George Wuerch, Mayor

Street Sediments and Adsorbed Pollutants: Data Report

Document No. WMP APr00003

MUNICIPALITY OF ANCHORAGE
WATERSHED MANAGEMENT PROGRAM

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WATERSHED MANAGEMENT

Office of Planning, Development & Public Works

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Department of Public Works
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WATERSHED MANAGEMENT

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Abbreviation and Acronym List

µg/L	microgram per liter
ADT	average daily traffic
AKDOT/PF	Alaska Department of Transportation and Public Facilities
ASTM	American Society for Testing Materials
CBD	Central Business District
CFU	colony-forming unit
DPW	Department of Public Works
FHA	Federal Highway Administration
GC	gas chromatograph
gpm	gallons per minute
ICP	inductively coupled plasma
LCS	laboratory controlled sample
LCSD	laboratory controlled sample duplicate
mg/L	milligram per liter
MOA	Municipality of Anchorage
MPN	most probable number
MRL	method reporting limit
MS	mass spectroscopy
NA	not applicable
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, comparability, and completeness
PQL	practical quantitation limit
RPD	relative percent difference
SIM	selected ion monitoring
TOC	total organic carbon
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
WMS	Watershed Management Section

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Executive Summary

Sediment adsorbed pollutant data collected in spring and summer 2000 focused on sediment from streets and runoff collected at the Gambell/Ingra storm water outfall. These sediment data were supplemented with data from street waste sweeping samples collected from various locations within the Anchorage Bowl. The data have been summarized spatially (by location), temporally (by time), and physically (by particle size for sediment and by solubility for runoff) for each street type.

Spring melt took place in mid-March, prompting runoff sampling at the Gambell/Ingra outfall. Street sediment sampling occurred in late April and the first week of May, when streets were dry but prior to street sweeping. Street sediment sampling occurred again in late July to gather data about summer sediment-adsorbed pollutants concentrations. Street sweeping waste sediment was gathered in late summer and early fall to gather fecal coliform data.

The major contributors to street sediment and adsorbed pollutants identified in the design document include the following:

- Traction sand and deicers
- Vehicle-related emissions, depositions, and spills
- Fecal material
- Vegetation sources
- Pavement wear and decomposition residue, primarily from tire studs

Fourteen sediment sampling sites were selected at seven controlled intersections to represent two major road types in the Anchorage Bowl. Road types were derived from United States Environmental Protection Agency (USEPA) classifications based on average daily traffic (ADT) volume and include local, collector, minor arterial, and major arterial/freeway. These categories are based on ADTs of <= 2,000; 2,000 – 10,000; 10,000 – 20,000; and >= 20,000, respectively. Samples were collected in early spring before street sweeping and again in midsummer.

One storm water outfall was also selected for runoff sampling. Runoff samples were collected at the storm water outfall at the convergence of Gambell and Ingra Streets. Storm water outfall receives runoff from a drainage area that includes four of the sediment sampling locations and discharges to Chester Creek. Samples were collected during spring street runoff. A baseflow sample was collected in mid-June.

All sediment samples were analyzed for sediment particle sizes greater than and less than 140 microns. Sediment was also analyzed for polynuclear aromatic hydrocarbons (PAH), fecal coliform, total organic carbon (TOC), chloride, chromium, copper, lead, and zinc in the fine fraction and the total sample. In addition, three sediment samples were analyzed for these constituents in the coarse fraction. Selected runoff samples were analyzed for chloride, cyanide, total suspended solids (TSS), and hexavalent chromium in the total water matrix. All runoff samples were also analyzed for total and dissolved fractions of fecal coliforms, calcium, magnesium, chromium, copper, lead, zinc, and PAHs. The following is a summary of the raw results.

Sediment

- Sampling analysis from seven arterial streets showed that total sediment loading in gutters during the spring round on arterial streets (87.7 – 128.8 g/sq.ft.) was greater than loading on four arterial streets in the summer round (17.4 – 43.4 g/sq.ft.). This differentiation was also evident on collector/residential streets between seven spring samples (21.4 – 124.9 g/sq.ft.) and four summer samples (19.2 – 56.9 g/sq.ft.). PAHs were present during the spring round on collector and residential streets (0.76 – 44.5 mg/Kg) and on arterials (1.17 – 4.02 mg/Kg).
- Chromium was present in spring on collector and residential streets (17.8 – 32.9 mg/Kg) and on arterials (23.4 – 35.0 mg/Kg). Concentrations on fine sediments were higher than total concentrations (33.5 – 50.1 mg/Kg on residential/collector streets and 36.2 – 55.6 mg/Kg on arterials). In summer, chromium loading was about the same as in the spring on collector and residential streets (28.7 – 43.9 mg/Kg) and on arterials (28.7 – 43.7 mg/Kg). For comparison, the ADEC soil cleanup level for chromium is 23 mg/Kg (18 AAC 75.341).
- Copper was present in spring on collector and residential streets (23.6 - 114 mg/Kg) and on arterials (22.5 – 31.5 mg/Kg). Concentrations on fine sediments were about the same as total concentrations (35.5 – 52.2 mg/Kg on residential/collector streets and 36.4 – 49.2 mg/Kg on arterials). In summer, copper loading was about the same as in the spring on collector and residential streets (24.4 – 48.9 mg/Kg) and on arterials (27.6 – 82.9 mg/Kg).
- Lead was present in spring on collector and residential streets (11.8 – 36.0 mg/Kg) and on arterials (12.4 – 46.2 mg/Kg). Concentrations on fine sediments were higher than total concentrations (43.8 – 81.9 mg/Kg on residential/collector streets and 44.9 – 99.7 mg/Kg on arterials). In summer, lead loading was about the same as in the spring on collector and residential streets (26.0 – 84.0 mg/Kg) and on arterials (21.7 - 107 mg/Kg). For comparison, the ADEC soil cleanup level for lead is 400 mg/Kg (18 AAC 75.341).
- Zinc was present in spring on collector and residential streets (57.0 – 111 mg/Kg) and on arterials (62.4 - 153 mg/Kg). Concentrations on fine sediments were higher than total concentrations (112 - 212 mg/Kg on residential/collector and 29.9 - 242 mg/Kg on arterials). In summer, zinc loading was greater than in the spring on collector and residential streets

(126 - 219 mg/Kg) and on arterials (89.8 - 232 mg/Kg). For comparison, the ADEC soil cleanup level for zinc is 8,100 mg/Kg (18 AAC 75.341).

- Chloride was present in spring on collector and residential streets (6.7 – 65.2 mg/Kg) and on arterials (4.7 – 45.7 mg/Kg). Concentrations on fine sediments were higher than total concentrations (45.4 - 117 mg/Kg on residential/collector and 34.4 – 176 mg/Kg on arterials). In summer, chloride was again detected on collector and residential streets (4.3 - 1230 mg/Kg) and on arterials (2.5 – 70.8 mg/Kg).

- Total fecal coliform was measured on 13 streets during the spring round. Sediment concentrations varied between non-detect and 0.2 most probable number (MPN)/g. During the summer round, both total sediment and fines were analyzed for fecal coliform. Values ranged from 0.2 to 16,700 MPN/g on residential/collector streets and 0.4 to 17.1 MPN/g on arterials.

Outfall Runoff

Outfall runoff flow data indicated strong diurnal variation due to the daily freeze-thaw cycles that occur during the breakup season. Samples gathered during this time period only estimate mean concentrations of pollutants at the outfall and may not accurately represent runoff characteristics.

