Infiltration Feasibility Assessment and Successful Infiltration Design

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Topics

• Infiltration feasibility fundamentals
  - Geologic characterization
  - Geotech to civil stormwater translator
  - Estimating design infiltration rates

• Review guidance
  - Geotech report
  - Checklist

• Questions
Geologic Characterization

• Understand where water put in the ground goes

• What is the geology (subsurface soil)?
   Thickness and lateral extent of permeable unit
   Separation from perching layers and water table
   Permeability, vertical infiltration
“The geological origin of a deposit determines both its pattern of stratification and the physical properties of its constituents. The pattern of stratification is of outstanding engineering importance because it determines the degree of accuracy with which the performance of the subsoil... can be predicted on the basis of boring records and test data.”

Karl Terzaghi, 1955

Source: Kathy Troost, UW

Geologic Characterization
How did glaciers affect Puget Sound?

• The Great Lowland Fill
• Changed the landscape
  ▪ Eroded out valleys and smoothed hilltops
  ▪ Deposited sediment, filling valleys
  ▪ Created landforms
• Altered watersheds
• Depressed the land (Isostacy)
• Altered base (lake, sea) levels
Glaciofluvial infilling and scour of the Puget Lowland, Washington, during ice-sheet glaciation

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ABSTRACT

The Puget lobe, the southwesternmost extension of the Cordilleran ice sheet, last advanced into the Puget Lowland of western Washington at about 15 ka. The advancing ice sheet deposited voluminous sediment on a prograding, proglacial outwash plain that extended from the Olympic Mountains to the Cascade Range, herein recognized as the “great Lowland fill.” Subsequent overrunning by the ice sheet excavated deep linear troughs now occupied by the large lakes and marine waters of Puget Sound. Excavation of these troughs and valleys of the Puget Lowland required the net transport of about 1000 km³ of sediment, almost entirely during ice occupation and primarily by subglacial water. These landforms of glaciofluvial deposition and erosion define the modern landscape here, emphasizing the importance of these processes in the region’s geomorphology.

GEOLOGY, v. 22, p. 695–698, August 1994
Geologic Characterization - Outwash

- Water sorted, **stratified**
- Can be over-consolidated by ice (advance) or normally consolidated (recessional)
- Good infiltration receptor
Geologic Characterization - Till

- Highly compressed
- Bimodal particle size distribution
- Very low permeability
- Groundwater mounding
- 1 to 1-1/2 inches per month of vertical recharge through till
- Good for earthen dams/berms
Drainage Report

Surface water model refers to **soils**

Soils in glaciated terrain → weathered “parent” geologic material

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Geotech to Civil Storm Translator

Know your A, B, Cs, Hydrologic Soils Class

- A: low runoff, high inf: Everett, Indianola, Spanaway
  - Outwash -> A

- C: mod-high runoff, low inf: Alderwood, Harstine, Tokul
  - Till -> C
Water Flow on a Till Site

Weathered till = Type C soil
WWHM/MGS: Runoff = both surface RO + interflow
Fate of water?

Unweathered Fresh Till
(Hardpan, Nature’s concrete)
Very Low Permeability
Typ. range 5 to 30 feet thick
Rarely over 100 feet

Vashon Advance Outwash
MODERATE TO HIGH PERMEABILITY
When Mistakes are made...

- **Flow controls goals**
  - Protect receiving bodies – save our streams and salmon
  - Avoid liability, lawsuits, drainage complaints
  - When flow control goes bad, it’s ugly, P.R. nightmare

- **Upper photo**: new bioretention cell, shows cut extends through weathered till horizon, into underlying unweathered till
- **Lower photo**: Fall rains. Note slumping, failures of soil where excavation was near-vertical.
Need for better characterization

- One year later... Amended soils have slumped off sidewalls
- No effective infiltration
- Limited infiltration occurs into weathered till horizon through interflow zone
- Fate of the water?
Water Flow on a Till Site

Unweathered Fresh Till
(Hardpan, Nature’s concrete)
Very Low Permeability
Typ. range 5 to 30 feet thick

Lateral seepage at base of adjacent block wall
Estimating Design Infiltration Rates

- Early stormwater infiltration requirements
- 6-inch-Ø stand pipe tests
  - Septic design based
  - Small footprint, small volume
  - Not representative
- Impressive failures
- Improved testing methods – Pilot Infiltration Testing, small and large

Unfortunately, soils are made by nature and not by man and the products of nature are always complex...

