Permeable Reactive Weirs (PRWs):
Technology Overview and Applications

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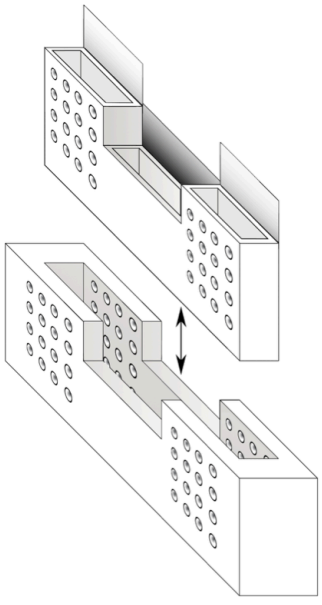
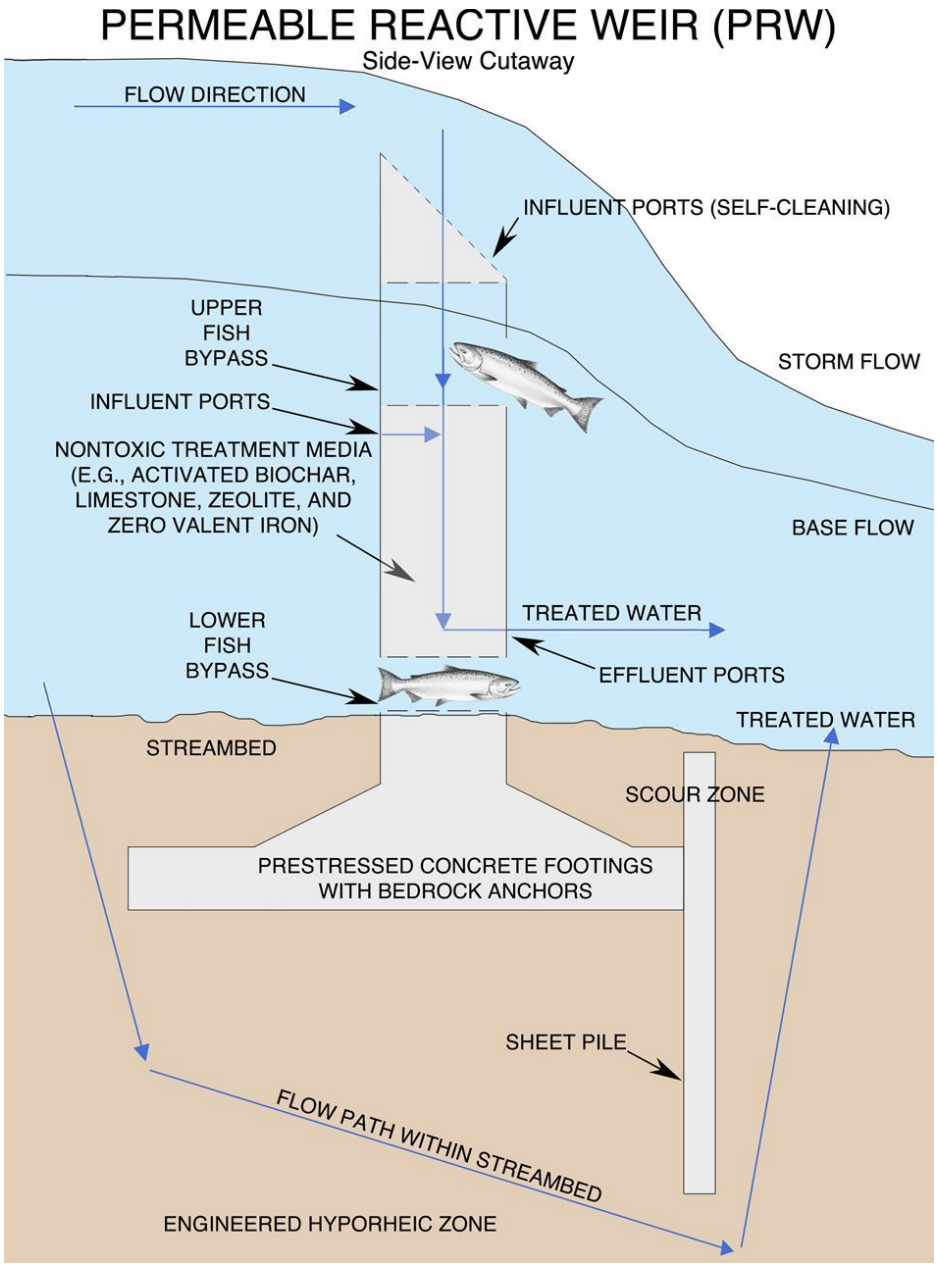
Overview: Permeable reactive weirs are hollow dams that contain water treatment equipment with optional fish and boat passage features. Permeable reactive weirs (PRWs) can (1) improve aquatic habitats by removing pollutants; (2) reduce temperatures by inducing flow within the streambed; and (3) increase dissolved oxygen by creating cascades. Water treatment equipment within the weir may be selected to remove a wide variety of contaminants including agrochemicals (e.g., herbicides and insecticides), heat, metals, nanoparticles, nitrogen, pathogens, petroleum hydrocarbons, phosphorus, salts, surfactants, suspended solids, and other toxic organics.

