstream along Hale Street. Upgrades include 222 manholes, 888 inlets with 17,760 feet of inlet lateral pipes, and 52,861 feet of storm sewer main lines ranging in size from 24-inch diameter to 8' x 12' (96" x 144") reinforced concrete box culvert.

Proposed Projects	
A	Hale Street Project
B	Jackson Street System



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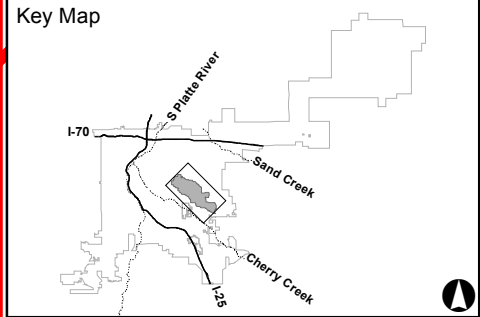
4500-01

4500-03

4401-03

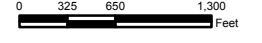
4600-02

4600-03



**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 4500-04 (Park Hill - 6th Avenue)**

- Sub-Basin Label
- Design Point
- Routing Element
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



**ASCG**  
 INCORPORATED

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## Basin 0062-01/4500-02 (36<sup>th</sup> & Downing)

### Existing System Description:

This basin includes a mix of industrial, commercial and residential land uses, and includes 2,858 tributary acres (4.47 square miles). The basin is fully built-out with older neighborhood residential in the upper reaches and commercial in the lower reaches. This basin includes Lower Downtown, Coors Field, rail yards, and a number of existing residential neighborhoods. It is characterized by terrace topography in the upper portions of the basin and near flat outfalls near the South Platte River. This condition results in inadvertent detention near the basin headwaters and surcharge of storm sewers in lower reaches.

Currently, most of the drainage (nearly 80% of the basin) outfalls through one 81-inch storm pipe at 36<sup>th</sup> Street. Design Point 1560 shows that 2,260 acres are tributary to this one outfall. This pipe has approximately 475 cfs capacity, but the hydrology indicates the flow will be 1,215 cfs in a 2-year event, and 1,957 cfs in a 5-year event (design flow). There are opportunities for regional water quality treatment off the existing 81-inch pipe near the South Platte outfall since it currently can convey a ½-inch rainfall (WQCV) over such a large developed basin area.

### Drainage Deficiencies:

The existing drainage system has less than a 1-year capacity. Rainfall runoff in excess of the storm drain capacity has a history of ponding in the sump and flat areas. Many of the existing storm drains surcharge out the manholes during large storm events. Major drainage problems have been experienced in this basin, particularly north of Coors Field.

Split flow conditions exist in the basin, whereby storm runoff is exported and imported out and into this basin. During a major storm event, runoff will flow west over Grant Street into basin 4600-01. Flow in excess of pipe capacity will then overtop Market Street and re-enter this basin.

### Proposed Capital Improvements:

This basin requires improvements primarily to the outfall since the lateral network is currently extensive in this basin. The outfall should have 5-year capacity, whereas the lateral network through the residential areas should have a 2-year capacity.

The existing 81-inch outfall is undersized, and additional outfalls are needed to relieve the burden on the existing pipe. Constructing two new outfalls in this basin will reduce the tributary area of the existing outfall. Five major drainage projects are proposed for this basin as described below:

**Project A: 31<sup>st</sup> Street Outfall** includes a completely new 120-inch outfall in 31<sup>st</sup> Street. This proposed storm drain will continue up the basin in Downing Street and branch into new laterals around Children’s Hospital. The existing pipe will be cut and plugged to provide additional capacity in the downstream system where the new pipe crosses the existing storm pipe. Work on this project should begin at the outfall and extend upward to improve the level of drainage service in the basin.

**Project B: 27<sup>th</sup> Street Improvements** includes maximizing the use of the newly constructed 108-inch pipe in 29<sup>th</sup> Street for the Coors Field Parking Lot. Currently, the tributary area to the pipe is only 81 acres. The outfall will extend up 27<sup>th</sup> Street and then Washington Street and Clarkson Street with a 96-inch pipe transitioning down to smaller pipe up into the basin.

**Project C: 36<sup>th</sup> Street Outfall** includes replacing the existing outfall from an 81-inch pipe to a 108-inch pipe. Efforts were made to preserve this pipe by sending more stormwater to new outfalls, however, this became impractical, and the existing outfall must be replaced or a parallel pipe constructed.

**Project D: East 33<sup>rd</sup> Avenue** includes balancing out the remainder of the basin tributary to the existing outfall. A new 42-inch pipe at 33<sup>rd</sup> and Humboldt Street will disconnect the existing pipe and convey runoff to the large 81-inch pipe in Downing.

**Project E: North Marion Street** includes balancing out the remainder of the basin tributary to the existing 36<sup>th</sup> Street outfall. A new 48-inch pipe in Marion between 25<sup>th</sup> and 30<sup>th</sup> Avenues will collect six laterals and convey runoff to the large 81-inch pipe in Downing. Marion was selected as an appropriate alignment due to the apparent absence of existing utilities in the street corridor.

**Project F: 20<sup>th</sup> Street Improvements** include replacing the existing 72-inch pipe in 20<sup>th</sup> Street with a new 9’ x 4’ concrete box culvert. This proposed storm drain will continue into Wynkoop Street and improve drainage conditions around Union Station. Additionally, the existing 72-inch storm drain constructed for the *Lincoln at Prospect Park* development can be extended across the railroad tracks to collect major event flows along the north side of Coors Field.

**Project G: N. Grant Street Improvements** Cost effective drainage improvements utilize the existing system and re-route drainage via a new outfall, thereby reducing the burden on the existing outfall. Capturing runoff above the Central Business District at 13<sup>th</sup> & Grant and routing it via a new 78-inch outfall in 13<sup>th</sup> Avenue to Cherry Creek will benefit this basin and downtown. This project is continued in Basin 4600-01.

**Project H: E. 12<sup>th</sup> Ave Improvements** include replacing existing small pipes with 18-inch diameter pipes to meet current drainage criteria, improve collection/conveyance and reduce maintenance problems.

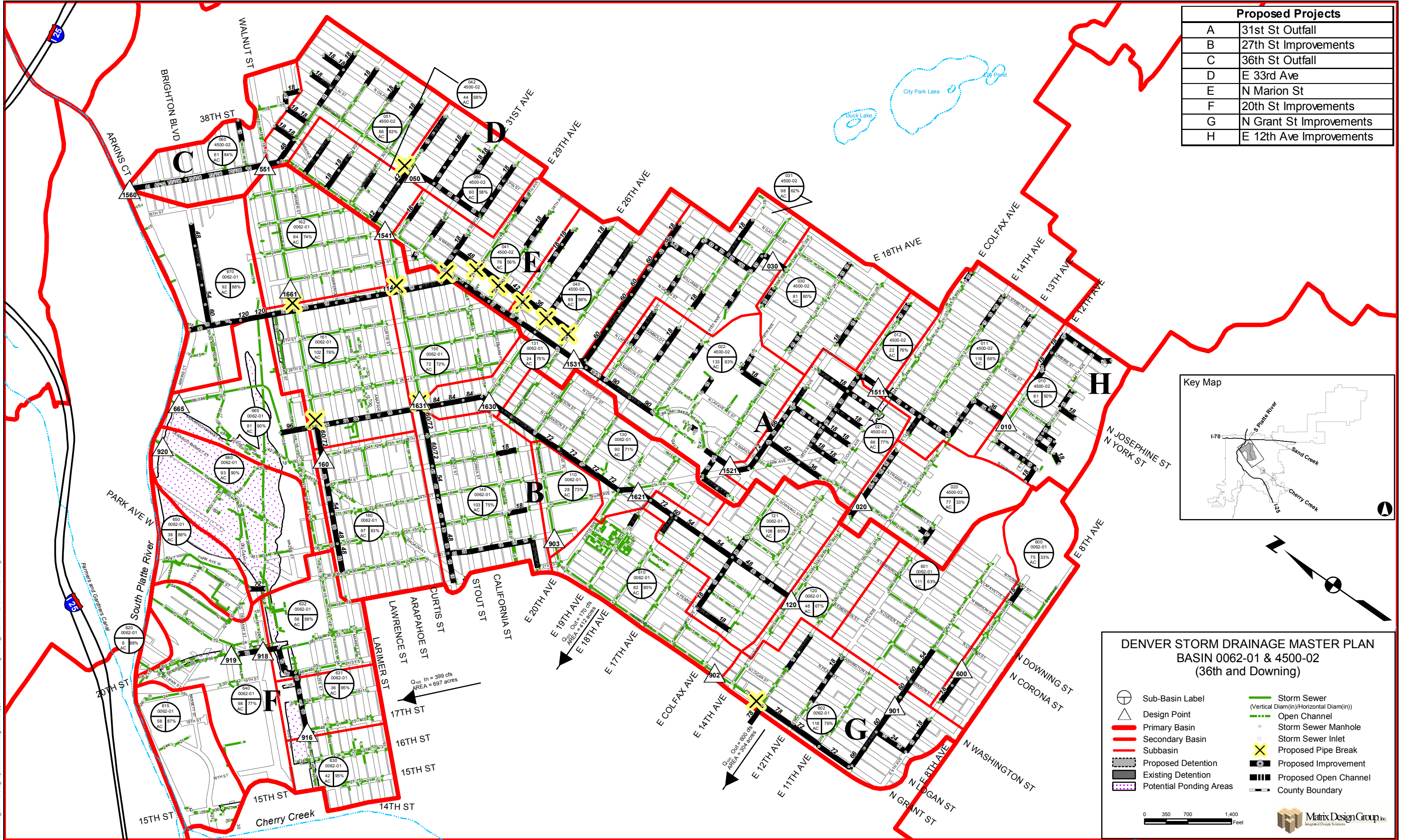
### BASIN 0062-01, 4500-02 Existing Hydrology:

Design Point Minor Event Model	Design Point Overland Flow Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge*		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	NA	10	79	67	125	NA
20	NA	20	77	38	87	NA
30	NA	30	80	117	176	NA
50	NA	50	60	53	92	NA
120	NA	120	47	55	90	NA
160	NA	160	93	141	209	NA
551	1550	10-51,110-162,600-610,800	2184	1198	1933	<b>4044</b>
600	NA	600	75	28	63	NA
665	1765	665	81	134	194	<b>1232</b>
901	NA	600,601	186	141	246	NA
902	100	600-602	304	218	341	<b>873</b>
903	1120	600-610	385	197	293	<b>586</b>
916	NA	600-610,80,81,90-92,100,101,125-127,630	757	72	102	NA
918	1281	600-610,80,81,90-92,100,101,125-127,630-632	849	206	298	<b>810</b>
919	1740	600-610,80,81,90-92,100,101,125-127,630-632,640	947	236	296	<b>475</b>
1511	10	10,11	195	173	295	<b>1053</b>
1521	NA	10-21	380	265	479	NA
1531	1530	10-31	691	505	753	<b>2307</b>
1541	1540	10-41,110-150,600-610	1715	976	1535	<b>3173</b>
1560	1560	10-60,110-162,600-610,800	2260	1215	1957	<b>4144</b>
1621	120	120121	155	192	282	<b>656</b>
1630	1660	110-130,600-610	660	415	642	<b>1195</b>
1631	1640	110-140,600-610	787	473	740	<b>1446</b>
1661	NA	160,161	195	223	321	NA

\* 100-year discharge in **bold** represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths.



Proposed Projects	
A	31st St Outfall
B	27th St Improvements
C	36th St Outfall
D	E 33rd Ave
E	N Marion St
F	20th St Improvements
G	N Grant St Improvements
H	E 12th Ave Improvements



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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 0062-01 & 4500-02  
(36th and Downing)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet

Matrix Design Group, Inc.  
Integrated Design Solutions

## Basin 4600-01 (Central Business District)

### Existing System Description:

This basin consists of 1,392 acres (2.17 square miles) and is fully built-out within the Central Business District. The basin extends from 6<sup>th</sup> Avenue to the confluence with Sand Creek along the Cherry Creek corridor. *Blueprint Denver* shows the downtown area subject to change. Only the small residential neighborhoods south of Colfax and west of Cherry Creek are shown as being “Areas of Stability”.

All formal drainage facilities from this basin outfall into Cherry Creek, but surface flows from the Downtown area drain to the South Platte River. Intercepted stormwater is discharged in at least 42 separate storm drainage outfalls into Cherry Creek. Some of the more major outfalls include:

- 16’x 4’ box culvert from the Pepsi Center
- 10’x 5’ box culvert recently constructed for the Convention Center up to 14<sup>th</sup> & Stout
- 96-inch pipe outfalling at 14<sup>th</sup> & Market Street draining large pipe in Larimer Street
- 54-inch pipe from Delgany Street

The storm drain infrastructure consists of a network of separate outfalls and laterals in most streets. A grid pattern of laterals exists in the downtown area. As street improvements are constructed, inlets have been improved to current standard designs. Drainage from downtown is constrained by the elevation of the Cherry Creek floodplain elevation, which generally reduces capacity and creates sump or surcharge conditions during major storm events.

### Drainage Deficiencies:

In general, the existing drainage system has capacity to convey the 2 to 5 to 100-year storm event to Cherry Creek. Redevelopment and current drainage criteria has required the construction of 100-year capacity outfalls, or at the least to construct the largest storm pipe possible.

### Proposed Capital Improvements:

This basin requires improvements primarily by increasing the capacity of the outfalls and lateral network. Outfalls through the commercial areas (and especially the Central Business District) should have a minimum 5-year capacity. Few opportunities exist for detention in this densely developed basin. Therefore, improvements have generally included upsizing conveyance facilities. Proposed projects include:

**Project A: Stout Street Outfall East** A new 5-foot x 10-foot box culvert has recently been installed as part of redevelopment of the Convention Center to create an expanded outfall to Cherry Creek. The tributary sub-basins (90-93) comprise 100 acres that routes drainage directly via a 54-inch storm sewer to Stout & 14<sup>th</sup> Street. Split flow caused by limited capacity drains upgradient and local topography increases the tributary area to the new outfall to 537 acres. Improvements are needed to intercept this runoff and utilized the capacity of the new box culvert outfall.

**Project B: Cherry Creek Outfalls** Existing outfalls have 1-2 year capacity and should be upsized to 5-year capacity by criteria. In addition, all 12 and 15-inch pipes should be replaced with 18-inch pipes.

**Project C: West 14<sup>th</sup> Avenue Outfall** A proposed 60-inch storm drain in 14<sup>th</sup> Avenue north of Cherry Creek will improve the capacity of the existing 24-inch pipe.

**Project D: West 8<sup>th</sup> Avenue Outfall** The outfalls in 8<sup>th</sup> Street north of Cherry Creek should be upsized from and existing 24-inch pipe to a 48-inch pipe to provide 5-year protection.

**Project E: West 9<sup>th</sup> Avenue Outfall** The existing outfall in 9<sup>th</sup> Street north of Cherry Creek should be upsized from a non-standard 26-inch pipe (shown in the GIS) to a 36-inch pipe to provide 5-year protection.

**Project F: West Colfax Avenue Outfall** A new 84-inch outfall in Colfax north of Cherry Creek will replace the existing 38-inch outfall and provide 5-year capacity.

**Project G: Curtis Street Outfall** Basins 60 and 65 currently drain 127 acres via an existing 39-inch pipe. Upsizing this outfall to a 60-inch pipe would provide 5-year storm capacity. Alternatively, detention in Lincoln Park was considered to avoid upsizing the outfall. However, current land use in the park, existing trees and the ridge topography in the park have prompted the consideration of conveyance over detention.

**Project H: N Bannock St Improvements** Existing 12- and 15-inch pipes are proposed to be replaced with 18-inch pipes to meeting current drainage criteria and reduce maintenance.

**Project I: N Speer Blvd Improvements** Existing 12- and 15-inch pipes are proposed to be replaced with 18-inch pipes to meeting current drainage criteria and reduce maintenance.

**Project J: West 13<sup>th</sup> Avenue Outfall** A new 90-inch outfall in 13<sup>th</sup> north of Cherry Creek will improve the capacity of the existing laterals in 13<sup>th</sup>, 12<sup>th</sup> and 11<sup>th</sup> Streets. This proposed outfall will import runoff from Basin 0062-01 to reduce the burden on the existing, undersized system in Grant Street.

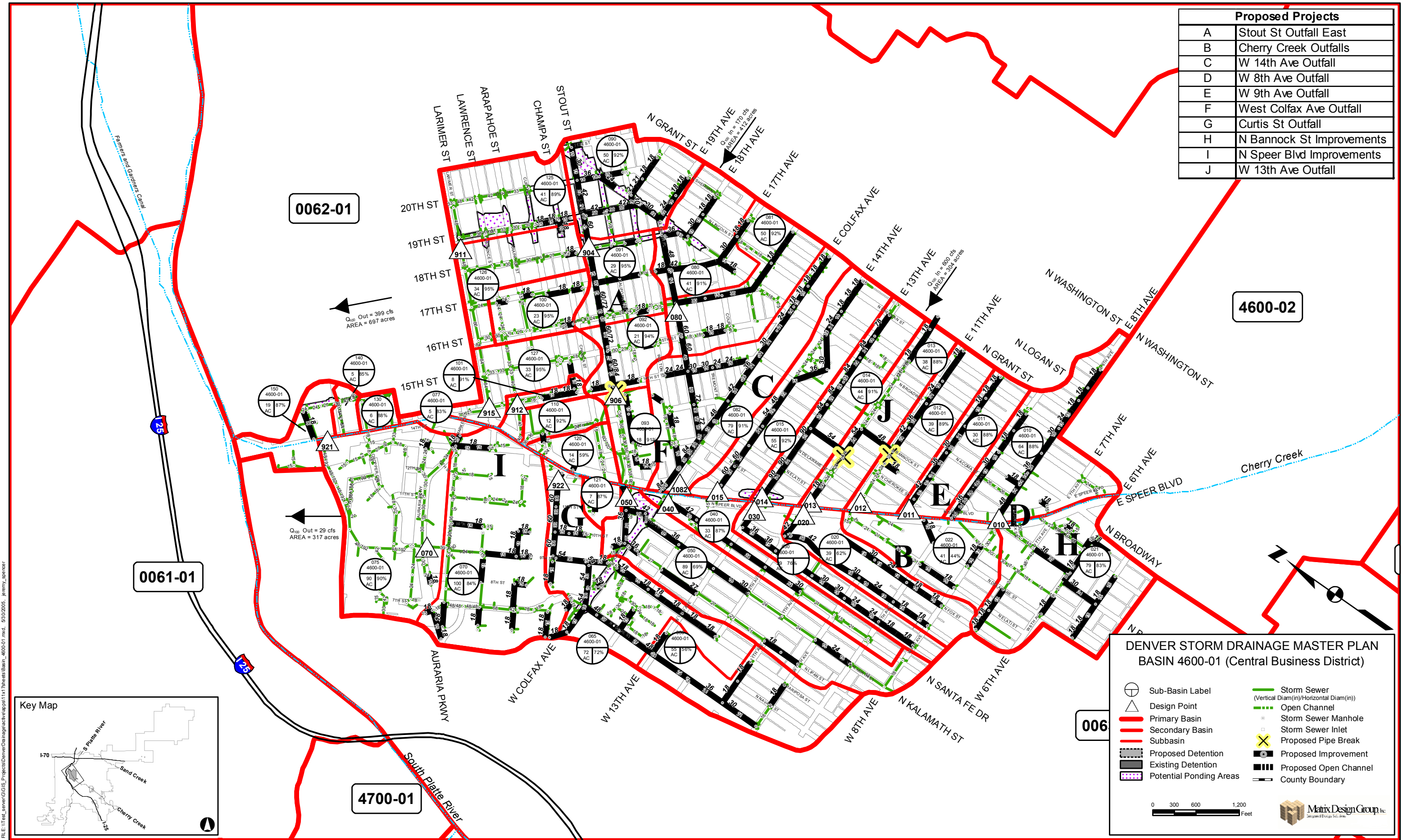
### Hydrology Summary:

#### BASIN 4600-01

Design Point Minor Event Model	Design Point Overland Flow Model	Contributing Basins Minor Event Model	Tributary Area Minor Event Model (acres)	Peak Discharge*		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10		10	64	85	125	263
11		11	30	48	69	144
12		12	39	57	83	173
13		13	38	53	77	162
14		14	44	57	83	174
15		15	55	90	130	265
20		20	39	42	71	171
30		30	29	37	57	127
40		40	33	41	61	130
50		50	89	72	115	274
70	NA	70	100	185	270	<b>NA</b>
80	NA	80	41	68	98	<b>NA</b>
904	NA	600-610,90	396	112	161	<b>NA</b>
906	1200	600-610,80,81,90,91,92	537	100	128	<b>784</b>
911	NA	600-610,90,125	437	63	102	<b>NA</b>
912	NA	600-610,80,81,90,91,92,100,101	568	35	43	<b>NA</b>
915	1230	600-610,80,81,90-92,100,101,125-127	676	156	222	<b>762</b>
921	1540	70,75	190	249	361	<b>827</b>
922	1510	60,65	127	93	147	<b>80</b>
1082	1590	80-82	170	194	240	<b>882</b>

\* 100-year discharge in bold represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths. Since several pipe networks do not follow overland drainage paths, this differing approach in modeling could create significant differences in peak flow distribution between storm events.

Proposed Projects	
A	Stout St Outfall East
B	Cherry Creek Outfalls
C	W 14th Ave Outfall
D	W 8th Ave Outfall
E	W 9th Ave Outfall
F	West Colfax Ave Outfall
G	Curtis St Outfall
H	N Bannock St Improvements
I	N Speer Blvd Improvements
J	W 13th Ave Outfall



0061-01

0062-01

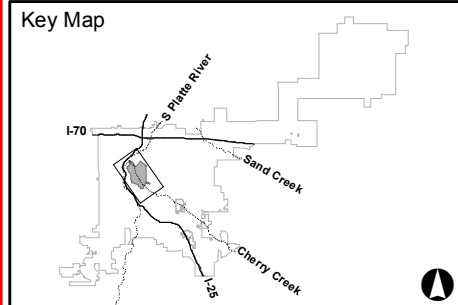
4600-02

Q<sub>100</sub> Out = 29 cfs  
AREA = 317 acres

Q<sub>100</sub> Out = 399 cfs  
AREA = 697 acres

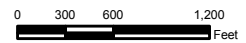
4700-01

006



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4600-01 (Central Business District)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin 4600-01 (Central Business District) (Alternative 100-Year System)

### Alternative 100-Year System to Reduce Potential Ponding:

Rainfall runoff in excess of the storm drain capacity has a history of ponding in the sump and flat areas of downtown. It could be argued that the Central Business District should have a higher level of protection – potentially a 100-year capacity drainage system.

Drainage problems have been experienced along Wynkoop Street, along Broadway, along 19<sup>th</sup> Avenue, and along Colfax Avenue. During a 100-year storm, runoff exceeds the capacity of the storm drain network (approximately a 2 to 5 year system). Potential ponding in the Upper Downtown area near 19<sup>th</sup> & Broadway includes inundation of approximately 35 structures with a total structure value of \$10.2M (per 2003 Denver Assessors' records). These structures are located within the 24.5-acre zone identified as most severely impacted by the flooding.

There are many potential alignments of new storm drains to achieve a 100-year system; however, the many existing utilities in the downtown streets prevent installation of new pipe. A possible 100-year drainage system to solve the potential ponding problem in this area would include a new collector in Broadway to capture runoff from the area between Grant and Broadway before it drains into downtown (see "Basin 4600-01: 100-Year Alternative" map on the facing page). Reducing the amount of off-site inflow into the Central Business District obviates the need to upsize many of the existing drainage facilities in the downtown area beyond the previously described 5-year systems. New storm pipe in Broadway beginning at 11<sup>th</sup> Avenue with a 36-inch pipe, extending to Colfax with a 90-inch pipe ( $Q_{100} = 600$  cfs), and continuing to Market Street with a 108-inch pipe would provide 100-year protection. The Broadway system would follow a 25<sup>th</sup> Avenue alignment to Denargo Street and outfall to the South Platte with a 120-inch pipe or equivalent box culvert.

Proposed and existing drainage systems in the downtown area for 5-year capacity would provide 100-year capacity by utilizing the Broadway storm pipe, except along Wynkoop. A new 72-inch pipe at Wynkoop & 16<sup>th</sup> Street, extending to 19<sup>th</sup> Street with an 84-inch pipe would provide 100-year protection in the lower downtown reach. The pipe could follow 20<sup>th</sup> Street and outfall at Lipan with a 102-inch pipe.

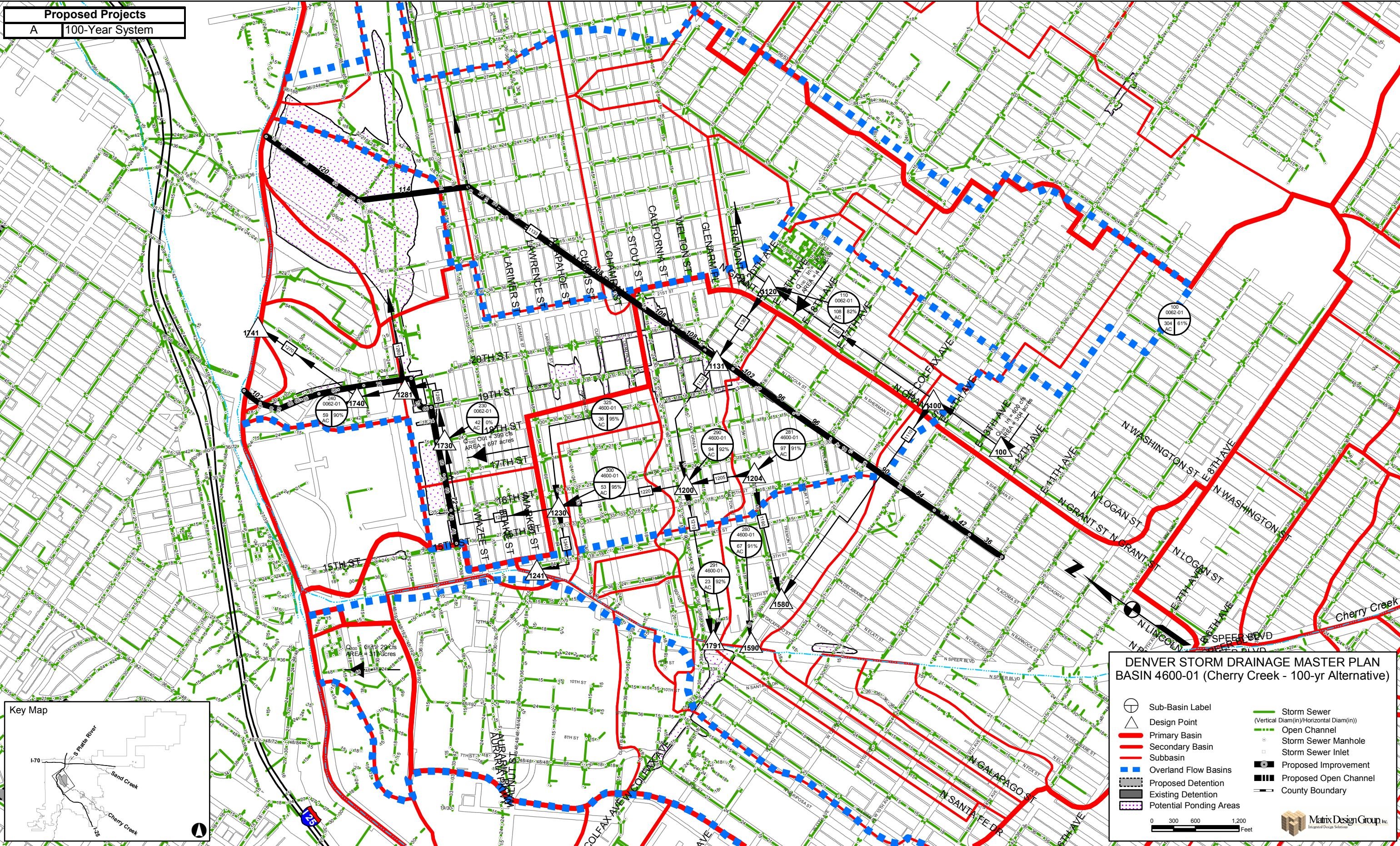
The approximate cost for upgrading the core downtown system to 5-year capacity is approximately \$18.4M (Projects A, C, F & J). The cost to eliminate the potential ponding in the core Central Business District and improve the level of service to a 100-year system is approximately an additional \$20M. Damage estimates are \$1M from a 5-year storm event, and \$1.3M from a 100-year storm event (based upon FEMA flood depth verses damage tables). This damage figure does not include opportunity costs from lost revenue, down time, and traffic delays, and is certainly the lowest possible estimate. Corresponding annualized flood damage costs are estimated to be \$0.14M and \$0.22M for 5-year and 100-year return periods, respectively.

The above figures are provided to address questions about the appropriate *level of service* and the *design storm* for the downtown area, and are very coarse and preliminary. A detailed study in the downtown area is recommended to further study 100-year drainage systems and corresponding benefit-cost ratios.

**HYDROLOGIC SUMMARY TABLE: BASIN 4600-01 MAJOR EVENT MODEL**

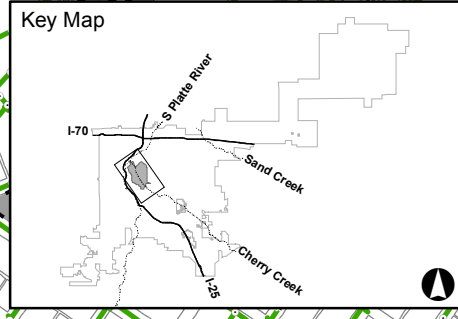
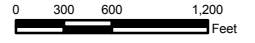
<u>Design Point</u>	<u>Contributing Basins</u>	<u>Tributary Area</u> (acres)	<u>Peak Discharge</u> <u>100-Year</u> (cfs)
100	100	0	873
1100	100	304	873
1120	100,110 minus split	412	586
1131	100,110 minus split	412	378
1200	100,110,281,290 minus split	608	784
1204	281 minus split	81	392
1230	100,110,281,290,300,325 minus split	697	762
1241	100,110,281,290,300,325 minus split	697	300
1281	100,110,230,281,290,300,325 minus split	885	810
1580	100,281 minus split	385	756
1590	100,280,281 minus split	468	882
1730	100,110,230,281,290,300,325 minus split	885	832
1740	100,110,230,240,281,290,300,325 minus split	935	475
1741	100,110,230,240,281,290,300,325 minus split	935	471
1791	100,110,281,290,291 minus split	630	307

**Proposed Projects**  
A 100-Year System



**DENVER STORM DRAINAGE MASTER PLAN**  
BASIN 4600-01 (Cherry Creek - 100-yr Alternative)

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Overland Flow Basins
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin 4600-02 (Cherry Creek Mall)

### Existing System Description:

This basin consists of 2,952 acres (4.61 square miles) and is fully built-out. The basin extends from Colorado Boulevard to 6<sup>th</sup> Avenue along the Cherry Creek corridor and includes the Denver Country Club and the Cherry Creek Mall in the center of the basin. *Blueprint Denver* shows the area bounded by Colorado Boulevard, 6<sup>th</sup> Avenue, York Street and Cherry Creek as an area subject to change. The remainder (over two-thirds of the basin) is shown as being an “Areas of Stability”.

All drainage from this basin outfalls to Cherry Creek. Intercepted stormwater is discharged in over 24 separate storm drainage outfalls into Cherry Creek. Some of the more major outfalls include:

- 56-inch pipe at 1<sup>st</sup> and Marion Street
- 66-inch pipe from Cherry Creek Mall at University Boulevard and Cherry Creek
- 60-inch pipe from the east side of the Cherry Creek Mall near Steele Street.
- 3’x 8’ box culvert in Steele Street.
- 48”x76” elliptical pipe in Colorado Boulevard north of Cherry Creek
- 66-inch pipe at Garfield Street and Cherry Creek
- 42-inch pipe from University Boulevard south of Cherry Creek
- 72-inch pipe from Washington Street south of Cherry Creek draining 618 acres

### Drainage Deficiencies:

Storm drain infrastructure in this basin has undersized outfalls and incomplete networks of storm drain laterals. The north Cherry Creek area (north of the mall) has been prone to flooding and frequent complaints. Portions of basins 230 through 260 have been re-directed by pipe flow to Cherry Creek, diverting flow from the topographic I-25 basin. This creates a *split-flow* condition that causes shallow overland flooding during major storm events where the storm sewer capacity is exceeded. There is currently no defined drainage system or outfall to convey flow from the Bonnie Brae neighborhood (Basin 230 and 231). Basins north of the Denver Country Club (Basins 70, 80, 90, and 100) comprise 423 acres that drain to an undersized existing 56-inch storm sewer.

### Proposed Capital Improvements:

Portions of the former City Ditch conveyed via a 30-inch pressure pipe are being inspected for potential reuse. Denver Water Board proposes to abandon/vacate the pipeline north of Cherry Creek, and it could be reused to provide stormwater conveyance or underground detention at little cost. The reach from 8<sup>th</sup> Avenue south to Cherry Creek has potential reuse as a storm drain if inlets are connected to the pipeline. The average slope is 1% in this reach, which could provide a new outfall with approximately 40 cfs capacity. However, half the reach (from Speer to 5<sup>th</sup> Avenue) appears to be lower than Cherry Creek, thereby creating outfall problems.

The following projects are proposed to raise the level of service and meet current drainage criteria:

**Project A: Downing Street Outfall** Construct a new 54-inch outfall at Downing south of Cherry Creek to take some burden off the existing 72-inch pipe in Washington Street draining 618 acres (DP 1760).

**Project B: Lafayette Street Outfall** Construct a new storm drain in 7<sup>th</sup> Avenue to take some of the tributary area off the current Cherry Creek Mall storm drain. This maximizes the use of the existing system by draining areas currently tributary to over-taxed storm outfalls. This completes the upper reaches of the storm drain outfall constructed as part of the 2004 Radium Streets project.

**Project C: East 5<sup>th</sup> Avenue Outfall** Construct additional storm drains in Broadway discharging into Cherry Creek to alleviate known ponding problems.

**Project D: East 6<sup>th</sup> Avenue Outfall** Upsize the existing 39-inch outfall to a 60-inch pipe.

**Project E: East Cedar Avenue** Extend laterals on existing storm drains into the neighborhood.

**Project F: Steele Street Outfall** Create a new 8’x4’ box culvert and 66-inch pipe outfalls. Extend the lateral network east of Steele Street to fully utilize the capacity of the Steele outfall.

**Project G: South Bonnie Brae Blvd** Extend the local storm sewer network within the neighborhood.

**Project H: Colorado Boulevard Outfall** Construct a new 5’ x 3’ box culvert outfall in Colorado Blvd.

**Project I: University Outfall** The existing storm drain system north of the Cherry Creek Mall is often overwhelmed. A new 54-inch outfall in University is necessary to prevent nuisance flooding and provide the standard 5-year level of service.

**Project J: 5<sup>th</sup> Avenue Improvements** An existing 24-inch storm drain system in 5<sup>th</sup> Avenue should be replaced with a new 42-inch pipe.

**Project K: Bayaud Outfall** This project extends the laterals for the 66-inch outfall shown as part of Project F. These laterals extend east of Colorado Boulevard, northeast of Leetsdale.

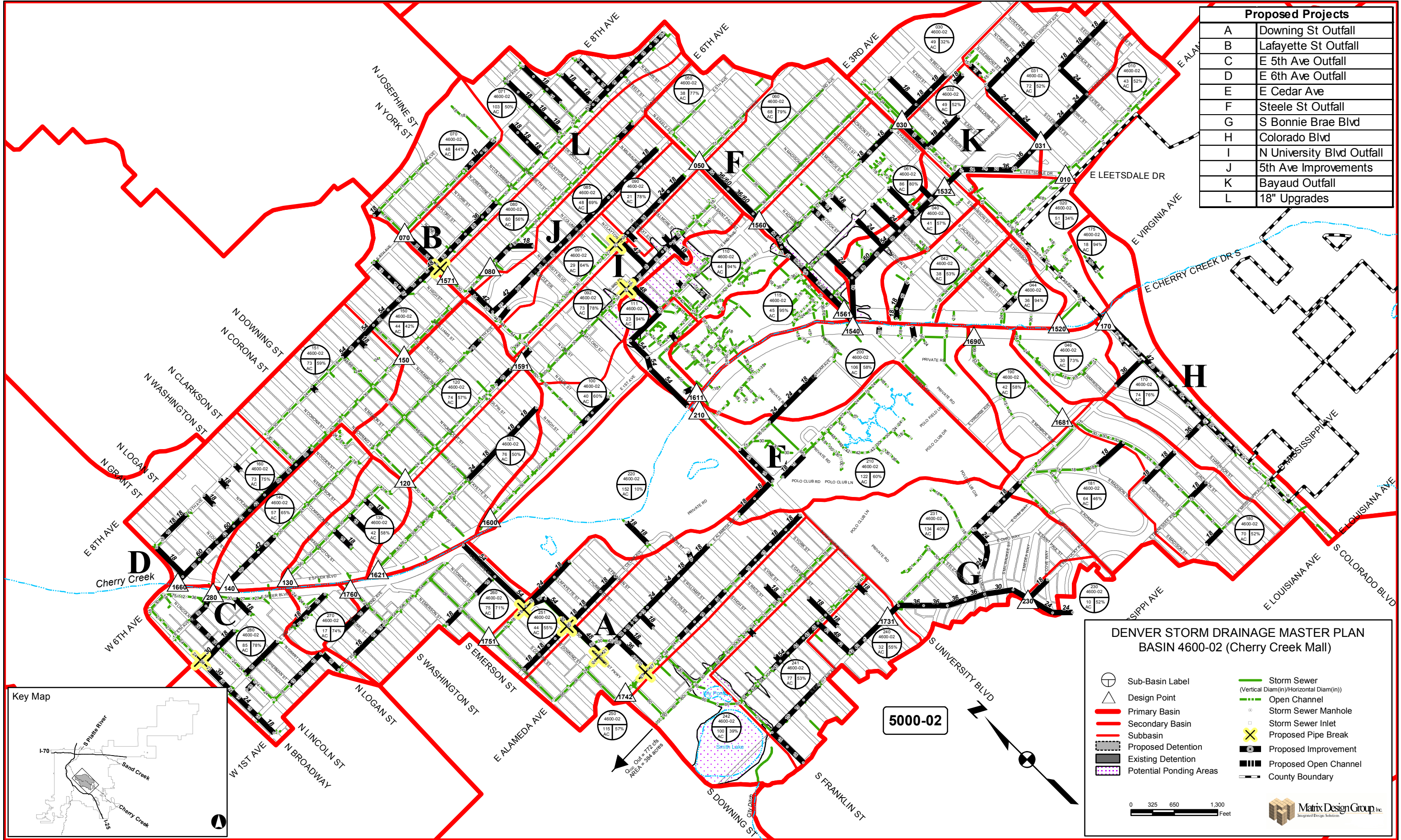
**Project L: 18” Upgrades** Existing 12-inch and 15-inch pipes in 7<sup>th</sup> & 8<sup>th</sup> Avenues are proposed to be upgraded with 18-inch pipe to meet current criteria, improve conveyance and reduce maintenance.

