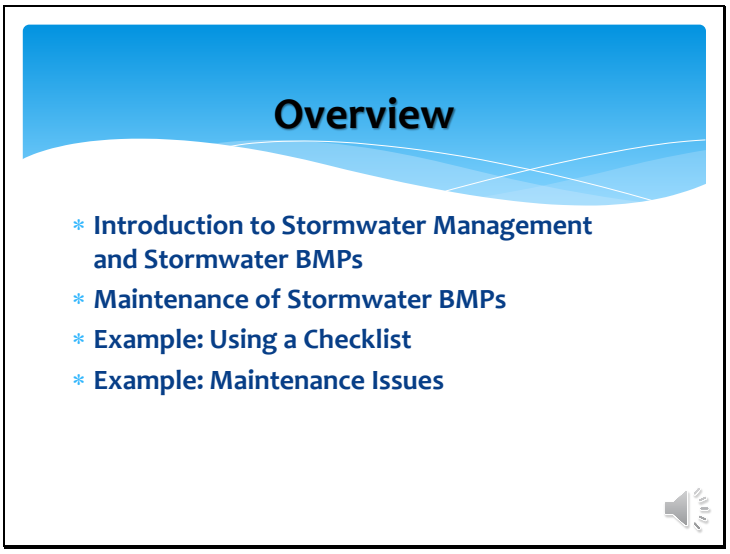
Slide 1

This Stormwater Management Training is intended to give an overview regarding the Stormwater Best Management Practices (or “BMPs”) and the maintenance requirements under the New Jersey Administrative Code 7:8-5.8, which are also known as the Stormwater Management Rules, as well as the various Municipal Stormwater General Permits issued under N.J.A.C. 7:14A. In addition to this regulatory and permitting requirement, this training provides a holistic view of the maintenance work that ensures the Stormwater BMPs function well.

Slide 2



This training is divided into two parts covering four topics:

The first part, Introduction to Stormwater Management and Stormwater BMPs provides a general understanding of the Stormwater Best Management Practices, that is, how they function, what they look like, and the basic requirements to ensure they work correctly.

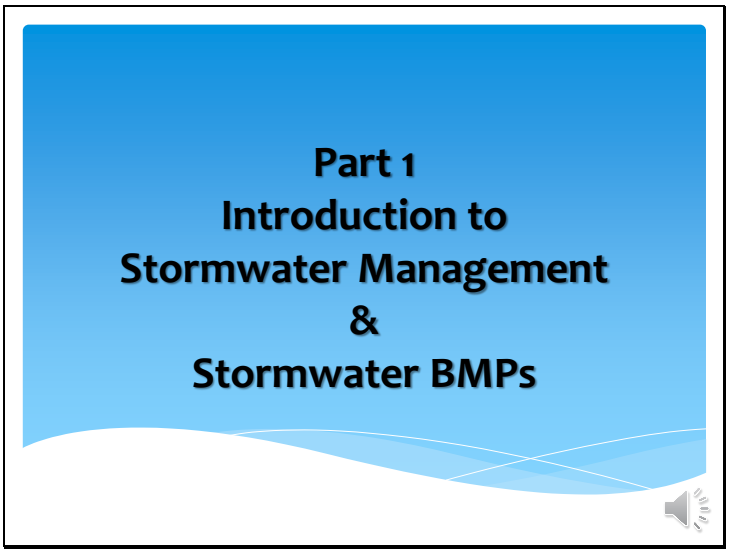
The second part covers the following three topics:

Maintenance of Stormwater BMPs - the elements of maintenance and the tools to assure the maintenance is properly performed.

An example of using a checklist to inspect a BMP.

Examples of commonly occurring maintenance issues.

Slide 3


Part 1
Introduction to
Stormwater Management
&
Stormwater BMPs

Slide 4

Why do we need to manage stormwater? When it rains, some of the precipitation will soak into the ground to either be absorbed by plants or will migrate into groundwater. The rest becomes runoff, which flows to nearby streams, stormwater collection systems, or to lower lying areas.

How much rain is retained in the ground and how much rain becomes runoff are, generally speaking, affected by the type of land cover.

If the land is covered by vegetation, the soil and the plants will intercept a fair portion of rain and produce less runoff.

If the land is covered by hard, smooth impervious surfaces, like asphalt and solid concrete, most of the rain falling on the impervious surface will become runoff. This runoff will wash pollutants, such as particles from a car's exhaust emissions, trash, and oil or grease that was previously deposited on the impervious surfaces, into nearby streams and pollute the water.

The runoff from the impervious surfaces may cause concentrated flow which can then cause flooding and soil erosion on neighboring lands.

Therefore, stormwater runoff needs to be properly managed to avoid increasing pollution, flooding, and erosion.

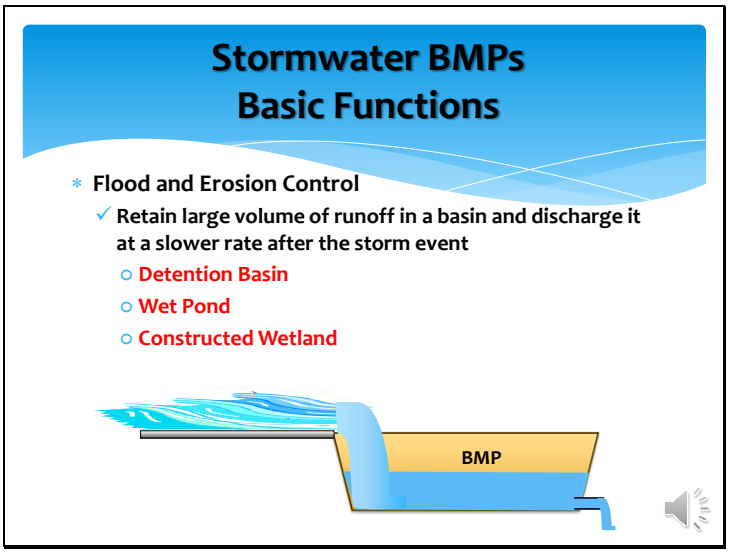
Construction which results in increased runoff also leads to a reduction in groundwater recharge.

Slide 5

The Department of Environmental Protection protects the waters of the State through many means, some of which include the requirements to manage stormwater runoff from major development and through the Municipal Stormwater General Permit Program, which includes permits issued to Highway Agencies, Municipal Separate Storm Sewer Systems ("MS4s"), and Public Complexes. Under these rules and permits, stormwater management is required to address the impacts of runoff for pollutants, increases in flow, erosion, and applicable groundwater issues.

To meet those requirements, stormwater management measures, as known as Stormwater Best Management Practices or BMPs, are commonly utilized in the field of stormwater management and engineering. Basically, stormwater runoff flows through a BMP, while removing pollutants from the runoff, reducing the rate or volume of flow, and then recharging groundwater. Cleaner runoff is then safely discharged into a nearby stream, the ground as groundwater recharge, a municipal separate storm sewer system, a combined sewer overflow, or an area located at a lower elevation.

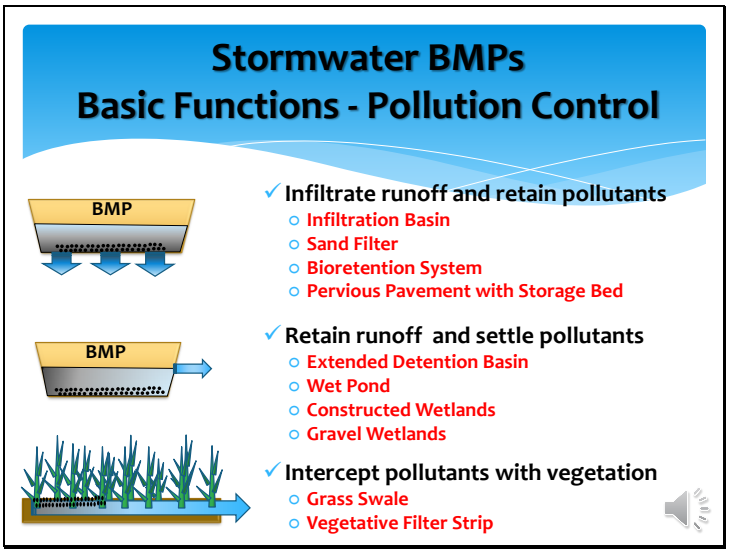
Slide 6



Here, we would like to briefly introduce the function of stormwater BMPs. This is important because one of goals of performing maintenance is to keep the BMPs functioning as they are intended. By understanding the basic functions of BMPs, you will have a better sense of what shall be done or what shall not be done in your maintenance work.

Stormwater BMPs are designed to perform pollution control, flood control, and erosion control, as well as provide groundwater recharge. In order to provide flood control, the BMP retains the volume of runoff produced by the drainage area, and then releases the runoff slowly. Detention basins, wet ponds, and constructed wetlands are BMPs that control flooding. Some of these BMPs will discharge the runoff entirely and empty completely, but some of the BMPs will retain some depth of water after discharging runoff. We will discuss these BMPs in more detail later.

Slide 7

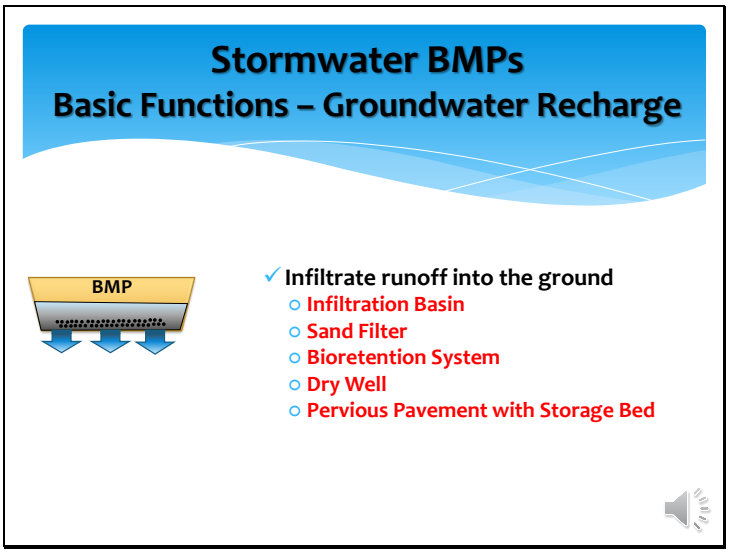


For pollution control, stormwater BMPs use three primary mechanisms – infiltration, settling and vegetative uptake or filtering. A stormwater BMP can collect runoff in a basin, and let the runoff go through the basin bottom into the subsoil. This is called infiltration. After all the runoff is infiltrated, sediments and pollutants will be kept within the basin. Infiltration basins, sand filters and bioretention systems are three examples of BMPs that use infiltration as a pollution control mechanism.

Another way stormwater BMPs remove pollutants is by collecting runoff in a basin and keeping the runoff for a period of time. While the runoff is contained, gravity causes heavy solids (also known as total suspended solids) and pollutants to settle on the basin bottom while the cleaner runoff is discharged through the basin outlet pipe. Extended detention basins, wet ponds, constructed wetlands, and subsurface gravel wetlands are examples that use settling as a pollution control mechanism.

