Regenerative Stormwater and Stream Conveyance
OUTLINE

Brief introduction
Nature of the problem
Regenerative stormwater conveyance
Regenerative Stream restoration
RSC performance
What is Regenerative Stormwater Conveyance?
Also called: regenerative step pool storm conveyance or biofiltration conveyance

**Design philosophy:**
- Sand seepage wetlands mimic natural wetlands
- Regenerate by returning water to the system
- Reconnect stream to floodplain and re-establish natural habitat

**Applies to various landscape positions:**
- Ephemeral channels
  - in upper part of basins
  - retrofits for eroding gullies
  - at end of outfall pipe, tie-ins to stream
- Perennial streams
  - Spread stormflows onto floodplain
  - Use instream weirs and seepage wetland
- Other man-made
  - Roadside swales
  - Stormwater pond retrofits w/ inline bioretention (RSC)
Negative Feedback Loop

Disturbance to a stream corridor system typically results in a causal chain of alterations to stream corridor structure and function.
Geomorphic Impacts

- < 5%
- 8-10%
- > 65%
- 30%
- 20%
Regenerative Systems

Living Systems
Diversity
Reciprocity

Restorative
Humans doing things to nature – assisting the evolution of sub-systems

Less energy required
More stable

Sustainable
Natural – 100% less bad (McDonough)

Green
LEED, Green Globe, GB tool, etc.

Conventional Practice

More energy required
Less stable

Simplification
Fragmentation
Monocultures
Degenerating Systems

Trajectory of Environmental Design (Reed, 2006; Modified by Bowers, 2007)
Stream Functions Pyramid

1. HYDROLOGY » Transport of water from the watershed to the channel

2. HYDRAULIC » Transport of water in the channel, on the floodplain, and through sediments

3. GEOMORPHOLOGY » Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

4. PHYSIOCHEMICAL » Temperature and oxygen regulation; processing of organic matter and nutrients

5. BIOLOGY » Biodiversity and the life histories of aquatic and riparian life

http://www.fws.gov/chesapeakebay/Newsletter/Fall11/Pyramid/pyramid_-overview.jpg
Effects of Channel Work Associated with Increased Runoff
Regenerative Stormwater Conveyance
Riffle Pool Profile Section

HYPORHEIC FLOW

3 FT
Riffle Grade Controls
POST RESTORATION

PRE RESTORATION
Carriage Hills

22-ft incised

Adverse effect on shallow groundwater and downstream flows
Carriage Hills Post-restoration
ROAD / REGENERATIVE STORMWATER CONVEYANCE
BOULDER PORTION OF WEIR CROSS SECTION

- 3 FT DEPTH
- SANDSTONE BOULDERS
- GEOTEXTILE
- TAILINGS
- 1-1/2" HOTMIX ASPHALT SURFACE COURSE (SN) AND
  3" BASE COURSE (8) AND
  6" DENSE GRADED AGGR. BASE
  COURSE. (PLACED IN TWO COURSES)
- SAND/WOOD CHIP FILL
  (3" DEPTH x 5" WIDTH)
# Holladay Park - Cost Comparison

## Phase 1 - Original Design

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<tr>
<th>Pipe</th>
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<td><strong>Total LF</strong></td>
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## Current Costs

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<th>Costs</th>
<th>Amount</th>
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<tr>
<td>Grading/Excess</td>
<td>$248,750.00</td>
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<td>SWM Pond</td>
<td>$80,131.00</td>
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<tr>
<td>Pipe</td>
<td>$23,194.00</td>
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<td>Risers/structures/headwalls</td>
<td>$30,000.00</td>
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<td>24&quot; Pipe</td>
<td>$8,420.00</td>
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<td>Sandstone Weirs</td>
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<td><strong>Total</strong></td>
<td><strong>$404,855.00</strong></td>
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## Costs

<table>
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<td>SWM Pond</td>
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<td>RCP</td>
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<td>SWM Access Rd</td>
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<td>Fences for SWM Pond</td>
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<td>Sediment Controls</td>
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1. **HYDROLOGY**
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5. **BIOLOGY**
   Biodiversity and the life histories of aquatic and riparian life

Geology

Climate
Natural Channel Restoration
See the equipment in the channel?
Milkhouse Ford RSC – 4 yrs later
Linnean Park RSC
Floodplain
Reconnection
SEEPAGE RESERVOIR
seepage reservoir  
capillarity  
porous carbon-rich  
seepage bed  
seepage  
existing ground  

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top of seepage reservoir  
bottom of seepage reservoir  
seepage zone
Seepage berm / trail surface during construction
Berms allow infiltration from the water stored at higher elevation and exfiltration into the stream channel as base flow.
Wetland condition on upslope side of sand seepage berm /trail
Dynamic soil system, not static sand bed
How this approach performs

Hydrographs during individual storms - Wilelinor

Source: Solange Filoso, University of Maryland
Number of runoff responses in the perennial downstream channel

Storm event precipitation total, inches

Control stream
Restored stream

Source: Solange Filosa 2012
Figure 17. Discharge-weighted mean concentrations of TN in stormflow samples collected during different storms at Howard’s Branch. The dark bars represent concentrations upstream of the restored reach and the light bars represent concentrations downstream.

Figure 19. Discharge-weighted mean concentrations of TSS in stormflow samples collected during different storms at Howard’s Branch. The dark bars represent concentrations upstream of the restored reach and the light bars represent concentrations downstream.

Source: Palmer and Filoso, 2009
Solang Filoso, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory
Benefits of Regenerative Stormwater Conveyance

• Dissipates energy at outfall discharge points

• Improves water quality through infiltration, retention, & microbial activity in hyporheic zone

• Provides stable conveyance of 100-year storm events

• Attenuates stormwater peak discharge

• Reduces construction impacts to adjacent trees

• Enhances ecological functions through groundwater recharge, creation of riffle-pool complex, and supports riparian vegetation
Red Butte Creek in Miller Park Bird Refuge and Nature Preserve Salt Lake City
Thank you!

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