45 Asheville Road
Chestnut Hill, MA
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April 7, 2014

Ms. Allison Steinfeld
Planning Director
Town of Brookline
333 Washington Street
Brookline, MA 02445

**Re: Proposed Residence of South Brookline 40B Development/Comments Regarding the Civil/Stormwater Management Study for Hancock Village**

**Dear Ms. Steinfeld:**

I want to build on the previous comments I made on the stormwater design for Hancock Village during the ZBA meeting I spoke at when the public was permitted to testify. The comments below should be considered in tandem with the written comments I had provided via e-mail before that public meeting.

As you know I'm a registered professional engineer with experience in civil and stormwater design. I feel there are serious issues that still need to be addressed to properly evaluate this proposed project. These include:

1. **The General Comments are misleading**

The first remark of the General Review comments is that the plans provided are too small to read. I agree. At a minimum 40 scale drawings should have been provided and based on the overall site size, 20 scale drawings would be more appropriate. There is no way a comprehensive review could have been done with the plans provided.

The Peer reviewer states that "the project proposes to clear some large trees . . .". The project, as supported by the drainage calculations, will be removing 98% of the trees in the study area. This is dozens of trees, not "some" as reported.

2. **Site Demolition, Earthwork and Site Preparation are incomplete**

Review comment D1 requests that earthwork calculations need to be done to accurately determine earth and rock removal quantities and number of truck trips. What the reviewer failed to note was the boring information gathered for the project is not adequate to determine these values with any precision. It is clear that the rock elevations are highly variable. I suspect that the rock is extremely high in most areas and there will be a substantial, much more that the project designers will admit, amount of rock to be blasted and removed.

Review comment D2 asks for the proposed truck route for moving the hundreds of yards of material from the work site. The truck route should not only say how material will be moved from point A to point B, but it should have time of day restrictions and a commitment to have full time police details to protect the public from this dangerous situation.

Comment D4 asks for a blasting plan. This plan should accurately describe the monitoring requirements that will be established for the blasting program and the methods used to ensure these procedures are being followed. Typically when operations such as blasting are utilized there will be full time safety officers provided by the project and instrument monitoring with multiple seismographs employed not just within the project area but also throughout adjacent properties to ensure damage will be limited. I have been involved in this type of monitoring in my work as a structural engineer and would be happy to provide guidelines for protecting the neighborhood.

More importantly, before any blasting or rock excavation is to start the project should provide professional engineers to provide site assessments of all abutter's properties. These site assessments would require a professional site assessor to come to each abutters' home and document the existing conditions of our homes and other structures noting things like cracks in walls and masonry, indications of settlement and squareness of windows and door ways. Having properly documented existing conditions will be essential to evaluating the impacts of the proposed work and settling legal matters.

**3. The Site Plans and Details review is incomplete**

Comment S1 notes that the exercise equipment will be impacted by the expansion. The developer should indicate how long these will be out of service. As these exercise stations are part of a comprehensive exercise circuit the owner should provide an alternate route during construction and indicate what signage, if any, will be provided to alert users that several of the stations are out of service and prevent people from entering construction zones.

Also, I did not see any discussion on ADA compliance within the project. Walkways should not have grades that exceed the ADA minimum and for significant changes in elevation, such as around the high rise, it will be necessary to provide walkways with level landings and possibly railings.

Hancock village advertises itself as "pet friendly" on their website. There are stations within the proposed site that have bags to clean up after your dog. The site plan should note where residents will exercise their pets once all the green space is paved over.

Finally, there is no discussion of what security measures are going to be provided at the complex. Will call boxes, panic alarms, camera systems be provided?

4. **The Site Access, Parking & Loading review is incomplete**

One of the biggest question I have with this project is whether or not the proposed travelways driveways or roads? This should be clarified by the developer.

Comment P1 suggests that additional ingress/egress routes be provided. I think there has to be a comprehensive review/explanation as to why the primary ingress/egress route to the largest part of the expansion, behind Russet Road, is not via the VFW Parkway. This road is more appropriate to handle the type of traffic expected and the Asheville Road entrance should be gated off to only allow emergency vehicles to enter the sight.

