### Acknowledgements

This project was supported and developed by the efforts of leaders and staff at the City and County of Denver, a consulting team, and numerous stakeholders and citizens.

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Executive Summary

Background

The Platte to Park Hill Stormwater Systems program is focused in the near-term on the northern neighborhoods of Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Five Points and Northeast Park Hill. These neighborhoods are within two of the top priority drainage basins, the Montclair Basin and the Park Hill Basin, within the City and County of Denver. The Montclair Basin is the city’s largest basin (10.9 square miles) without a defined open waterway. The Park Hill Basin is approximately 5.75 square miles and also is served by a deficient storm drainage system. Both of these basins experience a high flood risk because they are large in size, fully developed, relatively flat, and both lack an adequate ‘backbone’ drainage system. Stormwater modeling shows that during moderate to large storm events, the existing pipe systems reach capacity and the excess runoff is carried on the surface at depths of three feet or more on many streets over multiple city blocks. Several hundred properties are shown to be at-risk during a major event. The estimated flood risk in the Montclair Basin alone is in the hundreds of millions of dollars. The estimated flood risk during lesser storms is also significant for both basins.

The Platte to Park Hill Stormwater Systems program is made up of four distinct projects under the Two Basin Drainage Project and the Globeville Landing Outfall project. The collective aim of these projects is to provide improved flood protection, better control stormwater, provide community amenities/parkland (where appropriate), and improve water quality. The four projects are detailed below.

Globeville Landing Outfall Project

1. Globeville Landing Outfall – Drainage design, park re-design, and water quality.

Two Basin Drainage Project

2. 39th Avenue Open Channel and Greenway - Linear open space and greenway incorporating an open stormwater channel, recreational trail and water quality in the Cole and Clayton neighborhoods.
3. Montclair Basin detention – Location to collect, control, and temporarily hold stormwater and provide water quality.
4. Park Hill Basin detention and conveyance – Location to collect, control, and temporarily hold stormwater and provide water quality.

Figure 1 below graphically depicts the general location of the Two Basin Drainage Project and the Globeville Landing Outfall project. The focus of this alternatives analysis is on the Two Basin Drainage projects. However, information on the Globeville Landing Outfall is referenced within this document from a technical standpoint because it is hydrologic and hydraulically connected to the Two Basin
Drainage project’s alternatives and solutions. This alternatives analysis focuses only on the 39th Avenue Open Channel, Montclair Basin Detention and Park Hill Basin Detention. Collectively, these three projects are known as the Two Basin Drainage Project.

**Figure 1. Platte to Park Hill Stormwater Systems Project Context Map**

**Project Goals**

Project goals were established to guide the decision-making throughout the process. From discussions with stakeholders and through many community and public meetings, a series of goals were established for the projects. These goals informed the preferred plan.

1. **Provide a base system for the protection of areas of the Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Five Points, River North and Northeast Park Hill neighborhoods impacted by the Montclair and Park Hill drainage basins up to and including a 100-year flood event.**
2. **Provide new community amenities that are integrated into the urban context.**
3. **Enhance multimodal connectivity.**
4. **Restore functionality to the Montclair and Park Hill drainage basins and increase nature and ecology within these basins to the South Platte River.**

5. **Involve and engage the community in an inclusive process and gear the project toward their neighborhood well-being and best interests.**

6. **Keep the project on schedule and on budget.**

**Public Process**

A three phase public process was conducted with a strong emphasis on stakeholder and neighborhood involvement. These phases included 1) information gathering, analysis and project framework, 2) establishing potential design criteria and creation of alternatives, and 3) screening alternatives and development of a preferred plan. Throughout the process, feedback from over 1,700 stakeholders was received. Additionally, a Stakeholder Working Group helped guide the process and input at five community/public meetings that was incorporated into the project.

Feedback received during the process included the concern about property impacts, desire for water quality, need for neighborhood connectivity, and the desire for a transparent and collaborative on-going relationship.

**Alternatives Analysis**

Extensive hydrologic analysis, environmental evaluations and neighborhood planning were completed on both the Montclair and Park Hill Basins to develop alternatives.

Through the extensive hydrologic analysis, the project identified two key drainage concepts to manage the Montclair Basin’s runoff from the area upstream (south) of 39th Avenue:

- Provide stormwater capture and conveyance within the Cole and Clayton neighborhoods in order to intercept and convey surface flows toward the South Platte River. The stormwater will outlet to pipes under the railroad tracks at approximately 40th Street and Blake Street, to the Globeville Landing Outfall Project.

- Provide stormwater detention within the middle to lower portion of the basin to slow down and temporarily hold stormwater. The two feasible locations for stormwater detention are within the Cole neighborhood (between 39th and 40th) or at City Park Golf Course.
Additionally, two key drainage concepts were identified to handle the Park Hill Basin’s 100-year runoff from the area upstream (south) of Smith Road:

- Provide formalized regional detention at the northeast corner of the privately owned Park Hill Golf Club. A majority of the surface flow within the western portion of the drainage basin naturally flows north through the golf course to this existing low point where water naturally collects. This project proposes to utilize this natural collection point and provide enough detention volume to allow the planned 84-inch Park Hill Phase V pipe to handle the 100-year event west of Forest Street. The owner of the golf club property, the Clayton Trust, is a willing land owner in this discussion.

- From the low point detention area near 38th and Holly Street, an east-west storm drain system is proposed to convey flows in excess of the existing Forest Street outfall’s capacity. The pipe will convey stormwater to the west into the proposed Park Hill Golf Club detention facility. This diversion of stormwater will allow the Forest Street outfall to handle the 100-year event from the east.

**Preferred Plan**

The recommended plan is comprised of elements of work in the Park Hill Basin, at City Park Golf Course, and in the 39th Avenue area of the Cole neighborhood in the lower Montclair Basin.

**Montclair Basin**

The team recommends City Park Golf Course to temporarily hold and slow stormwater during major storm events. Outside of periods during and immediately after rainfall events, the golf course area will remain dry. The detention area will be integrated into an updated design of the golf course. Detention in the golf course will significantly protect more homes and businesses, minimize property impacts, and create a better opportunity to minimize future infrastructure cost, and provide more opportunity for water quality.

In addition, the team recommends the 39th Avenue open channel from Franklin Street to Steele Street in the Cole and Clayton neighborhoods to safely collect and convey the stormwater to the South Platte River.

**Park Hill Basin**

In addition to the formalized detention needed within the Park Hill Golf Club, the team recommends implementation of 39th Avenue pipe alignment alternative to convey the stormwater from the Holly detention area to the new Park Hill Golf Club detention area.
Introduction

Preface
In the summer of 2015, the City and County of Denver (City) began the Platte to Park Hill Stormwater Systems program. This program is the overarching structure for multiple projects examining improvements to storm drainage and flood protection in the neighborhoods north and east of downtown Denver. The Platte to Park Hill Stormwater Systems program encompasses multiple drainage and flood protection projects including the Two Basin Drainage Project and the Globeville Landing Outfall Project. Through these projects, the City is taking a comprehensive approach to better protect people, facilities, infrastructure and property against flooding through better management of stormwater while improving water quality in the neighborhoods of Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Five Points and Northeast Park Hill.

When rain falls on the neighborhoods in the Montclair and Park Hill Basins, the water generally flows south to north through the neighborhoods trying to make its way to the South Platte River. Both the Montclair and Park Hill Basins are fully developed and all of the natural waterways that would typically slow and control the stormwater have been built over during the City’s early development. While the existing storm sewer system works to address water from typical storms, medium and larger storms have the potential to overwhelm these systems. This results in flooding of the low lying areas in many neighborhoods throughout the Montclair and Park Hill Basins. With no natural waterways, changing weather patterns, and limited natural areas to collect stormwater; the likelihood of catastrophic flooding persists. Therefore, the City is taking this opportunity to advance projects to begin to prepare for storm events in the City’s most at-risk neighborhoods north and east of downtown.

Report Purpose
The purpose of this report is to document the Two Basin Drainage Project’s Conceptual Planning Alternatives Analysis (part of the Platte to Park Hill Stormwater Systems program). The Two Basin Drainage project is specifically focused on identifying technical solutions to improve flood protection and manage stormwater in both the Montclair and Park Hill drainage basins. Drainage basins are large geographic areas where rainfall collects and flows because the shape of the land (topography) directs the stormwater to low lying areas (typically rivers, gulches, and other waterways).

An alternatives analysis is a process where multiple potential solutions are evaluated to eliminate options that do not adequately meet the goals of the project or other criteria set by the project team and stakeholders. This narrowing of options ultimately results in the identification of the preferred plan of technical solutions. The evaluation process utilizes both quantitative and qualitative criteria to compare and contrast the benefits of each option. Each criterion is developed based on the projects’
purpose and need. The process is further informed by input received from project stakeholders at key milestone points in the evaluation.

The alternatives analysis for the Two Basin Drainage project followed a multi-stepped process including:

- Clarifying the project problem, purpose, and need and establishing goals.
- Researching context information, background, existing and planned drainage improvements, and modeling potential future flooding potential.
- Seeking public and stakeholder input to inform the evaluation process at key decision points throughout the process.
- Identifying the full range of potential technical solutions to improve flood protection and better manage stormwater within the two drainage basins.
- Comparing and contrasting the potential solutions to ultimately identify the recommended set of technical solutions (the preferred plan).

Report Organization

This alternatives analysis document is structured in six core chapters with additional technical backup included in the appendices. The information in each chapter provides context for the subsequent chapters. A brief description of each chapter is provided below as a preface to the document.

- **Introduction** – The first chapter provides a general guide to the alternatives analysis and the key considerations that led to the development of this analysis.
- **Project Context and Process** – The chapter presents the project study area and documents the background information and studies researched to fully understand the study area. This chapter also presents the multi-stepped process of the alternatives analysis to arrive at the recommended technical solutions.
- **Project Purpose and Need** – This chapter defines the flooding problem that the Two Basin Drainage project is focused on beginning to solve. Additional research and data are presented related to the City’s existing flood protection needs, existing flooding, and the modeling of future flood potential.
- **Alternatives Description** – This chapter details the criteria used to compare and contrast the concepts considered to address the projects’ purpose and need.
- **Montclair Basin Alternative Analysis and Evaluation** – Montclair Basin alternative concepts are described, analyzed and evaluation outcomes are provided.
- **Park Hill Basin Alternative Analysis and Evaluation** – Park Hill Basin alternative concepts are described, analyzed and evaluation outcomes are provided.
- **Preferred Plan** – The chapter sets out the priority solutions identified through the evaluation process. A summary of the key technical points and stakeholder input that informed the process is provided.
Background

The Platte to Park Hill Stormwater Systems program is focused in the near-term on the northern neighborhoods of Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Five Points and Northeast Park Hill. These neighborhoods are within the two priority drainage basins, the Montclair Basin and the Park Hill Basin. The Montclair Basin is the city’s largest basin (10.9 square miles) without a defined open waterway. The Park Hill Basin is approximately 5.75 square miles and also is served by a deficient storm drainage system. Both of these basins experience a high flood risk because they are large in size, fully developed, relatively flat, and both lack an adequate ‘backbone’ drainage system. Stormwater modeling shows that during moderate to large storm events, the existing pipe systems reach capacity and the excess runoff is carried on the surface at depths of three feet or more on numerous streets over multiple city blocks. Several hundred properties are shown to be at-risk during a major event. The estimated flood risk in the Montclair Basin alone is in the hundreds of millions of dollars and the estimated flood risk during lesser storms is also significant for both basins.

The Platte to Park Hill Stormwater Systems program is made up of four distinct projects under the Two Basin Drainage Project and the Globeville Landing Outfall project. The collective aim of these projects is to provide improved flood protection, better control stormwater, provide community amenities/parkland (where appropriate), and improve water quality. The four projects are detailed below.

Globeville Landing Outfall Project

1. **Globeville Landing Outfall** – Drainage design, park re-design, and water quality.

Two Basin Drainage Project

2. **39th Avenue open channel and greenway** - Linear open space incorporating an open stormwater channel, recreational trail and water quality in the Cole neighborhood.

3. **Montclair Basin detention** – Location to collect, control, and hold stormwater and provide water quality.

4. **Park Hill Basin detention and conveyance** – Location to collect, control, and hold stormwater and provide water quality.

Figure 2 graphically depicts the general location of the Two Basin Drainage project and the Globeville Landing Outfall project. The focus of this alternatives analysis is on the Two Basin Drainage project. However, information on the Globeville Landing Outfall is referenced within this document from a technical standpoint because it is hydrologic and hydraulically connected to the Two Basin Drainage project’s alternatives and solutions. This alternatives analysis focuses only on the 39th Avenue Open Channel, Montclair Basin Detention and Park Hill Basin Detention. Collectively, these three projects are known as the Two Basin Drainage Project.
Project Goals

The Two Basin Drainage Project include conceptual planning for drainage improvements that are near-term and have funding identified. The outcomes of this alternatives analysis focuses not only on addressing the drainage challenges in the Montclair and Park Hill Basins, but also, using these drainage projects as a catalyst for other community improvements like pedestrian and bicycle connectivity, new park space, and other amenities. All of these considerations are reflected in the goals for the Two Basin Drainage Project.

The key goals of the project include:

1. Provide a base system for the protection of areas of the Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Northeast Park Hill and River North neighborhoods impacted by the Montclair and Park Hill drainage basins up to and including a 100-year flood event.
2. Provide new community amenities that are integrated into the urban context.
3. Enhance multimodal connectivity.
4. **Restore functionality to the Montclair and Park Hill drainage basins and increase nature and ecology within these basins to the South Platte River.**

5. **Involve and engage the community in an inclusive process and gear the project toward their neighborhood well-being and best interests.**

6. **Keep the project on schedule and on budget.**

A 100-year flood event is a potentially catastrophic flood if appropriate drainage facilities and open drainageways are not in place to effectively manage and control the stormwater. A 100-year flood event has a 1% change of happening in any given year. Managing a 100-year flood event in the Montclair and Park Hill Basins can be accomplished by developing a series of related stormwater improvements including natural open channels to control and move stormwater, new stormwater pipes, and detention areas (typically green spaces designed to collect and temporarily hold stormwater).