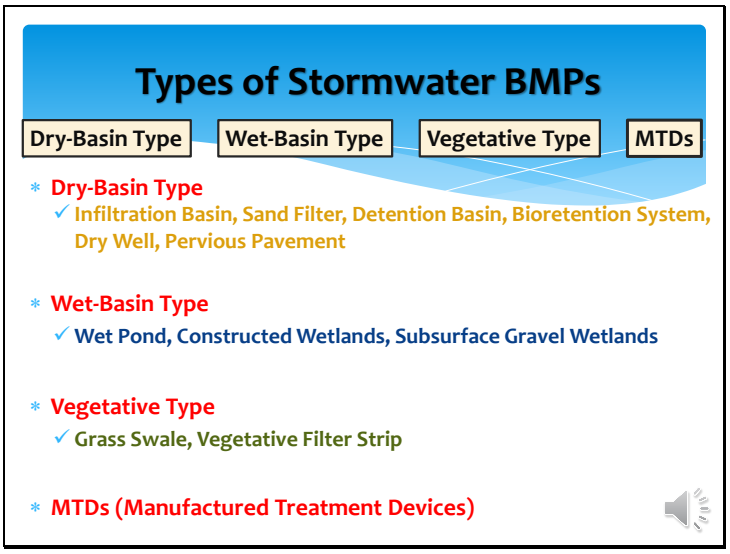
The third way to remove pollutants from runoff is by allowing it to flow through a vegetated area. Pollutants are either filtered out by physical contact or taken up by the plants through their roots. Examples of BMPs that use vegetative uptake or filtering include vegetative filter strips and grass swales. Subsurface gravel wetlands also use vegetative uptake, in part, to remove pollutants from stormwater runoff. An additional biochemical reaction also takes place within the confines of the subsurface gravel bed to remove nitrogen from the runoff.

Slide 8



For groundwater recharge, stormwater BMPs use infiltration to direct runoff into the ground, below the root zone of plants, where it helps to maintain the groundwater table. A stormwater BMP can collect runoff in a basin, where it soaks through the basin bottom material for treatment, with clean runoff infiltrating into the subsoil. The result is that sediments will be trapped on the basin bottom and pollutants are retained in the basin media. Infiltration basins, sand filters, and bioretention systems that have no underdrain pipes, dry wells, and pervious pavement systems with storage beds are examples of BMPs that use infiltration as a pollution control mechanism.

Slide 9



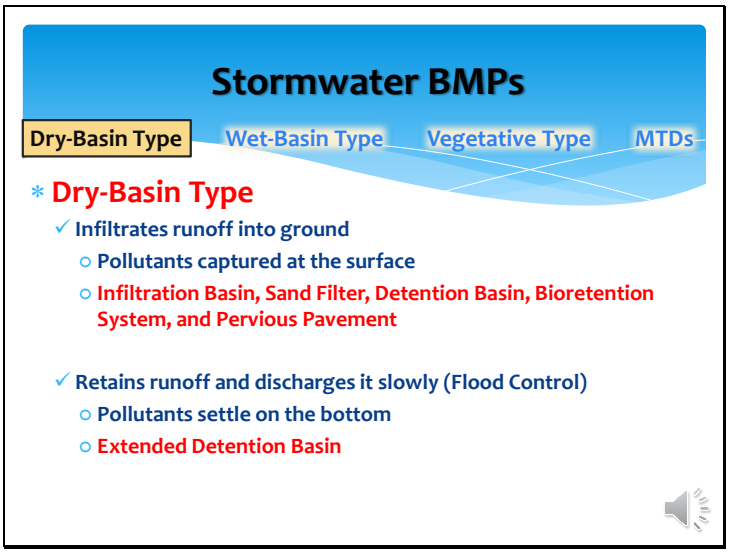
After understanding the functions of stormwater BMPs, let's take a moment to see what basic attributes are normally present. Generally, for maintenance purposes, the Stormwater BMPs can be categorized into four types - Dry-Basins, Wet-Basins, Vegetative BMPs, and Manufactured Treatment Devices.

For the Dry-Basin type, the stormwater basin normally has no water in it and the top of the basin bottom is dry, if it has not rained in the past three days.

For the Wet-Basin type, the basin is always filled with collected runoff.

For the Vegetative BMPs, the top of the vegetative area is normally dry, and water or ponding should not be visible within that area if it has not rained in the past three days.

Slide 10

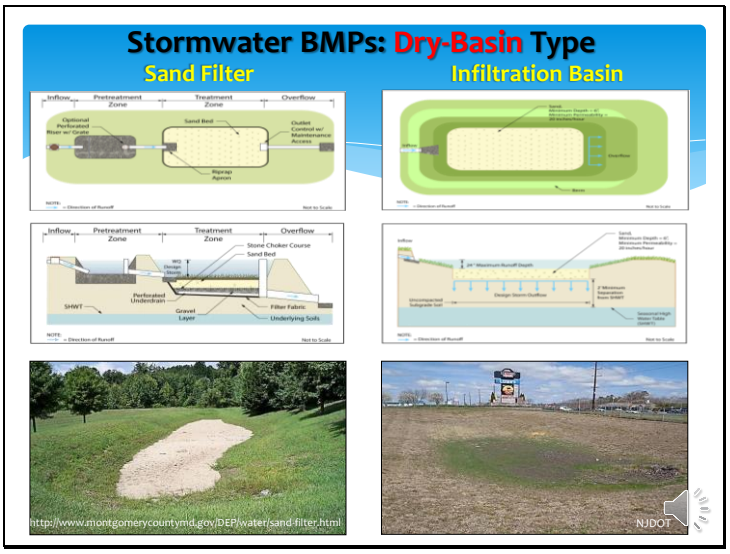


To reiterate, dry-basin type BMPs are normally empty of water, meaning no visible water or ponding in the bottom of the BMP. This type includes infiltration basins, sand filters, (extended) detention basins, bioretention systems, and pervious pavement.

These BMPs remove pollutants from runoff by trapping them at the surface while runoff soaks through the bottom of the basin into the subsurface layers.

The (extended) detention basin holds stormwater runoff and discharges it slowly over a prolonged period of time, providing flood control. It may take 10 to 12 hours to empty most of the runoff collected in a detention basin, and take up to 72 hours to entirely drain the basin. The detention basin removes pollutants via settling.

Slide 11



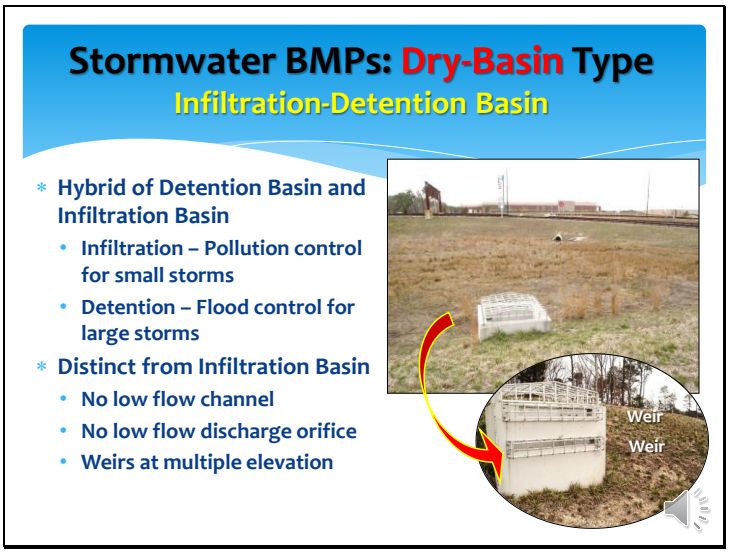
Here are schematic views and photos of sand filters and infiltration basins. The top and the profile views of the basins show how the runoff goes into the basin and enters the subsurface layers of the basin, but they normally look like the photo: dry and no visible ponding.

The distinction between a sand filter and a infiltration basin is not easily made from their appearance.

Both have optional vegetative cover. The sand filter has a minimum sand layer thickness of 18 inches, with an optional underdrain below the required stone choker course. The sand itself has a maximum field permeability of 4 inches per hour. On the other hand, the infiltration basin requires a minimum sand layer thickness of 6 inches, with a much higher allowable field permeability and no underdrain. Both generally hold no more than 2 feet of collected runoff and also have a required minimum 2 foot separation between the bottom of the lowest layer and the seasonal high water table. This minimum distance is reduced to 1 foot for the sand filter with underdrain.

I mention this separation requirement because the presence of standing water in either a sand filter or an infiltration basin, 72 or more hours after a rainfall event, indicates a serious problem with the BMP. There is normally enough room for all of the runoff to soak below the ground surface while the pollutants are trapped at the surface. Standing water means the basin bottom may clogged or compacted or else the seasonal high water table and soil properties were incorrectly determined.

Slide 12

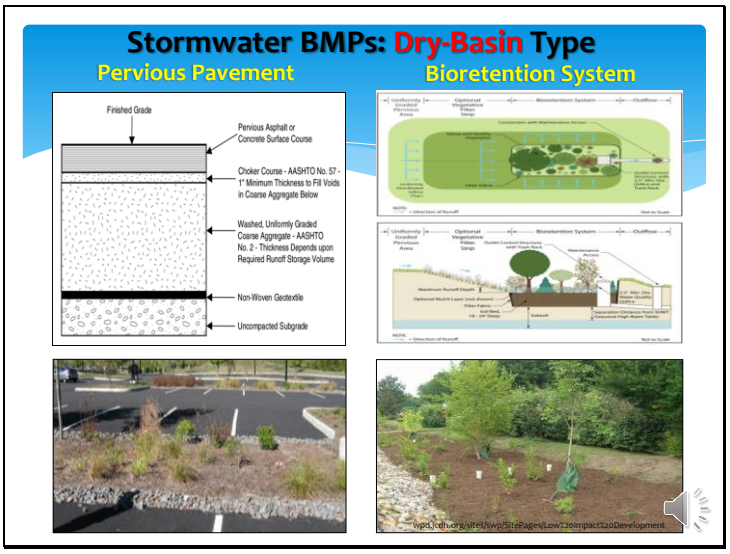


Sometimes, a stormwater basin is designed to incorporate two functions: infiltration for smaller storms and extended detention, or flood control, for larger storms. In this case, there will be no small orifice located near the bottom of the outlet control structure. This configuration allows runoff from the smaller storms to soak into the ground and subsoil. Excess runoff will discharge if the water level reaches or exceeds that of the bottom weir.

In this photo, we gather clues that this basin is a combination type in part because there is no low flow channel, and more importantly in that there is no small orifice near the bottom of the outlet structure. Runoff produced by a moderate storm will flow out through the bottom weir. Runoff will flow out both weirs during larger storms. Excessive storms will also see flow overtop the outlet structure. If the basin were no longer able to infiltrate runoff, there would be standing water present.

