DISCUSSIONS ON LOW IMPACT DEVELOPMENT (LID) BIOSWALE SOLUTIONS

SAN DIEGO ASLA STEWARDSHIP COMMITTEE WORKSHOP
March 14, 2014
2:00 pm – 3:15 pm  
Introduction:  Tim Smith, ASLA Stewardship Committee Chair, Wynn-Smith Landscape Architecture

Bioswale Basics and Regulations:  Jim Kuhlken, Rick Engineering Company

What Makes A Good Bioswale Media:  Garn Wallace, Wallace Labs

Storm Water Treatment:  Craig Kolodge, Filtrexx

Plant Material for Bioretention:  Mike Klaerich, Green Meadow Growers

Bioretention Maintenance:  Chris Cutler, Steve Smith Landscape

3:15 pm – 3:30 pm  Break

3:30 pm – 4:15 pm  
Bioswales and Bioretention Case Studies & Discussion

4:15 pm – 5:00 pm  Question & Answers
Jim Kuhlken
Principal of the Landscape Architecture Division

RICK ENGINEERING COMPANY

(RICK) is a full-service, multi-disciplinary planning, design, and engineering firm with more than 59 years of local San Diego experience.

SAN DIEGO ASLA STEWARDSHIP COMMITTEE
DISCUSSIONS ON LID DEVELOPMENT BIOSWALES AND BIORETENTION
March 14, 2014
Where have we been?

Changes to Storm Water Treatment Standards (2007)

- Projects over 1 acre and 5,000 s.f. of hardscape removal and replacement
- Infiltration or bioretention preferred
- Filtration and/or extended detention also accepted
- Can treat and release runoff
Typical Bioretention Systems

Countywide Model SUSMP “Bioretention” Facility
(treatment-only)

San Diego BMP Sizing Calculator Methodology
“Bioretention” Facility
(treatment plus flow control)

“Cistern with Bioretention” or “Bioretention Plus Cistern”
(treatment-only or treatment plus flow control)
**What have we done?**

**CONSTRUCTED:**
- SWMP for Poinsettia Properties (The Tides), dated April 5, 2011 - WQ
- SWMP for San Pasqual Academy - WQ
- WQTR for California Proton Therapy Center – WQ
- WQTR for National City Streetscape – WQ
- SWMP for Palomar Airport Auto Parking Lots – WQ (pre-bioretention)
- WQTR for Illumina – WQ and HMP (for one building)
- SWMP for Camp Pendleton Dining Facilities - WQ
- SWMP for Brighton Place Housing – LID (pre-treatment)
- Valencia Library - Santa Clarita, CA
- Newhall Parking Lot Expansion : Bioretention and Permeable Pavement
- Westfield West Covina Mall Expansion: Permeable Pavement
- Habitat for Humanity – Central Coast, CA
- Century City Parking Garage - Los Angeles, CA

**UNDER CONSTRUCTION:**
- WQTR and HMP for Casa Aldea II, dated January 24, 2013 (Most solutions are LID) – WQ and HMP
- WQTR for Torrey Reserve Phase III (Some solutions are LID) – WQ and DET
- Westfield Century City Parking Garage Biofiltration System: WQ
- City of Santa Clarita Valencia Library: Bioretention

**FINAL COMPLETE DESIGN** (Not Yet Constructed):
- WQTR and HMP for Santaluz Memory Care Facility, dated April 26, 2013 – WQ and HMP
- USMP for H Street – WQ
- WQTR for Millenia Streetscape – WQ + some HMP
Miramar Water Treatment Plant
Scripps Proton Therapy Center
BIOSWALE BASICS & REGULATIONS

SAN DIEGO ASLA STEWARDSHIP COMMITTEE
DISCUSSIONS ON LID DEVELOPMENT BIOSWALES AND BIORETENTION
March 14, 2014
What have we learned?

