Literature Review on Stormwater Management Basin Retrofits

I. Introduction

This document reviews various aspects of storm water management basins and basin retrofits. Critical characteristics and other factors of original stormwater management basins will be identified so as to explain why retrofits are needed. Moreover, previous studies and their applications of basin retrofits will be reviewed to assess retrofits as a possible approach for improving stormwater management basins.

The original use of stormwater management basins was to mitigate floods; they were known as flood control detention basins. They were designed on a site-by-site basis to limit the peak flow rate at the site’s outlet by temporarily storing water. This is done by allowing large amounts of stormwater to enter and limit the outflow by having a small opening at the lowest point of the structure. Flood control detention basins were often constructed to control extreme storm events, specifically 2- to 100-year storms. (Emerson et al., 2005) Small storms events and the quality of the water were generally not affected by these basins.

Detention of storm water runoff began to appear as a storm water management practice in the late 1960s to control peak runoff rates from new land-development sites. This was initially applied to control 10-, 25-, 50-, or 100-year storm flow rates. Later, several jurisdictions mandated detention to control 2-yr peak flow rates in order to manage stream bank erosion. (Barfield et. Al, 2004) Although detention basins have been constructed to reduce peak stormwater runoff rates since the early 1970s, it is only since the late 1980s that sufficient information has been available to design these basins to improve the quality of the stormwater. Subsequently, the Federal Clean Water Act shifted the focus of stormwater detention design from flood control to stormwater quality control. (Guo, J, 2009) To meet new requirements for stormwater quality, many detention basins have been retrofitted in the past. However, there are still numerous detention basins that have not been retrofitted yet, and even some that must be retrofitted again to remove the necessary amount of pollutants.

From the time rain water hits the ground to when it enters receiving waters, it collects various pollutants from different contaminant sources. The impact of urban runoff pollutants on the water quality of a receiving water body may vary significantly depending upon its existing water quality and the rates at which these pollutants are introduced into the system. Pollutants such as suspended solids, heavy metals, and hydrocarbons are commonly found in stormwater runoff. The suspended solids concentration includes contributions from street dust and eroded sediment. These solids could then deposit at the bottom of a stream, disturbing aquatic habitat. Heavy metals are found in the environment from motor vehicles, industrial land uses, and commercial land uses. Oils, grease, and other hydrocarbons are also frequently found in highway runoff. (Tsihrintzis and Hamid, 1997) Older basins can be redesigned and retrofitted to reduce or stop the pollutants that are entering receiving waters. However, an important consideration in retrofitting a detention basin is to ensure that the original flood control function is still maintained. Under space and budget restrictions, a trade-off between flood control and water quality improvement may be necessary. (Guo, Q, 2005)
II. Problems with Original Basins

With a significant growth in nonpoint source pollution, there has been an increase in contaminants in storm water. Detention basins made solely for flood control cannot handle both mitigating floods and meeting water quality standards. However, with a new design, these basins can be retrofitted to accomplish both. Before possible adjustments are considered, problems with the original storm water detention basins must be assessed. Existing storm water detention basins are often inadequate for original flood control possibly because of sedimentation in the basin, more stormwater from sea level rise, and unexpectedly larger and faster runoff input (Guo, Q, 2005). Another problem faced by existing detention basins is that they were not designed to dissipate runoff volume. Although peak flow rate may sometimes be reduced, extended runoff rates and increased volume are known to increase stream bank erosion. (Emerson et. al, 2005).

A critical component in the design of stormwater detention basins is the outlet design, because it controls the time available for filtration to occur. Outlets commonly consist of a perforated riser with flow rate control, which is provided by an outlet orifice. Because urban stormwater has substantial quantities of both settleable and floatable solids, the outlets are prone to clogging (Middleton and Barrett, 2008).

Many existing detention basins are simple dry bottom designs, where a low-flow channel is present. Often, these low-flow channels are paved with concrete. This allows short-circuiting and does not allow the storm water to be infiltrated into the ground. Short-circuiting occurs when any portion of runoff entering the basin is carried directly to the outlet. When runoff begins to discharge from the facility at the instant that the runoff reaches the outlet, higher effluent concentrations may be observed. Consequently, the stormwater that first enters the basin, which often contains the highest pollutant concentrations, has the shortest residence time and receives the least treatment. (Middleton and Barrett, 2008).

