LID at Wetland Studies and Solutions, Inc.

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Natural & Cultural Resource consulting firm

75 Staff:

- Archeology;
- Engineering;
- Environmental Science & Ecology;
- Environmental Technology;
- Compliance;
- GIS;
- Regulatory;
- Surveying;
- Wildlife Biology

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The Basics of LID at WSSI

- **Conservation and protection** of natural features that provide stormwater control.
- **Minimization** of impervious areas and impacts to natural areas.
- **Direction of runoff** to natural areas to slow down and capture water so it can infiltrate natural areas, evaporate, or be reused.
- Use of **multiple small-scale controls** that reproduce natural hydrologic processes including infiltration, detention, retention, evaporation, and groundwater recharge.
- **Pollution prevention** through erosion and sediment control and prevention of soil compaction during site preparation and construction.
- **Education** regarding the importance, implementation, and maintenance of low-impact stormwater management techniques.

Why Did Wetland Studies Implement LID?

- WSSI's building is serviced by an existing regional pond
  - No on-site stormwater management is required
- Why Implement LID?
  - Mimic predevelopment hydrology, minimizing Urban Stream Syndrome
  - Satisfy our curiosity:
    - To see how different types of pervious pavement systems perform relative to their cost
    - To determine the actual maintenance requirements of an LID project
    - To determine the *real* cost of an LID project
    - To determine the barriers to LID implementation
  - Provide a laboratory for the study of LID performance
  - Create an integrated LID plan, rather than using a slapdash approach to LID

How Can LID Help?

- **Reduce both runoff and potable water demand** by using rainwater on-site in toilets and irrigation.
- **Reduce the post-development curve number** to the pre-development curve number by using permeable paving surfaces.
- **Minimize the effect of increased runoff volume on downstream waters** by reducing the post-developed runoff rate below the pre-developed, forested rate through increased storage and time of concentration.
- **Comply with Chesapeake Bay Preservation Ordinance and stormwater management ordinance regulations** without a conventional stormwater management/BMP facility.

