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ARBUTUS DESIGN LLC

Washington State Department of Enterprise Services

WEST CAPITOL CAMPUS
DRAINAGE MASTER PLAN

DES Project No. 2014–155 C (3)

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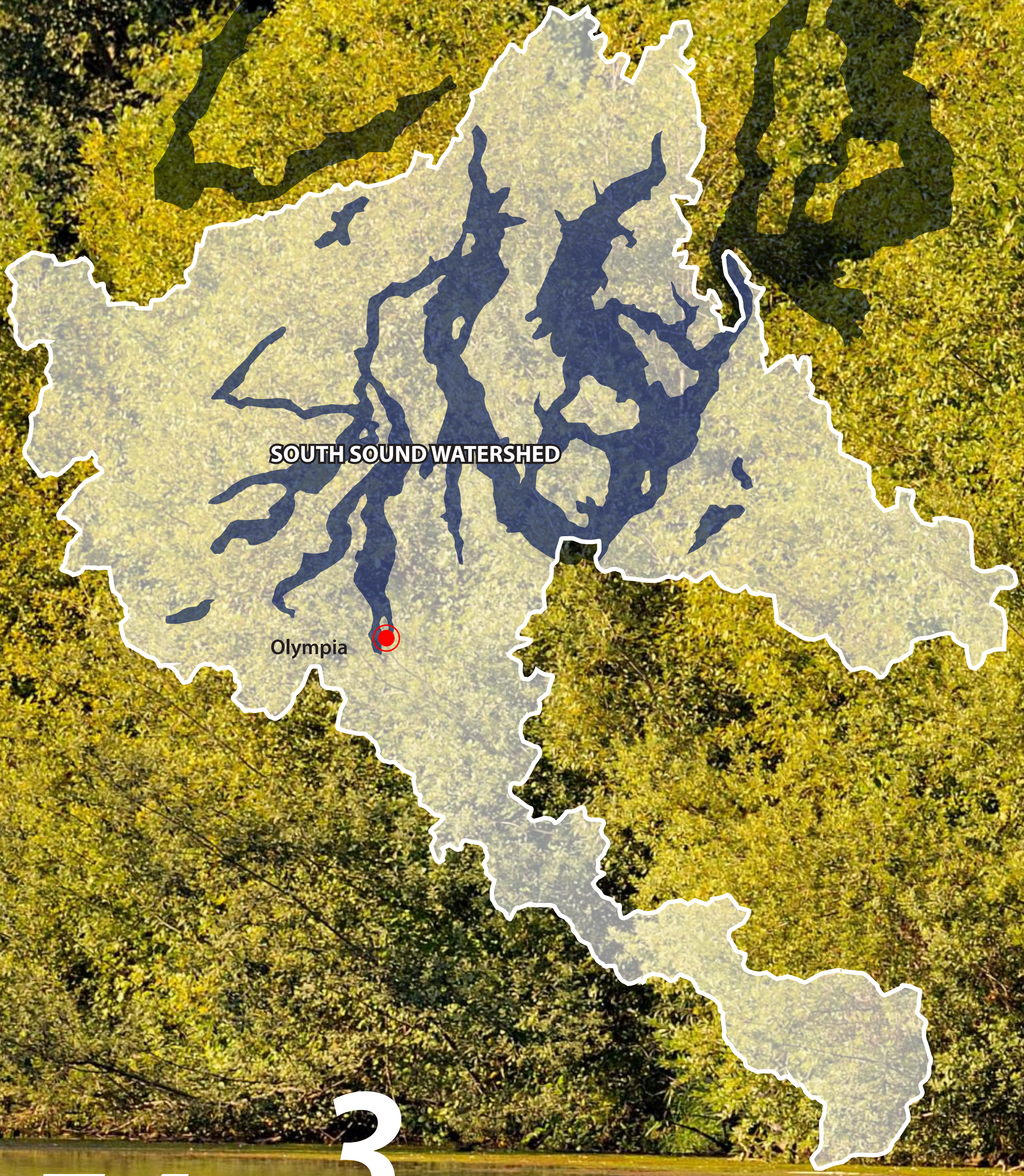
Acronyms

WCC	West Capitol Campus
VMP	Vegetation Management Plan
SIS	Secretary of the Interior's Standards
Fig.	Figure
Figs.	Figures
CCDAC	Capitol Campus Design Advisory Committee
DES	Department of Enterprise Services
GA	the Washington State Department of General Administration
HCEOB	Heritage Center and Executive Office Building
N.T.S.	not to scale
HABS	Historic American Buildings Survey
LTL	Large Tree Layer, or Large Tree Layer Plan
UGA	Urban Growth Area



3 *acres*
pollution generating surface area treated *

54 *%*
open space improved *

EXECUTIVE SUMMARY

The Washington State West Capitol Campus is a valuable cultural resource, not only for the residents of Washington State but for the nation as a whole. As a campus grounds of historic importance – it symbolizes our highest ideals as a democratic society, state and nation. The West Capitol Campus Drainage Master Plan is part of an integrated series of documents that when used together supports improvements to the campus that continue to reinforce Washington State's role as a national model for innovation and effective management. The Drainage Plan leverages multiple goals as it addresses upgrading aging infrastructure in the context of the campus's historic Olmsted Brothers landscape, future uses of the campus, and modification of utilities and stormwater systems. Benefits from leveraging these investments include the multiple advantages of combining green (or vegetated) infrastructure with gray (pipes and cisterns), maintenance cost savings and the long sought establishment of a significant historic landscape. The thoughtful stewardship of the State's civic campus celebrates history, invites awareness and understanding of best practices and engages citizens in a functional and inspiring landscape.

*The proposed projects, recommended in this report, would result in a total of roughly three acres of pollution generating surface treated by low impact development strategies. The recommended projects represent an area greater than half of the campus open space which would receive improvements to landscape, utilities, and drainage infrastructure.

Authority and Scope

In 2014, the Washington State Department of Enterprise Services (DES) authorized Reid Middleton, Inc., to develop a drainage master plan for the West Capitol Campus in Olympia, Washington. Reid Middleton is the primary consultant and project lead, collaborating with subconsultants Mithun, Inc., and Arbutus Design, LLC.

DES is the contracting authority for this work. The objective of the drainage master plan is to provide general drainage design guidance for future development and improvements on the West Capitol Campus. The scope of the drainage master plan addresses:

- Deficiencies in the existing drainage system.
- Campus compliance with the National Pollutant Discharge Elimination System (NPDES) requirements.
-
- Separation of the combined sewer system within the project limits, if feasible.
- Low impact development (LID) strategies to address specific site conditions.
- Existing irrigation issues and conceptual zones.
- Well defined concepts for drainage improvements to lawns and open spaces which support healthy vegetation growth and enable the implementation of the historic landscape plan.

Project Boundary

The drainage master plan is limited to the West Capitol Campus. The West Capitol Campus is bounded by Capitol Way S to the east, the top of the slope adjacent to Capitol Lake on the west, 15th Avenue SW (and south of the Pritchard Building) to the south, and 11th Avenue SW to the north. The project area is approximately 39 acres.

Existing Conditions

An assessment of the existing storm system was conducted to set a baseline for future redevelopment projects on campus. The system was evaluated by utilizing hydrological and hydraulic processes to identify conveyance system deficiencies. It was determined that a number of sections of the existing system does not possess the capacity required to convey flow to meet the current City of Olympia standards.

Figure 1-1 (previous page):
Native forest edge of Capitol Lake
(Sept. 2009, Source: Mithun)

Figure 1-2
Olympia's Watershed and Regional Waterbodies

Implementation Plan

Drainage System Improvements

The existing and proposed dedicated storm drainage network was analyzed at the 25- and 100 year peak flow with the additional area from the proposed redevelopment projects included. Stretches of the existing system were upsized to contain flow up to the 100-year peak flow events.

Drainage Improvements at Lawn and Landscape Areas

The lawn and landscape areas on campus suffer from poor drainage and overwatering. A number of alternatives were evaluated to address these issues such as soil amendments, underdrains, permeable pavement, area drains, and water quality treatment measures.

Irrigation Recommendations

The irrigation system is outdated and difficult to maintain. It is recommended that a thorough investigation and evaluation of the existing system be conducted to fully comprehend existing conditions, zoning, and pipe sizing requirements.

Planned Developments

The 2006 Master Plan identified several future redevelopment projects for government facilities on the West Capitol Campus. These sites were deemed either undeveloped or underdeveloped and are desirable for short- and long-term improvements. This document intends to implement comprehensive planning-level recommendations that address storm drainage, soils, irrigation, plantings, and trees for each redevelopment site.

Conclusion

This drainage master plan addresses the deficiencies in the existing drainage system, reviews opportunities to separate runoff from the combined sewer system, evaluates LID strategies, outlines irrigation needs and requirements, proposes drainage improvements to landscape and conveyance systems, and discusses adherence to the Historic Preservation Landscape Master Plan. From the findings developed in this report, it is recommended that the current stormwater management plan be updated, a drainage site plan created, and a Stormwater Pollution Prevention Plan (SWPPP) developed, providing staff with current guidelines for operations, maintenance, and pollution prevention for stormwater facilities.

INTRODUCTION

The quality of the Capitol grounds is an embodiment of the State's ideals and goals. As host to a complex network of environmental, social issues and iconic elements, the campus is a physical example of the importance of integrating information. Similarly, the Drainage Plan is designed to be used in conjunction with an understanding of existing conditions, historic reports, proposed systems and new studies to ensure the vitality of the campus for years to come.

Authority and Scope

In 2014, the Washington State Department of Enterprise Services (DES) authorized Reid Middleton, Inc., to develop a drainage master plan for the West Capitol Campus in Olympia, Washington. Reid Middleton is the primary consultant and project lead, collaborating with subconsultants Mithun, Inc. for landscape architecture, and arborist, Arbutus Design, LLC.

DES is the contracting authority for this work. The objective of the drainage master plan is to provide general drainage design guidelines for future development and improvements on the West Capitol Campus. The scope of the drainage master plan addresses:

- Deficiencies in the existing drainage system
- Campus compliance with the National Pollutant Discharge Elimination System (NPDES) requirements
- Separation of the combined sewer system within the project limits, if feasible
- Low impact development (LID) strategies to address specific site conditions
- Existing irrigation issues and conceptual zones
- Well defined concepts for drainage improvements to lawns and open spaces which support healthy vegetation growth and enable the implementation of the historic landscape plan.
- Preliminary cost estimates for each proposed project.

Project Boundary

Figure 1-3 *(previous page)***:**
Campus Planting

Figure 1-4
Project Boundary

This West Capitol Campus Drainage Master Plan encompasses the grounds addressed in the 1928 Landscape Plan developed by the Olmsted Brothers and the State Capitol Historic District (designated in the National Register of Historic Places). The Capitol Campus is situated along a bluff overlooking Capitol Lake, Budd Inlet, and downtown Olympia, Washington. The drainage master plan is limited to the West Capitol Campus. The West Capitol Campus is bounded by Capitol Way S to the east, Capitol Lake on the west, 15th Avenue SW (and south of the Pritchard Building) to the south, and 11th Avenue SW to the north. The project area is approximately 39 acres.

“State Capitol buildings and grounds are a source of beauty and pride, and a resource for celebrating our heritage and democratic ideals. (They) should be managed and maintained to the highest standards of excellence, while maximizing opportunity for public access and enjoyment”

2006 Master Plan for the Capitol of the State of Washington

Background

Figure 1-5
Historic view of Capitol from the northeast corner of the West Campus.
(1930s, Source: Washington State Archives)

Figure 1-6 *(opposite page)***:**
Clay Tile Installation, 1935
(1935, Source: Washington State Archives)

History of Campus Master Plan

The 2006 Master Plan identifies the critical function of the campus as a civic gathering place serving diverse users (business people, activists, educators school children, elected officials, and state employees). Completion of the updated Capitol Campus Master Plan is anticipated by the end of 2015.

The 2009 West Capitol Campus Historic Landscape Preservation Master Plan (Historic Landscape Preservation Master Plan) is integral to the master plan documents and guides the development and maintenance of the Capitol grounds. The Historic Landscape Preservation Master Plan is the continuation of the vision developed by the Olmsted Brothers in the 1928 Landscape Plan for the campus. In 1974, the West Capitol Campus was designated as a National Register Historic District, which includes the prominent Legislative Building. The campus offers some of the most valued views in the state, including the Olympic Mountains, Mt. Rainier, and the Capitol Dome and Capitol Group atop the bluff. The campus scene is reflected by Capitol Lake to the north and west and is framed by the heritage trees that surround it.

A priority recommendation, from these master plans, is the development of a West Capitol Campus drainage master plan. The intent of the recommendation is to address existing drainage deficiencies, identify overcapacity and aging facilities, and implement drainage improvements to facilitate redevelopment and restoration projects on the campus.

History of Drainage on Campus

The West Capitol Campus suffers from poorly-drained soils throughout campus. A large region of the campus was formed by filling a ravine with a native material containing soft silt (reworked recessional lacustrine), which has poor water infiltration properties. The site is underlain with impervious glacial till at varying depths, translating to inconsistent patterns of saturation across the site. Subsurface water flows from the south-southeast to the northwest, toward the bluff face, where it emerges as springs and contributes to potential landslides. While drainage is somewhat better on higher ground, wet spots are found at the tops of slopes and wherever soil is compacted. Large expanses of lawn and trampled bare soil increase surface water accumulation down slope, as does rapidly-applied or excessive amounts of irrigation, making poor drainage more than just a wet-season occurrence.

Saturated conditions allow water-borne fungi and other plant pathogens to proliferate, contributing significantly to plant disease and mortality. Year-round mowing,together with foot traffic, crushes soil pores that would otherwise hold and slowly release water. Public use within the landscaped areas exacerbates poor environmental conditions.

Clay tile underdrains were installed in lawns and landscape areas with the original campus development, and a catch basin and underground pipe system was designed and constructed to collect and convey surface storm runoff away from the campus. The majority of the collected surface water is discharged to Capitol Lake, while some areas are directed to the combined stormwater and sewer system beneath Capitol Way.

Current Condition of Drainage on West Campus

The near-surface drainage on the West Capitol Campus has gradually deteriorated since the grounds were constructed. The clay tile and underdrain system has failed throughout the campus lawn area. It is common to witness areas of standing water on campus even during extensive periods of dry weather. The near-surface soils retain water from either rainfall or on-site irrigation practices.

The site, within the project boundary, is served by four main storm drainage systems, three of which are dedicated storm facilities, while the fourth connects to the Lacey, Olympia, Tumwater, and Thurston County (LOTT) Alliance's combined sewer system (beneath Capitol Way). In many areas of the campus, the existing conveyance structures are aging and deficient in capacity when evaluated by current standards for conveyance flow. Some locations on campus are adversely impacted by peak flow events. These areas of concern will be discussed in the "Existing Conditions" section of this report.

The drainage system at West Capitol Campus was developed prior to the existence of stormwater management as a code requirement in the State of Washington. As a result, there was no dedicated stormwater flow control (detention) or water quality treatment on the West Capitol Campus, prior to the recent Sid Snyder Way project. The Sid Snyder Way project introduced bioretention cells (water quality treatment) to the campus when the roadway was redeveloped in 2014.

The West Capitol Campus complies with NPDES requirements for the existing system. The campus does not hold its own NPDES permit, maintaining NPDES compliance through the City of Olympia (City) as a Secondary Permittee to the City.

Historic Reports and Plans

Figure 1-7 :
West Capitol Campus: Historic Landscape Master Preservation Plan

The master drainage plan is one of a series of inter-related campus master plan documents that together can effectively leverage investments, achieve multiple goals and result in integrated solutions.

2006 Master Plan for the Capitol of the State of Washington: Future Development Opportunities for State Government Facilities

Overview

The 2006 Master Plan identifies state-owned properties that are undeveloped or underdeveloped and future Opportunity Sites for expansion of state government activities. The 2006 Master Plan provides a framework for future development on the campus and its impacts on the surrounding community and visitors to the state capitol.

<u>Implementation</u>

The plan outlines seven guiding principles for stewardship of State Capitol properties to responsibly utilize and care for available resources, and accommodate future growth. The plan describes the present use, development opportunities, and major development constraints of each property.

The 2006 Master Plan

- Offers a values-based framework for ongoing planning
- Defines public use and access to state government facilities and the delivery of public services as primary functions of those facilities
- Underscores the role that state government facilities play in contributing to the community's vitality
- Notes the value of historic preservation for state government facilities and vital communities

Defines quality design, durability, and financial performance as essential values for planning and stewardship of state facilities.

West Capitol Campus: Historic Landscape Master Preservation Plan, 2009

<u>Overview</u>

The Historic Landscape Preservation Master Plan presents a vision for the redevelopment and rehabilitation of West Capitol Campus as a sustainable and evolving landscape feature within an urban setting. The plan honors the design principles of the 1928 Olmsted Brothers Landscape Plan. The main elements include a 50-year Master Plan, a Large Tree Layer Plan, a Vegetation Management Plan, Development Guidelines, and Lighting Considerations.

<u>Implementation</u>

The Historic Landscape Preservation Master Plan recognizes that the "stewardship of this legacy is multi-faceted, encompassing cultural, environmental and economic concerns," the plan stresses that while implementation is intended to be gradual, some actions, such as stewarding existing resources and the replacement of aging resources with new generations of trees and shrubs, can begin immediately.

Objectives

- Reinforce the primary importance of people at the center of governance
- Improve the pedestrian experience throughout the West Capitol Campus
- Demonstrate a multi-faceted sustainable approach to landscape stewardship, celebrating and preserving cultural resources, while protecting natural resources and responsibly investing limited economic resources
- Establish three-dimensional spatial hierarchy throughout the West Campus
- Restore axis strength and symmetry
- Define gateways and reinforce seams
- Preserve or improve views
- Establish parameters for integrating "Opportunity Sites," including buildings, monuments, and memorials
- Identify priority action items for immediate implementation and phased action items to inform future investments
- Provide a safe and accessible campus

Recommendations and Actions

- Implement a Tree Management and Monitoring Program
- Conduct a Campus-wide drainage study and implement drainage improvements
- Replenish generations of trees through strategic replanting
- Invest in soil health to improve plant performance
- Remove invasive plant species, particularly ivy in trees
- Begin incremental installation of original Olmsted planting plan, interpreting and substituting resource-intensive species with historically compatible native species
- Provide training for DES landscape professionals regarding Vegetation Management Plan
- Begin the replacement of resource-intensive lawn with more ecologically sound lawn and historically compatible species through the implementation of a testing area for eco-lawn seed mixes
- Begin relocation of parking from civic spaces to nearby garages or lots
- Increase commute-trip reduction strategies
- Identify convenient bicycle parking areas
- Educate and engage the public

- Use lighting to highlight strategic visual connections and key points on the campus

2009 Stormwater Management Program

Overview

The Washington State Department of General Administration's (GA) Stormwater Management Program for Washington State Capitol Campus (Stormwater Management Program (SWMP)) documented DES's efforts to conform to the Western Washington Phase II Municipal Stormwater Permit for West and East Capitol Campus. The GA is a secondary permittee under the City's coverage. GA coordinated with the City to meet permit requirements.

Implementation

The SWMP conducted a public education program aimed at staff, tenants, and visitors. The intent was to inform and educate on measures to remove illicit discharges, decrease spill response time, train staff, and monitor flow at the outfalls. The plan also delved into construction stormwater control and post-construction management for new development and redevelopment projects.

Recommendations and Actions

- Label storm drains and develop a storm sewer map
- Distribute educational information and make the SWMP available to the Public
- Outline current practices and implementation of protocols for illicit discharge detection and elimination
- Define compliance standards for stormwater runoff control during construction
- Outline post-construction stormwater management guidelines for new development and redevelopment projects
- Define compliance with the operation and maintenance (O&M) plan to minimize stormwater pollution

2009 West Capitol Campus Inventory, Analysis, and Recommendations

Overview

The West Capitol Campus Inventory, Analysis, and Recommendations for: Potable Water, Storm Drainage, Sanitary Sewer, and Irrigation provided a comprehensive review of the existing utility systems on campus. The storm drainage and irrigation sections of the report were reviewed as part of this assessment.

Implementation

The analysis and recommendations provided by the plan set forth a preliminary evaluation of the physical condition of the drainage and irrigation systems. Projects were identified, an opinion of construction costs was provided, and a recommendation for implementing the replacement or rehabilitation of the existing conveyance network and irrigation systems were outlined. It is our understanding that DES has completed a number of projects associated with this plan and has submitted proposals for future improvements to the systems.

Recommendations and Actions

- Identify risk of failure within the drainage system
- Provide recommendations for action to rehabilitate or replace various pipelines on campus
- Define an operations and maintenance task list
- Provide opinions of probable construction costs for rehabilitation or replacement of drainage facilities
- Perform periodic maintenance on the irrigation system
- Identify and map irrigation zones
- Provide new backflow prevention devices for the existing system
- Perform physical flow tests to determine existing characteristics of the flow and any limiting factors of the irrigation system
- Replace and/or decommission "High Risk" irrigation system components

DES has completed a number of the projects and repairs identified in this report.

2013 West Capitol Campus Storm and Sanitary Sewer Inspection Report

Overview

The West Capitol Campus Storm and Sanitary Sewer Inspection Report compiles the data obtained through the inspection of the sanitary sewer and stormwater conveyance systems and prioritizes the sewer maintenance activities. The inspections were conducted in November and December of 2012 and January of 2013.

Implementation

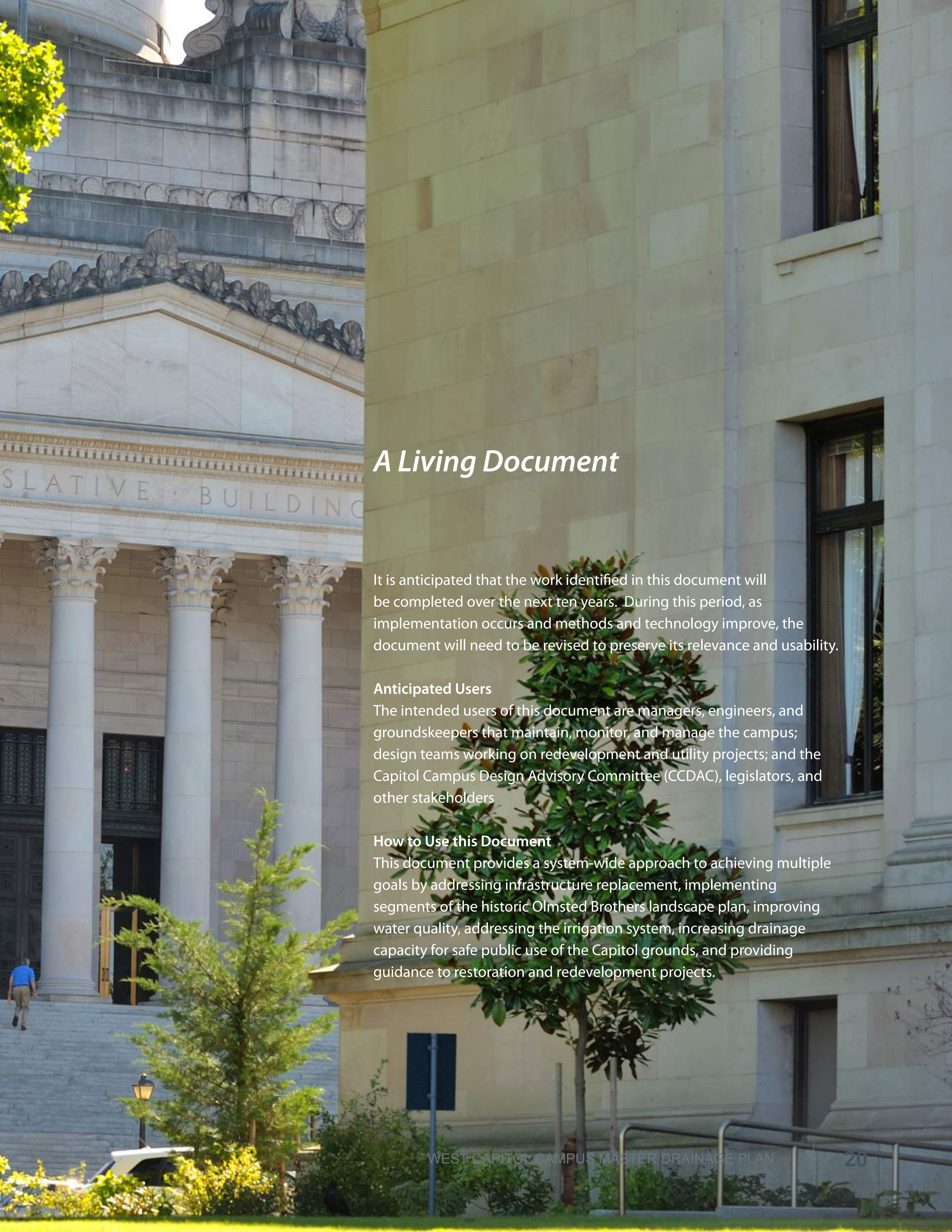
Pipe Experts, LLC, performed a cleaning and inspection of 4,450 feet of stormwater and sanitary sewer pipe on the West Capitol Campus. A report was completed that compiled the information collected during the inspection and provided a list of pipe deficiencies. The deficiencies were cataloged according to their severity based on criteria developed in the inspection report.

Recommendations and Actions

- Clean, inspect, and catalog existing stormwater and sanitary sewer pipelines
- Assess pipe structures and assign severity of pipe condition
- Recommend modifications to the existing stormwater and sanitary sewer system within the study area
- Provide alternative pipeline repair methods

DES has completed a number of the projects and repairs identified in this report.

Figure 1-8 : Washington State Legislative Building (Oct. 2009, Source: Mithun)

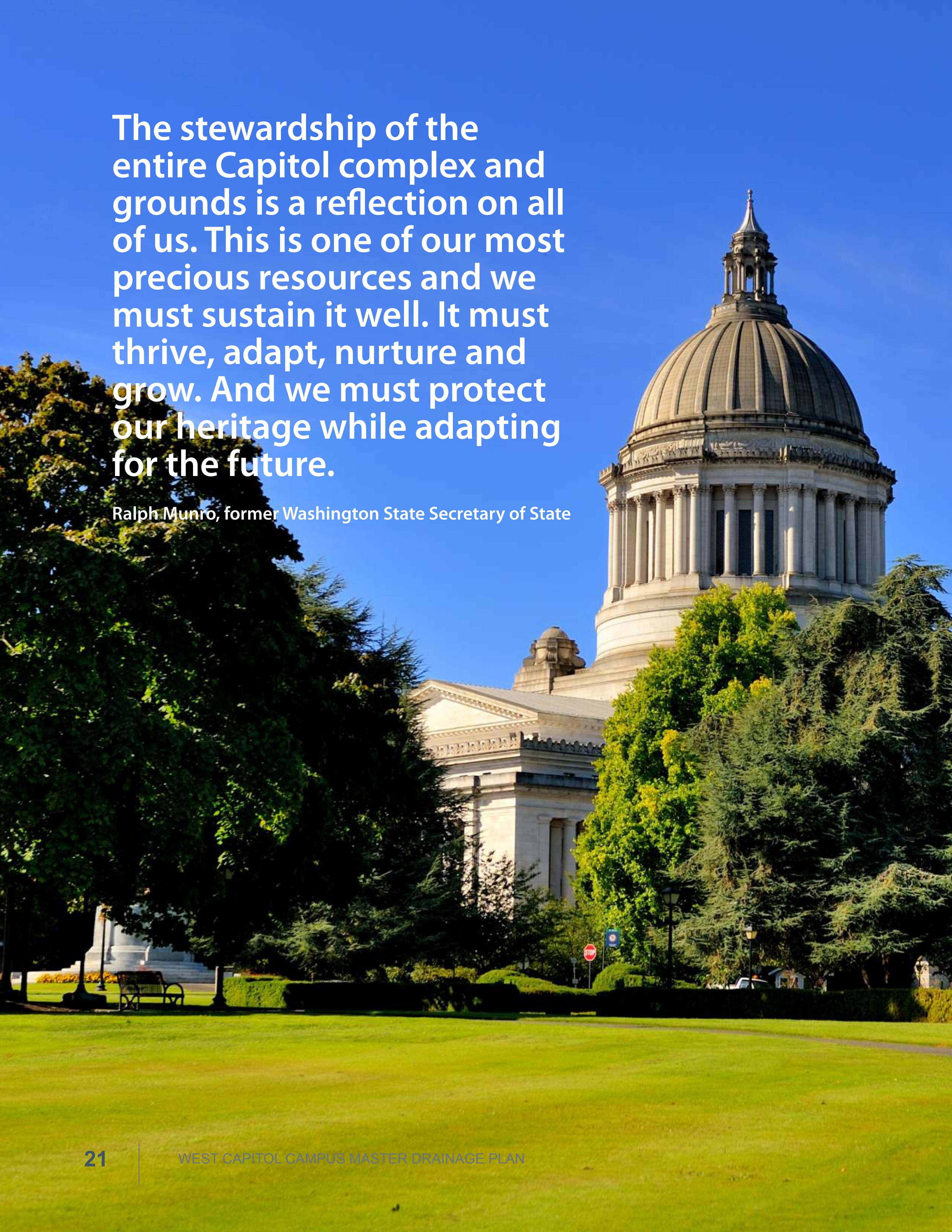


A Living Document

It is anticipated that the work identified in this document will be completed over the next ten years. During this period, as implementation occurs and methods and technology improve, the document will need to be revised to preserve its relevance and usability.

Anticipated Users
The intended users of this document are managers, engineers, and groundskeepers that maintain, monitor, and manage the campus; design teams working on redevelopment and utility projects; and the Capitol Campus Design Advisory Committee (CCDAC), legislators, and other stakeholders

How to Use this Document
This document provides a system-wide approach to achieving multiple goals by addressing infrastructure replacement, implementing segments of the historic Olmsted Brothers landscape plan, improving water quality, addressing the irrigation system, increasing drainage capacity for safe public use of the Capitol grounds, and providing guidance to restoration and redevelopment projects.



The stewardship of the entire Capitol complex and grounds is a reflection on all of us. This is one of our most precious resources and we must sustain it well. It must thrive, adapt, nurture and grow. And we must protect our heritage while adapting for the future.

Ralph Munro, former Washington State Secretary of State

Goals

- **Provide context and information to support an integrated approach to campus development – inclusive of drainage, landscape, soils, and irrigation – and address economic, environmental, and cultural objectives.**

- **Respond to the recommendations for a drainage master plan on the West Capitol Campus, from the 2006 Campus Master Plan for the Capitol Campus and the 2009 West Capitol Campus Historic Landscape Preservation Master Plan.**

- **Provide general drainage design guidelines for future development and redevelopments.**

- **Increase the application of LID strategies on campus for stormwater quality treatment.**

- **Identify redevelopment projects to address multiple issues (drainage, irrigation, landscaping, etc.) on site.**

- **Improve infrastructure.**

  Increase capacity to meet current and future stormwater requirements

  Replace aging infrastructure

  Increase public safety

  Provide a higher level of protection from flooding

  Implement water quality treatment systems (by using LID solutions that can adapt and recover quickly in response to peak flow events)

- **Establish the historic landscape**

  Improve site drainage to provide proper soil moisture and allow for the implementation of the Historic Preservation Landscape Master Plan

  Improve soils, plant trees, shrub layers, and lawns

  Allow the implementation of Historic Preservation Landscape Master Plan in phases or discrete projects

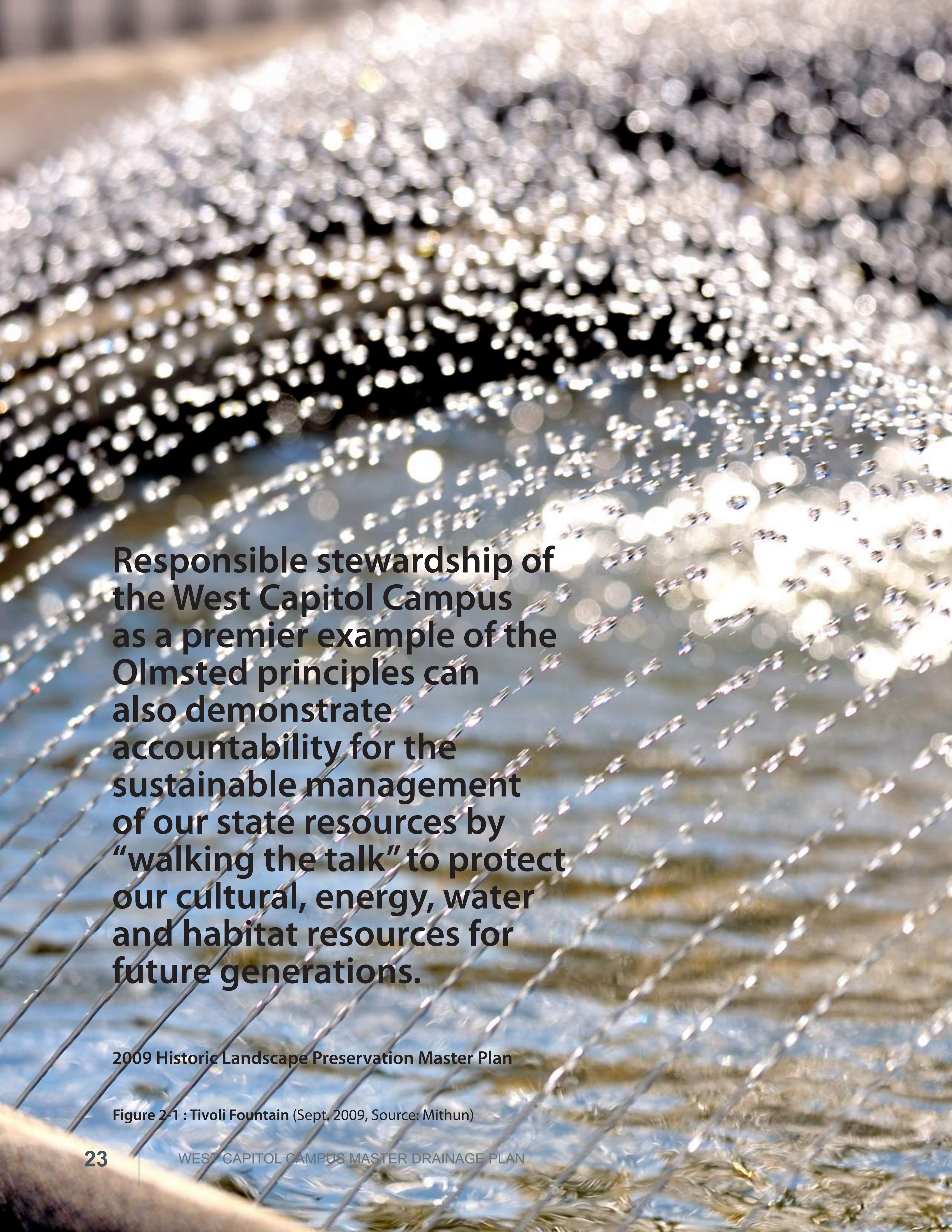
- **Improve local and regional environmental conditions.**

  Healthy soils

  Clean water

  Moderate temperatures

Figure 1-9 : West Lawn and Washington State Legislative Building
(Oct. 2009, Source: Mithun)



Responsible stewardship of the West Capitol Campus as a premier example of the Olmsted principles can also demonstrate accountability for the sustainable management of our state resources by "walking the talk" to protect our cultural, energy, water and habitat resources for future generations.

2009 Historic Landscape Preservation Master Plan

Figure 2-1 : Tivoli Fountain (Sept. 2009, Source: Mithun)

EXISTING CONDITIONS

Soils with low infiltration rates and aging infrastructure contribute to on-going maintenance and management challenges of West Capitol Campus.

In order to address these issues and support a healthy and high performance landscape consider the following:

- Hydrological Characteristics
- Drainage System Hydraulics
- Soil Conditions
- Irrigation System Conditions
- Landscape Preservation

General

The existing storm drainage facilities on campus are a complex network of pipelines, catch basins, manholes, swales, depressions, and outfalls. The system was constructed early in the 20th century and required a decade to complete. Site drainage is impacted by the diverse foliage, irrigation systems, soil types, topography, and hardscaping. An assessment of the existing system was conducted to set a baseline for future redevelopment projects on campus. The following passages review the regulations and standards governing maintenance and improvements, assess hydrologic characteristics and evaluate existing facilities, present a general overview of the soil conditions, outline current irrigation conditions, and incorporate tree and planting preservation plans.

Regulations and Standards

Phase II – NPDES Permit

In 1972, the federal government enacted the Clean Water Act (CWA), which governs water pollution to water bodies within the United States. The act's objective is to restore and maintain the physical, chemical, and biological composition of the nation's waterways and maintain the integrity of wetlands. The state of Washington has adopted general policies pertaining to water quality standards that meet or exceed the requirements of the CWA. The state's policies are subject to review and approval by the federal Environmental Protection Agency (EPA). The Washington State Department of Ecology (Ecology) is the entity responsible for regulating individual permits for the state.

Ecology reissued the Western Washington Phase II Municipal Stormwater Permit in August of 2013. This permit combines the requirements from the federal Phase II NPDES Permit program and the State of Washington Water Pollution Control Law. Ecology sets out regulations for the municipal separate storm sewer system (MS4) operators within the state of Washington. All operators of regulated small MS4s, such as the City of Olympia, are required to apply for and obtain coverage in accordance with the Western Washington Phase II Municipal Stormwater Permit. The City owns and operates a municipal separate storm sewer system, which discharges into local water bodies. The City functions as the jurisdictional Western Washington Phase II Municipal Stormwater Permit holder. The City must follow the guidelines of this permit to regulate and manage the discharge of stormwater to surface or groundwater.

The stormwater system on the West Capitol Campus is owned by Washington State and operated by DES. Washington State does not hold an individual Phase II Municipal Stormwater Permit for the drainage system at West Capitol Campus. Instead, the campus system is under the City's coverage as a local Phase II Secondary Permittee to the City.

City of Olympia Drainage Standards

For the state of Washington, Ecology issues a drainage manual that consolidates the requirements of the Western Washington Phase II Municipal Stormwater Permit and outlines the required evaluation and assessment of stormwater treatment and rate of stormwater runoff. The City produces a specific manual tailored to handling stormwater within the City's Urban Growth Area (UGA).

The latest version of the City's manual is the 2009 Drainage Design and Erosion Control Manual for Olympia. This manual conforms to the standards and regulations set forth in Ecology's 2005 Stormwater Management Manual for Western Washington (2005 SMMWW). The City is currently in the development stage of updating their drainage design and erosion control manual. The revised manual will include changes and edits reflecting the latest update to Ecology's the SMMWW. Additionally, the City is undertaking an extensive code and policy update for LID methods for the city. Adoption of the new codes, policy changes, and stormwater manual is anticipated for the summer of 2016.

As a Secondary Permittee, DES must apply for and receive an approved stormwater permit for construction (under the Construction Stormwater General Permit) from Ecology. This is required if the project is engaged in clearing, grading, and excavating activities that disturb one or more acres and discharges to surface waters within the state. Additionally, smaller sites may require coverage if they are part of a large plan redevelopment, which disturb one acre or more. A determination must be in place prior to the start of construction activities.

General Codes and Criteria

City Code and Design Standards

The following chapters of the City of Olympia Municipal Code apply to the West Capitol Campus:

- Chapter 13.16, Storm and Surface Water Utility
- Title 18, Unified Development Code

Currently, the following standards apply to the West Capitol Campus and were referenced in the development of conceptual plans and layouts:

- 2009 Drainage Design and Erosion Control (DDEC) Manual for Olympia
- 2012 City of Olympia Engineering Design and Development Standards (EDDS)
- 2012 Low Impact Development (LID) Technical Guidance Manual for Puget Sound
- 2012 Washington State Department of Ecology Stormwater Management Manual for Western Washington

Table 1-1. Performance Standards

Summarizes the conveyance, flow control, water quality, and source control standards for the West Capitol Campus, based on current design standards.

Category	Performance Standards	Source
Conveyance System Capacity	Developed 25- and 100-year Peak Storm Event	DDEC Volume I, Appendix I-F
Flow Control Requirements *	Predeveloped Flow Frequency, Durations for 50% of 2- to 50-year	DDEC Volume III, Chapters 2 & 3 SMMWW Volume III, Chapters 2 & 3
Water Quality Treatment	Low Impact Development	DDEC Volume III, Appendix III-C LID Technical Guidance 6.1 SMMWW Volume, Appendix III-C

* Discharges to a flow control exempt surface water

The drainage concepts laid out in this report provide recommendations based on Ecology's 2012 SMMWW and the 2012 Low Impact Development Technical Guidance Manual for Puget Sound. As mentioned above, the City is updating their storm drainage requirements, which will implement standards and concepts contained in these two documents.

The drainage master plan will not be reviewed or approved by the City. There is no period of vesting for this drainage master plan. In the future, city code will be updated and revised, and new requirements will likely be developed. Future construction projects must comply with the city code in effect at the time that projects are submitted for permit review.

Engineering Criteria
The following criteria should apply to projects at the West Capitol Campus:

- Use an integrated approach to projects (i.e., soil amendments, landscape plantings, stormwater drainage, irrigation, etc.).
- New and redevelopment projects at the West Capitol Campus must meet the City's code requirements as described above.
- Stormwater drainage design at West Capitol Campus shall comply with city code requirements in effect at the time when the projects are designed and submitted for permit review. This is necessary to meet the ever-evolving development code requirements within the City of Olympia.
- The drainage improvements will be achieved incrementally through major redevelopment and localized improvement projects.
- Infiltration facilities shall not be allowed on the West Capitol Campus, except under limited circumstances, to maintain slope stability and avoid increasing groundwater levels. Under no circumstances shall infiltration facilities be placed within 100 feet of the bluff edge.

Owner Requirements
The following criteria should apply to projects at the West Capitol Campus:

- Integrated approach that includes soil amendments, landscape plantings, stormwater drainage, and irrigation
- Compatible with Historic Landscape Preservation Master Plan
- Low maintenance requirements
- Extended facility life-cycle

Hydrology Characteristics and Evaluation

Existing Drainage System Overview

<u>Overview</u>

The existing drainage system on the West Capitol Campus is a complex network of below-grade pipelines, catch basins, and sewer manholes. With the majority of the facilities residing beneath the surface, it can be difficult to assess, troubleshoot, and resolve issues until a catastrophic failure occurs. It is imperative to follow a routine maintenance schedule for cleaning and maintaining the existing facilities, since the majority of the utilities were constructed and installed at the turn of the last century.

The existing drainage facilities contain both a dedicated storm drainage system and a combined sewer system. The dedicated storm drainage system, within the study area (West Capitol Campus), discharges through three threshold discharge areas (TDA) to Capitol Lake. There are no off-site storm drainage facilities that affect the dedicated drainage system; however, there is tributary flow that contributes to the combined sewer system on campus. Table 1-2 outlines the tributary area to the drainage facilities.

Table 1-2. Existing Drainage Basin Areas

Basin	Discharge Facility	Area (AC)
1	Dedicated Storm Drainage	1.3
2	Dedicated Storm Drainage	1.6
3	Dedicated Storm Drainage	23.1
4	Combined Sewer System	12.8
	Total Area =	**38.8**

The following outlines the findings developed from historical documents, existing as builts and base maps, and discussions with the personnel responsible for maintaining the system.

Drainage Basin Characteristics

Drainage basin boundaries were delineated within the West Capitol Campus by using the existing utility and topographic mapping provided by DES. It is our understanding that the topographic mapping was developed from an aerial LiDAR survey conducted on the campus in 2002.

A three-dimensional model was built from the topographic information in a computer-aided drafting program (AutoCAD). Grade breaks were verified by visible field checks or using mapping software. From the rim elevation data found on the existing utility map, it appeared that the elevations differed between 6 and 18 inches in elevation (vertical datum) from the LiDAR survey. The accuracy of the drainage basin boundaries from this study may vary slightly from actual field observations.

The assessment area was broken into three storm drainage basins compromising 17 subbasins and one combined sewer drainage basin composed of 4 subbasins. A region constituted a drainage basin if the area possessed a discharge structure that conveys surface water off site, commonly referred to as a Threshold Discharge Area (TDA). A basin was broken into subbasins depending on the topography of the site. Please refer to Figures 1 and 3 at the back of the report for a breakdown of the drainage basins by area.

Dedicated Storm System

The existing project limits contain roughly 26 acres (contributing drainage area) of developed streetscaping, buildings, and lawn area. The project area consists of three drainage basins (dedicated storm system only), which were divided into multiple subbasins. The subbasins were determined from the existing site topography and drainage features.

Dedicated Storm Drainage Basin No. 1, located in the southwest corner of the West Capitol Campus, collects surface water flow from the O'Brien and Pritchard Buildings, along with the northwest portion of the parking area east of the Pritchard Building. This drainage basin was divided into seven subbasins for this evaluation. The stormwater runoff is conveyed through a series of pipelines and catch basins prior to discharging into Capitol Lake along the western bluff.

Dedicated Storm Drainage Basin No. 2 is located in the northwest corner of the Mansion parking lot. For this drainage master plan, the basin was not divided into smaller subbasins. It collects and conveys flow from the impervious parking lot surface and discharges flow to Capitol Lake.

Dedicated Storm Drainage Basin No. 3 comprises the majority of the West Capitol Campus and discharges to Capitol Lake along the bluff. This drainage basin was divided into 10 subbasins. A main drainage interceptor collects flow from branch systems across the West Capitol Campus. The storm interceptor originates near the intersection of Sid Snyder Way SW, Capitol Way S, and South Diagonal. The main is progressively upsized as it collects from the branch systems, from 12 to 24 inches in diameter.

The main conveys flow along the north side of South Diagonal. Near the Vietnam Veteran's Memorial, the main gains flow from a 12-inch-diameter pipe servicing the areas in and around the Cherberg and Irv Newhouse Buildings. The main progresses toward the northwest and is diverted around the Winged Victory Monument within the north side of the Winged Victory Circle. Flow is added to the main within the intersection of Winged Victory Circle and North Diagonal, which is the runoff from the southwest section of North Diagonal.

At the intersection of Cherry Lane SW and Capitol Grounds, the interceptor collects flow from the area north of the Washington Supreme Court Building and runoff from the south side of the Washington State Legislative Building. From this location, the interceptor extends to the west and then runs along the north side of the circle drive, between the Washington Supreme Court and Washington State Legislative buildings.

West of the circle drive, at the intersection between Pleasant Lane SW and Capitol Grounds, the interceptor gains flow from the Governor's Mansion to the south and from the area northwest of the Washington Supreme Court Building. The interceptor continues to the west, underneath the Governor's Mansion parking lot and then down the bluff, discharging to Capitol Lake. As it progresses, the facility gains flow from both the grounds maintenance building and the Governor's Mansion parking lot.

Capitol Lake

Capitol Lake is a 206-acre manmade water body adjacent to the West Capitol Campus, created by the construction of an earthen dam and concrete spillway in 1951 at the mouth of the Deschutes River. The creation of the lake submerged the mud flats west of the current-day capitol grounds and eliminated the effects of tidal action in the area. Capitol Lake is a vital part of the drainage system for the West Capitol Campus as the receiving waterbody for the grounds. Every attempt should be made to implement measures that do not adversely affect the water quality or the aquatic life in these waters.

Combined Sewer System

Overview

DES owns and maintains a combined sewer system on the West Capitol Campus. The flow from the campus's combined sewer discharges to the LOTT alliance combined sewer beneath Capitol Way. The LOTT alliance is a nonprofit corporation responsible for the wastewater management services in the urban areas of Thurston County. The corporation was needed to consolidate operations for wastewater management and save on capital expenditures to own and operate separate facilities within the region. The joint facilities include wastewater treatment plants, pump stations, sewer interceptors (pipelines), and reclaimed water distribution piping.

LOTT Condition Assessment

A combined sewer system collects and conveys flow from both wastewater and stormwater through one central system. LOTT owns and operates the sewer system adjacent to the West Capitol Campus. There are several reaches within the campus drainage system that discharge to a combined sewer, which is owned and operated by the state. The flow from this system discharges to LOTT's combined sewer pipeline below Capitol Way S. In application, combined sewer systems pose potential water pollution issues due to the large variations in flow between dry and inclement weather. This type of sewer system is no longer desirable. At the turn of the last century, combined sewer systems were typically designed to carry three to five times the average dry weather flows, which may not account for current build-out or fluctuations in flow capacity. With the advent of continuous storm modeling, a design can better account for peak storm events and their impact on sewer and storm systems. The models have a factor of safety built into the calculations to prevent potential facilities from being overtaxed by peak events beyond the historic data programmed into the software.

According to LOTT's latest capital improvement plan, the sewer basin that services the West Capitol Campus ranks highly on the Inflow and Infiltration (I&I) severity for their system. Inflow is surface water routed into the sewer system (such as a combined sewer system), while infiltration is groundwater seepage into the sewer pipes at joints or cracks. A goal of the drainage master plan is to identify sections of the campus that discharge stormwater to the combined system that can be rerouted into the dedicated storm facilities. It is anticipated that LOTT may not have the capacity to convey and treat stormwater, which may cause the combined sewer to overflow and discharge to a receiving body of water without treatment. LOTT may also initiate or increase fees for discharging stormwater to the sanitary sewer system in the future.

Combined Sewer Drainage Basin

There is one combined sewer TDA, with 7 subbasins, on the West Capitol Campus that conveys stormwater flow from a 12.6-acre tributary area. The recent Underground Utilities and Drainage – Sid Snyder Way project, which was completed in early 2015, eliminated two combined sewer subbasins. This project rerouted approximately 0.24 acre of contributing area, from the combined sewer basins within the parking lot and central region of the roadway, to the dedicated system. However, the project had to direct approximately 0.22 acre of contributing area to the combined sewer within the intersection of South Diagonal, Sid Snyder Way, and Capitol Way S. The net decrease of contributing area to the combined sewer was 0.02 acre.

The main contributing area to the combined sewer is the region of campus east of Cherry Lane SW, which is predominately hardscaping and lawn. The secondary contributory area is the parking lot east of the Pritchard Building and plots on either side of Columbia Street SW that contain the Press Buildings, the Visitor's Center, and the adjacent parking lot. DES has identified these lots as proposed future development areas. The Underground Utilities and Drainage – Sid Snyder Way project provided a 12-inch-diameter pipeline and catch basin, south of the intersection of Sid Snyder Avenue SW and Columbia Street SW, for a future connection to the dedicated storm drainage system for the redevelopment projects. Funding for the proposed redevelopment projects has not been programmed by the state at this time.

Storm Drainage Conveyance Issues

DES maintenance staff maintains a list of drainage issues on campus. The drainage issues typically result in localized flooding of the system. Table 1-3 summarizes the storm drainage issues and notes the locations and causes.

Table 1-3: Problematic Drainage Facilities

Item	ID No.	Location	Notes
1	11085	East of Territorial Sundial	Poorly draining catch basin (CB)
2	11131	West of Territorial Sundial	Poorly draining CB
3	11330	Capitol Building Parking Lot (southwest corner/north of O'Brien Bldg.)	Perceived capacity issue with pipe/CB
4	11241	15th Ave. SW (north of Pritchard Building)	Cleaned several times; no debris found typically
5	70022	Insurance Building (south side)	Yard drain occasionally floods area
6	30012	Cherry Lane SW & Capitol Grounds (southeast corner)	Cleaned several times; no debris found typically
7	30010	Cherry Lane SW & Capitol Grounds (western half)	Slow-draining after peak storm events
8	32178	12th Avenue SW (northwest of Temple of Justice)	Plugs frequently with debris at grate
9	32268	Mansion Parking Lot (south side)	Plugs frequently with debris
10	32943	Water Street SW	Does not drain at all

The identification numbers (ID No.) were derived from the basemap provided by DES. A composite map was created that captures these known conveyance issues and problematic surface drainage problems in the grassy lawn areas. The map was refined each time the project team visited the site or met with representatives from DES. The map is included in this document as Figures 5 and 7 in the back of the report.

Existing Water Quality and Flow Control Measures

The drainage system at West Capitol Campus was developed prior to the existence of stormwater management as a code requirement in the state of Washington. As a result, there was no dedicated stormwater flow control or water quality treatment on the West Capitol Campus prior to the recent Sid Snyder Way project. The Sid Snyder Way project introduced bioretention cells (water quality treatment) to the campus when the roadway was redeveloped in 2014.

The outfalls from campus discharge to Capitol Lake, which is identified as an exempt receiving water body. Therefore, the site does not need to detain stormwater runoff prior to discharging to the lake.

Existing Storm Drainage Evaluation

Overview

A hydrological and hydraulic evaluation was conducted on the existing storm drainage system for the West Capitol Campus to identify conveyance system deficiencies. The following passage will outline the hydrological and hydraulic criteria used in the assessment process, and the results of the evaluation process of the existing drainage system on the West Capitol Campus.

Hydrological and Hydraulic Criteria

Design criteria were developed to assess the existing drainage system on campus. The Rational Method was used to determine the peak flow events, and Manning's Equation was employed to calculate pipe flow capacity (pipe barrel capacity at normal-flowing, full conditions). This is a simple and accurate method for assessing basins composed primarily of impervious surfaces. Rainfall intensity for Olympia, Washington, was calculated using the means and methods outlined in the 2015 Washington State Department of Transportation's (WSDOT) Hydraulic Manual. The hydraulic manual utilizes a rainfall intensity equation first developed from the 1973 National Oceanic and Atmospheric Administration Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume IX Washington. WSDOT determined the dimensionless coefficients used to calculate rainfall intensity for all major cities in Washington State for the 2-, 5-, 10-, 25-, 50-, and 100 year mean recurrence intervals (MRIs).

For the analysis of pipe capacity, it was assumed that the flow within the existing, and later the proposed, piping system is uniform and the frictional head loss in the pipe barrel controls capacity. The values for Manning's roughness factor ('n') for uniform flow analysis are 15 percent higher to account for entrance, exit, junction, and bend head losses. Storm drainage pipelines were evaluated using the 25-year storm, the current city requirement. The 25-year peak flow was analyzed to determine the pipelines that failed to accommodate the peak flow under "open channel" conditions with low pressure and without overflowing the inlet grates. Lastly, a low pressure backwater analysis was performed for the 25- and 100-year storm to identify areas where flow will overflow catch basin grates. Appendix E at the end of the report contains the pipe sizing calculations for the existing system.

Assessment

The existing drainage system does not have sufficient capacity in some locations of the pipe network. These areas are generally flat and/or not sized appropriately to meet current regulation flow requirements. Table

1-4 outlines the sections of the drainage system that do not possess the capacity to convey the 25-year peak flow event. Appendix D at the end of the report contains the calculations for the system at the 25- and 100-year peak flow for the existing system.

Table 1-4
Pipes Failing the Conveyance Capacity: 25-year Peak Flow.
(Not under pressure)

From	To	Pipe Diameter (inches)	Runoff (cfs)	Pipe Capacity (cfs)	Capacity Used (%)
Subbasin A – Capitol Building Parking Lot (south of Capitol and north of O'Brien Bldg.)					
32741	10701	8	5.78	1.17	494
10701	30015	10	8.84	2.40	368
30015	30010	12	8.24	6.67	124
Subbasin B – Cherberg Building (east side)					
10965	135102	6	0.59	0.4	149
135102	135106	8	1.58	1.11	143
Subbasin C – South Diagonal					
10106	10107	12	4.47	3.76	119
Subbasin E – Winged Victory Circle					
30065	Mid Pt	6	1.25	0.79	157
Mid Pt	10033	6	1.27	0.52	246
Subbasin F – Cherry Lane SW (east of Temple of Justice)					
31280	31246	8	1.49	1.35	110
31246	31245	8	1.90	1.35	140
31245	31244	8	4.30	0.89	484
31244	31239	8	4.25	1.07	399
31239	30010	8	4.20	1.79	234
Subbasin H – Pleasant Lane SW (west of Capitol Building)					
31424	31768	10	3.98	1.61	247
CB II	32169	10	6.06	4.58	132
Subbasin I – Pleasant Lane SW (west of Temple of Justice)					
32214	32173	8	5.57	2.11	264
32173	32172	8	5.35	1.24	431
32172	32171	8	5.57	2.25	247
32171	32169	8	5.51	2.22	248
Subbasin J – Mansion Parking Lot					
32169	CB II-2	24	17.73	12.38	143
CB II-2	32266	20	17.99	7.54	239
32266	2012	20	17.82	7.54	237

Table 1-5

Pipes Failing the 25-year Peak Flow.

(Low pressure conveyance)

Table 1-5 identifies the system sections that have the potential to back up with downstream flow due to insufficient capacity in the system and overtop the catch basin grate and rim.

From	To	Rim Elev. (ft)	Headwater Elev. (ft)	Height Above Grate & Rim (ft)
Subbasin A – Capitol Building Parking Lot (south of Capitol and north of O'Brien Bldg.)				
30015	10701	124.7	162.8	38.1
10701	32741	124.6	236.2	111.6
32741	11309	124.5	238.3	113.8
Subbasin F – Cherry Lane SW (east of Temple of Justice)				
30010	31239	110.0	122.3	12.3
31239	31244	108.1	127.3	19.2
31244	31245	108.1	133.0	24.9
32145	31246	107.8	134.9	27.1
31246	31280	109.0	136.3	27.3
31280	32216	109.7	136.3	26.6
Subbasin I – Pleasant Lane SW (west of Temple of Justice)				
32169	32171	110.0	123.3	13.3
32171	32172	109.5	129.0	19.5
32172	32173	109.4	133.7	24.3
32173	32214	109.9	159.8	49.9

The backwater results from the 25-year peak flow event identify a number of sections of the pipe system that overtop catch basin grates and rims. There are actions that may be taken to correct the lack of capacity within these limited reaches of the drainage system; however, there are restraints that may limit the corrective actions, such as site topography, lack of pipe cover, environmental concerns, permitting, and capital costs. A staged approach should be taken to rehabilitate or replace aging and undersized drainage facilities.

This would ensure continued use of the existing infrastructure and alleviate the risk associated with failing structures within the system. The Implementation Plan section will discuss and identify areas of the existing system that can be replaced to increase capacity and alleviate the risk of flooding.

Soil Overview

General

Campus-wide soil explorations and investigations were not conducted for this campus drainage master plan. The statements and opinions discussed in this section are based on historical geotechnical data and information gathered from correspondence with campus operations staff.

A large portion of the West Capitol property was formed by filling a ravine that bisected the West Capitol Campus. Fill was brought in from regrading activities in other regions of the capitol site. During storm events, the topsoil layer of the lawns and landscape areas, which are underlain by this fill material and glacial till, becomes saturated quickly. The century-old underdrain system has failed, and the lawns and tree planters routinely possess areas of standing water. Leakage from drainage, water, and irrigation mains further exacerbate the soil and lawn conditions.

Subsurface Conditions

Soil information presented here is a summary of the available geotechnical information from past projects at the campus. The latest geotechnical exploration on the West Capitol Campus was conducted for the Underground Utilities and Drainage – Sid Snyder Way project in the spring of 2014. Hand probes in the grass landscaped areas north of Sid Snyder Way encountered 2 to 3 feet of fill below the topsoil. The fill consisted of soft silt and appeared to be composed of reworked recessional lacustrine. Underlying this layer, a band of recessional lacustrine was observed that consisted of soft to medium stiff silt. Groundwater was not encountered during the geotechnical engineer's explorations in 2014. It was noted that the groundwater conditions may vary greatly depending on local subsurface conditions, the weather, the season, and other factors.

The geotechnical engineer also conducted a preliminary assessment on the soils with regard to infiltration for the Sid Snyder Way project, which proposed utilizing stormwater infiltration through LID techniques to treat the runoff from Sid Snyder. The infiltration rate of the existing soils is 0.01 inches per hour, which is an extremely low rate for infiltrating stormwater. LID measures (bioretention swales) installed for the Sid Snyder Way Underground Utilities and Drainage project implemented an underdrain system that collects and conveys water away from the treatment site to be discharged in Capitol Lake.

Another geotechnical investigation was conducted for the Hillside Evaluation and Preliminary Design project in 2014. This investigation recorded various depths of fill over dense glacial deposits, which were consistent with the aforementioned geotechnical findings on campus.

Site Observations

The project team visited the site and discussed problematic drainage areas as part of developing this plan. The site was visited in both the wet (January, February, and April) and dry (June and August) seasons. In general, the lawn areas on the West Capitol Campus suffer from poor drainage near the surface. It was common to observe saturated soils in lawn areas and along hardscaping (sidewalks, curbs, and roadways) throughout the campus. A site observation map (Figures 5 and 7 at the end of the report) was developed to capture information and documentation from visits to the campus and discussions with DES staff. The map identifies surface areas of concern on the West Capitol Campus as discussed above. The following list describes specific saturated lawn areas observed directly or as identified by DES staff:

- The grass area surrounding Tivoli Fountain showed saturated soils during each site visit. This region of the campus slopes from North and South Diagonal toward the fountain and then drops gradually to the east in the direction of Capitol Way South. The sidewalk plaza to the east of the fountain is at or near the lowest elevation in the area. According to the grounds crew, the fountain loses slightly less than two gallons of water per minute during its operation in the dry (summer) months. DES is interested in detecting leakage from their existing water lines near the fountain; however, the leakage from the fountain, or its associated piping system, only compounds the surface drainage issues in this area during the summer months. Saturated soils were also observed in the wet (winter) months.

- The soils northwest of the intersection of Capitol Way S and South Diagonal were relatively saturated during a site visit in February 2015. According to DES staff, the poorly draining soil in this area has had an adverse effect on the trees and other plantings.

