Lower Jordan Creek

Watershed Management Plan

Stormwater management and riparian restoration for sediment, PAH, and metals

February 2021

Trout Street Ditch in the Lower Jordan Creek watershed.

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Executive Summary

Jordan Creek is a salmon stream in Juneau, Alaska. It drains 1,664 acres of mostly undisturbed forest in the Mendenhall Valley before entering a highly developed commercial and residential area (downstream of Egan Drive) referred to as the lower watershed. The Lower Jordan Creek watershed comprises less than 5% of the total watershed area, but its extensive impervious surfaces, heavy traffic, and degraded riparian corridor have contributed to impaired sediment and water quality and degraded stream and riparian habitat. The Alaska Department of Environmental Conservation listed Jordan Creek as an impaired waterbody in 1998. Causes of impairment include litter, sediment loads, and low streambed interstitial oxygen levels.

Jordan Creek is one of 5 impaired water bodies that drain into the Mendenhall Wetlands, an Audubon-designated globally Important Bird Area and an important estuary for recreation, wildlife, and salmon and other commercially important fish species. Urban stormwater runoff, which carries sediment and pollutants, generally flows unimpeded and untreated from the lower watershed to Jordan Creek and eventually into the wetlands.

This watershed management plan focuses on managing and reducing sediment transport from the urban watershed area to Jordan Creek (i.e., lower watershed). Management measures that reduce sediment transport will also reduce water and sediment-associated pollution and improve riparian habitat. Additional educational and outreach activities will further benefit the watershed by encouraging residents to help steward the watershed.

This watershed plan divides lower Jordan Creek into 10 contributing areas or sub-drainages. Most stormwater runoff from each contributing area is conveyed to Jordan Creek by a conventional stormwater system (i.e., curb and gutter, catch basins, pipes, etc.). The plan evaluated each system and its associated contributing area for opportunities to install stormwater management infrastructure (hereafter referred to as stormwater Best Management Practices or BMPs) and alter land management and maintenance activities to reduce sediment and pollutant loads to Jordan Creek. The proposed sediment load reduction from Lower Jordan Creek watershed is 93%. A large portion of this goal can be reached over the next 15 years if the proposed BMPs are implemented on the proposed schedule.

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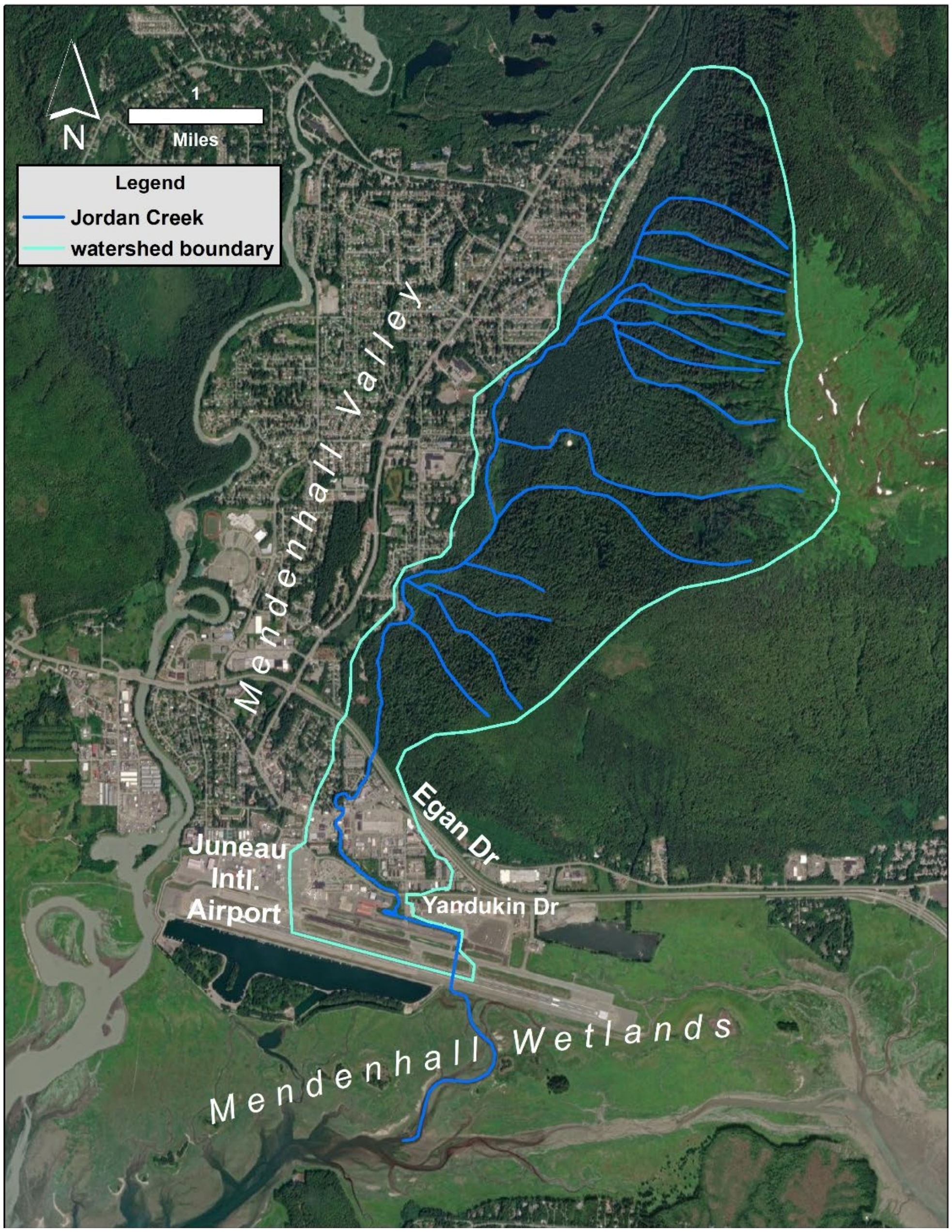

Figure 1. The Lower Jordan Creek watershed.

Jordan Creek watershed is located in Juneau, Alaska in the Mendenhall Valley (Figure 1). Within its 3.5-square mile watershed, the main channel of Jordan Creek flows 4 miles to an estuary in the Mendenhall Wetlands. Jordan Creek is one of five state-designated impaired water bodies that drain into the Mendenhall Wetlands, a globally recognized Important Bird Area and an important estuary for recreation, wildlife, salmon and other commercially important fish species (Armstrong et al 2009).

Jordan Creek supports numerous anadromous and resident fish species, including Coho, sockeye, pink, and chum salmon; cutthroat and steelhead trout; Dolly Varden char; and stickleback, sculpin, and flatfishes. As many as 26,000 Coho smolts emigrate from Jordan Creek in the spring (Lum and Glynn 2007) and adult Coho salmon escapement ranges up to 562 fish (Coyle and Love 2009). While the stream is not open to sportfishing, an estimated 238 Jordan Creek Coho salmon were harvested in recreational, commercial, and hatchery cost recovery fisheries in marine waters (Briscoe et al 2008).

Upper Watershed

The upper watershed (upstream of Egan Drive) is relatively intact and drains the western side of Thunder Mountain. Development in the upper watershed is limited to a small portion of the watershed and consists of public trails, 3 road/driveway crossings, and numerous private properties along the west side of the channel. The main channel receives runoff from numerous tributaries that flow down the flanks of Thunder Mountain. The absence of surface flow in the main channel upstream of Egan Drive is rare.

Lower Watershed

Below Egan Drive the watershed is highly developed, with mostly commercial and some residential properties (Figure 2). Development in this area deeply encroaches on the riparian zone in many places; less than half of the native vegetation remains within a 50-foot wide buffer on each side of the stream Sumner 2018). Between Egan Drive and Yandukin Drive impervious surfaces cover 63% of the watershed[1]. The high density of retail and office space in the lower watershed contributes to very high traffic densities.

Development in the lower watershed has degraded water and sediment quality, and riparian and in-stream habitat. Although Jordan Creek still provides spawning and rearing habitat for salmon and other fish species, especially in the upper watershed, poor habitat conditions and seasonally dry stream reaches likely limit fish production in the lower watershed. Periodic loss of surface flows in the lower watershed also impact fish and other aquatic life and can be attributed to a gradual lowering of the water table associated with post-glacial isostatic rebound (Host and Neal 2004). Loss of wetlands and extensive impervious land cover in the lower stream reaches may also contribute to low stream flows due to reduced groundwater recharge and storage. Progressively lower stream discharge in a downstream direction has been documented in this study and by the U.S. Geological Survey (Host and Neal 2004).

The Lower watershed experiences flooding, most commonly between Trout Street and Glacier Highway. Flood damage is limited to inundation of crawl spaces and garage floors. Some homes have experienced flooded living spaces during extreme high water.

[1] Hereafter, we use lower watershed to refer to the watershed between Egan and Yandukin Drives, which excludes most of Juneau International Airport property.

Jordan Creek is also important to the people that live in the Mendenhall Valley. The stream flows through an urban area highly used by residents and workers of the surrounding business district. The stream corridor provides open space for walking, lunch breaks, and other activities. The Lower Jordan Creek Greenbelt is situated between the Juneau International Airport, transitional housing units of the St Vincent De Paul Society, the future home of The Glory Hall Homeless Shelter, the Extended Stay Hotel, and businesses. A collaboration between these stakeholders has turned this former neglected area into a safe, parklike area enjoyed by many.

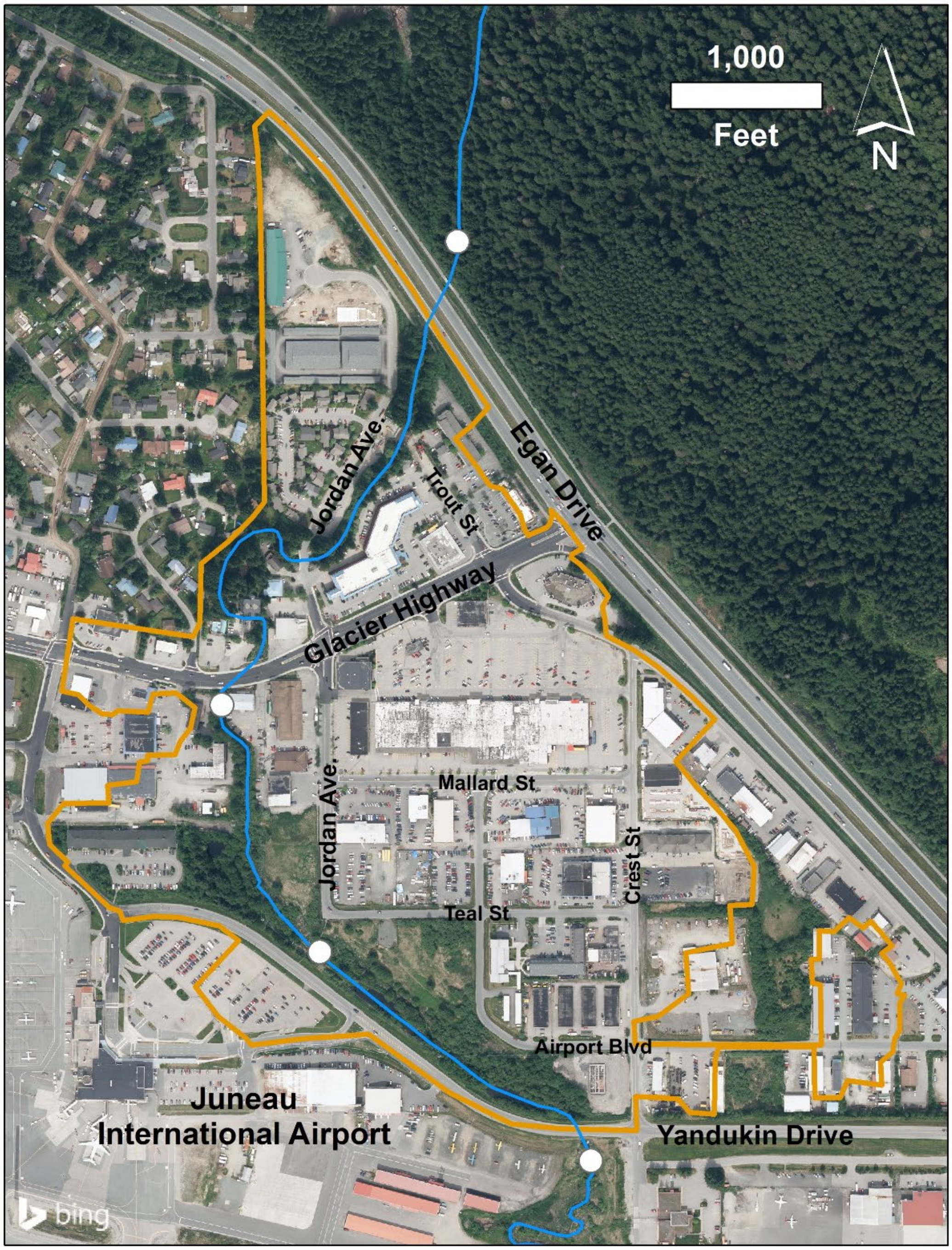

Figure 2. Map of the Lower Jordan Creek watershed. White symbols indicate sampling sites referenced in this document and named for the adjacent crossing road.

Impairments and Areas of Concern[2]

Fresh waters of the State of Alaska are protected by criteria for different uses: water supply; water recreation; and growth and propagation of fish, shellfish, other aquatic life, and wildlife. All designated uses must be addressed unless specifically exempted in Alaska. This action plan uses the most stringent of the criteria among all the uses (as outlined in 18 AAC 70.020[b]). With respect to toxic and other deleterious organic and inorganic substances (e.g., polycyclic aromatic hydrocarbons and metals), water quality criteria for the designated uses above are narrative. Therefore, National Oceanic and Atmospheric Administration (NOAA) Threshold Effects Levels (TELs) and Probable Effects Levels (PELs) were used to evaluate Jordan Creek sediment quality and effects to aquatic life exposed to those sediments (NOAA 2008). The TEL is the pollutant level below which adverse biological effects are expected to occur rarely; the PEL is the pollutant level above which adverse biological effects are expected to occur frequently.

For Alaska Water Quality Standard Toxic and Other Deleterious Organic and Inorganic Substances for Fresh Water Uses, Jordan Creek does not support the designated uses for the Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife and for Water Supply Aquaculture, due to elevated levels of Pb, Zn, Cu, and PAH in streambed sediments.

[2] Raw data presented in the graphs in the section are available from SAWC upon request.

Data Review and Analysis

Lower Jordan Creek is highly urbanized and suffers from many common urban pollutants and disturbances. Briefly, these include:

1. **Sediment Polycyclic Aromatic Hydrocarbons (PAHs):** Total PAH concentration in sediment exceeded the TEL of 264.1 ug/kg in samples from Glacier Hwy and Yandukin on four of five sampling occasions[3], with maximum total PAH concentration 14.8 and 5.0 times higher than the TEL, respectively (Figure 3). All individual PAH concentrations were below the detection limit at the reference sampling location upstream of urban development (i.e., Egan Drive). See Figure 2 for the location of sampling sites.

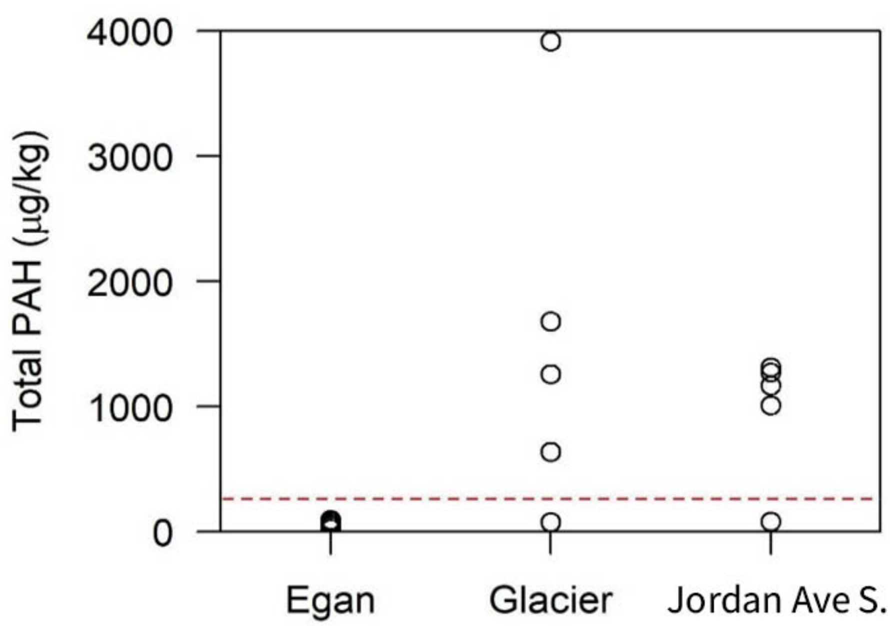

Figure 3. Total PAH concentration in sediment samples from the reference site (Egan) and two urbanized sites (Glacier and Yandukin). The red dotted line corresponds to the TEL of 264.1 µg/kg.

[3] One-half of the laboratory-reported Practical Quantitation Limit (or Limit of Quantitation) was used for individual PAH compounds that were not detected, per Alaska Dept. of Environmental Conservation guidance for TAH in water.)

2. **Sediment metals:** Background concentrations of several metals, including arsenic, cadmium, copper, nickel, and zinc, that are particularly concerning for aquatic life are near or exceed TELs at the reference site, indicating high concentrations in the native sediment (Figure 4). Concentrations of copper, lead, and zinc are even higher at downstream sites, although not above PEL. Background arsenic and nickel concentrations are above their respective PEL, with even higher concentrations of arsenic downstream.

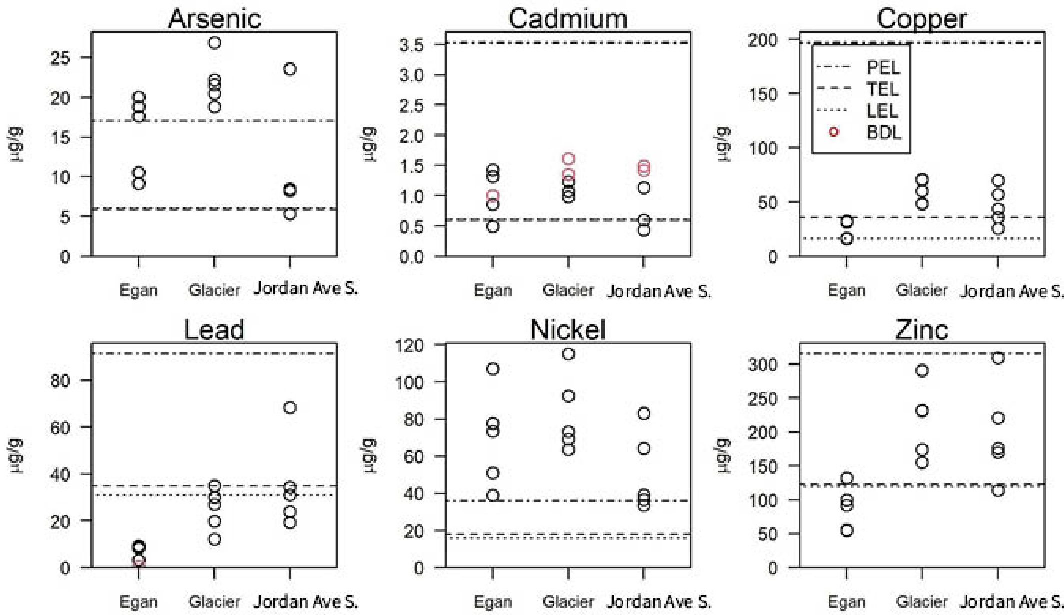

Figure 4. Sediment metal concentrations across five sampling dates, compared to LEL[4], TEL and PEL. For samples below detection limits, one half of the laboratory practical quantitation limit is plotted (red).

3. **Sediment size and interstitial dissolved oxygen (DO)**:

   Sediment size

   The State of Alaska first listed Jordan Creek for non-attainment of sediment and interstitial dissolved oxygen (DO) in 1998. A TMDL was completed in 2009 (ADEC 2009). Urban stormwater runoff can be a source of fine-textured sediments and the low-gradient nature of Jordan Creek may limit the channels capacity to transport sediment (ADEC 2009). Alaska Water Quality Standards (WQS) establish a sediment size criterion for waters that support the growth and propagation of fish, shellfish, other aquatic life, and wildlife (ADEC 2020). That criterion establishes a maximum level of fine sediment allowed in gravel beds of waters used by anadromous and resident fish. As shown by a grain size accumulation graph, the 0.1 mm to 4.0 mm fine sediment range in gravel beds may not exceed a maximum of 30% by weight. Most sediment samples from Egan Drive and Jordan Ave. South exceeded the sediment criterion (Figure 5).

[4] Lowest effects level (LEL) is the level of a pollutant that can be tolerated.

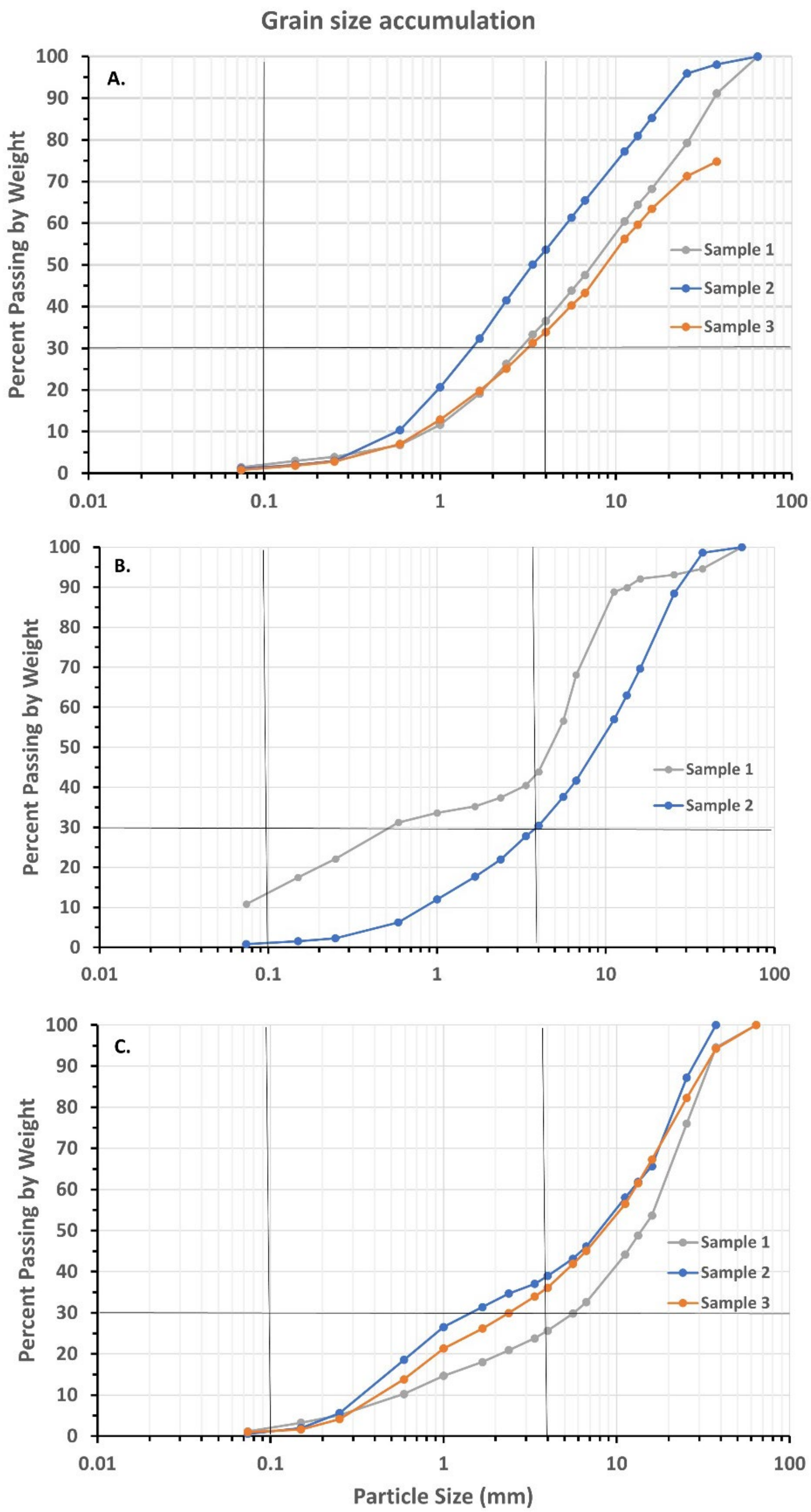

Figure 5. Grain size accumulation plots from streambed sediment samples collected at Egan Drive (A), Glacier Hwy.(B), and Jordan Ave. South (C). Sample numbers refer to the individual sediment samples collected at each site.

Interstitial dissolved oxygen

Adequate dissolved oxygen levels in the interstitial waters within a streambed are essential for the survival of aquatic invertebrates and the early stages of various fishes. The State of Alaska criterion for interstitial dissolved oxygen in anadromous and resident fishes water bodies is ≥ 5 mg/l to a depth of 20 cm. The size composition of streambed sediment can influence the amount of dissolved oxygen in interstitial spaces. Generally, as the amount of small diameter sediment in the streambed increases, interstitial dissolved oxygen levels decrease. Interstitial dissolved oxygen levels were measured in 3 vertical pipes installed at the Egan Drive, Glacier Hwy., and Jordan Ave. South sampling stations. The 3.8-cm diameter by 1.5-m long pipes were installed into the sediment to a depth of 24 cm. Interstitial water entered the pipes through 24 6-mm diameter holes drilled into a 4 cm long section near the end of each pipe.

Interstitial dissolved oxygen levels varied among pipes, sampling stations, and seasons (Figure 6). Interstitial water was absent in 2 pipes at Glacier Hwy. That is, after removing water from the pipes prior to taking a measurement, the pipe failed to refill with water presumably due to the lack of interstitial water near the pipe. When pipes refilled with interstitial water, DO levels were below 5 mg/L in at least 1 pipe at each station. The high percentages of fine-textured sediment at all stations likely contributed to the absence of interstitial water or low DO levels in some pipes. Water column DO levels exceeding the State of Alaska criterion of 8 mg/L at all stations (Figure 6) provides further evidence that hyporheic water exchange is reduced or absent in certain parts of the streambed. High sediment loads and low sediment transport potential, a consequence of low stream gradient and power, appear to promote sedimentation throughout the watershed (ADEC 2009). However, hyporheic exchange and interstitial DO appears to be enhanced by streambed scour and sediment sorting induced by large wood debris at the site scale (Hudson 2008).

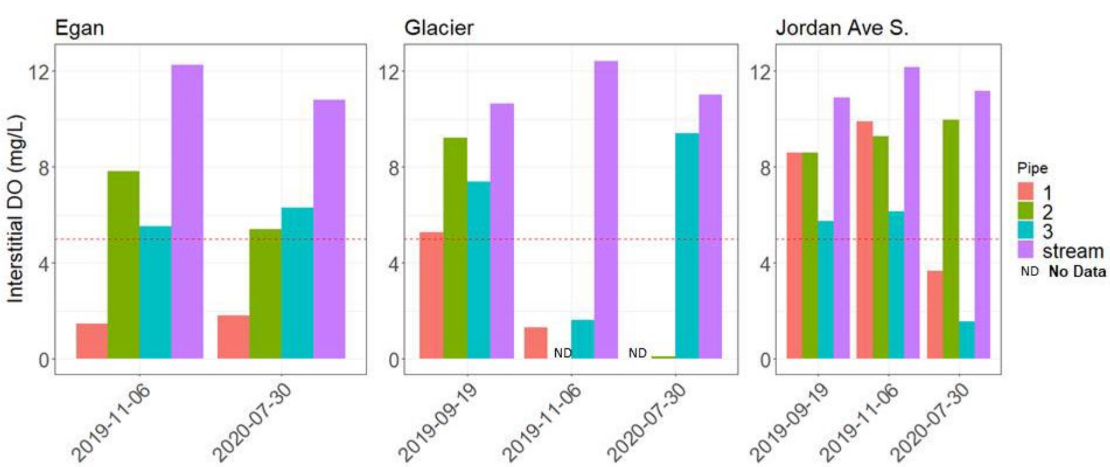

Figure 6. Interstitial dissolved oxygen levels as measured in 3 pipes installed at 3 sampling stations in the Lower Jordan Creek watershed. The horizontal dashed line indicates 5 mg/L. ND indicates pipes that did not refill after removing interstitial water prior to measuring DO.

4. **Riparian habitat:** The City and Borough of Juneau (CBJ) has established a 50-foot wide no-disturbance buffer on each side of salmon streams in the borough, including Jordan Creek. The purpose of the buffer is to protect the important ecological and hydrological functions of the riparian zone. While most of the riparian buffer in the upper watershed remains intact, most of the buffer in the lower watershed was developed prior to enactment of protections. Within the first 25 feet of the buffer, only 45% of the land cover is natural (i.e., native species) vegetation; 12% of the land is impervious development, another 6% is pervious development, and 37% is covered by invasive species. From 25-50 feet, the buffer is only 34% natural vegetation; 32% is impervious development, 8% is pervious development, and 26% is invasive species (Sumner 2018) (Figure 7).

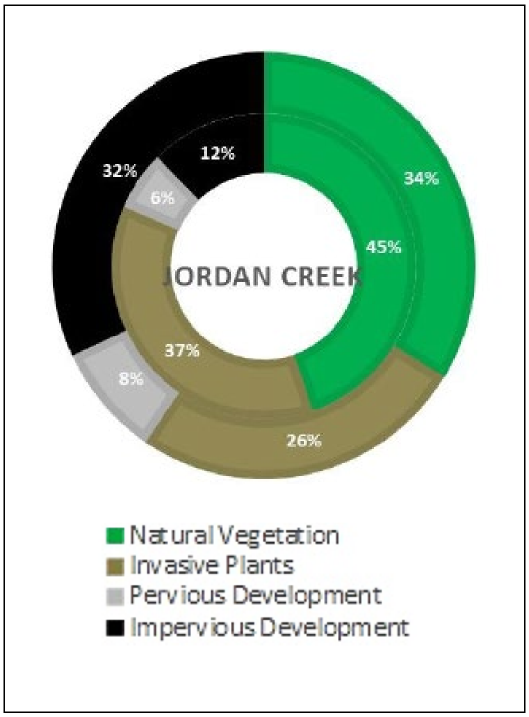

Figure 7. Land cover distribution within the 25 foot (inner circle) and 25-50 foot riparian buffer of lower Jordan Creek. Adapted from Figure 12 in Sumner 2018.

5. **Bacteria:** Fecal coliform bacteria and E. coli were quantified in water samples collected from the stream channel by SAWC (Figure 8) and ADEC (Table 1) in 2019 and 2020, respectively. The samples collected by SAWC were intended to provide an initial screening of bacteria levels in the stream. Seven (7) water samples were collected at Egan Drive, Glacier Hwy., and Jordan Ave. South. between October 2019 and August 2020. Fecal coliform levels varied from 2 to 1,200 FC/100 ml and E. coli. levels varied from 1 to 1700 MPN/100 ml. The highest bacteria concentrations in stream water samples were observed during and after storm events.