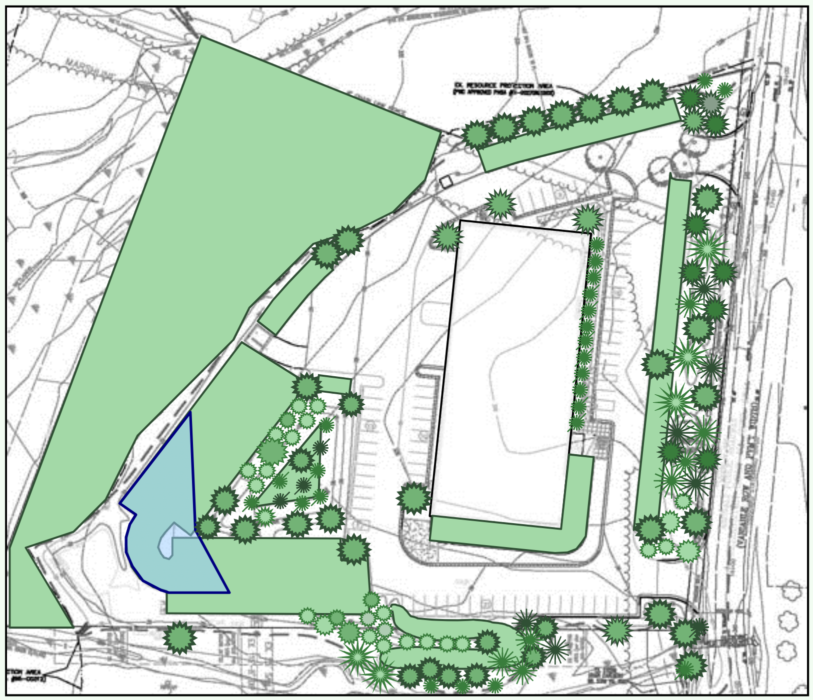
Implementation at WSSI


Green Roof


Naturalistic Landscape


Pervious Parking


Irrigation and Toilet Cisterns



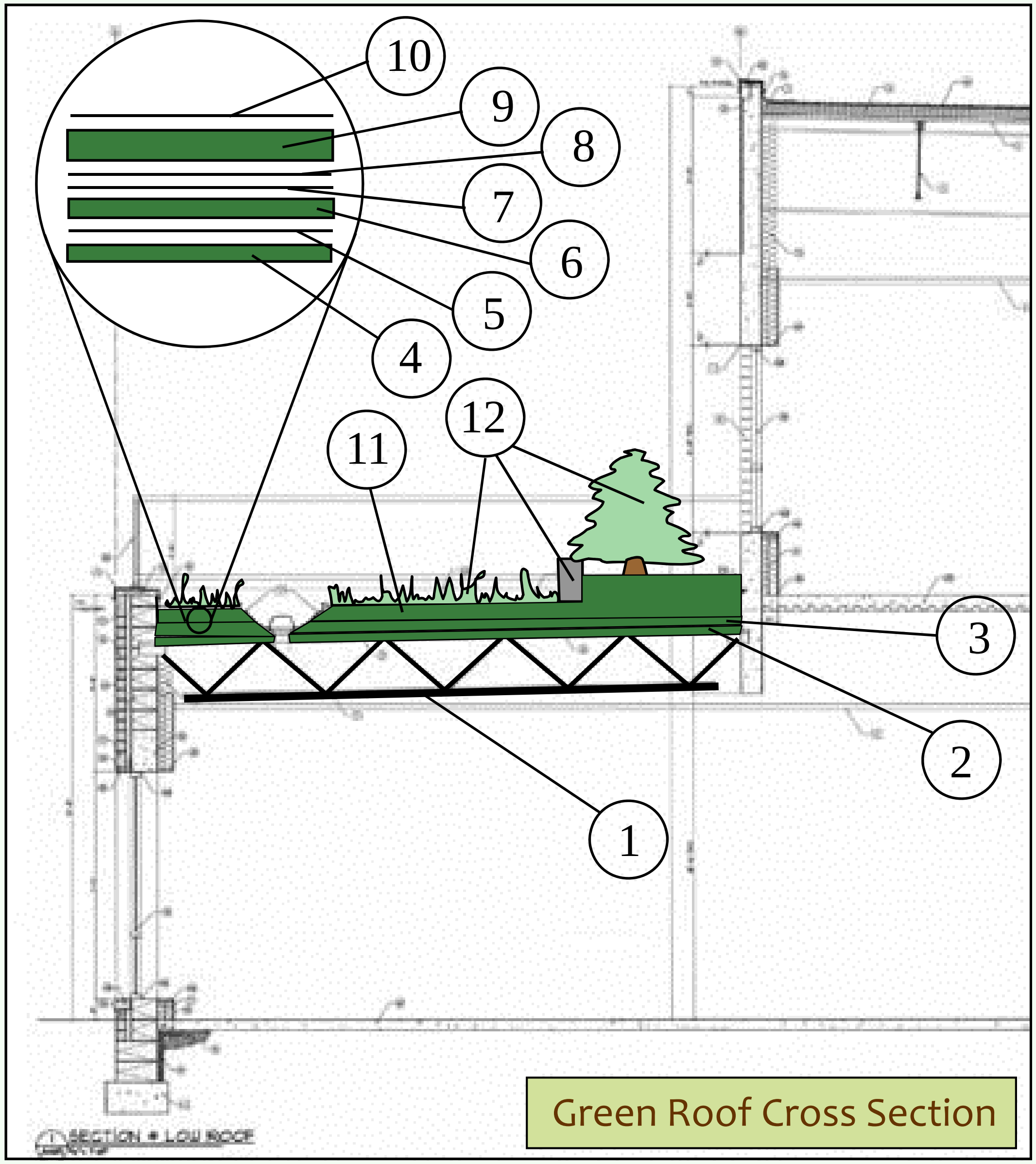

Gravel Detention


Rain Garden


Water Quality Swale

The Green Roof

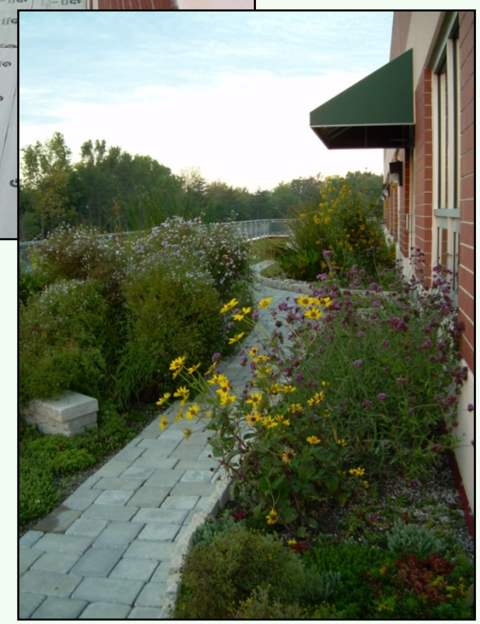
1. Steel joists
2. Metal roof deck
3. 5” R-30 foam insulation
4. ½” gypsum protection board
5. 75 mil ethylene propylene diene monomer (EPDM) membrane
6. ½” foam protection board
7. 40 mil high-density polyethylene (HDPE) root barrier
8. Protection fabric
9. 1” drainage layer
10. Filter fabric
11. 3-9” lightweight growing medium
12. Stone features, sedum, and native perennials and shrubs



Green Roof Cross Section

The Green Roof

- Combination of extensive (3-4” soil) and intensive (4-9” soil) planting areas
- Reduces impervious area by 3,626 sf
- Reduces roof runoff
- Engineered to support 62 lbs/sf
- Increases green area and provides amenity
- Cost: $31.80/sf installed

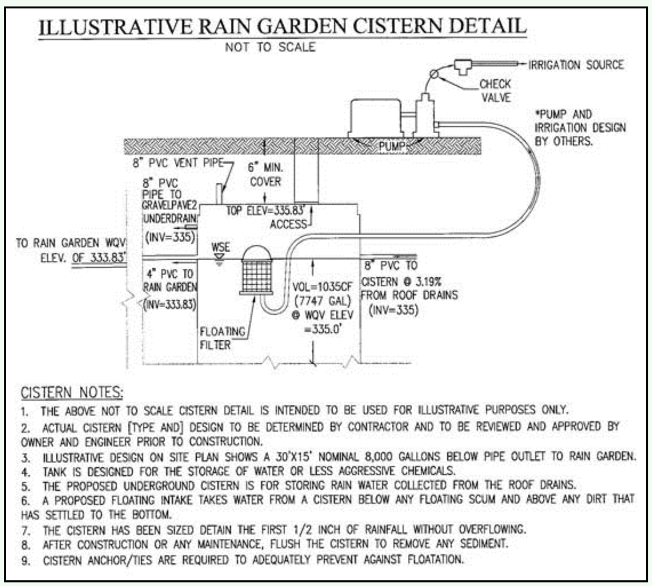


8,000 Gallon Irrigation Cistern

- Collects the "first flush" of roof runoff (1/2" from entire of the roof)
- Provides irrigation water
- Overflows to rain garden and gravel bed detention
- Cost: $3.88/gal installed

