Field Soil Assessment for Infiltration-Based Stormwater Control Measures

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New Water Board Post Construction Requirements

- Will often necessitate better knowledge of project native soil conditions because of LID requirements and emphasis on infiltration-based Stormwater Control Measures (SCMs)
- Under some geotechnical conditions, infiltration is not required but “poor” soils is not one of them!

Guidance Development:
Soil Infiltration Assessment for LID

Current effort by Earth Systems Pacific and the LID Initiative intended to:

Provide cost-effective field soil analyses methodologies to inform

a) site opportunities/constraints for infiltration

b) SCM sizing

Preliminary Desk Information Needed

- Slope / topography of parcel
- Descending slopes nearby
- Protected vegetation or habitat (heritage oaks, endangered species, etc.)
- Springs, seeps
- Bedrock outcrops
- Nearby wells

Preliminary Desk Information Needed

- Soil types from USDA Soil Charts, local geologic / geotechnical knowledge, etc.

- Soil or groundwater contamination

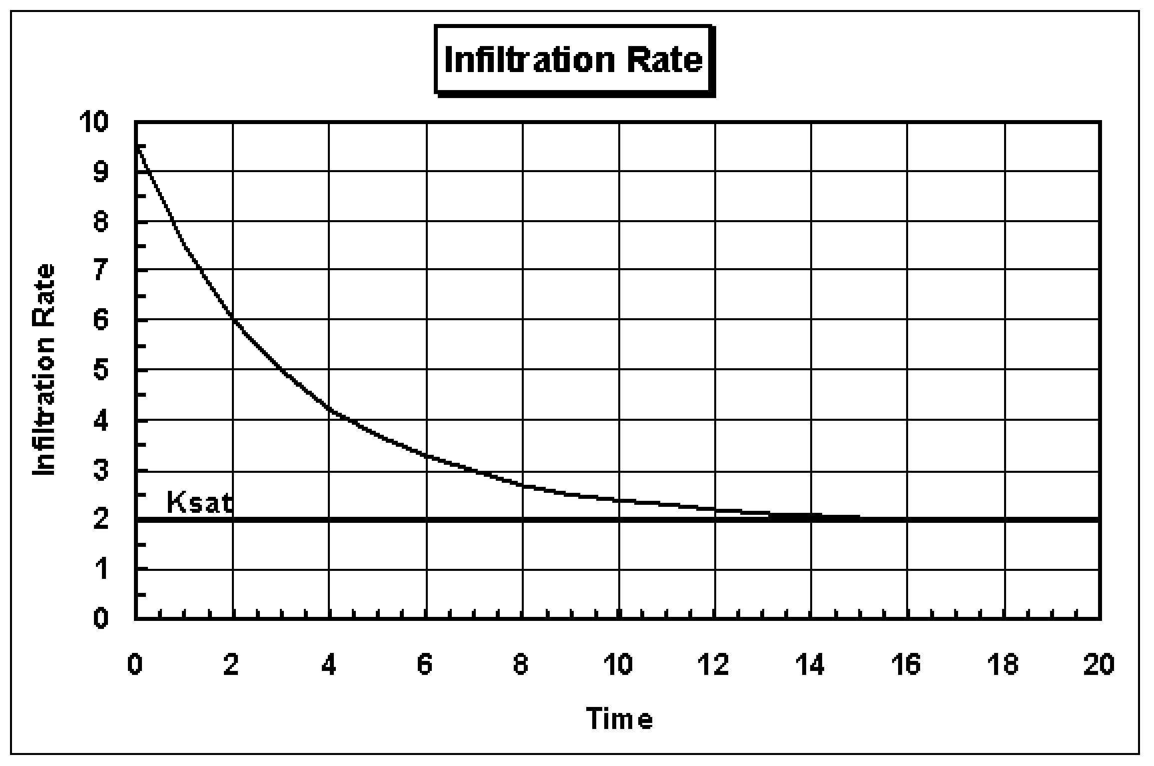
- Other geotechnical / geologic constraints impacting public safety or property

- Other constraints that would render areas unavailable for SCM based infiltration

What Design Information Do We Need?

