Daniel A. Sullivan, Mayor

Monitoring, Evaluation, and Quality Assurance Plan

APDES Permit No. AKS-052558

Document No. WMP APd10001

MUNICIPALITY OF ANCHORAGE
WATERSHED MANAGEMENT PROGRAM

October 2012

WATERSHED MANAGEMENT

HDR

Monitoring, Evaluation, and Quality Assurance Plan
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October 2012

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WMS Project No.	99002
Prepared for:	Alaska Department of Environmental Conservation Division of Water
Prepared by	HDR Alaska, Inc. 2525 C Street, Suite 305 Anchorage, AK 99503 and Municipality of Anchorage Project Management and Engineering Department Watershed Management Services

A. Project Management Elements

A.1 Title and Approval Page

______________________________ **Date________**

MOA Watershed Management Project Manager
QA Officer

______________________________ **Date________**

Kristi Bischofberger
MOA Watershed Management
Program Manager

______________________________ **Date________**

William Ashton
Alaska Department of Environmental Conservation
Project Manager

______________________________ **Date________**

Richard Heffern
Alaska Department of Environmental Conservation
QA Officer

______________________________ **Date________**

HDR Alaska
Contractor Project Manager

______________________________ **Date________**

HDR Engineering
Contractor QA Officer

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A.2 Table of Contents

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List of Acronyms

ADEC	Alaska Department of Environmental Conservation
ADOT&PF	Alaska Department of Transportation & Public Facilities
APDES	Alaska Pollutant Discharge Elimination System
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
C	Celsius
CoC	Chain of Custody
DO	Dissolved Oxygen
DMRQA	Discharge Monitoring Report-Quality Assurance
DQO	Data Quality Objective
LID	Low Impact Development
mg/L	milligrams per liter
µg/L	micrograms per liter
mS/cm	milli-Siemens/centimeter
µS/cm	micro-Siemens/centimeter
MOA	Municipality of Anchorage
MS4	Municipal Separate Storm Sewer System
NELAC`	National Environmental Laboratory Accreditation Conference
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OGS	Oil Grit Separator
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
SOP	Standard Operating Procedure
TAH	Total Aromatic Hydrocarbons
TAqH	Total Aqueous Hydrocarbons
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WMS	Watershed Management Services

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A.3 Distribution List

Signees shall receive a copy of this Quality Assurance Project Plan (QAPP), all attachments, and all subsequent revisions. Offers of official copies of this QAPP and any subsequent revisions will be extended to individuals on the Distribution List.

Table 1. Distribution List

Name, Title	Position	Agency	Division/ Branch	Contact Information
Kristi Bischofberger, Watershed Manager	Program Manager	Municipality of Anchorage (MOA)	Watershed Mgmt. Services (WMS)	(907) 343-8057 BischofbergerKL@ci.anchorage.ak.us
TBD Watershed Hydrologist	Project Manager, QA Officer	MOA	WMS	(907) 343-7523 TBD
Ingrid Corson	Contractor Project Manager	HDR Alaska	FERM Business Group	(907) 644-2113 Ingrid.Corson@hdrinc.com
Cindy Milligan	Contractor QA Officer	HDR Alaska	FERM Business Group	(907) 644-2017 Cynthia.Milligan@hdrinc.com
Cindy Milligan	Sampling and Analysis Manager	HDR Alaska	FERM Business Group	(907) 644-2017 Cynthia.Milligan@hdrinc.com
Steve Crupi	Lab Project Manager	SGS Laboratory	Environmental Business Line	(907) 550-3213 Steven.Crupi@sgs.com
Heather Hall	Lab QA Officer	SGS Laboratory	Environmental Business Line	(907) 550-3213 Heather.Hall@sgs.com
Tim Stevens	ADEC Project Manager	Alaska Department of Environmental Conservation (ADEC)	Water Quality Standards, Assessment & Restoration	(907) 269-7515 Tim.Stevens@ak.gov
Richard Heffern, Chemist	ADEC Water QA Officer	ADEC	Water Quality Standards, Assessment & Restoration	(907) 465-5305 Richard.Heffern@ak.gov
William Ashton, Mgr Stormwater and Wetlands Section	Permit Writer	ADEC	Wastewater Discharger Authorization	(907) 269-7564 William.Ashton@ak.gov

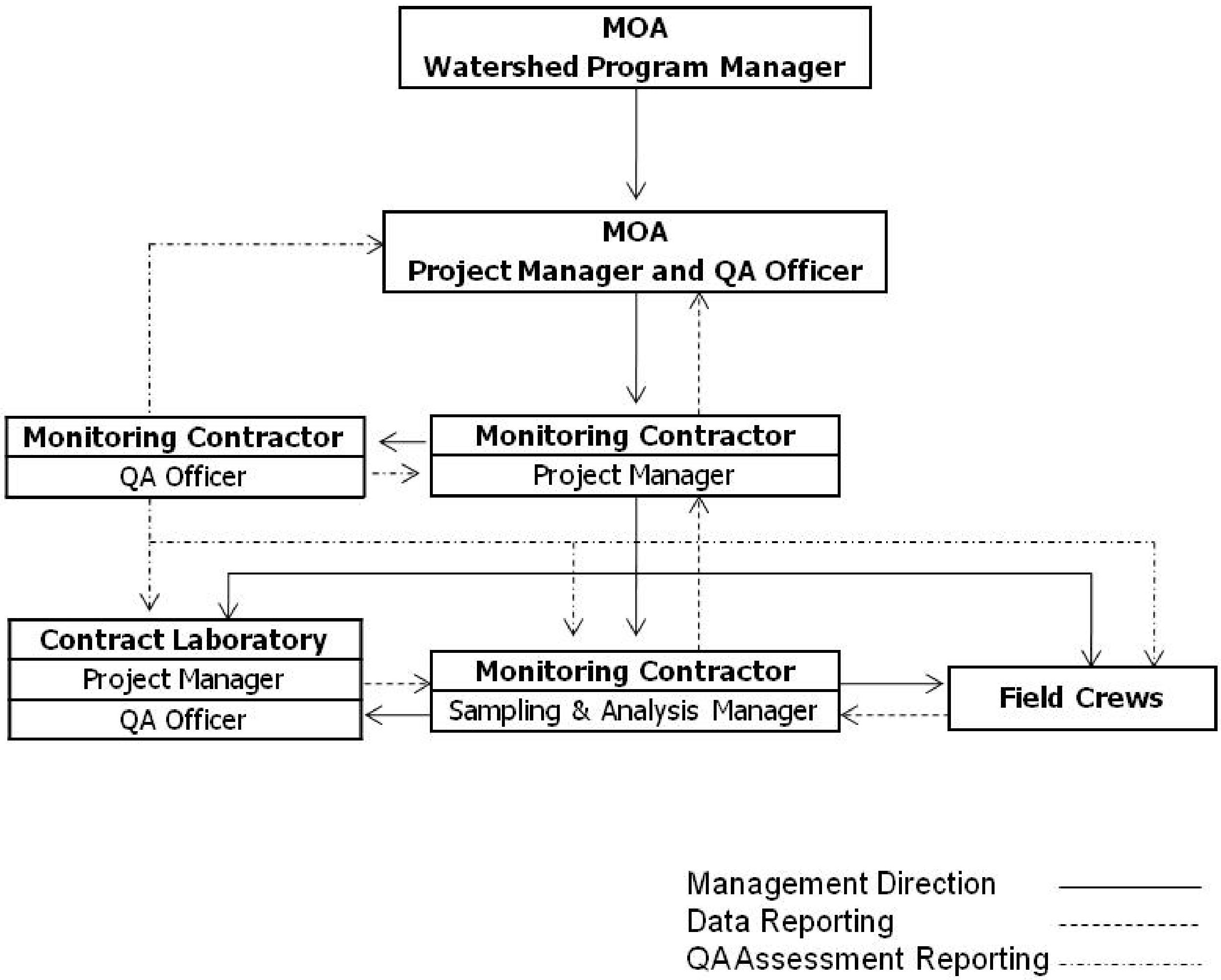
Record of Revisions

Table 2 provides a record of when and how this QAPP has been revised.

Table 2. Record of Revisions

Date	Section	Description
June 4 2012	All, except App D	Updated for the 2012 season
Oct 2012	All, except App D	Final for 2012 season

Figure 1. Project/ Task Organization



A.4 Key Contacts and Responsibilities

The Watershed Management Services (WMS) will appoint a person to serve as the Municipality of Anchorage (MOA) Project Manager. This person will oversee the projects described in the monitoring plans appended to this QAPP, provide technical support, QAPP review, review of any modifications of the proposed sampling plans, and review all reports. She/he will appoint the sampling crews from MOA staff or develop a contract to perform the sampling and reporting tasks associated with this QAPP. The person will also serve as the Quality Assurance (QA) Officer reviewing data validated by the Contract QA Officer to ensure quality objectives are met and data entry is conducted appropriately.

Kristi Bischofberger (WMS) will oversee the water quality monitoring program efforts and projects conducted to comply with Alaska Pollutant Discharge Elimination System (APDES) Municipal Separate Storm Sewer System (MS4) permit AKS-052558 and this QAPP. She will provide or ensure adequate resources for the overall monitoring program.

Monitoring Contractor MOA will hire a contractor to oversee and implement the monitoring plans. The Contractor will provide a Project Manager, a QA Officer, a Contract Sampling and Analysis Manager, and field crews.

> **Contract Project Manager** will ensure that all aspects of this QAPP are implemented in conducting the monitoring projects; appoint a qualified QA officer (Contract QA Officer); assign qualified and trained field crews; contract with a laboratory; and interface with the MOA Project Manger.
>
> **Contract QA Officer** will ensure or provide training to, examinations for, and oversight of the field crews; perform QA review and validation of the laboratory and field data; and provide QA review of the data entered into the spreadsheets and databases.
>
> **Contract Sampling and Analysis Manager** will provide direction to the field crews and will coordinate with the laboratory project manager. This person will receive direction from the Contract Project Manager and will receive feedback from the QA Officer. The Contract Sampling and Analysis Manager will: ensure that all equipment is functional prior to field sampling; ensure all supplies are available and that calibration chemicals have not exceeded their expiration dates; and assist in training field sampling crews, as needed.
>
> **Field Crews** will be either MOA staff or will be hired as contractors to conduct the work. Trained field crews will collect samples for the MOA APDES MS4 monitoring program in compliance with the permit and this QAPP. If field crews are appointed by the MOA Project Manager, they will be integrated into the contractor field crews and receive the same training and oversight.

Laboratory – The Contract Project Manager will contract with a laboratory that will perform the chemical analyses and meet the precision, accuracy, and completeness requirements of this QAPP. The contract laboratory must be currently certified for parameters of interest under the Alaska Department of Environmental Conservation's (ADEC) Drinking Water Program (http://dec.alaska.gov/eh/lab/index.htm) or be certified for water/wastewater analytes by a National Environmental Laboratory Accreditation Conference (NELAC) accrediting body or the Washington State Department of Ecology Laboratory Accreditation program (http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html) to perform the analyses required. The laboratory will deliver results to the Monitoring Contractor in an electronic format specified by WMS. The laboratory will provide a Project Manager and a QA Manager.

Laboratory Project Manager is responsible for the overall technical and contractual management of this project. This person will receive day to day direction from the Contract Sampling and Analysis Manager concerning the day to day arrival of samples, turnaround times, reporting of deliverables, and will receive feedback from the Laboratory and Contract QA Officers. This person will oversee and coordinate analyses within the laboratory and provide results to both the Contract Sampling and Analysis Manager and the Contract Project Manager.

Laboratory QA Manager is responsible for the QA/QC of the water quality laboratory analyses as specified in the QAPP. Along with the Laboratory Project Manager, the Laboratory QA Officer reviews and verifies the validity of the sample data results as specified in the QAPP and appropriate EPA-approved methods.

A.5 Problem Definition/ Background and Project Objectives

Urban stormwater can contribute to the degradation of the quality of water bodies. Runoff from precipitation and snowmelt events can transport contaminants from impervious surfaces, such as driveways, sidewalks, and roads and semi-pervious surfaces, such as lawns, into the local water bodies. Most stormwater runoff flows into a storm sewer system or directly to a water body, often without receiving treatment to remove the pollutants.

The U.S. Environmental Protection Agency (EPA) has recognized urban stormwater as a major contributor to pollution of the nation's streams, rivers, and lakes. EPA and delegated states are using the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit to control pollutants from urban stormwater to the maximum extent practicable. EPA re-issued the MS4 permit in 2009 to co-permittees: the Municipality of Anchorage (MOA) and the Alaska Department of Transportation and Public Facilities (ADOT&PF). Figure 2 depicts the area regulated by the MS4 permit. The MOA has taken the lead role in implementing the monitoring requirements of the permit. Since permit issuance, EPA has delegated the NPDES stormwater program to the ADEC who now oversees its implementation. The permit is administered by ADEC as an Alaska Pollutant Discharge Elimination System (APDES) permit.

The APDES MS4 permit establishes minimum control measures requiring the co-permittees to develop programs and policies, and implement actions designed to prevent and control contaminants entering publicly-owned storm sewer systems.

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Municipality of Anchorage
Watershed Management Services

FIGURE 2
Municipality of Anchorage Watersheds

Watershed Boundary
Lakes
Streams
Highway
Major road
Railroad
Municipality of Anchorage
Park

N

0 2 4
Miles

Date: June 07, 2011
Source data: HDR, MOA.
Projection: AK State Plane
Zone 4, NAD 83 ft.
File: Fig2_MOAWatersheds_11x17.mxd
Author: HDR Alaska, Inc.

In issuing the Anchorage MS4 permit, EPA recognized that a number of water bodies in the greater Anchorage watershed have been categorized as impaired under section 303(d) of the Clean Water Act. For thirteen of the water bodies impaired for elevated concentrations of fecal coliform and one water body impaired for petroleum hydrocarbons, ADEC has developed (and EPA has approved) Total Maximum Daily Loads (TMDL) plans to improve water quality to the extent that the waters will meet the current standards. The TMDLs identify stormwater runoff as a contributor of fecal coliform and petroleum hydrocarbon contamination to the water bodies; and the TMDLs establish reduction goals for concentrations of these pollutants in stormwater.

The monitoring elements of the MS4 permit are designed to identify sources of stormwater pollution, such as fecal coliform and petroleum hydrocarbons, monitor the effectiveness of best management practices (BMPs), and monitor the status of stormwater outfalls and receiving waters. The permit describes six specific monitoring projects.

This QAPP describes common elements across the six monitoring projects and provides direction and QA QC procedures for all the monitoring projects. Detailed, project-specific monitoring plans are provided in the following appendices to this QAPP:

- Pesticide Screening Plan – Appendix A
- Stormwater Outfall Monitoring Plan – Appendix B
- Structural Controls Effectiveness Monitoring Plan – Appendix C
- Snow Storage Site Retrofit Monitoring Plan – Appendix D
- Low Impact Development Pilot Project Monitoring Plan – Appendix E
- Dry Weather Screening Monitoring Plan – Appendix F

A.6 Project /Task Description and Schedules

Each monitoring plan provided in the appendices includes descriptions of the specific tasks to be implemented to meet the objectives of the permit, and the associated schedules.

A.7 Quality Objective and Criteria For Measurement of Data

Data Quality Objectives (DQOs) for this program have been established to ensure that the data acquired meet the goals described in each of the monitoring plans – identifying illicit discharges by water quality screening, determining structural controls' effectiveness, and detecting changes and trends in stormwater quality. In preparing the NPDES permit, EPA identified the following monitoring objectives in the NPDES MS4 Fact Sheet:

- To broadly estimate annual pollutant loading of fecal coliform and petroleum products to receiving waters from the MS4
- Assess the adequacy and effectiveness of a least two stormwater control measures
- To identify and prioritize portions of the MS4 and the MS4 operations that need additional controls

Stormwater monitoring is designed to provide a feedback loop for the permittees to improve the stormwater management program and best management practices, rather than to assess compliance with effluent limits or water quality standards.

Measurement Quality Objectives (MQOs) are a subset of DQOs and are derived from the monitoring project's DQOs. MQOs are designed to evaluate and control various phases (sampling, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the project's DQOs. MQOs are defined in terms of the following data quality indicators: detectability, precision, bias/accuracy, completeness, representativeness, and comparability. Tables 3 through 5 define the objectives of detectability, precision, and accuracy for each parameter tested by the methods and field probes MOA anticipates using. For all monitoring plans, the sampling matrix is water. Table 6 provides similar information for precipitation and discharge monitoring methods. MQOs for detectability, precision, accuracy, representativeness, comparability, and completeness are discussed below.

Project DQOs may be revised in the future if the MOA Project Manager determines that different objectives would be more effective in meeting program goals. Any changes in DQOs will require this QAPP to be revised and submitted to ADEC for approval prior to implementation.

A.7.1 Detectability

Detectability is the ability of an analytical method to reliably measure a pollutant concentration above background concentrations. Two components define detectability: the Method Detection Limit (MDL) and the Practical Quantification Limit (PQL), also known as the Reporting Limit (RL).

- The MDL is the minimum value at which the instrument can discern presence of the parameter apart from background noise, without certainty as to the accuracy of the measured value. For field measurements, the manufacturer's listed instrument detection limit (IDL) is used.
- The PQL or RL is the minimum value that can be reported with confidence (usually a multiple of the MDL).

Sample data measured below the MDL will be reported as a non-detected value (ND). A sample measured above the MDL but below the PQL will be reported as the value with an estimated qualification flag. Results reported above the PQL will be reported as reliable, unless otherwise qualified based on the specific sample analyses.

Table 3. Measurement Quality Objectives for Field Instruments

Parameter	Method/Range	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
pH	EPA 150.2 YSI 556 hand-held/ 0-14 pH units	0.01 units	NA	± 0.2 units	± 0.2 units	Standard solutions at pH 4, 7, and 10
Turbidity	EPA 180.1 Rev 2.0 M Hach 2100P Turbidimeter/ 0 – 1,000 NTU	0.01 for 0 - 9.99 NTU 0.1 for 1 - 10 NTU 1 for 100 -1000 NTU	NA	±1 NTU	± 2% 0-500 NTU ±3% 500-1000 NTU	Primary standards, 0, 20, 100, 800 NTU (Hach method 8195)
Turbidity	EPA 180.1 Rev 2.0 M YSI 600 OMS V2 data logger/ 0 – 1,000 NTU	0.1 NTU	NA	±1 NTU	± 2% or 0.3 NTU, whichever is greater	Standard Solutions 0, 12.7, 126, and 1,000 NTU
Conductance	EPA 120.1 YSI 556 hand-held probe / 0.001 - 200 mS/cm	0.001 – 0.1 mS/cm range dependent	NA	± 0.001	± 5% of reading or 0.001 mS/cm, whichever is greater	Standard solution 3 pt cal (0 – 100, 100 – 1000, > 1000 µS/cm)
Conductance	EPA 120.1 YSI 600 OMS V2 data logger/ 0.001 - 200 uS/cm	0.001 – 0.1 mS/cm range dependent	NA	± 0.001	± 5% of reading or 0.001 mS/cm, whichever is greater	Standard solution 3 pt cal (0 – 100, 100 – 1000, > 1000 µS/cm)
Temperature	SM 2550 B YSI 556 hand-held probe/ -5 – 45°C	0.01 °C	NA	0.4 °C	± 0.15 °C	Comparison with a NIST-certified thermometer [a] at 0°C and 20°C
Temperature	SM 2550 B YSI 600 OMS V2 data logger/ -5 – 70°C	0.01 °C	NA	0.4 °C	± 0.15 °C	Comparison with a NIST-certified thermometer [a] at 0°C and 20°C
Dissolved Oxygen (DO)	EPA 360.1 YSI 556 hand-held probe/ 0 - 50 mg/L	0.01 mg/L	NA	± 10%	± 0.2 mg/L	100% air saturation (refer to YSI 556 Manual)

[a] NIST-certified thermometer will have a greater resolution than the probe it will be used to calibrate
M = Modified per manufactures' recommendations

Table 4. Measurement Quality Objectives for Illicit Discharge Screening (Field Test Kits)

Parameter	Method[a]/Range	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
Total Chlorine	LaMott Chlorine Octaslide Bar colorimetric (EPA Method 330.5)/ 0.1 - 6.0 mg/L	0.1 mg/L	NA	± 30%	± 0.5 mg/L	NA
Total Copper	Lamotte Total Copper EC-70 Cuprizone Color Chart	0.05 mg/L	NA	± 30%	± 0.5 mg/L	NA
Detergents	Hach model DE-1 Toluidine blue colorimetric (Analytical Chemistry #38-791)/ 0.05 - 1 mg/L	0.05 mg/L	NA	± 30%	± 0.5 mg/L	NA
Total Phenols	4 Amino Anti-Pyrine (4AAP) colorimetric (SM 5530C)/ 0.1 - 1 mg/L	0.1 mg/L	NA	± 30%	±0.5 mg/L	NA

[a] Field screening parameters are recommended by CWP and Pitt (2004) for illicit discharge detection

Table 5. Measurement Quality Objectives for Laboratory Methods

Parameter	Method	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
Fecal Coliform	SM 9222D	1 cfu/100 mL	1 cfu/100 mL	60 RPD	NA	Control checks for sterility and temperature
Chloride	EPA 300.0 Rev 2.1	0.031mg/L	0.10 mg/L	20 RPD	90-110%	5-point curve
Total Copper	EPA 200.8 Rev 5.4	0.034 µg/L	0.1 µg/L	20 RPD	85-115%	5-point curve
BOD	SM 5210 B	2 mg/L	2 mg/L	NA	84-115%	DO meter calibration
TSS	SM 2540D	0.15 mg/l[a]	0.5 mg/l	25 RPD	75-125%	Standard balance calibration
2,4-D	EPA 515.4	1 µg/L	5 µg/L	30 RPD	70-130%	6-point curve
Carbaryl	EPA 531.2	2 µg/L	10 µg/L	30 RPD	65-135%	6-point curve
Total Organic Carbon	SM 5310B					
SpG	ASTM D854					
Passive Collection Device	EPA 8260/8270		0.02 µg/L	25 RPD	< 10% RSD	5-point external
TPH		0.006 µg/L				
BTEX						
Benzene		0.003 µg/L				
Toluene		0.003 µg/L				
Ethylbenzene		0.007 µg/L				
m-, p-xylene		0.007 µg/L				
o-xylene		0.003 µg/L				
Diesel Range Alkanes						
Undecane		0.003 µg/L				
Tridecane		0.003 µg/L				
Pentadecane		0.003 µg/L				
TMB						
1,3,5-trimethylbenzene		0.007 µg/L				
1,2,4-trimethylebenzene		0.003 µg/L				
PAH						
Naphthalene		0.003 µg/L				
2-methyl naphthalene		0.003 µg/L				
acenaphthene		0.01 µg/L				
acenaphthylene		0.02 µg/L				
fluorene		0.01 µg/L				
phenanthrene		0.02 µg/L				

anthracene		0.02 µg/L				
fluoranthene		0.02 µg/L				
pyrene		0.02 µg/L				
Methyl t-butyl ether		0.021 µg/L				
octane		0.007 µg/L				
Parameter	**Method**	**Sensitivity (MDL)**	**PQL**	**Precision**	**Accuracy**	**Calibration Method**
TAH	EPA 624					
Benzene		0.12 µg/L	0.4 µg/L	20 RPD	80-120%	Internal standard analysis
Toluene		0.31 µg/L	1 µg/L	20 RPD	77-120%	Internal standard analysis
Chlorobenzene		0.15 µg/L	0.5 µg/L	20 RPD	80-120%	Internal standard analysis
Ethylbenzene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
p & m Xylene		0.62 µg/L	2 µg/L	20 RPD	80-120%	Internal standard analysis
o-Xylene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
1,3-Dichlorobenzene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
1,4-Dichlorobenzene		0.15 µg/L	0.5 µg/L	20 RPD	80-120%	Internal standard analysis
1,2-Dichlorobenzene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
TAqH	EPA 625					
Acenaphthylene		0.015 µg/L	0.05 µg/L	30 RPD	58-105%	Internal Standard analysis
Acenaphthene		0.015 µg/L	0.05 µg/L	30 RPD	57-110%	Internal Standard analysis
Fluorene		0.015 µg/L	0.05 µg/L	30 RPD	59-120%	Internal Standard analysis
Phenanthrene		0.015 µg/L	0.05 µg/L	30 RPD	60-115%	Internal Standard analysis
Anthracene		0.015 µg/L	0.05 µg/L	30 RPD	63-120%	Internal Standard analysis
Fluoranthene		0.015 µg/L	0.05 µg/L	30 RPD	63-125%	Internal Standard analysis

Pyrene		0.015 µg/L	0.05 µg/L	30 RPD	62-130%	Internal Standard analysis
Benzo(a)anthracene		0.015 µg/L	0.05 µg/L	30 RPD	61-120%	Internal Standard analysis
Chrysene		0.015 µg/L	0.05 µg/L	30 RPD	71-120%	Internal Standard analysis
Benzo(b) fluoranthene		0.015 µg/L	0.05 µg/L	30 RPD	66-130%	Internal Standard analysis
Benzo(k)fluoranthene		0.015 µg/L	0.05 µg/L	30 RPD	67-120%	Internal Standard analysis
Benzo(a)pyrene		0.015 µg/L	0.05 µg/L	30 RPD	57-120%	Internal Standard analysis
Indeno(1,2,3-cd) pyrene		0.015 µg/L	0.05 µg/L	30 RPD	59-125%	Internal Standard analysis
Dibenzo (a,h) anthracene		0.015 µg/L	0.05 µg/L	30 RPD	56-125%	Internal Standard analysis
Benzo(g,h,i)perylene		0.015 µg/L	0.05 µg/L	30 RPD	60-125%	Internal Standard analysis
Naphthalene		0.031 µg/L	0.1 µg/L	30 RPD	56-108%	Internal Standard analysis

Table 6. Measurement Quality Objectives for Precipitation and Discharge Monitoring Methods

Parameter	Method/Range	Sensitivity	PQL	Precision	Accuracy	Calibration Method
Precipitation	Tipping Bucket Model TB3/Minilog digital data logger 0-700 mm/hr	1 tip	NA	0.2 mm/0.01 in	± 2% for intensities from 25 to 500 mm/hr	Factory calibration
Discharge	V-notch weir with 45, 60, 120 degree notches /0.02-2 cfs	0.01 inch stage height	NA	0.01 in	± 3%	Factory calibration and field calibration at deployment
	Volumetric Method[a]	NA [b]	NA [b]	[b]	[b]	Factory calibration of bucket and stopwatch
	KPSI 720 with Hobo U30 datalogger	0.00001 psi	NA	0.00001 psi	±0.25% at full scale	Factory calibration
	YSI 600 OMS V2	0.001 ft	NA	0.001 ft	± 0.06ft	Factory Calibration

[a] For small flows that can be concentrated into a single calibrated container

[b] Per USGS WSP 2175 because the measurement is taken 3 to 4 times the results are consistent and have no errors

A.7.2 Precision

Precision is the degree of agreement among repeated measurements of the same parameter and gives information about the consistency of methods. It applies to all analytical techniques and field replicates. Precision is expressed in terms of the relative percent difference (RPD) between two measurements (A and B).

