PATHWAY GUIDE

Stormwater Transformation and Enhancement Program

MARCH 2022

MHFD MILE HIGH FLOOD DISTRICT

Pisces Foundation

DENVER WATER

HIGH LINE CANAL CONSERVANCY

STEP PATHWAY GUIDE

Contents

INTRODUCTION

The High Line Canal (Canal) has long been a cherished asset across our region. An extraordinary feat of engineering now nearly 140 years old, the 71-mile-long Canal has historically delivered irrigation water from the foothills of the Rocky Mountains to the plains. Flash forward to today, the Canal, still owned and maintained by Denver Water, is outliving its life as an irrigation utility and has taken on new life as a recreational and ecological resource.

Today, the Canal faces new challenges. Water scarcity and unprecedented growth of our region, combined with the inefficiency of the Canal as a means of delivering water to customers — on average, 60 to 80 percent of the water diverted to the Canal from the South Platte River seeps into the ground or evaporates — has precipitated the need to reassess the use and future role of the Canal.

The Start of the Canal in Waterton Canyon

Historic Farm Property along the Canal

Building on a three-year, community-driven planning initiative, the High Line Canal Conservancy (Conservancy) and partners Denver Water, Mile High Flood District (Flood District) and local governmental jurisdictions (jurisdictions) are working together to transform the Canal into an inspiring model of green infrastructure for stormwater management through an initiative called the Stormwater Transformation and Enhancement Program (STEP).

The STEP Pathway Guide and Your Stormwater Project

Thank you for considering the High Line Canal to address your stormwater management needs.

The purpose of this Pathway Guide (Guide) is to assist project owners and partners, engineers, and the jurisdictions in navigating the process of implementing Canal stormwater management capital projects.

The Guide is a compilation of information from the early phases of transforming the Canal from an irrigation conveyance to a stormwater management system. The Guide does not provide an exhaustive description of the implementation process and each jurisdiction may determine its own process for the successful completion of projects using the Canal for stormwater management.

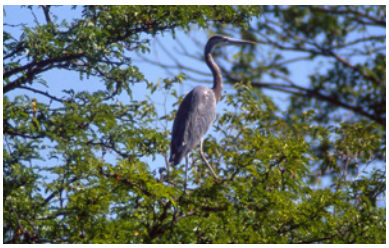
The Guide was completed through the collaborative efforts of Denver Water, Arapahoe and Douglas counties, the City and County of Denver, the cities of Littleton, Greenwood Village, Cherry Hills Village, and Aurora, Highlands Ranch Metro District, Southeast Metro Stormwater Authority (SEMSWA) (which includes the City of Centennial), the Flood District, and the Conservancy. This collaboration equates to a combined estimated professional knowledge base of over 200 years of stormwater management experiences.

The collaborative partnership listed above is planning for and implementing a transformation of the Canal into an inspiring model of green infrastructure for stormwater management through STEP. Owned by Denver Water, the Canal was originally constructed as a water delivery utility, but as that use is declining, it is now well-suited to integrate into the regional stormwater management system as a green infrastructure that can convey stormwater and improve water quality. As a part of the existing regional system, it will be a distinctively different component because of the extent of the Canal's reach (no other single component of the system affects as large a geographic area), its ability to mimic natural functions without significant alteration (the Canal already acts as green infrastructure), and its potential to merge into a system across multiple stormwater management entities. The Canal has the potential to also deliver a set of important benefits that include:

Recreational users on the High Line Canal trail

- Repurposing an outdated utility into a multi-use asset.
- Formalizing stormwater flows that already reach the Canal.
- Promoting a sustainable greenbelt that connects the region.
- Bringing sustainable water into the Canal environment that can provide for a healthy and thriving greenway for vegetation and wildlife and deliver ecosystem benefits.
- Protecting high-quality riparian areas.
- Allowing conveyance for new and existing stormwater.
- Improving water quality before it returns to natural water courses.
- Addressing local flood management issues.
- Augmenting local stormwater management.
- Fostering local economic development through support of local planning efforts.
- Offering opportunities to educate the public on stormwater and green infrastructure's purpose and goals.
- Offering other potential benefits such as improved air quality and community health.

Dry Canal North of Colfax



Great Blue Heron (credit John Fielder)

Transforming the Canal and integrating stormwater management is a new endeavor that presents unique challenges because of the Canal's size and complexity and the need for a high level of coordination and collaboration between the surrounding jurisdictions, stormwater managers and Denver Water. This Pathway Guide, developed through STEP, is intended to be a resource in support of the transition in uses, and to serve as a tool for the government entities and jurisdictions[1] encompassing the Canal to navigate the capital project[2] development (or project development) process and identify the key steps from project conceptualization through implementation.

The capital project development process that is described in this document is summarized in the following infographic. The specific tasks and processes at each step may vary somewhat depending on jurisdiction and project type and size, but overall, the pathway of steps is a guide to identifying, designing, and implementing stormwater projects in the Canal.

Big Dry Creek Waste Gate at deKoevend Park (credit Denver Water)

[1] The term jurisdictions throughout this guide refers to the cities, counties, park and recreation districts, and metropolitan districts that are authorized to operate and manage specific functions and facilities within the Canal corridor or through which the Canal passes.

[2] Capital projects (also referred to in this guide as projects or the project) construct, maintain or improve a public asset, often called infrastructure.

High Line Canal Stormwater Project Pathway Steps

1

Check the Master Plan to determine proximity to the Canal

2

Determine scope and regional areas of opportunities

3

Coordinate with stakeholders – the Intergovernmental Agreement

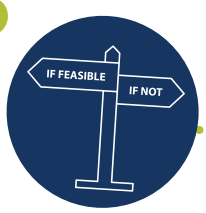
4

Gather conceptual data: scope of project design and maintenance plan

5

Conduct Benefit-Cost Analysis

6



Establish feasibility:
- Collect specific data
- Detailed investigations
- Check/revise the model

7a

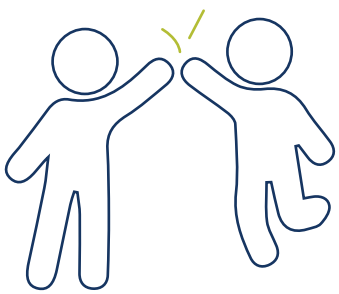
Initiate local government submittal process

7b

Finalize permitting process

8

Build the project



CELEBRATE!

USING THE PATHWAY GUIDE

The STEP Pathway Guide is intended for use by the jurisdictions as a tool to navigate the capital project development process and identify key steps from project conceptualization through implementation, and to serve as a single source of information and bank of knowledge to further the use of the Canal for stormwater purposes.

Through this Guide and the STEP program, reuse of the Canal's existing infrastructure will deliver multiple benefits along more than 62 miles of urban greenway (note that, while the Canal is 71 miles long, only a portion of the total Canal can be used for stormwater management). The end of this Guide has a section that will assist jurisdictions in identifying and evaluating those benefits. In many cases, the evaluation will demonstrate that the cost of using the Canal will be less than new, traditional/gray infrastructure and that stormwater in the Canal will enhance multiple environmental, recreational, and social benefits for this major urban greenway corridor.

Jurisdictions should use this document to guide them through processes that include preparing an intergovernmental agreement (IGA) with Denver Water, working with the Flood District to run the master plan's hydraulic model, consulting and coordinating with regulatory agencies, preparing permits, and collaborating and coordinating with other jurisdictions and the Conservancy.

Based on a 2016 Tree Inventory, there are more than 10,000 Mature Cottonwood Trees along the Canal Corridor.

BACKGROUND

Since 2009, several studies have investigated the need for and feasibility of transforming the Canal to green stormwater infrastructure. Together, the findings of these studies conclude that the Canal is well positioned to capture and handle stormwater for water quality, conveyance and local flood mitigation purposes.

Tree Care Studies

The Canal's vibrant tree canopy, established over decades of irrigation delivery in the channel, is one of its greatest assets for recreational trail users. With the potential for Denver Water's reduction of irrigation water delivery, tree health and tree care has been a long-standing concern. Denver Water began studying the long-term health of cottonwoods, water status, and management options *(Impact of Canal Water Flow on the Health of Cottonwood Trees Growing Adjacent to Colorado's Historic High Line Canal)*[3] in 2009. The study determined the amount of water needed to relieve drought conditions in cottonwoods, when or how often this minimal water is needed, and if rainfall has any impact on the water status of the cottonwoods. The study concluded that two weeks of water in the spring and two weeks of water in the summer/fall in the Canal would be enough water to keep cottonwoods healthy.

The 2009 water flow study in conjunction with the 2014 stormwater feasibility study prompted a complete inventory of Canal trees in 2016. The inventory recorded nearly 24,000 trees greater than six inches in diameter along the 71-mile Canal. The data was used to identify high-priority trees in need of care in all areas along the corridor. Tree care and maintenance began in 2018 to treat the highest priority trees and will continue until all of the highest priority trees have been trimmed or removed.

Stormwater Feasibility and Operations Planning

As a consideration for transitioning the Canal for stormwater management, the *2014 High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment*[4] concluded that the Canal could temporarily store 200 acre-feet of stormwater runoff per storm, which represents 68% of the needed water quality storage volume for the defined tributary areas; that the Canal is suitable to provide stormwater management and water quality improvements; and that stormwater quality facilities are feasible from a physical hydraulic perspective and would yield cost savings over traditional gray infrastructure.

In 2018 the *High Line Canal Stormwater and Operations Master Plan – Final Report*[5] (master plan) explored formalizing existing stormwater in the Canal and the needed improvements to allow the Canal to provide water quality and stormwater management to many properties adjacent to the Canal. It included recommendations for modifications to the Canal in order to protect people and property during 100-year storm events. Flood District, formerly Urban Drainage and Flood Control District, developed a hydraulic Stormwater Management Model (SWMM) to analyze the stormwater capacity of the Canal both with and without irrigation water, and analyzed alternatives to maximize water quality treatment, minimize flooding and maximize infiltration and filtration of the water. The Flood District will continue to manage and operate the model to evaluate all future stormwater projects in the Canal. The *High Line Canal SWMM Users Manual V2*[6] is available at the link below, as well as *Guidelines for Model Approval for Use of the High Line Canal for Stormwater Purposes*[7] for modeling, submittal requirements, and Flood District approval of proposed project designs.