Additional details on the project goals are provided in the Alternatives Description chapter.
Project Context and Process

Study Areas

The Platte to Park Hill Stormwater System program is aimed at addressing stormwater issues within two distinct drainage basins – the Montclair Basin and the Park Hill Basin. These two basins sit adjacent to each other and exhibit similar physical characteristics, drainage patterns, and land uses. Figure 3 generally shows how stormwater moves across the multiple drainage basins within the City. The topography of an area defines the basin and attempts to move stormwater to the low points, typically towards rivers, gulches, and other waterways.

Figure 3. Denver Drainage Basins

Montclair Basin

The Montclair Basin encompasses a total area of approximately 10.9 square miles. Flows from the basin generally travel from southeast to northwest, with the upstream limit of the watershed located at the Fairmount Cemetery near the intersection of South Quebec Street and East Alameda Avenue.

The Montclair Basin is fully developed and land use varies 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 basin. The overall imperviousness of the basin is measured at 48% based on the City’s “Imperviousness layer” in Geographic Information Systems (GIS) database.

The basin maintains a fairly consistent width of approximately 1.5 miles with a length of approximately 6 miles. Soils within the basin are generally classified as being part of hydrologic soil group C throughout the basin, which have low infiltration rates when thoroughly wetted and consist primarily of soils with a layer that impedes downward movement of stormwater. Topography within the study area is generally flat with grades ranging from 1% to 5%.

Stormwater runoff in smaller events is conveyed through the basin through an existing system of storm pipes. During larger storm events the existing pipes reach capacity and excess runoff is conveyed primarily by the streets as surface flow. Most of the basin lacks a formal drainageway to convey this excess stormwater. In the lower basin there are numerous obstacles that impede drainage and split surface runoff in at least two directions, such as railroad embankments, local roadways, highways, and underpasses. These surface flow “splits” combined with the basin’s outfall pipes conveying stormwater in various directions creates a relatively complex lower drainage basin. In general, at 40th Avenue, storm drain pipes convey stormwater west under the Union Pacific rail yards and under Brighton Boulevard to the South Platte River. Surface flows continue to the north through the Elyria and Swansea residential neighborhoods and surrounding commercial/industrial areas.

In the center portion of the basin, stormwater is conveyed through City Park, where Ferril Lake detains a portion of the excess runoff during moderate to large storms.

In the upper basin, generally described as south of Ferril Lake, there exists a series of underground pipes, many of which capture and convey less than the 1-year storm event. In addition, there are two primary surface flow paths – one along Hale Parkway, and the other along 16th/Colfax Avenues and Monaco Parkway.

**Montclair Basin Outfall and Detention Descriptions**

The Montclair Basin discharges to the South Platte River through a single outfall, a 10’ x 10’ reinforced concrete box culvert, located in Globeville Landing Park approximately 500 feet northeast of the intersection of 38th Street and Arkins Court. Just upstream of the Park along 40th Street, the outfall pipe is comprised of a 120-inch diameter circular brick pipe which was constructed in 1933. The Globeville Landing Outfall project includes pipe upgrades, water quality improvements and a park re-design which are considered existing conditions for the purposes of this report.

During flood events, surface flows that bypass this primary outfall at Globeville continue to the north under I-70 through the Elyria and Swansea neighborhoods.

Two regional detention ponds are located within the Montclair Basin. The first is Ferril Lake located in the southern end of City Park. Improvements were made to Ferril Lake in 2006/2007 to provide a 5-year
detention volume for the basin. Low flows bypass the lake through a 96-inch diversion pipe and continue north, but as the pipe surcharges during larger storm events, excess stormwater enters the lake through an underground spillway structure. After the lake acts as a peak-shaving facility during the storm event, excess stormwater stored in the lake flows back out the inflow pipe into the 96-inch diversion pipe once hydraulic pressures in the pipe subside. The second detention facility is a relatively small facility in Crestmoor Park near the upper end of the basin at Monaco Parkway and Cedar Avenue.

There are many local private detention ponds in Montclair as well. Most of these ponds are the result of new developments which are greater than 1.0 acres in size with an increased imperviousness; the ponds are necessary for the development to conform to city code to not adversely impact downstream properties with increased runoff and to provide water quality. These detention ponds are not accounted for in the hydrologic modeling because they are typically too small to have a regional benefit, and more importantly, because the City cannot guarantee that they are maintained and functioning properly.

**Park Hill Basin**

The Park Hill Basin encompasses a total area of approximately 5.75 square miles with majority located within the City boundaries and is fully developed. Topography within the study area is generally mild with grades ranging from 0.5% to 2%. Existing pipe systems collect and convey stormwater generally north to outlets at Park Hill Pond (near 53rd Avenue & Steele) as well as at Sand Creek near Dahlia Street. When the area’s stormwater pipes are at capacity and cannot accept more water, stormwater flows overland through streets, yards, parks, businesses, etc. The overland flows of stormwater generally travel from south to north, entering the South Platte River approximately 2,500 feet downstream of Brighton Boulevard, east of York Street.

Most of the basin lacks a formal drainageway to convey stormwater. Several of the existing storm drain pipes terminate at the Denver city limit, where a small and somewhat informal drainage channel moves stormwater through Adams County to the South Platte River. However, throughout the basin there are numerous obstacles that impede drainage and split surface stormwater flows in at least two directions, such as railroad embankments, local roadways, highways, and underpasses.

The Park Hill Basin includes a mix of industrial and residential land uses. The upper portion of the basin above (south of) 38th Avenue is primarily residential, while the lower basin (north of 38th Avenue) includes mostly industrial and commercial land use. The overall imperviousness of the basin is measured at 63% based on the City’s GIS “Imperviousness layer” and Blueprint Denver’s anticipated land uses.

**Park Hill Basin Outfall and Detention Descriptions**

The Park Hill Basin has one primary surface flow outfall to the South Platte River through Adams County along the Union Pacific and Rock Island Railroads east of York Street. The outfall channel is relatively small with an approximate bottom width of 10 feet and depth of approximately 2 feet, and it crosses several railroad embankments and the Burlington Ditch through a series of small culverts before
reaching the South Platte River. There are several other pipe conveyance outfalls that serve the Park Hill Basin, including a 120-inch diameter pipe in Magnolia Street, a 90-inch diameter Park Hill storm drain system, and a 42-inch diameter pipe along York Street serving the western portion of the lower basin.

Within the Park Hill Basin, two regional detention ponds have been constructed by the City in the past several years to help reduce peak flow rates. The first was the 38\textsuperscript{th} and Holly Detention Pond which was constructed in 2007 which outfalls to the Magnolia Street storm drain system. The second was the Park Hill (Triangle) detention pond, which is designed to reduce flow rates leaving the City jurisdictional boundary and heading into Commerce City.

There are many local private detention ponds in Park Hill as well. Most of these ponds are the result of new developments which are greater than 1.0 acre in size with an increased imperviousness; the ponds are necessary for the development to conform to city code to not adversely impact downstream properties with increased runoff and to provide water quality. These detention ponds are not accounted for in the hydrologic modeling because they are typically too small to have a regional benefit, and more importantly, because the city cannot guarantee that they are maintained and functioning properly.

Related Planning Efforts, Studies and Reports

\textit{Related Planning Efforts}

The following related planning efforts were either ongoing or completed recently within or adjacent to the study areas. The planning team coordinated with each of these efforts to ensure consistency:

- Elyria & Swansea Neighborhoods Plan (2015)
- Globeville Neighborhood Plan (2015)
- National Western Center Master Plan (2015)
- 40\textsuperscript{th} & Colorado Next Steps Study (ongoing)
- 38\textsuperscript{th} & Blake Height Amendments Planning Process (ongoing)
- Brighton Boulevard Design and Construction (ongoing)
Technical Studies and Reports Referenced

**Park Hill Basin**

Drainage studies, as-built plans for storm drains, and regional detention facilities designs were gathered from local agencies and the following were used as references for this study:

- Park Hill Storm, Phase III As-Builts, Falcon Surveying, August 20, 2007.
- East Corridor Drainage Master Plan, RTD, October 2008.
- Sand Creek (4400-02) and Upper Park Hill (0060-01, 4400-02, & 4500-01) Basins Final Drainage Study, Atkins, July 2011.
- RTD East Corridor Storm Sewer Plan and Profile, Denver Transit Partners, May 16, 2012.
• I-70 PCL MATT Technical Memorandum – Park Hill Drainage Basin Hydrologic Analysis, Enginuity, August 1, 2014.
• City and County of Denver Storm Drainage Master Plan (SDMP), September 2014.
• Park Hill Storm, Phase V, Draft 65% Construction Plans, the City, December 3, 2015.

Montclair Basin
Drainage studies, as-built plans for storm drains, and regional detention facilities designs were gathered from local agencies and the following were used as references for this study:

• 40th Avenue Corridor Infrastructure Improvement Study, Sellards & Grigg, July 2002.
• East Corridor Drainage Master Plan, RTD, October 2008.
• RTD East Corridor Storm Sewer Plan and Profile, Denver Transit Partners, May 16, 2012.
• Montclair Creek Drainage Feasibility Evaluation, Denver Public Works, June 30, 2014.
• City and County of Denver Storm Drainage Master Plan (SDMP), September 2014.
• National Western Center Master Plan, March 9, 2015.
• DRAFT - Lower Montclair Basin Outfall Systems Plan (ongoing/in-progress), Enginuity, May 2016.
• DRAFT – the City and Urban Drainage and Flood Control District (UDFCD) Globeville Landing Outfall Design Report, Merrick, (ongoing/in-progress).

Planning Process
The conceptual planning process began in summer 2015 and lasted approximately nine months continuing through early 2016 and included three primary phases of work (see Figure 4):

1. Information gathering, analysis and developing a project framework.
2. Establishing potential design criteria and creation of alternatives.
3. Screening of alternatives and development of the preferred plan.

A key part of the process involved gathering stakeholders together for multiple community meetings, small group meetings, and one-on-ones for stakeholders to bring their unique thoughts, perspectives and priorities to the planning process. The stakeholders provided input in multiple ways at each step in
the process helping to establish potential design criteria, select alternatives and influence the preferred plan.

**Figure 4. Planning Process**

Information Gathering, Analysis and Project Framework

The first step in the process involved gathering all available information and data relating to the project areas, conducting an in-depth analysis, and identifying goals and objectives to guide the process and decision making.

Information was gathered through a variety of methods including meetings with City staff, reviewing past planning efforts and reviewing previous technical analysis. Base mapping information was collected using GIS layers that were obtained from the City, UDFCD, and from other public sources including the Colorado Department of Transportation (CDOT) and the U.S. Geological Survey.

Analysis was conducted through an iterative process compiling and overlaying base information in order to better understand existing conditions, environmental considerations and the opportunities and constraints within all alternatives.

Lastly, during this phase of work, a project framework was established that identified project principles, goals and objectives to guide the process and inform decision-making during the analysis of the alternatives.
Establishing Potential Design Criteria and Creation of Alternatives

The second phase of work included establishing potential design criteria for the alternatives to be analyzed and the creation and development of alternatives.

- An initial broad look was completed throughout the entire general study area to identify drainage improvement alternatives to address our project needs. From there, detention locations were further studied and analyzed to identify the feasible locations.
- The goals and objectives created during the first phase of work directly informed the creation of the potential design criteria which were used to screen the alternatives.
- Final design criteria will be established in the next phase of the project.

Screening Alternatives and Development of Preferred Plan

The third phase of work began with screening the conceptual planning alternatives and initial screening was completed and more detailed design alternatives were developed which were also screened. Finally, the preferred plan emerged and next steps were outlined.

Public Outreach and Engagement

The planning and public engagement process included meetings and input from over 1,700 community members. At key milestones during the process, Stakeholder Working Groups (SWG) meetings were held, as well as five (5) public/community meetings.

Additionally, the outreach strategy included other methods used to both inform and engage the public. More information on each of these methods can be found in the appendix.

- Stakeholder interviews and one-on-one outreach
- Community leader engagement
- Stakeholder Working Group meetings
- Public meetings
- Registered Neighborhood Organization and community organization meetings
- Block information sessions
- Community tours
- Program webpage and digital resources
- E-Newsletters
- Media outreach
- Community partnership program
- Multicultural outreach
The 9-month process was organized into three major tasks: Information Gathering and Analysis, Creation of Alternatives and Preferred Plan. Precedent projects, plans, sections, three-dimensional renderings of the proposed concepts were developed to convey the design ideas.

Throughout the process, the team gathered extensive feedback on all aspects of the Platte to Park Hill Stormwater Systems program. Through comment forms, emails, telephone hotline messages and input at meetings, the following themes emerged:

- **Cole Neighborhood Detention**: Prior to the removal of option 1B\(^1\) (see Alternative Development and Evaluation chapter), a great number of community members were concerned with the amount of homes that could be impacted with this alternative. They stated the Cole Neighborhood option should not be considered and prefer the alternative with the least amount of impact to homes.

- **City Park Golf Course Detention**: Community members expressed some preference for this alternative over detention in Cole because it has less impact to homes and private property and protects a larger area from flooding, while others were concerned about the potential impact associated with detention in the golf course including its historic designation and impact to trees.

- **Connectivity Enhancement**: Numerous community members stated the importance of increasing and prioritizing bicycle/pedestrian connections, specifically in the Cole/Clayton neighborhoods.

