PROGRESS REPORT

Cascade Park, Cameron County Drainage District #1

13/043/000/6910

November 2015

Task 1: Permeable pavement parking lot – Phase 2

- Status of the task during this reporting period: ☐in progress ☒completed
- Estimated Task Percentage Completed __100_%
- Briefly describe major accomplishments for this reporting period.

Construction of the 17,500 sq. ft. permeable surface parking lot is complete, including the bioswale and entrance. A photograph of the parking lot was presented as a good example of porous pavement in the Center for Research in Water Resources (UT-Austin) publication *Guidance for Sustainable Stormwater Drainage on the Texas Coast* (pg. 49).

- List the deliverable(s)/milestone(s) completed during this reporting period. (Submit a copy of your completed deliverable(s)/milestone(s) with this report.)
- Were there any problems or obstacles encountered during this reporting period (e.g., delays, remedial action taken, schedule revision). ☐Yes ☒No If yes, please explain:
- Briefly describe plans for the next reporting period.

None.

Task 2: Wetlands construction and biofiltration

- Status of the task during this reporting period: ☐in progress ☒completed
- Estimated Task Percentage Completed __100_%
- Briefly describe major accomplishments for this reporting period.

Cascade Park contains approximately 18 acres of wetlands/stormwater detention. The Districts primary drainage ditch runs through the property and water can be diverted into two nine-acre ponds. The pond on the north side was an existing detention pit and will be used as a deep pond, with water depth maintained at 6-8 feet. A nine-acre, 18 ft. deep pond was excavated to the south of the District's main ditch as part of this grant project. The south pond water level will normally be controlled at 1-2 feet, but can be filled in the case of a stormwater emergency, e.g. large tropical storm or hurricane. Native vegetation was planted to filter ditch water as it flows through the wetland. The District had planned to utilize biologs to help establish native vegetation along the banks of the wetland, but the native vegetation was successfully directly planted on the banks instead.

- List the deliverable(s)/milestone(s) completed during this reporting period. (Submit a copy of your completed deliverable(s)/milestone(s) with this report.)
- Were there any problems or obstacles encountered during this reporting period (e.g., delays, remedial action taken, schedule revision). ☐Yes ☒No If yes, please explain:
- Briefly describe plans for the next reporting period.

None

Task 3: Education

- Status of the task during this reporting period: ☐in progress ☒completed

- Estimated Task Percentage Completed __100_%
- Briefly describe major accomplishments for this reporting period.

Non-point source educational and informational signage has been installed throughout the park. Particularly important are the informational signs near each LID element, including those in this grant project. Tours of the project have taken place during the construction of the park. Photographs of the tours and group information are included in the photos of the project. A children's poster from the TECQ is available in both English and Spanish at the District office at the front of Cascade Park (GI-379 You Can Take Care of Texas Too!, see attached PDF).

- List the deliverable(s)/milestone(s) completed during this reporting period. (Submit a copy of your completed deliverable(s)/milestone(s) with this report.)
- Were there any problems or obstacles encountered during this reporting period (e.g., delays, remedial action taken, schedule revision). ☐Yes ☒No If yes, please explain:
- Briefly describe plans for the next reporting period.

None.

Task 4: Monitoring – Water Quality

- Status of the task during this reporting period: ☐in progress ☒completed
- Estimated Task Percentage Completed __100_%
- Briefly describe major accomplishments for this reporting period.

Water quality monitoring was performed by environmental engineers and students from TAMUK to determine the amount of non-point source pollution being diverted from Texas coastal surface waters.

- List the deliverable(s)/milestone(s) completed during this reporting period. (Submit a copy of your completed deliverable(s)/milestone(s) with this report.)
- Were there any problems or obstacles encountered during this reporting period (e.g., delays, remedial action taken, schedule revision). ☐Yes ☒No If yes, please explain:
- Briefly describe plans for the next reporting period.

None.

Task 5: Monitoring - Education

- Status of the task during this reporting period: ☐in progress ☒completed
- Estimated Task Percentage Completed _100_%
- Briefly describe major accomplishments for this reporting period.

Because the park was not opened during the grant period, education monitoring was done with a small sample. A pre- and post-tour test was administered to a group that visited the park on August 8. Informal feedback received from other groups was extremely positive, but no written documentation was received.

- List the deliverable(s)/milestone(s) completed during this reporting period. (Submit a copy of your completed deliverable(s)/milestone(s) with this report.)
- Were there any problems or obstacles encountered during this reporting period (e.g., delays, remedial action taken, schedule revision). ☐Yes ☒No If yes, please explain:
- Briefly describe plans for the next reporting period.

None

Project Contact Information:

Patty Alexander, palexander@rgv.rr.com, 956-551-5009

Please provide a current budget breakdown. (Double Click on budget tables to activate Excel.)

