CAPITOL HILL
WATER QUALITY PROJECT
(SWALE ON YALE)

PRESENTED BY:
David Schwartz, PE, LEED AP,
KPFF Consulting Engineers
Over 435 acre drainage basin drains to Lake Union off of Capitol Hill
PROJECT CONSTRAINTS

» Densely built urban environment
» 100 years worth of new & abandoned utility infrastructure
» Shallow drainage system
» Limited public funds
» Limited space in right-of-way
THE GENERAL PLAN

» Divert stormwater from the main line for offline biofiltration treatment. Intent is to treat smaller storms that carry the greatest amount of pollutants.

» Treated stormwater discharged back into mainline for continuation to discharge point into Lake Union. No new outfall.

» Four swales that function as parallel independent systems.

» Treat up to 7.2 cubic feet per second of flow during storm events with flow through system and 9 minute residence time.

» Have the facilities be an amenity to the neighborhood.
Close coordination between private developer (Vulcan) and City of Seattle to maximize capacity of treatment system and usable space for pedestrians

» Memorandum of Agreement (MOA) developed between Vulcan and SPU

- Agreement defines the intent and goals of each entity
- Allocates responsibility of shared areas, such as restoration of roadway for which both entities have responsibility
- Identifies project funding, reimbursement, and fees.
- Identifies future O&M responsibilities of each organization
SYSTEM DESIGNED IN TWO PARTS
SYSTEM DESIGNED IN TWO PARTS

FLOW SPLITTER & OVERFLOW STRUCTURES

OVERFLOW STRUCTURE

VORTECHS PRE-TREATMENT

DIVERSION STRUCTURE

EX. 72” PSD

INCOMING FLOW FROM SPU PORTION OF DESIGN (SCHEDULE B)

END OF CITY DESIGN

THOMAS STREET

YALE AVENUE N
» Flow splitter structures
» Conveyance system
» Swales
» Connection back to main
**RISK ASSESSMENT**

**Project management plan**

» Multiple meetings with the City and the Design Team to identify risk and assess the potential impact to the project using PMP methodology

**RISK EVENT:** Waiver of “public works contracting” for Vulcan construction is reversed and the project is killed

**IMPACT RATING:** 5–Very High

**PROBABILITY RATING:** 3–Moderate

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<table>
<thead>
<tr>
<th>Risk Identification</th>
<th>Expected Phase of Occurrence</th>
<th>Impact Rating</th>
<th>Probability Rating</th>
<th>Score</th>
<th>Priority</th>
<th>Response</th>
<th>Contingent Response (if applicable)</th>
<th>Contingency Reserve</th>
<th>Assigned to</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closes funding and project gets canceled</td>
<td>Design</td>
<td>5 - Very High</td>
<td>3 - Moderate</td>
<td>15</td>
<td>Critical</td>
<td>Mitigate</td>
<td>Keep as a highly visible project in Management/Council views Apply for grants Keep Vulcan engaged with City/Community</td>
<td>$</td>
<td>Jason Sharpley</td>
<td>RESOLVED: PDQ confirmed the existing exemption would remain valid per Nancy Locke 8/17/2011</td>
</tr>
<tr>
<td>Waiver of &quot;public works contracting&quot; for Vulcan construction is reversed and the project is killed</td>
<td>Design</td>
<td>5 - Very High</td>
<td>3 - Moderate</td>
<td>15</td>
<td>Critical</td>
<td>Mitigate</td>
<td>Secure SPU management support and frequent conversations with DEA</td>
<td>$</td>
<td>Jason Sharpley</td>
<td>RESOLVED: PDQ confirmed the existing exemption would remain valid per Nancy Locke 8/17/2011</td>
</tr>
<tr>
<td>SDOT requires substantial roadway paving or related improvements (same as above)</td>
<td>Design</td>
<td>4 - High</td>
<td>3 - Moderate</td>
<td>12</td>
<td>High</td>
<td>Contingent Response</td>
<td>Pay for extra paving $250,000 50%</td>
<td>$125,000</td>
<td>Jason Sharpley</td>
<td>IN PROCESS - SPU Design Engineer creating Drainage Report as the basis for future voluntary contribution by SDOT</td>
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<tr>
<td>SDOT wants to &quot;buy-in&quot; to the WQ treatment provided by the swales for their future paving projects, but it was not set up to do so and SPU loses potential SDOT monies</td>
<td>Design</td>
<td>4 - High</td>
<td>3 - Moderate</td>
<td>12</td>
<td>High</td>
<td>Accept</td>
<td></td>
<td>$</td>
<td>Jason Sharpley</td>
<td></td>
</tr>
</tbody>
</table>
Utility investigation

» Provided information on location and elevation of existing utilities including power, gas, communication ducts, and multiple City systems.

» Identification of utilities that were not identified in City records such as fiber optic.