- **Program Communication and Program Pace**: Prior to the outreach extension in the last two months of the alternatives analysis phase, community members were concerned that this is a fast-paced program and there was not sufficient time to provide adequate feedback.

- **Environmental Justice**: Several community members expressed concern that the program was targeting the Cole neighborhood because of its ethnic diversity and lower socio-economic residents.

- **Water Quality and Environmental Health**: Community members are interested in how stormwater improvements will affect water quality and what type of environmental and public safety considerations need to be made.

\(^1\) Since the removal of option 1B concerns over loss of private property have subsided
• **Alternative Development:** Community members were curious if all possible detention options had been vetted before narrowing to the two known alternatives in the Lower Montclair Basin.

• **Relationship to Other Projects:** Many community members raised questions about how the program relates to other significant infrastructure projects in the area like the expansion of I-70, RTD’s A-Line, future development at the National Western Center and private development in the area.

• **Partnership and Communication:** Attendees believed an ongoing, transparent, collaborative relationship with the City is crucial to the success of the program (beyond the conceptual planning phase).

This stakeholder feedback and the key themes that emerged guided the project team and City on the decision of the preferred plan.
Purpose and Need

Two Basin Drainage Project Purpose and Needs Statements

Purpose Statement:
The purpose of the Two Basin Drainage Project is to provide drainage system improvements resulting in increased flood protection within portions of the Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Five Points and Northeast Park Hill neighborhoods. The focus of the project is to provide up to 100-year flood protection where practicable. The infrastructure improvements created through these projects will form a ‘backbone’ drainage system for projects (planned or future) to continue to build upon with additional improvements to provide more areas within the Montclair and Park Hill Basins with 100-year flood protection.

Needs Statement:
The needs for the Two Basin Drainage Project is documented in multiple planning documents, historic flooding reports, multiple drainage project assessments, and future flood modeling conducted by the project team. Past planning efforts have identified historic flooding and inadequacies in the existing stormwater system as referenced in the Elyria/Swansea Neighborhood Plan, the 2014 Stormwater Master Plan, and the Draft Lower Montclair Outfall Systems Plan. As the largest drainage basins in the City with limited or no open drainageway to collect and move stormwater flows, the Montclair and Park Hill Basins have been identified as the most at-risk for catastrophic flooding. The Montclair Basin is fully urbanized and the Park Hill Basin has limited undeveloped lands. While the City is implementing a program city wide to develop green infrastructure (City streets, buildings, etc.) and new development/redevelopment must address their individual stormwater impacts on site; these efforts are simply not significant enough on their own to address the stormwater challenges present in the Montclair and Park Hill Basins. The probability of a storm that may cause significant impacts to property and life grows each day and the City must begin to address these challenges as quickly and responsibly as possible.

Purpose and Needs - Supporting Research, Analysis, and Documentation

Before the founding of Denver, the Montclair and Park Hill Basin areas had open creeks and gulches that moved stormwater through the basins to the South Platte River (where Elyria and Swansea neighborhoods are today). But as Denver has grown from a city of about 130,000 in 1900, to over
660,000 today, the demand for property has increased. Homes, businesses, streets, and industry have developed over these naturally flowing drainageways. Figure 5 shows the alluvial sand, silt, clay and gravel within the Montclair and Park Hill Basins which is typical streambed material. Most basins in Denver still have creeks and gulches that provide natural open channel drainage for stormwater; however, this is not true of the Montclair and Park Hill basin. The natural drainageways were replaced with pipe systems which may have been adequate at the time, but are no longer sized to safely handle today’s flows. The pipes collect only the minor events, or less depending on location. The larger events are conveyed by the streets generally along their natural paths. The difference today is that stormwater flows through densely populated residential and commercial neighborhoods at levels that can flood property and have severe impacts to the surrounding neighborhoods.

**Figure 5. USGS Geological Survey (USGS, 1979). Alluvial soils shown in yellow.**

Stormwater deficiencies are not confined to only Montclair and Park Hill. There are numerous other drainage basins and drainageways across the city that require major upgrades as well. However,
Montclair and Park Hill have been identified as a high priority because they have the highest flood risk to life and property.

**Flood History**

**Park Hill Basin**

On August 17, 2000, Denver Firefighter Bob Crump died in the line of duty after rescuing a woman from floodwaters in the vicinity of East 49th Avenue and Colorado Boulevard. Bob and fellow firefighters were directing traffic during a flash flood at East 50th Avenue and Colorado Boulevard when they saw a woman stranded and clinging to a metal post. The two waded into the intersection to retrieve the woman, but Crump was pulled under by the swirling stormwaters of a submerged 36-inch storm drain.

Less than a month before Crump’s death, local business people had complained to the City about drainage problems and flooding near the site. They were told that the storm sewer system for that area was not due for overhaul for several more years. Crump’s death has prompted significant talks among the City staff and fire chiefs about safety practices.

Elsewhere in the basin, major drainage problems have been experienced along Vasquez Boulevard near Sand Creek, along York Street, and at the Denver Water Recycle Plant located in Adams County just downstream of the City’s boundary. The Smith Road corridor has also experienced flooding, including failure of the Union Pacific Railroad embankment on August 18, 2004 west of Colorado Boulevard. Further upstream in the basin, several extensive flooding events have been observed at 38th and Holly, along 36th Avenue, along Niagara Street, along the 3300 block of Olive Street, and at 30th and Quebec.

**Montclair Basin**

Widespread flooding has been documented throughout much of the Montclair Basin over the past 100-years including the significant flood events in 1912, 1933 and 1965. In 1886, construction began on both City Park and the Denver Union Stock Yard Company stockyards, and since this time, the Montclair Basin has continued to urbanize. Because watershed science was not part of the planning and design process when these significant public investments were constructed and the urbanization began, little thought was put into regional stormwater management. It wasn’t until after the flood of 1965 that regional approaches were considered.

Within the basin, there are numerous sump areas that exist today and experience relatively frequent flooding. Most notably, the Coca-Cola bottling plant located near the intersection of Race Street and 38th Avenue has reported frequent flooding at their facility. Also, frequent street flooding is reported along High Street north of City Park and along 17th Avenue on the south side of City Park. Higher in the basin, flooding has been reported on East Severn Place between Jersey Street and Jasmine Street, along 16th Avenue between Dahlia Street and Glencoe Street, Colfax Avenue between Glencoe Street and Ivy Street, and along 14th Avenue between Jasmine Street and Krameria Street. Stormwater surging out of manholes along Hale Parkway has also been reported.
The evolution of hydrologic modeling software has advanced significantly over recent years. In 2009 the first application of FLO-2D (see Figure 6) software was used to map flood risk in Denver’s urban areas. This advancement allowed experts and city officials to understand the flood risk in much greater detail and this type of analysis is what was used for this process.
Figure 6. Montclair and Park Hill FLO-2D
Storm Drainage Master Plan

The City’s Storm Drainage Master Plan (SDMP) is updated every 5 years to capture and memorialize the findings of studies that are ongoing during the intervening years between updates. The SDMP identifies high level needs (i.e. larger pipe systems), however these are based upon city-wide, master plan level guidelines that can fall short of providing the City’s desired level of service in large basins without defined open waterways. In those cases, it is necessary to evaluate in more detail, on a smaller scale, to determine more precise basin-level system needs that meet the City’s stormwater criteria. These next level studies are called Outfall Systems Plans (or OSPs) and are typically co-sponsored with the UDFCD and the recommendations and findings for system needs and upgrades are incorporated in the next master plan.

The SDMP is not a static document. For example, the 2014 SDMP update captured and memorialized the findings of studies that were done after the 2009 SDMP was adopted, including studies on Cherry Creek, the Marston Lake North Drainageway, and the analysis of the Park Hill drainage basin (finalized in 2011).

The ongoing Montclair Outfall Systems Plan, which includes Platte to Park Hill Stormwater Systems as a backbone drainage system, will be finalized in 2017 and the recommendations of this plan will fold into the 2019 SDMP. Similarly, the 2019 SDMP update will capture and memorialize the findings of studies that are currently underway, including those for Dry Gulch, Harvard Gulch, Weir Gulch, and the Montclair and Park Hill drainage basins.

For several years, the City has been working on a number of ways to address the stormwater issues and has been increasing the size of storm sewer pipes, requiring developers to address stormwater associated with their properties, slowing stormwater down in parks/open space, and requiring reconstructed or new streets to incorporate methods to slow and address stormwater. While these efforts have a benefit, and are helping, they do not have a large enough impact by themselves to solve the drainage issues the City is facing (especially in the Montclair and Park Hill Basins). The City must be prepared for major storms to avoid loss of life, homes, and businesses. The lack of storm drainage facilities to slow and better manage larger storms not only causes damage and is expensive, but can be dangerous. Therefore, the City is taking a comprehensive approach to better protect people and property against flooding which improving water quality.
Alternatives Description

Project Description
The project team developed a cohesive project description to unify and align the project’s alternatives and evaluation process and to identify that this effort would be aligned with past and concurrent efforts and would leverage the mutual benefit of other agencies’ partnerships with the City. The statement was developed by the team and then reviewed with the City leadership and project stakeholders.

PROJECT DESCRIPTION
The Two Basin Drainage Project will provide enhanced multimodal connectivity, innovative placemaking and urban design, much needed 100-year flood event protection, and other neighborhood improvements to portions of the Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Five Points, and Northeast Park Hill communities. The project is a collaborative effort being led by the City and County of Denver and capitalizes on partnerships with the Colorado Department of Transportation, the Regional Transportation District, and the Urban Drainage and Flood Control District.

Montclair Basin

Existing Conditions
The Montclair Basin has an existing 120-inch storm drain that runs diagonally northwest under City Park, the Denver Zoo and City Park golf course. From 26th Avenue, the backbone drain conveys flow north in High Street to Franklin Street. At Franklin Street, the pipe turns north/northwest and runs in 39th Avenue to Blake Street. The backbone system is then tunneled under the railroad tracks, underneath Brighton Boulevard at roughly 41st Avenue, through the Pepsi Bottling Plant, and into Globeville Landing Park where there is an outfall, over the Metro Wastewater Sewer Lines, to the South Platte River. The existing 120-inch backbone drain is capable of handling only minor storms; in some locations this is less than the 2-year event. During larger events, the existing system fills to capacity and excess runoff spills into the neighborhood streets.

In the Cole neighborhood, to the east of the pipe system in High Street and along 39th Avenue, exists an abandoned railroad line, known as the “Market Lead,” which was between York and Steele Streets and then turns to the north near Monroe Street. This former rail alignment has been purchased by the City to provide east/west connectivity for storm infrastructure and multimodal transportation.

Drainage Concepts
The Platte to Park Hill Stormwater Systems program proposes to manage the Montclair Basin’s runoff from the area upstream (south) of 39th Avenue utilizing two key drainage concepts:
• Provide stormwater capture and conveyance within the Cole and Clayton neighborhoods in order to intercept and convey surface flows toward the South Platte River. The stormwater will outlet to pipes under the railroad tracks at approximately 40th Avenue and Blake Street, to the Globeville Landing Outfall Project.

• Provide stormwater detention within the middle to lower portion of the basin to slow down and temporarily hold stormwater.

Within the Cole and Clayton neighborhoods, the collection and conveyance of stormwater was identified to be approximately along the 39th Avenue alignment due to the ability to utilize that City-owned property and the proximity to the pipe connection and outfall to the South Platte River. For this alignment, pipe (closed) system and open channel system options for the following segments of 39th Avenue were evaluated:

• Blake to Franklin
• Franklin to High
• High to Race
• Race to York
• York to Steele

The collection of stormwater was also identified in the north/south segments of Clayton Street just north of 40th Avenue and along the north/south alignment of the Market Lead tying into the 39th Avenue alignment. Analysis and evaluations were also completed for these segments.
Figure 7. Montclair Basin Drainage Concept

Park Hill Basin

Existing Conditions
Since 2000, the City has spent millions of dollars to improve drainage in the Park Hill Basin. The previous drainage systems had capacity in some locations to convey less than the 1-year storm event to the outfall. Major outfall systems are commonly constructed from downstream to upstream and since 2000, seven projects in northeast Elyria/Swansea and Northeast Park Hill have been constructed on an incremental basis, starting at Sand Creek and the South Platte River, and moving upstream (south) into the basin. The Park Hill projects have consisted of detention and pipe conveyance, and extend to 48th Avenue and Dahlia. The next phase of construction, called Park Hill Phase V, is proposed on Dahlia Street from 48th Avenue to Smith Road.

Additional stormwater detention is also needed in the Park Hill Basin to retain excess runoff and meter it out slowly within the capacity of the storm pipes. The privately owned Park Hill Golf Club is at an ideal location to detain stormwater due to its location as a natural low point in the basin.

Drainage Concepts
The Platte to Park Hill Stormwater Systems program proposes to handle the Park Hill Basin’s 100-year runoff from the area upstream (south) of Smith Road utilizing two key drainage concepts:

- Provide formalized regional detention at the northeast corner of the privately owned Park Hill Golf Club. A majority of the surface flow within the western portion of the drainage basin
naturally flows north through the golf course to this existing low point where water naturally collects. This project proposes to utilize this natural collection point and provide enough detention volume to allow the planned 84-inch Park Hill Phase V pipe to handle the 100-year event west of Forest Street. The owner of the golf club property, the Clayton Trust, is a willing land owner in this discussion.

• From the low point detention area near 38th Avenue and Holly Street, an east-west storm drain system is proposed to convey flows in excess of the existing Forest Street outfall’s capacity. The pipe will convey stormwater to the west into the proposed Park Hill Golf Club detention facility thereby allowing the Forest Street outfall to handle the 100-year event from the east. The pipe alignments identified and studied as part of this analysis include the following:
  - Pipe alignment within Smith Road
  - Pipe alignment within 41st Avenue and Forest Street
  - Pipe alignment within 39th Avenue and Forest Street

Figure 8. Park Hill Basin Drainage Concept
Criteria and Constraints

The following criteria and constraints were considered as part of the alternative development and evaluation process.

