Appendix E

Construction Site Stormwater Activities

Design & Construction of BMPs- April 9, 2014

Thank you for Attending!

PLEASE SIGN IN

	Name	Affiliation	Sign-in
1	Terry Angle	Angle Consulting Engineering	
2	David Buchanan	City of Bend	
3	Chris Chambers	DEVTECH	
4	Wendy Edde	City of Bend	
5	Chris Henningsen	CA Rowles Engineering	
6	Jennifer VanCamp	HHPR	
7	Dennis Collins	StormWaterServices	
8	~~Chris Chambers~~		
9	TERRY ANGLE		
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

CWP Webinar 4/8/2014 "Design & Construction of BMPs"

No. of Attendees: 8 No. of Survey Responses: 4 (50% Response rate)

Question 1:

Presentation Evaluation (1 being poor and 5 being excellent)

	1	2	3	4	5	Count Response
Presentation			50% (2)	50% (2)		4

Additional Comments:

- Webinar did not discuss the design of BMPs as per the title.
- Speakers where knowable but didn't really touch on the topic as advertised.

Question 2:

Facility/ Refreshments Evaluation (1 being poor and 5 being excellent)

	1	2	3	4	5	Count Response
Facility				17% (2)	17% (2)	4
Refreshments			66% (1)	17% (3)		4

Additional Comments:

- Everything was great.

Question 3:

List one or more things you learned as part of the presentation:

- Collaboration with contractors.
- Use onsite/ recycled materials.
- Concepts to save money on design and construction.
- Advantages of early collaboration with all parties involved with the project.
- Allow design flexibility during construction to improve results and save cost.

Question 4:

Other additional comments/ Suggestions:

- Scotts presentation was the only section the really covered the webinars topic.
- Where were the design topics discussed for BMPs?

Watershed & Stormwater Management • Webcast Series

Series 1: The Life of a Stormwater Practice
Session 2: Design & Construction of BMPs

Watershed & Stormwater Management • Webcast Series

Welcome to the Webcast

- **Continuing Education Credits** – We are offering CEUs for our watershed and stormwater management webcast series. A registered attendee must watch the entire webcast to be eligible to earn the CEU. A pdf Certificate of Completion will be sent out after webcast to the person who registered for the webcast. The Certificate has a blank name field so that each attendee at your location can receive a certificate. While our training programs are developed with IACET criteria in mind, the varying nature of certification requirements for each state means we cannot guarantee that CEU's will be awarded and it is up to the individual to determine if CEU's or PDH's will be awarded based on the policies of their local certifying board. Email webcast@cwp.org with questions.
- **Resources** – After the webcast, we will email a resources sheet, speaker contact information, and the presentation.

Watershed & Stormwater

To Adjust How the Slides Appear on Your Screen – To make the slide area larger, go to Full Screen under the Meeting Tab.

To Answer a Poll Question – Polling questions appear during the webcast. To answer a poll question, click on the radio button to the left of your answer and click submit. Do not type your answer in the chat box.

To Ask a Question – The right corner of the screen contains a Q&A chat box. Type your question in the box and click on the send question icon to submit it. We will try to answer as many questions as possible during and after the webcast.

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Webcast Team

Jason Vogel, PhD., P.E.
Assistant Professor & Stormwater Specialist
Riata 'Green' Entrepreneurship Faculty Fellow
Biosystems and Agricultural Engineering
Oklahoma State University

Bryan Seipp
Watershed Manager/Professional Forester, Center

Scott McGill
Principal, Geomorphologist
Ecotone, Inc.

Joe Battiata, P.E.
Senior Water Resources Engineer, Center

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POLL QUESTION #1

How many people are participating today in the webcast at your location?

a) Just me
b) 2 to 5
c) 6 to 10
d) More than 10

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POLL QUESTION #2

I work for a

- Phase I community
- Phase II community
- Municipality
- State government
- Federal government
- Private consultant
- Nonprofit organization
- University
- Other (tell us in the chat box)

Watershed & Stormwater Management • Webcast Series

Webcast Outline

- Design & Construction, Big Picture (Bryan)
  - Q&A
- Research findings and BMP optimization (Jason)
  - Q & A
- Rules of thumb for successful projects (Scott)
  - Q & A
- Panel Discussion (Bryan, moderator)
  - Q&A
- Wrap Up, Conclusions, and Resources

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Big Picture

- **Innovation**
  - The quest to discover mythical practices that are inexpensive to design and install, require little to no maintenance, and are increasingly effective at removing pollutants.
- **Validation**
  - Determine application, performance, and acceptance
- **Optimization**
  - How to implement better, faster, and cheaper
- **Broad Scale Implementation**
  - Techniques, specifications, standards, and expectations are well understood by the community
- **Sustainable Implementation**
  - Collaboration, communication, creativity, and flexibility drive increased sustainability and cost effectiveness.

