Lake Lucile Stormwater Outfall Source Area Estimates

Final Report for the Alaska Department of Environmental Conservation: July 2019

Aquatic Restoration & Research Institute

Cover Photograph. East Lake Lucile Stormwater Outfall May 2019.

Background

Lake Lucile (also spelled Lucille) is located within Wasilla, Alaska, Matanuska-Susitna Borough. The 365 acre lake receives direct and point-source stormwater runoff from city roads and businesses. Stormwater runoff collected in the Wasilla storm-drain system discharges into the west Lake Lucile outfall, east Lake Lucile outfall, the Iditapark Retention Basins, and Cottonwood Creek (via a vegetated swale).

Stormwater runoff has the potential to negatively affect water quality in receiving waters. Studies evaluating the water quality of discharging into Cottonwood Creek and Lake Lucile found evidence of increased levels of copper, lead, and zinc in outfall discharge and receiving waters during storm events (Davis et al. 2013a). Based upon these results additional Lake Lucile sediment sampling was conducted around the east and west outfalls. Results from Lake Lucile sediment sampling surrounding the two outfalls found sediment metals at concentrations that likely have biological effects (Davis et al. 2013b). Based upon the results of these two studies, the State of Alaska, Department of Environmental Conservation (DEC) added Lake Lucile to the 2014/2016 Integrated Report 303(d) Category 5 list of impaired waters for lead and zinc in lakebed sediments. Copper is a pollutant of concern threatening water quality. DEC will likely include polycyclic aromatic hydrocarbons (PAH) in the 2018 Integrated Report 303(d) Category 5 list of impaired waters (personal communication DEC).

The Alaska Department of Environmental Conservation and the City of Wasilla would like to develop options to minimize the discharge of pollutants to Lake Lucile and restore water quality. Information on runoff sources and their potential to contribute sediment-bound metals to Lake Lucile is necessary to develop potential treatment options. In an effort to provide necessary information this study was developed with the objectives to:

1. Measure discharge and turbidity from the east and west Lake Lucile outfalls during spring breakup and any storm events,
2. Measure the impervious surface area of roads and other development over which stormwater would flow prior to entering storm drains, and
3. Qualitatively assess different surfaces as relative sources of stormwater metals and hydrocarbons.

Methods

Outfall Discharge and Turbidity

East and west Lake Lucile outfall discharge was monitored during the spring and early summer of 2019. Water discharging from the east outfall passes through a trash rack and then an approximately 10 m long channel to Lake Lucile. A water level logger and staff gauge were installed on May 19, 2019 in the outlet channel of the east outfall (see Photograph A5) and an additional pressure logger was installed adjacent to the outfall to measure changes in air pressure. Discharge was measured using a Swoffer velocity meter intermittently on seven occasions from March 19 through April 7, 2019. Water samples were collected concurrent with discharge measures (Table 1). The turbidity of water samples was measured using a LaMotte turbidimeter.

Water discharging from the west outfall passes through a trash rack with the dispersed flow cascading directly into Lake Lucile. On May 19, 2019, discharge was estimated by collecting the majority of the flow into 1 L sample bottles and recording the time; however, on May 22, the dispersed flow could not be collected and discharge was estimated. Water samples were collected in 2, 1-L clean sample bottles from the outfall discharge when flow was present on May 19 and May 22, 2019. Water sample turbidity was measured from collected water samples. No metals or PAH concentrations were analyzed in the stormwater discharge water during this study.

Impervious Service Area Determination.

The impervious surface area of all roads and business that could potentially contribute stormwater to the east or west outfalls to Lake Lucile and the location of storm drains was determined by analyzing aerial photographs using ArcMap, foot surveys, and Google Maps.

Road and foot surveys were conducted to determine the general location of storm drains and road topography. Current aerial photography (2017) was downloaded from the Matanuska-Susitna Borough. We used ArcMap to calculate the surface area of roads, parking areas, and businesses. Google Maps was used to identify business names and addresses and the street view was used to further identify storm drain locations.

The study area included all roads and businesses between the Parks Highway to the south and Nelson Avenue to the north (Figure 1). Segments of Lucas Road and Lucile Street north of Nelson Road were also included. The western boundary was Deskas Road but we included portions of Nicola Avenue as it appeared that the storm drain system was connected to Deskas Road. We included all roads and businesses east up to, but excluding Main Street. Main Street was not included because topography and location of drains indicates that stormwater is diverted toward the Cottonwood Creek drainage.

Areas south of the Parks Highway and Alaska Railroad Corporation are not believed to be connected to the stormwater drainage system and were not considered in the calculations. Gravel roads north of Nelson Avenue also were not quantified as we hypothesize that they do not contribute stormwater runoff that enters Lake Lucile. Similarly, the area of house roofs in residential areas not on parking lots was not calculated as we estimated that flow from these roofs likely enters groundwater rather than surface water flow. Roads and businesses east of Knik Street (North of the Parks Highway) and west of Main Street were included; however, flow may be directed toward the stormwater system draining into Cottonwood Creek.