For field measurements, precision is assessed by measuring replicate (paired) samples at the same locations as soon as possible to limit temporal variance in sample results. Field and laboratory precision are measured by collecting blind (to the laboratory) duplicate samples. For paired and small data sets, project precision is calculated using the following formula:

$$RPD = \frac{(A - B) \times 100}{(A+B)/2}$$

For larger sets of paired precision data (e.g., overall project precision) or multiple replicate precision data, the following formula is used:

$$RSD = 100^{*} \text{ (standard deviation/mean)}$$

Duplicate samples will be taken a described in Section B.5. Goals for precision are described for each element of the monitoring effort in Tables 3 through 5.

A.7.3 Bias (Accuracy)

Bias/Accuracy is a measure of confidence that describes how close a measurement is to its "true value." Methods to determine and assess accuracy of field and laboratory measurements include: instrument calibrations, various types of QC checks (e.g., sample split measurements, sample spike recoveries, matrix spike duplicates, continuing calibration verification checks, internal standards, field and laboratory blanks, external standards), and performance audit samples. Accuracy is usually assessed using the following formula:

$$\text{Accuracy} = \frac{\text{Measured value}}{\text{True value}} \times 100$$

Accuracy will be estimated by re-analyzing a sample to which a material of known concentration or amount of pollutant has been added, and results will be expressed as percent recovery. Matrix spikes and matrix spike duplicates will be collected for this purpose. Accuracy DQOs are provided in Tables 3 through 5.

A.7.4 Representativeness

Representativeness is the extent to which measurements actually represent the true environmental condition. Representativeness will not be routinely monitored throughout the projects, but is incorporated as data are interpreted. Representativeness is particularly difficult to achieve for stormwater quality as it changes depending on the storm size, phase of the storm, antecedent conditions, land use, and the amount of impermeable surface contributing to the discharge. Routine sampling over multiple seasons as well as flow proportional composite sampling can aid in understanding the variation associated with a particular outfall or subbasin. Sample locations, dates, times, sampling frequency, and environmental conditions will be selected for each of the monitoring plans to provide a framework for evaluating the representativeness of the data and meet the permit requirements.

A.7.5 Comparability

Comparability is the degree to which data can be compared directly to similar studies. Standardized sampling techniques, standard analytical methods, and units of reporting with comparable sensitivity will be used to ensure comparability. The MOA has selected EPA clean water act (CWA) approved field and analytical methods from Standard Methods for the Examination of Water and Wastewater and EPA-approved methods. All field crew members will be trained to follow the standard protocols for each parameter as described in this monitoring plan prior to conducting field work. Where possible, efforts to replicate conditions in previous studies have been made.

A.7.6 Completeness

Completeness is the comparison between the amount of useable data collected and the amount of data identified in the monitoring plan. Completeness is measured as the percentage of total samples collected and analyzed as a whole and for individual parameters and sites as compared to the goals established in the monitoring plan. Completeness will be measured as a percentage of useable samples of the total number of planned samples.

$$\text{Completeness} = \frac{\text{No. planned samples} - \text{No. unacceptable/incomplete samples}}{\text{No. planned samples}} \times 100$$

A completeness goal of 90% is established for hand-held field instruments, illicit discharge screening parameters, and for laboratory analyses. Thus, the lab will achieve 90% acceptable chemical and biological data under the QC conditions described in this QAPP. However, holding time limitations for fecal coliform may have an effect on this completeness goal.

A.8 Training Requirements

A.8.1 Routine Monitoring

Training will be conducted by the Contract Project Manager, Contract QA Officer, Contract Sampling and Analysis Manager,, the MOA QA Officer, and/or the laboratory staff depending on the type of training. The Contract QA Officer will ensure that field crews have or receive training on the following topics:

- General field safety
- Traffic safety
- Boat operation and safety (for pesticide screening field crew)
- Map reading

- Proper recording of data in field log books or data sheets including records of visual observations
- Flow measurements and data logger flow calibration

The Contract QA Officer, the Contract Sampling and Analysis Manager, the laboratory staff, and/or the MOA QA Officer will provide training on the following topics:

- Sampling protocols
- Field quality control samples
- Sample preservation and packaging
- Holding times
- Chain of custody completion and procedures
- Laboratory location

This training will include the pre-field checks for the proper number and types of bottles, proper handling and maintenance of sample bottles, field sample preservation, proper packing, and completion of the chain of custody forms.

As appropriate for the type of monitoring being conducted, field crew members will receive training in the use and calibration of the YSI 556 and Hach 2100P hand-held probes including procedures for calibration and measurement of pH, dissolved oxygen (DO), specific conductance, temperature, and turbidity. Field crews conducting the dry weather screening will have or receive training in monitoring, recording and reporting for data collected with the total phenols, detergents, total copper and total chlorine field test kits.

Trainers will include those people listed above who are senior technical experts with no fewer than 100 hours of field experience performing water quality sampling. To participate in a field crew, staff will be required to score 80% or better on a written exam covering the topics listed above.

A.8.2 Automated Probes Monitoring

Prior to entry into the field, training on both deployment, set up, and disassembly of all automated monitoring equipment and data loggers will be required for all field staff associated with projects requiring these specialized pieces of equipment. Training will be provided in the following areas:

- Tipping bucket rain gages
- Installation and use of pressure transducers
- Installation and use of temporary weirs
- Flow monitoring data loggers
- Automated probes that monitor temperature, specific conductance, pH, DO, temperature, and/or turbidity, such as the YSI 600 OMS V2 or equivalent

Equipment training may be offered by the equipment manufacturer, the rental company, or a senior technical expert who has at least 100 hours of field experience with the specific piece of equipment. Training will include operation and calibration of all hand-held and automated probes, and downloading data collected from these pieces of equipment. To participate in a field crew, staff who will use the equipment in the field will be required to score 80% or better on a written and practical exam covering the topics listed above.

A.9 Documentation and Records

All data gathered in the field will be recorded on-site in waterproof field log books or datasheets at the time of sampling. Each monitoring project will have a separate field log book that will be used throughout the duration of the monitoring project. Field crews will record instrument calibration data in the field log books, as well as other specific observations identified in each of the monitoring plans. Field log books and datasheets will become part of the record maintained by MOA. Recordings from the field instruments (i.e., pH, specific conductance, DO, temperature, and turbidity) and records of field test kit results will be made in the field log books or datasheets, then transferred to the database or spreadsheet for the specific monitoring project. A unique data file name will be assigned to each of the monitoring plans. The QA review process for field data is described in Section B.10, Data Management.

For data gathered via data logger, automated probe, or automated sampler, all data will be saved as raw data files before QA is performed. For each set of data gathered from these instruments, a unique data file name will be created each time the instrument is deployed and will include a root identifier specific to the monitoring plan. In addition to a project identifier that will link field data with automated data, the file name will contain the location and the date of deployment. Upon retrieval of the instrument, the data will be downloaded and saved as an Excel file. The QA review process is described in Section B.10, Data Management, and outlines how all data will be saved in the appropriate format and with the appropriate file names for easy retrieval.

Laboratory results associated with each of the monitoring plans will also be maintained electronically. The laboratory will provide results electronically in a format specified by the MOA. The laboratory data QA review process is described in Section B.10 and outlines how all data will be saved in the appropriate format and with the appropriate file names with a file identifier that links it to the specific monitoring plan for easy retrieval.

MOA will maintain records of all electronic data and field log books for a minimum of five years. Table 7 provides a list of the records and locations of their storage.

Table 7. Project Documents and Records

Category	Record/Document Type	Location
Site Information	Site maps in specific monitoring report	WMS
	Site Photographs in specific monitoring report	WMS
Environmental Data Operations	QAPP	WMS
	Field SOPs – Appended to QAPP	WMS
	Field log books and/or datasheets including sample handling, field observations, and field instrument	WMS

	calibration	
	Chain of custody forms	WMS
	Equipment inspection and maintenance records	WMS
Data Reporting	Monitoring reports	WMS
	Project summary reports	WMS
	Lab analysis reports	Contract Laboratory
Data Management	Data algorithms appended to specific Monitoring reports	WMS
	Water quality data (field and laboratory results) in spreadsheets	WMS
	Flow and automatic field water quality electronic data	WMA
Quality Assurance	Field inspection reports	WMS
	Lab control charts	Contract Laboratory
	Performance evaluation samples	Contract Laboratory
	Lab audits	Contract Laboratory
	Lab QA reports/corrective action reports	Contract Laboratory
	Field equipment and field inspection reports/corrective action reports and response	WMS

B. Data Generation and Acquisition

B.1 Sampling Process Design

The design for each of the monitoring plans including monitoring objectives, sample locations, parameters, sampling frequencies, and site-specific procedures are described in the following appendices:

- Pesticide Screening Plan – Appendix A
- Stormwater Outfall Monitoring Plan – Appendix B
- Structural Controls Effectiveness Monitoring Plan – Appendix C
- Snow Storage Site Retrofit Monitoring Plan – Appendix D
- LID Pilot Project Monitoring Plan – Appendix E
- Dry Weather Screening Plan – Appendix F

B.2 Sampling Methods Requirements

B.2.1 Sample Types

Grab samples or flow-weighted composite samples will be obtained depending on the monitoring plan. Continuous monitoring of some parameters will also be obtained. Sample types are discussed in each of the monitoring plans in the appendices.

B.2.2 Sample Containers and Equipment

All sampling equipment and sample containers will be cleaned according to the equipment specifications and/or the laboratory. Bottles supplied by the contract laboratory for sample analysis will be pre-cleaned. These will only be used for samples and will not be pre-rinsed. Sample equipment will be pre-cleaned and cleaned between sample locations as specified in Appendix G.

Samples collected in the field for laboratory analysis will be collected as described in Section B.2 and the SOPs in Appendix G, labeled as described below, and will be packed into insulated ice chests with either gel ice (freezable gel packs) or crushed ice that is double-bagged in zip-locked plastic bag. Samples will be maintained at temperatures listed in Table 8 (plus or minus $2^{o}C$) until delivered to the laboratory. Temperature in transit will be monitored with a temperature blank provided by the laboratory. A chain of custody form will be completed by the field personnel for each packed ice chest, will be placed in a plastic zip-locked bag, and placed in the ice chest. All samples will be in control of the field crew until they are delivered to the laboratory, at which time the chain of custody form will be signed by the laboratory personnel indicating that they have assumed custodial responsibility. In the event that full sample coolers are removed from the direct control of the sampling team without being transferred to the laboratory, custody seals will be placed on the cooler from lid to base and taped in place with clear packing tape.

For samples that will be analyzed by the laboratory, the bottle requirements, sample volumes, preservatives, and holding times are described in Table 8. Because some of these samples will be obtained in the afternoon or at times that are not normal operating times, special arrangements may need to be made to ensure that the laboratory is still able to process the samples within the specified holding times.

Table 8. Containers, Volumes, Preservation Methods, and Holding Times for Laboratory Analyzed Parameters

Parameter	Matrix	Container Type	Volume Required	Preservation	Holding Time
BOD	Stormwater	HDPE	1 Liter	Cool to $\leq$ 6 ^{o}C, keep in the dark, lab temp receipt must be recorded to 2 significant figures	48 hours
TSS	Stormwater	HDPE	1 Liter	Cool to $\leq$ 4 ^{o}C	7 days
Fecal Coliform	Stormwater	HDPE	125 mL sterile bottle	Cool to < 10 ^{o}C, do not freeze	< 6 hours to lab; < 2 hours from lab receipt to sample prep; Not additive
Total Copper	Stormwater	HDPE	250 mL	HNO_3 to pH< 2	6 months
2,4-D	Surface water	AG	2 - 1 Liter	Sodium sulfite Cool to $\leq$ 6^{o}C, do not freeze	14 days until extraction, 40 days after extraction
Carbaryl	Surface water	AG	2 - 1 Liter	Potassium citrate, monobasic Cool to $\leq$ 4 ^{o}C, do not freeze,	7 days until extraction, 40 days after extraction
Chloride	Stormwater	HDPE	500 mL	NA	28 days
TAH	Stormwater	G, Teflon lined septum	3-40 mL vials, sample filled to meniscus	HCl pH <2, Cool to $\leq$ 6 ^{o}C, do not freeze, (0.0008% $Na_2S_2O_3$)[a]	14 days
TAqH	Stormwater	AG, Teflon-lined cap	2 - 1 Liter	Cool to $\leq$ 6 ^{o}C, (0.0008% $Na_2S_2O_3$)[a], do not freeze, store in dark	7 days until extraction, 40 days after extraction

G= glass; HDPE = high density polyethylene; AG = amber glass.

[a] Sodium thiosulfate required only if sample contains chlorine

B.2.3 Sampling Methods

Sampling methods are described in specific monitoring plan, Appendix G, and Section B.3.

B.3 Sampling Handling and Custody Requirements

B.3.1 Sampling Event Preparation

The Contract Sampling and Analysis Manager is responsible for ensuring the following has been completed prior to a field crew entering the field:

- Written instructions have been prepared and provided to each of the field crew
- Each field crew member has received the appropriate training to enter the field
- Each field crew has necessary field equipment and bottles from the laboratory
- Each field crew member has completed an in-office review of the anticipated conditions and sampling protocols

The field monitoring probes will be calibrated on the day of the sampling event prior to entry into the field or in the field. Calibration procedures will be documented in the field log book, including the expiration dates of the standards and the results from all calibration tests.

B.3.2 Sampling Procedures

Where stormwater grab samples will be collected from low flows for field parameters or laboratory analysis, the field crew will collect samples in accordance with the field sampling protocols described in Appendix G. Field sample crews will collect an adequate volume of sample for all sample bottles, replicates, and field monitoring analyses.

Where samples are to be collected from flow over a temporary or permanent weir or where water is free falling from a pipe, sample bottles will be held under the flow. For samples collected directly in laboratory analysis bottles that contain preservative, field crew should apply care not to overtop the sample bottles.

Where a stream is being sampled, the field crew will face up-stream and obtain a sample by inverting the clean sampling bottle below the water surface, righting the bottle, and drawing the bottle up through the water column. If the water is shallow, the field crew will use a shallower grab to ensure that no sediments are entrained in the sample.

Sample bottles for TAH must not contain any air bubbles. This is accomplished by pouring the sample from the sample collection bottle into the 40 mL bottle until there is a slight convex meniscus at the top of the bottle, placing and tightening the cap, and inverting the bottle to ensure no air bubbles are trapped. Standard Operation Procedures (SOPs) for sampling specific parameters are provided in Appendix G.

Field crew members will assign a unique sample number as described in Section B.3, label the bottles with indelible ink, add any preservative required (unless the laboratory has provided the preservative in the bottle already), prepare the chain of custody form, and pack the bottles as described in Section B.3.

The YSI 556 probe measurements will be collected from flowing water and probe measurements will be recorded in the field log book.

B.3.3 Unique Sample Identification Numbers

In 2011, each sample received a unique 13-digit, alpha-numeric sample number. The sample number included a station location identifier of five alpha-numeric characters, a 2-digit sample number, and a 6-digit date. The time of collection was recorded both on the sample label and in the field log book. For example, a sample collected January 15, 2011 at Lake Otis could have the following identifier: LOT01-01-01-15-11. However, this identification system was confusing for field staff and was not easily usable in the database created to store the information connected with each of these samples.

Starting in 2012, the sample identification will include the site name, a separate line for the date, and another line for the sample time. These three fields combined will create a unique identifier for each sample. For example, A sample taken at C St Up Station for the Sedimentation Basin Study on August 30th, 2012 at 4 pm will be labeled as follows:

Site Name: CSTUP

Date: 8/30/2012

Time: 1600

When field duplicates are collected along with primary samples the word "DUP" will be attached to the end of the site name.

All sample names, dates, times, and duplicate sample information will be filled in on each sample label and logged in the field book or on the associated datasheet.

B.3.4 Sample Labels

Each sample transported to the laboratory will have a label with the following information on it in indelible ink:

- Site Name
- Date sample collected
- Time sample collected (using 24-hour clock)
- Analyses required
- Preservation (if any)
- Initials of the field crew member who collected the sample

Sample Label Example

XXX Laboratory

Field Information:

Sample Name: ________________

Date: __________________________

Time:__________________________

Preservation Method: _____________

Name & Signature of Sample Collector:

____

____

Phone: _________________________

Comments: _____________________

B.3.5 Chain of Custody Forms

Chain of custody (CoC) forms provided by the laboratory will be used for samples submitted to the laboratory for analysis. An example CoC form is provided at the end of Appendix G. The chain of custody form must contain the following information for each sample:

- Unique sample number
- Type of sample (e.g., water)
- Sample location
- Date and time sample collected (time recorded on 24-hour clock)
- Analyses required by analyte name and method number
- Printed name of person collecting sample
- Printed name and signature of person with responsibility for custody of samples until receipt by the laboratory
- Time and date received at laboratory and
- Printed name and signature of laboratory person with responsibility for ensuring custody of samples

The completed chain of custody forms will be scanned and returned to the MOA with the data package.

B.3.6 Field Log Book

In addition to the information itemized in each of the monitoring plans, field crew members will record the following information in the log book at each sampling station:

- Weather conditions, time, date, and location of sample
- Unique sample identification numbers
- Other unusual conditions

Each page of the field log books will be numbered, signed, and dated by the sampling crew member who completed it. Where a page is left partially blank, a note should be made with a line through the clean portion of the page; and each page must be signed and dated.

B.3.7 Automated Multiprobes

The YSI 600 OMS V2 probes will be calibrated and calibration procedures recorded on calibration forms prior to deployment. The probes will be cleaned, recalibrated, redeployed, and documented on calibration forms on a consistent basis to prevent drift (approximately once every three weeks or more frequently if necessary). The calibrated probes will be programmed using a computer to begin sampling and recording at designated intervals of no less than 15 minutes throughout the storm or runoff event. Instruments will be placed in approximately mid-channel both vertically and horizontally in locations of moderate to slow velocity. Where instruments must remain submerged, a special device will be created to ensure continuous submersion.

Multiprobes and data loggers will be protected from vandalism.

A unique file name will be created each time a multiprobe is programmed and deployed with a route identifier unique to the monitoring project. The file name will contain the location and date of deployment. Upon retrieval, the data will be downloaded and saved as an Excel file using the unique file name.

Chain of custody forms will not be used for data obtained from automated data logging probes.

B.3.8 Flow Monitoring

Where flow monitoring is conducted manually, the field crew will accurately measure and record the staff gage level to the nearest 0.01 inch.

When flow will be recorded with data loggers, field crew will calibrate the data logger as described in the SOPs in Appendix G on a routine basis to ensure accuracy and record the calibration on the datalogger maintenance data form. During a storm event when they are obtaining samples, field crew will manually read and record staff gage measurements (and time), and compare the value to those recorded by the data logger, as described in Appendix G.

B.4 Analytical Methods Requirements

Tables 3, 4, and 5 provide the analytical methods, precision and accuracy requirements that apply to all of the Monitoring Plans (Appendices A through F). The contract laboratory will be provided a copy of this QAPP to ensure that they can meet the measurement quality objectives for detectability, precision, accuracy, comparability, and completeness prior to being awarded the contract. Once a laboratory has been selected by the Contract Project Manager, the laboratory Quality Management Plan (QMP) will be appended to this QAPP. QMPs for all local laboratories that have been approved under the Drinking Water Program are maintained on file at ADEC. Once selected, the Contract laboratory will provide their approved QMP to the ADEC Division of Water Quality Assurance Officer, if it has not already been approved.

B.5 Quality Control Requirements

Quality control begins with training the field staff. As described in Section A.8, training will be conducted by the Contract Project Manager, the Contract QA Officer, the Contract Sampling and Analysis Manager, the MOA QA Officer, and/or the laboratory staff depending on the type of training. The Contract QA Officer will ensure that field crews receive appropriate training for those facets of monitoring that they will conduct.

Quality control activities in the field will include adherence to documented SOPs, comprehensive documentation of sample collection information, and field instrument calibration data. A rigidly enforced chain of custody program will ensure sample integrity and identification. The chain of custody will document the handling of each sample from the time the sample was collected until its arrival and acceptance at the laboratory.

Table 9 lists the types of field QC samples that will be collected for samples to be analyzed in the laboratory.

Field replicates provide a way to estimate the variability of individual results. If conditions in the stormwater change faster than the procedure is repeated, the precision calculated from duplicate samples will also include that variability. Both field samples (kits and hand-held probes) and laboratory samples will be replicated at a rate of 15% or one per field day, whichever is greater.

Trip blanks are samples that are prepared in the laboratory and carried into the field to determine whether samples are exposed to contamination in transit from lab to field or field to lab, from sampling handling procedures, or from conditions in the field such as boat or vehicle exhaust.

Equipment rinse analyses (Equipment Blanks) will be conducted for all parameters, except pH and temperature, for each sampling event where a sampling device is used to collect the sample. This type of analysis ensures that sample equipment is clean and uncontaminated. After decontaminating the sampling equipment, deionized water will be poured through the equipment and samples will be collected for analyses.

