Evapotranspirative Landfill BioCover (ET-LBC) for mitigation of landfill gas emissions and leachate generation

Hiva Jalilzadeh (M.Sc. Student)
Centre for Environmental Engineering Research and Education
Schulich School of Engineering

Supervisor: Dr. Patrick Hettiaratchi
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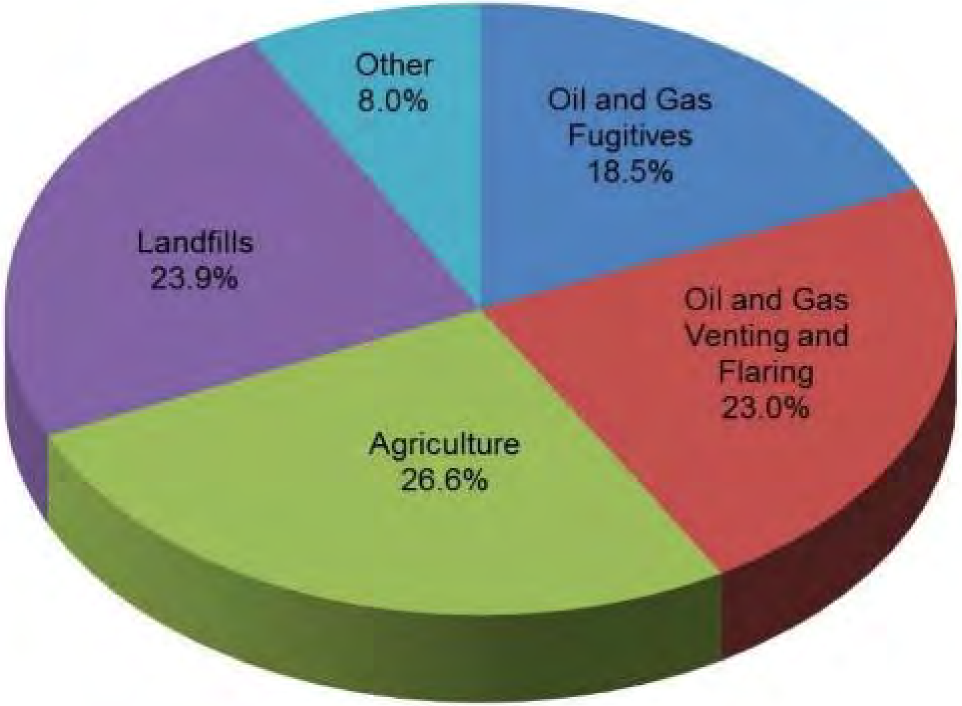
Introduction

- Global Warming Potential of Methane 34 times greater than CO2
- Primary sources of Canada's anthropogenic CH4
  - Oil and Gas Industry
  - Landfilling

Decomposition of organic waste produces landfill gas.

- Methane emission in 2014: 108 Mt CO2eq. (Canada)
  - Alberta and Saskatchewan responsible for 91% of these emissions



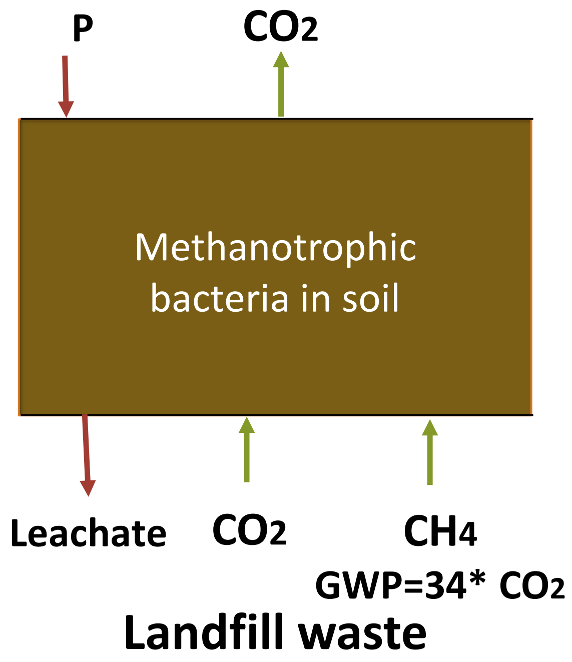
Methane Emission by Source (2014)

Source: Environment and Climate Change Canada; National Inventory Report 1990-2014

Introduction

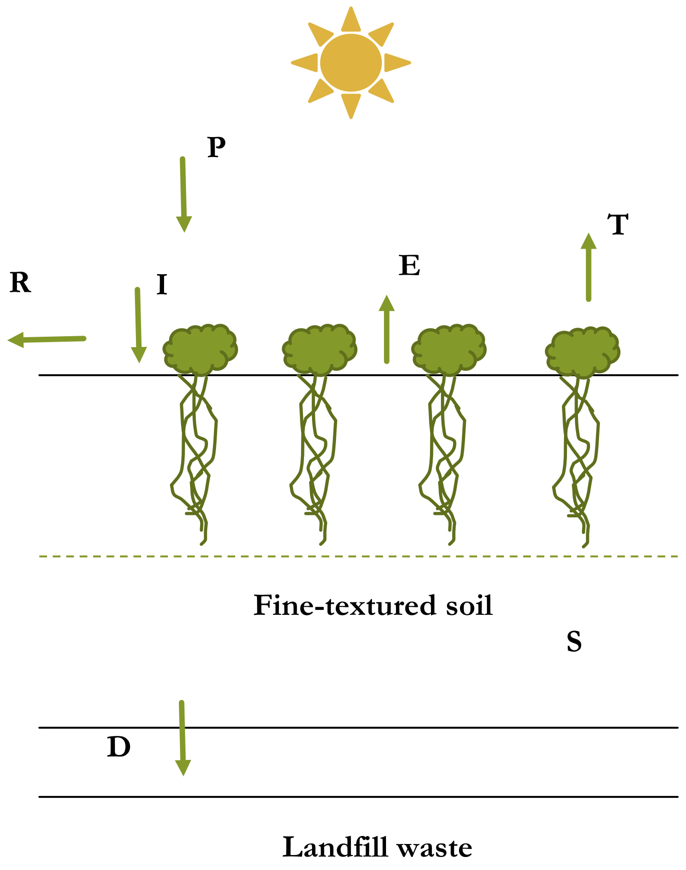
- Landfill biocover can mitigate GHG emissions
  - Methanotrophs are able to oxidize methane (up to 90%) and convert it to carbon dioxide without creating toxic by-products
  - Methanotrophs are aerobic organisms which require oxygen, moisture, high temperature and nutrients to oxidize methane