Roads were identified by road type (primary, secondary, and tertiary) as an estimate of relative use. The Parks Highway was identified as a primary road. Roads intersecting with the Parks Highway were classified as secondary roads, and all other roads as tertiary.

Information for road segments was entered into an Excel spreadsheet with columns as described in Table 1. Additional columns can be added as more information becomes available. Total road area for each road segment was determined by drawing a polygon around the area in ArcMap.

A large number of businesses along the north side of the Parks Highway are separated from the highway by a vegetated swale which likely intercepts a portion of the stormwater runoff prior to reaching the stormwater system. Therefore, the surface area contributing runoff to Lake Lucile may be overestimated.

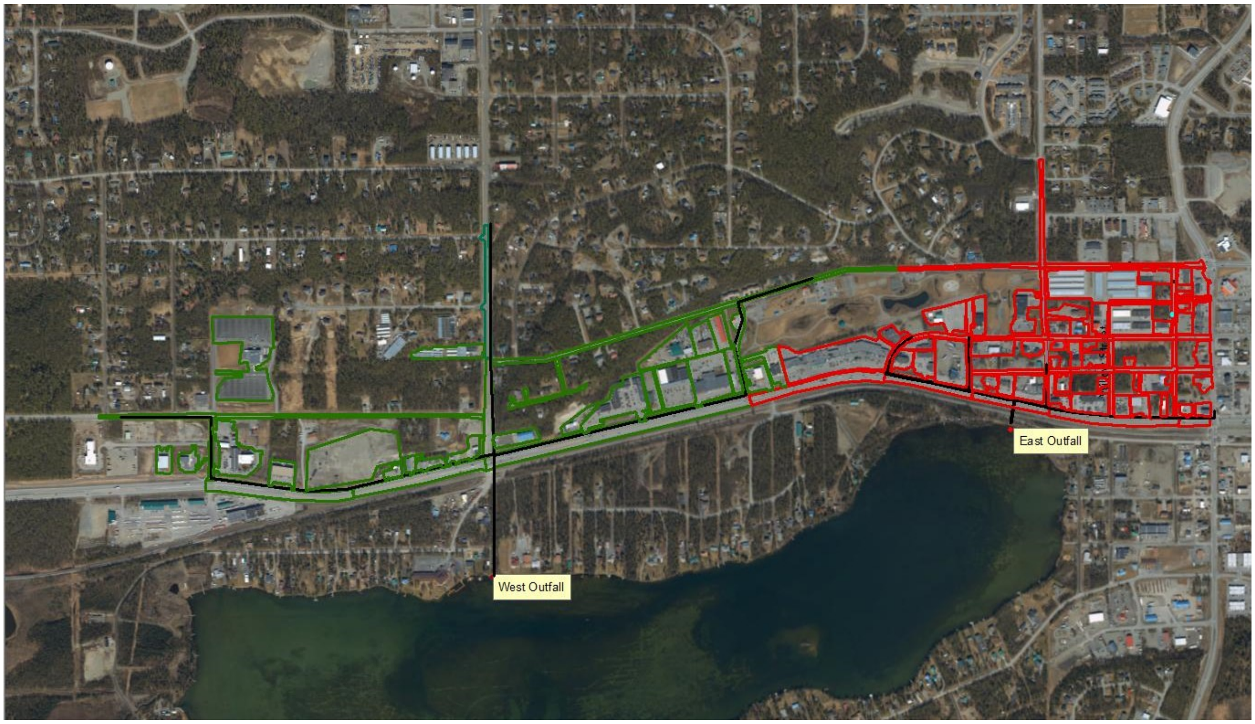

Figure 1. Area included surface area estimates for the west (green) and east (red) Lake Lucile outfalls.

The area of ground covered by buildings and associated parking were similarly quantified using aerial photography and ArcMap. Business names and addresses were obtained from Google Maps and area calculated by drawing a polygon around the structure and parking lots using ArcMap. Data were entered into an Excel spreadsheet containing the columns shown in Table 2.

Table 1. Description of information within the Excel workbook, Road Area worksheet.

Column	Description
Road Name	Road name from Google Maps.
Road Segment	Start to end "to" or "through" (including) an intersection.
Type	Primary, Secondary, Tertiary
Drainage	East or west Lake Lucile outfall
Surface	Paved or gravel.
Road drainage	Storm drain, vegetated swale, none
Area	Calculated area in square feet, square meters, and acres
Notes	Notes on drainage or connection to stormwater system.

Table 2. Description of information within the Excel workbook, Parking and Structures worksheet.

