MOA and ADOT&PF
2015 Low Impact Development
Project Performance Monitoring Report

Prepared for:

The Municipality of Anchorage

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And

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1. Introduction and Project Description

AWR Engineering, LLC (AWR) and HDR Alaska are assisting the Municipality of Anchorage (MOA) Watershed Management Services (WMS) with performance monitoring and reporting for seven Low Impact Development (LID) and Green Infrastructure (GI) projects. The 2015 performance monitoring continued the MOA monitoring and reporting program that began in 2013 per the requirements of the MOA and Alaska Department of Transportation and Public Facilities (ADOT&PF) Alaska Pollutant Discharge Elimination System (APDES) permit. The permit-driven monitoring and reporting requirements were satisfied in 2014, but the MOA elected to continue the program to provide on-going project performance information that may aid in future LID/GI designs. This report presents the results of the 2015 monitoring program and provides recommendations for future projects based on the results.

The MOA 2015 monitoring program included visual monitoring of seven sites by AWR. Of these sites, two were owned by the MOA, three were owned by ADOT&PF, and two were privately owned sites. The MOA and ADOT&PF sites were also discussed in the 2013 and 2014 LID Project Performance Monitoring Reports. The privately owned sites had not been previously monitored by the MOA.

In addition to this, the MOA and AWR orchestrated volunteer monitoring of an additional six GI sites by members of the MOA Green Infrastructure Working Group (GIWG). The volunteer monitoring was completed intermittently based on member availability, and the sites were selected by the GIWG members.

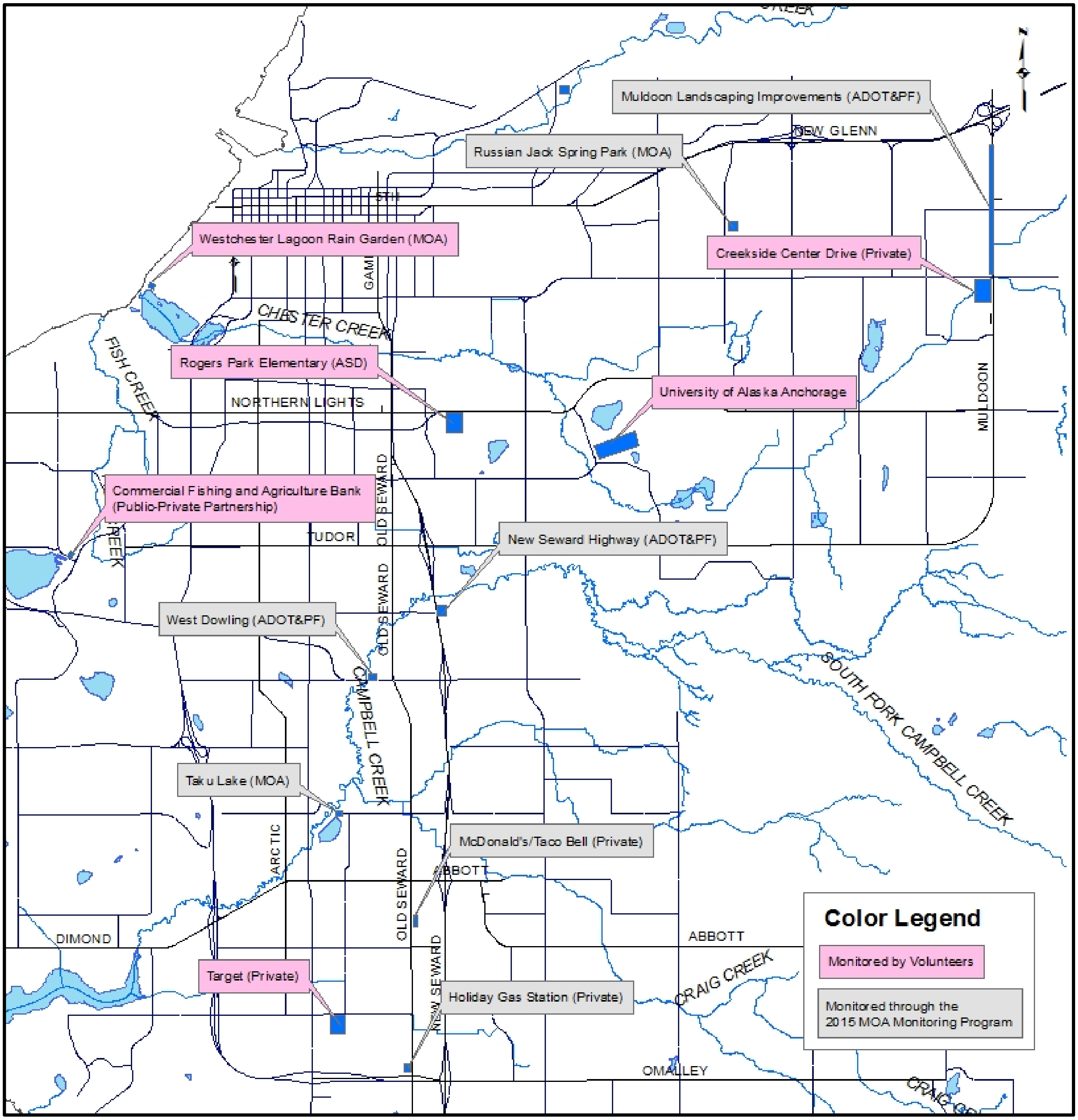
A summary of the 2015 monitoring sites is presented in Table 1 and the site locations are shown in Figure 1.

Table 1: 2015 Performance Monitoring Site Summary

Facility Owner	LID/GI Facility	Included in Prior Monitoring Report	2015 Monitoring Completed By
ADOT&PF	West Dowling Road Bioswale	2013	MOA/AWR
	Muldoon Road Landscape Improvements	2013	MOA/AWR
	New Seward Highway Infiltration Basin	2014	MOA/AWR
MOA	Russian Jack Springs Park Parking Lot	2013 &2014	MOA/AWR
	Taku Lake Rain Garden	2013 & 2014	MOA/AWR
Private Owner	Taco Bell/McDonald's on Old Seward Hwy – Site Landscaping	N/A	MOA/AWR
	Holiday Gas Station on Old Seward Hwy – Rain Garden	N/A	MOA/AWR
MOA	Westchester Lagoon Rain Garden	N/A	GIWG
Private Owner	Commercial Fishing and Agriculture Bank Rain Garden	2013	GIWG
Private Owner	Target Stormwater Pond	N/A	GIWG
Private Owner	Creekside Center Drive	N/A	GIWG
UAA	UAA Bioswale	N/A	GIWG
ASD*	Rogers Park Elementary Infiltration Area	N/A	GIWG

*Anchorage School District

Figure 1: LID/GI Monitoring Sites Vicinity Map



1.1. 2015 Monitoring Program and APDES Requirements

The 2010 to 2015 APDES permit required that the performance of five LID pilot projects be monitored and documented. The permit also included requirements for monitoring parking lot retrofits and rain gardens. As discussed above, these requirements were satisfied during the 2014 monitoring program, and a summary of the completed requirements is included in the 2014 Project Performance Monitoring Report dated January of 2015. The 2015 MOA monitoring was primarily visual monitoring supported by basic measurements. The monitoring was completed in the fall of 2015. The monitoring program did not include site instrumentation, and correspondingly, this report does not include hydrograph development or computation of runoff quantities or rates.

2. Rainfall Data

Rainfall data for characterization of storm event magnitude, duration, and distribution was obtained from the National Climatic Data Center (NCDC) which is a section of the National Oceanic and Atmospheric Administration. Because the sites discussed in this report are distributed across Anchorage, rainfall data from two recording stations were used to estimate the rainfall events for each site during visual observations. The two recording stations used were Anchorage International Airport (ANC) and Merrill Field Airport (MRI). These stations were selected based on proximity to the monitoring sites and on reliability of the data.

Rainfall events were selected for monitoring based on variation in total rainfall depths as well as rainfall intensity. The monitoring program sought to observe the LID/GI sites under a variety of rainfall conditions, from light to heavy. September of 2015 was the wettest September on record for Anchorage with a total of 7.71 inches of rainfall recorded at ANC. Visual monitoring for the MOA-monitored sites was completed three times during the month of September. The dates of observation and a description of the associated rainfall are provided below. Sites that were monitored by volunteers were generally monitored less regularly, and during differing rainfall events. Rainfall events for the volunteer monitoring are discussed in subsequent sections of this report.

1. September 11-12, 2015: This event resulted in 0.52 inches of rainfall in 24 hours at ANC, and 0.39 inches of rainfall in 24 hours at MRI. In both cases, the preceding 48-hours were not without rainfall, and significant rainfall was recorded on September 8 at ANC. Thus, conditions are expected to have been somewhat saturated at the beginning of this event.
2. September 26-29, 2015. Site observations were made twice during this multi-day rainfall event that resulted in a total of 2.84 inches of rain at ANC and 3.02 inches of rain at MRI. The daily rainfall totals for each recording station are shown in Table 2. Observations were made during in the late morning on September 28, 2015 and again in the afternoon and early evening on September 29, 2015. Rainfall records from ANC indicate that this rain event continued past September 29, though with notably decreased intensity and depth.

Table 2: September 26-29 Daily Rainfall Totals

Date	Daily Rainfall (inches)	
	ANC	MRI
9/26/2015	0.27	0.19
9/27/2015	0.72	0.77
9/28/2015[1]	0.42	0.43
9/29/2015[1]	1.43[2]	1.63
4-day total	2.84	3.02

1. Indicates visual monitoring occurred.
2. Rainfall data from the NCDC shows a discrepancy in the daily totals vs. the combined hourly totals on this day. The combined hourly totals are used in this report.

These three monitoring events provide a good representation of facility performance at varying rainfall events and saturation conditions. The first event represents a small rainfall under generally partially saturated conditions. The two observations made during the second event represent moderate rain under saturated conditions and heavy rain under saturated conditions.

Rainfall hyetographs for each of these events are presented in Figures 2 and 3 below. Supporting data is including in Appendix A.

Figure 2: Event 1 September 11-12, 2015 Rainfall Hyetograph

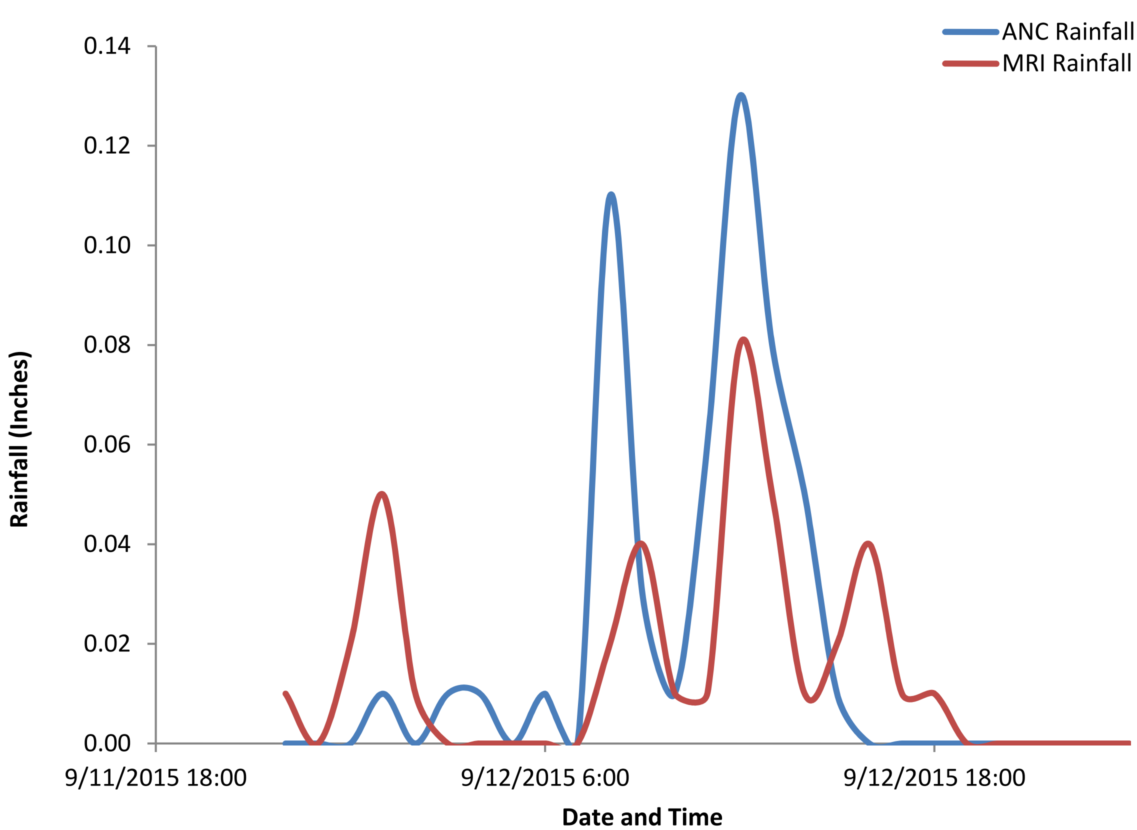
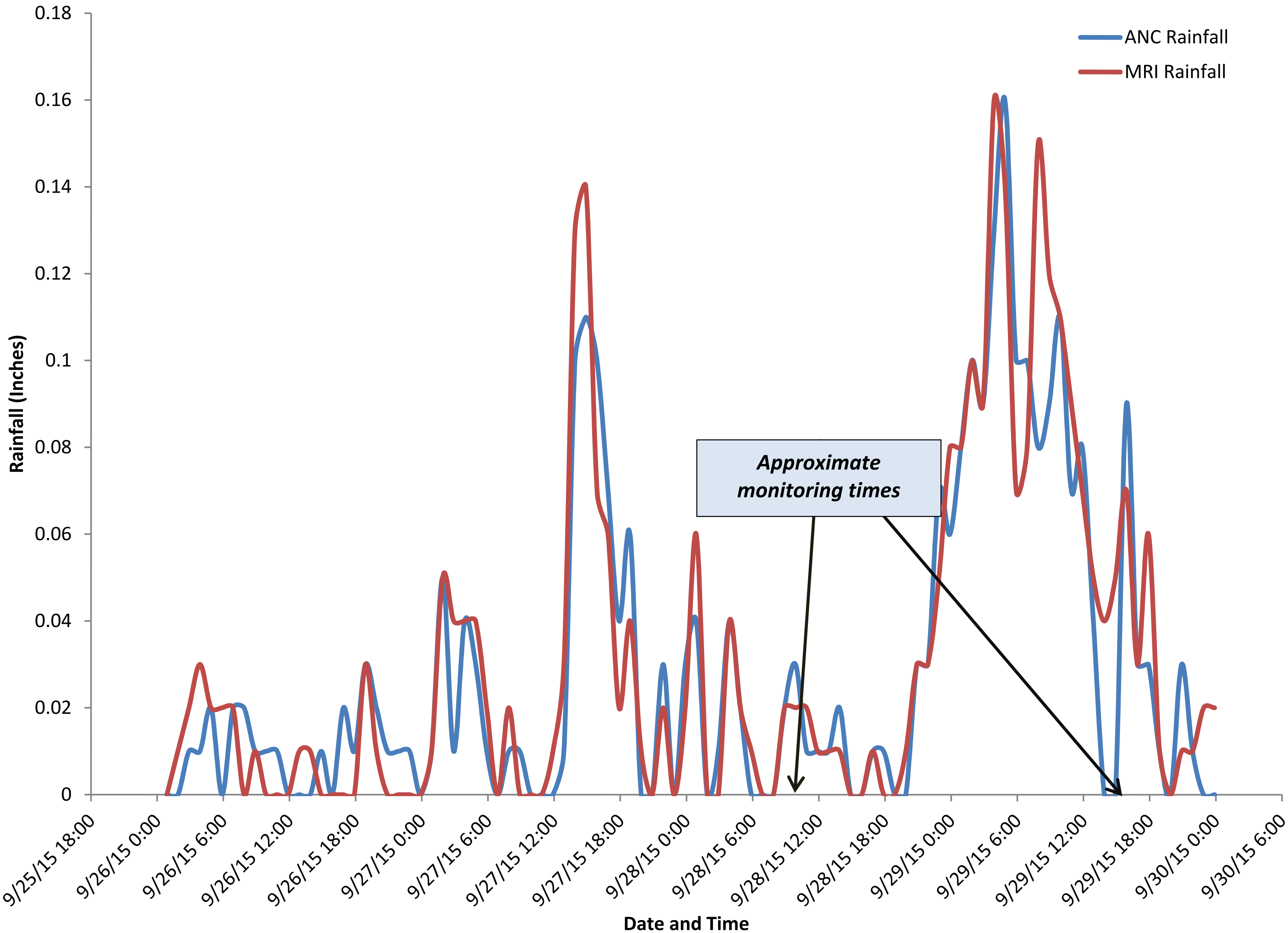


Figure 3: Event 2 September 26-29, 2015 Rainfall Hyetograph



3. West Dowling Road Phase I – Bioswale (ADOT&PF)

Dowling Road is an east-west roadway in Anchorage, connecting Elmore Road to Minnesota Drive. The West Dowling Road Extension Phase I project was constructed in 2012 and widened the corridor from the Old Seward Highway (OSH) to C Street from a two-lane road to a four-lane road with a center median. The project also constructed new pedestrian facilities and drainage improvements. The project lies in the Campbell Creek Watershed and crosses Campbell Creek via a bridge between Potter Drive and the OSH.

