Simulation and Validation of Seasonal Soil Temperature Variations Using COMSOL Multiphysics® Software

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Abstract

Low Impact Development (LID) best management practices (BMP) practices to treat urban stormwater runoff is governed by the mass balance equation of the near ground surface soil column. Considerations include precipitation, infiltration and evaporation. In areas where infiltration and/or conventional evaporation potential considerations are low or marginal, the feasibility of LID practices often comes into question.

Inaccurate consideration of evaporation potential may lead to erroneous conclusions regarding the viability of LID BMP's in soils characterized as marginal from an infiltration perspective.
The evaporation component of LID design has typically been based upon pan evaporation data or, reported more recently, correlation studies. These two approaches, while acceptable, do not recognize the underlying physics of what is actually happening within the LID facility. With a better understanding of the underlying physics of LID, it is postulated that a better appreciation of the potential of LID might be realized. A better understanding of the physics will open more opportunities for creative solutions to LID design challenges.

This paper focuses on the evaporative component of the LID BMP mass balance equation from the underlying principles of the physics of heat and mass transport. A discussion is presented related to the physics of evaporation. The properties of temperature and pressure are presented as they relate to the evaporation process. The concept of the ground's role as a heat source that moderates and stabilizes the ability of LID BMP's to sustain evaporative processes is illustrated.

Results of temperature monitoring in an LID installation is discussed with respect to the seasonal variation of temperature in the reservoir layer of porous pavement in the Puget Sound area of Washington State.

This paper presents the results of heat transfer simulations using COMSOL Multiphysics® software in LID BMP's and is preparatory to consideration of mass transport phenomenon which will be the topic of a future paper.

Figures used in the abstract

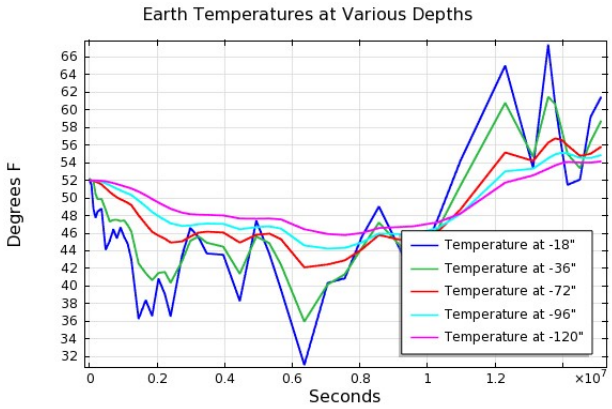

Figure 1: COMSOL simulation results showing soil temperature variations.