Flood control detention basins are mainly designed for 2- to 100-year storms, which constitute only a small fraction of yearly storm events (Emerson et. al, 2004). Flood control engineers often consider the 2-year storm event to be quite a small storm; however, it produces a runoff greater than 95% of the events that may occur in a watershed (Guo, J, 2009). Although these 2-year storm events, or micro events, constitute a major fraction of the runoff that run through detention basins, they simply pass through the detention basin without being significantly affected. Often, the outlet structure for a flood control detention basin constructed to mitigate major storm events is too big for micro events. When small storm runoff flows straight through the low-flow channel and the outlet opening, there is little to no storage effect. (Guo, J, 2009)

Emerson, Welty, and Traver (2005) examined how on-site detention basins affect watershed-wide storm water flow from medium and small storm events. An existing system of detention basins was surveyed and integrated into a watershed-wide hydrologic model. The model was used to compare the watershed’s response with six measured storms, both with and without flood control detention basins. Results indicated that the existing detention basins had little impact on the watershed-wide stormwater flow system. The detention basins provided an average of only 0.3% peak flow rate reduction for the six measured storms.
It is apparent from this data that one solution to modifying these detention basins is to alter the outlet structure. Modifications on the outlet structure will allow detention basins to retain stormwater for a longer period of time, making it possible for an increase in stormwater runoff treatment to occur.

III. Retrofit Designs

Aside from altering the outlet structure, there is a large range of possible retrofits for a traditional detention basin. Retrofitting techniques include replacing the paved low-flow channels with vegetated swales, re-vegetating basin bottoms with wetland plants, excavating settling basins at the inlets and/or outlet, or lengthening flow paths to stop short-circuiting by installing low berms (Dreher, 1998).

Outlet modification is a relatively easy and inexpensive retrofitting technique. Outlet structures are retrofitted to increase a basin’s detention times for smaller storms. This can be done by restricting the low-flow orifice or completely replacing the outlet structure (Dreher, 1998).

After testing the peak flow rate reductions of flood control detention basins, Emerson et al. (2005) changed their model to test the concept of watershed-wide outlet modifications. The hydrological model was modified such that the low-flow orifices of all the detention basins were restricted to a diameter of 10 cm (4 in.). The six measured storm events were all re-analyzed with the model containing the modified outlet structures. The peak flow results from these simulations can be found in Table 1. The results show improved detention and peak flow reductions compared with the previous simulations with the unmodified outlet structures, with an average of 4%. (Emerson et. al, 2005)

<table>
<thead>
<tr>
<th>Storm Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak flow rate reduction before retrofit</td>
<td>-2.1%</td>
<td>2.3%</td>
<td>0.62%</td>
<td>0.39%</td>
<td>-3.5%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Peak flow rate reduction after retrofit</td>
<td>0.56%</td>
<td>7.2%</td>
<td>0.62%</td>
<td>7.4%</td>
<td>0.67%</td>
<td>9.3%</td>
</tr>
</tbody>
</table>

James Guo (2009) altered a detention basins outlet by adding a perforated plate and riser in a concrete vault in front of the existing outlet structure. The slow outflow through a perforated plate creates the detention effect and increases the residence time. He also added an infiltrating bed at the low point in the detention basin for enhancing the storm water quality. To calculate the volume of the infiltrating bed, he used what he called a runoff-volume capture curve. This curve represents the relationship between the storage volume of the infiltrating bed and the runoff rate. Based on a review of runoff distribution, it is suggested to have a storage volume equal to the runoff volume from a storm of a 4-month return period. The runoff-volume capture curve \( C_v \) is based on the following parameters: \( V_o \), the infiltration bed control volume; \( D \), the rainfall event depth; \( D_m \), the average rainfall event depth; \( D_i \), the initial runoff depth; and \( C \), the runoff rate, which is equal to the value of \( V_o/(D-D_i) \). It is then calculated in the following equation:

\[
C_v = 1 - e^{-D_i/D_m} - V_o/C\cdot D_m
\]
Figure 1 shows a set of runoff capture curves produced from the equation with various runoff rates. It can be observed that the curvature of the runoff capture curve increases when the runoff rate decreases. The runoff capture curve becomes more linear when the runoff rate is equal to 1, which reflects that the more impervious a watershed, the less the detention there is.

These modifications allowed the outlet to have three levels of release, including water quality release for micro events, low flow release for 10-year event, and 100-year high flow release. Table 2 summarizes the outflow results made for the existing box culvert and for the new concrete vault. These results show that the outflow rates were dramatically reduced for small and frequent storms without limiting the capabilities for major storm events.

