Sun Valley Redevelopment – Green Infrastructure and Stormwater Management Options

Prepared for

U.S. Environmental Protection Agency as technical assistance to the Denver Housing Authority and the City and County of Denver, CO

Final Report - June 2016

Contents

Acronyms and Abbreviations

CCoD	City and County of Denver
DHA	Denver Housing Authority
EPA	Environmental Protection Agency
ICF	ICF International
OBLR	Office of Brownfields and Land Revitalization
VMWP	Van Meter Williams Pollack, LLP

Introduction

Beginning in 2010, the City and County of Denver (CCoD) began an area-wide planning effort to improve conditions along the South Platte River corridor in Denver, Colorado and revitalize brownfield sites in the area to enhance public health and community value. The Sun Valley neighborhood (see Figure 1) was identified as a priority study area for redevelopment as it has a significant number of residents living below the poverty line, is directly adjacent to the South Platte River, and is near historical industrial uses that have left contaminants in the area.

The Sun Valley Homes redevelopment will include a high density, mixed income, rental and ownership community that includes mixed use commercial space. A primary goal of redevelopment efforts for Sun Valley is rebuilding the community with features and mechanisms that promote site sustainability, including stormwater conveyance and treatment.

In order to support the goals of minimizing contaminant run-off from brownfield sites and implementing sustainable redevelopment solutions, CCoD and the Denver Housing Authority (DHA) have requested technical assistance from Environmental Protection Agency's (EPA's) Office of Brownfields and Land Revitalization (OBLR) to develop and evaluate green stormwater management alternatives that can be incorporated into the Sun Valley Homes Master Plan. This report presents three stormwater design alternatives for the site and provides a performance and cost assessment of these alternatives to be considered for the Sun Valley Homes Master Plan.

This report is the result of a collaborative effort lead by ICF International (ICF) and includes conceptual design alternatives developed by the Denver-based team of Van Meter Williams Pollack, LLP (VMWP) and stormwater performance analysis and cost estimates generated by CH2M HILL.

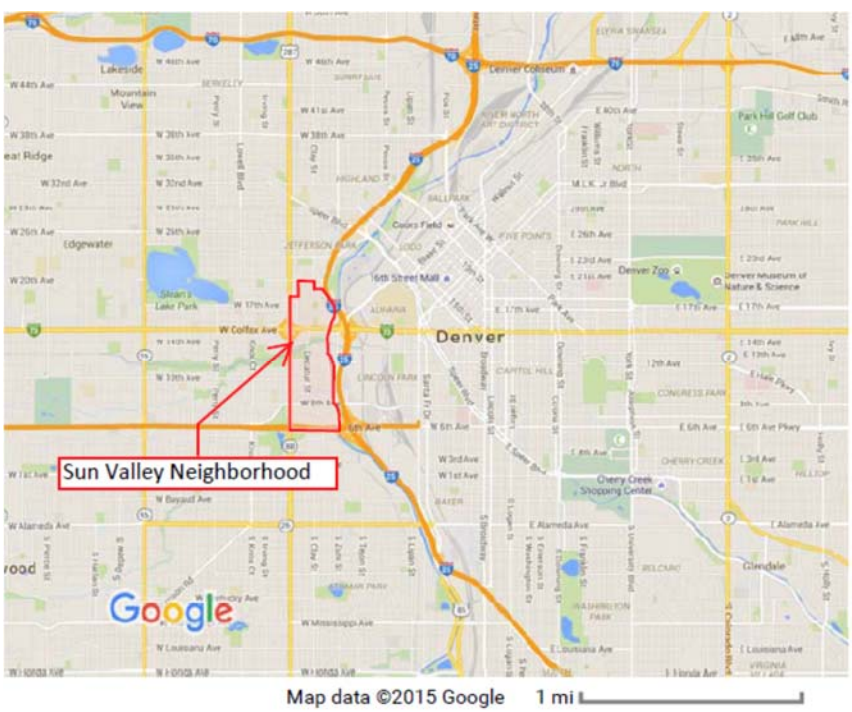

Figure 1-1. Site Location

SECTION 2

Sun Valley Stormwater Design Alternatives

The Sun Valley neighborhood is currently 33 acres of two-story public housing with an irregular street network with site stormwater discharging directly to the South Platte River. The redevelopment of this neighborhood will reshape its existing layout into 20 distinct urban blocks that include higher density residences (three, five, and eight stories) with a greatly interconnected street grid, and more pedestrian oriented sidewalks, streets and riverfront park access.

Three conceptual design options have been developed for the Sun Valley neighborhood's stormwater infrastructure. These options were developed to consider baseline and multiple green infrastructure solutions, and compare the performance and cost of these solutions in order to select a preferred design. Each concept has a different method for stormwater management as follows:

- Option 1 – Conventional Conveyance and Site Retention/Detention (Baseline)
- Option 2 – Green Infrastructure with Centralized Site Retention/Detention
- Option 3 – Green Infrastructure with De-Centralized Site Retention/Detention

The concept designated as Option 2 was developed as part of the Sun Valley master planning effort by Wilson & Company and DesignWorkshop for DHA's consideration in the late spring of 2015. DHA wished to consider additional stormwater design options that would offer other green infrastructure features that would contribute to site sustainability goals. Therefore, VMWP developed the Option 1 and Option 3 concepts as additional design alternatives in the fall of 2015. These alternatives feature designs that have fewer "green" elements (Option 1, baseline option) and more leading edge sustainability components (Option 3) than the initial design (Option 2) proposed by Wilson & Company and DesignWorkshop. Hence, the nomenclature used to label these alternatives follows the progression of green features being added to the stormwater designs.

The basis of design used for developing all Options presented were developed by Wilson & Company and include the following:

- The internal storm system was designed for a 10-year storm event.
- The 100-year storm will be discharged to the South Platte River, undetained.
- The 1% reduction of additional impervious area in the overall basin per Mithun & Design Workshop's September Draft documents was not analyzed.
- 85% impervious area for the entire basin was used regardless of Mithun & Design Workshop's approach.
- Storm laterals were sized and shown for the servicing of sites "green streets" including porous pavers, bio-swales, etc.
- Stormwater detention ponds are designed for water quality improvement and the 10-year storm only (4 ponds at 252,283 cubic feet detention originally in Option 2).

Each design was developed to successfully manage on- and off-site stormwater at the Sun Valley Homes site and help to reduce contaminant flow into the South Platte River. Specific stormwater design elements and differing sustainability features of each Option are described below and illustrated in Appendix A (Stormwater Conceptual Design Options).

2.1 Option 1 – Conventional Conveyance and Site Retention/Detention

VMWP developed the concept for Option 1 as a conventional, closed conveyance storm drainage system combined with decentralized on-site, block-by-block, retention/detention vaults to meet City of Denver stormwater code in concert with water quality requirements. While this design was developed as the baseline option, it does incorporate the same green terrace courtyards on rooftops of parking structures as proposed by Wilson & Company and DesignWorkshop in Option 2 to maintain a baseline green feature for comparison. To comply with the City of Denver stormwater code, Option 1 detention size has been increased to handle the 100-year storm event. It is assumed that the 10-year storm event will be handled by the storm sewer as stated above with the additional flow during the 100-year event contained within the roadway without exceeding capacity.

The vaults specified will be located in each block's lower elevation and provide retention/detention for the entire block it is located on. Estimates for vault sizes required for a 100-year storm event are included in Table 1 below.

Table 2-1 - 5-ft Diameter Vault Volumes for Option 1

Vault Block	Volume (ft^3)	Vault Block	Volume (ft^3)
1	10,110	10	4,140
2	8,070	11	7,160
3	8,840	13	5,130
4	5,750	15	3,520
5	6,450	16	5,430
6	8,320	17	7,410
7	2,300	18	5,260
8	6,630	19	3,630
9	8,560	20	5,760

Water quality elements will be located on top of the vault and or nearby on site. The closed stormwater conveyance system will generally consist of concrete curb and gutter, a series of collection structures (area drains, inlets and catch basins), and storm drain pipes to collect and convey on site and surface runoff to four detention ponds. Ponds will ultimately discharge to the South Platte River. These detention ponds will be approximately 30% of the size of the ponds specified by Wilson & Company in Option 2, as the vaults in Option 1 will provide greater on-site storage thereby reducing the need for pond detention volume.

Option 1 is the most conventional and straightforward approach to stormwater infrastructure organized for individual blocks. The permitting process and construction technologies for this design are well known and understood by agencies, consultants and developers. However, the traditional stormwater infrastructure proposed in this Option does not meet sustainability goals for the redevelopment of this area. A conceptual rendering of Option 1 is included in Appendix A.

2.2 Option 2 – Green Infrastructure with Centralized Site Retention/Detention

Option 2 uses a green stormwater infrastructure system consisting of extensive bioswales, porous pavements and rain garden type facilities. These features will be located within the public right of way to reduce the stormwater requirements for the entire project site (public and private). This design is anticipated to reduce the stormwater runoff rate and volume, as well as meet the requirements of the City of Denver code. Each development parcel would not be required to meet the stormwater requirements since a project-scale stormwater management strategy is in place. Each of these green features will collect, treat, and convey surface runoff as well as:

- Reduce the effective impervious area of the right-of-way.
- Attenuate surface runoff resulting in reduced peak flow rates for minor storm events.
- Provide interception and minor evapotranspiration of rain water to reduce flow volumes for minor storm events.
- Provide opportunities to infiltrate stormwater and recharge the groundwater, though this would be minimal due to the poor soil conditions.

Four retention/detention ponds will collect stormwater runoff from this system and meet the minimum stormwater requirements. The ponds in Option 2 are the largest of all the Options, and are a “last chance” at retention and water quality enhancement before flows reach the South Platte River and Weir Gulch. Constructed wetlands are planned near Pond C along with highland and lowland riparian areas adjacent to the length of the South Platte River. Some natural treatment and water quality benefit will be realized from these areas during typical storm and runoff events.

Green terrace courtyards on rooftops of parking structures are also planned for Option 2. These will most likely consist of recreation spaces such as benches, picnic areas, and constructed planting boxes for vegetation. CH2MHILL assumed these features to be similar to other projects completed by Mithun as represented in their Mosler Lofts project[1]. Vegetative elements on rooftops are assumed to cover 50% of rooftop areas and will provide minimal stormwater and/or water quality benefit to the site. However, terraces will add value to residents as an outdoor amenity.

Option 2 recommends many features considered to be sustainable and best practices for green communities, but it will also represent a steeper learning curve for both permitting and construction in comparison to Option 1. The extensive use of natural elements and vegetated areas proposed in this Option may pose concerns for long-term maintenance obligations and will require dedicated funding sources for this maintenance. A conceptual rendering of Option 2 is included in Appendix A.