### Basin 4600-02

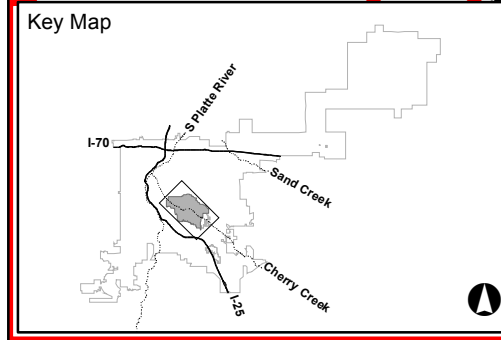
Desian Point Minor Event	Desian Point Overland Flow	Contributing Basins Minor Event Model	Tributary Area Minor Event (acres)	Peak Discharge*		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10		10	43	30	55	143
30		30	49	22	52	159
31		31	72	57	103	273
50		50	38	52	80	177
70		70	48	34	68	187
80		80	60	45	80	203
120		120	74	63	110	281
130		130	42	36	63	160
140		140	57	50	83	200
150		150	44	30	60	169
170		170	79	70	108	249
210		210	122	110	189	463
230	NA	230	41	32	58	<b>NA</b>
280		280	85	98	150	334
1520		10,20	94	48	88	264
1532		30-32	170	112	217	604
1540		30-40	211	98	195	609
1560		50,60	106	143	217	455
1561		50-61	192	190	289	671
1571		70,71	151	88	166	448
1591		70-91	310	218	388	1031
1600		70-100	423	230	405	1156
1611		110,111	67	100	141	276
1621		120,121	150	85	157	441
1660		150-160	190	149	233	602
1681		180,181	138	101	185	514
1690		180-190	180	131	213	608
1731	230	230,231	176	102	211	<b>744</b>
1742	1155	230-242	384	159	303	<b>1132</b>
1751	950	230-251	543	234	378	<b>787</b>
1760	960	230-260	618	229	394	<b>995</b>

\* 100-year discharge in **bold** represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths. Since several pipe networks do not follow overland drainage paths, this differing approach in modeling could create significant differences in peak flow distribution between storm events.

Proposed Projects	
A	Downing St Outfall
B	Lafayette St Outfall
C	E 5th Ave Outfall
D	E 6th Ave Outfall
E	E Cedar Ave
F	Steele St Outfall
G	S Bonnie Brae Blvd
H	Colorado Blvd
I	N University Blvd Outfall
J	5th Ave Improvements
K	Bayaud Outfall
L	18" Upgrades



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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4600-02 (Cherry Creek Mall)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 325 650 1,300 Feet

Matrix Design Group Inc.  
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5000-02

On On = 77.0%  
WCA = 384.40%

## **Basin 4600-02 (Cherry Creek Mall) (Alternative 100-Year System)**

### **Alternative 100-Year System to Reduce the Potential Ponding:**

Ponding is predicted north of the Cherry Creek Mall between 2<sup>nd</sup> & 3<sup>rd</sup>, and between Steele and University. A total of 72 structures with a total structure value of \$38.9M (per 2003 Denver Assessors' records) lie within the 30-acre zone most severely impacted by the flooding. During a 100-year storm, runoff estimated to be 1158 cfs from 361 tributary acres, exceeds the capacity of the storm drain network (approximately a 1-year system).

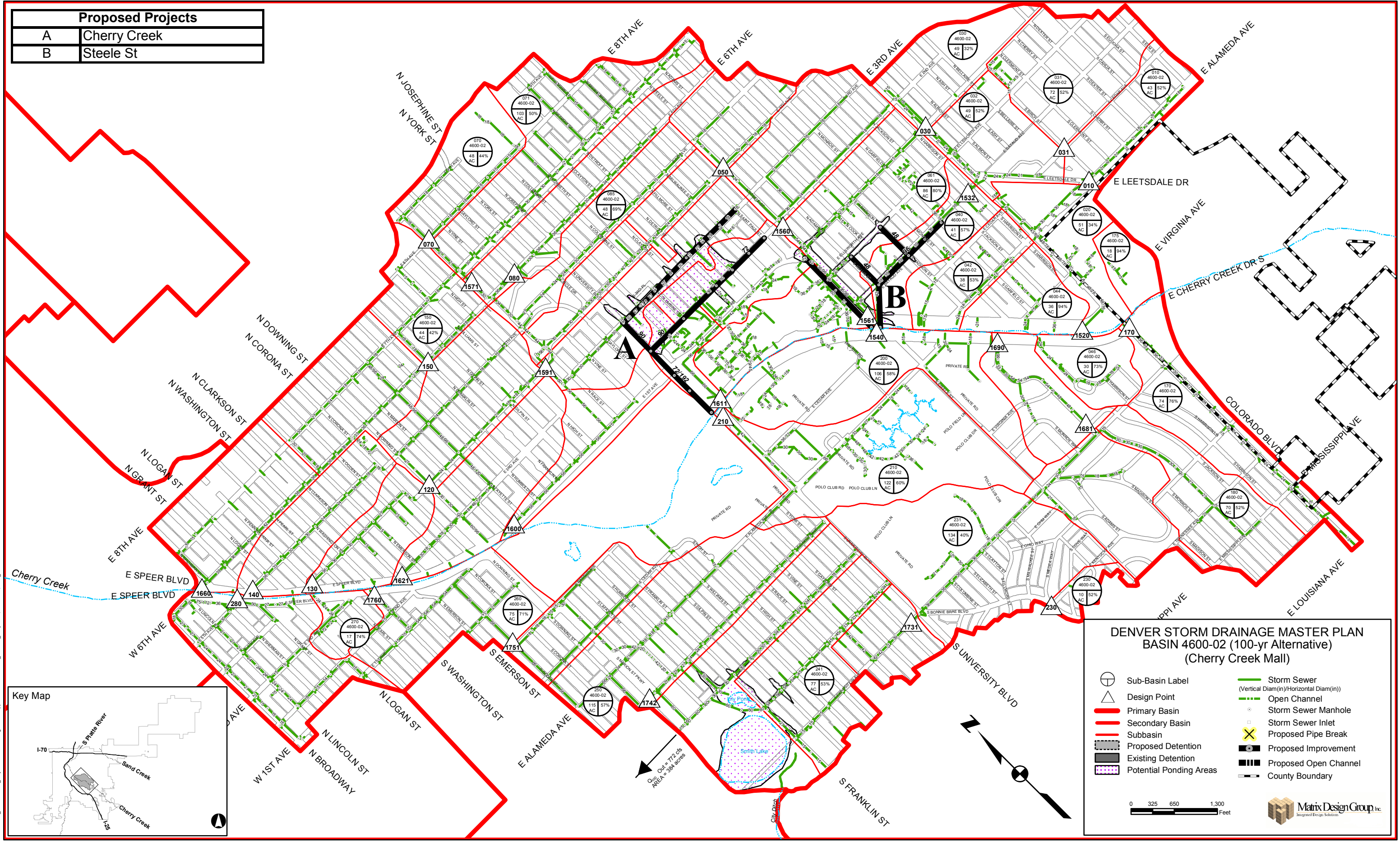
A 100-year drainage system to solve the potential ponding problem in this area would include twin 8'x6' box culverts outfalling to Cherry Creek at University Boulevard. In addition, new laterals and inlets would be required to capture the 100-year runoff.

Approximate cost to eliminate the potential ponding in the basin is estimated to be \$10.0M. The capital recovery factor assuming a 30-year pay-off period at 5% interest is \$0.66M. Damage estimates are \$2.72M from a 5-year storm event, and \$4.28M from a 100-year storm event (based upon FEMA flood depth verses damage tables). Annualized flood damage costs are estimated to be \$0.41M and \$0.66M for 5-year and 100-year return periods, respectively. The benefit-cost ratio performed for this cursory study for the 100-year solution is close to unity due to the high cost of real estate in this basin, and therefore a correspondingly high estimated annualized damage cost.

This benefit-cost ratio is assumed to be a minimum figure because it only assumes physical damage, and does not include the following impacts:

1. Closure time for repair and lost opportunity costs,
2. Loss of inventory to commercial businesses,
3. Impacts to roadways and commuter routes,
4. Inundation of underground and subterranean parking, and damage to parked cars, and
5. Loss of power and services to business resulting in closure during flooding.



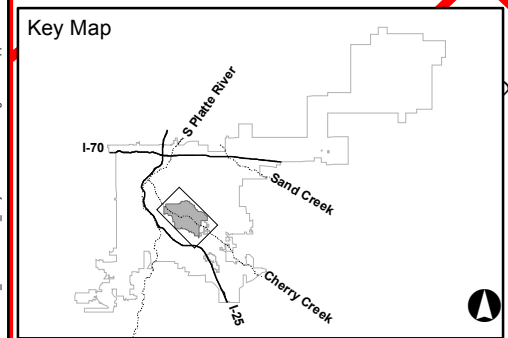


Proposed Projects	
A	Cherry Creek
B	Steele St

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4600-02 (100-yr Alternative)  
(Cherry Creek Mall)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Proposed Detention		Proposed Pipe Break
	Existing Detention		Proposed Improvement
	Potential Ponding Areas		Proposed Open Channel
			County Boundary

0 325 650 1,300 Feet



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## Basin 4600-03 (Upper Cherry Creek)

### Existing System Description:

This basin consists of 3,597 acres (5.62 square miles) and is one of the newer development regions of the entire study area. For this reason, outfalls generally have more capacity than some of the older sections of the City. Nonetheless, many of the outfalls do not meet current drainage criteria and laterals need to be extended further up into the basin. The lower reach of this basin is outside Denver limits in the City of Glendale. The upper reaches of the basin are in Aurora. All drainage from this basin outfalls to Cherry Creek downstream of the Cherry Creek dam.

Most of this basin has been developed into neighborhood residential and parks. *Blueprint Denver* shows the entire basin as an “Areas of Stability”. No areas have been identified as “Areas of Change”.

This basin is characterized by smaller tributaries to Cherry Creek with travel paths generally less than 1 mile to each outfall. This reach of the Cherry Creek basin includes the Goldsmith Gulch outfall; however, the Phase I Study Area excludes areas tributary to Goldsmith Gulch. Intercepted stormwater is discharged in at least 19 separate storm drainage outfalls. Major outfalls larger than 36-inch include the following:

- 54-inch in Birch Street south of Cherry Creek with 80 tributary acres (DP 250)
- 60-inch in Cherry Street south of Cherry Creek with 92 tributary acres (DP 240)
- 72-inch in Cherry Street north of Cherry Creek with 130 tributary acres (DP 1621)
- 72-inch in Exposition Avenue north of Cherry Creek with 601 tributary acres (DP 1611)
- 42-inch in Kentucky Avenue south of Cherry Creek with 44 tributary acres (DP 220)
- 42-inch in Mississippi Avenue south of Cherry Creek with 276 tributary acres (DP 1701)
- 36-inch in Honey Avenue south of Cherry Creek with 215 tributary acres (DP 1671)
- 42-inch through Garland Park north of Cherry Creek with 51 tributary acres (DP 70)
- 34”x53” elliptical near Niagara Street north of Cherry Creek with 63 acres (DP 60)
- 72-inch in Florida Avenue north of Cherry Creek with 526 tributary acres (DP 1551)
- 42-inch in Oneida Avenue south of Cherry Creek with 41 tributary acres (DP 160)
- 60”x38” elliptical near Quebec Street north of Cherry Creek with 88 acres (DP 20)

The existing storm drain infrastructure consists of a numerous large outfalls. Priority improvements in this basin are to extend the laterals further up into the basin. Next priority is to upsize outfall for the standard level of service. No opportunities for regional detention were identified in this basin.

Recent drainage infrastructure improvements by Denver in this basin includes implementation of the 1989 master plan project known as “Virginia Village.” This project included extending storm drains into the neighborhood south of Cherry Creek between Holly and Monaco Streets.

### Drainage Deficiencies:

No significant drainage problems are known to exist in this basin. Localized drainage problems have been reported according to the complaints database.

### Proposed Capital Improvements:

**Project A: Exposition Avenue Outfall** includes upsizing the existing 72-inch outfall to 90-inch and extending laterals on existing outfalls (Exposition and North Cherry Streets). Storm pipes should also be extended north of Leetsdale Drive.

**Project B: Forest Street Outfall** includes upsizing the existing 42-inch outfall to a 54-inch pipe and then into a 5’x4’ box culvert near Potenza Park. The project also includes extending the laterals further into the basin.

**Project C: Holly Street Outfall** includes a new 36-inch outfall west of the Garland Park.

**Project D: Honey Way Outfall** includes replacing 12 and 15-inch pipes with 18-inch pipes. Most of the major drainage improvements have recently been constructed in this area.

**Projects E: Florida Avenue Outfall** includes re-routing and existing storm drain to a new outfall in Quebec Street, north of Cherry Creek. The project includes replacement of an existing 24-inch outfall with an 84-inch pipe. Improvements include extension of the storm drain lateral network further into the basin. Large stub-outs have been shown at the City limits for Aurora to extend.

**Project F: Oneida Street Outfall** includes extension of the storm lateral network to reduce potential ponding at the intersection of Oneida and Mexico.

**Project G: Vale Drive Outfall** includes a new outfall east of the Historic Four Mile Park. Currently, runoff is collected in the residential neighborhood streets and a formal pipe outfall is necessary.

**Project H: Jewell Avenue Outfall** A new outfall is proposed in Quebec Street south of Cherry Creek. This pipe begins in Jewell Avenue and discharges via a 42-inch pipe.

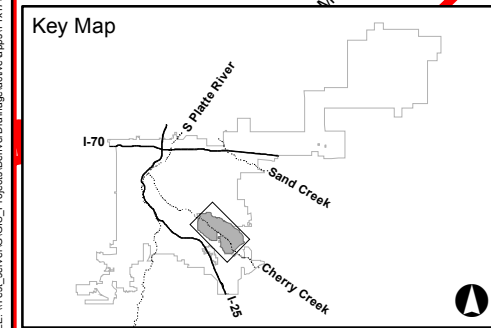
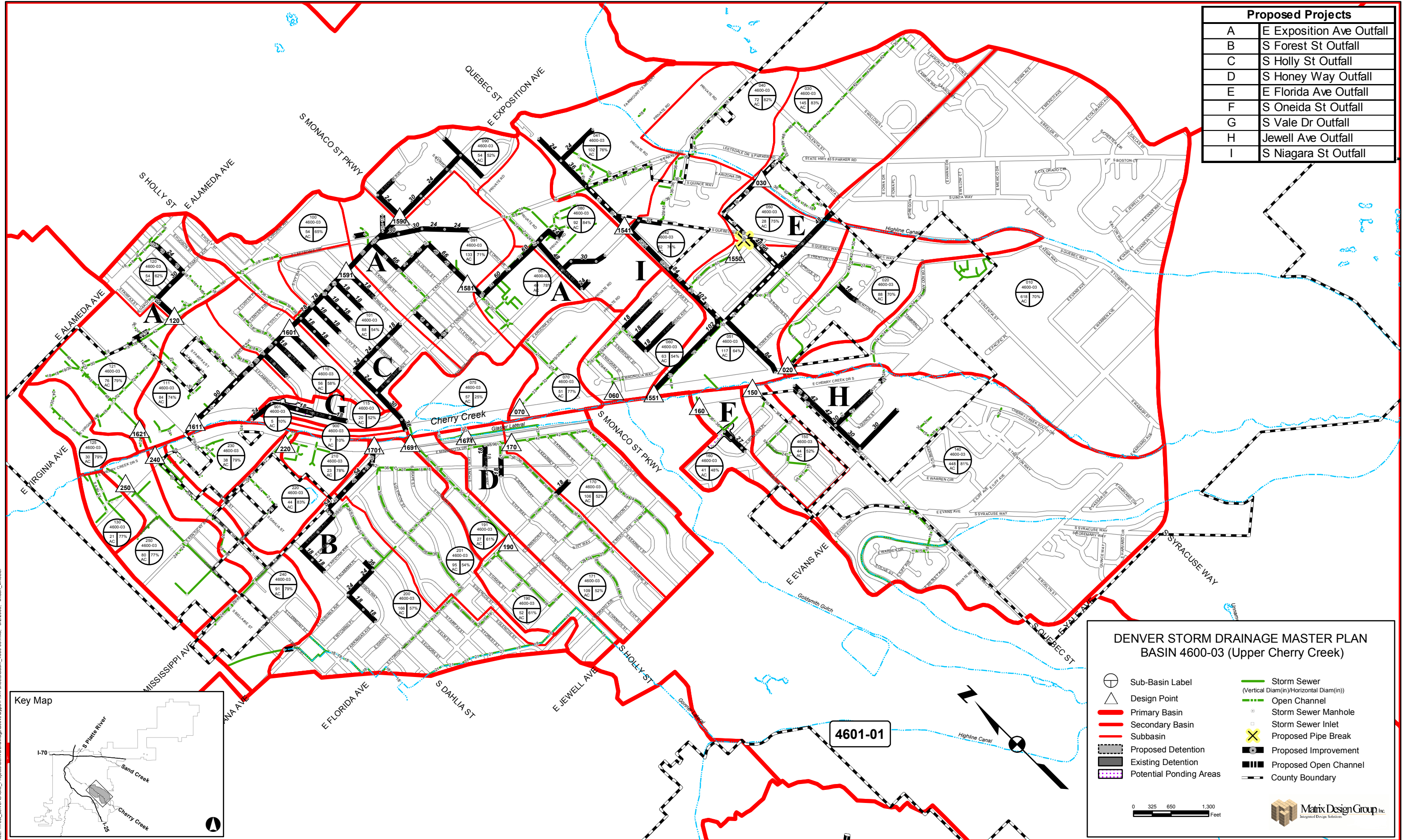
**Project I: S. Niagara Street Outfall** includes replacement of an existing 72-inch outfall with a 102-inch pipe. Improvements include extension of the storm drain lateral network further into the basin, primarily along Quebec Street.

### Existing Hydrology:

#### **BASIN 4600-03**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
20	20	88	85	136	318
30	30	145	209	311	667
60	60	63	48	85	219
70	70	51	57	88	199
120	120	54	59	99	240
150	150	44	32	57	151
160	160	41	24	46	124
170	170	106	75	137	357
190	190	53	56	95	231
220	220	44	60	90	193
240	240	92	122	185	407
250	250	80	88	135	304
1541	40,41	174	243	353	774
1550	30,50	173	233	352	774
1551	30-51	526	365	581	1538
1581	80,81	132	150	233	531
1590	80-90	186	132	222	592
1591	80-91	319	266	421	1082
1601	80-101	461	342	568	1509
1611	80-111	601	401	677	1903
1621	120-121	130	137	210	459
1671	170,171	215	137	257	706
1691	190,191	80	61	104	280
1701	200,201	276	222	410	1087

Proposed Projects	
A	E Exposition Ave Outfall
B	S Forest St Outfall
C	S Holly St Outfall
D	S Honey Way Outfall
E	E Florida Ave Outfall
F	S Oneida St Outfall
G	S Vale Dr Outfall
H	Jewell Ave Outfall
I	S Niagara St Outfall



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4600-03 (Upper Cherry Creek)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 325 650 1,300 Feet

Matrix Design Group Inc.  
Integrated Design Solutions

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## Basin: 4600-04 (Cherry Creek Reservoir)

### Existing System Description:

There are numerous existing outfalls into Cherry Creek in this basin. The major outfalls east of Cherry Creek include a 72" in Dartmouth Avenue and a 60" adjacent to the Highline Canal. Major outfalls west of Cherry Creek include a 66" in Hampden Avenue, a 48" near Geneva Street, dual 36" pipes at Chester Court, a 68"x 43" box in Yosemite Street, and a 36" in Yale Avenue.

### Drainage Deficiencies:

- Basins 10, 20, 40, and 50 comprise 417 acres that drain to an existing 42-inch storm sewer beginning near Hampden Avenue and Dayton Street. This existing system travels to the east, down Hampden and then transitions into a 66-inch storm sewer at Hampden and Galena Street. The 42-inch portion of the system is undersized.
- Frequent ponding occurs at the intersection of Hampden and Girard. Subbasin 90 is 77 acres in area and currently has no storm sewers. Runoff flows east down Girard Avenue towards Hampden and frequently floods the intersection.
- The system draining basins 100, 110, and 120 (218 acres) is undersized. The upper reaches of the basin include some commercial development which then requires a 5-year capacity storm drain by current criteria. The existing 48-inch system has capacity for 80 cfs, and the 5-year design flow is approximately 196 cfs.
- Basin 180 is comprised of 116 acres that drains via a 36 inch storm sewer system and outfalls directly to Cherry Creek. The 2-year basin flow is approximately 109 cfs. The current outfall system is undersized and the upstream network is adequate for intercepting initial storm flows.
- The storm drain system beginning just south of the intersection of Parker Road and Dartmouth Avenue is undersized for handling the 5-year flows. An area of approximately 479 acres (DP 250) drains to the upper portion of the system and an area of 656 acres (DP 280) drains to the lower portion of the system. The upper portion of the system consists of 54-inch storm pipe with capacity for 290 cfs. The 5-year flow for this reach is 697 cfs. The lower portion of the system is also a 54-inch storm pipe with a capacity of 325 cfs and a design flow for the 5-year event of 844 cfs.

### Proposed Capital Improvements:

**Project A: 18-Inch Upgrades** Upsizing various pipes to the City's 18-inch minimum diameter is proposed to meet current drainage criteria.

**Project B: E. Cornell Ave. Outfall** The 30"/48" system located in a tract of land between subdivisions stretching from Akron Street to Cherry Creek should be improved to convey a 5-year flow of 196 cfs. Increasing the system to include a 4'x5' CBC from Floyd Place to Clinton Court, a 4'x6' CBC from Clinton Court to Galena Court, and a 5'x7' CBC from Galena Court to the outfall would provide the necessary 5-year conveyance.

Basin 180 contains several laterals that sufficiently drain the subbasin, but the dual 36" pipe outfall cannot convey the flows to Cherry Creek. Replacing the westernmost pipe with a 42" pipe will provide the necessary conveyance for the basin.

**Project C: E. Hampden Ave. Outfall** The 36"/42"/66" storm sewer in Hampden Avenue could be improved to convey a 5-year flow of 510 cfs. Increasing the existing pipe to a 78" to 90" pipe from north of Dayton Street to Florence Street would provide the necessary 5-year conveyance in the upper portion of the system. A proposed 4'x10' CBC in Girard Avenue will provide easier construction compared to upsizing the existing system in Hampden, and will provide a 5-year level of service.

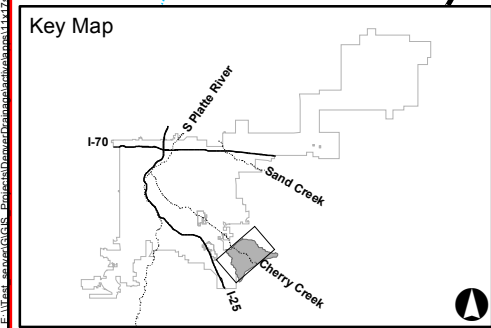
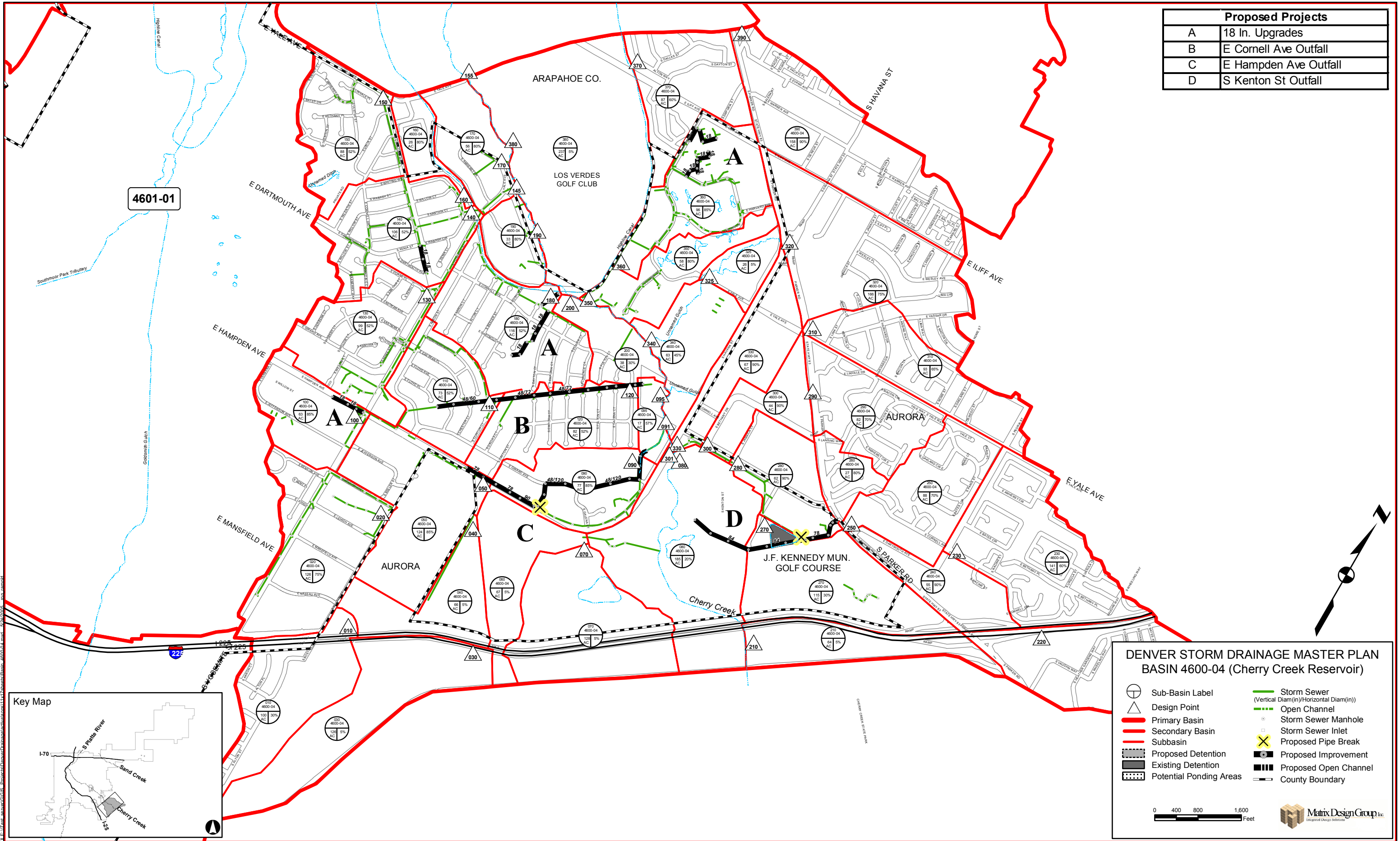
**Project D: S. Kenton St. Outfall** The 54"/60"/66" system in Dartmouth Avenue east of Cherry Creek needs to be improved to convey a 5-year flow of 697 cfs in the upper reaches and 844 cfs in the lower reaches. A new 84" outfall extending from the existing system, running north of the park and south of the development west of the park along the bike path alignment to Cherry Creek would convey flows from the upper portion of the basin. The lower portion of the basin would still drain to the existing system which would then be adequate for the runoff from the new drainage area.

### Existing Hydrology:

HYDROLOGIC SUMMARY TABLE: **BASIN 4600-04**

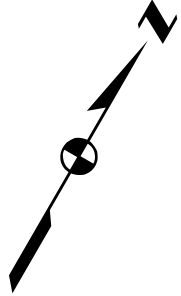
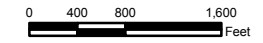
Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	101	31	75	239
20	20	126	173	270	607
30	30	126	3	26	126
40	10, 40	167	19	68	305
50	10, 20, 40, 50	417	345	506	1223
60	60	67	4	38	163
70	30, 60, 70	322	10	98	431
80	30, 60, 70, 80	507	31	125	629
90	10, 20, 40, 50, 90	495	317	510	1380
91	10, 20, 40, 50, 90	495	323	501	1380
95	95	17	0	8	35
100	100	63	83	122	260
110	100, 110	137	118	177	434
120	100, 110, 120	218	120	196	550
130	130	99	89	162	422
140	130, 140	205	160	299	793
145	130, 140	205	162	295	819
150	150	88	57	105	275
155	150	88	55	100	264
160	160	26	29	43	96
170	170	56	80	120	262
180	180	116	109	201	517
190	190	33	46	69	152
200	200	38	13	32	101
210	210	64	3	32	137
220	220	167	243	358	760
230	230	141	130	223	548
240	240	55	62	90	191
250	220, 230, 240, 250, 260	479	469	697	1657
260	260	27	37	56	123
270	220, 230, 240, 250, 260, 270	594	495	779	1942
280	220, 230, 240, 250, 260, 270, 280	656	537	862	2150
290	290	82	73	117	274
300	220, 230, 240, 250, 260, 270, 280, 290, 300	781	647	1008	2511
301	220, 230, 240, 250, 260, 270, 280, 290, 300	781	653	1013	2495
310	310	93	85	141	337
320	310, 320	258	246	394	929
325	310, 320, 325	284	236	394	970
330	330	67	80	117	246
340	210, 320, 325, 340	347	235	407	1064
350	350, 360	155	200	298	654
360	360	96	146	215	457
370	370	88	77	132	324
380	380	237	10	90	405
390	390	162	215	313	653

Proposed Projects	
A	18 In. Upgrades
B	E Cornell Ave Outfall
C	E Hampden Ave Outfall
D	S Kenton St Outfall



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4600-04 (Cherry Creek Reservoir)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



## Basin: 4601-01 (Lower Goldsmith Gulch)

### Existing System Description:

This portion of Goldsmith Gulch basin has a total drainage area of about 3.92 square miles. It is the lower portion of Goldsmith Gulch from TREX and I-225 to Cherry Creek. The basin is located in the southeast Denver metropolitan area within the City and County of Denver. The main stream of Goldsmith Gulch starting from Orchard Road is tributary to Cherry Creek with the Confluence near Monaco Boulevard that is approximately 4 miles downstream of the Cherry Creek Reservoir. The entire basin extends from Cherry Creek about 8 miles southeast to Arapahoe Road. Seventeen roads and highways cross the gulch along with the Highline Canal.

### Drainage Deficiencies:

The existing development in this basin has encroached into the gulch creating a large number of households within the floodplain. Localized drainage problems occur in the residential area within basins 590, 610, 440 and 360.

### Proposed Capital Improvements:

This basin requires improvements primarily to upsize the existing storm sewer system from a 2-year capacity to a 5-year capacity.

Project A: 18-inch Upgrades Several existing storm sewers are required within the basin in order to meet Denver’s storm water criteria.

Project B: E. Iliff Avenue includes upsizing the existing lateral between E. Asbury and Evans from Goldsmith Gulch west past Kearney Drive. This upgrade is required to meet the City and Counties requirements for service to a commercial area. Similarly, a new storm sewer will be extended along E. Iliff Ave. east to S. Monaco Parkway and connect to the existing storm sewer system that outfalls to Goldsmith Gulch. The system will extend up S. Monaco Parkway and connect to the proposed storm sewer in E. Iliff Avenue. This system is required to meet the City and County of Denver’s minimum requirements for commercial areas.

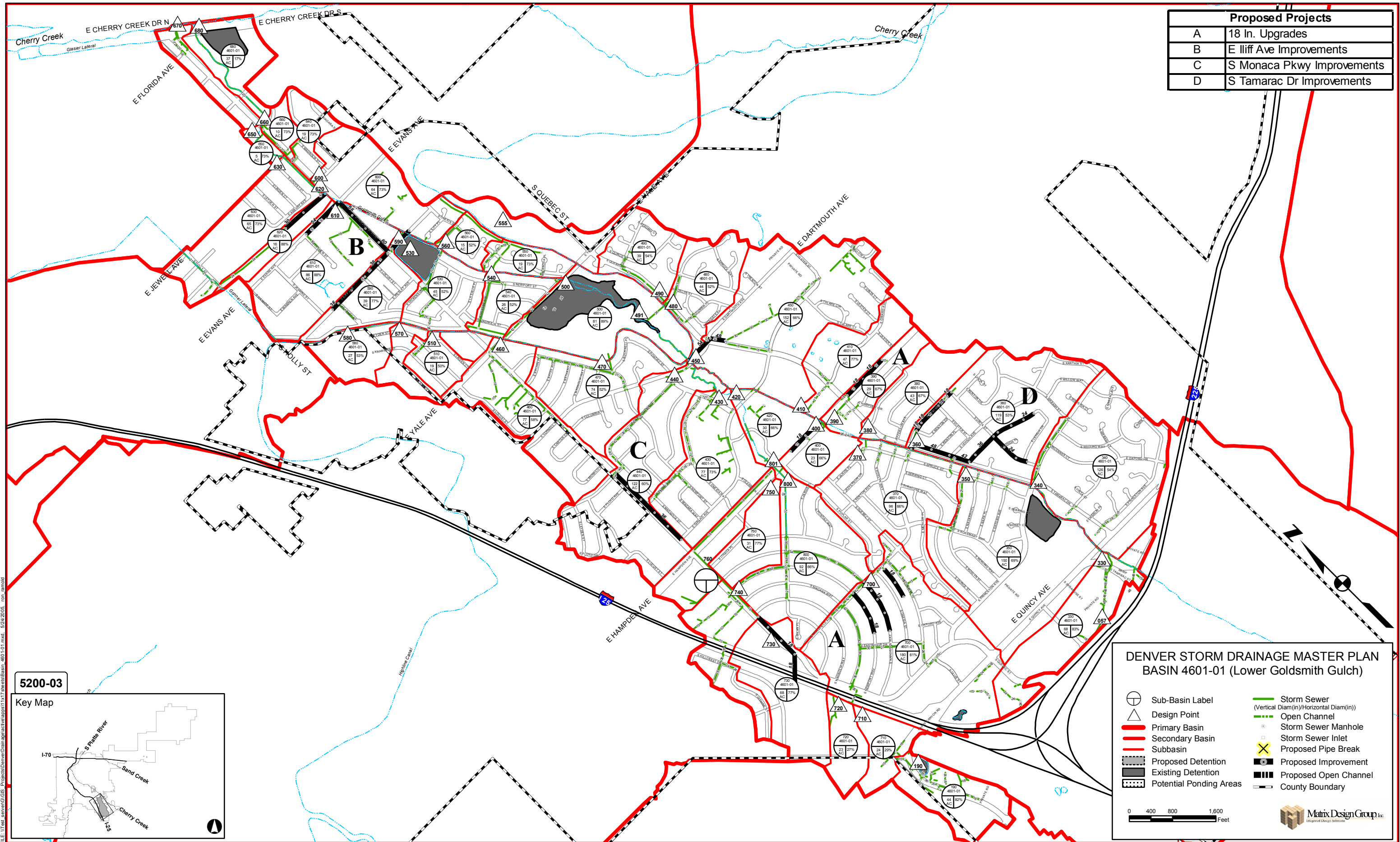
Project C: S. Monaco Parkway Improvements requires a new 36-inch storm sewer to extend south along S. Monaco Parkway to E. Girard Ave. The systems will meet Denver’s minimum criteria for both residential and commercial developments

Project D: S. Tamarac Drive Improvements. A two-year capacity system is required to adequately drain the residential area. A 24-inch lateral will be extended to the south along S. Uinta Street. The storm sewer will be extended to and along S. Tamarac Drive to the north. The storm sewer will outfall to Goldsmith Gulch at S. Kenyon Drive and S. Tamarac Drive.

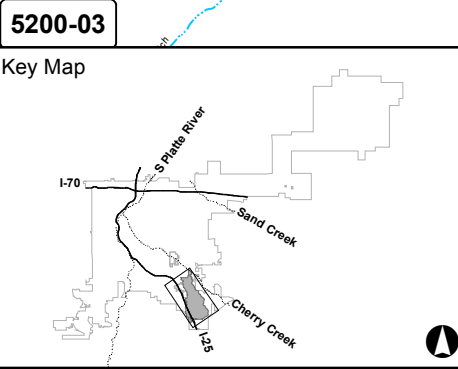
## BASIN 4601-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
57	T-REX INPUT HYDROGRAPH		30	42	81
330	330,TREX	150	235	355	756
340	340	127	102	193	472
350	350	150	138	230	526
360	360	119	92	175	422
370	370	94	67	128	312
380	380	43	37	64	146
390	390	29	27	46	102
400	400	23	56	81	163
410	410	47	48	77	167
420	420	29	38	56	113
430	430	80	75	123	276
440	440	122	65	128	326
450	450	152	153	262	590
460	460	77	50	91	219
470	470	74	54	104	258
480	480	44	34	63	162
490	490	39	29	55	137
491	480,490	84	63	94	92
500	500	80	106	160	327
510	510	19	14	26	68
520	520	8	0	4	14
530	530	45	42	80	200
540	540	26	21	39	99
550	550	20	15	29	72
555	555	35	30	50	114
560	560	55	46	86	220
570	570	18	12	22	56
580	580	27	18	35	86
590	590	40	43	70	150
600	600	64	51	90	213
610	610	93	149	221	460
620	620	17	21	32	66
630	630	53	51	85	190
640	640	19	14	27	69
650	650	6	8	13	28
660	660	10	8	15	38
670	670	20	12	24	59
680	680	39	5	24	82
700	700	179.9	147	258	614
710	710	24.3	8	21	61
720	720	23.4	8	20	62
730	730	67.8	72	115	251
740	730,740	112.0	110	177	396
750	750	34.0	33	55	122
760	760	32.9	42	63	128
800	800	88.9	56	100	239
801	700,710,720,730,740,750,760,800	495.5	375	657	1475

Proposed Projects	
A	18 In. Upgrades
B	E Iliff Ave Improvements
C	S Monaca Pkwy Improvements
D	S Tamarac Dr Improvements



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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4601-01 (Lower Goldsmith Gulch)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 400 800 1,600 Feet

## Basin: 4601-02 (Middle Goldsmith Gulch)

### Proposed Capital Improvements:

No capital improvements are proposed for this basin. The developer is providing 100-year storm systems throughout out the Lowry development. Basin: 4601-02 (Lower Goldsmith Gulch)

### Existing System Description:

This section of the Goldsmith Gulch basin has a total drainage area of about 1.4 square miles. It is located in the southeast Denver metropolitan area and is entirely within the City and County of Denver. The main stream of Goldsmith Gulch flows under I-225 at DTC Boulevard and continues into the Lower Goldsmith Gulch Basin, which is tributary to Cherry Creek. The entire basin extends from Cherry Creek about 8 miles southeast to Arapahoe Road. Seventeen roads and highways cross the gulch along with the Highline Canal.

### Drainage Deficiencies:

The drainage facilities within this basin are newer with the construction of the TREX project along the I-25 and I-225 corridors. The facilities within the Denver Tech Center are also relatively new and no drainage problems have been identified.