Column	Description
Business Name	Name of business
Address	Street address
Business Type	General roofs and parking or description of business.
Source Potential	Potential source of metals ranked 1 (low) to 3 (high)
Outfall	East or west outfall drainage
Surface	Paved or gravel
Road Drainage	Location of nearest storm drains.
Area	Surface area in square feet, square meters, and acres (US).

Results

East and West Outfall Discharge

Discharge was first observed on March 18, 2019 in the east outfall but not the west outfall. West outfall discharge was present during two dates but likely extended over a 5 to 6 day period (March 19 - 24). West outfall discharge was extremely turbid with a maximum measured value over 1300 NTU (Table 3).

East outfall discharge was first observed on March 18, 2019. Discharge from the east outfall continued through April 6, 2019 (Table 3 and Figure 2). Discharge was turbid for an approximately 5 day period (March 18 – 22) with a maximum value 52.4 NTU. During this same time period, an estimated 0.5 acre-feet of water entered Lake Lucile through the east outfall. While discharge continued, turbidity decreased to approximately 1 NTU. Turbidity increases with concentrations of inorganic suspended sediment, and metals are transported adsorbed to fine inorganic sediment. Therefore, increases in turbidity are an indication of an increased potential for the delivery of metals (i.e. Copper, Zinc, or Lead) to Lake Lucile.

Increases in discharge also were observed following local precipitation events; however, water samples were not collected. During the storm event from April 16 to April 18 (Figure 2) an estimated 0.52 acre-feet of water entered Lake Lucile and during the storm event from May 2 through May 3 and estimated 0.18 acre-feet of water was discharged from the east outfall. The extended time clear water was discharging from the west outfall suggests that the stormwater system is collecting groundwater, possibly through perforated pipes. Dilution from groundwater input also could explain lower turbidity in the east relative to the west outfall.

Table 3. Outfall discharge and turbidity from field observations during March and April of 2019.

	East Outfall		**West Outfall**	
Date	Discharge (cfs)	Turbidity (NTU)	Discharge (cfs)	Turbidity (NTU)
3/15/2019	0	0	0	0
3/18/2019	0.14*	No Sample	0	0
3/19/2019	0.14	52.4	0.008	46
3/22/2019	0.18	5.19	0.035*	1300
3/26/2019	0.14	1.24	0	
4/1/2019	0.10		0	
4/7/2019	0.12	1.16	0	

* estimated value

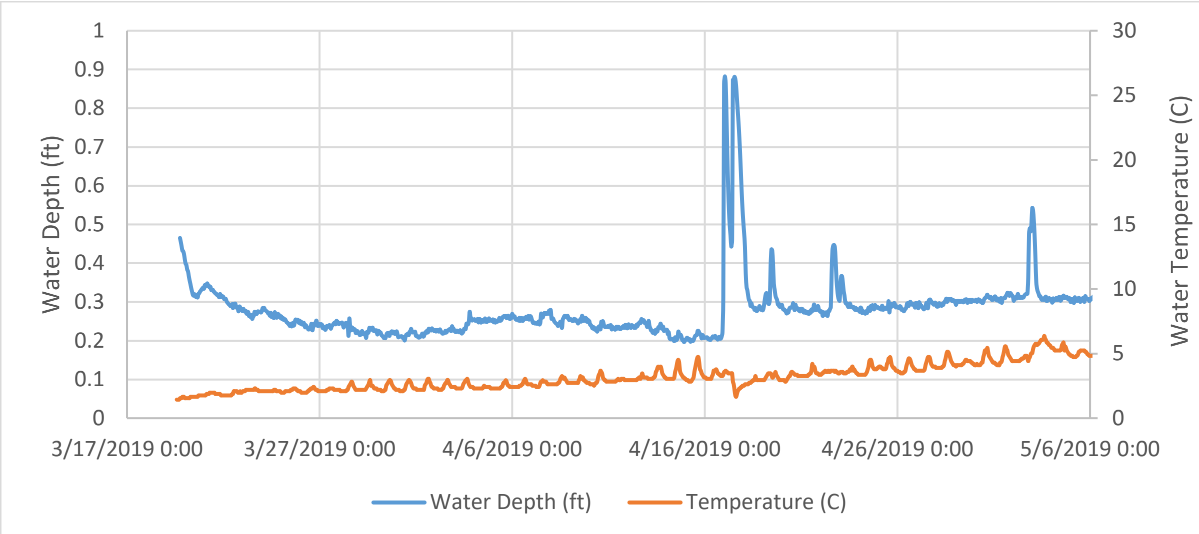

Figure 2. Water depth and surface water temperature measured in the small channel carrying east outfall discharge to Lake Lucile.

