Soil Improvement for Stormwater Management, Erosion Control, and Landscape Success

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Soils for Salmon Project
Washington Organic Recycling Council
www.soilsforsalmon.org **www.buildingsoil.org**

Edited from presentation developed for WSU , UW & DOE Low Impact Development courses - last updated August 2014

Handouts for this presentation

- **Building Soil**: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Manual for Western WA
  www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf

- **Natural Landscaping**: Design, Build, Maintain
  www.buildingsoil.org/tools/Landscaping_Guide.pdf

- **Managing Stormwater Onsite**: LID practices for landscape & building professionals
  www.buildingsoil.org/tools/Managing_Stormwater_Onsite.pdf

Summary of Soil Best Management Practices

New Construction

- Retain and protect native topsoil & vegetation (esp. trees!)
  - Minimize construction footprint
  - Store and reuse topsoil from site
  - Retain “buffer” vegetation along waterways
- Restore disturbed soils by tilling 2-4" of compost into upper 8-12" of soil. Rip to loosen compacted layers.

Existing Landscapes

- Retrofit soils with tilled-in compost when re-landscaping
- Mulch beds with organic mulches (leaves, wood chips, compost), and topdress turf with compost
- Avoid overuse of chemicals, which may damage soil life

Building Soil
Foundation for Success

Builders, developers, and landscapers

are adopting practices that preserve and improve the soil on building sites, grow healthier landscapes, and protect waterways. Local governments are beginning to require these practices.

5 Steps to Building Soil

Best management practices (BMPs) during construction:

1. **Retain and protect native topsoil & vegetation where practical**
2. **Restore disturbed soils, to restore healthy soil functions, by:**
   - **stockpiling & reusing good quality site soil, or**
   - **tilling 2-3" of compost into poor site soils, or**
   - **bringing in 8" of compost- amended topsoil**
3. **Loosen compacted subsoil, if needed, by ripping to 12" depth**
4. **Mulch landscape beds after planting**
5. **Protect restored soils from erosion or [illegible] by heavy e[illegible]**

Why build healthy soil?

- More marketable buildings and landscapes
- Better site erosion control
- Reduced need for water and chemicals
- Less stormwater runoff, better water quality
- Healthy landscapes = satisfied customers

Washington State's stormwater permits require these soil BMPs. That requirement is taking effect locally as towns and counties around Western Washington update their stormwater codes (as required by law). Some jurisdictions already require the soil BMPs – all will soon.

The good news is, it's easy, and customers want it. New home buyers say they are happy to pay more for a healthy, easy to care for landscape – and that starts with the soil.

Successful Project
Learn more about thes

preserving vegetation, stockpiling topsoil

Building Soil
Foundation for Success

amending existing soil with compost

placing compost amended topsoil

Tools for builders

View slide show (PDF 5MB) Why, how-to tips, and successful projects, or brochure

Watch video (on King County's website)

Building Soil Manual
the builder's guide:
– summary (PDF) with links to compost calculator, suppliers, specs, and more
– full Building Soil Manual (PDF, 4MB)

Soil BMP requirements in state and local codes, or text of State BMP (PDF)

Landscaping guide (PDF) Design, building, and maintenance tips for professionals

When to amend? (PDF) Construction sequencing for soil protection and restoration

Erosion control with compost (PDF) Meet your TESC requirements, build healthy soil, work faster, and save money.

Homebuyer factsheet (PDF) Print and use to promote your healthy soil and landscape practices to your customers. It sells!

Learn More – Background, science, specs and resources for designers, and related information are available on our partner website:
www.soilsforsalmon.org

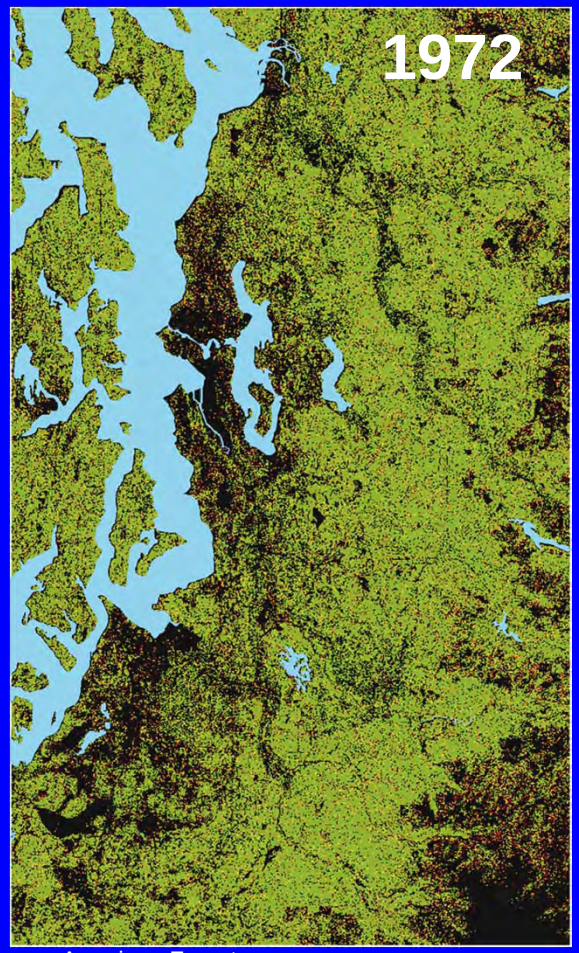
Science and design: www.SoilsforSalmon.org

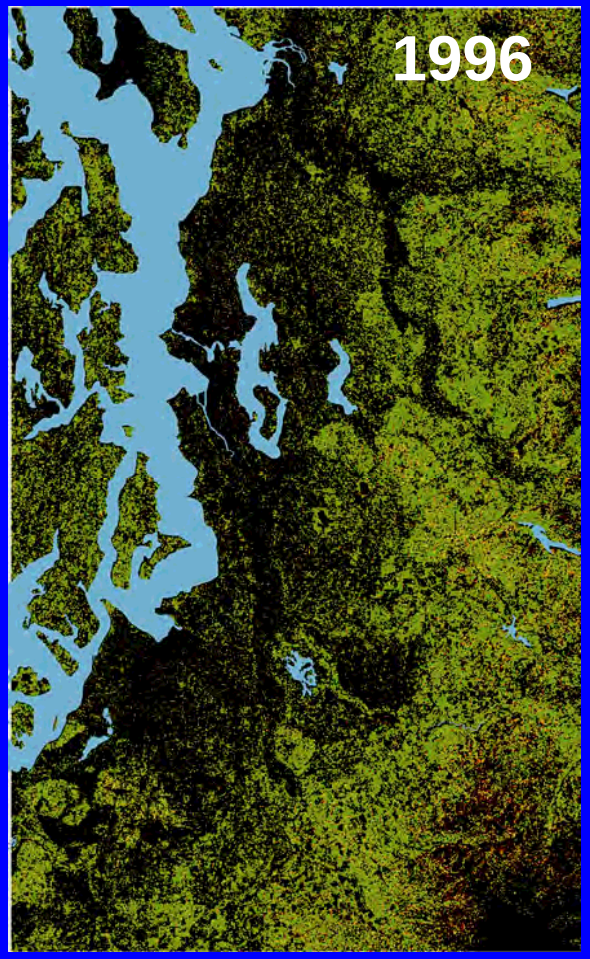
Builder's info: www.BuildingSoil.org

Why a Soil Strategy is Essential: The Connection Between Soil and Water

The Stormwater Problem:
Impacts of turning spongy forests into cities

1972-1996: Amount of land with 50% tree cover decreased by 37% in Puget Sound region (from 42% of land down to 27%).





American Forests

Impervious surface increased proportionately.

WA population doubled 1962-1998– more coming.