The West Dowling Road Phase I project included several LID/GI features, but the focus of the 2015 monitoring program was the project's large bioswale located on the north side of the road, east of the OSH. Based on review of the project's design documents and on observations from site visits, the functional area of the swale is estimated to be 2,800 square feet with a gentle longitudinal slope of less than one percent. The swale was constructed of local material which is primarily sands and gravels according to the project geotechnical report.

Stormwater runoff from approximately 17.4 acres of residential and industrial areas is directed to the swale via a series of storm drain collection pipes that outfall at various locations along the length of the swale. The primary purpose of the bioswale is to improve water quality before the runoff enters Campbell Creek. Treatment is achieved via infiltration, transpiration, and filtration to remove sediment and associated pollutants. This bioswale was also included in the MOA's 2013 LID monitoring program, and was found to also be providing attenuation of peak flows for lower rainfall events, generally less than the 10-year event. An overview of the swale site is presented in Figure 4.

Figure 4: West Dowling Bioswale Site Overview

3.1. Visual Monitoring Results

The bioswale was visually monitored during each of the storm events discussed in Section 2 of this report. Generally, the bioswale was observed to be performing well. The vegetation lining the sides and bottom of the bioswale has fully matured, improving performance from 2013 observations.

During the observations on September 12 and September 28, water was slowly and steadily entering the bioswale from four of the five storm drain outfalls that discharge to the swale. Water was ponding on the swale bottom and slowing trickling toward the swale outlet. Figures 5 through 8 provide an overview of the swale and photos of the outfalls. The slow movement of water through the existing vegetation allows sediment to fall out of the water. It was noted that most of the grassy vegetation is being mowed and kept very short. One outfall was observed to be partially blocked by vegetation, but did not appear to be causing any problems. Water downstream of the bioswale was observed to be ponding on the surface instead of flowing into Campbell Creek, allowing for additional treatment potential.

During the site observations on September 29, the swale was observed to be holding significantly more water than previous site visits. The water was flowing more rapidly, though still fairly slowly, toward the outlet. The water was observed to be more sediment-laden than in previous site visits, as evident by the water color. The swale outlet was flowing steadily. Downstream of the outlet, water was flowing into Campbell Creek, though it was bypassing the intended flow route and entering the creek by flowing under the embankment riprap. This is not expected to be problematic and did not appear to be causing erosion issues.

Additional information from the visual monitoring is presented in the Site Monitoring Reports in Appendix B.

Figure 5: Bioswale Overview 9/28/15

Figure 6: Bioswale Overview on 9/29/15

Figure 7: Outfall Discharging to Bioswale

Figure 8: Vegetation Blocking Outfall

Figure 9: Bioswale Outlet

3.2. Summary and General Recommendations for Future Projects

- Bioswales remain one of the most versatile GI applications for Anchorage. They tend to be successful in a variety of site conditions and require minimal maintenance.
- The vegetation in this bioswale is kept very short. General bioswale performance related to both attenuation of peak flows and sediment/pollutant removal is expected to be improved if vegetation along the swale bottom and lower edges were allowed to grow and become more established. However, care

should be taken to ensure that vegetation does not block flow from the storm drain outfalls into the swale, which could cause upstream flooding (see next bullet). There is a variety of vegetation that can be selected based on maximum height, minimizing the need for extensive vegetation maintenance. This approach would reduce maintenance costs while increasing the performance of the bioswale.

- Care should be taken to ensure that vegetation does not block inflow to the facility, which could result in upstream flooding issues. This could be resolved by keeping tall vegetation away from the areas immediately surrounding outfalls, or by placing outfalls vertically higher than the flow line of the swale. Placing outfalls higher than the flow line may also help reduce drainage problems if the swale flow line aggrades over time due to sediment deposition and vegetation. Storm drain outfall elevations and the elevation of the swale may be limited by existing pipe elevations, the elevation of the downstream receiving system, and the groundwater table elevation.

4. Muldoon Road Pedestrian and Landscape Improvements (ADOT&PF)

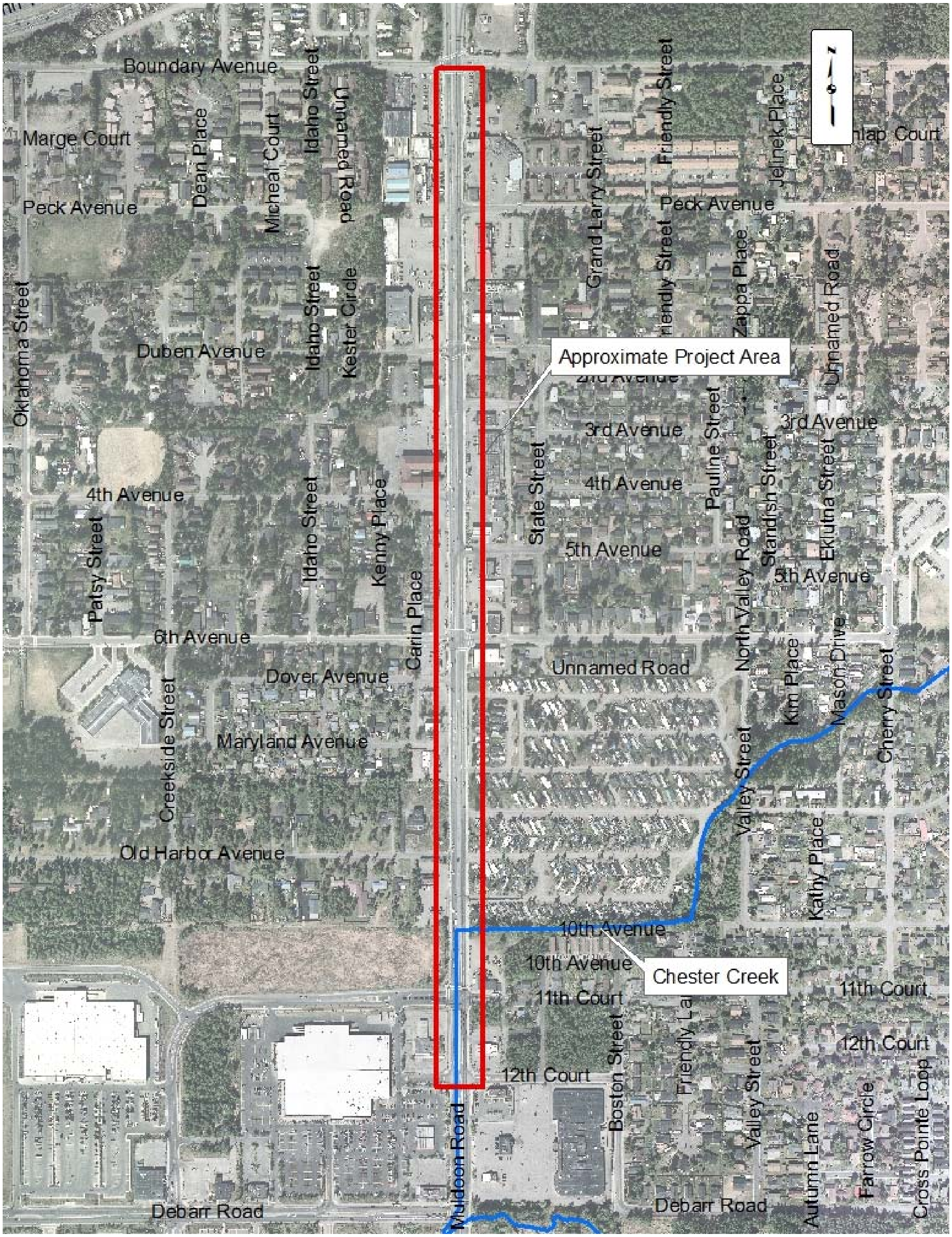
The Muldoon Road Pedestrian and Landscaping Improvements project was designed to provide safer pedestrian facilities and install landscape features along Muldoon Road from north of Debarr Road to south of the Glenn Highway interchange in Anchorage. The project was constructed in three phases, and the final phase was completed in 2012. See Figure 10 for an overview of the project area.

The project corridor is surrounded primarily by commercial and industrial areas that are largely impervious. The project’s LID technique was to reduce impervious cover in the project corridor through the use of landscape features. Before the project was constructed, all runoff from the project corridor flowed directly to the local storm drain system and was then discharged to nearby Chester Creek, which is an impaired water body.

The landscape features installed for this project were designed to fit into available space between the roadway’s drivable surface and the edge of the right-of-way (ROW). Based on information obtained from the project’s design documents, the landscape planting beds used a variety of trees, shrubs, and flowers planted in free-draining top soil. The surrounding surface was topped with wood-chip based mulch. The landscape features also included decorative walls of various sizes.

This project was included in the MOA 2013 LID monitoring program, and was generally found to be moderately successful at reducing peak flows from smaller rainfall events. In 2013, the vegetation was in need of maintenance, and topsoil and mulch in the area were subject to erosion issues. Performance was found to be reduced by the inclusion of impervious landscape walls, which added additional runoff and in some cases, blocked flow from adjacent impervious areas from entering the landscape beds.

Figure 10: Muldoon Landscaping Project Overview



4.1. Visual Monitoring Results

This site was visually inspected during the September 12 storm event. Inspection was not repeated because AWR found that only limited performance data of the landscaped areas could be obtained through visual inspection. Generally, the facility appeared to be performing the same or better than it was in 2013. The vegetated areas were largely unkempt, and some of the planted vegetation appeared to be missing. However, the planted areas were relatively well-vegetated with grasses and other “weeds.” While this is not aesthetically ideal, it is expected to have improved stormwater treatment performance by increasing transpiration and reducing runoff. A comparison of vegetation from 2013 to today is shown in Figures 11 and 12 below. Decorative walls were still in place and continue to block flow paths and increase runoff.

4.2. Summary and General Recommendations for Future Projects

Utilizing vegetation and landscape features for stormwater treatment is an excellent way to achieve on-site GI treatment without requiring additional site space. The following list summarizes key changes that future projects could incorporate for improved performance of landscape features as stormwater treatment facilities.

1. Design the landscape features to accept stormwater runoff from the surrounding areas. If the landscape features are small, performance could be enhanced through installation of a subdrain pipe that connects to a storm drain system or other downstream receiving system. This would allow the landscaping to accept water from a larger area, maximizing treatment benefits and providing some detention.
2. Include a freeboard depth and an overflow mechanism that would prevent erosion of the topsoil and mulch during large flow events. Provide thorough vegetative cover to help stabilize the soil and maximize transpiration benefits.
3. Omit landscape walls since they can actually impede drainage and add impervious surface.
4. Require regular maintenance of the top soil and mulch to ensure that it does not clog due to winter sanding.

Additional information from the visual monitoring is presented in the Site Monitoring Reports in Appendix B.

Figure 11: 2013 Landscape Areas

Figure 12: 2015 Landscape Areas

5. New Seward Highway Improvements – Dowling to Tudor (ADOT&PF)

The New Seward Highway (NSH) is located in Anchorage and serves as one of the city's primary north-south highway corridors. The New Seward Highway Improvements – Dowling to Tudor project, constructed from 2013-2014, expanded the existing highway corridor from four lanes to six lanes and reconstructed portions of the frontage roads. The majority of the project lies in the Campbell Creek watershed, and the highway crosses Campbell Creek via a bridge located north of International Airport Drive and south of Tudor Road. A small portion of the Tudor-NSH intersection lies within the Fish Creek watershed. Fish Creek crosses Tudor Road. via a piped storm drain near this intersection. Both Campbell Creek and Fish Creek are listed as Impaired Water Bodies in the APDES permit.

This project incorporated several types of GI/LID treatment, including vegetated swales with check dams and an infiltration basin. The infiltration basin was the focus of the 2015 monitoring program. The infiltration basin is located near the intersection of Brayton Drive and Alpenhorn Avenue, and is collecting stormwater runoff from approximately 9.4 acres, 6.7 of which is impervious surface. The retention basin is approximately 150 feet long and 45 feet wide, with gentle side slopes and an approximate average depth of two feet. The basin is vegetated with grasses, and riprap is present near the inlet and outlet. The basin inlet is a 24-inch diameter culvert on the southwest side of the basin, and the outlet is a small earthen berm on the north side. The outlet berm is overtopped when the inflow exceeds the basin capacity. The infiltration basin was designed to capture and infiltrate the runoff generated from the water quality event (0.52 inches of rain in 24 hours). Larger events were designed to overflow from the pond to a vegetated ditch that discharges to Campbell Creek.

The infiltration basin's contributing area is comprised of the highway, the highway frontage roads, and the surrounding ditches and medians. Based on the project's Drainage Analysis Report, the topography of the contributing area is fairly flat, with average slopes of approximately 0.3 percent. Water is routed to the infiltration basin via a series of pipes and vegetated ditches. And overview of the infiltration basin site is shown in Figure 13.

Figure 13: NSH Site Overview

The infiltration basin was included in the MOA 2014 monitoring program and was found to be performing very well. The basin was able to fully infiltrate most regular storm events, and provided attenuation of peak flows from larger events. This performance was observed despite the fact that the basin was used as a sediment trap during construction, and sediment was not removed prior to the facility being placed into service.

5.1. Visual Monitoring Results

For the 2015 monitoring program, the infiltration basin was visually inspected during each of the monitoring events discussed in Section 2. Generally the infiltration basin was observed to be performing well and exceeding design expectations. The basin continues to fully capture small to moderate storm events while providing detention of peak flows from larger events.

During the September 12 site visit, water was flowing into the facility via the culvert inlet, and the basin was storing a small amount of water on the basin floor. The outlet was not flowing, indicating that all inflow was being either infiltrated or stored. Similarly, on the September 28 site visit, water was flowing into the facility, but the outlet was not flowing. The basin was holding significantly more water than was previously observed. Standing water depths were approximately 13 to 15 inches. Generally, this indicates that the facility was still infiltrating and storing all of the basin inflow. The September 12 event was generally close to the rainfall event the facility was designed for. However, the rainfall that occurred from September 26 to September 28 was approximately 1.41 inches (based on ANC date), which exceeds the design event in both magnitude and duration.

The site was visited again on September 29, following an additional 1.43 inches of rain in 24 hours. During this site visit, both the inlet and outlet were actively flowing, and water depth was estimated to be approximately three inches over the outflow weir.

Figure 14: Infiltration Basin Outlet (left) and Inlet (right)

Figure 15: Infiltration Basin 9/28/15

Figure 16: Infiltration Basin 9/29/15

5.2. Summary and General Recommendations for Future Projects

- Design for potential failures. Infiltration basins have received criticism for general use in Anchorage, and many designers and developers have been wary of their performance due to factors such as sediment-laden inflow, slowly infiltrating soils, lack of ability to infiltrate large storms, and decreased performance when soils are frozen. The NSH infiltration basin provides an excellent example of how these concerns can be addressed and accounted for in the facility design.
    - The facility is designed to accept stormwater from small events and provides a safe overflow for any inflow that the basin cannot store or infiltrate. This addresses concerns for both large storm events and frozen conditions.

  - Some upstream pre-treatment for sediment is provided by the vegetated swales that direct water to the facility. There is no other sediment pretreatment in the design, and as discussed, the facility was used as a sediment trap during construction. While this is not a recommended practice, the facility's subsequent success indicates that sediment deposition does not always render a facility unusable.
  - Design documents for this basin report that two percolations tests were performed during the design process with average results of 2.1 inches per hour and 6.3 inches per hour. These are slow to moderate infiltration rates, yet the facility is exceeding design expectations.

- ~ Provide Vegetation. This infiltration basin is fully vegetated, which is anticipated to be increasing its performance. The vegetation is grass that is not mowed, and is estimated to about 12 inches tall. The vegetation is promoting infiltration by keeping the soil from becoming overly compacted and by providing additional transpiration. It also prevents erosion.

- ~ Keep it Shallow. This basin is designed such that the maximum depth is approximately two feet. This ensures that the soils under the basin are not compacted by the weight of the water in the basin, which would reduce the infiltrative capacity of the basin.

Additional information from the visual monitoring is presented in the Site Monitoring Reports in Appendix B.

6. Russian Jack Springs Park Parking Lot (MOA)

The Russian Jack Spring Park (RJSP) parking lot is located at 821 Pine Street in Anchorage, which is south of 6th Avenue, and north of Debarr Road. The parking was retrofitted in 2012-2013 to provide improved parking and safer pedestrian facilities for park users. The project was a joint effort between WMS and the MOA Parks and Recreation Department (Parks). The RJSP parking lot is used in the summer months for access to the softball fields located north and south of the parking lot and the soccer fields to the east. It is also used year-round for access to the park's popular trail system. The parking lot LID features include porous asphalt and an underground infiltration gallery. The parking lot layout is shown n Figure 17.