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[3] *https://www.dropbox.com/s/gkr67f9lczyx2dj/2009 DW Tree Assessment Study.pdf?dl=0*

[4] *https://www.dropbox.com/s/3xwai9ci04mjuw8/2014 HLC Stormwater Feasibility Study.pdf?dl=0*

[5] *https://www.dropbox.com/s/v5q39powr6nkp5z/20181031%20HLC%20Master%20Plan%20-%20Final%20Report.pdf?dl=0*

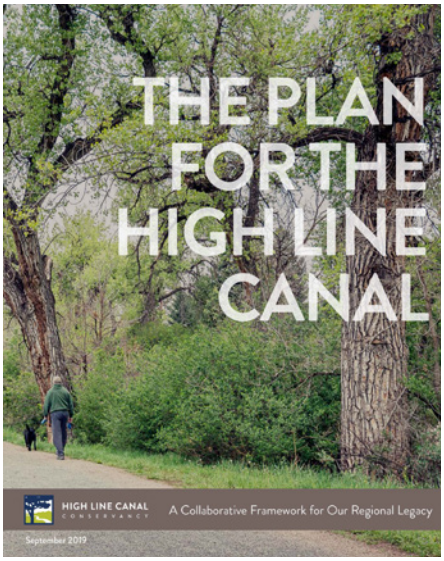
[6] *https://www.dropbox.com/s/078mmiefcc6j3uc/HLC SWMM Model Users Manual V2.docx?dl=0*

[7] *https://www.dropbox.com/s/xoivzn686swh0ye/UDFCD HLC Model Approval Guidelines.docx?dl=0*

High Line Canal Vision and Framework Planning

Between 2015 and 2019 comprehensive planning was completed for the Canal. The *2017 Community Vision Plan for the High Line Canal*[8] created a long-term vision for the Canal, and provided the critical first step toward protection, preservation and enhancement of the Canal as a regional greenway that will endure for generations to come. The plan outlined guiding principles that the Canal remain a natural, connected and continuous, varied, managed and enhanced resource for the region. In 2019, *The Plan for the High Line Canal: A Collaborative Framework for Our Regional Legacy*[9] (The Plan) laid out clear guidance for implementing the Community Vision Plan, repurposing the historic Canal, improving the health of people and the environment, and increasing accessibility and enjoyment. The Plan design guidelines provide guidance for planning and designing stormwater infrastructure in the Canal and managing and enhancing the Canal's vegetation and landscape.

Community Vision Plan



Plan Cover

Cyclist on the Canal Trail

[8] *https://www.dropbox.com/s/0v8b5rl5rkbigo4/20170411_HLC Final report_LOW RES.pdf alias?dl=0*

[9] *https://www.dropbox.com/s/q9hdah0bg388glu/DRAFT - Design Guidelines Jan 2019.pdf?dl=0*

COLLABORATIVE MANAGEMENT

A collaborative partnership is essential to the successful implementation of STEP. Project planning and implementation will be largely managed through each jurisdiction's planning and public works processes and guidelines and as authorized through IGAs between Denver Water and each jurisdiction. However, the broader, Canal-wide, collaborative partnership will serve important functions to advise on project scoping and initiation, provide input on conformance with Canal-wide objectives and guidance, provide hydrologic modeling services and oversight on Canal-wide stormwater performance, and assist in coordination and consultation with external agencies. Following is an overview of the roles of the primary partners.

High Line Canal Conservancy — The nonprofit philanthropic Conservancy serves as the facilitator and backbone organization within the collaborative partnership of Denver Water, the jurisdictions and the Flood District, referred to as the Canal Collaborative. As the lead partner for Canal-wide planning and implementation, the Conservancy fills an advisory role to review project proposals and ensure that they align with The Plan.

Denver Water — As the owner of the Canal, Denver Water enters into agreements with each jurisdiction for the purpose of authorizing jurisdiction's use of the Canal for the conveyance and treatment of stormwater and recreation management. Denver Water reviews and approves all proposed modifications within the Canal corridor. Denver Water will continue to deliver irrigation water to customers and conduct the required maintenance for those deliveries as delivery contracts are in place.

Mile High Flood District — The Flood District is a partner with metro cities and counties to design and construct flood control and warning measures. The Flood District prepared the master plan and model in 2018 in consultation with Denver Water and sponsoring jurisdictions. The master plan and model established the baseline stormwater management conditions for the Canal and recommended design solutions to best manage existing and future stormwater flows. The model is maintained by the Flood District and will be run for every proposed project to determine effects and hydraulic feasibility. The Flood District serves in an advisory capacity to review and approve projects and ensure that each is consistent with the master plan.

Jurisdictions — Jurisdictions are any agency that has the capacity to enter into an agreement with Denver Water and to independently provide for the maintenance and operations of the Canal. They are the authorized entities to review and approve land use and development changes in the jurisdiction's boundary, which includes stormwater projects in the Canal. Each jurisdiction is responsible for coordination of internal partners (e.g. parks and recreation, public works, roads and transportation) and external partners (e.g., adjacent jurisdictions, referral agencies, regulatory authorities) to ensure that all regulatory policies and procedures are in compliance.

When a jurisdiction initiates a project, they are responsible for determining the costs of the project and may seek to quantify potential benefits. This includes cost of design, construction, and long-term maintenance and repair, as well as associated benefits such as environmental, social, and local and regional economic benefits. See the Stacked Benefits Analysis section (p. 24) for further discussion of benefit-cost analysis (BCA) and project priority setting. Project priority setting will also include collaborative processes within the Canal Collaborative.

The jurisdiction is responsible for working with Denver Water to prepare and sign an IGA that conveys authorizations and responsibilities to the jurisdiction including:

- Designing, constructing, and installing stormwater infrastructure in the Canal to convey stormwater.
- Operating and maintaining the Canal within the authorized area for the purpose of conveying stormwater as needed.
- Ensuring regulatory compliance.

Regulatory Agencies

Consultation and coordination with state and federal regulatory agencies are the responsibilities of the local jurisdiction, though support is provided by the Conservancy and the STEP team. Agencies may include the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, Colorado Department of Transportation, Colorado Department of Public Health and Environment, Colorado Department of Parks and Wildlife, History Colorado/State Historic Preservation Office (SHPO) and the Denver Regional Council of Governments. Permits may be required under § 404 of the Clean Water Act, 33 U.S.C. §§ 1251 et seq., the Colorado Water Quality Control Act, 25 U.S.C. §§ 25-8-101 et seq., and wastewater discharge permits required under Regulation No. 5 CCR 1002-61. Jurisdictions may also be required to comply with the National Historic Preservation Act, 16 U.S.C. §§ 470 et seq.

STEP Team Meeting

Regulatory compliance requirements, including consultation, review, and permitting, will be determined based on the specific nature and location of each project. For additional discussion of regulatory compliance see Stormwater Project Pathway Steps — Step 7.

Marjorie Perry Nature Preserve (credit Evan Anderman)

STORMWATER PROJECT PATHWAY STEPS

The following steps will apply to both the implementation of the master plan recommended solutions that formalize existing stormwater and projects that bring new stormwater into the Canal. Some projects may also be developer-driven. Refer to Appendix F: Developer Toolkit for more information.

Rendering of the Canal with Stormwater in the Prairie Retreat Character Zone

Step 1: Check the Master Plan[10] to determine proximity to the Canal

Potential stormwater projects may be initiated in several ways such as a solution to an existing stormwater issue, as part of the drainage design of a new adjacent development, or in response to increased flows from other changes in the watershed. When a project is proposed, the first step will be to verify that the project:

- Is in the watershed of the Canal.
- Conforms to the recommendations of the master plan.
- Has a clearly defined purpose and need.

See Appendix A: Stormwater Operations and Master Plan Recommendations for a summary of the master plan.

[10] RESPEC developed and maintains the Master Plan in partnership with the Flood District.

Step 2: Determine scope and regional areas of opportunities

Scoping the project will identify initial alternatives and costs that address the project purpose and need. The master plan has identified preliminary solutions to address the baseline condition of the Canal for both water quality and conveyance. Projects may include either or both of these functions and project scoping will verify this and begin to refine the conceptual assumptions of the master plan solutions.

The master plan recommends water quality berms to improve water quality and a series of improvements to reduce the risk of uncontrolled Canal overtoppings including constructed overflows, spillways and raised embankments. Water quality berms can provide water quality treatment and help manage discharge rates. While 92 potential locations for berms are identified in the master plan, any feasible location may be considered for a water quality berm. Conveyance solutions presented in the master plan include adding constructed overflows at locations where they would be most effective for controlling existing spills over the downstream embankment, adding spillways, and moving spill locations downstream by increasing the height of the downstream embankment at certain locations. These solutions can improve capacity and increase Canal freeboard to support future increases in stormwater input and help mitigate local flooding. Projects that include new inflows may consider options for outlets into the Canal and adjacent infrastructure such as forebays or water quality vaults.

The Plan includes *design guidelines*[11] for stormwater improvements (see pages 119-125 of The Plan) that will ensure improvements are compatible with the surrounding landscape and are functionally and aesthetically well-integrated into the Canal character and experience. Stormwater improvements should provide practical connection points for stormwater to enter into the Canal and enhance the Canal's ecological functions through sustainable design practices. A cross-disciplinary team may be assembled to review additional project goals and initial scoping should include opportunities to meet these goals. In addition, Steps 3 and 4 provide guidance on incorporation of additional benefits.

Initial project scoping may also include outreach to other potential project partners and funders, neighbors and user groups to incorporate their input into project planning.

Other Co-Benefit Opportunities

- Increasing stormwater quality treatment in Canal.
- Reducing risk of uncontrolled Canal overflows by providing constructed overflows or raising embankments in reaches with little to no freeboard.
- Providing additional capacity to manage local flooding by directing additional stormwater to reaches with moderate to high available freeboard.
- Improving ecosystem benefits (services) through stormwater projects in vulnerable communities.
- Protecting high quality riparian areas by providing supporting stormwater.
- Improving poor quality riparian areas by providing stormwater and plantings.
- Maintaining areas of high climate resiliency through stormwater related projects.
- Improving below average climate resiliency areas through provision of stormwater to support riparian health.

