Rocky Branch Enhancement Project

Task 2: Site Investigation; Preliminary Stream Alignment and Landfill Reuse Concept Development

Dix Park

PRODUCED FOR THE CITY OF RALEIGH PARKS AND RECREATION

by

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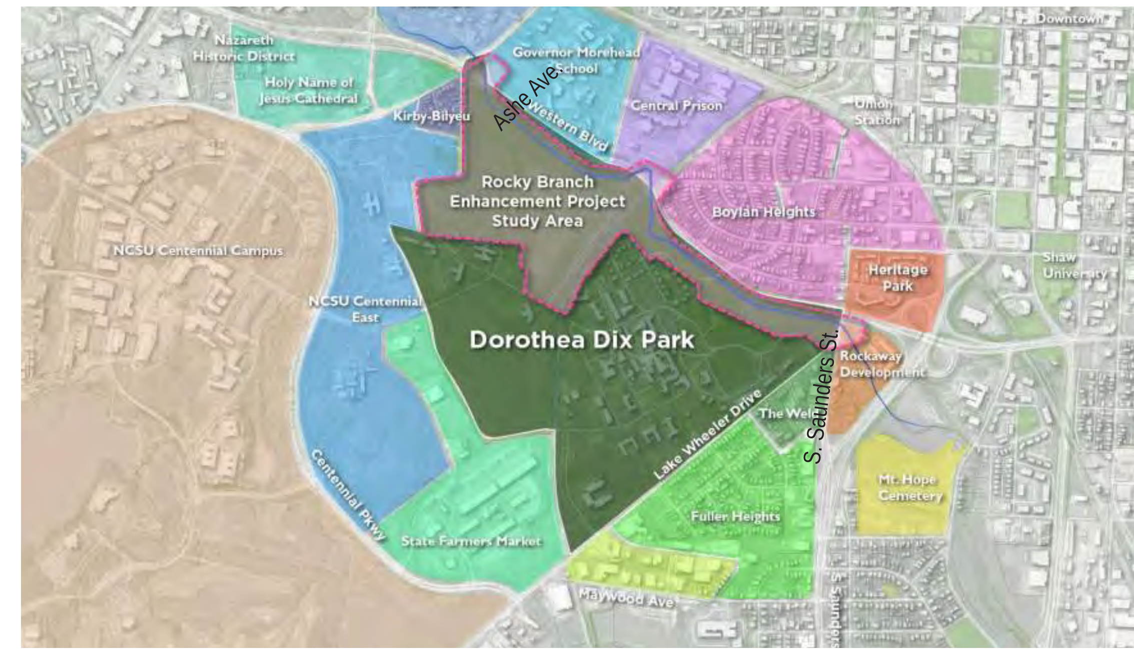
PROJECT INTRODUCTION AND BACKGROUND

The Creek, as referenced within the Dix Park Master Plan, refers to the project that will restore the Rocky Branch, a key natural element of Dix Park that has been neglected for decades. The restoration of the Rocky Branch corridor is vital to the vision for Dix Park. The vision of The Creek project is to create a Raleigh waterfront, a place that is a truly unique community resource and a regional destination that educates and instills a sense of wonder into those who visit and experience it.

The project study area stretches from the northernmost corner of Dix Park near Western Boulevard and Ashe Avenue southeastward to the corner of the park at Western Boulevard and South Saunders Street. The overall length of this study area is approximately one mile and consists of approximately 50 acres.



(Above) Rocky Branch Enhancement Project Area and Context.

PROJECT PURPOSE

This Rocky Branch Enhancement Project feasibility study was broken into two tasks. Task 1 of the feasibility study was completed in October 2022. The intent of Task 1 was to establish a comprehensive foundation for the next phases of the feasibility study. The primary objectives of Task 1 included:

1. Review and Evaluate the Available Data and Identify Scope of Investigation Needed for Task 2,
2. Identify Key Agencies and Stakeholders that the Rocky Branch Project Will Coordinate With,
3. Identify Key Adjacent Property Owners and Concurrent Projects that the Rocky Branch Project Will Coordinate With, and
4. Develop a Strategy for Grant Management Reporting and Meet with Grant Agency Representatives.

Task 2 of The Rocky Branch Enhancement Project evaluates the feasibility of transforming the degraded urban Rocky Branch into an engaging, vibrant, and resilient waterfront amenity. The primary objectives of Task 2 were to evaluate the proposed plan for The Creek landscape presented in the Dix Park Master Plan which includes a meandering channel, improved floodplain bench, adjacent stormwater wetlands and ponds, park program spaces, fields and meadows, native riparian vegetation, Western Boulevard land bridge crossing, and a greenway system. Task 2 evaluates three different scenarios that meet the goals of the Master Plan, yet vary in terms of level of intervention and cost.

PROJECT GOALS

The intent of this project is to identify feasible scenarios that successfully navigate combined efforts of stream restoration and landfill reuse, as well as land bridge scenarios, to create spaces that are reflecting the Core Principles of the Dix Master Plan: “Open up and connect”, “Build from what is there” and “Offer something for everyone”. Within these Core Principles are further specified goals for The Creek:

1) Open Up and Connect
- Leverage proximity to adjacent assets
- Enhance gateway potential
- Enliven park edge
- Promote connectivity

2) Build From What is There
- Restoration
- Reuse
- Rehabilitation
- Resiliency
- Reflect the region’s ecosystems

3) Offer Something for Everyone
- Celebrate Dorothea Dix Park’s cultural landscapes
- Create ‘Nature Escapes’
- Create dynamic and flexible spaces

A series of landscape improvement goals specific to the Rocky Branch Enhancement Project were identified within the Dix Master Plan. This feasbility study ensures that these goals are carried through within all the established design Scenarios A, B and C.

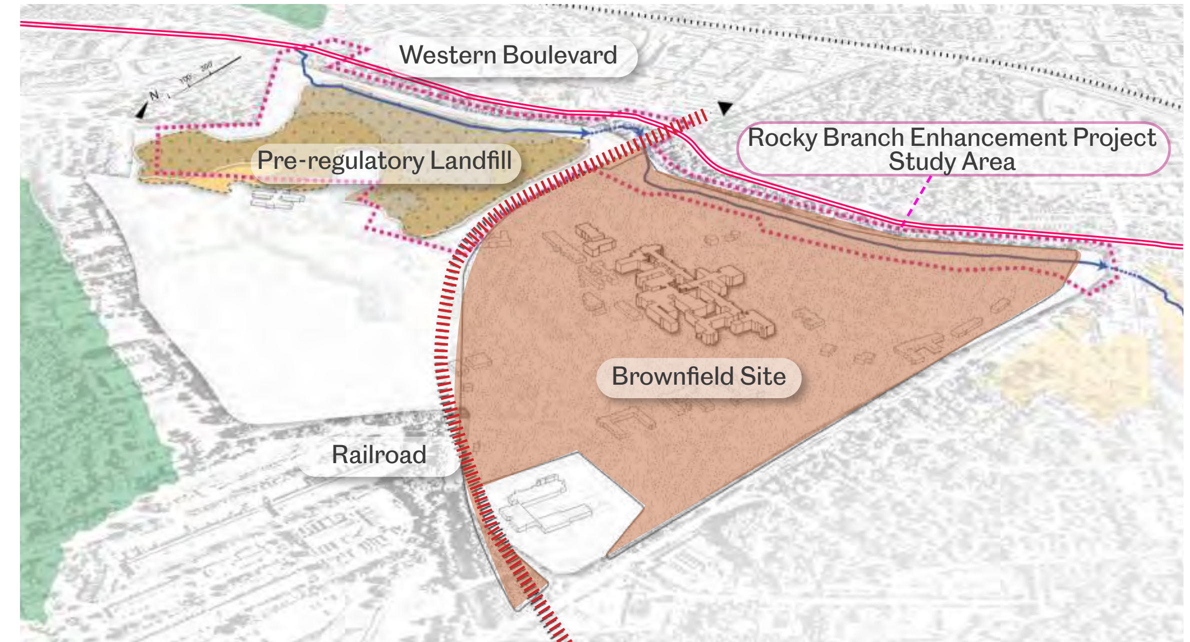
Goals:
- Restore Habitat
- Improve Ecological Function
- Showcase Piedmont Ecology
- Widen Creek Floodplain
- Mitigate Flood Impacts on Site and Downstream
- Improve Water Quality

KEY CHALLENGES

There are several key challenges to the Rocky Branch Enhancement project. The proximity of Rocky Branch to the existing pre-regulatory landfill is a key challenge to the project. Redevelopment within the landfill will be regulated under the North Carolina Department of Environmental Quality (NCDEQ), Division of Waste Management (DWM), Inactive Hazardous Sites Branch (IHSB), and Superfund Section Pre-Regulatory Landfill Unit (PRLU). The eastern portion of the Rocky Branch Enhancement Project (area east of the Norfolk Southern Railway) occurs within the Dorothea Dix Brownfield Property (Dorothea Dix Park and South Saunders Street Assemblage). Redevelopment within the Brownfield Property portion of the site will be regulated by NCDEQ, DWM, and the Brownfield Redevelopment Section (BRS).

Another key challenge of this project is the proximity of the stream to Norfolk Southern Railroad. This includes both physical and regulatory barriers to the project’s design opportunities.

Western Boulevard, the (4) lane road that runs parallel to Rocky Branch along the entire northern boundary,



(Above) Key challenges for the Rocky Branch Enhancement Project are illustrated.

has a substantial impact on the project. This close proximity limits the ability of the stream to be restored to its more natural shape and form. In addition to the physical constraints, there are also stormwater impacts to the stream including water quality and stormwater runoff volume from Dix Park, as well as upstream and adjacent conditions.

SYNTHESIS PROCESS

Stream Conditions Assessment

A thorough stream conditions assessment was performed by Wildlands Engineering, Inc. to evaluate the stream’s geology, soils, and geomorphic conditions within the extents of Dix Park. The findings within the existing stream conditions assessment inform key considerations within the proposed design scenarios developed for the restoration of Rocky Branch. Specific detailed findings can be found within this report and the Appendix B.

Site Analysis

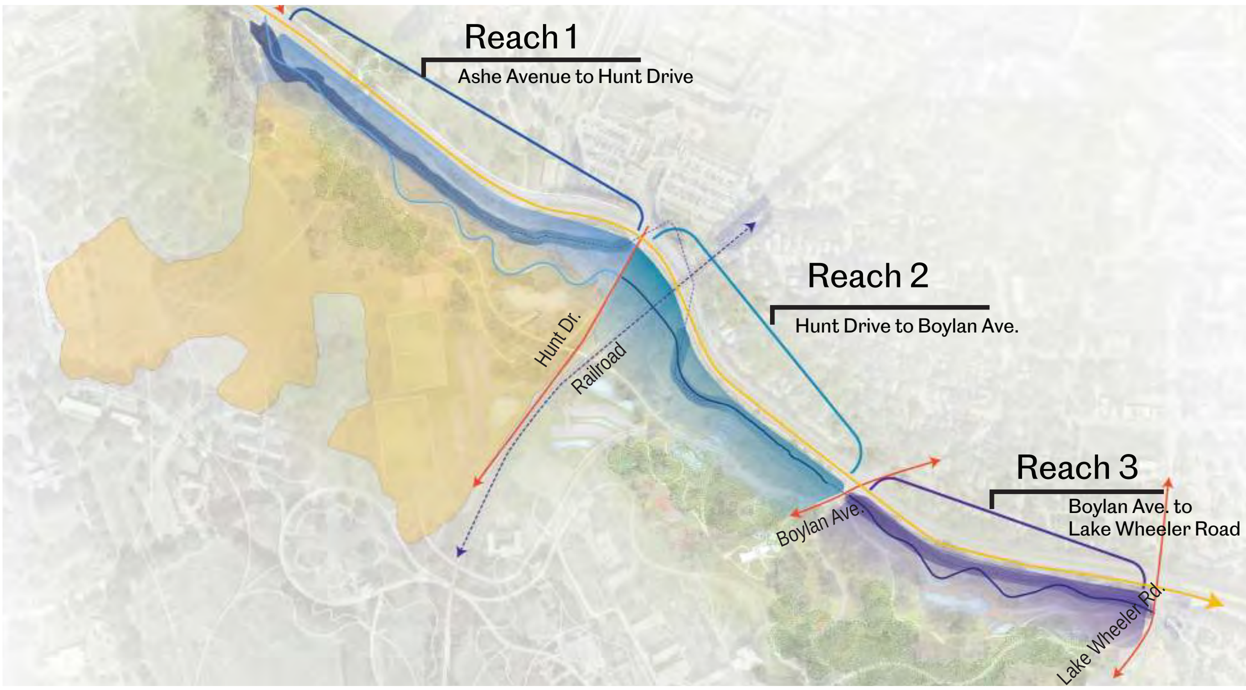
A site analysis studied: Soils, Topography, Landfill Extents and Composition, Hydrology, Vegetation Characteristics, Microclimate, Wildlife, Circulation, Sensory Experience, and Cultural Significance. These findings were then layered to begin to identify particular constraints and opportunities that would be instrumental in developing the design scenarios for the restoration of Rocky Branch.

Stream Reach Delineation & Overview

Along the course of Rocky Branch, varying streambed and bank conditions exist. Existing conditions such as topography, valley width, infrastructure and built conditions help to naturally delineate three different Reaches or sections of the stream. For purposes of this study, the stream alignments developed will refer to Reach 1, Reach 2, and Reach 3 for each of the three Scenarios. In addition to providing distinguishable sections in which the stream alignments can be evaluated, these Reaches provide opportunities for considering how the Rocky Branch restoration could be implemented in a series of phases. Below are the general extents defining the scope of the three reaches of Rocky Branch discussed in this report.

Reach Extents of Rocky Branch within Project Extents

Reach 1 – Ashe Avenue to Hunt Drive
Reach 2 – Hunt Drive to Boylan Avenue
Reach 3 – Boylan Avenue to South Saunders Street



(Above) Map identifying reach or section delineation of Rocky Branch within Dix Park as related to this feasibility study.

DESIGN SCENARIOS

Preliminary Stream Alignment Scenarios

Key to the successful implementation of The Rocky Branch Enhancement Project will be the carefully orchestrated design of stream restoration and management of landfill waste, soil, and associated contamination. Development of soil management and cleanup plans that meet regulatory requirements, managing ongoing settlement of the landfill surface from natural degradation of the landfill waste, and strategically balancing the site earthwork within the respective regulatory boundaries of both the landfill and the broader brownfield site will be critical steps in navigating the design and construction of this scope of work.

Each scenario meets the project goals but varies in terms of level of intervention and cost. Scenario A represents a design most consistent with the Master Plan and carries the highest project costs, while Scenario C represents the lowest cost design. Scenario B falls between A and C.

1. **Scenario A - Rocky Branch Realignment**
   This scenario for the stream realignment reflects a design most consistent with the vision of the Dix Park Master Plan, It provides the most significant realignment and introduces new stream meanders as well as raised stream elevations by approximately 5 feet in the upper Reach 1. Additionally, Scenario A proposes relocating Rocky Branch fully onto Dix Park property from its existing culverted course on Central Prison property. In lieu of crossing beneath Western Boulevard to and from Central Prison property, Rocky Branch would flow through a new, shorter culvert beneath the active railway embankment, remaining entirely on the Dix Park property. The upper and lower reaches of Rocky Branch would be fully restored with ideal meanders, stream bed and bank conditions, improved buffers, and widened floodplains. Additionally, Scenario A includes significant site grading and optimizes amenities; including pedestrian circulation and connectivity, overlooks and engagement with adjacent park features, and stormwater management opportunities.

Considering the maximized approach to all aspects of the realignment and design, Scenario A also presents the most significant potential hurdles.

- The raised elevation of Reach 1 requires considerable further exploration to ensure there are no adverse flooding or flood plain impacts to Dix Park or neighboring properties, adding a level of complexity to potential permitting.
- The considerable realignment of the stream in Reach 1 presents the most significant landfill impact and will require extensive environmental, geotechnical, and soil management work.
- The relocation of Rocky Branch to remove it from the Central Prison site entirely onto Dix Park involves significant coordination and permitting with Department of Transportation and Norfolk Southern Railway, while simultaneously increasing anticipated construction costs considerably.

(Above) Proposed Scenario A Design

2. **Scenario B - Rocky Branch Realignment**

This scenario for the stream realignment shares many features of Scenario A but simplifies the design and reduces the order of magnitude of costs. Scenario B still meets the established goals for the project with a transformative design for Rocky Branch and Dix Park. Scenario B proposes to maintain the elevation of Rocky Branch in Reach 1 as well as maintain the stream's current alignment where it crosses Western Boulevard onto the Central Prison site, before returning to Dix Park east of the railway crossing. These are key differentiating factors that separate Scenario A from Scenario B. Similar to Scenario A, in Scenario B, Reach 1 and 3 of Rocky Branch would be fully restored. Reach 2 would receive considerable stream enhancements except for the section remaining on Central Prison, as potential improvements to that section would need to be further evaluated. Floodplain improvements are still proposed for the entire length of Rocky Branch within Dix Park. Scenario B still includes significant site grading as well as significant opportunities for park program. Only slight reductions are proposed for pedestrian circulation and connectivity, overlooks and engagement, and stormwater management opportunities.

Considering the reduced elevation of Reach 1 and the proposed alignment at the railway, Scenario B has fewer potential project hurdles.

- By maintaining Rocky Branch nearer its existing elevations, the potential for adverse flood impacts is greatly reduced, allowing for simplified permitting, and ensuring feasibility of the proposed design.
- There is still considerable realignment of the stream in Reach 1 and maintaining the lower stream elevations while still providing more ideal floodplain widths will likely increase landfill disturbance slightly. These in combination still present significant environmental, geotechnical, and soil management impacts.
- By maintaining Rocky Branch on the Central Prison site, Scenario B simplifies coordination and permitting with the Department of Transportation and Norfolk Southern Railway while simultaneously reducing anticipated construction costs for culvert infrastructure.

3. **Scenario C - Rocky Branch Realignment**

This scenario for the stream realignment again meets the established goals for the project but proposes some additional measures to potentially reduce construction costs and ease permitting challenges. Scenario C simplifies the stream realignment in both reach 1 and 3 compared to the previous two scenarios. In both cases, these reaches would receive stream enhancements, but no longer full restorations. The alignments are simplified and generally remain closer to the current course they run today. Similar to Scenario B, Scenario C proposes that Rocky Branch maintain its current alignment at Central Prison. While the stream is an enhancement project ensuring improved stream bed and bank stability within its current channel, the flood plain is still proposed to be widened significantly in all three reaches within Dix Park. While site grading is still significant to account for proposed adjacent park improvements, the reduced scale of stream realignment, particularly in Reach 1, has the potential to greatly simplify the environmental impacts and management requirements of the project compared to the designs represented in Scenario A and B.

Considering the significant adjustments to proposed realignment, Scenario C carries reduced potential hurdles.

- By reducing the meander and simplifying the stream realignment, particularly in Reach 1, Scenario C further reduces landfill disturbance and therefore, reduces environmental, geotechnical and soil management impacts compared to previous scenarios.

Western Boulevard Bridge Scenarios

The Land Bridge at Dix Park is a major element of the Dix Master Plan and is envisioned to cross Western Boulevard and Rocky Branch stream just south of Ashe Avenue. The Land Bridge will provide pedestrian and bicycle circulation at Rocky Branch Trail connecting Pullen Park and the broader city with Dix Park.

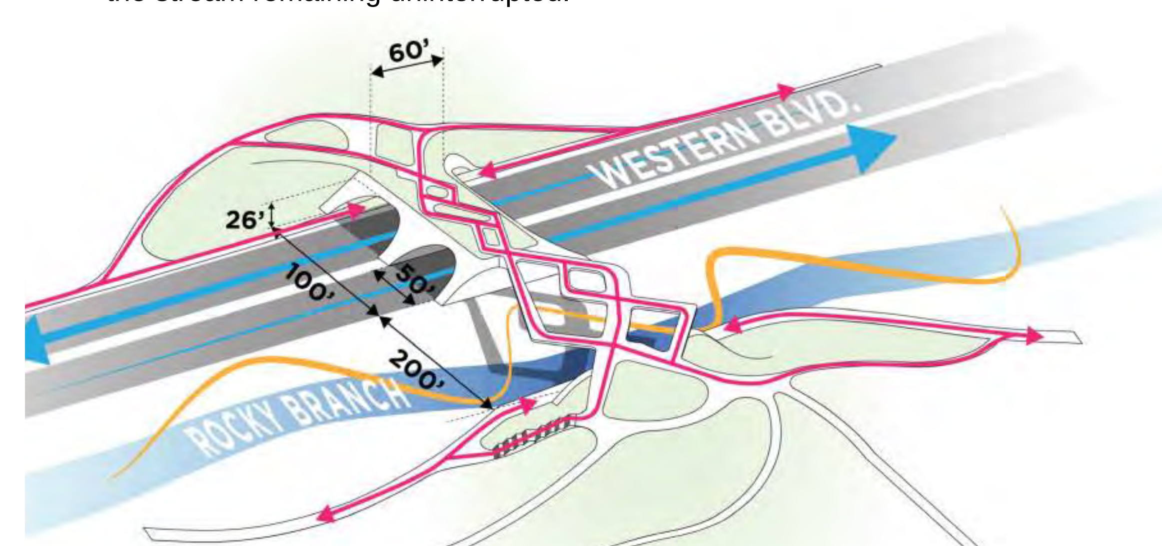
Taking cues and considerations from precedents, the Design Team developed a range of pedestrian crossing options for the Western Boulevard crossing. The team analyzed the bridge options based on how they interact with current traffic modes including vehicular, bike and pedestrians, as well as the future, planned Western Boulevard Bus Rapid Transit (BRT).

The Western Boulevard Bridge will be the primary pedestrian and bicycle connection on the north end of the park, enhancing safety by separating pedestrian and bicycle circulation from vehicle traffic. The bridge scenarios identify a range of potential scope that will provide flexible cost and permitting considerations to be factored as the project moves forward. Those bridge options include:

1. **Scenario A - Landbridge**
   - The Land Bridge design reflected in Scenario A is most consistent with the vision of the Dix Park Master Plan. The tunnels will be for vehicle traffic only. The Land Bridge will mimic the piedmont prairie in providing habitat, food source for pollinator species and a habitat corridor for migratory species. The Land Bridge will act as a vegetated roof for this section of Western Boulevard, mitigating the effects of stormwater by capturing and cleaning runoff and decreasing the effects of urban heat island temperatures, serving as an icon for a greener and more resilient future.

2. **Scenario B - Green Bridge**
   - This bridge design has many similar features to the Land Bridge but with one clear difference – the stream crossing will be open and not tunneled. The northern section of the bridge remains very similar to the Land Bridge concept, only reducing in width, while the southern section of the bridge is noticeably different. The vegetated portion of the Green Bridge exists only across Western Boulevard, transitioning to a steel pedestrian bridge across Rocky Branch. The stream is more open to sunlight and precipitation, providing opportunities for improved flora and fauna. This open structure will also create a safe environment for pedestrians accessing the stream beneath the crossing.

3. **Scenario C - Pedestrian and Bicycle Bridge**
   - This bridge is a more traditional pedestrian and bicycle bridge. It provides for safe pedestrian crossing with no additional structure for plant material. Scenario C provides the optimum structure over Rocky Branch similar to Scenario B, with sunlight, precipitation and animal migration along the stream remaining uninterrupted.



(Above) Western Boulevard Bridge Scenario B - Green Bridge

KEY FINDINGS & RECOMMENDATIONS

The development of a project phasing plan should be guided by the principles established in the Master Plan and identified within this document. Referring to those principles throughout the decision-making process will allow the City of Raleigh to foster collaboration among key stakeholders, identify priorities and set goals for each phase. The three Scenarios and subsequent three Reaches provide decision makers with flexibility and alternatives in determining which Reach and Scenario to proceed with. This adaptability will allow the City of Raleigh to best match funding with project priorities. The design team's recommendations are anchored in the findings of this report and listed by Reach below.

Reach 1 Summary

- **Green Bridge (Recommend Scenario B)**
  - The Green Bridge balances pedestrian circulation, and stream ecology by providing a safe circulation system and daylight to the stream, still worthy of being an icon for a resilient future.

- **Stream (Recommend Scenario C)**
  - The concept study details the ecological benefits of Reach 1 for Concepts A and B; however, the cost associated with excavation of the landfill material likely outweighs these benefits.
  - Higher risk of flooding for Scenario A due to raised stream elevations will likely complicate the design and operation of remedial engineering controls. This likely would require an even more robust soil cover design, toe-slope retaining wall and engineered stream bed systems to mitigate erosion and water infiltration concerns during increased potential flooding.
  - The stream alignment suggested in Scenario C represents a stream enhancement as opposed to a full restoration. More specifically, it includes significant stream improvements, bank stabilization, stream buffers and flood plain improvements. By maintaining an alignment nearest existing conditions, it does not eliminate landfill impacts, but likely reduces them significantly.
  - Avoids impacts to Rocky Branch at the Central Prison site and Norfolk Southern Railroad.

- **Earth/Environmental (Recommend Scenario C)**
  - Raising the stream bed as suggested in Scenario A may still require undercutting the area to remove all landfill waste and as such, there is a risk for increased soil and landfill waste management.
  - Realignments suggested in Scenario A and B will likely result in increased soil and landfill waste management compared to Scenario C.
  - Scenario C will likely be the least complicated in terms of design and operation of remedial engineering controls.

- **Stormwater (Recommend Scenario C)**
  - Recommend the reduced stormwater improvements represented in Scenario C. This will enable a stormwater amenity on the Dix Park side of Rocky Branch.
  - Stormwater systems could be identified in this Reach, allowing for future integration and installation.
  - Stormwater educational opportunities are highlighted along the greenway.

- **Circulation (Recommend Scenario C)**
  - Recommend the reduced circulation improvements represented in Scenario C be integrated into the stream alignment and design.
  - Enhanced pedestrian and bicycle experience, safety and engagement with stream and natural systems.
  - Provides views to adjacent City of Raleigh Skyline.
  - Provides safe and accessible connections to Pullen Park, Western Boulevard and Dix Park.

- **Engagement (Recommend Scenario C)**
  - Recommend the reduced educational and engagement opportunities represented in Scenario C be integrated into the stream alignment and design.
  - Additional opportunities could be incorporated in the future with additional funding sources.

(Above) Proposed Rocky Branch Looking Westward Towards Land Bridge

Reach 2 Summary

- **Stream (Recommend Scenario B)**
  - Represents a stream enhancement and maintains existing stream alignment and elevations.
  - Follows existing culverts at Hunt Drive and Western Boulevard, avoiding impacts to Norfolk Southern Railway.

- **Earth/Environmental (Recommend Scenario B)**
  - Reduces earthwork at railway, disturbance of landfill waste and soils from Scenario A design.
  - Reduces impact to groundwater from Scenario A design.
  - Simplifies Environmental Management strategy from Scenario A design.
  - Reduces impact to existing woodland east of railway from Scenario A design.
  - Presents opportunities for reforestation along stream, pathways, and stormwater systems.

- **Stormwater (Recommend Scenario B)**
  - Stormwater treatment for Reach 2 is similar in all scenarios.
  - Stormwater systems constructed in this phase, based on future parking and future master plan program such as botanical gardens.
  - Stormwater systems could be identified in this Reach, allowing for future integration and installation.
  - Stormwater educational opportunities are highlighted along greenway.

- **Circulation (Recommend Scenario B)**
  - Recommend the slightly reduced circulation improvements represented in Scenario B be integrated into the stream alignment and design.
  - Provides pathways on both sides of Rocky Branch.
  - Provides enhanced pedestrian and bicycle experience, safety and engagement with stream and natural systems.
  - Provides at grade crossings at Boylan Avenue.
  - Provides safe and accessible connections to Dix Park.

- **Engagement (Recommend Scenario B)**
  - Recommend the slightly reduced educational and engagement opportunities represented in Scenario B
  - Additional opportunities could be incorporated in the future with additional funding sources.

Reach 3 Summary

- **Stream (Recommend Scenario B)**
- Optimizes stream alignment and significantly increases meander of stream.
  - Provides full restoration of the stream channel.
  - Maximizes floodplain improvements.

- **Earth/Environmental (Recommend Scenario B)**
  - Slightly reduced soil impacts due to the number of reduced stormwater systems from what is represented in Scenario A.

- **Stormwater (Recommend Scenario B)**
  - Significant opportunity for treatment south of Rocky Branch, opportunity for an educational large-scale stormwater amenity.
  - Reduced number of terraced stormwater wetlands from Scenario A design.
  - Additional stormwater systems could be identified in this Reach, allowing for future integration and installation with additional funding sources.
  - Stormwater educational opportunities highlighted along greenway.

- **Circulation (Recommend Scenario B)**
  - Recommend the slightly reduced circulation improvements represented in Scenario B be integrated into the stream alignment and design.
  - Provides enhanced pedestrian and bicycle experience, safety and engagement with stream and natural systems.
  - Provides views to adjacent City of Raleigh Skyline.
  - Provides safe and accessible connections to S. Saunders Street, Lake Wheeler, and Dix Park.

- **Engagement(Recommend Scenario B)**
  - Significant educational and engagement opportunities within a variety of site ecotones.
  - Additional opportunities could be incorporated in the future with additional funding sources.

PHASING AND IMPLEMENTATION RECOMMENDATIONS

The recommendation is that the City should prioritize the design and construction for Reach 3 of Scenario B as a first phase. Reach 3 is essentially the same in both scenarios A and B, representing a realignment and full stream restoration within this stream Reach. Work within Reach 3 is relatively unconstrained; however, it will impact subsurface utilities, such as sewer and stormwater. Environmental soil management likely will be required to an extent considering the Brownfield aspect of the site, although it is greatly simplified and less expensive from what considerations will be necessary to address the landfill at the western end of the site.

Implementation of Scenario B in this lower Reach 3 can provide a wonderful representation of what the full Rocky Branch Enhancement Project could aspire to. History shows that the first phase of any project is critical to generate excitement and community support, demonstrate the possibility of what could occur along the entire length within the park, and encourage donors and grant support. We think it has the potential to generate a tremendous amount of early excitement around Rocky Branch, maintain momentum, and doing so at a fraction of the cost and risk associated with the more difficult and complicated Reach 1.

** General Considerations:*
Options that disturb a greater area of the footprint of the landfill have a higher risk due to the inherent uncertainties about subsurface landfill conditions encountered during construction. Greater volumes of landfill waste encountered during construction increase risk for managing costs and schedule.

Building Reach 3 first should have no effect or constraint on the selected approach to Reaches 1 and 2. The only potential risk to constructing Reach 3 first is the possibility of future sedimentation. This should be addressed with a combination of extra protective measures to be implemented during future Reach 1 and 2 construction, and potential minor remedial rework in Reach 3 as needed.

(Above) Perspective - Improved Floodplains Provide Flexible Amenity Lawn Along the Banks of Rocky Branch.

COST OPINION SUMMARY

The following cost opinion outlines the anticipated construction costs to implement the recommended Scenario for each reach of Rocky Branch. These phases are representative of the order in which design and construction is recommended to proceed.

First Phase Design and Construction
- Project Area = Reach 3 (Boylan Street to S. Saunders Street)
- Recommend Scenario B Design
- Anticipated Project Costs = $10,000,000 - 12,500,000

Second Phase Design and Construction
- Project Area = Reach 2 (Hunt Drive to Boylan Street)
- Recommend Scenario B Design
- Anticipated Project Costs = $11,000,000 - 13,500,000

Third Phase Design and Construction
- Project Area = Reach 1 (Ashe Avenue to Hunt Drive)
- Recommend Scenario B Design (Green Bridge)
- Recommend Scenario C Design (All other scope implementation)
- Anticipated Project Costs = $65,000,000 - 80,000,000

Additional details regarding projected cost for implementation of Scenario designs are included in Appendix K of this report.

2. SYNTHESIS & OPPORTUNITIES

2. Synthesis & Opportunities

DESIGN APPROACH
CORE PRINCIPLES

OPEN UP AND CONNECT

BUILD FROM WHAT IS THERE

SOMETHING FOR EVERYONE

CONCEPT DRIVERS

ECOLOGY

- Stream Restoration
- Habitat Restoration
- Complexity/Diversity
- Riparian Buffer Improvement
- Water Quality/Temperature/Dissolved Oxygen
- Stream Aesthetics
- Stormwater Management

ENGAGEMENT

- STEAM Education Opportunities
- "Nature" Escapes
- Activity at Edges
- Spaces for Wellness/Healing
- Accessibilty to Stream
- Accessible/Safe/Inclusive
- Spaces for Creative Expression

CONNECTIVITY

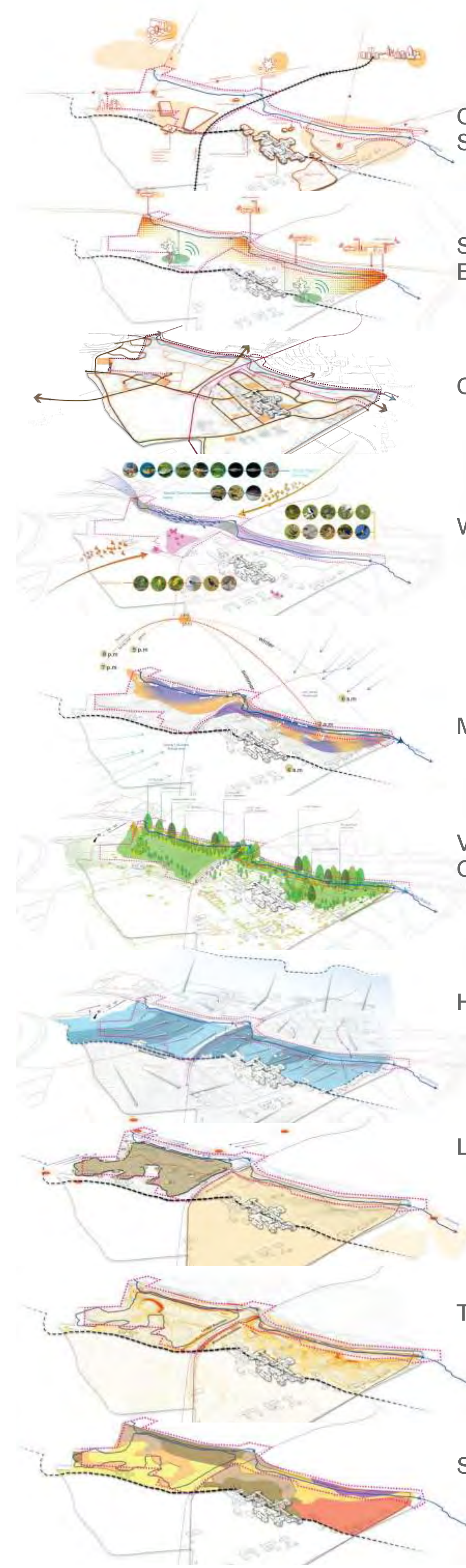
- Access to downtown
- Access to Walnut Creek Trail
- Access to Pullen Park
- Gateway opportunities

REUSE/REHABILITATION

- Vegetation Preservation
- View preservation
- Utility infrastructure reuse
- Landfill rehab
- Landfill material reuse

CONSTRAINTS / COSTS

- Culvert Replacement Costs
- Landfill Waste & Soil Management Costs
- Landfill Leachate & Groundwater Management
- Landfill Gas Management
- Enviornmental Stormwater & Sediment Management
- Pre-Regulatory Unit Regulatory Coordination
- Geotechnical/Total and Differential Landfill Settlement
- Environmental Operations, Maintenance, and Monitoring
- Facility Maintenance (Post Occupancy)
- Railroad Collaboration
- Potential for Adverse Flood Impacts
- Permit Risk
- Compliance with Transportation Objectives
- Utility Relocation Cost
- Central Prison Collaboration
- Potential offsite Environmental Concerns
- Landbridge landing at gas station and UST Section Regulatory Coordination
- Landbridge not landing at gas station



The Core Principles, as identified in the Master Plan, have driven the design process to arrive at the three Scenarios presented. The Design Team further dissected the principles of Open Up and Connect, Build from What is There, and Something for Everyone into Concept Drivers that are also informed by the Team's expertise and values. The Concept Drivers become the method of evaluating the proposed scenarios, ensuring that all Scenarios are tied back to those three Core Principles.

The Principles and Concept Drivers informed the Team's collection and analysis of Site Inventory, as presented in Appendices C THE CREEK - AN OVERVIEW. The opportunities are evidenced in overlays of the Inventory diagrams, as presented in the following Opportunity diagrams where the existing assets and their potential are emphasized.

OPPORTUNITIES

OPEN UP AND CONNECT

- -Leverage Proximity to Adjacent Assets
- -Enhance Gateway Potential
- -Enliven Park Edge
- -Promote Connectivity

BUILD FROM WHAT IS THERE

- -Restoration
- -Reuse
- -Rehabilitation
- -Resiliency
- -Reflect Region's Ecosystems

SOMETHING FOR EVERYONE

- -Celebrate Dix Park's Cultural Landscapes
- -Create "Nature Escapes"
- -Dynamic Spaces

OPPORTUNITIES & DESIGN SYNTHESIS
SITE HYDROLOGY ACCESS & IMPROVEMENT OPPORTUNITIES

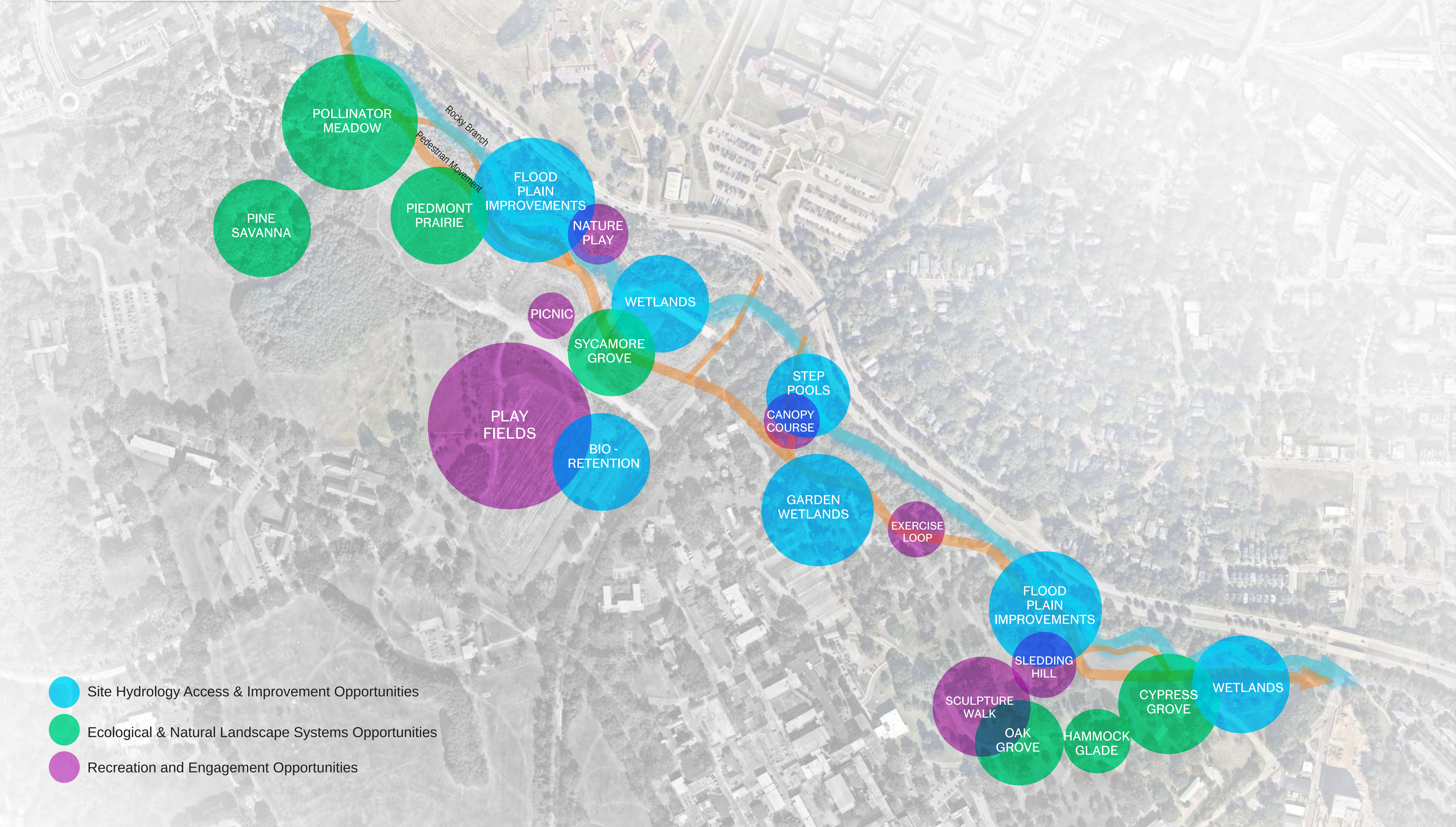
OPPORTUNITIES & DESIGN SYNTHESIS

ECOLOGICAL & NATURAL LANDSCAPE SYSTEMS OPPORTUNITIES

OPPORTUNITIES & DESIGN SYNTHESIS

RECREATION & ENGAGEMENT OPPORTUNITIES

OPPORTUNITIES & DESIGN SYNTHESIS
PROGRAM INTEGRATION



Site Hydrology Access & Improvement Opportunities

Ecological & Natural Landscape Systems Opportunities

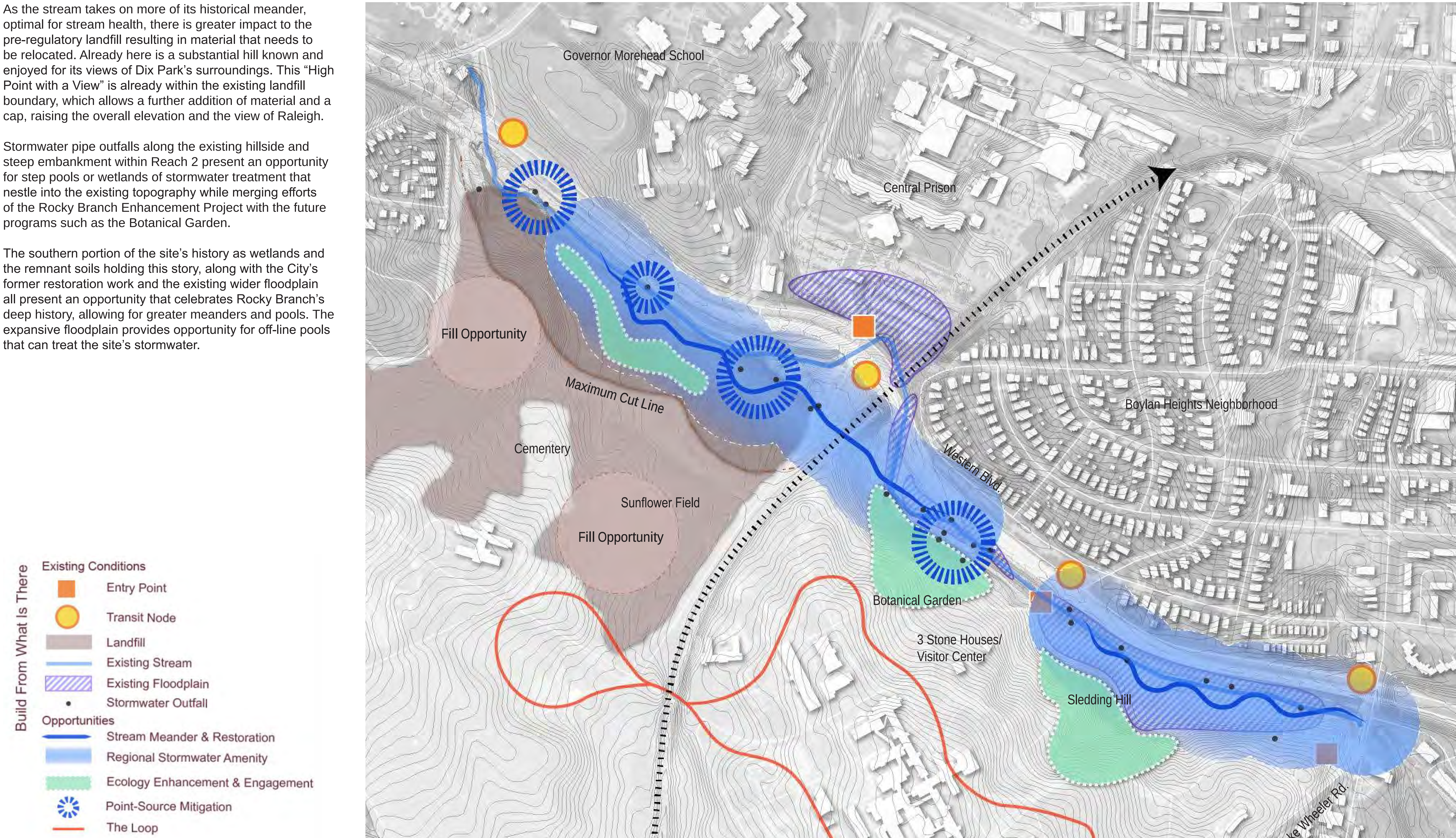
Recreation and Engagement Opportunities

BUILD FROM WHAT IS THERE

As the stream takes on more of its historical meander, optimal for stream health, there is greater impact to the pre-regulatory landfill resulting in material that needs to be relocated. Already here is a substantial hill known and enjoyed for its views of Dix Park's surroundings. This "High Point with a View" is already within the existing landfill boundary, which allows a further addition of material and a cap, raising the overall elevation and the view of Raleigh.

Stormwater pipe outfalls along the existing hillside and steep embankment within Reach 2 present an opportunity for step pools or wetlands of stormwater treatment that nestle into the existing topography while merging efforts of the Rocky Branch Enhancement Project with the future programs such as the Botanical Garden.

The southern portion of the site's history as wetlands and the remnant soils holding this story, along with the City's former restoration work and the existing wider floodplain all present an opportunity that celebrates Rocky Branch's deep history, allowing for greater meanders and pools. The expansive floodplain provides opportunity for off-line pools that can treat the site's stormwater.



OPEN UP & CONNECT

In enhancing and restoring the Rocky Branch corridor, there is opportunity to diversify and enliven the surrounding habitat. A healthy stream is a diverse stream, which includes its banks and floodplain. There is opportunity for more life throughout the corridor, stretching into the park as the Rocky Branch Enhancement Project merges with future development, showcasing the interconnectedness of the park's water systems and the visitor's experience.

As the topography levels out towards intersections and grading therefore has a lessened impact on the landfill, the three scenarios propose stormwater wetland features as the gateway that introduces the park visitor to Dix Park's water systems.

All of the scenarios complement and build from the Master Plan and the proposed adjacent programming. The scenarios present opportunities for tying Rocky Branch into the adjacent programs.

The existing physical connections are a great foundation for Rocky Branch as a Gateway. At the major intersections along Western Boulevard, there's opportunity to enhance these areas, welcome visitors into the park, and connect them directly with the program and opportunities that communicate Dix Park's values.

SOMETHING FOR EVERYONE

Public Space for All - Communities are seeking more than just access to public space, they are pursuing active engagement in influencing their surroundings, seeking an understanding of a site's cultural and natural history with benefits for all. The Rocky Branch project redefines our understanding of an urban stream restoration project by creating environments that promote inclusivity, accessibility and diversity.

Nature Escapes & Urban Playgrounds - The Rocky Branch project can transform how we engage our public space, integrate ecology and sustainability. Urban playgrounds are places of discovery and learning, they provide a 'third home' and educate us about the natural world around us. Throughout the design of the restored stream, citizens find places of play, pause and passage; open spaces that promote well-being and physical activity become key drivers.

The restored stream corridor will encourage access to wooded areas, open meadows, meandering streams, and wetlands. These spaces will provide a variety of climates throughout the day and seasons of the year. These urban spaces will be adaptable for individuals, small groups and large gatherings, informal and formal. Through the restoration of a floodplain, the stream will expand and contract, respond to weather conditions, and decrease flashing to downstream communities.

The existing physical connections are a great foundation for Rocky Branch as a Gateway. At the major intersections along Western Boulevard, there's opportunity to enhance these areas, welcome visitors into the park, and connect them directly with the program and opportunities that communicate Dix Park's values.

STORMWATER MANAGEMENT ASSESSMENT

The Rocky Branch Enhancement Project Site can be broken up into 7 microwatersheds, defined and delineated according to the topography moving north from The Ridge that dissects the Park north-south.

The Drainage Area and volumes are calculated using quantities of existing impervious surfaces. The Minimum sizing for the Wet Pond/Wetland Hybrid/Wetlands depicted below and in the chart to the side therefore reflect the sizing required to treat that existing impervious surface square footage. This quantity will presumably decrease following Dix Park's enaction of their plans to selectively preserve and demolish buildings and parking lots within the Park.

The SCM figures below are loosely placed within their microbasin only to communicate their sizing requirements related to their microwatershed.

Below right is an adaptation of the Wetland sizing per microwatershed, locating the minimum required sizing for Wet Pond/Wetland Hybrid and Wetlands according to the three Scenario's design approaches that treat stormwater regionally, treating multiple microwatersheds in optimal locations rather than each individually.

The locations optimize the existing topography, reflect the location of historical wetlands, and become Gateway opportunity areas at key entrances to the Park as they treat the Park's stormwater before it enters Rocky Branch - introducing park-goers to the water systems of Dix Park.

These stormwater management systems have potential to fulfill the three Core Principles as they provide STEM learning opportunities, gathering areas, and areas for reprieve in nature, all while working with the existing infrastructure and topography of the site to treat, clean, and celebrate the Park's waters as they reenter the overall Rocky Branch Watershed.

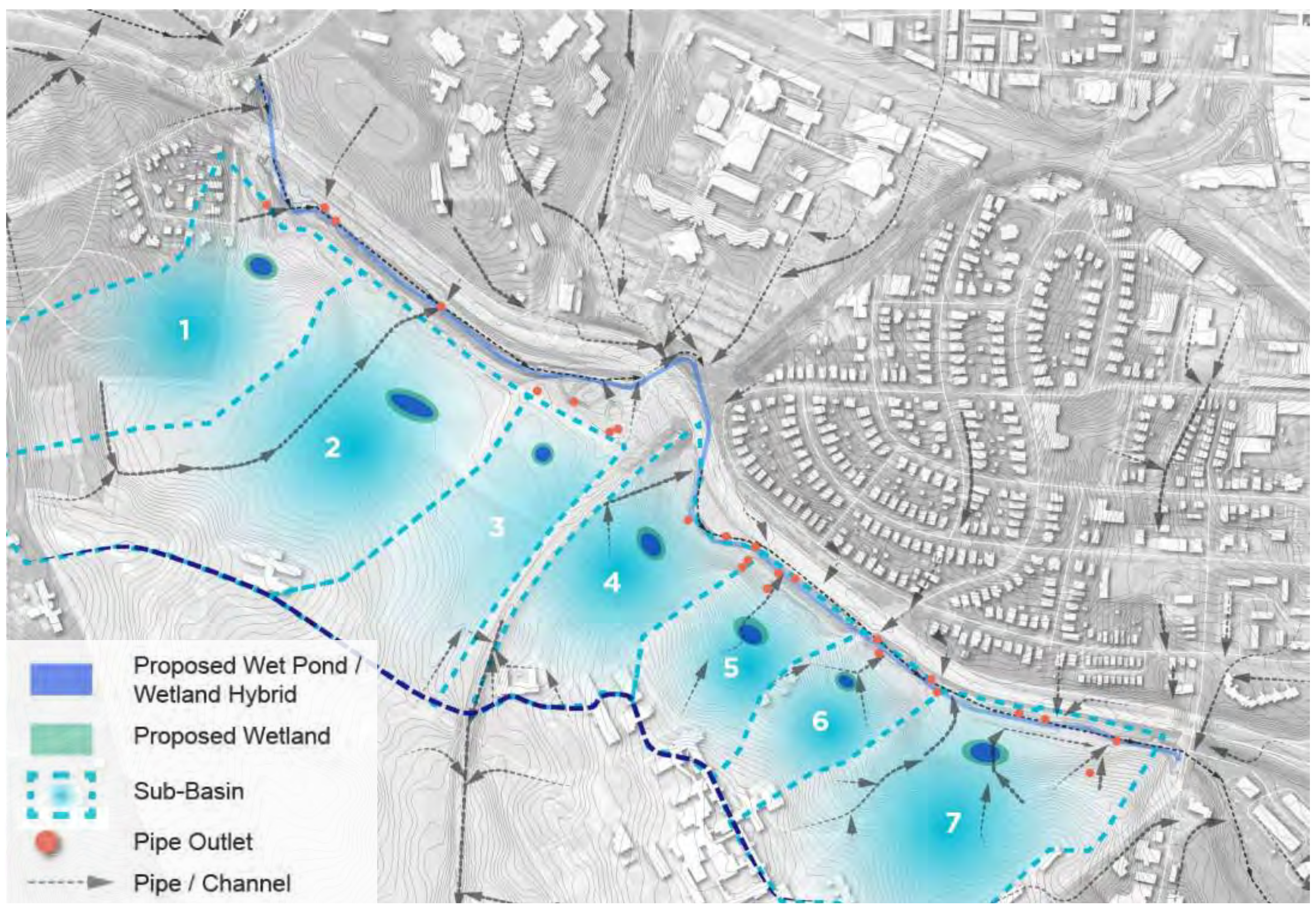
Dix Park - Rocky Branch Enhancement Project

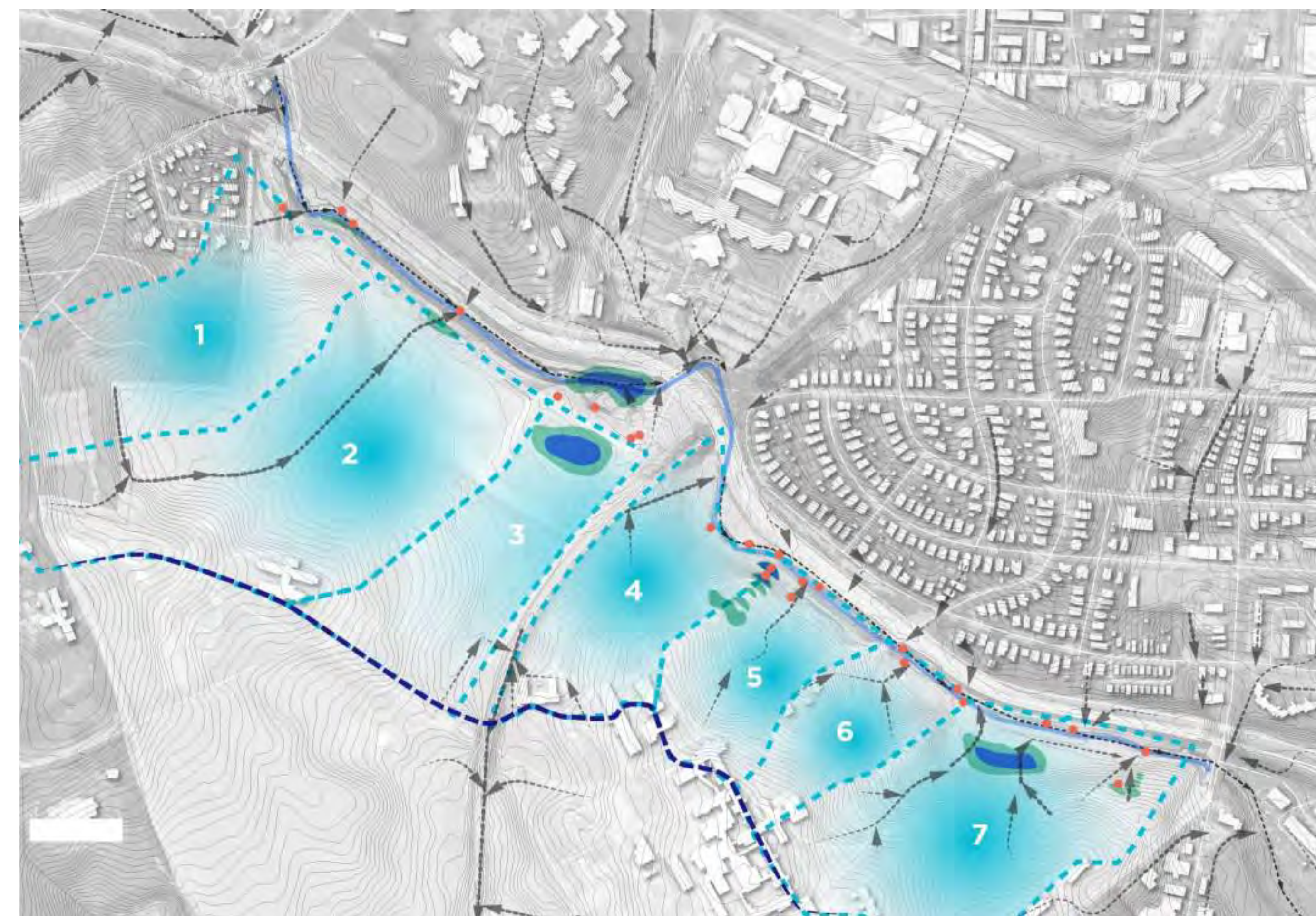
Preliminary Assessment for Stormwater Control Measures

Site Drainage Sub-Basin	Drainage Area (Sq. Ft.)	Design Volume (Cu. Ft.)	Minimum Wet Pond / Wetland Hybrid Surface Area (Sq. Ft.)	Minimum Wetland Surface Area (Sq. Ft.)
1	1,273,538	17,904	6,803	14,323
2	1,921,532	33,524	12,756	26,819
3	856,099	10,777	4,051	8,622
4	783,667	19,968	7,615	15,975
5	566,175	20,064	7,580	16,051
6	438,112	8,509	3,187	6,807
7	1,433,183	26,082	9,914	20,866

*Assumes a pond depth of 6 ft

**Minimum surface areas calculated using methods described in NCDEQ Stormwater Design Manual





3. PRELIMINARY STREAM ALIGNMENT DESIGN SCENARIOS

3. Preliminary Stream Alignment Design Scenarios

STREAM REACH DELINEATION & OVERVIEW

Along the course of Rocky Branch as it traverses the northern edge of Dix Park, varying streambed and bank conditions are represented. Additionally, other existing conditions such as topography, valley width, infrastructure and built conditions help to naturally delineate three different Reaches or sections of the stream. For purposes of this study, the stream alignment developed will refer to Reach 1, Reach 2 and Reach 3 for each of the three Scenarios.

In addition to providing distinguishable sections in which the stream alignments can be evaluated, these Reaches provide opportunities for considering how the Rocky Branch restoration could be implemented in a series of phases. Below are some typical characteristics found within the three reaches of Rocky Branch.

Reach 1

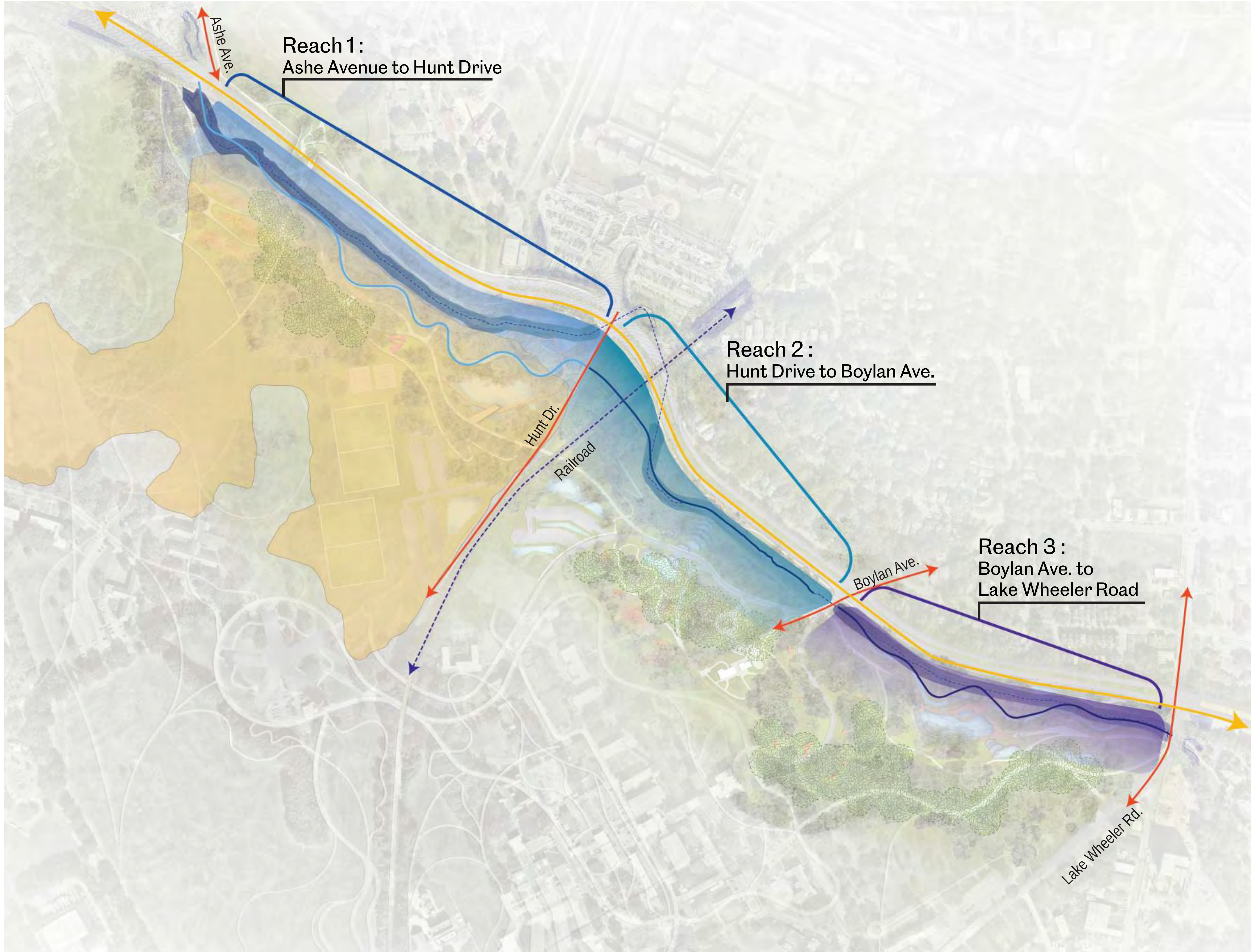
- Extends from Ashe Avenue to Hunt Drive
- Current stream alignment crosses Ashe Avenue and Western Boulevard via a series of concrete culverts.
- Current elevation of culvert at Ashe Avenue is perched and presents a condition that impedes fish passage.
- Consistent occurrence of concrete and debris, signs of bank failure, shallow gradient, and significant sediment deposition
- This reach is generally characterized as a wide channel with steep banks, often eroded and poorly stabilized banks.
- The alignment and condition of the stream has historically been influenced by the landfill.

Reach 2

- Extends from Hunt Drive to Boylan Avenue
- Crosses Western Boulevard onto Central Prison at Hunt Drive intersection via a concrete culvert
- Traverses through Central Prison site via an existing concrete ditch, prior to crossing back onto Dix Park via a second concrete culvert beneath Western Boulevard east of the Norfolk Southern Railway line.
- This reach is generally characterized by being channelized in a narrow corridor between Western Boulevard and an existing steep bank that is heavily wooded.
- Represents a relatively stable section of Rocky Branch.

Reach 3

- Extends from Boylan Avenue to S. Saunders Street
- Most stable and most natural reach within Dix Park
- Low bank height ratio, allows for more frequent floodplain flooding at 'The Grove'
- Includes series of bedrock glides serving as precedent for implementation of such features within the realignment design



STREAM REALIGNMENT | SCENARIO A

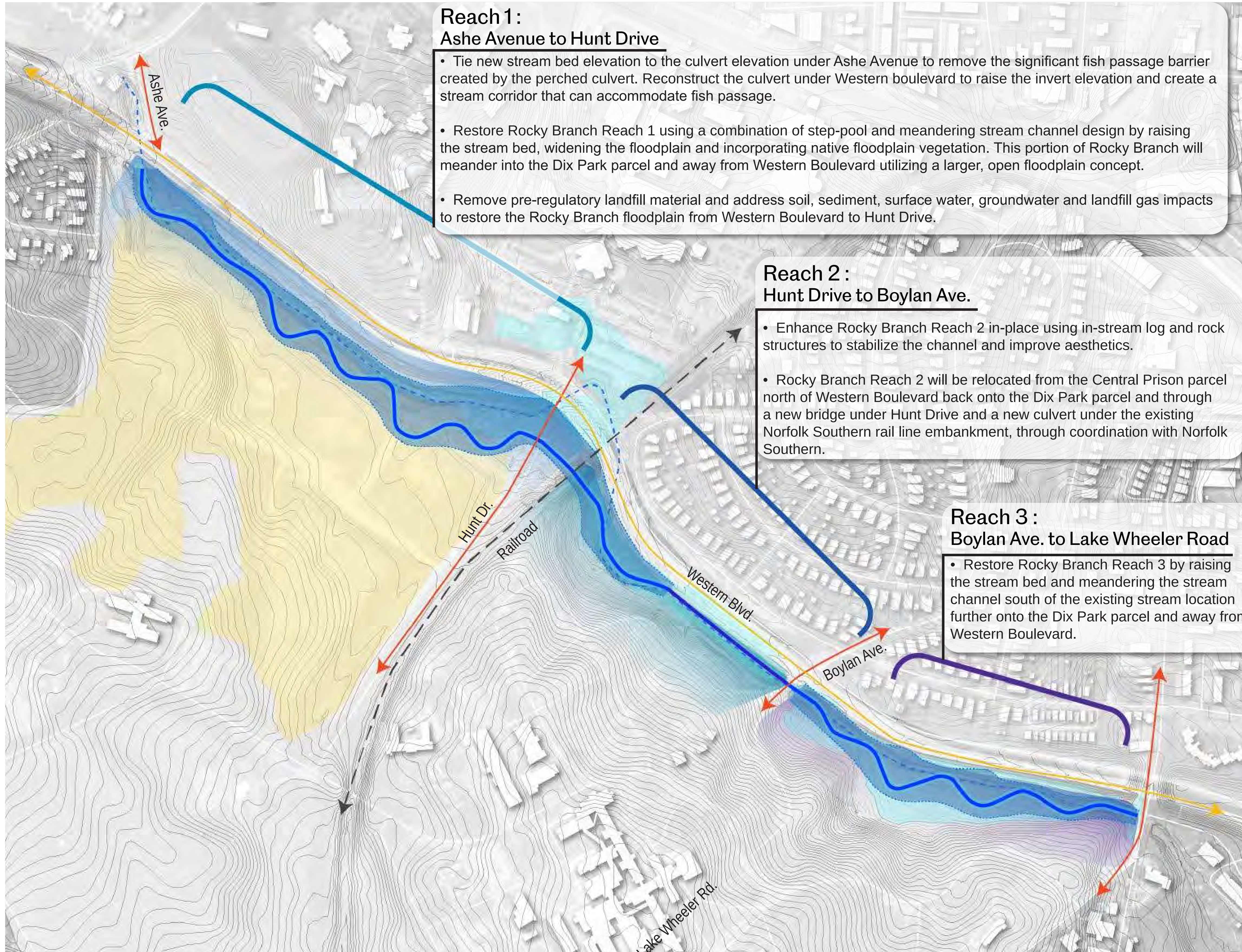
Addressing The Creek Goals in Scenario A:

- Habitat Restoration
  - Restored channels and varying channel depths will create habitats to support aquatic macroinvertebrates and fish populations throughout all seasons.
  - Aquatic passage barriers will be removed by tying stream bed elevations to culvert invert elevations at Ashe Avenue and replacing 3 existing culverts at Western Boulevard (upstream), Hunt Drive, and Western Boulevard (downstream) to appropriate invert elevations to maximize fish passage through Rocky Branch.
  - Rocky Branch will be removed from the concrete channel on Central Prison campus and restored to a natural stream system on Dix Park property.

