

Task 11

Project Title: Watering Station Best Management Practices (BMP) – Effectiveness, Demonstration, and Education

Sponsoring Agency: FDACS Office of Agricultural Water Policy

Project No. 117714

Investigating Agency: University of Florida (UF), Institute of Food and Agricultural Sciences (IFAS)

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FDACS Contract No. 21147

Introduction

Pursuant to the Florida Watershed Restoration Act (FWRA), the Florida Department of Agriculture and Consumer Services (FDACS) Office of Agricultural Policy (OAWP), develops, adopts, and assists with the implementation of agricultural Best Management Practices (BMPs) to protect and conserve water resources. Funding for BMP projects that complement the OAWP's mission is consistent with FWRA objectives. In this regard the University of Florida's, Institute of Food and Agricultural Sciences (UF/IFAS) continues to play an important role in assisting the nursery industry with implementing BMPs. This BMP project proposes to demonstrate the mitigation of runoff from watering stations.

Description of Task

Task 11: Final report that summarizes all tasks with data presented for appropriate tasks.

Deliverable: Submit final summary report to FDACS.

Background

The 2014 BMP manual (*Water Quality/Quantity Best Management Practices for Florida Nurseries*) has a new BMP No. 1A.2.13 regarding watering station runoff mitigation. The BMP states “*If your container operation has a watering station used to irrigate plants immediately after potting, collect runoff in a small basin, direct the runoff to an existing basin, or route runoff through an onsite vegetative treatment area.*” The intent of the new BMP is to minimize the impact of watering stations on surface waters.

Watering stations are a central location where plants are irrigated thoroughly after transplanting. Immediately after planting, containers are transported on wagons to the watering station where irrigation water is applied rapidly with high-volume, shower-like nozzles that are elevated above plants at close spacing. Plants are often passed through the water station several times to apply enough water to “settle” the potting substrate around roots and ensure the substrate achieves maximum water-holding capacity. Water not retained by the container substrate (leachate) in addition to water falling between containers becomes runoff. This runoff is a potential source of surface and ground water contamination due to its nitrogen (N) and phosphorus (P) content. The

source of N and P is due to leaching of readily soluble nutrients released from controlled-release fertilizers (CRF) as well as fertilizer prills that splash from containers during the application of the large volume of water.

The work completed for this project demonstrated how two different mitigation features could be implemented based on the characteristics of each site. In addition, educational events about design and construction of watering stations and the management of runoff were conducted for county extension personnel, FDACS staff, and the nursery industry.

Work Performed - Effectiveness

A mitigation feature installed in Gadsden County (Site 1) involved the addition of a wall of boards in a ditch (Figs. 1 and 2). The wall created a detention basin that slowed runoff water flow and reduced downstream sediment. For the second feature that was installed in Sumter County (Site 2), a concrete pad was installed and runoff was collected in a channel on one side of the concrete pad (Figs. 3 and 4). The runoff was conveyed down the slope of the channel and traveled by pipe to a grass area.

The mitigation features installed at Site 1 and 2 accomplished the intent of BMP 1A.2.13. In addition, the features exemplified how the characteristics of a site are considered when mitigating runoff from a watering station.

To obtain data on the influence that mitigation features had on N and P concentrations in runoff and loading, samples were collected and analyzed for total Kjeldahl nitrogen (TKN), nitrate nitrogen ($\text{NO}_3\text{-N}$), and total phosphorus (TP) by the Environmental Water Quality Laboratory at University of Florida. At Site 1, the objective was to determine the impact of the wall on concentrations of nutrients in runoff. Samples obtained from the ditch that conveyed runoff were collected prior to the wall installation and after the wall installation. Samples were obtained at the same locations in the ditch before and after the wall installation.

At Site 2, the objective was to determine the nutrient load that results from a wagon of plants passing under the watering station shower. Samples were taken from the channel in the concrete pad and runoff volume measured after a wagon passed under the shower. Sample collection was repeated three additional times.

Results for Site 1

Data for Site 1 prior to wall installation

Shower runoff water and runoff water in conveyance ditch above and below proposed wall location were sampled on Oct. 9, 20, and 30. Three samples were collected at each of the three times from each of three locations (runoff from shower, runoff in ditch before proposed wall location, and runoff in ditch after proposed wall location). Mean concentrations for each sampling time and location are given in Figs. 5, 6, and 7.

Nitrate nitrogen and TKN exhibited an elevation in concentration as samples were collected at locations further away from shower runoff spillway (SP) on Oct. 20 and 30. For example, on Oct. 30 TKN concentration was 7 mg/L at SP, 7.5 mg/L before wall (BW) and 10.3 mg/L after

proposed wall location (AW). Total phosphorus exhibited the same trend on Oct. 9 and 30, but not on Oct. 20. An explanation is not evident for the variation in response between nutrients for the sampling dates; although, it is worth noting that #1 or trade one gallon container plants were passed under shower on Oct. 20 and #3 or trade three gallon plants were passed under shower on other dates.