- Samples from March 24, 2000, were analyzed for PAHs. Morning sampling results showed total PAH concentrations totaling 0.23 µg/L and fine fraction concentrations totaling 0.10 µg/L. Afternoon results showed total PAH concentrations totaling 0.49 µg/L and fine fraction concentrations totaling 0.22 µg/L.

- Chromium results from mornings (12.9 – 13.9 µg/L) were less than results from the afternoons (28.4-43.8 µg/L). Dissolved fraction concentrations were typically less than the total concentration (4.5 – 9.5 µg/L from mornings and 4.9-8.3 µg/L from afternoons).

- Copper results from mornings (10.7 – 15.8 µg/L) were less than results from the afternoons (41.0 – 52.8 µg/L). Dissolved fraction concentrations were typically less than the total concentration (5.5 – 7.7 µg/L from mornings and 8.8 – 14.0 µg/L from afternoons).

- Lead results from mornings (2.55 – 10.1 µg/L) were less than results from the afternoons (53.1 – 82.9 µg/L). Dissolved fraction concentrations were typically less than the total concentration (0.30 – 0.75 µg/L from mornings and 0.34 – 1.62 µg/L from afternoons).

- Zinc results from mornings (99 - 141 µg/L) were less than results from the afternoons (261 – 371 µg/L). Dissolved fraction concentrations were typically less than the total concentration (27 - 80 µg/L from mornings and 24 - 74 µg/L from afternoons).

- Calcium results from mornings (24,400 – 38,000 μg/L) were about the same as results from the afternoons (23,300 – 34,600 μg/L). The majority of this total was the dissolved fraction (24,100 – 35,400 μg/L from mornings and 18,400 – 29,200 μg/L from afternoons).
- Magnesium results from mornings (7,280 – 12,900 μg/L) were greater than results from the afternoons (12,500 – 22,500 μg/L). The majority of this total was the dissolved fraction (7,000 – 11,700 μg/L from mornings and 7,190 – 16,600 μg/L from afternoons).
- Two samples were analyzed for cyanide content, both with laboratory results of non-detect. These samples were also analyzed for hexavalent chromium content, again with results of non-detect.
- TSS varied from 9 to 444 mg/L during spring runoff sampling. Fecal coliform measurements in runoff ranged from non-detect to 26o colony-forming units (CFU)/100 mL out of eight spring samples.

1 Introduction

The information described in this data report was collected by Montgomery Watson under Department of Public Works (DPW) Watershed Management Section (WMS) Project No. 95003 T99003. The data collection effort was performed to meet design parameters defined in Municipal Assessment Document No. WMP 95003, "Street Sediment and Adsorbed Pollutants Study Design" (MOA, 2000b). The following subsections summarize project purpose, primary data collection objectives, important limitations of actual data collected, and project and report organization.

1.1 Project Purpose

The Municipality of Anchorage (MOA) and the Alaska Department of Transportation and Public Facilities (AKDOT/PF) apply sand and deicing material to Anchorage streets to enhance vehicle traction throughout the winter months. Street sediment buildup occurs during winter and washes through drainage collection systems and into receiving waterbodies in spring and summer. The data collection effort was initiated to gather data for estimating the pollutant mass adsorbed to sediments in Anchorage area streets.

1.1.1 PROBLEM STATEMENTS

This data report is intended to present information critical to answering the following watershed management questions:

- What are the significant pollutant types and loads adsorbed to Anchorage street sediments?
- How do these pollutants vary physically, spatially, temporally, and physically?
- What fraction of the street sediment pollutant load is mobilized in storm water during snowmelt and rainfall runoff events?

This data report summarizes laboratory analyses and observations from collected samples and associated documentation generated for the street sediment and adsorbed pollutants assessment effort. Both tabular and graphical summaries are presented with data quality documentation and conclusions.

1.1.2 DATA LIMITATIONS

Information acquired in this study pertains to street sediment character on Anchorage streets in 2000. The study focuses primarily on quantifying street sediment and associated pollutants. (Pollutants from other areas such as parking lots may be addressed in other studies.)

Collected data represent the unique climate and street maintenance practices during spring and summer 2000, and only can be calibrated approximately to average Anchorage conditions. Similarly, these data only can be extrapolated to areas with similar climatic conditions and sand application and street maintenance practices. Given these limitations of the study, however, it is believed that the metals and PAH sediment concentrations results of the assessment are reasonably representative and useful in meeting management objectives of MOA. However, as described in Section 2.2.5 fecal coliform and runoff data may not represent actual Anchorage conditions.

This data report describes the quantity, quality, and character of the collected data only, in the context of the 2000 design document (MOA, 2000b). It contains validated data (data that have been determined to be reasonably free of error) that can be used in later analysis to answer watershed management questions, as appropriate.

1.2 Project Organization

The MOA Street Sediment Loading Assessment Design Report and Data Report (MOA, 1997b and 1997a) identified street sediment loads varying by season, street type, and location within the street. Data in this study were collected to describe the character of pollutants adsorbed to street sediments that vary physically, spatially, and temporally for each street type. This document was preceded by a study design (MOA, 2000b) and is intended to present validated data from the sampling effort. This data and similar data from other studies will be used to estimate the fraction of critical adsorbed pollutants that are found on Anchorage streets. This information and data from other studies will also provide a basis for accurately assessing receiving water use impacts and selecting and prioritizing effective management practices targeted to critical pollutants and their sources. Samples were collected in spring and summer 2000 to fulfill the objectives set forth in the study design.

1.3 Organization of Data Report

This data report was preceded by a project design (MOA, 2000b).

This document has been organized in the following manner:

<u>Introduction.</u> Summarizes the context of the 2000 Street Sediment Adsorbed Pollutants Assessment, presents a statement of the information required by watershed managers, discusses data limitations, and describes the organization of this document.

<u>Data Collection.</u> Briefly describes the method and logic used in the 2000 data collection effort.

<u>Data Summary.</u> Describes the data collected from street sediments, the outfall, and waste sediment.

References. Contains the references cited in this report.

Appendix A includes data from street sediment sampling.

Appendix B contains data from runoff sampling at the Gambell/Ingra outfall.

Appendix C presents a description and annotation of the photographic summary included with this report. The photographic summary is provided electronically only; no hard copies are provided.

Appendix D includes raw field forms and notes.

Appendix E contains tables summarizing fecal coliform data from other studies.

All figures and tables follow the written text in which they are referenced. Selected field observations and data tabulations are appended.

2 Data Collection

This section documents how data were reported and used to characterize systems, processes, accumulation, and runoff of street sediment and associated pollutants. It also describes how data were collected, and any significant variations from the original sampling design. In addition, data quality achievements are summarized and collection problems and solutions are identified.

2.1 Data Purpose

The MOA WMS intends to use information provided by this document to quantify sediment-adsorbed pollutants in Anchorage street gutters. Data were collected to represent temporal, spatial, and physical variation in sediment-adsorbed pollutant loading. Temporally, it is assumed that sediment loading and vehicle performance characteristics change seasonally, prompting sampling rounds in both spring and summer. Spatially, data were collected from 15 streets, an outfall of the Anchorage storm water drainage system, and from street sweeping waste piles in an attempt to characterize the variability of sediment-adsorbed pollutants in different locations. To physically relate pollutant loading to sediment by particle size fraction, analyses were performed for the fine fraction (less than 106 microns) of samples and for the total fraction. A complete description of the data collection approach is included in the 2000 design document (MOA, 2000b).