- Improvement of Ecological Function
  - Establishing a native riparian buffer along the stream.
  - Removal of non-native species will allow native vegetation to flourish on stream banks, in the restored floodplain, and in wetland systems.
  -

- Showcase Piedmont Ecology
  - Stream restoration will showcase the ecology of the Piedmont, Fall Line, and Inner Coastal Plain through creation of meandering and step/pool channels.
  - Floodplain wetlands will support native wetland tree and herbaceous species.

- Widen the Flood Plain
  - Flood flows will dissipate energy and deposit fine sediment on the restored floodplain.
  - Flood waters will interact with floodplain vegetation and percolate into groundwater which will remove nutrients, sediment, and toxins from the creek system.



Reach 1 :
Ashe Avenue to Hunt Drive

- Tie new stream bed elevation to the culvert elevation under Ashe Avenue to remove the significant fish passage barrier created by the perched culvert. Reconstruct the culvert under Western boulevard to raise the invert elevation and create a stream corridor that can accommodate fish passage.

- Restore Rocky Branch Reach 1 using a combination of step-pool and meandering stream channel design by raising the stream bed, widening the floodplain and incorporating native floodplain vegetation. This portion of Rocky Branch will meander into the Dix Park parcel and away from Western Boulevard utilizing a larger, open floodplain concept.

- Remove pre-regulatory landfill material and address soil, sediment, surface water, groundwater and landfill gas impacts to restore the Rocky Branch floodplain from Western Boulevard to Hunt Drive.

Reach 2 :
Hunt Drive to Boylan Ave.

- Enhance Rocky Branch Reach 2 in-place using in-stream log and rock structures to stabilize the channel and improve aesthetics.

- Rocky Branch Reach 2 will be relocated from the Central Prison parcel north of Western Boulevard back onto the Dix Park parcel and through a new bridge under Hunt Drive and a new culvert under the existing Norfolk Southern rail line embankment, through coordination with Norfolk Southern.

Reach 3 :
Boylan Ave. to Lake Wheeler Road

- Restore Rocky Branch Reach 3 by raising the stream bed and meandering the stream channel south of the existing stream location further onto the Dix Park parcel and away from Western Boulevard.

DESIGN OVERVIEW
SCENARIO A- ALIGNMENT & DESIGN

DESIGN OVERVIEW

Scenario A exhibits a proposed design for the Rocky Branch corridor that is the most ambitious and most representative of the full design and vision established within the Dix Park Master Plan. Scenario A intends to restore Rocky Branch to an alignment and design that is most similar to the pre-disturbance conditions in the northern Reach 1, stretching from Ashe Avenue to South Saunders Street.

- This scenario represents the most significant adjustments to the existing stream, specifically within Reach 1, where not only the alignment is revised, but the elevation of the stream is altered to alleviate fish passage barriers at existing culverts beneath Ashe Avenue. This scenario will reconstruct multiple culverts beneath Western Boulevard.
- Includes removal of significant amounts of landfill material to adjust the Rocky Branch meander and restore much of the adjacent floodplain within the extents of Reach 1. Meandering the stream further into Dix Park and providing a widened floodplain allows for a restored stream corridor designed to better accommodate a variety of rain event intensities.
- Reach 2 of the Rocky Branch corridor relocates the stream corridor to no longer cross beneath Western Boulevard and diverts it from the Central Prison site to remain on Dix Park the entire length of the north park boundary. This stream alignment will install a new culvert crossing beneath the existing Norfolk Southern Railway line as well as a new vehicular bridge crossing at Hunt Drive. Downstream of the Norfolk Southern Railway, the stream will utilize in-stream log and rock structures to traverse the topography change, stabilizing the channel and improving stream aesthetics.
- Reach 3 will significantly meander the stream channel southward from its existing alignment, increasing separation from Western Boulevard allowing for it to become more integrated into the Dix Park experience.

The following pages will provide a summary of key differentiating factors that will be evaluated for design and cost opinion considerations between the different reaches of Scenario A. This approach allows for Scenario A to be compared on a reach-by-reach basis to the design alternative Scenarios B and C.

See Appendices I, Reach Detail Summaries for the evaluation of how project goals are met in Scenario A.

SCENARIO A- ALIGNMENT & DESIGN

REACH 1

Representing full implementation of the Master Plan, this design provides an optimal approach to restoring the stream and creates maximum engagement and connectivity opportunities. Reach 1 of the Rocky Branch corridor is by far the most complex section of the stream. It is important to understand that this design likely presents the most significant constraints that will need to be addressed during design and permitting.

Some of these considerations include the following:

- Most significant coordination with Norfolk Southern, Central Prison, DOT, and the Pre-regulatory Landfill Unit.
- Presents most significant permitting risk by raising stream elevation and affecting flood dynamics. Further research & analysis would be needed
- Presents most significant costs, i.e., infrastructure, utilities, earthwork and environmental.
- Presents most significant need for environmental landfill design.
- Presents most significant need for environmental,
- soil, groundwater, surface water, sediment, landfill gas and waste management.
- Manage settlement of the landfill surface over time from ongoing natural degradation of landfill waste.

Summary of Key Factors:

- **Stream**
  - Optimizes stream alignment, preserves north high point of site
  - Optimizes stream elevation by raising stream 5' in Reach 1
- **Landbridge**
  - Maximizes scale of Landbridge, providing 100' wide landbridge crossing south of Rocky Branch to north of Western Boulevard
- **Earthwork/ Environmental**
  - Significant landfill impact
  - Earthwork reduced due to raising stream elevation by 5'
  - Potential for maximized environmental implications due to raised stream elevation
  - Landfill material completely excavated north of Limits of Full Landfill Excavation line below. This coincides with the floodplain bench. Material to be relocated within the existing landfill boundary
  - South of the Excavation Limit line, landfill material is reduced and relocated, then capped per regulations
- **Stormwater**
  - Optimizes opportunities for treatment north and south of Rocky Branch, maximizing stormwater management and treatment potential
- **Circulation**
  - Maximizes pathways and stream/ wetland crossings
  - Requires new vehicular bridge at Hunt Drive
- **Engagement**
  - Maximizes impact of stream and wetland overlooks, engagement, and program spaces

REACH DETAILED SUMMARIES

SCENARIO A- ALIGNMENT & DESIGN

REACH 1 EXPERIENCE

REACH DETAILED SUMMARIES

SCENARIO A- ALIGNMENT & DESIGN

REACH 1 EXPERIENCE

REACH DETAILED SUMMARIES
REACH 1- ALIGNMENT & DESIGN

REACH 2

While the majority of Reach 2 maximizes existing conditions, the western end is raised to meet Scenario A, Reach 1 elevation and realigned onto Dix Park property, where most of the complexity comes into play. The generally stable, narrower channel and valley unique to Reach 2 inform design decisions to maintain much of this reach alignment and preserve more of the adjacent steep hillside vegetation.

Just as in Reach 1, the Scenario A design of Reach 2 represents full implementation of the Master Plan vision and presents the greatest degree of complexity for both design and permitting.

Some of these considerations include the following:

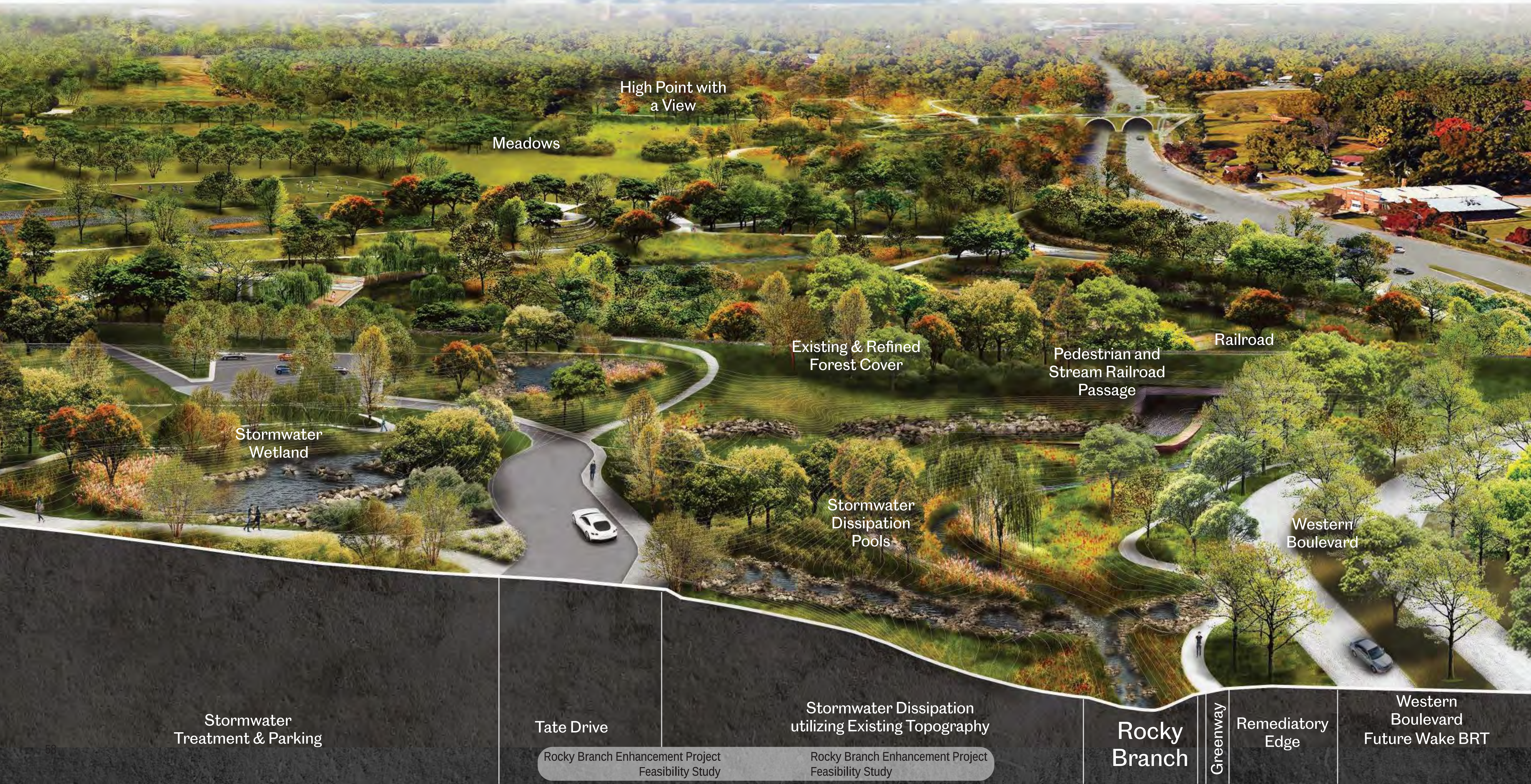
- Most significant coordination with Norfolk Southern, Central Prison, and DOT
- Presents most significant permitting risk due raised stream elevations on western end of Reach 2
- Presents most significant costs, i.e., infrastructure, utilities, earthwork and environmental

Summary of Key Factors:

- **Stream**
  - Optimizes stream alignment, stream is rerouted to pass beneath Hunt Drive and through a culvert at Norfolk Southern Railway, remaining entirely on Park property
  - Optimizes stream elevation by raising stream, will step down to existing grade east of Norfolk Southern Railway via a series of stepped falls or bedrock glides
- **Earthwork/ Environmental**
  - Most significant landfill impact for Reach 2, result of raised elevation and realignment
  - Impact on lower half of Reach 2 is minimal as stream alignment remains close to existing channel course
- **Stormwater**
  - Optimizes opportunities for treatment south of Rocky Branch, maximizing stormwater management and treatment potential and integrating with adjacent future Master Plan program elements such as the Botanical Gardens and parking areas
  - Stormwater management on the north side of Rocky Branch is relatively confined due to the narrow stream valley, primarily focused on dissipation pools to slow incoming runoff at outfall locations.
- **Circulation**
  - Maximizes pathways and variety of pathway experience, potential for at grade and at stream elevation crossings of both Hunt Drive and Norfolk Southern Railway
  - Requires new vehicular bridge at Hunt Drive and new culvert at Railway
- **Engagement**
  - Maximizes engagement and integration with adjacent park program opportunities

SCENARIO A- ALIGNMENT & DESIGN

REACH 2 EXPERIENCE



Rocky Branch Enhancement Project Feasibility Study

SCENARIO A- ALIGNMENT & DESIGN

REACH 3

Reach 3 of the Rocky Branch corridor is unique in that it most closely resembles a natural stream corridor and bank condition in its existing conditions. Just as in Reach 1 and 2, the design of Scenario A Reach 3 represents full implementation of the Master Plan vision.

Not only does this realignment of Rocky Branch represent an ideal condition from a stream restoration perspective, it also maximizes the potential for stormwater management and creating the most impactful visitor experience. Pathway systems represented in Scenario A provide for the greatest variety of interaction with the stream and wetlands, offering both overlook experiences as well as a series of at grade boardwalks.

Connectivity to adjacent park program is also maximized within this Scenario A.

While the entirety of this project exists within a Brownfield site, in general, Reach 3 does not present the complexities that exist within Reach 1 and the western end of Reach 2. Considering the advantageous topography of Reach 3 as well as it being further removed from the landfill, the earthwork, permitting, and environmental management required to implement the Reach 3 design are anticipated to be significantly reduced from that of Reach 1 and 2.

Summary of Key Factors:

- **Stream**
  - Optimizes stream alignment, significantly increases meander of stream
  - Restores stream channel and maximizes floodplain
- **Earthwork/ Environmental**
  - Most significant impact to realign stream and provide for perched stormwater measures
- **Stormwater**
  - Optimizes opportunities for treatment south of Rocky Branch, leverages the existing topography of the Grove to provide for regional wetland. Provides for terraced wetlands perched on higher topography of the Grove.
  - Provides minimal stormwater management treatment north side of Rocky Branch, primarily focused on dissipation pools to slow incoming runoff at outfall locations.
- **Circulation**
  - Maximizes pathways and variety of pathway experience
- **Engagement**
  - Maximizes engagement and access with the stream; fully integrates design with adjacent park program opportunities

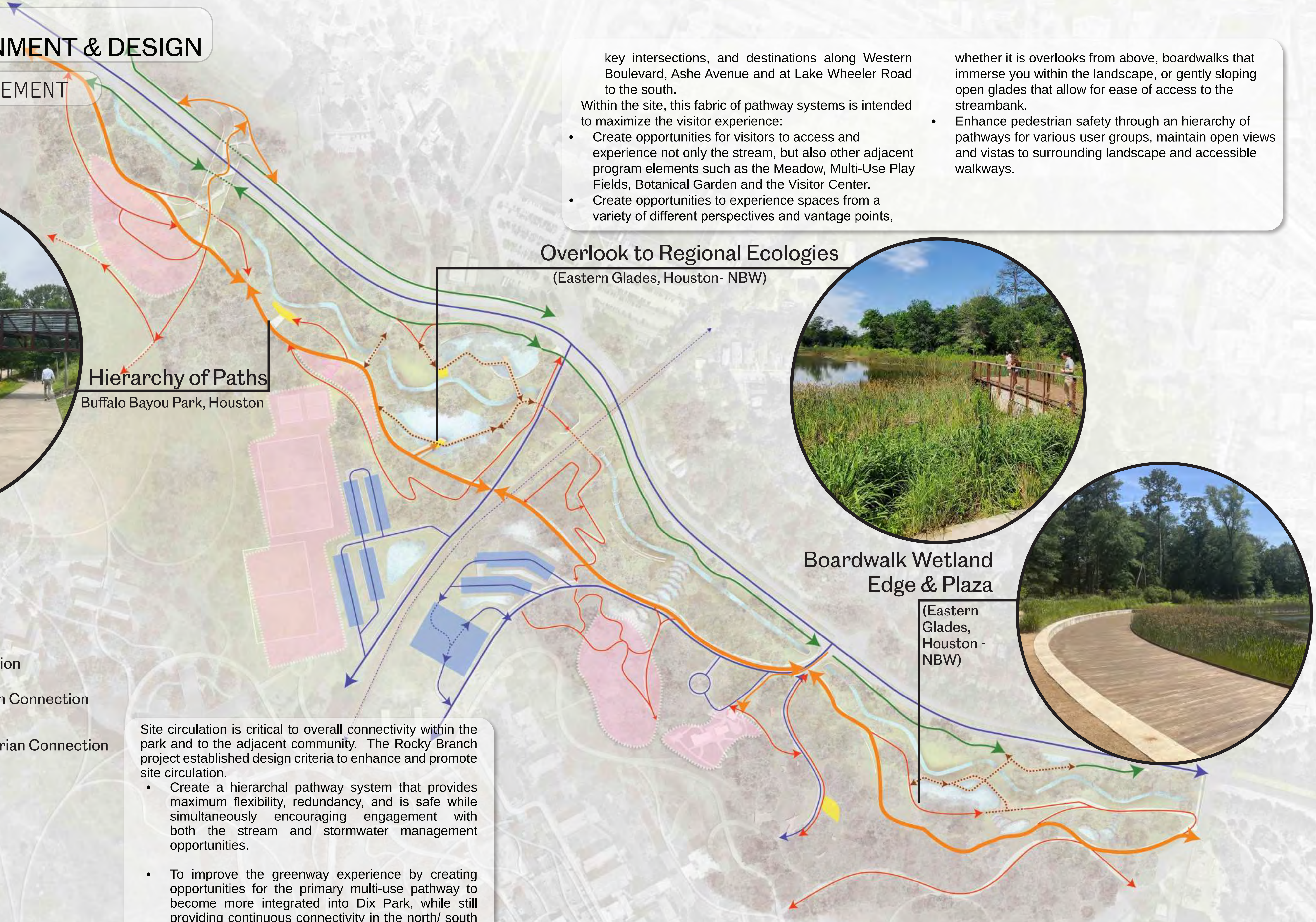
REACH DETAILED SUMMARIES
SCENARIO A- ALIGNMENT & DESIGN
REACH 3 THE GROVE EXPERIENCE

REACH 3- ALIGNMENT & DESIGN

REACH 3 THE GROVE EXPERIENCE

SCENARIO A- ALIGNMENT & DESIGN

CIRCULATION & ENGAGEMENT



Legend

- Vehicular Connection
- Primary Pedestrian Connection [Multi-use Trail]
- Secondary Pedestrian Connection
- Boardwalk
- Greenway
- Railroad
- Parking
- Activated / Programmed Space
- Gathering Space

Site circulation is critical to overall connectivity within the park and to the adjacent community. The Rocky Branch project established design criteria to enhance and promote site circulation.

- Create a hierarchal pathway system that provides maximum flexibility, redundancy, and is safe while simultaneously encouraging engagement with both the stream and stormwater management opportunities.
- To improve the greenway experience by creating opportunities for the primary multi-use pathway to become more integrated into Dix Park, while still providing continuous connectivity in the north/ south direction along the park edge. Design for the site circulation to create campus gateways. Pathways to provide ample connections to neighborhoods, key intersections, and destinations along Western Boulevard, Ashe Avenue and at Lake Wheeler Road to the south.

Within the site, this fabric of pathway systems is intended to maximize the visitor experience:

- Create opportunities for visitors to access and experience not only the stream, but also other adjacent program elements such as the Meadow, Multi-Use Play Fields, Botanical Garden and the Visitor Center.
- Create opportunities to experience spaces from a variety of different perspectives and vantage points, whether it is overlooks from above, boardwalks that immerse you within the landscape, or gently sloping open glades that allow for ease of access to the streambank.
- Enhance pedestrian safety through an hierarchy of pathways for various user groups, maintain open views and vistas to surrounding landscape and accessible walkways.

DESIGN DRIVERS

SCENARIO A- ALIGNMENT & DESIGN

STREAM, STORMWATER, & HYDROLOGY

Bedrocks Glides

(Rocky Branch Downstream Reference Reach)

Stream Alignment

- Introduces meander in Reach 1,raises stream elevation in Reach 1 by 5', realigns stream to remain on Dix Park property
- Step pools to traverse grade in Reach 2, new culvert at railroad
- Introduces meander in Reach 3, transforms existing floodplain into a diverse landscape balancing stream and stormwater management

Wetland & Floodplain Boardwalk

(Houston Arboretum)

Flood Plain Improvements

- Develops minimum flood plain bench width of 80'
- Provides increased flood plain widths in strategic locations where site conditions allow

Outdoor Meandering Classroom

Legend

- Proposed Wet Pond/ Wetland
- Proposed Floodplain Bench
- Proposed Stream
- Stormwater Flow
- Surface Flow
- Stream Realignment & Restoration
- Enhanced in Place

(NCMA - S678)

Stepped Stormwater Treatment

Stormwater Management

- Provides combination of Regional stormwater measures north and south of Rocky Branch, as well as small scale control measures proximate to point source,
- Provides treatment for Western Boulevard & future Bus Rapid Transit (BRT) project,
- In Reach 2 and 3, presents opportunities for dissipation of offsite drainage flow velocities at outfall locations,
- Creates opportunities for public access, engagement, and outdoor learning,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

DESIGN DRIVERS

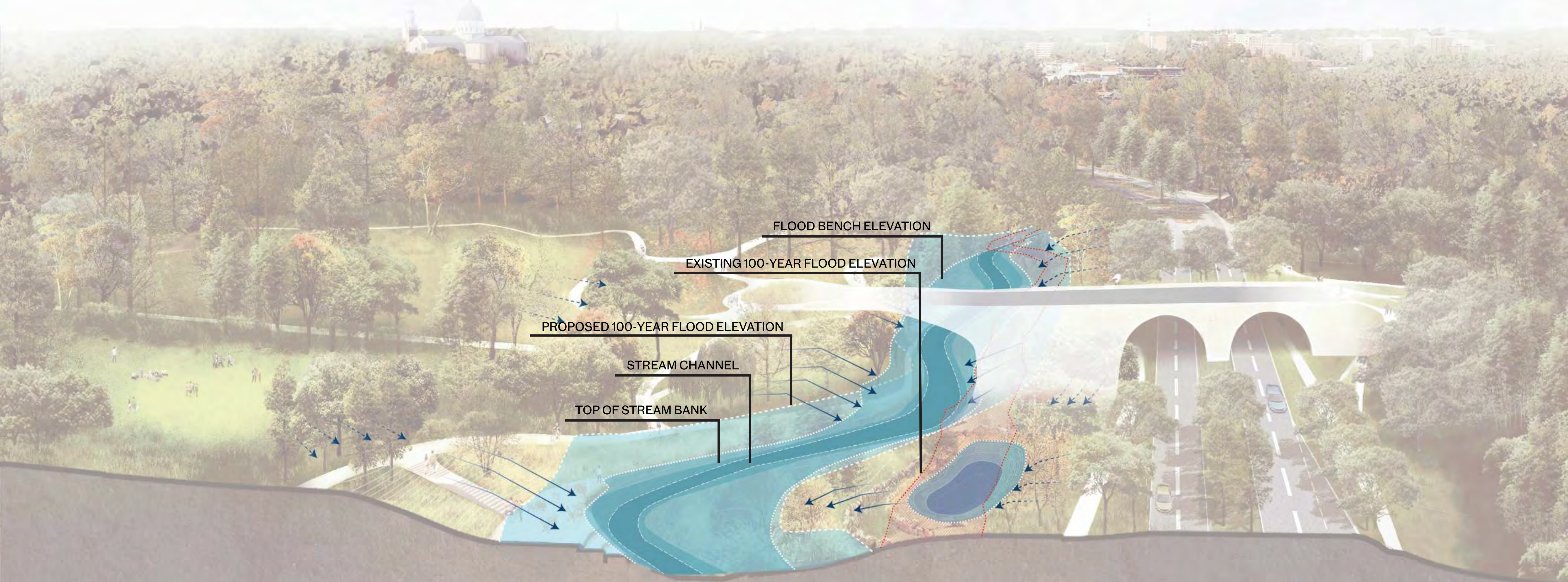
REACH 1- ALIGNMENT & DESIGN

FLOODPLAIN PERFORMANCE & RESILIENCY

The realignment of Rocky Branch within Reach 1 greatly improves the floodplain conditions of the stream, providing for a wide bench that is capable of allowing the banks to overflow during rain events. This diagram represents the improved stream and floodplain performance near the west end of Reach 1. As the stream continues past the Landbridge to the east, the proposed grading and stream alignment begins to more significantly meander into the Dix Park site.

This alignment really begins to transform the floodplain of Rocky Branch, providing a wider flood bench more appropriately sized for the capacity of the stream during rain events. This meander also presents opportunities for stormwater management integration on the north side of Rocky Branch. These voluntary treatment measures contribute to the performance of Rocky Branch as a whole, providing integrated measures that will help to protect and preserve the stream corridor.

In the lower left corner, the terraced stream overlooks exhibit the characteristics of designed floodable landscape. Designing such program spaces that allow visitors to immerse themselves within this natural landscape and to engage with the stream on a day-to-day basis, but still perform within a floodplain illustrates the importance of resiliency and its need to be woven throughout the entirety of the Rocky Branch design.



DESIGN DRIVERS

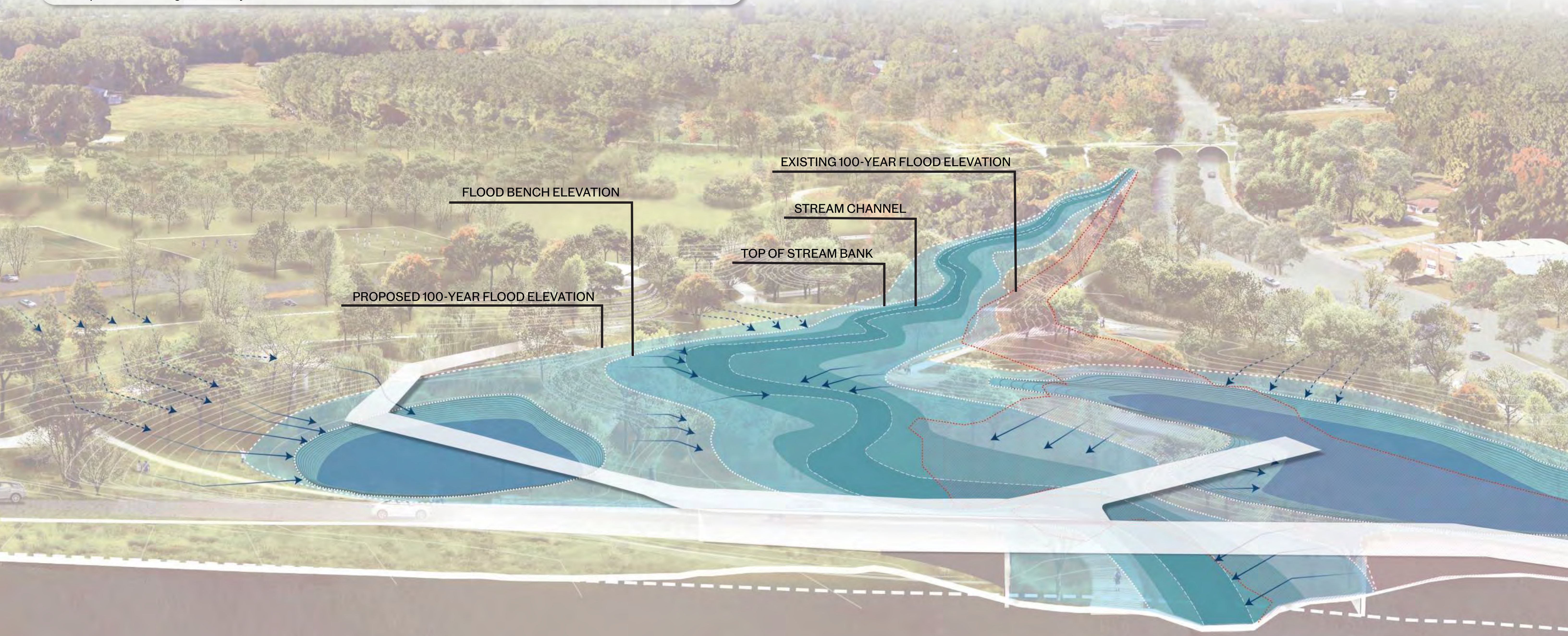
REACH 1- ALIGNMENT & DESIGN

FLOODPLAIN PERFORMANCE & RESILIENCY

The realignment of Rocky Branch within Reach 1 greatly improves the floodplain conditions of the stream, providing a wide bench which is capable to accomodate stream overflow during key rain events. The east end of Reach 1 is particularly interesting as it not only provides an expanded floodplain, but also integrates large scale, regional stormwater management wetlands on both the north and south sides of Rocky Branch.

A diverse network of pathways, boardwalks, overlooks and flexible, waterfront landscapes offer a range of potential user experiences designed to fully immerse visitors in this transformed landscape. Visitors will be able to observe diverse and evolving natural systems in action, providing perspectives to active streams, changing floodplain conditions, stormwater wetlands, and restored riparian buffers showcasing native Piedmont ecology.

Resiliency is at the forefront of the design discussion, creating landscapes that are designed to mimic natural systems in terms of longevity, durability, and flexibility while offering unforgettable experiences that are truly unique to Raleigh.



DESIGN DRIVERS

REACH 2- ALIGNMENT & DESIGN

FLOODPLAIN PERFORMANCE & RESILIENCY

Rocky Branch within Reach 2 shares some similarities to the western end of Reach 1 in that it operates within a more confined valley. While realignment to this stretch of the stream was minimized in an effort to preserve the character of the adjacent wooded slopes of the Park, it does offer significantly improved floodplain performance as can be seen below.

Additionally, this diagram clearly illustrates how the integral design of both stream and stormwater management is critical to the vision for the Rocky Branch corridor. Careful consideration must be placed on the realignment of the stream, allowing it the space to function with a healthy and stabilized bank system, while looking for opportunities to widen the flood bench as needed to create a more resilient system that performs during high intensity rain events.

Utilizing topography to the site's advantage and integrating the adjacent program of the Park create some unique opportunities to showcase these systems in nature. Here, stormwater management systems from the adjacent botanical gardens and parking areas are both shown in close proximity to the stream. Collecting and treating runoff from adjacent Park program areas is key to the design of Rocky Branch.

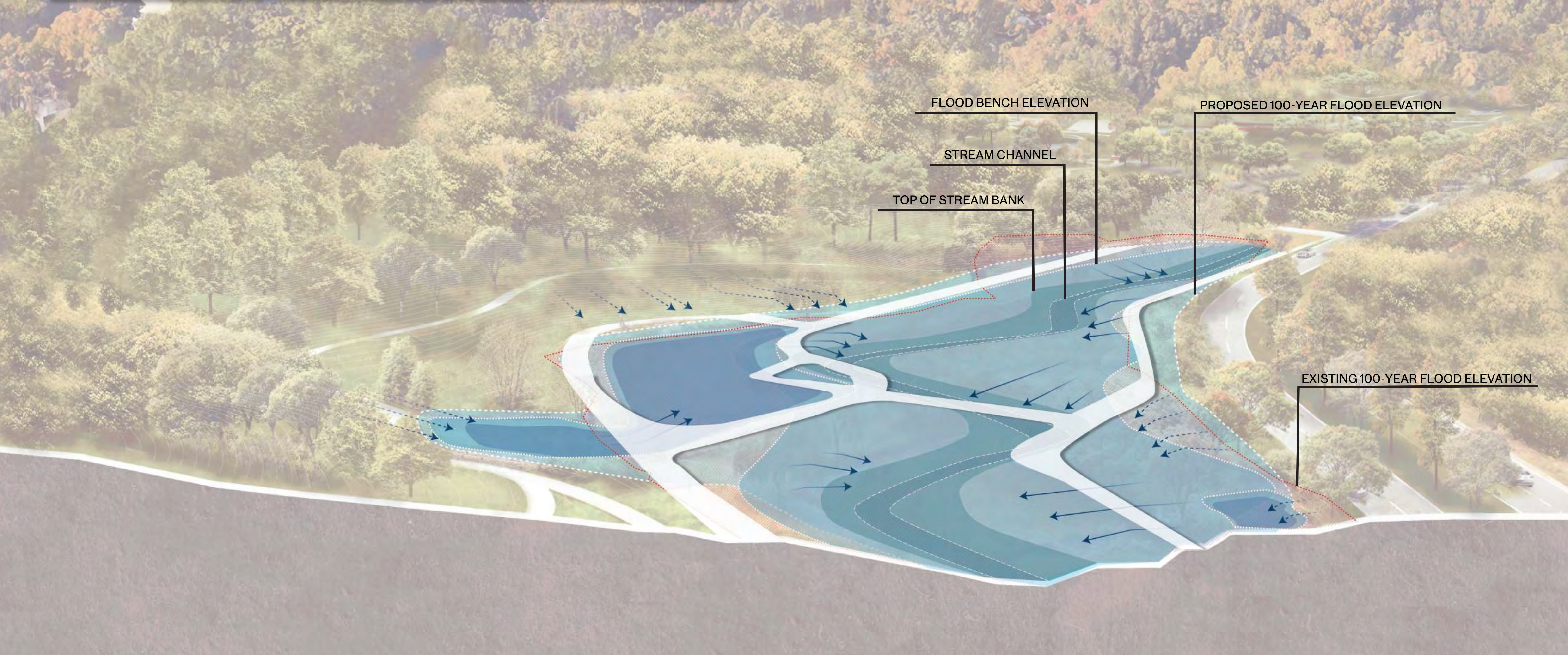
REACH 3- ALIGNMENT & DESIGN

FLOODPLAIN PERFORMANCE & RESILIENCY

The realignment of Rocky Branch within Reach 3 improves an area of Rocky Branch that is already most natural of any stream section on site. The proposed realignment significantly meanders the stream further into Dix Park, providing the space to further separate from the edge of Western Boulevard and integrate more within the Park footprint.

The low lying, relatively flat topography of The Grove allows for a unique opportunity to create a broad riparian landscape that combines both the stream and adjacent stormwater wetlands. The integrated design of these systems into a singular landscape creates a unique and high performing space, providing both the stream and floodplain improvements while simultaneously creating a diverse system of stormwater wetlands that transforms this area of Dix Park into a showcase of resilient design.

A system of pathways and overlooks offers the ability for visitors to truly experience the space from all perspectives in a truly unique way. Smaller pathways and more intimate spaces are intended to allow one to immerse themselves within the landscape, while at the same time the multi-use pathway traverses this area of the park via a boardwalk, offering a variety of users access to the stream.



STREAM REALIGNMENT | SCENARIO B

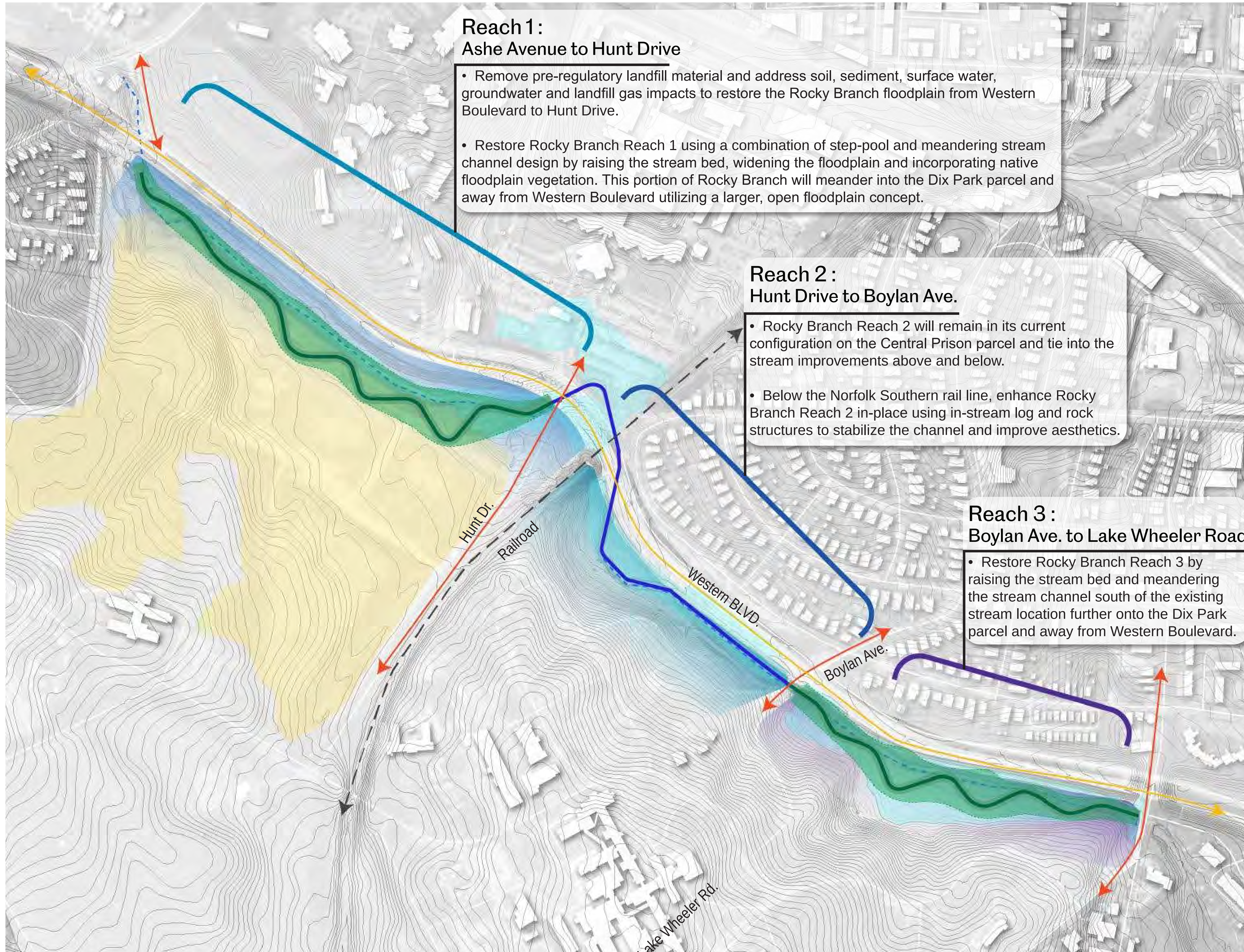
Addressing The Creek Goals in Scenario B

- Habitat Restoration
  - Restored channels and varying channel depths will create habitats to support aquatic macroinvertebrates and fish populations throughout all seasons.
  - Aquatic passage will be improved at existing Ashe Avenue, Western Boulevard (upstream), and Western Boulevard (downstream) culverts by incorporating step-pool channel design to gently drop the stream bed grades from existing perched culverts.

- Improvement of Ecological Function
  - Establishing a native riparian buffer along the stream.
  - Removal of non-native species will allow native vegetation to flourish on stream banks, in the restored floodplain, and in wetland systems.

- Showcase Piedmont Ecology
  - Stream restoration will showcase the ecology of the Piedmont, Fall Line, and Inner Coastal Plain through creation of meandering and step/pool channels.
  - Floodplain wetlands will support native wetland tree and herbaceous species.

- Widen the Floodplain
  - Flood flows will dissipate energy and deposit fine sediment on the restored floodplain.
  - Flood waters will interact with floodplain vegetation and percolate into groundwater which will remove nutrients, sediment, and toxins from the creek system.
  - The narrower floodplain on Concept B vs Concept A will limit these functional improvements.



Rocky Branch Enhancement Project
Feasibility Study

DESIGN OVERVIEW

SCENARIO B- ALIGNMENT & DESIGN

SCENARIO B- ALIGNMENT & DESIGN

DESIGN OVERVIEW

Scenario B proposes a design for the Rocky Branch corridor that still meets the goals and objectives of the Dix Park Master Plan while proposing some reductions in order of magnitude that would begin to reduce costs and potentially simplify construction. .

- Scenario B still intends to restore Rocky Branch to optimal alignments where its most feasible and aside from isolated differentiations at some key locations, much of the stream alignment proposed in Scenario B will resemble that of Scenario A.
- While Reach 1 still includes the management of significant amounts of landfill material to adjust the Rocky Branch meander and restore much of the adjacent floodplain, Scenario B will retain the existing grade of the stream channel within Reach 1. This is a key differentiating factor between Scenario A and B, as it likely does have impacts to flood study conditions and does impact earthwork quantifications.
- Reach 2 of the Rocky Branch corridor is where the most significant differentiating realignment between Scenario A and B exists. While Scenario A altered the stream course to relocate entire onto Dix Park, Scenario B retains the existing culverts at Western Boulevard that allow the stream to leave the site at Hunt Drive and reconnect east of the Norfolk Southern Railway.
- Reach 3 will significantly meander the stream channel southward from its existing alignment, increasing separation from Western Boulevard allowing for it to become more integrated into the Dix Park experience, very similar to the approach taken in Scenario A.

Design integration of circulation, engagement opportunities and stormwater management is still achieved at a high level with the implementation of Scenario B, again just looking at opportunities to reduce order of magnitude at which these may be imagined. In general, Scenario B still looks to provide significant improvements to stormwater management. Opportunities for large, regional treatments still exists south of Rocky Branch, while in some locations the proposed stormwater management north of Rocky Branch is shown to be reduced in Scenario B. Similarly with pathways and program spaces, the concept is to provide slight reductions in the amount and scale of each while still maintaining the goals of campus and community connectivity.

SCENARIO B- ALIGNMENT & DESIGN

REACH 1

In Scenario B, the stream alignment is still optimized for much of the length, but reconnects with the current alignment to cross Western Boulevard just west of Hunt Drive onto Central Prison property.

This option still optimizes and restores considerable lengths of the Reach 1 stream while offering significant reductions in complexity by alleviating some constraints of Scenario A. While not eliminating design coordination and collaboration, it has the potential to greatly simplify the processes of approvals and removes some design hurdles.

- It no longer requires a new vehicular bridge and crossing at Hunt Drive.
- It no longer requires a new culvert crossing of the Norfolk Southern Railway south of Western Boulevard.

While this option does reduce the disturbance area slightly from Scenario A, interaction with the landfill still presents complexity:

- Due to stream elevations, the earthwork involved is potentially greater than Scenario A. This option still presents significant impacts for environmental landfill design and soil management and presents similar needs for environmental landfill gas and waste management.

Summary of Key Factors

- **Stream**
  - Maintains improved alignment of Scenario A
  - Maintains Western Boulevard culverts, stream remains on Central Prison site and connects back on Dix Park east of Norfolk Southern Railway
  - Maintains existing stream elevation
- **Green Bridge**
  - Provides for a green bridge, providing 60' wide landbridge crossing Western Boulevard transitioning to a steel pedestrian bridge across Rocky Branch
- **Earthwork/ Environmental**
  - Most significant landfill impact, maintains significant environmental impact
  - Earthwork increased from Scenario A due to maintaining lower, existing stream elevation and grading in floodplain.
  - Landfill material completely excavated north of Limits of Full Landfill Excavation line below. This coincides with the floodplain bench. Material to be relocated within the existing landfill boundary
  - South of the Excavation Limit line, landfill material is reduced and relocated, then capped per regulations
- **Stormwater**
  - Opportunities for treatment south of Rocky Branch remain similar to Scenario A
  - Reduces opportunities for treatment north of Rocky Branch
- **Circulation**
  - Reduces pathways and crossings from Scenario A
- **Engagement**
  - Reduces magnitude of overlooks from Scenario A, maintains similar program spaces

SCENARIO B- ALIGNMENT & DESIGN

REACH 2

Reach 2 of the Scenario B design incorporates significant changes on the western end from what was represented in Scenario A. The primary difference is that the stream is not realigned to remain on Dix Park, but rather will utilize the existing system of culverts to cross onto Central Prison at the Hunt Drive intersection and will rejoin the Dix Park site east of the Norfolk Southern Railway where it does so today.

As described in the Reach 1 summary, this Scenario provides a design alternative that can seemingly be implemented with a reduced degree of complexity for design, permitting and construction.

This greatly simplifies many aspects of the implementation of Reach 2, removing several key considerations that were integral to the Scenario A.

- It no longer requires a new vehicular bridge and crossing at Hunt Drive.
- It no longer requires a new culvert crossing of the Norfolk Southern Railway south of Western Boulevard.

The generally stable, narrower channel and valley unique to Reach 2 still informs design decisions in Scenario B in order to maintain much of this reach within its alignment; therefore, maximizing the preservation of the adjacent hillside topography and vegetation.

Summary of Key Factors

- **Stream**
  - Maintains existing stream alignment, eliminates realignment beneath Hunt Drive and through a culvert at Norfolk Southern Railway, follows existing culverts at two crossings
- **Earthwork/ Environmental**
  - Reduces impact from Scenario A, primarily as a result of eliminating the realignment at Western Boulevard, earthwork is significantly reduced on west end of Reach 2
- **Stormwater**
  - Maintains very similar stormwater treatment opportunities on both north and south of Rocky Branch
- **Circulation**
  - Provides pathways on both sides of stream but reduces number of pathways and variety of pathway types from Scenario A
  - Does not requires new vehicular bridge at Hunt Drive or new culvert at Railway
- **Engagement**
  - Slightly reduces the scale and magnitude of stream engagement from A

SCENARIO B- ALIGNMENT & DESIGN

REACH 3

Reach 3 of the Rocky Branch corridor is unique in that it most closely resembles a natural stream corridor and bank condition in its existing conditions. Just as in Reach 1 and 2, the design of Scenario A Reach 3 represents full implementation of the Master Plan vision.

Not only does this realignment of Rocky Branch represent an ideal condition from a stream restoration perspective, it also maximizes the potential for stormwater management and creating the most impactful visitor experience. Pathway systems represented in Scenario A provide for the greatest variety of interaction with the stream and wetlands, offering both overlook experiences as well as a series of at grade boardwalks.

Connectivity to adjacent park program is also maximized within this Scenario A.

While the entirety of this project exists within a Brownfield site, in general, Reach 3 does not present the complexities that exist within Reach 1 and the western end of Reach 2. Considering the advantageous topography of Reach 3 as well as it being further removed from the landfill, the earthwork, permitting, and environmental management required to implement the Reach 3 design are anticipated to be significantly reduced from that of Reach 1 and 2.

Summary of Key Factors:

- **Stream**
  - Optimizes stream alignment, significantly increases meander of stream
  - Restores stream channel and maximizes floodplain
- **Earthwork/ Environmental**
  - Most significant impact to realign stream and provide for perched stormwater measures
- **Stormwater**
  - Optimizes opportunities for treatment south of Rocky Branch, leverages the existing topography of the Grove to provide for regional wetland. Provides for terraced wetlands perched on higher topography of the Grove.
  - Provides minimal stormwater management treatment north side of Rocky Branch, primarily focused on dissipation pools to slow incoming runoff at outfall locations.
- **Circulation**
  - Maximizes pathways and variety of pathway experience
- **Engagement**
  - Maximizes engagement and access with the stream; fully integrates design with adjacent park program opportunities

STREAM REALIGNMENT | SCENARIO C

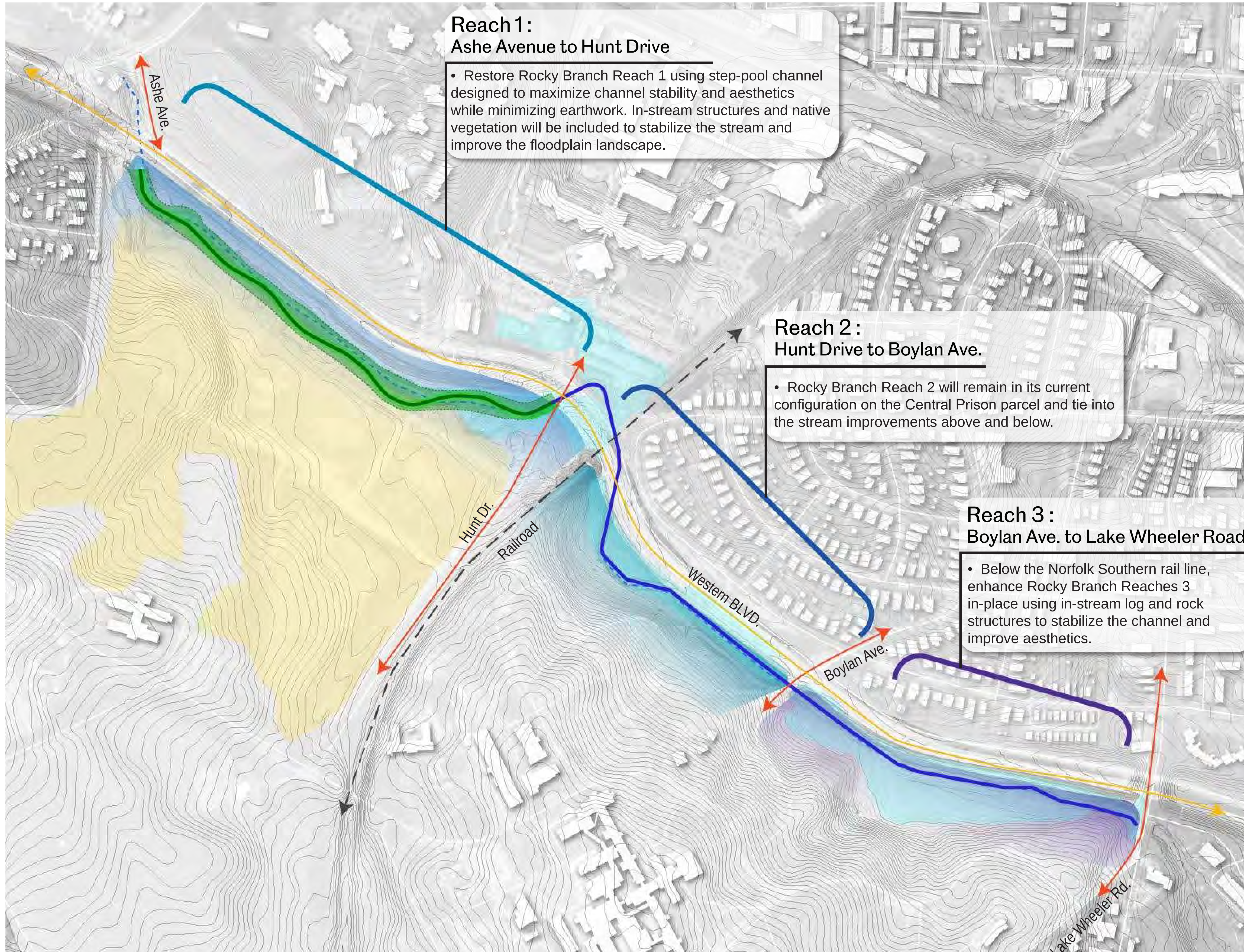
Addressing The Creek Goals in Scenario C

- Habitat Restoration
  - Enhanced channels will create riffle and woody debris habitats to support aquatic macroinvertebrates, an important component of the food chain in creek systems.
  - Aquatic passage will be improved at existing Ashe Avenue, Western Boulevard (upstream), and Western Boulevard (downstream) culverts by incorporating step-pool channel design to gently drop the stream bed grades from existing perched culverts

- Improvement of Ecological Function
  - Establishing a native riparian buffer along the stream.
  - Removal of non-native species will allow native vegetation to flourish on stream banks, in the restored floodplain, and in wetland systems.

- Showcase Piedmont Ecology
  - Floodplain wetlands will support native wetland tree and herbaceous species.

- Widen the Floodplain
  - Flood flows will dissipate energy and deposit fine sediment on the restored floodplain.
  - Flood waters will interact with floodplain vegetation and percolate into groundwater which will remove nutrients, sediment, and toxins from the creek system.
  - The narrower floodplain on Concept C vs Concepts A and B will limit these functional improvements.



DESIGN OVERVIEW
SCENARIO C- ALIGNMENT & DESIGN

SCENARIO C- ALIGNMENT & DESIGN

DESIGN OVERVIEW

Scenario C proposes a design for the Rocky Branch corridor that still meets the goals and objectives of the Dix Park Master Plan while proposing some reductions in order of magnitude that would reduce costs and potentially simplify construction.

- Scenario C largely intends to enhance Rocky Branch within its current alignment, yet provides a widened floodplain where it's most feasible.
- Reach 1 still includes the management of significant amounts of landfill material to provide a widened floodplain, but impact to the landfill is significantly reduced. As in Scenario B, Scenario C will retain the existing grade of the stream channel within Reach 1.
- Reach 2 of the Rocky Branch corridor is very similar to Scenario B. Scenario C retains the existing culverts at Western Boulevard and proposes minimal disturbance to existing forest cover east of the railroad. Scenario C stabilizes the stream bed and bank, enhancing the banks and habitats of this already relatively healthy portion of the stream.
- Reach 3 will maintain the existing stream alignment and floodplain, proposing enhancement to the stream banks. Scenario C still proposes a stormwater feature in Reach 3 within the wide floodplain, to become a gateway to the park.

Design integration of circulation, engagement opportunities and stormwater management is still achieved at a high level with the implementation of Scenario C, again just looking at opportunities to reduce order of magnitude at which these may be imagined. In general, Scenario C still looks to provide significant improvements to stormwater management. Opportunities for large, regional treatments still exists south of Rocky Branch, while in some locations the proposed stormwater management north of Rocky Branch is shown to be reduced in Scenario C. Similarly with pathways and program spaces, the concept is to provide slight reductions in the amount and scale of each from Scenario B while still maintaining the goals of campus and community connectivity.

SCENARIO C- ALIGNMENT & DESIGN

REACH 1

Reach 1 of the Rocky Branch corridor still remains the most complex section of the stream in Scenario C. In Scenario C, the realignment is significantly reduced to follow a course much more closely representing what is exists today. In this Scenario, the stream represents an enhancement rather than a full restoration within this reach length.

While this no longer represents a full restoration, the enhanced stream would see significant improvements to its floodplain conditions, therefore, still requiring substantial earthwork and environmental management within Reach 1.

Similar to Scenario B, this Scenario C utilizes more of the existing stream route to further simplify the design's complexity through several key considerations. While this option further reduces the disturbance area from Scenario B, it still represents a design of significant complexity.

- This options still presents significant impacts for environmental landfill design and soil management, although there would be reductions from Scenario B.
- Presents similar needs for environmental landfill gas and waste management, although there would be reductions from Scenario B.

The similar savings in infrastructure costs associated with the reduced bridge and culvert indicated in Scenario B, again do hold for this Scenario as well.

Summary of Key Factors

- **Stream**
  - Maintains existing alignment and elevation similar to existing conditions while still improving floodplain, significantly reduced from Scenario B
  - Represents a stream enhancement, not a restoration
  - Maintains Western Boulevard culverts, stream remains on Central Prison site and connects back on Dix Park east of Norfolk Southern Railway
- **Pedestrian Bridge**
  - Provides a pedestrian bridge; reduces impacts, permitting considerations, and costs
- **Earthwork/ Environmental**
  - Reduced landfill and environmental impacts from Scenario A and B
  - Landfill material completely excavated north of Limits of Full Landfill Excavation line below. This coincides with the floodplain bench. Material to be relocated within the existing landfill boundary
  - South of the Excavation Limit line, landfill material is reduced and relocated, then capped per regulations
- **Stormwater**
  - Opportunities for treatment south of Rocky Branch remain similar Scenario A and B
  - Reduces opportunities for treatment north of Rocky Branch
- **Circulation**
  - Reduces pathways and crossings from Scenario B
  - Hunt Drive bridge remains
- **Engagement**
  - Reduces magnitude of overlooks, engagement and program from Scenarios A and B

SCENARIO C- ALIGNMENT & DESIGN

REACH 2

Similar to Reach 2 of the Scenario B, this Scenario C design again proposes to utilize the existing system of culverts to cross onto Central Prison at the Hunt Drive intersection and will rejoin the Dix Park site east of the Norfolk Southern Railway where it does so today.

While this Scenario C still strives to achieve the same goals and objectives, it sees only minor reductions for most characteristics when compared to Scenario B. For the most part, Reach 2 remains relatively unchanged between Scenario B and C.

Summary of Key Factors

- **Stream**
  - Maintains existing stream alignment, unchanged from Scenario B
- **Earthwork/ Environmental**
  - Slightly reduces impact from Scenario B
- **Stormwater**
  - Unchanged from Scenario B
- **Circulation**
  - Provides pathways on the south side of the stream, further reduces number of pathways and variety of pathway types from Scenario B
- **Engagement**
  - Unchanged from Scenario B

SCENARIO C- ALIGNMENT & DESIGN

REACH 3

Reach 3 of the Rocky Branch corridor in Scenario C indicates a pretty significant change in realignment of the stream. This Scenario actually removes the realignment and implements an enhancement approach as opposed to a full restoration.

Scenario C still presents a wonderful opportunity for both stormwater management and creating a unique landscape that invites visitors to engage with the steam and stormwater wetlands.

Connectivity to adjacent park program is slightly reduced in Scenario C, but circulation still provides considerable connectivity both within the park and to the adjacent points of access.

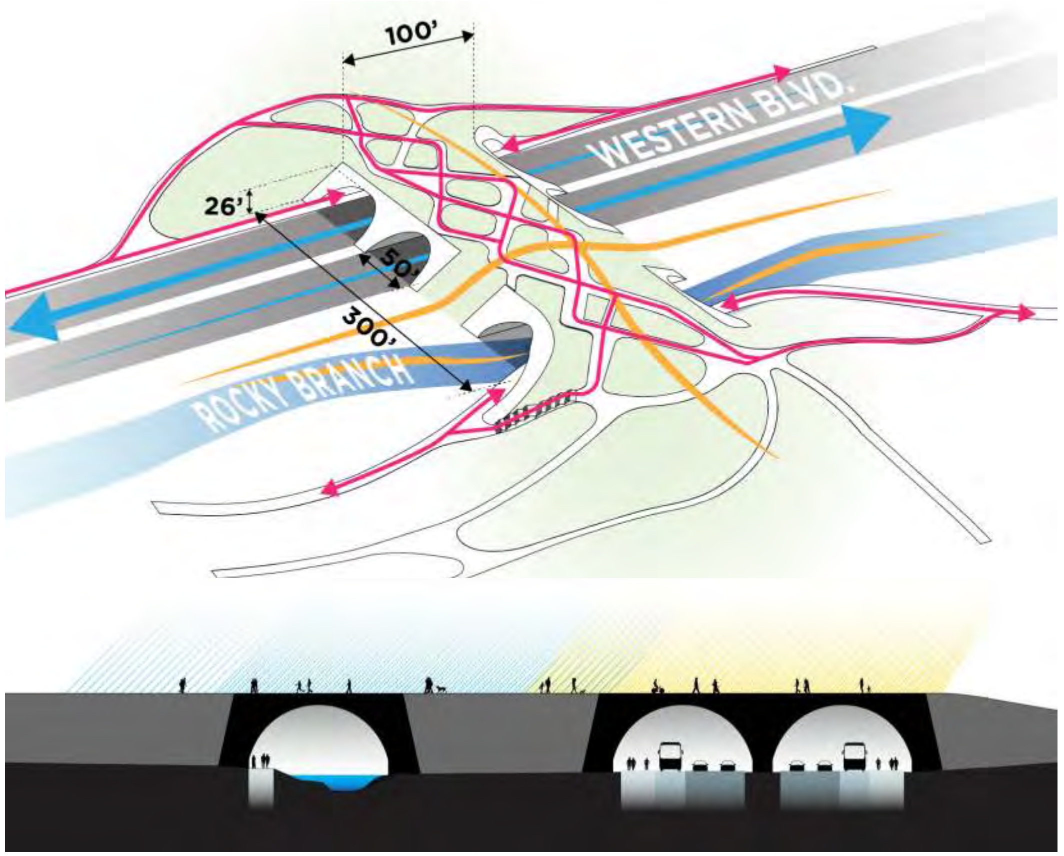
Summary of Key Factors:

- **Stream**
  - Maintains existing stream alignment, improves floodplain
  - Represents a stream enhancement, not a restoration
- **Earthwork/ Environmental**
  - Reduced impact from Scenario B
- **Stormwater**
  - Significant opportunity for treatment south of Rocky Branch still exists
  - Unchanged from Scenario B
- **Circulation**
  - Provides pathways on the south side of the stream, further reduces number of pathways and variety of pathway types from Scenario B
- **Engagement**
  - Slightly reduced from Scenario B as the stream and stormwater wetland are further separated, reduced scale engagement opportunities exist for both

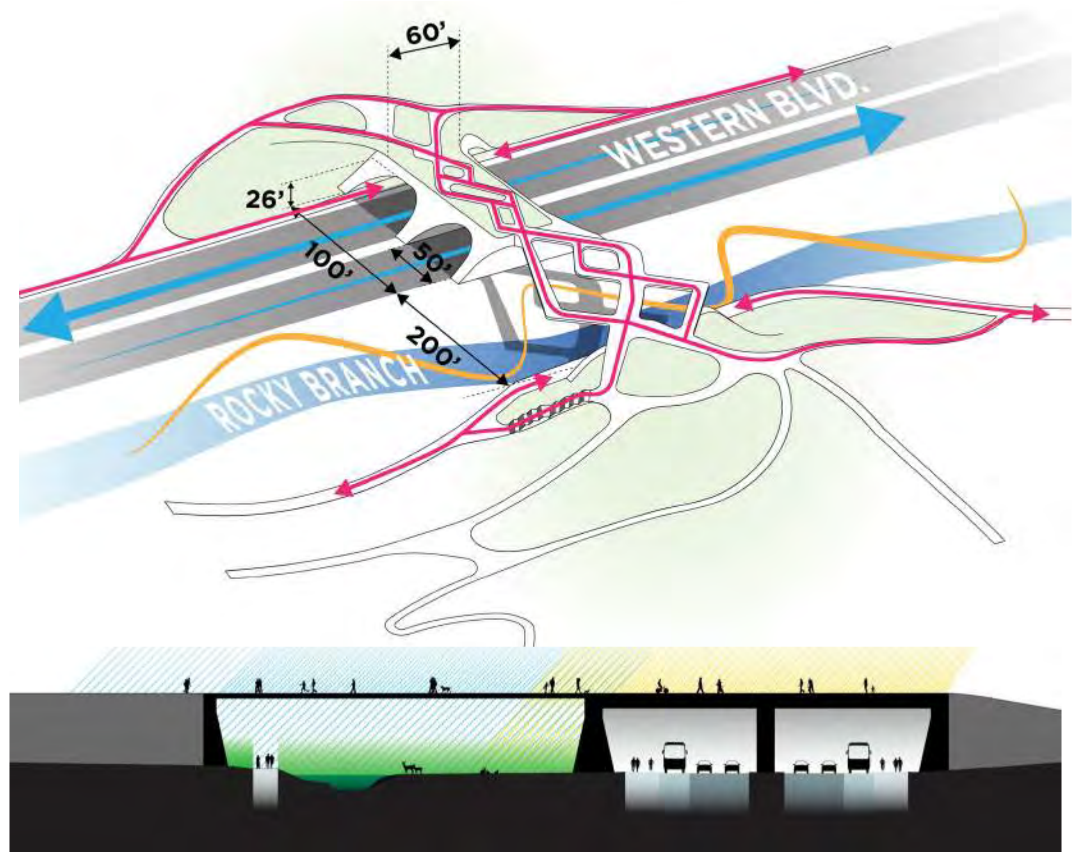
SCENARIO A B C , REACH 1

SIDE BY SIDE COMPARISONS

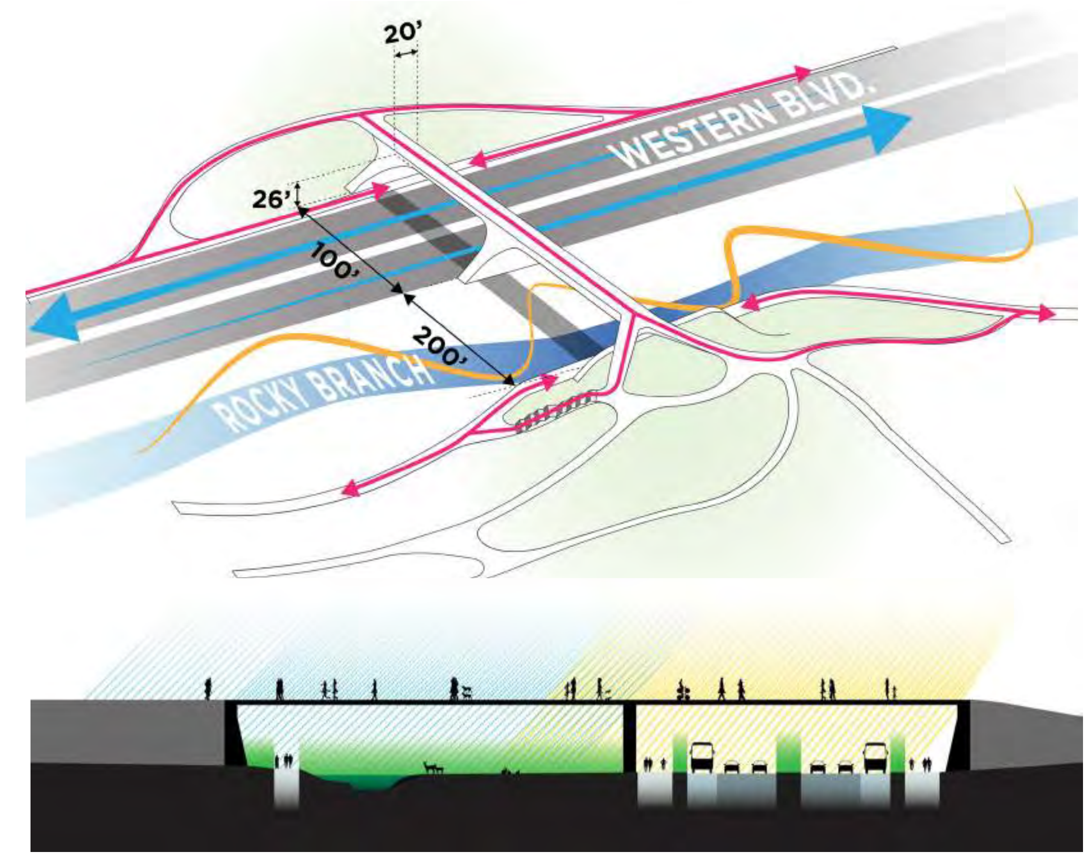
Scenario A



Scenario B



Scenario C



DESIGN DRIVERS

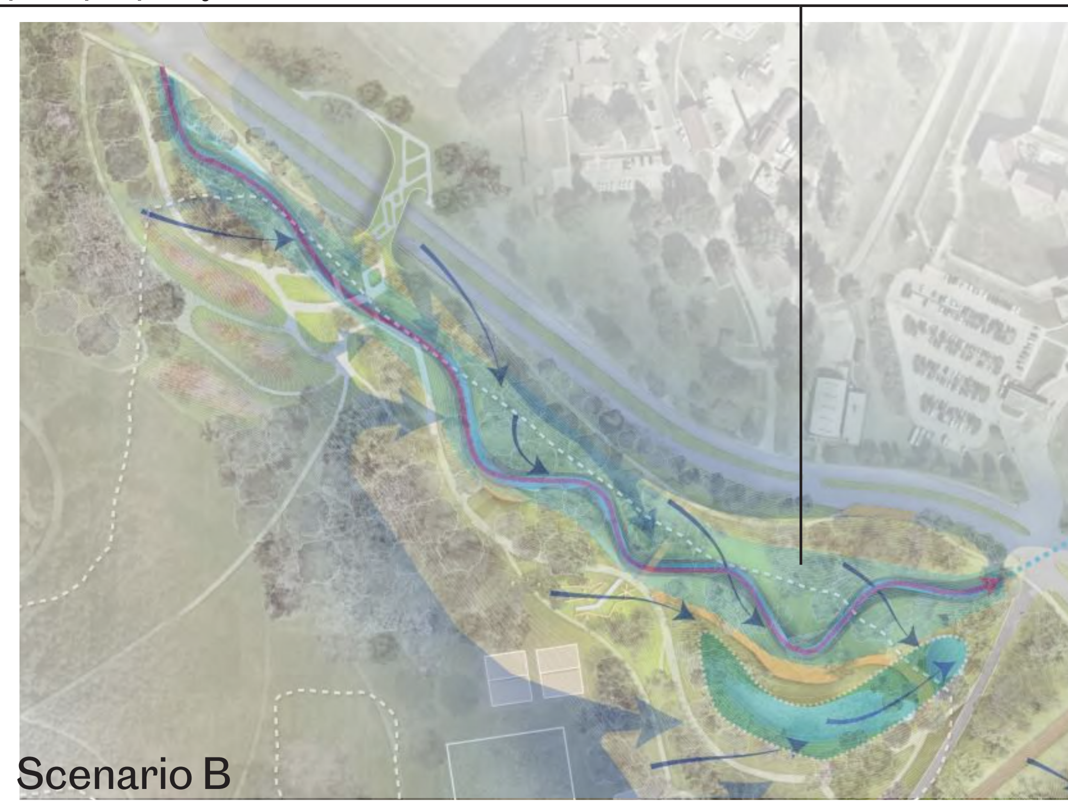
SCENARIO A B C, REACH 1

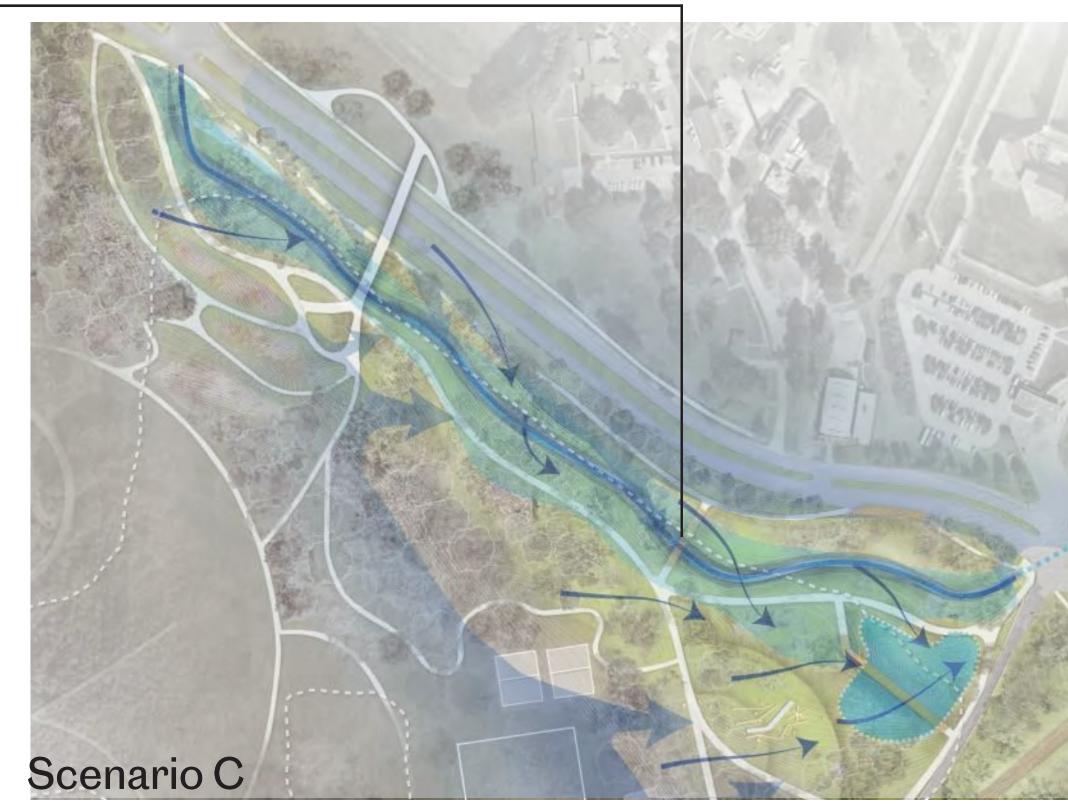
STREAM, STORMWATER, & HYDROLOGY

Proposed Wet Pond/ Wetland
Proposed Floodplain Bench
Proposed Stream
Stormwater Flow
Surface Flow
Stream Realignment & Restoration
Enhanced in Place

A - Realignment of Rocky Branch to remain on park property

C - Reduced extents of stream meanders





Stream Alignment
- Introduces meander in Reach 1, raises stream elevation in Reach 1 by 5', realigns stream to remain on Dix Park property,

Flood Plain Improvements
- Develops minimum flood plain bench width of 80',
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Provides combination of Regional stormwater measures north and south of Rocky Branch, as well as small scale control measures proximate to point sources,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

Stream Alignment
- Introduces meander in Reach 1 similar to Scenario A but maintains existing stream elevation,
- Does not realign stream at Hunt Drive, utilizes existing Western Boulevard culverts to maintain current alignment on Central Prison and around the Norfolk Southern Railway,

Flood Plain Improvements
- Develops minimum flood plain bench width of 80',
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Provides Regional stormwater measures south of Rocky Branch, as well as some small scale control measures proximate to point source,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project, particularly looking to utilize dissipation pools to slow runoff velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

Stream Alignment
- Slightly improves existing stream alignment, introduces minimal meander in Reach 1 but significantly reduced as compared to Scenarios A and B, maintains existing stream elevation,
- Does not realign stream at Hunt Drive, utilizes existing Western Boulevard culverts to maintain current alignment on Central Prison and around the Norfolk Southern Railway,

Flood Plain Improvements
- Develops minimum flood plain bench width of 80',
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Slightly reduces stormwater management potential from Scenario B, still provides regional stormwater measure south of Rocky Branch,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project, particularly looking to utilize dissipation pools to slow runoff velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

DESIGN DRIVERS

SCENARIO A B C, REACH 1

CIRCULATION & ENGAGEMENT

Legend

- Vehicular Connection
- Primary Pedestrian Connection [Multi-use Trail]
- Secondary Pedestrian Connection
- Boardwalk
- Greenway
- Railroad
- Parking
- Activated / Programmed Space
- Gathering Space

Scenario A

Scenario B

Scenario C

- Creates a hierarchal pathway system that provides maximum flexibility, redundancy, and is designed for longevity while simultaneously encouraging engagement with both the stream and stormwater management opportunities,
- Scenario A provides the greatest number of connections to adjacent programs, the greatest number of stream crossings and points of access to the stream. See above the multiple overlooks, platforms that provide access depending on the flow elevation, and paths that traverse closer to stream elevation,
- While all three scenarios design for a mile-long gateway between the park and City, Scenario A provides the largest areas and for greatest interaction between park users in these spaces as well as between park users and the stream and wetlands,
- Creates the most opportunities to experience spaces from a variety of different perspectives and vantage points, whether its overlooks from above, boardwalks that immerse you within the landscape, or gently sloping open glades that allow for ease of access to the streambank,
- Scenario A illustrates the full landbridge.