Personnel	$ -	$ -	$ -	$ -
Fringe	$ -	$ -	$ -	$ -
Travel	$ -	$ -	$ -	$ -
Supplies	$ -		$ -	$ -
Equipment	$ -	$ -	$ -	$ -
Contractual	$ 100,000.00	$ 95,375.55	$ -	$ 4,624.45
Other	$ -	$ -	$ -	$ -
Subtotal	$ 100,000.00	$ 95,375.55	$ -	$ 4,624.45
Indirect Costs	$ -	$ -	$ -	$ -
Totals	$ 100,000.00	$ 95,375.55	$ -	$ 4,624.45

	Current Local Budget	Billed to Date	Obligated* Local Budget	Remaining Local Budget
Personnel	$ 60,858.82	$ 60,858.82	$ -	$ -
Fringe	$ 11,193.60	$ 11,193.60	$ -	$ -
Travel	$ -	$ -	$ -	$ -
Supplies	$ -	$ -	$ -	$ -
Equipment	$ -	$ -	$ -	$ -
Contractual	$ -	$ -	$ -	$ -
Other	$ -	$ -	$ -	$ -
Subtotal	$ 72,052.42	$ 72,052.42	$ -	$ -
Indirect Costs	$ -	$ -	$ -	$ -
Totals	$ 72,052.42	$ 72,052.42	$ -	$ -

	Current 3rd Party Budget	Billed to Date	Obligated* 3rd Party Budget	Remaining 3rd Party Budget
Personnel	$ -	$ -	$ -	$ -
Fringe	$ -	$ -	$ -	$ -
Travel	$ -	$ -	$ -	$ -
Supplies	$ -	$ -	$ -	$ -
Equipment	$ -	$ -	$ -	$ -
Contractual	$ -	$ -	$ -	$ -
Other	$ -	$ -	$ -	$ -
Subtotal	$ -	$ -	$ -	$ -
Indirect Costs	$ -	$ -	$ -	$ -
Totals	$ -	$ -	$ -	$ -

***Obligated includes - funds that have been incurred by the recipient but have not been paid by the recipient, such as executed contract agreements or acquired supplies/materials/equipment.**

Cameron County Drainage District #1
Cascade Park
July 2015

The grant elements, plus several great additions, are complete. Cascade Park is filled with non-point source pollution BMPs, picnic facilities, butterfly gardens, playgrounds, a splash pad, fantastic views, and so much more. Fun recreational opportunities surround the thriving pond and wetland that still function as stormwater detention ponds to prevent flood hazards to lives,

Parking Lot with Bioretention Areas and Native Vegetation

Parking lot July 2011

Parking lot Feb. 2014

The innovative parking lot includes parking spaces that feature a permeable surface and underground stormwater retention. It is paired with a bioswale that incorporates many native plant species. Non-point source pollution reduction is being monitored by engineers and students from TAMUK. Solar energy powers monitoring equipment and a light in the park.

Stormwater Pond Improvements
North Pond

Two 9-acre wetlands are the basis of Cascade Park and the education that the Cameron County Drainage District is providing to the public. The north pond provides deep water (6-8”) habitat, while the south wetland provides shallow water and moist soils. Both ponds are designed to provide an estimated 120 acre-feet of stormwater detention during hurricanes and other flood emergencies. Native wetland vegetation is installed in the south wetland. Educational signage on water pollution, flood mitigation measures, and water quantity and quality issues is posted.


Before – stormwater detention pit

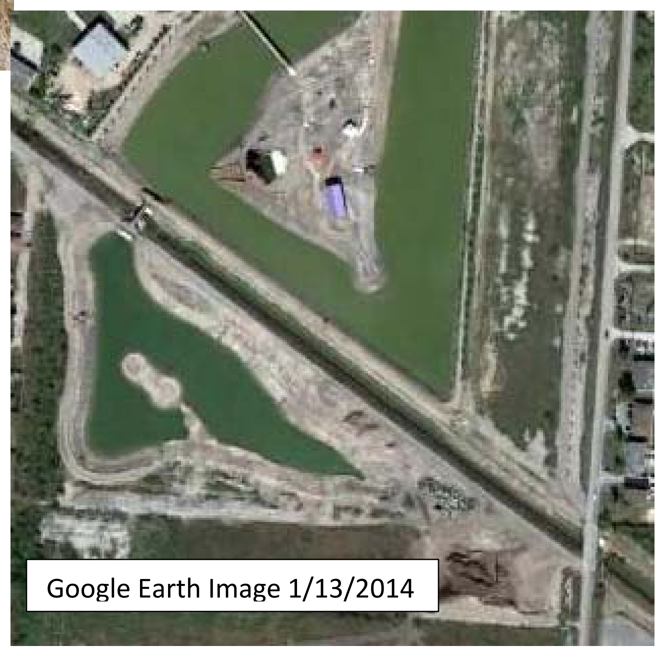

After – stormwater detention and park

Stormwater Pond Improvements
South Pond


January 2009 – vacant lot on south side of ditch.


July 2013

2009


Google Earth Image 1/13/2014


In 2013, a Roseate Spoonbill and a Wood Stork stopped by to supervise the excavation of the south wetland. Coastal wetland habitat continues as a priority, and many species have been sighted.

March 2012

September 2012

July 2013

January 2014

August 2014

January 2015

Summer 2015 - Native vegetation has been installed in and around the shallow wetland. Species include several Montezuma Baldcypress and Retama trees, along with emergent and riparian species that will recreate wildlife habitat and encourage ecotourism.

ADA Trails

Viewing Piers

Educational Signage

In order to create awareness of water quality, water conservation, and flood management, signage has been installed in high traffic areas of the park. These have been developed in partnership with the LRGV TPDES Stormwater Task Force and Texas A&M University – Kingsville.

Tours and Presentations

Community tour November 1, 2012.

LRGV TPDES Stormwater Task Force tour, July 1, 2013.

Winter Haven RV Park tour, August 8, 2015.