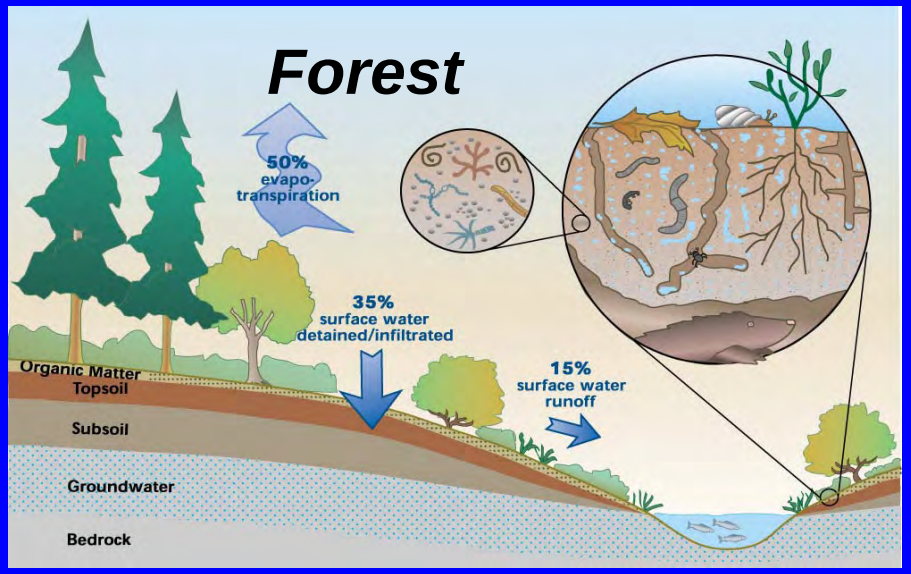
Our climate is changing – more intense rain events?

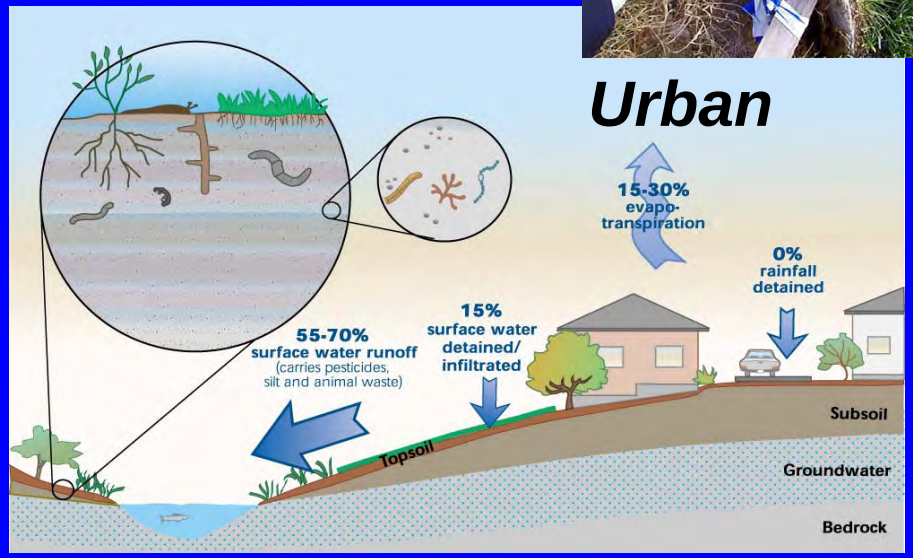
What happens to soils and soil functions as we turn forests into cities?

↑compaction
↑erosion
↑loss of topsoil
↓soil organisms
↓soil structure
↓natural fertility & disease prevention
↑impervious surface

cause:

↑winter runoff
↑need for irrigation & chemicals
↓biofiltration of pollutants



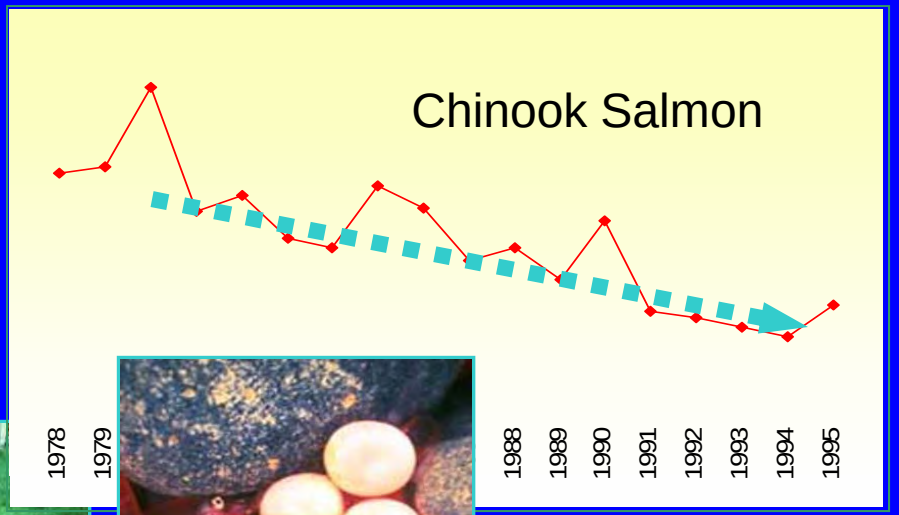


What happens to streams as we turn forests into cities?

- ↑**runoff = ↑peak storm flows**
- ↑erosion of stream bank and bed
- ↑fine sediment choking spawning gravels
- ↑pollutants (automotive, landscape fertilizer and pesticides)
- ↓**groundwater recharge**
- ↓summer low flows
- ↑summer stream temperature
- ↓oxygen in spawning gravels
- ↓LWD - logs and rootwads that young salmon need
- ↓food supply for young salmon

What are the impacts?

- Salmon decline
- Pollution
- Erosion
- Flooding & property damage
- Failing landscapes, resulting in more chemical use

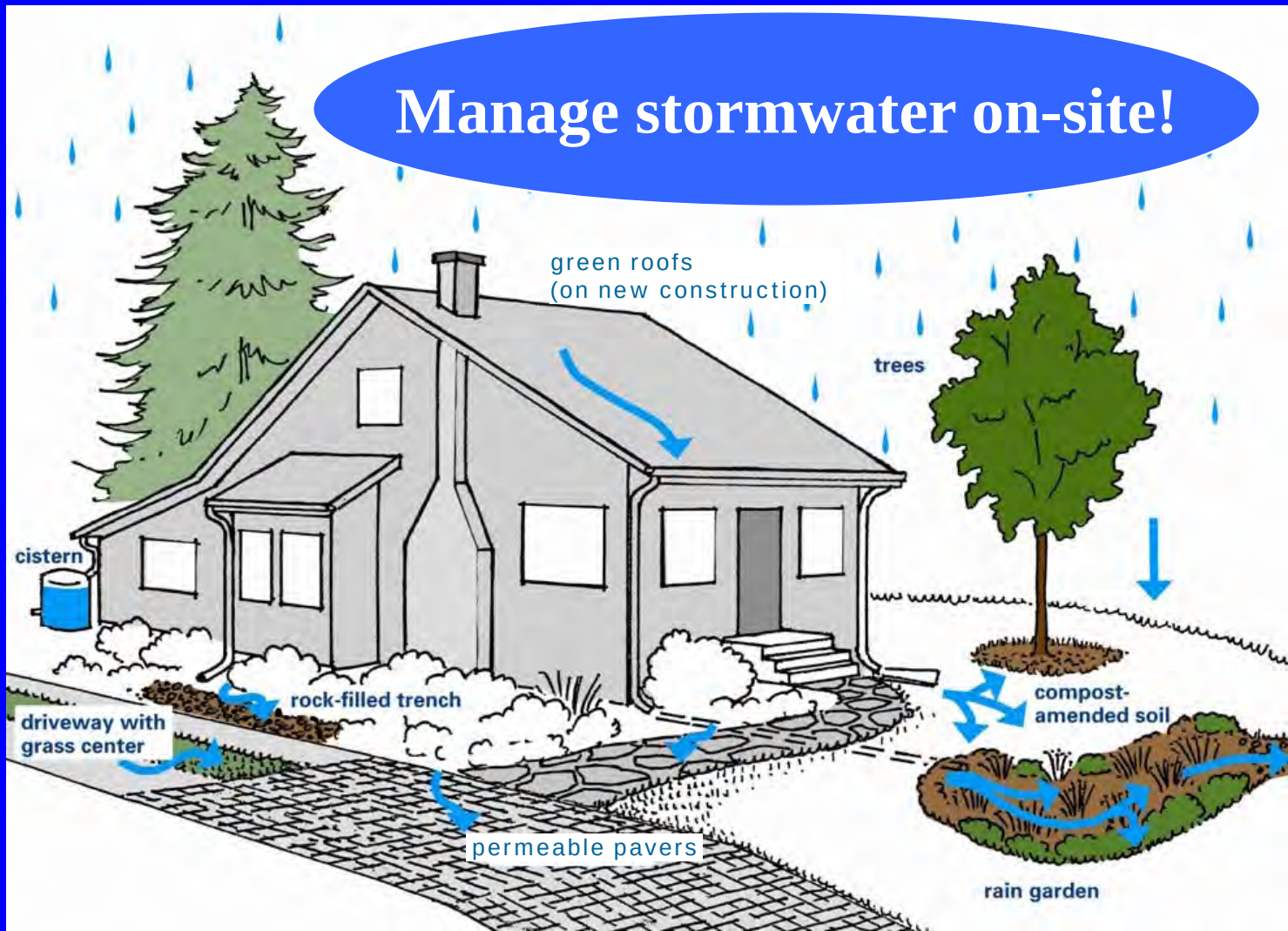


The solution: “Low Impact Development”
= “Green Stormwater Infrastructure”

Protect watersheds by managing stormwater upstream, on each site.