- The number of pathways is slightly reduced in Scenario B. The primary multi-use pathway still becomes significantly more integrated into Dix Park than exists today and provides full north/ south continuous connectivity within the greenway system,
- Pathways still amplify park edge as a gateway and provide much improved connectivity to neighborhoods, key intersections, and destinations along Western Boulevard. The size and number of key areas of interaction are reduced,
- While Scenario B does look to reduce the number of and size of some program spaces within the circulation network, the concept is still to deliver a rich experience that provides opportunities for visitors to immerse themselves within the landscape of Rocky Branch, having access to varied types of trail systems, overlooks and gathering spaces,
- As the stream maintains its existing course under Western Boulevard to Prison property, pedestrian circulation and the stream diverge as in existing conditions, reducing pedestrian proximity to stream from Scenario A,
- Scenario B illustrates a Green Bridge - a partial landbridge that crosses Western Boulevard then maintains a daylit stream as it transitions to a pedestrian bridge.

- While the same hierarchal pathway system is designed to provide flexibility, redundancy, durability, and connectivity to park program and the community, the number of pathways is further reduced from what was represented Scenario B. The primary multi-use pathway still becomes significantly more integrated into Dix Park than exists today and provides full north/ south continuous connectivity within the greenway system,
- Pathways still create campus gateways and provide much improved connectivity to neighborhoods, key intersections, and destinations along the park's edge. See above the reduced size of wetlands/stormwater areas and opportunities for interaction,
- Fewer direct opportunities to interact with the stream are provided,
- While Scenario C still provides opportunities for visitors to immerse themselves within the landscape of Rocky Branch, having access to varied types of trail systems, overlooks and gathering spaces - just a reduced amount depending on topography of the enhanced stream banks. Reach 1 allows for few direct stream access points because of the steep topography to avoid impact to the landfill,
- Pedestrian bridge is scaled back.

SCENARIO A B C , REACH 2

SIDE BY SIDE COMPARISONS

Key area of difference - realignment keeps Rocky Branch on Dix Park property

B & C - Rocky Branch remains on Central Prison property

Scenario A

Scenario B

Scenario C

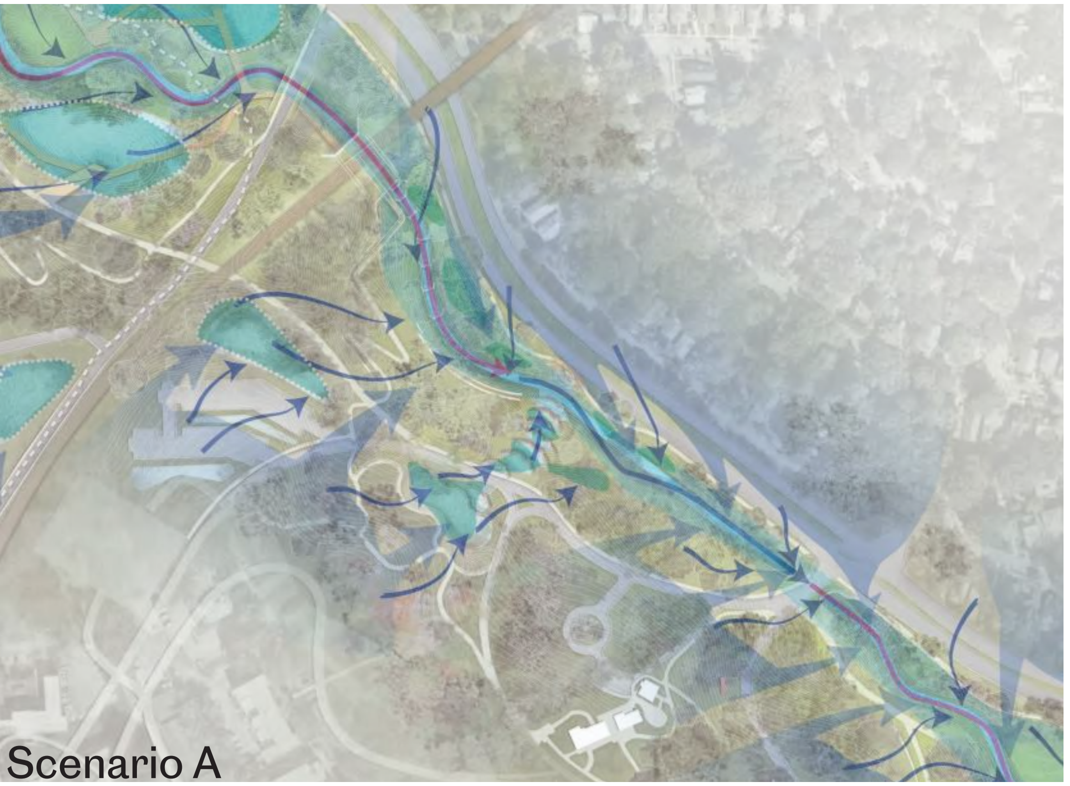
Designs enhance this already stable portion of the stream, using the existing topography to treat and dissipate stormwater as it approaches the channel.

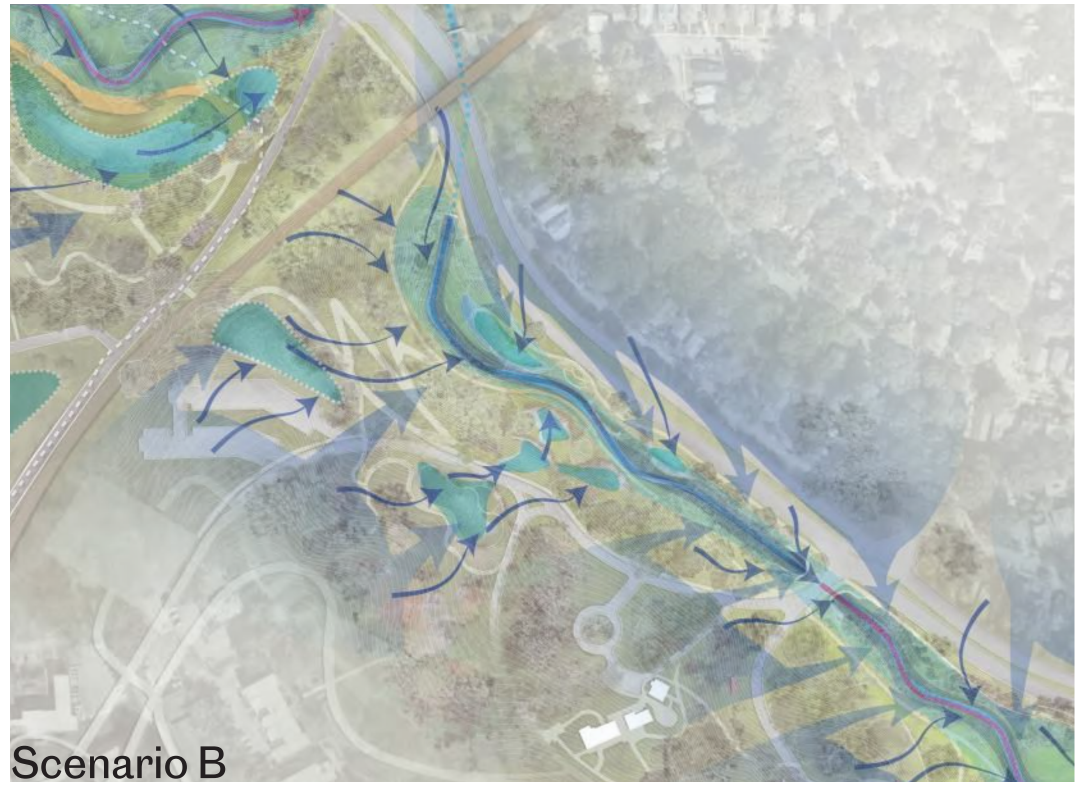
DESIGN DRIVERS

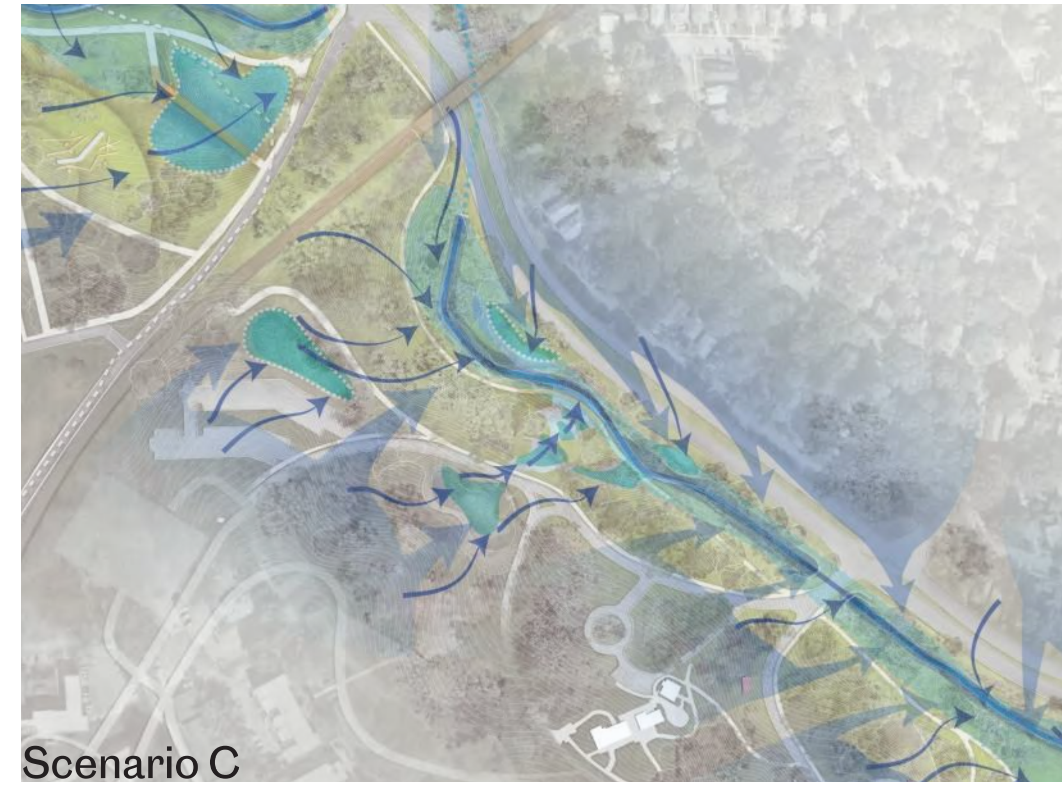
SCENARIO A B C, REACH 2

STREAM, STORMWATER, & HYDROLOGY

Stormwater Flow
Surface Flow
Stream Realignment & Restoration
Enhanced in Place
Proposed Wet Pond/ Wetland
Proposed Floodplain Bench
Proposed Stream







Stream Alignment
- Step pools to traverse grade in Reach 2, new culvert at railroad,

Flood Plain Improvements
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Provides combination of Regional stormwater measures south of Rocky Branch, as well as small scale control measures proximate to point sources north and south of Rocky Branch,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project,
- In Reach 2 and 3, presents opportunities for dissipation of offsite drainage flow velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

Stream Alignment
- Does not realign stream at Hunt Drive, utilizes existing Western Boulevard culverts to maintain current alignment on Central Prison and around the Norfolk Southern Railway,
- Reach 2 Alignment remains relatively unchanged from existing conditions,

Flood Plain Improvements
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Provides Regional stormwater measures south of Rocky Branch, as well as some small scale control measures proximate to point source,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project, particularly looking to utilize dissipation pools to slow runoff velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

Stream Alignment
- Does not realign stream at Hunt Drive, utilizes existing Western Boulevard culverts to maintain current alignment on Central Prison and around the Norfolk Southern Railway,
- Reach 2 Alignment remains relatively unchanged from Scenario B and existing conditions,

Flood Plain Improvements
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Slightly reduces stormwater management potential from Scenario B, still provides regional stormwater measure south of Rocky Branch,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project, particularly looking to utilize dissipation pools to slow runoff velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

Rocky Branch Enhancement Project
Feasibility Study

DESIGN DRIVERS

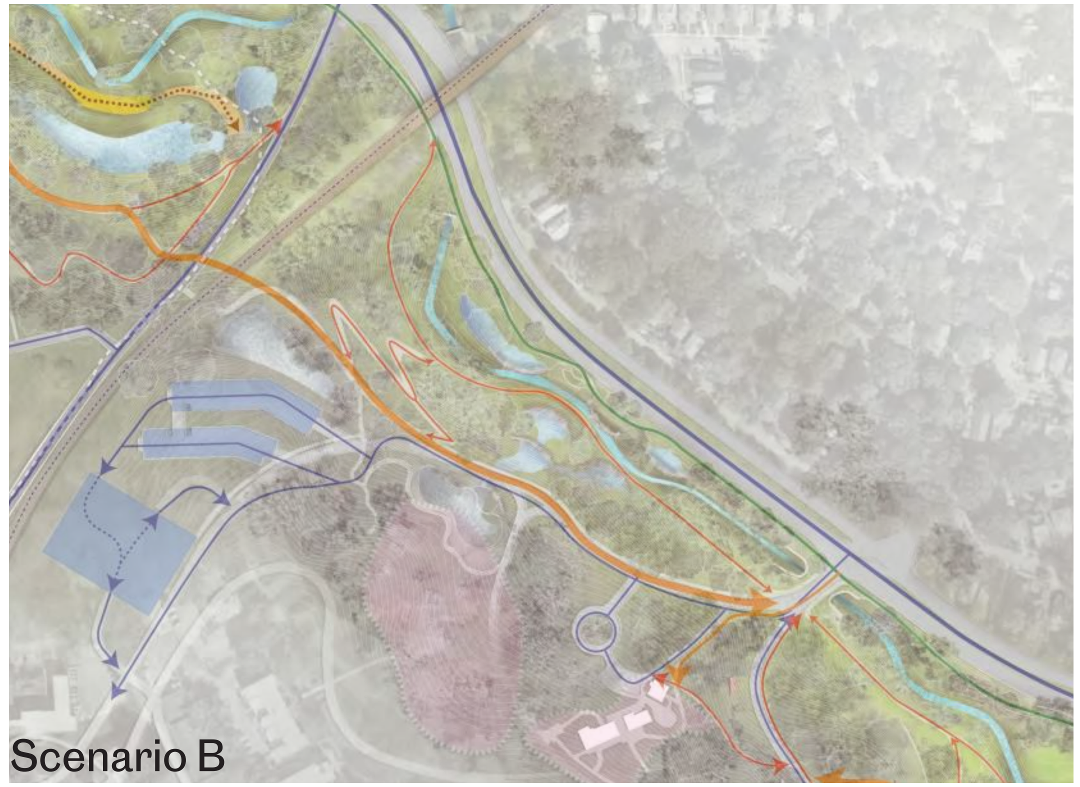
SCENARIO A B C, REACH 2

CIRCULATION & ENGAGEMENT

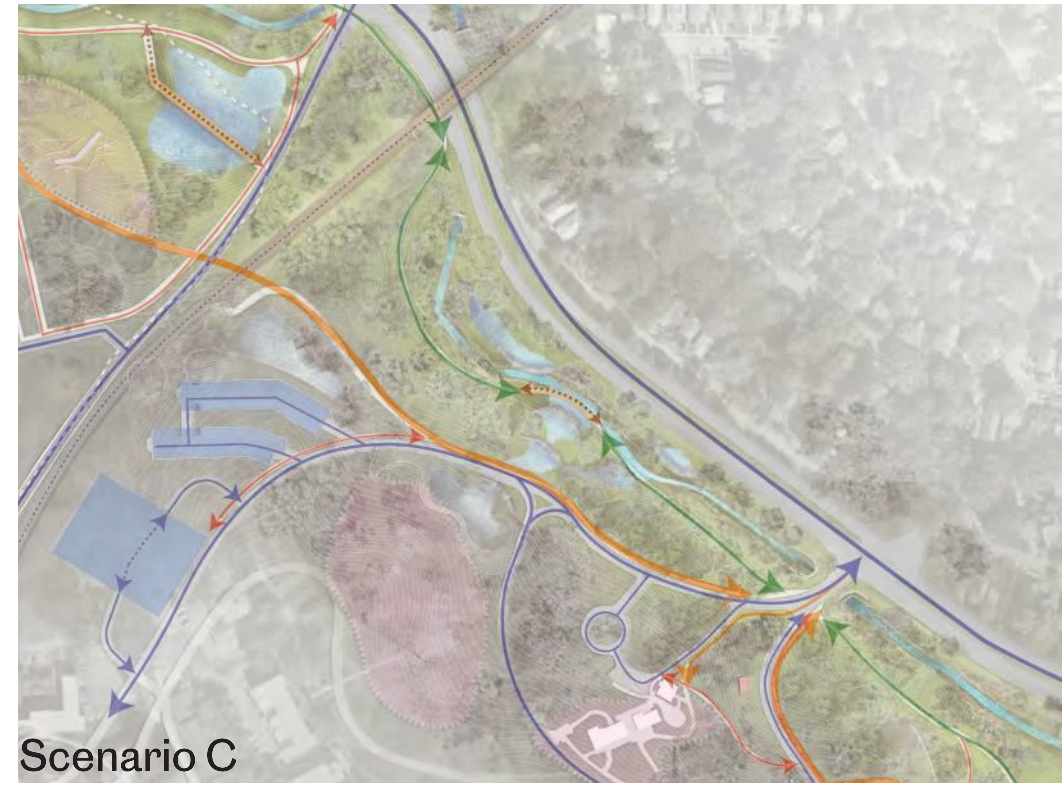
Legend

- Vehicular Connection
- Primary Pedestrian Connection [Multi-use Trail]
- Secondary Pedestrian Connection
- Boardwalk
- Greenway
- Railroad
- Parking
- Activated / Programmed Space
- Gathering Space

- The primary multi-use pathway maintains a higher elevation through Reach 2, lowering closer to stream and Western Boulevard elevations to meet the existing connections at Boylan Ave,
- Scenario A provides a pedestrian path that follows alongside Rocky Branch under the proposed Hunt Drive bridge and culvert through the railroad embankment as a secondary pathway system,
- Scenario A provides the greatest number of connections to adjacent programs with secondary paths, specifically the Master Plan-identified Botanical Gardens in Reach 2. Also includes a series of wooded meandering pathways east of the railroad embankment.



- Scenario B provides very similar primary circulation to Scenario A in Reach 2,
- The existing greenway, or a similar alignment, becomes a secondary path in Scenario B, with wooded connections up to the primary multi-use path through the largely preserved and improved wooded landscape east of the railroad embankment,
- The primary multi-use path and the existing paths intersect at the existing crossing of Boylan Ave.



- Scenario C provides very similar primary circulation to Scenario B in Reach 2,
- The existing greenway remains, with a slightly shifted alignment and fewer connections provided up to the primary multi-use path,
- Connections between pathways are reduced, joining only at the existing intersection at the crossing of Boylan Ave.

Rocky Branch Enhancement Project
Feasibility Study

SCENARIO A B C , REACH 3

SIDE BY SIDE COMPARISONS

A & B - Ideal stream meanders flow into existing and enhanced floodplain with off-line stormwater management feature

C - Bank stabilization and enhancement in place with off-line stormwater management feature

Scenario A

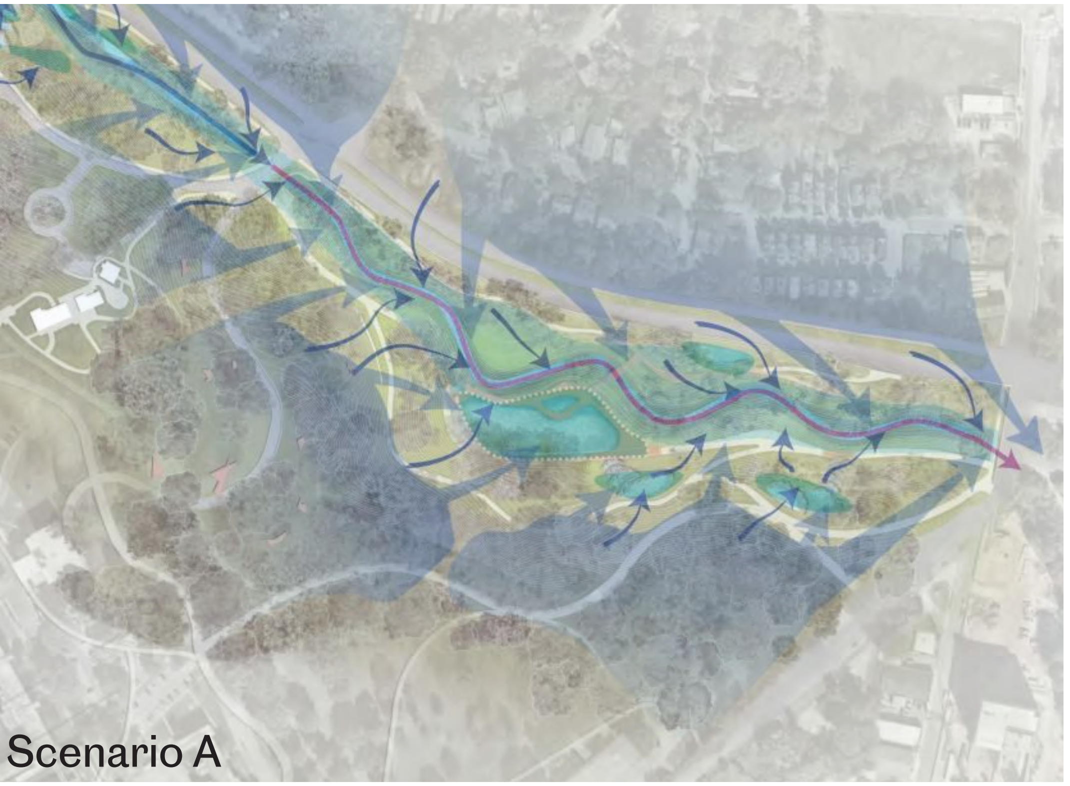
Scenario B

Scenario C

SCENARIO A B C, REACH 3

STREAM, STORMWATER, & HYDROLOGY

Proposed Wet Pond/ Wetland
Proposed Floodplain Bench
Proposed Stream
Stormwater Flow
Surface Flow
Stream Realignment & Restoration
Enhanced in Place

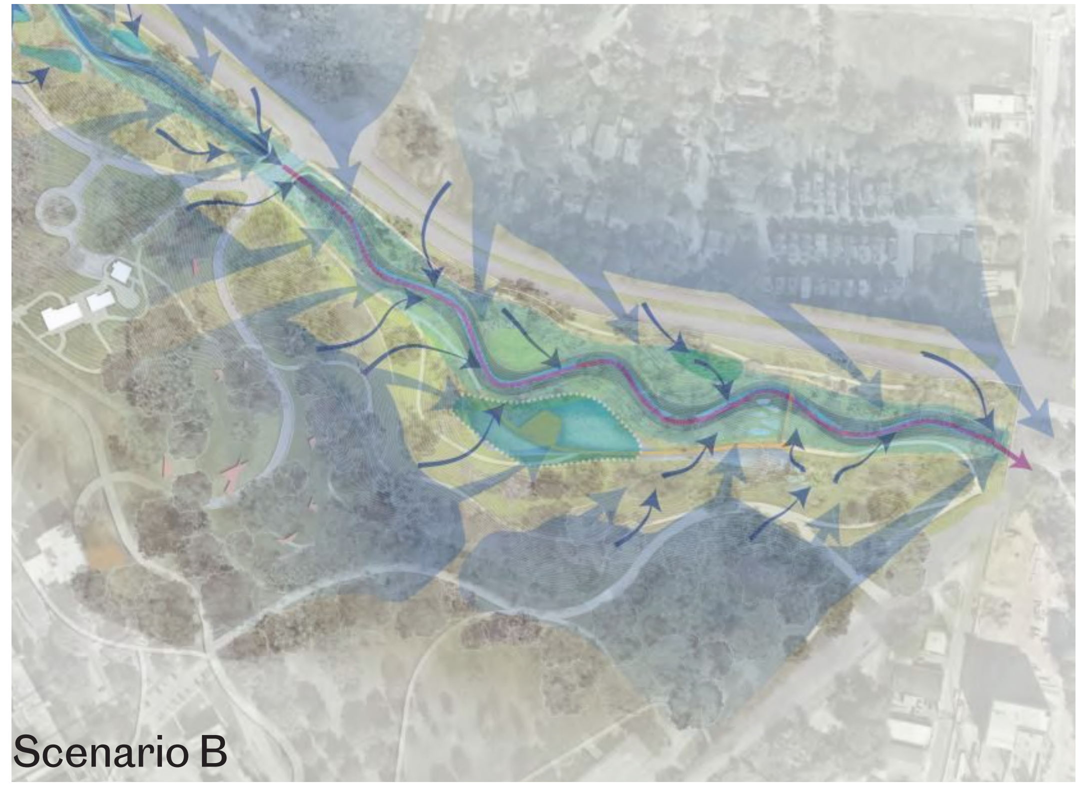


Scenario A

Stream Alignment
- Introduces meander in Reach 3, transforms existing floodplain into a diverse landscape balancing stream and stormwater management,

Flood Plain Improvements
- Develops minimum flood plain bench width of 80',
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Provides regional stormwater measure south of Rocky Branch, as well as small scale control measures north and south of Rocky Branch proximate to point sources,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project,
- In Reach 2 and 3, presents opportunities for dissipation of offsite drainage flow velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

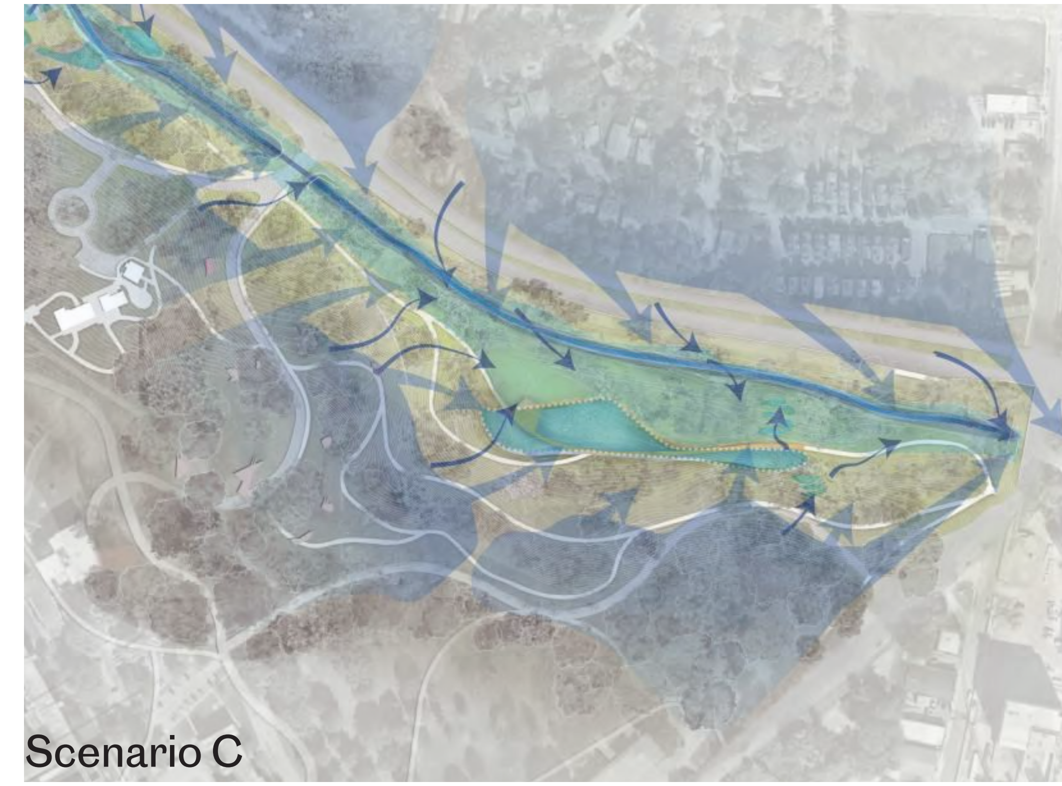


Scenario B

Stream Alignment
- Introduces meander in Reach 3, transforms existing floodplain into a diverse landscape balancing stream and stormwater management,

Flood Plain Improvements
- Develops minimum flood plain bench width of 80',
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Provides Regional stormwater measures south of Rocky Branch, as well as some small scale control measures proximate to point sources,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project, particularly looking to utilize dissipation pools to slow runoff velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.



Scenario C

Stream Alignment
- Maintains existing stream alignment, represents stream enhancement rather than full restoration. Still improves floodplain conditions and allows for implementation of regional stormwater measures, more or less unchanged from Scenario B,

Flood Plain Improvements
- Develops minimum flood plain bench width of 80',
- Provides increased flood plain widths in strategic locations where site conditions allow,

Stormwater Management
- Slightly reduces stormwater management potential from Scenario B, still provides regional stormwater measure south of Rocky Branch,
- Provides some treatment for Western Boulevard & future Bus Rapid Transit (BRT) project, particularly looking to utilize dissipation pools to slow runoff velocities at outfall locations,
- Creates opportunities for public access and engagement, and creates opportunities for outdoor learning laboratory,
- Stormwater is designed at elevations to minimize occurrences of flooding & reduce maintenance requirements.

Rocky Branch Enhancement Project
Feasibility Study

DESIGN DRIVERS
SCENARIO A B C, REACH 3
CIRCULATION & ENGAGEMENT

Legend

- Vehicular Connection
- Primary Pedestrian Connection [Multi-use Trail]
- Secondary Pedestrian Connection
- Boardwalk
- Greenway
- Railroad
- Parking
- Activated / Programmed Space
- Gathering Space


Scenario A

- Similarly to Reach 1 and 2, Scenario A provides the greatest number and extent of access points to Rocky Branch in Reach 3, as well as the greatest number of connections between the primary and secondary paths,
- Scenario A provides the most extensive wetland/stormwater management system as a gateway feature, with paths providing access throughout,
- Scenario A presents a greenway that maintains a similar location to existing, though reconstructed to allow for the stream and floodplain realignment to move further into park property. The greenway is therefore to the north of Rocky Branch. Multiple paths connect the park to Lake Wheeler Road.


Scenario B

- Scenario B provides very similar primary circulation to Scenario A in Reach 3,
- The number of connections between the primary and secondary paths is reduced in Scenario B,
- Scenario B still provides the extensive wetland/stormwater management system as a gateway feature, but with fewer paths providing access throughout,
- Scenario B presents a greenway that maintains a similar location to existing, though reconstructed to allow for the stream and floodplain realignment to move further into park property. The greenway is therefore to the north of Rocky Branch. Multiple paths connect the park to Lake Wheeler Road.


Scenario C

- Scenario C provides very similar primary circulation to Scenario B in Reach 3,
- The number of connections between the primary and secondary paths is reduced in Scenario C,
- Scenario C still provides the wetland/stormwater management system as a gateway feature, but with fewer paths providing access throughout,
- The existing greenway remains south of Rocky Branch that maintains its existing course, but is slightly realigned to move through the floodplain and wetland/stormwater system before connecting to Lake Wheeler Road.

4. LANDFILL & BROWNFIELD REUSE CONCEPT DEVELOPMENT

4. Landfill & Brownfield Reuse Concept Development

LANDFILL & BROWNFIELD REUSE CONCEPT DEVELOPMENT

Impact to Landfill:

Construction of Reach 1, as envisioned in the Master Plan, involves excavating into the landfill waste to restore Rocky Branch. Each of the three alignment concepts include the excavation of overlying existing landfill cover soils and waste to varying degrees and placement of the soils and waste within other portions of the landfill. This process will create three distinct zones within the landfill that will need to be managed during site design and construction in accordance with applicable NCDEQ regulations. The overall impact to landfill area is indicated for Scenario A in the below diagram.

1) Restored Stream Bed:
The overlying cover soils and landfill waste will need to be entirely removed to native soils and/or bedrock to create a new stream bed. Since residual soil and groundwater contamination will be present from the landfill waste that formerly overlaid this area, an engineered base for the stream bed will need to be designed to provide physical separation from the underlying contamination. There are a number of proven design options to consider for engineered barriers that will need to be evaluated as restoration concepts are advanced. Additional technologies to clean up contaminated soil and groundwater to reduce contaminant concentrations below the stream bed may also be considered in combination with phytoremediation which uses specific plant species to capture and metabolize contaminants.

2) Stream Bed Landfill Transition Area:
The newly constructed stream bed will transition into remaining landfill waste and will require the design and construction of engineering controls to prevent contaminants from migrating into the stream and to physically separate and stabilize the new toe slope of the landfill under normal stream flows and flood conditions. This may include the use of barrier/retaining walls, and landfill leachate, gas, and groundwater collection and treatment systems and/or other technologies.

3) Landfill Area:
NCDEQ allows the landfill waste to be reused on other portions of the landfill as removal of the waste for off-site disposal is often cost prohibitive and strains the availability of limited landfill space across the State. Prior to construction of the stream bed area, the remaining landfill will need to be prepared to receive excavated soil and landfill waste. Once the site is prepared, landfill waste excavated from the stream bed area will be placed and compacted. Engineered controls will need to be implemented to safely manage the landfill waste during construction. A landfill gas collection system consisting of a number of vertical collection wells tied together in a network of underground piping will need to be installed. Finally, an engineered soil cap ranging in thickness from 10 to 18-inches will need to be installed on top of the landfill waste to create a final landscaped surface. The cap will include the use of one or more geotextile fabric layers to provide additional stability for differential settlement and the selection of plant species that will help maintain the integrity of the soil cover system over time. The soils within the cover system will need to be tested to confirm contaminants are not present at unsafe levels. Available assessment data suggests that current cover soils will be available to construct the final soil cover system to avoid the costly import of soil. Landfill waste can only be reused on the landfill itself. Regulations require testing to confirm that the soil cover is safe for use for recreation by park visitors. Certain rules apply for the import and export of soils on and off the landfill property to other portions of the Dorothea Dix Park (Brownfield Property) or other adjacent properties that will require development of soil management plans for NCDEQ approval.

Impact to Brownfield Property:
NCDEQ will require assessment of Reach 1 portions of the restoration project to evaluate potential for impacted soil, sediment, soil gas, and groundwater from the adjacent landfill to have migrated onto this portion of the project. The assessment will be used to evaluate the potential need for additional stream bed, groundwater, soil/landfill gas, soil cover, and barrier systems similar to those described for the landfill for Reach 1. Different from the landfill, the NCDEQ BRS Program will require a 24-inch-thick soil cover system. This will likely not include the use of geotextile layers but, as with the landfill, will require testing to confirm that contaminants are not present in the 24-inch soil layer at unsafe levels. As with the landfill, certain regulatory rules will apply for preparation of soil management plans for import and export of soils and associated testing.

Future Maintenance Implications:
Construction of greenways, utilities, buildings, and other park improvements will need to address total and differential settlement. Because the landfill will continue to settle over time, additional costs will be incurred to maintain uniformity of land surfaces and slopes. Previously described engineered systems to manage contaminated media and stabilize slopes and stream beds will also require maintenance. NCDEQ will require the development of operations and maintenance plans and periodic reporting on the efficacy of the engineered systems and modifications and improvements, as needed.

Summary:
Large volumes of soil and landfill waste will need to be managed for the restoration project. Concept A includes the greatest quantities of soil and landfill waste and engineering controls to manage residual contamination that will drive costs considerations. Concepts B and C include a reduction of the quantity of soil and engineering control, which in turn reduce costs. For all restoration concepts, the same level of technical standards will apply to support the ultimate goal of providing a safe environment for park visitors and the surrounding community that is acceptable to NCDEQ. The type and quantity of engineering controls selected is uncertain at this time which provides variability for associated estimated costs at this time.

Moving forward, additional assessment of environmental media will need to be conducted to further advance the selection and feasibility evaluation of the previously described engineering controls for each restoration concept and to further refine cost estimates. Recognizing that a significant amount of assessment has been conducted to date, future additional assessment will be targeted in nature to advance the development of restoration design concepts through a feasibility evaluation design process. The engineering controls that will ultimately be evaluated and selected will have undergone a rigorous design and regulatory review process and will include well established proven methods that have been successfully used on other projects. The design process will require collaboration with other design team members, the Dix Park Conservancy, other stakeholders, and the City, and will be conducted in an iterative process to develop the design concept that best meets the Master Plan vision, needs of the community, and NCDEQ regulatory requirements. Pilot testing may be needed to evaluate and support final selection of engineering controls. Once a final concept has been selected, plans and designs will be prepared by the design team that will be reviewed and approved by NCDEQ and other regulatory agencies to support construction planning. As a result, as the design process progresses, associated estimated costs can be further refined.

LANDFILL & BROWNFIELD REUSE EARTHWORK ASSESSMENT

A critical factor in all three scenarios is the volume of earth movement, considered here as 'Cut' and 'Fill'. The numbers below represent the volume, in cubic yards, of earth that will be moved according to the scenarios presented in this feasibility study.

These calculations are an estimate based on assumptions the design team has made based on the data we have to date. Upon further investigation, testing, and design development, these volumes will likely adjust. The numbers below are approximate and inform a baseline understanding of the earthwork, the impact to the landfill, and the implications for cost for the three scenarios.

The following diagrams depict Cut (material to be moved) as red and Fill (Where material is to be placed) in green. The diagrams reflect these zones based on information to date and will evolve throughout design development.

Scenario A Cut/ Fill Assessment

Region	Cut	Fill	Net
Reach 1	330,000cy	155,000cy	174,000cy net cut
Reach 2	95,000cy	23,000cy	72,000cy net cut
Reach 3	79,000cy	56,000cy	23,000cy net cut
Landfill Limits	289,000cy	29,000cy	260,000cy net cut

*All volumes run using a cut factor of 1.0 and fill factor of 1.35 for best conservative estimate of earthwork balance during construction
*The margin of error for these earthwork numbers is potentially 20% or more. These numbers should not be used as basis for decision-making between three scenarios.

Scenario B Cut/ Fill Assessment

Region	Cut	Fill	Net
Reach 1	454,000cy	30,000cy	423,000cy net cut
Reach 2	108,000cy	41,000cy	67,000cy net cut
Reach 3	79,000cy	57,000cy	22,000cy net cut
Landfill Limits	422,000cy	2,000cy	420,000cy net cut

Scenario C - Cut/ Fill Assessment

Region	Cut	Fill	Net
Reach 1	423,000cy	26,000cy	397,000cy net cut
Reach 2	108,000cy	41,000cy	67,000cy net cut
Reach 3	79,000cy	57,000cy	22,000cy net cut
Landfill Limits	385,000cy	2,000cy	383,000cy net cut

5. WESTERN BOULEVARD PEDESTRIAN CROSSING

5. Western Boulevard Pedestrian Crossing

A. Bridge Design Scenario A Assessment - Land Bridge

B. Bridge Design Scenario B Assessment - Green Bridge

C. Bridge Design Scenario C Assessment - Pedestrian & Bicycle Bridge

WESTERN BOULEVARD PEDESTRIAN CROSSING
BRIDGE DESIGN SCENARIO A

Land Bridge Scenario A
The Land Bridge at Dorothea Dix Park is a major element of the Dorothea Dix Master Plan adopted by the Raleigh City Council 19 February 2019. The Land Bridge is will cross Western Boulevard and Rock Branch stream just south of Ashe Avenue. The Land Bridge will provide pedestrian and bicycle circulation at Rocky Branch Trail connecting Pullen Park and the broader city with Dix Park.

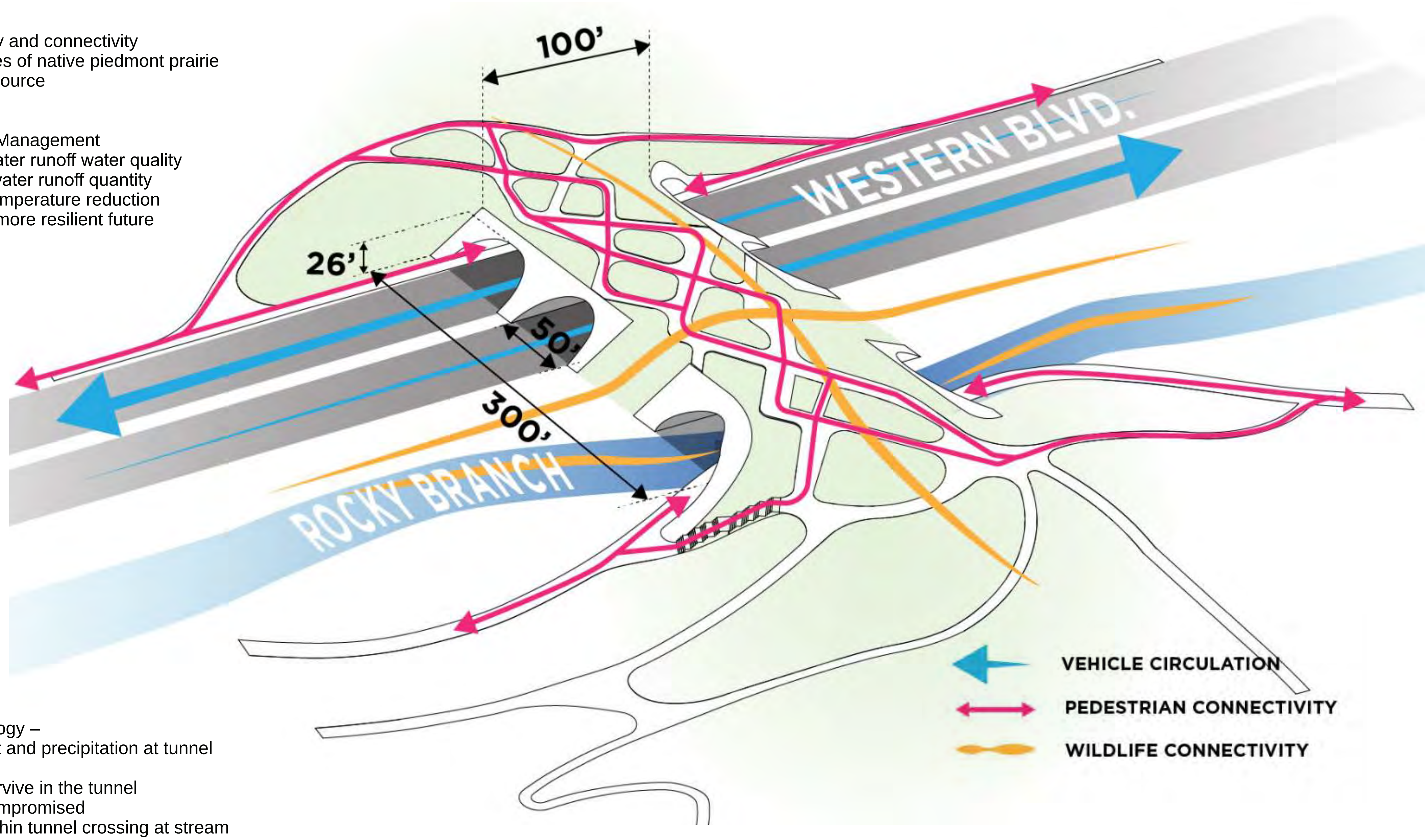
The Land Bridge requires coordination with several projects on the boards including Realignment of Ashe Avenue, Western Boulevard Bus Rapid Transit (BRT) and Pullen to Baine water line. The BRT project proposes two BRT lanes to be centered running down Western Boulevard, with a signalized intersection at the realigned portion of Ashe Avenue. The Land Bridge would touch down at the Governor Morehead Campus which will require further coordination.

A high level feasibility study was conducted by NCDOT in 2021 to look at potential options for a bridge crossing Western Boulevard from Governor Morehead School and Dix Park. NCDOT proposed a metal arch with 2 or 3 barrels to accommodate the proposed BRT guidelines. A more traditional concrete type Land Bridge with end bents, concrete girders and concrete deck. This bridge type could be adapted to align with the Dix Park Master Plan goals for a 'Land Bridge' type pedestrian bridge. The general vertical clearance over Western Boulevard for either structure type would be a minimum 17.5' over the travel lands to the low girder or structure.

The Land Bridge will be the primary pedestrian and bicycle connection on the north end of the park, enhancing safety by separating pedestrian and bicycle circulation from vehicle traffic. The tunnels will be for vehicle traffic only.

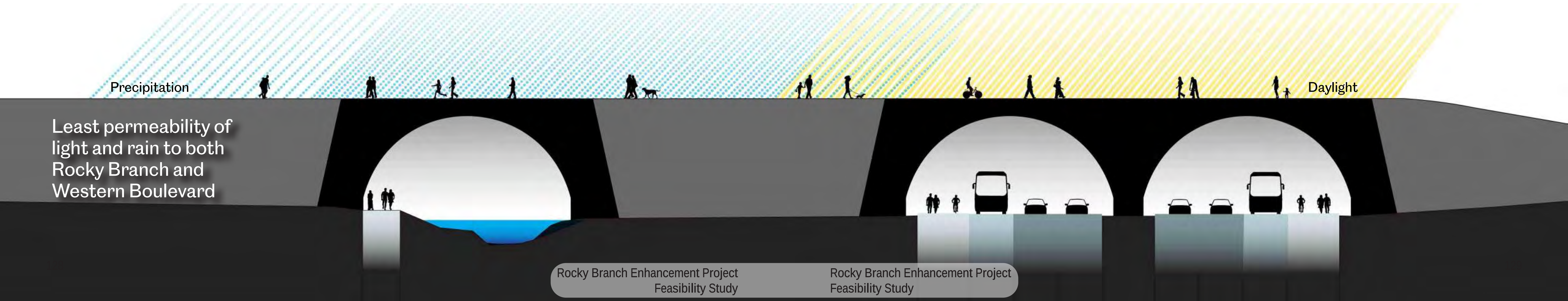
The Land Bridge will provide an opportunity to demonstrate the piedmont prairie providing habitat, source of food for pollinator species and a habitat corridor for migratory species. The Land Bridge will act as a 'green roof' for this section of Western Boulevard mitigating the effects of stormwater by capturing and cleaning runoff, decreasing the effects of urban heat island temperatures; becoming an icon for a greener and more resilient future.

Land Bridge Summary
- Provides greater safety and connectivity
- Creates nearly (3) acres of native piedmont prairie
  - Pollinators/food source
  - Habitat
  - Shelter
- Improves Stormwater Management
  - Increase stormwater runoff water quality
  - Decrease stormwater runoff quantity
- Urban Heat Island – temperature reduction
- Icon to a greener and more resilient future



Challenges
- Impact to Stream Ecology –
  - Reduced sunlight and precipitation at tunnel crossing
  - Plants will not survive in the tunnel
  - Fauna habitat compromised
- Safety and visibility within tunnel crossing at stream

Opinion of Probable Cost- $25,000,000.00



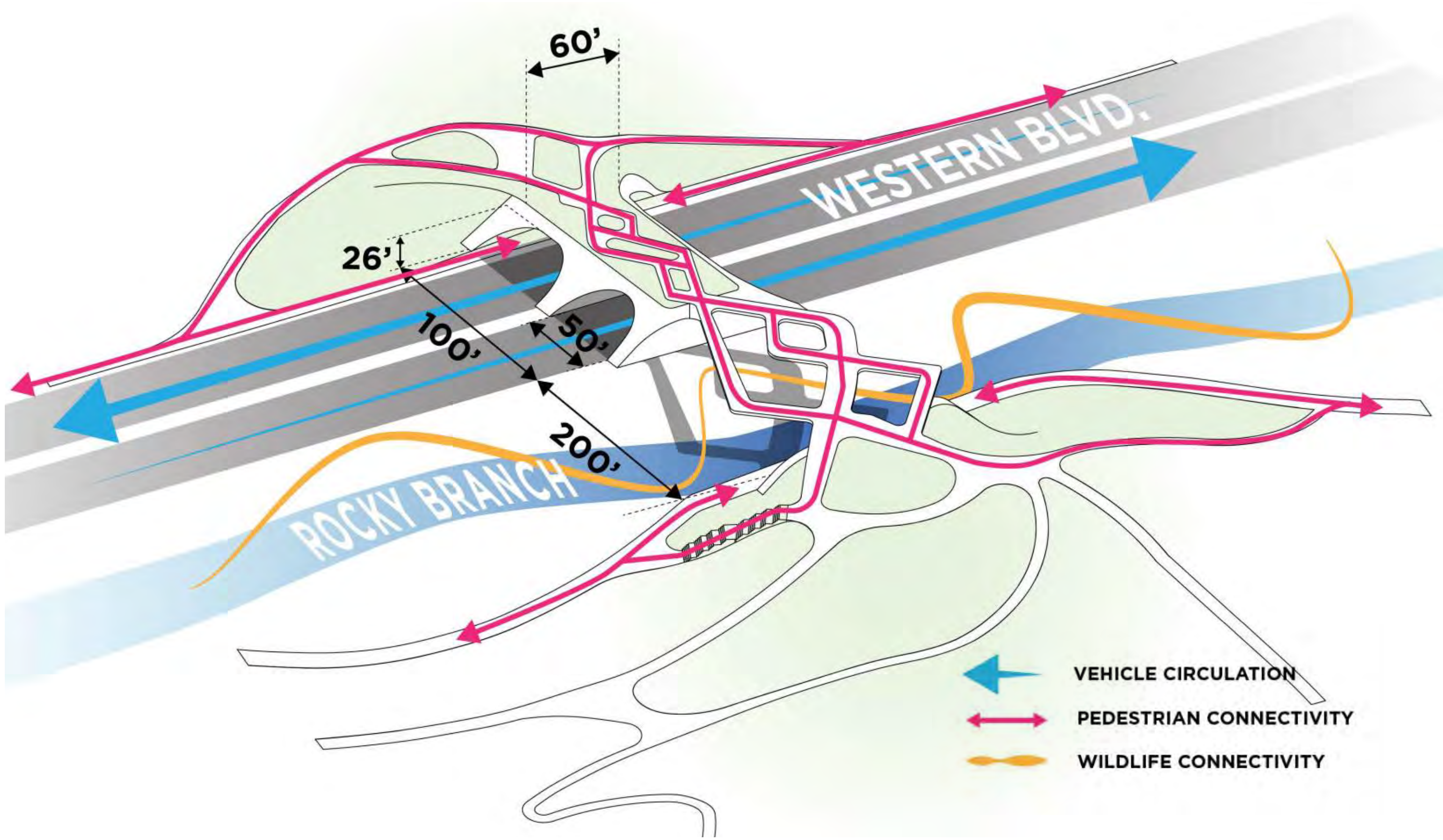
WESTERN BOULEVARD PEDESTRIAN CROSSING
BRIDGE DESIGN SCENARIO B

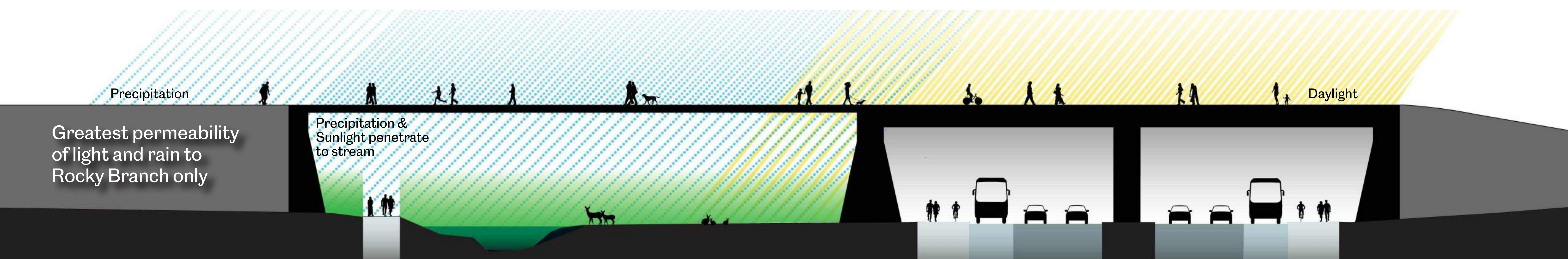
Green Bridge Scenario B
The Green Bridge will be the primary pedestrian and bicycle connection on the north end of the park, enhancing safety by separating pedestrian and bicycle circulation from vehicle traffic. The tunnels will be for vehicle traffic only.

The Green Bridge in Scenario B has many similar features to Scenario A but with one clear difference – the stream crossing will be open and not tunneled. The vehicle circulation will be in a tunnel with the Green Bridge similar to Option 1 but crossing the stream the vegetated portion of the Green Bridge stops, providing an open crossing for pedestrians and bicycles. The stream is open to sunlight, precipitation allowing for a more natural stream system for flora and fauna. This open structure will also create a safe environment for pedestrians accessing the stream beneath the Land Bridge crossing.

Green Bridge Summary
- Provides greater safety and connectivity
- Creates nearly (1.5) acres of native piedmont prairie
  - Pollinators/food source
  - Habitat
  - Shelter
- Improves Stormwater Management
  - Increase stormwater runoff water quality
  - Decrease stormwater runoff quantity
- Urban Heat Island - temperature reduction
- Icon to a greener and more resilient future
- Enhanced and restored stream ecosystem for flora and fauna.

Opinion of Probable Cost - $20,000,000.00





Rocky Branch Enhancement Project
Feasibility Study

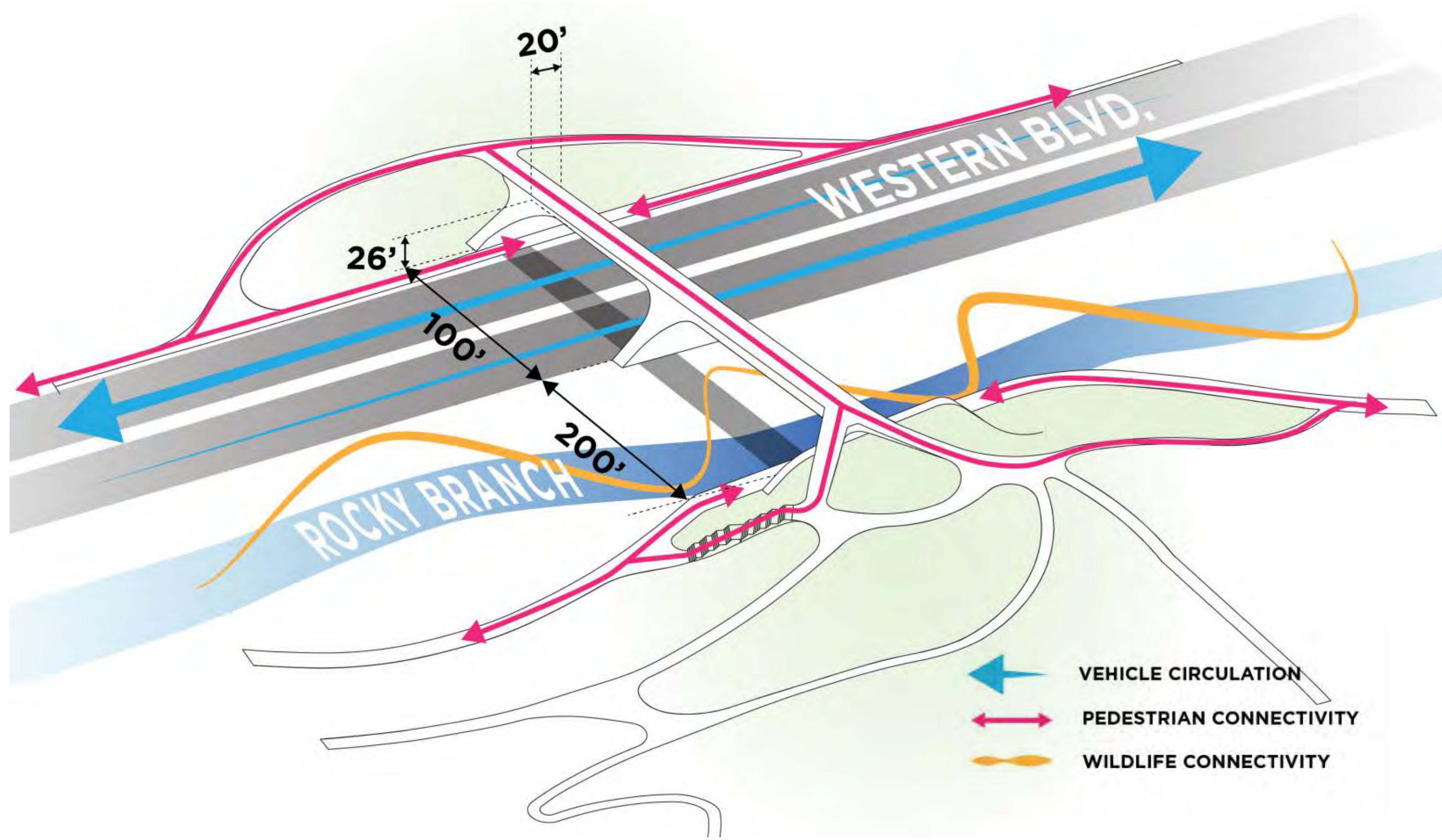
BRIDGE DESIGN SCENARIO C

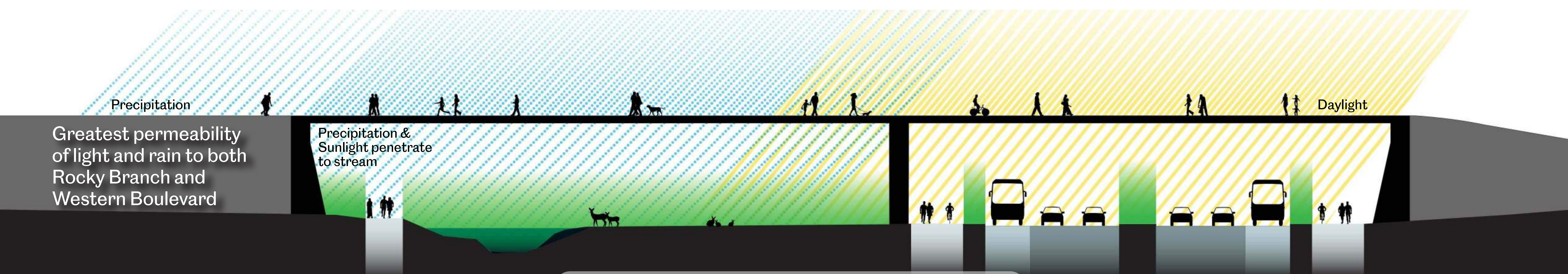
Pedestrian & Bicycle Bridge Scenario C
The Pedestrian and Bicycle Bridge will be the primary pedestrian and bicycle connection on the north end of the park, enhancing safety by separating pedestrian and bicycle circulation from vehicle traffic.

Scenario C is your traditional pedestrian and bicycle bridge. It provides for safe pedestrian crossing with no additional structure for plant material. Scenario C provides the optimum structure over Rocky Branch similar to Scenario B, with sunlight, precipitation and animal migration along the stream uninterrupted.

Pedestrian & Bicycle Bridge Summary
- Provides greater safety and connectivity
- Icon to a greener and more resilient future
- Enhanced and restored stream ecosystem for flora and fauna.