[11] https://www.dropbox.com/s/q9hdah0bg388glu/DRAFT - Design Guidelines Jan 2019.pdf?dl=0

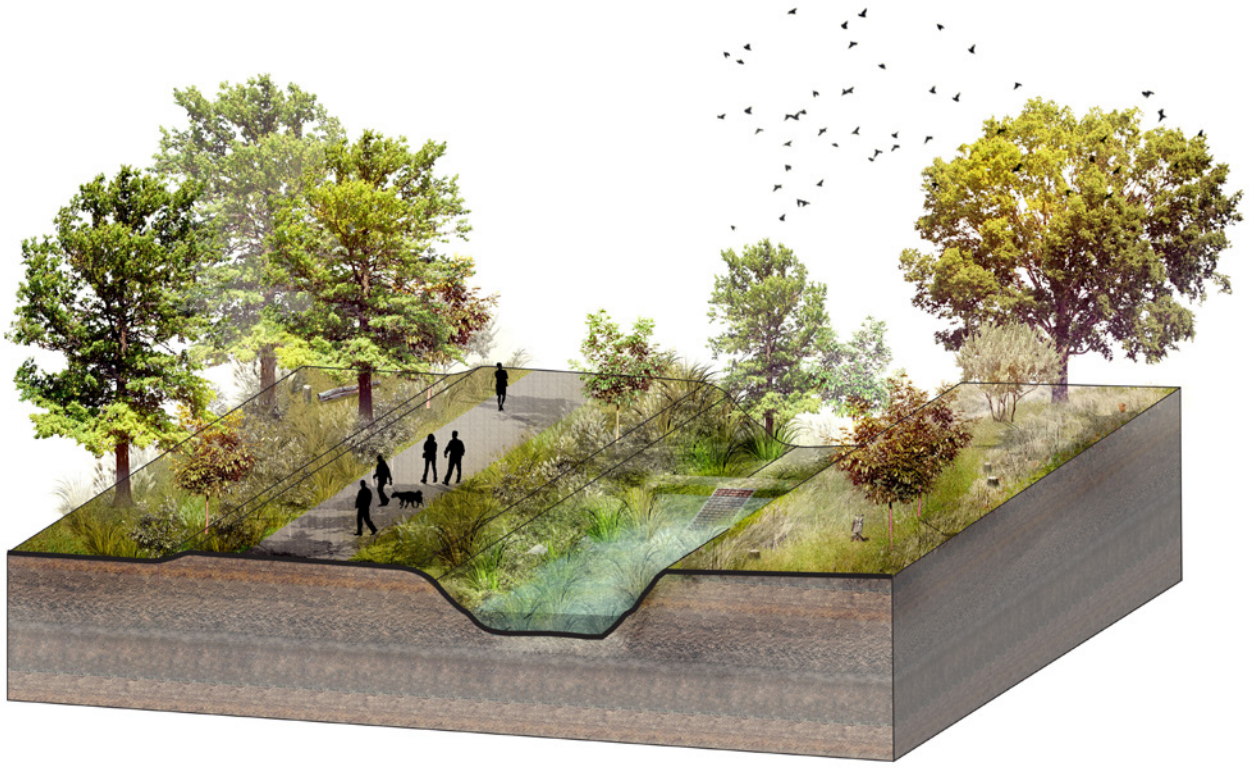
Step 3: Coordinate with internal and external stakeholders for an IGA

An IGA or similar agreeement must be prepared and approved between a jurisdictional agency and Denver Water prior to implementation of Canal stormwater projects unless the project lies within the authorized area of an existing agreement. The IGA will document and memorialize commitments by the jurisdiction and Denver Water as well as define responsibilities for implementing and maintaining the change in use of the Canal for stormwater management. Six to 12 months should be allowed for IGA preparation and execution. The following steps should be taken when initiating an IGA:

1. Define the parties to be included in the IGA. These may include one of the city or county jurisdictions or a special district or authority. Private developers may not enter into an IGA with Denver Water (see Appendix F for private development steps).
2. Review existing IGAs to determine whether the proposed project is within the authorized area of an existing IGA. If so, the IGA may need to be revised or amended to incorporate conditions relevant to the proposed project.
3. If the proposed project does not fall within the authorized area of an existing IGA, a new IGA should be initiated with Denver Water.
4. Coordinate with adjacent jurisdictions, as needed. The master plan hydraulic model can evaluate (see Step 6) the potential interface between jurisdictions and identify whether a project's area of effect would require interjurisdictional coordination and agreement.
5. Coordinate all internal stakeholders such as parks and recreation, public works, and transportation.

For additional guidance on coordinating with Denver Water to prepare an IGA contact:

Amy Turney, Director of Engineering – Property & Distribution
Denver Water, 1600 West 12th Ave, Denver, CO 80204-3412
Amy.Turney@denverwater.org, telephone direct: 303.628.6625



Stormwater Berm

Step 4: Gather conceptual data: scope of project and maintenance plan

The conceptual development phase will refine the scope of the project, identify long-term project needs, and result in a schematic design for the project. Primary steps should include:

1. Gather and evaluate base engineering data and site conditions and determine engineering feasibility. This should include analysis of project risk and fatal flaws.
2. Obtain base data and review stacked benefit mapping tool and information to assess ecological and cultural opportunities. Refer to the Conservancy's website *http://highlinecanal.org/stormwater* and RESPEC online map *http://highlinecanalcolorado.com*.
3. Conduct site assessment for concept development and co-benefit integration.
4. Determine stormwater inputs, both the location and estimated volumes.
5. Specify and map the project boundary including length of the affected Canal reach or reaches.
6. Review local standard operating procedures (SOPs) related to stormwater infrastructure inspection and maintenance.
7. Review Municipal Separate Storm Sewer System (MS4) requirements and local regulations for permanent water quality facilities and required inspection/maintenance.
8. Identify and estimate long-term maintenance needs including mowing, tree care, invasive weed control, debris and trash removal, and Canal inspection, maintenance and repair of stormwater structures (also see Appendix B: Maintenance of Canal Stormwater Infrastructure).
9. Scope and initiate jurisdiction planning/community development review and approval process. Plans must be approved through the city/county with jurisdiction for the project. Application and review processes should be followed and include input from the community and referral agencies and culminate in all necessary local government approvals (see Step 7 on p. 17).
10. Identify other permitting requirements as described in Step 7. These may include 404 permitting, SHPO consultation, and local and state health, safety, and water quality compliance.
11. Develop schematic design alternatives utilizing design concepts from scoping that meet project purpose and need and do not exceed funding targets.

Step 5: Conduct benefit-cost analysis

With an increase in community awareness on the need for clean water and healthy watersheds, there is a growing demand for public agencies to pursue multi-benefit projects. Conducting a BCA provides a platform by which stormwater managers and developers can evaluate the impacts of infrastructure re-use projects across project alternatives from traditional gray infrastructure to green infrastructure options. It is an important step that compares the capital, long-term operations and maintenance and other potential costs (e.g. land acquisition) with the environmental, economic and social benefits related with the alternatives.

The Conservancy, along with its STEP partners, developed a comprehensive Canal-wide BCA that helps to elevate the efficacy of the Canal's potential as a green stormwater infrastructure system. The results of the BCA factored in:

- The value of treating stormwater in the Canal as opposed to off-site treatment ($39M in savings).
- The increase in maintenance costs assumed by the jurisdictions ($1M).
- The value of the Canal's vast tree canopy and associated costs to replace them ($58M).
- The avoided cost of replacing habitat value for the Canal's wildlife ($25M).

The BCA also included community health benefits realized through access and connectivity to the Canal resulting in medical cost savings of $47M while identifying 50% adjacent Canal residents as socially vulnerable as defined by the Center for Disease Control. Over a 50-year lifecycle span, the quantified stacked benefits resulted in $168M or $2.7M per mile (of the 62-miles eligible for stormwater).

The methods for characterizing and analyzing these stacked benefits of implementing stormwater projects in the Canal vary. The Conservancy can develop a reach or project-specific analysis that helps to identify high value multiple-benefit stormwater projects while considering the risks and costs for capital projects and associated operations and maintenance costs. The BCA and reach-specific BCA can also provide a framework for communicating to decision makers, stakeholders and the public, and provide documentation to support a preferred approach to the project.

Additional discussion can be found in Appendix C: Stacked Benefits Analysis.

Mile 17 (credit Denver Water)

Shea Homes Solstice Development

Step 6: Establish feasibility: collect specific data, detailed investigations, check/revise the model

In addition to the BCA, the preliminary design should be supported by other investigations. The selection of the preferred design alternative should be based on the evaluation of the relevant data, analysis of benefits and costs, and coordination and collaboration of stakeholders. From here, the next steps in design development can proceed.

Relevant data and investigations to support the schematic design stage may include:

- Geotechnical and soils investigation of the Canal and embankment.
- Topographic and slope analysis.
- Vegetation analysis.
- Existing physical features (bridges, headgates, recreation amenities, etc.).
- Utilities.
- Hydraulic analysis with the master plan model.
- Easement and/or right of way analysis.

Master Plan Model — The master plan presented example solutions for all reaches of the Canal based on the hydraulic model and the objectives presented in The Plan. The final master plan solutions and all future stormwater improvements are not anticipated to be constructed simultaneously or exactly as recommended by the master plan. Each improvement must be evaluated individually prior to final design and construction. The Flood District will keep the Canal model up to date to record and monitor the cumulative effect of all projects and to be able to correctly design the master plan's solutions and additional projects over time.

The Flood District maintains the *High Line Canal SWWM Users Manual V2*[12] and the *Guidelines for Model Approval for Use of the High Line Canal for Stormwater Purposes*[13]. These documents should be consulted early in the formulation of project designs.

Shea Homes Solstice Development (credit Evan Anderman)

[12] *https://www.dropbox.com/s/078mmiefcc6j3uc/HLC SWMM Model Users Manual V2.docx?dl=0*

[13] *https://www.dropbox.com/s/xoivzn686swh0ye/UDFCD HLC Model Approval Guidelines.docx?dl=0*

Step 7: Project and permit submittal process

Step 7 is a two-part simultaneous process that local governments can initiate to advance the project.

Part 1: Local government project submittal process

Implementation of STEP projects in the Canal requires early and continual coordination of internal and external jurisdiction stakeholders to avoid stove piping decision making processes. Engagement of all stakeholders throughout the project development process will:

- Improve coordination between jurisdictional departments including parks and recreation, public works, roads and transportation, and planning.
- Ensure that funding sources are in place and appropriately allocated within the jurisdiction.
- Facilitate coordination with adjacent jurisdictions where stormwater project influences may overlap.
- Draw beneficial knowledge and experience from the Canal Collaborative.

At the completion of the draft construction documents, the project will be ready for local jurisdiction review, approval, and permitting. This process varies somewhat from jurisdiction to jurisdiction. The general required steps are as follows:

1. **Pre-submittal** — jurisdictions will require either a pre-submittal application or a pre-submittal staff meeting. At this time, jurisdictional staff will review design concepts.
2. **Neighborhood meeting** — several jurisdictions require that the project proponent gather input from immediate stakeholders prior to application submittal.
3. **Application** — the project development or building application and construction documents will be completed and submitted to the jurisdiction planning and/or public works department.
4. **Staff review** — jurisdictional staff will review the design and it will be modified based on jurisdiction comments.
5. **Referral agency review** — referral agencies and stakeholders will review the design and it will be modified based on referral review comments.
6. **Additional reviews** — depending on the nature and magnitude of the project and previous comments, additional rounds of review may be required.
7. **Public hearing** — depending on the nature and magnitude of the project, a public hearing may be required.
8. **Planning commission or city/county board hearing** — depending on the nature and magnitude of the project, a hearing may be required.
9. **Approval** — at the completion of all required reviews and hearings, and upon demonstration of compliance with all regulatory requirements, the project will have jurisdictional approval.