It is interesting to note that $\text{NO}_3\text{-N}$ concentrations, particularly at the SP were low, compared to what was expected based on previous research. Million et al., (2007) determined that $\text{NO}_3\text{-N}$ concentrations in runoff from the initial watering of #1 containers with a hose and breaker were 48-81 mg/L when the substrate was amended with Osmocote® 18-6-12. Nutricote® 18-6-8 was used as the amendment in this evaluation and might have influenced the concentration of nutrients in the runoff. However, an important consideration is that a larger volume of water was applied with the shower and possibly more dilution occurred than in the study by Million et al., (2007).

Data for Site 1 after wall installation during the second week of February

Shower runoff water and runoff water in conveyance ditch above and below wall of boards stacked on edges were sampled on March 3, 16, and 24. Three samples were collected at each of the three times from each of five locations: runoff from shower at spillway (SP), runoff before wall (BW), runoff near front of wall (NW), runoff after wall (AW), and water from shower nozzle (SO). On March 16 and 23, six locations were sampled because runoff was also collected approximately 220 feet downstream (DS) from the wall. Mean concentrations for each sampling time and location are given in Figs. 8, 9, and 10.

Samples collected about 25 feet after the wall (AW) compared with the samples collected from runoff at the spillway (SP), exhibited elevated concentrations for $\text{NO}_3\text{-N}$ and TKN on March 16 and elevated concentrations of TP on March 3 and 16. A general rise in nutrient concentrations was also detected as samples were collected at locations further away from the shower runoff spillway. This was also observed for the sampling in Oct. 2014.

The increase or rise in nutrient concentrations might have been influenced by several factors such as nutrients in runoff from the container plants. Also, there could have been residual nutrients associated with sediments in the ditch. As runoff flowed, turbulence disturbed the sediments and pushed nutrient-laden particles further downstream toward the wall. As the water approached the wall, water velocity slowed and nutrients accumulated. Nutrients in the runoff water from the previous showering of plants and the amount of runoff resident in the ditch could have also impacted the concentrations. However, these assumptions could not be quantitatively verified because the parameters needed for verification were not measured as part of this study.

Because concentrations were elevated after the wall, samples were obtained approximately 220 feet downstream (DS) from the wall on March 16 and 24. TP concentrations downstream (DS) and approximately 25 feet after wall (AW) were similar. It could be inferred that the majority of TP was conveyed in the runoff as soluble phosphorus and not attached to transported particles in the runoff. Additional support for this inference comes from the fact that runoff collected after

the wall (AW) had fewer particulates than runoff collected before but near wall (NW) as seen in Fig. 11.

The percent increase in nutrient concentrations for sampling locations before the wall (BW) and after the wall (AW) for $\text{NO}_3\text{-N}$, TKN, and TP collectively, increased 60% for samples taken after the wall was installed (average of March 3, 16, and 24) compared to samples taken before the wall was installed (average of Oct. 9, 20, and 30). This indicates the wall had an impact on nutrient concentrations. Because it is important to minimize the movement of nutrients offsite, results indicate that additional mitigation is needed to achieve concentrations downstream that approximate the source (SO). A slight decrease in nitrogen concentrations was measured downstream (DS) compared to concentrations for samples taken at the location 25 feet past the wall (AW). On March 16, $\text{NO}_3\text{-N}$ concentrations (mg/L) were 1.47 for AW and 0.97 for DS and TKN concentrations were 0.74 for AW and 0.67 for DS. On March 24, TKN concentrations (mg/L) were 0.15 for AW and 0.01 for DS. The slight decrease in nitrogen concentrations downstream (DS) might be attributable to natural filtration, deposition of sediment, and denitrification.

In summary, concentrations of nutrients in runoff from watering recently planted container plants were lower than expected based on previous research by Million et al., (2007). This is likely because nutrient concentrations at the sampling locations were diluted due to the volume of water applied by the shower. Visual observation revealed that runoff contained fewer particulates when sampled approximately 25 feet after the wall than when sampled at locations prior to wall. Even though runoff sampled 25 feet after the wall had fewer particulates, nutrient concentrations in the runoff were higher than in runoff leaving the concrete spillway where a wagon of plants was showered. The differences in concentrations are likely impacted by volume, but it will be important to minimize the movement of the concentrated runoff downstream. This might be accomplished by a solid wall, rather than stacked boards, or dam of soil so all the runoff is retained on site.

Results for Site 2

Data for Site 2

Two wagons of plants each passed once under the shower on May 6. Concrete pad and channel were cleaned of debris and residual liquid removed from channel before each pass. Each wagon contained 69 trade 3 gallon containers of *Rhaphiolepis indica* in a 60% pine bark, 40% Florida peat substrate amended with 20 pounds/cubic yard of 17-5-10 controlled-release fertilizer. Shower water was sampled once for each wagon due to short duration of water applied and three replicate samples were collected from the channel after each wagon passed under shower.