- However, there is a potential for percolation and leachate generation
  - Potential groundwater contamination
  - Leachate treatment



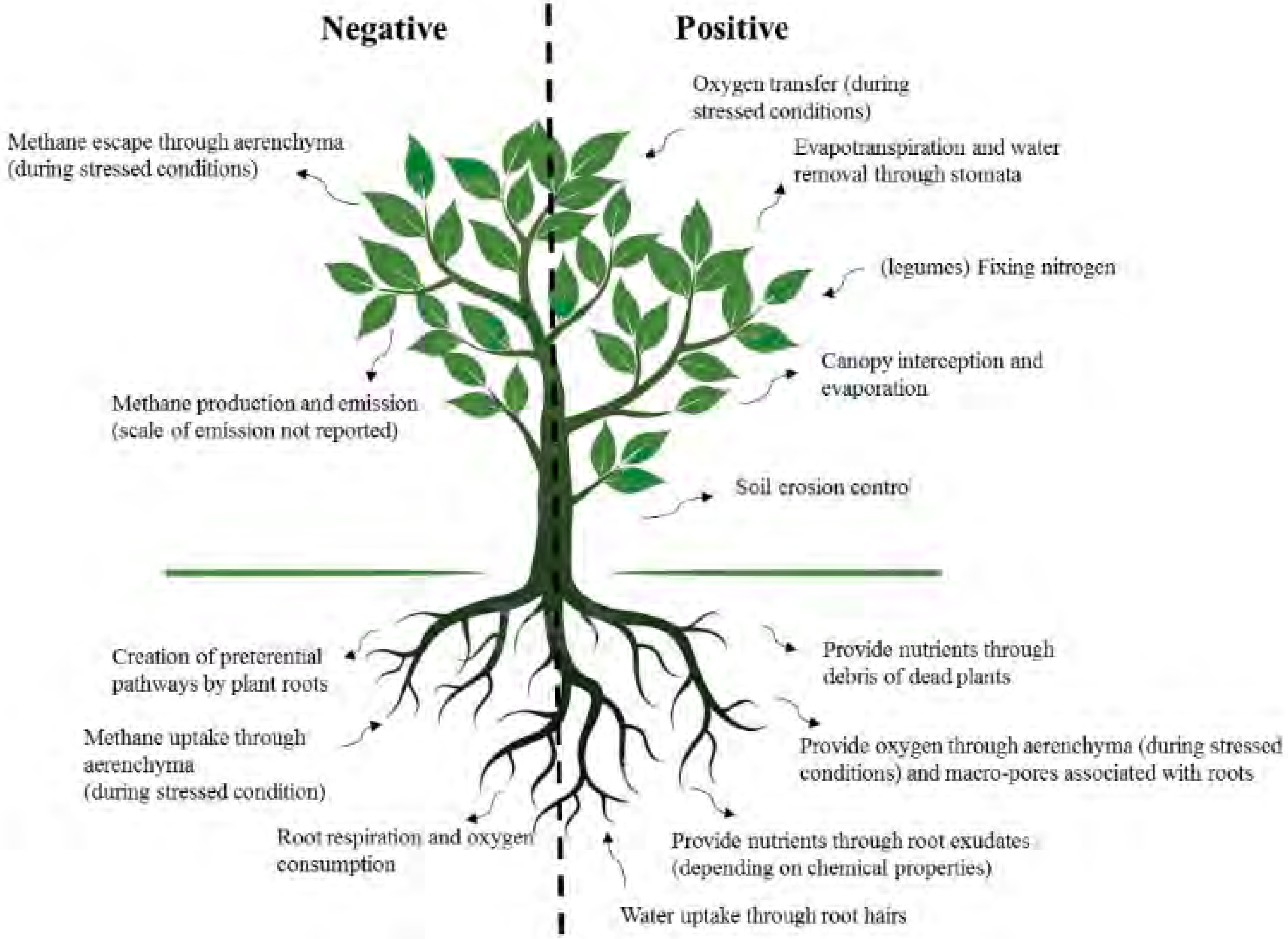
Landfill bio cover (LBC)

- Evapotranspirative Landfill BioCover (ET-LBC)
  - Reduce percolation by:
    - Canopy evaporation and interception
    - Water storage in soil matrix
    - Plant evapotranspiration
  - Effect on methanotrophy
    - Enhanced oxygen diffusion
    - Nutrients
    - Preferential pathways
    - Plant conduit



Gaps

- Plant-soil-water-gas interactions are fairly complex
- Current models are not able to predict methane emissions when plants are present
  - Water balance models have been studied extensively in US but not in Canada
  - Most of the gas transport models are static with regard to moisture content and temperature
  - Direct methane transport via plant conduits have not been considered in ET-LBC models



Objectives

- What are the key processes/parameters which control the performance of an ET-LBC system?

- Which water balance model can best describe field conditions in cold climatic conditions like Canada? Are existing water balance models efficient for sites here? (UNSAT-H, HELP, VADOSE/W, HYDRUS)

- How does moisture content change with time and depth and what is the effect on methane oxidation?

- What is the effect of vegetation on minimizing water percolation? Which type of vegetation has the best performance in terms of ET?