Part 2: Finalize permitting process

Segments of the Canal may be determined to be waters of the U.S. (jurisdictional waters), the Canal may be considered a historically significant resource and may be eligible for listing on the state register of historic places and areas of the Canal may also support plant and animal species of special concern. Determining these designations and whether a project will trigger compliance requirements necessitates consultation with relevant state and federal agencies. This consultation and coordination are the responsibility of the project proponent which can be the local jurisdiction. Agencies with whom consultation may be required, and potential permitting, may include the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service, History Colorado/SHPO, Colorado Department of Transportation, Colorado Department of Public Health and Environment (CDPHE), Colorado Department of Parks and Wildlife, and the Denver Regional Council of Governments. Permits may include those required under § 404 of the Clean Water Act, 33 U.S.C. §§ 1251 et seq., the Colorado Water Quality Control Act, 25 U.S.C. §§ 25-8-101 et seq., and wastewater discharge permits required under Regulation No. 5 CCR 1002-61. Jurisdictions may also be required to comply with the National Historic Preservation Act, 16 U.S.C. §§ 470 et seq.

Six to 12 months should be allowed in the project schedule for consultation and permitting. General steps include scoping the consultation and permitting pathway, pre-application consultation with respective regulatory agencies (e.g. USACE), application submittal, public notice and comment, project modifications and responses based on public and agency comment and permit issuance.

MS4 Permits – each jurisdiction with stormwater management authority has an MS4 permit issued under the authority of CDPHE, Water Quality Control Division (WQCD). Depending on the nature and extent of the project, review and permitting may be required.

Mile 16 (credit Denver Water)

Step 8: Build the Project

After securing the required permits, commence construction of the project. Continue to monitor construction progress to ensure desired outcomes are being achieved. Complete close out requirements at conclusion of construction.

CONCLUSION

The goal of this Pathway Guide is to serve as a valuable resource for moving stormwater projects forward and lowering barriers that may slow the initiation of a project.

The next major steps are to identify and design projects that will be beneficial to the jurisdiction and goals of STEP and demonstrate the multiple benefits of transforming the Canal as a signature piece of the region's green infrastructure. Please consult with and direct questions to the Conservancy, Flood District, Denver Water, or your jurisdiction representative in the Canal Collaborative. Help will be available to navigate initial steps including identifying and screening candidate project areas, running the stormwater operations model, planning the permitting and compliance process including insights into lessons learned from prior projects, and measuring project benefits. During project implementation, the collaborative partnership can provide on-going help with project peer reviews and inspections, preparation of operations and maintenance manuals and project close-out documents, support for public engagement, communications, and interpretive activities, and aid in analyzing and reporting project benefits.

This document will be updated over time. The process of identifying, evaluating, and implementing projects will bring a wealth of new information that will need to be presented in the Pathway Guide. This will include additions to lessons learned and case studies, updates to regulatory and compliance requirements, and building a library of quantified benefits from successful projects.

Canal at sunset

APPENDIX A: STORMWATER OPERATIONS AND MASTER PLAN RECOMMENDATIONS

In 2018, the Flood District completed the *High Line Canal Stormwater and Operations Master Plan*[14] which examined Canal operational and flood control considerations and the recommended improvements to use the Canal for conveyance, water quality and flood control purposes. The study explores formalizing the management of the existing stormwater and directing additional stormwater in the Canal while maintaining the corridor as a recreational asset and thriving natural environment. The master plan highlights areas of concern and recommends stormwater modifications to the Canal to protect people and property during 100-year storm events.

Recommendations were developed through use of a hydraulic model that analyzed the capacity of the Canal, both when it is dry, and while being utilized to deliver irrigation water. Alternatives were then proposed to maximize water infiltration and water quality treatment as well as minimize flooding. This plan of improvements provides one approach for the entire Canal that allows for long-range planning of costs and benefits. Some of the modifications include:

- Adding constructed overflows where extra water can discharge into another natural waterway.
- Increasing the height of embankments to direct flows to certain areas.
- Adding formalized channels for water to discharge into other waterways.
- Introducing over 92 water quality berms to slow down water and increase water available for trees.

The steps within this Guide address how to implement the master plan, adjust and refine its recommended solutions for consideration by jurisdictions and developers and incorporate new projects within the capacity of the Canal infrastructure. Refer to the *High Line Canal SWMM Users Manual V2*[15].

Pedestrian on the Canal

Stormwater Infrastructure, Littleton

DeLaney Farm, Aurora

[14] *https://www.dropbox.com/s/v5q39powr6nkp5z/20181031 HLC Master Plan - Final Report.pdf?dl=0*

[15] *https://www.dropbox.com/s/078mmiefcc6j3uc/HLC SWMM Model Users Manual V2.docx?dl=0*

APPENDIX B: MAINTENANCE OF CANAL STORMWATER INFRASTRUCTURE

With the transition to stormwater management, operations and maintenance will continue to be required for the Canal and associated stormwater infrastructure. The jurisdictions or special districts as designated MS4 owners and operators under the National Pollutant Discharge Elimination System (NPDES) will operate and maintain the stormwater functions and infrastructure. Within the State of Colorado, CDPHE, WQCD administers the NPDES program. Each designated MS4 owner or operator must submit an application to the CDPHE for coverage to discharge stormwater from the stormwater system to waters of the State. The coverage in the State of Colorado is granted under the Colorado Discharge Permit System (CDPS). One of the requirements for CDPS coverage is to develop a stormwater management program that addresses minimum control measures or "minimum measures". One of the minimum measures is to develop SOPs for municipal pollution prevention or "good housekeeping" program to reduce the potential for polluting or negatively impacting local receiving water quality from stormwater runoff.

Little Dry Creek Waste Gate

Waterton Canyon (credit Chris Englert)

Generally, existing MS4 SOPs can provide guidance for the development of maintenance guidelines for managing stormwater in the Canal. The jurisdiction's IGA with Denver Water will further outline the operations and maintenance scope (note: jurisdiction scope will generally not include maintenance for irrigation conveyance). The IGA, as discussed above, will also define the geographic extent or authorized area within which operations and maintenance responsibilities will apply.

The SOPs will seek to ensure that consistent and effective practices are implemented for all Canal facilities to minimize the potential for degrading local receiving water quality. Current jurisdictional MS4 park and open space maintenance SOPs include operation of equipment such as mowers and tractors; disposal of waste from mowing, planting, weeding, raking, pruning and trash collection; application of pesticides, herbicides and fertilizers; cleaning and maintenance of park amenities such as play equipment, restrooms, and structures; and snow removal.

Goal: Establish a level of service through collaboration of Denver Water, Flood District, the Conservancy and the jurisdictions that will guide operations and maintenance standard operating procedures to ensure consistency in the High Line Canal landscape management level of service, channel and installation conditions and vegetation management.

OPERATIONS AND MAINTENANCE CONSIDERATIONS

Phase 1

- Conduct routine observation of the channel and report back on maintenance needs for general stormwater passage.
- Maintain any installation(s) (for example stormwater discharges with associated erosion protection) constructed by the jurisdiction under the terms of the IGA.
- Remove and dispose of minor amounts of sediment (two or less cubic yards), channel debris, trash, leaves and obstructions in the channel.
  - » Denver Water will be responsible for debris removal necessary for the passage of irrigation water.
  - » Specifications of the amounts of accumulated material, timing and other triggers for jurisdiction action would be included in the IGA.
- Maintain access to the project infrastructure and the Canal right-of-way.
- Observe for potential biohazard material including known and orphan waste into the Canal.
- Observe, inspect and report back on areas of bank and channel instability.
- Remove stormwater-obstructing (i.e., capacity-reducing) downed trees/branches and vegetation and control noxious weeds and vectors.
- Account for intermittent seasonal events that may require additional maintenance.
- Routinely observe Canal for human, health and safety status.

Phase 2

- Perform minor bank repairs on a case-by-case basis only.
- Perform cleanup of biohazard material on an incident-based scenario only.
- Perform any minor repairs on infrastructure.
- Perform removal of major sediment.

Funding — sources for operations and maintenance funds should be identified early during the project development and design phase and established in multi-year budgets. The existing jurisdiction's park and recreation, grounds, or utilities operations and maintenance program may cover some activities. Other activities will require additional staff and/or skills that will need to be programmed and funded through storm drainage capital and maintenance funds or stormwater enterprise funds (if available).

Communications — a communications plan should be prepared to inform the public of the project, the new activities that can be expected on the Canal, and jurisdiction contact information. This might also be a vehicle to generate community and neighborhood volunteer participation in some maintenance activities, such as community clean up or debris removal events coordinated through the Conservancy and sponsoring jurisdictions.

In 2021, the Flood District and the Conservancy partnered with three jurisdictions to pilot a centralized maintenance contract. This contract helped the jurisdictions to streamline maintenance activities associated with their stormwater project and helped to increase the understanding of what it will cost to maintain the Canal as green stormwater infrastructure. This centralized maintenance contract will continue in 2022, coordinating channel maintenance, noxious weed treatment, tree inspections and tree canopy care. This centralized approach has the potential to create economies of scale while ensuring consistency in the way the corridor is maintained.

APPENDIX C: STACKED BENEFITS ANALYSIS

A project prioritization and evaluation tool was developed to assist in the analysis of the multiple environmental, social, and economic benefits of proposed projects. Areas of benefit include water quality and flood management, landscape and natural environment, resiliency and community health and livability and social vulnerability. The tool prioritizes key reaches of the Canal where the transition to green stormwater infrastructure provides the greatest benefit to environmental health as well as to adjacent communities. The mapping tool considers both areas of need, where the risk of Canal overtopping can be mitigated, as well as areas of opportunity, where the Canal's transformation would benefit vulnerable populations.

Employing the tool to evaluate proposed projects and building a library of project analyses will:

- Help to ensure implementation of new stormwater projects that are consistent with the objectives in The Plan.
- Aid the preparation of cost-benefit analyses of stormwater project alternatives.
- Institutionalize processes to assist jurisdictions in embedding smart water applications in current practices.
- Systematically scale up the transformation by leveraging existing Conservancy and jurisdictional programming and planning initiatives and resources.
- Elevate successful transformation by fostering partnerships with jurisdictional staff from stormwater engineering, public works, parks and recreation, green infrastructure and floodplain management along with city, county and agency leadership.
- Streamline project conceptualization and implementation by providing technical guidance, key tools and resources for elected officials, agency heads and staff as well as developers.
- Advance stacked benefit evaluation methods and prioritization tools and communicate the multiple benefit results.