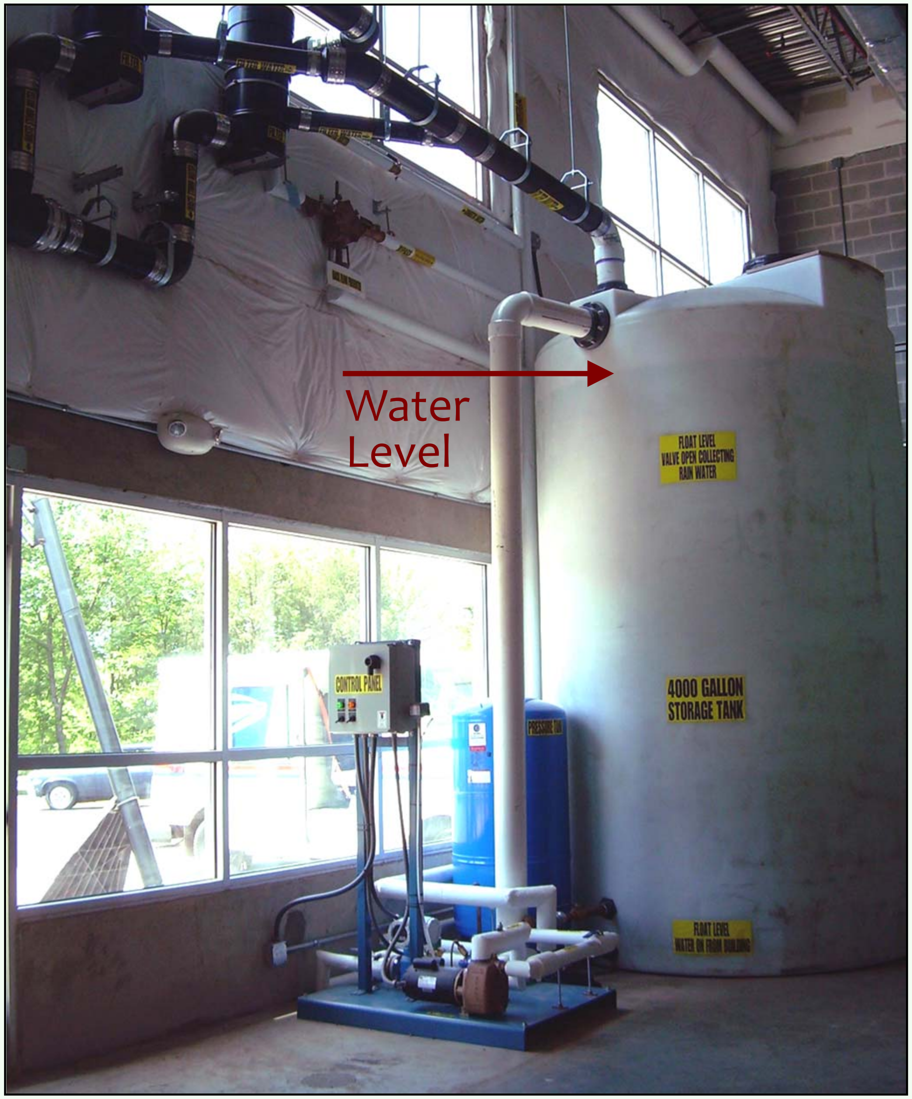
  $1.23/ sf impervious area treated

  (Cistern material only cost: $2.88/gal)



