Recommendations of the Expert Panel to Define Removal Rates for Erosion and Sediment Control Practices

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Construction In the Bay Watershed

- Highest Unit Area Sediment Load of any Bay Land Use (Edge of Field)
- About 84,500 acres of construction in any given year
- CBWM: 16% of delivered sediment load from urban sector

Comparison of Edge of Field Sediment Loads By Land Use in the Bay Watershed (CBWM 5.3.2)

Bay Model Land Use Category	Annual EoF Sediment Load (tons/acre/year)
Construction Sites, No ESC Practices	**24.4**
Construction Sites, with ESC Practices [1]	**14.6**
Degraded Riparian Pasture	14.0
Extractive, Uncontrolled	10.0
Crops, Conventional Till	5.8
Urban Impervious Cover	5.0
Crops, Conservation Till	3.9
Pasture	1.6
Hay	1.5
Urban Pervious Cover	1.2
Forest (un-harvested)	0.3

Sources: Table 9-1 and 9.12 in Chesapeake Bay Phase 5.3 Community Watershed Model (EPA CBP, 2011)
Note: Application of BMPs can reduce sediment loads as shown above
[1] ESC practices are assumed to have a 40% removal rate, per the existing CBP-approved removal rate

Construction Sites are More than Bare Ground

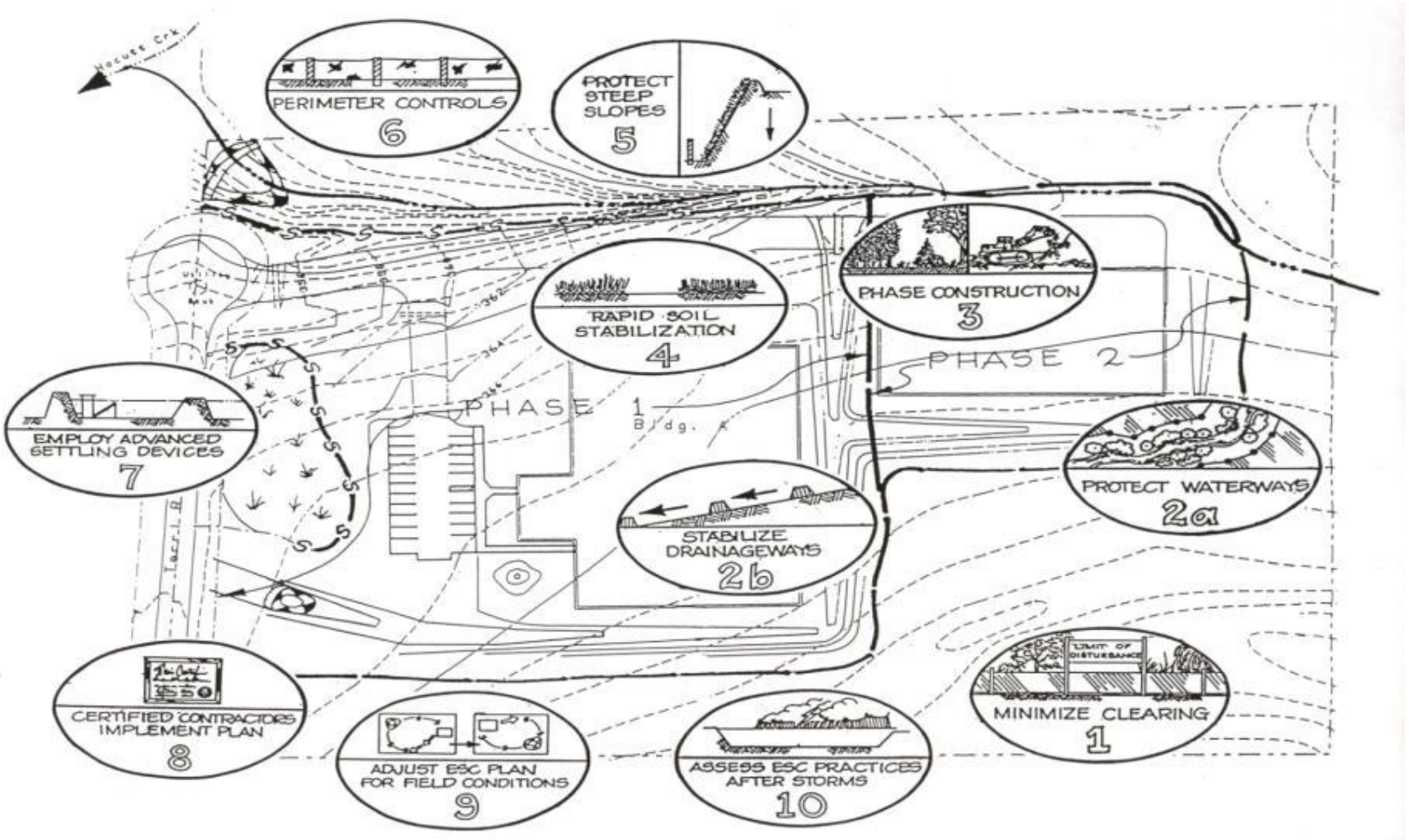
Construction Sites are Highly Dynamic

Construction process involves initial clearing and grading, earth-moving, installation of streets and storm drains, building construction and finally, the final stabilization of the site.

The hydrology of a construction site constantly changes, based on soil exposure, new slopes, the growing season, grass cover, addition of hard surfaces, stormwater conveyance, and the condition and performance of ESC practices.

Construction site erosion potential changes constantly over time, although significant soil loss is always expected during heavy or intense rainfall events.

Erosion and Sediment Control Practices



Four Levels of ESC Practice

Practices	Level 1 ESC	Level 2 ESC	Level 3 ESC
Protect Natural Resources	Locate natural areas and mark LOD (up to edge of natural area)	Do #1 and add buffers to LOD to prevent discharge to natural area	Do # 2, and provide enhanced perimeter controls at LOD boundary for sensitive areas
