

Eric Konzelmann,  
CPESC, CPSWQ, NICET  
Assistant District Manager

Montgomery County Conservation District

## Post-Construction Stormwater BMPs

- ❖ **Very high rate of infiltrator failures and design issues!**
- ❖ **Must be working for permit termination.**
- ❖ **Developer/Contractor may remain responsible for long-term O&M!!**
- ❖ **Licensed Professional sign-off is required**  
**– yes, it states that the project meets 102**

# What if PCSM BMPs don't work?

**NPDES Permit Condition 1. h. - Reduction, Loss or Failure of BMP: “Upon reduction, loss, or failure of any BMP, the permittee and co-permittee shall take immediate action to restore, repair, or replace the BMP or provide an alternative method of treatment.**

**Are the outlet structures leaking?**

**Are the BMPs functioning as credited?**

# Could changes in soil be the biggest part of our stormwater problems?

- ▶ Compaction
- ▶ Lack of topsoil replacement depths
- ▶ Changes in root structures
- ▶ Changes in infiltration rates
- ▶ Inaccurate post-development curve numbers
- ▶ Lack of adequate seedbed preparation

Perhaps our biggest stormwater problem is soil related!

Roots cannot penetrate overly compacted soils - this is from an area of compost soil amendments



# Bulk Densities in Soil (study from NRCS)

## Bulk Density of Soils in New Jersey

Permeability Measurements of Sampled Layers within 20" of Soil Surface

Site	Bulk Density (g/cubic cm)	Permeability (in/hr)
Woods	1.42	15
Pasture	1.47	9.9
Single House	1.67	7.1
Subdivision Lawn	1.79	0.14
Garage Lawn	1.82	0.04
Cleared Woods	1.83	0.13
Subdivision Lawn 2	2.03	0.03
Athletic Field	1.95	0.01

Reference: Bulk Density for Concrete is 2.2 g/ cubic cm

# Rain Gardens

- Infiltration
- Under-drained?
- Plantings
- Soils
- Overflow structure & leaking concerns





03.13.2012



*Proactive Approach:*

*Used Sod*

*Watered Sod*

*Inlet tops and all joints must  
be sealed*

*Bio-Retention / Rain Gardens*

# ERNST Rain Garden Seed Mix – Year 1



**Is this what a new home buyer wants?**

**Companion crop for stabilization – Spring Oats w/Ernst  
Rain Garden Mix and plenty of straw mulch**



**Earthen spillway - No leaky pipes for an overflow.**



**Year 2 – Ernst Rain Garden Seed Mix  
(2-3 year grow-in period)**



**Year 3**



**Year 7 - Much of the original vegetation is gone, replaced by invasives (likely due to no seasonal mowing/maintenance).**



**Mulch stabilization with containerized plantings is probably best – Use Hardwood Bark Mulch, it doesn't float**



09/20/2013

**Seed mixes did not work in mulch**



**IMPORTANT – Cover the Soils!**



**Soils must be dry in order to restore!**

Soon to fail rain garden!

Eroded sediments will clog soil pores

Use stabilized inflows, not steep slopes

Don't specify mulch if using seed mix to establish slopes

Don't use the "sheet flow" excuse for not providing a stable inflow





**Combination of seed mix and plantings**

03.27.2012



Always armor forebay spillways!

03.27.2012



**Watertight joints**

**Soil mix is critical!**

06/13/2013

A photograph showing a person's hand holding a clump of dark, rich soil. The soil is being held over a patch of green grass. The background shows more soil and grass, suggesting an outdoor setting. The image is used to illustrate the importance of soil composition for planting.

## **Planting soils are extremely important!**

**1/3 - sand**

**1/3 – compost/peat mixture**

**1/3 - triple shredded hardwood bark mulch**

**Avoid loose or unspecified onsite soil allowances  
– could contain way too much clay!**



**Rain gardens can work in bad soils!**

06/10/2015

PVC riser with  
glued joints and  
trash guard

No underdrain to  
void volume  
credits!