Matrix spike/matrix spike duplicate samples provide an estimate of laboratory accuracy and precision and will be gathered for the relevant laboratory parameters listed in Table 9.

Table 9. Frequency of QC Samples to be Collected in the Field

Parameter	Field Replicate (15% or 1/day whichever is greater)	Trip Blank (one per day)	Equipment Rinse Blank (1/day or 15% whichever is greater)	MS/MSD (15% or 1/day whichever is greater)

Hand-Held Probes and Field Test Kit Methods				
pH	X			
Conductance	X			
Turbidity	X			
Temperature	X			
Total chlorine	X			
Detergents	X			
Phenols	X			
Laboratory Analyses				
Fecal Coliform	X			
Chloride	X		X	X
Total Copper	X			
BOD	X			
TSS	X			
2,4-D	X		X	X
Carbaryl	X		X	X
TAH	X	X	X	X
TAqH	X		X	X

QC acceptance criteria for trip blanks and equipment rinse blanks are equal the PQLs defined in Table 5. Replicate QC acceptance criteria for field replication and MS/MSDs are defined as precision and accuracy for the parameters in Tables 3 though 5.

Automated water quality instrument readings will be verified against calibrated hand-held probes for water quality parameters on a tri-weekly basis or more frequently if necessary. This level of replication will allow determination of whether or not the automated instruments are accurate, need recalibration, or data should be adjusted for drift.

Discharge measurements using the bucket method will be performed in quadruplicate to assure precision and accuracy. Field discharge monitoring using weirs and data loggers will be checked either on a monthly basis or when sampling, downloading of data, or maintenance is occurring by comparing a visual reading of the staff gage against the data logger. This level of replication for the hydrology (discharge measurements) will allow determination of whether or not the automated instrument is accurate, needs recalibration (by adjusting the reference level), or data should be adjusted for drift. Data loggers that do not meet the accuracy tests prior to deployment will be returned to the manufacturer. Comparison of visual or handheld instrument data sets will be appended to the monitoring report.

Laboratory QC sample frequencies and QC acceptance criteria are described in Tables 10 and 11. The laboratory will provide analytical results after verification and validation by the laboratory QA Officer. The laboratory will provide all relevant QC information with its summary of data results for each analytical batch. The Contract QA Officer will perform a review of the laboratory results to ensure that the required QC measurement criteria have been met. If a QC concern is identified in the review process, the Contract Project Manager and QA Officer will seek additional information from the laboratory to resolve the issue and take appropriate corrective action.

Table 10. Frequency of Laboratory QC Samples

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
Fecal Coliform	SM 9222D	1 per daily batch	NA	NA	NA	1 per daily batch	NA
Chloride	EPA 300.0 Rev 2.1	1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	1 per 10 samples and at end of run	1 MS and 1 duplicate per 10 samples	1 per analytical batch or daily	NA
Total Copper	EPA 200.8 Rev 5.4	1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	1 per 10 samples and at end of run	1 MS per 10 samples	After each calibration curve	NA
BOD	SM 5210 B	3 per batch of ≤ 20 samples	3 per batch of ≤ 20 samples	NA	NA	NA	NA
TSS	SM 2540D	1 per batch of ≤ 20 samples	NA	NA	1 duplicate per 10 samples	1 per batch of ≤ 20 samples	NA
2,4-D	EPA 515.4	1 per batch of ≤ 20 samples	NA	Beginning of each batch, after every 10 samples, and at end of batch	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard
Carbaryl	EPA 531.2	1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	Beginning of each batch, after every 10 samples, and at end of batch	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard
TAH	EPA 624						
Benzene Toluene Chlorobenzene Ethylbenzene m,p-Xylene		1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	Beginning of each 12-hour tune period	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
o-Xylene							
1,3-Dichlorobenzene							
1,4-Dichlorobenzene							
1,2-Dichlorobenzene							
TAqH	EPA 625						
Acenaphthylene		1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	Beginning of each 12-hour tune period	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard
Acenaphthene							
Fluorene							
Phenanthrene							
Anthracene							
Fluoranthene							
Pyrene							
Benzo(a)anthracene							
Chrysene							
Benzo(b)fluoranthene							
Benzo(k)fluoranthene							
Benzo(a)pyrene							
Indeno(1,2,3-cd) pyrene							
Dibenzo (a,h) anthracene							
Benzo(g,h,i)perylene							
Naphthalene							

Table 11. Laboratory QC Samples Acceptance Criteria

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
Fecal Coliform	SM 9222D	No growth	NA	NA	NA	Growth present	NA
Chloride	EPA 300.0 Rev 2.1	<PQL	±10%	±10%	MS = ±10% Dup. = RPD ≤ 20 or absolute difference < LOQ	±10%	NA
Total Copper	EPA 200.8 Rev 5.4	< PQL	±15%	±15%	70 – 130% if analyte concentrations are < 4 times the spike	±10%	NA
BOD	SM 5210 B	Maximum depletion of ± 0.2 mg/L	TV = 198 ± 30.5 mg/L	NA	NA	NA	NA
TSS	SM 2540D	< PQL	NA	NA	Duplicate RPD ≤ 25	75 – 125%	NA
2,4-D	EPA 515.4	< PQL	NA	70 – 130%	70 – 130%, RPD ≤ 30	70 – 130%	70 – 130%
Carbaryl	EPA 531.2	< PQL	70 – 130%	70 – 130%	70 – 130%, RPD ≤ 20	70 – 130%	70 – 130%
TAH	EPA 624						
Benzene		< PQL	80 – 120	% Difference ≤ 20%	80 – 120	80 – 120%	
Toluene			77 – 120		77 – 120		
Chlorobenzene			80 – 120		80 – 120		
Ethylbenzene			80 – 120		80 – 120		
m,p-Xylene			80 – 120		80 – 120		
o-Xylene			80 – 120		80 – 120		
1,3-Dichlorobenzene			80 – 120		80 – 120		
1,4-Dichlorobenzene			80 – 120		80 – 120		
1,2-Dichlorobenzene			80 - 120		80 - 120		
1,2-Dichloroethane-d_4 (surr.)		NA	73 - 120		73 - 120		73 - 120
Toluene-d_8 (surr.)		NA	80 - 120		80 - 120		80 - 120
4-Bromofluorobenzene (surr.)		NA	76 – 120		76 – 120		76 – 120

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
TAqH	EPA 625						
Acenaphthylene		< PQL	53 - 105	% Difference ≤ 20%	53 - 105	70 – 130%	
Acenaphthene			53 – 110		53 – 110		
Fluorene			56 - 110		56 - 110		
Phenanthrene			58 - 115		58 - 115		
Anthracene			59 - 110		59 - 110		
Fluoranthene			59 - 115		59 - 115		
Pyrene			62 - 128		62 - 128		
Benzo(a)anthracene			64 - 110		64 - 110		
Chrysene			63 – 110		63 – 110		
Benzo(b) fluoranthene			57 - 120		57 - 120		
Benzo(k)fluoranthene			58 - 124		58 - 124		
Benzo(a)pyrene			58 – 110		58 – 110		
Indeno(1,2,3-cd) pyrene			51 – 125		51 – 125		
Dibenzo (a,h) anthracene			53 - 125		53 - 125		
Benzo(g,h,i)perylene			48 - 123		48 - 123		
Naphthalene			45 - 100		45 - 100		
2-Fluorophenol (surr.)		NA	21 – 88		21 – 88		21 – 88
Phenol-d_6 (surr.)		NA	28 – 97		28 – 97		28 – 97
Nitrobenzene-d_5 (surr.)		NA	41 – 110		41 – 110		41 – 110
2-Fluorobiphenyl (surr.)		NA	50 – 110		50 – 110		50 – 110
2,4,6-Tribromophenol (surr.)		NA	45 – 124		45 – 124		45 – 124
Terphenyl-d_{14}		NA	52 - 135		52 - 135		52 - 135

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

The training described in Section A.8 includes expectations for proper field equipment handling and the inspection of field test kits, hand-held monitoring equipment, sampling equipment, and laboratory bottles prior to entering the field.

All equipment and field test kits are checked upon receipt from the manufacture by the Contract Sampling and Analysis Manager to ensure that equipment is properly operating and the kits are complete. Before a sampling event, the field crew will inspect all kits for completeness. Equipment that is not operating properly or cannot be calibrated will not be used in the field. Field equipment and test kits will also be inspected when the field crew returns from the field by the Contract Sampling and Analysis Manager.

Automated probes will be inspected prior to their deployment into the field. Instruments that fail to calibrate appropriately or fail to function (i.e., automatic samplers) will be sent to the manufacturer for repair. Data logged from the automatic instruments will be graphed when they are returned from the field or in the field if possible to detect erratic measurements. All instrument maintenance, testing, and storage will follow the manufacturer's recommendations.

B.7 Instrument Calibration and Frequency Procedures

Instrument calibration will follow the manufacturer's recommendation.

Hand-held water quality monitoring instruments will be calibrated daily before use. Tables 3 through 5 list the calibration standards for each type of hand-held and automated device. Calibration procedures for the YSI 556 and the Hach 2100P are provided in Appendix H. Water temperatures will be calibrated against a NIST-certified thermometer accurate to $0.01^{o}C$. Calibration checks for water temperature will be conducted at $0^{o}C$ and $20^{o}C$. A record of equipment calibration and calibration standards will be maintained in the field log books, which will be maintained for 5 years.

When MOA has purchased the automated water quality multiprobes (e.g., YSI 600 OMS V-2 or equivalent) the manufacturer's instrument calibration instructions will be added to Appendix H. When the YSI 600 OMS V-2 is deployed, the water quality parameters it records will be checked against a hand-held YSI 556 and/or Hach 2100P turbidimeter on a tri-weekly basis or more frequently if necessary as described in Section B.5.

For those projects where precipitation will be recorded, a tipping bucket rain gage and data logger that records in 0.01 inch increments will be used. These instruments are calibrated by the manufacturer prior to field deployment and require no additional calibration.

Weirs and installed staff gages will be calibrated at installation. The field crew will check calibration prior to a predicted storm event, during event grab sampling, and following the event.

B.8 Inspection and Acceptance Requirements for Supplies

Monitoring supplies such as sample bottles, preservatives, sample labels, ice, coolers, and chain of custody forms will be provided by the contract laboratory. Calibration solutions and deionized water, and other supplies will be maintained at the field office. The Contract Sampling and Analysis Manager is responsible for ordering supplies and equipment and ensuring adequate supplies are available for use at the time of sampling. It is also the responsibility of the Contract Sampling and Analysis Manager to ensure that the calibration chemicals and supplies have not past their expiration date.

Automated multiprobes and data loggers will be checked for proper operation upon receipt from the manufacturer and prior to each deployment. Multiprobes will be calibrated prior to deployment. It is the responsibility of the Contract Sampling and Analysis Manager to ensure that the calibration chemicals and supplies are not expired. All equipment will be inspected upon retrieval from the sites. Any problems or concerns resulting from inspections will be documented and brought to the attention of the Contract Project Manager, and if necessary, to the MOA Project Manager.

B.9 Data Acquisition Requirements for Non-Direct Measurements

Weather data such as antecedent precipitation is readily available and can be downloaded from the National Oceanic and Atmospheric Administration web site (http:://www.ncdc.noaa.gov/oa/ncdc.html) for a small fee. These data are assumed to be accurate and usable.

B.10 Data Management

Data review and management are also part of the QC process. The description below identifies three levels of QC review, and the data review process is depicted in Figure 3.

As previously discussed, field log books and/or data sheets will be used to record instrument calibration data, locations of the sampling station, date and time of sample collection, recorded measurements, deviations from the sampling protocols, and observations as described in each of the monitoring plans. Field staff will document records in waterproof ink or pencil. At the end of each day's sampling event, the field log books will be reviewed and initialed by the Field Staff Lead for the project. Corrections will be made by drawing a single line through the corrected entry and will be initialed and dated.

Proper data management is necessary to effectively collect, display, and evaluate data. Data from filed log books and continuously recorded data will be compiled to produce discharge and water quality data. Field data (both manual and electronic) will be stored with spatial coordinates in a database that interfaces with GIS for management, storage, and analysis. Manual data refer to data that are recorded in the field log books. Electronic data include pressure transducer records, discharge meter measurements, GPS files, continuously recording YSI meters, and tipping bucket rain gages. Data management includes processes that range from pre-field activities through compilation and export of data; it includes the following activities:

- Database file creation and organization
- Electronic scanning and organization of field log books
- Uploading raw manual field data into the project database
- Uploading, adjusting, and organizing flow and continuously recording water quality data

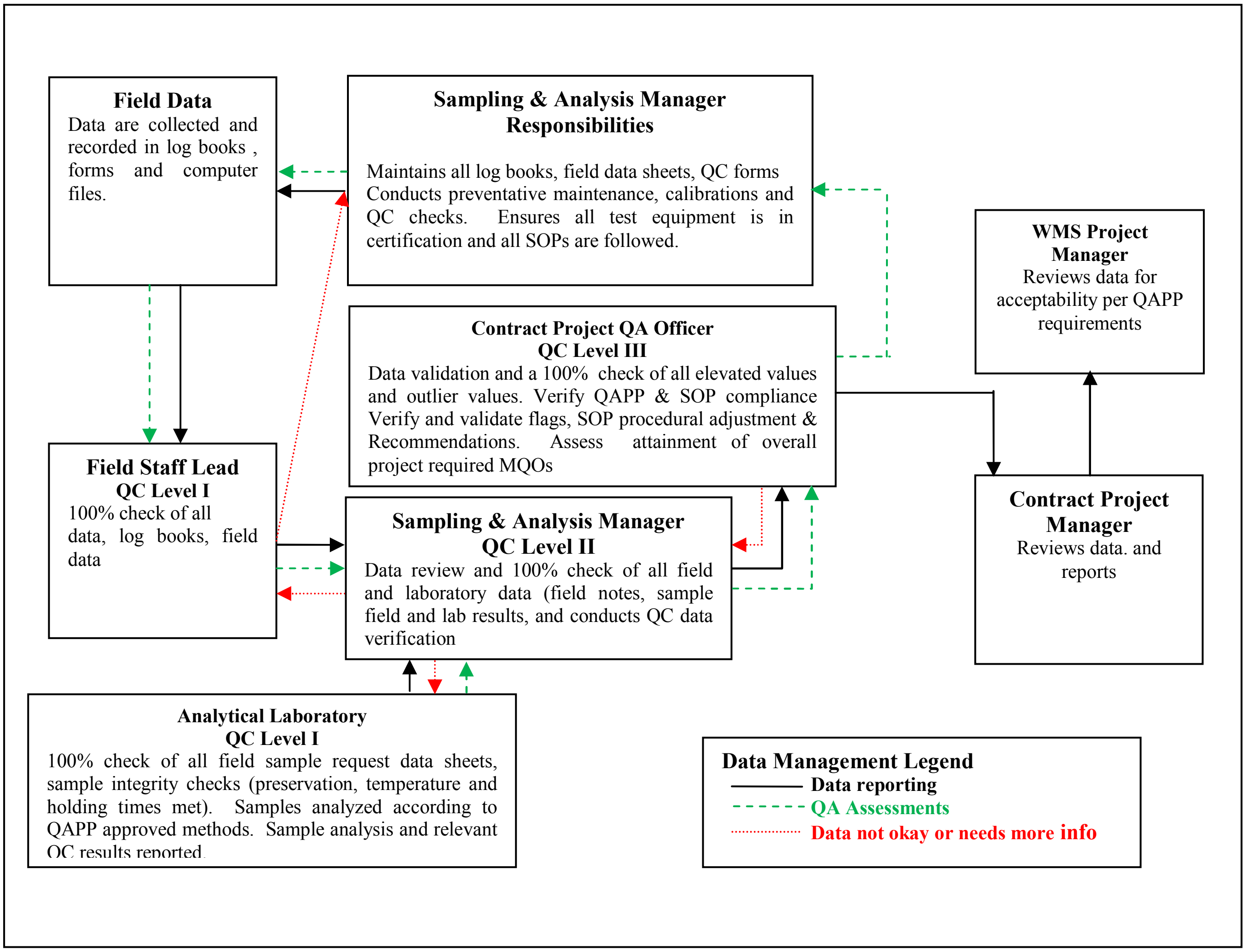
- Compiling and organizing GIS data
- Compiling surveyed gage elevations
- Periodic data exportation to WMS

The QC program for each monitoring project's field data is designed to meet the data quality objectives at three levels. A QC Level I review includes a daily review of field log books to assure data integrity and completeness. This will be conducted by the Field Staff Lead, who will initial the logbooks at the end of each field day to document that QC Level I has been completed. Data transfers of electronically collected data (e.g., stream gage, YSI continuously recording meters, and GPS data) will also be reviewed and documented using a datalogger download form (Appendix H) to ensure data integrity and completeness. Data are typically transferred to the database in the office, and 100% of these data will be reviewed weekly.

Once the data are stored in the database, the Contract Sampling and Analysis Manager will conduct a QC Level II review to check for data entry errors. Corrections for data entry errors are implemented as warranted. For spatial data, QC Level II review confirms that the data set was downloaded and projected properly and that the spatial locations are plotted correctly. For water quality data, the QC Level II is performed after uploading the laboratory-validated files. Data downloaded from data loggers will be imported into Excel files.

For all data types, the Contractor QA Officer, or her/his designee, conducts a QC Level III review using queries and professional judgment to find identifiable errors, outliers, missing data, and data that do not meet the MQOs. Suspect data are investigated further and, if technically appropriate, they are corrected or flagged. Data will also be reviewed for indications of water quality concerns such as erratic or unexpectedly high or low results based on professional judgment. All data files will be backed up on the MOA server, and data will be stored for no less than 5 years

Figure 3. Data Flow and QC Responsibilities



C. Assessment and Oversight

C.1 Assessment/Oversight

As described in Section B.10, once data are reviewed by the Contract QA Officer data are submitted to the database. If problems are discovered with data quality or management, it is the responsibility of the Contract QA Officer to address them in a timely manner.

Procedures for inspection, acceptance, calibration and maintenance of equipment and supplies are described in detail in Sections B.6, B.7, and B.8. If problems with data quality are traceable to equipment failure, inspection, calibration and maintenance will be scheduled more frequently.

The Contract QA Officer or the Sampling and Analysis Manager will spot check field crews at 10% of the sampling locations/events to observe sample collection. If sampling technique problems are observed, corrective action will be taken immediately to resolve the problem. Observations of problems and corrective actions will be included in a corrective action report (reporting errors observed and actions taken to correct the errors). The Contract QA Officer will submit corrective action reports to the MOA Project Manager/QA Officer within two business days of the identification of the need for corrective action. Corrective action reports will also be appended to each of the monitoring reports, as appropriate. Data quality assessment for completeness, bias, and precision will be included in each of the monitoring reports submitted to ADEC.

The contractor laboratory selected for the analyses will be certified in the DMRQA program for water/wastewater annually, the Contractor laboratory will participate in the DMRQA for water/wastewater samples from a 3rd party certified vendor.

C.2 Revisions to QAPP

The MOA Project Manager and Contract Project Manager will review this QAPP and overall design of the monitoring plans annually and may suggest procedural refinements or additional testing procedures. This may include changes to procedures in use or new parameters to be measured. Minor revisions such as identified project staff, QAPP distribution list, and minor editorial changes, will be made without formal review by ADEC. Other changes will be subject to ADEC review and approval.

C.3 QA Reports to Management

Table 12 provides the QA assessment reports, frequencies, and responsible individuals.

Table 12. QA Reports to Management

QA Report	Description	Presentation Method	Report Issued by	Report As Needed
Field Inspection Report	Description of field inspection results, audit methods, standards/equipment used, and any recommendations	Written text/tables	Contract QA Officer	Each field audit/inspection
Corrective Action Recommendation	Description of problem(s), recommended action(s) required, time frame for feedback on resolution of problem(s)	Written text/table	QA Officer/auditor	As required
Response to Corrective Action Report	Description of problem(s), description/date corrective action(s) implemented and/or scheduled to be implemented	Written text/table	Project Manager overseeing sampling and analysis	As required
3rd Party PT Sample (DMRQA, etc.) Audit Report	Description of audit results, methods of analysis, and any recommendations	Written text and charts, graphs displaying results	3rd Party PT provider report issued to: • Lab QA Officer/Manager • Project QA Officer • ADEC DOW Compliance • ADEC DOW QA Officer Note: responsibility of lab to self-enroll and ensure reports are issued to ADEC	Annually and as required by APDES permit
Data Validation	Data validation in comparison to MQOs	Data spreadsheet with data qualifiers; written text (as needed)	Contract QA Officer provides to Project QA Officer for review	With completion of each monitoring project or season
QA Report to Management	Summary assessment of whether QC measures are effectively meeting DQOs and corrective actions taken	Written text/tables	Contract QA Officer provides to Project QA Officer for review, ADEC Project Manager and ADEC Water QA Officer receive with NPDES annual report	Annually

D. Data Validation and Usability

D.1 Data Review, Verification, and Validation Requirements

The purpose of this section is to state the criteria used to review and validate—that is, accept, reject or qualify data in an objective and consistent manner. It is a way to decide the degree to which each data item has met its quality specifications as described in B above.

Data Validation means determining if data satisfy QAPP-defined user requirements; that is, that the data refer back to the overall data quality objectives. Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set to ensure that the reported data values meet the quality goals of the environmental data operations (method specific data validation criteria).

Data Verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. The primary goal of verification is to document that applicable method, procedural, and contractual requirements were met in field sampling and laboratory analysis. Verification checks to see if the data were complete, if sampling and analysis matched QAPP requirements, and if SOPs were followed.

Data review is the process that evaluates the overall data package to ensure procedures were followed and that reported data is reasonable and consistent with associated QA/QC results.

The Contract QA Officer will be assigned to conduct data review and validation as described in Sections B.10 and A.7. In addition, the MOA Project Manager/QA Officer will conduct data review following validation. Data that are obtained using equipment that has been stored and calibrated correctly and that meets the precision and accuracy data quality objectives will be used. Data that do not meet these objectives will be flagged.

D.2 Validation and Verification Methods

As described in Section B.10, the data verification and validation process includes three levels of QC with responsibilities for QC Level I identified for both field staff lead and analytical laboratory reviews; QC Level II is the responsibility of the Contract Sampling and Analysis Manager. The Contract Sampling and Analysis Manger will correct errors in data entry and will flag inconsistencies for further review. The Contract QA Officer will review data and flag any values that are outside of the MQOs range for each parameter. QC Level III review, including final data validation and verification will be conducted by the Contract QA Officer. . The MOA Project Manager/QA Officer will review the validated data after entry into the database/spreadsheet.

The summary of all laboratory analytical results will be reported to the Contract Sampling and Analysis Manager. Data validation will be performed by the laboratory for all analyses prior to the release of data. All laboratory data will be validated according to the laboratory's QAP and SOPs and as specified in the Monitoring Project's QAPP. Lab reports will include the results of all QC data and their acceptance/rejection criteria used to validate/invalidate sample report data. The rationale for any anomalies in the QA/QC of the laboratory data will be provided to the Contract Sampling and Analysis Manager with the data results. Completed Chain-of-Custody or Transmission forms (if required) will be sent back from the laboratory to the Contract Project Manager.

The laboratory will calculate and report the Relative Percent Difference (RPD) and percent analyte recovery of analytical duplicate samples and MS/MSD samples. RPDs greater than the project requirements will be noted. The Contract Project Manager, and the Contract QA Officer, will decide if any QA/QC corrective action will be taken if the precision, accuracy (bias), and data completeness values exceed the project's MQO goals.

D.3.1 Practical Quantitation Limits

The practical quantitation limits (PQLs) are the lowest concentration that can be reliably achieved within specified limits of precision and accuracy for field and lab measurement methods. Estimated PQLs should be equal to or below the RL but above the MDL and are provided in Table 5 in Section A.7.

The Contract QA Officer or his/her designee will calculate the RPD between field replicate samples.

The Contract QA Officer will also be responsible for reviewing the maintenance and calibration records show all monitoring equipment in use to be in compliance with this QAPP (Sections B.6, B.7, and B.8). If data quality questions cannot be adequately resolved, data will not be entered into the database without being flagged as questionable. The Contract QA Officer will arrange for corrective measures (e.g., re-training, equipment recalibration).

