Green Stormwater Infrastructure:
Operations & Maintenance Program

Finding solutions to NPDES permit asset management requirements
Drainage Basin Type

Creek
Polluted stormwater runoff drains directly to urban creeks, untreated. Seattle’s urban creeks are: Thornton Creek, Piper’s Creek, Longfellow Creek, Taylor Creek, Rainierview Creek, and Schmitz Creek.

Combined
Polluted stormwater runoff combines with sewage water in one pipe. Combined runoff and sewage can overflow directly into water bodies untreated during rain storms. In drier weather, water is treated by a wastewater treatment facility.

Partially Separated
Polluted stormwater runoff from roads and the roofs of older buildings drains to a “separated” stormwater pipe underground, and discharges into water bodies like Puget Sound and Lake Washington. Stormwater runoff from roofs of newer buildings drains to a “combined” sewer.

Fully Separated
Polluted stormwater from roads, roofs, and downspouts drains to a “separated” stormwater pipe underground and discharges into water bodies like Puget Sound and Lake Washington.

Management Goals

- Sustain creek biology
- Preserve base flow in summer
- Improve water quality in creek
- Prevent combined sewer overflows into Puget Sound, Lake Washington, Salmon Bay & the Ship Canal, and Longfellow Creek.

- This can be achieved by preventing stormwater volume from reaching the combined pipe or by delaying the flow until after the peak of the storm has passed.
- For runoff from roofs, refer to combined system.
- Clean and slow polluted stormwater run-off before it is discharged into receiving water bodies like Puget Sound, Lake Washington, or the Duwamish River.

- Preserve the finite capacity and function of our existing underground (pipe and pump) stormwater system so that we can adapt well to changes in precipitation and to new urban growth.
- Avoid having to build new (expensive and disruptive) underground facilities.
- Convey stormwater runoff to protect public health and safety, prevent flooding and prevent damage to public infrastructure.

Kind of Storm to Manage

- Small - Medium
- Small - Medium
- Small - Medium
- Small (frequent)
- Small (frequent)
- Small - Large
- Medium - Large
GSI Program Current and Forecasted

Current (2000-13):
• Approx 4 acres of vegetated area
• $500K O&M budget

Forecasted: 2015-2020 (area managed):
• SPU: 42 acres
• SDOT: +/- 2.5 acres
• KCWTD: 442 acres
• Code Required: ~12 blks per year
• $1.3M O&M budget
SPU/WTD’s Practice Changes

- **Asset management tracking**
  1. Equipment #'s (EQ#’s) assigned and noted on CD level drawings

- **Design for major program maintenance**
  1. Improve standard design and specifications (ROW Improvement Manual and standard details)
  2. GSI Design Phase Asset checklist
     - Non-standard elements require approval early in design process
     - Identifies in design potential long term cost issues of non standard elements. (O&M vetted in design)

- **Third party inspection**
  - Engineer of record
  - Landscape Architect of record
  - Geotechnical Engineer of record

- **Clarity on acceptable maintenance**
  - Compliance with NPDES
  - Communicating standard maintenance for function
Example: Design Phase GSI ROW Checklist for O&M Asset Management to ensure consistency in approach as the program grows.

A. Facility Footprint
B. Inlets/Outlets/Pipes – Surface
C. Inlets/Outlets/Pipes – Subsurface
D. Vegetation
E. Mulch
F. Watering
G. Deep Infiltration (over 6 feet)
H. Permeable Pavement Facility
I. Hardscape/ Specialty Elements
Maintenance Management - Current

- Two crews
  - Hardscape: city crew
  - Landscape: contractor through 2020
- Semi annual inspections
  - pre fall
  - pre spring
- Post storm events
Operations and Maintenance - Future

- Operations and Maintenance Manual Update
  1. Landscape Maintenance (Acceptable/Unacceptable)
  2. Hardscape Maintenance
  3. Structure Maintenance UIC’s
  4. O&M Facility Checklists

- Maintenance Costs
  1. Staffing and outsourcing
  2. Equipment & Materials
  3. Communications (engagement, notice, reporting)

- GIS - assess based tracking
Updated GSI O&M Manual for ROW

- Summary of Topics
  - Transition from construction and establishment
  - Operations: Defining parameters and resources
  - Bioretention surface maintenance
  - Structures and subsurface maintenance
  - Deep infiltration maintenance
  - Permeable pavement maintenance
  - Outsourcing and stewardship
  - Storm events
  - Inspection
  - Public engagement
  - Maintenance agreements
Right of Way Context - Typical Elements
Focus on Acceptable

http://www.kingcounty.gov/environment/wtd/Construction/Seattle/BartonCSO-GSI/LandscapeMaint.aspx
Acceptable Meets Permit Requirements

• Ex: Stormwater sedimentation structures are less than ½ full or in accordance with NPDES requirements