### Proposed Capital Improvements:

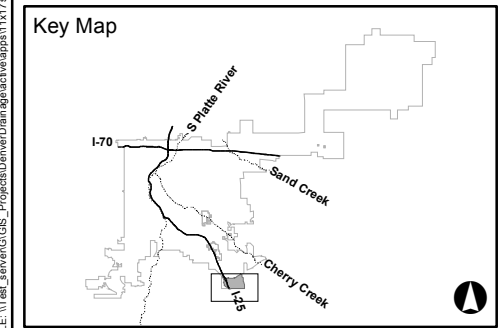
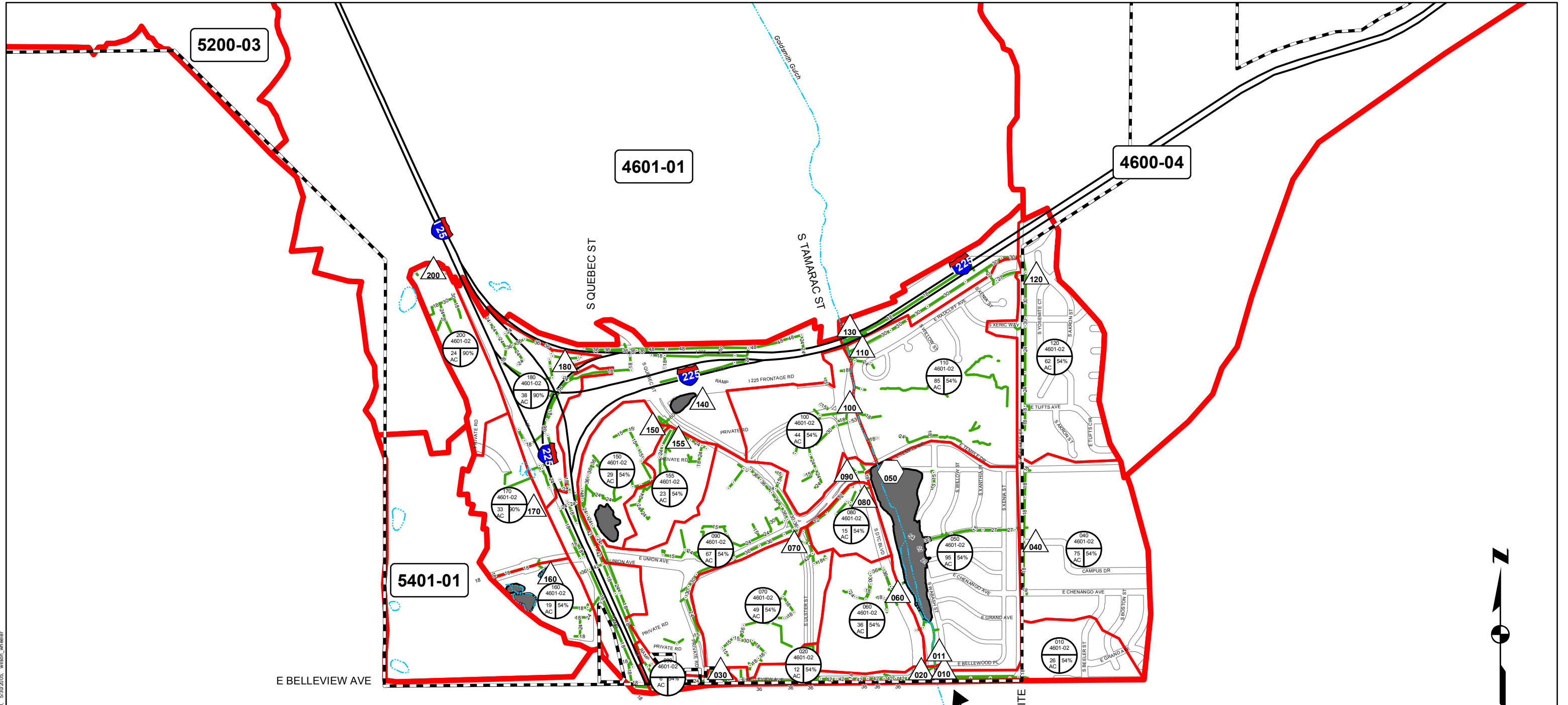
This basin requires no improvements.

### Existing Hydrology:

#### BASIN 4601-02

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	26	22	39	88
20	20	19	23	35	72
30	30	6	9	14	29
40	40	70	46	90	222
50	50	95	68	129	316
60	60	36	49	74	156
70	70	49	75	110	224
80	80	63	90	135	274
90	90	49	58	87	180
100	100	44	59	89	183
110	110	84	82	137	310
120	120	62	52	90	208
130	130	24	30	46	94
140	140	100	138	207	420
150	150	28	41	63	132
155	155	22	34	51	106
160	160	19	29	43	89
170	170	35	46	72	158
180	180	39	54	81	167
190	190	44	56	86	185





$Q_2$  In = 378 cfs  
 $Q_5$  In = 425 cfs  
 $Q_{100}$  In = 2274 cfs

### DENVER STORM DRAINAGE MASTER PLAN BASIN 4601-02 (Middle Goldsmith Gulch)

	Sub-Basin Label		Storm Sewer
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.  
Regional Design Solutions

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## Basin: 4700-01 (Sloan Lake)

### Existing System Description:

This basin drains to the South Platte River and is generally between Colfax and 32<sup>nd</sup> Avenues and extends westerly from the South Platte River to Garrison Street. Approximately half of the basin (eastern) is located within the City of Denver, while the western half is within the cities of Lakewood, Wheat Ridge, and Edgewater. The areas outside of Denver drain to two specific crossing points under Sheridan Boulevard at 24<sup>th</sup> Avenue and 18<sup>th</sup> Avenue (Sloan Lake Lateral). Sloan Lake occupies approximately 77 acres and is located just west of Sheridan Boulevard. It receives storm water runoff from the majority of the basin and provides significant detention volume for flooding events. Below the lake, a 24-inch storm sewer system conveys outflow from the lake and localized drainage to the South Platte River. The basin within Denver is almost completely residential with the exception of Sloans Lake Park, some commercial areas along Sheridan Boulevard, Federal Blvd, Colfax Avenue, and Invesco Field.

### Drainage Deficiencies:

Sloan Lake is extremely effective in reducing peak flow rates to drainage systems lower in the basin. However, the existing system below the lake cannot sufficiently handle localized stormwater runoff. The existing 24- to 54-inch trunk line draining this basin below Sloan Lake is undersized for the 5-year event. The 54-inch outfall along Colfax Avenue can convey 124 cfs, while the 5-year design flow is 366 cfs (DP 1030). If detention in the Lake were increased to reduce flows to the lower system, the need to upsize the outfall for local drainage would still exist. It is important to note that the 100-year regulatory floodplain out of Sloan Lake does not show inundation of buildings. Therefore, the streets may be able to contain flows beyond the capacity of the existing storm drains up to the 100-year event.

The existing lateral in Colfax Avenue west of Federal Boulevard is undersized.

The small systems draining 17<sup>th</sup> Avenue, which discharge into Sloan Lake, do not adequately drain the roadway during the 2-year event.

The existing system that wraps around the eastern edge of Sloan Lake and drains 20<sup>th</sup> Avenue is undersized for the 2-year event.

### Proposed Capital Improvements:

Projects A and B: N. Stuart St. Outfall and N. Wolfe St. Outfall Two 18-inch laterals are proposed to provide additional inlets and drainage facilities for 17<sup>th</sup> Avenue.

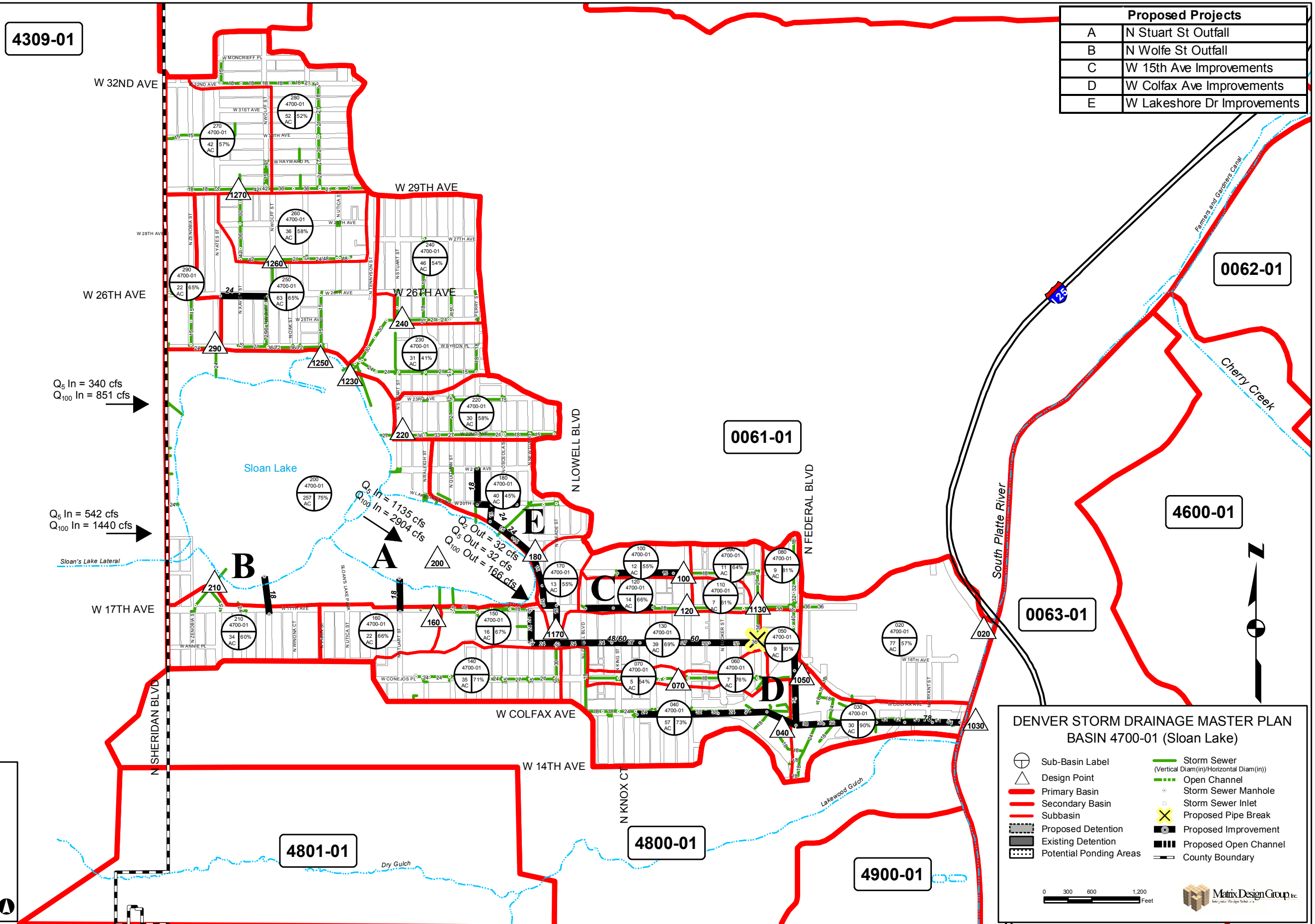
Projects C and D: W 15<sup>th</sup> Ave. and W. Colfax Ave. Improvements Upsizing the South Platte outfall with a 78-inch pipe is proposed, while a 42-inch pipe is recommended higher in the basin just below the Sloan Lake outlet facility. Up-sizing the storm sewer in Colfax Avenue between Knox Court and Federal Boulevard is proposed to upgrade the system to a 5-year capacity.

Project E: W. Lakeshore Dr. Improvements The system draining 20<sup>th</sup> Avenue east of Sloan Lake should be up-sized to handle the 2-year event.

### Existing Hydrology:

#### BASIN 4700-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
20	20	77	62	109	273
40	40	57	56	88	203
70	70	5	4	7	18
100	100	12	10	18	47
120	120	14	14	24	57
160	160	22	22	37	88
180	180	39	25	49	136
200	200	257	176	287	706
210	210	34	30	52	129
220	220	30	24	42	106
240	240	46	33	60	154
290	290	22	20	33	79
1030	Off Site, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180	2692	224	366	964
1050	Off Site, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180	2605	180	289	746
1130	Off Site, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180	2575	155	251	649
1170	Off Site, 140, 150, 160, 170, 180,	2522	120	191	456
1230	230, 240	77	45	87	247
1250	250, 260, 270, 280	193	138	223	597
1260	260, 270, 280	130	93	148	405
1270	270, 280	94	64	111	292



Proposed Projects	
A	N Stuart St Outfall
B	N Wolfe St Outfall
C	W 15th Ave Improvements
D	W Colfax Ave Improvements
E	W Lakeshore Dr Improvements

4309-01

0062-01

0061-01

4600-01

0063-01

4801-01

4800-01

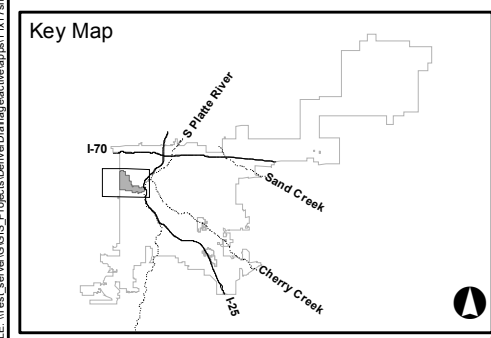
4900-01

Q<sub>5</sub> In = 340 cfs  
Q<sub>100</sub> In = 851 cfs

Q<sub>5</sub> In = 542 cfs  
Q<sub>100</sub> In = 1440 cfs

Q<sub>5</sub> In = 1135 cfs  
Q<sub>100</sub> In = 2904 cfs

Q<sub>5</sub> Out = 32 cfs  
Q<sub>100</sub> Out = 166 cfs



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4700-01 (Sloan Lake)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

Matrix Design Group Inc.

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## Basins 4800-01 & 4801-01 (Lakewood & Dry Gulches)

### Existing System Description:

Lakewood Gulch is a major drainageway with a 16 square mile watershed, and Dry Gulch is a north bank tributary to Lakewood Gulch. The gulches begin in Lakewood and terminate into the South Platte River at 14<sup>th</sup> Avenue. Only about 10% of the total tributary area is within the City & County of Denver. Lakewood Gulch has 750 acres (1.17 square miles) tributary, and Dry Gulch has 248 acres (0.39 square miles) tributary within the City & County of Denver. The basins are long, narrow basins running west to east, generally along 6<sup>th</sup> Avenue and Colfax Avenue.

The basins within Denver are fully built-out primarily with neighborhood residential, except for commercial along arterial transportation corridors. *Blueprint Denver* shows linear corridors along Dry Gulch and Colfax subject to change. These are proposed light rail and other transit oriented improvements that may occur in these basins in the future. The residential neighborhood is shown as an “Areas of Stability”.

All drainage from these basins outfalls into the South Platte River. Runoff generally flows down the relatively steep roadways into these major drainageways. Relatively little storm pipe is necessary in these basins due to the capacity of the streets to convey stormwater. Intercepted stormwater in the pipes is discharged in small, local storm drainage outfalls to the drainageways. The only large outfall is a 39-inch drain from Colfax Avenue discharging into Lakewood Gulch at Lowell Boulevard.

The condition of the inlets is unknown at this time, but it is assumed they perform adequately with proper maintenance.

Unique to this basin, is the need to evaluate roadway bridge crossings for conveyance of the flood events. Urban Drainage & Flood Control District has evaluated improvements in two studies completed in 1979. The following roadway/railway crossings occur on these drainageways:

#### Lakewood Gulch:

1. Sheridan Boulevard
2. Wolff Street
3. Tennyson Street
4. Perry Street
5. 10<sup>th</sup> Avenue
6. Two Railroad Bridges
7. Knox Street
8. Federal Boulevard
9. Decatur Street
10. Canosa Street

#### Dry Gulch:

1. Sheridan Boulevard
2. Two Railroad Bridges
3. Perry Street

### Drainage Deficiencies:

No major drainage complaints have been reported in these basins outside the regulatory floodplains. These two basins generally meet Denver drainage criteria. The bridges and open channel convey the 100-year flood event, and the roads and drainage pipe convey the 2-year storm event.

### Proposed Capital Improvements:

This area represents an important corridor for future light rail extension. There is a confined floodplain relating to Dry Gulch, however bridges need to be adequately sized to ensure that the rail facilities are not adversely impacted. Other minor pipe improvements include the following:

Project A: N. Stuart Street To improve drainage conveyance on Colfax Avenue, a new outfall is proposed into Dry Gulch. This can be completed by connecting to the existing 33-inch pipe in Colfax and outfalling with a new 42-inch pipe in Stuart Street to Dry Gulch. This maximizes the re-use of existing pipe and improves the outfall capacity.

Project B: N. Knox Court Another new outfall is proposed in Knox Court with a 24-inch pipe outfalling to Lakewood Gulch.

Project C: N. Irving Street Existing small storm drains will be replaced with 18-inch pipe to meet current drainage criteria.

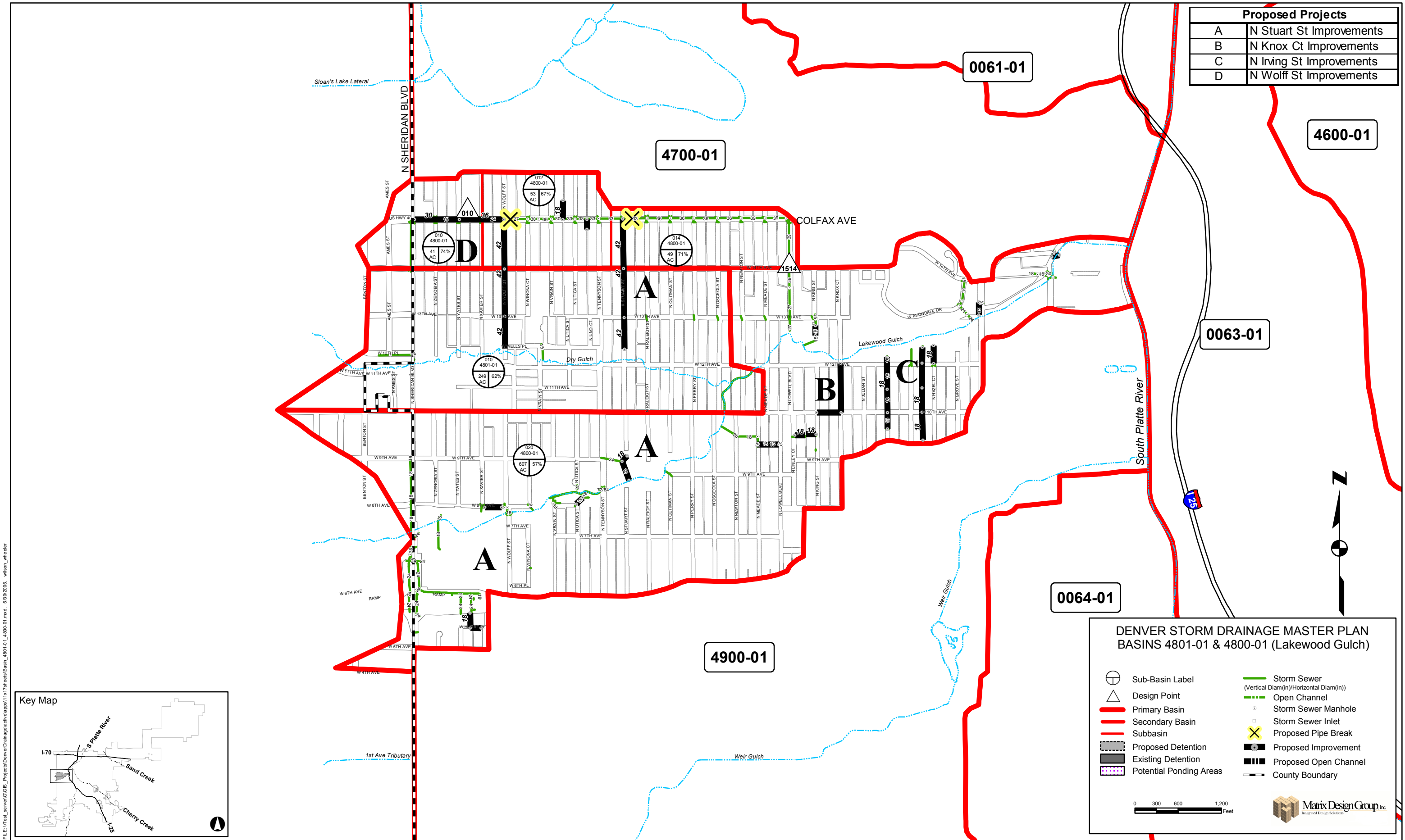
Project D: N. Wolff Street To improve drainage conveyance on Colfax Avenue, existing pipe can be replaced and a new outfall is proposed into Dry Gulch. A new 42-inch outfall in Wolff Street is proposed to Dry Gulch.

### Existing Hydrology:

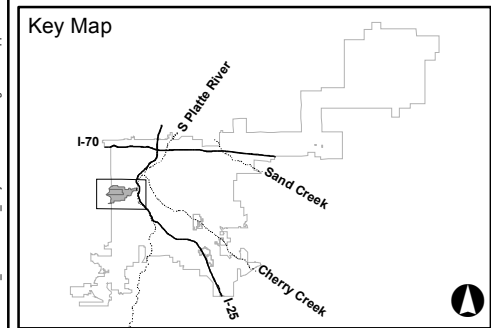
#### BASIN 4800-01

<u>Design Point</u>	<u>Contributing Basins</u>	<u>Tributary Area</u> (acres)	<u>Peak Discharge</u>		
			<u>2-Year</u> (cfs)	<u>5-Year</u> (cfs)	<u>100-Year</u> (cfs)
10	10	41	52	81	184
1514	10,12,14	143	106	172	454

Proposed Projects	
A	N Stuart St Improvements
B	N Knox Ct Improvements
C	N Irving St Improvements
D	N Wolf St Improvements



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**DENVER STORM DRAINAGE MASTER PLAN  
BASINS 4801-01 & 4800-01 (Lakewood Gulch)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

**Matrix Design Group Inc.**  
Integrated Design Solutions



## Basin: 4900-01 (Weir Gulch)

### Existing System Description:

Much of the Weir Gulch basin is located to the west and upstream of the City of Denver. The upper basin originates near Alameda Parkway and Green Mountain Drive in Lakewood. The portion of the basin located within the City of Denver is east of Sheridan Boulevard and generally lies as a long, narrow basin following the drainageway between the Center Avenue/ Sheridan Boulevard intersection at the southwestern end to the outfall at the South Platte near 9<sup>th</sup> Ave at the northeastern end. The 1<sup>st</sup> Avenue Tributary and Dakota Avenue Tributary are two drainageways which outfall to Weir Gulch within the Denver basin. Most of the upper and central basin within Denver is comprised of residential neighborhoods. The lower portion of the basin is made up of commercial and industrial facilities along the South Platte.

### Drainage Deficiencies:

The 42" to 54" system in Irving Street draining 208 tributary acres is undersized for the 2-year event.

No major drainage complaints have been reported in this basin outside the regulatory floodplain due to the relatively steep gradient toward the receiving drainageway and lack of sumps or flat areas. This basin generally meets Denver drainage criteria for the 2-year storm event in residential areas. Flooding that occurs along the main Weir Gulch drainageway and the 1<sup>st</sup> Avenue and Dakota Avenue Tributaries is considered within a "regional drainageway" and not included for analysis within the scope of this report.

### Proposed Capital Improvements:

**Project A: N. Yates St. Improvements** A 24" lateral is proposed to provide 2-year storm drainage to the 4<sup>th</sup> Avenue/Yates Street residential area.

**Project B: S. Julian St. Outfall** A new outfall along Julian Street and Ellsworth Avenue is proposed to alleviate the Irving Street system. The new system will drain the northern half of sub-basin 50, while the existing system in Irving Street will continue to drain the southern half of the sub-basin.

**Project C: W. 5<sup>th</sup> Ave. Improvements** A 24" lateral is proposed along 1<sup>st</sup> Avenue to extend the existing system in Grove Street and improve localized drainage in 1<sup>st</sup> Avenue.

**Project D: W. Bayaud Ave. Improvements** A 24" lateral is proposed along Bayaud Avenue to extend the existing system in Grove Street and improve localized drainage in Bayaud Avenue.

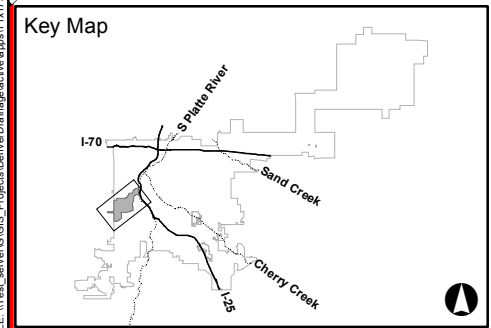
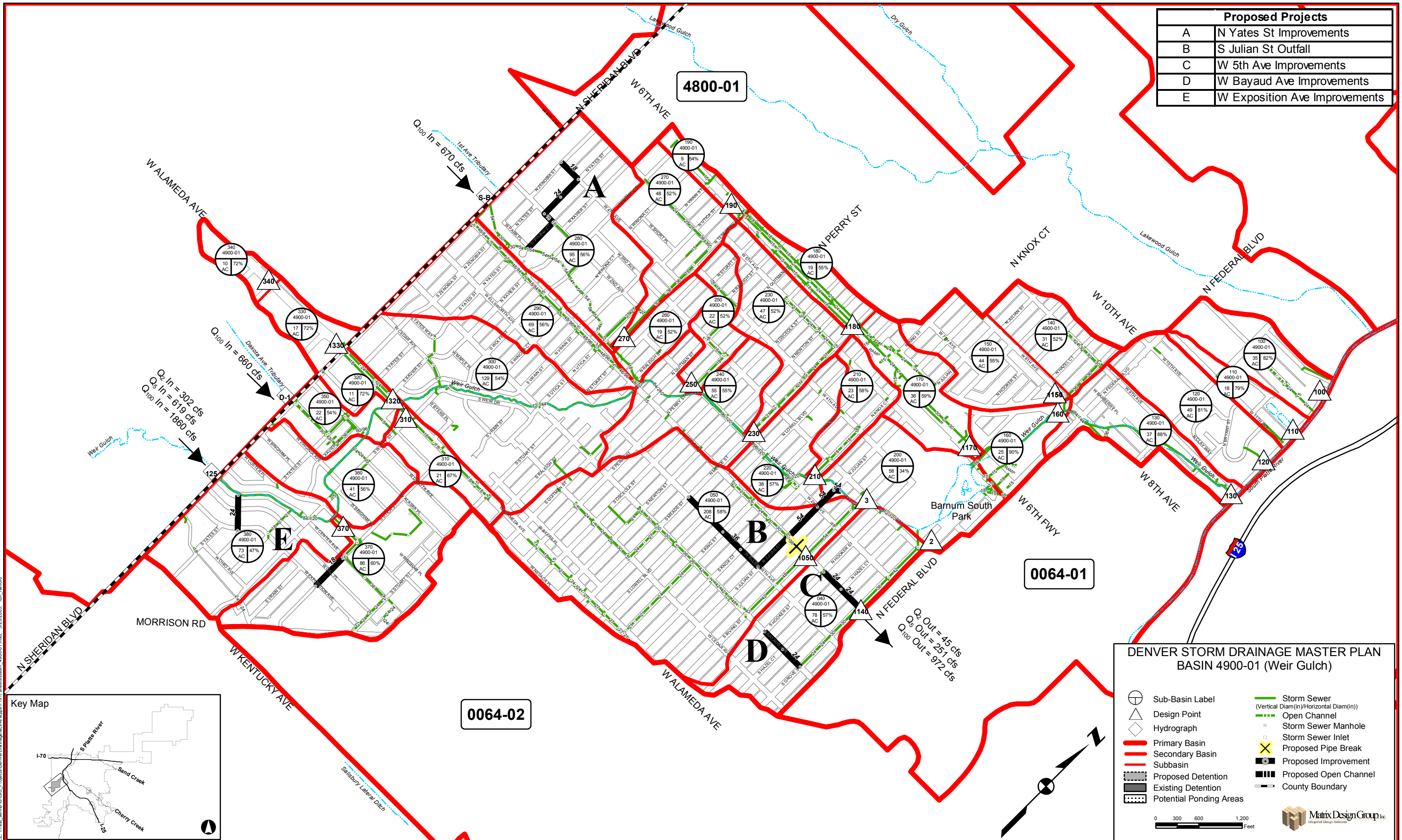
**Project E: W. Exposition Ave. Improvements** Small 18" to 24" laterals are proposed in Utica and Xavier Streets to improve localized drainage in the vicinity of Exposition Avenue.

### Existing Hydrology:

#### BASIN 4900-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
2	split	split	76	76	76
3	split	split	139	139	139
100	100	35	44	66	143
110	110	18	20	30	66
120	120	49	59	89	194
130	130	37	46	67	143
190	190	9	8	14	36
210	210	23	16	28	72
230	230	47	27	49	131
250	250	22	14	26	67
270	270	48	28	51	136
310	310	21	20	33	79
340	340	10	12	19	44
370	370	86	72	123	304
1050	50	split	209	361	915
1140	40	split	121	327	1048
1150	50	208	70	222	776
1170	170, 180, 190	64	47	81	194
1180	180, 190	28	20	34	91
1320	320, 330, 340	38	41	63	154
1330	330, 340	27	28	46	109

Proposed Projects	
A	N Yates St Improvements
B	S Julian St Outfall
C	W 5th Ave Improvements
D	W Bayaud Ave Improvements
E	W Exposition Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 4900-01 (Weir Gulch)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Hydrograph		Storm Sewer Manhole
	Primary Basin		Storm Sewer Inlet
	Secondary Basin		Proposed Pipe Break
	Subbasin		Proposed Improvement
	Proposed Detention		Proposed Open Channel
	Existing Detention		Potential Ponding Areas
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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## Basin 5000-01 (West Washington Park)

### Existing System Description:

This basin consists of 802.55 acres (1.25 square miles) and is fully built-out with older neighborhood residential in the upper reaches and commercial in the lower reaches. *Blueprint Denver* shows the commercial areas west of Broadway subject to change. The residential neighborhood is shown as an “Areas of Stability”. All drainage from this basin outfalls to the South Platte River. Intercepted stormwater is discharged in at least 13 storm drainage outfalls, which are comprised of the following:

- 54-inch with 602 tributary acres, or 75% of basin 5000-01
- 36-inch for the I-25 & Sante Fe intersection
- 30-inch for the Sante Fe & Alameda intersection
- 30-inch for the Alameda & I-25 intersection
- 2-24-inch for local I-25 drainage
- 2-18-inch for local I-25 drainage
- 5-15-inch for local I-25 drainage

The storm drain infrastructure consists of a detailed network of laterals in most streets. A grid pattern of laterals is collected in Pennsylvania and Broadway streets. The inlets are old sandstone/granite catch basins with limited capacity due to design and numerous asphalt overlays throughout the years. As improvements and handicap ramps are installed in the neighborhood, these inlets are being replaced with current standard inlets. Many of these old inlets must be replaced to improve collection efficiency. Drainage from the I-25 basin is constrained by the elevation of the South Platte River and I-25, which generally reduces capacity and creates sump or surcharge conditions during major storm events.

### Drainage Deficiencies:

The existing drainage system has capacity to convey an approximately 1-year storm event to the South Platte River. Rainfall runoff in excess of the storm drain capacity has a history of ponding in the sump and flat areas. Major drainage problems have been experienced in the sump on Alameda at the Sante Fe intersection. Ponding also occurs on the flat commercial areas by backing up water behind the railroad and I-25.

The basin delineation is based upon the storm drain network, which contravenes the site topography. Land east of the 5000-01 basin drains to Cherry Creek during minor storm events, and enters this basin in major events when the storm drain pipes are overwhelmed with runoff or plugged. In a major event, two additional areas drain into this basin: 384 acres from 4600-02, and 324 acres from 5000-02. This split flow contribution exacerbates the flooding experienced in the lower basin.

### Proposed Capital Improvements:

The existing lakes at Washington Park could be reconfigured to act as “peaking” facilities by detaining stormwater only in major events when the pipe capacity is exceeded.

This basin requires improvements primarily to the outfall since the lateral network is currently extensive in this basin. Storm pipes through the commercial areas should have 5-year capacity, whereas the lateral network through the residential areas should have at least a 2-year capacity.

Project A: 18” Upgrades Existing 12- and 15-inch pipes along Dakota and Virginia Streets are proposed to be replaced with 18-inch pipes to meeting current drainage criteria and reduce maintenance.

Project B: Alameda Avenue Outfall The existing system should be re-used to the extent possible. Rather than replacing existing large pipe, a new parallel pipe to intercept a portion of the existing storm drains is most effective. An 8’x5’ box culvert along the Center Street projected alignment from the South Platte to

Pennsylvania will improve drainage conveyance. This alignment was selected as the most efficient route; however, Center Street west of Broadway is not City-owned and therefore a drainage easement will be required. Alternatively, a different alignment could be selected. Regardless of alignment, a new crossing under the railroad tracks and I-25 is necessary. This new outfall should be considered during the next phase of TREX construction for the I-25 crossing.

Project C: Dakota Avenue Improvements Existing small storm drains will be replaced with 18-inch pipe to meet current drainage criteria as the minimum pipe size on collector drains.

Project D: Alameda & Sante Fe Outfall The sump at Alameda and Santa Fe is a chronic flood problem area and will require construction of an enlarged outfall to the Platte River across I-25. Currently, the storm drain at the point of the sump is 18-inch, which should be upsized to a 30-inch pipe.

Project E: Center Avenue Outfall Existing small storm drains are proposed to be replaced with 18-inch pipes to meeting current drainage criteria and reduce maintenance. Also, a new collector drain in Grant Street is proposed that ties into the proposed Center Avenue outfall. This new collector will reduce historic flooding in Broadway by capturing sheet flow runoff. Grant Street was selected as the preferred alignment for the collector since it has the fewest existing utilities. Construction in Broadway is discouraged to avoid disruption to arterial traffic flow and existing utilities.

### Existing Hydrology:

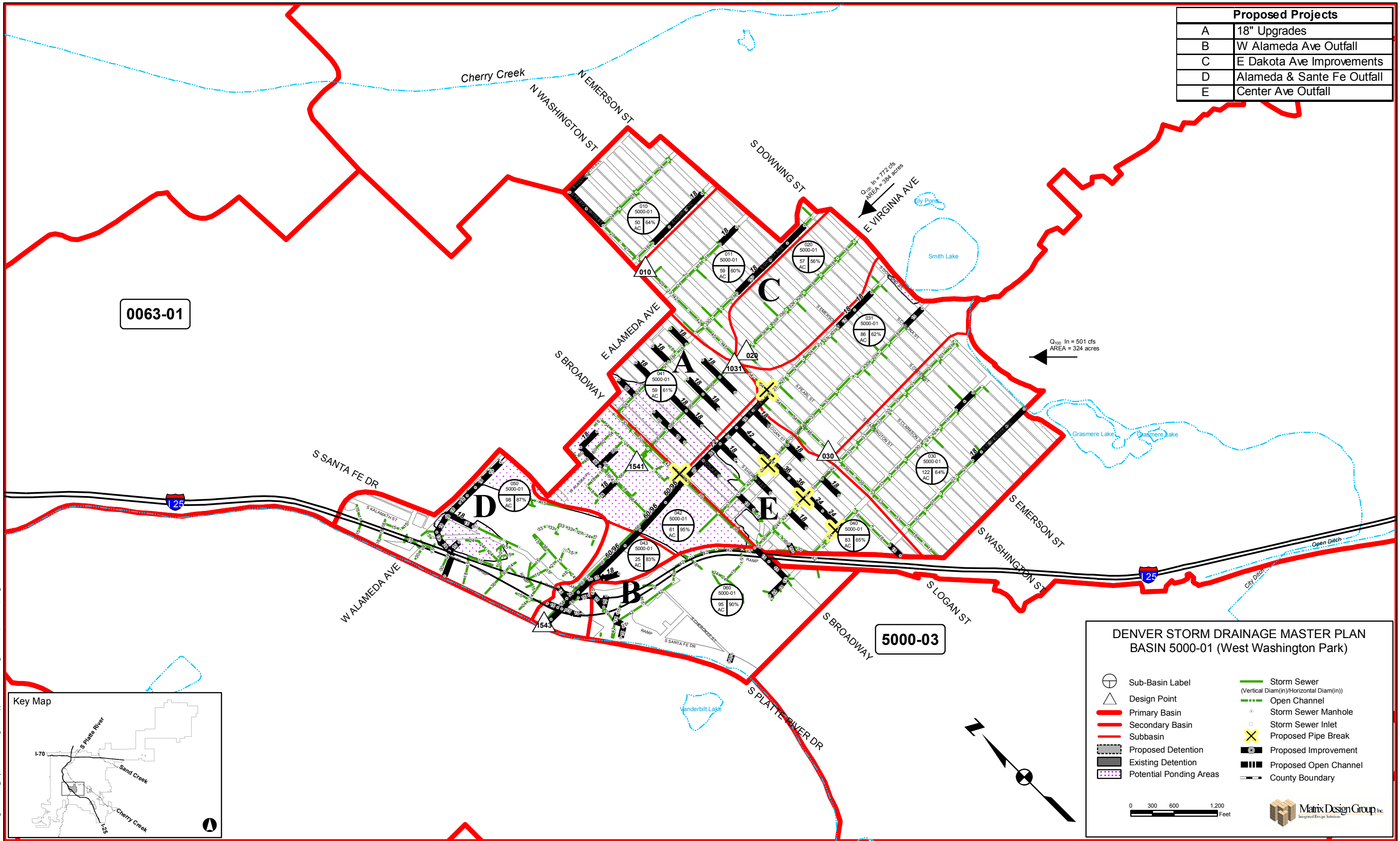
#### BASIN 5000-01

<u>Design Point</u> Minor Event Model	<u>Design Point</u> Overland Flow Model	<u>Contributing Basins</u> Minor Event Model	<u>Tributary Area</u> Minor Event Model (acres)	<u>Peak Discharge*</u>		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	NA	10	50	56	93	NA
20	NA	20	57	45	80	NA
30	NA	30	119	131	218	NA
1031	1530	10-31	376	311	528	<b>2029</b>
1541	NA	10-41	516	378	650	NA
1543	120	10-43	602	387	654	<b>2558</b>

\* 100-year discharge in **bold** represents analysis based on "overland" drainage paths determined from topography. Other events (2-year, 5-year, and remaining 100-year) are analyzed based on existing pipe network flow paths. Since several pipe networks do not follow overland drainage paths, this differing approach in modeling could create significant differences in peak flow distribution between storm events.