Opinion of Probable Cost - $15,000,000.00





6. Appendices

A. Project Schedule

B. Existing Conditions Report

C. The Creek - An Overview

D. Data Gap Analysis
  1. Information needed for next phase of Design

E. Dix Park Leadership Committee Engagement
  1. Feedback/Minutes

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G. Raleigh Department of Transportation/ RDOT Engagement
  1. Summary/ Feedback/ Minutes

H. City of Raleigh Stormwater Engagement
  1. Summary/ Feedback/ Minutes

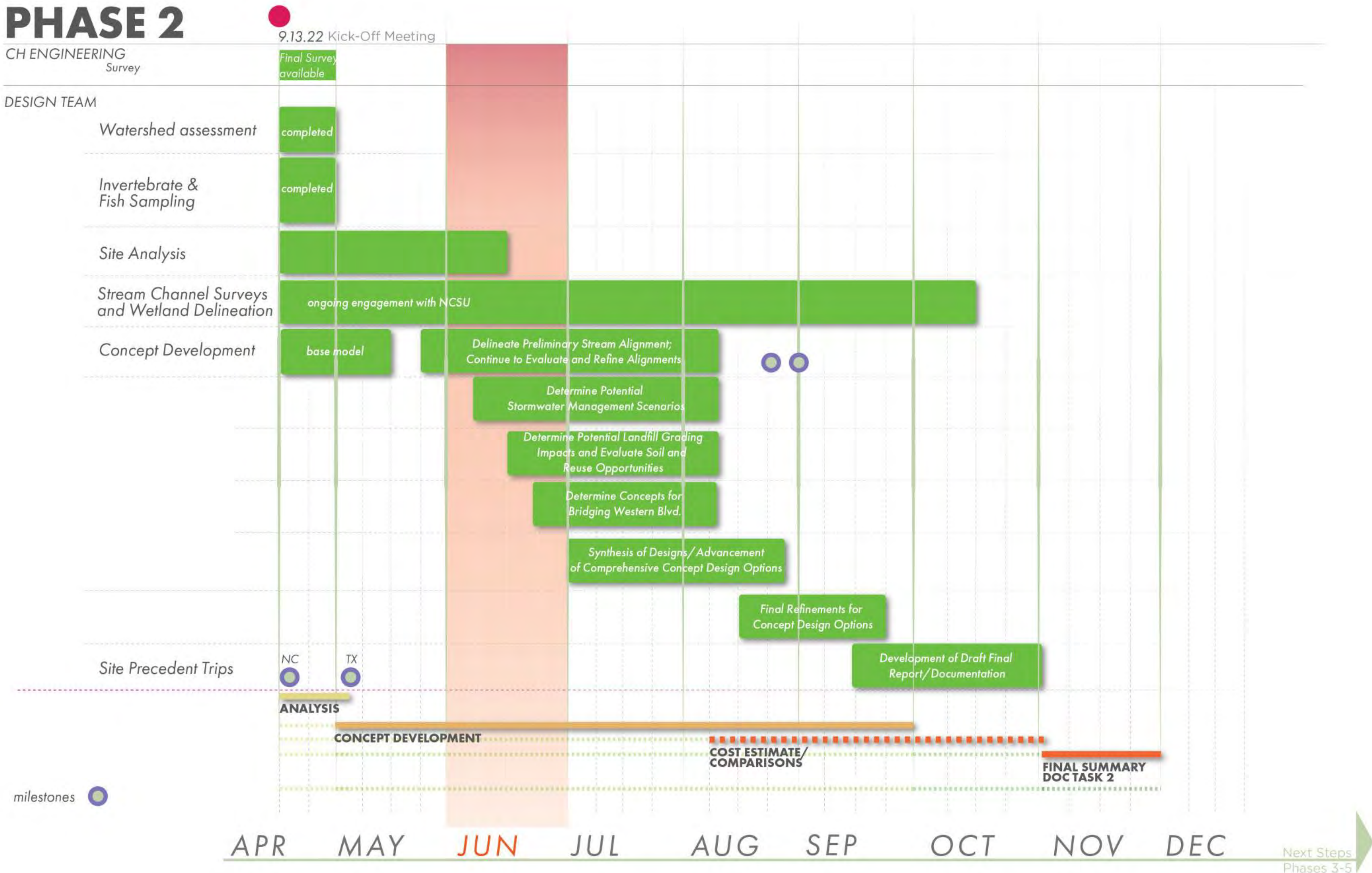
I. Reach Detailed Summaries

J. Precedent Trip Summary

K. Cost Opinion Summary

L. Environmental Site Assessment (ESA) 2023

PROJECT SCHEDULE



Rocky Branch Enhancement Project

TASK 2: ROCKY BRANCH EXISTING CONDITIONS AND DESIGN REPORT

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1.0 INTRODUCTION

Rocky Branch Reach 1 and Western Boulevard Culvert

In July 2015, the City of Raleigh purchased the Dorothea Dix campus from the State of North Carolina. The goal for the property is to create a great park in the heart of the City. Rocky Branch plays an important role in the future use of the park site and forms the northern edge of the Park. Over time, Rocky Branch has been transformed from a broad natural channel with gentle meanders to the state's most polluted urban stream in the 1970's (Dorothea Dix Park Master Plan, 2019). The stream valley has been filled and constrained by a municipal landfill, realignment of Western Boulevard, and expansion of stormwater and sewer systems.

The Surface678 team has been contracted to develop design concepts for the restoration of Rocky Branch. This report provides a summary of existing conditions assessments as well as an overview of the three design concepts for the restoration project along with the goals of each concept. The three concepts range from the most ambitious design (Concept A) which expands on the ideas laid out in the Master Plan to a more scaled back approach in Concept C. This report details site analysis goals, methodologies, and results. Chapter 6 will discuss the three design concepts and details of the Master Plan goals achieved in each design.

2.0 GEOMORPHIC CONDITION

2.1 Introduction

The following section describes the geology, soils, and geomorphic conditions along Rocky Branch within Dorothea Dix Park.

2.2 Geology

The project lies within the Raleigh Belt geologic formation of the Piedmont physiographic province. The Piedmont is characterized by gently rolling, well-rounded hills with long low ridges, with elevations ranging anywhere from 300 to 1500 feet above sea level. The Raleigh belt contains granite, gneiss and schist. In the 19th century, there were a number of small building stone quarries in this region, but today the main mineral product is crushed stone for construction and road aggregate. There are several instances of shallow, exposed bedrock throughout the Site, both in the channels and floodplain.

2.3 Soils

The National Resource Conservation Service (NRCS) provides official soils mapping for the entire United States. According to the NRCS Web Soil Survey, three map units exist along the Rocky Branch corridor within the project corridor. The soil units are listed in Table 1 below and shown on Figure 1.

Table 1. Soil Units

Soil Name	Description
Urban Land	Urban Land consists of impervious layers over human transported material.
Wake-Rolesville Complex	Wake-Rolesville Complex soils are excessively drained very rocky soils. They are typically located on side slopes or valley walls with slopes ranging from 15 to 25%. Their permeability is high.
Chewacla and Wehadkee	Chewacla and Wehadkee soils are somewhat poorly drained soils, found on slopes ranging from 0 to 2%. They are frequently flooded and typically located on floodplains. Permeability is moderately high to high. They consist of loamy alluvium derived from igneous and metamorphic rock.

Source: Soil Survey of Guilford and Rockingham Counties, North Carolina, USDA-NRCS, https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

2.4 Stream Geomorphic Conditions

Rocky Branch will be divided into three stream reaches to address the major stressors and opportunities for uplift in each area (Figure 2). These reaches from upstream to downstream are:

- Reach 1 – Ashe Avenue to Hunt Drive
- Reach 2 – Hunt Drive to Boylan Avenue
- Reach 3 – Boylan Avenue to South Saunders Street

2.4.1 Reach 1 – Ashe Avenue to Hunt Drive

Reach 1 begins at the perched culvert under Ashe Avenue. This culvert is a significant impediment to fish passage within Rocky River. Below the culvert the stream has been channelized around the back of the Pullen Mart convenience store. The channel is lined with rip rap and broken concrete from Ashe Avenue to the culvert under Western Boulevard. Slope is high between these culverts at 2.9% including a 3.1-foot drop from the Ashe Avenue culvert to the next riffle feature downstream of the plunge pool. The channel is highly incised with a bank height ratio (BHR) of 3.4 (Cross Section 1). Cross sections are shown on Figure 2 and in Appendix 1.

Between Western Boulevard and Hunt Drive, Rocky Branch has been channelized between the toe of the fill slope from Western Boulevard and a pre-regulatory unlined landfill. The channel is lined with rip rap and broken concrete slabs. Erosion is not evident due to the heavily armored slopes, however slopes covered with recently applied riprap are evidence of frequent and recent bank failure. The channel is extremely incised with a BHR ranging from 3.7 to 5.6 (Cross Sections 2 and 3). The streambed has more natural sediment than is seen upstream of Western, likely due to the lower slope allowing sediment to settle.

2.4.2 Reach 2 – Hunt Drive to Boylan Avenue

Rocky Branch Relocation in the 1990s

At the upstream end of this reach Rocky Branch flows into a culvert that routes it under the intersection of Hunt Drive with Western Boulevard and onto Central Prison campus, north of the Park property, where it flows through a concrete flume around a railroad bridge abutment. The channel then flows back onto Dorothea Dix campus from a culvert under Western Boulevard. Reach 2 is mostly stable despite being channelized between Western Boulevard to the north and a steep, rocky hill slope to the south. The channel is highly incised with a BHR ranging from 1.8 to 3.6 (Cross Sections 4 and 5). The channel contains a moderate amount of large woody debris and has better bedform diversity than Reach 1. Several areas of moderate instability were noted during the assessment.

2.4.3 Reach 3 – Boylan Avenue to South Saunders Street

Stable Conditions in Rocky Branch Reach 3

Reach 3 is the most stable and natural of the three reaches. Five cross sections were surveyed in Reach 3 to compare with regional curves (Appendix 1). The cross sections indicate that Reach 3 is stable with a bank height ratio of 1.0-1.2. The channel is lined with rip rap and concrete slabs similar to the other reaches. Because this reach has a low bank height ratio, it is able to flood into its floodplain more frequently than the other reaches trapping less energy in the channel and reducing high flow shear stresses. Bed form diversity is greater than the other reaches and the channel drops grade over several bedrock glides.

This reach was relocated between 1993 and 1998 when Western Boulevard was widened. A scientist at NCDOT used early concepts in stream restoration to size and stabilize the channel during this relocation (Barbara Doll, *personal communication*). Although the channel is hardened and lacks natural pattern and habitat variability, this work resulted in a much more stable channel than earlier relocation projects on Rocky Branch.

3.0 STREAM HYDRAULIC AND HYDROLOGIC ANALYSIS

3.1 Introduction

Wildlands conducted a hydraulic and hydrologic study on Rocky Branch using a combination desktop and field assessment methodologies. The purpose was to understand baseflow and flood condition flow regimes and use this as a basis for stream design.

3.2 Methodology and Results

Stream restoration reaches on the Site will be hydraulically connected to their existing floodplains to allow for energy dissipation and prevent erosion. To achieve this, a design discharge was selected that allows for frequent overbank events. The following desktop methods were used to develop design discharges for the restoration reaches:

- Published regional curve data from the North Carolina State University (NCSU) NC Rural Piedmont Regional Curve (Harman et al., 1999);
- Published regional curve data from the North Carolina State University (NCSU) NC Urban Piedmont Regional Curve (Doll et al., 2002);
- Unpublished data from the Natural Resources Conservation Service (NRCS) NC Rural Piedmont Regional Curve (Walker, unpublished);
- Regional flood frequency analysis performed by Wildlands using U.S. Geological Survey (USGS) gage sites;
- North Carolina urban flood frequency equations from U.S. Geological Survey (Robbins and Pope, 1996)
- Regional flood-frequency equations for ungaged urban and small, rural streams in Georgia, South Carolina, and North Carolina from U.S. Geological Survey (Feaster, Gotvald, and Weaver, 2014)
- PeakFQ and Partial Duration Analyses of USGS Rocky Branch gage in Pullen Park;
- Rocky Branch HEC-RAS nearest model XS 2-year discharge;

Discharge Measurements at ½ Bankfull

In addition to the desktop methods Wildlands conducted several assessment methods on Rocky Branch. First, Wildlands selected five cross sections to survey within Reach 3 on Dix Park campus. The cross section locations were selected based on the presence of reliable bankfull indicators such as the back of point bars, depositional bench features, and consistent scour lines. The surveyed cross sections ranged in area from 61 to 95 square feet. Discharge was calculated at each of the cross sections using Mannings Equation. The discharge estimates ranged from 283 to 467 cubic feet per second (CFS).

Wildlands installed a pressure transducer stream stage measurement device between Cross Sections 3 and 4. Staff developed a stage/discharge rating curve using USGS published methodology (Turnipseed et al., 2010). The methodology involves measuring discharge at the cross section using a flow velocity meter to take measurements across the channel while measuring stream stage. Staff obtained multiple discharge measurements at a range of flows from baseflow to approximately 1/2 bankfull. Flows over that level were too dangerous to sample due to depth and velocity of flow, debris flow, and channel size. A regression equation was developed correlating stage to discharge. This relationship was then used to convert the continuous stage measurements from the pressure transducer to discharge.

The USGS maintains a stream gage on Rocky Branch in Pullen Park. Wildlands obtained the gage notes, NAVD88 conversion, and full gage record from 1996 to June 2023 when the survey was conducted. Staff then conducted a survey of the gage to relate bankfull indicators to the stream stage. This allowed assessment of the recurrence interval of bankfull flows and determination of a bankfull discharge at the gage location. The bankfull discharge at the gage was determined to be 186 cubic feet per second (CFS). The Partial Duration Analysis indicates flows at or above this value occur, on average, 14 times per year. While this discharge is likely the flow that moves the most sediment over time and represents the bankfull discharge, using this for design would result in overbank events every month on average in the Park. This frequency was determined to be incompatible with a park setting and likely would result in excessive scour on the floodplain and difficulty in establishing vegetation. Analyzing the historic data at the USGS gage site at Pullen Park, we identified a discharge at the gage that, based on historical records, yielded approximately eight out-of-bank events each year.

Wildlands developed a regression equation relating discharge measurements at the USGS gage to discharge measurements at the gage installed in Reach 3 where the stage discharge curve was developed. We then used the regression analysis to determine the design discharges for each of the three design reaches of Rocky Branch on our site with the goal of yielding a similar frequency of out-of-bank events each year. Higher design discharges were selected because of the highly impervious, developed watersheds of the project streams and the desire to minimize out-of-bank events based on historic measurements on Rocky Branch recorded between 2005-2018. Results for the design discharge analysis are shown in Table 2 below. The selected design discharges for each reach are similar to the 5-year flood frequency discharges and published NC urban curve (Doll, et al, 2007) and the discharge predicted to flood out of bank approximately eight times per year from the Rocky Branch USGS gage survey.

Table 2. Design Discharge Analysis Results

		Rocky Branch - R1	Rocky Branch - R2	Rocky Branch - R3	Pullen Park - USGS gage
	DA (acres)	1045	1255	1497	749
	DA (sq. mi.)	1.63	1.96	2.34	1.17
	% Impervious	34.7	34.8	37.3	41.8
		Qbkf (cfs)	*Qbkf (cfs)*	*Qbkf (cfs)*	*Qbkf (cfs)*
Wildlands Regional Flood Frequency Analysis	**1-yr event**	38	44	51	29
	1.2-yr event	111	128	145	87
	1.5-yr event	157	179	204	124
	1.8-yr event	192	219	248	151
	2-yr event	209	238	270	165
	5-yr event	376	428	485	297
Manning's Equation at Surveyed Riffle XS from Mecklenburg Spreadsheets	**XS1**			418	
	XS2			467	
	XS3			397	
	XS4			283	
	XS5			354	
Piedmont Regional Curve	**low range**	45	51	59	35
	exact calc	127	145	164	100
	high range	358	408	462	282

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		Rocky Branch - R1	Rocky Branch - R2	Rocky Branch - R3	Pullen Park - USGS gage
	DA (acres)	1045	1255	1497	749
	DA (sq. mi.)	1.63	1.96	2.34	1.17
	% Impervious	34.7	34.8	37.3	41.8
		Qbkf (cfs)	*Qbkf (cfs)*	*Qbkf (cfs)*	*Qbkf (cfs)*
Alan Walker Curve	**exact calc**	82	95	109	63
Piedmont Urban Curve	**exact calc**	415	465	519	337
NC Urban Flood Frequency Analysis, 1996	**2-yr event**	544	625	746	484
Flood Frequency Analysis for Ungaged Urban and Small Rural Streams in GA, SC, and NC, 2014	**1.2-yr extrapolated**	585	665	665	607
	1.5-yr extrapolated	628	715	715	635
	2-yr event	668	763	933	655
Max Q - Determined from Manning's Equation at Surveyed TOB				456	
PeakFQ Analysis of USGS Gage in Pullen Park	**1-yr event**				406
	1.25-yr event				735
	1.5-yr event				871
	2-yr event				1054
Partial Duration Method, USGS Gage in Pullen Park	**1-yr event**				578
	1.2-yr event				622
	1.5-yr event				720
	1.8-yr event				745
	2-yr event				769
Pullen Gage - Onsite Gage regression equation	**Pullen gage Q @ 8 out-of-bank events per year (2005-2018)**	384	440	502	300
Rocky Branch - HEC-RAS model discharges, nearest XS	**2-yr event**	954	988	1166	863
Final Design Q		380	440	500	

8

4.0 SEDIMENT SAMPLING

4.1 Introduction

The Rocky Branch Enhancement Project required a sediment transport study in order to determine how much sediment is transported by the stream during high flow events. This data is then used to ensure that the design can efficiently transport the sediment load.

Sediment Collection Box Installation

4.2 Methodology

Two sediment collection boxes were constructed by NC State's department of Biological and Agricultural Engineering's research shop. These aluminum boxes measure 45" x 15" x 12" and are split into three compartments. Two of these boxes were constructed and installed in two sections of Rocky Branch, one downstream of the Western Boulevard culvert (Upstream) and one along the greenway in Reach 3 (Downstream). The locations are noted on Figure 2. The boxes were buried flush with the stream bed which allows any sediment transported during a storm even to fall into the box for collection.

The sediment was collected from the two boxes after seven large storm events. A sieve analysis was conducted on the initial collections to find the particle size distribution of the transported sediment. The particle size distribution was consistent in the initial collections therefore only total volume was collected for all other samples. Initially samples were being collected from both sites, but on 5/2/2023 the box located in Reach 3 was washed away and lost during a large storm event. This data was then compiled along with discharge data from the USGS gauge upstream.

Table 3. Rocky Branch Sediment Volume by Storm Event

Date Collected	Peak Flow (cfs)	Volume of Sediment (L) Upstream	Volume of Sediment (L) Downstream
3/22/2023	14	0.2	0.1
3/27/2023	62.8	0.5	0.35
4/9/2023	149	36.5	27.03
4/18/2023	186	10.8	11.8
4/27/2023	573	114.84	127.87
5/3/2023	174	132.73	-
5/22/2023	210	47.23	-
6/20/2023	63.8	28.1	-
6/21/2023	78.4	31.76	-
6/22/2023	330	132.73	-
6/23/2023	39.8	10.59	-
6/30/2023	107	55.38	-
7/7/2023	125	76.96	-
7/14/2023	202	132.73	-
7/21/2023	84.8	11.4	-
7/24/2023	87	8.96	-

Table 4. Sediment Distribution by Storm Event

Date	Location	Peak flow (cfs)	% Sand/Silt/Clay	% Gravel	% Cobble
3/22/2023	Upstream	14	60.1%	39.9%	0.0%
3/22/2023	Downstream	14	95.3%	4.7%	0.0%
3/27/2023	Upstream	62.8	73.4%	26.6%	0.0%
3/27/2023	Downstream	62.8	95.8%	4.2%	0.0%
4/9/2023	Upstream	149	26.0%	74.0%	0.0%
4/9/2023	Downstream	149	83.0%	17.0%	0.0%
4/18/2023	Upstream	186	36.7%	63.3%	0.0%
4/18/2023	Downstream	186	87.7%	12.3%	0.0%
4/27/2023	Upstream	573	62.3%	37.7%	0.0%
4/27/2023	Downstream	573	67.4%	32.6%	0.0%
5/22/2023	Downstream	174	35.9%	63.1%	1.0%
		Average:	**65.8%**	**34.1%**	**0.1%**

4.3 Analysis

The results of the analysis indicate that very little sediment moves through the system at baseflow. A minimum of 100 cfs flow is required to initiate movement of measurable sediment volume. The sediment collection boxes typically filled when flows exceeded 200 cfs. Above this flow, sediment movement likely increases relative to flow similar to the rate of increase below 200 cfs flow but is outside of our ability to measure with the current devices due to safety limitations in sampling. A peak flow of 174 cfs filled the boxes on 5/3/23 but this was likely due to three smaller rain events occurring in succession on a single day.

Sediment moving through Rocky Branch appears to be nearly 100% fine sediment and gravel. Some larger cobble is observed in the system and is likely moving at high events but was not captured during the study period. Future design considerations include ensuring the channel has adequate competence to move larger particle sizes and adequate capacity to move the volume of sediment being supplied to the system. This analysis indicates that channel competence will not be an issue because the current system is not moving much sediment larger than gravel for the range of flows captured during this study. A capacity analysis will be more important to ensure the proposed channels can move sediment volume. However, visual observations of the current channel, such as a lack of mid channel bars or excessive buildup of other bar features, indicates that capacity is unlikely to be a limiting factor in design considerations.

5.0 BIOLOGICAL SAMPLING

5.1 Introduction

Wildlands Engineering, Inc. conducted biological monitoring assessments within the proposed stream restoration reach along Rocky Branch. Baseline biological monitoring included fisheries and benthic assessments to document the existing biological communities. Wildlands also contracted with a subconsultant called Transystems to conduct freshwater mussel surveys. These results are documented in the report included in Appendix 2.

5.2 Methodologies

5.2.1 Fisheries

A fish community assessment was conducted in September 2022 within the downstream extent of the project site. The Standard Operating Procedures Stream Fish Community Assessment Program developed by the Environmental Sciences Section Biological Assessment Unit of the NCDENR – Division of Water Quality (NCDWR, 2013) was used for the sampling methodology and reporting of biological integrity. The North Carolina Index of Biological Integrity (NCIBI) methods incorporate information about species richness and composition, pollution indicator species, trophic composition, fish abundance, fish condition, and reproductive function by the cumulative assessment of 12 parameters or metrics. Each metric is designed to contribute unique information to the overall assessment. The values provided by the metrics are converted into scores on a 1, 3, and 5 scale. A score of 5 represents conditions commonly associated with undisturbed reference streams in the specific river basin or ecoregion. A score of 1 indicates that conditions deviate greatly from those typically observed in undisturbed streams of the region. The scores for all metrics are then summed to obtain the overall NCIBI score, which is an even number between 12 and 60. The score is then used to determine the biological integrity class of the stream (i.e., Poor, Fair, Good-Fair, Good, or Excellent). A fish community rated as Excellent, Good, or Good-Fair is considered to be Fully Supporting its Aquatic Life Use Support stream classification. Conversely, a fish community rating of Fair or Poor is considered as Not Supporting its Aquatic Life Use Support stream classification and that water quality standards are not being met (NCDWR, 2013).

5.2.2 Benthic Macroinvertebrates

The benthic macroinvertebrate communities were assessed following the Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates. Collections were made with the use of a riffle-kick, bank/root sweep, direct visual, leaf pack, and fine-mesh wash samples. The Qual-4 collection method was utilized on three sampling locations in November 2022 (Figure 2). The specimens were preserved in glass vials containing 95% ethyl alcohol and transported to a certified laboratory for identification purposes where the results were based on the Version 5 – February 2016 SOP (NCDEQ, 2016).

The organisms identified were reported with their tolerance values, along with a relative abundance of each taxon, which helped determine physical habitat and/or water quality problems. Species with a higher tolerance value are indicative or Fair to Poor water quality, whereas the EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera) have a low tolerance of water pollutions and are indicative of Excellent to Good water quality. Habitat evaluations were also completed for each location using the Biological Assessment Branch, NCDWR Habitat Assessment method for Mountain/Piedmont Streams (NCDWR 2013). The assessment provides a numerical score from 1-100 for each location based on the surrounding stream conditions (i.e., bank stability, vegetation) that assesses the quality and quantity of instream habitat and the riparian zone. The higher the score, the better the overall habitat. In addition to the above, the North Carolina Biotic Index was used to evaluate the streams health, with a higher value indicating stressors within a benthic community.

5.3 Results and Discussion

5.3.1 Fish Community Results and Discussion

Rocky Branch Fisheries Assessment

The Rocky Branch fish community assessment included one sampling point within Reach 3 of the project site. This particular reach appears to have been historically channelized and relocated to the edge of the valley. However, existing instream habitat is not severely degraded and included a combination of riffles and pools within the assessment reach. While the riparian zone is narrow, existing vegetation is providing sufficient shading over the majority of the reach. Twelve fish species were documented within the assessment reach (Table 4). While no sucker species or intolerant species were documented, all other NCIBI metric scores were moderate or high resulting in an overall Good rating (Table 5). Restoration efforts are expected to further improve habitat and water quality resulting in opportunities for potential uplift to the fish community.

Table 5. Baseline Fish Species

Scientific Name	Common Name	Trophic Status	Tolerance Rating	Diseased Fish	Multiple Age Groups	Total Number
Etheostoma nigrum	Johnny Darter	Insectivore	Intermediate	No	Yes	8
Lepomis auritus	Redbreast Sunfish	Insectivore	Tolerant	No	Yes	18
Lepomis macochirus	Bluegill Sunfish	Insectivore	Intermediate	No	Yes	55
Lepomis microlophus	Redear Sunfish	Insectivore	Intermediate	No	Yes	1
Micropterus salmoides	Largemouth Bass	Piscivore	Intermediate	No	Yes	5
Nocomis leptocephalus	Bluehead Chub	Omnivore	Intermediate	No	Yes	49
Notropis procne	Swallowtail Shiner	Insectivore	Intermediate	No	Yes	69
Luxilus albeolus	White Shiner	Insectivore	Intermediate	No	Yes	10
Hybognathus regius	Eastern Silvery Minnow	Herbivore	Intermediate	No	Yes	9
Ameiurus natalis	Yellow Bullhead	Omnivore	Tolerant	No	No	1
Ameiurus platycephalus	Flat Bullhead	Insectivore	Tolerant	No	No	1
Anguilla rostrata	American Eel	Piscivore	Intermediate	No	No	1

Table 6. NCIBI Metrics, Values, and Scores

Metric	Value	Score
No. of Species	12	3
No. of Fish	227	5
No. Darter Species	1	3
No. Sunfish Species	3	3
No. Sucker Species	0	1
No. Intolerant Species	0	1
Percentage Tolerant	8	5
Percentage Omnivore + Herbivore	26	5
Percentage Insectivores	71	5
Percentage Piscivores	3	5
Percentage Diseased Fish	0	5
Percentage Species Multiple Ages	98	5
NCIBI Score	**46**	
NCIBI Rating	**Good**	

5.3.2 Benthic Macroinvertebrates Results and Discussion

Sample #1 Looking Downstream

The Rocky Branch benthic macroinvertebrate assessment included three sampling points: one within the lower extent of the project sites (Sample #1), one across from the historic landfill, (Sample #2), and one upstream of the project site, (Sample #3). Sample locations #1 and #2 appear to have been historically channelized and relocated to the edge of the valley. However, existing instream habitat is not severely degraded and included a combination of riffles and pools within the assessment reach.

While the riparian zone is narrow, existing vegetation is providing sufficient shading over the majority of the reach. Sample location #3 was a part of the Rocky Branch Phase III stream restoration project conducted in the early 2000s by NC State. Sample #1 and #3 rated as "Fair" for NC Biotic Index and Sample #2 rated slightly better as "Good-Fair". While Sample #2 has a better NC Biotic Index value than the other two samples, it also had the lowest number of total individuals. The low diversity and abundance can correspond to lack of suitable habitat and/or poor water quality. All three sample sites rated as "Poor" for EPT Richness. Restoration efforts are expected to further improve habitat and water quality resulting in opportunities for potential uplift to the diversity and abundance of the benthic macroinvertebrate community.

Table 7. Benthic Macroinvertebrate Results

Sample Location	Total Individuals	Taxa Richness	NC Biotic Index	NC Biotic Index Rating	EPT Richness	EPT Richness Rating	Habitat Field Assessment Score
Sample #1	73	11	6.08	Fair	3	Poor	63
Sample #2	46	12	5.5	Good-Fair	4	Poor	69
Sample #3	61	11	5.92	Fair	6	Poor	58

6.0 CONCEPT DESIGN DISCUSSION

6.1 Master Plan Goals

The 2019 Dix Park Master Plan notes that "the intention of the City is to create a great park, a beloved public space, a common ground for all of Raleigh to enjoy, and a place that reflects the broadest desires and opportunities for the community." The Plan goes on to list the three primary goals of the park as: *Open Up and Connect*; *Build from What is There*; and *Offer Something for Everyone*.

All of the concept designs will follow these three guiding principles as described below:

- Open Up and Connect
  - Open up the historic floodplain
  - Connect stream systems to greenway trails and other park elements
- Build From What is There
  - Mimic existing boulder step pool systems identified within and downstream from the park
  - Use lessons learned from upstream restoration on NC State campus
- Offer Something for Everyone
  - Greenways will have views over the creek
  - Boulders will be used to create access to the creek directly
  - Floodplain wetlands and adjacent green stormwater infrastructure will treat stormwater and create unique environments

While these goals are important to the overall park development, the goals specific to restoring Rocky Branch are the primary focus of this report. The Master Plan notes four important project goals in slides titled, *The Six Landscapes*, *The Creek: Restore the Creek Corridor*, and *Experience the Water of Rocky Branch* (pages 70-73).

- Habitat Restoration
- Improvement of Ecological Function
- Showcase Piedmont Ecology
- Widened Creek Channel (later clarified as widening the floodplain)

Each discussion of the design concepts below will note how these four goals will be addressed.

6.2 Design Concept A

Design Concept A builds off the ideas laid out in pages 60, 61, 70-75, and 178-183 of the Master Plan. This is the most ambitious of the three concepts and seeks to restore Rocky Branch to something similar to its pre-disturbance conditions from Ashe Avenue to South Saunders Street. Key elements of the proposed design are bulleted below and illustrated on Figure 3A:

- Tie new stream bed elevation to the culvert elevation under Ashe Avenue to remove the significant fish passage barrier created by the perched culvert.
- Reconstruct the culvert under Western boulevard to raise the invert elevation and create a stream corridor that can accommodate fish passage.
- Remove pre-regulatory landfill material to restore the Rocky Branch floodplain from Western Boulevard to Hunt Drive.
- Restore Rocky Branch Reach 1 using a combination of step-pool and meandering stream channel design by raising the stream bed, widening the floodplain and incorporating native floodplain vegetation. This portion of Rocky Branch will meander into the Dix Park parcel and away from Western Boulevard utilizing a larger, open floodplain concept.

- Rocky Branch Reach 2 will be relocated from the Central Prison parcel north of Western Boulevard back onto the Dix Park parcel and through a new bridge under Hunt Drive and a new culvert under the existing Norfolk Southern rail line embankment, through coordination with Norfolk Southern.
- Enhance Rocky Branch Reach 2 in-place using in-stream log and rock structures to stabilize the channel and improve aesthetics.
- Restore Rocky Branch Reach 3 by raising the stream bed and meandering the stream channel south of the existing stream location further onto the Dix Park parcel and away from Western Boulevard.

Design Concept A will address the four Creek specific goals from the Master Plan as noted below:

- Habitat Restoration
  - Restored channels will create riffle and woody debris habitats to support aquatic macroinvertebrates, an important component of the food chain in creek systems.
  - Aquatic passage barriers will be removed by tying stream bed elevations to culvert invert elevations at Ashe Avenue and replacing 3 existing culverts at Western Boulevard (upstream), Hunt Drive, and Western Boulevard (downstream) to appropriate invert elevations to maximize fish passage through Rocky Branch.
  - Varying channel depths will create necessary habitat for fish populations throughout the year.
  - Rocky Branch will be removed from the concrete channel on Central Prison campus and restored to a natural stream system on Dix Park property.
- Improvement of Ecological Function
  - Establishing a native riparian buffer along the stream will improve nutrient uptake from surface flow.
  - Removal of non-native species will allow native vegetation to flourish on stream banks, in the restored floodplain, and in wetland systems.
- Showcase Piedmont Ecology
  - Stream restoration will showcase the ecology of the Piedmont, Fall Line, and Inner Coastal Plain through creation of meandering and step/pool channels.
  - Floodplain wetlands will be created with native wetland tree and herbaceous species.
- Widened Creek Channel (later clarified as widening the floodplain)
  - Flood flows will dissipate energy and deposit fine sediment on the restored floodplain.
  - Flood waters will interact with floodplain vegetation and percolate into groundwater which will remove nutrients, sediment, and toxins from the creek system.

6.3 Design Concept B

Design Concept B will maintain many of the design components included in Design Concept 1 but with less infrastructure coordination hurdles and will be more cost-effective. Key elements of the proposed design are bulleted below and illustrated on Figure 3B:

- Remove pre-regulatory landfill material to restore the Rocky Branch floodplain from Western Boulevard to Hunt Drive.
- Restore Rocky Branch Reach 1 using a combination of step-pool and meandering stream channel design by raising the stream bed, widening the floodplain and incorporating native floodplain vegetation. This portion of Rocky Branch will meander into the Dix Park parcel and away from Western Boulevard utilizing a larger, open floodplain concept.
- Rocky Branch Reach 2 will remain in its current configuration on the Central Prison parcel and tie into the stream improvements above and below.
- Below the Norfolk Southern rail line, enhance Rocky Branch Reach 2 in-place using in-stream log and rock structures to stabilize the channel and improve aesthetics.

- Restore Rocky Branch Reach 3 by raising the stream bed and meandering the stream channel south of the existing stream location further onto the Dix Park parcel and away from Western Boulevard.

Design Concept B will address the four Creek specific goals from the Master Plan as noted below:

- Habitat Restoration
  - Restored channels will create riffle and woody debris habitats to support aquatic macroinvertebrates, an important component of the food chain in creek systems.
  - Aquatic passage will be improved at existing Ashe Avenue, Western Boulevard (upstream), and Western Boulevard (downstream) culverts by incorporating step-pool channel design to gently drop the stream bed grades from existing perched culverts.
  - Varying channel depths will create necessary habitat for fish populations throughout the year.
- Improvement of Ecological Function
  - Establishing a native riparian buffer along the stream will improve nutrient uptake from surface flow.
  - Removal of non-native species will allow native vegetation to flourish on stream banks, in the restored floodplain, and in wetland systems.
- Showcase Piedmont Ecology
  - Stream restoration will showcase the ecology of the Piedmont, Fall Line, and Inner Coastal Plain through creation of meandering and step/pool channels.
  - Floodplain wetlands will be created with native wetland tree and herbaceous species.
- Widened Creek Channel (later clarified as widening the floodplain).
  - Flood flows will dissipate energy and deposit fine sediment on the restored floodplain.
  - Flood waters will interact with floodplain vegetation and percolate into groundwater which will remove nutrients, sediment, and toxins from the creek system.
  - The narrower floodplain on Concept B vs Concept A will limit these functional improvements.

6.4 Design Concept C

Design Concept C will meet the main goals of the Park Master Plan but with limited design enhancements and minimal infrastructure, cost, or timeline constraints. Key elements of the proposed design are bulleted below and illustrated on Figure 3C:

- Restore Rocky Branch Reach 1 using step-pool channel designed to maximize channel stability and aesthetics while minimizing earthwork. In-stream structures and native vegetation will be included to stabilize the stream and improve the floodplain landscape.
- Rocky Branch Reach 2 will remain in its current configuration on the Central Prison parcel and tie into the stream improvements above and below.
- Below the Norfolk Southern rail line, enhance Rocky Branch Reaches 2 and 3 in-place using in-stream log and rock structures to stabilize the channel and improve aesthetics.

Design Concept C will address the four Creek specific goals from the Master Plan as noted below:

- Habitat Restoration
  - Enhanced channels will create riffle and woody debris habitats to support aquatic macroinvertebrates, an important component of the food chain in creek systems.
  - Aquatic passage will be improved at existing Ashe Avenue, Western Boulevard (upstream), and Western Boulevard (downstream) culverts by incorporating step-pool channel design to gently drop the stream bed grades from existing perched culverts.

- Improvement of Ecological Function
  - Establishing a native riparian buffer along the stream will improve nutrient uptake from surface flow.
  - Removal of non-native species will allow native vegetation to flourish on stream banks, in the restored floodplain, and in wetland systems.
- Showcase Piedmont Ecology
  - Floodplain wetlands will be created with native wetland trees and herbaceous species.
- Widened Creek Channel (later clarified as widening the floodplain).
  - Flood flows will dissipate energy and deposit fine sediment on the restored floodplain.
  - Flood waters will interact with floodplain vegetation and percolate into groundwater which will remove nutrients, sediment, and toxins from the creek system.
  - The narrower floodplain on Concept C vs Concepts A and B will limit these functional improvements.

6.5 Future Design Considerations

In order to maximize the ecological uplift and minimize potential risk to the surrounding neighborhood, Wildlands has identified additional opportunities for investigation.

	Concept A	Concept B	Concept C
Perform a cursory study of stream flood modeling to understand design limitations and minimize flood risk	X	X	X
Preliminary bridge and culvert replacement designs and cost evaluation at Western Boulevard (upstream), Hunt Drive, and Norfolk Southern rail line	X		
Preliminary cost of landfill remediation based on floodplain excavation	X	X	X
Contact with Norfolk Southern Rail to determine viability of culvert installation through existing railroad embankment	X		
Contact with Central Prison to determine viability of abandoning existing concrete flume and relocating Rocky Branch onto Dix property	X		
Final City BRT plans for Western Boulevard and Hunt Drive realignment	X	X	X

7.0 REFERENCES

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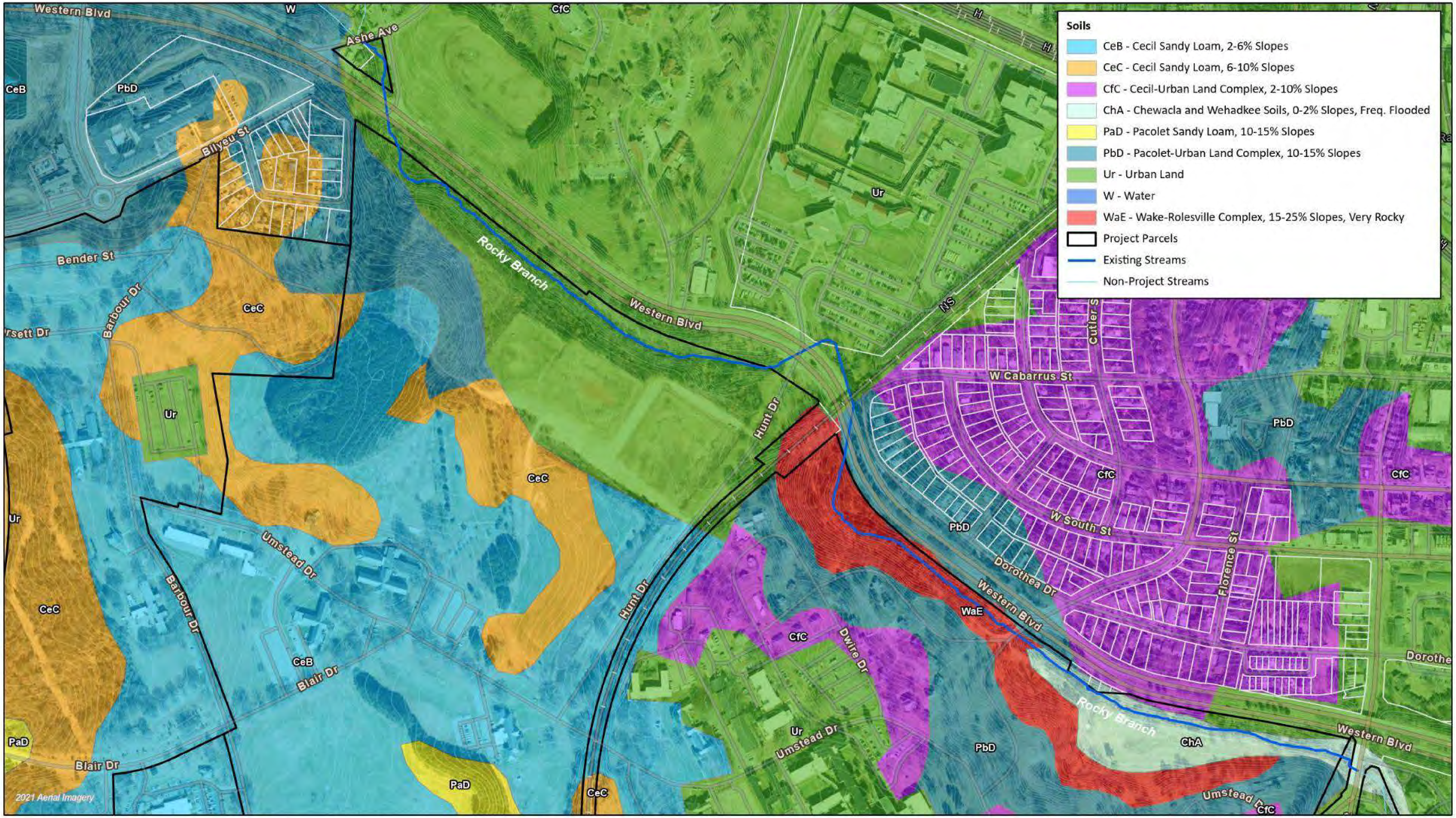
FIGURES



WILDLANDS ENGINEERING

Figure 1 Soil Map
Dorothea Dix Park

Wake County, NC

Figure 2 Site Map
Dorothea Dix Park

Wake County, NC

WILDLANDS ENGINEERING

0 200 400 Feet

N

Figure 3A - Concept A
Dorothea Dix Park

Wake County, NC

WILDLANDS ENGINEERING

Figure 3B - Concept B
Dorothea Dix Park

Wake County, NC

10/23/2023 ktriplett

0 200 400 Feet

Figure 3C -Concept C
Dorothea Dix Park

Wake County, NC

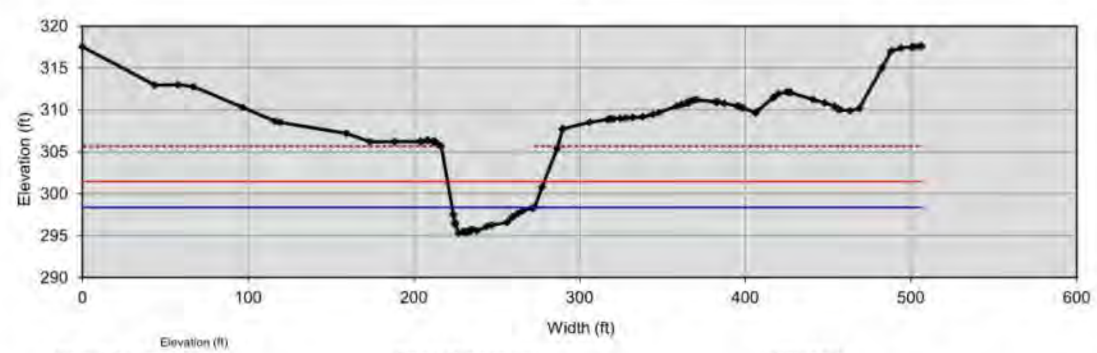
10/23/2023 ktriplett

Rocky Branch Enhancement Project
Feasibility Study

APPENDIX

Cross Section 1 - between Aahe Ave and Western Blvd

riffle



Bankfull Dimensions	
89.6	x-section area (ft.sq.)
49.6	width (ft)
1.8	mean depth (ft)
3.1	max depth (ft)
50.9	wetted perimeter (ft)
1.8	hydraulic radius (ft)
27.4	width-depth ratio

Flood Dimensions	
58.4	W flood prone area (ft)
1.2	entrenchment ratio
10.4	low bank height (ft)
3.4	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
33	threshold grain size (mm):

Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

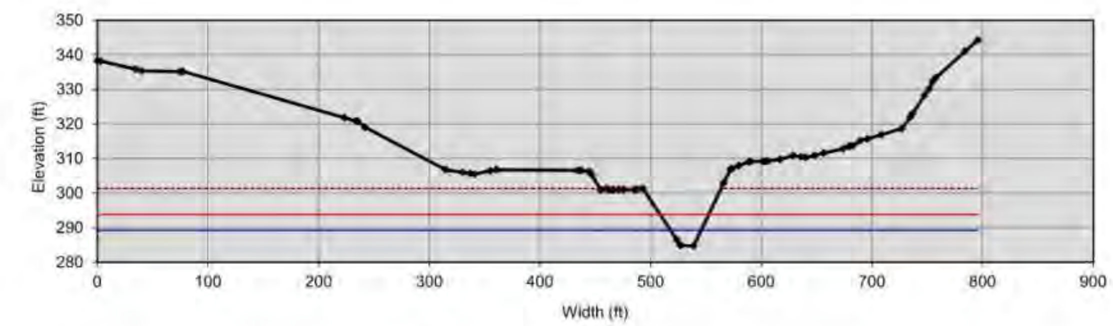
Bankfull Flow	
4.2	velocity (ft/s)
380.0	discharge rate (cfs)
0.56	Froude number

Flow Resistance	
0.040	Manning's roughness
0.15	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.61	channel slope (%)
0.67	shear stress (lb/sq.ft.)
0.59	shear velocity (ft/s)
2.9	unit strm power (lb/ft/s)

Cross Section 2 - between Western Blvd and Hunt Dr

riffle



Bankfull Dimensions	
88.1	x-section area (ft.sq.)
27.7	width (ft)
3.2	mean depth (ft)
4.5	max depth (ft)
30.1	wetted perimeter (ft)
2.9	hydraulic radius (ft)
8.7	width-depth ratio

Flood Dimensions	
43.8	W flood prone area (ft)
1.6	entrenchment ratio
16.6	low bank height (ft)
3.7	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
29	threshold grain size (mm):

Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

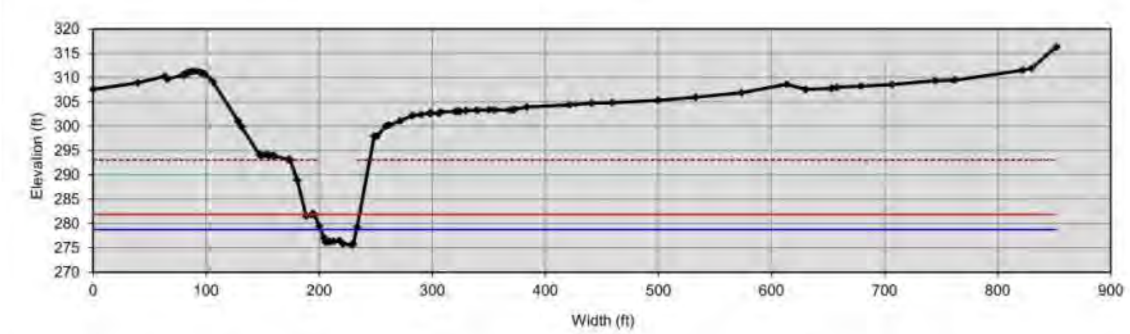
Bankfull Flow	
4.3	velocity (ft/s)
380.0	discharge rate (cfs)
0.44	Froude number

Flow Resistance	
0.040	Manning's roughness
0.13	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.32	channel slope (%)
0.58	shear stress (lb/sq.ft.)
0.55	shear velocity (ft/s)
2.7	unit strm power (lb/ft/s)

Cross Section 3 - between Western Blvd and Hunt Dr

riffle



Bankfull Dimensions	
74.6	x-section area (ft.sq.)
31.8	width (ft)
2.4	mean depth (ft)
3.1	max depth (ft)
33.8	wetted perimeter (ft)
2.2	hydraulic radius (ft)
13.5	width-depth ratio

Flood Dimensions	
45.6	W flood prone area (ft)
1.4	entrenchment ratio
17.5	low bank height (ft)
5.6	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
44	threshold grain size (mm):

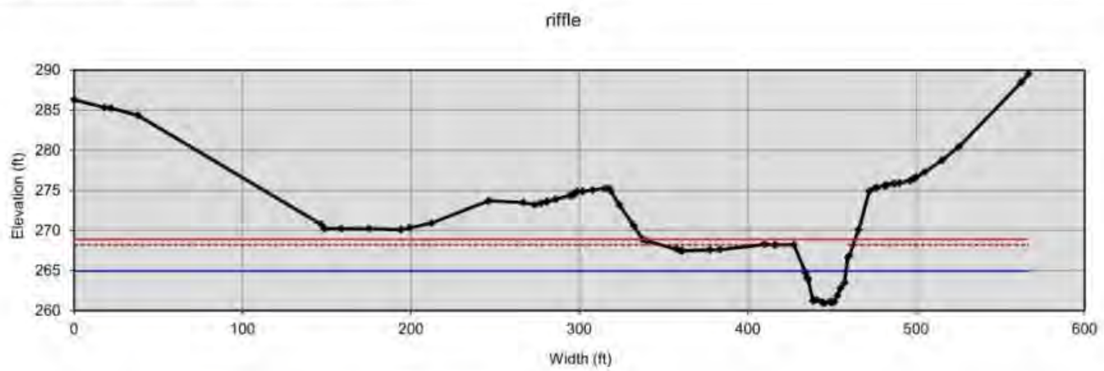
Rosgen Stream Type	
c	Missing: , , Sinuosity, D50,

Bankfull Flow	
5.1	velocity (ft/s)
380.0	discharge rate (cfs)
0.60	Froude number

Flow Resistance	
0.040	Manning's roughness
0.14	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.65	channel slope (%)
0.90	shear stress (lb/sq.ft.)
0.68	shear velocity (ft/s)
4.9	unit strm power (lb/ft/s)

Cross Section 4 - between Hunt Dr and Boylan Ave



Bankfull Dimensions	
71.9	x-section area (ft.sq.)
24.4	width (ft)
3.0	mean depth (ft)
4.0	max depth (ft)
27.0	wetted perimeter (ft)
2.7	hydraulic radius (ft)
8.2	width-depth ratio

Flood Dimensions	
126.2	W flood prone area (ft)
5.2	entrenchment ratio
7.3	low bank height (ft)
1.8	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
60	threshold grain size (mm):

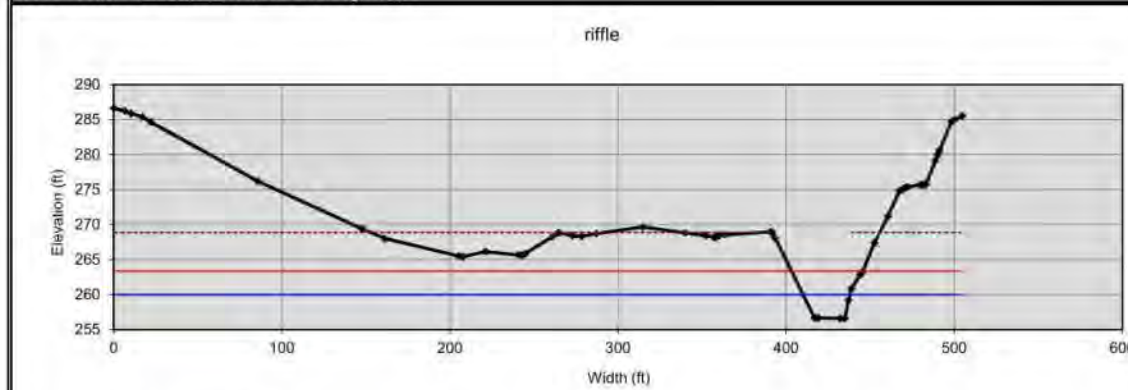
Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

Bankfull Flow	
6.1	velocity (ft/s)
440.0	discharge rate (cfs)
0.66	Froude number

Flow Resistance	
0.040	Manning's roughness
0.13	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.73	channel slope (%)
1.22	shear stress (lb/sq.ft.)
0.79	shear velocity (ft/s)
8.2	unit strm power (lb/ft/s)

Cross Section 5 - between Hunt Dr and Boylan Ave



Bankfull Dimensions	
76.8	x-section area (ft.sq.)
27.9	width (ft)
2.8	mean depth (ft)
3.4	max depth (ft)
30.2	wetted perimeter (ft)
2.5	hydraulic radius (ft)
10.1	width-depth ratio

Flood Dimensions	
42.5	W flood prone area (ft)
1.5	entrenchment ratio
12.3	low bank height (ft)
3.6	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
53	threshold grain size (mm):

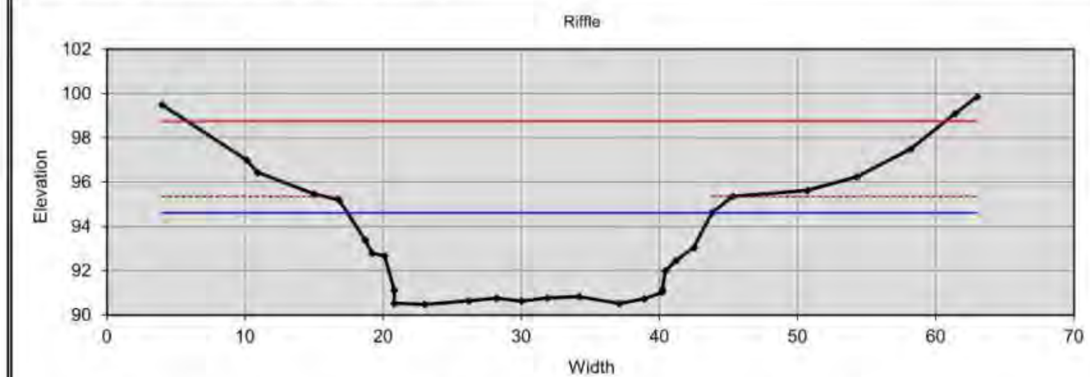
Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

Bankfull Flow	
5.7	velocity (ft/s)
440.0	discharge rate (cfs)
0.63	Froude number

Flow Resistance	
0.040	Manning's roughness
0.14	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.68	channel slope (%)
1.08	shear stress (lb/sq.ft.)
0.75	shear velocity (ft/s)
6.7	unit strm power (lb/ft/s)

Cross Section 6 - between Boylan Ave and S Saunders



Bankfull Dimensions	
87.9	x-section area (ft.sq.)
26.4	width (ft)
3.3	mean depth (ft)
4.1	max depth (ft)
30.6	wetted perimeter (ft)
2.9	hydraulic radius (ft)
7.9	width-depth ratio

Flood Dimensions	
54.9	W flood prone area (ft)
2.1	entrenchment ratio
4.9	low bank height (ft)
1.2	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
35	threshold grain size (mm):

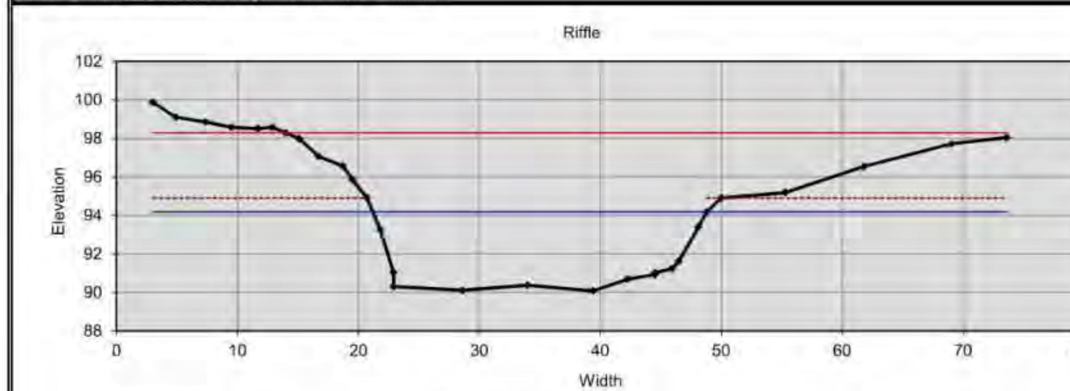
Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

Bankfull Flow	
4.8	velocity (ft/s)
417.5	discharge rate (cfs)
0.49	Froude number

Flow Resistance	
0.040	Manning's roughness
0.13	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.4	channel slope (%)
0.72	shear stress (lb/sq.ft.)
0.61	shear velocity (ft/s)
3.9	unit strm power (lb/ft/s)

Cross Section 7 - between Boylan Ave and S Saunders



Bankfull Dimensions	
95.3	x-section area (ft.sq.)
27.6	width (ft)
3.5	mean depth (ft)
4.1	max depth (ft)
31.7	wetted perimeter (ft)
3.0	hydraulic radius (ft)
8.0	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
4.8	low bank height (ft)
1.2	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
37	threshold grain size (mm):

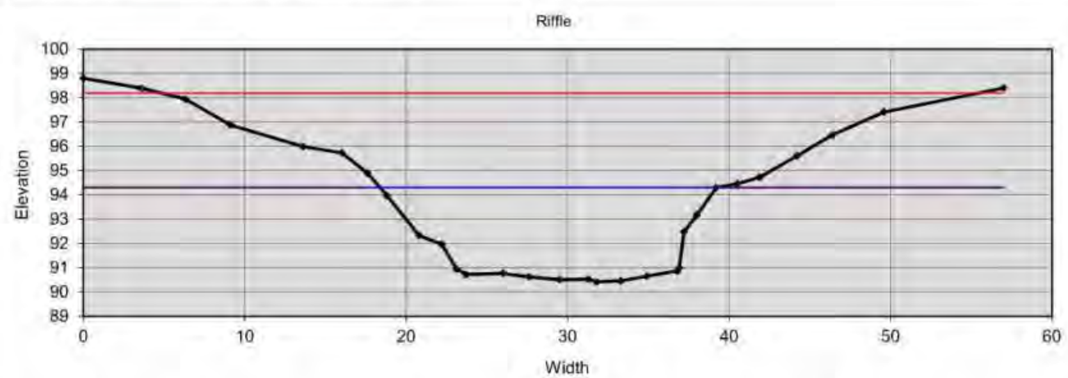
Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

Bankfull Flow	
4.9	velocity (ft/s)
467.2	discharge rate (cfs)
0.50	Froude number

Flow Resistance	
0.040	Manning's roughness
0.13	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.4	channel slope (%)
0.75	shear stress (lb/sq.ft.)
0.62	shear velocity (ft/s)
4.2	unit strm power (lb/ft/s)

Cross Section 8 - between Boylan Ave and S Saunders



Bankfull Dimensions	
61.4	x-section area (ft.sq.)
20.8	width (ft)
2.9	mean depth (ft)
3.9	max depth (ft)
24.1	wetted perimeter (ft)
2.5	hydraulic radius (ft)
7.1	width-depth ratio

Flood Dimensions	
50.6	W flood prone area (ft)
2.4	entrenchment ratio
3.9	low bank height (ft)
1.0	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
34	threshold grain size (mm):

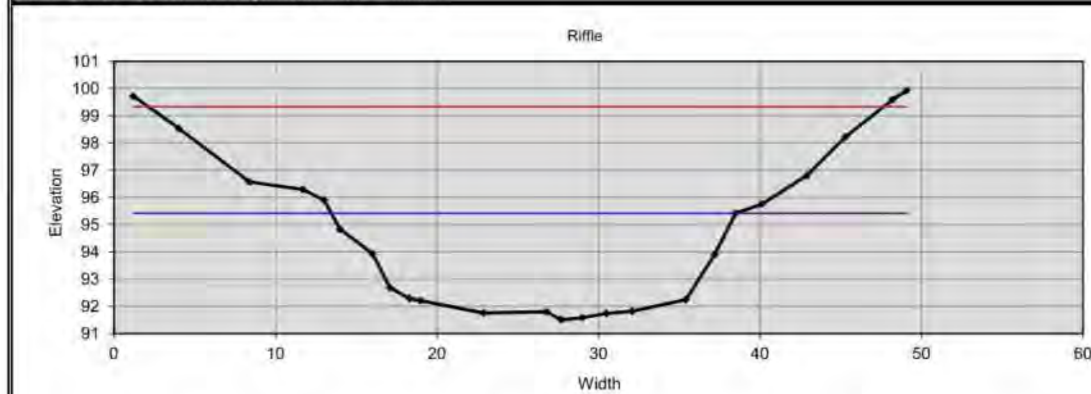
Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

Bankfull Flow	
4.6	velocity (ft/s)
282.8	discharge rate (cfs)
0.51	Froude number

Flow Resistance	
0.040	Manning's roughness
0.14	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.44	channel slope (%)
0.70	shear stress (lb/sq.ft.)
0.60	shear velocity (ft/s)
3.7	unit strm power (lb/ft/s)

Cross Section 9 - between Boylan Ave and S Saunders



Bankfull Dimensions	
74.2	x-section area (ft.sq.)
25.1	width (ft)
3.0	mean depth (ft)
3.9	max depth (ft)
27.6	wetted perimeter (ft)
2.7	hydraulic radius (ft)
8.5	width-depth ratio

Flood Dimensions	
45.5	W flood prone area (ft)
1.8	entrenchment ratio
3.9	low bank height (ft)
1.0	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
36	threshold grain size (mm):

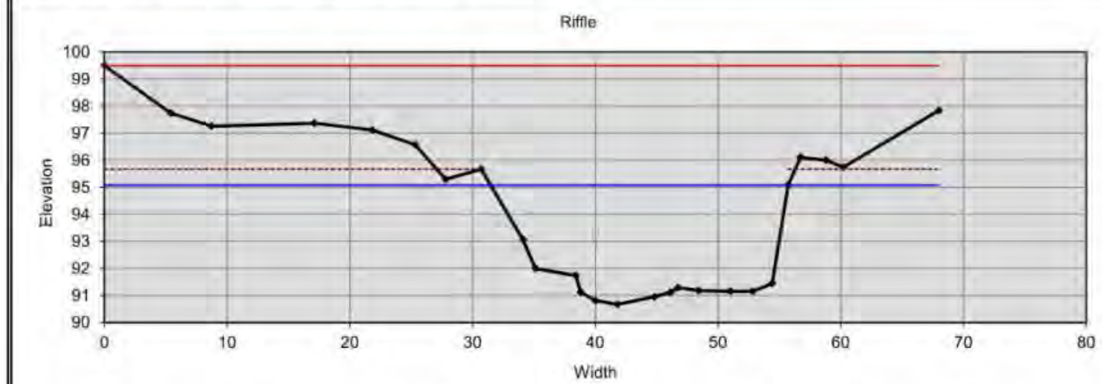
Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

Bankfull Flow	
4.8	velocity (ft/s)
354.4	discharge rate (cfs)
0.51	Froude number

Flow Resistance	
0.040	Manning's roughness
0.13	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.44	channel slope (%)
0.74	shear stress (lb/sq.ft.)
0.62	shear velocity (ft/s)
3.9	unit strm power (lb/ft/s)

Cross Section 10 - between Boylan Ave and S Saunders



Bankfull Dimensions	
82.6	x-section area (ft.sq.)
24.2	width (ft)
3.4	mean depth (ft)
4.4	max depth (ft)
28.4	wetted perimeter (ft)
2.9	hydraulic radius (ft)
7.1	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
5.0	low bank height (ft)
1.1	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
36	threshold grain size (mm):

Rosgen Stream Type	
---	Missing: , , Sinuosity, D50,

Bankfull Flow	
4.8	velocity (ft/s)
396.5	discharge rate (cfs)
0.50	Froude number

Flow Resistance	
0.040	Manning's roughness
0.13	Darcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.4	channel slope (%)
0.73	shear stress (lb/sq.ft.)
0.61	shear velocity (ft/s)
4.1	unit strm power (lb/ft/s)

Freshwater Mussel Surveys

Rocky Branch Stream Mitigation Site

Wake County, North Carolina

Prepared For:

Jeff Keaton
Senior Water Resources Engineer

Wildlands Engineering, Inc.
312 West Millbrook Road, Suite 225
Raleigh, NC 27609

August 2023

Prepared by:

TRANSYSTEMS

1 Glenwood Avenue, Suite 600
Raleigh, NC 27603

Contact Person:

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919-417-2732

1.0 INTRODUCTION

Transystems was contracted by the Wildlands Engineering to conduct freshwater mussel surveys for the Rocky Branch Stream Mitigation Site as part of required evaluation of potential project-related impacts to federally protected species.

2.0 SURVEY EFFORTS

2.1.1 Freshwater Mussel Survey Methods

Field efforts were conducted by Transystems personnel Chris Sheats (ES Permit # 23-ES00558, 23-SF00249), Jason Hall on June 13 and 14, 2023. Freshwater mussel surveys were completed using bathyscopes, visual and tactile survey methods using a two-person survey team. The freshwater mussel survey reach for Rocky Branch totals approximately 2750 meters, which includes 100 meters upstream of the Pullen Road crossing and 400 meters downstream of the South Saunders Street crossing. All species observed were recorded and returned to the stream.

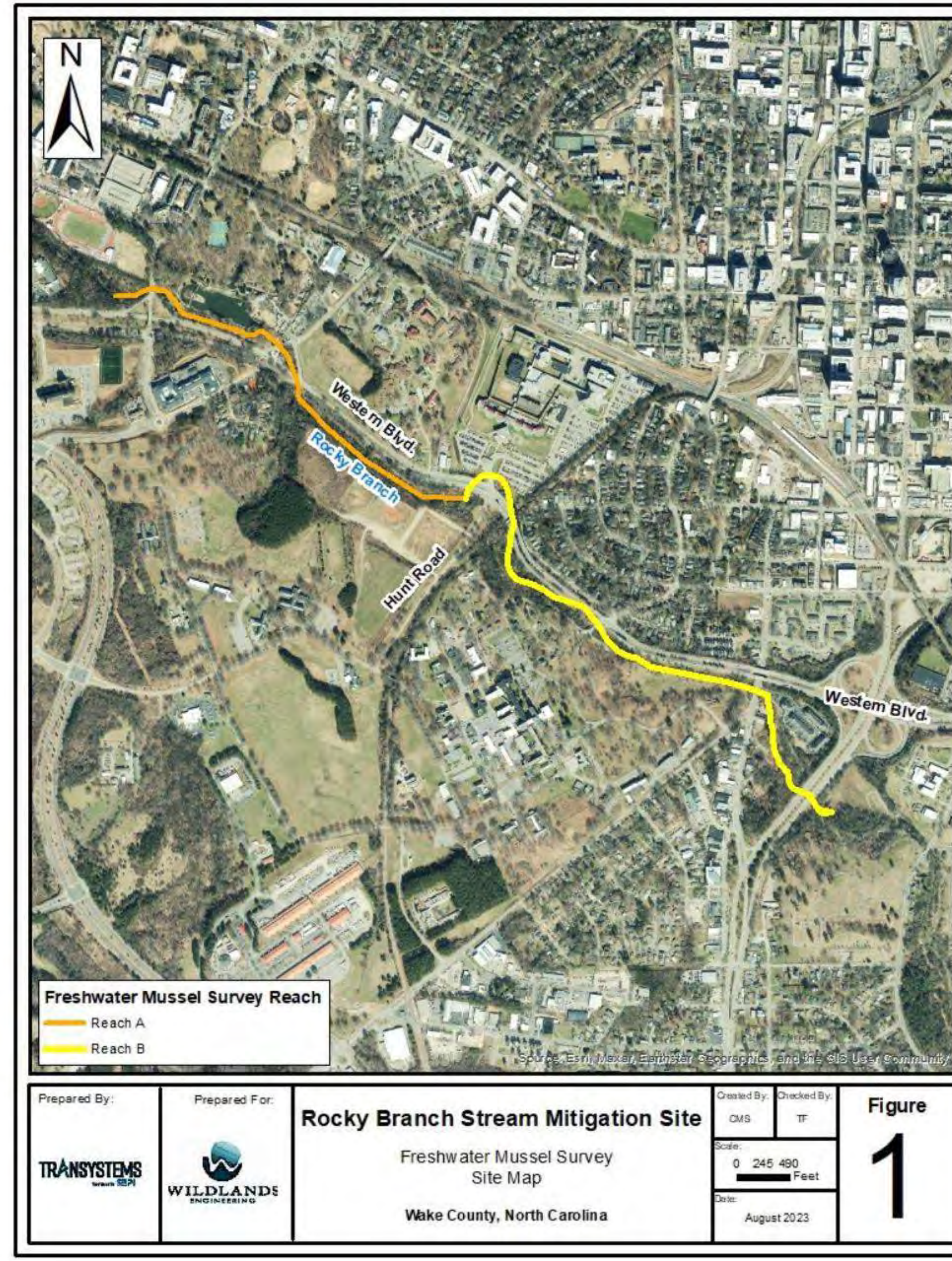
3.0 RESULTS

The survey was divided into Reach A (400 meters downstream of South Saunders Road Crossing up to just upstream of the Hunt Road Crossing), and Reach B (Just upstream of the Hunt Rd/Western Blvd Crossing) to 100 meters upstream of Pullen Road Crossing) Figure 1).

No freshwater mussels or snails were observed in Reach A or B. The only mollusk observed was the Asian Clam (*Corbicula fluminea*), which was uncommon throughout Rocky Branch.