• Annual reporting for documenting achievement of minimum requirement for SPU Management & WA ECY
• Identify asset categories
• Tie to Washington State Ecology
• Priority for function and safety
• Key observation items
• Maintenance activity
• Frequency
• Performance standard
• Adaptable for Maximo
• Adaptable for Work Order contracting
Example: Infiltration Failure
Function & Safety  Unacceptable

• Evidence of a cell holding water for more than 24 hours needs to be reported
• Operations and Maintenance Asset Manager-informed
• Monitor swale for ponding water
• Retrofit swale
Maintenance Costs
Total Maintenance Cost

- Total $$ = Vegetation + Hardscape
- Initial Vegetation – 3 years
  - SPU cost: $2.21
  - Watering method and frequency increase cost up to 4X
- Established Vegetation – 4 plus
  - SPU cost: $1.66
  - 25% reduction
- Replacement costs - $0.50 per sq. ft.
- Hardscape - $0.31 per sq. ft.
Permeable Pavements

- SPU pervious concrete pavement spec
- Inspector and installer checklists
- BMP’s
- Frequency schedule & method
- Standardized infiltration testing
- Recommended maintenance activities
- Technical Report - available
Additional Tools and Resources

- **Internal-Inter Departmental Team**
  1. Reviews next practices
  2. Integration with Standard Details and Specifications
  3. Right of Way Improvement Update

- **External- Partnership with King County Waste Water Treatment Division**
  1. Joint program
  2. Common GSI Manual
  3. Community engagement- consistent messaging
  4. Staffing resource – adds expertise

- Common Community Engagement Plan
- Permeable pavements
- Client Assistance memos or TIP’s
Client Assistance Memos

• Mostly for Private Facilities
• Post Construction Soil Management
• Bioretention Cells (Rain Gardens)
• Permeable Pavement Surfaces and Facilities
• Tree Planting
• Green Roofs
• Bioretention Planters
GIS Integration & Role in GSI Asset Management

- Map/Model GSI infrastructure and provide a spatial inventory of GSI assets
- Allow synchronization between GIS and internal business systems
  - DWW GIS staff maintained tables
  - Maximo asset management system
  - User tables updated by GSI subject matter experts (data stewards)
- Publish GSI presentation data to users and provide tools for research and investigation
DWW GIS Maintenance Staff - Data Creation

- Source Document – Engineering Drawing
GIS Representation – High Point
Maximo Asset Management System Integration

- All assets in GIS are assigned a unique feature key
- Weekly synchronization process between Maximo and GIS creates a relationship between the GIS feature key and Maximo asset number
- Enables GIS to be used as a tool for work order creation
- Child asset mapping – relationship allows us to map assets that don’t actually live in GIS (i.e. hydrobrakes, weirs, sluice gates)
GSI Data Steward Integration

- Generic Table Editor (GTE)
GSI Data Steward Integration

- **Bioretention Swale Table & GSI Project Table**
  - Allows subject matter experts to enter information/attributes critical to asset management, maintenance, and compliance into a stand-alone table
  - This information is easily appended to the GIS presentation data
  - GSI projects are treated as systems with regard to preventative maintenance (PM) scheduling in Maximo
  - Enables users to link GIS assets that “live” in a particular project area to a unique project number (i.e. GSI007 = High Point Revitalization)
  - Linkage between asset and project is easily pushed to Maximo for PM work order creation
GSI Presentation Data

- “DWW Green Storm Infrastructure” layer

- Available for users of UtiliView or ArcMap
- Dataset compiled with input from DWW GIS staff, Maximo, and subject matter experts
Research Tool

- Preventive Maintenance(s)
  - PM Number: 92116, Activity: Condition Based Maintenance
  - PM Number: 92115, Activity: Condition Based Maintenance
  - PM Number: 92114, Activity: Condition Based Maintenance
  - PM Number: 92113, Activity:

- Work Order(s)
    - Equipment Number = 564979
    - Equipment = CATCH BASIN - SWC MINOR AVE/MARION ST
    - Work Order Number = 2184522
    - Work Type = Reactive Maintenance
    - Work Group = DWRC
    - Priority = Public service interruption, regulatory violations, time-sensitive.
    - Description = INLET - MINOR AVE / MARION ST
    - Call Reason =
    - Cause = LEAVES
    - Problem = INLET MALFUNCTION
    - Remedy = CLEANED
    - Completed = 1/4/2010
    - Report Date = 1/4/2010
    - Target Start = 1/4/2010
    - Target Finish = Unknown
    - Address = MINOR AVE / MARION ST
    - Address Location = SWC MINOR AVE/MARION ST
    - Project = DRAINAGE INSPECTION
    - Assigned Person = SANTOSE
    - Actual Loaded Labor = $54.68
    - Actual Material Cost = $0.00
    - Actual Tool Cost = $7.85
Summary: ROW Facilities Documentation

- Design for O&M
- Asset management
- Construction and installation checklist
- Third party inspection checklist for construction closeout
Evolving Systems

- Work, work, work with field or contracting crews
- Update photos to continue refining doc.
- Include BMP’s
- Document lessons learned & Update