Criteria

Prior to beginning work on the alternatives, the project team also developed a focused mission statement along with project goals and objectives built off of the purpose and need. These items were used by the team throughout the alternative development process as criteria for the evaluation process.

MISSION STATEMENT

To create an innovative community amenity for North Denver that reduces flood potential, creates a vibrant public realm, provides enhanced multimodal connectivity, and reconnects the Montclair and Park Hill drainage basins and their ecologies to the South Platte River.

Project Goals and Objectives

1. Provide a foundation for the protection of areas of the Elyria, Swansea, Cole, Clayton, Skyland, Whittier, Five Points and Northeast Park Hill neighborhoods impacted by the Montclair and Park Hill drainage basins up to and including a 100-year flood event.
   • Integrate innovative stormwater management strategies while improving water quality and increasing public safety.
   • Be imaginative when reconfiguring of the right of way, public and private lands.
   • Provide detention that is a community asset and multi-functional.

2. Provide new community amenities that are integrated into the urban context.
   • Be responsive to existing land uses, existing businesses and future development.
   • Provide a vibrant public realm and active edges with economic development opportunities.
   • Include urban design elements that are responsive to the character of the neighborhoods.
   • Increase outdoor spaces for recreation and gathering.
   • Create flexible, multi-functional spaces to be used year-round.
   • Recognize and respond to historic resources in the study area.
3. **Enhance multimodal connectivity.**
   - Improve the quality and comfort of the pedestrian environment.
   - Increase connectivity to existing bike and trail systems.
   - Increase connectivity to transit.
   - Look for opportunities to improve and reconnect the urban grid.

4. **Restore functionality to the Montclair and Park Hill basins and increase nature and ecology within these basins to the South Platte River.**
   - Where possible, create an open channel corridor that recreates the historic drainage basin that was lost to development.
   - Increase the quality and quantity of habitat for urban ecologies.
   - Improve water quality to contribute to the restoration of the health of the South Platte River.
   - Provide water quality green infrastructure enhancements throughout the drainage basins.

5. **Involve and engage the community in an inclusive process and gear the project development toward their neighborhood well-being and best interests.**
   - Create a unified vision that is supported equally by residents, businesses and developers.
   - Be mindful of the community fabric.
   - Cultivate ownership of the plan so that the community can take pride in it as their own.
6. **Keep the project on schedule and on budget.**
   - Identify the community’s interests and needs and make decisions to help achieve those interests and needs.
   - Consider the interrelationships between this and other projects.
   - Strategically phase project elements to achieve best long-term community benefit.
   - Thoroughly analyze all feasible (technical, constructible) options to understand the comparative benefits and costs.

**Constraints**

Implementation of alternatives may face multiple challenges including, but not limited to, right-of-way acquisition, cost, constructability, long term maintenance issues, technical feasibility, environmental impacts, and public acceptance. These constraints have been considered as part of the development process. In some cases, avoidance of one or more of these challenges may not be possible, but solutions to these challenges presented in this document will allow for implementation when available.
Montclair Basin Alternative Analysis and Evaluation

Detention Alternatives

As stated previously, stormwater detention in the Montclair Basin is a requirement in order for the City to control, capture, and manage the flow of stormwater through the basin. The amount of stormwater that flows through this basin in a 100-year event requires approximately 200 acre-feet of detention within the basin. (An acre-foot is a volume of water equal to one-foot depth of water over one acre.) This approximate amount of detention is a baseline value from stormwater modelling and assumes basic fundamentals like formalized detention in large open areas along the major thalwegs (line of lowest elevation within the drainageway), not dissected into smaller detention basins and/or onto high lands where efficiency in storage and timing can be lost and additional volume may be required.

Providing detention within the Montclair Basin allows for the following potential benefits to the community:

- Opportunities for water quality: With the poorest water quality in Denver, this basin would significantly benefit from the chance to incorporate water quality elements into new facilities.

- Opportunity to reduce flooding for neighborhoods: Depending upon the location and design of the detention facility, the proposed improvements may provide flood reduction potential for portions of the basin.

- Opportunity to create new public open space amenities: Detention facilities require large amounts of land, which in turn provides opportunity for the creation of open space amenities for surrounding neighborhoods.

As part of the initial development of the Two Basin Drainage Project, a range of stormwater detention location options within the Cole and City Park neighborhoods were studied and narrowed to the feasible options. (See Figure 9) Once the feasible options were determined, a more detailed evaluation was completed.
These neighborhoods were studied due to their location as low points within the Montclair basin and can be identified in the map and a description of each area's suitability is as follows:

1 - **Union Pacific Railroad (UPRR) Intermodal Rail Yard** – This area was deemed unsuitable due to the known complexities with UPRR, as well as the anticipated cost of purchasing the land.

2 - **Northwestern Industrial Properties** – This area was deemed unsuitable due to its limited size and proximity to the outlet pipe, not allowing this area to function like a typical detention area. Existing land uses include several industrial properties.

3 - **Properties North of Open Channel** – This area is hydrologically feasible and would be able to store the required volume of stormwater. Existing land uses include industrial, commercial and some residential.

4 - **Public Right of Way** – Though hydrologically feasible, this area was deemed unsuitable due to the limited volume of stormwater it could store. Additionally, it would greatly impact vehicular circulation through the area.

5 - **Cole Residential Neighborhoods** – Though hydrologically feasible and capable of storing the required volume of stormwater, this area was deemed unsuitable through conversations with Cole neighborhood leadership expressing concern over the impact to residential homes.
6 - **Properties East of York Street** – This area was deemed unsuitable due to the difficulty of conveying stormwater against natural grade to the site location. Existing uses include institutional, industrial and recreational.

7 - **Russell Square Park** – Though hydrologically feasible, this area was deemed unsuitable since it is not capable of storing the required volume of stormwater while continuing to function as a public park.

8 - **Morrison Park** – Though hydrologically feasible, this area was deemed unsuitable since it is not capable of storing the required volume of stormwater while continuing to function as a public park.

9 - **Fuller Park** – Though hydrologically feasible, this area was deemed unsuitable since it is not capable of storing the required volume of stormwater while continuing to function as a public park.

10 - **City Park Golf Course** – This area is hydrologically suitable by being directly in the path of primary stormwater flow, and would potentially be able to store the required volume of stormwater while maintaining primary functionality as a golf course; however, impacts to the golf course would need to be mitigated.

11 - **City Park Recreation Fields** – This area was deemed unsuitable due to the difficulty of conveying stormwater uphill against natural grade. The ballfields are upstream of the flow path and the elevation of the stormwater crossing 23rd Avenue is approximately 40-feet lower than the recreation fields. In addition to the difficulties in conveying the stormwater to the fields, the area is not large enough to store all the stormwater.

12 - **Ferril Lake** – The lake’s location is hydrologically suitable by being directly in the path of primary stormwater flow and it is currently used for stormwater detention. However, additional modification of this facility to detain additional flows are challenged by potential jurisdictional dam requirements, as well as historic and public concerns of changes to this beloved and cherished park amenity.

13 – **Riverside Cemetery** near Brighton Boulevard and York Street (not included on corresponding map) – Detention in Denver’s oldest operating cemetery has been inquired about by the public. It is a large, natural open area on the far north end of the basin. However, it is not a suitable location for flood risk reduction for either Montclair or Park Hill because its location sits too far north in the basin to provide any discernable protection. Detaining flow here would only reduce the impact to the South Platte River, which is not impacted by this project.

14 – **9th Avenue & Colorado** (not included on corresponding map) – The former and transitioning University of Colorado Health Sciences campus has been inquired about for detention by multiple Denver residents. This location is not suitable for regional detention for Montclair because it is located too far upstream in the basin to provide a significant benefit to the watershed.
Green Infrastructure (not included on corresponding map) - Green infrastructure (GI) has been found to reduce runoff for small frequent storm events, but not for major events. The City has recently completed a draft of its own Ultra-Urban Green Infrastructure guide and their benefits to water quality.

Feasible Alternatives

Through the evaluation process, considering all above options, two areas were identified as meeting the hydrologic (getting the stormwater to the site location) and volumetric (capacity to store the needed volume of stormwater) requirements for the project. These two areas were #3 and #10, Cole and City Park Golf Course, respectively.

Once the two feasible areas for detention were identified, a more detailed evaluation and range of options were studied to understand the opportunities and impact. For Cole neighborhood detention, four alternatives were further studied.

- Option 1a: detention located north of 39th Avenue and east of High Street
- Option 1b: detention located south of 39th Avenue and approximately between Williams Street and High Street
- Option 1c: detention located north of 39th Avenue between Williams Street and Race Street
- Option 1d: detention located north of 39th and east of York Street

For City Park Golf Course, three feasibility studies were completed to confirm that the stormwater requirements could be met while ensuring continued playability of the golf course. Opportunities and impacts to the golf course were also identified. The following explains this evaluation in greater detail.

Alternative 1 - Cole Neighborhood

Detention within this area would require a large detention basin located somewhere between Franklin and York (east/west) and 40th and 39th Avenues (north/south). The detention area would need to be roughly the size of three city blocks and would appear and function as a typical park with grass, trees and other landscaped areas. Amenities could include ballfields, walking paths, gatherings spaces and seating areas. Four initial detention locations were studied, (see Figures 10-13).
Figure 10. Cole Detention Option 1a

Figure 11. Cole Detention Option 1b

Figure 12. Cole Detention Option 1c
While all four options met the requirement for stormwater detention and were technically feasible, Option 1b had significantly greater impact to existing residential properties. Following discussions with the community and their concern about Option 1b, this was removed from further consideration leaving the area north of 39th Avenue and south of 40th Avenue as the potential area for detention. (See Figure 14)
The detention alternative in Cole would meet the requirements for stormwater detention, provide a new park amenity for the neighborhood and provide water quality opportunities. However, for this alternative the area north of 39th Avenue and south of 40th Avenue would still require multiple property acquisitions and would provide flood protection only for the neighborhoods north of 39th Avenue.

**Alternative 2 - City Park Golf Course**

Detention at City Park Golf Course would occur on the westerly portion of the course, where a low point exists within the basin and where stormwater naturally flows and collects today. The golf course can meet the requirements for stormwater detention (mostly dry area that slows down, collects and temporarily holds stormwater), without impacting other private properties while also providing more water quality opportunity. Additionally, providing detention within the golf course would minimize future downstream infrastructure costs.

However, redesigning the golf course to include detention will result in the loss of trees which would need to be replaced per the City tree replacement policy. The golf course would also not be playable while under construction which could be a 2-year timeframe.
To further test the feasibility of incorporating detention into City Park Golf Course, three golf feasibility studies were completed to ensure that the golf course could remain playable and meet the needs of the course users while also incorporating detention into the western portion of the golf course. As is common across many golf courses around the country, detention can be incorporated into the golf course maintaining the same look, feel and playability. The three feasibility studies show different locations for the clubhouse, golf course routing and other facilities. These feasibility studies are not intended to represent designs, but rather studies to determine opportunities and impact. Any design changes or updates to the golf course would include further public process.

To complete these feasibility studies, initial feedback was incorporated about the deficiencies and challenges of the golf course today, including the driving range being too small, limited room for First Tee (youth golf program) expansion to meet their growth goals, and the desire to add interest to the golf course.

The first feasibility study shown below in Figure 16 keeps the clubhouse, golf course routing and practice range in the existing locations, but regrades the western portion of the golf course to provide a
detention area during storm events. The detention area would be landscaped like a golf course and would also include trees within the detention area.

**Figure 16. City Park Golf Course Feasibility Study 1**

Because a portion of the golf course would be regraded to accommodate the detention, some of the existing trees would be impacted. Figure 17 below shows the area that would be impacted in Feasibility Study 1 which includes approximately 153 trees out of 872 total trees on the golf course. Of these trees, 47% are 12” or less in caliper. Trees would be replaced per the City tree replacement policy.

**Figure 17. City Park Golf Course Feasibility Study 1 – Tree Impact Areas**

The second feasibility study shown below in Figure 18 moves the clubhouse to a more central location within the overall golf course and adjusts the golf course routing accordingly and the practice range moves to a location closer to the new clubhouse. By moving these elements of the golf course, there is greater flexibility with the grading and design of the detention area. The detention area would be landscaped appropriately for a golf course and would also include trees within the detention area.
Figure 18. City Park Golf Course Feasibility Study 2

Figure 19 below shows the area that would be impacted in Feasibility Study 2 which includes approximately 280 trees out of 872 total trees in the golf course. Of these trees, 49% are 12” or less in caliper and trees would be replaced per the City tree replacement policy.

Figure 19. City Park Golf Course Feasibility Study 2 – Tree Impact Areas

The third feasibility study shown below in Figure 20 moves the clubhouse just west of the maintenance facility and adjusts the golf course routing accordingly and the practice range is reoriented with the new clubhouse location. By adjusting several elements of the golf course, there is greater flexibility with the grading and design of the detention area and also includes a natural stream through the golf course to channelize low flows. The detention area would be landscaped appropriately for a golf course and would also include trees within the detention area.
Figure 20. City Park Golf Course Feasibility Study 3

Figure 21 below shows the area that would be impacted in Feasibility Study 3 which includes approximately 246 trees out of 872 total trees in the golf course. Of these trees, 49% are 12” or less in caliper and trees would be replaced per the City tree replacement policy.