The process was repeated on May 14. Each of the wagons contained 69 trade 3 gallon containers of *Ilex cornuta* 'Burfordii Nana' in a 60% pine bark, 40% Ferti-Comp® compost substrate amended with 18 pounds/cubic yard of 17-5-10 controlled-release fertilizer.

Mean concentrations of $\text{NO}_3\text{-N}$, TKN, and TP in runoff were 0.98, 1.60, and 4.99 mg/L, respectively (Table 1). These concentrations ($\text{TN} = \text{NO}_3\text{-N} + \text{TKN}$ and TP) exceeded stream flow concentrations proposed for Florida (EPA). The average load of TN and TP in runoff was

231 (92 + 139) and 440 mg, respectively. Thus, 231 mg of TN would be loaded off the concrete pad for each wagon. If the nursery planted 69,000 3-gallon plants per year or 1000 wagons of 69 plants each, this would result in approximately 0.5 pounds of TN load if the plants were passed under the watering station shower. The TP load would be about twice as much based on these data. However, it is important to note this nursery injects a phosphate compound in the irrigation water to precipitate indigenous iron.

Nutrient load is impacted by the amount of water applied and by amount of runoff volume. The volume of runoff in the channel was approximately 57% of the water applied and the container substrate absorbed 43% of the water applied. Nutrient concentrations in the water applied were generally less than the concentrations in runoff indicating that fertilizer contributed to nutrients in runoff. The absorption of the water by the substrate is an important way to keep nutrients from running off in large amounts as each wagon is watered. Efficient application of shower water to minimize leaching will be important to minimize nutrient loads in runoff.

Data from site 2 indicated that excessive leaching of nutrients did not occur, likely because of the large amount of water absorbed by the substrate. However, it is important to realize that more nutrients could be lost in runoff in a situation where a large volume of water was applied per wagon or a fertilizer used with very rapid initial nutrient loss.

Future work might investigate methods to increase substrate absorption to minimize nutrient loss. Also, additional data need to be taken over several months to further verify the nutrient loads from watering stations.

Education and Demonstration

A very important component of this project was to provide education regarding the BMP. One important part of the project was to produce educational resource materials so video and fact sheet were produced about the mitigation features at Site 1 and 2. The video is 3.13 minutes long and like the fact sheet, explains how the mitigation features were selected and constructed at each site. The video titled *Watering Stations* and script were provided to FDACS for inclusion in the web-based version of *Water Quality/Quantity Best Management Practices for Florida Nurseries*. The fact sheet will be available in the future at <http://edis.ifas.ufl.edu>.

FDACS and IFAS personnel training

Educational trainings were conducted at demonstration Site 1 and Site 2 for FDACS and IFAS personnel. Site 1 training was conducted on May 19 (Havana) and Site 2 training was conducted on May 26 (Webster). Three participants attended the training on May 19 and 12 participants attended on May 26. Each participant received an agenda, topic outline, and schematic of the mitigation feature for their respective site of attendance. Agendas are provided below.

Agenda
Watering Station BMP Education
May Nursery, Havana, Florida
May 19, 2015
4 pm - 6 pm

Introductions

BMPs added to the 2014 Nursery Manual

Watering Station BMP Topics from Outline

View Watering Stations Video

Onsite visit to Watering Station

Questions and Discussion

Summary

Agenda
Watering Station BMP Education
Hibernia Nursery, Webster, Florida
May 26, 2015
10 am - 1 pm

Introductions

Background and purpose of Watering Station

Onsite visit to Watering Station

Operation of Watering Station

Move to inside location, continue education

Watering Station BMP topics from outline

Questions and discussion

Summary

A presentation and video about the mitigation features for both sites were presented at each of the trainings. The presentations contained information on selection of mitigation features based on site characteristics, a review of how each feature was constructed at each site, and summary of nutritional data for Site 1.

Industry personnel training

Educational trainings were conducted at demonstration Site 1 and Site 2 for industry personnel. Site 1 training was conducted on May 28 (Havana) and Site 2 training was conducted on June 9 (Webster). Eight participants attended the training on May 28 and 11 participants attended on June 9. Each participant received an agenda, topic outline, and schematic of the mitigation feature for their respective site of attendance. Agendas are provided below.

Agenda
Watering Station BMP Education
May Nursery, Havana, Florida
May 28, 2015
4:30 pm – 5:30 pm

Introductions

Watering Station BMP added to the 2014 Nursery Manual

Watering Station BMP Topics from Outline

View Watering Stations Video

Onsite visit to Watering Station

Questions and Discussion

Agenda
Watering Station BMP Education
Hibernia Nursery, Webster, Florida
June 9, 2015
5:30 pm – 8:00 pm

Introductions

Onsite visit to Watering Station

Watering Station BMP Topics from Outline

View Watering Stations Video

Questions and Discussion

A presentation and video about the mitigation features for both sites were presented at each of the trainings. The presentations contained information on selection of mitigation features based on site characteristics, a review of how each feature was constructed at each site, and general information about sampling for nutritional data at Site 1.