- The soils northeast of the Vietnam Veteran's Memorial, between the memorial and South Diagonal, were saturated during site visits in January, February, April, June, and August.

- The soils at or near the World War II Memorial were saturated during visits in January, February, April, June, and August. The lawn directly south of the memorial, where numerous yard drains were installed to capture the surface water, does not drain sufficiently and the lawn appears saturated. The lawn surface is graded in a manner that does not properly promote draining.

- In the planter strips along Cherry Lane SW, poor-draining soils have adversely affected the cherry trees. Many of the original trees have been removed or replaced over time. It is our understanding that DES plans to replace all of the trees along the roadway within the next 10 to 15 years. From our site observations, the near-surface soils did not appear saturated, but were soft or spongy in some areas. The grounds crew stated that water was observed in excavated holes when removing and replacing a few of the trees along the roadway.

- At the top of the slope surrounding the Sunken Garden, the grounds crew stated that there are typically areas of saturation in the lawn. The interior of the Sunken Garden does not appear to have issues with poorly draining soil.

- In the lawn south of the General Administration Office, near the intersection of Water Street SW and 11th Avenue SW, there were areas of saturation and standing water in the upper 4 to 6 inches of soil along the sidewalk.

- The lawn area north of the Temple of Justice Building suffers from poorly draining soils. According to DES staff, soft soils are encountered at both the top and bottom of the slopes north of the building.

Irrigation System Condition

According to the West Capitol Campus Inventory, Analysis, and Recommendations for: Potable Water, Storm Drainage, Sanitary Sewer, and Irrigation:
"The current irrigation distribution system serving the West Capitol Campus is a network of old pipe systems and irrigation laterals. Current records show that the oldest systems in service date back to 1931, constructed of cast iron, which pose the most immediate concern for failure and/or maintenance problems. The entire network is served from the City of Olympia's water distribution system and is fed from 8 individual points of connection to the existing potable water main."

The facilities have exceeded their life expectancy and are starting to show signs of age. It is common to observe areas of the campus that are over-irrigated by the existing system. The grounds crew has no means to adequately monitor and adjust the system to rapidly changing conditions during the summer months. The over-irrigation of lawn areas directly affects the soil drainage concerns and creates additional inflow to the storm drainage system. The Implementation Plan section will outline the recommended improvements to the existing irrigation system.

According to the According to data provided by DES, for the Capitol Campus Reclaimed Water Assessment completed by Gray & Osborne, Inc. for the LOTT Clean Water Alliance, peak irrigation demand is estimated to be approximately 500 gallons per minute (gpm) and the monthly average demands between 2003 and 2015 are as follows:

Month	Irrigation Demand (gallons per day)	Tivoli Fountain Water Demand (gallons per day)
January	64	
February	589	
March	1,499	
April	3,221	
May	17,299	2,400
June	75,296	2,400
July	72,867	2,400
August	54,679	2,400
September	12,610	2,400
October	1,703	
November	765	
December	566	

*In the summer of 2015 DES substantially reduced irrigation water use in response to drought conditions

Tree and Planting Preservation

The ongoing maintenance and preservation of the existing trees is an important consideration in campus drainage improvements, along with establishing historic landscape principles as intended by the Olmsted Brothers plan. The existing and future components of the drainage system need to allow for the continued growth of plantings and not adversely affect the health of existing landscape features.

Existing Trees

The condition of the existing soils and the potential for overwatering are major concerns for the existing trees on campus. Saturating soils fills available pore space between soil particles that are normally occupied by air. When this occurs, oxygen is no longer available to tree roots for respiration; if this occurs frequently, tree roots will eventually suffocate and die. Saturated soils also provide favorable conditions for root rot organisms and tree diseases. Some tree varieties are more susceptible to excess water conditions than others.

Several trees around the West Capitol Campus have been removed or replaced due to poor root conditions caused by saturated soils and root rot. The Cherry trees throughout the campus have fungal conks on lower stems, which is indicative of incursion of decay from below. Many of the existing trees exhibit surface rooting which is an indication of the tree avoiding suffocation from saturated soils by growing its roots near the surface. In these cases, the trees are more susceptible to pathogens when under stressed conditions. Fungi has been found to be present on the exposed roots, trunk bases, and the ground surrounding trees around the campus. These conditions were documented in a comprehensive survey which was completed in 2009 as a part of the Historic Landscape Preservation Plan.

Establishing the Historic Landscape

The current configuration of the drainage system will not allow for landscape development in accordance with the Historic Landscape Preservation Master Plan. The failing underdrains in the landscape areas do not properly convey water from the surface to the downstream drainage system. Without improving the existing soil conditions and subsurface drain system, it will not allow for sustainable growth of new plantings due to the saturation in the upper region of the soil. The Implementation Plan will discuss preventative measures for protecting existing trees and outline implementation projects to properly drain the soil regions beneath trees.

The West Capitol Campus, in particular, is the iconic center of our State governance, where people gather to engage in debate and shape policy, finding inspiration from the past as they aspire to a more just and equitable future.

2009 Historic Landscape Preservation Master Plan

IMPLEMENTATION PLAN

Integrated approaches will help solve complex drainage issues. This implementation plan respects the historical significance of the campus and includes sustainable strategies that can serve as a model for projects across the State and beyond.

Key points of the plan:

- Address pipe capacity issues
- Separate combined sewer
- Install underdrains
- Evaluate and upgrade irrigation system
- Eco-lawn test plots

Overview

This section presents the implementation plan for drainage improvements, water quality, irrigation improvements, and low impact design strategies. It also outlines the proposed redevelopments and their capital impacts. The drainage, landscaping, and irrigation systems are all part of a symbiotic circle, where a deficiency in one area will affect the others. The intention of this section, and the Drainage Master Plan in general, is to tie together previously conducted evaluations at the site and present the overall vision for the campus in one document.

General Proposed Improvements

Figure 3-1 *(previous page)*
West Lawn Aerial from the North

Figure 3-2
World War II Memorial
(Source: Legislative Support Services)

Based on the evaluation criteria discussed in the previous section, the peak flow events were used to evaluate the capacity of the existing storm drainage system. The recommended improvements and opportunities discussed in this section are needed to mitigate existing system deficiencies and accommodate future growth within the West Capitol Campus.

Existing System Limitations

The existing storm drainage system was analyzed for conveyance of the 25- and 100-year peak storm runoff events. The existing system consists of swales, depressions, catch basins, outfalls, and various types of storm piping. The structures shall exhibit free-flowing conditions through the existing conveyance system. The outfalls within the project area are 12- and 24 inch diameter high-density polyethylene (HDPE) pipe.

As discussed in the "Existing Conditions" section, there are a few reaches of the existing conveyance system that limit the capacity of the overall drainage network to less than the 25-year peak storm runoff event. It appears that, even with surcharging the upstream facilities, the system may overtop in a number of areas at the peak storm events. Overtopping is normally allowed from 100-year peak events as long as the excess water does not create or aggravate severe flooding or erosion issues on the site.

It appears that, based on today's city code requirements, segments of the existing system are either sloped too flat or sized too small to carry flow from the tributary areas. It is recommended that either the overcapacity sections in the system are replaced with larger diameter pipelines or flow control facilities are installed within redevelopment areas to mitigate their impacts on the existing system. It is assumed that the existing system may require the use of hydraulic head from backwater to thoroughly drain the site in the overloaded areas during slight to moderate storm events.

System Improvements Criteria

As future redevelopment projects progress, it is recommended that a detailed alternative analysis be conducted to evaluate the improvement alternatives. The following contains a list of relevant criteria that should be reviewed during the predesign phase for each project.

- **Coordination with Other Projects:** Consider the potential benefits of completing improvements in coordination with other DES or agency projects, such as utility and transportation upgrades.

- **Permit and Regulatory Reviews:** Consider the impacts of permit processes and approvals from regulatory reviews and their associated timelines.

- **Potential Environmental Impacts:** This component considers the anticipated environmental impacts, such as wetlands, steep slopes, waterfronts, or other environmentally-sensitive areas.

- **Constructability:** Consider the constructability of the project relative to surface and subsurface utility conflicts, existing site constraints, and compatibility with the existing system. This review shall also include factors such as construction techniques and complexities, availability of construction materials, and other contributing factors.

- **Vehicle and Pedestrian Traffic:** Due to the locations of the redevelopment projects, vehicle and pedestrian control will be required to ensure public safety and facilitate construction activities. Traffic control and signage should be considered as part of the project costs.

- **Utility Conflicts:** Consider the potential impacts associated with both below- and above grade utility components and structures.

- **Geotechnical Investigation Requirements:** This component should consider the relevant subsurface investigations required as part of the project design.

- **Archeological Impacts:** Consider the impacts of potentially unknown or identified archeological sites on the campus.

- **Capital Costs:** Consider the project cost of the alternative, including construction cost, contingencies, engineering, and other associated costs.

- **Life Cycle Costs:** This component considers the life-cycle costs associated with alternatives, including the capital, operation, and maintenance costs.

- **Schedule:** Review and consider the implementation schedule that can be anticipated for each project.

At the current planning-level stage, the majority of the aforementioned tasks can only be assumed. The design team for the proposed redevelopment projects will conduct an informal or formal process, similar to this approach, where they weight each category, based on DES's priorities and other economic impacts, and provide an alternative scoring spreadsheet.

Sewer Separation Opportunities

A combined sewer system serves a portion of the West Capitol Campus, conveying both sanitary sewage and stormwater through a single pipe. Typically, in dry weather conditions and during light to moderate rainfall, the combined sewage system is able to adequately convey all flows to the wastewater treatment facility. However, during periods of heavy rainfall, the capacity of the combined sewer can be limited. There is a desire to review and identify opportunities to separate stormwater flow from the combined sewer whenever possible on campus.

There are three main areas on the campus that discharge to the combined sewer system as defined in the "Existing Conditions" section. It appears that two of the three regions can be redirected to the dedicated stormwater network as part of future redevelopment projects. In the Pritchard Building Parking Lot area, roughly 75 percent (0.75 acre) of the pollution-generating surface discharges to the combined sewer. At this time, it is our understanding that DES has two alternatives they are reviewing for the redevelopment of this parking lot: 1) Provide an open green landscape area and a below grade parking garage, or 2) Provide a parking area for school bus parking. The combined sewer separation can be achieved with the redevelopment of this area. For either case, the flow from the site can be directed to the dedicated stormwater system. The perceived difference between the two options, with regard to stormwater, is the size of the flow control and water quality treatment facilities. Flow control facilities are required for mitigating the impacts of the redirected flow on the existing dedicated stormwater system. Storm runoff from the pollutant generating impervious areas needs to be treated prior to discharging to the dedicated stormwater system.

The second separation opportunity is in the area of the Visitor Center property. The 2006 Master Plan proposed redevelopment of this area in the near future. The project limits are bordered on the west by Water Street SW (Irv Newhouse Building), Capitol Way S on the east, Sid Snyder Avenue SW to the north, and 15th Avenue SW to the south. This project area comprises approximately 3.2 acres, and roughly half of the area currently discharges to the combined sewer. It is anticipated that the redevelopment will provide ample green space in conformance with the Historic Preservation Landscape Master Plan. The Historic Preservation Landscape Master Plan identifies using the frontage area south of Sid Snyder Avenue SW for green space. The remaining region of the site will potentially house a series of structures for public use by visitors to the campus. As with the Pritchard Building Parking Lot area, flow control and water quality treatment facilities are required for redirecting stormwater into the dedicated stormwater system.

The third area discharging to the combined sewer system is located at the northeast corner of the campus. This is generally a lawn and landscaping area consisting of approximately 10 acres. Storm runoff from this region of campus is collected by catch basins and conveyed off site by underground pipelines to the combined sewer main underneath Capitol Way. According to the 2006 Master Plan, no redevelopment is planned in this area. Without reconstruction, a significant section of the existing storm main west of this area is too high to redirect stormwater from this region to the dedicated stormwater system. Our recommendation is to leave this area unchanged and allow water from this nonpollution-generating area continue to discharge to the combined sewer system. Please refer to the "Planned Developments" section for more information regarding opportunities for separating the combined sewer.

Future Conveyance Improvement Opportunities

As mentioned in the "Existing Conditions" section, a series of existing storm drainage pipelines within the dedicated storm drainage system are undersized, based on the current design code guidelines. With new redevelopment projects planned at the campus, the capacity of the system will be decreased further, requiring upgrades to the drainage system.

The existing and proposed dedicated storm drainage network was analyzed at the 25- and 100 year peak flow with the additional area from the proposed redevelopment projects. The system was analyzed in order to identify if and where overtopping the system would occur at the 25 and 100-year peak flow. Stretches of the existing system were upsized to contain flow up to the 100-year peak flow events. It is recommended to size any new or redeveloped sections to contain the 100-year peak flow, since it is difficult to ensure that the overtopping flow would discharge at the natural location (outfall to Capitol Lake) for the project site. However, it is not anticipated that any overflow in the system would create or aggravate a severe flooding or severe erosion problem on the site. Appendix C contains the pipe sizing calculations for the 25- and 100-year peak flow events for the proposed system. Table 1-6 outlines the locations where it is recommended to increase capacity within the existing system.

Table 1-6
Proposed Main-Line Replacement.

From	To	Existing Pipe Size (in)	Proposed Pipe Size (in)
Subbasin A – Capitol Building Parking Lot			
11309	32741	8	12
32741	10701	8	18
10701	30015	10	18
30015	30010	12	18
Subbasin B – Cherberg Building (east side)			
10965	135102	6	8
135102	135106	8	12
30149	SDMH	12	18
SDMH	10107	12	18
Subbasin C – South Diagonal			
10106	30967	12	18
10106	10107	12	18
Subbasin D – South Diagonal			
10107	10037	15	18
10037	10030	15	18
10030	10032	18	24
10032	10033	18	24
Subbasin E – Winged Victory Circle			
30065	Mid Pt	6	8
Mid Pt	10033	6	12
10033	30010	18	24
Subbasin F – Cherry Lane SW (east of Temple of Justice)			
31280	31246	8	12
31246	31245	8	12
31245	31244	8	18
31244	31239	8	18
31239	30010	8	18
Subbasin H – Pleasant Lane SW (west of Capitol Building)			
31618	31617	6	8
31617	11310	6	8
31424	31768	10	18
31768	CB TYP II	10	18
CB TYP II	32169	10	18

Table 1-6 : Proposed Main-Line Replacement *(continued)*

From	To	Existing Pipe Size (in)	Proposed Pipe Size (in)
Subbasin I – Pleasant Lane SW (west of Temple of Justice)			
32214	32173	8	12
32173	32172	8	18
32172	32171	8	18
32171	32169	8	18

Stormwater flow control basins were incorporated into the conceptual site layout to reduce the peak rate of discharge and decrease the capital cost of upgrading downstream reaches of the storm system. Flow control facilities are designed to contain excess flow during the most intense portion of a runoff event and then release the flow as capacity in the drainage system becomes available. The conceptual flow control capacities/volumes were computed by using a hydrologic computer model (Western Washington Hydrology Model – WWHM 2012). The durations were based on the predeveloped flow frequency of 50 percent of the 2-year to the 50-year storm events.

The redevelopments at the Visitor Center and Pritchard Building Parking Lot will affect the existing system. As mentioned in the "Existing Conditions" section, the Rational Method does not factor in the attenuation effects on the existing storage features within a given basin. The designer for either redevelopment project, within the existing combined sewer system, should analyze the effects of redirecting the flow into the dedicated system in detail rather than at a conceptual level. If storage is used for these sites, it is anticipated that the effects on the downstream system would be greatly reduced.

The output calculations from WWHM identify the required size of the flow control facility along with the discharge structure dimensions (riser height and diameter). The Vault Hydraulic Table within the output file identifies the volume and discharge rate depending on the depth of water within the control structure. Appendix E at the end of the report contains the flow control calculations for the proposed system.

Drainage Improvements at Lawn and Landscape Areas

Figure 3-3
Capitol Building from across West Lawn
(Sept. 2009, Source: Mithun)

During the predesign and design phase of redevelopment projects, consideration should be given to a number of options for drainage improvement on the West Capitol Campus. One alternative typically does not fully address problematic areas at a site. By implementing a combination of below- and at-grade methods, it is anticipated that the measures would address one or multiple issues at once. Additionally, a tree root assessment should be made prior to any excavation work near existing trees. It is important to recognize that tree roots extend well beyond the drip line. It is recommended that a landscape architect be retained during the predesign phase of projects to assess and evaluate tree root conditions. The following passage outlines several means and methods for addressing drainage concerns observed on the West Capitol Campus.

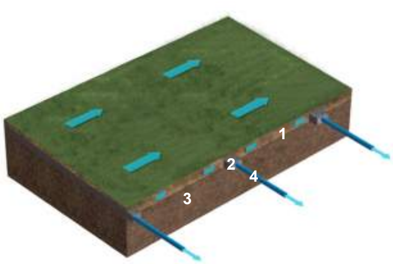
Soil Amendments

A soil amendment is any material added to a soil to improve its physical properties. There are a number of factors to consider in selecting a soil amendment, such as soil texture and structure, water retention, permeability, water infiltration, aeration, soil salinity, pH, and longevity of the amendment mixed in soil. Products like wood chips, compost, peat, biosolids, and animal manure are commonly used. The goal of a soil amendment is to provide a better environment for root growth through nutrient-rich admixtures. Soil amendments may be required in areas where understory plantings or trees are to be installed. Soil reports will determine the extent to which these soils will be amended based on the existing soil quality and whether the soils are to serve as a bioretention media or planting media.

On the West Capitol Campus, disturbing soils during construction or maintenance activities will require adding soil amendments to the existing subsurface to promote healthy soils. This includes, and is not limited to, all projects outlined in the "Planned Developments" section.

Figure 3-4
Underdrains at landscape areas, Axon

1 Existing Topsoil
2 Gravel Base
3 Existing Subgrade
4 Perforated Underdrain



(Source: Mithun)

Underdrains at Landscape Areas

For poorly drained lawns, where water does not infiltrate and pooling is present, underdrains (or French drains) may be used to capture and convey surface and inter-layer flow to a downstream storm drainage conveyance system. The addition of drains will remove excess water which would be present when soils are oversaturated and infiltration is minimal. Underdrains are installed within excavated trenches, situated along surface contour lines, possessing perforated pipes that are surrounded by a column of aggregate. The bottoms of the trenches are lined with filter fabric and a thin layer of aggregate is placed along with the perforated pipe. The column of aggregate is commonly 18 to 24 inches thick and 12 to 30 inches deep.

In the case of the West Capitol Campus, an underdrain system is recommended to be installed below the surface of the existing west lawn area, giving the appearance of a continuous green-space without detracting from the overall aesthetics of the site. The underdrains are an option for formal areas where turf lawns must be maintained. The drains would prevent ground and surface water from adversely affecting landscaped features on the West Capitol Campus. Care should be taken to limit negative impacts on the existing trees. Prior to underdrain installation, a tree root assessment is recommended to minimize root conflicts with pipe routing.

Soil Replacement with Underdrain Addition

Removing and replacing the existing poorly-draining, near-surface soil layer and installing an underdrain system is an alternative for the pervious regions on campus. This option recommends removing the upper 12 to 18 inches of soil and replacing it with a free-draining, amended soil mixture that allows for infiltration through the upper crest of soil. Removing and replacing soils would allow for designing and specifying a soil mixture that would accommodate infiltration and provide a firm, walkable surface on campus. The removal and replacement of soils with the addition of underdrains will be required in new bioretention areas as well as other areas designed to treat stormwater runoff. In addition to bioretention areas, street trees with poor drainage may require soil replacement and additional underdrains. Soil replacement with the addition of underdrains is not a practical solution for areas where existing trees are present with extensive root systems. The underdrain system would follow the guidelines discussed above. Ideal areas on campus are in the west lawn and within the lawn in the circle drive (between Temple of Justice and the State Capitol Building).

Permeable Paving

Permeable pavement refers to a wide variety of surfaces, including concretes, asphalts, and various types of grid and paver systems. Permeable pavement has a network of void spaces that allows water to pass through and infiltrate to the subsurface. Installations typically include below-ground, load-bearing stone reservoirs that can detain runoff for either infiltration through native soils or discharge downstream to a conveyance system.

Permeable paving surfaces keep pollutants in place and allow for water seepage. In the void spaces of the surface, micro-organisms digest oils and other common pollutants from vehicles. Permeable pavements require regular maintenance intervals to clean and remove pore space blockage along the upper surface. Given the soil conditions at the campus and the need to protect the bluff stability, underdrain systems are recommended for permeable paving. Ideal locations for permeable paving are within the parking area south of the Capitol Building, along both Diagonal Streets, and Water Street SW. Other opportunities for use on campus should be explored in the future.

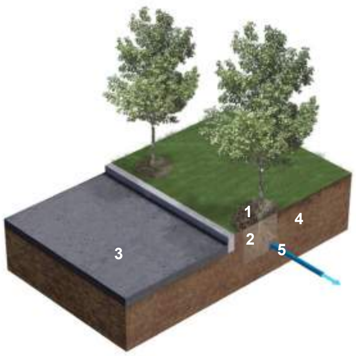
Area Drains

Area drains provide localized drainage relief at grade within a landscaped area. Area drains are typically small catch basins or yard

Figure 3-5

Street Tree Drainage, Axon

1 Mulch
2 Imported Soil Mix
3 Adjacent Pollution Generating Surface
4 Existing Subgrade
5 Perforated Underdrain



(Source: Mithun)

drains connected to a large storm drainage system. Grading within a landscaped area needs to promote movement of surface water toward area drains. It is recommended to provide slopes of 2 percent or greater within landscaped surfaces to ensure proper surface flow. Area drains can be used in combination with subsurface underdrain systems to adequately drain a region of turf. Drains should be located at low points in planting beds or lawns to provide drainage from these locations. Additional area drains may be required where a slope meets an existing walkway or hardscape barrier. These hardscape features act as a barrier to the passage of water, resulting in water ponding in these locations. Ideally, area drains will be implemented along with an underdrain system within soggy lawn locations on campus. Please refer to Figure s 5 and 7 at the back of the report for information on saturated soil areas.

Street Tree Drainage

Root zone drainage appears to be a significant issue on the West Capitol Campus. Oversaturating a root ball has an adverse effect on the overall health of a tree or other planting. To alleviate this effect, it is recommended to provide proper drainage for trees throughout the landscape region of campus. Additionally, crowning the grade surrounding the trees will promote surface drainage away from the root ball and discourage pooling in these areas. The existing near-surface soils will need to be amended or replaced with a well-draining soil mixture. Underdrains should also be installed below the root zones and connected to the dedicated storm drainage system whenever new trees are planted on campus. Underdrains should be provided for trees being replaced or added in poorly draining areas or spaces confined by hardscape or compacted soils. Each instance of tree replacement/addition should be studied to determine the feasibility of connecting the proposed undrain system to the existing storm drainage system. For existing trees that are experiencing adverse effects of poor drainage, underdrains may be installed to provide drainage from the roots and avoid the existing root structure. It is recommended that tree drainage be utilized along both streetscape areas of Cherry Lane SW.

Water Quality Treatment

It is anticipated that basic water quality treatment methods will be used for future development and redevelopment projects on campus. The implementation of LID strategies is a priority of the state for all future redevelopment projects. LID strategies aim to treat and manage stormwater runoff using natural processes that mimic the hydrological functionality of predeveloped conditions. Please refer to Appendix B for more information on Water Quality and LID Strategies for the West Capitol Campus, and recommendations for water quality treatment on the Planned Development section below.

Eco-Lawn

Figure 3-6

West Lawn Aerial from the North

(Source: Legislative Support Services)

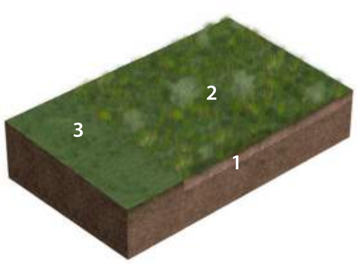
General

In addition to the aforementioned strategies, the application and installation of eco-lawn as a standalone solution or in tandem with other strategies can go a long way to alleviate drainage issues and restore campus landscape aesthetics according to the Historic Preservation Landscape Master Plan. Eco-lawn is a blend of low growing herbaceous vegetation which is specifically designed as a replacement for standard turf. Because plant diversity contributes to an extensive and resilient root structure, eco-lawn provides an ecologically conscience and resource sensitive replacement for the turf monoculture. Eco-lawn is designed to increase the overall plant diversity, improving the drought tolerance of the landscape, while at the same time, reducing fertilization, irrigation and maintenance requirements. An eco-lawn can be made up of a variety of non-woody vegetation including noninvasive fescues and broadleaf perennials. Because eco-lawn is comprised of multiple plant species, it gives the appearance of a textured lawn rather than the crisp clean aesthetic of hyper-maintained standard turf. Eco-lawn is compatible with the proposed campus aesthetic and would not inhibit the uses that currently occur on the lawn throughout the West Capitol Campus.

Figure 3-7

Ecolawn, Axon

Existing Subgrade	1
Eco-lawn	2
Standard Lawn	3



(Source: Mithun)
enlarged detail found in Appendix B

Use of Eco-Lawn on the west Capitol Campus

Eco-lawn or similar lawn mixes have been used on State properties in the past with mixed results. At the lawn to the west of the O'Brien Building a seed mix called "Turf-Type Tall Fescue" (TTTF) was used as a performance test to determine the applicability across the West Capitol Campus. The seed mix used at this location was comprised of Gooden Tall Fescue, WPEZE Tall Fescue, and Wolverine Tall Fescue and was designed as a drought-resistant, wear-resistant, shade-tolerant alternative to standard lawn. After installation, the TTTF was determined to be underperforming relative to expectations. The TTTF filled in thinly and patchy, and where the TTTF did not fill in, native weeds quickly took hold and outcompeted the TTTF mix. Many factors may have contributed to the underperformance of the test plot including: too much shade, poor soil quality, poor drainage, and inadequate erosion control measures. Although the application of Eco-lawn has not been successful on the West Capitol Campus thus far, future testing and application should not be deterred. Future eco-lawn specifications and installations should build upon the lessons learned from this project.

Aesthetic Considerations

Because eco-lawn has an aesthetic that varies from the existing lawn on the West Capitol Campus, consideration must be given to the installation and ongoing maintenance in order to maintain the aesthetic that defines the State Capitol. Seed mixes typically contain fescues and broadleaf perennials which create a carpet that appears patchier than standard turf, are allowed to grow taller than standard turf, and can go dormant in drought conditions. These features will create a distinct aesthetic which can vary greatly from a lawn maintained with constant irrigation and mowing.

The use of eco-lawn should first be limited to test areas in order to determine the optimal growing conditions and/or species mixes. Through testing, the following shall be determined: seed mix containing an acceptable amount of diversity between fescues and broadleaf perennials, proper soil mix, adequate erosion control measures for plant establishment, acceptable plant growth height and mowing schedule, acceptable minimum irrigation requirements, and ongoing maintenance requirements.

When an acceptable combination of growing conditions, species mix, and maintenance practices are established through testing, eco-lawn can be applied throughout the campus. This application should be limited to areas which are designated as eco-lawn in the Historic Preservation Landscape Master Plan.

Project Implementation

Eco-lawn may be installed as a standalone project or may be installed in conjunction with soil amendments, soil replacement, underdrains, and area drains, as detailed in the previous section. For best performance, soils should be amended or replaced and area drains and underdrains installed where applicable. Eco-lawn may be installed with one or any number of the previously mentioned soil and drainage strategies. If the implementation of soil and drainage improvements is not possible, as in areas where extensive tree roots are present, a passive approach to establishing eco-lawn may be used.

One passive approach to eco-lawn is to simply mow and irrigate the existing lawn less frequently, and let other plant species naturally invade the existing turf. If a specific species mix is desired, the existing turf areas may be overseeded with those seeds over time.

Maintenance and Management

As a general practice, eco-lawns require more up front maintenance during plant establishment, periodic weeding, less mowing, and less irrigating. For detailed maintenance guidelines refer to "Ecologically Sound Lawn Care for the Pacific Northwest: Findings from the Scientific Literature and Recommendations from Turf Professionals" (McDonald, 1999) and "Low Maintenance Turf?" (Cook, 2005).

Recommendations

Based on the review of contemporary literature and lessons learned from eco-lawn application on campus, the recommendations for implementation of eco-lawn on the West Capitol Campus include:

- Establishing eco-lawn test plot(s) on the West Capitol Campus to determine site specific

- Eco-lawn species mix that will meet desired standards in terms of performance, aesthetics and any desired certifications
- Soil amendment or replacement requirements
- Drainage infrastructure requirements (underdrains, area drains, French drains, etc.)
- Sun/Shade requirements
- Acceptable growth heights
- Mowing frequencies
- Irrigation frequencies
- Maintenance requirements

-Upon the success of test plot(s), installation of eco-lawn where designated in the Historic Preservation Landscape Master Plan

Irrigation Recommendations

Figure 3-8
Campus Heritage Tree
(Sept. 2008, Source: Mithun)

General

The irrigation system is starting to show signs of age and becoming increasingly difficult to maintain. There is strong desire and need to replace the entire main line system and service laterals. It is recommended that a thorough investigation and evaluation of the existing system be conducted to fully comprehend existing conditions, zoning, and pipe sizing requirements. This study would provide a better understanding of where failures are occurring, to what degree the system needs replacing, and how to phase the replacement of the irrigation system. The following will discuss project implementation, zoning, and landscape irrigation best practices.

Project Implementation

There is desire to replace the entire main line system as a separate project. DES staff have expressed a desire to include a connection to LOTT's reclaimed water system to feed the future irrigation system. Utilizing reclaimed water would insulate the irrigation system from draught conditions imposed on potable water sources.

The implementation of replacing the irrigation service laterals should be handled project by project. This tactic would allow for sections of the irrigation system to be installed with each redevelopment project. As projects are constructed, the overall efficiency of the system will improve and the old system will be decommissioned.

It is recommended to conduct a tree root assessment prior to construction activities on the irrigation system. It is important to recognize that tree roots extend well beyond the drip line. The irrigation replacement should consider the effects of the application type (e.g., sprinklers, driplines, etc.) and zoning on the trees and other plantings. These considerations include but are not limited to: required spray area, sun exposure, existing and proposed vegetation types, and aesthetic requirements. The zoning of the landscaped and lawn areas should be separated to increase efficiency of the system and prevent overwatering.

Zoning

The proper zoning of the new irrigation system is imperative to ensure the vitality of the vegetation while maximizing system efficiency. The campus includes a diverse variety of vegetation types, such as trees, shrubs, native and ornamental groundcover, and turf. The replacement of the existing system should include zoning the lawn (turf) and the planting areas separately. This will allow for the appropriate amount and frequency of irrigation water to be delivered to the landscaped areas.

Landscape Irrigation Best Management Practices

Landscape irrigation BMPs should be followed to maximize efficiency and effectiveness of the irrigation system. The following outlines general guidelines for efficiency, water reuse, and frequency.

Efficiency

Each irrigation zone should be evaluated for water delivery practices to determine if efficiency can be improved. As an example, it may be beneficial to replace sprinkler heads with bubblers or drip lines to improve water use and decrease the amount of water spreading outside of landscape areas, onto sidewalks, roadways, and parking lots.

Water Reuse

If stormwater can be collected, held, and distributed from either a centralized cistern or a number of decentralized cisterns, there is potential for that water to be reused for landscape irrigation. Direct runoff can be reused for irrigation if it meets water quality standards. Where it does not meet standards, pretreatment through an appropriate water quality treatment facility or in-cistern treatment would be required prior to reuse for irrigation.

It is also desirable to install and implement reclaimed treated wastewater as part of the mainline irrigation system replacement. Reclaimed water would be provided by the LOTT Alliance feeder system. If reuse measures are instituted on campus, it would greatly reduce the consumption of potable water and alleviate concerns about drought conditions (dry weather periods).

Frequency

Irrigation frequency has a significant impact on water use and drainage issues throughout the West Capitol Campus. To reduce overwatering and other inefficiencies, two landscape design considerations are recommended for upcoming redevelopment projects.

1. Selection of plant species: Native and drought-tolerant species should be used where applicable. Drought tolerant species and eco-lawn can go dormant if water is not readily available, without compromising the plant's ability to recover. The campus aesthetic should be considered when these species and irrigation strategies are chosen to determine if they are right for this landscape.
2. Campus aesthetics: Turf, which can be found throughout the campus, requires an inordinate amount of water compared to other landscape zones. A switch to eco lawn and understory plantings will have a noticeable impact on water use.

For more information on irrigation BMPs, please refer to the Landscape Irrigation Best Management Practices manual published by the Irrigation Association and American Society of Irrigation Consultants.

Planned Developments

Figure 3-9

West Lawn Aerial

(source: Legislative Support Services)

A series of onceptual designs have been identified from the 2006 Master Plan, discussions during the development of this report and the budgeting process for the 2014-2016 biennium. Each design includes drainage, irrigation, landscape improvements and a statement of probable cost.

The plans capitalize on multiple benefits of

- Replacing aging infrastructure
- Implementing low impact development strategies
- Implementing the historic intent of the Olmsted Brothers plan

The 2006 Master Plan identified several future redevelopment projects for government facilities on the West Capitol Campus. These sites were deemed either undeveloped or underdeveloped and are desirable for short- and long-term improvements. The following section outlines several of the recommended infrastructure, planting, and drainage improvements for these areas. Some of these improvements are developed to respond to the Master Plan, while some are additional sites earmarked during the development of this report. A number of the projects were developed during the budgeting process for the next biennium (2014-2016) during the late summer of 2014.

Integrated Plan

The plans for each of the following projects were developed with an integrated approach to the future planning, design, construction, and maintenance activities. Improvements to the existing infrastructure, soils, planting, and irrigation shall be coordinated to provide a holistic solution to campus-wide drainage issues. An initial assessment of infrastructure, soils, planting, and irrigation has influenced the development of these conceptual plans. The continuation of this integrated approach is expected as these projects are taken beyond conceptual design.

Figure 3-10

Drainage, Tree, & Shrub Composite Plan

(Source: Mithun)

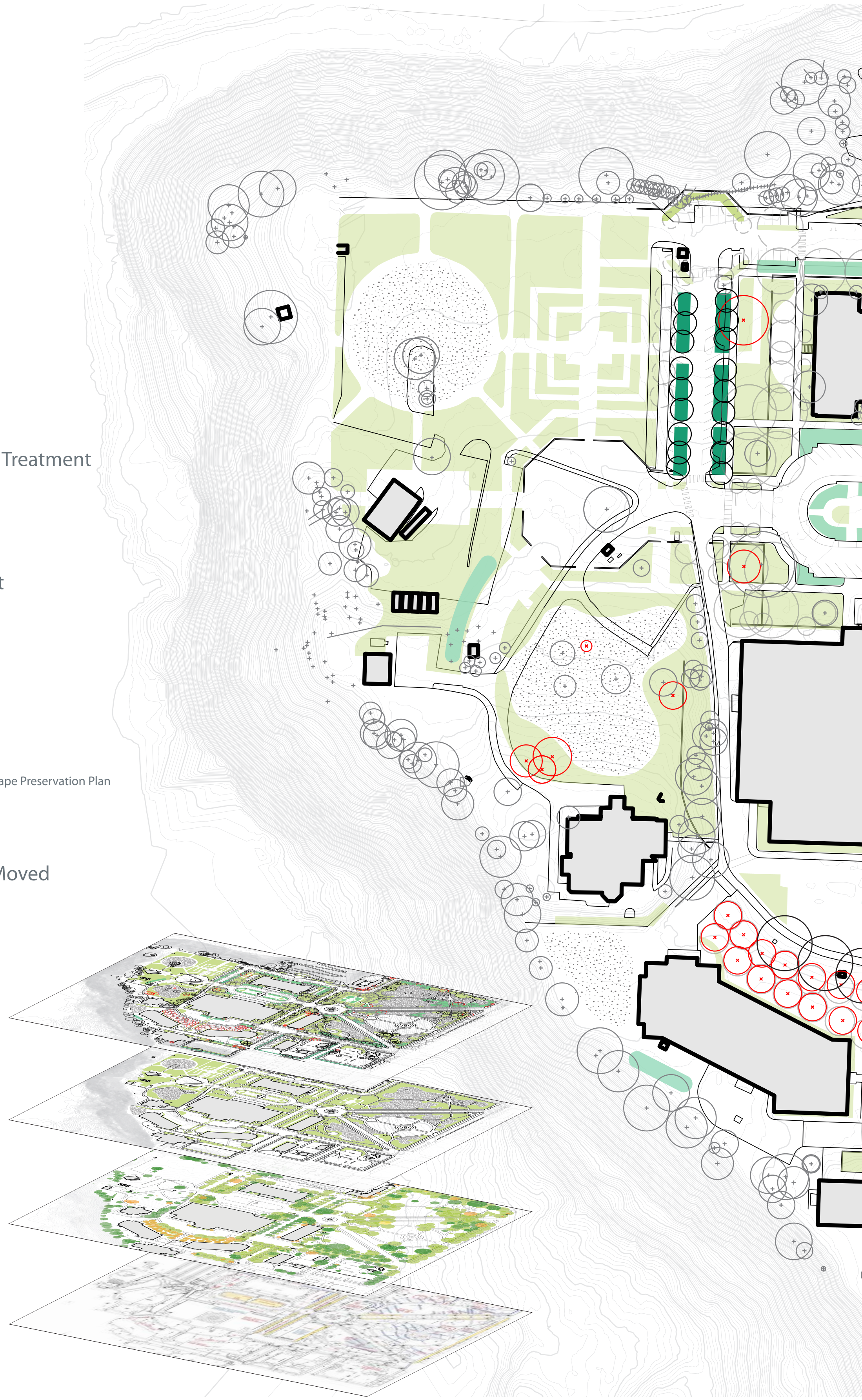
Proposed Projects

- Shrub Layer
  Historic Landscape Preservation Plan
- Proposed Stormwater Treatment

Future Considerations

- Shrub Layer
  Historic Landscape Preservation Plan
- Stormwater Treatment

- Ecolawn
- Standard Lawn
- Future Tree - Historic Landscape Preservation Plan
- Existing Tree
- Tree to be Removed/Moved
- Existing Project

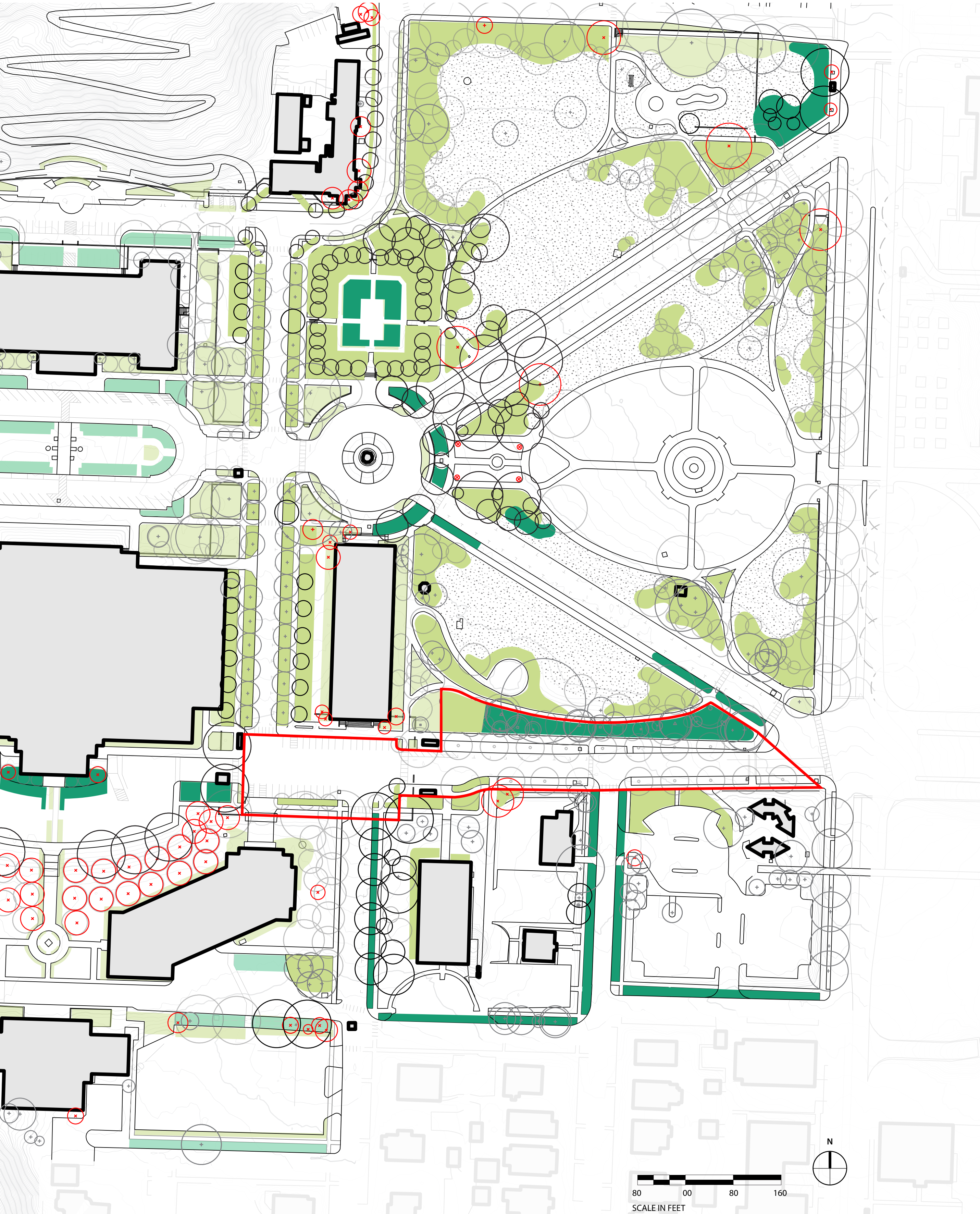


Drainage, Tree, & Shrub Composite Plan

Shrub Plan
Historic Landscape Preservation Plan

Tree Plan
Historic Landscape Preservation Plan

Drainage Observations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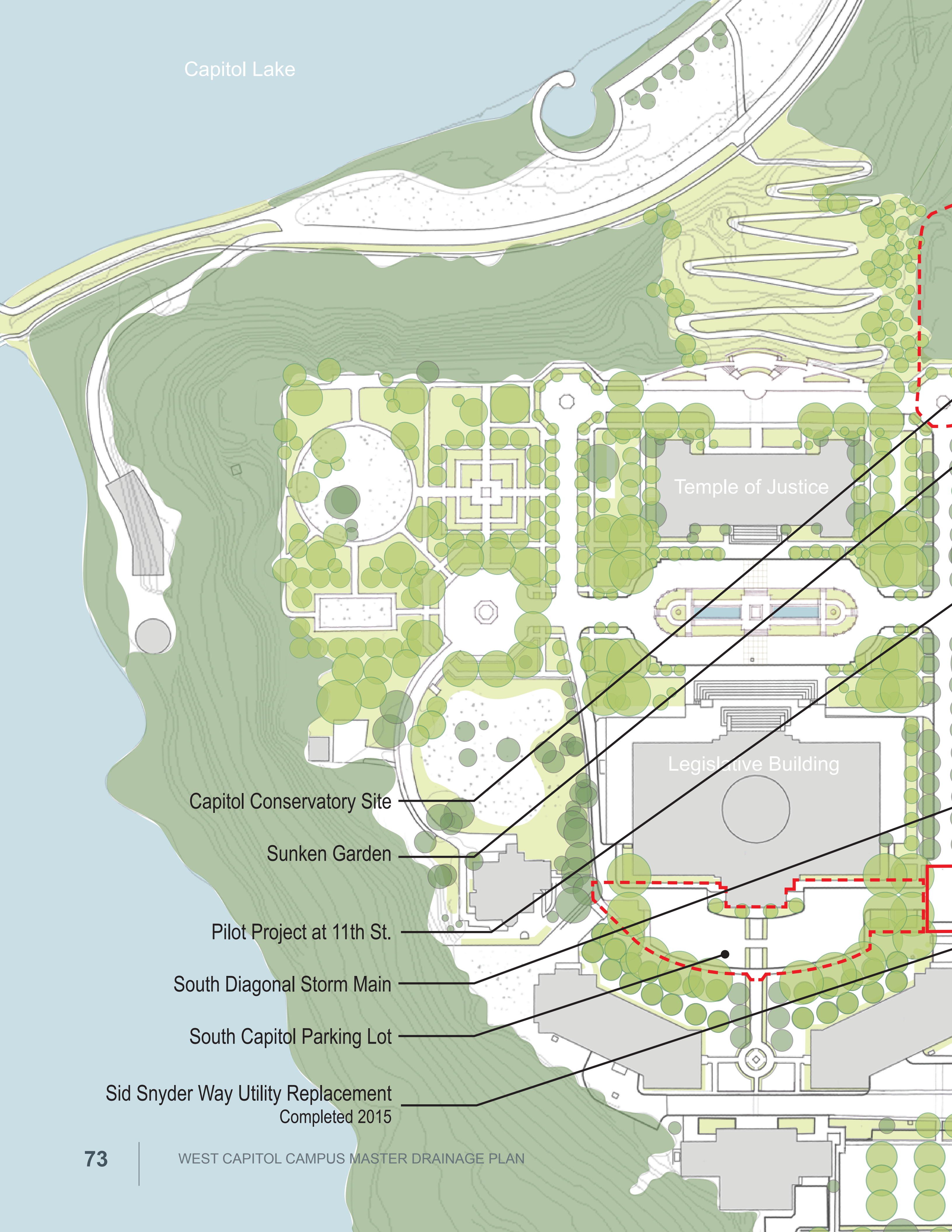
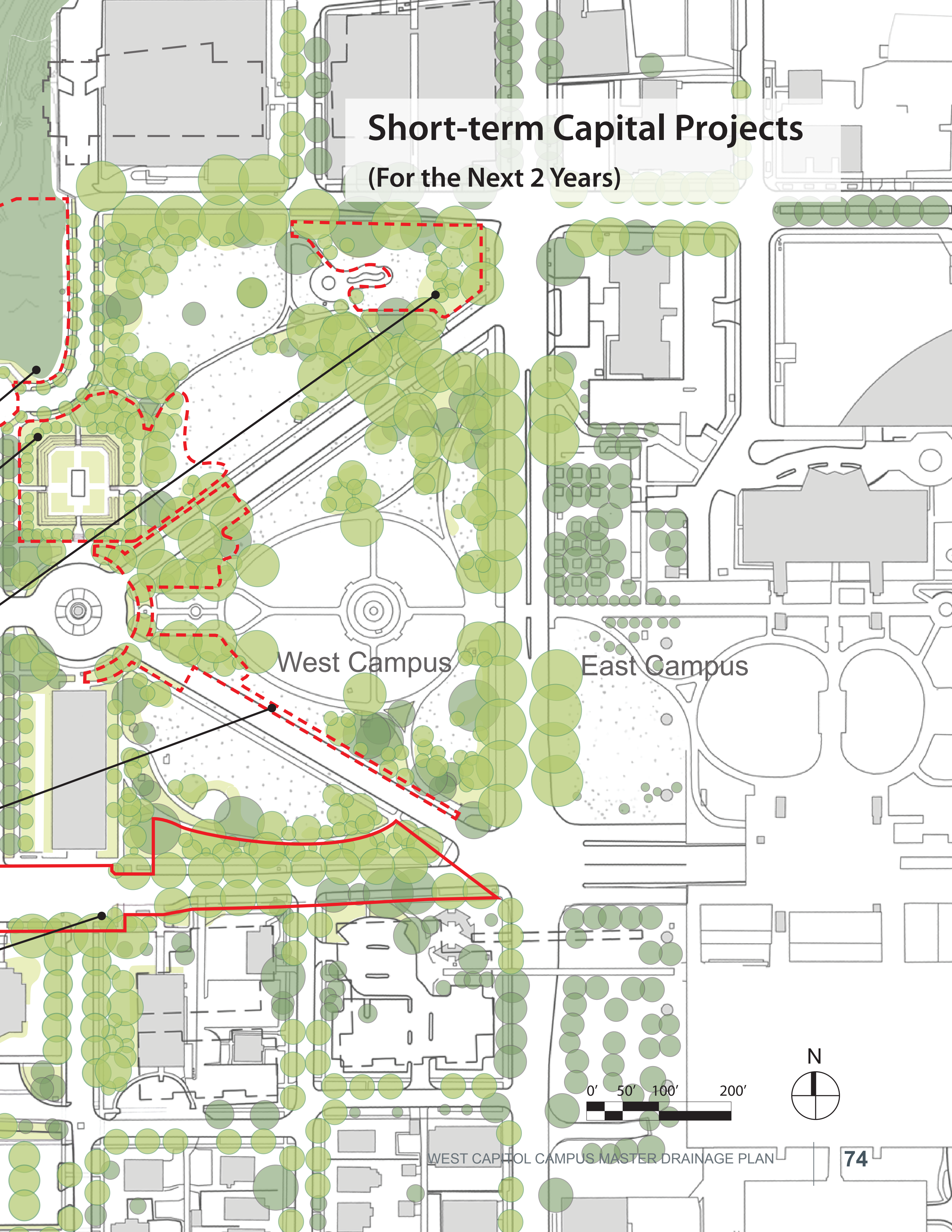
SCALE IN FEET


Capitol Lake
Temple of Justice
Legislative Building
Capitol Conservatory Site
Sunken Garden
Pilot Project at 11th St.
South Diagonal Storm Main
South Capitol Parking Lot
Sid Snyder Way Utility Replacement
Completed 2015

Short-term Capital Projects

(For the Next 2 Years)



Capitol Conservatory Site
Existing Conditions

Figure 3-11 ***(previous page) :***
Proposed Short-term Developments
(Source: Mithun)

Figure 3-12
View of Capitol Conservatory from 12th Ave SW
(Oct. 2009, Source: Mithun)

Overview

The Capitol Conservatory site is located along the top of a forested bluff, northeast of the Temple of Justice building, on the West Capitol Campus. The site includes the DES grounds maintenance shop and a public greenhouse, which has been closed since 2008. The greenhouse was originally built in 1939 and later expanded in 1963. In 2001, the structure was deemed eligible for the National Register of Historic Places as a contributing element to the State Capitol Historic District.

The site was originally developed by filling in the ravine that bisected the campus with fill material and other debris. Severe settling has and continues to occur at the site. In 2010, the Hillside Evaluation and Preliminary Design project was conducted on Capitol Campus to evaluate slopes for stability and risk of failure and identify potential consequences of slope failure. The evaluation identified the conservatory site as having a high risk for shallow slope failures, which would adversely affect the existing buildings at the site. The geotechnical consultant identified that shallow failures are relatively common in the Puget Sound area and occur in loose surface soils, natural colluvium, fill, debris, and landscaping materials. Failures are typically caused by saturation of the soil during or soon after periods of wet weather.

The site is constrained by the ravine and a 230-foot-long soldier pile wall to the west and north, and Water Street to the south and east. The soldier pile wall supports the parking and storage areas north of the greenhouse and west of the maintenance shop, along with the parking areas west of the General Administration (GA) building to the north.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on the West Capitol Campus.

Development Opportunities

A number of alternatives have been suggested for the redevelopment of the site; however, due to the risk associated with the west slope, redevelopment may be somewhat limited. In order to move forward with redevelopment, an alternative location for the DES grounds maintenance shop will have to be selected, designed, and constructed.

With the available information, it is recommended at this time to redevelop the site in conformance with the Historic Landscape Preservation Master Plan. The plan identifies a green space containing a restored native edge to be constructed at this location. The plan also recommends that the intersection of 12th Avenue and Cherry Lane be redesigned to incorporate elements of the Olmsted Plan for this location as shown in the Historic Preservation Landscape Master Plan. This recommendation promotes ongoing efforts to improve views to and from the campus as well improve pedestrian connectivity.

The following outlines the recommendations from this conceptual plan:

- Redevelop the intersection of 12th Avenue and Cherry Lane
- Provide native trees, shrubs, and groundcover restoration for the entire site, and construct a new pedestrian pathway on the north and west side of the street
- Import or amend soils to provide soils consistent with the requirements of bioretention, tree, and planting areas
- Install irrigation consistent with planting, tree requirements, and slope conditions

Capitol Conservatory Site

Legend

Project Boundary

Shrub Layer - Historic Landscape Preservation Plan

Proposed Tree

Existing Tree

Future Tree - Historic Landscape Preservation Plan

Cost Summary

Temporary Erosion Control	$16,00
Demolition	$257,000
Earthwork	$76,000
Storm Drainage	$13,000
Landscaping Restore to native condition, as shown in Historic Landscape Preservation Plan. Includes native plantings, 9 street trees, new soil, irrigation, sidewalk, and identifies future water quality treatment bioretention area.	$340,000
Total	**$704,000**

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.

Figure 3-13 ***(opposite page) :***
Capitol Conservatory Key Map

Figure 3-14
Capitol Conservatory Site, Proposed Development

Sunken Garden
Existing Conditions

Figure 3-15
Existing Conditions, Sunken Garden
(Sept. 2009, Source: Mithun)

Overview
The Sunken Garden is a central landscape element on the West Capitol Campus. The center portion of the garden is lower compared to the surrounding topography, with shrubs lining the outer edges of the garden at the crest of the landscape feature. However, at this time, the garden is in need of rehabilitation. The Historic Landscape Preservation Master Plan recommends restoring the garden to its intended historic design, rehabilitating the adjacent landscaping, and adding historically planned trees.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on the West Capitol Campus.

Development Opportunities

The installation of a sanitary sewer pipe is currently being proposed to connect the sewer main northwest of the Sunken Garden (within the intersection of 12th Avenue SW and Cherry Lane SW) to a location near the middle of North Diagonal. The proposed main will bisect the lawn area directly northeast of the Sunken Garden. As part of this project, there may be an opportunity to rehabilitate the Sunken Garden and install water treatment features within the garden's boundary. In addition to the work within the Sunken Garden, adjacent areas should be updated with understory plantings and trees based on the recommendations in the Historic Landscape Preservation Master Plan. The following outlines the conceptual plan for this project:

- Redevelop the Sunken Garden area to utilize the interior for water quality treatment through bioretention planters. A bioretention area in the Sunken Garden provides additional capacity for future water quality treatment when nearby paved surfaces are replaced.
- Redevelop the lawn area south of the Sunken Garden and west of North Diagonal for water quality treatment using a bioretention cell
- Redirect the dedicated storm drainage flow from North Diagonal Way and send the surface water to the Sunken Garden
- Provide understory and tree plantings consistent with the Historic Landscape Preservation Master Plan
- Import or amend soils to provide soils consistent with the requirements of bioretention, tree, and planting areas
- Install irrigation consistent with bioretention, planting, and tree requirements
- Provide underdrains for bioretention, trees, and planting areas where necessary
- Sanitary sewer replacement is not included in the opinion of cost for this project

The Sunken Garden area has ample space for installing treatment facilities within its boundaries. Without regrading the existing topography, the site is somewhat limited in the amount of surface water that can be piped to the area. An opportunity may present itself to reconstruct a section of Cherry Lane SW or Water Street SW where flow from the roadway surface can be conveyed back to the Sunken Garden for treatment and then discharged to the existing drainage system.

Pollution-generating Surface Area Treated / in this project: 7,000 SF

Bioretention Area Required / for this project: 700 SF

Bioretention Capacity / in this project: 4,000 SF (3,300 SF available for future projects)

Sunken Garden

Legend

- Project Boundary
- Pollution Generating Surface to be Treated
- Connection to existing system
- Catch Basin Type 1
- Flow Direction
- Proposed Piping
- SD Storm drains
- Shrub Layer - Historic Landscape Preservation Plan
- Proposed Bioretention Planter
- Proposed Bioretention Cell
- Proposed Tree
- Existing Tree
- Future Tree - Historic Landscape Preservation Plan

Cost Summary

Temporary Erosion Control	$14,000
Demolition	$22,000
Earthwork	$60,000
Storm Drainage Replace broken pipe under Conservatory. Add concrete curbed planters for water quality treatment.	$38,000
Site Paving Replace concrete panels disturbed by utility work.	$16,000
Landscaping Restore to native condition, as shown in Historic Landscape Preservation Plan. Includes native plantings, 9 street trees, new soil, irrigation, sidewalk, and identifies future water quality treatment bioretention area.	$416,000
Total	**$563,000**

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.

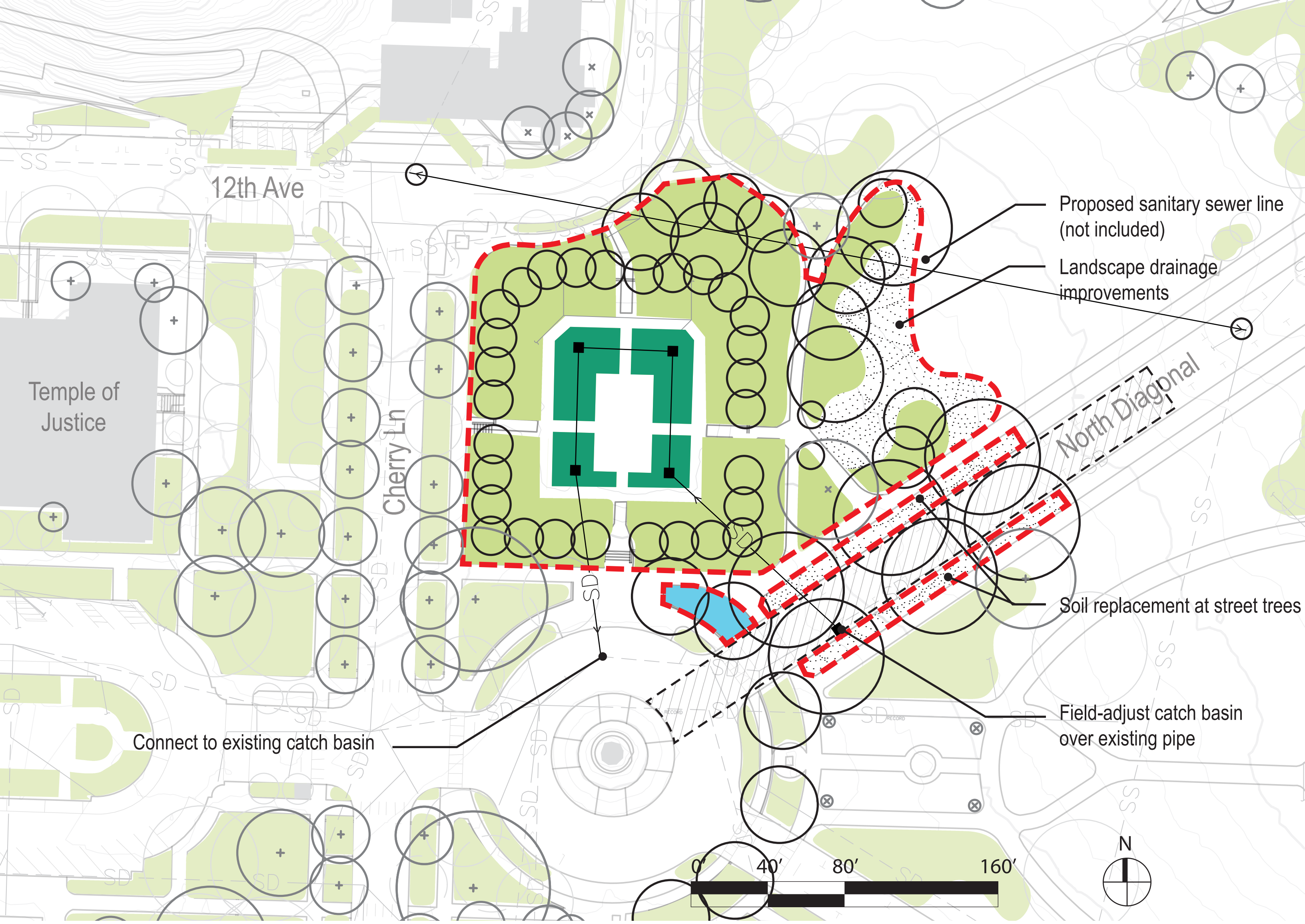


Figure 3-16
Sunken Garden Key Map

Figure 3-17
Sunken Garden, Proposed Development

Pilot Project at 11th Street

Existing Conditions

Figure 3-18
Existing Conditions from Capitol Way South

(Sept. 2009, Source: Mithun)

Overview

The landscape area near the World War II Memorial, at the intersections of 11th Avenue SW, Capitol Way, and North Diagonal presents an opportunity to achieve multiple goals in improving drainage conditions, implementing stormwater quality treatment, and creating a gateway to the West Capitol Campus. The intent is to implement features from the original Olmsted Brothers Landscape Plan as detailed in the Historic Landscape Preservation Master Plan in conjunction with bioretention. The plan calls for the installation of eco-lawn, bioretention cells, native trees, shrubs, and groundcover restoration.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on West Capitol Campus.

