Retention Pond

About Retention Ponds

Retention ponds, or "wet ponds," are among the most common stormwater treatment systems used today. They are not to be confused with detention basins or "dry basins," which hold runoff for a specified period of time, and then release the entire volume of the runoff. Retention ponds retain a resident pool of standing water, which improves water quality treatment between storms. Retention ponds demonstrate a reasonably strong water quality treatment, particularly in comparison to dry pond systems. However, lack of maintenance often leads to pollutant export and a gradual erosion within the system for large flows.

Where to Use It

Acceptance of retention ponds is widespread, and examples of these systems can be found all over the world in any climate, soil, and development setting.

In many areas, retention ponds are the system of choice, a preference likely due to their ease of design, which can be adapted to provide water quality treatment and water quantity control in a variety of settings.

Implementation

While retention ponds are common, their use raises concerns related to human and ecosystem health. Standing water, for example, can be a drowning hazard. They also serve as a habitat for mosquitoes associated with diseases. Ponds that contain excess nutrients can foster eutrophication. In hot weather, retention ponds can superheat already warm parking lot runoff, impacting aquatic habitats and cold water fisheries. Some innovative retention pond outlet designs include the use of gravel subdrains to cool effluent.

The cost to install a retention pond system to treat runoff from one acre of impervious surface was $13,500. This does not include maintenance expenditures, which may involve routine inspection, periodic mowing, and sediment dredging, as needed. For more information about this design, contact the UNHSC.

During the first year of operation, the retention pond at UNHSC was reasonably effective in removing many of the pollutants commonly found in runoff. However, during its second year, researchers observed a reduction in its water quality performance. This indicates that its performance may continue to diminish over time.

Fast Facts

CATEGORY TYPE
Stormwater Pond, Sedimentation

BMP TYPE
Structural, Conventional

DESIGN SOURCE
New York State Stormwater Management Design Manual

BASIC DIMENSIONS
Surface Area: 46 ft X 70 ft (varies)

SPECIFICATIONS
Catchment Area: 1 acre
Peak Flow: 1 cfs
Water Quality Volume: 3,264 cf

TREATMENT FUNCTION
Physical Settling & Biological

INSTALLATION COST PER ACRE TREATED
$13,500

MAINTENANCE
Maintenance Sensitivity: Low
Inspections: Low
Sediment: Low

How the System Works

Design

The retention pond tested at the UNHSC is comprised of a sedimentation forebay and a larger basin sized to hold a resident pool of water. It was installed below the water table to maintain a permanent pool of water, and in clay soils, which effectively act as a lining for the system. Side slopes were stabilized with grass, and spillways with stone and geotextile.

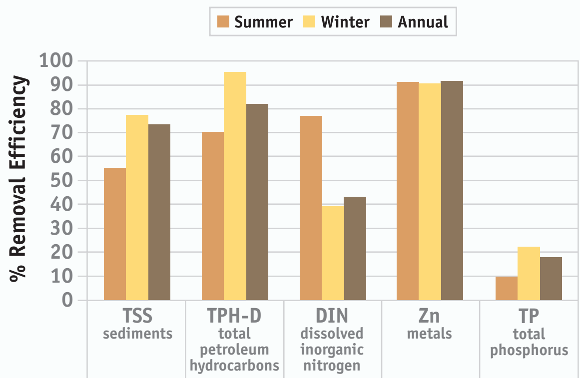
Improved designs, not used here, would include stabilization of wetland perimeter with stone and fabric. This perimeter was the location of failure for the pond. In this area, vegetation could not establish and soils were prone to erosion.

In general, these ponds can be designed either above or below the groundwater table. Ponds are commonly designed for both aesthetic and habitat function.

The system is designed to treat the water quality volume. Typically, channel protection volumes (CP_V) are conveyed through the system within 24 to 48 hours.

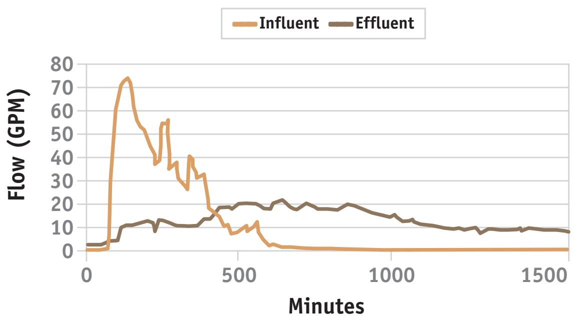
During conveyance protection volume (Q_P) rain events, stormwater is conveyed through the system, and bypasses the water quality treatment process.