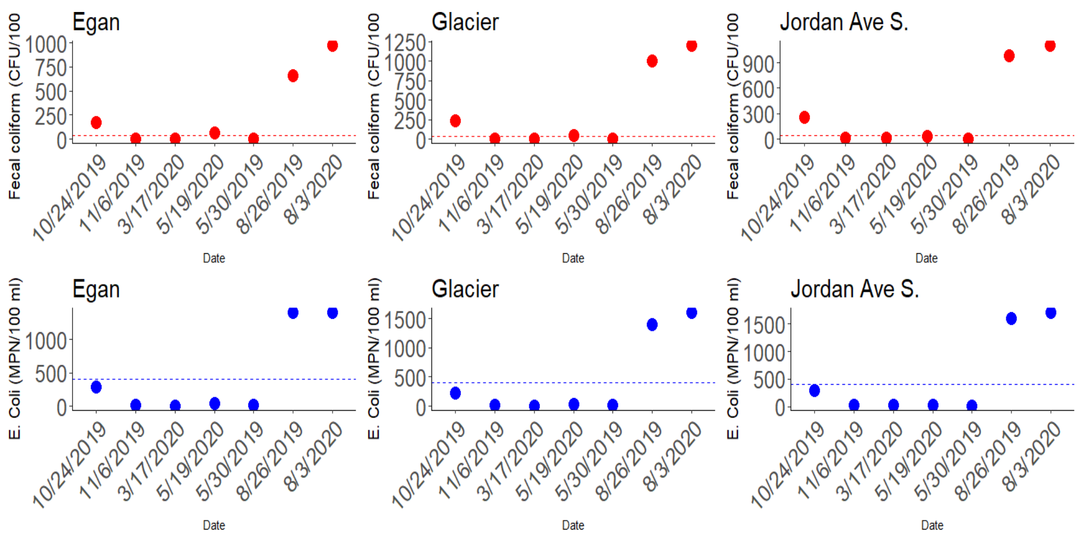

Figure 8. Fecal coliform and E. coli levels at Egan Drive, Glacier Hwy., and Jordan Ave. South seven (7) sampling dates between October 2019 and August 2020. Dashed lines represent the Alaska Waters Quality Standard.

Assessing bacteria levels relative to Alaska Waters Quality Standards requires collecting multiple water samples during a 30-day period. ADEC staff collected water samples for bacteria analysis immediately downstream of Yandukin Drive (Figure 2) on 5 dates between June 11 and July 8, 2020 (Table 1). The bacteria criterion was exceeded for both the Water Supply and Water Recreation uses.

Table 1. Bacteria concentrations in water samples collected by ADEC from Jordan Creek downstream of Yandukin Drive in June and July 2020. Bold red font indicates exceedance of criteria.

	Parameter	
Date	**Fecal coliform[1] (FC/100 ml)**	**E. coli[2] (MPN/100 ml)**
6/11/2020	50	28
6/18/2020	220	290
6/24/2020	17	16
7/1/2020	22	18
7/8/2020	980	460
geometric mean	**83.4**	**64.0**
% exceedances	**60**	**20**

ADEC Water Quality Standards
Bacteria Criteria for Freshwater Uses
[1](A) Water Supply, (i) drinking, culinary, and food processing: In a 30-day period, the geometric mean may not exceed 20 fecal coliform/100 ml, and not more than 10% of the samples may exceed 40 fecal coliform/100 ml.
[2](B) Water Recreation, (i) contact recreation: In a 30-day period, the geometric mean of samples may not exceed 126 Escherichia coli (E. coli) colony forming units (CFU)/ 100ml, and not more than 10% of the samples may exceed a statistical threshold value (STV) of 410 E. coli CFU/100 ml.

To understand the role of stormwater as a source of bacteria in Lower Jordan Creek, SAWC collected water samples from 5 stormwater outfalls at the beginning of a runoff event on August 3, 2020 (Table 2, Figure 10). Samples were analyzed for fecal coliform and E.coli as a screening effort to understand the role of stormwater runoff in delivering bacteria to the stream. The results are not comparable to Alaska Water Quality Standards. Although the exact sources of bacteria in stormwater is not known, pet waste is one likely source.

Table 2. Bacteria levels in water samples collected at 5 stormwater outfalls during a runoff event on August 3, 2020.

Outfall	Fecal coliform (FC/100 ml)	E. coli. (MPN/100 ml)
3	1800	2400
5	1200	1800
6	1000	1200
9	>2400	1000
10	>600	>2400

6. **Residue & Litter** (i.e., debris: human-caused residues such as litter and improperly stored garbage): Residue in the Jordan Creek watershed is hereafter referred to as litter as most residue consists of trash. The state of Alaska first listed Jordan Creek as impaired for non-attainment of litter in and around the stream in 1998. Litter enters Jordan Creek and the riparian zone directly as inadvertently or purposefully discarded litter or indirectly from flooding, stormwater runoff, wind, and wildlife (e.g. bears) (ADEC 2005). The Total Maximum Daily Load (TMDL) for litter in the waters of Jordan Creek is established as zero (i.e., no allowable debris (trash) load) add citation to debris TMDL.

Causes of Impairment:

1. **Sediment PAHs:** The PAH compounds that are elevated are generally the higher molecular weight compounds, indicating pyrolytic sources, rather than petrogenic sources (i.e. the PAHs come from incomplete combustion rather than raw oil or fuel). Some pyrogenic sources include vehicle exhaust, wood burning, cooking foods, cigarette smoke, and coal tar asphalt sealant. When volatile PAHs deposit on the land, they become associated with sediment particles and can be transported to the stream via stormwater runoff. Sediment PAH concentrations were all below detection limit at the reference stream site upstream of urban development, indicating that PAH pollution is nearly exclusively coming from the urbanized lower watershed.

2. **Sediment metals**: Common sources of metals in urban settings include brake dust, tire wear, vehicle corrosion, metal roofs, plumbing, paints, and other industrial activities. Metals readily bind to sediment and can be transported to the stream via stormwater runoff. Storm drain water samples taken during a summer rainstorm had high concentrations of dissolved and total metals, particularly copper, lead, and zinc (Figure 9), with an average of 44% associated with particulates. These same metals exhibited elevated concentrations in sediments in the urban sites relative to the reference site (Figure 4). Because background concentrations of many metals in sediments of lower Jordan Creek are already at or near TELs and PELs, and urban stormwater appears to be further elevating metal concentrations, action should be taken to prevent further degradation.

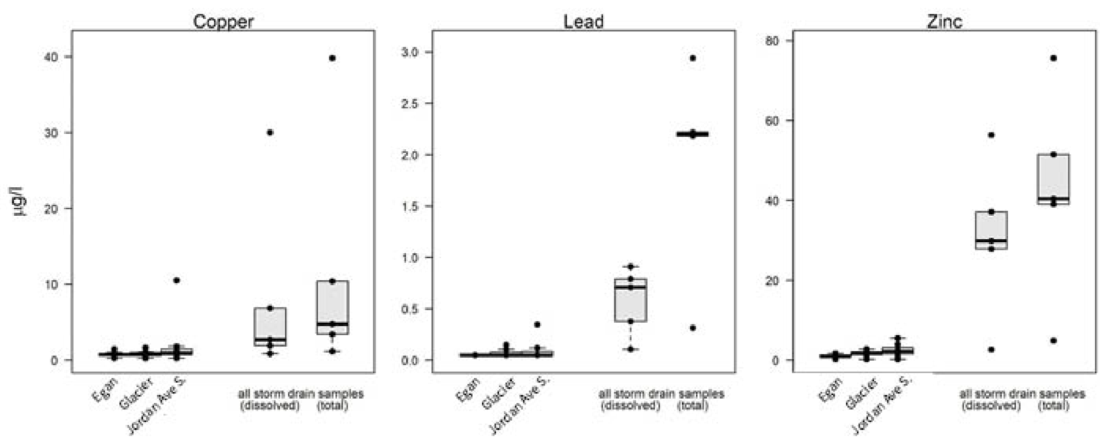

Figure 9. Stream water and storm drain concentrations of copper, lead, and zinc. Stream samples are for all sample dates at each sampling site (Egan, Glacier, and Jordan Ave S.). Storm drain samples were collected from 5 storm drains during a single storm event.

3. **Sediment size and interstitial dissolved oxygen:** Stormwater runoff transports sediment from the urban landscape. Sediment sources include unpaved parking lots, vehicles, bare soil, traction sand/gravel applied to ice-covered roads and parking lots, and flood events that can erode unstable stream banks. Much of the impervious cover in lower Jordan Creek is directly connected to the stream by pipes and ditches, with little opportunity for sediment to be retained (Figure 10). Additionally, the low-gradient/low-velocity nature of Jordan Creek likely reduces sediment transport potential in the channel (ADEC 2009).

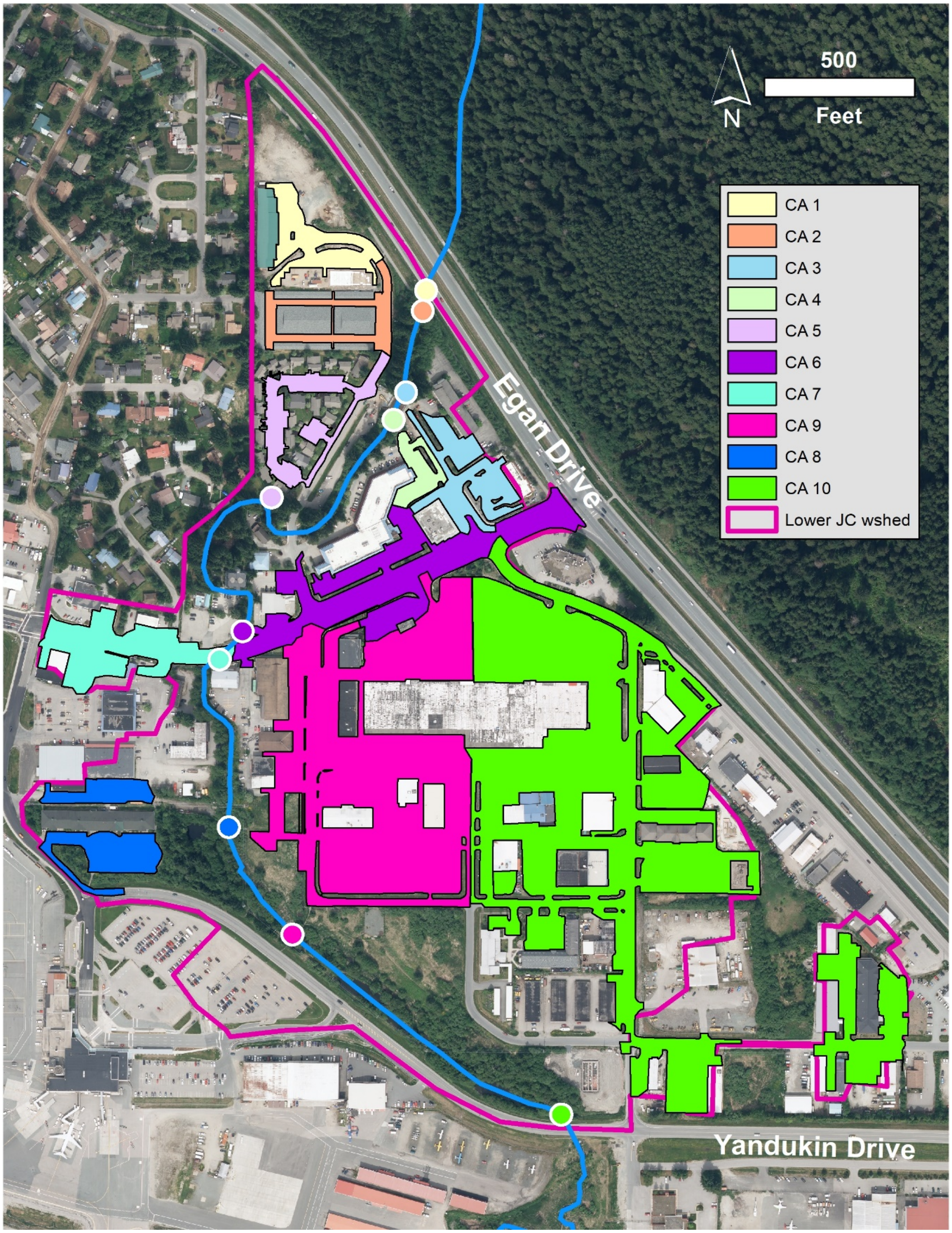

Figure 10. Stormwater contributing areas (CA) and associated outfalls in the Lower Jordan Creek watershed between Egan Drive and Yandukin Drive. Each contributing area consists of non-rooftop impervious surfaces, like roads, sidewalks, and parking lots that shed runoff into stormwater systems. Each of the 10 stormwater systems conveys runoff and associated pollutants into Jordan Creek at the outlet of a pipe or ditch (i.e., outfall). Rooftop runoff likely drains into stormwater systems, but connections were not investigated.

Riparian vegetation: *Development and invasive plant species within the 50-foot riparian buffer next to Jordan Creek have resulted in the loss of over half of the native vegetation (Figure 11). Additionally, existing riparian vegetation is being damaged by disposal of yard waste, snow removal and storage, and parking (Sumner 2018).*

Figure 11. A parking area within the 50-foot riparian buffer along Jordan Creek. (SAWC photo)

4. **Bacteria:** The exact source(s) of bacteria in Jordan Creek stream water is not known. Wildlife and pets are the likely source upstream of Egan Drive at the reference site. High bacteria levels in water collected from stormwater outfalls in the lower watershed during this project suggest that pet waste is a likely source (Figure 12). We have no information indicating that the sewer system (via leakage) is contributing to elevated concentrations, and there are no septic systems in the area. However, human waste has been observed on the ground and illegal camping occurs near the stream in the lower watershed.

Figure 12. Pet waste near a catch basin in the Crest Street right-of-way. An example of a bacteria source in the Lower Jordan Creek watershed. (SAWC photo)

5. **Litter:** The lower Jordan Creek watershed experiences a high volume of both vehicle and foot traffic which increases the likelihood for debris to be deposited within the watershed (Figure 13). It was noted in the residue TMDL that most debris in and around Jordan Creek appeared to be a product of direct input from residential, commercial, and industrial areas or indirect inputs brought into the creek by wind, snowmelt, runoff, or wildlife (ADEC 2005).

Figure 13. Litter in a drainage ditch along Trout Street in the Lower Jordan Creek Watershed.

Watershed Plan Goals:

1. Reduce bacteria levels
2. Reduce the abundance of litter
3. Protect, enhance, or restore the riparian zone within the 50-foot stream setback area
4. Meet sediment water quality standards for metals, PAHs, and sediment size

These goals were developed by SAWC to address the impairments to Jordan Creek listed above. They are intended to guide efforts within the watershed to improve water quality, fish and wildlife habitat, and improving the aesthetic value and community enjoyment of the stream.

Bacteria

Many traditional urban stormwater BMPs are not highly effective at removing bacteria from water, and in some cases can exacerbate the problem. Reducing the sources of bacteria on the landscape can be a more effective approach. Stewardship activities including beautifying the greenbelt and discouraging illicit activities such as camping, creating barriers to prevent damage to the riparian area, and installing garbage cans and pet waste bag dispensers can reduce the amount of fecal waste deposited on the landscape and made available for transport to the stream by stormwater runoff.

Litter

Litter has been identified as a Juneau-wide issue and efforts to work collaboratively to reduce litter city-wide will benefit many watersheds. The highly urbanized portion of the Lower Jordan Creek watershed will be the focus for reducing litter input from residential, commercial, and industrial areas. Stewardship activities such as the annual spring clean-up will be necessary to remove litter that has already been deposited, but efforts to reduce the input of litter on the forefront will be important in reducing the overall litter abundance. One such effort could be a partnership among the CBJ and businesses to install and maintain waste receptacle in the lower watershed. Recently, SAWC partnered with the Juneau International Airport to install bearproof trash cans in the Lower Jordan Creek greenbelt area near the south end of Jordan Ave.

Additionally, efforts to remove litter throughout the year such as partnering with Litter Free, Inc. and the Glory Hall will be important. Litter has been identified as a Juneau-wide issue and efforts to work collaboratively to reduce litter city-wide will benefit many. Glory Hall is an emergency shelter, soup kitchen, and care center that is relocating to the lower watershed. SAWC is actively working with the Glory Hall to enlist their patrons in helping to keep the lower watershed free of litter.

Riparian Enhancement

Restoring and enhancing the riparian zone adjacent to Jordan Creek can be accomplished through a two-fold approach: 1) by protecting or restoring existing riparian areas and 2) by enforcing the City and Borough of Juneau anadromous stream setback ordinance. With a few exceptions, the ordinance prevents disturbance to soil and vegetation within 50 feet of the ordinary high-water mark on both sides of the stream channel. Both efforts are effective in conjunction with education and outreach to inform the public on the role of riparian habitat and how to restore, protect, and enhance that habitat along Jordan Creek.

Sediment as Target Water Quality Constituent

This watershed plan will target sediment in urban stormwater runoff to directly and indirectly address the water quality and habitat issues that have been identified in lower Jordan Creek. BMPs designed to intercept urban stormwater and reduce sediment transport will directly address the issue of streambed sediment size distribution and interstitial dissolved oxygen. Additionally, because sediment transports metals and PAHs from the urban landscape, reducing sediment loads to the stream will simultaneously reduce those pollutant loads. BMPs that are proposed to mitigate sediment transport include improving riparian habitat by increasing riparian area width, reducing damage to vegetation, and improving snow storage practices. Additionally, BMPs that retain stormwater reduce peak storm flow and bank erosion.

Existing Sediment Load Calculations:

Without detailed field sampling, sediment loads can be estimated based on watershed characteristics. A common approach (the Simple Method) estimates sediment yields (weight/area per time) for broad land-use categories (e.g. commercial, residential) based on literature values for runoff coefficients and average sediment concentrations in runoff associated with the different land uses (see Jordan Creek sediment TMDL, ADEC 2009). However, this approach is problematic at the scale of lower Jordan Creek because existing stormwater BMPs may reduce the amount of runoff and sediment concentrations in runoff from existing land cover types relative to these average values, and load estimates will be insensitive to future improvements in stormwater management; the Simple Method will assume a commercial lot produces the same sediment load, regardless of whether stormwater from the lot is piped directly to the stream, or is routed to a bioretention BMP, where most of the stormwater infiltrates into groundwater and sediment settles out.

Because detailed information about land cover and stormwater routing has been mapped for lower Jordan Creek, an alternative approach is to estimate sediment loads based on the area of impervious cover directly connected to Jordan Creek. Studies have found pollutant loads and biotic indicators to be more sensitive to directly connected impervious area than total impervious area in a watershed (e.g. Hatt et al 2004, Taylor et al 2004, Walsh 2004), and strong correlations between annual sediment yields and directly connected impervious area have been documented (Bannerman et al, 1979, Hatt et al, 2004). This method assumes the same relationships observed in the study areas apply to Juneau, but this assumption also exists for the Simple Method.

Annual sediment yield to lower Jordan Creek was estimated using the following equation (Bannerman et al, 1979):

Sediment yield (kg/ha/y) = -13.01 + 17.85*%DCIA

Where DCIA = directly connected impervious area.

DCIA includes paved and gravel parking lots, sidewalks, and roads in stormwater drainage areas with direct connections to Jordan Creek via storm drains, as well as those cover types that drain to the stream through less than 50 feet of riparian vegetation (Sumner 2018). For lower Jordan Creek, the DCIA is 40 ac or 39.9% of the lower watershed area (Table 3).

Table 3. Existing annual sediment load to lower Jordan Creek

Lower Jordan Creek contributing area (ac)	Directly connected impervious area (ac)	% Directly connected impervious area	Annual sediment yield (lb/ac)	Annual sediment load (lb)
100.3	39.98	39.86	622	62,400

Load Reductions Needed

Sediment load reduction targets are calculated to address total PAH concentrations in sediment, the pollutant with the greatest exceedance over criteria. The maximum total PAH concentration measured in sediment was 3916 µg/kg at Glacier Hwy, 15 times as high as the TEL of 264.1 µg/kg. Conservatively assuming that all incoming sediment from urban runoff has a total PAH concentration that, when mixed with background sediment inputs from upstream, results in the highest concentration observed in the stream bed, total sediment load from urban stormwater runoff in lower Jordan Creek watershed should be reduced by 93 percent[5] to meet PAH criteria (Table 4).

Table 4. Sediment load reduction target for Jordan Creek

Existing Sediment Load (lbs/y)	Percent Reduction Needed	Target Sediment Load (lbs/y)	Sediment Load Reduction Needed (lbs/y)
62,400	93	4,368	58,032

The use of a single sample maximum (SSM, i.e., 3916 µg/kg) PAH concentration observed in the stream bed at Glacier Highway for the basis of a sediment load reduction goal is intended to provide a conservative estimate of sediment reduction that would result in the entire stream attaining water quality standards and be most protective of aquatic life. This said, the SSM is over 3 times higher than the next highest PAH concentration detected (1256.5 ug/kg), also at Glacier Highway. The Glacier Highway sampling site receives stormwater inputs from areas with extremely high vehicular traffic, including the McDonalds and Breeze In parking lots and Glacier Highway. It is likely that this traffic contributes to the high PAH concentrations found at Glacier Highway, and it is unknown if PAH concentrations as high as the SSM are common. While the maximum PAH concentration found at the Jordan Ave. South site (1272.25 µg/kg) was still nearly 5 times higher than the TEL, it is possible that this site could attain water quality standards for PAH with only a 26% reduction in total sediment load.

The next sections outline a plan to address total sediment load throughout the watershed through cost effective and modest stormwater BMPs, with the goal of an overall reduction of sediment by 93% or 58,032 lbs/year (Table 2). As shown in Sections B, Expected Load Reductions, and Section C, Description of Stormwater Management Projects, this level of sediment reduction may not be possible without more intrusive and extensive measures, particularly for the priority outfalls likely contributing to the high level of PAH found at Glacier Highway. For this reason, a recommendation includes re-evaluating the sediment reduction goal after the completion of the priority projects listed in Section C (See Section F. Implementation Schedule). If sediment reduction has not decreased PAH concentration sufficiently at the Glacier Highway site, it is possible more intrusive and expensive built infrastructure may be necessary to treat runoff from stormwater systems 3, 6, and 7 to attain water quality standards.

B. Expected Load Reductions from Management Measures

Many new BMPs throughout the watershed will be required to reduce sediment transport to Jordan Creek. Ideally, urban stormwater is treated near the source, but because of the dense development in lower Jordan Creek watershed, "end-of-pipe" treatment infrastructure is also likely going to be required to reach sediment reduction goals. A comprehensive list of BMP options for lower Jordan Creek is included in Appendix B. Table 3 (below) includes BMPs thought to be the most efficacious and/or

[5] 100 - (264.1/3916 µg/kg * 100)

feasible at the time of writing this report, but landowner priorities and funding opportunities may dictate the selection of different options.

The sediment load reduction associated with each BMP is estimated based on the amount of impervious area that it drains and disconnects from the stream and an "effectiveness" factor that is applied to account for incomplete treatment. Based on equation 1, each decrease of 1% DCIA results in a sediment yield decrease of 17.85 kg/ha/y. The following conversions were used to estimate the annual sediment load reduction associated with the disconnection of and complete treatment of stormwater from 1 acre of impervious cover in lower Jordan Creek watershed:

$$\frac{17.85\text{ kg}}{\text{ha*y*1\%DCIA}} * \frac{1\text{ ha}}{2.47105\text{ ac}} * \frac{2.20462\text{ lb}}{1\text{ kg}} * \frac{1\%\text{ DCIA}}{1.003\text{ ac}} * \frac{100.3\text{ ac}}{} = 1593\text{ lb}$$

Effectiveness factors for BMPs were derived from a recent summary report of the effectiveness of a variety of BMP types at removing different types of pollutants from stormwater (Clary et al, 2017). We selected the median effectiveness of total suspended solids (TSS) removal associated with the BMP type from the study that was most similar to the proposed BMP. In some cases, when we knew the proposed BMP was undersized or had some other mitigating condition, we further reduced the effectiveness factor. In the case of bioretention BMPs, we increased the effectiveness factor from the reported median value of 0.75 to 0.85 to account for greater expected performance due to enhanced design and maintenance procedures.

Stormwater enters Jordan Creek in two different ways. Conventional stormwater systems - consisting of curb and gutter, catch basins, pipes, and ditches - deliver stormwater to the stream at the outlet of a pipe or ditch. Stormwater also enters Jordan Creek without the assistance of special infrastructure. This type of runoff is associated with distinct flow paths or indistinct sheet flows from paved parking lots into narrow riparian areas. Most of the sediment in this type of runoff is assumed to reach the stream.

TSS load reductions associated with proposed stormwater management projects are provided in Tables 5 and 6. The load reduction refers to the annual weight of sediment that will not enter Jordan Creek as a result of the management projects. Table 5 lists stormwater management projects that are associated with a conventional stormwater system (i.e., systems 1-10, Figure 10). Table 6 lists stormwater management projects that address stormwater entering the stream by means other than a conventional system as described above.

Summed together, the BMPs in Table 5 and Table 6 will capture 49,729 lbs. of the current 62,400 lb. estimated annual sediment load, an 80% reduction. However, realized load reductions from current levels may be lower for two reasons: 1) some of the proposed BMPs are nested within stormwater sub-catchments, and the sediment load reductions for individual BMPs are estimated assuming no upslope BMPs are installed. If upslope BMPs are implemented, less sediment would reach downslope BMPs (e.g.

a bioswale installed at an outfall would retain less sediment if upstream bioretention BMPs are also installed); and 2) some of the projects listed are alternatives for the same sub-catchment area. Therefore, if all projects in *Table 5* and Table 6 are implemented, the total amount of sediment removed may likely be less than a simple total of estimated removal provided here.

Table 5. Estimated reduction in sediment load from stormwater management projects proposed for stormwater systems in the Lower Jordan Creek watershed. Management projects are labeled according to the stormwater system number and project number (e.g., management project 2.1 refers to project 1 in stormwater system 2. Refer to Figure 10 and Appendix A for stormwater system maps and descriptions).

Management project	***Efficiency Factor***[6]	***Area affected (ac)***	***Load reduction (lb/y)***[7]	***Estimated Financial Cost***[8]
2.1 Enhance existing basin	0.69	0.86	945	$$
3.1 Enhance existing ditch	0.23	1.46	535	$
3.2 Convert existing landscaping areas in McDonald's parking lot to bioretention BMPs	0.85	0.46	623	$$$$
3.3 Replace Breeze In parking lot with permeable pavement	.72	0.21	241	$$$$
4.1 Convert the two parking lot catch basins to bioretention BMPs.	0.85	0.35	4,474	$$$
5.1 Construct stormwater wetland	0.55	1.32	1,157	$$$
5.2 Construct bioretention BMPs near catch basins where space is available in grass or landscaped areas.	0.85	0.36	487	$$$
5.3 Replace the catch basins at each end of the private loop drive with sand filter vaults.	0.84	0.98	1,311	$$$$
6.1 Construct bioretention BMPs near catch basins where space is available in grass or landscaped areas.	0.85	2.36	3,196	$$$$
6.2 Install curb cuts to infiltrate runoff in riparian zone	0.29	0.07	32	$

[6] Unless otherwise noted, efficiency values are from Clary et al, 2017, International Stormwater BMP Database 2016 summary statistics. The median change in TSS from inlet to outlet associated with the relevant BMP type is presented in this table.
[7] Acres affected X efficiency factor X 1590. Conversion to sediment load reduction derived from Bannerman et al. 1979 relationship between percent of the watershed that is impervious area directly connected to the stream and annual sediment load.
[8] *$ <$1,000, $$ $1,000-$5,000, $$$ $5,000-$15,000, $$$$ >$15,000*

6.3 Resurface First National Bank parking lot with permeable pavement	0.72	0.22	252	$$$$
7.1 Construct bioretention BMPs near catch basins where space is available in grass or landscaped areas.	0.85	0.74	1,002	$$$$
9.1 Route all runoff from this system into a wet biofiltration swale constructed on CBJ land at the south end of Jordan Ave.	0.75	10.29	12,294	$$$
9.2 Construct bioretention BMPs near catch basins where space is available in grass or landscaped areas	0.85	5.26	7,122	$$$$
10.1 Work with Valley Lumber management to stop staff from parking in swales that slope to catch basins.	0.16	1.11	283	$$
10.2 Manage ditches on both sides of Teal Street East as stormwater BMPs (install check dams and protect vegetation)	0.23	2.55	934	$$
10.3 Where feasible, construct bioretention BMPs near catch basins.	0.85	8.80	11,916	$$$$
10.4 Convey runoff in the Teal St. East ditches into the swale along the east side of Alpine Ave. south	1.00	1.14	1,816	$$$$
10.5 Replace asphalt parking lots with permeable pavement on 4 private parcels	0.72	1.84	2,110	$$$$
Total		**40.4**	**46,730**	

Table 6. Estimated reduction in sediment load from stormwater management projects proposed for parking lot runoff that is not associated with a conventional stormwater system (i.e., pipe or ditch) in the Lower Jordan Creek watershed.

Management project/measure	***Efficiency Factor***	***Area affected (ac)***	***Load reduction (lb/y)***	***Estimated Financial Cost***
JCC.1 Remove unneeded parking spaces and restore riparian vegetation in reclaimed areas.	1	0.05	87	$$$
JCC.2 Resurface parking areas with permeable pavement or install infiltration strips at the edge of pavement	0.72	1.02	1170	$$$-$$$$
JSN.1 Convey primary runoff flow paths from the parking lot area into a bioretention BMP or infiltration trench in the riparian buffer.	0.85	0.50	677	$$$
JSN.2 Eliminate parking on the northwest side of the building and revegetate.	1.0	0.06	96	$$
JSS.1 Relocate snow storage outside of riparian zone and revegetate with native plants	0.75	0.28	336	$
JSS.2 Enhance narrow buffer strip at edge of parking area	0.29	0.50	227	$
CC.1 Install a stormwater BMP to intercept runoff on the north side of the office building.	0.85	0.30	406	$$
Total		**1.88**	**2,998**	

C. Description of Stormwater Management Projects

Lower Jordan Creek is highly urbanized, but there is still space for stormwater BMPs to be installed in many locations to treat runoff either at the source or just prior to entering the stream. Descriptions of specific BMPs and their locations are detailed below. BMPs are also discussed in greater detail in Appendix A. In addition to location-specific infrastructure, area-wide changes in some types of behaviors and management are needed to meet the goals of reducing bacteria and litter, restoring riparian buffers, and reducing sediment runoff and preventing further degradation.

Stormwater System 2

2.1 The basin should be enlarged to the greatest extent possible to increase capacity and retention time. To eliminate the short circuit, install a new outlet at the north end of the basin and convey overflow under the adjacent multi-use trail to a grass swale on the south side of Egan Drive.

Stormwater System 3

3.1 Install check dams in a ditch on the north side of Trout Street. The purpose of the dams is to promote runoff storage and infiltration. Establish wetland plants in the ditch to promote sedimentation and stormwater treatment. This project should be considered a low-cost temporary BMP as the ditch is undersized for the contributing area and very high pollutant loads.

3.2 Convert landscaped areas in the McDonald's parking lot to bioretention BMPs.

3.3 Replace the asphalt parking lot at the Breeze In with permeable pavement.

Stormwater System 4

4.1 Convert the two existing catch basins to bioretention BMPs.

Stormwater System 5

5.1 Stormwater from this system is discharged to Jordan Creek from a pipe. Remove the last 30 feet of pipe and construct a stormwater wetland to treat runoff.
5.2 Construct bioretention BMPs around the catch basins that are in grass or landscaped areas along Jordan Ave. and on private property.
5.3 Replace the catch basins at each end of the Jordan Creek Condos Loop with sand filter vaults. The basins are in the center of the roadway.

Stormwater System 6

6.1 Convey roadway and parking area stormwater to bioretention BMPs constructed in vegetated areas on the back side of sidewalks along Glacier Hwy. and Jordan Ave. Convey runoff from existing curb and gutter into the basins through slot drains installed in sidewalks immediately upstream of each catch basin. Install a bioretention BMP around the catch basin at the northwest edge of the Nugget Mall Parking lot.

6.2 Install multiple curb cuts on the west side of First National Bank to spread runoff along a narrow riparian strip next to Jordan Creek. Eradicate invasive reed canarygrass and plant native vegetation in the strip.
6.3 Resurface the First National Bank parking lot with permeable pavement.

Stormwater System 7

7.1 Convey roadway and parking area stormwater to bioretention BMPs constructed in vegetated areas on the back side of sidewalks. Convey runoff from existing curb and gutter into the basins through slot drains installed in sidewalks immediately upstream of each catch basin.