We want to know the ability of the native soils to move water under saturated conditions

Generally described as Hydraulic Conductivity (Ksat or Ks)



Penn State Cooperative Extension

Options for Obtaining Hydraulic Conductivity Values

1. Existing data associated with the project location (e.g., USDA - NRCS data)

2. Use an existing field methodology and computations

Options for Obtaining Hydraulic Conductivity Values: Existing Data

Values from look up tables may not be accurate and result in over- or under-sizing a facility

However, in many cases, may be totally appropriate

Options for Obtaining Hydraulic Conductivity Values: Field Methods

There are many field methods and computations to derive Ksat

They can be costly, complex and inaccurate

Done well, can generate very good information

Courtesy of the Seattle Public Utilities

Is there a Field Methodology that can approximate Ksat information in a cost-effective manner?

We Think So!

Small Sites

(limited areas for infiltration-based SCMs)

- Drill 1 profile boring and 2 infiltration test borings in each potential SCM area

Acreage and unconstrained sites

Up to 5 acres

- Drill 1 profile boring and 2 infiltration test borings per acre potentially usable for SCMs

Over 5 acres:

- Drill 1 profile boring per geologic unit that may be usable for SCMs, with 2 to 4 infiltration test borings associated with each profile boring.

Profile Borings

- 6” to 12” diameter
- Extend 5’ to 10’ below planned invert of SCM
- Log:
  - USCS classification
  - Consistency
  - Presence of moisture or free water
  - Color
  - Impermeable and permeable zones
  - Other characteristics that may be pertinent

Infiltration Test Borings

Shallow SCM's

- Drill or dig by any means

- Test the zone from about the elevation of the top of the planned SCM to 2' below the elevation of the *invert* of the SCM

- 6" to 12" in diameter in test zone

- Insert perforated pipe, fill annulus with gravel

Infiltration Test Method

•Establish datum from which to take measurements

•Add water to the approximate elevation of *top* of the planned SCM

•Maintain the head for 30 minutes

•Shut off water and record volume of water that entered the test boring

•Measure the fall of the water for 4 hours

•If a test boring runs dry, refill the boring and continue measuring the falling head to end of original 4-hour period.

Similar Method for Deep SCMs

Small Sites

- Drill 2 profile / test borings in each potential deep SCM area

Acreage and unconstrained sites

Up to 5 acres

- Drill 3 profile / test borings per acre potentially usable for SCMs

Over 5 acres

- Drill 4 profile / test borings per geologic unit that may be usable for SCMs.

Typical Data

A	B	C	D	E

DATE DRILLED: 6/18/15 **DATE TESTED: 6/19/15**

TESTED BY: RW/PF **DIAMETER: 6 inches**

INFILTRATION TEST LOCATION: 1 **DEPTH: 8 Feet**

CONSTANT HEAD RESULTS: Time: 30 min Volume: 3.5 gallons

Water elevation maintained at 12 inches below existing surface.

FALLING HEAD RESULTS

INTERVAL (minutes)	**READING (feet)**	**FALL (feet)**	**INFILTRATION RATE (minutes/inch)**	**INFILTRATION RATE (inches/hour)**
0.00	1.00	---	---	---
30.00	1.67	0.67	3.7	16.1
30.00	2.75	1.08	2.3	25.9
30.00	3.42	0.67	3.7	16.1
30.00	3.96	0.54	4.6	13.0
30.00	4.42	0.46	5.4	11.0
30.00	4.75	0.33	7.6	7.9
30.00	4.96	0.21	11.9	5.0
30.00	5.13	0.17	14.7	4.1

Converting Infiltration Rates to K_{sat}

- Still in development stage

- Exploring adaptation of existing equations from the literature

- All equations are logarithmic

- One is for cased borehole (Hvorslev, 1951):

$$K_s = (A/F * D * t) * \ln (h_1/h_2)$$

K_s = Saturated Hydraulic Conductivity
A = Cross sectional area of infiltrometer
F = Shape factor (2.75 for flat bottom)
D = Diameter of infiltrometer
t = Time between head readings
h_1 = Initial head
h_2 = Final head

Possible Adaption of Hvorslev Equation

$$K_s = (A^* \, h_{avg}/F * D^* \, t) * \ln (h_1/h_2)$$

$$h_{avg} = (h_1 + h_2)/2$$

When is obtaining field data for infiltration potential especially a good idea?

