Green Infrastructure at KSU:
Initial Comparison of Performance between Native Design and Traditional Turf

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NRES Capstone – Spring 2016 – Dr. Trisha Moore

ABSTRACT

Green infrastructure (GI) has become a popular method for Kansas State University to restore native systems back into the now turf landscape of the university's campus. The aim of this study is to compare properties of these GI systems to those of turf grass systems.

OBJECTIVES

- Determine maintenance and design aspects of the Meadow
- Determine soil type, soil moisture, and bulk density
- Measure infiltration rates to access runoff potential and compare to that of turf
- Analysis of nitrogen & phosphorus in runoff as well as expected trace elements and heavy metals concentration of runoff
- Analyze potential downstream impacts of GI systems

Image 1: The Meadow located on K-State campus (photo by K-State Communications and Marketing)

STUDY AREA

The Meadow is a recent green infrastructure addition to K-State's Manhattan, Kansas campus. The Meadow was established in 2013 and modeled after the Konza Prairie to feature natural grasses, flowers, and trees. The primary function of this green infrastructure site is education-based instead of having a intended function such as flood or erosion control. However, it does has strong potential to mitigate floods.

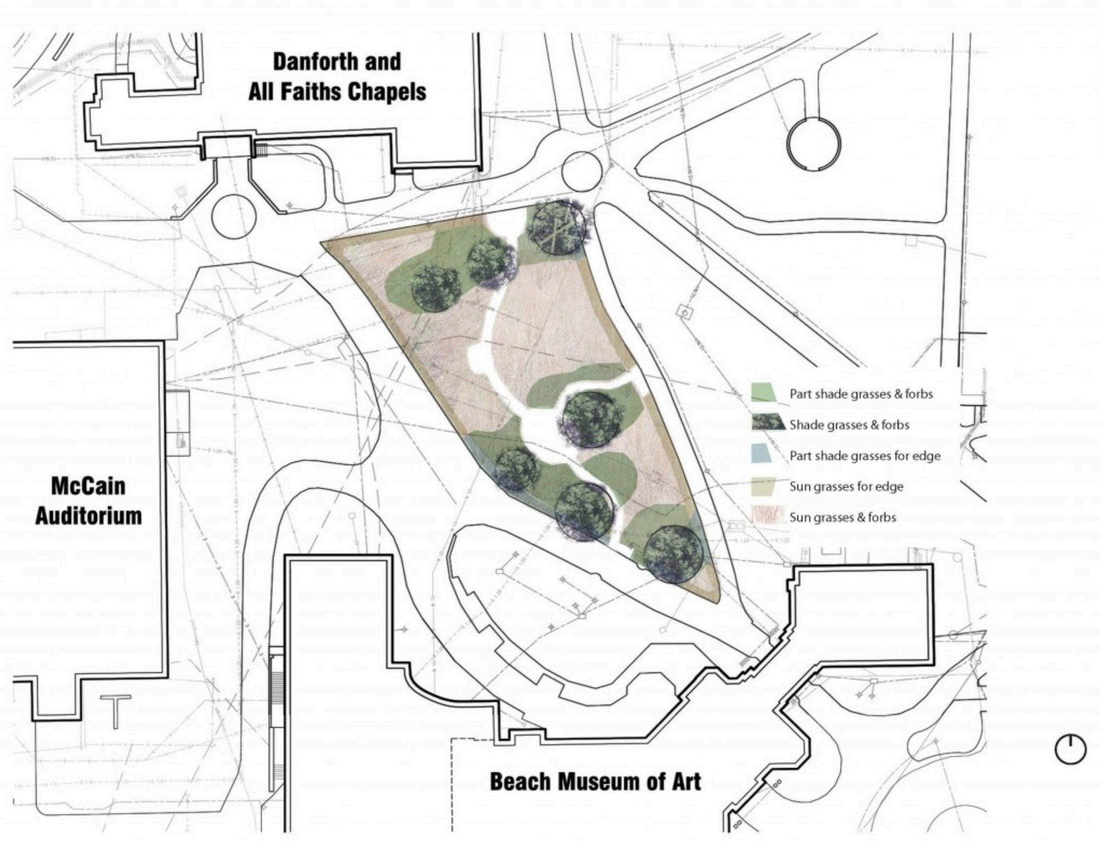


Image 2: The Meadow schematic (image by landscape architect Prof. Katie Kingery-Page)

STUDY AREA, Cont.