2.3 Option 3 – Green Infrastructure with De-Centralized Site Retention/Detention

Option 3 proposes a green stormwater infrastructure system in the public right-of-way similar to Option 2, but separates the public and private stormwater management systems and requires each private parcel to meet the stormwater management requirements of the City of Denver. This approach would necessitate privately-funded, on-site retention/detention facilities. These on-site, private retention/detention facilities are recommended as Blue Roofs[2] (roof top detention on the larger 5 story and 8 story structures), Green Roofs[2] (roof top detention on top of the structured parking facilities intended semi-public space), on site rain gardens, and/or other water features. Similar to Option 1, detention ponds are recommended for Option 3 to provide additional treatment and retention prior to release to the South Platte River and Weir Gulch. Pond sizes are the same in both Option 1 and Option 3 as these account for similar detention volumes on-site in vaults and blue roofs/bioswales, respectively.

Option 3 has many of the same advantages and disadvantages as Option 2, with one significant caveat. Because the public and private parcels are not combined, each building would incur the higher capital cost of the individual retention/detention facilities and future parcel owners would incur higher maintenance costs. Blue and Green

[1] Mosler Lofts Green Story: http://mithun.com/knowledge/article/mosler_lofts/

[2] A green roof is a partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane, and may also include additional layers such as a root barrier, and drainage and irrigations systems. A blue roof is a roof design that is explicitly intended to store water, typically rainfall, while also putting the rainwater to other good uses such as cooling of solar panels and irrigation of a green roof.

roofs require no additional land area for detention. Blue roofs (also known as rooftop detention) are easy to install and maintain and are very similar to a standard roof. Green roofs require more maintenance but also add significant water quality enhancement elements. Both Blue and Green roofs have many other benefits, such as increased roof life, lower energy costs, water quality enhancement, aesthetic improvements, and even potential for food production[3]. However, while Option 3 has several sustainability advantages, navigating and negotiating legal water limitations in Colorado and Denver could lead to project approval/permitting delays and implementation challenges.

Option 3 is the most sustainable and leading edge option and allows green stormwater infrastructure to be installed in conjunction with project phasing, whereas the centralized retention/detention facility proposed in Option 2 must be built in the initial construction phase so that it is in operation prior to beginning construction in order to mitigate the planned redevelopment. A conceptual rendering of Option 3 is included in Appendix A.

2.4 Relevant Literature Reviewed for Performance Analysis

CCoD and DHA provided and/or referenced several documents to guide the performance review of each stormwater Option. The documents reviewed and key informative details provided helpful context for major stormwater quantity and quality issues faced by CCoD and DHA. These issues, along with project sustainability goals described by DHA, guided the performance assessment and comparison of each design Option.

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3 Rooftop Detention: A Low-Cost Alternative for Complying with New York City's Stormwater Detention Requirements and Reducing Urban Runoff, NYC Department of Environmental Protection (www.nyc.gov/html/dep/pdf/rooftop_detention.pdf; http://www.nyc.gov/html/dep/html/stormwater/green_pilot_project_ps118.shtml)

SECTION 3

Performance Analysis of Stormwater Options

A performance assessment was conducted for each Option to guide decision makers with DHA towards a preferred design alternative, encapsulating benefits and drawbacks in a technical manner for each of six key performance categories. Each performance category used and described below has not been “weighted” at present, but presents DHA with opportunities for priority ranking each Option’s design elements based on the Sun Valley redevelopment project’s specific limitations and goals. Though DHA may flexibly utilize the information presented here, overall Option recommendations are outlined in Section 5.

The tradeoffs and benefits of each proposed stormwater design Option were considered in a performance matrix format. Similar to scoring formats used in sustainability rating systems such as the U.S. Green Building Council’s LEED® or the Institute for Sustainable Infrastructure’s Envision®, performance criteria were divided into six distinct categories understood to be most important to DHA. The categories defined for this performance analysis are:

1. Water Quality
2. Flow and Drainage
3. Public Value, Health and Safety
4. Construction and Maintenance
5. Planning and Legal
6. Sustainability and Climate Change

Within each of these six categories, performance criteria were further defined, as described in more detail below. Given the preliminary and conceptual nature of stormwater designs, the following key assumptions were made prior to performance analysis:

- All infrastructure in each Option are sized properly for a 100-year storm event.
- All equipment and features are functioning properly during storm events.
- Categories were considered in isolation such that no double-counting would occur.

Performance of each Option was evaluated and scored for each criteria separately in a qualitative manner due to the preliminary and conceptual nature of designs at the current planning stage. Qualitative scores balance project benefits and drawbacks as positive (+) and negative (-) scores or, in cases where no effect was anticipated, criteria could be scored as null (0) as defined in Table 3-1.

Table 3-1 – Qualitative Scoring Approach for Performance Analysis

Category Score Value	Definition
- -	Design will result in major complications, drawbacks, costs or other obstacles that may cause the design to be unfeasible or less than desirable to dwellers.
-	Design will not provide enhanced benefit to the overall stormwater management strategy for the site, may prove complicated to execute, or be a nuisance to dwellers.
0	Conceptual design will not enhance or reduce overall stormwater management, or the design is considered industry standard and offers no innovation or sustainable benefit beyond general design practice.
+	Design will support stormwater management on site in a way that is an enhancement to the sites value and meets critical functional requirements for site drainage and water quality.
+ +	Design goes beyond industry standard to provide ancillary benefits to the site or its community. Design will offer additional features that will be seen as valuable to dwellers and rehabilitates the site to a more desirable landscape.

Once scores for each criteria were established, scores for each Option were summarized for the performance category. In many cases, criteria scores offset each other when summed for the total category score. The full performance analysis matrix including logic for each score proposed is provided in Appendix B.

3.1 Water Quality Performance Criteria

Enhancing water quality prior to stormwater release into the South Platt River or Weir Gulch is a major priority of the CCoD due to persistent water quality issues, especially in the Denver's urban corridor. Therefore, each stormwater design Option was analyzed for how its design features would improve water quality before releasing to these surface waters. Table 3-2 displays the Water Quality performance criteria each Option was scored against and qualitative scoring of these items.

Table 3-2 – Water Quality Category Score Summary

Criteria	Option 1	Option 2	Option 3
Brownfield Contamination Exposure Risk	- -	-	0
Site Level Water Quality Enhancement	-	+ +	+
Regional Area Water Quality Benefits	0	+	+
Sediment Capture (Regional + Site)	+	+	0
Initial Vegetation Establishment Costs	0	- -	-
Infiltration/Groundwater Recharge Benefits	-	+ +	+
Net Performance	**- - -**	**+ + +**	**+ +**

As shown, Option 2 is predicted to provide the greatest water quality enhancement potential of the three Options considered. The extensive use of vegetated bioswales adjacent to roadways that will convey runoff, wetlands upstream of a major detention ponds, and riparian areas buffering the South Platte River provide for a series of opportunities to capture contaminants before any stormwater flows are released. At the site-level, maintaining the stormwater elements above the ground surface reduces the risk of disturbing pollutants in the soil that may have resulted from neighboring industrial activities. Likewise, these vegetated bioswales will allow for contaminants to be attenuated in plant material, and the hydraulic roughness of the swales will slow flows, allowing sediments to settle thereby increasing detention time to allow for groundwater percolation.

3.2 Flow and Drainage Performance Criteria

Conveying stormwater away from buildings, public spaces, and vehicle or pedestrian traffic routes is a key necessity for site functionality during all predictable storm events. Stormwater will need to flow offsite in a reasonable timeframe or drain from detention features within 72 hours. The community should not be unnecessarily hindered from "business as usual" while stormwater is flowing or draining from the site. Table 3-3 displays the Flow and Drainage performance criteria each Option was scored against and qualitative scoring of these items.

Table 3-3 – Flow and Drainage Category Score Summary

Criteria	Option 1	Option 2	Option 3
Intense Precipitation Event Site Functionality/Resiliency	+	+	+
Regional Drainage Area Flow Absorption	+	-	-
Reduces Peak Flow hydrograph of runoff volume to detention ponds and South Platte River	-	+	+ +
Site Drainage Duration	+	+	-
Net Performance	**+ +**	**+ +**	**+**

In this category, both Option 1 and Option 2 are expected to provide the best flow and drainage performance. Option 1 will provide greater opportunity to capture storm flows entering the site from areas surrounding the site, and will contain flow volumes below ground, away from surface roads and spaces used by the public. Option 2 will more widely distribute flows across the site and allow for localized percolation and slow, steady site drainage. All Options are considered to function equally well during a 100-year storm event.

3.3 Public Value, Health, and Safety Performance Criteria

DHA wishes to redevelop the Sun Valley neighborhood in a manner that will increase its value, both as it is perceived by the public and as it is experienced by the community living there. Likewise, DHA intends to provide an environment that promotes the health and safety for all people visiting or dwelling in the neighborhood. Therefore, this category considers how each Option will add value and increase multi-functional amenities for the community at large and reduce potential health and safety risks from stormwater management. Table 3-4 displays the Public Value, Health, and Safety performance criteria each Option was scored against and qualitative scoring of these items.

Table 3-4 – Public Value, Health, and Safety Category Score Summary

Criteria	Option 1	Option 2	Option 3
Appearance	-	+	+ +
Education	-	+ +	+ +
Minimize Use of Green Space	+	-	+
Public Health and Safety	+	-	-
Net Performance	**0**	**+**	**+ + + +**

Option 3 out performs Options 1 and 2 in this category for some distinct reasons. The more cutting edge sustainability features such as blue and green roofs, porous pavement, and water features will have the most visibility of all the Options and also the greatest potential to educate the community on sustainable living. This Option also diminishes the need for ground level green space use by moving stormwater features to rooftops. However, this approach does come with a drawback that careful maintenance of blue roofs will be needed to prevent attraction of vectors, such as mosquitos.

3.4 Construction and Maintenance Performance Criteria

This category considers the traditional construction, cost, and operation parameters of engineering and architecture projects. Cost elements carry a major weight in this category, but go beyond near term cost to construct and operation cost over a 20-year lifespan. Cost criteria for each Option include an order-of-magnitude cost estimate developed by CH2M and described in the section below, the value of land that will be removed from functional spaces as a result of stormwater designs, and estimated increases in land value as a result of the neighborhoods redevelopment. Table 3-5 displays the Construction and Maintenance performance criteria each Option was scored against and qualitative scoring of these items.

Table 3-5 – Construction and Maintenance Category Score Summary

Criteria	Option 1	Option 2	Option 3
Ease of Construction	+	-	- -
Cost to Construct	+	-	- -
Economics of Land Utilization	0	+ +	+
Maintenance Requirements	-	+ +	-
Net Performance	**+**	**+ +**	**- - - -**

While some features of Option 2 such as wetlands and riparian areas may prove complicated to establish and incur additional costs for establishment and maintenance, this Option offers a strong value for cost and benefits. Many of the ground-level natural features of this Option can potentially enhance the landscape aesthetic of the neighborhood with minimal and uncomplicated maintenance requirements. Unfortunately, the cutting edge innovative sustainability features of Option 3 are quite expensive in terms of capital and operating costs, resulting in this Option's poor performance in this category. While Option 1 performs well in this category, the easier construction and lower cost has the largest sustainability tradeoffs.