D.3 Reconciliation with Data Quality Objectives

The Contract QA Officer will compare the results and associated variability, precision, accuracy and completeness with project objectives. If data quality indicators do not meet the program specifications established in Tables 3 through 5, data will not be entered into the database system, unless flagged. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration, and maintenance procedures will be reassessed and improved. In some cases, accuracy MQOs may be modified; when this occurs, strong rational justification for modification, problems associated with collecting and analyzing data, and potential solutions will be reported.

If failure to meet program specifications is found to be unrelated to equipment methods or crew error, specifications may be revised. Revisions to this QAPP will be submitted to ADEC for approval.

Appendix A

Pesticide Screening Plan

Table of Contents

A. Pesticide Screening Plan

1.0 Introduction

1.1 Background

The Municipality of Anchorage (MOA) is not an agricultural area and has predominantly urban use of pesticides within the municipality. Past pesticide screening required by the National Pollutant Discharges Elimination System (NPDES) permit issued in 1999 for discharge from the municipal separate storm sewer system (MS4) has not indicated detectable levels of pesticides in the MOA waterbodies. The permit is now administered under the Alaska Pollutant Discharge Elimination System (APDES).

The term pesticide is defined by the State of Alaska to be "a chemical or biological agent intended to prevent destroy, repel, or mitigate plan or animal life, and any substance intended for use as a plant regulatory, defoliant, or dessicant, including insecticides, fungicides, rodenticides, herbicides, nematocides, and biocides." For purposes of the stormwater program, the term pesticide includes herbicides, insecticides and fungicides (MOA, 2000).

The pesticides used in the Anchorage area include broadcast pesticides such as insecticides and aphid spray applied by homeowners and localized pesticides (those pesticides applied along roads and trails most often by agencies). The MOA conducted a pesticide use survey (MOA, Watershed Management Services 1999) and found seven pesticides were used most prevalently. Two of the most prevalent pesticides were selected for screening (MOA, 2000). These two pesticides were Sevin FL (Carbaryl), which is used in the summer for aphid and spruce beetle control, and 2,4-D, a broadcast herbicide used by homeowners for lawn care and aquatic vegetation control.

The pesticide screening program was originally designed to collect screening data within areas that are most likely to accumulate pesticides. The U.S. Environmental Protection Agency (EPA) and the Alaska Department of Environmental Conservation (ADEC) suggested that sampling the water column of closed-basin lakes (lakes without defined surface water outlets) would meet the criteria. Three closed-basin lakes were sampled in years two and four (2000 and 2002) in compliance with the 1999 MS4 permit.

The MOA obtained grab samples from the water column at least 10 meters offshore of each lake during years two and four of the permit. Samples were obtained and analyzed for 2,4-D and Carbaryl. The monitoring revealed no detection of pesticides in the three lakes that were sampled.

1.2 Problem Definition

Pesticides are used for a variety of reasons in the Anchorage area such as home application for lawn care, golf course maintenance, and industrial applications within utility corridors. The MOA also uses pesticides for maintenance of street landscapes, right-of-ways, and fields.

Pesticides are applied most commonly in the MOA area during the spring and summer months, which coincides with the heaviest rainfall period (July through September). The practice can potentially cause applied pesticides to be washed into local waterways in runoff. Since degradation of some pesticides is slow, concentrations can accumulate in waterbodies even from the legal application of these chemicals.

Under the 2009 APDES permit, MOA must continue pesticide screening in the same three closed-basin lakes monitored under the previous permit: Lake Otis, Hideaway Lake, and Little Campbell Lake.

1.3 Goals and Objectives

The goal of this monitoring plan is to determine whether pesticides commonly used in the Anchorage area are present in the three closed-basin lakes specified above. The objective of this pesticide screening program is to sample the water columns of the three lakes for 2,4-D and Carbaryl, the two most commonly used pesticides in the Anchorage area.

2.0 Description of Program and Rationale

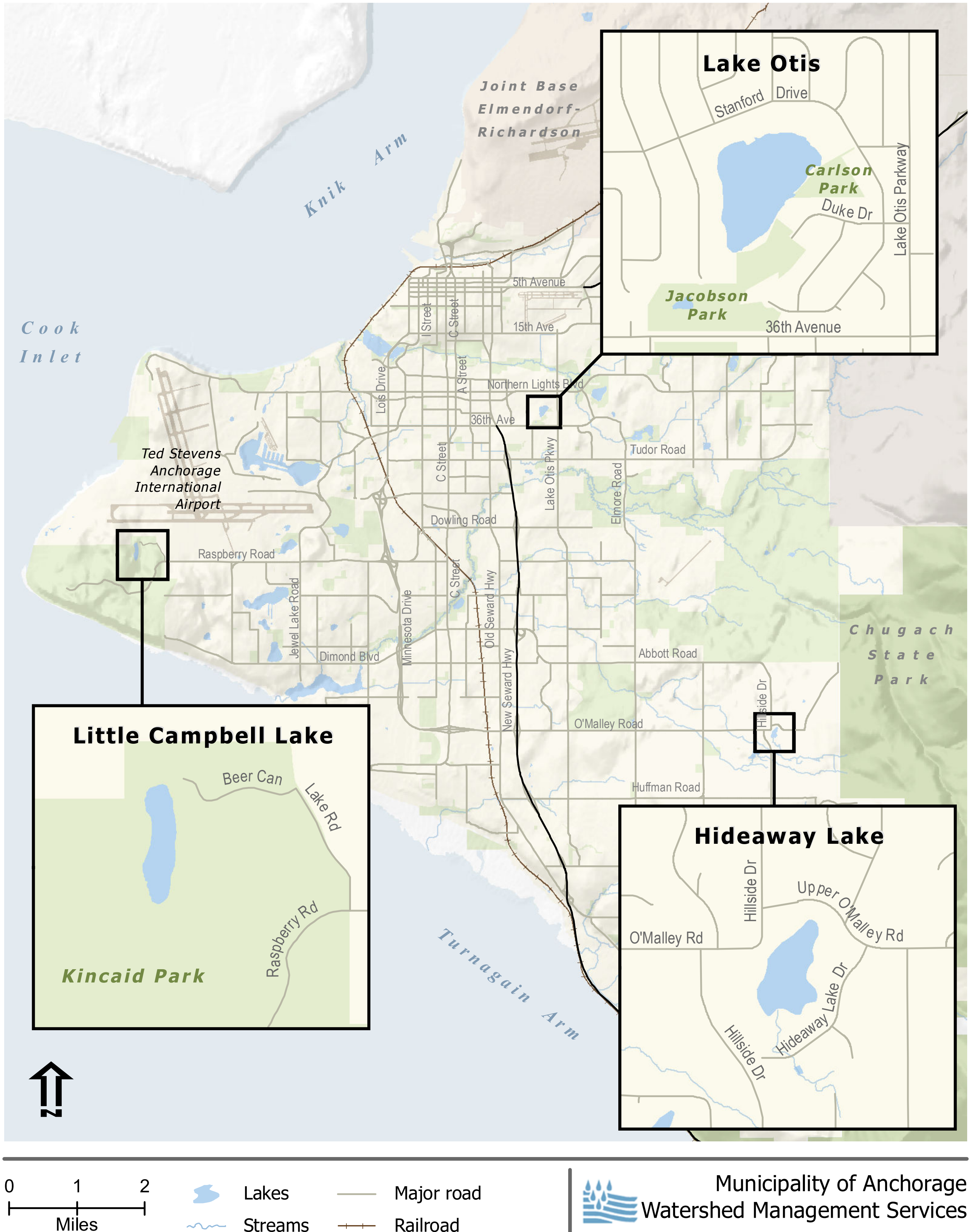
2.1 Sampling Design

MOA will sample for 2,4-D and Carbaryl in each of the three lakes as representative pesticides. Three sample locations (Lake Otis, Hideaway Lake, and Little Campbell Lake) are depicted on Figure A-1. During years two and four (2011 and 2013) of the permit, sampling will be conducted during mid to late summer, as required in the APDES permit

The 2009 APDES permit specifies that pesticides are to be screened using a field immunoassay kit and any positive readings will be verified by a laboratory sample. However, immunoassay kits are no longer available for carbaryl. The cost of immunoassay screening for 2,4-D plus laboratory analysis for carbaryl is substantially greater than laboratory analysis for the two chemicals. Further, laboratory analyses provide higher level of resolution in detecting the presence of pesticides. Thus, MOA will submit samples for laboratory analysis for these two chemicals.

2.2 Schedule of Sampling

The MOA will conduct pesticide screening one time at each of the three lakes in 2011 and one time in 2013 in accordance with the APDES permit. Each sampling event will be conducted during mid to late summer. Ideally, sampling should occur following a rain event that follows a period of at least 48 hours of dry weather. Under these circumstances, pesticides that have been applied during dry weather would be most likely to wash off.



Date: January 18, 2011
Source data: HDR, MOA.
Projection: AK State Plane
Zone 4, NAD 83 ft.
File: Fig A1_vicinity_map.mxd
Author: HDR Alaska, Inc.

Municipality of Anchorage
Watershed Management Services

Pesticide Screening Plan

FIGURE A-1
SAMPLING LOCATIONS

3.0 Monitoring Locations

MOA will sample water from approximately the deepest portions of Lake Otis, Hideaway Lake, and Little Campbell Lake, at least 10 meters from the shore. The locations coincide with those sampled under the previous permit and provide a sample representative of the overall water quality of the lake. Specific sample locations are shown in Figures A-2, A-3 and A-4 and GPS coordinates are provided on the figures and in Table A-1. (Note: The GPS coordinates obtained from the 2000 sampling effort were digitized and found to not coincide with the lakes that were to be sampled. Therefore, new approximate coordinates were obtained using GIS and creating points that mimic the locations from the 2000 sampling maps).

Table A-1. GPS Coordinates of Sampling Locations

Site	Latitude (Degrees, mins, sec)	Longitude (Degrees, mins, sec)
Lake Otis	61° 11’28.91”	-149° 50’40.20”
Hideaway Lake	61° 07’23.24”	-149°44’33.90”
Little Campbell Lake	61° 09’45.51”	-150° 01’28.25”

Date: September 1, 2010
Source data: HDR, MOA.
Projection: AK State Plane
Zone 4, NAD 83 ft.
File: Fig A2_Lake Otis.mxd
Author: HDR Alaska, Inc.

Municipality of Anchorage
Watershed Management Services

Pesticide Screening Plan

FIGURE A-2
SAMPLING LOCATION: LAKE OTIS

0 200 400
Feet

Sample Location

Streams

Date: September 1, 2010
Source data: HDR, MOA.
Projection: AK State Plane
Zone 4, NAD 83 ft.
File: Fig A3_Hideaway Lake.mxd
Author: HDR Alaska, Inc.

Municipality of Anchorage
Watershed Management Services

Pesticide Screening Plan

FIGURE A-3
SAMPLING LOCATION:
HIDEAWAY LAKE

0 250 500
Feet

Sample Location

Park

Airport property boundary

Date: September 1, 2010
Source data: HDR, MOA.
Projection: AK State Plane
Zone 4, NAD 83 ft.
File: Fig A4_Little Campbell Lake.mxd
Author: HDR Alaska, Inc.

Municipality of Anchorage
Watershed Management Services

Pesticide Screening Plan

FIGURE A-4
SAMPLING LOCATION:
LITTLE CAMPBELL LAKE

4.0 Parameters to be Measured and Methods

Table A-2 lists the parameters and methods that MOA will use for analysis.

Table A-2. Parameters to be Measured for Pesticide Screening

Parameters	Method	Range
Temperature (°C)	SM 2550 B YSI 556 hand-held probe	-5° – 45° C
pH	EPA 150.2 YSI 556 hand-held probe	0 - 14 STD
2,4-D	EPA 515.4	NA
Carbaryl	EPA 531.2	NA

5.0 Sampling Methods

5.1 Site-Specific Sample Methods, Handling, and Field QC

One two-person team will conduct the field sampling when weather allows for safe boating conditions.

Samples will be collected from a boat or float tube at a location at least 10 meters from the shoreline and at approximately the deepest portion of each lake (using the approximate GPS locations from the previous study). The field crew will record the weather conditions, including ambient temperature, and the GPS coordinates of the sampling location. The crew will collect a single water column sample from 1 to 2 meters below the water surface using a plastic Niskin bottle sampler. Water column temperature and pH will be recorded in the field notebook. Sample bottles will be filled for the pesticides analyses.

The Niskin sampler will be cleaned and decontaminated between each use. Decontamination procedures are described in Appendix G.

5.2 Sample Preservation and Packing

The pesticide samples will be collected, preserved, and packed for shipment to the laboratory as described in the Quality Assurance Project Plan (QAPP).

5.2.1 Chain of Custody

Use and completion of the chain of custody forms is provided in Appendix G of the QAPP.

5.3 Field Instrument Calibration

Instrument calibration is addressed in Appendix H of the QAPP. Each field instrument will be calibrated daily according to the manufacturer's directions provided with the instrument.

6.0 Training

Each field crew member will learn and demonstrate his/her ability to safely operate the boat; properly perform all field tests, calibrations, and sampling procedures; and accurately report the information prior to conducting sampling.

7.0 Report

MOA will prepare a brief report following each sampling event that will be appended to the annual APDES report. The report will include a description of the sampling event, field and laboratory results, a discussion of the results, and any recommended changes to the protocols for future sampling events.

8.0 References

MOA. 2000. Draft Pesticide Sampling Anchorage Alaska, Data Report. Prepared by CH2M Hill, Inc. Prepared for Watershed Management Section, Municipality of Anchorage. December 2000. Publication No. WMP APR00006.

MOA. 1999. Pesticide Screening at Anchorage Alaska, Conceptual Design. Prepared by CH2M Hill, Inc. Prepared for Watershed Management Section, Municipality of Anchorage. December 1999. Publication No. W MP App 99003.

Appendix B
Stormwater Outfall Monitoring Plan

Table of Contents

B. Stormwater Outfall Monitoring Plan

1.0 Introduction

1.1 Background

The U.S. Environmental Protection Agency (EPA) issued the Municipality of Anchorage (MOA) and the Alaska Department of Transportation and Public Facilities (ADOT&PF) a Municipal Separate Storm Sewer System (MS4) permit under the National Pollutant Discharge Elimination System (NPDES) in 1999. EPA re-issued the permit in October 2009 with a requirement to conduct stormwater outfall monitoring at 10 priority stormwater outfalls beginning in the second year of the permit. The permit identifies a number of objectives for monitoring. The objective most relevant to stormwater outfall monitoring is to broadly identifying fecal coliform and petroleum product loading from stormwater. To accomplish this objective, a variety of land uses must be included to ensure representative water quality conditions across the MS4. (The permit is now administered under the Alaska Pollutant Discharge Elimination System (APDES)).

1.2 Problem Definition

Stormwater outfall monitoring is conducted to characterize the water quality of stormwater that is discharged to waters of the United States (in this case, streams, creeks, and rivers). Storm drains that discharge to the MS4 can introduce pollutants from runoff from commercial and industrial facilities, residential areas, and even parks. This monitoring plan is designed to characterize the quality of the stormwater, with respect to specific pollutants discharged to the MS4 pursuant to the APDES permit requirements.

1.3 Goals and Objectives

The goal of the MOA's stormwater monitoring is to obtain sufficient data to characterize the quality of the stormwater runoff for pollutants identified in the permit. By monitoring the same outfalls over the four-year period, the results should provide a qualitative characterization to meet the objectives identified in the NPDES Permit Fact Sheet (EPA, 2009).

The stormwater outfall monitoring program will measure pollutants and pollutant indicators during precipitation events that generate runoff at 10 high priority stormwater outfall sites. The monitoring program will allow MOA to meet the EPA objectives. In preparing the permit, EPA anticipated that the stormwater outfall monitoring would address the following objectives:

- Broadly estimate the annual pollutant loading for fecal coliform and petroleum hydrocarbon to specific watersheds
- Assess the effectiveness of existing stormwater controls
- Prioritize portions of the MS4 that need additional controls
- Provide feedback on whether TMDL objectives are being met.

2.0 Description of Program and Rationale

2.1 Sampling Design

Each year, beginning in the spring of 2011, the 10 priority outfalls will be sampled four times when there is sufficient precipitation to generate runoff. Samples will be analyzed for pollutants that serve as indicators of illicit discharges. At each outfall the following parameters will be monitored to evaluate the quality of the stormwater: flow, dissolved oxygen (DO), pH, temperature, turbidity, 5-day biochemical oxygen demand (BOD_5), fecal coliform, and total suspended solids (TSS). For outfalls whose tributary land uses are predominantly commercial, industrial, or paved collector or arterial streets or parking lots, samples will also be analyzed for total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH).

2.2 Outfall Selection Methodology and Rationale

The stormwater outfall monitoring prescribed in the permit requires the MOA to monitor specific water quality parameters and flow four times each year at 10 locations. To best meet the permit objectives as described in Section 1.3, the outfalls selected should represent a diversity of land uses.

The MOA must identify these 10 locations as the highest priority locations from a list of 30 medium to high priority outfalls. Stormwater outfall monitoring will begin in the spring of 2011 during the wet season. Precipitation events that are likely to generate runoff may be as low as 0.1 to 0.25 inches per 24 hours, depending on the amount of impervious surface within a subbasin.

The MOA developed a selection process for identifying the outfalls. First, MOA identified the following criteria for targeted monitoring within the Anchorage Basin:

- Include a variety of land uses
- Include storm drains that discharge to water quality impaired (303(d)-listed) stream(s)
- Experience approximately the same annual precipitation
- Be geographically diverse while allowing relatively easy access to all outfalls during a single rainfall event.

To meet these criteria, MOA selected a portion of the MS4 that extends from C Street on the west to Lake Otis Parkway on the east, and from the northern portion of the Chester Creek watershed to the southern edge of the Furrow Creek Watershed. The targeted area includes substantially urbanized portions of the watershed tributary to Chester Creek, Furrow Creek, and Campbell Creek. These three streams are impaired for fecal coliform and have an approved TMDL and therefore, meet one of the permit objectives.

Within the target area, the MOA identified as priorities outfalls representative of homogeneous land use subbasins, heterogeneous land use subbasins, and subbasins with and without oil/grit separator (OGS) devices. This diversity of land uses and structures can be used to meet the permit objectives of broadly quantify pollutant loading and assess effectiveness of existing best management practices (BMPs).

For the subbasins with a homogeneous land use:

- Data will identify specific pollutants originating from a predominant land use that require additional controls. Specific controls could be tailored to a specific land use and targeted for use in those watersheds.
- Data may be used to develop estimates of fecal coliform and TAH loading, as described below.
- Fecal coliform, TAH, and TAqH data can be compared to water quality criteria.
- Fecal coliform data can be compared with TMDL reduction goals for fecal coliform to determine improvement over time.

For subbasins with heterogeneous land uses:

- Data will be used to develop estimates of fecal coliform and petroleum hydrocarbon loading.
- Data will identify pollutants originating across land uses that require additional controls, and additional BMP controls can be applied across the basin.
- Fecal coliform and petroleum hydrocarbon data can be compared to water quality criteria.
- Fecal coliform data can be compared with TMDL reduction goals for fecal coliform to determine improvement over time.

For subbasins with or without OGS systems:

- Data will be used to assess the effectiveness of the OGS systems and determine whether additional OGS systems could be installed to improve stormwater quality.
- Petroleum hydrocarbon data can be compared to water quality criteria.

MOA used its hydrogeographic database (HGDB) and other municipal geographic data to select subbasins with the aforementioned characteristics (subbasins with homogeneous and heterogeneous land uses and subbasins with and without OGS systems). The Municipality's HGDB is a geographic database that contains information about streams; drainage ways; storm drainage piping, inlets, outlets, and outfalls; stormwater treatment devices (such as the OGS systems); and subbasins. Specifically, subbasins are delineated based on hydrologic divides between drainage areas or piped drainage networks and are generally associated with one or more outlets or outfalls. The HGDB is a work in progress; it is continually updated to reflect refinements in mapping and changes on the ground. Thus, information from the HGDB should be used with this qualification.

The HGDB and other MOA GIS coverages including zoning, aerial photography, and topographic information were used to characterize land use in the delineated subbasins or to determine the presence or absence of OGS systems associated with subbasins. Using these data and GIS tools, 60 subbasins were selected, representing the following:

- Subbasins zoned for a single predominant land use (homogeneous subbasins) tributary to an identified outfall. The land uses were specifically categorized as:
    - Residential (R) (single, dual, and multifamily residential)
    - Commercial/Industrial (CI) (including rail road right-of-ways and transportation corridors)

  - Institutional (e.g., schools and hospitals)
  - Parks and vacant land
- Subbasins zoned for a high variety of land uses (heterogeneous subbasins). These were identified as those with the smallest standard deviation of the percentages of each of the four categories of land uses.
- Subbasins known to include OGSs and those without OGSs.

With approximately 60 subbasins identified, MOA eliminated those subbasins that did not have stormwater outfalls that are part of the MS4, as defined in 40 CFR122.26 (b)(9)[1].

Next, MOA ground-truthed the sites in the field by visiting outfalls from the remaining subbasins to ensure:

- Outfalls could be located
- Sampling locations were safely accessible (from the perspective of vehicular and sampler access)
- Outfalls were not submerged in the receiving stream
- Outfalls had an elevation drop between the outfall and the receiving steam to enable a portable weir to be used to measure flow.

The resulting list of outfalls comprised the 30 priority outfalls required by the permit to be identified. All of the outfalls identified through this process are considered high priority as they meet the intended objectives of 1) discharging to impaired water bodies, 2) representing a variety of land uses and associated pollutants, and 3) representing discharges with and without BMPs. The list of subbasins and outfalls is provided in Table B-1.

The final selection of the top 10 sites that will be sampled included an element of practicality based on field ground-truthing to ensure all outfalls could be sampled and to eliminate the need to identify those during field sampling. Wet weather sampling will be conducted under wet, inclement weather conditions, and must be done quickly to capture runoff from temporary events. Thus, the 10 top priority sites were selected using a metric that characterized three factors:

A. Likelihood of having discharge – as measured by the directly connected impervious area for the storm drain system leading to the outfall, not the entire subbasin. These were ranked from 1 to 30.
B. Sampler safety – steep slopes on embankments above the outfalls and sampler proximity to large and/or deep flows. These were assigned a value of 1, 3, or 5 (very good, adequate, or caution advised, respectively).
C. Accessibility – convenient legal parking. These were assigned an integer value from 1 through 5, from no road to cross and short (< 20 yard) walking distance (1) to cross or walk along a busy road and walk more than 20 yards (5).

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[1] At the point where a municipal separate storm sewer discharges to waters of the United States and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the United States and are used to convey waters of the United States.