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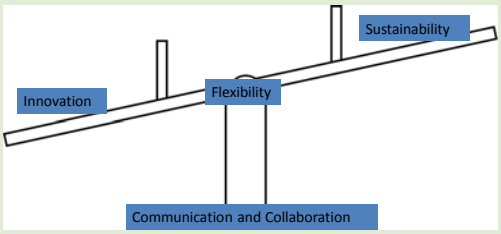
Providing Flexibility



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Drivers and Hurdles

- Project Goals
- Appearance
- Specifications
- Collaboration
- Communication
- Creativity

- Regulatory programs
- Permit Requirements
- Review/Inspections
- Material availability
- Context

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Q & A

Follow-Up Questions: webcast@cwp.org

Watershed & Stormwater Management • Webcast Series

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- Wrap Up, Conclusions, and Resources

The Evolution of LID Design: Validation, Optimization, & Implementation

Jason R. Vogel, Ph.D., P.E.
Biosystems and Agricultural Engineering
Oklahoma State University

ECOLOGICALLY PROGRESSIVE INFRASTRUCTURE CENTER
at Oklahoma State University

Presentation Outline

I. Definition of terms
II. Oklahoma examples
III. Where do we go from here?
   a) Integration
   b) The Land Grant University

Validation, Optimization, and Implementation

- **Validate:** *to support or corroborate on a sound or authoritative basis;*

  to recognize, establish, or illustrate the worthiness or legitimacy of
- From an LID Research standpoint
  - First time installations and monitoring

Source: merriam-webster.com

Validation

Environment | Design & Aesthetics | Policy & Standards | Economic, Social & Education

These projects are often funded by grant funding and are limited in scope and visibility, many times without standards for design or installation. However, they are an essential step.

Validation

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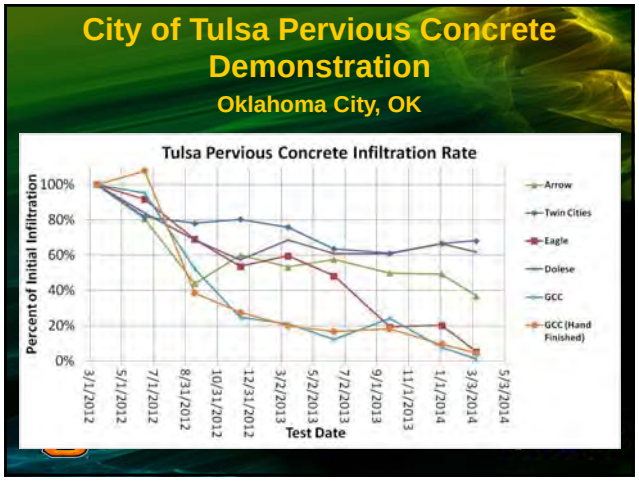
Oklahoma Validation Examples

(note that I will have pictures of these and briefly discuss each)

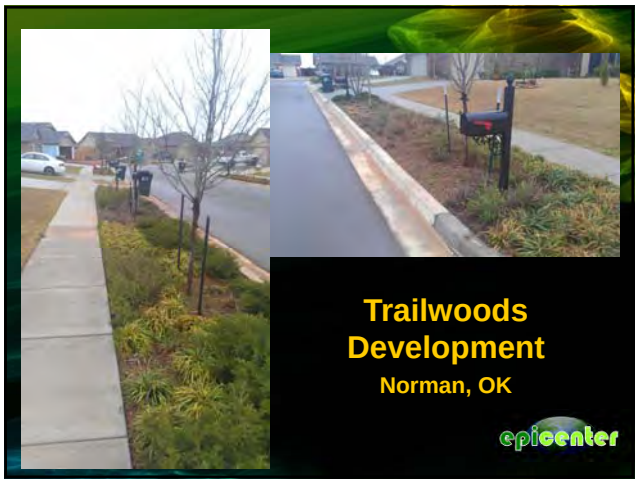
- Grove, Oklahoma Bioretention Cells
- City of Tulsa Pervious Concrete Demonstration Site
- OSU Botanic Garden LID Demonstrations
- City of Edmond Xeriscape Gardens
- Trailwoods and Carrington Lakes Subdivision in Norman
- Cedar Valley Nursery Submerged-flow Engineered Wetlands
- Illinois River Stream Natural Stream Restoration Demonstration Sites


Residential
Rain Garden
Grove, OK
epicenter


City of Tulsa Pervious Concrete Demonstration
Oklahoma City, OK


City of Tulsa Pervious Concrete Demonstration
Oklahoma City, OK
Tulsa Pervious Concrete Infiltration Rate
Percent of Initial Infiltration
100%
80%
60%
40%
20%
0%
3/1/2012
5/1/2012
7/1/2012
8/31/2012
10/31/2012
12/31/2012
3/2/2013
5/2/2013
7/2/2013
9/1/2013
11/1/2013
1/1/2014
3/3/2014
5/3/2014
Test Date
Arrow
Twin Cities
Eagle
Dolese
GCC
GCC (Hand Finished)