**This one has an underdrain**

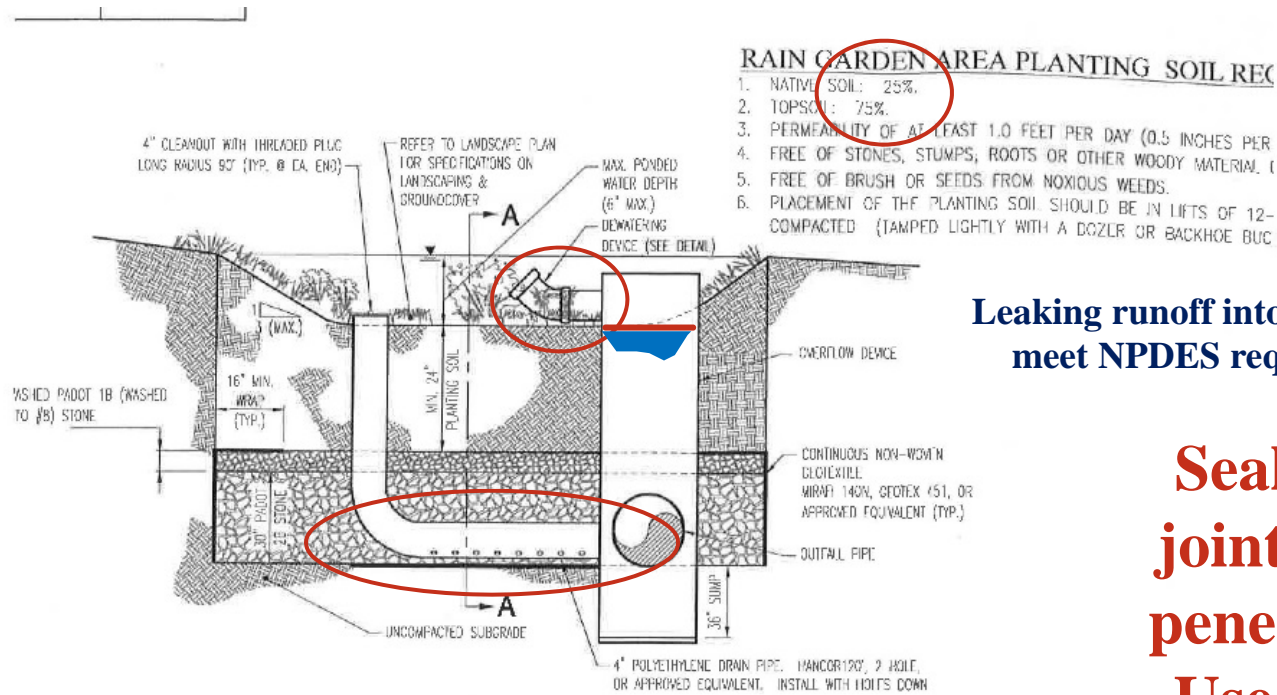
09.04.2012



10/01/2013

**Nice looking residential application**

# Cut-N-Paste Rain Garden Detail



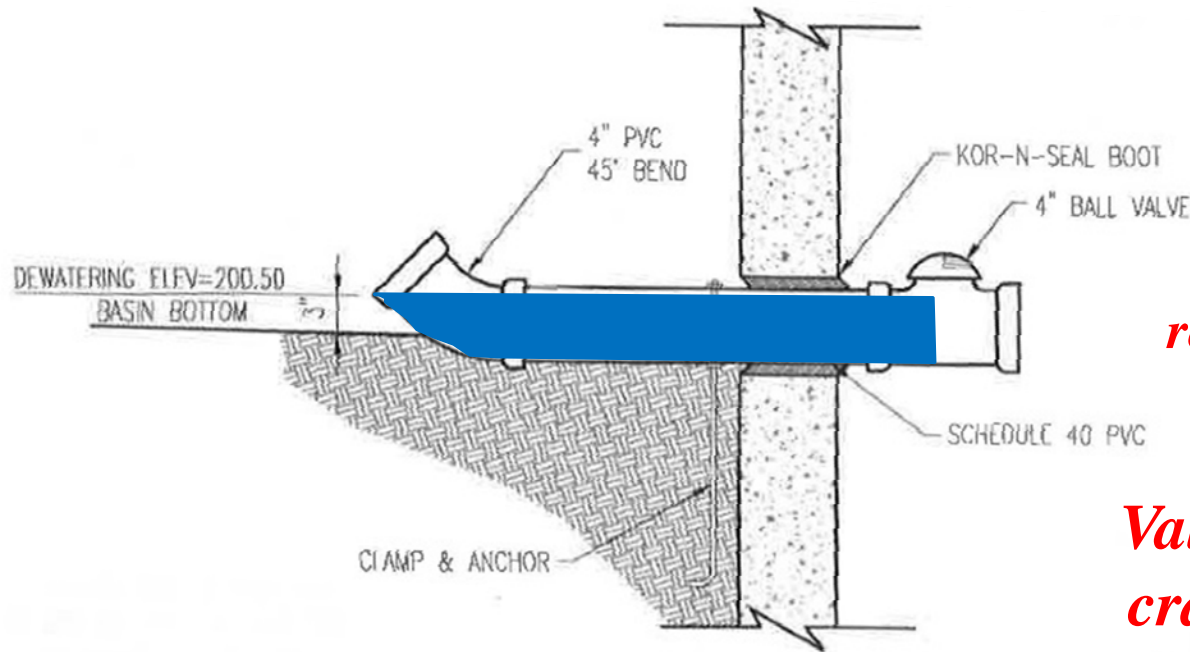
Leaking runoff into storm sewer doesn't meet NPDES requirements for WQ

Sealed riser joints & pipe penetrations?  
Use Mastic!

## RAIN GARDEN CONSTRUCTION SEQUENCE

- 1.) THE RAIN GARDEN FACILITY SHALL BE EXCAVATED TO THE DEPTH AND SIZE REQUIRED. THE CONTRACTOR MUST TAKE CARE IN-SITU SOILS.
- 2.) SUBSOILS IN THE ENTIRE GARDEN AREA MUST BE THOROUGHLY AND DEEPLY SCARIFIED BEFORE THE CONTRACTOR PLACES T MATERIAL. SCARIFYING MUST BE DONE WITH A "TOOTHED" BACKHOE.
- 3.) EVERY RAIN GARDEN FACILITY SHALL HAVE AN UNDERDRAIN AND AN OVERFLOW DRAIN. THESE SHALL BE INSTALLED BEFORE
- 4.) THE UNDERDRAIN IS BE INSTALLED IN AN AGGREGATE LAYER AT THE DEPTH SHOWN IN THE TYPICAL RAIN GARDEN FACILITY / AGGREGATE LAYER IS TO BE WRAPPED IN NON-WOVEN GEOTEXTILE FABRIC.
- 5.) INSTALL PEA GRAVEL LAYER AS REQUIRED.
- 6.) INSTALL PLANTING SOIL MIX TO DEPTH REQUIRED.
- 7.) PRE-SOAK THE PLANTING SOIL PRIOR TO PLANTING VEGETATION IN ORDER TO AID IN SETTLEMENT.
- 8.) PLANT RAIN GARDEN FACILITIES WORKING FROM THE BOTTOM OF THE BASIN UP SIDES. RAIN GARDEN FACILITY SHRUBS AND INSTALLED PER THE LANDSCAPE PLAN.
- 9.) THE CONTRACTOR SHALL COVER THE PLANTING SOIL MIX WITH A MAXIMUM OF 2 INCHES OF SUREDDLED WOOD MULCH AND F WITH SILT FENCE IF EROSION FROM SURROUNDING AREAS IS CONCERN UNTIL ADJACENT LANDSCAPE BECOMES ESTABLISHED.