2009

Google Earth Image 1/13/2014

Summary of Survey Results

An unusual number and severity of rain delays in the past year, along with construction of additional amenities, set the opening of Cascade Park back. As a result, fewer than expected tours of the facility were offered.

The Cameron County Drainage District #1 gave a tour to neighbors of the Cascade Park to measure the educational potential of the facility. The attached survey was given as a pre-test and again after the tour. A total of 22 respondents took the pre-test. Twelve of the respondents left the survey completely blank and verbally offered that they did not have any knowledge of non-point source pollution issues or solutions. Ten respondents had at least a general idea of what non-point source pollution is and that wetlands and vegetation helped in some way. Because the afternoon was extremely hot and humid, only 11 participants stayed after the tour to re-take the survey as a post-test. All respondents understood specifics about non-point source pollution and ways that Cascade Park helped to protect local surface waters. All respondents were able to answer all or most of the questions accurately.

Chapter 5: Cascade Park – Cameron county Drainage District #1

Outline

- Background
- Site description
- Project description
- Major hurdles

Site Description

Cameron County is located 140 miles south of Corpus Christi in the Rio Grande Plains region in South Texas. The county is bordered on the north by Willacy County, on the west by Hidalgo County, on the east by the Gulf of Mexico, and on the south by Mexico (Rio Grande). The county's largest town and county seat is Brownsville, which serves as the terminus of U.S Highways 77, 83, and 281 and the Missouri Pacific and Southern Pacific railroads. The region has its drainage conveyed through four major ditches. Cameron County drainage districts #1 is located north of Brownsville and runs right through Cascade Park in the Bahia Grande-Brownsville ship channel. The site of interest is located in Cascade Park.

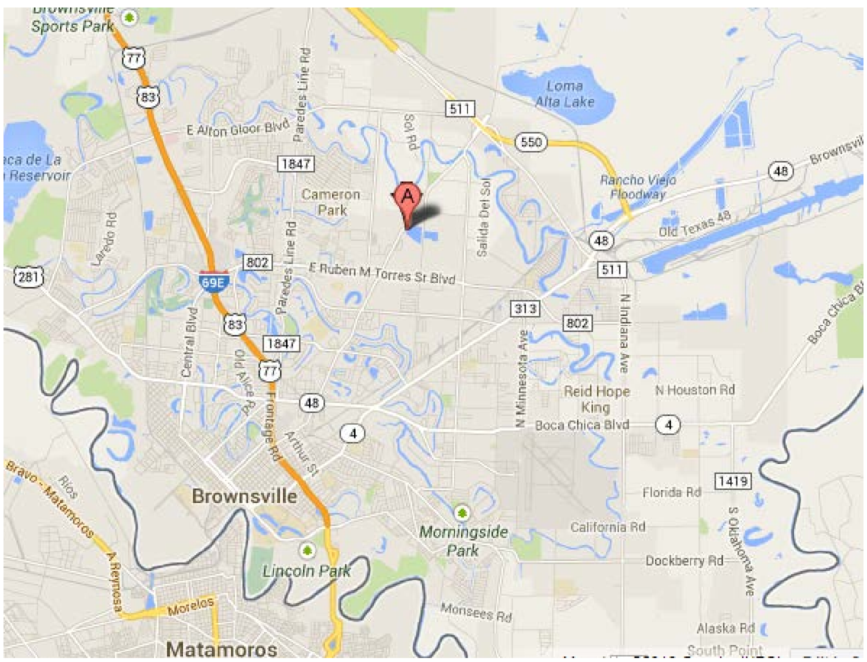
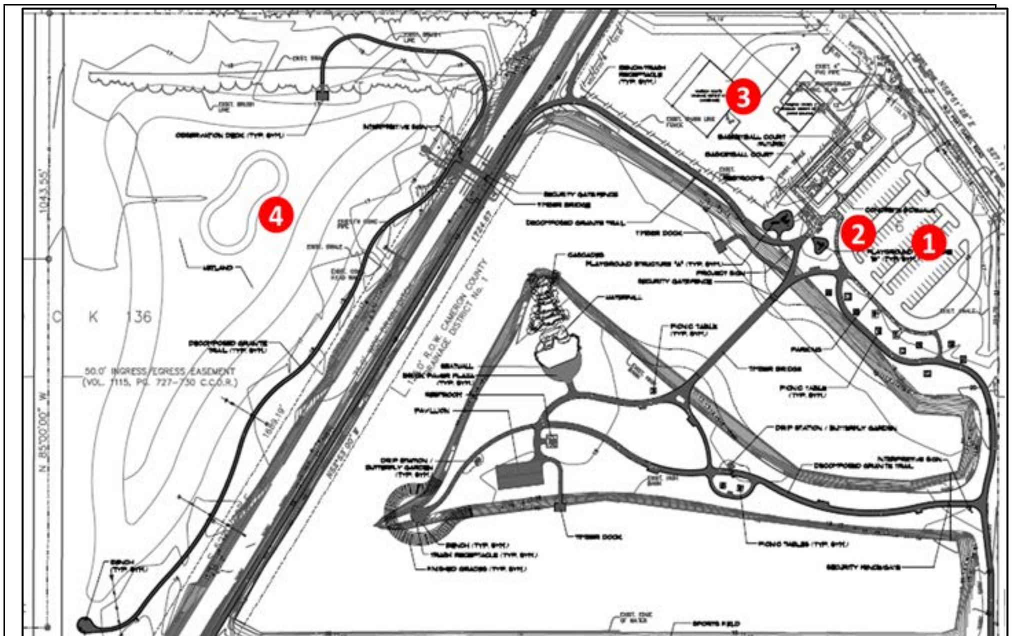


Figure 5.1. Cascade Park Area Description

Cameron county drainage district #1 encompasses 81,126 acres. The area is mainly flat with an elevation range of -0.8m to 22m. The soil is mainly reddish with loamy to clayey surface layers and clayey sub-soils. Cameron County has a subtropical and sub-humid climate with hot summers and mild winters. Temperature ranges from an average of 50°F to 69°F in January and from an average of high of 75°F to 94°F in July.

