Dwayne’s View of Green Infrastructure for Panel Discussion

Views and opinions do not necessarily reflect the views or official position of the Minnesota Department of Transportation.
Lots of Infrastructure, of different colors

- Vegetation, stormwater, natural resources, pavements, snow control, safety measures, buildings, ...

Green Infrastructure for Climate Resiliency

Climate change is impacting urban areas in many ways, from exacerbating the urban heat island effect to elevating flood risk. Build green infrastructure to help improve community resilience.

Green Infrastructure Builds Resiliency

- Flooding
- Drought
- Coastal Damage
- Urban Heat

1 out of 3 U.S. counties in the lower 48 states face higher risks of water shortages by mid-century.¹

50% of Americans live in coastal counties, where water and energy infrastructure are increasingly vulnerable to higher sea levels.²

Climate change will likely lead to more frequent and severe heat waves during summer months.³

Green Infrastructure Home
Build Green Infrastructure
Learn about Green Infrastructure
Basics: What Is Green Infrastructure?
Performance of Green Infrastructure
Green Infrastructure for Climate Resiliency
Green Infrastructure Research
Benefits of Green Infrastructure
Cost-Benefit Resources
Green Infrastructure Policy Guides
Integrating Green Infrastructure into Federal Regulatory Programs
Overcoming Barriers to Green Infrastructure
Green Infrastructure Webcast Series
Collaborate with Green Infrastructure Partners

What is Green Infrastructure?

Section 512 of the Clean Water Act defines green infrastructure as "...the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evaporate stormwater and reduce flows to sewer systems or to surface waters."

Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. While single-purpose gray stormwater infrastructure—conventional piped drainage and water treatment systems—is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at its source while delivering environmental, social, and economic benefits.

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls on our roofs, streets, and parking lots in cities and their suburbs, the water cannot soak into the ground as it should. Stormwater drains through gutters, storm sewers, and other engineered collection systems and is discharged into nearby water bodies. The stormwater runoff carries trash, bacteria, heavy metals, and other pollutants from the urban landscape. Higher flows resulting from heavy rains also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

When rain falls in natural, undeveloped areas, the water is absorbed and filtered by soil and plants. Stormwater runoff is cleaner and less of a problem. Green infrastructure uses vegetation, soils, and other elements and practices to restore some of the natural processes required to manage water and create healthier urban environments. At the city or county scale, green infrastructure is a patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the neighborhood or site scale, stormwater management systems that mimic nature soak up and store water.

Learn more about green infrastructure elements that can be woven into a community, from small-
Increased **frequency** and **intensity** of precipitation events

Resulting in:

- More frequent flooding and extreme rain events
- Damage to transportation, infrastructure, and property, especially water and sewer systems
- Increased burden on emergency management, and a growing financial toll on businesses, homeowners, and insurers

**Mega-Rain:**
6+ inches of rain over 1,000+ square miles delivering over 13,900,000,000 cubic feet of water, equal to this ½ mile cube shown in Downtown Minneapolis:

**Timeline of Minnesota's historic mega-rain events 1866 - 2016**

*Source: U.S. Global Change Research Program, Fourth National Climate Assessment*
Unequal green infrastructure investment and maintenance

- Tree canopy
- Tree cover diversity
- Stormwater harvest, reuse, gardens
Green Infrastructure With Many Names?

• Context sensitive solutions?
• Context sensitive design?
• Low Impact development?
• Complete streets?
• Climate resiliency program?
• Sustainable program?
• Vibrant Cities program?
• Visual design methods?
Green Infrastructure starts with preservation of topsoil.

- Salvage all topsoil
- Supplement with Engineered Topsoils
- Utilize topsoils for Stormwater management
- Keep vegetated for soil health
Can American soil be brought back to life?

A new idea: If we revive the tiny creatures that make dirt healthy, we can bring back the great American topsoil. But farming culture — and government — aren’t making it easy.

By JENNY HOPKINSON | 09/13/2017 05:00 AM EDT
Ideal: multiuse green infrastructure

- Recreational fields and stormwater
- Storm water harvest and reuse
- Pathways and stormwater
- Road edges and stormwater
- Stormwater and living walls
- Bioslopes
- Bioswales
Multi-purpose Green Infrastructure
Green Infrastructure has many options.
Topdressing 1 inch over poor vegetative catch (135 cu yd/ac)
Green Infrastructure Has Maintenance Requirements

• Need operator’s manuals
• Need cleanout access
• Need to know what to do with collected sediments and trash
• Need to invest (set aside actual money) for future maintenance work
GENERAL MAINTENANCE CARD