Xeriscape at Bickham-Rudkin Park
Edmond, OK
Xeriscape
Demonstration Garden



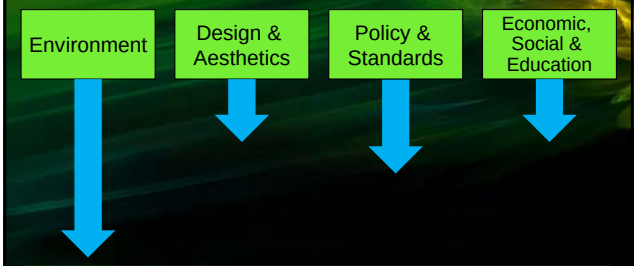
Validation, Optimization, and Implementation

- **Optimize:** *to make (something) as good or as effective as possible*
- From an LID Research standpoint
  - Assessment and improvements, often for a specific purpose
    - ie., design of the best bioretention media for nutrient reduction

Source: merriam-webster.com

epicenter

Optimization



These projects may be funded from grants, municipalities, or developers and are often focused on two or less specifically defined objectives. Policy or standard development may be part of optimization

Optimization

Environment | Design & Aesthetics | Policy & Standards | Economic, Social & Education

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Optimization

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These projects may be funded from grants, municipalities, or developers and are often focused on two or less specifically defined objectives. Policy or standard development may be part of optimization

Oklahoma Optimization Examples

- Grove, Oklahoma Bioretention Cell Enhanced Media
- Berry Family Nursery Submerged-flow Engineered Wetlands near Hulbert, Oklahoma
- City of Weatherford Stormwater Development Plan
- Sand Cisterns in Stillwater
- Deerfield Estates Bioretention Cells and Experimental Bioswale Demonstration in Oklahoma City

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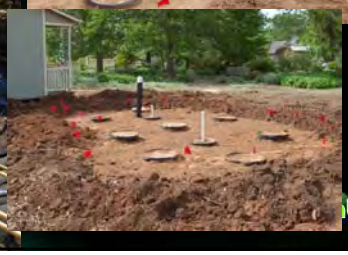
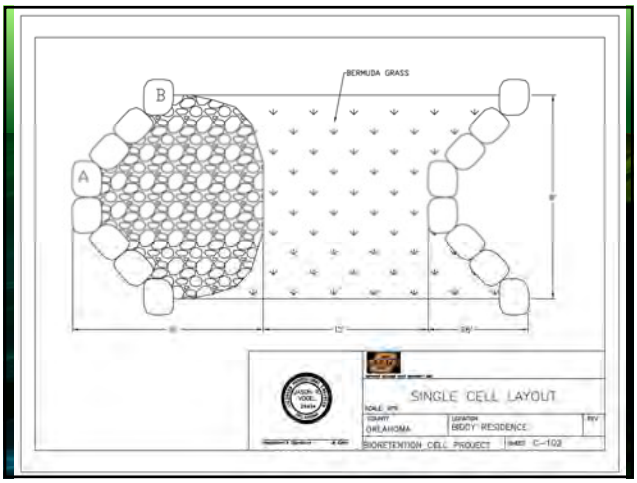
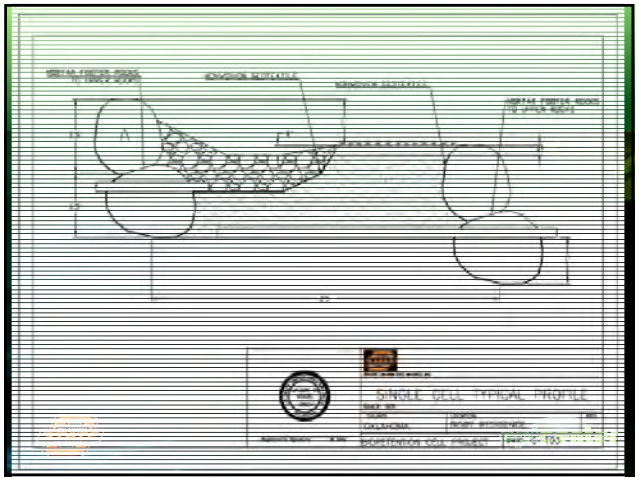
SAND CISTERN
STILLWATER, OK