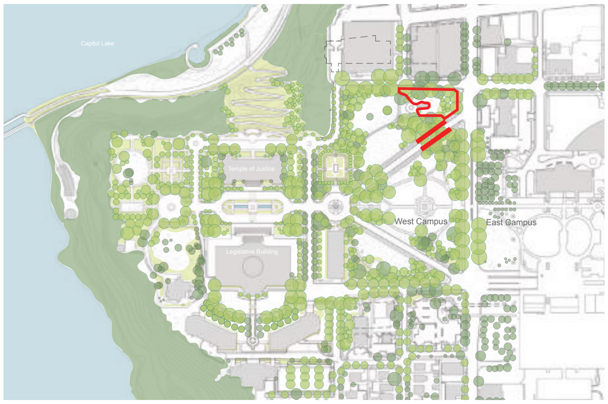
Development Opportunities

This site provides the opportunity to implement a test plot for integrating drainage, irrigation, and landscape planting components in concert. The site would be used to test multiple options and identify effective solutions to implement elsewhere on campus. Great care should be taken to minimize the impacts on the existing trees due to their nature and prestige on campus. The following outlines potential alternatives:

- Remove the upper soil layer (assumed to be 12 to 18 inches deep) and replace it with a mixture that is free-draining and firm soil. An underdrain system would be installed below the new soil mix to capture and convey excess surface water infiltrating through the layer above. The underdrain would be beneficial to both the grass lawn and the tree and shrub plantings. It is anticipated that one or several blends of eco-lawn would be planted in this area to determine the desired aesthetic for the lawn.

- If replacing the upper crust of soil is not desirable, then a more passive approach to the implementation of eco-lawn can be taken. The grounds staff could alter their current maintenance practices in the area to allow for the natural growth of eco-lawn. For this approach, standard mowing intervals would be decreased to allow the vegetation to grow to a desired height. Irrigation timing and quantities would be also decreased to allow the vegetation to go dormant in summer months and during drought conditions.

- Upgrades to the irrigation system within this area could potentially include the replacement of the irrigation main and branch lines. The system could also include the installation of compatible controllers, sensors, and flow monitoring and programming equipment. Sophisticated monitoring capabilities would allow for the grounds crew to quickly diagnose and correct leaks, breaks, and flooding in the lawn area.



Pollution-generating Surface Area Treated / in this project: 8,050 SF

Bioretention Area Required / for this project: 850 SF

Bioretention Capacity / in this project: 1,700 SF (850 SF available for future projects)

Pilot Project at 11th Street

Legend

	Project Boundary
—UD—	Underdrains
— SD —	Storm drains
—	Proposed Piping
	Pollution Generating Surface to be Treated
	Proposed Bioretention Cell
	Ecolawn
	Proposed Tree
+	Existing Tree
	Future Tree - Historic Landscape Preservation Plan

Cost Summary

Temporary Erosion Control	$10,000
Demolition	$30,000
Earthwork	$266,000
Storm Drainage	$43,000
Landscaping	$199,000
Total	$548,000

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.

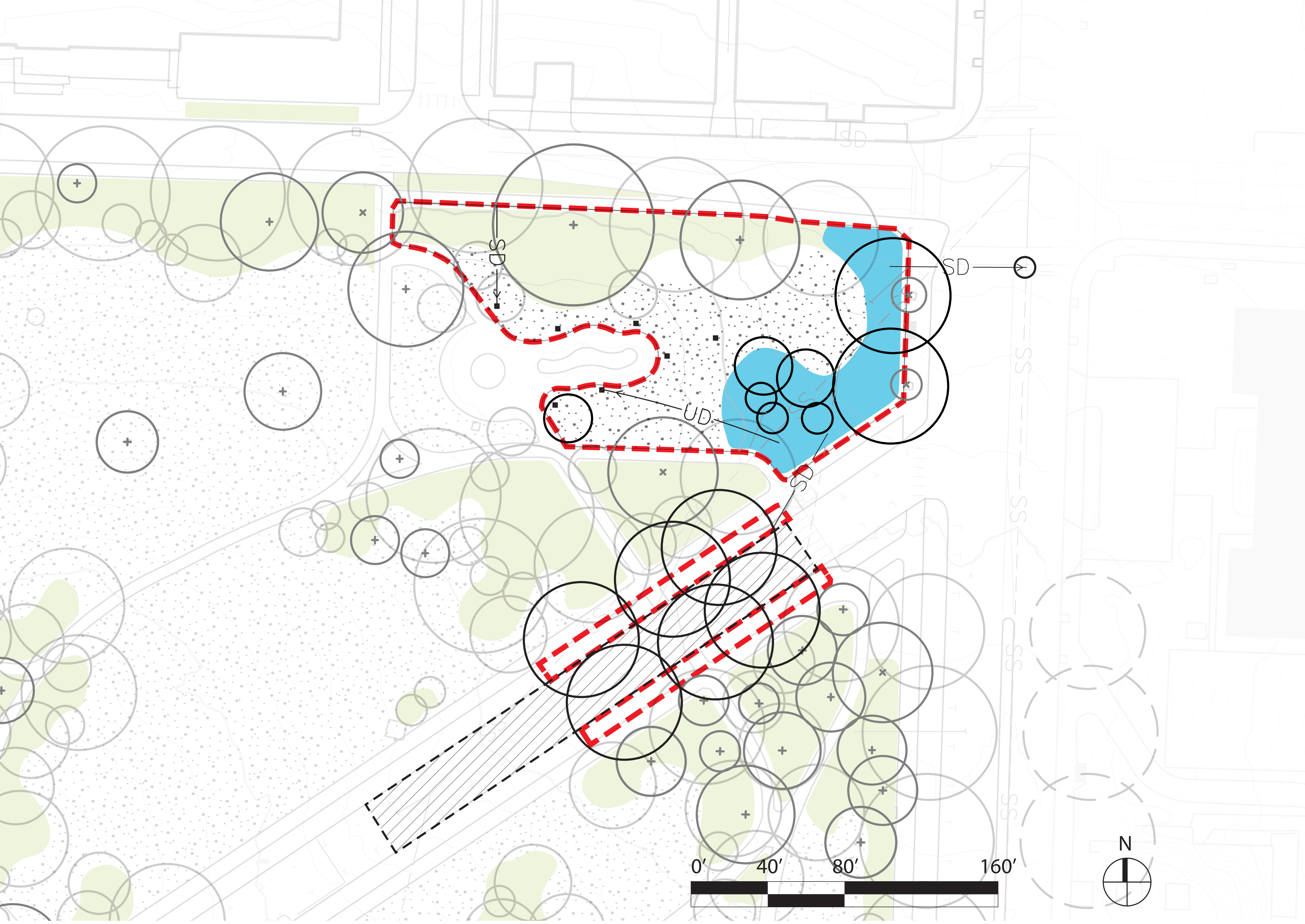


Figure 3-19

Pilot Project Key Map

Figure 3-20

Pilot Project Proposed Development

South Diagonal Storm Main
Existing Conditions

Figure 3-21
View of the Capitol Building from South Diagonal
(Oct. 2009, Source: Mithun)

Overview
The existing storm drainage pipe north of South Diagonal is a corrugated polyethylene pipe with a smooth interior. The West Capitol Campus Inventory, Analysis, and Recommendations for: Potable Water, Storm Drainage, Sanitary Sewer, and Irrigation report identified that this pipe has developed a number of sags along its vertical alignment. The pipe is currently 12 inches in diameter from SD 047 to 046, and then increases in size to 15 inches in diameter between SD 046 and 050. The pipe is generally under a grass landscape area, outside of the hardscape.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on the West Capitol Campus

Development Opportunities

The replacement of the existing main along South Diagonal will provide an opportunity to treat a portion of the runoff from the roadway surface. Because of the existing grading along South Diagonal Way, approximately 60 percent of the pollution-generating impervious surface can be captured and treated along the edge of the street through bioretention cells and planters. The following outlines the recommendations for this opportunity:

- Abandon and replace existing storm sewer pipeline north of South Diagonal Way. Increase size to accommodate current standards for capacity.
- Utilize existing roadway and planter strip topography to provide water quality treatment. A combination of bioretention planters and cells will provide treatment to sections of the roadway.
- Reconstruct sections of the curb and gutter to accommodate surface water flow to the water quality treatment areas.
- Provide understory and tree plantings consistent with the Historic Landscape Preservation Master Plan.
- Replace soil and lawn on the north side of South Diagonal Way to improve drainage and provide an adequate landing for the bus drop-off area, or relocate bus drop-off to another location on campus.
- Import or amend soils to provide soils consistent with the requirements of bioretention, tree, and planting areas.
- Install irrigation consistent with bioretention, planting, and tree requirements.
- Provide underdrains for bioretention, trees, and planting areas where necessary.

The bioretention planter areas along South Diagonal have potential capacity for excess storm drainage treatment; however, with the existing roadway topography, it appears difficult to capture and convey flow off the remaining portion of the street surface. It is anticipated that any future reconstruction project would require treatment for storm runoff from the roadway surface and, at that time, the roadway could be graded in a manner that promotes capturing and conveying flow to treatment facilities.

Pollution-generating Surface Area Treated / in this project: 9,200 SF

Bioretention Area Required / for this project: 920 SF

Bioretention Capacity: 3,000 SF

South Diagonal Storm Main

Legend

- Project Boundary
- Pollution Generating Surface to be Treated
- Connection to existing system
- Catch Basin Type 1
- Proposed Piping
- Shrub Layer - Historic Landscape Preservation Plan
- Proposed Bioretention Planter
- Proposed Bioretention Cell
- Proposed Tree
- Existing Tree
- Future Tree - Historic Landscape Preservation Plan

Cost Summary

Temporary Erosion Control	$22,000
Demolition	$33,000
Earthwork	$42,000
Storm Drainage Replace storm sewers from Capitol Way to Winged Victory Circle. Add concrete curbed planters for water quality treatment.	$183,000
Landscaping New soil, irrigation and plantings from Historic Landscape Preservation Plan includin 23 trees, bioretention areas for water quality treatment, and new soil adjustment to bus drop-off zone to provide more durable lawn surface.	$216,000
Total	**$496,000**

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.

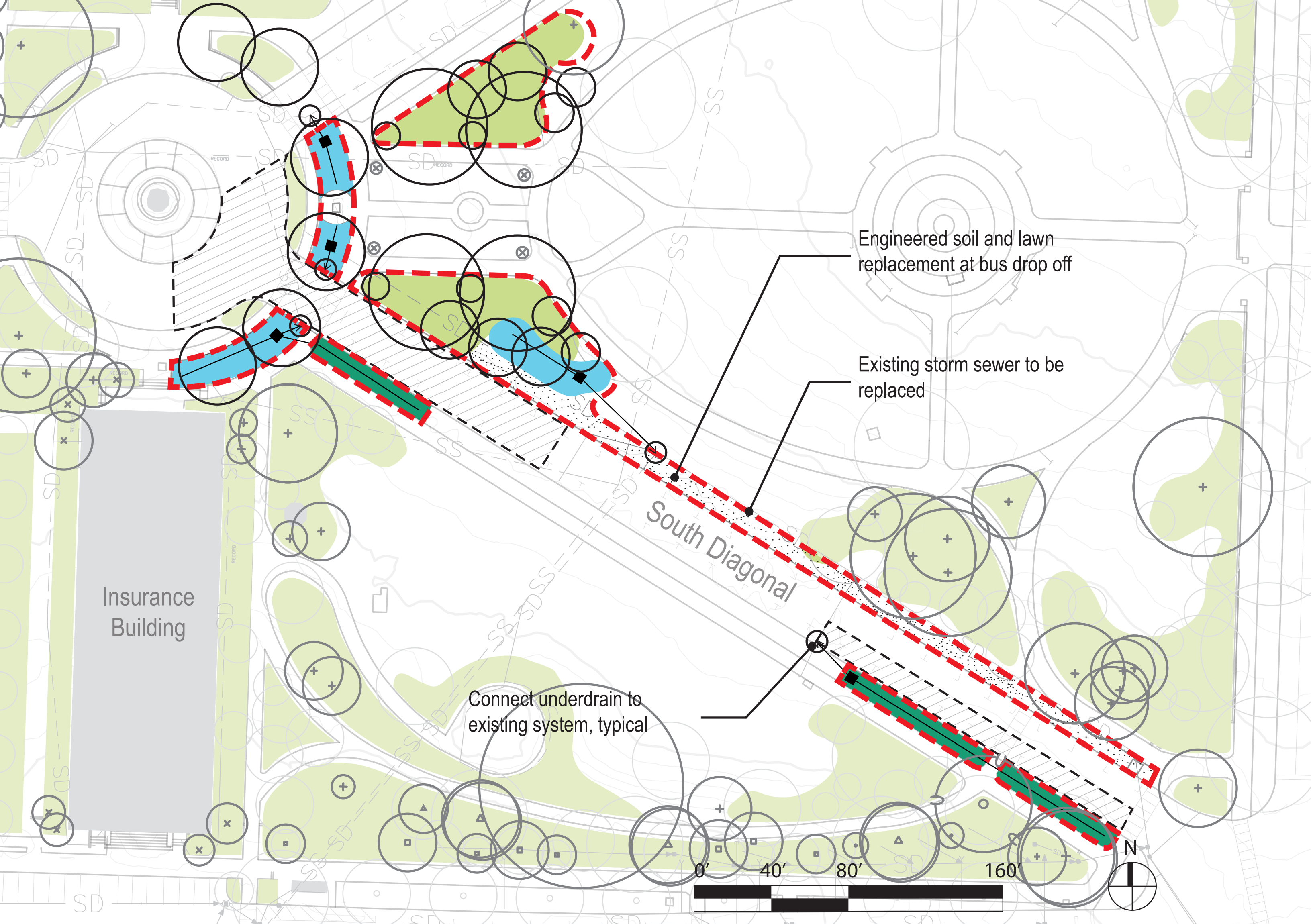


Figure 3-22

South Diagonal Storm Main Key Map

Figure 3-23

South Diagonal Storm Main, Proposed Development

South Portico Parking Lot
Existing Conditions

Figure 3-24
Existing Conditions, South Portico Parking Lot
(Oct. 2009, Source: Mithun)

Overview
The concrete roadway pavement at the south entrance of the Legislative Building is starting to show its age and is in need of replacement in the near future. The recently-completed Sid Snyder Way Underground Utilities and Drainage project completely replaced the existing concrete pavement and installed a bioretention swale that infiltrates the stormwater runoff from the street, trees, and understory in conformance with the Historic Landscape Preservation Master Plan. There is interest in extending this type of redevelopment to the south of the Legislative Building.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on the West Capitol Campus

Development Opportunities

When the existing concrete pavement is replaced south of the Legislative Building, there will be an opportunity to treat surface water through the installation of LID facilities. Due to spatial and aesthetic concerns, it is desirable to install bioretention cells, planters, and catch basin filter units at this location. The conceptual design adjusts the parking stall layout, which would optimize the use of space for water quality treatment. The following outlines the recommendations for this proposal:

- Replace existing pavement surface with new concrete pavement
- Replace existing storm sewer system to accommodate proposed water quality treatment measures and upgrade surface water capacity
- Proposed treatment:

    Center: Regrade pavement to direct flow to north. Utilize bioretention planters directly south of the capitol building to treat surface water.

    West: Regrade pavement to direct flow west. Install catch basin insert to treat surface water.

    East: Regrade pavement to direct flow east. Redevelop grass area near the intersection of Cherry Lane and Sid Snyder Avenue. Install bioretention cells.
- Provide understory and tree plantings consistent with the Historic Landscape Preservation Master Plan
- Import or amend soils to provide soils consistent with the requirements of bioretention, tree, and planting areas
- Install irrigation consistent with bioretention, planting, and tree requirements
- Provide underdrains for bioretention, trees, and planting areas where necessary

Pollution-generating Surface Area Treated / in this project:
30,000 SF

Bioretention Area Required / for this project:
3,000 SF

Bioretention Capacity:
3,100 SF

South Portico Parking Lot

Legend

Project Boundary

Pollution Generating Surface to be Treated

Catch Basin Type 1

Catch Basin Type 2

Proposed Piping

— SD — Storm drains

Shrub Layer - Historic Landscape Preservation Plan

Proposed Bioretention Planter

Proposed Bioretention Cell

Proposed Tree

Existing Tree

Future Tree - Historic Landscape Preservation Plan

Cost Summary

Temporary Erosion Control	$28,000
Demolition	$245,000
Earthwork	$137,000
Storm Drainage Bioretention planters and cells, catch basin inserts, and pipe.	$115,000
Site Paving Vechicular and pedestrian.	$623,000
Landscaping Soil, irrigation and plantings from Historic Preservation Plan including 8 trees.	$170,000
Total	**$1,318,000**

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.

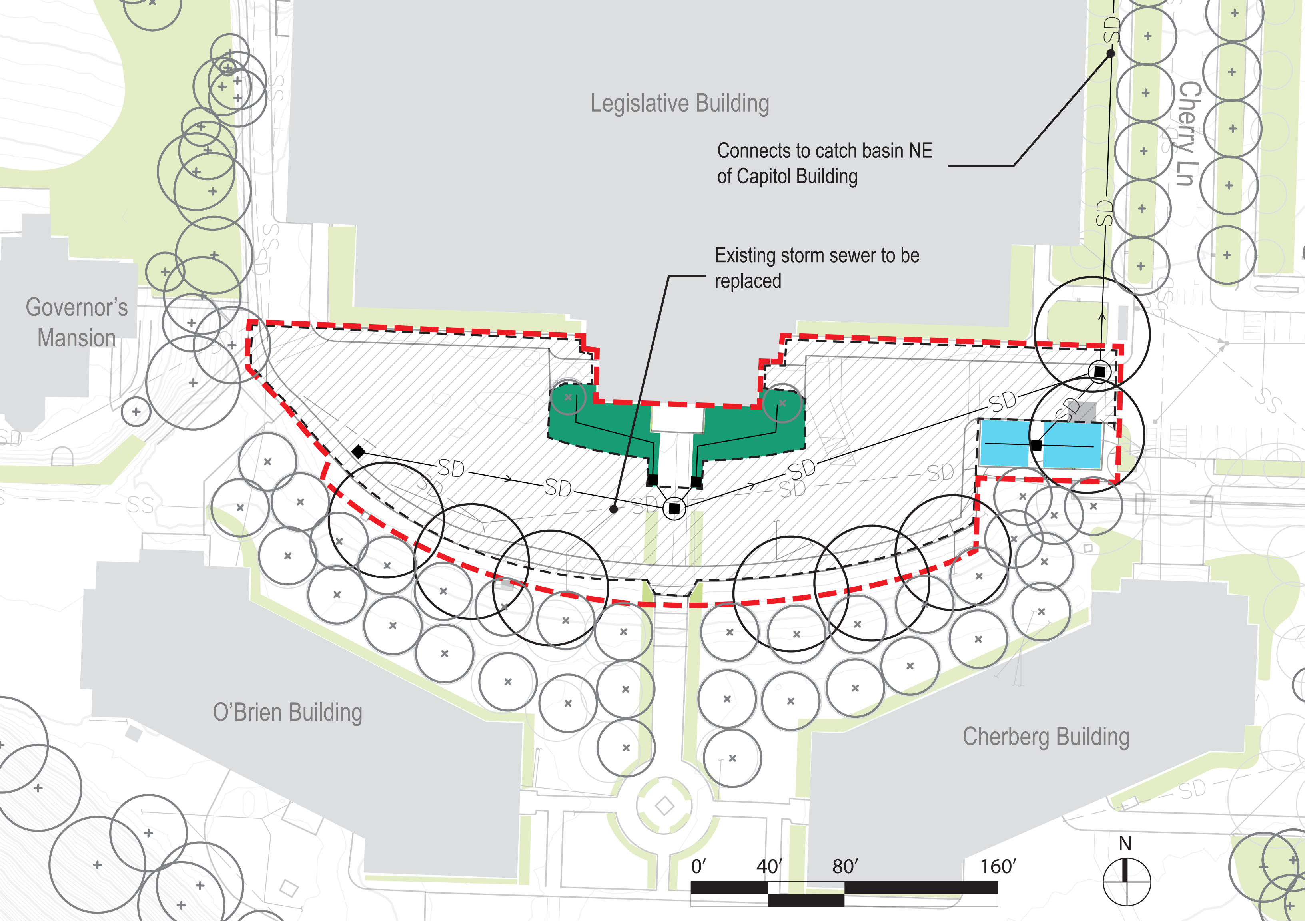
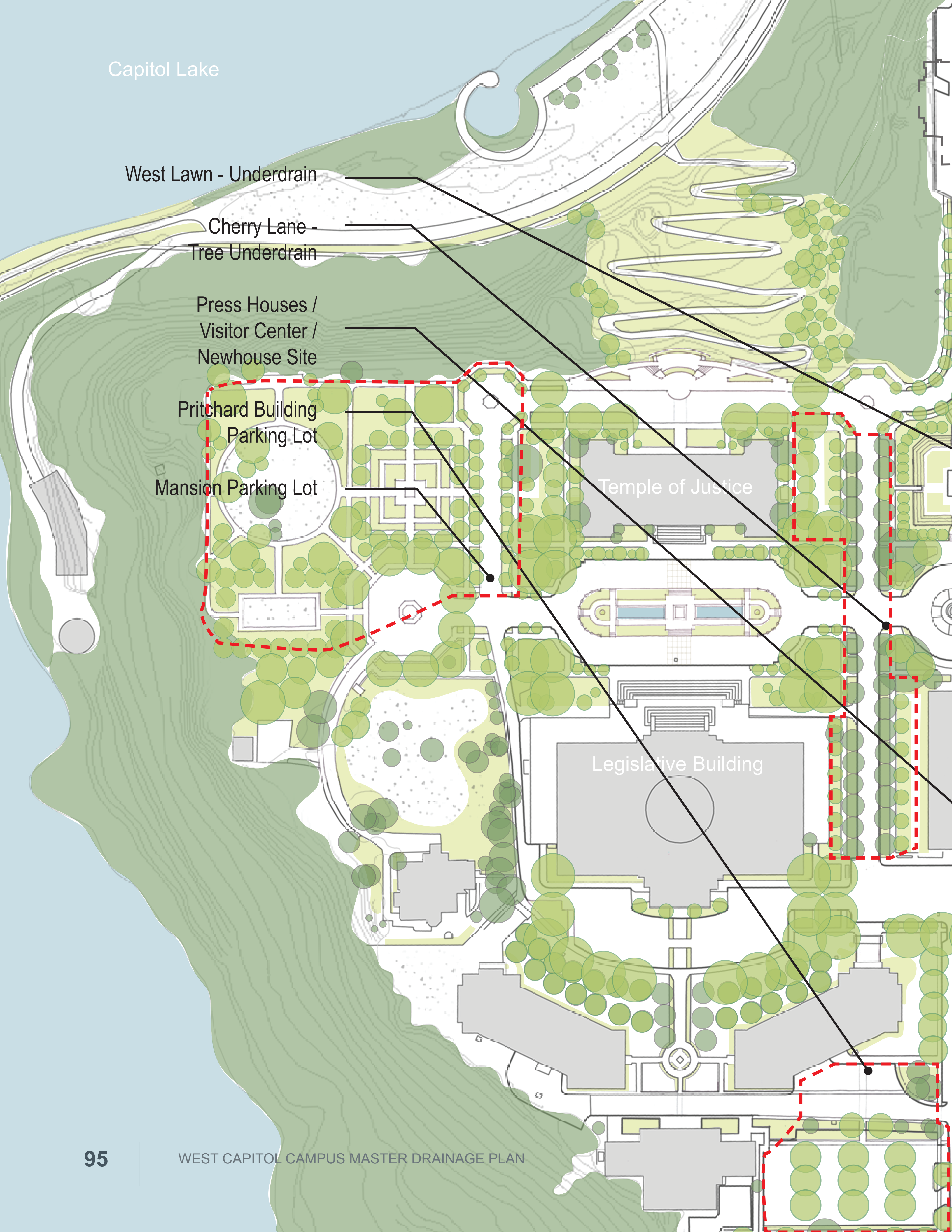


Figure 3-25

South Portico Parking Lot Key Map

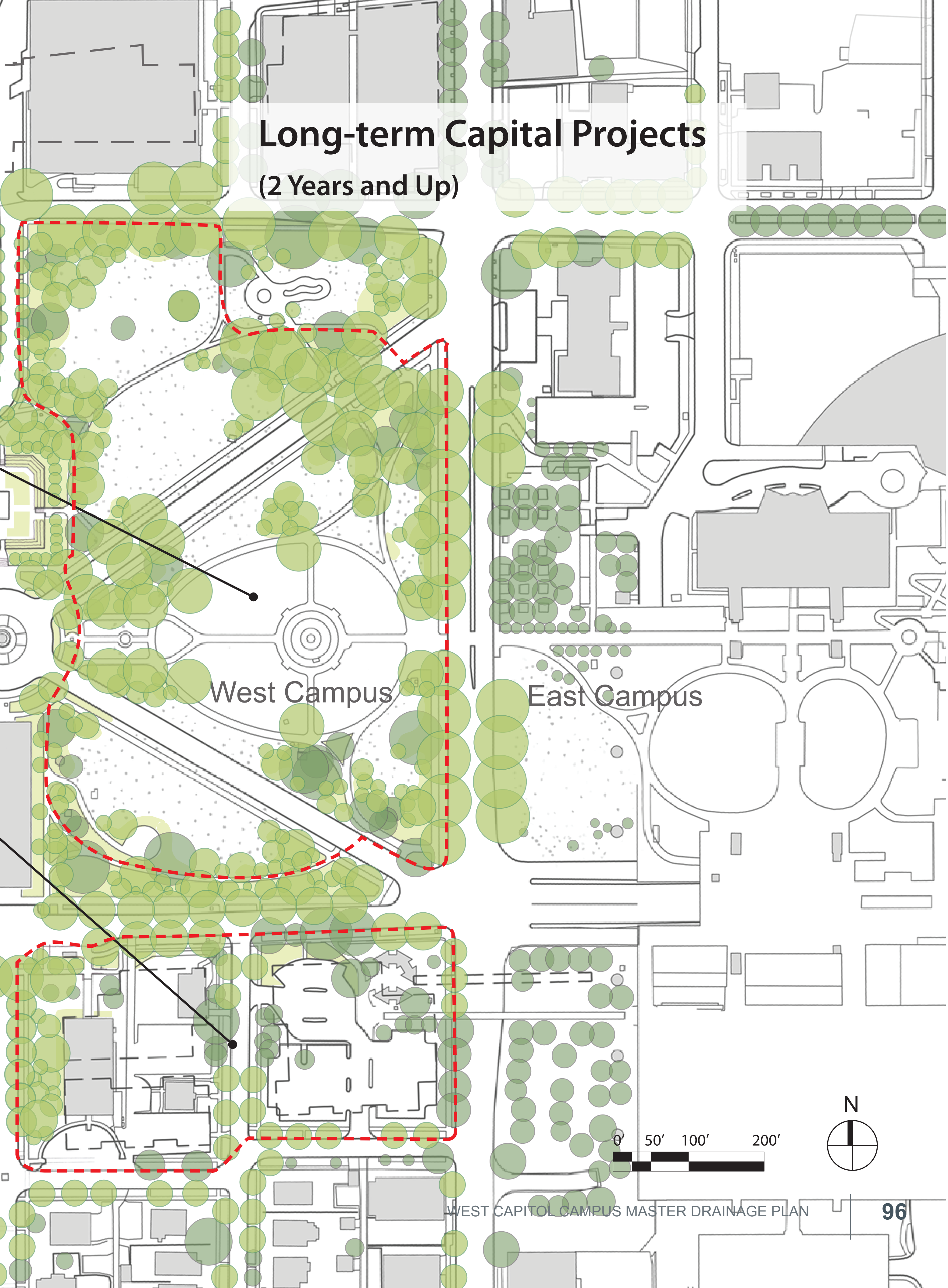
Figure 3-26

South Portico Parking Lot, Proposed Development


Capitol Lake
West Lawn - Underdrain
Cherry Lane -
Tree Underdrain
Press Houses /
Visitor Center /
Newhouse Site
Pritchard Building
Parking Lot
Mansion Parking Lot
Temple of Justice
Legislative Building

Long-term Capital Projects

(2 Years and Up)



West Lawn Underdrain
Existing Conditions

Figure 3-27 : *(previous page)*
Proposed Developments, Long-term Capitol Projects

Figure 3-28
Existing Condition, West Lawn
(Sept. 2009, Source: Mithun)

Overview
The existing lawn entrance into the West Capitol Campus suffers from poor draining soils and a generally flat topography. The west lawn is bounded by Cherry Lane SW (west), Capitol Way S (east), 11th Avenue SW (north), and Sid Snyder Avenue SW (south). The site consists of roughly 10 acres of grass and hardscaping, with a number of large trees dispersed throughout. There are areas in this region of campus that have saturated soils throughout much of the year. The lawn area is used for group gatherings, sporting events (volleyball tournament), weddings, political rallies and other significant life events.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on West Capitol Campus.

Development Opportunities

A goal for the West Capitol Campus Drainage Master Plan is to eliminate or mitigate the effect of saturated soils within the lawn areas. A number of options were discussed for addressing the poor drainage and soils:

- Remove the upper layer (12 to 18 inches) of soil and replace it with a more well-graded/sandier soil mixture.
- Amend existing soil through an annual, incremental top-dressing of the existing lawn with a desired soil mix
- Install underdrains in the locations of known problematic areas.
- For standard lawn areas, passively convert to eco-lawn over time.

The following outlines the conceptual plan to install underdrains beneath the existing lawn area:

- Excavate and install underdrains within the west lawn area
- Underdrains shall be 6-inch-diameter perforated pipe encased in well-graded aggregate and wrapped in geotextile fabric
- Backfill over the underdrains with an amended soil mixture
- Adjust irrigation zone timing as required
- Provide understory plantings in conformance with the Historic Landscape Preservation Master Plan

The strategy of a conversion from standard lawn to eco-lawn would integrate eco-lawn mixes into top-dressed areas of existing lawn to promote species diversity, resulting in a more drought-tolerant landscape that requires less irrigation and maintenance:

- Top-dress existing lawn with desired soil or compost mix
- Integrate eco-lawn mix into existing lawn area
- Establish and maintain eco-lawn at a height and irrigation level to conserve resources while balancing public use needs.

West Lawn Underdrain

Legend

	Project Boundary
	Proposed Pilot Project Boundary
—UD—	Underdrains
— SD —	Storm drains
	Connection to existing system
	Flow Direction
	Proposed Piping
	Eco-Lawn
	Shrub Layer - Historic Landscape Preservation Plan
	Existing Tree
	Future Tree - Historic Landscape Preservation Plan
	Catch Basin Type 1

Cost Summary

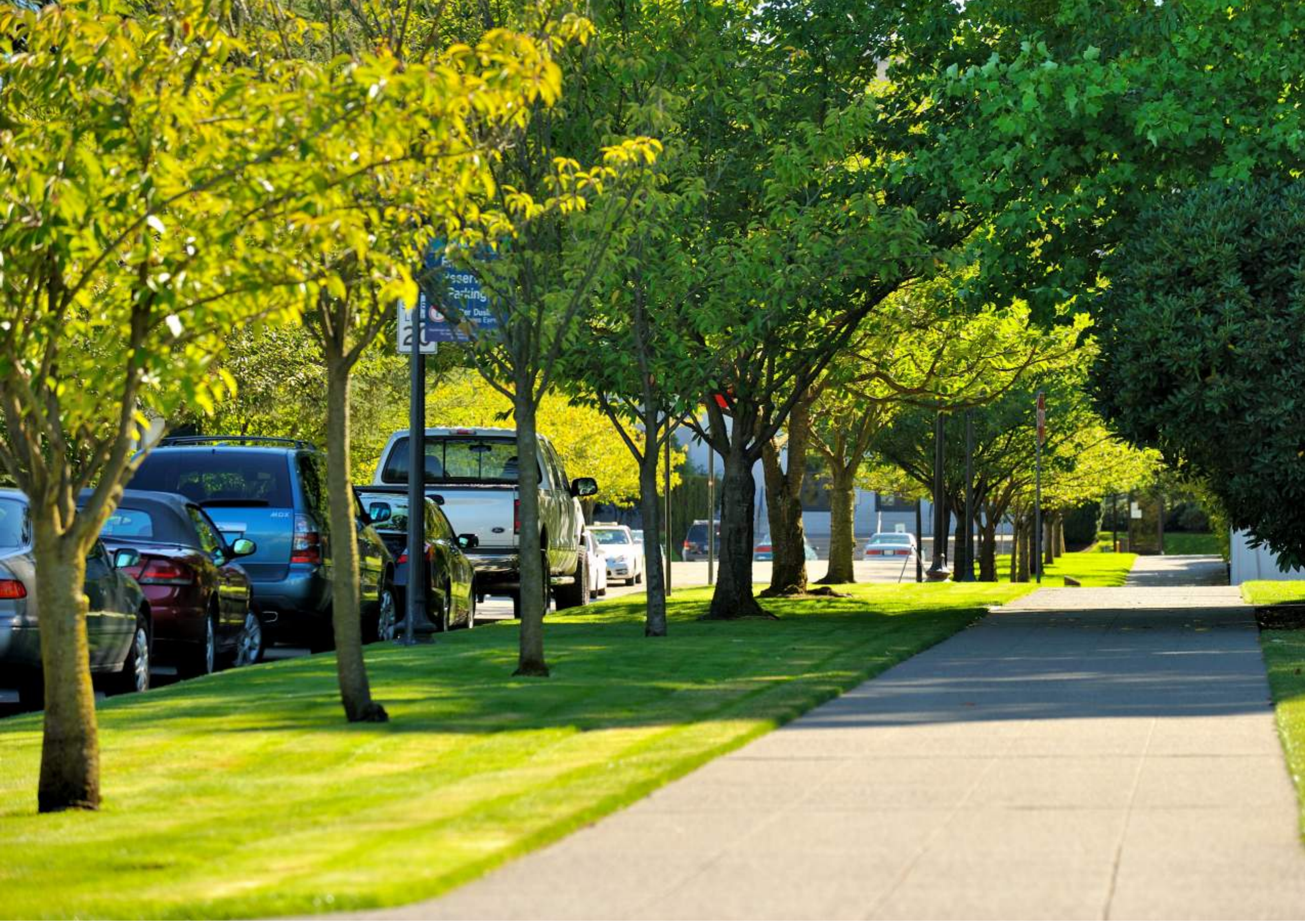
Temporary Erosion Control	$22,000
Demolition	$10,000
Earthwork	$61,000
Storm Drainage	$490,000
Landscaping Restore to native condition, as shown in Historic Landscape Preservation Plan. Includes native plantings, 9 street trees, new soil, irrigation, sidewalk, and identifies future water quality treatment bioretention area.	$144,000
Total	**$727,000**

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.

Figure 3-29
West Lawn Underdrain Key Map

Figure 3-30
West Lawn Underdrain, Proposed Development

* at a different scale than other projects



Cherry Lane Tree Underdrain

Existing Conditions

Figure 3-31

Existing Conditions, Cherry Lane

(Sept. 2009, Source: Mithun)

Overview

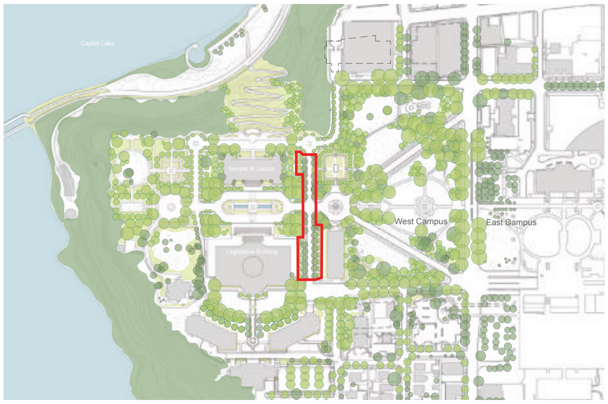
Cherry Lane provides an aesthetically pleasing ancillary roadway for both pedestrians and motorists. Unfortunately, the soil conditions in the upper layer of the landscape strip are very poor and commonly saturated. This has had an adverse effect on the health of the cherry trees lining the roadway. Many of the original trees have been replaced and DES is no longer planting replacements due to poor conditions.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on West Capitol Campus.

Development Opportunities

An option for resolving the drainage issues encountered along Cherry Lane is to replace all of the cherry trees and install an underdrain below the root zone. Replace the existing soils with an amended soil mixture to promote better growth and allow surface water to pass through the soil and discharge to an underdrain system. The following outlines the conceptual plan to install underdrain beneath the street trees:

- Remove all existing trees along Cherry Lane
- Excavate and install underdrains below the street trees
- Underdrains shall be 6-inch-diameter perforated pipe encased in well-graded aggregate and wrapped in geotextile fabric
- Backfill over the underdrains with an amended soil mixture
- Replace existing storm sewer system below Cherry Lane SW to accommodate peak storm events
- Provide native trees, shrubs, and groundcover restoration in conformance with the Historic Landscape Preservation Master Plan. The original trees intended in this allée are the native Pacific dogwood. Because of the susceptible nature of these trees to disease, it is not recommended to replace the cherry trees with the native Pacific dogwood as was intended per the Historic Landscape Preservation Master Plan but instead with a less susceptible hybrid.
- Plant a second row of trees alongside the new proposed row of Pacific dogwoods, per the Historic Landscape Preservation Master Plan, on both sides of the roadway
- Install irrigation consistent with planting and tree requirements



Cherry Lane Tree Underdrain

Legend

- Project Boundary
- Connection to existing system
- Proposed Piping
- Shrub Layer - Historic Landscape Preservation Plan
- Proposed Tree
- Existing Tree
- Future Tree - Historic Landscape Preservation Plan
- —UD— Underdrains

Cost Summary

Temporary Erosion Control	$9,000
Demolition	$22,000
Earthwork	$14,000
Storm Drainage	$100,000
Landscaping Restore to native condition, as shown in Historic Landscape Preservation Plan. Includes native plantings, 9 street trees, new soil, irrigation, sidewalk, and identifies future water quality treatment bioretention area.	$325,000
Total	**$470,000**

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.

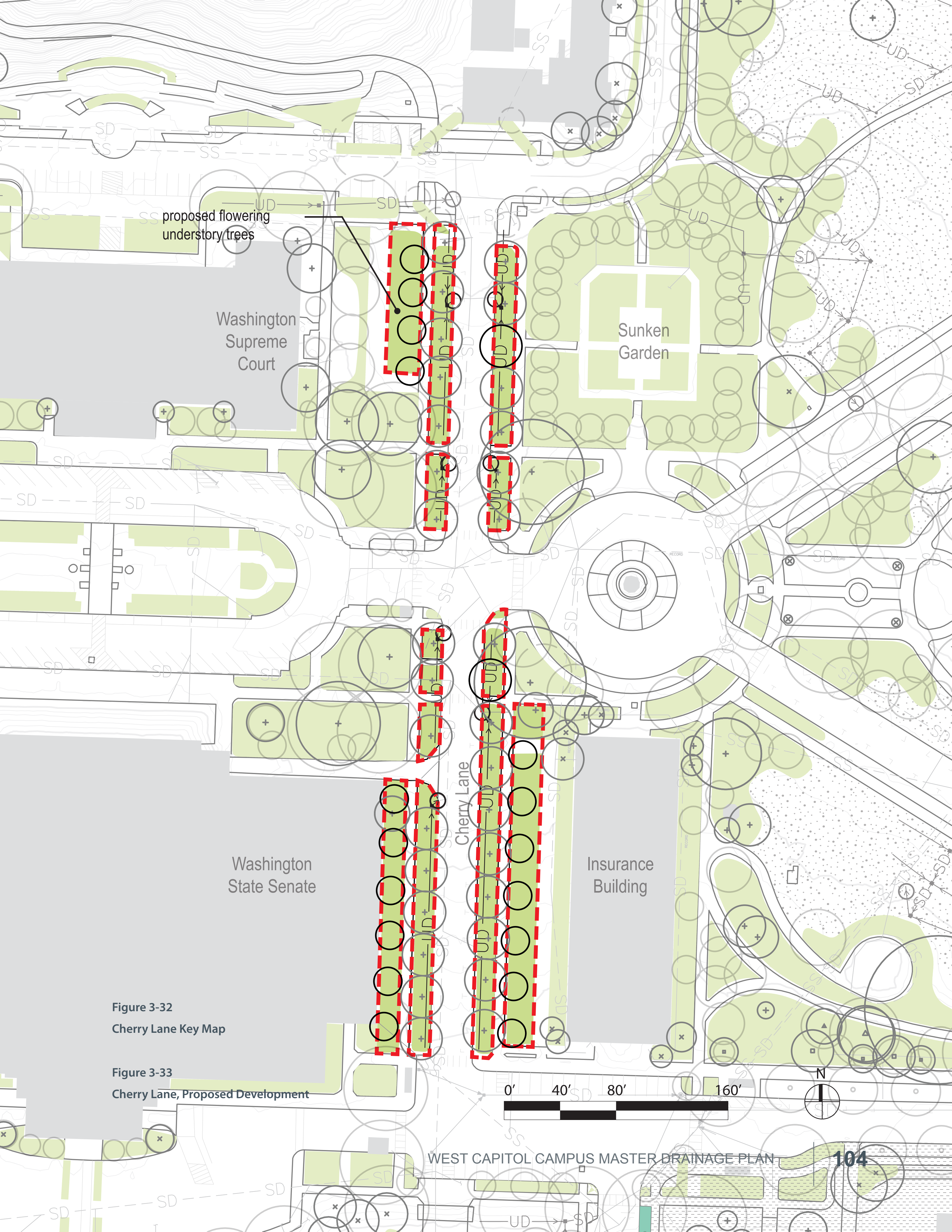


Figure 3-32
Cherry Lane Key Map

Figure 3-33
Cherry Lane, Proposed Development

Press Houses / Visitor Center / Newhouse Site
Existing Conditions

Figure 3-34
View of the Visitor Center from the Pedestrian Bridge

(Sept. 2009, Source: Mithun)

Overview

This site consists of 3.5 acres of prime redevelopment space on the West Capitol Campus. The site includes the Visitor Center, two former residences, and a paved parking lot. Columbia Street SW bisects the site and provides access between 15th Avenue SW and Sid Snyder Avenue SW. The visitor's center was constructed in 1981 as a "temporary" building and is situated at the southwest corner of Sid Snyder Avenue SW and Capitol Way S. The former residences were built in 1921 and 1937. In 2001, these buildings were deemed eligible for the National Register of Historic Places as a contributing element to the existing State Capitol Historic District.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on West Capitol Campus.

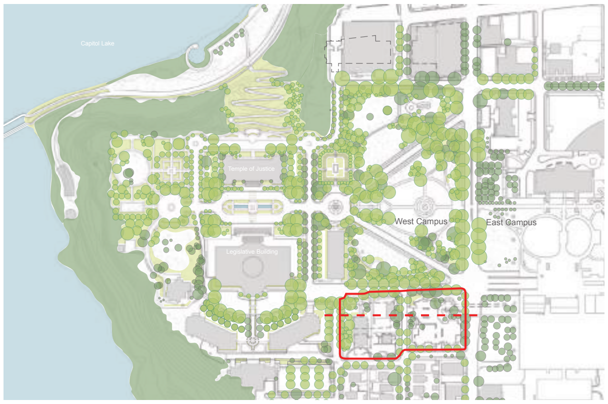
Development Opportunities

Surface water is currently discharged to the combined sewer system at this site; however, it is desirable to reroute flow from the combined sewer and direct flow to the dedicated stormwater system. To reroute the flow from the site, it is recommended that the redevelopment of the site include flow control facilities to mitigate the loading on the existing storm drainage system.

A storm main was installed that crossed under Sid Snyder Avenue, when the street was redeveloped in 2014. A catch basin was installed south of the intersection of Sid Snyder Avenue and Columbia Street SW, and a 12-inch diameter pipe was extended beneath Sid Snyder Avenue and capped near the bioretention facilities. The future redevelopment needs to connect to the catch basin and the capped end north of Sid Snyder Avenue. The main will need to be extended and connected to the existing storm drainage system north of South Diagonal.

The redevelopment of the site should take into account the impacts on the residential community and historic character of the neighborhood. Transitioning softer landscape features to the residences and neighborhood south of 15th Avenue SW is recommended. A projected impervious surface quantity of 0.75 acre was used in sizing the stormwater flow control and water quality facilities for the site. At this time, a preferred redevelopment action has not been selected.

Depending on the final grading of the site, the street-edge bioretention planters may or may not be able to capture storm runoff from pollutant-generating impervious areas within the project limits due to site topography. Some trading of pollutant-generating impervious areas within the adjacent streets may need to be considered for this redevelopment project.



Pollution-generating Surface Area Treated / in this project:
44,000 SF

Bioretention Area Required / in this project: 4,400 SF

Bioretention Capacity:
4,400 SF

Press Houses / Visitor Center / Newhouse Site

Legend

Project Boundary

— SD — Storm drains

Pollution Generating Surface to be Treated

Shrub Layer - Historic Landscape Preservation Plan

Proposed Bioretention Planter

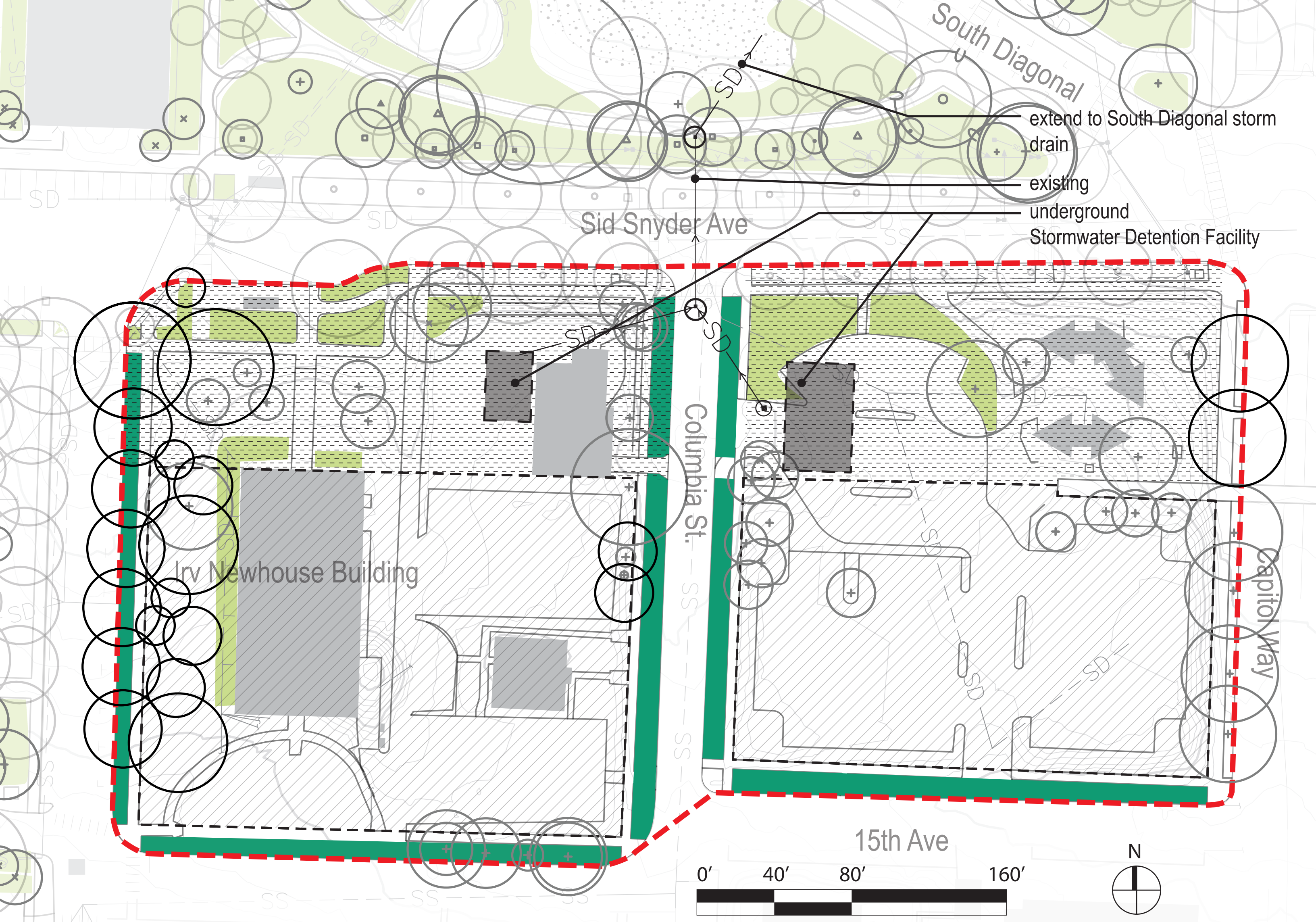
Catch Basin Type 2

Proposed Open Space, identified in Historic Landscape Preservation Plan, aligned with Pritchard Building

Proposed Tree

Existing Tree

Future Tree - Historic Landscape Preservation Plan



*Opinion of probable construction costs can vary based on the scope (to be determined).

Figure 3-35
Press Houses / Visitor Center / Newhouse Key Map

Figure 3-36
Press Houses / Visitor Center / Newhouse, Proposed Development

Pritchard Building Parking Lot

Existing Conditions

Figure 3-37

Cherberg Building from Parking Lot

(Sept. 2009, Source: Mithun)

Overview

The lot east of the Pritchard building consists of asphalt pavement surfacing for parking. The site is roughly three-quarters of an acre. An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on the West Capitol Campus.

Development Opportunities

The desired alternative for this site is to construct a below-grade parking structure with landscaping at the surface. This option will conform to the Historic Landscape Preservation Master Plan by adding trees and other landscape features. Parking on the West Capitol Campus is somewhat limited and not aesthetically pleasing. By designing and constructing a below-grade parking facility, parking would be removed from primary civic gathering spaces of the campus, which could then be enhanced by landscape or architectural features. The following outlines drainage options should the area see redevelopment as a below-grade parking structure:

- Reconfigure parking layout adjacent to the Cherberg Building and 15th Avenue for additional open space and water quality treatment area
- Install a storm sewer system to collect and convey runoff to the water quality treatment site and size to meet capacity needs
- Provide plantings consistent with the Historic Landscape Preservation Master Plan
- Import or amend soils to provide soils consistent with the requirements of bioretention, tree, and planting areas
- Install irrigation consistent with bioretention, planting, and tree requirements
- Provide underdrains for bioretention, trees, and planting areas where necessary

The majority of the surface water flow from the parking lot is currently discharged to the combined sewer system. It is desirable to reroute flow from the combined sewer to the dedicated stormwater system for this project. To reroute the flow from the site, it is recommended that the redevelopment of the site includes flow control facilities to mitigate the loading on the existing storm drainage system. An assumed quantity of impervious and pervious surfacing was used to size the stormwater flow control and water quality facilities for this site.

Pritchard Building Parking Lot

Legend

Project Boundary

—UD— Underdrains

— SD — Storm drains

Connection to existing system

Catch Basin Type 1

Catch Basin Type 2

Flow Direction

Proposed Piping

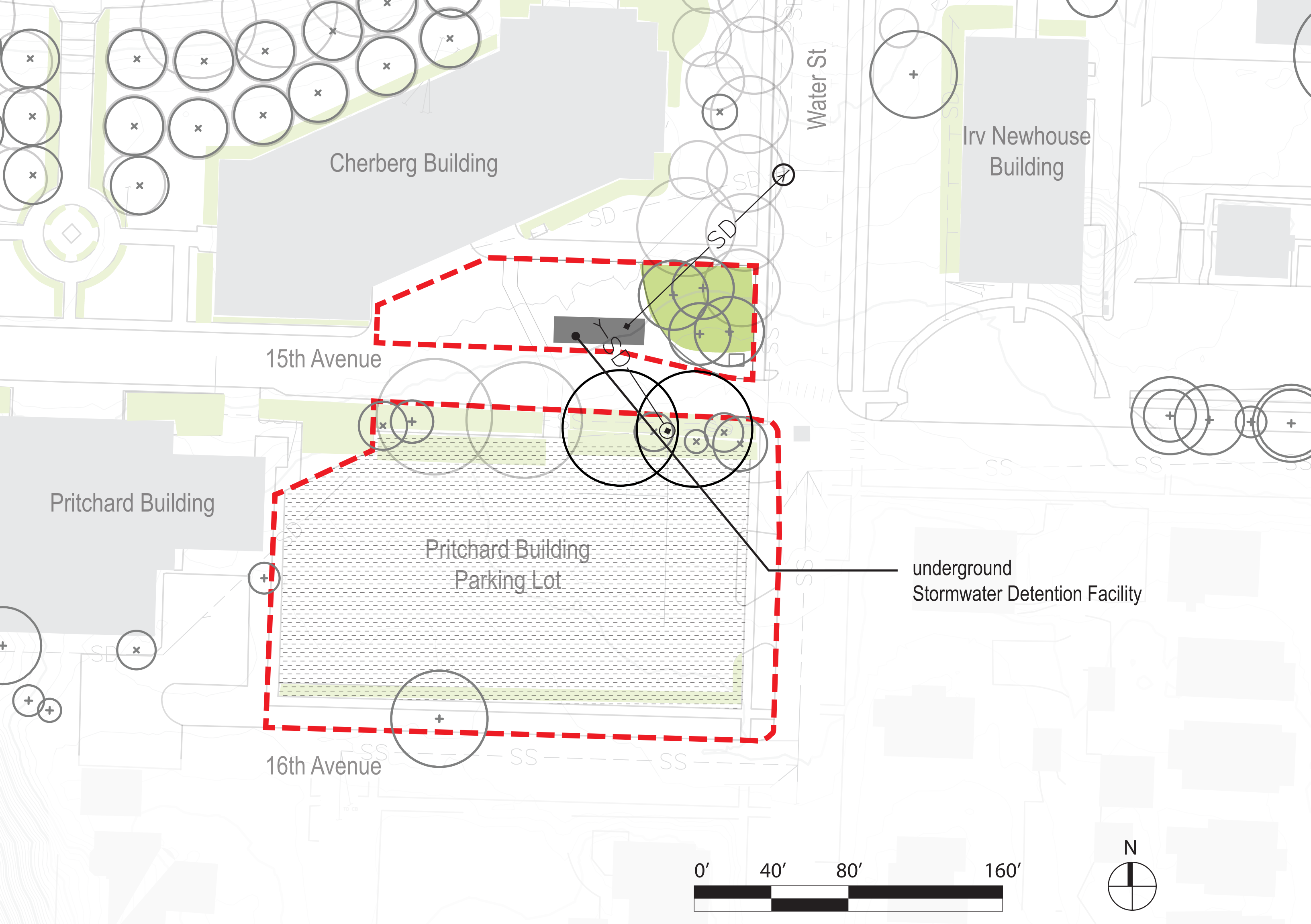
Shrub Layer -
Historic Landscape Preservation Plan

Proposed Open Space

Proposed Tree

Existing Tree

Future Tree -
Historic Landscape Preservation Plan



*Opinion of probable construction costs can vary based on the scope (to be determined).

Figure 3-38
Pritchard Building Parking Lot Key Map
Figure 3-39
Pritchard Building Parking Lot, Proposed Development

Mansion Parking Lot
Existing Conditions

Figure 3-40
Existing Condition, Mansion Parking Lot

(Sept. 2009, Source: Mithun)

Overview
Paradoxically, Mansion Parking Lot is the largest consolidation of parking on the campus and is located in the most ecologically sensitive areas of campus and furthest from a major road. The approximately 2.5-acre parking lot sits at the western edge of the campus on top of the bluff above Capitol Lake. The slope, along the western and northern edge, has a moderate risk for shallow slope failures according to the 2010 Hillside Evaluation and Preliminary Design by Golder Associates. There are several utilities below the pavement area, including storm drainage lines, natural gas, sanitary sewer, communications lines, power,

chilled water supply and return, and the utilidor tunnel running to the Powerhouse. The utilidor contains steam, condensate, power, communications, and potable water lines. At the time of the geotechnical exploration, there were no observed cracks or settlement activities that were perceived as related to slope instability in the area.

According to the Master Plan, the Mansion Parking Lot was originally intended to be the location of the permanent Governor's mansion. In the Olmsted Brothers Landscape Plan for the campus, the area was planned to include a formal garden, symmetrical to the Sunken Garden. The Olmsted Brothers Landscape Plan was never fully implemented and the garden was eventually filled in, served as a helipad, and then converted into a parking lot.

An initial assessment of infrastructure, soils, planting, and irrigation was used to develop the following recommendations for the conceptual plan. This integrated approach should continue during future design, construction, and maintenance to ensure the best possible management of the natural and cultural resources on the West Capitol Campus.

Development Opportunities

The Historic Landscape Preservation Master Plan proposes to transform this area into a series of formal and informal gardens, pathways, open spaces, and viewpoints. This area of campus offers the opportunity to capture some of the best viewpoints. Any future redevelopment of this section of the West Capitol Campus, it should take advantage of the untapped visual resources at the site and accommodate access to this civic and democratic landscape for an increasing population.

The existing parking lot area is bounded by a native edge along the north and west sides. The long-term plan for this region of the campus is to redevelop the site in conformance with the Historic Landscape Preservation Master Plan. The redevelopment of the property will require offloading parking to other sites on or near the campus, and relocating the maintenance building and storage area currently at the south of the parking lot. It is anticipated that the redevelopment would require a staged approach over a number of years.

Without redeveloping and regrading the existing parking area, there are limited short-term options for treating stormwater runoff from the parking lot. One interim option would augment the planting island located in the southwest section of the lot with additional planting islands throughout the parking lot, removing or reconfiguring parking and installing bioretention planters. Parking removed to make way for these bioretention planters would be relocated where the planting island was vacated. Water quality treatment is minimized based on the need to retain parking stalls. For optimal treatment of the existing lot, a number of parking stalls would need to be removed or relocated to make room for adequate treatment area.

A viable option for treating stormwater and restablishing the historic landscape in this area is to replace parking along Pleasant Lane with bioretention planters and to reconfigure the intersection of Pleasant Lane and 12th Avenue to match the historic intent of the Historic Landscape Preservation Master Plan.

Pollution-generating Surface Area Treated / in this project:
8,050 SF

Bioretention Area Required / for this project: 805 SF

Bioretention Capacity:
5,600 SF (4,795 SF available for future projects)

Mansion Parking Lot

Legend

Project Boundary

Shrub Layer - Historic Landscape Preservation Plan

Proposed Bioretention Planter

Proposed Open Space

Proposed Tree

Existing Tree

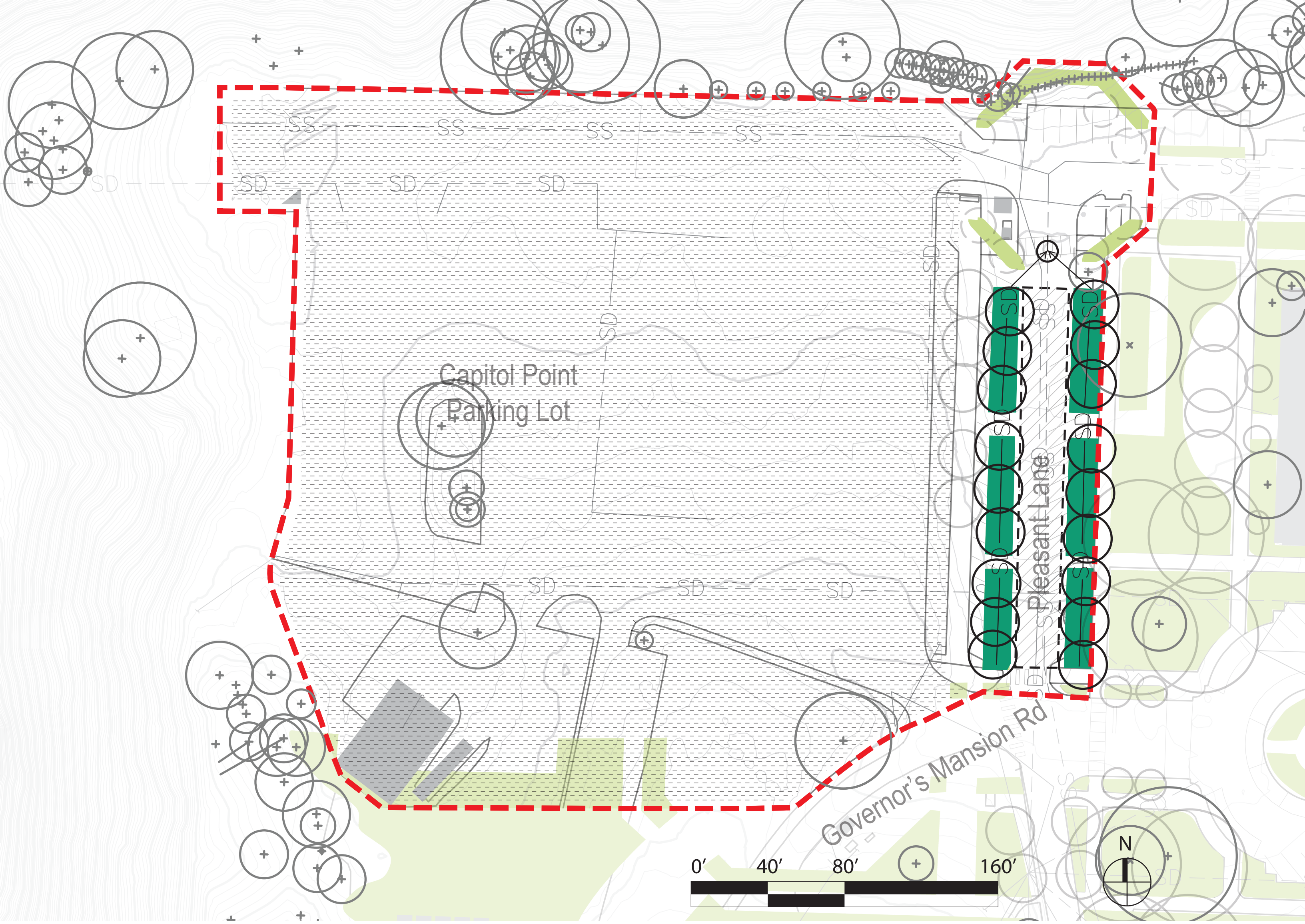
Future Tree - Historic Landscape Preservation Plan

Pollution Generating Surface to be Treated

Cost Summary

Temporary Erosion Control	$17,000
Demolition	$95,000
Earthwork	$19,000
Storm Drainage	$65,000
Landscaping	$187,000
Total	$383,000

Note: The cost figures listed above contain a design and construction contingency, general conditions, and general contractor's overhead and profit markup. The costs do not include sales tax and other soft costs such as design, permitting, and construction assistance.