Project Description

The LID project in CCDD #1 is aimed at enhancing stormwater runoff and drainage ditch water quality from offsite through incorporated BMPs. The idea is to retain and utilize as much off-site drainage ditch water as possible and hence reduce Stormwater mean flow and non-point source pollutant loading. The four main LID elements of Cascade Park shown in figure x below include an engineered retention wetland, pervious parking lot bordered by bioretention areas and pervious channels, bioswale and cisterns for rain water collection.



1.	Pervious Parking Lot	17,000 sq ft
2.	Bioswale	120 ft
3.	Rainwater collection system	One 5,000 gal cisterns
4.	Wetland	10 ac

Figure 5.2. Cascade Park at CCDD#1: BMP layout

Permeable Pavement Parking lot

The parking area entails a LID pervious pavement consisting of 9,000 square feet. The driveway is constructed with traditional impermeable materials and is graded to direct runoff water to the parking stalls where the permeable pavement is installed. For monitoring purposes, two different parking lot sections were studied, one on the west side and one on the east side of the bioswale (numbers 2 and 1, respectively, as shown in Figure 5.2 below).

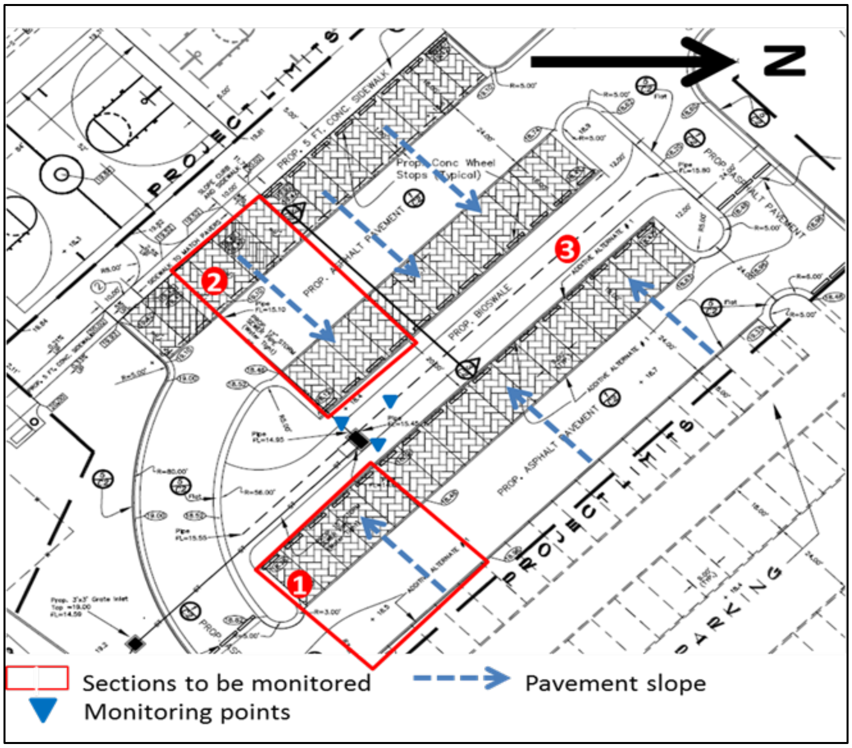


Figure 5.3. 1. East side monitoring section; 2. West side monitoring section; 3.Bioswale

The hydraulic and pollutant loadings is measured from the runoff from each section. Inflow through the porous section is estimated from rainfall measured by a rain gauge (ISCO 674 or equivalent) installed on the property. Each monitoring section is hydraulically isolated with temporary speed bumps that prevented run-on from outside the monitoring area. The sides adjacent to bioswale have berms that conveys the water to one point of discharge where flow measurements and water samples were taken (see monitoring sites in the figure 5.3. above).

Figure 5.4. Cameron County Drainage District #1 Parking lot

Space between pavements is about 2 inches as shown above in figure 5.4. Flow measurements were taken with the aid of flumes and bubbler flow meters. Samples were manually grabbed. The performance of both parking sections were compared to the performance and cost of the traditional parking lot to be constructed in La feria. Table 5.1 below shows the reduction in runoff volume.