![Figure 1: Runoff capture curves for different runoff coefficients](image)

### Table 2: Detention Basin Outflow Before and After Retrofits

<table>
<thead>
<tr>
<th>Water Depth (ft)</th>
<th>0.0</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>7.0</th>
<th>8.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Outflow (cfs)</td>
<td>0.0</td>
<td>6.79</td>
<td>22.89</td>
<td>28.04</td>
<td>32.37</td>
<td>36.20</td>
<td>39.65</td>
<td>42.83</td>
<td>45.78</td>
</tr>
<tr>
<td>Retrofitted Outflow (cfs)</td>
<td>0.0</td>
<td>0.24</td>
<td>0.62</td>
<td>10.92</td>
<td>32.37</td>
<td>36.20</td>
<td>39.65</td>
<td>42.83</td>
<td>45.78</td>
</tr>
</tbody>
</table>

As previously stated, another retrofit would be to plant wetland vegetation into the basin bottoms. Hogan and Walbridge (2007) tested several detention basins that were constructed to maintain partially flooded soil conditions, alongside being planted with a variety of wetland plant species to mimic natural wetlands. These retrofitted detention basins increased retention time and vegetation filtering, promoting both nutrient removal and sediment retention to improve water quality. Athey et. al (1998) assessed the retrofits of 17 flood control detention basins in Bucks County, Pennsylvania; their results for average removal efficiencies of different pollutants can be found in Table 3. Each was retrofitted with: an extended detention dry pond; a wet pond; a vegetated swale; constructed wetlands; or a sand filter. Detention basins that were retrofitted with constructed wetlands, similar to the one studied by Hogan and Walbridge, proved to be beneficial for flood control and erosion control as well as removing several pollutants. A sand filter can also be added to a detention basin to effectively remove pollutants. However, they are only feasible in areas smaller than 5 acres, and don’t have effective water quality control for intense storms.

Excavating a settling basin at the inlet or outlet may allow a dry or wet pond to form, which slowly release or store stormwater. Extended detention dry ponds are intentionally
designed to capture and slowly release stormwater runoff from small, frequent storms. To achieve a 60% total suspended solids removal rate, a minimum of 10% of the runoff must remain in the basin at least 24 hours after the maximum runoff storage is achieved. (NJDEP, 2005). This removal is mainly due to sedimentation and flocculation. In addition, a considerable amount of infiltration may occur in the extended dry pond when the runoff is being stored. A wet pond, or retention basin, maintains a permanent pool of water with relatively long term storage. (Tsihrintzis and Hamid, 1997) The presence of a permanent pool is important because it permits treatment to occur between storm events, it increases sedimentation efficiency by dissipating runoff energy, and it provides a habitat for algae and aquatic plants which can assist in the removal of soluble pollutants. (Walker, 1987) However, Athey et. al (1998) provided data that showed both extended dry ponds and wet ponds are beneficial for flood control and erosion control, but provided little water quality improvement. They both require a lot of space, but wet ponds had a higher relative cost.

Table 3: Average pollutant removal efficiencies for different retrofits

<table>
<thead>
<tr>
<th></th>
<th>TSS</th>
<th>TP</th>
<th>TN</th>
<th>COD</th>
<th>Lead</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructed wetlands</td>
<td>65%</td>
<td>25%</td>
<td>20%</td>
<td>50%</td>
<td>65%</td>
<td>35%</td>
</tr>
<tr>
<td>Vegetated swale</td>
<td>60%</td>
<td>20%</td>
<td>10%</td>
<td>25%</td>
<td>70%</td>
<td>60%</td>
</tr>
<tr>
<td>Sand filter</td>
<td>80%</td>
<td>60%</td>
<td>35%</td>
<td>55%</td>
<td>80%</td>
<td>65%</td>
</tr>
<tr>
<td>Extended detention pond</td>
<td>45%</td>
<td>25%</td>
<td>30%</td>
<td>20%</td>
<td>50%</td>
<td>20%</td>
</tr>
<tr>
<td>Wet pond</td>
<td>60%</td>
<td>45%</td>
<td>35%</td>
<td>40%</td>
<td>75%</td>
<td>60%</td>
</tr>
</tbody>
</table>

The U.S. EPA and N.J. DEP categorize storm water management basins in three categories: extended detention basins, wet ponds, and infiltration basins. Their designs are based on certain regulations, and various parameters will be discussed.