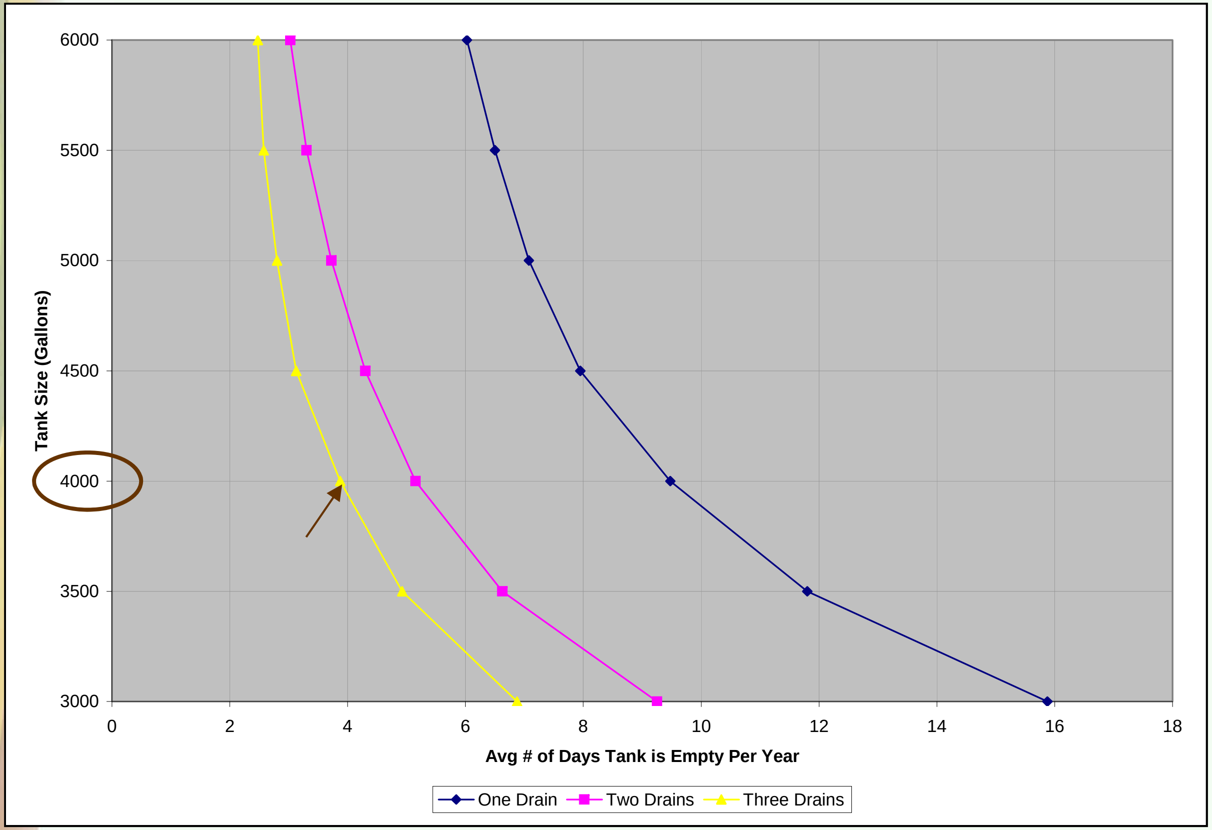
4,000 Gallon Toilet Cistern

- Collects runoff from 3 of the roof's 5 downspouts
- Collects the "first flush" of roof runoff (0.5" from ½ roof or approximately 4,000 gal.)
- Cost: $26.18/gal installed
  (Cistern: $4,430)
  (Pump/filters/valves/pipes: $45,425)
  (Labor: $48,378)
  (Design: $8,620)
  (Permit: $660)
- $7.85/ sf impervious area treated
- Cost would have been substantially lower if the system had been installed during initial construction.
- Overflows to underground cistern



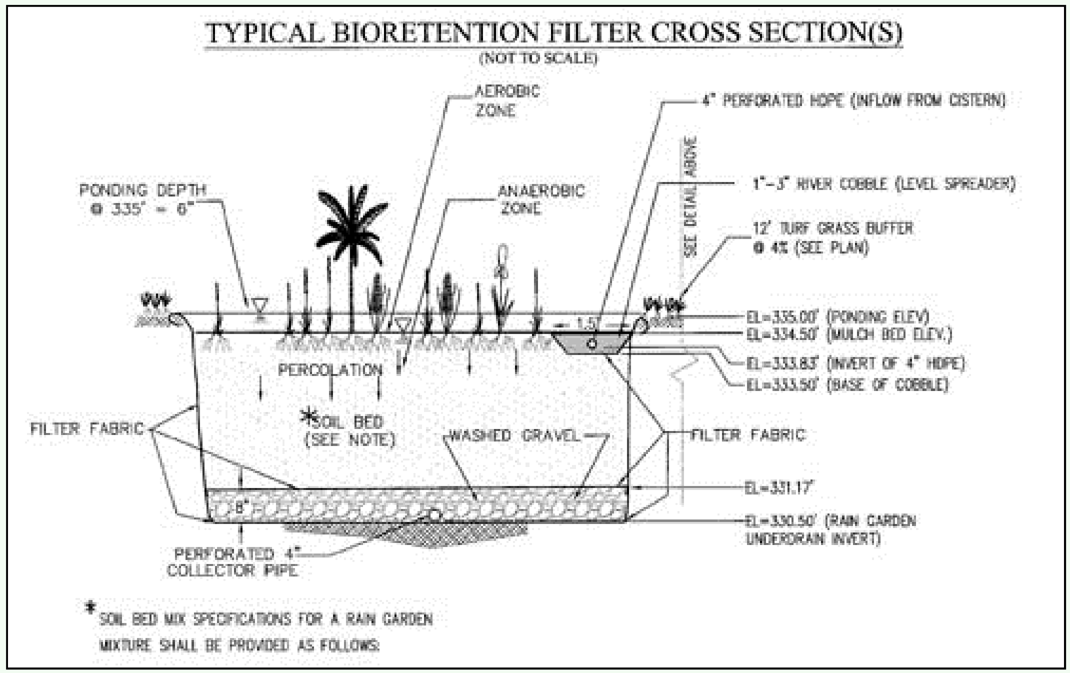
4,000 Gallon Toilet Cistern

- Design assumptions:
  - 75-people; 2 flushes per person, per day; 1.1 gal. per flush
  - Historic rain data from 1964-2006
- Calculated results:
  - Cistern will be empty approximately 4 days per year
  - Cistern did not go dry during 2009