The next page is an infographic of the Canal-wide assessment of the multiple benefits quantified using the Canal as green stormwater infrastructure over a 50-year lifecycle.

Aerial View of Canal (credit Evan Anderman)

STORMWATER

It can make the world green.
That's the power of STEP.

OVER 50 YEARS, THE HIGH LINE CANAL (CANAL) WOULD PROVIDE $168M IN BENEFITS OR $2.7M PER MILE AS GREEN STORMWATER INFRASTRUCTURE

Evaluating the Multiple Benefits of the Canal's Transition to Green Stormwater Infrastructure.

The Stormwater Transformation and Enhancement Program (STEP) seeks to advance stormwater projects that will realize the social, economic and environmental benefits of managing stormwater in the Canal.

$38 MILLION

Water Management Benefits = $38M

Value of Treating Stormwater $39M
Jurisdictions can save $39M over 50 years by managing stormwater in the Canal as opposed to the cost of managing it off site

Increased Cost of Maintenance (–$1M)
Increased cost of maintenance for the Canal compared to offsite maintenance

$83 MILLION

Environmental Benefits = $83M

Tree Value & Preservation $58M
Value of the Canal's 19,055 healthy, mature trees + avoided costs to replace over 10,000 trees

Wildlife Habitat Value $25M
Avoided cost to replace the Canal's wildlife habitat

$47 MILLION

Community Health Benefits = $47M

Medical Cost Savings $47M
Avoided medical costs for 2,643 residents living within ¼ mile of the Canal through regular use of the Canal trail

Supporting Vulnerable Populations 50%
Over half of the residents that live along the Canal are considered socially vulnerable as defined by the Centers for Disease Control

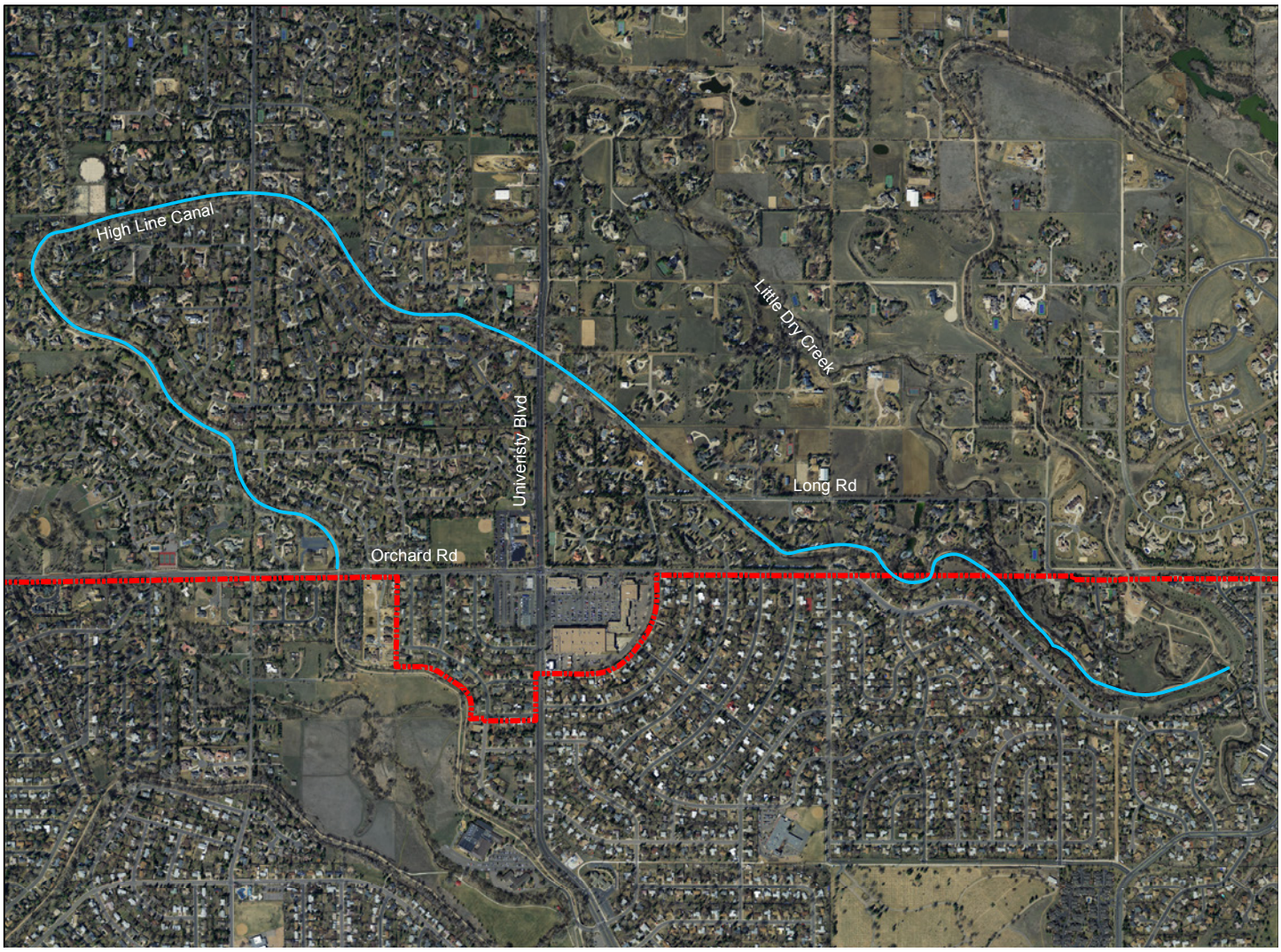
All values represent a 50-year life cycle and assume that the 62 miles of the 71-mile Canal that are eligible for stormwater management are transformed.

APPENDIX D: STORMWATER PROJECT DESCRIPTIONS

Six stormwater projects are underway along the Canal. These projects are the first of many to come and provide valuable lessons learned that will benefit future projects. Following is a brief description the projects. Appendix E presents the lessons learned from these ground-breaking projects.

City of Greenwood Village

The Greenwood Village stormwater pilot project includes formalizing the use of the Canal for stormwater conveyance through 2.5 miles from Orchard Road west of University Boulevard to the jurisdictional boundary west of Little Dry Creek via an IGA with Denver Water. Additionally, two water quality berms will be installed through the reach. Currently, the IGA is complete but the berms have not been installed. Berm installation is pending completion of regulatory consultation and approval of a USACE 404 permit.



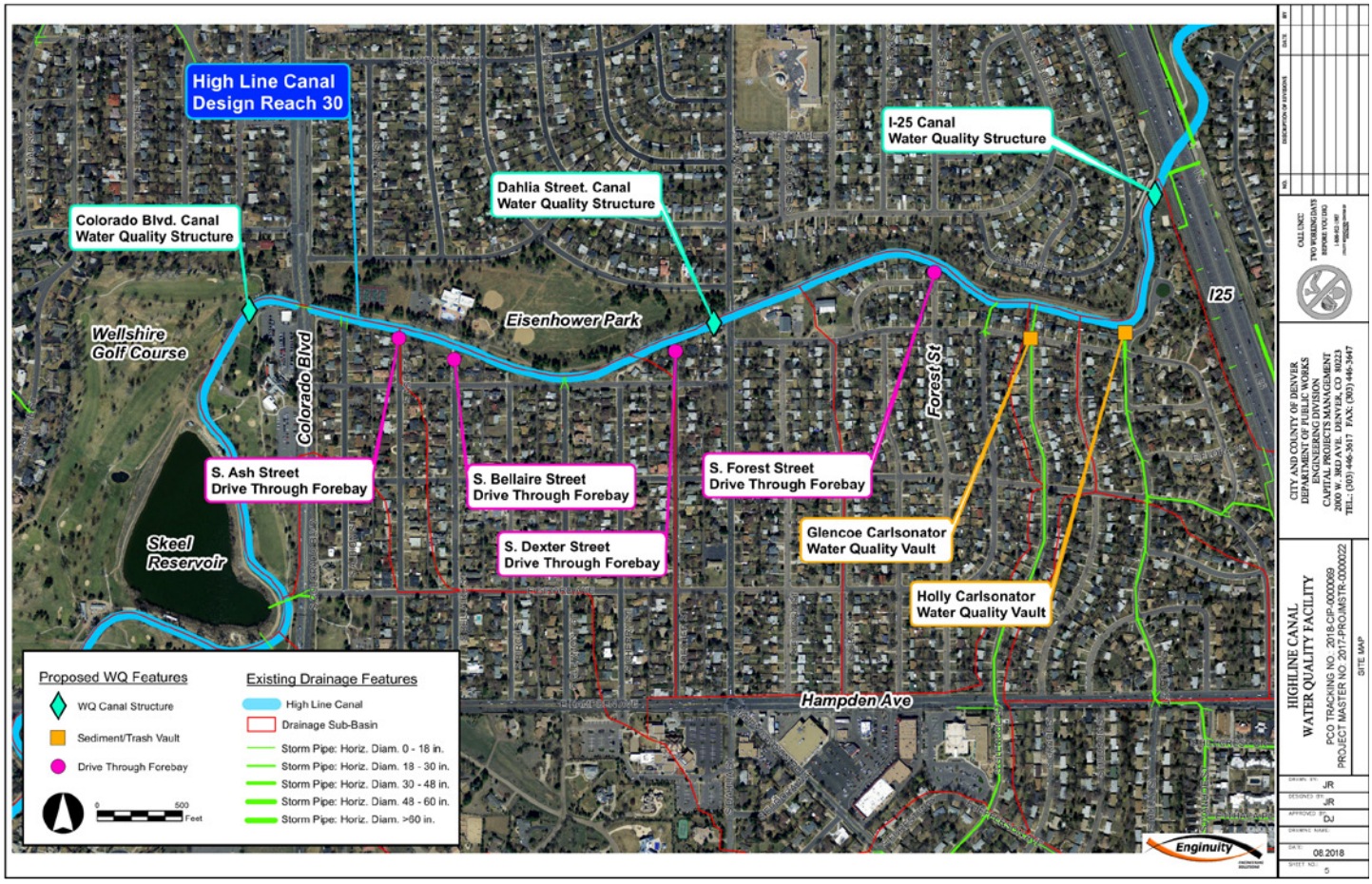
Map – City of Greenwood Village Stormwater Pilot

Stormwater reach

Greenwood Village/Centennial border

City and County of Denver

The first Canal stormwater project within the City and County of Denver retrofitted just over one mile of the Canal from Skeel Reservoir on Wellshire Golf Course through Eisenhower Park and ending just past the Interstate I-25 underpass. The project includes three water quality berms within the Canal, two water quality vaults at existing storm drain outfalls and four forebays where street surface flow outfalls from residential neighborhoods on the south side of the Canal. Control structures allow for infiltration of stormwater into the Canal and forebays catch sediments, trash and other floatables before entering the Canal. The berm structures detain the water longer and increase infiltration into the Canal banks. A second project phase will address vegetation strategies and plant pallets for the banks and bed of the Canal.