# Dewatering all but 3" .....why?



*Valve not specified to remain closed*

*Valves found to crack and leak after 1<sup>st</sup> winter*

**B** INFILTRATION BASIN DEWATERING DEVICE  
S5 SCALE: N.T.S.

REV.: 2015.03.09

**Remove unnecessary points of leaking, BMP could be easily pumped out if needed**



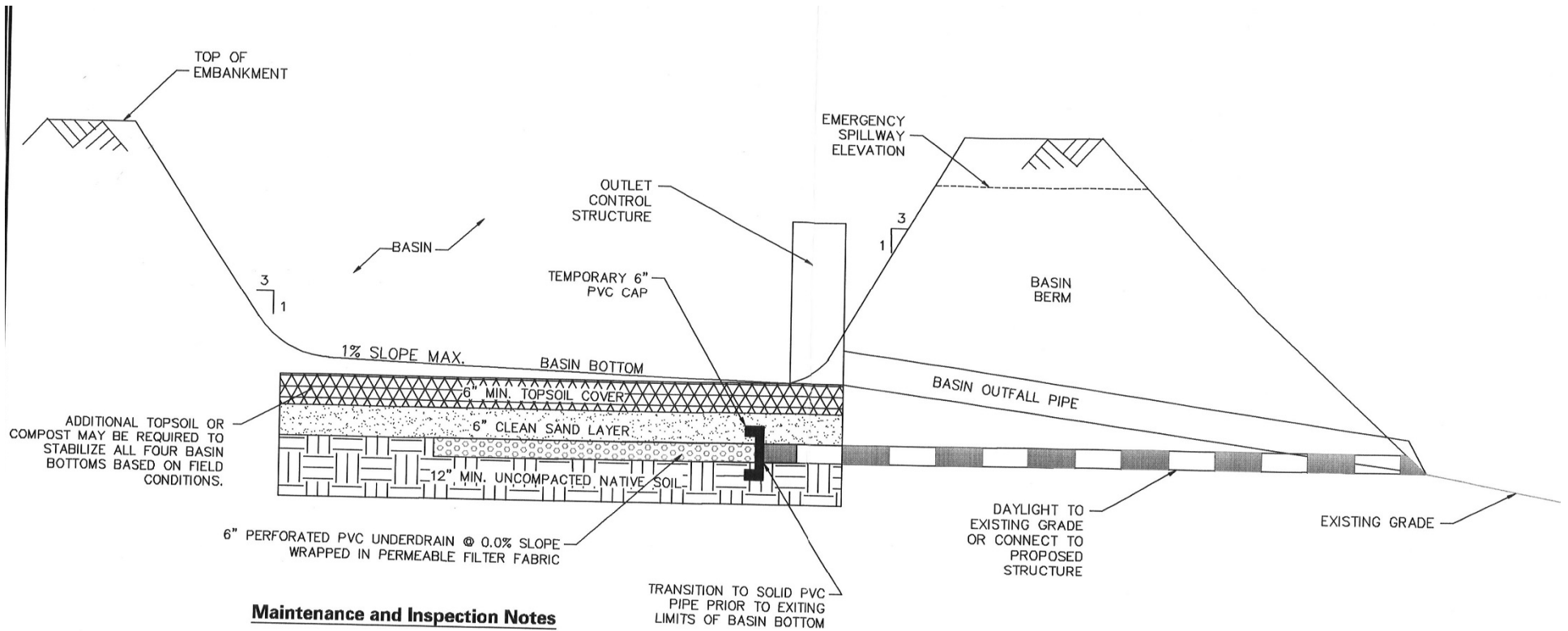
Unsealed Inlet = 80%  
WQ volume lost



# PVC lined Rain Garden - after retrofit to fix "the moat"

**Evapotranspiration with no infiltration has proven to be a failure in Rain Gardens so far.**





### **Maintenance and Inspection Notes**

- Catch basins and inlets (upgradient of infiltration basin) should be inspected and cleaned at least two times per year and after runoff events.
- The vegetation along the surface of the infiltration basin should be maintained in good condition and any bare spots revegetated as soon as possible.
- Vehicles should not be parked or driven on an infiltration basin, and care should be taken to avoid excessive compaction by mowers.
- Inspect the basin after runoff events and make sure that runoff drains down within 72 hours. Mosquito's should not be a problem if the water drains in 72 hours.
- Also inspect for accumulation of sediment, damage to outlet control structures, erosion control measure, signs of water contamination/spills and slope stability in berms.
- Mow only as appropriate for vegetative cover species.
- Remove accumulated sediment from basins as required. Restore original cross section and infiltration rate. Properly dispose of sediment.