Porous Asphalt. Portions of the parking lot are constructed with porous asphalt. Rain water that falls on these areas flows through the asphalt into a subsurface rock storage area. Water is stored here and slowly infiltrated as capacity becomes available. Two of the three porous asphalt sections were installed with a perforated subdrain near the top of the asphalt's structural section. Figure 18 shows a schematic of a typical porous asphalt section. One section was installed without the subdrain in order to compare the performance of the two types. The porous asphalt was designed to store and infiltrate up to the 10-year, 24-hour rainfall event. In the event that the asphalt's structural section should become filled with water in excess of this amount, water would be collected in the subdrain pipe and directed away from the asphalt. The subdrain pipes are routed to the subsurface infiltration gallery via an on-site storm drain system.

Infiltration Chambers. Water that falls on the traditional asphalt is directed to a subsurface infiltration chamber facility via traditional stormwater conveyance piping. The chambers are designed to store and infiltration up to the 100-year, 24-hour event. Figure 20 shows a schematic of a chamber system typical section.

Figure 17: RJSP Parking Lot Layout

Figure 18: Typical Porous Asphalt Section

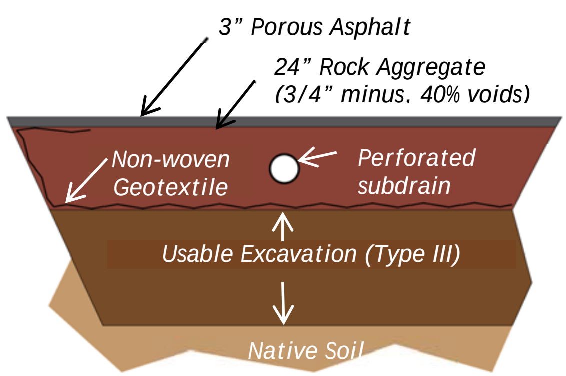
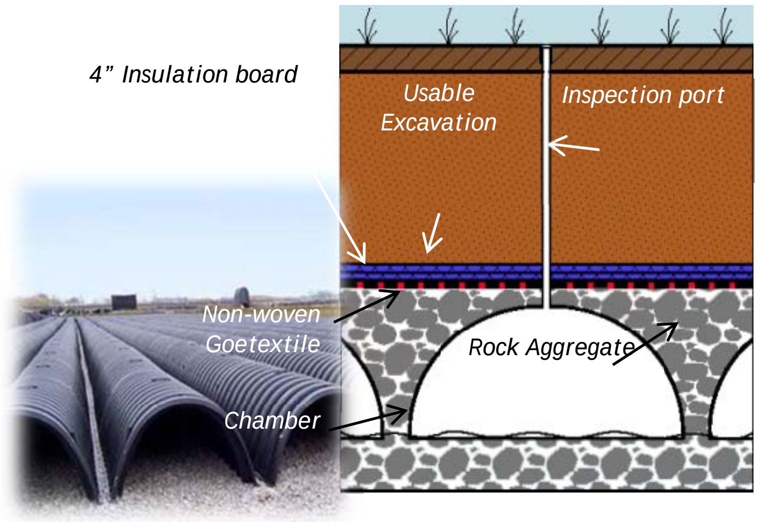


Figure 19: Typical Infiltration Gallery Section



Previous Monitoring. The RJSP parking lot was included in both the 2013 and 2014 MOA LID monitoring programs, and additional information can be found in each year's monitoring report. The 2013 and 2014 monitoring generally found the parking lot to be performing well, but maintenance and general area use has been an ongoing concern for the porous asphalt. Previous concerns that have required mitigation are described below.

- Lack of regular parking lot sweeping has resulted in debris and leaves scattered across the parking lot. As cars drive over these items, they are ground into the pores of the porous asphalt, reducing infiltration capacity. Limited access to vacuum sweepers means the pores are not easily cleaned out once they become clogged.

- Wood chip mulch that was originally placed in the parking lot planting beds became a significant concern, as the mulch was regularly scattered across the parking lot and driven over by local traffic. The wood chip mulch was replaced with rock mulch and this concern was resolved in 2014.

- In 2014, vehicles drove in unauthorized grassy areas on the east side of the parking lot, creating large areas of exposed earth. During rain events, large amounts of sediment were washed onto the parking lot, tracked onto the porous asphalt by local traffic, and carried into the infiltration chambers. This posed a concern for clogging both the asphalt and the infiltration gallery. Traffic access to unauthorized areas was stopped by placing porta-potties to block the access area.

Despite these concerns, previous years monitoring found both the asphalt and the infiltration chambers to be performing well, and the infiltration chambers were found to be exceeding design expectations in 2013 and 2014.

6.1. Visual Monitoring Results

The RJSP parking lot was monitored during each of the three monitoring events discussed in Section 2. The general parking lot performance was similar for each site visit. During all three site visits, the porous asphalt was generally well-drained, with no notable areas of standing water. Standing water on the porous asphalt indicates clogging of the asphalt pores. The interface between the porous asphalt and the traditional asphalt on the north side of the parking lot was showing mild ponding, and some heaving of the parking was visible at the asphalt interface on the west side. (See Figure 20.) The most notable concern observed with the porous asphalt was surface raveling, likely caused by vehicle turning traffic. The parking lot was scattered with small rocks from surface raveling of the porous asphalt. Because the parking lot does not appear to be swept regularly, the rocks are being ground into the asphalt, compounding the raveling problem. This is shown in Figures 21 and 22.

The disturbed area east of the parking lot remained laden with sediment, and vegetation is not re-established. Significant ponding in this area was observed, but flow from this area onto the parking lot appeared to be somewhat lessened compared to the 2014 site conditions. See Figure 23.

Despite these concerns, the porous asphalt appears to still be hydraulically performing at or beyond the design levels. Infiltration under the porous asphalt was checked by measuring water levels in three existing monitoring wells. There is one well in each section of porous asphalt. The monitoring wells showed that water levels remained low in both the central well and the west well. Water levels were notably higher in the north well, indicating slower draining soils in this section. The north well is the only section of asphalt that is not installed with a perforated subdrain as show in Figure 18. However, water levels in the central and west well were not high enough to result in flow through the subdrains based on design elevations, and subdrain flow was not observed during site visits. Water levels in the north well did not appear to be impacting asphalt performance.

Figure 20: Asphalt Interface During Rain

Figure 21: Unraveling of the Porous Asphalt Surface

Figure 22: Loose Rocks Collecting on the Asphalt

Figure 23: Ponding on the East Side of Parking Lot

Water levels in the infiltration chambers were also checked via the chamber's inspection ports and standing water was not observed. This indicates that the chamber system continues to exceed design infiltration expectations.

6.2. Summary and General Recommendations for Future Projects

- Due to the ongoing maintenance and associated performance concerns with the porous asphalt at RJSP, porous asphalt is only recommended for use in areas where consistent, ongoing maintenance can be provided. This should include regular vacuum sweeping. This is particularly true for areas with relatively high traffic volumes, even if the traffic is slow moving, such as a parking lot.
- If porous asphalt is used, the asphalt mix design should be modified to better resist turning traffic movements.
- Avoid mulch or other organic materials as landscaping if the asphalt is located in areas where this material may come into contact with the asphalt pores.
- Subsurface chamber systems have seen success is several locations in Anchorage, including RJSP. They are an excellent choice for locations where protection from freezing is required and/or site surface space is limited.

Additional information from the visual monitoring is presented in the Site Monitoring Reports in Appendix B.

7. Taku Lake Rain Garden (MOA)

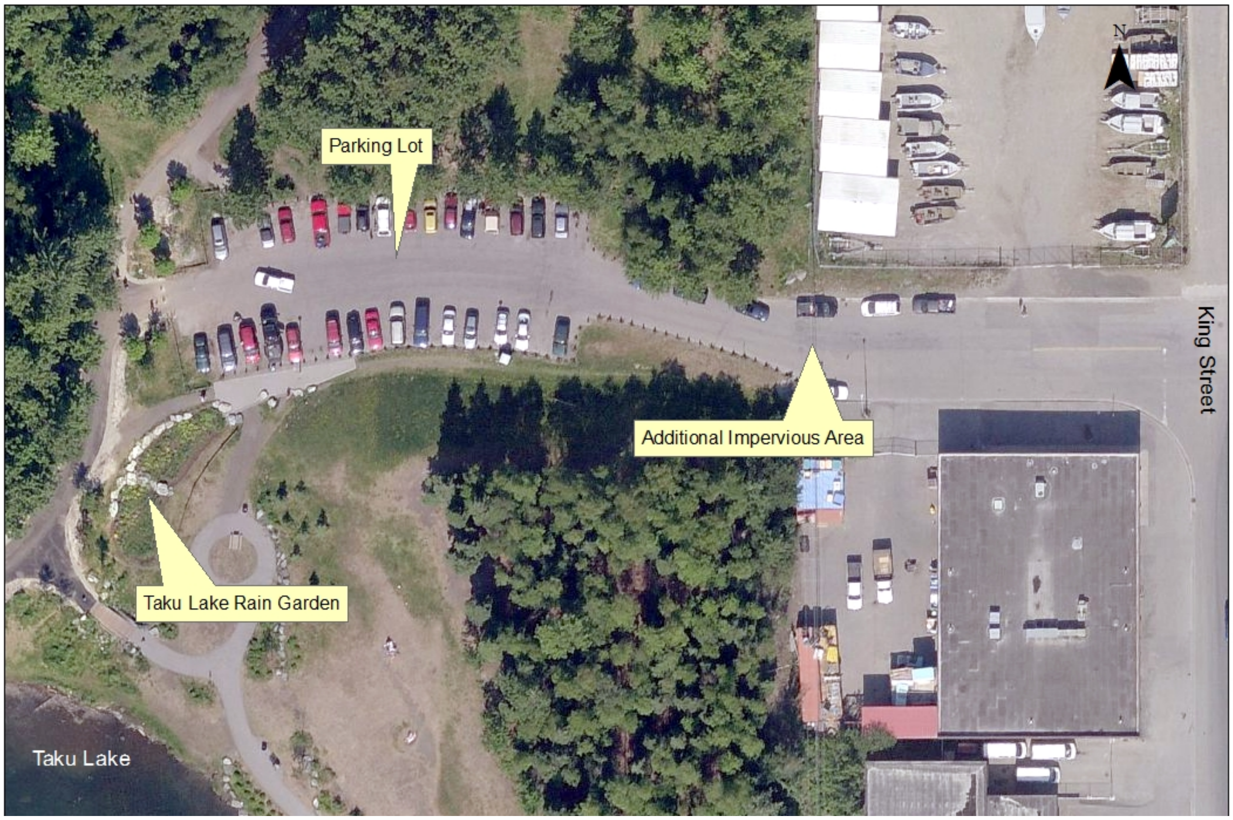
The Taku Lake Rain Garden project was completed by the MOA in 2007 as part of an effort to improve a localized drainage and flooding problem at the Taku Lake parking lot. Taku Lake is located in Anchorage, north of Dimond Boulevard and west of King Street. The Campbell Creek trail is adjacent to the lake, and the area is popular year-round for recreational activities including walking, running, skiing, biking, and remote-control boats. The paved parking lot is approximately 12,150 square feet, and runoff from the parking lot and surrounding area originally flowed directly into Taku Lake via overland flow. The west portion of the parking lot was experiencing localized flooding and seasonal glaciation due to poor grading and drainage. The MOA needed to repair this deficiency and saw an opportunity to concurrently improve the runoff quality and decrease runoff quantity into Taku Lake by incorporating LID into the repair. The MOA designed and constructed a large rain garden on the southwest side of the parking lot to intercept overland flow before it discharges to Taku Lake.

The Taku Lake Rain Garden is approximately 1,400 square feet, and is located approximately 60 feet from the normal edge of water of Taku Lake. The local average groundwater table is approximately five feet below the surface at the rain garden location. The rain garden consists of approximately 1.3 feet of amended topsoil on top of 2.3 feet of large drain rock. The drain rock is surrounded by geotextile separation fabric. A four-inch diameter perforated drain pipe was installed one foot from the bottom of the rain garden to collect excess water that is not infiltrated into the native subgrade. The perforated drain pipe discharges at the west end of the rain garden near the edge of Taku Lake. The MOA planted a variety of native vegetation in the rain garden including wildflowers, ferns, and grasses. The perimeter of the rain garden is lined with large rock boulders. The rain garden has approximately one foot of surface freeboard.

The rain garden was designed to accept and infiltrate runoff from smaller, more frequent rainfall events. Water beyond the design capacity is either collected in the subdrain or is allowed to overflow from the rain garden and flow into the lake via overland flow. Figure 24 below shows the rain garden and its contributing area.

The rain garden was monitored as part of the 2013 and 2014 MOA monitoring programs and was found to be performing very well. The rain garden was consistently infiltrating small, frequent rain events with no flow out the subdrain. For larger rain events, the rain garden provided water quality treatment as well as some attenuation of peak flows by infiltrating water through the rain garden soils prior to discharge. During larger events, excess water was observed to flow out the subdrain to Taku Lake.

Figure 24: Taku Lake Rain Garden Site



7.1. Visual Monitoring Results

Visual inspections of the Taku Lake rain garden were completed during each of the rain events discussed in Section 2.

The monitoring results showed that the rain garden is performing well. It continues to provide infiltration and storage for small rain events, and filtration and detention of larger events. During each monitoring event, concentrated flow from the parking lot was observed flowing into the rain garden on the garden's northeast side. The volume of this flow was fairly heavy during the September 29 site visit. Outflow from the rain garden's underdrain was only observed during the site visit on September 29. September 29 was also the only time that surface ponding was observed in the rain garden, on the upstream side near the inlet.

The vegetation in the rain garden was somewhat overgrown with grasses, small trees, and other plants that have taken root there. Near the inlet, some of the thick vegetation was observed to be lying flat, potentially from wildlife bedding. The thick, fallen vegetation tended to cause the surface ponding near the inlet, as water was unable to quickly penetrate the fallen leaves.

Site visit photos are shown in Figures 25 through 28. Additional information from the visual monitoring is presented in the Site Monitoring Reports in Appendix B.

7.2. Summary and General Recommendations for Future Projects

- Similar to bioswales, rain gardens continue to be one of the most widely used and versatile GI tool for use in Anchorage. They can be easily incorporated into landscaping features and can take a variety of shapes and sizes.
- A key design feature of this rain garden is the use of an overflow mechanism for larger storm events. This facility includes an underdrain that keeps water moving if the rain garden's infiltration and storage capacity is exceeded. It also includes an earthen berm that would provide surface overflow if excess surface ponding should occur. This has not been observed, and ponding levels in the rain garden have not been observed to exceed a few inches near the inlet.
- Vegetation in this rain garden is mature and has become relatively low maintenance. There are a wide variety of plant types in this rain garden, which help keep it both aesthetically pleasing and low maintenance. Overgrown vegetation is not expected to be problematic for hydrologic performance as long as large trees are not allowed to grow in the rain garden. Generally, most types of vegetation provide increased evapotranspiration and deeper roots for improved infiltration.
- The ratio of contributing impervious area to rain garden area to is approximately 15:1. While this low ratio is not always achievable, it may help improve facility longevity.

Figure 25: Taku Lake Rain Garden

Figure 26: Concentrated Flow from the Parking Lot 9/28/15

Figure 27: Ponding Near the Inlet 9/29/15

Figure 28: Subdrain Flow 9/29/15

8. Holiday Gas Station on Old Seward (Private)

The Holiday Gas Station located on the Old Seward Highway (OSH) just north of the intersection of the OSH and O'Malley Road utilizes a landscaped area for treatment of stormwater runoff from the facility parking lot and roof. While design details for this facility were not available, the landscaped area appears to be a rain garden with an impermeable liner. The liner is visible along the edges of the facility, and because the runoff is coming from a gas station, an impermeable liner would be required to avoid potential petroleum contamination to the groundwater table. The facility lot is approximately 1.5 acres and the lined rain garden is roughly 1,970 square feet. The site is sloped toward the rain garden, and the rain garden is collecting runoff from most of the lot. A small portion of the paved driveway area drains directly to the OSH. The rain garden is surrounded by traditional curb, and appears to be filled with top soils, rocks, and sparse grass-like vegetation. Runoff enters the rain garden via a curb cut along the west side. Figure 29 shows an overview of the rain garden site.

Figure 29: Holiday Gas Station Site

8.1. Visual Monitoring Results

Visual inspections of the Holiday Gas Station were completed on September 12 and September 28th. Based on observations made on September 28, a visit on September 29 was determined to be unnecessary. Generally, the facility did not appear to be functioning well.