Reach A (Upstream of the Hunt Rd/Western Blvd Crossing to 100 meters upstream of Pullen Road Crossing): Between Hunt Road and Ashe Avenue, the stream was shaded with a slightly more consolidated and stable sand, silt, gravel, cobble, and boulder substrate. Riffle, run, slack and pool habitats were present. Water depth ranged from 0.25 – 1 meter. The Asian clam was rarely observed up to the Ashe Avenue crossing. Upstream of Ashe Avenue, the stream was predominantly shallow, excluding a large pool just upstream of the road crossing. Upstream of the Pullen Road crossing, a large beaver dam (approximately 1.5 meters tall) was observed within the survey reach impounding waters beyond the stream banks. Asian clams were not observed upstream of Ashe Avenue. No freshwater mussels or snails were observed within Reach B.

Reach B (400 meters downstream of South Saunders Road Crossing to upstream of the Hunt Rd/Western Blvd. Crossing): The stream was shaded throughout with a substrate of unconsolidated shifty sand, silt, with some cobble and gravel particles. Riffle, run, slack and pool habitats were present. Water depth ranged from 0.25 – 1 meter. No freshwater mussels or snails were observed. Asian clams were rarely observed. Many dead fish were observed in the lower half of this reach.



APPENDICES C
THE CREEK - AN OVERVIEW

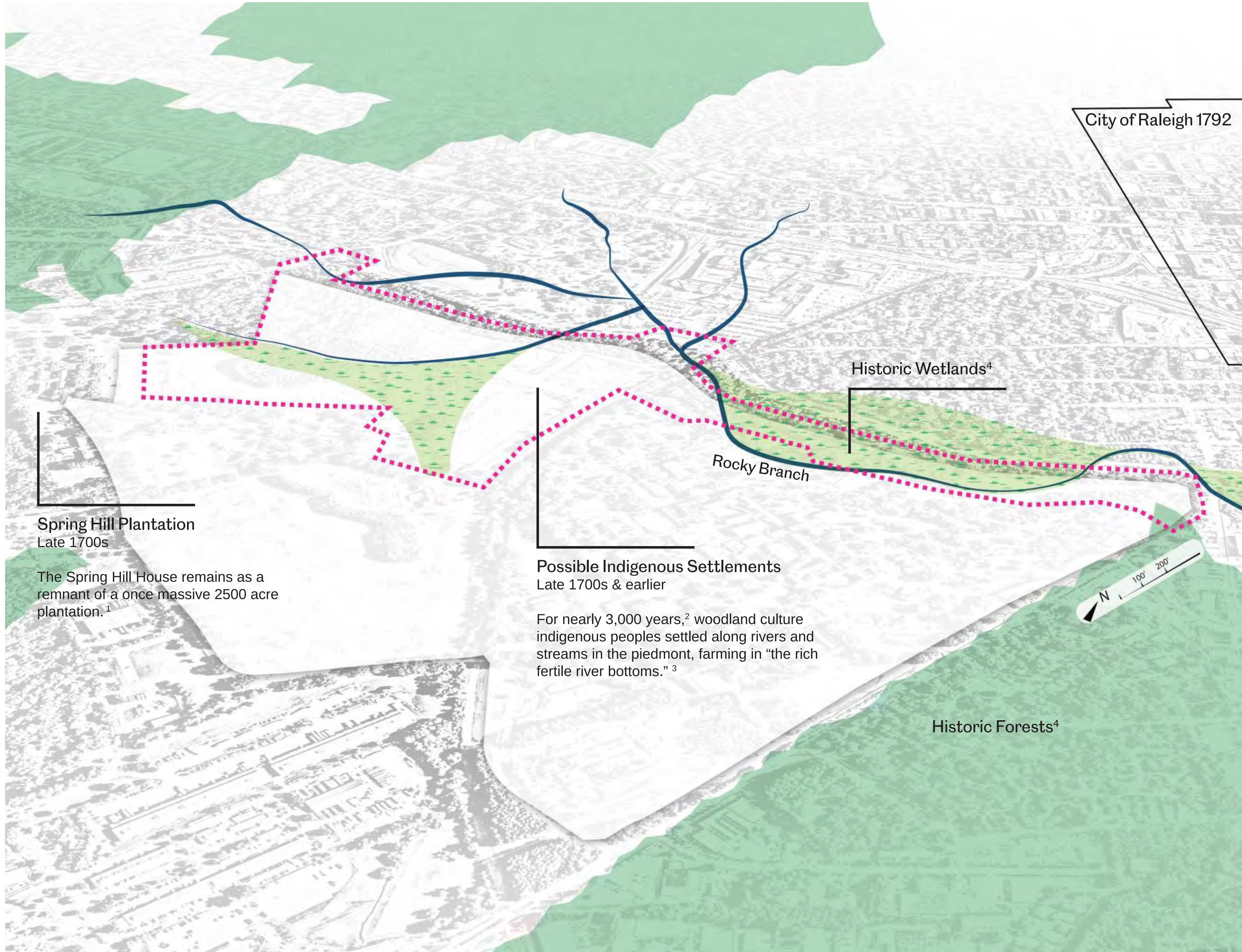
C The Creek - An Overview

SITE HISTORY - Pre-1800s

WOODLAND TO PLANTATION

The hilly terrain typical of the transition zone from the Coastal Plain to the Piedmont contributed to the formation of swales and creeks like Rocky Branch. Prior to urban development, Rocky Branch followed a natural path as the water navigated through this small valley south of Raleigh, flanked with wetlands and forest cover. As early as 1000 BCE[2], woodland culture indigenous peoples settled along rivers and streams in the Piedmont region, farming in "the rich fertile river bottoms."[3] The land on which Dix Park sits has been recognized as beloinging to the Coharie, Cherokee, Haliwa-Saponi, Lumbee, Meherrin, Occaneechi, Sappony, and Waccamaw Siouan, in a 2020 land acknowledgment and blessing.[5]

As colonialism took root, deforestation, such as that at Spring Hill Plantation, cleared the way for agriculture. By 1790, this massive 2,500-acre plantation was worked by the second largest population of enslaved laborers in Wake County.[1] The plantation doubled in size while in operation, spanning south of Crabtree Creek to portions of Rocky Branch and Walnut Creek,[1] transforming the character of the land through which these waters flowed.



1. Suzanne Turner Associates. Dix Park Master Plan, Discovery Phase: Historical Data Report. Historical Data Report, Dec. 2017.

2. "North Carolina American Indian History Timeline." Ncmoha.com. 2016. North Carolina Museum of History. www.ncmuseumofhistory.org/american-indian/handouts/timeline. Accessed 02 October 2023.

3. Harris, Ron. "Indian Arrowheads of the Piedmont: What these ancient artifacts reveal about North Carolina's earliest inhabitants." carolinacountry.com. September 2003. www.carolinacountry.com/carolina-stories/indian-arrowheads-of-the-piedmont. Accessed 30 November 2017.

4. Drayton, B. Map of the Rebel Lines at Raleigh N.C. U.S. National Archives and Records Administration.

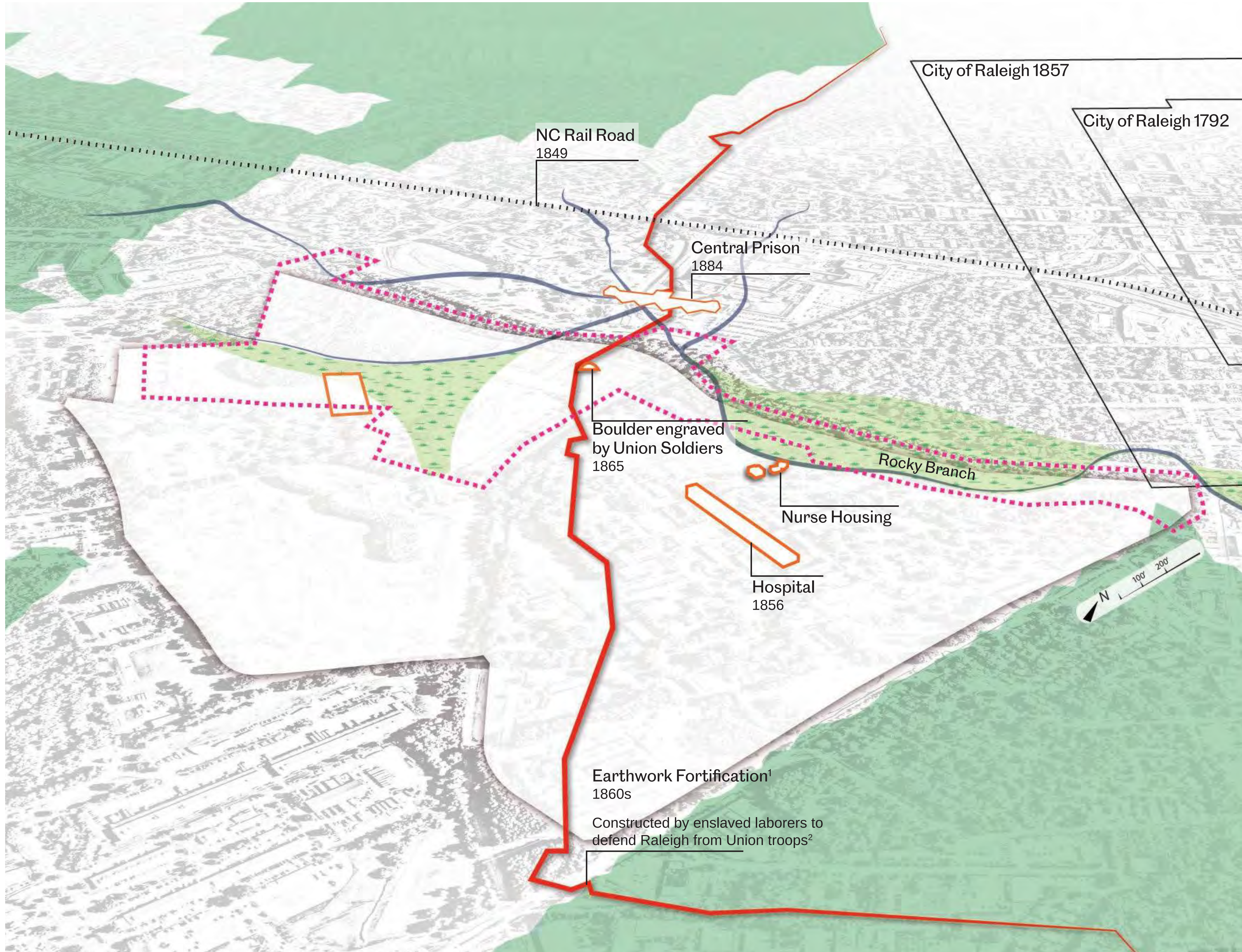
5. Explore Dix Park: Interpretive Signage. "Historical Signage Virtual Exhibit ," August 6, 2021. https://storymaps.arcgis.com/stories/398c93bff75f41f58f82654d8fe855b7.

EXTRACTING WEALTH & WELLNESS

By the 1840s much of the original Spring Hill Plantation had been divided among descendants, with a portion sold for the opening of Dorothea Dix Hospital. Founded in 1850 to treat patients struggling with mental health, the hospital diverted water from Rocky Branch for washing, lavatories, steam, and fire suppression, while drinking water was supplied by a nearby spring.[2] The hospital grounds played an integral role in treatment by employing therapeutic methods rooted in farming, gardening, and passive recreation in nature.[1] Though charitable in its ambitions, the hospital utilized multiple forms of unpaid labor to build and maintain the hospital grounds. Enslaved laborers were employed to build the hospital, [1] and maintenance of the grounds and surrounding landscape regularly fell to patients without pay.[2]

When the Civil War broke out, about 260 enslaved laborers were forced to construct a massive earthwork that fortified Raleigh against the Union army,[4] running through the hospital grounds and Rocky Branch.[3] In April of 1865, an army of 17,000 camped along this earthwork, "around the asylum from Rocky Branch southwest to Rhamkatte Road," named Lake Wheeler Road, today. During the war, a number of soldiers became hospital patients, suffering from conditions described as "war excitement." [2]

Just three years later, the state legislature adopted a constitution that provided the state's first prison, located on the north side of Rocky Branch. The prison continued the practice of unpaid labor by leasing inmates for work.[5] In 1879, inmates widened and deepened the canal of Rocky Branch to improve the hospital's water supply.[2] Development upstream began polluting Rocky Branch and the hospital wells by the end of the century, resulting in documented typhoid outbreaks.[2] As human manipulation of the creek continued, the water quality and ecological health diminished.



1. Suzanne Turner Associates. "Dix Park Master Plan, Discovery Phase: Historical Data Report." Historical Data Report, December 2017.

2. O'Rorke, Marjorie Lehman. Haven on the Hill: A History of North Carolina's Dorothea Dix Hospital. Raleigh: Office of Archives and History, North Carolina Dept. of Cultural Resources, 2010.

3. Drayton, B. "Map of the Rebel Lines at Raleigh N.C." 1865. 8 in. = 1 mile. U.S. National Archives and Records Administration.

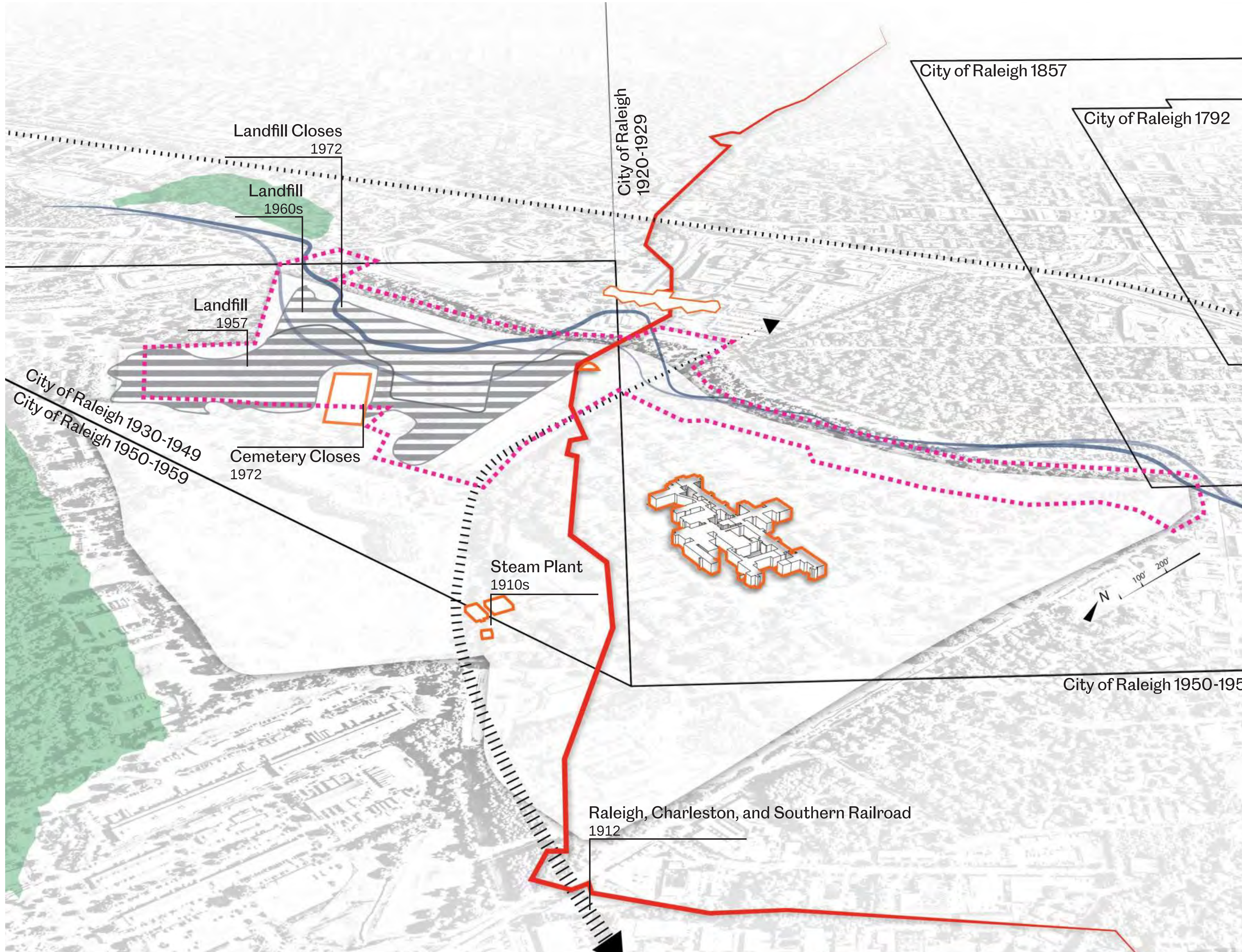
4. Raleigh News & Observer, 1935.

5. "History of NC Prisons - Part 1." Accessed October 25, 2023. https://www.doc.state.nc.us/admin/page1.htm.

INCREASED URBANIZATION & POLLUTION

As Raleigh's urban core continued to expand in the 20th century, Rocky Branch became increasingly neglected. In 1956, the hospital entered into an agreement with the city to permit the use of an area adjacent to the creek and wetlands as a landfill for the city's refuse. Over the next 15 years the landfill rapidly grew, continuously pushing the path of Rocky Branch farther north. The landfill eventually surrounded the hospital cemetery on three sides.[1] The cemetery suffered damage from the landfill operations, vandalism, erosion, and lack of funds for maintenance. The cemetery closed in 1972 in a neglected state with exposed caskets and subsided, unmarked graves.

The landfill operations ceased in 1972, when it was discovered that the landfill could not be upgraded to meet current standards.[1] Reports indicated that the landfill was situated in a "marshy, low area..." where there was "no suitable separation of waste from ground water; furthermore, the site received runoff from adjacent higher ground."[3] In 1978, Rocky Branch was designated as "the most polluted urban stream in North Carolina" by the N.C. Division of Water Quality.[4]



1. Suzanne Turner Associates. "Dix Park Master Plan, Discovery Phase: Historical Data Report." Historical Data Report, December 2017.

2. "244 DOROTHEA DIX HOSPITAL CEM Wake County North Carolina Cemeteries." Accessed October 27, 2023. https://cemeterycensus.com/nc/wake/cem244.htm.

3. "Old City Landfill Information." City of Raleigh Research Information. 31 August 1973.

4. Coastwatch. "Restoring Inland Streams, Renewing Coastal Waters." Accessed October 4, 2023. https://ncseagrant.ncsu.edu/4. coastwatch/previous-issues/2002-2/autumn-2002/renewing-coastal-waters/.

5. Office of Chief Engineer. "Right-of-Way and Track Map; Norfolk Southern R.R. Main Line - Wester Division Station 0+00 to Station 105+60." Norfolk, VA, June 30, 1914.

TOWARD RESTORATION & RECIPROCITY

After decades of pollution and neglect, movements began to restore Rocky Branch and Dix Park. Following its closure, the City capped and seeded the landfill with plans to intercept "surface run-off by terracing, dikes, and ditches; thereby, controlling the movement of water into the stream to prevent further erosion of stream banks."[2] Later in 1997, the area was converted into soccer fields, though issues with erosion and subsidence continue.[1] A group of volunteers began to restore the cemetery in 1991, working to identify and mark the graves. [1] The hospital officially closed in 2012 was converted to offices for the NC Department of Health and Human Service.[3]

Throughout the 1960s and '70s, the national environmental movement gained momentum, with landmark legislation passing to protect air quality, water quality, and endangered species. In the early 1980s, North Carolina became known as the birthplace of the environmental justice movement, with protests siting a state landfill in the predominantly African-American community of Warren County.[4] In the late 1980s the state developed a water quality management plan, that led to three-phase restoration plan for Rocky Branch, with the first phase completed early 2000s.[5]

Despite increased environmental awareness, urban demands continue to put pressure on Rocky Branch. The construction of Western Boulevard in the mid 1990s, and later expansion not only required "the relocation of Rocky Branch Creek,"[6] but also cut off access to the creek for city neighborhoods.

As the 2017 Dorothea Dix Park Master Plan illustrated, there is inherent potential in this section of Rocky Branch to serve as a Gateway, a fluid threshold between downtown Raleigh, Dorothea Dix Park, and south to Walnut Creek and Dix Edge Area[7].

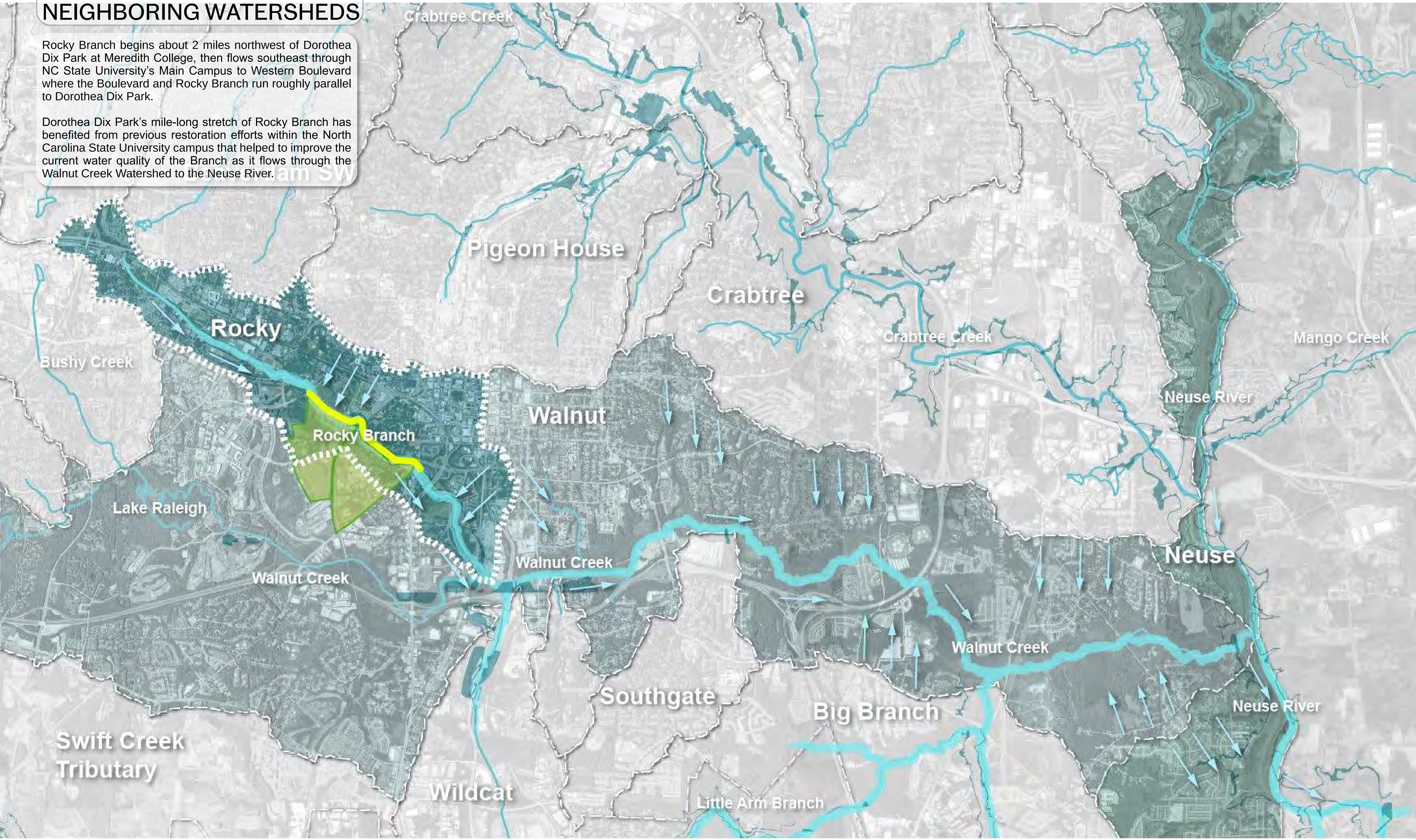
1. Suzanne Turner Associates. "Dix Park Master Plan, Discovery Phase: Historical Data Report." Historical Data Report, December 2017.
2. "Old City Landfill Information." City of Raleigh Research Information. 31 August 1973.
3. Explore Dix Park: Interpretive Signage. "Historical Signage Virtual Exhibit ," August 6, 2021. https://storymaps.arcgis.com/stories/398c93b-ff75f41f58f82654d8fe855b7.
4. U.S. Department of Energy, Office of Legacy Management. "Environmental Justice History." Accessed October 27, 2023. https://www.energy.gov/lm/environmental-justice-history.
5. Coastwatch. "Restoring Inland Streams, Renewing Coastal Waters." Accessed October 4, 2023. https://ncseagrant.ncsu.edu/4. coastwatch/previous-issues/2002-2/autumn-2002/renewing-coastal-waters/.
6. "North Carolina Dorothea Dix Property Study Commission Interim Report to the Joint Legislative Commission on Governmental Operations of the 2003 General Assembly" 20 April 2004.
7. City of Raleigh Planning and Development. "Dix Edge Area Study: Connecting Communities. Shaping a Shared Future." 07 December 2023

SITE OVERVIEW

NEIGHBORING WATERSHEDS

Rocky Branch begins about 2 miles northwest of Dorothea Dix Park at Meredith College, then flows southeast through NC State University's Main Campus to Western Boulevard where the Boulevard and Rocky Branch run roughly parallel to Dorothea Dix Park.

Dorothea Dix Park's mile-long stretch of Rocky Branch has benefited from previous restoration efforts within the North Carolina State University campus that helped to improve the current water quality of the Branch as it flows through the Walnut Creek Watershed to the Neuse River.



Rocky Branch Enhancement Project
Feasibility Study

STREAMBED CONDITIONS

The Rocky Branch project lies within the Raleigh Belt geologic formation of the Piedmont physiographic province. This area is generally characterized by gently rolling hills and low ridges, containing granite, gneiss and schist. There are several instances of shallow, exposed bedrock throughout the project site, occurring both within channels and the floodplain.

Rocky Branch will be divided into three stream reaches to address the major stressors and opportunities for uplift in each area. These reaches are indicated on the below graphic and will be described in further detail later within this report.

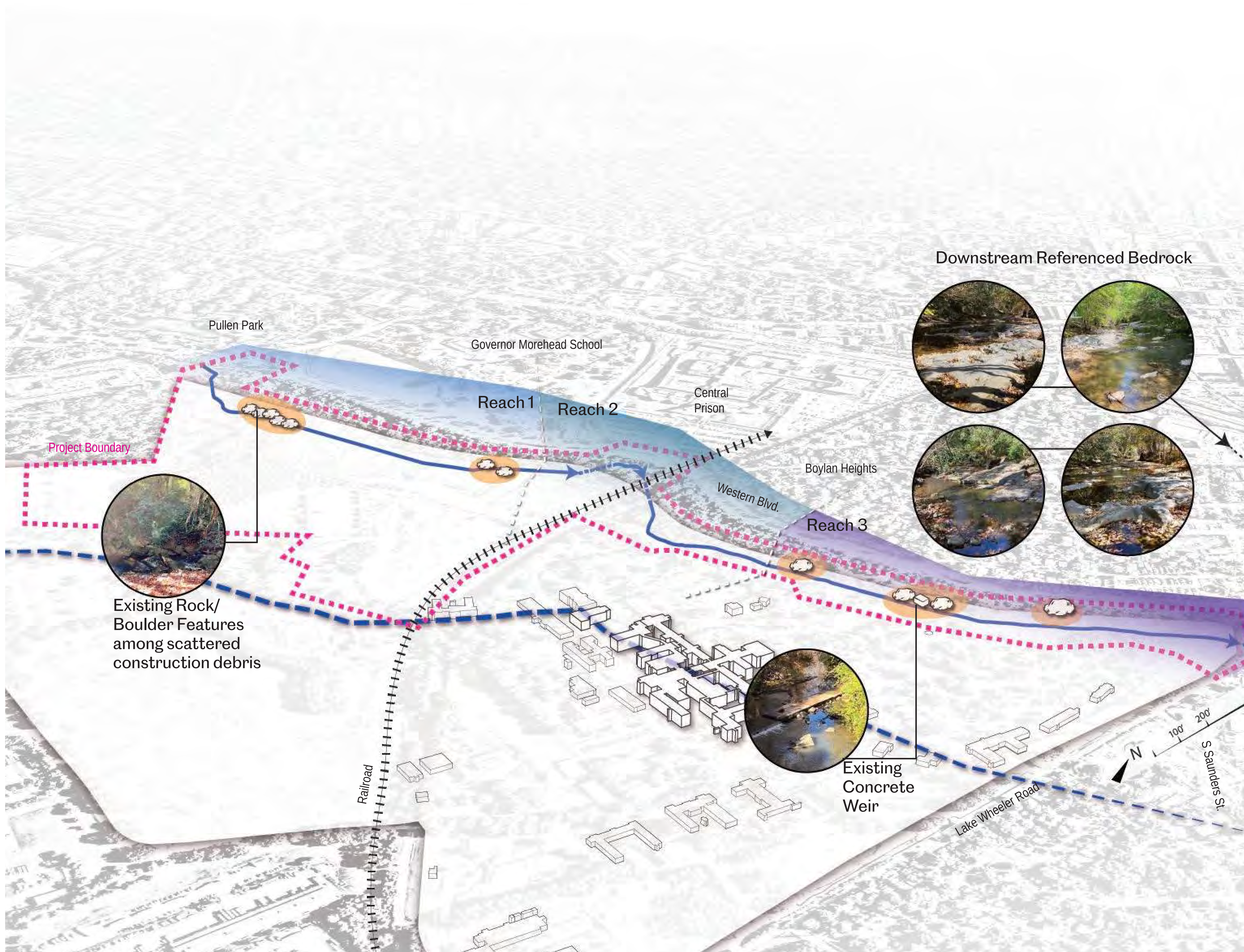
The Reach 1 streambed is defined by multiple culverts, including the Ashe Avenue one with a perched existing condition that greatly impedes fish passage. The alignment of Reach 1 has historically been influenced by the landfill and potential impacts to sediments and surface water will need to be evaluated for the restoration process. The Reach 1 channel is consistently lined with rip rap and concrete debris, evidence that much of this was placed to remediate ongoing bank failure. The lower section of Reach 1 also contains considerable sediment deposits, likely due to the low slope conditions.

Reach 2 crosses Western Boulevard via a culvert where it then flows through a segment of Central Prison parcel in a concrete flume. It quickly returns to the Dix Park campus via another culvert beneath Western Boulevard. While reach 2 is channelized between Western Boulevard and a steep, rocky slope on the south bank, it remains mostly stable with only isolated areas of moderate instability.

The Reach 3 streambed is the most secure and most natural of the three. While the channel is generally very stable, it is still lined with rip rap and concrete. Due to the low bank height ratio, the stream is able to more frequently flood into the adjacent floodplain, reducing concentrated energy and shear stress on the streambed. There are also several bedrock glides, which provide precedents for the implementation of such features within the proposed alignment and designs.

Existing conditions such as streambed, channel width, valley width, bank height ratio, and adjacent features were all taken into account during the development of stream alignment scenarios for each reach. Where conditions allow and are favorable to consider more significant realignment, such moves were proposed. In other cases, where conditions are more constrained the proposed alignment may more closely resemble current stream morphology.

Downstream Referenced Bedrock:
informs the designs' navigation of topography within the stream channel - using exposed bedrock, or imitation thereof, to step down in elevation and aerate the water while still allowing for fish passage.



SOILS

An understanding of the characteristics of the site's soils, hydrology, and environmental conditions informs the overall design approach and allows the design team to respond to historical factors such as wetlands, agricultural land, a landfill, and a neighbor to Western Boulevard.

Soils mapped for the site include the following:

Ur - Urban land complex in Reach 1 - is a 'miscellaneous' undefinable - soil type that corresponds to area impacted by Western Blvd development and the pre-regulatory landfill on site.

PbD - Pacolet Urban Land complex - 30-40% of this soil type consists of 'miscellaneous' urban land, with the rest typical of interfluves on uplands and showing evidence of parent material.

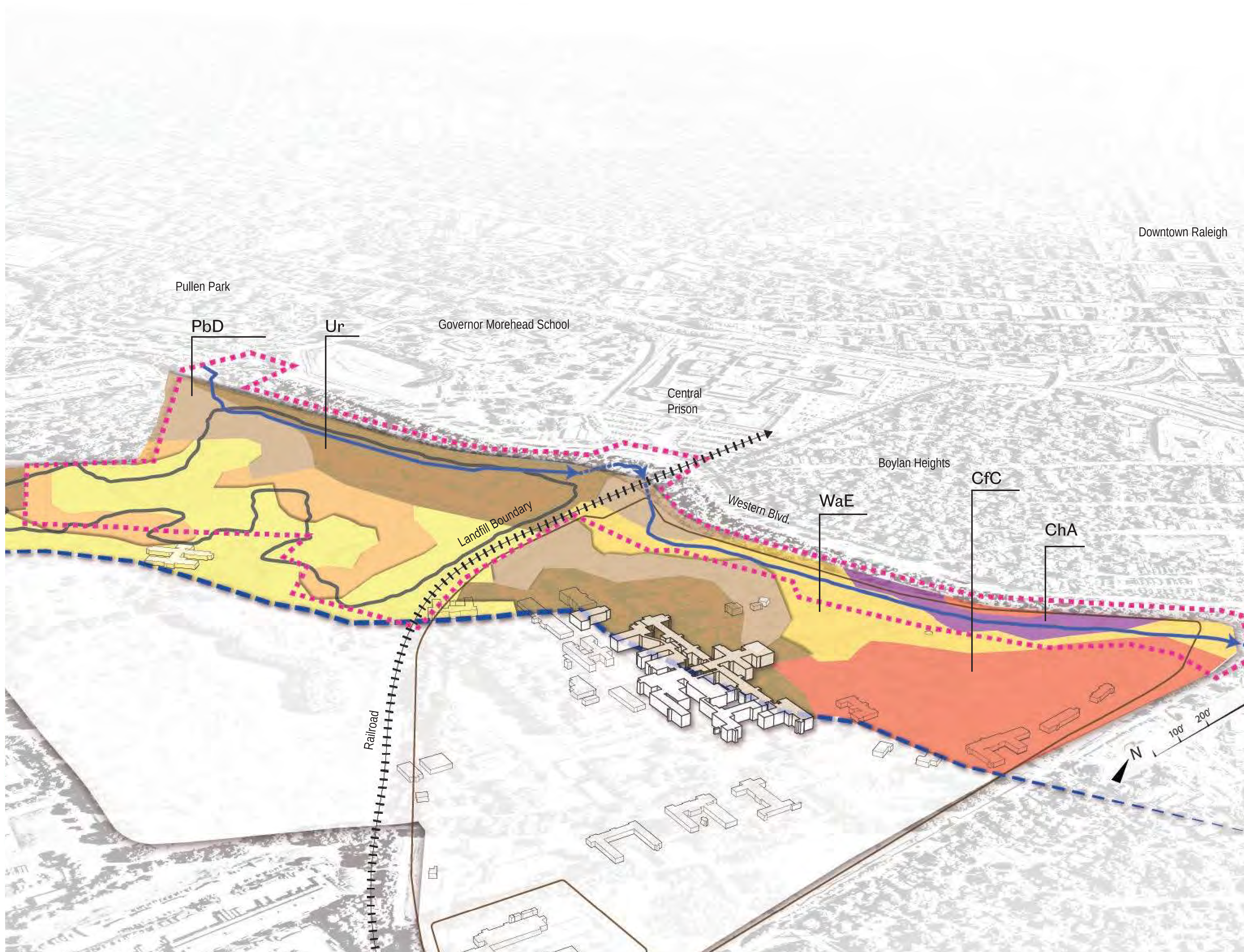
WaE - Wake Rolesville Complex - This 'very rocky' and 'excessively drained' soil type makes up the majority of the soils within Reach 2 - between the Railroad and Boylan Ave, where the steep banks are visibly rocky.

Cha - Chewacla and Wehadkee soils are most clearly remnant of this stream corridor's historical conditions, as seen on Site's History : 1800s and earlier, where wetlands flanked the stream along its course.

Typical household waste items and soil from City construction projects has been placed in the the footprint of the landfill. Additional assessment of placed materials is needed to confirm and further evaluate soil types across the site in support of the restoration project.

Legend

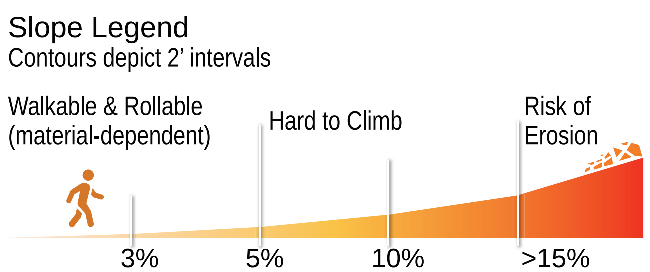
- CfC — Cecil-Urban land complex; Cecil, Urban land, Udorthents
- CeC — Cecil Sandy Loam; Cecil, Pacolet, Spartanburg
- CeB — Cecil Sandy Loam; Cecil, Pacolet
- Ur — Urban land; Urban land
- PbD — Pacolet- Urban land complex; Pacolet, Urban land, Udorthents
- ChA — Chewacla and Wehadkee soils; Chewacla, Wehadkee, Riverview
- ApB — Appling Sandy Loam; Appling, Helena
- WaE — Wake-Rolesville complex; Wake, Rolesville, Ashlar, Rock outcrop



TOPOGRAPHY

The varying topography within Dix Park is one of the defining factors of the site's character and, while becoming a barrier in some areas, also contributes to stunning views and vistas. The High Point with a Northwest view, formed by the accumulation of construction waste material within the pre-regulatory landfill, offers one of the best views of Raleigh's skyline. While the view is available, it is not necessarily accessible, due to the topography illustrated below as well as the lack of accessible paths to this asset (p. 21).

The areas of deep orange in this diagram represent slopes of greater than 15%, which to the southeast of the site, making up the Grove, forms a Raleigh-favorite Sledding Hill. Areas where these steep slopes present opportunities for improvement are along Rocky Branch itself, where the stream has been pushed into a very narrow and steep valley along Western Boulevard, as well as along the railroad that bisects the site and presents a barrier to pedestrians moving through the site.



Stream Banks of Steep Slopes:
Rocky Branch has been forced into a narrower and steeper channel over time. While the stream is stable in such a condition between the railroad and Boylan Ave., such a narrow channel can act as a chute, not allowing Rocky Branch the width to slow its flow, resulting in further erosion where the banks are not armored (with rip rap, construction debris, boulders).

Railroad Embankment:
The railroad, and the probability of needing to maintain railroad operations during construction, present one of the greatest barriers to restoring the stream to meanders within the Dix Park property. The stream flows +/- 40' below the elevation of the railroad, which speaks to the dramatic topography in this section of the stream.

The Grove:
The hillside of the Grove defines the floodplain of this lower length of Rocky Branch, forming the wall of an earthen bowl and allowing the stream room to meander and flood. The topography is remnant of the historic wetlands and inspires further enhancement and restoration of such a landscape.

LANDFILL & BROWNFIELD BOUNDARY

A 56-acre pre-regulatory landfill covers the majority of the northwestern portion of the Site, with its northern boundary bulging towards Rocky Branch. Outside of being used for former agricultural purposes and as a former municipal waste landfill (~1956-1972), construction and demolition waste, including soil, was reportedly placed or stockpiled on the landfill from various City projects beginning in the 1980s through the early 2000s. Extensive historical assessment performed on the landfill identified the location and concentration of contaminants in soil, sediment, surface water, groundwater and soil gas in connection with NCDEQ PRLU regulatory requirements as documented in NCDEQ files (p. ii, ESA Executive Summary; Appendix J).

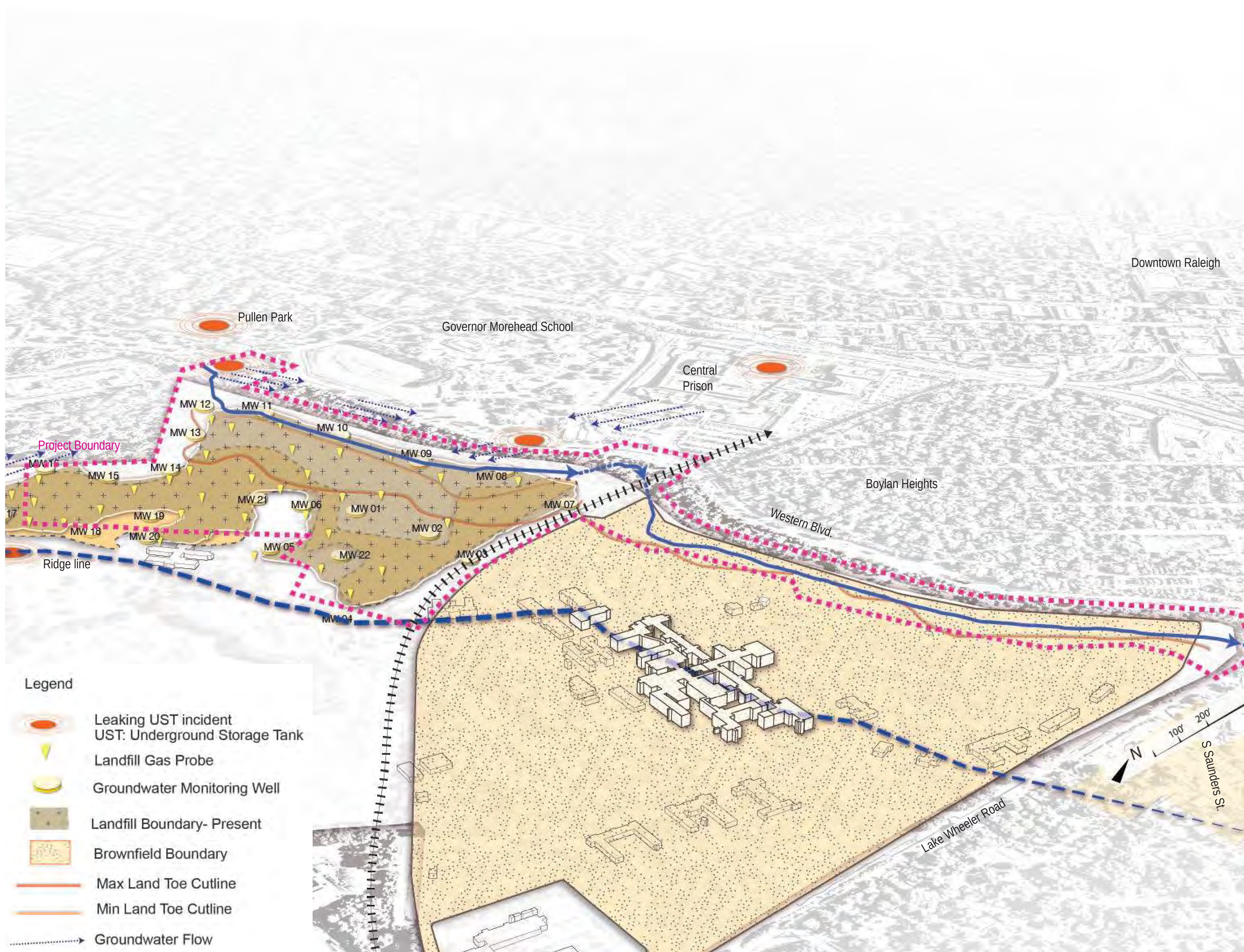
As recorded in the Environmental Site Assessment and explained in Chapter 5, there remain unknowns regarding the type and depth of the contents in the landfill. Study of the landfill revealed it is possible to cut into the material and relocate it, to expand the creek's floodplain. The implications of the various degrees of interfering with the landfill are investigated within this report, as well as the opportunities that arise for restoration and preservation of the systems involved (soil, stream, groundwater). There is work to be done to protect the longevity of the park and health of the stream, and the wealth of landfill assessment activities conducted to date will support stream restoration work.

While multiple soil constituents (metals, Volatile Organic Compounds, semi-volatile organic compounds, and general chemical components) exceed Residential and Industrial Preliminary Soil Remediation Goals, as discussed within CDM Smith's 2017 REMEDIAL INVESTIGATION SUMMARY REPORT,

Restoration work for all three reaches will need to be conducted under applicable North Carolina Department of Environmental Quality (NCDEQ) regulations. Work within the boundaries of the landfill (Reach 1), will be managed under the NCDEQ Division of Waste Management (DWM), Superfund Section, Inactive Hazardous Sites Branch (IHSB), Pre-Regulatory Landfill Unit (PRLU). Work for the majority of Reaches 2 and 3 fall within the boundaries for a portion of the Dorothea Dix Brownfield Property and will be managed under the NCDEQ DWM Brownfield Redevelopment Section (BRS) Program.

Due to the nature of the work, both of the NCDEQ regulatory agencies named above will need to be engaged in a coordinated fashion to develop technical strategies to manage landfill waste, leachate, gas, soil, surface water, sediment, and groundwater in a manner that is protective of park visitors, area residents, and the environment. As described in the following pages, additional testing and assessment of site conditions will be needed to support the development of technical plans and designs for NCDEQ review and approval.

See Chapter 5 Landfill and Site Reuse Concept Development and Appendix, part D Environmental Site Assessment for more information.



LANDFILL & BROWNFIELD PROPERTY IMPLICATIONS

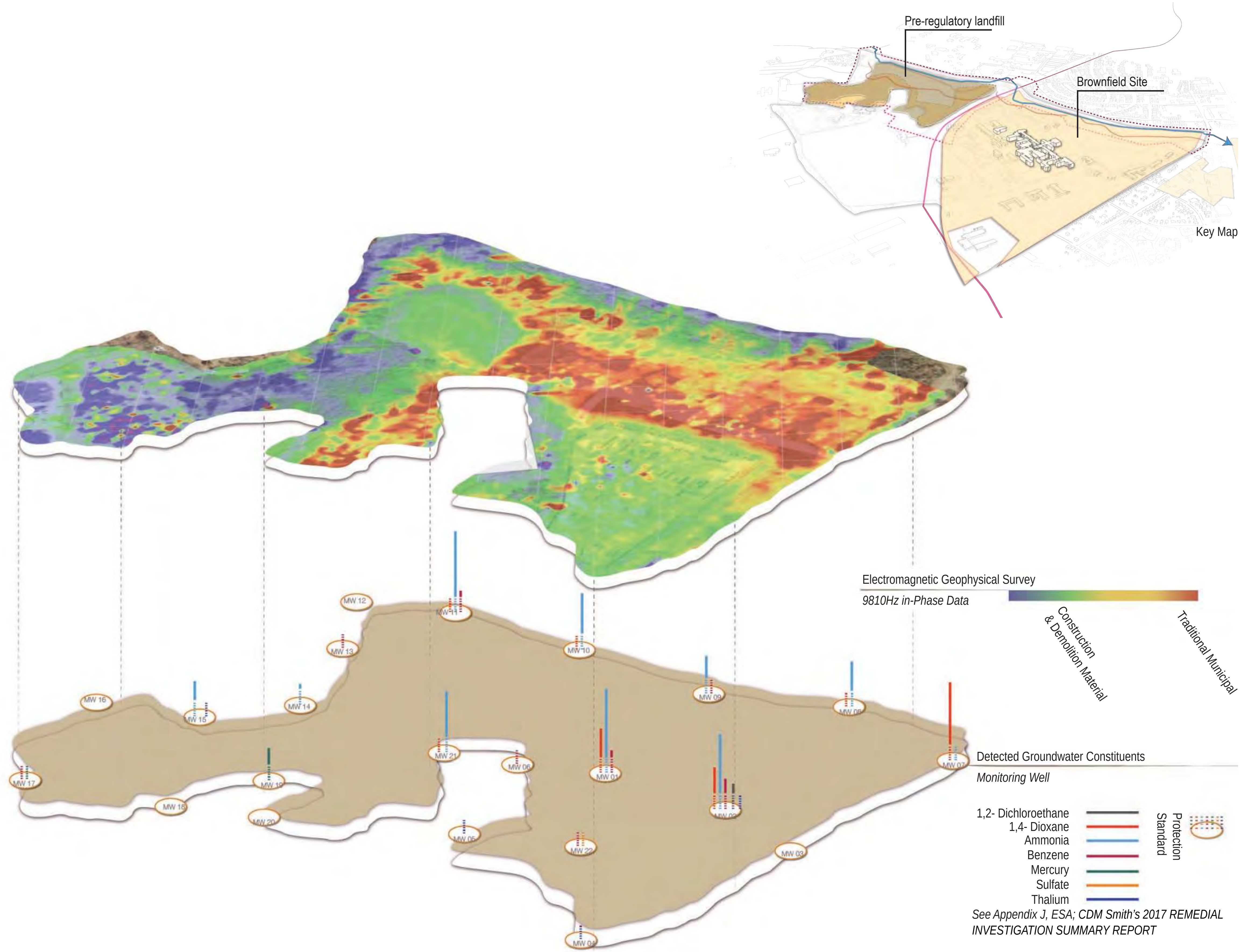
The extensive assessments of the environmental conditions of the landfill are documented in the Limited Environmental Assessment Report (ESA) presented in Appendix K. Because the landfill was a household waste depository, relatively low levels of contamination are present in waste, soils and underlying groundwater. Additionally, due to the age of the landfill, the amount of landfill gasses from the ongoing natural degradation of the waste has decreased over the years.

Although the Rocky Branch restoration project will only disturb a portion of the landfill, the nature of the work in combination with regulatory requirements will require the development of strategies to manage environmental risks for the entire landfill. Environmental risks associated with the presence of contaminants in the underlying landfill waste, soils, groundwater, gasses from the ongoing natural degradation of the landfill waste, surface water, and sediment (environmental media) will need to be managed for the entire footprint of the landfill in order to be protective of the surface waters of Rocky Branch, downstream residents, and park visitors.

As the landfill continues to naturally biodegrade, materials will continue to settle in the subsurface resulting in ground surface elevation changes. Due to the variability of waste in the landfill, certain wastes will degrade and behave differently and cause the overlying land to settle at different rates. Total and differential settlement will need to be managed when developing designs for the restoration of Rocky Branch and closure of the landfill.

As described in the ESA, no known environmental conditions were identified for the Rocky Branch enhancement portion of the Dorothea Dix Brownfield Property with the exception of possible impacts from the adjacent landfill property. The proximity of the landfill to Reaches 1 and 2 create the potential for contamination to migrate off the landfill. Potential impacts are most likely to occur on the portion of Reach 2 that lies next to the landfill. Because of these conditions and since a portion of the restoration project (Reaches 2 and 3) lie within the Dorothea Dix Brownfield Property, regulatory requirements will apply for managing environmental media for Reaches 2 and 3. The project area within the Brownfield Property will require additional testing and the preparation of plans and designs for regulatory review and approval to document that the work is being conducted in a manner that is protective of park visitors, area residents, and the environment.

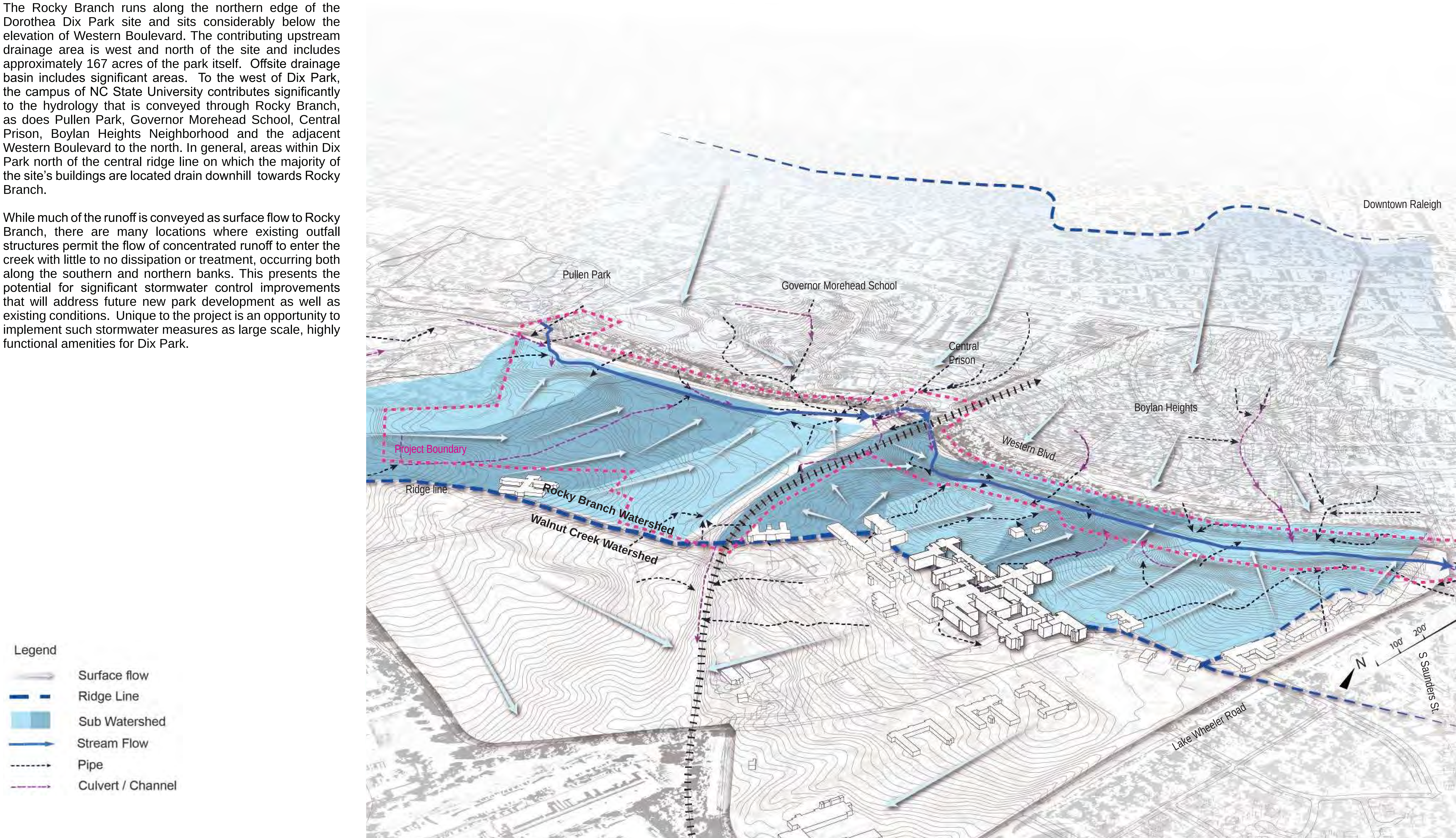
Evaluation of properties adjacent to and in the vicinity of the Dorothea Dix Park and Rocky Branch did not identify the presence of environmental conditions that could significantly impact the project. Several adjacent properties with known or potential contamination were identified, including the Circle K gasoline station near Pullen Park, would need to be considered for off-site construction activities, such as final placement of the land bridge. ESA findings confirm previous concepts that management of landfill conditions will be the primary environmental focus for the restoration project.



HYDROLOGY

The Rocky Branch runs along the northern edge of the Dorothea Dix Park site and sits considerably below the elevation of Western Boulevard. The contributing upstream drainage area is west and north of the site and includes approximately 167 acres of the park itself. Offsite drainage basin includes significant areas. To the west of Dix Park, the campus of NC State University contributes significantly to the hydrology that is conveyed through Rocky Branch, as does Pullen Park, Governor Morehead School, Central Prison, Boylan Heights Neighborhood and the adjacent Western Boulevard to the north. In general, areas within Dix Park north of the central ridge line on which the majority of the site's buildings are located drain downhill towards Rocky Branch.

While much of the runoff is conveyed as surface flow to Rocky Branch, there are many locations where existing outfall structures permit the flow of concentrated runoff to enter the creek with little to no dissipation or treatment, occurring both along the southern and northern banks. This presents the potential for significant stormwater control improvements that will address future new park development as well as existing conditions. Unique to the project is an opportunity to implement such stormwater measures as large scale, highly functional amenities for Dix Park.



VEGETATION CHARACTERISTICS & SPECIMEN TREES

The Rocky Branch corridor is heavily vegetated in most instances, consisting of a diverse palette of young and mature trees, and a relatively thick cover of understory vegetation. Much of the understory vegetation contains invasive species, which will require careful and strategic management plans to remove and prevent regrowth.

While a project of this undertaking with the ambitious goals of realigning a stream corridor and widening a floodplain will require significant earthwork, it must strategically balance this with the selective protection and preservation of vegetation. There are numerous locations within the Rocky Branch corridor where existing heritage trees and significant stands of mature trees should be carefully factored into the design. Whether it's the realigning of Rocky Branch, regrading for improved or new pedestrian and multi-use circulation, or excavation and earthwork involved in developing stormwater control measures, the design team and City will need to consider and evaluate existing vegetative conditions to determine what is best for the project.

In many cases the design may be able to minimize impacts, work within tighter constraints, and therefore preserve mature vegetation. While maximizing the amount of tree preservation is certainly ideal, it may not be feasible or in the overall best interest of the broader project goals in specific circumstances. In these cases, it may be in the best interest to selectively remove vegetation, even mature wooded areas, to provide an optimal stream alignment and floodplain condition. In these situations, the existing vegetation can still inform the design. The timber harvested from the site can be reused for various site elements. Cues can be taken from existing species and plant communities within the Rocky Branch corridor and planting palettes can be implemented that pay tribute to these plant communities.

40" Red Oak:
Where the ideal stream realignment allows, established trees will remain. This Oak at Rocky Branch's entrance to the Park is likely one such specimen.

Cucumber Leaf Magnolia:
A Star in the park and along the Stream.

The Grove Wall:
20"-30" Oaks - all to remain

Legend

- Heritage Tree
- Tree Mass
- Lawn|Turf Area
- Wooded Area

WILDLIFE MIGRATION

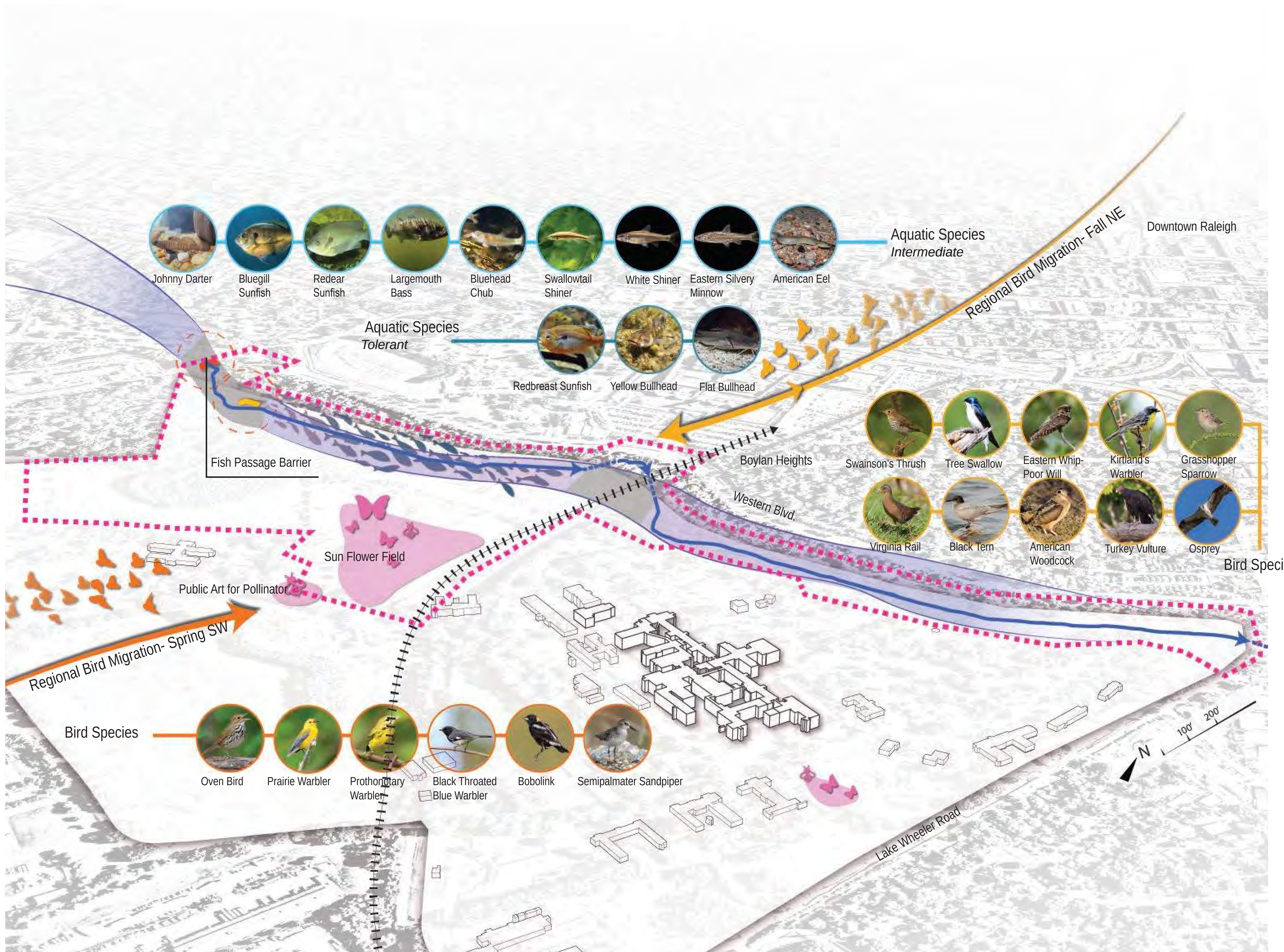
While Rocky Branch has historically been channelized and relocated to the edge of the valley, directly adjacent to Western Boulevard, the existing in-stream habitat is not severely degraded and included a combination of riffles and pools within the assessment reach (See 7.0 Appendix B Existing Conditions Report).

Wildlands Engineering, through biological sampling, found that the overall North Carolina Index of Biological Integrity (NCIBI) rating for this +/- 1 mile of Rocky Branch is "Good". No 'intolerant' species were recorded, nor the more sensitive species whose presence indicates Excellent to Good Quality Water. The lack of diversity and abundance within the studied area could be due to lack of suitable habitat and/or poor water quality.

The culverts at Ashe Avenue and Western Boulevard form a fish passage barrier, prohibiting fish from swimming further upstream to spawn. One element of ensuring a healthier waterway would be to remove all fish passage barriers where possible. This culvert at Ashe Ave is the primary barrier within the Site, with a vertical drop of 8', an unswimmable condition.

The existing diverse and dense vegetation provides habitat for pollinators and multiple bird species. As mentioned, Oaks and Sycamores line the stream, providing habitat and food for some of the greatest number and diversity of Lepidoptera (butterflies/moths). Further, the rich life the trees support, along with a dense understory and activated soils that provide further nourishment and security for the micro and macro biologies on site.

Restoration efforts are expected to improve habitat and water quality, which would result in potential increase in diversity and abundance of the fish, birds, reptiles, amphibians, mammals and macroinvertebrate communities.



UTILITIES

Rocky Branch and the many utilities serving this area of Raleigh share a common corridor, with minimal distance between the stream channel, underground utilities, and Western Boulevard. In many cases, the utilities are old, fragile, and due for repair and replacement.

In multiple locations, pipes cross the stream, airborne. The City's infrastructure becomes a part of the riparian systems, protruding from the banks like fallen trees throughout the site, bridging the channel.

In restoring Rocky Branch, there is opportunity to repurpose utility infrastructures, or at least reframe the park visitor's perception of the utilities by making the typically hidden infrastructures into visible systems to study alongside a restored stream recovering from the burdens imparted over time.

Stormwater outfalls and sanitary sewers have been studied for potential relocation or for capture and treatment in the designs:

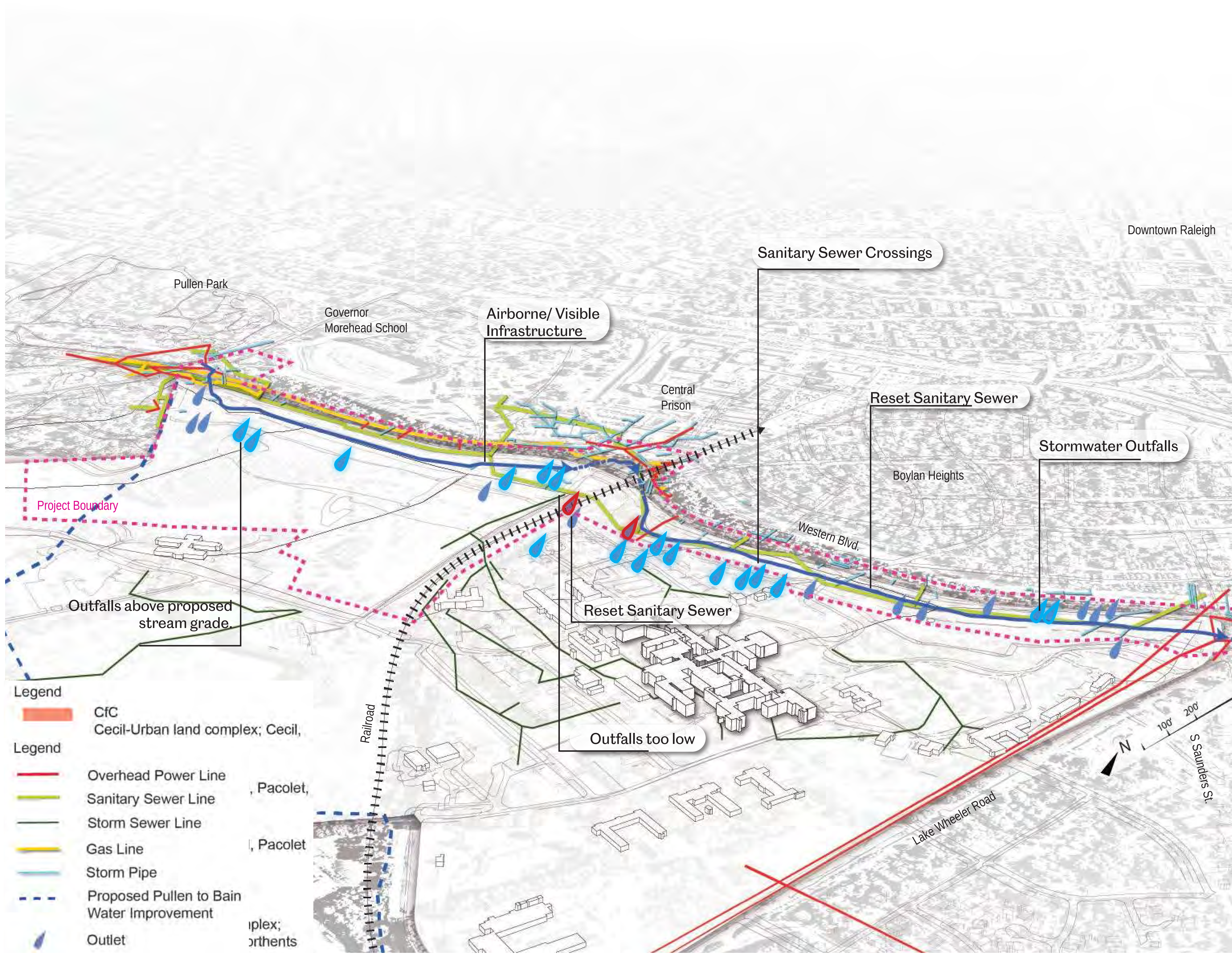
Stormwater Outfalls: Pipe Outlets along the stream release stormwater straight into Rocky Branch. In some cases, the outfalls are partly up an embankment and the water therefore has an opportunity to filter before hitting the stream. Where major topography change and outfalls coincide, there's opportunity use the grade change to treat the water before it reenters Rocky Branch. In areas of flatter topography are opportunities for larger water features reminiscent of the site's historical wetlands.

Outfalls above proposed stream grade: are likely to remain in place, if not daylit sooner. In these locations, there is potential for stormwater treatment to become an amenity for the park, a location to showcase regional ecologies and potentially form a gateway to not only the park, but to understanding the larger watershed.