Table 5.1: Sampled rain events (grab) for the permeable pavement: Precipitation, flow volume and volume reduction

Date	Prcp(in)	Inflow (L)	Outflow(L)	Vol Red (L)	Fractional Runoff Reduction
9/13/2014	2.76	110717.83	27350.42	83367.41	0.75
9/27/2014	0.25	10028.79	6.12	10022.67	1.00
10/18/2014	2.64	105904.01	40755.49	65148.52	0.62
10/22/2014	0.67	26877.15	869.89	26007.27	0.97
10/31/2014	0.26	10429.94	7.82	10422.12	1.00
11/6/2014	0.98	39312.85	4852.33	34460.52	0.88
11/7/2014	1.54	61777.34	14815.23	46962.10	0.76
11/8/2014	0.06	2406.91	13.59	2393.32	0.99
12/7/2014	0.71	28481.76	3302.85	25178.91	0.88
12/8/2014	0.62	24871.40	16.99	24854.41	1.00
1/3/2015	0.01	401.15	61.16	339.99	0.85
1/10/2015	1.85	74213.04	22780.12	51432.91	0.69
2/3/2015	0.35	14040.30	2929.07	11111.24	0.79
2/4/2015	0.09	3610.36	27.18	3583.18	0.99
Average	**0.91**	**36648.06**	**8413.45**	**28234.61**	**0.87**

Inflow volume and volume reduction were calculated as follows:

Inflow = Precipitation * Contributing area

Outflow = Discharge * Contributing area

Runoff volume reduction = Inflow – Outflow

$$\text{Fractional runoff reduction} = \frac{\text{Inflow} - \text{Outflow}}{\text{Inflow}}$$

Displayed below (figure 5.5) is a plot of the fractional runoff against measured precipitation events. The figure shows a slight decrease in reduction rate with increasing precipitation. For small events of less than an inch of precipitation, runoff volume is highly reduced and may be near infinitesimal (for fractional reduced values of 1) as the water gets completely infiltrated.

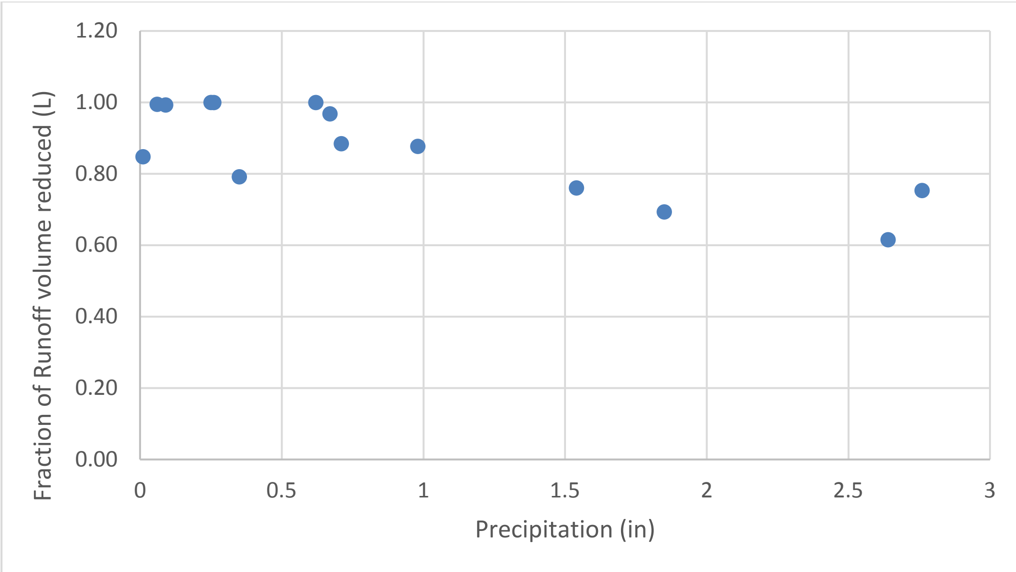


Figure 5.5. Precipitation versus fractional runoff volume reduced

Flowrate values for the pervious pavement in CCDD#1 and the traditional pavement in La feria are shown in table 5.2. A comparism of both BMPs shows a trend in tandem with flowrates increasing correspondingly with precipitation. The graph in figure 5.6 depicts no significant difference in runoff values for the traditional and pervious pavements though the traditional pavement have slightly higher flowrate values.

Table 5.2. Flowrates for both Pervious and traditional pavements.

Date	Precipitation (in)	PP Flowrate (cfs)	TP Flowrate (cfs)
9/13/2014	2.76	8.049	7.752
9/27/2014	0.25	0.0018	2.465
10/22/2014	0.67	0.256	0.716
11/6/2014	0.98	1.428	19.845
11/7/2014	1.54	4.36	5.945
11/8/2014	0.06	0.004	0.082
12/7/2014	0.71	0.972	0.01