BMP Site: BH-1
Location: Booth Avenue (Blue Heron Watershed)
Facility: Extended Detention Pond
Property: NYC Dept. of Parks & Recreation

MAJOR AREAS OF BMP:
A) Forebay
B) Micropool
C) Outlet Structure (w/ outlet nutch)
D) Concrete Pipe Culvert
E) Permanent Pool
F) Extended Detention

SHORT-TERM MEASURES (FREQUENCY: AT LEAST ONCE A MONTH)

Drainage Issues:
1) Inspect Permanent Pool wetland surface area
   - Remove accumulated debris/floatables by hand or skimmer, use waders if required.
   - Note the presence of excessive algae, if present.
2) Visually inspect the 60’ x 18” inlet pipe and concrete pipe collar (see Location D on Fig.1)
   - Remove accumulated debris by hand or skimmer, use waders if required.
   - Repair cracks in pipe/collar using a sealant, if required.
3) Inspect the 20’ foot weir wall with 4-inch nutch and steel plate (see Locations C on Fig.1).
   - Complete outlet structure Checklists (attached).
   - Repair cracks/damage on weir wall, if present.
4) Inspect steel plate (10” x 12” x 1/2”) and lock for damage
   - Manually remove debris in catch, as required; dispose of debris properly off-site.
   - Replace damaged outlet protection field stone.
5) Inspect adjacent catch basin grates and manhole covers.
   - Remove accumulated debris; dispose of properly off-site.
   - Secure manhole covers using a lock.

Landscaping Issues:
5) Inspect overall condition of installed vegetation
   - Remove invasive plants manually if possible, ensuring root removal; dispose of properly off-site. Consult Field Manager for advice, if required.
   - Retrace existing and/or provide exclusion devices; consult Field Manager if required.
   - Cut grass located along street frontage, as required.
   - Trim shrubs along street frontage, as required.

Perimeter Treatment:
6) Inspect overall condition of the perimeter treatment areas
   - Remove accumulated debris by hand, dispose of properly off-site.
   - Promptly notify DEC police regarding illegal dumping areas.
   - Lubricate locks and hinges, as required.
   - Inspect and repair damaged fencing, guardrails, and BMP signs, as required.
   - Rehabilitate concrete pavers/pavement on access roads and fields, as required.

MODERATE-TERM MEASURES (FREQUENCY: ONCE EVERY SIX MONTHS)

Drainage Issues:
1) Measure the sediment depth at forebay/micropool (see Locations A and B on Fig.1).
2) Inspect for unstable embankments.
   - Repair/reinforce unstable embankments using field stone, plantings, etc.

Landscaping Issues:
3) Inspect for septic inflow and nuisance odors
   - If septic inflow exists, introduce plantings that promote nutrient uptake.
   - Remove dead annuals causing foul odors, if present.
4) Inspect plant mortality
   - Remove dead plants by hand; dispose of properly; replant as necessary.
   - Trim and remove specified trees, as required.

LONG-TERM MEASURES (FREQUENCY: ONCE EVERY TWO YEARS)

Drainage Issues:
1) Vector sediment from forebay/micropool.
2) Vector sediment from adjacent catch basins.

LONG-TERM MEASURES (FREQUENCY: ONCE EVERY TEN YEARS)

Drainage Issues:
1) Vector accumulated sediment from entire shallow marsh wetland.
2) Replace native wetland plants.

Note: Fill out the attached Short-term and Long-term General Inspection Checklists during inspection of the site.

Required Maintenance Permit Checklist:

<table>
<thead>
<tr>
<th>Issuing Agency</th>
<th>Regulated Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Army Corps of Engineers</td>
<td>Placement of fill within wetlands; streambank stabilization; restoration</td>
</tr>
<tr>
<td>NYS DEC</td>
<td>Temporary damming of wetland; sediment removal; revegetation, herbicide application</td>
</tr>
<tr>
<td>NYC Parks Department</td>
<td>Tree removal</td>
</tr>
</tbody>
</table>

FIGURE 1

5) Inspect for herbivore damage
   - Repair nerve damage caused by mammals, or other contacts.
   - Introduce alternative plantings, if required. Consult Field Manager.
**MAINTENANCE OVERVIEW**

Bioretention basins provide temporary storage of runoff and allow infiltration of the water quality volume (WQV).

**Bioretention**

- **Biotreatment basins** provide temporary storage of runoff and allow infiltration of the water quality volume (WQV).

**Maintenance Needs Example for Bioretention**

Not to Scale

**BIORETENTION BASIN QUICK FACTS**

**Description**

Bioretention basins are shallow basins in low lying areas that provide storage and treats stormwater through filtration by selecting plantings and infiltration within the basin and sand/compost infiltration cell (shown by light blue).

