Detention Basin Condition Assessment Form (CAF)

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The state of California requires local cities to periodically perform infrastructure evaluations. One of these evaluations is the assessment of a municipality's stormwater infrastructure systems. These inspections determine the performance of a cities infrastructure and provides additional funding if needed. There are many types of stormwater structures that control the runoff water from either rainstorm, snow melt, or any tropical storm. A detention basin is a fundamental part of a city's stormwater infrastructure, typically basins are at the end of the line and catch all the stormwater from reaching natural rivers, lakes, and the ocean. The purpose of a catch basin is to naturally allow the water from the previous storm percolate into the ground, replenishing the groundwater. BMPs are the best practices used by cities to manage their stormwater systems and are recognized and encouraged by the state of California. This document will improve the process of evaluating the BMPs allowing all municipalities in the state to record and report important information. The document will also expedite the process by providing an inclusive easy to execute procedure to evaluate your stormwater systems. Creating a uniform document will allow the state of California to easily identify and diagnose areas of poor percolation and provide specific funding to areas in need.

Key Words: Stormwater, Infrastructure, Detention Basin, Municipalities, Catch Basins

Introduction

For the past two years, I have worked as an intern for MNS engineering a civil engineering company that provides for municipalities. One of my first projects was to perform Condition assessment forms for the cities stormwater system. The process was difficult as I had never done it before, it required me to navigate through three or four documents and perform a field that did not always reflect the field sheets. In the second year, I came back and was tasked to perform the same tests and evaluations. Still, the tests did not make sense, and information got lost between the four documents. My document combines all the field forms, calculations, and test data into one concise document. The document still provides all the necessary data required when submitting to the State of California and does so in a neat efficient way.

Stormwater infrastructure comes in many different shapes and sizes. There are typically five types the first being a detention basin, whose main purpose is to collect rainwater and let it percolate into the ground. This left trash, chemicals, and other harmful pollutants on the surface as the soil acts as a natural purifier. Retention basins, on the other hand, try to keep the water on the surface, this allows new ecosystems to emerge and looks better than a dry basin. Outfalls, catch basins, and BMP's are all structures that usually aid or perform the same tasks. For example, a best management practice is to fill the detention basins with decorative plants or flowers to improve the visual appearance of the basin.

The main concerns of stormwater infrastructure include:

1. Embankment and outlet stabilization

2. Sedimentation
3. Outlet blockages
4. Broken or clogged channels
5. Standing water or wet soils
6. Floatables and debris
7. Weeds or woods vegetation

All the listed above could inhibit the basins from what they are designed to do. It is important to ensure the stormwater infrastructure is functioning properly to ensure that the municipality has proper drainage, is not causing a biohazard, and is not allowing trash into natural bodies of water.

Process

Checking the condition of the detention basins is a rather simple process that requires a visual inspection as well as a field test. The Environmental Protection Agency (EPA) provides this document outlining how to perform visual inspections. This document describes the process of what to look for. There are seven main items of concern. A broken headwall can mean the stormwater cannot flow into the basin. Sedimentation could mean there is dirt getting into your stormwater system, or overgrown vegetation not allowing the water to flow into an outfall or properly drain. All these factors state information about the rest of the stormwater infrastructure. For example, if one of the detention basins is collecting an abundant amount of trash and debris you can then follow the flowline and see where the garbage is originating and stop it from occurring in the first place.

A city can learn a lot about its own infrastructure through its end of the line BMPs and detention basins. An example is the city of Buellton which was accumulating a large amount of trash and debris in a singular dry basin. The company I worked for used the maps of the stormwater as-builts to determine where the trash could be originating. They traced the trash back to the industrial buildings where there was clear evidence trash was being let into stormwater drains. You can also determine the state of your roads by tracking the amount of sediment accumulated in the basin. The dirt is originally blown onto the road then washed down the drain when it rains. Installing barriers or nets could decrease the amount of sand on the road and make the roads a safer place. These are only two examples of how basins can be used to investigate larger issues in a community.

Steps to Completing the Condition Assessment Field Form
Part A

Step 1:

The first step of the DBCAF is to identify the BMP identification number or location. This is typically found on a stormwater map depicting all the cities infrastructure in one document. Under observation type, you must determine the type of stormwater practice being inspected defined as a retention or detention basin. Lastly, date and print your name to record who performed the inspection and when the basin was inspected last. This should be written on the field-form then transferred over to the calculation sheet just to ensure documentation.

Step 2:

Once you get to the area you are assessing the first task you are prompted is to observe the area you are assessing and roughly determine the percentage of what covers the ground. The five categories are wetland/ riparian species, tree species, grass species, bare soil, and any other type of graded or manufactured area. This calculation is important to determine the percentage of bare ground to percolation rate in the basin. Without this calculation, you could have a detention basin that absorbs water but does not replenish the groundwater table. This could be detrimental or beneficial depending on the situation

Step 3:

This step is probably the most intense and requires a field test to be performed. This test will give the percolation rate of the basin. The test is simple yet tedious and requires some equipment.