The following outlines the recommendations from this conceptual plan:

- Remove parking along the east and west sides of Pleasant Lane and replace areas with bioretention planters
- Redevelop the intersection of Pleasant Lane and 12th Avenue to the configuration outlined in the Historic Landscape Preservation Master Plan
- Provide plantings consistent with the Historic Landscape Preservation Master Plan
- Import or amend soils to provide soils consistent with the requirements of bioretention, tree, and planting areas
- Install irrigation consistent with bioretention, planting, and tree requirements
- Provide underdrains for bioretention, trees, and planting areas where necessary

Figure 3-41
Mansion Parking Lot Key Map

Figure 3-42
Mansion Parking Lot, Proposed Development

Capital Impacts

Figure 3-43:
Tivoli Fountain

(Sept. 2009, Source: Mithun)

The opinions of costs presented in the proposed development worksheets, Appendix F, are based on the general master planning-level concepts. A number of factors that may affect the actual costs of the projects, such as labor and material costs, competitive market conditions at bidding, detailed utility and topographic surveys, schedule, final project scope, and other variables unknown at this time.

The understanding of site-specific conditions for each project is limited to the planning-level stage of design; therefore, each project cost contains a 30-percent design and a 10-percent construction contingency. Also included in the estimates are an 8-percent additive for general conditions and a 12-percent markup for the general contractor's overhead and profit for each project. The opinion of probable construction costs does not include soft costs, such as design, permitting, and construction administration. Table 1-7 identifies the Engineer's Opinion of Probable Construction Costs for the redevelopment projects.

Table 1-7: Capital Improvement Projects.
Opinion of Probable Construction Costs

	No.	Description	Cost Estimate
	1	South Portico Parking Lot	$ 1,318,000.00
	2	South Diagonal	$ 496,000.00
	3	Sunken Garden	$ 566,000.00
	4	Capitol Conservatory Site	$ 704,000.00
	5	West Lawn - Underdrain	$ 727,000.00
	6	Cherry Lane - Tree Underdrain	$ 542,880.00
	7	Prichard Building Parking Lot	NA
	8	Press Houses/Visitor Center/Newhouse Site	NA
*	9	Mansion Parking Lot	$ 389,220.00
*	10	Pilot Project at 11th Street	$ 551,850.00

* Estimates for drainage, stormwater management, and landscape only. Other site improvements and building constructions are not included.

An engineer's opinion of costs was not included for the sections of the existing system that are potentially over capacity. At this time, none of the upgrades to the existing system are scheduled in an upcoming biennium capital improvements project. It is assumed that upgrades to the system will be performed with upcoming roadway or other redevelopment projects.

Consideration of the capital impacts of proposed or future developments should take into account the cost comparison between using a status quo grey infrastructure approach and a low impact development, green infrastructure approach. Although grey infrastructure is less expensive than green infrastructure up front, over the lifespan of the project, green infrastructure can be more cost effective. It is also important to recognize the external costs of grey infrastructure which are in turn transferred to the general population or the environment. Some externalities which should be considered include: replacing aging infrastructure in the future, downstream pipe sizing, impacts on flora and fauna due to water quality impairments, impacts on local and regional economies reliant on water resources, etc.

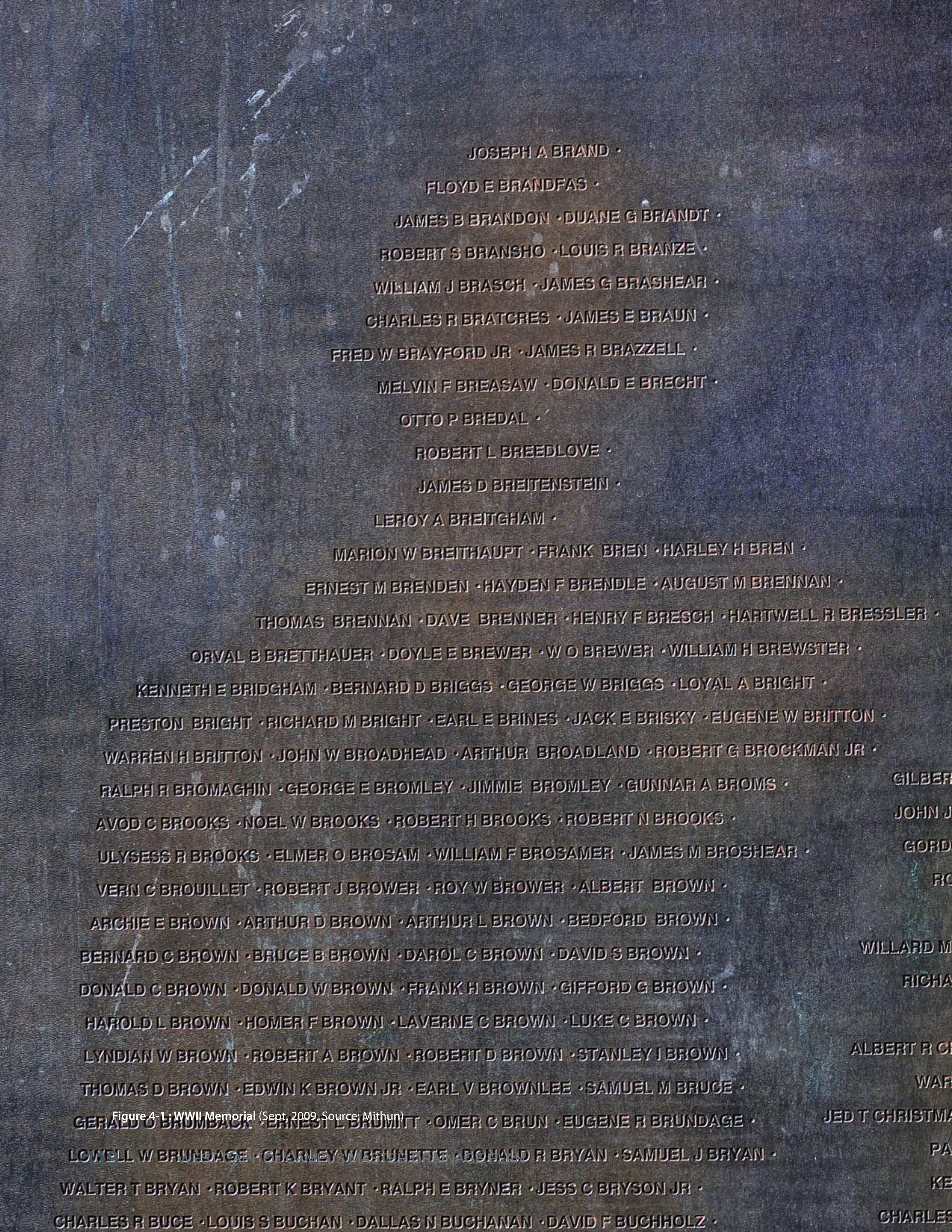


Figure 4-1 : WWII Memorial (Sept, 2009, Source: Mithun)

LIMITATIONS, UNCERTAINTIES, AND FUTURE WORK

Gaps in existing data were identified during the development of the Drainage Master Plan. Conducting the following studies to fill these information gaps will support improved outcomes and efficient use of funds when approaching specific design plans.

- Utility Master Plan
- Irrigation system performance
- Mapping extent of existing tree roots
- Parking relocation and reduction strategy

Drainage System Maintenance & Monitoring

Figure 4-2
Bioretention Cell at **Sid Snyder Way**

(June 2015, Source: Mithun)

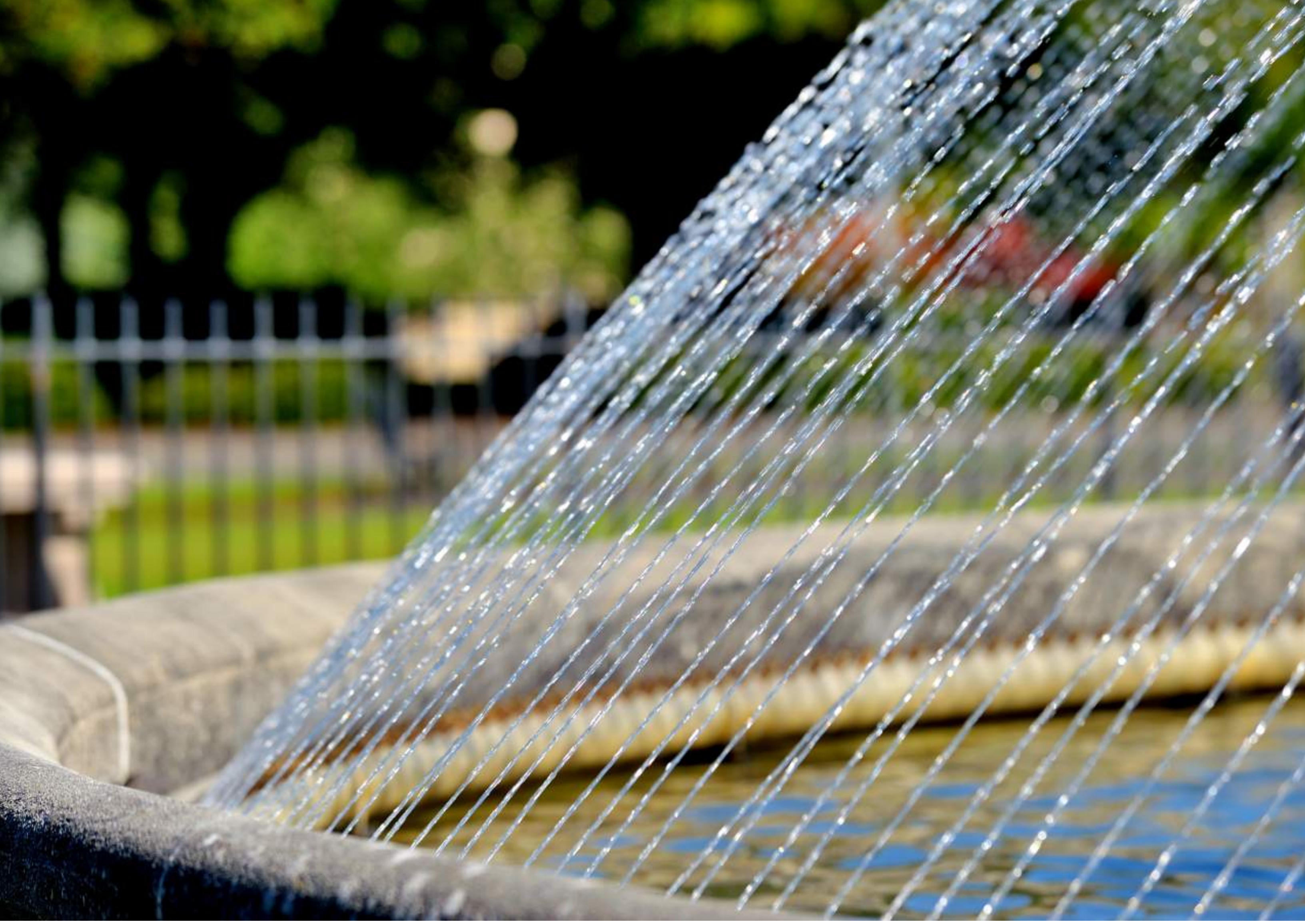
General

Stormwater is generated when precipitation from rain or snowmelt flows over land. Runoff occurs when the water flow does not percolate into the surface, either at impervious or poorly-draining pervious layers. Stormwater monitoring intends to characterize runoff at limited but representative locations, which allows for the analysis of loadings and water quality variations over time. Periodic stormwater sampling at designated locations is necessary to fulfill the NPDES permit requirements.

Implementation

The stormwater management plan in place does not currently violate NPDES permit requirements; however, the plan should be revised as new and redevelopment projects occur on campus. Drainage improvements at the West Capitol Campus are a long-term effort that will be achieved project by project. Additionally, the improvement projects in this master plan will not resolve all drainage issues, now or in the future, on campus. It is recommended that water quality treatment and conveyance improvements be conducted as part of future roadway reconstruction, parking lot repairs, or other redevelopment projects.

It is also recommended that the Capitol Campus Stormwater Management Plan be updated periodically to keep up with the evolving campus drainage system and to comply with NPDES permit requirements.



Utility Master Plan

Figure 4-3
Tivoli Fountain Detail

(Sept. 2009, Source: Mithun)

Overview

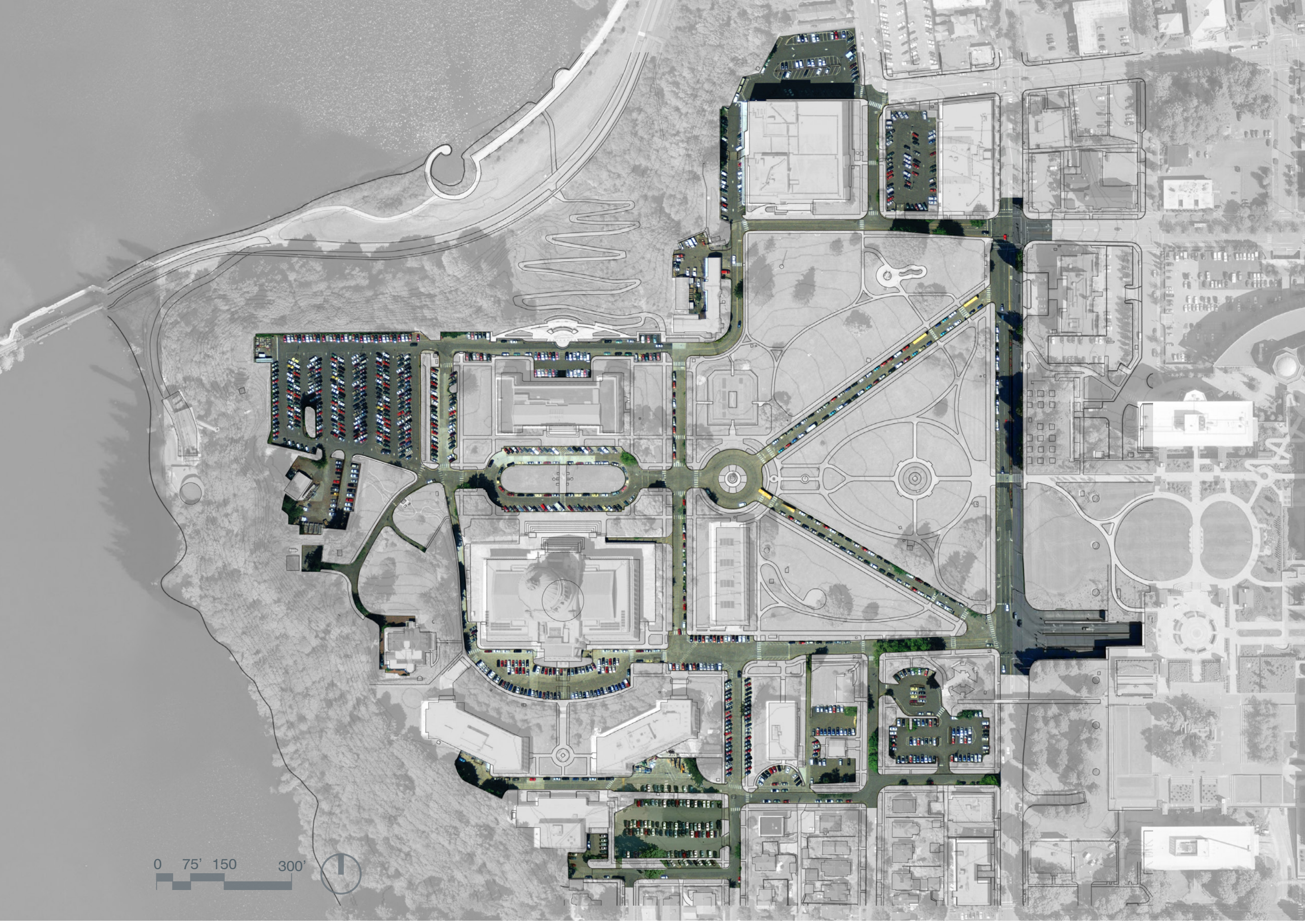
The West Capitol Campus Inventory, Analysis, and Recommendations for: Potable Water, Storm Drainage, Sanitary Sewer, and Irrigation was developed in 2009. The plan outlined a number of deficiencies in the existing utility systems and identified measures to replace or rehabilitate the facilities on campus. Over time, a number of the deficient facilities have been improved, while others are scheduled as part of future development or redevelopment projects. It is recommended that an update to this original plan be conducted to physically reassess the existing facilities and provide new recommendations, based on current conditions of the facilities. The Utility Master Plan should include water, sanitary sewer, power, gas, and communication facilities. The Utility Master Plan should not include surface water management.

Implementation

The proposed new and redevelopment projects will significantly expand the present building footprint on site. An updated utility master plan must be flexible and incremental to adapt to available budgetary resources for the campus. The existing utility systems are well maintained, but it is anticipated that parts of the distribution systems are approaching maximum capacity and exceeding their intended capabilities. The following tasks should be reviewed as part of this plan:

- Existing Conditions Evaluation
- Future Conditions Evaluation
- Alternative Analysis
- Recommended Strategy and Implementation Plan

The updated plan should conform to the latest jurisdictional standards and regulations. These items may have impacts on the sizing of facilities and load requirements. Additionally, the plan should institute standards on siting and provide evaluation criteria for new development and redevelopment projects. Projects shall minimize potential impacts on cultural resources, natural resources, and visual aesthetics in developing new infrastructure on the West Capitol Campus.



Strategy for Parking Relocation and Reduction of Pollution Generating Surfaces

Figure 4-4
Existing Campus aerial with parking and vehicular circulation areas highlighted

The largest parking and vehicular circulation area is located adjacent to the most ecologically sensitive portion of the Campus.

(Mar. 2009, Source: Mithun)

The 2006 Master Plan, the Historic Landscape Preservation Master Plan, and this document all recognize the role parking plays in the function of the campus. Each plan provided a goal for the study, planning, and reduction of vehicular parking on the campus, along with improving infrastructure for bike and pedestrian traffic.

A campus-wide goal is to gradually reduce and eventually eliminate the majority of dedicated surface parking lots and redevelop the property to better serve people and visitors. By removing impervious asphalt and concrete surfacing, invaluable green space and architectural features can be utilized for water quality treatment, public and civic gatherings and showcase the beauty that the West Capitol Campus has to offer the region. It is anticipated that redevelopment projects will include landscape features in conformance with the Historic Preservation Landscape Master Plan.

Proposed parking reduction strategies:

- Include additional parking capacity with future redevelopment projects outside of prominent areas of the campus. Strategically remove parking stalls elsewhere on site.
- Accelerate commute reduction and telework strategies
- Boost bike and pedestrian infrastructure investments
- Attrition (do not replace parking when spaces are eliminated from a redevelopment project)

Non-point source pollution from parking lots is the major contributor to unhealthy waters, affecting aquatic species, people, and the larger ecological system. An interim solution is to adaptively design the existing parking lots by providing LID strategies, such as bioretention swales or carbon filters, to remove and treat the heavy metals and toxins from car brake linings and vehicle oil leaks.

The northwest corner of the West Capitol Campus is a rare and beautiful location that is being encroached upon by the largest concentration of surface parking, maintenance, and service activities. This area is situated along the edge of the bluff that overlooks Capitol Lake to the west and Puget Sound and the Cascade Mountain Range to the north. Without developing additional parking elsewhere on site or nearby, however, it is difficult to implement water quality treatment due to the existing topography. The introduction of interim drainage solutions must be addressed comprehensively to achieve an effective solution.

Performance Benchmarking

Figure 4-5
Capitol Lake and Washington State Legislative Building

(Sept. 2009, Source: Mithun)

Performance benchmarking existing infrastructure provides an avenue to keep sites accountable for their downstream impacts on the surrounding ecosystem. DES is currently evaluating a number of appropriate processes for the Capitol Campus. The following certifications are recommended for consideration.

The Sustainable Site Initiative (SITES) is a national rating tool for landscape performance. It was developed through extensive cross-disciplinary evaluation of best management practices. The tool is designed to be aligned with LEED standards, streamlining the process for projects to target both LEED and SITES certifications. SITES is administered by the Green Building Certification Institute (GBCI), which also serves as the third-party to LEED. As of 2015, 46 projects have reached pilot certification nationwide. SITES Operations + Maintenance can be used as a stand alone guide for best management practices.

http://www.sustainablesites.org

SalmonSafe is a regional certification program that aims to transform land management practices to lessen their impacts on salmon. SalmonSafe addresses similar soil quality, stormwater management, and vegetation issues as SITES. This organization targets both urban and agricultural settings throughout the West Coast range of Pacific salmon.

http://www.salmonsafe.org

Figure 4-6
Heritage Tree

(Source: Mithun)

CONCLUSION

This drainage master plan addresses the deficiencies in the existing drainage system, reviews opportunities to separate runoff from the combined sewer system, evaluates LID strategies, outlines irrigation needs and requirements, proposes drainage improvements to landscape and conveyance systems, and discusses adherence to the Historic Preservation Landscape Master Plan. From the findings developed in this report, it is recommended that the current stormwater management plan be updated, a master site plan created, and a Stormwater Pollution Prevention Plan (SWPPP) developed, providing staff with current guidelines for operations, maintenance, and pollution prevention for stormwater facilities. These resources will promote the informed development of the proposed projects outlined in the report.

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LIST OF APPENDIX FIGURES

SEE INSERT AT END OF DOCUMENT

APPENDIX A : DEFINITIONS

Bioretention

Shallow depressions receiving stormwater from contributing areas, with plants and a soil mix designed to treat stormwater and promote healthy growth of plants. A variety of plants are used in bioretention cells, including trees, shrubs, grasses, and other plants. Bioretention cells may or may not provide stormwater infiltration and are not designed as a part of a conveyance system.

Bioretention Planter

Incorporate the same design features as a bioretention cell; however, bioretention planters possess an impervious reservoir (e.g., concrete, clay, or ultraviolet resistant geo-membrane liners). These may be designed as a stand-alone element or as part of a conveyance system.

Bioretention Swales

Incorporate the same function and design features as bioretention cells; however, bioretention swales are designed as a part of a conveyance system and have relatively gentle side slopes and flow depths.

Catch Basin Insert

A retrofit to an existing catch basin, designed to capture sediment, debris, and oils.

Cistern

An above or below ground storage facility used for storage and potential reuse of stormwater.

Combined Sewer

A type of sewer system that collects and conveys sewage waste and surface runoff through a common pipe system.

Conveyance

A mechanism for transporting water from one point to another, including pipes, ditches, and channels.

Design Rainstorm

A rainfall event, defined by storm frequency and storm duration, used to design drainage structures and/or conveyance facilities.

Detention basin

An impoundment structure designed to reduce peak runoff flow rates by retaining a portion of the runoff during periods of peak flow and then releasing the runoff at lower flow rates.

Drainage

Is the collection, conveyance, containment, and/or discharge of surface water runoff.

Drainage basin

A geographic and hydrologic subunit of a watershed. Areas are typically defined by topographic and drainage features.

Eco-Lawn

A blend of grass seeds designed as a replacement for standard turf applications. This mix of low-growing grasses is an alternative for grassy areas and requires less maintenance, less fertilization, and less watering than typical grass mixes.

Landscape Irrigation BMP

Irrigation strategies that are economical, practical, and sustainable, which will maintain a healthy, functional landscape without exceeding the minimum water requirements of the plants or the maximum water allowance where applicable.

Permeable Pavement

A surface paving alternative designed to allow water to permeate through voids in the material or through joints in the case of pavers.

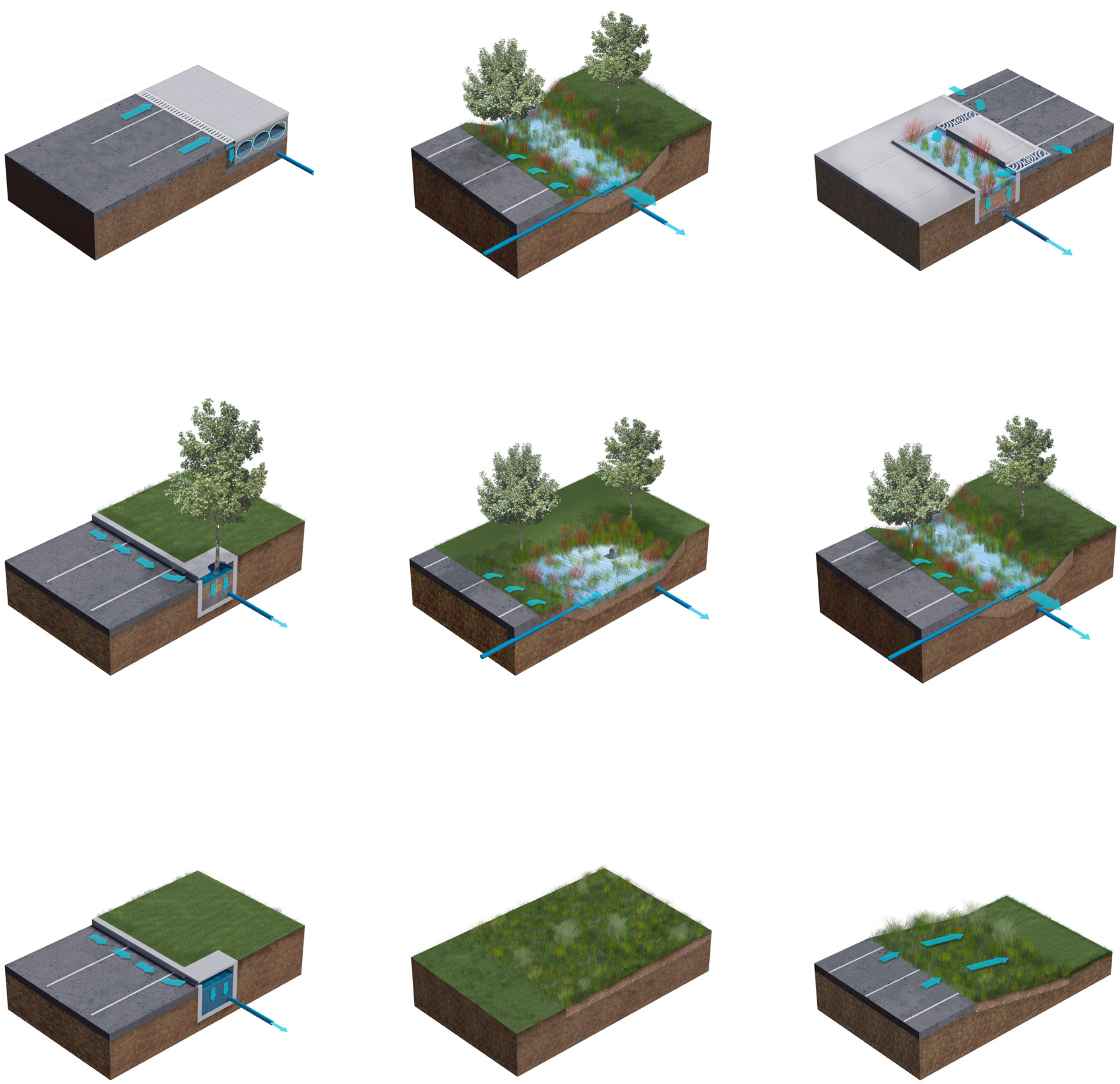
Predeveloped Condition

The native vegetation and soils that existed prior to the Euro-American settlement. The pre-developed condition shall be assumed to be a forested land cover unless reasonable, historic information is provided that indicates the site was prairie prior to settlement.

Rational Method	A means of computing storm drainage flow rates (Q) by the use of the Rational Method formula Q = CIA, where C is a coefficient describing the physical drainage area, I is the rainfall intensity, and A is the defined area.
Redevelopment	A conversion of an existing development to another type of land use.
Storm frequency	The time interval between major storms of predetermined intensity and volumes of runoff, based on historic data collection and forecasting. Storm frequency is typically expressed in years, such as a 2-year, 10-year, or 100-year storm.
Threshold Discharge Area	An onsite area draining to a single natural discharge location, or multiple natural discharge locations that combines within one-quarter mile downstream (as determined by the shortest flow path).
Treatment Facility	A BMP that intends to remove pollutants from surface water.
Tree Box Filter	In-ground containers used to treat water quality as well as provide detention capacity through the integration of a designed soil mix and vegetation.
Vegetated Filter Strip	A sloped area populated with dense vegetation designed to treat water draining as sheet flow from adjacent polluting surfaces.
Watershed	A geographic region within which water drains into a body of water.
Water table	The upper surface of the saturated portion of the soil layer.
Waterbody	Surface waters that include rivers, streams, lakes, marine waters, estuaries, and wetlands.

APPENDIX B:

WATER QUALITY & LID STRATEGIES



General

It is recommended that a combination of grey and green infrastructure strategies be implemented on campus to improve drainage conditions and to best manage stormwater runoff. There are many opportunities for the implementation of LID strategies on campus as projects arise or infrastructure is replaced. LID strategies aim to treat and manage stormwater runoff using natural processes that mimic the hydrological functionality of predevelopment conditions. However, the historic and cultural character of the State Capitol requires a very specific landscape aesthetic and not all LIDs will be successful, either functionally or aesthetically, in this setting. Additionally, a tree root assessment should be conducted prior to the selection of the desired LID strategy. It is important to recognize that tree roots extend well beyond the drip line. The following are water quality and LID strategies that are applicable for future developments within the West Capitol Campus.

Figure 5-1
L.I.D. Toolkit

(Source: Mithun)

Bioretention Cell

Overview

Bioretention cells are engineered landscape depressions with plantings and a designed soil mixture used to filter and treat runoff. Bioretention cells receive water from contributing hardscape and softscape areas. In addition to water quality treatment, bioretention features also reduce runoff rates during storm events by slowing down the flow and allowing it to disperse at more natural rates. Due to the site's poor infiltration rate and the priority of bluff stability, it is recommended that all bioretention features include underdrain systems.

Special consideration should be taken with bioretention constructed with imported compost materials within one-quarter mile of phosphorus-sensitive waterbodies such as Capitol Lake. This requirement is included in Ecology's 2012 SMMWW document, which may be adopted as part of the update to the Drainage Design and Erosion Control manual for the City. Alternative enhancements or measures may be required for a bioretention installation within one-quarter mile of Capitol Lake in the future.

Application

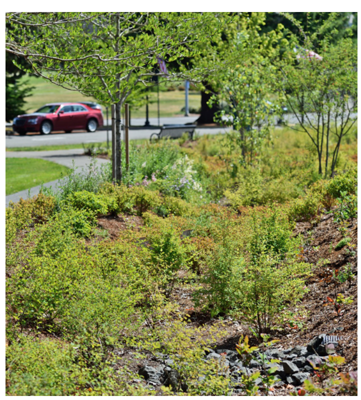
Bioretention cells have a low shrub and grass aesthetic that supports the goals and vision of the Historic Landscape Preservation Plan. The implementation of bioretention cells should be designed and planted to complement the layout proposed in the Historic Preservation Master Plan. The application of bioretention cells should be limited to existing or proposed areas of understory planting beds.

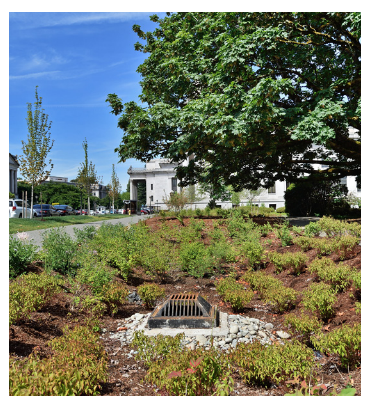
For more information on bioretention cells, please refer to the SMMWW and the Low Impact Development Technical Guidance Manual for Puget Sound.

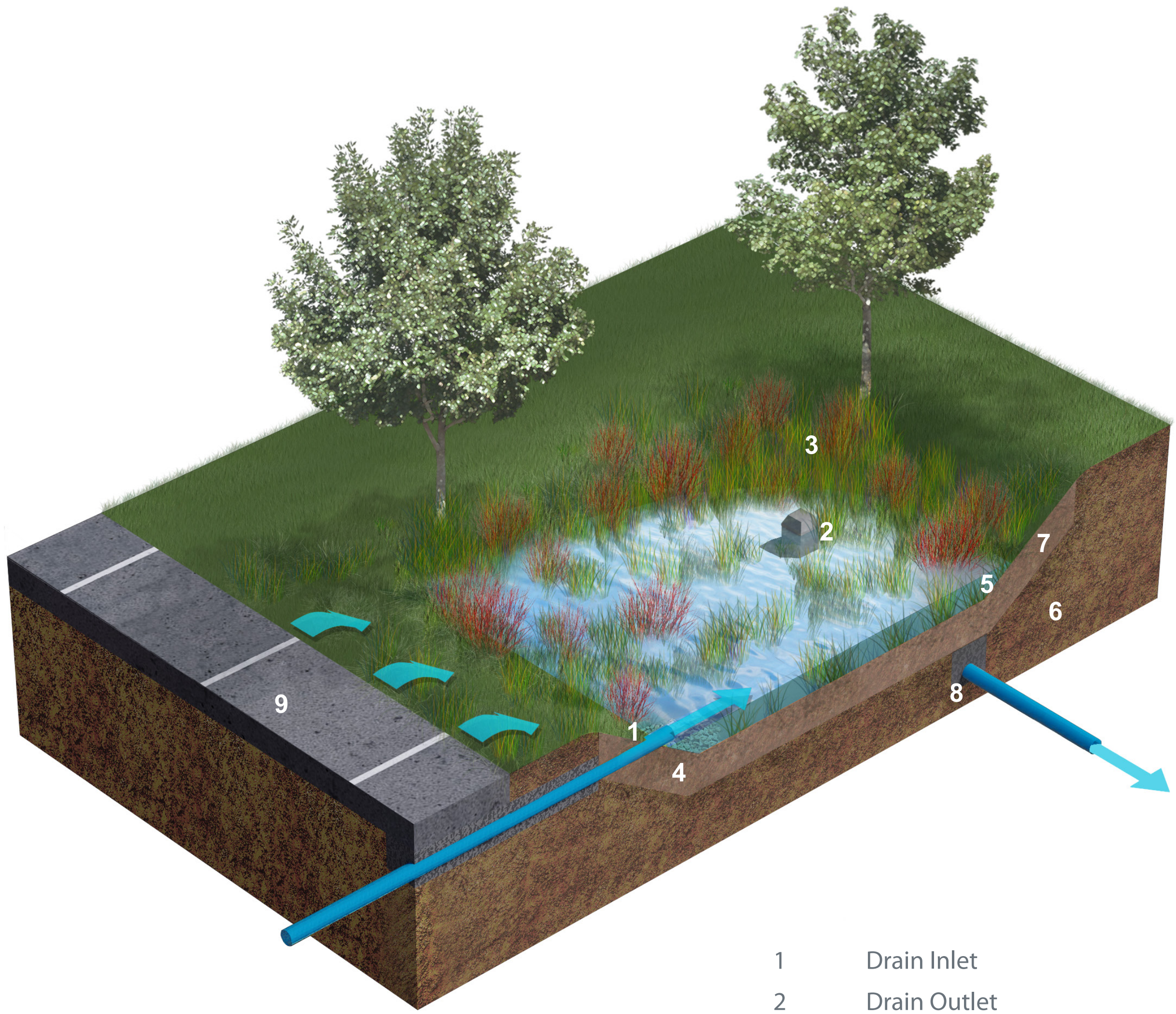
Figure 5-2
Sid Snyder Underground Utility Replacement
(June 2015, Source: Mithun)

Figure 5-3
Sid Snyder Underground Utility Replacement
(June 2015, Source: Mithun)

Figure 5-4
Bioretention Cell Axon
(Source: Mithun)







1	Drain Inlet
2	Drain Outlet
3	Understory Plantings
4	Bioretention Soil Mix
5	Temporary Ponding Depth
6	Existing Subgrade
7	Finished Side Slope
8	Perforated Underdrain
9	Pollution Generating Surface

Bioretention Swale

Overview

Bioretention swales are similar to bioretention cells in that they are an engineered landscape depression with plantings and a designed soil mix used to treat stormwater. The key distinction between a bioretention cell and a bioretention swale is that a bioretention swale is used to convey treated runoff to downstream facilities.

Application

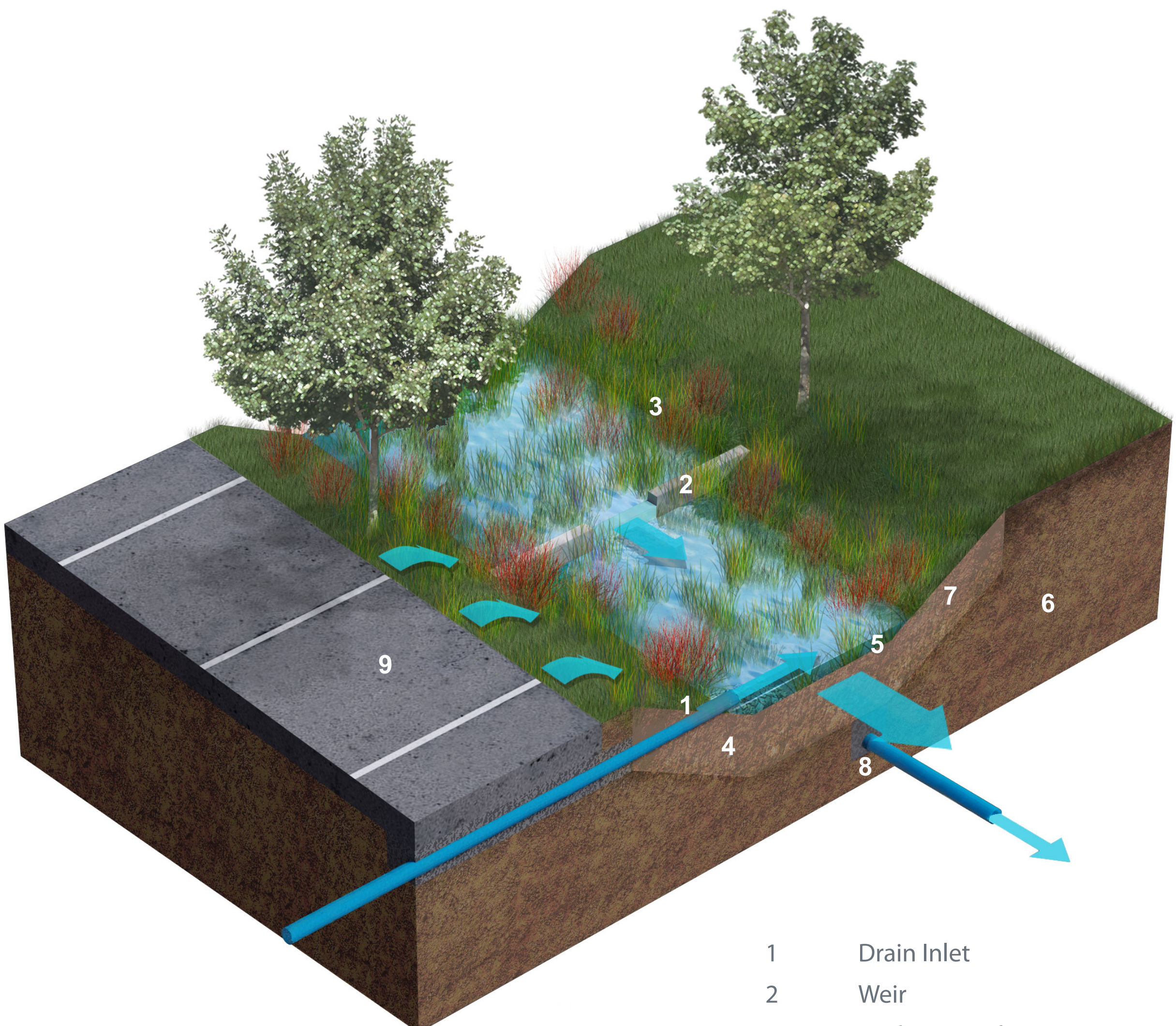
It is recommended that bioretention swales are installed with existing or proposed understory planting beds. This aesthetic will match the intent of the Historic Preservation Master Plan, as these swales are planted with low shrubs, grasses, and ground covers. To properly locate a bioretention swale, the designed area must have slopes specific to the desired treatment requirements of the swale. Bioretention swales will require underdrains to remove water from the bottom of the facilities and convey flow to downstream drainage features.

For more information, refer to the SMMWW and the Low Impact Development Technical Guidance Manual for Puget Sound.

Figure 5-5
Sid Snyder Underground Utility Replacement
(June 2015, Source: Mithun)

Figure 5-6 **Goodwill Job Training and Education Center** (May 2013, Source: Mithun)

Figure 5-7
Bioretention Swale, Axon
(Source: Mithun)



1	Drain Inlet
2	Weir
3	Understory Plantings
4	Bioretention Soil Mix
5	Temporary Ponding Depth
6	Existing Subgrade
7	Finished Side Slope
8	Perforated Underdrain
9	Pollution Generating Surface

Bioretention Planter

Overview

Similar to both bioretention cells and swales, a bioretention planter is a landscape feature with plantings and a designed soil mix used to treat stormwater. Bioretention planters are intended for spatially constrained areas and are contained within a concrete structure with or without a concrete-lined bottom. Bioretention planters can be used as a stand-alone feature to treat water, or in a system, to treat and convey water. Where planters are intended to treat and convey stormwater, they should be constructed as a treatment train, allowing one planter to fill up and flow into the next planter until stormwater is adequately treated.

Application

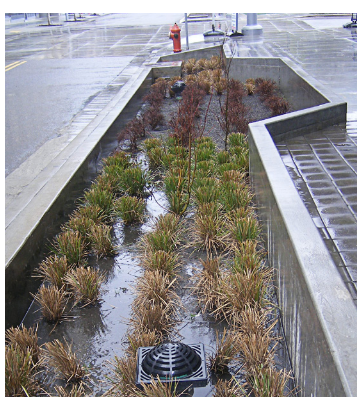
Due to the constructed nature of bioretention planters, the application of these features should be held within formal areas and in situations of limited space or an aesthetic conflict with using bioretention cells or swales. Typically, bioretention planters are located adjacent to roads, parking lots, or buildings. For the campus, it is recommended to install bioretention planters with a concrete bottom and underdrain piping, due to the poor infiltration rate within the existing soils. Vegetation in the planter can be planted in a formal arrangement so that the aesthetics match the existing or proposed landscape.

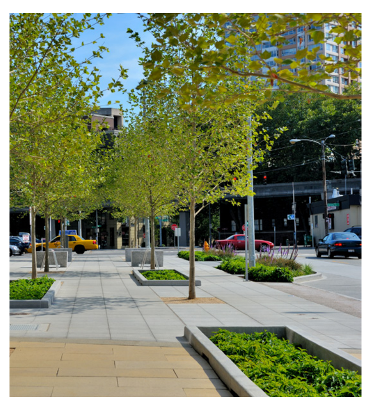
For more information, refer to the SMMWW and the *Low Impact Development Technical Guidance Manual for Puget Sound*.

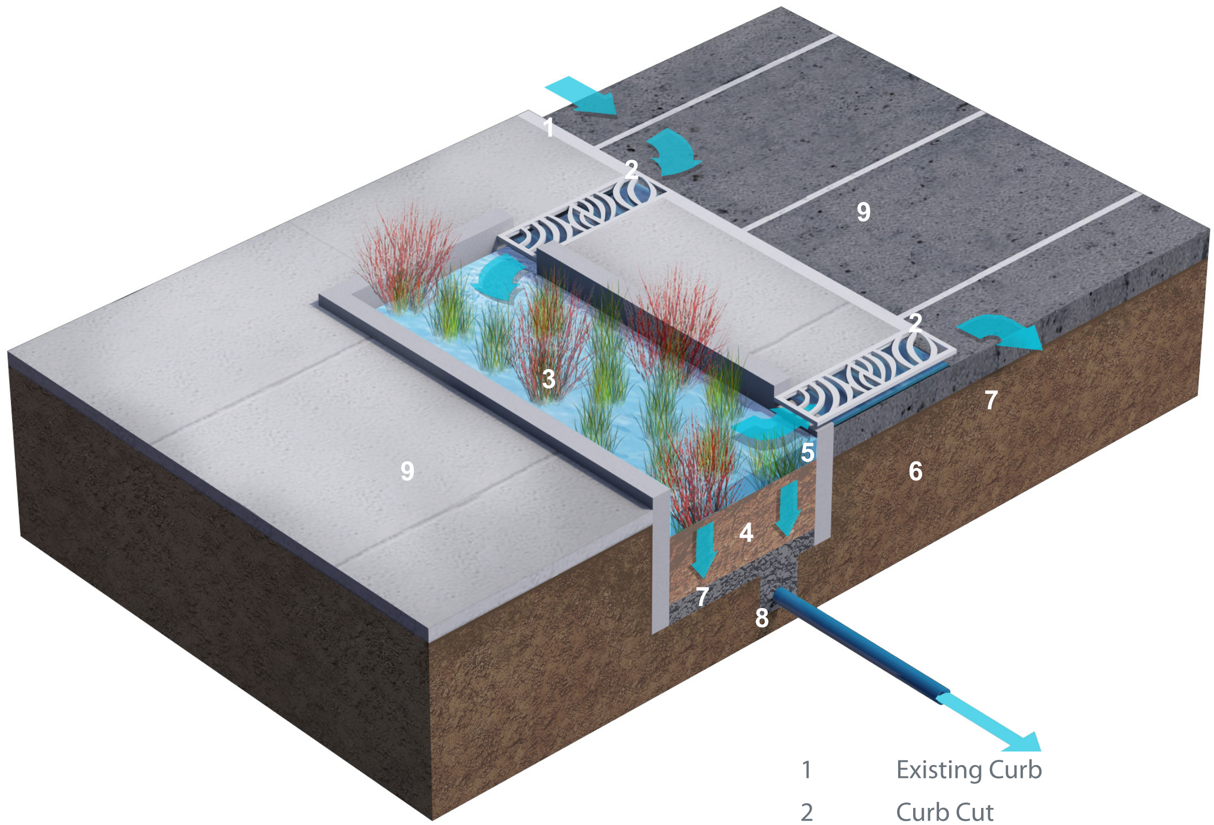
Figure 5-8
Bioretention Planter
(Mar. 2009, Source: Mithun)

Figure 5-9
Bioretention Planter, Taylor 28
(Feb. 2009, Source: Mithun)

Figure 5-10
Bioretention Planter, Axon
(Source: Mithun)







1	Existing Curb
2	Curb Cut
3	Understory Plantings
4	Bioretention Soil Mix
5	Temporary Ponding Depth
6	Existing Subgrade
7	Aggregate or Base Liner
8	Perforated Underdrain
9	Pollution Generating Surface

Biofiltration Swale

Overview
Biofiltration swales are vegetated trapezoidal channels that are composed of a specialized grass seed mixes and underlain by amended soils. These drainage features are used to convey and treat runoff from pollution-generating surfaces. Pollutants that are typically trapped by biofiltration swales are litter, total suspended solids, and particulate metals. The swales remove pollutants through vegetation, uptake by biomass, sedimentation, adsorption of particles, and infiltration through the soil.

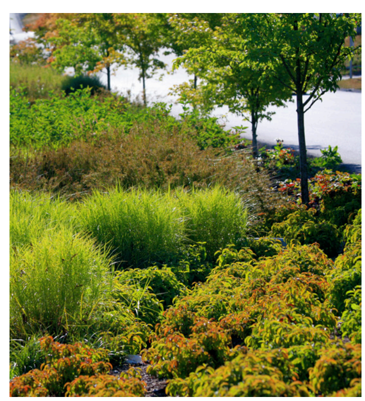
Application
Biofiltration swales are an applicable means to treat and convey runoff from pollution-generating surfaces. These types of facilities fit in well with the aesthetic of the campus landscape due to their vegetated nature and flexibility in seed mixes. Underdrains should be installed below these drainage features to convey flow that has infiltrated through the amended soils.

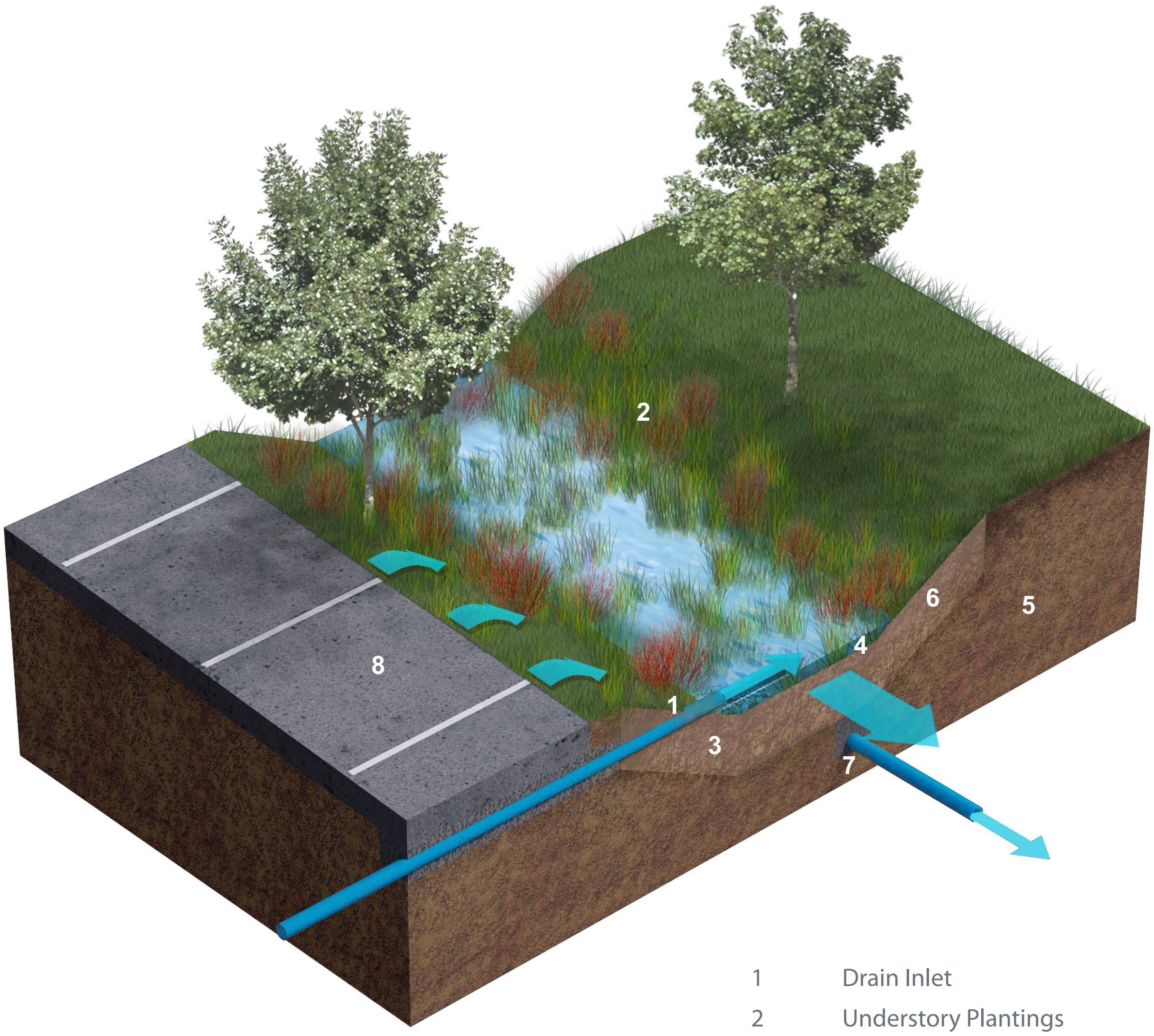
For more information, refer to the EPA Storm Water Technology Fact Sheets.

Figure 5-11
High Point, Seattle WA
(Sept. 2005, Source: Mithun)

Figure 5-12
Planting Detail, High Point
(Sept. 2005, Source: Mithun)

Figure 5-13
Biofiltration Swale, Axon
(Source: Mithun)





1	Drain Inlet
2	Understory Plantings
3	Bioretention Soil Mix
4	Temporary Ponding Depth
5	Existing Subgrade
6	Finished Side Slope
7	Perforated Underdrain
8	Pollution Generating Surface

Vegetated Filter Strip

Overview

A filter strip is a vegetated, sloped area adjacent to pollution-generating surfacing. As a storm event occurs, runoff from the landscaping travels over the filter strip and the runoff percolates through the feature as a means for water quality treatment. Stormwater is distributed as sheet flow through the grasses, groundcovers, and low shrubs, filtering sediments and course material and treating the water before it is conveyed to the storm sewer system.

Application

It is recommended to install filter strips within existing and proposed understory planting beds due to their use of low shrubs, grasses, and other groundcovers. Filter strips are sized based on the flow and/or volume required to provide suitable treatment to pollution-generating surfaces.

For more information, refer to the SMMWW.

Figure 5-14
Filter Strip, Portland, Oregon
(Mar, 2010. Source: Mithun)

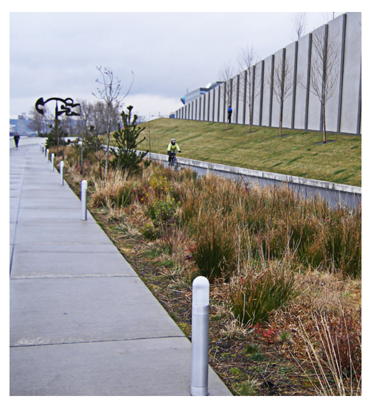
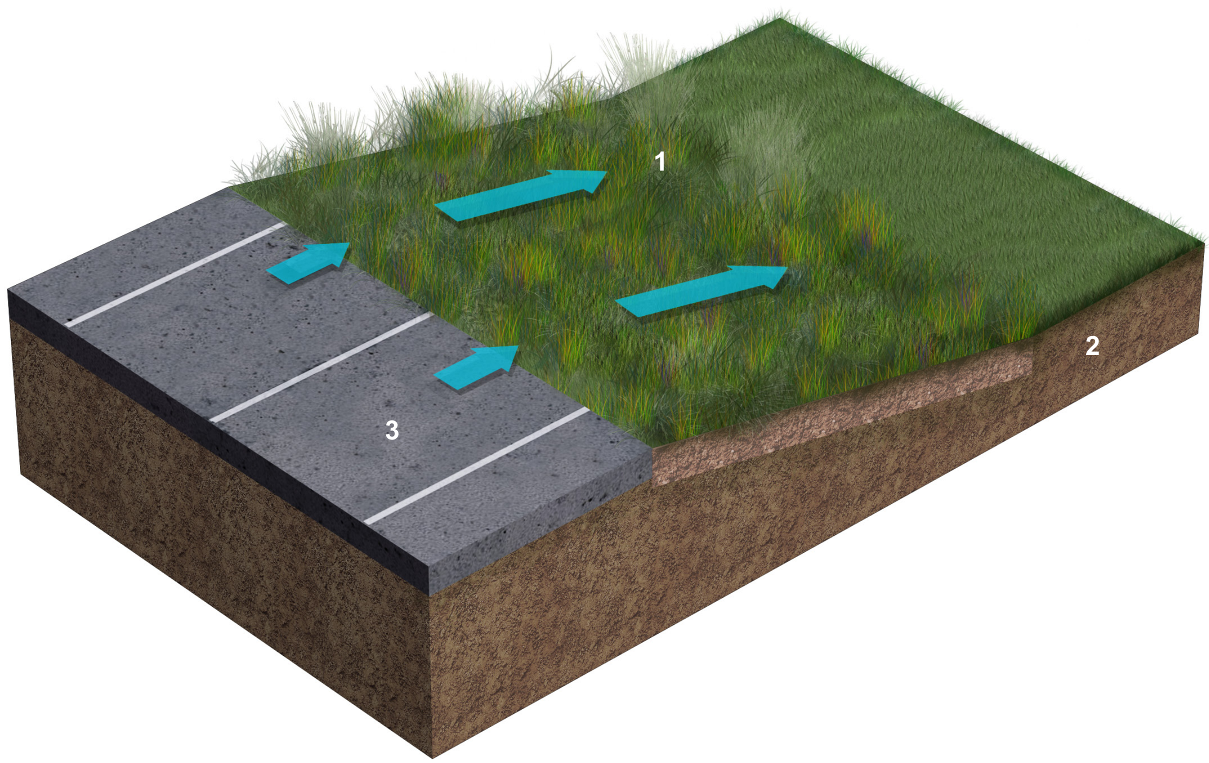


Figure 5-15
Filter Strip, Seattle, Washington
(Mar, 2010. Source: Mithun)

Figure 5-16
Vegetated Filter Strip, Axon
(Source: Mithun)



1 Understory Plantings
2 Existing Subgrade
3 Pollution Generating Surface

Tree Box Filter

Overview

Tree box filters are in-ground containers used for water quality treatment and flow control. These filters are a proprietary product containing a designed soil mix and tree or shrub material. The box filter acts as a catch basin where a polluted contributing area is drained and then treated through chemical processes in both the soil and plant material. The filter possesses an underdrain to convey treated water downstream to a storm sewer system.

Application

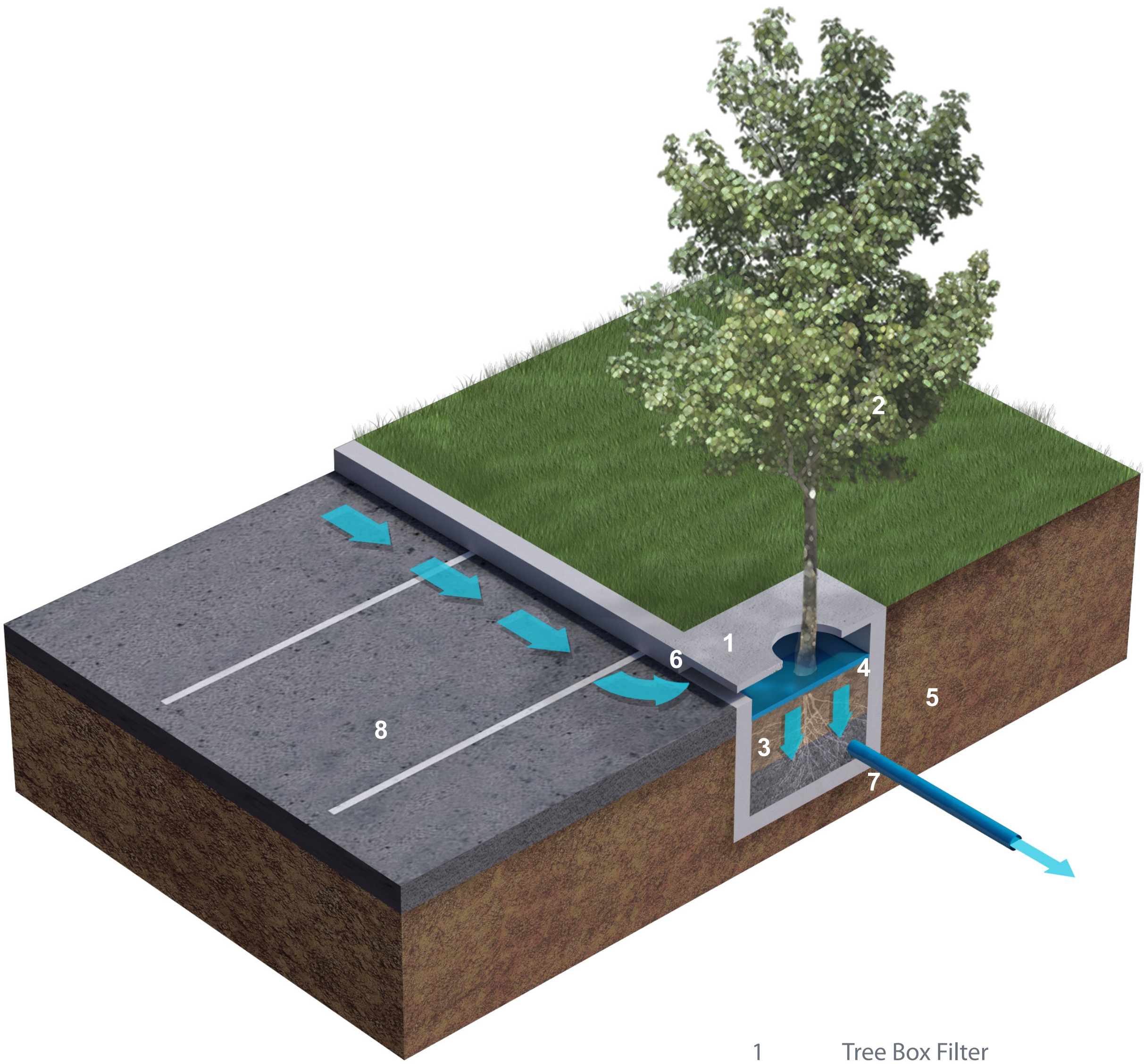
Tree box filters are recommended in areas with spatially constrained or have aesthetic limitations. Tree box filters are commonly installed along roadways, parking lots, or large paved pedestrian spaces.