Comment P2 simply suggests the 10% grade of the proposed Asheville Road be re-graded with no maximum design criteria suggested. I feel that a maximum 6% grade is appropriate for the site. The final roadway grades should not be set without doing a comprehensive speed limit study to make sure that the appropriate speed limits that correspond to roadway geometry are enforceable.

5. **The Stormwater Management System review is flawed**

The Peer reviewer noted that the project relies on three primary methods of mitigating the increase in stormwater runoff generated by removing all the green space and trees; porous pavement, hydrodynamic separators and subsurface infiltration/storage. As I covered extensively in my presentation to the ZBA board, porous pavement is totally incompatible with the site. The high ledge, high water table and steep slopes in the will doom this system to failure. As I noted in my report the EPA has provided guidelines that state that 75% of porous pavement installations will fail. The EPA has also provided guidance for hydrodynamic separators. The EPA report states "*Site constraints, including the availability of suitable land, appropriate soil depth, and stable soil to support the unit structurally, may also limit the applicability of the hydrodynamic separator.*" I think the designer needs to provide a detailed engineering design that supports the use of these hydrodynamic separators for the project. I don't believe the soil depth is adequate for their use.

Also, the report states that the current drainage system is a closed drainage system. This is not entirely correct. Asheville Road has cape cod berms at the edge of pavement. All water from the roadways and adjoining parking areas runs down the road and crosses over at the entrance of the site and runs directly onto my property. The nearest catch basins are not until the intersection of Asheville and Russet roads.

The last sentence in the second paragraphs notes “Monitoring wells indicate high ground water in some areas.” and does not go on to expand on this observation. High groundwater should be considered and extremely significant issue as the amount of storage capacity in the soil is directly related to the water table elevation. The Peer review should also focus on the fact that the water table elevations used for the stormwater analysis were based on misleading data. A true evaluation cannot be done until accurate water table readings are gathered and precise water table elevations are determined using proven engineering methods.

Comment SW2 mistakenly states “The design incorporates a conservative approach by assuming no infiltration beneath the porous pavement and utilizes it primarily as a storage and filtration system.” The Peer reviewer cannot establish if this is truly a conservative assumption as there is no clear subsurface data to support the claim. It is not conservative to assume that ledge will not absorb water, it’s just a fact. If ledge or water tables are higher than what was assumed by the designer, which they surely are, then the approach is not conservative it is speculative.

Bullet b. for SW2 asks for the designer to provide previous similar projects. The projects that are provided should have long term history of success and should note the maintenance that was utilized to use as basis for determining the maintenance plan for the proposed application.

Comment SW6 states that all access driveways direct stormwater towards catch basins and curb lines. Are there catch basins proposed for the roadways? Will all run-off be captured before it leaves the site. These questions remain unanswered.

Comment SW7 asks for clarification if DMH17 is intended to function as a manhole or leaching catch basin. If it is intended to function as a leaching catch basin the designer should have a boring done at the location to determine the ledge elevation. Also, a leaching catch basin must be installed well above the water table. The relation to the bottom of basin to the season high ground water should be provided.

Comment SW8 talks about the significant regrading that is proposed. It fails to mention the numerous retaining walls that are required. These retaining walls will need to be built with weep holes to equalize the hydrostatic pressure on either side of the wall. If walls are built directly on the property lines then these weep holes will be directing water onto the adjacent properties and contributing to existing water issues the neighborhood is already facing.

Comment SW17 points out the discrepancy in the calculations and details regarding the amount of gravel below the porous pavement. Not only should these be coordinated, but the designer needs to confirm that the amount of gravel that is required can be placed based on the existing subsurface conditions. The developer should also discuss what will be done if construction begins and site conditions are drastically different from the designers’ assumptions how will that be documented and how will the design be revised to meet these new conditions. Often, once the design in accepted the there are no means to ensure designer intent is met. The contractor will not be familiar with the design process and if high ledge is encountered it will be a cost savings to him as less gravel will be needed to complete the project. He will have no incentive to report the discrepancies and wait for a redesign. When the system does fail the engineer, if consulted, will surely cite “differing site conditions” to support why his design did not work.

