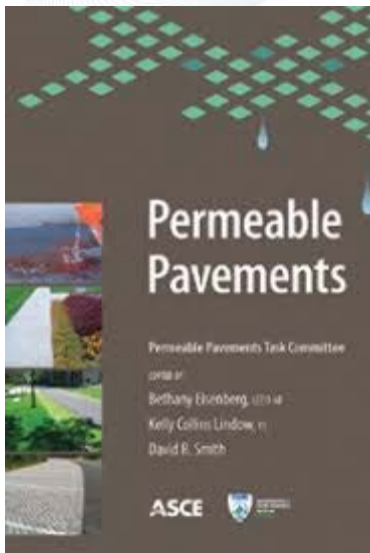


Life-Cycle Cost for Permeable Pavements – Do We Have It Right?



Paving Type	Summary Rating	Climate Change	Fossil Fuel Depletion	Ozone Depletion	Human Toxicity to air & water	Waste Disposal	Water Extraction	Acid Deposition	Ecotoxicity	Eutrophication	Summer Smog	Minerals Extraction	Typical Replacement Interval, yrs	Recycled Content	Recyclability	Recycled Currently	Energy Saved by Recycling	Initial Cost
Asphalt	C	C	C	A	C	C	A	C	C	C	C	A	20	C	B	B	A	Low
Clay pavers	B	B	B	A	A	B	A	A	A	A	C	A	40	C	A	A	A	Medium

GREEN INFRASTRUCTURE
THE BENEFITS OF GREEN STORMWATER INFRASTRUCTURE ON PRIVATE COMMERCIAL PROPERTY

GREEN ROOFTOPS
Residential buildings with green roofs reduced a 50% overall greenhouse gas emissions in one study.
Green roofs typically save tenants an average of \$0.05 per sq. ft. per year in energy costs.
The green roof on the Target Center Arena in Minneapolis has decreased annual energy costs by \$300,000.

LANDSCAPING WITH RAIN GARDENS AND BIOSWALES
Well-designed landscaping benefits average rental rates for office buildings by approximately 7 percent.

ECO-LABELS
LEED, Sustainable Sites Initiative or other certifications can increase property values, rents, and occupancy rates in commercial office buildings.

TREE COVER
Trees can reduce a building energy demand for heating and cooling by providing shade, insulation and blocking wind in winter. Multiple trees on a plot can save hundreds of dollars in annual energy costs.
Retail customers are willing to pay 1% to 2% more for products in shopping centers with mature tree canopy.

RAIN BARRELS AND CISTERNS
Installing rain barrels and cisterns can save up to \$100 for household water bills and other water-related water costs.

PERMEABLE PAVEMENT
Permeable pavement systems can reduce runoff and allow water to soak into the ground and soil below. These systems can have significant water management costs that are offset by the reduced maintenance costs that are associated with traditional pavement, resulting in lower overall life-cycle costs.

What is the lifecycle value of permeable pavement?

Low Impact Development Costing Tool
Please select an LID practice to open costing sheets

- Bioretention (BR)
- Enhanced Grass Swale (EGS)
- Green Roof (GR)
- Infiltration Chamber (IC)
- Infiltration Trench (IT)
- Permeable Interlocking Concrete Pavers (PICP)
- Rainwater Harvesting (RWH)

Typical Life-Cycle Cost for Infrastructure

- Life-cycle costing has become an essential component of any modern infrastructure design
- Maintenance and rehabilitation costs, not just the immediate initial construction costs should be considered
- LCCA can be used to benchmark other potential options such as permeable and conventional pavements to determine which is the most cost effective
- Traditionally only the standard capital costs for initial construction and maintenance and rehabilitation costs for each pavement types are considered

Typical Life-Cycle Cost for Infrastructure

- To truly evaluate compare permeable and convention, the analysis should take into account all benefits:
 - Reducing stormwater runoff volume (and facilities)
 - Reducing stormwater runoff peak flows
 - Reducing surface ponding
 - Reducing stormwater pollutant load
 - Decreased downstream erosion
 - Increase groundwater recharge, etc.
- Overall long-term life-cycle costs have the potential to be very competitive if consideration is given to off-road benefits

Typical Components for LCCA

- Initial construction costs for pavements
 - Excavation, fill, subbase, base, permeable surface, line painting, drainage system, etc. (common items for all pavement types can be excluded)
- Maintenance and rehabilitation costs
 - Crack filling, patching, resurfacing, joint filler replacement, partial and full depth concrete repairs, worn and cracked paver replacement, joint filler replacement, routine preventive vacuuming, restorative (clogged) surface vacuuming, etc.

Off-Road LCCA Considerations

- Reduced stormwater facilities
- Reduced stormwater flow in combined sewer systems
- Alternative land use
- Stormwater runoff control
- Water quality improvement
- Reduced winter maintenance activities
- Utility cut restoration
- Pavement striping
- Traffic calming
- Reduce the percentage of “heated” impervious area

Difficulties in Quantifying Benefits?

