Appendix B: Studies Examining Impacts of Impervious Surfaces on Stream Health

Summary of literature review on the effects of impervious surfaces on stream health.

Reference	Key Findings	Location
Schueler 1994	Stream degradation occurs at 10%-20% watershed imperviousness Degradation was measured in loss of in-stream habitat structure, increased contaminants in water, higher stream water temperature and decreased aquatic biodiversity Clustered high-density development with stormwater BMPs is the best way to avoid stream degradation due to impervious cover. Proposes a watershed based zoning process.	U.S northwest and southeast
USDA 1995	Baseflow in Malibu Creek increased from 205 ac-ft per year in 1934, to 2050 ac-ft per year in 1995, not including wastewater discharge Likely due to changes in land use, i.e. increased imperviousness	U.S. semi-arid southwest
Basnyat et al. 1999	Urban land cover contributes higher nutrient loads to streams than forested/grassland or active agriculture.	U.S. southeast
Walsh et al. 2001	Intensive urban drainage (i.e. areas with many storm drain outfalls per area) was strongly related severe degradation of benthic communities even at low urban density.	Australia southeast
Paul and Meyer 2001 (literature review)	Increased impervious cover alters hydrology and geomorphology of streams and increases runoff loads of nutrients, metals, pesticides and other contaminants.	Global
Center for Watershed Protection 2003 (literature review and analysis)	Increased impervious cover causes degradation of aquatic habitats. In the regions most studied, a 10% increase in impervious cover is associated with: • increased unit area pollutant load in stormwater (in direct proportion to increased impervious cover) • increased runoff volume, peak discharge and bankfull flows • channel enlargement, increased substrate embeddedness, loss of pools and riffles and increased temperature • decreased diversity of fish and invertebrate communities. Existing biotic indices may not be sensitive enough to detect effects on the benthic community in watersheds with less than 10% impervious cover. More research is needed on mitigating effects of BMPs and other watershed treatments.	U.S. northwest, Midwest and southeast
Hale et al. 2004	Percent impervious cover in the watershed correlated with decreased benthic index scores in small estuaries.	U.S. mid-Atlantic
Walsh et al. 2005 (literature review)	Urban streams consistently show a reduction or lack of sensitive species of benthic macroinvertebrates and consist	Global

	primarily of disturbance-tolerant species. Many studies show correlations between stream condition and catchment imperviousness.	
Walsh et al. 2007	Assemblage composition of benthic macroinvertebrates was strongly correlated with catchment urbanization and less impacted by riparian deforestation. Sites with high levels of imperviousness had fewer sensitive taxa; sites with >4% total imperviousness rarely contained sensitive taxa.	Australia southeast
King et al. 2011	Documented threshold declines in stream macroinvertebrates in response to low levels of impervious cover. Declines happened at levels as low as 0.5-2% impervious cover.	U.S. Maryland

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