Extended detention basins work to address water quality in addition to runoff quantity by extending the storm water detention time to promote pollutant removal, mainly through sedimentation. The lower areas in the basin accomplishes this by detaining runoff while the higher areas attenuate flood and erosion control for large storms. Extended detention basins began to be used as retrofits of flood control basins and are designed to remain dry between storm events when it is not detaining runoff. When an extended detention basin is built or if a flood control detention basin is retrofitted, the diameter of any outlet orifice must be at least 2.5 inches. If a low flow channel exists, it must be at or above the seasonal high groundwater table; the rest of the basin must be at least 1 foot above the groundwater table. The first storm water runoff control outlet should be no greater than 3 feet above the basin bottom. (DEP, 2004) Any area within the basin can be vegetated, as long as it is in accordance with the Standard for Permanent Vegetative Cover for Soil Stabilization (Section 3.2 of the Soil Erosion and Sediment Control Standards). An example extended detention basin is shown in Figure 2. The extended detention basin must comply with the provisions of the Stormwater Management Act of 1981, and NJDEP regulations related to that Act should apply. (NJ DOT, 2008)
Figure 2: Example Extended Detention Basin (DEP, 2004)

A wet pond, or retention basin, is a storm water best management practice similar to an extended detention basin, except that it has a permanent pool at the bottom of the basin. The outlet structure creates this pool and retains the influent runoff during the interval between storms, to further treat the water. The basic design parameter is the ratio of its permanent pool volume to the entering runoff volume, which is determines the pond’s TSS removal rate. The permanent pool must be at least the size of the storm water quality design storm runoff volume. The pools surface area must be at least .25 acres, with a mean depth of 3-6 ft. Wet ponds require sufficient drainage area to function properly, the minimum drainage area is 20 acres. The pond’s length to width ratio should be at least 3:1 to treat the runoff by chemical reactions as well as dispersion and settlement. If this ratio isn’t possible for a certain basin, berms can be added to the increase the residence time. If a riser structure is used in the basin, it must be sized to drain the pool within 40 hours so the sediment can be removed when necessary. Figure 3 shows the components of a basic wet pond. (DEP, 2004)
Infiltration basins are similar to detention basins except that they are designed to allow infiltration to occur. This difference allows them to remove pollutants through filtration in the soil as well as biochemical activities within the soil. For proper infiltration and storage of runoff, the basin must be constructed within highly permeable soils. The storm water leaves the basin through the surrounding soil, so a structural outlet is usually not needed. Infiltration also helps to reduce the quantity of storm water runoff, but the basin must be able to fully drain it within 72 hours. If runoff stays any longer, there may be mosquito breeding problems. Infiltration basins may be used to meet the groundwater recharge requirements of the NJDEP Stormwater Management Rules. To ensure that groundwater contamination doesn’t occur, these basins can’t be used in areas where high pollutant and sediment loadings are anticipated, and the bottom of the basins must be at least 2 feet above the seasonal high groundwater table. A 6 inch layer of sand must be placed on the bottom of the basin to ensure a proper infiltration rate is maintained and also to capture silt, sediment, and debris that could clog soil below the basin. If the basin receives runoff from large storm events, a minimum infiltration rate of 0.5 inches/hour must be used. The infiltration, or permeability, rate can be found using Darcy’s Law, where \( Q = KIA \). In the equation \( Q \) is the rate of infiltration in cfs, \( K \) is the hydraulic conductivity of the soil in fps, \( I \) is the hydraulic gradient, and \( A \) is the area of infiltration in ft². An example infiltration basin can be found in figure 4. (DEP, 2004)
Before a retrofit technique is chosen for a detention basin, the basin should be surveyed to assess groundwater levels and infiltration parameters. No single retrofit is ideally suited for every situation; they must be chosen on a site-by-site basis.

IV. Benefits of Retrofitting

Several different studies have been done to examine the exact benefits of retrofitting detention basins. This mainly consists of data that study the differences in water quality from retrofitting either a flood control detention basin or an existing stormwater management detention basin.