Figure 21. City Park Golf Course Feasibility Study 3 – Tree Impact Areas

The greatest benefit to locating detention in City Park Golf Course is the reduction of flooding for more neighborhoods within the Montclair Basin. Figure 22 below shows that the area in yellow, the secondary flood protection area, will also see additional protection with the detention located in City Park Golf Course. The purple area depicts the neighborhoods that will benefit from 100-year protection.
The two detention alternatives, Cole neighborhood and City Park Golf Course, were evaluated using a screening as typical in an alternatives analysis process. The screening criteria listed in Table 1 below are the same as the goals and objectives identified early in the process with the community and listed in the Alternatives Description chapter.
Table 1. Montclair Basin - Detention Location Screening

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
<th>Technical Outcomes</th>
</tr>
</thead>
</table>
| Provide a foundation for the protection of the areas of the Cole, Park Hill, River North, Elyria and Swansea neighborhoods impacted by the Montclair and Park Hill drainage basins up to and including a 100-Year flood event. | • Integrate innovative stormwater management strategies  
• Be imaginative when reconfiguring the right of way, public and private lands  
• Provide detention that is a community asset and multi-functional  
• Be responsive to existing land use, future development, and existing businesses | Innovation: 0 1  
Stormwater Control: 0 0  
Regional Flood Risk Reduction: 1 1  
Public Safety: 1 1  
Environmental Impact Minimization: -1 0  
Minimize Impacts to Private Property: -1 1 |
| Provide new community amenities that are integrated into the urban context. | • Provide a vibrant public realm and active edges with economic development opportunities  
• Include urban design elements that are responsive to the character of the neighborhood  
• Increase outdoor spaces for recreation and gathering  
• Create flexible, multi-functional spaces to be used year round  
• Recognize and respond to historic resources in the study area | Economic Development/Redevelopment Opportunities: 1 0  
Enhancement of Neighborhood Character: 0 0  
Creation of Quality Public Spaces: 1 1  
Cultural Resource Preservation: -1 -1 |
| Enhance multimodal connectivity in the area and reconnect the street grid. | • Improve the quality and comfort of the pedestrian environment  
• Increase connectivity to existing bike and trail systems  
• Increase connectivity to transit  
• Look for opportunities to improve and reconnect the urban grid | Multimodal Connectivity: 0 0  
Definition and Reconnection of the Transportation Network: -1 0 |
| Restore functionality to the Montclair and Park Hill basins and increase nature within these basins to the South Platte River. | • Where possible, create an open channel corridor  
• Increase the quality and quantity of habitat for urban ecologies  
• Contribute to restoring the health of the South Platte  
• Provide water quality green infrastructure enhancements throughout the drainage basins | Channel Creation: 1 1  
Biodiversity: 1 1  
Water Quality: 1 1 |
| Keep the project on schedule and on budget. | • Identify the community’s interests and needs and make decisions to help achieve those interests and needs  
• Consider the interrelationships between this and other projects | Alignment with Previous Plans: 0 0  
Long-term O&M: -1 0  
Constructability: 1 1 |
Strategically phase project elements to achieve best long-term community benefit

Thoroughly analyze ALL feasible (technical, constructible) options to understand the comparative benefits and costs

<table>
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<tr>
<th>Schedule Feasibility</th>
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<tbody>
<tr>
<td>Technical Feasibility</td>
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Scoring: 0=neutral, 1=good, -1=poor

### 39th Avenue Alternatives

Within the Cole and Clayton neighborhoods, the collection and conveyance of stormwater was identified to be approximately along the 39th Avenue alignment due to the ability to utilize that City-owned property and to outlet to pipes under the railroad tracks at approximately 40th Street and Blake Street, to the Globeville Landing Outfall Project. The character of the stormwater connection between Monroe Street on the east to the 40th/Blake Street area could vary based on hydrology and varying conditions within the 39th Avenue corridor. Consequently, this corridor has been divided up into “reaches” for purposes of analysis and decision-making. Each reach represents a location with different character, use, and stormwater demand. Different types of open channel and closed systems (pipe) were considered for each of the reaches.

Open channel and pipe alternatives have been analyzed for each reach and an open channel alternative would:

- Capture stormwater more quickly and efficiently, as stormwater is able to freely flow into the channel without drains or inlet structures.
- Guarantee capture of a major storm, as the system does not require drains or inlet structures which can get clogged or blocked.
- Promote easier and less costly maintenance because the facilities are easily accessible to maintenance personnel.
- Align with the Elyria & Swansea Neighborhood Plan by:
  - Providing opportunity for east/west bicycle and pedestrian connectivity.
  - Providing opportunity for creation of public amenity spaces.
  - Providing opportunity for water quality and habitat creation.

A closed system (pipe) would:

- Minimize property acquisition because pipes are generally located within public right-of-way.
- Maintain existing north/south transportation network.

Each reach between Blake and Monroe is described in additional detail below.
Reach 1: Blake to Franklin

Reach 1 is identified as Blake Street to Franklin Street which is a moderately trafficked public street with an existing 75’ right-of-way (ROW). Adjacent properties consist of industrial properties, many of which are currently under redevelopment into high density mixed-use developments. This area is also directly adjacent to the new commuter rail A Line station at 38th and Blake Street. This reach is very important in conveying stormwater to the outlet and under the tracks and approximately 40th and Blake Street.

Figure 23. Reach 1

- **Opportunities**
  - New commuter rail station at 38th and Blake provides opportunities to increase bike and pedestrian connectivity.
  - Proximity to commuter rail as well as new redevelopment make this reach an opportunity for urban place-making.
  - Existing public ROW reduces the need for property acquisitions.

- **Constraints**
  - Access to these industrial properties including many loading docks located along 40th Street.
  - A number of utilities are currently located within the right-of-way.

- **Alternatives**
  - Pipe
    - Existing utilities will make a new pipe alignment difficult.
    - No opportunity for water quality.
  - Open Channel
    - Existing ROW is not wide enough to accommodate the necessary peak flow rate of stormwater flows requiring property acquisition.
    - Vehicular connectivity needs to be maintained.
    - Limited surface flows in this reach do not require open channel for capture.
• Moving existing utilities would be cost prohibitive.
• Open channel would be beneficial for water quality purposes.

For each reach, both the pipe and open channel alternatives were screened. The screening criteria listed in Table 2 below are based on the goals and objectives identified early in the process with the community and listed in the Alternatives Description chapter.

Table 2. Blake to Franklin Screening

<table>
<thead>
<tr>
<th>Project Element</th>
<th>Project Opportunities</th>
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<tr>
<td>Open Channel</td>
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</tbody>
</table>

Scoring: 0=no opportunity, 1=minimal opportunity, 2=average opportunity, 3=high opportunity

Reach 2: Franklin to High

Reach 2 between Franklin Street to High Street is a low traffic local street with approximately 65’ public right-of-way. The north side of this reach includes Porta Power, a potentially historic industrial property and some commercial properties. To the south, there are several industrial storage yards along with single and multi-family housing. The residential properties to the south include some potentially historic structures.

Due to the amount of stormwater coming into this reach, we screened a 90’ open channel and a 120’ open channel. The 90’ open channel does not meet Urban Drainage criteria, however the 120’ open channel does.
Figure 24. Reach 2

- **Opportunities**
  - Proximity to commuter rail station creates an opportunity for increased bike and pedestrian connectivity.
  - Existing public right-of-way could reduce the need for property acquisitions.

- **Constraints**
  - Fully built out neighborhood requiring property acquisitions if more than existing right-of-way is needed.
  - Existing utilities are in the current ROW which might conflict with an open channel and could be costly to relocate.

- **Alternatives**
  - **Pipe**
    - Surface flows are too great to be captured by traditional inlet structures.
    - Minimizes property acquisitions.
    - No opportunity for water quality.
  - **90’ Open Channel**
    - Ability to adequately capture and convey surface flows into the area.
    - Would require some property acquisitions.
    - Does not fully meet Urban Drainage criteria for open channel due to the depth and fast moving flow.
  - **120’ Open Channel**
    - Would be able to adequately capture and convey surface flows into the area.
    - Would require the greatest amount of property acquisitions.
    - Meets Urban Drainage criteria for open channel design.
Table 3. Franklin to High Screening

<table>
<thead>
<tr>
<th>PROJECT ELEMENT</th>
<th>REGIONAL AND COMMUNITY PROTECTION</th>
<th>PHASED AESTHETIC IMPROVEMENTS</th>
<th>PUBLIC SAFETY</th>
<th>WATER QUALITY</th>
<th>PLACEMAKING (SINGLE VS. MULTIPLE-USE FACILITY)</th>
<th>BICYCLE/PEDESTRIAN CONNECTIVITY</th>
<th>VEHICULAR CONNECTIVITY</th>
<th>MINIMIZED ENVIRONMENTAL IMPACTS</th>
<th>CONSTRUCTABILITY</th>
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<th>PUBLIC &amp; AGENCY ACCEPTANCE</th>
<th>NUMBER OF REAL ESTATE ACQUISITIONS/EASEMENTS</th>
<th>OPERATIONS &amp; MAINTENANCE COSTS</th>
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</tbody>
</table>

Scoring: 0=no opportunity, 1=minimal opportunity, 2=average opportunity, 3=high opportunity

Reach 3: High to Race

Reach 3 between High Street and Race Street includes an existing 65’ right-of-way for the western portion of the reach with 39th Avenue stopping at the alley just east of Race Street. The western half of the block relates to the residential neighborhood while the eastern half transitions into large-scale industrial uses, including the Coca-Cola bottling plant. The High Street Bar, a community gathering place, is located on the southeast corner of High Street and 39th Avenue. The existing 120-inch storm sewer pipe runs north along High Street and turning west on 39th Avenue within this reach.

Due to the amount of stormwater coming into this reach, we screened a 90’ open channel and a 120’ open channel. The 90’ open channel does not meet Urban Drainage criteria, however the 120’ open channel does.
Figure 25. Reach 3

- **Opportunities**
  - Utilizing existing public ROW could reduce the need for property acquisitions.

- **Constraints**
  - At midblock between High and Race public ROW ends and the remainder of the block to the east is privately owned.
  - Most of the surface flows are coming down High Street since this is the lowest line of elevation.

- **Alternatives**
  - **Pipe**
    - Surface flows in this area are too great to be captured by traditional inlets.
    - Pipe would require an easement through private property.
    - No opportunity for water quality.
  - **90’ Open Channel**
    - The existing 120-inch storm sewer provides challenges to the open channel design.
    - Would require some property acquisitions.
    - Does not fully meet Urban Drainage criteria for open channel design due to depth and velocity.
    - Opportunity for water quality.
  - **120’ Open Channel**
    - 120’ is wide enough to hold the required volume while remaining shallow enough to get over the existing storm sewer and utilities.
    - Would require the most number of property acquisitions.
    - Meets Urban Drainage criteria for open channel.
    - Opportunity for water quality.
Table 4. High to Race Screening

<table>
<thead>
<tr>
<th>PROJECT ELEMENT</th>
<th>PROJECT OPPORTUNITIES</th>
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<tbody>
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<td>120' Open Channel</td>
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Scoring: 0=no opportunity, 1=minimal opportunity, 2=average opportunity, 3=high opportunity

Reach 4: Race to York

Reach 4 between Race Street and York Street has adjacent existing large industrial properties, including the Coca-Cola Bottling Plant. There is no existing public right-of-way within this reach.

Figure 26. Reach 4

• Opportunities
  • Opportunity for east/west bike/ped connection.
  • Limited impacts to residential properties due to predominantly industrial land use.
- **Constraints**
  - Existing utilities along the north side of the Coca-Cola bottling plant would be costly to move.
  - Public bike/pedestrian connectivity through the private properties creates security concerns.
  - The western part of this reach has large surface flows of stormwater during large events, while the eastern portion has lower flows.

- **Alternatives**
  - Pipe
    - Surface flows in the western part of the reach are too great to be captured by traditional inlets.
    - Surface flows in the eastern part of the reach are low enough to be captured by inlets.
    - Reduces impacts to existing land use.
    - Reduces property acquisitions.
    - Would require an easement through private property.
    - No opportunity for water quality.
  - Open Channel
    - The existing 120-inch storm sewer provides challenges to the open channel design.
    - Would require both full and partial property acquisitions.
    - Would impact Coca-Cola's operations by bisecting their property and leased property.
    - Access over the channel for Coca-Cola would need to be ensured.
    - Opportunity for water quality.

**Table 5. Race to York Screening**

<table>
<thead>
<tr>
<th>PROJECT ELEMENT</th>
<th>REGIONAL AND COMMUNITY PROTECTION</th>
<th>PHASED AESTHETIC IMPROVEMENTS</th>
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<th>PLACEMAKING (SINGLE VS. MULTIPLE-USE FACILITY)</th>
<th>BICYCLE/PEDESTRIAN CONNECTIVITY</th>
<th>VEHICULAR CONNECTIVITY</th>
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Reach 5: York to Steele

Reach 5 between York Street and Steele Street is considered the Market Lead with a 100’ right-of-way. This property was recently purchased by the City with primarily industrial properties to both the north and south side of the Market Lead. Bruce Randolph High School is located just north of the Market Lead along Steele Street. Surface stormwater in-flows in this area are fairly minimal.

**Figure 27. Reach 5**

- **Opportunities**
  - The existing Market Lead is wide enough to accommodate either an open channel or pipe (no additional property acquisition).
  - The Market Lead can be a key stretch of east/west connectivity for both cars and bike/peds connecting the 38th/Blake Station with the 40th/Colorado Station.

- **Constraints**
  - No north/south connectivity can be incorporated along this section of the Market Lead without acquiring properties.