3.5 Planning and Legal Performance Criteria

Colorado Water Rights law significantly restricts the manner in which stormwater may be detained/retained across the state. In general, stormwater cannot be detained for longer than 72-hours, excessive groundwater infiltration or surface water evaporation is questioned and often barred, and the use of stormwater for recycling purposes is prohibited. Should these restrictions be upheld in the case of this project, they would prevent innovative sustainability opportunities that could drastically reduce potable water demand at the site, and have become common practice in other states. Navigating these legal limitations, whether in pursuit of general approvals/agreements or formal permits, will impact project planning schedules and could significantly delay project construction activities. Hence, planning and legal actions required for each stormwater Option will likely define the project's critical path. Table 3-6 displays the Planning and Legal performance criteria each Option was scored against and qualitative scoring of these items.

Table 3-6 – Planning and Legal Category Score Summary

Criteria	Option 1	Option 2	Option 3
Compatibility with Neighborhood and Regional Plans	-	+	+
Water Rights Compliance	+	+	-
Coordination with Federal and State Departments for Project Planning	+	- -	- -
Permitting Schedule/Complexity	0	-	- -
Net Performance	**+**	**-**	**- - - -**

As demonstrated above, planning and legal project activities will be tedious in most cases for all Options, and especially difficult to execute Option 3 given the legal water limitations in Colorado and Denver. Option 1 is a very common practice for stormwater management in the Denver metro area, hence planning activities and coordination are well understood and followed. While Option 1 is a preferred approach for planning and legal activities with the CCoD broadly, its primary drawback is that it does not support the sustainability goals of neighborhood and regional plans.

3.6 Sustainability and Climate Change Criteria

The long-term sustainability of the Sun Valley redevelopment project is of particular interest to DHA for the value it will bring to installing systems optimized for their distinctive needs, ensuring sound financial investments and returns, and providing community dwellers with desirable spaces to live. Site stormwater infrastructure selection and stormwater management will significantly contribute to the perceived and proven sustainability of the Sun Valley neighborhood. Similarly, the site's ability to respond to normal and withstand extreme precipitation events will test design resiliency and influence site-level climate change indicators. Table 3-7 displays the Sustainability and Climate Change performance criteria each Option was scored against and qualitative scoring of these items.

Table 3-7 – Sustainability and Climate Change Category Score Summary

Criteria	Option 1	Option 2	Option 3
Seasonal/Climate Performance Drawbacks	0	-	-
Use of Regional/Sustainable Materials	+	+ +	-
Addition of Water Capture and Storage to Offset Potable Irrigation Demand	0	+	+ +
Greenhouse Gas Reduction or Carbon Sequestration	0	+	+ +
Energy Offset Benefits	0	0	+ +
Net Performance	**+**	**+ + +**	**+ + + +**

Option 3 design features offer a combination of sustainability features that are both practical and innovative. Design features such as Blue and Green roofs are newer technologies being utilized in the Denver area, but have been successfully utilized for projects similar to this in other metropolitan areas[4]. For example, the New York City Department of Environmental Protection and the School Construction Authority have pioneered the use of Blue roofs by installing them in 14 new schools and other buildings citywide[5]. Blue roofs will retain water that could potentially be used for irrigation systems across the site and the light colored rooftop liners will reflect heat from rooftops, reducing top floor HVAC demands during the cooling season. Green roofs will also have an insulating effect to building rooftops. The combination of vegetated features for Option 3 green roofs and bioswales will allow for a wider variety of plants to sequester carbon across the site.

4 www.arcsa-edu.org/epa_pdf's/MitchellBlueRoofTechnology.pdf

5 Rooftop Detention: A Low-Cost Alternative for Complying with New York City's Stormwater Detention Requirements and Reducing Urban Runoff, NYC Department of Environmental Protection (www.nyc.gov/html/dep/pdf/rooftop_detention.pdf; http://www.nyc.gov/html/dep/html/stormwater/green_pilot_project_ps118.shtml)

Order-of-Magnitude Cost Estimate

The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final cost for the project will depend on such criteria as actual labor and material costs, competitive market conditions, actual site conditions, final project scope, and other variables. The cost estimate presented in this study is a "Class 3" estimate, as defined by the Association for the Advancement of Cost Engineering International (AACE-International). It is normally expected that an estimate of this type would be accurate within plus 30 percent or minus 20 percent. This range implies that there is a high probability that the final project cost will fall within the range.

Costs include initial construction costs and operation costs for the system predicted for 20 years of operation. For costs of unique green features, such as Blue Roofs, only the incremental costs were accounted for (that is, Blue Roof costs were $\$5/ft^2$ to represent the difference between the $\$18/ft^2$ of an installed conventional roof versus $\$23/ft^2$ of an installed Blue Roof). Table 4-1 summarizes the capital and operating costs for each option, with full detailed cost estimate files provided in Appendix C of this report.

Table 4-1 – Conceptual Cost Estimate Summary

Option	Capital Cost	Annual Operating Costs	Total NPV Costs (20-YR)
Option 1 – Conventional Conveyance and Site Retention/Detention	$11,217,600	$617,600	$21,374,300
Option 2 – Green Infrastructure with Centralized Site Retention/Detention	$12,525,400	$752,700	$24,902,500
Option 3 – Green Infrastructure with De-Centralized Site Retention/Detention	$15,870,100	$1,621,300	$42,530,700

Wilson and Company had previously developed cost estimate values for Option 2, therefore, CH2M utilized the same or similar unit rate costs to their estimate to provide comparable values. CH2M also utilized RSMeans for piping and various materials estimates, as is industry standard. However, unique materials required for construction of Blue roofs and Green roofs were researched to represent recent market values for projects similar to this one. As shown in the full cost estimate (Appendix C), CH2M HILL references costs published by a thesis work from The Earth Institute at Colombia University[6]. These costs were vetted by the recent and local experience of VMWP. Labor activities and hours associated with maintenance effort costs were developed by CH2M based on professional operating experience and are included in the detailed cost estimate.

In general, Option 1 will provide future private development benefits from the project-scale stormwater management strategy due to reduced, parcel-scale stormwater management costs. However, initial costs for this Option will be significant for the individual large retention/detention vaults that would have to be paid for early on in the project. Costs for Option 2 include some materials and features that will perform “double duty” as items such as planting strips and sidewalks will need to be built regardless of the stormwater approach selected. The larger ponds recommended in Option 2 will need to be built in the initial construction phase and pose a significant upfront cost. Option 3 green stormwater elements will allow for installation in conjunction with project phasing, though the water quality enhancements and sustainability features of this option are much more costly.

6 Amar, Mikael, Nick Bauter, Jordan Bonomo, Alan Burchell, Kamal Dua, Casey Granton, Harry McLellan, and Danielle Prioleau. Bringing the City of Newark's Stormwater Management System into the 21st Century. Thesis. The Earth Institute at Colombia University, 2014. New York: Integrative Capstone Workshop, 2014. Print.

SECTION 5

Stormwater Performance Assessment Recommendations

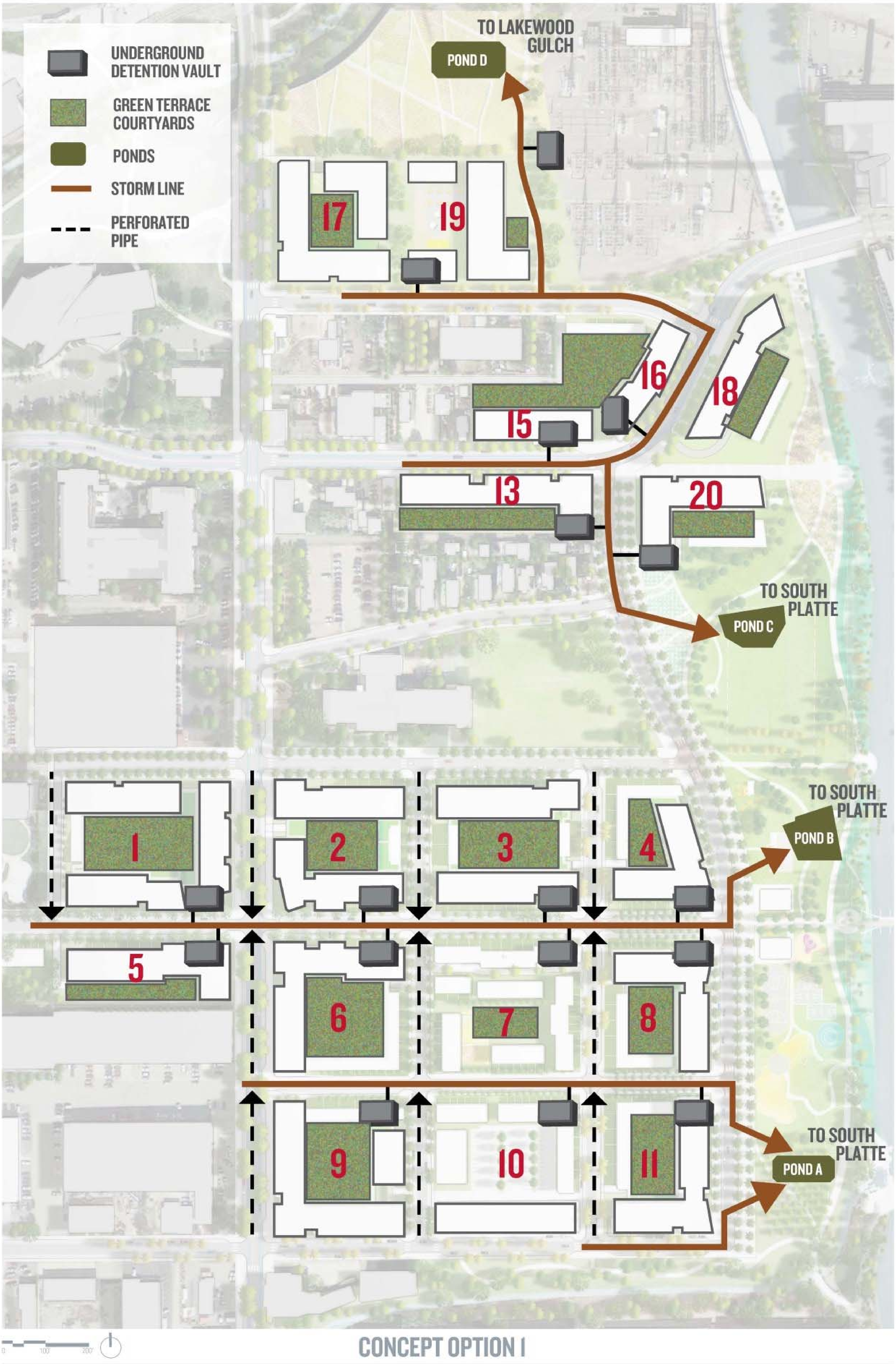
Option 1 presents the most conventional and thereby simplistic and cost effective design alternative for implementation. Should this baseline design be selected, it would be anticipated to efficiently meet CCoD approval and have a quick installation period. However, as mentioned previously, this Option does not promote the overall sustainability goals of the site and does not offer innovative stormwater management solutions.