Permeable reactive weirs may be installed in a variety of configurations including linear, labyrinth, piano key, or arched designs. These configurations may be selected to reduce upstream pool depth, accommodate passage of watercraft, and improve pollutant removal efficiency. Below are figures of an arched PRW design (A) comprised of multiple replaceable cartridges that contain filter media or other water treatment equipment (B).

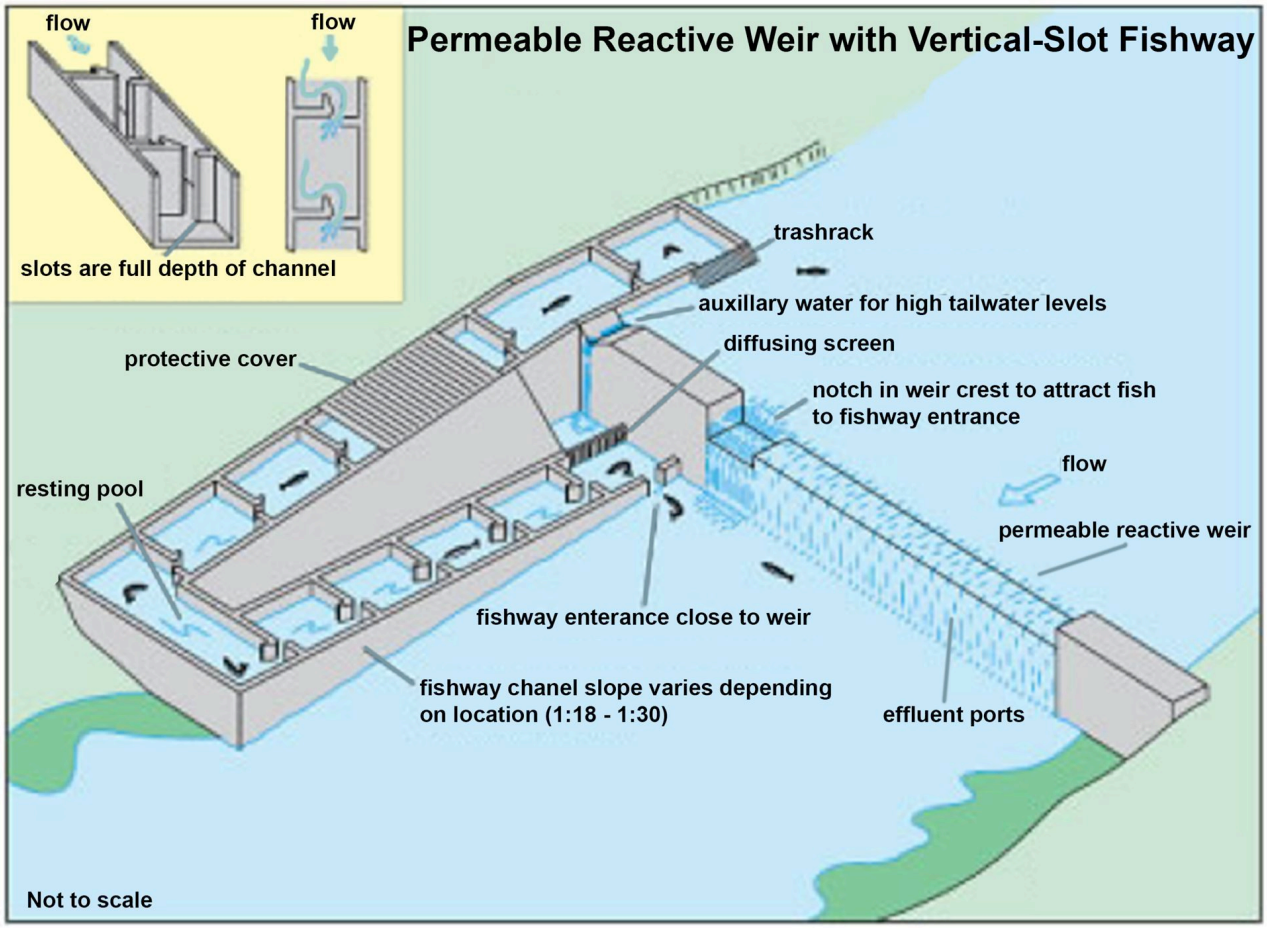
A.  B. 