SOIL MIX
- 70% Sand
- 30% Compost/Sandy Loam

SOIL PLACEMENT
- long term, in place infiltration rate of at least 5 inch per hour
- Compact 85% - 90%
"Task Force" of Professionals

RICK Engineering Company

Brendan Hastie, Water Resource Engineer  
Laura Henry, Water Resource Engineer  
John Goddard, Civil Engineer/QC Chairperson  
Tim Gabrielson, Civil Engineer  
Tim Pruss, Landscape Architect  
Jim Kuhlken, Landscape Architect

Regional Task Force

Jeremy Fantaroni, County of San Diego  
Stuart Kuhn, County of San Diego  
James Nabong, City of San Diego  
Yvana Hrovat, Tetra Tech  
Jason Wright, Tetra Tech  
Laura Lord, Tetra Tech  
Brad Wardynski, Tetra Tech  
Mary Matava, AGRI Services  
Glenn Schmidt, Schmidt Design Group  
Jeff Justus, Schmidt Design Group  
Tim Pruss, RICK Engineering  
Jim Kuhlken, RICK Engineering  
Brendan Hastie, RICK Engineering

Outside Consultants

Trevor Myers, Geotechnical Engineer, GEOCON  
Mary Matava, Agronomist, AGRI Services  
Garn Wallace, Wallace Laboratories
Where are we going?

Changes to Storm Water Treatment Standards (2013)

- Projects with 10,000 s.f. of non-porous surfaces or more, driveways over 5,000 s.f., but all projects require LID treatment

- Implement LID BMP designed to retain onsite 85th percentile runoff (infiltrate, evaporate, evapotranspire, harvest and use)

- If not feasible to retain runoff on-site, use biofiltration sized with new sizing criteria given in R9-2013-0001

- If not feasible to RETAIN or use biofiltration, use flow-through treatment control BMPs AND mitigate (off-site) for the design capture volume that was not retained on-site
Capture & Reuse

Feasibility vs. Infeasibility

- Irrigation Demand - Parks
- Toilet Flushing - Commercial/Industrial

Infeasibility Analysis
- Required capture Volume vs. Demand
- Letter Report for Landscape Architect demonstrating infeasibility

SAN DIEGO ASLA STEWARDSHIP COMMITTEE
DISCUSSIONS ON LID DEVELOPMENT BIOSWALES AND BIORETENTION
March 14, 2014
Proton Therapy Rainwater Collection Model

- Rainwater/Stormwater Collection
- Irrigation Demand: Landscape

MONTHS: JAN, FEB, MARCH, APRIL, MAY, JUNE, JULY, AUGUST, SEPTEMBER, OCTOBER, NOVEMBER, DECEMBER

GALLONS: 0, 20,000, 40,000, 60,000, 80,000, 100,000, 120,000, 140,000, 160,000, 180,000, 200,000
NOVEMBER

1.72 PERCIPITATION IN INCHES
248,984 GAL

TURF IRRIGATION REQUIREMENTS
-57,363

EVAPORATION
-1.20

SHRUB IRRIGATION REQUIREMENTS
0.0

ECS SYSTEM

STORAGE TANKS

1,795,362 GAL AVAILABLE STORAGE
191,621 GAL RUNNING TOTAL COLLECTION
Assessment of Existing Roadside Swales with Engineered Filter Soil: I. Characterization and Lifetime Expectancy

Garn Wallace, President
Wallace Labs

- Simon T. Ingversten, Karin Cederkvist, Yoann Régent, Harald Sommer, Jakob Magid, and Marina B. Jensen
- University of Copenhagen


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DISCUSSIONS ON LID DEVELOPMENT BIOSWALE AND BIORETENTION
March 14, 2014
Fig. 1. Schematic diagram of a typical German swale-trench infiltration system. (1) road surface, (2) grassed swale, (3) engineered soil mixture (~30 cm), (4) gravel filled trench, and (5) drainpipe.
Table 1. German guidelines for the design and construction of infiltration swales and basins (DWA, 2005).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>10–30 cm, depending on the anticipated need for treatment and the treatment capacity of the soil</td>
</tr>
<tr>
<td>pH</td>
<td>6–8; if adjusted, this should be done with slowly soluble lime</td>
</tr>
<tr>
<td>Infiltration rate</td>
<td>Not lower than $10^{-5}$ and not higher than $10^{-3}$ m/s on construction</td>
</tr>
<tr>
<td>Clay + silt</td>
<td>Not more than 10% of the total soil mass</td>
</tr>
<tr>
<td>Organic matter</td>
<td>1–3% of the total soil mass</td>
</tr>
</tbody>
</table>

$10^{-5}$ m/s is 1.42 inches per hour
• For roofs consisting of zinc or copper material, very high metal concentrations can be expected in the runoff water; hence, the topsoil is recommended to be replaced every 2 to 4 yr.

