LID: A Sensible Approach to Design, Construction and Maintenance
Integrated Design Impacts Triple Bottom Line

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Green Infrastructure Specialists
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Business Unit Synergies

SWPPP
Post Construction Turnkey Compliance
Consulting
Inspections
Documentation & Permitting
BMP Installation & Maintenance
All Final Preciasco 10K Certified Enforcements
Advanced BMPs

SWQMP
Post Construction Turnkey Compliance
Consulting
Permitting
Documentation
PE Certification
BMP & Pond Maintenance
Enforcement Mediation
Inspections
Mowing

CES CLIENTS
General Contractors
Architects
Civil Engineers
Property Owners
Property Managers
Landscape Architects
Municipalities
Counties

SYSTEMS
Advanced Infrastructure Technologies & Pavement Solutions
LID Systems
Green Infrastructure
Routing & Detention
Inlet & End-of-Pipe Treatment
Hydraulic Erosion Control Blankets
Agronomic Prescriptives
Green Armor
ACE Fiber
Current Situation

- Polluted Outfalls
  - Property development leads to increased runoff.

- Urban Flooding
- Severe Erosion

- Roman design completely seals the soil surface.
  - Even the inlets are the same!

- Designed to collect and remove storm water as quickly as possible.
Current Situation

Resolution: Reduce, slow or eliminate runoff by using Ponds
- Unattractive
- Waste of valuable real estate
- Contributes to sprawl
- Liability due to potential accidents
- West Nile concerns

Why Multifunctional Design?
- Increases productive use of the land
- Improves aesthetics
- Lowers up front costs
- Improves water quality
- Reduces flooding
- Allows for creativity/thought/engineering

Adapting what would typically be a singular solution to solve a multitude of problems

What is LID?
A land planning and engineering design approach that:
- Attempts to match pre-development hydrology
- Mimics natural processes
- Manages runoff as close to the source as possible
- Manages stormwater on-site through small, distributed and connected practices
- Values stormwater as a resource instead of treating it as a waste product
- Addresses stormwater quality and quantity

Focus on quantity = Impact on quality
The Future is Multifunctional Systems

- Systems as opposed to “products”
- Solve multiple problems with single solution
  - Pavements
  - Landscapes
  - Rooftops
  - Hardscapes
- Aesthetically appealing water management

WHAT IF THE STORMWATER INDUSTRY THINKS MORE LIKE THE TECHNOLOGY INDUSTRY?
Start With the End in Mind

Mimic Predevelopment Hydrology

Think Maintenance First
Maintenance

Maintenance has to be Simple

Maintenance has to be Simple

Maintenance has to be Simple

Maintenance has to be Simple
Maintenance has to be Simple

Maintenance has to be Cost Effective
Surface Detention

Hard Costs
- 7 Acres @ .65 ACFT/AC = 198,000 CF
- 198,000 CF @ $.50 CF (Excavation & Haul off) = $99,000
- 5,000 SY ESC @ $1.00SY = $5,000
Total Hard Cost = $104,000 ($53 CF) + Maintenance + Regrade

Opportunity Costs
- 198,000 CF Pond @ 6' Deep = 38,000 SF (.87 acres)
- 38,000 SF = 2 Buildings or 48 Additional Units
- 48 Units @ $1,000 each = $48,000 Month/Revenue
- $48,000 month x 12 months = $576,000
- $576,000 years x 10 years = $5,760,000
Low Impact Development

- Biofiltration
- Permeable pavement (parking)
- Underground storage
- Bioswales

Mimic Predevelopment Hydrology

[Graph showing hydrological data]

5/25/2017
Low Impact Development

Hard Costs
- 7 Acres @ .35 ACFT/AC = 106,000 CF

Integrated Design Approach
- 43,560 SF Porous Pavers @ $12 SF = $522,720 (- $217,800) = $304,920
- 21,000 CF UG Detention / Drainage @ $6 = $126,000 (- $50,000) = $76,000
- 600 SF Biofiltration System @ $100 SF = $60,000
- 50,000 CF @ $.50 CF (Bioswale Excavation & Haul off) = $25,000
- 2,500 SY Sod @ $1.30 SY = $3,250
Total Cost = $469,170

Opportunity Seized – ROI = 10 Months

Queenston Manor Apartments

Typical Design in San Antonio
The Multifunctional Tool-Box

- Pavements
- Landscapes
- Rooftops
- Detention Systems

Multifunctional Pavements

THE PAVEDRAIN® SYSTEM SERVES THREE PURPOSES:
It Paves, It Drains AND It Stores!