Option 2 provides for sustainable elements of stormwater management using bioswales, detention ponds, wetlands, and riparian areas. While these features are also conventional in some respects, they can be implemented in ways that optimize stormwater management, water quality enhancement, site aesthetic value, and long-term resiliency for the site. This Option will require close coordination with Denver Parks and Recreation, Denver Planning, and potentially several federal agencies for execution, but at the mid-cost range, Option 2 presents a strong performance for its' value.

Option 3 is the most innovative stormwater design and would make the buildings in Sun Valley in a cutting edge class for site sustainability in Denver. This Option combines stormwater management with a resilient, and sustainable plan for the future as well as beautiful landscape and roofscape elements for the neighborhood's dwellers. These innovations come at a higher cost than Option 1 or Option 2, yet pending DHA's resources and desire to create a trendsetting sustainable community, Option 3 could meet and exceed the goals of the Regional Plan. While Option 3 has several sustainability advantages, it would require the most significant degree of navigating and negotiating legal water limitations in Colorado and Denver, which could lead to project approval/permitting delays and challenges.

Appendix A
Stormwater Conceptual Design Options

(Van Meter Williams Pollack, LLP)

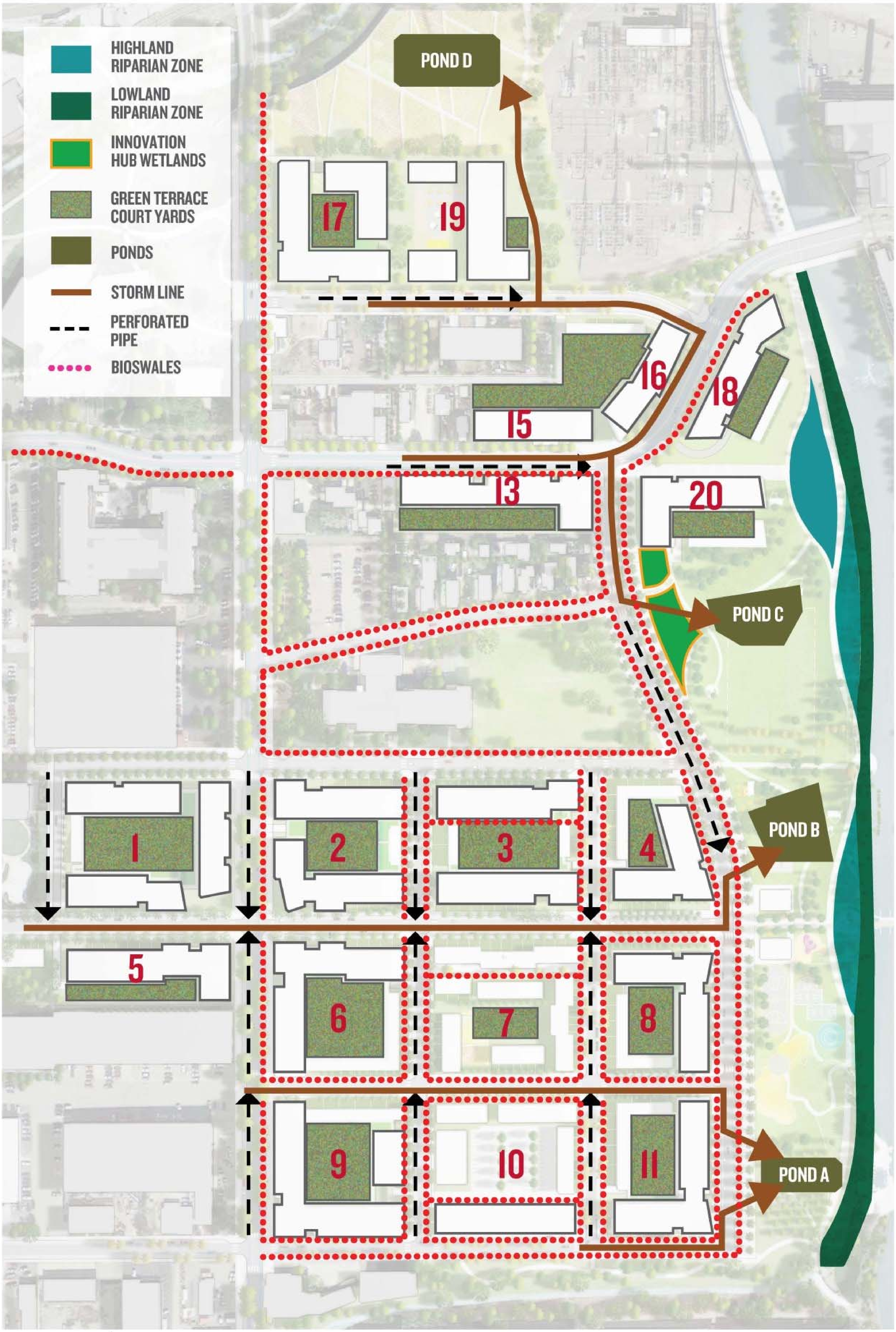


CONCEPT OPTION 1

SUN VALLEY REDEVELOPMENT
DENVER, COLORADO | 10/30/15 | # 1512

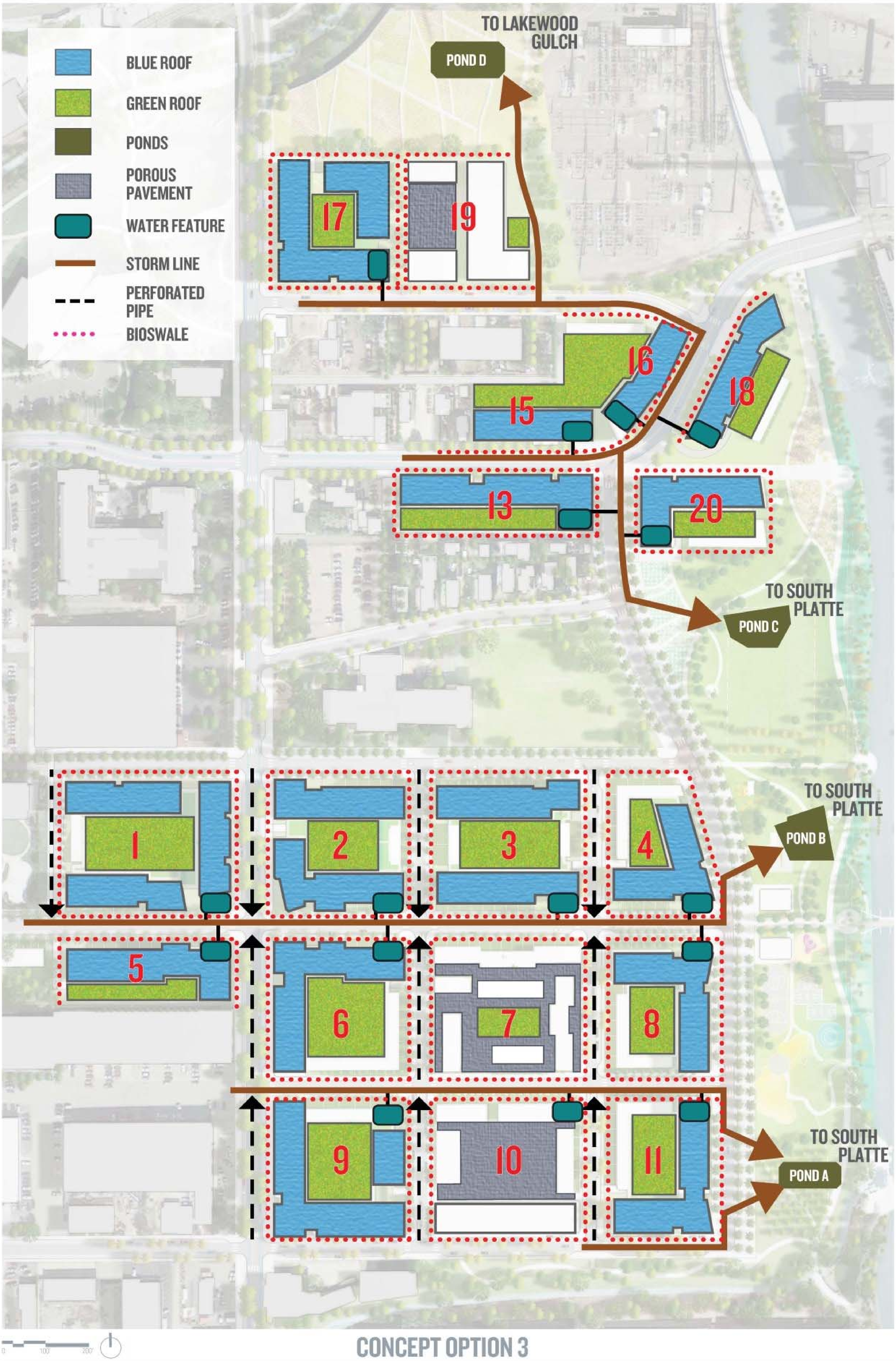
ON-SITE CONVENTIONAL DETENTION, WATER QUALITY, AND CONVEYANCE ALTERNATIVE

ICF INTERNATIONAL
VAN METER WILLIAMS POLLACK LLP



CONCEPT OPTION 2

OFF-SITE DETENTION AND WATER QUALITY:
GREEN STREETS AND PONDS



CONCEPT OPTION 3

SUN VALLEY REDEVELOPMENT
DENVER, COLORADO | 10/30/15 | # 1512

ON-SITE DETENTION AND WATER QUALITY: BLUE ROOF, GREEN ROOF, AND GREEN STREETS

ICF INTERNATIONAL
VAN METER WILLIAMS POLLACK LLP

Appendix B
Stormwater Performance Analysis Matrix
(CH2M HILL)