Stormwater System 9

9.1 Construct a wet biofiltration swale on undeveloped CBJ land at the south end of Jordan Ave.

9.2 Convey roadway and parking area stormwater to bioretention BMPs constructed on the back side of sidewalks. Convey runoff from existing curb and gutter into the basins through slot drains installed in sidewalks immediately upstream of each catch basin.

Stormwater System 10[9]

10.1 Work with Valley Lumber management to avoid parking in a grass swale along the northeast edge of Crest Street. Vehicle use of this area has caused severe rutting, damage to vegetation, and erosion. Runoff from this area carries suspended sediment, and likely pollutants from vehicles, into nearby catch basins.

10.2 Manage ditches on both sides of Teal Street East as stormwater BMPs. Install check dams and maintain vegetation to promote runoff filtration and infiltration. Encourage adjacent landowners to avoid storing plowed snow in the ditches.

10.3 Where feasible, convey roadway and parking area stormwater to bioretention BMPs constructed on the back side of sidewalks. Convey runoff from existing curb and gutter into the basins through slot drains installed in sidewalks immediately upstream of each catch basin.

10.4 Runoff in ditches on both sides of Teal Street East flows into stormwater system 10 at Crest Street. Route runoff from these ditches towards the west and eventually into an existing grass swale on the east side of Alpine Ave. South. This project will require installing a culvert under Teal Street to connect the north ditch to the swale.

10.5 Replace asphalt parking lots with permeable pavement at the Aspen Suites Hotel, Valley Lumber, Juneau Print Group, and Honda Hut parcels.

Jordan Creek Center

JCC.1 There is a parking lot on the west side of Jordan Creek that encroaches on the stream. Remove a small portion of the parking lot at the north end and restore native riparian vegetation at the site.

[9] CBJ is planning to reconstruct Crest Street in 2021. As of January 2021, CBJ staff and engineering contractors are suggesting a bioswale along most of the east side of the street. Stormwater runoff from the street and adjacent properties will be routed to the swale to the greatest extent possible.

JCC.2 Parking areas on the east and west sides of Jordan Creek encroach to within a few feet of the stream. Replace asphalt with permeable pavement or install infiltration strips at the edge of the paved areas.

Jordan Square North

JSN.1 Reconfigure the Jordan Square North parking lot to reclaim the maximum amount of riparian area that is possible. Construct a bioretention BMP in the southeast corner of the parcel to receive parking lot runoff.

JSN.2 Eliminate streamside parking on the northwest side of the building and revegetate.

Jordan Square South

JSS.1 Work with the Jordan Square South owner to avoid storing snow in unpaved portions of the riparian setback. Plant native vegetation in setback areas that have been used for snow storage to improve habitat and enhance the effectiveness of runoff treatment.

JSS.2 Plant native vegetation in the narrow buffer strip between the parking area and Jordan Creek to enhance infiltration and treatment of runoff, and to provide shade and habitat.

Central Council Tlingit and Haida Indian Tribes of Alaska (CCTHITA) Parcel

CC.1 Install a stormwater BMP to intercept runoff from a new parking area expansion on the north side of the building.

Stormwater Management Measures:

The following are stormwater management measures that are not infrastructure related or do not address sediment loading.

Stormwater System 1

- Investigate the functionality of existing BMPs. For example, assess stormwater infiltration rate and storage capacity during runoff events.

Stormwater System 3

- Determine if the two existing catch basins are oil/water separators and replace with separators if necessary.

Stormwater System 4

- Work with landowner to store snow in areas where meltwater will not flow into the stream and where snow piles will not damage riparian vegetation.

- Investigate functionality and maintenance of existing oil/water separator.

Stormwater System 8

- Replant infiltration trench corridor on the north side of the Extended Stay hotel using native trees and shrubs, as per original 404 permit.
- Install educational signage describing the existing stormwater BMPs.

CCTHITA Parcel

- Investigate the functionality of the existing infiltration trench during runoff events.

Yandukin Drive Middle and East:

- Monitor the outfall areas (i.e., swales in right-of-way) during large runoff events to ensure adequate stormwater storage and infiltration within the swale. If runoff enters the stream as a surface flow, modify the swale areas to increase infiltration and storage capacity.
- The Yandukin Drive East stormwater outfall discharges runoff into a swale next to Jordan Creek. Juneau International Airport has historically stored snow on the swale and the banks of Jordan Creek. Annually remind the airport to avoid this practice. Also, plant native woody plants on the stream banks in this area to provide habitat, improve runoff treatment, and increase transpiration rates from the swale.

Area-Wide Recommended Management Measures:

1. When reconstructing roads and parking lots:
    a) if ditches are replaced with conventional stormwater infrastructure (i.e., curb/gutter, catch basins, pipes) install stormwater BMPs to treat and infiltrate runoff.
    b) route runoff to new stormwater BMPs that offer maximum flow control (infiltration) and runoff treatment (e.g., bioretention).
    c) replace impermeable asphalt with permeable pavement/pavers to eliminate or minimize runoff
2. Improve snow management
    a) store snow where meltwater will not flow directly into the stream
    b) don't store snow on riparian vegetation or within the 50-foot riparian setback
    c) avoid damaging riparian vegetation during snow management activities

3. Don't use coal-tar asphalt sealant; runoff from sealed surfaces can be toxic to aquatic life
4. Remove sediment from streets and parking lots frequently
5. Vacuum sediment from catch basins regularly
6. Maintain and clean oil and water separators, and other existing BMPs
7. Limit ditch cleaning and protect or remove/replace vegetation when cleaning does occur

8. Prevent further riparian encroachment (work with landowners to comply with setback ordinance) and restore setback areas when possible.
9. Restore impacted stream setback areas if feasible
10. Require stormwater BMPs in new construction and reconstruction

Stormwater System Priority Levels:

The human and financial resources available to manage stormwater in the Lower Jordan Creek watershed are limited. Table 7 assigns one of four priority levels to each stormwater system to ensure that stormwater management resources are directed to areas that have the greatest impact on Jordan Creek. Priority levels reflect our best professional judgement and consideration of the size of the stormwater contributing area, presence, and effectiveness of existing BMPs, traffic/parking density, landowner support, constructability, and our visual assessment of runoff water quality (e.g., turbidity).

Table 7. Stormwater system prioritization

Storm-water System	Priority Level	Rating Notes
1	Low	Existing BMPs appear to be well designed and functioning properly. BMPs will be assessed during storm events to identify opportunities for improvements.
2	Med-high	Existing BMP is undersized for the contributing area, BMP should be enlarged and reconfigured to maximize effectiveness, landowner willingness and constructability is likely high
3	High	Contributing area experiences high vehicle use, runoff quality appears to be very low, no existing BMPs except for a vegetated ditch, inexpensive temporary solutions are available until funding for permanent BMPs are available
4	Med-low	Existing oil/water separator, small size, low vehicle use
5	Med-high	Large contributing area, lack of BMPs, space available for low-cost bioretention BMPs in existing grass areas, potential for end-of-pipe treatment and in-stream habitat improvement
6	High	Large contributing area, poor water quality, only BMP is an oil/water separator just before the outfall
7	Med-low	Space limited, high vehicle use
8	Low	Existing BMPs that appear to be high functioning, low vehicle use
9	High	Large catchment, limited BMPs
10	High	Large contributing area, poor water quality observed in outfall ditch, space available for bioretention BMPs near existing catch basins, opportunity to construct an effective stormwater BMP at downstream end as a midterm solution

Priority Stormwater Management Projects:

High priority stormwater management projects are listed in Table 8. These projects are considered a priority for implementation in the next 5 years because they are in high priority stormwater systems, are supported by the landowner, or are cost-effective means of reducing sediment loading in Jordan Creek. Stormwater management projects and measures that are in lower priority stormwater systems are a secondary priority and will be evaluated for financial and technical resources, but their implementation will be on a longer time track. Implementing projects across all stormwater systems is important from a watershed perspective to ensure a robust and functioning system throughout all reaches.

D. Technical and Financial Assistance

Implementing the management projects discussed above will require technical and financial assistance from partnering organizations (Table 9). A strategic approach for identifying and securing funding will be necessary given the breadth of project types and landowners and managers. Some known funding opportunities that fit the projects proposed include the Alaska Clean Water Actions (ACWA) grant program, National Fish & Wildlife Foundation (NFWF), CBJ capital improvement funds, ADEC Clean Water State Revolving Fund, and USFWS Habitat Restoration Program. In addition to these funding sources, financial assistance for project implementation could be secured through partnering with the City and Borough of Juneau and/or ADOT&PF when roads are scheduled to be repaved or redesigned, as is the case with Crest Drive (stormwater system 10), and with landowners and businesses where possible.

Table 8. Highest priority stormwater management measures.

High priority stormwater management projects	***Load reduction (lb/y)***
3.1 Enhance existing ditch	*535*
3.2 Convert existing landscaping areas in McDonald's parking lot to bioretention BMPs	*550*
JCC.1 Remove unneeded parking spaces and restore riparian vegetation in reclaimed areas.	*87*
6.1 Construct bioretention BMPs near catch basins where space is available in grass or landscaped areas.	*2820*
9.1 Route all runoff from this system into a wet biofiltration swale constructed on CBJ land at the south end of Jordan Ave.	*12,294*
9.2 Construct bioretention BMPs near catch basins where space is available in grass or landscaped areas	*6284*
10.3 Construct bioretention BMPs near catch basins	*11,916*

Table 9. Potential lead organization, technical and financial assistance needed, partners, and potential obstacles associated with priority BMPs. Estimated cost categories: $ < $1,000, $$ 1,000-$5,000, $$$ 5,000-$15,000, $$$$ > $15,0000.

Project	**Lead Org.**	**Partners**	**Estimated Cost/Funding Sources**	**Technical Resources Needed**
2.1: Enhance existing infiltration basin.	SAWC	CBJ	$$ CBJ	Informal designs, CBJ approval
3.1: Enhance existing ditch	SAWC	CBJ	$$	informal design for CBJ review and approval
3.2: Construct bioretention planters in McDonald's lot	SAWC	private landowner	$$$$	Professional engineering designs
4.1: Convert two parking lot catch basins into bioretention planters	SAWC	private landowner	$$	Professional engineering designs or possibly a standard design
5.1: Construct stormwater wetland	SAWC	private landowner	$$$	Informal designs
5.2: Construct bioretention BMPs	SAWC	CBJ	$$$	Professional engineering designs
5.3: Replace catch basins with sand filters	SAWC	landowner	$$$$	Professional engineering designs
6.1: Construct bioretention BMPs	ADOT& PF	SAWC, JCC, CBJ, Nugget Mall	$$$$	Professional engineering designs
6.2 Install curb cuts to infiltrate runoff in riparian zone	SAWC	private landowner	$$	NA
6.3 Resurface First National Bank parking lot with permeable pavement	landow ner	SAWC	$$$$	Professional engineering designs
7.1 Construct bioretention planters near catch basins where space is available in grass or landscaped areas.	ADOT& PF	SAWC and various private landowners	$$$$	Professional engineering designs
9.1 Route all runoff from this system into a wet biofiltration swale constructed on CBJ land at the south end of Jordan Ave.	SAWC	private landowner	$$$	informal designs
9.2 Construct bioretention planters near catch basins where	SAWC	ADOT&PF and private landowners	$$$$	Professional engineering designs

space is available in grass or landscaped areas				
10.1 Work with Valley Lumber management to stop staff from parking in swales that slope to catch basins.	CBJ	SAWC	$	NA
10.2 Manage ditches on both sides of Teal Street East as stormwater BMPs (install check dams and protect vegetation)	SAWC	CBJ	$$	Informal designs, CBJ approval
10.3 Where feasible, construct bioretention BMPs near catch basins.	CBJ	SAWC	$$$$	CBJ redesign (all of 10)
10.4 Convey runoff in the Teal St. East ditches into the swale along the east side of Alpine Ave. south	SAWC	CBJ, landowners	$$$$	Professional engineering designs
10.5 Replace asphalt parking lots with permeable pavement on 4 private parcels	SAWC	landowners	$$$$	Professional engineering designs

E. Education and Outreach Component

Through education and outreach SAWC aims to convey to local stakeholders the importance of Jordan Creek, the status of water quality in Jordan Creek, the causes of impairment, and the nonpoint source management measures that can be implemented to restore Jordan Creek. An overarching goal of all education and outreach activities has been to develop lasting relationships with landowners and land managers within the Jordan Creek Watershed to foster long-term stewardship of the watershed. The target stakeholders and the associated education and outreach message and method to convey that message are detailed in Table 10.

Table 10. Education and outreach stakeholders, directed messages to each stakeholder, and the methods to convey that message.

Stakeholder/audience	Education & Outreach Message	Methods to Convey Message
CBJ	Management entity for land that surrounds Jordan Creek, an impaired waterbody	Meetings, project reports, presentations and site tours that educate relevant staff about Jordan Creek
ADOT&PF	Management entity for land that surrounds Jordan Creek, an impaired waterbody	Meetings, project reports, presentations and site tours that educate relevant staff about Jordan Creek
Residents	Jordan Creek is an important waterbody that is currently impaired. Together we can help restore Jordan Creek.	Press releases, project reports, community presentations, interpretive signs, direct conversations, site tours, flyers
Business owners	Jordan Creek is an important waterbody that is currently impaired. Together we can help restore Jordan Creek.	Press releases, project reports, community presentations, direct conversations, site tours, flyers
Juneau Community	Jordan Creek is an important waterbody that is currently impaired. Together we can help restore Jordan Creek.	Press releases, project reports, community presentations, interpretive signs, site tours
Local nonprofit organizations	Jordan Creek is an important waterbody that is currently impaired. Together we can help restore Jordan Creek.	litter clean up campaigns, annual spring clean-up, collaborations on projects of shared interest

Below are specific education and outreach activities that have been implemented as part of the development of this Plan.

- SAWC staff have met with and been in close communication with CBJ Engineering and Public Works staff to ensure an open line of communication regarding implementation of stormwater management measures that are proposed throughout the Jordan Creek watershed.
- SAWC hosted a tour of the Lower Jordan Creek Watershed with the ADEC Division of Water Director to highlight water quality impairments and management measures that have been installed and locations for proposed projects.
- SAWC staff have met with several landowners in the lower watershed to discuss urban impacts on Jordan Creek and how landowners can help improve habitat and water quality in the stream.
- SAWC developed 2 flyers and a post card that were sent/delivered to most businesses, renters, and landowners in the Lower Jordan Creek watershed. These materials described the importance of the watershed, the impaired status of the stream, causes of impairment, stewardship recommendations, and past and future restoration and enhancement efforts.
- SAWC organized a meeting with the Glory Hall director, members of Litter Free, Inc., and the Juneau International Airport deputy manager to discuss opportunities to partner on stewardship opportunities, including letter prevention and clean-ups.
- SAWC organized a riparian restoration event in which local cub scouts planted trees
- SAWC worked with CBJ engineering staff and contractors to incorporate stormwater BMPs in the Crest Street reconstruction project.
- SAWC staff gave presentations about the Lower Jordan Creek watershed to the Juneau Chapter of the Audubon Society, Alaska Capital Engineers, two Juneau Rotary clubs, a UAA environmental class, and management of the Nugget Mall.

These education and outreach efforts are critical to achieving the goals outlined in this plan: (1) to reduce bacteria contamination and litter, (2) restore and enhance native vegetation in riparian buffer areas, and (3) meet sediment water quality standards for metals, PAHs, and sediment size.

F. Implementation Schedule

The implementation schedule outlines a suggested timeline that is reasonably expeditious in guiding efforts to restore Jordan Creek and accounts for prioritization of outfalls, financial and technical resources needed, and project readiness (Table 11). This schedule will be reevaluated by SAWC staff annually and updated as needed. SAWC is proposing to implement 9 high priority projects in the next 5 years. Following the implementation of these high priority, high impact projects SAWC will monitor and evaluate the effectiveness of these projects in reducing sediment load to Jordan Creek.

Table 11. Project implementation timeline. Projects are split between primary (high priority) and secondary (lower priority). The first project effectiveness monitoring period will be in 2025-26.

Stormwater Management Project (high priority, see Sect. A above for details)	**2021**	**2022**	**2023**	**2024**	**2025**	**2026-2030**	**2031-2035**
3.1		*X*					
3.2						*X*	
JCC.1	*X*	*X*					
6.1						*X*	
9.1	*X*	*X*					
9.2				*X*	*X*	*X*	
10.3			*X*	*X*			
Secondary Projects (lower priority, see Sect. A above for details)							
2.1				*X*			
3.3						*X*	*X*
4.1						*X*	*X*
5.1				*X*			
5.2						*X*	*X*

5.3						*X*	*X*
7.1						*X*	*X*
6.2				*X*			
6.3						*X*	
10.1				*X*			
10.2				*X*			
10.4				*X*			
10.5					*X*		
10.6						*X*	

G. Milestones

Project implementation depends on the convergence of many factors, including the availability of money, willing landowners, and organizational capacity to complete the project. Therefore, the timing of projects outlined in Table 11 may vary from the exact path of progress toward improved sediment and water quality in Jordan Creek. However, these milestones are reasonable targets for implementation of management projects and measures (Table 12).

Table 12. Indicators to be monitored and associated milestones (i.e., targets).

Indicator	**Year 2025 interim target**	**Year 2030 interim target**	**Year 2035 Target**
Sediment loading indicator			
1. PAH[1] (sediment)	concentrations are below 2019/20 levels	Concentrations are below 2025 levels	Concentrations are below TEL
2. Zinc[1] (sediment)	concentrations are below 2019/20 levels	Concentrations are below 2025 levels	Concentrations are below TEL
3. Lead[1] (sediment)	concentrations are below 2019/20 levels	Concentrations are below 2025 levels	Concentrations are below TEL
4. Copper[1] (sediment)	concentrations are below 2019/20 levels	Concentrations are below 2025 levels	Concentrations are below TEL
5. Sediment size[1]	The average (of 3 samples) fine sediment range (0.1 to 4 mm) is reduced from 32% to 30% or lower	The average (of 3 samples) fine sediment range (0.1 to 4 mm) is 28% or lower	The average (of 3 samples) fine sediment range (0.1 to 4 mm) is 26% or lower
Other indicators			
6. Bacteria[1]	Establish baseline fecal coliform & E.coli levels at a reference and urban site in the lower watershed by 2022. Sampling to occur in July.	Fecal coliform & E.coli levels at the urban sampling site reduced by 50% from baseline levels. Sampling to occur in July.	Fecal coliform & E.coli levels meet Alaska Water Quality Standards for the *contact recreation* designated use. Sampling to occur in July.
7. Riparian vegetation	0-25 feet: achieve 50% coverage with natural vegetation	0-25 feet: achieve 55% coverage with natural vegetation	0-25 feet: achieve 60% coverage with natural vegetation

	25-50 feet: achieve 40% coverage with natural vegetation	25-50 feet: achieve 44% coverage by natural vegetation	25-50 feet: achieve 47% coverage by natural vegetation
8. Litter	Establish a litter abundance index area in 2021. Establish a baseline value from annual measurements in 2021-2023	Litter abundance in the index area reduced by 25% from baseline level	Litter abundance in the index area reduced by 50% from baseline level
Project Implementation	70% of projects proposed are implemented	85% of projects proposed are implemented	95-100% of projects proposed are implemented
[1]as measured at the sample sites shown in Figure 2			

H. Criteria for Assessing Progress

The following criteria will be used to assess progress towards meeting the goals of this action plan, including progress towards sediment loading reductions required to meet water quality standards (Table 13). Assessing progress over time will inform SAWC and project partners on our efforts toward attaining water quality standards in Jordan Creek.

Table 13. Indicators and the associated criteria for assessing progress.

Indicator	Criteria for Assessing Progress
Sediment loading indicators	
1. PAH	PAH concentrations assessed through sampling at three sites (Egan, Glacier, Yandukin) and analyzed by a qualified laboratory.
2. Zinc	Zinc concentrations assessed through sampling at three sites (Egan, Glacier, Yandukin) and analyzed by a qualified laboratory.
3. Lead	Lead concentrations assessed through sampling at three sites (Egan, Glacier, Yandukin) and analyzed by a qualified laboratory.
4. Copper	Copper concentrations assessed through sampling at three sites (Egan, Glacier, Yandukin) and analyzed by a qualified laboratory.
5. Sediment size	Streambed sediment size will be assessed through sampling at three sites (Egan, Glacier, Yandukin) and analyzed by SAWC.
Other Indicators	
6. Bacteria	Fecal coliform and E. Coli levels detected at the Egan Drive reference site and Yandukin Drive.
7. Riparian Vegetation	Natural vegetation cover within 0-25 and 25-50 feet of the stream as documented through the riparian condition assessment.
8. Litter	Litter quantity as documented through the annual litter assessment conducted within the 100 linear foot index reach and extending 50 feet laterally.

I. Monitoring

Monitoring will allow evaluation of BMP effectiveness over time as measured against the criteria listed above. Monitoring will take place on a project-specific level and at the watershed scale. Table 14 below outlines the monitoring deliverables that are associated with each indicator. In addition to monitoring these indicators, project-specific monitoring should occur following each project implementation. In 2026, a full sediment load analysis is proposed to track progress toward reaching the overall watershed sediment load reduction of 93% (i.e., 58,032 lb/year). This monitoring will assess which stormwater systems future efforts may need to target and if larger scale interventions are necessary to reduce sediment PAH concentrations from high traffic areas such as Glacier Highway and the McDonalds/Breeze-In parking lots (see discussion on load reductions needed in Section A). Monitoring will be contingent on the availability of funds and the schedule below may change depending on actual implementation date and other factors.

Table 14. Indicators and the associated monitoring deliverable.

Indicator	Monitoring Deliverable
Sediment loading indicator	
1. PAH[1] ((sediment)	Sampling every 3 years
2. Zinc[1] (sediment)	Sampling every 3 years
3. Lead[1] (sediment)	Sampling every 3 years
4. Copper[1] (sediment)	Sampling every 3 years
5. Sediment Size	Sampling every 3 years
Other Indicators	
6. Bacteria	Conduct bacteria monitoring (fecal coliform and E. Coli) annually within Jordan Creek. Measure levels at the Egan Drive reference site and Yandukin Drive.
7. Riparian vegetation	Conduct riparian condition assessment every 3 years. Identify sites where riparian conditions have changed (e.g., % impervious surface) and document activities/actions that contribute to the change.
8. Litter	Conduct a litter assessment annually within an index reach representative of Lower Jordan Creek. The reach should be 100 ft. long and extend 50 ft. laterally from each streambank. Quantify litter within the index area and examine trends relative to litter education initiative and cleanup efforts.

Appendices (available as separate documents)

Appendix A. Stormwater System Descriptions and Stormwater Best Management Practice Actions for the Lower Jordan Creek Watershed, February 2021.

Appendix B. Stormwater Best Management Practices Appropriate for the Lower Jordan Creek Watershed. February 2021.

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Appendix A

Stormwater System Descriptions

and

Stormwater Best Management Practice Actions

for the Lower Jordan Creek Watershed

February 2021

Stormwater from the west end of Mallard Street drains to stormwater system 9 in the Lower Jordan Creek watershed.

Contents

Introduction

Stormwater

Stormwater is water that originates from rain or melted snow and ice. In urban areas, impervious surfaces such as rooftops, roads, and parking areas accumulate and shed stormwater, which is commonly referred to as runoff (Figure 1). Runoff originating on impervious surfaces often contains pollutants like heavy metals, nutrients, petroleum hydrocarbons, sediment, and bacteria. These pollutants can degrade the quality of surface and groundwater and can be harmful to aquatic life.

Figure 1. Rain and melted snow from a parking lot flow into a catch basin at the intersection of Old Dairy Road and Crest Street in the Lower Jordan Creek watershed. January 2013.

Urban stormwater runoff from impervious surfaces is usually conveyed to a stormwater system. These systems consist of a series of interconnected infrastructures that collect and convey runoff, most often to a surface water body like a stream, lake, or wetland. A typical urban runoff pathway begins when stormwater accumulates upon and then flows across an impervious surface (e.g. paved parking lot). These surface flows commonly enter underground catch basins that are interconnected by pipes. Runoff exiting the most downstream catch basin is discharged from the end of the pipe (i.e. outfall) into a water body or a stormwater BMP. For this project, the ends of ditches that convey runoff to a water body are also considered to be stormwater outfalls.

The surfaces that collect and convey runoff to stormwater infrastructure are collectively referred to as the contributing area. Each stormwater outfall connected to Jordan Creek is associated with its own unique contributing area, although the contributing area may consist of two disjunct areas (see Outfall 10 below). The contributing area maps in this project do not include rooftops because mapping the fate of rooftop runoff is difficult. Most rooftop runoff in the Lower Jordan Creek watershed likely enters a stormwater system.

Managing Stormwater

Impervious surfaces and stormwater systems in urban areas prevent runoff from infiltrating the ground, thereby contributing to flooding, channel erosion, and degraded water and habitat quality in urban streams. These adverse impacts can be reduced or eliminated by 1) mapping stormwater systems to understand the origin and fate of runoff; 2) implementing best management practices (BMPs) to reduce runoff rates (i.e., flow control) and remove pollutants from runoff (i.e., runoff treatment), and 3) changing practices to reduce pollutant levels on impervious surfaces. This appendix contains maps for urban stormwater systems in the Lower Jordan Creek watershed (Figure 2), detailed descriptions of each system, and BMP recommendations for reducing runoff volume and improving water quality.

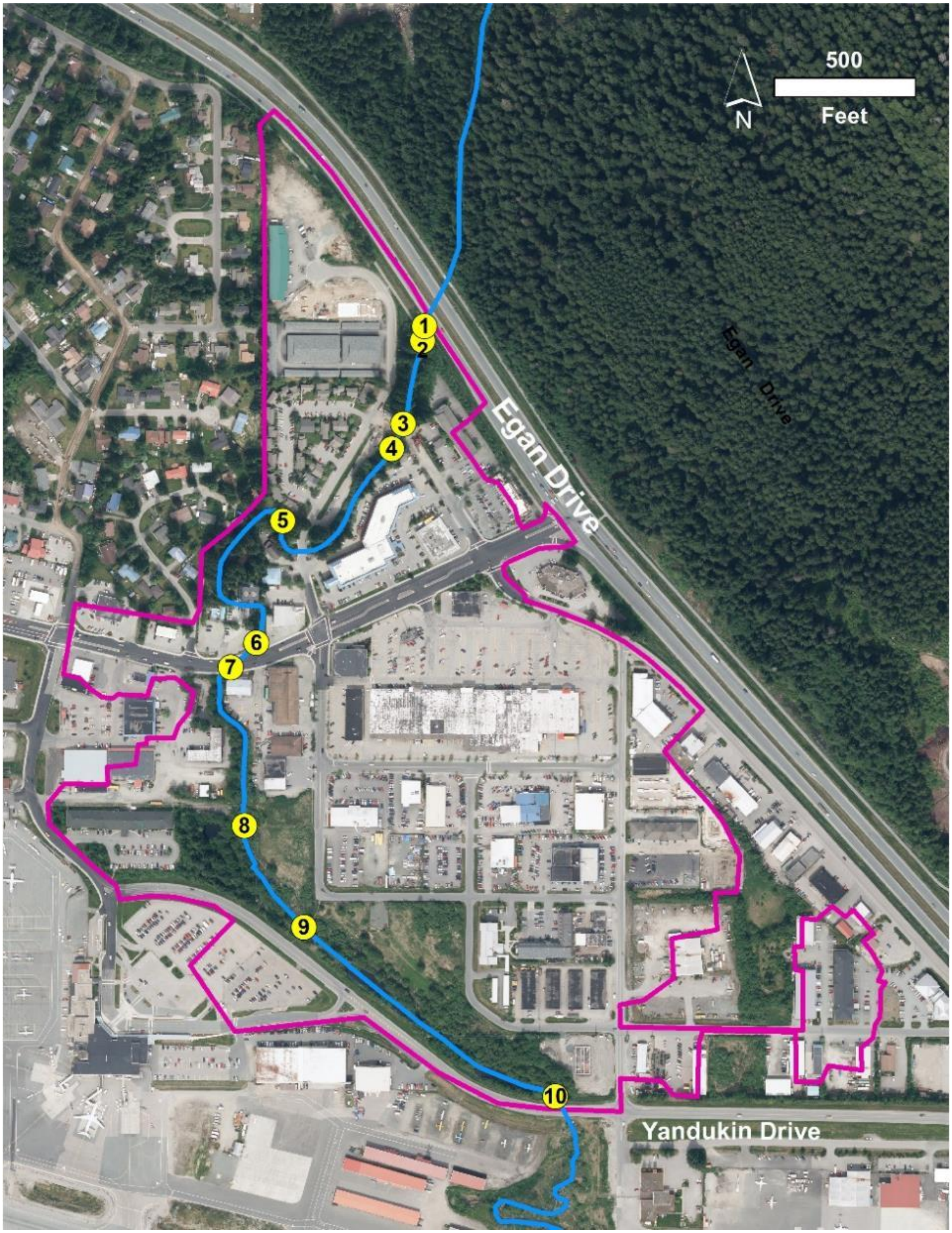
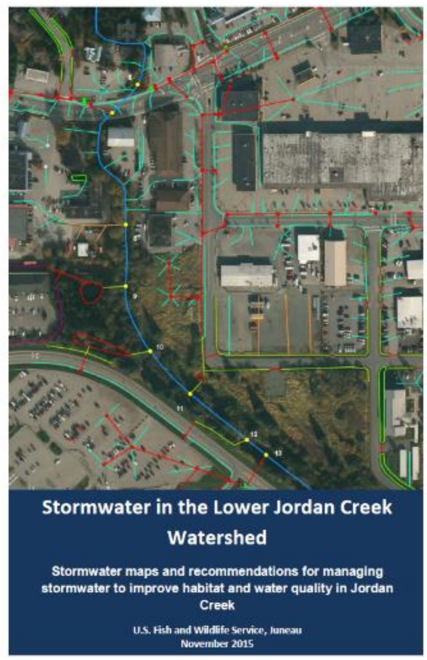


Figure 2. Lower Jordan Creek watershed map. Most stormwater runoff within the watershed boundary (purple) is conveyed to Jordan Creek by one of ten stormwater systems. Yellow symbols represent the point at which runoff is discharged into the stream by a pipe or ditch; numbers indicate a specific stormwater system. REPLACE WITH MAP THAT INCLUDES KOOTZNOOWOOD PARCEL.

Stormwater Maps

The stormwater maps[1] and BMP recommendations in this section build upon a previous effort to understand and address stormwater infrastructure and issues in the Lower Jordan Creek watershed. That effort was documented in a report titled *Stormwater in the Lower Jordan Creek Watershed - Stormwater Maps and Recommendations for Managing Stormwater to Improve Habitat and Water Quality in Jordan Creek* by the U.S. Fish and Wildlife Service (USFWS 2015). The report describes the different components that comprise a stormwater system and the methods used to inventory and map stormwater infrastructure, as well as recommendations to improve stormwater management. Since the completion of the 2015 report, existing stormwater systems have been altered and new stormwater systems have been installed to convey runoff from impervious surfaces constructed after 2015. This section includes updated (as of August 2020) stormwater system maps that reflect those changes as well as corrections to the original maps based on new information. This report also provides updated recommendations for reducing stormwater impacts on Lower Jordan Creek.



Individual stormwater systems in the Lower Jordan Creek watershed are referenced by their outfall number. The most significant change to stormwater system maps after 2015 was the elimination of several outfalls[2]. Two outfalls (8 and 10, USFWS 2015) have been removed from maps after stormwater BMPs were installed to infiltrate runoff to the ground. Stormwater outfalls 12, 13, and 14 (USFWS 2015) have been removed from maps because the runoff discharged from these systems was found to infiltrate the ground in a ditch or swale rather than flow directly into the stream. Although the stormwater systems and contributing areas associated with these former outfalls lack a direct connection to Jordan Creek, we include maps and recommendations for the systems below. These systems provide on-the-ground examples of how BMPs help to protect habitat and water quality in this highly urbanized area.