Considering the volume of runoff the basin can store, the design will also provide some flood control by limiting the rate of flow leaving the basin after the larger storms.

Slide 13



Here are schematic views and photos of a section of pervious pavement and a bioretention system. The runoff enters the top layer of the BMP and moves downwards into the subsurface layers. Just like the photos, the surface is normally dry, with no visible ponding.

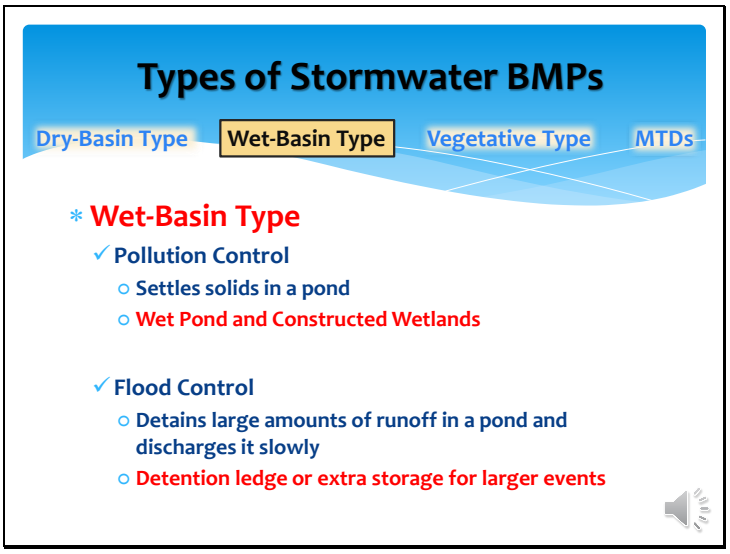
These are both complex systems with special requirements and limitations, which are discussed in the respective chapters of the BMP Manual available online.

Slide 14

Let's recap the basic requirements of the Dry-Basin type BMPs. These requirements are to ensure the basins function as intended by the design. A Dry-Basin type BMP is supposed to be dry most of time. Therefore, if it is not fully drained 72 hours after a rain event, it may indicate a failing basin issue caused by a clogged basin bottom, soil compaction, or a high ground water table. We will talk about how to prevent and fix these issues later.

It is especially important that the bottom of a dry basin BMP not be compacted. Therefore, heavy equipment, like trucks, tractors, and heavy mowers must not be driven onto the basin at any time, including periodic maintenance.

Slide 15

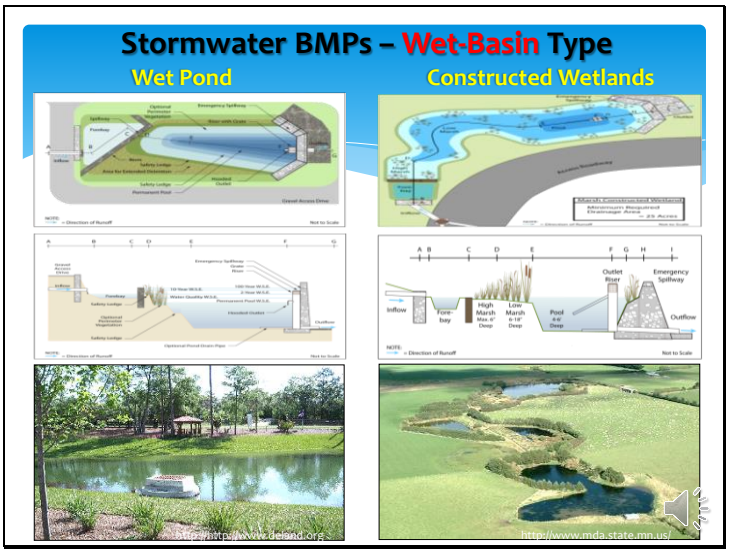


The second type of stormwater BMP is the Wet-Basin type, which is normally filled with water at a fixed depth. Stormwater runoff transports solids and pollutants into the pond. The heavy particles settle on the pond bottom. The clean runoff, or supernatant, is later discharged from an orifice located above the pond bottom.

A Wet-Basin type BMP can also be designed to have extra space above the normal water surface level to provide temporary storage of stormwater runoff and later release it slowly as a means to provide flood control. Wet-Basin type BMPs include wet ponds, constructed wetlands and subsurface gravel wetlands.

It should be noted that the required pool can be a safety issue.

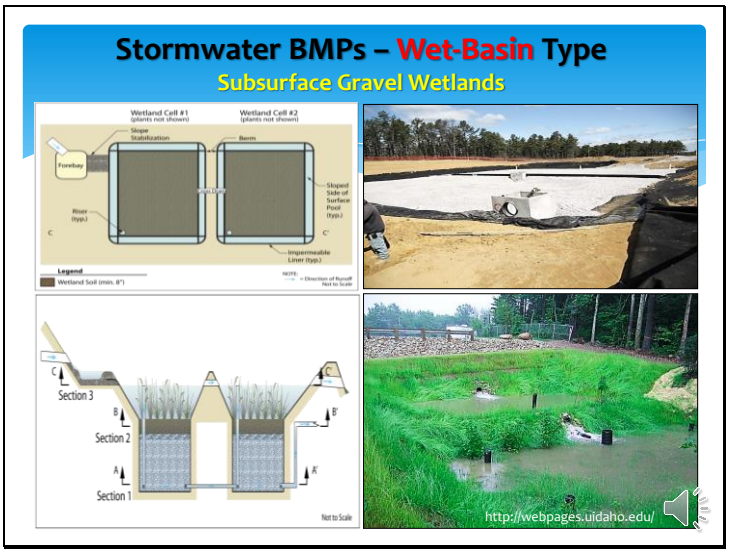
Slide 16



Here are schematic views and photos of a wet pond and constructed wetlands. The distinction between these two BMPs is that a constructed wetlands has extensive shallow areas that feature a dense growth of wetland plants with a small, deep pool area while a wet pond has a large deep pool area with limited, if any, areas of perimeter vegetation.

Normally, the water depth of wet-pond and the pool area of a constructed wetlands shall be around 3 to 6 feet in order to provide space for storage of settled solids and reduce thermal impacts on a receiving water body. Shallow areas will warm up, especially in summer. If stagnation occurs, conditions might lead to mosquito problems, algal bloom, and the development of odorous anaerobic conditions. It may be necessary to aerate the pool area to reduce these problems.

Slide 17



Here are schematic views and images of a subsurface gravel wetlands. The illustrations depict the system full after the water quality design storm event. The runoff is piped into the gravel bed where it will undergo biochemical reactions between storm events. The top photo shows the construction of the lined gravel bed. The completed BMP in action is shown in the lower photo.

You can see that the system is lined, filled with gravel and topped with soil. In contrast to wet ponds and constructed wetlands, subsurface gravel wetlands contain a limited amount of runoff above the soil layer that allows the wetland plants to grow. The soil layer is poorly drained and must stay moist to support the vegetation. Large particles and debris are trapped by the vegetation and remain on the surface. There is some uptake of these pollutants by the plants. The plants are required in order to support the subsurface biochemical reactions.

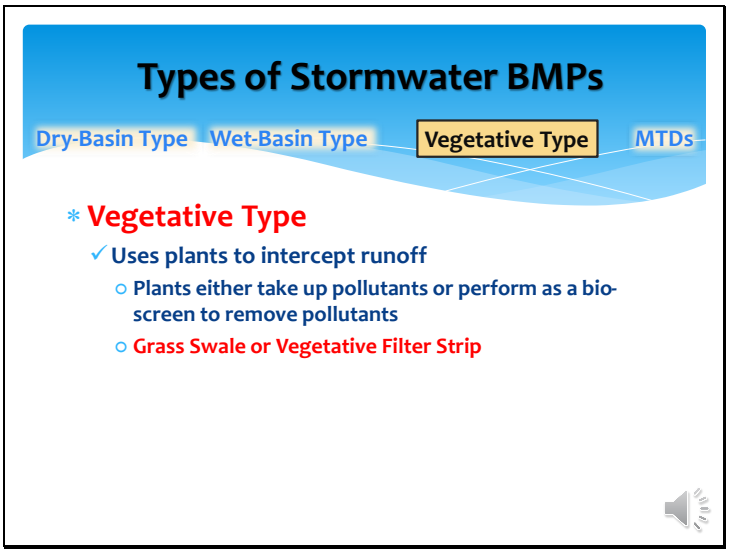
A subsurface gravel wetlands normally has 2 compartments, which are called cells. Runoff is piped into the gravel bed of each cell, displacing runoff stored from the previous event. Between events, biochemical reactions take place in the void spaces of the gravel beds using raw materials from the plants. The next storm event pushes the treated stormwater out.

The surface wetlands cells have shallow water and are prone to mosquito breeding and odor issues. However, aeration of water is not feasible because the typical aerator cannot operate in such shallow water. Therefore, special care has to be taken for subsurface gravel wetlands.

Slide 18

Let's recap the basic requirements of the Wet-Basin type BMPs to ensure proper functioning. For wet ponds and constructed wetlands, the specific water depth of the pond shall be maintained. If the water depth becomes too shallow, removal of sediment may be required. Also, they shall not have anaerobic, mosquito breeding, and algal blooming problems. Also, special attention must be paid to safety measures to prevent the risk of drowning.

Slide 19



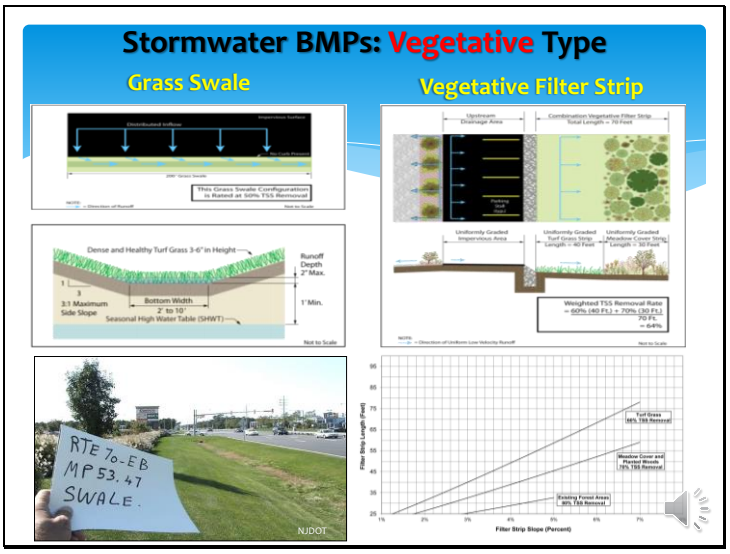
The vegetative type BMPs use vegetation to intercept pollutants in the runoff.

Runoff flows through a densely vegetated area at a shallow water depth, approximately two inches or less.

A grass swale is a channel-shaped area of turf grass, which not only removes pollutants but also conveys runoff as a open channel.