A rating metric, R, was assigned to each outfall using the following equation:

$$R = 3 - \left(\frac{A}{30} + \frac{B}{5} + \frac{C}{5} \right)$$

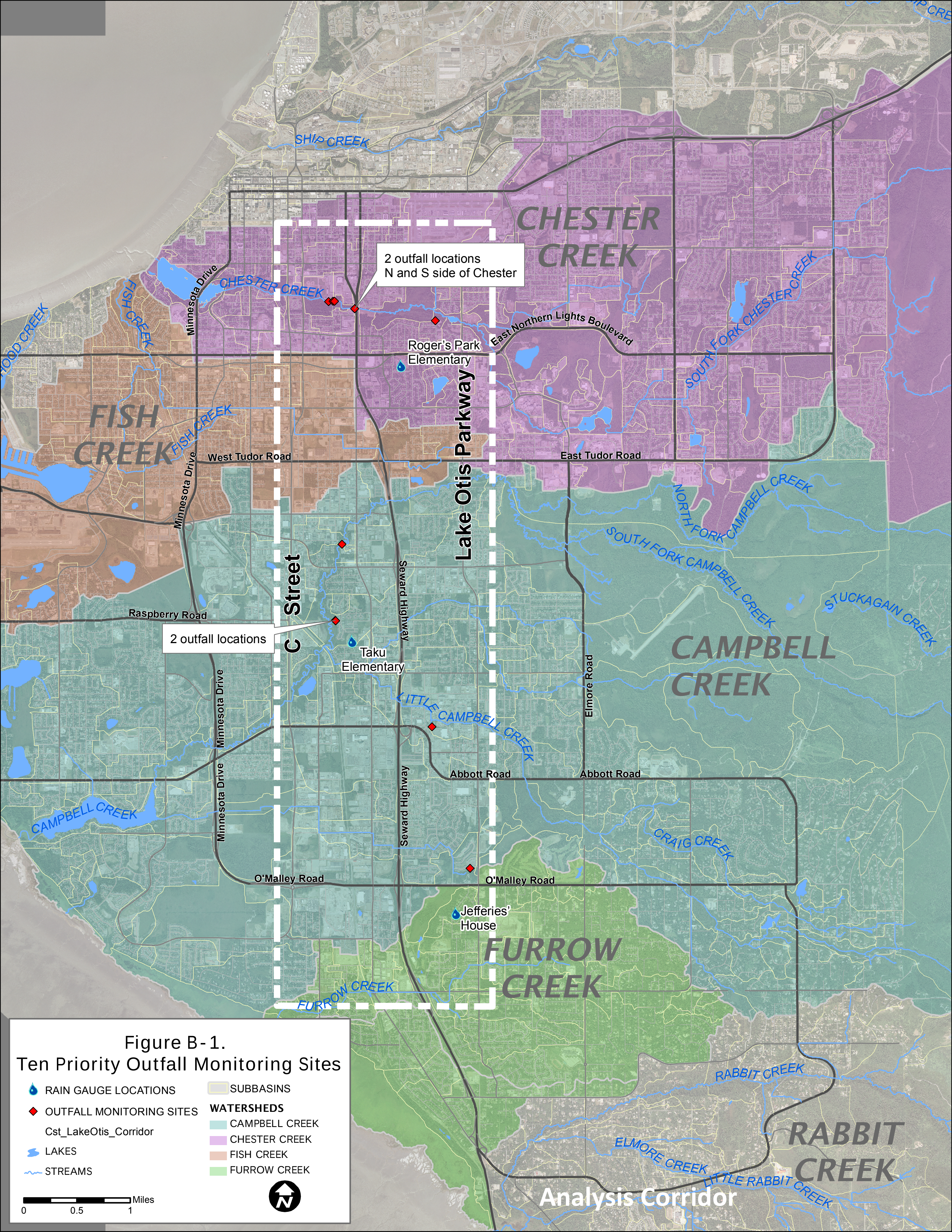
The equation resulted in a number between 0 and 3; these numbers were ranked from 1 to 30, with low numbers representing higher priority sites and higher numbers representing lower priority sites. (Several outfall sites were tied.) The 10 outfalls selected represent the 10 high priority sites that will be monitored throughout the term of the permit. The sites are listed in Table B-1and depicted on Figure B-1.

Since a given subbasin may have more than one outfall and may be comprised of more than one land use, each of the prioritized outfalls was assigned a land use category for the area actually tributary to the outfall. Land uses of R, CI, (defined above) and M (for mixed) were assigned based on aerial photography and the associated piped or ditch system leading to the outfall. The presence or absence of an OGS device on the portion of the MS4 system leading to the outfall was determined from information in the HGDB. These land use and OGS categories are also shown in Table B-1.

Table B-1. Stormwater Outfalls with 10 Top Priority Outfalls Identified for Stormwater Outfall Monitoring.

Subbasin ID	Watershed	Contributing Land Use*	OGS Present?	Priority Rank
10 Identified Priority Outfalls				
805	Campbell Creek	CI	Yes	1
219	Chester Creek	R	Yes	2
1224a	Campbell Creek	R	Yes	3
132	Chester Creek	CI	Yes	4
554	Chester Creek	M	No	5
549	Chester Creek	M	No	6
1224b	Campbell Creek	R	Yes	6
133	Chester Creek	CI	No	8
507	Chester Creek	CI	No	8
1040b	Campbell Creek	R	No	10
Medium Priority Outfalls				
619	Chester Creek	R	Yes	11
1040a	Campbell Creek	R	No	12
320	Campbell Creek	R	No	13
523	Chester Creek	M	Yes	14
127	Chester Creek	M	Yes	15
815	Campbell Creek	M	Yes	16
1210	Campbell Creek	CI	No	17
497	Chester Creek	R	Yes	18
580	Chester Creek	R	Yes	18
737	Campbell Creek	R	Yes	18
505	Chester Creek	R	Yes	21
1197	Campbell Creek	R	Yes	21
495	Chester Creek	M	No	23
1198	Campbell Creek	R	Yes	23
828	Campbell Creek	R	Yes	25
404	Campbell Creek	M	Yes	26
610	Chester Creek	CI	Yes	27
1050	Furrow Creek	R	No	28
389	Campbell Creek	CI	No	29
1199	Campbell Creek	CI	No	29

*R = Residential; CI = Commercial and Industrial; M = Mixed



CHESTER CREEK
FISH CREEK
CAMPBELL CREEK
FURROW CREEK
RABBIT CREEK
SHIP CREEK
CHESTER CREEK
SOUTH FORK CHESTER CREEK
NORTH FORK CAMPBELL CREEK
SOUTH FORK CAMPBELL CREEK
STUCKAGAIN CREEK
LITTLE CAMPBELL CREEK
CAMPBELL CREEK
CRAIG CREEK
FURROW CREEK
RABBIT CREEK
ELMORE CREEK
LITTLE RABBIT CREEK
2 outfall locations
N and S side of Chester
2 outfall locations
Roger's Park Elementary
Taku Elementary
Jefferies' House
Minnesota Drive
East Northern Lights Boulevard
West Tudor Road
East Tudor Road
Raspberry Road
Seward Highway
Elmore Road
Abbott Road
O'Malley Road
C Street
Lake Otis Parkway
Figure B-1.
Ten Priority Outfall Monitoring Sites
RAIN GAUGE LOCATIONS
OUTFALL MONITORING SITES
Cst_LakeOtis_Corridor
LAKES
STREAMS
SUBBASINS
WATERSHEDS
CAMPBELL CREEK
CHESTER CREEK
FISH CREEK
FURROW CREEK
0 0.5 1 Miles
Analysis Corridor

2.3 Schedule of Sampling

MOA will conduct stormwater outfall monitoring during up to four rain events that result in runoff each year in accordance with the permit. MOA will be prepared to conduct monitoring when weather predictions indicate that a rainfall event sufficient to produce runoff is probable. Since stormwater outfall monitoring activities are weather dependant, the exact dates of sampling events may vary from year to year. There may be years in which fewer than four storm events will be sampled due to insufficient runoff generation.

3.0 Monitoring Locations

The 10 specific outfall locations are listed in Table B-1. These locations will be sampled four times per year throughout the duration of the permit resulting in a total of 16 samples that will be taken at each outfall prior to the expiration of the permit.

4.0 Parameters to be Measured and Methods

An acoustic doppler velocimeter or bucket will be used to measure instantaneous flow dependent upon outfall conditions.

Table B-2 lists the field and laboratory parameters, type of samples, frequency of monitoring, and the sample timing. Table B-3 provides a list of the parameters, field or laboratory analysis method, and purpose of the analysis. MOA will use a field probe, such as a YSI 556 and the Hach 2100P, to monitor field water quality parameters. These instruments will serve as an instantaneous recording device for temperature, turbidity, DO, and pH at the outfall.

Table B-2. Parameters to be Monitored for at 10 Priority Outfalls

Parameters	Type of Sample	Frequency	Sample Timing	No. of Measurements in permit cycle
Flow	IR	4 times/year	Catch runoff from the storm event	16
DO	IR	4 times/year	Catch runoff from the storm event	16
pH	IR	4 times/year	Catch runoff from the storm event	16
Turbidity	IR	4 times/year	Catch runoff from the storm event	16
Temperature	IR	4 times/year	Catch runoff from the storm event	16
BOD_5	G	4 times/year	Catch runoff from the storm event	16
Fecal Coliform	G	4 times/year	Catch runoff from the storm event	16
TSS	G	4 times/year	Catch runoff from the storm event	16
TAH	G	4 times/year	Catch runoff from the storm event	16
TAqH	G	4 times/year	Catch runoff from storm event in areas where commercial and industrial land uses are predominant	16

IR = instantaneous recording of field analysis; G = grab sample for laboratory analysis

Table B-3. Parameters, Methods, and Purpose(s) for Monitoring Priority Outfalls

Parameter	Method	Purpose(s) for Monitoring
Flow	Acoustic doppler or bucket	Characterize flow
DO	EPA 360.1/ YSI 556	Characterize stormwater quality
pH	EPA 150.2/ YSI 556	Characterize stormwater quality
Turbidity	EPA 180.1 M/ YSI 556	Characterize stormwater quality
Temperature	SM2550B/ YSI 556	Characterize stormwater quality
BOD_5	SM 5210 B	Characterize stormwater quality
Fecal Coliform	SM 9222D	Characterize stormwater quality; estimate loading
TSS	SM 2540D	Characterize stormwater quality
TAH	EPA 624	Characterize stormwater quality; estimate loading
TAqH	EPA 624 + 625	Characterize stormwater quality in subbasins where commercial and industrial land uses predominate

M = Modified for field use per manufacture's recommendations

Table B-4 identifies the parameters that will be monitored at each outfall location. The CI land uses in the table represent predominantly commercial, industrial, or paved collector or arterial streets or parking lots. Outfalls dominated by these land uses are likely to contribute petroleum hydrocarbon pollutants to stormwater and will be monitored for TAH and the TAqH in addition to the other parameters.

Table B-4. Parameters to be Monitored at Each Subbasin Outfall

Subbasin ID	Watershed	Contributing Land Use*	OGS Present?	Parameters to be Monitored									
				Flow	pH	Temp	DO	Turb	BOD	TSS	FC	TAH	TAqH
805	Campbell Creek	CI	Yes	x	x	x	x	x	x	x	x	x	x
219	Chester Creek	R	Yes	x	x	x	x	x	x	x	x		
1224a	Campbell Creek	R	Yes	x	x	x	x	x	x	x	x		
132	Chester Creek	CI	Yes	x	x	x	x	x	x	x	x	x	x
554	Chester Creek	M	No	x	x	x	x	x	x	x	x		
549	Chester Creek	M	No	x	x	x	x	x	x	x	x		
1224b	Campbell	R	Yes	x	x	x	x	x	x	x	x		

	Creek												
133	Chester Creek	CI	No	x	x	x	x	x	x	x	x	x	x
507	Chester Creek	CI	No	x	x	x	x	x	x	x	x	x	x
1040b	Campbell Creek	R	No	x	x	x	x	x	x	x	x		

*R = Residential; CI = Commercial and Industrial; M = Mixed

Precipitation will be recorded using a tipping bucket rain gauge and data logger recording in 0.01 inch increments. During precipitation events, the collection cup in the gauge collects precipitation until it reaches the equivalent of 0.01 inches of precipitation where upon the bucket tips, triggering a reed switch and recording an event with a time stamp. These events are stored in the data logger and downloaded into a computer program where they can be summarized over different time intervals or graphed over time to produce a hyetograph.

Three rain gauges are to be located within the sampling corridor. One in the southern portion and known as Jefferies' House, one in the central section on top of Taku Elementary, and one in the northern section known as Roger's Park Elementary.

4.1 Site-specific Non-Direct Measurements

Prior to entering the field, the field crew will assess the predicted rainfall to ensure the event will produce runoff. They will identify the locations of the rain gages within each subbasin and will record the antecedent rain event: date, time, and volume.

Also prior to leaving for the field, the crew will familiarize themselves with the locations of the outfalls. These are depicted in Figure B-1. Upon arriving at the outfall, the field crew will record the following information in the field log book:

- Time of sampling
- Vegetation surrounding the outfall
- Outfall water conditions
    - Odors
    - Color
    - Clarity
    - Floatables
    - Deposits or stains
    - Sheen
    - Surface scum
    - Debris
- Other unusual conditions.

Following storm event sampling, the field crew will download the data associated with the tipping rain gages within each subbasin sampled. In addition to preparing the hyetographs for the storm event, they will record:

- Time rain event began
- Total 24-hour rainfall.

5.0 Sampling Methods

5.1 Site-Specific Sample Methods, Handling, and Field QC

One two-person team will conduct the stormwater outfall sampling when weather permits. Sampling will be conducted only during or after a storm event that creates runoff in the MS4. Typically, a measurable storm event will be defined as rain of greater than or equal to 0.1 inch in 24 hours preceded by 24 hours of less than 0.1 inch of precipitation. This size event is expected to generate runoff from the basin and should provide adequate opportunities to capture four rain events per year.

The team will have the outfall list, site maps with outfall areas; the locations of the rain gages in each subbasin; portable weirs and buckets; field equipment such as the water quality analysis probe needed to obtain field measurements; laminated water analysis sampling protocols; a digital camera; measuring tape; a stop watch; and field log book. For each outfall, team members will record the general information listed in Section 4.1 above in the field log book.

5.1.1 Flow Analyses

From a position of safety, the field crew will obtain a velocity measurement using an acoustic doppler velocimeter. After the velocity of the water flowing out of the outfall has been measured, the field team will determine the depth of water flowing out of the outfall with a ruler. They will use the appropriate equation for to calculate discharge by using the size of the outfall, the depth of the water, and the velocity measured on site.

If the acoustic doppler cannot be used at a site due to shallow water conditions, the crew will use the alternative method of determining flow; they will measure the length of time required to fill a calibrated 1- or 5-gallon bucket using a stop watch. They will repeat the measurement four times to obtain an average discharge rate. At the office, they will calculate gallons per unit of time and convert to cfs.

5.1.2 Water Quality Sampling

After measuring flow, the field crew will measure pH, temperature, DO, and turbidity, using a specified field probe. All water samples must be collected from the water flowing out of the end-of-pipe. Field measurements will be recorded on the field form.

The crew will obtain water samples necessary to fill the laboratory bottles for BOD, TSS, fecal coliform, and TAqH. The water quality samples will be collected to represent the water column by collecting samples from the water flowing out of the end-of-pipe. Sample crews should take care not to disturb any accumulated sediment (with the bottom of the bottles or the sampler) when collecting a water sample.

Once the water samples have been collected, the field crew will record visual observations and measurements. Visual observations include the clarity of the water and its color.

The field team will conduct equipment blank analyses prior to field mobilization of a specific wet weather sampling event. Equipment blank procedures are described in the Quality Assurance Project Plan (QAPP). The field crew will conduct replicate sample analyses at a rate of 5 percent per day or once per day per parameter, whichever is greater. Replicate sampling procedures are described in the QAPP. The field crew will also collect replicate samples for the laboratory parameters at a rate of 15 percent per day or once per day per parameter, whichever is greater.

5.2 Sample Preservation and Packing

BOD, TSS, fecal coliform, and TAqH samples will be collected, preserved, and packed for shipment to the laboratory as described in the QAPP.

5.2.1 Chain of Custody

Instructions for the use and completion of the chain of custody forms are provided in Appendix G of the QAPP.

5.3 Field Instrument Calibration

Instrument calibration is addressed in Appendix H of the QAPP. The specified field probe will be calibrated each day it will be used in the field according to the manufacturer's directions and for each parameter to be monitored.

6.0 Training

Each field crew member must complete the following training prior to conducting field work:

- Field safety
- Downloading precipitation data
- Installation of portable weirs
- Proper flow monitoring
- Proper and complete recording of data on field log book
- Calibration and operation of all field water quality monitoring equipment
- Sampling protocols
- Visual monitoring requirements
- Field quality control samples
- Sample preservation and packaging

- Chain of custody completion
- Familiarity with laboratory location.

Before field crew members are allowed to do reportable work, they must demonstrate competence in conducting field analyses. A tenured field crew member will ensure that new field crew members are competent in all field procedures and test protocols.

7.0 Report

The results of stormwater outfall monitoring will be used for several purposes. First, where water quality standards are promulgated for the measured parameters, the parameters will be compared to the water quality criteria. If there are exceedances, the MOA will identify likely causes and take actions such as education and outreach or installation of additional BMPs to reduce the pollutant loading.

Second, beginning in year three of the permit, the MOA will prepare an annual report of the results of wet weather sampling, as well as other monitoring results. This report will include dates of sample collection, location, analyses performed, and results. If water quality criteria have been exceeded, those results will be noted.

Finally, when all four years of sampling have been completed, the MOA will prepare a summary report. The report will include a brief introduction, a description of the wet weather monitoring; outfalls selected; field and laboratory results; quality control/quality assurance; a discussion of the results; and an interpretation of the results. In analyzing the results, MOA will:

- Calculate the median, range, and 90^{th} percentile of concentrations measured for each parameter, except fecal coliform. For fecal coliform, the geometric mean will be calculated. A separate evaluation of concentrations may be conducted by land use, if differences are noted between land uses.
- Evaluate whether differences in stormwater quality exist between basins with and without OGSs.
- Estimate fecal coliform loading in each of the subbasins. The results will be used to estimate loading across the MOA MS4 using the methodology described below.
- Estimate TAH and TAqH loadings in each of the subbasins where commercial and industrial land uses predominate. The results will be applied to estimate loading across the MOA MS4 using the methodology described below.

Depending on the results, one of several methods may be used to estimate fecal coliform and TAH/TAqH loadings. One option is to use the median and 90^{th} percentile concentrations of the samples obtained across all sample dates to calculate loading using the Simple Method (SMRC, 2010). The concentrations obtained for specific subbasins will be extrapolated to other subbasins of similar land use and treatment levels (i.e., presence or absence of OGSs) for those basins that discharge to the 303(d) impaired water bodies.

The Simple Method has been developed under an EPA grant to provide Phase II communities with tools to protect their local watersheds (SMRC, 2010). This method estimates stormwater runoff pollutant loads for urban areas and requires the following information: subbasin drainage area and impervious cover, flow weighted or event mean stormwater runoff pollutant concentrations, and annual precipitation. With the Simple Method, calculations can be based on specific land use areas, such as residential, commercial, industrial, and roadway to calculate annual pollutant loads for each type of land use. It can also be use for more generalized pollutant values for land uses such as new suburban areas, older urban areas, central business districts, and highways. Calculations for the Simple Method are described in Attachment B-1. Note the limitations this method has when applied to grab samples rather than flow-weighed data, to data with high variability, and to watersheds greater than one square mile (Schueler, 2000). Also note that available documentation for this method does not address its applicability to organic compounds such as petroleum hydrocarbons.

A second alternative for estimating loadings is to apply different concentrations seasonally as performed in the TMDLs for Campbell and Furrow Creeks (ADEC, 2004 and ADEC, 2006). The applicability of this approach would depend on whether MOA is able to discern seasonal differences in the samples obtained. Again, the Simple Method would then be applied to specific land uses to generate estimates for the various land use types and amount of impervious area.

A third approach for estimating loadings is that employed for the Chester Creek TMDL (ADEC, 2005) which coupled surface runoff and water quality data in the Storm Water Management Model (SWMM). The SWMM model simulates the quantity and quality of stormwater runoff in urban watershed (ADEC, 2005). Other models, such as the Hydrologic Simulation FORTRAN Model, could also be considered if this approach is followed.

Finally, because the highly variable nature of fecal coliform, an approach suggested by flow duration curve analysis (USEPA, 2007) may be determined to be more appropriate and therefore employed.

The approach used will be selected based on the nature of the monitoring results and the complexity of applying a given approach.

8.0 References

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Attachment B-1
Simple Method to Calculate Stormwater Loading

The Simple Method to Calculate Urban Stormwater Loads

This information is reproduced from The Stormwater Managers Resource Center website:

http://www.stormwatercenter.net/monitoring%20and%20assessment/simple%20meth/simple.htm#limitations

Introduction

The Simple Method estimates stormwater runoff pollutant loads for urban areas. The technique requires a modest amount of information, including the subwatershed drainage area and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. With the Simple Method, the investigator can either break up land use into specific areas, such as residential, commercial, industrial, and roadway and calculate annual pollutant loads for each type of land, or utilize more generalized pollutant values for land uses such as new suburban areas, older urban areas, central business districts, and highways.

Stormwater pollutant concentrations can be estimated from local or regional data, or from national data sources. Tables 1 through 3 summarize pollutant concentration data for Total Suspended Solids (Table 1), Total Phosphorous (Table 2), and Total Nitrogen (Table 3) for residential, commercial, industrial, and roadway land uses, and identify default values. Table 4 identifies pollutant concentration values for Phosphorus, Nitrogen, COD, BOD, and some metals for more generalized land use categories. In general, the selected data sources are nationwide in scope, or are summaries of several regional studies. Some studies included in these data did not characterize stormwater concentrations for specific land uses, and instead reported a concentration for "urban runoff." In these instances, the data are reported as the same concentration for each land use in Tables 1 through 3.

Fecal coliform is more difficult to characterize than other pollutants. Data are extremely variable, even during repeated sampling at a single location. Because of this variability, it is difficult to establish different concentrations for each land use. Although some source monitoring data exists (Steuer *et al.*, 1997; Bannerman *et al.*, 1993), the simple method assumes a median urban runoff default value, derived from NURP data (Pitt, 1998), of 20,000 MPN/100ml. For more information on sources and pathways of bacteria in urban runoff, consult Schueler (1999).

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where: L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

For bacteria, the equation is slightly different, to account for the differences in units. The modified equation for bacteria is:

$$L = 1.03 * 10^{-3} * R * C * A$$

Where: L = Annual load (Billion Colonies)
R = Annual runoff (inches)
C = Bacteria concentration (#/100 ml)
A = Area (acres)
$1.03 * 10^{-3}$ = Unit conversion factor

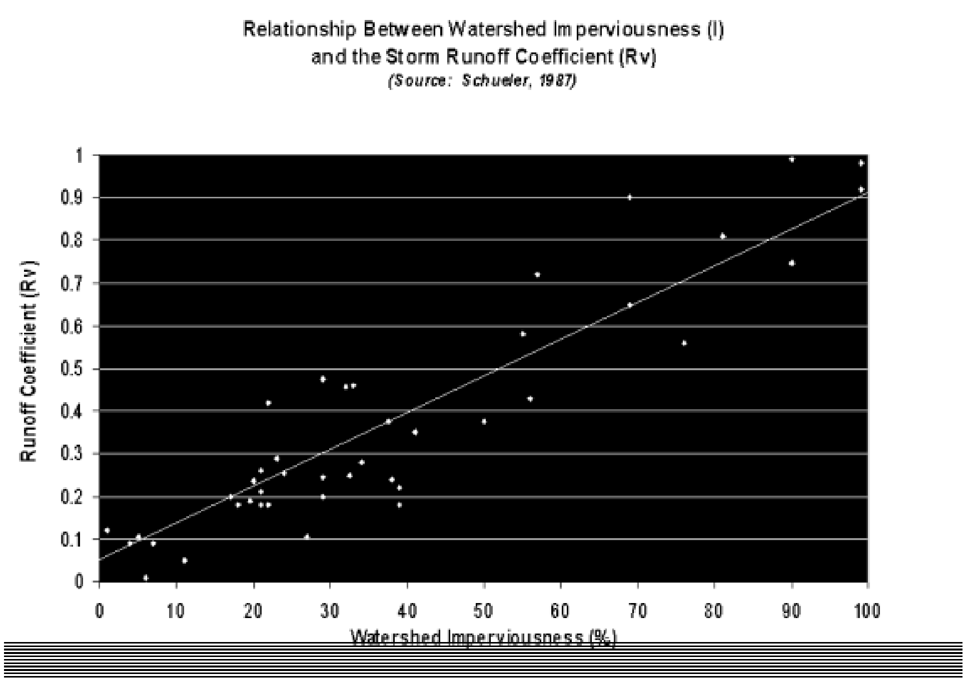
Annual Runoff

The Simple Method calculates annual runoff as a product of annual runoff volume, and a runoff coefficient (Rv). Runoff volume is calculated as:

$$R = P * P_j * Rv$$

Where: R = Annual runoff (inches)
P = Annual rainfall (inches)
P_j = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

In the Simple Method, the runoff coefficient is calculated based on impervious cover in the subwatershed. This relationship is shown in Figure 1. Although there is some scatter in the data, watershed imperviousness does appear to be a reasonable predictor of Rv.