Comment SW18 correctly notes that the designer ignored the fact that porous pavement is shown on grade. He suggests the calculations be revised to show the diminished storage capacity. The Peer reviewer should have also noted that porous pavement will not be effective on slopes and should not be used for these conditions.

**Recharge to groundwater (Standard Number 3)**

Again, the Peer reviewer claims that the designer used a conservative approach to his design. This cannot be confirmed until the actual subsurface conditions are properly established.

Comment SW20 should be expanded to not only ask for the existing boring information but it should ask that a comprehensive subsurface exploration program be developed to determine a comprehensive subsurface profile showing limits of each stratum of each soil type to bedrock.

Comment SW21 should be expanded to include a study to ensure that cracks in the existing ledge that will be created by the blasting program do not allow pollutant infiltration to the site.

Comment SW22 is an extremely important observation and should be given the highest priority to be resolved. Without correct groundwater information the entire stormwater analysis is on theoretical.

Comments SW23 is incomplete. Not only should the bottom of the Storm Tanks be two feet above the ledge, they should also be two feet above the seasonally high ground water.

**80% TSS Removal (Standard Number 4)**

The Peer reviewer says “The stated TSS removal rate for the project ranges from 80% to 96%”. However he does not seem to question whether or not this has been achieved. The designer relies heavily on the Stormcepters to remove TSS. According to the EPA Technology Fact Sheet on Hydrodynamic Separators the Stormcepter is only capable of removing 50% to 80% of total sediment load “when used properly”. Proper use means installing in well draining soils with enough separation from the ledge or high ground water. Even with optimum conditions the Stormceptor would have to be operating at peak performance just to meet the absolution minimum 80% requirement. The EPA report goes on to say that proper maintenance is required for the system to be effective. There were no maintenance plans submitted regarding these Stormceptor installations.

Comment SW24 is also extremely important. I do not agree that a redundant system should be installed to offset the almost certain fact that the porous pavement will fail. The designer should not use porous pavement in the first place. The design should be based on a proven system with a high certainty of success.

**Higher Potential Pollutant Loads (Standard Number 5)**

The Peer reviewer assumes this is not applicable. However, the owner has not provided a method of clearing snow and ice from the porous pavement as salt and sanding will be prohibited. If chemicals are used in lieu of salt these chemicals should be noted and confirmed that they are not classified as a pollutant.

**Critical Areas (Standard Number 6)**

While there may not be a current DEP mapped aquifer, there is substantial evidence that there is an underground stream running through the property and the DEP should be notified and an investigation should be performed to ensure that aquifers are not put in danger by this project.

**Construction Period Erosion and Sediment Controls (Standard Number 8)**

The designer should provide a series of construction staging plans showing how many stages of construction will be needed to complete the project. Traffic and pedestrian flows during each stage should be clearly shown with the corresponding erosion control measures. The owner should clarify if temporary easements will be required to complete the retaining wall construction, etc.

**Operations/maintenance plan (Standard Number 9)**

This plan should also include anticipated design life of pavements and storm management systems and how they will be replaced without serious impact on the site traffic and pedestrian movements. The plan should also discuss the current age of existing drainage structures, the remaining useful service life of these structures and if these systems will be replaced in kind or with alternate systems.

An complete investigate of the existing underground drainage system should be done to confirm all drainage structures and piping is in good condition. Camera systems should be utilized and photographs should be taken and filed to provide a baseline if future issues arise.

**Landscaping and Lighting**

The lighting design for the project is minimal for the numerous new structures, parking garages, parking lots, walkways, etc. I have experience working on several projects in my engineering career with street and pedestrian lighting as part of the project. There are always extensive studies done to ensure that lighting is adequate to meet safety and security concerns without overwhelming adjacent areas. Light pollution could be a series problem with the proposed development as most of the new construction will be built in close proximity to the rear of existing homes and could have lights shining in bedrooms all night long.

