Stormwater Solutions in Ohio

Ursuline College Bioretention

Bioretention cell installed at the edge of parking lot with installed monitoring equipment at Ursuline College.

About this Project

Ursuline College is located in the City of Pepper Pike within the Pepper Creek subwatershed, a tributary to the Chagrin River. A stream restoration was planned on campus to restore part of a headwater tributary of Pepper Creek. Since Ursuline College was interested in innovative stormwater management, a 1,960 ft^2 bioretention cell was added to the construction plans. The bioretention cell is located between an existing 0.69 acre parking lot and the stream.

Design

The bioretention cell (henceforth, cell) treats all stormwater runoff from the adjacent parking lot. In order to channel runoff into the cell, the original design called for 12 curb cuts. However, this was changed to a single 3 foot wide flush curb cut and a rock forebay because of feedback from the Collaborative Learning Group (CLG). The forebay acts as a pretreatment for runoff by reducing the velocity of inflow allowing sediment and trash to settle out before they enter the cell.

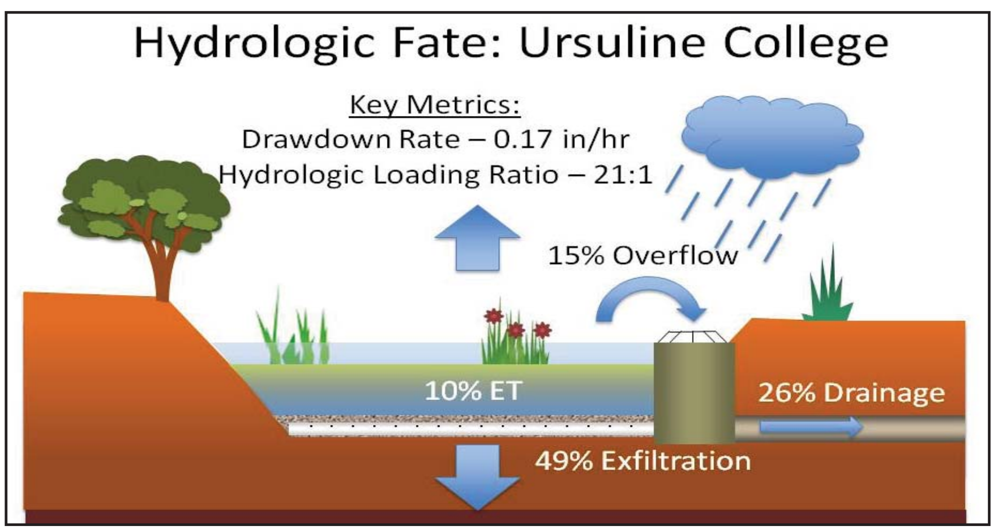
The top 24 inches of the cell are composed of bioretention media followed by 18 inches of aggregate below. The bioretention media (Kurtz Brothers Hydro Clear Bioretention Soil) is an engineered soil that is "loamy sand" texture with less than 5% clay, and does not contain particles larger than 0.04 inches. The Ursuline College bioretention cell contains Osorb (supplied by ABSMaterials, Inc.) which is not a normal component of Kurtz Brothers Hydro Clear Bioretention Soil. Osorb is an organically modified silica based absorbent material which helps absorb contaminates such as pesticides, hydrocarbons, pharmaceuticals, and other dissolved organic molecules.

To create the soil layer, 9 inches of bioretention media was placed, then a 6 inch layer of mixed bioretention media and Osorb, followed by 9 inches of the non-Osorb mixed bioretention media to backfill on top. The aggregate layers below consists of: 3 inches of washed medium concrete sand, 3 inches of #78 washed pea gravel, and a 12 inch layer of #57 washed gravel.

A network of underdrain pipes span the length of the cell and were plumbed into a concrete catch basin located in the center of the cell. An upturned elbow connected to a 12 inch perforated PVC pipe allowed water drainage from the catch basin into the outflow pipe and out to the stream. This design included a 24 inch internal water storage (IWS) zone, of which 6 inches was within the bioretention cell media. Two overflow devices were used in this system: (1) a 3 ft by 3 ft concrete catch basin into which the underdrains were routed, and (2) a broad crested weir in the berm of the cell that acts as an emergency overflow. Vegetation for the site consists of low-mow grass on the side slopes and over 1,400 plant plugs of native grass, sedge, and forb species within the filter bed.