Minimize Disturbance	No numeric construction phasing requirement	Construction phasing required for largest projects (e.g., 25 + acres)	Construction phasing required for smaller projects
Stabilize Soils	Stabilize w/in 14 to 21 days	Stabilize w/in 7 -14 days	Stabilize w/in a week
Internal Drainage	Temporary swales	Swales/diversions with check-dams and erosion control blankets	Do #2, but enhance with passive use of polymer (e.g., floc logs or wattles)
Perimeter Controls	Standard Controls (e.g., hay bales, entrance stabilization)	Reinforced silt fence and berms/diversions	Enhanced perimeter controls (i.e., super silt fence, compost logs, and filtering practices).
Sediment Traps and Basins	Sediment traps, filters, and basins that meet the 0.5" (1,800 cu.ft/acre) standard	Sediment basins that meet the 1.0" (3,600 cu.ft/ac) standard, with permanent pools and/or dewatering control devices (e.g., skimmers)	Do # 2, but enhance performance with passive use of chemical additives to improve settling, filtration and surface outlets
Inspections	Monthly	Every 1 to 3 weeks	Inspections once every seven days and after each precipitation event > 1.0"
Level 4 ESC	Do Level 3 and employ active chemical treatment system (ATS) with fully automated pumps, controls, settling tanks, and sand filters that are specifically designed to achieve low numeric turbidity effluent concentrations for construction site discharge		

Level 1 ESC Practice

- Historical Level of Practice (2005 and before)
- Assumed Performance for CBWM Calibration (1990-2005)
- Less stringent sizing, technology and inspection requirements
- No Bay states currently operate at this level of practice

Level 2 ESC Practice

- Reflects more stringent ESC regulations and permits adopted in recent years
- Improved sizing, stabilization, phasing and inspection requirements
- All Bay states now safely operating at Level 2 ESC

Level 3 ESC Practice

- ESC Practice Level 2, plus additional passive chemical treatment to reduce turbidity, with a reliance on polyacrylamide (PAM) and other flocculants
- Enhanced design features on ESC practices to improve performance
- No Bay states are currently operating at this level, although several states are shifting toward it