Recommendations

This report recommends BMPs to reduce or eliminate runoff generated by each stormwater system in the Lower Jordan Creek watershed. Recommendations are not listed in order of priority and are not necessarily mutually exclusive. For example, one or more of the recommendations may individually provide complete stormwater flow control and runoff treatment, whereas the remaining recommendations may provide only partial control, either individually or in combination. We expect that the types of BMPs that are ultimately implemented will depend on funding, landowner approval, and site

[1] Aerial imagery used for maps is from June 2013.
[2] Stormwater outfall numbers used in this report do not correspond to outfall numbers used in the 2015 report because some outfalls have been eliminated after BMPs were installed or, upon closer inspection, all runoff discharged from the outfall infiltrates the ground.

constraints (e.g., space limitations, soil permeability). Given the numerous factors that can influence the type and location of stormwater BMPs, this report leaves stormwater management decisions to the various entities that have jurisdiction or that collaborate to manage stormwater in the Lower Jordan Creek watershed. To reduce flooding and improve water quality in Jordan Creek, stormwater management should attempt to capture and infiltrate the maximum amount of urban runoff that currently enters stormwater systems that flow directly into the stream.

Lower Jordan Creek Stormwater Systems

Stormwater System 1

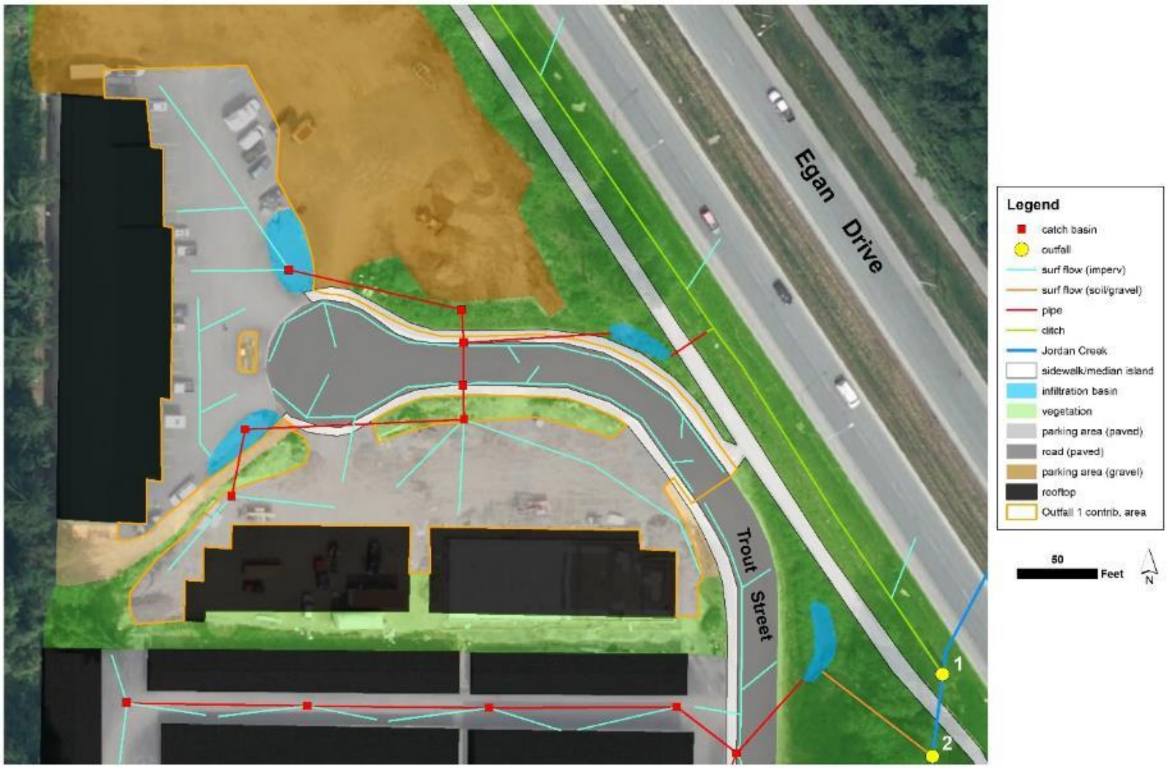


Figure 3. Stormwater system 1 map.

Landowners (land use):

- Valley Professional Business Condominium Owners Association (condominium)
- Great Land Investment Company LLC (undeveloped lot)
- Jordan Avenue Condominiums Association (condominium)
- City and Borough of Juneau (Jordan Ave.)

Contributing area surface types and acreage (excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
1.2	71.1	0.0	0.0	22.2	6.2

Stormwater system narrative: Stormwater system 2 discharges runoff into a ditch on the west side of Egan Drive (Figure 3). This ditch also receives runoff from the west lane of Egan Drive. The contributing area consists of a 300-ft long section of CBJ roadway and 5 private parcels at the north end of Jordan

Ave. Three of the parcels have been developed for condominiums and two parcels are undeveloped and covered with gravel and scattered vegetation. The developed parcels have parking areas that are paved with asphalt. The roadway and cul-de-sac are paved with asphalt and are bordered by curb and gutter and asphalt sidewalks.

This is one of the few stormwater systems in the lower watershed with non-oil/water separator BMPs that were part of the site design. The BMPs consist of 2 infiltration basins in the parcel at the end of Jordan Ave. (Figure 4). The basins receive runoff from a parking area in front of a building. Each basin has a catch basin equipped with a raised drain. The remaining 4 catch basins in the system collect runoff from parking areas on other private parcels and from curb and gutter at the north end of Jordan Ave. Two catch basins are in the roadway curb and gutter, 1 catch basin is in an undeveloped parcel, and 1 catch basin is in a paved parking area on the south side of Jordan Ave. The catch basins route runoff through an underground pipe system that eventually outfalls to a 300-s.f. vegetated infiltration basin that often contains ponded water during periods between runoff events (Figure 5). Overflow from the basin flows through a pipe into a ditch that connects to Jordan Creek on the south side of Egan Drive (Figure 5).

Recommendations:

The densely vegetated ditch at the lower end of this stormwater system and the 3 infiltration basins within the system may provide adequate flow control and runoff treatment. Consequently, the recommendations provided below may not be warranted.

1. Visit the stormwater system during an extreme runoff event to visually gauge the performance of existing stormwater BMPs. If overflows are common, increase the size or infiltration rate of the basins.
2. Determine if adding soil and vegetation will improve the effectiveness of the two gravel-lined infiltration basins.
3. Construct a bioretention planter in the parking area owned by the Jordan Avenue Condominiums Association. Consider integrating the planter into an existing nearby landscaping bed. Modify the catch basin to function as an overflow drain. Route runoff from the nearby curb and gutter on Jordan Ave. into the planter through trench drains installed in the sidewalk.
4. Route runoff from the remaining curb and gutter through trench drains in the sidewalk that connect to bioretention areas on the back side of the sidewalks.
5. The catch basin on the undeveloped lot should be integrated into an infiltration BMP if a future development conveys stormwater runoff to the basin.
6. Maintenance of the Egan Drive ditch should take care to remove and replace vegetated mat to

Figure 4. One of 2 infiltration basins near at the end of Jordan Ave. in August 2020.

Figure 5. Left: An existing infiltration basin near the downstream end of stormwater system 1. View looking towards inlet pipe (upper right) in May 2020. Right: Runoff from stormwater system 1 flows through a pipe into this ditch on the west side of Egan Drive. The ditch connects to Jordan Creek in the distance. View looking southeast from the pipe outlet. May 2020.

Stormwater System 2

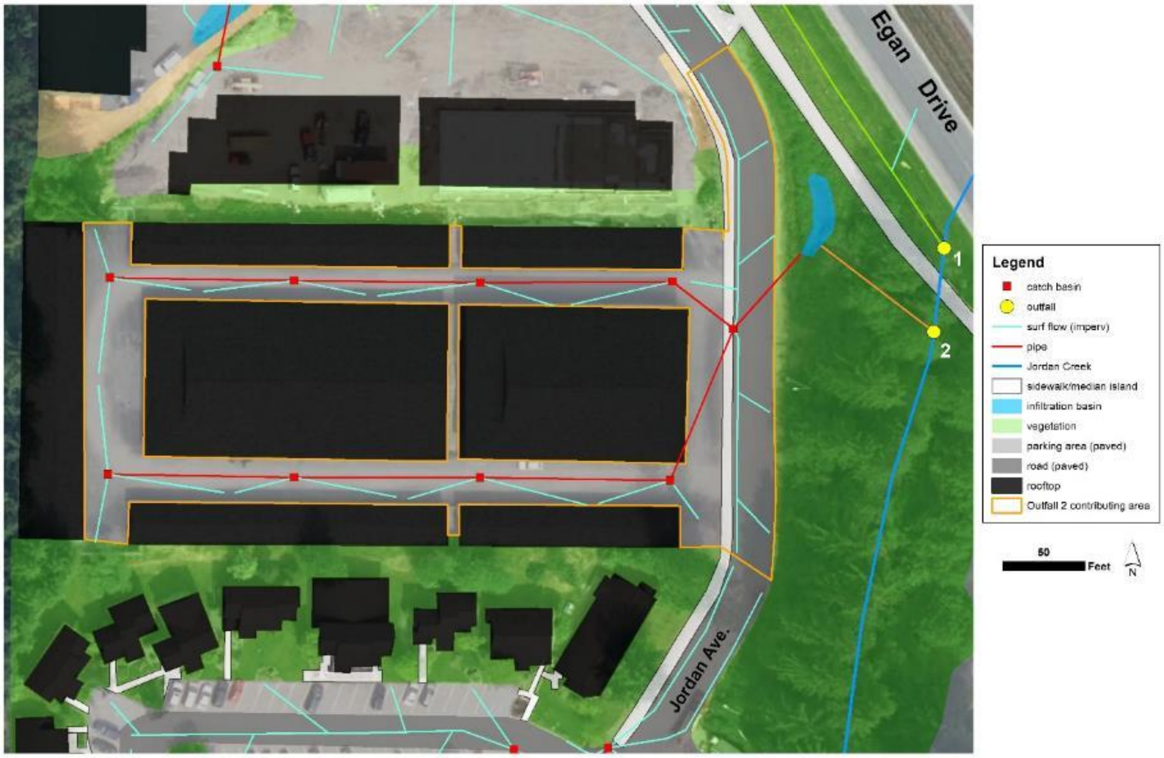


Figure 6. Stormwater system 6 map.

Landowners:

- Jordan Creek Self Storage LLC (storage units)
- City and Borough of Juneau (Jordan Ave.)

Contributing area surface types and acreage (excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
0.9	74.3	0.0	0.0	21.4	4.4

Stormwater system narrative: Stormwater system 2 discharges runoff into Jordan Creek through a gravel ditch downstream of Egan Drive on the west side of the stream (Figure 6). The contributing area consists mostly of rooftops and asphalt paved areas used to access storage units. A 250-foot long portion of Jordan Ave. and a sidewalk, both paved with asphalt, comprise the remainder of the contributing area.

Figure 7. An infiltration basin at the downstream end of stormwater system 2 in April 2020. Arrows indicate the inlet pipe (right) and outlet trench (left). View from north end of basin looking south in April 2020.

This is one of the few stormwater systems in the lower watershed with a stormwater BMP. The stormwater system consists of 9 catch basins that discharge runoff into an infiltration basin next to Jordan Creek (Figure 7). Eight of the contributing basins are on the private parcel and 1 catch basin is in Jordan Ave. Overflow runoff from the infiltration basin enters Jordan Creek through a 40-foot long ditch lined with coarse gravel. Although the basin supports the growth of grasses and other herbaceous plants, vegetation has been removed from the basin in the past as a means of enhancing infiltration.

Recommendations:

1. The size of the infiltration basin is insufficient to store runoff from the contributing area. To be effective, an infiltration basin must store the volume of runoff generated from a specific amount of rainfall (i.e., water quality rainfall depth). We used the Water Quality Volume Determination method in the CBJ Manual of Best Stormwater Management Practices to calculate the basin

volume required to store runoff from a 1.51-inch deep rain event (4,687 cubic feet). The measured volume of the basin (646 c.f.) is only 14% of the calculated water quality volume, indicating the basin is considerably undersized relative to the contributing area. In addition, stormwater filtration and sedimentation in the basin is limited by the proximity of the inlet pipe and outlet ditch. When runoff volume exceeds the storage and infiltration capacities of the basin, this “short-circuit” arrangement limits the amount of retention time for capturing settleable solids and associated pollutants. The volume of the basin should be increased as much as possible by enlarging the basin to the north. To further enhance stormwater treatment in this system, block the existing outlet ditch and convey runoff under the nearby multi-use trail and into an existing ditch next to Egan Drive that connects to Jordan Creek.

Stormwater System 3

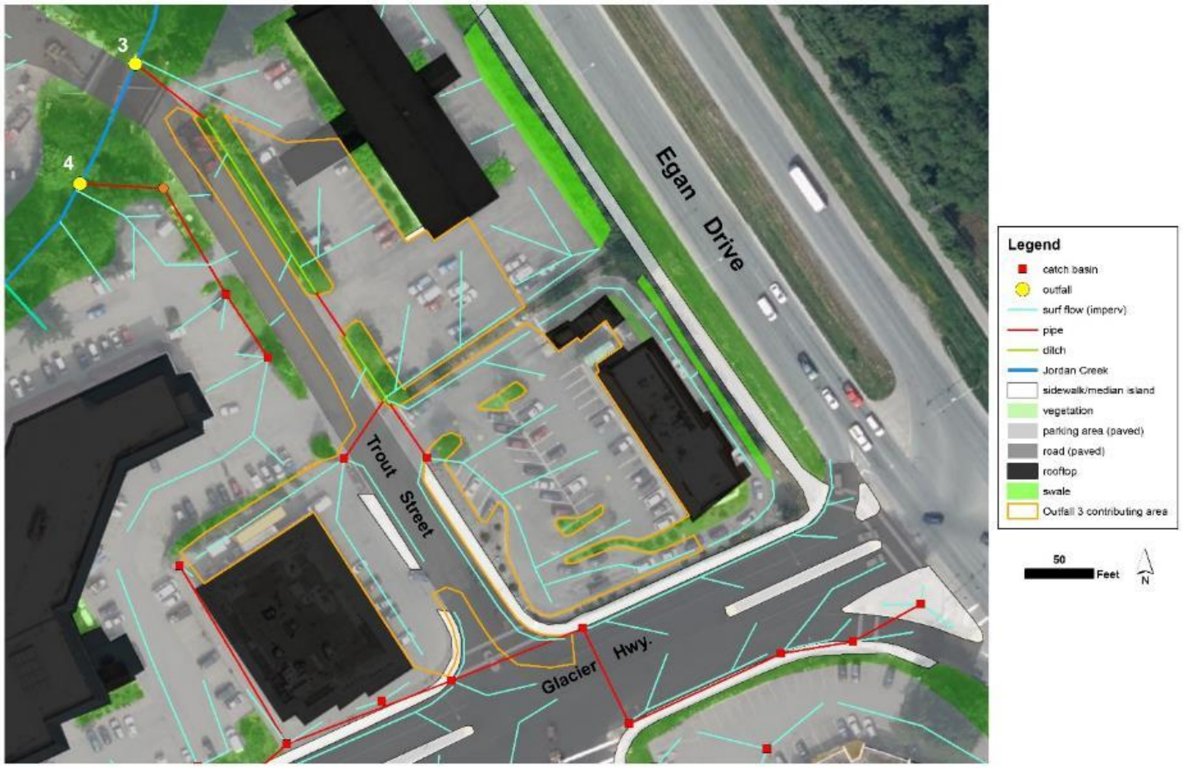


Figure 8. Stormwater system 3 map.

Landowners (land use):

- Valley Centre Development LLC (McDonald's, Super 8)
- Alcor Lands LLC (Breeze-In)
- Jordan Creek Center LLC (several offices and businesses)
- City and Borough of Juneau (Trout Street)
- AK Dept. of Transportation and Public Facilities (Glacier Hwy.)

Contributing area surface types and acreage (excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
1.5	79.2	0.0	0.0	18.5	1.2

Stormwater System Narrative: Stormwater system 3 discharges runoff into Jordan Creek from a pipe on the east side of the stream immediately upstream of Trout St. (Figure 8). The contributing area consists of the McDonald's restaurant, Breeze In convenience store, the south and west sides of the Super 8 hotel and a small portion of Glacier Hwy. The contributing area also includes a 450-ft long section of Trout Street. The system receives runoff from rooftops, parking areas, driveways, and Trout Street and Glacier Hwy. The contributing area receives extremely high levels of vehicle traffic, primarily patrons of the McDonald's restaurant and Breeze In convenience store.

Figure 9. Stormwater runoff from the west side of the McDonald's parcel enters stormwater system 3 at the entrance driveway. Runoff from the driveway and Trout Street flows into the catch basin. View looking southeast along Trout Street in May 2010.

The two catch basins in this system are in the Trout Street right-of-way at the entrances to McDonalds (Figure 9) and Breeze In. These catch basins receive runoff from parking lots at the respective businesses as well as runoff from curb and gutter along the south end of Trout Street. Runoff from the basins discharges to a series of grass-lined ditches and driveway culverts along the west edge of the Super 8 parcel. The ditches also receive runoff from the west side of the Super 8 parking lot and the adjacent section of Trout Street. The most downstream culvert discharges runoff into Jordan Creek, immediately upstream of the Trout Street bridge. These ditches, collectively referred to as the "Trout Street Ditch," are commonly filled with litter and vegetation that is coated with an oily black residue (Figure 10). Stormwater runoff originating near the McDonalds dumpster flows into the ditch and has been observed to have an oily surface residue. The ditch likely receives petroleum hydrocarbons and other pollutants from other parts of the contributing area. When the ditch is cleaned, loss of vegetative cover reduces the biofiltration capacity of the ditch and increases soil erosion (Figure 10).

Stormwater from the McDonald's drive-through is directed to a vegetated swale on the north side of the building where it infiltrates into the ground. The surface of the drive-through lane has an oily sheen and runoff from the lane has an oily surface residue. Runoff on the east and north sides of the Super 8 parcel flows into a forested swale or a greenbelt next to Jordan Creek.

Figure 10. Left: Oil residue on stormwater runoff in the Trout Street Ditch. Right: The Trout Street Ditch following maintenance to remove vegetation and sediment. View looking northwest towards Jordan Creek in October 2018.

Recommendations:

1. Work with McDonald's management to reduce stormwater runoff from the parking area into the Trout Street ditch. During facility remodels, the McDonald's Corporation encourages franchises to include "native and/or drought-tolerant landscaping, along with storm water management through the use of rain gardens, permeable pavement and rainwater collection and reuse." (Figure 111).

   Assess the McDonald's parking lot for on-site stormwater management opportunities. There are several raised landscaping strips and islands in the parking lot. Identify landscaped areas that can be modified or reconstructed into bioretention planters to infiltrate and treat runoff.

Figure 11. Stormwater runoff from a McDonald's restaurant in Westminster, MD is collected in a trench drain (center) at the drive-through entrance and conveyed to a landscaped infiltration BMP (right). Note the square-shaped raised overflow drain. Google Street View.

2. Pave the Breeze in parking lot with porous pavement
3. Replace the existing catch basins with oil and water separators.
4. Install check dams in the Trout Street Ditch to sustain native aquatic vegetation and enhance stormwater storage and infiltration potential. Clean the ditch with a sediment vacuum and conduct cleaning outside of the growing season to minimize impacts to the vegetation.

Stormwater System 4

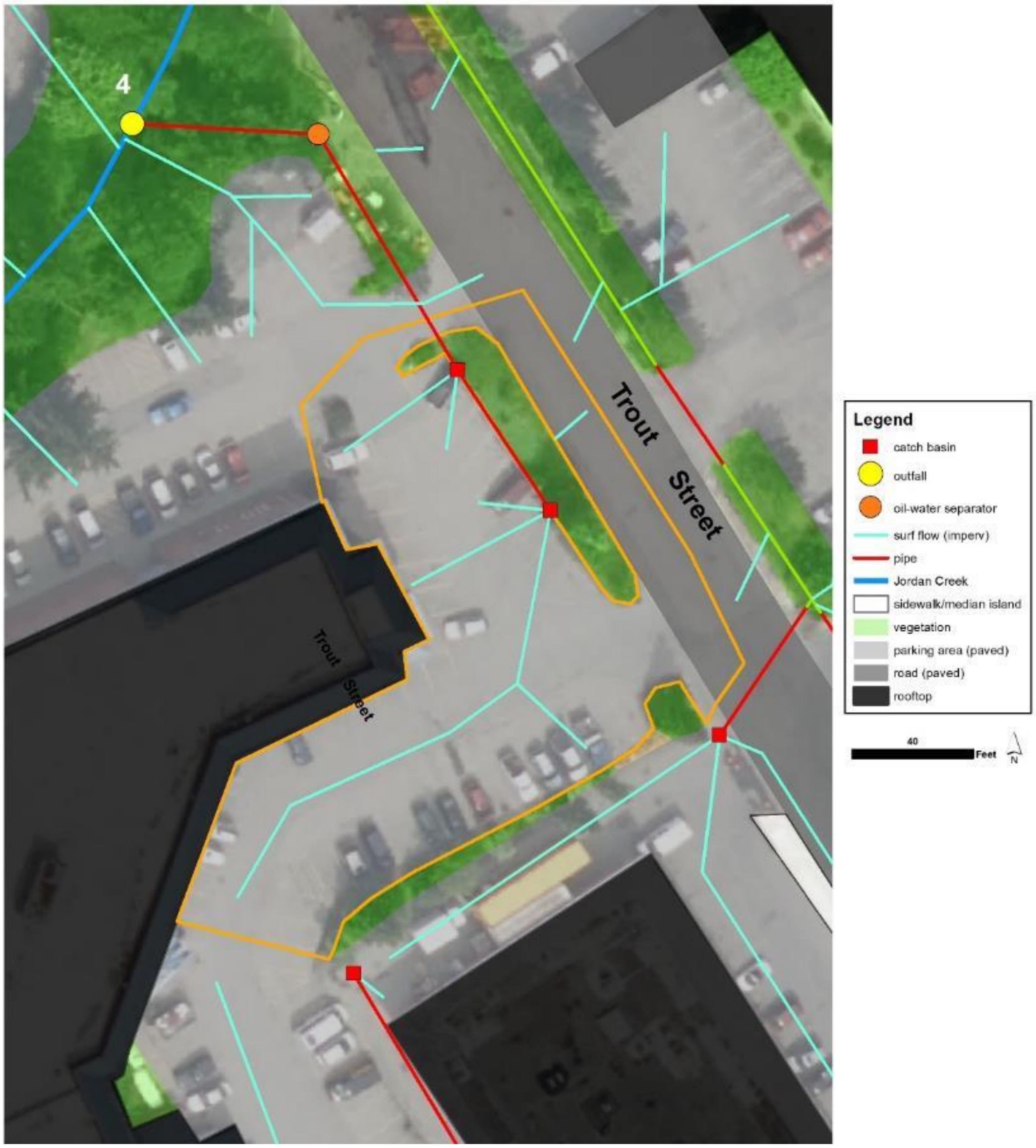


Figure 12. Stormwater system 4 map.

Landowners (land use):

- Jordan Creek Center LLC (offices, businesses)
- City and Borough of Juneau (Trout Street)

Contributing area surface types and acreage (excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
0.5	86.2	0.0	0.0	13.6	0.0

Stormwater System Narrative: Stormwater system 4 drains a small contributing area on the north end of Jordan Creek Center (Figure 12). Most of the contributing area consists of an asphalt paved parking area and a portion of Trout Street. Stormwater infrastructure includes two catch basins at the edge of the parking area and an oil and water separator. A pipe discharges runoff from the separator into the east side of Jordan Creek downstream of Trout Street. The separator is in a vegetated area near the pavement edge and the lid is often obscured by gravel, soil, and a layer of sod.

Recommendations:

1. Replace conventional asphalt parking areas that drain to the stream with porous pavement to provide runoff treatment and flow control.
2. Check the oil and water separator to ensure proper functioning condition, remove accumulated sediments and oil if needed, and establish a maintenance routine to ensure proper functioning condition.
3. Construct bioretention planters around the existing catch basins.

Stormwater System 5

Figure 13. Stormwater system 5 map.

Landowners (land use):

- Jordan Creek Office Condominium Owners Association Inc. (offices)
- City and Borough of Juneau (Jordan Ave.)

Contributing area surface types and acreage (excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
1.3	51.2	0.0	0.0	38.0	8.9

Stormwater System Narrative: Stormwater system 5 discharges runoff into Jordan Creek from a pipe on the north side of the stream downstream of Jordan Ave. (Figure 13). The contributing area includes Jordan Creek Condos Loop, a 650-ft long private access drive bordered by 105 parking spaces and numerous small office buildings. Each end of the drive intersects with Jordan Ave. The condominium complex also includes a small, isolated parking lot with 14 parking spaces that is accessed from Jordan Ave. All roadway and parking areas are paved with asphalt. Runoff from the loop drive and adjacent parking areas sheet flows to a low point in the center of the drive and flows north or south to catch basins near each end of the drive. Runoff from the small parking area flows into a catch basin near the entrance. The stormwater system also includes 5 catch basins in the Jordan Ave. right-of-way. Most of the runoff flowing to these basins comes from the street. All catch basins discharge runoff to a pipe outfall 150 feet downstream of Jordan Ave. (Figure 14). There are no stormwater BMPs in this system.

Recommendations:

Short-term

1. Install a wet biofiltration swale at the outfall pipe. The Jordan Creek channel near outfall 5 is about 3 times wider than the channel immediately upstream and downstream of the outfall, providing space for constructing a wet biofiltration swale. To construct the swale, a vegetated berm would be placed in the channel. The berm would constrict the channel to the approximate width of the adjacent channel. Aquatic vegetation would be planted in the area between the berm and the outfall. Alder and willow would be planted on the berm to prevent erosion during high water. An outlet channel, weir, or pipe would be installed near the downstream end of the berm to discharge treated runoff to Jordan Creek. This project would require removing about 30 feet of exposed outfall pipe and thinning overstory trees/branches to increase light levels for enhancing growth and survival of the aquatic and upland plants.

2. Replace asphalt surfaces in the contributing area with permeable pavement that is appropriate for the site.

3. Install a sand filter vault at each end of the drive and the entrance to the small parking lot. These vaults should be located to intercept the greatest amount of runoff practicable. Connect the vaults to existing stormwater infrastructure.

4. Construct bioretention cells or planters that encompass the catch basins in the Jordan Ave. right-of-way (Figure 15). Use catch basin inlets as overflow structures. Construct the cells in curb extensions if necessary.

Figure 14. Stormwater outfall 5. Stream flow is from right to left. View looking north in March 2020.

Figure 15. A catch basin near the intersection of Jordan Ave. and the south entrance to Jordan Creek Condos Loop drive. Biofiltration BMPs that encompass this and 4 other basins in the right-of-way can be constructed to provide flow control and runoff treatment. View looking north along Jordan Ave. in April 2020.

Stormwater System 6

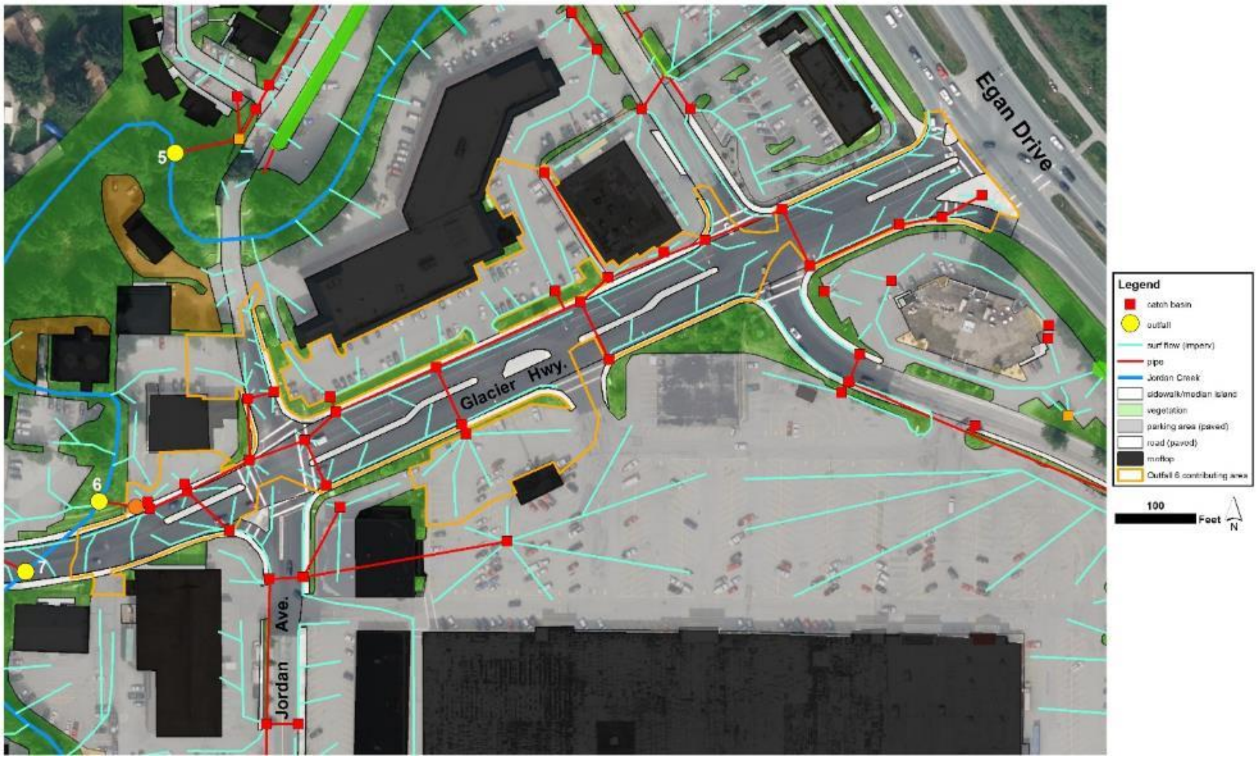


Figure 16. Stormwater system 6 map.

Landowners (land use):

- Alaska Dept. of Transportation & Public Facilities (Glacier Hwy.)
- City and Borough of Juneau (Jordan Ave.)
- Jordan Creek Center LLC (offices, businesses)
- First National Bank of Alaska (business)
- Breeze-In Corporation (business)

Contributing area surface types and acreage (excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
3.9	37.5	0.0	0.0	49.3	13.0

Stormwater System Narrative: Stormwater system 6 spans 1,300 feet of Glacier Hwy. between Jordan Creek and Egan Drive (Figure 16). Glacier Hwy. has the highest daily traffic count of any roadway in the

Lower Jordan Creek watershed. Runoff collected by 27 catch basins in the system is discharged from an outfall pipe into Jordan Creek immediately upstream of Glacier Hwy.

All runoff entering this system originates on impervious surfaces, including roadways, parking areas, and sidewalks. Runoff from Glacier Hwy. flows into 15 catch basins in the curb and gutter of the roadway. Two catch basins collect runoff from the First National Bank of Alaska parking area, two basins collect runoff from the parking area on the south side of Jordan Creek Center, and 1 catch basin receives runoff from a small portion of the Nugget Mall parking area. Three catch basins on the south and west sides of Breeze-In collect runoff from asphalt pavement that receives little or no vehicle traffic. All runoff from this system flows through and oil and water separator before flowing into Jordan Creek from a pipe upstream of Glacier Hwy (Figure 17).

There is a very limited amount of space available for constructing BMPs near runoff sources in this system. Most of the contributing area is covered with sidewalk or roadway infrastructure. Vegetated areas that could function as BMPs or provide space for constructing BMPs are limited to narrow strips on private land adjacent to the Glacier Hwy. right-of-way. Therefore, it is likely that highway runoff will have to be conveyed to BMPs constructed on land that is currently in private ownership.

