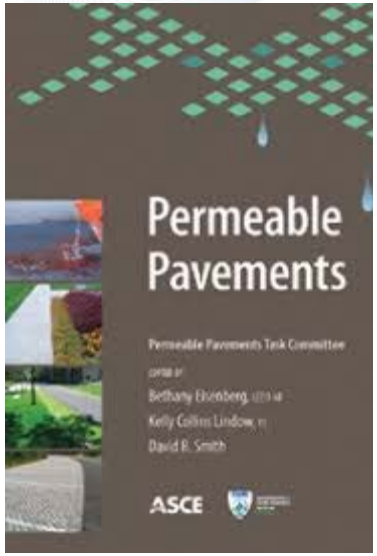
Life-Cycle Cost for Permeable Pavements – Do We Have It Right?



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
	A	A	A	A	A													
	A	A	A	A	A													
	A	A	A	A	A													
	C	C	A	A	B													
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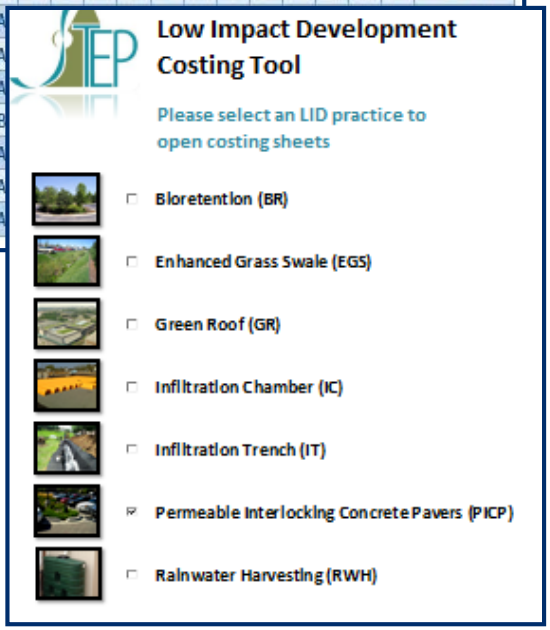

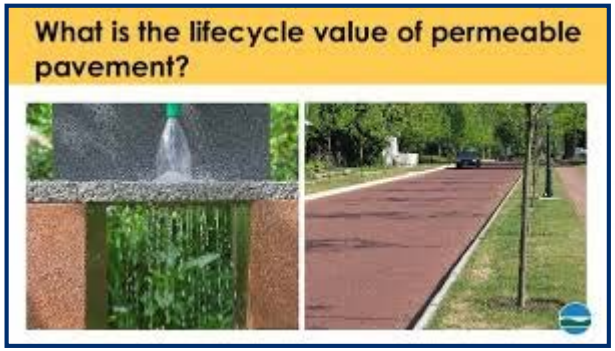

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Typical Life-Cycle Cost for Infrastructure

- 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

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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

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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.

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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

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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)

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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

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Benefit	Key Issue	Quantifiable	Feasibility Ranking
Stormwater Management Pond Reduction	• 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	• Defer capital upgrades. • May be dependent on whether sewer system LCCA information is available.	Yes	Low
Combined Sewer System WWTP Operating Cost	• Reduce annual operating cost.	Yes	High
Combined Sewer System WWTP Upgrades	• Defer capital upgrades. • May be dependent on whether WWTP LCCA information is available.	Yes	Low
Combined Sewer System Pipe Sizes	• Reduce sizing. • Maybe difficult due to desire to move away from combined system instead of upgrading.	Difficult	Low
Stormwater Temperature Reduction	• Keep receiving waters at acceptable temperatures.	Difficult	Low
Freshwater Ecosystems	• Protect/repair systems. • Maintain fish populations, etc.	Difficult	Low
Flooding/Property Damage	• Reducing damage, cost, insurance, inconvenience, etc.	Risk Based	Medium
Stormwater Management Costs (Regulatory compliance)	• Reduce costs associated with meeting requirements.	Difficult	Medium
Erosion Control	• Prevent infrastructure damage due to erosion and loss of subgrade	Risk Based	High
Multiuse System	• Dual use of land, i.e., parking lot and infiltration bed.	Yes	High

Benefit	Key Issue	Quantifiable	Feasibility Ranking
Multiuse System	• Dual use of land, i.e., parking lot and infiltration bed.	Yes	High
Rainwater Harvesting	• Reduced cost of fresh water for municipal, commercial or domestic irrigation and/or gray water system use.	Yes	Medium
Impervious Fees	• Reduce stormwater fees associated with high percentage of impermeable land use. • Related to development.	Yes	Medium
Urban Foliage Canopy	• 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	• 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	• Protect drinking water sources.	Yes	Low
Winter Maintenance	• Reduce the need and cost associated with winter deicing activities.	Yes	High
Utility Cut Restoration	• Reduce cost of utility cut restoration • Service life impact	Yes	High
Paint Markings	• Reduced cost to maintain paint markings	Yes	High
Traffic Calming	• Reduce direct cost to associated with traffic calming devices • Increase driver and/or pedestrian safety	Yes	High
Urban Climate	• 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 defendable?
- Is it getting too complicated?

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