## **TYPICAL INFILTRATION BASIN CROSS SECTION (SCHEMATIC)**

**Stone screenings are not the same as sand but can they work  
in basin soil mixes?**



**Very clayey “topsoil” prevented much of the infiltration  
into the underdrain for discharge**

# Compost Soil Amendment Stormwater BMP



**Add compost or other products to topsoil and  
relieve compaction of subsoil**



*Notice the lack of roots and grass cover!*

11/30/2015

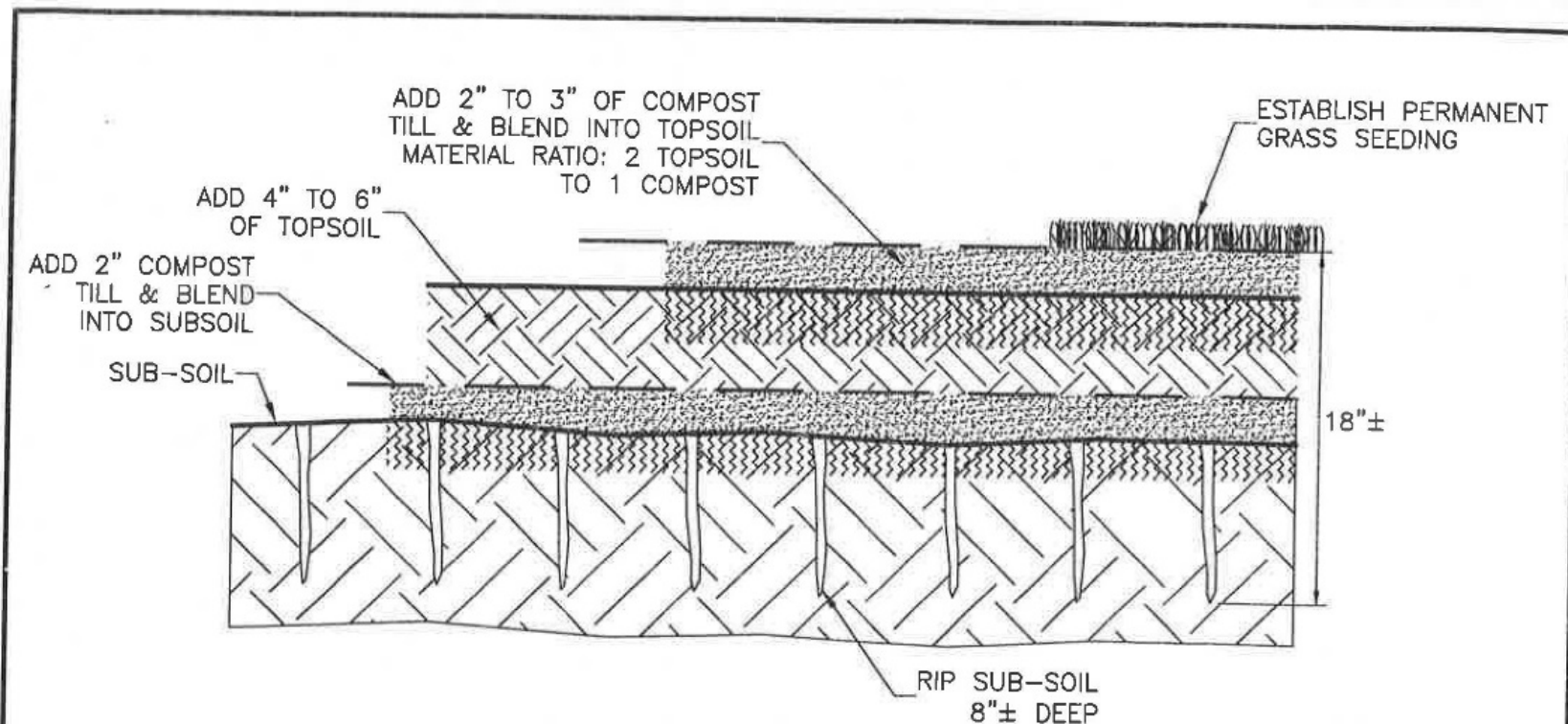
**Some effort made but not per plan requirements**



**What it should look like**

11/30/2015

# Soil Amendment Detail



RIPPING SHOULD BE DONE WITH A SOLID SHANK RIP TEETH ON REAR OR TRACK MACHINE. DO NOT RIP SOIL IS WET. AVOID RIPPING EXISTING TREE ROOTS. SPACE RIP CHANNELS 12" TO 36" APART. TILLING AND BLENDING MAY BE DONE WITH ROTOTILLER, DISK HARROW, CHISEL PLOW, SPRING TOOTH HARROW, OR OTHER SUITABLE EQUIPMENT