2.2 Data Collection

This section provides an overview of project data collection history and how aspects of the project varied from the approach outlined in the design document.

2.2.3 DATA COLLECTION HISTORY

Sediment from the gutters of 15 streets in the Anchorage Bowl was collected and analyzed. During the spring round, 14 streets were sampled. During the summer sampling round, 7 of these 14 streets were sampled again, with the addition of Sprucewood Street, for a total of 8 summer street samples. Each street was classified according to type (residential/collector or major/minor arterial) and all types were represented in both sampling rounds. Figure 2-1 shows intersection and outfall locations within the Anchorage Bowl. Table 2-1 shows street locations by intersecting street, street type, and sampling round.

A datalogger was installed at the storm water drainage system outfall for Gambell and Ingra Streets from March 6 to April 12 and again from July 27 to August 13 to monitor flow depth and conductivity. Six grab samples were taken during periods of high flows in late March. A baseline flow grab sample was taken on June 13. Extra grab samples were taken throughout the spring monitoring periods to attempt to validate flow and conductivity.

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Figure 2-1 Sampling Intersection Locations

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Waste sediment from summer street sweepings at various locations also was sampled. Figure 2-2 shows street sweeping sources that include the Central Business District (CBD) and streets in midtown. Samples were taken on the dates shown in Table 2-2 from waste piles that originated in these areas. The residential waste pile was accumulated from many areas; specific location descriptions are not available.

Table 2-1
STREET SAMPLING LOCATIONS

Street	Intersecting Street	Street Type	Spring	Summer
Dimond	King	Major Arterial	√	√
King	Dimond	Collector	√	√
DeBarr	Muldoon	Minor Arterial	√	√
Muldoon	DeBarr	Major Arterial	√	
Reeve	Glenn	Collector	√	√
Glenn	Reeve	Major Arterial	√	
LaTouche	Northern Lights	Minor Arterial	√	√
Northern Lights	LaTouche	Major Arterial	√	
Fireweed	Fairbanks	Major Arterial	√	√
Eagle	Fireweed	Collector	√	
Bannister	Glenwood	Residential	√	
Bannister	Sprucewood	Residential		√
Glenwood	Bannister	Residential	√	
Sprucewood	Bannister	Residential		√
16^{th}	Columbine	Residential	√	
Columbine	16^{th}	Residential	√	

Table 2-2
STREET SWEEPING WASTE SEDIMENT SAMPLING DATES AND SOURCE LOCATIONS

Date	Source
July 31	CBD
July 31	Midtown
August 15	CBD
September 11	CBD
October 27	Residential

Sampling methods

The sampling plan quantified the physical character of street and waste sediment by classifying it as either fine or course. The distinction between fine and coarse material was drawn at 106 microns due to dry sieve analysis limitations.

Sample Handling and Analysis

Physical character in runoff was classified by a distinction between total and dissolved sample portions. For PAHs and fecal coliform, the dissolved phase was separated from the total sample by centrifuging. For all other pollutant analyses, the separation was accomplished by filtering through a 0.45 micron filter.

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Figure 2-2 Street Sweeping Source Locations

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2.2.4 VARIATIONS FROM DESIGN

Due to unforeseen circumstances, several aspects of the original project design were changed to meet field and laboratory conditions. These variations include where (spatial network) and how (sampling procedures) samples were collected and how (laboratory procedures) they were analyzed. The following sections itemize these changes.

Spatial Network Variations

Fourteen streets at seven intersections were originally selected for sediment sampling. During the first round of sampling, Sprucewood Street still contained substantial snow berms in the gutter that prevent sampling. Glenwood Street was sampled instead, a similar residential street two blocks to the east that intersected Bannister Street. Also during the first round of sampling, Fairbanks Street was deemed unsuitable due to the high proportion of driveable curb along its length. Eagle Street, a similar street one block west of Fairbanks Street, was sampled instead.

To reduce laboratory costs, only eight streets were sampled in the second round of street sediment sampling during the summer. These streets included Sprucewood Street, which was not sampled during the spring round. It is assumed that Sprucewood Street and Glenwood Street are directly comparable for the purposes of this study.

Street sweeping waste sampling took place during summer sampling only and was not included in the design document. The purpose of its later inclusion was to further quantify sources of fecal coliform in the study area.

Temporal Network Variations

Two sampling rounds were scheduled in the project design to measure end-of-winter and midsummer sediment loads. During the first round, most streets were sampled according to the schedule shown in the project design (April 10 – April 20). In residential areas, however, street melt occurred about 3 weeks after the design timeframe on higher volume streets, delaying sampling until the first week of May.

The summer round of runoff sampling was cancelled after it was determined that runoff samples could not be correlated with summer sediment samples. Rainfall events after sediment sampling and before runoff sampling mobilization likely washed most street sediment through the system before it could be sampled. Sampling runoff after this washoff would not be not representative of sediment buildup present in the system during street sediment sampling. Correlation of post-washoff runoff with the pre-washoff sediment would produce inconclusive results.

Sampling Procedure Variations

Sediment sampling procedures were altered from the first round to the second round. During the first round, sampling followed the procedure outlined in the design document. This method specified sampling the 2-foot wide gutter at five 50-foot increments along the street beginning 50 feet from the intersection. During the second round, it was possible that the mass of material available on the streets in sampling locations would not be enough to perform all needed laboratory analyses. For the second round, therefore, vacuuming began at the intersection and proceeded continuously for a distance of 300 feet up the 2-foot wide street gutter.

Because procedures for sampling street sweeping waste piles were not included in the design document, a brief description of this sampling procedure is described herein.

Street maintenance personnel dumped street sweeping waste into individual piles and notified Montgomery Watson within 24 hours of sweeping. They also placed a source-identifying marker in each pile and supplied Montgomery Watson with a source map of streets swept. Montgomery Watson personnel gathered five sub-samples from random locations in each pile and composited these into one for each pile. The samples were analyzed for coarse and fine fecal coliform counts. Photographic documentation of each pile was also performed. In addition, two samples were analyzed for particle size distribution.

Sampling Analysis Variations

The project design specified particle size distribution parameters and an American Society for Testing and Materials (ASTM) method that was impractical for use in concert with other sediment analyses. The particle size analysis specified in the design included a wet wash and drying the sample with heat, which may alter results for PAHs, TOC, and fecal coliform. To ensure accurate test results for these constituents, sieve analysis was altered to a dry sieve without heat, isolating only coarse and fine fractions rather than a series of particle class sizes. The boundary between coarse and fine was drawn at Sieve No. 140, or 106 microns. Because a dry sieve was used instead of standard grain size analysis methods, the fractions for coarse and fine materials are approximations.

Additional Data

To further characterize the presence of fecal coliform on Anchorage streets, street sediment sampling during the summer was expanded to include an observation of the entire block of each street sampled. Included in the observations were fecal sources, migration pathways, and location descriptions of point sources. An interview was conducted with a local dog trainer to learn patterns of dog behavior and potential preferences for deposition points. Also, a national literature review was conducted to identify patterns observed in other studies that may be applicable to Anchorage conditions.

2.2.5 REPRESENTATIVE QUALITY OF SAMPLES

Due to the exploratory nature of the project, some critical system elements were well represented by the results while other results were insufficient for drawing management-oriented conclusions. The data collection specified in the design was effectively followed, and field and laboratory objectives were met.