During the September 12 and September 28 site visits, sheet flow from the parking lot was observed to be collecting in the facility curb line and flowing into the rain garden via the curb cut. Flow from the parking lot had a visible oil sheen. The rain garden facility was filled to capacity and, on the September 12 site visit, was overflowing the curb on the north side. Water was ponded in the facility at depths ranging from 9 to 12 inches. Water that overflowed the facility was discharged into the curb line on the OSH and flowed north along the OSH ROW. There did not appear to be a designated facility outlet. The lined rain garden did not appear to have an underdrain, or if an underdrain was present, it appeared to be clogged or otherwise not functioning. The facility appeared to be acting as a basin with no outlet, and, because the impervious liner prevents infiltration, it did not appear to have a way to drain between rainfall events. Without an underdrain, the facility presents little to no treatment benefits. Once the basin is filled, it also provides no detention benefit, as water simply flows in and then overflows. Photos of the facility are provided in Figures 30 through 32.

Additional information from the visual monitoring is presented in the Site Monitoring Reports in Appendix B.

Figure 31: Holiday Rain Garden Overview

Figure 30: Holiday Rain Garden Inlet

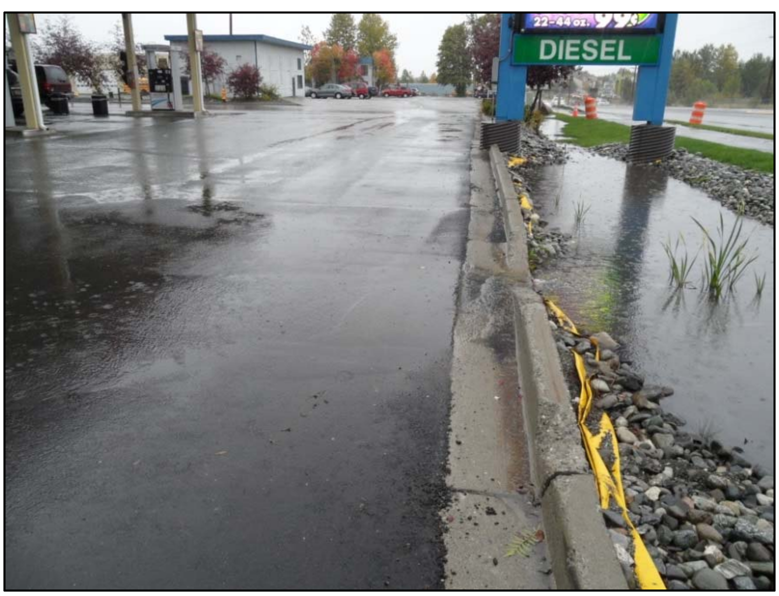


Figure 32: Overflow Along North Side of Holiday Rain Garden

8.2. Performance Summary and Recommendations for Future Projects

- Using a rain garden as treatment for hotspot runoff is a good concept. When rain gardens are properly designed and constructed, they can provide excellent water quality treatment for petroleum-contaminated runoff.
- This facility appears to be fully lined with an impermeable liner, and as such, should include an underdrain. The underdrain would collect water after it is filtered through the soil media and plants, and discharge it to an approved location, such as a storm drain system. The underdrain should include cleanouts or other means of access to provide maintenance access and prevent clogging.
- The facility would benefit from an approved overflow/bypass. It is possible that the overflow on the north side of the facility is the design intent, but it was causing ponding near the gas station entrance. This could become a problem during wintertime rain events or during snow melt conditions.
- This facility would benefit from additional vegetation. Vegetation promotes evapotranspiration and helps provide additional stormwater treatment.
- This facility has an estimated ratio of impervious surface to treatment area of approximately 33:1. This high ratio may have contributed to the poor performance and/or potential clogging of an underdrain, if one is present.

9. McDonald's/Taco Bell on Old Seward (Private)

The McDonald's and Taco Bell restaurants located on the OSH just south of 88th Ave share a drainage system that utilizes landscaping and vegetated swales to collect, treat, and convey stormwater from the restaurants' parking lots and walkways. The system may also be collecting water from the building roof tops, but this was not clear from visual inspection. Together, the total site area is approximately 1.9 acres and the two restaurants have approximately 1.24 acres of asphalt parking lots and concrete walkways. Rooftops add another 8100 square feet (0.2 acres) of impervious surface, but it is not clear where the rooftop drainage is discharged. Runoff from the parking lot and walkways is generally directed to the north or the west and collected in landscape planters and a large grassy swale around the western perimeter of the site. The landscape features are connected to the grassy swale, and the swale has a central storm drain overflow inlet at its low point that is raised above the flow line. This inlet would provide overflow in the event that the swale capacity is exceeded. A site overview is provided in Figure 33.

Figure 33: Taco Bell/Mc Donald's Site Overview

9.1. Visual Monitoring Results

Visual inspections of the Taco Bell/Mc Donald's site were completed during each of the rain events discussed in Section 2. The system was generally found to be performing very well.

During each site visit, water from the parking lots and walkways was observed to be flowing via overland flow to the parking lot perimeter and into the landscaping and grassy swales via curb cuts and perforated drains. (See Figures 34 and 35.) Generally, the curb cuts appeared to be much more effective, as the drains were partially clogged and flowing slowly. The number of curb cuts significantly exceeds the drains, and it is expected that drains were used only in locations that curb cuts were determined to be not feasible for traffic reasons.

The vast majority of the site was very well-drained. Landscaped areas and the large vegetated swale were taking in large quantities of runoff and effectively providing infiltration and filtration. The swale provided a slow movement of water toward the swale's center low point where there appears to be two storm drain inlets. One is at the lowest point, and one is elevated above the flow line. However, the one at the lowest point was not flowing. This beehive-style casting is either not connected to a piped system, or is blocked by an old sediment trap or something similar. Flow was observed to be ponding in this area. When ponding becomes roughly 8 inches deep, the elevated storm drain begins to flow. This was observed only during the September 29 site visit. These observations indicate that the facility is providing both stormwater treatment through infiltration and filtration, as well as significant reduction in peak flows through onsite storage. Site photos are provided in Figures 34 through 37. Additional information from the visual monitoring is presented in the Site Monitoring Reports in Appendix B.

Figure 34: Curb Cuts Draining to Landscaping

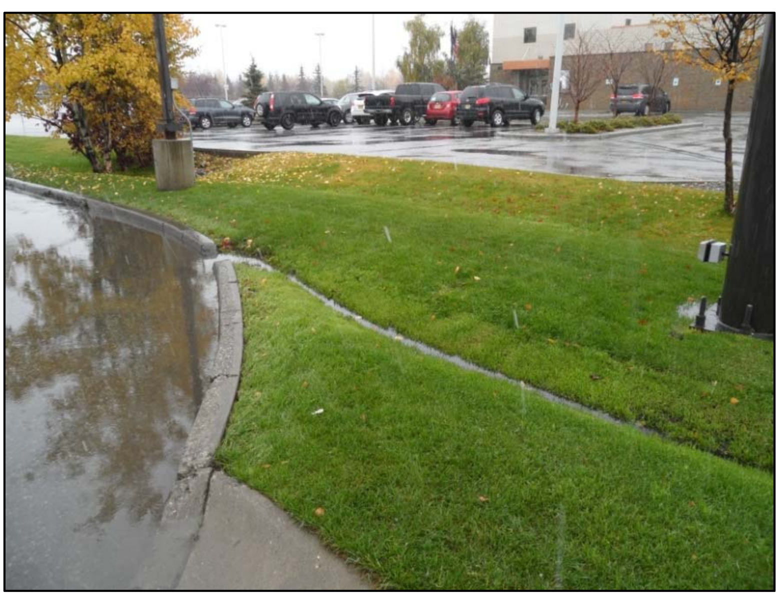
Figure 35: Vegetated Swale

Figure 36: Ponding in Swale Low Point

Figure 37: Elevated Storm Drain Inlet

Notable ponding on impervious surfaces was observed in one location, at the south end of the Mc Donald's drive through. In this area, runoff is directed to a small swale and a culvert that passes under a pedestrian walkway. The small swale connects to the larger vegetated swale on the west side of the facility, but was generally not graded well to provide positive drainage. Ponding in the drive-through area is required in order for water to obtain enough head elevation to flow through the culvert. This could be easily fixed by lowering the elevation of the small swale and the pathway culvert. As it is, the ponding water did not appear to be causing adverse impacts. This area is illustrated in Figure 38.

Figure 38: Ponding and Swale at Mc Donald's Drive Through



The effectiveness of the landscaping to treat and store stormwater was observed to be reduced in one location by what appears to be an unauthorized pedestrian pathway located near the intersection of the OSH and 88th Ave. This pathway cuts through the landscaping and through a parking lot curb cut. During higher rain events, water flowing into the curb cut tends to flow down the pathway toward the intersection limiting the quantity of water that flows into the adjacent landscape areas. It appears that someone tried to correct this issue by creating a small depression in the pathway, which slows the flow of water and allows more water to enter the surrounding landscape. This issue could also be fixed by filling in the pathway and extending the decorative fencing to block pedestrian access through the landscaping. The pathway area is illustrated in Figure 39.

Figure 39: Pedestrian Pathway Drainage

9.2. Performance Summary and Recommendations for Future Projects

- This site provides an excellent example of utilizing landscaping and perimeter buffers to effectively treat, manage, store, and convey stormwater onsite. The facility is functioning well, providing excellent stormwater benefits, and still maintaining good site drainage.
- Similar to other successful LID/GI sites in Anchorage, this system is designed to manage small to moderate rainfall events onsite and allow larger flows to exit the system via an overflow inlet to a storm drain. This allows the facility to function and maintains positive site drainage under a variety conditions such as frozen soils or snow melt events.
- The vegetation used by the site is well-maintained, and plants appeared to be healthy. The grass in the large swale was mowed, but was thick which promotes filtration. Although un-mowed grass is generally preferable for stormwater sites, this site demonstrates successful use of mowed grass.
- The site has a low ratio of impervious surface to treatment area. Due to the expansiveness of the site, the proximity to the OSH, and the unknown discharge location for rooftop runoff, this ratio was difficult to determine, but is generally estimated to be between 3:1 and 5:1. This low ratio is partially due to the use of regular site landscaping for stormwater management.

- The GI features of this site have been specifically tailored to this site's conditions, and it is clear from visual inspection that stormwater management was integrated into the site design as opposed to being added as an afterthought. This site shows good coordination between the projects civil designers, drainage designers, and landscape architects. The result is that this site is highly functional for the heavily-used fast food restaurants, provides efficient on-site stormwater management, and is aesthetically attractive.

10. Sites Monitored by the GIWG

The members of the MOA GIWG volunteered to monitor various GI/LID sites around Anchorage during the fall of 2015. The sites monitored were selected by the participants based on geographic location, ease of access, and personal interest in the project performance. Four GIWG members participated and gathered information on the performance of six sites. The participants' results, observations, and recommendations are provided below.

10.1. Westchester Lagoon Rain Garden

<u>Description</u>. The Westchester Lagoon Rain Garden is located on the northwest side of Westchester Lagoon in Anchorage. This small rain garden is intended to accept runoff from a parking lot that provides access to the lagoon and potentially from a portion of adjacent U Street. The parking lot is approximately 7500 square feet of traditional asphalt. The parking lot and the surrounding area are relatively flat. The rain garden is approximately 800 square feet and is located north of the parking lot. It is connected to the parking lot via a small drainage swale.

<u>Observations</u>. This site was visited on August 13, 2015. The weather during the site visit was noted as raining. Rainfall records from ANC and MRI indicate trace amounts of rainfall that day.

During the site visit, ponded water was noted around the rain garden, at the edges of the parking lot and the side of U Street. Sediment and grass appeared to be obstructing flow from entering the rain garden, and water inside the rain garden was not observed. The rain garden vegetation appeared to be healthy, but was somewhat overgrown by weeds and small cottonwood trees.

Notes from the volunteer monitoring are included in Appendix C.

<u>Summary and Recommendations</u>.

- The rain garden and drainage swale from the parking lot are in need of maintenance. In areas where grades are particularly flat, ongoing maintenance is required to ensure that GI facilities continue to function as needed to maintain positive drainage. These observations were made following during a light rain event. During a heavier rain event with more runoff generated, it is not known if water would be able to overcome the sediment build up and flow into the rain garden.
- Vegetation maintenance is important to facility longevity. Species like cottonwoods can be damaging to rain gardens by harming other plants and causing root interference with subdrains or liners.

Figure 40: Westchester Lagoon Rain Garden and Parking Lot

Photo credit: Patricia Joyner, GIWG

10.2. Commercial Fishing and Agriculture Bank Rain Garden

Description. The Commercial Fishing and Agriculture Bank (CFAB) rain garden was constructed in 2009 as part of an expansion and remodeling project for the CFAB building. WMS partnered with the CFAB owners and provided a portion of the rain garden funding through the MOA Rain Garden Program. The project is located at the corner of Lakeshore Drive and Wisconsin Avenue, near Spenard Road in Anchorage. The project site is in the Fish Creek watershed, which is cataloged as an impaired water body. This project was included in the MOA 2013 LID monitoring program.

The rain garden utilizes the site's landscaping to capture and infiltrate stormwater. It is designed to capture stormwater runoff from the approximately 11,000 square-foot parking lot and from approximately 2,600 square feet of the building roof. Smaller events are generally captured by the rain garden, and larger flows are discharged to an adjacent municipal storm drain via a bee-hive inlet in the center of the garden. Some volume reduction and attenuation of peak flows is also provided for larger rain events. The 2013 monitoring program found the rain garden to be performing well.

Observations. This site was visited at 4 pm on September 15, 2015. Rainfall data from ANC reports 0.94 inches of rain that day with significant amounts of rain in the preceding three days. Weather conditions were reported as steady rain during the site visit.

It was noted during the site visit that the landscape vegetation looked healthy. The facility appeared to be well-maintained. Some water was entering the rain garden area, as noted by small amounts of ponded water inside the facility, as shown in Figure 41. The parking lot appeared to be well-drained. However, flow into the rain garden area appeared to be restricted in some locations by a decorative landscape edging. It was noted that facility performance would likely be increased if the edging were removed. The landscape edging is shown in Figure 42.

Notes from the volunteer monitoring are included in Appendix C.

Summary and Recommendations.

The facility is a great example of incorporating landscaping into stormwater management features and keeping those facilities well-maintained. However, the success and optimal performance of these types of GI facilities can often be impacted by small things, such as the landscape edging in this situation. Providing an unobstructed flow path would improve facility performance and should be noted for future landscape applications.

Figure 41: CFAB Rain Garden

Photo credit: Kevin Doniere, PLA, GIWG

Figure 42: CFAB Landscape Edging

Photo credit: Kevin Doniere, PLA, GIWG

10.3. Target on C Street Stormwater Pond

Description. The Target Store and the adjacent Cabela's Store on C Street both contribute stormwater to a large stormwater collection pond located in the middle of the two parking lots. This location is not served by a municipal storm drain system, and the pond is thought to be the only stormwater outlet for the contributing area. The contributing area is almost entirely impervious surface and is approximately 30 acres. The entire pond area is approximately 3 acres. Water is directed to the pond via a network of subsurface storm drain pipes and catch basins, as well direct inflow through curb cuts.

Observations. This site was visited at 5 pm on September 15, 2015. Rainfall data from ANC reports 0.94 inches of rain that day with significant amounts of rain in the preceding three days. Weather conditions were reported as light rain following a steady rain event.

It was noted during the site visit that the facility appears to be functioning well, and water fowl were observed to be using pond. Substantial flow was entering the pond via multiple pond inlets, and the pond did not appear to be at or beyond its design capacity. Erosion protection measures were in place in locations where curb cuts and outfalls discharge to the pond, and these seemed to be working well. No erosion was observed. Pond inlets are shown in Figure 43.

It was noted during the site visit that maintenance of the inlets and trash racks was needed, as these areas were holding trash and debris. The pond includes a boardwalk to allow for wildlife observation, and it was noted that the boardwalk is not fully accessible. The walkway to the boardwalk is gravel, making wheelchair access difficult and there is a step up from the walkway to the boardwalk. The step up was not intentional and it was noted that the boardwalk was not level. These issues may be the result of frost heaving.

Notes from the volunteer monitoring are included in Appendix C.

Summary and Recommendations.
This facility demonstrates successful use of a stormwater pond for a relatively large-scale drainage basin with a high percentage of impervious surfaces. Stormwater ponds that maintain a permanent pool of water tend to perform better with larger contributing areas such as this site. This pond is providing both stormwater treatment and storage capacity. It was integrated into the landscape of the area to also provide a visually attractive site and one that can be utilized by wildlife.