Data Collection

8 test cells specifically designed to simulate the landfill biocover at a controllable scale

- **ET-LBC media optimization**

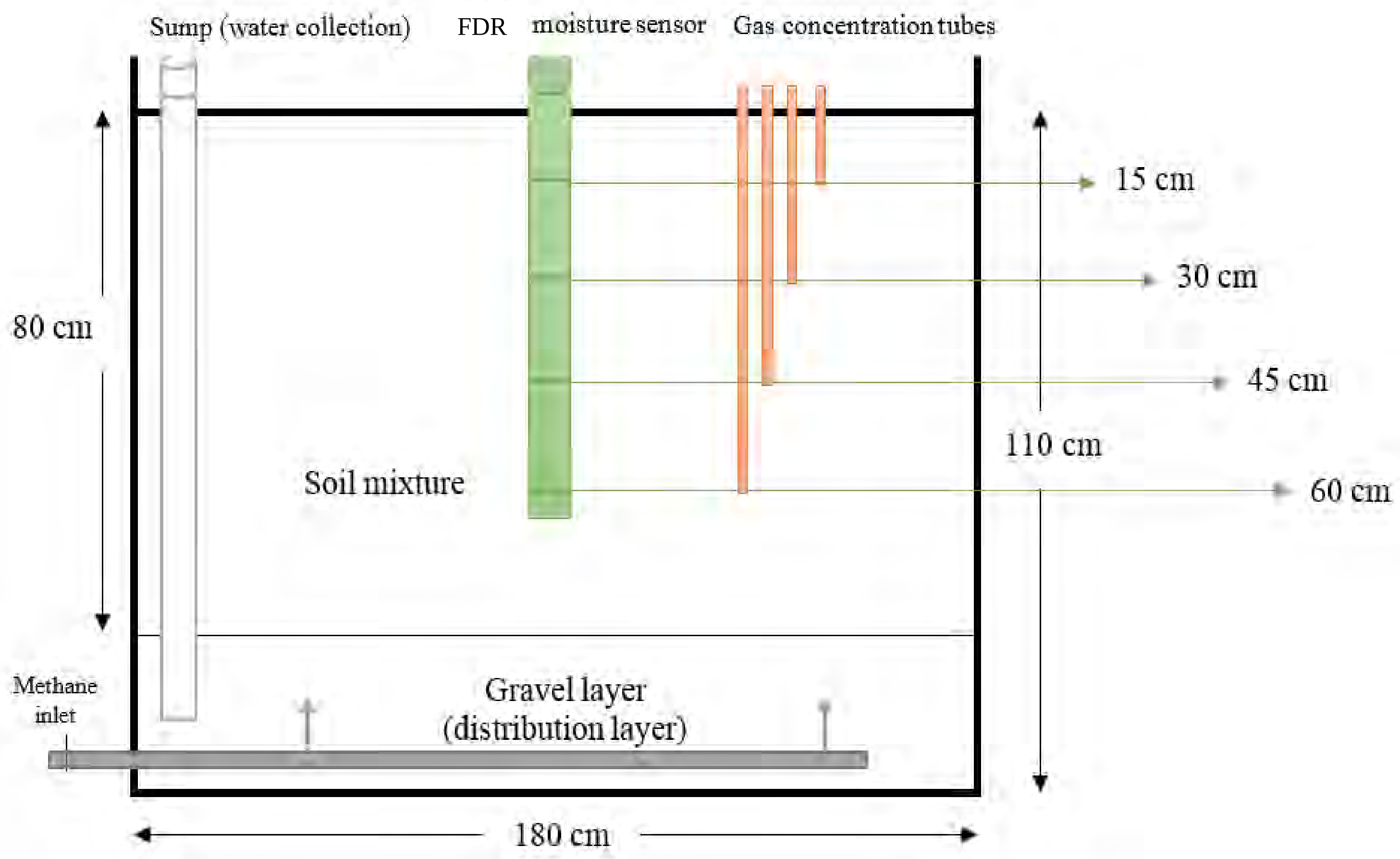
(Compost mixture and Topsoil)

- **ET-LBC vegetation study**

(Native grass, Japanese Millet, Alfalfa)

Demonstrate the effects of vegetation on water storage and ET capabilities, as well as CH_4 oxidation

Scale-up study in Leduc Landfill

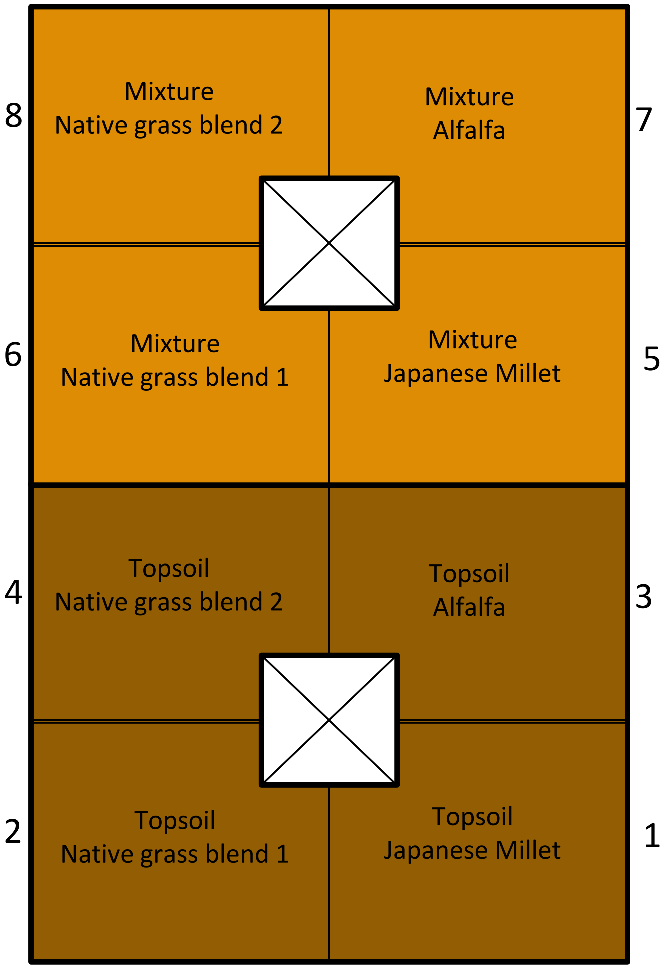


Experimental set-up

- Moisture profile is recorded with the use of FDR moisture probes dynamically through a data logger
- Gas concentration tubes are installed in the depths of 15, 30, 45 and 60 cm and will be analysed by GC.
- Oxidation efficiency and Methane flux are measured by flux chamber method
- Volume of percolation is measured through the sumps
- Plant growth will be measured by measuring plant biomass, rooting depth, leaf area and plant height during different stages of growth