Level 4 ESC Practice

- Best available technology for turbidity control to achieve low numerical turbidity standards
- Has been piloted at some sites in Pacific Northwest
- Involves expensive Active Treatment Systems that pump, treat and filter construction site runoff
- No Bay state is operating at this level

Review of the Science

- Sediment Discharge
- Turbidity Discharge
- Nutrient Dynamics

Sediment Loads Discharged from Construction Sites

- Review of about 25 recent and historical studies

Panel Best Estimates of Base Construction Site Sediment Loads

Table 16 Comparative Summary of ESC Scenarios (tons/ac/yr)				
ESC Scenario	Worst Case	Mid-point	Best Case	**Best Estimate**
Construction w/o ESC	22.3	8.6	5.1	**12.0**
Sites Operating at Level 1	2.5	1.8	1.1	**1.8**
Sites Operating at Level 2	1.6	1.0	0.7	**1.1**
Sites Operating at Level 3	1.05	0.57	0.31	**0.65**
Sites Operating at Level 4	ND	ND	ND	**ND**
Important Note: Actual sediment loads for all 4 ESC levels will be higher when moderate and extreme storms exceed or overwhelm ESC capacity, and thus create functional deficiency, and much lower removal rates. ND= No data				

See Appendix A for technical assumptions with each load calculation

Defining Functional Deficiency

Functional Deficiency

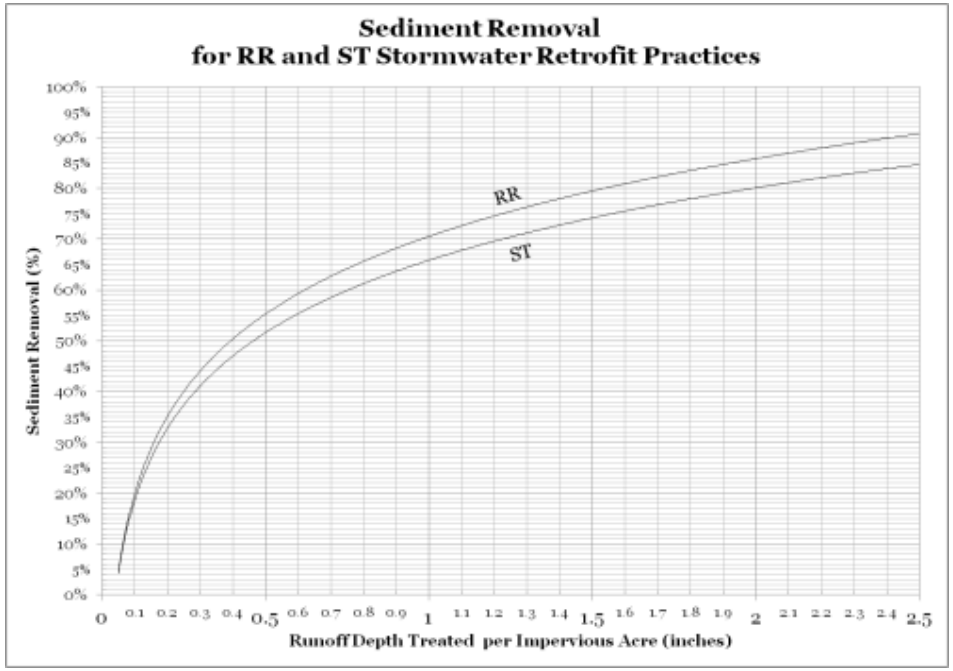
- The four levels of ESC practice assume proper installation and maintenance of practices, as well as normal rainfall conditions that are within the design capacity of the practices. These assumptions are violated at some proportion of all construction sites, and at all sites during extreme storm events.

- Two levels of functional deficiency defined based on hydrologic considerations
  - *Moderate deficiency* occurs for rainfall events that exceed the designed sediment trapping capacity of ESC practices.
  - *Extreme functional deficiency* occurs for major storm events that exceed intensity or volume thresholds, and overwhelm the treatment capacity.

