Managing Stormwater and Saving Money in Urban Transportation Corridors with Green Infrastructure
Bio – Aaron Gwinnup

- Farm Boy
- Carpenter
- Contractor
- Engineer
- Stream Nerd
- Daddy

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Big Picture
Urban Environments Shed Water
• Faster
• More
• Dirtier

...than they used to

...this is bad

(The good news is, reducing the impact isn’t so hard after all)
Development of Impervious Cover

Image Credit:
- Shutterstock
- Konza Prairie – Kansas State Univ.
- Iowa Stormwater Management Manual

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...Changes to Hydrograph

More water faster

FLOW

TIME

Developed

Pre-Development
One Urban Watershed in Sioux City

Peak Flow - Percent Change

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ALTERED URBAN HYDRAULICS

Urban streams act somewhat like desert streams
- Low baseflow and high storm flows

Image Credit:
• Pete Merten
• Marty Melchoir

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So what…Who cares?
Streams at Risk

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Infrastructure at Risk

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Property at Risk
Impacts Affect Everyone

Runoff Rate Impacts –
  - Receiving-stream channel instability
  - Flooding
  - Reduced aquifer recharge

Runoff Quality Impacts –
  - Urban contaminants
    - Heavy metals, hydrocarbons, and bacteria, oh my!
  - Nutrients = lost assets upstream
    - + downstream algae blooms
    - + dead zones and other ecological impacts
SO WHAT CAN WE DO?
- GREEN INFRASTRUCTURE CAN HELP

Developed
Developed with BMP
Development

FLOW
TIME

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SO WHAT CAN WE DO?

MODERN STORMWATER MANAGEMENT OPTIONS

- Start with the basics – **Widely Distributed Infiltration**:
  - TOPSOIL - strive for 5 (% Organic Matter)
    - 1% additional OM holds 0.6” additional rainwater
  - Detention / Retention / Rain Barrels
  - Basic Infiltration

- Work toward the “frosting”:
  - Green roofs, bioswales, raingardens, permeable paving…
Case Studies – Green vs Gray

Coralville
  West Land Use Area
  Coral Ridge Avenue

Hinsdale – The Woodlands

External Research
Coralville’s New Stormwater Ordinance

- Commercial and Residential Development (more than single parcel)
  - Stream buffers
  - Detention requirements (5-yr / 100-yr)
  - 6 inches topsoil (!)
  - Infiltrate Water Quality volume onsite (1.25” Storm Runoff)
  - AND infiltrate or extended detention of Channel Protection volume onsite (2.4” Storm Runoff)
Coralville’s New Stormwater Ordinance

• Practicing what they preach
• The City adds stormwater BMPs to roadway and other municipal improvements whenever feasible (even if barely!) with the same standards as the ordinance
• The fire chief and staff are some of the best practitioners…
Case Study #1 – West Land Use Area

~3 square miles

Last large area to develop

Mostly agricultural, some woodland, some already developed
Case Study #1 – West Land Use Area

Some Results of Master Plan Study –

Enforcing onsite CPv results in:

- ~40% less regional detention required
  (more space to develop!)
- Smaller storm sewer trunk lines
- Smaller culverts
  (lower SW utility connection fees!)
- Less stream maintenance
- Enhanced aesthetics…
Case Study #2 – Coral Ridge Avenue

- City of Coralville needed to rebuild ½ mile arterial gateway
  - Increase from one lane each way to two, with turn lanes
  - Add 10’ recreational trail with underpass tunnel
  - Upgrade to traditional curb and gutter
  - Add streetscaping and aesthetic elements
  - Maintain progressive stormwater management standards
Coralville’s New Stormwater Ordinance

- Stormwater design goals for Coral Ridge Avenue
  - Treat Water Quality volume at a minimum
  - Prefer to treat Channel Protection volume from entire 10 acre site
  - Make BMPs unobtrusive and aesthetically appealing
    - OK, will do

- Save money vs traditional infrastructure
  - Wait, is that possible?
Functional, Appealing, Unobtrusive

6 large bioretention cells and 6 bioswales added to medians and rights-of-way.
How did we do?