In summary, metals and PAH data are valid for use with other data gathered in projects that mirror the critical system elements of this project. Fecal coliform and outfall runoff data are not valid for such a use, nor can any conclusions be drawn from this data alone.

Street Sediment

During sediment sampling in the spring, five residential/collector streets retained snow for several weeks longer than arterial streets. These streets were sampled for sediment about 3 weeks after arterial streets were sampled. Comparison of samples taken before and after the 3-week time lapse may contain some variability, but this is accepted as valid for comparison to sediment gathered before the time lapse.

Street gutter sediment data for metals and PAHs are deemed to be reasonably represented for the purposes of this study. These pollutants are largely traffic-related, and the project was designed with strata classified largely by traffic volumes and spatial patterns. These data also can be correlated with data from other Anchorage studies that have gathered sediment from street gutters at similar times of the year.

Outfall Runoff

Data collected by the datalogger at the Gambell/Ingra outfall indicated large diurnal variability in flow and conductivity during the spring melt period. There was not enough validation of the flows measured by the pressure transducer at the datalogger, nor of the conductivity metered there. Grab samples for flow and conductivity comparison were too few to show confidence in datalogger data magnitudes. Grab samples for other pollutant concentrations can only estimate the variability of washoff concentrations during the spring melt period due to the large diurnal variation and inconclusive flow magnitudes. Other outfalls may demonstrate different street runoff and flow patterns, and may have more or less infiltration from groundwater than the outfall at Gambell/Ingra.

Fecal Coliform

Fecal coliform results ranged from zero to thousands. In an attempt to qualify the data as representative or not, several other approaches were utilized. National fecal coliform literature was reviewed to determine typical loading patterns and how fecal coliform is different from other pollutants. Fecal coliform observations were also collected during Round 2 of the gutter sediment sampling and sediment samples were gathered from street sweeping waste piles in the late summer and early fall. In addition, an interview was conducted with a local dog trainer to gain insight on dog behavior.

When compared to national literature, samples from this project may not have been gathered within strata that would best represent fecal coliform loading on streets. The sample collection methodology mirrored that of other non-biological constituents primarily generated by vehicle traffic, potentially resulting in a non-comprehensive sampling regime for fecal coliform. An expanded data collection approach may be necessary to meet this objective. This literature review and an annotated bibliography are included in Appendix F.

Street waste sampling also was inconclusive because there were only five samples gathered from waste piles. Three of these samples were from the CBD, where there are likely to be fewer dogs and sources than residential areas. Only one residential sample was gathered, and this sample was from a large pile that had been accumulating at the Kloep Maintenance Yard for several days, unlike the single sweeper piles from the other four samples. The sampling technique also may have been inadequate, as five sub-samples taken from the surface of each pile may not have been sufficient to represent the whole pile. In summary, no conclusions can be drawn from the street waste pile data, nor should it be used in conjunction with other street waste data.

2.3 Data Quality

Data collection activities conformed to data quality objectives, as established in the project design document (MOA, 2000b). Standard methods and analytical procedures were used for quality control, including:

- Field and quality control sampling
- Instrument calibration procedures
- Sample preservation
- Chain-of-custody and data tracking
- Use of a certified laboratory

Representative data and trends were assessed in periodic meetings and frequent visits to field sampling sites.

Columbia Analytical Services, a local state-certified analytical testing laboratory, performed all sample analyses. Water and soil data for the 2000 DPW Sediment-Adsorbed Pollutants project sampling were reviewed for precision, accuracy, representativeness, comparability, and completeness (PARCC). A total of 70 samples were submitted to Columbia Analytical Services for analysis. Table 2-3 shows all analytical methods for project water and soil with reporting limits, detection limits, precision, and accuracy qualifications.

To review PARCC, the following specific quality control samples, indicators, and associated documentation were reviewed: field and laboratory blanks, field and laboratory duplicates, laboratory control samples (LCS), laboratory control sample duplicates (LCSD), method reporting limits (MRL), surrogates, and sample handling documentation.

All data reported by Columbia Analytical Services are deemed acceptable for the purposes of this project with the qualifications described in this section. The samples listed below were received at the laboratory with temperature exceedences (Table 2-4). Positive results were flagged with "JL" in the "alldata" file in the electronic deliverable, indicating that the results are biased low due to temperature exceedence. Practical quantitation limit (PQL) analytes were flagged with a "J" indicating that the PQL is an estimated value when the sample did not contain detectable amounts of analyte.

The samples above were high in percent solids (between 95-99 percent); therefore, the only parameter qualified due to temperature exceedences was PAHs selected ion monitoring (SIM). Other parameters, including metals, TOC, chloride, fecal coliform, and TSS, were assumed not to be impacted by temperature exceedences due to sample matrix and lack of moisture in samples.

<u>PAH SIM by SW8270C SIM</u>

The surrogate fluoranthene-d10 was recovered (32 percent) below laboratory acceptance limits (39-124 percent) and the surrogate terpheyl-d14 recovered (32 percent) below acceptance limits (44-127 percent) for sample CHGI004B (sampled on 3/24/00). Positive results were qualified as estimates with a low bias and flagged with "JL" and PQLs were flagged with "J," indicating that the PQL is an estimated value.

The surrogate terphenyl-d14 was recovered (32 percent) below laboratory acceptance limits (44-127 percent) for sample CHGI004A (sampled on 3/24/00). Positive results were qualified as estimates with a low bias and flagged with "JL" and PQLs were flagged with "J," indicating the PQL is an estimated value.

<u>Hexavalent Chromium (Cr VI) by SW3060A</u>

The matrix spike was recovered below (38 percent) acceptance criteria (75-125 percent) for sample Fireweed (sampled on 4/12/00). The Cr VI result for this sample was flagged with "JL," indicating that the result is an estimated biased low value due to matrix interference.