The first thing you will need is an infiltrometer. The most common type is a double ring infiltrometer like the one depicted below. This device is used to measure the rate of water infiltration into the soil. The rate of infiltration is measured by the amount of water per surface area and the amount of time it takes to seep into the soil. It is important to note that when measuring the percolation rate to only use the inner ring which allows the water to run vertically. The outer ring of the infiltrometer works as a separation.

When placing the infiltrometer (see figure 1.1) into the ground it is important that it lays flat and all the sides are pressed into the ground. This can be ensured by bringing a rubber mallet to beat the rings into the round. They only need to be 1-1.5 inches into the soil.

Figure 1.1. Double ring infiltrometer

The second thing needed is a water source. This can be gallon jugs or a bucket of water it does not matter (see Figure 1.2). Be aware to bring enough water because if you run out and do not fill the infiltrometer to a measurable height you will have to change locations and start the test over. When applying the water to the ring it is crucial to first remove any debris that might get into the way of your readings like small sticks or dead grass. When pouring the water make sure to pour it easy as the impact of water can break the surface and provide inconsistent results.

Figure 1.2. Water jug

Lastly, you will need a stopwatch and a tape measurer (see figure 1.3) to record the data from your tests. When using the tape, make sure to measure from the same location in the ring every time. Differences in the terrain might alter your findings.

Figure 1.3. Tape measurer (left) Stopwatch (right)

Step 1: the first part of the testing procedure is to print out the Dry Basin-Field Form fill out the top section and vegetation cover. Step two is to determine how many tests you need to perform. Use the vegetation cover to determine the number of surface types. In this example, there are three, tree species, grass species, and bare soil. Since there are three use the chart below to determine you need nine test locations.

Table 1 below:

DRY BASIN - Condition Assessment Form						
Field Observations						
BMP ID	ID #1					
Observation Type	Detention Basin					
Observation Date	##/##/####					
Observer Name	Observer					
Vegetation Cover						
	Vegetation type					
	Wetland/Riparian Species	Tree Species	Grass Species	No Vegetation (Bare Soil)	Other (Graded Area, etc.)	Total =100
Cover %	0	10	10	80	0	
Infiltration						
Measurement Type: Infiltrometer				Notes:		
Number of surface types	1	2	3	4		
Number of test locations required	3	6	9	12		

Table 1: Field Observations

Next perform a test at nine different locations. Mixing up the type of surface is good practice but does not always work as some spots are naturally wet and others too hard to penetrate the infiltrometer. (see table 2)

1. Place the infiltrometer in the soil
2. Fill the water at least two inches deep into the soil.
3. Record the type of surface being tested
4. Record the original depth in inches
5. Start timer
6. After two minutes have passed take another measurement
7. Repeat at five minuets

Location	A		B		C		D		E		F	
Measurement #	1	2	1	2	1	2	1	2	1	2	1	2
Surface type												
Original Depth (in)												
Time (min)	2	5	2	5	2	5	2	5	2	5	2	5
Recorded Depth (in)												

Table 2: Infiltration

This concludes the field test and provides all the data you need to determine the percolation rate of your basin. Although the state does not require a graph of these points, however, it is important to know the shape and what these numbers mean. Typically, if you plot these three numbers the first being at zero inches after zero time has passed you should see an exponential curve where the water percolates quickly at first then begins to slow down over time. This is a natural occurrence and means the soils beneath are acting as they should. If you achieve a more linear path, then the soil is dry. This could mean you live in a dry area where water has evacuated the top surface. This could mean several different things but shrinking land can affect things like foundations and existing structures.

Step 4:

The next step consists of recording the material accumulation from sediment deposits in your basin. Dirt and other things get washed off your roads into the storm drains and eventually end up at the end of the line. Every basin should have a staff plate. A staff plate is just a measuring instrument that consists of a post with marked measurements. These staffs are used to measure sedimentation. The more the staff gets covered the more sedimentation your basin is experiencing. These staffs should be located near an inlet o record the best results. In the document, you need to record the depth in feet to give you a total depth of the BMP storage in feet. This is calculated for you and the only requirement is the lowest value visible. If there are multiple staffs take the average as your final number. (see table 3)

Material Accumulation	
Staff Plate Description	Depth (ft) Lowest Value Visible
Average Depth (if multiple staff plate locations)	#DIV/0!
Total Depth of the BMP Storage in feet (benchmark only)	

Table 3: Material Accumulation

Step 5:

Next, address the conveyance of your basin. This section records important data pertaining to any future or current maintenance required to keep the BMP functioning. First, you need to record the number of inlets and outlets in the detention basin. The number of functioning and the total number in the basin, describe this entered in the table as a fraction. For example, if one out of three is functioning then 1/3 are operational. The next two steps are to determine why the inlets or outlets are not functional. Either sedimentation or debris removal are the two categories. These are yes or no questions. (See table 4 below)

Total Depth of the BMP Storage in feet (benchmark only)					
Conveyance					
Location	Functioning as intended? (# functioning / total)			If any NOT functioning as intended, indicate the type of action required: Requires sediment/debris removal? (Y/N)	Possible advanced maintenance? (Y/N)
Inlets		/			
Outlets		/			