- The Panel developed method to compute the additional sediment load produced at functionally deficient sites, which is added to the estimated sediment load during normal conditions for appropriate level of ESC practice.

Accounting for Functional Deficiency

Computation of Sediment Removal Rates for Four Levels of ESC				
ESC Scenario	Discharged Load [1]	Removal Rate	MFD [2] Adjustment	Effective Removal Rate [3]
Sites Operating at ESC Level 1	1.8	85%	3.1	**74%**
Sites Operating at ESC Level 2	**1.1**	**92%**	**1.8**	**85%**
Sites Operating at ESC Level 3	0.6	95%	1.3	**90%**
Sites Operating at ESC Level 4	ND	ND	ND	**ND**



Level 1: = 25% of time in MFD
Level 2/3 =15% of time in MFD

Turbidity Findings

- Level 1 and 2 ESC practices have little capability to reduce turbidity
- Concern on turbidity's impact to aquatic health in streams, lakes, rivers and estuaries
- Turbidity indicates fine sediments might have a higher delivery ratio to the Bay
- Recommend shift to Level 3 ESC Practice to provide more effective turbidity control

Nutrient Dynamics At Construction Sites

Five pathways for nutrient export from construction sites:

1. Nutrients attached to eroded soils
2. Wash off of fertilizer due to hydro-seeding and permanent stabilization
3. Wash-off of nutrients deposited from the atmosphere
4. Decay of organic material used to cover soil (i.e., compost, mulches, erosion control blankets, etc)
5. Leaching into groundwater (primarily nitrate).

See Appendix B for more details

Typical Fertilization Rates at Construction Sites in Bay States to Achieve Vegetative Stabilization

ESC Stabilization Recommendations	Formulation (N-P-K)	Application Rate lbs/ac	N Rate N lbs/ac	P Rate * P lbs/ac
Temporary Stabilization	10-10-10	500-600	**50**	**27**
Permanent Stabilization	10-20-10	500-1000	**65**	**48**
Total Fertilizer Application		**600 to 1500**	**115**	**75**

See Table 24 for variation among Bay States.
* Adjusted to convert phosphate PO_4 to TP
Suggested application rate in the absence of a soil test or urban nutrient management plan. May be replaced by mulching in the non-growing season.

- 3 to 4 week "hi risk window" for grass to germinate and achieve desired density, as well as 1 to 3 years "moderate risk window" for starter lawns

- Construction sites have 7 or more of the 12 fertilizer wash-off hi risk factors as defined by UNM Expert Panel

Risk of Fertilizer Wash-off

Bi-Modal N/P Concentrations in Construction Site Runoff

Comparison of nutrient concentrations in construction site runoff (mg/l)				
Study	TN	DIN	TP	Notes
Kayhanina et al 2001	3.5	1.06	0.95	California, N=72 Highway
Line, 2007	1.7		0.47	NC, N=16
Cleveland and Fashokun, 2006		1.26	0.47 as PO_4	Above basin
Cleveland and Fashokun, 2006		1.57	0.21 as PO_4	Below basin
Kalanaisan et al 2008			0.72 as PO_4	Below basin
Soupir et al 2004	**57.5**	**15.96**	**5.6**	Fertilized test plot
Faucette et al 2008	Nd	Nd	**31.8**	Fertilized test plot
McLaughlin and King, 2008	5.18	Nd	3.1	JACK
McLaughlin and King, 2008	**19.8**		**34.6**	BUNC
McLaughlin and King, 2008	3.78		0.3	WAKE
Horner et al, 1990	--	--	In: **12.3/2.25**/0.55 Out: 0.44/0.6/0.14	3 basins in Seattle

Future Research and Mgmt Needs

- The Panel urges funding for a short-term, intensive monitoring study
- Focus on sampling nutrient concentrations in construction site discharges during the period of high fertilizer wash-off risk that occurs during and after site stabilization.
- Scope may involve a total of 100 - 200 flow-weighted composite samples to measure nutrient concentrations in 10 to 15 different construction sites in the Bay region to get more accurate EMC estimates for N and P.