Try to restore pre-development site hydrology, through distributed on-site detention and infiltration.

Rainfall:
- ***slow it***
- ***spread it***
- ***filter it***
- ***soak it in.***



Restoring Soil Functions with Organic Amendments

Stormwater management

- Incorporate 15-30% compost (by volume) into soil before planting
- Compost amendment builds soil structure, moisture-holding capacity
- Increases surface porosity

UW trials, turf on glacial till soil

Compost-amended till soil – up to 50% reduction in storm water runoff

Erosion and sediment management

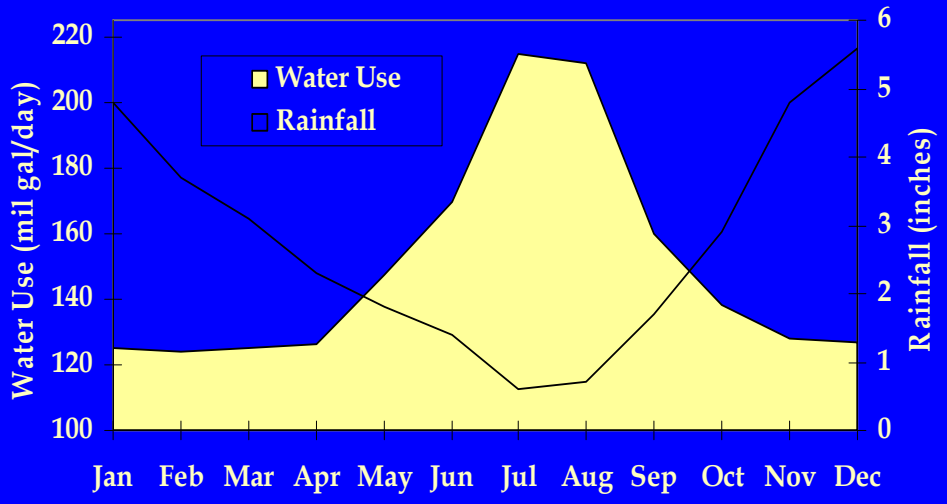
- Compost berms or blankets – slow water, bind surface soil, and reduce erosion immediately
- Enhance survival/growth of plantings, helping to stabilize slopes over long term.

Berms instead of silt fence

Compost blankets on steep slopes

Added benefits of soil amendment

- Bio-filtration of urban pollutants
- Improved fertility & plant vigor:
  - less need for fertilizers and pesticides
  - reduced maintenance costs
  - Increased regrowth of protective canopy
- Reusing “wastes” (yard waste, manure, biosolids, construction, land clearing waste)
- Reduced summer irrigation needs

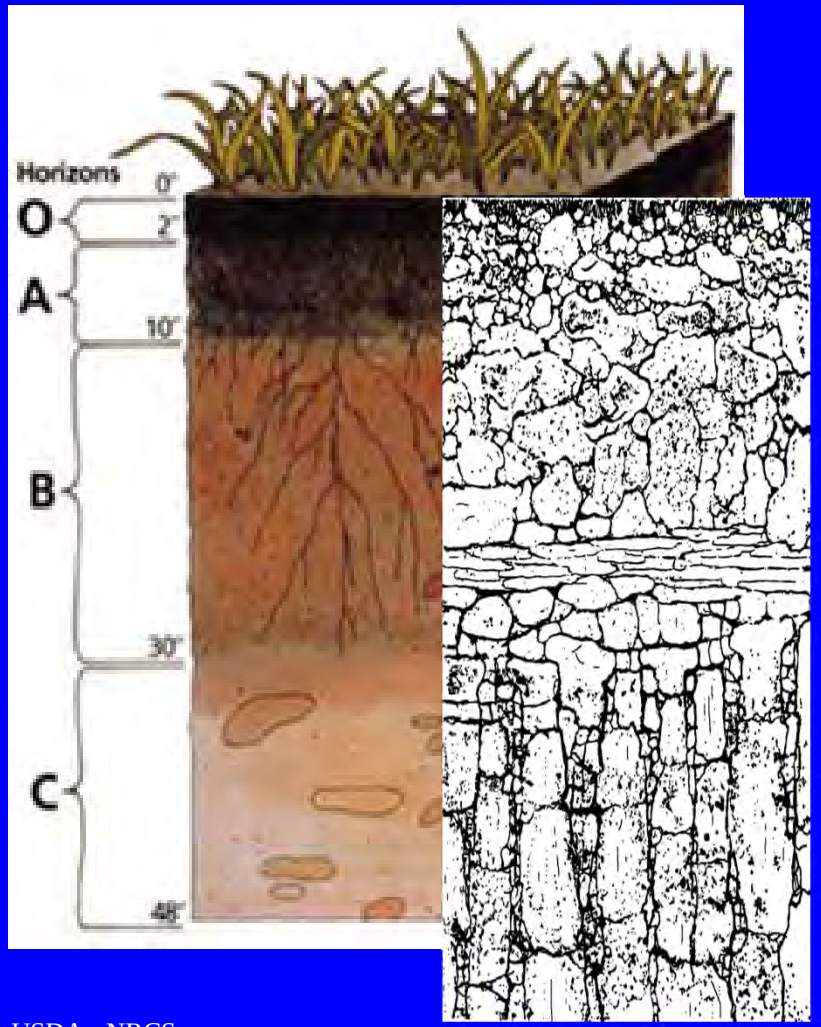


Understanding Soil:
development from parent "dirt" & rock

Soil horizons & their evolution

- Substratum (C) or bedrock (R) weathers physically & chemically to subsoil (B)

- Primarily biological processes create topsoil (A) and organic (O) horizons



USDA - NRCS

http://soils.usda.gov

Sub-Soils in the Puget Sound Basin: Leftovers from glaciers & volcanoes

glacial till: unsorted, unstratified mixtures of clay, silt, sand, gravel, and boulders; deposited under ice, or in moraines

hardpan: till compacted under glacier

outwash soils: layers sorted by particle size by water - sand / gravel / rocks

lake/marine bed soils: clay or silt that settled out in lakes & estuaries

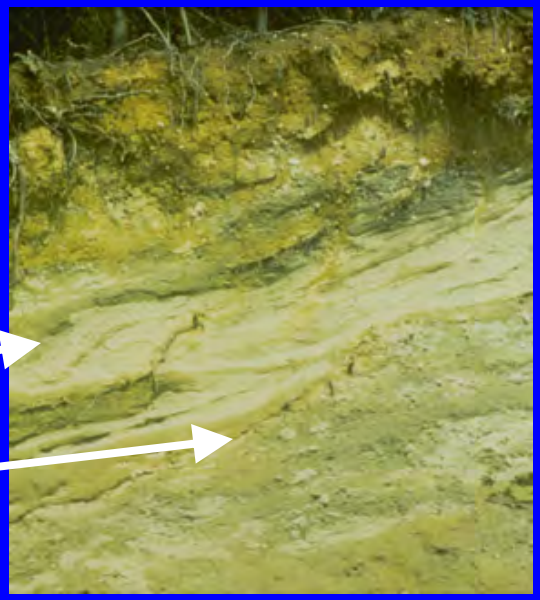
volcanic ash: light, fertile, holds moisture - mostly blown east of Cascades

mudflows: mixed size, compact - like till

Learn about Puget Sound soils at:
www.puyallup.wsu.edu/soilmgmt/Soils.htm

Layers upon layers…
ignore them at your peril!

- Sandy outwash over compacted basal till hardpan
- Thin soil over bedrock
- Clay lenses over hardpan, or inter-layered with sand (unstable!)