A vegetative filter strip is an area of dense plants, which may be woods, turf grasses, or meadow. The runoff is spread out into these vegetative areas. Unlike grass swales, a vegetative filter strip basically does not function as a conveyor of runoff.

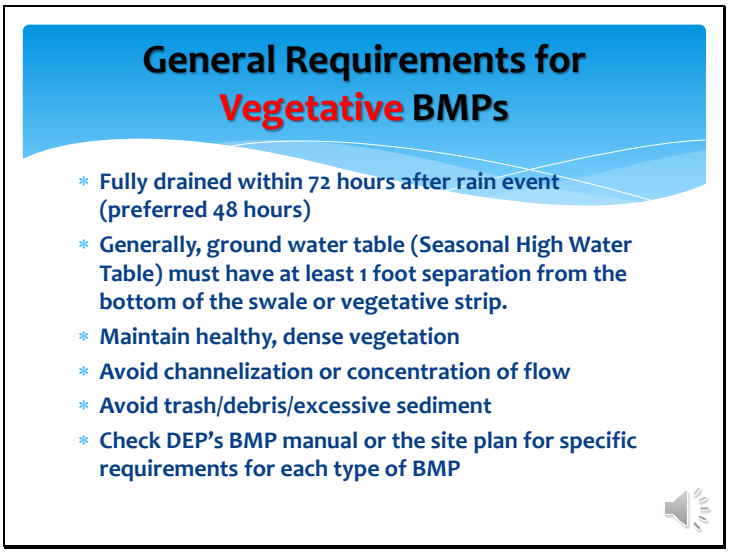
Slide 20



Here are the schematic views and images of or pertaining to grass swales and vegetative filter strips. Note that the vegetative filter strip allowed in slopes only between 4.6% to 8%, depending on the vegetation types and the soil types, but grass swales can have longitude slope up to 10%.

All vegetative type BMPs need healthy, dense vegetation without channelization of flow. Also, both grass swales and vegetative filter strips must be devoid of ponded areas of water, spots of dead vegetation or bare soil, and areas exhibiting erosion of soil.

Slide 21

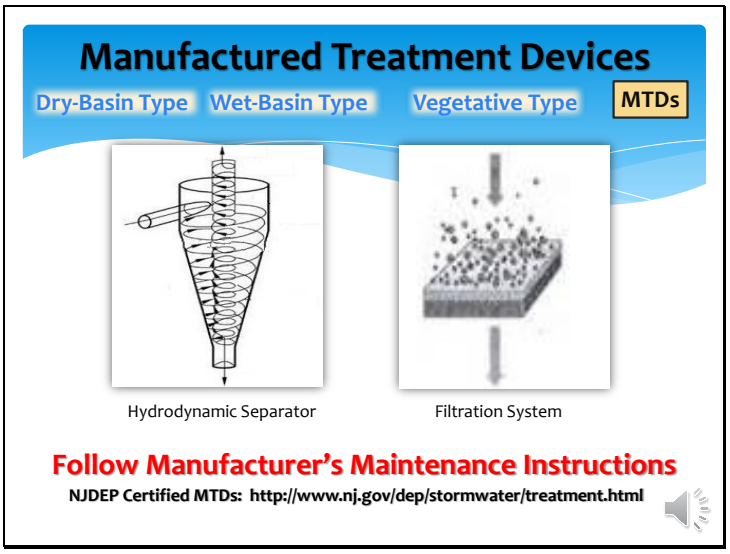


Let's recap the basic requirements of the vegetative type BMPs:

Fully drained within 72 hours after rain event; Ground water level shall be separated by at least 1 foot from the bottom of the swale or vegetative strip; Healthy, dense vegetation, and no channelization through the vegetative area.

Also, any trash, debris, or excessive sediment that tend to clog the outlet and inlet of a grass swale and result in water ponding in the grass swale shall be removed.

Slide 22



A special type of stormwater BMP is the manufactured treatment device, or MTD. They are not like the other three types of BMPs, which generally are constructed on the site. Most MTDs are pre-fabricated, transported to the site, and installed.

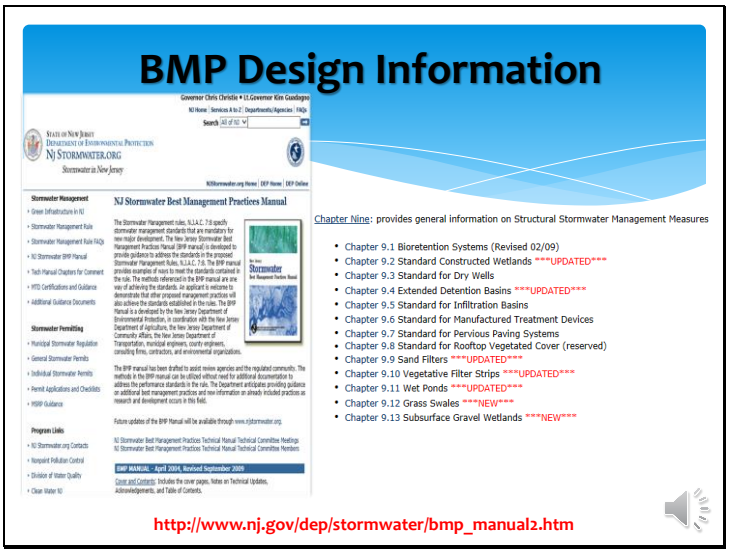
The MTDs recognized by NJDEP are all geared toward to controlling suspended sediment. They have special features to remove pollutants from the runoff. Thirteen MTDs are currently certified for use in New Jersey, under specific limitations and conditions.

Some of the MTDs work like a centrifuge, using "cyclone action" to separate heavy solids from the runoff, and are called Hydrodynamic Separators.

Some of the MTDs use filter media or other treatment media to intercept and remove pollutants.

Regardless of which methods and principles they adopt, MTD normally need more frequent care to remove sediments or replace the treatment media. Those MTDs certified by NJDEP are available on the DEP's website. But, in order to keep the MTDs functioning correctly, care must be taken to strictly follow the manufacturers' Operation and Maintenance Manual.

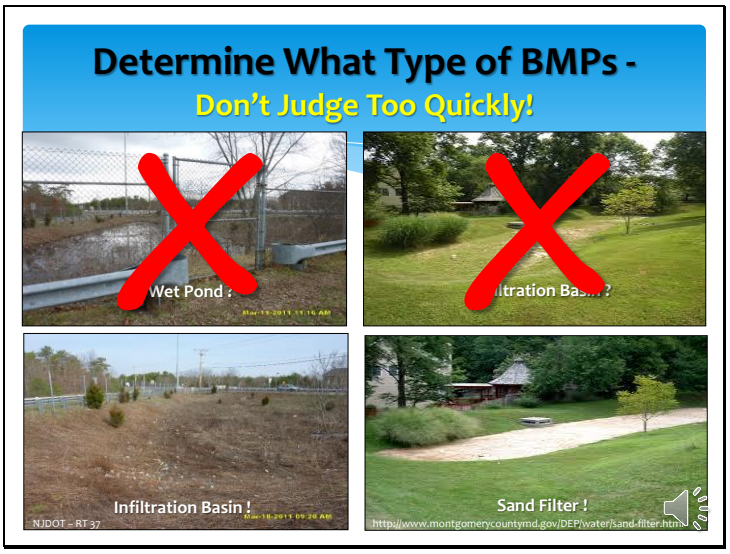
Slide 23



For this training, we provide only a brief introduction to stormwater BMPs. Details of a BMP's working principles, design requirements, maintenance requirements are all available on NJDEP's website.

The DEP has recently updated some of its BMP manual chapters. The graphics and language have all been updated to make it easier for both designers and maintenance crews to understand. You can either use the hyperlink shown on the slide or search online for "NJDEP stormwater."

Slide 24



When performing maintenance work, it is important to know the type of BMP present and its design details, such as the minimum depth of sand, water depth, etc. Misjudgment of a BMP's type will not only result in ineffective maintenance, but also cause the BMP to fail. Therefore, it is important to know what type of BMP is present before performing the inspection and maintenance work.

After the previous introduction to the various types of BMPS, let's use that information to guess what type of basins are shown in these two photos.

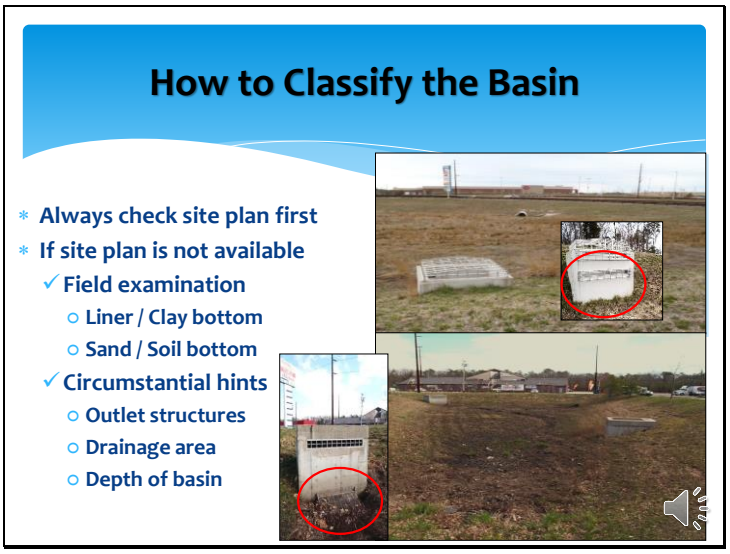
The basin in the top left looks like a wet pond because it is filled with water approximately 4 feet deep. The basin in the top right photo looks like an infiltration basin because it looks a shallow basin with vegetation.

However, the top left basin is actually an infiltration basin or possibly a detention basin. The top left photo was taken on a day that had received approximately 1 inch of rain. The bottom left photo was taken a week later. There had been no rain in the three days prior to the second photo being taken. You may notice in the photo some water has ponded in the basin. But, basically, it is a dry-type basin.

The basin in the top right photo is actually a sand filter. The top right photo and bottom right photo were taken at different times of the year and you can see that some vegetation took root in the sandy bottom at one time.

From these two examples, it can be seen that the appearance of BMPs are sometimes deceiving. Therefore, the best way to know the type of basin you are dealing with is to refer back to the design documents, specifically the site plans and the stormwater management design report.

Slide 25



What if the site plans and stormwater management design reports are not available? The best you can do is to make a educated guess based on a field examination and some detective work.