Green infrastructure designed for stormwater management has to consider a number of design criteria based on the performance objectives. The goals of these kinds of projects are slowing and reduction of runoff by increasing infiltration and storage capacity (Pataki et al). Additionally, the plants and growth media involved can act as natural filtration systems, reducing the concentration of stormwater pollutants.

However, successful operation of GI depends on a careful maintenance regimen to ensure the system is meeting its performance goals. Periodic testing of the system's functions can improve overall performance by identifying areas that are under-performing and determining which aspect of the system may be malfunctioning (Feehan).

METHODS

Soil Testing

- Soil core samples were taken using a borer.
- Soil sample calculations

  Soil moisture : (Wet Weight [g] - Dry Weight) [g] / Dry Weight [g]

  Bulk density : Dry Weight [g] / Volume [cm^3]

Infiltration Testing

- Fill infiltrometers with water
- Keep outer ring at a constant head
- Record water level drop on 2-minute and 5-minute intervals
- As inner ring water level drops below a certain level, add water to ensure relatively constant pressure head
- Results in **Figure 2.**

Nitrogen and Phosphorus Testing

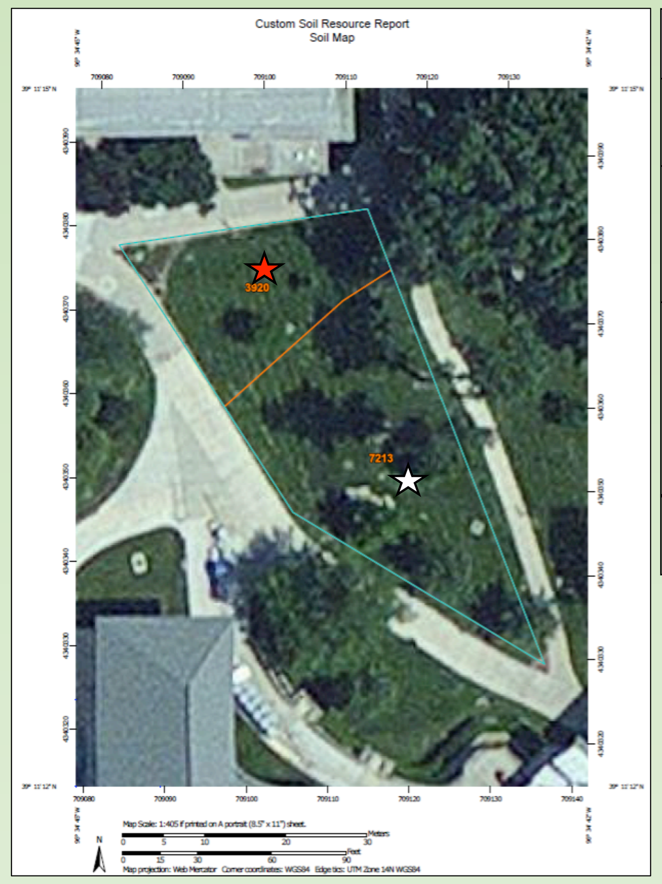
- Water samples were taken at locations on and off campus, as well as in the Meadow
- Samples were tested for nitrogen and phosphorus concentrations.
- Results in **Table 1**.

Downstream Impacts

Urban inputs into streams causes:

- Decrease health and survival of downstream biota (Gillis 2012)
- Unnatural water temperature and chemistry (Lieb & Carline 2000) Aalgal blooms due to excess nutrients (Bayram et al., 2013)
- Higher concentrations/suspension of heavy metals, bioaccumulation (Wei & Morrison 1993)
- Increased potential for sedimentation and channelization

RESULTS



Riley County, Kansas (KS161)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
3920	Smolan silt loam, 3 to 7 percent slopes	0.1	32.5%
7213	Reading silt loam, moderately wet, very rarely flooded	0.2	67.5%
Totals for Area of Interest		0.3	100%

Image 3: Web Soil Survey Report. Each infiltration site is a separate soil type. The NW Meadow (32.5 %) has a Saturated Hydraulic Conductivity (Ksat) of 2.84 [µm/s]. The Beehave (67.5%) has a Ksat of 3.33 [µm/s] .