Assessment of Existing Roadside Swales with Engineered Filter Soil: I. Characterization and Lifetime Expectancy
Hope Street
Dec. 2008
Hope Street
June 2011

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DISCUSSIONS ON LID DEVELOPMENT BIOSWALES AND BIORETENTION
March 14, 2014
Trace Metal Contamination Influenced by Land Use, Soil Age, and Organic Matter in Montreal Tree Pit Soil


• Short life span of many street trees in the Montreal downtown area may be due in part to higher than standard concentrations of trace metals in the tree pit soils.
• Significantly higher concentrations of Cu, Cd, Zn, and Pb were observed in soils from commercial streets, possibly as a result of heavier traffic as compared with residential streets.
SANDS

• The best sand size for horticultural purposes is clean, narrowly graded, sized sand with particles about 0.5 - 0.8 millimeter in diameter (20 to 30 mesh). Coarser sand has insufficient water holding capacity and finer sand has insufficient air porosity when moist. Cement sand and plaster sand are designed to cement. They contain widely graded sands in order to more fully fill the voids with sand.
SAN DIEGO ASLA STEWARDSHIP COMMITTEE
DISCUSSIONS ON LID DEVELOPMENT BIOSWALES AND BIORETENTION
March 14, 2014
Cation Exchange Capacity to bind soluble metals

- Clays
- Peats
- Organic matter
- Zeolites
Cation Exchange

- Calcium
- Magnesium
- Potassium
- Sodium
- Hydrogen

Available but not soluble – decreases salinity but does not limit availability
Zinc

Parts per million

- EPA 503 limit: 2,800
- UK limit: 400
- Canada limit: 315
- German limit: 300
Copper

Parts per million

- EPA 503 limit: 1,500
- UK limit: 200
- Canada limit: 100
- German limit: 70
EPA 503 Regs

- These regulations were adopted for the use of biosolids applied as a nitrogen source for farm soils where several tons are applied per acre at the agronomic rate for nitrogen mineralization.
EPA 503 Regs

• The EPA 503 Regulations also assumed that the initial heavy metal loading of farm soil was zero. They calculated the number of years that would be required to increase the concentrations of heavy metals with annual applications of biosolids to the point of being toxic.
Clayey Soil Benefits

- High nutrient content
- High water holding capacity
- High cation exchange capacity

Clayey Soil Disadvantages

- Slow rate of water infiltration
- Slow rate of water percolation
- Low porosity and low aeration
- Difficult to till and to amend
Sandy Soil Benefits

• High porosity
• High aeration
• High infiltration and percolation
• More tilth and workability

Sandy Soil Disadvantages

• Low water retention
• Low nutrient retention
• Low cation exchange capacity
Growth Factors/Inhibitors

- Moisture
- Acidity
- Salinity
- 14 mineral nutrients
- Soil porosity/texture/compaction
- Soil organic matter
- Absence of toxicity - minerals
- Absence of toxicity - organic
- Pathogens
Compost-Based Stormwater Best Management Practices

Using Compost to Improve Stormwater Management and Erosion Control On Roadsides

Craig Kolodge, Filtrexx

Chris Newman, US EPA Region 5, Chicago, IL
Compost-Based BMPs

- Compost-based stormwater best management practices (BMPs) control both stormwater quantity and quality
  - They meld two important EPA initiatives
    - Resource Conservation Challenge (RCC)
    - National Pollutant Discharge Elimination System (NPDES)

- EPA developed fact sheets for three compost-based BMPs—compost blankets, compost filter berms, and compost filter socks
  - See EPA Stormwater Phase II (NPDES) Menu of BMPs
Resource Conservation Challenge

• Focus of the RCC is to increase waste recycling and reuse in the U.S.
  • One focus of the RCC is to increase recycling of municipal solid waste (MSW)
    • Goal: Increase recycling of MSW to 35 percent by 2008
    • Goal: Increase recycling of MSW to 40 percent by 2011

• Organic materials (green yard waste and food waste) are a focus area to increase recycling of MSW
  • Increasing high-value markets for compost is one way to support increased recycling of organic waste
National Pollutant Discharge Elimination System

- NPDES regulates the quantity and quality of stormwater discharges to waters of the U.S.
  - Control of stormwater quality is a particular concern at construction sites
  - Large disturbed areas may contribute sediment and other pollutants to stormwater