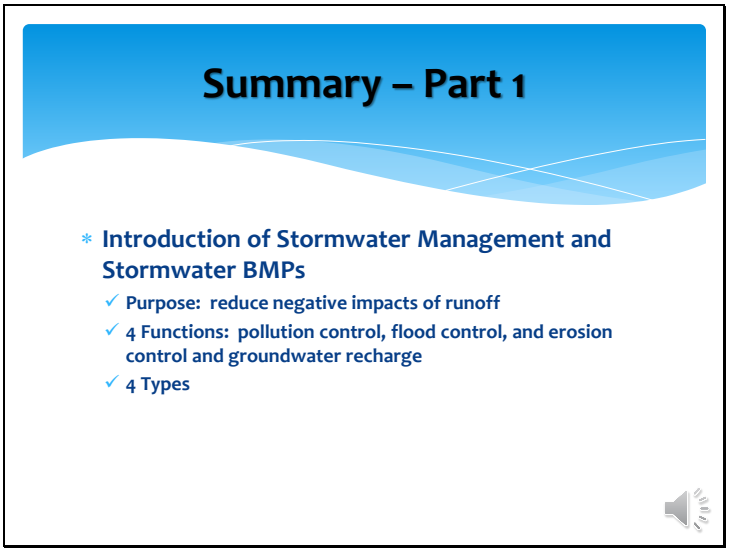
For example, a Wet-Basin type BMP may have a impermeable geosynthetic or clay liner on its bottom to keep water in the wet basins. However, in high water table area, a wet pond may not need liner because the ground water will sufficiently supply water into the wet pond. Sometimes, a detention basin will have a lined basin bottom too. Nevertheless, an infiltration basin and sand filter will not have a clay nor an impermeable, geosynthetic liner. Therefore, an examination of the bottom liner may give major direction as to the type of the basin. Another example is to check the depth of the sand layer. A bottom with 18 inches of sand will most likely be a sand filter, rather than a infiltration basin.

Also, although it has been said that the appearance of a basin is not an accurate way to identify the type of basin, examining the outlet control structure will help you on your way to making an educated guess. For example, if you see a small (2.5" to 3") diameter orifice near the bottom with a low flow channel, it is probably a detention basin. However, if there is no such orifice, the BMP is likely to be either an infiltration basin or combination infiltration-extended detention basin.

Another hint is the size of the drainage area; for wet ponds and constructed wetlands, the drainage requirement is at least 10 acres for a wet pond and 10 or 25 acres for a constructed wetlands. For an infiltration basin or detention basin, the drainage area can be much smaller.

A further hint is the depth of the basin. As mentioned above, a wet pond and a constructed wetlands require a pond depth from 3 to 6 feet, but an infiltration basin normally will not have such a depth. However, a detention basin can have depth ranging from 3 to 12 feet. Therefore, use of the depth as a hint must be done cautiously. Having said that, it shall be emphasized again that good record keeping of the site plans and stormwater management design report will greatly help the maintenance work.

Slide 26



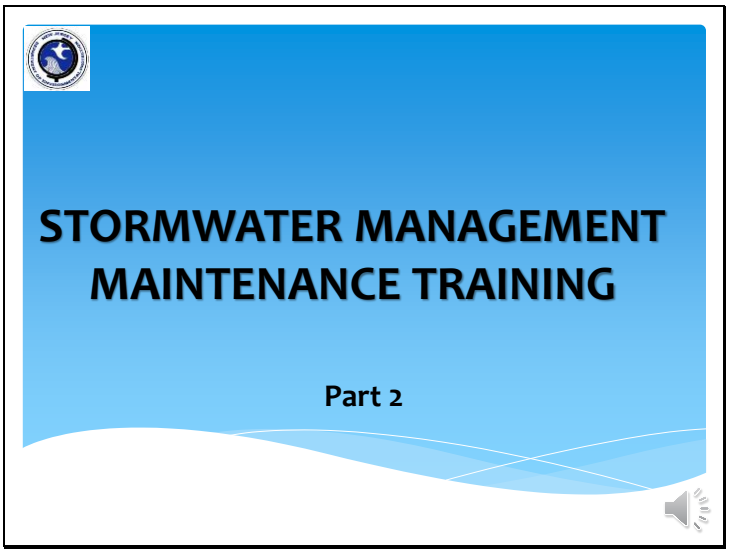
Let's summarize this presentation regarding the Introduction to Stormwater Management and Stormwater BMPs.

We talked about the reasons we need stormwater management. Stormwater runoff needs to be properly managed to avoid increasing pollution, flooding, and erosion.

The basic functions of stormwater BMPs include pollution control, flood control, and erosion control. Also included is groundwater recharge.

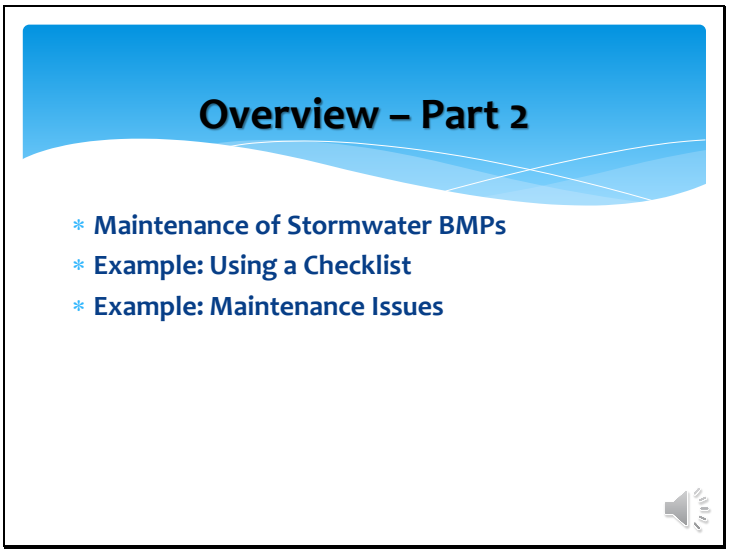
The types of stormwater BMPs, categorized for the purpose of maintenance, includes the dry-basin type, the wet-basin type, the vegetative type, and MTDs (Manufactured Treatment Devices).

Slide 27



This Stormwater Management Training is a continuation of the material covered in Part 1. This training provides a holistic view of the maintenance work that ensures the Stormwater BMPs function well.

Slide 28



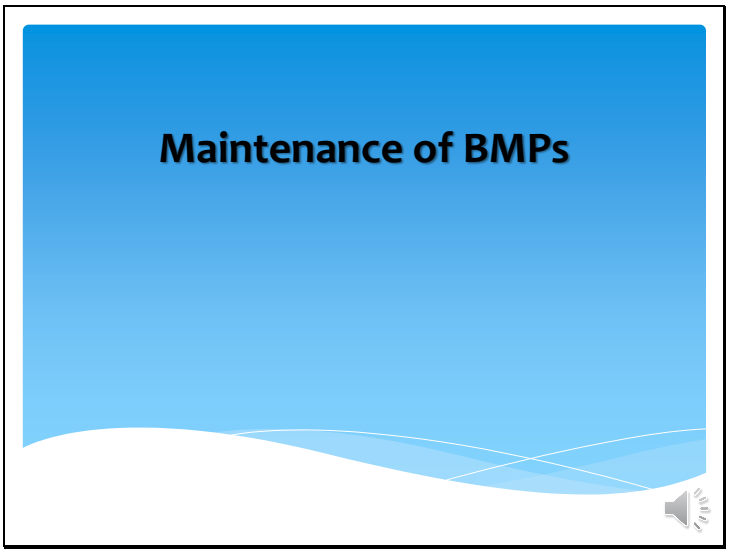
This part of the training covers three topics:

The first topic, Maintenance of Stormwater BMPs provides the elements of maintenance and the tools to assure the maintenance is properly performed.

The second gives an example of using a checklist to inspect a BMP.

The final topic provides several examples of commonly occurring maintenance issues.

Slide 29



Now, let’s talk about the maintenance work.

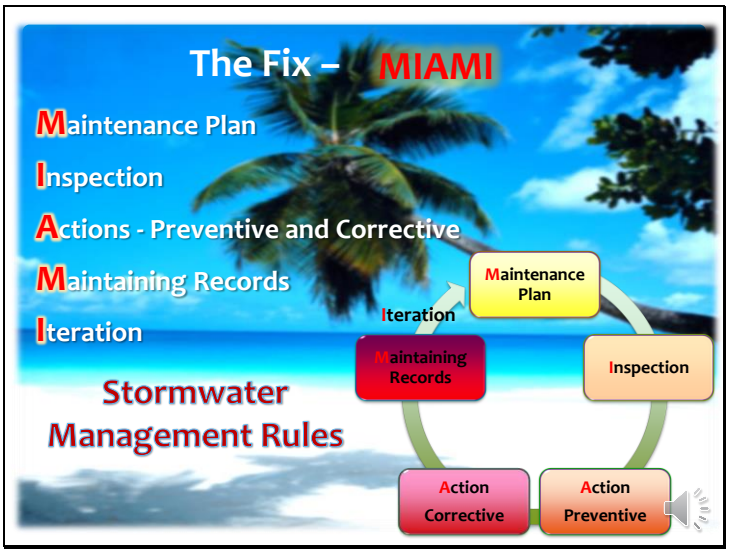
Slide 30

As previous mentioned, the purpose of maintenance work is to ensure the stormwater BMPs function as designed. For example, the inlet of a basin shall be clear of obstacles, such as vegetation, trash, and sediment so that the runoff can freely flow into the basin and get treated. These are some examples of good maintenance on the inlets of NJDOT's stormwater basins.

Slide 31

However, it is not always sunny here in New Jersey; it has to rain sometime. Here are a few examples of inlets in bad condition. These can be easily fixed by clearing the sediment, trash and vegetation. However, the quick fix will not be the best way to keep these bad conditions from re-occurring. We need a long term, consistent way to prevent these bad situations.

Slide 32

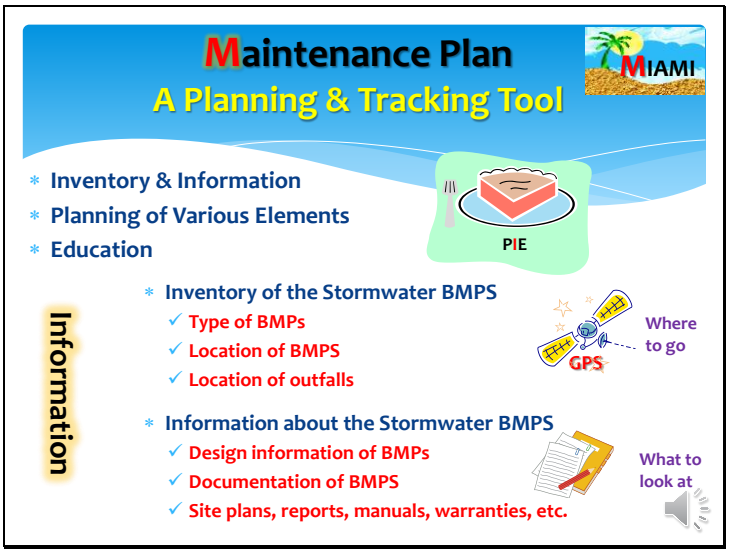


So, what is the best way to fix a bad situation?

The fix is best remembered as “MIAMI.” This acronym stands for Maintenance plan, Inspection, Actions-preventive action and corrective action, Maintaining records, and it is an Iteration that you have to evaluate annually for the effectiveness of the maintenance plan. MIAMI is required by the Stormwater Management Rules, under which all Major Development is required to have a maintenance plan for stormwater BMPs.