For more information, refer to the EPA Stormwater Best Management Practices.

Figure 5-17

Tree Box Filter, Axon

(Source: Mithun)



1	Tree Box Filter
2	Selected Vegetation
3	Designed Soil Mix
4	Temporary Ponding Depth
5	Existing Subgrade
6	Drain Inlet
7	Perforated Underdrain
8	Pollution Generating Surface

Permeable Pavement

Overview

Permeable pavement and pavers are an alternative to standard asphalt and concrete for hardscape areas. As opposed to standard paving applications, permeable technologies are designed to allow water to permeate through voids or joints in the material. This reduces the amount of runoff that flows overland and slows the overall movement of runoff during a storm event. As a part of this process, course and fine sediments are removed from the flow as it permeates through the surface and subsurface materials.

Application

There is little aesthetic difference between permeable pavement and standard pavements, although it is difficult to match existing surfaces when installing new permeable pavement. Permeable pavement and permeable pavers can be used throughout the campus where other surface treatment or flow control options are not viable.

For more information, refer to the SMMWW.

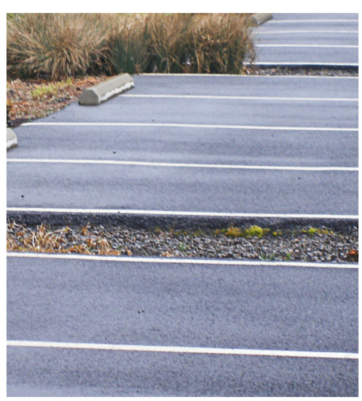
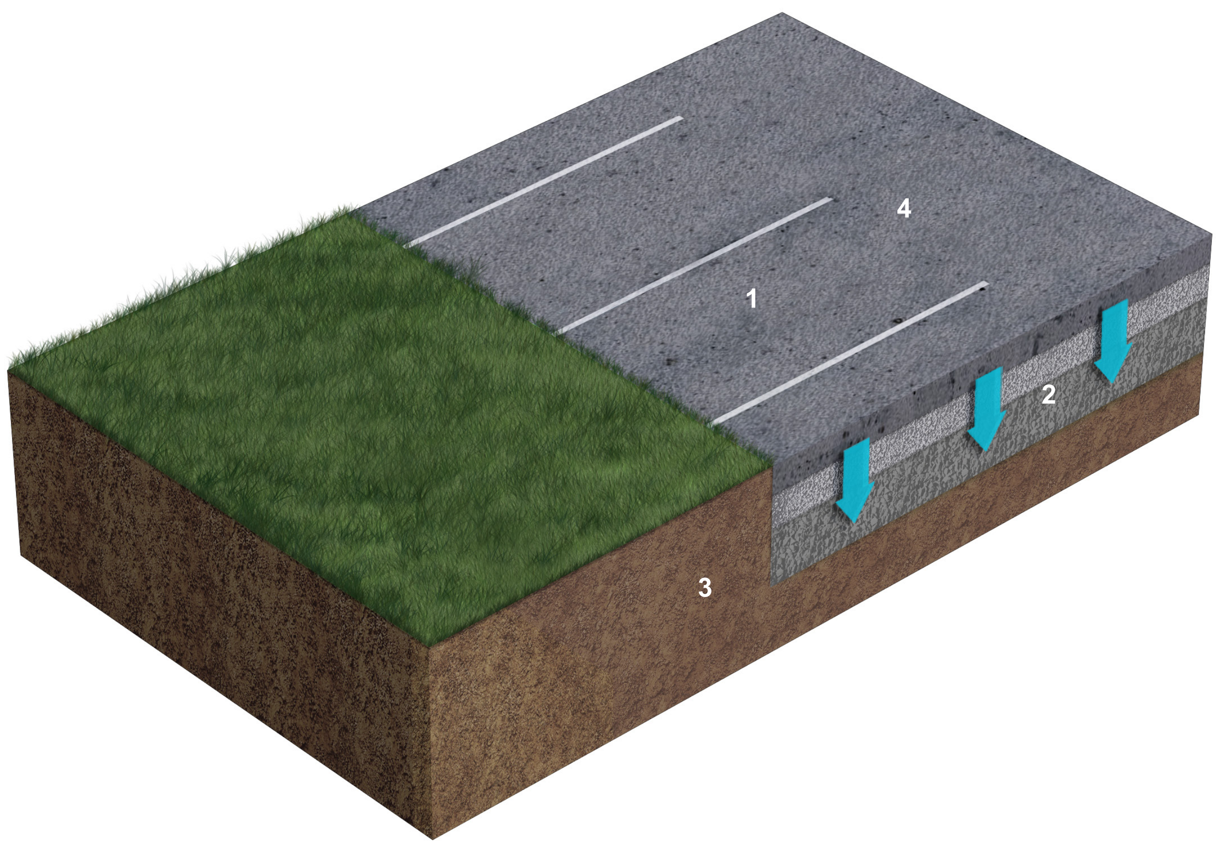


Figure 5-18
Permeable Pavement
(Mar, 2009. Source: Mithun)

Figure 5-19
Permeable Pavement, Axon
(Source: Mithun)



1	Permeable Paving
2	Base Material
3	Existing Subgrade
4	Pollution Generating Surface

Ecolawn

Overview

Eco-lawn is a grass seed blend that is specifically designed as a replacement for standard turf applications. Eco-lawn has an aesthetic that diverges from the existing campus lawns. As opposed to the monoculture of grass species that exists throughout campus, eco-lawn is composed of a number of different grass species. This variation is not perceived from a distance, but can be distinguished up close. In addition to the diversity of grass species, the minimal irrigation required for eco-lawn allows the grass to go dormant during summer months.

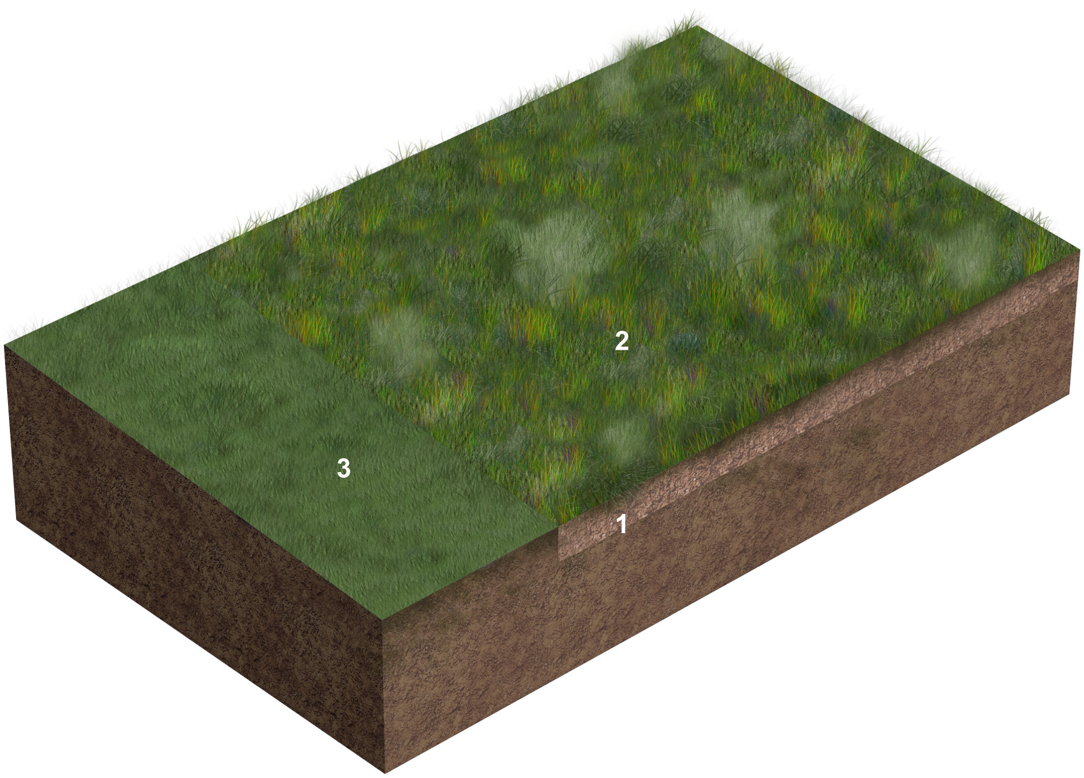
Application

Eco-lawn can be used to replace turf at edges that are bordered by understory plantings or in areas with poor drainage. Eco-lawns typically have deep root systems and allow for enhanced infiltration and interception of runoff during storm events. This mixture of low-growing grasses is an alternative to turf and requires minimal maintenance effort, low amounts of fertilization, and less frequent watering than common northwest grass seed mixes.

Figure 5-20
Eco-lawn test plots,
Coeur d'Alene, Idaho
(Source: Mithun)

Figure 5-21
Eco-lawn, Seattle University
(August 2008, Source: Mithun)

Figure 5-22
Eco-lawn, Axon
(Source: Mithun)



1	Existing Subgrade
2	Eco-Lawn
3	Standard Lawn

Catch Basin Insert

Overview

Catch basin inserts are a retrofit to an existing catch basin structure that are designed to capture sediment, debris, and oils during a storm event. These inserts are designed to fit most drainage inlets and can be installed at any point after the initial construction of the inlet.

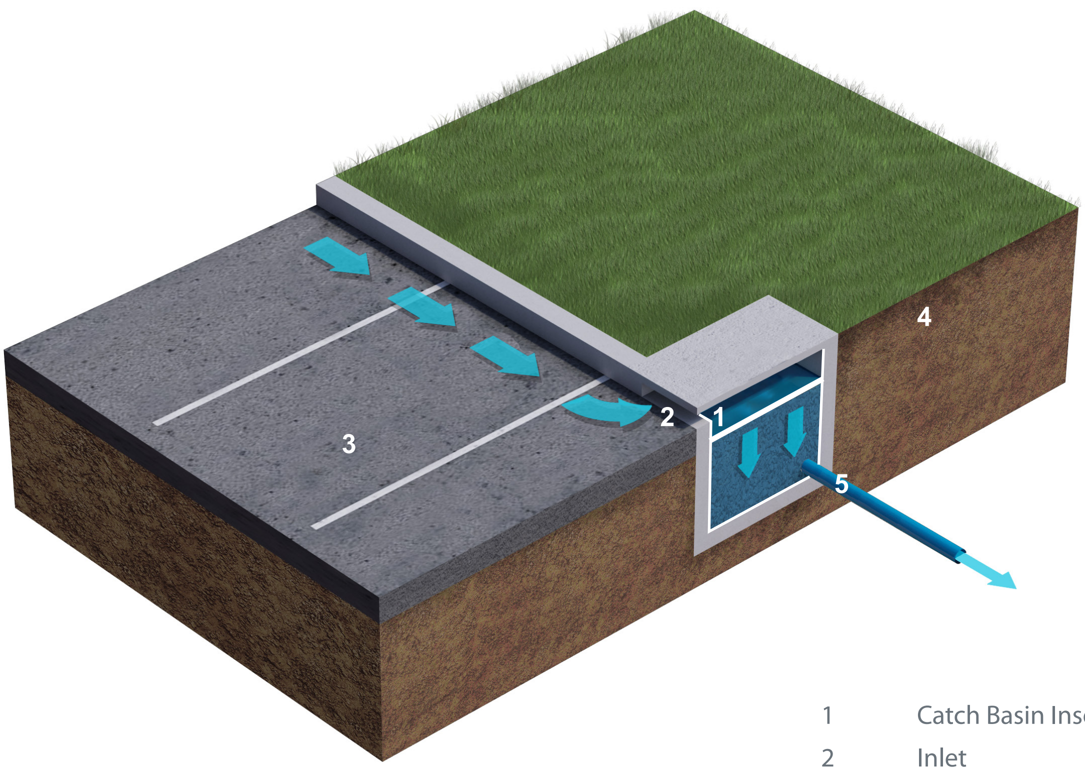
Application

Catch basin inserts have no aesthetic impacts, since the systems are installed within the existing infrastructure. Catch basin inserts are commonly installed in paved areas such as parking lots and roadways. Catch basin inserts are an effective alternative to stormwater quality treatment in locations where other measures are not viable due to spatial or aesthetic constraints.

Figure 5-23

Catch Basin Insert, Axon

(Source: Mithun)



1	Catch Basin Insert
2	Inlet
3	Pollution Generating Surface
4	Existing Subgrade
5	Perforated Underdrain

Cistern

Overview

Cisterns are a stormwater harvesting technology that stores water for future use or for eventual return to the storm sewer system. Cisterns can receive stormwater from a pollution-generating surface directly or from pretreatment facilities. If water is being received from an untreated source, the cistern will need to be sized to contain the required water quality volume in order to meet water quality standards.

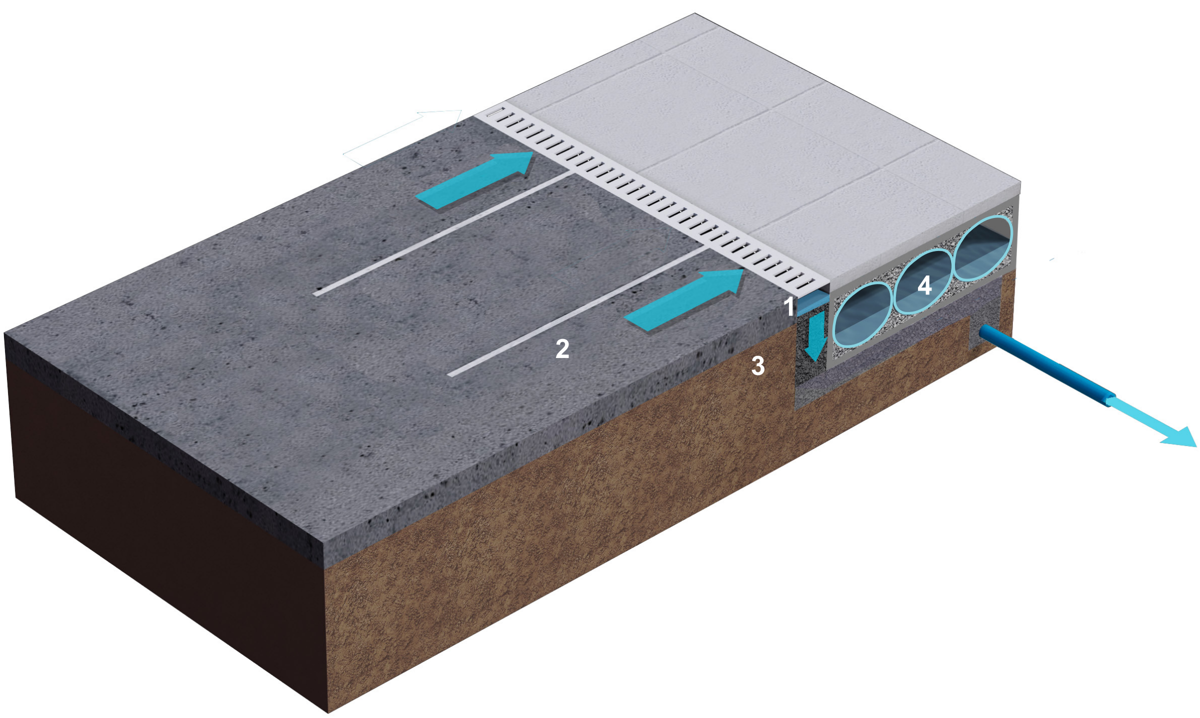
Application

Stormwater cisterns are commonly located near the contributing pollution-generating surfacing, such as a parking lot, road, pedestrian hardscape area, or building. Cisterns can be located either above or below the grade. Due to visual and aesthetic concerns, below-grade cisterns are recommended for the West Capitol Campus. Cisterns may be difficult to implement as a stand-alone project at this campus due to the State funds process for projects. It is anticipated that cisterns would be considered and/or included with new development or redevelopment projects.

Figure 5-24
Above ground cistern, Goodwill Job Training and Education Center
(July 2014, Source: Mithun)

Figure 5-25
Below ground cistern, Chatham University
(September 2013, Source: Mithun)

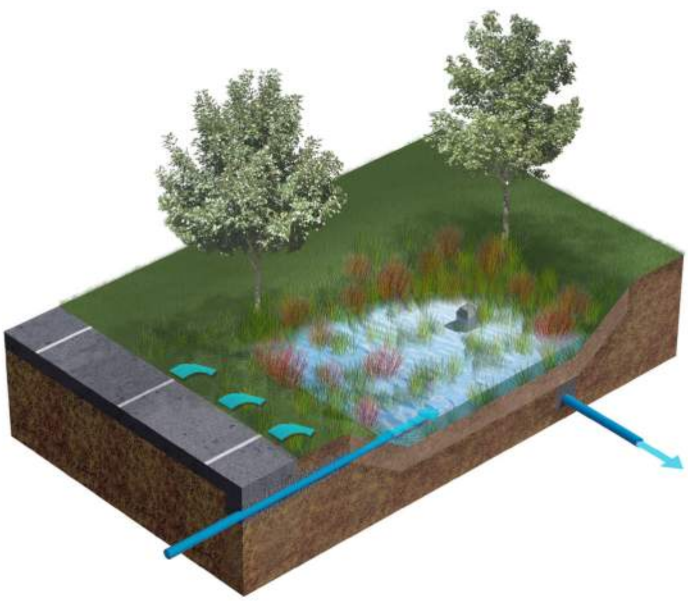
Figure 5-26
Cistern, Axon
(Source: Mithun)



1 Inlet
2 Pollution Generating Surface
3 Existing Subgrade
4 Subsurface Storage

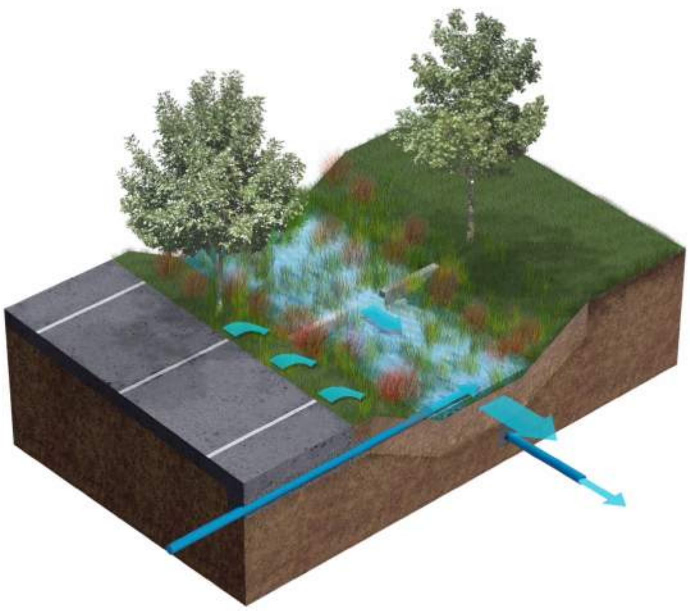
APPENDIX C :

GENERAL MAINTENANCE GUIDELINES

Maintenance Guidelines	Defect	
	Trash and Debris	
	Erosion	
	Vegetation	
	Poor Vegetation Coverage	
	Excessive Shading	
	Inlet/Outlet	
	Settlement of Weir/Berm	
Bioretention Cell	Overflow	

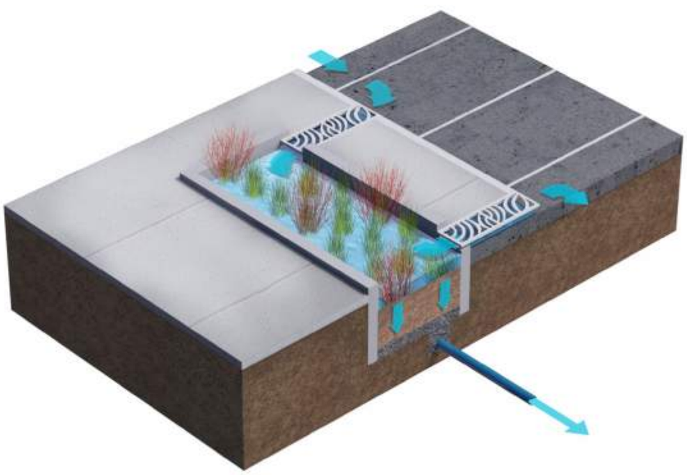
* Adapted from the Stormwater Management Manual for Western Washington.

Condition	Result
Accumulation that exceeds 1 CF per 1000-SF of cell area.	Trash and debris removed from pond.
Erosion of the cell's side slopes and/or scouring of the cell bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded.
When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
Components have settled 4-inches or lower than the design elevation.	Weir/berm is repaired so that surface is leveled to allow water to flow evenly over entire length of weir/berm.
Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

Maintenance Guidelines	Defect	
 **Bioretention Swale**	Sediment Accumulation	
	Standing Water	
	Vegetation	
	Poor Vegetation Coverage	
	Excessive Shading	
	Inlet/Outlet	
	Trash and Debris Accumulation	
	Erosion/Scouring	

* Adapted from the Stormwater Management Manual for Western Washington.

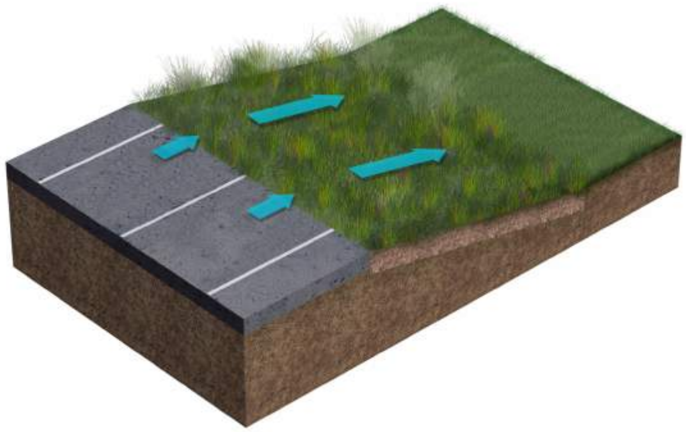
	Condition	Result
	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Water stands in the swale and does not drain.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains
	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Remove grass clippings.
	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and debris accumulated in the swale.	Remove trash and debris from swale.
	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Maintenance Guidelines	Defect	
 **Bioretention Planter**	Sediment Accumulation	
	Standing Water	
	Vegetation	
	Poor Vegetation Coverage	
	Excessive Shading	
	Inlet/Outlet	
	Trash and Debris Accumulation	
	Erosion/Scouring	

* Adapted from the Stormwater Management Manual for Western Washington.

	Condition	Result
	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the planter. When finished, planter should be level from side to side and drain freely toward outlet.
	Water stands in the planter and does not drain.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of planter, add underdrains
	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Trim vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	When grass is sparse or bare or eroded patches occur in more than 10% of the planter bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the planter bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and adjacent brushy vegetation.
	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and debris accumulated in the planter.	Remove trash and debris from planter.
	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Maintenance Guidelines

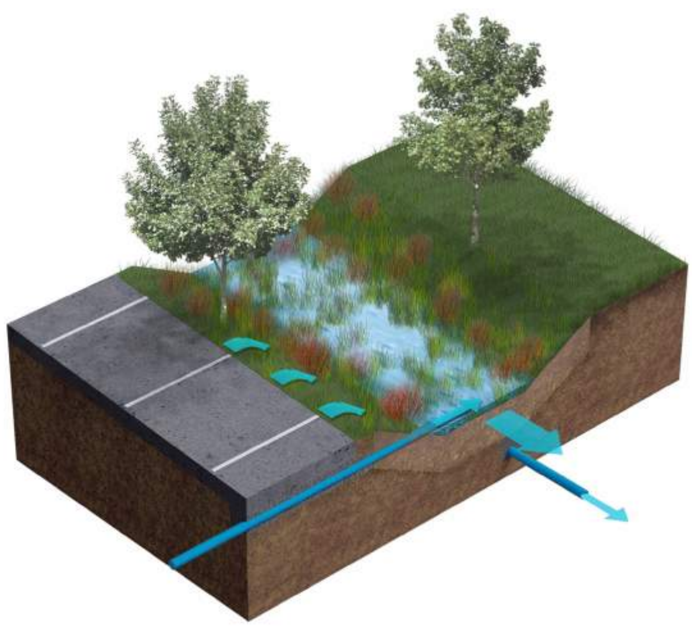


Vegetated Filter Strip

Defect	
Sediment Accumulation	
Vegetation	
Erosion/Scouring	
Trash and Debris Accumulation	

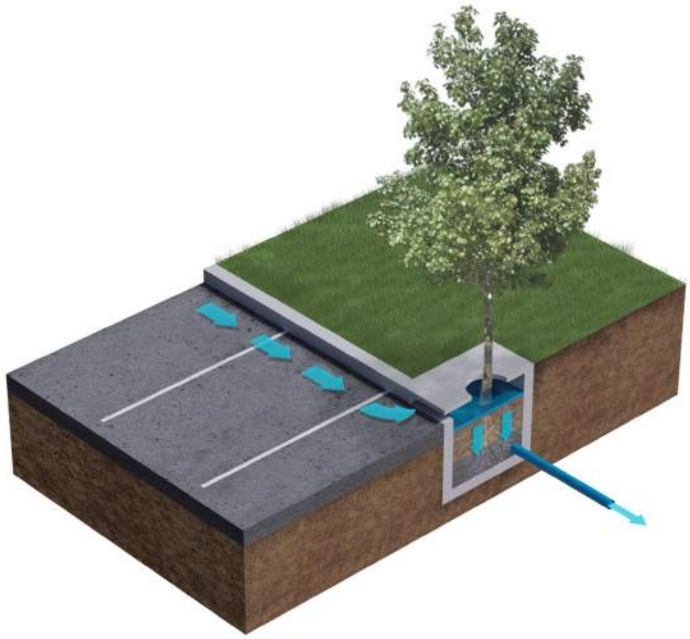
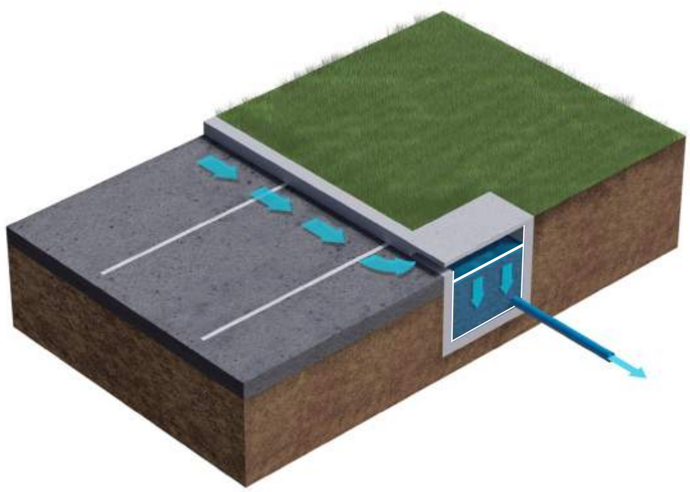
* Adapted from the Stormwater Management Manual for Western Washington.

Condition	Result
Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.
Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.

Maintenance Guidelines	Defect	
 **Biofiltration Swale**	Sediment Accumulation	
	Standing Water	
	Vegetation	
	Poor Vegetation Coverage	
	Excessive Shading	
	Inlet/Outlet	
	Trash and Debris Accumulation	
	Erosion/Scouring	

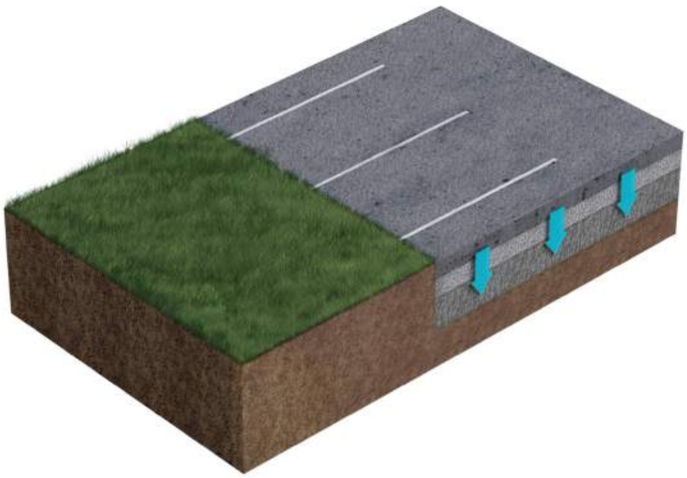
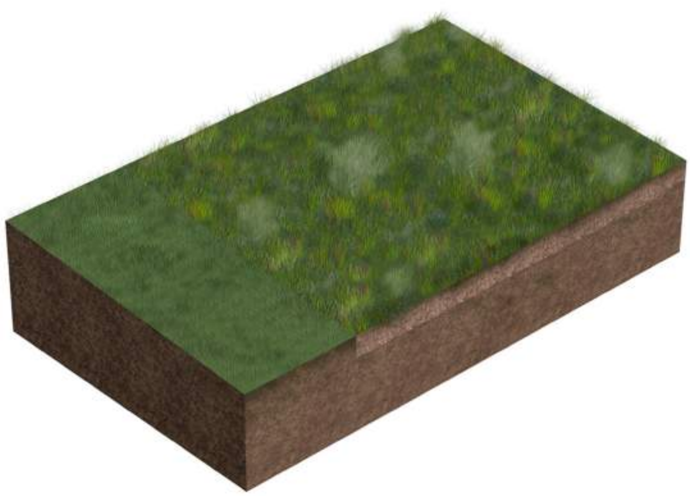
* Adapted from the Stormwater Management Manual for Western Washington.

Condition	Result
Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
Water stands in the swale and does not drain.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, add underdrains
When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Remove grass clippings.
When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
Trash and debris accumulated in the swale.	Remove trash and debris from swale.
Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Maintenance Guidelines	Defect	
 **Tree Box Filter**	Sediment Accumulation	
	Trash and Debris Accumulation	
	Vegetation	
	Filter Not Removing Pollutants	
 **Catch Basin Insert**	Sediment Accumulation	
	Trash and Debris Accumulation	
	Media Insert Not Removing Oil	
	Media Insert Water Saturated	

* Adapted from the Stormwater Management Manual for Western Washington.

Condition	Result
When sediment forms a cap over the soil media of the insert and/or unit.	No sediment cap on the soil media.
Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from unit. Runoff freely flows into filter.
Vegetation in the filter is in poor condition.	Determine the cause of the deterioration of the vegetation. Replace soil media or vegetation as necessary to maintain a functioning filter.
No treatment being provided.	Assess the quality of the soil media and vegetation to determine the cause. Replace media or vegetation if determined necessary.
When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert

Maintenance Guidelines	Defect	
 Permeable Pavement	Poor surface Infiltration	
	Snow/ Ice on surface	
	Surface Damage	
 Eco-Lawn	Vegetation	
	Irrigation	
	Poor Vegetation Coverage	
	Excessive Shading	

* Adapted from the Stormwater Management Manual for Western Washington.

Condition	Result
Pavement has become clogged.	Vacuum pavement twice a year to prevent clogs in the surface material. Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface. Maintain planted areas adjacent to pavement.
Snow/Ice accumulation on surface preventing drainage.	Do not apply abrasives such as sand or cinders on or adjacent to pavement. Snow plowing is fine but should be done carefully (i.e. set the blade slightly higher than usual). Salt application is acceptable.
Repairs are necessary to resurface areas of pavement.	Surface should never be seal-coated. Inspect for pavement rutting/raveling on an annual basis (some minor ruts may occur in the porous pavement from stationary wheel rotation). Damaged areas less than 50 square feet can be patched with porous or standard asphalt. Larger areas should be patched with an approved porous asphalt.
When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation. Remove grass clippings.
Vegetation is dormant.	Dormant vegetation is acceptable based on irrigation requirements of specific eco-lawn mixes. Irrigation is required for establishing vegetation but can be limited once established.
When grass is sparse or bare.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass. Or re-seed into loosened, fertile soil.
Grass growth is poor because sunlight does not reach surface.	If possible, trim back over-hanging limbs and adjacent brushy vegetation .

APPENDIX D :

HYDROLOGIC & HYDRAULIC CALCULATIONS – EXISTING

Runoff Coefficients for Rational Method
10-Year Return Frequency

General Land Covers			
	C		
Land Cover	Flat	Rolling 2%-10%	Hilly Over 10%
Pavement and roofs	0.90	0.90	0.90
Earth shoulders	0.50	0.50	0.50
Dirves and walks	0.75	0.80	0.85
Gravel pavement	0.50	0.55	0.60
City business areas	0.80	0.85	0.85
Surburban residential	0.25	0.35	0.40
Single family residential	0.30	0.40	0.50
Multi units, detached	0.40	0.50	0.60
Multi units, attached	0.60	0.65	0.70
Lawns, very sandy soil	0.05	0.07	0.10
Lawns, sandy soil	0.10	0.15	0.20
Lawns, heavy soil	0.17	0.22	0.35
Grass shoulders	0.25	0.25	0.25
Side slopes, earth	0.60	0.60	0.60
Side slopes, turf	0.30	0.30	0.30
Median areas, turf	0.25	0.30	0.30
Cultivated land, clay and loam	0.50	0.55	0.60
Cultivated land, sand and gravel	0.25	0.30	0.35
Industrial areas, light	0.50	0.70	0.80
Industrial areas, heavy	0.60	0.80	0.90
Parks and cemeteries	0.10	0.15	0.25
Playgrounds	0.20	0.25	0.30
Woodland and forests	0.10	0.15	0.20
Meadows and pasture land	0.25	0.30	0.35
Pasture with frozen ground	0.40	0.45	0.50
Unimproved areas	0.10	0.20	0.30

ource: WSDOT Hydraulics Manual, M 23-03.03, January 2015, Figure 2-5

Runoff Coefficients for Rational Method
25-Year Return Frequency

General Land Covers			
	C		
Land Cover	Flat	Rolling 2%-10%	Hilly Over 10%
Pavement and roofs	0.99	0.99	0.99
Earth shoulders	0.55	0.55	0.55
Dirves and walks	0.83	0.88	0.94
Gravel pavement	0.55	0.61	0.66
City business areas	0.88	0.94	0.94
Surburban residential	0.28	0.39	0.44
Single family residential	0.33	0.44	0.55
Multi units, detached	0.44	0.55	0.66
Multi units, attached	0.66	0.72	0.77
Lawns, very sandy soil	0.06	0.08	0.11
Lawns, sandy soil	0.11	0.17	0.22
Lawns, heavy soil	0.19	0.24	0.39
Grass shoulders	0.28	0.28	0.28
Side slopes, earth	0.66	0.66	0.66
Side slopes, turf	0.33	0.33	0.33
Median areas, turf	0.28	0.33	0.33
Cultivated land, clay and loam	0.55	0.61	0.66
Cultivated land, sand and gravel	0.28	0.33	0.39
Industrial areas, light	0.55	0.77	0.88
Industrial areas, heavy	0.66	0.88	0.99
Parks and cemeteries	0.11	0.17	0.28
Playgrounds	0.22	0.28	0.33
Woodland and forests	0.11	0.17	0.22
Meadows and pasture land	0.28	0.33	0.39
Pasture with frozen ground	0.44	0.50	0.55
Unimproved areas	0.11	0.22	0.33

Note: Added 10% increase to values of return for 10-Year frequency, per WSDOT Hydraulics Manual, M 23-03.03, January 2015, Paragraph 2-5.2.

Runoff Coefficients for Rational Method
100-Year Return Frequency

General Land Covers			
Land Cover	**C**		
	Flat	**Rolling 2%-10%**	**Hilly Over 10%**
Pavement and roofs	1.13	1.13	1.13
Earth shoulders	0.63	0.63	0.63
Dirves and walks	0.94	1.00	1.06
Gravel pavement	0.63	0.69	0.75
City business areas	1.00	1.06	1.06
Surburban residential	0.31	0.44	0.50
Single family residential	0.38	0.50	0.63
Multi units, detached	0.50	0.63	0.75
Multi units, attached	0.75	0.81	0.88
Lawns, very sandy soil	0.06	0.09	0.13
Lawns, sandy soil	0.13	0.19	0.25
Lawns, heavy soil	0.21	0.28	0.44
Grass shoulders	0.31	0.31	0.31
Side slopes, earth	0.75	0.75	0.75
Side slopes, turf	0.38	0.38	0.38
Median areas, turf	0.31	0.38	0.38
Cultivated land, clay and loam	0.63	0.69	0.75
Cultivated land, sand and gravel	0.31	0.38	0.44
Industrial areas, light	0.63	0.88	1.00
Industrial areas, heavy	0.75	1.00	1.13
Parks and cemeteries	0.13	0.19	0.31
Playgrounds	0.25	0.31	0.38
Woodland and forests	0.13	0.19	0.25
Meadows and pasture land	0.31	0.38	0.44
Pasture with frozen ground	0.50	0.56	0.63
Unimproved areas	0.13	0.25	0.38

Note: Added 25% increase to values of return for 10-Year frequency, per WSDOT Hydraulics Manual, M 23-03.03, January 2015, Paragraph 2-

Manning's Coefficient of Roughness - Channel Linings
Table 2. Manning's "n" Values for Various Channel Linings
(Channel Full)

Pipe Material	Roughness Coefficient "n"
Concrete	0.012
Short grass	0.030
Stony bottom and weedy banks	0.035
Cobble bottom and grass banks	0.040
Dense weeds as high as flow	0.080
Dense woody brush as high as flow	0.120

Source: Volume I - Minimum Technical Requirements Drainage Design and Erosion Control Manual for Olympia, WA

Manning's Coefficient of Roughness - Closed Conduit
Table 3. - Manning's "n" for Pipes

Pipe Material	Roughness Coefficient "n"
Concrete	0.013
Annular CMP or Pipe Arch	
2-2/3 x 1/2 corrugation	0.024
3 x 1 corrugation	0.027
6 x 2 corrugation	0.030
Helical	0.024
Spiral Rib	0.016
Ductile Iron (cement lined)	0.013
Plastic	0.010

Source: Volume I - Minimum Technical Requirements Drainage Design and Erosion Control Manual for Olympia, WA

Index to Rainfall Coefficients (English Units)

Source: WSDOT Hydraulics Manual, M 23-03.04, January 2015

Location	2-Year MRI		5-Year MRI		10-Year MRI		25-Year MRI		50-Year MRI		100-Year MRI	
	m	n	m	n	m	n	m	n	m	n	m	n
Aberdeen and Hoquiam	5.100	0.488	6.220	0.488	7.060	0.487	8.170	0.487	9.020	0.487	9.860	0.487
Bellingham	4.290	0.549	5.590	0.555	6.590	0.559	7.900	0.562	8.890	0.563	9.880	0.565
Bremerton	3.790	0.480	4.840	0.487	5.630	0.490	6.680	0.494	7.470	0.496	8.260	0.498
Centralia and Chehalis	3.630	0.506	4.850	0.518	5.760	0.524	7.000	0.530	7.920	0.533	8.860	0.537
Clarkston and Colfax	5.020	0.628	6.840	0.633	8.240	0.635	10.070	0.638	11.450	0.639	12.810	0.639
Colville	3.480	0.558	5.440	0.593	6.980	0.610	9.070	0.626	10.650	0.635	12.260	0.642
Ellensburg	2.890	0.590	5.180	0.631	7.000	0.649	9.430	0.664	11.300	0.672	13.180	0.678
Everett	3.690	0.556	5.200	0.570	6.310	0.575	7.830	0.582	8.960	0.585	10.070	0.586
Forks	4.190	0.410	5.120	0.412	5.840	0.413	6.760	0.414	7.470	0.415	8.180	0.416
Hoffstadt Cr. (SR 504)	3.960	0.448	5.210	0.462	6.160	0.469	7.440	0.476	8.410	0.480	9.380	0.484
Hoodsport	4.470	0.428	5.440	0.428	6.170	0.427	7.150	0.428	7.880	0.428	8.620	0.428
Kelso and Longview	4.250	0.507	5.500	0.515	6.450	0.509	7.740	0.524	8.700	0.526	9.670	0.529
Leavenworth	3.040	0.530	4.120	0.542	5.620	0.575	7.940	0.594	9.750	0.606	11.080	0.611
Metaline Falls	3.360	0.527	4.900	0.553	6.090	0.566	7.450	0.570	9.290	0.592	10.450	0.591
Moses Lake	2.610	0.583	5.050	0.634	6.990	0.655	9.580	0.671	11.610	0.681	13.630	0.688
Mt. Vernon	3.920	0.542	5.250	0.552	6.260	0.557	7.590	0.561	8.600	0.564	9.630	0.567
Naselle	4.570	0.432	5.670	0.441	6.140	0.432	7.470	0.443	8.050	0.440	8.910	0.436
Olympia	3.820	0.466	4.860	0.472	5.620	0.474	6.630	0.477	7.400	0.478	8.170	0.480
Omak	3.040	0.583	5.060	0.618	6.630	0.633	8.740	0.647	10.350	0.654	11.970	0.660
Pasco and Kennewick	2.890	0.590	5.180	0.631	7.000	0.649	9.430	0.664	11.300	0.672	13.180	0.678
Port Angeles	4.310	0.530	5.420	0.531	6.250	0.531	7.370	0.532	8.190	0.532	9.030	0.532
Poulsbo	3.830	0.506	4.980	0.513	5.850	0.516	7.000	0.519	7.860	0.521	8.740	0.523
Queets	4.260	0.422	5.180	0.423	5.870	0.423	6.790	0.432	7.480	0.423	8.180	0.424
Seattle	3.560	0.515	4.830	0.531	5.620	0.530	6.890	0.539	7.880	0.545	8.750	0.545
Sequim	3.500	0.551	5.010	0.569	6.160	0.577	7.690	0.585	8.880	0.590	10.040	0.593
Snoqualmie Pass	3.610	0.417	4.810	0.435	6.560	0.459	7.720	0.459	8.780	0.461	10.210	0.467
Spokane	3.470	0.556	5.430	0.591	6.980	0.609	9.090	0.626	10.680	0.635	12.330	0.643
Stevens Pass	4.730	0.462	6.090	0.470	8.190	0.500	8.530	0.484	10.610	0.499	12.450	0.513
Tacoma	3.570	0.516	4.780	0.527	5.700	0.533	6.930	0.539	7.860	0.542	8.790	0.545
Vancouver	2.920	0.477	4.050	0.496	4.920	0.506	6.060	0.515	6.950	0.520	7.820	0.525
Walla Walla	3.330	0.569	5.540	0.609	7.300	0.627	9.670	0.645	11.450	0.653	13.280	0.660
Wenatchee	3.150	0.535	4.880	0.566	6.190	0.579	7.940	0.592	9.320	0.600	10.680	0.605
Yakima	3.860	0.608	5.860	0.633	7.370	0.644	9.400	0.654	10.930	0.659	12.470	0.663

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan**

WO: 21-2014-008

DATE: 1/5/2015

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 25yr BASIN

PIPE SIZING

(Runoff by Rational Method)

(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious
c = 0.24 Lawn

m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)
n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
BASIN 1 - Pritchard Building (west side)																			
11074	11032	6480	675	0.16	0.92	0.15	0.15	6.30	2.76	0.42	0.013	6	1.77	135	0.75	56	3.80	0.59	Concrete
11032	11301	7029	0	0.16	0.99	0.16	0.31	6.89	2.64	0.82	0.013	12	13.52	108	13.10	6	16.68	0.11	Concrete
11301	11294	0	2592	0.06	0.24	0.01	0.33	7.00	2.62	0.85	0.013	12	2.09	139	5.15	17	6.56	0.35	Concrete
11294	11288	16835	1070	0.41	0.95	0.39	0.71	7.35	2.56	1.83	0.013	12	2.12	147	5.19	35	6.61	0.37	Concrete
11284	11288	17775	0	0.41	0.99	0.40	0.40	6.30	2.76	1.11	0.013	12	1.07	43	3.69	30	4.69	0.15	Concrete
11288	Outfall 1	0	0	0.00	0.24	0.00	1.12	7.51	2.53	2.83	0.013	12	106.00	100	36.68	8	46.71	0.04	Concrete
BASIN 2																			
Subbasin 2A - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																			
11309	32741	20497	20917	0.95	0.61	0.58	0.58	6.30	2.76	1.60	0.013	8	2.56	115	1.93	83	5.54	0.35	Ductile Iron (DI)
32741	10701	60776	34150	2.18	0.72	1.57	2.15	6.65	2.69	5.78	0.013	8	0.94	356	1.17	494	3.36	1.77	
10701	30015	61925	22054	1.93	0.79	1.53	3.68	8.41	2.40	8.84	0.013	10	1.20	351	2.40	368	4.40	1.33	Concrete
30015	30010	0	0	0.00	0.24	0.00	3.68	9.74	2.24	8.24	0.013	12	3.50	83	6.67	124	8.49	0.16	
Subbasin 2B - Cherberg Building (east side)																			
10965	135102	8902	2192	0.25	0.84	0.21	0.21	6.30	2.76	0.59	0.013	6	0.50	170	0.40	149	2.02	1.40	DI
135102	135106	16386	8268	0.57	0.74	0.42	0.63	7.70	2.50	1.58	0.010	8	0.50	122	1.11	143	3.18	0.64	Polyvinyl chloride (PVC)
135106	30130	10298	10768	0.48	0.61	0.29	0.93	8.34	2.41	2.23	0.010	12	2.82	39	7.78	29	9.90	0.07	Corrugated Plastic Pipe (CPP)
30130	30149	30216	1548	0.73	0.95	0.70	1.62	8.41	2.40	3.90	0.010	12	4.39	57	9.70	40	12.36	0.08	CPP
30149	SDMH	0	0	0.00	0.24	0.00	1.62	8.48	2.39	3.88	0.010	12	2.00	229	6.55	59	8.34	0.46	ADS
SDMH	10107	2876	5446	0.19	0.50	0.10	1.72	8.94	2.33	4.01	0.010	12	1.34	105	5.36	75	6.83	0.26	CPP
Subbasin 2C - South Diagonal																			
30969	30967	51001	37583	2.03	0.67	1.37	1.37	6.30	2.76	3.77	0.010	12	2.41	54	7.19	52	9.16	0.10	CPP -- Includes Sid Snyder Ave. SW
30967	10106	0	0	0.00	0.24	0.00	1.37	6.40	2.74	3.74	0.010	12	1.23	170	5.14	73	6.54	0.43	CPP
11D	11B	3124	16080	0.44	0.36	0.16	0.16	6.30	2.76	0.44	0.013	8	0.53	57	0.88	50	2.52	0.38	DI
11B	12945	4306	4367	0.20	0.61	0.12	0.28	6.68	2.68	0.76	0.010	8	4.29	29	3.25	23	9.32	0.05	PVC
12945	10106	3797	0	0.09	0.99	0.09	0.37	6.73	2.67	0.98	0.010	8	6.75	12	4.08	24	11.69	0.02	PVC

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 25yr BASIN

PIPE SIZING
(Runoff by Rational Method)
(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious
c = 0.24 Lawn

m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)
n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
10106	10107	0	0	0.00	0.24	0.00	1.74	7.28	2.57	4.47	0.010	12	0.66	122	3.76	119	4.79	0.42	CPP
30066	31087	1547	3832	0.12	0.46	0.06	0.06	6.30	2.76	0.16	0.010	8	0.10	29	0.50	31	1.42	0.34	PVC
31087	10107	964	0	0.02	0.99	0.02	0.08	6.64	2.69	0.21	0.010	8	10.80	37	5.16	4	14.79	0.04	PVC
Subbasin 2D - South Diagonal																			
10107	10037	0	0	0.00	0.24	0.00	3.53	12.28	2.00	7.08	0.010	15	0.80	215	7.51	94	6.12	0.59	CPP
10037	10030	0	0	0.00	0.24	0.00	3.53	12.87	1.96	6.92	0.010	15	2.00	60	11.88	58	9.68	0.10	CPP
10026	10028	6106	5264	0.26	0.64	0.17	0.17	6.30	2.76	0.46	0.010	8	0.69	130	1.30	35	3.74	0.58	PVC
10028	10030	5383	2872	0.19	0.73	0.14	0.31	6.88	2.64	0.81	0.010	8	0.43	118	1.03	79	2.95	0.67	PVC
10030	10032	8210	1313	0.22	0.89	0.19	4.03	14.22	1.87	7.54	0.010	18	0.60	83	10.58	71	5.99	0.23	CPP
10032	10033	0	0	0.00	0.24	0.00	4.03	14.45	1.85	7.48	0.010	18	0.49	41	9.56	78	5.41	0.13	CPP
Subbasin 2E - Winged Victory Circle																			
10046	Mid Pt	1788	4165	0.14	0.47	0.06	0.06	6.30	2.76	0.18	0.010	6	0.50	213	0.52	34	2.63	1.35	PVC - Estimated slope
30065	Mid Pt	13627	25857	0.91	0.50	0.45	0.45	6.30	2.76	1.25	0.013	6	2.00	88	0.79	157	4.04	0.36	DI - Estimated slope
Mid Pt	10033	0	0	0.00	0.24	0.00	0.52	8.01	2.46	1.27	0.010	6	0.50	89	0.52	246	2.63	0.56	PVC - Estimated slope
10033	30010	25228	3792	0.67	0.89	0.59	5.14	16.85	1.72	8.87	0.010	18	0.57	89	10.31	86	5.83	0.25	PVC
Subbasin 2F - Cherry Lane SW (east of Temple of Justice)																			
32216	31280	0	0	0.00	0.24	0.00	0.00	6.30	2.76	0.00	0.010	8	0.39	311	0.98	0	2.81	1.84	PVC
31280	31246	25878	4133	0.69	0.89	0.61	0.61	8.14	2.44	1.49	0.010	8	0.74	81	1.35	110	3.87	0.35	PVC
31246	31245	6943	4525	0.26	0.69	0.18	0.79	8.49	2.39	1.90	0.010	8	0.74	81	1.35	140	3.87	0.35	PVC
31245	31244	35412	42222	1.78	0.58	1.04	1.83	8.84	2.34	4.30	0.010	8	0.32	31	0.89	484	2.55	0.20	PVC
31244	31239	0	0	0.00	0.24	0.00	1.83	9.04	2.32	4.25	0.010	8	0.46	44	1.07	399	3.05	0.24	PVC
31239	30010	0	0	0.00	0.24	0.00	1.83	9.28	2.29	4.20	0.010	8	1.30	193	1.79	234	5.13	0.63	PVC

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan** **PIPE SIZING**

WO: 21-2014-008 (Runoff by Rational Method) Calculated by: BTS

DATE: 1/5/2015 (Pipe Capacity by Manning's Eqn.) Checked by: HK

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 25yr BASIN Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)

c = 0.24 Lawn n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
30010	SD-100(54)	0	0	0.00	0.24	0.00	6.98	20.46	1.57	10.96	0.010	24	0.86	187	27.27	40	8.68	0.36	PVC
Subbasin 2G - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																			
32630	SD-100(54)	7229	3578	0.25	0.74	0.18	0.18	6.30	2.76	0.51	0.010	8	0.50	68	1.11	46	3.18	0.36	PVC - Estimated slope
31344	SD-100(54)	3822	3183	0.16	0.65	0.10	0.10	6.30	2.76	0.29	0.010	6	0.50	68	0.52	56	2.63	0.43	PVC - Estimated slope
SD-100(54)	31730	0	0	0.00	0.24	0.00	7.27	21.61	1.53	11.12	0.010	24	0.50	39	20.80	53	6.62	0.10	PVC - Estimated slope
31730	31734	17706	15266	0.76	0.64	0.49	7.75	21.71	1.53	11.84	0.010	24	0.38	210	18.13	65	5.77	0.61	PVC
31734	31735	14385	11132	0.59	0.66	0.39	8.14	22.31	1.51	12.27	0.010	24	0.26	38	15.00	82	4.77	0.13	PVC
31735	32169	0	0	0.00	0.24	0.00	8.14	22.45	1.50	12.24	0.010	24	0.34	89	17.15	71	5.46	0.27	PVC
Subbasin 2H - Pleasant Lane SW (west of Capitol Building)																			
31618	31617	9824	2066	0.27	0.86	0.23	0.23	6.30	2.76	0.65	0.010	6	1.04	82	0.74	87	3.79	0.36	PVC
31617	11310	0	0	0.00	0.24	0.00	0.23	6.66	2.68	0.63	0.010	6	8.25	212	2.10	30	10.67	0.33	PVC
11310	31423	0	0	0.00	0.24	0.00	0.23	6.99	2.62	0.62	0.010	8	4.06	106	3.17	19	9.07	0.19	PVC
31423	31424	50721	7349	1.33	0.90	1.19	1.43	7.19	2.59	3.70	0.010	10	3.07	140	4.99	74	9.15	0.25	PVC
31424	31768	3724	9309	0.30	0.46	0.14	1.56	7.44	2.55	3.98	0.010	10	0.32	62	1.61	247	2.95	0.35	PVC - Assumed size and slope
32681	31768	12942	7533	0.47	0.71	0.34	0.34	6.30	2.76	0.93	0.010	10	1.65	157	3.66	25	6.71	0.39	PVC
31768	CB TYP II	981	3151	0.09	0.42	0.04	1.94	8.18	2.43	4.72	0.010	10	3.49	83	5.32	89	9.76	0.14	PVC
CB TYP I-1	CB TYP I-2	1203	2767	0.09	0.47	0.04	0.04	6.30	2.76	0.12	0.010	12	3.67	60	8.87	1	11.30	0.09	PVC
CB TYP I-2	CB TYP II	12050	23502	0.82	0.50	0.40	0.45	6.39	2.74	1.22	0.013	12	3.75	24	6.90	18	8.78	0.05	DI
CB TYP I-3	CB TYP II	3197	15198	0.42	0.37	0.16	0.16	6.30	2.76	0.43	0.013	12	2.22	36	5.31	8	6.76	0.09	DI
CB TYP II	32169	0	0	0.00	0.24	0.00	2.54	8.55	2.38	6.06	0.010	10	2.59	58	4.58	132	8.40	0.12	PVC
31737	32169	3893	1730	0.13	0.76	0.10	0.10	6.30	2.76	0.27	0.010	8	6.30	84	3.94	7	11.30	0.12	PVC
Subbasin 2I - Pleasant Lane SW (west of Temple of Justice)																			

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan**

PIPE SIZING

WO: 21-2014-008

(Runoff by Rational Method)

Calculated by: BTS

DATE: 1/5/2015

(Pipe Capacity by Manning's Eqn.)