Disturbed soils in urban areas

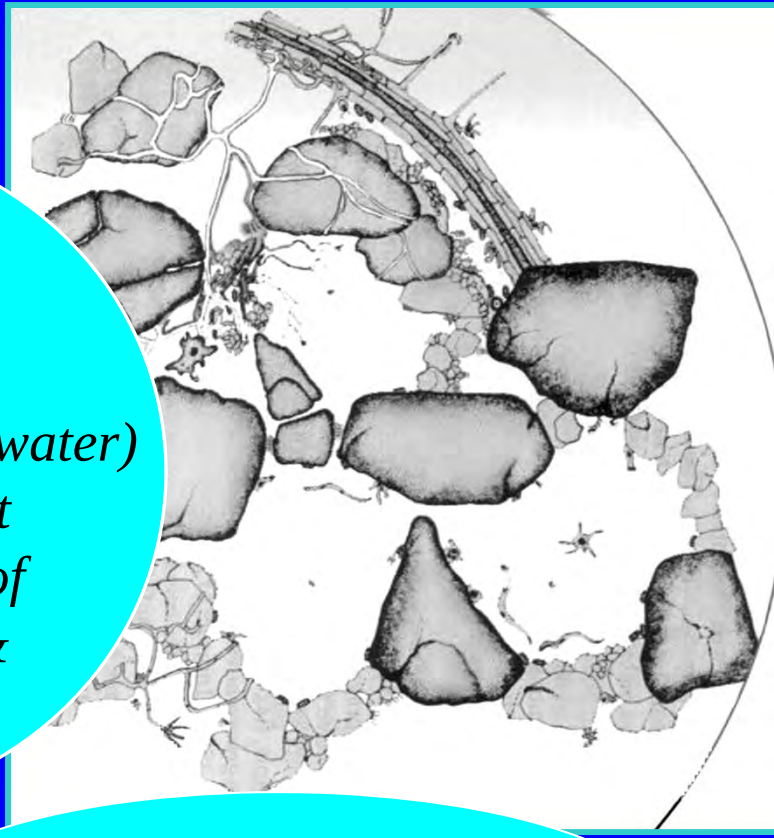
- **Topsoil layer removed**
- **Compaction**
- **Subsoil (or worse) fill layers.**
- **Debris or toxins?**

Understanding soil:
texture, structure, & pore space (thus infiltration)

Soil components:

- "The Dirt" (mineral part)
  - sand
  - silt
  - clay
- Air and Water
- Organic Matter and Soil Life (create aggregates & pores)

Good soil is about
- half mineral
- half space (air & water)
- plus a smaller but essential amount of organic matter & soil life

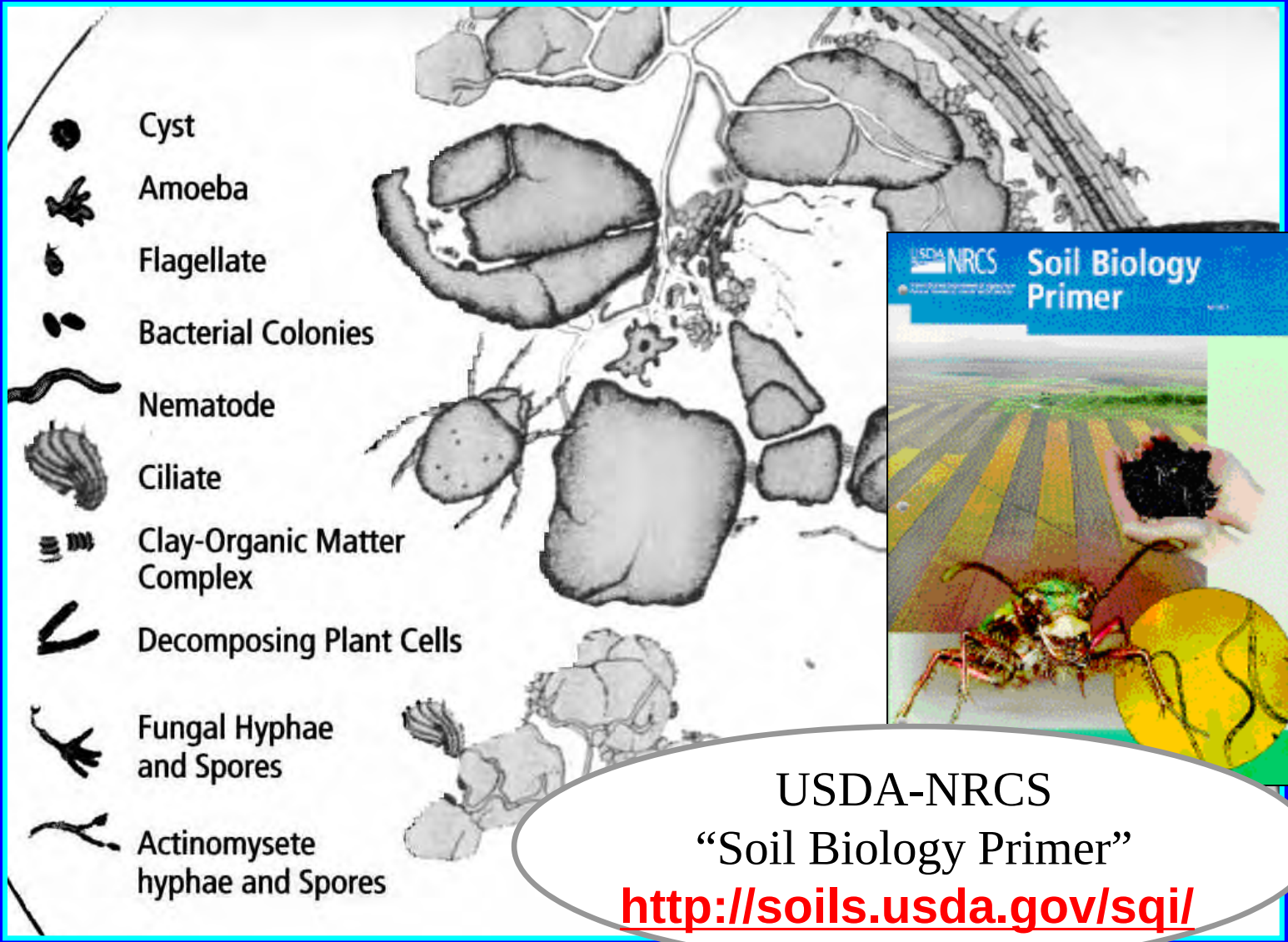


"Loam" is a mix of sand, silt, clay and organic, formed over time by nature

Understanding Soil Biology

Soil life provides essential functions

Soil is alive!

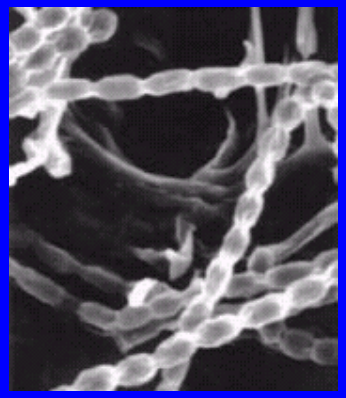


USDA-NRCS
"Soil Biology Primer"
http://soils.usda.gov/sqi/

S. Rose & E.T. Elliott

Common organisms in the soil foodweb

- Bacteria

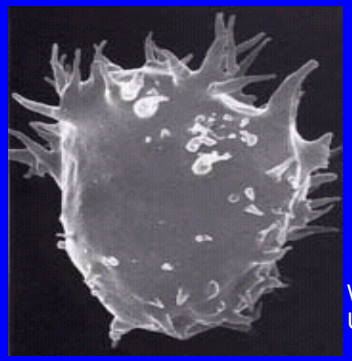


- Fungi

Paul R. August, University of Minn.

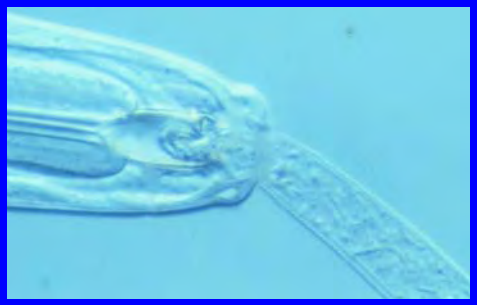
Soil Foodweb Inc.

- Protozoa



Wilhelm Foissner, University of Salzburg

- Nematodes



Soil Foodweb Inc.