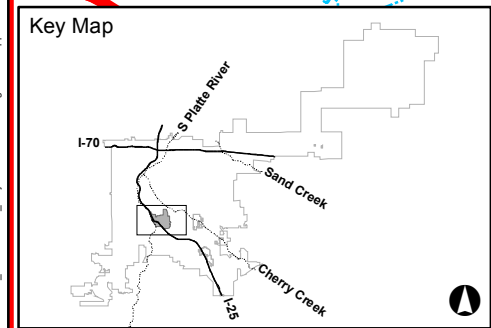
Proposed Projects	
A	18" Upgrades
B	W Alameda Ave Outfall
C	E Dakota Ave Improvements
D	Alameda & Sante Fe Outfall
E	Center Ave Outfall



0063-01

5000-03

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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5000-01 (West Washington Park)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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Integrated Design Solutions

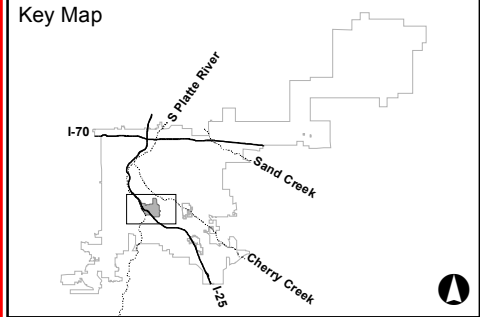
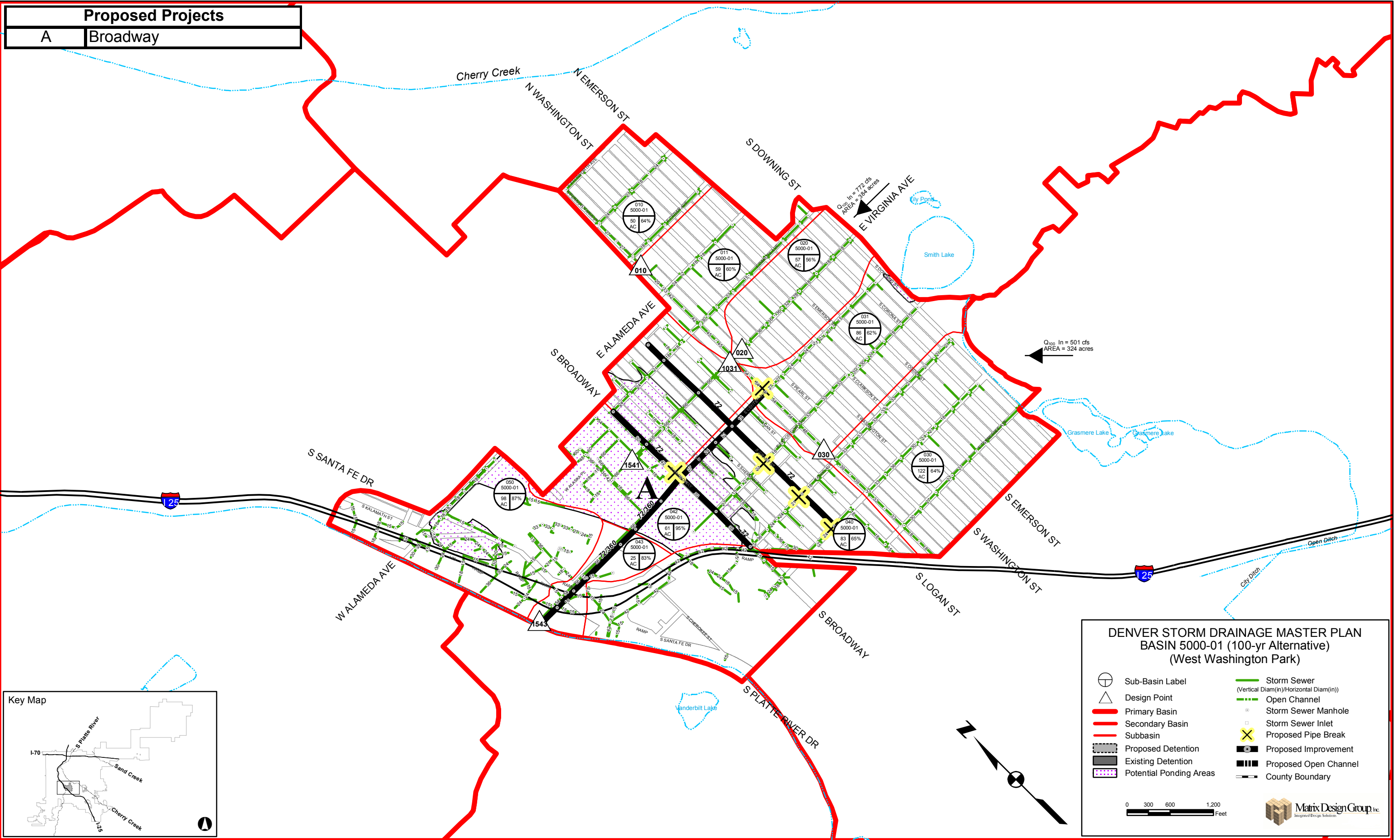
## **Basin 5000-01 (I-25 Basin) (Alternative 100-Year System)**

### **Alternative 100-Year System to Reduce the Potential Ponding:**

Ponding is predicted in the retail plaza and RTD Park-N-Ride area near Broadway and Alameda. During a 100-year storm, runoff beyond the capacity of the pipe network is imported into the basin, estimated to be 772 cfs from 384 acres. The combined effect from runoff in the 5000-01 basin and off-site flow from basin 4600-02 results in a 100-year flow of 2,558 cfs at the outfall. A 100-year drainage system must cross under I-25 and the railroad tracks; therefore, a box culvert system would be more appropriate than an open channel system. A triple 10' x 6' box culvert constructed from the outfall in the South Platte to Broadway (2,720 lf) would convey the 100-year flow. In addition, new laterals and inlets would be required to capture the 100-year runoff (see Alternative 100-Year map on the facing page).

The approximate increase in cost to raise the level of service from a 5-year system to a 100-year system and eliminate the potential ponding in the basin is \$24.1M (high cost due to jack & bore pipe under the railroad and I-25 to reach the South Platte River). The cost of the 5-year system is estimated to be \$8.8M. The total cost of the 100-year system is roughly \$32.9M. However, physical damage estimates are at least \$4.3M from a 5-year storm event, and \$9.4M from a 100-year storm event (based upon FEMA flood depth verses damage tables), which do not include indirect costs and opportunity costs.

Proposed Projects	
A	Broadway



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5000-01 (100-yr Alternative)  
(West Washington Park)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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## Basin 5000-02 (University and Mexico North)

### Existing System Description:

This basin is tributary to the South Platte River. In general this basin is located east of the South Platte River. This basin consists of 1700 acres (2.66 square miles) and includes residential and commercial properties. The outfalls include:

#### South Platte River

- I-25 Storm Tunnel 13-foot outfall with 1659 tributary acres

Much of the basin has adequate storm sewers for the 2 and 5 year return periods but lacks adequate protection for the 100-year return period.

### Drainage Deficiencies:

In sub-basin 200 there is flooding at Florida Avenue and Franklin Street on the west side of South High school. The street on the west side of South High School gets the overflow from Veterans Park. High flood flows on Florida Avenue can enter the I-25 corridor through an offset in the sound walls. The street flow depths in University Boulevard are non-compliant with Denver criteria primarily north of Iowa Avenue.

The primary problem in sub-basin 300 is the amount of flow that is carried in Mexico Avenue. The low point in the Mexico Avenue profile is at Madison Street. Stormwater flows do not release from this low point until the depth of ponding heads up enough to flow southward to Montana Place where the flow can come back to the Cook Street Intake sump. The break in the sound wall near the Cook Street intake allows for excess flow to enter the I-25 corridor when the capacity of the Cook Street Intake structure has been surcharged.

In sub-basin 400 between Evans Avenue and Warren Avenue there are non-compliant depths of street flooding. The 42-inch storm sewer in Jewell Avenue is undersized.

### Potential Ponding Areas:

An area of potential ponding has been identified within sub-basin 100 at the intersection of Tennessee and Franklin near Washington Park. Ponding occurs for storms in excess of the 5-year storm and several homes around the intersection could be inundated during a 100-year storm.

### Proposed Capital Improvements:

**Project A: Dahlia St. and Jewel Avenue** For the major storm the addition of an interceptor in Dahlia St. and Jewell Ave. that connects to the outfall at Jewell Ave. and Bellaire. The Dahlia Street Interceptor begins at Warren Avenue as a 54" RCP and increases in size to a 72" RCP at Jewell Avenue. The Jewell Avenue Interceptor is an 8'x5' box that connects to the outfall at Jewell and Bellaire. This project also includes the addition of 30" and smaller pipes in the upper reaches of the basin to meet street flow criteria for the initial storm.

**Project B: Mexico Avenue** For the major storm the addition of an interceptor in Mexico Avenue that connects to the Cook Street intake structure. The Mexico Avenue Interceptor begins on the east side of Colorado Boulevard as a 24" RCP and increases in size to a 60" RCP at Monroe Street. The interceptor then turns down Monroe Street and becomes a 72" RCP to Montana Street where it increases in size to a 7'x4' box culvert that goes down Montana to the Cook Street Intake. There is also a 48" RCP Mexico Street Interceptor coming from the west that turns down Cook Street and connects to the Cook Street Intake Structure. There will also be new inlets installed at the Cook Street Intake to pick up any surface flow in the street. This project also includes the addition of 30" and smaller pipes in the upper reaches of the basin to meet street flow criteria for the initial storm.

**Project C: South High School Detention** Install 1650 linear feet of 48" RCP and inlets in Florida Avenue east of South High School and Gaylord Street to meet criteria for the initial storm (2-year). For the major storm (100-year) the proposed project involves detention at South High School. 15 acre-feet of storage for the 100-year event is required at South High School. The outlet from the detention pond is an 8' x5' box culvert that connects to the Lafayette intake structure in Florida Avenue.

**Project D: Tennessee and Franklin** Install 660 linear feet of 18" RCP and inlets in Kentucky Avenue east of University Boulevard to meet criteria for the initial storm (2-year). For the major storm (100-year) provide no improvements to the intersection of Tennessee and Franklin and inform the residents within the ponding area of their risk of flooding. The only outflow from the inundation area at Tennessee and Franklin is the 66-inch storm sewer outfall. If the 66-inch storm sewer outfall from Washington Park were to become blocked, the inundation level would increase very little before overflowing the berm in Washington Park.

### Existing Hydrology:

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
113	101, 102, 103	371	156	271	288
115	101, 102, 103, 105, 106, 107	517	72	146	326
117	106, 107	88	44	87	235
118	101, 102, 103, 105, 106, 107	517	228	420	600
212	201, 202	129	4	51	486
213	201, 202, 203	260	39	95	293
215	204	85	82	139	304
315	301, 302, 303	108	0	0	144
317	306, 307	86	33	68	206
319	301, 302, 303, 306, 307, 308	278	106	193	655
320	301, 302, 303	108	125	195	430
413	401, 402	104	27	32	229
414	401, 402, 403, 404	338	198	376	1097
416	401, 402	104	54	83	409

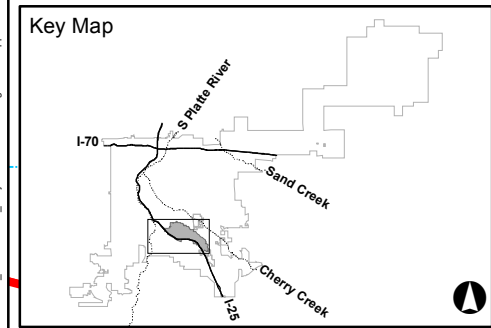
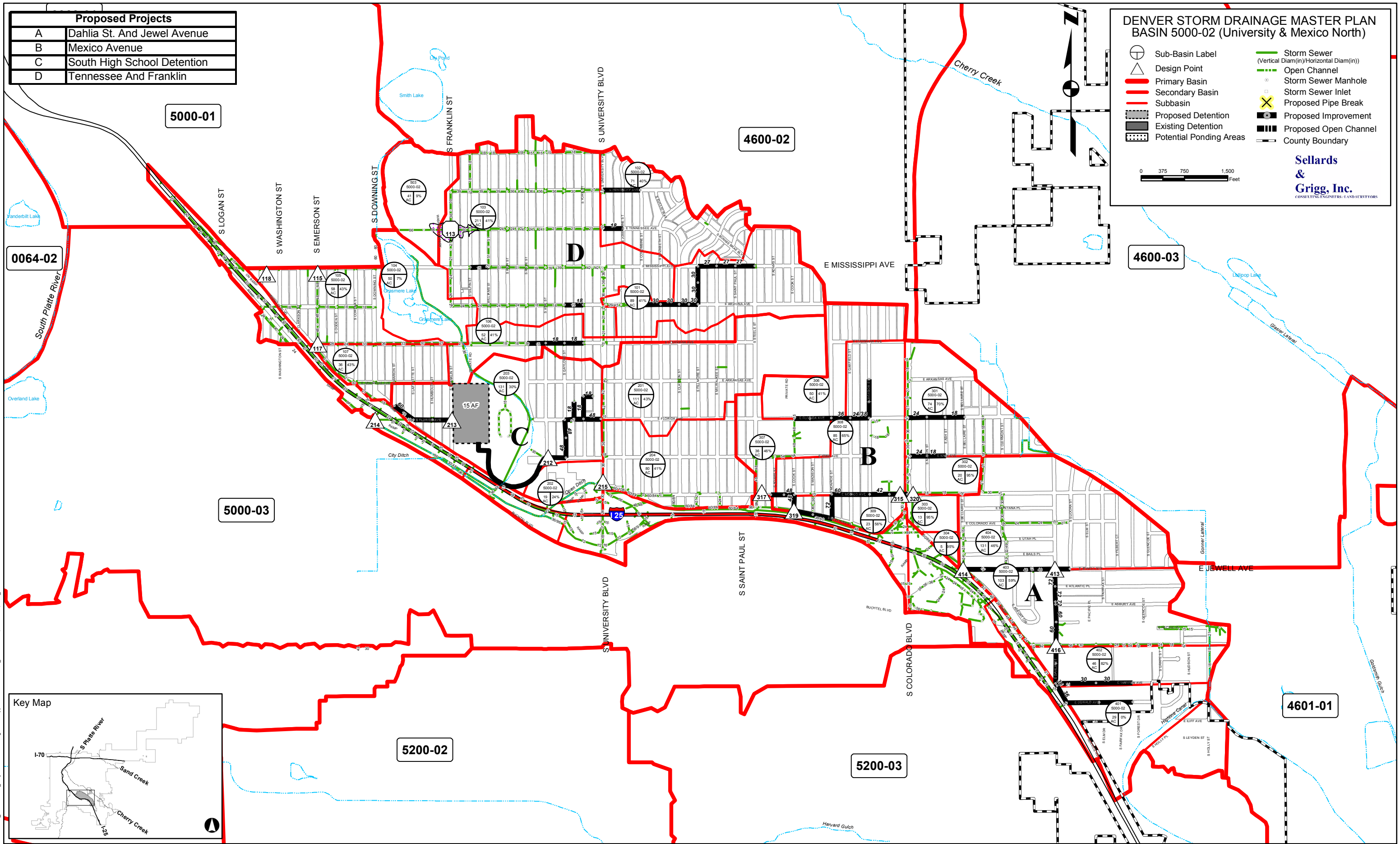
Proposed Projects	
A	Dahlia St. And Jewel Avenue
B	Mexico Avenue
C	South High School Detention
D	Tennessee And Franklin

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5000-02 (University & Mexico North)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 375 750 1,500 Feet

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## Basin 5000-03 (University and Mexico South)

### Existing System Description:

This basin is tributary to the South Platte River. In general this basin is located east of the South Platte River. This basin consists of 1571 acres (2.45 square miles) and includes residential, industrial and commercial properties. The outfalls include:

#### South Platte River

- Arizona Avenue 84-inch outfall with 560 tributary acres
- Mississippi Avenue 78-inch outfall with 572 tributary acres
- I-25 Storm Tunnel 13-foot outfall with 89 tributary acres

Smith Environmental Inc. (SEI) conducted a search of federal, state, and local environmental databases for the area within the University and Mexico Basin to identify sites where hazardous substances, petroleum products, and other deleterious substances may have been released or disposed. These environmental conditions have the potential to impact the design and construction of storm sewers, ponds, and associated structures.

The radium disposal site, SW Shattuck Chemical Company at 1805 South Bannock Street, represents the greatest concern of the high-risk sites due to its location near a proposed storm sewer corridor on Florida Avenue. The Shattuck site is currently being remediated under a Superfund action in which the radioactive materials are being excavated and hauled to an off-site disposal facility. Groundwater will not be actively remediated, but rather, the aquifer will be monitored to verify that groundwater contaminants naturally attenuate in the soils over time. The groundwater plume extends in a northwest direction towards Overland Lake and through the proposed Florida Avenue corridor. The major contaminants of concern are uranium and molybdenum. The existing storm sewer that parallels Santa Fe Drive is also known to contain contaminated water, possibly from groundwater infiltration within the Shattuck plume area. It is recommended that any new storm drains installed within or near the contaminant plume be fitted with seals to prevent groundwater infiltration.

### Drainage Deficiencies:

Broadway itself is the most significant damage corridor in the Basin. Broadway receives large storm flows from the east and the street crown for Broadway is generally at a higher elevation than the finish floor elevations for the commercial establishments on the east side of Broadway. The result is that the street crown in Broadway acts as a dam that inundates the commercial establishments along the east side of Broadway for relatively low return period events. Other areas of the basin do not meet street flow criteria for the major storm event and need to be upsized.

Sub-basin 800, which includes the Broadway Street Corridor, had additional criteria specific to the problems within the sub-basin. The additional criteria for sub-basin 800 were that no finish floors of any business along Broadway or Pearl Street would be inundated during the 100-year event. Survey data was acquired by Sellards & Grigg to determine the finish floor elevations along Broadway and Pearl Street.

### Potential Ponding Areas:

An area of potential ponding has been identified at the intersection of Williams St. and Colorado Ave. 100-year runoff to the Williams St. sump results in 4.5 feet of ponding in the sump.

An option for improving the flooding at the Williams Street sump would be to formalize the detention storage. However, the grading depth is limited to the elevation of the Williams Street lateral, only a few feet below the existing sump elevation. This would require acquisition of several properties.

The area is likely to redevelop in the near future. Proximity to the light rail station and Denver University is likely to greatly increase property values and lead to higher density development such as the existing apartment building on the northeast corner of Williams Street and Colorado Avenue. Given information of flood depths, appropriate measures can be taken to mitigate flood damages. The inundation zone could be mapped and the affected property owners could be notified of their flood risk.

### Proposed Capital Improvements:

**Project E: Sub-Basin 600 & 700 Improvements** Enlarge the inlet capacity in Milwaukee St. south of Colorado Ave. to prevent clogging and reduce flood depths. Remove cross culverts under railroad embankment. Provide an improved roadside channel along South Buchtel with regular series of inlets connected to the existing storm drainage system in South Buchtel. Remove the existing 6-ft by 3-ft box culvert outfall from Columbine St. Grade an open channel extension to the T-REX southeast University detention basin. Provide a low-head scupper type entrance to the open channel from Columbine St. Grade an overflow spillway from the Colorado Ave. pond to the open channel extension. Modify the outlet works of the Colorado Ave. pond to provide a standard water quality outlet. Upsize all pipes smaller than 18" in diameter.

**Project F: Florida Ave. Outfall** This project is a 100-year system that involves the addition of interceptors along Logan Street and Florida Avenue, trunk lines along Mexico Avenue and Pearl Street, and an outfall to the South Platte River through Overland Lake. The interceptor along Logan Street consists of conduit ranging in size from 48" RCP to 96" RCP. The interceptor along Florida Avenue consists of conduit ranging in size from 36" RCP to 8'x10' box culvert. This alternative also involves the upsizing of 2022 linear feet of 36" pipe in Broadway to 54" RCP.

Some advantages of this project are listed below:

- Meets finish floor criteria on Broadway and Pearl Street.
- Does not require any detention.
- Has the ability to provide water quality measures in Overland Lake.
- Does not require an additional outfall in Mississippi Avenue.
- Lowest cost of alternatives that do not require an additional Mississippi Avenue outfall.
- Allows for the connection of a storm sewer system that would eliminate the constant flooding problem at Bannock Street and Mexico Avenue.

### Existing Hydrology:

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
614	601, 602, 603, 604, 609	165	70	146	436
618	601, 602, 603, 604, 605, 608, 609	258	118	239	694
713	701, 703	92	40	82	70
714	701, 702, 703	164	69	112	264
904	818	182	56	121	365
909	805	270	38	77	224
956	814	52	25	57	229
961	804	353	52	106	321
1153	816	75	89	184	502
1161	803	160.9	133	209	490
1165	801	218	150	224	537
1402			24	63	250
1404	828	49	34	49	143

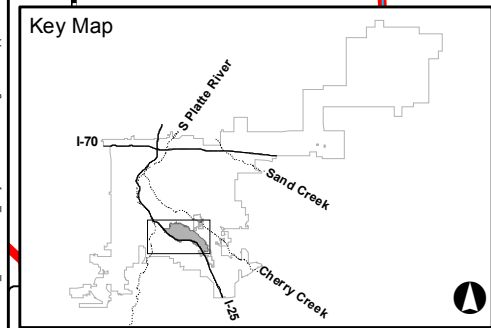
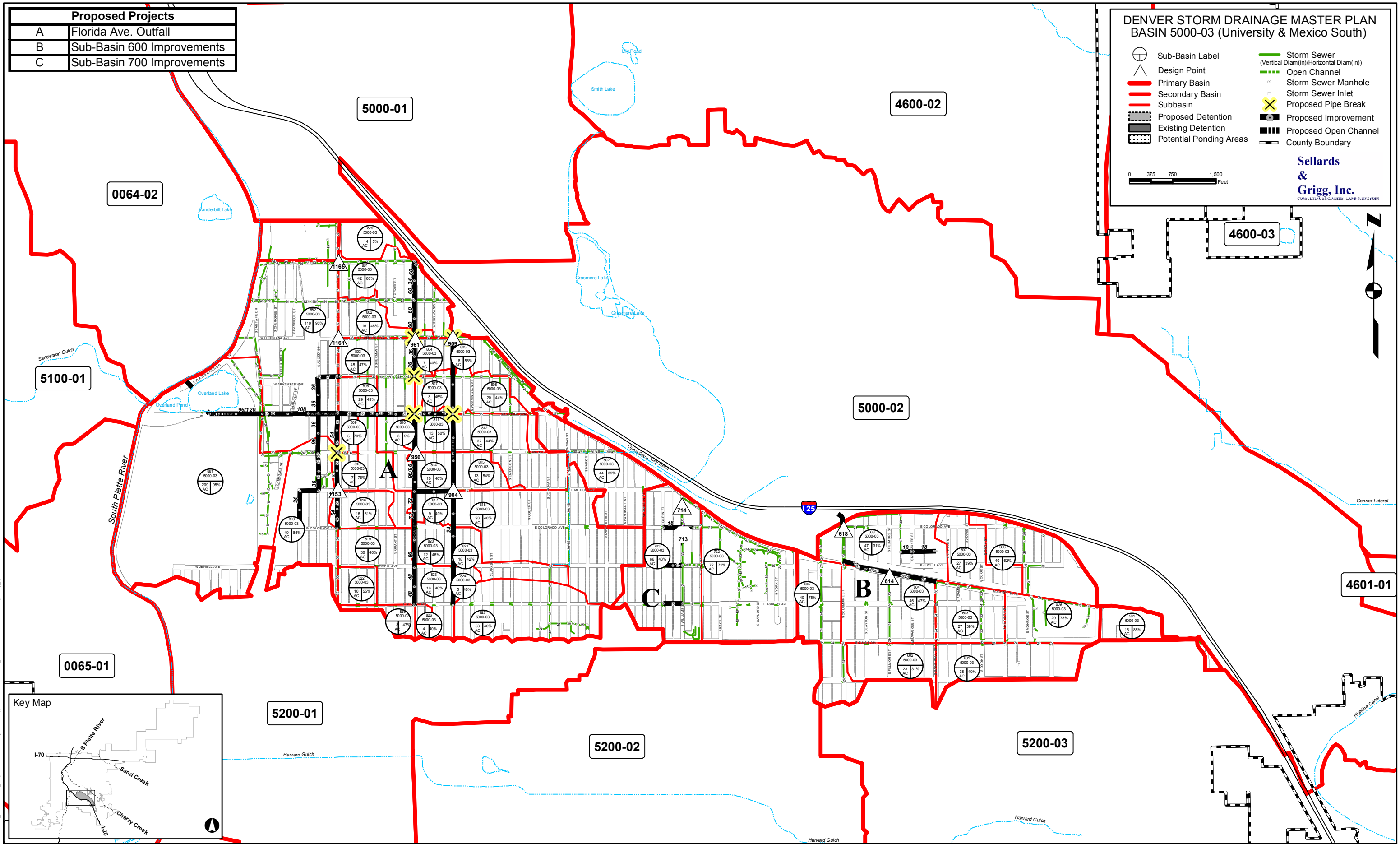
Proposed Projects	
A	Florida Ave. Outfall
B	Sub-Basin 600 Improvements
C	Sub-Basin 700 Improvements

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5000-03 (University & Mexico South)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 375 750 1,500 Feet

**Sellards & Grigg, Inc.**  
CONSULTING ENGINEERS - LAND SURVEYORS



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## Basin 5100-01 (Sanderson Gulch)

### Existing System Description:

The entire Sanderson Gulch Basin has a total drainage area of approximately 7.6 square miles. For this study, only tributary basins to Denver's system were analyzed and include approximately 5.6 square miles. Sanderson Gulch is located in the southwest metropolitan area through portions of the City & County of Denver, the City of Lakewood and Jefferson County. Sanderson Gulch starts at the top of Green Mountain and extends east to the South Platte River just north of West Florida Avenue. It drains approximately 1.4 square miles. The basin is currently fully developed and is primarily residential with some commercial.

### Drainage Deficiencies:

The existing development in this basin has encroached into the gulch creating a large number of households within the floodplain. The existing systems draining basins 670 and 680 are adequate for the 2-year storm. However, the potential for flooding of properties during the 5-year and 100-year storm is high due to the limited capacity of the drainageway.

Basin 630 drains to an existing 54-inch storm sewer within Mississippi Avenue and flows east to Pecos Street. The system then drains to Sanderson Gulch. This system is undersized for the 2-year storm event. Also, basins 405, 410, 420, 430 comprise 230 acres that is served by an existing 24-inch storm sewer system draining along Mississippi Avenue. The 2-year base flow is approximately 77 cfs. It appears that this outfall is undersized and the upstream network appears deficient for adequately intercepting flows. Basins 600 and 610 drain to an existing 18-inch storm sewer that cannot convey the 2-year storm flow of 24 cfs. Basin 260 has a 2-year base flow of 46 cfs that is drained by an existing 24-inch storm sewer that is undersized. Basins 230 and 240 comprise 108 acres that is drained by an existing 21-inch storm sewer. The storm sewer capacity is not able to handle the 2-year storm flows. Basins 320,340 and 400 comprise 392 acres and are serviced by an existing 66-inch storm sewer. The 2-year flow rate is approximately 295 cfs. The 66-inch storm sewer capacity is unable to handle this flow rate.

### Proposed Capital Improvements:

Structure improvements to the channel can reduce flood hazard areas. Proposed improvements for the channel are not included in this study.

Project A: 18-inch Upgrades This upgrade is recommended to meet the City and County of Denver's Criteria.

Project B: S. Carlan St. Outfall The outfall will provide drainage to the surrounding neighborhood and commercial areas. The upstream portion should be sized for the 5-year frequency storm. The storm sewer will extend along Arkansas Avenue to S. Carlan St. and will outfall to Sanderson Gulch.

Project C: S. Navajo St. Outfall A 5-year frequency storm sewer is required from Sanderson Gulch upstream to Mexico Ave. and Colorado Ave. Laterals will be required at each intersection as shown on the plan.

Project D: S. Federal Blvd. Outfall The outfall will be sized to handle the 5-year frequency storm. The existing storm sewer is undersized due to the commercial property that it surrounds.

Project E: S. Navajo St. Outfall requires a proposed drainage facility to serve the residential area in basin 670 and 680. The upgrade to the existing storm sewer will provide a 5-year frequency storm sewer system and meet Denver's criteria.

A new storm sewer system is proposed to collect and route flows from Mississippi Avenue directly to Sanderson Gulch along S. Clay Street and S. Zuni Street. Also, a new storm sewer system is proposed to drain basins 405,410 and 420 along Kentucky Avenue east to Lowell and outfall south to Garfield Lake.

The existing 18-inch storm sewer that drains basins 600 and 610 should be extended to the north and upsized to handle at least the 2-year event. The existing storm sewer capacity is close to handling the 2-year flow rate of approximately 295 cfs.

Project F: S. Quitman St. Improvements A proposed 24-inch storm sewer in S. Quitman will connect to the existing storm sewer at Arkansas Ave. and extend north to Arizona St. This will provide a 2-year frequency storm sewer to service the residential area.

Project G: S. Tejon St. Outfall Currently, no storm sewer exists to service the residential and commercial areas. A 5-year capacity, 48-inch storm sewer is proposed.

Project H: S. Tennyson St. Improvements A proposed 96-inch (or equivalent) storm sewer will be connected to the existing storm sewer at Florida Ave. and S. Tennyson St. The proposed storm sewer requires upsizing the existing storm sewer. The new portion will provide service to the surrounding residential area.

Project I: S. Utica Outfall The lower section of this outfall will be sized for the 5-year frequency storm. This system will accept flows from Project H and will include a new lateral extending west along Florida Ave. Both systems will be sized for the 5-year frequency storm. The existing storm sewer within Utica will be replaced.

Project J: S. Vrain St. Outfall A new storm sewer and laterals are proposed to service the surrounding neighborhood upstream of the outfall. This storm sewer can be a 2-year frequency system.

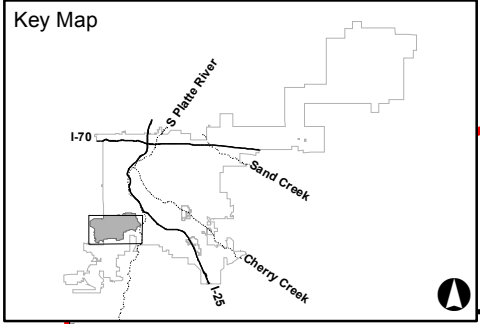
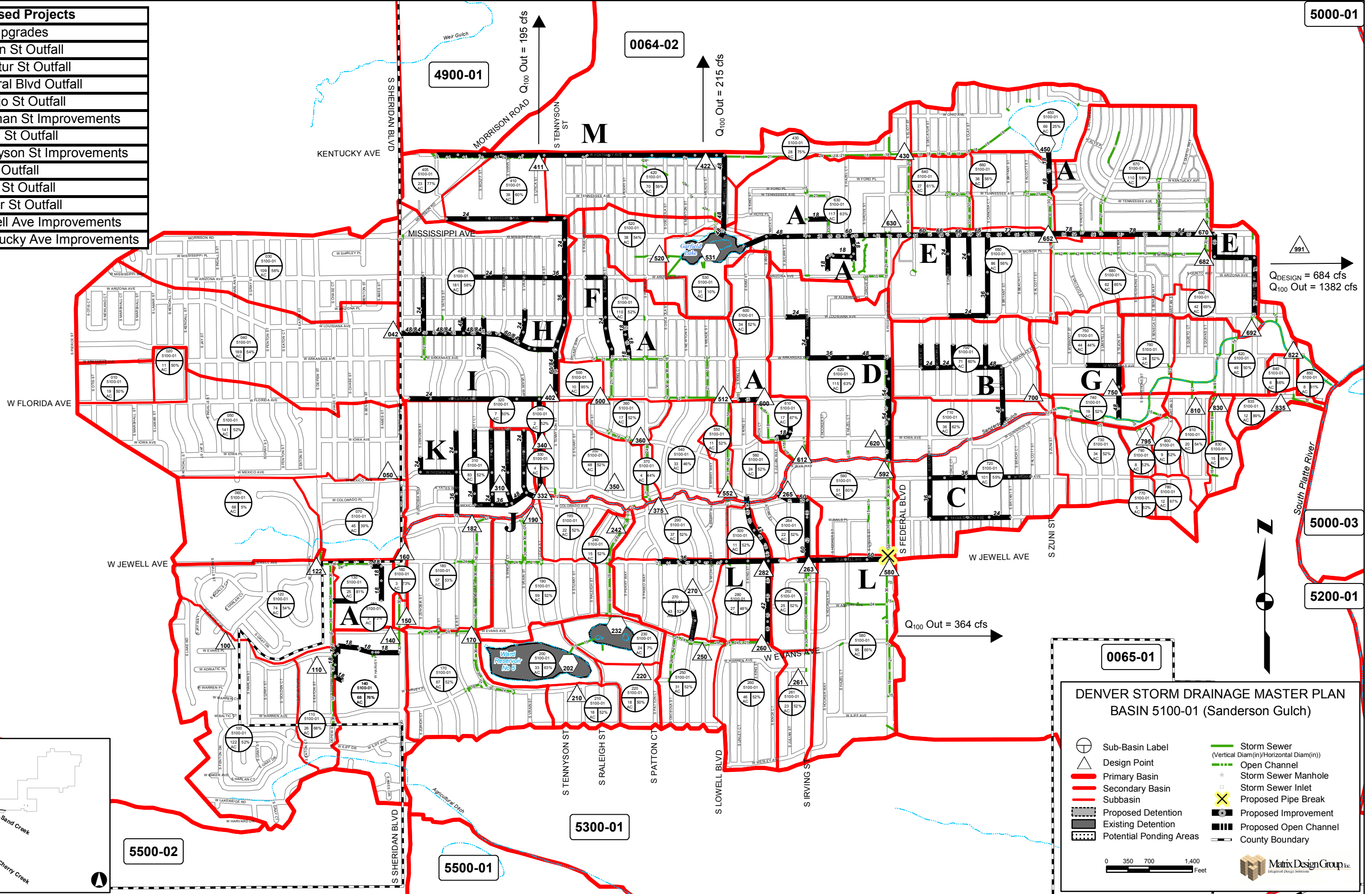
Project K: S. Xavier St. Outfall The proposed storm sewer will extend from Sanderson Gulch up to Iowa Avenue. The storm sewer will provide a 2-year level of service for the residential neighborhood. A lateral will be extended along Oregon Place to Zenobia St.

Project L: W. Jewell Ave. Improvements The proposed 54-inch outfall will upsize the existing storm sewer's capacity in Knox Ct and W. Jewell Avenue to a 5-year capacity. New 5-year capacity storm sewer is proposed to extend east along W. Jewell Ave. to Federal Blvd. A lateral from W. Jewell Ave. will outfall to Sanderson Gulch along S. Irving and W. Colorado Ave. This lateral will provide relief to the storm trunk downstream allowing for a smaller and more economical system.

Project M: W. Kentucky Ave. Outfall A new outfall system is proposed along Kentucky Ave. to intercept runoff from basins 405, 410 and 420. This system will be sized for the 5-year storm. Currently there is no existing storm sewer in Kentucky Ave. During the 100-year frequency storm however, runoff from these basins exceed the capacity in W. Kentucky Ave. and will flow to Basin 0064-02. (See the following 100-year Alternative Plan.)



Proposed Projects	
A	18 In. Upgrades
B	S Carlan St Outfall
C	S Decatur St Outfall
D	S Federal Blvd Outfall
E	S Navajo St Outfall
F	S Quitman St Improvements
G	S Tejon St Outfall
H	S Tennyson St Improvements
I	S Utica Outfall
J	S Vrain St Outfall
K	S Xavier St Outfall
L	W Jewell Ave Improvements
M	W Kentucky Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5100-01 (Sanderson Gulch)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1400 Feet

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## Basin: 5100-01 (Sanderson Gulch) 100-Year Alternative

Three 100-year conveyance alternatives are proposed for this outfall and are shown on the 100-year Alternative Plan. The property directly downstream of Mosier Place at South Quivas could be used for a 100-year regional detention pond; however, it is felt that a pond in this location would be too close to the South Platte River's 100-year floodplain to provide significant benefit since it is close to the outfall. A capital improvement plan utilizing and incorporating one of the three identified 100-year conveyance alternatives would be more cost effective than regional detention in this basin.

The three 100-year conveyance alternatives include:

**Alternative 1:** The entire 100-year flow from the tributary area upstream to Sanderson Gulch will be collected and routed through the proposed Navajo St. outfall. The open channel on the property downstream of Mosier Place and South Quivas would be filled in. The old channel thalweg is serviced by an existing storm sewer system. This storm sewer collects flow along the developed thalweg which is now Mosier Place, and is undersized for the 5-year storm. Due to the location, special consideration must be given to how storm flows will be collected and routed.

**Alternative 2:** This alternative will route flows in excess of 684 cfs directly to Sanderson Gulch through the proposed Navajo Street outfall. The storm sewer would then connect to the newly constructed 6' x 8' reinforced concrete box culvert (RCBC), which has a capacity of 684 cfs. The storm sewer will be extended from the end of the 6' x 8' RCBC through basin 0064-02 and outfall to the South Platte River as shown on the alternative plan. The existing storm sewer laterals would also be upsized as shown. Special consideration should be given to this alternative due to the proximity of the South Platte River 100-year floodplain.

**Alternative 3:** A 100-year storm sewer is proposed to intercept flow at Clay Street and at Zuni. Each lateral would be extended south and outfall directly to Sanderson Gulch. All laterals and trunk lines upstream of these two outfalls would need to be upsized. The existing system downstream could then remain in place.

All pipe sizes shown on the 100-year alternative plan are estimates. A more detailed analysis for each alternative should be completed in order to determine pipe configuration, location feasibility and costs.

### BASIN 5100-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
42	30,40	278	250	442	1145
50	10,20,50	171	104	192	508
100	100	122	92	169	437
110	110	26	26	42	101
122	100,110,120,130	246	172	308	817
140	140	68	76	118	266
150	140,150	71	81	128	284
160	140,150,160	74	80	131	301
170	170	67	46	85	221
182	170,180	125	85	154	378
190	190	59	39	72	188
202	200,210	51	45	77	192
210	210	18	15	27	71
220	220	18	13	24	64
232	200,210,220,230	92	53	91	235
242	232,240	108	57	102	273
250	250	31	21	38	100
260	250,260	77	52	89	243
261	261	23	15	28	74
263	261,262	49	33	60	146
265	261,262,264	70	45	75	201
270	270	43	30	54	141
282	250,260,270,280	147	89	161	453
310	310	83	52	95	251
332	30,40,190,320,330,340,400	531	320	572	1630
340	30,40,340,400	461	296	527	1464
350	350	48	30	55	144
360	360	17	14	26	67
375	360,370	21	16	29	77
402	30,40,400	459	296	524	1444
411	405,410	62	58	95	230
422	405,410,420	133	65	115	250
430	405,410,420,430	161	70	125	119
450	450	69	22	60	198
500	500	10	15	22	44
512	500,510	120	109	200	512
520	520	38	28	51	132
531	520,530	69	2	5	15
552	500,510,550	131	102	191	501
580	580	95	106	176	423
592	580,590	241	133	224	242
600	600	34	30	54	141
612	600,610	51	41	73	192
620	620	115	97	162	397
630	405,410,420,430,520,530,630	347	144	242	572
652	405,410,420,430,520,530,630,640,650,660	498	249	447	1199
670	405,410,420,430,520,530,630,640,650,660,670	608	314	515	1486
682	405,410,420,430,520,530,630,640,650,660,670,680	670	364	586	1680
692	405,410,420,430,520,530,630,640,650,660,670,680,690	712	327	355	451
700	700	71	59	101	250
750	750	44	30	58	162
795	770,790	13	10	18	48
810	810	20	16	28	73
822	820	55	36	66	173
830	830	15	23	33	71
835	835	12	19	28	58
991	split	split	66	288	1382



## Basin: 5200-01 (Harvard Gulch Lower Basin)

### Existing System Description:

Harvard Gulch is a right-bank tributary of the South Platte River draining a 7.5 square mile basin located in south-central Denver. According to Urban Drainage and Flood Control District (UDFCD) Drainage Basin Description Maps (UDFCD, 1990), the Harvard Gulch basin is subdivided into a lower basin and upper basin designated as 5200-01 and 5200-02, respectively. The following discussion focuses on the lower basin, followed by a discussion of the upper basin.

Land use in the 0.8 square mile lower basin is predominately residential with commercial development along major transportation corridors (Broadway and Santa Fe Drive) and industrial use between the Regional Transportation District Light Rail/Southern Pacific Railroad lines and Delaware Street. The basin is nearly fully developed with Rosedale Park and Community Gardens the only remaining significant open space. Blueprint Denver (CCD 2003) has identified a 60 acre industrial/commercial zone located between Logan and Sherman Streets for potential future redevelopment.

The Harvard Gulch major drainageway consists of a 9-foot by 14-foot buried box culvert extending easterly from the South Platte River 4,000 feet along West Wesley Avenue to Logan Street. The initial storm drain system is comprised of approximately 38,000 feet of storm sewers ranging from 15- to 60- inches in diameter that convey initial storm flows (2- or 5-year frequency events) to Harvard Gulch. Two initial storm drain systems convey flow directly to the South Platte River via outfalls located at West Asbury and West Evans Avenues.

### Drainage Deficiencies

The Harvard Gulch Flood Hazard Area Delineation Study (UDFCD, 1979) estimated that 591 parcels would be inundated by a 100-year frequency storm event due to major drainageway box culvert conveyance capacity limitations. Flooding is predicted to be shallow (less than three feet deep) and occurs along the entire Harvard Gulch drainageway and extends to the northwest as overland flow through the Overland Golf Course and to the South Platte River.

Master Plan hydrologic modeling (UDSWM) concluded that the majority of the initial storm drain system does not to meet City level of service criteria. Model results indicated extensive initial storm drain system capacity deficiencies: 56 percent could not handle the 2-year frequency storm event and 100 percent could not convey the 5-year frequency storm event. Localized flooding has also been noted at the siphons located at street intersections where capacity is periodically restricted by an accumulation of debris and sediment.

A summary of hydrologic model peak flow predictions at key basin locations is presented in the table at the end of this section.