Checked by: HK

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 25yr BASIN

Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious

c = 0.24 Lawn

m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)

n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
32214	32173	73775	23774	2.24	0.81	1.81	1.81	6.30	2.76	4.98	0.010	8	1.80	156	2.11	236	6.04	0.43	PVC
32173	32172	0	0	0.00	0.62	0.00	1.81	6.73	2.67	4.83	0.010	8	0.63	32	1.24	389	3.56	0.15	PVC
32172	32171	0	0	0.00	0.62	0.00	1.81	6.88	2.64	4.78	0.010	8	2.05	39	2.25	212	6.44	0.10	PVC
32171	32169	0	0	0.00	0.24	0.00	1.81	6.98	2.62	4.75	0.010	8	2.00	170	2.22	214	6.36	0.45	PVC
Subbasin 2J - Mansion Parking Lot																			
32169	CB TYP II-2	0	0	0.00	0.24	0.00	12.59	25.75	1.41	17.73	0.024	24	1.02	225	12.38	143	3.94	0.95	CMP - Conflicting pipe sizes (i.e., 20 vs. 24)
CB TYP II-2	32266	11899	24264	0.83	0.49	0.41	13.00	26.70	1.38	17.99	0.024	20	1.00	108	7.54	239	3.45	0.52	Corrugated Metal Pipe (CMP)
32266	2012	0	0	0.00	0.24	0.00	13.00	27.22	1.37	17.82	0.024	20	1.00	142	7.54	237	3.45	0.69	Conflicting material types (i.e., CMP vs. DI)
32268	2012	2309	24033	0.60	0.31	0.19	0.19	6.30	2.76	0.51	0.013	6	20.00	142	2.51	20	12.78	0.19	Concrete
2012	Outfall	0	0	0.00	0.24	0.00	13.19	28.09	1.35	17.81	0.013	20	44.62	186	92.93	19	42.60	0.07	DI
BASIN 3 - Mansion Parking Lot (north side)																			
32250	32265	3035	0	0.07	0.99	0.07	0.07	6.30	2.76	0.19	0.013	6	0.94	64	0.54	35	2.77	0.38	Concrete
32265	Tee	1539	0	0.04	0.99	0.03	0.10	6.68	2.68	0.28	0.013	6	2.70	148	0.92	30	4.70	0.53	Concrete
32247	Tee	17117	0	0.39	0.99	0.39	0.39	6.30	2.76	1.07	0.010	6	0.87	58	0.68	158	3.47	0.28	PVC
Tee	32248	0	0	0.00	0.24	0.00	0.49	7.49	2.54	1.25	0.010	6	1.00	10	0.73	171	3.72	0.04	Concrete
32248	Mid1	5251	0	0.12	0.99	0.12	0.12	7.53	2.53	0.30	0.010	8	2.00	108	2.22	14	6.36	0.28	PVC
Mid1	Mid2	22085	0	0.51	0.99	0.50	0.50	7.82	2.49	1.25	0.010	8	2.00	59	2.22	56	6.36	0.15	PVC - Conflicting pipe sizes (6 vs. 8)
Mid2	33250 (Outfall)	18957	0	0.44	0.99	0.43	0.43	7.97	2.46	1.06	0.010	8	30.00	269	8.60	12	24.65	0.18	CPP - Conflicting pipe sizes (6 vs. 8)

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 100yr BASIN

PIPE SIZING
(Runoff by Rational Method)
(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious
c = 0.28 Lawn

m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)
n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
BASIN 1 - Pritchard Building (west side)																			
11074	11032	6480	675	0.16	1.04	0.17	0.17	6.30	3.38	0.58	0.013	6	1.77	135	0.75	78	3.80	0.59	Concrete
11032	11301	7029	0	0.16	1.12	0.18	0.35	6.89	3.23	1.14	0.013	12	13.52	108	13.10	9	16.68	0.11	Concrete
11301	11294	0	2592	0.06	0.28	0.02	0.37	7.00	3.21	1.19	0.013	12	2.09	139	5.15	23	6.56	0.35	Concrete
11294	11288	16835	1070	0.41	1.07	0.44	0.81	7.35	3.14	2.54	0.013	12	2.12	147	5.19	49	6.61	0.37	Concrete
11284	11288	17775	0	0.41	1.12	0.46	0.46	6.30	3.38	1.55	0.013	12	1.07	43	3.69	42	4.69	0.15	Concrete
11288	Outfall 1	0	0	0.00	0.28	0.00	1.27	7.88	3.03	3.85	0.013	12	106.00	100	36.68	11	46.71	0.04	Concrete
BASIN 2																			
Subbasin 2A - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																			
11309	32741	20497	20917	0.95	0.70	0.66	0.66	6.30	3.38	2.23	0.013	8	2.56	115	1.93	116	5.54	0.35	Ductile Iron (DI)
32741	10701	60776	34150	2.18	0.82	1.79	2.45	6.65	3.29	8.05	0.013	8	0.94	356	1.17	687	3.36	1.77	
10701	30015	61925	22054	1.93	0.90	1.74	4.19	8.41	2.94	12.30	0.013	10	1.20	351	2.40	513	4.40	1.33	Concrete
30015	30010	0	0	0.00	0.28	0.00	4.19	9.74	2.74	11.46	0.013	12	3.50	83	6.67	172	8.49	0.16	
Subbasin 2B - Cherberg Building (east side)																			
10965	135102	8902	2192	0.25	0.96	0.24	0.24	6.30	3.38	0.82	0.013	6	0.50	170	0.40	207	2.02	1.40	DI
135102	135106	16386	8268	0.57	0.84	0.48	0.72	7.70	3.07	2.21	0.010	8	0.50	122	1.11	199	3.18	0.64	Polyvinyl chloride (PVC)
135106	30130	10298	10768	0.48	0.69	0.33	1.05	8.34	2.95	3.11	0.010	12	2.82	39	7.78	40	9.90	0.07	Corrugated Plastic Pipe (CPP)
30130	30149	30216	1548	0.73	1.08	0.79	1.84	8.41	2.94	5.42	0.010	12	4.39	57	9.70	56	12.36	0.08	CPP
30149	SDMH	0	0	0.00	0.28	0.00	1.84	8.48	2.93	5.40	0.010	12	2.00	229	6.55	82	8.34	0.46	ADS
SDMH	10107	2876	5446	0.19	0.57	0.11	1.95	8.94	2.85	5.57	0.010	12	1.34	105	5.36	104	6.83	0.26	CPP
Subbasin 2C - South Diagonal																			
30969	30967	51001	37583	2.03	0.76	1.55	1.55	6.30	3.38	5.25	0.010	12	2.41	54	7.19	73	9.16	0.10	CPP -- Includes Sid Snyder Ave. SW
30967	10106	0	0	0.00	0.28	0.00	1.55	6.40	3.35	5.21	0.010	12	1.23	170	5.14	101	6.54	0.43	CPP
11D	11B	3124	16080	0.44	0.41	0.18	0.18	6.30	3.38	0.62	0.013	8	0.53	57	0.88	70	2.52	0.38	DI
11B	12945	4306	4367	0.20	0.70	0.14	0.32	6.68	3.28	1.05	0.010	8	4.29	29	3.25	32	9.32	0.05	PVC
12945	10106	3797	0	0.09	1.12	0.10	0.42	6.73	3.27	1.37	0.010	8	6.75	12	4.08	34	11.69	0.02	PVC
10106	10107	0	0	0.00	0.28	0.00	1.97	7.28	3.15	6.22	0.010	12	0.66	122	3.76	165	4.79	0.42	CPP

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 100yr BASIN

PIPE SIZING
(Runoff by Rational Method)
(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious
c = 0.28 Lawn

m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)
n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
30066	31087	1547	3832	0.12	0.52	0.06	0.06	6.30	3.38	0.22	0.010	8	0.10	29	0.50	44	1.42	0.34	PVC
31087	10107	964	0	0.02	1.12	0.02	0.09	6.64	3.29	0.29	0.010	8	10.80	37	5.16	6	14.79	0.04	PVC
Subbasin 2D - South Diagonal																			
10107	10037	0	0	0.00	0.28	0.00	4.01	10.98	2.59	10.38	0.010	15	0.80	215	7.51	138	6.12	0.59	CPP
10037	10030	0	0	0.00	0.28	0.00	4.01	11.57	2.52	10.13	0.010	15	2.00	60	11.88	85	9.68	0.10	CPP
10026	10028	6106	5264	0.26	0.73	0.19	0.19	6.30	3.38	0.64	0.010	8	0.69	130	1.30	49	3.74	0.58	PVC
10028	10030	5383	2872	0.19	0.83	0.16	0.35	6.88	3.24	1.13	0.010	8	0.43	118	1.03	109	2.95	0.67	PVC
10030	10032	8210	1313	0.22	1.01	0.22	4.58	12.92	2.39	10.97	0.010	18	0.60	83	10.58	104	5.99	0.23	CPP
10032	10033	0	0	0.00	0.28	0.00	4.58	13.15	2.37	10.87	0.010	18	0.49	41	9.56	114	5.41	0.13	CPP
Subbasin 2E - Winged Victory Circle																			
10046	Mid Pt	1788	4165	0.14	0.53	0.07	0.07	6.30	3.38	0.24	0.010	6	0.50	213	0.52	47	2.63	1.35	PVC - Estimated slope
30065	Mid Pt	13627	25857	0.91	0.57	0.52	0.52	6.30	3.38	1.74	0.013	6	2.00	88	0.79	219	4.04	0.36	DI - Estimated slope
Mid Pt	10033	0	0	0.00	0.28	0.00	0.59	8.01	3.01	1.77	0.010	6	0.50	89	0.52	343	2.63	0.56	PVC - Estimated slope
10033	30010	25228	3792	0.67	1.01	0.68	5.85	15.55	2.19	12.79	0.010	18	0.57	89	10.31	124	5.83	0.25	PVC
Subbasin 2F - Cherry Lane SW (east of Temple of Justice)																			
32216	31280	0	0	0.00	0.28	0.00	0.00	6.30	3.38	0.00	0.010	8	0.39	311	0.98	0	2.81	1.84	PVC
31280	31246	25878	4133	0.69	1.01	0.69	0.69	8.14	2.99	2.07	0.010	8	0.74	81	1.35	153	3.87	0.35	PVC
31246	31245	6943	4525	0.26	0.79	0.21	0.90	8.49	2.93	2.64	0.010	8	0.74	81	1.35	195	3.87	0.35	PVC
31245	31244	35412	42222	1.78	0.66	1.18	2.08	8.84	2.87	5.98	0.010	8	0.32	31	0.89	673	2.55	0.20	PVC
31244	31239	0	0	0.00	0.28	0.00	2.08	9.04	2.84	5.91	0.010	8	0.46	44	1.07	555	3.05	0.24	PVC
31239	30010	0	0	0.00	0.28	0.00	2.08	9.28	2.80	5.84	0.010	8	1.30	193	1.79	326	5.13	0.63	PVC
30010	SD-100(54)	0	0	0.00	0.28	0.00	7.93	19.16	1.98	15.70	0.010	24	0.86	187	27.27	58	8.68	0.36	PVC
Subbasin 2G - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																			
32630	SD-100(54)	7229	3578	0.25	0.84	0.21	0.21	6.30	3.38	0.71	0.010	8	0.50	68	1.11	64	3.18	0.36	PVC - Estimated slope

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 100yr BASIN

PIPE SIZING
(Runoff by Rational Method)
(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious
c = 0.28 Lawn

m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)
n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
31344	SD-100(54)	3822	3183	0.16	0.74	0.12	0.12	6.30	3.38	0.40	0.010	6	0.50	68	0.52	78	2.63	0.43	PVC - Estimated slope
SD-100(54)	31730	0	0	0.00	0.28	0.00	8.26	20.31	1.93	15.90	0.010	24	0.50	39	20.80	76	6.62	0.10	PVC - Estimated slope
31730	31734	17706	15266	0.76	0.73	0.55	8.81	20.41	1.92	16.93	0.010	24	0.38	210	18.13	93	5.77	0.61	PVC
31734	31735	14385	11132	0.59	0.75	0.44	9.25	21.01	1.89	17.53	0.010	24	0.26	38	15.00	117	4.77	0.13	PVC
31735	32169	0	0	0.00	0.28	0.00	9.25	21.15	1.89	17.47	0.010	24	0.34	89	17.15	102	5.46	0.27	PVC
Subbasin 2H - Pleasant Lane SW (west of Capitol Building)																			
31618	31617	9824	2066	0.27	0.98	0.27	0.27	6.30	3.38	0.90	0.010	6	1.04	82	0.74	121	3.79	0.36	PVC
31617	11310	0	0	0.00	0.28	0.00	0.27	6.66	3.29	0.88	0.010	6	8.25	212	2.10	42	10.67	0.33	PVC
11310	31423	0	0	0.00	0.28	0.00	0.27	6.99	3.21	0.86	0.010	8	4.06	106	3.17	27	9.07	0.19	PVC
31423	31424	50721	7349	1.33	1.02	1.36	1.62	7.19	3.17	5.15	0.010	10	3.07	140	4.99	103	9.15	0.25	PVC
31424	31768	3724	9309	0.30	0.52	0.15	1.78	7.44	3.12	5.54	0.010	10	0.32	62	1.61	344	2.95	0.35	PVC - Assumed size and slope
32681	31768	12942	7533	0.47	0.81	0.38	0.38	6.30	3.38	1.29	0.010	10	1.65	157	3.66	35	6.71	0.39	PVC
31768	CB TYP II	981	3151	0.09	0.48	0.05	2.21	8.18	2.98	6.57	0.010	10	3.49	83	5.32	123	9.76	0.14	PVC
CB TYP I-1	CB TYP I-2	1203	2767	0.09	0.53	0.05	0.05	6.30	3.38	0.16	0.010	12	3.67	60	8.87	2	11.30	0.09	PVC
CB TYP I-2	CB TYP II	12050	23502	0.82	0.56	0.46	0.51	6.39	3.35	1.70	0.013	12	3.75	24	6.90	25	8.78	0.05	DI
CB TYP I-3	CB TYP II	3197	15198	0.42	0.42	0.18	0.18	6.30	3.38	0.60	0.013	12	2.22	36	5.31	11	6.76	0.09	DI
CB TYP II	32169	0	0	0.00	0.28	0.00	2.89	8.55	2.92	8.44	0.010	10	2.59	58	4.58	184	8.40	0.12	PVC
31737	32169	3893	1730	0.13	0.86	0.11	0.11	6.30	3.38	0.38	0.010	8	6.30	84	3.94	10	11.30	0.12	PVC
Subbasin 2I - Pleasant Lane SW (west of Temple of Justice)																			
32214	32173	73775	23774	2.24	0.92	2.06	2.06	6.30	3.38	6.94	0.010	8	1.80	156	2.11	329	6.04	0.43	PVC
32173	32172	0	0	0.00	0.70	0.00	2.06	6.73	3.27	6.72	0.010	8	0.63	32	1.24	541	3.56	0.15	PVC
32172	32171	0	0	0.00	0.70	0.00	2.06	6.88	3.24	6.65	0.010	8	2.05	39	2.25	296	6.44	0.10	PVC
32171	32169	0	0	0.00	0.28	0.00	2.06	6.98	3.21	6.61	0.010	8	2.00	170	2.22	297	6.36	0.45	PVC
Subbasin 2J - Mansion Parking Lot																			

EXISTING CONDITIONS

PROJ: **WCC Drainage Master Plan**

PIPE SIZING

WO: 21-2014-008

(Runoff by Rational Method)

Calculated by: BTS

DATE: 1/5/2015

(Pipe Capacity by Manning's Eqn.)

Checked by: HK

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Pipe Capacity – Existing Conditions.xls]Pipe Sizing 100yr BASIN

Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious

m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)

c = 0.28 Lawn

n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
32169	CB TYP II-2	0	0	0.00	0.28	0.00	14.31	24.45	1.76	25.21	0.024	24	1.02	225	12.38	204	3.94	0.95	CMP - Conflicting pipe sizes (i.e., 20 vs. 24)
CB TYP II-2	32266	11899	24264	0.83	0.55	0.46	14.77	25.40	1.73	25.55	0.024	20	1.00	108	7.54	339	3.45	0.52	Corrugated Metal Pipe (CMP)
32266	2012	0	0	0.00	0.28	0.00	14.77	25.92	1.71	25.30	0.024	20	1.00	142	7.54	336	3.45	0.69	Conflicting material types (i.e., CMP vs. DI)
32268	2012	2309	24033	0.60	0.35	0.21	0.21	6.30	3.38	0.71	0.013	6	20.00	142	2.51	28	12.78	0.19	Concrete
2012	Outfall	0	0	0.00	0.28	0.00	14.98	26.79	1.69	25.26	0.013	20	44.62	186	92.93	27	42.60	0.07	DI
BASIN 3 - Mansion Parking Lot (north side)																			
32250	32265	3035	0	0.07	1.12	0.08	0.08	6.30	3.38	0.26	0.013	6	0.94	64	0.54	49	2.77	0.38	Concrete
32265	Tee	1539	0	0.04	1.12	0.04	0.12	6.68	3.28	0.39	0.013	6	2.70	148	0.92	42	4.70	0.53	Concrete
32247	Tee	17117	0	0.39	1.12	0.44	0.44	6.30	3.38	1.49	0.010	6	0.87	58	0.68	219	3.47	0.28	PVC
Tee	32248	0	0	0.00	0.28	0.00	0.56	7.49	3.11	1.74	0.010	6	1.00	10	0.73	239	3.72	0.04	PVC
32248	Mid1	5251	0	0.12	1.12	0.14	0.14	7.53	3.10	0.42	0.010	8	2.00	108	2.22	19	6.36	0.28	PVC
Mid1	Mid2	22085	0	0.51	1.12	0.57	0.57	7.82	3.04	1.74	0.010	8	2.00	59	2.22	78	6.36	0.15	PVC - Conflicting pipe sizes (6 vs. 8)
Mid2	33250 (Outfall)	18957	0	0.44	1.12	0.49	0.49	7.97	3.02	1.48	0.010	8	30.00	269	8.60	17	24.65	0.18	CPP - Conflicting pipe sizes (6 vs. 8)

Table 4.2.1.D
Manning's "n" Values for Pipes

Type of Pipe Material	Analysis Method	
	Uniform Flow (Preliminary design)	Backwater Flow (Capacity Verification)
A. Concrete pipe and LCPE pipe	0.014	0.012
B. Annular Corrugated Metal Pipe or Pipe Arch		
1. 2-2/3" x 1/2" corrugation (riveted):		
a. plain or fully coated	0.028	0.024
b. paved invert (40% of circumference paved):		
1) flow at full depth	0.021	0.018
2) flow at 80% full depth	0.018	0.016
3) flow at 60% full depth	0.015	0.013
c. Treatment 5	0.015	0.013
2. 3" x 1" corrugation	0.031	0.027
3. 6" x 2" corrugation (field bolted)	0.035	0.030
C. Helical 2-2/3" x 1/2" corrugation and CPE pipe	0.028	0.024
D. Spiral rib metal pipe and PVC pipe	0.013	0.011
E. Ductile iron pipe cement lined	0.014	0.012
F. SWPE pipe (butt fused only)	0.009	0.009

Source: 2009 King County, WA Surface Water Design Manual

EXISTING CONDITIONS

Backwater Calculation Sheet

100-year Storm

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Backwater – Existing Conditions.xls]BACKWATR-25yr

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM (ft)	Overtopping
BASIN 1 - Pritchard Building (west side)																				
Outfall 1	11288	2.83	100	12	0.012	0	106.85	0.785	3.603	0.202	0.845	0.532	1.377	0.040	0.202	1.619	0.031	1.588	128.85	No
11288	11284	1.11	43	12	0.012	110.3	110.76	0.785	1.413	0.031	111.015	0.035	111.050	0.006	0.031	111.087	0.084	111.003	127.31	No
11288	11294	1.83	147	12	0.012	112.59	115.7	0.785	2.330	0.084	113.370	0.327	113.697	0.017	0.084	113.798	0.018	113.780	130.79	No
11294	11301	0.85	139	12	0.012	117.9	120.8	0.785	1.082	0.018	118.585	0.067	118.652	0.004	0.018	118.674	0.017	118.657	132.66	No
11301	11032	0.82	108	12	0.012	120.9	135.5	0.785	1.044	0.017	121.585	0.048	121.633	0.003	0.017	121.654	0.071	121.583	140.98	No
11032	11074	0.42	135	6	0.012	135.5	137.9	0.196	2.139	0.071	135.815	0.637	136.452	0.014	0.071	136.537	0.000	136.537	140.02	No
BASIN 2																				
Subbasin 2J - Mansion Parking Lot																				
Outfall Elevation: Capitol Lake surface 0 FT																				
Outfall	2012	17.81	186	20	0.012	0	91	2.182	8.163	1.035	1.595	2.576	4.171	0.207	1.035	5.413	1.141	4.272	98.88	No
2012	32268	0.51	142	6	0.012	91.2	110	0.196	2.597	0.105	91.550	0.987	92.537	0.021	0.105	92.663	0.000	92.663	111.72	No
2012	32266	17.82	142	20	0.012	92.4	94.9	2.182	8.168	1.036	93.995	1.969	95.964	0.207	1.036	97.207	1.056	96.151	114.76	No
32266	CB TYP II-2	17.99	108	20	0.012	92.4	94.9	2.182	8.246	1.056	96.151	1.526	97.677	0.211	1.056	98.944	0.495	98.450	119.05	No
CB TYP II-2	32169	17.73	225	24	0.012	95.1	97.4	3.142	5.644	0.495	98.450	1.169	99.618	0.099	0.495	100.212	5.037	95.175	114.33	No
Subbasin 2I - Pleasant Lane SW (west of Temple of Justice)																				
32169	32171	4.75	170	8	0.012	100	103.4	0.349	13.608	2.875	100.650	22.129	122.779	0.575	2.875	126.230	2.912	123.318	110	YES
32171	32172	4.78	39	8	0.012	103.5	104.3	0.349	13.694	2.912	123.318	5.141	128.459	0.582	2.912	131.953	2.973	128.980	109.46	YES
32172	32173	4.83	32	8	0.012	104.6	104.8	0.349	13.837	2.973	128.980	4.307	133.287	0.595	2.973	136.855	3.161	133.694	109.36	YES
32173	32214	4.98	156	8	0.012	104.8	107.6	0.349	14.267	3.161	133.694	22.321	156.016	0.632	3.161	159.808	0.000	159.808	109.89	YES
Subbasin 2H - Pleasant Lane SW (west of Capitol Building)																				
32169	31737	0.27	84	8	0.012	107.5	112.8	0.349	0.773	0.009	107.950	0.035	107.985	0.002	0.009	107.996	0.000	107.996	115.34	No
32169	CB TYP II	6.06	58	10	0.012	98.4	99.9	0.545	11.111	1.917	99.215	3.741	102.956	0.383	1.917	105.256	0.005	105.252	115.82	No
CB TYP II	CB TYP I-3	0.43	36	12	0.012	112.3	113.1	0.785	0.547	0.005	112.930	0.004	112.934	0.001	0.005	112.940	0.000	112.940	115.73	No
CB TYP II	CB TYP I-2	1.22	24	12	0.012	112.4	113.6	0.785	1.553	0.037	113.125	0.024	113.149	0.007	0.037	113.194	0.000	113.193	116.27	No
CB TYP I-2	CB TYP I-1	0.12	60	12	0.012	113.5	113.7	0.785	0.153	0.000	114.100	0.001	114.101	0.000	0.000	114.101	0.000	114.101	118.71	No
CB TYP II	31768	4.72	83	10	0.012	99.9	102.8	0.545	8.654	1.163	105.252	3.248	108.499	0.233	1.163	109.895	0.872	109.023	119.48	No
31768	32681	0.93	83	10	0.012	103.1	105.7	0.545	1.705	0.045	109.023	0.126	109.149	0.009	0.045	109.203	0.000	109.203	117	No
31768	31424	3.98	62	10	0.012	103	105.5	0.545	7.297	0.827	109.023	1.725	110.748	0.165	0.827	111.740	0.715	111.025	117.98	No
31424	31423	3.7	140	10	0.012	105.9	110.2	0.545	6.784	0.715	111.025	3.366	114.391	0.143	0.715	115.249	0.049	115.200	123.79	No
31423	11310	0.62	106	8	0.012	119.2	123.5	0.349	1.776	0.049	119.785	0.235	120.020	0.010	0.049	120.079	0.160	119.919	124.82	No
11310	31617	0.63	212	6	0.012	123.7	141.19	0.196	3.209	0.160	124.035	2.249	126.284	0.032	0.160	126.476	0.170	126.306	143.79	No
31617	31618	0.65	82	6	0.012	141.34	142.2	0.196	3.310	0.170	141.680	0.926	142.606	0.034	0.170	142.810	0.000	142.810	142.85	No

EXISTING CONDITIONS

Backwater Calculation Sheet

100-year Storm

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
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Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM (ft)	Overtopping
Subbasin 2G - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																				
32169	31735	12.24	89	24	0.012	98.3	98.6	3.142	3.896	0.236	100.060	0.220	100.280	0.047	0.236	100.563	0.237	100.326	114.33	No
31735	31734	12.27	38	24	0.012	98.6	98.7	3.142	3.906	0.237	100.326	0.095	100.421	0.047	0.237	100.705	0.221	100.485	114.81	No
31734	31730	11.84	210	24	0.012	98.6	99.4	3.142	3.769	0.221	100.485	0.486	100.971	0.044	0.221	101.236	0.195	101.041	114.47	No
31730	SD-100(54)	11.12	39	24	0.012	99.8	?	3.142	3.540	0.195	101.041	0.080	101.121	0.039	0.195	101.354	0.256	101.098	114.5	No
SD-100(54)	31344	0.29	68	6	0.012	?	113.4	0.196	1.477	0.034	101.098	0.153	101.251	0.007	0.034	101.292	0.000	101.292	115.93	No
SD-100(54)	32630	0.51	68	8	0.012	?	104.37	0.349	1.461	0.033	101.098	0.102	101.200	0.007	0.033	101.240	0.000	101.240	116.65	No
Subbasin 2F - Cherry Lane SW (east of Temple of Justice)																				
SD-100(54)	30010	10.96	187	24	0.012	?	101.6	3.142	3.489	0.189	101.098	0.371	101.469	0.038	0.189	101.696	4.348	97.348	115.75	No
30010	31239	4.2	193	8	0.012	101.6	104.1	0.349	12.032	2.248	102.260	19.642	121.902	0.450	2.248	124.600	2.302	122.298	110.02	YES
31239	31244	4.25	44	8	0.012	104.1	104.3	0.349	12.175	2.302	122.298	4.585	126.883	0.460	2.302	129.645	2.356	127.289	108.95	YES
31244	31245	4.3	31	8	0.012	103.7	104.4	0.349	12.319	2.356	127.289	3.307	130.596	0.471	2.356	133.424	0.460	132.964	108.11	YES
32145	31246	1.9	81	8	0.012	104	106	0.349	5.443	0.460	132.964	1.687	134.651	0.092	0.460	135.203	0.283	134.920	107.77	YES
31246	31280	1.49	81	8	0.012	105.9	106.6	0.349	4.269	0.283	134.920	1.038	135.957	0.057	0.283	136.297	0.000	136.297	108.98	YES
31280	32216	0.0	311	8	0.012	106.6	107.8	0.349	0.029	0.000	136.297	0.000	136.297	0.000	0.000	136.297	0.000	136.297	109.72	YES
Subbasin 2E - Winged Victory Circle																				
30010	10033	8.87	89	18	0.012	101.5	102	1.767	5.019	0.391	102.920	0.536	103.456	0.078	0.391	103.926	0.928	102.998	117.07	No
10033	Mid Pt	1.27	89	6	0.012	103.8	?	0.196	6.468	0.650	104.200	3.838	108.038	0.130	0.650	108.817	0.629	108.188	117	No
Mid Pt	30065	1.25	88	6	0.012	?	104.2	0.196	6.366	0.629	108.188	3.676	111.864	0.126	0.629	112.619	0.013	112.606	116.58	No
Mid Pt	10046	0.18	213	6	0.012	?	104.6	0.196	0.917	0.013	108.188	0.184	108.372	0.003	0.013	108.388	0.000	108.388	112.1	No
Subbasin 2D - South Diagonal																				
10033	10032	7.48	83	18	0.012	101.8	102	1.767	4.233	0.278	102.998	0.356	103.353	0.056	0.278	103.687	0.283	103.404	117.15	No
10032	10030	7.54	41	18	0.012	102	102.5	1.767	4.267	0.283	103.404	0.178	103.583	0.057	0.283	103.922	0.577	103.345	116.67	No
10030	10028	0.81	118	8	0.012	103.4	103.9	0.349	2.320	0.084	103.800	0.447	104.247	0.017	0.084	104.347	0.027	104.320	112.53	No
10028	10026	0.46	130	8	0.012	103.9	104.8	0.349	1.318	0.027	104.300	0.159	104.459	0.005	0.027	104.491	0.000	104.491	108.16	No
10030	10037	6.92	215	15	0.012	102.5	103.7	1.227	5.639	0.494	103.345	2.083	105.428	0.099	0.494	106.020	0.517	105.503	117.54	No
10037	10107	7.08	60	15	0.012	103.7	105.4	1.227	5.769	0.517	105.503	0.608	106.112	0.103	0.517	106.732	0.913	105.819	117.48	No
Subbasin 2C - South Diagonal																				
10107	31087	0.21	37	8	0.012	110.5	114.5	0.349	0.602	0.006	110.900	0.009	110.909	0.001	0.006	110.916	0.003	110.913	117.15	No
31087	30066	0.16	29	8	0.012	114.7	114.3	0.349	0.458	0.003	115.100	0.004	115.104	0.001	0.003	115.108	0.000	115.108	117.16	No
10107	10106	4.47	130	12	0.012	108.3	109.1	0.785	5.691	0.503	109.225	1.726	110.951	0.101	0.503	111.555	0.122	111.433	118.47	No
10106	12945	0.98	12	8	0.012	114.1	114.91	0.349	2.807	0.122	114.575	0.066	114.641	0.024	0.122	114.788	0.074	114.715	117.76	No
12945	11B	0.76	29	8	0.012	114.96	115.3	0.349	2.177	0.074	115.410	0.097	115.507	0.015	0.074	115.595	0.025	115.570	117.58	No
11B	11D	0.44	57	8	0.012	115.9	115.8	0.349	1.261	0.025	116.330	0.064	116.394	0.005	0.025	116.423	0.352	116.071	117.38	No

EXISTING CONDITIONS

Backwater Calculation Sheet

100-year Storm

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Calculated by: BTS
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Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM (ft)	Overtopping
10106	30967	3.74	170	12	0.012	109.2	111.3	0.785	4.762	0.352	111.433	1.580	113.013	0.070	0.352	113.435	0.358	113.078	118.35	No
30967	30969	3.77	54	12	0.012	112	113.3	0.785	4.800	0.358	113.078	0.510	113.588	0.072	0.358	114.017	0.000	114.017	118.28	No
Subbasin 2B - Cherberg Building (east side)																				
10107	SDMH	4.01	105	12	0.012	110.4	111.9	0.785	5.106	0.405	111.310	1.122	112.432	0.081	0.405	112.918	0.379	112.539	119.75	No
SDMH	30149	3.88	229	12	0.012	111.9	116.4	0.785	4.940	0.379	112.539	2.291	114.830	0.076	0.379	115.285	0.383	114.902	125.72	No
30149	30130	3.9	57	12	0.012	117.1	119.6	0.785	4.966	0.383	118.010	0.576	118.586	0.077	0.383	119.046	0.125	118.920	125.61	No
30130	135106	2.23	39	12	0.012	119.7	120.8	0.785	2.839	0.125	118.920	0.129	119.049	0.025	0.125	119.200	0.318	118.881	125.47	No
135106	135102	1.58	122	8	0.012	121.4	126.6	0.349	4.526	0.318	122.035	1.757	123.792	0.064	0.318	124.174	0.140	124.034	130.88	No
135102	10965	0.59	170	6	0.012	127	131.88	0.196	3.005	0.140	127.340	1.582	128.922	0.028	0.140	129.090	0.000	129.090	132.73	No
Subbasin 2A - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																				
30010	30015	8.24	83	12	0.012	111.3	111.7	0.785	10.491	1.709	112.285	3.745	116.030	0.342	1.709	118.081	4.079	114.002	116.64	No
30015	10701	8.84	351	10	0.012	111.9	115.5	0.545	16.208	4.079	114.002	48.174	162.177	0.816	4.079	167.072	4.257	162.814	124.71	YES
10701	32741	5.78	356	8	0.012	115.6	121.52	0.349	16.558	4.257	162.814	68.618	231.432	0.851	4.257	236.541	0.326	236.215	124.62	YES
32741	11309	1.6	115	8	0.012	121.52	123.6	0.349	4.584	0.326	236.215	1.699	237.914	0.065	0.326	238.305	0.000	238.305	124.46	YES
BASIN 3 - Mansion Parking Lot (north side)																				
33250(Outfall)	Mid2	1.06	269	8	0.012	11	106.56	0.349	3.037	0.143	11.480	1.744	13.224	0.029	0.143	13.396	0.011	13.384	13.37	YES
Mid2	Mid1	1.25	59	8	0.012	106.56	107.74	0.349	3.581	0.199	107.060	0.532	107.592	0.040	0.199	107.831	0.629	107.201	133.19	No
Mid1	32248	0.3	108	8	0.012	107.74	109.9	0.349	0.859	0.011	108.160	0.056	108.216	0.002	0.011	108.230	0.629	107.601	112.68	No
32248	Tee	1.25	10	6	0.012	112.59	115.7	0.196	6.366	0.629	113.015	0.418	113.433	0.126	0.629	114.188	0.493	113.695	112.1	YES
Tee	32247	1.07	58	6	0.012	117.9	120.8	0.196	5.449	0.461	118.305	1.775	120.080	0.092	0.461	120.634	0.000	120.634	112	YES
Tee	32265	0.28	148	6	0.012	120.9	135.5	0.196	1.426	0.032	121.215	0.310	121.525	0.006	0.032	121.563	0.015	121.549	117.3	YES
32265	32250	0.19	64	6	0.012	135.5	137.9	0.196	0.968	0.015	135.815	0.062	135.877	0.003	0.015	135.894	0.000	135.894	117.59	YES

NOTE: See Section 4.2.1.2 (Starting on Page 4-21) of the King Ccounty Surface Water Design Manual for the corresponding equations and a detailed explaination on how to use this spreadsheet. Items 16, 18, and 19 equaled zero for this analysis; therefore, they were not included within this spreadsheet.

EXISTING CONDITIONS

Backwater Calculation Sheet

100-year Storm

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Backwater – Existing Conditions.xls]BACKWATR-100yr

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM (ft)	Overtopping
BASIN 1 - Pritchard Building (west side)																				
Outfall 1	11288	4.13	100	12	0.012	0	106.85	0.785	5.258	0.429	0.920	1.134	2.054	0.086	0.429	2.569	0.060	2.508	128.85	No
11288	11284	1.55	43	12	0.012	110.3	110.76	0.785	1.974	0.060	111.055	0.069	111.124	0.012	0.060	111.196	0.000	111.196	127.31	No
11288	11294	2.54	147	12	0.012	112.59	115.7	0.785	3.234	0.162	113.440	0.630	114.070	0.032	0.162	114.265	0.036	114.230	130.79	No
11294	11301	1.19	139	12	0.012	117.9	120.8	0.785	1.515	0.036	118.635	0.131	118.766	0.007	0.036	118.809	0.033	118.776	132.66	No
11301	11032	1.14	108	12	0.012	120.9	135.5	0.785	1.451	0.033	121.635	0.093	121.728	0.007	0.033	121.768	0.135	121.632	140.98	No
11032	11074	0.58	135	6	0.012	135.5	137.9	0.196	2.954	0.135	135.835	1.214	137.049	0.027	0.135	137.212	0.000	137.212	140.02	No
BASIN 2																				
Subbasin 2J - Mansion Parking Lot																				
Outfall Elevation: Capitol Lake surface 0 FT																				
Outfall	2012	25.26	186	20	0.012	0	91	2.182	11.578	2.082	1.640	5.182	6.822	0.416	2.082	9.320	2.291	7.029	98.88	No
2012	32268	0.71	142	6	0.012	91.2	110	0.196	3.616	0.203	91.575	1.914	93.489	0.041	0.203	93.732	0.000	93.732	111.72	No
2012	32266	25.3	142	20	0.012	92.4	94.9	2.182	11.597	2.088	94.040	3.969	98.009	0.418	2.088	100.515	2.130	98.385	114.76	No
32266	CB TYP II-2	25.55	108	20	0.012	92.4	94.9	2.182	11.711	2.130	98.385	3.078	101.463	0.426	2.130	104.019	1.000	103.019	119.05	No
CB TYP II-2	32169	25.21	225	24	0.012	95.1	97.4	3.142	8.025	1.000	103.019	2.363	105.382	0.200	1.000	106.581	9.785	96.797	114.33	No
Subbasin 2I - Pleasant Lane SW (west of Temple of Justice)																				
32169	32171	6.61	170	8	0.012	100	103.4	0.349	18.936	5.568	100.670	42.853	143.523	1.114	5.568	150.205	5.636	144.569	110	YES
32171	32172	6.65	39	8	0.012	103.5	104.3	0.349	19.051	5.636	144.569	9.950	154.520	1.127	5.636	161.283	5.755	155.528	109.46	YES
32172	32173	6.72	32	8	0.012	104.6	104.8	0.349	19.251	5.755	155.528	8.337	163.865	1.151	5.755	170.771	6.138	164.633	109.36	YES
32173	32214	6.94	156	8	0.012	104.8	107.6	0.349	19.882	6.138	164.633	43.349	207.982	1.228	6.138	215.347	0.000	215.347	109.89	YES
Subbasin 2H - Pleasant Lane SW (west of Capitol Building)																				
32169	31737	0.38	84	8	0.012	107.5	112.8	0.349	1.089	0.018	108.170	0.070	108.240	0.004	0.018	108.262	0.000	108.262	115.34	No
32169	CB TYP II	8.44	58	10	0.012	98.4	99.9	0.545	15.474	3.718	99.230	7.256	106.486	0.744	3.718	110.948	0.009	110.939	115.82	No
CB TYP II	CB TYP I-3	0.6	36	12	0.012	112.3	113.1	0.785	0.764	0.009	112.940	0.009	112.949	0.002	0.009	112.959	0.000	112.959	115.73	No
CB TYP II	CB TYP I-2	1.7	24	12	0.012	112.4	113.6	0.785	2.165	0.073	113.170	0.046	113.216	0.015	0.073	113.303	0.001	113.303	116.27	No
CB TYP I-2	CB TYP I-1	0.16	60	12	0.012	113.5	113.7	0.785	0.204	0.001	114.100	0.001	114.101	0.000	0.001	114.102	0.000	114.102	118.71	No
CB TYP II	31768	6.57	83	10	0.012	99.9	102.8	0.545	12.046	2.253	110.939	6.292	117.232	0.451	2.253	119.935	1.689	118.246	119.48	No
31768	32681	1.29	83	10	0.012	103.1	105.7	0.545	2.365	0.087	118.246	0.243	118.489	0.017	0.087	118.593	0.000	118.593	117	YES
31768	31424	5.54	62	10	0.012	103	105.5	0.545	10.157	1.602	118.246	3.342	121.588	0.320	1.602	123.511	1.384	122.126	117.98	YES
31424	31423	5.15	140	10	0.012	105.9	110.2	0.545	9.442	1.384	122.126	6.521	128.648	0.277	1.384	130.309	0.094	130.215	123.79	YES
31423	11310	0.86	106	8	0.012	119.2	123.5	0.349	2.464	0.094	130.215	0.452	130.667	0.019	0.094	130.780	0.312	130.469	124.82	YES
11310	31617	0.88	212	6	0.012	123.7	141.19	0.196	4.482	0.312	130.469	4.389	134.857	0.062	0.312	135.232	0.326	134.906	143.79	No
31617	31618	0.9	82	6	0.012	141.34	142.2	0.196	4.584	0.326	141.700	1.776	143.476	0.065	0.326	143.867	0.000	143.867	142.85	YES

EXISTING CONDITIONS

Backwater Calculation Sheet

100-year Storm

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Backwater – Existing Conditions.xls]BACKWATR-100yr

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM (ft)	Overtopping
Subbasin 2G - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																				
32169	31735	17.47	89	24	0.012	98.3	98.6	3.142	5.561	0.480	100.050	0.449	100.499	0.096	0.480	101.075	0.483	100.592	114.33	No
31735	31734	17.53	38	24	0.012	98.6	98.7	3.142	5.580	0.483	100.592	0.193	100.784	0.097	0.483	101.365	0.451	100.914	114.81	No
31734	31730	16.93	210	24	0.012	98.6	99.4	3.142	5.389	0.451	100.914	0.995	101.908	0.090	0.451	102.449	0.398	102.052	114.47	No
31730	SD-100(54)	15.9	39	24	0.012	99.8	?	3.142	5.061	0.398	102.052	0.163	102.215	0.080	0.398	102.692	0.516	102.175	114.5	No
SD-100(54)	31344	0.4	68	6	0.012	?	113.4	0.196	2.037	0.064	102.175	0.291	102.466	0.013	0.064	102.544	0.000	102.544	115.93	No
SD-100(54)	32630	0.71	68	8	0.012	?	104.37	0.349	2.034	0.064	102.175	0.198	102.373	0.013	0.064	102.450	0.000	102.450	116.65	No
Subbasin 2F - Cherry Lane SW (east of Temple of Justice)																				
SD-100(54)	30010	15.7	187	24	0.012	?	101.6	3.142	4.997	0.388	102.175	0.762	102.937	0.078	0.388	103.402	8.466	94.937	115.75	No
30010	31239	5.84	193	8	0.012	101.6	104.1	0.349	16.730	4.346	102.260	37.977	140.237	0.869	4.346	145.452	4.451	141.001	110.02	YES
31239	31244	5.91	44	8	0.012	104.1	104.3	0.349	16.931	4.451	141.001	8.867	149.868	0.890	4.451	155.209	4.557	150.652	108.95	YES
31244	31245	5.98	31	8	0.012	103.7	104.4	0.349	17.131	4.557	150.652	6.396	157.048	0.911	4.557	162.516	0.888	161.628	108.11	YES
32145	31246	2.64	81	8	0.012	104	106	0.349	7.563	0.888	161.628	3.257	164.885	0.178	0.888	165.951	0.546	165.405	107.77	YES
31246	31280	2.07	81	8	0.012	105.9	106.6	0.349	5.930	0.546	165.405	2.002	167.408	0.109	0.546	168.063	0.000	168.063	108.98	YES
31280	32216	0.0	311	8	0.012	106.6	107.8	0.349	0.029	0.000	168.063	0.000	168.063	0.000	0.000	168.063	0.000	168.063	109.72	YES
Subbasin 2E - Winged Victory Circle																				
30010	10033	12.79	89	18	0.012	101.5	102	1.767	7.238	0.813	102.920	1.115	104.035	0.163	0.813	105.011	1.849	103.161	117.07	No
10033	Mid Pt	1.77	89	6	0.012	103.8	?	0.196	9.015	1.262	104.215	7.454	111.669	0.252	1.262	113.183	1.219	111.964	117	No
Mid Pt	30065	1.74	88	6	0.012	?	104.2	0.196	8.862	1.219	111.964	7.123	119.086	0.244	1.219	120.550	0.023	120.527	116.58	YES
Mid Pt	10046	0.24	213	6	0.012	?	104.6	0.196	1.222	0.023	111.964	0.328	112.292	0.005	0.023	112.320	0.000	112.320	112.1	YES
Subbasin 2D - South Diagonal																				
10033	10032	10.87	83	18	0.012	101.8	102	1.767	6.151	0.588	103.161	0.751	103.912	0.118	0.588	104.617	0.598	104.019	117.15	No
10032	10030	10.97	41	18	0.012	102	102.5	1.767	6.208	0.598	104.019	0.378	104.397	0.120	0.598	105.115	2.002	103.113	116.67	No
10030	10028	1.13	118	8	0.012	103.4	103.9	0.349	3.237	0.163	103.900	0.869	104.769	0.033	0.163	104.965	0.052	104.912	112.53	No
10028	10026	0.64	130	8	0.012	103.9	104.8	0.349	1.833	0.052	104.350	0.307	104.657	0.010	0.052	104.720	0.000	104.720	108.16	No
10030	10037	10.13	215	15	0.012	102.5	103.7	1.227	8.255	1.058	103.113	4.464	107.577	0.212	1.058	108.846	1.111	107.735	117.54	No
10037	10107	10.38	60	15	0.012	103.7	105.4	1.227	8.458	1.111	107.735	1.308	109.043	0.222	1.111	110.376	0.011	110.366	117.48	No
Subbasin 2C - South Diagonal																				
10107	31087	0.29	37	8	0.012	110.5	114.5	0.349	0.831	0.011	110.925	0.018	110.943	0.002	0.011	110.956	0.006	110.950	117.15	No
31087	30066	0.22	29	8	0.012	114.7	114.3	0.349	0.630	0.006	115.100	0.008	115.108	0.001	0.006	115.115	0.000	115.115	117.16	No
10107	10106	6.22	130	12	0.012	108.3	109.1	0.785	7.920	0.974	110.366	3.343	113.708	0.195	0.974	114.877	0.239	114.638	118.47	No
10106	12945	1.37	12	8	0.012	114.1	114.91	0.349	3.925	0.239	114.638	0.130	114.768	0.048	0.239	115.055	0.140	114.914	117.76	No
12945	11B	1.05	29	8	0.012	114.96	115.3	0.349	3.008	0.140	114.914	0.184	115.099	0.028	0.140	115.267	0.049	115.218	117.58	No
11B	11D	0.62	57	8	0.012	115.9	115.8	0.349	1.776	0.049	115.218	0.126	115.345	0.010	0.049	115.404	0.683	114.720	117.38	No

EXISTING CONDITIONS

Backwater Calculation Sheet

100-year Storm

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Existing Conditions\[Backwater – Existing Conditions.xls]BACKWATR-100yr

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM (ft)	Overtopping
10106	30967	5.21	170	12	0.012	109.2	111.3	0.785	6.634	0.683	114.638	3.067	117.705	0.137	0.683	118.525	0.694	117.831	118.35	No
30967	30969	5.25	54	12	0.012	112	113.3	0.785	6.684	0.694	117.831	0.989	118.820	0.139	0.694	119.653	0.000	119.653	118.28	YES
Subbasin 2B - Cherberg Building (east side)																				
10107	SDMH	5.57	105	12	0.012	110.4	111.9	0.785	7.092	0.781	110.366	2.165	112.531	0.156	0.781	113.468	0.734	112.734	119.75	No
SDMH	30149	5.4	229	12	0.012	111.9	116.4	0.785	6.875	0.734	112.870	4.438	117.308	0.147	0.734	118.189	0.739	117.449	125.72	No
30149	30130	5.42	57	12	0.012	117.1	119.6	0.785	6.901	0.739	118.070	1.113	119.183	0.148	0.739	120.070	0.243	119.827	125.61	No
30130	135106	3.11	39	12	0.012	119.7	120.8	0.785	3.960	0.243	119.827	0.251	120.077	0.049	0.243	120.370	0.622	119.747	125.47	No
135106	135102	2.21	122	8	0.012	121.4	126.6	0.349	6.331	0.622	121.960	3.438	125.398	0.124	0.622	126.145	0.271	125.874	130.88	No
135102	10965	0.82	170	6	0.012	127	131.88	0.196	4.176	0.271	127.325	3.056	130.381	0.054	0.271	130.706	0.000	130.706	132.73	No
Subbasin 2A - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																				
30010	30015	11.46	83	12	0.012	111.3	111.7	0.785	14.591	3.306	112.300	7.245	119.545	0.661	3.306	123.512	7.897	115.615	116.64	No
30015	10701	12.3	351	10	0.012	111.9	115.5	0.545	22.552	7.897	115.615	93.265	208.880	1.579	7.897	218.357	8.258	210.098	124.71	YES
10701	32741	8.05	356	8	0.012	115.6	121.52	0.349	23.061	8.258	210.098	133.099	343.198	1.652	8.258	353.108	0.634	352.474	124.62	YES
32741	11309	2.23	115	8	0.012	121.52	123.6	0.349	6.388	0.634	352.474	3.299	355.773	0.127	0.634	356.534	0.000	356.534	124.46	YES
BASIN 3 - Mansion Parking Lot (north side)																				
33250(Outfall)	Mid2	1.65	269	8	0.012	11	106.56	0.349	4.727	0.347	11.550	4.225	15.775	0.069	0.347	16.192	0.475	15.717	13.37	YES
Mid2	Mid1	1.93	59	8	0.012	106.56	107.74	0.349	5.529	0.475	107.125	1.268	108.393	0.095	0.475	108.963	0.027	108.936	133.19	No
Mid1	32248	0.46	108	8	0.012	107.74	109.9	0.349	1.318	0.027	108.215	0.132	108.347	0.005	0.027	108.379	1.439	106.940	112.68	No
32248	Tee	1.89	10	6	0.012	112.59	115.7	0.196	9.626	1.439	113.030	0.955	113.985	0.288	1.439	115.711	0.000	115.711	112.1	YES
Tee	32247	1.49	58	6	0.012	117.9	120.8	0.196	7.588	0.894	118.315	3.442	121.757	0.179	0.894	122.830	0.000	122.830	112	YES
Tee	32265	0.39	148	6	0.012	120.9	135.5	0.196	1.986	0.061	121.250	0.602	121.852	0.012	0.061	121.925	0.027	121.898	117.3	YES
32265	32250	0.26	64	6	0.012	135.5	137.9	0.196	1.324	0.027	135.825	0.116	135.941	0.005	0.027	135.973	0.000	135.973	117.59	YES

NOTE: See Section 4.2.1.2 (Starting on Page 4-21) of the King Ccounty Surface Water Design Manual for the corresponding equations and a detailed explaination on how to use this spreadsheet. Items 16, 18, and 19 equaled zero for this analysis; therefore, they were not included within this spreadsheet.

APPENDIX E :

HYDROLOGIC & HYDRAULIC CALCULATIONS – PROPOSED

Runoff Coefficients for Rational Method
10-Year Return Frequency

General Land Covers			
	C		
Land Cover	Flat	Rolling 2%-10%	Hilly Over 10%
Pavement and roofs	0.90	0.90	0.90
Earth shoulders	0.50	0.50	0.50
Dirves and walks	0.75	0.80	0.85
Gravel pavement	0.50	0.55	0.60
City business areas	0.80	0.85	0.85
Surburban residential	0.25	0.35	0.40
Single family residential	0.30	0.40	0.50
Multi units, detached	0.40	0.50	0.60
Multi units, attached	0.60	0.65	0.70
Lawns, very sandy soil	0.05	0.07	0.10
Lawns, sandy soil	0.10	0.15	0.20
Lawns, heavy soil	0.17	0.22	0.35
Grass shoulders	0.25	0.25	0.25
Side slopes, earth	0.60	0.60	0.60
Side slopes, turf	0.30	0.30	0.30
Median areas, turf	0.25	0.30	0.30
Cultivated land, clay and loam	0.50	0.55	0.60
Cultivated land, sand and gravel	0.25	0.30	0.35
Industrial areas, light	0.50	0.70	0.80
Industrial areas, heavy	0.60	0.80	0.90
Parks and cemeteries	0.10	0.15	0.25
Playgrounds	0.20	0.25	0.30
Woodland and forests	0.10	0.15	0.20
Meadows and pasture land	0.25	0.30	0.35
Pasture with frozen ground	0.40	0.45	0.50
Unimproved areas	0.10	0.20	0.30

ource: WSDOT Hydraulics Manual, M 23-03.03, January 2015, Figure 2-5

Runoff Coefficients for Rational Method
25-Year Return Frequency

General Land Covers			
	C		
Land Cover	Flat	Rolling 2%-10%	Hilly Over 10%
Pavement and roofs	0.99	0.99	0.99
Earth shoulders	0.55	0.55	0.55
Dirves and walks	0.83	0.88	0.94
Gravel pavement	0.55	0.61	0.66
City business areas	0.88	0.94	0.94
Surburban residential	0.28	0.39	0.44
Single family residential	0.33	0.44	0.55
Multi units, detached	0.44	0.55	0.66
Multi units, attached	0.66	0.72	0.77
Lawns, very sandy soil	0.06	0.08	0.11
Lawns, sandy soil	0.11	0.17	0.22
Lawns, heavy soil	0.19	0.24	0.39
Grass shoulders	0.28	0.28	0.28
Side slopes, earth	0.66	0.66	0.66
Side slopes, turf	0.33	0.33	0.33
Median areas, turf	0.28	0.33	0.33
Cultivated land, clay and loam	0.55	0.61	0.66
Cultivated land, sand and gravel	0.28	0.33	0.39
Industrial areas, light	0.55	0.77	0.88
Industrial areas, heavy	0.66	0.88	0.99
Parks and cemeteries	0.11	0.17	0.28
Playgrounds	0.22	0.28	0.33
Woodland and forests	0.11	0.17	0.22
Meadows and pasture land	0.28	0.33	0.39
Pasture with frozen ground	0.44	0.50	0.55
Unimproved areas	0.11	0.22	0.33

Note: Added 10% increase to values of return for 10-Year frequency, per WSDOT Hydraulics Manual, M 23-03.03, January 2015, Paragraph 2-5.2.

Runoff Coefficients for Rational Method
100-Year Return Frequency

General Land Covers			
	C		
Land Cover	Flat	Rolling 2%-10%	Hilly Over 10%
Pavement and roofs	1.13	1.13	1.13
Earth shoulders	0.63	0.63	0.63
Dirves and walks	0.94	1.00	1.06
Gravel pavement	0.63	0.69	0.75
City business areas	1.00	1.06	1.06
Surburban residential	0.31	0.44	0.50
Single family residential	0.38	0.50	0.63
Multi units, detached	0.50	0.63	0.75
Multi units, attached	0.75	0.81	0.88
Lawns, very sandy soil	0.06	0.09	0.13
Lawns, sandy soil	0.13	0.19	0.25
Lawns, heavy soil	0.21	0.28	0.44
Grass shoulders	0.31	0.31	0.31
Side slopes, earth	0.75	0.75	0.75
Side slopes, turf	0.38	0.38	0.38
Median areas, turf	0.31	0.38	0.38
Cultivated land, clay and loam	0.63	0.69	0.75
Cultivated land, sand and gravel	0.31	0.38	0.44
Industrial areas, light	0.63	0.88	1.00
Industrial areas, heavy	0.75	1.00	1.13
Parks and cemeteries	0.13	0.19	0.31
Playgrounds	0.25	0.31	0.38
Woodland and forests	0.13	0.19	0.25
Meadows and pasture land	0.31	0.38	0.44
Pasture with frozen ground	0.50	0.56	0.63
Unimproved areas	0.13	0.25	0.38

Note: Added 25% increase to values of return for 10-Year frequency, per WSDOT Hydraulics Manual, M 23-03.03, January 2015, Paragraph 2-

Manning's Coefficient of Roughness - Channel Linings
Table 2. Manning's "n" Values for Various Channel Linings (Channel Full)

Pipe Material	Roughness Coefficient "n"
Concrete	0.012
Short grass	0.030
Stony bottom and weedy banks	0.035
Cobble bottom and grass banks	0.040
Dense weeds as high as flow	0.080
Dense woody brush as high as flow	0.120

Source: Volume I - Minimum Technical Requirements Drainage Design and Erosion Control Manual for Olympia, WA

Manning's Coefficient of Roughness - Closed Conduit
Table 3. - Manning's "n" for Pipes

Pipe Material	Roughness Coefficient "n"
Concrete	0.013
Annular CMP or Pipe Arch	
2-2/3 x 1/2 corrugation	0.024
3 x 1 corrugation	0.027
6 x 2 corrugation	0.030
Helical	0.024
Spiral Rib	0.016
Ductile Iron (cement lined)	0.013
Plastic	0.010

Source: Volume I - Minimum Technical Requirements Drainage Design and Erosion Control Manual for Olympia, WA

Index to Rainfall Coefficients (English Units)

Source: WSDOT Hydraulics Manual, M 23-03.03, June 2010

	2-Year MRI		5-Year MRI		10-Year MRI		25-Year MRI		50-Year MRI		100-Year MRI	
Location	m	n	m	n	m	n	m	n	m	n	m	n
Aberdeen and Hoquiam	5.100	0.488	6.220	0.488	7.060	0.487	8.170	0.487	9.020	0.487	9.860	0.487
Bellingham	4.290	0.549	5.590	0.555	6.590	0.559	7.900	0.562	8.890	0.563	9.880	0.565
Bremerton	3.790	0.480	4.840	0.487	5.630	0.490	6.680	0.494	7.470	0.496	8.260	0.498
Centralia and Chehalis	3.630	0.506	4.850	0.518	5.760	0.524	7.000	0.530	7.920	0.533	8.860	0.537
Clarkston and Colfax	5.020	0.628	6.840	0.633	8.240	0.635	10.070	0.638	11.450	0.639	12.810	0.639
Colville	3.480	0.558	5.440	0.593	6.980	0.610	9.070	0.626	10.650	0.635	12.260	0.642
Ellensburg	2.890	0.590	5.180	0.631	7.000	0.649	9.430	0.664	11.300	0.672	13.180	0.678
Everett	3.690	0.556	5.200	0.570	6.310	0.575	7.830	0.582	8.960	0.585	10.070	0.586
Forks	4.190	0.410	5.120	0.412	5.840	0.413	6.760	0.414	7.470	0.415	8.180	0.416
Hoffstadt Cr. (SR 504)	3.960	0.448	5.210	0.462	6.160	0.469	7.440	0.476	8.410	0.480	9.380	0.484
Hoodsport	4.470	0.428	5.440	0.428	6.170	0.427	7.150	0.428	7.880	0.428	8.620	0.428
Kelso and Longview	4.250	0.507	5.500	0.515	6.450	0.509	7.740	0.524	8.700	0.526	9.670	0.529
Leavenworth	3.040	0.530	4.120	0.542	5.620	0.575	7.940	0.594	9.750	0.606	11.080	0.611
Metaline Falls	3.360	0.527	4.900	0.553	6.090	0.566	7.450	0.570	9.290	0.592	10.450	0.591
Moses Lake	2.610	0.583	5.050	0.634	6.990	0.655	9.580	0.671	11.610	0.681	13.630	0.688
Mt. Vernon	3.920	0.542	5.250	0.552	6.260	0.557	7.590	0.561	8.600	0.564	9.630	0.567
Naselle	4.570	0.432	5.670	0.441	6.140	0.432	7.470	0.443	8.050	0.440	8.910	0.436
Olympia	3.820	0.466	4.860	0.472	5.620	0.474	6.630	0.477	7.400	0.478	8.170	0.480
Omak	3.040	0.583	5.060	0.618	6.630	0.633	8.740	0.647	10.350	0.654	11.970	0.660
Pasco and Kennewick	2.890	0.590	5.180	0.631	7.000	0.649	9.430	0.664	11.300	0.672	13.180	0.678
Port Angeles	4.310	0.530	5.420	0.531	6.250	0.531	7.370	0.532	8.190	0.532	9.030	0.532
Poulsbo	3.830	0.506	4.980	0.513	5.850	0.516	7.000	0.519	7.860	0.521	8.740	0.523
Queets	4.260	0.422	5.180	0.423	5.870	0.423	6.790	0.432	7.480	0.423	8.180	0.424
Seattle	3.560	0.515	4.830	0.531	5.620	0.530	6.890	0.539	7.880	0.545	8.750	0.545
Sequim	3.500	0.551	5.010	0.569	6.160	0.577	7.690	0.585	8.880	0.590	10.040	0.593
Snoqualmie Pass	3.610	0.417	4.810	0.435	6.560	0.459	7.720	0.459	8.780	0.461	10.210	0.467
Spokane	3.470	0.556	5.430	0.591	6.980	0.609	9.090	0.626	10.680	0.635	12.330	0.643
Stevens Pass	4.730	0.462	6.090	0.470	8.190	0.500	8.530	0.484	10.610	0.499	12.450	0.513
Tacoma	3.570	0.516	4.780	0.527	5.700	0.533	6.930	0.539	7.860	0.542	8.790	0.545
Vancouver	2.920	0.477	4.050	0.496	4.920	0.506	6.060	0.515	6.950	0.520	7.820	0.525
Walla Walla	3.330	0.569	5.540	0.609	7.300	0.627	9.670	0.645	11.450	0.653	13.280	0.660
Wenatchee	3.150	0.535	4.880	0.566	6.190	0.579	7.940	0.592	9.320	0.600	10.680	0.605
Yakima	3.860	0.608	5.860	0.633	7.370	0.644	9.400	0.654	10.930	0.659	12.470	0.663

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan**

PIPE SIZING

WO: 21-2014-008

(Runoff by Rational Method)

Calculated by: BTS

DATE: 1/5/2015

(Pipe Capacity by Manning's Eqn.)