Outfalls too Low: In locations where the outfalls are too low or too close in elevation to the stream bed, the pipe will likely need to be raised or otherwise reconfigured for the purpose of the enhancement project.

Reset Sanitary Sewer: Relocating these lengths of sanitary sewer to Western Boulevard would allow for the best realignment of the stream.

Sanitary Sewer Crossings: Two pipes crossing Rocky Branch west of Boylan Road, forming a 'V', cross at stream bed elevation and can likely stay as they are. The stream is stable here in its narrow channel. The three scenarios reflect that and use the topography to help restore and enhance the stream without requiring relocation of the sewer crossings.



VEHICULAR CIRCULATION

Dorothea Dix Park currently favors the driver, with asphalt roads and sparse sidewalks forming the circulation on site. As the site developed, the goal was not always to have people meander through the site, but to get from point to point by car and then leave. As a park, the site can benefit from some of these pathways and intersections already in place and use them towards a goal of a more connected system. The following scenarios complement the City's previous studies of potential methods of navigating the barriers that the auto-focused infrastructure presents.

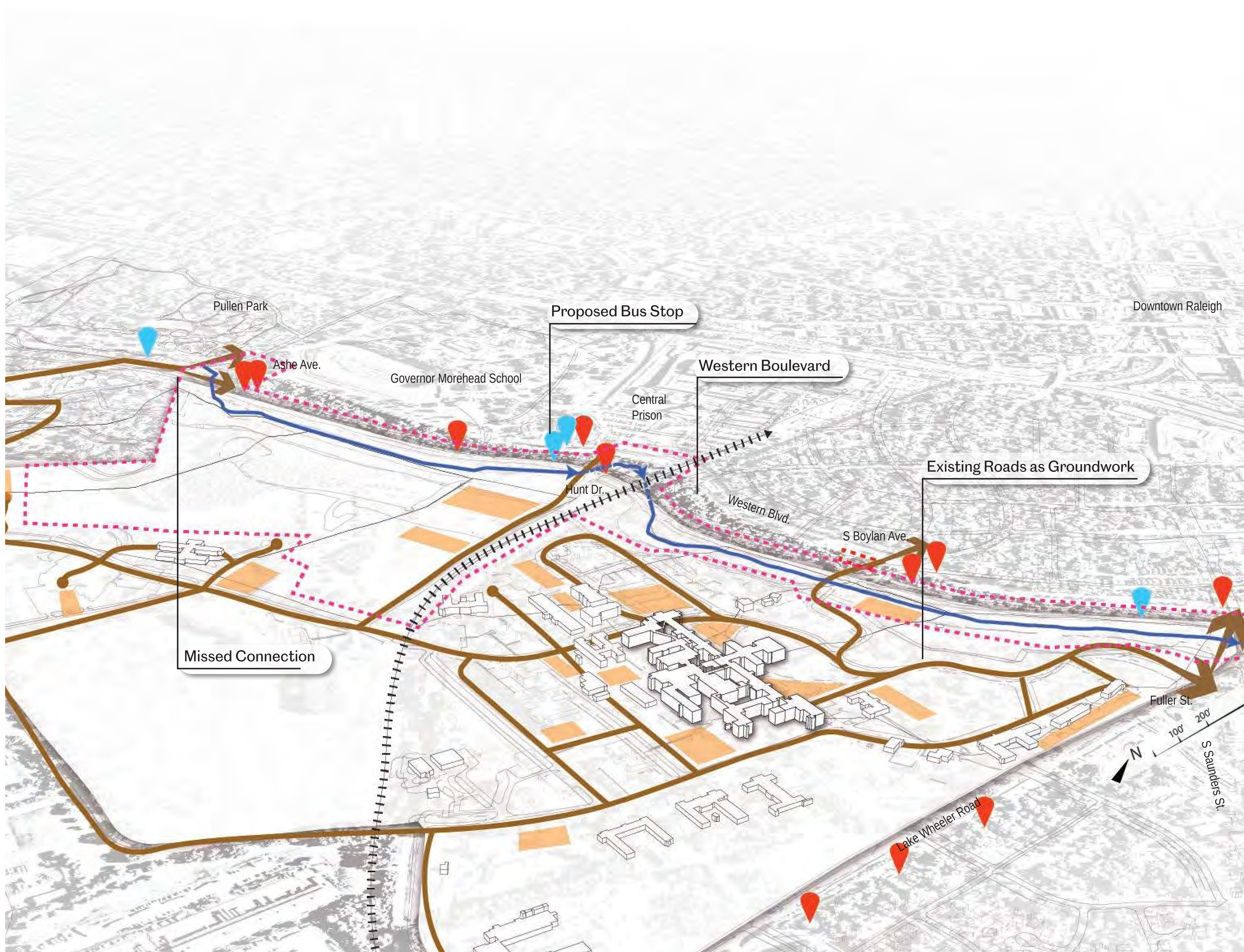
Umstead Drive bisects the park East - West, connecting the otherwise disjointed park across the barrier of the railroad. The Rocky Branch Enhancement Project treats the current points of access as gateways to the Branch system, to the park, and connects them back to Umstead Drive (and the Loop as depicted in the Master Plan).

Western Boulevard effectively gets drivers into and out of Raleigh. It also, unfortunately, is the primary barrier between connecting Dix Park and its neighbors to downtown Raleigh. Along with connecting to proposed transportation advancements (Wake BRT)and existing pedestrian connections, the following scenarios propose networks of pedestrian circulation that cross barriers Raleigh's infrastructure can impose.

Some key access points and potential gateway areas are the bus stop locations, existing and as proposed within the Wake Bus Rapid Transit 15% Design plans. Both the proposed and existing stops are located in relatively close proximity to key traffic intersections, which helps concentrate access into the park into a few key areas. The following scenarios use these points as anchors for the proposed site circulation that brings people into the park and into engagement with Rocky Branch.

Existing Roads as Groundwork: The roadways that have, over time, effectively led folks into the Park's former programs provide, in instances, a foundation for proposed circulation. The Master Plan incorporates some of these roadways as paths - The Loop, for instance, that builds off of Umstead Dr. and becomes a backbone for further connections. The following scenarios continue this effort of utilizing the existing circulation that works for the park, while connecting back to the Master Plan's proposed overall Park circulation.

Missed Connection: As identified in previous studies - the Master Plan and Raleigh Planning and Development's Wake BRT: Western Blvd Corridor Study; Urban Design Report - the Intersection of Ashe Ave and Western Blvd. presents a great opportunity to reimagine the Rocky Branch channel and pedestrian navigation.



INVENTORY & ANALYSIS: SITE EXPERIENCE

PEDESTRIAN CIRCULATION

The Dix Park site is vehicle-focused with a limited network of sidewalks and greenways. Until more recently, Dix Park has not been a park - pedestrian circulation through the site has not been an emphasis of the entities historically occupying the buildings on site. This has resulted in both the pedestrian and stream being relegated to the edge. There is opportunity to bring both into the park.

The Rocky Branch Greenway, which runs parallel to the creek, does provide connections to the east and west connecting Dix Park to other key destinations such as Pullen Park and Walnut Creek Wetland Center. The restoration and enhancement of the creek provides opportunities to create a new system of bicycle and pedestrian infrastructure that encourages interaction with the stream and related program in support of the park visitor's experience, all while enhancing existing connections.

Legend

- Pedestrian Path
- Offsite Connection Entrance/ Exit
- Rocky Branch Greenway

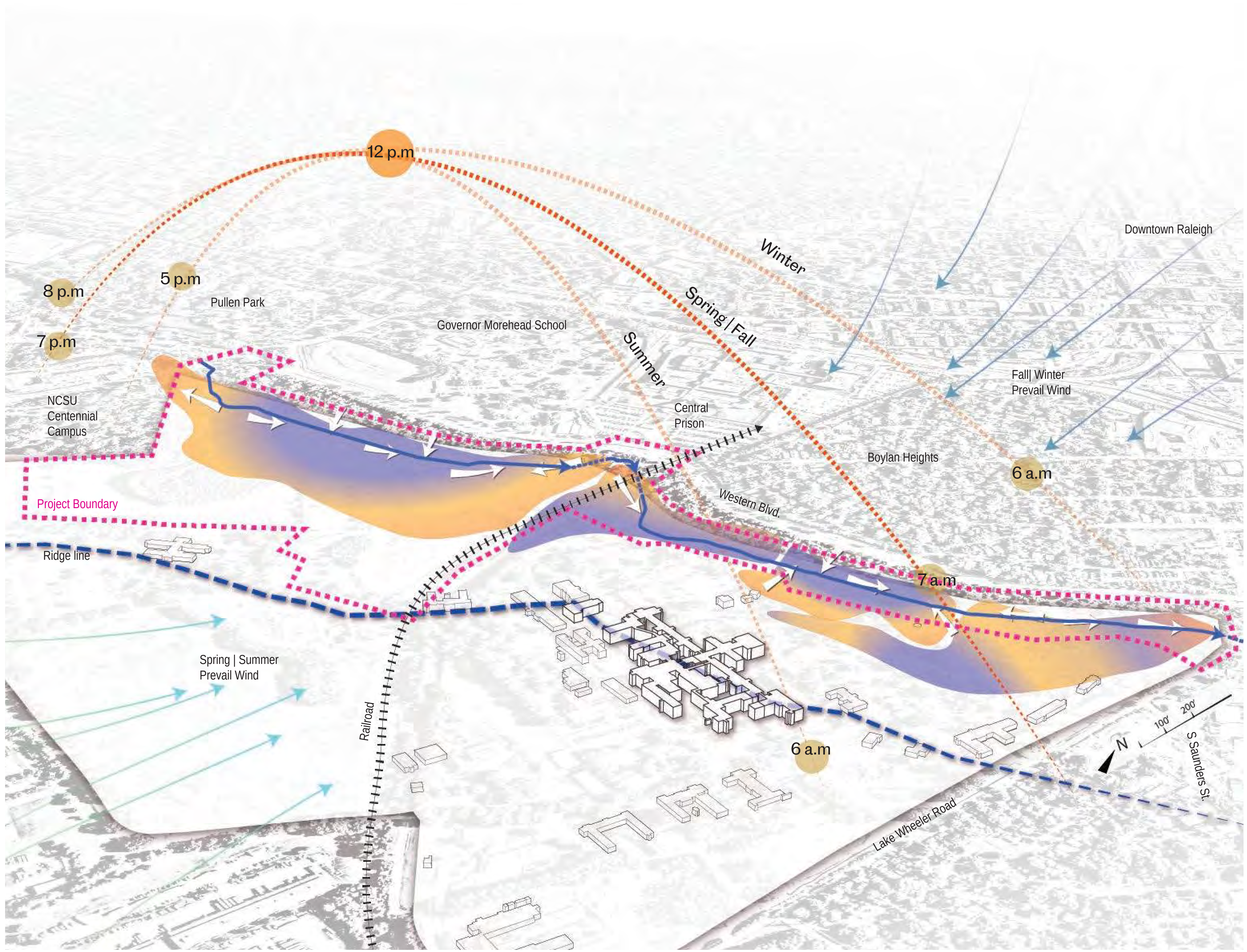
CLIMATE

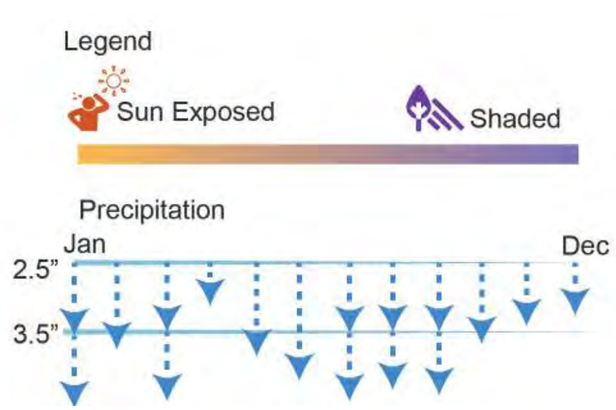
The site's topography, solar orientation, prevailing breezes, and vegetation are key drivers of the microclimactic experience of the Site.

Starting from the Northwest, it is cooler and shadier along the Greenway. The dense vegetation that occupies this area provides shade for the Greenway north of the stream. The open fields just north west of the railroad and where the sunflower field is today are the contrast. The orange areas below have greater exposure to the sun, and are generally more open. The vegetation is more sparse and the topography is relatively flat.

As the pedestrian paths throughout the Park are limited, the current primary pedestrian experience of the Park is the Greenway, which, for the majority of its length within the park has canopy coverage. As canopies open closer to intersections with Western Boulevard and the floodplain widens on the south east end with few trees lining the greenway, the User experience is more open and exposed to views into the Park or across potential amenities.

This spectrum of Exposed to Shaded conditions along the existing stream corridor are reflected in the proposed Scenarios that enhance opportunities for forested reprieve and those for open gateways to the park. The major open areas in the diagram below correspond to the High Point with a View, the play and sunflower fields and their view into the Park, The Visitor Center, and the floodplain just north of the Grove. These areas are defined by that character and have great potential as the major gateways into Dix Park.

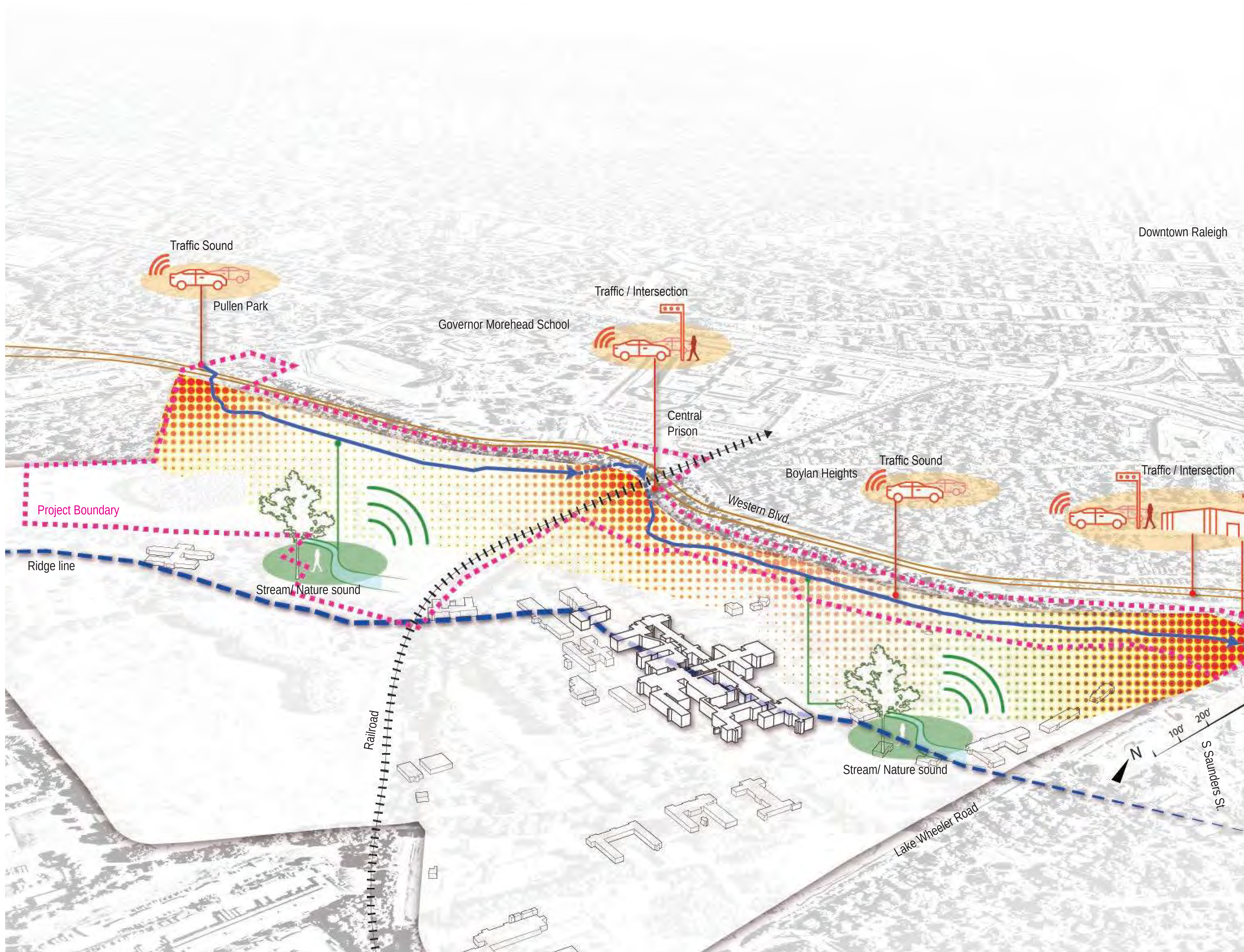




AUDITORY EXPERIENCE

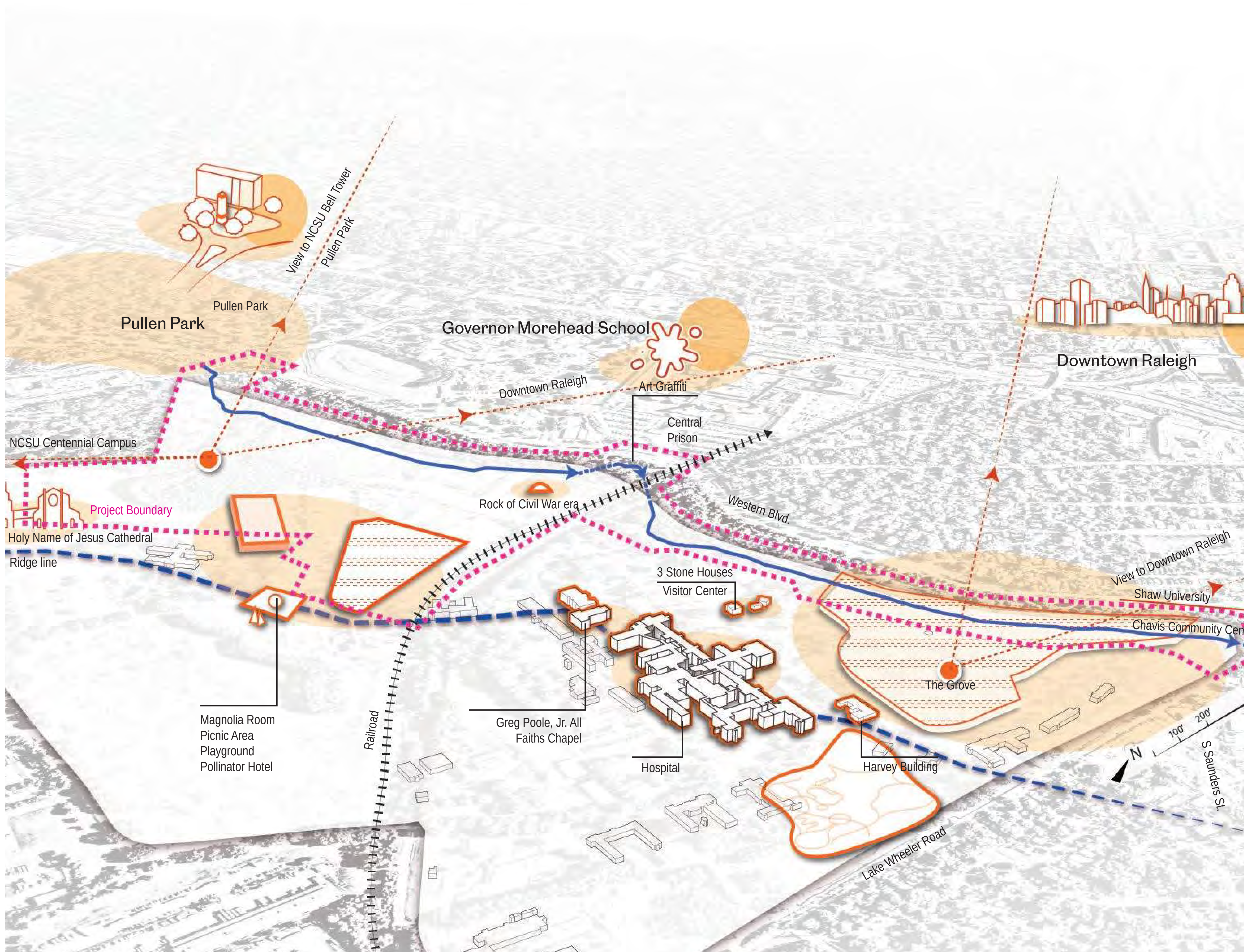
Western Boulevard contributes the most noise to the experience of Rocky Branch and the northern edge of Dix Park. The auditory experience is much louder as the greenway nears Western Boulevard and the intersections with it. Where the Greenway is distanced from Western Boulevard corresponds to the areas of lower decibel depicted below. Distance is the primary method of separating the park user from the exposure to Western Boulevard's noise.

The proposed scenarios leverage that distance from Western Boulevard by providing multiple paths connecting the stream and programs throughout the site, adding complexity and depth to the auditory experience of Rocky Branch. While supplementing with variations in grade and vegetation buffers aid in muting the sounds of the traffic, distance from the source of the sound is the primary factor. Restoring the stream provides opportunity to introduce diversity into the existing soundscape. Examples of this are enhancing streambed conditions that produce different soundscapes, like bedrock glides or step pools that result in small falls and the sounds of water traversing that grade change. Restoration and reintroduction of habitats will also add additional layers of sounds to the experience of Dix Park, as songbirds find refuge in the replanted or enhanced buffers, and spring peepers find homes in potentially restored wetlands.



POINTS OF INTEREST

One of the primary assets of the Dix Park experience are the views to the surrounding cityscape and downtown Raleigh. The High Point with a View atop the landfill and Harvey Hill provide spectacular views of the Raleigh Skyline. Part of honoring that visual connection will be providing accessible pedestrian connectivity throughout the project site, opening the gateway to a broader public. Especially with the implementation of some elements of the Master Plan to date and some already active spaces throughout the park (dog park and playgrounds by the Magnolia Room, southwest of the sunflower field), Dix Park has many amenities. What the site analysis shows is that its connections between these amenities and the Park's surroundings that are lacking, where there's opportunity for improvement. All three design scenarios propose circulation patterns that connect the City of Raleigh with not only Rocky Branch, but to the current and future points of interest within the site.



MASTER PLAN IMPLEMENTATION

Task 2 of The Rocky Branch Enhancement Project evaluates the feasibility of transforming the degraded urban Rocky Branch into an engaging, vibrant, and resilient waterfront amenity. This involves navigating combined efforts of stream restoration and landfill reuse as well as landbridge scenarios in efforts to create spaces that are reflecting the Core Principles of the Dix Master Plan: “Open up and connect”, “Build from what is there” and “Offer something for everyone”. The primary objectives of Task 2 were to evaluate the proposed plan for The Creek landscape as presented in the Dix Park Master Plan which includes a meandering channel, improved floodplain bench, adjacent stormwater wetlands and ponds, park program spaces, fields and meadows, native riparian vegetation, Western Boulevard land bridge crossing, and a greenway system. Task 2 proposes and evaluates three different scenarios that meet the goals of the Master Plan and provide similar programming and stream engagement, yet vary both in terms of level of intervention and cost.

DATA GAP ANALYSIS SUMMARY - ENVIROMENTAL AND GEOTECHNICAL EVALUATIONS									
	Soil								
REACH	Existing Soil	Stockpiled Soil	Cover Soil	Landfill Waste	Groundwater	Surface Water	Sediment	Landfill Gas	Geotechnical Evaluation
Pre-Construction Characterization									
1	N/A	Collect cover soil and stockpile samples to evaluate soil management and reuse options		Collect landfill waste samples to evaluate waste management	Install monitoring wells along Rocky Branch (more focused in area of landfill) to evaluate the extent of groundwater impacts and groundwater elevations in relation to the proposed footprint of stream restoration activities.	Collect surface water samples in Rocky Branch to obtain current data at up, at, and down gradient of landfill prior to construction	Collect sediment samples in Rocky Branch to obtain current data at up, at, and down gradient of landfill prior to construction	Collect landfill gas samples to evaluate soil gas concentrations in landfill waste unit to support design of landfill cover and ventilation system	Advance soil test borings in the landfill to evaluate subsurface conditions and to conduct differential and total settlement analysis for construction of foot bridge, retaining walls, slope stability, stream bed stabilization, and infrastructure
2	Sample existing soils to develop resue strategies.	N/A	May need to consider in the event waste extends beyond the landfill boundary into Reach 2					N/A	
3		N/A	N/A	N/A				N/A	N/A
Constrution Monitoring / Pre-occupancy Sampling									
1	N/A	N/A	Sample final surface soils for prior to occupancy to confirm that surface soils meet applicable regulatory reuse requirements	N/A	N/A	Collect surface water samples in Rocky Branch to obtain current data at up, at, and down gradient of landfill during construction	Collect sediment samples in Rocky Branch to obtain current data at up, at, and down gradient of landfill during construction	Landfill gas mitigation system testing and pre-occupancy sampling	N/A
2	Sample soils to confirm that surface soils meet applicable regulatory reuse requirements	N/A	N/A	N/A	N/A			N/A	N/A
3		N/A	N/A	N/A	N/A			N/A	N/A
Post Construction Monitoring									
1	N/A	N/A	N/A	N/A	Long term compliance monitoring of landfill following closure	Monitoring of surface water quality in Rocky Branch following landfill closure	Monitoring of sediment in Rocky Branch following landfill closure	Landfill gas ventilation system Operations and Maintenance Sampling	N/A
2	N/A	N/A	N/A	N/A	N/A			N/A	N/A
3	N/A	N/A	N/A	N/A	N/A			N/A	N/A

DATA GAP ANALYSIS SUMMARY - STREAM REALIGNMENT AND DESIGN CONSIDERATIONS				
	Scenario A Design	Scenario B Design	Scenario C Design	Notes
Perform a cursory study of stream flood modeling to understand design limitations and minimize flood risk.	X	X	X	
Preliminary bridge and culvert replacement designs and cost evaluation at Western Boulevard (upstream), Hunt Drive, and Norfolk Southern rail line.	X			
Preliminary cost of landfill remediation based on floodplain excavation	X	X	X	
Contact with Norfolk Southern Rail to determine viability of culvert installation through existing railroad embankment	X			
Contact with Central Prison to determine viability of abandoning existing concrete flumes and relocating Rocky Branch onto Dix property.	X			
Final City of Raleigh Bus Rapid Transit (BRT) design for Western Boulevard and Hunt Drive realignment	X	X	X	

Dix Park

Leadership Committee

Date: Tuesday, November 28, 2023
Time: 9:00 AM – 10:30 AM
Location: All Faith's Chapel 1030 Richardson Drive

Committee Members Attending
Orage Quarles, Dix Park Conservancy, Vice-Chair
Council Member Corey Branch
Jim Goodmon, Dix Park Conservancy
Carlton Midyette, Dix Park Conservancy
Beverly Clark, Chair, Parks Recreation Greenways Advisory Board
Ashton Fisher, Co-Chair, Dix Park Community Committee
Stephen Bentley, Director, Parks Recreation and Cultural Resources Department
Tansy Hayward, Deputy City Manager
Alicia Knight, Associate Vice Chancellor, University Real Estate and Development, NC State University
David Smith, Deputy Commissioner, NC Department of Agriculture
Bill Ross, Dix Park Conservancy
Nancy McFarlane, Dix Park Conservancy

Staff & Consultants Attending
Kate Pearce, Executive Director, Dix Park
Dean Peary, Senior Planner, Dix Park
Eric Davis, VP and Landscape Architect, Surface 678
Robert Pratt, Principal and Landscape Architect, Surface 678
John Hutton, VP and Senior Project Wildlands Engineering
Jeff Tyburski, Senior Principal, Geosyntec
Janet Cowell, President & CEO, Dix Park Conservancy

A. Call Meeting to Order
B. Public Comment
   1. Doug Johnson: I think we can get really excited about the progress we've made. There are three sides to Dix Park. One is Lake Wheeler Rd, the second is Western Blvd, and third is Barber Biggs drive. Lake Wheeler Rd is already underway with play Plaza. Western Blvd is going to have a great water feature. A Raleigh waterfront who would have thought it. There is also going to be one on Industrial drive as well. On Biggs and Arbor there were somethings that were at a little bit of a limbo with making sure that that part helps in the effort to make the park feel like it has that indefinite extent that you like in a natural open space. I hope that we'll find a way to get busy on that part of the project sooner rather than later. Tom Gibson's great work, as I mentioned the last time on the play Plaza Duke Energy Sunflowers again, who would have thought an

energy company busy with coal and nuclear has its emblem In Dix Park as a Sunflower. Maybe there's a connection there for the notion of its energy role. That's one of the key things that we've learned from the experience with the sunflowers, the relationship with other parties that are key to the success of the park. Lake Wheeler Rd pretty much under our control, although anytime you work with the DOT, you must worry about that. But they really did come around on this project. Likewise, project on the Rocky Creek restoration is going to be a very key water feature. I hope we'll find a way, maybe using the relationships and resources. I think immediately if Chuck Flinks organization at Community contribution from the Department of Design, maybe even the appearance Commission for some set of sorts of beginning Charette, or don't use a fancy name. Maybe consider a work group to see what the resources are and how much can we begin on productively now knowing many of the things we do. Thank you.

C. Welcome & Approval of Minutes
   1. Motion, Councilman Corey Branch. Second, David Smith
D. Community Committee Report
   1. Ashton Fisher: We have sent a survey out to community committee members to get their input on what we did well this year and what we can do better next year and how we can better partner with this group as well. But I think everybody feels good about where the committee has come from, we are looking forward to next year and looking forward to seeing everybody at the holiday party.
E. Project Updates
   1. Rocky Branch Enhancement Update
      a. Nancy McFarlane: Why are there separate bubbles for things opposed to the concepts we've been looking at?
      b. Robert Pratt: Through our site analysis we were able to find natural systems which are the green circles that we can leverage and build upon. For instance, in some of those areas, they have strong stands of trees where they have wonderful parts of topography that we think should be brought forward and integrated as part of the experience. When we overlay circulation pass or when we look at connections between rocky branch and the program that could occur within Dix Park, how we can approach that in a way that's safe but also in a way that restores and builds upon those natural systems.

c. Orage Quarles: Can you give an example of recreation and engagement?

d. Robert Pratt: Rocky Branch is not isolated. The master plan engaged and brought a sense of vitality and presence along the stream edge. The area that you see highlighted where it says play that's a series of structured ball fields that could occur in the master plan. We wanted to think about if there's a programs sport activity in the master plan, and how we would connect that up to Rocky Branch. For example, if I come to enjoy the sports, how can I also come and enjoy the stream? How can I come and enjoy the storm water features? How can I come and engage in the stream and the natural water features? Play takes on a variety of activities, both in terms of active and then more passive in terms of picnic and or outdoor education. We think there's a variety of play opportunities that could occur.

e. Councilman Corey Branch: Is this standing water or moving water?

f. Robert Pratt: In these bio retention systems, the drawdown for some of our systems is 12 to 24 hours. There will be limited standing water. It is a movement and circulation where we're very acute vectors and making sure that we don't create issues that could be for mosquitoes.

g. Councilman Corey Branch: Currently does the stream run under the prison? Are there any new changes being made to changing the location?

h. Robert Pratt: Yes, we've looked at the morphology, the stream currently goes through Western Blvd then it goes back to the South, and it comes back under Western Blvd again. It crosses under Western Blvd twice and leaves west of the railroad and then it comes back east of the railroad.

i. Orage Quarles: If I started at the far end the west end, I can physically walk down a path?

j. Robert Pratt: Yes, you can walk a path all the way from the northwest corner, top left to the bottom right, and you can walk multiple paths as well off that main path, we're going to have secondary paths that provide alternative experiences.

k. Stephen Bentley: When you say path, is this gravel or is it paved?

l. Eric Davis: This would be a paved path. We're thinking it's about like a 14-foot-wide Greenway standard type.

S678 will highlight the proposed meandering paths, all of which are intended as accessible paths.

m. Stephen Bentley: For primary I get its 14 feet, but the secondary ones are they natural surface? I'm thinking ADA and the ability to connect with nature, there must be mobility consideration.

n. Eric Davis: We're thinking there be mobility, they would be solid surfaces. The other piece of this is from a maintenance perspective, as we get in closer to it. This is a stream. It's a living changing thing, the durability of this and these landscapes is critical. The longevity of the site, longevity of this design and the implementation for the park holds true. We'll think about materials as we think about longevity.

o. Orage Quarles: The length of the path is approximately how long?

p. Eric Davis: It's approximately one mile ±.

q. Carlton Midyette: Is this a relocation of the Greenway?

r. Eric Davis: Yes, that's envisioned to be a relocation of the Greenway. Pulling it in again and kind of weaving it through more of the experiential spaces within the park following the Greenway.

s. Carlton Midyette: Is the creek being moved?

t. Eric Davis: The Creek is being moved and it's being moved in various amounts in various regions of these of these alternatives. Where it runs today will be adjusted and so that paths, distance, and separation from the Creek is going to sort of evident foil like in some distances it might be a greater separation and in some it might be right up on the water's edge at a higher elevation, and then it may be like a step down or a terrorist overlook or something like that.

S678 will highlight areas of proximity to creek.

u. Carlton Midyette: Will it feel like you're walking along the creek?

v. Eric Davis: Yes, that's the goal.

w. Jim Goodman: What does the landfill mean to us? In terms of what we can and can't do?

x. Eric Davis: What we're able to do is we are able to modify the grade within it. We were able to move that soil and the landfill waste around on the site, but it needs to remain on the site. As we dig into that hill, we must think about where else that dirt needs to be moved and how it needs to be utilized on the site.

y. Jim Goodman: It can't be hauled away?

z. Jeff Tyburski: Yes, but it will be very cost prohibitive. There are ways to safely keep the landfill waste in place and work around it. Basically, what this project entails is digging into the landfill and create safe reuse and expand the stream. This has been done before, there are a lot of tools we can use to safely do this and create unique spaces. As far as the remaining landfill waste, we use engineering controls to basically encapsulate it and create a engineered soil cover that's placed over the waste. Then there's landfill gas collection systems to manage the ongoing degradation of the waste and gases that come off that. These are well established methods that we are evaluating right now.

aa. Jim Goodman: How big is the landfill?

bb. Kate Pearce: The whole landfill is 53 acres.

cc. Jim Goodman: Are we going to keep the hill?

dd. Kate Pearce: We'll make more hills will take hills down it's about creating more topography.

ee. Eric Davis: We're trying to work with the hill where we're utilizing that as an opportunity, a high point on the site. We're the hillside Meadow is shown is sort of building upon the idea of that hill, it becomes a sort of an iconic piece at the northern end of the site. We're thinking about a hillside Meadow there where there's pathways that wind their way through that and it becomes, an experience that's unique to Dix Park. We want to make sure as you arrive and depart the land bridge that you have slope conditions that allow you and I to move, whether we're walking or whether we're riding within a reasonable slope condition.

S678 and consultants will talk to implications of engaging with Landfill site within the Report.

ff. Janet Cowell: As far as capping. Are you having to remove and put a liner underneath? Or will it remain without a liner?

gg. Jeff Tyburski: You don't need to put a liner under the existing landfill, but where you remove the waste and create the stream bed. There are certain liners and systems that we will put to create a new stream bread bed to create safe separation of residual contaminants that leach down through the landfill overtime, you have clean storm water and safe places to explore the park on. On top of that, and that's what we're considering right now in our

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process. And again, these are well established methods that have been used in other large waterfront time type stream restoration projects.

hh. Nancy McFarlane: Can you get in the water?

ii. Eric Davis: Yes, you can.

jj. Kate Pearce: There are multiple places where you could access the water, but when we get down into reach 3 is where it kind of flattens out more down by Lake Wheeler Rd. This isn't a stream we are going to be able to raft down but there are going to be ways to get your toes in it.

kk. Beverly Clark: Within the master plan a big part of the Restoration project was the ability to interact and connect water because we don't have that.

ll. Stephen Bentley: I think it's recognized this in urban stream, the master plan set we wanted access to it, but the realization is if you choose to get in the water or not will be a big decision, because it's still an urban stream.

mm. Eric Davis: It is an urban stream and there's only so much control we have.

nn. Orage Quarles: At its widest point, what are we talking about in terms of width?

oo. Eric Davis: The channel of the stream is 20 feet; the normal channel width is 15 to 20 feet. During any rain event it's going to quickly start to rise, and that width will increase. There's relatively a shallow channel and there's a floodplain bench. In a heavy rain event that would go 100 plus feet in multiple locations along this corridor. It's designed to be a stream on your day to day with a base flow, but then more accommodating to these flood events. Where you don't have a flood bench up in this area adjacent to the gravel parking lot out there today, you have much more significant meander on the stream as it's designed here and then it's a much healthier ecological system that allows that stream to flood. The baseline flow is going to be 15- to 20-foot-wide stream.

pp. Councilman Corey Branch: What is the cost centered around the railroad?

qq. Eric Davis: That covert alone, and this is just dealing with the covert alone, that covert alone is probably in the about $20 million to do that type of construction. These are ± numbers at this point, but $20 million is approximately what it's going to cost to put that stream under the railroad.

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rr. Nancy McFarlane: What is in between the creek and the road?

ss. Eric Davis: Between the Creek and the road, you're going to have slopes Topography. There's going to be a floodplain bench. That's where the topography is going to be very gently sloping away from the Creek that allows the stream to flood safely and stay within a design footprint. Then it's going to transition to more of a 5 to 1 slope, it's going to be steeper, but not incredibly steep. Its easily maintainable There would be repairing and buffer planting, there would be a combination of vegetation, trees, reforestation, where we're able to. We'll try to preserve significant stands of trees on site, and then there's another trail system. There's a smaller trail there, 8 to 10 feet wide. That is a pathway and that again is pulled inbound just a few feet so that it's not right back of curb and then you've got another green strip of vegetation. The idea is to pull as much of that pedestrian circulation into the park. To get it away from the noise and the congestion of Western Blvd.

tt. Nancy McFarlane: What about Berm?

uu. Eric Davis: We have graded there. There is a shallow berm graded that'll allow you a little bit of a visual separation and then that can be planted. There's a little bit of noise benefit from that and then you'll get a little bit of visual separation as well. There's not a berm on the entire length of this due to where and that's just a balance of where we can grade it and where we can't grade it in. But where we do have the room to do that, we can certainly accommodate with that berm.

vv. Councilman Corey Branch: Is this information based on four lanes divided?

ww. Eric Davis: This is based on four lanes divided and we've started to think about collaboration with the BRT as well.

xx. Robert Pratt: The BRT has been considered here as well and that would also include the bus stops, especially near hunt.

yy. Janet Cowell: Earlier in the spring you all presented one where you realign the road and the BRT station shifted. In this case, are you still looking to realign hunt or is that gone away?

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zz. Eric Davis: We're not suggesting it be realigned in this study, but I don't think there's anything that would preclude it as design from it being something that happens, 20-30 years down the road.

aaa. Bill Ross: Is this design dried detention opposed to wet detention?

bbb. Eric Davis: The wetlands would be wet. There's a permanent amount of water that would be in some of these features and then some of the other features that are higher up on the slopes and closer proximity to like parking and things like that would probably be permanently dry and they would, they would indicate, and they would be out fast. They would drain down quickly.

ccc. Carlton Midyette: Are these pathways flat?

ddd. Eric Davis; These pathways are more or less flat, and they have flat connectivity out to Lake Wheeler. You will have full accessibility through this area of the site.

S678 to more explicitly illustrate potential to interact with stream.

eee. Kate Pearce: A lot of the questions are centered around access to the water and one thing we can do moving forward is look at the plan diagrams and highlight those specifically. You can see the multiple points along the Creek Corridor where you could have access if you wanted it.

fff. Carlton Midyette: I understand that the realities on the site don't necessarily meet. The picture of the broad stream with kids skipping rocks and sailing boats and merrily enjoying Raleigh, the waterfront is reflected in this plan, and it may be topographic and frame hydrology realties. What is the difference between how this would be used and how the original master plan let us to think that'll be used? This doesn't seem to reflect the image of the Raleigh's waterfront in the original master plan.

ggg. Kate Pearce: I don't necessarily agree. I think it increases the amount of pond like features that were first imagined in the master plan. After the technical analysis and learning what we learned, some things have changed. But I don't think this decreases the amount of interaction or fun that you can have along the system. I think there's more pond like experiences where stuff could happen.

hhh. Tansy Hayward: I think some of this is pictorial depictions. This shows a lot of the bird's eye kind of experience, whereas I think some of the master plan

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S678 will provide eye-level graphics showcasing human engagement with the proposed water systems.

showed people interacting in the spaces, which we don't have much here. That may be an iteration that we get into as we start to narrow in and personalize images.

iii. Kate Pearce: The scale of these drawings is important to consider also, we can look at some different renderings that would put you at the water's edge for that experience. We're at a different scale and perspective.

jjj. Carlton Midyette: I'm not criticizing, I'm just saying that this stream has a hard edge on both sides. And there's a difference in a pond experience and getting at water level as opposed to being able to get in the water easily and safely. Maybe it's not necessary. I don't see any point yet that provides easy parental and child access to splash, and it may be a smaller scale or a more evolved design.

kkk. Jim Goodman: This is a terrific plan. It is a lot more complicated. There is a lot of things going on here than we had an anticipated. Have y'all done a cost estimate?

lll. (LLL) Eric Davis- Yes, we've done a high-level preliminary cost estimate to start to develop some ranges on these various scenarios. What we're really looking at are a range ± of the 120 mark is what we're thinking on this 120 million, 115,000,000 and then ± a lot. There are some unknowns as we dig into that landfill as we fully design how much we're impacting that landfill that might push and pull on that number a little bit but that is sort of the midpoint of that range.

mmm. Kate Pearce: The conceptual cost estimate from the master plan, it was $100 million.

nnn. Carlton Midyette: Do we have enough water in the creek to do all of this?

ooo. Eric Davis: The base flow is not really going to change much from what we're thinking from what exists there today. There might be opportunities we could think about possibly charging in with other things from on-site sources. But the base flow movement will be what it is.

ppp. John Hutton: Rocky branch for an urban system in this part of North Carolina has surprisingly good base flow with clear water at base flow. I won't say the same when it's a storm event. If you've been out there when it's really rolling

through, there's a lot of sediment and debris moving through the system, but it base floats. We have talked about supplementing that base flow with syncing some wells to supplement clear water coming in, especially during the summer months. I don't think it's as necessary as I would have thought early on. I'm going to address one question that came up earlier about the difference in the stream width from the master plan getting at that base flow question based on what water is moving through on a normal day. If we did make a 7100-foot-wide stream channel you would not have enough water to support the flow through there and it also wouldn't transport the sediment that's coming through. It would create a lot of problems within sort of a natural stream. What we tried to do in exchange for that is when a natural stream comes around a meander bend, whether it's kind of moving to the left or right. Those bins that you see the stream will widen out and those areas more maybe than the plan currently depicts and will flatten out those areas.

qqq. Beverly Clark: Which crossings will be at grade?

rrr. Eric Davis: The west one is at grade and the one located on the right is an underpass.

sss. Kate Pearce: There will be two Greenway paths, one would follow the existing, the one that hugs Western Blvd right under the railroad would stay the same because we're not moving the railroad. We are not messing with the culvert, there would be a secondary one further into the park under the railroad.

ttt. Councilman Corey Branch: I'm really concerned. I don't see NC railroad allowing an at grade pedestrian crossing.

uuu. Kate Pearce: We have one grade crossing at the park now. It would probably be challenging to have a secondary at grade crossing. That is something we need to consider looking at.

S678 will not address this concern at this time. S678 will continue to show the proposed at-grade crossing with the intention that the design team would continue to coordinate with the Railroad as the City's decisions and the ensuing design progress.

vvv. Janet Cowell: What's the cost estimate for scenario B?

www. Eric Davis: I would say 85 and that's the median of our range. It would be ± 85 million.

xxx. Kate Pearce: The main cost difference there is the moving of the stream from Central prison site to the park site being the culvert.

S678 will clarify, graphically, the edges of the scope covered by the cost opinions.

yyy. Stephen Bentley: Does this include the ball fields, the botanical garden? Does it include the uphill features?

zzz. Eric Davis: It doesn't include the Botanical Garden or the ball field. It includes sort of the meadows. It includes the scope of the site that the project would be grading to create. Basically, the Meadow and it would skirt along sort of the edge of like the volleyball fields and the soccer fields and the parking that is not necessarily captured within that.

aaaa. Kate Pearce: What we can do is highlight each scenario and each cost component right and graphically demonstrate what is included and what is not.

bbbb. Stephen Bentley: I thought what you're highlighting in green is what we would be paying for. I didn't realize there was like an invisible line.

cccc. Eric Davis: We're trying to show how we're collaborating with that program, but yeah, we need to draw a line on the map in terms of what costs represents.

dddd. Stephen Bentley: For the hilltop area are storm water controls being considered based on the redevelopment of the top of the hill? That water must go someplace have we accounted for all that?

eeee. Eric Davis: We have not accounted for all the future impervious, we have accounted for at least what is there today. We're in a comfortable range as we looked at what we have out there today and we what we're representing captures what we needed to for today.

ffff. Kate Pearce: If we're thinking about the future of the park, we're reducing impervious.

gggg. Tansy Hayward: The existing culvert that I assume is an NC DOT culvert that takes the stream under Western. Where is it and its useful life?

hhhh. John Hutton: It doesn't appear to be in bad shape at this point, I would imagine it's got some life left.

2. Upcoming Grant Opportunities

a. Nancy McFarlane: Do we have ability to move forward with the grant process when it comes to storm water control? Is there a way that we can move forward on getting some of those grant applications done?

b. Kate Pearce: We have been very opportunistic and our grants strategy, the four that we received that funded this part of it, we didn't have a clear vision of what everything would be. I do think especially around storm water. The land and water fund are our most imminent and viable, given that we were already funded and that they funded the planning section We have been working with Geo Syntex team around some other grants specific to the landfill. I do think we can look at the components and think about that. This goes back to capacity and resource and making sure we're going after the grants that are most viable and we have the best chance of winning.

c. Tansy Hayward: As far as the land bridge, I think to manage expectations there, we can certainly consult a little bit with Department of Transportation. The nature of this bridge would be very difficult to find grant federal funds because the purpose here is much more recreational habitat than it is traditional transportation objectives that would be weighed highly there. We are working very closely between the Dix team and the Western BRT team in terms of design considerations on the pollen bridge that help with robust connections, we can certainly follow up on that question of with without knowing more about the design, but just the function that this bridge would serve, how likely a candidate would it be for some kind of grant money. Given what I know about transportation allocation, it likely would not be very competitive.

d. Councilman Corey Branch: Can we go back and look at what Denver did for the land bridge that they built?

e. Tansy Hayward: That was part of an I-70 rebuild. The motivation there was really that was an add-on to a major project it did reconnect some historical land use impacts because of prior transportation investments. They had two things going on there that probably helped that we don't necessarily have the similar circumstances here.

f. Jim Goodman: Did we price the land bridge?

g. Robert Pratt: The land bridge and scenario A, we looked at ± 25 million.

h. Nancy McFarlane: Did we have conversations with Geosyntec around grant writing?

i. Kate Pearce: We applied for an EPA grant last cycle with the help of Geosyntec we were not successful but got a lot of good feedback on what we needed to improve for the next round of application. I think it is important to identify what we think are the most viable grants and going after those. We need to be strategic in the grants that we target to go after and that's what we're doing right now.

j. Nancy McFarlane: Why would you not apply?

k. Janet Cowell: It's a massive amount of time, energy and then also if you got them, the administration of them, even the National Endowment for the humanities has taken a massive amount of staff time. When we consulted with Kelly O'Brien at UNC Chapel Hill, she also advised us really to be strategic, have deep relationship and go for maybe two land and water would be one and then try to figure out what that other high probability is because of the bandwidth issues.

l. Stephen Bentley: It all depends on the grant, and I think what Kate saying is knowing the ones that are favorable to the most based off the information we have, we target those versus casting the net wide because sometimes you can put months into a grant, and you can't spend that money because you're not ready to for two or three years. It's keeping the momentum of the project as the intention.

3. Dix Park Conservancy Update

a. Janet Cowell: We have the lunch and learn on December 6 at noon which will be discussing the creeks. We are inviting NC State. December 7th Contemporary Art Museum at 6:00 o'clock we're having a party we will have music and food, we are very appreciative of all the partners of this huge project, we just hope it's about fun, celebratory night on December 7th.

F. Around the Table Discussion

G. Adjournment

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Dorothea Dix Park
Community Committee

OCTOBER 17TH, 2023: 5:00PM-7:30PM AT THE CHAPEL

Meeting Agenda

- 5:00-5:50 PM: Optional pre meeting tour of Rocky Branch Creek lead by Dean Perry and Consultants. Please meet in front of the Chapel at 4:50 and wear study, closed toed shoes.
- 6:00 PM: Welcome/Introductions and Call to Order – Chairs
- Approval of Minutes - Chairs
- Discussion – Ashton shares discussion from Leadership Committee (Creek and Grove)
    - a. Rocky Branch Creek Enhancement Project Update (Dean Perry and Surface 678)
        - i. Table Discussion- Chairs Lead
    - b. Cultural Interpretive Plan Update (Eric Regensburger)
        - i. Table Discussion- Chairs Lead
- Co-Chair Report
- Staff Update –
    - a. Projects – Kate/Eric
        - i. Community Garden- Kate
    - b. Conservancy Update- Nick
- Committee Comments – Chairs will ask Committee for comments.
- Adjournment- Chairs

Dix Park
Community Committee

Dix Park Community Committee
Meeting Minutes

DATE: Tuesday, October 17, 2023
TIME: 5:00 PM
LOCATION: Dix Park Chapel, 1030 Richardson Drive Raleigh, NC 27603

Committee Members
Ashton Fisher, Co-Chair
Shana Overdorf, Co-Chair
Amy Simes
Kelly Arnold
Chris Herndon
Sarah Reeves
Dakia Davis
Amy Simes
Ebony Haywood
Delores Paylor
Dwight Dolby
Myrick Howard
Megan Evans
Larry Zucchino
Charlie Leffler
Jenny Harper
Bill King
Maureen Bowman

City Staff
Eric Regensburger, Sr. Planner
Lauren Danforth, Marketing and Communications
Kate Pearce, Executive Director of Dix Park
Dean Perry, Sr. Planner
Joey Vaska, Program Supervisor

Conservancy Staff
Anna Torres, Communications
Nick Neptune, Director of Outreach
Rob Maddrey, VP of Development

Members of the Public
Marcee Silver
Anne Franklin, DPC Legacy Committee
Joseph Huberman

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Anna Behnke
George Jones
Anna Smith
Jay Spain
May Holley
Nicole Milins
Vicki Garlington
Janie Daywhitworth
Eric Davis
Jeff Tyburski
Amin Davis

Meeting Agenda

I. Optional pre meeting tour of Rocky Branch Creek
   I. lead by Dean Perry and Consultants (Surface 678 & Wildlands Engineering)

II. Welcome/Introductions and Call to Order
   I. Co-Chair Ashton Fisher calls the meeting to order.

III. Approval of Minutes
   I. Ashton Fisher motions for Minutes from 8.15.23 to be approved. Committee approved Minutes.

IV. Discussion
   I. <u>Rocky Branch Creek Enhancement Project Update</u> (Dean Perry and Surface 678)
      i) What was imagined for the creek in the master plan?
      ii) Surface 678 Presentation
         I. Introduction
            - Surface Design Team
            - Goals+drivers+inventory = opportunity
            - Design drivers (and later evaluation criteria) driven by the Master Plan goals as well as the design team's priorities.
         II. Current Conditions
            - Showed diagrams of existing conditions
         III. Opportunity
            - Understanding the site via these site analyses and visits, we have identified these areas of opportunity.
            - Showed existing aerials with these areas of opportunity outlined.
            - Design Options
               i. Option A
                  1. Drivers/Key Aspects: Most expensive and most ambitious. Will move creek onto Dix Property and have large Landbridge.
               ii. Option B
                  1. Drivers/Key Aspects: Middle ground, will keep creek crossing western. Smaller Landbridge
               iii. Option C
                  1. Drivers/Key Aspects: Keep creek across western. Pedestrian bridge instead of land bridge. Less meander in stream, less grading work. Stream enhancement, not restoration.
               iv. Renderings/ Design Progress Drawings and Diagrams
                  1. They conveyed the recommended improvements and interventions of the three options, as well as conveyed early development of the character of what the Rocky Branch corridor is envisioned to become and offer for the City and Dix Park.
      iii) Group Discussion with Consultants
         I. Do you have any questions about any of the options? What most resonates with you about this project?
            I. I am most excited about the Landbridge, and options A & B are most exciting to me as it offers the most connectivity. It would make people more exciting for the project.
            II. Is there a sense of urgency for picking an option?
               (i) Ideally what comes out of this project is a preferred direction as well as cost estimates.
            III. Would the General Public be able to see all options?
               (i) Yes, at the public summit early next year.
            IV. Can you provide some examples of other beautiful pedestrian bridges?
               (i) Yes, we can.
            V. I like the ideas of ecological corridors and wildlife protection. How can we incorporate residents of the community?
               (i) We need to connect natural history with cultural history. We hope that the new cultural interpretation plan will help address that.
            VI. Will Civil War Rocks be protected?
               (i) Yes, we are aware of the rock and will try our best to preserve landscape around it.
            VII. How will you deal with built up pollutants in Stormwater ponds over time?
               (i) Design of ponds will reduce pollutants naturally (bioremediation). There will also be regular maintenance. Ponds will actually be rich habitats.
            VIII. Can we think of the options as phases instead? Can e do plan C now without affecting attempts at option A in the future?
               (i) We think its better to pick an option upfront and then work on geographical phases to help cost. For example, Reach 3 would be the easiest to implement while Reach 1 would be most complex.
            IX. What if Western Blvd is expanded?
               (i) We have coordinated with BRT development on Western Blvd. We have identified stops and areas which will have additional width.
            X. Did option C have any wetlands?
               (i) There are some but significantly less than other options.
            XI. How expensive is the Landbridge?
               (i) Currently unknown but each option is significantly different in price. Expensive, more expensive, most expensive.

XII. Are pieces like the Landbridge interchangeable in each option?
(i) Yes
XIII. Do the different options treat water differently?
(i) It's part of the models we are running. We will have better answers in futures phases of the project.
XIV. Do all the options have culverts? Will that be a negative in the future?
(i) Yes, they do, and perhaps? There are considerations being made on how culverts will affect streams such as fish corridors. There are also a lot of culverts downstream from the property, sometimes it's the best option.
XV. I perked up when you mentioned restoring the historic meander to the creek. Is it historically accurate that the creek crosses over to the prison?
(i) It did go to the prison, but the expansion of western Blvd. pinched it into its current confined position. We can't bring it back to exact historical conditions due to the current site constraints.
XVI. How will each of the three options affect wildlife along the entirety of the creek?
(i) The idea is to create a healthier ecology that helps animals connect. We looked at the mammal, plant, bird and fish perspectives. Option A is overall the best but all three offer significant improvements to current conditions. Currently the culvert at ash eave is the most damaging to fish migration.
XVII. I have memories of riding my bike along the creek, so the land bridge sounds incredible! I would like to bring native plants back.
XVIII. I think a summary/bullet point sheet would be helpful to explain each option.

II. <u>Cultural Interpretive Plan Update (Eric Regensburger)</u>
i) Process & Schedule
I. Completed Work
II. Current and Future Work
ii) Key Engagement Take-aways.
iii) Challenges for interpretation
iv) Goals for Interpretation
v) Table Discussion- Chairs Lead
I. How do you currently use the park and how would you like to see Dix Park history and interpretation integrated into that area, recreational activity, or event? (Or not!). If you don't want interpretation in the areas you use, activities you do, or events you attend now, what approaches to interpretation would provide a new way for you to use the park now, or area to go to?
(i) Table 1:
1. Sculptures of people that were here; ArtWalks to explain. Ex. someone hoeing a field, more literal interpretations. Paintings with scenes embedding in greenway.
2. Rocks carved, have sculptures of soldiers.
3. Accounts of history or moment of silence at events, acknowledgement.
4. Information at parking and in bathrooms. Guerilla interpretation.
5. Lessons on you phone (App or QR code)
6. Layers: nature, social, park history, wildlife. History of the landfill, sculpture of freedom. Ongoing part of the story.

7. Buildings (tool for preservation)
8. Corridor along creek branded as a storytelling experience. Branded, iconic. Connection points with other paths as in Option A of creek design.
9. Raised sections near culvert to go down to the stream.
10. Free expression tunnel similarities. Spaces for murals in bridge underpasses, on stairs leading down.
11. Letting people know where else they can go (ex. greenway to NCMA)
12. Tunnels as a different alternative to land bridge.

(ii) Table 2
1. We use the park for restoration, flowers, greenway, art, picnic, running, and flying kites.
2. Stop and look at art while recreating. Selfie stations, rotating, deliberate teaching legacy.
3. What do we stop and read? Display boards along pathways. "I never knew?" information markers.
4. Strategic stumble? Make interesting.
5. People need various trails that could be named to inform.
6. Informational plaques at hammock rooms, picnic table
7. Audio tracks for trails, or even a bench with QR codes.
8. Point to teach history, but also resources on trauma.
9. Rescue from a bad convention.

(iii) Table 3
1. Display or interactive visual learning pieces similar to a museum with some language/history about the space "did you know?"
2. Scavenger hunt display "While you are here."
3. Digital display, 1-2 at certain entrances
4. Interact with families to gather history.
5. Provide honest details and history. Fact checks info and be honest about history.
6. AR codes- throughout with videos or direct to info- website, photos, interview.

(iv) Table 4
1. We use the park for meetings, yoga, pow wow, nostalgic dries, walking, sanctuary.
2. Invitation, not too much stuff
3. Consistent signage
4. Ambassadors? Tours?
5. Dix Day where people learn history.
6. Bus trolley shuttles
7. Restore the creek for healing, therapeutic properties.

V. Staff Update –
I. Projects
i) Community Garden- Kate Pearce
I. We need 1-2 Community Committee members to volunteer for the steering committee. Please email Eric by EOB 10/20/23 for consideration.

II. Programs and Events
   i) Time had run out but there was a quick run-through of the slides as well as notifying the committee that the presentation will be sent to them via email.

VI. Adjournment
   I. Shana Adjourned meeting.

Rocky Branch Enhancement Project
Feasibility Study

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Meeting Agenda

Re: **Rocky Branch Enhancement Project (RBEP) – Team & RDOT Meeting**
Meeting Date: **July 06, 2023**
Meeting Time: **1:00 PM- 2:00 PM**
Location: **Virtual – Teams**

Organization	Initials	Name	Position
City of Raleigh	DP:	Dean Perry	City of Raleigh
City of Raleigh DOT	CR:	Cara Russell	
	HP:	Het Patel	
	JN:	Jed Niffenegger	
Surface 678:	ED:	Eric Davis	Vice President/Principal in Charge
	RP:	Robert Pratt	Project Manager/Principal
	JDW:	Janie Day Whitworth	Project Landscape Designer
AECOM:	EE:	Ed Edens	Civil & Roadway
	NC:	Nathan Chapman	Civil & Roadway

Introductions

Items to Discuss:

Surface 678 provided an update on what was presented to the Dix Park Committee:

- 3 adjacent projects were discussed and how they coordinate/ impact with the Rocky Branch Project, those include:
  - Western Blvd BRT Project
  - Lake Wheeler Drive Improvements
  - Ashe Ave. Realignment Study

TRANSPORTATION:

Western Boulevard – Wake BRT-

Are there any updates to Stormwater Management plans? What is the current status and potential residuals?

COMMENT:

- HP – will produce a drainage report, NCDOT and Sally Hoyt's team would identify what needs to happen stormwater-wise.
- BRT schedule: At 10% right now. 30% anticipated Spring 2024, submitting rating applications August 2024, which ties into their federal asks for the project. Some level of drainage work should be done as part of the 30% design package

Hunt Drive – Realignment

Is City open to re-aligning Hunt Drive intersection, further north than Master Plan has it currently illustrated?

- This would move the full intersection to the Gov. Morehead School road rather than the prison site, so that Hunt Drive would align with a new Governor Morehead School drive.
- What is timing looking like for this?
  DP - Hunt Drive realignment is probably 20-30 years out.

COMMENT:

- JN asks for update on Hunt Dr. proposals.
- JN expressed concerns regarding the current Master Plan's Hunt Drive realignment
- DP – concern would be introducing another intersection / traffic lights in close proximity to other existing intersections along Western Blvd.
- Western is NCDOT's, not the city. Western is carrying the bulk of Raleigh's eastern traffic, this increased with recent Hillsborough Street modifications. NCDOT not in favor or of adding additional traffic light at this location.
- JN – concerned about pushback from Prison and/or Morehead school .
- NC – asks whether BRT is studying removing this curve in Western BLVD.
  - HP – no. have not talked about realigning Western BLVD to this extent
  - HP -- from timing and scheduling perspective – RBEP should continue to plan based on current Western BLVD BRT plans. Update that they did move a proposed station from Boylan up to Hunt Drive.
  - HP will share updated BRT plans – to show most recent Station locations
- RP – How to represent the Hunt Drive realignment in the RBEP feasibility studies?
  - DP – Wants RDOT to approve of Hunt Drive realignment before we continue to include it in Concept A
  - JN – Prison won't be moving any time soon. City of Raleigh has some type of allocated easement on Gov. Morehead property that allows pedestrian passage/ bridge as part of property purchase agreements.
  - DP says to keep design on the property as best we can
  - If RDOT supports the realignment (which would need to be signalized), NCDOT may say City needs to take control of Western Blvd
  - Introducing signals would impact BRT operation as well
  - DP – need to minimize signalization of roads.
  - JN – can share that it's in Park's best interest to realign Hunt, can leave out the details of how it'd be done. Can draw the ideal realignment and not call for signal
  - HP – RDOT okay with showing the future realignment, without showing details. Set Hunt Dr. up for success for whenever it comes time to realign it…make the earth work easier…
  - JN – has anyone approached Central Prison about future plans for the prison, the drive, and who would take over ownership of the plat .
    - DP says he can follow up with Kate about this discussion.
- ED – If park does realign Hunt Drive, what would impacts be to the BRT? We need a better understanding of implications/challenges.
  - HP - BRT station location is identified based on grade – cannot exceed 5%
  - HP - RDOT open to recommendations . BRT would be sooner than Hunt Drive realignment
  - JN - Western is NCDOT – if we wanted to make another entrance to the park, we'd have to go to the state and get a driveway permit. Would be a big discussion about what's needed, right in, right out…State would not look favorably on adding a full intersection in ADDITION
- ED – Could Hunt Drive align with the emergency drive across W. BLVD?
  - JN – again, it'd require the driveway opening discussions.
- HP -- may work as a dashed line for now, until we have a better understanding of what will happen on the northern parcels . But this information is far out, until we have information from Raleigh regarding what will happen to these properties in the future, and NCDOT's plans for BLVD

Ashe Avenue/ Western Boulevard- Pedestrian underpass proposed in 2020

RP - Are there any updates on this?
Can we make these elevations work if stream is also raised 5 feet?
We would want to coordinate also regarding impact of realignment to nearby environmental issues (gas station, fuel lab…)
If RDOT has any more information, please share, so we can overlay impact

COMMENT:

- Pullen Bridge – NCDOT project for Pullen Bridge replacement.
- HP will share their conversations with NCDOT and NCState to let us know any details or further information.
- More recent conversations imply this would be a larger project, no updates here, though. For the moment.
- HP – needing coordination on NCDOT realignment of Ashe ave –
- HP -- the Ashe Ave realignment may not have been identified in the Bond, so probably not funds to do it right now, but it is definitely being thought about and considered in the future.
- JN – difficult intersection. Been talking about it for long time. Very expensive project, which we don't have funding for because of the structure involved.
- RP – our feasibility study is showing these culverts being redeveloped as a recommendation for the stream improvements.
  -JN – would help with Pedestrian movement

ACTION ITEMS:
- S678 to send follow-up minutes/ notes documenting what we've taken away from the call.
- Group can reconvene and or provide feedback on provided meeting minutes (following Pullen call, etc.)

SURFACE 679 TAKE-AWAYS:

STORMWATER:
- Continue proposing treatment of Wake BRT/Western BLVD Run-off as well as outfalls from the parcels north of Western Blvd as conditions allow this for consideration within the scope and extents of the Rocky Branch project.
- Based on prior discussion with CoR Stormwater, RBEP project will continue to propose daylighting/treating of outfalls within and from the Park as part of the project. If this does not fit entirely within current scope of the project, the feasibility study should propose design that sets it up for future implementation.
- HP will share drainage studies when available for the BRT project design.
  - Based on prior discussion with CoR Stormwater, the design will ultimately need to perform pollution modeling to determine whether installation of a SWM SCM is the appropriate/best approach

HUNT DR. REALIGNMENT:
- S678's takeaway was for the feasibility study to plan for Hunt Drive to remain as is where it is located today. This is what the design linework on the developed concepts would illustrate. ***Request confirmation on this approach from the group.***
- S678's understanding is that the feasibltiy study will develop a graphic indicating what the future realignment could look like. This graphic would illustrate a distant future possible scenario to illustrate that the design being proposed considers this as a possibility and does not prohibit the future realignment. ***Request confirmation on this approach from the group.***

ASHE AVENUE REALIGNMENT:
- S678 to provide analysis of the Ashe Avenue / Western Blvd intersection, as well as suggested options of vehicular and pedestrian circulation for CoR to review.
- A decision will then be made as to what needs to be represented within the Rocky Branch feasibility documentation
- Previous Ashe Avenue Study and Current BRT Design will both be considered during the process of developing suggested options for the intersection

PULLEN BRIDGE:

- CoR to provide RBEP design team with updates following next scheduled meeting for the Pullen Bridge Project
- In previous discussions with CoR, DP noted that proposed bridging elements along Western Blvd should not duplicate efforts

NEXT STEPS:
- Requests feedback / comments on these minutes and notes.
- Develop consensus on what should be represented for Hunt Drive Intersection and Ashe Avenue Intersection within the Rocky Branch Feasibility Study.

Requests updates/CAD files at key milestones as BRT and other adjacent projects move forward

Surface

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Meeting Minutes

Re: Rocky Branch Enhancement Project (RBEP) – Stormwater Review
Meeting Date: October 02, 2023
Meeting Time: 1:00 PM- 2:00 PM
Location: Virtual – Teams

Organization	Initials	Name	Position
City of Raleigh:	DP	Dean Perry	Senior Planner / City of Raleigh
Surface 678:	ED:	Eric Davis	Vice President/Principal in Charge
	RP:	Robert Pratt	Project Manager/Principal
	JDW:	Janie Day Whitworth	Project Landscape Designer
AECOM:	TSJ:	Todd St. John	
City of Raleigh Stormwater:	HD:	Heather Dutra	Water Quality Supervisor
	KB:	Kevin Boyer	Stormwater Consultant

Allison Bryan – Senior Stormwater Engineer
Dan Clinton – Senior Stormwater Engineer (Maintenance)
Sheryl Smith – Senior Stormwater Engineer (Planning and Asset Management, overseeing watershed study Rocky Branch)
Sally Hoyt – Stormwater Review Supervisor
Kendall Effler – Senior Stormwater Plans Reviewer
Megan Walsh – Stormwater Senior Engineer
David Kiker – Engineering Supervisor (CIP)
Kyle Bucher – Senior Stormwater Engineer (CIP)
Emily Smull – Senior Stormwater Engineer (CIP)

Items to Discuss:

1. Site Inventory [relevant to COR - Hydrology graphic, utilities graphic]
   - Storm outfalls
   - Pipes to potentially daylight
   - Culverted portions of stream
   - Drainage Areas (analysis of onsite and offsite drainage areas/ watershed)
2. Opportunities
   - Opportunity graphics highlighting primary areas of intervention (as pertains to stormwater)
   - AECOM's stormwater graphics
     i. Wetland
     ii. Vs. Wet pond/Wetland Hybrids
     iii. Dissipation Pools in some locations without treatment

   Comment –

Surface

SH- clarifying questions – showing square footage to treat existing impervious

3. Proposed scenarios
   - Scenario A –
     i. Stormwater wetlands, step pools, largest footprint for stormwater management
   - Scenario B –
     i. Reduced footprint for stormwater management systems, still catching/treating all possible
   - Scenario C –
     i. Significant reductions for offsite treatment, dissipating flow as minimum. Reduced treatment for onsite drainage

COMMENT:
DK: Has there been any discussions on designing conveyance systems (engineered swales or RSCs) to create a treatment train prior to the wetlands or ponds down on the floodplain or just off the floodplain?
RP: Yes, not detailed, but we do have areas where we're specifying conveyance (ex. From parking, and between dissipation pools, step pools)
SH: long-term maintenance standpoint – grey infrastructure and educational piece. Great benefit if the surface conveyance is visible. Lots of opportunity
DK : more impervious cover will come later – set up a mitigation bank on another project, in the form of a planning study – so that projects that came on board later on weren't required to make treatment facilities per each smaller development when already taken into account in larger management facility
HD: thanks, David. We've been talking about this within Stormwater, too. They've got plans

DK: Has there been any discussions with onsite detention (Rocky Branch) to offset the West Street project that is going to result in large increases to peak flows along Rocky Branch? No need to answer this now but wanted to get this in the chat as a reminder and for a future discussion.