Table 2-3
ANALYTICAL METHODS, REPORTING LIMITS

Method	Analyte	Matrix	Method Reporting Limit	Method Detection Limit	Precision (RPD)	Accuracy (percent REC)
300.0 / SM 4110B	Chloride	Soil	2 mg/Kg	NA	20	90-110
Ion Chromatography	Chloride	Water	0.2 mg/L	0.05 mg/L	20	90-110
ASTM D4129-82M	Total Organic Carbon	Soil	0.05 percent	0.02 percent	20	85-115
415.1	Total Organic Carbon	Water	0.5 mg/L	0.09 mg/L	20	85-115
SM 9222D	Fecal Coliform	Soil/Water	2 CFU/100 mL	NA	NA	NA
200.8 (ICP/MS)	Chromium	Soil	0.2 mg/Kg	0.05 mg/Kg	30	70-130
200.8 (ICP/MS)	Copper	Soil	0.1 mg/Kg	0.01 mg/Kg	30	70-130
200.8 (ICP/MS)	Lead	Soil	0.05 mg/Kg	0.02 mg/Kg	30	70-130
200.8 (ICP/MS)	Zinc	Soil	0.5 mg/Kg	0.05 mg/Kg	30	70-130
200.8 (ICP/MS)	Chromium	Water	0.2 µg/L	0.05 µg/L	20	85-115
200.8 (ICP/MS)	Copper	Water	0.1 µg/L	0.03 µg/L	20	85-115
200.8 (ICP/MS)	Lead	Water	0.02 µg/L	0.006 µg/L	20	85-115
200.8 (ICP/MS)	Zinc	Water	0.5 µg/L	0.2 µg/L	20	85-115
200.7 (ICP)	Calcium	Water	50 µg/L	20 µg/L	20	85-115
200.7 (ICP)	Magnesium	Water	10 µg/L	5 µg/L	20	85-115
GC/MS-SIM	Naphthalene	Soil	5 µg/Kg	0.4 µg/Kg	40	30-116
GC/MS-SIM	2-Methylnaphthalene	Soil	5 µg/Kg	0.3 µg/Kg	40	30-116
GC/MS-SIM	Acenaphthene	Soil	5 µg/Kg	0.2 µg/Kg	40	30-116
GC/MS-SIM	Acenaphthylene	Soil	5 µg/Kg	0.2 µg/Kg	40	30-116
GC/MS-SIM	Anthracene	Soil	5 µg/Kg	0.2 µg/Kg	40	30-116
GC/MS-SIM	Benzo(a)anthracene	Soil	5 µg/Kg	0.4 µg/Kg	40	25-129
GC/MS-SIM	Benzo(a)pyrene	Soil	5 µg/Kg	0.3 µg/Kg	40	29-129
GC/MS-SIM	Benzo(b)fluoranthene	Soil	5 µg/Kg	0.8 µg/Kg	40	25-129
GC/MS-SIM	Benzo(g,h,i)perylene	Soil	5 µg/Kg	0.6 µg/Kg	40	29-129
GC/MS-SIM	Benzo(k)fluoranthene	Soil	5 µg/Kg	0.4 µg/Kg	40	25-129
GC/MS-SIM	Chrysene	Soil	5 µg/Kg	0.5 µg/Kg	40	25-129
GC/MS-SIM	Dibenzo(a,h)anthracene	Soil	5 µg/Kg	0.4 µg/Kg	40	29-129
GC/MS-SIM	Dibenzofuran	Soil	5 µg/Kg	0.3 µg/Kg	40	30-116
GC/MS-SIM	Fluoranthene	Soil	5 µg/Kg	0.6 µg/Kg	40	30-116
GC/MS-SIM	Fluorene	Soil	5 µg/Kg	0.3 µg/Kg	40	30-116
GC/MS-SIM	Indeno(1,2,3-cd)pyrene	Soil	5 µg/Kg	0.6 µg/Kg	40	29-129
GC/MS-SIM	Phenanthrene	Soil	5 µg/Kg	0.4 µg/Kg	40	30-116
GC/MS-SIM	Pyrene	Soil	5 µg/Kg	0.5 µg/Kg	40	25-129
GC/MS-SIM	Naphthalene	Water	0.02 µg/L	0.007 µg/L	30	47-129
GC/MS-SIM	2-Methylnaphthalene	Water	0.02 µg/L	0.003 µg/L	30	47-129
GC/MS-SIM	Acenaphthene	Water	0.02 µg/L	0.005 µg/L	30	28-116
GC/MS-SIM	Acenaphthylene	Water	0.02 µg/L	0.003 µg/L	30	47-129
GC/MS-SIM	Anthracene	Water	0.02 µg/L	0.002 µg/L	30	28-116
GC/MS-SIM	Benzo(a)anthracene	Water	0.02 µg/L	0.003 µg/L	30	32-130
GC/MS-SIM	Benzo(a)pyrene	Water	0.02 µg/L	0.003 µg/L	30	47-130
GC/MS-SIM	Benzo(b)fluoranthene	Water	0.02 µg/L	0.003 µg/L	30	32-130
GC/MS-SIM	Benzo(g,h,i)perylene	Water	0.02 µg/L	0.003 µg/L	30	47-130
GC/MS-SIM	Benzo(k)fluoranthene	Water	0.02 µg/L	0.005 µg/L	30	32-130
GC/MS-SIM	Chrysene	Water	0.02 µg/L	0.005 µg/L	30	32-130
GC/MS-SIM	Dibenzo(a,h)anthracene	Water	0.02 µg/L	0.005 µg/L	30	47-130
GC/MS-SIM	Dibenzofuran	Water	0.02 µg/L	0.002 µg/L	30	47-129
GC/MS-SIM	Fluoranthene	Water	0.02 µg/L	0.002 µg/L	30	28-116
GC/MS-SIM	Fluorene	Water	0.02 µg/L	0.003 µg/L	30	28-116
GC/MS-SIM	Indeno(1,2,3-cd)pyrene	Water	0.02 µg/L	0.006 µg/L	30	47-130
GC/MS-SIM	Phenanthrene	Water	0.02 µg/L	0.003 µg/L	30	28-116
GC/MS-SIM	Pyrene	Water	0.02 µg/L	0.002 µg/L	30	32-130

Table 2-4
SAMPLES WITH TEMPERATURE EXCEEDENCES

Sample ID	Sample Date	Parameters	Temperature When Received
16th	05/02/00	PAH SIM	20ºC
Columbine	05/02/00	PAH SIM	20ºC
Glenwood	05/02/00	PAH SIM	20ºC
Bannister	05/02/00	PAH SIM	20ºC
Eagle	05/02/00	PAH SIM	20ºC
Bannister	08/01/00	PAH SIM	20ºC
LaTouche	08/01/00	PAH SIM	20ºC
Reeve	08/04/00	PAH SIM	20ºC
Dimond	08/04/00	PAH SIM	20ºC

TSS by 160.2

The TSS LCSD result (26 mg/L) for GI0004 (sampled on 6/13/00) agreed with the primary sample TSS result (20 mg/L). The relative percent difference (RPD) between the primary sample and the LCSD was 26 percent and laboratory acceptance is < 20 percent. Due to the lack of agreement, the TSS result was flagged with "J," indicating an estimated value due to low precision.

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3 Data Summary

The data summary presented in this section provides key site and data characteristics important to understanding the critical system elements for each site and within each stratum. Figure 2-1 illustrates site locations within the Anchorage Bowl for both street sediment and outfall sampling. Tables contain sediment and runoff concentrations information. Data are also graphically summarized in relation to different strata and pollutants. Appendix A provides concentrations for individual streets for all pollutants.

3.1 Street Sediment

Street gutter sediment load characteristics varied between spring and summer, as shown in the summary in Table 3-1. Loads were considerably larger during spring breakup due to the presence of traction sand and winter accumulation. Fine loads were consistently between 9 and 10 percent of the total, and the majority of sediment consisted of coarse material during both spring and summer. Sampling analysis showed total sediment loading in gutters during the spring round on arterial streets (87.7 – 128.8 g/sq.ft.) was greater than loading in the summer round (17.4 – 43.4 g/sq.ft.). This differentiation was also evident on collector/residential streets between spring (21.4 – 124.9 g/sq.ft.) and summer (19.2 – 56.9 g/sq.ft.). All sediment laboratory results are shown in Appendix A.

Table 3-1
MEDIAN SEDIMENT LOADS IN GUTTERS DURING SPRING AND SUMMER SAMPLING

	(g/sq. ft.)	Total	Fine	Coarse
Spring	Major/Minor Arterial	93.3	9.2	88.0
Spring	Collector/Residential	63.8	5.9	52.9
Summer	Major/Minor Arterial	27.2	2.6	24.9
Summer	Collector/Residential	27.8	2.7	25.1

PAH

Laboratory results indicated that PAHs were present during the spring round on collector and residential streets (762 – 44,508 µg/Kg) and on arterials (1168 – 4022 µg/Kg). Concentrations on fine sediments were higher than total concentrations (3044 – 126,062 µg/Kg on residential/collector streets and 3453 – 5370 µg/Kg on arterials). In summer, PAH loading was about the same as in the spring on collector and residential streets, but had dropped by about 77 percent on the arterials. Table 3-2 shows a summary of spring and summer concentrations.