- Municipal separate storm sewer systems (MS4s) and construction site operators must control stormwater quantity and quality from construction and post-construction activities
RCC and NPDES Working Together

• Compost-based BMPs bring these two programs together

• Benefits to NPDES program
  • Compost BMPs help control sheet-flow runoff
  • Compost provides effective stormwater treatment

• Benefits to RCC program
  • High-value markets can drive demand for more compost
  • Increased recycling of organic waste will help increase the national MSW recycling rate
Benefits of Compost in Stormwater BMPs

• Compost retains a large volume of water
  • Prevents or reduces rill erosion
  • Reduces runoff volume
  • Promotes establishment of vegetation

• Compost improves downstream water quality by retaining/adsorbing pollutants
  • Heavy metals, nitrogen, phosphorus, oil and grease, fuels, herbicides, and pesticides
  • Nutrients and pollutants are decomposed by naturally occurring microorganisms
Benefits of Compost in Stormwater BMPs, cont.

- Compost improves soil structure and nutrient content
  - Reduces need for chemical fertilizers, pesticides, and herbicides

- Compost-based BMPs remove as much or more sediment and pollutants from stormwater as traditional perimeter controls, such as silt fence
  - Allow a larger volume of clear water to pass through
Compost Quality

- Use sanitized, mature compost with no identifiable feedstock constituents or odors
- Must meet all local, state, and federal quality requirements
- U.S. Composting Council certifies compost products
  - Seal of Testing Assurance program
  - Products certified under program have a standard product label for comparison of products
- Some composts contain metals and/or nutrient concentrations that are higher than topsoil; these do not result in higher stormwater concentrations
Compost Quality, cont.

- American Association of State Highway Transportation Officers (AASHTO) standards
  - Quality and particle size specifications for compost to be used in compost blankets, compost filter berms, and vegetated compost filter socks

- Quality and particle size specifications for unvegetated compost filter socks provided in EPA fact sheet

- Many State Departments of Transportation (DOT) also have specifications for compost quality and particle size used in BMPs
Compost BMP Fact Sheets

- Fact sheets provide the following information about the compost BMPs:
  
  - Description of how the BMP is used
  - Applicability of the BMP (e.g., sheet flow only or some more concentrated flow)
  - Siting and design
  - Installation, limitations, and maintenance
  - Effectiveness
  - Costs
  - References for further information
What is a compost blanket?
- Loosely applied compost placed on soil in disturbed areas

Controls erosion and retains runoff resulting from sheet flow

Typically used in place of hydromulch, geotextiles, or drill-seeding with straw matting
Benefits of Compost Blankets

• Can be used on any soil surface
  • Rocky or frozen ground
  • Steep slopes (1:1)

• Seed mixed into compost before it is placed allows even seed distribution
• Compost retains water, which helps seed germination
• Compost provides soil nutrients and aids in plant growth
• Blanket can be blown onto surface, so equipment and workers do not need to access slope
Construction of an addition disturbed a slope adjacent to a church.

A compost blanket was installed to stabilize and revegetate the slope.

Netting provided additional slope stabilization before the seeded compost blanket was installed.

Filtrexx products installed:
- Lockdown netting
- EcoBlanket
Effectiveness of Compost Blankets

- Study conducted by Iowa State University for Iowa DOT
- Study compared:
  - Direct seeding into embankment topsoil
  - Imported topsoil/seeding of embankment Compost blankets also suppressed weed growth
  - Seeded compost blanket
    - Erosion rate from blanket area was 0.02 percent that of the topsoil areas
    - Compost blankets also suppressed weed growth
Compost Filter Berms

• What is a compost filter berm?
  • A dike of compost placed perpendicular to sheet flow runoff in a disturbed area
• Controls erosion, retains sediment, and adsorbs pollutants
  • Use in concentrated flow conditions if drainage area is small
• Replaces traditional BMPs such as straw waddles and silt fence
Benefits of Compost Filter Berms

• Can be used on rocky or frozen ground
• Does not require trenching for installation
• Low profile is not blown down by high winds
• Seed mixed into compost before placement allows even seed distribution
• Compost retains water, which helps seeds germinate and anchor berm to soil surface
• Berm has higher permeability than silt fence, allowing more clean water to pass through
Example Sediment Control in Road Ditch

- Texas DOT installed a compost filter berm and a silt fence to compare their effectiveness in removing sediment.

- Stormwater is backed up behind silt fence.