	#	CRITERIA	CRITERIA DESCRIPTION	Option 1 - Conventional	Option 2 - GI Centralized	Option 3 - GI Decentralized	Notes on Logic
Water Quality Performance	1	Brownfield Contamination Exposure Risk	Considers whether there is any remaining risk that the design could pose given historical industrial uses and previous contamination of soils and groundwater in the area. Should contaminants or constituents remain in the area, considers whether the design option would increase the chance of exposure of these concerns or interactions between existing soil chemistry and infiltrated stormwater (i.e. stormwater percolation and contaminant volatilization and escape through soil pores).	– –	–	0	Option 1 will disrupt soils to a minimum of 6-ft depths for infrastructure placement, which increases potential for encountering contaminants. Likewise, Option 1 will contain groundwater in pipes and vaults, much of these materials are concrete, which will be porous and could potentially allow soil chemistry and stormwater interaction in underground storage. Should a portion of the stormwater system fail, all water is detained underground and leakages/interactions could not be easily detected for remediation. Option 2 promotes infiltration and groundwater recharge to the greatest extent, and therefore has a risk potential for water interaction with contaminants if these remain on site. Using rooftop detention methods, Option 3 will not promote as much infiltration from site catchment systems as the other methods, though porous pavers and bioswales are still recommended. The rooftop detention in Option 3 will keep a large amount of precipitation from infiltrating and could reduces contaminant interactions to the greatest degree.
	2	Site Level Water Quality Enhancement	Considers only the stormwater benefits that will be seen from functionality of the design Option within the site itself (not upstream catchment from other areas or downstream releases to S. Platte River). Focuses on ability to attenuate dissolved constituents (i.e., nitrogen, hydrocarbons, and metals).	–	+ +	+	Option 1 will capture sediments in vaults and some stormwater in rooftop terraces, but will not provide treatment beyond capture for stormwater on the site. Option 2 will allow for much of the stormwater to be taken up by plants and attenuated in bioswale areas. The placement of bioswales throughout the site surrounding most impervious areas that will runoff will provide a high level of on-site water quality enhancement for both sediments and other pollutants. Option 3 will attenuate chemicals and pollutants also in bioswales, but there is less area planned to provide such treatment. While green roofs in Option 3 will attenuate some water-bound chemicals, they will not be from impervious surface runoff.
	3	Regional Area Water Quality Benefits	Accounts for measures in place to allow for stormwater catchment from areas outside the site (i.e. capture upstream volume) and provide water quality enhancement before waters reach S. Platte River. Similar to 2 above, this criteria also focuses on ability to attenuate dissolved constituents (i.e. nitrogen, hydrocarbons, and metals).	0	+	+	Option 1 should be able to capture some of the sediment carried by surface runoff from the surrounding areas since infrastructure capacity should allow for capture of this flow and likely will be connected. However, this Option provides minimal "pre-treatment" of constituents besides sediment/phosphorus prior to release in the S. Platte River. Option 1 may result in poorer water quality downstream in ponds where citizens and pets may recreate. Option 2 provides the most surface area to divert upstream flow as well as larger areas to provide "natural" treatment; however bioswales may reach capacity during some larger storm events where regional runoff enters the site and overflow before treatment. Option 3's storage and slow release of stormwater from rooftops and direct site infiltration through porous pavers will allow for more capacity of bioswales to be immediately available for regional stormwater flows entering the site and treatment of these flows.
	4	Sediment Capture (Regional + Site)	Evaluates whether the system would adequately capture sediment from the catchment area and thus reduce pollution conveyance to the S. Platte River.	+	+	0	Option 1 will capture sediments in vaults upstream of ponds in a concentrated location, but could perform poorer over time as vaults fill after each storm event. Option 2 will capture sediment across the system and has more potential for capturing sediments upstream of ponds due to more surface area and roughness of bioswales widely distributed across the site. Option 3 will capture fewer sediments from impervious surface since fewer bioswales and other sediment trap structures are planned.
	5	Initial Vegetation Establishment Costs	Considers whether additional irrigation infrastructure, water, and fertilizers will be needed for initial vegetation establishment and/or sustained requirements to prevent death or loss of vegetation. Primarily focuses on the first year of operation.	0	– –	–	Option 1 does not require specialized vegetation, except for in rooftop terrace plantings. Option 2 will use similar rooftop terrace vegetation, and also prescribes vegetated bioswales that may require irrigation and fertilizers for establishment and maintenance (especially in wetlands and riparian areas). Option 2 will also require wetland and riparian vegetation establishment which will be more labor intensive and may require more initial labor to establish. Option 3 will require specialized vegetation as prescribed for height and weight on green rooftops and for bioswales, though to a lesser extent in bioswales as in Option 2. Option 3 vegetation will likely require sensitive selection and monitoring for establishment.
	6	Infiltration/ Groundwater Recharge Benefits	Considers potential for system to provide water infiltration and recharge to aquifers, groundwater, or vegetation root zones in their immediate vicinity. Accounts for percolation filtration benefits before groundwater reaches S. Platte River.	–	+ +	+	Option 1 has less perforated pipe and will be designed to convey water away from the site to detention ponds along the riverfront. Option 2 will provide more on-site detention and therefore has the most probability of inundation of soils for recharge to soil roots and percolation strata below. Option 3 will capture some water before it reaches the ground and only slowly release, but still has significant soil water storage potential.
			NET PERFORMANCE	– – –	+ + +	+ +	

NOTE: All performance analysis assumes equipment and features depicted in all conceptual designs are appropriately sized and functioning properly.

Flow and Drainage Performance

#	CRITERIA	CRITERIA DESCRIPTION	Option 1 - Conventional	Option 2 - GI Centralized	Option 3 - GI Decentralized	Notes on Logic
7	Intense Precipitation Event Site Functionality/ Resiliency	Considers the response and resiliency of the system at the site level in an extreme precipitation event such as a 100-year storm (1% chance of happening any year). Primarily focuses on risk to citizens and community infrastructure.	+	+	+	Option 1 will concentrate flows to fill up vaults and potentially backup into perforated pipes, providing limited means for stormwater drainage and conveyance off site. Option 2 will result in more significant surface water ponding in bioswales during an intense storm, but will distribute stormwater across the site promoting surface drainage and infiltration over a wide area simultaneously. Both Option 1 and Option 2 will capture some of the storm event in rooftop terraces, but this will be a small percentage of volume. Option 3 will also have bioswale ponding and drainage, but will alleviate some of this ground level storage by holding water volumes on rooftops with slow release and foster localized infiltration with pervious pavement.
8	Regional Drainage Area Flow Absorption	Considers whether design concept has flexibility to take on additional flow volumes from the Regional Drainage Area outside of the site itself in high flow events. Considers how the Option would perform if additional water drained to the site.	+	–	–	Option 1 should be able to capture and convey additional surface water flow from the regional level beyond the site if designed properly and considered for design of sitewide stormwater planning. Option 2 bioswales may fill up if regional drainage is exceedingly large, and bioswales might not perform well if regional drainage is concentrated in one location rather than dispersed across the site. Option 3's blue roof detention features on rooftops will not accept additional regional flows; additional bioswales or other infrastructure would need to be added if regional water volumes increased significantly. Similar to Option 2, bioswales may not perform well in Option 3 if additional regional flows are localized.
9	Reduces Peak Flow Hydrograph of runoff volume to Detention Ponds and S. Platte River	Considers how well the system will retard flow to the planned ponds and S. Platte River, reducing flow energy, erosion potential, and flashiness of overall water conveyance system.	–	+	+ +	Option 1 will detain flows with vault storage, but during a large event may not have adequate pipe roughness and flow separation to dramatically reduce flow spikes at outfalls. Option 2 will provide more time for infiltration on the site upstream of ponds and higher roughness slowing flows, but is the only retardation method in the design. Options 1 and 2 will add minimal rooftop terrace storage. Option 3 reduces impervious area of the site, thereby diminishing runoff, and will retain and release water more slowly by adding retention in blue and green roofs upstream of bioswales, which will then perform similarly to Option 2. Therefore, Option 3 provides for several "layers" of detention, slowing flows to the River.
10	Site Drainage Duration	Considers the amount of time it will take for water to percolate/drain/flow off the site to the degree that there is no surface ponding after a typical thundershower during the rainy season.	+	+	–	Option 1 will focus overland flow into drains and will be sloped for quick drainage or storage underground where it will not restrict surface use. Pending soil characteristics, bioswales in Option 2 could take several hours to fully drain and dry, but water should be distributed across the site and be accomplished short time. Precipitation captured in rooftop terraces will not likely flow offsite. Option 3 will have a few steps for site drainage and while it will not have as much initial water at the site surface, a steady release from rooftop elements will keep bioswales full and/or wet for potentially >8-hrs.
		NET PERFORMANCE	+ +	+ +	+	

NOTE: All performance analysis assumes equipment and features depicted in all conceptual designs are appropriately sized and functioning properly.

Public Value, Health & Safety

#	CRITERIA	CRITERIA DESCRIPTION	Option 1 - Conventional	Option 2 - GI Centralized	Option 3 - GI Decentralized	Notes on Logic
11	Appearance	Considers visibility and appeal of the system to community dwellers. Includes whether it will be easy to be aware of the infrastructure's presence and/or whether it will increase or decrease aesthetic appeal.	–	+	+ +	Option 1 vaults and stormwater conveyance will not be visible to community members except for heavy grates and outfalls. Option 2 will be visible, but bioswales may not be intuitive to laypeople as a beneficial for water quality or sustainability. Option 2's riverfront habitat enhancement will provide aesthetic benefit to the public, but is removed from the immediate area of site dwellers. The extensive bioswales and constructed wetlands/riparian areas used in this option will have less visual appeal during winter months when vegetation is dormant, but will be attractive most of the year. Option 1 & 2 rooftop terraces will improve appearances of buildings and provide recreation and meeting space. Option 3 elements including green roofs and porous pavement will be the most visible. Option 3's combination of bioswales and rooftop sustainable design elements often seen as "sexier" to the public and will provide layers of aesthetic enhancement on several planes throughout the community. Vegetation in Option 3 will likely have a similar dormancy period as Option 2.
12	Education	Considers whether educational opportunities will exist for community dwellers on the system in place and whether the system or its technology could be seen as beneficial.	–	+ +	+ +	Option 1 primary stormwater elements will not be visible and education would likely take place only when a failure occurred. Option 2 will provide opportunity for education as a stormwater element and a few instructional signs could be placed near a heavily traveled area of bioswales. This education could lead to a greater appreciation of the feature and better use/maintenance. Option 3 could provide the greatest potential educational opportunity since these technologies may be recognizable but not well understood. Signs could be placed at entrances of buildings and next to porous pavement to provide explanation, and dwellers would benefit from an orientation to these elements as part of initial lease paperwork.
13	Minimize Use of Greenspace	Considers amount of green/public/usable space that will no longer be accessible or usable for recreation or exercise by community dwellers.	+	–	+	Option 1 will place infrastructure underground and consume the least public/green spaces within the site. Option 2 will reduce riverfront space as well as reduce open/green space throughout the neighborhood because it has larger detention ponds and uses bioswales that may not be multi-functional or allow for multi-use. Additional constructed wetlands and riparian areas of Option 2 will also reduce usable riverfront park and green space. Rooftop terraces in Option 1 and Option 2 will provide some additional recreation and meeting space, but access to these will likely be limited to building dwellers and not available to the general public. Option 3 will disturb or reduce less planned green spaces in the property area than Option 2, and similar to Option 1, moves stormwater treatment out of surface level greenspaces.
14	Public Health and Safety	Accounts for risks to public health (i.e. vectors) and safety (i.e. ponded water).	+	–	–	Option 1 will attract vectors and accumulate trash, but will direct and maintain vectors and trash away from the surface and potentially reduce human encounters on the site. Option 2 relies on storing stormwater volumes on the surface or in perforated pipe, which may allow for trash settling/collection, attract vectors when water is stagnant, and produce larger volumes of overland flow disrupting pedestrians especially when there is potential for freezing. Option 3 provides more capture and percolation areas that will prevent surface storage (with exception of some bioswale areas) thereby reducing attractiveness to vectors and interfaces with public. However, ponded water on rooftops may be especially attractive to mosquitos and birds/bats. It is understood that blue roof storage will be designed to match snow load designs for safety.
		NET PERFORMANCE	**0**	+	+ + + +	

NOTE: All performance analysis assumes equipment and features depicted in all conceptual designs are appropriately sized and functioning properly.