In summary, the trainings were an effective means to communicate what can be done by nurseries to implement the Watering Station BMP. The small groups made it possible to have onsite visits at nurseries for enhanced interaction with knowledge gain.

Overall Summary

The tasks accomplished by this project demonstrated and provided education for IFAS, FDACS, and industry personnel about watering station selection and installation based on site characteristics. It was determined the wall effectively detained particulates transported in runoff water; however, nutritional analyses of runoff revealed that additional work is needed to document the benefits of runoff detention and quantify nutrient loads. This additional work is proposed for 2016.

References

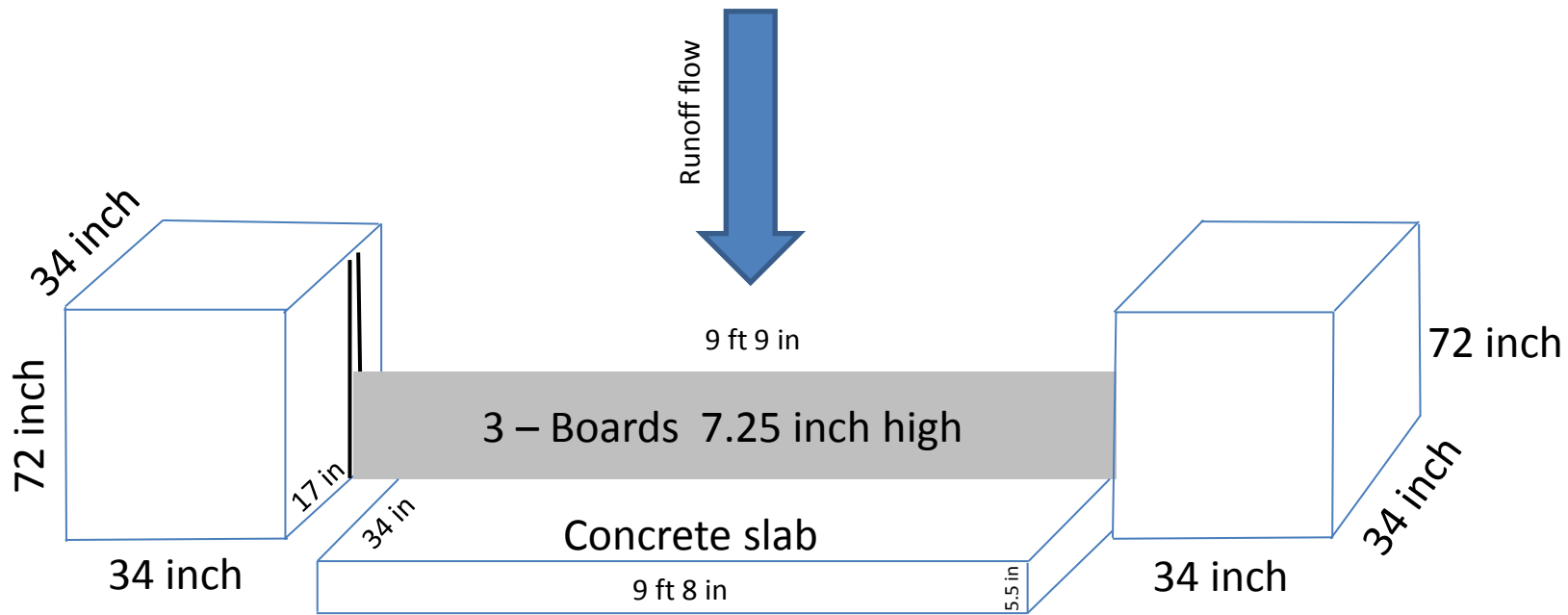
Environmental Protection Agency. 2010. Water quality standards for the state of Florida's lakes and flowing waters; final rule. Federal Register. 75(233):1-47.

Million, J., T. Yeager, and J. Albano. 2007. Consequences of excessive overhead irrigation on runoff during container production of Sweet Viburnum. J. Environ. Hort. 25(3):117-125.

Information in this report has not been peer reviewed and is not a recommendation of UF/IFAS. Trade names and products are mentioned for informational purposes only and do not constitute an endorsement.

Table 1. Volume of water applied or collected as runoff was multiplied by the concentration of NO₃-N, TKN, and TP to determine total amounts of nutrients in water applied or in runoff. Samples were collected twice on May 6 and May 14, 2015.