Longer Term Study

- Investigate whether fertilization rate/formulation recommendations, vegetative stabilization methods and/or down-gradient ESC practices could be modified in order to reduce nutrient export…….while still maintaining effective vegetative and soil cover during the entire construction process.

- Potential benefits of incorporating low doses of PAM to hydro-seeding mixes on erosion-prone soils should be sampled

Inspections as Verification

- Each individual construction site is now subject to both self inspections by the contractor and regulatory inspections by the local or state ESC enforcement authority that occur multiple times during the construction year.

- Construction sites are subject to more on-site verification than any other urban or agricultural BMP used in the watershed.

- Current construction inspection protocols are more than sufficient to meet the CBP verification principles for crediting BMPs in the TMDL.

- Panel does not recommend any additional field verification protocols beyond those that are already in place in the Bay states.

State and Local ESC Reporting

- **State:** Two options for reporting annual construction acres (existing method or submit annual CGP acreage data)
- **State:** No geographic data, just which ESC Level is being used
- **Locals:** No reporting requirements, beyond existing permit mandates

WTWG Phasing in the Panel Recommendations

Phasing in the Panel recommendations

Table E-2: Sediment and Nutrient Removal Rates for Construction Sites with Erosion and Sediment Control Practices (%)

Practice Type	Sediment		Nitrogen		Phosphorus	
	Phase 5.3.2	Phase 6	Phase 5.3.2	Phase 6	Phase 5.3.2	Phase 6
Level 1 ESC	40	74/0*	25	0 **	40	0 **
Level 2 ESC	65	85/42*	25	0 **	40	0 **
Level 3 ESC	77	90/58*	25	0 **	40	0 **

**The reductions are listed for two possible base conditions. The first is a reduction from a construction site without ESC practices, while the second is a reduction from a construction site with Level 1 ESC practices. The ultimate Phase 6 loading rates will be selected by the Modeling Workgroup and will be subject to Water Quality GIT approval.*

*** The expert panel proposed that the zero removal rate be applied to the current nutrient loading rates for construction land in Phase 6 of the CBWM unless new monitoring data acquired between now and then provides evidence that the target nutrient loads from construction sites with Level 2 or Level 3 ESC practices should be increased or decreased. The ultimate Phase 6 loading rates will be selected by the Modeling Workgroup and will be subject to Water Quality GIT approval.*

- All reductions were set relative to current model reductions for Level 1 ESC.
- Higher sediment reductions available for Level 2 and Level 3 ESC in current model.
- No increases (or decreases) to nutrient efficiencies in current model.
- Reductions for Phase 6 will be finalized when the Modeling Workgroup and Water Quality GIT approve Phase 6 loading rates.

Additional Reporting Points

- All current ESC practices likely qualify as Level 2 ESC, and should be reported as such in 2014 Progress.
- All historic ESC practices from 1985 through 2013 should be revised and resubmitted to NEIEN with the appropriate ESC level (1 or 2) prior to recalibration of the watershed model (summer, 2016).
- Jurisdictions can report acres of construction with **qualifying** urban nutrient management plans. Please refer to the Urban Nutrient Management Panel's report for a description of qualifying conditions.

Questions?

Bonus slides

Measured Sediment Loading Rates for Construction Sites, w/ or w/o ESC

Study	Region	Tons/ac/year	ESC Used?	Notes
CBWM	Bay	24.4	No	Model Assumption
Yorke and Herb, 1978	MD	33	No	
Nelson, 1984	SE US	100 to 300	No	
Cleaves et al, 1970	SE US	218.9	No	
Likens and Borman, 1974	NE US	48.4	No	
Cywin and Hendricks, 1969	SE US	134	No	
Line and White,2007	NC	13.0	Yes	Residential
Daniel et al, 1979	WI	7.8	Yes	Residential
Line, 2007	NC	18.5	Yes	Highway
Line and White, 2001	NC	4.4	Yes	Residential
Owens et al, 2000	WI	1.7-6.7	Yes	Resid./Comm.
Lee and Ziegler, 2010	KS	0.5 to 2.5	Yes	Residential