Checked by: HK

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 25yr BASIN

Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious

m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)

c = 0.24 Lawn

n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
BASIN 1 - Pritchard Building (west side)																			
11074	11032	6480	675	0.16	0.92	0.15	0.15	6.30	2.76	0.42	0.013	6	1.77	135	0.75	56	3.80	0.59	Concrete
11032	11301	7029	0	0.16	0.99	0.16	0.31	6.89	2.64	0.82	0.013	12	13.52	108	13.10	6	16.68	0.11	Concrete
11301	11294	0	2592	0.06	0.24	0.01	0.33	7.00	2.62	0.85	0.013	12	2.09	139	5.15	17	6.56	0.35	Concrete
11294	11288	16835	1070	0.41	0.95	0.39	0.71	7.35	2.56	1.83	0.013	12	2.12	147	5.19	35	6.61	0.37	Concrete
11284	11288	17775	0	0.41	0.99	0.40	0.40	6.30	2.76	1.11	0.013	12	1.07	43	3.69	30	4.69	0.15	Concrete
11288	Outfall 1	0	0	0.00	0.24	0.00	1.12	7.51	2.53	2.83	0.013	12	106.00	100	36.68	8	46.71	0.04	Concrete
BASIN 2																			
Subbasin 2A (Green) - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																			
11309	32741	20497	20917	0.95	0.61	0.58	0.58	6.30	2.76	1.60	0.013	12	2.56	115	5.70	28	7.26	0.26	Ductile Iron (DI) - Increased pipe diameter
32741	10701	60776	34150	2.18	0.72	1.57	2.15	6.56	2.70	5.82	0.013	18	0.94	356	10.18	57	5.76	1.03	Increased pipe diameter
10701	30015	61925	22054	1.93	0.79	1.53	3.68	7.59	2.52	9.28	0.013	18	1.20	351	11.51	81	6.51	0.90	Concrete - Increase pipe diameter
30015	30010	0	0	0.00	0.24	0.00	3.68	8.49	2.39	8.80	0.013	18	3.50	83	19.65	45	11.12	0.12	Increased pipe diameter
Subbasin 2B (Blue) - Cherberg Building (east side)																			
10965	135102	8902	2192	0.25	0.84	0.21	0.21	6.30	2.76	0.59	0.013	8	0.50	170	0.85	69	2.45	1.16	DI - Increased pipe diameter
CB3	135102	30000	3500	0.77	0.91	0.70	0.70	6.30	2.76	1.93	0.013	12	1.35	145	4.14	47	5.27	0.46	CPP -- Assume Imper & Perv Areas (Pritchard)
135102	135106	16386	8268	0.57	0.74	0.42	1.33	7.92	2.47	3.30	0.010	12	0.50	122	3.28	101	4.17	0.49	Polyvinyl chloride (PVC) - Increased pipe dia
135106	30130	10298	10768	0.48	0.61	0.29	1.63	8.40	2.40	3.91	0.010	12	2.82	39	7.78	50	9.90	0.07	Corrugated Plastic Pipe (CPP) - Increased pipe
30130	30149	30216	1548	0.73	0.95	0.70	2.32	8.47	2.39	5.56	0.010	12	4.39	57	9.70	57	12.36	0.08	CPP
30149	SDMH	0	0	0.00	0.24	0.00	2.32	8.55	2.38	5.54	0.010	18	2.00	229	19.31	29	10.93	0.35	ADS
SDMH	10107	2876	5446	0.19	0.50	0.10	2.42	8.90	2.34	5.65	0.010	18	1.34	105	15.81	36	8.95	0.20	CPP - Potentially replace with 18" diameter
Proposed -- Visitor Center																			
CB1	CB2	42000	0	0.96	0.99	0.95	0.95	6.30	2.76	2.63	0.010	12	0.50	87	3.28	80	4.17	0.35	CPP -- Assume Imper & Perv Areas
CB2	10106	0	0	0.00	0.24	0.00	0.95	6.65	2.69	2.56	0.010	12	5.00	190	10.36	25	13.19	0.24	CPP -- Assume Imper & Perv Areas

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan**

WO: 21-2014-008

DATE: 1/5/2015

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 25yr BASIN

PIPE SIZING

(Runoff by Rational Method)

(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS

Checked by: HK

Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious

c = 0.24 Lawn

m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)

n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
Subbasin 2C (Red) - South Diagonal																			
30969	30967	51001	37583	2.03	0.67	1.37	1.37	6.30	2.76	3.77	0.010	12	2.41	54	7.19	52	9.16	0.10	CPP -- Includes Sid Snyder Ave. SW
30967	10106	0	0	0.00	0.24	0.00	1.37	6.40	2.74	3.74	0.010	18	1.23	170	15.15	25	8.57	0.33	CPP
11D	11B	3124	16080	0.44	0.36	0.16	0.16	6.30	2.76	0.44	0.013	8	0.53	57	0.88	50	2.52	0.38	DI
11B	12945	4306	4367	0.20	0.61	0.12	0.28	6.68	2.68	0.76	0.010	8	4.29	29	3.25	23	9.32	0.05	PVC
12945	10106	3797	0	0.09	0.99	0.09	0.37	6.73	2.67	0.98	0.010	8	6.75	12	4.08	24	11.69	0.02	PVC
10106	10107	0	0	0.00	0.24	0.00	2.69	7.76	2.49	6.71	0.010	18	0.66	122	11.09	61	6.28	0.32	CPP - Increased pipe diameter
30066	31087	1547	3832	0.12	0.46	0.06	0.06	6.30	2.76	0.16	0.010	8	0.10	29	0.50	31	1.42	0.34	PVC
31087	10107	964	0	0.02	0.99	0.02	0.08	6.64	2.69	0.21	0.010	8	10.80	37	5.16	4	14.79	0.04	PVC
Subbasin 2D (Turquoise) - South Diagonal																			
10107	10037	0	0	0.00	0.24	0.00	5.19	11.26	2.09	10.84	0.010	18	0.80	215	12.21	89	6.91	0.52	CPP - Increased pipe diameter
10037	10030	0	0	0.00	0.24	0.00	5.19	11.78	2.04	10.61	0.010	18	2.00	60	19.31	55	10.93	0.09	CPP - Increased pipe diameter
10026	10028	6106	5264	0.26	0.64	0.17	0.17	6.30	2.76	0.46	0.010	8	0.69	130	1.30	35	3.74	0.58	PVC
10028	10030	5383	2872	0.19	0.73	0.14	0.31	6.88	2.64	0.81	0.010	8	0.43	118	1.03	79	2.95	0.67	PVC
10030	10032	8210	1313	0.22	0.89	0.19	5.69	13.11	1.94	11.05	0.010	24	0.60	83	22.78	49	7.25	0.19	CPP - Increased pipe diameter
10032	10033	0	0	0.00	0.24	0.00	5.69	13.31	1.93	10.97	0.010	24	0.49	41	20.59	53	6.55	0.10	CPP - Increased pipe diameter
Subbasin 2E (Tan) - Winged Victory Circle																			
10046	Mid Pt	1788	4165	0.14	0.47	0.06	0.06	6.30	2.76	0.18	0.010	6	0.50	213	0.52	34	2.63	1.35	PVC - Estimated slope
30065	Mid Pt	13627	25857	0.91	0.50	0.45	0.45	6.30	2.76	1.25	0.013	8	2.00	88	1.71	73	4.90	0.30	DI - Estimated slope - Increased pipe diameter
Mid Pt	10033	0	0	0.00	0.24	0.00	0.52	7.95	2.47	1.28	0.010	12	0.50	89	3.28	39	4.17	0.36	PVC - Estimated slope - Increased pipe diamete
10033	30010	25228	3792	0.67	0.89	0.59	6.80	15.42	1.80	12.23	0.010	24	0.57	89	22.20	55	7.07	0.21	PVC - Increased pipe diameter

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan**

WO: 21-2014-008

DATE: 1/5/2015

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 25yr BASIN

PIPE SIZING

(Runoff by Rational Method)

(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS

Checked by: HK

Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious

c = 0.24 Lawn

m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)

n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
Subbasin 2F (Gray) - Cherry Lane SW (east of Temple of Justice)																			
32216	31280	0	0	0.00	0.24	0.00	0.00	6.30	2.76	0.00	0.010	8	0.39	311	0.98	0	2.81	1.84	PVC
31280	31246	25878	4133	0.69	0.89	0.61	0.61	8.14	2.44	1.49	0.010	12	0.74	81	3.98	37	5.07	0.27	PVC - Increased pipe diameter
31246	31245	6943	4525	0.26	0.69	0.18	0.79	8.41	2.40	1.91	0.010	12	0.74	81	3.98	48	5.07	0.27	PVC - Increased pipe diameter
31245	31244	35412	42222	1.78	0.58	1.04	1.83	8.68	2.37	4.34	0.010	18	0.32	31	7.73	56	4.37	0.12	PVC - Increased pipe diameter
31244	31239	0	0	0.00	0.24	0.00	1.83	8.79	2.35	4.31	0.010	18	0.46	44	9.26	47	5.24	0.14	PVC - Increased pipe diameter
31239	30010	0	0	0.00	0.24	0.00	1.83	8.93	2.33	4.28	0.010	18	1.30	193	15.57	27	8.81	0.37	PVC - Increased pipe diameter
30010	SD-100(54)	0	0	0.00	0.24	0.00	8.63	18.42	1.65	14.26	0.010	24	0.86	187	27.27	52	8.68	0.36	PVC
Subbasin 2G (Pink) - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																			
32630	SD-100(54)	7229	3578	0.25	0.74	0.18	0.18	6.30	2.76	0.51	0.010	8	0.50	68	1.11	46	3.18	0.36	PVC - Estimated slope
31344	SD-100(54)	3822	3183	0.16	0.65	0.10	0.10	6.30	2.76	0.29	0.010	6	0.50	68	0.52	56	2.63	0.43	PVC - Estimated slope
SD-100(54)	31730	0	0	0.00	0.24	0.00	8.92	19.56	1.61	14.32	0.010	24	0.50	39	20.80	69	6.62	0.10	PVC - Estimated slope
31730	31734	17706	15266	0.76	0.64	0.49	9.41	19.66	1.60	15.07	0.010	24	0.38	210	18.13	83	5.77	0.61	PVC
31734	31735	14385	11132	0.59	0.66	0.39	9.80	20.27	1.58	15.46	0.010	24	0.26	38	15.00	103	4.77	0.13	PVC
31735	32169	0	0	0.00	0.24	0.00	9.80	20.40	1.57	15.42	0.010	24	0.34	89	17.15	90	5.46	0.27	PVC
Subbasin 2H (Yellow) - Pleasant Lane SW (west of Capitol Building)																			
31618	31617	9824	2066	0.27	0.86	0.23	0.23	6.30	2.76	0.65	0.010	8	1.04	82	1.60	40	4.59	0.30	PVC - Increased pipe diameter
31617	11310	0	0	0.00	0.24	0.00	0.23	6.60	2.70	0.63	0.010	8	8.25	212	4.51	14	12.93	0.27	PVC - Increased pipe diameter
11310	31423	0	0	0.00	0.24	0.00	0.23	6.87	2.64	0.62	0.010	8	4.06	106	3.17	20	9.07	0.19	PVC
31423	31424	50721	7349	1.33	0.90	1.19	1.43	7.07	2.61	3.73	0.010	10	3.07	140	4.99	75	9.15	0.25	PVC
31424	31768	3724	9309	0.30	0.46	0.14	1.56	7.32	2.57	4.01	0.010	18	0.32	62	7.73	52	4.37	0.24	PVC - Increased pipe diameter
32681	31768	12942	7533	0.47	0.71	0.34	0.34	6.30	2.76	0.93	0.010	10	1.65	157	3.66	25	6.71	0.39	PVC
31768	CB TYP II	981	3151	0.09	0.42	0.04	1.94	7.95	2.47	4.79	0.010	18	3.49	83	25.51	19	14.44	0.10	PVC - Increased pipe diameter
CB TYP I-1	CB TYP I-2	1203	2767	0.09	0.47	0.04	0.04	6.30	2.76	0.12	0.010	12	3.67	60	8.87	1	11.30	0.09	PVC
CB TYP I-2	CB TYP II	12050	23502	0.82	0.50	0.40	0.45	6.39	2.74	1.22	0.013	12	3.75	24	6.90	18	8.78	0.05	DI

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan**

WO: 21-2014-008

DATE: 1/5/2015

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 25yr BASIN

PIPE SIZING

(Runoff by Rational Method)

(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS

Checked by: HK

Date Checked: 06.08.15

Storm: **Olympia 25 Year**

c = 0.99 Impervious

c = 0.24 Lawn

m = 6.630 (see WSDOT Hydraulics Manual Figure 2.5.4A)

n = 0.477 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
CB TYP I-3	CB TYP II	3197	15198	0.42	0.37	0.16	0.16	6.30	2.76	0.43	0.013	12	2.22	36	5.31	8	6.76	0.09	DI
CB TYP II	32169	0	0	0.00	0.24	0.00	2.54	8.27	2.42	6.16	0.010	18	2.59	58	21.98	28	12.44	0.08	PVC - Increased pipe diameter
31737	32169	3893	1730	0.13	0.76	0.10	0.10	6.30	2.76	0.27	0.010	8	6.30	84	3.94	7	11.30	0.12	PVC
Subbasin 2I (Orange) - Pleasant Lane SW (west of Temple of Justice)																			
32214	32173	73775	23774	2.24	0.81	1.81	1.81	6.30	2.76	4.98	0.010	12	1.80	156	6.21	80	7.91	0.33	PVC - Increased pipe diameter
32173	32172	0	0	0.00	0.62	0.00	1.81	6.63	2.69	4.86	0.010	18	0.63	32	10.80	45	6.11	0.09	PVC - Increased pipe diameter
32172	32171	0	0	0.00	0.62	0.00	1.81	6.72	2.67	4.83	0.010	18	2.05	39	19.55	25	11.06	0.06	PVC - Increased pipe diameter
32171	32169	0	0	0.00	0.24	0.00	1.81	6.77	2.66	4.81	0.010	18	2.00	170	19.31	25	10.93	0.26	PVC - Increased pipe diameter
Subbasin 2J () - Mansion Parking Lot																			
32169	CB TYP II-2	0	0	0.00	0.24	0.00	14.25	23.16	1.48	21.10	0.024	24	1.02	225	12.38	171	3.94	0.95	CMP - Conflicting pipe sizes (i.e., 20 vs. 24)
CB TYP II-2	32266	11899	24264	0.83	0.49	0.41	14.66	24.11	1.45	21.29	0.024	24	1.00	108	12.25	174	3.90	0.46	Corrugated Metal Pipe (CMP) - Inc pipe dia
32266	2012	0	0	0.00	0.24	0.00	14.66	24.57	1.44	21.10	0.024	24	1.00	142	12.25	172	3.90	0.61	Conflicting material types (i.e., CMP vs. DI) -
																			Increased pipe diameter
32268	2012	2309	24033	0.60	0.31	0.19	0.19	6.30	2.76	0.51	0.013	6	20.00	142	2.51	20	12.78	0.19	Concrete
2012	Outfall	0	0	0.00	0.24	0.00	14.84	25.36	1.42	21.05	0.013	24	44.62	186	151.12	14	48.10	0.06	DI - Increased pipe diameter
BASIN 3 - Mansion Parking Lot (north side)																			
32250	32265	3035	0	0.07	0.99	0.07	0.07	6.30	2.76	0.19	0.013	6	0.94	64	0.54	35	2.77	0.38	Concrete
32265	Tee	1539	0	0.04	0.99	0.03	0.10	6.68	2.68	0.28	0.013	6	2.70	148	0.92	30	4.70	0.53	Concrete
32247	Tee	17117	0	0.39	0.99	0.39	0.39	6.30	2.76	1.07	0.010	6	0.87	58	0.68	158	3.47	0.28	PVC
Tee	32248	0	0	0.00	0.24	0.00	0.49	7.49	2.54	1.25	0.010	6	1.00	10	0.73	171	3.72	0.04	Concrete
32248	Mid1	5251	0	0.12	0.99	0.12	0.12	7.53	2.53	0.30	0.010	8	2.00	108	2.22	14	6.36	0.28	PVC
Mid1	Mid2	22085	0	0.51	0.99	0.50	0.50	7.82	2.49	1.25	0.010	8	2.00	59	2.22	56	6.36	0.15	PVC - Conflicting pipe sizes (6 vs. 8)
Mid2	33250 (Outfall)	18957	0	0.44	0.99	0.43	0.43	7.97	2.46	1.06	0.010	8	30.00	269	8.60	12	24.65	0.18	CPP - Conflicting pipe sizes (6 vs. 8)

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 100yr BASIN

PIPE SIZING
(Runoff by Rational Method)
(Pipe Capacity by Manning's Eqn.)

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious
c = 0.28 Lawn

m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)
n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
BASIN 1 - Pritchard Building (west side)																			
11074	11032	6480	675	0.16	1.04	0.17	0.17	6.30	3.38	0.58	0.013	6	1.77	135	0.75	78	3.80	0.59	Concrete
11032	11301	7029	0	0.16	1.12	0.18	0.35	6.89	3.23	1.14	0.013	12	13.52	108	13.10	9	16.68	0.11	Concrete
11301	11294	0	2592	0.06	0.28	0.02	0.37	7.00	3.21	1.19	0.013	12	2.09	139	5.15	23	6.56	0.35	Concrete
11294	11288	16835	1070	0.41	1.07	0.44	0.81	7.35	3.14	2.54	0.013	12	2.12	147	5.19	49	6.61	0.37	Concrete
11284	11288	17775	0	0.41	1.12	0.46	0.46	6.30	3.38	1.55	0.013	12	1.07	43	3.69	42	4.69	0.15	Concrete
11288	Outfall 1	0	0	0.00	0.28	0.00	1.27	7.88	3.03	3.85	0.013	12	106.00	100	36.68	11	46.71	0.04	Concrete
BASIN 2																			
Subbasin 2A - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																			
11309	32741	20497	20917	0.95	0.70	0.66	0.66	6.30	3.38	2.23	0.013	12	2.56	115	5.70	39	7.26	0.26	Ductile Iron (DI) - Increased pipe diameter
32741	10701	60776	34150	2.18	0.82	1.79	2.45	6.56	3.31	8.10	0.013	18	0.94	356	10.18	80	5.76	1.03	Increased pipe diameter
10701	30015	61925	22054	1.93	0.90	1.74	4.19	7.59	3.09	12.92	0.013	18	1.20	351	11.51	112	6.51	0.90	Concrete - Increase pipe diameter
30015	30010	0	0	0.00	0.28	0.00	4.19	8.49	2.93	12.25	0.013	18	3.50	83	19.65	62	11.12	0.12	Increased pipe diameter
Subbasin 2B - Cherberg Building (east side)																			
10965	135102	8902	2192	0.25	0.96	0.24	0.24	6.30	3.38	0.82	0.013	8	0.50	170	0.85	96	2.45	1.16	DI - Increased pipe diameter
CB3	135102	30000	3500	0.77	1.04	0.80	0.80	6.30	3.38	2.69	0.013	12	1.35	145	4.14	65	5.27	0.46	CPP -- Assume Imper & Perv Areas (Pritchard)
135102	135106	16386	8268	0.57	0.84	0.48	1.52	7.92	3.03	4.59	0.010	12	0.50	122	3.28	140	4.17	0.49	Polyvinyl chloride (PVC) - Increased pipe dia
135106	30130	10298	10768	0.48	0.69	0.33	1.85	8.40	2.94	5.44	0.010	12	2.82	39	7.78	70	9.90	0.07	Corrugated Plastic Pipe (CPP) - Increased pipe dia
30130	30149	30216	1548	0.73	1.08	0.79	2.64	8.47	2.93	7.74	0.010	12	4.39	57	9.70	80	12.36	0.08	CPP
30149	SDMH	0	0	0.00	0.28	0.00	2.64	8.55	2.92	7.70	0.010	18	2.00	229	19.31	40	10.93	0.35	ADS - Increased pipe diameter
SDMH	10107	2876	5446	0.19	0.57	0.11	2.75	8.90	2.86	7.87	0.010	18	1.34	105	15.81	50	8.95	0.20	CPP - Increased pipe diameter
Proposed -- Visitor Center																			
CB1	CB2	42000	0	0.96	1.12	1.08	1.08	6.30	3.38	3.66	0.010	12	0.50	87	3.28	112	4.17	0.35	CPP -- Assume Imper & Perv Areas
CB2	10106	0	0	0.00	0.28	0.00	1.08	6.65	3.29	3.57	0.010	12	5.00	190	10.36	34	13.19	0.24	CPP -- Assume Imper & Perv Areas

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan**

PIPE SIZING

WO: 21-2014-008

(Runoff by Rational Method)

Calculated by: BTS

DATE: 1/5/2015

(Pipe Capacity by Manning's Eqn.)

Checked by: HK

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 100yr BASIN

Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious

m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)

c = 0.28 Lawn

n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
Subbasin 2C - South Diagonal																			
30969	30967	51001	37583	2.03	0.76	1.55	1.55	6.30	3.38	5.25	0.010	12	2.41	54	7.19	73	9.16	0.10	CPP -- Includes Sid Snyder Ave. SW
30967	10106	0	0	0.00	0.28	0.00	1.55	6.40	3.35	5.21	0.010	18	1.23	170	15.15	34	8.57	0.33	CPP
11D	11B	3124	16080	0.44	0.41	0.18	0.18	6.30	3.38	0.62	0.013	8	0.53	57	0.88	70	2.52	0.38	DI
11B	12945	4306	4367	0.20	0.70	0.14	0.32	6.68	3.28	1.05	0.010	8	4.29	29	3.25	32	9.32	0.05	PVC
12945	10106	3797	0	0.09	1.12	0.10	0.42	6.73	3.27	1.37	0.010	8	6.75	12	4.08	34	11.69	0.02	PVC
10106	10107	0	0	0.00	0.28	0.00	3.06	7.76	3.06	9.34	0.010	18	0.66	122	11.09	84	6.28	0.32	CPP - Increased pipe diameter
30066	31087	1547	3832	0.12	0.52	0.06	0.06	6.30	3.38	0.22	0.010	8	0.10	29	0.50	44	1.42	0.34	PVC
31087	10107	964	0	0.02	1.12	0.02	0.09	6.64	3.29	0.29	0.010	8	10.80	37	5.16	6	14.79	0.04	PVC
Subbasin 2D - South Diagonal																			
10107	10037	0	0	0.00	0.28	0.00	5.90	11.26	2.56	15.07	0.010	18	0.80	215	12.21	123	6.91	0.52	CPP - Increased pipe diameter
10037	10030	0	0	0.00	0.28	0.00	5.90	11.78	2.50	14.75	0.010	18	2.00	60	19.31	76	10.93	0.09	CPP - Increased pipe diameter
10026	10028	6106	5264	0.26	0.73	0.19	0.19	6.30	3.38	0.64	0.010	8	0.69	130	1.30	49	3.74	0.58	PVC
10028	10030	5383	2872	0.19	0.83	0.16	0.35	6.88	3.24	1.13	0.010	8	0.43	118	1.03	109	2.95	0.67	PVC
10030	10032	8210	1313	0.22	1.01	0.22	6.46	13.11	2.38	15.35	0.010	24	0.60	83	22.78	67	7.25	0.19	CPP - Increased pipe diameter
10032	10033	0	0	0.00	0.28	0.00	6.46	13.31	2.36	15.25	0.010	24	0.49	41	20.59	74	6.55	0.10	CPP - Increased pipe diameter
Subbasin 2E - Winged Victory Circle																			
10046	Mid Pt	1788	4165	0.14	0.53	0.07	0.07	6.30	3.38	0.24	0.010	6	0.50	213	0.52	47	2.63	1.35	PVC - Estimated slope
30065	Mid Pt	13627	25857	0.91	0.57	0.52	0.52	6.30	3.38	1.74	0.013	8	2.00	88	1.71	102	4.90	0.30	DI - Estimated slope - Increased pipe diameter
Mid Pt	10033	0	0	0.00	0.28	0.00	0.59	7.95	3.02	1.77	0.010	12	0.50	89	3.28	54	4.17	0.36	PVC - Estimated slope - Increased pipe diameter
10033	30010	25228	3792	0.67	1.01	0.68	7.73	15.42	2.20	16.98	0.010	24	0.57	89	22.20	76	7.07	0.21	PVC - Increased pipe diameter

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan** — **PIPE SIZING**

WO: 21-2014-008 — (Runoff by Rational Method) — Calculated by: BTS

DATE: 1/5/2015 — (Pipe Capacity by Manning's Eqn.) — Checked by: HK

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 100yr BASIN — Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious — m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)

c = 0.28 Lawn — n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
Subbasin 2F - Cherry Lane SW (east of Temple of Justice)																			
32216	31280	0	0	0.00	0.28	0.00	0.00	6.30	3.38	0.00	0.010	8	0.39	311	0.98	0	2.81	1.84	PVC
31280	31246	25878	4133	0.69	1.01	0.69	0.69	8.14	2.99	2.07	0.010	12	0.74	81	3.98	52	5.07	0.27	PVC - Increased pipe diameter
31246	31245	6943	4525	0.26	0.79	0.21	0.90	8.41	2.94	2.65	0.010	12	0.74	81	3.98	67	5.07	0.27	PVC - Increased pipe diameter
31245	31244	35412	42222	1.78	0.66	1.18	2.08	8.68	2.90	6.03	0.010	18	0.32	31	7.73	78	4.37	0.12	PVC - Increased pipe diameter
31244	31239	0	0	0.00	0.28	0.00	2.08	8.79	2.88	5.99	0.010	18	0.46	44	9.26	65	5.24	0.14	PVC - Increased pipe diameter
31239	30010	0	0	0.00	0.28	0.00	2.08	8.93	2.86	5.95	0.010	18	1.30	193	15.57	38	8.81	0.37	PVC - Increased pipe diameter
30010	SD-100(54)	0	0	0.00	0.28	0.00	9.81	18.42	2.02	19.80	0.010	24	0.86	187	27.27	73	8.68	0.36	PVC
Subbasin 2G - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																			
32630	SD-100(54)	7229	3578	0.25	0.84	0.21	0.21	6.30	3.38	0.71	0.010	8	0.50	68	1.11	64	3.18	0.36	PVC - Estimated slope
31344	SD-100(54)	3822	3183	0.16	0.74	0.12	0.12	6.30	3.38	0.40	0.010	6	0.50	68	0.52	78	2.63	0.43	PVC - Estimated slope
SD-100(54)	31730	0	0	0.00	0.28	0.00	10.14	19.56	1.96	19.88	0.010	24	0.50	39	20.80	96	6.62	0.10	PVC - Estimated slope
31730	31734	17706	15266	0.76	0.73	0.55	10.69	19.66	1.96	20.91	0.010	24	0.38	210	18.13	115	5.77	0.61	PVC
31734	31735	14385	11132	0.59	0.75	0.44	11.13	20.27	1.93	21.46	0.010	24	0.26	38	15.00	143	4.77	0.13	PVC
31735	32169	0	0	0.00	0.28	0.00	11.13	20.40	1.92	21.39	0.010	24	0.34	89	17.15	125	5.46	0.27	PVC
Subbasin 2H - Pleasant Lane SW (west of Capitol Building)																			
31618	31617	9824	2066	0.27	0.98	0.27	0.27	6.30	3.38	0.90	0.010	8	1.04	82	1.60	56	4.59	0.30	PVC - Increased pipe diameter
31617	11310	0	0	0.00	0.28	0.00	0.27	6.60	3.30	0.88	0.010	8	8.25	212	4.51	20	12.93	0.27	PVC - Increased pipe diameter
11310	31423	0	0	0.00	0.28	0.00	0.27	6.87	3.24	0.86	0.010	8	4.06	106	3.17	27	9.07	0.19	PVC
31423	31424	50721	7349	1.33	1.02	1.36	1.62	7.07	3.20	5.19	0.010	10	3.07	140	4.99	104	9.15	0.25	PVC
31424	31768	3724	9309	0.30	0.52	0.15	1.78	7.32	3.14	5.59	0.010	18	0.32	62	7.73	72	4.37	0.24	PVC - Increased pipe diameter
32681	31768	12942	7533	0.47	0.81	0.38	0.38	6.30	3.38	1.29	0.010	10	1.65	157	3.66	35	6.71	0.39	PVC
31768	CB TYP II	981	3151	0.09	0.48	0.05	2.21	7.95	3.02	6.66	0.010	18	3.49	83	25.51	26	14.44	0.10	PVC - Increased pipe diameter
CB TYP I-1	CB TYP I-2	1203	2767	0.09	0.53	0.05	0.05	6.30	3.38	0.16	0.010	12	3.67	60	8.87	2	11.30	0.09	PVC
CB TYP I-2	CB TYP II	12050	23502	0.82	0.56	0.46	0.51	6.39	3.35	1.70	0.013	12	3.75	24	6.90	25	8.78	0.05	DI

PROPOSED CONDITIONS

PROJ: **WCC Drainage Master Plan** — **PIPE SIZING**

WO: 21-2014-008 — (Runoff by Rational Method) — Calculated by: BTS

DATE: 1/5/2015 — (Pipe Capacity by Manning's Eqn.) — Checked by: HK

FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Pipe Capacity – Proposed Conditions.xls]Pipe Sizing 100yr BASIN — Date Checked: 06.08.15

Storm: **Olympia 100 Year**

c = 1.13 Impervious — m = 8.170 (see WSDOT Hydraulics Manual Figure 2.5.4A)

c = 0.28 Lawn — n = 0.480 (see WSDOT Hydraulics Manual Figure 2.5.4A)

From	To	Inc. Area (sf) (Imperv)	Inc. Area (sf) (Perv)	Inc. Area (ac)	Runoff Coef.	A*C	Sum A*C	Time of Conc (min)	Rain Intens (in/hr)	Runoff (cfs)	n Value	Diam (inch)	Slope (%)	Length (feet)	Pipe Capac (cfs)	% Capac Used	Veloc Full (ft/sec)	Flow Time (min)	Remarks
CB TYP I-3	CB TYP II	3197	15198	0.42	0.42	0.18	0.18	6.30	3.38	0.60	0.013	12	2.22	36	5.31	11	6.76	0.09	DI
CB TYP II	32169	0	0	0.00	0.28	0.00	2.89	8.27	2.96	8.57	0.010	18	2.59	58	21.98	39	12.44	0.08	PVC - Increased pipe diameter
31737	32169	3893	1730	0.13	0.86	0.11	0.11	6.30	3.38	0.38	0.010	8	6.30	84	3.94	10	11.30	0.12	PVC
Subbasin 2I - Pleasant Lane SW (west of Temple of Justice)																			
32214	32173	73775	23774	2.24	0.92	2.06	2.06	6.30	3.38	6.94	0.010	12	1.80	156	6.21	112	7.91	0.33	PVC - Increased pipe diameter
32173	32172	0	0	0.00	0.70	0.00	2.06	6.63	3.30	6.77	0.010	18	0.63	32	10.80	63	6.11	0.09	PVC - Increased pipe diameter
32172	32171	0	0	0.00	0.70	0.00	2.06	6.72	3.28	6.73	0.010	18	2.05	39	19.55	34	11.06	0.06	PVC - Increased pipe diameter
32171	32169	0	0	0.00	0.28	0.00	2.06	6.77	3.26	6.70	0.010	18	2.00	170	19.31	35	10.93	0.26	PVC - Increased pipe diameter
Subbasin 2J - Mansion Parking Lot																			
32169	CB TYP II-2	0	0	0.00	0.28	0.00	16.19	23.16	1.81	29.28	0.024	24	1.02	225	12.38	237	3.94	0.95	CMP - Conflicting pipe sizes (i.e., 20 vs. 24)
CB TYP II-2	32266	11899	24264	0.83	0.55	0.46	16.65	24.11	1.77	29.53	0.024	24	1.00	108	12.25	241	3.90	0.46	Corrugated Metal Pipe (CMP) - Inc pipe dia
32266	2012	0	0	0.00	0.28	0.00	16.65	24.57	1.76	29.26	0.024	24	1.00	142	12.25	239	3.90	0.61	Conflicting material types (i.e., CMP vs. DI) -
																			Increased pipe diameter
32268	2012	2309	24033	0.60	0.35	0.21	0.21	6.30	3.38	0.71	0.013	6	20.00	142	2.51	28	12.78	0.19	Concrete
2012	Outfall	0	0	0.00	0.28	0.00	16.86	25.36	1.73	29.19	0.013	24	44.62	186	151.12	19	48.10	0.06	DI - Increased pipe diameter
BASIN 3 - Mansion Parking Lot (north side)																			
32250	32265	3035	0	0.07	1.12	0.08	0.08	6.30	3.38	0.26	0.013	6	0.94	64	0.54	49	2.77	0.38	Concrete
32265	Tee	1539	0	0.04	1.12	0.04	0.12	6.68	3.28	0.39	0.013	6	2.70	148	0.92	42	4.70	0.53	Concrete
32247	Tee	17117	0	0.39	1.12	0.44	0.44	6.30	3.38	1.49	0.010	6	0.87	58	0.68	219	3.47	0.28	PVC
Tee	32248	0	0	0.00	0.28	0.00	0.56	7.49	3.11	1.74	0.010	6	1.00	10	0.73	239	3.72	0.04	Concrete
32248	Mid1	5251	0	0.12	1.12	0.14	0.14	7.53	3.10	0.42	0.010	8	2.00	108	2.22	19	6.36	0.28	PVC
Mid1	Mid2	22085	0	0.51	1.12	0.57	0.57	7.82	3.04	1.74	0.010	8	2.00	59	2.22	78	6.36	0.15	PVC - Conflicting pipe sizes (6 vs. 8)
Mid2	33250 (Outfall)	18957	0	0.44	1.12	0.49	0.49	7.97	3.02	1.48	0.010	8	30.00	269	8.60	17	24.65	0.18	CPP - Conflicting pipe sizes (6 vs. 8)

Table 4.2.1.D
Manning's "n" Values for Pipes

Type of Pipe Material	Analysis Method	
	Uniform Flow (Preliminary design)	Backwater Flow (Capacity Verification)
A. Concrete pipe and LCPE pipe	0.014	0.012
B. Annular Corrugated Metal Pipe or Pipe Arch		
1. 2-2/3" x 1/2" corrugation (riveted):		
a. plain or fully coated	0.028	0.024
b. paved invert (40% of circumference paved):		
1) flow at full depth	0.021	0.018
2) flow at 80% full depth	0.018	0.016
3) flow at 60% full depth	0.015	0.013
c. Treatment 5	0.015	0.013
2. 3" x 1" corrugation	0.031	0.027
3. 6" x 2" corrugation (field bolted)	0.035	0.030
C. Helical 2-2/3" x 1/2" corrugation and CPE pipe	0.028	0.024
D. Spiral rib metal pipe and PVC pipe	0.013	0.011
E. Ductile iron pipe cement lined	0.014	0.012
F. SWPE pipe (butt fused only)	0.009	0.009

Source: 2009 King County, WA Surface Water Design Manual

PROPOSED CONDITIONS

Backwater Calculation Sheet

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Backwater – Proposed Conditions.xls]BACKWATR-25yr

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM	Overtopping
BASIN 1 - Pritchard Building (west side)																				
Outfall 1	11288	2.83	100	12	0.012	0	106.85	0.785	3.603	0.202	0.845	0.532	1.377	0.040	0.202	1.619	0.031	1.588	128.85	No
11288	11284	1.11	43	12	0.012	110.3	110.76	0.785	1.413	0.031	111.015	0.035	111.050	0.006	0.031	111.087	0.084	111.003	127.31	No
11288	11294	1.83	147	12	0.012	112.59	115.7	0.785	2.330	0.084	113.370	0.327	113.697	0.017	0.084	113.798	0.018	113.780	130.79	No
11294	11301	0.85	139	12	0.012	117.9	120.8	0.785	1.082	0.018	118.585	0.067	118.652	0.004	0.018	118.674	0.017	118.657	132.66	No
11301	11032	0.82	108	12	0.012	120.9	135.5	0.785	1.044	0.017	121.585	0.048	121.633	0.003	0.017	121.654	0.071	121.583	140.98	No
11032	11074	0.42	135	6	0.012	135.5	137.9	0.196	2.139	0.071	135.815	0.637	136.452	0.014	0.071	136.537	0.000	136.537	140.02	No
BASIN 2																				
Subbasin 2J - Mansion Parking Lot																				
Outfall Elevation: Capitol Lake surface 0 FT																				
Outfall 2	2012	21.05	186	24	0.012	0	91	3.142	6.700	0.697	1.640	1.362	3.002	0.139	0.697	3.838	0.805	3.033	98.88	No
2012	32268	0.51	142	6	0.012	91.2	110	0.196	2.597	0.105	91.530	0.987	92.517	0.021	0.105	92.643	0.000	92.643	111.72	No
2012	32266	21.1	142	24	0.012	92.4	94.9	3.142	6.716	0.700	94.200	1.045	95.245	0.140	0.700	96.085	0.713	95.372	114.76	No
32266	CB TYP II-2	21.29	108	24	0.012	92.4	94.9	3.142	6.777	0.713	95.372	0.809	96.181	0.143	0.713	97.037	0.700	96.336	119.05	No
CB TYP II-2	32169	21.1	225	24	0.012	95.1	97.4	3.142	6.716	0.700	96.900	1.655	98.555	0.140	0.700	99.396	0.687	98.709	114.33	No
Subbasin 2I - Pleasant Lane SW (west of Temple of Justice)																				
32169	32171	4.81	170	18	0.012	100	103.4	1.767	2.722	0.115	101.155	0.301	101.456	0.023	0.115	101.594	0.116	101.478	110.00	No
32171	32172	4.83	39	18	0.012	103.5	104.3	1.767	2.733	0.116	104.655	0.070	104.725	0.023	0.116	104.864	0.117	104.746	109.46	No
32172	32173	4.86	32	18	0.012	104.6	104.8	1.767	2.750	0.117	104.746	0.058	104.804	0.023	0.117	104.945	0.624	104.321	109.36	No
32173	32214	4.98	156	12	0.012	104.8	107.6	0.785	6.341	0.624	105.750	2.571	108.321	0.125	0.624	109.070	0.000	109.070	109.89	No
Subbasin 2H - Pleasant Lane SW (west of Capitol Building)																				
32169	31737	0.27	84	8	0.012	107.5	112.8	0.349	0.773	0.009	107.900	0.035	107.935	0.002	0.009	107.946	0.000	107.946	115.34	No
32169	CB TYP II	6.16	58	18	0.012	98.4	99.9	1.767	3.486	0.189	98.709	0.168	98.877	0.038	0.189	99.103	0.005	99.099	115.82	No
CB TYP II	CB TYP I-3	0.43	36	12	0.012	112.3	113.1	0.785	0.547	0.005	112.925	0.004	112.929	0.001	0.005	112.935	0.000	112.935	115.73	No
CB TYP II	CB TYP I-2	1.22	24	12	0.012	112.4	113.6	0.785	1.553	0.037	113.125	0.024	113.149	0.007	0.037	113.194	0.000	113.193	116.27	No
CB TYP I-2	CB TYP I-1	0.12	60	12	0.012	113.5	113.7	0.785	0.153	0.000	114.100	0.001	114.101	0.000	0.000	114.101	0.000	114.101	118.71	No
CB TYP II	31768	4.79	83	18	0.012	99.9	102.8	1.767	2.711	0.114	101.065	0.146	101.211	0.023	0.114	101.348	0.125	101.223	119.48	No
31768	32681	0.93	83	10	0.012	103.1	105.7	0.545	1.705	0.045	103.695	0.126	103.821	0.009	0.045	103.875	0.000	103.875	117.00	No
31768	31424	4.01	62	18	0.012	103	105.5	1.767	2.269	0.080	104.125	0.076	104.201	0.016	0.080	104.297	0.726	103.571	117.98	No
31424	31423	3.73	140	10	0.012	105.9	110.2	0.545	6.839	0.726	106.655	3.421	110.076	0.145	0.726	110.947	0.049	110.898	123.79	No
31423	11310	0.62	106	8	0.012	119.2	123.5	0.349	1.776	0.049	119.670	0.235	119.905	0.010	0.049	119.964	0.051	119.913	124.82	No
11310	31617	0.63	212	8	0.012	123.7	141.19	0.349	1.805	0.051	124.135	0.485	124.620	0.010	0.051	124.681	0.054	124.627	143.79	No

PROPOSED CONDITIONS
Backwater Calculation Sheet

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Calculated by: BTS
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Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM	Overtopping
31617	31618	0.65	82	8	0.012	141.34	142.2	0.349	1.862	0.054	141.790	0.200	141.990	0.011	0.054	142.054	0.000	142.054	142.85	No
Subbasin 2G - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																				
32169	31735	15.42	89	24	0.012	98.3	98.6	3.142	4.908	0.374	98.709	0.350	99.058	0.075	0.374	99.507	0.376	99.131	114.33	No
31735	31734	15.46	38	24	0.012	98.6	98.7	3.142	4.921	0.376	99.131	0.150	99.281	0.075	0.376	99.732	0.357	99.375	114.81	No
31734	31730	15.07	210	24	0.012	98.6	99.4	3.142	4.797	0.357	99.375	0.788	100.163	0.071	0.357	100.592	0.323	100.269	114.47	No
31730	SD-100(54)	14.32	39	24	0.012	99.8	?	3.142	4.558	0.323	100.269	0.132	100.401	0.065	0.323	100.788	0.387	100.402	114.50	No
SD-100(54)	31344	0.29	68	6	0.012	?	113.4	0.196	1.477	0.034	100.402	0.153	100.554	0.007	0.034	100.595	0.000	100.595	115.93	No
SD-100(54)	32630	0.51	68	8	0.012	?	104.37	0.349	1.461	0.033	100.402	0.102	100.504	0.007	0.033	100.543	0.000	100.543	116.65	No
Subbasin 2F - Cherry Lane SW (east of Temple of Justice)																				
SD-100(54)	30010	14.26	187	24	0.012	?	101.6	3.142	4.539	0.320	100.402	0.628	101.030	0.064	0.320	101.414	0.711	100.702	115.75	No
30010	31239	4.28	193	18	0.012	101.6	104.1	1.767	2.422	0.091	102.740	0.271	103.011	0.018	0.091	103.120	0.092	103.028	110.02	No
31239	31244	4.31	44	18	0.012	104.1	104.3	1.767	2.439	0.092	105.240	0.063	105.303	0.018	0.092	105.413	0.094	105.320	108.95	No
31244	31245	4.34	31	18	0.012	103.7	104.4	1.767	2.456	0.094	105.320	0.045	105.364	0.019	0.094	105.477	0.092	105.385	108.11	No
32145	31246	1.91	81	12	0.012	104	106	0.785	2.432	0.092	105.385	0.196	105.581	0.018	0.092	105.692	0.056	105.636	107.77	No
31246	31280	1.49	81	12	0.012	105.9	106.6	0.785	1.897	0.056	106.650	0.120	106.770	0.011	0.056	106.837	0.000	106.837	108.98	No
31280	32216	0.0	311	8	0.012	106.6	107.8	0.349	0.029	0.000	106.837	0.000	106.837	0.000	0.000	106.837	0.000	106.837	109.72	No
Subbasin 2E - Winged Victory Circle																				
30010	10033	12.23	89	24	0.012	101.5	102	3.142	3.893	0.235	103.150	0.220	103.370	0.047	0.235	103.652	0.231	103.422	117.07	No
10033	Mid Pt	1.28	89	12	0.012	103.8	?	0.785	1.630	0.041	104.535	0.097	104.632	0.008	0.041	104.681	0.199	104.482	117.00	No
Mid Pt	30065	1.25	88	8	0.012	?	104.2	0.349	3.581	0.199	104.482	0.793	105.276	0.040	0.199	105.515	0.013	105.501	116.58	No
Mid Pt	10046	0.18	213	6	0.012	?	104.6	0.196	0.917	0.013	105.501	0.184	105.686	0.003	0.013	105.702	0.000	105.702	112.10	No
Subbasin 2D - South Diagonal																				
10033	10032	10.97	83	24	0.012	101.8	102	3.142	3.492	0.189	103.422	0.165	103.587	0.038	0.189	103.814	0.192	103.622	117.15	No
10032	10030	11.05	41	24	0.012	102	102.5	3.142	3.517	0.192	103.622	0.083	103.705	0.038	0.192	103.935	0.643	103.292	116.67	No
10030	10028	0.81	118	8	0.012	103.4	103.9	0.349	2.320	0.084	103.860	0.447	104.307	0.017	0.084	104.407	0.027	104.380	112.53	No
10028	10026	0.46	130	8	0.012	103.9	104.8	0.349	1.318	0.027	104.380	0.159	104.539	0.005	0.027	104.571	0.000	104.571	108.16	No
10030	10037	10.61	215	18	0.012	102.5	103.7	1.767	6.004	0.560	103.875	1.853	105.728	0.112	0.560	106.400	0.584	105.815	117.54	No
10037	10107	10.84	60	18	0.012	103.7	105.4	1.767	6.134	0.584	105.815	0.540	106.355	0.117	0.584	107.056	0.229	106.827	117.48	No
Subbasin 2C - South Diagonal																				
10107	31087	0.21	37	8	0.012	110.5	114.5	0.349	0.602	0.006	110.910	0.009	110.919	0.001	0.006	110.926	0.003	110.923	117.15	No
31087	30066	0.16	29	8	0.012	114.7	114.3	0.349	0.458	0.003	115.110	0.004	115.114	0.001	0.003	115.118	0.000	115.118	117.16	No
10107	10106	6.71	130	18	0.012	108.3	109.1	1.767	3.797	0.224	109.560	0.448	110.008	0.045	0.224	110.277	0.357	109.920	118.47	No

PROPOSED CONDITIONS

Backwater Calculation Sheet

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WO: 21-2014-008
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Calculated by: BTS
Checked by: HK
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Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM	Overtopping
10106	12945	0.98	12	8	0.012	114.1	114.91	0.349	2.807	0.122	114.580	0.066	114.646	0.024	0.122	114.793	0.074	114.720	117.76	No
12945	11B	0.76	29	8	0.012	114.96	115.3	0.349	2.177	0.074	115.440	0.097	115.537	0.015	0.074	115.625	0.025	115.600	117.58	No
11B	11D	0.44	57	8	0.012	115.9	115.8	0.349	1.261	0.025	116.380	0.064	116.444	0.005	0.025	116.473	0.000	116.473	117.38	No
10106	30967	3.74	170	18	0.012	109.2	111.3	1.767	2.116	0.070	109.920	0.182	110.102	0.014	0.070	110.185	0.358	109.828	118.35	No
30967	30969	3.77	54	12	0.012	112	113.3	0.785	4.800	0.358	112.905	0.510	113.415	0.072	0.358	113.844	0.000	113.844	118.28	No
Proposed -- Visitor Center																				
10106	CB2	2.56	190	12	0.012	111.97	121.47	0.785	3.259	0.165	112.795	0.828	113.623	0.033	0.165	113.821	0.174	113.646	124.8	No
CB2	CB1	2.63	87	12	0.012	121.47	121.9	0.785	3.349	0.174	122.295	0.400	122.695	0.035	0.174	122.904	0.000	122.904	126.4	No
Subbasin 2B - Cherberg Building (east side)																				
10107	SDMH	5.65	105	18	0.012	110.4	111.9	1.767	3.197	0.159	111.600	0.257	111.857	0.032	0.159	112.047	0.153	111.894	119.75	No
SDMH	30149	5.54	229	18	0.012	111.9	116.4	1.767	3.135	0.153	113.100	0.538	113.638	0.031	0.153	113.821	0.778	113.043	125.72	No
30149	30130	5.56	57	12	0.012	117.1	119.6	0.785	7.079	0.778	118.070	1.171	119.241	0.156	0.778	120.175	0.385	119.790	125.61	No
30130	135106	3.91	39	12	0.012	119.7	120.8	0.785	4.978	0.385	120.610	0.396	121.006	0.077	0.385	121.468	0.274	121.194	125.47	No
135106	135102	3.3	122	12	0.012	121.4	126.6	0.785	4.202	0.274	122.300	0.883	123.183	0.055	0.274	123.512	0.138	123.374	130.88	No
135102	CB3	1.93	145	12	0.012	121.4	126.6	0.785	2.457	0.094	123.374	0.359	123.733	0.019	0.094	123.845	0.000	123.845	130.88	No
135102	10965	0.59	170	8	0.012	127	131.88	0.349	1.690	0.044	127.435	0.341	127.776	0.009	0.044	127.830	0.000	127.830	132.73	No
Subbasin 2A - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																				
30010	30015	8.8	83	18	0.012	111.3	111.7	1.767	4.980	0.385	112.600	0.492	113.092	0.077	0.385	113.554	0.428	113.126	116.64	No
30015	10701	9.28	351	18	0.012	111.9	115.5	1.767	5.251	0.428	113.126	2.314	115.440	0.086	0.428	115.954	0.168	115.786	124.71	No
10701	32741	5.82	356	18	0.012	115.6	121.52	1.767	3.293	0.168	116.800	0.923	117.723	0.034	0.168	117.925	0.064	117.861	124.62	No
32741	11309	1.6	115	12	0.012	121.52	123.6	0.785	2.037	0.064	122.280	0.196	122.476	0.013	0.064	122.553	0.000	122.553	124.46	No
BASIN 3 - Mansion Parking Lot (north side)																				
33250 (Outfall)	Mid2	1.06	269	8	0.012	11	106.56	0.349	3.037	0.143	11.480	1.744	13.224	0.029	0.143	13.396	0.011	13.384	13.37	YES
Mid2	Mid1	1.25	59	8	0.012	106.56	107.74	0.349	3.581	0.199	107.060	0.532	107.592	0.040	0.199	107.831	0.629	107.201	133.19	No
Mid1	32248	0.3	108	8	0.012	107.74	109.9	0.349	0.859	0.011	108.160	0.056	108.216	0.002	0.011	108.230	0.629	107.601	112.68	No
32248	Tee	1.25	10	6	0.012	112.59	115.7	0.196	6.366	0.629	113.015	0.418	113.433	0.126	0.629	114.188	0.493	113.695	112.1	YES
Tee	32247	1.07	58	6	0.012	117.9	120.8	0.196	5.449	0.461	118.305	1.775	120.080	0.092	0.461	120.634	0.000	120.634	112	YES
Tee	32265	0.28	148	6	0.012	120.9	135.5	0.196	1.426	0.032	121.215	0.310	121.525	0.006	0.032	121.563	0.015	121.549	117.3	YES
32265	32250	0.19	64	6	0.012	135.5	137.9	0.196	0.968	0.015	135.815	0.062	135.877	0.003	0.015	135.894	0.000	135.894	117.59	YES

NOTE: See Section 4.2.1.2 (Starting on Page 4-21) of the King Ccounty Surface Water Design Manual for the corresponding equations and a detailed explaination on how to use this spreadsheet. Items 16, 18, and 19 equaled zero for this analysis; therefore, they were not included within this spreadsheet.

PROPOSED CONDITIONS

Backwater Calculation Sheet

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Backwater – Proposed Conditions.xls]BACKWATR-100yr

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM	Overtopping
BASIN 1 - Pritchard Building (west side)																				
Outfall 1	11288	3.85	100	12	0.012	0	106.85	0.785	4.902	0.373	0.920	0.985	1.905	0.075	0.373	2.353	0.060	2.292	128.85	No
11288	11284	1.55	43	12	0.012	110.3	110.76	0.785	1.974	0.060	111.055	0.069	111.124	0.012	0.060	111.196	0.000	111.196	127.31	No
11288	11294	2.54	147	12	0.012	112.59	115.7	0.785	3.234	0.162	113.440	0.630	114.070	0.032	0.162	114.265	0.036	114.230	130.79	No
11294	11301	1.19	139	12	0.012	117.9	120.8	0.785	1.515	0.036	118.635	0.131	118.766	0.007	0.036	118.809	0.033	118.776	132.66	No
11301	11032	1.14	108	12	0.012	120.9	135.5	0.785	1.451	0.033	121.635	0.093	121.728	0.007	0.033	121.768	0.135	121.632	140.98	No
11032	11074	0.58	135	6	0.012	135.5	137.9	0.196	2.954	0.135	135.835	1.214	137.049	0.027	0.135	137.212	0.000	137.212	140.02	No
BASIN 2																				
Subbasin 2J - Mansion Parking Lot																				
Outfall Elevation: Capitol Lake surface 0 FT																				
Outfall 2	2012	29.19	186	24	0.012	0	91	3.142	9.291	1.341	1.930	2.619	4.549	0.268	1.341	6.157	1.550	4.607	98.88	No
2012	32268	0.71	142	6	0.012	91.2	110	0.196	3.616	0.203	91.530	1.914	93.444	0.041	0.203	93.687	0.000	93.687	111.72	No
2012	32266	29.26	142	24	0.012	92.4	94.9	3.142	9.314	1.347	94.320	2.009	96.329	0.269	1.347	97.945	1.372	96.573	114.76	No
32266	CB TYP II-2	29.53	108	24	0.012	92.4	94.9	3.142	9.400	1.372	96.573	1.556	98.129	0.274	1.372	99.776	1.349	98.427	119.05	No
CB TYP II-2	32169	29.28	225	24	0.012	95.1	97.4	3.142	9.320	1.349	96.573	3.187	99.760	0.270	1.349	101.379	1.327	100.052	114.33	No
Subbasin 2I - Pleasant Lane SW (west of Temple of Justice)																				
32169	32171	6.7	170	18	0.012	100	103.4	1.767	3.791	0.223	101.245	0.584	101.829	0.045	0.223	102.097	0.225	101.872	110	No
32171	32172	6.73	39	18	0.012	103.5	104.3	1.767	3.808	0.225	104.745	0.135	104.880	0.045	0.225	105.150	0.228	104.923	109.46	No
32172	32173	6.77	32	18	0.012	104.6	104.8	1.767	3.831	0.228	104.923	0.112	105.035	0.046	0.228	105.308	1.212	104.096	109.36	No
32173	32214	6.94	156	12	0.012	104.8	107.6	0.785	8.836	1.212	105.785	4.994	110.779	0.242	1.212	112.233	0.000	112.233	109.89	YES
Subbasin 2H - Pleasant Lane SW (west of Capitol Building)																				
32169	31737	0.38	84	8	0.012	107.5	112.8	0.349	1.089	0.018	107.910	0.070	107.980	0.004	0.018	108.002	0.000	108.002	115.34	No
32169	CB TYP II	8.57	58	18	0.012	98.4	99.9	1.767	4.850	0.365	100.052	0.326	100.378	0.073	0.365	100.817	0.009	100.808	115.82	No
CB TYP II	CB TYP I-3	0.6	36	12	0.012	112.3	113.1	0.785	0.764	0.009	112.960	0.009	112.969	0.002	0.009	112.979	0.000	112.979	115.73	No
CB TYP II	CB TYP I-2	1.7	24	12	0.012	112.4	113.6	0.785	2.165	0.073	113.180	0.046	113.226	0.015	0.073	113.313	0.001	113.313	116.27	No
CB TYP I-2	CB TYP I-1	0.16	60	12	0.012	113.5	113.7	0.785	0.204	0.001	114.100	0.001	114.101	0.000	0.001	114.102	0.000	114.102	118.71	No
CB TYP II	31768	6.66	83	18	0.012	99.9	102.8	1.767	3.769	0.221	100.808	0.282	101.089	0.044	0.221	101.354	0.242	101.112	119.48	No
31768	32681	1.29	83	10	0.012	103.1	105.7	0.545	2.365	0.087	103.720	0.243	103.963	0.017	0.087	104.067	0.000	104.067	117	No
31768	31424	5.59	62	18	0.012	103	105.5	1.767	3.163	0.155	104.225	0.148	104.373	0.031	0.155	104.560	1.406	103.154	117.98	No
31424	31423	5.19	140	10	0.012	105.9	110.2	0.545	9.516	1.406	106.715	6.623	113.338	0.281	1.406	115.025	0.094	114.931	123.79	No
31423	11310	0.86	106	8	0.012	119.2	123.5	0.349	2.464	0.094	119.695	0.452	120.147	0.019	0.094	120.260	0.099	120.162	124.82	No
11310	31617	0.88	212	8	0.012	123.7	141.19	0.349	2.521	0.099	124.195	0.947	125.142	0.020	0.099	125.261	0.103	125.157	143.79	No
31617	31618	0.9	82	8	0.012	141.34	142.2	0.349	2.578	0.103	141.835	0.383	142.218	0.021	0.103	142.342	0.000	142.342	142.85	No

PROPOSED CONDITIONS

Backwater Calculation Sheet

PROJ: **WCC Drainage Master Plan**
WO: 21-2014-008
DATE: 1/5/2015
FILE: H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Backwater – Proposed Conditions.xls]BACKWATR-100yr

Calculated by: BTS
Checked by: HK
Date Checked: 06.08.15

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM	Overtopping
Subbasin 2G - Capitol Lawn (between the Capitol & Temple of Justice Buildings)																				
32169	31735	21.39	89	24	0.012	98.3	98.6	3.142	6.809	0.720	100.052	0.673	100.725	0.144	0.720	101.589	0.725	100.864	114.33	No
31735	31734	21.46	38	24	0.012	98.6	98.7	3.142	6.831	0.725	100.864	0.289	101.153	0.145	0.725	102.023	0.688	101.335	114.81	No
31734	31730	20.91	210	24	0.012	98.6	99.4	3.142	6.656	0.688	101.335	1.517	102.852	0.138	0.688	103.678	0.622	103.056	114.47	No
31730	SD-100(54)	19.88	39	24	0.012	99.8	?	3.142	6.328	0.622	103.056	0.255	103.310	0.124	0.622	104.057	0.745	103.311	114.5	No
SD-100(54)	31344	0.4	68	6	0.012	?	113.4	0.196	2.037	0.064	103.311	0.291	103.602	0.013	0.064	103.679	0.000	103.679	115.93	No
SD-100(54)	32630	0.71	68	8	0.012	?	104.37	0.349	2.034	0.064	103.311	0.198	103.509	0.013	0.064	103.586	0.000	103.586	116.65	No
Subbasin 2F - Cherry Lane SW (east of Temple of Justice)																				
SD-100(54)	30010	19.8	187	24	0.012	?	101.6	3.142	6.303	0.617	103.311	1.211	104.522	0.123	0.617	105.263	1.376	103.887	115.75	No
30010	31239	5.95	193	18	0.012	101.6	104.1	1.767	3.367	0.176	103.887	0.523	104.410	0.035	0.176	104.621	0.178	104.443	110.02	No
31239	31244	5.99	44	18	0.012	104.1	104.3	1.767	3.390	0.178	104.443	0.121	104.564	0.036	0.178	104.778	0.181	104.597	108.95	No
31244	31245	6.03	31	18	0.012	103.7	104.4	1.767	3.412	0.181	104.597	0.086	104.683	0.036	0.181	104.900	0.177	104.723	108.11	No
32145	31246	2.65	81	12	0.012	104	106	0.785	3.374	0.177	104.723	0.378	105.101	0.035	0.177	105.313	0.108	105.206	107.77	No
31246	31280	2.07	81	12	0.012	105.9	106.6	0.785	2.636	0.108	106.690	0.231	106.921	0.022	0.108	107.050	0.000	107.050	108.98	No
31280	32216	0.0	311	8	0.012	106.6	107.8	0.349	0.029	0.000	107.000	0.000	107.000	0.000	0.000	107.000	0.000	107.000	109.72	No
Subbasin 2E - Winged Victory Circle																				
30010	10033	16.98	89	24	0.012	101.5	102	3.142	5.405	0.454	103.887	0.424	104.311	0.091	0.454	104.855	0.445	104.410	117.07	No
10033	Mid Pt	1.77	89	12	0.012	103.8	?	0.785	2.254	0.079	104.410	0.185	104.596	0.016	0.079	104.690	0.386	104.304	117	No
Mid Pt	30065	1.74	88	8	0.012	?	104.2	0.349	4.985	0.386	104.304	1.537	105.842	0.077	0.386	106.305	0.023	106.281	116.58	No
Mid Pt	10046	0.24	213	6	0.012	?	104.6	0.196	1.222	0.023	106.281	0.328	106.609	0.005	0.023	106.637	0.000	106.637	112.1	No
Subbasin 2D - South Diagonal																				
10033	10032	15.25	83	24	0.012	101.8	102	3.142	4.854	0.366	104.410	0.319	104.729	0.073	0.366	105.168	0.371	104.798	117.15	No
10032	10030	15.35	41	24	0.012	102	102.5	3.142	4.886	0.371	104.798	0.160	104.957	0.074	0.371	105.402	1.245	104.157	116.67	No
10030	10028	1.13	118	8	0.012	103.4	103.9	0.349	3.237	0.163	104.157	0.869	105.027	0.033	0.163	105.222	0.052	105.170	112.53	No
10028	10026	0.64	130	8	0.012	103.9	104.8	0.349	1.833	0.052	105.170	0.307	105.477	0.010	0.052	105.540	0.000	105.540	108.16	No
10030	10037	14.75	215	18	0.012	102.5	103.7	1.767	8.347	1.082	104.157	3.581	107.739	0.216	1.082	109.037	1.129	107.908	117.54	No
10037	10107	15.07	60	18	0.012	103.7	105.4	1.767	8.528	1.129	107.908	1.043	108.951	0.226	1.129	110.306	0.444	109.861	117.48	No
Subbasin 2C - South Diagonal																				
10107	31087	0.29	37	8	0.012	110.5	114.5	0.349	0.831	0.011	110.900	0.018	110.918	0.002	0.011	110.931	0.006	110.925	117.15	No
31087	30066	0.22	29	8	0.012	114.7	114.3	0.349	0.630	0.006	115.100	0.008	115.108	0.001	0.006	115.115	0.000	115.115	117.16	No
10107	10106	9.34	130	18	0.012	108.3	109.1	1.767	5.285	0.434	109.861	0.868	110.730	0.087	0.434	111.250	0.695	110.555	118.47	No
10106	12945	1.37	12	8	0.012	114.1	114.91	0.349	3.925	0.239	114.610	0.130	114.740	0.048	0.239	115.027	0.140	114.886	117.76	No

PROPOSED CONDITIONS

Backwater Calculation Sheet

PROJ:	**WCC Drainage Master Plan**	Calculated by:	BTS
WO:	21-2014-008	Checked by:	HK
DATE:	1/5/2015	Date Checked:	06.08.15
FILE:	H:\21Cp\14\008 West Capitol Campus Drainage Plan\Hydraulics\Pipe Capacity\Proposed Conditions\[Backwater – Proposed Conditions.xls]BACKWATR-100yr		

Pipe Segment CB	to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Diameter (in)	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Velocity (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entrance HGL Elev (ft)	(13) Entrance head loss (ft)	(14) Exit head loss (ft)	(15) Outlet contr. Elev (ft)	(17) Approach vel. head (ft)	(20) HW elev. (ft)	RIM	Overtopping
12945	11B	1.05	29	8	0.012	114.96	115.3	0.349	3.008	0.140	115.470	0.184	115.654	0.028	0.140	115.823	0.049	115.774	117.58	No
11B	11D	0.62	57	8	0.012	115.9	115.8	0.349	1.776	0.049	116.300	0.126	116.426	0.010	0.049	116.485	0.000	116.485	117.38	No
10106	30967	5.21	170	18	0.012	109.2	111.3	1.767	2.948	0.135	110.555	0.353	110.908	0.027	0.135	111.070	0.694	110.377	118.35	No
30967	30969	5.25	54	12	0.012	112	113.3	0.785	6.684	0.694	112.955	0.989	113.944	0.139	0.694	114.777	0.000	114.777	118.28	No
Proposed -- Visitor Center																				
10106	CB2	3.57	190	12	0.012	111.97	121.47	0.785	4.545	0.321	112.860	1.609	114.469	0.064	0.321	114.854	0.337	114.517	124.8	No
CB2	CB1	3.66	87	12	0.012	121.47	121.9	0.785	4.660	0.337	122.360	0.775	123.135	0.067	0.337	123.539	0.000	123.539	126.4	No
Subbasin 2B - Cherberg Building (east side)																				
10107	SDMH	7.87	105	18	0.012	110.4	111.9	1.767	4.453	0.308	111.700	0.498	112.198	0.062	0.308	112.567	0.295	112.273	119.75	No
SDMH	30149	7.7	229	18	0.012	111.9	116.4	1.767	4.357	0.295	112.273	1.039	113.312	0.059	0.295	113.666	1.508	112.158	125.72	No
30149	30130	7.74	57	12	0.012	117.1	119.6	0.785	9.855	1.508	118.085	2.269	120.354	0.302	1.508	122.164	0.745	121.419	125.61	No
30130	135106	5.44	39	12	0.012	119.7	120.8	0.785	6.926	0.745	121.419	0.767	122.186	0.149	0.745	123.080	0.530	122.550	125.47	No
135106	135102	4.59	122	12	0.012	121.4	126.6	0.785	5.844	0.530	122.550	1.708	124.258	0.106	0.530	124.894	0.268	124.627	130.88	No
135102	CB3	2.69	145	12	0.012	121.4	126.6	0.785	3.425	0.182	124.627	0.697	125.324	0.036	0.182	125.543	0.000	125.543	130.88	No
135102	10965	0.82	170	8	0.012	127	131.88	0.349	2.349	0.086	127.455	0.659	128.114	0.017	0.086	128.217	0.000	128.217	132.73	No
Subbasin 2A - Capitol Building Parking Lot (south of Capitol and north of O'Brien Building)																				
30010	30015	12.25	83	18	0.012	111.3	111.7	1.767	6.932	0.746	112.710	0.954	113.664	0.149	0.746	114.559	0.830	113.729	116.64	No
30015	10701	12.92	351	18	0.012	111.9	115.5	1.767	7.311	0.830	113.729	4.486	118.215	0.166	0.830	119.211	0.326	118.884	124.71	No
10701	32741	8.1	356	18	0.012	115.6	121.52	1.767	4.584	0.326	118.884	1.788	120.673	0.065	0.326	121.064	0.125	120.939	124.62	No
32741	11309	2.23	115	12	0.012	121.52	123.6	0.785	2.839	0.125	122.335	0.380	122.715	0.025	0.125	122.865	0.000	122.865	124.46	No
BASIN 3 - Mansion Parking Lot (north side)																				
33250 (Outfall)	Mid2	1.48	269	8	0.012	11	106.56	0.349	4.240	0.279	11.550	3.399	14.949	0.056	0.279	15.284	0.386	14.899	13.37	YES
Mid2	Mid1	1.74	59	8	0.012	106.56	107.74	0.349	4.985	0.386	107.125	1.031	108.156	0.077	0.386	108.619	0.022	108.596	133.19	No
Mid1	32248	0.42	108	8	0.012	107.74	109.9	0.349	1.203	0.022	108.215	0.110	108.325	0.004	0.022	108.352	1.219	107.132	112.68	No
32248	Tee	1.74	10	6	0.012	112.59	115.7	0.196	8.862	1.219	113.030	0.809	113.839	0.244	1.219	115.303	0.000	115.303	112.1	YES
Tee	32247	1.49	58	6	0.012	117.9	120.8	0.196	7.588	0.894	118.315	3.442	121.757	0.179	0.894	122.830	0.000	122.830	112	YES
Tee	32265	0.39	148	6	0.012	120.9	135.5	0.196	1.986	0.061	121.250	0.602	121.852	0.012	0.061	121.925	0.027	121.898	117.3	YES
32265	32250	0.26	64	6	0.012	135.5	137.9	0.196	1.324	0.027	135.825	0.116	135.941	0.005	0.027	135.973	0.000	135.973	117.59	YES

NOTE: See Section 4.2.1.2 (Starting on Page 4-21) of the King Ccounty Surface Water Design Manual for the corresponding equations and a detailed explaination on how to use this spreadsheet. Items 16, 18, and 19 equaled zero for this analysis; therefore, they were not included within this spreadsheet.

APPENDIX F :

FLOW CONTROL CALCULATIONS – PROPOSED

WWHM2012
PROJECT REPORT

Project Name: Pritchard Site
Site Name: WCC MP
Site Address:
City :
Report Date: 6/9/2015
Gage : Courthouse
Data Start : 1955/10/01
Data End : 2011/09/30
Precip Scale: 1.00
Version : 2013/11/20

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Flat	.75
Pervious Total	0.75

Impervious Land Use	Acres
Impervious Total	0
Basin Total	0.75

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	Acres

C, Lawn, Flat **.25**

Pervious Total **0.25**

Impervious Land Use	**Acres**
PARKING FLAT	**0.5**

Impervious Total **0.5**

Basin Total **0.75**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Vault 1	Vault 1	

Name : Vault 1
Width : 41.6792689897846 ft.
Length : 83.3585379795702 ft.
Depth: 6 ft.
Discharge Structure
Riser Height: 5 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.010 ft.
Notch Height: 1.753 ft.
Orifice 1 Diameter: 0.659 in. **Elevation:** 0 ft.