- Clean stormwater passed through filter berm; sediment retained on upstream side.

Compost filter berm, US HWY 281 (Texas) on 1/30/2001

Silt fence, US HWY 281 (Texas) on 1/30/2001
Effectiveness of Compost Filter Berms

- Study conducted for Metropolitan Service District (Portland, Oregon)
- Tested yard debris compost for erosion control
- Compared silt fence and filter berms made of yard-debris compost
- Study results showed filter berm was:
  - 90 percent effective in removing suspended and settable solids, when compared to control plot
  - 66 percent more effective than silt fence in removing suspended and settable solids
Compost Filter Socks

• What is a compost filter sock?
  • A mesh tube filled with compost placed perpendicular to runoff

• Controls erosion, retains sediment, and adsorbs pollutants
  • Use to treat sheet flow runoff or concentrated runoff from small drainages

• Replaces traditional BMPs such as silt fence, rock berms, and straw waddles
Benefits of Compost Filter Socks

- Can be used on rocky or frozen ground or on paved areas; does not require trenching for installation
- Shorter socks can be removed and reused
- Low profile is not blown down by high winds
- Can be placed in many environments:
  - Steep slopes
  - Small drainageways
  - Storm drain inlet protection on pavement
  - Stacked to provide slope stability

- Higher permeability than silt fence, allowing more clean water to pass through
Examples—Texas DOT

- Silt caught by sock on slope
- Perimeter fencing
- Check dams
- Protection of concrete area
STORMWATER TREATMENT

DISCUSSIONS ON LID DEVELOPMENT BIOSWALES AND BIORETENTION

March 14, 2014
DISCUSSIONS ON LID DEVELOPMENT BIOSWALES AND BIORETENTION

March 14, 2014
Effectiveness of Compost Filter Socks

- Qualitative studies: filter socks are effective in removing settleable and total suspended solids
  - At least as effective as traditional BMPs, such as silt fence

- Quantitative study performed by Filtrexx International:
  - Laboratory test of filter socks with 13 types of compost
  - All filter socks removed over 50 percent of motor oil in simulated stormwater (1,000 to 10,000 mg/L)
  - Seven removed over 95 percent of motor oil
Need More Information?

• Full-length fact sheets for each BMP are available on EPA’s National Menu of Stormwater BMPs
  • http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm
  • At menu, type in name of BMP (compost blanket, compost filter berm, compost filter sock)

• Fact sheets provide many references and links to other sites with information about compost BMPs
• Chris Newman
  • US EPA Region 5
  • newman.christopherm@epa.gov
  • 312-353-8402
Plant Material for Bioretention