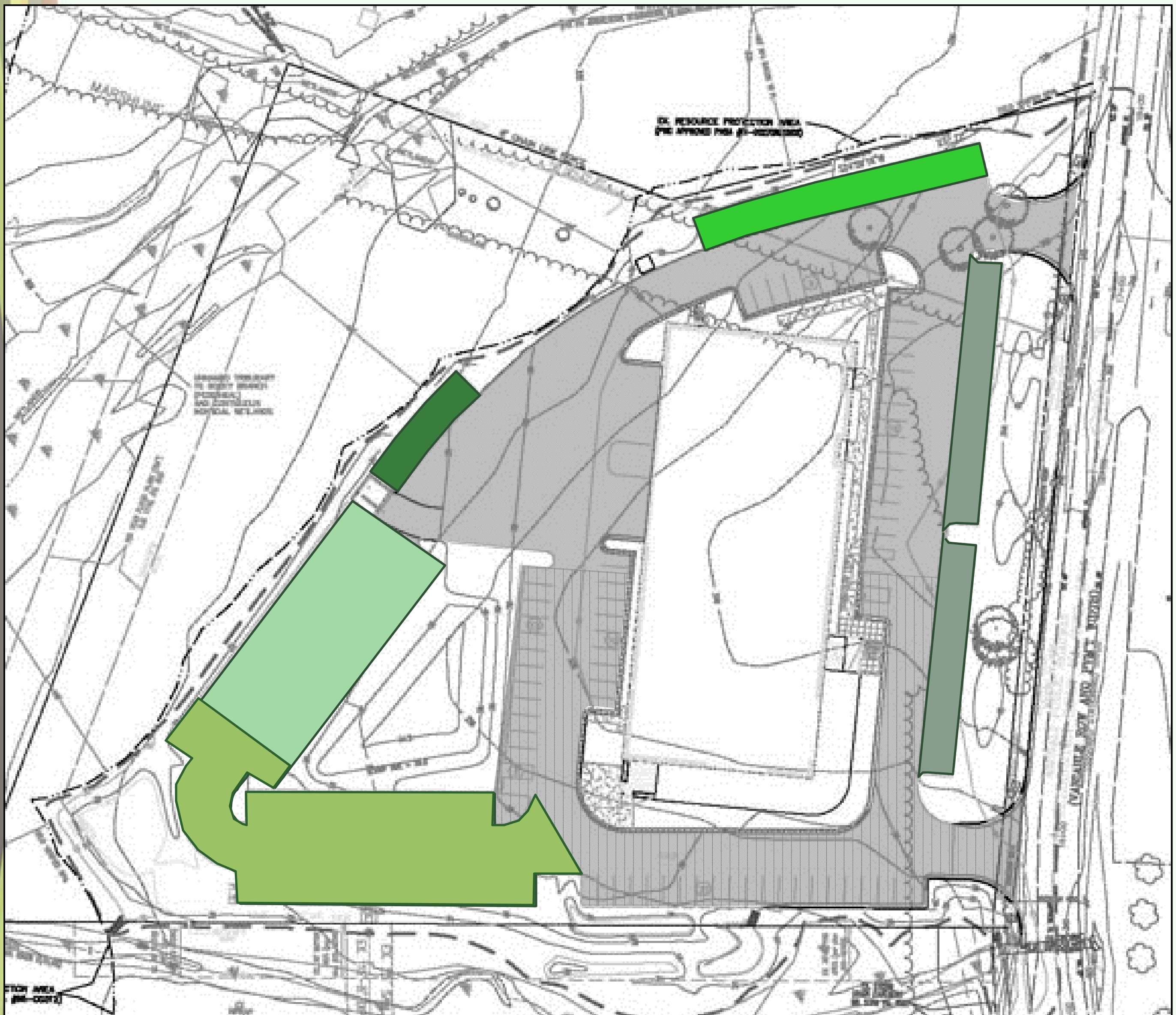


The Rain Garden

- Treats 34,660 sf of impervious roof and parking lot area
- 1,536 sf bed; 11,693 sf grassed buffer
- Drains to gravel bed detention
- Cost: $2.60 /sf impervious area treated



Pervious Parking



Pervious Concrete
11,800 sf

Porous Asphalt
8,120 sf

Gravel Paving
1,275 sf

GravelPave2
3,280 sf

Concrete Pavers
5,502 sf

Asphalt
55,896 sf

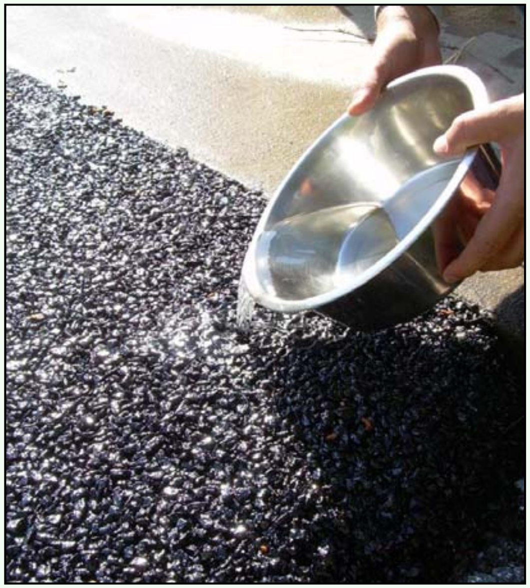
Pervious Concrete

- Reduce impervious area by 11,800 sf. (13.7% of total parking area)
- Drains to gravel bed detention
- Approximate cost: $6.00/sf installed

  (Asphalt cost (2005): $2.56/sf)

Porous Asphalt

- Reduce impervious area by 8,120 sf. (9.4% of total parking area)
- Drains to gravel bed detention
- Approximate cost (2010): $6.73/sf installed (Asphalt cost (2005): $2.56/sf)