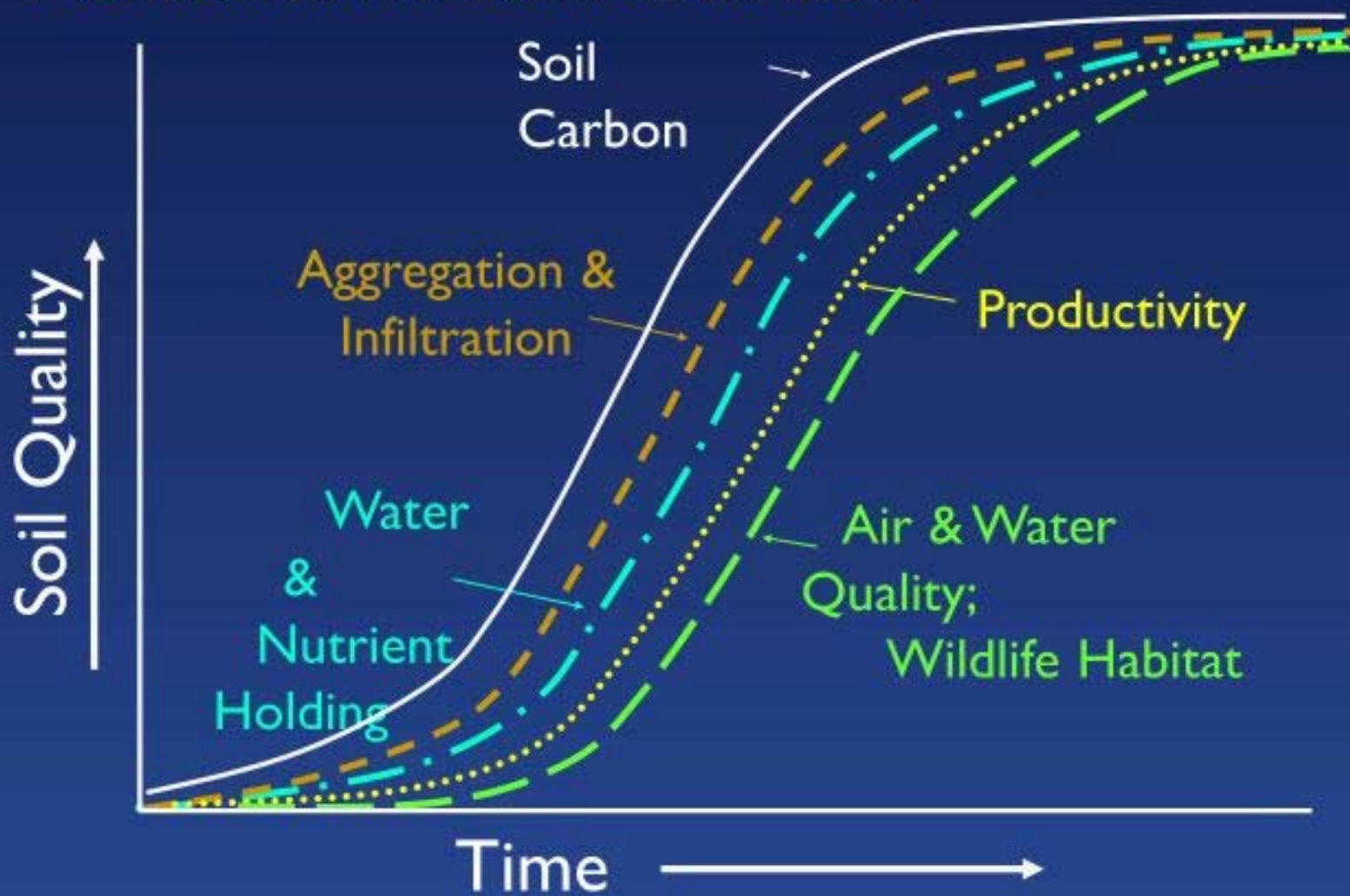
SOIL RESTORATION MAINTENANCE:  
WATER GRASS AS NEEDED FOR VIGOROUS HEALTH. APPLY ADDITIONAL COMPOST AS NEEDED FOR NOURISHMENT. AVOID COMMERCIAL FERTILIZER AND PESTICIDES.

## SOIL AMENDMENT & RESTORATION DETAIL

NO SCALE

**It takes Mother Nature approximately 500 years to make 1” of topsoil so put it all back, it’s a resource!**

## Benefits of Soil Carbon



**Are check dams really  
a good idea?**



10.08.2012



**Infiltration Swale**





# Missed Opportunities

- better drainage patterns for more treatment
- more trees for thermal mitigation and aesthetics
- volume control lost – drains to storm sewer

08.16.2011

# Failing Infiltration Basins, Lots of them!



# Infiltration Basin Conversion

- Extremely High Rate of Failure!!
- When used as a sediment basin during construction the underlying clogged soils must be removed to restore infiltration capability. Permit requires re-testing soil perc.
- BMP Manual (Appendix C) states over-excavation of at least 1 foot below the sediment basin bottom elevation
- Suggest excavating holes at 1', 2', & 3' and conducting soil investigation to determine depth of removal necessary.
- Replace with sandy soil mixture, suggest using pure 3"-6" sand on top for immediate stabilization and easy maintenance (BMP Manual suggests sand for slow percs).
- Was Licensed Professional onsite???



**Was muddy runoff from site or basin bottom itself?**

08.10.2011



10.05.2011



10.05.2011

***1' over-excavation would not have been enough***





- Stone on back of berm where topsoil slid off
- Spillway implemented – far away from outlet riser
- Sand for surface stabilization and easy maintenance
- Notice runoff color – site is mostly stable 2011

1-year later



1 ½ -years later



# Costs to Convert & Repair

- Initial Conversion per plans = \$6,932.87
- Resulted in failure to infiltrate and berm failure
- Subsequent Repair = \$7,812.50
- Over-excavation, soil replacement, berm repair
- Low cost since basin is small and onsite sand was used for most of the backfill
- Final cost more than double what client was expecting from original quotes – could have been much more!