- Arthropods

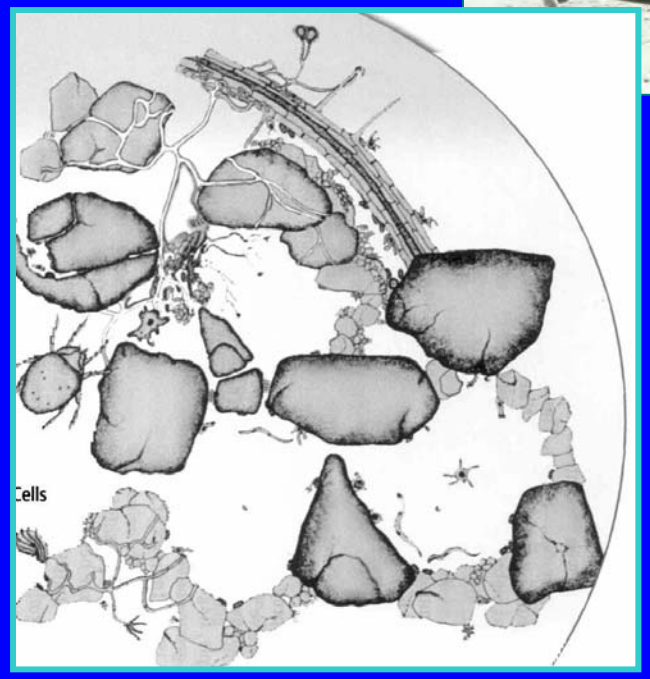
SSSA

- Earthworms

Restoring soil life, to restore soil functions

Soil organisms create:

- soil structure
- fertility = nutrient cycling
- plant disease protection
- biofiltration
- erosion control
- stormwater detention



Compost kickstarts the soil ecosystem!
(Provides food and home for organisms)

How can we enhance & restore soil biodiversity, to improve plant growth, water quality, and reduce runoff?

- Prevent /reduce compaction (keep heavy machinery off)
- Reduce intensive use of pesticides & soluble fertilizers
- Incorporate compost into soil to feed soil life

organic matter + soil organisms + time
creates ⇒
soil structure, biofiltration, fertility, & stormwater detention

Soil Amendment: A cost-effective solution for new development

- Much better plant survival = fewer callbacks

- Easier planting

- Can cut irrigation needs by 50% = 3-7 year payback on irrigation savings alone

Improving soil function in existing development

- Amend soil when re-landscaping
- Plant native trees & shrubs, especially near waterways
- Mulch beds annually with leaves, chips, compost, etc.
- Topdress turf areas with compost (aerate, topdress, rake in)

WA DOE Guidance on soil & LID BMPs: *Stormwater Mgmt. Manual for Western WA*

- Equivalency required for Phase I & II NPDES permittees
- Volume V, Chapter 5 - "On-Site Stormwater Mgmt."
  - Downspout, sheet, & concentrated flow dispersion
  - **BMP T5.13 Post-Construction Soil Quality and Depth**
  - Other Site Design BMP's include preserving vegetation, cisterns, rain gardens, porous paving, soil compaction prevention, & T5.41 "Better Site Design"
- Volume III, Chapter 3 - "Flow Control Design"
  - Downspout infiltration and dispersion
- Flow model credits for amended soils

www.ecy.wa.gov/programs/wq/stormwater/manual.html

BMP T5.13: Runoff Model Representation

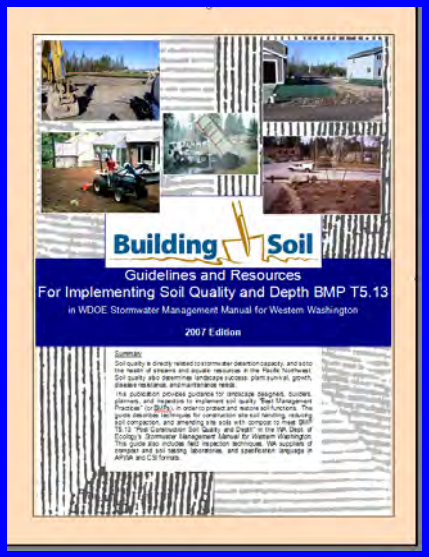
- Areas meeting the design guidelines may be entered into approved runoff models as “Pasture” rather than “Lawn.”

- Flow reduction credits can be taken in runoff modeling when BMP T5.13 is used as part of a dispersion design under the conditions described in:
  - BMP T5.10B Downspout Dispersion
  - BMP T5.11 Concentrated Flow Dispersion
  - BMP T5.12 Sheet Flow Dispersion
  - BMP T5.18 Reverse Slope Sidewalks
  - BMP T5.30 Full Dispersion (for public road projects)

DOE BMP T5.13
Post-Construction Soil Quality and Depth

- Retain native soil and duff wherever possible
- All areas cleared and graded require 8 inch soil depth:
  - Organic matter content ≥ 10% dry weight (now ≥ 5% for turf)
  - Use native topsoil, amend existing soil with compost, or import topsoil blend
  - Subsoil scarified 4 inches below 8-inch topsoil layer
  - Protect amended soil from compaction
  - Mulch after planting
  - Maintenance practices to replenish organic content

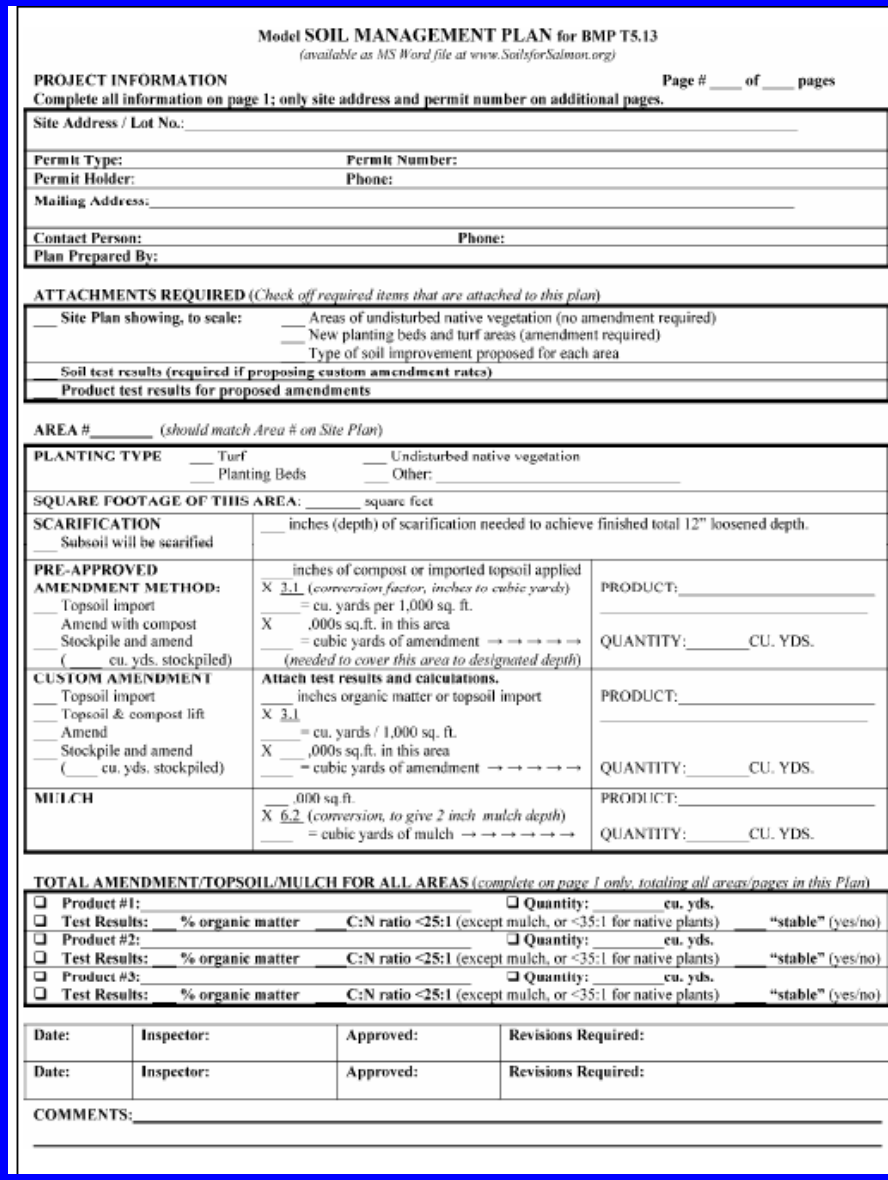
Guidelines Manual for Implementing BMP T5.13