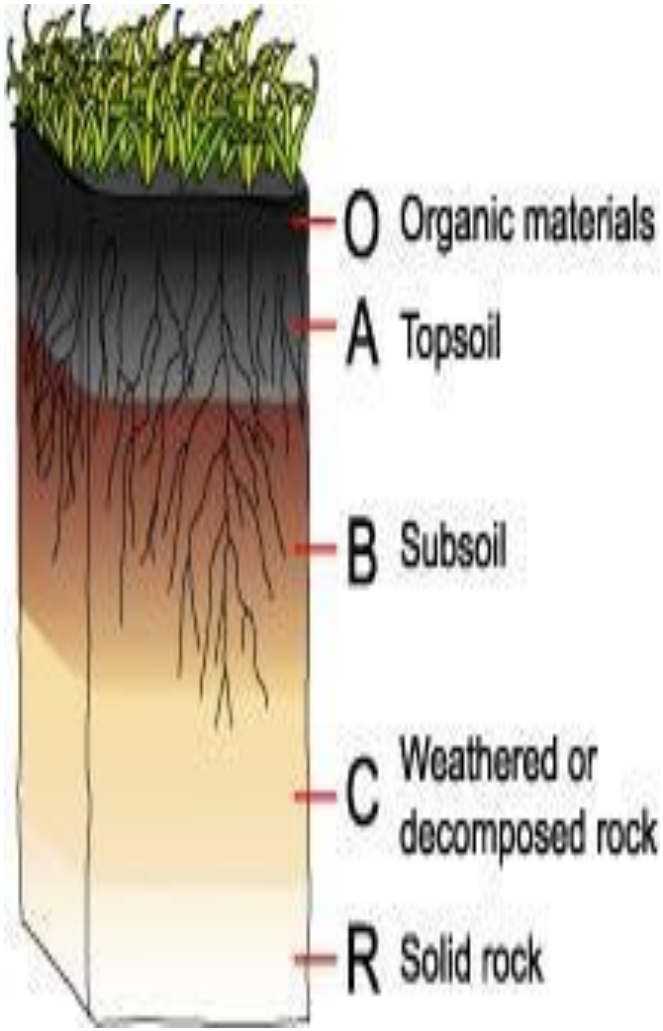
Sediment Discharged From Construction Sites

Mean TSS Inflow and Outflow Concentrations in Relationship to ESC Practice Level			
ESC Level	TSS IN (Mg/l)	TSS OUT (Mg/l)	Sediment Removal Efficiency
LEVEL 1 ESC	**1583**	**812**	**49%/50% [1]**
LEVEL 2/3 ESC	**6188**	**557**	**90%/83% [1]**
Grand Mean	**3598**		
[1] First is based on level 1 means, second is mean percent removal			
Based on 13 research studies 1990 to 2008, N=6 for Level 1 and N=7 for Level 2/3 .			

Turbidity Discharged From Construction Sites

Turbidity in relationship to ESC Practice Level, Summary of Literature				
Summary of Research	Turbidity IN (NTUs)	Turbidity OUT (NTUs)	Removal Efficiency %	Notes
LEVEL 1 and 2 MEANS	**2327**	**1919**	**~ 25**	NO PAM
LEVEL 3 MEANS	**1423**	**165**	**80-90**	PAM

Exposed Construction Site Soils Have Low Sediment Nutrient Content



Nutrient Content by Soil Horizon in USDA Soil Survey		
	Silt Loam	Loamy Sand
Organic Content	O Horizon: 5.5% AB Horizon: 1.8%	O Horizon: 9.5% AB Horizon: 1.4%
Total Nitrogen (mg/kg)	O Horizon: **2,900** AB Horizon: **1,000**	O Horizon: **4,700** AB Horizon: **700**
Total Phosphorus (mg/kg)	O Horizon: **35** AB Horizon: **5**	O Horizon: **16** AB Horizon: **2**