Construction & Maintenance

#	CRITERIA	CRITERIA DESCRIPTION	Option 1 - Conventional	Option 2 - GI Centralized	Option 3 - GI Decentralized	Notes on Logic
15	Ease of Construction	Considers: whether standard construction measures and equipment are sufficient for design execution, duration of construction period, whether specific contractors or construction oversight will be needed, and degree of disruption construction will incur.	+	–	– –	While Option 1 will be disruptive, it is industry standard, has a well known installation sequence, and will have localized disturbances for major infrastructure away from most dwellings. Option 2 will require the use of heavy equipment to be in greenspaces in early weeks of construction, and will be a widespread interruption across the site for ponds, wetlands, and bioswales which will need to be coordinated with other construction phases. Option 2 construction will directly abut dwellings, walkways, and roads. Rooftop terraces will require specialized construction measures, but should be minimally invasive. Option 3 will require specialty installation of rooftop elements, and will disrupt both dwellings and green space construction. This design could also result in an elongated construction period and involve complicated scheduling.
16	Cost to Construct	Cost of construction including materials, equipment, and labor.	+	–	– –	See FINAL Cost Estimate - Option 1 $11.2M; Option 2 $12.5M; Option 3 $15.8M
17	Economics of Land Utilization	Accounts for the value of land that stormwater design elements will utilize and take away from public/functional space. Likewise, accounts for the increase of land value that will occur with the revitalization of this area.	0	+ +	+	Options 1 and 3 will require ~10 fewer surface acres for detention ponds in riverfront spaces. Option 1 will compromise the least surface area of the site for stormwater capture since most conveyance is underground, but offers minimal change from existing designs and provides no revitalization. Option 2 will require the most surface area to be designated for stormwater purposes as this Option recommends the addition of more bioswales, larger ponds, and intends to convert some riverfront space as wetlands and riparian habitat area. However, the habitat and riverfront park refurbishment will likely increase the overall value of the neighborhood as the recreational space is enhanced and revitalized for enjoyment of community dwellers and attracts the general public. Option 3 will "cost" less land by moving surface treatment off the ground surface to rooftop spaces and using fewer bioswales, this design doesn't have the extent of landscape and community revitalization of Option 2.
18	Maintenance Requirements	Considers required equipment to complete maintenance, anticipated frequency of maintenance (i.e. labor cost & community disruption), complexity and safety of maintenance activities for workers.	–	+ +	–	Option 1 will require a vac-truck for sediment removal and will be a noisy intrusion into the community when needed. Maintenance on these structures will also be a guessing game, not allowing for an optimized cleaning schedule since all underground or an emergency when a failure is detected. Option 2 will require cleaning after major storm events (trash removal monitoring) and mowing on a regular basis, but uses readily available equipment. Rooftop terraces in Option 1 and Option 2 will require some maintenance, but this should be able to be accomplished by volunteers from the dwellings. Option 3 will require similar maintenance to Option 2 for bioswales and should require less frequent, but unique maintenance equipment for rooftop systems. A tradeoff of Option 3 is that maintenance will occur on rooftops, which heightens risk of laborers to complete maintenance activities.
		NET PERFORMANCE	+	+ +	– – – –	

NOTE: All performance analysis assumes equipment and features depicted in all conceptual designs are appropriately sized and functioning properly.

	#	CRITERIA	CRITERIA DESCRIPTION	Option 1 - Conventional	Option 2 - GI Centralized	Option 3 - GI Decentralized	Notes on Logic
Planning & Legal	19	Compatibility with Neighborhood and Regional Plans	Evaluates whether the system will fit into with existing or planned land uses in public spaces and riverfront park neighboring the area. In particular, considers Sun Valley Neighborhood Decatur-Federal Station Area Plan	–	+	+	Option 1 would not address sustainability preferences for Denver riverfront planning except for some benefit from rooftop terraces. Option 2 bioswales and habitat areas are preferred elements of neighborhood plans as valuable water quality elements for the revitalization of the Sun Valley Neighborhood and surrounding region. Option 3 features would be in support of sustainability goals of the neighborhood plans, but these plans do specifically recommend the extent of sustainability technologies recommended by this option. (All Options recommend riverfront park area for detention ponds that will not be preferred by Denver Parks, but is a preferred design element included as part of the Sun Valley Neighborhood Plan. Coordination elements for Parks is captured under Criteria #21).
	20	Water Rights Compliance	Considers whether the system will have issues with or could be considered to be in direct conflict with CO Water Law such that design would not be approved or timeline/resources for approval would be prohibitive. (CWL considers: infiltration of water within 72 hours of precipitation, evaporation costs, minimization of consumption by vegetation, etc.)	+	+	–	Option 1 is historically designed and used in compliance with local water and stormwater regulations. Option 2 will need to be designed to ensure release of water within 72-hours from all bioswales, but this practice is common in Denver. Option 3 may be viewed to be in conflict with water rights laws given the retention of waters on rooftops and potential evaporative losses; therefore, a potential major risk for successful project implementation.
	21	Coordination with Federal and State Departments for Project Planning	Considers requirements for coordination, meeting, approval, etc. with other City and County of Denver Departments (i.e. Public Works, Planning, Parks and Recreation, etc.) and activity LOE to appropriately coordinate.	+	– –	– –	Due to the use of detention ponds in Park space in all options, these designs will need to be shared and approved by Denver Parks and Planning requiring early and frequent coordination. These departments may also be concerned about water quality in detention ponds should Option 1 be implemented. The planned wetlands in Option 2 may, at a minimum, need to meet City horticultural criteria, and may trigger Federal coordination with USFWS and/or USACE. Option 3 will require unique meetings to determine whether the use of blue roofs is legal under Colorado Water Rights law. This coordination could involve multiple State departments, and could be slow and extensive.
	22	Permitting Schedule/ Complexity	Examines whether unique or critical-path permits will be necessary to complete construction within schedule and budget and the complexity of these processes.	0	–	– –	Options 1 and 2 will likely follow a standard stormwater planning and permitting process, especially for Option 1 which is a conventional stormwater technology. Option 2 bioswales should not require unique or complex permits, but wetlands and riparian construction may require permits from USACE or USFWS. Due to potential water rights concerns, Option 3 will likely require a unique permitting and approval approach at the State level requiring additional time and effort and may end up being denied. (Pending activities for pond construction, it is possible that all Options could require a NWP through USACE if impacting wetlands and WOUS.)
			NET PERFORMANCE	**+**	**–**	**– – – –**	

NOTE: All performance analysis assumes equipment and features depicted in all conceptual designs are appropriately sized and functioning properly.

	#	CRITERIA	CRITERIA DESCRIPTION	Option 1 - Conventional	Option 2 - GI Centralized	Option 3 - GI Decentralized	Notes on Logic
Sustainability & Climate Change	23	Seasonal/Climate Performance Drawback	Evaluates whether climate extremes will compromise system functionality or require additional design features. Specifically considers impacts from prolonged drought or freezing conditions and potential for damage from these cases that would require refurbishment or replacement of portions of the stormwater system.	0	–	–	Due to proximity to the river and the potential for a high groundwater table in this location, vault depths may not be able to be placed below grade enough to provide full freeze protection, but will benefit from being underground and perform well during temperature extremes. Option 2 will have potential for surface water freezing and clogging such that the system may not perform well during winter months. Option 1 and 2 rooftop terrace planters may need special care and replanting seasonally. Option 3 bioswales may perform similar to Option 2 and porous pavement may be subject to heaving and damage during freezing conditions. Vegetative loss could occur in Options 2 and 3 during a significant drought should species not be selected for and adapted to Denver's climate.
	24	Use of Regional/ Sustainable Materials	Evaluates whether materials that can be sourced from within 100 miles of the project site, reducing transit resource use and improving sustainability of the supply chain.	+	+ +	–	Estimation based on uniqueness of materials required. Option 2 will likely utilize native seed mixes and should be available from local nurseries. Option 3 utilizes some specialized equipment for blue roofs and green roof vegetation that may require sourcing beyond metro Denver.
	25	Addition of Water Capture and Storage to offset Potable Irrigation Demand	Considers if the stormwater system could easily be coupled with a surface water collection system (i.e. rain barrels upon City approval) to store precipitation for irrigation use on the site's lawns or agriculture areas.	0	+	+ +	Flows could conceivably be diverted from Option 1's configuration into storage containers, but pumps (i.e., energy) would be required to move this water above grade. Option 2 directly infiltrates most water, disallowing water capture. However, Option 2's porous piping could be better integrated into a site irrigation system and offset irrigation demands after a storm event if a sophisticated system (or system with an override) were specified. Option 3 would allow for precipitation collection at downspouts or above grade for use in irrigation. Pumps may still be needed, but less energy would be needed, and pumps could easily be incorporated into an irrigation system.
	26	Greenhouse Gas Reduction or Carbon Sequestration	Evaluates whether the stormwater system elements will act to reduce GHG emissions or sequester carbon on the project site.	0	+	+ +	Option 1 will not have a major impact to GHGs or carbon sequestration as this option does not recommend any sustainable elements. Option 2 includes plans for wetlands and riparian areas as well as bioswale vegetation that will act as carbon sink in the area and could be used as a mitigation bank. Option 3 will provide carbon sequestration from rooftop plant use and bioswales, providing more surface area for vegetative GHG cycling.
	27	Energy Offset Benefits	Considers additional offsets to energy resources that may be realized by the design.	0	0	+ +	Options 1 and 2 will have no net impact on other energy resource consumption. Option 3's green roofs will add an additional layer of insulation to building rooftops, while each blue roof's white reflective material will reduce the heat island effect during summer months. These features will reduce HVAC energy demands and could prove to be a significant cost savings for site dwellers over time.
			NET PERFORMANCE	+	+ + +	+ + + +	

NOTE: All performance analysis assumes equipment and features depicted in all conceptual designs are appropriately sized and functioning properly.