Figure 43: Inlets to Target Stormwater Pond

Photo credit: Kevin Doniere, PLA, GIWG

10.4. Grass Creek Village

Description. The Grass Creek Village development in northeast Anchorage is a low-income housing development featuring 1-, 2-, 3-, and 4-bedroom townhouses. The 8-acre development is approximately 75% impervious and utilizes a series of vegetated swales and a stormwater detention pond and to collect, convey, treat, and store stormwater prior to discharge to adjacent Chester Creek. The swales are located between buildings, along the roadway, and separating buildings from Chester Creek. These facilities collect stormwater from residential buildings, parking areas, and roadways. The swales and the detention pond are vegetated with grass. Grass in the residential swales is mowed and maintained to blend into the residential lawn landscape. The vegetation in the detention pond is taller and appears to be un-mowed grass, as shown in Figure 44.

Observations. This site was monitored twice—once at noon on August 9, 2015 and again at 4 pm on September 15, 2015. Rainfall data from MRI (which is closer to this site than ANC) reports 0.26 inches of rainfall on August 9 and 1.15 inches of rain on September 15. The September 15 rainfall event followed two previous days of notable rain. Weather conditions were noted as following a recent rain on August 9 and as raining on September 15.

Generally, this site appears to be functioning well. During the site visit on August 9, it was noted that runoff was being successfully shed from parking lots and buildings, and flowing into the swales and the detention pond. Small amounts of ponded water were present in the detention pond at that time. It was noted that the swale between buildings was holding water instead of conveying it, and it was not clear if this was the design intent. During the September 15 site visit, proper routing of water and good general drainage was noted again. It was also observed that the detention pond was storing significantly more water than the previous site visit, which, given the amounts of rain received prior to the site visits, indicates that it was successfully attenuating peak runoff flows from the site. Generally, the vegetation in both the swales and the detention pond looked healthy, and the facilities appeared to be well-maintained. The condition of the detention pond and one of the swales during each site visit is shown in Figures 45 and 46. Figure 47 shows the swale being used for drainage between buildings and the road.

A field inlet was observed to be receiving some stormwater inflow from adjacent roadway and parking surfaces. The field inlet did not appear to be connected to the municipal storm drain system. It was not clear if this inlet is connected to a piped system that outlets to the pond, or if it is a type of dry well.

Notes from the volunteer monitoring are included in Appendix C.

Summary and Recommendations.
This facility demonstrates successful use of stormwater facilities incorporated into a residential landscape. This is particularly notable because the residential area is higher density apartments with limited space between units. These facilities are using green infrastructure to provide treatment of stormwater flows while still maintaining good site drainage even under higher rainfall events. The area of treatment surface was not readily available for this analysis, so a ratio of impervious surface to treatment area was not computed. However, by incorporating treatment facilities such as vegetated swales throughout the site, the development was able to disperse the runoff from the impervious areas over multiple facilities, maximizing treatment benefits while still maintaining good site drainage.

Figure 44: Detention Pond Vegetation

Photo credit: Mel Langdon, PE, GIWG

Figure 45: Detention Pond on 8/9/15 (Top) and 9/15/15 (Bottom)

Photo credit: Mel Langdon, PE, GIWG

Figure 46: Swale on 8/9/15 (Left) and 9/15/15 (Right)

Photo credit: Mel Langdon, PE, GIWG

Figure 47: Drainage Swale

Photo credit: Mel Langdon, PE, GIWG

10.5. UAA Science Center Parking Garage

Description. The University of Alaska Anchorage (UAA) campus utilizes many GI facilities for stormwater treatment and management, including a series of four bioswales located around the Science Center parking garage. These bioswales are intended to accept runoff from the parking garage surfaces and surrounding walkways and driveways. The swales vary in size and depth.

Observations. This site was monitored once, at noon on August 9, 2015. Rainfall data from ANC and MRI report 0.31 and 0.26 inches of rainfall respectively for August 9. Weather conditions were noted as following a recent rain.

The bioswales' performance varied. In one location, the bioswale was receiving runoff from adjacent areas and appeared to functioning well. In other locations, the bioswales did not appear to be receiving much inflow. It was noted that water from an adjacent sidewalk and plaza area was directed to a catch basin connected to a storm drain system instead of being routed to the bioswale. It was also noted a downdrain from the parking structure appeared to be routed directly to a piped storm drain system instead of flowing onto an adjacent vegetated area. This piped storm drain may outlet to a bioswale downstream, but it was unclear why the runoff was directed into a pipe. Generally, the vegetation looked healthy and well-maintained. Site photos are provided in Figure 48.

Notes from the volunteer monitoring are included in Appendix C.

Summary and Recommendations.
In this facility, a good bioswale design appears to be underutilized by inconsistent site grading and drainage. Although it is not clear why this occurred at this site, underutilization can often result from overlooking GI during initial site layout. GI is generally most successful when it is a central part of the initial site layout and the facility grading and drainage plans.

Figure 48: UAA Science Center Parking Area Bioswales

Photo credit: Mel Langdon, PE, GIWG

10.6. Rogers Park Elementary Infiltration Area

Description. The Roger's Park Elementary School site incorporates surface infiltration areas to collect and infiltrate stormwater runoff from the asphalt parking lot. These infiltration areas are located on either side of the entrance and exit to the parking lot. They are approximately 10ft x 10ft rock patches that extend several feet below grade. The rock area creates pore space below the surface to store runoff and infiltrate it over time.

Observations. Specific details about this site's volunteer monitoring were not available for this report. However, one important observation was made regarding ongoing facility maintenance. This site was visited several times during the fall of 2015 including on September 12, 2015. The September 12 rainfall event is described in Section 2. During visual inspection, it was noted that flow from the parking lot into the infiltration area was being blocked by built-up sediment, grass, and leaves. The GIWG volunteer removed the debris with a hand shovel and noted that the facility began accepting water immediately. This is shown in Figure 49 below.

Figure 49: Rogers Park Elementary Debris Blockage Before (Top) and After (Bottom)

Photo credit: Jonny Hayes, PLA, GIWG

Summary and Recommendations. Ongoing facility maintenance is essential to the function and longevity of GI facilities. Even very small maintenance activities can have a notable impact on facility performance. It is also important to note that the availability of detailed maintenance varies based on facility owner. Designers of GI facilities should be aware of the level of maintenance that the facility is expected to receive and accommodate that in the facility design as much as possible. Small design changes can often greatly reduce the maintenance frequency needed. For example, in the Roger's Park Elementary School site, the elevation of the treatment areas could have been designed to fall away more steeply from the parking lot grade, making it much more difficult for the inlet to be blocked as shown in Figure 49.

11.Conclusion

Green Infrastructure and LID facilities are becoming more and more prevalent for onsite stormwater management in Anchorage, and their use is expected to continue to grow as a result of updated stormwater management requirements. Monitoring results show that GI/LID facilities are most successful when the following general design steps are taken:

1. Choose a facility type that works well with the local site conditions. Consider the size of the development, the amount of surface space available, the ability to connect to a downstream receiving system, the infiltrative capacity of the soil, the location of other utilities, etc. Select GI/LID techniques that can accommodate these site-specific conditions.
2. Incorporate GI/LID into the overall site design from the beginning of the project as much as possible. Ensure that designers across multiple design disciplines are working together on this effort. (E.g. civil engineers and landscape architects.)
3. Consider the ratio of impervious surface to facility treatment area, particularly if no upstream pretreatment for sediment is provided. Although there is not a specific ratio requirement, facilities with lower ratios tend to perform better than those with higher ratios.
4. Ensure that the facility is properly maintained. If frequent maintenance is not going to be available, consider this in the facility design process.
5. Where possible, select vegetation that does not require mowing. Choose plants that are low-maintenance once they are mature.

Appendix A: Rainfall Data

1. Hourly Rainfall Data for Select Storm Events
2. Daily Rainfall Summaries for August and September 2015

Hourly Rainfall Data
National Climatic Data Center
Anchorage International Airport and Merrill Field Airport

Date and Time	ANC Rainfall	MRI Rainfall
9/11/15 0:53	0	
9/11/15 1:53		T
9/11/15 2:53		
9/11/15 3:53		
9/11/15 4:53		
9/11/15 5:53		
9/11/15 6:53		
9/11/15 7:53		
9/11/15 8:53		
9/11/15 9:53		T
9/11/15 10:53	T	0.02
9/11/15 11:53	0.03	0.03
9/11/15 12:53	T	T
9/11/15 13:53	T	T
9/11/15 14:53	T	
9/11/15 15:53	0.02	0.01
9/11/15 16:53		T
9/11/15 17:53		
9/11/15 18:53		
9/11/15 19:53		
9/11/15 20:53	T	
9/11/15 21:53		0.01
9/11/15 22:53	T	T
9/11/15 23:53	T	0.02
9/12/15 0:53	0.01	0.05
9/12/15 1:53	T	0.01
9/12/15 2:53	0.01	
9/12/15 3:53	0.01	
9/12/15 4:53	T	
9/12/15 5:53	0.01	T
9/12/15 6:53	T	T
9/12/15 7:53	0.11	0.02
9/12/15 8:53	0.03	0.04
9/12/15 9:53	0.01	0.01
9/12/15 10:53	0.06	0.01
9/12/15 11:53	0.13	0.08
9/12/15 12:53	0.08	0.05
9/12/15 13:53	0.05	0.01
9/12/15 14:53	0.01	0.02
9/12/15 15:53	T	0.04
9/12/15 16:53	T	0.01
9/12/15 17:53		0.01
9/12/15 18:53		T
9/12/15 19:53		
9/12/15 20:53		
9/12/15 21:53		
9/12/15 22:53		
9/12/15 23:53		

Date and Time	ANC Rainfall	MRI Rainfall
9/26/15 0:53		
9/26/15 1:53		0.01
9/26/15 2:53	0.01	0.02
9/26/15 3:53	0.01	0.03
9/26/15 4:53	0.02	0.02
9/26/15 5:53		0.02
9/26/15 6:53	0.02	0.02
9/26/15 7:53	0.02	T
9/26/15 8:53	0.01	0.01
9/26/15 9:53	0.01	T
9/26/15 10:53	0.01	T
9/26/15 11:53		T
9/26/15 12:53	T	0.01
9/26/15 13:53	T	0.01
9/26/15 14:53	0.01	T
9/26/15 15:53	T	
9/26/15 16:53	0.02	
9/26/15 17:53	0.01	T
9/26/15 18:53	0.03	0.03
9/26/15 19:53	0.02	0.01
9/26/15 20:53	0.01	T
9/26/15 21:53	0.01	
9/26/15 22:53	0.01	
9/26/15 23:53	T	T
9/27/15 0:53	0.01	0.01
9/27/15 1:53	0.05	0.05
9/27/15 2:53	0.01	0.04
9/27/15 3:53	0.04	0.04
9/27/15 4:53	0.03	0.04
9/27/15 5:53	0.01	0.02
9/27/15 6:53	T	T
9/27/15 7:53	0.01	0.02
9/27/15 8:53	0.01	T
9/27/15 9:53		
9/27/15 10:53		
9/27/15 11:53	T	0.01
9/27/15 12:53	0.01	0.03
9/27/15 13:53	0.1	0.13
9/27/15 14:53	0.11	0.14
9/27/15 15:53	0.1	0.07
9/27/15 16:53	0.07	0.06
9/27/15 17:53	0.04	0.02
9/27/15 18:53	0.06	0.04
9/27/15 19:53	T	0.01
9/27/15 20:53	T	T
9/27/15 21:53	0.03	0.02
9/27/15 22:53	T	T
9/27/15 23:53	0.03	0.02

Hourly Rainfall Data
National Climatic Data Center
Anchorage International Airport and Merrill Field Airport

Date and Time	ANC Rainfall	MRI Rainfall
9/28/15 0:53	0.04	0.06
9/28/15 1:53	T	T
9/28/15 2:53	0.01	T
9/28/15 3:53	0.04	0.04
9/28/15 4:53	0.02	0.02
9/28/15 5:53	T	0.01
9/28/15 6:53		T
9/28/15 7:53	T	
9/28/15 8:53	0.02	0.02
9/28/15 9:53	0.03	0.02
9/28/15 10:53	0.01	0.02
9/28/15 11:53	0.01	0.01
9/28/15 12:53	0.01	0.01
9/28/15 13:53	0.02	0.01
9/28/15 14:53	T	T
9/28/15 15:53	T	T
9/28/15 16:53	0.01	0.01
9/28/15 17:53	0.01	T
9/28/15 18:53	T	T
9/28/15 19:53	T	0.01
9/28/15 20:53	0.03	0.03
9/28/15 21:53	0.03	0.03
9/28/15 22:53	0.07	0.05
9/28/15 23:53	0.06	0.08
9/29/15 0:53	0.08	0.08
9/29/15 1:53	0.1	0.1
9/29/15 2:53	0.09	0.09
9/29/15 3:53	0.13	0.16
9/29/15 4:53	0.16	0.14
9/29/15 5:53	0.1	0.07
9/29/15 6:53	0.1	0.08
9/29/15 7:53	0.08	0.15
9/29/15 8:53	0.09	0.12
9/29/15 9:53	0.11	0.11
9/29/15 10:53	0.07	0.09
9/29/15 11:53	0.08	0.07
9/29/15 12:53	0.04	0.05
9/29/15 13:53		0.04
9/29/15 14:53		0.05
9/29/15 15:53	0.09	0.07
9/29/15 16:53	0.03	0.03
9/29/15 17:53	0.03	0.06
9/29/15 18:53	0.01	0.01
9/29/15 19:53	T	T
9/29/15 20:53	0.03	0.01
9/29/15 21:53	0.01	0.01
9/29/15 22:53	T	0.02
9/29/15 23:53		0.02

Date and Time	ANC Rainfall	MRI Rainfall
9/30/15 0:53		T
9/30/15 1:53	T	0.01
9/30/15 2:53	0.07	0.01
9/30/15 3:53	0.05	T
9/30/15 4:53	0.04	T
9/30/15 5:53	0.03	T
9/30/15 6:53	T	T
9/30/15 7:53		
9/30/15 8:53		
9/30/15 9:53		
9/30/15 10:53		
9/30/15 11:53		
9/30/15 12:53		
9/30/15 13:53		
9/30/15 14:53		
9/30/15 15:53		
9/30/15 16:53		
9/30/15 17:53		
9/30/15 18:53		
9/30/15 19:53		
9/30/15 20:53		
9/30/15 21:53		
9/30/15 22:53		
9/30/15 23:53		

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 120 ft. Lat: 61.169° N Lon: 150.028° W

Station: **ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US GHCND:USW00026451**

Observation Time Temperature: Unknown Observation Time Precipitation: 2400

Preliminary	Year	Month	Day	Temperature (F)			Precipitation(see **)					Evaporation		Soil Temperature (F)					
				24 hrs. ending at observation time		at Observation	24 Hour Amounts ending at observation time				At Obs Time			4 in depth			8 in depth		
				Max.	Min.		Rain, melted snow, etc. (in)	Flag	Snow, ice pellets, hail (in)	Flag	Snow, ice pellets, hail, ice on ground (in)	24 Hour Wind Movement (mi)	Amount of Evap. (in)	Ground Cover (see *)	Max.	Min.	Ground Cover (see *)	Max.	Min.
	2015	8	1	78	55		0.00		0.0		0								
	2015	8	2	73	57		0.00		0.0		0								
	2015	8	3	79	54		0.00		0.0		0								
	2015	8	4	78	57		0.00		0.0		0								
	2015	8	5	73	54		0.00		0.0		0								
	2015	8	6	72	57		0.00		0.0		0								
	2015	8	7	77	55		0.00		0.0		0								
	2015	8	8	70	54		0.00		0.0		0								
	2015	8	9	64	58		0.31		0.0		0								
	2015	8	10	68	56		T		0.0		0								
	2015	8	11	69	51		0.00		0.0		0								
	2015	8	12	71	48		0.00		0.0		0								
	2015	8	13	69	47		T		0.0		0								
	2015	8	14	67	50		0.00		0.0		0								
	2015	8	15	60	48		0.15		0.0		0								
	2015	8	16	58	53		0.11		0.0		0								
	2015	8	17	60	52		0.28				0								
	2015	8	18	71	54		0.10		0.0		0								
	2015	8	19	68	51		T		0.0		0								
	2015	8	20	66	46		0.00		0.0		0								
	2015	8	21	64	49		T				0								
	2015	8	22	70	46		0.00		0.0		0								
	2015	8	23	69	50		0.00		0.0		0								
	2015	8	24	66	45		0.00		0.0		0								
	2015	8	25	67	51		T		0.0		0								
	2015	8	26	61	56		0.03		0.0		0								
	2015	8	27	66	48		T		0.0		0								
	2015	8	28	60	41		0.00		0.0		0								
	2015	8	29	56	40		0.00		0.0		0								
	2015	8	30	57	43		0.00		0.0		0								
	2015	8	31	59	41		0.00		0.0		0								
			Summary	67.3	50.5		0.98		0.0										

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 120 ft. Lat: 61.169° N Lon: 150.028° W

Station: **ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US GHCND:USW00026451**