Fish Passage and Hyporheic Treatment: Engineered streambeds (i.e., hyporheic zones) may be installed below the permeable reactive weir to

improve aquatic habitats by removing pollutants from water and reducing thermal pollution by cooling the water during hyporheic flow. Surface water upstream of the weir is pushed into the streambed by the hydraulic head differences between the upstream and downstream sides of the weir. A cutaway illustration of a PRW installed above an engineered hyporheic zone is shown below.



PRWs may accommodate fish passage via integrated fish bypasses (shown above), or integrated fishways (shown below).

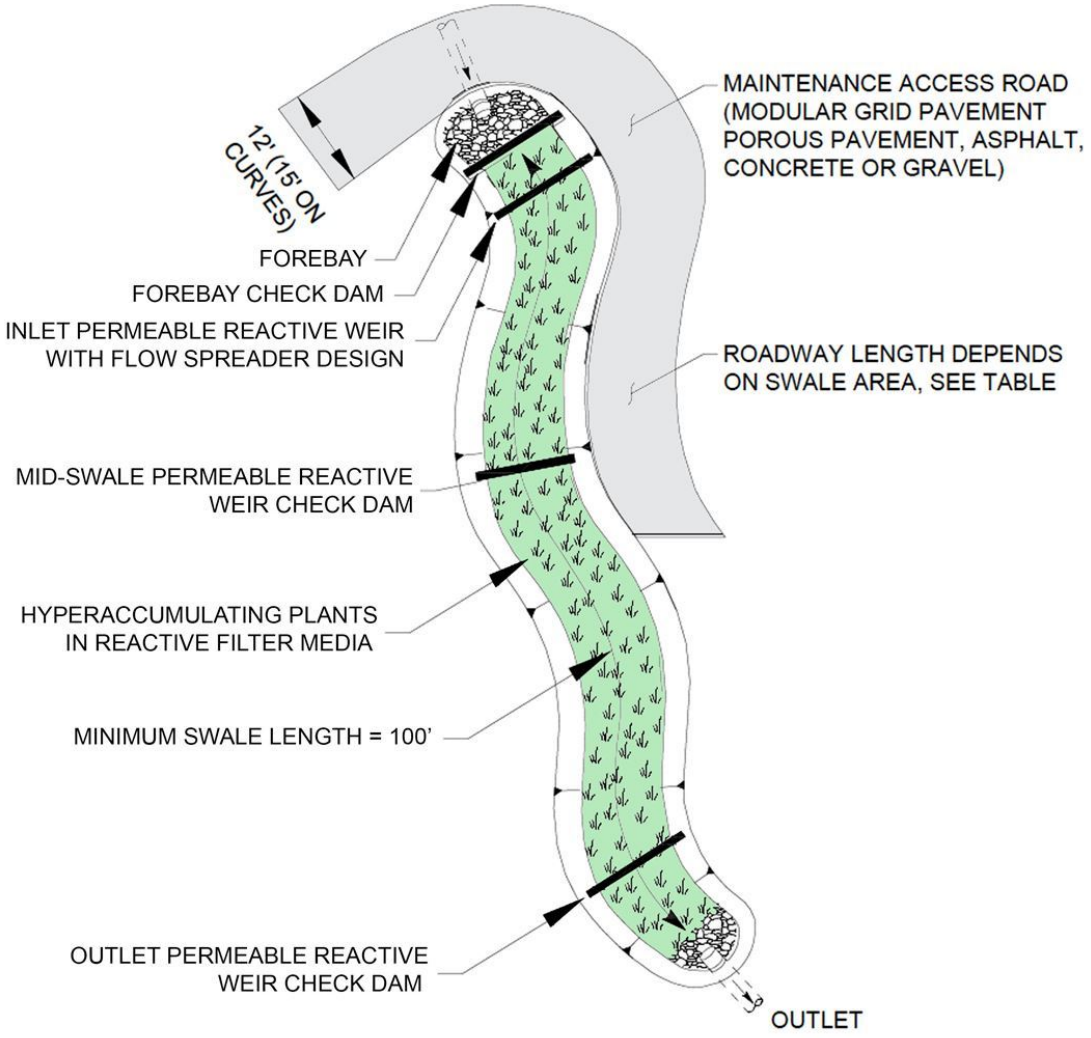


Powered PRWs and Remote Operation: PRWs may be connected to a mechanical or electrical power source. The mechanical power may be supplied by a collocated or integrated water wheel that rotates a cam shaft. Electrical power may be supplied by the local utility grid, or via dedicated hydroelectric, photovoltaic, or wind generator systems with battery storage. The connected power source may energize water treatment equipment and performance monitoring equipment within the weir. Performance monitoring equipment may relay telemetry via wireless internet connection. The internet connection may allow remote monitoring, flow control via servo-valves, and maintenance cycling (e.g., bubble scrubbing and back flushing). Monitoring equipment may include fish sensors that record fish type and count, and automatically open fish passage when fish are present.