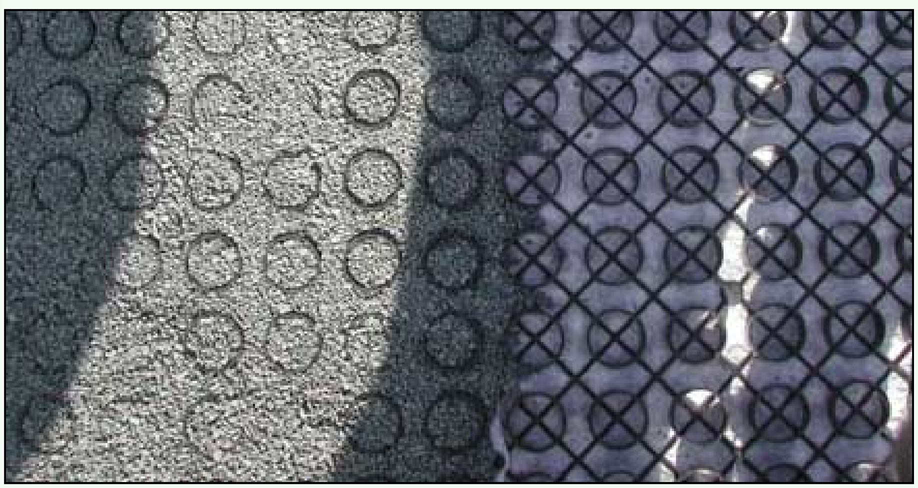
GravelPave2 and Gravel Parking

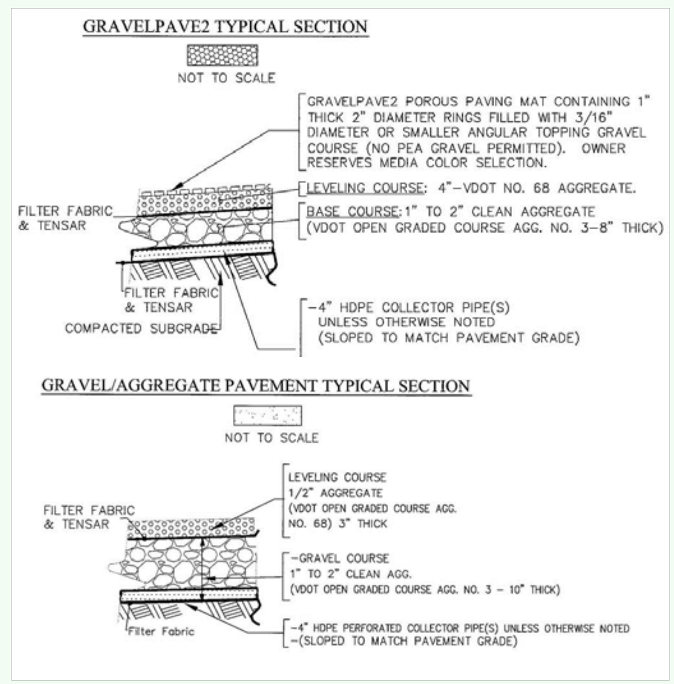
- Reduce impervious area by 4,555 sf (5.3% of total parking area)
- Drains to gravel bed detention or existing vegetated floodplain
- GravelPave2 cost: $6.00/sf installed

  Gravel paving cost: $4.32/sf installed

  (Asphalt cost (2005): $2.56/sf)

  (GravelPave2 materials only cost: $3.20/sf)



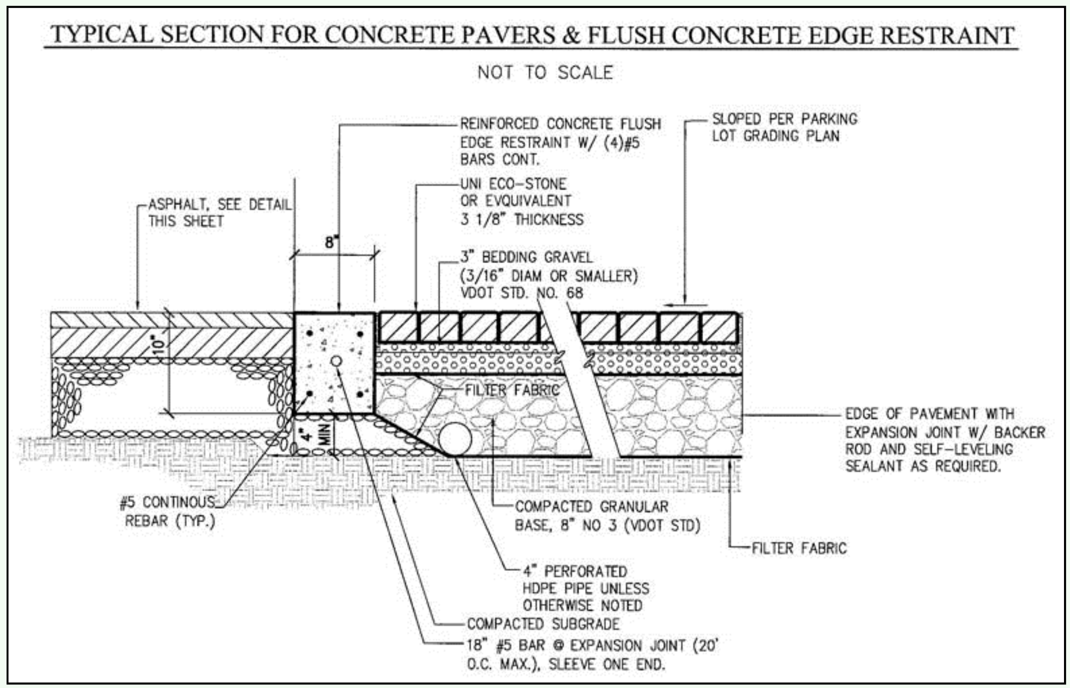


Concrete Pavers

- Reduce impervious area by 5,502 sf. (6.4% of total parking area)
- Drains to existing vegetated floodplain
- Cost: $7.10/sf installed + $0.80/sf header curb