- Manual developed regionally with experts
- 10% O.M. for landscape beds; 5% for turf
- Develop a "Soil Management Plan" for each site
- Four options for soil management (can use 1 or more / site):
  1) Retain undisturbed native soil & vegetation, protect from compaction
  2) Amend existing soil in place with compost
  3) Stockpile topsoil prior to grading, and reuse on site (amend if needed)
  4) Import topsoil meeting organic matter content requirements
- Choose pre-approved or custom calculated amendment rates
- Simple field inspection and verification procedures
- Includes model specs written in CSI and APWA formats
- Available **www.soilsforsalmon.org** or **www.buildingsoil.org**

Developing A Soil Management Plan (SMP)

- A scale-drawing identifying areas where each soil treatment option will be applied.
- A completed SMP form identifying treatment options, amendment products and calculated application rates for each area.
- Copies of laboratory analyses for compost and topsoil products to be used, with OM content and C:N



Model SOIL MANAGEMENT PLAN for BMP T5.13

(available as MS Word file at www.SoilsforSalmon.org)

PROJECT INFORMATION Page # ____ of ____ pages

Complete all information on page 1; only site address and permit number on additional pages.

Site Address / Lot No.:

Permit Type: **Permit Number:**

Permit Holder: **Phone:**

Mailing Address:

Contact Person: **Phone:**

Plan Prepared By:

ATTACHMENTS REQUIRED (*Check off required items that are attached to this plan*)

___ **Site Plan showing, to scale:** ___ Areas of undisturbed native vegetation (no amendment required); ___ New planting beds and turf areas (amendment required); ___ Type of soil improvement proposed for each area

___ **Soil test results (required if proposing custom amendment rates)**

___ **Product test results for proposed amendments**

AREA #_____ (*should match Area # on Site Plan*)

PLANTING TYPE ___ Turf ___ Planting Beds ___ Undisturbed native vegetation ___ Other:

SQUARE FOOTAGE OF THIS AREA: _____ square feet

SCARIFICATION ___ Subsoil will be scarified	___ inches (depth) of scarification needed to achieve finished total 12" loosened depth.	
PRE-APPROVED AMENDMENT METHOD: ___ Topsoil import; ___ Amend with compost; ___ Stockpile and amend (____ cu. yds. stockpiled)	____ inches of compost or imported topsoil applied X 3.1 (*conversion factor, inches to cubic yards*) ____ = cu. yards per 1,000 sq. ft. X ____ ,000s sq.ft. in this area ____ = cubic yards of amendment → → → → → (*needed to cover this area to designated depth*)	PRODUCT: QUANTITY:_____CU. YDS.
CUSTOM AMENDMENT ___ Topsoil import; ___ Topsoil & compost lift; ___ Amend; ___ Stockpile and amend (____ cu. yds. stockpiled)	**Attach test results and calculations.** ____ inches organic matter or topsoil import X 3.1 ____ = cu. yards / 1,000 sq. ft. X ____ ,000s sq.ft. in this area ____ = cubic yards of amendment → → → → →	PRODUCT: QUANTITY:_____CU. YDS.
MULCH	___ ,000 sq.ft. X 6.2 (*conversion, to give 2 inch mulch depth*) ____ = cubic yards of mulch → → → → → →	PRODUCT: QUANTITY:_____CU. YDS.

TOTAL AMENDMENT/TOPSOIL/MULCH FOR ALL AREAS (*complete on page 1 only, totaling all areas/pages in this Plan*)

❑ **Product #1:** ❑ **Quantity:** _____ **cu. yds.**
❑ **Test Results:** ___ **% organic matter** ___ **C:N ratio <25:1** (except mulch, or <35:1 for native plants) ___ **"stable"** (yes/no)
❑ **Product #2:** ❑ **Quantity:** _____ **cu. yds.**
❑ **Test Results:** ___ **% organic matter** ___ **C:N ratio <25:1** (except mulch, or <35:1 for native plants) ___ **"stable"** (yes/no)
❑ **Product #3:** ❑ **Quantity:** _____ **cu. yds.**
❑ **Test Results:** ___ **% organic matter** ___ **C:N ratio <25:1** (except mulch, or <35:1 for native plants) ___ **"stable"** (yes/no)

Date:	**Inspector:**	**Approved:**	**Revisions Required:**
Date:	**Inspector:**	**Approved:**	**Revisions Required:**

COMMENTS:

How to Select Compost

Know your supplier!

- Field tests:
  - earthy smell - not sour, stinky, or ammonia
  - brown to black color
  - uniform particle range
  - stable temperature (does not get very hot if re-wetted)
  - not powdery or soaking wet
- Soil/compost lab test info:
  - Nutrients
  - Salinity
  - pH
  - % organic content (OM)
- Mfr.-supplied info:
  - Meets US Compost Council (STA) "Seal of Testing Assurance", State & WsDOT specs
  - C:N ratio
  - Weed-seed trials
  - Nutrients, salinity, contaminants
  - Size: "screen", % fines
- Specifications:
  - WsDOT
  - Bioretention Soil: Compost spec

www.seattle.gov/util/GreenInfrastructure

Compost Application Methods

Compost application & incorporation methods:

- Blowing
- Spreading
- Tilling / ripping
- Blending off-site

Blowing & spreading

- Blower trucks
- Various construction grading equipment
- Other equipment :
  golf course & farm spreaders

Issaquah Highlands – the big scale

PB
PORT BLAKELY
COMMUNITIES
Integrity and Innovation

Incorporating amendments into soil

- Range of equipment for different-sized sites
- Till in to 8” depth
- If compacted, rip to 12” depth before/while amending

Stockpile site soils & amend, after road & foundation work

- Allows mass grading
- Can reduce hauling & disposal costs
- Set grade to allow re-application of topsoil & allow for settling
- Amend stockpile to spec offsite, or after reapplication
- Spread after concrete work
- Rip in first lift, to reduce sub-grade compaction

Redmond Ridge: current method

- Grade site 12 in. below finish
- Install foundation, along with driveway & walkway rock pads
- Spread 14 in. amended soil mix, (will settle to 12 inches) rip in first lift to mix with subsoil
- Soils blended offsite from native duff plus compost
- Soil organic matter controlled to ~10%, pH and C:N ratio for optimal plant growth

Importing “Topsoil”

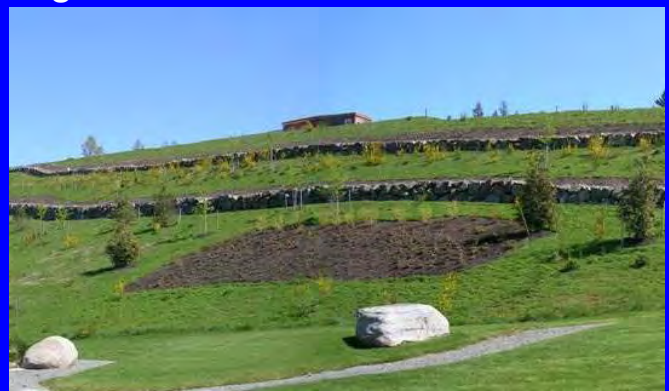
- “Topsoil” is not a defined, regulated product. Topsoil products often include subsoil, uncomposted organic material, land-clearing and construction debris…
- Best to use mixes containing only clean compost and mined sand or “sandy loam” as defined by USDA.
- Important to avoid clay that can inhibit drainage – spec <5% passing #200 sieve

- See Seattle/WSU/PSP “Bioretention Soil” specification at www.seattle.gov/util/GreenInfrastructure under “Stormwater code”

Compost Based Erosion Control BMPs

- EPA-approved BMPs: **blankets**, **berms**, and **socks** see www.buildingsoil.org
- "2 for 1" – use compost for erosion control, then till in at end to meet soil BMP:
  - No disposal costs
  - Faster planting, better growth
- Costs: blankets similar to rolled products, but savings on disposal, plus 2 for 1 benefits
- Learn more at www.buildingsoil.org/tools/Erosion_Control.pdf

"2 for 1" – construction erosion control and soil quality BMPs are met with compost at Issaquah Highlands.