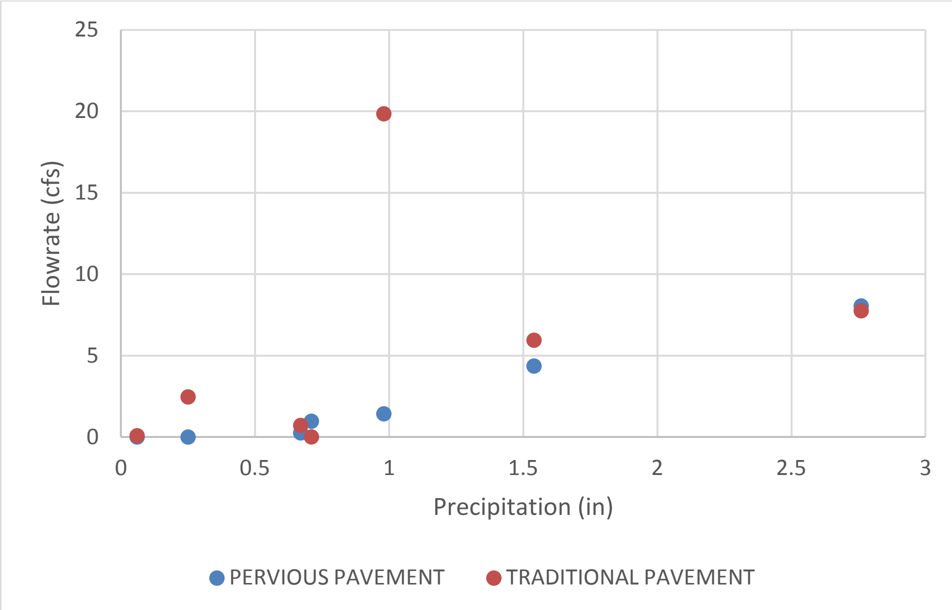


Figure 5.6. Runoff values for both pervious and traditional pavements

Mass pollutant loading for some stormwater criteria pollutants was also estimated. Table 5.3 below shows the range of values for BOD and TSS loading. While there was an average of 2.1E+07mg of TSS in the inflow, the outflow recorded an average of 3.7E+06, effecting an 86 percent reduction average for all measured events. Likewise, average BOD values of 5.30E+05mg, 1.18E+05mg and 87% were recorded for inflow, outflow and pavement efficiency respectively.

Table 5.3. BOD and TSS mass loading for pervious pavement

Date	**Prcp (in)**	**TSS LoadIn(mg)**	**BOD LoadIn(mg)**	**TSS Loadout (mg)**	**BOD loadout(mg)**	**TSS Reduced (mg)**	**BOD Reduced (mg)**	**TSS Efficiency**	**BOD Efficiency**
9/13/2014	2.76	2.8E+07	1.38E+06	6.89E+06	3.42E+05	2.10E+07	1.04E+06	75.30	75.30
10/22/2014	0.67	2.6E+07	2.00E+05	8.35E+05	6.47E+03	2.50E+07	1.93E+05	96.76	96.76
11/7/2014	1.54	2.9E+07	5.15E+05	7.07E+06	1.23E+05	2.24E+07	3.91E+05	76.02	76.02
11/8/2014	0.06	4.2E+05	2.11E+04	2.35E+03	1.19E+02	4.14E+05	2.09E+04	99.44	99.44
Average	1.2575	2.1E+07	5.30E+05	3.7E+06	1.18E+05	1.7E+07	4.12E+05	86.88	86.88

Bioswale

The bioswale is sited in between the parking lot sections as shown in Figure 5.7. It received and treated stormwater runoff from the parking lot sections that is not channeled to the permeable pavement for monitoring (i.e. the bioswale tributary area is the parking spaces outside the red rectangles on Figure 5.2. Concrete curbs are flat along the bioswale to allow for water discharge. The inflow volume is calculated as that in the permeable pavement explained above.

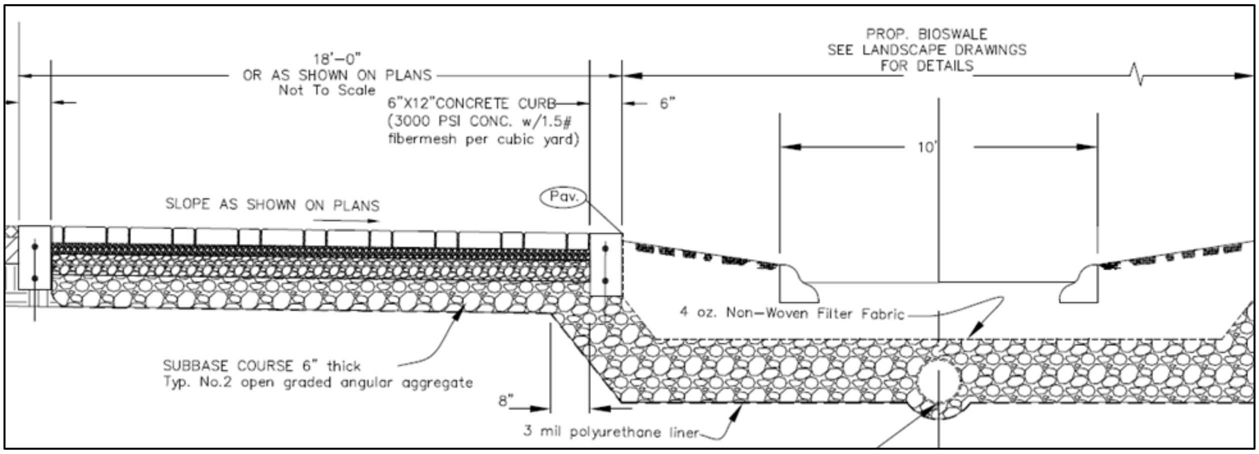


Figure 5.8. Bioswale cross section at CCDD#1 Cascade Park

In Figure 5.8 above, the monitoring station before the stormwater inlet has a flume installed to measure flow. Direct flow measurement was taken from the parking lot sections (red squares Figure 5.3) and discharged directly into the storm drain. The runoff from the rest of the parking lot was treated by the bioswale. Flow meters were synchronized with the samplers based on specified trigger parameters. The bioswale was planted with suitable native vegetation on the slopes and base channel to reduce erosion as well as act as a potential filter strip. Table 5.4 records the mass load load per liter of sampled event for TSS, BOD, TP and E.coli while table x records their corresponding mass reductions.

