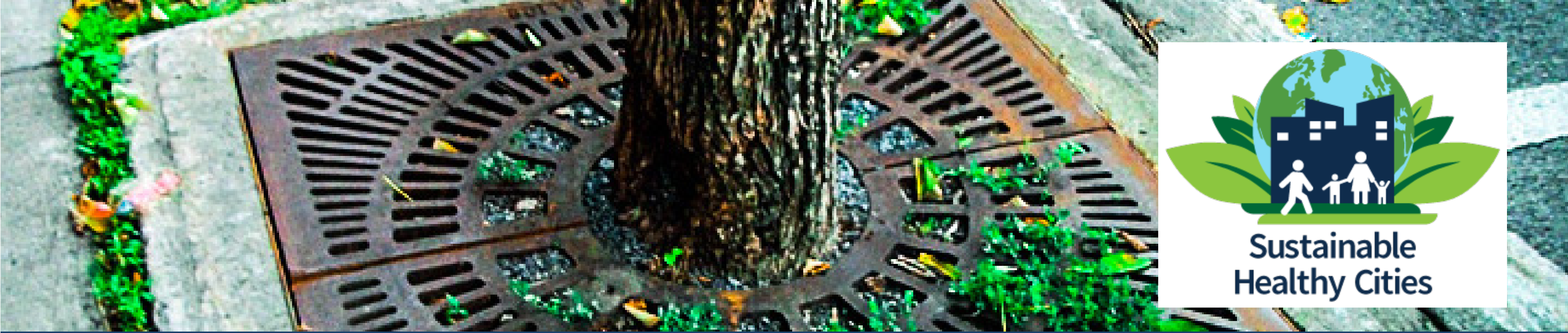

JOURNAL BRIEF: Urban Tree Pit Design Factors for Stormwater Management Performance

Sustainable Healthy Cities Journal Brief - 2018, No. 6 - Urban Tree Pit Design Factors

This brief is adapted from the following peer-reviewed journal article: Elliott, R.M., Adkins, E.R., Culligan, P.J., & M.I. Palmer. (2018). "Stormwater infiltration capacity of street tree pits: Quantifying the influence of different design and management strategies in New York City." *Ecological Engineering*, 111(2018), 157-166.

Study Intent and Research Question

Street trees in the urban environment provide important ecosystem services including stormwater management, reducing pollutant discharges and flooding by lessening surface runoff. Does the design of an urban tree pit affect its ability to absorb stormwater? If so, how? This study identifies key physical design features that affect the stormwater management performance of tree pits. Between June and July of 2014, the study measured the ability of 40 street tree pits in New York City to soak up stormwater, capturing performance measures for multiple tree pit types commonly found in New York and other cities.

Key Background Information

The stormwater management capacity of various types of green infrastructure—green roofs, bioswales, rain gardens, rainwater harvesting, and permeable paving—is determined by the amount of water they can capture and store, their ability to expel stored water through evapotranspiration, and their capacity to infiltrate stormwater into the subsurface.

Street trees can divert urban stormwater in three ways: 1) leaves and branches directly hold rainwater (interception), 2) the tree structure channels water to the base of the trunk (stemflow), and 3) water enters the ground via the tree pit soil surface (infiltration).

For trees housed in tree pits, stormwater capture is a function of the soil's infiltration capacity at the base of the tree, which determines how quickly a tree pit surface can absorb stormwater.

Common variation in design features of street tree pits include: 1) guarded vs. unguarded; 2) bare surface vs. groundcover (plants or mulch); 3) level, raised, or recessed positioning with the sidewalk; 4) absolute size of pit and tree size.

Key Findings

The most significant factor influencing the stormwater infiltration capacity of tree pits was the presence of a guard, with guarded tree pits having higher water infiltration rates.

Tree guards prevent pedestrians from walking on the soil surface, thus preventing compaction and associated decrease in infiltration capacity. Unguarded pits were found to be significantly more compacted than guarded pits.

For guarded tree pits, higher infiltration rates were associated with larger pit areas, raised surface elevations, and the combined presence of ground cover planting and mulch. Tree size was found to be a less significant indicator of the infiltration rate.

Single design factors including raised pit elevation, mulched ground cover, and planted ground cover were not significant individual factors affecting infiltration by themselves.

In guarded pits, the combined design factors of mulch and planted groundcover increased infiltration capacity.

In guarded pits, larger surface area was found to have a positive relationship with the infiltration rate. This may be due to larger, guarded areas being able to support healthier soil ecosystems.

In unguarded pits, larger surface size was found to have a slightly negative relationship with infiltration rate. A potential explanation is that the larger pit areas, without a guard, are more subject to compaction from foot traffic.

Nearly all the tree pit soils examined in the study were coarser (a feature associated with less compaction) than required by design standards, yet still exhibited significantly reduced water infiltration rates, indicating that soil guidelines alone are not enough to ensure long-term stormwater infiltration.

Policy and Practice Implications

Many engineered green infrastructure (GI) systems can occupy small spaces in the urban landscape, but they can also be costly and difficult to integrate into a dense, built-up environment. Measuring and optimizing the performance of existing urban vegetation can help justify the expense of future GI investments and on-going maintenance.

City design standards for tree pits should prioritize guarded pits (as opposed to unguarded pits), especially in areas with heavy foot traffic. Not installing a guard can lead to significant soil compaction reducing the ability of the tree pit to absorb stormwater.

Noting street tree design characteristics during street tree census efforts would help generate tree pit design data that can help inform whether a community can expect high or low stormwater infiltration performance from its street tree pits. This type of information can contribute to neighborhood stormwater management planning efforts.

Green Infrastructure

Stormwater

Technology & Design Innovation

Further Reading and References

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About the Sustainable Healthy Cities Network

The Sustainable Healthy Cities Network is a U.S. National Science Foundation supported sustainability research network focused on the scientific advancement of integrated urban infrastructure solutions for environmentally sustainable, healthy, and livable cities. We are a network of scientists, industry leaders, and policy partners, committed to building better cities through innovations in infrastructure design, technology and policy. Our network connects across nine research universities, major metropolitan cities in the U.S. and India, as well as infrastructure firms, and policy groups to bridge research and education with concrete action in cities.

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