WsDOT: Erosion control, water quality, successful landscapes with lower mtce. costs

SR 14, Vancouver
Coarse compost, blown in
Note erosion where not applied

Compost amendment,
ripped in

Extensive soil bio-engineering info at:
http://www.wsdot.wa.gov/Design/Roadside/

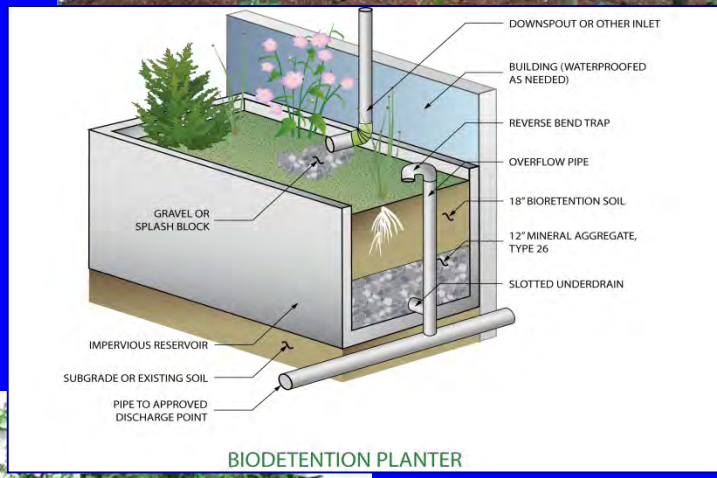
Combine methods as needed for best water quality and flow control

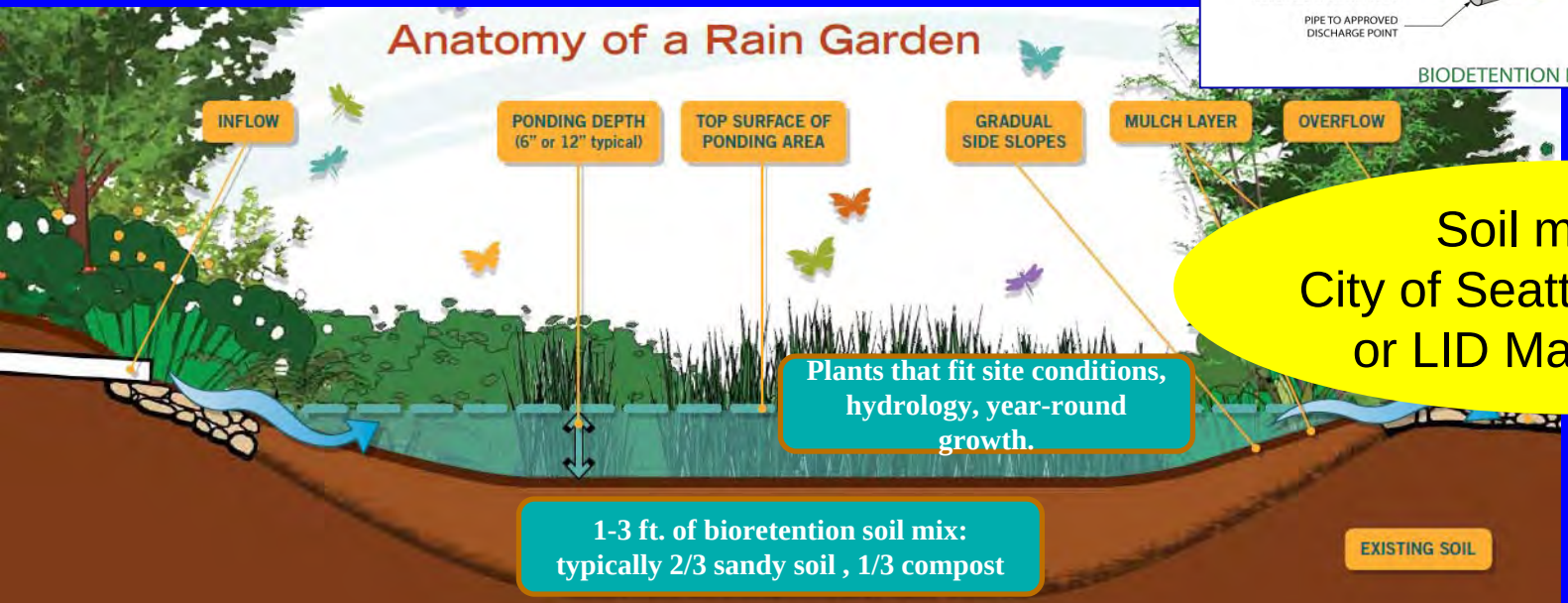
WsDOT - Protecting Wetland Area from I-5 Runoff

Bioretention

Depressions with amended soil and plants to infiltrate & treat runoff from roofs & pavement

- **Bioretention swales**: usually roadside
  - 1-4% slope conveys water while treating
- **Bioretention cells (aka "raingardens")**
  - Closed drainage (low spot) with overflow
- **Stormwater planters**
  - Engineered for tight spaces





Soil mix: use City of Seattle Std. Spec, or LID Manual spec.

Putting organics to work - SEA Streets

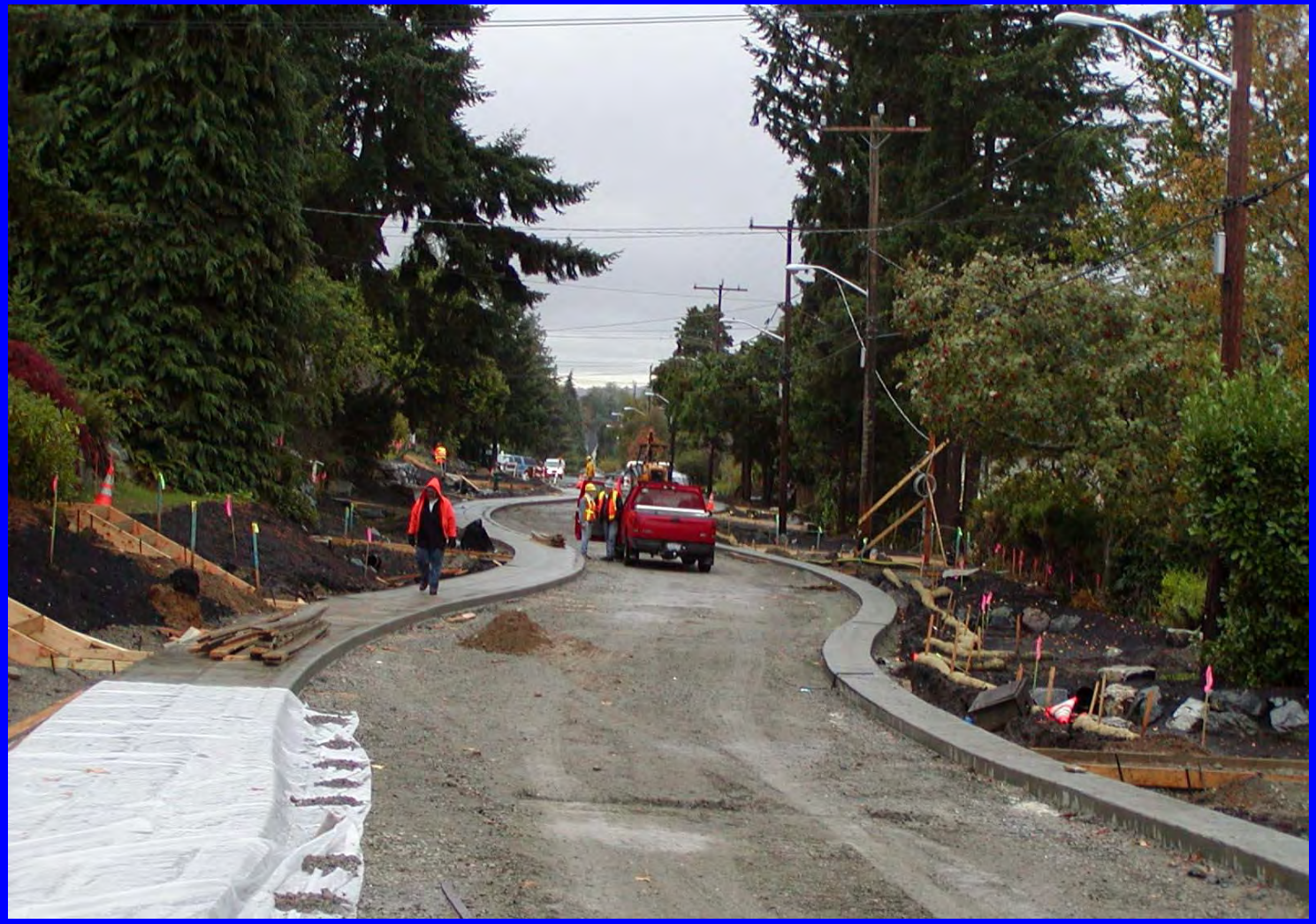
Street Edge Alternative onsite detention demo, Seattle Public Utilities and SDOT.