Lighting is also a critical security issue. The project designers have decided it is appropriate for a significant amount of parking to be located in satellite parking lots. This will mean there will be a large number of vehicles left overnight that will be tempting to thieves. Vehicle break-ins are a problem that has been plaguing this South Brookline neighborhood for a long time. Two relatives, one living down the street on Russet and one living on Beverly, have recently had their cars broken into and one was seriously vandalized.

Also, the shade impacts of the proposed structures need to be studied. The proposed multi-story structures will cast shadows over our neighborhood impacting our ability to grow grass, plant gardens and have direct sun exposure on our homes. It is my understanding that minimum setbacks from property lines will be violated and existing grades will be raised to make the site buildable and this will exacerbate the effects of shade. I, like many of my neighbors, have wood shingle siding. This needs to dry out after rain events or it will warp and degrade. If the sun is blocked and the siding is not allowed to dry out it could result in a significant financial burden for me as it will have to be replaced/repaired more often.

The significant removal of grass and trees will contribute to creating a micro Heat Island effect in the surrounding areas. Heat Islands are caused when built up areas are hotter than the surrounding areas. The developer should discuss ways to mitigate this effect. Solutions could include using lighter color building materials, roof gardens and tree planting. The EPA provides a wealth of information on Heat Islands.

**Environmental and Cultural Impacts**

Although I am not a certified wetland scientist, I do believe there are vernal pools on the property. I have attached photos showing the extremely wet areas after a recent storm.

Thank you for giving me the opportunity to present comments. I would be happy to meet with you to discuss these important issues facing our South Brookline Community. If you have any questions, please let me know.

Sincerely,

William M. Varrell III

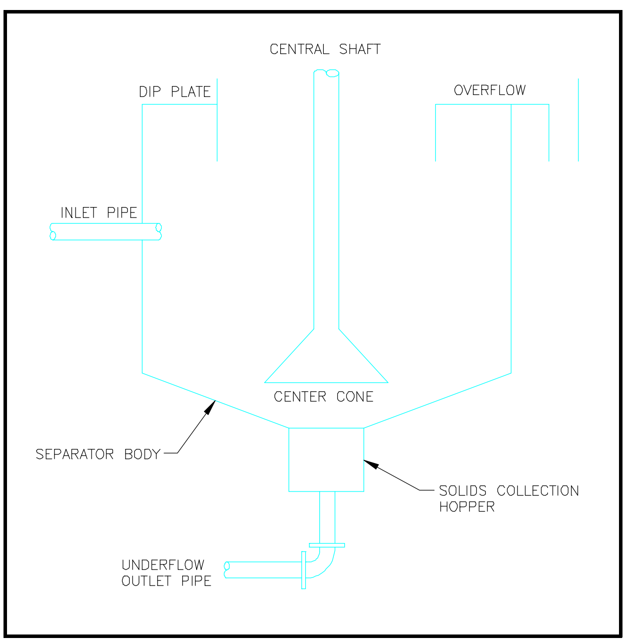
William M. Varrell, III, P.E., LEED AP

United States Environmental Protection Agency
Office of Water Washington, D.C.
EPA 832-F-99-017
September 1999

# Storm Water Technology Fact Sheet
# Hydrodynamic Separators

## DESCRIPTION

Hydrodynamic separators are flow-through structures with a settling or separation unit to remove sediments and other pollutants that are widely used in storm water treatment. No outside power source is required, because the energy of the flowing water allows the sediments to efficiently separate. Depending on the type of unit, this separation may be by means of swirl action or indirect filtration. A generalized schematic of a unit is shown in Figure 1. Variations of this unit have been designed to meet specific needs.




Source: Fenner and Tyack, 1997.

**FIGURE 1 GENERALIZED HYDRODYNAMIC SEPARATOR**

Hydrodynamic separators are most effective where the materials to be removed from runoff are heavy particulates - which can be settled - or floatables - which can be captured, rather than solids with poor settleability or dissolved pollutants.

In addition to the standard units, some vendors offer supplemental features to reduce the velocity of the flow entering the system. This increases the efficiency of the unit by allowing more sediments to settle out.

