Green Infrastructure Maintenance Cost Model

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Goals for Today

• Understand the importance of maintaining green infrastructure
• Understand how the GI Maintenance Cost Model can be used
• Understand the research and information that went into the development of the GI Maintenance Cost Model
• Learn how to customize the GI Maintenance Cost Model to use outside of San Francisco
• Learn how to use the GI Maintenance Cost Model
Presentation Outline

1) Intro to the GI Maintenance Cost Model
2) Applications of GI Maintenance Cost Model
3) Model Development
4) Customizing the Model
5) How to Use the Model
6) Model Tutorial
7) Questions
GI Maintenance Cost Model

The GI Maintenance Cost Model is a planning tool that is used to:

• Inform the scale of existing, planned, proposed, and future GI maintenance burdens

• Plan and budget for future maintenance obligations in terms of both labor and dollar costs

• Support data-driven decision making
GI Maintenance Model Outputs

Outputs:

- Estimated budget required
- FTE
- Labor hours

Displayed by Category:

- Project
- BMP type
- Watershed

Example Project: Holloway Green Street, San Francisco
Applications of the GI Maintenance Model

Program Level Staffing and Budgeting:
Estimate long-term staffing and budget requirements of capital green infrastructure plan – initiate process of hiring staff early

Project Level Staffing Budgeting:
Estimate short-term staffing and budget requirements of individual green infrastructure projects – JOC contracts

Promoting Green Infrastructure:
Graphics, FTE, and dollar values used for in-reach: Executive Management presentations, presentations to Commission
MODEL DEVELOPMENT
Model Development

- Case Study Analysis
- GI Project Definition
- Cost Estimates
- Other Inputs
- Model Production
- Model Validation & Finalization
Maintenance Categories

**Preventative Maintenance**: Performed on a scheduled basis – activities protect the facility, reduce the probability of failure and prevent degradation

**Remedial Maintenance**: Performed as required – activities eliminate an identified source of potential failure before failure occurs

**Corrective Maintenance**: Performed when a component of an installation begins to fail or has failed – activities keep the facility in working order by repairing, restoring or replacing the individual component(s)

**Replacement and Rehabilitation**: Performed after the entire installation has failed – activities rebuild the installation to its original condition and reestablish the designed performance levels
BMP Types Supported

• Bioretention/Bioswale
• Infiltration Gallery/Infiltration Basin
• Pervious Paving
• Constructed Wetland
• Vegetated Roof
• Blue Roof
• Rainwater Harvesting
• Creek Daylighting
BMP Components: Bioretention

**Typical Bioretention:**
- Mobilization/Demobilization
- Inlet & Outlet, Low-flow channel
- Splash Pad / Forebay
- Planting
- Mulch (wooden or stone)
- Weeds and Trash
- Soil Media
- Aggregate Subgrade Layer
- Structural Elements (curbs, curb walls, check dams)
- Irrigation System
- Reporting

**Underdrained Bioretention:**
- Underdrains and cleanouts
- Impermeable liner (membrane)

**Additional Features:**
- Trench Drain
- Monitoring Wells
- Driveway/HP Ramp Extensions
Maintenance Unit Costs

**Labor Hours per 1,000 sf of GI area:** Labor hours required to perform maintenance tasks for each BMP component.

**Materials Cost per 1,000 sf of GI area:** Fixed costs of materials for monthly and annual visits.

**Example Assumptions (Bioretention):**

1) The average site is assumed to manage one acre of impervious area and contain 3,000 sf of bioretention area.

2) An average rain garden is assumed to have a footprint of 250 sf.

3) A field crew of three is assumed for maintenance and rehab activities.

4) Preparation is assumed to take 30 minutes in the morning, traveling to the site is assumed to take 30 minutes, 15 minutes to set up, and traveling home at the end of the day 30 minutes.

5) It is assumed that a crew can handle one site in one full working day for the eleven monthly visits, and one site in two full days for the annual visit.
## Example Maintenance Tasks: Bioretention

<table>
<thead>
<tr>
<th>BMP Component</th>
<th>Example Maintenance Task (Monthly Visit)</th>
<th>Example Maintenance Task (Annual Visit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting</td>
<td>Trim/prune vegetation</td>
<td>Replace diseased and dead plants</td>
</tr>
<tr>
<td></td>
<td><strong>0.8 hrs/1,000 sf</strong></td>
<td><strong>1.2 hrs/1,000 sf</strong></td>
</tr>
<tr>
<td>Underdrains and cleanouts</td>
<td>Clear obstructing debris</td>
<td>Snake or jet pipe</td>
</tr>
<tr>
<td>Trench Drain</td>
<td>Clean trench drain</td>
<td>Repair or replace broken trench drain grates</td>
</tr>
</tbody>
</table>
## Levels of Service