KB: Has there been any preliminary cost analysis of A vs. B? Thinking about the realignment of the channel near Western Blvd, Railroad Tracks, Hunt Drive, etc. in Option A might be significantly more in cost (and coordination) vs. keeping the existing alignment in Option B

HD: Raising the groundwater table – any other questions about this?

KB: question for Dean – talk between Dix and Urban Design Center – acquiring Circle K and daylighting stream here? Wondering if the idea has gone away?
DP: having the team stay within the footprint of Dix Park property line. To maintain scope. Surface has the material from the Urban Design Center regarding the corner at Ashe Ave.

HD: Maintenance is a big concern – SWM has taken on maintenance of SCMs in perpetuity – asking Dan/Ben/Kendall/ Sally for their input regarding maintenance and $$
HD: THRILLED by the integration of stormwater as an amenity.

SH: echo Heather's excitement about integration of SWM as amenity. Trying to move away from Wet Ponds – encouraging folks to look at wetlands or bioretention. Consider primarily wetlands if the seasonal water table is constant.
Bio-retention when the seasonal water table is separated. Also keep David's conveyance in consideration.
RP: How about mimicked RSC – step pools, using topography
SH: yes, step pool design would be great as well
DC : Dedicated access maintenance pointed out – intentional access points – including equipment access points.

Surface

Maximize the floodplain. Keep in mind that if we're putting SCMs in floodplain, do not constrict the floodplain.
ED: is the multimodal pathway 14'standard for COR adequate for maintenance access?
DC : I think so, but what about the points that aren't accessible by the trail specifically? Include hardened points where maintenance access will be needed.
DP: Definitely need to include these points in the report
HD: reach out to team to discuss side slopes, etc. for the stormwater
SH: stormwater management report is now in public review – specific requirements for access
BL: keep size of forebays/ponds in check to keep maintenance devices smaller
Similar concern regarding the regional approach.
RP: wondering how STW feels about the regional vs. point-source approach?
HD: If we can figure out the maintenance, the regional approach is favorable – visible, attractive, an amenity
BL: maintenance concern with regional approach is mainly regarding wet ponds.

KB:Has there been any preliminary cost analysis of A vs. B? Thinking about the realignment of the channel near Western Blvd, Railroad Tracks, Hunt Drive, etc. in Option A might be significantly more in cost (and coordination) vs. keeping the existing alignment in Option B

4. Remaining Questions
    - Are we considering an appropriate area to treat? We have been considering the microwatersheds between the Dix Park Ridgeline to the south and north (Boylan)…
        i. We will need to acknowledge that future development within the park will also be treating stormwater, we are providing opportunities for treatment, not replacing it elsewhere.

5. Any further suggestions from COR Stormwater?

Possible Grant Funding Opportunities and/or Sources

Surface

SCENARIO A- REACH 1 SUMMARY ASSESSMENT

	Challenges Remain	3	2	1	1	2	3	Site Improvement
ECOLOGY	(-)							(+)
Stream Restoration							3	
Habitat Restoration							3	
Complexity/Diversity							3	
Riparian Buffer Improvement							3	
Water Quality/Temperature/Dissolved Oxygen							3	
Stream Aesthetics							3	
Stormwater Management							3	
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes							3	
Activity at Edges							3	
Spaces for Wellness/Healing							3	
Accessibilty to Stream							3	
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression							3	
CONNECTIVITY								
Access to downtown							3	
Access to Walnut Creek Trail							3	
Access to Pullen Park							3	
Gateway opportunities							3	
REUSE/REHABILITATION								
Vegetation Preservation		-3						
View preservation							3	
Utility infrastructure reuse							3	
Landfill rehab							3	
Landfill material reuse							3	
CONSTRAINTS / COSTS								
Culvert Replacement Costs		-3						
Landfill Waste & Soil Management Costs		-3						
Landfill Leachate & Groundwater Management		-3						
Landfill Gas Management		-3						
Enviornmental Stormwater & Sediment Management		-3						
Pre-Regulatory Unit Regulatory Coordination		-3						
Geotechnical/Total and Differential Landfill Settlement		-3						
Environmental Operations, Maintenance, and Monitoring		-3						
Facility Maintenance (Post Occupancy)		-3						
Railroad Collaboration		-3						
Potential for Adverse Flood Impacts		-3						
Permit Risk		-3						
Compliance with Transportation Objectives		-3						
Utility Relocation Cost		-3						
Central Prison Collaboration		-3						
Potential offsite Environmental Concerns			-2					
Landbridge landing at gas station and UST Section Regulatory Coordination			-2					
Landbridge not landing at gas station		-3						

SCENARIO A- REACH 2 SUMMARY ASSESSMENT

	Challenges Remain	3	2	1	1	2	3	Site Improvement
	(-)							(+)
Stream Restoration							3	
Habitat Restoration							3	
Complexity/Diversity							3	
Riparian Buffer Improvement							3	
Water Quality/Temperature/Dissolved Oxygen							3	
Stream Aesthetics							3	
Stormwater Management						2		
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes							3	
Activity at Edges						2		
Spaces for Wellness/Healing							3	
Accessibilty to Stream						2		
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression							3	
CONNECTIVITY								
Access downtown						2		
Access to Walnut Creek Trail							3	
Acces to Pullen Park							3	
Gateway opportunities						2		
REUSE/REHABILITATION								
Vegetation Preservation						2		
View preservation							3	
Utility infrastructure reuse							3	
CONSTRAINTS AND COSTS								
Culvert Replacement Costs		-3						
Environmental Stormwater & Sediment Management		-3						
Environmental Soil Management		-3						
Brownfields Regulatory Coordination		-3						
Facility Maintenance (Post Occupancy)			-2					
Railroad Collaboration		-3						
Potential for Adverse Flood Impacts			-2					
Permit Risk		-3						
Compliance with Transportation Objectives		-3						
Utility Relocation Cost		-3						
Central Prison Collaboration		-3						

SCENARIO A- REACH 3 SUMMARY ASSESSMENT

	Challenges Remain	3	2	1	1	2	3	Site Improvement
	(-)							(+)
Stream Restoration							3	
Habitat Restoration							3	
Complexity/Diversity							3	
Riparian Buffer Improvement							3	
Water Quality/Temperature/Dissolved Oxygen							3	
Stream Aesthetics							3	
Stormwater Management							3	
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes							3	
Activity at Edges							3	
Spaces for Wellness/Healing							3	
Accessibilty to Stream							3	
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression							3	
CONNECTIVITY								
Access downtown							3	
Access to Walnut Creek Trail							3	
Access to Pullen Park							3	
Gateway opportunities							3	
Access to City Park South							3	
REUSE/REHABILITATION								
Vegetation Preservation						2		
View preservation							3	
Utility infrastructure reuse							3	
CONSTRAINTS AND COSTS								
Culvert Replacement Costs				-1				
Enviornmental Stormwater & Sediment Management		-3						
Enviornmental Soil Management		-3						
Brownfields Regulatory Coordination		-3						
Facility Maintenance (Post Occupancy)			-2					
Potential for Adverse Flood Impacts			-2					
Permit Risk			-2					
Compliance with Transportation Objectives				-1				
Utility Relocation Cost			-2					

SCENARIO B- REACH 1 SUMMARY ASSESSMENT

EVALUATION CRITERIA	Challenges Remain (-)	3	2	1	1	2	3	Site Improvement (+)
	Reach 1 (Ashe to Hunt)							
ECOLOGY								
Stream Restoration						2		
Habitat Restoration							3	
Complexity/Diversity						2		
Riparian Buffer Improvement							3	
Water Quality/Temperature/Dissolved Oxygen							3	
Stream Aesthetics							3	
Stormwater Management						2		
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes							3	
Activity at Edges							3	
Spaces for Wellness/Healing							3	
Accessibilty to Stream						2		
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression							3	
CONNECTIVITY								
Access to downtown							3	
Access to Walnut Creek Trail							3	
Access to Pullen Park							3	
Gateway opportunities							3	
REUSE/REHABILITATION								
Vegetation Preservation			-2					
View preservation							3	
Utility infrastructure reuse						2		
Landfill rehab							3	
Landfill material reuse						2		
CONSTRAINTS / COSTS								
Culvert Replacement Costs					1			
Landfill Waste & Soil Management Costs			-2					
Landfill Leachate & Groundwater Management			-2					
Landfill Gas Management			-2					
Enviornmental Stormwater & Sediment Management			-2					
Pre-Regulatory Unit Regulatory Coordination			-2					
Geotechnical/Total and Differential Landfill Settlement			-2					
Environmental Operations, Maintenance, and Monitoring			-2					
Facility Maintenance (Post Occupancy)			-2					
Railroad Collaboration								
Potential for Adverse Flood Impacts			-2					
Permit Risk			-2					
Compliance with Transportation Objectives					1			
Utility Relocation Cost				-1				
Central Prison Collaboration					1			
Potential offsite Environmental Concerns			-2					
Landbridge landing at gas station and UST Section Regulatory Coordination			-2					
Landbridge not landing at gas station							3	

SCENARIO B- REACH 2 SUMMARY ASSESSMENT

REACH 2	Challenges Remain	3	2	1	1	2	3	Site Improvement
ECOLOGY	(-)							(+)
Stream Restoration						2		
Habitat Restoration						2		
Complexity/Diversity						2		
Riparian Buffer Improvement							3	
Water Quality/Temperature/Dissolved Oxygen							3	
Stream Aesthetics							3	
Stormwater Management						2		
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes							3	
Activity at Edges							3	
Spaces for Wellness/Healing							3	
Accessibilty to Stream					1			
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression							3	
CONNECTIVITY								
Access downtown						2		
Access to Walnut Creek Trail							3	
Acces to Pullen Park							3	
Gateway opportunities							3	
REUSE/REHABILITATION								
Vegetation Preservation							3	
View preservation							3	
Utility infrastructure reuse						2		
CONSTRAINTS AND COSTS								
Culvert Replacement Costs					1			
Enviornmental Stormwater & Sediment Management			-2					
Enviornmental Soil Management			-2					
Brownfields Regulatory Coordination			-2					
Facility Maintenance (Post Occupancy)			-2					
Railroad Collaboration					1			
Potential for Adverse Flood Impacts					1			
Permit Risk					1			
Compliance with Transportation Objectives					1			
Utility Relocation Cost				-1				
Central Prison Collaboration					1			

SCENARIO B- REACH 3 SUMMARY ASSESSMENT

REACH 3	Challenges Remain	3	2	1	1	2	3	Site Improvement
ECOLOGY	(-)							(+)
Stream Restoration							3	
Habitat Restoration							3	
Complexity/Diversity							3	
Riparian Buffer Improvement							3	
Water Quality/Temperature/Dissolved Oxygen							3	
Stream Aesthetics						2		
Stormwater Management						2		
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes							3	
Activity at Edges							3	
Spaces for Wellness/Healing							3	
Accessibilty to Stream							3	
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression							3	
CONNECTIVITY								
Access downtown							3	
Access to Walnut Creek Trail							3	
Access to Pullen Park							3	
Gateway opportunities							3	
Access to City Park South							3	
REUSE/REHABILITATION								
Vegetation Preservation							3	
View preservation							3	
Utility infrastructure reuse							3	
CONSTRAINTS AND COSTS								
Culvert Replacement Costs					1			
Enviornmental Stormwater & Sediment Management			-2					
Enviornmental Soil Management			-2					
Brownfields Regulatory Coordination			-2					
Facility Maintenance (Post Occupancy)			-2					
Potential for Adverse Flood Impacts			-2					
Permit Risk			-2					
Compliance with Transportation Objectives					1			
Utility Relocation Cost			-2					

SCENARIO C- REACH 1 SUMMARY ASSESSMENT

REACH 1	Challenges Remain	3	2	1	1	2	3	Site Improvement
ECOLOGY	(-)							(+)
Stream Restoration					1			
Habitat Restoration						2		
Complexity/Diversity						2		
Riparian Buffer Improvement						2		
Water Quality/Temperature/Dissolved Oxygen						2		
Stream Aesthetics						2		
Stormwater Management					1			
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes							3	
Activity at Edges						2		
Spaces for Wellness/Healing						2		
Accessibilty to Stream					1			
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression						2		
CONNECTIVITY								
Access to downtown							3	
Access to Walnut Creek Trail							3	
Access to Pullen Park							3	
Gateway opportunities						2		
REUSE/REHABILITATION								
Vegetation Preservation				-1				
View preservation							3	
Utility infrastructure reuse						2		
Landfill rehab					1			
Landfill material reuse					1			
CONSTRAINTS / COSTS								
Culvert Replacement Costs					1			
Landfill Waste & Soil Management Costs				-1				
Landfill Leachate & Groundwater Management				-1				
Landfill Gas Management				-1				
Enviornmental Stormwater & Sediment Management				-1				
Pre-Regulatory Unit Regulatory Coordination				-1				
Geotechnical/Total and Differential Landfill Settlement				-1				
Environmental Operations, Maintenance, and Monitoring				-1				
Facility Maintenance (Post Occupancy)				-1				
Railroad Collaboration				-1				
Potential for Adverse Flood Impacts				-1				
Permit Risk				-1				
Compliance with Transportation Objectives					1			
Utility Relocation Cost					1			
Central Prison Collaboration					1			
Potential offsite Environmental Concerns			-2					
Landbridge landing at gas station and UST Section Regulatory Coordination			-2					
Landbridge not landing at gas station							3	

SCENARIO C- REACH 2 SUMMARY ASSESSMENT

REACH 2	Challenges Remain	3	2	1	1	2	3	Site Improvement
ECOLOGY	(-)							(+)
Stream Restoration					1			
Habitat Restoration						2		
Complexity/Diversity						2		
Riparian Buffer Improvement						2		
Water Quality/Temperature/Dissolved Oxygen						2		
Stream Aesthetics					1			
Stormwater Management					1			
ENGAGEMENT								
STEAM Education Opportunities					1			
"Nature" Escapes						2		
Activity at Edges					1			
Spaces for Wellness/Healing						2		
Accessibilty to Stream						2		
Accessible/Safe/Inclusive							3	
Spaces for Creative Expression						2		
CONNECTIVITY								
Access downtown					1			
Access to Walnut Creek Trail						2		
Access to Pullen Park						2		
Gateway opportunities						2		
REUSE/REHABILITATION								
Vegetation Preservation							3	
View preservation							3	
Utility infrastructure reuse					1			
CONSTRAINTS AND COSTS								
Culvert Replacement Costs					1			
Enviornmental Stormwater & Sediment Management				-1				
Enviornmental Soil Management				-1				
Brownfields Regulatory Coordination				-1				
Facility Maintenance (Post Occupancy)			-2					
Railroad Collaboration					1			
Potential for Adverse Flood Impacts					1			
Permit Risk					1			
Compliance with Transportation Objectives					1			
Utility Relocation Cost					1			
Central Prison Collaboration					1			

SCENARIO C- REACH 3 SUMMARY ASSESSMENT

REACH 3	Challenges Remain	3	2	1	1	2	3	Site Improvement
ECOLOGY	(-)							(+)
Stream Restoration					1			
Habitat Restoration					1			
Complexity/Diversity					1			
Riparian Buffer Improvement						2		
Water Quality/Temperature/Dissolved Oxygen						2		
Stream Aesthetics						2		
Stormwater Management					1			
ENGAGEMENT								
STEAM Education Opportunities							3	
"Nature" Escapes						2		
Activity at Edges						2		
Spaces for Wellness/Healing						2		
Accessibilty to Stream						2		
Accessible/Safe/Inclusive						2		
Spaces for Creative Expression						2		
CONNECTIVITY								
Access downtown						2		
Access to Walnut Creek Trail						2		
Access to Pullen Park						2		
Gateway opportunities						2		
Access to City Park South						2		
REUSE/REHABILITATION								
Vegetation Preservation							3	
View preservation							3	
Utility infrastructure reuse						2		
CONSTRAINTS AND COSTS								
Culvert Replacement Costs					1			
Enviornmental Stormwater & Sediment Management				-1				
Enviornmental Soil Management				-1				
Brownfields Regulatory Coordination				-1				
Facility Maintenance (Post Occupancy)			-2					
Potential for Adverse Flood Impacts					1			
Permit Risk					1			
Compliance with Transportation Objectives					1			
Utility Relocation Cost					1			

APPENDICES J
PRECEDENT TRIP SUMMARY

NORTH CAROLINA TRIP (RDU AND CHARLOTTE)

NORTH CAROLINA PRECEDENT SITES TOUR

RESEARCH TRIANGLE PARK, STREAM RESTORATION
DURHAM, NC

LITTLE SUGAR CREEK ENVIRONMENTAL RESTORATION AND GREENWAY PROJECT
CHARLOTTE, NC

CHANTILLY ECOLOGICAL SANCTUARY AT BRIAR CREEK
CHARLOTTE, NC

BRIAR CREEK STREAM RESTORATION AND ENHANCEMENT PROJECT
CHARLOTTE, NC

Dix Park Conservancy   Raleigh   Surface   WILDLANDS ENGINEERING

STREAM ENHANCEMENT RESEARCH TRIANGLE PARK HUB

CLIENT: Research Triangle Foundation

COMPLETION DATES: 2023

CONSTRUCTION COST: $30 M
Phase I (part of larger infrastructure project)

DESIGN TEAM:
Surface678 (landscape architect)
McAdams (stream design)

The +/-1,000 LF of stream enhancement is just a part of this 20 acre project that will include two hotels, corporate office towers, incubator space, and 300,00 SF of retail.

Previously an engineered stream with riprap base, the streambed has been expanded and allowed a more meandering path with strategically located boulders, j-hooks, and riffler bars. In order to both provide the stream the ideal floodplain width and grade the 20 acre site for further development, the stream banks get up to 3:1 slope in some areas, with the 100-year floodzone starting +/- 3/4 of the way up the bank in most places. Covering the banks are at least two layers of jute matting to mitigate any erosion, with an extra layer of matting for permanent erosion control in areas more frequently flooded.

The planting is made up of highly articulated swaths, with species carefully selected in coordination with NC State Extension Office and ornamental grass experts, for their form, function, and (eco and aesthetic) relationship to neighboring swaths.

Downstream, and also within the Northeast Creek Watershed, is the proposed stormwater meadow.

WHAT WORKED:

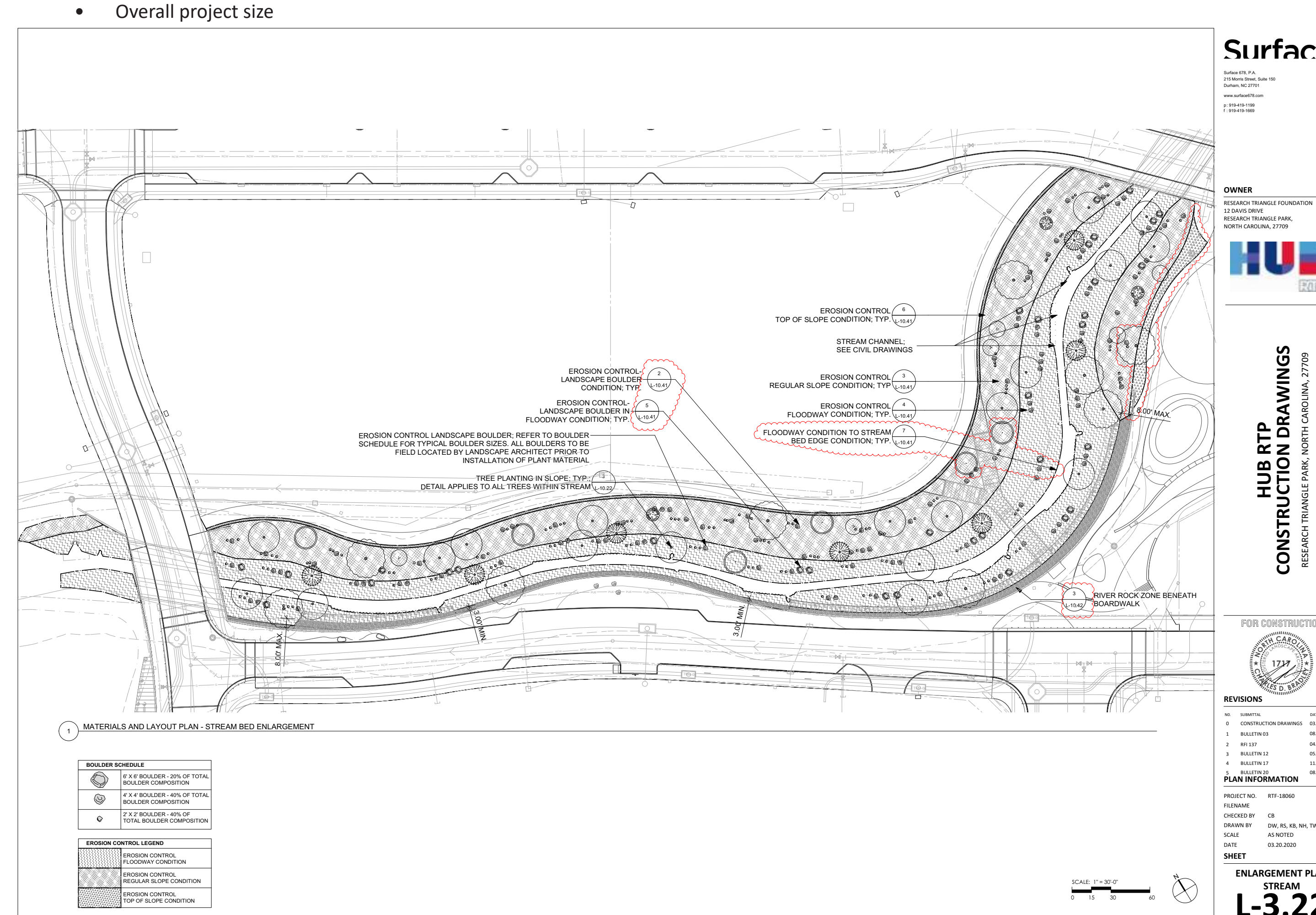
WHAT TO IMPROVE:

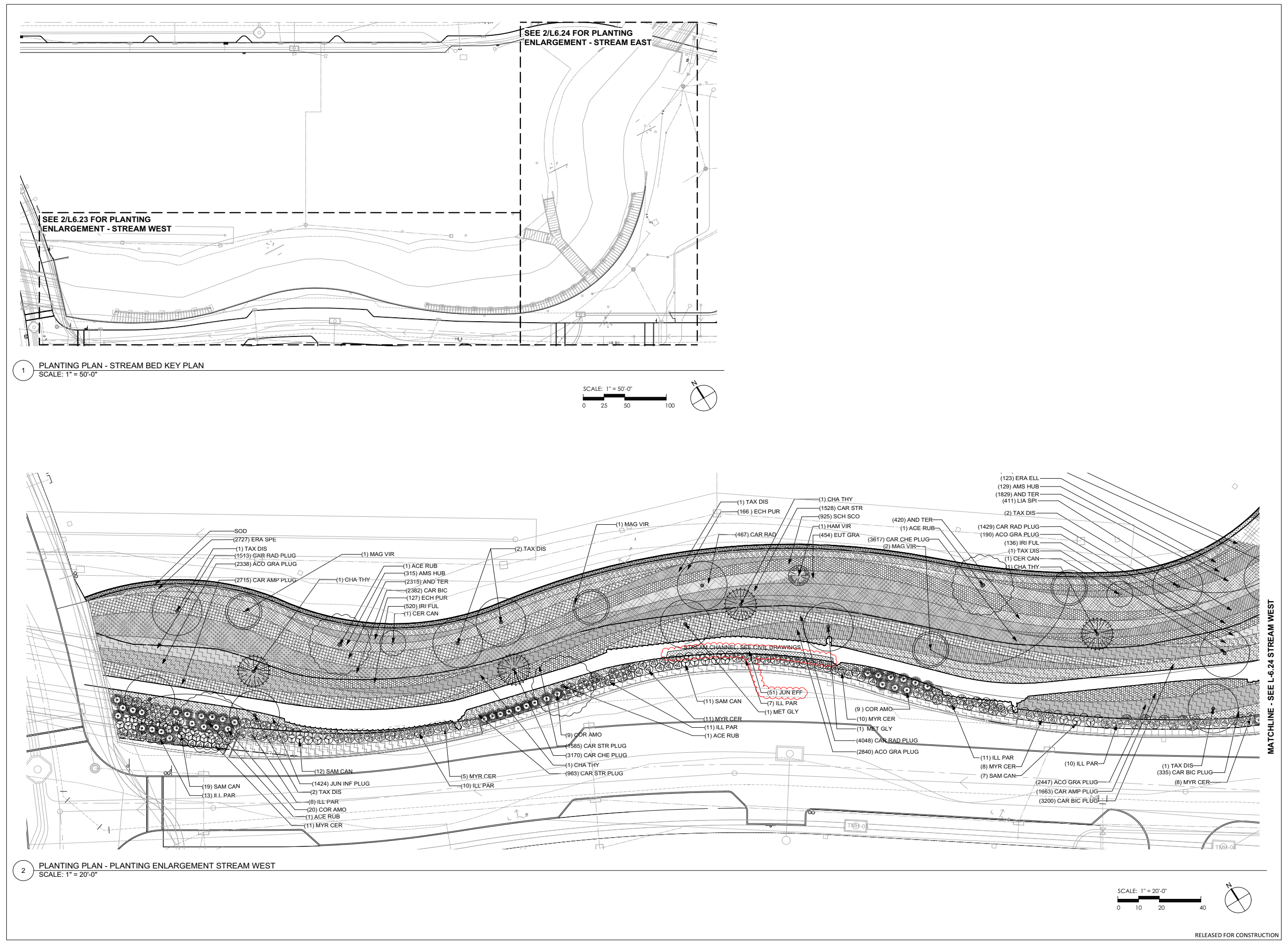
ROLE OF CITY:

COMMUNITY IMPACT:

KEY TAKEAWAYS (Research Triangle Park HUB)

- **Stormwater**
  - Wetland is separated from stream
  - Scale of wetland is significant and offers a unique habitat
  - Follow up and understand what the wetland is serving
  - No road runoff into stream (confirm with Daniel/Charlie)
  - Confirm size of plant material at time of install
- **Utility Impacts**
  - Not applicable
- **Vegetation**
  - Combination of ornamental grasses, perennials, shrubs and trees
  - Confirm size of plant material at install (plugs, container, other)
  - Date of Plant Installation – Fall 2022
- **Existing Site Condition**
  - Trapezoid stone channel, 12' deep riprap channel, 2:1 side slopes
  - Qualitative testing of stream flora and fauna (stream inaccessible)
  - Parking lot and buildings
- **Economic Impact**
  - Funding sources
  - Investment
  - ROI
  - Projects in design and/or construction
- **Stream Design**
  - Enhancement
  - Restoration
  - Pedestrian access
  - Safety - visibility across the site
  - Community Amenity
- **Scale Comparison**
  - Length of stream
  - Overall project size





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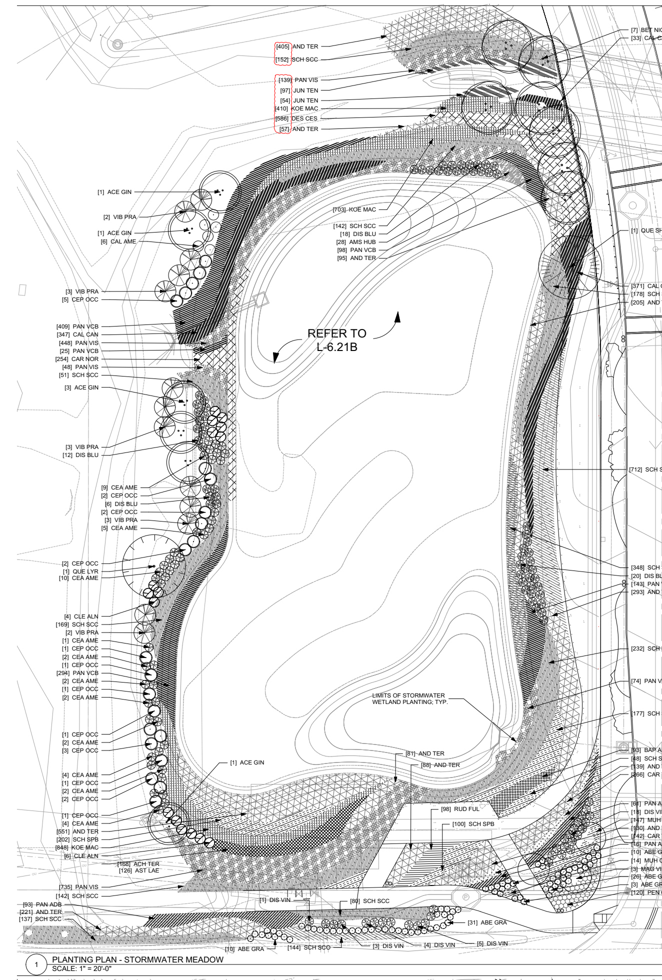
FOR CONSTRUCTION

REVISIONS

PLAN INFORMATION

SHEET
PLANTING ENLARGEMENT - STREAM PLANTING
L-6.23



UPPER STORMWATER MEADOW PLANT SCHEDULE - CONTRACTOR SHALL SATISFY ALL MEASUREMENTS NOTED - EXCEED SIZES UPON APPROVAL

KEY	QTY	LATIN NAME	COMMON NAME	CONTAINER | SIZE | HT | W | SPACING	COMMENTS
DECIDUOUS TREES					
UNDERSTORY DECIDUOUS TREES					
EVERGREEN TREES					
DECIDUOUS SHRUBS					
EVERGREEN SHRUBS					
PERENNIALS					
AMS HUB	28	AMSONIA HUBRICHTII 'BLUESTAR'	TEXAS BLUE STAR	1 GAL. / 12" / 12" / 24" O.C.	
AST LAE	126	ASTER LAEVIS 'BLUE BIRD'	BLUE BIRD ASTER	1 GAL. / 12" / 12" / 12" O.C.	
BAP AUS	93	BAPTISIA AUSTRALIS	BLUE WILD INDIGO	1 GAL. / 30" / 24" / DENSE; MATCHING	
RUD FUL	98	RUDBECKIA FULGIDA VAR. FULGIDA	BLACK-EYED SUSAN	1 GAL. / 12" / 12" / 18" O.C.	
ORNAMENTAL GRASSES					
AND TER	2,265	ANDROPOGON TERNARIUS	SPLIT-BEARD BROOMSEDGE	1 GAL. / 12" / 12" / 18" O.C.	
CAL CAN	751	CALAMAGROSTIS CANADENSIS	BLUE REED GRASS	1 GAL. / 12" / 12" / 18" O.C.	
CAR NOR	254	CAREX NORMAILS	GREATER STRAW SEDGE	1 GAL. / 12" / 12" / 18" O.C.	
CAR TEX	408	CAREX TEXENSIS	TEXAS SEDGE	PLUG / 8" / 8" / 9" O.C.	
DES CES	586	DESCHAMPSIA CESPITOSA	TUFTED HAIR GRASS	PLUG / 12" / 8" / 18" O.C.	
JUN TEN	151	JUNCUS TENUIS	RUSH	1 GAL. / 8" / 8" / 18" O.C.	
KOE MAC	1,961	KOELERIA MACRANTHA	JUNE GRASS	1 GAL. / 18" / 10" / 12" O.C.	
MUH CAP	201	MUHLENBERGIA CAPILLARIS 'WHITE CLOUD'	WHITE MUHLY GRASS	1 GAL. / 18" / 18" / 18" O.C.	
PAN ADB	170	PANICUM AMARUM 'DEWEY BLUE'	BITTER SWITCHGRASS	1 GAL. / 12" / 12" / 24" O.C.	
PAN VCB	969	PANICUM VIRGATUM 'CAPE BREEZE'	CAPE BREEZE DWARF SWITCHGRASS	1 GAL. / 12" / 12" / 18" O.C.	
PAN VIS	1,444	PANICUM VIRGATUM 'SHENANDOAH'	SHENANDOAH SWITCH GRASS	1 GAL. / 12" / 12" / 18" O.C.	
PEN OKR	120	PENNISETUM ORIENTALE 'KARLEY ROSE'	ORIENTAL FOUNTAIN GRASS	1 GAL. / 18" / 12" / 18" O.C.	
SCH SCO	1,204	SCHIZACHYRIUM SCOPARIUM	LITTLE BLUESTEM	1 GAL. / 8" / 8" / 15" O.C.	
SCH SCC	1,283	SCHIZACHYRIUM SCOPARIUM 'CAROUSEL'	CAROUSEL LITTLE BLUESTEM	1 GAL. / 8" / 8" / 24" O.C.	
SCH SPB	527	SCHIZACHYRIUM SCOPARIUM 'PRAIRIE BLUES'	PRAIRIE BLUES LITTLE BLUESTEM	1 GAL. / 8" / 8" / 18" O.C.	

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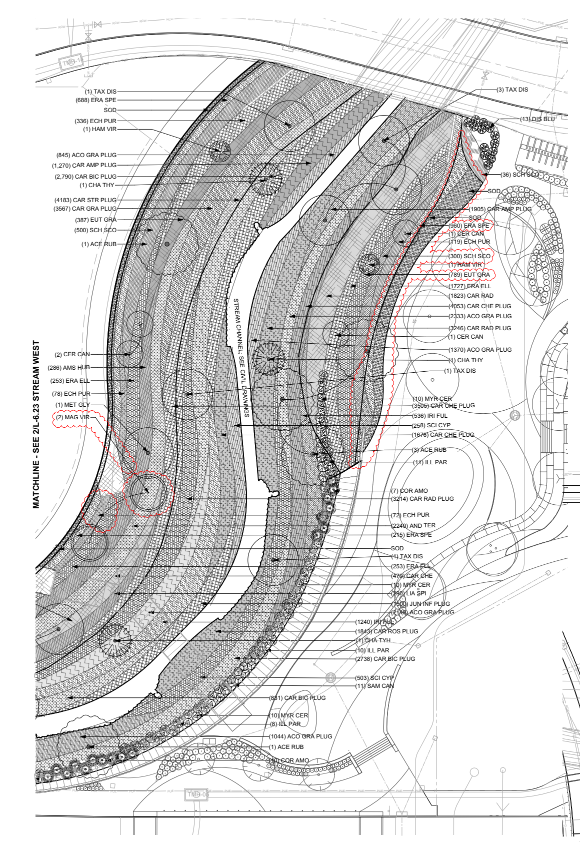
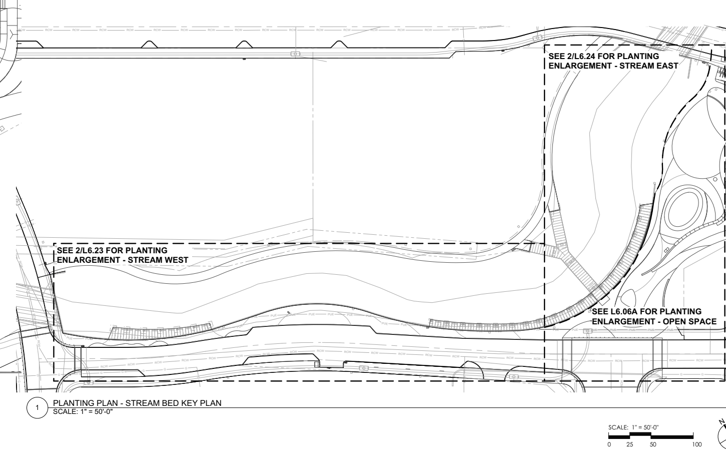


PLANTING SCHEDULE STREAM- CONTRACTOR SHALL SATISFY ALL MEASUREMENTS INDICATED

SYM	QTY	BOTANICAL NAME	COMMON NAME	MIN CAL/RT	MIN SPR.	MIN HT	SPACING	REMARKS
CANOPY TREES								
ACE RUB	9	ACER RUBRUM 'FRANKSRED'	RED SUNSET MAPLE	5" CAL.	6'-0"	16'-0"	AS SHOWN	STRONG CENTRAL LEADER; EVENLY BRANCHED; FULL
CER CAN	6	CERCIS CANADENSIS	EASTERN REDBUD	3.5" CAL.	6'-0"	12'-0"	AS SHOWN	MULTISTEM; EVENLY BRANCHED, FULL
CHA THY	7	CHAMAECYPARIS THYOIDES HENRYAE 'ATLANTA'	ATLANTA WHITE CEDAR	5" CAL.	6'-0"	16'-0"	AS SHOWN	STRONG CENTRAL LEADER; EVENLY BRANCHED; FULL
MAG VIR	6	MAGNOLIA VIRGINIANA	SWEETBAY MAGNOLIA	3.5" CAL	6'-0"	16'-0"	AS SHOWN	MULTISTEM; EVENLY BRANCHED, FULL
MET GLY	3	METASEQUOIA GLYPTOSTROBOIDES	DAWN REDWOOD	5" CAL.	6'-0"	16'-0"	AS SHOWN	STRONG CENTRAL LEADER; EVENLY BRANCHED; FULL
TAX DIS	16	TAXODIUM ASCENDENS 'CAROLYN MALONE'	GREENFEATHER POND CYPRESS	5" CAL.	6'-0"	16'-0"	AS SHOWN	STRONG CENTRAL LEADER; EVENLY BRANCHED; FULL
SHRUBS								
COR AMO	55	CORNUS AMOMUM	SILKY DOGWOOD	5 GAL	24"	36"	AS SHOWN	FULL; DENSE, MATCHING
DIS BLU	13	DISTYLIUM 'BLUE CASCADE'	BLUE CASCADE DISTYLIUM	3 GAL	24"	36"	AS SHOWN	FULL; DENSE, MATCHING
HAM VIR	3	HAMAMELIS X INTERMEDIA 'ARNOLD'S PROMISE'	ARNOLD'S PROMISE WITCH HAZEL	7 GAL	36"	48"	AS SHOWN	FULL; DENSE, MATCHING
ILL PAR	99	ILLICIUM PARVIFLORUM	SMALL ANISE TREE	7 GAL	30"	60"	AS SHOWN	FULL; DENSE, MATCHING
MYR CER	83	MORELLA CERIFERA	WAX MYRTLE	7 GAL	30"	60"	AS SHOWN	FULL; DENSE, MATCHING
SAM CAN	60	SAMBUCUS CANADENSIS	AMERICAN BLACK ELDERBERRY	7 GAL	24"	36"	AS SHOWN	FULL; DENSE, MATCHING
ORNEMENTAL GRASSES, PERENNIALS AND GROUNDCOVERS								
ACO GRA PLUG	14,015	ACORUS GRAMINEUS 'OGON'	SWEET FLAG	PLUG	-	-	8" O.C.	---
AMS HUB	730	AMSONIA HUBRICHTII	BLUE STAR	1 GAL	24"	24"	24" O.C.	FULL; DENSE, MATCHING
AND TER	6,804	ANDROPOGON TERNARIUS 'BLACK MOUNTAIN'	BLACK MOUNTAIN SPLITBEARD BLUESTEM	1 QT	12"	12"	12" O.C.	5-7 BIBS, WELL ROOTED
CAR AMP PLUG	9,268	CAREX AMPHIBOLA	CREEK SEDGE	PLUG	-	-	8" O.C.	---
ERA SPE	4,590	ERAGROSTIS SPECTABILIS	PURPLE LOVEGRASS	1 QT	4"	4"	10" O.C.	5-7 BIBS, WELL ROOTED
LIA SPI	701	LIATRIS SPICATA	BLAZING STAR	1 QT	12"	12"	14" O.C.	5-7 BIBS, WELL ROOTED
CAR BIC	2,382	CAREX BICKNELLII	PRAIRIE SEDGE	1 QT	4"	4"	12" O.C.	5-7 BIBS, WELL ROOTED
CAR BIC PLUG	9,894	CAREX BICKNELLII	PRAIRIE SEDGE	PLUG	-	-	8" O.C.	---
CAR CHE	688	CAREX CHEROKEENSIS	CHEROKEE SEDGE	1 QT	4"	4"	12" O.C.	5-7 BIBS, WELL ROOTED
CAR CHE PLUG	16,021	CAREX CHEROKEENSIS	CHEROKEE SEDGE	PLUG	-	-	8" O.C.	---
CAR GRA PLUG	1,969	CAREX GRAYI	GRAY'S SEDGE	PLUG	-	-	8" O.C.	---
CAR RAD	3,355	CAREX RADIATA	EASTERN STAR SEDGE	1 QT	4"	4"	12" O.C.	5-7 BIBS, WELL ROOTED
CAR RAD PLUG	17,134	CAREX RADIATA	EASTERN STAR SEDGE	PLUG	-	-	8" O.C.	---
CAR STR	1,528	CAREX STRICTA	TUSSOCK SEDGE	1 QT	4"	4"	12" O.C.	5-7 BIBS, WELL ROOTED
CAR STR PLUG	6,731	CAREX STRICTA	TUSSOCK SEDGE	PLUG	-	-	8" O.C.	---
ECH PUR	909	ECHINACEA PURPUREA	PURPLE CONEFLOWER	1 QT	12"	12"	18" O.C.	12-15 BIBS, WELL ROOTED
ERA ELL	2,356	ERAGROSTIS ELLIOTTII 'WIND DANCER'	WIND DANCER LOVE GRASS	1 GAL.	12"	12"	24" O.C.	5-7 BIBS, WELL ROOTED
EUT GRA	1,176	EUTHAMIA GRAMINIFOLIA	FLAT-TOP GOLDENROD	1 QT	12"	12"	14" O.C.	12-15 BIBS, WELL ROOTED
JUN INF PLUG	2,924	JUNCUS INFLEXUS SPECIES	HARD RUSH	PLUG	-	-	8" O.C.	---
JUN EFF	51	JUNCUS EFFUSUS	COMMON RUSH	1 GAL.	18"	12"	24" O.C.	5-7 BIBS, WELL ROOTED
IRI FUL	2,432	IRIS FULVA	COPPER IRIS	1 GAL.	12"	12"	12" O.C.	5-7 BIBS, WELL ROOTED
SCH SCO	1,761	SCHIZACHYRIUM SCOPARIUM	LITTLE BLUESTEM	1 GAL.	12"	12"	24" O.C.	5-7 BIBS, WELL ROOTED
SCI CYP	761	SCIRPUS CYPERINUS	WOOLGRASS	1 GAL.	12"	12"	18" O.C.	5-7 BIBS, WELL ROOTED



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PLAN INFORMATION

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PLANTING ENLARGEMENT - STREAM PLANTING
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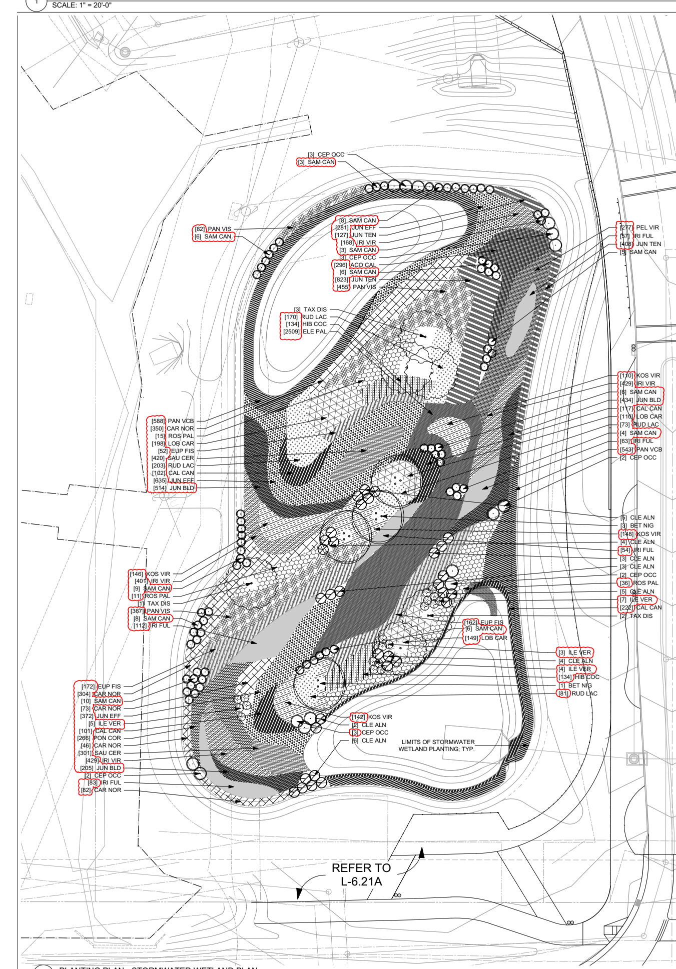

LOWER STORMWATER MEADOW PLANT SCHEDULE - CONTRACTOR SHALL SATISFY ALL MEASUREMENTS NOTED - EXCEED SIZES UPON APPROVAL

KEY	QTY	LATIN NAME	COMMON NAME	CONTAINER | SIZE | HT | W | SPACING	COMMENTS
DECIDUOUS TREES					
TAX DIS	6	TAXODIUM DISTICHUM 'MICKELSON'	SHAWNEE BRAVE BALDCYPRESS	6" CAL. / 18'-0" / 8'-0" / AS SHOWN	STRONG CENTRAL LEADER
UNDERSTORY DECIDUOUS TREES					
BET NIG	4	BETULA NIGRA 'DURA-HEAT'	DURA-HEAT RIVER BIRCH	1.5" CAL. PER CANE / 16'-0" / 8'-0" / AS SHOWN	MULTI-STEM; MIN (3) CANE
DECIDUOUS SHRUBS					
CEP OCC	15	CEPHALANTHUS OCCIDENTALIS	BUTTONBUSH	7 GAL. / 36" / 36" / AS SHOWN	FULL; DENSE; MATCHING
CLE ALN	32	CLETHRA ALNIFOLIA 'HUMMINGBIRD'	HUMMINGBIRD SUMMERSWEET	7 GAL. / 30" / 30" / AS SHOWN	FULL; DENSE; MATCHING
ILE VER	19	ILEX VERTICILLATA	WINTERBERRY HOLLY	5 GAL. / 30" / 30" / AS SHOWN	MALE AND FEMALE PLANTS SHALL BE PROVIDED IN A RATIO NO LESS THAN 1:5; FULL; DENSE; MATCHING
SAM CAN	74	SAMBUCUS CANADENSIS	AMERICAN BLACK ELDERBERRY	7 GAL. / 36" / 36" / AS SHOWN	FULL; DENSE; MATCHING
PERENNIALS					
ACO CAL	296	ACORUS CALAMUS	SWEET FLAG	1 GAL. / 18" / 12" / 18" O.C.	
EUP FIS	386	EUPATORIADELPHUS FISTULOSUS 'GATEWAY'	GATEWAY JOE-PYE WEED	1 GAL. / 12" / 12" / 24" O.C.	
HIB COC	268	HIBISCUS COCCINEUS 'TEXAS STAR'	TEXAS STAR SCARLET ROSE MALLOW	3 GAL. / 36" / 36" / 18" O.C.	
IRI FUL	369	IRIS FULVA	COPPER IRIS	1 GAL. / 12" / 8" / 24" O.C.	
IRI VIR	1,427	IRIS VIRGINICA	BLUE FLAG IRIS	1 GAL. / 12" / 8" / 12" O.C.	
KOS VIR	546	KOSTELETZKYA VIRGINICA	SEASHORE MALLOW	5" PLUG / 12" / 12" / 18" O.C.	
LOB CAR	457	LOBELIA CARDINALIS	CARDINAL FLOWER	1 GAL. / 36" / 18" / 18" O.C.	
PEL VIR	277	PELTANDRA VIRGINICA	GREEN ARROW ARUM	1 GAL. / 12" / 8" / 12" O.C.	
PON COR	266	PONTEDERIA CORDATA	PICKEREL WEED	1 GAL. / 12" / 8" / 18" O.C.	
ROS PAL	62	ROSA PALUSTRIS	SWAMP ROSE	3 GAL. / 24" / 24" / 60" O.C.	
RUD LAC	527	RUDBECKIA LACINIATA	CUTLEAF CONEFLOWER	1 GAL. / 24" / 12" / 18" O.C.	
SAU CER	721	SAURURUS CERNUUS	LIZARD'S TAIL	1 GAL. / 8" / 12" / 12" O.C.	
ORNAMENTAL GRASSES					
CAL CAN	542	CALAMAGROSTIS CANADENSIS	BLUE REED GRASS	1 GAL. / 12" / 12" / 18" O.C.	
CAR NOR	855	CAREX NORMAILS	GREATER STRAW SEDGE	1 GAL. / 12" / 12" / 18" O.C.	
ELE PAL	2,509	ELEOCHARIS PALUSTRIS	COMMON SPIKE RUSH	1 GAL. / 18" / 12" / 12" O.C.	
JUN EFF	1,288	JUNCUS EFFUSUS	COMMON RUSH	1 GAL. / 18" / 18" / 18" O.C.	
JUN BLD	1,153	JUNCUS INFLEXUS 'BLUE ARROWS'	BLUE ARROWS RUSH	1 GAL. / 12" / 12" / 12" O.C.	
JUN TEN	1,358	JUNCUS TENUIS	RUSH	1 GAL. / 8" / 8" / 18" O.C.	
PAN VCB	1,131	PANICUM VIRGATUM 'CAPE BREEZE'	CAPE BREEZE DWARF SWITCHGRASS	1 GAL. / 12" / 12" / 18" O.C.	
PAN VIS	904	PANICUM VIRGATUM 'SHENANDOAH'	SHENANDOAH SWITCH GRASS	1 GAL. / 12" / 12" / 18" O.C.	

Surface

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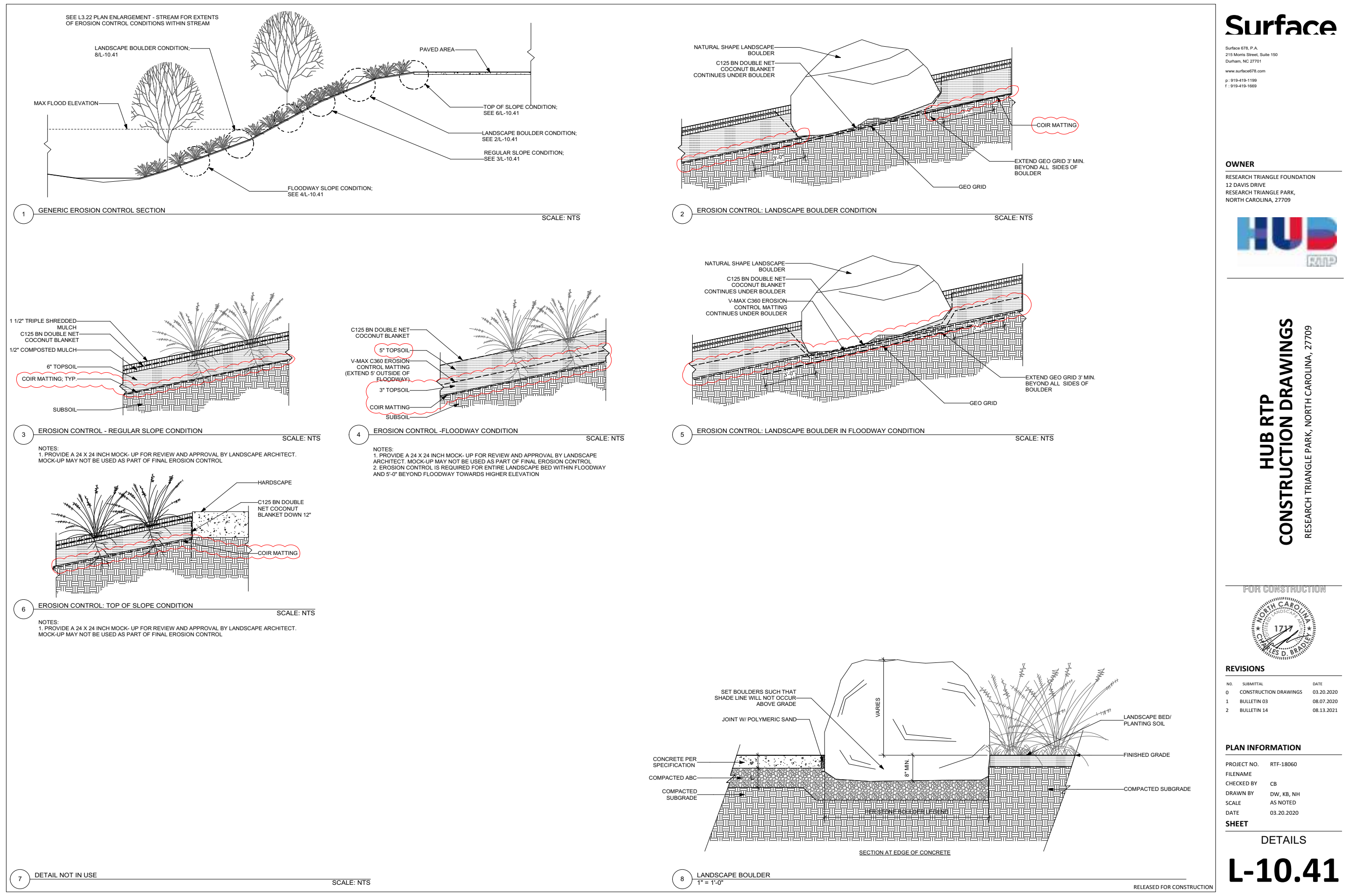
PLANTING ENLARGEMENT - STORMWATER PLANTING
L-6.21B



LITTLE SUGAR CREEK ENVIRONMENTAL RESTORATION AND GREENWAY PROJECT

Midtown Reach, Kings Drive Reach and Elizabeth Reach

CLIENTS: Mecklenburg County Asset & Facility Management and Storm Water Services

COMPLETION DATES: 2009 (Midtown and Kings Drive Reaches); 2012 (Elizabeth Reach)

CONSTRUCTION COST: $25M

DESIGN TEAM:
Wildlands (stream design), LandDesign (greenway design)

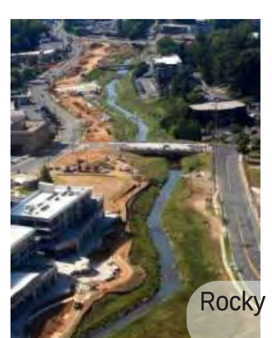
These urban park projects include 4,600 LF of stream and floodplain enhancement features coordinating with an urban park and greenway trail south of uptown Charlotte. This work included daylighting 1,800 LF of channel that was previously capped by concrete parking decks. The stream and floodplain enhancement made use of in-stream boulder structures, excavated floodplain benches, and a planted riparian buffer to improve the stability, habitat, and aesthetics of the stream corridor. The stakeholder group included Mecklenburg County Storm Water Services, Park & Recreation, Asset & Facility Management, and City of Charlotte Storm Water Services. The project was funded in part by FEMA buyout grants to remove floodprone structures from the floodplain, County land purchase bond funds, and the NC Land & Water Fund (formerly known as the Clean Water Management Trust Fund).

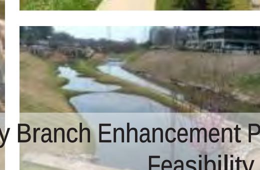
WHAT WORKED:

WHAT TO IMPROVE:

ROLE OF CITY:

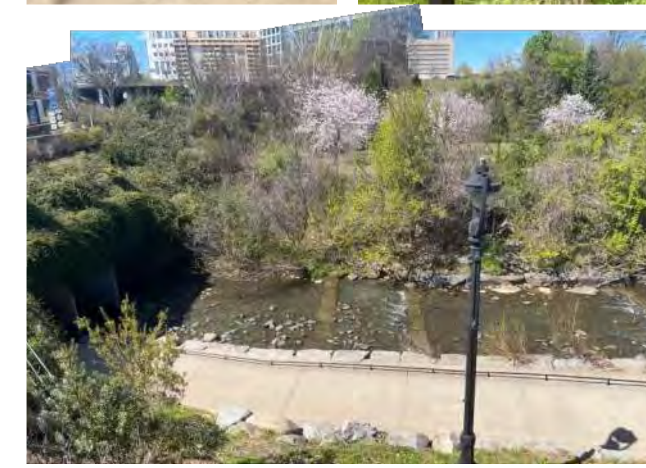
COMMUNITY IMPACT:





KEY TAKEAWAYS (Little Sugar Creek Greenway)

- **Stormwater**
  - Road runoff released directly into stream
  - Bioretention along stream bank
    - Can fill up from stream – need to reinforce both sides of the dam or outlet
    - Can fill up from adjacent runoff -level spreader protected for creek overflowing into BMP and visa versa
    - Requires routine maintenance [These had been cleared once in 15 years]
  - Bocci courts used as bioretention, sand filter type of system?
- **Utility Impacts**
  - Existing Sanitary Sewer
  - Overhead power lines - Duke Energy easement through site - limited the structure design in portions of site, minimal meandering allowed
  - City had a sewer upgrade planned for 2 years after LSC construction -- put construction on hold to get this city work done before having to rip out greenway later
- **Vegetation**
  - Combination of ornamental grasses, perennials, shrubs and trees. Native plant material along stream; more stylized plant material along greenway and commercial development
  - Confirm size of plant material at install (plugs, container, other)
  - Date of Plant Installation – 2013?
  - Succession – shrubs and grasses have been shaded out from the canopy. Early in the project you could not see the stream
  - Today the stream is visible from the greenway
  - Managing Expectations
- **Existing Site Condition**
  - Piped below a parking structure
  - Brownfield site
  - Removed fuel tanks
  - Contingency funds for construction for inspection of contaminated soils and any buried surprised (old foundations, etc.)
  - Parking lot and buildings
- **Economic Impact**
  - Funding sources
  - Investment
  - ROI- Tenfold return on investment
  - Projects in design and/or construction
- **Stream Design**
  - Enhancement
  - Restoration
  - No Pedestrian access - 'look don't touch' - using riffles and vanes to maximize stream interest, aeration, sound (near overlook areas)
  - Safety
- Community Amenity - negotiation for width of stream corridor for stable stream versus width needed for linear park programming
- Ground plane treatment below bridges
- Homeless encampments
- Stream flashes 12' – 14' within 20 minutes to an hour
- Runoff flashes 12' within 20 minutes to an hour
- **Scale Comparison**
  - Length of stream
  - Overall project size

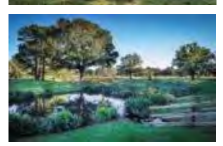


CHANTILLY ECOLOGICAL SANCTUARY AT BRIAR CREEK

CLIENT: Charlotte-Mecklenburg Storm Water Services
COMPLETION DATES: 2018
CONSTRUCTION COST: $3.9M
DESIGN TEAM:
Wildlands (stream design)

WHAT WORKED:

WHAT TO IMPROVE:



ROLE OF CITY:

COMMUNITY IMPACT:

Charlotte-Mecklenburg Storm Water Services and the City of Charlotte's Storm Water Services (CMSWS) partnered on this stream restoration, enhancement, and stormwater quality retrofit project along Briar Creek in a densely urban area of the City of Charlotte. The overall goals of the project were to restore Briar Creek, Edwards Branch, and Chantilly Tributary, improve water quality through improved stormwater management, and obtain stream mitigation credits for the City of Charlotte's Umbrella Mitigation Bank. Prior to the project, Mecklenburg County purchased and demolished flood-prone buildings as part of the FEMA flood mitigation buyout program. This buyout provided the space necessary to expand the existing community park, incorporate stormwater quality retrofits, and restore portions of degraded streams. Over 4,450 LF of stream restoration and enhancement were performed, two stormwater quality best management practices (BMPs) were installed within the floodplain of Briar Creek, and the ground was prepared for greenway and recreational trails to be expanded in the future. Extensive hydraulic analysis was required to support a floodplain no-rise certification. Wildlands integrated hydraulic modeling with design to avoid raising floodplain elevations on adjacent private parcels. Wildlands also prepared a feasibility study and an alternatives analysis for the Chantilly Tributary and BMP components of the project. Wildlands Realty, our sister realty firm, negotiated five donated stormwater easements on private parcels. Construction was completed in 2018. Rough grading for a future greenway corridor was included in the design and construtcion package, in preparation for future greenway funding allocations.

KEY TAKEAWAYS (Chantilly Ecological Sanctuary - Briar Creek)

- **Stormwater**
  - Constructed Wetland
  - Used a 'flap' in the outflow pipe to prevent stream from backing up into and flooding wetland
  - Wet Pond
  - Controls runoff from upstream impervious, parking lots and buildings

- **Utility Impacts**
  - Existing Sanitary Sewer
  - Existing overhead power lines
  - Both require easements and restrictions for planting

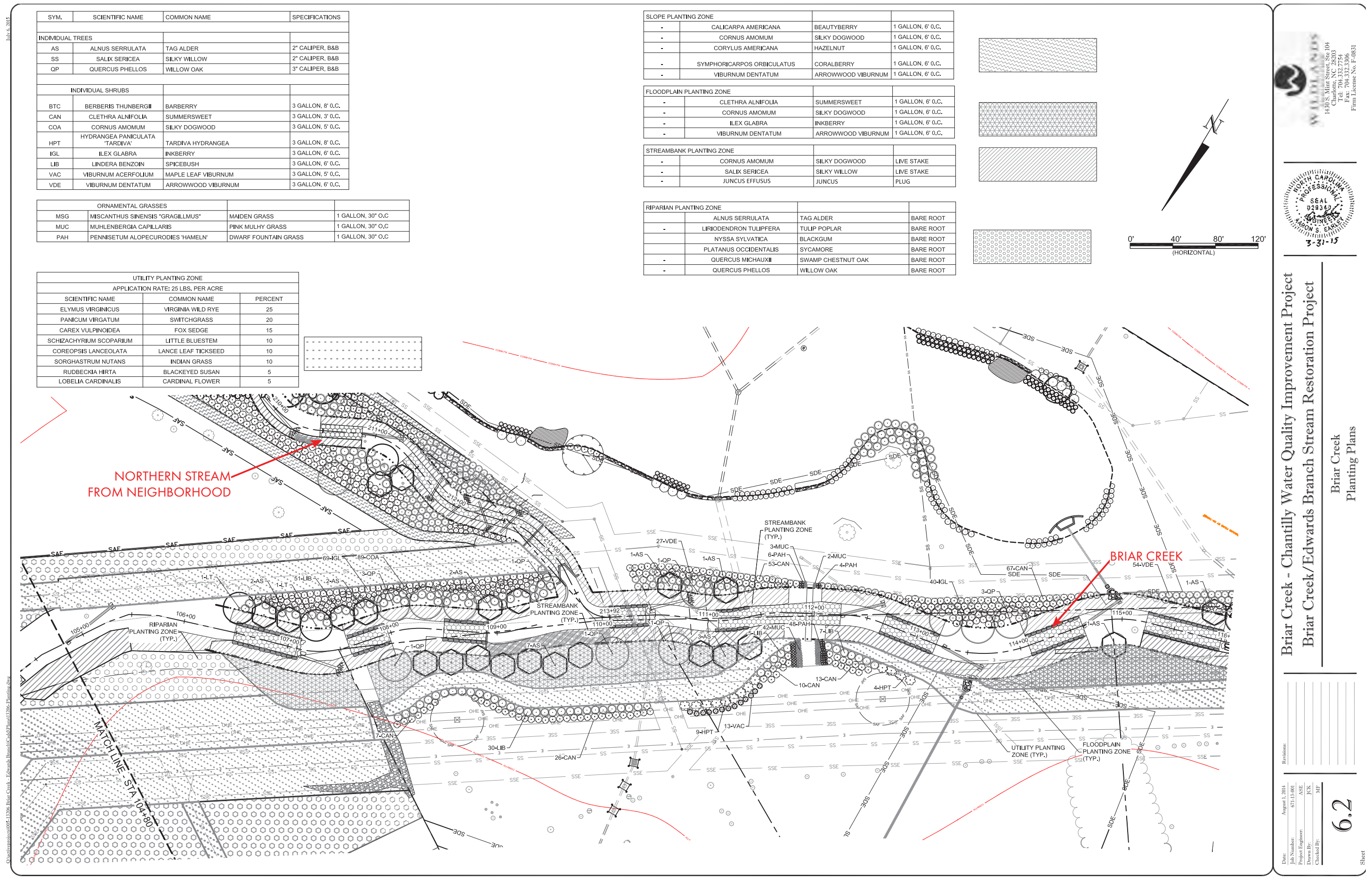
- **Vegetation**
  - Combination of ornamental grasses, perennials, shrubs and trees. Native plant material along stream; more stylized plant material along greenway and commercial development
  - Confirm size of plant material at install (plugs, container, other)
  - Date of Plant Installation – 2018?
  - Succession – Community Planting
  - Plants unable to establish along main stream due to flashes--confirm additonal bank stabilization methods

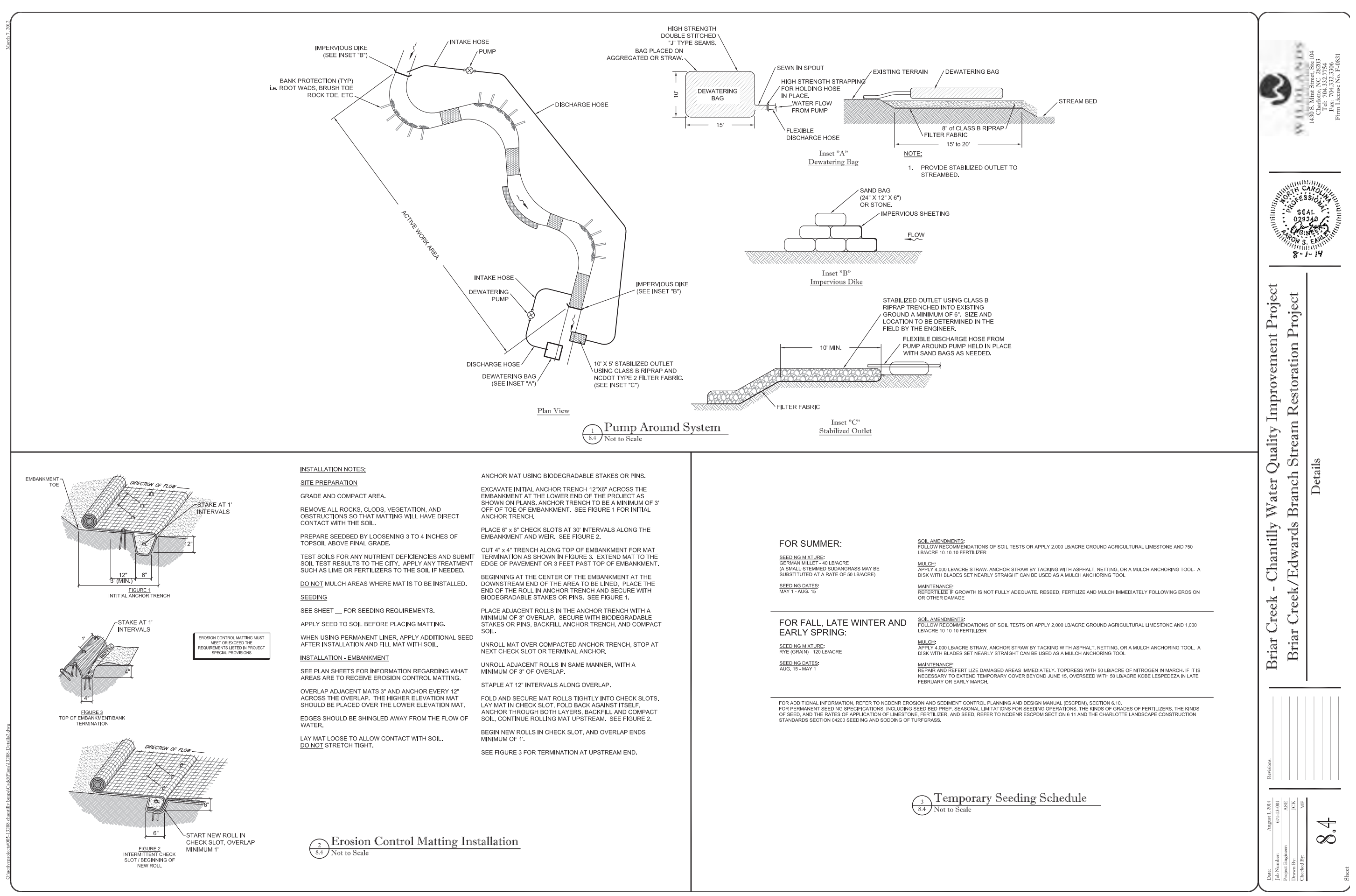
- **Existing Site Condition**
  - Brownfield site?
  - Removed +/-300 Apartment units (Relocated residents); Flooding not mitigated with upstream development that likely accelerated flooding intensity and frequency downstream, displacing the residents living in the floodplain.
  - FFE of Apartment units was 12' below Flood stage
  - Parking

- **Economic Impact**
  - Funding sources (FEMA)
  - Investment
  - ROI
  - Gentrification – Impacts to local neighborhood, people who lived on the land prior and people downstream (what is the flood mitigation impact? what is the gentrification/development impact?)
  - Projects in design and/or construction – tear down and rebuilds

- **Stream Design**
  - Enhancement
  - Restoration
  - Pedestrian bridges, grass/stone paths
  - Safety
  - Community Amenity

- **Scale Comparison**
  - Length of stream
  - Overall project size





BRIAR CREEK STREAM RESTORATION AND ENHANCEMENT PROJECT

Randolph to Meadowbrook Road

CLIENT: Charlotte-Mecklenburg Storm Water Services

COMPLETION DATES: 2018

CONSTRUCTION COST: $2.7M

DESIGN TEAM:

Wildlands (stream design), Benesch (greenway design)

Wildlands provided stream enhancement on 5,100 LF of Briar Creek and uncapped and restored 900 LF of a minor system tributary along the Mint Museum and Eastover Park in Charlotte, NC. The project scope included existing conditions geomorphic assessment, design, permitting, City and County easement coordination, coordination with an adjacent Park & Recreation greenway project, and construction administration assistance.