## APPLICABILITY

This technology may be used by itself or in conjunction with other storm water BMPs as part of an overall storm water control strategy. Hydrodynamic separators come in a wide size range and some are small enough to fit in conventional manholes. This makes hydrodynamic separators ideal for areas where land availability is limited. Also, because they can be placed in almost any specific location in a system, hydrodynamic separators are ideal for use in potential storm water "hotspots"--areas such as near gas stations, where higher concentrations of pollutants are more likely to occur.

The need for hydrodynamic separators is growing as a result of decreasing land availability for the installation of storm water BMPs. This fact sheet discusses hydrodynamic separator systems from four vendors. Although there are many hydrodynamic separation systems available, these four address the major types.

They are the following:

- Continuous Deflective Separation (CDS).

- Downstream Defender™.
- Stormceptor®.
- Vortechs™.

**Continuous Deflective Separation (CDS)**

CDS' hydrodynamic separator technology is suitable for gross pollutant removal. The system utilizes the natural motion of water to separate and trap sediments by indirect filtration. As the storm water flows through the system, a very fine screen deflects the pollutants, which are captured in a litter sump in the center of the system. Floatables are retained separately. This non-blocking separation technique is the only technology covered in this fact sheet that does not rely on secondary flow currents induced by vortex action.

The processing capacities of CDS units vary from 3 to 300 cubic feet per second (cfs), depending on the application. Precast modules are available for flows up to 62 cfs, while higher flow processing requires cast-in-place construction. Every unit requires a detailed hydraulic analysis before it is installed to ensure that it achieves optimum solids separation. The cost per unit (including installation) ranges from $2,300 to $7,200 per cfs capacity, depending on site-specific conditions and does not include any required maintenance.

Maintenance of the CDS technology is site-specific but the manufacturer recommends that the unit be checked after every runoff event for the first 30 days after installation. During this initial installation period the unit should be visually inspected and the amount of deposition should be measured, to give the operator an idea of the expected rate of sediment deposition. Deposition can be measured with a calibrated "dip stick". After this initial operation period, CDS Technologies recommends that the unit should be inspected at least once every thirty days during the wet season. During these inspections, the floatables should be removed and the sump cleaned out (if it is more than 85 percent full). It is also recommended that the unit be pumped out and the screen inspected for damage at least once per year.

A recently completed study by UCLA for CDS Technologies evaluating the effectiveness of four different sorbent materials in removing used motor oil at concentrations typically found in storm water runoff. They applied the sorbents in a CDS unit separation chamber and reported captures of 80-90 percent. The test found that polypropylene or co-polymer sorbents to be the most effective in the capture of the used motor oil.

**Downstream Defender**

The Downstream Defender, manufactured by H.I.L. Technology, Inc., regulates both the quality and quantity of storm water runoff. The Downstream Defender is designed to capture settleable solids, floatables, and oil and grease. It utilizes a sloping base, a dip plate and internal components to aid in pollutant removal. As water flows through the unit, hydrodynamic forces cause solids to begin settling out. A unique feature of this unit is its sloping base (see Figure 1), which is joined to a benching skirt at a 30-degree angle. This feature helps solids to settle out of the water column. The unit's dip plate encourages solids separation and aids in the capture of floatables and oil and grease. All settled solids are stored in a collection facility, while flow is discharged through an outlet pipe. H.I.L. Technology reports that this resulting discharge is 90 percent free of the particles greater than 150 microns that originally entered the system.

The Downstream Defender comes in predesigned standard manhole size, typically ranging from 4 to 10 feet in diameter. These units have achieved 90 percent removal for flows from 0.75 cfs to 13 cfs. To meet specific performance criteria, or for larger flow applications, units may be custom designed up to 40 feet in diameter. (These are not able to fit in conventional manholes.) The approximate capital and installation costs, range from $10,000 to $35,000 per pre-cast unit.