Mike Klaerich
Green Meadow Growers
# Bioswale Grass Ideas 2013

## Bio Swale Grasses Ideas 2013

<table>
<thead>
<tr>
<th>Bio Swale Grasses</th>
<th>California Native Grass</th>
<th>Evergreen</th>
<th>Time to cut back</th>
<th>Foliage Color</th>
<th>Snowy Flowers</th>
<th>Sun or Part Sun</th>
<th>Lawn Substitute / Meadow</th>
<th>Water Needs</th>
<th>Grass Forms</th>
<th>Erosion Control / Slopes</th>
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<tbody>
<tr>
<td>Bouteloua gracilis ‘Blond Ambition’</td>
<td>.</td>
<td>New Semi</td>
<td>Winter</td>
<td>Med.</td>
<td>Green</td>
<td>Yes</td>
<td>Sun</td>
<td>Yes</td>
<td>Low</td>
<td>Mound</td>
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<td>Bouteloua gracilis ‘Blue Grama Grass’</td>
<td>Yes</td>
<td>Semi</td>
<td>Winter</td>
<td>Med.</td>
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<td>Yes</td>
<td>Sun</td>
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<td>Mound</td>
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<td>Buchloe dactyloides 'UC Verde' Buffalograss</td>
<td>D</td>
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<td>Green</td>
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<td></td>
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<td>Spreading</td>
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<tr>
<td>Calamagrostis foliosa 'Leafy Reed Grass'</td>
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<td>D</td>
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<td>Yes</td>
<td>Sun</td>
<td>Med.</td>
<td>Mound</td>
<td></td>
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<td>Carex granularis 'Golden Fruited Sedge' aurea</td>
<td>.</td>
<td>Yes</td>
<td>E</td>
<td>Med.</td>
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<td>S&amp;P</td>
<td>High</td>
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<td>any</td>
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<td>Green</td>
<td>Sun</td>
<td>Yes</td>
<td>Low</td>
<td>Spreading</td>
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<tr>
<td>Carex pansa ‘California Meadow Sedge’</td>
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<td>E</td>
<td>any</td>
<td>Low</td>
<td>Green</td>
<td>Sun</td>
<td>Yes</td>
<td>Low</td>
<td>Spreading</td>
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<tr>
<td>Carex praegracilis ‘California Field Sedge’</td>
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<td>E</td>
<td>any</td>
<td>Low</td>
<td>Green</td>
<td>Sun</td>
<td>Yes</td>
<td>Low</td>
<td>Spreading</td>
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<tr>
<td>Carex (Divisa) tumuloca ‘Berkeley Sedge’</td>
<td>.</td>
<td>Yes</td>
<td>E</td>
<td>after/fwr</td>
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<td>S&amp;P</td>
<td>Yes</td>
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<td>Mound</td>
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<td>Carex spissa ‘San Diego Sedge’</td>
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<td>Chondropetalum tectorum ‘Small Cape Rush’</td>
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<td>Sun</td>
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<td>Deschampsia cespitosa ‘Tufted Hair Grass’</td>
<td>Yes</td>
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<td>Yes</td>
<td>S&amp;P</td>
<td>Yes</td>
<td>Low</td>
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<td>Distichlis spicata ‘Salt Grass’</td>
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<td>D</td>
<td>Med.</td>
<td>Blue</td>
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<td>S&amp;P</td>
<td>Low</td>
<td>Upright</td>
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<td>Dianella caerulea ‘Casa Blue’</td>
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<td>E</td>
<td>Low</td>
<td>Blue</td>
<td>Yes</td>
<td>S&amp;P</td>
<td>Low</td>
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<td>Dianella revoluta ‘Little Rev’</td>
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<td>S&amp;P</td>
<td>Low</td>
<td>Upright</td>
<td></td>
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</table>
## Bioswale Grass Ideas 2013