Deerfield Estates

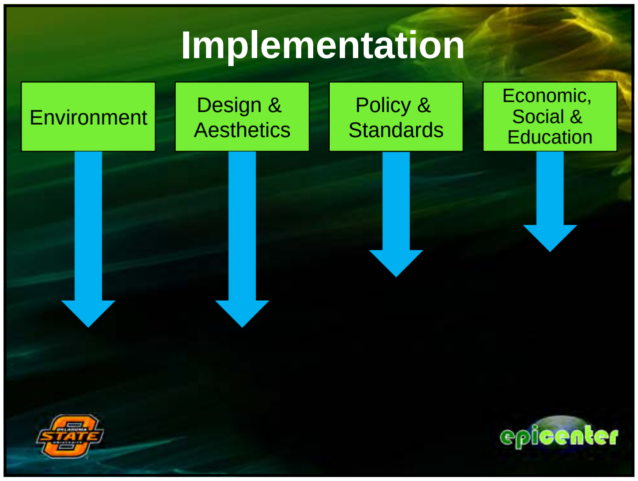




Validation, Optimization, and Implementation

- **Implementation:** *carry out, accomplish; especially: to give practical effect to and ensure of actual fulfillment by concrete measures*
- From an LID Research standpoint
  - All pertinent parties are working together to ensure efficient and effective widespread adoption of optimized LID systems

Source: merriam-webster.com


Implementation
Environment
Design & Aesthetics
Policy & Standards
Economic, Social & Education
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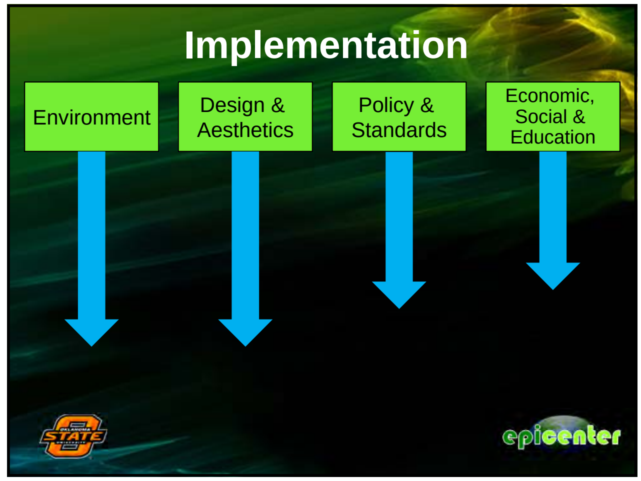
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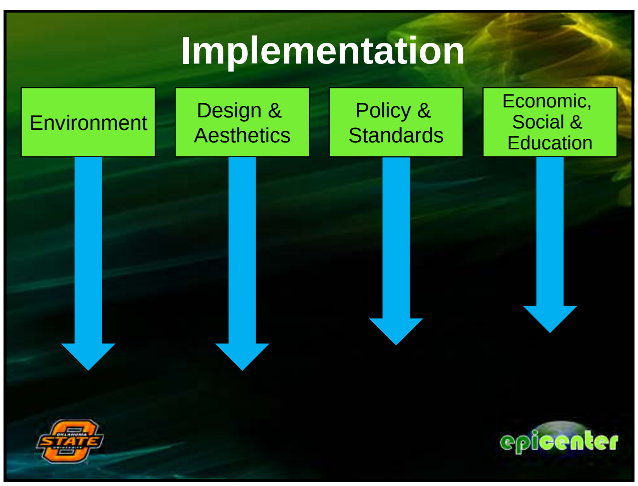
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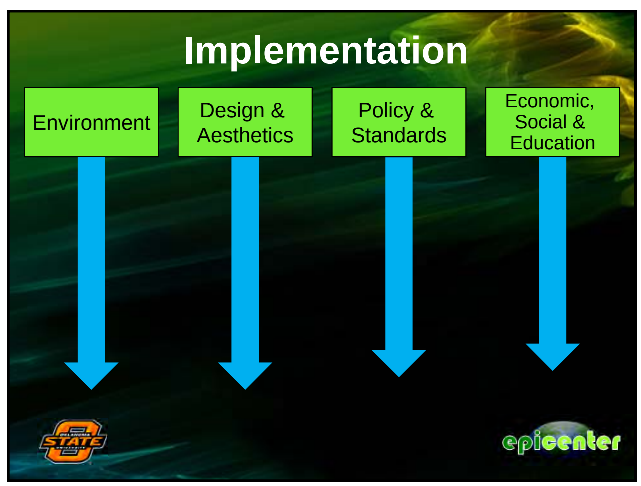
Implementation
Environment
Design & Aesthetics
Policy & Standards
Economic, Social & Education
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Implementation

Environment | Design & Aesthetics | Policy & Standards | Economic, Social & Education

Fully optimized, widespread implementation will economically maximize co-benefits for the region, planned at a watershed scale. How do we get there?

epicenter

Oklahoma Implementation Example

- Green Country Low Impact Development Design Competition

because every drop counts....
GREEN COUNTRY
SUSTAINABILITY FORUM

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Site Plan: Urban Residential Redevelopment

LID Toolbox:

- Flow Through Planters
- Infiltration Trench
- Bioretention Median
- Canal

SITE PLAN: URBAN RESIDENTIAL REDEVELOPMENT

What do we need to reach the implementation stage?