	<i>Volume</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>
5/6/15	Liters	NO₃-N Mg/L	NO₃-N Mg	TKN Mg/L	TKN Mg	TP Mg/L	TP Mg
Applied	217	0.57	124	0.78	169	5.16	1119
Runoff	135	1.53	206	1.83	247	6.17	833
	<i>Volume</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>
5/6/15	Liters	NO₃-N Mg/L	NO₃-N Mg	TKN Mg/L	TKN Mg	TP Mg/L	TP Mg
Applied	121	0.64	77	0.93	113	4.72	571
Runoff	70	1.20	84	1.55	108	4.94	345
	<i>Volume</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>
5/14/15	Liters	NO₃-N Mg/L	NO₃-N Mg	TKN Mg/L	TKN Mg	TP Mg/L	TP Mg
Applied	129	0.26	34	0.92	119	4.46	576
Runoff	65	0.47	31	1.63	106	4.48	291
	<i>Volume</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>	<i>Conc.</i>	<i>Total</i>
5/14/15	Liters	NO₃-N Mg/L	NO₃-N Mg	TKN Mg/L	TKN Mg	TP Mg/L	TP Mg
Applied	122	0.55	67	0.95	116	5.02	615
Runoff	67	0.70	47	1.4	94	4.35	292



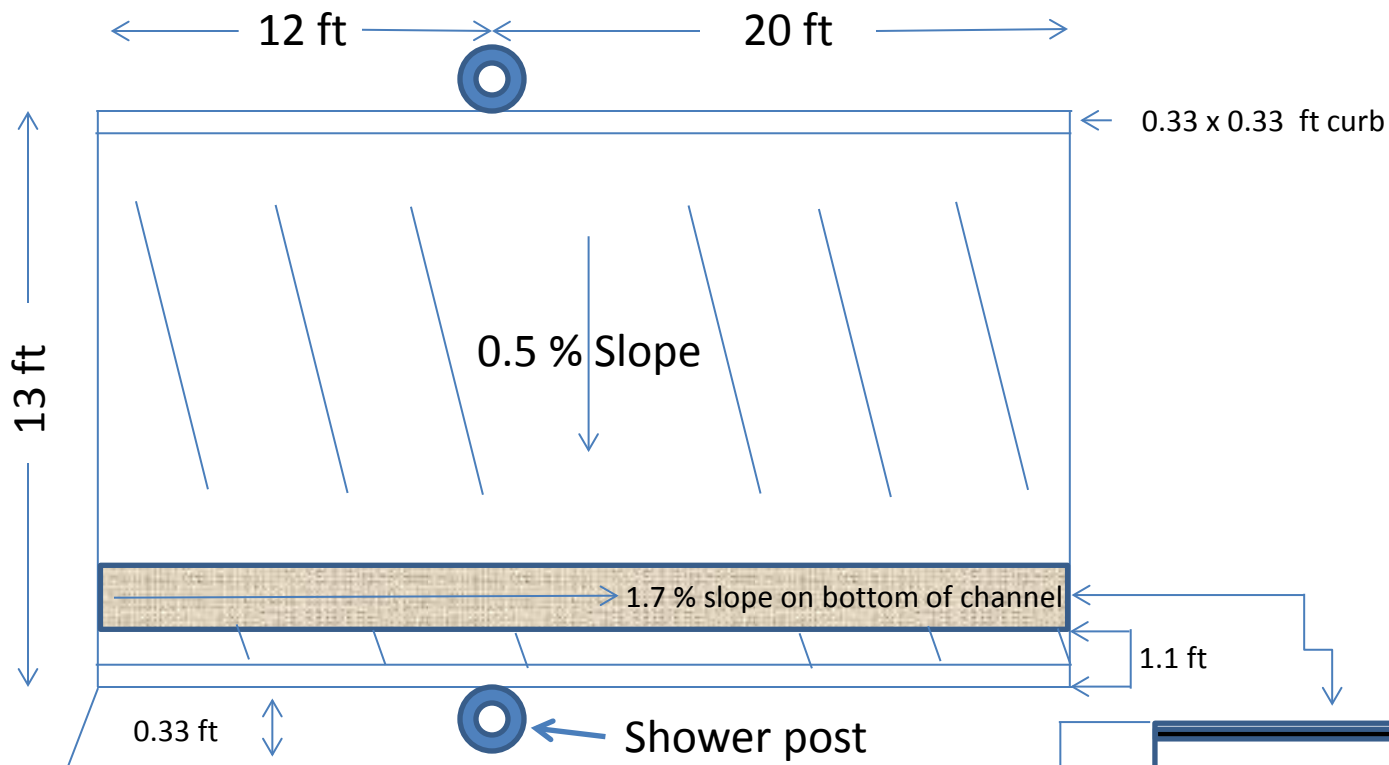
Concrete columns have metal brackets 2x1 inch (outside dimensions) for removing boards. Each column has 12 metal rods spaced horizontally throughout for structural integrity. Six rods are perpendicular to six additional rods. Columns extend approximately 2 inches below bottom of concrete slab that was added between columns.

Bottom of lowest board was inserted approximately 1 inch in concrete slab.

Figure 1. Schematic (not-to-scale) of wall installed for runoff management.



Figure 2. Photo of wall installed for runoff management.