The following equation represents the best fit line for the dataset (N=47, R^2=0.71).

$$Rv=0.05+0.9Ia$$

Where: Ia = Impervious fraction

Impervious Cover Data

The model uses different impervious cover values for separate land uses within a subwatershed. Representative impervious cover data, along with Model default values, are presented in Table 5. A study is currently being conducted by the Center for Watershed Protection under a grant from the U.S. Environmental Protection Agency to update impervious cover estimates for these and other land uses. The results of this study will be available by 2001. In addition, some jurisdictions may have detailed impervious cover information if they maintain a detailed land use/land cover GIS database.

Limitations of the Simple Method

The Simple Method should provide reasonable estimates of changes in pollutant export resulting from urban development activities. However, several caveats should be kept in mind when applying this method.

The Simple Method is most appropriate for assessing and comparing the relative stormflow pollutant load changes of different land use and stormwater management scenarios. The Simple Method provides estimates of storm pollutant export that are probably close to the "true" but unknown value for a development site, catchment, or subwatershed. However, it is very important not to over emphasis the precision of the results obtained. For example, it would be inappropriate to use the Simple Method to evaluate relatively similar development scenarios (e.g., 34.3% versus 36.9% Impervious cover). The simple method provides a general planning estimate of likely storm pollutant export from areas at the scale of a development site, catchment or subwatershed. More sophisticated modeling may be needed to analyze larger and more complex watersheds.

In addition, the Simple Method only estimates pollutant loads generated during storm events. It does not consider pollutants associated with baseflow volume. Typically, baseflow is negligible or non-existent at the scale of a single development site, and can be safely neglected. However, catchments and subwatersheds do generate baseflow volume. Pollutant loads in baseflow are generally low and can seldom be distinguished from natural background levels (NVPDC, 1979). Consequently, baseflow pollutant loads normally constitute only a small fraction of the total pollutant load delivered from an urban area. Nevertheless, it is important to remember that the load estimates refer only to storm event derived loads and should not be confused with the total pollutant load from an area. This is particularly important when the development density of an area is low. For example, in a large low density residential subwatershed (Imp. Cover < 5%), as much as 75% of the annual runoff volume may occur as baseflow. In such a case, the annual baseflow nutrient load may be equivalent to the annual stormflow nutrient load.

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Appendix C
Structural Controls Effectiveness Monitoring Plan

Table of Contents

C. Structural Controls Effectiveness Monitoring Plan

1.0 Introduction

1.1 Background

The U.S. Environmental Protection Agency (EPA) issued the Municipality of Anchorage (MOA) and the Alaska Department of Transportation and Public Facilities (ADOT&PF) a Municipal Separate Storm Sewer System (MS4) permit under the National Pollutant Discharge Elimination System (NPDES) in 1999. EPA re-issued the permit in October 2009 with a requirement to evaluate effectiveness of sedimentation basins and oil grit separator (OGS) systems within the Anchorage MS4. The permit is now administered under the Alaska Pollutant Discharge Elimination System (APDES).

1.2 Problem Definition

Storm drains that discharge to the MS4 can introduce pollutant runoff from commercial and industrial facilities, residential areas, and parks. Stormwater controls are engineered structures that are designed to remove pollutants such as sediment, petroleum-based oils, and fecal coliform. Effectiveness evaluations of stormwater structural controls are important in assessing the intrinsic capability of different devices to remove targeted pollutants and/or in determining the local storm water system impacts on those intrinsic capabilities. This monitoring plan describes the approach proposed for completing an effectiveness evaluation of sedimentation basins and OGS systems within the Municipality of Anchorage.

1.2.1 Sedimentation Basins

The Anchorage MS4 maintains a number of sedimentation basins as end-of-pipe storm water treatment, particularly for contributing basins that are highly urbanized and otherwise provide limited opportunities for localized storm water runoff control and treatment. The MOA has conducted several studies of treatment efficiencies of these sediment basins. Parameters commonly measured included turbidity, fecal coliform, heavy metals (total and dissolved), specific conductance, and petroleum hydrocarbons. Study reports generally conclude high particulate removal rates are achieved in Anchorage sedimentation basins (as much as 80 to 100% removal of suspended sediments reported in one study). Local studies also indicate that the sediment trapped in the basins typically carry a significant adsorbed pollutant load, including higher molecular weight petroleum hydrocarbon fractions and heavy metals. Conversely, scour and re-suspension are known to occur in Anchorage sedimentation basins, particularly in basins with simple open cell designs or those having limited or no vegetative filtering elements. Anchorage basins designed and constructed with wetland filtering elements are believed to perform significantly better in this regard. However, short circuiting of flow through the filtering wetlands is known to create upsets in these types of systems as well. Design of flow distributaries that will adequately control such short circuiting remains a local design issue. Quantification of this effect relative to basic basin design factors and identification of those factors impacting wetland scrubbing particularly in terms of short circuiting flow distributary designs will be important to complete effectiveness evaluation of sedimentation basins in Anchorage.

1.2.2 Oil and Grit Separators

Anchorage MS4 street maintenance operators maintain several hundred oil and grit separator (OGS) water treatment devices across the Anchorage storm water drainage system. These devices generally fall into one of three categories: enhanced manholes (typically simple baffle systems installed within the manhole), site-specific engineered devices (typically baffled concrete or large-diameter pipe vaults), and proprietary manufactured devices (typically hydrodynamic swirl separators). Extensive monitoring and assessment of both the simple and large baffled devices by MOA in the past suggested that these devices have limited utility in removing pollutants in storm water, particularly for finer particulates. However nationally-standardized analyses of the performance of modern hydrodynamic swirl separators indicate a greatly improved intrinsic treatment performance for these types of devices, particularly for fine particulates and at small treatment flow rates. However, performance under local conditions is highly dependent upon the actual size distribution and character of the local pollutant load and the character of the runoff flows that transport these pollutants. Determination of the characteristics of Anchorage street sediments in this regard and controlled testing using these size distributions at flows typical of Anchorage contributing basins is critical to evaluation of the local effectiveness of these modern devices—and key to developing improved guidance in their application and design within the Anchorage MS4.

1.3 Goals and Objectives

The goal of the Anchorage MS4 permittees' Best Management Practices (BMP) effectiveness monitoring is to evaluate the effectiveness of two types of BMP treatment systems installed within the Anchorage MS4 area: sedimentation basins and OGS systems as identified in the APDES permit. Monitoring of the systems will provide the MOA with information to: 1) evaluate local effectiveness of pollutant removal by the BMPs; 2) develop improved guidance for design and maintenance practices; and 3) provide guidance in identifying the applicability of use these types of BMPs at various Anchorage MS4 localities. Specifically, objectives for evaluation of sedimentation basin and OGS devices at Anchorage are as follows.

- Assess the effectiveness of select Anchorage sedimentation basins as they represent varying uses and designs of vegetation filtration and flow controls (particularly to the degree that these controls remove fine particulates or limit or manage short circuiting). To achieve this objective, three or more Anchorage sedimentation basins (selected based on review and analysis of all Anchorage sedimentation basins in context with the objective stated here) are proposed to be selected and measured for flow and pollutant capture effectiveness,.
- Assess the effectiveness of one or more select hydrodynamic swirl separator devices in terms of their performance under Anchorage MS4 runoff and pollutant loading conditions (particularly with reference to particle size distributions of street sediments generated under different basin conditions and at different times of the year). To achieve this objective, local pollutant and precipitation sampling and characterization (specific to OGS function), sampling of select local OGS to establish other pollutant capture effectiveness by these

devices, and multiple controlled laboratory analyses of performance of a common hydrodynamic separator operated under these conditions will be completed to support development of improved applicability and design parameters for these devices under Anchorage conditions.

2.0 Description of Program and Rationale

2.1 Sampling Design

For evaluation of sedimentation basins effectiveness in Anchorage, three or more sedimentation basins will be selected for assessment based on presence of conditions reflecting various degrees of presence of critical design elements as described in the project objectives above (i.e., filtration vegetation and flow distributaries). Basins will be instrumented and continuously monitored and/or sampled to characterize performance under both storm flow and dry weather conditions. As necessary to provide calibration for sensor data and otherwise characterize pollutant treatment, basins will be sampled periodically to evaluate the effectiveness of pollutant capture and treatment by the sedimentation basin. Sensor and sampling parameters will include at minimum measurements for turbidity, conductivity, flow, temperature, and pH. Additional grab, composited and passively collected (accumulating) samples will also be collected and tested for a range of parameters as they address project objectives or permit requirements. Results will be interpreted and used to develop recommendations for guidance for future sedimentation basin use and design.

For OGS evaluation, this program will test and address the applicability and efficiency of hydrodynamic swirl separators in Anchorage through full-scale bench-top testing of a common manufactured device using local characteristic pollutant loads (street sweepings or inorganic particle mixtures sized to reflect local street sweepings), run under a range of runoff flows characteristic of Municipal urbanized areas. Work will include identification and characterization of archetypal Anchorage contributing basins (to include large commercial and public parking lots) and runoff flows, sampling and characterization of street sediments (including at minimum particle size analysis using laser or other particle counter technology to resolve fine fractions (to 5 µm) and characterization of organic and inorganic particulate fractions), sampling and chemical pollutant characterization of sediment captured by Anchorage OGS as stratified by basin archetypes and season, and full-scale laboratory testing of hydrodynamic separators under the range of identified Anchorage loading and flow conditions. Results will be interpreted and used to develop recommendations for guidance for selection and design of hydrodynamic separator devices in the Anchorage MS4.

2.2 Controls Selection Methodology and Rationale

2.2.1 Sedimentation Basins

For sedimentation basin evaluation the permittees will select three or more Anchorage sedimentation basins for monitoring, selected for assessment based on presence of conditions reflecting various degrees of presence of critical design elements as described in the project objectives above (i.e., design and condition of filtration vegetation and flow distributaries). Existing characteristics of all Anchorage urban storm water treatment sedimentation basins will be reviewed and considered for assessment in this program. However, the strategy for this program is based on assessment of the relative performance of wetlands and flow distributary design elements as they currently exist (and reflect Municipal design criteria requirements) in Anchorage systems. Therefore, the basins selected for testing will be those that represent the fullest range in the quality of these design elements in existing sedimentation basins. Assessment strategy will include both assessment of actual treatment performance of each basin over the testing period as well as comparison of performance between the basins (as they reflect different design conditions). Research on storm water end-of-pipe sedimentation basins, both local and national, demonstrates that basins with wetland treatment elements and uniformly distributed flows perform significantly better than open-water basins, even in multi-cell designs. However, snowmelt runoff occurring at Anchorage while significant ice cover remains on these basins will affect seasonal performance of all basins. The evaluation program laid out here attempts to address these difficulties.

This sedimentation evaluation plan proposes testing to assess the range of seasonal treatment performance of Anchorage systems as well as to compare relative performance of wetland and non-wetland designs. Performance will be assessed using continuous sensor data and cumulative passive collection devices (PCDs) for chemical and particulate pollutants or their surrogates calibrated with runoff and baseflow event pollutant parameter data collected using grab sampling as triggered by flow telemetry alarms. Data collection will be performed at downstream and upstream locations relative to each basin to allow characterization of the annual and seasonal performance (sum of loads) of the monitored basins. Comparison of relative performance between basins will also be made to provide insight into effects of the primary design elements targeted by this project. Program reports will include summaries of basin conditions, tabulations of field and laboratory results of parameter measurements, annualized flow and pollutant and pollutant loading and overall treatment performance, comparison of basin performance, and specific recommendations for updated criteria for use in application and design of large sedimentation basins at Anchorage.

The monitoring plan for this approach includes the following primary tasks:

1. Compilation, review and summary of sedimentation basins currently in operation at Anchorage, including description of principle design elements.
2. Review and compilation of existing local data of physical, chemical, and biologic characteristics of Anchorage street sediments, and sediments washed off and captured by sedimentation basins (this information will mirror that collected under the OGS evaluation program).
3. Compilation, review and summary of rainfall and design storm parameters currently used in Anchorage Municipal storm water drainage and water quality control design particularly as these events affect sedimentation basin-scale treatment processes.
4. Collection of local precipitation and weather data as necessary to support storm event and sum of loads analysis of water quality data.
5. Collection of inflow and outflow water quality data for select basins including continuous sensor data for flow, turbidity, temperature, and cumulative (seasonal) collection of select petroleum hydrocarbon pollutants using passive, time-integrated collection devices (e.g.,

POSCI, GORE, or other samplers). Additional discrete sampling and laboratory analyses will be conducted as necessary to calibrate sensor and passively sampled data and to collect samples for testing parameters more sensitive to handling and preservation.

6. Summary reporting document including tabulation of review, analyses, and test results; analytical and interpretive discussion of applicability and efficiencies of Anchorage sedimentation basins relative to basin design type; and recommendations for guidance in application and design of these devices within the Municipality.

2.2.2 Oil and Grit Separators

The MOA proposes to evaluate the effectiveness of a common hydrodynamic separator design as part of this program. Though having some utility as emergency detention for spills, the enhanced manholes and the site-specific engineered devices installed at Anchorage in the past have proven to have limited effectiveness at treating storm water flows. Tested at national standards, current hydrodynamic separator designs have shown much greater treatment effectiveness, but, despite their growing use here, no information is available quantifying their applicability or effectiveness under Anchorage conditions. However, the range in Anchorage conditions, both seasonally and spatially, will make testing these devices for purposes of determining their efficacy area-wide difficult. The evaluation program laid out here attempts to address these difficulties.

This OGS evaluation plan proposes testing and addressing applicability and efficiency of hydrodynamic swirl separators (OGS) in Anchorage through full-scale bench-top testing of a typical manufactured device using local pollutant loads (street sweepings or inorganic particle mixtures sized to reflect local street sweepings), and runoff flows characteristic of the Municipal urbanized areas. Full-scale testing will focus on particle treatment over a range of Anchorage-specific flows and use this data to estimate annual sum-of-load treatment for different basin archetypes. Additional sediment samples collected from four in-place OGS devices at Anchorage will be used to estimate correlated treatment of adsorbed pollutant types. Testing and data collection will be structured to characterize seasonal and spatial variability across the urbanized portions of the Anchorage MS4. Program reports will include summaries of Anchorage urban basins, runoff, and pollutant and pollutant loading characteristics, laboratory results of device tests, specific recommendations for OGS "or equal" devices for use in Anchorage, and updated criteria for use in selecting and designing OGS devices at Anchorage.

The monitoring plan for this approach includes the following primary tasks:

1. Compilation, review and summary of geometry and pollutant generating characteristics of outfall basins mapped in Anchorage, and identification and description of principle classes of archetypal basin characteristics based on this review.
2. Compilation, review and summary of rainfall and design storm parameters currently used in Anchorage Municipal storm water drainage and water quality control design particularly as these events affect OGS treatment processes.
3. Analysis and tabulation of representative range in peak runoff flows resulting from low-frequency design storms for range of mapped outfall basin sizes having archetypal characteristics. Very small flows, reflecting large commercial and public parking lots, will also be addressed.

4. Review and compilation of existing local data of physical, chemical, and biologic characteristics of Anchorage street sediments, and sediments washed off and captured by OGS devices. Additional sediment sampling and laboratory testing of street and OGS device sediments and these pollutants' correlation to particle size will be performed to qualify and expand existing data.
5. Compilation of existing information and additional select sampling to characterize particle size distribution (PSD) of street sediments appropriately stratified to reflect seasonal, street type, and maintenance practices differences. Sample collection shall include representation of both streets and large parking lots. Characterization will include visual descriptions and laboratory testing of representative samples of collected sediments, including at minimum testing for:
    a. mineral and organic composition (e.g. using testing for organic content in soils by loss of ignition, AASHTO T267, or similar)
    b. Specific gravity of the mineral fraction.
    c. Particle size distribution of the mineral fraction, measured from 5 to 20,000 µm (using wet sieve or other technology for fractions larger than 53 µm, and particle counter—e.g., Coulter or Malvern counters, or other laser diffraction or similar high resolution technology for sizes smaller than 53 µm).
6. Laboratory analysis of select manufactured hydrodynamic swirl separator using PSD's and specific gravity representative of stratified Anchorage street sediments, and flow rates reflecting storms and runoff characteristic of Anchorage outfall basin archetypes as determined in earlier analyses.
7. Summary reporting document including tabulation of review, analyses, and test results; analytical and interpretive discussion of applicability and efficiencies of hydrodynamic swirl separators under the range of Anchorage conditions; and detailed guidance in selecting and designing these devices within the Municipality.

2.4 Schedule of Sampling

For each sedimentation basin, MOA will conduct BMP effectiveness monitoring over a period of one year. Field data collection will be performed continuously from breakup to freezeup for select parameters and during three or more discrete storm runoff events where sampling is required to test for parameters selected for laboratory analysis. Field sensors will be operated to collect data continuously, but only runoff events that result in runoff to the systems will be sampled. Sampling for OGS evaluation will be conducted once when the OGS are cleaned and sediments are stockpiled to characterize significant differences in pollutant loading, character, and transport.

Throughout the season, the permittees will maintain continuous sensor operation as necessary to provide representative data. For discrete sampling events, the permittees will be prepared to conduct monitoring when the National Weather Service (or an equivalent service) predictions indicate that a rainfall event of 0.1 inches in 24 hours or more is probable or as indicated or triggered by flow or other sensors set as alarms or sampling triggers. Since stormwater monitoring activities are weather dependant, the exact dates of discrete sampling events will vary. Sampling schedules will begin at or after breakup to allow access to the sites and installation of dataloggers and continuous recording probes will end with the onset of the first freezing conditions (approximately May through October).

3.0 Monitoring Locations

The locations of the three sedimentation basins will be selected as described above. Selection will be made on the basis of a review of all existing Anchorage end-of-pipe storm water sedimentation basins and will considered both the type and quality of design elements present in a candidate system and opportunities to safely and efficiently access appropriate basin features for installation of equipment and for sampling. Candidate hydrodynamic systems selected for sampling in Anchorage will be selected based on results of stratification by their type and their associated contributing basin, pollutant loading, and runoff characteristics. All hydrodynamic swirl separators currently in operation in Anchorage will be considered for sampling, though limited or unsafe access will be considered a sufficient reason for removing a device as a candidate. Locations for sampling of street and parking lot sediments will be determined during initial analysis and classification of basin archetypes and pollutant loading characteristics. Sampling of street and parking lot sediments will be designed to represent seasonal and spatial conditions through subsampling and compositing of street sediments swept from these surfaces. The schedule imposed by permit conditions will not allow an annualized normalization of results; however, results will be compared and described in context with data collected in previous Anchorage studies.

4.0 Parameters to be Measured and Methods

Table C-1 provides the sample locations, purpose for monitoring and criteria for selection of the sites. Table C-2 summarizes the samples and types of samples to be collected for each parameter.

Table C-1. Sampling Site Representativeness

Site ID	Monitoring Purpose	Criteria for Site Selection
Sedimentation Basins		
Minnesota	Characterize Influent and effluent from sedimentation basin	Basin influent and effluent
Meadow St	Characterize Influent and effluent from sedimentation basin	Basin influent and effluent
C St	Characterize Influent and effluent from sedimentation basin	Basin influent and effluent
OGS Systems		
*TBD	Characterize sediment captured in OGS systems	OGS sediment trap by OGS type and basin/pollutant loading archetype
*TBD	Characterize street/parking lot sediment	Swept surfaces by seasonal strata, surface type/use, sanding practice

*TBD – to be determined upon project review and characterization of all candidate devices/sites

Table C-2. Sampling Summary

Site ID	Flow	Temperature	Turbidity	DO	pH	BOD5	TSS	FC	POLs
Continuous Recording						Flow Proportional Composites (FPCs)		Discrete, PCDs	
Sedimentation Basins									
Minnesota Up	X	X	X	X	X	X	X	X	X
Minnesota Down	X	X	x	X	X	X	X	X	X
Meadow St Up	X	X	X	X	X	X	X	X	X
Meadow St Down	X	X	X	X	X	X	X	X	X
C St Up	X	X	X	X	X	X	X	X	X
C St Down	X	X	X	X	X	X	X	X	X

Although TSS is being sampled and analyzed using the test method 2450D the lab per our instructions will use the entire sample in analysis instead of using an aliquot or subsample to determine TSS. According to USGS papers and others the TSS method has not been standardized and has determined that by pulling an aliquot or subsample does not represent the sample. Therefore, to account for this, we are having the entire grab sample analyzed. The PSDs will be used to collect data on DRO and PAH and will analyzed by Gore using the company's sorber technology.

Table C-3. Sampling Summary

OGS Systems		
Site ID	SpG	PSD
*TBD	X	X
*TBD	X	X
*TBD	X	X

Table C-3 identifies the parameters that will be monitored at each monitoring location and the sample type, frequency, and timing.

Table C-3. Parameters to be Monitored, Sample Type, Frequency, and Timing

Parameters	Type of Sample	Frequency	Sample Timing
Flow	C	NA	Continuous-multiple storm events
Turbidity	C	NA	Continuous-multiple storm events
Temperature	C	NA	Continuous-multiple storm events
DO	C	Each event	Discrete sampling during storm event
pH	C	Each event	Discrete sampling during storm event
BOD_5	C	4 storm events	Discrete sampling during storm event
TSS	grab	Each event	Flow proportional sampling by storm event or discrete samples
Fecal Coliform	grab	4 storm events	Referigerated flow-proportional sampling by storm event or discrete samples
POLs	PCD	NA	Continous-multiple storm events

[a] C - continuous monitoring; FPC - flow-proportional composite sample; rFPC - refrigerated flow proportional composite samples; POLs - petroleum hydrocarbons including DRO and select GRO and PAH parameters; PCD - passive collection device

To measure flow, MOA will use either existing weirs, or where no weir is currently in place, MOA will install a weir (temporary or permanent) at the beginning of the season. Flow monitoring equipment will be installed at the beginning of the season in which sampling is to occur. MOA will download data and ensure that the equipment is functioning properly as necessary. The monitoring equipment will be removed in October to prevent freezing.

Table C-4 provides a list of the parameters and field or laboratory analysis method, range of detection, and purpose of the analysis. MOA will install field probes that are capable of monitoring and recording temperature, turbidity, DO, and pH.

Table C-4. Parameters, Methods, Ranges, and Purpose(s) for Monitoring

Parameter	Method	Range	Purpose(s) for Monitoring
Flow	Weir and sensor	as required	Characterize flow
DO	EPA Method 360.1	0 - 20 mg/L	Characterize BMP effluent quality
pH	EPA Method 150.2	0 - 14	Characterize BMP effluent quality
Turbidity	EPA Method 180.1 M nephalometric	0 – 1,000 NTU	Characterize BMP effluent quality
Temperature	SM 2550B	-5 – 70°C	Characterize BMP effluent quality
BOD_5	SM 5210 B	NA	Evaluate BMP effluent quality
Fecal Coliform	SM 9222D	NA	Evaluate BMP effluent quality
TSS	SM 160.2	NA	Evaluate BMP effluent quality
POLs	EPA 624, Ak101-2, SW846	NA	Evaluate BMP effluent quality

5.0 Sampling Methods

5.1 Site-Specific Sample Methods, Handling, and Field QC

A one or two-person team will conduct BMP effectiveness monitoring, dependent upon site and event sampling and safety requirements. Team members will monitor weather predictions to prepare for sampling events, but will primarily respond to site flow alarms or other site sampling triggers to initiate discrete sampling events. Continuous sensor data will be collected periodically during dry weather intervals. They will have the list of monitoring points; site maps; field equipment such as calibration kits needed to calibrate field equipment; laminated water analysis sampling protocols; a digital camera; and field log book or required data sheets. For each sample location, team members will record general information listed in Section 5.4.

5.1.1 Meteorological Records

Precipitation will be either compiled from official NWS weather station data or collected from appropriately-located stations operated by the permittees using a tipping bucket rain gage and data logger recording in 0.01 inch increments. These instruments are calibrated by the manufacturer prior to field deployment. The rain gages will be appropriately located to reflect precipitation timing received by the BMP being sampled. Data from tipping-bucket rain gages will be downloaded periodically during dry weather intervals in conjunction with other MS4 projects.