Integration

- *Disciplines: Physical, Biological, Design, Social, Educational, and Policy*
- *Balancing and valuating co-benefits*
- *Industry Standards and design specifications*
- *Fundamental & Applied Research*
- *Academic--municipal--private partnerships*

The Role of the Land Grant University

The 3-legged Stool:
Teaching-Research-Extension

- *Connection to industries and municipalities for high-impact, pertinent research*
- *Accessibility for two-way communication of discoveries by both academics, policy-makers, and practitioners*
- *Practical education that exposes students to be real-world applications and life-long learning*

For more information, visit

lidcompetition.okstate.edu & lid.okstate.edu

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Q & A

Follow-Up Questions: webcast@cwp.org

POLL QUESTION #3

DO YOU WANT TO ADD A POLL QUESTION?

IF SO WHAT DO YOU WANT TO ASK?

Webcast Outline

- Design & Construction, Big Picture (Joe)
  - Q&A
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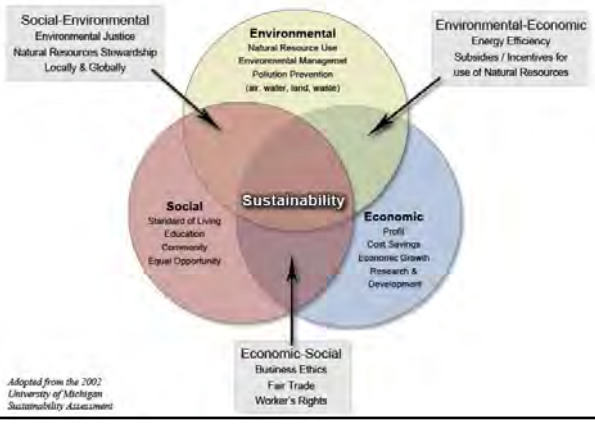
Integrating Sustainability and Constructability into Ecological Restoration

Scott G. McGill
Ecotone, Inc.
Forest Hill, MD
smcgill@ecotoneinc.com

Takeaways:

1. Incorporate sustainability into projects at the 3 stages of a project's development
2. Sustainability IS cost effectiveness
3. Embrace creativity, innovation, and collaboration

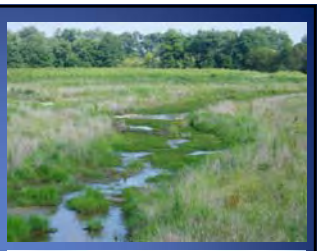
The Three Spheres of Sustainability



Sustainability as it relates to Ecological Restoration

1. Transportation Costs - reduce/eliminate haul off/haul in
2. More vegetation, less rock
3. Utilize salvaged materials
4. Avoid exotic materials
5. Allow creativity and innovation by the Owner/Contractor
6. Recycle/Reuse

	QUANTITY	DESCRIPTION	UNIT PRICE	SUBTOTAL
ACTUAL	11,400	SQUARE YARDS PLACING **FURNISHED** TOPSOIL	$10.00	$114,000
HYPOTHETICAL SUSTAINABLE ALTERNATIVE	11,400	SQUARE YARDS PLACING **SALVAGED** TOPSOIL	$3.00	$34,200
			SAVINGS	**$73,600**

- What function are the specified materials to provide?
- Can rock be reduced or replaced with vegetation?
- What is available locally?


Item Number	UNIT	QUANTITY	DESCRIPTION	UNIT PRICE	SUBTOTAL
River Jacks, 4-18" Boulders (DEL VAL)	TON	1,261	Del Val Cobble D50=10"	MATERIAL $ 15.00 **DELIVERY $ 31.50** TOTAL/TON $ 46.50	$ 58,637
ALTERNATIVE/ ADDITIONAL BID ITEM	TON	1,261	MIX OF ANGULAR QUARRY ROCK, CLASS 0 AND CLASS I, AND LOCAL WASHED GRAVELS	MATERIAL $ 16.00 DELIVERY $ 7.00 TOTAL/TON $23.00	$29,003
*Note – material only				**SAVINGS**	**$29,634**

Stage 1: Identify opportunities for reuse of materials at initial site analysis.

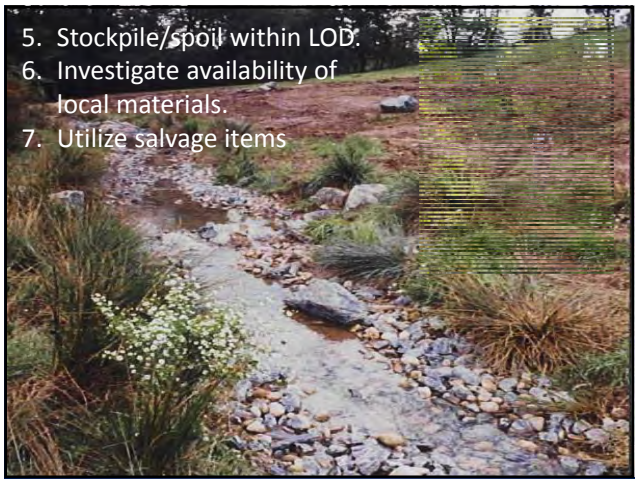
1. On-site vegetation
2. Woody material
3. Rock/Gravel
4. Topsoil!