Table 4: Conveyance

Step 6:

The final step is to roughly draw the basin as a plan view and make sure to include the locations of the inlets and outlets, the staff plate location, and the locations you performed the percolation tests. This is just a rough sketch used to track where the tests were administered. Any notes or comments are left here as well, this could be a crack in the outfall headwall or an excessive amount of trash or debris. (see table 5 below)

Notes/Draw sketch of test locations labeled A, B, C, etc.
Fill in per requirements

Table 5: Notes/Description

Condition Assessment Forms Calculations and Submittal
Part B

Benchmark and Condition Assessment calculations

Once you have completed the field form you can now return to the office and complete the calculation form. The calculation form is identical to the field assessment form except the document has calculations and equations built into the file. Just enter the information recorded from your field data and the document will produce a benchmark and threshold calculation as well as a Condition assessment calculation. All the equations and formulas in the spreadsheet are provided by the state of California. These formulas are used to determine a score for a specific BMP. The State then uses this data to award funding and calculate the areas most affected by stormwater. No data entry is required for these last two tables. It pulls the information from the data recorded on the field form and self calculates.

Condition Assessment Calculation							
Observation	**Description**	**Current Value (Cv)**	**Score Calculation**		**Score (AS)**	**Weight (W)**	**Weighted Score**
		Copy from cells in current obs. form	Cv **IS** between the Benchmark and Threshold values	Cv **IS NOT** between the Benchmark and Threshold values		Defaults	AS*W
Vegetation Cover	% cover of wetland/ riparian species		$AS = \frac{3(C_v - H_v)}{B_v - H_v} + 2$	$AS = \frac{2(C_v - H_v)}{H_v - 100} + 2$	#DIV/0!	0.15	#DIV/0!
Infiltration	Average Infiltration rate	#DIV/0!	$AS = \frac{3(C_v - H_v)}{B_v - H_v} + 2$	$AS = \frac{2(C_v - H_v)}{H_v} + 2$	#DIV/0!	0.5	#DIV/0!
Material Accumulation	Average Depth	#DIV/0!	$AS = \frac{3(C_v - H_v)}{B_v - H_v} + 2$	$AS = \frac{2(C_v - H_v)}{H_v - D} + 2$	#DIV/0!	0.35	#DIV/0!
Initial BMP Assessment Score (sum of weighted scores)							#DIV/0!
		# Functioning	**Total**				
Conveyance	Inlets			$AS = functioning\ inlets * 5$	#DIV/0!	0.5	#DIV/0!
	Outlets			$AS = \frac{functioning\ outlets * 5 + nonfunctioning\ outlets * 2}{total\ outlets}$	#DIV/0!	0.5	#DIV/0!
Conveyance Score (Inlet Score + Outlet Score)							#DIV/0!
Overall BMP Condition Assessment Score (Initial BMP Assessment Score / 5 * Conveyance Score)							#DIV/0!

Here is a look at the final table used to calculate the overall BMP condition assessment score. All the equations are displayed for easier access and in case there are any irregularities.

Project Benefits

This form was created to improve the process of BMP assessment forms. Anyone in the state of California can use these forms to perform assessments or calculations necessary to determine the state of detention basins. All practices and calculations are in line with the EPA and state regulations. It is important that cities ensure that their stormwater management infrastructure is functional and efficient. Just by inspecting BMP's you can ensure that your city does not flood and provide a safe and clean area. Attached is the entire document needed to perform and submit CAFs to the state of California and for local and state municipalities to utilize for their own use.

Lessons Learned

Stormwater flows from rooftops, over non-permeable surfaces, into our stormwater systems collecting pollutants such as oils, pesticides, and other harmful chemicals along the way. It is important to have a stormwater system that functions properly keeping the city clean and its inhabitants unaware of the system running underneath the sidewalks. Undoubtedly a vital component to a city's infrastructure, stormwater systems need to be tested and manages periodically to ensure compliance with state and local requirements. BMP's and other basins are generally overlooked when it comes to state spending. This document should provide all the necessary information needed for the state of California to assess the condition of its stormwater systems. With compliance from the EPA and state regulations, this document can be utilized however needed. Remember to keep your city clean and only allow rain down the storm drain.

Reference & Appendix

Citing figures and tables:

Figure 1.1

Supplies, Tiger. “Double Ring Infiltrometer.” *Turf-Tec*, 2019, image.tigersupplies.com/Products/LargeImages/TURIN7-W.jpg.

Figure 1.2

“Water Jug.” *Amazon*, images-na.ssl-images-amazon.com/images/I/61hITyIcaEL._SX466_.jpg.

Figure 1.3

Stanley. “Tape Measure.” *Tape Measure*, 2019, encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcSj3-D60EYQW9x7ox0YH5bvuBndsYW7CTc1Ki4lNIB0BGBWb3CbM4I6Qwa0Ao1U7zOtuunbZqs&usqp=CAc.

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