Recommendations:

1. Where space allows, construct bioretention BMPs near each catch basin on the back side of sidewalks along Glacier Hwy. and Jordan Ave. Convey runoff from the curb and gutter to the BMP in trench drains constructed in the sidewalk immediately upstream of each basin (Figure 18). If feasible, convey runoff from adjacent parking areas and other paved areas into these BMPs.
    a) Construct bioretention BMPs in two vegetated strips between Glacier Hwy. and a parking area on the south side of Jordan Creek Center (Figure 19). Convey runoff from the north side of the highway, parking area, and, if possible, the south and west sides of Breeze-In, into the BMPs.
    b) Construct a bioretention planter in a landscaping strip that parallels Glacier Hwy. on the south edge of the McDonald’s restaurant parcel. Convey curb and gutter runoff from the north side of Glacier Hwy. (between Trout Street and Egan Drive) to the planter.
    c) Construct bioretention BMPs in privately owned vegetated strips on the south side of Glacier Hwy., between Egan Drive and Jordan Ave (Figure 20).

2. Construct a biofiltration planter around the catch basin in the northwest part of the Nugget Mall parking area. Modify the catch basin to function as an overflow drain.

3. Construct bioretention planters on private property near the two catch basins on Jordan Ave.

Figure 17. Stormwater runoff containing suspended sediment flows into Jordan Creek from the stormwater system 6 outfall pipe (upper right) and mixes with clear water in Jordan Creek upstream of Glacier Highway in May 2020.

Figure 18. Trench drains (covered with iron grates) in a pedestrian strip convey stormwater from curb and gutter to a bioretention planter.

Figure 19. Two grass swales border an entrance drive connecting Jordan Creek Center to Glacier Hwy. Converting the swales into bioretention BMPs would provide treatment and infiltration of runoff from Glacier Highway and the parking area. Google Street View looking southwest in July 2011.

Figure 20. Google Street View of the intersection of Old Dairy Road (right) and Glacier Hwy. (left) in July 2011 (view looking east). Highway runoff could be directed form the curb and gutter to a stormwater BMP constructed in the grass-covered area in the Old Dairy Road right-of-way.

4. Runoff originating on the west side of the First National Bank Alaska is concentrated by a curb before flowing through a narrow strip of vegetation and into Jordan Creek. To increase the opportunity for filtration and infiltration, install multiple cuts in the curb to spread the flow over a greater area of the vegetated strip. Eradicate invasive reed canarygrass and plant native grass, shrubs, and trees in the strip to enhance the riparian zone. Work with the bank to avoid plowing snow into the riparian setback and stream and install signage explaining the importance of protecting riparian areas.

5. First National Bank Alaska hired an engineering firm to design a parking lot reconstruction project a few years ago. Juneau Watershed Partnership was invited to make recommendations for reducing stormwater runoff impacts on Jordan Creek. Although the bank indicated they did not have the financial resources to implement any of the recommendations, only minor improvements have been made to the lot. Contact the bank to suggest stormwater BMPs and offer help securing funds to implement projects.

Stormwater System 7

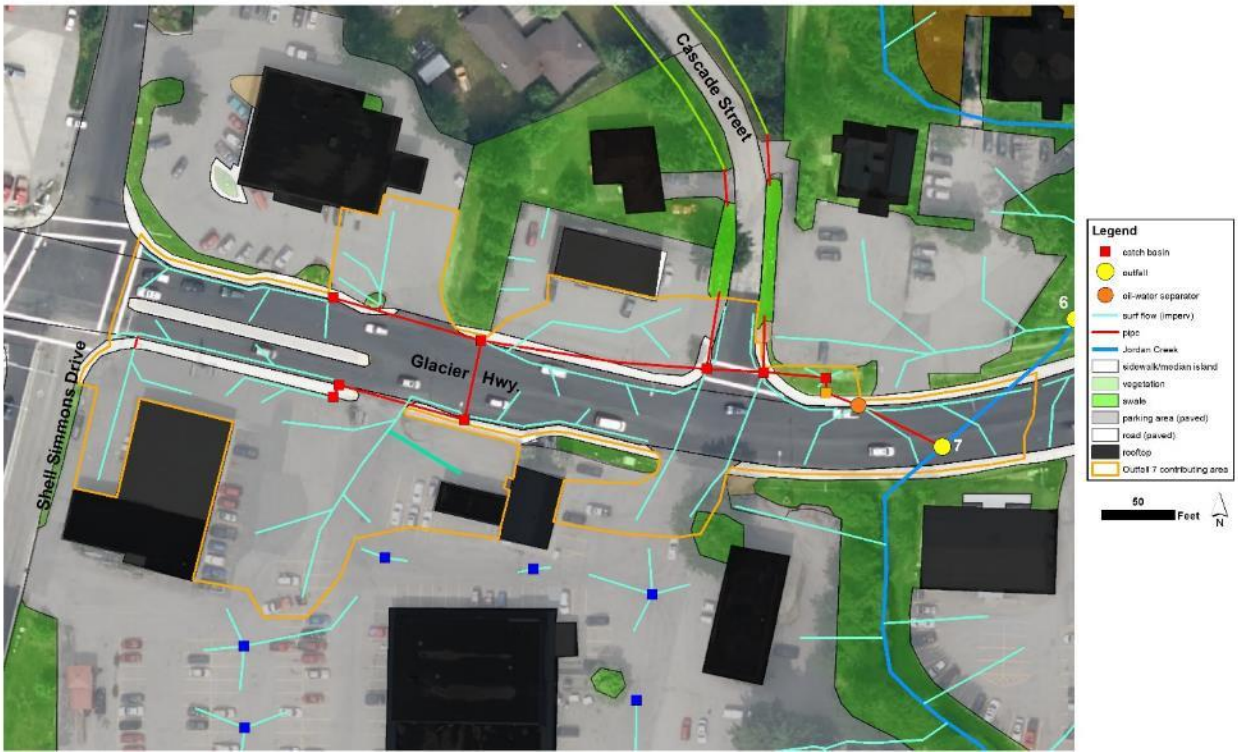


Figure 21. Stormwater system 7 map.

Landowners (land use):

- Alaska Dept. of Transportation & Public Facilities (Glacier Hwy.)
- City and Borough of Juneau (Cascade Street)
- Clif and Loretta Beadle Living Trust (State Farm Insurance)
- National Bank of Alaska (Wells Fargo Bank)
- D's Investment Group LLC (Airport Shopping Center)
- St. Vincent de Paul Society (thrift store)
- Dale Anderson & Honey Bee Trust (Powell Realty)

Contributing area surface types and acreage (impervious surface excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
2.1	53.3	0.0	0.0	35.3	8.8

Stormwater System Narrative: The outfall 7 stormwater system spans 640 feet of Glacier Hwy. between Jordan Creek and the Shell Simmons/Lee Smith Drives intersection (Figure 21). In addition to Glacier Hwy., the contributing area includes portions of 5 private parcels abutting the highway. Glacier Hwy. has the highest daily traffic count of any roadway in the Lower Jordan Creek watershed.

Nine catch basins in the system collect stormwater runoff from impervious roadways, parking areas, and sidewalks. Runoff is discharged to Jordan Creek within the western-most of two culverts that convey the stream under Glacier Hwy. Runoff originating from Glacier Hwy. and portions of parking areas adjacent to the highway enters one of 7 catch basins in the curb and gutter of the highway and Cascade Street. The two catch basins in Cascade Street are connected to grass-lined ditches that extend into a residential area. The ditches likely covey runoff to the stormwater system only during extreme runoff events. The remaining 2 catch basins in the system collect parking lot runoff from small contributing areas on the Airport Shopping Mall, Wells Fargo, and State Farm Insurance parcels. The system contains one stormwater BMP, an oil and water separator within the most downstream catch basin.

Recommendations:

Due to the lack of undeveloped space, and the likely presence of underground utility conflicts, opportunities for installing stormwater BMPs in this system are limited. BMPs will have to be constructed solely on private parcels. Use trench drains to convey stormwater from the highway to stormwater BMPs on adjacent parcels near the back side of sidewalks (Figure 22).

1. Convey stormwater from parking areas and Glacier Hwy. to bioretention planters constructed on the back side of sidewalks near catch basins. For example, construct planters in existing landscaped areas or grass-covered areas on the Wells Fargo, State Farm Insurance, and Powell Realty parcels. Design the planters to receive runoff from both the highway and adjacent parking areas. Where space is limited and the contributing area is small, construct small bioretention planters containing a single tree.

Figure 22. Google Street View of the north side of Glacier Hwy. at Cascade Street in July 2020. Parking lot and highway runoff could be conveyed into stormwater BMPs constructed in existing grass-covered (photo-right near hydrant) and landscaped (photo-left near stop sign) areas on private parcels that abut the roadways.

Stormwater System 8

Figure 23. Stormwater system 8 map.

Landowners (land use):

- Bre/Esa Alaska LLC (Extended Stay Hotel)
- City and Borough of Juneau Airport (greenbelt)
- City and Borough of Juneau (Yandukin Drive, Shell Simmons Drive)
- D's Investment Group LLC (Airport Shopping Center, businesses)

Contributing area surface types and acreage (impervious surface excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
1.6	64.4	24.7	0.0	9.6	0.0

Stormwater System Narrative: The outfall 8 stormwater system collects runoff from the Extended Stay hotel parcel and short sections of Yandukin and Shell Simmons Drives (Figure 23). A small portion of the contributing area also includes a gravel/asphalt alley along the south edge of the Airport Shopping Center parcel. Although the system runs through a greenbelt area owned by the airport, this area is not part of the contributing area.

This stormwater system was required as a condition of Dept. of Army permit 4-970735, Jordan Creek 17. The permit authorized placement of fill into wetlands to construct the hotel and parking area. The stormwater system consists of 2 infiltration trenches (referred to as “strip drains” in the permit and on project drawings) on the north and south sides of the hotel parcel. Design drawings in the permit show the trenches as 2-foot wide by 3-foot deep trenches excavated in the native peat soil. 6-inch and 8-inch diameter underdrain pipes, presumably with perforations, were placed in the bottom of the trenches. Vertical pipes were attached to the undrain pipes and the trench was backfilled with washed rock and covered with filter fabric. The north trench area was to be covered with peat and planted with alder and willow. The south trench area was to be covered with peat and planted with vegetated mat salvaged from the site prior to placing the fill.

The south trench receives runoff from the parking lot and Yandukin Drive and passes through airport and hotel property. The north trench runs through a grass swale and receives runoff from the hotel rooftop and the adjacent parcel. The underdrains pipes carry runoff from each trench to a junction box where the combined flow is piped to a diffuser area on the edge of the pond. In design drawings, the diffuser is shown as a 10’ to 25’-foot wide by 3’ to 5’-foot deep rock-filled excavation on the west bank of the pond. Outflow from the pond passes through a short culvert into a floodplain wetland next to Jordan Creek. The culvert inlet is covered with a fine-meshed wire screen to prevent fish from entering the pond. Overbank flows in Jordan Creek backwater the pond.

The south drain is currently covered with dense stands of native woody shrubs (e.g., willow and alder) growing in a wet swale (Figure 25). A dense stand of native trees and other vegetation growing over the north drain was removed sometime after July 2006 (Figure), apparently in violation of mitigation plans approved by the Dept. of Army permit.

Recommendations:

1. Plant willow, alder, and other native plants on the north filter strip to increase the runoff treatment capacity of the trench.
2. Make the landowners aware of permit requirements to ensure protection and proper function of the trench drain system and associated native plant communities.
3. Control reed canarygrass infestations on the south side of the parcel and the north edge of Yandukin Drive.

Figure 24. A hedge of alder and willow shrubs indicates the location of an infiltration trench on the south side of the Extended Stay Hotel in Juneau. Note invasive reed canarygrass in center left of photo. Google Street View in September 2017.

Figure 26. An infiltration trench on the north side of the Extended Stay Hotel after native vegetation was removed between July 2006 and July 2010. View looking west in July 2010.

Stormwater System 9

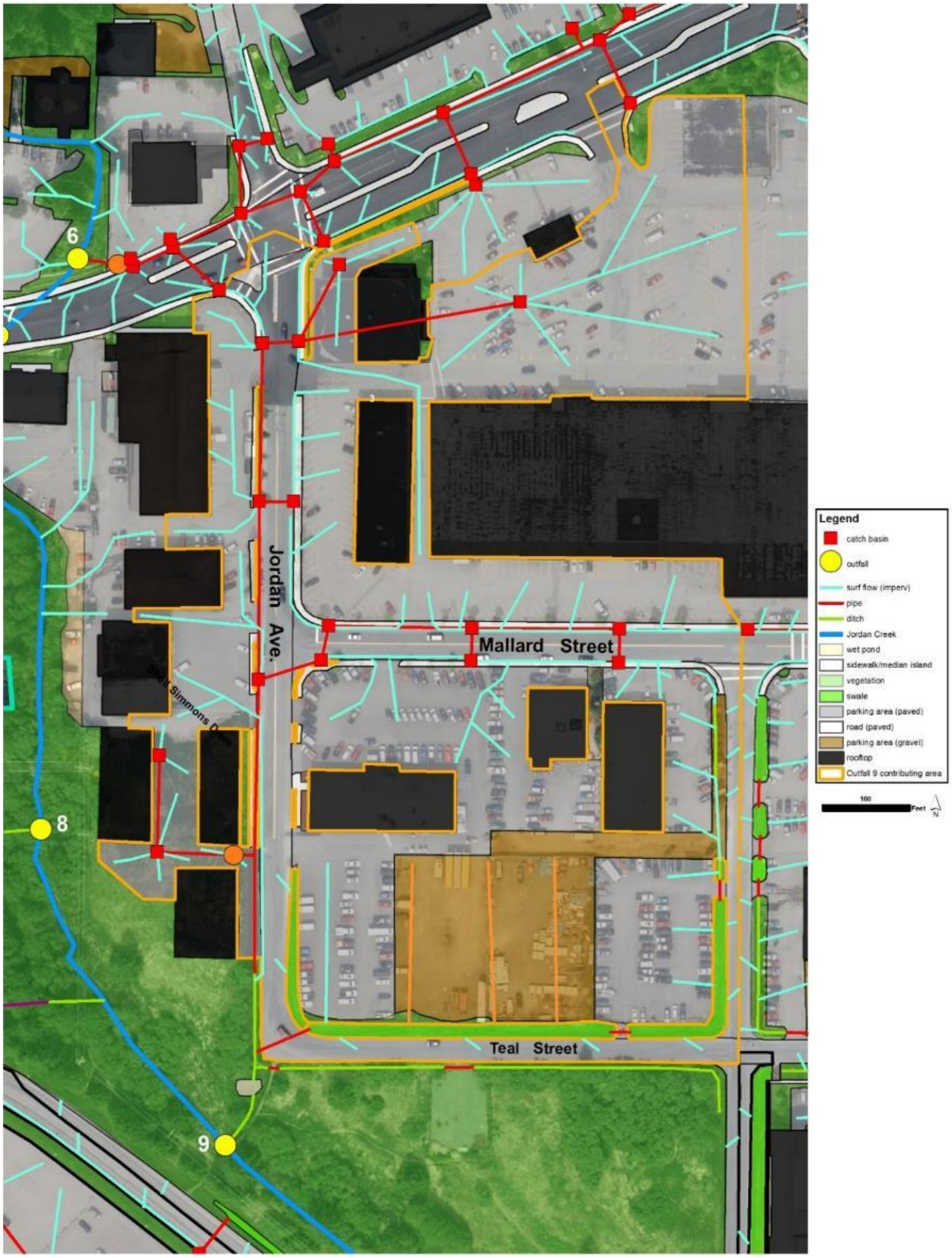


Figure 25. Stormwater system 9 map.

Landowners (land use):

- CPIF Nugget Mall LLC (businesses)
- Lyles Home Furnishings Inc. (business)
- Juneau Youth Services Inc. (social services)
- Bryan Wilson and Anne Mclean (businesses, apartments)
- Jordan Meadow Condominium Owners Association (condominiums)
- S & R Condominium Owners Association (condominiums)
- Alaska Glacier Seafoods, Inc (business)
- Glacier Holdings LLC (business)
- Affordable Auto Enterprises LLC (business)
- City and Borough of Juneau (Jordan Ave., Mallard St.)

Contributing area surface types and acreage (impervious surface excluding rooftops):

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
10.6	66.8	11.5	0.0	15.6	3.1

Stormwater System Narrative: The outfall 9 stormwater system collects runoff from a contributing area that includes Jordan Ave. South and the western half of Mallard St., including adjacent buildings and parking areas (Figure 27). The stormwater system extends the length of Jordan Ave. South from Glacier Hwy. to Teal St. and along the western half of Mallard St. between Alpine Ave. and Jordan Ave. South. Runoff collected by 16 catch basins in the system is eventually discharged into a ditch at the south end of Jordan Ave. Grass ditches on the west side of Alpine Ave. and the north and south sides of Teal St. connect to this ditch; however, runoff that enters these ditches appears to infiltrate the ground. Runoff in the Jordan Ave. South ditch flows into a 270-s.f. detention basin, which is connected to Jordan Creek by a short ditch (i.e., outfall 9). All roadways and parking areas in the contributing area are paved with asphalt. The two roadways are owned by CBJ. Rooftop runoff from buildings also enters this stormwater system.

Five catch basins in the curb and gutter of Jordan Ave. South collect runoff from the roadway and adjacent parking areas. Three of these catch basins are on the west side of the roadway and collect runoff from the roadway and parking areas adjacent to the roadway. Two catch basins on the east side of Jordan Ave. South collect runoff from the roadway and the west end of the Nugget Mall parcel.

Two catch basins on the northwest portion of the Nugget Mall parcel collect runoff from a large parking area as well as from a drive-through lane used to access a bank.

Six catch basins in curb and gutter on the west end of Mallard Street collect runoff from the roadway and adjacent parking areas adjacent to Mallard St.

The three remaining catch basins in this stormwater system collect runoff from parking areas on two condominium parcels at the southwest end of Jordan Ave. South. The most downstream of the basins is equipped with an oil and water separator. (Note: condominium parcels were developed after the date of aerial imagery used for maps in this document).

Recommendations:

1. Reconstruction of roadways in this contributing area should avoid replacing grass ditches with stormwater infrastructure (e.g., curb and gutter) that concentrates and accelerates runoff conveyance to Jordan Creek.
2. Construct a wet biofiltration swale on undeveloped CBJ-owned land at the south end of Jordan Ave. South (Figure 2). Modify the existing detention basin in this area to function as a pretreatment forebay for trapping large sediment particles and debris. Install check dams in the ditch to create shallow ponded areas that sustain sedges for additional sediment trapping and stormwater treatment through biofiltration.
3. Install stormwater bioretention planters in the right-of-way near catch basins on Mallard St. and Jordan Ave. South (Figure 29). Where right-of-way space is limited, construct planters in parking spaces on privately-owned parcels outside of the right-of-way. Convey parking area runoff to the planters to the greatest extent possible; install additional planters to capture parking area runoff that cannot be conveyed to planters installed near catch basins. Consider installing planters within curb extensions (Figure) constructed on Mallard St. if space is not available in the right-of-way or in adjacent parking spaces.
4. Install a bioretention planter around the catch basin in the northwest part of the Nugget Mall parking area (Figure 3).
5. Replace impervious asphalt pavement on the bank drive-through lane with permeable pavement.

Figure 268. A wet biofiltration swale concept for treating stormwater runoff from the outfall 9 stormwater system. View of the Jordan Creek greenbelt area near the south end of Jordan Ave. World Imagery, June 2019.

Figure 2927. Tree planters occupy a narrow strip of right-of-way on the back side of sidewalks bordering Jordan Ave. South (above) and Mallard St. (below). Existing tree planters can be replaced with bioretention planters that receive runoff from the roadway through trench drains installed in the sidewalk and from adjacent parking areas. Google Street View views of Jordan Ave. South looking north near Mallard St. and Mallard St. looking west near Alpine Ave. in July 2011.

Figure 30. Bioretention planters can be installed in curb extensions where space is limited.

Figure 281. Bioretention planters in parking lots can treat and infiltrate runoff from large contributing areas and provide attractive landscaping for retail properties. An overflow drain (center left) can convey excess runoff to grey stormwater infrastructure or to another stormwater BMP. (credit: https://www.owp.csus.edu/lid/site/lot-7-bioretention-planter.html)

Stormwater System 10

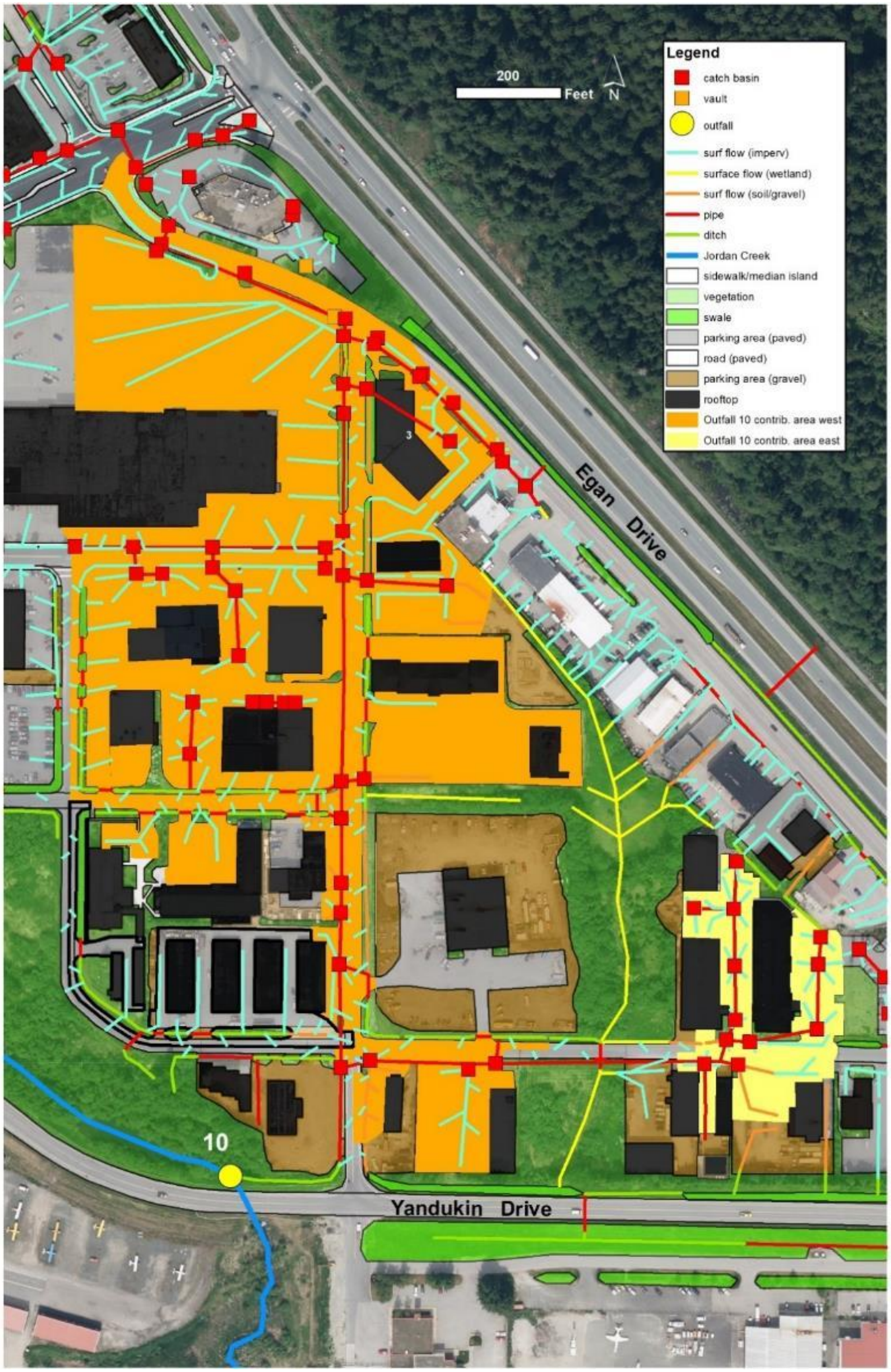


Figure 292. Stormwater system 10 overview map. UPDATE MAP FROM ARC, redraw contrib area to include Kootznoowoo, Inc parcel.

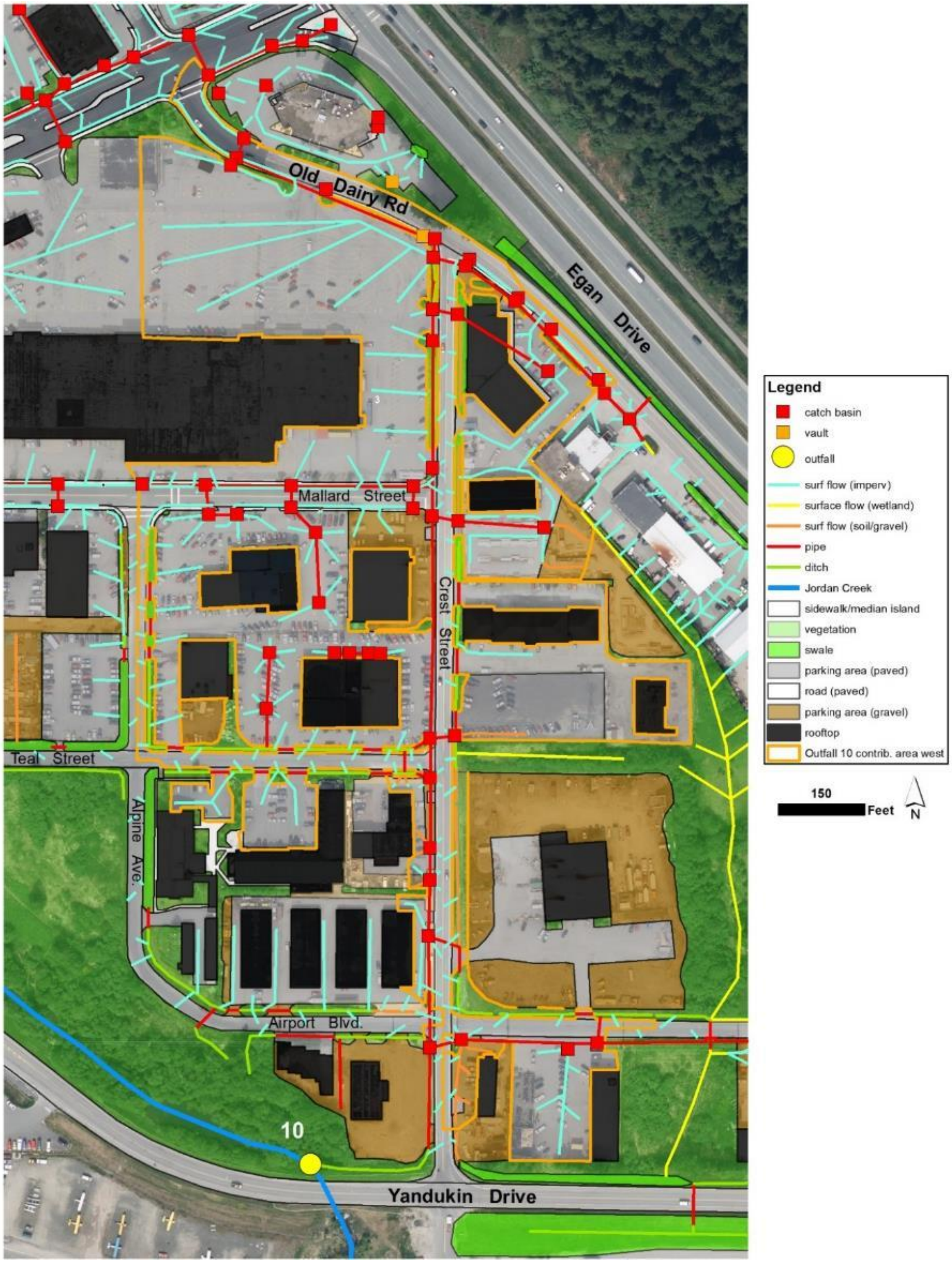


Figure 33. Stormwater system 10 map (west branch). *UPDATE MAP FROM ARC*

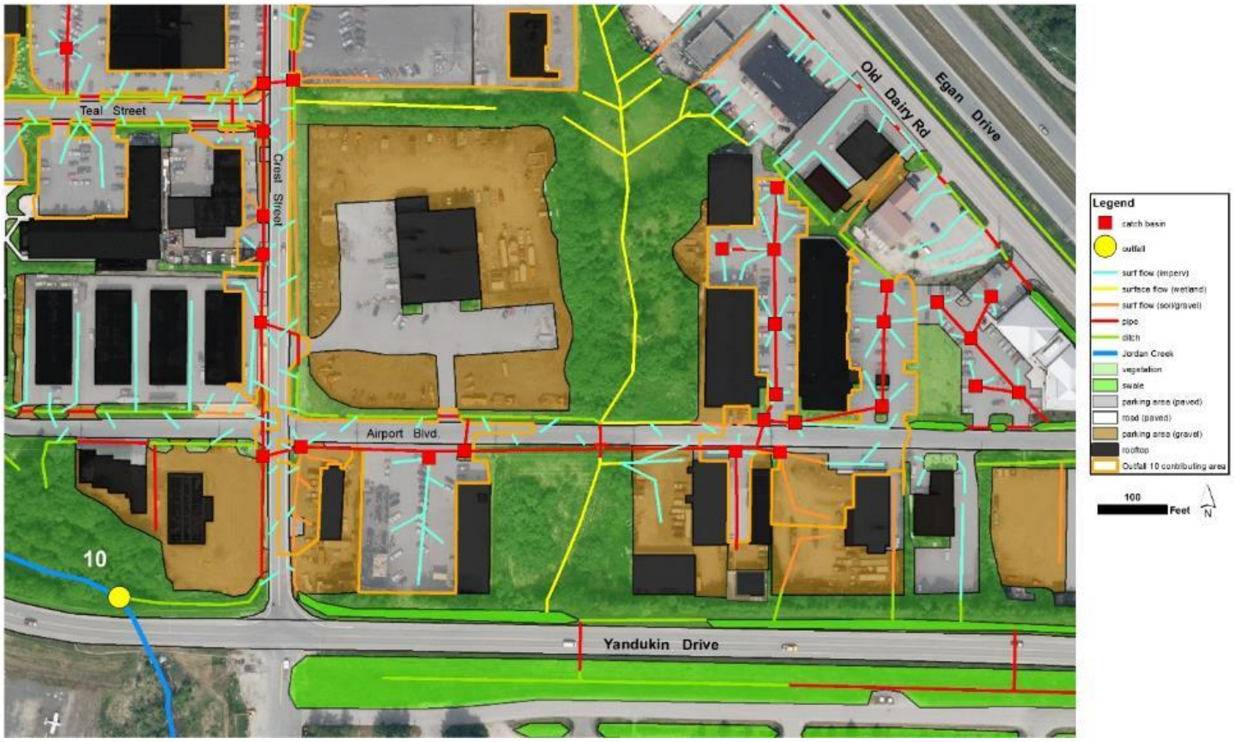


Figure 34. Stormwater system 10 map (east branch).

Landowners (land use):

- City and Borough of Juneau (Crest Dr., Mallard St., Teal St., Airport Blvd.)
- Alaska Dept. of Transportation and Public Facilities (Old Dairy Rd.)
- Numerous businesses, including the eastern half of the Nugget Mall

Contributing area surface types and acreage (impervious surface excluding rooftops): add table

Total Area (acres)	Paved Parking (%)	Gravel Parking (%)	Other Gravel (%)	Road (%)	Sidewalk (%)
17.4	71.9	7.3	0.8	13.1	1.7

Stormwater System Narrative: The outfall 10 stormwater system has the largest contributing area of any system in the Lower Jordan Creek Watershed (Figure 3Figure 3Figure Figure). The system discharges runoff into Jordan Creek through a grass ditch on the east side of the stream immediately upstream of Yandukin Dr. The outer reaches of the system include the Glacier Hwy.-Old Dairy Road intersection, the Crest Street-Old Dairy Road intersection, the intersection of Alpine Ave. with Mallard and Teal Streets, a portion of Teal Street North, and the east end of Airport Blvd.