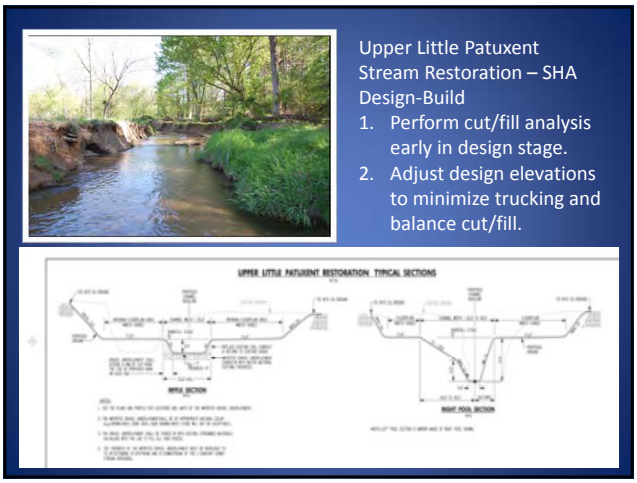
East Branch Winters Run – Constructed 2003
Inventoried on-site resources:
1. Wetland sod
2. Woody materials
3. On-site spoil areas
4. Topsoil.

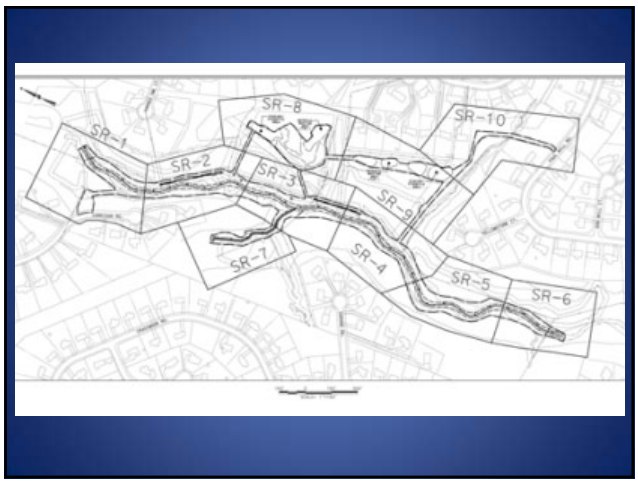
- Wetland vegetation to be disturbed was utilized for bankside sod along the restored stream.
- Trees to be removed were used for bank stabilization.
- No haul off

Stage 2: Sustainability in the design process.

1. Sustainability review at 10% design level, then again at 60%.
2. Collaborate with Contractors (Design-Build Option)
3. Minimization of transport costs.
4. Balance cut/fill.


5. Stockpile/spoil within LOD.
6. Investigate availability of local materials.
7. Utilize salvage items


Upper Little Patuxent Stream Restoration – SHA Design-Build
1. Perform cut/fill analysis early in design stage.
2. Adjust design elevations to minimize trucking and balance cut/fill.
UPPER LITTLE PATUXENT RESTORATION TYPICAL SECTIONS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SR-2
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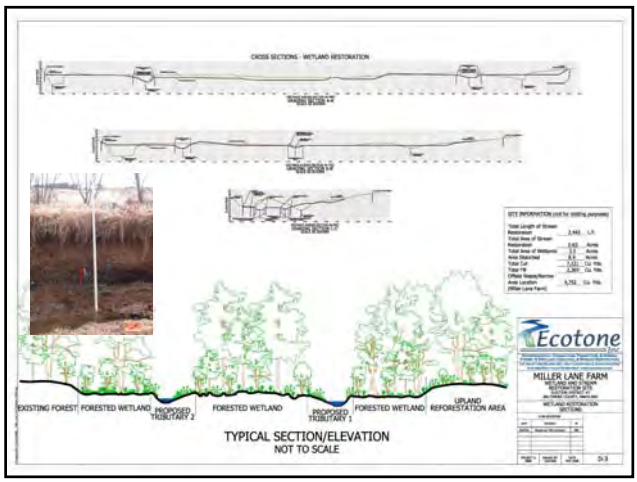
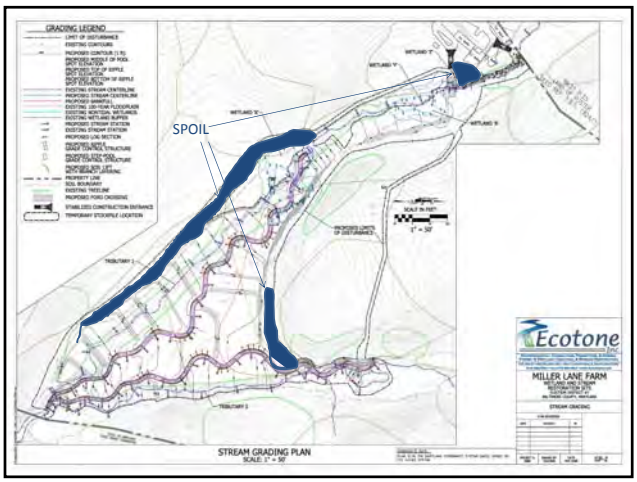
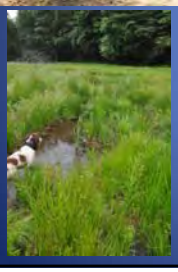