Map — City and County of Denver Stormwater Pilot

City of Littleton

Littleton's project re-routed a storm sewer inverted-siphon that ran under the Canal to discharge directly into the Canal at Windermere Street and discharges at Lee Gulch, about a one mile stretch. The existing siphon flows from south to north, beneath the Canal in an 18" pipe on the east side of Windermere Street and outlets into a ditch farther north. The storm sewer collects runoff on the south side of the Canal from an existing 12" pipe from the west and 18" pipe from the east. These will combine into a single 24" outfall pipe draining into the Canal. There were horizontal and vertical constraints associated with discharge of the siphon pipe in its current alignment, including a water line, narrow right of way, existing fences and landscaping, and the existing bridge abutment. As a result, the outfall was placed on the west side of Windermere Street, discharging between two large cottonwood trees. City of Littleton will continue to evaluate and monitor this site for any possible impacts to the large cottonwood roots.

The city partnered with an adjacent land developer, who would have otherwise needed to extend the length of storm sewer siphon pipe under proposed sidewalk paving to connect to a sewer farther north or install bubbler inlets. The city was interested in removing the maintenance work associated with an inverted siphon and bubbler inlets.

A water quality berm in the canal is not proposed at this time. The new storm sewer has a trash collector in the inlet prior to discharge into the Canal.

Map — City of Littleton Stormwater Project

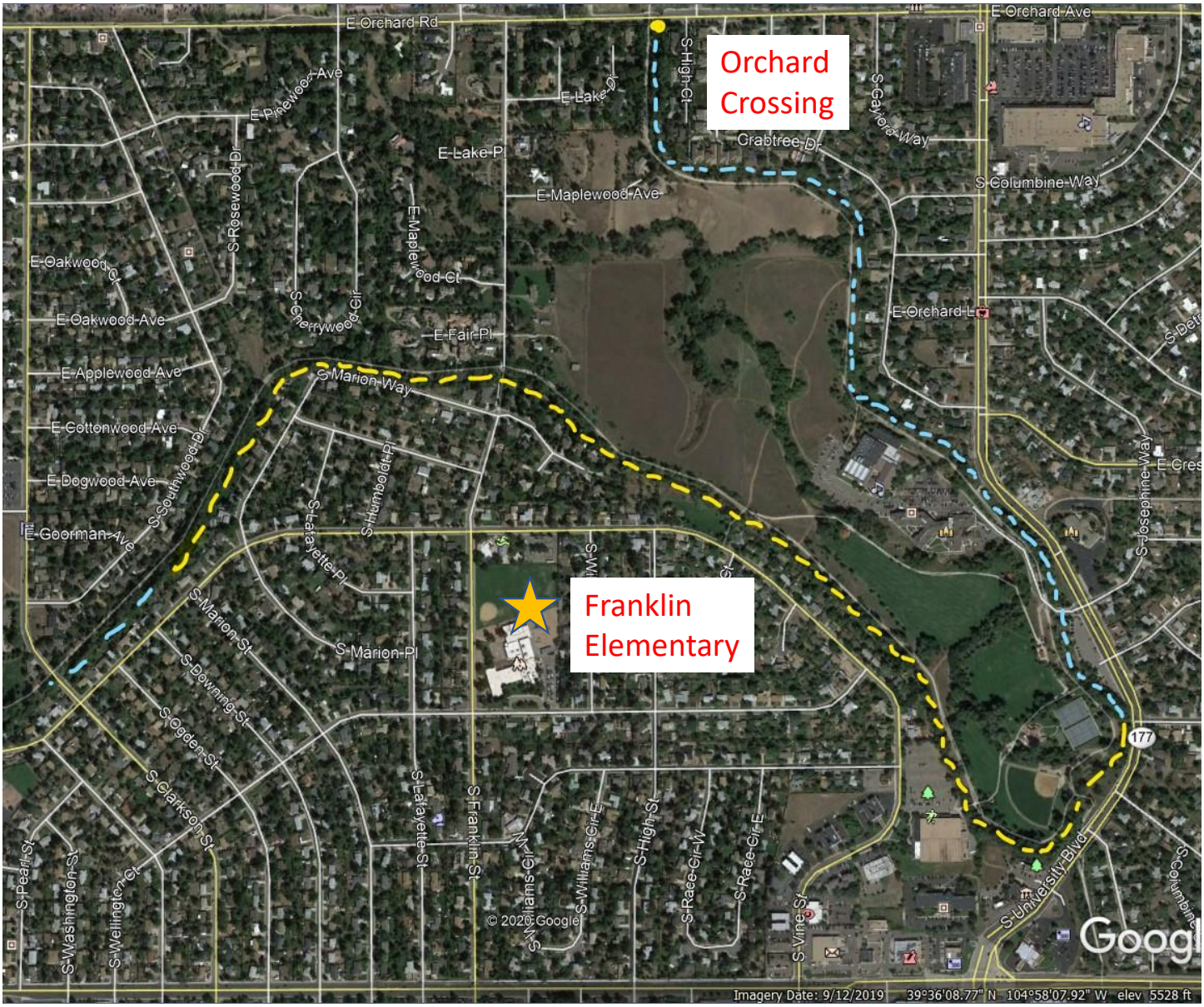
Shea Homes Solstice Development

The Solstice development borders the southern perimeter of Chatfield State Park and will include up to 1,100 homes, forming the Mirabelle Metro District. The first phase will be bisected by approximately three-quarters of a mile of the Canal extending from the west side of Roxborough Park Road westward to the development's southwestern boundary. The Canal corridor will be developed as the primary open space for the development and will be incorporated into the development's stormwater management system to convey stormwater for discharge into Plum Creek. To serve the detention function, the Canal has been regraded and widened to increase its capacity to convey stormwater. An IGA has been completed between the Mirabelle Metro District and Denver Water. The district is responsible for stormwater management and manages and maintains the Canal over approximately three miles from the development's southwest boundary to Plum Creek where stormwater is discharging into the natural waterway.

Map - Solstice Development Stormwater Project

SEMSWA Stormwater Project

As part of the Franklin Elementary School redevelopment project, stormwater is now being discharged into the Canal through an existing outfall at Franklin Street. As this project is in Centennial, SEMSWA has taken over management and maintenance of the Canal channel. SEMSWA's project extends 1.5 miles from Marion Street to the Big Dry Creek waste gate located at the southern end of deKoevend Park. South Suburban Parks and Recreation will continue to maintain the trail.



Map - SEMSWA Stormwater Project

Santa Fe/U.S. 85 Stormwater Project

Douglas County signed a license agreement with Denver Water to formalize stormwater discharging from Santa Fe Drive into the Canal at Spring Gulch to Marcy Gulch. This 1.5-mile stretch is part of Douglas County and the Colorado Department of Transportation's highway improvement project planned for Santa Fe Drive. Stormwater runoff from the proposed highway improvement project is pretreated before discharging into the Canal through an existing 72-inch storm sewer pipe that flows into the Canal. Douglas County is responsible for maintaining and managing this portion of Canal to ensure safe passage of stormwater.

Map - Douglas County Stormwater Project

APPENDIX E: LESSONS LEARNED

Key lessons were compiled from the four projects presented in Appendix D — City of Greenwood Village, City and County of Denver, City of Littleton, and Shea Homes.

1. Early engagement with regulatory agencies is critical, especially for USACE 404 permitting, jurisdictional determination, and SHPO consultation. The Shea Homes project also required protected species (Prebles jumping mouse) consultation with the Fish and Wildlife Service. For four out of five projects, this took longer than expected.
2. Coordinate early with Denver Water to prepare and finalize the IGA. In the first four projects, it took longer than expected because the process is new. Hopefully, future projects will encounter a more standardized and streamlined process.
3. Educate and inform internal stakeholders early in the process including jurisdiction leadership and elected officials and all related departments (parks, public works, transportations, etc.). As the project proceeds, expectations should continually be managed on timelines for project delivery.
4. Many obstacles were overcome through the cooperation of all entities and a common vision of incorporating the Canal into green stormwater infrastructure. In all projects, stakeholders saw this as the right thing to do.
5. The project team will learn as the project proceeds. Expect some curve balls. Ultimately, the six projects were not more complex than other public works or development projects. The issues encountered were engineering that needed to be solved. All projects have these.
6. Identify feasibility and engineering solutions before design begins to minimize redesign. This includes early coordination with the Flood District to run the hydrologic model. Conditions that arose that could have been identified earlier in the process included:
    - Needs for permanent easements from adjacent landowners.
    - Cost sharing between jurisdiction and developer/project proponent as well as cost sharing across departments within a jurisdiction.
    - Project area resource conditions such as locations of large Canal trees and avoidance of important root systems.
7. Cost savings may not be present compared to a traditional gray infrastructure approach. The Littleton and Shea Homes projects both encountered issues that may have resulted in costs exceeding the initial gray infrastructure costs. However, in four of the six projects there was agreement of broader benefits that would be achieved through green infrastructure use of the Canal and costs were justified by the long-term benefits.
8. Planning for revegetation should not be overlooked. This includes selection of an appropriate plant palette, in accordance with design guidelines in The Plan, a watering plan for plant establishment and estimates of long-term maintenance.
9. As the construction proceeds there may be concerns from the public and advocacy groups over changes to the Canal environment such as tree removal and Canal regrading.
10. Be persistent in seeing the process through!

APPENDIX F: DEVELOPER TOOLKIT

When and Why Should Developers Consider the Canal for Stormwater Management?
Private developers along the Canal are an increasingly important partner in the green infrastructure transformation of the Canal. Effective use of the Canal and its integration into a development's stormwater management design can have significant payoffs for the project owner, the Canal, and the community.

This guide is intended to highlight the opportunities that are present and to direct developers and their design teams to the sections in the main body of this Guide that can serve as a resource for planning and designing a successful project in collaboration with Canal partners.