When you aren't sure of the local native soil conditions (type, heterogeneity)

When you have a large site and associated SCM where error risk is compounded

When consequences of failure dictate a better understanding of the actual soils

-More relevant when you assume good soils and actually not

- Assuming poor soils will provide more conservative design but may oversize the facility

Common Mistakes

- No site specific geotechnical information provided
- Relying on NRCS soil database for geotechnical information when site parameters indicate that acquiring field data would be wise
- Geotechnical report does not identify infiltration rates for the site
- Not adequate number of infiltration tests for larger sites
- Depth to groundwater – need site specific information
- Inappropriate infiltration test methods

What is the Worth of Field Data and Standardized Methods for Acquisition of Field Data?

For the Designer:

- “Real" data from the project for can allow better SCM siting
- Can help to confirm (or refute) data obtained from existing tables
- Can provide information when none exists

For the Reviewer:

- Allows the jurisdiction to provide guidance to the Project Applicant on a methodology that is cost-effective when site soil data is needed/required

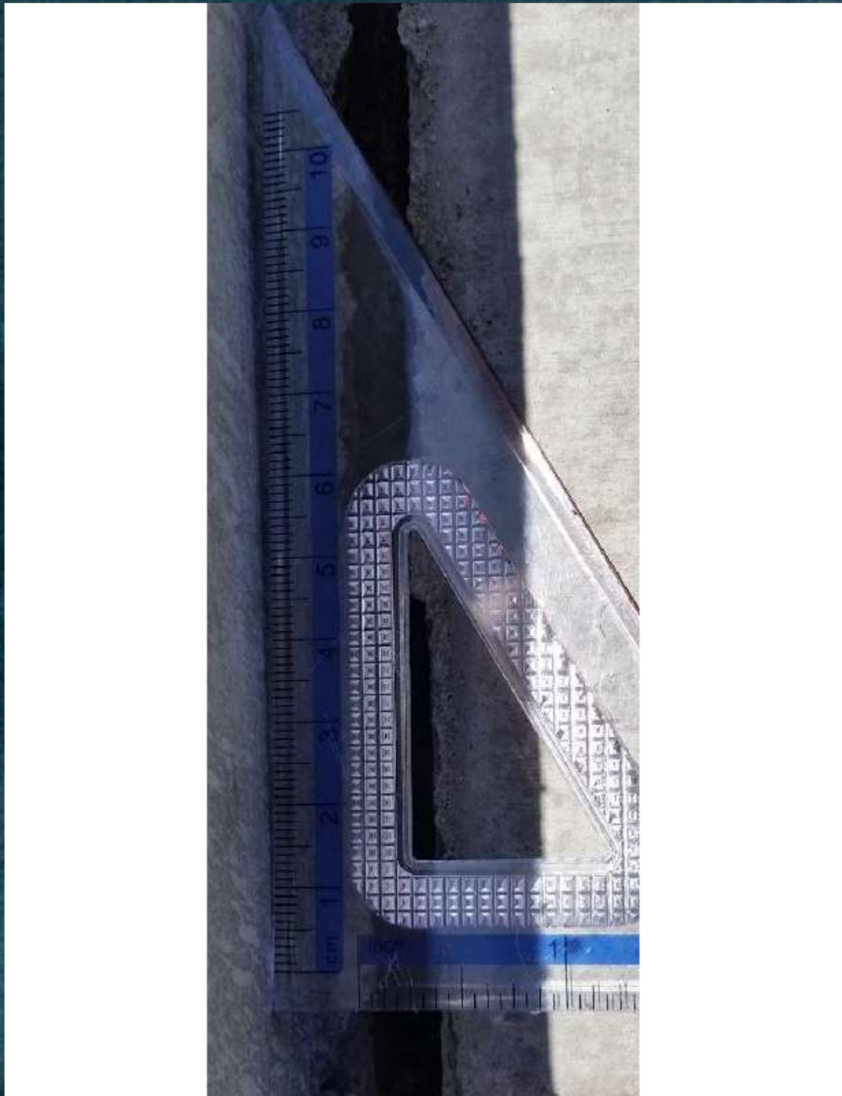
Cautionary Tales/True Life Adventures Part 1

Cautionary Tales/True Life Adventures Part 2

Cautionary Tales/True Life Adventures Part 3a

Cautionary Tales/True Life Adventures Part 3b

Cautionary Tales/True Life Adventures Part 3c



Cautionary Tales/True Life Adventures Part 3d