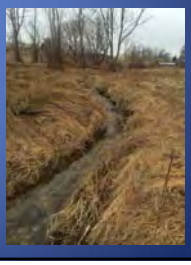


Soft rush	*Juncus effusus*	20%	FACW
Straw Colored Flat Sedge	*Carex straminea*	12%	OBL
Canada rush	*Juncus canadensis*	7%	OBL
Barnyard grass	*Echinochloa crusgalli*	7%	FACU
Cattail	*Typha latifolia*	5%	OBL
Tussock sedge	*Carex stricta*	5%	OBL
Lurid Sedge	*Carex lurida*	3%	OBL
Square stem Money flower	*Mimulus ringus*	<2%	FACW
Walter Millet	*Echinochla walteri*	<2%	FACW
Pennsylvania smartweed	*Polygonum pensylvanicum*	<2%	FACW
Rice Cutgrass	*Leersia oryzoides*	<2%	OBL
Slender St. Johns Wort	*Hypericum mutilum*	<2%	FACW
Eastern burreed	*Spargianium americanum*	<2%	OBL
Jewelweed	*Impatiens capensis*	<2%	FACW
Blunt Spike rush	*Eleocharus obtusa*	<2%	OBL
American Water horehound	*Lycopus americanus*	<2%	OBL
American Water Wort	*Elatine americana*	<2%	OBL
Seedbox	*Ludwigia paulustris*	<2%	OBL
Beaked spike rush	*Eleocharis rostellata*	<2%	OBL
False Nettle	*Bohemaria cylindrica*	<2%	OBL
Boneset	*Eupatorium perfoliatum*	<2%	FACW
Soft Stem Bulrush	*Scirpus validus*	<2%	OBL
Woolgrass	*Scirpus cyperinus*	<2%	FACW
White Clover	*Trifolum repens*	<2%	FACU
Duck Potato	*Sagittaria latifolia*	<2%	OBL
Swamp milkweed	*Asclepias incarnata*	<2%	OBL
Littleleaf Goldenrod	*Solidago graminacea*	<2%	FAC
White Aster	*Aster vimminuem*	<2%	FAC
Arrow arum	*Peltandra virginica*	<2%	OBL
Black Eyed Susan	*Rudbeckia hirta*	<2%	FACU
Arthraxon	*Arthraxon hispidus*	<2%	NI
Morning Glory	*Ipomea eriocarpa*	<2%	FACU
Goldenrod	*Solidago spp*	<2%	FACU
Speedwell	*Veronica anagallis-aquatica*	<2%	OBL

Imbricated Rock Wall vs. Toe Wood

	unit	QTY	Unit Price	Total Cost
Imbricated Rock Wall	linear foot	100	$ 87.08	$ 8,708.33
Toe Wood	linear foot	100	$ 30.75	$ 3,075.00
		saving	**$ 56.33**	**$ 5,633.33**
			65 % SAVINGS	

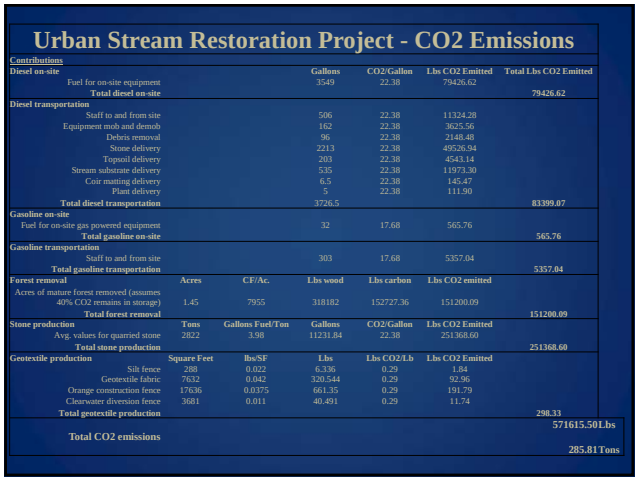
*assumes 100 foot bank length and 3 foot high bank