Project owners are encouraged to reach out to the Conservancy and Canal Collaborative partners at the earliest reasonable point in the project conception process (see list of points of contact on page 36). Through engagement with the Conservancy, Denver Water, the Flood District, or the Canal Collaborative representative in the local jurisdiction, project owners can begin early to incorporate sustainable and likely cost-saving alternatives for stormwater management. Benefits that are possible include:

- Reduced detention and conveyance costs.
- Increased usable land on the project site.
- Potential increase in development feasibility where conventional stormwater discharge options are limited or nonexistent.
- Increase in recreation and open space amenities for both residential and commercial projects.
- Increased resiliency and ecological benefits delivered to the surrounding community.

How Does the Process Work? Steps to help ensure effective stormwater project development in coordination with appropriate Canal partners.
The steps outlined in the main body of the Guide generally apply to private development projects in the same way that they apply to public works projects. The following provides a summary of the major Guide steps as they apply to private development projects.

Lee Gulch Flume (credit Evan Anderman)

Early Coordination and Communications (Pathway Guide Steps 3 and 7): As mentioned above, the project owner should begin conversations with key Canal partners as early in the project development process as possible. The Conservancy can be a valuable partner early on and can provide important guidance and input on the project, the stormwater opportunity, and actions that can facilitate effective coordination with the appropriate High Line Canal partners.

Contact should be initiated early with Denver Water and the jurisdiction within which the project is located. This step will first determine the status of the IGA or other agreements. IGAs for stormwater uses of the Canal are between Denver Water and the local jurisdiction (either a city or county government entity or a special district) and must be in place prior to discharging stormwater into the Canal. The IGA defines responsibilities for implementing and maintaining the change in use of the Canal for stormwater management. Coordination with Denver Water and the jurisdiction will identify: Presence of an existing IGA and geographic scope of the IGA — is the project within the geographic area covered by an existing agreement?

- Consistency of the proposed project scope and stormwater management need with the scope and terms of the existing agreement.
- Needs to modify the scope or terms of the existing agreement to include the proposed project.
- If there is not an existing IGA, coordination of needs with the local jurisdiction and Denver Water to determine feasibility and timeframe for establishing a new IGA or agreement suitable to include the proposed project.
- Necessary commitments and obligations that the project developer or participating jurisdiction will assume under the agreement.

Consultation with regulatory agencies can be a critical step and will be the responsibility of the project owner (Pathway Guide page 18). Regulatory compliance requirements, including consultation, review, and permitting, will be determined based on the specific nature and location of each project. The Stormwater Project Pathway Steps section — Step 7— provides an overview of regulatory considerations. Some compliance and permitting steps could require six to 12 months to complete.

Project Development (Pathway Guide Steps 4-6): These steps will serve to gather and present conceptual project data, identify project costs and benefits, and establish project feasibility, and will:

- Fully communicate the purpose and scope of the project.
- Develop and demonstrate the broad set of environmental, social, and economic benefits that can be realized by the project (see Appendix C: Stacked Benefits Analysis section of the Pathway Guide).
- Demonstrate how the project will avoid negative impacts.
- Identify the long-term operations and maintenance needs and interfaces between the project owner and the jurisdiction.

APPENDIX G: FREQUENTLY ASKED QUESTIONS

1. **What are the potential benefits to using the Canal for stormwater?**
    a. Potential opportunities to save valuable space on development sites by avoiding or decreasing on-site water quality ponds and other BMPs.
    b. Save money by defraying the cost of other on-site or off-site infrastructure (ponds, pipes, etc.).
    c. Support the planned for and maintained vegetation along the Canal, sustaining a valuable public recreation, open space, and environmental resource.
    d. Enhance property values adjacent and nearby the Canal by improving vegetation health and quantity.

2. **What are the main differences between using the Canal for stormwater and discharging into a typical public storm sewer or open channel?**
    a. Water is discharged to property owned by Denver Water, instead of a local government, so an agreement is needed with Denver Water.
    b. The Flood District must review proposed discharges to the Canal for potential flood impacts, and the "Living Model" must be routinely updated.
    c. The Canal returns water to natural streams by means of "waste gates" that may be open or closed depending on Denver Water operations, varying the potential capacity of the Canal in some locations, and possibly transferring water to a different local waterway than it would have drained to previously.
    d. Water quality berms should be constructed in the Canal to provide water quality capture volume.

3. **How is using the Canal for stormwater similar to a traditional stormwater project?**
    a. The local jurisdiction must review and approve the stormwater discharge, and water quality pre-treatment may be accomplished prior to discharge into the Canal.
    b. Water quality treatment in the Canal must drain completely within the timeline established by the State Engineer.

4. **Is using the Canal for stormwater going to lead to additional maintenance burden for a city?**
    a. For private developments discharging into the Canal, local jurisdictions may allow the developer to enter into an agreement directly with Denver Water for private maintenance of the Canal (with a public drainage easement or other right of access).
    b. Properly designed and maintained water quality treatment facilities actually reduce standing water in the Canal, and therefore reduce the likelihood for uncontrolled growth of weeds, mosquitos, and other nuisances that currently plague certain portions of the Canal (especially downstream sections).

5. **What are a city's maintenance responsibilities after installing a berm or discharging water into the Canal?**
    a. This will be municipality specific and dependent on the agreement with Denver Water and the character of the section of the Canal within the municipality beyond listing the usual considerations of tree maintenance, mowing, weeding etc.

6 **Who should I contact at Denver Water to pursue an IGA?**

Amy Turney
Director of Engineering — Property & Distribution
Denver Water
1600 West 12th Ave, Denver, CO 80204-3412
Amy.Turney@denverwater.org, Office: 303.628.6625

7 **Who should I contact at Mile High Flood District to confirm design standards or master planned project recommendations?**

Jon Villines, P.E., CFM
Watershed Manager
Mile High Flood District
2480 W. 26th Ave Suite 156-B, Denver, Colorado 80211
jvillines@udfcd.org, Office: 303-455-6277, Direct: 303-749-5411

8 **Who should I contact at RESPEC to discuss modeling of stormwater discharges?**

Alan Leak, P.E.
Principal
RESPEC
720 S. Colorado Blvd., Suite 410S, Denver, CO 80246
Alan.leak@respec.com , Office: 720-775-6406

Jessie Nolle, P.E., CFM
RESPEC
720 S. Colorado Blvd., Suite 410S, Denver, CO 80246
Jessica.nolle@respec.com, Office: 720-775-6412

9 **Which departments should be included in the discussion?**

a. Likely departments could include jurisdiction parks and recreation, grounds crews, public works, water, utilities, and community development/planning.

10 **Will the Canal be classified as a Waters of the U.S.?**

a. The Canal was previously considered to be a Waters of the U.S. under the Rapanos' ruling administered by the USACE. This was changed in June 2020, when the Navigable Waters Protection Rule reduced the Corps' jurisdiction and removed many waterways and wetlands from protection. Some reaches of the Canal may be considered jurisdictional and a determination should be undertaken in advance of implementing projects that include infrastructure in the Canal.

11 **Will ponding water in the Canal cause mosquito breeding grounds?**

a. Management of stormwater in the Canal will help to keep stagnant water moving and filtrating into the earth, therefore reducing the amount of standing water. Colorado State water law states that water can only be held for 72 hours before being released to return into the ground. Mosquito management would be similar to Denver Water's current methods, which includes applying mosquito briquettes or dunks.

12 Will Denver Water still cleanup debris in the Canal that floats down by irrigation water?

a. As long as Denver Water is running irrigation water, they will conduct cleanups necessary to deliver irrigation water or as a result of irrigation water delivery. Each jurisdiction will also be responsible for Canal cleanup under the terms of their IGA.

13 Will stormwater ponding in the Canal increase flood risk on adjacent properties outside the Canal boundary?

a. One of the purposes of the master plan model was to identify modifications to the Canal that would minimize the risk of flooding in the presence of stormwater. In places, the grade and variation in the bottom of the Canal results in standing water. These areas of standing water are smaller in area, of lower volume, and present for shorter periods of time than traditional irrigation flows. The risk of seepage affecting adjacent properties should be lowered with only stormwater present in the Canal.

APPENDIX H: STEP WEBPAGE AND RESOURCES

The STEP webpage can be found at: https://highlinecanal.org/stormwater/

The webpage is the home of the STEP Toolkit in which can be found valuable resources for management and promotion of your project. These include:

- Newsletter write-up
- Videos
- Social media posts
- STEP fact sheet
- Media packet

Additional resources for your reference:

- ***EPA Augmented Alternative Analysis: STEP as a Case Study*** — Highlights how STEP applied sustainability criteria developed through community input and jurisdictional partners to understand the multiple benefits of using the Canal as green stormwater infrastructure. See infographic on next two pages for more information..
- ***WaterNow Alliance***[16] — Supports water leaders who are championing sustainable, affordable and climate resilient water strategies. Recently launched a campaign called *Tap into Resilience*[17] that's aimed at helping utilities scale investments in onsite water management solutions.
- ***US Water Alliance***[18] — Promotes policies and programs towards building a sustainable water future. Spearheading One Water movement nationally and in Canada.
- ***Green Infrastructure Leadership Exchange***[19] — Peer learning network of 60 organizations across North America. Promotes governmental leaders who are implementing the use of green stormwater infrastructure.
- **Case study: City of Camden, NJ**[20] — Presentation outlining how the city is using state revolving funds to change the trajectory of its aging water utility system using green infrastructure.

[16] *https://waternow.org/*

[17] *https://tapin.waternow.org/*

[18] *http://uswateralliance.org/*

[19] *https://giexchange.org/*

[20] *https://2wvq1t1cqijt89rrweqcedrn-wpengine.netdna-ssl.com/wp-content/uploads/2020/04/Camden-County-Case-Study.pdf*

STORMWATER

It can make the world green. That's the power of STEP.

AUGMENTED ALTERNATIVES ANALYSIS (AAA) PROCESS

The U.S. Environmental Protection Agency (EPA) developed the AAA framework to help water utilities and water resource managers make smart infrastructure choices. This 10-step process expands upon traditional alternatives analysis, providing a pathway for decision-makers to turn community priorities and broad goals into specific, measurable metrics, allowing for hard-to-compare alternatives to be compared to one another. EPA selected the High Line Canal Conservancy's Stormwater Transformation and Enhancement Program (STEP) as a case study to apply their method as the High Line Canal (Canal) transitions to green stormwater infrastructure.

Central to this process is identifying three alternatives to manage existing inflows of stormwater into the Canal. The alternatives below: 1) display a total score based on how they measure against the metrics on page two; 2) compare the annualized project cost; and 3) display a benefit-cost ratio that represents the relationship between the alternative's performance across metrics and cost. A higher benefit-cost ratio provides a greater benefit for the investment.