Design of cells

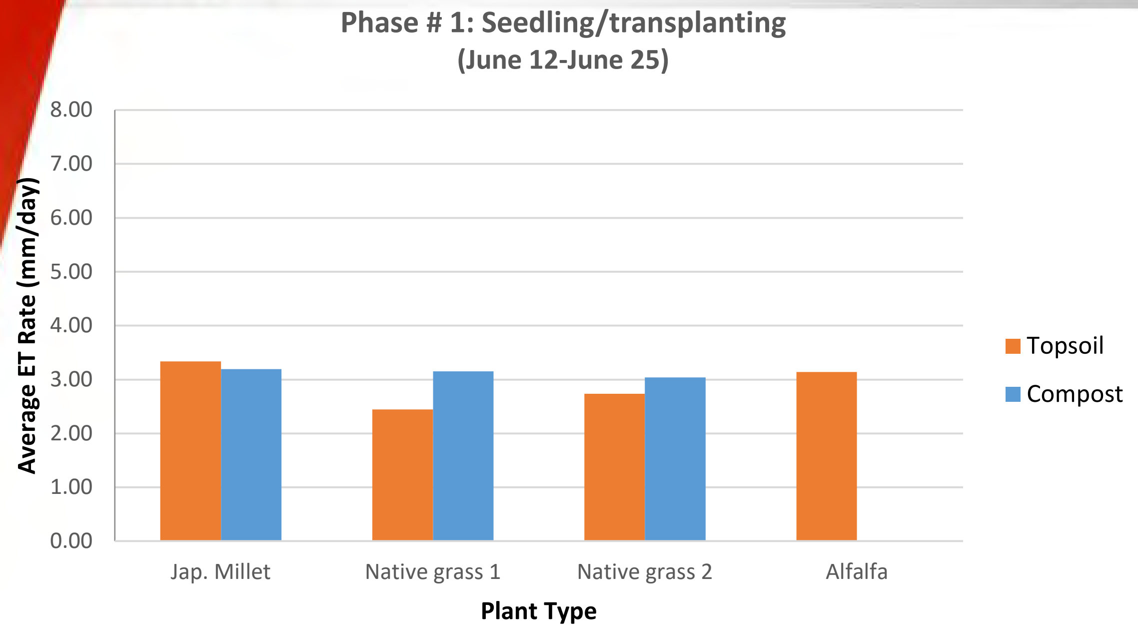
- Native grass types:
  - Northern wheatgrass
  - Tufted hairgrass
  - Awned wheatgrass
  - June grass
  - Rough fescue