Inspecting the Downstream Defender periodically (once a month) over the first year of operation will aid in determining the rate of sediment and floatables accumulation. A probe (or dipstick) may be used to help determine the sediment depth in the collection facility. (With this inspection information a maintenance schedule may be established.) A sump vac (commercial or municipally-owned) may be used to remove captured floatables and solids. With proper upkeep, H.I.L. Technology reports the Downstream Defender will treat storm water for more than 30 years.

**Stormceptor**

Stormceptor Corporation is based in Canada and has licensed manufacturers throughout Canada and the United States. Stormceptor is designed to trap and retain a variety of non-point source pollutants, using a by-pass chamber and treatment chamber. Stormceptor reports that it is capable of removing 50 to 80 percent of the total sediment load when used properly.

Stormceptor units are available in prefabricated sizes up to 12 feet in diameter by 6 to 8 feet deep. Customized units are also available for limited spaces. Stormceptor recommends its units for the following areas:

- Redevelopment projects of more than 2,500 square feet where there was no previous storm water management (even if the existing impervious area is merely being replaced).

- Projects that result in doubling the impervious area.

- Projects that disturb at least half of the existing site.

The cost of the Stormceptor unit is based on the costs of two important system elements:

- A treatment chamber and by-pass insert.

- Access way and fittings.

Typically, the cost for installation of a unit for a one acre drainage area is $9,000. This cost will vary depending on site-specific conditions. Stormceptor units range from 900 to 7,200 gallons and cost between $7,600 and $33,560. Cleaning costs depend on several factors, including the size of the installed unit and travel costs for the cleaning crew. Cleaning usually takes place once per year and costs approximately $1,000 per structure.

Vacuum trucks are used to clean out the Stormceptor unit. Although annual maintenance is recommended, maintenance frequency will be based on site-specific conditions. The need for maintenance is indicated by sediment depth; typically, when the unit is filled to within one foot of capacity, it should be cleaned. Visual inspections may also be performed and are especially recommended for units that may capture petroleum-based pollutants. The visual inspection is accomplished by removing the manhole cover and using a dipstick to determine the petroleum or oil accumulation in the unit.

If the Stormceptor unit is not maintained properly, approximately 15 percent of its total sediment capacity will be reduced each year.

**Vortechs**

The Vortechs™ storm water treatment system, manufactured by Vortechnics™ of Portland, Maine, has been available since 1988. Like the other hydrodynamic separators, Vortechs removes floating pollutants and settleable solids from surface runoff. This system combines swirl-concentrator and flow-control technologies to separate solids from the flow. Constructed of precast concrete, Vortechs uses four structures to optimize storm water treatment through its system. These are:

- *Baffle wall*: Situated permanently below the water line, this structure helps to contain floating pollutants during high flows and during clean outs.

- *Circular grit chamber*: This structure aids in directing the influent into a vortex path. The vortex action encourages sediment to be caught in the swirling flow path and to settle out later, when the storm event is complete.

- *Flow control chamber*: This device helps keep pollutants trapped by reducing the forces that encourage resuspension and washout. This chamber also helps to eliminate turbulence within the system.

- *Oil chamber*: This structure helps to contain floatables.

Vortechnics manufactures nine standard-sized units. These range from 9 feet by 3 feet to 18 feet by 12 feet. The unit sizes depend on the estimated runoff volume to be treated. For specific applications, dimensions of the runoff area are used to customize the unit. Vortechnics reports that Vortechs systems are able to treat runoff flows ranging from 1.6 cfs to 25 cfs. The cost for these units ranges from $10,000 to $40,000, not including shipment or installation.

As with other hydrodynamic separator systems, maintenance of the Vortechs system is site-specific. Frequent inspections (once a month) are recommended during the first year and whenever there may be heavy contaminant loadings: after winter sandings, soil disturbances, fuel spills, or sometimes, intense rain or wind.

The Vortechs unit requires cleaning only when the system has nearly reached capacity. This occurs when the sediment reaches within one foot of the inlet pipe. The depth may be gauged by measuring the sediment in the grit chamber with a rod or dipstick. To clean out the system, the manhole cover above the grit chamber is lifted and the sediment is removed using as vacuum truck. Following sediment removal, the manhole cover is replaced securely to ensure that runoff does not leak into the unit.