Element Flows To:

Outlet 1	**Outlet 2**

Vault Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.079	0.000	0.000	0.000
0.0667	0.079	0.005	0.002	0.000
0.1333	0.079	0.010	0.004	0.000
0.2000	0.079	0.016	0.005	0.000
0.2667	0.079	0.021	0.005	0.000
0.3333	0.079	0.026	0.006	0.000
0.4000	0.079	0.031	0.007	0.000
0.4667	0.079	0.037	0.007	0.000
0.5333	0.079	0.042	0.008	0.000
0.6000	0.079	0.047	0.008	0.000
0.6667	0.079	0.053	0.009	0.000
0.7333	0.079	0.058	0.009	0.000
0.8000	0.079	0.063	0.010	0.000
0.8667	0.079	0.069	0.010	0.000
0.9333	0.079	0.074	0.011	0.000
1.0000	0.079	0.079	0.011	0.000

1.0667	0.079	0.085	0.011	0.000
1.1333	0.079	0.090	0.012	0.000
1.2000	0.079	0.095	0.012	0.000
1.2667	0.079	0.101	0.012	0.000
1.3333	0.079	0.106	0.013	0.000
1.4000	0.079	0.111	0.013	0.000
1.4667	0.079	0.117	0.013	0.000
1.5333	0.079	0.122	0.014	0.000
1.6000	0.079	0.127	0.014	0.000
1.6667	0.079	0.132	0.014	0.000
1.7333	0.079	0.138	0.015	0.000
1.8000	0.079	0.143	0.015	0.000
1.8667	0.079	0.148	0.015	0.000
1.9333	0.079	0.154	0.015	0.000
2.0000	0.079	0.159	0.016	0.000
2.0667	0.079	0.164	0.016	0.000
2.1333	0.079	0.170	0.016	0.000
2.2000	0.079	0.175	0.016	0.000
2.2667	0.079	0.180	0.017	0.000
2.3333	0.079	0.186	0.017	0.000
2.4000	0.079	0.191	0.017	0.000
2.4667	0.079	0.196	0.017	0.000
2.5333	0.079	0.202	0.018	0.000
2.6000	0.079	0.207	0.018	0.000
2.6667	0.079	0.212	0.018	0.000
2.7333	0.079	0.218	0.018	0.000
2.8000	0.079	0.223	0.019	0.000
2.8667	0.079	0.228	0.019	0.000
2.9333	0.079	0.234	0.019	0.000
3.0000	0.079	0.239	0.019	0.000
3.0667	0.079	0.244	0.020	0.000
3.1333	0.079	0.249	0.020	0.000
3.2000	0.079	0.255	0.020	0.000
3.2667	0.079	0.260	0.020	0.000
3.3333	0.079	0.265	0.021	0.000
3.4000	0.079	0.271	0.023	0.000
3.4667	0.079	0.276	0.024	0.000
3.5333	0.079	0.281	0.026	0.000
3.6000	0.079	0.287	0.028	0.000
3.6667	0.079	0.292	0.030	0.000
3.7333	0.079	0.297	0.032	0.000
3.8000	0.079	0.303	0.034	0.000
3.8667	0.079	0.308	0.037	0.000
3.9333	0.079	0.313	0.039	0.000
4.0000	0.079	0.319	0.041	0.000
4.0667	0.079	0.324	0.044	0.000
4.1333	0.079	0.329	0.046	0.000
4.2000	0.079	0.335	0.049	0.000
4.2667	0.079	0.340	0.051	0.000
4.3333	0.079	0.345	0.054	0.000
4.4000	0.079	0.350	0.057	0.000
4.4667	0.079	0.356	0.060	0.000
4.5333	0.079	0.361	0.063	0.000
4.6000	0.079	0.366	0.067	0.000
4.6667	0.079	0.372	0.083	0.000
4.7333	0.079	0.377	0.087	0.000
4.8000	0.079	0.382	0.092	0.000

4.8667	0.079	0.388	0.096	0.000
4.9333	0.079	0.393	0.101	0.000
5.0000	0.079	0.398	0.106	0.000
5.0667	0.079	0.404	0.357	0.000
5.1333	0.079	0.409	0.817	0.000
5.2000	0.079	0.414	1.413	0.000
5.2667	0.079	0.420	2.118	0.000
5.3333	0.079	0.425	2.918	0.000
5.4000	0.079	0.430	3.802	0.000
5.4667	0.079	0.436	4.764	0.000
5.5333	0.079	0.441	5.797	0.000
5.6000	0.079	0.446	6.897	0.000
5.6667	0.079	0.452	8.059	0.000
5.7333	0.079	0.457	9.281	0.000
5.8000	0.079	0.462	10.56	0.000
5.8667	0.079	0.467	11.89	0.000
5.9333	0.079	0.473	13.28	0.000
6.0000	0.079	0.478	14.71	0.000
6.0667	0.079	0.483	16.20	0.000
6.1333	0.000	0.000	17.73	0.000

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.75
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0.25
Total Impervious Area:0.5

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.036396
5 year	0.05987
10 year	0.074542
25 year	0.091486
50 year	0.102875
100 year	0.113239

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.018612
5 year	0.028939
10 year	0.037703
25 year	0.051342
50 year	0.063622
100 year	0.077952

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1956	0.038	0.019
1957	0.069	0.018
1958	0.030	0.013
1959	0.028	0.018
1960	0.101	0.037
1961	0.033	0.018
1962	0.013	0.013
1963	0.073	0.021
1964	0.034	0.018
1965	0.032	0.016
1966	0.019	0.014
1967	0.061	0.017
1968	0.041	0.014
1969	0.018	0.014
1970	0.030	0.019
1971	0.039	0.019
1972	0.114	0.031
1973	0.034	0.022
1974	0.037	0.018
1975	0.020	0.014
1976	0.042	0.020
1977	0.010	0.011
1978	0.029	0.020
1979	0.029	0.013
1980	0.033	0.019
1981	0.051	0.018
1982	0.028	0.019
1983	0.047	0.017
1984	0.096	0.015
1985	0.015	0.014
1986	0.057	0.020
1987	0.046	0.026
1988	0.023	0.017
1989	0.026	0.013
1990	0.055	0.019
1991	0.100	0.099
1992	0.037	0.019
1993	0.020	0.014
1994	0.018	0.014
1995	0.051	0.039
1996	0.075	0.096
1997	0.004	0.011
1998	0.006	0.008
1999	0.038	0.042
2000	0.026	0.017
2001	0.011	0.012
2002	0.050	0.037
2003	0.030	0.018
2004	0.075	0.054
2005	0.035	0.016
2006	0.046	0.020
2007	0.039	0.047

2008	0.064	0.033
2009	0.047	0.020
2010	0.014	0.014
2011	0.042	0.019

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	0.1136	0.0987
2	0.1014	0.0963
3	0.1001	0.0537
4	0.0959	0.0466
5	0.0752	0.0417
6	0.0750	0.0394
7	0.0733	0.0375
8	0.0692	0.0368
9	0.0641	0.0330
10	0.0610	0.0312
11	0.0567	0.0257
12	0.0554	0.0216
13	0.0514	0.0207
14	0.0505	0.0199
15	0.0504	0.0196
16	0.0475	0.0196
17	0.0465	0.0196
18	0.0459	0.0195
19	0.0457	0.0193
20	0.0425	0.0193
21	0.0421	0.0192
22	0.0410	0.0191
23	0.0391	0.0187
24	0.0387	0.0186
25	0.0382	0.0186
26	0.0376	0.0186
27	0.0370	0.0185
28	0.0368	0.0184
29	0.0346	0.0184
30	0.0340	0.0181
31	0.0338	0.0180
32	0.0330	0.0178
33	0.0326	0.0177
34	0.0322	0.0175
35	0.0301	0.0169
36	0.0299	0.0168
37	0.0296	0.0168
38	0.0293	0.0160
39	0.0292	0.0158
40	0.0284	0.0148
41	0.0283	0.0145
42	0.0265	0.0145
43	0.0258	0.0145
44	0.0235	0.0144
45	0.0202	0.0142
46	0.0195	0.0139
47	0.0192	0.0137
48	0.0179	0.0136

49	0.0179	0.0133
50	0.0148	0.0133
51	0.0139	0.0132
52	0.0132	0.0126
53	0.0108	0.0120
54	0.0104	0.0110
55	0.0060	0.0105
56	0.0037	0.0075

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0182	21462	20382	94	Pass
0.0191	19176	14601	76	Pass
0.0199	17022	10132	59	Pass
0.0208	15035	6922	46	Pass
0.0216	13470	5922	43	Pass
0.0225	12176	5182	42	Pass
0.0233	11053	4711	42	Pass
0.0242	9979	4312	43	Pass
0.0250	8972	3961	44	Pass
0.0259	8106	3593	44	Pass
0.0268	7318	3334	45	Pass
0.0276	6609	3071	46	Pass
0.0285	5954	2794	46	Pass
0.0293	5361	2545	47	Pass
0.0302	4887	2292	46	Pass
0.0310	4457	2097	47	Pass
0.0319	4027	1915	47	Pass
0.0327	3658	1726	47	Pass
0.0336	3320	1571	47	Pass
0.0344	3024	1429	47	Pass
0.0353	2798	1297	46	Pass
0.0362	2594	1192	45	Pass
0.0370	2368	1101	46	Pass
0.0379	2152	1020	47	Pass
0.0387	1969	941	47	Pass
0.0396	1818	849	46	Pass
0.0404	1710	784	45	Pass
0.0413	1606	733	45	Pass
0.0421	1484	684	46	Pass
0.0430	1370	655	47	Pass
0.0439	1261	616	48	Pass
0.0447	1146	582	50	Pass
0.0456	1036	537	51	Pass
0.0464	947	485	51	Pass
0.0473	855	454	53	Pass
0.0481	788	431	54	Pass
0.0490	723	407	56	Pass
0.0498	639	384	60	Pass
0.0507	575	355	61	Pass
0.0516	535	325	60	Pass

0.0524	500	301	60	Pass
0.0533	462	270	58	Pass
0.0541	408	243	59	Pass
0.0550	382	229	59	Pass
0.0558	357	213	59	Pass
0.0567	335	198	59	Pass
0.0575	311	180	57	Pass
0.0584	292	167	57	Pass
0.0593	276	156	56	Pass
0.0601	262	142	54	Pass
0.0610	247	127	51	Pass
0.0618	232	119	51	Pass
0.0627	216	106	49	Pass
0.0635	198	101	51	Pass
0.0644	172	94	54	Pass
0.0652	156	88	56	Pass
0.0661	138	80	57	Pass
0.0670	124	74	59	Pass
0.0678	115	70	60	Pass
0.0687	99	69	69	Pass
0.0695	92	66	71	Pass
0.0704	87	65	74	Pass
0.0712	82	64	78	Pass
0.0721	79	62	78	Pass
0.0729	76	59	77	Pass
0.0738	72	56	77	Pass
0.0746	71	54	76	Pass
0.0755	66	54	81	Pass
0.0764	63	53	84	Pass
0.0772	62	53	85	Pass
0.0781	60	52	86	Pass
0.0789	58	52	89	Pass
0.0798	55	51	92	Pass
0.0806	54	50	92	Pass
0.0815	52	50	96	Pass
0.0823	50	49	98	Pass
0.0832	48	46	95	Pass
0.0841	46	46	100	Pass
0.0849	44	44	100	Pass
0.0858	41	42	102	Pass
0.0866	37	40	108	Pass
0.0875	34	37	108	Pass
0.0883	32	35	109	Pass
0.0892	31	33	106	Pass
0.0900	29	30	103	Pass
0.0909	28	27	96	Pass
0.0918	26	25	96	Pass
0.0926	25	22	88	Pass
0.0935	23	22	95	Pass
0.0943	22	18	81	Pass
0.0952	21	15	71	Pass
0.0960	16	10	62	Pass
0.0969	13	6	46	Pass
0.0977	12	5	41	Pass
0.0986	11	1	9	Pass
0.0995	6	0	0	Pass
0.1003	2	0	0	Pass

0.1012	2	0	0	Pass
0.1020	1	0	0	Pass
0.1029	1	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault 1 POC	N	118.49			N	0.00			
Total Volume Infiltrated		118.49	0.00	0.00		0.00	0.00	0%	No Treat. Credit

Compliance with LID Standard 8
Duration Analysis Result = Failed

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Press House/Visitor Center/Newhouse Site
Site Name: WCC MP
Site Address:
City :
Report Date: 6/9/2015
Gage : Courthouse
Data Start : 1955/10/01
Data End : 2011/09/30
Precip Scale: 1.00
Version : 2013/11/20

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Flat	.85
Pervious Total	**0.85**

Impervious Land Use	Acres
Impervious Total	**0**
Basin Total	**0.85**

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	Acres

C, Lawn, Flat **.1**

Pervious Total **0.1**

Impervious Land Use	**Acres**
PARKING FLAT	**0.75**

Impervious Total **0.75**

Basin Total **0.85**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Vault 1	Vault 1	

Name : Vault 1
Width : 48.8752896280595 ft.
Length : 97.7505792561181 ft.
Depth: 6 ft.
Discharge Structure
Riser Height: 5 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.011 ft.
Notch Height: 1.763 ft.
Orifice 1 Diameter: 0.7 in. **Elevation:** 0 ft.

Element Flows To:

Outlet 1	**Outlet 2**

Vault Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.109	0.000	0.000	0.000
0.0667	0.109	0.007	0.003	0.000
0.1333	0.109	0.014	0.004	0.000
0.2000	0.109	0.021	0.005	0.000
0.2667	0.109	0.029	0.006	0.000
0.3333	0.109	0.036	0.007	0.000
0.4000	0.109	0.043	0.008	0.000
0.4667	0.109	0.051	0.008	0.000
0.5333	0.109	0.058	0.009	0.000
0.6000	0.109	0.065	0.010	0.000
0.6667	0.109	0.073	0.010	0.000
0.7333	0.109	0.080	0.011	0.000
0.8000	0.109	0.087	0.011	0.000
0.8667	0.109	0.095	0.012	0.000
0.9333	0.109	0.102	0.012	0.000
1.0000	0.109	0.109	0.012	0.000

1.0667	0.109	0.117	0.013	0.000
1.1333	0.109	0.124	0.013	0.000
1.2000	0.109	0.131	0.014	0.000
1.2667	0.109	0.138	0.014	0.000
1.3333	0.109	0.146	0.014	0.000
1.4000	0.109	0.153	0.015	0.000
1.4667	0.109	0.160	0.015	0.000
1.5333	0.109	0.168	0.015	0.000
1.6000	0.109	0.175	0.016	0.000
1.6667	0.109	0.182	0.016	0.000
1.7333	0.109	0.190	0.016	0.000
1.8000	0.109	0.197	0.017	0.000
1.8667	0.109	0.204	0.017	0.000
1.9333	0.109	0.212	0.017	0.000
2.0000	0.109	0.219	0.018	0.000
2.0667	0.109	0.226	0.018	0.000
2.1333	0.109	0.234	0.018	0.000
2.2000	0.109	0.241	0.019	0.000
2.2667	0.109	0.248	0.019	0.000
2.3333	0.109	0.255	0.019	0.000
2.4000	0.109	0.263	0.019	0.000
2.4667	0.109	0.270	0.020	0.000
2.5333	0.109	0.277	0.020	0.000
2.6000	0.109	0.285	0.020	0.000
2.6667	0.109	0.292	0.021	0.000
2.7333	0.109	0.299	0.021	0.000
2.8000	0.109	0.307	0.021	0.000
2.8667	0.109	0.314	0.021	0.000
2.9333	0.109	0.321	0.022	0.000
3.0000	0.109	0.329	0.022	0.000
3.0667	0.109	0.336	0.022	0.000
3.1333	0.109	0.343	0.022	0.000
3.2000	0.109	0.351	0.023	0.000
3.2667	0.109	0.358	0.023	0.000
3.3333	0.109	0.365	0.024	0.000
3.4000	0.109	0.372	0.026	0.000
3.4667	0.109	0.380	0.028	0.000
3.5333	0.109	0.387	0.030	0.000
3.6000	0.109	0.394	0.032	0.000
3.6667	0.109	0.402	0.034	0.000
3.7333	0.109	0.409	0.036	0.000
3.8000	0.109	0.416	0.039	0.000
3.8667	0.109	0.424	0.041	0.000
3.9333	0.109	0.431	0.044	0.000
4.0000	0.109	0.438	0.047	0.000
4.0667	0.109	0.446	0.050	0.000
4.1333	0.109	0.453	0.052	0.000
4.2000	0.109	0.460	0.055	0.000
4.2667	0.109	0.468	0.058	0.000
4.3333	0.109	0.475	0.061	0.000
4.4000	0.109	0.482	0.065	0.000
4.4667	0.109	0.489	0.068	0.000
4.5333	0.109	0.497	0.072	0.000
4.6000	0.109	0.504	0.076	0.000
4.6667	0.109	0.511	0.094	0.000
4.7333	0.109	0.519	0.099	0.000
4.8000	0.109	0.526	0.104	0.000

4.8667	0.109	0.533	0.109	0.000
4.9333	0.109	0.541	0.114	0.000
5.0000	0.109	0.548	0.120	0.000
5.0667	0.109	0.555	0.371	0.000
5.1333	0.109	0.563	0.831	0.000
5.2000	0.109	0.570	1.427	0.000
5.2667	0.109	0.577	2.132	0.000
5.3333	0.109	0.585	2.932	0.000
5.4000	0.109	0.592	3.816	0.000
5.4667	0.109	0.599	4.778	0.000
5.5333	0.109	0.606	5.811	0.000
5.6000	0.109	0.614	6.911	0.000
5.6667	0.109	0.621	8.073	0.000
5.7333	0.109	0.628	9.296	0.000
5.8000	0.109	0.636	10.57	0.000
5.8667	0.109	0.643	11.90	0.000
5.9333	0.109	0.650	13.29	0.000
6.0000	0.109	0.658	14.73	0.000
6.0667	0.109	0.665	16.21	0.000
6.1333	0.000	0.000	17.74	0.000

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.85
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0.1
Total Impervious Area:0.75

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.041249
5 year	0.067852
10 year	0.084481
25 year	0.103684
50 year	0.116591
100 year	0.128338

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.021421
5 year	0.033339
10 year	0.04346
25 year	0.059221
50 year	0.07342
100 year	0.089997

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1956	0.043	0.021
1957	0.078	0.020
1958	0.034	0.015
1959	0.032	0.021
1960	0.115	0.040
1961	0.037	0.021
1962	0.015	0.015
1963	0.083	0.023
1964	0.038	0.020
1965	0.036	0.018
1966	0.022	0.017
1967	0.069	0.020
1968	0.046	0.016
1969	0.020	0.016
1970	0.034	0.021
1971	0.044	0.022
1972	0.129	0.034
1973	0.038	0.024
1974	0.042	0.021
1975	0.022	0.016
1976	0.048	0.022
1977	0.012	0.013
1978	0.033	0.023
1979	0.033	0.015
1980	0.037	0.021
1981	0.058	0.020
1982	0.032	0.021
1983	0.054	0.019
1984	0.109	0.017
1985	0.017	0.016
1986	0.064	0.022
1987	0.052	0.030
1988	0.027	0.020
1989	0.029	0.016
1990	0.063	0.022
1991	0.113	0.112
1992	0.042	0.021
1993	0.023	0.016
1994	0.020	0.017
1995	0.057	0.048
1996	0.085	0.109
1997	0.004	0.013
1998	0.007	0.009
1999	0.043	0.051
2000	0.030	0.020
2001	0.012	0.014
2002	0.057	0.050
2003	0.034	0.020
2004	0.085	0.068
2005	0.039	0.018
2006	0.052	0.023
2007	0.044	0.055

2008	0.073	0.035
2009	0.053	0.022
2010	0.016	0.017
2011	0.048	0.021

Stream Protection Duration

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1287	0.1116
2	0.1149	0.1094
3	0.1135	0.0676
4	0.1087	0.0546
5	0.0852	0.0507
6	0.0850	0.0496
7	0.0831	0.0480
8	0.0784	0.0400
9	0.0726	0.0352
10	0.0691	0.0340
11	0.0642	0.0302
12	0.0628	0.0238
13	0.0583	0.0234
14	0.0572	0.0225
15	0.0571	0.0225
16	0.0538	0.0224
17	0.0527	0.0222
18	0.0520	0.0220
19	0.0517	0.0218
20	0.0481	0.0218
21	0.0477	0.0214
22	0.0465	0.0214
23	0.0443	0.0214
24	0.0438	0.0212
25	0.0433	0.0210
26	0.0427	0.0208
27	0.0419	0.0208
28	0.0417	0.0207
29	0.0392	0.0206
30	0.0385	0.0205
31	0.0383	0.0203
32	0.0374	0.0203
33	0.0370	0.0202
34	0.0365	0.0201
35	0.0341	0.0199
36	0.0339	0.0198
37	0.0336	0.0190
38	0.0332	0.0184
39	0.0331	0.0178
40	0.0322	0.0171
41	0.0320	0.0169
42	0.0300	0.0169
43	0.0292	0.0165
44	0.0266	0.0164
45	0.0229	0.0162
46	0.0221	0.0162
47	0.0218	0.0161
48	0.0203	0.0158

49	0.0203	0.0155
50	0.0168	0.0153
51	0.0157	0.0152
52	0.0149	0.0147
53	0.0122	0.0140
54	0.0118	0.0133
55	0.0068	0.0129
56	0.0042	0.0091

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0206	21442	20519	95	Pass
0.0216	19176	14725	76	Pass
0.0226	17003	10018	58	Pass
0.0235	15031	6935	46	Pass
0.0245	13454	6103	45	Pass
0.0255	12174	5575	45	Pass
0.0264	11041	5058	45	Pass
0.0274	9969	4514	45	Pass
0.0284	8976	4096	45	Pass
0.0293	8106	3743	46	Pass
0.0303	7322	3424	46	Pass
0.0313	6609	3167	47	Pass
0.0323	5956	2849	47	Pass
0.0332	5361	2584	48	Pass
0.0342	4889	2360	48	Pass
0.0352	4455	2134	47	Pass
0.0361	4027	1946	48	Pass
0.0371	3656	1803	49	Pass
0.0381	3320	1692	50	Pass
0.0390	3022	1557	51	Pass
0.0400	2796	1421	50	Pass
0.0410	2592	1310	50	Pass
0.0420	2366	1215	51	Pass
0.0429	2152	1137	52	Pass
0.0439	1969	1065	54	Pass
0.0449	1818	981	53	Pass
0.0458	1710	889	51	Pass
0.0468	1607	822	51	Pass
0.0478	1483	755	50	Pass
0.0487	1371	700	51	Pass
0.0497	1261	650	51	Pass
0.0507	1147	605	52	Pass
0.0516	1035	564	54	Pass
0.0526	947	533	56	Pass
0.0536	855	499	58	Pass
0.0546	788	447	56	Pass
0.0555	721	416	57	Pass
0.0565	639	396	61	Pass
0.0575	575	380	66	Pass
0.0584	535	360	67	Pass

0.0594	500	333	66	Pass
0.0604	462	310	67	Pass
0.0613	409	292	71	Pass
0.0623	382	272	71	Pass
0.0633	357	246	68	Pass
0.0642	335	230	68	Pass
0.0652	311	211	67	Pass
0.0662	292	193	66	Pass
0.0672	276	172	62	Pass
0.0681	262	154	58	Pass
0.0691	247	143	57	Pass
0.0701	232	128	55	Pass
0.0710	216	120	55	Pass
0.0720	198	113	57	Pass
0.0730	173	104	60	Pass
0.0739	156	92	58	Pass
0.0749	138	86	62	Pass
0.0759	124	81	65	Pass
0.0768	115	78	67	Pass
0.0778	100	77	77	Pass
0.0788	92	76	82	Pass
0.0798	87	72	82	Pass
0.0807	82	72	87	Pass
0.0817	79	71	89	Pass
0.0827	76	69	90	Pass
0.0836	72	68	94	Pass
0.0846	71	67	94	Pass
0.0856	66	66	100	Pass
0.0865	63	64	101	Pass
0.0875	62	62	100	Pass
0.0885	60	62	103	Pass
0.0894	58	60	103	Pass
0.0904	55	58	105	Pass
0.0914	54	56	103	Pass
0.0924	52	55	105	Pass
0.0933	50	54	108	Pass
0.0943	48	50	104	Pass
0.0953	46	47	102	Pass
0.0962	44	45	102	Pass
0.0972	41	42	102	Pass
0.0982	37	40	108	Pass
0.0991	34	37	108	Pass
0.1001	32	35	109	Pass
0.1011	31	34	109	Pass
0.1021	29	31	106	Pass
0.1030	28	29	103	Pass
0.1040	26	26	100	Pass
0.1050	25	23	92	Pass
0.1059	23	21	91	Pass
0.1069	22	17	77	Pass
0.1079	21	15	71	Pass
0.1088	16	11	68	Pass
0.1098	13	6	46	Pass
0.1108	12	4	33	Pass
0.1117	11	0	0	Pass
0.1127	6	0	0	Pass
0.1137	2	0	0	Pass

0.1147	2	0	0	Pass
0.1156	1	0	0	Pass
0.1166	1	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault 1 POC	N	148.05			N	0.00			
Total Volume Infiltrated		148.05	0.00	0.00		0.00	0.00	0%	No Treat. Credit

Compliance with LID Standard 8
Duration Analysis Result = Failed

Perlnd and Implnd Changes

No changes have been made.

APPENDIX G:

OPINION OF PROBABLE CONSTRUCTION COSTS

ReidMiddleton

Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SOUTH OF CAPITOL

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
Check By: JDJ

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$16,000
2.0	DEMOLITION		$144,800
3.0	EARTHWORK		$81,000
4.0	STORM DRAINAGE		$67,700
5.0	SITE PAVING		$368,100
6.0	LANDSCAPING		$100,100
SUBTOTAL			**$777,700**
Design contingency		30%	$233,310
CONSTRUCTION SUBTOTAL			**$1,011,000**
General conditions		8%	$80,880
General contractor's OH & P		12%	$121,320
Construction Contingency		10%	$101,100
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$1,314,300**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES.   ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

H:\21Cp\14\008 West Capitol Campus Drainage Plan\$construction_cost\[Planning Cost Estimate – 05.27.15.xls]Proj No. 10 - Details

ReidMiddleton

Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SOUTH OF CAPITOL

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
Check By: JDJ

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	Silt Fence	lf	1,200	$5.00	$6,000
1.02	Construction Entrance	ls	1	$3,000.00	$3,000
1.03	CB Filter	ea	8	$250.00	$2,000
1.04	Miscellaneous Erosion Control Items	ls	1	$5,000.00	$5,000
TOTAL EROSION CONTROL					**$16,000**
2.0	**DEMOLITION**				
2.01	Sawcut Concrete Pavement	lf	1,000	$3.50	$3,500
2.02	Remove Concrete Pavement	sf	30,000	$3.00	$90,000
2.03	Dispose of Demolition Debris	cy	650	$25.00	$16,250
2.04	Abandon Manholes	ea	12	$1,000.00	$12,000
2.05	Abandon & Plug Utility Lines	ls	1	$10,000.00	$10,000
2.06	Traffic Control	ls	1	$10,000.00	$10,000
2.07	Remove Curb & Gutter	lf	1,000	$3.00	$3,000
TOTAL DEMOLITION					**$144,800**
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	2,500	$30.00	$75,000
3.02	Fine Grading	sf	30,000	$0.20	$6,000
TOTAL EARTHWORK					**$81,000**
4.0	**STORM DRAINAGE**				
4.01	Connect to Existing System	ea	1	$500.00	$500
4.02	6" PVC Underdrain Pipe	lf	235	$30.00	$7,050
4.03	8" Storm Drain Pipe, including trench	lf	210	$25.00	$5,250
4.04	12" Storm Drain Pipe, including trench	lf	230	$35.00	$8,050
4.05	18" Storm Drain Pipe, including trench	lf	325	$55.00	$17,875
4.06	Catch Basin Type I	ea	3	$1,250.00	$3,750
4.07	Catch Basin Type 2, 48-inch	ea	2	$3,000.00	$6,000
4.08	Catch Basin Insert for treatment	ea	1	$5,000.00	$5,000
4.09	Bioretention Garden Excavation	cy	350	$5.00	$1,750
4.10	Compost for Bioretention	cy	40	$40.00	$1,600
4.11	Gravel for Underdrain System	cy	35	$45.00	$1,575
4.12	Gravel Borrow for Trench Backfill	cy	260	$32.00	$8,320
4.13	Foundation Material for Pipe	cy	30	$32.00	$960
TOTAL STORM DRAINAGE					**$67,700**

ReidMiddleton

Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SOUTH OF CAPITOL

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

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Item No.	Description	Unit	Quantity	Unit Price	Current Amount
5.0	**SITE PAVING**				
5.01	Overexcavation for Base Course Installation	cy	1,150	$4.50	$5,175
5.02	PCC Concrete Sidewalk	sf	1,000	$5.50	$5,500
5.03	PCC Concrete Pavement	sf	30,000	$10.00	$300,000
5.04	Color Concrete for Color	sf	200	$11.00	$2,200
5.05	ADA Ramp	ea	2	$1,500.00	$3,000
5.06	Concrete Curb & Gutter	lf	450	$20.00	$9,000
5.07	Roadway Channelization	ls	1	$3,000.00	$3,000
5.08	Crushed Surfacing Top Course for Sidewalk	ton	130	$25.00	$3,250
5.09	Gravel Borrow for Fill	cy	1,200	$30.00	$36,000
5.10	Permanent Signing	ls	1	$1,000.00	$1,000
TOTAL SITE PAVING					**$368,100**
6.0	**LANDSCAPING**				
6.01	Planting Soil, Bioretention & Standard Planting Soil	cy	245	$45.00	$11,025
6.02	Standard Planting Soil Mix	cy	300	$45.00	$13,500
6.03	Bioretention Planters (Vertical Concrete Curbs)	lf	650	$30.00	$19,500
6.04	Planting (Shrub and Groundcover Layer)	sf	13,500	$2.50	$33,750
6.05	Lawn (Seeded, not including soil or irrig.)	sf	4,000	$0.20	$800
6.06	Mulch (PA plus trees in lawn)	cy	50	$35.00	$1,750
6.07	Trees - 3" caliper deciduous	ea	8	$600.00	$4,800
6.08	Trees - 10' ht. multi-stemmed deciduous	ea	4	$600.00	$2,400
6.09	Irrigation	sf	8,400	$1.50	$12,600
TOTAL LANDSCAPING					**$100,100**
	SUBTOTAL				**$777,700**

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

H:\21Cp\14\008 West Capitol Campus Drainage Plan\$construction_cost\[Planning Cost Estimate – 05.27.15.xls]Proj No. 10 - Details

ReidMiddleton

Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SOUTH DIAGONAL

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
Check By: JDJ

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$13,000
2.0	DEMOLITION		$19,100
3.0	EARTHWORK		$24,500
4.0	STORM DRAINAGE		$108,000
5.0	LANDSCAPING		$127,300
SUBTOTAL			**$291,900**
Design contingency		30%	$87,570
CONSTRUCTION SUBTOTAL			**$379,500**
General conditions		8%	$30,360
General contractor's OH & P		12%	$45,540
Construction Contingency		10%	$37,950
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$493,350**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

ReidMiddleton

Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SOUTH DIAGONAL

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
Check By: JDJ

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	Silt Fence	lf	500	$5.00	$2,500
1.02	Construction Entrance	ls	1	$3,000.00	$3,000
1.03	CB Filter	ea	10	$250.00	$2,500
1.04	Straw Bale Barrier	lf	500	$10.00	$5,000
TOTAL EROSION CONTROL					**$13,000**
2.0	**DEMOLITION**				
2.01	Sawcut Concrete Pavement	lf	200	$3.50	$700
2.02	Remove Concrete Pavement	sf	200	$3.00	$600
2.03	Dispose of Concrete Debris	cy	10	$25.00	$250
2.04	Abandon & Plug Utility Lines	ea	1	$6,000.00	$6,000
2.05	Traffic Control	ls	1	$10,000.00	$10,000
2.06	Remove Curb & Gutter	lf	500	$3.00	$1,500
TOTAL DEMOLITION					**$19,100**
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	750	$30.00	$22,500
3.02	Stripping	cy	100	$5.00	$500
3.03	Fine Grading	sf	7,500	$0.20	$1,500
TOTAL EARTHWORK					**$24,500**
4.0	**STORM DRAINAGE**				
4.01	Connect to Existing System	ea	7	$500.00	$3,500
4.02	6" PVC Underdrain Pipe	lf	260	$30.00	$7,800
4.03	8" Storm Drain Pipe, including trench	lf	110	$25.00	$2,750
4.04	18" Storm Drain Pipe, including trench	lf	500	$55.00	$27,500
4.05	Trench Drain	lf	100	$60.00	$6,000
4.06	Catch Basin Type I	ea	5	$1,250.00	$6,250
4.07	Catch Basin Type 2, 48-inch	ea	4	$3,000.00	$12,000
4.08	Bioretention Garden Excavation	cy	350	$5.00	$1,750
4.09	Compost for Bioretention	cy	30	$40.00	$1,200
4.10	Gravel for Underdrain System	cy	40	$45.00	$1,800
4.11	Gravel Borrow for Trench Backfill	cy	410	$45.00	$18,450
4.12	Foundation Material for Pipe	cy	70	$32.00	$2,240
4.13	Pavement Patching	sf	135	$50.00	$6,750
4.14	Concrete Curb & Gutter	lf	500	$20.00	$10,000
TOTAL STORM DRAINAGE					**$108,000**

ReidMiddleton

Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SOUTH DIAGONAL

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
Check By: JDJ

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
5.0	**LANDSCAPING**				
5.01	Planting Soil, Bioretention & Standard Planting Soil	cy	920	$45.00	$41,400
5.02	Bioretention Planters (Vertical Concrete Curbs)	lf	510	$30.00	$15,300
5.03	Planting (Shrub and Groundcover Layer)	sf	12,500	$2.50	$31,250
5.04	Lawn (Seeded, not including soil or irrig.)	sf	4,000	$0.20	$800
5.05	Trees - 3" caliper deciduous	ea	9	$600.00	$5,400
5.06	Trees - 10' ht. multi-stemmed deciduous	ea	14	$600.00	$8,400
5.07	Irrigation	sf	16,500	$1.50	$24,750
TOTAL LANDSCAPING					**$127,300**
	SUBTOTAL				**$291,900**

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SUNKEN GARDEN

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
Check By: JDJ

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$8,000
2.0	DEMOLITION		$12,500
3.0	EARTHWORK		$35,000
4.0	STORM DRAINAGE		$22,400
5.0	SITE PAVING		$8,900
6.0	LANDSCAPING		$246,000
SUBTOTAL			**$332,800**
Design contingency		30%	$99,840
CONSTRUCTION SUBTOTAL			**$432,600**
General conditions		8%	$34,608
General contractor's OH & P		12%	$51,912
Construction Contingency		10%	$43,260
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$562,380**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SUNKEN GARDEN

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	Silt Fence	lf	250	$5.00	$1,250
1.02	Construction Entrance	ls	1	$3,000.00	$3,000
1.03	CB Filter	ea	15	$250.00	$3,750
TOTAL EROSION CONTROL					**$8,000**

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
2.0	**DEMOLITION**				
2.01	Sawcut Concrete Pavement	lf	200	$3.50	$700
2.02	Remove Concrete Pavement	sf	400	$3.00	$1,200
2.03	Dispose of Concrete Debris	cy	15	$25.00	$375
2.04	Abandon & Plug Utility Lines	ls	1	$5,000.00	$5,000
2.05	Traffic Control	ls	1	$5,000.00	$5,000
2.06	Remove Curb & Gutter	lf	60	$3.00	$180
TOTAL DEMOLITION					**$12,500**

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	500	$30.00	$15,000
3.02	Fine Grading	sf	25,000	$0.20	$5,000
3.03	Gravel Borrow for Fill	cy	500	$30.00	$15,000
TOTAL EARTHWORK					**$35,000**

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
4.0	**STORM DRAINAGE**				
4.01	Connect to Existing System	ea	2	$500.00	$1,000
4.02	6" PVC Underdrain Pipe	lf	170	$30.00	$5,100
4.03	8" Storm Drain Pipe, including trench	lf	200	$25.00	$5,000
4.04	Clean Outs	ea	2	$250.00	$500
4.05	Catch Basin Type I	ea	2	$1,250.00	$2,500
4.06	Quarry Spalls Outlet Protection	ea	1	$300.00	$300
4.07	Bioretention Garden Excavation	cy	450	$5.00	$2,250
4.08	Compost for Bioretention	cy	40	$40.00	$1,600
4.09	Gravel for Underdrain System	cy	25	$45.00	$1,125
4.10	Gravel Borrow for Trench Backfill	cy	70	$32.00	$2,240
4.11	Foundation Material for Pipe	cy	25	$32.00	$800
TOTAL STORM DRAINAGE					**$22,400**

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
5.0	**SITE PAVING**				
5.01	PCC Concrete Sidewalk	sf	500	$5.50	$2,750
5.02	PCC Concrete Pavement	sf	400	$10.00	$4,000
5.03	Crushed Surfacing Top Course for Sidewalk	ton	12	$25.00	$300
5.04	Concrete Curb & Gutter	lf	40	$20.00	$800
5.05	Pavement Marking	ls	1	$1,000.00	$1,000
TOTAL SITE PAVING					**$8,900**

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
SUNKEN GARDEN

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
6.0	**LANDSCAPING**				
6.01	Planting Soil, Bioretention & Standard Planting Soil	cy	2,000	$45.00	$90,000
6.02	Standard Planting Soil Mix	cy	250	$45.00	$11,250
6.03	Bioretention Planters (Vertical Concrete Curbs)	sf	565	$30.00	$16,950
6.04	Planting (Shrub and Groundcover Layer)	sf	13,500	$2.50	$33,750
6.05	Lawn (Seeded, not including soil or irrig.)	sf	8,000	$0.20	$1,600
6.06	Trees - 3" caliper deciduous	ea	41	$600.00	$24,600
6.07	Trees - 10' ht. multi-stemmed deciduous	ea	8	$600.00	$4,800
6.08	Trees - 10' ht. conifer	ea	6	$500.00	$3,000
6.08	Irrigation	sf	40,000	$1.50	$60,000
TOTAL LANDSCAPING					**$246,000**
	SUBTOTAL				**$332,800**

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
CAPITOL CONSERVATORY SITE

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
Calc By: BTS
Check By: JDJ

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$9,000
2.0	DEMOLITION		$151,500
3.0	EARTHWORK		$44,800
4.0	STORM DRAINAGE		$7,700
5.0	LANDSCAPING		$201,300
SUBTOTAL			**$414,300**
Design contingency		30%	$124,290
CONSTRUCTION SUBTOTAL			**$538,600**
General conditions		8%	$43,088
General contractor's OH & P		12%	$64,632
Construction Contingency		10%	$53,860
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$700,180**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
CAPITOL CONSERVATORY SITE

Job#: 21-14-008
Created: 08/04/2014
Updated: 07/08/2015
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Check By: JDJ

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	Silt Fence	lf	300	$5.00	$1,500
1.02	Construction Entrance	ls	1	$3,000.00	$3,000
1.03	CB Filter	ea	10	$250.00	$2,500
1.04	Straw Bale Barrier	lf	200	$10.00	$2,000
TOTAL EROSION CONTROL					**$9,000**
2.0	**DEMOLITION**				
2.01	Building Demolition	sf	12,000	$8.00	$96,000
2.02	Remove Asphalt Pavement	sy	1,700	$15.00	$25,500
2.03	Dispose of Asphalt & Concrete Debris	cy	200	$25.00	$5,000
2.04	Plug & Abandon Utility Lines & CDF Fill	ls	1	$5,000.00	$5,000
2.05	Traffic Control	ls	1	$20,000.00	$20,000
TOTAL DEMOLITION					**$151,500**
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	1,000	$30.00	$30,000
3.02	Earthwork	cy	1,925	$5.00	$9,625
3.03	Fine Grading	sf	26,000	$0.20	$5,200
TOTAL EARTHWORK					**$44,800**
4.0	**STORM DRAINAGE**				
4.01	Catch Basin Type I	ea	1	$1,250.00	$1,250
4.02	12" Storm Drain Pipe, including trench	lf	80	$35.00	$2,800
4.03	Gravel Borrow for Trench Backfill	cy	30	$32.00	$960
4.04	Foundation Material for Pipe	cy	10	$32.00	$320
4.05	Pavement Patching	sf	240	$10.00	$2,400
TOTAL STORM DRAINAGE					**$7,700**

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
CAPITOL CONSERVATORY SITE

Job#: 21-14-008
Created: 08/04/2014
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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
5.0	**LANDSCAPING**				
5.01	Planting Soil, Bioretention & Standard Planting Soil	cy	1,515	$45.00	$68,175
5.02	Standard Planting Soil Mix	cy	215	$45.00	$9,675
5.03	Planting (Shrub and Groundcover Layer)	sf	13,500	$2.50	$33,750
5.04	PCC Concrete Sidewalk	sf	2,100	$5.50	$11,550
5.05	Crushed Surfacing Top Course for Sidewalk	ton	50	$25.00	$1,250
5.05	Lawn (Seeded, not including soil or irrig.)	sf	2,820	$0.20	$564
5.06	Trees - 3" caliper deciduous	ea	40	$600.00	$24,000
5.07	Trees - 10' ht. multi-stemmed deciduous	ea	20	$600.00	$12,000
5.08	Trees - 10' ht. conifer	ea	20	$500.00	$10,000
5.08	Irrigation	sf	20,250	$1.50	$30,375
TOTAL LANDSCAPING					**$201,300**
	SUBTOTAL				**$414,300**

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
CHERRY LANE

Job#: 21-14-008
Created: 05/27/2015
Updated: 07/08/2015
Calc By: MKH
Check By: DCY

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$5,000
2.0	DEMOLITION		$12,800
3.0	EARTHWORK		$8,000
4.0	STORM DRAINAGE		$59,100
5.0	LANDSCAPING		$191,800
SUBTOTAL			**$276,700**
Design contingency		30%	$83,010
CONSTRUCTION SUBTOTAL			**$359,700**
General conditions		8%	$28,776
General contractor's OH & P		12%	$43,164
Construction Contingency		10%	$35,970
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$467,610**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
CHERRY LANE

Job#: 21-14-008
Created: 05/27/2015
Updated: 07/08/2015
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Check By: DCY

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	CB Filter	ea	20	$250.00	$5,000
TOTAL EROSION CONTROL					**$5,000**
2.0	**DEMOLITION**				
2.01	Traffic Control	ls	1	$10,000.00	$10,000
2.02	Remove Curb & Gutter	sf	700	$3.00	$2,100
2.03	Sawcut & Remove Pavement along curb & gutters	lf	200	$3.50	$700
TOTAL DEMOLITION					**$12,800**
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	100	$30.00	$3,000
3.02	Fine Grading	sf	24,800	$0.20	$4,960
TOTAL EARTHWORK					**$8,000**
4.0	**STORM DRAINAGE**				
4.01	Connect to Existing System	ea	7	$500.00	$3,500
4.02	6" PVC Underdrain Pipe	lf	910	$30.00	$27,300
4.03	12" Storm Drain Pipe, including trench	lf	40	$35.00	$1,400
4.04	Catch Basin Type I	ea	7	$1,750.00	$12,250
4.05	Gravel for Underdrain System	cy	70	$45.00	$3,150
4.06	Gravel Borrow for Trench Backfill	cy	15	$45.00	$675
4.07	Foundation Material for Pipe	cy	5	$32.00	$160
4.08	Pavement Patching	sf	100	$100.00	$10,000
4.09	Concrete Curb & Gutter	lf	35	$20.00	$700
TOTAL STORM DRAINAGE					**$59,100**

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
CHERRY LANE

Job#: 21-14-008
Created: 05/27/2015
Updated: 07/08/2015
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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
5.0	**LANDSCAPING**				
	Planting Soil, Standard Planting Soil mix: 24" depth				
5.01	at lawn in planting strips with trees	cy	1,840	$45.00	$82,800
5.02	Planting (Shrub and Groundcover Layer)	sf	13,500	$2.50	$33,750
5.03	Mulch (PA plus trees in lawn)	sf	230	$35.00	$8,050
5.04	Trees	ea	50	$600.00	$30,000
5.05	Irrigation	sf	24,800	$1.50	$37,200
TOTAL LANDSCAPING					**$191,800**
	SUBTOTAL				**$276,700**

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
WEST LAWN - UNDERDRAINS

Job#: 21-14-008
Created: 05/27/2015
Updated: 07/08/2015
Calc By: MKH
Check By: DCY

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$12,500
2.0	DEMOLITION		$5,400
3.0	EARTHWORK		$36,000
4.0	STORM DRAINAGE		$289,500
5.0	LANDSCAPING		$0
SUBTOTAL			**$343,400**
Design contingency		30%	$103,020
CONSTRUCTION SUBTOTAL			**$446,400**
General conditions		8%	$35,712
General contractor's OH & P		12%	$53,568
Construction Contingency		10%	$44,640
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$580,320**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
WEST LAWN - UNDERDRAINS

Job#: 21-14-008
Created: 05/27/2015
Updated: 07/08/2015
Calc By: MKH
Check By: DCY

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	Silt Fence	lf	1,000	$5.00	$5,000
1.02	Construction Entrance	ls	1	$5,000.00	$5,000
1.03	CB Filter	ea	10	$250.00	$2,500
TOTAL EROSION CONTROL					**$12,500**
2.0	**DEMOLITION**				
2.01	Sawcut Concrete Pavement	lf	100	$3.50	$350
2.02	Dispose of Concrete Debris	cy	3	$25.00	$75
2.03	Traffic Control	ls	1	$5,000.00	$5,000
TOTAL DEMOLITION					**$5,400**
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	880	$30.00	$26,400
3.02	Fine Grading	sf	48,000	$0.20	$9,600
TOTAL EARTHWORK					**$36,000**
4.0	**STORM DRAINAGE**				
4.01	Connect to Existing System	ea	13	$500.00	$6,500
4.02	6" PVC Underdrain Pipe	lf	3,600	$30.00	$108,000
4.03	12" Storm Drain Pipe, including trench	lf	1,600	$35.00	$56,000
4.04	Catch Basin Type I	ea	38	$1,750.00	$66,500
4.05	Gravel for Underdrain System	cy	280	$45.00	$12,600
4.06	Gravel Borrow for Trench Backfill	cy	600	$45.00	$27,000
4.07	Foundation Material for Pipe	cy	200	$32.00	$6,400
4.08	PCC Concrete Sidewalk	sf	1,000	$6.50	$6,500
TOTAL STORM DRAINAGE					**$289,500**

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
WEST LAWN - UNDERDRAINS

Job#: 21-14-008
Created: 05/27/2015
Updated: 07/08/2015
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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
5.0	**LANDSCAPING**				
5.01	Planting Soil, Bioretention & Standard Planting Soil	cy		$45.00	$0
5.02	Bioretention Planters (Vertical Concrete Curbs)	lf		$30.00	$0
5.03	Planting (Shrub and Groundcover Layer)	sf		$2.50	$0
5.04	Lawn (Seeded, not including soil or irrig.)	sf		$0.20	$0
5.05	Trees - 3" caliper deciduous	ea		$600.00	$0
5.06	Trees - 10' ht. multi-stemmed deciduous	ea		$600.00	$0
5.07	Irrigation	sf		$1.50	$0
TOTAL LANDSCAPING					**$0**
	SUBTOTAL				**$343,400**

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
MANSION PARKING LOT

Job#: 21-14-008
Created: 05/27/2015
Updated: 7/8/2015
Calc By: BTS
Check By: DCY

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$10,000
2.0	DEMOLITION		$56,200
3.0	EARTHWORK		$10,800
4.0	STORM DRAINAGE		$38,100
5.0	LANDSCAPING		$110,200
SUBTOTAL			**$225,300**
Design contingency		30%	$67,590
CONSTRUCTION SUBTOTAL			**$292,900**
General conditions		8%	$23,432
General contractor's OH & P		12%	$35,148
Construction Contingency		10%	$29,290
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$380,770**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
MANSION PARKING LOT

Job#: 21-14-008
Created: 05/27/2015
Updated: 7/8/2015
Calc By: BTS
Check By: DCY

PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	Silt Fence	lf	1,000	$5.00	$5,000
1.02	CB Filter	ea	20	$250.00	$5,000
TOTAL EROSION CONTROL					**$10,000**
2.0	**DEMOLITION**				
2.01	Sawcut Concrete Pavement	lf	550	$3.50	$1,925
2.02	Remove Concrete Pavement	sf	8,250	$3.00	$24,750
2.03	Dispose of Demolition Debris	cy	180	$25.00	$4,500
2.04	Abandon & Plug Utility Lines	ls	2	$10,000.00	$20,000
2.05	Traffic Control	ls	1	$5,000.00	$5,000
TOTAL DEMOLITION					**$56,200**
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	305	$30.00	$9,150
3.02	Fine Grading	sf	8,250	$0.20	$1,650
TOTAL EARTHWORK					**$10,800**
4.0	**STORM DRAINAGE**				
4.01	Connect to Existing System	ea	6	$500.00	$3,000
4.02	6" PVC Underdrain Pipe	lf	330	$30.00	$9,900
4.03	8" Storm Drain Pipe, including trench	lf	170	$30.00	$5,100
4.04	Catch Basin Type I	ea	6	$1,750.00	$10,500
4.05	Bioretention Garden Excavation	cy	700	$5.00	$3,500
4.06	Compost for Bioretention	cy	60	$40.00	$2,400
4.07	Gravel for Underdrain System	cy	25	$45.00	$1,125
4.08	Gravel Borrow for Trench Backfill	cy	60	$32.00	$1,920
4.09	Foundation Material for Pipe	cy	20	$32.00	$640
TOTAL STORM DRAINAGE					**$38,100**

ReidMiddleton	**Department of Enterprise Services** **West Capitol Campus Drainage Master Plan** **MANSION PARKING LOT** **PLANNING PHASE** **OPINION OF PROBABLE CONSTRUCTION COSTS**	**Job#: 21-14-008** Created: 05/27/2015 Updated: 7/8/2015 Calc By: BTS Check By: DCY

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
5.0	**LANDSCAPING**				
5.01	Planting Soil, Bioretention & Standard Planting Soil	cy	380	$45.00	$17,100
5.02	Bioretention Planters (Vertical Concrete Curbs)	lf	1,200	$30.00	$36,000
5.03	Planting (Shrub and Groundcover Layer)	sf	13,500	$2.50	$33,750
5.04	Mulch (PA plus trees in lawn)	cy	70	$35.00	$2,450
5.05	Trees	ea	18	$600.00	$10,800
5.06	Irrigation	sf	6,750	$1.50	$10,125
TOTAL LANDSCAPING					**$110,200**
	SUBTOTAL				**$225,300**

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
PILOT PROJECT AT 11TH STREET, 1063 BETTERMENT

Job#: 21-14-008
Created: 05/27/2015
Updated: 7/8/2015
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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

ESTIMATE SUMMARY

Item No.	Description		Current Amount
1.0	TEMPORARY EROSION CONTROL		$5,800
2.0	DEMOLITION		$17,700
3.0	EARTHWORK		$157,000
4.0	STORM DRAINAGE		$25,300
5.0	LANDSCAPING		$117,700
SUBTOTAL			**$323,500**
Design contingency		30%	$97,050
CONSTRUCTION SUBTOTAL			**$420,600**
General conditions		8%	$33,648
General contractor's OH & P		12%	$50,472
Construction Contingency		10%	$42,060
Sales Tax - **not included**			
TOTAL CURRENT CONSTRUCTION COST			**$546,780**

Notes & Assumptions:

1. Assumed on-site materials are not contaminated. Site cleanup & mitigation is not included.
2. Assumed native soil is not suitable for utility trench backfill
3. Soft costs such as design, construction assistance, and permitting fees are not included.

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE CHANGES, OR OTHER FACTORS BEYOND THE CONTROL OF THE ESTIMATOR.

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
PILOT PROJECT AT 11TH STREET, 1063 BETTERMENT

Job#: 21-14-008
Created: 05/27/2015
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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
1.0	**TEMPORARY EROSION CONTROL**				
1.01	Silt Fence	lf	400	$5.00	$2,000
1.02	CB Filter	ea	15	$250.00	$3,750
TOTAL EROSION CONTROL					**$5,800**
2.0	**DEMOLITION**				
2.01	Sawcut Concrete Pavement	lf	50	$3.50	$175
2.02	Remove Concrete Pavement	sf	750	$3.00	$2,250
2.03	Dispose of Concrete Debris	cy	10	$25.00	$250
2.04	Abandon & Plug Utility Lines	ls	2	$5,000.00	$10,000
2.05	Traffic Control	ls	1	$5,000.00	$5,000
TOTAL DEMOLITION					**$17,700**
3.0	**EARTHWORK**				
3.01	Dispose of Unsuitable	cy	1,900	$30.00	$57,000
3.02	Import Soil	cy	1,900	$45.00	$85,500
3.03	Earthwork	cy	1,900	$5.00	$9,500
3.04	Fine Grading	sf	25,000	$0.20	$5,000
TOTAL EARTHWORK					**$157,000**

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Department of Enterprise Services
West Capitol Campus Drainage Master Plan
PILOT PROJECT AT 11TH STREET, 1063 BETTERMENT

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PLANNING PHASE
OPINION OF PROBABLE CONSTRUCTION COSTS

Item No.	Description	Unit	Quantity	Unit Price	Current Amount
4.0	**STORM DRAINAGE**				
4.01	Connect to Existing System	ea	3	$500.00	$1,500
4.02	6" PVC Underdrain Pipe	lf	120	$30.00	$3,600
4.03	12" Storm Drain Pipe, including trench	lf	110	$35.00	$3,850
4.04	Catch Basin Type I	ea	3	$1,250.00	$3,750
4.05	Bioretention Garden Excavation	cy	700	$5.00	$3,500
4.06	Compost for Bioretention	cy	60	$40.00	$2,400
4.07	Gravel for Underdrain System	cy	10	$45.00	$450
4.08	Gravel Borrow for Trench Backfill	cy	40	$32.00	$1,280
4.09	Foundation Material for Pipe	cy	12	$32.00	$384
4.10	PCC Concrete Sidewalk	sf	750	$5.50	$4,125
4.11	Crushed Surfacing Top Course for Sidewalk	ton	20	$25.00	$500
TOTAL STORM DRAINAGE					**$25,300**
5.0	**LANDSCAPING**				
5.01	Planting Soil, Bioretention & Standard Planting Soil	cy	330	$45.00	$14,850
5.02	Standard Planting Soil Mix, 24" depth	cy	430	$45.00	$19,350
5.03	Lawn (Seeded, not including soil or irrig.)	sf	11,700	$0.20	$2,340
5.04	Planting (Shrub and Groundcover Layer)	sf	13,500	$2.50	$33,750
5.05	Mulch (PA plus trees in lawn)	cy	120	$35.00	$4,200
5.06	Trees	ea	12	$600.00	$7,200
5.07	Irrigation	sf	24,000	$1.50	$36,000
TOTAL LANDSCAPING					**$117,700**
	SUBTOTAL				**$323,500**

THIS COST ESTIMATE IS APPROXIMATE AND SHOULD BE USED ONLY FOR PRELIMINARY PLANNING PURPOSES. ACTUAL CONSTRUCTION BIDS MAY VARY SIGNIFICANTLY FROM THIS STATEMENT OF PROBABLE COSTS DUE TO TIMING OF CONSTRUCTION, CHANGED CONDITIONS, LABOR RATE

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EXISTING STORM DRAINAGE TRIBUTARY AREAS

West Capitol Campus Drainage Master Plan

November 2015

Figure 1

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EXISTING DEDICATED STORM CONVEYANCE SYSTEM
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Figure 2

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COMBINED SEWER CONVEYANCE SYSTEM & TRIBUTARY AREAS
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Figure 3

PIPES FAILING CONVEYANCE CAPACITY (25 YEAR)
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Figure 4

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EXISTING SATURATED SOIL AREAS
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Figure 5

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PROPOSED REDEVELOPMENTS ï LONG-TERM
West Capitol Campus Drainage Master Plan
November 2015

Figure 6

LEGEND

ıggish drainage area, noted in
e walk-through with DES.

lditional wet area, from DES-provided map.

xxx ıtes from on-site walk-through with DES.

ıprox. slope

ıtential French drains

ıtential area drains

ıw fast-draining sandy soil with underdrains, typ.
ır street trees, see alternate approach below.

ainage appeared adequate per DES staff comment

eneral Comments from On-Site Walk-through:
rig. boxes full of water from lawns.
rigation leaks are hard to find, due to saturation.
rigation zoning doesn't coordinate between wet vs. dry areas.

ANDSCAPE DRAINAGE STRATEGIES

new trees in areas without apparent drainage problems:
Evaluate subsurface conditions on case-by-case basis by digging test les and assessing conditions.

Amendment existing topsoil across a broad area at each tree.

f grades allow, add additional fast-draining topsoil to increase topsoil pth. Consider underdrains where topsoil is deep enough.

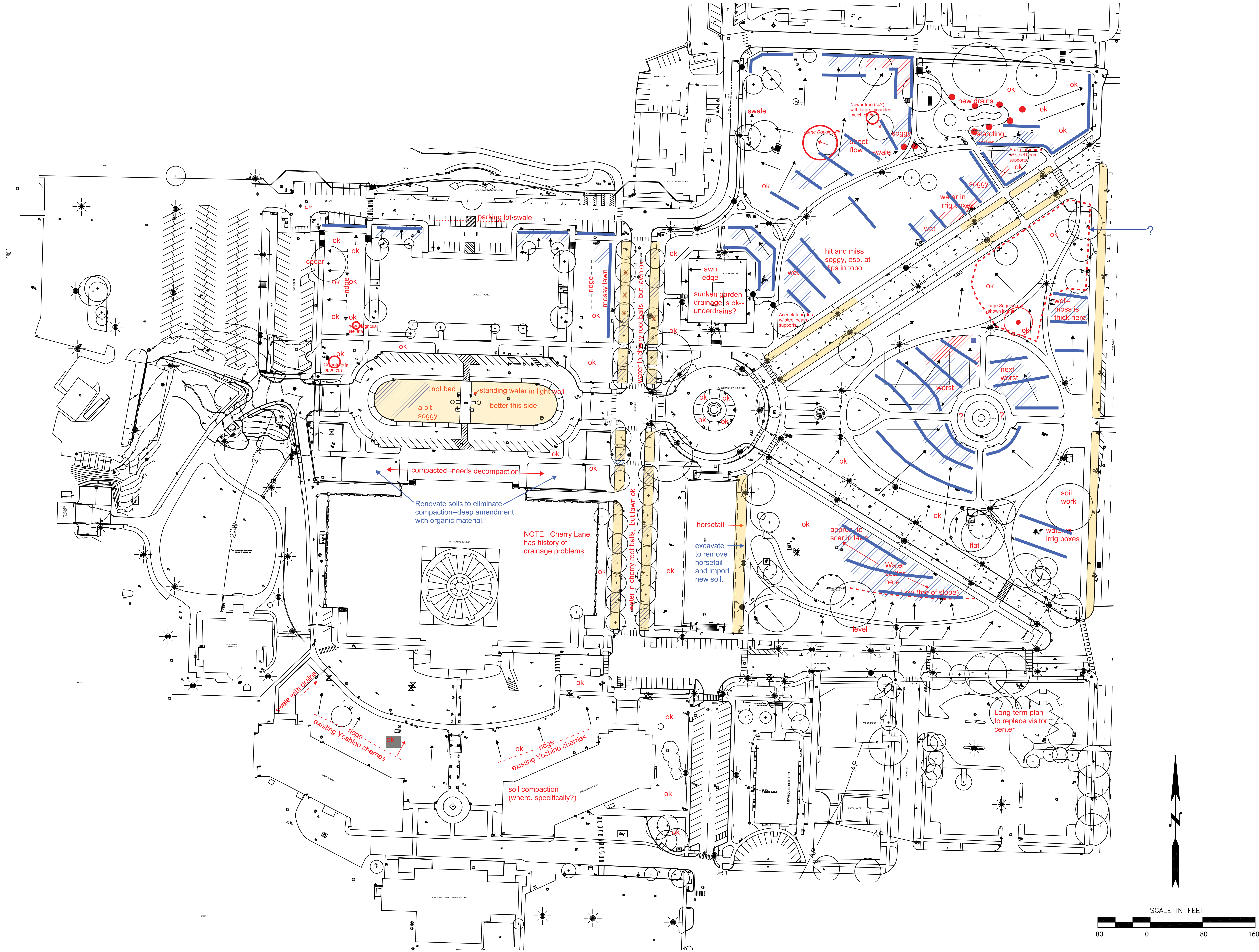
Plant new trees in gently crowned areas, adding area drains or french ains, if drainage is impeded by regrading.

new trees in areas with sluggish drainage:
At larger areas: Install parallel French drains to intercept water moving ough topsoil layer or over the surface. At low points or where existing es are, add area drains downhill from the lowest French drains where nching is not possible.

At selected small- and medium-sized areas: Excavate existing soil, port deep and fast-draining new soil, taking care to blend the interface tween the layers. Include underdrains.

new street trees in all areas:
Deeply amend existing soils in tree planting strips as planned for Sid yder, finishing with crowned tree planting strip.

At selected tree planting strips: Excavate existing soil, import deep and st-draining new soil, taking care to blend the interface between the yers. Include underdrains.



DRAINAGE OBSERVATIONS
West Capitol Campus Drainage Master Plan
December 2015

Figure 7

TREE PLAN - Historic Landscape Preservation Plan
West Capitol Campus Drainage Master Plan
December 2015

Figure 8

SHRUB PLAN - Historic Landscape Preservation Plan
West Capitol Campus Drainage Master Plan
December 2015

Figure 9

DRAINAGE, TREE, & SHRUB COMPOSITE PLAN
West Capitol Campus Drainage Master Plan
December 2015

Figure 10