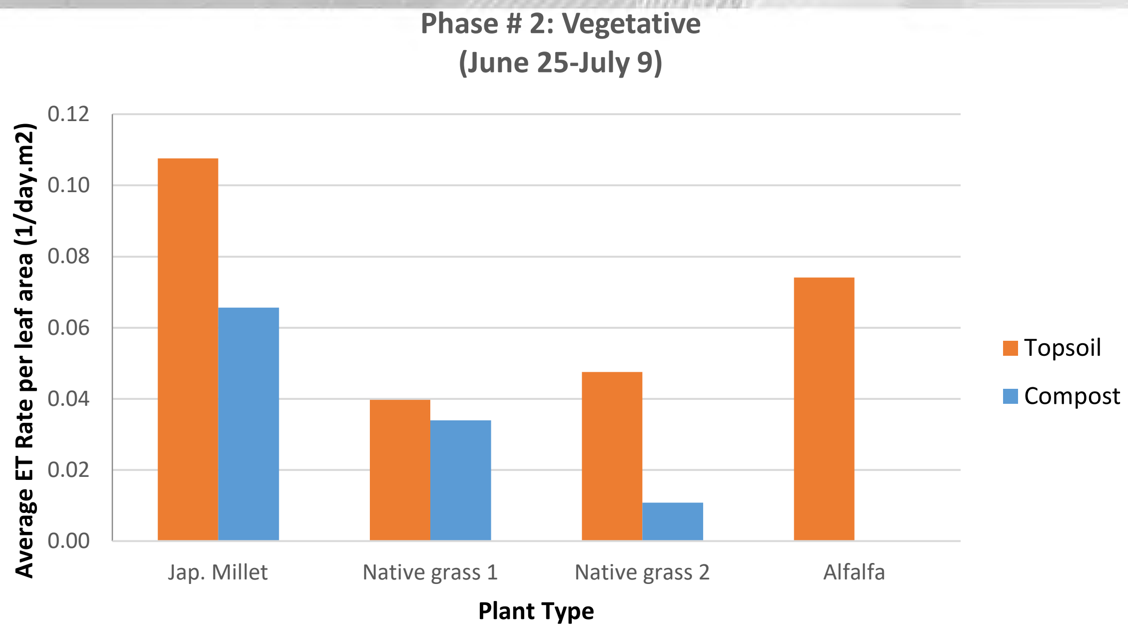


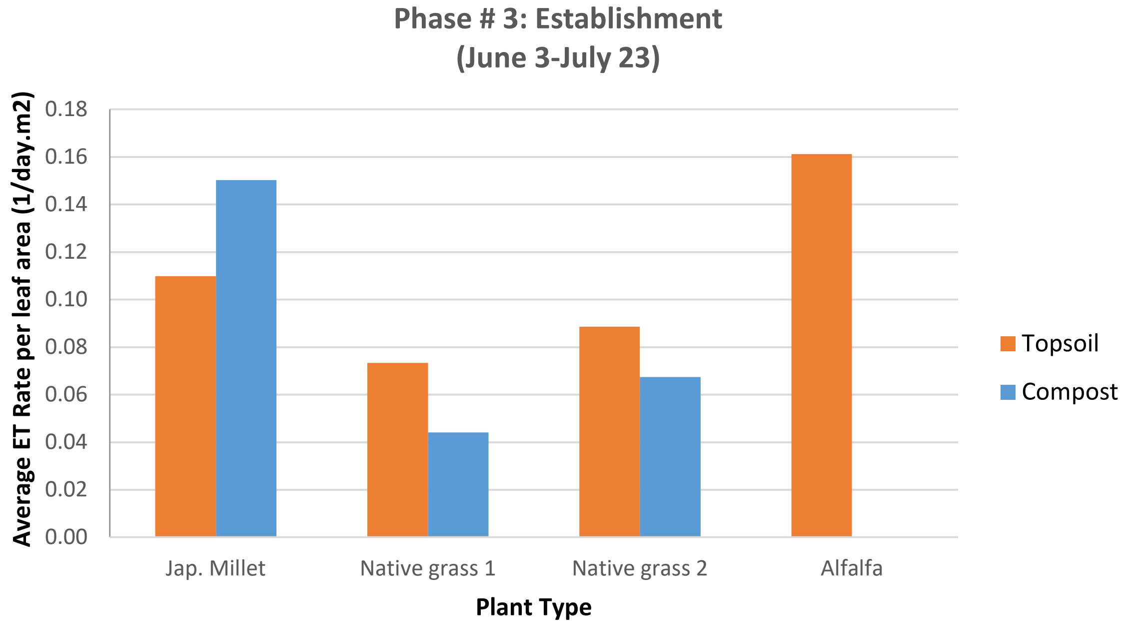
Experimental Set-up

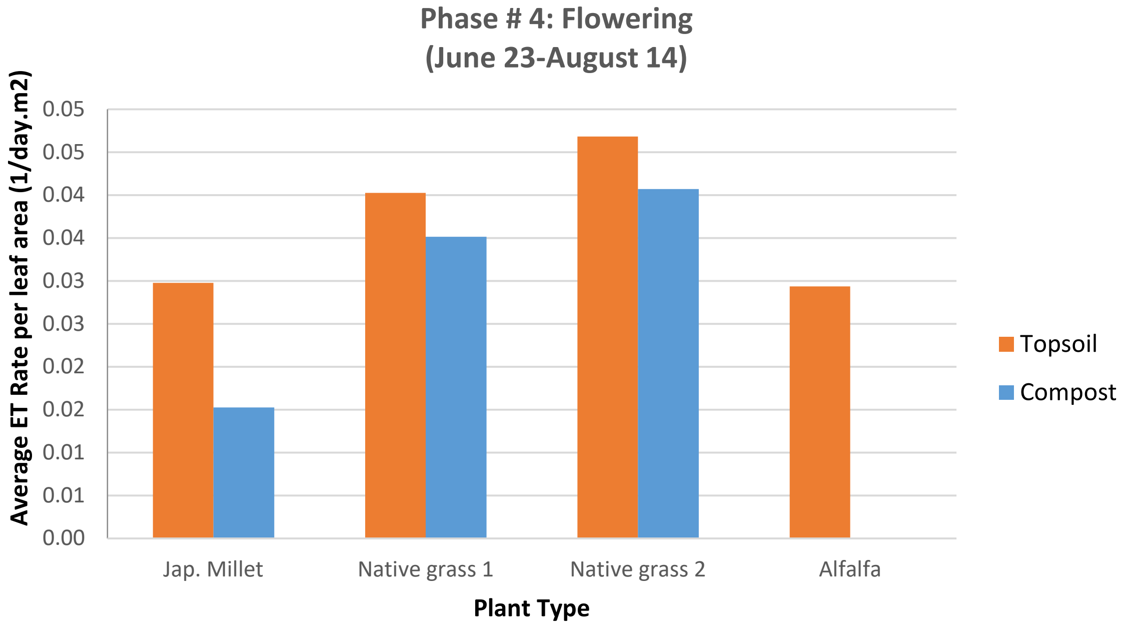
- Summer 2018

Results (ET comparison)