For each rainfall/runoff event that is sampled, the following data will be gathered: total precipitation, beginning and ending time, and date of each storm event flow. A hyetograph will be generated from the collected data.

5.1.2 Flow Analyses

At the beginning of the season, the field crew install a weir to measure effluent discharge as necessary and will install a local elevation reference point, and data logger and field monitoring equipment. During grab sampling for water quality parameters, staff will note water level relative to the local reference point and the time for subsequent comparison to data collected by the flow monitoring equipment. The field crew will download data and ensure that the equipment is functioning properly after every monitored storm event.

5.1.3 Water Quality Sampling

At the beginning of the season, a field crew will install field probes, and data loggers at each BMP system as appropriate to that system. The equipment will be protected from vandalism. Continuous recording sensors will be used to monitor, temperature, water level and turbidity.

Once an alarm is triggered for a rain event for which any discrete (grab) samples are to be collected, the field crew manager will determine if sampling may occur. Once it has been determined that sampling will occur, the field crew will mobilize. At that time grab samples for fecal coliform and for any other parameters to be sampled at that site that are sensitive to handling or preservation conditions. For the sedimentation basins, any such grab sampling will be timed to capture flow through the basin from the particular storm event. The water quality samples will be collected to represent the water column by collecting samples from the water flowing over the weir or immediately above the weir. Sample crews should take care not to disturb any accumulated sediment if sampling above the weir (with the bottom of the sampler) when collecting a water sample.

Once the grab samples have been collected, the field crew will record visual observations and measurements. Visual observations include sheen, scum, debris, water elevation relative to the local elevation reference point, and time. Field measurements will be recorded in the field notebooks.

Replicate samples and field blanks will each be collected for analyses at a rate of 15% per storm event or once per storm event per parameter, whichever is greater. Replicate sampling procedures for water quality parameters are described in the QAPP.

5.2 Sample Preservation and Packing

BOD, TSS, fecal coliform, and all POL samples will be collected, preserved, and packed for shipment to the laboratory as described in the QAPP.

5.2.1 Chain of Custody

Instructions for the use and completion of the chain of custody forms are provided in Appendix G of the QAPP.

5.3 Field Instrument Calibration

Tipping bucket rain gages are calibrated by the manufacture prior to deployment. No additional field calibration nor replication of measurement is necessary. Weirs and installed staff gages will be calibrated at installation. The field crew will check calibration prior to a predicted event, during event grab sampling, and following the event.

Water quality field instrument calibration is addressed in Appendix H of the QAPP. Hand-held field monitoring equipment will be calibrated each day and will be used in the field according to the manufacturer's directions and for each parameter to be monitored.

5.4 Site-specific Non-Direct Measurements

MOA will estimate storage in the sedimentation basins to determine the appropriate time to obtain grab samples after the commencement of the runoff event.

For each monitoring point, the field crew will record the following observations and measurements at the time of sampling:

- Time each grab sample is obtained
- Water conditions at the monitoring point

  - Odors
  - Floatables
  - Sheen
  - Surface scum
  - Debris
- Other unusual conditions.

6.0 Training

Each field crew member must complete the following training prior to conducting field work:

- Field safety
- Installation of monitoring equipment
- Calibration and operation of all field water quality monitoring equipment
- Proper and complete recording of data in field log books
- Sampling protocols
- Visual monitoring requirements
- Field quality control samples
- Sample preservation and packaging
- Chain of custody completion
- Familiarity with laboratory location.

Before field crew members are allowed to do reportable work, they must demonstrate competence in conducting field analyses. A tenured field crew will ensure that new field crews are competent in all field procedures and test protocols.

7.0 Report

MOA will prepare a brief report following each of the sampling seasons at each BMP that will be submitted as part of the annual APDES report. The brief report will include a description of field and laboratory results for the preceding season.

At the end of the fourth year of sampling, MOA will compile the results from all sampling events into a report of BMP effectiveness. This report will include the following sections:

- Executive Summary
- Monitoring program background and objectives
- BMP descriptions and monitoring station descriptions

- Sampling methodology including analytical parameters, methods, reporting limits for field, and laboratory measurements
- Results including
    - Precipitation hyetographs
    - Weir equations that relate stage height with flow rate
    - Hydrographs for each event
    - Graphs of field data for each storm event (i.e., pH, turbidity, DO, temperature)
    - Correlations between TSS and turbidity at the sedimentation basins.
    - Descriptive statistics and event mean effluent concentration and/or sum of loads as appropriate for measured parameters over seasonal periods and for each sampled storm event. For fecal coliform, the geometric mean will be used to develop event mean concentrations
    - Quality control/quality assurance
- Discussion of the results
    - Flow data in relationship to precipitation
    - Graphical presentation of parameter concentration in relation to flow
    - Comparison of effectiveness of the different sedimentation basin designs at treating the pollutants.
- Conclusions and recommendations
    - Conclusions that can be drawn from the data
    - Recommended changes to the protocols for future sampling events
    - Recommended changes to BMPs use and maintenance, as appropriate.

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Attachment C-1

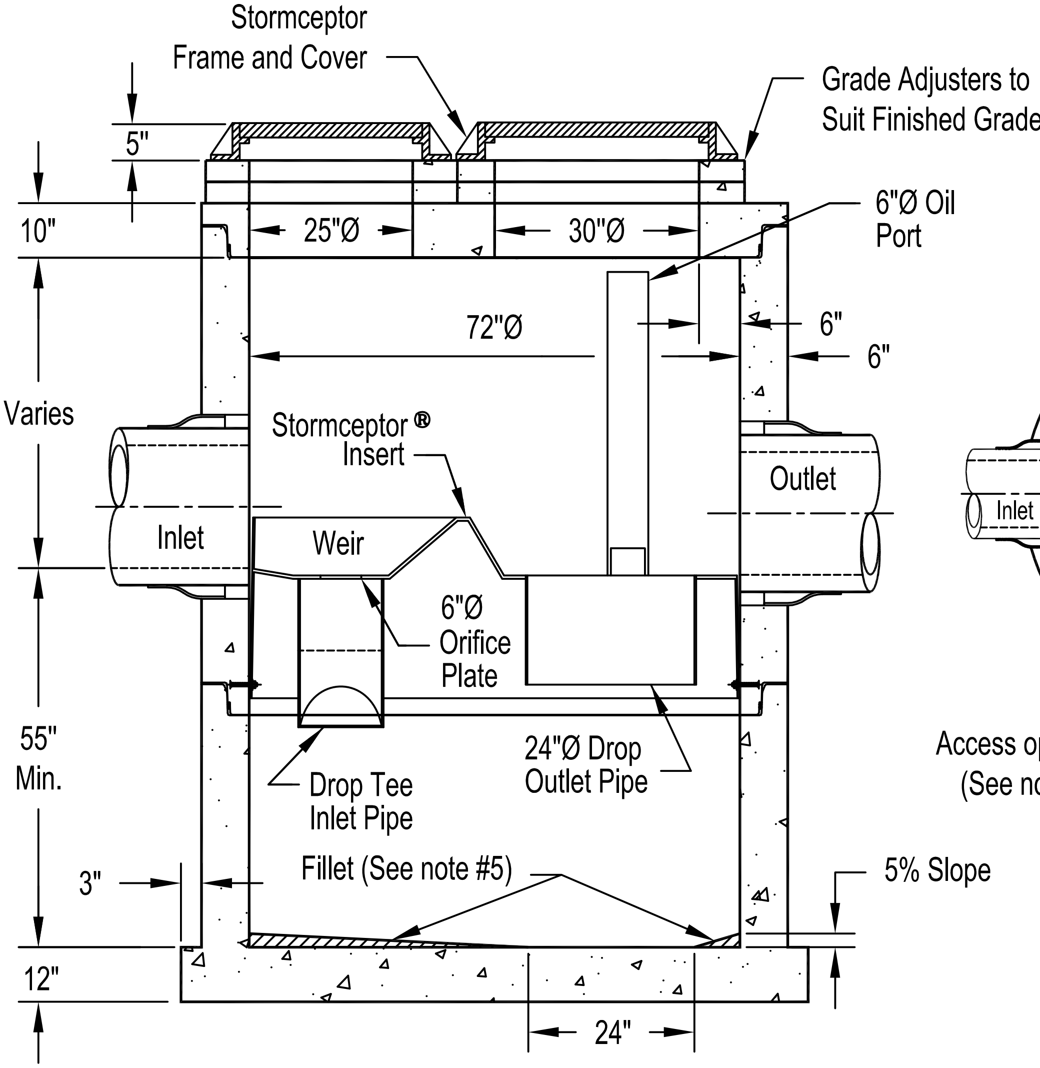
Schematic Diagrams of OGS Systems
Vortechs 9000

Stormceptor

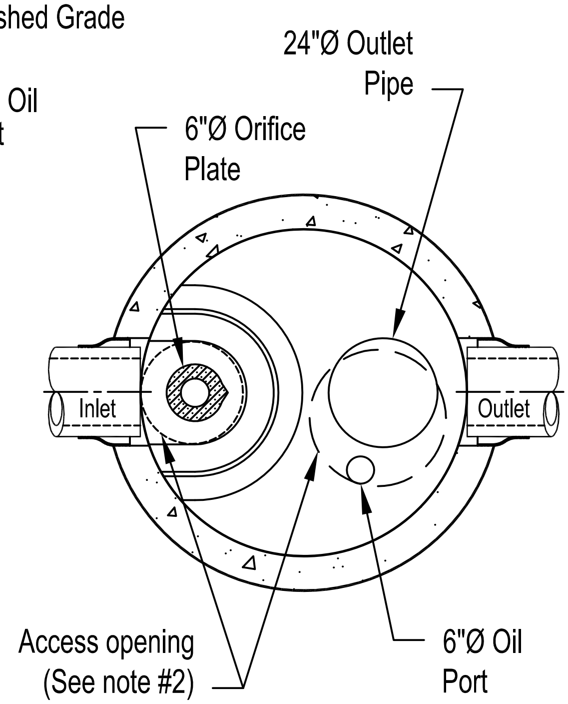
Rinker MATERIALS™

Concrete Pipe Division

STC 900 Precast Concrete Stormceptor ®
(900 U.S. Gallon Capacity)
Municipality of Anchorage Standard



Section Thru Chamber



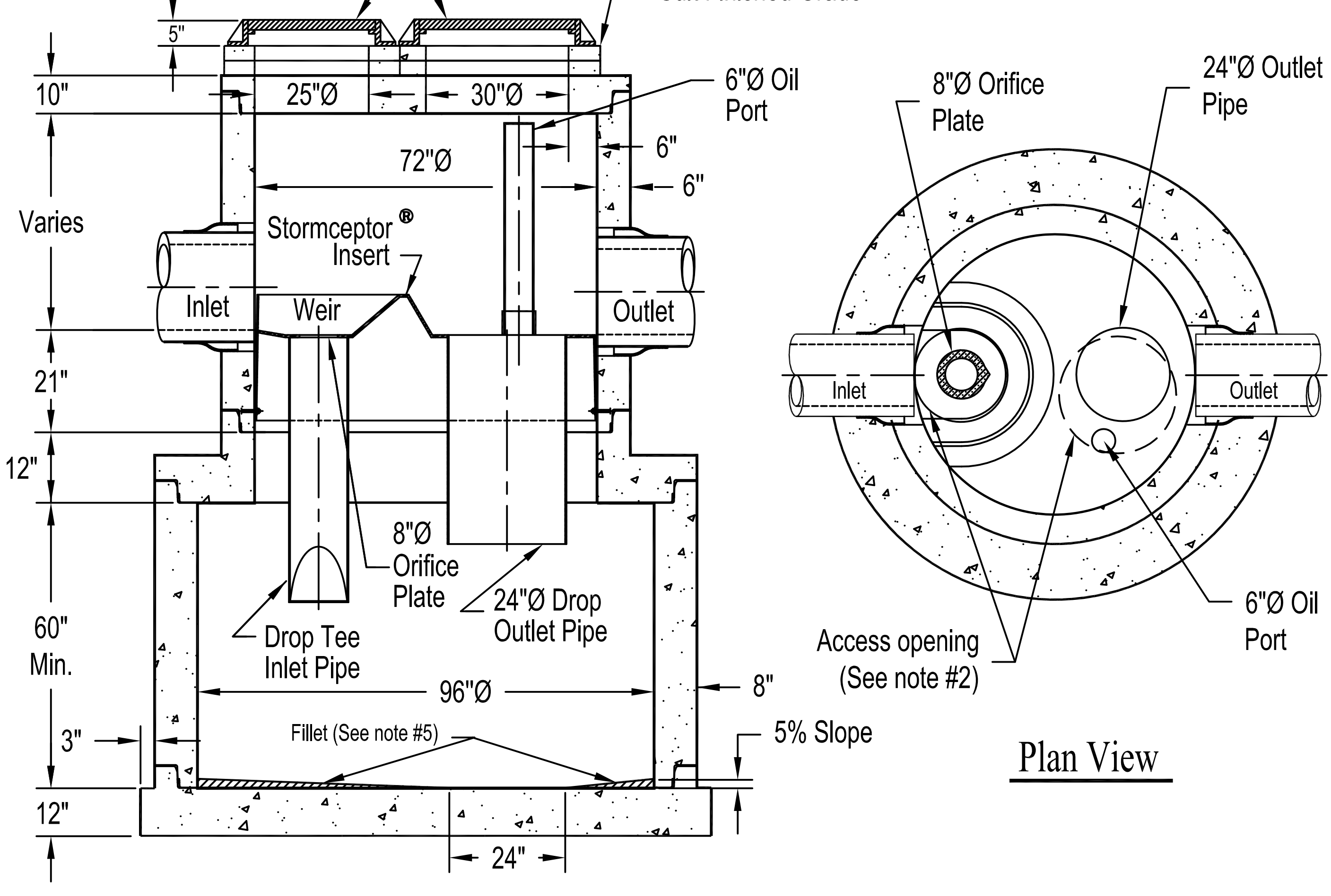
Plan View

Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The 30"Ø Opening Will be Positioned Over The Outlet Drop Pipe and The Oil Port. The 25"Ø Opening Will be Positioned Over The Inlet Drop Tee.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.
5. Contractor is responsible to make arrangements with the Precaster to cast the "fillet" prior to delivery.
6. Dimensions may vary with local manufacture; D&S Concrete Inc., 2140 E. 84th Court, Anchorage, AK 99507.

Rev: 3.25.09

STC 2400 Precast Concrete Stormceptor®
(2400 U.S. Gallon Capacity)
Municipality of Anchorage Standard



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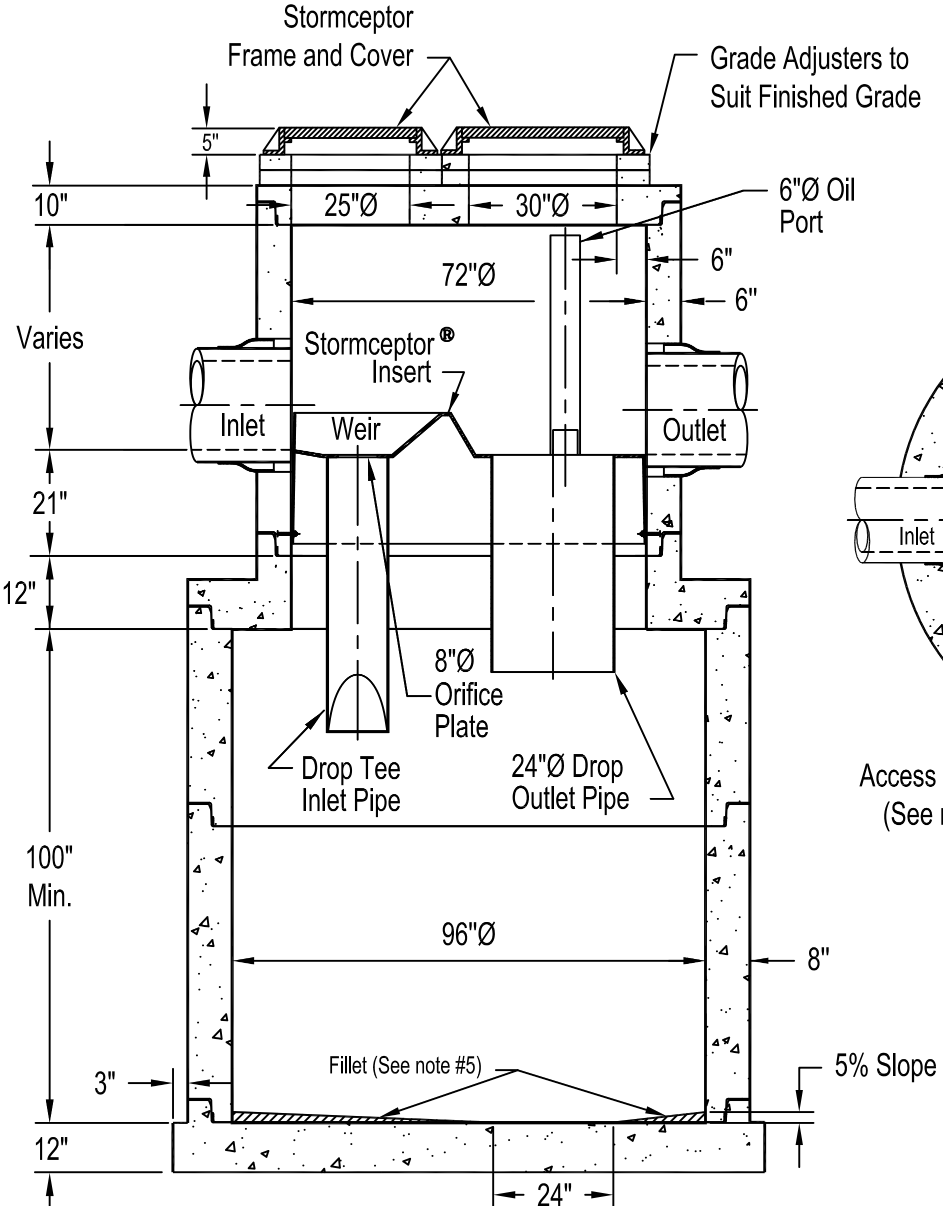
Rinker MATERIALS™

Concrete Pipe Division

STC 3600 Precast Concrete Stormceptor®
(3600 U.S. Gallon Capacity)
Municipality of Anchorage Standard



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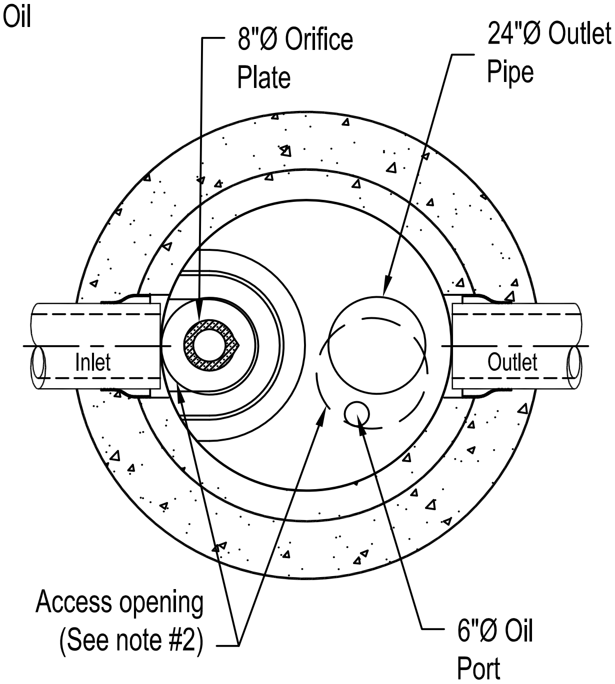

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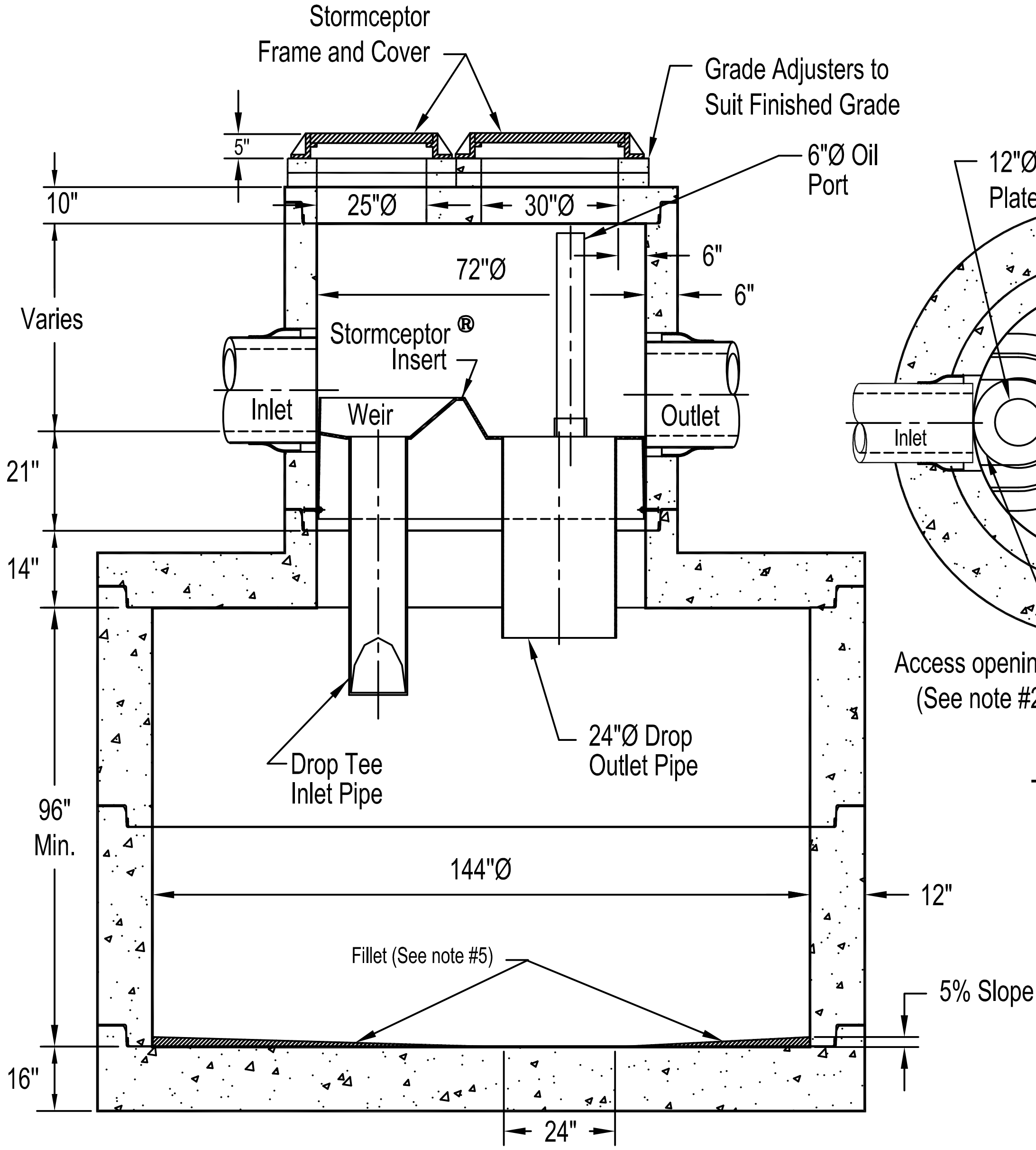
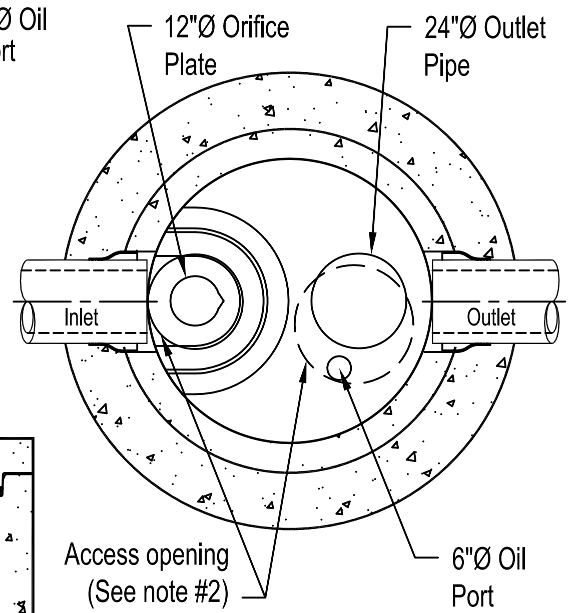
2. The 30"Ø Opening Will be Positioned Over The Outlet Drop Pipe and The Oil Port.
   The 25"Ø Opening Will be Positioned Over The Inlet Drop Tee.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.
5. Contractor is responsible to make arrangements with the Precaster to cast "fillet" prior to delivery.
6. Dimensions may vary with local manufacture; D&S Concrete Inc., 2140 E. 84th Court, Anchorage, AK 99507.