# Soils tests do not always lead to success

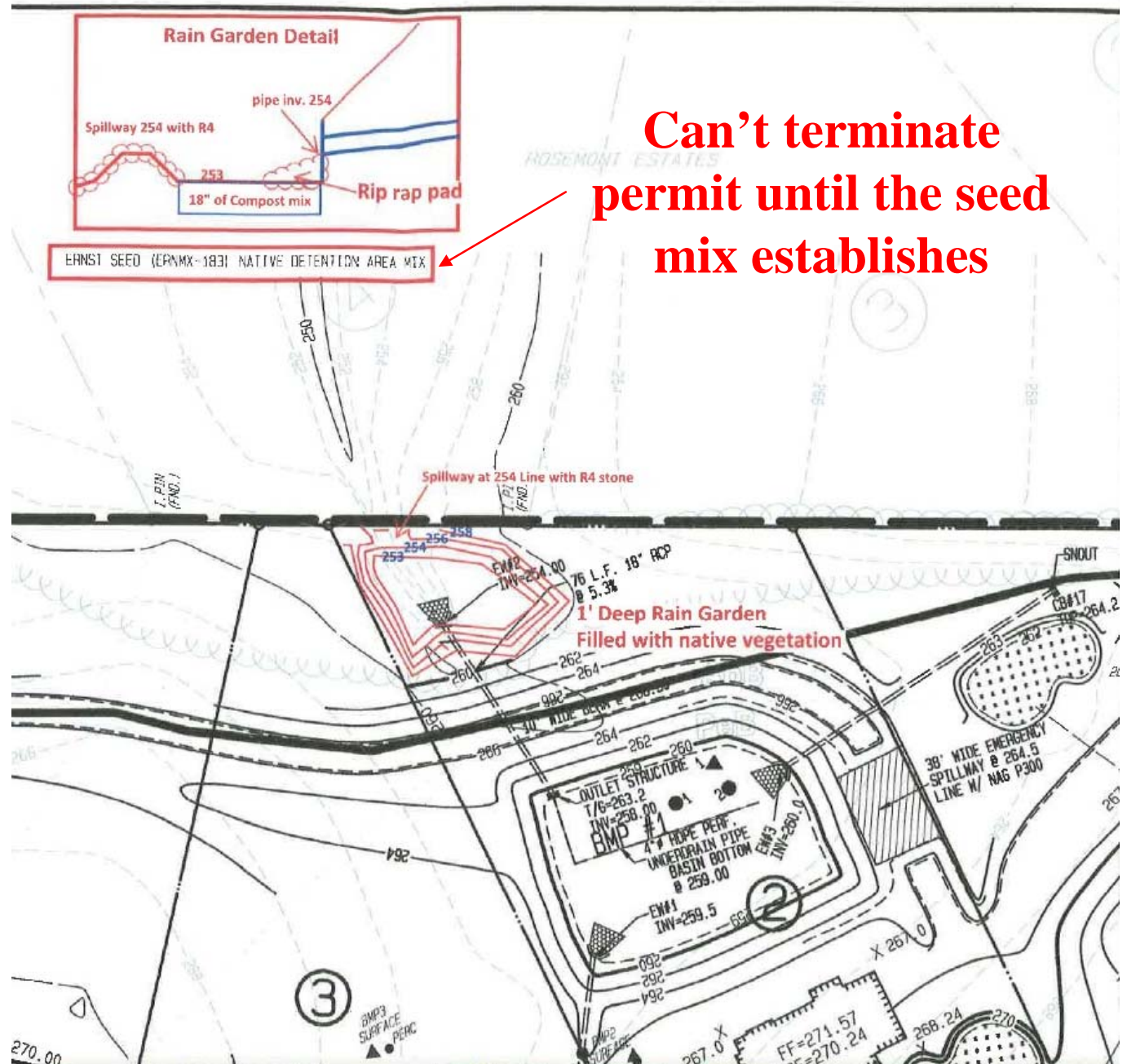
PERCS/PROBE RESULTS

LOT #	INFILTRATION RATE (INCHES/HOUR)	DRAINAGE CLASS	DEPTH TO RESTRICTIVE LAYER
1	8"	WELL DRAINED	44"
2	11"	WELL DRAINED	26"
3	13"	WELL DRAINED	24"
4	11"	WELL DRAINED	36"
5	7.75"	WELL DRAINED	23"
6	6.25"	WELL DRAINED	38"
7	5"	WELL DRAINED	38"
8	3"	WELL DRAINED	48"
9	4.5"	WELL DRAINED	36"
10	8.25"	WELL DRAINED	36"
11	4.5"	WELL DRAINED	26"
BASIN TESTS (6-30-07)			
PERC#1	.25" PER HOUR		
PERC#2	.15" PER HOUR		

*Yes, the infiltration basin failed.....*

Designer's proposed repair is to add another BMP on the same lot with no soil tests to prove it will work.