Eastover Park is well-loved by the local community, and the public was adamant that the mature canopy within the programmed park area be preserved to the greatest extent possible. As a participating stakeholder, Catawba Lands Conservancy required that impacts be minimized to its forested conservation tract. Wildlands and the landscape architecture firm worked together and integrated the stream and greenway designs to avoid the majority of mature trees. The minor system tributary was removed from buried culvert pipes, and the team performed hydraulic modeling to assess the effects of daylighting and restoring a natural channel during a range of storm events. The project also included upsizing a stormwater pipe network through Eastover Park.

Wildlands completed environmental permitting for both the stream and greenway work. Since the project is surrounded by private properties, the project had to be designed in a way that resulted in 'no-rise' to the FEMA floodplain. Wildlands developed a detailed hydraulic model, and Wildlands and Benesch worked together to design the stream and greenway grading iteratively to meet the no-rise condition.

During construction, Wildlands tracked construction line items for payment by three different City and County departments. The project resulted in improved channel stability, diverse in-stream habitat, and a well-used greenway, all designed in a way that protected adjacent infrastructure and private properties.

WHAT WORKED:

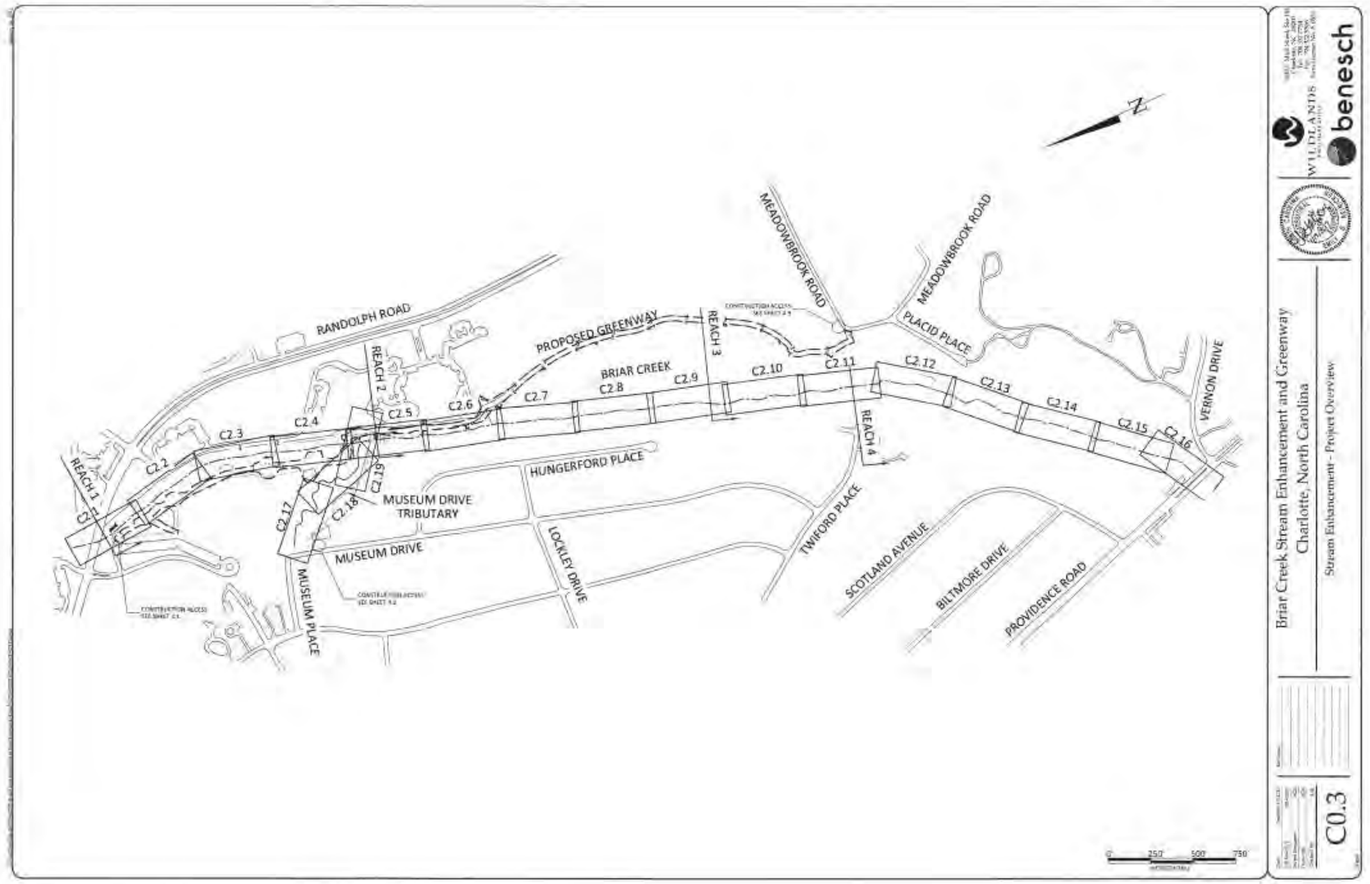
WHAT TO IMPROVE:

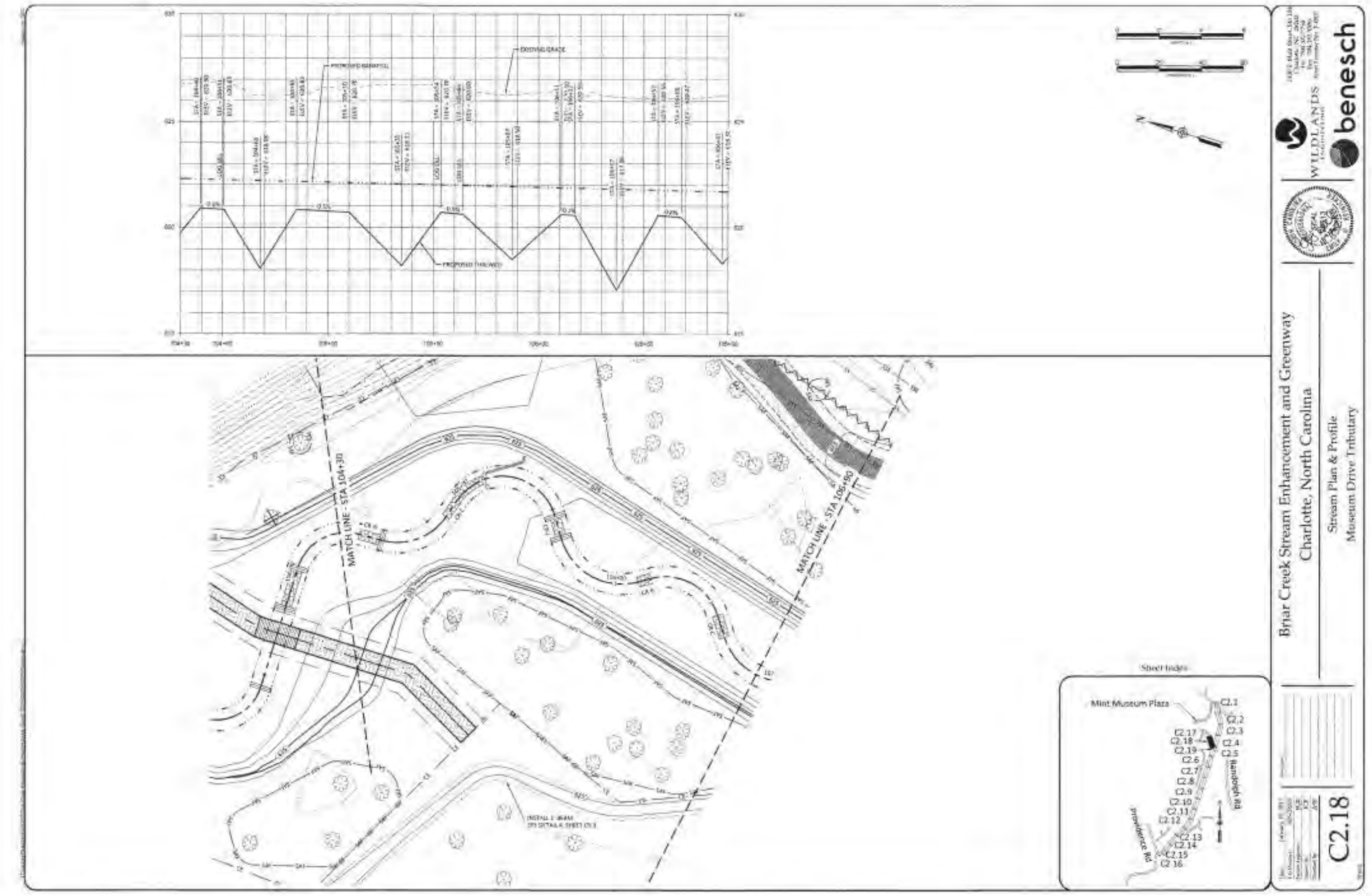
ROLE OF CITY:

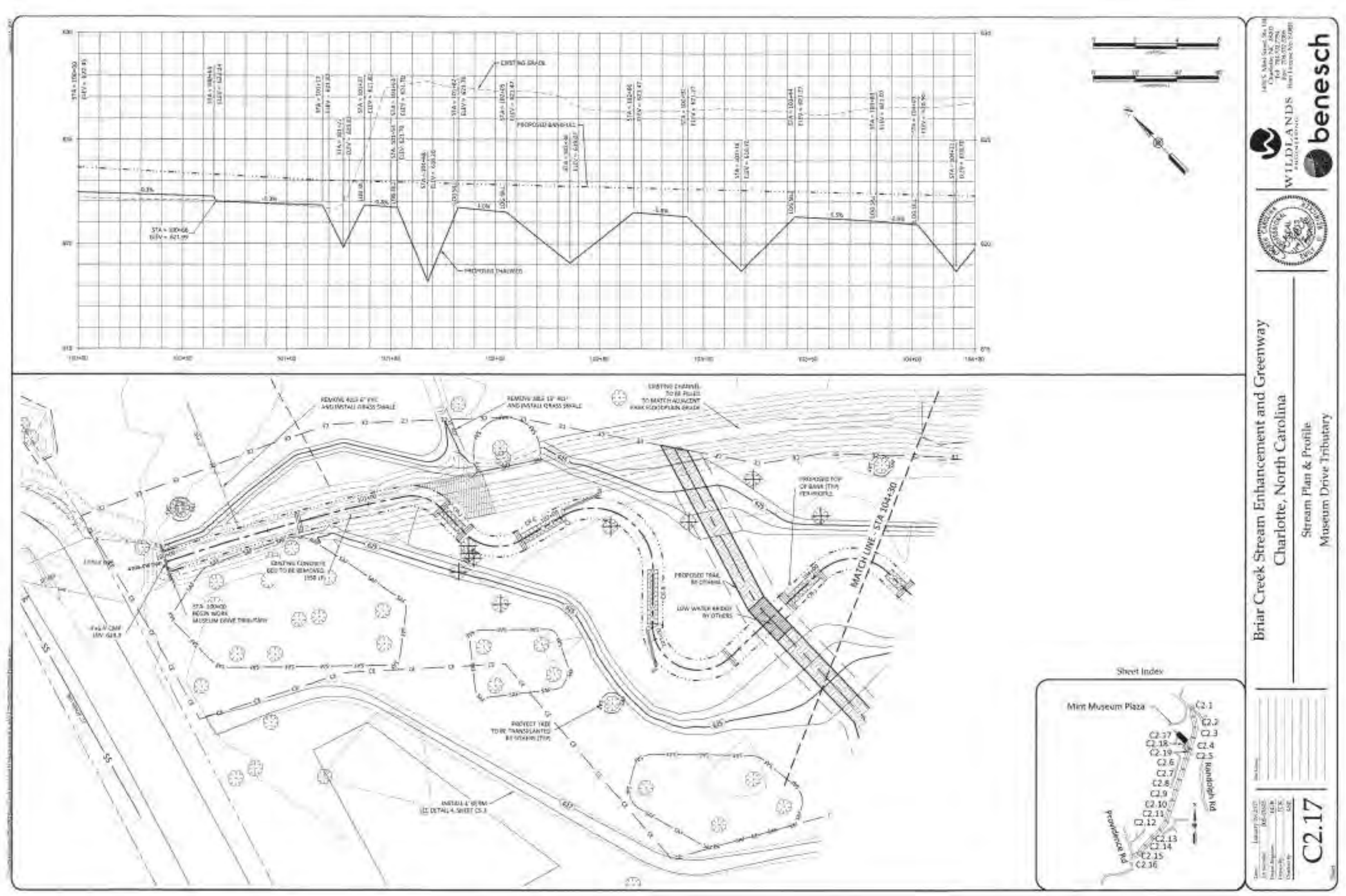
COMMUNITY IMPACT:

KEY TAKEAWAYS (Briar Creek Stream Restoration and Enhancement)

- **Stormwater**
  - Grass Swale conditions
  - Other?
- **Utility Impacts**
  - Existing Sanitary Sewer
  - Existing overhead power lines
  - Both require easements and restrictions for planting
- **Vegetation**
  - Combination of ornamental grasses, perennials, shrubs and trees. Native plant material along stream; more stylized plant material along greenway and commercial development
  - Confirm size of plant material at install (plugs, container, other)
  - Date of Plant Installation – 2020?
  - Succession –
  - Tree Save – Community input
- **Existing Site Condition**
  - Greenfield Site?
  - Parking
- **Economic Impact**
  - Funding sources
  - Investment
  - ROI
  - Gentrification – Impacts to local neighborhood
- **Stream Design**
  - Enhancement
  - Restoration
  - Pedestrian bridges and asphalt trails
  - Safety
  - Community Amenity
- **Scale Comparison**
  - Length of stream
  - Overall project size


RANDOLPH ROAD
PROPOSED GREENWAY
BRIAR CREEK
MEADOWBROOK ROAD
PLACID PLACE
VERNON DRIVE
REACH 1
REACH 2
REACH 3
REACH 4
C2.2
C2.3
C2.4
C2.5
C2.6
C2.7
C2.8
C2.9
C2.10
C2.11
C2.12
C2.13
C2.14
C2.15
C2.16
C2.17
C2.18
C2.19
HUNGERFORD PLACE
MUSEUM DRIVE TRIBUTARY
MUSEUM DRIVE
MUSEUM PLACE
LOCKLEY DRIVE
TWYFORD PLACE
SCOTLAND AVENUE
BILTMORE DRIVE
PROVIDENCE ROAD
WILDLANDS
benesch
Briar Creek Stream Enhancement and Greenway
Charlotte, North Carolina
Stream Enhancement - Project Overview
C0.3


WILDLANDS
benesch
Briar Creek Stream Enhancement and Greenway
Charlotte, North Carolina
Stream Plan & Profile
Museum Drive Tributary
Sheet Index
Mint Museum Plaza
C2.18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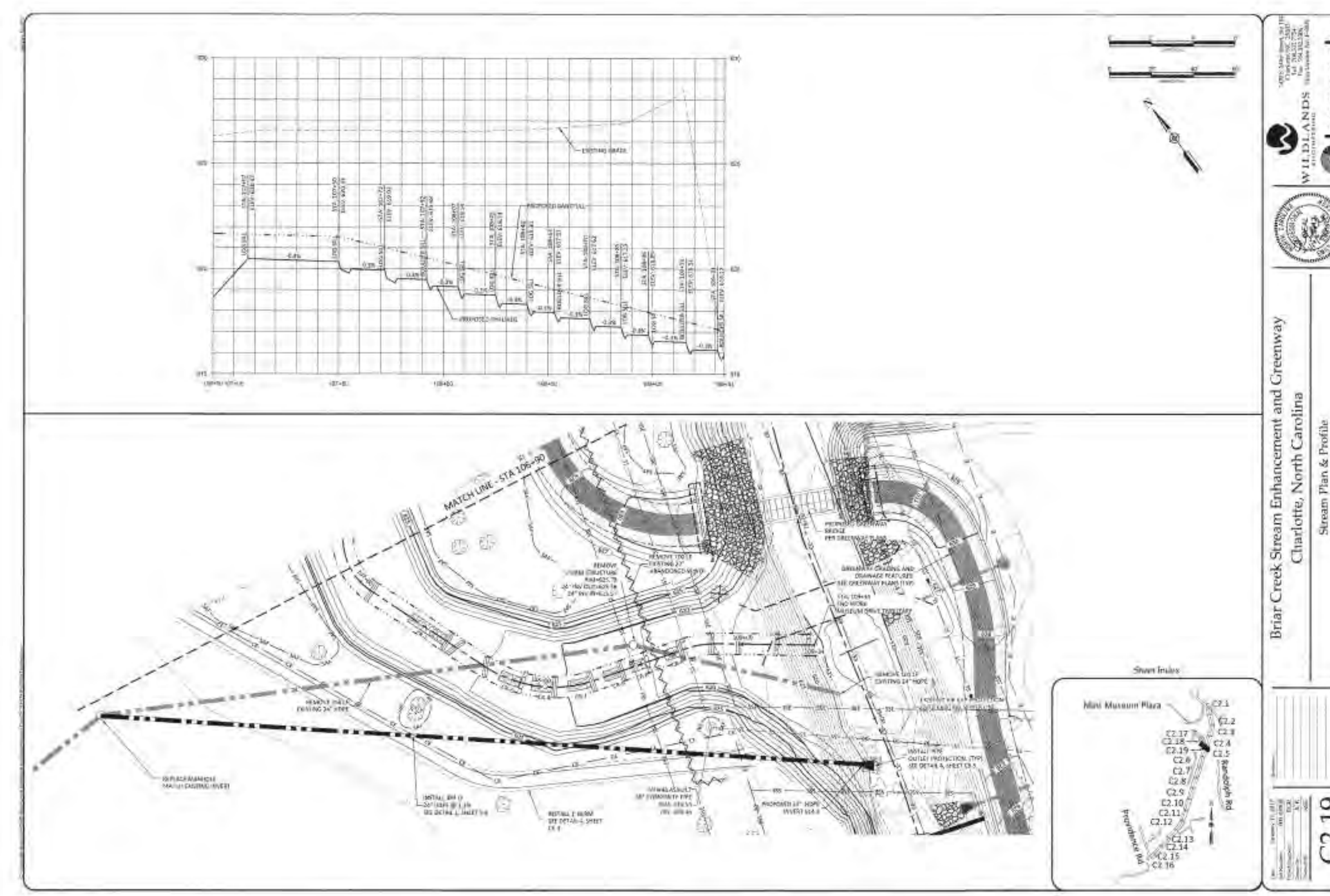
Briar Creek Stream Enhancement and Greenway
Charlotte, North Carolina
Stream Plan & Profile
Museum Drive Tributary
Sheet Index
Mint Museum Plaza
C2.17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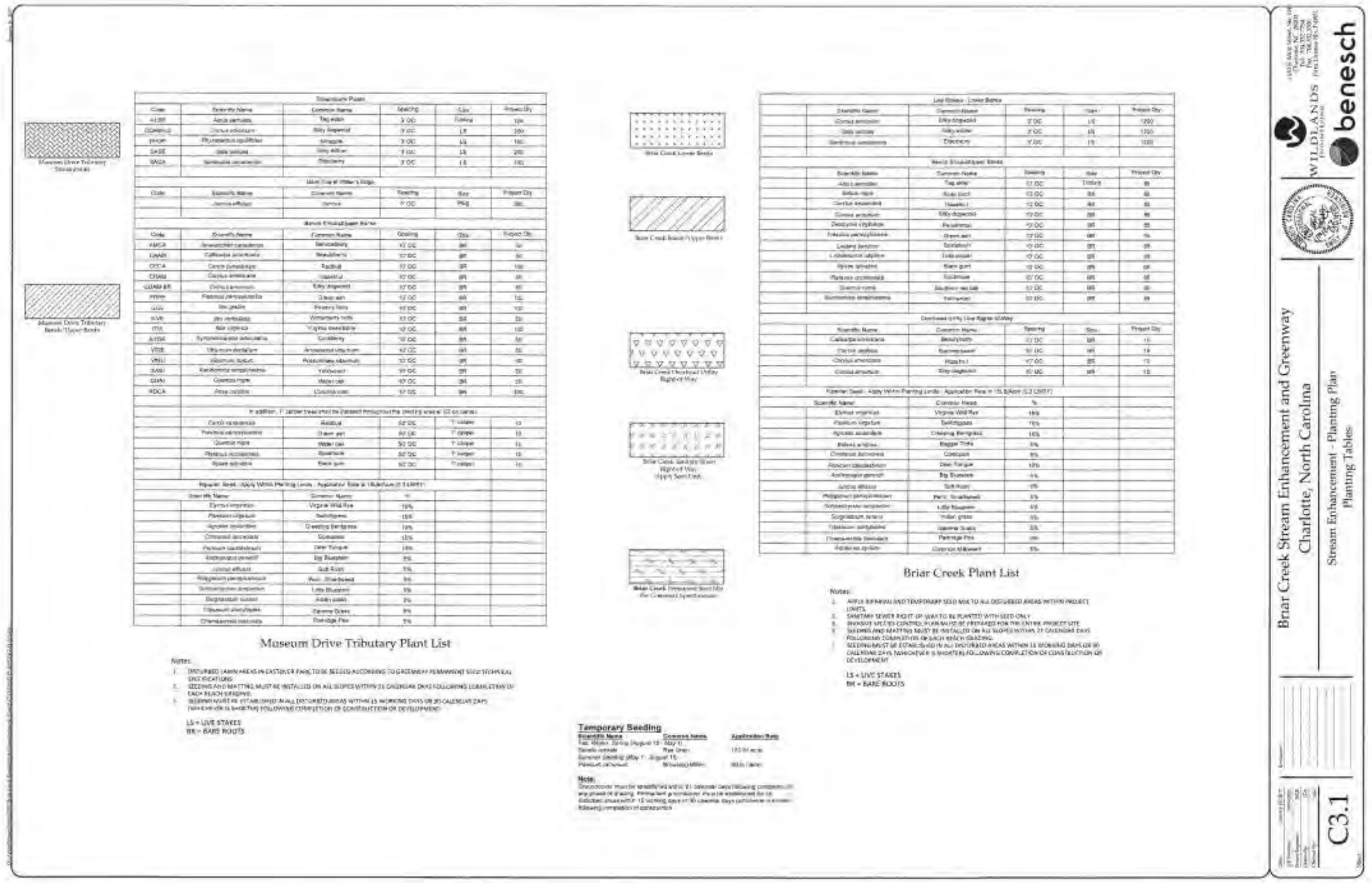
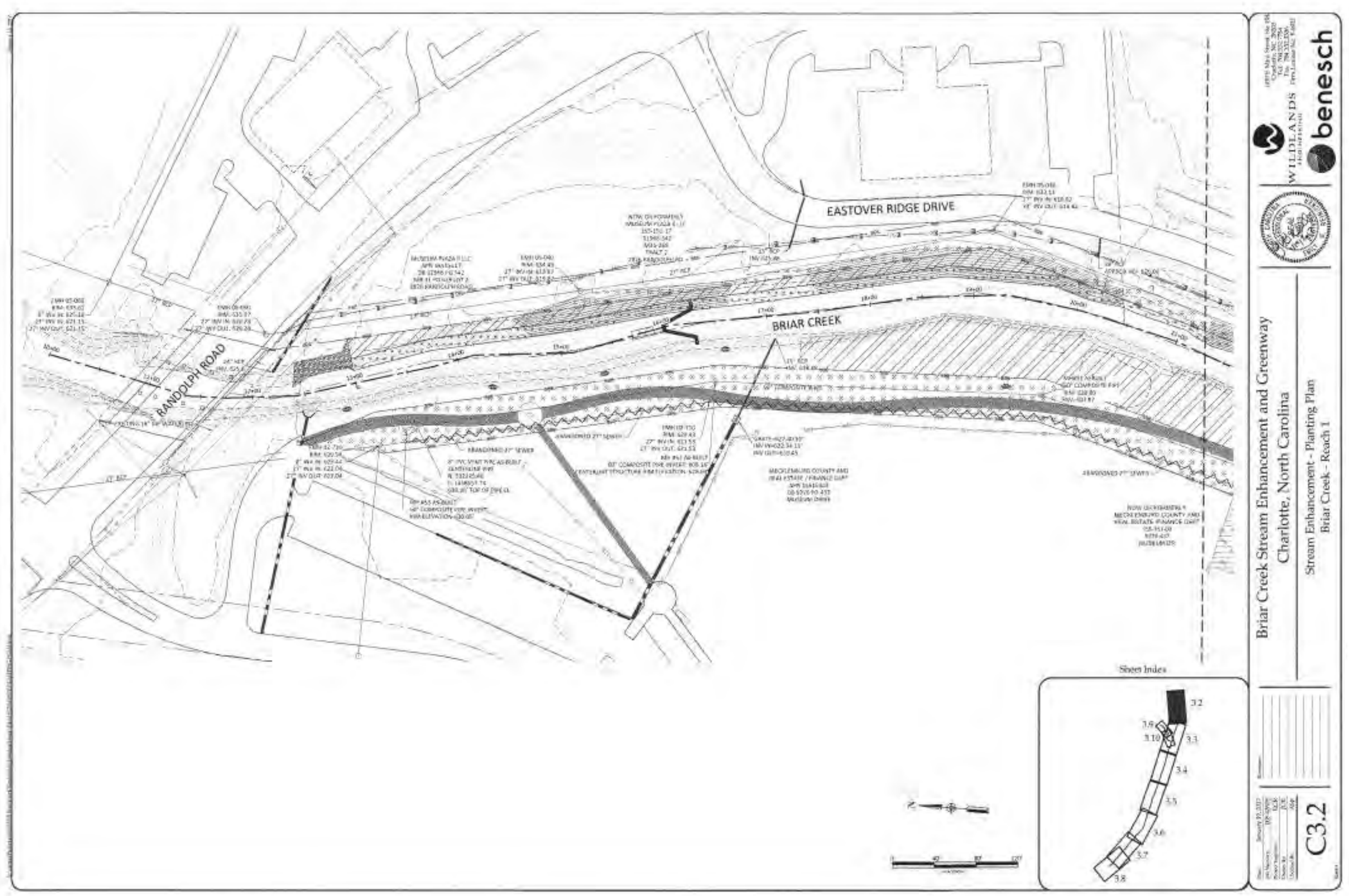
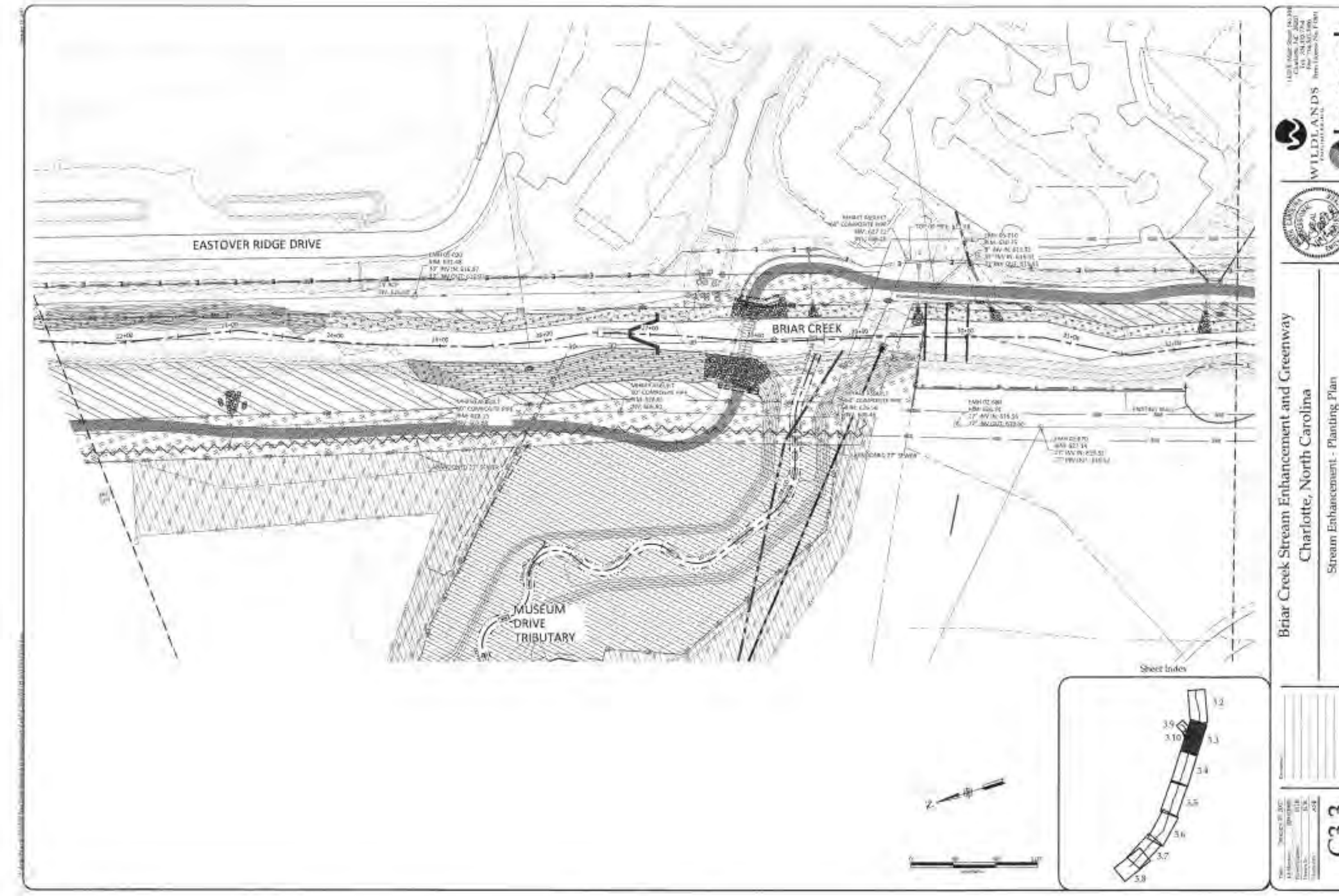
benesch
Briar Creek Stream Enhancement and Greenway
Charlotte, North Carolina
Stream Plan & Profile
Museum Drive Tributary
Sheet Index
Mint Museum Plaza
C2.19







ATTENDEES

CITY OF RALEIGH:
KATE PEARCE
DEAN PERRY
EMMA LILES
GARY CLAIBORNE
TJ McCOURT

DIX PARK CONSERVANCY:
JANET COWELL

SURFACE678:
ERIC DAVIS
ROBERT PRATT
JANIE DAY WHITWORTH

WILDLANDS ENGINEERING:
JEFF KEATON
EMILY REINICKER

GUEST GUIDES:

AARON EARLEY - WILDLANDS- CHANTILLY
CRYSTAL GOODE - MECKLENBURG COUNTY STORMWATER SERVICES- CHANTILLY
JIM HIGGINBOTHAM - MECKLENBERG COUNTY ASSET AND FACILITY MANAGEMENT- LITTLE SUGAR CREEK

HOUSTON, TX TRIP

HOUSTON, TX PRECEDENT SITES TOUR

BUFFALO BAYOU
GREEN TREE NATURE AREA
**TAPLEY TRIBUTARY*
SABINE PROMENADE
ALLEN'S LANDING
SESQUICENTENNIAL PARK

MEMORIAL LANDBRIDGE

EASTERN GLADES

HOUSTON ARBORETUM

Dix Park Conservancy   Raleigh   Surface   WILDLANDS ENGINEERING

BUFFALO BAYOU PARK

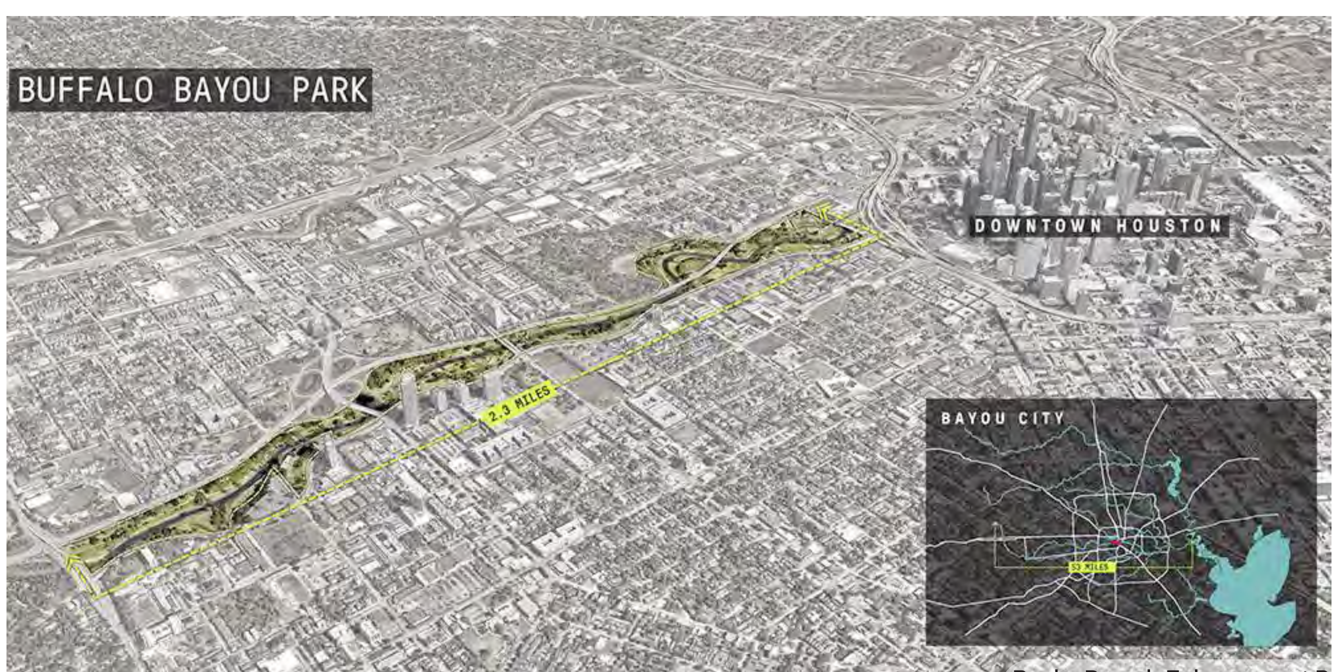
CLIENT: City of Houston, TX

COMPLETION DATES: 2020 (2016-2020)

CONSTRUCTION COST:

DESIGN TEAM: SWA

160 acre Buffalo Bayou Park from Shepherd Drive to Sabine Street between Allen Parkway and Memorial Drive.



WHAT WORKED:

WHAT TO IMPROVE:

ROLE OF CITY:

COMMUNITY IMPACT:

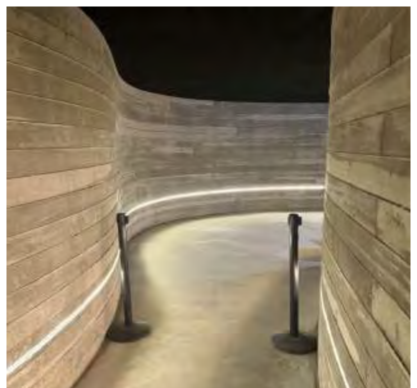
Bayou Greenways, Interactive Map:

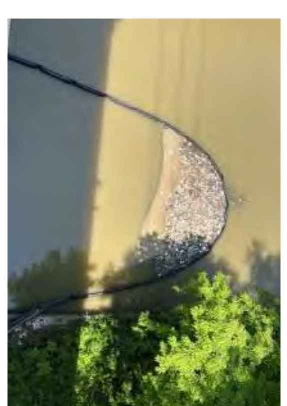
McGovern Cascade
Yeshurun Cemetery
Lost Lake outlet to Bayou

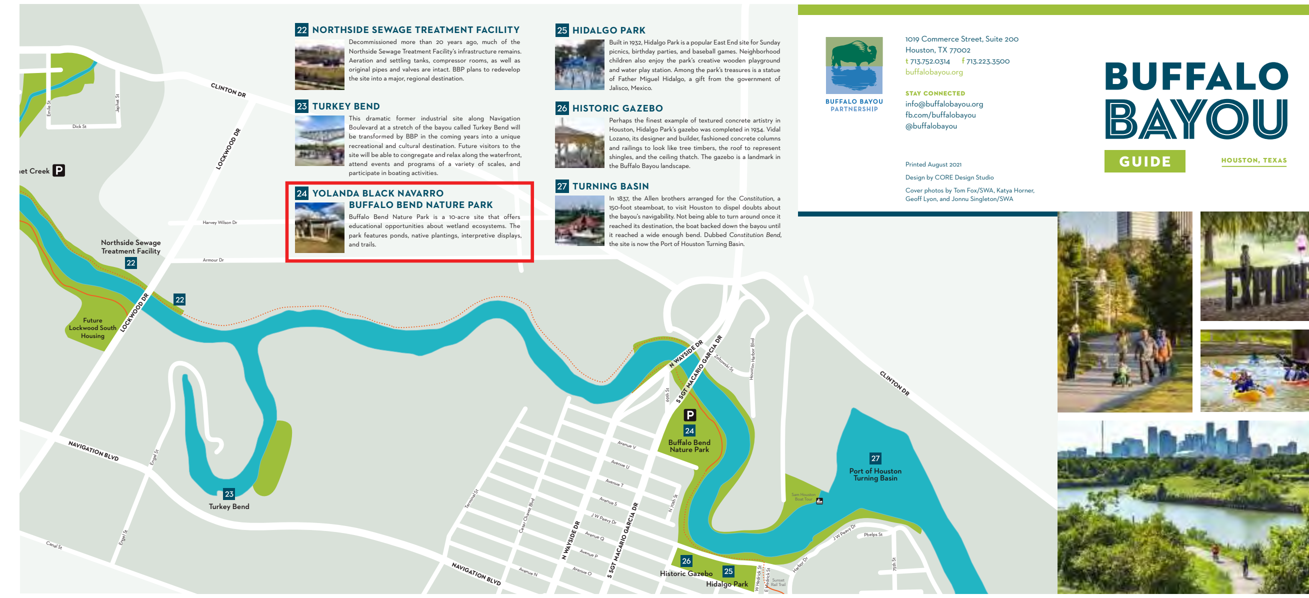
The Green Tree Nature Trail portion of the BBP is an attempt to showcase an ecosystem that is at least similar to what it would have been in the 1800s prior to the Bayou being 'concretized'.

Houston was part of a coastal prairie ecosystem, with a few rich and dense riparian corridors, of which the Green Tree Nature Area is an example.

"Late Houston landscape architect Charles Tapley designed this inspirational site in the late 1970s to feature a bayou tributary, riparian plantings, granite steps and seating areas. Recent improvements include a wetland, native Texas prairie and a footbridge. Besides being a place to picnic and to view the downtown skyline, Tapley and other nearby tributaries have become wonderful outdoor learning centers." buffalobayou.org







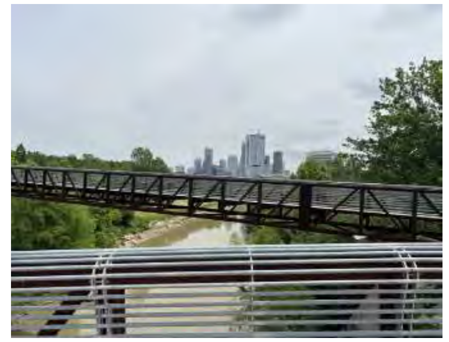
<u>**KEY TAKEAWAYS (Buffalo Bayou)**</u>

- **Stormwater**
  - Wetland is separated from stream
  - Wetlands throughout project
  - Amenity at the Visitor/Nature Center
  - Scale of wetland (retention pond) is significant and offers a unique habitat .Amenity. Pine as structural element on its side.
- **Utility Impacts**
- **Vegetation**
  - Combination of ornamental grasses, perennials, shrubs and trees
  - Rooms shaped by trees (Live Oak - reflection room)
  - Sculptures planted next to sculptural trees
  - playing with form - sycamore trunks of sabine promenade blend with overpass columns
- **Existing Site Condition**
  -
- **Economic Impact**
  -
- **Stream Design**
  - flat surfaces are a hindrance to fish passage (concrete block steps below ped bridge leading to Tapley Tributary)
  - Questioning creating a hard edge to control flow (banks of porous pavers)
  - Buffalo Bayou was not really realigned for this project. Pretty straight
  - Opprortunity to show "old well" - pump water that would return to stream

Episodic Flooding
- Pipe and capture water (John hutton clarify?)
  - Reuse - provide moment along pathway
  - Release
- Maintenance Access to mitigate impacts of flooding

- **Scale Comparison**
  - The constructed portion is 2.3 miles. Much larger than Rocky Branch, and much more money (donors) involved. Stream itself is larger.
  - After enhanced, Dix Park could have similar activity levels, if connected effectively to downtown Raleigh and surrounding areas
- **Walkways**
  - effective hierarchy. If doing it again, BBP would do 15' rather than 10' as the multi-use trail
  -







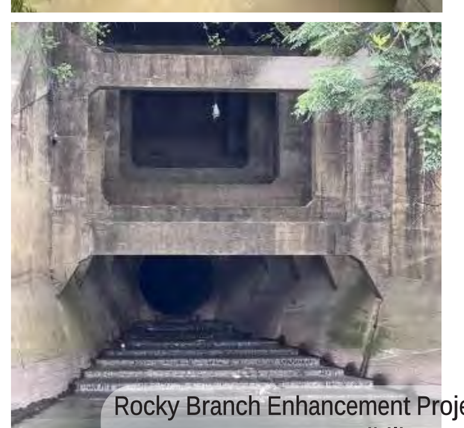










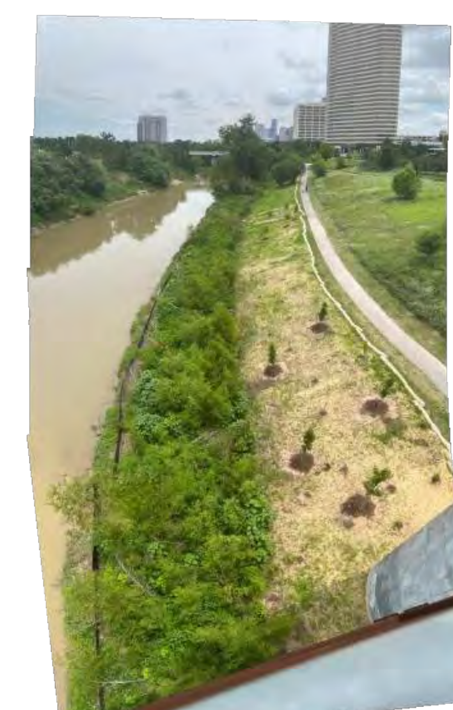












HOUSTON ARBORETUM

WHAT WORKED:

CLIENT: Houston Arboretum & Nature Center

COMPLETION DATES: Pilot plot 2016

CONSTRUCTION COST:

WHAT TO IMPROVE:

DESIGN TEAM: Masterplan - Design Workshop, Lake Flato Architects, Main Street Design

ROLE OF CITY:

COMMUNITY IMPACT:

"The land on which the Houston Arboretum & Nature Center sits is part of Memorial Park, one of the largest urban parks in the country. From 1917 to 1923, the land was the site of Camp Logan, a World War I Army training camp. After the war, in 1924, the land was deeded to the City of Houston to be set aside as a park dedicated to the memory to the fallen soldiers of World War I.

The idea to create an arboretum began with local ecologist and educator Robert A. Vines who advocated carving out a piece of land from Memorial Park to serve as a nature sanctuary. In 1951, City Council agreed to his proposal and set aside **265 acres as an arboretum and botanical garden; since that time, roads and their rights-of-way have reduced the size of the arboretum to 155 acres.**

On February 17, 1967, ground was broken for a nature center building.

The Meadow Restoration Project began in 1999 with a gift from Marie and Anthony Kraft. Through cooperation of many state and local agencies, the **Arboretum was able to perform a much-needed prescribed burn to renovate soil and improve vegetation in the meadow.**

The Charlotte Couch Memorial Birding Walkway was dedicated in the fall of 2000. Designed and built to reduce impact to the forest habitat, this raised walkway allows **visitor access to views of Buffalo Bayou and the forest canopy while protecting a fragile ecotone**.

A Wildlife Garden, which demonstrates plantings appropriate to attract hummingbirds, butterflies and other wildlife to an urban backyard, and the Carol Tatkon Sensory Garden featuring native plants attractive to the senses are the latest additions to the Arboretum's ever-changing landscape." houstonarboretum.org

"Two major natural disasters, Hurricane Ike in 2008 and then a severe drought in the summer of 2011, significantly impacted the Houston Arboretum & Nature Center. **The result was a 50% loss of our tree canopy** and subsequent encroachment of invasive species.

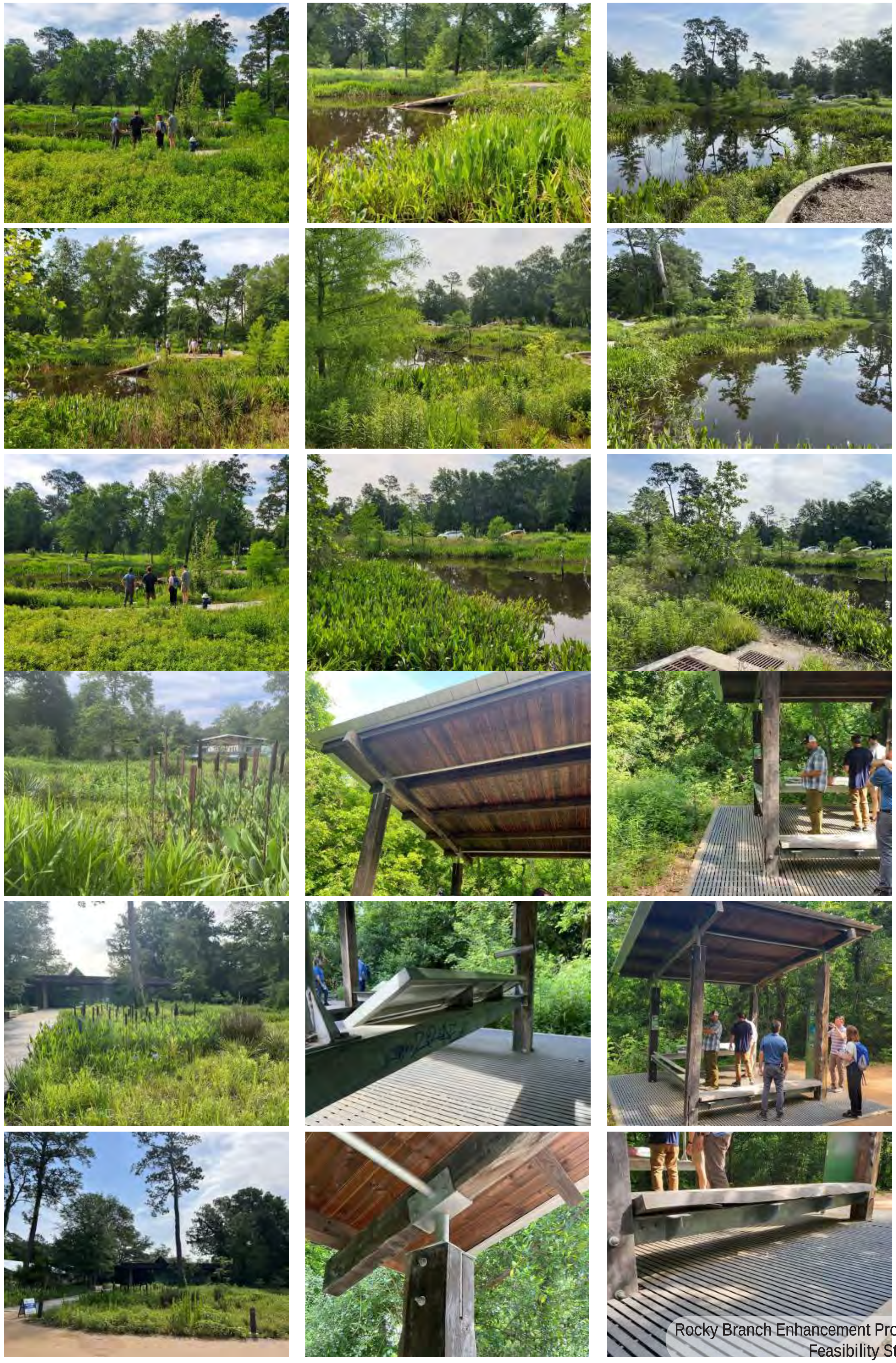
The hurricane and drought made apparent a pre-existing problem and it highlighted the poor over grown ecological condition of the Arboretum's landscape. It created an **opportunity to change the relationship of how we managed and viewed our grounds**. It also created an opportunity to strengthen the educational mission by tying it to the site more directly." -houstonarboretum.org

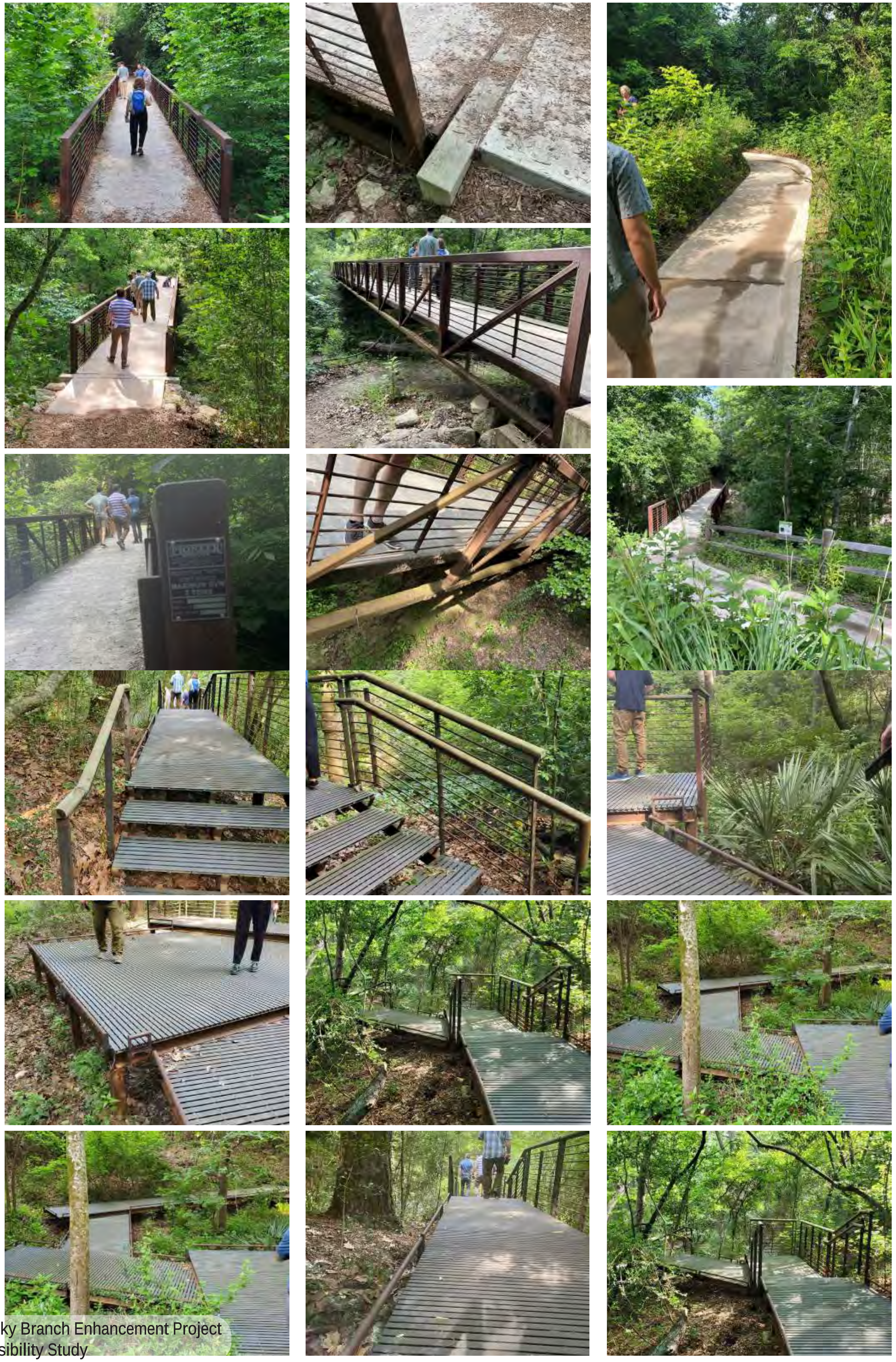
Devastation to Resilience: The Houston Arboretum & Nature Center
Reed|Hilderbrand and Design Workshop, Inc.

ASLA Honor Award

KEY TAKEAWAYS (Houston Arboretum)

- **Stormwater**
  - Wetland is separated from stream
  - Wetlands throughout project
  - Amenity at the Visitor/Nature Center
  - Scale of wetland (retention pond) is significant and offers a unique habitat .Amenity. Pine as structural element on its side.
- **Utility Impacts**
  - culvert into Arboretum's Ravine area from Memorial Park - diagonal log steps across creek (Road runoff, etc.)
- **Vegetation**
  - Combination of ornamental grasses, perennials, shrubs and trees
  -
- **Existing Site Condition**
  -
- **Economic Impact**
  -
- **Stream Design**
  - Restoration of "Ravine"
  - Safety - visibility across the site
  - Community Amenity - metal boardwalk through the woods. Can see through this decking to the ground below - observe plants. Does
- **Scale Comparison**
  - Length of stream
  - Overall project size
  -
- **Walkways**
  - metal boardwalks - McNichols Steel catwalks and decking





CLIENT: City of Houston, TX

COMPLETION DATES: 2020 (2016-2020)

CONSTRUCTION COST: $35 M

DESIGN TEAM: Nelson Byrd Woltz (Landscape Design)

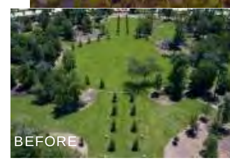
WHAT WORKED:

WHAT TO IMPROVE:

ROLE OF CITY:

COMMUNITY IMPACT:

CLAY FAMILY EASTERN GLADES



100 Acres

The Eastern Glades is the first project of Memorial Park's Ten-Year-Plan Masterplan.

Progress on the project was accelerated following a $70 Million gift from the Kinder Foundation.

Memorial Park was Camp Logan, a military training ground during WWI. Ecological restoration and infrastructural work were the drivers of this project. The restoration involves reforestation and invasive species removal over multiple years, Hines lake as a basin for the reclamation and reuse of stormwater, and wetlands (5.5 acres) and aquatic plants to further purify stormwater for irrigation use.
Included in the infrastructural work, NBW resurfaced some old paths from the time of the training camp, paved paths and boardwalks through the restored landscapes, and extended the Seymore Lieberman Trail around the park.

KINDER LANDBRIDGE

CLIENT: City of Houston, TX

COMPLETION DATES: February 2023

CONSTRUCTION COST: $70 M

DESIGN TEAM: Nelson Byrd Woltz (Landscape Design)

WHAT WORKED:

WHAT TO IMPROVE:

ROLE OF CITY:

COMMUNITY IMPACT:

LIVING BRIDGE

"It is amazing how one structure can improve a park so drastically," said Joe Turner, Director, Houston Parks and Recreation Department. "Raising cyclists and pedestrians above the street will not only provide a safe way for visitors to cross Memorial Drive, but it will also create an additional multi-use loop for the hardy exercise group since it connects with the existing Memorial and Woodway Drive tunnels. The Living Bridge is a testament to the hard work and dedication of the Conservancy and the individuals who have contributed monetarily to raise the funds necessary to build this dream, and we thank each and every one of them." houstontx.gov

CLIENT: Memorial Park Conservancy and Houston Parks and Recreation Department

COMPLETION DATES: 2009 , 3 acres

CONSTRUCTION COST: Phase I of a $10M Capital Campaign

DESIGN TEAM: Clark Condon

WHAT WORKED:

WHAT TO IMPROVE:

ROLE OF CITY:

COMMUNITY IMPACT:

ATTENDEES

CITY OF RALEIGH:
DEAN PERRY
GARY CLAIBORNE

SURFACE678:
ERIC DAVIS
ROBERT PRATT
JANIE DAY WHITWORTH

WILDLANDS ENGINEERING:
JOHN HUTTON

GUEST GUIDES:

BUFFALO BAYOU PARTNERSHIP:
ANNE OLSON - PRESIDENT
DR. GABI SOSA - CONSERVATION MANAGER

SWA GROUP LANDSCAPE ARCHITECTS:
SCOTT MCCREADY

HOUSTON ARBORETUM:
STEPHEN BENIGNO - CONSERVATION DIRECTOR

COST OPINION SUMMARY

INTRODUCTION

The following represents the opinion of probable construction cost prepared by Surface 678, Wildlands Engineering, Geosyntec and AECOM based on programmatic input and information received from City of Raleigh Parks, Recreation and Cultural Resources Department. This opinion of cost is preliminary and will be utilized as one of the criteria for determining the specific components of the final project scope.

The design team evaluated the cost for three Scenarios, A, B and C. Each scenario is broken down per 'Reach' or stream section- 1, 2, or 3. Within in 'Reach', the cost opinion has six key categories – Stream, Landbridge, Earthwork, Stormwater Management, Circulation (Pedestrian, Bike and Micro-mobility) and Amenity/Stream Engagement & Access/Program. The breakdown allows the Scenarios to be compared by Reach and Category which aids the city in financial planning and provides a greater flexibility when selecting key categories per Reach.

All Scenarios consider design collaboration and alignment with adjacent, future projects and program for Dix Park including multi-use recreation fields, botanical gardens, parking, vehicular and pedestrian connections.

Scenario A

The master plan is fully realized in this option. The Scenario has the most significant impact on Reach 1 and the stream morphology. The stream is re-aligned and brought back onto Dix Park property, crossing beneath Hunt Drive and Railroad with new tunnel crossings.

- Stream – Optimal alignment and stream elevation. Is re-aligned and brought back onto Dix Park, going under a new bridge at Hunt Drive. The greenway crosses under the railroad tracks with a new tunnel and connection south to the park.
- Land Bridge – Full crossing with tunnels over Western Boulevard and Rocky Branch
- Earthwork/Environmental – Significant landfill impacts to allow for broader stream morphology
- Stormwater – Maximizes current and future stormwater opportunities and access
- Circulation – Maximizes pathways and crossings, and New Hunt Bridge
- Amenity/Stream Engagement/Program Provides numerous opportunities for visitors to engage the stream, outdoor learning & Classrooms, Nature Play, Boardwalks and Walkways

Scenario A

Category	Stream	Landbridge	* Earthwork/ Environmental	Stormwater Management	Circulation (Includes Culverts and Bridges)	Amenity/ Engagement/ Program	Reach Total Cost
Reach 1	$ 1,910,000.00	$ 25,000,000.00	$ 45,000,000.00	$ 2,735,000.00	$ 16,000,000.00	$ 3,800,000.00	$ 94,445,000.00
Reach 2	$ 540,000.00	$ -	$ 3,800,000.00	$ 1,350,000.00	$ 16,888,000.00	$ 750,000.00	$ 23,328,000.00
Reach 3	$ 1,200,000.00	$ -	$ 1,100,000.00	$ 4,060,000.00	$ 1,720,000.00	$ 1,250,000.00	$ 9,330,000.00
Total Project Cost	$ 3,650,000.00	$ 25,000,000.00	$ 49,900,000.00	$ 8,145,000.00	$ 34,608,000.00	$ 5,800,000.00	
						Total Project Cost	$ 127,103,000.00

** Earthwork/ Environmental/ Geotech cost opinions represent anticipated minimums within a potential range.*

Scenario B

Key reductions in scope and cost are primarily found in Reach 1. With the stream remaining in its current configuration will cross over and back across Western Boulevard. Hunt Drive will remain in its current location. There will be no new crossings at Hunt Drive or the Railroad. The Land Bridge section is reduced and extends only over Western Boulevard, with the bridge crossing over the stream open and visible. Hunt Drive crossing remains.

- Stream – Improves alignment and maintains Western Boulevard crossings. For Reach 2 and 3 – optimal alignment.
- Land Bridge – Green Bridge, enhances steam ecology and pedestrian safety.
- Earthwork/Environmental – Significant landfill impacts to allow for broader stream morphology
- Stormwater – Reduces improvements north of Rocky Branch
- Circulation – Reduces pathways and crossings, Hunt Drive remains in its current location
- Amenity/Stream Engagement/Program – Reduced opportunities for visitors to engage the stream, outdoor learning & Classrooms, Nature Play, Boardwalks and Walkways

Scenario B

Category	Stream	Landbridge	* Earthwork/ Environmental	Stormwater Management	Circulation (Includes Culverts and Bridges)	Amenity/ Engagement/ Program	Reach Total Cost
Reach 1	$ 1,780,000.00	$ 25,000,000.00	$ 33,500,000.00	$ 1,650,000.00	$ 2,400,000.00	$ 2,340,000.00	$ 66,670,000.00
Reach 2	$ 230,000.00	$ -	$ 2,900,000.00	$ 1,825,000.00	$ 3,565,000.00	$ 750,000.00	$ 9,270,000.00
Reach 3	$ 1,200,000.00	$ -	$ 900,000.00	$ 2,810,500.00	$ 1,700,000.00	$ 1,250,000.00	$ 7,860,500.00
Total Project Cost	$ 3,210,000.00	$ 25,000,000.00	$ 37,300,000.00	$ 6,285,500.00	$ 7,665,000.00	$ 4,340,000.00	
						Total Project Cost	$ 83,800,500.00

** Earthwork/ Environmental/ Geotech cost opinions represent anticipated minimums within a potential range.*

Scenario C

Key reductions in scope and cost are primarily found in Reach 1. With the stream remaining in its current configuration will cross over and back across Western Boulevard. Hunt Drive will remain in its current location. There will be no new crossings at Hunt Drive or the Railroad. The Land Bridge is a Pedestrian Bridge in this scenario.

- Stream – Improves alignment and maintains Western Boulevard crossings. For Reach 2 and 3 – optimal alignment.
- Land Bridge – Pedestrian Bridge
- Earthwork/Environmental – Significant landfill impacts to allow for broader stream morphology
- Stormwater – Reduces improvements north of Rocky Branch
- Circulation – Reduces pathways and crossings, Hunt Drive remains in its current location
- Amenity/Stream Engagement/Program – Reduced opportunities for visitors to engage the stream, outdoor learning & Classrooms, Nature Play, Boardwalks and Walkways

Scenario C

Category	Stream	Landbridge	* Earthwork/ Environmental	Stormwater Management	Circulation (Includes Culverts and Bridges)	Amenity/ Engagement/ Program	Reach Total Cost
Reach 1	$ 1,630,000.00	$ 15,000,000.00	$ 32,000,000.00	$ 1,400,000.00	$ 1,850,000.00	$ 2,340,000.00	$ 54,220,000.00
Reach 2	$ 230,000.00	$ -	$ 1,600,000.00	$ 1,825,000.00	$ 1,700,000.00	$ 750,000.00	$ 6,105,000.00
Reach 3	$ 1,090,000.00	$ -	$ 700,000.00	$ 1,210,500.00	$ 1,300,000.00	$ 850,000.00	$ 5,150,500.00
Total Project Cost	$ 2,950,000.00	$ 15,000,000.00	$ 34,300,000.00	$ 4,435,500.00	$ 4,850,000.00	$ 3,940,000.00	
						Total Project Cost	$ 65,475,500.00

** Earthwork/ Environmental/ Geotech cost opinions represent anticipated minimums within a potential range.*

NOTE: ITEMS NOT INCLUDED IN THE COST OPINION

Items not included in the Opinion of Probable Construction Cost but understood to be part of the overall project cost are as follows:

- Land Acquisition Costs
- Environmental Assessments
- Testing – Including Geotechnical
- Site Survey
- Permit Fees
- Special Inspections
- Design Fees for basic services, additional services – programing models, presentations, etc.
- Contingencies – Unanticipated or unforeseen conditions including but not limited to design error or omissions, concealed site conditions, utility conflicts, and extended overhead resulting from weather or other delay.
- Associated Construction Costs
- Printing, advertising, copying, public events, or beyond that required as part of the project design process.
- Signage – Code required site signage and building signage, wayfinding and informational signage