Site Evaluation

Project team members augured 3-4 feet below the excavated bottom of the bioretention cell to generate a soil profile. The soil profile revealed the underlying soil had 95-120 inches of uncompacted fill composed of silt-loam placed on top of native soil, unexpected to the contractor. The fill was most likely brought in from another area on campus. Project team members conducted three single-ring infiltrometer tests which revealed infiltration rates of 0.02, 0.02, and 0.03 in/hr. During infiltration testing, the project team observed water infiltrating much quicker from the other end of the cell. An additional infiltration test was attempted in this quick draining area but was unsuccessful.



Construction

Construction took place in April and May 2014. One contractor was responsible for planting, mulching, and watering vegetation, and a subcontractor managed excavation and construction. Before excavation began, a dandy bag (or silt bag) was placed over the existing storm sewer pipe to prevent construction sediment from entering the stream. The bottom of the cell was excavated 18 inches below the existing storm sewer pipe and was scarified 4-6 inches to allow for better stormwater infiltration. Some ponding occured in one area of the excavation and the construction contractor re-scarified the bottom to roughen it and relieve compaction. Construction machinery was not driven inside the cell to avoid compacting the subgrade.

Next, the catch basin and the underdrain piping were installed. Aggregate was mechanically placed into the cell then manually spread and raked to final grade. An excavator backfilled bioretention media with the Osorb mix layer around the catch basin and over the aggregate layers. Next, native plant plugs were placed inside the cell and three inches of coarse aged shredded hardwood mulch was spread around the plants. Using an excavator, the side slopes were cut at a 2:1 slope back toward the parking lot. A low-mow seed mix and straw was placed on the side slopes to help prevent erosion and increase side slope stability. Lastly, sod and scour-stop matting was lain at the emergency spillway area. Due to incorrect interpretation of the engineering plans, the construction contractors cut into the existing storm sewer pipe, thinking the plan was to tie the new outflow pipe into the existing storm sewer. The monitoring contractor patched the cut to make sure flow did not short-circuit into the storm sewer.

After construction was completed, a large sink hole formed over the new outlet pipe within bioretention cell. Formation of the sink hole was caused by material settling. The sink hole was addressed by the primary contractor who filled it in. Careful observation of the cell after construction allowed corrective actions to take place and remedy the situation.

A one-year warranty was established with the primary contractor involving: a care plan for plant replacement, post-installation care service, and watering during inadequate rainfall. Having a plant warranty ensured adequate and long-term establishment and survivability of the vegetation.

During construction, slumping of the side slopes occurred multiple times. The construction contractor mechanically pulled slumped soil out of the cell and mounded it on both sides. Despite efforts to address slumping, it still occurred, creating very rough side slopes. This made it difficult for grass to establish. A few months after the project was completed, the side slopes were smoothed and the low-mow grass seed replaced.

Monitoring

Monitoring equipment was installed both during and post–construction. The monitoring contractor installed an automated rain gauge and two auto-samplers. One autosampler collected stormwater runoff samples as water entered the bioretention cell. The second collected combined drainage and overflow to allow for direct comparison of inlet and outlet water quality. Inflow hydrology from the parking lot was estimated using the curve number and rational methods. The drainage system was kept separate from the existing storm sewer to isolate flows for monitoring purposes. Within the catch basin, a weir and baffle system was installed to collect hydrologic data from combined drainage and overflow. The cell was monitored for hydrology and water quality. A temperature sensor nest and a water table well were installed within the cell to measure drawdown rates between rain events.

Results

During the seven month monitoring period, a total of fifty rainfall events occurred. Out of those rainfall events, 33 had no outflow due to the relatively high average exfiltration rate (0.17 in/hr) and deep IWS zone (24 inches). The cell reduced runoff by 59%. Partially because of the effectiveness of the cell at reducing runoff, the team was unable to get enough samples at this site to evaluate water quality performance.

More information about the NERRS SC project is available at: http://www.crwp.org/index.php/projects/research-projects/nerrs-science-collaborative.

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