Riffle Grade Control vs. Log Cross Vane

	unit	QTY	Unit Price	Total Cost
Riffle Grade Control	per each	1	$ 2,666.67	$ 2,666.67
Log Cross Vane	per each	1	$ 1,250.00	$ 1,250.00
		saving	**$ 1,416.67**	**$ 1,416.67**
			53 % SAVINGS	

*assumes 15' wide channel, 25' length



Urban Stream Restoration Project - CO2 Emissions

Contributions						
Diesel on-site			**Gallons**	**CO2/Gallon**	**Lbs CO2 Emitted**	**Total Lbs CO2 Emitted**
Fuel for on-site equipment			3549	22.38	79426.62	
Total diesel on-site						**79426.62**
Diesel transportation						
Staff to and from site			506	22.38	11324.28	
Equipment mob and demob			162	22.38	3625.56	
Debris removal			96	22.38	2148.48	
Stone delivery			2213	22.38	49526.94	
Topsoil delivery			203	22.38	4543.14	
Stream substrate delivery			535	22.38	11973.30	
Coir matting delivery			6.5	22.38	145.47	
Plant delivery			5	22.38	111.90	
Total diesel transportation			3726.5			**83399.07**
Gasoline on-site						
Fuel for on-site gas powered equipment			32	17.68	565.76	
Total gasoline on-site						**565.76**
Gasoline transportation						
Staff to and from site			303	17.68	5357.04	
Total gasoline transportation						**5357.04**
Forest removal	**Acres**	**CF/Ac.**	**Lbs wood**	**Lbs carbon**	**Lbs CO2 emitted**	
Acres of mature forest removed (assumes 40% CO2 remains in storage)	1.45	7955	318182	152727.36	151200.09	
Total forest removal						**151200.09**
Stone production	**Tons**	**Gallons Fuel/Ton**	**Gallons**	**CO2/Gallon**	**Lbs CO2 Emitted**	
Avg. values for quarried stone	2822	3.98	11231.84	22.38	251368.60	
Total stone production						**251368.60**
Geotextile production	**Square Feet**	**lbs/SF**	**Lbs**	**Lbs CO2/Lb**	**Lbs CO2 Emitted**	
Silt fence	288	0.022	6.336	0.29	1.84	
Geotextile fabric	7632	0.042	320.544	0.29	92.96	
Orange construction fence	17636	0.0375	661.35	0.29	191.79	
Clearwater diversion fence	3681	0.011	40.491	0.29	11.74	
Total geotextile production						**298.33**
Total CO2 emissions						**571615.50Lbs**
						285.81Tons

Urban Stream Restoration Project - CO2 Sequestration (25 Yrs)

Attenuation	Quantity	Lbs CO2/Year	Years	Lbs CO2 Absorbed	Total Lbs CO2 Absorbed
Tree and shrub planting					
Trees	471	16.56	25	195036.82	
Shrubs	234	0.83	25	4844.86	
Live Stakes	1992	0.83	25	41243.45	
Total tree and shrub planting					**241125.14**
Total CO2 sequestration					**241125.14Lbs**
					120.56Tons

Urban Stream Restoration Project Carbon Balance:

- Total CO2 Emissions: 285.8 Tons
- Total CO2 Sequestration*: (120.6) Tons
- CO2 Balance: 165.2 Tons

*Assumes 25 years of forest growth

Equivalent to the average annual CO2 emissions of 8.7 Americans

Or a whole bunch of Kenyans

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Q & A

Follow-Up Questions: webcast@cwp.org

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Webcast Outline

- Design & Construction, Big Picture (Joe)
  - Q&A
- Research findings and BMP optimization (Jason)
  - Q & A
- Rules of thumb for successful projects (Scott)
  - Q & A
- Panel Discussion (Bryan, moderator)
  - Q&A
- Wrap Up, Conclusions, and Resources

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PANEL DISCUSSION
Q & A

Follow-Up Questions: webcast@cwp.org

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Summary

- Take home points and lead in to the next webcast, BMP maintenance

Series 1, The Life of a Stormwater practice
Session 1, The Role of Local Codes ✔
Session 2, Design & Construction of BMPs ✔
Session 3, BMP Maintenance **– up next**

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Upcoming Webcasts

Series 1: The Life of a Stormwater Practice

- The Role of Local Codes
  - March 12, 2014, 1:00 – 3:00 PM EDT
- Design & Construction of BMPs
  - April 9, 2014, 1:00 – 3:00 PM EDT
- **BMP Maintenance**
  - May 21, 2014, 1:00 – 3:00 PM EDT
- **How to Pick the Right Vegetation for Bioretention & Its Cousins**
  - June 11, 2014, 1:00 – 3:00 PM EDT

See our 2014 webcasts
http://www.cwp.org/webcast-home

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Series 1: The Life of a Stormwater Practice
Session 2: Design & Construction of BMPs