Impervious surfaces in the contributing area include asphalt roadways and parking areas, sidewalks, and rooftops. The only formal stormwater BMP in this system is an oil and water separator near the Old Dairy Road and Crest Street intersection.

This stormwater system contributing area includes a parcel owned by Kootznoowoo, Inc. The parcel is northeast of the Nugget Mall on the north side of Old Dairy Road. Five small catch basins in the parcel collect runoff from the paved parking area surrounding a building. Although the underground connections among basins have not been mapped, runoff flows into a sump on the east side of the parcel (Figure). Due to the low elevation of the sump, a pump lifts and discharges the stormwater into a vault on the south side of Old Dairy Road west of Crest Street.

Figure 35. The Kootznoowoo parcel and building at 8585 Old Dairy Road. Stormwater runoff collected in 5 catch basins on the parcel flows to a sump (lower right of photo) and is then pumped into stormwater system 10.

There are 55 catch basins in this stormwater system. The main trunk of the system runs down the west side of Crest Street (Figure 3), with system branches extending along intersecting roadways and into adjacent properties. For the purposes of this narrative, the system has been divided into the following subsystems associated with specific roadways.

1. *Old Dairy Road – 11 basins*
   Eight catch basins in the curb and gutter of Old Dairy Road receive runoff from the roadway (impervious asphalt) between the east edge of the Valley Lumber parcel to the Glacier Hwy. intersection. Three additional catch basins are connected to those above: one is located at the northeast edge of the Nugget Mall parking area and two are in landscaped areas in road right-of-way on the north side of the Valley Lumber parcel.

2. *Crest Street – 16 basins*
   The Crest Street stormwater subsystem includes 14 catch basins in the right-of-way. Two of these basins (on the east side of the roadway) are connected to two catch basins on the Valley

Lumber parcel. The basins in the right-of-way receive runoff from Crest Street, grass and gravel areas in the road right-of-way, and gravel and asphalt parking areas on adjacent properties. Seven of the basins are in grass swales of varying sizes, 7 basins are in areas surfaced with gravel, and 2 basins are in asphalt paved areas.

Most of the Crest Street right-of-way between Mallard Street and Old Dairy Road consists of grass swales separated by short asphalt entrance drives. These swales contain 6 catch basins, which receive runoff from impervious asphalt on Crest Street and the eastern half of the Nugget Mall parking area. A seventh catch basin in the right-of-way is in a grass-covered area near the southwest corner of Crest Street and Airport Blvd. The remaining catch basins are in gravel-surfaced portions of the right-of-way on the west side of Crest Street and receive runoff from the roadway and from gravel and asphalt parking areas and access drives (Figure 35).

Figure 30. A stormwater catch basin in a gravel-surfaced area in the Crest Street right-of-way. View looking north towards Teal Street in January 2013.

The two catch basins in the Valley Lumber parcel are in the customer parking area on the north side of the store and in the lumber yard in the south side of the parcel. Although both basins are in asphalt paved areas, the lumber yard basin receives runoff from impervious asphalt as well as from a large gravel-surfaced area used to access and store lumber and other building materials.

3. *Mallard Street East area – 10 basins*

Catch basins in this area receive runoff from Mallard Street between Alpine Ave. and Crest Street and from parking areas at a car dealership on the south side of the roadway. Six basins are in the curb and gutter along Mallard Street and 4 basins are in the dealership parking area. All basins receive runoff from impervious asphalt.

4. *Toyota-Honda dealership (8602 Teal Street) – 2 basins*
   Two catch basins on the west side of this parcel receive runoff from a parking area. The runoff is discharged from a pipe into a ditch on the north side of Teal Street (Figure 36). The Teal Street East ditch system is discussed below. There are 4 additional basins in a drive-through lane on the north side of the dealership parcel; however, the fate of runoff entering these basins could not be determined.

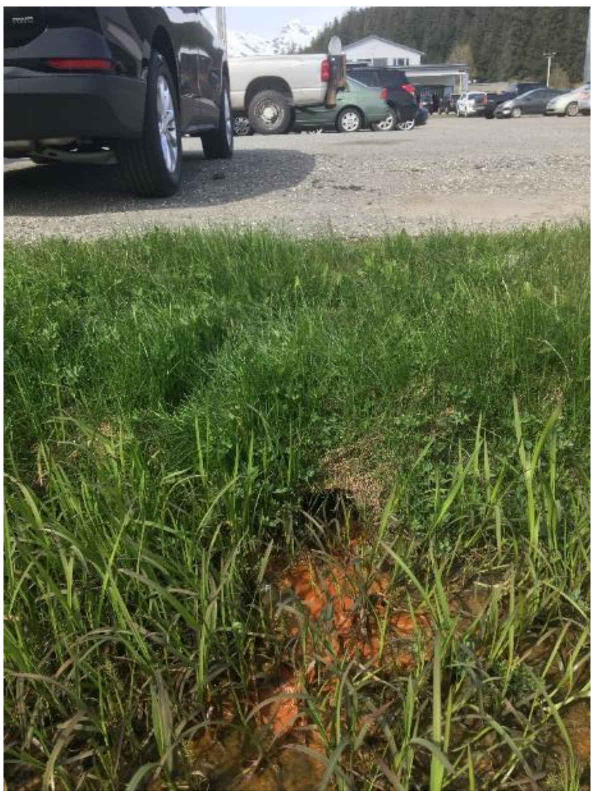


Figure 31. The outlet of a pipe connected to two catch basins in a parking area on the west side of the Toyota-Honda dealership. The Teal Street ditch is in the foreground and flows to the right. View looking north in June 2020.

5. *Airport Blvd. East – 15 basins*
   Fifteen catch basins in the Airport Blvd. East area receive runoff from the roadway and parking areas on adjacent parcels. The contributing area consists almost entirely of impervious asphalt. Five catch basins are in the road right-of-way on the south side of Airport Blvd. and 9 basins are in parking areas on parcels owned by the Alaska Print Group LLC (Alaska Litho), Shaub Alaska LLC (Les Shwab Tires), and Juneau Residences LLC (Aspen Hotel).

6. *Teal Street East and Alpine Ave. North Ditches and Swales*
   The north and south sides of Teal Street are bordered by a series of vegetated ditches interconnected by driveway culverts. The ditches, which appear to function as biofiltration swales, receive runoff from the roadway and parking areas on adjacent properties, including runoff collected by two catch basins on the west side of the Toyota-Honda dealership. The west end of the north Teal Street ditch connects to a series of swales on the east side of Alpine Ave. North, between Mallard and Teal Streets (Figure 37). These swales appear to infiltrate all the stormwater they receive from the adjacent roadway and parking areas.

Figure 32. Stormwater swales on the east side of Alpine Ave. North. View looking south towards the Teal Street intersection in June 2020.

Recommendations:

1. All catch basins in the curb and gutter of Old Dairy Road are near greenspaces (i.e., lawn, landscaping) on the back side of sidewalks. Install bioretention planters in green spaces near each basin to treat and infiltrate runoff from the curb and gutter. Use trench drains to convey runoff across the sidewalks. Use portions of the adjacent parking areas if additional space is need for the planters.

2. Seven catch basins in the Crest Street right-of-way are in grass swales or are surrounded by grass. The catch basin inlets are flush with the surrounding grade, which limits the opportunity for runoff to infiltrate the ground instead of entering the stormwater system. Additionally, some of the basins are at the edge of the swales/grass areas limiting opportunity for runoff to infiltrate the soil before entering a catch basin. Modify the swales to function as bioretention cells or infiltration trenches. Install bioretention planters around catch basins in small grass areas. Depending on the characteristics of the native underlying soils, it may be necessary to add drain rock and soil amendments to improve runoff treatment and promote infiltration. In all cases, raise the basin inlets to function as overflow drains.

   Due to limited parking on the property, Valley Lumber employees park their vehicles in the grass swales that border Crest Street next to the store. The vehicles have damaged grass and rutted soil in the swale (Figure 38) reducing the runoff treatment and flow control effectiveness of the swale and causing soil erosion. Work with the property owner to find alternative parking areas for employee vehicles, restore the swale, and install “no parking” signs along the roadway.

Figure 33. Vehicles parked in a swale in the Crest Street right-of-way near Valley Lumber. View looking north near the east end of Mallard Street in March 2020.

Most of the right-of=way on the east side of Crest Street (between Teal Street and Airport Blvd.) has been rutted by vehicles (Figure 39). The ruts accumulate runoff which flows towards a catch basin next to the intersection of Teal Street and Crest Street. Work with the City and Borough of Juneau to restore a stormwater swale in this area and prevent vehicles from accessing the site.

Figure 34. Ruts left by vehicles driving in the Crest Street right-of-way. View looking north between Teal Street and Airport Blvd. in October 2020.

3. Seven catch basins in the Crest Street right-of-way are in gravel-surfaced areas (Figure 35). The basins receive sediment-laden runoff from contributing areas used by vehicles for parking and access to parking. Construct bioretention planters around the basins to treat and infiltrate runoff. Raise the basin inlets to function as overflow drains. The planters can provide a physical separation between the roadway and adjacent parking areas (Figure 40).

Figure 35. A bioretention planter between a parking area and an access drive (credit: https://www.hazenandsawyer.com/publications/urban-green-infrastructure-solutions/)

4. Install stormwater bioretention planters in the right-of-way near catch basins on Mallard St. Where right-of-way space is limited, construct planters in parking spaces on privately-owned parcels outside of the right-of-way. Convey parking area runoff to the planters to the greatest extent possible; install additional planters to capture parking area runoff that cannot be conveyed to planters constructed near catch basins. If space is not available in the right-of-way or in adjacent parking spaces, consider installing planters within curb extensions (Figure) constructed on Mallard Street.

5. Gravel-surfaced areas in the Valley Lumber lumberyard produce large quantities of sediment-laden runoff that flows to a catch basin in the center of the yard (Figure 41). Encourage the landowner to surface gravel areas with permeable pavement and install a bioretention planter around the existing catch basin.

Figure 36. The Valley Lumber lumberyard produce large quantities of sediment-laden stormwater, some of which enters stormwater system 10. May 2019.

6. Determine the fate of runoff that enters 4 catch basins on the north side of the Toyota-Honda dealership (Figure 33). If the runoff enters a conventional stormwater system that lacks BMPs, identify suitable BMPs to treat and infiltrate the runoff.

7. Grass-lined ditches next to Teal Street East and Alpine Ave. North connect to this stormwater system and likely help improve the quality of stormwater runoff. If these roadways are reconstructed with curb and gutter, ensure that all runoff is treated and infiltrated at the source and not conveyed to a greywater system. Avoid unnecessary cleaning of the ditches to protect the integrity of the vegetation mat. When ditch cleaning is necessary, remove the vegetation mat and replace it after excess sediment is removed. Install check dams in the downstream reaches of the ditches to enhance sediment trapping and infiltration, particularly in winter when vegetation is absent.

8. The north edge of the NC Machinery parcel contains a 0.4-acre strip of natural vegetation. Work with the landowner to protect this area and determine if runoff from adjacent impervious surfaces can be directed into the strip to treat and infiltrate stormwater.

9. Install bioretention planters around catch basins in the right-of-way of Airport Blvd. East.

10. 8 catch basins on the Alaska Print Group LLC (Alaska Litho) and Juneau Residences LLC (Aspen Hotel) parcels drain large asphalt-paved parking areas. With the exception of replacing the impervious asphalt with pervious pavement, there are no opportunities to infiltrate runoff in nearby pervious areas due to the slope and contour of the parking areas.

11. The recommendations above address stormwater management at numerous runoff source areas over a wide area encompassing large numbers of parcels and streets. While managing stormwater at sources areas is preferred, implementing these BMPs will require many years depending on funding availability, landowner support, and schedules for infrastructure reconstruction or improvement projects.

    As an alternative to the above recommendations or to manage stormwater runoff until most source area BMPs are fully implemented, it may be possible to redirect runoff from the Crest Street ditch to a 1,400-foot long grass swale on the southeast side of Yandukin Drive (Figure 42 and Figure 43). Project feasibility would depend on the location of underground utilities, and it will be necessary to lower the bottom elevation of the swale to ensure gravity flow under the road.

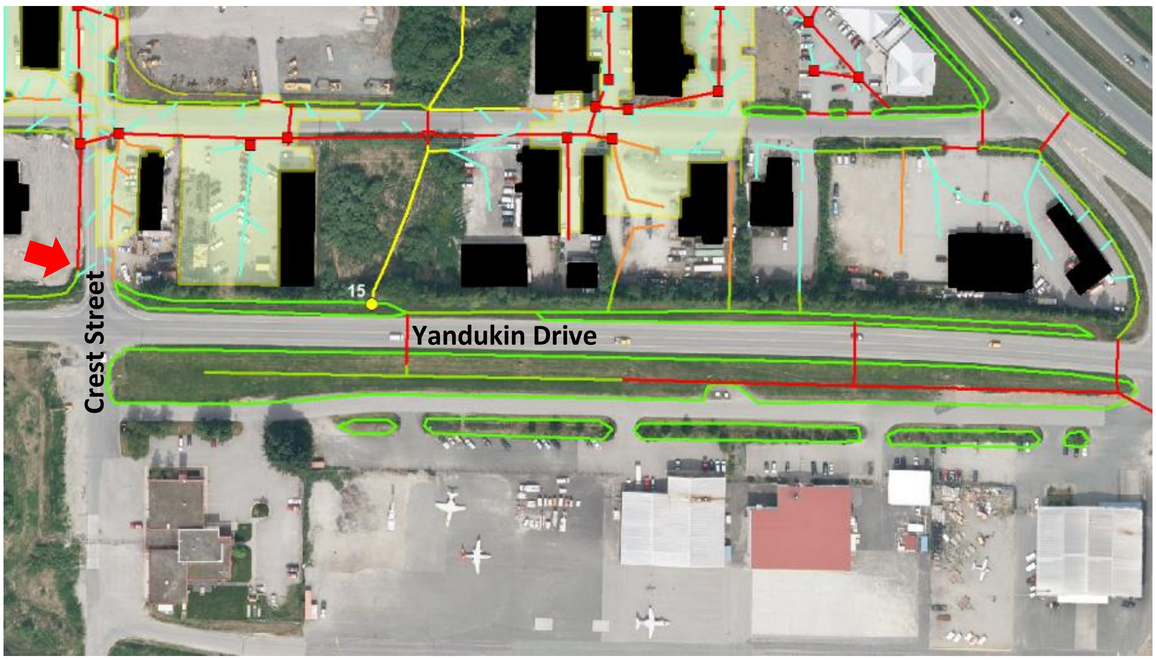


Figure 37. A large grass swale on the south side of Yandukin Drive East could potentially receive stormwater runoff from stormwater system 10. The arrow indicates the existing outfall pipe.

Figure 38. A grass swale on the south side of Yandukin Drive East. View looking west towards the Crest Street in October 2014.

Other Stormwater Inputs to Jordan Creek

The stormwater systems described above consist of conventional stormwater infrastructure (i.e., curb/gutter, catch basins, pipes) that discharge large volumes of runoff to the stream at a discrete point, either the end of a pipe or ditch (outfall). Stormwater also enters Jordan Creek as low-volume surface flows from small impervious contributing areas. This type of runoff enters the stream as dispersed sheet flow or flow confined within small channels. Sometimes channels are constructed by landowners to drain ponded stormwater. This type of runoff typically flows into narrow strips of riparian vegetation that may not provide adequate infiltration and treatment before the stormwater enters the stream. Although individually small in volume, these forms of runoff may have significant cumulative impacts on the total volume of stormwater and associated pollutants entering Jordan Creek. Stormwater management recommendations are provided for managing this stormwater on several parcels adjacent to Jordan Creek.

Jordan Creek Center

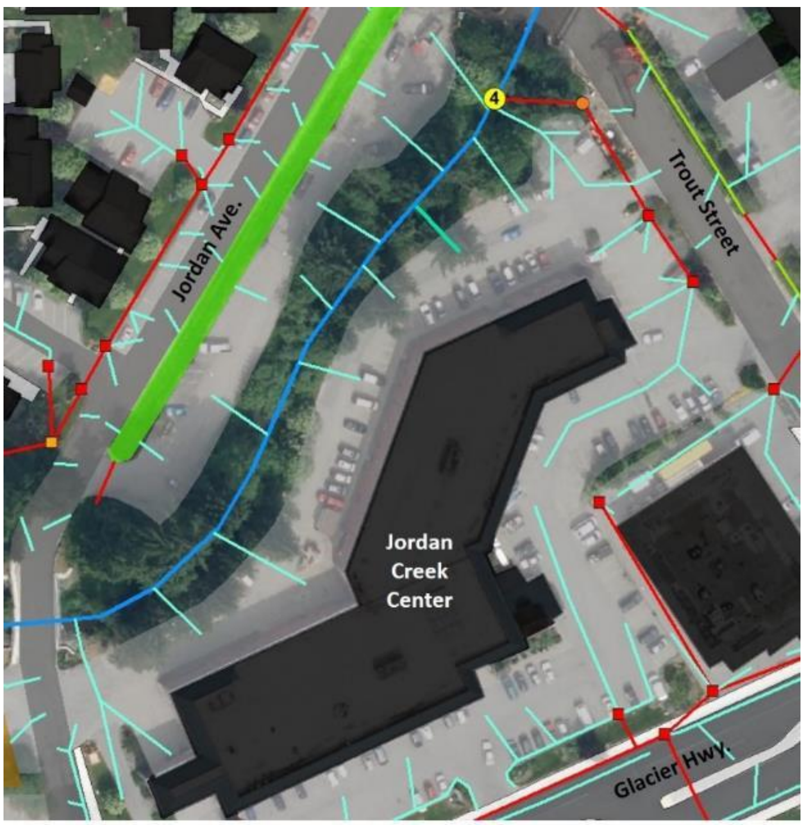


Figure 39. Parking areas encroach on Jordan Creek within the Jordan Creek Center parcel.

Stormwater System Narrative:

The Jordan Creek Center building houses numerous offices and businesses. Parking spaces extend along the north and south sides of Jordan Creek within the parcel. Numerous parking spaces are immediately adjacent to the stream bank (Figure 44) and the remaining parking spaces and access lanes are separated from the stream by narrow (5-15 feet) strips of riparian vegetation (Figure 45). Runoff from these asphalt parking areas sheet-flows to the edge of the riparian buffer.

The piles of plowed snow from parking areas sometimes extend into the buffer damaging riparian plants, preventing the establishment of new plants, and introducing gravel, litter, and likely other pollutants into the buffer and stream (Figure 46). Additionally, plowing has damaged the exposed roots of large spruce trees growing in a narrow riparian strip between parking spaces and the channel on the south side of the stream. Plowed snow on the north side of the stream is stored near the north end of the parking area and meltwater flows into the stream through a narrow riparian strip of vegetation (Figure 46).

Figure 40. Only a narrow strip of riparian vegetation exists between parking spaces and Jordan Creek near the west end of the Jordan Creek Center parcel. View looking west from the south side of Jordan Creek in May 2020.

Figure 41. Plowed snow from a parking lot next to Jordan Creek Center is stored next to Jordan Creek. March 2020.

Recommendations:

1. Use permeable pavement when the existing asphalt must be replaced.
2. Avoid storing snow in riparian buffers. Store snow on paved areas where the riparian buffer is widest to maximize runoff treatment and infiltration.
3. Avoid damaging riparian vegetation during snow plowing.
4. Consider removing parking spaces that exceed parking needs and restore vegetation in reclaimed areas.
5. Where parking areas cannot be removed, replace a narrow strip of edge pavement with permeable pavement to infiltrate runoff.

Jordan Square North and Powell Realty

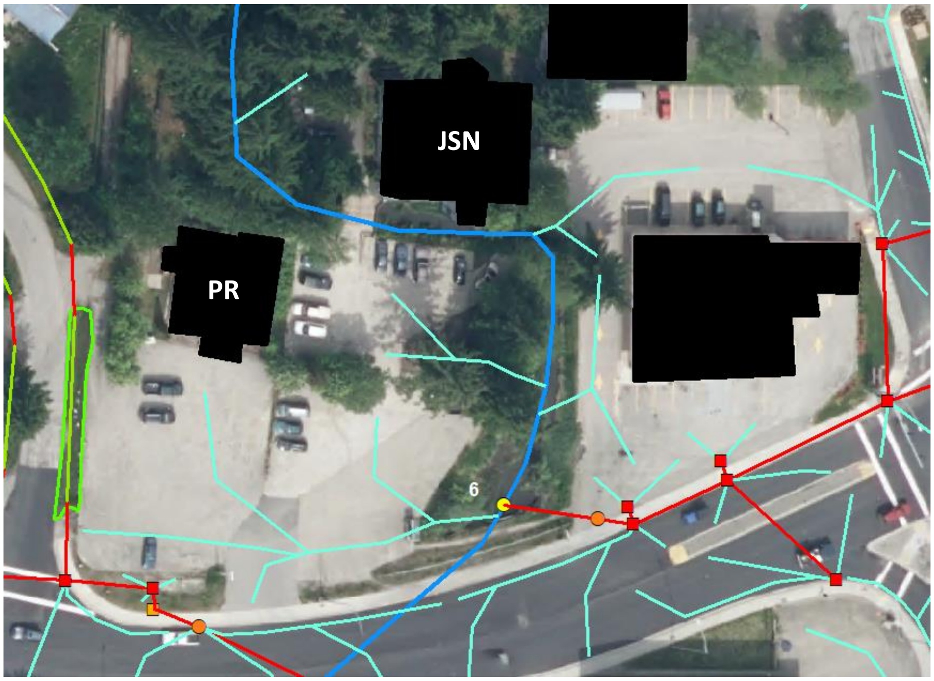


Figure 42. Stormwater flow paths that connect to Jordan Creek on the Powell Realty (left), Jordan Creek Square North (center), and First National Bank Alaska (right) parcels.

Stormwater System Narrative:

Powell Realty is a real estate business and Jordan Square North is an office/business building. Concrete and asphalt parking areas on the south sides of Powell Realty and Jordan Square North slope towards Jordan Creek (Figure 47). Stormwater runoff from these parking areas flows into Jordan Creek after passing through a narrow riparian strip (Figure 48). On the northwest side of the Jordan Square North building, a small parking area encroaches on the stream bank (Figure 49).

Recommendations:

1. Parking spaces in front of the Jordan Square North building do not use available space effectively. Redesign the parking area to provide the same or additional parking capacity while enlarging the width of the riparian buffer. This will likely require removing one or more large Sitka spruce trees; however, the additional riparian area that will be reclaimed can be planted with other trees and vegetation that provide more ecological functions (e.g., shade, energy subsidies for the stream) and stormwater treatment than the Sitka spruce.
2. Use permeable pavement when the existing asphalt must be replaced.
3. Eliminate the parking area on the northwest side of the Jordan Square North building and revegetate (Figure 49).
4. If the enlarged riparian area is not able to treat runoff adequately, route runoff into a bioretention cell constructed in the riparian zone.

Figure 43. Runoff from a parking area on the south side of the Jordan Square North parcel flows through a narrow strip of vegetation before entering Jordan Creek. View looking west in May 2015.


Figure 44. A small parking area next to the Jordan Square North building extends onto the banks of Jordan Creek. View looking southwest /downstream in January 2014.

Jordan Square South and Central Council Tlingit and Haida Indian Tribes of Alaska (CCTHITA) parcels

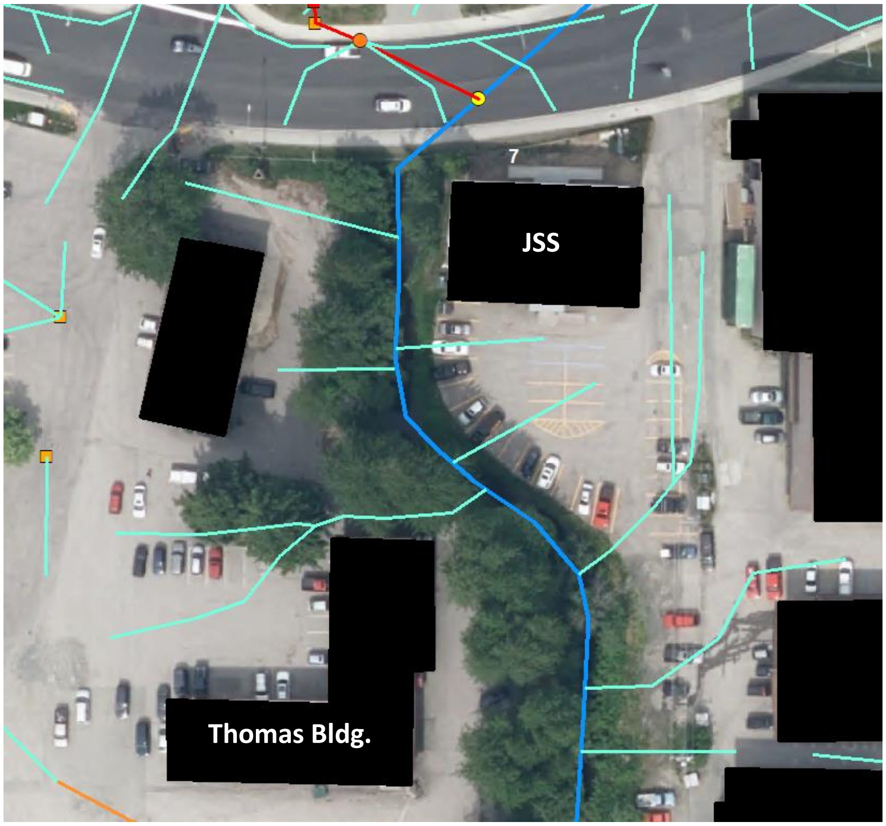


Figure 45. Stormwater flow paths on the CCTHITA (left side of stream) and Jordan Square South (right side of stream) parcels.

Stormwater System Narrative:

These parcels are on opposite sides of Jordan Creek immediately downstream of Glacier Highway (Figure 50). Parking area runoff from the parcels enters a narrow riparian buffer as sheet flow or discrete low-volume flow paths. Some of the flow paths deliver stormwater directly to Jordan Creek with little opportunity for runoff treatment. Runoff originating on the northwest side of the Edward K. Thomas building formerly infiltrated a low basin that contained two large Sitka spruce trees. The trees were removed and the basin was filled to create parking spaces in 2019.

The riparian buffer on the Jordan Square South parcel is very narrow and is managed as lawn and used for snow storage, which has removed or damaged native plants (Figure 51). A stormwater flow path that begins between the office building and Lyle's Home Furnishings enters Jordan Creek in this area.

Figure 46. Plowed snow and gravel cover the banks of Jordan Creek at the edge of a parking area on the Jordan Square South parcel. View looking east from the west side of Jordan Creek in January 2014.

Recommendations:

1. Construct infiltration trenches at the edge of parking areas and/or in the riparian buffer to intercept runoff from stormwater flow paths.
2. Plant native vegetation in the narrow riparian strip on the Jordan Square South parcel. In addition to enhancing runoff infiltration and treatment, the trees will shade the stream and provide habitat.
3. Work with the Jordan Square South owner to avoid storing snow in the riparian setback. Plant native vegetation in setback areas that have been used for snow storage to improve habitat and enhance the effectiveness of runoff treatment.

Stormwater systems in the Lower Jordan Creek watershed that lack a surface connection to Jordan Creek

Several stormwater systems consisting of conventional stormwater infrastructure (i.e., curb and gutter, catch basins, pipes) in the Lower Jordan Creek watershed collect runoff from contributing areas that are very close to the stream, but do not convey runoff directly to the stream. Instead, runoff from these systems infiltrates the ground in a formal or informal BMP, typically a grass swale. These systems have been mapped and are described below. Recommendations to protect and improve the flow control and runoff treatment functions of the systems are provided.

Central Council Tlingit and Haida Indian Tribes of Alaska

Figure 47. Runoff from asphalt paved and gravel-surfaced parking areas near the Edward K. Thomas Building flows into an L-shaped infiltration trench constructed next to Jordan Creek in 2015.

Stormwater System Narrative:

The Edward K. Thomas building is an office building on the west side of Jordan Creek downstream of Glacier Highway (Figure 52). The building is owned and occupied by the Central Council Tlingit and Haida Indian Tribes of Alaska. Stormwater runoff from asphalt paved parking areas on the west side of the building and paved and gravel-surfaced areas on the south side of the building formerly flowed directly into Jordan Creek. The runoff contained high loads of suspended sediment and oil sheens were often visible on the surface of the water (Figure 53). An infiltration trench was constructed near the downstream end of the flow path in October 2015 (Figure 54). The excavated trench was filled with coarse rock. The rock fill in the downstream half of the trench was surfaced with topsoil and planted with native vegetation. The basin stores and infiltrates stormwater produced during all but the largest runoff events.

Figure 48. Stormwater runoff from gravel and paved parking areas near the Edward K. Thomas building flows towards Jordan Creek prior to construction of the infiltration trench. View looking southeast in February 2016.

Figure 49. Stormwater runoff enters an infiltration trench (photo center) on the south side of the Edward K. Thomas building. The vegetated portion of the trench is behind the concrete barriers. View looking southeast in August 2016.

Recommendations:

1. Monitor the infiltration capacity of the trench during high-volume runoff events to ensure adequate storage and infiltration of runoff.

2. Remove invasive plants and discarded construction debris and yard waste from the vegetated portion of the infiltration trench.

Yandukin Drive Area

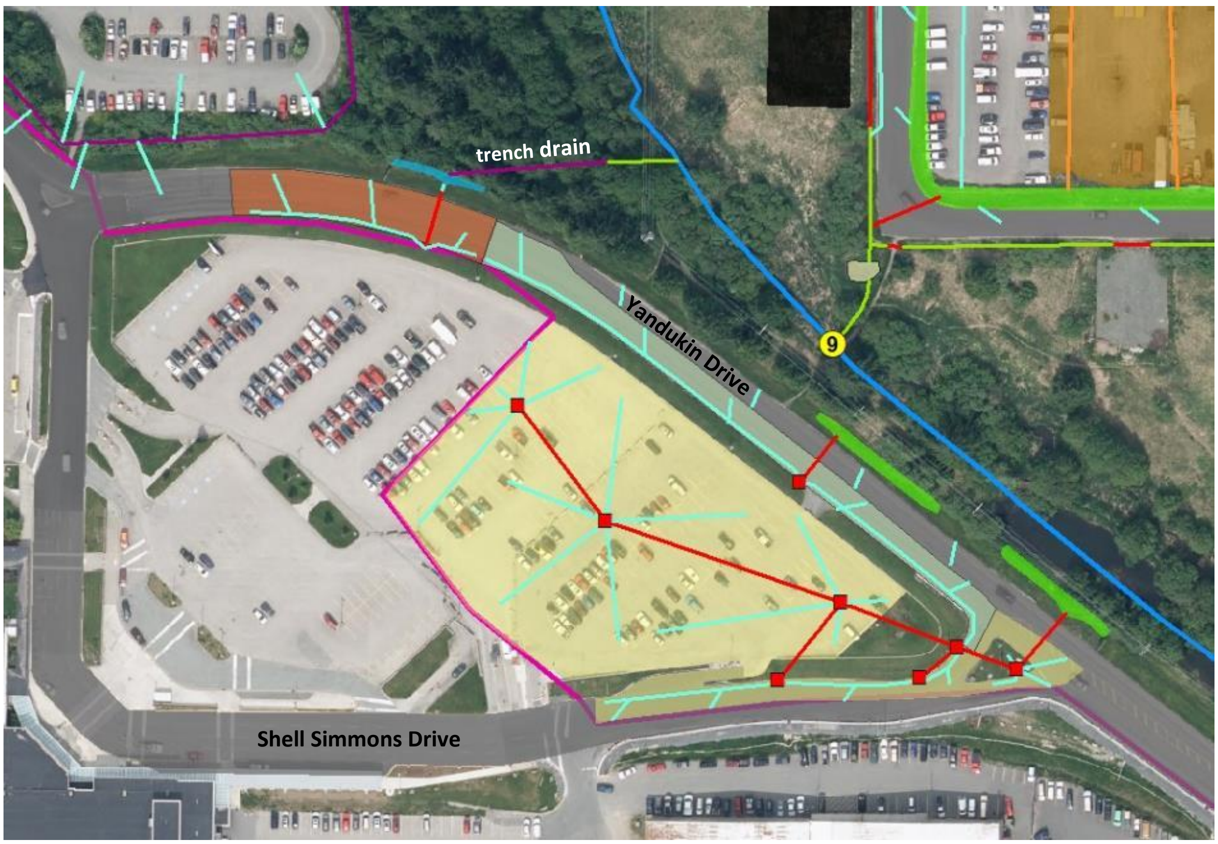


Figure 50. Three stormwater systems at the west end of Yandukin Drive discharge stormwater into areas where runoff infiltrates the ground. The system contributing areas are shown in orange (west), green (middle), and yellow (east).