**What about Real Estate disclosure issues?**



**Can't terminate permit until the seed mix establishes**

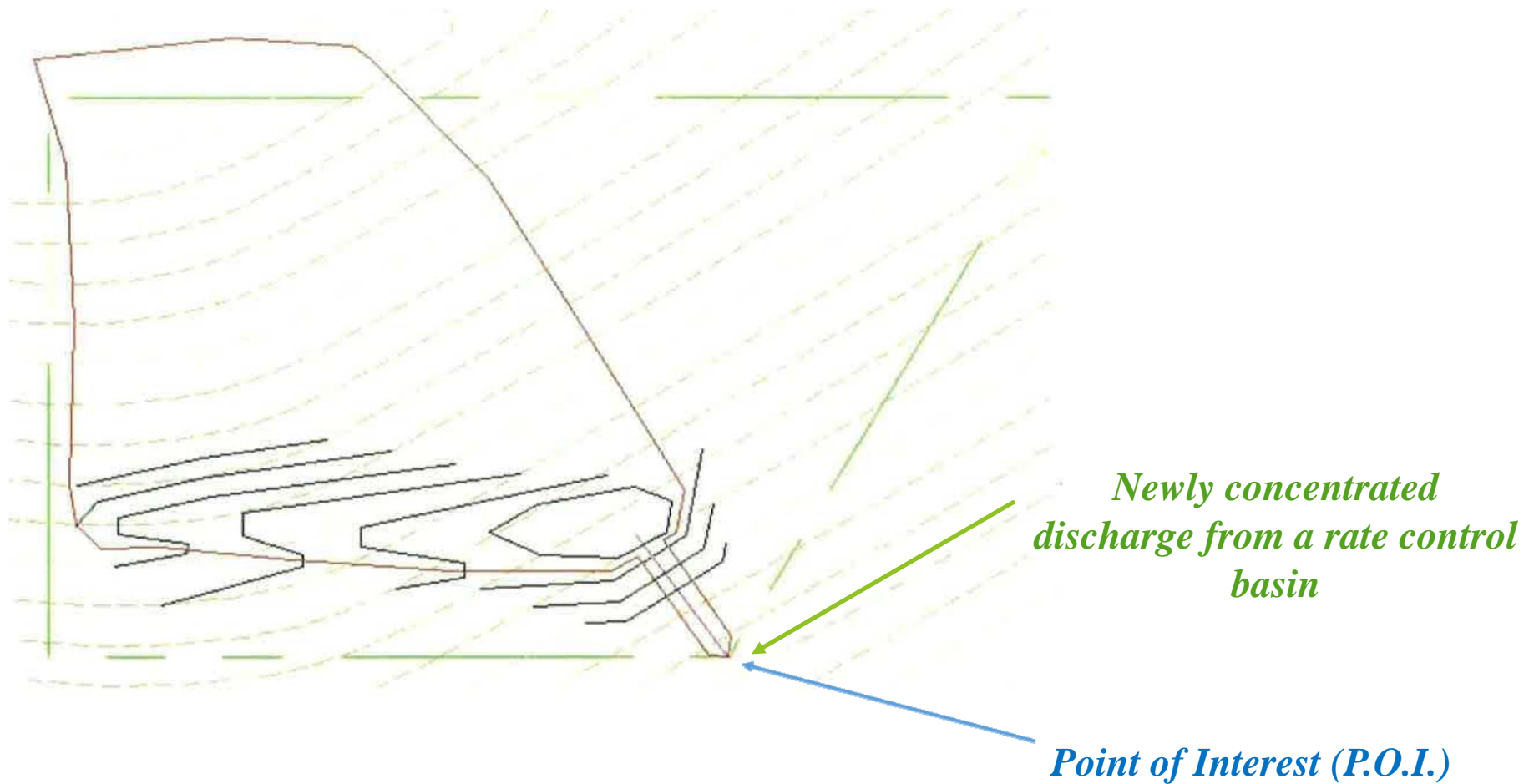
# Prove No Erosion - Newly Concentrated Discharges

See #14 & #15 in E&S Manual, page 161 for specifics.

Make sure you are comparing apples to apples.