» Investigation included significant potholing once preliminary conveyance alignment was determined.
**FINAL DESIGN FEATURES**

**North Swales**
- 1.0’+ sidewalk on private property
- 6.0’ sidewalk
- Depth varies (less than two feet)

**South Swales**
- 1.0’ sidewalk easement
- 5.0’ sidewalk
- Depth varies (less than two feet)
» Relocation of gas and water mains
  
  • Need to relocate these lines was determined during the potholing and updated design activity
FINAL DESIGN FEATURES

North Swales
» Swale on Yale roughly 300 LF, 10.5' wide
» Swale on Pontius roughly 300 LF, 16.5' wide

South Swales
» Swale on Yale roughly 260 LF, 11.5' wide
» Swale on Pontius roughly 300 LF, 16.5' wide
FUNCTIONAL ASPECTS OF FINAL DESIGN

Diversion Structure

» Simple design consists of large maintenance hole saddled on the existing 48 inch storm main

» Adjustable weir diverts base and first flush flows out of the main

» Higher flows in the main overtop the weir structure and bypass treatment
FUNCTIONAL ASPECTS OF FINAL DESIGN

Swirl Separator

» An off-the-shelf product sized to handle a maximum design flow rate specific to the project
» Vortex motion within the precast structure removes floatables and heavy particulates in the diverted stormwater
» System oversized to reduce the frequency of maintenance
FUNCTIONAL ASPECTS OF FINAL DESIGN
Flow Splitters with Overflows

» Precast concrete structures with a downturned elbow outlet with orifice plate to divert flows to each swale

» Orifice plates can be switched out by maintenance crews for different size orifice plates if different flow rates are desired

» Overflow standpipe provided to limit flow rate to each swale and to handle flows during system maintenance or overflow conditions due to obstructions with in the conveyance piping
FUNCTIONAL ASPECTS OF FINAL DESIGN

Pipe Network

» System is very shallow; in some cases, top of pipe is within lower portions of pavement

» Ductile iron pipe used with brass markers placed every 50 feet and at every pipe bend
FUNCTIONAL ASPECTS OF FINAL DESIGN

Inflow Trench Drain

» Incoming flows “swell up” through trench drains with raised grates to initially spread water across the width of the swale.
Weirs

» Periodic weirs maintain sheet flow through plantings by preventing channeling or concentrated flows that would short-circuit the system.
FUNCTIONAL ASPECTS OF FINAL DESIGN

Plantings and Soil Mix

» Plants for north swales pre-grown in bioretention soil

» Plants for south swales planted bare-root

» Over 20,000 plants in total spaced roughly 10” on-center

» Plants inspected at the nursery and again at the job site by KPG and the Contractor to ensure initial plant health
Plantings and Soil Mix

» Basic bioretention soil in all swales (60-65% sand, 35-40% compost)

» Polishing layer in south swales (gravel amended with activated alumina and iron aggregate), intended to remove ortho-phosphates

» Bioretention soils tested for copper and zinc levels to address a concern related to other bioretention facilities brought up by the Dept. of Ecology
Plants Chosen for Visual Appeal and Functionality

- Bowles Golden Sedge
- Sough Sedge
- Orange New Zealand Sedge
- Elk Blue California Gray Rush
- Quartz Creek Soft Rush
FUNCTIONAL ASPECTS OF FINAL DESIGN

Planted Swales

Newly Planted (South Swale)

Several Years After Planting (North Swale)
FUNCTIONAL ASPECTS OF FINAL DESIGN

Swale Edge Treatments

Decorative Precast Curb

Decorative Railing

Benches
FUNCTIONAL ASPECTS OF FINAL DESIGN

Interpretive Signage

» Information signage to educate the public regarding the function of the system and to raise awareness of stormwater pollution issues
FUNCTIONAL ASPECTS OF FINAL DESIGN

Pedestrian Bridges (Used Recycled Steel from Inside Laundry Building)

» Bridges across three of the four swales to accommodate mid-block pedestrian traffic

» Owned and maintained by SDOT; this means the design had to be closely coordinated with SDOT engineers and maintenance crews

» Stakeholders in look and function of bridges included:

• Seattle Design Commission
• Design Review Board
• SDOT
• SPU

• Vulcan
• KPG (swale landscape architect)
• Berger Partnership (Vulcan’s on-site landscape architect)
• KPFF (Civil & Structural)
FUNCTIONAL ASPECTS OF FINAL DESIGN
FUNCTIONAL ASPECTS OF FINAL DESIGN

Irrigation

Needed for establishment and during dry season

Infrastructure for Monitoring Equipment

» Vaults include 120V power GFI outlets for equipment
» Pontius monitoring quality measured upstream and downstream
» Yale monitoring measures quantity and quality upstream and downstream; Underdrain quantity and quality also monitored downstream
CONSTRUCTION
PHASES

1 & 4: Diversion Structure & Conveyance Pipe (Water & Gas Relocation)

2: North Block Development / Swale Construction

3: North Block Development / Overlay

5: South Block Development / Swale Construction

6: South Block Pavement / Overlay
FLOW SPLITTER

DIVERSION STRUCTURE

SWIRL SEPARATOR

FIRST CELL IN NORTH SWALE (YALE AVE)
GRADED SWALE SUBGRADE (NORTH)
GRAVEL BACKFILL
BIORETENTION SOIL AND PEDESTRIAN BRIDGE
PLANT INSTALLATION
DEVELOPED PLANTS
EDGE TREATMENT
SUCCESS STORY

Result of coordination and design efforts were recognized by an In-the-Works Design Excellence Award from Seattle Design Commission

» Project presented as a “water cleansing natural machine”

» Commission created the award specifically for this project to recognize unique collaboration of public/private partnership and potential of treatment system itself
SWALE PERFORMANCE

Ortho-Phosphate Increase >150%

Flow Reduction > 20%
Total Phosphorous Reduction > 25%
Total Copper Reduction > 83%
Suspended Solids (TSS) Reduction > 85%
LESSONS LEARNED

» Significant sediment loading

» Bioretention soil increased ortho-phosphates in north swales per preliminary testing
LESSONS LEARNED

» Curved walls were difficult to get constructed properly

» North swales used bentonite liner; south swales used Hycrete admixture in concrete walls and footing
LESSONS LEARNED

» Maintenance needs to be early and often
» Needed clear discussion about public vs private roles for maintenance with adjacent property