Hogan and Walbridge (2007) compared the performance of 3 retrofitted detention basins to that of 3 flood control detention basins with similar levels of urbanization, in the same watershed. The levels of urbanization were characterized by the % ISC, or percent of impervious surface cover. The retrofitted basins were previously reconstructed with wetland vegetation to focus on detention time and contact with soil and vegetation, and on small storms rather than less frequent, greater intensity storms. These basins had significantly greater phosphorus concentration in its soil than the flood control ones (831.9±32.5 kg/ha and 652.1±18.8 kg/ha, respectively). This suggests that it had greater sorption capabilities, resulting in greater soil phosphorus removal and retention from stormwater. Hogan and Walbridge also found that the retrofitted basins’ soil had increased iron concentrations and relatively greater amounts of crystalline iron, suggesting that it had increased sediment deposition.
A study done by Drury et. Al (1998) showed the affects of retrofitting a flood control dry detention basin with pumped outflow and operating it as an extended detention basin with a seasonal wet pond and pumped outflow. The original detention basin had an open channel over a submerged 36-inch pipe, which connected the inlet and outlet. The retrofit included installing a gabion weir at the outlet, placing a riser over the entrance to the 36-inch pipe, and placing a rock barrier in the channel to minimize short-circuiting. The outflow pump schedule was modified to create a permanent pool at the outlet when the stormwater depth was less than 2 feet, create a temporary pool when the storm water depth was between 2 and 2.4 feet, and slowly release stormwater when the depth was above 2.4 feet, instead of immediately releasing stormwater as it enters the basin. Although they didn’t record data prior to retrofitting the basin, the treatment performance was predicted to be quite low, based on its design and operation. Their data after the retrofitting indicated that the retrofitted detention basin removed 29% of total chromium, 42% of copper, 53% of lead, 51% of nickel, 44% of zinc, and 50% of TSS.

Middleton and Barrett (2008) retrofitted an extended dry detention basin to provide batch treatment of stormwater runoff. The extended dry detention basin was designed to improve stormwater quality, but it did not meet regulations that require removal of 80% of increased TSS from new development. The original detention basin had an outlet structure that consisted of a 400mm PVC outlet pipe connected to a perforated riser pipe enclosed by a trash screen, constructed of wire fabric filled with rocks. To convert the basin to a batch-type reactor, a new outlet structure was retrofitted with a 150mm outlet pipe with an automated valve, which allowed water to be retained in the basin for a preset length of time (12 hours in this case). Because all the runoff is stored for the first 12 hours of a storm, the water that first enters the basin is expected to have a longer residence time and greater treatment. Storing all the runoff should also reduce short-circuiting, capture the sediment that was suspended by the initial flow of runoff into the basin, and increase infiltration. The influent and effluent of the basin before and after the retrofit were monitored for several pollutants; the results can be found in Table 4. The modified basin had substantially better pollutant removal than the original extended detention basin, and now meets the TSS regulation. As expected, short-circuiting was reduced and the sediment suspended by the first runoff was captured. However, no benefit of increased infiltration was observed at the study site because of the impermeable liner. Therefore, they attributed the increase in pollutant removal to the reduction of short-circuiting, the capturing of re-suspended sediment particles, and the different holding time.

Table 4: Mean discharge concentrations for different constituents (Nitrogen represents nitrogen, nitrate and nitrite; TN represents total Kjeldahl nitrogen) (Middleton and Barrett, 2008)

<table>
<thead>
<tr>
<th></th>
<th>Total copper (µg/L)</th>
<th>Total lead (µg/L)</th>
<th>Total zinc (µg/L)</th>
<th>Nitrogen (mg/L)</th>
<th>Dissolved P (mg/L)</th>
<th>TP (mg/L)</th>
<th>TN (mg/L)</th>
<th>TSS (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch-type</td>
<td>3.9</td>
<td>1.0</td>
<td>15.9</td>
<td>0.19</td>
<td>0.09</td>
<td>0.14</td>
<td>0.83</td>
<td>7</td>
</tr>
<tr>
<td>Extended detention</td>
<td>22</td>
<td>24</td>
<td>115</td>
<td>0.98</td>
<td>0.14</td>
<td>0.32</td>
<td>1.85</td>
<td>39</td>
</tr>
</tbody>
</table>
V. Water Quality and Quantity Methods

Different methods were used to calculate the quality of the stormwater. They mainly consisted of finding the concentrations of certain pollutants in both the influent and effluent stormwater. Middleton and Barrett (2008) monitored the performance of the retrofitted basin by an automatic sampling system placed at the inlet and outlet of the basin. Inflow sampling was performed using an area velocity flow meter, a sampler, and a tipping-bucket rain gauge located adjacent to the sedimentation basin inlet. The flow meter and sampler were fastened to the floor of the inlet box culvert, and the sampler stored storm influent in a 9.4 L bottle when the flow meter detected a certain amount of runoff. Outflow concentrations were collected using a bubbler flow meter and a sampler. The flow meter's bubbler hose and the sampler intake were placed in the outlet pipe, on the outlet side of the valve. The flow meter was used to detect the level in the pipe and start a timed sampling sequence in the sampler. Their sample analysis was performed using the testing parameters and test method from the U.S. EPA publication SW-846.