Stormwater runoff from impervious asphalt roadways and a parking lot at the west end of Yandukin Drive enters one of three stormwater systems, referenced here as Yandukin Drive West, Middle, and East (Figure 55). These systems discharge runoff into the right-of-way on the north side of Yandukin Drive where the runoff infiltrates the ground.

A. Yandukin Drive West

Stormwater System Narrative:

The Yandukin Drive West stormwater system collects runoff from a 240-ft long section (0.23 acres) of Yandukin Drive (Figure 55). The roadway is owned and maintained by the CBJ. Prior to 2019, this system discharged runoff into a wet pond on land managed by the Juneau International Airport. The pond was connected to Jordan Creek by a ditch, although there was no evidence that surface water flowed from the pond to the stream. In 2019, the Juneau International Airport filled the pond and a portion of the outlet ditch. A 150-ft. long trench drain was constructed in the former pond area; the drain connects the outfall area to a remaining section of ditch. Road runoff discharged from this system collects in a small basin next to the trench inlet and eventually infiltrates the ground, presumably within the trench drain (Figure 56). No improvements to this system are recommended at this time.

Figure 51. The outfall area of a small stormwater system at the west end of Yandukin Drive. Runoff from a stormwater outfall pipe (red arrow) collects in the ditch and enters a trench drain. The inlet of the drain is indicated by the gravel-faced embankment above. View looking east in June 2020.

B. Yandukin Drive Middle Outfall

Stormwater System Narrative:

This stormwater system discharges runoff into a grass swale in the right-of-way on the north side of Yandukin Drive (Figure 57). The contributing area is 0.34 acres in size and includes a 550-foot long section of Yandukin Dr. and a small portion of Shell Simmons Dr. (Figure 55). Both roads are owned and maintained by the CBJ. Roadway runoff sheet-flows to the south side of the road where it infiltrates the ground. Runoff that does not infiltrate flows along the edge of the road to a catch basin, and from the basin into a pipe that outfalls into a grass swale on the north side of the road. A berm between the swale and the stream suggests that all runoff infiltrates the swale. This stormwater system appears to provide a high level of flow control and runoff treatment. No improvements to this system are recommended at this time.

Figure 52. The Yandukin Drive Middle stormwater system discharges runoff from a pipe (indicated by red arrow) into a grass swale next to Jordan Creek (left of photo). View looking southeast from the north side of Yandukin Drive in June 2020.

C. Yandukin Drive East Outfall

Stormwater System Narrative:

The Yandukin Drive East stormwater system discharges runoff into a grass swale next to Jordan Creek on the north side of Yandukin Drive (Figure 58). The stormwater system contributing area (1.88 acres, Figure 55) consists of a 335-ft. long section of Shell Simmons Drive, a portion of the Shell Simmons Drive/Yandukin Drive intersection, and the eastern half of the Juneau International Airport parking area. The CBJ owns and maintains the contributing area. The system has 7 catch basins: 4 catch basins in the parking area, 3 catch basins in curb and gutter on the north side of Shell Simmons Drive, and 1 catch basin near the edge of a grass island at the intersection of the two roadways. All roadway and parking areas surfaces are covered with impervious asphalt pavement.

Runoff entering the swale is prevented from flowing directly into Jordan Creek by a earthen berm along the stream bank. All runoff that enters the swale appears to infiltrate the swale soil.

Juneau International Airport often stores plowed snow in the swale, on the edge of the pond, and in the pond. The snow damages riparian vegetation and introduces pollutants into the stream. The airport has agreed to avoid this practice as of spring 2020.

Recommendations

1. Monitor the outfall area during large runoff events to ensure adequate runoff storage and infiltration within the swale. Modify the swale to increase infiltration and storage capacity if runoff overflows into the stream.
2. Avoid storing plowed snow in the protected riparian setback area next to the pond (Figure 59). Plant native woody plants on the banks of the pond to provide habitat, improve runoff treatment, and increase transpiration rates from the swale.

Figure 53. The Yandukin Drive East stormwater system discharges runoff from a pipe (indicated by red arrow) into a grass swale next to Jordan Creek. Jordan Creek is visible at top of photo. View looking northwest from the north side of Yandukin Drive in May 2020.

Figure 54. Plowed snow from Shell Simmons Drive is stored in the Yandukin Drive East stormwater swale and on the bank of an excavated pond in Jordan Creek (right). View looking west from the north side of Yandukin Drive in January 2014.

Alpine Ave. South-Airport Blvd. West

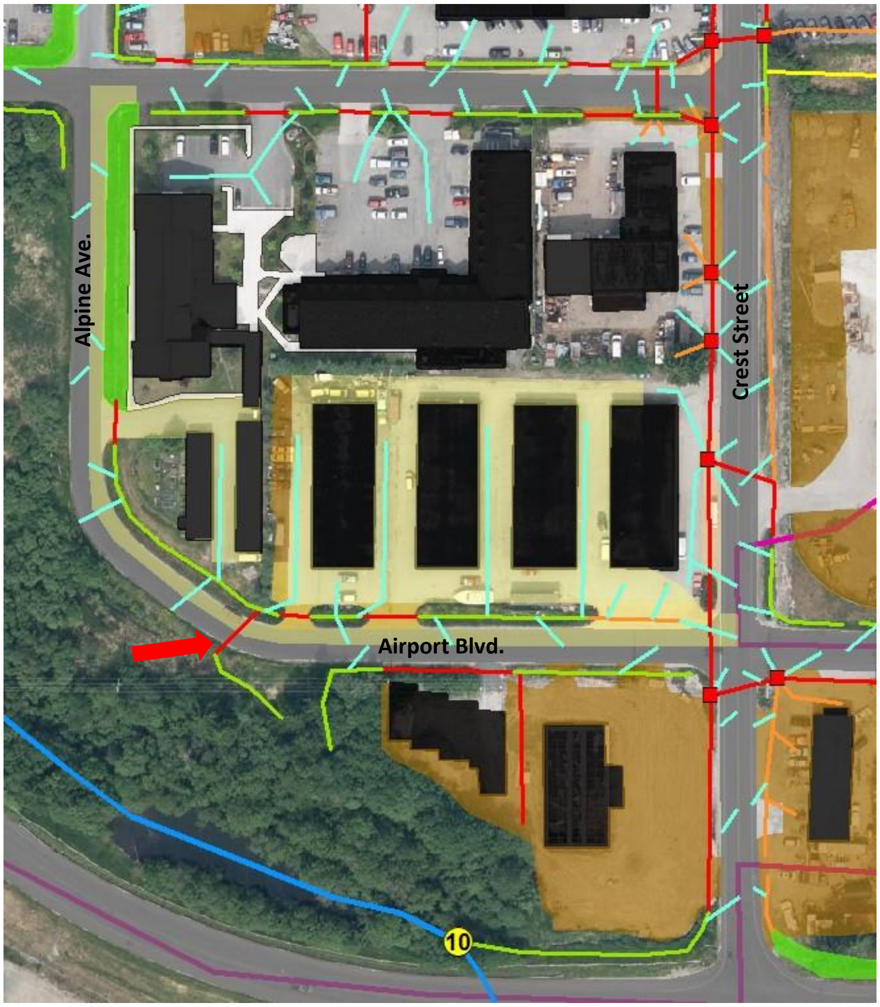


Figure 55. The Alpine Ave. South – Airport Blvd. West stormwater system. The contributing area is shown in yellow; red arrow indicates the outfall pipe.

Stormwater System Narrative:

The stormwater system contributing area includes the eastern half of Alpine Ave., the northern half of Airport Blvd., and driveways, parking areas, and rooftops of buildings on adjacent parcels (Figure 60). Runoff enters the ditches as sheet flow from roadways or low-volume flow paths from parking lots, driveways, and access lanes. The roadways, parking areas, and building access lanes on private parcels are paved with impervious asphalt. Two short driveways in the contributing area are surfaced with gravel.

This stormwater system consists of an interconnected series of grass-lined ditches on the east and north sides of Alpine Ave. South and Airport Blvd. West, respectively. The ditch adjacent to Alpine Ave. has a wide flat bottom and appears to function as a biofiltration swale (Figure 61). The Airport Blvd. ditches are narrow and well vegetated. It appears that stormwater runoff entering these ditches infiltrates the ground and is not conveyed downstream. The ditches meet at the junction of the two roadways where a culvert extends to the south side of the roadway. The culvert inlet is perched causing runoff to pool in the ditch (Figure 62). The culvert outlet is plugged with soil and vegetation preventing runoff from flowing into a wetland adjacent to Jordan Creek.

Recommendations:

1. This stormwater system provides complete flow control and runoff treatment in its current state. There is no evidence of surface runoff entering Jordan Creek. If roadways in this contributing area are reconstructed, avoid replacing the grass ditches with stormwater infrastructure that concentrates and accelerates surface runoff conveyance to Jordan Creek, or replace the ditches with BMPs that provide the same flow control and treatment functions.

2. Stormwater ditches adjacent to Teal Street East receive parking lot and roadway runoff with little treatment and infiltration before it enters stormwater system 10 at the Crest Street intersection. The narrow ditches have a limited ability to treat runoff and vegetation is removed when the ditches are cleaned. To enhance treatment and infiltration of runoff from this area, investigate the feasibility of directing ditch runoff from Teal Street East (particularly on the north side of the roadway) into the grass swale adjacent to Alpine Ave. South.

Figure 56. A grass-lined swale on the east side of Alpine Ave. South. View looking north towards Teal Street in October 2014.

Figure 57. Stormwater runoff pools in a ditch at the junction of Alpine Ave. and Airport Blvd. View looking southeast in May 2020.

Airport Blvd. East Wetland

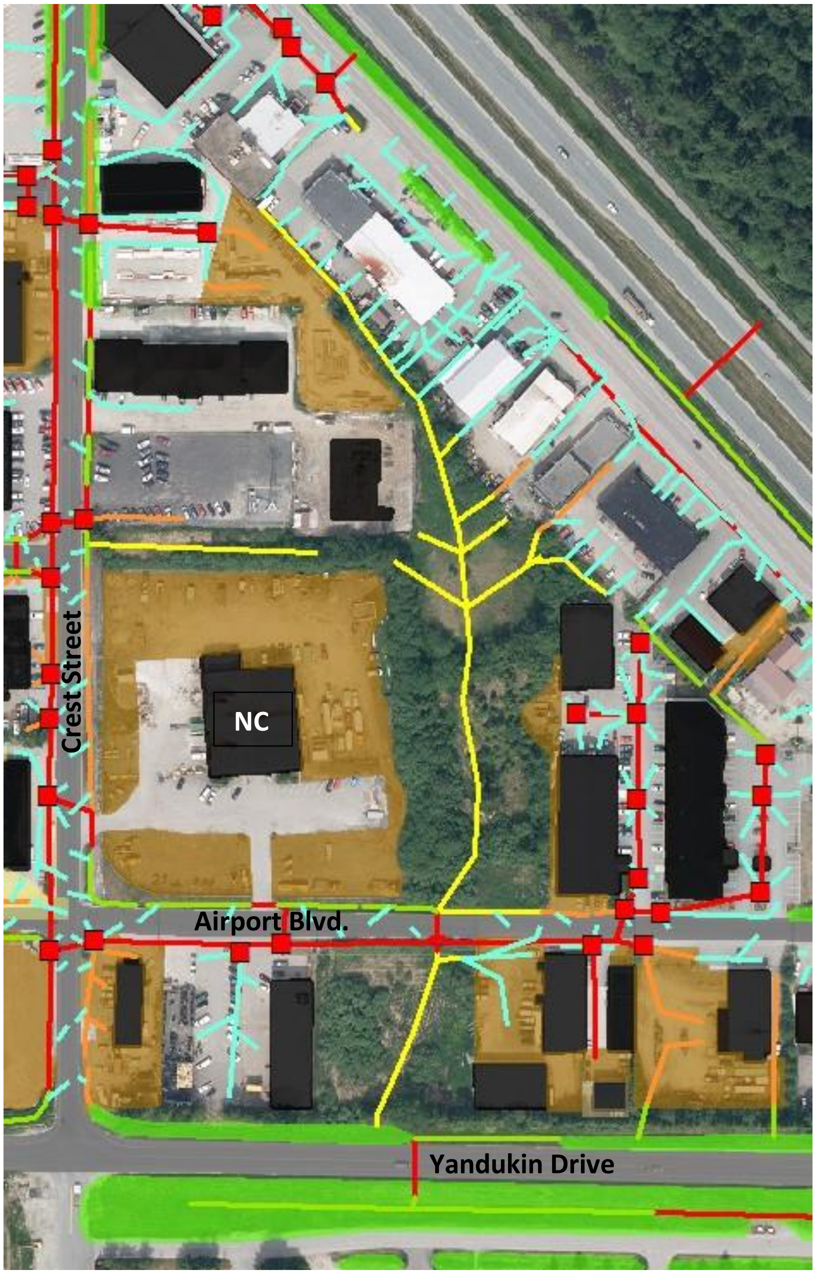


Figure 58. A wetland on the north side of Airport Blvd. East receives parking lot and storage area runoff from numerous parcels. The yellow line indicates the general flow of stormwater through the area from north to south. The undeveloped parcel on the south side of Airport Blvd. was filled in the summer of 2020.

Stormwater System Narrative:

NC Machinery owns a large parcel of land at the intersection of Crest Street and Airport Blvd. (Figure 63). The east side of the parcel consists of 3 acres of open space that is mostly wetlands (Figure 64). Runoff from this parcel flows to the south, under the roadway in a pipe, and into a parcel containing wetlands that was filled in 2020. All runoff exiting this parcel appears to infiltrate a grass swale on the north side of Yandukin Drive east of Crest Street. There is no surface connection between the system and Jordan Creek. The contributing area includes the uplands and wetlands themselves as well as rooftops and gravel and asphalt parking and storage areas on adjacent properties, including portions of the Urgent Care and Valley Lumber parcels.

Recommendations:

1. Work with the Landowner and Southeast Alaska Land Trust to preserve this area for its open-space and stormwater management values and functions.

2. Stormwater runoff from several parcels near the wetland flows to Jordan Creek in stormwater system 10. Investigate the feasibility of redirecting runoff from stormwater system 10 into the wetland.

Figure 59. The north end of an undeveloped portion of the NC Machinery Parcel on the north side of Airport Blvd. East. View looking north in October 2011.

Appendix B

Stormwater Best Management Practices

Appropriate for the Lower Jordan Creek Watershed

A stormwater infiltration basin at the north end of Jordan Ave. is designed to receive runoff from a parking lot near Jordan Creek.

Contents

Stormwater Best Management Practices

This document describes the different types of Best Management Practice (BMPs) that can prevent or reduce the impacts of stormwater on flooding and water pollution in urban water bodies. For this document, a stormwater BMP is defined as an engineered structure, device, or system that directs surface stormwater to groundwater (i.e., infiltrates) or that removes pollutants from stormwater. Infiltrating BMPs thus provide *flow control* while those that remove pollutants provide *runoff treatment*. Many types of stormwater BMPs provide both stormwater flow control and treatment, although effectiveness varies among types.

Three general categories of stormwater BMPs that are appropriate for the Lower Jordan Creek watershed include:

A. Infiltration BMPs
B. Biofiltration BMPs
C. Filtration BMPs

A. Infiltration BMPs

Infiltration BMPs rely on the filtration, adsorption, and biological properties of native and engineered soils to remove pollutants from stormwater as it flows downward (vertically) through the BMP (Stormwater Management Manual for Western Washington, SWMMWW). In contrast, biofiltration BMPs (discussed below) treat runoff primarily by filtering pollutants from the water as it flows horizontally through vegetation.

The typical infiltration BMP is designed to temporarily impound stormwater runoff in a basin or swale containing plants and soil, or in a rock-filled trench that contains overlying plants and soil. As the impounded runoff flows through vegetation and into the ground, pollutants are filtered by plants and removed or transformed by the soil and associated microbes. Bioretention BMPs, a type of infiltration BMP, provide the highest level of runoff treatment by incorporating a design soil mix – the bioretention soil mix (BSM).

Infiltration BMPs can function as both flow control and runoff treatment BMPs by treating runoff to remove pollutants and infiltrating runoff into the native underlying soil or groundwater. To provide for runoff treatment, the native or design soil must have adequate organic content and sorption capacity. Flow control is achieved by directing runoff away from conventional stormwater infrastructure (e.g., pipe), which helps to recharge groundwater, reduce peak flows in streams, and minimize flood risk in the receiving water body (NACTO 2017). If native soils do not provide adequate infiltration, treated water may be discharged to greywater infrastructure, a surface water body, or a BMP that provides runoff treatment.

Types of infiltration BMPs:

1. permeable pavements

2. infiltration trenches and basins
3. bioretention cells, swales, and planters

1. Permeable Pavements

Permeable pavements are made from porous material that allows runoff to flow through it or from nonporous blocks that are spaced so that water can flow through the gaps between blocks. Permeable pavements are typically underlain by base layers, including an aggregate/reservoir layer where water is temporarily stored before infiltrating the underlying native soils and a choker/leveling coarse that traps particles to prevent them from filling the voids of the reservoir layer (Figure 1) When runoff inflows exceed storage and infiltration capacities, incorporate underdrains and overflow pipes into the permeable pavement system.

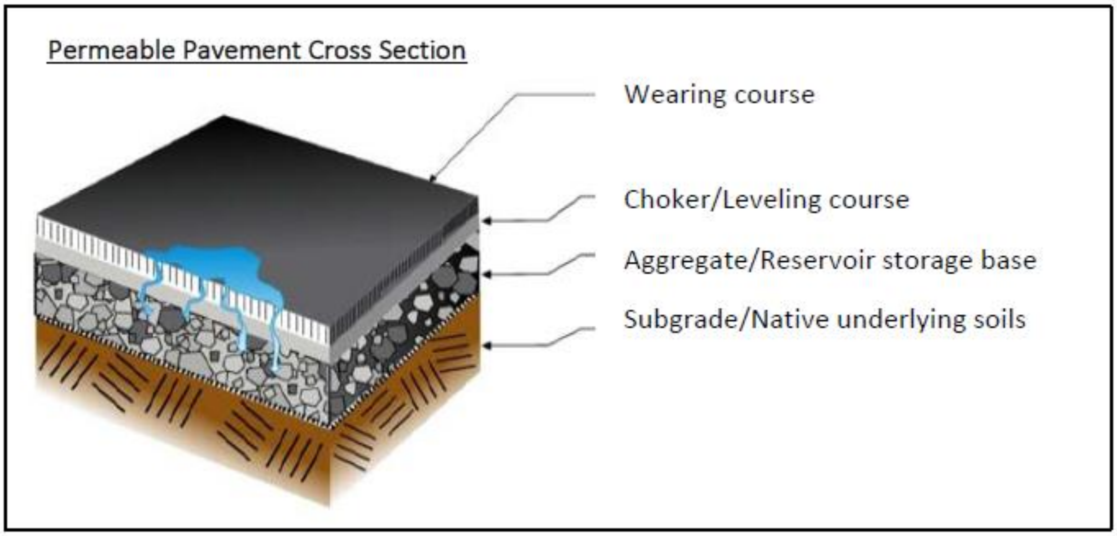


Figure 1. Typical layers in a permeable pavement system (Washington Stormwater Center LID Training Manual).

Permeable pavement can provide stormwater flow control and runoff treatment by:

- Reducing runoff volume by promoting infiltration of stormwater into the vadose zone (i.e., unsaturated soil profile).
- Reducing the amount of vehicle spray by reducing the amount of ponded water on the road surface (spray from vehicles washes pollutants from the surface of vehicles onto the road surface).
- Increasing contact time between stormwater and microbes that assimilate or degrade pollutants.
- Trapping large particulate matter and adsorbing pollutants as runoff percolates through the wearing and underlying reservoir courses.
- Promoting volatilization of certain organic pollutants in stormwater through longer residence times and exposure to air.

- Reducing the amount of deicing salts entering surface waters by allowing snowmelt and rain to infiltrate into the permeable pavements and underlying reservoir coarse.

Four common types of permeable pavements:

Porous asphalt (Figure 2)

- a flexible pavement that is similar to conventional asphalt pavement
- produced by reducing or eliminating the amount of fine-grained material in the pavement mix, which creates voids that allow water to flow through the aggregate
- typically used in parking lots

Figure 2. Left: A parking lot paved with porous asphalt. Right: porous asphalt closeup (Washington Stormwater Center LID Training Manual)

Pervious concrete (Figure 3)

- similar to conventional concrete pavement
- produced by reducing or eliminating the amount of fine-grained material in the pavement mix, which creates voids that allow water to flow through the aggregate
- the only permeable pavement that is rigid
- suitable for parking lots, bike lanes, sidewalks, and driveways

Figure 3. Left: pervious concrete sidewalk, driveways, and a street in a residential setting. Right: pervious concrete closeup. (Washington Stormwater Center LID Training Manual)

Permeable pavers

- installed on an open-graded (i.e., large void spaces) aggregate bedding course
- joints between pavers are filled with aggregate to allow runoff to infiltrate into base layers
- gravel dislodged or eroded from joints can be replaced
- can withstand high vehicle loads at low speeds

Permeable paver types:

<u>Permeable interlocking concrete pavements</u> (PICP) are modular precast impervious pavers made with high-strength Portland cement (Figure 4). PICP can support high vehicle loads at low speeds.

<u>Aggregate pavers</u> (a.k.a., pervious pavers or AGGs) are modular precast pavers made with uniformly sized aggregates bound together with Portland cement and high-strength epoxy. Aggregate pavers are intended for pedestrian traffic only.

Figure 4. Left: a parking lot paved with PICP. Right: PCIP closeup (Washington Stormwater Center LID Training Manual).

Grid systems

- grids systems are interlocking systems of open cells made with concrete or plastic (Figure 5)
- grid openings are filled with soil or aggregate; soil is planted with grass or other vegetation
- typically installed on aggregate bases
- provide the largest amount of void space in the wearing course layer among the four types of permeable pavements
- appropriate for trails, paths, maintenance access roads, and parking lots
- capable of high vehicle loads
- best suited for low speeds and infrequent vehicular traffic

Figure 5. Left: park access road constructed with plastic grid and gravel. Right: plastic grid system (Washington Stormwater Center LID Training Manual).

2. Infiltration Trenches and Basins

Infiltration Trench

An infiltration trench is a shallow trench filled with coarse washed aggregate and surrounded by permeable soil (Figures Figure 6 and Figure 7). Stormwater runoff entering the trench is temporarily stored in the voids between the aggregate and eventually infiltrates into the underlying native soil. To function as a Runoff Treatment BMP, an additional stormwater element(s) must be added upstream of the basic infiltration trench design. For example, an oil and water separator can function as a pretreatment facility by removing insoluble hydrocarbons (e.g. oil), settleable solids, and floatables such as plastics before runoff enters the trench. Infiltration trenches may include an underdrain or bypass to convey excess runoff to gray stormwater infrastructure, a surface water body, or another stormwater BMP (Figure 7). See Figures Figure 8 and Figure 9 for examples of infiltration trenches in the Lower Jordan Creek watershed.

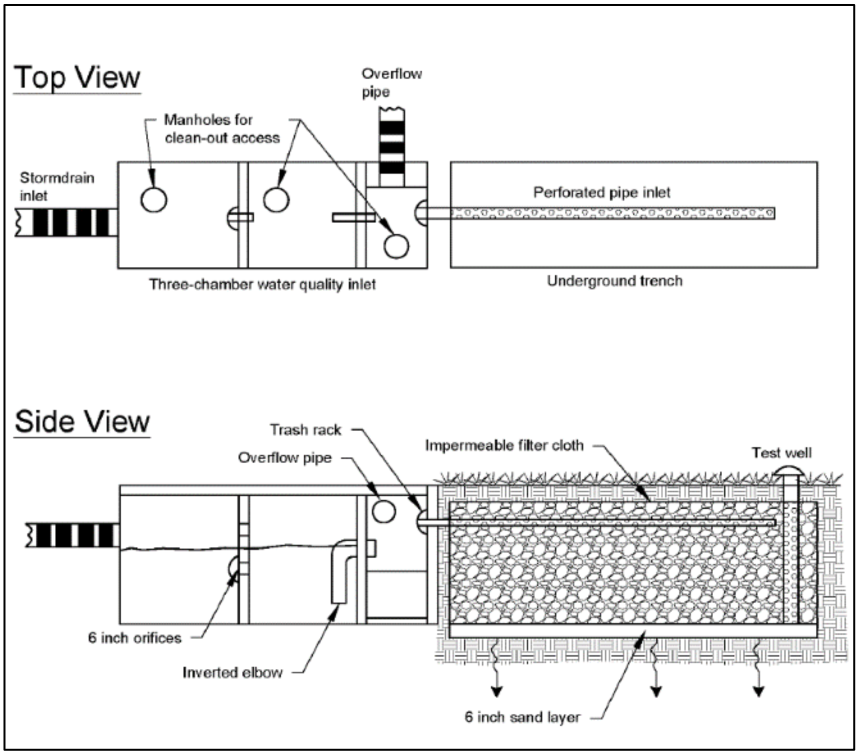


Figure 6. Infiltration trench with oil/grit pretreatment chamber (Washington Department of Ecology).

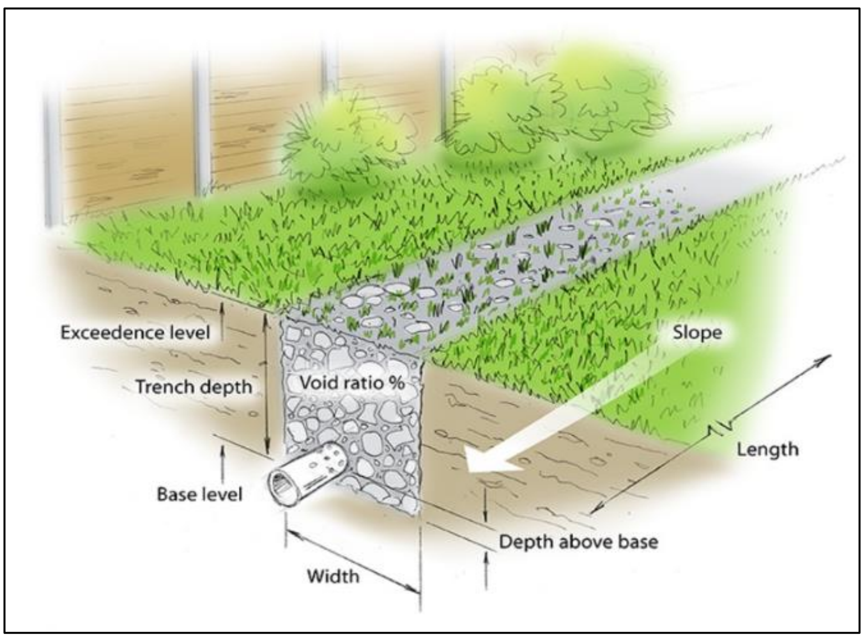


Figure 7. An infiltration trench equipped with an underdrain pipe (Innovyze®).

Figure 8. An infiltration trench (left of barriers) on the west side of Jordan Creek, downstream of Glacier Highway in Juneau. Runoff enters from the lower right of photo; Jordan Creek is left of photo.

Figure 9. The inlet end of a 150-foot long infiltration trench that receives runoff from the west end of Yandukin Drive near Jordan Creek.

Infiltration Basin

Infiltration basins are earthen impoundments that collect, temporarily store, and infiltrate stormwater runoff (WWSWMM) (Figure 10, Figure 11, & Figure 12). Infiltration basins designed with vegetation and bioretention soil mix can remove pollutants from runoff. The addition of a pretreatment facility, such as a settling basin/forebay, helps to remove settleable solids from stormwater runoff before it enters the basin proper (Figure 11).

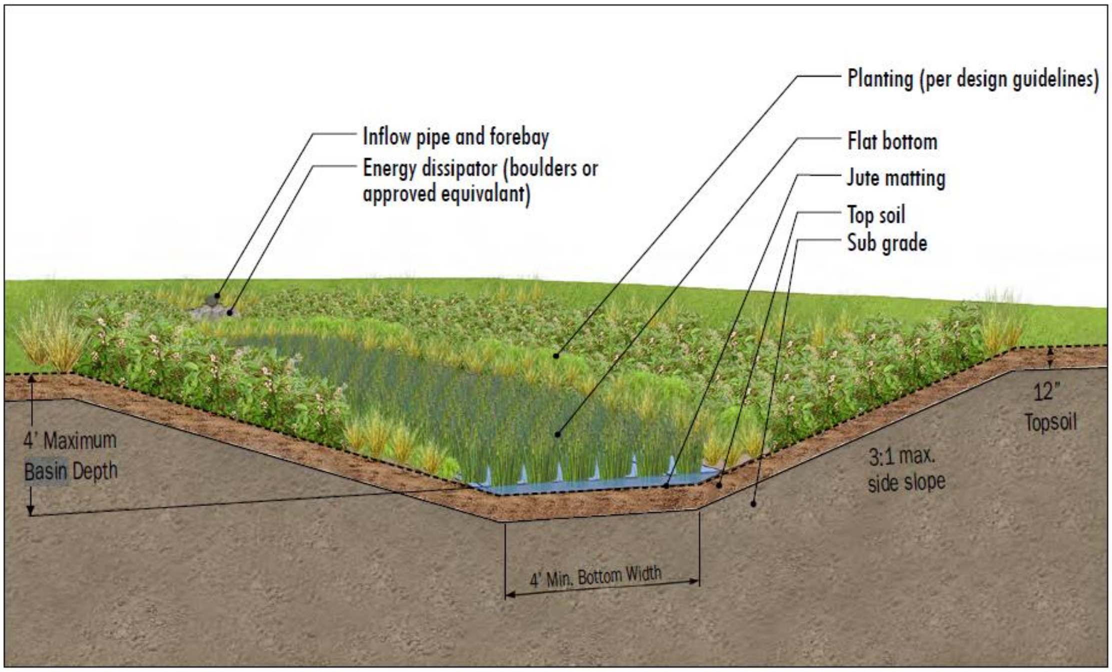


Figure 10. Cross-section view of an infiltration basin (Clean Water Services).