Karl Terzaghi
Volume Comparison, at 0.3 and 3 in/hr

- 6-inch-Ø pipe
- Fill 3x = ~4 gal
- Double ring, less

- Small PIT, 12-32 SF, 7 hr,
  - 0.3 iph = 16-32 gal
  - 3 iph = 160-420 gal

- Large PIT, 100 SF, 6 hr
  - 0.3 iph = 112 gal
  - 3 iph = 1,120 gal
Estimating Design Infiltration Rates

• Will groundwater mounding reduce long term design infiltration rate with time?
• What effect, if any, would a groundwater mound have on nearby facilities, wells, slopes, etc.?
Estimating Design Infiltration Rates

- What about grain-size based estimates?
  - Context is very important
  - Grain size testing homogenizes soil, removes layering, averages grain size content
  - Ecology grain size formula is not reliable for gravel or silty sands
  - Can overestimate permeability
  - In-house comparison of hundreds of PITs and grain-size based estimates

Unfortunately, soils are made by nature and not by man and the products of nature are always complex... Karl Terzaghi
Review – Typical Data Requirements

- Receptor soil characteristics
- Geologic unit
- Stratification
- Infiltration rate - vertical
- Depth to groundwater
- Depth to aquitard
- Groundwater flow direction
Review Guidance

• Geotech Report

• 3 general types of geotech reports:
  ▪ Infeasibility/Feasibility Documentation
  ▪ “Standard” Infiltration Design – larger than single family
  ▪ Limited Infiltration Assessment – single family
Review Guidance

• Infiltration
Feasibility/Infeasibility
Documentation
  ▪ Standard Infiltration Assessment vs Single Family (very small site)
  ▪ Different requirements
All Projects Require Basic Documentation

- Site maps and testing locations
- Local site geology, including soil or rock units likely to be encountered, groundwater regime, and geologic history of site
- Discussion of soil and groundwater conditions found
- Results, including detailed logs for each subsurface exploration
  - Logs must include depth of pit or borehole, geologic unit, soil descriptions, depth to water, and presence of stratification
- Depth to groundwater and to hydraulically-restrictive material
- Geologic hazards considerations
• Basic Documentation
• Receptor horizon – thickness, permeability
• **Basis** for seasonal high water level determination
• Seasonal fluctuation of groundwater table
• Nearby wells or drainfields
• Less common:
  • Assessment of ambient groundwater quality
  • Native soil treatment testing - CEC, OM, grain size
Review Guidance Standard Checklist -2

- Field-measured and design infiltration rate
- Discussion of correction factors
- Geologic cross section -> shows lateral extent
- Pathway of discharged stormwater, potential drainage impacts to adjacent properties, geologic hazards, wells, springs, wetlands, streams
- Groundwater mounding analysis and potential for groundwater mounding or seepage as a result of proposed infiltration facilities
Review Guidance – Limited (SFR)

• Basic Documentation
• Receptor horizon – thickness, permeability
• Infiltration – Prescriptive grain size sizing
  ▪ Grain size tests are USDA version, not USCS
  ▪ For medium-grained or coarser outwash type soils
  ▪ caution caution caution when sizing for finer-sands and silty soils
• Basis for seasonal high water level determination.
• Lateral extent of infiltration receptor horizon
• Pathway of discharged stormwater – nearby utilities, foundations, retaining walls
USDA SCS/NRCS

- Discussion question
- Septic-based methods for stormwater disposal
- What is the loading from a septic perspective vs the storm event that these are supposed to be sized for?
- Septic - allowable disposal rate for linear foot of drain field for a single family application
- For dosing at a 200-300 gpd, whole series of lateral trenches
Natural Compaction – Compare Everett and Alderwood Soils

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<th>EVERETT GRAVELLY SANDY LOAM</th>
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Key Items to Check

• Look for disconnects
  ▪ Geotech report doesn’t describe volume for testing and infiltration rate is less than 1 inch/hour
  ▪ Drainage/TIR has Soil Type C but infiltration is checked
  ▪ Drainage plan includes infiltrating pavements but site is importing Fill to make grades

• Is there site specific data, is it deep enough?

• Where is the water going – esp. on low rate or spatially variable sites?
Key Items to Check

• Drainage report and plan review –
  ▪ Where was infiltration testing vs facility location and depth?
  ▪ Does the grading plan remove the tested horizon?
  ▪ Will the water be captured by utility trenches

• Safe overflow path

• Contactor communication and construction observations

• Make sure it is built right...inspections, as-built testing or post-construction monitoring
Questions?