- Compost in wet and dry zones
- **98% reduction in runoff.**

www.seattle.gov/util/GreenInfrastructure

Broadview Green Grid, Seattle

Compost-amended soil in bio-retention swales



Broadview -

Erosion control with compost blankets, berms, and socks

WsDOT projects around Washington

Erosion control and plant establishment on steep site using compost blankets

Chelan

Photos courtesy of Sandy Salisbury, WSDOT

Compost

No Compost

I-5 Marvin Rd. Interchange

Selling soil BMP's to builders, landscape contractors, & homeowners:

Value to builder/contractor

- Less plant loss = fewer callbacks
- Making money on materials and labor
- Quicker planting in prepped soil
- Easier maintenance
- Better appearance sells next job

Sell quality & savings to customer

- Better plant survival/ health/ growth/ appearance
- Lower water bills
- Lower maintenance costs
- Reduced chemical needs
- Better for salmon because:
  - reduced storm runoff
  - improved water quality

Links to useful soil specifications:

Building Soil: Guidelines for Implementing WDOE Soil Quality & Depth BMP (includes APWA & CSI specs)
www.soilsforsalmon.org or www.buildingsoil.org

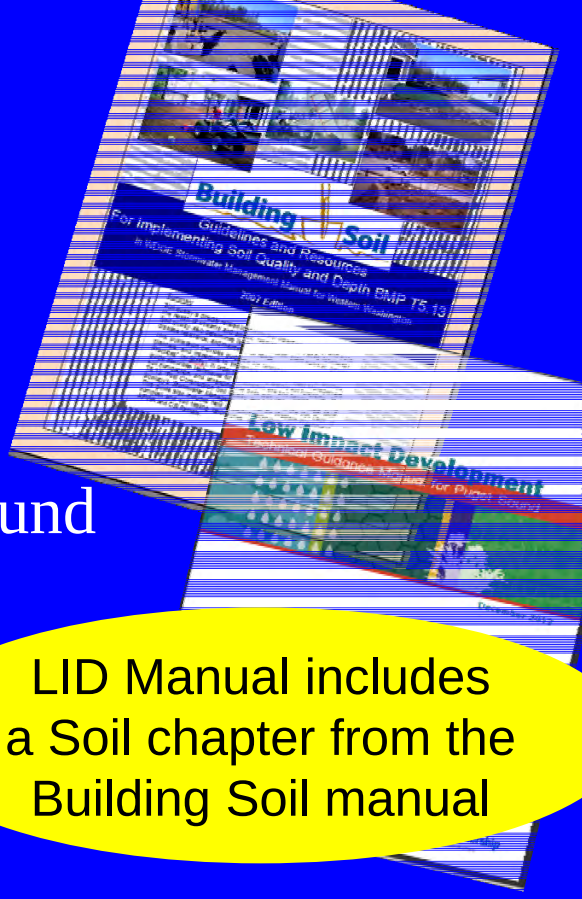
LID Technical Guidance Manual for Puget Sound
www.psp.wa.gov/stormwater.php
Eastern WA: www.wastormwatercenter.org

WsDOT "Soil Bioengineering" specs
www.wsdot.wa.gov/Design/Roadside/

Seattle "Natural Drainage Systems" projects & "Green Stormwater Infrastructure" specs www.seattle.gov/util/GreenInfrastructure

King County soil regs (in Grading code)
http://your.kingcounty.gov/solidwaste/greenbuilding/soil-standard.asp

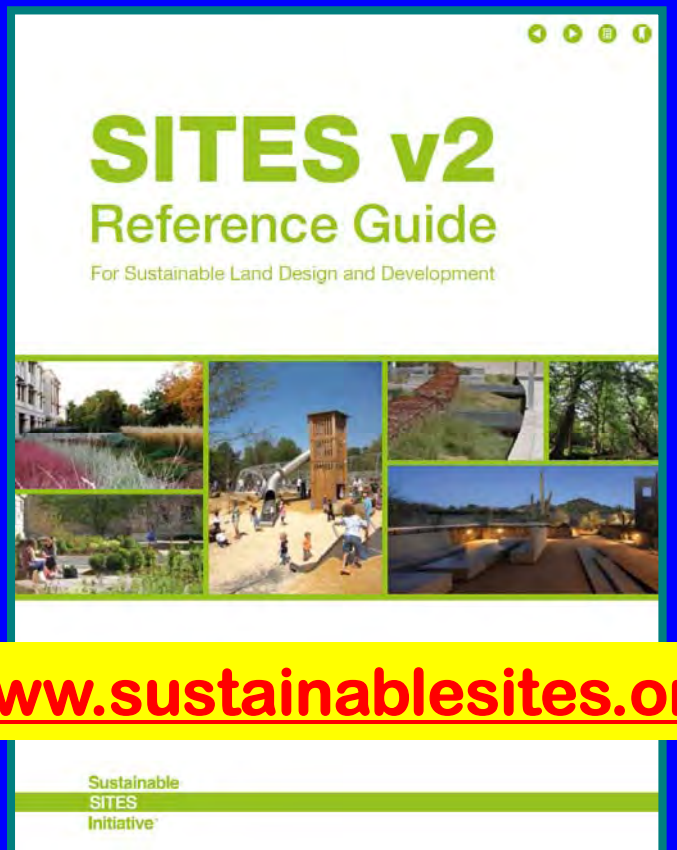
City of Seattle soil regs (in Stormwater code)
http://www.seattle.gov/dpd/codesrules/codes/stormwater/default.htm



LID Manual includes a Soil chapter from the Building Soil manual

Related national standards: 2014 Sustainable Sites (SITES™)

- **SITES is the new national site & landscape equivalent to the USGBC's LEED™ green building certification system.**
- SITES includes soil protection and restoration requirements modeled on Washington's
- Includes Soil Management Plan requirement
- Similar Green Stormwater BMP requirements to WA LID & DOE stormwater manuals

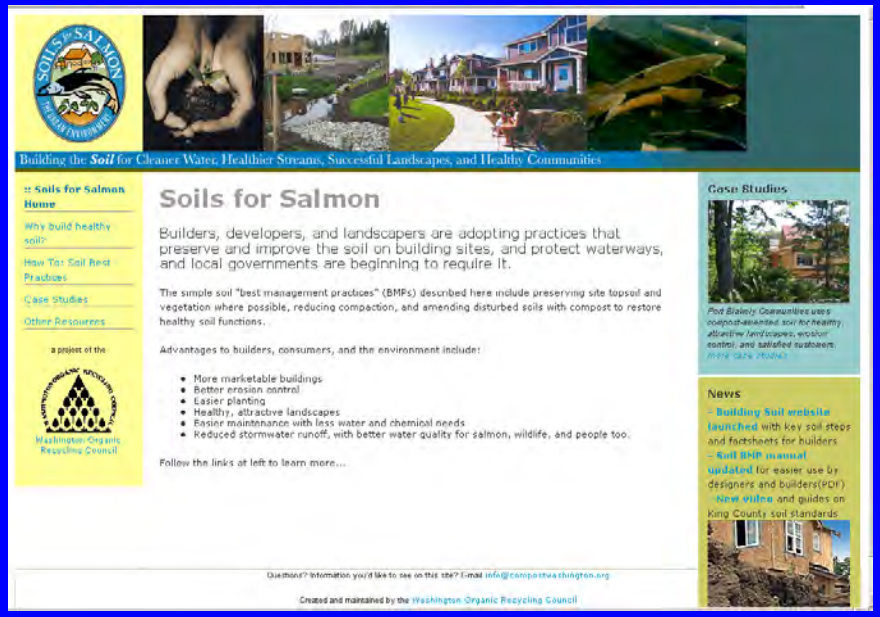


www.sustainablesites.org

A natural solution -
for healthier streams, and healthier landscapes

- Conserve existing soils and vegetation where possible.
- Restore natural functions in disturbed soils by reducing compaction and using organic amendments.

www.BuildingSoil.org



www.SoilsforSalmon.org