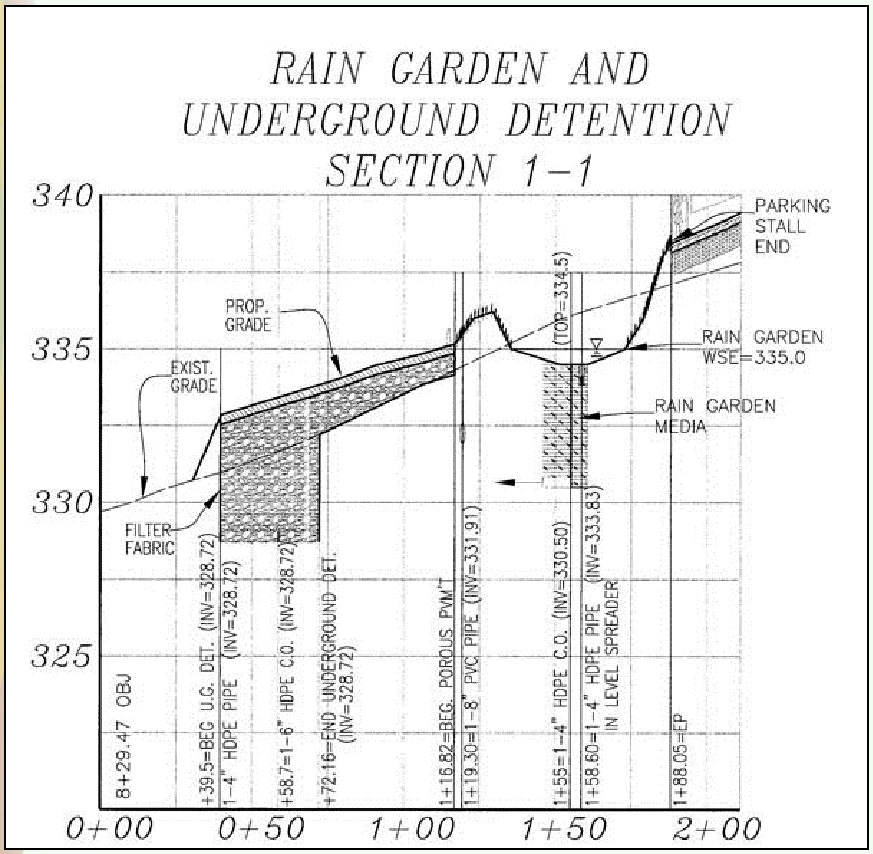
  (Asphalt cost (2005): $2.56/sf)

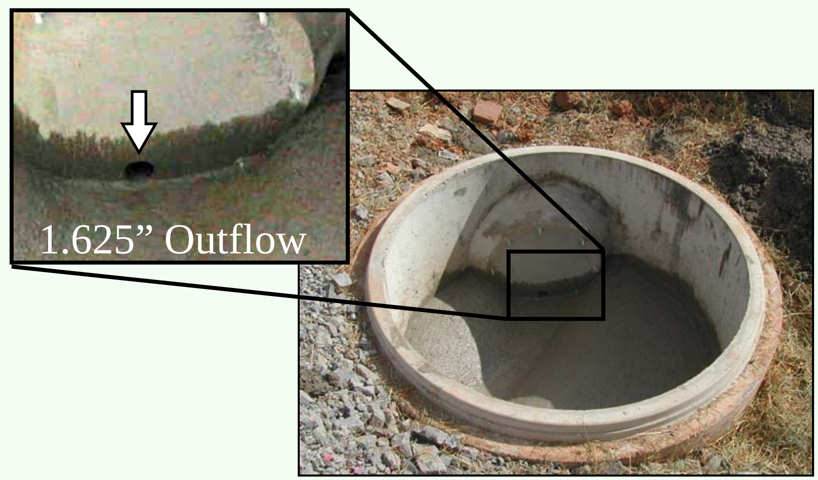
  (Paver material only cost: $2.55/sf)