Observation Time Temperature: Unknown Observation Time Precipitation: 2400

Preliminary	Year	Month	Day	Temperature (F) 24 hrs. ending at observation time Max.	Temperature (F) 24 hrs. ending at observation time Min.	Temperature (F) at Observation	Precipitation(see **) 24 Hour Amounts ending at observation time Rain, melted snow, etc. (in)	Flag	Snow, ice pellets, hail (in)	Flag	At Obs Time Snow, ice pellets, hail, ice on ground (in)	Evaporation 24 Hour Wind Movement (mi)	Amount of Evap. (in)	Soil Temperature (F) 4 in depth Ground Cover (see *)	4 in depth Max.	4 in depth Min.	8 in depth Ground Cover (see *)	8 in depth Max.	8 in depth Min.
	2015	9	1	61	42		0.00		0.0		0								
	2015	9	2	63	36		0.00		0.0		0								
	2015	9	3	55	48		0.27		0.0		0								
	2015	9	4	55	48		0.09		0.0		0								
	2015	9	5	57	51		0.01		0.0		0								
	2015	9	6	59	50		T		0.0		0								
	2015	9	7	61	51		0.28		0.0		0								
	2015	9	8	54	51		1.11		0.0		0								
	2015	9	9	62	50		0.06		0.0		0								
	2015	9	10	60	46		0.06		0.0		0								
	2015	9	11	52	42		0.05				0								
	2015	9	12	52	40		0.52		0.0		0								
	2015	9	13	54	38		0.08		0.0		0								
	2015	9	14	53	44		0.28		0.0		0								
	2015	9	15	53	46		0.94		0.0		0								
	2015	9	16	51	41		0.18		0.0		0								
	2015	9	17	45	39		0.61		0.0		0								
	2015	9	18	51	34		T		0.0		0								
	2015	9	19	50	34		T		0.0		0								
	2015	9	20	50	32		0.00		0.0		0								
	2015	9	21	53	33		0.00		0.0		0								
	2015	9	22	54	36		0.00		0.0		0								
	2015	9	23	49	31		0.00		0.0		0								
	2015	9	24	46	28		0.00		0.0		0								
	2015	9	25	47	32		T		0.0		0								
	2015	9	26	43	36		0.27		0.0		0								
	2015	9	27	46	39		0.72		0.0		0								
	2015	9	28	52	44		0.42		0.0		0								
	2015	9	29	46	33		1.56		0.3		0								
	2015	9	30	43	32		0.19		2.5		1								
			Summary	52.6	40.2		7.70		2.8										

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 138 ft. Lat: 61.217° N Lon: 149.855° W

Station: **ANCHORAGE MERRILL FIELD, AK US GHCND:USW00026409**

Observation Time Temperature: Unknown Observation Time Precipitation: Unknown

Preliminary	Year	Month	Day	Temperature (F) 24 hrs. ending at observation time Max.	Min.	at Observation	Precipitation(see **) 24 Hour Amounts ending at observation time Rain, melted snow, etc. (in)	Flag	Snow, ice pellets, hail (in)	Flag	At Obs Time Snow, ice pellets, hail, ice on ground (in)	Evaporation 24 Hour Wind Movement (mi)	Amount of Evap. (in)	Soil Temperature (F) 4 in depth Ground Cover (see *)	Max.	Min.	8 in depth Ground Cover (see *)	Max.	Min.
	2015	8	1	78	56		0.00												
	2015	8	2	72	61		0.00												
	2015	8	3	76	54		0.00												
	2015	8	4	78	56		0.00												
	2015	8	5	71	55		0.00												
	2015	8	6	73	55		0.00												
	2015	8	7	77	55		0.00												
	2015	8	8	69	57		0.00												
	2015	8	9	63	57		0.26												
	2015	8	10	67	57		T												
	2015	8	11	68	52		0.00												
	2015	8	12	70	47		0.00												
	2015	8	13	70	50		0.00												
	2015	8	14	71	53		0.00												
	2015	8	15	61	50		0.09												
	2015	8	16	60	55		0.11												
	2015	8	17	62	54		0.30												
	2015	8	18	73	55		0.17												
	2015	8	19	69	51		T												
	2015	8	20	69	46		0.00												
	2015	8	21	64	51		0.01												
	2015	8	22	72	46		0.00												
	2015	8	23	69	48		0.00												
	2015	8	24	67	44		0.00												
	2015	8	25	69	56		T												
	2015	8	26	66	57		0.04												
	2015	8	27	69	49		0.01												
	2015	8	28	62	43		0.00												
	2015	8	29	58	38		0.04												
	2015	8	30	59	42		0.00												
	2015	8	31	62	42		0.00												
			Summary	68.2	51.4		1.03		0										

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Elev: 138 ft. Lat: 61.217° N Lon: 149.855° W

Station: **ANCHORAGE MERRILL FIELD, AK US GHCND:USW00026409**

Observation Time Temperature: Unknown Observation Time Precipitation: Unknown

Preliminary	Year	Month	Day	Temperature (F)			Precipitation(see **)					Evaporation		Soil Temperature (F)					
				24 hrs. ending at observation time		at Observation	24 Hour Amounts ending at observation time				At Obs Time			4 in depth			8 in depth		
				Max.	Min.		Rain, melted snow, etc. (in)	Flag	Snow, ice pellets, hail (in)	Flag	Snow, ice pellets, hail, ice on ground (in)	24 Hour Wind Movement (mi)	Amount of Evap. (in)	Ground Cover (see *)	Max.	Min.	Ground Cover (see *)	Max.	Min.
	2015	9	1	65	37		0.00												
	2015	9	2	65	37		0.00												
	2015	9	3	56	50		0.23												
	2015	9	4	56	48		0.06												
	2015	9	5	60	52		0.00												
	2015	9	6	61	52		T												
	2015	9	7	63	53		0.05												
	2015	9	8	59	52		0.15												
	2015	9	9	64	51		0.05												
	2015	9	10	64	48		0.05												
	2015	9	11	55	43		0.09												
	2015	9	12	52	43		0.36												
	2015	9	13	56	37		0.30												
	2015	9	14	54	45		0.32												
	2015	9	15	50	47		1.15												
	2015	9	16	51	43		0.27												
	2015	9	17	47	41		0.51												
	2015	9	18	52	35		0.05												
	2015	9	19	53	32		0.00												
	2015	9	20	52	30		0.00												
	2015	9	21	54	31		0.00												
	2015	9	22	56	32		0.00												
	2015	9	23	50	27		0.00												
	2015	9	24	47	25		0.00												
	2015	9	25	52	30		T												
	2015	9	26	44	41		0.19												
	2015	9	27	47	41		0.77												
	2015	9	28	53	46		0.43												
	2015	9	29	48	33		1.63												
	2015	9	30	45	33		0.02												
			Summary	54.4	40.5		6.68		0										

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"s" This data value failed one of NCDC's quality control tests.
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Appendix B: Site Visit Reports

1. Site Visit September 12, 2015
2. Site Visit September 28, 2015
3. Site Visit September 29, 2015

General Information

Number of Sites Visited: 8

Date: September 12, 2015

Taku Lake Rain Garden

Approximate Arrival Time: 11:45 am – Raining

Observations: Rain was falling heavily and it was windy at the time of the site visit. Concentrated drainage was seen flowing from the parking lot to the rain garden. Water was pooling at the inlet. The rain garden underdrain was flowing lightly, and water was also ponding in the vegetation at the outlet so that it was not a free-flowing outlet. Taku Lake was at an average-to-high elevation.

There was no surface water standing or ponding inside the rain garden. Vegetation looks healthy and somewhat overgrown. Some tall grass-like plants have either fallen down or been laid down my wildlife (moose).

Overall, the rain garden looks good.

Water flowing to the rain garden linlet.

Left: Water flow toward the inlet. Right: Ponding at the inlet.

Left: Vegetation inside the rain garden. Right: Underdrain outfall

West Dowling Bioswale

Approximate Arrival Time: 12:15 pm – Raining heavily.

Observations: Water was steadily flowing into the bioswale from 4 of the 5 storm drains that outfall to the swale. At the far west storm drain outfall, vegetation was partially blocking the outfall, causing ponding and back of water in the storm drain pipe. Did not appear to be a problem at this flow rate. There was standing water in the swale that was tricking slowing toward the swale outlet on the east side. Water was flowing slowly into the bioswale outlet pipe. The bioswale vegetation looks good. Overall the system is looks to be performing very well. Inflowing water is slowed down, ponding occurs, and water moves slowly through the vegetation to the outlet.


Overview and storm drain outfall to bioswale.


Inflow to bioswale and ponding at storm drain inflow pipe.

Inflow partially blocked by vegetation.

Bioswale outfall – flowing slowly.

Pacific Rim Properties Parking Lot

Approximate Arrival Time: 1:20 pm -- Raining

Observations: The site was visitied because it was reported to have vegetation accepting runoff from the parking lot. However, upon inspection, water from the parking lot is sloped away from existing vegetation. Storm inlet are collecting runoff. Not considered an LID/GI site.

Parking lot on either side of the building

Holiday Gas Station – Old Seward and O'Malley

Approximate Arrival Time: 1:35 pm - Raining

Observations: The majority of the gas station parking lot is flowing to a rock/vegetation landscaping area adjacent to the OSH. The landscaped area is fairly deep (depth not determined), but was overflowing at the time of the site visit. It is not clear if the facility is intended to promote infiltration.

The size of the facility appears small compared to the area draining to it. It is accepting runoff from the entire south and east parking lot area. The north and west areas flow down the driveway and toward the curb and gutter along the OSH.

A yellow liner was observed at the edges of the facility. The facility may be lined since gas stations are considered a hotspot.

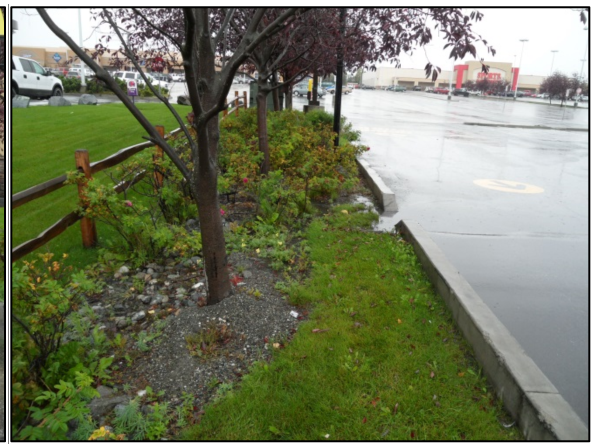
Above left: Water flowing into the facility via a curb cut.
Above right: Overflow at the downstream end (north)
Left: Facility Overview. Below: Parking lot

<u>Taco Bell and McDonald's on Old Seward</u>

Approximate Arrival Time: 1:50 pm – Raining upon arrival, slowed to a sprinkle during visit.

The vegetated swale with overflow inlets is capturing runoff from the entire Taco Bell Parking Lot and most of the MacDonald's parking lot. Water enters the facility through curb cuts and small drains.

Most of the system appears to be working very well. On the north side of Taco Bell, a considerable amount of water is bypassing the system via a man-made foot path that has created a depression. On the south side of MacDonald's, localized ponding is occurring because one of the parking lot outlets is not flowing well. The facility is also receiving some water from the property to the south, though it does not appear to be designed to do so.

Taco Bell Parking Lot


Left: Vegetated Swale. Right: overflow beehive. (It was not clear why the beehive isn't flowing. Another storm drain manhole with a top grate is located near this beehive.

Left: Water entering swale from drive-through. Right: Water entering vegetation from parking lot.

Left and Right: Water bypassing vegetation via footpath.

NSH Infiltration Basin

Approximate Arrival Time: 2:50 pm – Overcast/light rain.

The fence surrounding the basin was locked so observations were made from outside the fence.

Water was observed to be flowing into the facility from the inflow culvert, and some ponded water in the floor of the basin was visible. No outflow was observed. Instrumentation tools for 2014 monitoring were still in place.


Left: Inlet Right: Ponding in the facility


Facility outlet

Russian Jack Parking Lot

Approximate Arrival Time: 3:30 pm – Light rain

Observations:

- The inspection began as a significant rainfall event was slowing.
- Small pieces of rock from the raveling porous asphalt were scattered around the parking lot, and the parking needed to be swept. Driving on these small rocks is anticipated to further worsen the raveling, thus creating a "snowball" effect. The loose rocks are also flowing to the curb inlets leading to the infiltration gallery.
- The rock mulch in the planning beds looked good.
- Water is still flowing from the east side of the parking lot onto the parking lot.
- Curb inlets were full of trash, and rocks were washing into the inlets.
- Some heaving and movement could be seen at the west interface of the porous asphalt and traditional asphalt. It is not clear what this is caused from.
- A barricade to prevent vehicles from driving on the east side was not visible.

The inspection ports could not be opened without a pipe wrench, so water levels in the infiltration gallery were not inspected.

The water levels in each of the porous asphalt monitoring wells were checked.

- North MW: Water was observed to be 53.5 inches from the top of the casing, and the total well depth from TOC is 81 inches. (27.5 inches of standing water.)
- West MW: Water was observed to be 79 inches from the top of the casing, and the total well depth from TOC is 84 inches. (5 inches of standing water.)
- Central MW: Water was observed to be 78.5 inches from the top of the casing, and the total well depth from TOC is 84 inches. (5.5 inches of standing water.)


Left: Surface raveling. Right: Interface heaving

<u>Muldoon Landscaping</u>

Approximate Arrival Time: 4:10 pm – Overcast/light rain.

The landscape beds along the Muldoon corridor are in poor condition. Vegetation in most places is not healthy. The placement of the landscape areas and associated landscape walls is not promoting capture and infiltration of water, and in some cases are actually impeding the flow of water from adjacent areas to the landscaped areas. In many cases, adjacent natural vegetation looks healthier than the planted areas.

General Information

Number of Sites Visited: 6

Date: September 28, 2015

Holiday Gas Station – Old Seward and O'Malley

Approximate Arrival Time: 9:50 am – Raining steadily

Observations: The majority of the gas station parking lot was sheet flowing to the rock/vegetation landscaping area adjacent to the OSH. Standing water depths in the landscaping were 9 to 12 inches on the south side, and 5 inches on the north side. The facility does not appear to have an outlet, and was very close to overflowing the curb line on the north side. The limited vegetation looked to be in good condition.

Taco Bell and McDonald's on Old Seward

Approximate Arrival Time: 10:05 am – Steadily raining.

The vegetated swale and associated landscaping appeared to be working quite well. The footpath near the north end of the Taco Bell parking lot was not flowing, but looked as though it had been recently. Water was not flowing through the lowest beehive inlet in the swale. Grass was observed to be growing through the beehive. It is believed that either 1) there isn't an actual inlet in this location or 2) the inlet has been blocked by a sediment trap, such as a witch's hat, that has been in place for quite some time.


Taco Bell Parking Lot – North Side. Foot path not overflowing.


Left: Vegetated Swale, standing water visible. Right: overflow beehive that is not flowing.

Left: Grass growing through the beehive inlet. Right: Water entering vegetation from parking lot near the McDonald's drive-through area.

Left and Right: Water entering the vegetation from the parking lot via curb cuts.

<u>Taku Lake Rain Garden</u>

Approximate Arrival Time: 10:25 am – Raining Steadily

Observations: Rain was falling heavily concentrated drainage was observed flowing from the parking lot and into the rain garden. There was no surface water standing or ponding inside the rain garden. The rain garden outlet was not actively flow. Vegetation looked healthy.


Left and right: Water flow toward the rain garden inlet.


Left: Vegetation inside the rain garden. Right: Underdrain outfall area

West Dowling Bioswale

Approximate Arrival Time: 10:35 pm – Raining steadily.

Observations: Water was steadily flowing into the bioswale from 4 of the 5 storm drains that outfall to the swale. At the far west storm drain outfall, vegetation continued to partially block the outfall, causing ponding in the storm drain pipe, but did not appear to be problematic. There was standing water in the swale that was flowing slowing toward the swale outlet on the east side. Water was flowing slowly into the bioswale outlet pipe. The bioswale vegetation was mowed fairly short. Overall performance is expected to be improved if the grass were allowed to grow taller. Water from the system was not flowing into Campbell Creek, east of the outlet. Instead, it was ponding upstream of the creek, which is apt to be further improving water quality.


Overview of bioswale.


Inflow to bioswale and ponding at storm drain inflow pipe.

NSH Infiltration Basin

Approximate Arrival Time: 11:00 am – Raining steadily.

Water was observed to be flowing into the facility from the inflow culvert, and some water in the floor of the basin was visible. No flow over the outfall weir was observed. Standing water was 13 to 15 inches deep.


Left: Ponding in the facility. Right: Inlet actively flowing.