POLLUTANT REMOVAL: 2004–2006



Median Annual Influent Event Mean Concentrations (EMC) in mg/L				
55.5	894.0	.49	.06	.124

HYDRAULIC PERFORMANCE



	Winter	Summer	Annual Average
Average Peak Flow Reduction	84%	79%	81%
Average Lag Time (minutes)	540	321	424

Water Quality Treatment

During the first year of operation, the retention pond was reasonably effective in removing many of the pollutants commonly found in runoff. It consistently met EPA's recommended level of removal for total suspended solids, as well as regional ambient water quality criteria for petroleum products, metals, and nutrients. However, during its second year, researchers observed a 25 percent reduction in its TSS median removal efficiency—from 81 percent down to 71 percent. This indicates that while the pond still effectively treats most contaminants, its performance may continue to diminish. Like the other systems evaluated at UNHSC, it does not provide chloride removal, but can dampen chloride peaks.

The chart at top left reflects the system's performance in removing total suspended solids, total petroleum hydrocarbons, dissolved inorganic nitrogen, total phosphorus, and zinc. Values represent results recorded over a two-year monitoring period, with the data further divided into summer and winter components.

Water Quantity Control

Retention ponds exhibit a tremendous capacity to reduce peak flows, retain channel protection volume, and provide flood protection for up to 48 hours. In the figure at bottom left, the retention pond demonstrates effective peak flow reduction and long lag times, regardless of season. However, in general, these systems do not reduce runoff volume.

Research indicates that the extended duration effluent flows typical of retention ponds negatively impact receiving streams, particularly when post-development runoff subjects streams to erosive flows for long periods. This phenomenon is observed in urban areas, where it leads to channel instability and lost ecological value and function.

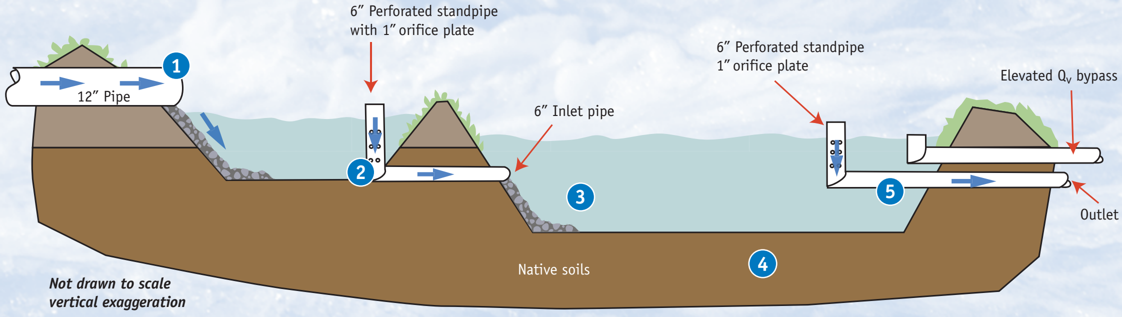
Maintenance

Minimal need for maintenance contributes to the popularity of retention ponds. However, while little maintenance may be required to support their ability to manage peak flow and floods, more frequent attention is critical for effective water quality treatment. Previous research has demonstrated that erosion and re-suspension of benthic sediments in these systems leads to sediment export. Since sedimentation is the main water quality treatment mechanism, inspections are critical to maintaining performance in sites with heavy sediment loads. Dredging for debris and trash is also needed. While not necessary for these systems to function, the establishment of a viable pond ecosystem can enhance treatment, prolong the system's lifespan, and increase aesthetic appeal.

Cold Climate

The system's ability to treat water quality and manage water quantity remained effective during cold winter months. While some variation in both kinds of performance does occur in cold conditions, it does not warrant significant alterations to system design to compensate.

Water Quality Treatment Process



1. **Runoff flows into a forebay that removes large objects and allows larger sediment particles to settle.**
2. **Runoff exits the forebay though a perforated standpipe and flows into the pond. When forebay capacity is reached, the overflow spills across a weir into the retention pond basin.**
3. **Water quality treatment is a function of storage volume and retention time, i.e., larger storage volumes and longer retention times promote better treatment. The removal of TSS, some phosphorus, petroleum hydrocarbons, and metals occurs primarily through sedimentation.**
4. **Several components contribute to biological treatment. Nutrients removal occurs primarily through the activity of macroinvertebrates, microorganisms, and plants. Long-term breakdown of petroleum hydrocarbons is through microbial processes. Metals that accumulate in the sediment may be taken up by the roots of aquatic vegetation.**
5. **The runoff is conveyed by a perforated standpipe modified with a one-inch outlet which regulates flow from the system.**