- Some are relatively straight forward:
 - Reduction in size or elimination of stormwater ponds, increased land use
 - Reduced size of stormwater system, i.e. catchbasins, outlets or pipe size
 - Reduced alternative LID facilities construction and maintenance
 - Compliance with local regulations, i.e. water quantity and quality
 - Flooding and property damage reduction
- Others are more difficult:
 - Safety as no storm water ponds
 - Improved construction efficiency due to reduction in traditional stormwater facilities
 - Longer pavement life, i.e. no trenches in the roadway to settle
 - Reduced water quantity at water plant
 - Availability of water for reuse (both potable and non-potable)

Difficulties in Quantifying Benefits?

- Others are more difficult:
 - Waste water treatment plant operating costs
 - Deferral of waste water plant construction or expansion costs
 - Value of improvement to aquatic life
 - Improve overall urban tree health and longevity
 - Reduce the amount of watering required for trees and plants

Benefit	Key Issue	Quantifiable	Feasibility Ranking
Stormwater Management Pond Reduction	<ul style="list-style-type: none"> Reduce size or eliminate ponds Maintenance rarely completed. Lack of maintenance results in high rehabilitation costs to restore function. May need to address existing and new development areas separately. 	Yes	High
Stormwater Sewer System Upgrades	<ul style="list-style-type: none"> Defer capital upgrades. May be dependent on whether sewer system LCCA information is available. 	Yes	Low
Combined Sewer System WWTP Operating Cost	<ul style="list-style-type: none"> Reduce annual operating cost. 	Yes	High
Combined Sewer System WWTP Upgrades	<ul style="list-style-type: none"> Defer capital upgrades. May be dependent on whether WWTP LCCA information is available. 	Yes	Low
Combined Sewer System Pipe Sizes	<ul style="list-style-type: none"> Reduce sizing. Maybe difficult due to desire to move away from combined system instead of upgrading. 	Difficult	Low
Stormwater Temperature Reduction	<ul style="list-style-type: none"> Keep receiving waters at acceptable temperatures. 	Difficult	Low
Freshwater Ecosystems	<ul style="list-style-type: none"> Protect/repair systems. Maintain fish populations, etc. 	Difficult	Low
Flooding/Property Damage	<ul style="list-style-type: none"> Reducing damage, cost, insurance, inconvenience, etc. 	Risk Based	Medium
Stormwater Management Costs (Regulatory compliance)	<ul style="list-style-type: none"> Reduce costs associated with meeting requirements. 	Difficult	Medium
Erosion Control	<ul style="list-style-type: none"> Prevent infrastructure damage due to erosion and loss of subgrade 	Risk Based	High
Multiuse System	<ul style="list-style-type: none"> Dual use of land, i.e., parking lot and infiltration bed. 	Yes	High

Benefit	Key Issue	Quantifiable	Feasibility Ranking
Multiuse System	<ul style="list-style-type: none"> Dual use of land, i.e., parking lot and infiltration bed. 	Yes	High
Rainwater Harvesting	<ul style="list-style-type: none"> Reduced cost of fresh water for municipal, commercial or domestic irrigation and/or gray water system use. 	Yes	Medium
Impervious Fees	<ul style="list-style-type: none"> Reduce stormwater fees associated with high percentage of impermeable land use. Related to development. 	Yes	Medium
Urban Foliage Canopy	<ul style="list-style-type: none"> Reduce the need and cost for external watering of urban trees. Healthier, improved canopy and longer life spans. Improved air quality, urban micro-climate, property values, and urban character. 	Difficult	Low
Pollutant Removal	<ul style="list-style-type: none"> Achieve similar design pollutant removal efficiencies for total suspended solids (TSS), total phosphorus, total nitrogen, metals, and/or oils. 	Yes	High
Drinking Water Quality Preservation	<ul style="list-style-type: none"> Protect drinking water sources. 	Yes	Low
Winter Maintenance	<ul style="list-style-type: none"> Reduce the need and cost associated with winter deicing activities. 	Yes	High
Utility Cut Restoration	<ul style="list-style-type: none"> Reduce cost of utility cut restoration Service life impact 	Yes	High
Paint Markings	<ul style="list-style-type: none"> Reduced cost to maintain paint markings 	Yes	High
Traffic Calming	<ul style="list-style-type: none"> Reduce direct cost to associated with traffic calming devices Increase driver and/or pedestrian safety 	Yes	High
Urban Climate	<ul style="list-style-type: none"> Reduce micro-climate temperatures via high reflectance surface and evaporative cooling 	Yes	Low

Feasibility Ranking for LCCA

- What do we include?
- How difficult will it be to quantify?
- Where will we look to obtain reasonable capacity costs for inclusion in the LCCA
- What types of maintenance will/may be required?
- Will the LCCA be defensible?
- Is it getting too complicated?