Table 5.4. Mass load per liter of measured parameters

Date	**Prcp (in)**	TSS (mg/l)	BOD (mg/l)	TP (mg/l)	E.coli (mg/l)
10/22/2014	0.67	15.5	4.75	0.118	1732.9
11/7/2014	1.54	31	3.61	0.336	209.8
11/8/2014	0.06	110	2.16	0.418	613.1

Table 5.5. Mass load ins and load outs for measured pollutants

Date	Inflow (L)	Outflow (L)	TSS LoadIn (mg)	BOD LoadIn (mg)	TP LoadIn (mg)	E.coli LoadIn (mg)	TSS LoadOut (mg)	BOD LoadOut (mg)	TP LoadOut (mg)	E.coli LoadOut (mg)
10/22/2014	2.69E+04	8.70E+02	4.17E+05	1.28E+05	3.17E+03	4.66E+07	1.35E+04	4.13E+03	1.03E+02	1.51E+06
11/7/2014	6.18E+04	1.48E+04	1.92E+06	2.23E+05	2.08E+04	1.30E+07	4.59E+05	5.35E+04	4.98E+03	3.11E+06
11/8/2014	2.41E+03	1.36E+01	2.65E+05	5.20E+03	1.01E+03	1.48E+06	1.50E+03	2.94E+01	5.68E+00	8.33E+03
Average	3.04E+04	5.23E+03	8.65E+05	1.19E+05	8.31E+03	2.03E+07	1.58E+05	1.92E+04	1.70E+03	1.54E+06

As shown in table 5.5, for an average inflow of 30,400 l of water through the bioswale, there was a corresponding mass load of 8.65E+05mg, 1.19E+05mg, 8.31E+03mg, and 2.03E+07mg for TSS, BOD, TP and E.coli respectively. Also, mass load averaged in the outflow recorded 1.58E+05mg, 1.92E+04mg, 1.70E+03mg and 1.54E+06mg for TSS, BOD, TP and E.coli respectively. Catalogued in table 5.6, is the mass of pollutant reduced. For an average precipitation of 0.76 inches, percentage values of 81.73%, 83.80%, 79.60%, 92.42% can be observed for TSS, BOD, TP & E.coli respectively during the measurement period. E.coli has the highest percentage reduction while TP has the lowest reduction percentage.

Table 5.6: Load reduction values for measured pollutants

Date	**Prcp (in)**	TSS reduced (mg)	BOD reduced (mg)	TP Reduced (mg)	E.coli reduced (mg)	TSS Reduced (lb)	BOD Reduced (lb)	TP Reduced (lb)	E.coli Reduced (lb)
10/22/2014	0.67	4.0E+05	1.2E+05	3.1E+03	4.5E+07	0.89	0.272	0.007	99.36
11/7/2014	1.54	1.5E+06	1.7E+05	1.6E+04	9.9E+06	3.21	0.374	0.035	21.72
11/8/2014	0.06	2.6E+05	5.2E+03	1.0E+03	1.5E+06	0.58	0.011	0.002	3.23
Average	0.76	7.07E+05	9.94E+04	6.62E+03	1.88E+07	1.560	0.219	0.015	41.438

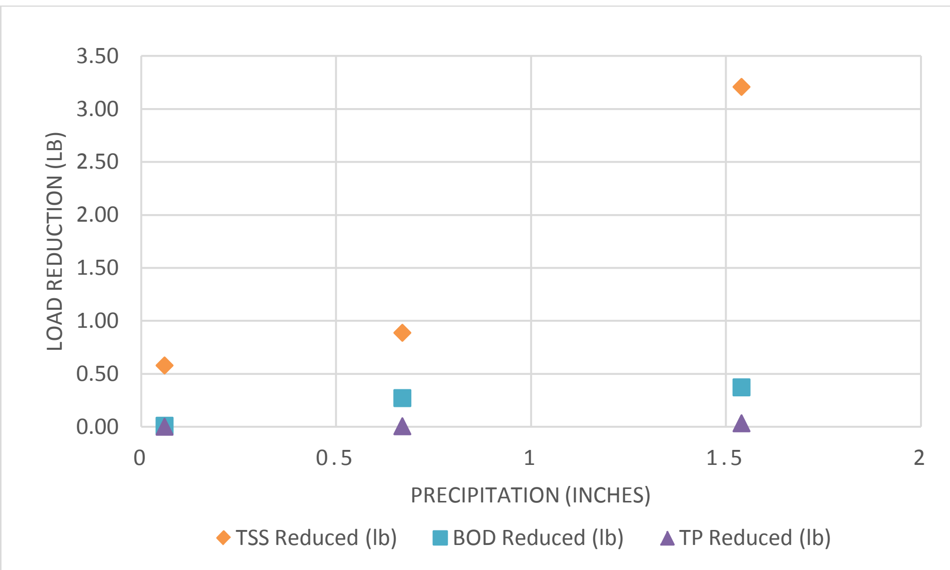


Figure 5.9. Load reduction and precipitation for TSS, BOD & TP

As can be observed in figure 5.9, for all parameters except TP, mass load reduction increased with an increase in precipitation. Total phosphorus seems to be the least responsive to the BMP treatment compared to other parameters. This can also be seen in the amount reduced in table 5.6, where it averaged the lowest mass reduced and the also the lowest percentage reduction value.

Treatment wetland

The wetland (Figure 5.10 below) would function as a retention basin and treat stormwater runoff from a subdivision located north of the Cascade Park.