Gravel Bed Detention

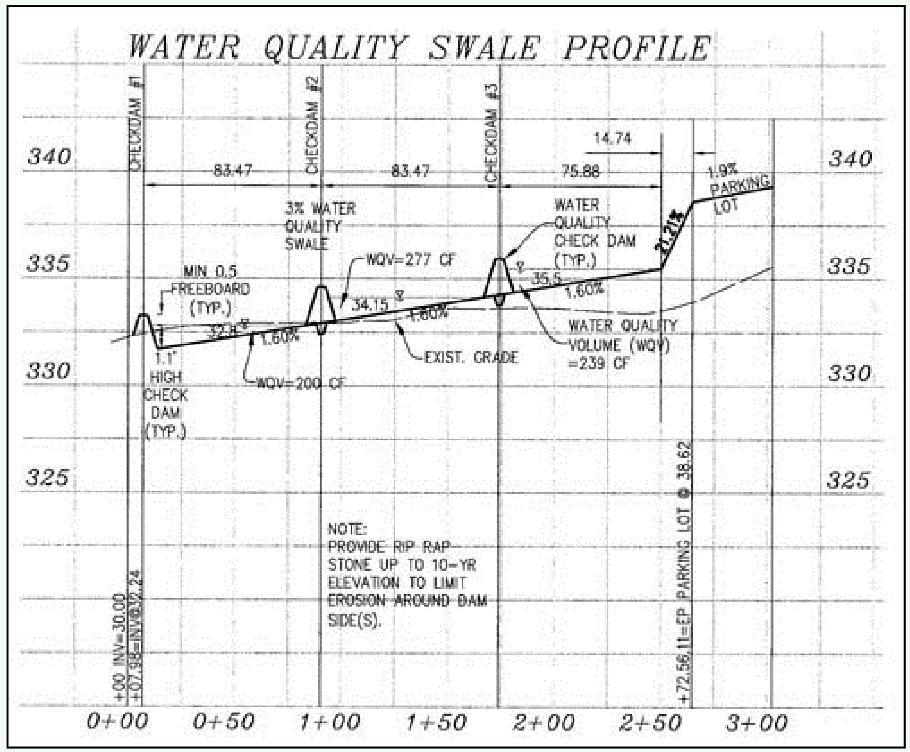
- Orifice controlled- drains to existing stream
- Detains the 1-yr storm over 24 hours.
- Cost: $2.28/cf treatment volume installed
  $0.32/sf impervious area treated





Water Quality Swale

- Collects runoff from 12,650 sf of impervious parking surfaces
- Slows runoff
- Water quality volume filters through check dams
- Cost: $3.68/sf impervious area treated



Naturalistic Landscaping

- Maintains habitat
- Decreases water consumption
- Uses a drip irrigation system and captured rainwater
- Landscape and drip irrigation cost: $125,864

  (Typical landscape and irrigation cost: $80,000)

Modeled Site Performance

Total Phosphorus (TP) Load Reduction:

Pre-developed, forested TP load (based on the VRRM*)	0.11 lb/ac/yr
Post-development TP load without SWM (based on the VRRM*)	0.99 lb/ac/yr
Post-development TP load (based on the VRRM*)	**0.13 lb/ac/yr**

* Draft Virginia Runoff Reduction Method worksheet dated March 3, 2011

Volume Reduction:

Pre-developed, forested runoff volume (based on 1” rainfall)	922 cf
Post-development runoff volume without SWM (based on 1” rainfall)	7,625 cf
Post-development volume (based on 1” rainfall)	**1,607 cf**

Peak Runoff Reduction:

Pre-development runoff rate (based on 1.5-year storm)	9.42 cfs
Post-development runoff rate (based on 1.5-year storm)	**7.94 cfs**

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Actual Site Performance

Peak Runoff Rate Reduction:

Conventional site peak runoff rate (1.1” rainfall)	5.65 cfs
Pre-developed, forested runoff rate (1.1” rainfall)	0.36 cfs
Post-development runoff rate (1.1” rainfall)	**0.05 cfs**

Volume Reduction:

Total rainfall	7,900 cf
Conventional site volume	7,300 cf
Pre-developed, forested volume (modeled)	400 cf **
Post-development volume (measured)	**2,300 cf**

* Petrey, S., “Low Impact Development (LID) Case Study: Wetland Studies and Solutions, Inc. Headquarters, Gainesville, Virginia.” 2007

** The forested volume on this and the preceding slide do not agree because of modeling differences between the VRRM and TR-55

Energy Balance*: $Q_{developed} \leq \text{I.F.} \times Q_{pre\text{-}developed} \times RV_{pre\text{-}developed} / Rv_{developed}$

$\leq 0.8 \times 0.36 \text{ cfs} \times 400 \text{ cf} / 2{,}300 \text{ cf}$

$\leq 0.05 \text{ cfs}$

*Note that the 1.1” event is NOT equivalent to the 1-year, 24-hour storm. This example only shows the Energy Balance theory.

Site Cost Analysis

Item	**$/sf impervious**	**Cost**
Rain garden	$2.60	$90,000
Irrigation cistern (8,000-gal.)	$1.23	$31,000
Toilet cistern (4,000-gal.)	$7.85	$109,940
Green roof	$31.80	$115,316
Pervious concrete pavers	$7.90	$39,000
Gravel pavement	$4.32	$5,500
GravelPave2 system	$6.00	$143,500
Pervious concrete	$6.00	N/A
Porous Asphalt	$6.73	N/A
Gravel bed detention	$0.32	$24,000
Swale	$3.68	$46,525
Native landscaping and drip irrigation	N/A	$125,864
	Total	**$730,645**
Standard asphalt / curb-and-gutter estimate		$360,115

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Thanks to the WSSI Project Team

- **User** – Wetland Studies and Solutions, Inc.
- **Project Management** – The Peterson Companies
- **LID Concept Plan** – Wetland Studies and Solutions, Inc.
- **Civil Engineering** – Urban Engineering and Associates, Inc.
- **Architecture** – W.A. Brown & Associates, P.C.
- **Mechanical, Electrical, Plumbing** – Potomac Energy Group, Inc.
- **Interior Design** – Bartzen + Ball
- **Building Commissioning** – Advanced Building Performance, Inc.
- **General Contracting** – EEReed Construction, LP
- **Site Work** – S.W. Rodgers
- **Green Roof Installation** – The Furbish Company
- **Pervious Concrete** – Virginia Ready-Mixed Concrete Association
- **Toilet Cistern Design** – E.K. Fox & Associates, Ltd.
- **Photos** – Ron O. Blunt Photography

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Questions?

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