The next slides will explain MIAMI.

Slide 33



The first M of MIAMI stands for Maintenance Plan. The Stormwater Management Rules at N.J.A.C. 7:8-5.8 spell out the components of a maintenance plan.

It is basically a planning and tracking tool containing sub-plans, including Inventory of the stormwater BMPs, Information about the Stormwater BMPs, Planning of Preventive and Corrective Maintenance Actions, Planning of the logistics, Planning of the disposal method, Planning of the Cost, and Education of Staff for training on safety procedures and maintenance work. It can be basically grouped into three areas – Information, Planning, and Education. To make it easy to remember, you can think of the word “PIE.” Basically making a maintenance plan is as easy as making a PIE.

First, the maintenance plan needs to have an inventory of all BMPs, including the type of BMPs (sand filter, wet pond…), their location (located by GPS references or State Plane Coordinates), and their outfalls.

Second, the maintenance plan needs to provide detailed information of each BMP present. The detailed information includes their design information, such as the depth of the basin, the depth of the pond, the number of inlets, the size of the outlet orifices, the design detention time, the drain time, the material comprising the basin bottom, whether vegetation is required, etc. Also, the maintenance plan shall include as-built plans, soil log reports, field testing data, and the manufacturer’s warrantee and operation and maintenance manual for specific machines or manufactured treatment devices.

Slide 34

Third, the maintenance plan shall have plans for preventive and corrective maintenance tasks. We will talk about preventive and corrective actions later. Also, the frequency and schedule of the maintenance tasks are required. For example, the basin may need to be inspected quarterly, and the sand layer of sand filter may need to be replaced every two years.

Fourth, the maintenance plan shall have a plan for the logistics required to perform maintenance tasks. It includes what type of maintenance personnel and the skills required to perform the tasks, the equipment, tools, and supplies needed to do the work. You may think that the maintenance yard already has everything needed, but it is easy to overlook some crucial element in the planning of logistics. Let's take a look what tools and equipment may be needed to maintain stormwater BMPs.

Slide 35

Here we list some of the tools and equipment needed to perform maintenance work. Some of them are common items, such as a lawn mower, pry bar, shovels; however, some of them are less common, such as a vacuum truck and a lightweight backhoe.

Why we need a vacuum truck? Some types of MTDs have a sump or collection area on the bottom to store settled solids and debris and the opening of the MTD maybe is too small for a person to climb inside to dig out the collected material. Therefore, you will need a vacuum truck to remove the sediment with suction.

Also, why do we need a lightweight backhoe? As previously mentioned, soil compaction must be avoided in an infiltration basin. Therefore, when you replace sand or re-grade the soil of the infiltration basin, you must use a lightweight backhoe to do the work.

Slide 36

A maintenance plan also needs to include the disposal method and the cost. The disposal method has to consider how to transport the removed vegetation and sediment to the disposal site. Measures may be necessary to prevent leakage of wet sediment during transport to the disposal site, which may be a municipal or privately operated landfill, or in some cases, involve on-site disposal. Since permits are often required for disposal at these facilities, it is essential to plan ahead for the costs, time and tasks associated with these permits.

After planning the tasks and subjects mentioned above, you will have an estimate of the costs involved, which are always required for both budgeting purposes and compliance with the Stormwater Management Rules.

Slide 37

A maintenance plan shall also include a plan to educate and train staff regarding safety procedures and measures, especially the safety procedures for confined space entry. The maintenance plan shall also set up a training schedule for maintenance staff on the stormwater BMPs, maintenance work, use of tools, operation of equipment, and record keeping of performed tasks.

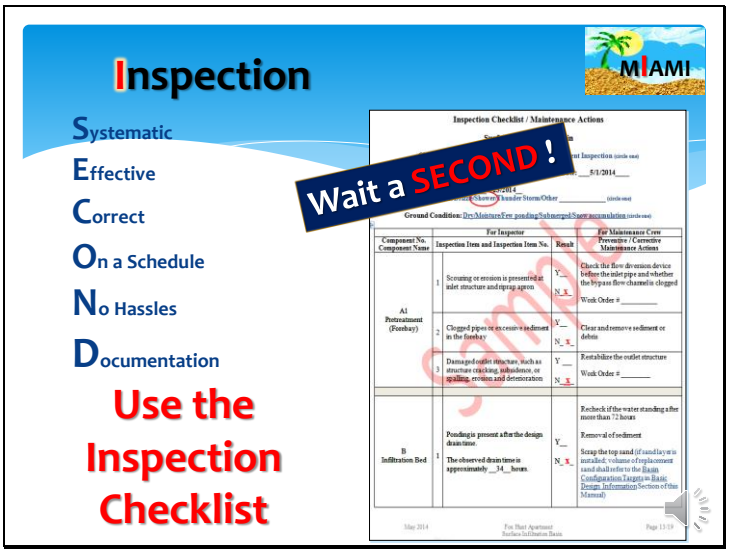
To recap the maintenance plan, what components are required? Basically, making a maintenance plan is as easy as remembering the word “PIE,” which is short for “Planning, Information, and Education.”

The Planning part of a maintenance plan includes:
Planning of Preventive and Corrective Maintenance Actions,
Planning of the logistics,
Planning of the disposal method,
Planning of the costs.

The Information part of a maintenance plan includes:
Inventory of the stormwater BMPs and Information about the Stormwater BMPs.

The Education part of a maintenance plan includes:
Education of staff on safety procedures and elements required to perform maintenance work.

Slide 38



The next step in the solution is the “I” of MIAMI, which stands for Inspection. Regular inspections of the stormwater BMPs help us discover problems before they evolve into big issues. As seen in the photos of poor conditions at basin inlets, one may wonder when those inspections had last been conducted.

Another acronym may help us remember what an inspection entails. It is the word “SECOND.” The Stormwater management rules and the BMP manual require regular inspections and records of those inspections. However, before we hit the road to perform an inspection, we should consider how we will do them in a way that is systematic, effective and correct.

A permittee may have many basins to manage; therefore, a tight schedule may be necessary if we are to inspect all of the basins in a timely fashion. Furthermore, we don’t want to have a dispute about whether or not an inspection has been conducted nor what problems were found in the inspection. Therefore, we want the problems that were discovered to be followed up on and resolved; therefore, we need a written way to keep track of everything.

All of these considerations can be addressed by using an inspection checklist which lists the items to be inspected, tells us how to check, and provides a space to record the problems, plus other important information, such as the weather on the day of the inspection, who was present, etc.. It is worth noting that each type of BMP may have different items to check; an obvious example is that inspection of a wet pond will be different greatly from that of a sand filter.

NJDEP has developed an inspection checklist for each of the commonly used BMPs. We will talk about them later.

Slide 39

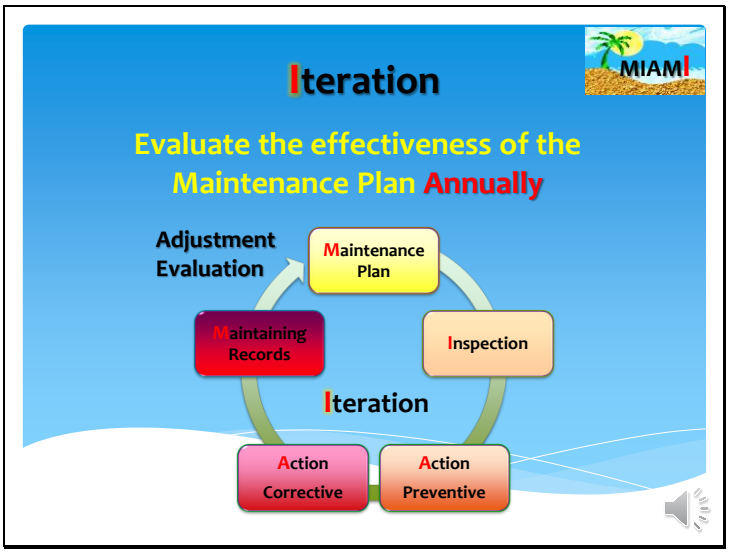
After the inspection, what is the next part of maintenance work? The Actions. They include preventive maintenance tasks and corrective maintenance tasks. Preventive action is geared towards housekeeping on a regular basis. The corrective actions are more likely to occur incidentally in response to the problems discovered during the inspection.

Here is a list of preventive actions and corrective actions. It is by no means a full list; the actions could be more, depending on the type of BMPs and the variation of the design. For example, the sand layer of a sand filter or infiltration basin needs to be replaced at least once every two years. However, if these BMPs are located in an area having high solids loading, the designer of the BMP may request a more frequent replacement of sand.

Slide 40

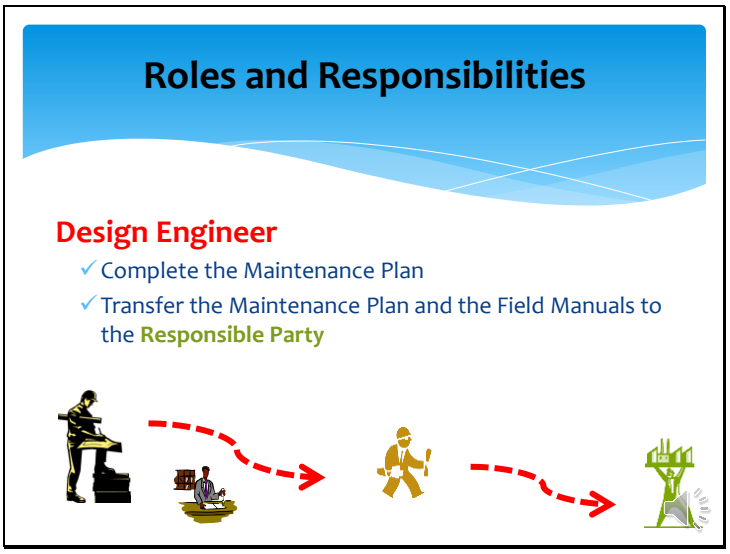
The next part of maintenance work is to maintain good records of the inspection, preventive actions, and corrective actions that have been performed. Keeping those records are also required by the Stormwater Management Rules. Practically speaking, it is good to keep those record for tracking down whether the issues have been resolved, finding a trend or tracking how an issue evolved, and providing as evidence the work was performed. The maintenance records serve as an searchable archive of the inspections and the resulting work orders for preventive actions and repairs.

Slide 41



Finally, the maintenance work is an ongoing, evolving process. The Stormwater Management Rules require that the effectiveness of the maintenance plan be evaluated annually. The maintenance plan must be adjusted according to the resulting evaluation. Maintenance personnel shall provide comments and suggestions to the manager for consideration on how to perform the work more effectively in the future. The manager shall also review the inspections and preventive and corrective records to find whether any improvement can be made.