Alternative 1

Off-Site Treatment

Gray Conveyance, Green Treatment

- Redirect existing stormwater inflows before they reach the Canal
- Construct conventional gray infrastructure for stormwater conveyance
- Construct green infrastructure for stormwater treatment
- Stormwater no longer reaches the Canal

TOTAL SCORE	ANNUALIZED PROJECT CAPITAL AND O&M COST	BENEFIT - COST RATIO
3	$1.2M	2.5

Alternative 2

In-Canal Treatment

Manage Existing Stormwater Inflows

- Repurpose the Canal as green infrastructure for stormwater conveyance, treatment and flood attenuation
- Implement all green stormwater infrastructure recommended in the High Line Canal Stormwater and Operations Master Plan

TOTAL SCORE	ANNUALIZED PROJECT CAPITAL AND O&M COST	BENEFIT - COST RATIO
138	$1.2M	117

Alternative 3

In-Canal Treatment + Landscape Enhancement

Manage Existing Stormwater Inflows while Planting Trees and Shrubs

- Repurpose the Canal as green infrastructure for stormwater conveyance, treatment and flood attenuation
- Implement all green stormwater infrastructure recommended in the Master Plan
- Plant 50 native and/or drought-tolerant trees per mile and 50 shrubs per mile as directed by The Plan for the High Line Canal

TOTAL SCORE	ANNUALIZED PROJECT CAPITAL AND O&M COST	BENEFIT - COST RATIO
225	$1.4M	167

OPPORTUNITIES FOR SUCCESS

Through public engagement and interaction with STEP leaders, four overarching goals were developed along with objectives and metrics to evaluate these goals.

(Best outcomes are highlighted)

GOAL 1: **Stormwater Management: Conveyance, Treatment, and Flood Mitigation**

OBJECTIVES	METRICS	Alt 1	Alt 2	Alt3
Improve water quality	% increase of volume treated to Mile High Flood District standards	**High**	**High**	**High**
Support flood attenuation	Change in peak stormwater flows to natural waterways	**Medium**	**Low**	**Low**
Provide stormwater conveyance	Additional capacity required to convey baseline stormwater inflow	**Negative**	**Minimal required**	**Minimal required**

GOAL 2: **Community Livability**

OBJECTIVES	METRICS	Alt 1	Alt 2	Alt3
Enhance recreational use and experience	% change in trail users over 10 years	**Negative**	**Low**	**High**
Improve environmental conditions	% change in area of tree canopy cover over 10 years	**Negative**	**Medium**	**High**

GOAL 3: **Public Understanding of Stormwater Management**

OBJECTIVES	METRICS	Alt 1	Alt 2	Alt3
Advance community understanding of stormwater management	High, medium, low opportunity to increase awareness and understanding	**Low**	**High**	**High**
Promote green infrastructure	% increase in prioritization of green infrastructure in survey results over 10 years	**High**	**Medium**	**High**

GOAL 4: **Ecological Enhancement**

OBJECTIVES	METRICS	Alt 1	Alt 2	Alt3
Maintain/expand habitat along Canal	% change in adjacent riparian land cover within a 75ft buffer over 10 years	**Negative**	**Low**	**High**
Maintain/expand plant diversity	Change in number of native and pollinator plant species	**Negative**	**None**	**Medium**
Support the water cycle	High, medium, low opportunity for groundwater recharge	**Low**	**Medium**	**Medium**

To learn more, please visit **highlinecanal.org/stormwater**

HIGH LINE CANAL CONSERVANCY

EPA

APPENDIX I: GLOSSARY

Benefit-Cost Analysis — an analysis of all project costs and benefits. This may be both direct and indirect and monetary and nonmonetary (see Stacked Benefits). A ratio of benefits to costs can be calculated and is useful to compare the performance of project alternatives.

Capital project — (also referred to in this guide as projects) construct, maintain or improve a public asset, often called infrastructure.

CDPHE — Colorado Department of Public Health and Environment is charged with protecting and maintaining the health and environment of the citizens of Colorado.

USACE — U.S. Army Corps of Engineers. Responsible for oversight and permitting under the federal Clean Water Act.

Collaborative management — the process by which the multiple entities responsible for Canal management, operations, and maintenance cooperatively make decisions.

Canal Collaborative — the Conservancy, Denver Water, Mile High Flood District and the local jurisdictions along the Canal have come together to form a collaborative management structured called the Canal Collaborative. The partners include: Douglas County, Highlands Ranch Metro District, City of Littleton, SEMSWA (which includes the City of Centennial), City of Greenwood Village, City of Cherry Hills Village, City and County of Denver, City of Aurora, and the High Line Canal Conservancy.

Constructed overflows — formalized overflow paths in the canal embankment intended to direct canal flows that exceed the canal capacity to natural waterways or channels that can safely accommodate the water.

Construction documents — the 100 percent complete project design including drawings and specifications and documents upon which construction bids can be made and accurate construction completed.

Consultation and coordination — the process of engaging with responsible government agencies to communicate project intent and details and ensure compliance with local, state, and federal regulations.

Conveyance — the process of water flowing in the canal from its point of entry to a location of discharge from the canal.

Design Guidelines — a set of recommendations towards good practice in the design of Canal amenities and capital projects. They are intended to provide clear instructions to designers and developers on how to adopt specific principles as laid out in The Plan for the High Line Canal.

Flood management — detaining, channeling, and directing stormwater in a manner and to locations that will avoid impacts or damage to developed property.

Forebay — a pool and settling basin constructed at the incoming discharge points of a stormwater into the Canal designed to provide retention for a portion of the stormwater runoff and allow sediment to settle out from the incoming stormwater before it reaches the Canal.

FWS — U.S. Fish and Wildlife Service. Responsible for oversight and compliance with the federal Endangered Species Act.

Gray infrastructure — constructed stormwater facilities typically including tunnel and pipe systems, storage tanks, in-line storage facilities, sewer lines, etc.

Green infrastructure — Section 502 of the Clean Water Act defines green infrastructure as "...the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters."

Greenway — a strip of undeveloped land near an urban area, set aside for recreational use or environmental protection.

Guiding principles — The High Line Canal Community Vision Plan established principles for the future protection, preservation, and enhancement of the Canal. The five guiding principles include natural, continuous and connected, varied, managed, and enhanced.

Hydrologic model — a simplification of a real-world system (e.g., surface water, soil water, wetland, groundwater, estuary) that aids in understanding, predicting, and managing water resources. Both the flow and quality of water are commonly studied using hydrologic models. Mile High Flood District and the engineering consultant, RESPEC developed the hydrologic model for the High Line Canal.

Infiltration — the process by which water on the ground's surface enters the soil. It is commonly used in both hydrology and soil sciences.

Intergovernmental agreement (IGA) — any agreement that involves or is made between two or more governments in cooperation to solve problems of mutual concern. Intergovernmental agreements can be made between or among a broad range of governmental or quasi-governmental entities.

Irrigation water — water that is conveyed and applied in controlled amounts to plants at needed intervals.

Jurisdictions — in this guide, refers to a legal entity granted authority to administer justice, laws, and regulations.

Jurisdictional waters — also referred to as Waters of the U.S. and defines all bodies of water that fall under U.S. federal jurisdiction and the Clean Water Act.

Mile High Flood District — formerly titled Urban Drainage and Flood Control District, the district partners with metro cities and counties to design and construct flood control and warning measures, open space, regional paths, and remove trash and debris in streams.

MS4 — Municipal Separate Storm Sewer System is a conveyance or system of conveyances that is owned by a state, city, town, village, or other public entity that discharges to waters of the U.S., designed or used to collect or convey stormwater (e.g., storm drains, pipes, ditches).

Natural waterway — a natural water body such as a river, stream, creek, gulch or lake.

NPDES — National Pollutant Discharge Elimination System is a permit program addressing water pollution by regulating point sources that discharge pollutants to waters of the United States.

Operations master plan — refers to the High Line Canal Operations Master Plan and Model completed by RESPEC under contract to Mile High Flood District. It presents a set of recommended actions that should be taken before new sources of stormwater are discharged into the Canal. It also provides the hydrologic model that will be used in the analysis and design of all future stormwater projects.

Project development — the process of identifying and defining the purpose and scope of a capital project, preparing detailed drawings and specifications to support accurate construction, obtaining permits and government approvals, and bidding and constructing the project.

Regulatory compliance — an organization's adherence to laws, regulations, guidelines and specifications relevant to its business processes.

Schematic design — the first phase of design that determines the project requirements, and goals and often produces rough drawings of a site plan, elevations and often illustrative sketches or computer renderings.

Scoping — project planning that involves determining and documenting a list of specific project goals, deliverables, features, functions, tasks, deadlines, and costs.

SHPO — State Historic Preservation Office. Responsible for oversight and compliance with the federal National Historic Preservation Act.

Stacked Benefits Analysis — an evaluation of a project, such as a stormwater infrastructure project, to measure a broad set of environmental, economic and social benefits that would result from the project.

Standard operating procedures (SOPs) — a set of "good housekeeping" practices to be employed at applicable facilities to reduce the potential for polluting or negatively impacting local receiving water quality from stormwater runoff.

Stormwater — precipitation that runs off impervious surfaces, such as driveways, parking lots or rooftops, and eventually flows into our waterways.

Stormwater Transformation and Enhancement Program (STEP) — program of the Conservancy guiding the Canal's transformation in collaboration with jurisdictional partners and stormwater experts.

Waste gates — operable openings or gates in the Canal where it crosses a natural waterway. Waste gates allow Canal flows to be diverted into the natural waterway when necessary, such as with large storms and high flows.

Water quality treatment — any process that reduces pollutants in stormwater. Treatment can occur before stormwater enters the Canal or can occur in the Canal under certain conditions.

Water quality berms — low dam-like structures constructed in the bottom of the Canal intended to slow water down and increase infiltration into the soil. Berms also detain water for up to 72 hours allowing for some water quality improvements.

APPENDIX J: REFERENCES

Denver Water. 2008. Impact of Canal Water Flow on the Health of Cottonwood Trees Growing Adjacent to Colorado's Historic High Line Canal.

High Line Canal Conservancy. 2016. Community Vision Plan for the High Line Canal.

High Line Canal Conservancy. 2019. The Plan for the High Line Canal: A Collaborative Framework for Our Regional Legacy.

RESPEC Consulting and Service, Inc. 2014. High Line Canal Feasibility Study for Stormwater Runoff Reduction & Treatment. Urban Drainage and Flood Control District.

RESPEC Consulting and Service, Inc. 2018. High Line Canal Stormwater and Operations Master Plan — Final Report. Urban Drainage and Flood Control District.

RESPEC Consulting and Service, Inc. 2019. High Line Canal SWWM Users Manual V2. Urban Drainage and Flood Control District.

Urban Drainage and Flood Control District. 2018. Guidelines for Model Approval for Use of the High Line Canal for Stormwater Purposes.

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