Facility outlet

Russian Jack Parking Lot

Approximate Arrival Time: 11:30am – Raining

Observations:

- The raveling porous asphalt unraveling was still visible. Rocks from the asphalt surface were scattered around the parking lot, and the parking needed to be swept. Driving on these small rocks is anticipated to further worsen the raveling, thus creating a “snowball” effect. The loose rocks are also flowing to the curb inlets leading to the infiltration gallery.
- The north interface between porous asphalt and traditional asphalt was ponding water.
- A barricade to prevent vehicles from driving on the east side was not visible.
- The cap on the easternmost observation port of the infiltration gallery was broken off.

The inspection ports were opened and standing water was not observed in any of the ports.

The water levels in each of the porous asphalt monitoring wells were checked.

- North MW: Water was observed to be 24.5 inches from the top of the casing, and the total well depth from TOC is 81 inches. (56.5 inches of standing water.)
- West MW: Water was observed to be 79 inches from the top of the casing, and the total well depth from TOC is 84 inches. (5 inches of standing water.)
- South (Central) MW: Water was observed to be 78 inches from the top of the casing, and the total well depth from TOC is 84 inches. (6 inches of standing water.)


Left: North asphalt interface. Right: West asphalt interface

General Information

Number of Sites Visited: 6

Date: September 28, 2015

Taku Lake Rain Garden

Approximate Arrival Time: 3:55 pm – Moderate wintery mix of rain and snow

Observations: Heavy concentrated flow as observed flowing from the parking lot and into the rain garden. Surface ponding in the upper half of the rain garden was observed to be approx. 2 to 4 inches deep. Significant ponding was observed at the rain garden inlet. The ponding appeared to be from the thick vegetated mat on the rain garden surface, not from water coming to the surface from the rain garden layers. No ponding was visible at the lower end of the rain garden. The underdrain pipe was flowing about half full with a steady stream of water flowing into Taku Lake.

Ponding at the rain garden inlet

Left: Significant concentrated flow running toward the rain garden. Right: Outlet flow

Outlet flow running to Taku Lake

Taco Bell and McDonald's on Old Seward

Approximate Arrival Time: 4:10pm – Heavy wintery mix

Observations

- Lots of sheet flow and concentrated flow from the parking lots to the vegetation areas.
- Significant amounts of water were flowing away from the site via the footpath.
- The two primary beehive inlets were actively flowing. The central beehive was not flowing, but significant ponding (approximately 8-inches deep) was observed and the area was overflowing to the secondary storm drain inlet nearby. (to the north).
- The culvert at the McDonald's drive-through was flowing and notable ponding of the drive-through asphalt surface was observed.


Taco Bell Parking Lot – North Side. Foot path overflowing.


Left: overflow beehive that is not flowing. Right: Ponding and outflow of McDonald's Drive through


Left: Flow from the parking lot to the vegetated swale via curb cuts. Right: water ponded in the vegetated swale.

<u>Russian Jack Parking Lot</u>

Approximate Arrival Time: 6:35 PM:– Light rain

Observations:

- No significant changes observed from the previous day's observations.
- All infiltration gallery ports were still dry.
- The storm drain inlets were holding trash and debris and needed to be cleaned out.

The water levels in each of the porous asphalt monitoring wells were checked.

- North MW: Water was observed to be 17 inches from the top of the casing, and the total well depth from TOC is 81 inches. (64 inches of standing water.)
- West MW: Water was observed to be 79 inches from the top of the casing, and the total well depth from TOC is 84 inches. (5 inches of standing water.)
- South (Central) MW: Water was observed to be 72 inches from the top of the casing, and the total well depth from TOC is 84 inches. (12 inches of standing water.)


Left: East asphalt interface. Right: Ponding east of the parking lot.

NSH Infiltration Basin

Approximate Arrival Time: 7:10pm – Light Rain.

Observations

- Water was flowing over the inflow and outflow weirs. The water height on the outflow weir was estimated to be about 3 inches.


Left: Facility outlet. Right: Facility inlet

Facility overview

West Dowling Bioswale

Approximate Arrival Time: 7:30 pm – Light mist.

Observations:

- More water in the swale than was present the previous day. Water was visibly dirty-looking and brown, particularly water that was flowing into the swale from the further east inlet on the north side.
- All inlets into the swale were flowing except the second one from the outlet on the north side.
- Downstream of the swale outlet, water was trickling into Campbell Creek from between the rocks on the shoreline. There is an armored pathway that appears to be intended to direct water from the swale into the creek. However, water does not enter the creek via that pathway. Instead, it turns to the south and flows under the rip rap on the shore of the creek and eventually flows into the creek near at the bridge.


Left: Overview of bioswale. Right: Bioswale outlet.


Left: Bioswale flow path to Campbell Creek. Right: Muddy water inflow.

Appendix C: Volunteer Monitoring Notes

MOA Green Infrastructure Group
Volunteer Facility Monitoring Guide

Site Name: Westchester Lagoon

Address or Location: ____

Data collected by: Patricia Joyner

Date: 8-13-15 Time: afternoon

Climate: (e.g. raining, sunny, following a recent rain) raining

1. What type(s) of stormwater facility are you monitoring? Rain garden

2. Are there indications that the facility is not functioning properly or that stormwater flows are bypassing the facility? Check all that apply.

   ☐ Vegetation outside the facility that is leaning unnaturally or lying on the ground

   ☐ Erosion or exposed soil in or around the facility,

   ☐ Standing water for long periods of time (3 or more days) after regular, small rainfall events

   ☒ Standing water in locations that should not have ponded water

   ☐ Visible drainage problems downstream of the facility

   ☐ No indications of improper function or bypassing of stormwater flows

   ☒ Other

3. If the facility contains vegetation, note the condition of the vegetation.

   Does vegetation look healthy? Some plants look healthy but are being crowded out by other plants coming in.

   Is it receiving stormwater runoff? I could not see water standing in the rain garden like it was outside the garden but there are too many plants to see the bottom. The area with gravel had a little standing water.

   Does it look like it's receiving adequate maintenance? No maintenance evident.

4. Do you notice any issues such a mosquitos, unpleasant odors, etc. No

5. General Observations. (Are there things that you like? Things that you don't like? Things you would change if you were going to re-design the facility?)

   The water can't get to the garden from the parking lot because of sediment and grass. The water is pooling on the edge of the pavement and in the grass outside the rain garden.

Plants that were not intended to be there are crowding what was planted. There are quite a few cottonwoods, grasses, and invasive weeds like butter and eggs and bird vetch.

It may not be a problem to have some new plants like willows but I don't think we don't want a lot of cottonwoods. The rain garden is so crowded it is hard to see if it is taking up water. It looks like more water is ponding outside the rain garden than inside it.

I'm not sure if there is supposed to be water in the ditch along the road but there was not any in it.

Please attach photos. If you want to describe or caption the photos, you can do that below.

MOA Green Infrastructure Group
Volunteer Facility Monitoring Guide

Site Name: Commercial Fishing and Agriculture Bank (CFAB) Building

Address or Location: 3040 Lakeshore Drive

Data collected by: Kevin Doniere

Date: 09.15.2015 Time: 4:00 pm

Climate: (e.g. raining, sunny, following a recent rain) steady rain

1. What type(s) of stormwater facility are you monitoring? Rain garden – vegetated swale at edge of parking lot

2. Are there indications that the facility is not functioning properly or that stormwater flows are bypassing the facility? Check all that apply.

   ☐ Vegetation outside the facility that is leaning unnaturally or lying on the ground

   ☐ Erosion or exposed soil in or around the facility,

   ☐ Standing water for long periods of time (3 or more days) after regular, small rainfall events

   ☐ Standing water in locations that should not have ponded water

   ☐ Visible drainage problems downstream of the facility

   ☐ No indications of improper function or bypassing of stormwater flows

   ☒ Other landscape edging would restrict flow of water from parking lot into the rock lined swale that should receive the stormwater runoff; also on the north entry drive, the swale on the northwest side drains back toward driveway into a trench drain; even with steady rain, the runoff into the landscape beds and rock-swale are minimal – small puddles just outside parking lot and planting beds.

3. If the facility contains vegetation, note the condition of the vegetation.

   Does vegetation look healthy? Vegetation is healthy

   Is it receiving stormwater runoff? Even with steady rain, it didn't show that water was running off into to the planting beds and rock-lined swale.

   Does it look like its receiving adequate maintenance? Rock swale looks good, and beehive looks open with no debris around it. The landscape edging is still popped up out of the ground and probably could be removed to allow more water infiltration into the swale.

4. Do you notice any issues such a mosquitos, unpleasant odors, etc. None

5. General Observations. (Are there things that you like? Things that you don't like? Things you would change if you were going to re-design the facility?)

   Even with steady rain, I didn't observe much water runoff from the parking lot into the planting beds and rock-lined swale. Should probably remove the edging along rock swale to allow as much water as possible into the swale.

Please attach photos. If you want to describe or caption the photos, you can do that below.

Updated photos of swale, plants, small puddles of water in planting beds at edge of parking lot.

MOA Green Infrastructure Group
Volunteer Facility Monitoring Guide

Site Name: ___Target Store Pond – South Anchorage___

Address or Location: __150 West 100th Avenue___

Data collected by: __Kevin Doniere___

Date: __09.15.2015___ Time: ____5:00 pm___

Climate: (e.g. raining, sunny, following a recent rain)___steady rain just stopped (light rain falling)

1. What type(s) of stormwater facility are you monitoring? ___Wetland pond - drainage from surrounding parking lots going into an existing pond

2. Are there indications that the facility is not functioning properly or that stormwater flows are bypassing the facility? Check all that apply.

   ☐ Vegetation outside the facility that is leaning unnaturally or lying on the ground

   ☐ Erosion or exposed soil in or around the facility,

   ☐ Standing water for long periods of time (3 or more days) after regular, small rainfall events

   ☐ Standing water in locations that should not have ponded water

   ☐ Visible drainage problems downstream of the facility

   ☒ No indications of improper function or bypassing of stormwater flows

   ☒ Other _grates on the outlets culvert pipes have a lot of debris/garbage on them, possibly restricting some flow on intense rain events – grates on pipes need to be cleaned out; water still flowing through these outlets despite the debris___

3. If the facility contains vegetation, note the condition of the vegetation.

   Does vegetation look healthy? Vegetation looks very healthy; pond is healthy with waterfowl in the pond

   Is it receiving stormwater runoff? Yes, outlets from parking lots had water flowing into inlets (catch basins) into culverts that were draining into the pond

   Does it look like its receiving adequate maintenance? Don't know; looks like they need to clean off grates at end of culvert outfall pipes from debris

4. Do you notice any issues such a mosquitos, unpleasant odors, etc. None

5. General Observations. (Are there things that you like? Things that you don't like? Things you would change if you were going to re-design the facility?)

    Boardwalk built out to pond to observe wildlife using pond is not accessible – the gravel walk out to the boardwalk has a step up to the boardwalk/observation deck. This may be a result of frost jacking because it looks like the deck has some of that happening in other locations – not level.

Please attach photos. If you want to describe or caption the photos, you can do that below.

Catch basins collecting water with an outfall into the pond. Rock around outfall pipe to prevent erosion seems to be working.

Healthy pond and waterfowl using the pond. Water flowing from catch basins into outfall pipes toward pond – updated photos below.

East side of pond – connector road from Target to Cabelas.

Catch basin on south side of pond (from Cabelas lot).

Catch basin on north side of pond, leading to culvert and discharge into pond.

Flow from culvert connected to catch basin at north side of pond (Target parking lot).

MOA Green Infrastructure Group
Volunteer Facility Monitoring – Creekside Centre Drive

Site Name: ______Creekside Center Drive___________________________________

Address or Location: ____7600 Creekside Center Drive________________________________

Data collected by: ____M Langdon____

Date: __8-9-2015_______________ Time: ___12:00 noon______________________

Weather: (e.g. raining, sunny, following a recent rain)_following a recent rain; 0.24" at Merrill Field this day; no precip during previous 2 days

What type(s) of stormwater facility are you monitoring? ___detention pond, vegetated swales______________

____

____

1. Are there indications that the facility is not functioning properly or that stormwater flows are bypassing the facility? Check all that apply.

   ☐ Vegetation outside the facility that is leaning unnaturally or lying on the ground

   ☐ Erosion or exposed soil in or around the facility,

   ☐ Standing water for long periods of time (3 or more days) after regular, small rainfall events

   X Standing water in locations that should not have ponded water (swale between buildings)

   ☐ Visible drainage problems downstream of the facility

   ☐ No indications of improper function or bypassing of stormwater flows

   ☐ Other ____

2. If the facility contains vegetation, note the condition of the vegetation.

   Does vegetation look healthy? Yes

   Is it receiving stormwater runoff? Yes

   Does it look like it's receiving adequate maintenance? Yes

3. Do you notice any issues such a mosquitos, unpleasant odors, etc. No

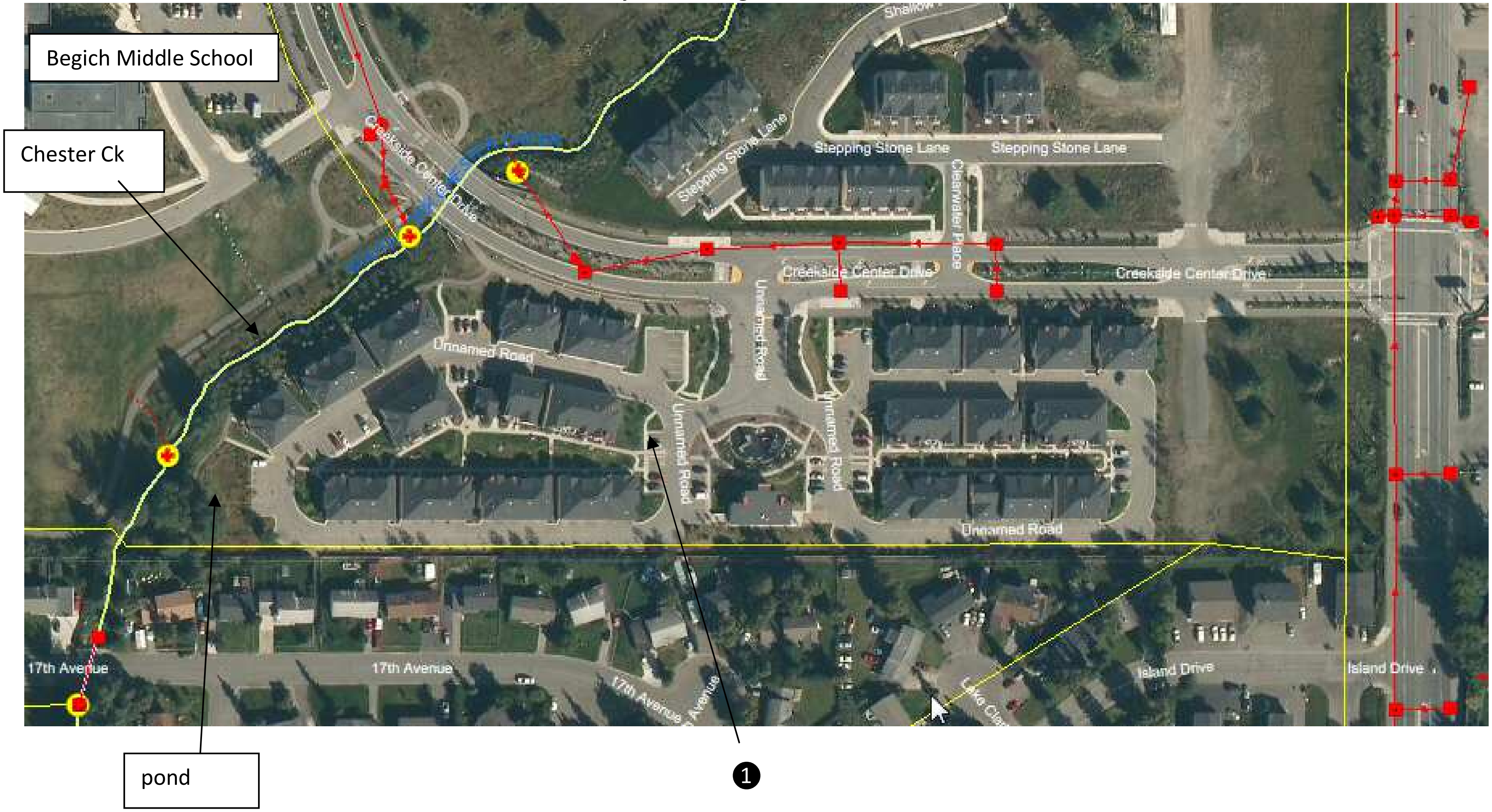
4. General Observations. (Are there things that you like? Things that you don't like? Things you would change if you were going to re-design the facility?)