What is PaveDrain?

THE PAVEDRAIN® SYSTEM SERVES THREE PURPOSES:
It Paves, It Drains AND It Stores!

Individual Block
- 12" x 12" x 5.65"

Assembled Mattress
- 7' x 17.5' (Typical)
- 7' x 36' (Largest)

Polyester Cable
Aluminum Crimps

It's a new and improved paving system
<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
<th>Labor</th>
<th>Installed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTank Required (Volume + Plastic)</td>
<td>63,197</td>
<td>CF</td>
<td>$      5.25</td>
<td>$0.75</td>
<td>$6.00</td>
<td>$379,182.00</td>
</tr>
<tr>
<td>Geosynthetic Fabric</td>
<td>5</td>
<td>Rolls</td>
<td>$600.00</td>
<td>$50.00</td>
<td>$650.00</td>
<td>$3,250.00</td>
</tr>
<tr>
<td>Geogrid</td>
<td>5</td>
<td>Rolls</td>
<td>$500.00</td>
<td>$50.00</td>
<td>$550.00</td>
<td>$2,750.00</td>
</tr>
<tr>
<td>Freight to Jobsite</td>
<td>63,197</td>
<td>CF</td>
<td>$0.38</td>
<td></td>
<td>$0.38</td>
<td>$23,698.88</td>
</tr>
<tr>
<td>Excavation &amp; Haul-Off</td>
<td>2,998</td>
<td>CY</td>
<td>$10.00</td>
<td></td>
<td>$10.00</td>
<td>$29,980.00</td>
</tr>
<tr>
<td>Backfill [soil]</td>
<td>658</td>
<td>CY</td>
<td>$20.00</td>
<td>$9.50</td>
<td>$29.50</td>
<td>$19,411.00</td>
</tr>
<tr>
<td>Inlet Protection (Fremontation)</td>
<td>8</td>
<td>Units</td>
<td>$350.00</td>
<td>$100.00</td>
<td>$450.00</td>
<td>$3,600.00</td>
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<tr>
<td>Concrete Parking Stalls</td>
<td>23,927</td>
<td>SF</td>
<td>$5.00</td>
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<td>$5.00</td>
<td>$119,635.00</td>
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</tbody>
</table>

**Total** $581,506.88

**Price Per CF** $7.31
## Economics of PaveDrain

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
<th>Labor</th>
<th>Installed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel Required</td>
<td>3,470</td>
<td>Tons</td>
<td>$28.00</td>
<td>$0.50</td>
<td>$17.50</td>
<td>$37.50</td>
</tr>
<tr>
<td>Pavers Required (Tread Placed / Grey)</td>
<td>23,927</td>
<td>SF</td>
<td>$6.50</td>
<td>$0.50</td>
<td>$7.00</td>
<td>$167,890.00</td>
</tr>
<tr>
<td>End Caps</td>
<td>2,700</td>
<td>LF</td>
<td>$6.00</td>
<td>$0.25</td>
<td>$6.25</td>
<td>$18,495.00</td>
</tr>
<tr>
<td>Freight to job site</td>
<td>20.10</td>
<td>Trucks</td>
<td>$300.00</td>
<td>$300.00</td>
<td>$600.00</td>
<td></td>
</tr>
<tr>
<td>Excavation &amp; Seal-Off</td>
<td>2,921</td>
<td>CY</td>
<td>$10.00</td>
<td>$10.00</td>
<td>$20.00</td>
<td>$29,213.74</td>
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<tr>
<td>Geotextile (Subgrade)</td>
<td>3</td>
<td>Rolls</td>
<td>$400.00</td>
<td>$50.00</td>
<td>$450.00</td>
<td>$1,350.00</td>
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<tr>
<td>12” Perforated Pipe</td>
<td>2,700</td>
<td>LF</td>
<td>$8.00</td>
<td>$2.00</td>
<td>$10.00</td>
<td>$27,000.00</td>
</tr>
<tr>
<td>Protective Geotextile (SWPPP)</td>
<td>2</td>
<td>Rolls</td>
<td>$500.00</td>
<td>$500.00</td>
<td>$1,000.00</td>
<td></td>
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</tbody>
</table>