### Proposed Capital Improvements

Drainage system improvements were developed using the City’s level of service criteria to address identified capacity deficiencies. For the major drainageway, proposed improvements were designed to provide 100-year frequency storm event level of service. For the initial storm drain system, a 2- or 5-year event level of service criteria was used to size facilities for residential or commercial/industrial land uses, respectively. Due to the lack of appropriate open land uses, initial storm drain improvements focused on upgrading conveyance capacity only, whereas major drainageway facilities considered both conveyance and detention alternatives.

Potential detention sites within the Harvard Gulch basin do not have capacity to sufficiently reduce 100-year event peak flows, resulting in the need to expand existing, major drainageway conduits. Therefore, the

detention alternative includes some conveyance system improvements. The conveyance alternative assumes that the 100-year event peak flow is fully contained to the South Platte River.

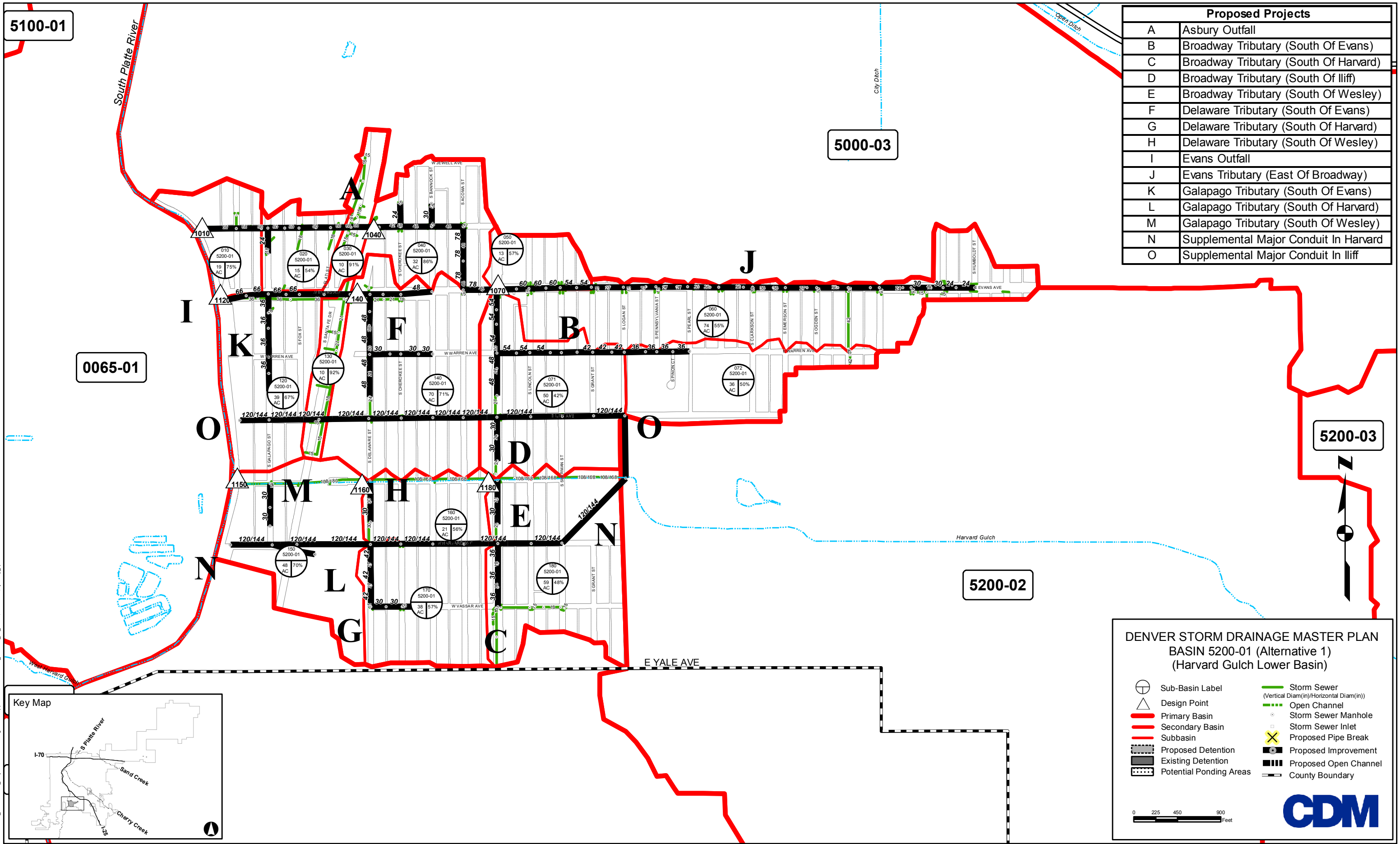
The proposed initial storm drain improvements were essentially the same for both major drainageway alternatives with minor difference in outfall alignments where they connect to the major drainageway conduits. Alternatives were evaluated based on hydraulic performance, constructability, cost, aesthetics, environmental considerations, and public safety considerations.

For the conveyance alternative, proposed improvements consist of supplementing the capacity of the existing box culvert in Wesley Avenue by constructing two new 10-foot by 12-foot box culverts, one in Harvard Avenue and the other in Iliff Avenue. These facilities are estimated to cost \$34.2 million. Approximately 24,300 feet of new and replacement pipelines are proposed for the initial storm drain system and are estimated to cost \$18.3 million. The cost opinion for the conveyance alternative (including initial storm drain facilities) total \$52.5 million.

Opportunities for detention in the Harvard Gulch basin were limited to Rosedale Park. Other sites were considered too small. A sculpted basin designed is proposed for Rosedale Park that could provide up to 45 acre feet of detention as well as enhance riparian habitat and offer a natural appearance. To meet the 100-year level of service with Rosedale Park detention, the major drainageway conveyance would need to be supplemented with a 10-foot by 14-foot box culvert in Harvard Avenue. The cost opinion for the detention facility is \$5.8 million and \$15.9 million for the new Harvard Avenue box culvert. Initial storm drain system improvements include 22,600 feet of new and replacement pipeline at an estimated cost of \$18.9 million. The detention alternative cost opinion totals \$40.6 million.

### Basin 5200-01 - Summary of Hydrologic Modeling Results

Design Point Minor Event Model	Design Point Overland Flow Model	Contributing Basin Minor Event Model	Tributary Area Minor Event Model (acre)	Peak Discharge		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
140		140	70	71	113	263
1010		1020, 10	250	151	221	652
1040		1070, 40	206	115	184	546
1070		1073, 50, 60, 71	173	94	175	496
1120		1130, 120	119	113	183	446
1150		1160, 150	3262	1102	2018	8344
1160		1180, 160, 170	3213	1093	2020	8260
1180		1080, 180	3154	1082	2032	8165



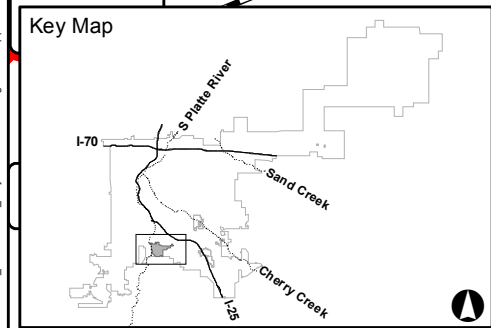
Proposed Projects	
A	Asbury Outfall
B	Broadway Tributary (South Of Evans)
C	Broadway Tributary (South Of Harvard)
D	Broadway Tributary (South Of Iliff)
E	Broadway Tributary (South Of Wesley)
F	Delaware Tributary (South Of Evans)
G	Delaware Tributary (South Of Harvard)
H	Delaware Tributary (South Of Wesley)
I	Evans Outfall
J	Evans Tributary (East Of Broadway)
K	Galapago Tributary (South Of Evans)
L	Galapago Tributary (South Of Harvard)
M	Galapago Tributary (South Of Wesley)
N	Supplemental Major Conduit In Harvard
O	Supplemental Major Conduit In Iliff

0065-01

5000-03

5200-03

5200-02



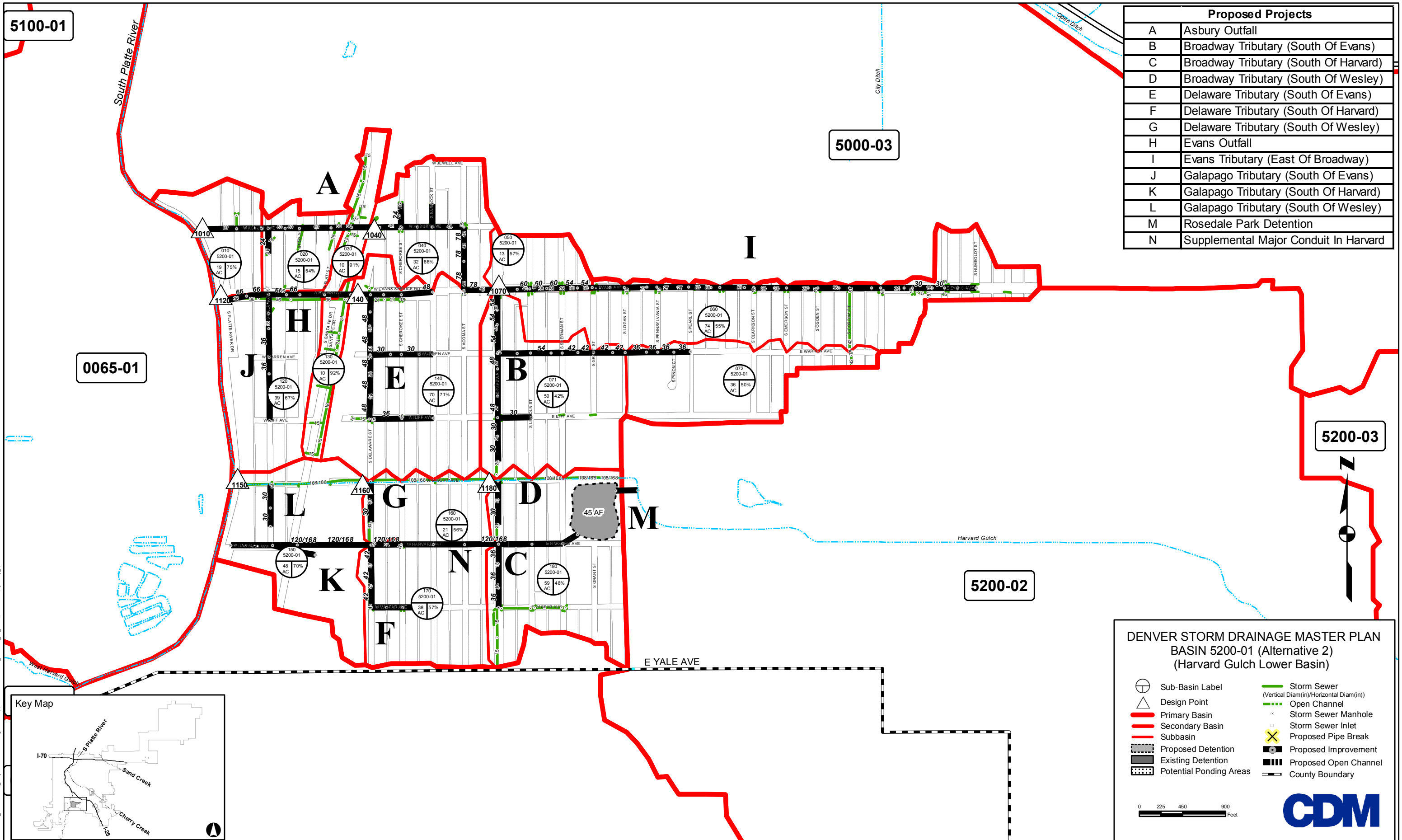
**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5200-01 (Alternative 1)  
(Harvard Gulch Lower Basin)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 225 450 900 Feet

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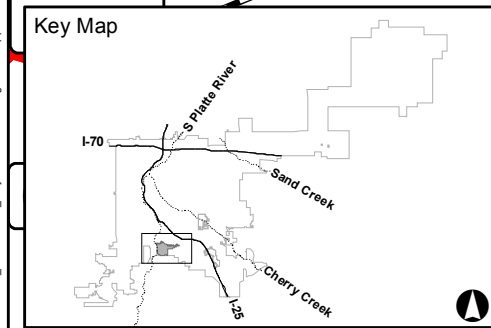


Proposed Projects	
A	Asbury Outfall
B	Broadway Tributary (South Of Evans)
C	Broadway Tributary (South Of Harvard)
D	Broadway Tributary (South Of Wesley)
E	Delaware Tributary (South Of Evans)
F	Delaware Tributary (South Of Harvard)
G	Delaware Tributary (South Of Wesley)
H	Evans Outfall
I	Evans Tributary (East Of Broadway)
J	Galapago Tributary (South Of Evans)
K	Galapago Tributary (South Of Harvard)
L	Galapago Tributary (South Of Wesley)
M	Rosedale Park Detention
N	Supplemental Major Conduit In Harvard

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5200-01 (Alternative 2)  
(Harvard Gulch Lower Basin)**

Sub-Basin Label	Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
Design Point	Open Channel
Primary Basin	Storm Sewer Manhole
Secondary Basin	Storm Sewer Inlet
Subbasin	Proposed Pipe Break
Proposed Detention	Proposed Improvement
Existing Detention	Proposed Open Channel
Potential Ponding Areas	County Boundary

0 225 450 900 Feet



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## Basin: 5200-02 (Harvard Gulch Middle Basin)

### Existing System Description:

Harvard Gulch is a right-bank tributary of the South Platte River draining a 7.5 square mile basin located in south-central Denver. According to Urban Drainage and Flood Control District (UDFCD) Drainage Basin Description Maps (UDFCD, 1990), the Harvard Gulch basin is subdivided into a lower basin and upper basin designated as 5200-01 and 5200-02, respectively. To accommodate presentation of mapping information, the upper basin (5200-02) has been divided into two basins—5200-02 and 5200-03 for mapping and display purposes. However, the following discussion focuses on drainage system description, deficiencies and proposed capital improvements for the entire upper basin.

Land use in the 6.7 square mile upper basin is primarily residential with commercial development along major transportation corridors (University Boulevard, Colorado Boulevard, Interstate Highway I-25 and Hampden, Yale, and Evans Avenues). The southern portion of the basin is located in unincorporated Arapahoe County, City of Englewood, and Cherry Hills Village. Arapahoe County enclaves exist along the eastern boundary of the upper basin (Holly Hills) and are bounded by the Harvard Gulch drainageway, Dahlia Street, and I-25. Approximately 2.0 square miles of the Harvard Gulch basin lies outside of the City and County of Denver municipal boundary.

Harvard Gulch, McWilliams, and DeBoer Parks are located along the Harvard Gulch major drainageway. Porter Hospital and Denver University campus are also located within the upper basin. Blueprint Denver (CCD 2003) has identified 168 acres that could potentially be redeveloped. These are centered in commercial areas located at Evans Avenue and Colorado Boulevard, and the area bounded by Yale Avenue to the north and Interstate-25 to the south. There is no industrial land use in the upper basin.

The upper basin includes two major drainageways: Harvard Gulch and Dry Gulch. The Harvard Gulch drainageway consists of open channel throughout Harvard Gulch Park (from Logan Street to Ogden Street), and enters a 10-foot by 14.5-foot buried box conduit extending from Ogden Street to Downing Street. Upstream of Downing Street, the major drainageway consists of approximately 12,000 feet of open channel (Sherman and Vassar Park/Harvard Gulch Golf Course, Downing Street to Jackson Street). The Dry Gulch drainageway is comprised of 700 feet of 2 parallel 43-inch by 68-inch buried elliptical pipe, and 800 feet of 72-inch buried circular pipe extending south from Harvard Gulch Park to the southern City boundary.

Approximately 94,000 feet of storm drains ranging from 12- to 84-inches in diameter convey initial storm flows to Harvard Gulch. The south and east portions of the basin is traversed by the Highline Canal which intercepts some initial storm flows from basin headwater tributaries. Stormwater runoff east of I-25 is routed to the Harvard Gulch drainageway via newly constructed facilities associated with the T-Rex improvements along I-25.

### Drainage Deficiencies

The floodplain delineated in the Harvard Gulch Flood Hazard Area Delineation study (UDFCD, 1979) estimated that 557 parcels would be inundated by a 100-year frequency storm event due to major drainageway capacity limitations. Flooding is predicted to be greater than 3 feet deep, and extends the entire Harvard Gulch and Dry Gulch drainageways within the City's municipal boundary. Fifty percent of parcels within the 100-year floodplain occur between Race Street and Ogden Street, where the channel is concrete-lined or underground. Flood problems are less frequent upstream of Ogden Street, confined primarily to adjacent properties.

Other drainageway deficiencies in Harvard Gulch occur at bridge crossings and closed conduit inlets where backwater effects create upstream flood conditions. Several flow restrictions exist in the Harvard Gulch major drainageway that cause overbank 100-year flows. These include constrictions at:

- Madison Avenue
- Entrance to the concrete trapezoidal channel at Vine Street at the west end of DeBoer Park
- Bridge crossings of the concrete trapezoidal channel from Vine Street to Downing Street
- Culvert entrance at Logan Street
- Culvert entrance at Downing Street

Many of these flow limiting facilities were sized for a 25-year event, but more recent analysis indicates capacities are closer to a 10-year event or less (UDFCD, 1978).

Master Plan hydrologic modeling (UDSWM) concluded that the majority of the initial storm drain system does not to meet City level of service criteria. Model results indicated extensive initial storm drain system capacity deficiencies: 40 percent could not handle the 2-year frequency storm event and 100 percent could not convey the 5-year frequency storm event. Localized flooding has also been noted at siphons where capacity is periodically restricted by an accumulation of debris and sediment.

A summary of hydrologic model peak flow predications at key basin locations is presented in the table at the end of this section.

### Proposed Capital Improvements

Proposed drainage system improvements were developed using the City's level of service criteria to address identified capacity deficiencies. For the major drainageways, proposed improvements were designed to convey the 100-year frequency storm event. For the initial storm drain system, a 2-year or 5-year event level of service criteria was used to size facilities for residential or commercial/industrial land uses, respectively. Initial storm drain improvements focused on upgrading conveyance capacity only, whereas major drainageway facilities considered both conveyance and detention alternatives.

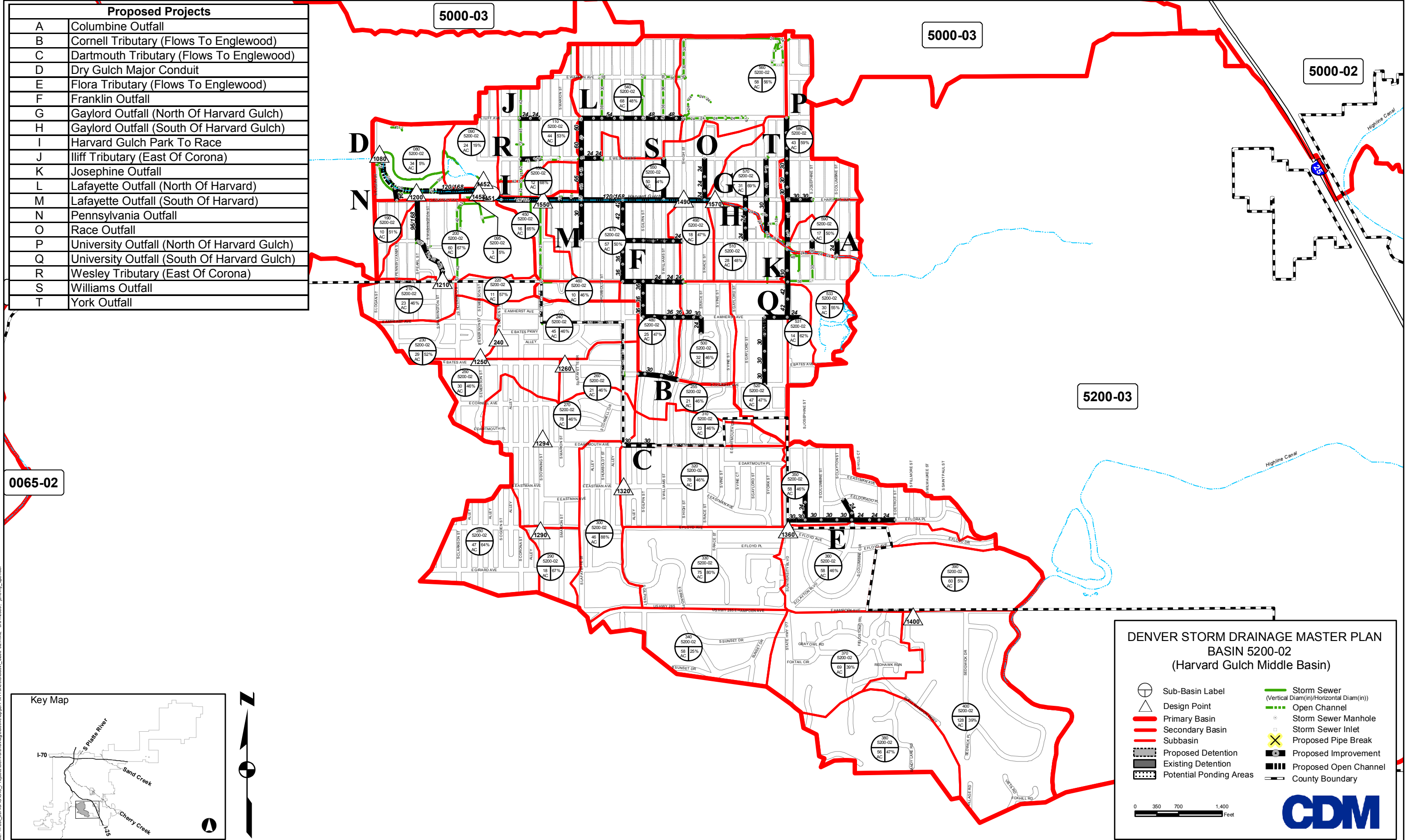
Detention sites initially considered in the upper basin included Harvard Gulch Park, Robert McWilliams Park, University Hills Shopping Center, Thomas Jefferson High School, University Park Elementary School, Observatory Park, Wellshire Golf Course, and Buell Mansion, but these sites do not have sufficient capacity to adequately reduce 100-year event peak flows. Redevelopment of Harvard Park to incorporate detention was considered to be cost prohibitive and too disruptive to current public activities to be feasible at this time.

However, improvements to Skeel Reservoir were considered, including embankment, spillway, and outlet improvements to capture and store 100-year storm runoff from both upstream tributary areas and a controlled overflow from the Highline Canal without overtopping the dam embankment or discharging through the emergency spillway. Proposed Skeel Reservoir improvements total \$1.5 million and were included as a component of the conveyance alternative.

The conveyance alternative assumes that the 100-year event peak flow is fully contained to the South Platte River. Alternatives were evaluated based on hydraulic performance, constructability, cost, aesthetics, environmental considerations, and public safety considerations. Several improvements are required for the Harvard Gulch major drainageway in the upper basin. Additional conveyance capacity is required in the reach from Vine Street to Harvard Gulch Park and along Dry Gulch.



Proposed Projects	
A	Columbine Outfall
B	Cornell Tributary (Flows To Englewood)
C	Dartmouth Tributary (Flows To Englewood)
D	Dry Gulch Major Conduit
E	Flora Tributary (Flows To Englewood)
F	Franklin Outfall
G	Gaylord Outfall (North Of Harvard Gulch)
H	Gaylord Outfall (South Of Harvard Gulch)
I	Harvard Gulch Park To Race
J	Iliff Tributary (East Of Corona)
K	Josephine Outfall
L	Lafayette Outfall (North Of Harvard)
M	Lafayette Outfall (South Of Harvard)
N	Pennsylvania Outfall
O	Race Outfall
P	University Outfall (North Of Harvard Gulch)
Q	University Outfall (South Of Harvard Gulch)
R	Wesley Tributary (East Of Corona)
S	Williams Outfall
T	York Outfall



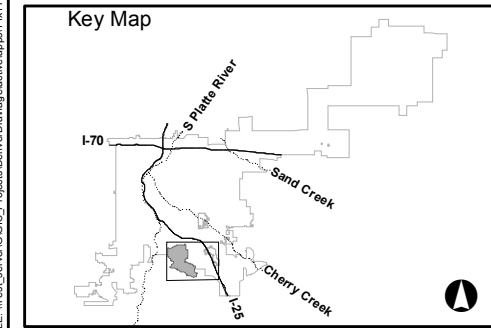
0065-02

5000-03

5000-03

5000-02

5200-03



**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 5200-02**  
 (Harvard Gulch Middle Basin)

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet

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### Basin: 5200-03 (Harvard Gulch Upper Basin, cont.)

(Continued from 5200-02 to accommodate presentation of mapping information, the upper basin (5200-02) has been divided into two basins—5200-02 and 5200-03. However, the following discussion is a continuation of the drainage system description, deficiencies and proposed capital improvements for the entire upper basin.)

Proposed improvements along the drainageway are estimated to cost \$28.8 million and consist of the following:

- Replacing the concrete channel between Race Street to Downing Street, the closed conduit from Downing Street to Ogden Street, and the natural channel 1000-feet east of Ogden Street (in Harvard Gulch Park) with a double 10-foot by 14-foot conduit (\$21.8 million). Replacing the natural channel in Harvard Gulch Park with 1000-feet of closed conduit will allow three acres of park land to be reclaimed for public use, and will eliminate the need for a walled, concrete-lined channel.
- Approximately 1,500 feet of the Dry Gulch drainageway extending from Yale Avenue to Harvard Avenue will be replaced with a 8-foot by 14-foot major conduit. A composite channel and two drop structures in Harvard Gulch Park are required to accommodate these proposed improvements (\$7.0 million).

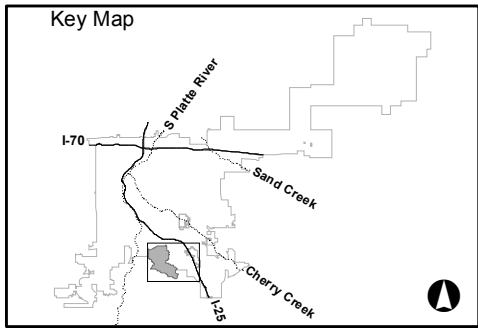
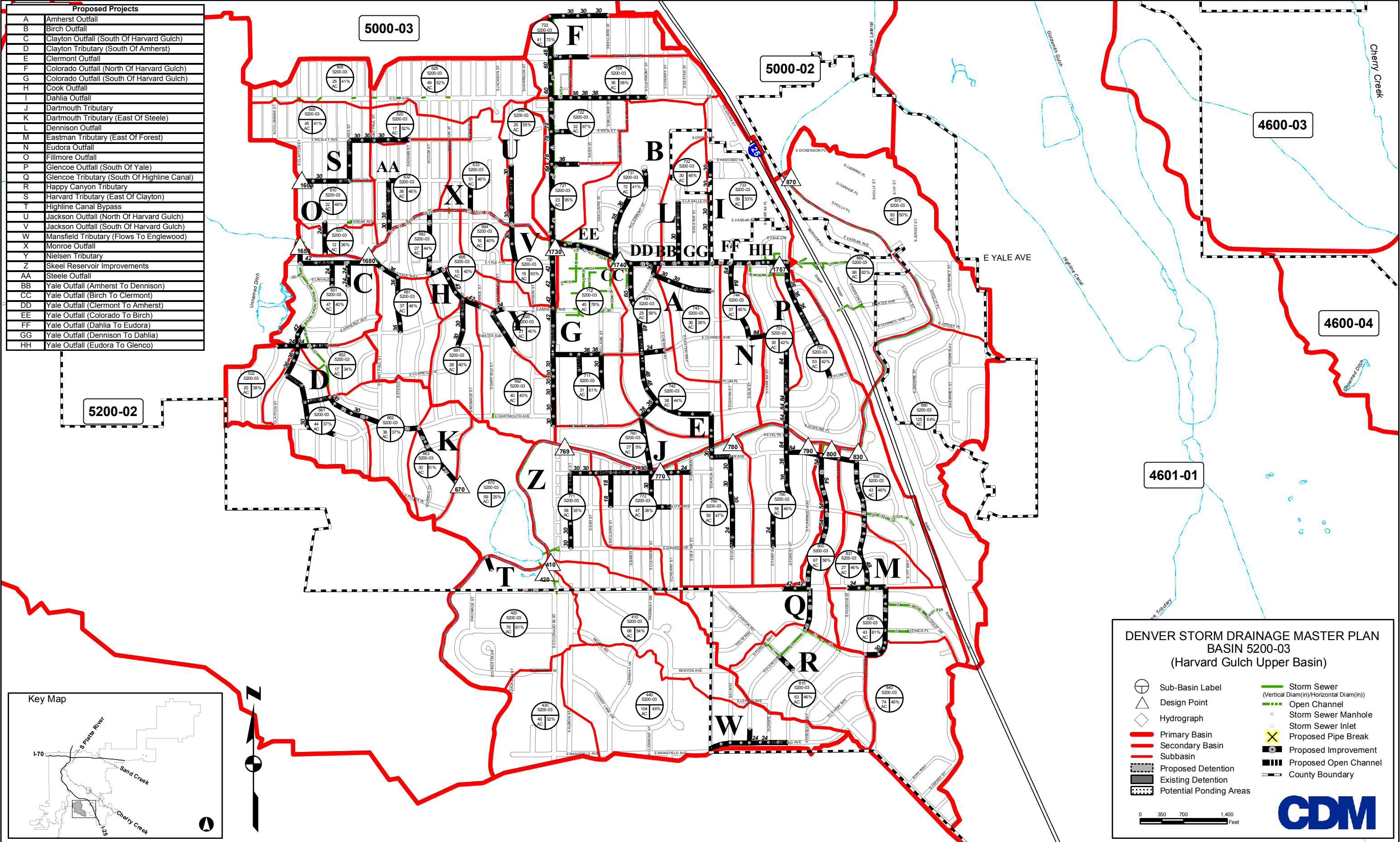
In addition, localized flooding upstream of Vine Street could be reduced by continuing the channel dredging project currently being conducted by the City and the Urban Drainage and Flood Control District.

New initial storm drain systems are proposed for many of the unsewered subbasins. The initial storm drain system is required to intercept flows upstream of the Highline Canal and convey them across the Highline Canal and directly to the major drainageway. Approximately 95,400 feet of new and replacement pipes are proposed for the initial storm drain system, at an estimated cost of \$48.4 million. The conveyance alternative is estimated to cost \$78.7 million.

**Basin 5200-02 and 5200-03 – Summary of Hydrologic Modeling Results**

Design Point Minor Event Model	Design Point Overland Flow Model	Contributing Basin Minor Event Model	Tributary Area Minor Event Model (acre)	Peak Discharge		
				2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
240		240	45	27	53	146
410		410	68	40	72	304
420		420	79	74	125	163
769		771	58	23	50	N/A
770		772	47	23	49	235
780		780	59	42	80	220
790		790	59	34	65	178
800		810,800	131	74	124	348
830		832, 1822	188	114	211	568
870		870	93	100	186	504
1080		1190, 80	3095	1068	2049	8087
1200		1096, 1090, 1210, 200	3052	1077	2046	8010
1210		1230, 210, 220	1034	378	742	2934
1250		1270, 250, 1260	926	361	688	2773
1260		255, 260	42	24	47	133
1290		280, 290	65	64	106	255
1294		1292, 310	776	330	595	2438
1320		1330, 320	641	225	482	2121
1360		1390, 350, 360, 1370	487	150	358	1759
1400		380, 400	184	66	140	1054
1451		1450	1875	723	1428	5237
1452		1451	0	0	139	2218
1453		1451	1875	723	1289	3019
1490		1570, 490, 500	1590	649	1288	4769
1550		1540, 470, 550, 480, 1490	1850	718	1407	5172
1570		1590, 510, 570, 520	1540	633	1257	4676
1600		605, 620, 600	137	76	145	303
1650		631, 1680, 610, 651, 1662	1330	593	1160	4309
1680		1690, 1686, 682, 632	905	477	886	3614
1730		1740, 731, 712, 1762, 721	610	389	692	2984
1740		1752, 1743, 741	309	190	342	1771
1757	1750	349, 752	53	89	111	1347

Proposed Projects	
A	Amherst Outfall
B	Birch Outfall
C	Clayton Outfall (South Of Harvard Gulch)
D	Clayton Tributary (South Of Amherst)
E	Clermont Outfall
F	Colorado Outfall (North Of Harvard Gulch)
G	Colorado Outfall (South Of Harvard Gulch)
H	Cook Outfall
I	Dahlia Outfall
J	Dartmouth Tributary
K	Dartmouth Tributary (East Of Steele)
L	Dennison Outfall
M	Eastman Tributary (East Of Forest)
N	Eudora Outfall
O	Fillmore Outfall
P	Glencoe Outfall (South Of Yale)
Q	Glencoe Tributary (South Of Highline Canal)
R	Happy Canyon Tributary
S	Harvard Tributary (East Of Clayton)
T	Highline Canal Bypass
U	Jackson Outfall (North Of Harvard Gulch)
V	Jackson Outfall (South Of Harvard Gulch)
W	Mansfield Tributary (Flows To Englewood)
X	Monroe Outfall
Y	Nielsen Tributary
Z	Skeel Reservoir Improvements
AA	Steele Outfall
BB	Yale Outfall (Amherst To Dennison)
CC	Yale Outfall (Birch To Clermont)
DD	Yale Outfall (Clermont To Amherst)
EE	Yale Outfall (Colorado To Birch)
FF	Yale Outfall (Dahlia To Eudora)
GG	Yale Outfall (Dennison To Dahlia)
HH	Yale Outfall (Eudora To Glencoe)



**DENVER STORM DRAINAGE MASTER PLAN**  
**BASIN 5200-03**  
 (Harvard Gulch Upper Basin)

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Hydrograph		Storm Sewer Manhole
	Primary Basin		Storm Sewer Inlet
	Secondary Basin		Proposed Pipe Break
	Subbasin		Proposed Improvement
	Proposed Detention		Proposed Open Channel
	Existing Detention		County Boundary
	Potential Ponding Areas		

0 350 700 1,400 Feet

## Basin: 5300-01 (West Harvard Gulch)

### Existing System Description:

The West Harvard Gulch Basin has a total drainage area of approximately 1.4 square miles. West Harvard Gulch flows east through Denver to its confluence with the South Platte River. The basin elevations range from 5525 feet to 5250 feet. East of Zuni Street, West Harvard Gulch is within Englewood. The basin is currently fully developed with the exception of a few scattered vacant lots. Ruby Hill borders West Harvard Gulch directly to the north and Dartmouth borders West Harvard Gulch directly to the south.

### Drainage Deficiencies:

The existing development in this basin extends to the edge of the gulch creating a large number of households within the floodplain. Basins 10 and 30 totaling 53 acres drains to an existing 21-inch storm sewer that exceeds the 2-year flow capacity of 25 cfs. A relatively flat residential/commercial area along Yale and Amherst Avenues currently has no storm sewer facilities.

### Proposed Capital Improvements:

Project A: 18-inch Upgrades The upgrades are proposed to meet minimum storm sewer size criteria.

Project B: S. Federal Blvd. Improvements An existing storm sewer system within South Green Court is undersized for the 2-year storm. A 24-inch to 30-inch, 2-year capacity storm sewer is proposed to convey storm flows to West Harvard Gulch. Upsizing the storm sewers shown on the plan within Federal Boulevard will increase capacity to the 5-year storm.

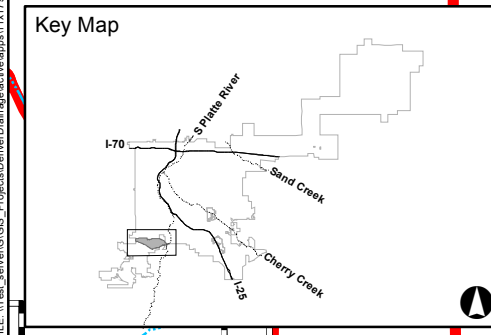
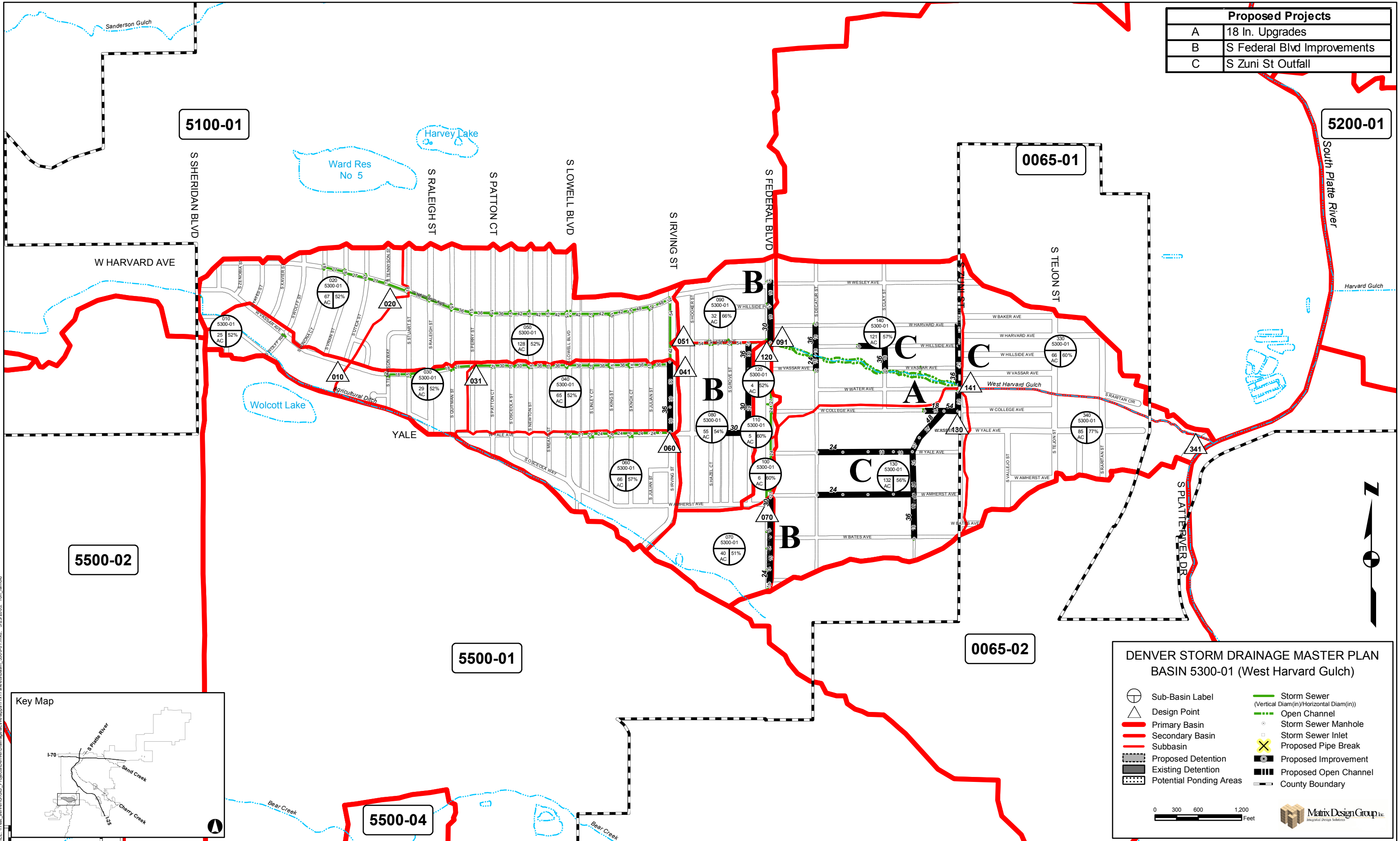
Project C: S. Zuni St. Outfall A new outfall facility to serve the residential area in Basin 130 and 140 is proposed to adequately drain the area and meet the City and County of Denver's criteria. The new system would be a 5-year capacity storm sewer and would include S. Decatur Street and S. Clay Street outfalls.