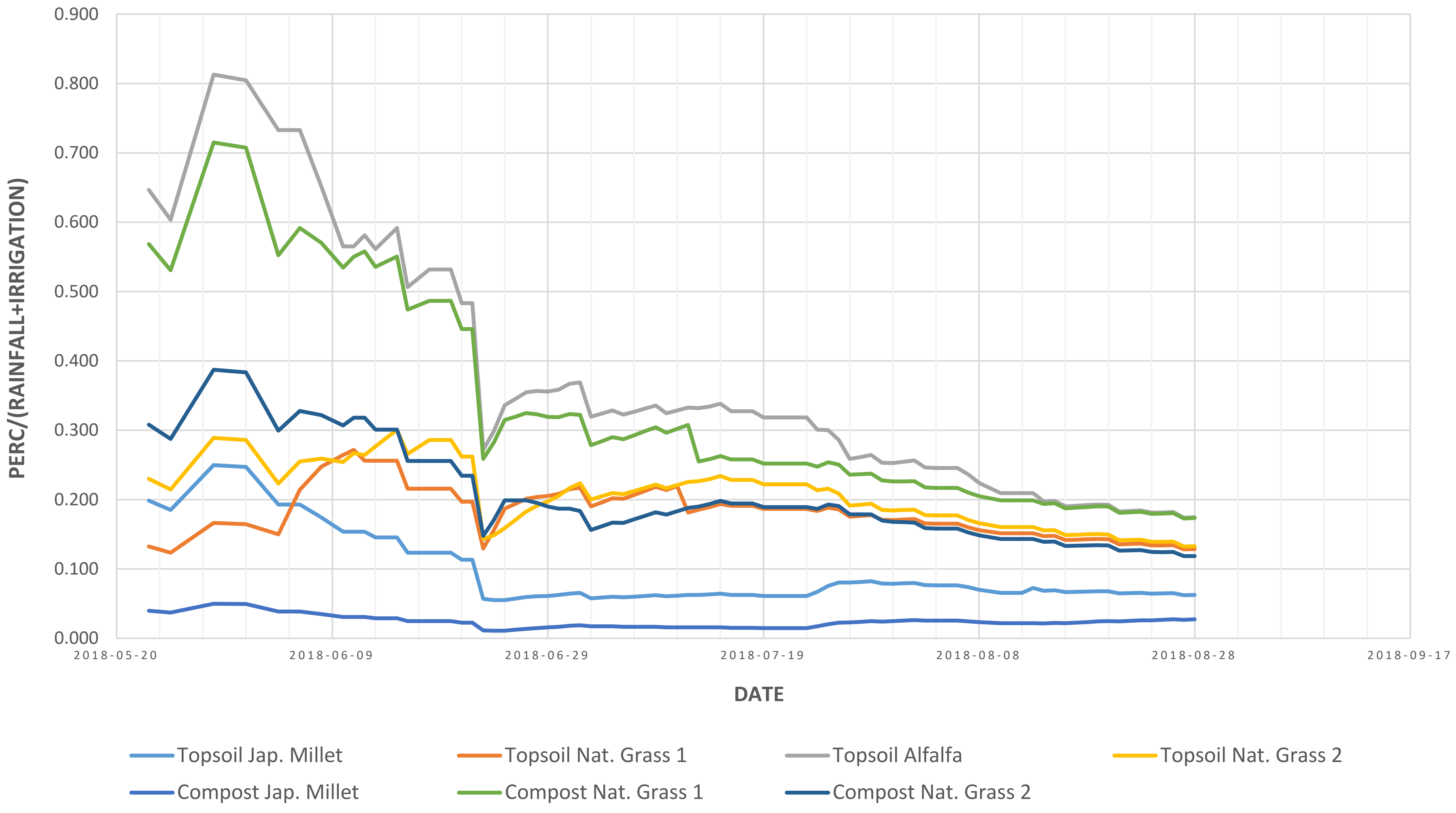






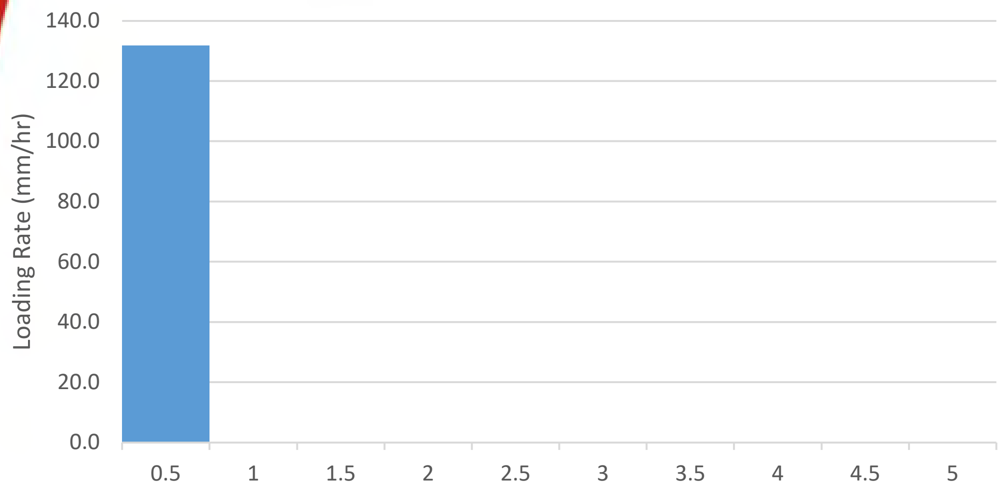


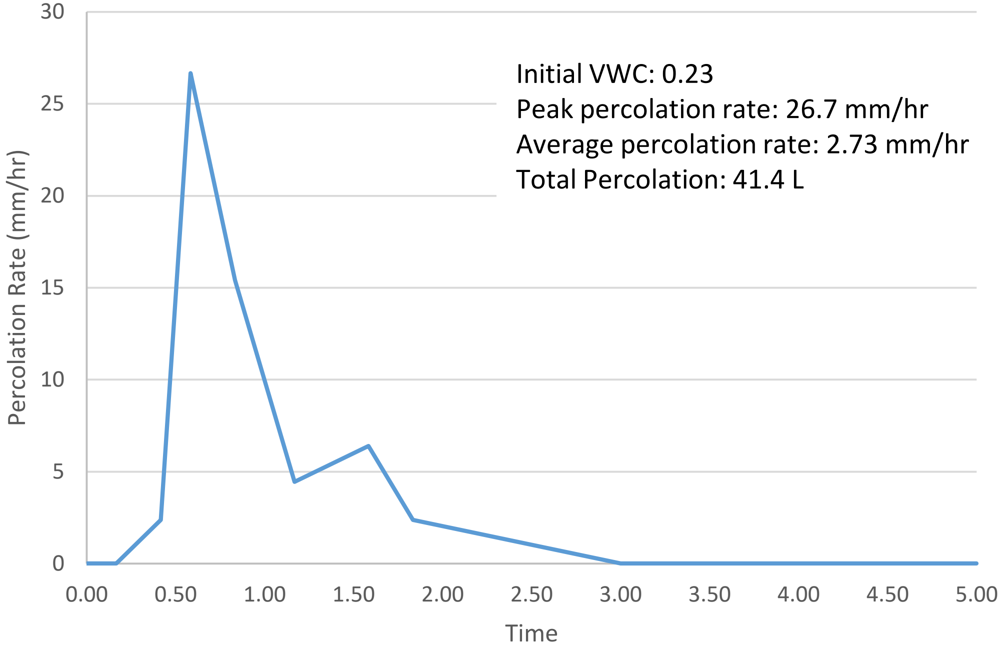
Results (Percolation)