<table>
<thead>
<tr>
<th>Service Level</th>
<th>Frequency of Visits</th>
<th># of Regular Maintenance Visit per Year</th>
<th># of Rehabilitation Visits per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Monthly: Visit every month</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Quarterly: Visit every three months</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>Semiannual: Visit every six months</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>Annual: Visit every twelve months</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>Quinquennial: Visit every five years</td>
<td>0</td>
<td>1/5</td>
</tr>
</tbody>
</table>
## Maintenance Cost Calculation

$$\left[ \left( \text{Labor Rate} \left( \frac{\$}{hr} \right) \times \text{Labor Rate} \left( \frac{hr}{sf} \right) \times \text{BMP Area} \left( sf \right) \right) + \left( \text{Materials Cost} \left( \frac{\$}{sf} \right) \times \text{BMP Area} \left( sf \right) \right) \right] \times \text{Number of visits}$$

*This equation is intended to offer an example of a conceptual-level calculation and does not incorporate the differences between regular and annual visits, discount rate, escalation factors, etc.*
CUSTOMIZING THE MODEL
GI Maintenance Model Resources

**Cover Letter**: High-level introduction to the SFPUC GI Maintenance Model

**User Guide**: Instructions on how to customize the GI Maintenance Model

**Technical Memorandum**: Detailed description of GI Maintenance Model development and assumptions

**BE SURE TO REVIEW THESE BEFORE USING THE MODEL!**
Purpose of Customizing the Model

Some Parameters are Location Specific: Climate, escalation rates, discount rates, BMP definitions, hourly wage, separate vs. combined sewer system

Maintenance Duration Varies: MOUs and maintenance agreements, life of assets

Maintenance Level of Service Varies: Frequency of maintenance visits, size of field crew, mobilization time

It is critical that the maintenance model be customized to more accurately reflect your municipality.
Mandatory Categories to Customize

**BMP Type, Sub-type and Size**: Unit costs are BMP-specific. Users should review BMP definitions, and select appropriate BMP type and sub-type. For example, soft-edge vs. hard-edge bioretention.

**Maintenance Start and End Dates**: Start and end dates determine long-term costs. Users should take into account life of asset and contractor maintenance periods.

**Hourly Wage Rate**: Users should enter local fully loaded hourly rate. The model assumes a team of three maintenance workers (two gardeners and one supervisor).

**Level of Service**: Frequency of maintenance activities for each BMP type. Users should review the BMP-specific unit costs for each level of service (monthly, quarterly, etc.).

**BMP Spatial Distribution**: Determines travel time and efficiency of maintenance activities. Users should review definitions in the Project Input Tab of the model.
Optional Categories to Customize

**Proportion of Cost**: Percentage of cost burden that your agency is responsible for.

**Escalation and Discount Rates**: Percentages relative to the Start Year for the model.

**Cost Adjustment Factor**: Applied as a percentage to reflect higher or lower anticipated costs of maintenance.
Adjusting Unit Cost Estimates

Scenario 1: Bioretention in High Sediment Yield Area

Assumption: High sediment yield drainage areas will require greater maintenance activity.

Solution: Multiply all sediment maintenance activities by 2X’s (clearing inlet & outlet, cleaning splash pad/forebay, clearing underdrain cleanouts, etc.)*

Result:

Original Unit Cost: $7.88/sf

New Unit Cost: $11.50/sf

Cost Adjustment Factor: $11.50/$7.88 = 146%

*Detailed Unit Costs can be found in Appendix C, Technical Memorandum
Adjusting Unit Cost Estimates

Scenario 2: Bioretention with only Subsurface Maintenance

Assumption: Maintenance crew does not perform maintenance on surface features.

Solution: Remove all activities associated with surface maintenance (trimming plants, weeding, removing trash, cleaning splash pad, etc.)*

Result:

**Original Unit Cost:** $7.88/sf

**New Unit Cost:** $4.46/sf

**Cost Adjustment Factor:** $4.46/$7.88 = 57%

*Detailed Unit Costs can be found in Appendix C, Technical Memorandum
BMP Dashboard

Select a BMP Type: Bioretention
Select a year: 2020

**Year 2020**

- **Budget Required:** $134,900
- **Full-time Equivalent Jobs:** 0.50
- **Labor Hours:** 1,095

**O&M Budget Trend**

NPV $44,835,000

**O&M Labor Hours Trend**

**FTE Trend**

Selected BMP(s):
- Bioretention

Selected Project(s):
- Cesar Chavez
- Chinatown Green Alley
- Fell/Oak Bike & Ped Improvement Project
- Holloway Green Street
- Mission Valencia Green Gateway
- Van Ness Corridor Transit Improvement Project
TUTORIAL
THANK YOU!

QUESTIONS?