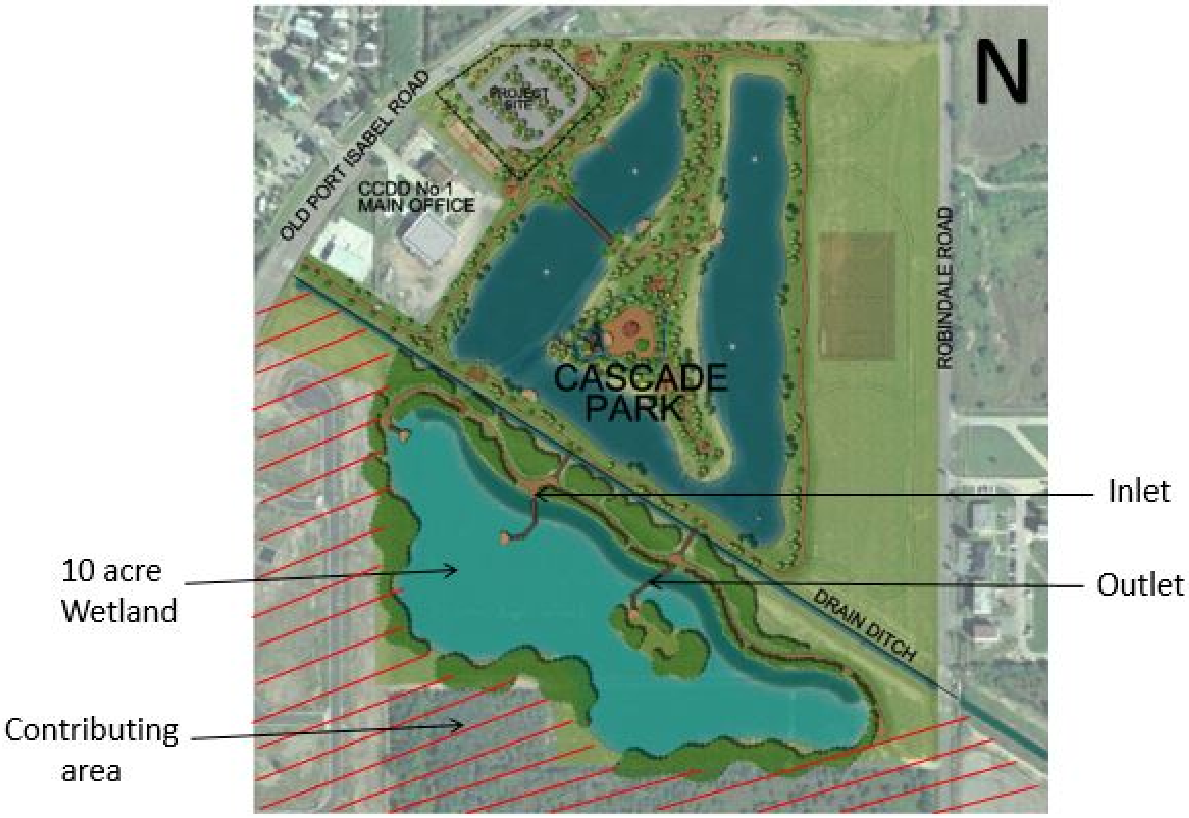


Figure 5.10. CCDD#1 Wetland

Inflow water source may originate from an overflow in the adjacent drainage ditch or directly from runoff from the contributing area. After a rain event the water level rises and the runoff is diverted into the wetland through the inlet structure (shown in figure 5.10 above) where measurement can be made. Outflow is quantified near the west end of the wetland where the water returns to the drainage ditch. Direct rainfall is also considered as part of the inflow and is measured by a rain gauge (ISCO 674) installed onsite. Values recording the runoff volume and volume retained by the wetland for various precipitation events are tabulated in table 5.7 below.

Table 5.7. Volume retained with corresponding precipitation events

Date	Prcp (in)	Prcp (ft)	Wetland vol (ft3)	runoff vol (ft3)	Vol retained (ft3)
10/22/2014	0.67	0.06	24321	2432.10	26753.10
11/7/2014	1.54	0.13	55902	5590.20	61492.20
11/8/2014	0.06	0.01	2178	217.80	2395.80
Average	**0.76**	**0.06**	**27467**	**2746.70**	**30213.70**

The wetland has an area of 435,600 square feet (10acre) and a contributing area of 108900 square feet. A runoff coefficient of 0.4[1] (unimproved areas) was used to calculate the generated runoff. Runoff volume was calculated using the rational equation and the result presented in table 5.7. Runoff calculation is shown below. An average volume of 30213cfs (225998 gallons) was retained during the monitoring period.

Whole area = 12.5 acre or 544500 square feet

Contributing area = 2.5 acre or 108900 square feet

Wetland area = Whole area – Contributing area

Wetland volume = Precipitation * Wetland area

For runoff calculation, the rational equation was used as shown below.

Q = CiA where Q = Runoff (cubic feet per day), i = rainfall intensity (ft) & A = Area (square feet)

C = Dimensionless runoff coefficient (0.4 for unimproved areas characterized by approximately 2% slope and flat surfaces)

Runoff volume = Precipitation * Wetland area * 0.4

Volume retained = Runoff volume + Wetland volume

Hurdles/Challenges

- Distance from site to other sites.
- Site construction activities interfering with already installed BMPs.
- Security of installed equipment on site
- Hard to control growth /high sprout of weed and exotic grasses with intense storm event

Reference

1. Wurbs, R. A., & James, W. P. (2002). *Water resources engineering*. Prentice Hall.