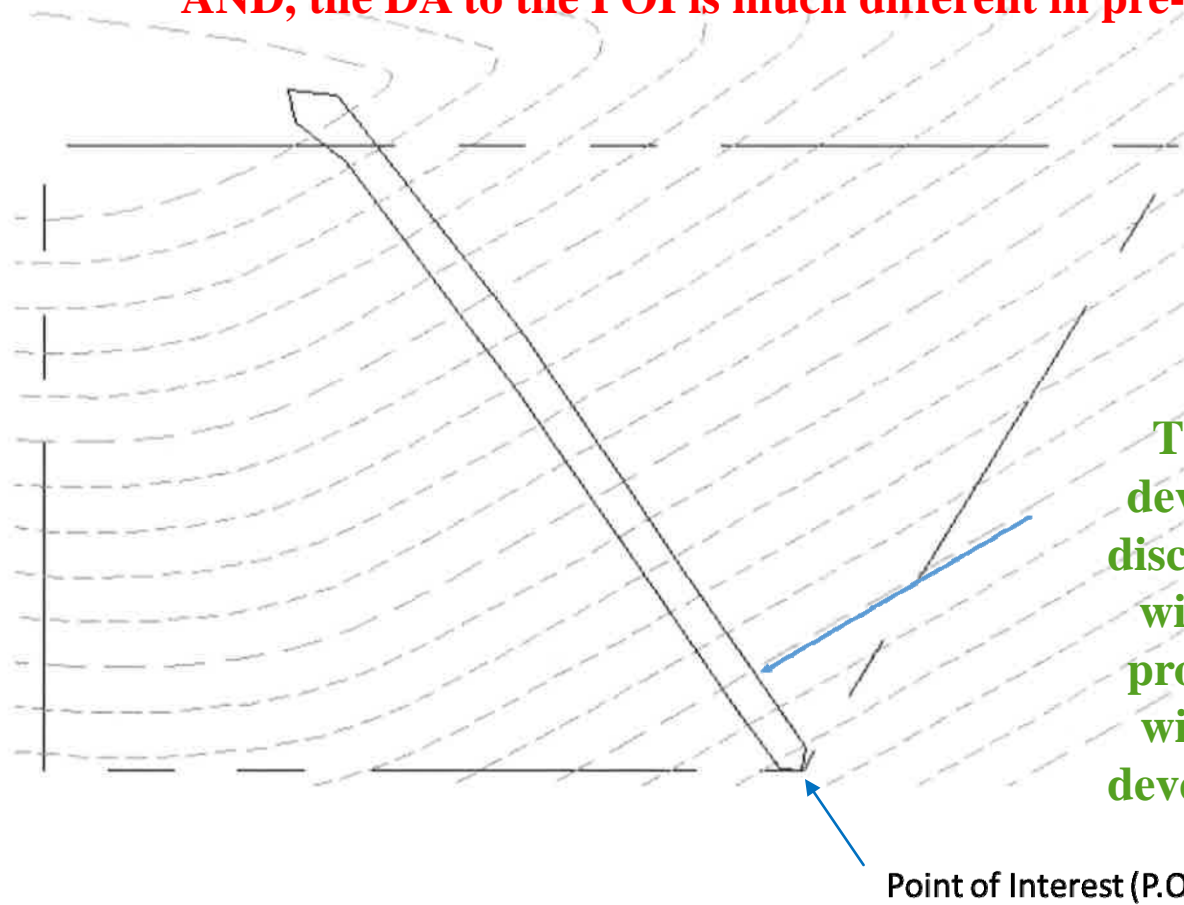


# Post-development Drainage Area (D.A.)



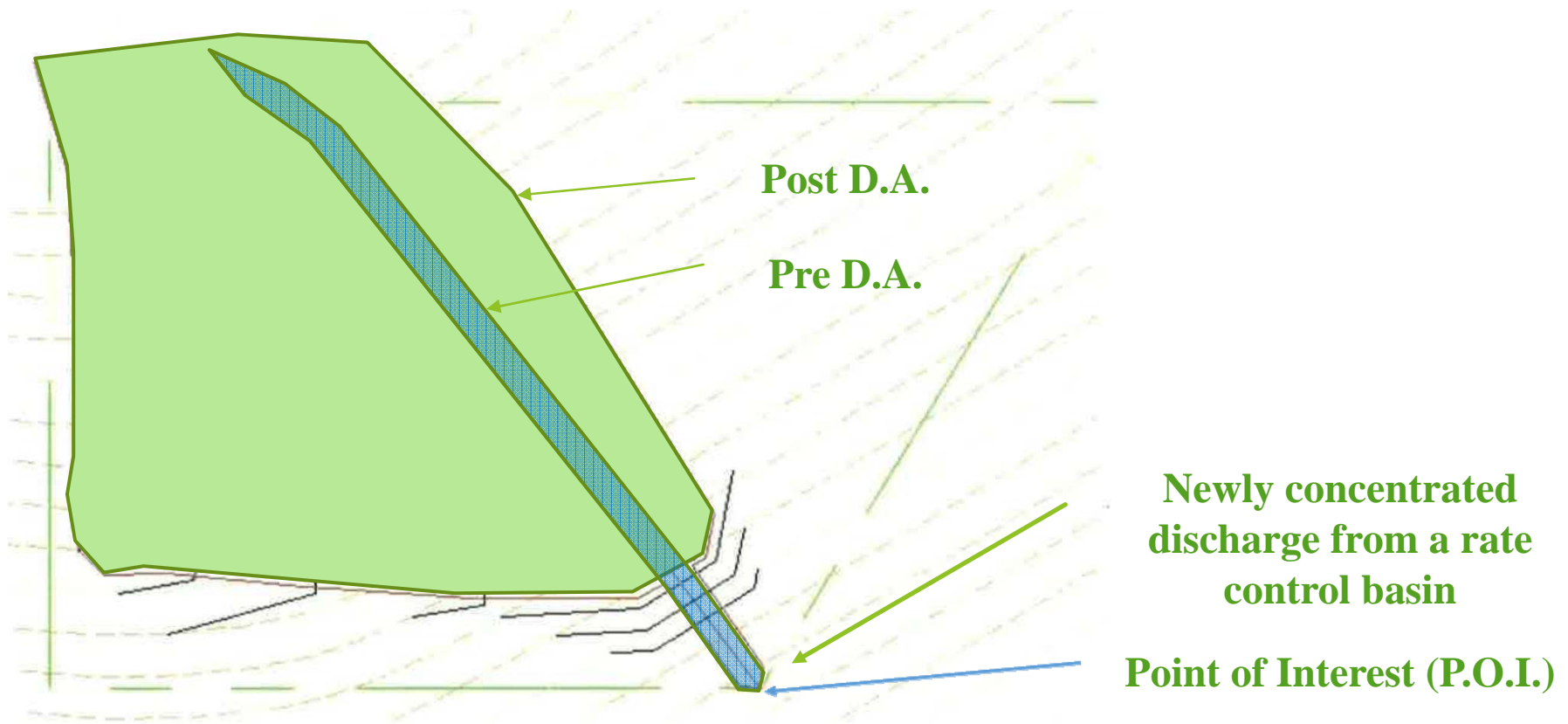
# Pre-development Drainage Area (D.A.)

**Discharges from the site in pre-condition is in the form of sheet flow, not concentrated flow.  
AND, the DA to the POI is much different in pre-vs. post.**



**This is the actual pre-development D.A. to the discharge location. Rarely will a design use this to prove no erosion as they will try to use the post-developed overall analysis**

# Compare Pre-development D.A. to Post-development Drainage Area (D.A.)



**Are we comparing apples to apples or apples to Chevy Trucks?**

# What About Level Spreaders?

- ▶ See technical paper on Level Spreaders in E&S Manual for further guidance.
- ▶ So far, observations in field inspections have shown these don't work.



# Curb Cuts

- problems
- solutions







Small lip  
in curb  
prevents  
flow to  
BMP

*90% bypass*


06.12.2012

# Pervious Paving



**No choker course**





**Provide back-up means for runoff to enter the stone bed**



***QUESTIONS?***