### Existing Hydrology:

#### BASINS 5300-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	25	16	30	78
20	20	67	42	77	203
31	10,30	53	34	61	167
41	31,40	118	107	194	535
51	41,50	246	218	402	1050
60	60	66	51	89	224
70	70	40	29	53	142
91	51,70,80,90,100,110,120	572	298	551	1499
100	70,100	46	32	60	164
120	70,100,110,120	95	39	68	189
130	130	132	108	191	481
141	130,140	825	399	721	2098
341	141,330,340	976	468	843	2439

Proposed Projects	
A	18 In. Upgrades
B	S Federal Blvd Improvements
C	S Zuni St Outfall



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## Basin: 5401-01 (Greenwood Gulch)

### Existing System Description:

This basin drains to Greenwood Gulch via Prentice Gulch in Greenwood Village. The basin generally follows Monaco Street from Union Avenue on the north to Belleview Avenue on the south. The basin is located in the southwestern corner of the Denver city limits and is generally known as “The 165 Subdivision.” The basin is primarily comprised of business and commercial buildings with lesser amounts of multi-family residential in the north part of the basin. There is an existing golf course in the east part of the basin.

There are major existing storm sewer trunk systems in Monaco Street that convey flows from the east to three separate detention ponds on the western edge of the basin. The storm sewer system branches up Belleview Avenue and Union Avenue. Approximately half of the basin is currently undeveloped with plans to develop in the near future. The existing Mountain View Golf property is currently being studied as part of the proposed Belleview Station Transit Oriented Development project. The golf course will be developed into very high-density residential, commercial and retail parcels in the future. Improvements to the detention pond at Monaco and Belleview will be made when the Belleview Station TOD property is developed.

### Drainage Deficiencies:

The storm sewer system in Monaco Street appears adequate for conveying flows to the existing detention ponds. There appear to be no significant drainage problems with the systems.

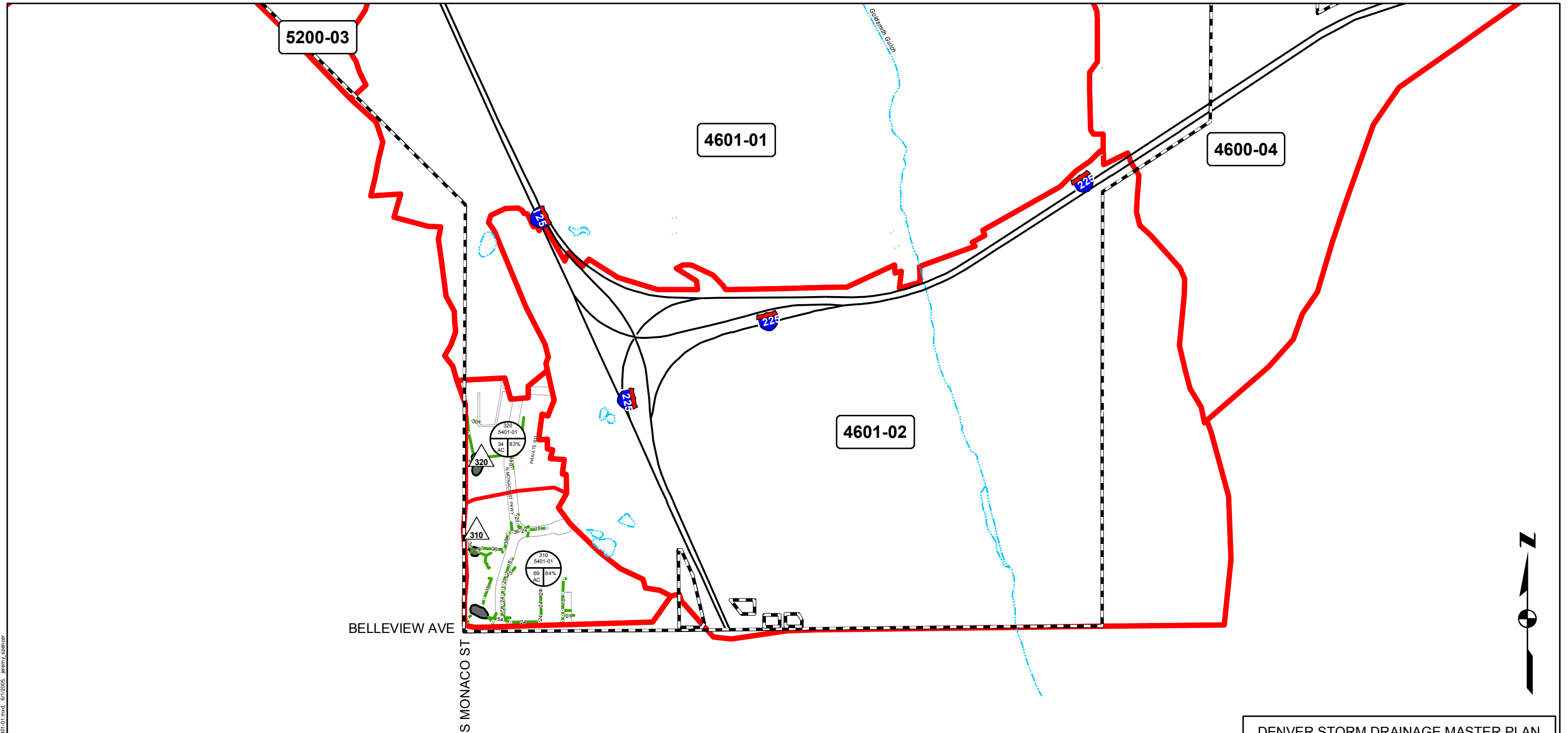
### Proposed Capital Improvements:

There are no required improvements for this basin.

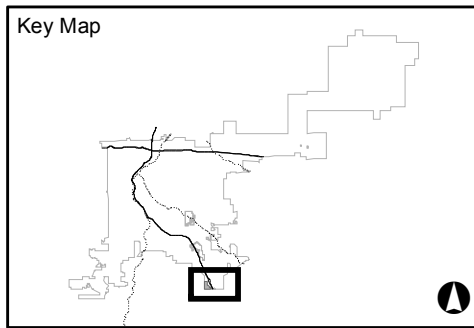
### Existing Hydrology:

#### BASIN 5401-01

Design Point	Contributing Basins	Tributary Area	Peak Discharge		
			2-Year	5-Year	100-Year
		(acres)	(cfs)	(cfs)	(cfs)
310	310	69	72	110	234
320	320	36	52	79	168



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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5401-01 (Greenwood Gulch)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

## Basin: 5500-01 (Bear Creek - Fort Logan)

### Existing System Description:

This basin begins at the confluence of Bear Creek with the South Platte River. The western side of the basin is bounded by Sheridan Boulevard. The basin extends north and south from the banks of Bear Creek. Travel distances are generally less than 1½ miles. Much of the upper basin is comprised of residential neighborhoods. Fort Logan comprises much of the central portion of the basin. Fort Logan includes cemetery facilities, undeveloped tracts and the medical facilities centered around the intersection of Lowell Boulevard and Oxford Avenue. Much of the lower portion of the basin is located within the City of Sheridan. The lower portion of the basin is made up residential areas, and commercial and industrial facilities. The existing drainage conditions are shown on the basin work map.

### Drainage Deficiencies:

- Lowell Boulevard north of Kenyon Avenue receives runoff from approximately 252 tributary acres but does not have a formalized storm sewer system.
- The Utica Street Storm Sewer (DP 380) has capacity for the 2-year event; however, flows are backing up against the embankment for Hampden Avenue warranting a 5-year system in this location.
- The system draining basins 400, 420, and 430 (179 acres) in Knox Court is undersized and cannot convey the 5-year flow of 211 cfs (element 1430). The system currently has capacity for approximately 100 cfs.
- Extensive portions of residential areas in the northwest area of the basin lack formalized storm sewer systems. The roadways are relatively steep allowing for good stormwater conveyance, but nuisance flows traveling long distances could pose a problem.
- Flows from basins 21, 22, and 23 cross over Kenyon Avenue and onto the Mullen High School property. Flows from this basin are very small (21 cfs for the 5-year), however, they may be a nuisance as they cross over Kenyon Avenue without any structure and directly flow to Mullen High School.
- 

### Proposed Capital Improvements:

Project A: 18-Inch Upgrades Upsizing various pipes to the city’s 18-inch minimum diameter is proposed to meet current drainage criteria.

Project B: S. Lowell Blvd. Outfall A 72” storm sewer is proposed along Lowell Boulevard to accept runoff from the eastern portion of Ft. Logan Cemetery. The system should collect flows from the Cemetery’s proposed open channel currently under construction.

Project C: S. Utica St Improvements Up-sizing the crossing of Hampden Avenue at Utica Street to a 78” conduit will provide a 5-year level of service.

Project D: W. Amherst Ave. Improvements Small 18” laterals are proposed along Amherst Ave., Stuart St., and Patton Ct. to convey nuisance flows through residential areas.

Project E: Ft. Logan Cemetery Improvements Multiple improvements are proposed by the Ft. Logan National Cemetery as part of their 2003 redevelopment plan. The improvements include re-grading the site to restore historic drainage patterns, two new detention ponds, and conveyance channels and pipes. The improvements are designed for the 100-year event and are currently under construction (2004).

Project F: Vrain St. Improvements An existing pipe at the north end of Vrain Street should be upsized to a 48” system to convey the 2-year event to Ft. Logan Cemetery.

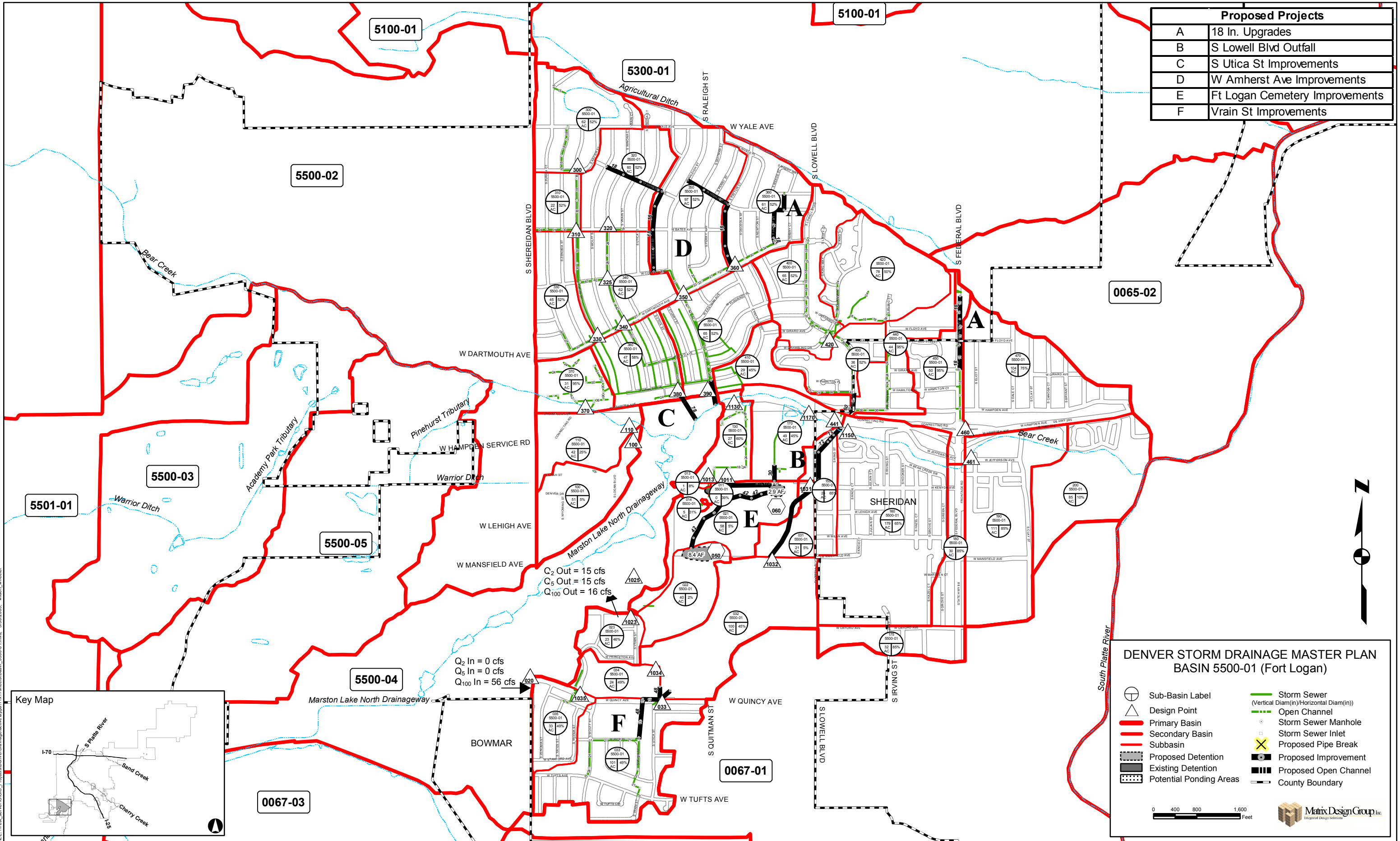
### Existing Hydrology:

#### BASIN 5500-01

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
33	33	101	71	133	356
50	22,23	63	0	8	12
60	21,22,23	121	3	22	82
100	100	59	3	32	135
110	110	42	13	34	113
300	300	62	43	78	205
310	300, 310	84	57	106	281
320	320	60	42	76	198
325	300, 310, 320	144	90	166	466
330	330	45	30	55	143
340	300, 310, 320, 330, 340	250	152	280	787
350	350, 360	159	115	211	546
360	360	61	40	73	193
370	370	31	53	75	150
380	300, 310, 320, 330, 340, 380 (diversion)	297	184	328	913
390	350, 360, 390 (diversion 300, 310, 320, 330, 340, 380)	521	199	454	1476
420	400, 420	143	97	179	471
430	400, 420, 430	179	114	218	596
441	400, 410, 420, 430, 440	252	182	319	842
1011	11	0.34	0	0	2
1013	13,14	0.51	0	0	5
1023	23	23	15	29	80
1031	31,32,34,35,220	252	131	268	862
1032	32,34,35,220	231	131	266	820
1034	34,35,220	131	108	206	602
1035	220,35	107	23	42	171
1130	11,13,14,130	28	32	56	139
1150	31,32,34,35,150,220	276	136	282	898
1170	21,22,23,170	170	34	68	203

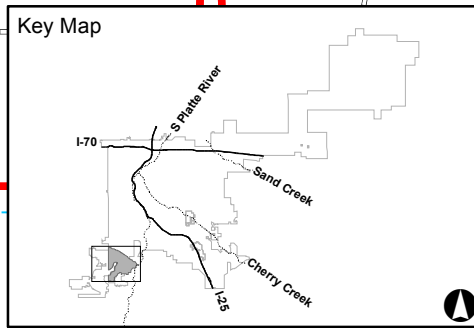


Proposed Projects	
A	18 In. Upgrades
B	S Lowell Blvd Outfall
C	S Utica St Improvements
D	W Amherst Ave Improvements
E	Ft Logan Cemetery Improvements
F	Vrain St Improvements



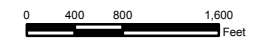
Q<sub>2</sub> Out = 15 cfs  
 Q<sub>5</sub> Out = 15 cfs  
 Q<sub>100</sub> Out = 16 cfs

Q<sub>2</sub> In = 0 cfs  
 Q<sub>5</sub> In = 0 cfs  
 Q<sub>100</sub> In = 56 cfs



**DENVER STORM DRAINAGE MASTER PLAN  
 BASIN 5500-01 (Fort Logan)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin: 5500-02 (Upper Bear Creek)

### Existing System Description:

This basin drains to Bear Creek and is generally bound by Lakeridge Road in Lakewood on the north, Quincy Avenue on the south, Wadsworth Boulevard on the west, and Sheridan Boulevard on the east. The land use within the basin is comprised of a mixture of single family residential, multi family residential, commercial, school, parks, and Pinehurst Country Club.

### Drainage Deficiencies:

The majority of this basin is newer construction compared to other areas of Denver. Most deficiencies are relatively minor and cause only nuisance flow problems.

### Proposed Capital Improvements:

Project A: 18-Inch Upgrades Upsizing various pipes to the city’s 18-inch minimum diameter is proposed to meet current drainage criteria.

Project B: S. Newland Street Outfall A 24” to 36” system is proposed in Newland Street to convey nuisance flows through residential areas.

Project C: S. Sheridan Blvd. Outfall A new/upsized outfall is proposed in Sheridan Boulevard extending up to Yale Avenue. The system will convey the 2-year storm through mostly residential areas.

Project D: S. Webster St. Outfall Collecting a large tributary drainage area from an undeveloped portion of Lakewood, the existing storm sewer in Webster Street should be upsized and extended from a 30” system to a 60” system. The proposed storm sewer will better serve both residential and commercial areas east of Wadsworth Boulevard.

Project E: W. Bates Ave. Improvements Minor lateral extensions are proposed along Bates Avenue to address localized street flows in residential areas.

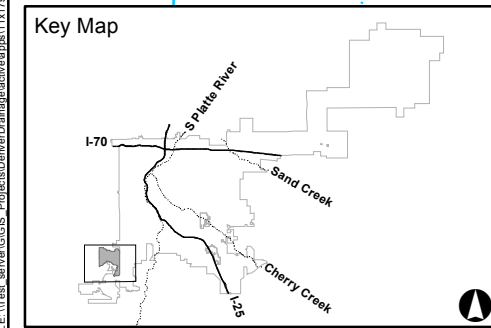
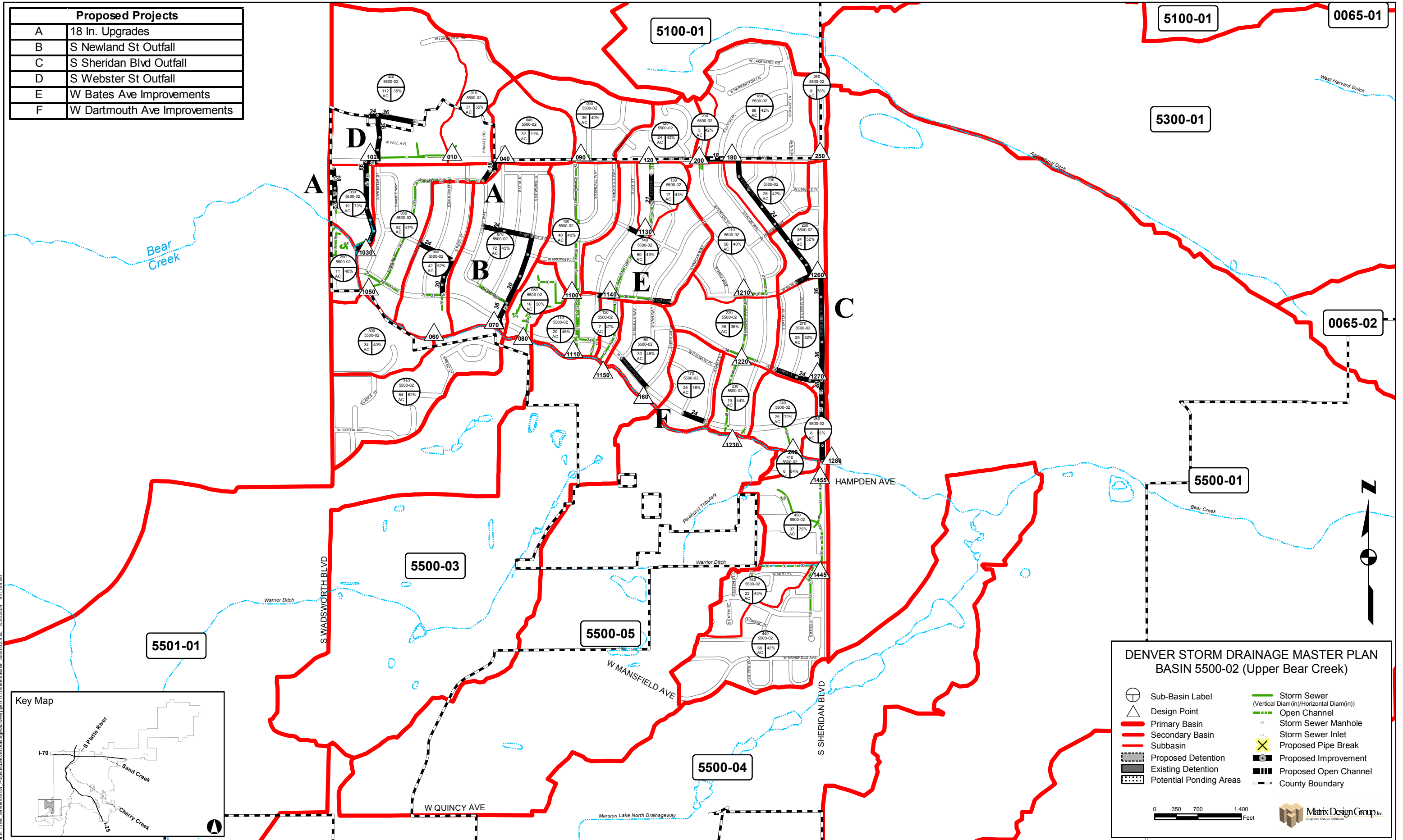
Project F: W. Dartmouth Ave. Improvements Minor lateral extensions are proposed along Dartmouth Avenue to address localized street flows in residential areas.

### Existing Hydrology:

**HYDROLOGIC SUMMARY TABLE: BASIN 5500-02**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	31	16	35	104
40	40	32	7	22	78
60	60	42	28	52	136
70	70	72	41	81	222
80	80	16	13	23	62
90	90	36	19	38	112
140	140	60	31	65	187
160	160	30	20	39	107
180	180	68	35	71	201
200	200	5	3	6	17
250	250	8	8	14	32
1020	10, 20	143	81	174	521
1030	10, 20, 30	162	94	200	582
1050	40, 50	84	32	66	188
1100	90, 100	76	38	80	225
1110	90, 100, 110	96	50	99	291
1130	120, 130	41	23	47	134
1150	120, 130, 140, 150	108	52	107	325
1210	180, 190, 200, 210	149	69	142	430
1220	180, 190, 200, 210, 220	185	83	173	528
1230	180, 190, 200, 210, 220, 230	204	82	171	562
1260	250, 260	32	25	44	113
1270	250, 260, 270	61	40	75	205
1280	250, 260, 270, 280	69	40	75	219
1445	430, 440	92	45	90	258
1455	430, 440, 450	129	84	140	388

Proposed Projects	
A	18 In. Upgrades
B	S Newland St Outfall
C	S Sheridan Blvd Outfall
D	S Webster St Outfall
E	W Bates Ave Improvements
F	W Dartmouth Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5500-02 (Upper Bear Creek)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1400 Feet

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Integral Design Solutions

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## Basin: 5500-03 (Academy Park Tributary)

### Existing Basin Description:

The Academy Park Tributary Watershed is a developed area in the southwestern portion of the Denver metropolitan area adjacent to the intersection of South Wadsworth Boulevard and Hampden Avenue (Highway 285). Three governmental entities; the City of Lakewood, the City and County of Denver, and Jefferson County each have jurisdiction over a portion of this watershed. Wadsworth Boulevard and Hampden Avenue are both very large streets in this area and both serve as drainage boundaries. The watershed covers an area of approximately 380 acres. The Henry's Lake Drainageway crosses through the watershed in pipes which run under Wadsworth, through the northwest corner of the watershed and under Hampden Avenue. The Warrior Ditch enters the watershed in a siphon that crosses under Wadsworth just south of Jefferson Avenue, and exists the watershed near Colorado Academy.

The areas west of Pierce Street and south of Hampden Avenue are mostly commercial development, and the areas east of Pierce Street and north of Hampden Avenue have developed as single-family residential areas.

### Drainage Deficiencies:

The watershed has three defined outfalls. The first outfall system drains the areas enclosed by Wadsworth Boulevard, Teller Street, Hampden Avenue, and Mansfield Street, and outfalls to the Henry's Lake Drainageway just before it is conveyed under Hampden Avenue. The second outfall in the watershed drains the rest of the area south of Hampden Avenue and west of Pierce Street to the intersection of Pierce and Hampden Avenue. The third outfall drains the areas east of Pierce Street and south of Hampden Avenue.

The drainage concentrated at each of these points normally reaches Bear Creek through a system of sufficient capacity to carry the stormwater from the areas south of Hampden Avenue during large runoff events. The capacity of the Henry's Lake Drainageway downstream of Hampden Avenue is limited by the existing pipe under Hampden Avenue. Stormwater flows during small events from areas upstream of the Warrior Ditch are intercepted by the ditch and conveyed out of the watershed to the east. Runoff exceeding the ditch capacity flows north along Pierce Street.

The existing detention facilities in the watershed are not included in the baseline hydrologic model as they are not publicly owned or maintained.

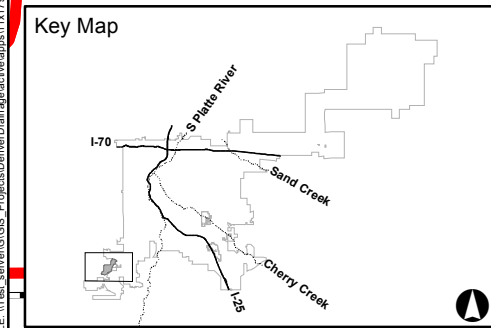
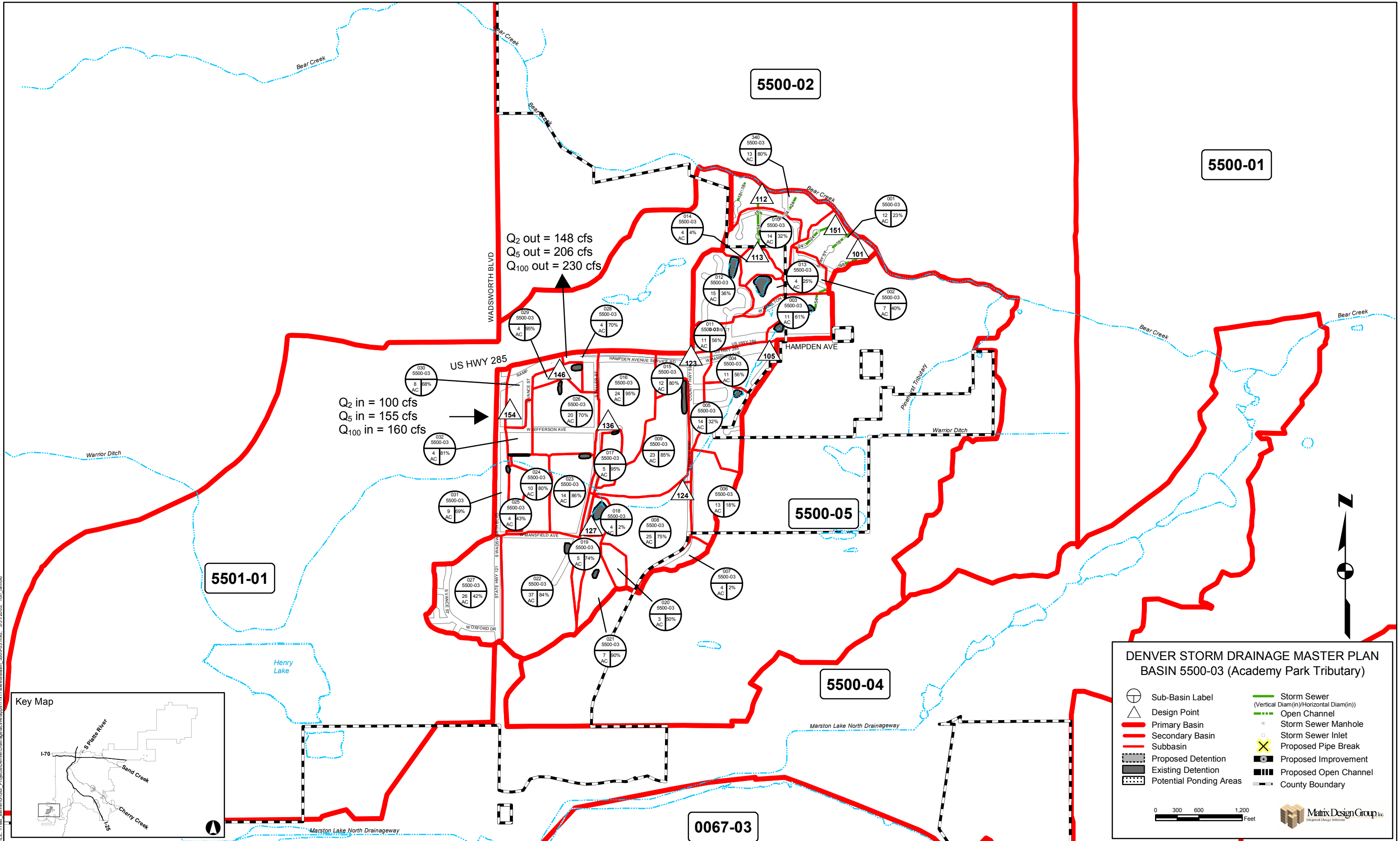
### Proposed Capital Improvements:

The majority of this basin lies outside the City of Denver, with only the outfall located within the City boundaries. An improvement project has recently been constructed at the outfall, and no further improvements are proposed within Denver.

### Existing Hydrology:

#### BASIN 5500-03

<u>Design Point</u>	<u>Peak Discharge</u>		
	<u>2-Year</u> (cfs)	<u>5-Year</u> (cfs)	<u>100-Year</u> (cfs)
101	59	85	190
105	46	63	148
112	181	288	886
113	183	295	893
123	165	246	758
124	148	208	408
127	97	148	318
136	26	38	80
146	157	225	455
151	17	29	91
154	100	155	160



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## Basin: 5500-04 (Bear Creek – Marston Lake North)

### Existing System Description:

This basin drains to Bear Creek via the Marston Lake North Channel and is generally bound by Stanford Avenue on the north, Wadsworth Boulevard on the east, Belleview Avenue on the south and Kipling Street on the west. The majority of the basin is located in Denver with the western edges lying in Lakewood. The Bowles Lateral crosses the basin from the northwest corner to the southeast corner, eventually flowing into Bowles Reservoir No. 1. Several storm sewers discharge into the Bowles Lateral, which flows roughly 80% full in the summer. There is a concrete weir adjacent to the ditch near Gar Way that diverts overflow from the ditch to the storm sewer system that discharges into Lakes Lake. Lakes Lake is in the northern portion of the basin. The Marston Lake North Channel originates at Lakes Lake, flows east to a detention pond on the east side of Wadsworth Boulevard, then runs along the north side of Marston Reservoir, eventually discharging into Bear Creek. Multiple storm sewers throughout the basin convey flows to the Marston Lake North Channel. The basin is comprised of primarily residential neighborhoods with commercial/retail areas located near Wadsworth Boulevard.

### Drainage Deficiencies:

- Several of the basins drain directly to the Bowles Lateral. To avoid potential disputes with the ditch companies concerning water rights and possible under grounding of the ditches, it would be preferable to create a storm sewer system independent of the Bowles Lateral.
- The 30"/36"/42" storm sewer system draining Basins 30, 31 and 32 is undersized. Flows from Basin 30 west of Kipling may not have been accounted for in the original sizing of this system. Future development south of Quincy Avenue is currently proposing a detention pond at d.p. 32, which will reduce peak flows to the system.
- The 42" storm pipe between Design Points 600 and 702 has the capacity to convey approximately 90 cfs, while the 2-year and 5-year flows are 168 cfs and 238 cfs, respectively.

### Proposed Capital Improvements:

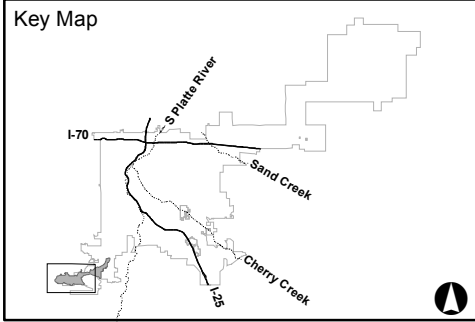
Project A: South Wadsworth Way Improvements Increase the size and/or capacity of the storm system in Wadsworth from Union Avenue to the Marston Lake North Channel.

Project B: W. Union Ave. Improvements Evaluate the potential to extend the 36" pipe that currently discharges into the Bowles Lateral near Kipling and Saratoga east to the open channel adjacent to Union Avenue to disconnect from the Bowles Lateral. Also, evaluate the potential to extend the 30" pipe that currently discharges into the Bowles Lateral near Field Way and Wagontrail Drive east to the storm sewer system in Dudley Street to disconnect from the Bowles Lateral.

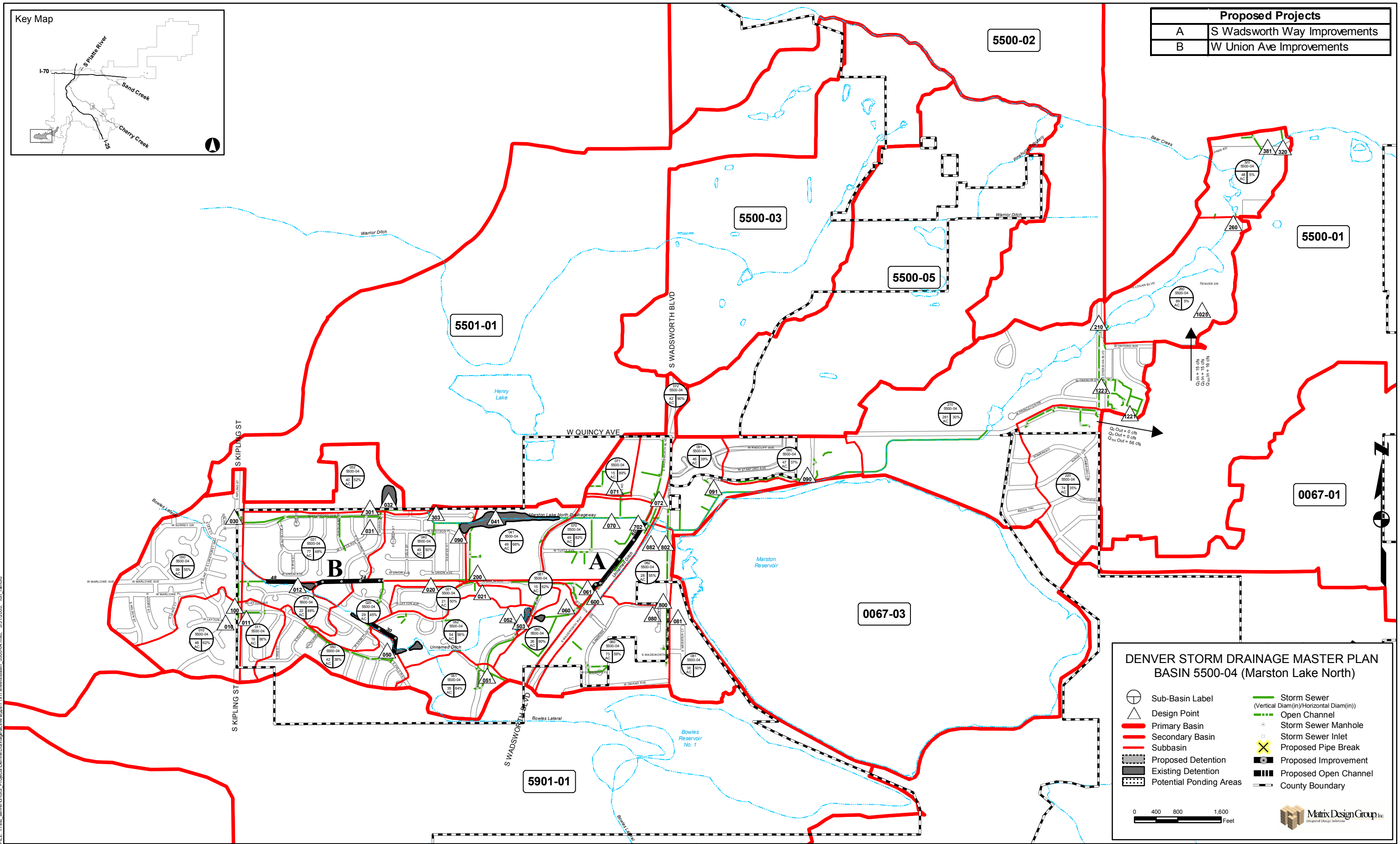
### Existing Hydrology:

**HYDROLOGIC SUMMARY TABLE: BASIN 5500-04**

Design Point / Flow Element	Discharge		
	Q2-yr	Q5-yr	Q100-yr
	(cfs)	(cfs)	(cfs)
10	70	118	294
11	24	41	107
12	30	57	158
20	16	32	88
21	19	36	93
30	95	169	430
31	59	111	301
32	35	64	167
40	55	100	277
41	87	143	344
50	20	42	125
51	43	73	171
52	52	91	230
60	51	74	149
61	14	24	59
70	73	109	234
71	42	61	126
72	112	161	328
80	72	125	311
81	24	46	119
82	41	62	138
90	67	118	312
91	95	159	382
100	94	159	401
151	85	157	395
200	35	68	181
251	35	67	180
301	133	256	695
303	165	321	867
350	79	153	394
352	130	258	700
354	159	311	878
503	107	191	448
550	18	38	100
551	44	74	159
552	102	174	444
600	160	238	603
651	138	228	609
702	299	452	1075
800	97	170	430
802	132	200	535
851	92	155	406

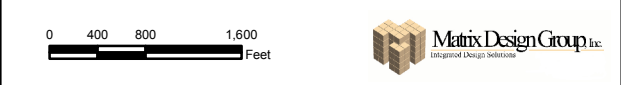


Proposed Projects	
A	S Wadsworth Way Improvements
B	W Union Ave Improvements



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5500-04 (Marston Lake North)**

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## Basin: 5500-05 (Pinehurst Tributary)

### Existing System Description:

The Pinehurst Tributary Watershed is a mostly developed area in the southwestern portion Denver west of Sheridan Boulevard and mostly south of Hampden Avenue. Three governmental entities; the City of Lakewood, the City and County of Denver, and Jefferson County each have jurisdiction over a portion of the watershed. The basin covers an area of approximately 460 acres (0.7 square miles). Land use consists of single family residential, multi family residential, commercial, school, and Pinehurst Country Club and golf course.

The existing major drainage system consists of storm sewers and open channel in the areas from Quincy Street downstream across the golf course. The runoff from this upstream drainage system is conveyed to Woody’s Pond located southeast of Colorado Academy. Woody’s Pond drains to a storm sewer that runs down Harlan Street to the upstream end of an open channel. The channel then runs through some private properties and the Tall Pines and Pebble Creek apartment complexes. From the downstream end of the open channel, the runoff is carried in a 48-inch pipe under Highway 285 to Bear Creek.

Two smaller outfalls exist in the basin: a 30-inch storm sewer along Fenton Street, and a 24-inch pipe draining a portion of the Tall Pines apartment complex.

The 1999 Pinhurst Tributary OSP has been incorporated into this report to address future development and previously proposed drainage improvements. Several of the proposed capital improvements shown on the mapping are currently under construction or recently constructed (2004).

### Drainage Deficiencies:

Historically, drainage problems have been identified along Harlan Street, east of Colorado Academy. The storm sewer conveyance system downstream (north) of Woody’s Pond was undersized and has caused flooding to several homes along Harlan Street during events greater than the 5-year frequency.

### Proposed Capital Improvements:

In order to address known flooding issues along Harlan Street, improvements have been recently constructed on the Colorado Academy property west of Harlan Street. A second detention pond was constructed at the northeast corner of the property, and an additional storm sewer has been installed west of Harlan Street. Other minor improvements were made to local drainage systems in the area.