Hydrodynamic separators are most effective where the separation of heavy particulate or floatable from wet weather runoff is required. (The typical concentrations of heavy particulate and floatable pollutants found in storm water are shown in Table 1.) They are designed to remove settleable solids and capture floatables; however, suspended solids are not effectively removed. Most units are small (depending on the flow entering needing to be treated) and may be able to fit into pre-existing manholes. For this reason, this technology is particularly well suited to locations where there is limited land available.

**TABLE 1 CONCENTRATION OF POLLUTANTS IN STORM WATER**

| Pollutant | Concentration |
|---|---|
| TSS | 100 mg/L |
| Total P | 0.33 mg/L |
| TKN | 1.50 mg/L |
| Total Cu | 34 µg/L |
| Total Pb | 144 µg/L |
| Total Zn | 160 µg L |

Source: U.S. EPA, 1995.

The units designed for hydrodynamic separators are generally prefabricated in set sizes up to twelve feet in diameter, but they may be customized for a specific site if needed. Some structures are available in concrete or fiberglass. (Fiberglass is recommended for areas of potential hazardous material spills.) These materials are both suitable for retrofit applications.

Hydrodynamic separators are also good for potential storm water “hotspots” or sites that fall under industrial NPDES storm water requirements. “Hotspots” are areas such as gas stations, where a higher concentration of pollutants is more likely to be found.

## ADVANTAGES AND DISADVANTAGES

The use of hydrodynamic separators as wet weather treatment options may be limited by the variability of net solids removal. While some data suggest excellent removal rates, these rates often depend on site-specific conditions, as well as other contributing factors. Pollutants such as nutrients, which adhere to fine particulates or are dissolved, will not be significantly removed by the unit.

Site constraints, including the availability of suitable land, appropriate soil depth, and stable soil to support the unit structurally, may also limit the applicability of the hydrodynamic separator. The slope of the site or collection system may necessitate the use of an underground unit, which can result in an extensive excavation.

Observable improvements in waterways are often attributable to the use of hydrodynamic separators. This is due to the reduction of sediments, floatables, and oil and grease in the flow out of the unit. These positive impacts are only achievable when proper design and O&M of the unit are implemented.

## PERFORMANCE

Hydrodynamic separators are designed primarily for removing floatable and gritty materials; they may have difficulty removing the less-settleable solids generally found in storm water. The reported removal rates of sediments, floatables, and oil and grease differ depending on the vendor. Proper design and maintenance also affect the unit's performance.

## OPERATION AND MAINTENANCE

Hydrodynamic separators do not have any moving parts, and are consequently not maintenance intensive. However, maintaining the system properly is very important in ensuring that it is operating as efficiently as possible. Proper maintenance involves frequent inspections throughout the first year of installation. The unit is full when the sediment level comes within one foot of the unit's top. This is recognized through experience or the use of a "dip stick" or rod for measuring the sediment depth. When the unit has reached capacity, it must be cleaned out. This may be performed with a sump vac or vacuum truck, depending on which unit is used. In general, hydrodynamic separators require a minimal amount of maintenance, but lack of attention will lower their overall efficiency.

## COSTS

The capital costs for hydrodynamic separators depend on site-specific conditions. These costs are based on several factors including the amount of runoff (in cfs) required to be treated, the amount of land available, and any other treatment technologies that are presently being used. Capitol costs can range from $2,300 to $40,000 per pre-cast unit. Units which are site-specifically designed, typically cost more and the price is based on the individual site.

Total costs for hydrodynamic separators often include predesign costs, capital costs, and operation and maintenance (O&M) costs. Again, these costs are site-specific. The predesign costs depend upon the complexity of the intended site. O&M costs vary based on the company contracted to clean out the unit, and may depend on travel distances and cleaning frequency. These costs generally are low (maximum of $1,000 a year) and vary from year to year.

The individual unit prices are discussed in the current status section previously mentioned. This covers a more in depth price range of the various systems.

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## ADDITIONAL INFORMATION

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OWM MTB
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