Slide 42



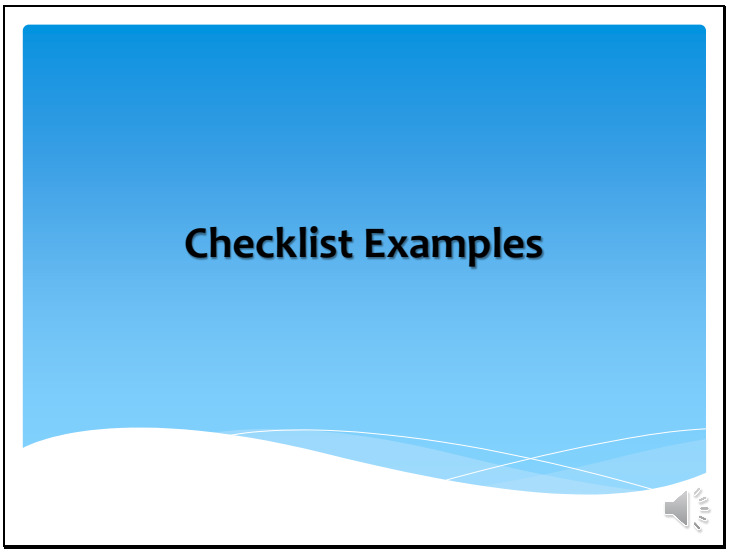
Up until now, we have talked about the need for a maintenance plan to lay out the maintenance tasks. We also talked about the inspections, the preventive actions and corrective actions, and the maintenance of records. One may wonder who has to prepare the maintenance plan, who performs the inspection, and who keeps the records.

Let's talk about roles and responsibilities. Under the Stormwater Management Rules, it is the design engineer's responsibility to prepare the maintenance plan because he or she is the one who best understands the requirements of the BMP designed. The design engineer also has the most knowledge of all of the site conditions specific to the BMP, such as the water table, the soil, and the drainage area, etc. However, if the design engineer did not properly prepare the maintenance plan or if the maintenance plan has been lost, the responsibility to prepare the plan may fall on the responsible party, who is typically the operator or owner of the facility. Often a permittee will be the responsible party, unless it has assigned others this responsibility.

Slide 43

The day-to-day performance of the maintenance tasks falls on the maintenance managers and the maintenance crew, with each having various responsibilities. For the inspector, it is a role that can be performed by people inside the responsible party. But, sometimes, inspector may be from a local authority, such as township's inspectors, or from state agencies, like DEP.

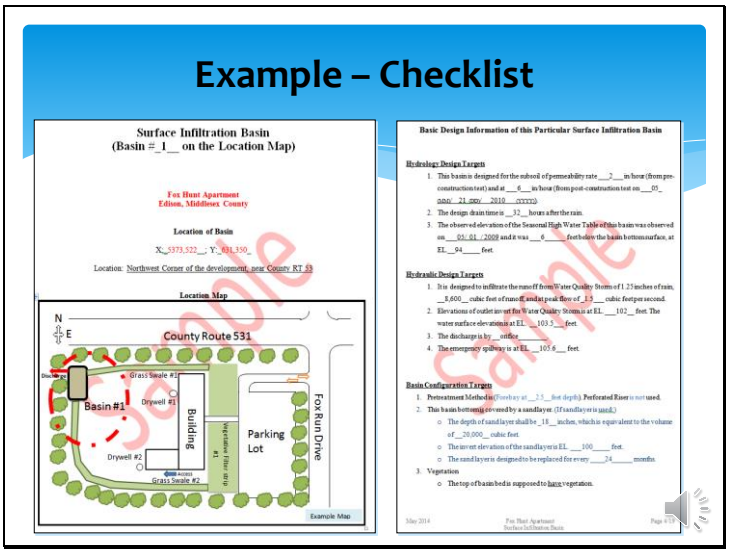
Slide 44



Let's look at an example of the checklists that DEP has been developing as part of a series of field manuals for the maintenance work of specific BMPs. Each field manual includes the information about the specific type of BMP, visual aids for conducting maintenance, an inspection checklist specifically tailored to that type of BMP, and the records for preventive and corrective actions.

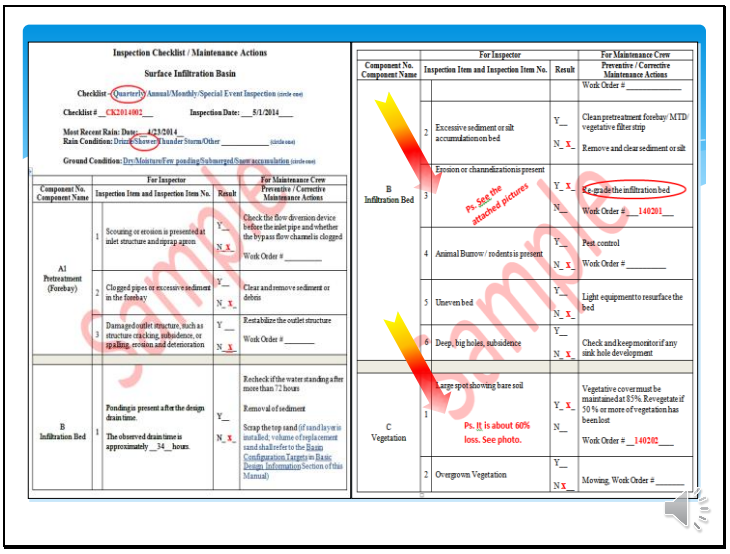
It is a template that the design engineer or the maintenance manager can change to meet the needs of their stormwater BMPs. The maintenance crew can take one field manual to do an inspection and record maintenance work every time they go out. They can read the information about the specific stormwater BMP they are going to inspect or work on. Then, they can record the inspection findings, maintenance work or repair work performed on the checklist and keep the maintenance record in the field manual. After coming back to the office, they can hand over the field manual to the manager, who can then track down the issues and keep the inspection checklist and maintenance records in the file.

Slide 45



Here is a look at an Infiltration Basin Checklist. The cover is the information needed to locate the BMP. The next page is the design information regarding the dimensions of the BMP, the expected drain time, and special requirements such as a sand layer or vegetation.

Slide 46



Inspection Checklist / Maintenance Actions

Surface Infiltration Basin

Checklist (Quarterly/Annual/Monthly/Special Event Inspection (circle one)

Checklist # CK2014002 Inspection Date: 5/1/2014

Most Recent Rain: Date: 4/23/2014
Rain Condition: Drizzle/Shower/Thunder Storm/Other (circle one)

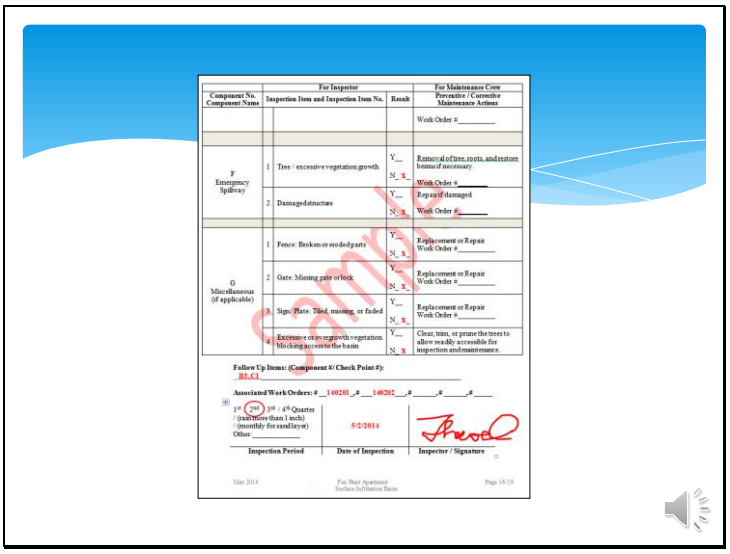
Ground Condition: Dry/Moisture/Few ponding/Submerged/Snow accumulation (circle one)

Component No. Component Name		For Inspector: Inspection Item and Inspection Item No.	Result	For Maintenance Crew: Preventive / Corrective Maintenance Actions
A1 Pretreatment (Forebay)	1	Scouring or erosion is presented at inlet structure and riprap apron	Y__ N_X_	Check the flow diversion device before the inlet pipe and whether the bypass flow channel is clogged Work Order # _____
	2	Clogged pipes or excessive sediment in the forebay	Y__ N_X_	Clear and remove sediment or debris
	3	Damaged outlet structure, such as structure cracking, subsidence, or spalling, erosion and deterioration	Y__ N_X_	Restabilize the outlet structure Work Order # _____
B Infiltration Bed	1	Ponding in present after the design drain time. The observed drain time is approximately __34__ hours.	Y__ N_X_	Recheck if the water standing after more than 72 hours Removal of sediment Scrap the top sand (if sand layer is installed; volume of replacement sand shall refer to the Basin Configuration Targets in Basic Design Information Section of this Manual)

Component No. Component Name		For Inspector: Inspection Item and Inspection Item No.	Result	For Maintenance Crew: Preventive / Corrective Maintenance Actions
B Infiltration Bed				Work Order # _____
	2	Excessive sediment or silt accumulation on bed	Y__ N_X_	Clean pretreatment forebay/ MTD/ vegetative filter strip Remove and clear sediment or silt
	3	Erosion or channelization is present Ps. See the attached pictures	Y_X_ N__	Re-grade the infiltration bed Work Order # __140201__
	4	Animal Burrow / rodents is present	Y__ N_X_	Pest control Work Order # _____
	5	Uneven bed	Y__ N_X_	Light equipment to resurface the bed
	6	Deep, big holes, subsidence	Y__ N_X_	Check and keep monitor if any sink hole development
C Vegetation	1	Large spot showing bare soil Ps. It is about 60% loss. See photo.	Y_X_ N__	Vegetative cover must be maintained at 85%. Revegetate if 50 % or more of vegetation has been lost Work Order # __140202__
	2	Overgrown Vegetation	Y__ NX__	Mowing, Work Order # _____

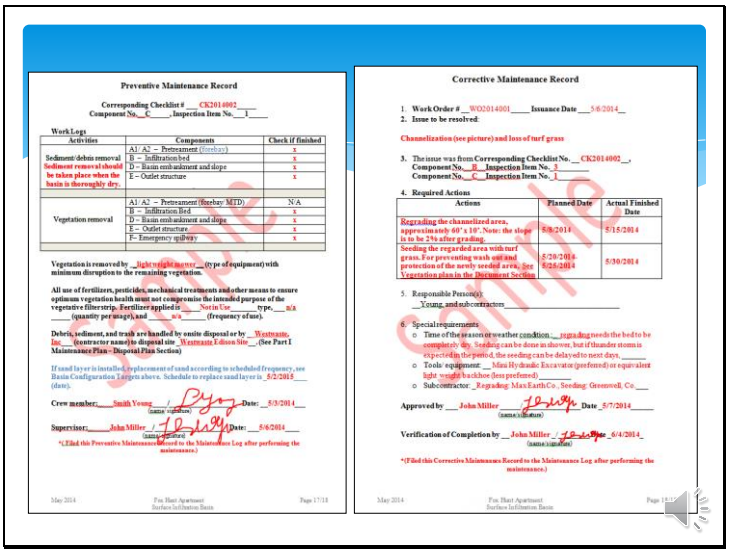
Then, there is the checklist for inspection which allows the inspector to record the site information such as the weather, the ground condition (wet, dry, ponding). Then the checklist lists the inspection items grouped by the major component of a BMP, such as the inlet, the basin bed, the embankment, the outlet, and vegetation, etc.. It also has the instructions of what condition is deemed to be normal, and the space to make comments and assign work orders for corrective actions.