- **Sediment buildup** may occur due to the nature of this facility. This can clog the infiltration cell and decrease the effectiveness of the basin.
- **Runoff from pipes**, as well as overland sheet flow from adjacent slopes, may cause erosion which will need to be filled in with amended soils and reestablished through seeding and erosion control blankets.
- If heavy equipment must be used within the basin, make sure it has tracks or low pressure tires, when replacing soils it should be lightly compacted to allow infiltration.

**MAINTENANCE ACTIVITY**

<table>
<thead>
<tr>
<th>Maintenance Activity</th>
<th>Do</th>
<th>Don’t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedy any standing water (2101).</td>
<td>Check the outlet structure and underdrain pipe for clog, look at compacted soils and sediment build up preventing infiltration.</td>
<td>Excavate infiltration cell until cause of water back-up is determined.</td>
</tr>
<tr>
<td>Remove sediment buildup (2101).</td>
<td>Remove sediment from the basin bottom with machinery through use of mud mats; working from the middle of basin bottom and scraping to the edges, or using a lighter machine like a skid steer for the foreslopes and Gradall stationed outside of the basin at the bottom.</td>
<td>Station machinery in the bottom of the basin or place machinery with overflowed tires.</td>
</tr>
<tr>
<td>Repair erosion and eliminate gullies (2102).</td>
<td>Fill in erosion with soil mix (contact RSU for details) and lightly compact. Cover with erosion control blanket or mulch.</td>
<td>Station machinery in the basin or place overflowed tires on machinery.</td>
</tr>
<tr>
<td>Maintain vegetation between 6&quot; and 12&quot; (2301, 2302).</td>
<td>Hand mow or machine mow.</td>
<td>Use large machinery to mow, instead use a push or riding lawn mower.</td>
</tr>
<tr>
<td>Remove trash and debris (2311).</td>
<td>Use handwork to pick up the trash and debris.</td>
<td>Use equipment to remove debris.</td>
</tr>
<tr>
<td>Reestablish vegetation (2315) and occasionally maintain through pesticides and herbicides (2303).</td>
<td>Use hand application of pesticides and herbicides, reference the Roadside Vegetation Establishment and Management for lists of invasive species.</td>
<td>Use pesticides or herbicides unless explicitly stated in inspection report.</td>
</tr>
</tbody>
</table>

Any maintenance concerns regarding the activity codes listed in the inspection form shall be directed to the Roadside Stabilization Unit (RSU) (402) 479-4656.

**Equipment/Crew/Materials**

<table>
<thead>
<tr>
<th>Activity Code</th>
<th>Description</th>
<th>Materials</th>
<th>Equipment</th>
<th>Crew Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2101</td>
<td>Machine Mowing</td>
<td>N/A</td>
<td>1 Tractor/Mower, 1 Pickup</td>
<td>1</td>
</tr>
<tr>
<td>2302</td>
<td>Hand Mowing</td>
<td>N/A</td>
<td>1 Pickup, 1 Mower</td>
<td>2</td>
</tr>
<tr>
<td>2301</td>
<td>Chemical Control of Insects and Roadside Trees and Shrubs</td>
<td>N/A</td>
<td>1 Tandem Truck, 1 Weed Sprayer, 1 Pickup, 1 Tractor</td>
<td>2</td>
</tr>
<tr>
<td>2311</td>
<td>Litter Pickup</td>
<td>N/A</td>
<td>1 Pickup</td>
<td>1</td>
</tr>
<tr>
<td>2315</td>
<td>Seeding and Sodding</td>
<td>Seed Mixtures, Erosion Control Mat</td>
<td>1 Pickup, 1 Tandem Truck, as required, 1 Tractor, and 1 Seed Drill</td>
<td>3</td>
</tr>
<tr>
<td>2350</td>
<td>Other Roadside Maintenance</td>
<td>Fill soil, Erosion Control Mat</td>
<td>1 Garden Tiller, 1 Skid Steer, 1 Pickup, 1 Tandem Truck, 1 Motor Grader*</td>
<td>2</td>
</tr>
</tbody>
</table>

*Caution: Heavy Equipment can compact soils and reduce effectiveness of STF.*
Doing with Less:
Engage Community & Business Practitioners

• Adopt a road.
• Adopt a landscape?
  • Michigan DOT
  • Virginia DOT
• Adopt a water treatment facility?
Competing Interests for the same physical space

• Where is green infrastructure valuable, needed most?
• Is environmental equity missing in green infrastructure?