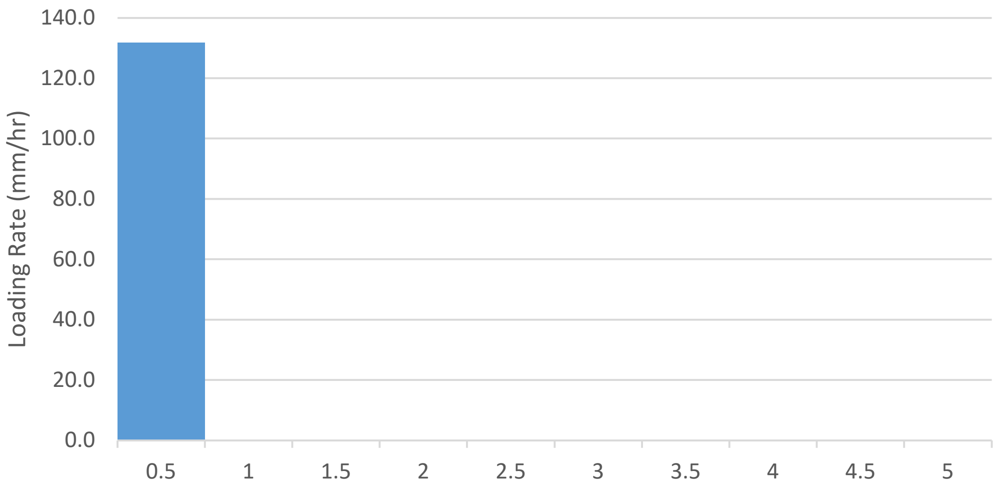
Rainfall Events

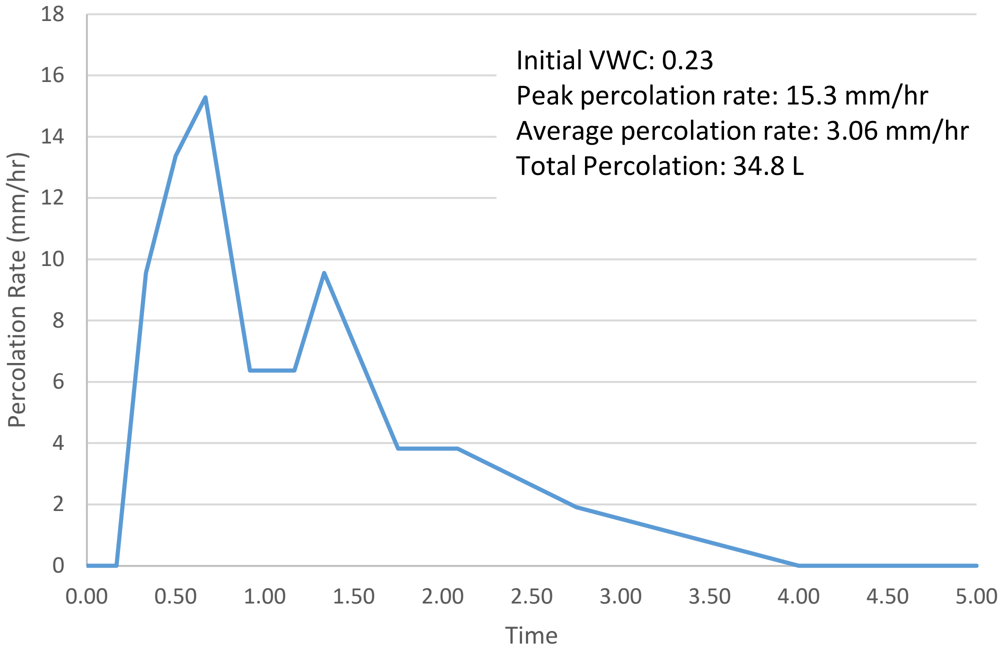
Rainfall Event Cell 2: Topsoil Native grass blend 1