Slide 47



Then, the inspector can sign off the inspection and the date.

Slide 48



Preventive Maintenance Record

Corresponding Checklist # ___CK2014002_____
Component No. __C_____, Inspection Item No. ___1____

Work Logs

Activities	Components	Check if finished
Sediment/debris removal Sediment removal should be taken place when the basin is thoroughly dry.	A1/A2 – Pretreament (forebay) B – Infiltration bed D – Basin embankment and slope E – Outlet structure	x x x x
Vegetation removal	A1/A2 – Pretreament (forebay MTD) B – Infiltration Bed D – Basin embankment and slope E – Outlet structure F– Emergency spillway	N/A x x x x

Vegetation is removed by __light weight mower___(type of equipment) with minimum disruption to the remaining vegetation.

All use of fertilizers, pesticides, mechanical treatments and other means to ensure optimum vegetation health must not compromise the intended purpose of the vegetative filter strip. Fertilizer applied is ____Not in Use_____ type, ___n/a ____ (quantity per usage), and ____n/a_____ (frequency of use).

Debris, sediment, and trash are handled by onsite disposal or by __Westwaste, Inc___(contractor name) to disposal site __Westwaste Edison Site__. (See Part I Maintenance Plan – Disposal Plan Section)

If sand layer is installed, replacement of sand according to scheduled frequency, see Basin Configuration Targets above. Schedule to replace sand layer is __5/2/2015___ (date).

Crew member:___Smith Young___/ _____ Date: __5/3/2014__
(name / signature)

Supervisor:_____John Miller_____/ _____ Date: ___5/6/2014___
(name / signature)

*(Filed this Preventive Maintenance Record to the Maintenance Log after performing the maintenance.)

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Corrective Maintenance Record

1. Work Order # ___WO2014001_____ Issuance Date ___5/6/2014_
2. Issue to be resolved:

Channelization (see picture) and loss of turf grass

3. The issue was from Corresponding Checklist No. ___CK2014002__,
   Component No. ___B___ Inspection Item No. _1_____
   Component No. ___C___ Inspection Item No. _1_____
4. Required Actions

Actions	Planned Date	Actual Finished Date
Regrading the channelized area, approximately 60' x 10'. Note: the slope is to be 2% after grading.	5/8/2014	5/15/2014
Seeding the regarded area with turf grass. For preventing wash out and protection of the newly seeded area, see Vegetation plan in the Document Section	5/20/2014-5/26/2014	5/30/2014

5. Responsible Person(s):
   Young, and subcontractors _____
6. Special requirements:
   - Time of the season or weather condition: _regrading needs the bed to be completely dry. Seeding can be done in shower, but if thunder storm is expected in the period, the seeding can be delayed to next days. _____
   - Tools/ equipment: __Mini Hydraulic Excavator (preferred) or equivalent light weight backhoe (less preferred)_____
   - Subcontractor: _Regrading: Max Earth Co., Seeding: Greenwell, Co.___

Approved by ___John Miller_____ Date _5/7/2014_____
(name / signature)

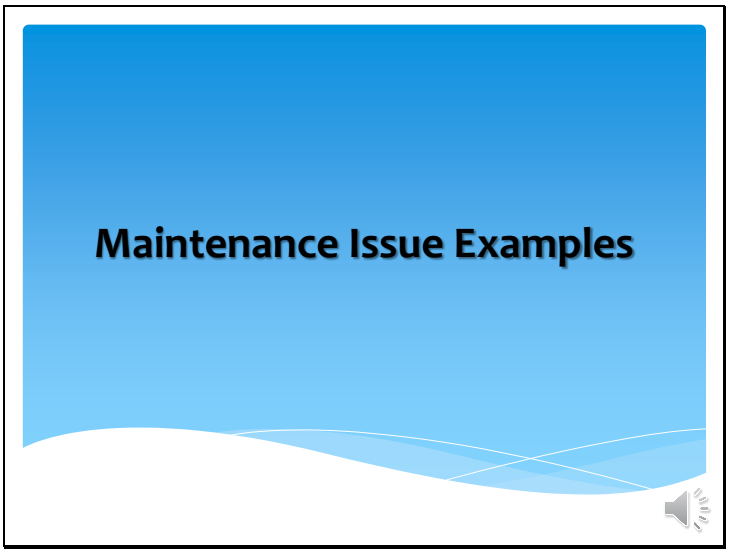
Verification of Completion by __John Miller_____ Date _6/4/2014_
(name / signature)

*(Filed this Corrective Maintenance Record to the Maintenance Log after performing the maintenance.)

May 2014 — Fox Hunt Apartment Surface Infiltration Basin

The field manual also contains the preventive maintenance record and corrective maintenance record. The maintenance personnel can record the work performed and any issues to be followed up on.

Slide 49



Now, let's see some photos of some common maintenance issues and how to correct them.

Slide 50

Recall that, in previous slides, we categorized the grass swale as a vegetative type BMP, which shall be dry and have good vegetative cover. These three photos show ponding problems which has caused a loss of vegetation in all or some part of the grass swales. To fix this, it is essential to find the cause of the ponding. If the outlet is clogged, remove the clog first and determine if the grass swale will dry up. If it is still ponding, it may be necessary to also check whether excessive sediment is making it difficult for water to flow. Also, revegetation of the area will be needed.

Slide 51

This is a infiltration basin that became an permanent impoundment. It has not rained during the past 72 hours; therefore, the basin should be dry. However, this photo was taken during wintertime. It may be necessary to recheck at a later time if the ground is frozen.

Neglecting the frozen conditions, how do we fix it? We could pump and remove the standing water, check the condition of the basin bottom and the water table. If the water table is low, we could replace the soil or sand layer of the basin bottom. The permeability and depth of replacement soil and sand must match the original design. However, if the ponding is caused by a high water table, we may want to check the original design and the soil logs to further evaluate the original design. We may need to retrofit the infiltration basin to another type of BMP that does not need to infiltrate runoff into the ground.

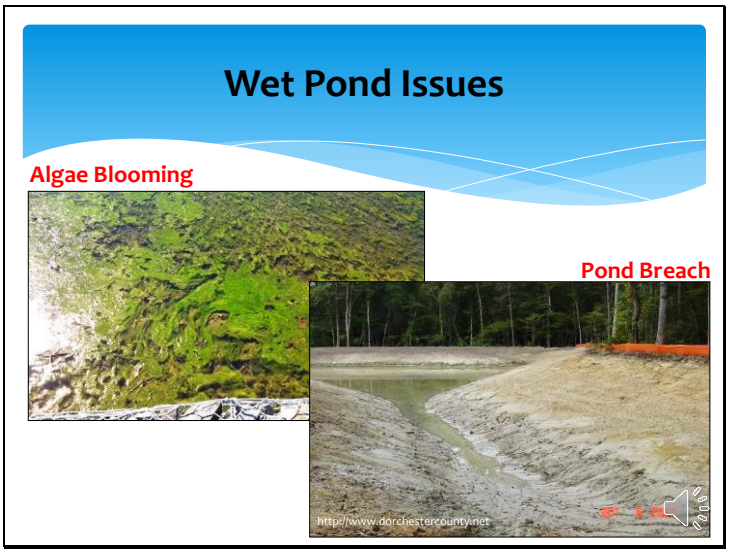
Slide 52

These two photos show a detention basin with a low flow channel. The trash rack to protect the low flow orifice is entirely clogged by debris and vegetation. The easy solution is to remove the debris and vegetation, but it may be necessary to conduct more frequent inspections and perform preventive actions to keep the trash racks clear.

Slide 53

These two photos show the trash racks of a detention basin that has been damaged. Corrective action is necessary to affix the trash racks onto the outlet structures. More frequent inspections may be necessary to check if it has fallen off entirely.

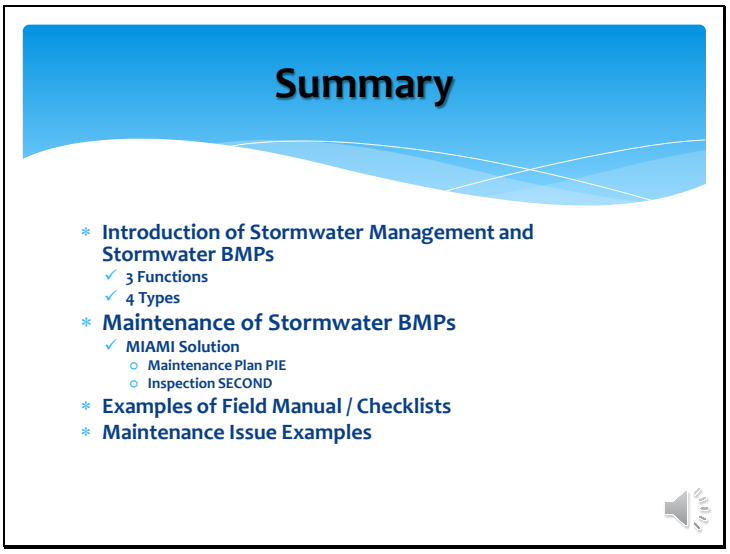
Slide 54



These two photos show problems at wet ponds. Algae blooming is one common problem of wet pond. Aeration of the pond and removal of the algae from the pond may be needed.

The bottom photo is a breach of a wet pond. A corrective action to repair the breach is needed. However, more frequent regular inspections may have discovered erosion and cracks in the embankment before it become enlarged.

Slide 55



Let's summarize this presentation regarding maintenance of stormwater BMPs.

In Part 1, we talked about the reasons we need stormwater management and the basic functions and types of stormwater BMPs. For the basic functions, they include pollution control, flood control, and erosion control. Also included is groundwater recharge.

The types of stormwater BMPs, which we've categorized for the purpose of maintenance, include the dry-basin type, the wet-basin type, the vegetative type, and MTDs (Manufactured Treatment Devices).

In Part 2, we then talked about the required maintenance of stormwater BMPs: the MIAMI solution - Maintenance plan, Inspection, Action-preventive and corrective, the Maintenance of records, and the Iteration of the maintenance work.

For creating a maintenance plan, it is as easy as making a PIE: Information about the BMPs, Planning of the Maintenance work, and Education of the personnel.

We also gave an example of a check list, which addressed the maintenance records and the items one would have to record during a site visit.

Finally, we talked about some maintenance issues and how to fix them.

Slide 56

Thank you for your attention.