





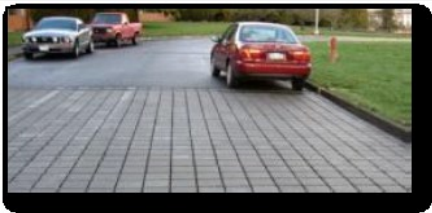

CITY OF LAKEWOOD

GREEN AND GREY INFRASTRUCTURE CONTROL STRATEGIES



TOOL BOX



Green Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
 <p>Rain gardens/Bioretention</p>	<p>\$ - \$\$\$</p>	<ul style="list-style-type: none"> - Increased risk of groundwater pollution if there is not adequate separation between bioretention facilities and groundwater table; - High groundwater may impede proper functioning; + Good for areas less than 2 acres, various land areas; + Reduces temperature, suspended solids, metals; - Requires ongoing maintenance. 	
 <p>Street Planters</p>	<p>\$\$ - \$\$\$</p>	<ul style="list-style-type: none"> + Reduced runoff/volume, pollutants, water temperatures; - Need adequate separation from groundwater table; + Can be used in sidewalks, curbside, and within roads in urban areas; + Runoff conveyed by sheet flow or curb cuts; - Requires regular maintenance and trash removal; - Utility interferences could impact cost. 	
 <p>Pervious Pavement</p>	<p>\$\$\$</p>	<ul style="list-style-type: none"> - Should not be used in areas of potential groundwater contamination; + Reduces suspended solids; + Reduces runoff volumes; + Filters solids and removes them in the sub-pavement layers; + Buffers water temperatures; + Reduces use of winter salt applications. 	







\$ - Least expensive to \$\$\$\$ very expensive

 - Least maintenance to  most maintenance

“+” - Considered to be a “pro” for this Control Strategy






“-” - Considered to be a “con” for this Control Strategy

Green Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
 <p>Sand/Infiltration Filter</p>	\$	<ul style="list-style-type: none"> + Water flows through sand or gravel and either into groundwater or a pipe, or into storage ; - Needs frequent maintenance depending on location; + Useful on smaller sites; - Prone to sediment clogging. 	
 <p>Tree Planting</p>	\$	<ul style="list-style-type: none"> + Intercepts rainfall, helps increase infiltration and ability of soil to store water; + Provides shade, reduces wind speed,; + Releases water into atmosphere; + Absorbs air pollutants, reduces energy consumption; - Poorly chosen trees can affect powerlines, broken limbs incurs clean-up costs, requires maintenance; - Leaves need to be cleaned up to prevent storm sewer clogging. 	
 <p>Downspout Disconnect</p>	\$	<ul style="list-style-type: none"> + Reduces stormwater in the sewer system; + Minimal maintenance and cost; - Need positive drainage around the downspout discharge to ensure stormwater does not pool; - Policies and controls need to be in place and implemented to ensure compliance. 	





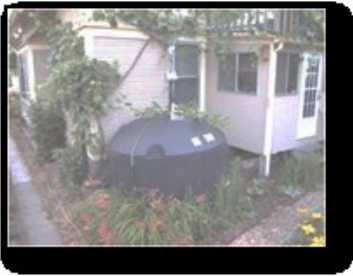

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Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
 <p>Green Roofs</p>	<p>\$\$\$\$</p>	<ul style="list-style-type: none"> + Stores large amounts of water in growing media; + Reduces amount of solar radiation; + Reduces roof surface temperature; - Limited amount of plant choices; - Greater weight on roof; - Need for irrigation and drainage system requiring energy, water, materials; - Higher capital and maintenance cost; - Could add nutrients to runoff. 	
 <p>Blue Roofs</p>	<p>\$\$\$\$</p>	<ul style="list-style-type: none"> + Non-vegetated detention systems placed on roofs that capture and temporarily store rainwater, slowly releasing to the sewer system; + Provides for evaporation; + Less costly than green roofs; - Greater weight on roof . 	
 <p>Rain Harvesting</p>	<p>\$\$</p>	<ul style="list-style-type: none"> + Reduces stormwater runoff by capturing rainfall where it lands—reduces flooding and erosion; + Reduce water treatment needs—reduces irrigation costs; + Used for non-drinking purposes; + Easy to maintain; - Unpredictable rainfall levels; - Initial moderate cost; - Roofs may seep chemicals into water; - Seasonal—not for winter. 	

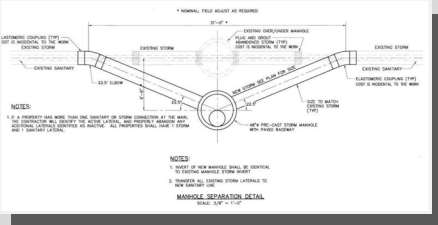



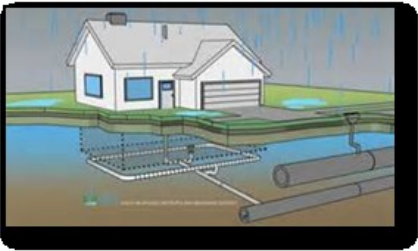

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Grey Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
 <p style="text-align: center;">Sewer Separation</p>	<p>\$\$\$</p>	<ul style="list-style-type: none"> + Reduction in basement and street flooding; + Reduction in CSO and resulting biological impacts to receiving waters; + Possible cost savings related to incidental infrastructure upgrades performed under the same project; - Extensive construction impacts. 	
 <p style="text-align: center;">Storage Tunnels</p>	<p>\$\$\$\$</p>	<ul style="list-style-type: none"> + Existing sewer system can remain in place; + Effective CSO reduction without increases to stormwater discharges; - High initial cost for construction; - Moderate to high construction impacts depending on the location; - On-going cost of maintaining the pumping station, cleaning, maintaining volume; - Fixed volume can be regularly exceeded. 	
 <p style="text-align: center;">Source Control</p>	<p>\$\$</p>	<ul style="list-style-type: none"> + Relatively inexpensive, though costs can vary widely; + Can reduce the likelihood of sewer backup into structures; + Multiple solutions and technologies available from which to choose; - Can be intrusive on private property owners; - Can reduce the level of service of storm sewers. 	

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Grey Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
 <p>High Rate Treatment</p>	<p>\$\$\$</p>	<ul style="list-style-type: none"> + Small footprint requires reduced space; + Competitively low cost when compared to WWTP upgrades; - Does not treat all nutrients; - Requires trained personnel to run and maintain with an increased cost to the City. 	
 <p>Waste Water Treatment Plant Up-grades</p>	<p>\$\$\$\$</p>	<ul style="list-style-type: none"> - Costs vary, but are relatively high for any infrastructure improvement; - Space requirements may be substantial. + Nutrient treatment; + High pollutant removal. 	

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