Metals

Chromium was present in spring on collector and residential streets (17.8 – 32.9 mg/Kg) and on arterials (23.4 – 35.0 mg/Kg). Concentrations on fine sediments were higher than total concentrations (33.5 – 50.1 mg/Kg on residential/collector streets and 36.2 – 55.6 mg/Kg on arterials). In summer, chromium loading was about the same as in the spring on collector and residential streets (28.7 – 43.9 mg/Kg) and on arterials (28.7 – 43.7 mg/Kg). Hexavalent

Table 3-2
SPRING AND SUMMER PAH CONCENTRATIONS IN STREET GUTTER SEDIMENT
(ug/Kg)

PAH µg/Kg	Spring: Major/Minor Arterial Total	Spring: Major/Minor Arterial Fine	Spring: Residential/Collector Total	Spring: Residential/Collector Fine	Spring: No. of Samples	Summer: Major/Minor Arterial Total	Summer: Residential/Collector Total	Summer: No. of Samples
2-Methylnaphthalene	19	45	15	30	7	11.5	14.5	4
Acenaphthylene	3	8	3	3	7	11	23.5	4
Acenaphthene	32	22	12	27	7	ND	ND	4
Dibenzofuran	29	23	12	25	7	27.5	65	4
Fluorene	54	43	22	39	7	82	225	4
Phenanthrene	540	510	280	610	7	89	250	4
Anthracene	57	60	26	72	7	120	315	4
Fluoranthene	350	460	210	530	7	67.5	167	4
Pyrene	570	850	270	960	7	95	300	4
Benz(a)anthracene	140	200	77	210	7	190	475	4
Chrysene	310	480	230	590	7	766	34.5	4
Benzo(b)fluoranthene	180	300	140	330	7	8.5	15.5	4
Benzo(k)fluoranthene	120	170	73	250	7	270	695	4
Benzo(a)pyrene	120	190	89	250	7	15	31.5	4
Indeno(1,2,3-cd)pyrene	64	120	61	210	7	69	170	4
Dibenz(a,h)anthracene	34	69	29	89	7	8	12.5	4
Benzo(g,h,i)perylene	110	220	88	250	7	180	460	4
Naphthalene	15	22	12	28	7	265	755	4
Total PAHs	**2917**	**3831**	**1647**	**4129**	7	**2275**	**4009**	4

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chromium was measured on two arterial streets during the spring round with results of 0.8 and 0.9 mg/Kg. For comparison, the ADEC soil cleanup level for chromium is 23 mg/Kg (18 AAC 75.341).

Copper was present in spring on collector and residential streets (23.6 - 114 mg/Kg) and on arterials (22.5 – 31.5 mg/Kg). Concentrations on fine sediments were about the same as total concentrations (35.5 – 52.2 mg/Kg on residential/collector streets and 36.4 – 49.2 mg/Kg on arterials). In summer, copper loading was about the same as in the spring on collector and residential streets (24.4 – 48.9 mg/Kg) and on arterials (27.6 – 82.9 mg/Kg).

Lead was present in spring on collector and residential streets (11.8 – 36.0 mg/Kg) and on arterials (12.4 – 46.2 mg/Kg). Concentrations on fine sediments were higher than total concentrations (43.8 – 81.9 mg/Kg on residential/collector streets and 44.9 – 99.7 mg/Kg on arterials). In summer, lead loading was about the same as in the spring on collector and residential streets (26.0 – 84.0 mg/Kg) and on arterials (21.7 - 107 mg/Kg). For comparison, the ADEC soil cleanup level for lead is 400 mg/Kg (18 AAC 75.341).

Zinc was present in spring on collector and residential streets (57.0 - 111 mg/Kg) and on arterials (62.4 - 153 mg/Kg). Concentrations on fine sediments were higher than total concentrations (112 - 212 mg/Kg on residential/collector streets and 29.9 - 242 mg/Kg on arterials). In summer, zinc loading was greater than in the spring on collector and residential streets (126 - 219 mg/Kg) and on arterials (89.8 - 232 mg/Kg). For comparison, the ADEC soil cleanup level for zinc is 8,100 mg/Kg (18 AAC 75.341).

Table 3-3 shows a summary of spring and summer metals concentrations.

TOC

TOC varied from 1.04 to 11.2 percent in the spring and 1.34 to 9.02 percent in the summer round. During the spring round, TOC in the fine fractions was 3.10 to 5.42 percent.

Chloride

Chloride was present in spring on collector and residential streets (6.7 – 65.2 mg/Kg) and on arterials (4.7 – 45.7 mg/Kg). Concentrations on fine sediments were higher than total concentrations (45.4 - 117 mg/Kg on residential/collector streets and 34.4 – 176 mg/Kg on arterials). In summer, chloride was again detected on collector and residential streets (4.3 - 1230 mg/Kg) and on arterials (2.5 – 70.8 mg/Kg). Chloride and TOC concentration summaries are shown in Table 3-4.

Fecal Coliform

Total fecal coliform was measured on 13 streets during the spring round. Sediment concentrations varied between non-detect and 0.2 MPN/g. During the summer round, both total sediment and fines were analyzed for fecal coliform. Values ranged from 0.2 to 16,700

MPN/g on residential/collector streets and 0.4 to 17.1 MPN/g on arterials. A summary of fecal coliform data is shown in Table 3-5.

Table 3-3
SPRING AND SUMMER METALS CONCENTRATIONS IN STREET GUTTER SEDIMENT (mg/Kg)

Metal	Spring					Summer		
	Major/Minor Arterial		Residential/Collector		No. of Samples	Major/Minor Arterial	Residential/Collector	No. of Samples
(mg/Kg)	Total	Fine	Total	Fine		Total	Total	
Chromium	26.4	44.1	24.7	41.4	7	36.1	34.5	4
Copper	27.6	42.3	28.4	44.8	7	34.3	34.85	4
Lead	23.6	72.0	33.2	59	7	41.3	37.9	4
Zinc	99.4	188	91.6	179	7	109.95	133.5	4

Table 3-4
SPRING AND SUMMER TOC AND CHLORIDE CONTENT IN STREET GUTTER SEDIMENT

	Spring					Summer		
	Major/Minor Arterial		Residential/Collector		No. of Samples	Major/Minor Arterial	Residential/Collector	No. of Samples
	Total	Fine	Total	Fine		Total	Total	
TOC (percent)	2.17	3.98	2.25	4.82	7	1.6	2.73	4
Chloride (mg/Kg)	11.9	96.6	28.9	81.2	7	5.5	10.85	4

Table 3-5
SPRING AND SUMMER FECAL COLIFORM CONCENTRATIONS IN STREET GUTTER SEDIMENT

	Spring					Summer				
	Major/Minor Arterial		Residential/Collector		No. of Samples	Major/Minor Arterial		Residential/Collector		No. of Samples
	Total	Fine	Total	Fine		Total	Fine	Total	Fine	
Fecal Coliform (MPN/g)	0.13	--	0.13	--	7	0.40	1.7	16,700	1.85	8

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3.2 Runoff From the Gambell/Ingra Storm Water Outfall

Montgomery Watson sampled runoff at the Gambell/Ingra outfall using a datalogger and with grab samples.