- **Alternatives**
  - Pipe
    - Surface flows are low enough that it could be captured by inlets.
    - Provides land for more flexible programming.
    - No water quality.
  - Open Channel
    - Provides opportunities for water quality and habitat creation.
    - Provides opportunity for programmable amenity space.
Table 6. York to Steele Screening

<table>
<thead>
<tr>
<th>PROJECT ELEMENT</th>
<th>REGIONAL AND COMMUNITY PROTECTION</th>
<th>PHASED AESTHETIC IMPROVEMENTS</th>
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Scoring: 0=no opportunity, 1=minimal opportunity, 2=average opportunity, 3=high opportunity

Reach 6: Steele to Monroe

Reach 6 between Steele Street and Monroe Street is a low traffic local street with an existing 50’ right-of-way. Surrounding this area is a densely packed residential neighborhood of single-family homes transitioning to some industrial properties towards the east of the reach. Future mixed-use development is being planned for this area and the Market Lead curves to the north and connects to the future 40th and Colorado Station. Surface stormwater flow in this area is fairly minimal.

Figure 28. Reach 6

- **Opportunities**
  - With proximity to the commuter rail station, there is an opportunity to increase bike/pedestrian connectivity.
- At the point where the Market Lead curves, there is additional land available to create a new community amenity such as a park.

- **Constraints**
  - Limited width of existing ROW

- **Alternatives**
  - Pipe
    - Surface flows are low enough that it could be captured by inlets
    - No property acquisitions
    - No water quality
  - Open Channel
    - Provides opportunities for water quality and habitat creation
    - Would require additional property acquisitions

### Table 7. Steele to Monroe Screening

<table>
<thead>
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<th>PROJECT ELEMENT</th>
<th>REGIONAL AND COMMUNITY PROTECTION</th>
<th>PHASED AESTHETIC IMPROVEMENTS</th>
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*Scoring: 0=no opportunity, 1=minimal opportunity, 2=average opportunity, 3=high opportunity*

### Other Stormwater Collection Needs

**Clayton Street**

Clayton Street between 40th Avenue and the commuter rail tracks is a local street with approximately 60’ existing right-of-way. Surrounding this area is a combination of residential, commercial and industrial properties. In the Elyria Swansea Neighborhoods Plan, Clayton Street was identified as a future north/south multi-modal connection due to its strong north/south connectivity and the connection with the Swansea neighborhood.
Along Clayton Street there is a need to capture a fairly small amount of stormwater flows. Because the flows are minimal, it can be captured in inlets and the proposed pipe can be accommodated within the existing ROW.

**Monroe Street**
The extension of the Market Lead to the north is along the alignment of Monroe Street. The width of the Market Lead in this section varies but is approximately 140’ wide and surrounding this area is a combination of land uses with a majority of them being industrial and commercial. Monroe Street provides a connection into the 40th and Colorado Commuter Rail Station.

In this area, there is a need to capture a limited amount of stormwater flows. Because of the minimal flows and the opportunity for redevelopment in and around the station, the stormwater can be captured in inlets with the pipe accommodated within the existing Market Lead alignment (Monroe Street). However, this would require some impacts to properties just south of 40th. Upon further study of the area, Madison Street was identified as a possible alignment for the pipe because there would be less impact to private property.

**Water Quality Opportunities**
The Montclair Basin is approximately 8 miles long and covers approximately 10.9 square miles. Stormwater flows northwest through an extensive storm drain network with two existing outfalls to the South Platte River; one at Globeville Landing Park and a smaller pipe upstream near 38th Street. The outfall at Globeville Landing Park is currently listed as a designated priority outfall under Denver’s Municipal Separate Storm Sewer permit due to elevated levels of E.coli during dry weather discharges. As of 2015, no open natural channels (surface drainageways) are present in this basin other than the short open channel segment at the outfall, and the basin is drained entirely by the piped storm sewer system.

In addition to stormwater runoff that is discharged to the river through the outfalls, the Montclair Basin has significant dry weather discharges likely in part from irrigation overspray, groundwater infiltration, and sump pump discharges to the storm drainage system. Wet and dry weather discharges contribute to continuously moist conditions in the Globeville Landing Outfall pipe which provides an ideal environment in which E.coli (biofilms) persist.

To improve water quality in the basin, strategies that allow wet and dry weather discharges to infiltrate into the ground and reduce the volume of the stormwater in the system are necessary. This is accomplished through the use of green infrastructure. On a large scale, green infrastructure refers to a network of parks, open spaces, drainageways, and floodplains which mitigate the impacts caused by impervious surfaces. Site-scale green infrastructure refers to smaller, engineered practices that mimic larger green infrastructure systems. Both regional and on site–scale green infrastructure will be implemented in the Montclair Basin, including water quality facilities in parks, open channels, and green
streets. This combined approach will improve water quality in one of Denver’s largest basins with undersized and aging drainage infrastructure.

Montclair Basin Hydrology/Hydraulic Analysis

The Multi-Agency Technical Team (MATT) was formed as a partnership between the City and County of Denver, CDOT, RTD and UFDCD during the fall of 2013 to collectively investigate the Montclair Basin’s hydrology and other inter-agency coordination issues. While the Montclair Basin hydrology had been previously documented to varying degrees in several previous studies, including Denver’s SDMP, there was a general presumption that the previously published flow rates could be overly conservative. Specific factors including impervious values, inadvertent detention, Colorado Unit Hydrograph Procedure (CUHP) model discretization, and limited accounting for floodplain flow routing were investigated.

The overall goal of the MATT analysis was to perform a technical review of the Montclair Basin hydrologic analysis and modify the modeling, if necessary, to provide CDOT with a mutually agreed upon 100-year design flow rate flowing from the 10.9 square mile watershed toward the I-70 Partial Covered Lowering (PCL) project. Modeling was completed and documented in a technical memorandum in August 2014. The MATT modeling is the basis for existing conditions for the Platte to Park Hill Stormwater Systems program modeling effort. The memorandum entitled “I-70 PCL Montclair Drainage Basin Hydrologic Analysis” is provided in the appendix of this report. Additionally, this analysis and memorandum served as the basis of the Intergovernmental Agreement (IGA) entered into between the City and CDOT demonstrating a working relationship to efficiently utilize and leverage taxpayer dollars, save time, and minimize the duration of the disruption to neighborhoods.


In the summer/fall of 2014, initial sizing of the Platte to Park Hill Stormwater Systems program facilities began. Specifically, the engineering team evaluated required detention volumes and release rates for the 100-year storm event for the Montclair Basin. This initial sizing analysis estimated that the required detention volume in the 39th Avenue area would be between 120 acre-feet (ac-ft) and 200 ac-ft, with release rates to Globeville Landing Outfall ranging from 2,700 cubic feet per second (cfs) to 3,300 cfs. This modeling used kinematic wave routing inside of Urban Drainage Stormwater Management (UDSWM) only. The results of this analysis were documented in a draft memorandum “CCD I-70 PCL Alternative Drainage Concept” (December 22, 2014; see appendix).

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2 The MATT memo and the associated modeling were independently reviewed by CH2M under a separate contract with UDFCD.
Inadvertent Detention
The MATT evaluated inadvertent detention (storage and ponding of stormwater runoff naturally occurring within the watershed) in City Park in 2014. Specific areas included:

- City Park below (north of) Ferril Lake (Duck Pond Area) – 45.5 ac-ft
- City Park Golf Course – 41.8 ac-ft
- City Park Ballfields (west of Colorado Boulevard and south of 23rd Avenue) – 18.2 ac-ft. Due to the higher elevation of the ballfields and not within a low area for the entire basin, the ballfields are only able to capture and store localized stormwater.

Following discussions and coordination with the Parks Department at the City, two locations were formalized via a legal agreement that preserves the existing detention volumes as follows:

- City Park below (north of) Ferril Lake (Duck Pond Area) – 36 ac-ft
- City Park Golf Course – 41.8 ac-ft

These inadvertent detention volumes provide flow reduction downstream of City Park without any improvements or grading, now that these areas are modeled, recognized, and documented as formalized detention.

Concept Level Hydrology/Hydraulics (2015)
In the spring/summer of 2015, several initial design concepts for the proposed detention near 40th and Blake Street were developed. In support of the concept level designs, the design team updated the UDSWM model to provide a more detailed level of hydrology/hydraulic analysis with the routing and conveyance based on the IGA combined Drainage System map.

Initial estimates using UDSWM generated storage volumes that were close to 200 ac-ft based on a release rate from the Montclair detention facility of 3,300 cfs (1,200 cfs in the existing brick system and 2,100 cfs in the new Globeville Landing Outfall system). The release rate was later increased (see following section regarding Environmental Protection Agency [EPA]-SWMM modeling) to 3,600 cfs, assuming 1,200 cfs going to the old brick pipe system and 2,400 cfs going to the new system in Globeville Landing Outfall.

The inflow/outflow stormwater hydrographs for Storage Facility #1546 (a node in the model along 39th Avenue) is shown in Figure 29 which shows how storage acts to capture the peak runoff and releases it at a slower rate after the peak of the storm has past. The inflow hydrograph shows how an anticipated major storm would result in flooding lasting approximately 2½ hours. Stormwater detention would hold back some of that floodwater as shown in the pond outflow hydrograph.
To fully account for downstream hydraulics of the Globeville Landing Outfall system, including pipe losses, and to further confirm the size of the proposed detention and release rates, the design team developed an EPA-SWMM model instead of the UDSWM model of the Lower Montclair system, which is a newer and more robust hydrologic modeling software using defined elevations throughout the system. This model provided analysis extending from the end of the Globeville Landing Outfall stormwater pipes to the Montclair detention. Dynamic routing was used to better account for downstream backwater effects and provide a more realistic discharge curve for the detention facility. While the final configuration assumes a 3,600 cfs discharge rate, other discharge rates versus required stormwater detention volumes were evaluated. A graph of design discharge versus required detention volume is provided in Figure 30.
Key results of the EPA-SWMM model for the Montclair detention volume and associated release rate to Globeville Landing Outfall were similar to the UDSWM results as shown below:

- **39th Avenue Area Detention Volume =** 150 ac-ft minimum for peak shaving
- **39th Avenue Area Maximum Inflow Rate =** 4,651 cfs
- **39th Avenue Area Release Rate =** 3,585 cfs

**Montclair Upstream Detention**

**Summary of Upstream Detention**

The concept of providing detention higher in the drainage basin rather than along 39th Avenue was evaluated in a variety of locations throughout the upper portions of the watershed, with more specific study at City Park Golf Course due to the nature and complexity of golf course design. The evaluations built on the initial master planning level analysis developed for the Montclair Basin in July 2015.

At that time, the design team provided a high-level feasibility analysis of detention alternatives at City Park. All three areas previously evaluated for inadvertent detention were also considered as potential locations to provide additional storage volume. Modifications to Ferril Lake to increase stormwater detention were also considered. Brief assessments of each location were made for general feasibility and potential impacts to existing facilities.
It was determined that City Park Golf Course had the greatest potential for increased detention volumes. In its existing condition, surface flows for large rainfall events travel directly through the western edge of the golf course, and flooding depths are significant. The major storm drain trunk line for the Montclair Basin also flows directly through the golf course making for a simple system connection for any improvements.

Multiple configurations of the potential detention facility at City Park Golf Course were evaluated, including one that provides a moderate level of detention at City Park Golf Course which still required additional detention at the lower 39th Avenue area portion of the project, and another that maximized detention at City Park Golf Course and eliminated the need for detention in the 39th Avenue area of the Montclair Basin.

Table 8. Alternative Summary: City Park Golf Course Detention

<table>
<thead>
<tr>
<th>ALTERNATIVE</th>
<th>TOTAL DETENTION AT CITY PARK GOLF COURSE (AC-FT)</th>
<th>MAX. OUTFLOW FROM CITY PARK GOLF COURSE (CFS)</th>
<th>MAX. INFLOW TO 39TH AVENUE. AREA (CFS)</th>
<th>MINIMUM REQUIRED DETENTION AT 39TH AVENUE. AREA (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Conditions (no new detention at City Park Golf Course)</td>
<td>41.8</td>
<td>3716</td>
<td>4579</td>
<td>150 ac-ft (online) 100 ac-ft (offline)</td>
</tr>
<tr>
<td>Detention at both City Park Golf Course and 39th Avenue</td>
<td>120</td>
<td>3949</td>
<td>4254</td>
<td>118 ac-ft (online) 39 ac-ft (offline)</td>
</tr>
<tr>
<td>Detention at City Park Golf Course only</td>
<td>145</td>
<td>3573</td>
<td>3720</td>
<td>0 ac-ft</td>
</tr>
</tbody>
</table>
Detention at both City Park Golf Course and 39th Avenue

A refined analysis of original master planning level modeling for the detention facility at City Park Golf Course was performed. The previous modeling was updated with a stage-volume-discharge curve that was developed to represent a typical outlet structure at City Park Golf Course. Based on the team’s Alternative 1 grading of City Park Golf Course, the detained volume would be 120 AF. Impacts to the required detention at the lower Montclair project area (39th and Franklin Street) were evaluated based on both an on-line and off-line detention configuration.

- In an on-line configuration where the main drainage flows through the storage area, the required detention volume at the lower Montclair facility to ensure a 3,600 cfs outflow to Globeville Landing Outfall and the existing brick system would be 118 ac-ft. Without detention at City Park Golf Course, the total detention required at the lower Montclair area is 153 ac-ft.

- In an off-line configuration where the drainageway flows bypasses the storage area until reaching a defined threshold where it spills into the storage area, the required detention volume at the lower Montclair facility to ensure a 3,600 cfs outflow to Globeville Landing Outfall would be 39 ac-ft. Without detention at City Park Golf Course, the total detention required at the lower Montclair area is 100 ac-ft.

Detention only at City Park Golf Course

An alternatives analysis that attempted to minimize detention volumes at City Park Golf Course and eliminate detention storage along 39th Avenue was conducted using EPA-SWMM and using dynamic
wave routing. A concept storage volume grading plan was used as the basis for the EPA-SWMM detention modeling.