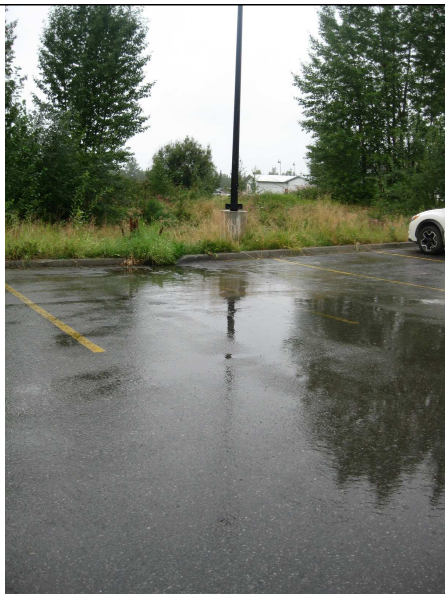
(+) no water in swale between building and creek; where standing water has been seen before
(-) water in swale between buildings
(+) runoff ponding on asphalt but draining across grass to field inlet
(+) runoff sheetflowing from interior driveways into pond
(+) no standing water in pond; vegetation healthy; does not appear to have much standing water

There is a field inlet at ❶. Not clear if this is piped somewhere or a drywell.

Please attach photos. If you want to describe or caption the photos, you can do that below.

MOA Green Infrastructure Group
Volunteer Facility Monitoring – Creekside Centre Drive



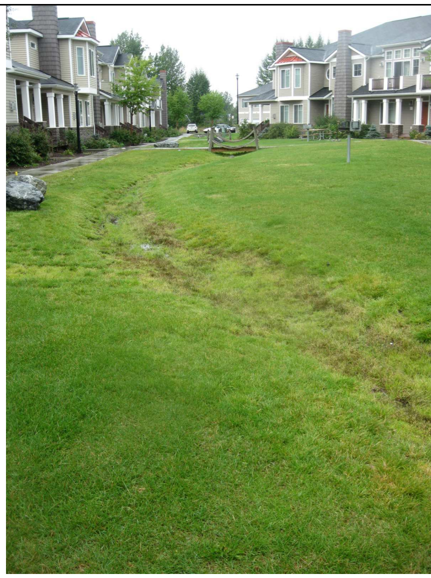


1 Inlet to pond

2 pond

3 East portion of north east-west swale
< some standing water in second cell from front >

4 West portion of north east-west swale

 5 Field inlet area	 6 Close-up of field inlet area
 7 East end of east-west swale between groups of buildings	 8 West end of east-west swale between groups of buildings

MOA Green Infrastructure Group
Volunteer Facility Monitoring – Creekside Centre Drive

Site Name: ______Creekside Center Drive___________________________________

Address or Location: ____7600 Creekside Center Drive________________________________

Data collected by: ____M Langdon____

Date: __9-15-2015_______________ Time: ___4:00 pm______________________

Weather: (e.g. raining, sunny, following a recent rain) during rain; Merrill Field: 1.16" total on 9/15; 0.38" on 9/14; 0.23" on 9/13

What type(s) of stormwater facility are you monitoring? ___detention pond, vegetated swales______________

____

____

1. Are there indications that the facility is not functioning properly or that stormwater flows are bypassing the facility? Check all that apply.

   ☐ Vegetation outside the facility that is leaning unnaturally or lying on the ground

   ☐ Erosion or exposed soil in or around the facility,

   ☐ Standing water for long periods of time (3 or more days) after regular, small rainfall events

   ☐ Standing water in locations that should not have ponded water

   ☐ Visible drainage problems downstream of the facility

   ☒ No indications of improper function or bypassing of stormwater flows

   ☐ Other ____

2. If the facility contains vegetation, note the condition of the vegetation.

   Does vegetation look healthy? Yes

   Is it receiving stormwater runoff? Yes

   Does it look like it's receiving adequate maintenance? Yes

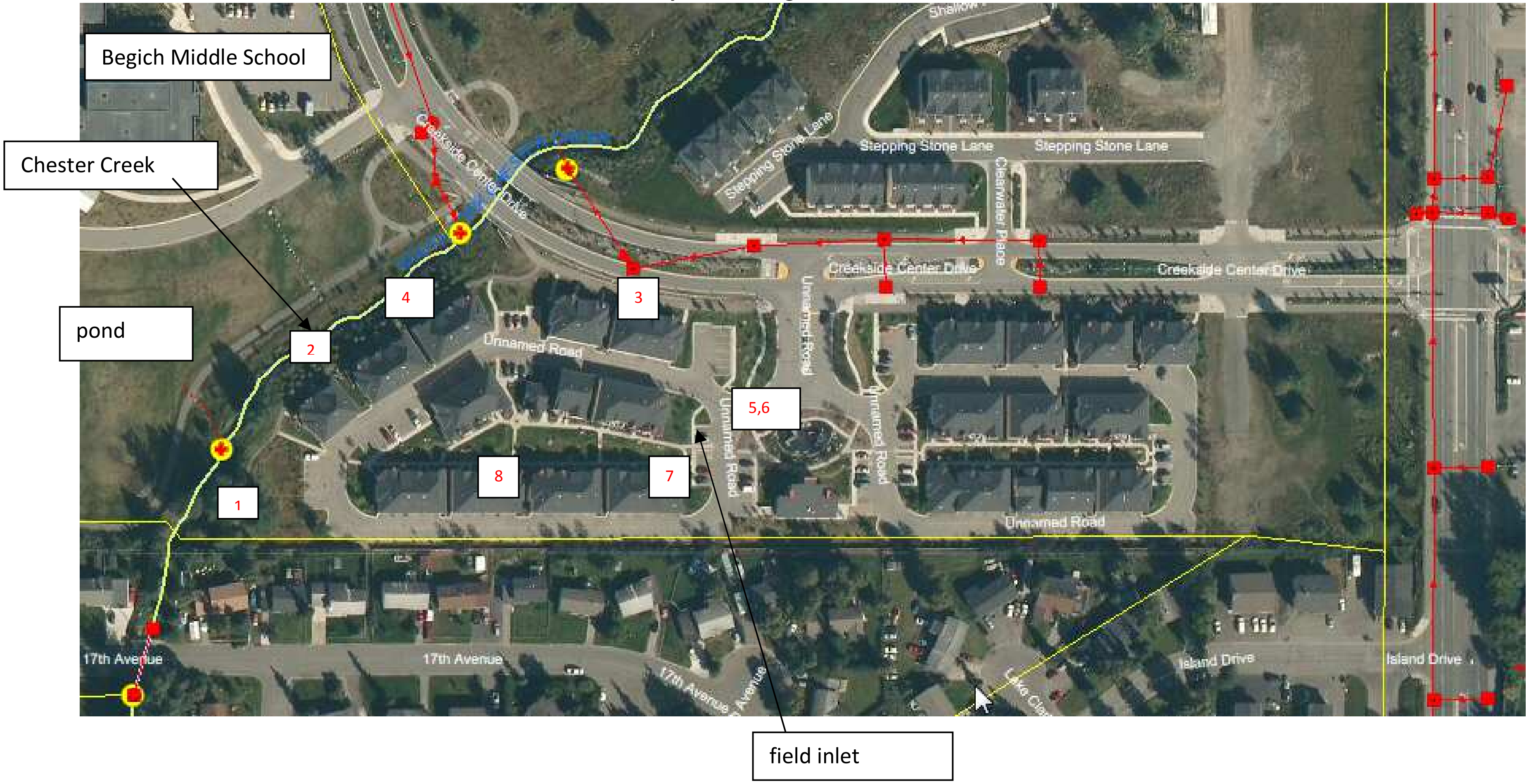
3. Do you notice any issues such a mosquitos, unpleasant odors, etc. No

4. General Observations. (Are there things that you like? Things that you don't like? Things you would change if you were going to re-design the facility?)

(+) deep ponding on asphalt draining across grass to field inlet
(+) runoff sheetflowing from interior driveways into pond
(+) water in pond; vegetation healthy; does not appear to have much standing water

Please attach photos. If you want to describe or caption the photos, you can do that below.

MOA Green Infrastructure Group
Volunteer Facility Monitoring – Creekside Centre Drive

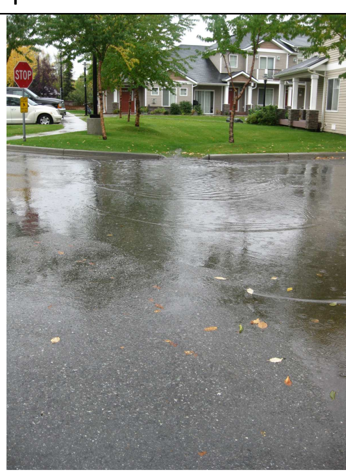


1 pond

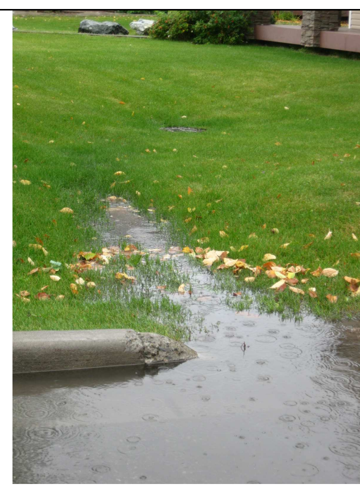
2 South-North Swale between bldgs

3 Easr portion of north east-west swale

4 West portion of North east-west swale



5 field inlet area



6 Close-up of field inlet area

7 East-west swale between groups of buildings

8 East-west swale between groups of buildings

MOA Green Infrastructure Group
Volunteer Facility Monitoring – UAA Science Building Parking Garage

Site Name: ____UAA Science Building Parking Garage Bioswale___________________________

Address or Location: _____3101 Science Circle____

Data collected by: ____M Langdon____

Date: __8-9-2015_ Time: _12:00 noon

Weather: (e.g. raining, sunny, following a recent rain)_following a recent rain; 0.24" at Merrill Field this day; no precip during previous 2 days _____

1. What type(s) of stormwater facility are you monitoring? _bioswale and vegetated area around field inlet__

   ____

   ____

2. Are there indications that the facility is not functioning properly or that stormwater flows are bypassing the facility? Check all that apply.

   ☐ Vegetation outside the facility that is leaning unnaturally or lying on the ground

   ☐ Erosion or exposed soil in or around the facility,

   ☐ Standing water for long periods of time (3 or more days) after regular, small rainfall events

   ☐ Standing water in locations that should not have ponded water

   ☐ Visible drainage problems downstream of the facility

   ☒ No indications of improper function or bypassing of stormwater flows

   ☐ Other ____

3. If the facility contains vegetation, note the condition of the vegetation.

   Does vegetation look healthy? Yes

   Is it receiving stormwater runoff? Not as much as one would expect

   Does it look like it's receiving adequate maintenance? yes

4. Do you notice any issues such a mosquitos, unpleasant odors, etc. no

5. General Observations. (Are there things that you like? Things that you don't like? Things you would change if you were going to re-design the facility?)

(?) Downdrain from roof of parking structure appear to be plumbed directly in to the piped storm drain system; does not flow over vegetated area; possibly (per plans) this does discharge to bioswale #1

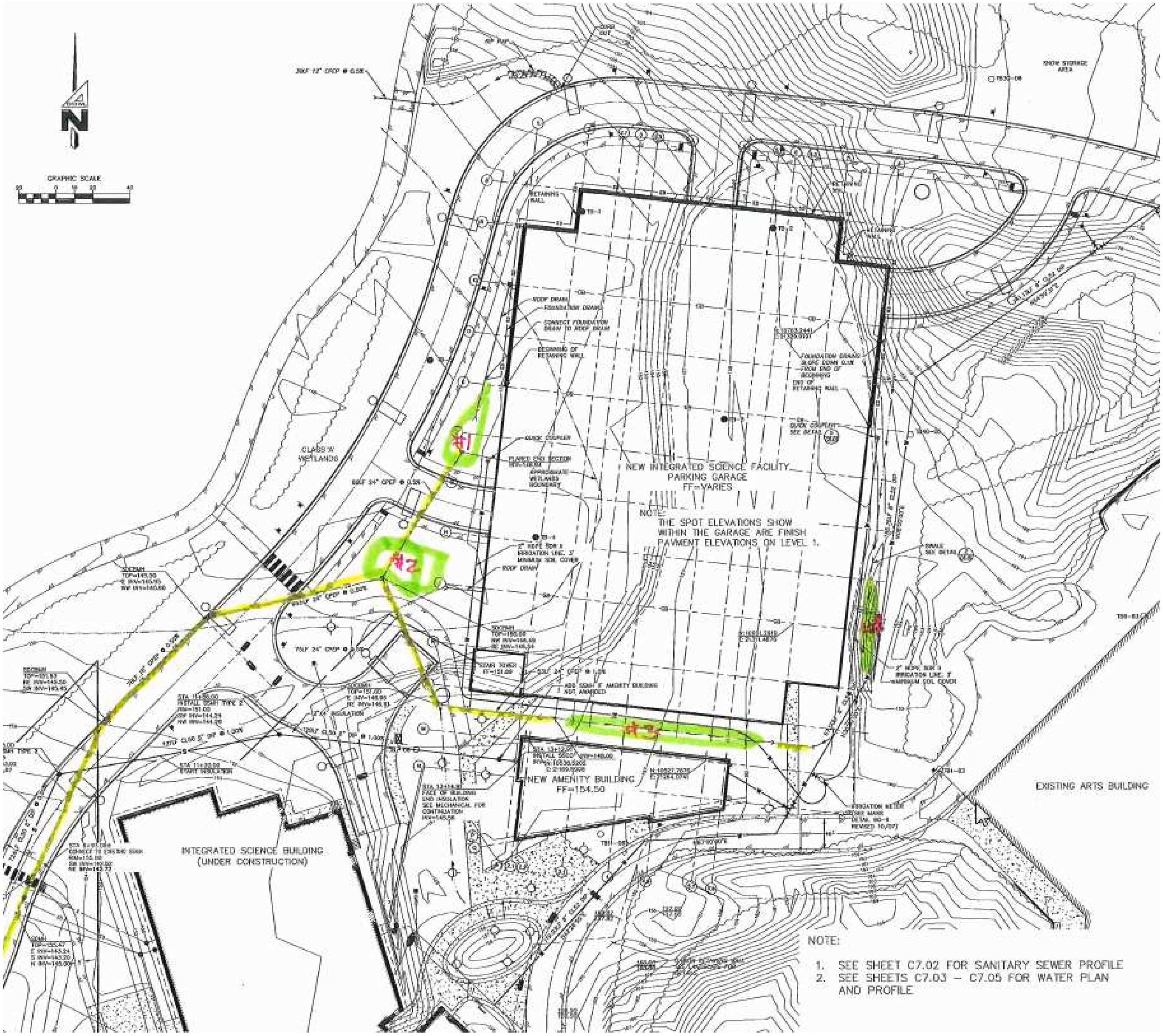
(-) Bioswale #3 appears quite robust but does not appear to get much flow

(-) Sidewalk/plaza area runoff goes directly to SDCBMH; maybe could have been routed to bioswale #2

(+) Northwest-most bioswale (#1 in site Plan) receiving flow

Please attach photos. If you want to describe or caption the photos, you can do that below.

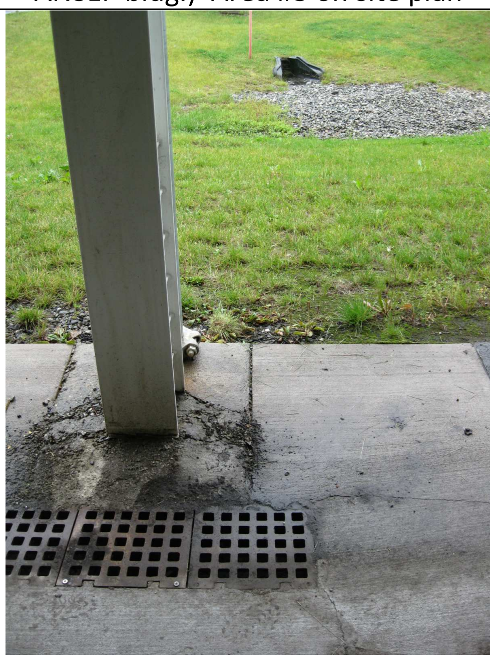
Aerial Photo


GRAPHIC SCALE
NEW INTEGRATED SCIENCE FACILITY
PARKING GARAGE
FF=VARIES
NOTE:
THE SPOT ELEVATIONS SHOW
WITHIN THE GARAGE ARE FINISH
PAVMENT ELEVATIONS ON LEVEL 1.
NEW AMENITY BUILDING
FF=154.50
INTEGRATED SCIENCE BUILDING
(UNDER CONSTRUCTION)
EXISTING ARTS BUILDING
CLASS 'A'
WETLANDS
STAIR TOWER
NOTE:
1. SEE SHEET C7.02 FOR SANITARY SEWER PROFILE
2. SEE SHEETS C7.03 – C7.05 FOR WATER PLAN
AND PROFILE
#1
#2
#3

Site Plan

1 looking west along bioswale btwn parking garage on right and ANSEP bldg. on left (north side of ANSEP bldg.) Area #3 on site plan

2 scupper on west side of ANSEP bldg. between Areas #2 and #3 on site plan



Parking garage grate with Depression at Area #2 in back ground

Outlet from Area #1