3.2.1 DATALOGGERS

Dataloggers monitoring runoff depth during the spring indicated a strong diurnal trend with lower flows occurring in the morning and higher flows in the afternoon (Figure 3-2). This can be attributed to daily freeze and thaw cycles that take place at this time of year. Monitoring took place from March 7 to April 12. A conductivity meter was also installed at the site during this period. Figure 3-1 shows conductivity variation for the same length of time.

Summer monitoring indicated a much smaller range of flows, with most flows under 1 gpm. Monitoring took place from July 28 to August 13. This period of the summer experienced few large rain events so much of the flow was likely baseflow. Figure 3-3 shows summer flow data from the Gambell/Ingra outfall station at the same scale as spring flow data.

3.2.2 GRAB SAMPLES

Several grab samples were taken in the spring in an attempt to verify datalogger information and perform analyses for potential pollutants. All results from grab samples are summarized in tabular and graphical form in Appendix B.

Figure 3-1 Spring Conductivity at the Gambell/Ingra Outfall

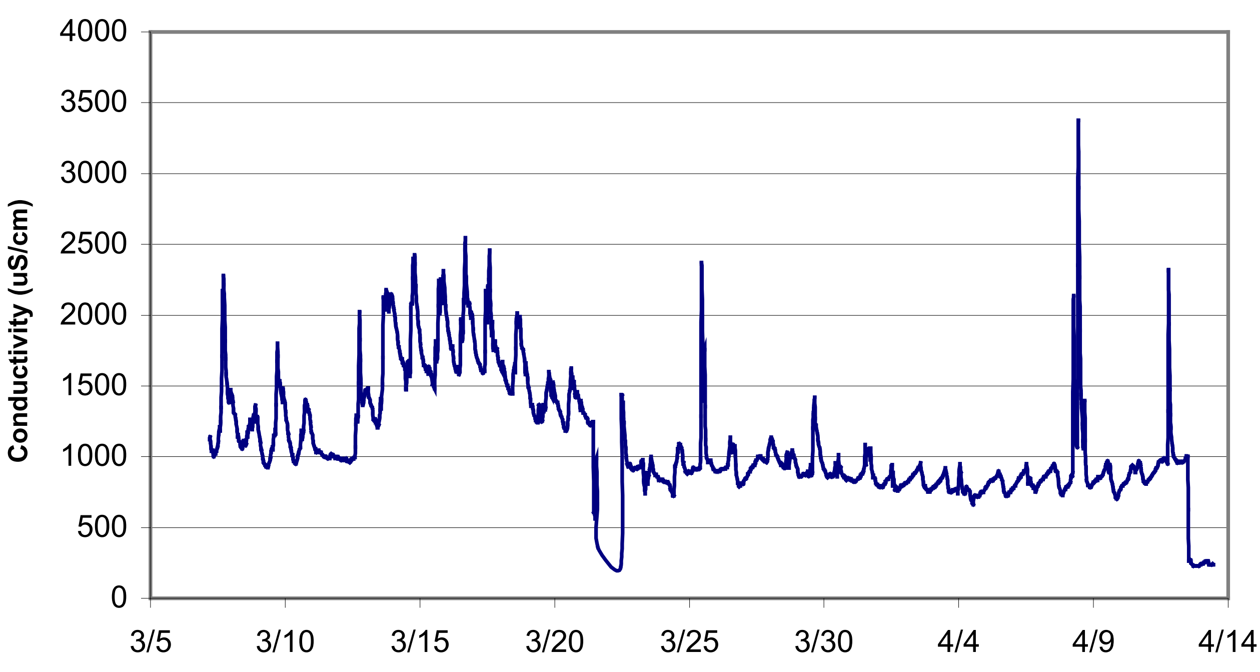


Figure 3-2 Spring Flow at the Gambell/Ingra Outfall

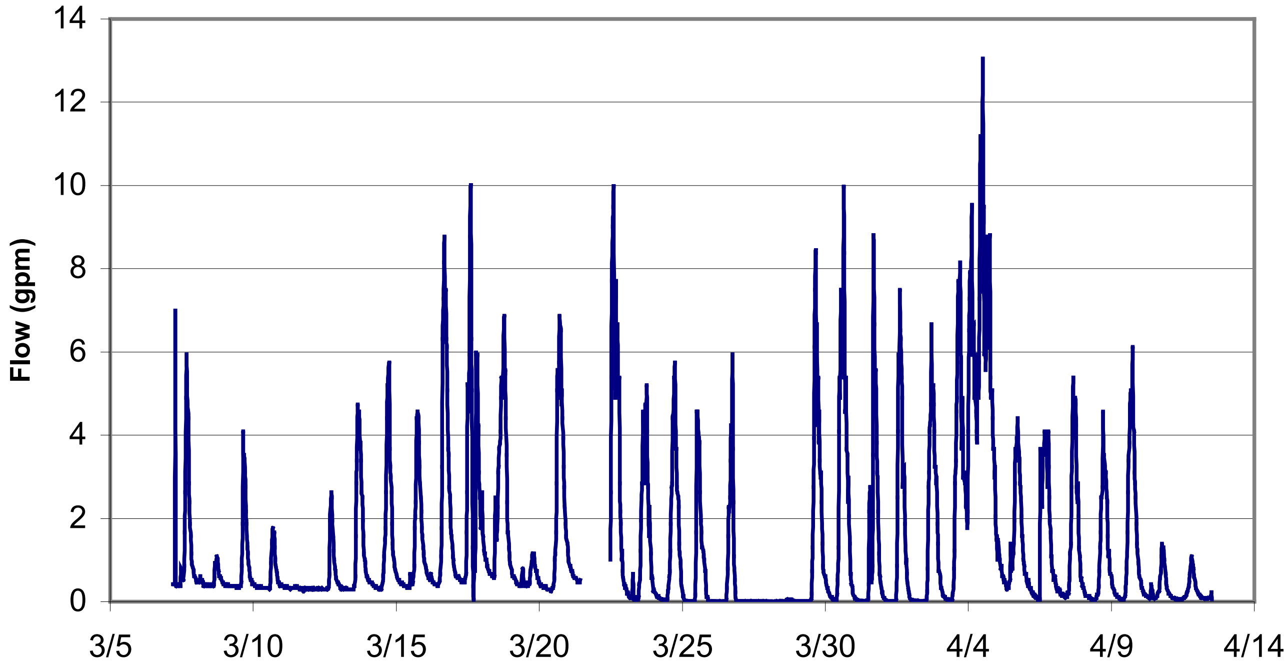
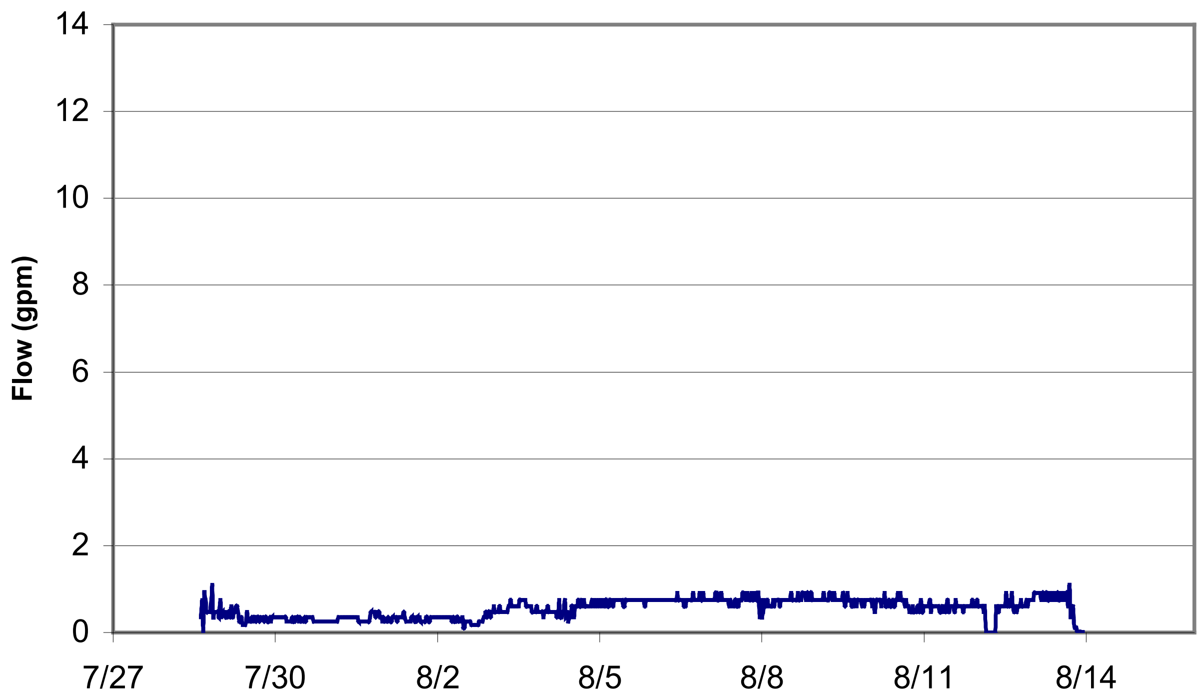