The alternatives analysis indicated the minimum amount of storage volume required at City Park Golf Course would be 145 ac-ft to reduce peak flows to match the conveyance capacity downstream by only functioning to reduce the peak of the 100-year flood event. This system reconfigured the existing storm drain system to flow around the proposed storage area, allowing flows up to approximately the 5-year event to bypass the storage facility. A water quality outlet allowing base flows to travel overland through the golf course could be added to this configuration to provide water quality treatment.

As part of this analysis, a review of how the storage area grading configurations impact storage volume was also completed. The results indicated that grading can have a significant impact on the required storage volumes, while producing similar peak discharges.
To further refine the feasibility analysis, the UDSWM model was modified to provide a more accurate representation of discharge curves from the proposed facility. The feasibility analysis used large pipe outfalls to control the release rate which allowed flow out of the detention area to essentially equal flow into the site with a maximum outflow. The original analysis did not consider downstream backwater, upstream headwater, and other hydraulic considerations.

To minimize detention for the City Park Golf Course, a broad crested weir was modeled to allow for larger flows to spill onto the surface and be conveyed through the streets at lower detention stages. The resulting storage discharge curve was input into the UDSWM model with a few adjustments for lower flows up to the tailwater elevation. Lower flows were calculated based on Manning’s equation for pipe capacity, and the stage/volume values were based upon the team’s Alternative 1 for City Park Golf Course (see Figure 33).
The minimum City Park Golf Course detention was revised upward to 160 ac-ft. Further refinements to the model changed the function of the City Park Golf Course detention from 100-year only, to also work at reducing flood damages in a 10-year event to the Cole community downstream of City Park Golf Course. By providing more frequent damage reduction and not just for the 100-year event, the conceptual design of storage volume in City Park Golf Course increased to 210 ac-ft. This increased storage volume is based upon the concept of storing runoff more frequently for water quality treatment and improved flood protection downstream in more frequent storm events.
Park Hill Basin Alternative Analysis and Evaluation

Alternatives

With the general detention location established as noted in the previous chapter, the team was tasked with the evaluation of the potential pipe alignments which would connect the existing detention pond at Holly and 39th to the new detention facility at the golf course.

Smith Road Alignment

Using Smith Road for the new pipe alignment would permit the utilization of existing stormwater infrastructure that runs north from the 38th and Holly detention facility down Grape Street and eventually connect into an existing pipe beneath Smith Road that runs west to Forest Street. From there, a new pipe and collection system would need to be constructed westward until it connects to the Park Hill Golf Club (approximately 1,400 linear feet).

The new pipe and collection system would significantly reduce surface flows crossing Smith Road to the north, but would not capture all surface runoff. Capturing all surface flows would require the construction of a floodwall, which would potentially raise the depth of flooding along Smith Road east of Forest Street and it would not provide any reduction in surface flows or flow depths to the south.

Additionally, integrating the new pipe and collection system into the Smith Road ROW would require careful design, including some relocation of existing utilities due to the significant number of utilities already in the ROW. It would also require the reconstruction of Smith Road, which was recently rebuilt as part of the commuter rail project and it would not require any private property acquisitions.

41st Avenue Alignment

Using 41st Avenue for the new pipe alignment would require that the new pipe be built exiting the 38th and Holly pond heading west along 39th Avenue to Forest Street. From there, the new pipe would head north along Forest until reaching 41st Avenue. At that point the flow would split, with a lesser portion of the flow heading north to connect to the existing infrastructure at Smith Road and the remainder would head west along 41st Avenue.

This pipe alignment would capture all surface flows without causing any adverse impacts. Its location to the south of Smith Road would also allow it to offer some additional flood protection to the properties located between 41st Avenue and Smith Road.
41\textsuperscript{st} Avenue is relatively free of utilities, which would allow the pipe to be constructed more easily and would minimize costs associated with utility relocation and it would not require any private property acquisitions.

\textbf{Rail Spur}

Using the rail spur for the new pipe alignment would require a new pipe to be constructed exiting the 38\textsuperscript{th} and Holly pond and heading west along 39\textsuperscript{th} to Forest Street. From there, a new pipe would head north along Forest Street until reaching the rail spur. At that point, the flows would split, with a lesser portion of the flow heading north along Forest in a new pipe. The remainder of the flows would continue west along the rail spur until reaching the golf course. This alignment discharges far enough south in the golf course that it may also require an open channel within the golf course to convey stormwater north to the detention pond. This open channel with the Park Hill Golf Club provides some opportunity for limited water quality.

This pipe alignment should capture all surface flows without causing any adverse impacts since it’s located as the option furthest to the south allowing it to offer additional flood protection to the largest number of properties compared to the other alternatives. The rail spur is all within private property requiring the acquisition of private property for this alignment to be utilized.

\textbf{39\textsuperscript{th} Avenue Alignment}

Using 39\textsuperscript{th} Avenue for the new pipe alignment would require a pipe to be constructed exiting the 38\textsuperscript{th} and Holly pond and heading west along 39\textsuperscript{th}. At Forest Street the flows would split, with a lesser portion of the flow heading north along Forest in a new pipe. The remainder of the flows would continue west into a pipe in the rail spur until reaching the golf course. This alignment empties far enough south in the golf course that it may also require an open channel within the golf course to convey stormwater north to the detention facility. This open channel with the Park Hill Golf Club provides some opportunity for limited water quality.

This pipe alignment should capture all surface flows without causing any adverse impacts. Its location as the option furthest to the south allows it to offer additional flood protection to the largest number of properties compared to the other alternatives.

39\textsuperscript{th} Avenue is relatively free of utilities, which would allow the pipe to be constructed quite easily and would minimize additional costs associated with utility relocation and it would not require any private property acquisitions.
Figure 34. Park Hill Pipe Alignment Alternatives

Park Hill Basin Hydrology/Hydraulic Analysis

The MATT also investigated the Park Hill Basin’s hydrology. Past modeling in Denver’s SDMP showed that excessive stormwater runoff can flow along Smith Road and drain into the Montclair Basin. The goal of the Park Hill study was to investigate solutions that manage 100-year flows in the Park Hill watershed without bypass flow into the Montclair Basin. The overall goal of the MATT analysis was to perform a technical review of Denver’s Park Hill Basin hydrologic analysis. Modeling was completed and documented in a full technical memorandum in August 2014. The MATT modeling is the basis for existing conditions for the Platte to Park Hill Stormwater Systems program modeling effort.

Park Hill Basin Overview

The Park Hill basin is primarily served by two storm drain outfalls in the project vicinity. A 120-inch pipe crosses I-70 at Forest Street and is served by the 38th & Holly detention facility further upstream (south) in the basin. A second 84-inch pipe outfall (Park Hill Phase V) is planned to cross I-70 at Dahlia Street but has not been constructed. Both of these systems convey the 5-year event in the underground (piped) system with excess runoff conveyed by surface flows draining to the South Platte River and Sand Creek.
The Stormwater Solutions project proposes to build upon the current system by utilizing two key drainage concepts:

- Provide formalized regional detention at the northeast corner of the Park Hill Golf Club. The City worked with the private land owner for Park Hill Golf Club to place a detention area in the northern portion of the golf course where stormwater naturally collects under existing conditions. A majority of the surface flow within the western portion of the drainage basin naturally flows north through the golf course to this existing sump location. The project proposes to utilize this natural collection point with formalized detention that releases at a controlled rate through the 84-inch pipe system in Dahlia.

- In the eastern portion of the basin, an east-west storm drain system is proposed to convey flows in excess of the existing Forest Street outfall’s capacity. The pipe will convey stormwater to the west into the proposed golf course detention facility. This diversion of stormwater will maximize the efficiency of the two systems by working hydraulically together.


In the summer and fall of 2014, initial sizing of the required drainage facilities began. Specifically, the engineering team evaluated required detention volumes and release rates for the 100-year storm event in the Park Hill Basin. This analysis was performed by first using the UDSWM and EPA-SWMM models developed by the MATT, and then modifying routing and infrastructure sizing. This initial sizing analysis investigated two separate scenarios as described below.

In 2014, initial estimates determined the required detention volume to be approximately 105 ac-ft, with release rates to the downstream pipe system (Park Hill Phase V) of approximately 400 cfs. This modeling used kinematic wave routing inside of UDSWM only. Dynamic modeling was not considered as part of this initial analysis, and simple Manning’s equation was used to estimate the outfall’s capacity.

Other improvements included the addition of a 12’x10’ box culvert in Smith Road with a capacity of up to 1,590 cfs to capture flows and deliver them to the Park Hill detention facility. The facility itself in this configuration, was to be a berm or wall on the outside of the golf course with little grading occurring on the golf course itself. The results of this analysis were documented in a draft memorandum “CCD Alternative Drainage Concept” (December 22, 2014; see appendix). As it was understood that this analysis was very high level, some potential modifications were noted in the memorandum that included:

- If the proposed collection system in Smith Road proves to be difficult, other east-west alignments can be investigated during design such as 41st, 39th, or 38th Avenues.

- An alternative alignment for the Park Hill Phase V alignment from Dahlia Street to the east side of Colorado Boulevard can be investigated during preliminary design.
In the spring and summer of 2015, additional configurations were investigated to evaluate both the downstream capacity of the Park Hill Phase V system and to evaluate how stormwater would be collected upstream in the basin and delivered to the Park Hill Golf Club detention facility. The first task completed as part of this work was to develop a basic volume versus release rate curve to evaluate a range of potential storage area sizes and outfall assumptions. Several conceptual grading plans were completed for the site. Approximate UDSWM kinematic wave modeling for a potential collection system along 38th Avenue and a connection to the existing 38th and Holly detention facility were completed. The system along 38th Avenue would require approximately 2,500 linear feet of additional box culvert compared to the Smith Road system.

In the fall of 2015, the design team completed more detailed dynamic modeling of the proposed Park Hill Golf Club detention facility and the collection system along Smith Road. A concept-level grading plan for the Park Hill Golf Club area was completed to function in conjunction with the Park Hill Phase V outfall as well as a proposed collection system in Smith Road.

**Park Hill Phase V Outfall Hydraulic Analysis**

Pipe analysis was completed using EPA-SWMM for the Park Hill Phase IV and V outfall system. A variety of pipe materials and sizes for Phase V were analyzed to determine the system’s potential full capacity. An option to allow the system to surcharge onto the street downstream (north) of I-70 was investigated, and resulting flow rates were documented. An 84” reinforced concrete pipe with no surcharging allowed (pressurized but hydraulic grade line (HGL) below ground level) was assumed for the outfall’s capacity of 450 cfs.

**EPA-SWMM Concept Level Model**

A small portion of the MATT EPA-SWMM modeling for the Lower Park Hill Basin was utilized and updated to reflect the proposed golf course detention and Smith Road collection system. The following outlines the model’s general parameters:

- Dynamic Wave flood routing was used to hydraulically connect the golf course detention and related backwater into the Smith Road collection system.
- Results from the previous Park Hill Phase V outfall system analysis were used as a fixed starting HGL elevation at Dahlia north of the project.
- Stage/storage information for the detention facility was incorporated into the model based on the concept level grading plans.

Results of the EPA-SWMM model for the Park Hill Golf Club detention facility volume and associated collection system and outfall release rates are:

- Park Hill Phase IV Outfall Release Rate = 448 cfs
• Smith Road Collection System Capacity (Interim and Final) = 1,588 cfs, 13’x10’ reinforced concrete box culvert

• Park Hill Detention Volume = 125 ac-ft

The inflow/outflow hydrographs for the proposed Park Hill Golf Club detention facility is shown in Figure 35 below. The figure shows the modeled 100-year flood (blue line) would have a relatively short duration of approximately 1 hour. The goal of detention is to store the flow more than the outfall release rate, and meter it out over a longer period of time (green line) of approximately 5 hours.

Figure 35. Park Hill Golf Club Inflow/Outflow Hydrographs

The four alternatives were evaluated using a screening as typical in an alternatives analysis process. The screening criteria listed in Table 9 are based on the goals and objectives identified early in the process with the community and listed in the Alternatives Description chapter.
## Table 9. Park Hill Screening

<table>
<thead>
<tr>
<th>PROJECT ELEMENT</th>
<th>REGIONAL AND COMMUNITY PROTECTION</th>
<th>PHASED AESTHETIC IMPROVEMENTS</th>
<th>PUBLIC SAFETY</th>
<th>WATER QUALITY</th>
<th>PLACEMAKING (SINGLE VS. MULTIPLE-USE FACILITY)</th>
<th>BICYCLE/PEDESTRIAN CONNECTIVITY</th>
<th>VEHICULAR CONNECTIVITY</th>
<th>MINIMIZED ENVIRONMENTAL IMPACTS</th>
<th>CONSTRUCTABILITY</th>
<th>COMPLIANCE WITH PROJECT CRITERIA</th>
<th>PUBLIC &amp; AGENCY ACCEPTANCE</th>
<th>NUMBER OF REAL ESTATE ACQUISITIONS/EASEMENTS</th>
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</table>

*Scoring: 0=no opportunity, 1=minimal opportunity, 2=average opportunity, 3=high opportunity*
Environmental Evaluations

The team completed research of the project area for hazardous materials, historic resources, and environmental justice issues. The associated reports are included in the appendix and are summarized below.