Appendix C
Class 3 Cost Estimate
(CH2M HILL)

CH2M HILL
SUN VALLEY REDEVELOPMENT PROJECT
PROJECT NO: 664030.01.01
PREPARED BY: E.R.MEYER

SUN VALLEY REDEVELOPMENT PROJECT
COST SUMMARY
(This estimate was prepared in October 2015, ENR CCI 20 City Average = 10128.32)

DESCRIPTION	INCLUDED IN ESTIMATE?	TOTAL CONSTRUCTION COST	ANNUAL O&M COST	NPV
OPTION 1 - Conventional Conveyance System & Site Retention/Detention	**Yes**	$11,217,660	$617,657	$21,374,249
OPTION 2 - Green Infrastructure with Centralized Site Retention/Detention	**Yes**	$12,525,420	$752,690	$24,902,448
OPTION 3 - Green Infrastructure with Decentralized Site Retention/Detention	**Yes**	$15,870,130	$1,621,320	$42,530,671

CH2M HILL
SUN VALLEY REDEVELOPMENT PROJECT
PROJECT NO: 664030.01.01
PREPARED BY: E.R.MEYER

To: Summary Sheet

SUN VALLEY REDEVELOPMENT PROJECT
(This estimate was prepared in October 2015, ENR CCI 20 City Average = 10128.32)

DESCRIPTION	**QUANTITY**	**UNIT**	**$/UNIT** ***(includes Material & Installation)***	**TOTAL COST**	**REFERENCE**
OPTION 1 - Conventional Conveyance System & Site Retention/Detention					
Underground Detention Vaults	17	EA	$150,000.00	$2,550,000	
Storm Lines:					
Storm Line, RCP 24-inch	500	LF	$102.00	$51,000	Based on 2015 RSM 02630-530-2040, includes pipe trenching, bedding, and backfill
Storm Line, RCP 30-inch	400	LF	$154.00	$61,600	
Storm Line, RCP 33-inch	350	LF	$177.00	$61,950	
Storm Line, RCP 36-inch	450	LF	$200.00	$90,000	
Storm Line, RCP 42-inch	2,000	LF	$262.00	$524,000	
Storm Line, RCP 48-inch	825	LF	$306.00	$252,450	
Storm Line, RCP 54-inch	900	LF	$376.00	$338,400	
Storm Line, RCP 60-inch	500	LF	$446.00	$223,000	
Perforated Piping					
Perforated Pipe 4-inch	3,600	LF	$33.85	$121,860	Based on 02620-630-2100, includes pipe trenching, bedding, and backfill
Perforated Pipe 6-inch	2,100	LF	$36.20	$76,020	Based on 02620-630-2110
Green Terrace Courtyards	132,504	SF	$30.00	$3,975,120	
Ponds:					
Pond A Area	725	CY	$50.00	$36,239	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Pond B Area	1,027	CY	$50.00	$51,333	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Pond C Area	953	CY	$50.00	$47,650	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Pond D Area	367	CY	$50.00	$18,333	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Subtotal				$8,478,956	
Allowance for Misc Items	5%		$8,478,955.72	$423,948	
Subtotal				$8,902,904	
ALLOWANCES:					
Finishes Allowance	0.00%		$8,902,903.51	$0	
I & C Allowance	0.00%		$8,902,903.51	$0	
Mechanical Allowance	0.00%		$8,902,903.51	$0	
Electrical Allowance	0.00%		$8,902,903.51	$0	
Subtotal				**$8,902,904**	
CONTRACTOR MARKUPS:					
Overhead	0%		$8,902,903.51	$0	
Subtotal				$8,902,904	
Profit	0%		$8,902,903.51	$0	
Subtotal				$8,902,904	
Mob/Bonds/Insurance	5.0%		$8,902,903.51	$445,145	
Subtotal				$9,348,049	
Contingency	20%		$9,348,048.68	$1,869,610	
Contingency for Equipment Items	10%		$0.00	$0	
SUBTOTAL with Markups				$11,217,658	
Escalation	0.0%		$11,217,658.42	$0	
SUBTOTAL Construction Cost with Escalation				**$11,217,658**	
Tax	0%		$6,730,595.05	$0	
TOTAL Construction Cost with Escalation & Tax				**$11,217,658**	
TOTAL Construction Cost with Escalation & Tax, and Location Adjustment Factor	100.00			**$11,217,658**	
Permitting Allowance	0%		$11,217,658.42	$0	
Engineering	0%		$11,217,658.42	$0	
SDC	0%		$11,217,658.42	$0	
Commissioning & Startup	0%		$11,217,658.42	$0	
TOTAL Construction Cost with Escalation & Tax, and Location Adjustment Factor, and Permitting Allowance				**$11,217,658**	

CH2M HILL
SUN VALLEY REDEVELOPMENT PROJECT
PROJECT NO: 664030.01.01
PREPARED BY: E.R.MEYER

To: Summary Sheet

SUN VALLEY REDEVELOPMENT PROJECT

(This estimate was prepared in October 2015, ENR CCI 20 City Average = 10128.32)

DESCRIPTION	**QUANTITY**	**UNIT**	**$/UNIT** *(includes Material & Installation)*	**TOTAL COST**	**REFERENCE**
Annual O & M Cost:					
Underground Detention Vaults	17	EA	***$1,840.00***	$31,280	
Storm Lines:					
Storm Line, RCP 24-inch	500	LF	$2.04	$1,020	Based on 50 year life
Storm Line, RCP 30-inch	400	LF	$3.08	$1,232	Based on 50 year life
Storm Line, RCP 33-inch	350	LF	$3.54	$1,239	Based on 50 year life
Storm Line, RCP 36-inch	450	LF	$4.00	$1,800	Based on 50 year life
Storm Line, RCP 42-inch	2,000	LF	$5.24	$10,480	Based on 50 year life
Storm Line, RCP 48-inch	825	LF	$6.12	$5,049	Based on 50 year life
Storm Line, RCP 54-inch	900	LF	$7.52	$6,768	Based on 50 year life
Storm Line, RCP 60-inch	500	LF	$8.92	$4,460	Based on 50 year life
Perforated Piping					
Perforated Pipe 4-inch	3,600	LF	***$1.87***	$6,732	
Perforated Pipe 6-inch	2,100	LF	***$1.87***	$3,927	
Green Terrace Courtyard Roof O&M	132,504	SF	***$2.39***	$316,950	
Green Terrace Courtyard Roof Replacement	132,504	SF	$0.75	$99,378	Based on Green Roof replaced every 40 years
Ponds:					
Pond A Area	1	EA	***$6,100.00***	$6,100	
Pond B Area	1	EA	***$6,100.00***	$6,100	
Pond C Area	1	EA	***$6,100.00***	$6,100	
Pond D Area	1	EA	***$6,100.00***	$6,100	
Subtotal Annual O&M Cost				$514,715	
Contingency	20%		$514,714.57	$102,943	
Total Annual O&M Cost				$617,657	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	20.00
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O & M Cost
0	$11,217,658		$11,217,658	
1	$636,187		$636,187	
2	$655,273		$655,273	
3	$674,931		$674,931	
4	$695,179		$695,179	
5	$716,034		$716,034	
6	$737,515		$737,515	
7	$759,641		$759,641	
8	$782,430		$782,430	
9	$805,903		$805,903	
10	$830,080		$830,080	
11	$854,982		$854,982	
12	$880,632		$880,632	
13	$907,051		$907,051	
14	$934,262		$934,262	
15	$962,290		$962,290	
16	$991,159		$991,159	
17	$1,020,894		$1,020,894	
18	$1,051,521		$1,051,521	
19	$1,083,066		$1,083,066	
20	$1,115,558		$1,115,558	
NPV			$21,374,249	$814,991

CH2M HILL
SUN VALLEY REDEVELOPMENT PROJECT
PROJECT NO: 664030.01.01
PREPARED BY: E.R.MEYER

To: Summary Sheet

SUN VALLEY REDEVELOPMENT PROJECT

(This estimate was prepared in October 2015, ENR CCI 20 City Average = 10128.32)

DESCRIPTION	QUANTITY	UNIT	$/UNIT (includes Material & Installation)	TOTAL COST	REFERENCE
OPTION 2 - Green Infrastructure with Centralized Site Retention/Detention					
Storm Lines:					
Storm Line, RCP 24-inch	500	LF	$102.00	$51,000	Based on 2015 RSM 02630-530-2040, includes pipe trenching, bedding, and backfill
Storm Line, RCP 30-inch	400	LF	$154.00	$61,600	
Storm Line, RCP 33-inch	350	LF	$177.00	$61,950	
Storm Line, RCP 36-inch	450	LF	$200.00	$90,000	
Storm Line, RCP 42-inch	2,000	LF	$262.00	$524,000	
Storm Line, RCP 48-inch	825	LF	$306.00	$252,450	
Storm Line, RCP 54-inch	900	LF	$376.00	$338,400	
Storm Line, RCP 60-inch	500	LF	$446.00	$223,000	
Perforated Piping:					
Perforated Pipe 4-inch	4,400	LF	$33.85	$148,940	Based on 02620-630-2100, includes pipe trenching, bedding, and backfill
Perforated Pipe 6-inch	2,600	LF	$36.20	$94,120	Based on 02620-630-2110
Bioswale length	15,400	LF	$25.00	$385,000	
Constructed Wetlands	10,000	SF	$25.00	$250,000	
Constructed Riparian Zone	100,000	SF	$25.00	$2,500,000	
Green Terrace Courtyards	132,504	SF	$30.00	$3,975,120	
Ponds:					
Pond A Area	2,416	CY	$50.00	$120,796	Based on sizes from Wilson & Co. narrative, 10% added for freeboard
Pond B Area	3,422	CY	$50.00	$171,111	Based on sizes from Wilson & Co. narrative, 10% added for freeboard
Pond C Area	3,177	CY	$50.00	$158,834	Based on sizes from Wilson & Co. narrative, 10% added for freeboard
Pond D Area	1,222	CY	$50.00	$61,111	Based on sizes from Wilson & Co. narrative, 10% added for freeboard
Subtotal				$9,467,432	
Allowance for Misc Items	5%		$9,467,432.41	$473,372	
Subtotal				$9,940,804	
ALLOWANCES:					
Finishes Allowance	0.00%		$9,940,804.03	$0	
I & C Allowance	0.00%		$9,940,804.03	$0	
Mechanical Allowance	0.00%		$9,940,804.03	$0	
Electrical Allowance	0.00%		$9,940,804.03	$0	
Subtotal				**$9,940,804**	
CONTRACTOR MARKUPS:					
Overhead	0%		$9,940,804.03	$0	
Subtotal				$9,940,804	
Profit	0%		$9,940,804.03	$0	
Subtotal				$9,940,804	
Mob/Bonds/Insurance	5.0%		$9,940,804.03	$497,040	
Subtotal				$10,437,844	
Contingency	20%		$10,437,844.23	$2,087,569	
Contingency for Equipment Items	10%		$0.00	$0	
SUBTOTAL with Markups				$12,525,413	
Escalation	0.0%		$12,525,413.08	$0	
SUBTOTAL Construction Cost with Escalation				**$12,525,413**	
Tax	0%		$7,515,247.85	$0	
TOTAL Construction Cost with Escalation & Tax				**$12,525,413**	
TOTAL Construction Cost with Escalation & Tax, and Location Adjustment Factor	100.00			**$12,525,413**	
Permitting Allowance	0%		$12,525,413.08	$0	
Engineering	0%		$12,525,413.08	$0	
SDC	0%		$12,525,413.08	$0	
Commissioning & Startup	0%		$12,525,413.08	$0	
TOTAL Construction Cost with Escalation & Tax, and Location Adjustment Factor, and Permitting Allowance				**$12,525,413**	

CH2M HILL
SUN VALLEY REDEVELOPMENT PROJECT
PROJECT NO: 664030.01.01
PREPARED BY: E.R.MEYER

To: Summary Sheet

SUN VALLEY REDEVELOPMENT PROJECT
(This estimate was prepared in October 2015, ENR CCI 20 City Average = 10128.32)