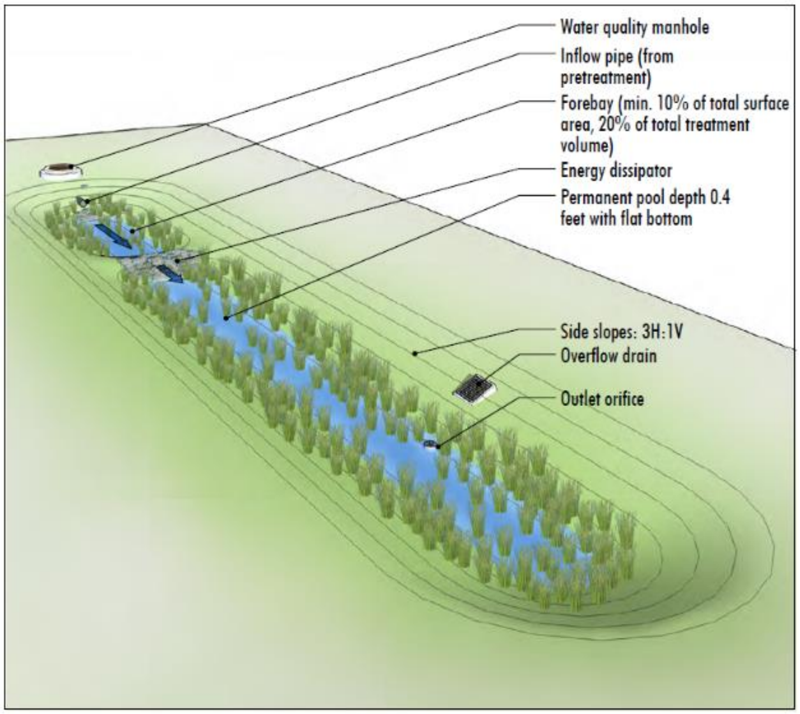


Figure 11. An infiltration basin with a forebay (Clean Water Services).

Figure 12. A stormwater BMP next to Eagle River in the Eagle Beach State Recreation Area in Juneau. Runoff flows from the parking lot to a biofiltration swale through a trench drain in the sidewalk. Runoff exiting the swale flows through a buried culvert (not depicted above) into an infiltration basin.

3. Bioretention Cells, Swales, and Planters

Bioretention is an infiltration type of BMP that uses the chemical, biological, and physical properties of plants, soil microbes, and the mineral aggregate and organic matter in soils to transform, remove, or retain pollutants from stormwater runoff (Eastern Wash. Low Impact Dev. Guidance Manual). Three types of bioretention BMPs include bioretention cells, swales, and planters.

Bioretention Cell

Bioretention cells are shallow depressions filled with BSM and plants, including trees, shrubs, grasses, and/or other herbaceous plants (SWMMSW) (Figure 13Figure 14). Bioretention cells do not function as a conveyance system and underdrains and flow controls are optional.

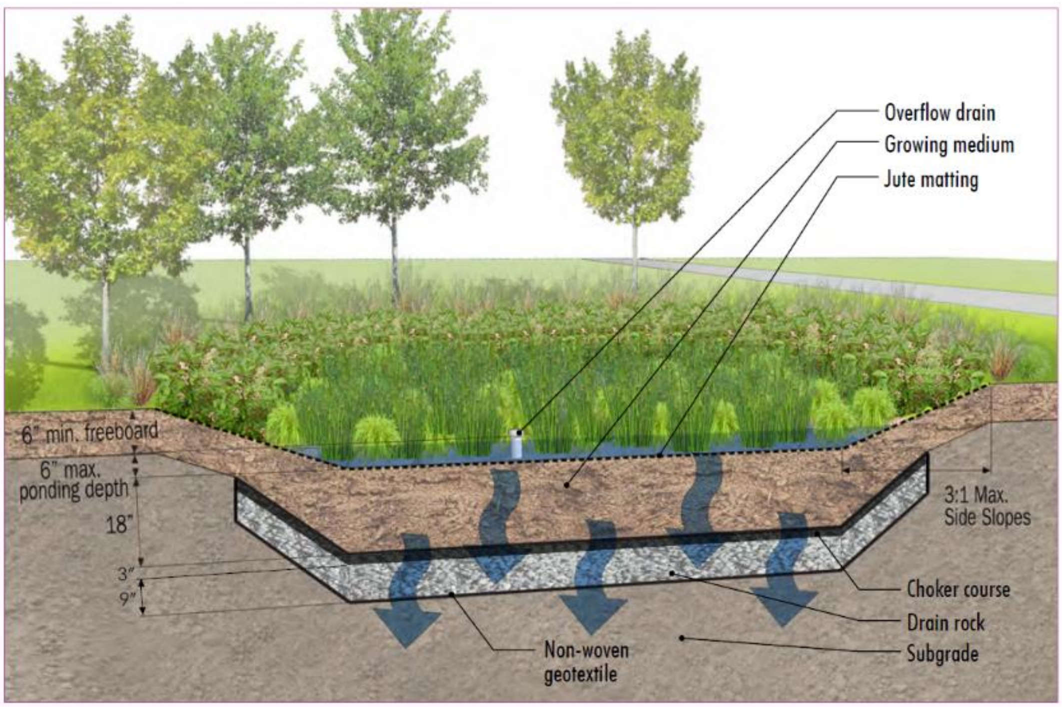


Figure 13. Cross-section view of a bioretention cell (Clean Water Services).

Figure 14. Bioretention cell. Note the overflow drain with beehive grate (center) and the two blue inlet pipes (center right) that convey runoff from the street into the cell (Washington Stormwater Center Training Manual).

Bioretention Swale

Bioretention swales use the same design features as bioretention cells. Unlike bioretention cells, bioretention swales are interconnected in a series to allow for conveyance of overflow from one swale to the next (Figure 15).

Figure 15. A series of bioretention swales. Check dams between cells impound and convey water to the downstream cell. (Washington Stormwater Center Training Manual)

Bioretention Planter

*Bioretention planters are stormwater infiltration BMPs with walled vertical sides and flat bottoms designed to capture, store, and treat stormwater runoff from streets (NACTO) (*Figure 16*,* Figure 17Figure 18*). Bioretention planters are commonly used where the right-of-way width is constrained. Where the right-of-way does not* *provide adequate space, planters can be constructed in curb extensions or medians (*Figure 19*). Plants and BSM in the planter remove many types of pollutants from the runoff. Planters have an open bottom allowing treated runoff to infiltrate native soils. Bioretention planter boxes are similar to planters but have an impervious bottom and must be equipped with an underdrain. Bioretention planters can be interconnected in series.*

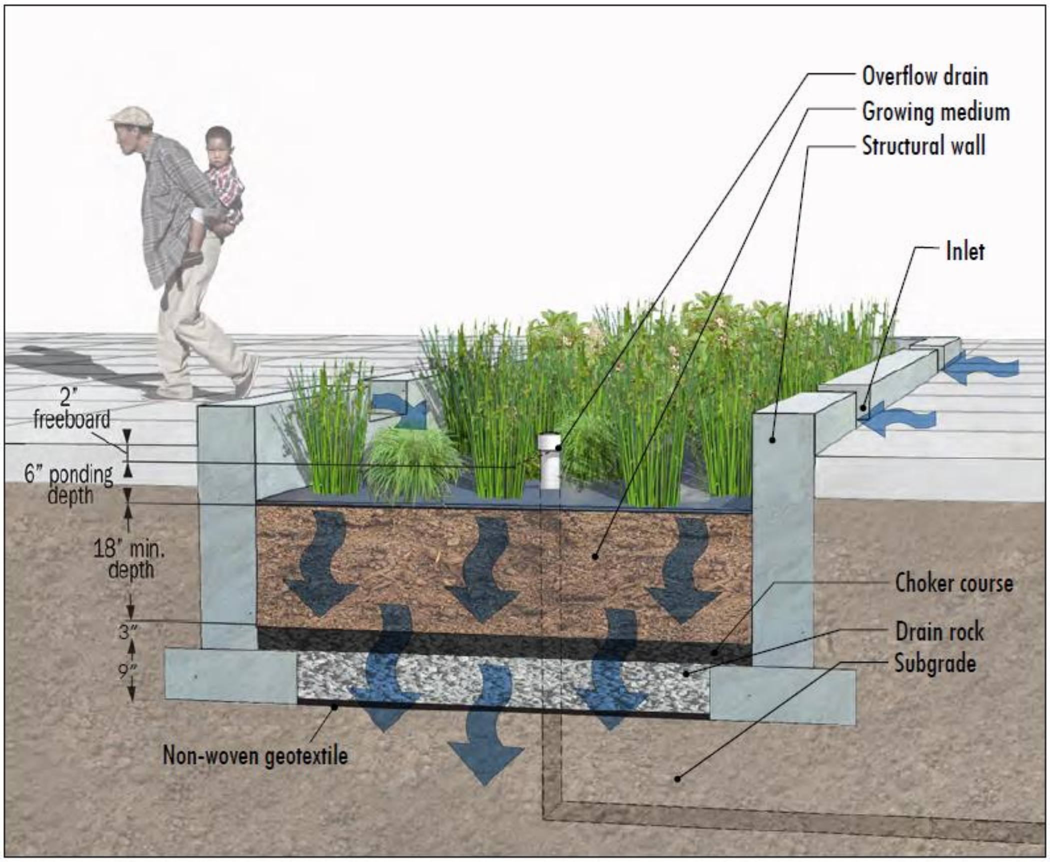


Figure 16. Cross-section view of a bioretention planter between a roadway/plaza (left) and a sidewalk (right) (Clean Water Services, 2016).

Figure 17. A bioretention planter in Portland, Oregon. Trench drains serve as inlets and outlets for street runoff; curb notches are inlets for sidewalk runoff. (Washington Stormwater Center Training Manual)

Figure 18. This bioretention planter containing a single tree intercepts runoff from curb and gutter immediately upstream of a catch basin (center left) in Seatac, WA. Note the sidewalk is constructed with pervious concrete.

Figure 19. A bioretention planter in a curb extension designed to receive runoff from the sidewalk and street in Portland, Oregon. Curb extensions provide space for stormwater BMPs where right-of-way space is limited and improve auto, pedestrian, and bicycle safety by shortening the crossing distance for pedestrians, improving sight lines, and providing a visual presence in the roadway to slow vehicles approaching intersections (Washington Stormwater Center Training Manual).

B. Biofiltration BMPs

Biofiltration BMPs use an engineered strip of vegetation, in combination with slow and shallow water flow, to filter sediment and pollutants from stormwater runoff. Pollutants are removed from the water by the combined effects of sedimentation, filtration, infiltration, settling, and plant uptake. The primary direction of stormwater flow through biofiltrations BMPs is along the horizontal axis.

Biofiltration BMPs remove low concentrations and quantities of total suspended solids (TSS), heavy metals, petroleum hydrocarbons, and nutrients from stormwater (WWSWMM). Compost can be mixed with the native soils in biofiltration BMPs to enhance biological treatment processes and improve plant health. For sites with high levels of TSS, debris, and hydrocarbons, incorporating a pretreatment facility into the design may be necessary. Three types of biofiltration BMPs are biofiltrations swales, wet biofiltration swales, and vegetated filter strips.

1. Biofiltration Swale

Biofiltration swales are linear, shallow, vegetated, open channels usually with parabola- or trapezoid-shaped cross sections (SWMMWW) (Figure 20, Figure 21, andFigure 22). Due to the high degree of variation in performance among biofiltration swales, it may be desirable to consider another runoff treatment BMP that is appropriate for the site. Biofiltration swales may be designed with longitudinal dividers to ensure an even distribution of flow within the swale and underdrains to remove treated water when local infiltration capacity is exceeded.

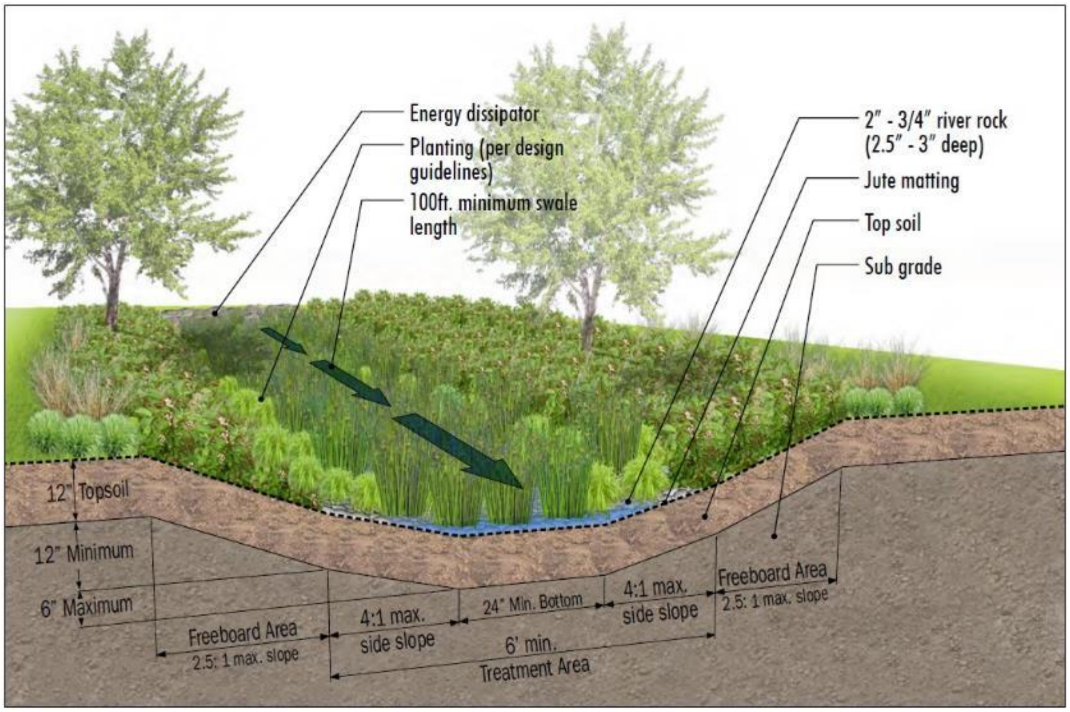


Figure 20. Section view of a typical biofiltration swale. (Clean Water Services)

Figure 21. Panoramic photo of a biofiltration swale at the intersection of Airport Blvd. and Old Dairy Road in October 2014. Swale inlet pipes are at top of photo; the outlet pipe is at left edge of photo.

Figure 22. A biofiltration swale at the southeast end of Alpine Ave. in the lower Jordan Creek watershed in October 2014.

2. Wet Biofiltration Swale

A wet biofiltration swale is a variation of the basic biofiltration swale for use on sites with saturated soils due to low slope, high groundwater table, or continuous inputs of low volume base-flows. Wet biofiltration swales are considered a type of runoff treatment BMP that can remove low concentrations of pollutants such as TSS, heavy metals, nutrients, and petroleum hydrocarbons (WWSWMM). Plants used in wet biofiltration swales must tolerate saturated soil conditions. A wet biofiltration swale is designed like a basic biofiltration swale design, but with a few modifications.

3. Vegetated Filter Strip

A vegetated filter strip is a flat strip of vegetation adjacent to an impervious surface such as a road, driveway, or parking lot (Figure 23, Figure 24, andFigure 25). Runoff enters the strip as sheet flow across the width of the strip. Runoff Treatment is provided by filtration through vegetation and infiltration through the soil. Native soils may be amended with the addition of compost to enhance treatment capability. A flow spreader may be added to a filter strip. The spreader uniformly spreads flow across the edge of the strip next to the impervious surface.

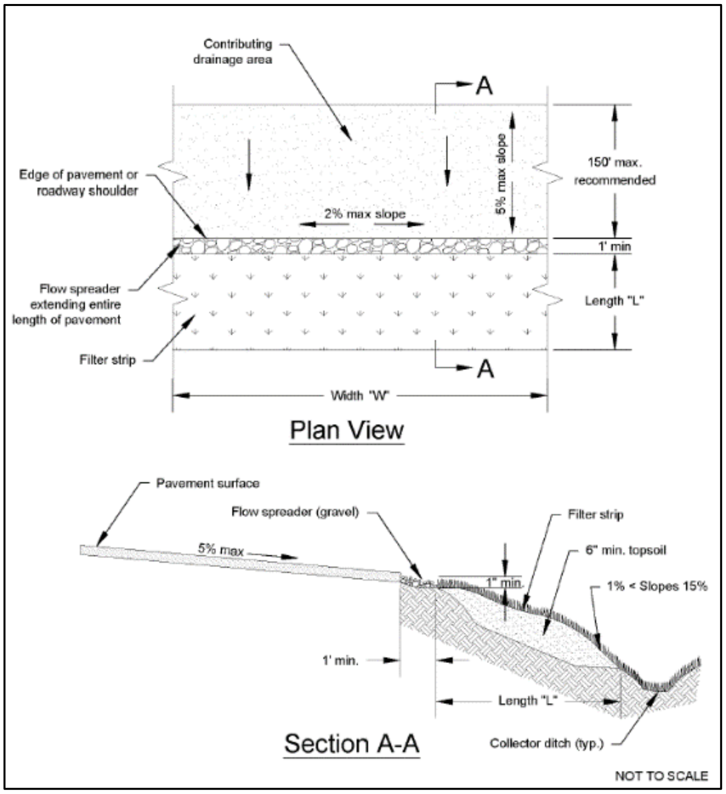


Figure 23. Typical design for a vegetated filter strip (SWMMWW).

Figure 24. The median and outer margins of Egan Drive function as vegetative filter strips. View looking northwest where the highway crosses Jordan Creek (Google Earth Street View).

Figure 25. A vegetated filter strip in a parking lot at the Oregon Zoo.

C. Filtration BMPs

Filtration BMPs collect and treat stormwater runoff to remove suspended solids, phosphorous, and insoluble organics (including oils). These pollutants are removed by the combined processes of settling (e.g. in a presettling cell) and percolation of runoff through a medium, typically a bed of sand (SWMMWW). Treated runoff is discharged through an underdrain system or infiltrates native soils. To prevent soluble pollutants in treated runoff from contaminating groundwater, an impermeable liner is placed under the BMP and the filtrate is conveyed to another BMP for additional treatment. Because they store relatively small amounts of water and typically discharge treated runoff to a stormwater system or water body, filtration BMPs provide little stormwater flow control.

Types of filtration BMPs:

1. Sand filter basins
2. Sand filter vaults
3. Linear sand filters

1. Sand Filter Basin

A sand filter basin resembles an infiltration basin, except that stormwater filters through a constructed sand bed at the bottom of the basin instead of through native soil (Figure 26 andFigure 27). Sand filter basins are constructed at grade and consist of a presettling cell followed by a filtration cell equipped with an underdrain system (Figure 26). Large particles are trapped in the presettling cell and small particles and other pollutants are filtered from the stormwater as it infiltrates the sand. Filtrate collected in the underdrain system is conveyed to another BMP, a conventional stormwater system, or a water body. In addition to removing sediment from runoff, sand filters are efficient at removing biological oxygen demand and fecal coliform bacteria. There must be a minimum difference of 4 feet between the inlet and outlet.

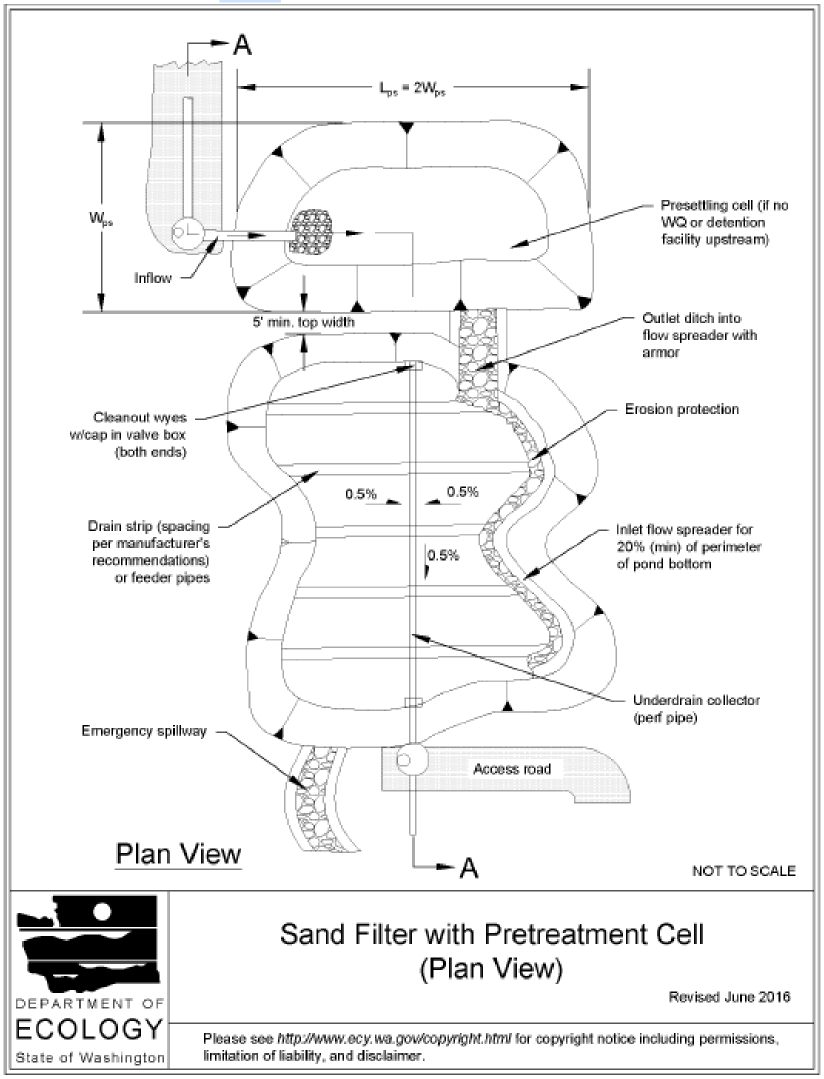


Figure 26. Plan view of a sand filter (State of Washington Department of Ecology).

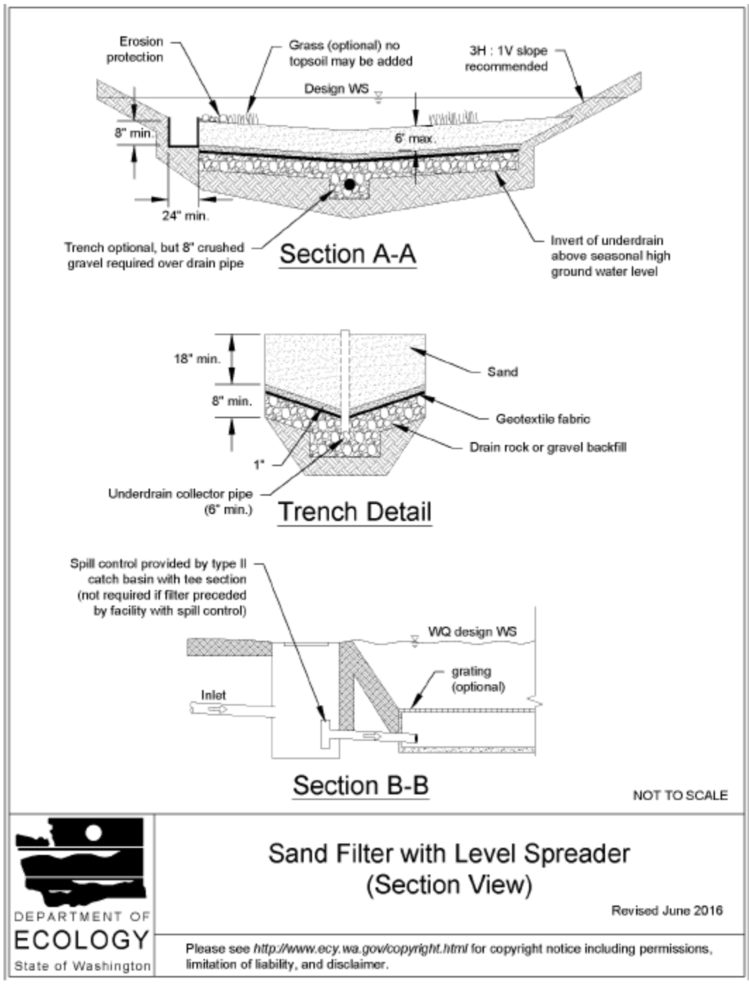


Figure 27. Section view of a sand filter (State of Washington Department of Ecology).

2. Sand Filter Vault

A sand filter vault (Figure 28Figure 29) is like a sand filter basin except the cells and underdrain system are contained within an underground vault. Sand filter vaults are suitable where space limitations exist, however, they are not suitable for sites with high water tables and high sediment loads. Like sand filter basins, there must be a 4-foot difference between the elevation of the inlet and outlet.

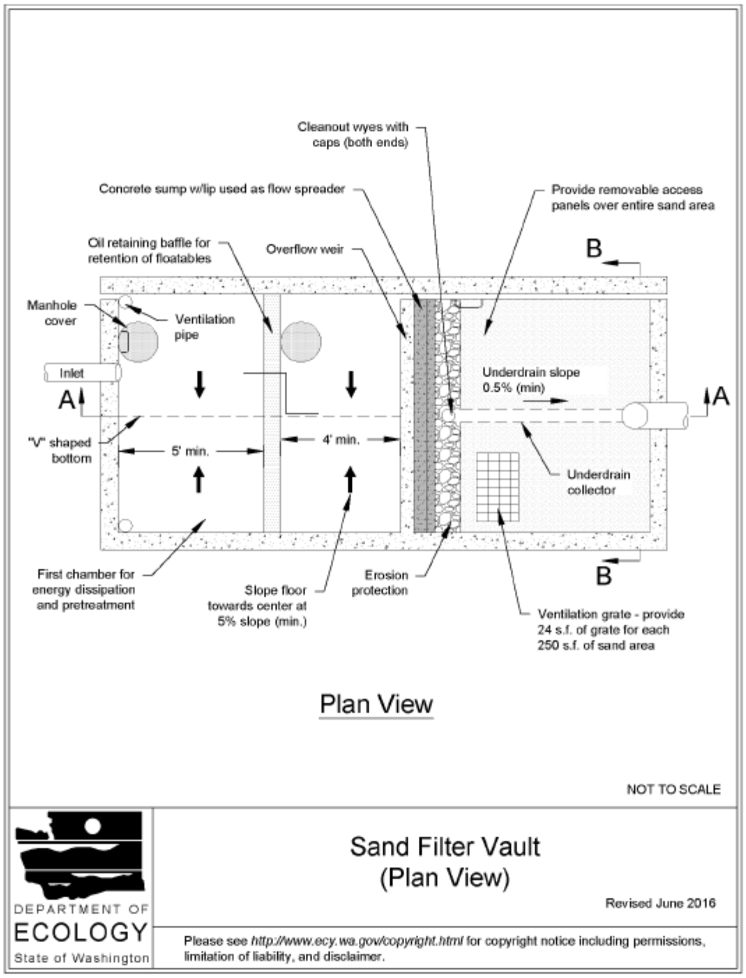


Figure 28. Plan view of a sand filter vault (State of Washington Department of Ecology).

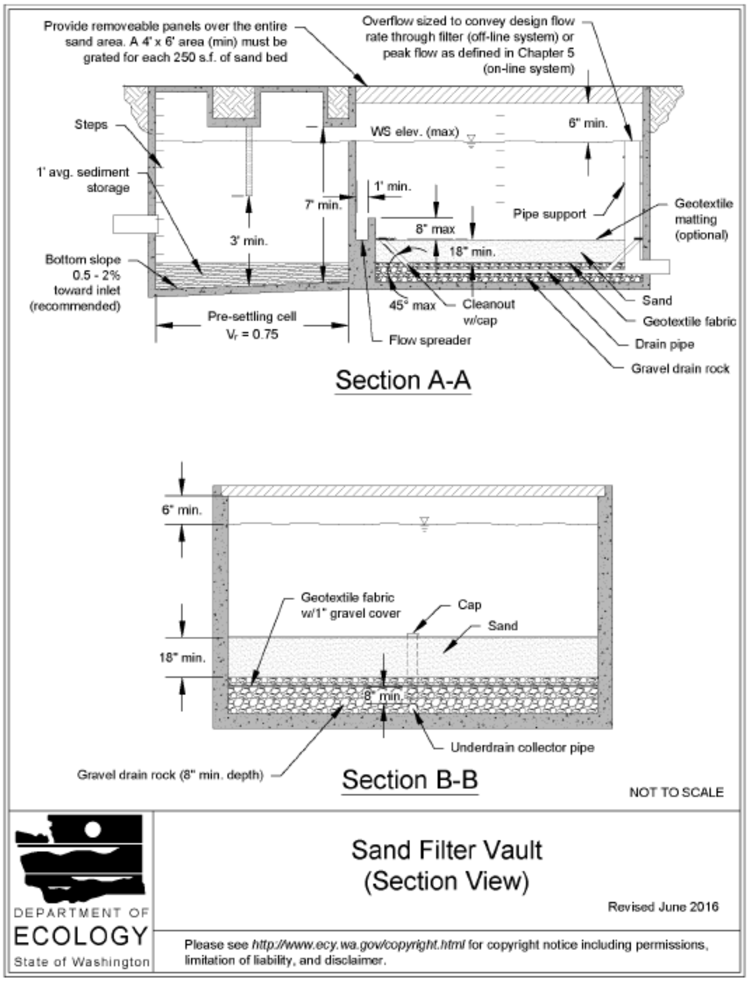


Figure 29. Section view of a sand filter vault (State of Washington Department of Ecology).

3. Linear Sand Filter

The typical linear sand filter is a long, shallow, two-chambered rectangular vault (SWMMWW) (Figure 30). As with other sand filters, a presettling cell precedes a filtration cell. Water passes over a weir between the two cells, through a sand bed, and into an underdrain system. The weir also functions as a flow spreader. Linear sand filters are suitable for narrow spaces and can be used in combination with filtration BMPs (downstream of) and infiltration BMPs (upstream of). The area contributing runoff to the filter should be less than 2 acres.

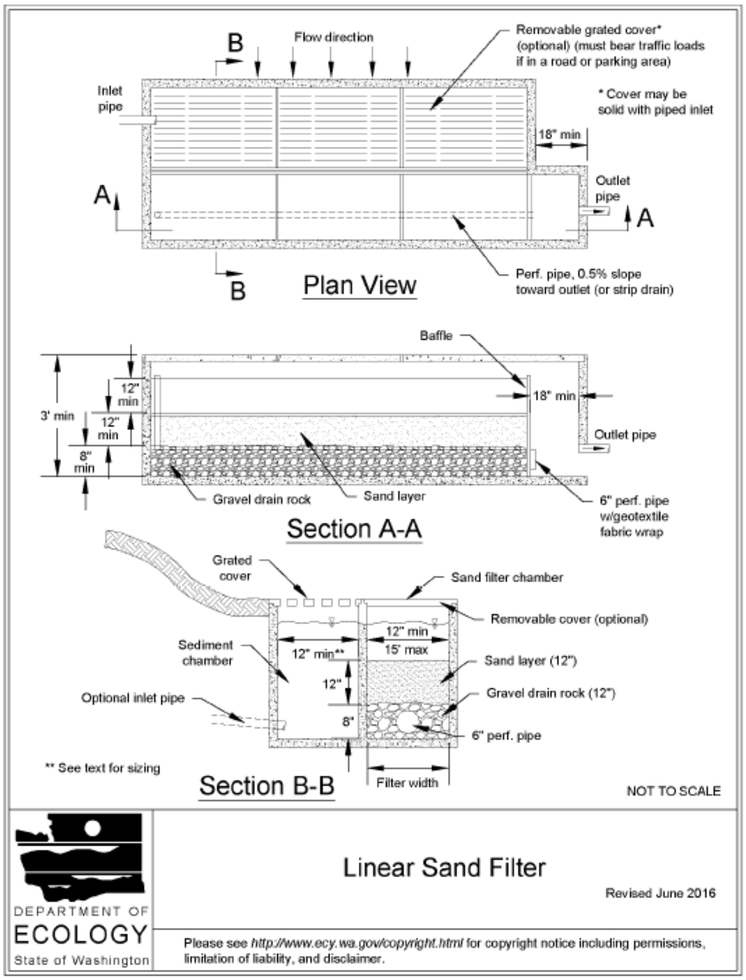


Figure 30. Plan and section views of a linear sand filter (State of Washington Department of Ecology).

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