- 84% of area drains to BMPs

✓ 160% of WQv Treated

✓ 123% CPv Treated
Lower Cost?

- **10% lower stormwater cost than traditional gray infrastructure only**

How?

- Few long large pipes
- Less storm structures
- Smaller pipes

* Includes fair assumptions
Case Study 3 – Hinsdale-The Woodlands

The Woodlands neighborhood had non-existent drainage with recurring flooding, deteriorated roadway conditions and aging infrastructure

2008 Study - Traditional gray infrastructure to collect and convey the 100-yr storm including other improvements (water, sewer and roadway) was $24.4 Million
Case Study 3 – Hinsdale-The Woodlands
Case Study 3 – Hinsdale-The Woodlands

2009 Study (and subsequent designs):
– Hybrid green / gray / underground detention system:
  $15 Million
  a 39% savings in capital cost alone

<table>
<thead>
<tr>
<th>SUMMARY STATISTICS - PHASE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease in Peak Outflow from Storm Sewer with BMPs compared to existing conditions</td>
</tr>
<tr>
<td>50-year 2-hour event</td>
</tr>
<tr>
<td>10-year 1-hour event</td>
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</tbody>
</table>

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<thead>
<tr>
<th>Green Infrastructure Footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Gardens</td>
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<tr>
<td>Bioswales</td>
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<tr>
<td>Underground Storage Volume</td>
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</tbody>
</table>
Case Study 4 (Actually 1.1)

Based on Coralville’s WLUA Master Plan Results:
If onsite CPv results in ~40% detention reductions…

...Can developers actually save money using GI?

Assuming:
Developers typically pay for:
  - local streets and related infrastructure
  - onsite practices
  - (and maybe local detention)
Case Study 4 (Actually 1.1)

Hypothetical case comparison:
Traditional local roadway section (with on-street parallel parking) vs. Same roadway with permeable pavers in parking lanes
Case Study 4 (Actually 1.1)

Assumptions:
WQv or CPv is treated onsite
100-yr / 5-yr detention is required
Streets designed per SUDAS 5-yr precipitation standard
   (net volume per unit length should pass into rock chamber below permeables, thus requiring **no inlets or storm pipes at all** except at roadway sag low points to capture major storm runoff)

Rainfall at Coralville
Water Quality volume event = 1.25”
Channel Protection volume event = 2.4”
5-yr event(Atlas 14) = 3.78”
Case Study 4 (Actually 1.1)

Results: Nearly identical total costs, slight savings with green infrastructure

1.4% total savings with onsite WQv

4.1% total savings with onsite CPv
External Research

Don’t just take my word for it:

A recent survey supra of 300+ registered Landscape Architects found that 75% of green infrastructure projects reduced or did not influence costs, and over half of these projects (59%) cost less than a comparable grey infrastructure design.

- data from nearly 479 projects
- across 43 states
- including, schools, universities, parks, streetscapes, commercial and residential construction.

1- “Banking on Green”, April 2012, AR, ASLA, ECON, WEF
Summary of Case Studies

The blanket argument “green infrastructure costs more than traditional”

**does not hold water**

Certainly it CAN cost more, but it CAN also cost less
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**Main Variables Are:**

- Space Available
- Engineering Constraints
- Public Safety
- Regulations & Permitting
- Local Ordinances
- Stormwater & Floodplain Management Goals
- Aesthetic Desires
- Existing Conditions
- Soils
- Hydraulics

**Success!** but not necessarily cost, because...
...cost is only part of the balance!

Green Infrastructure can deliver “Triple Bottom Line” benefits

As my dad once said to me:

“What’s the ‘payback period’ on the lunch you ate today?