Projects A, B, C, and G: Foothills GC Improvements and Pierce Way Detention Upstream (south) of Colorado Academy, improvements to an existing berm are proposed to protect the Pinehurst Village II condominium complex. The berm is located on the golf course property and will be owned and maintained by the Pinehurst Golf Course.

Development related detention ponds are proposed within the Cities of Lakewood and Denver in the upper reaches of the basin. Small conduits and open channels are proposed to drain these detention facilities across the golf course to the main channel. These improvements are to be development driven.

Projects D, E, and F: S. Harlan St. Detention Small on-line detention ponds are proposed along the Pinehurst Tributary south of Hampden Avenue. The ponds were proposed in the 1999 OSP study and will attenuate peak flows to the Hampden Avenue crossing and the existing 48” outfall to Bear Creek.

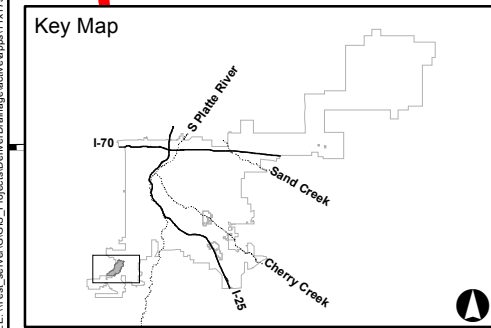
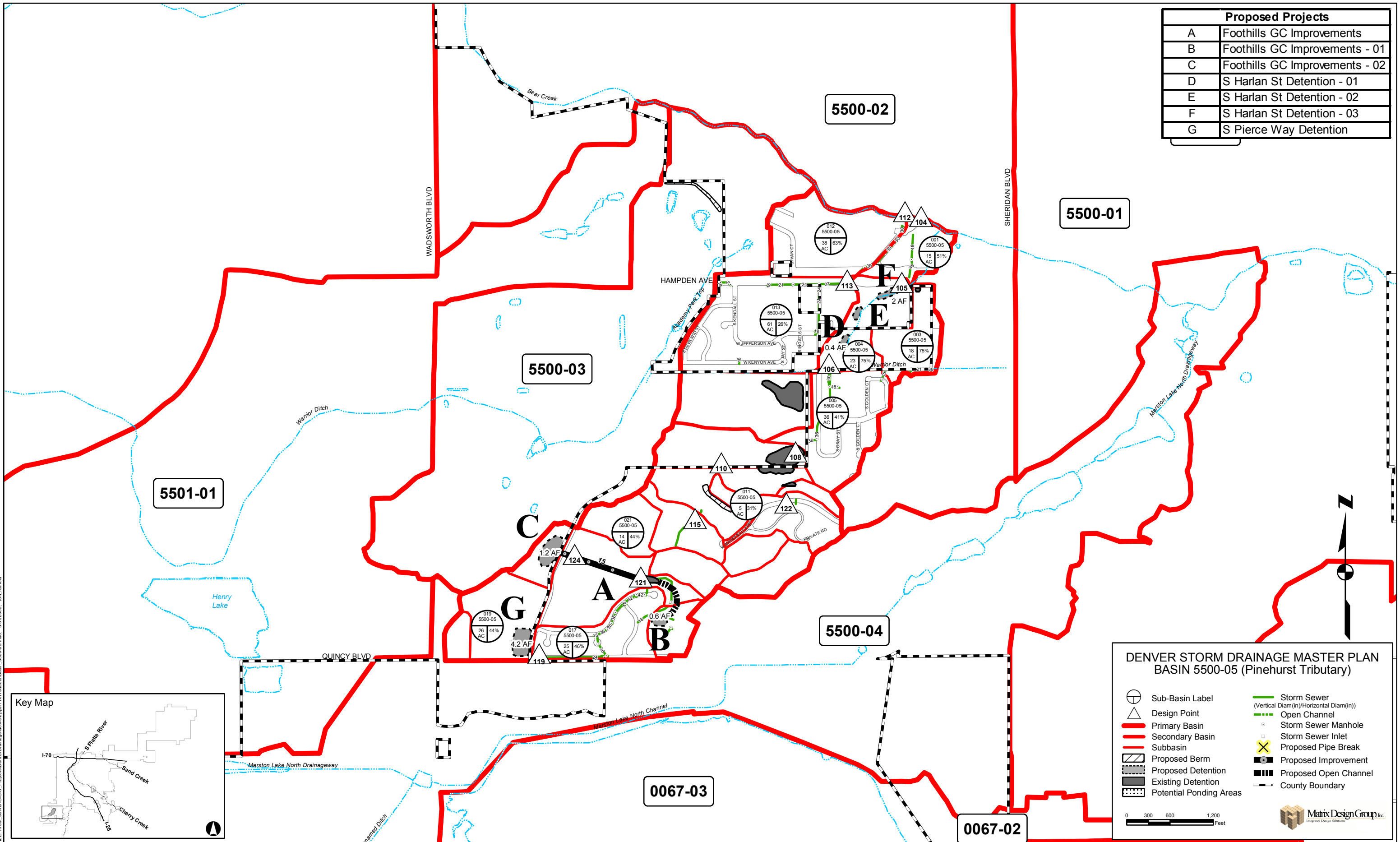
### Existing Hydrology:

#### BASIN 5500-05

Design Point	Peak Discharge		
	2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
104	50	76	270
105	50	77	271
106	38	59	132
108	30	46	232
110	21	35	184
112	51	67	126
113	36	58	155
115	20	30	161
119	2	3	24
121	26	41	113
122	24	37	99
124	1	1	6



Proposed Projects	
A	Foothills GC Improvements
B	Foothills GC Improvements - 01
C	Foothills GC Improvements - 02
D	S Harlan St Detention - 01
E	S Harlan St Detention - 02
F	S Harlan St Detention - 03
G	S Pierce Way Detention



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5500-05 (Pinehurst Tributary)**

Sub-Basin Label	Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
Design Point	Open Channel
Primary Basin	Storm Sewer Manhole
Secondary Basin	Storm Sewer Inlet
Subbasin	Proposed Pipe Break
Proposed Berm	Proposed Improvement
Proposed Detention	Proposed Open Channel
Existing Detention	County Boundary
Potential Ponding Areas	

0 300 600 1,200 Feet

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Integrating Design Solutions

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## Basin: 5501-01 (Henry's Lake)

### Existing System Description:

Henry's Lake Basin lies within the southwest portion of the Denver Metropolitan area and is a tributary to Bear Creek. The Henry's Lake Basin drains generally in a northeasterly direction. The upper end of the basin is located immediately west of Kipling Street at Quincy Avenue. The confluence with Bear Creek is located just east of Pierce Street. The basin is rural, large lot residential, and has no definitive channel.

The basin area tributary to Bear Creek is 1.33 square miles (850 acres). The total length of the basin is approximately 3.58 miles for a slope of 75-feet per mile (1.4%). The drainageway lies almost entirely within the City of Lakewood and Jefferson County. A small portion of the watershed near Henry's Lake lies within the City and County of Denver.

Henry's Lake has flood storage of approximately 18 acre-feet, and affords considerable downstream protection and flood peak reduction. The greatest reduction in peak flows occurs for the more frequent storms (2- to 10-years). Henry's Lake is also very effective as a detention facility for the rare events (50- to 100-year).

### Drainage Deficiencies:

Two irrigation ditches traverse the study area, the Warrior Ditch and the Marston Lake North Channel. The ditches carry integration water between the basins adjacent to Henry's Lake Basin. Urbanization of the basin has resulted in increased runoff collected by the ditches and subsequent overtopping. Some of the ditch has been piped, but a substantial portion of the Warrior Ditch remains open channel.

The drainageway consists of a 76" x 48" Horizontal Elliptical Reinforced Concrete Pipe (HERCP) culvert beneath Hampden Avenue. The 72" x 44" CMP beneath Wadsworth Boulevard discharges into an open top concrete vault ("bubbler"). Exiting from the vault is a smaller 48" RCP storm sewer. During the more intense storms, the headwater at the Hampden Avenue culvert overtops the frontage road, causing a flow split to the east.

### Proposed Capital Improvements:

No improvements are proposed for this basin within the City of Denver reach.

#### Project A: RTD Detention

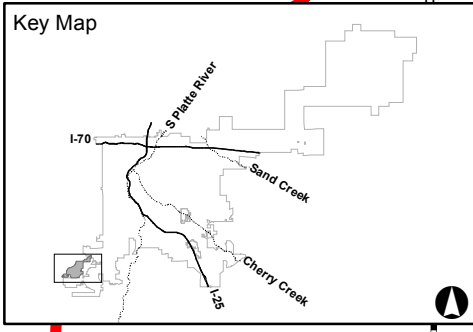
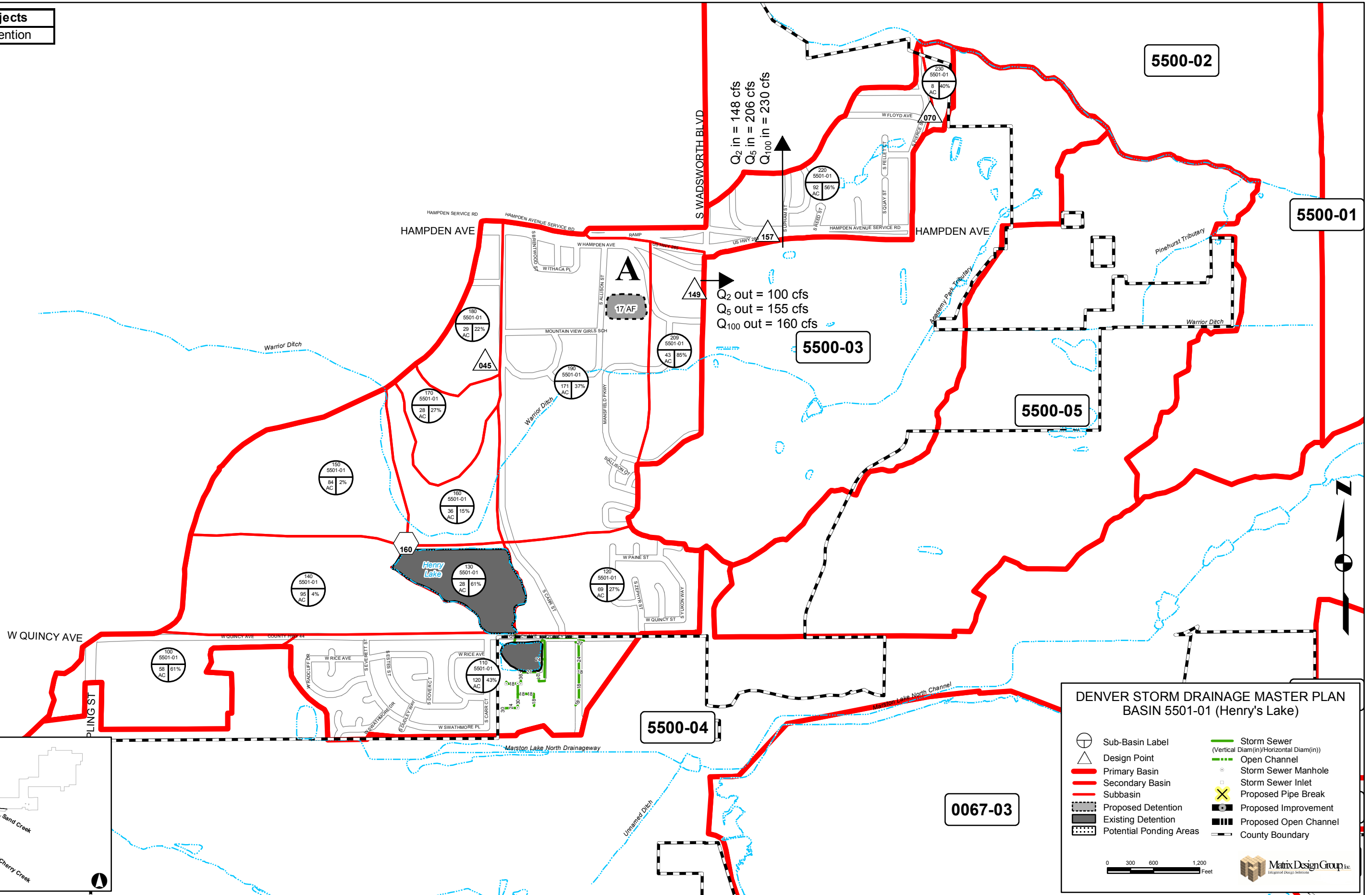
RTD owns land adjacent to the existing Park and Ride facility near Wadsworth Boulevard and Hampden Avenue in Jefferson County. RTD has expressed some interest in using the land for stormwater detention purposes.

### Existing Hydrology:

#### BASIN 5501-01

<u>Design Point</u>	<u>Peak Discharge</u>		
	<u>2-Year</u> (cfs)	<u>5-Year</u> (cfs)	<u>100-Year</u> (cfs)
45	33	61	412
70	191	285	585
149	129	216	634
157	148	206	230
160	19	43	364

Proposed Projects	
A	RTD Detention



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 5501-01 (Henry's Lake)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 300 600 1,200 Feet

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Engineering Design Solutions

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## Basin: 5901-01 (Coon Creek)

### Existing System Description:

This basin drains to Coon Creek and is generally bound by Belleview Avenue on the north, Sheridan Boulevard on the east, Bowles Avenue on the south and Kipling Street on the west. The majority of the basin is located in Jefferson County and the Denver city limits line zigzags in and out of the basin. Coon Creek flows in a southeasterly direction through the middle of the basin. Three major reservoirs are located within the basin: Bowles Reservoir No. 1, Grant B Reservoir and Grant C Reservoir. The basin is comprised of a mix of residential neighborhoods with commercial/retail areas located near the arterial roadways, a golf course, a large ballfield complex, and several reservoirs. Most of the flows are conveyed directly to Coon Creek via relatively small storm sewer systems in the roadways. Basins 60 and 61 drain to Grant B Reservoir, Basins 62, 63 and 64 drain to Bowles Reservoir No. 1, and Basins 70, 71 and 72 drain to Grant C Reservoir.

Since only a small portion of the basin is in Denver, there are few Denver-owned public outfalls. A 36" outfall on the north and a 30" outfall on the south discharge into Coon Creek just west of Wadsworth Boulevard. A few pipes that drain directly to the Bowles Reservoirs are owned and maintained by others.

### Drainage Deficiencies:

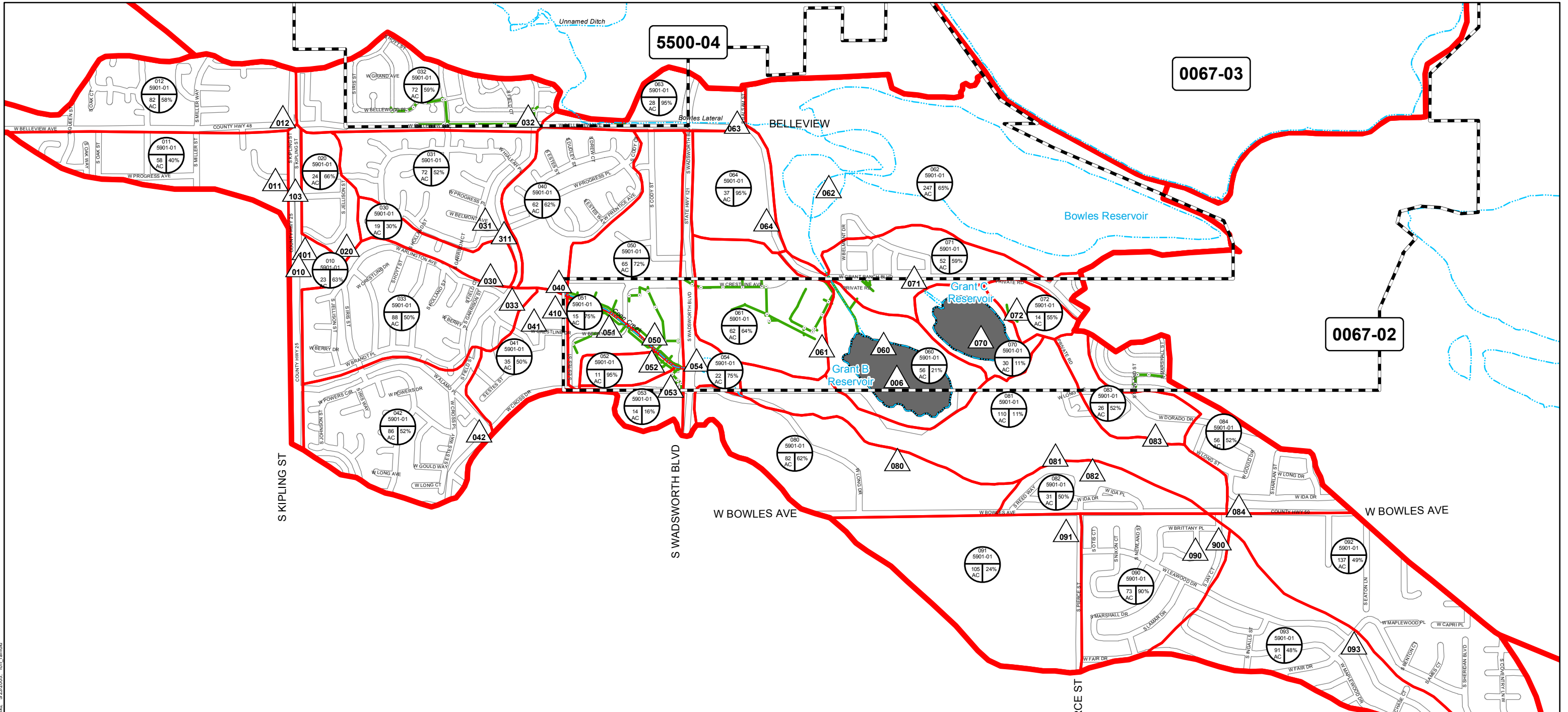
Development in this basin is relatively new. There appear to be no significant drainage problems with the systems located with the City of Denver.

### Proposed Capital Improvements:

There are no required improvements for this basin within the City & County of Denver.

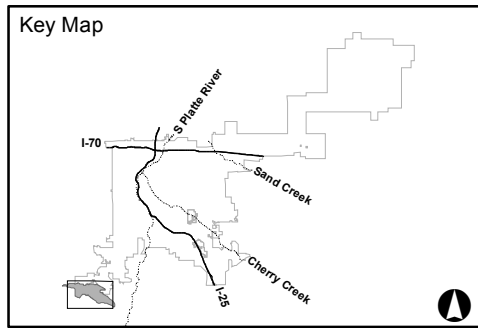
HYDROLOGIC SUMMARY TABLE: **BASIN 5901-01**

Design Point	Contributing Basins	Tributary Area (acres)	Peak Discharge		
			2-Year (cfs)	5-Year (cfs)	100-Year (cfs)
10	10	23	42	72	176
11	11	58	32	66	193
12	12	82	67	116	289
20	20	24	34	56	135
30	30	19	23	43	117
31	31	72	60	110	289
32	32	72	64	109	276
33	33	88	64	118	315
40	40	62	66	112	272
41	41	35	34	64	163
42	42	86	75	137	358
50	50	65	84	133	304
51	51	15	35	54	123
52	52	11	32	46	91
53	53	14	4	16	53
54	54	1	32	47	95
60	60	56	15	43	151
61	61	62	81	134	324
62	62	247	263	433	1047
63	63	28	56	80	157
64	64	37	107	153	301
70	70	30	7	37	138
71	71	52	77	132	336
72	72	14	22	39	102
80	80	82	175	300	743
81	81	110	22	109	392
82	82	31	45	84	232
83	83	26	27	50	129
84	84	64	53	96	252
90	90	73	58	104	276
91	91	105	34	92	309
92	92	140	187	347	969
93	93	91	71	134	363
100	12, 11, 10	163	115	198	551
101	12, 11	140	99	167	487
102	12, 11	140	98	178	483
103	12	82	67	114	299
310	32, 31	144	121	196	540
311	32, 31	144	119	196	535
312	32	72	64	96	274
410	42, 41	121	95	175	437
411	42	86	70	128	313
710	71	52	75	133	320
900	91, 90	178	89	194	568
901	91	105	33	92	304



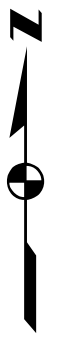
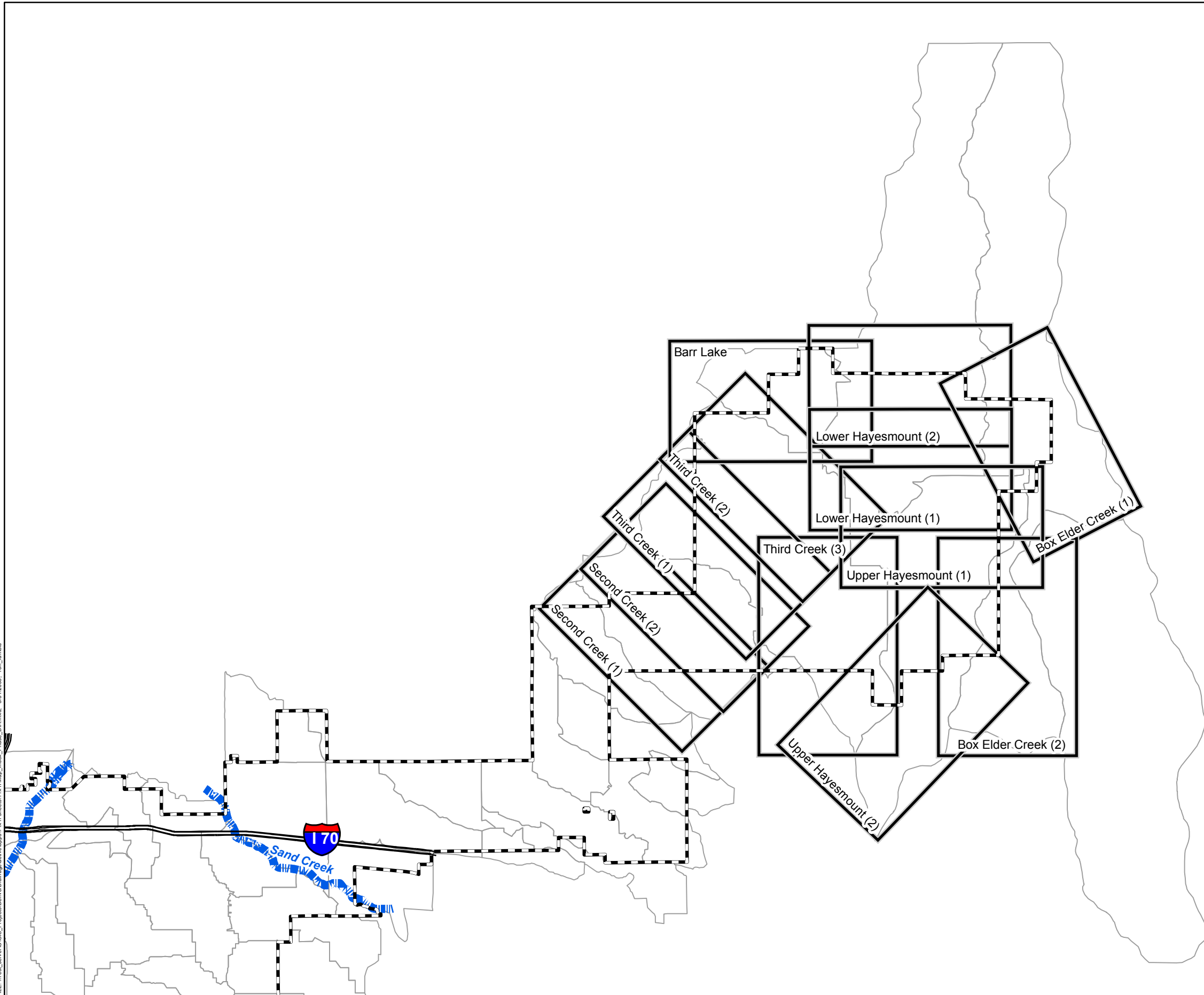
### DENVER STORM DRAINAGE MASTER PLAN BASIN 5901-01 (Coon Creek)

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary



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**DENVER STORMWATER MASTER PLAN  
MAP INDEX**

-  11x17 Map Sheet
-  Major Basin
-  Drainageway
-  City Boundary



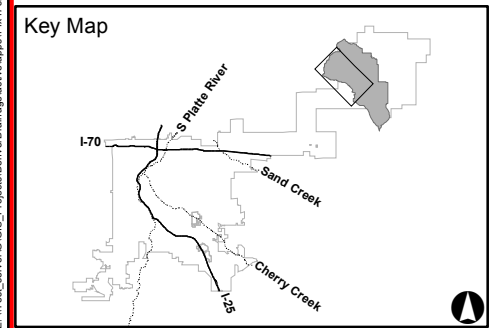
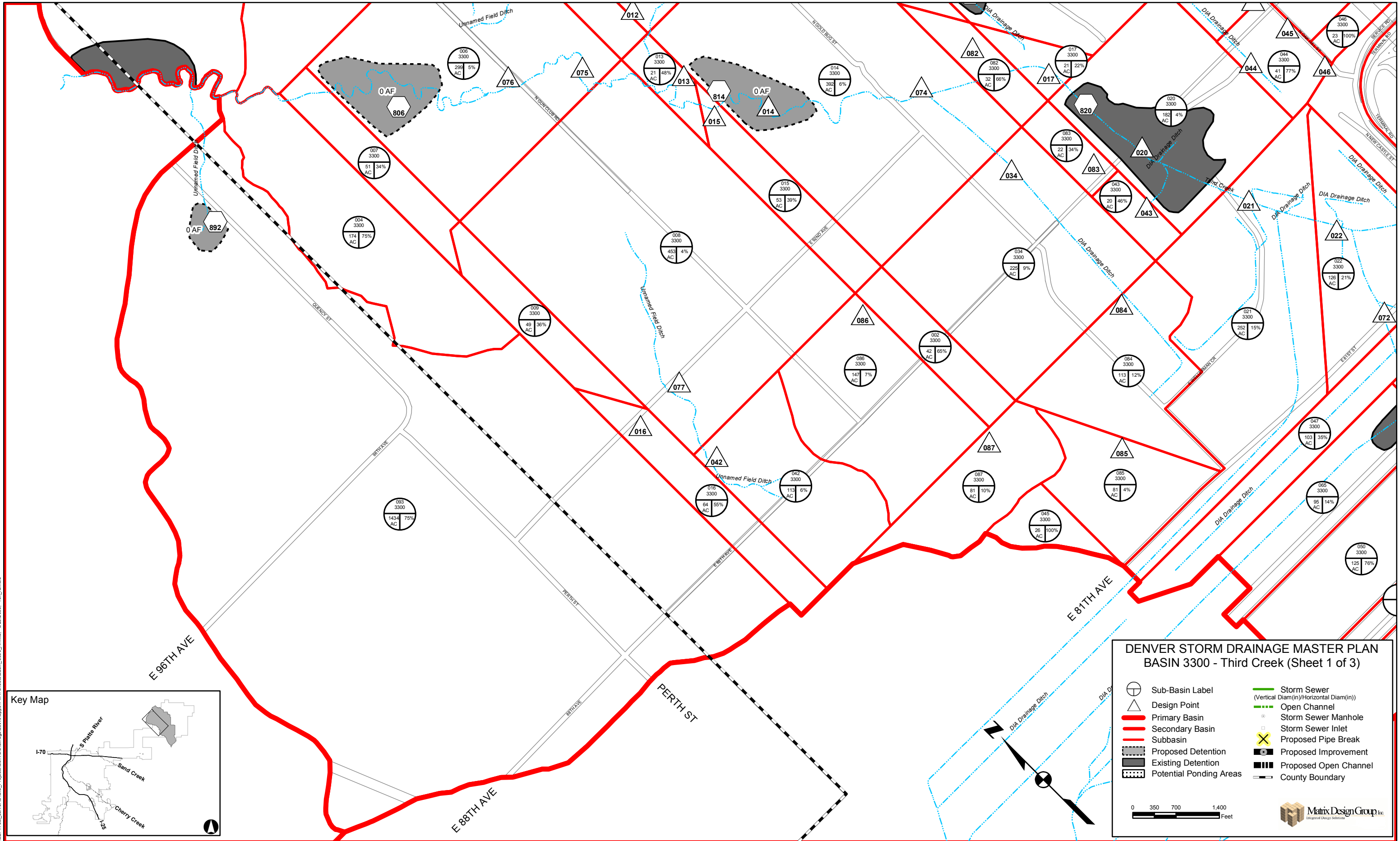
# DIA Drainage Basins

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## **Basin: 3300 (Third Creek)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.





**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3300 - Third Creek (Sheet 1 of 3)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet

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Integrating Design Solutions

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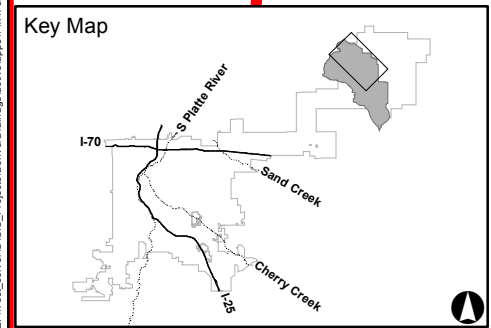
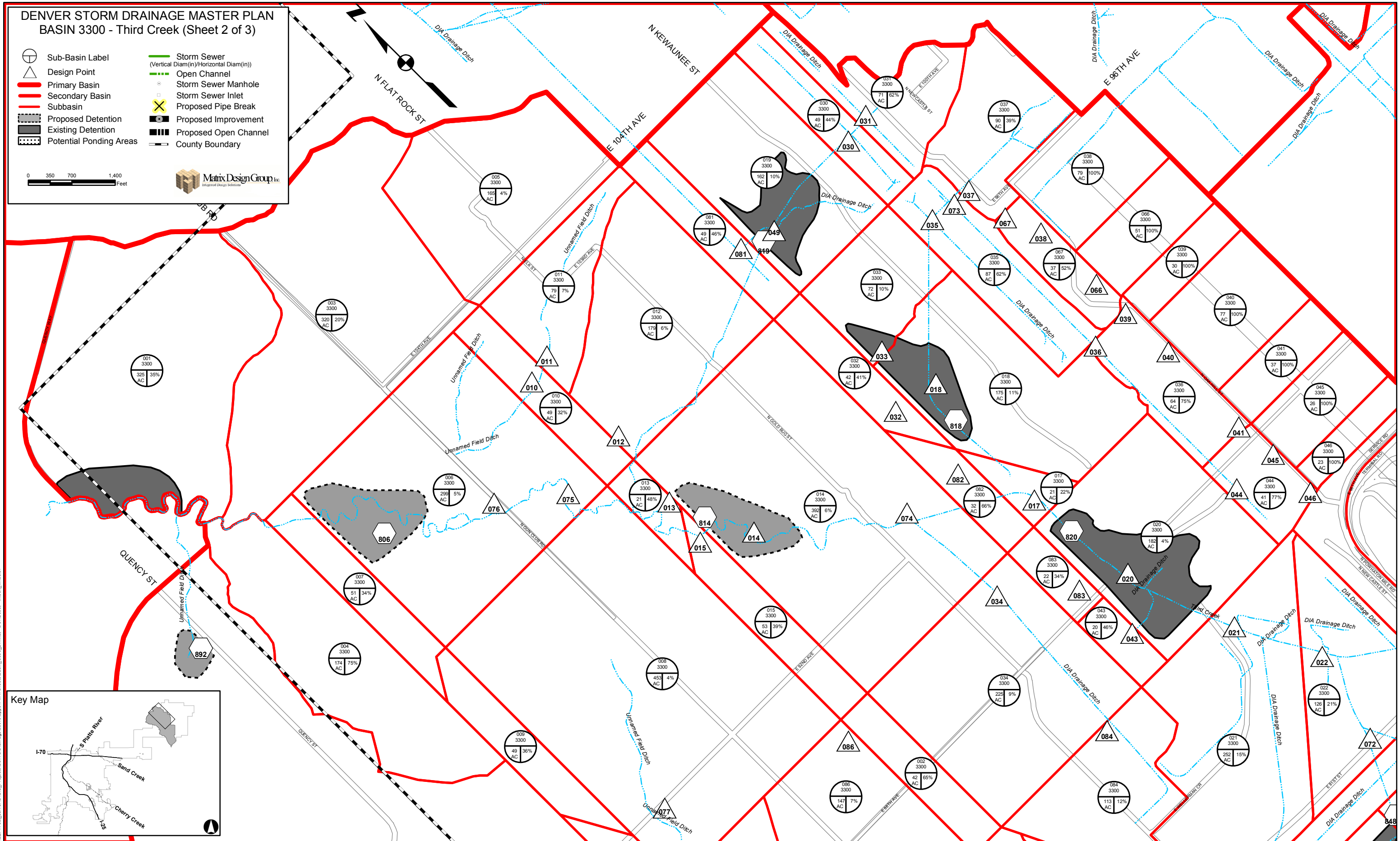
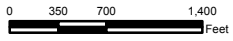
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## **Basin: 3300 (Third Creek)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.

# DENVER STORM DRAINAGE MASTER PLAN BASIN 3300 - Third Creek (Sheet 2 of 3)

- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer  
(Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary

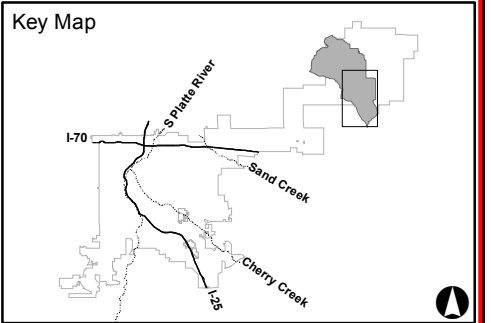
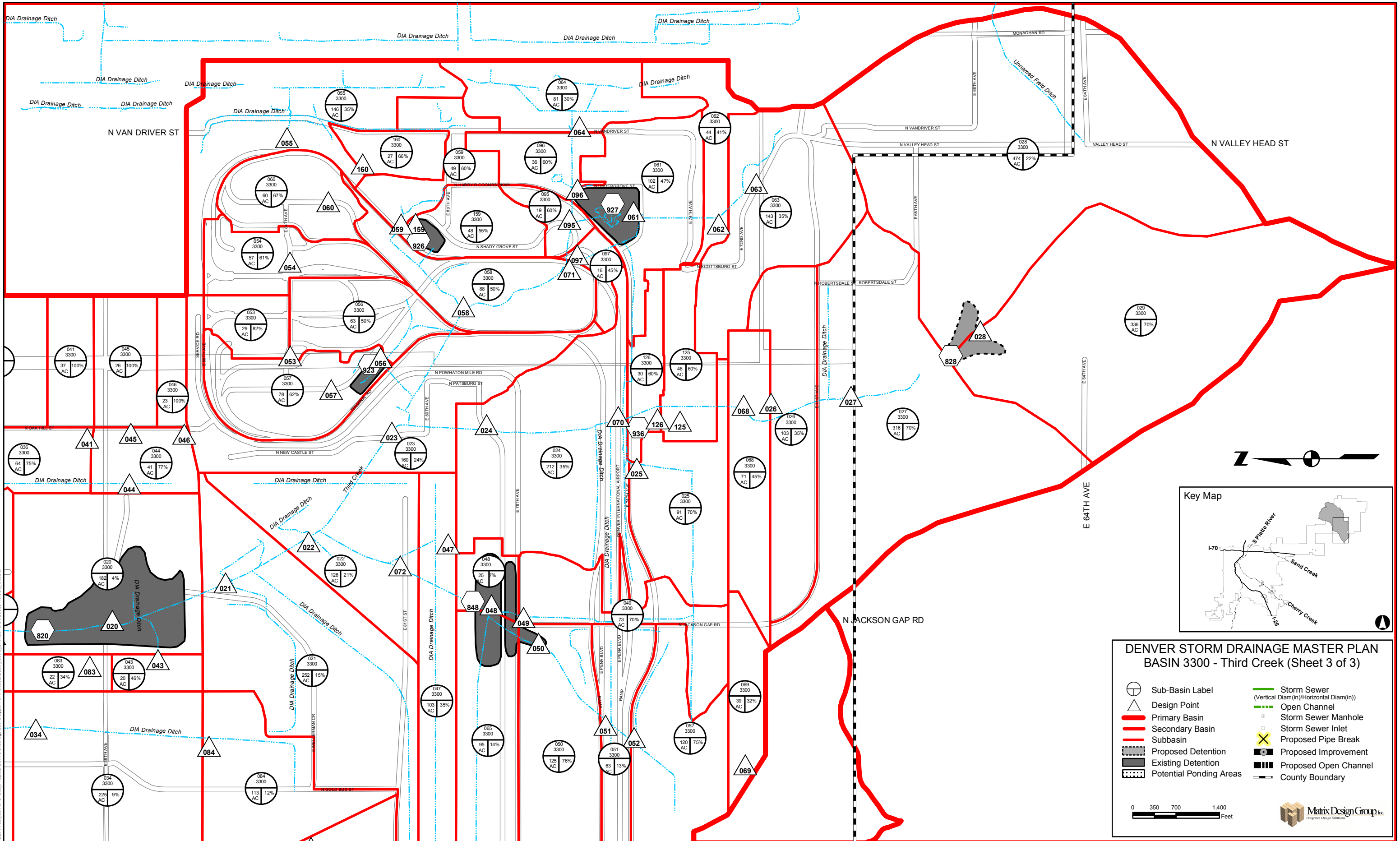


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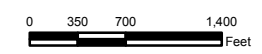
## **Basin: 3300 (Third Creek)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3300 - Third Creek (Sheet 3 of 3)**

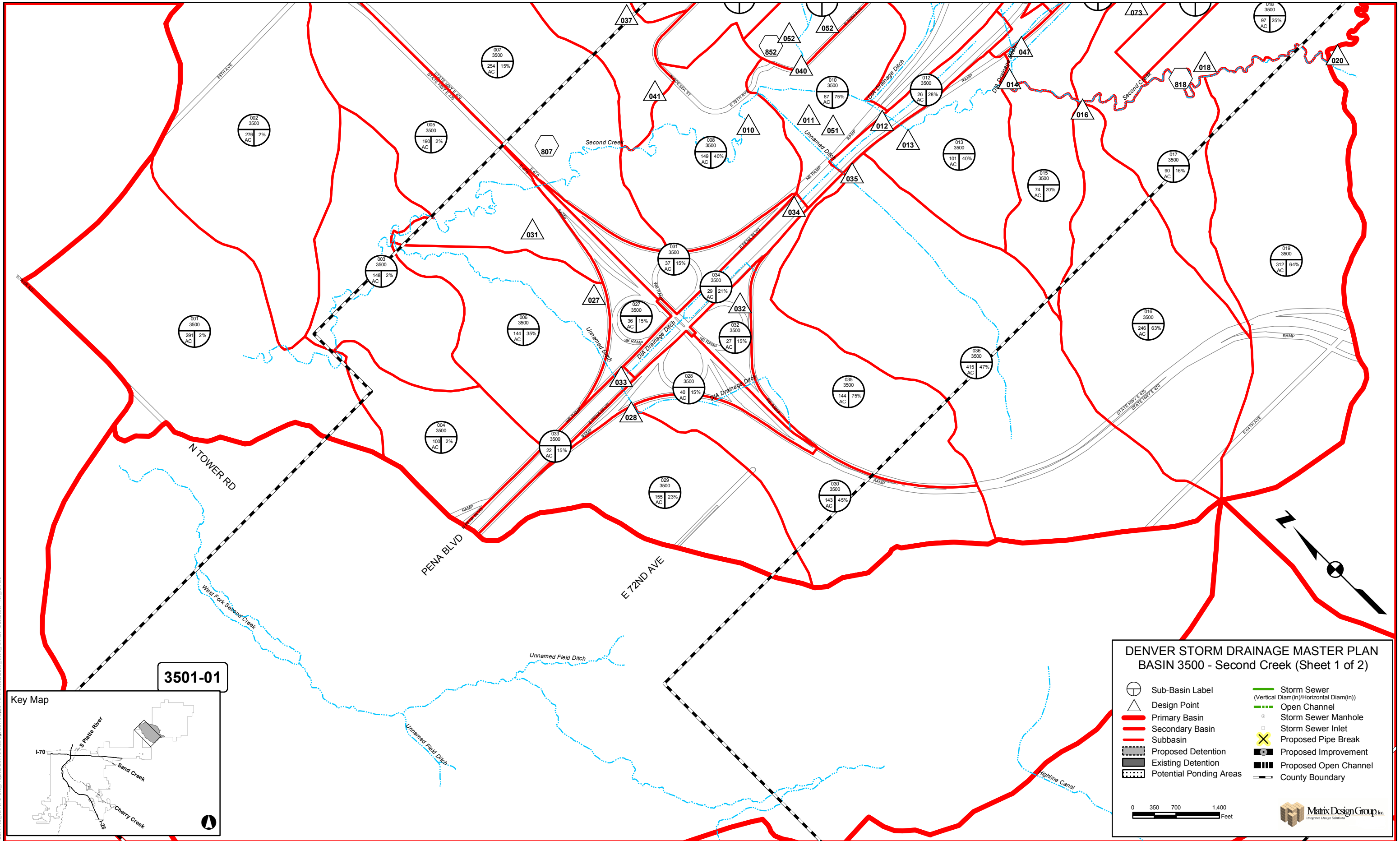
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|--|-------------------------|--|--|
|  | Sub-Basin Label         |  | Storm Sewer<br>(Vertical Diam(in)/Horizontal Diam(in)) |
|  | Design Point            |  | Open Channel   |
|  | Primary Basin           |  | Storm Sewer Manhole                                    |
|  | Secondary Basin         |  | Storm Sewer Inlet                                      |
|  | Subbasin                |  | Proposed Pipe Break                                    |
|  | Proposed Detention      |  | Proposed Improvement                                   |
|  | Existing Detention      |  | Proposed Open Channel                                  |
|  | Potential Ponding Areas |  | County Boundary  |



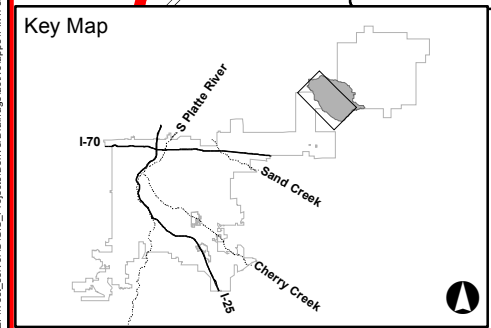
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## **Basin: 3500 (Second Creek)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.