Hazardous Materials

The EPA have determined that the operation of historical smelters within the Cole and Clayton neighborhoods may have contributed to elevated levels of metals (arsenic and lead) in the surface soil in resident’s yards. Operable Unit 1, a specific and separate activity undertaken as part of the cleanup, addressed residential soils, while Operable Unit 2 addressed industrially zoned land on, and near the Coliseum property. For Operable Unit 1, beginning in 1998, EPA investigated soils in almost all the yards in the Elyria, Swansea, Cole and Clayton neighborhoods, as well as portions of the Globeville and Curtis Park neighborhoods. In all, 4,429 yards were tested, and those that required action were cleaned and are now safe for unrestricted use, including children play areas and vegetable gardens. This clean-up addressed residential yards and included the tree lawn areas, however the clean-up did not clean under the existing paved streets. The areas investigated and cleaned extend throughout the Cole and Clayton neighborhoods, to the south to Martin Luther King, Jr. Boulevard. While nearly all of the homeowners agreed to the investigation, 55 homeowners did not allow EPA to complete their investigation. To protect future homeowners or tenants, EPA filed Notices of Environmental Condition on property records through Denver’s Office of the Clerk and Recorder for those properties. In addition, the EPA has shared a database containing information on all residential properties within the investigation area, so Denver can determine whether any property within the Platte to Park Hill Stormwater Systems program area has been sampled and cleaned.

It is standard practice for the City to conduct environmental due diligence on all properties acquired for infrastructure projects, including stormwater management projects. As part of this due diligence, Denver regularly checks property ownership records, including property records held by the Office of the Clerk and Recorder. The City of Denver is also aware of the VB/I-70 Superfund Site, and have been vigilant to stay informed regarding any actions taken by EPA on this site since 1998. Should Denver need to acquire and disturb properties as a part of this project, Denver would conduct environmental due diligence on every property, and ensure that adequate cleanup is conducted if necessary.

Should the Platte to Park Hill Stormwater Systems program disturb the streets or other paved areas in the areas covered by the Superfund site, the City and County of Denver will conduct sampling of the soils that would be exposed by pavement removal to determine if contamination is present. Should that sampling reveal contamination, it will be dealt with appropriately.

Figures 36 and 37 below highlight potential environmental concerns within the Cole and Clayton neighborhoods.
Figure 36. Hazardous Materials (Franklin to York)
Environmental Justice

An Environmental Justice analysis was conducted to determine if minority, low-income and/or aging populations are present within the study area and if the area should be considered an environmental justice community, and therefore, if any adverse effects would result from the construction or operation of the proposed action.

The study area for the environmental justice and aging population analysis covers in whole, eleven 2010 Census block groups as well as a portion of one additional block group. The study area also includes the Denver-designated neighborhoods of Clayton and Cole and a portion of the southwest corner of the Northeast Park Hill neighborhood. The geographic boundaries of the study area can generally be described as having its northern boundary along East 40th Avenue, Albion Street, and Smith Road; its eastern boundary along Dahlia Street; its southern boundary along Martin Luther King Jr. Boulevard; and its western boundary along Downing Street and Walnut Street.
Minority Populations

Within the study area, minority populations were found to be 26.9% higher than Denver County (74.2% compared to 47.3%, respectively). Within the study area, eight of the twelve block groups have a minority population 20 percentage points higher than Denver County.

During the analysis of the race data, in combination with local knowledge, it was found that a notable Hispanic or Latino origin population was present. The study area was found to have a Hispanic or Latino population 16.7% higher than Denver County (48.1% compared to 31.4%, respectively). Within the study area, five of the twelve block groups have a minority population 20 percentage points higher than Denver County.

Low-Income Populations

From the data available for low-income populations, the study area was found to have 29.3% of individuals living below the poverty level compared to 19.1% of Denver County’s individuals living below it. Within the study area, four of the twelve block groups were 10 percentage points higher than Denver County for individuals living below the poverty level.

Additionally, from the data available for low-income populations, within the study area, two of the twelve block groups have a very poor (under 50% of the poverty level) population 10 percentage points higher than the County.

Population by Age

Although older resident populations (age 60 or above in this analysis) are not specifically recognized as an environmental justice community based on the legal definition, it is the policy of the City to evaluate potential impacts by projects to older residents. For this analysis, the identification of older resident populations was determined by comparing countywide older resident population percentages to older resident population percentages at the block group level. None of the block groups within the study area are 10 or more percentage points higher than the County.

It can be concluded from the analysis that block groups in the study area include notable minority and low-income populations. Three of the twelve block groups contain a percentage of age 60 and over populations higher than the average for the entire City and County of Denver. However, none of these block groups contained older populations higher than 110% of the average City population.

After analyzing the data collected from the Census and other sources, it is apparent the project study area stretches along minority and low-income population residential areas and the proposed action would cause adverse impacts to minority, low-income, and aging populations. Conversely, it can be stated that the Montclair Drainage Basin project impacts would only be of a short-term nature during construction of the project and that the long-term effects of the project would in fact be highly beneficial to the populations within the study area.
Historic Assessment

In order to understand potential impacts of a drainage concept on historic resources, Denver conducted a cultural resource study within the Two Basin Drainage Project area. This effort involved archival research and extensive fieldwork documenting historic resources to determine whether historic properties (buildings, structures, districts, or objects eligible for listing on the national register of historic places) are present and may be affected by the proposed undertaking. As the project is planned to be funded in part by CDOT, and has the potential to impact properties on or eligible for listing in the State Register, CDOT and the City will comply with Colorado Revised Statute (CRS) 24-80.1-104, which requires that “…the action shall identify such properties located within the area of the proposed action, notify the society of the proposed action, request a determination of effect on such properties, and afford the society a period of 30 days in which to review the proposed action” (CRS 24-80.1-104). The cultural resource survey used the procedures and processes developed by CDOT for these types of efforts, and used the standards and evaluation criteria laid out for Colorado State Register.

Areas of Potential Effect (APE’S)

The project study area (PSA) was divided into three Areas of Potential Effect (APE’s) where a drainage design could create impacts to historic resources and include the following:

39th Avenue APE: The APE for this area consists of all affected roadways and adjacent parcels along 39th Avenue. At the west end of the APE a piped drainage system will be installed in 40th Street from Blake Street serving as a connection to Globeville Landing Outfall system. At Franklin Street the stormwater will be conveyed through an open channel that stretches from Franklin Street on the west to Steele Street on the east. Steele Street to Monroe will be a piped system which will include a spur in the Market Lead near the alignment of Monroe Street from 39th Avenue to approximately 42nd Avenue. It is also proposed as part of this project a pipe system be installed in Clayton Avenue from approximately 40th Avenue to 41st Avenue and then west down Clayton and connecting to an existing drainage system. Where piped systems are installed, surface features will be replaced in kind. The APE will extend out to the depth of one parcel from the corridor, and it also includes all areas were easements will be required or work will occur adjacent to historic or potentially historic properties. See 39th Avenue APE map for more detail.

City Park Golf Course APE: The APE for this option is centered on the City Park Golf Course and runs approximately from Colorado Boulevard (on the east), 26th Avenue (on the north), York Street (on the west) and 23rd Avenue (on the south). The APE extends out from Colorado Boulevard, 26th Avenue and York Street to adjacent residential areas to a depth of one parcel in the directions that visual impact could occur. While this APE accounts for any potential direct or indirect effects to historic resources, no direct impact is proposed or anticipated to any historic building or structure in the APE. Three non-historic buildings (all constructed in 2001) will be affected by this option.
Park Hill Golf Club APE: The APE for this option is centered on the northeast quarter of the Park Hill Golf Club that would be affected by the project, and encompasses the buildings and residences that lay along the eastern edge of the golf course running from approximately Smith Road (on the north) to 38th Avenue (on the south). The APE extends out from Dahlia Street to adjacent commercial and residential areas to a depth of one parcel in the directions that visual impact could occur. While this APE accounts for any potential direct or indirect effects to historic resources, no direct impact is proposed or anticipated to any historic building or structure in the APE. Where piped systems are installed surface features will be replaced in kind. The APE will extend out to the depth of one parcel from the corridor, and it also includes all areas where easements will be required or work will occur adjacent to historic or potentially historic properties. In addition, the project will extend to the adjacent pipe system that will be installed in 39th Avenue from Dahlia Street to Grape Street. There will also be a piped system installed within existing Forest Street from 39th Avenue to Smith Road.

Research and Evaluation Methodology

The following methodology was used to evaluate all historic resources in the APEs. Dates of construction and eligibility status for all properties in the three APEs were established through review of the Denver County Assessor records and the COMPASS database maintained by History Colorado. Survey and evaluation procedures of the properties within the three distinct APEs differed and are detailed below.

39th Avenue Open Channel APE

This project used data collected in previous studies to evaluate historic resources in the APE. A previous study (completed in 2015) included almost 400 properties and resources near and in the 39th Avenue APE. Each resource in the study area was recorded using Office of Archaeology and Historic Preservation (OAHP) form 1417 and a field evaluation of the property’s potential eligibility for the National Register of Historic Places (NRHP) was made.

CDOT has identified potentially eligible properties located one parcel out from the path of the open channel and other elements to account for any direct or indirect effects. Dates of construction and any previously determined eligibility status for each property or resource in the study area was established through review of the Denver County Assessor records and the COMPASS database maintained by History Colorado. Any property or resource falling with this area was evaluated using OAHP form 1403. In some cases, only key areas of the form (Sections I, II, III, IV, VI, VII & VIII) were completed. The abridged site forms were submitted to streamline determinations of eligibility for properties that demonstrate diminished historical physical integrity and are therefore unable to convey significance or be considered eligible to the National Register of Historic Places (NRHP).

City Park Golf Course APE

Data from the Denver County Assessor identified more than 100 properties that were at least 50 years old. In lieu of field documentation of this large number of resources, CDOT assumed each 50-year-old property was eligible, and evaluated for indirect effects. No direct effects would occur since all work
would be limited to the golf course itself. Within the golf course, CDOT will complete field evaluations of 50-year-old buildings and structures that are found, and assess eligibility, as well as direct and indirect effects.

**Park Hill Golf Club APE**

Data from the Denver County Assessor identified more than 70 properties that were at least 50 years old in the areas adjacent to the project area and along 39th Avenue. In lieu of field documentation of this large number of resources, CDOT would assume each 50-year-old property is eligible, and evaluate for indirect effects. No direct effects would occur since all work would be limited to the golf course itself or would involve the installation of subsurface conduits in existing right-of-way. Within the golf course, CDOT would complete field evaluations of 50-year-old buildings and structures that are found, and assess eligibility, as well as direct and indirect effects.
Preferred Plan

Plan Description

The recommended plan is comprised of elements of work in the Park Hill Basin, at City Park Golf Course, and in the 39th Avenue area of the Cole neighborhood in the lower Montclair Basin.

Figure 38. Platte to Park Hill Stormwater Systems program

Montclair Basin

The team recommended City Park Golf Course to temporarily hold and slow stormwater during major storm events. Outside of periods during and immediately after rainfall events, the golf course area would remain dry. The detention area would be integrated into an updated design of the golf course. Detention in the golf course would protect significantly more homes and businesses, minimize property impacts, and create a better opportunity to minimize future infrastructure cost, and provide more opportunity for water quality.
In addition, the team recommended the 39th Avenue open channel and greenway from Franklin Street to Steele Street in the Cole and Clayton neighborhoods to safely collect and convey the stormwater to the South Platte River.

**City Park Golf Course**

The team recommended implementation of detention at the City Park Golf Course. The course is able to detain sufficient volume (approximately 200 ac-ft) to eliminate any additional downstream detention in the 39th Avenue area in the Cole neighborhood, and the course can be returned to a playable condition upon completion of the construction.

**39th Avenue Area**

The team recommended the implementation of a closed system (pipe) between Blake and Franklin, an open channel between Franklin Street and Steele Street, and conduit/green street between Steele Street and Jackson Street. In addition, pipe networks needed to capture and carry additional stormwater in the Lower Montclair Basin include pipes along Clayton Street and Monroe Street. Refer to Figures 39, 40 and 41.

**Figure 39. Open Channel Vision between Franklin St and Williams St**
Figure 40. Open Channel Vision (view looking west from Williams St bridge)

Figure 41. Open Channel Vision (view looking west from Steele St)
The implementation of the open channel facility in the areas noted would capture the 100-year stormwater runoff event. Closed systems in this area would not provide 100% capture of stormwater, and would also introduce additional opportunities for system failure during major storm events.

The open channel between Franklin Street and Steele Street would be a linear open space adding approximately an additional 12-acres of open space to the Cole and Clayton neighborhoods. This linear open space would have a bike and pedestrian trail, as well as other small gathering areas. On the north side of the open channel between Franklin Street and Williams Street adjacent to the Porta Power property would be a shared street, see Figures 42 and 43. This narrow street type would minimize the segregation of modes (vehicular, bicycle and pedestrian) by allowing all modes to use the same space, making it safer for all due to the slower vehicular speeds.

**Figure 42. Open Channel and Shared Street conceptual section between Franklin St. and Williams St.**
The overall width of the open channel should be evaluated at a higher level of detail as the project moves into preliminary design. The alternatives screening included a comparison of a narrower (approximately 90’) section and a wider (approximately 120’) section, and the results of the screening were very close between those alternatives in the two reaches between Franklin and Race.

Additional evaluation is also needed between Race Street and York Street to balance property acquisition, pedestrian and bicycle connectivity, and stormwater capture and conveyance requirements.

As preliminary design begins, hydrologic/hydraulic modeling will need to be continually revised to match pipe sizes, inverts, grading, and other design details. The capacity of the discharge to the existing 120-inch pipe and planned Globeville Landing Outfall system is maximized at 3,600 cfs.

Additionally, all remnant parcels from the acquisition of property will be looked at for water quality opportunities.
Park Hill Basin

The team recommends implementation of 39th Avenue pipe alignment alternative. Additional evaluation during preliminary design is required to confirm cost efficiencies, constructability, and schedule constraints.

Additionally, as preliminary design begins, hydrologic and hydraulic modeling will need to be continually revised to match pipe sizes, inverts, grading, and other design details.