Wire in concrete pad, bell footing at all edges
 Rebar in channel walls, grate recessed on top of channel
 Curb on both long sides and slightly elevated edge on short
 sides followed by slope for vehicular approach and exit

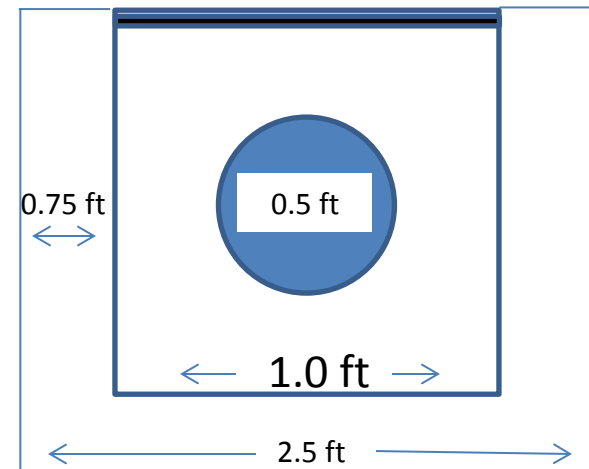


Figure 3. Schematic (not-to-scale) of concrete pad installed for runoff management.



Figure 4. Photo of concrete pad installed for runoff management.



Figure 5. Mean nitrate nitrogen ($\text{NO}_3\text{-N}$) concentrations (mg/L) for three samples collected Oct. 9, 20, and 30, 2014 from spillway runoff (SP), before proposed wall location (BW), after proposed wall location (AW), and shower water (SO). Samples were collected after a wagon of containers passed under the shower at watering station.

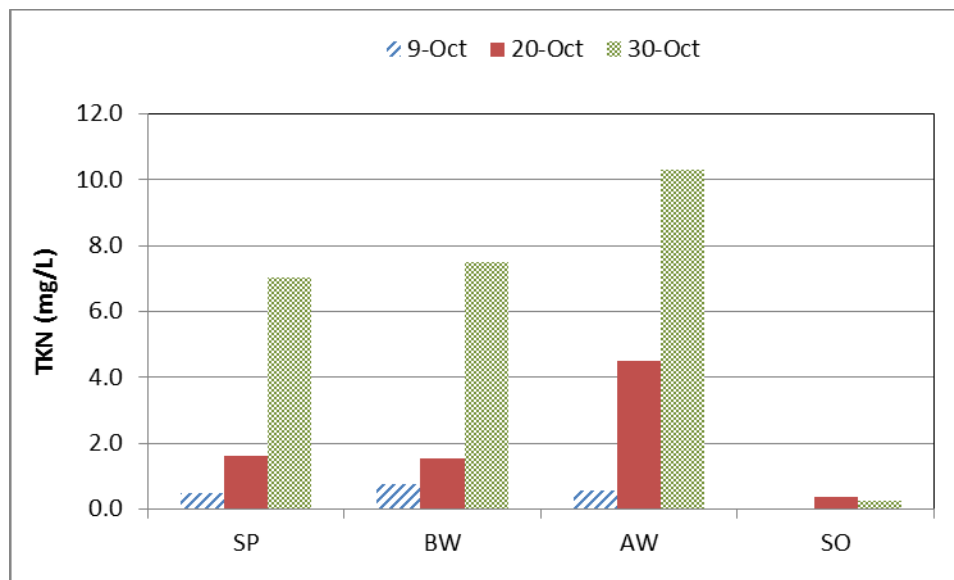


Figure 6. Mean total Kjeldahl nitrogen (TKN) concentrations (mg/L) for three samples collected Oct. 9, 20, and 30, 2014 from spillway runoff (SP), before proposed wall location (BW), after proposed wall location (AW), and shower water (SO). Samples were collected after a wagon of containers passed under the shower at watering station.



Figure 7. Mean total phosphorus (TP) concentrations (µg/L) for three samples collected Oct. 9, 20, and 30, 2014 from spillway runoff (SP), before proposed wall location (BW), after proposed wall location (AW), and shower water (SO). Samples were collected after a wagon of containers passed under the shower at watering station.