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3501-01

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 3500 - Second Creek (Sheet 1 of 2)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet

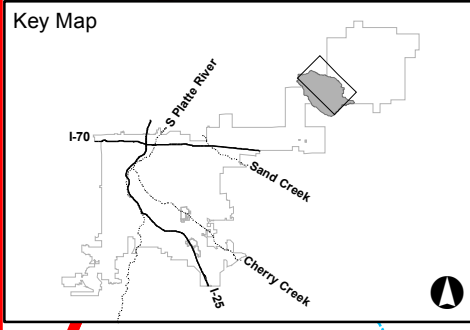
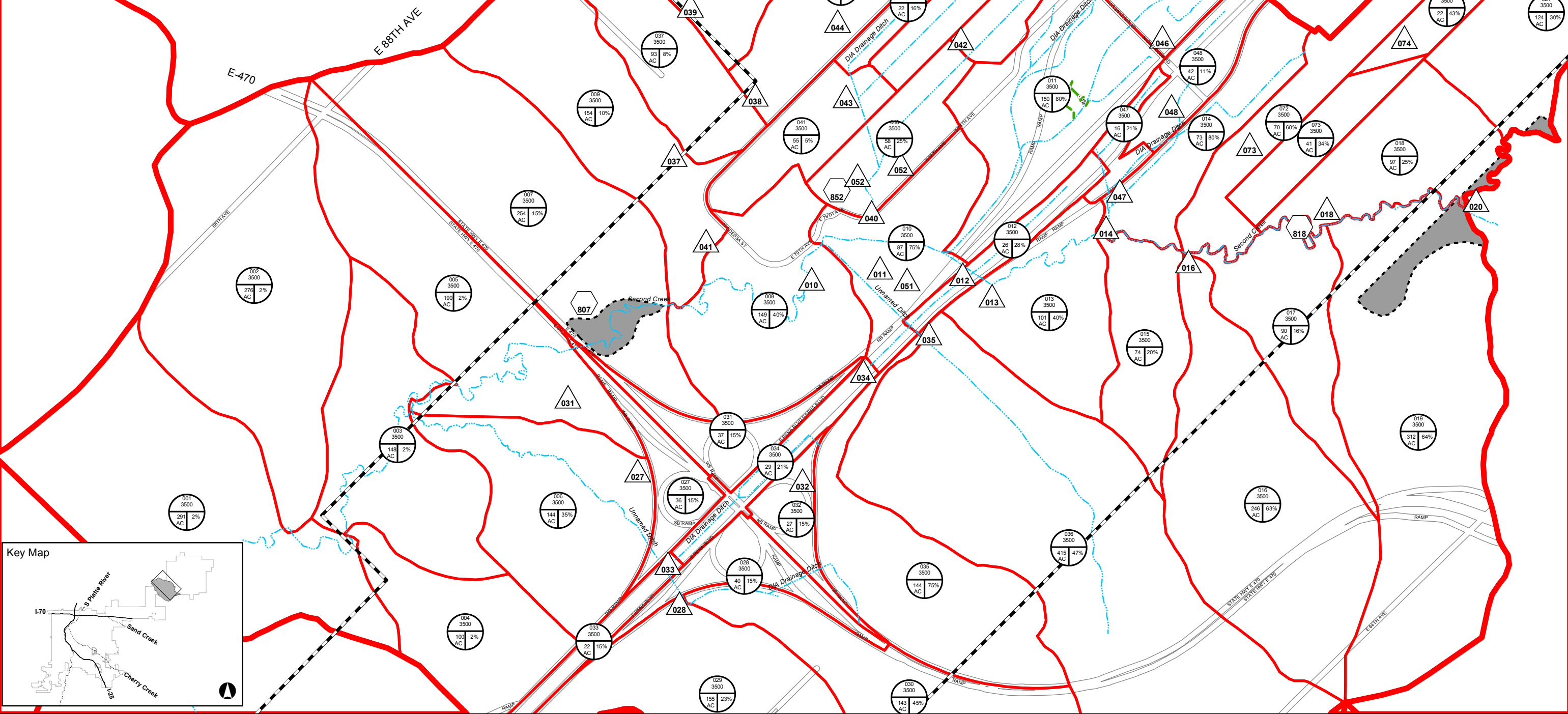
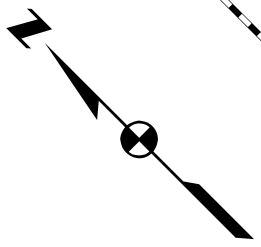
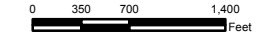
## **Basin: 3500 (Second Creek)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.



# DENVER STORM DRAINAGE MASTER PLAN BASIN 3500 - Second Creek (Sheet 2 of 2)

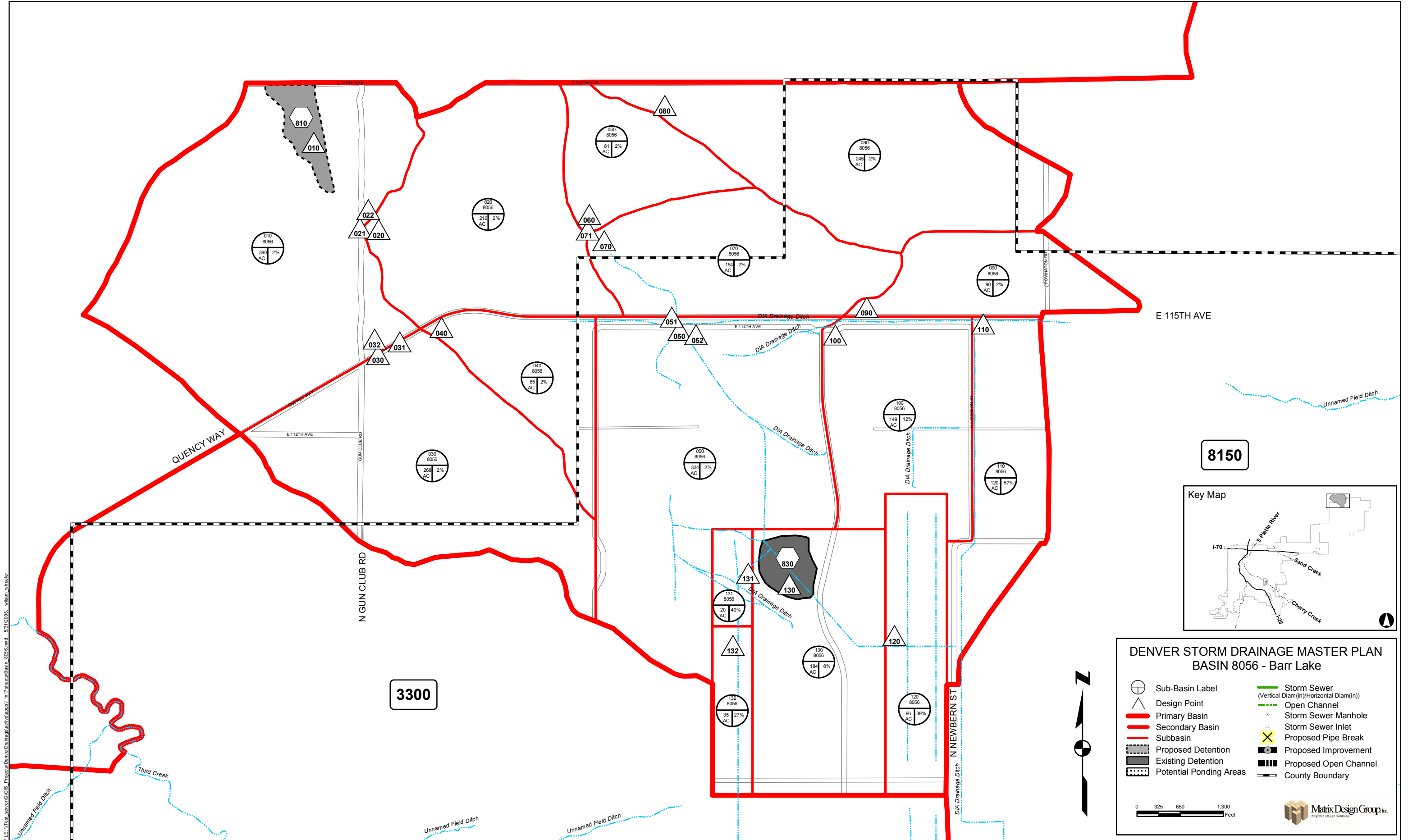
- Sub-Basin Label
- Design Point
- Primary Basin
- Secondary Basin
- Subbasin
- Proposed Detention
- Existing Detention
- Potential Ponding Areas
- Storm Sewer  
(Vertical Diam(in)/Horizontal Diam(in))
- Open Channel
- Storm Sewer Manhole
- Storm Sewer Inlet
- Proposed Pipe Break
- Proposed Improvement
- Proposed Open Channel
- County Boundary



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## **Basin: 8056 (Barr Lake)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.



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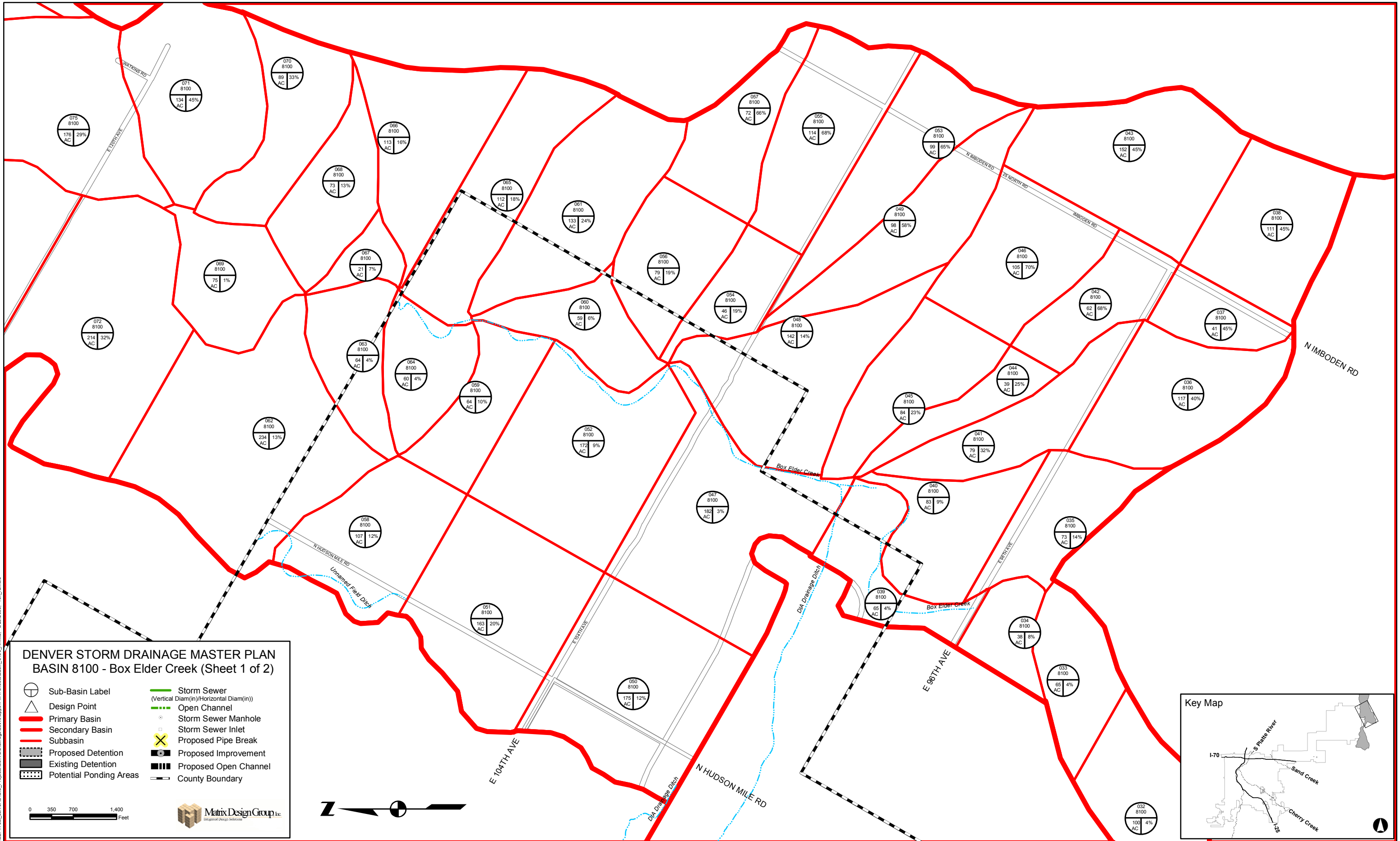
## **Basin: 8100 (Lower Box Elder Creek)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.

and

Reference “Preliminary Design Report for Lower Box Elder Creek Watershed,” by Wright Water Engineers, Inc., dated October 2001.

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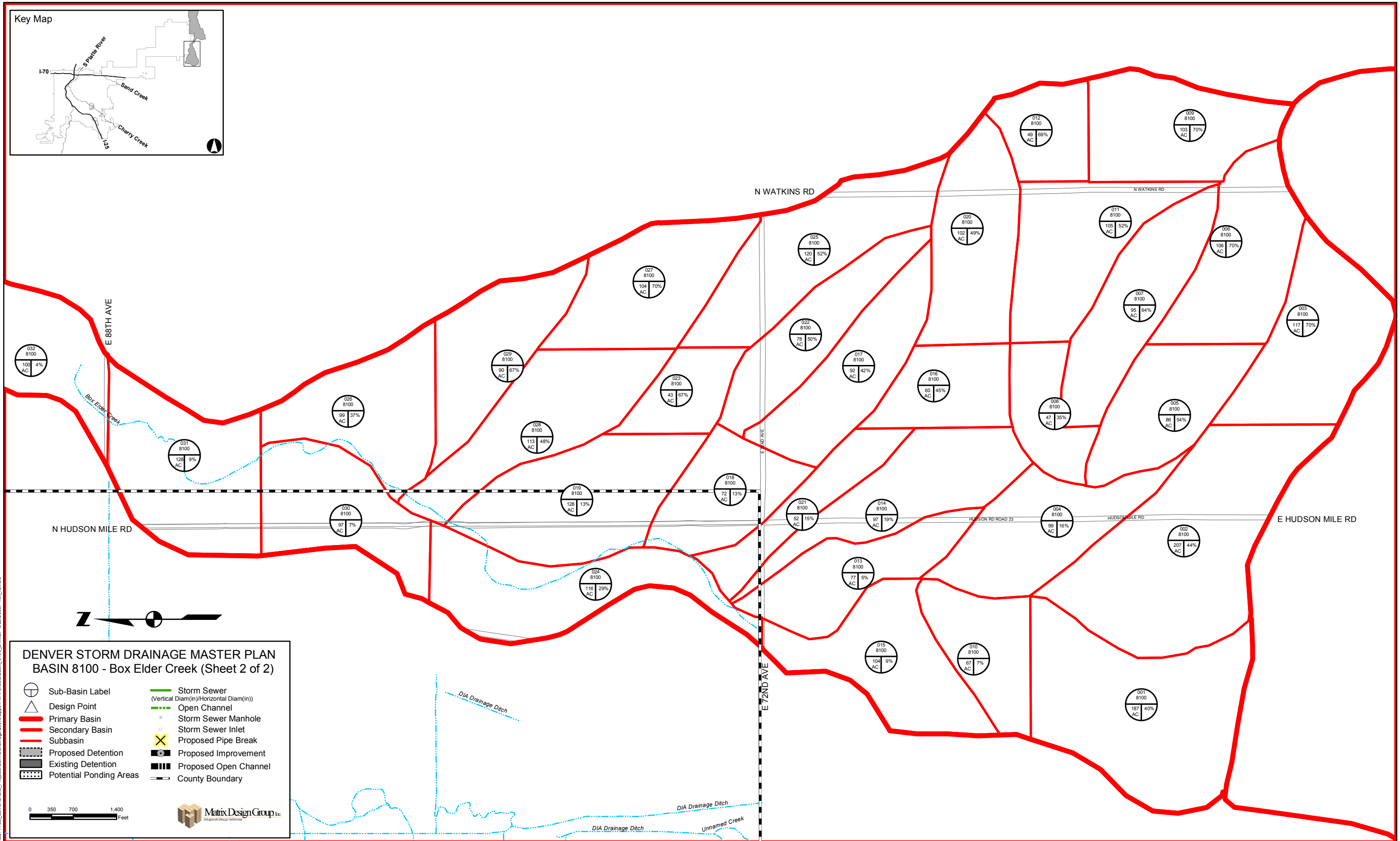
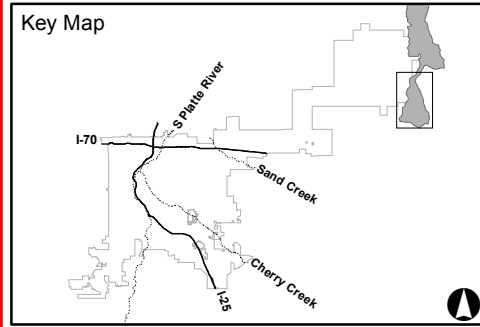
## **Basin: 8100 (Lower Box Elder Creek)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.

and

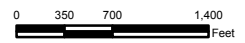
Reference “Preliminary Design Report for Lower Box Elder Creek Watershed,” by Wright Water Engineers, Inc., dated October 2001.

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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 8100 - Box Elder Creek (Sheet 2 of 2)**

- |  |                         |  |  |
|--|-------------------------|--|--|
|  | Sub-Basin Label         |  | Storm Sewer<br>(Vertical Diam(in)/Horizontal Diam(in)) |
|  | Design Point            |  | Open Channel   |
|  | Primary Basin           |  | Storm Sewer Manhole                                    |
|  | Secondary Basin         |  | Storm Sewer Inlet                                      |
|  | Subbasin                |  | Proposed Pipe Break                                    |
|  | Proposed Detention      |  | Proposed Improvement                                   |
|  | Existing Detention      |  | Proposed Open Channel                                  |
|  | Potential Ponding Areas |  | County Boundary  |



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## **Basin: 8150 (Lower Hayesmount)**

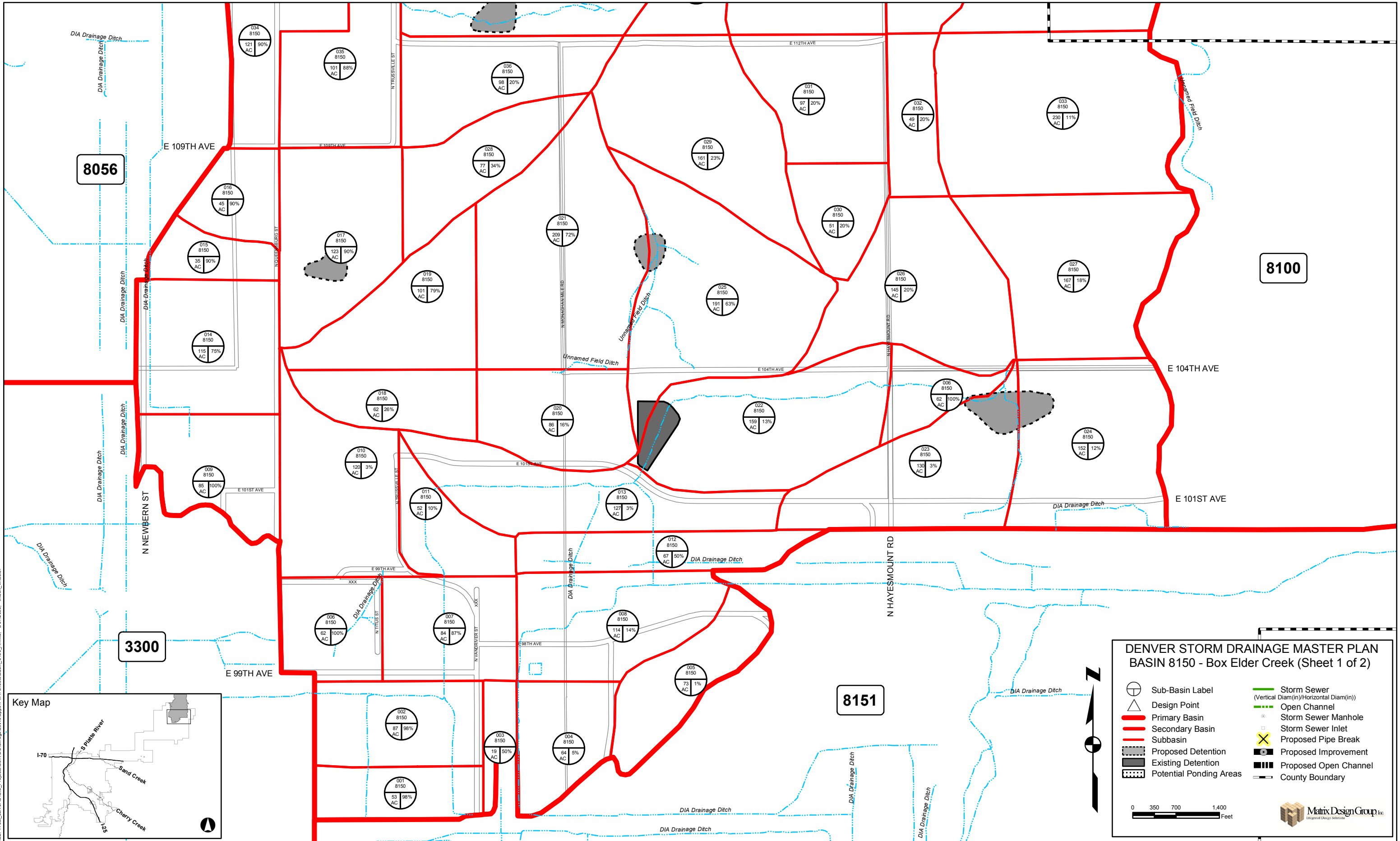
Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.

and

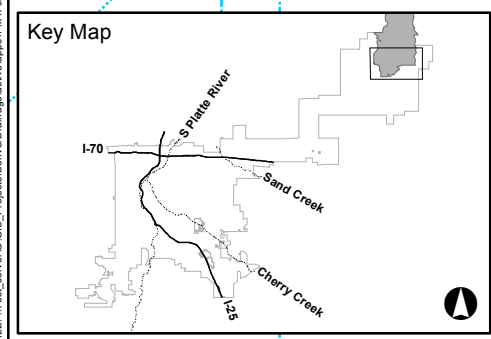
Reference “Preliminary Design Report for Lower Box Elder Creek Watershed,” by Wright Water Engineers, Inc., dated October 2001.

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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 8150 - Box Elder Creek (Sheet 1 of 2)**

	Sub-basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1400 Feet

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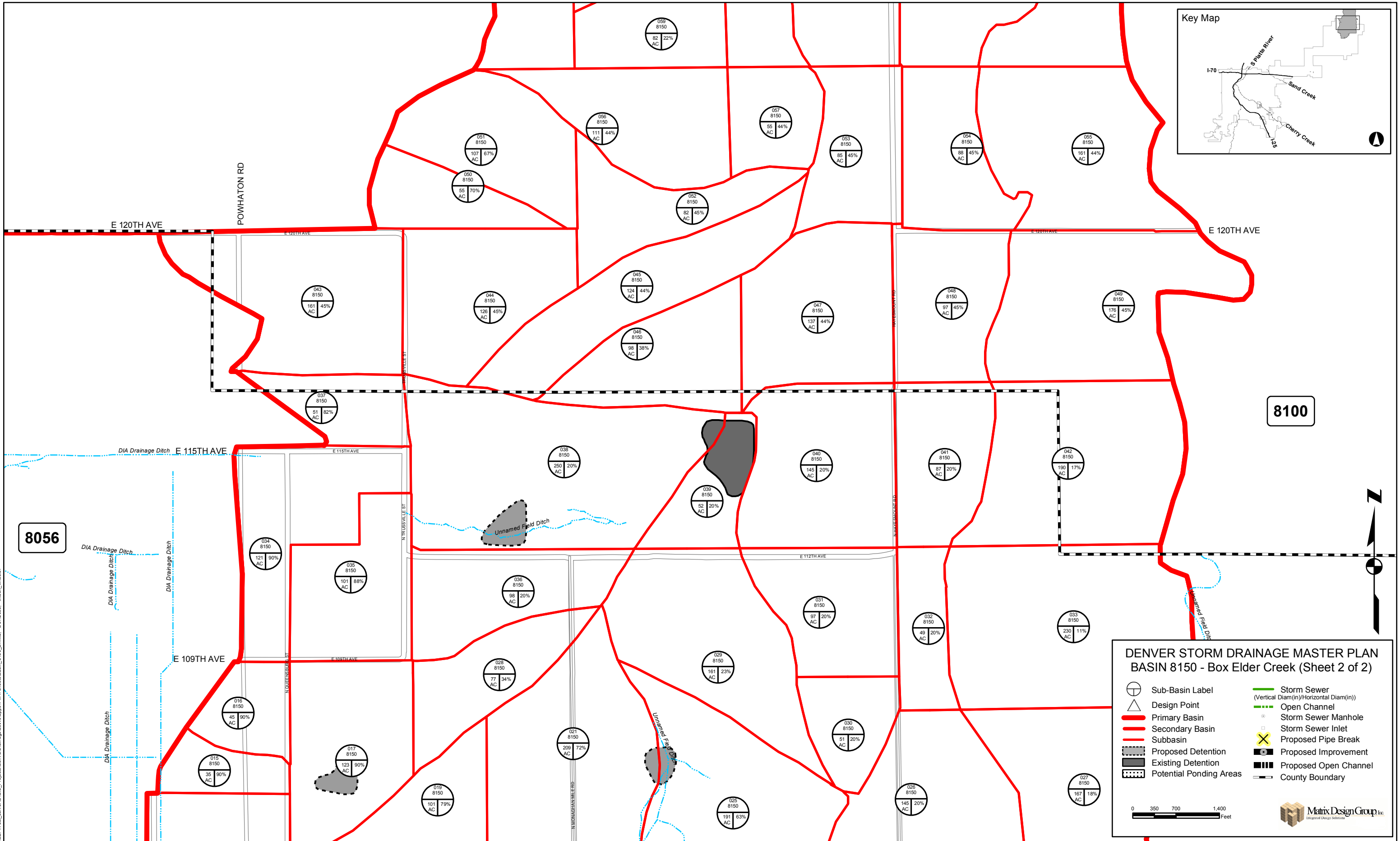
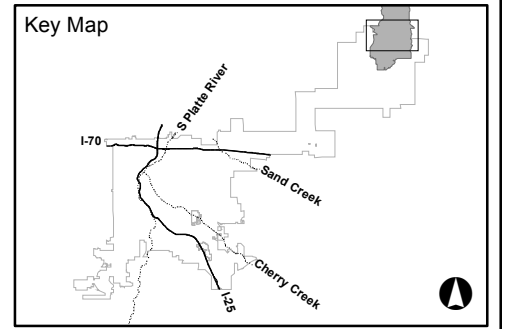
## **Basin: 8150 (Lower Hayesmout)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.

and

Reference “Preliminary Design Report for Lower Box Elder Creek Watershed,” by Wright Water Engineers, Inc., dated October 2001.

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8056

8100

**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 8150 - Box Elder Creek (Sheet 2 of 2)**

	Sub-basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1400 Feet

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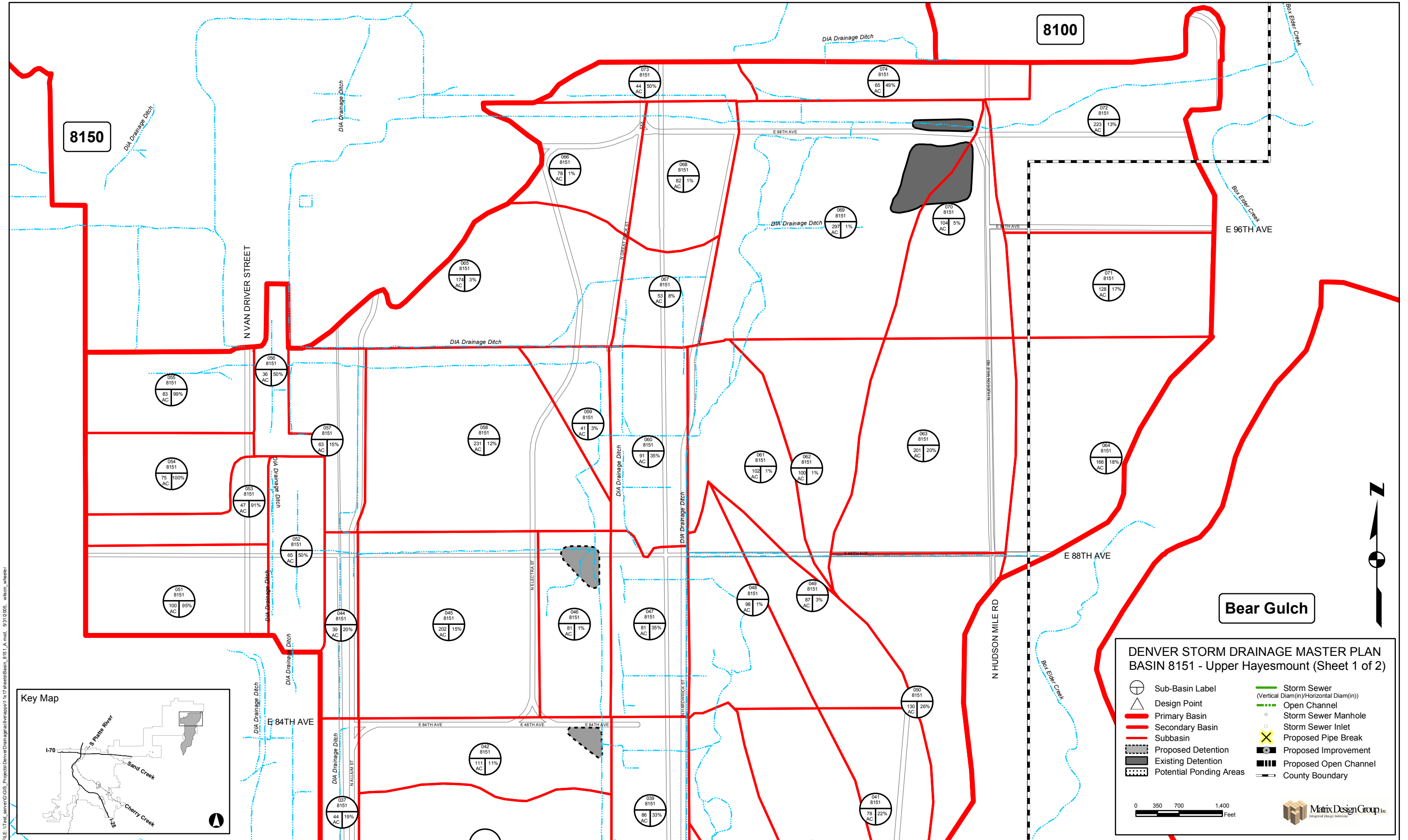
## **Basin: 8151 (Upper Hayesmount)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.

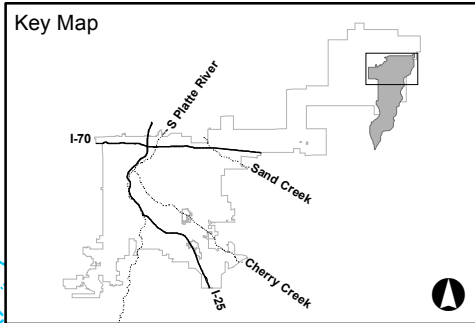
and

Reference “Preliminary Design Report for Lower Box Elder Creek Watershed,” by Wright Water Engineers, Inc., dated October 2001.

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**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 8151 - Upper Hayesmount (Sheet 1 of 2)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1400 Feet

**Matrix Design Group Inc.**  
Integral Design Solutions

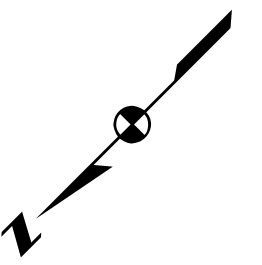
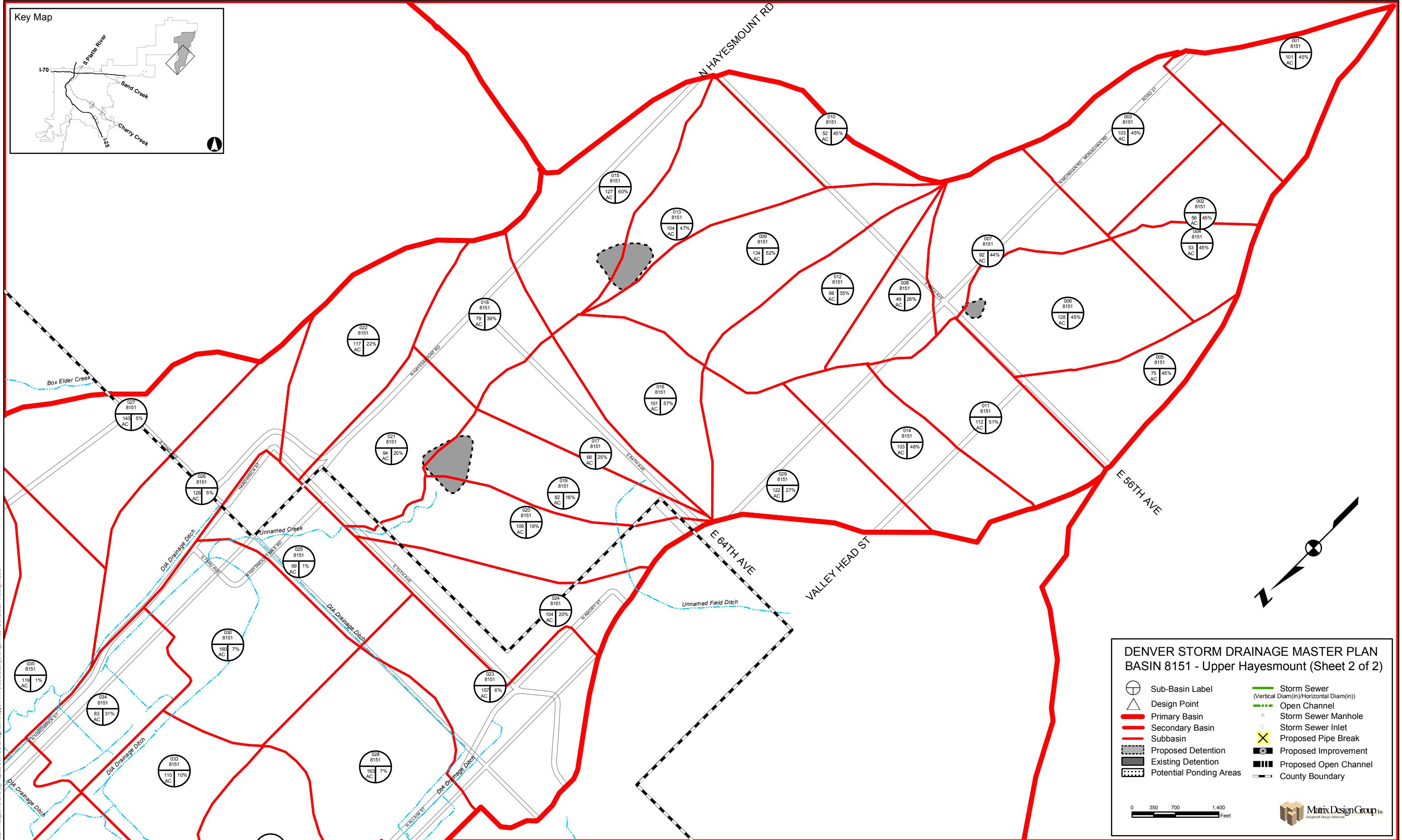
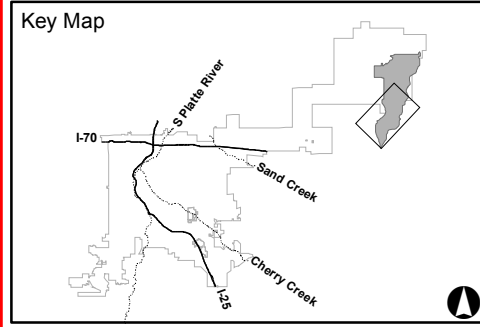
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## **Basin: 8151 (Upper Hayesmount)**

Reference “Denver International Airport, Drainage Master Plan – Part Three Analysis of Full Development Plan, Final Report,” by Martin/Martin, dated June 2004.

and

Reference “Preliminary Design Report for Lower Box Elder Creek Watershed,” by Wright Water Engineers, Inc., dated October 2001.



**DENVER STORM DRAINAGE MASTER PLAN  
BASIN 8151 - Upper Hayeshmount (Sheet 2 of 2)**

	Sub-Basin Label		Storm Sewer (Vertical Diam(in)/Horizontal Diam(in))
	Design Point		Open Channel
	Primary Basin		Storm Sewer Manhole
	Secondary Basin		Storm Sewer Inlet
	Subbasin		Proposed Pipe Break
	Proposed Detention		Proposed Improvement
	Existing Detention		Proposed Open Channel
	Potential Ponding Areas		County Boundary

0 350 700 1,400 Feet

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