Road Area

We estimated that there is a maximum of 45.11 acres of road area that could potentially drain into Lake Lucile. An estimated 27.2 acres through the west culvert and 17.9 through the east culvert. There is approximately 3 times more area of primary road surface area (Parks Highway) draining into the west outfall compared to the east outfall, whereas the east outfall receives runoff primarily from the secondary roads. The total surface area of roads draining into the east outfall is likely an overestimate as a portion of runoff from this area is directed toward the sediment basins in Iditapark and the Cottonwood Creek drainage.

Table 4. Measured surface area of roads that provide stormwater runoff to the east and west Lake Lucile outfall by road type.

Area by Road Type	East Outfall (acres)	West Outfall (acres)	Total (acres)
Primary	5.9	15.9	21.8
Secondary	11.0	5.8	16.8
Tertiary	1.0	5.5	6.5
Total	17.9	27.2	45.1

Businesses and Parking

We estimated a maximum of 97 acres of impervious surface area from businesses and parking areas providing stormwater flow to the east and west Lake Lucile outfalls. Impervious surface area was equally divided between the two drainages at approximately 50 acres. However, the surface area draining into the east outfall is likely an overestimate as a significant portion of stormwater flow within this drainage is directed toward the Iditapark retention ponds or the Cottonwood Creek drainage.

Approximately 5 acres within each drainage were estimated to have a higher potential to contribute metals and hydrocarbons to stormwater runoff. These areas consisted primarily of auto repair businesses. Moderate potential for contributing metals was slightly higher for the east outfall which was due primarily to a large greenhouse. However, we are not certain that runoff from this business contains metals or if runoff from the property enters the storm drain system.

Table 5. Surface area within the east and west Lake Lucile outfall drainages contributing stormwater runoff by ranked potential to contain metals or hydrocarbons.

Potential Metals Source	East (acres)	West (acres)	Total (acres)
High Potential	4.7	5.8	10.5
Moderate Potential	8.4	3.1	11.5
Low Potential	36.3	38.9	75.2
Total	49.4	47.8	97.2

Discussion

We anticipate that the results from this report, the accompanying Excel files, and ArcMap project can provide a baseline for determining the surface area that contributes stormwater discharge to the east and west Lake Lucile outfalls. We recommend these files be updated as more information becomes available.

There are a number of businesses within both drainages where runoff patterns were not clear and potential to contribute metals should be further investigated. Within the west drainage we included the greenhouse within our calculations however; we are not certain that runoff from this property reaches the storm drains on Lucas Road. We also were not certain if runoff from AIH and along Wasilla Drive reached the storm drain system on the Parks Highway or Weber Drive.

We are not certain if there are any storm drains within the vegetated swale south of the Parks Highway (between the highway and the railroad tracks). So it is not clear if runoff from snow storage in this area enters the storm drain system and Lake Lucile.

There were a number of businesses within the east outfall drainage area that contain a vegetated berm separating them from the Parks Highway. Therefore, a portion of runoff from these properties may not reach the storm drain system. Many other businesses are surrounded by vegetated soil that may divert runoff to the groundwater or filter fine sediments.

Runoff from the Parks Highway may be the primary source of road runoff to the east storm drain systems, when the roads diverting stormwater to the sediment ponds or the Cottonwood Creek drainage are excluded.

More small scale surveys should be conducted during storm events to determine the water quality and drainage patterns from businesses and road segments that have the potential to contribute contaminated storm water to Lake Lucile.

References

Davis, J.C., G.A. Davis, L.A. Jensen, and L. Eldred. 2013a. Matanuska-Susitna Stormwater Assessment 2011-2012. Final report for the Alaska Department of Environmental Conservation. Aquatic Restoration and Research Institute. Talkeetna, AK.

Davis, J.C. G.A. Davis, and R.J. Burns. 2013b. Lake Lucile Sediment Quality Sampling: spatial extent of impaired sediment due to outfall stormwater inputs. Final report for the Alaska Department of Environmental Conservation. Aquatic Restoration and Research Institute. Talkeetna, AK.

Appendix A. Project Photographs


Photograph A1. West outfall. (3/19/19)


Photograph A2. West outfall. (3/19/19)


Photograph A3. East outfall. (3/18/19)


Photograph A3. Turbid discharge from east outfall. (3/19/19)

Photograph A4. Staff gauge and pressure logger in outlet channel of east Lake Lucile outfall. (3/19/19)

Photograph A5. Snow storage and runoff between the Parks Highway and the ARRC tracks near the east outfall. (3/19/19)

Photograph A6. Turbid runoff from west outfall on 3/22/19.

Photograph A7. Discharge from east outfall on 3/22/19.

Photograph A7. No discharge from west outfall by 3/26/19.

Photograph A8. Clear discharge from east outfall on 3/26/19.

Photograph A9. Vegetated swale from Nelson Avenue to Iditapark Retention Pond. (6/3/19)

Photograph A10. Discharge outfall to Iditapark retention pond. (6/3/19)

Photograph A10. Second retention pond in Iditapark. (6/3/19).