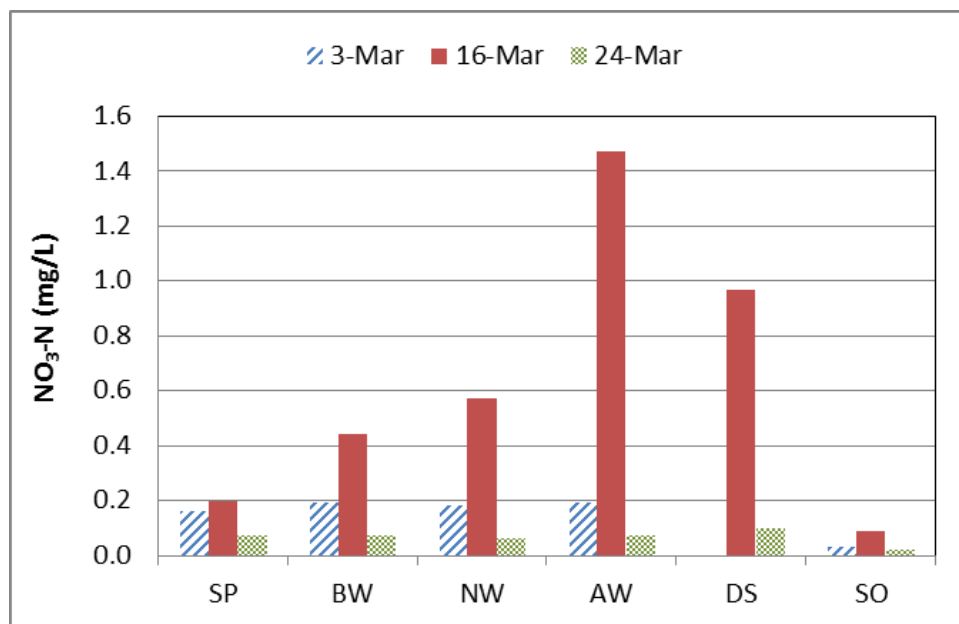


Figure 8. Mean nitrate nitrogen ($\text{NO}_3\text{-N}$) concentrations (mg/L) for three samples collected March 3, 16, and 24, 2015 from spillway runoff (SP), before wall location (BW), near front of wall (NW), after wall location (AW), downstream (DS), and shower water (SO). Samples were collected after a wagon of container plants passed under the shower at watering station.

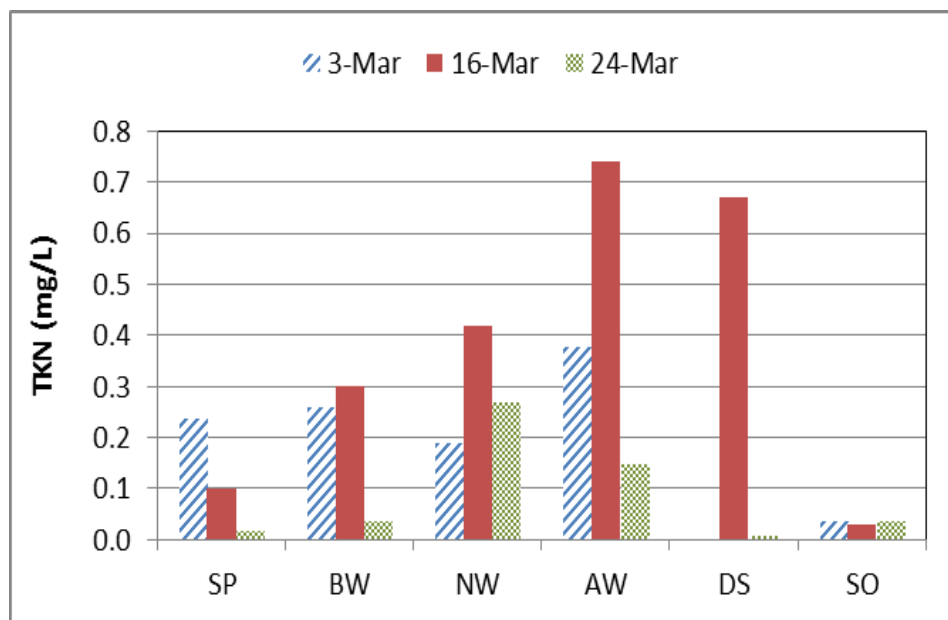


Figure 9. Mean total Kjeldahl nitrogen (TKN) concentrations (mg/L) for three samples collected March 3, 16, and 24, 2015 from spillway runoff (SP), before wall location (BW), near front of wall (NW), after wall location (AW), downstream (DS), and shower water (SO). Samples were collected after a wagon of container plants passed under the shower at watering station.