Figure 3-3 Summer Flow at the Gambell/Ingra Outfall



PAHs

Samples from March 24, 2000, were analyzed for PAHs. Morning results showed total PAH concentrations totaling 0.23 μg/L and fine fraction concentrations totaling 0.10 μg/L. Afternoon results showed total PAH concentrations totaling 0.49 μg/L and fine fraction concentrations totaling 0.22 μg/L.

Metals

Chromium results from mornings (12.9 – 13.9 μg/L) were less than results from the afternoons (28.4-43.8 μg/L). Dissolved fraction concentrations were typically less than total concentration (4.5 – 9.5 μg/L from mornings and 4.9-8.3 μg/L from afternoons).

Copper results from mornings (10.7 – 15.8 μg/L) were less than results from the afternoons (41.0 – 52.8 μg/L). Dissolved fraction concentrations were typically less than total concentration (5.5 – 7.7 μg/L from mornings and 8.8 – 14.0 μg/L from afternoons).

Lead results from mornings (2.55 – 10.1 μg/L) were less than results from the afternoons (53.1 – 82.9 μg/L). Dissolved fraction concentrations were typically less than total concentrations (0.30 – 0.75 μg/L from mornings and 0.34 – 1.62 μg/L from afternoons).

Zinc results from mornings (99 - 141 μg/L) were less than results from the afternoons (261 - 371 μg/L). Dissolved fraction concentrations were typically less than total concentrations (27 - 80 μg/L from mornings and 24 - 74 μg/L from afternoons).

Calcium results from mornings (24,400 – 38,000 μg/L) were about the same as results from the afternoons (23,300 – 34,600 μg/L). The majority of total was the dissolved fraction (24,100 – 35,400 μg/L from mornings and 18,400 – 29,200 μg/L from afternoons).

Magnesium results from mornings (7,280 – 12,900 μg/L) were greater than results from the afternoons (12,500 – 22,500 μg/L). The majority of the total was the dissolved fraction (7,000 – 11,700 μg/L from mornings and 7,190 – 16,600 μg/L from afternoons).

Two samples were analyzed for cyanide content, both with laboratory results of non-detect. These samples were also analyzed for hexavalent chromium content, again with results of non-detect.

Other Analytes

TSS varied from 9 to 444 mg/L during spring runoff sampling. Fecal coliform measurements in runoff ranged from non-detect to 26o CFU/100 mL in eight spring samples.

3.2.3 STREET SWEEPING WASTE SEDIMENT

Sediment samples were periodically gathered from waste piles at the Kloep Street Maintenance Station during late summer and fall 2000. DPW Street Maintenance personnel swept streets in the CBD, midtown, and residential areas to form the piles. Source streets for CBD and Midtown piles are shown in Figure 2-2. Grain size analyses (ASTM C-33M Sand) was performed on the September 11 and October 27 samples. Table 3-6 shows the dates, sources, and results for fecal coliform analysis of samples from waste piles. Tables 3-7 and 3-8 show the percent passing for several sieve sizes and associated fecal coliform values.

Table 3-6
WASTE PILE SAMPLE DESCRIPTIONS AND FECAL COLIFORM RESULTS

Date	Source	Total (MPN/g)	Fine (MPN/g)
July 31	CBD	800	500
July 31	Midtown	2400	1400
August 15	CBD	ND	ND
September 11	CBD	1.3	ND
October 27	Residential	43.9	16.3

Table 3-7
SIEVE ANALYSIS RESULTS FOR THE SEPTEMBER 11 SAMPLE

Sieve #	Sieve Size (mm)	percent Passing
No. 4	4.75	10.8
No. 10	2.00	12.6
No. 30	0.60	31.1
No. 60	0.25	29.0
No. 140	0.106	11.1
Pan	Pan	5.4

Table 3-8
SIEVE ANALYSIS RESULTS FOR THE OCTOBER 27 SAMPLE

Sieve #	Sieve Size (mm)	percent Passing
No. 4	4.75	86
No. 10	2.00	67
No. 20	0.85	52
No. 30	0.60	45
No. 60	0.25	28
No. 100	0.15	20
No.200	0.075	14
Pan	Pan	0

3.3 Fecal Coliform Source Observations

The field team performed visual inventories of the eight streets sampled for sediment during August. The team assessed many sources and migration pathways of fecal coliform, including sidewalks, gutters, driveways, storm drain inlets, and lawns adjacent to the streets. Two point sources (dog droppings) were found on the eight blocks that were inventoried. Both point sources were on or adjacent to residential lots. Field forms describing physical characteristics of the inventoried streets are included in Appendix E.

To further understand the patterns of fecal coliform sources on Anchorage streets, Montgomery Watson conducted an interview with a dog trainer who is familiar with dog behavior. The trainer indicated that, in her experience, most dogs preferred to defecate in grass rather than on sidewalks or asphalt (McLean, 2000). She observed that sometimes they do not have this opportunity when they are on short leashes, or when they are travelling quickly, such as when the owner is on a bicycle. The trainer also believed that most dog owners preferred to walk their dogs on trails and in parks rather than near streets. It is possible that a correlation could exist between frequency of fecal coliform contamination and proximity to parks and greenbelts. The trainer also discussed the manner in which many people dispose of wastes from pets. She stated that many dog owners leave plastic bags of the material on the curbside awaiting trash removal services. These bags may potentially leak directly to the street gutter. Likewise, even if these bags are in trash bins awaiting trash removal, the bags leak, and washwater from cleaning the bins may be discharged directly to the street gutter.

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