DESCRIPTION	QUANTITY	UNIT	$/UNIT *(includes Material & Installation)*	TOTAL COST	REFERENCE
Annual O & M Cost:					
Storm Lines:					
Storm Line, RCP 24-inch	500	LF	$2.04	$1,020	Based on 50 year life
Storm Line, RCP 30-inch	400	LF	$3.08	$1,232	Based on 50 year life
Storm Line, RCP 33-inch	350	LF	$3.54	$1,239	Based on 50 year life
Storm Line, RCP 36-inch	450	LF	$4.00	$1,800	Based on 50 year life
Storm Line, RCP 42-inch	2,000	LF	$5.24	$10,480	Based on 50 year life
Storm Line, RCP 48-inch	825	LF	$6.12	$5,049	Based on 50 year life
Storm Line, RCP 54-inch	900	LF	$7.52	$6,768	Based on 50 year life
Storm Line, RCP 60-inch	500	LF	$8.92	$4,460	Based on 50 year life
Perforated Piping:					
Perforated Pipe 4-inch	4,400	LF	***$1.87***	$8,228	
Perforated Pipe 6-inch	2,600	LF	***$1.87***	$4,862	
Bioswale length	15,400	LF	***$4.72***	$72,626	
Constructed Wetlands	10,000	SF	$0.63	$6,250	Based on "replacement" every 40 years
Constructed Riparian Zone	100,000	SF	$0.63	$62,500	Based on "replacement" every 40 years
Green Terrace Courtyard Roof O&M	132,504	SF	***$2.39***	$316,950	
Green Terrace Courtyard Roof Replacement	132,504	SF	$0.75	$99,378	Based on Green Roof replaced every 40 years
Ponds:					
Pond A Area	1	EA	***$6,100.00***	$6,100	
Pond B Area	1	EA	***$6,100.00***	$6,100	
Pond C Area	1	EA	***$6,100.00***	$6,100	
Pond D Area	1	EA	***$6,100.00***	$6,100	
Subtotal Annual O&M Cost				$627,242	
Contingency	20%		$627,241.97	$125,448	
Total Annual O&M Cost				$752,690	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	20.00
Annual Inflation % =	3.00%

Year	Default Cost	User Over-Ride	Cost Used in NPV Calculation	Adjusted Annual O & M Cost
0	$12,525,413		$12,525,413	
1	$775,271		$775,271	
2	$798,529		$798,529	
3	$822,485		$822,485	
4	$847,160		$847,160	
5	$872,574		$872,574	
6	$898,752		$898,752	
7	$925,714		$925,714	
8	$953,486		$953,486	
9	$982,090		$982,090	
10	$1,011,553		$1,011,553	
11	$1,041,899		$1,041,899	
12	$1,073,156		$1,073,156	
13	$1,105,351		$1,105,351	
14	$1,138,512		$1,138,512	
15	$1,172,667		$1,172,667	
16	$1,207,847		$1,207,847	
17	$1,244,082		$1,244,082	
18	$1,281,405		$1,281,405	
19	$1,319,847		$1,319,847	
20	$1,359,443		$1,359,443	
NPV			$24,902,448	$993,165

CH2M HILL
SUN VALLEY REDEVELOPMENT PROJECT
PROJECT NO: 664030.01.01
PREPARED BY: E.R.MEYER

To: Summary Sheet

SUN VALLEY REDEVELOPMENT PROJECT

(This estimate was prepared in October 2015, ENR CCI 20 City Average = 10128.32)

DESCRIPTION	**QUANTITY**	**UNIT**	**$/UNIT** *(includes Material & Installation)*	**TOTAL COST**	**REFERENCE**
OPTION 3 - Green Infrastructure with Decentralized Site Retention/Detention					
Storm Lines:					
Storm Line, RCP 24-inch	500	LF	$102.00	$51,000	Based on 2015 RSM 02630-530-2040, includes pipe trenching, bedding, and backfill
Storm Line, RCP 30-inch	400	LF	$154.00	$61,600	
Storm Line, RCP 33-inch	350	LF	$177.00	$61,950	
Storm Line, RCP 36-inch	450	LF	$200.00	$90,000	
Storm Line, RCP 42-inch	2,000	LF	$262.00	$524,000	
Storm Line, RCP 48-inch	825	LF	$306.00	$252,450	
Storm Line, RCP 54-inch	900	LF	$376.00	$338,400	
Storm Line, RCP 60-inch	500	LF	$446.00	$223,000	
Perforated Piping:					
Perforated Pipe 4-inch	3,600	LF	$33.85	$121,860	Based on 02620-630-2100, includes pipe trenching, bedding, and backfill
Perforated Pipe 6-inch	2,100	LF	$36.20	$76,020	Based on 02620-630-2110
Bioswale length	15,700	LF	$25.00	$392,500	
Green Roof	185,506	SF	$35.00	$6,492,696	
Blue Roof	299,305	SF	$5.00	$1,496,527	Incremental cost above conventional roof cost
Water Feature	40,000	SF	$19.00	$760,000	Incremental cost above asphalt pavement
Porous Pavement	100,000	SF	$9.00	$900,000	Incremental cost above asphalt pavement
Ponds:					
Pond A Area	725	CY	$50.00	$36,239	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Pond B Area	1,027	CY	$50.00	$51,333	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Pond C Area	953	CY	$50.00	$47,650	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Pond D Area	367	CY	$50.00	$18,333	Based on sizes from Wilson & Co. narrative, 10% added for freeboard. Sizing per Van Meter
Subtotal				$11,995,558	
Allowance for Misc Items	5%		$11,995,558.47	$599,778	
Subtotal				$12,595,336	
ALLOWANCES:					
Finishes Allowance	0.00%		$12,595,336.40	$0	
I & C Allowance	0.00%		$12,595,336.40	$0	
Mechanical Allowance	0.00%		$12,595,336.40	$0	
Electrical Allowance	0.00%		$12,595,336.40	$0	
Subtotal				**$12,595,336**	
CONTRACTOR MARKUPS:					
Overhead	0%		$12,595,336.40	$0	
Subtotal				$12,595,336	
Profit	0%		$12,595,336.40	$0	
Subtotal				$12,595,336	
Mob/Bonds/Insurance	5.0%		$12,595,336.40	$629,767	
Subtotal				$13,225,103	
Contingency	20%		$13,225,103.22	$2,645,021	
Contingency for Equipment Items	10%		$0.00	$0	
SUBTOTAL with Markups				$15,870,124	
Escalation	0.0%		$15,870,123.86	$0	
SUBTOTAL Construction Cost with Escalation				**$15,870,124**	
Tax	0%		$9,522,074.32	$0	
TOTAL Construction Cost with Escalation & Tax				**$15,870,124**	
TOTAL Construction Cost with Escalation & Tax, and Location Adjustment Factor	100.00			**$15,870,124**	
Permitting Allowance	0%		$15,870,123.86	$0	
Engineering	0%		$15,870,123.86	$0	
SDC	0%		$15,870,123.86	$0	
Commissioning & Startup	0%		$15,870,123.86	$0	
TOTAL Construction Cost with Escalation & Tax, and Location Adjustment Factor, and Permitting Allowance				**$15,870,124**	

CH2M HILL
SUN VALLEY REDEVELOPMENT PROJECT
PROJECT NO: 664030.01.01
PREPARED BY: E.R.MEYER

To: Summary Sheet

SUN VALLEY REDEVELOPMENT PROJECT
(This estimate was prepared in October 2015, ENR CCI 20 City Average = 10128.32)

DESCRIPTION	**QUANTITY**	**UNIT**	**$/UNIT** *(includes Material & Installation)*	**TOTAL COST**	**REFERENCE**
Annual O & M Cost:					
Storm Lines:					
Storm Line, RCP 24-inch	500	LF	$2.04	$1,020	Based on 50 year life
Storm Line, RCP 30-inch	400	LF	$3.08	$1,232	Based on 50 year life
Storm Line, RCP 33-inch	350	LF	$3.54	$1,239	Based on 50 year life
Storm Line, RCP 36-inch	450	LF	$4.00	$1,800	Based on 50 year life
Storm Line, RCP 42-inch	2,000	LF	$5.24	$10,480	Based on 50 year life
Storm Line, RCP 48-inch	825	LF	$6.12	$5,049	Based on 50 year life
Storm Line, RCP 54-inch	900	LF	$7.52	$6,768	Based on 50 year life
Storm Line, RCP 60-inch	500	LF	$8.92	$4,460	Based on 50 year life
Perforated Piping:					
Perforated Pipe 4-inch	3,600	LF	***$1.87***	$6,732	
Perforated Pipe 6-inch	2,100	LF	***$1.87***	$3,927	
Bioswale length	15,700	LF	***$4.72***	$74,041	
Green Roof O&M	185,506	SF	***$2.39***	$443,729	
Green Roof Replacement	185,506	SF	$0.88	$162,317	Based on Green Roof replaced every 40 years
Blue Roof O&M	299,305	SF	***$0.67***	$199,936	
Blue Roof Replacement	299,305	SF	$1.10	$329,236	Based on Blue Roof replaced every 20 years
Water Feature	40,000	SF	$0.83	$33,333	Based on "replacement" every 30 years
Porous Pavement	100,000	SF	***$0.41***	$41,400	
Ponds:					
Pond A Area	1	EA	***$6,100.00***	$6,100	
Pond B Area	1	EA	***$6,100.00***	$6,100	
Pond C Area	1	EA	***$6,100.00***	$6,100	
Pond D Area	1	EA	***$6,100.00***	$6,100	
Subtotal Annual O&M Cost				$1,351,100	
Contingency	20%		$1,351,100.19	$270,220	
Total Annual O&M Cost				$1,621,320	

Net Present Value (NPV) Calculation:

i =	5.00%
n =	20.00
Annual Inflation % =	3.00%

Year	**Default Cost**	**User Over-Ride**	**Cost Used in NPV Calculation**	**Adjusted Annual O & M Cost**
0	**$15,870,124**		**$15,870,124**	
1	**$1,669,960**		**$1,669,960**	
2	**$1,720,059**		**$1,720,059**	
3	**$1,771,660**		**$1,771,660**	
4	**$1,824,810**		**$1,824,810**	
5	**$1,879,555**		**$1,879,555**	
6	**$1,935,941**		**$1,935,941**	
7	**$1,994,019**		**$1,994,019**	
8	**$2,053,840**		**$2,053,840**	
9	**$2,115,455**		**$2,115,455**	
10	**$2,178,919**		**$2,178,919**	
11	**$2,244,286**		**$2,244,286**	
12	**$2,311,615**		**$2,311,615**	
13	**$2,380,963**		**$2,380,963**	
14	**$2,452,392**		**$2,452,392**	
15	**$2,525,964**		**$2,525,964**	
16	**$2,601,743**		**$2,601,743**	
17	**$2,679,795**		**$2,679,795**	
18	**$2,760,189**		**$2,760,189**	
19	**$2,842,995**		**$2,842,995**	
20	**$2,928,285**		**$2,928,285**	
NPV			**$42,530,671**	**$2,139,311**