Drury et. Al (1998) estimated pollutant removal effectiveness based on the difference between influent and effluent concentration. Flow data and water quality samples were also obtained by using automated samplers; these were located in the pump station and in the pipe entering the basin. Flow-weighted composite samples were obtained from eight storm events.

Hogan and Walbridge (2007) found nutrient and sediment retention measurements in the soil from soil cores (0–15 cm) by driving a 4 cm PVC pipe with a sharpened edge into the ground. At each site, four randomly located 4 by 4 m plots were established and divided into four 2 by 2 m subplots. One soil core was randomly collected within each subplot, and composited by plot to produce four distinct samples per study site. They stored the soils in polyethylene bags, kept them on ice in the field, and stored them at 4°C (field moist) in the laboratory.

The quantity of water was measured to evaluate the flow rate reduction and detention capabilities. One method involved surveying all the basins in a watershed and incorporating them into a hydrologic model. (Emerson et. al, 2005) The survey included measuring each outlet structure and recording its GPS coordinates, and pacing off the dimensions of each basin by foot and measuring the side and bottom slopes with a lock level and surveyor’s tape. The survey data was used to create scaled contoured drawings of each basin, which helped routing flows through reservoirs using the level pool routing subroutine in HEC-GeoHMS, an extension of the US Army Corps of Engineers Hydrologic Engineering Center’s Hydrologic Modeling System (HEC-HMS), using measured rainfall and observed stream flow obtained from a US Geological Survey (USGS) stream gauge.

Guo, J (2009) presented a model that determines the relationship between water-quality control volume and runoff capture, through a runoff-volume capture curve (a higher runoff capture ratio requires a larger storage volume). Using the runoff capture curve as the basis, the water quality control volume can be determined for a certain runoff capture target. Details can be found in the UD-DETENTION computer model at [www.udfcd.org](http://www.udfcd.org).

There are other methods available that can accurately analyze the runoff quality in detention basins. EPA’s Storm Water Management Model (SWMM), and the Storage, Treatment, Overflow Runoff Model (STORM) are both simulation programs that are commonly used. SWMM is a rainfall-runoff model used for runoff quantity and quality from mainly urban areas. It works by measuring precipitation and the runoff from sub-catchment areas. The program, STORM, is used to assist in the sizing of detention basins to control the quantity and
quality of storm water runoff and land surface erosion. It is capable of calculating concentrations of storm water constituents such as suspended and settleable solids, BOD, TN, TP, and total coliform. (EPA, 1986)

VI. Conclusion

Although many detention basins have been retrofitted to meet water quality improvement regulations, there are still many that still don’t have a significant affect on the water quality and others that are still only for flood control. These detention basins can be retrofitted, to reduce both peak flow rates and pollutant concentrations in the stream which will be receiving the discharged storm water. Some retrofitting techniques are better than others, but none are perfect for every detention basin. Each type of retrofit has its own benefits; some require a certain amount of space or cost, and some types focus on removing certain pollutants. Retrofits are designed on a site-by-site basis, meaning it depends on the status of the existing detention basin.

For example, if the detention basin experiences problems with short-circuiting, a rock barrier or low berm should be placed in the path of water. If stormwater travels through the basin without being slowed down or retained, the low-flow orifice can be blocked or restricted, or a vegetated swale can be placed in the low-flow channel. If water is retained but the quality of the water doesn’t improve, wetland plants should be planted in the basin floor. Not all retrofits are easy to install or work immediately; detention basins and their retrofits should be inspected and maintained frequently. When plants are used, the use of native plants is recommended to minimize the amount and frequency of maintenance (Dreher et al., 1998).

There is plenty of room for advancement regarding detention basins and their retrofits. It is evident that retrofitted stormwater detention basins can reduce peak flow rate and improve stormwater quality much better than flood control basins. However, they can still further reduce the flow rate and leave stormwater cleaner for receiving water. The methods used in evaluating the water quantity and water quality can also be improved. For example, simply sampling the influent and effluent stormwater for pollutants may not be the best way to assess stormwater quality. Further research must be conducted to find the solutions to these problems.

VII. References