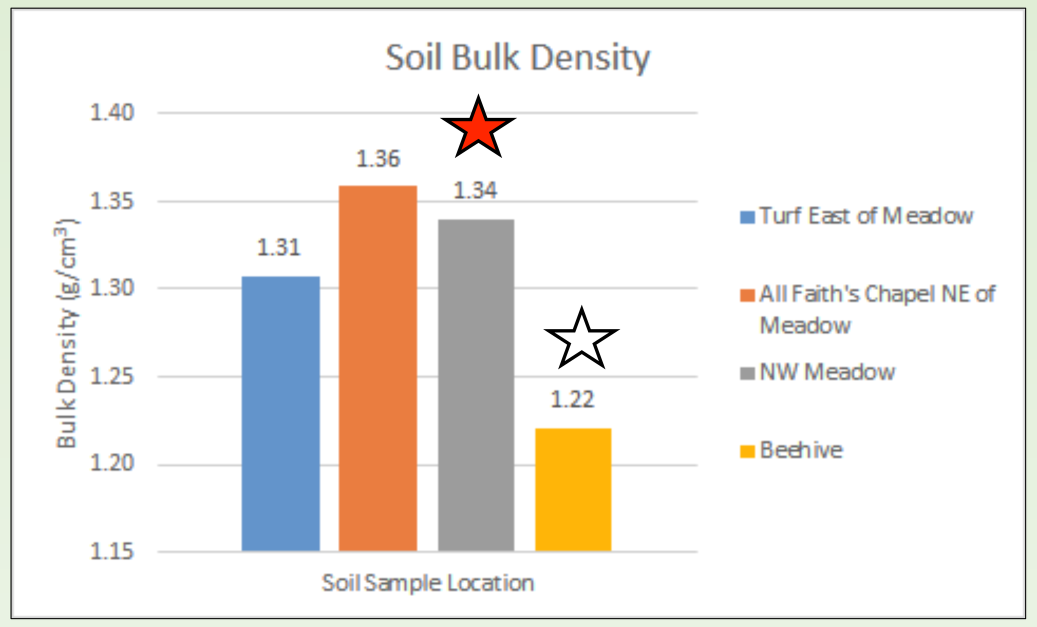


Figure 1: Bulk density results from soil testing, done March 12, 2016 Diameter of 2-inches. The bulk densities are very close in value. This is attributed to the young age of the Meadow, which was built in 2013.

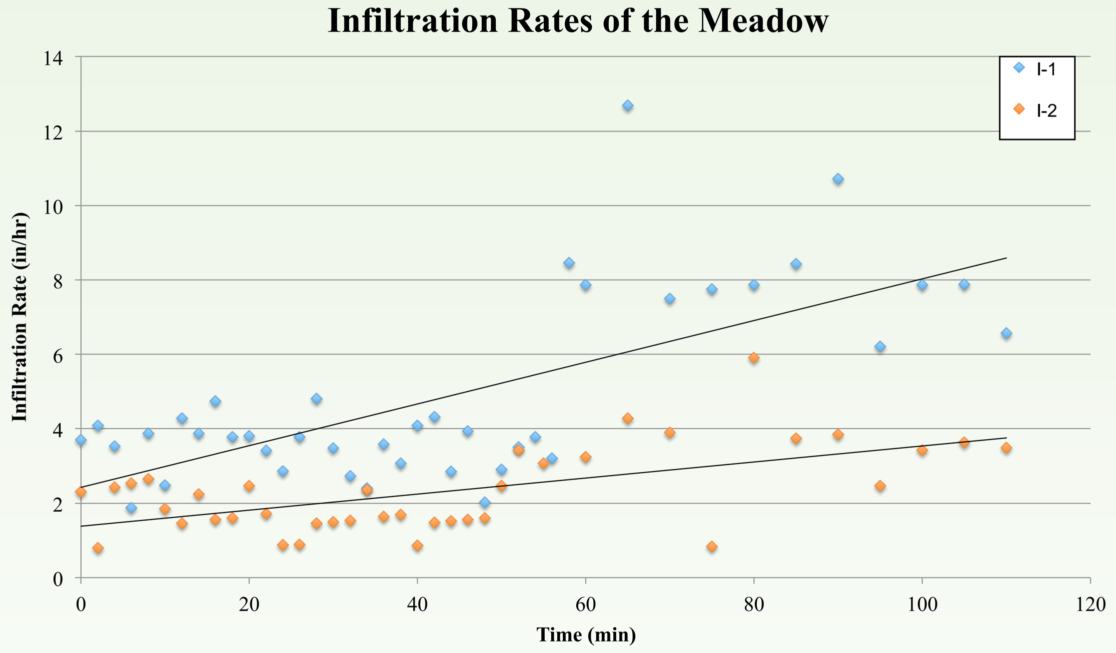


Figure 2: Results of infiltration testing. I-1 is located on the NW sloped hill of the Meadow and I-2 is located in the middle of the Meadow. Infiltration rates were opposite of what was expected– increasing rates with time. In general infiltration rates decrease gradually with time. These results are attributed to the heavy rainfall event saturating soils prior to infiltration testing.