**Total**                          |          |        |       |        |           | **$383,702.49** |
**Total SF**                       |          |        |       |        |           | **16.04** |
**Total CF**                       |          |        |       |        |           | **13.21** |
The Future is Multifunctional

- Pavements
- Landscapes
- Rooftops
- Detention Systems

Multifunctional Landscapes

The System Is More Valuable Than The Sum of Its Parts

FocalPoint’s Value is Limited Without It’s Process
Types of Bioretention

- < 10” Per Hour
- 30” – 60” Per Hour
- 100” – 200” Per Hour

Design + Costs of Design Strategies

<table>
<thead>
<tr>
<th>Infiltration Rate</th>
<th>Typical Media</th>
<th>SARA Media</th>
<th>High Flow Media FocalPoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5&quot;</td>
<td>6&quot;</td>
<td>50&quot;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SF/Acre Treated</th>
<th>Typical Media</th>
<th>SARA Media</th>
<th>High Flow Media FocalPoint</th>
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<tbody>
<tr>
<td>2030</td>
<td>870</td>
<td>134</td>
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</table>

<table>
<thead>
<tr>
<th>Install Costs</th>
<th>Typical Media</th>
<th>SARA Media</th>
<th>High Flow Media FocalPoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>$30/SF</td>
<td>$30/SF</td>
<td>$125</td>
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</table>

<table>
<thead>
<tr>
<th>Total Cost</th>
<th>Typical Media</th>
<th>SARA Media</th>
<th>High Flow Media FocalPoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>$62,700</td>
<td>$26,100</td>
<td>$16,750</td>
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</table>

Specification-Driven Performance

<table>
<thead>
<tr>
<th>Aggregate Characteristics (TYPICAL)</th>
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<tbody>
<tr>
<td>Combined Silt &amp; Clay</td>
</tr>
<tr>
<td>Sand – Fine</td>
</tr>
<tr>
<td>- &lt;5%</td>
</tr>
<tr>
<td>Sand – Medium</td>
</tr>
<tr>
<td>- 2% to 20%</td>
</tr>
<tr>
<td>Sand – Coarse</td>
</tr>
<tr>
<td>- 5% to 35%</td>
</tr>
<tr>
<td>Sand – Very Coarse</td>
</tr>
<tr>
<td>- 10% to 55%</td>
</tr>
<tr>
<td>Gravel</td>
</tr>
<tr>
<td>- 10% to 70%</td>
</tr>
<tr>
<td>Organic</td>
</tr>
<tr>
<td>- 5% to 30%</td>
</tr>
</tbody>
</table>

* Organic Specification
Listed by Organic Materials Review Institute

100% natural peat (no composted, sludge, yard or leaf waste)

<table>
<thead>
<tr>
<th>% passing 2.0 mm sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% to 100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% passing 1.0 mm sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;80%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;85%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carbon to Nitrogen Ratio</th>
</tr>
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<tbody>
<tr>
<td>15:1 to 23:1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Lignin Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>49% to 52%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Humic Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;18%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0 to 7.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>30% to 50%</td>
</tr>
</tbody>
</table>
Process – Engineered Media

90% Sand / 10% Peat
Sourced Locally

Process – Bridging Stone

Economies of Scale

VOLUME IS THE SAME

OUTFALL FLOW IS SAME
Keys to Success

- Verify maintainability
- Design with an emergency overflow
- Protect the system(s) during construction
- Push for turn-key installation
- Require performance certification in the specifications
- Always require maintenance

Questions?

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