Water treatment equipment may include reactive media filters, membranes, electrocoagulators, electrodeionizers, and nontoxic chemical oxidizer generators (e.g., ozone generators). Valves on the influent ports control the water flow rate through the weir. Multiple permeable reactive weirs may be used in series to improve pollutant removal. Screened hoods and drawdown orifices may be installed on the influent ports to prevent clogging by floating debris.

Technology Scalability and Applications: Permeable reactive weirs are scalable and configurable to site conditions. PRWs may be installed within ditches, small streams, large rivers, and stormwater treatment systems. PRWs may be located downstream of stormwater outfalls or within storm sewer systems. PRWs may be used as level spreaders and check dams within stormwater BMPs (shown below).

BIOSWALE WITH PERMEABLE REACTIVE WEIR CHECK DAMS
Modified from King County's 2016 Surface Water Design Manual
by Erick McWayne, Intracep, LLC 6/24/16



NOTE:
PREFERRED LONGITUDINAL SLOPE 1.5% TO 6%
FOR SLOPE < 1.5%, PROVIDE UNDERDRAIN OR WET BIOSWALE.
SLOPE > 6% REQUIRES CHECK DAMS AND VERTICAL DROPS TO REDUCE EFFECTIVE SLOPE.

For more information or to request a project proposal, please contact Erick McWayne, at (800) 684-6634 or emcwayne@intracep.com.