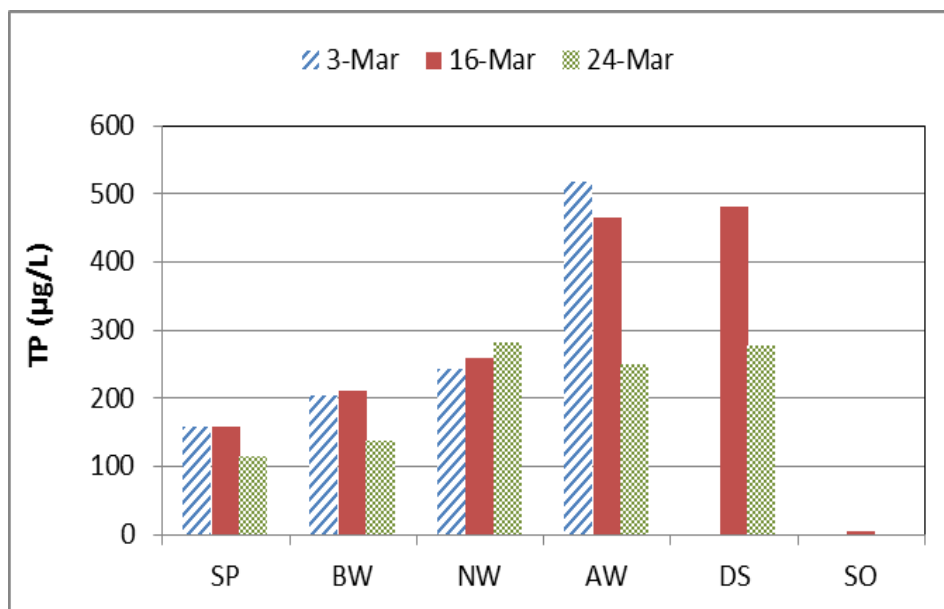


Figure 10. Mean total phosphorus (TP) concentrations ($\mu\text{g/L}$) for three samples collected March 3, 16, and 24, 2015 from spillway runoff (SP), before wall location (BW), near front of wall (NW), after wall location (AW), downstream (DS), and shower water (SO). Samples were collected after a wagon of container plants passed under the shower at watering station.

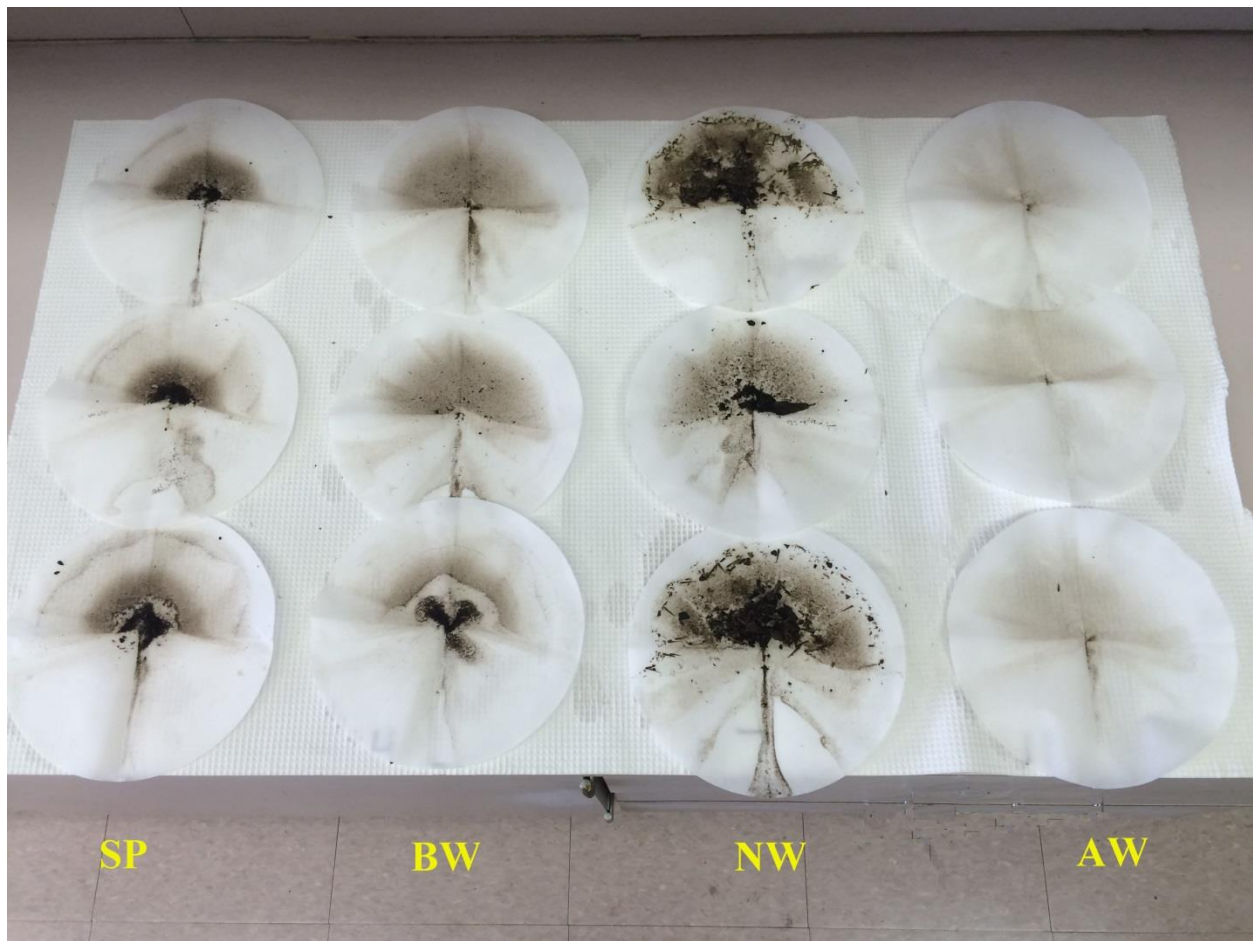


Figure 11. Photo of filter paper (#40) for samples collected March 24, 2015 from spillway runoff (SP), before wall location (BW), near front of wall (NW), and after wall location (AW). Samples were collected after a wagon of container plants passed under the shower at watering station.