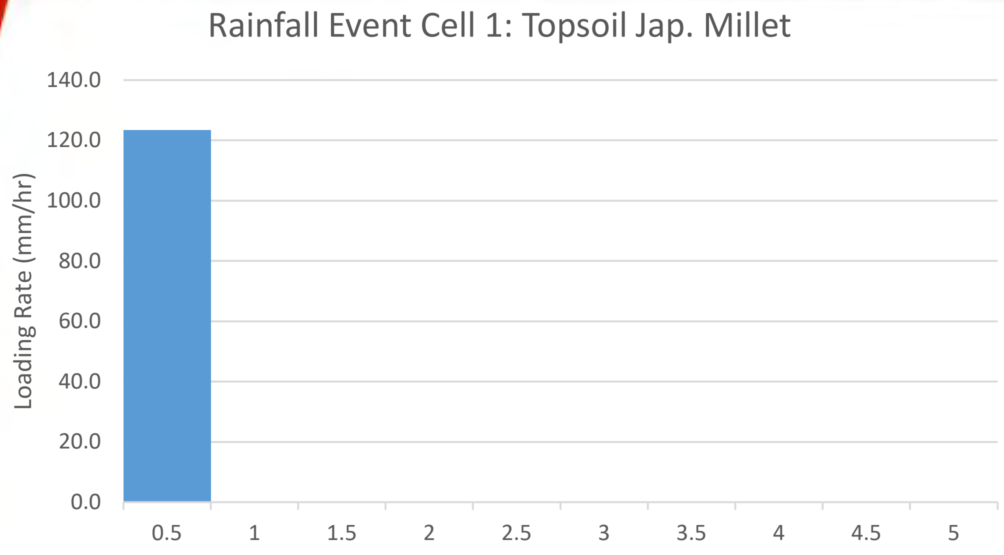


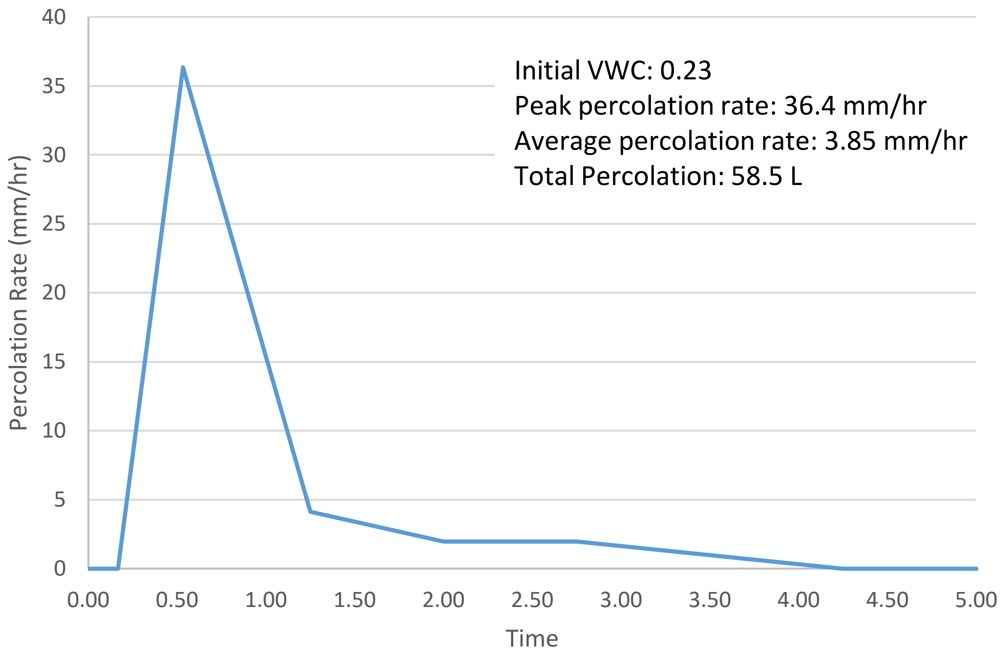
Rainfall Event Cell 6: Mixture Native grass blend 1

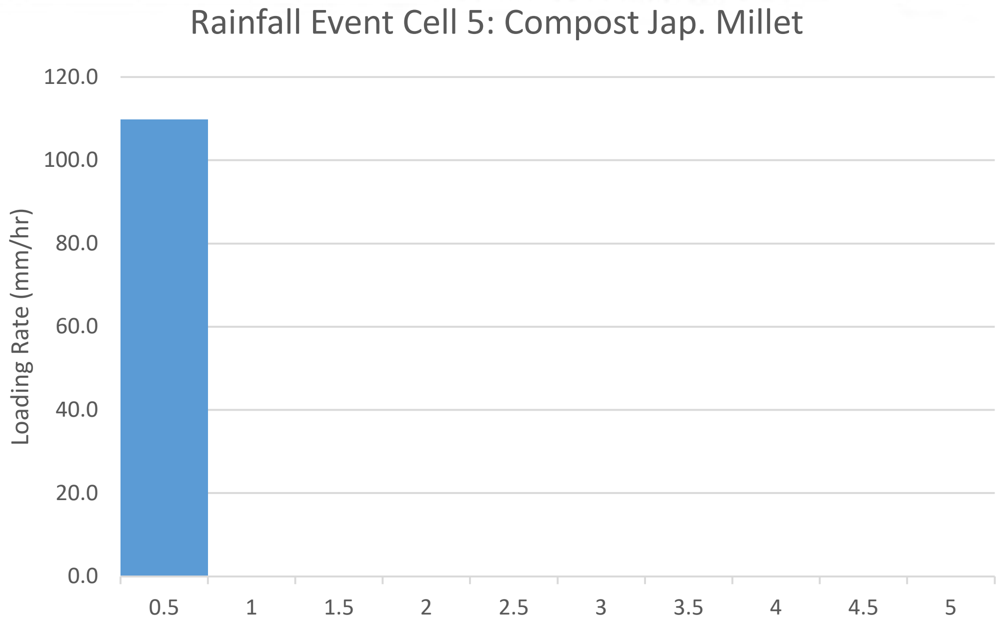


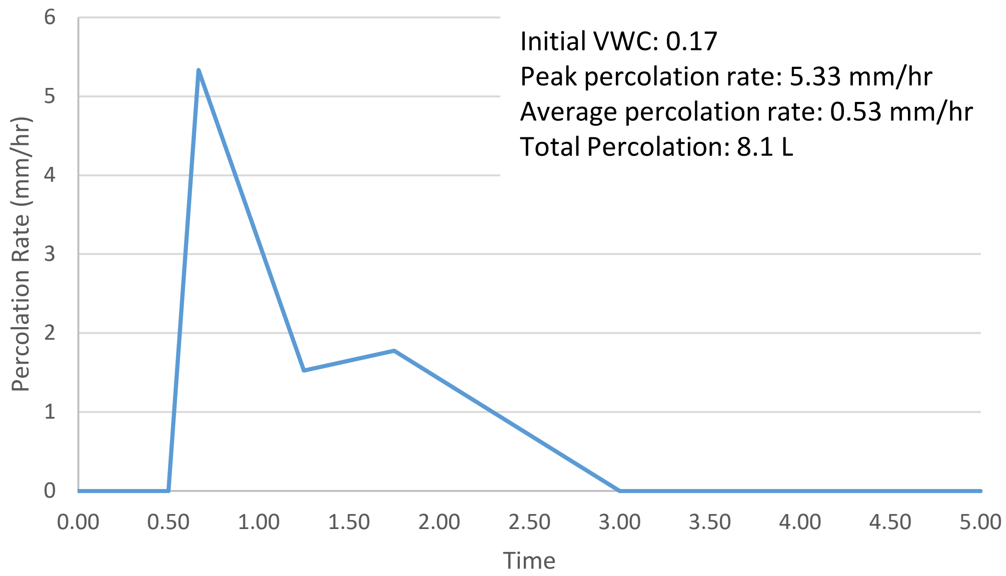


Rainfall Events









Experimental Set-up

- Summer 2018

Experimental Set-up

- Summer 2018

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Expected Results

- The proposed ET-LBC model will be able to predict the performance of the ET-LBC system with an acceptable level of accuracy
- Gas concentration profiles and methane oxidation efficiency will be predicted with the interaction of vegetation and cover soil
- Water storage, evapotranspiration and percolation can be predicted for the vegetative cover soil by the model

Thank you!