RESULTS, Cont.

Water Sample Location	Nitrate (mg/L)	Phosphate (mg/L)
Meadow (sidewalk by museum)	0	0.2
Meadow (from in beehive)	0	1
Quad (drain toward middle)	0	3
Engineering (just before draining to street)	0	0
New traffic circle on 17th street	1	3.8
Backyard Puddle	2	1.6
Rooftop drain	0	0
Runoff to storm drain	0	4
Road by Kendra's [;ace	0	0.2

Table 1: Results from the nitrate and phosphate tests done in the water lab at K-state. The samples were collected from various locations on campus and an urban area in Manhattan. Nitrates were much lower than expected. This could be due to the very heavy rainfall event.

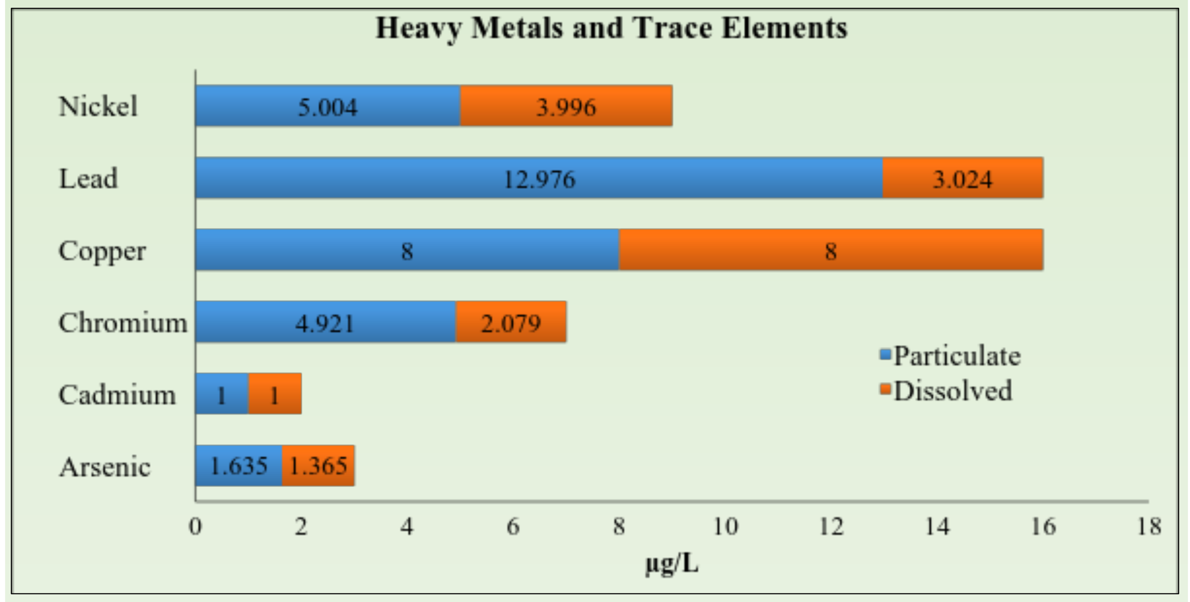


Figure 3: Expected heavy metal and trace element concentrations as determined and adapted by (Erickson, 2011).

DISCUSSION

When compared to turf grass, the Meadow's potential functionality as a flood and contamination reducer was more likely to occur. Turf grass on campus were shown to have much lower rates of infiltration (according to preexisting data from K-State research) compared to the Meadow. This suggests that the Meadow's functionality as a flood reducer is considerably higher than that of turf grass. Walt, et al. (2015) agrees that green infrastructure modeled from grasslands could reduce runoff and therefore flooding.

Further testing would need to be conducted to study in more depth the functionalities of both turf grass and green infrastructure; such as more extensive infiltration tests and soil analysis as well as on-site testing of trace elements and heavy metals.

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