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Season</th>
<th>Maturity</th>
<th>Growth Form</th>
<th>Sunlight</th>
<th>Spreading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Festuca californica 'California Fescue'</td>
<td>Yes</td>
<td>E</td>
<td>Med</td>
<td>Blu/Green</td>
<td>Sun</td>
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<tr>
<td>Festuca idahoensis 'Siskiyou Blue'</td>
<td>Yes</td>
<td>E</td>
<td>Low</td>
<td>Blu</td>
<td>S&amp;P</td>
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<tr>
<td>Festuca mairei 'Maire’s or Atlas Fescue'</td>
<td>E</td>
<td>Fall</td>
<td>Med</td>
<td>Green</td>
<td>Yes</td>
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<tr>
<td>Festuca paniculata 'Meadow Fescue'</td>
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</tr>
<tr>
<td>Festuca rubra 'Creeping Red Fescue' no mow</td>
<td>Yes</td>
<td>E</td>
<td>Low</td>
<td>Green</td>
<td>S&amp;P</td>
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<tr>
<td>Festuca rubra 'Molate Creeping Red Fescue'</td>
<td>Yes</td>
<td>E</td>
<td>Med</td>
<td>Green</td>
<td>S&amp;P</td>
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<tr>
<td>Juncus acutus 'Spiny Rush'</td>
<td>Yes</td>
<td>E</td>
<td>Tall</td>
<td>Green</td>
<td>Sun</td>
</tr>
<tr>
<td>Juncus effusus 'Quartz Creek' Rush</td>
<td>Yes</td>
<td>E</td>
<td>Med</td>
<td>Green</td>
<td>S&amp;P</td>
</tr>
<tr>
<td>Juncus inflexus 'Blue Arrows'</td>
<td>Yes</td>
<td>E</td>
<td>Med</td>
<td>Blue</td>
<td>S&amp;P</td>
</tr>
<tr>
<td>Juncus patens 'Elk Blue' compact</td>
<td>Yes</td>
<td>E</td>
<td>Med</td>
<td>Blue</td>
<td>S&amp;P</td>
</tr>
<tr>
<td>Leycesteria formosa 'Golden Lanterns'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juncus patens 'Will Fleming'</td>
<td>Yes</td>
<td>E</td>
<td>Med</td>
<td>Gray</td>
<td>S&amp;P</td>
</tr>
<tr>
<td>Leymus (Elymus) arenarius 'Findhorn Wild Rye' compact</td>
<td>Semi Winter</td>
<td>Low</td>
<td>Blu</td>
<td>Yes</td>
<td>Sun</td>
</tr>
<tr>
<td>Leymus condensatus 'Canyon Prince'</td>
<td>Yes</td>
<td>E</td>
<td>Tall</td>
<td>Blu/Green</td>
<td>Yes</td>
</tr>
<tr>
<td>Leymus triticoides 'Creeping Wild Rye'</td>
<td>Yes</td>
<td>E E</td>
<td>Med</td>
<td>Green</td>
<td>Sun</td>
</tr>
<tr>
<td>Lomandra hystrix 'Katie Belles'</td>
<td>E E</td>
<td>Med</td>
<td>Green</td>
<td>Yes</td>
<td>S&amp;P</td>
</tr>
<tr>
<td>Lomandra longifolia 'The Breeze'</td>
<td>E</td>
<td>Med</td>
<td>Green</td>
<td>S&amp;P</td>
<td>Low</td>
</tr>
<tr>
<td>Lomandra longifolia 'Tropic Belle'</td>
<td>D D</td>
<td>Med</td>
<td>Green</td>
<td>S&amp;P</td>
<td>Low</td>
</tr>
<tr>
<td>Lygeum spartenum 'Esparto Grass'</td>
<td>D D</td>
<td>Med</td>
<td>Gray</td>
<td>Yes</td>
<td>S&amp;P</td>
</tr>
<tr>
<td>Muhlenbergia capillaris 'Pink Muhly Grass'</td>
<td>D</td>
<td>Winter</td>
<td>Med</td>
<td>Green</td>
<td>Yes</td>
</tr>
<tr>
<td>Muhlenbergia dubia 'Pine Muhly Grass'</td>
<td>D E</td>
<td>Winter</td>
<td>Med</td>
<td>Green</td>
<td>Yes</td>
</tr>
<tr>
<td>Muhlenbergia 'Lindheimer Muhley Grass'</td>
<td>Winter</td>
<td>Tall</td>
<td>Gray</td>
<td>Yes</td>
<td>Sun</td>
</tr>
<tr>
<td>Muhlenbergia rigens 'Deer Grass'</td>
<td>Yes</td>
<td>Winter</td>
<td>Tall</td>
<td>Green</td>
<td>Yes</td>
</tr>
<tr>
<td>Nassella pulchra 'Purple Needle Grass'</td>
<td>Yes</td>
<td>Fall</td>
<td>Med</td>
<td>Green</td>
<td>Yes</td>
</tr>
<tr>
<td>Pennisetum orientale 'Oriental Fountain Grass'</td>
<td>Winter</td>
<td>Med</td>
<td>Green</td>
<td>Yes</td>
<td>Sun</td>
</tr>
<tr>
<td>Pennisetum 'Fairy Tails'</td>
<td></td>
<td>Med</td>
<td>Green</td>
<td>Yes</td>
<td>Sun</td>
</tr>
<tr>
<td>Pennisetum spathicladum 'Slender Velvdt Grass'</td>
<td>Semi</td>
<td>after</td>
<td>Low</td>
<td>Green</td>
<td>Yes</td>
</tr>
<tr>
<td>Scirpus cernus 'Fiber Optic Grass'</td>
<td>Yes</td>
<td>E</td>
<td>Low</td>
<td>Green</td>
<td>Sun</td>
</tr>
<tr>
<td>Sesleria autumnalis 'Autumn Moor Grass'</td>
<td>E</td>
<td>Med</td>
<td>Green</td>
<td>Little</td>
<td>Sun</td>
</tr>
<tr>
<td>Sesleria hybrid 'John Greennee'</td>
<td>E</td>
<td>Low</td>
<td>Blu/Green</td>
<td>Yes</td>
<td>Sun</td>
</tr>
<tr>
<td>Sisyrinchium bellum 'Blue Eyed Grass'</td>
<td>Yes</td>
<td>D</td>
<td>Fall</td>
<td>Low</td>
<td>Blu/Green</td>
</tr>
</tbody>
</table>
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Chris Cutler
Steve Smith Landscape, Inc.
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Replacement Naval Hospital Camp Pendleton
Replacement Naval Hospital Camp Pendleton
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