...not everything needs to be a financial transaction...”
Triple Bottom Line Benefits of Green Infrastructure (besides cost)

- Ecosystem and habitat (trees, plants and animals)
- Neighborhood (aesthetic, livability and property values)
- Local watershed (water quality, stream stability, hydrologic cycle restoration and flood hazard mitigation)
- Improved quality of life
  - people (air quality, safety, recreation, increased environmental awareness)
  - society (public health, environmental education)
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Triple Bottom Line Benefits of Green Infrastructure (besides cost)

**Improved Air Quality/Climate Change**

**Urban Heat Island**
Green infrastructure practices that include trees and other vegetation can reduce the urban heat island effect, which reduces energy use and the incidence and severity of heat-related illnesses.

**Air Quality**
Green infrastructure improves air quality by increasing vegetation, specifically trees, that absorb air pollutants, including CO₂, NO₂, O₃, SO₂, and PM₁₀.

**Greenhouse Gases**
Green infrastructure’s ability to sequester carbon in vegetation can help to meet greenhouse gas emission goals by contributing to a carbon sink.

**Water Quality and Quantity**

**Water Conservation**
Green infrastructure that incorporates locally adapted or native plants reduce the need for irrigation, which reduces demand for potable and recycled water. Rain barrels and cisterns that capture rainwater also reduce water use.

**Water Quality and Flood Mitigation**
Green infrastructure can decrease the frequency and severity of local flooding by reducing stormwater discharge volumes and rates.

**Habitat**
Vegetated green infrastructure can provide habitat for wildlife, particularly birds and insects, even at small scales of implementation.

**Quality of Life**

**Public Health**
Residents have more recreational opportunities in the presence of large-scale green space in their community, which can improve public health and well-being.

**Public Safety**
Green streets that include curb bump-outs at pedestrian crossings improve pedestrian safety by slowing traffic and decreasing the distance that pedestrians must travel in the roadway.

**Recreational Opportunities**
Large-scale green infrastructure facilities that include public access, such as constructed wetlands, offer recreational opportunities.

**Property Aesthetics**
Green infrastructure that includes attractive vegetation can improve property aesthetics, which can translate into increased property values.

**Educational Opportunities**

**Public Education**
The visible nature of green infrastructure offers enhanced public education opportunities to teach the community about mitigating the adverse environmental impacts of our built environment. Signage is used to inform viewers of the features and functions of the various types of facilities.

Source – The Value of Green Infrastructure, Center for Neighborhood Technology, American Rivers, 2010

Figure 3. Additional green infrastructure benefits
## Triple Bottom Line Benefits of Green Infrastructure (besides cost)

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Reduces Water Treatment Needs</th>
<th>Improves Water Quality</th>
<th>Reduces Grey Infrastructure Needs</th>
<th>Reduces Flooding</th>
<th>Increases Available Water Supply</th>
<th>Increases Groundwater Recharge</th>
<th>Reduces Salt Use</th>
<th>Reduces Energy Use</th>
<th>Improves Air Quality</th>
<th>Reduces Atmospheric CO₂</th>
<th>Reduces Urban Heat Island</th>
<th>Improves Community Livability</th>
<th>Improves Aesthetics</th>
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<th>Reduces Noise Pollution</th>
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<th>Cultivates Public Education Opportunities</th>
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<tbody>
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Questions?

Want to challenge my findings?

Want more info?

Wondering how Green can save you money and help your water?

Contact me!

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319-841-4357
Maintenance Comparison

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Additional Material

References for Material Reproduced Herein

Coral Ridge Avenue, The Woodlands, and the permeable pavement cost studies were conducted for HR Green-designed projects.

References


Additional Material

This study was funded by Iowa’s Watershed Improvement Review Board

And conducted by HR Green

For the City of Coralville

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STORMWATER MANAGEMENT OPTIONS - TURF BIORETENTION CELL?
STORMWATER MANAGEMENT OPTIONS

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