Rev: 3.25.09

STC 7200 Precast Concrete Stormceptor ®
(7200 U.S. Gallon Capacity)
Municipality of Anchorage Standard



Section Thru Chamber



Plan View

Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The 30"Ø Opening Will be Positioned Over The Outlet Drop Pipe and The Oil Port. The 25"Ø Opening Will be Positioned Over The Inlet Drop Tee.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.
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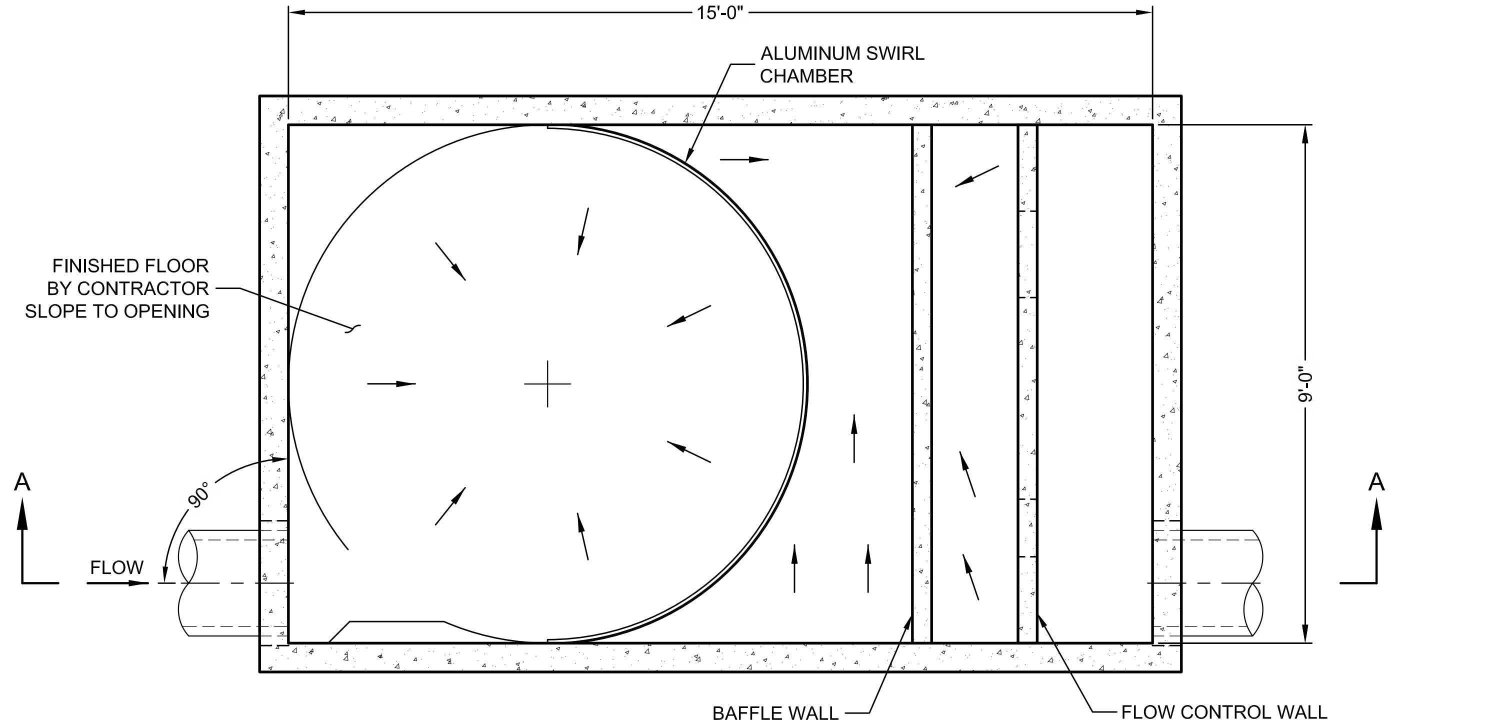
6. Dimensions may vary with local manufacture; D&S Concrete Inc., 2140 E. 84th Court, Anchorage, AK 99507.

Rev: 3.25.09

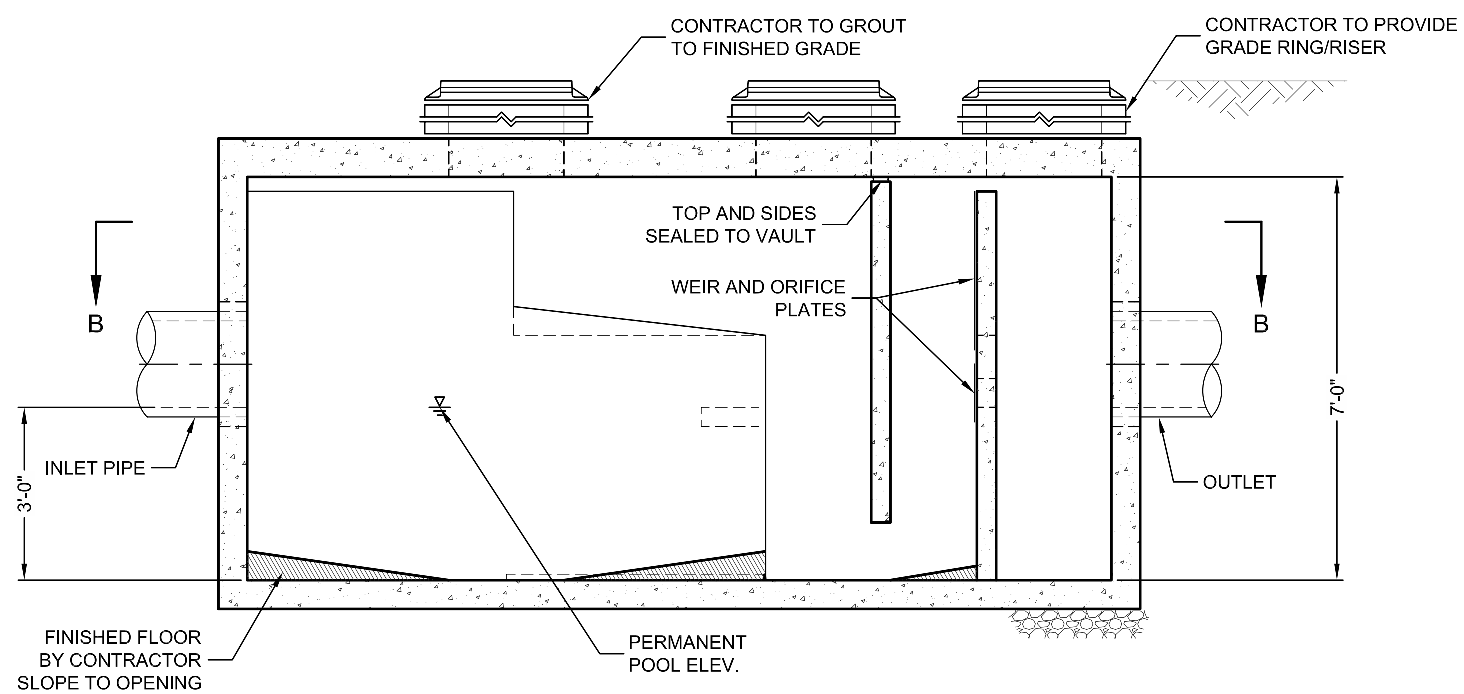
VORTECHS 9000 DESIGN NOTES

VORTECHS 9000 RATED TREATMENT CAPACITY IS 14 CFS, OR PER LOCAL REGULATIONS. IF THE SITE CONDITIONS EXCEED RATED TREATMENT CAPACITY, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

THE STANDARD INLET/OUTLET CONFIGURATION IS SHOWN. FOR OTHER CONFIGURATION OPTIONS , PLEASE CONTACT YOUR CONTECH CONSTRUCTION PRODUCTS REPRESENTATIVE. www.contech-cpi.com



SECTION B-B



SECTION A-A

FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			*
WATER QUALITY FLOW RATE (CFS)			*
PEAK FLOW RATE (CFS)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*
NOTES/SPECIAL REQUIREMENTS:			

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH CONSTRUCTION PRODUCTS REPRESENTATIVE. www.contech-cpi.com
4. VORTECHS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. INLET PIPE(S) MUST BE PERPEDICULAR TO THE VAULT AND AT THE CORNER TO INTRODUCE THE FLOW TANGENTIALLY TO THE SWIRL CHAMBER. DUAL INLETS NOT TO HAVE OPPOSING TANGENTIAL FLOW DIRECTIONS.
7. OUTLET PIPE(S) MUST BE DOWN STREAM OF THE FLOW CONTROL BAFFLE AND MAY BE LOCATED ON THE SIDE OR END OF THE VAULT. THE FLOW CONTROL WALL MAY BE TURNED TO ACCOMODATE OUTLET PIPE KNOCKOUTS ON THE SIDE OF THE VAULT.

INSTALLATION NOTES
1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE VORTSENTRY HS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
3. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
4. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
5. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

Vortechs®

CONTECH®
CONSTRUCTION PRODUCTS INC.
www.contech-cpi.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

VORTECHS 9000
STANDARD DETAIL - ANCHORAGE, ALASKA

I:\STORMWATER\DRAFTING\NEW STD CONVERSIONS\VORTECHS\STANDARD DETAILS\DWG\VX-9000-DTL-ANCHORAGE.DWG 12/10/2009 11:54 AM

Appendix D
Snow Storage Site Retrofit Monitoring Plan

Table of Contents

D.Snow Storage Site Retrofit Monitoring Plan

1.0 Introduction

1.1 Background

The Municipality of Anchorage (MOA) has conducted a number of studies to assess deicer and snowmelt impacts on receiving waters. These assessments provide quantitative, site-specific local data. In addition, these assessments were informed by reference to the literature on similar research.

In 1998 the MOA sampled snowmelt at four snow storage sites (Commercial Drive, Tudor Road, Sitka Street, and Anchorage International Airport), each with snow hauled from different types of land uses (MOA, 1998). This study was specifically targeted to assess the potential for meltwater from snow storage sites containing magnesium chloride deicer to impact Anchorage surface and subsurface receiving waters.

As a follow-up to the 1998 study, in 1999 the MOA sampled snowmelt at two snow storage sites (North Mountain View and Tudor Road) to determine whether the 1998 data accurately represented chloride impacts from snow site meltwater (MOA, 1999). In addition, this study monitored chloride concentrations in snowmelt runoff from three street sites and in receiving waters. This study estimated concentrations of anions and cations in snowmelt from samples to estimate the relative proportion of chloride, magnesium, and sodium in meltwater and receiving waters.

In 1999 EPA issued a National Pollutant Discharges Elimination System (NPDES) stormwater discharge permit (AKS 052558) to the MOA and the Alaska Department of Transportation and Public Facilities (ADOT&PF). The permit required these co-permittees to assess the effects of street deicers on water quality and to require the use of Best Management Practices (BMPs) at snow storage sites. Based on the permit requirements and building on monitoring efforts in 1998 and 1999, the MOA conducted several more years of monitoring at snow storage sites.

In 2000 the MOA conducted a study that estimated snow mass in the snow pack at Sitka, Tudor, and South Anchorage snow storage sites and assessed pollutant concentrations, including chloride and turbidity, in the snowmelt prior to settling or dilution in the detention basins (MOA, 2000b). In 2001 the MOA also conducted monitoring of snow storage site meltwater at the Tudor snow storage site.

Peak chloride and turbidity values from these past studies are summarized in Table D-1. Chloride concentrations were found to peak early in the monitoring period at approximately 400 mg/L at both the Tudor and Sitka Street snow storage sites in 2000 (MOA, 2000b) and at approximately 1,300 mg/L at the Tudor site in 2001 (MOA, 2001). Chloride concentrations at both sites diminished to less than half their peak concentrations within 4 to 10 days (MOA, 2000b and 2001). Flows from the sites peaked after peak chloride concentrations; and turbidity peaked toward the end of the melt period (MOA, 2001b).

The results of these studies show that the peak chloride concentration precedes the peak flow. This is thought to occur because of the high solubility of sodium and magnesium chloride.

Table D-1. Previous Sampling Results

Snow Site*	Monitoring Location Description	Monitoring Site ID	Maximum Chloride Values		Maximum Turbidity Values
			From correlation with specific conductance	Based on laboratory analyses	Field Sampling Results
			mg/L	mg/L	NTU
2000					
South Anchorage	Meltwater discharger to wetlands from adjacent ponding, east-central side	SANC01A	338	349	5800
	Meltwater discharge to wetlands directly from snow mass - 10 ft north of east pond	SANC01B	333	not sampled	30
	Meltwater discharge to wetlands from snow mass - 30 ft north of east pond	SANC01C	190	not sampled	11
	Meltwater discharging from NE corner of site	SANC02	266	not sampled	299
	Meltwater discharging from northern side about 50 ft from NE corner	SANC03	216	not sampled	299
Sitka Street	Meltwater entering detention pond from snowmass before the fence	SI01	392	405	267
	Meltwater discharging by the entrance gate just prior to off-site discharge	SI02	187	158	50
	Detention pond discharge	SI03	195	not sampled	50
Tudor Road	Discharge from NW edge of snow site into detention basin	TU01	436	428	3500
	Discharge from north central portion of snow site into detention basin	TU02	202	349	337
	Discharge from Eastern edge of snow site into detention basin	TU03	226	333	353
2001					
Tudor Road	Discharge off NW edge of snow site into detention basin	TU01	1338	1160	761
	Discharge from pilot area V-swales	TU03	821	not sampled	8.1

* Key:

Snow Site	General source of snow
Sitka Street	business and residential areas
South Anchorage	business and residential areas
Tudor Road	arterial roads, business and residential areas

Turbidity was found to follow the peak flow. This is thought to occur because the particulates are retained within the snow pack forming a crust on the snow which is the last to enter the discharge stream (MOA, 2000a). Based on these observations and literature information, the MOA proposed a treatment train of V-swales and detention basins as snow storage site BMPs.

In 2001, MOA studied the impact of a set of V-swales (also called V-pads) in a pilot area at the Tudor snow storage site. Installation of the pilot V-pad was intended to reduce turbidity in the snowmelt discharge. This assessment evaluated turbidity and chloride in the discharge over approximately six weeks of snowmelt and quantitatively assessed the effectiveness of the snow storage retrofit by measuring chloride and turbidity in the meltwater discharged prior to the detention pond (MOA, 2001). Study results (MOA, 2001) showed that turbidity in the discharge from the V-pad area of the snow storage site was reduced by an average of four times that of the standard practice storage area.

While the detention ponds are thought to ameliorate the peak chloride concentrations in the discharge to the creek (Langdon, pers. comm., 2010), neither of these studies assessed chloride discharged to the receiving waters from the detention ponds through the entire melt period. Thus, the combined effectiveness of V-pads plus detention pond BMPs has not been assessed.

The NPDES stormwater permit issued in 2009 to MOA is now administered under the Alaska Pollutant Discharge Elimination System (APDES). It requires quantitative assessment of the effectiveness of two full-scale snow storage retrofits by measuring chloride and turbidity in the meltwater discharged from the snow storage sites.

This study will evaluate the effectiveness of the snow storage area BMPs (specifically the V-pads and detention basins) at reducing turbidity and chloride concentrations in snowmelt runoff leaving the snow storage sites. In addition to the control provided by the V-pads and detention basin BMPs, results of this study will also reflect the effects of operational BMPs. These include changes in use of deicing chemicals in the source areas of snow destined for these sites and the placement of snow in these sites (including such considerations as sequencing of site fill, setbacks from berms, and height of the snow mass). The results of this study may also reflect season to season variability in snow filling operations due to the timing and amount of snowfall and application of sand and deicer in the Anchorage bowl.

1.2 Problem Definition

During the winter, MOA and ADOT&PF use de-icing and anti-icing agents that contain sodium and magnesium chloride to improve driving conditions. The salts mixed with traction aggregate applied to streets (to prevent clumping of the aggregate and to enhance bonding of the aggregate to snow and ice) and applied directly to Anchorage streets may be mobilized in meltwater from the street or snow containing these salts may be removed when snow is plowed and hauled to one of several snow storage sites within the Anchorage area. Data suggest that while most of the de-icing agents (sodium and magnesium chloride and aggregate) remain on or near the street application sites, a fraction of particulate and other street pollutants is incorporated into the stored snow (MOA 1998).

During spring thaw, the salts and particulates drain from the snow storage sites and may flow into local streams. Concern over the quality of the discharge from the snow storage sites resulted in the MOA retrofitting the snow storage sites at the Tudor Street snow storage site with windrows of V-shaped swales (or V-pads) for snow placement and detention basin. The pilot study of the Tudor site (MOA, 2001) indicated water quality improvements, specifically in reduced turbidity of the snowmelt discharge.

This study seeks to quantify changes in chloride and turbidity in meltwater discharged from MOA and ADOT&PF-owned or operated snow storage sites to determine whether the BMPs reduce turbidity and chloride concentrations that are discharged to the receiving waters.

1.3 Goals and Objectives

The goal of this monitoring plan is to evaluate retrofits of two snow storage areas to determine the effectiveness of the retrofit BMPs at reducing chloride and turbidity in the snowmelt runoff. Specific objectives are to measure specific conductance (as a surrogate for chloride) turbidity, and flow depth, which will be used to compute the flow of the snowmelt discharged at two snow storage areas that have been retrofitted with V-pads and detention ponds. This data will be used to determine whether the retrofits reduce turbidity and chloride concentrations when compared to data gathered prior to retrofits.

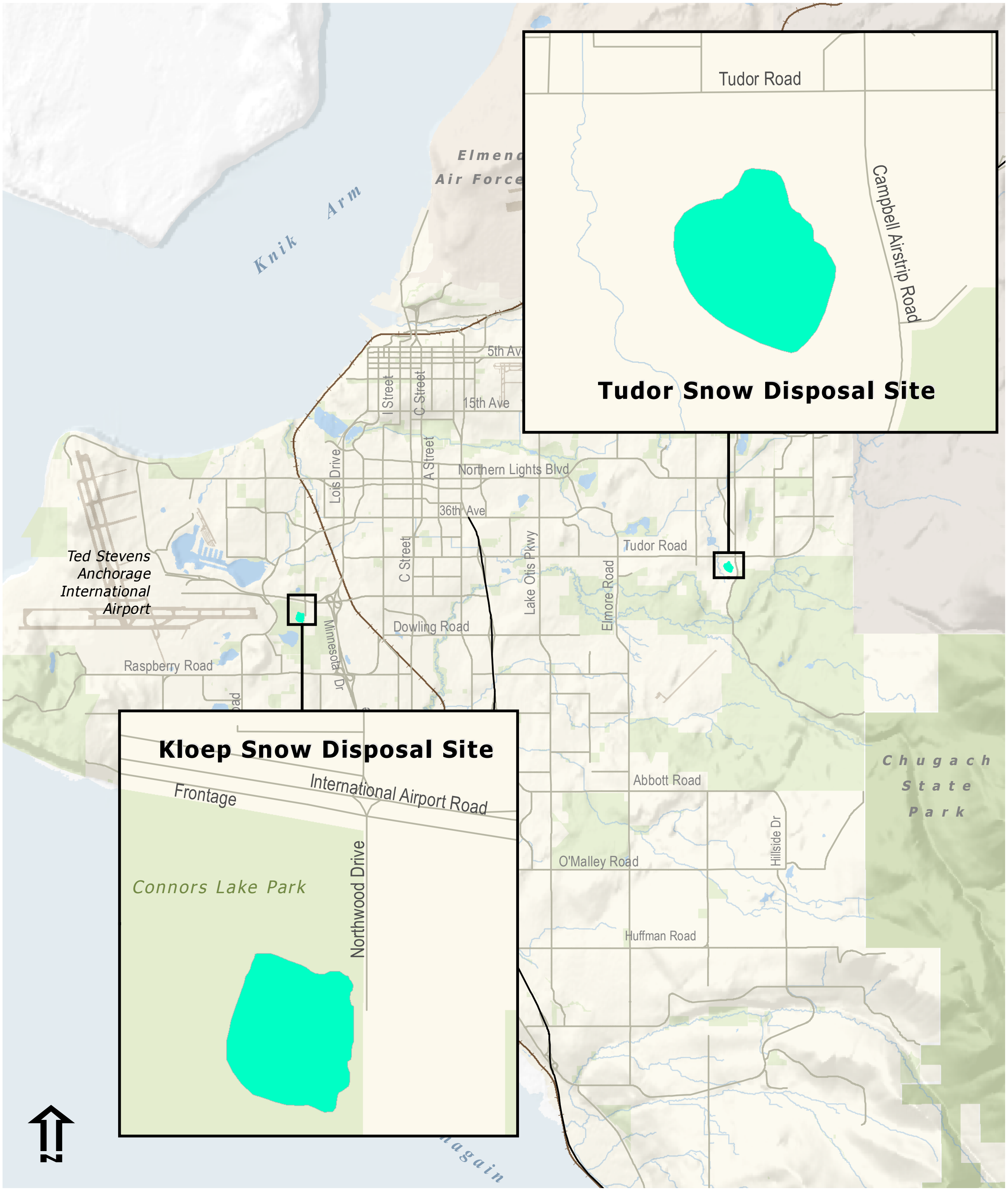
2.0 Description of Program and Rationale

2.1 Sampling Design

MOA will monitor the discharge of snowmelt at two snow storage sites that have been retrofitted with BMPs. The locations of the two sites, the Tudor Road and Kloep Station snow storage sites, are depicted in Figure D-1. If MOA identifies an alternative site for either of these, the site will have equivalent BMPs and sampling regime.

The Tudor snow storage site is located southwest of the intersection of Tudor Road and Campbell Air Strip Road. The site has a relatively high slope and historically turbid meltwater (MOA, 2000b). The Tudor site meltwater discharges into an unnamed branch of Chester Creek.

The Kloep Station snow storage facility is located west of Minnesota Drive on Northwood Drive, south of International Airport Road. The existing snow storage area is located on the west side of Northwood Drive; other portions of the maintenance facility, including three buildings and a storage yard, are located on the east side of Northwood Drive.



Date: December 3, 2010
Source data: HDR, MOA.
Projection: AK State Plane Zone 4, NAD 83 ft.
File: Fig D1_vicinity_map_Kloep.mxd

Municipality of Anchorage
Watershed Management Services

Snow Storage Site Retrofits

FIGURE D-1
SNOW DISPOSAL SITE LOCATIONS

Two types of BMPs have been installed at the Tudor site. The first is an expansion of the pilot study V-swales that now encompass the entire area where snow is placed in windrows. As the snowmelts, particulates that cause turbidity are retained within the swales. The V-pad discharges into the second BMP, a detention pond, which further removes solids by settling and serves to ameliorate the peak chloride concentrations.

The Kloep Station site has not yet been retrofitted with V-swales or a detention pond to reduce turbidity or chloride concentrations in the snowmelt discharge. MOA anticipates reconstructing the snow storage area with V-swales on the storage pad and re-contouring the site to direct meltwater to a detention basin on the north end of the site in 2011 or 2012. MOA will conduct monitoring at the Kloep Station in the season following BMP installation.

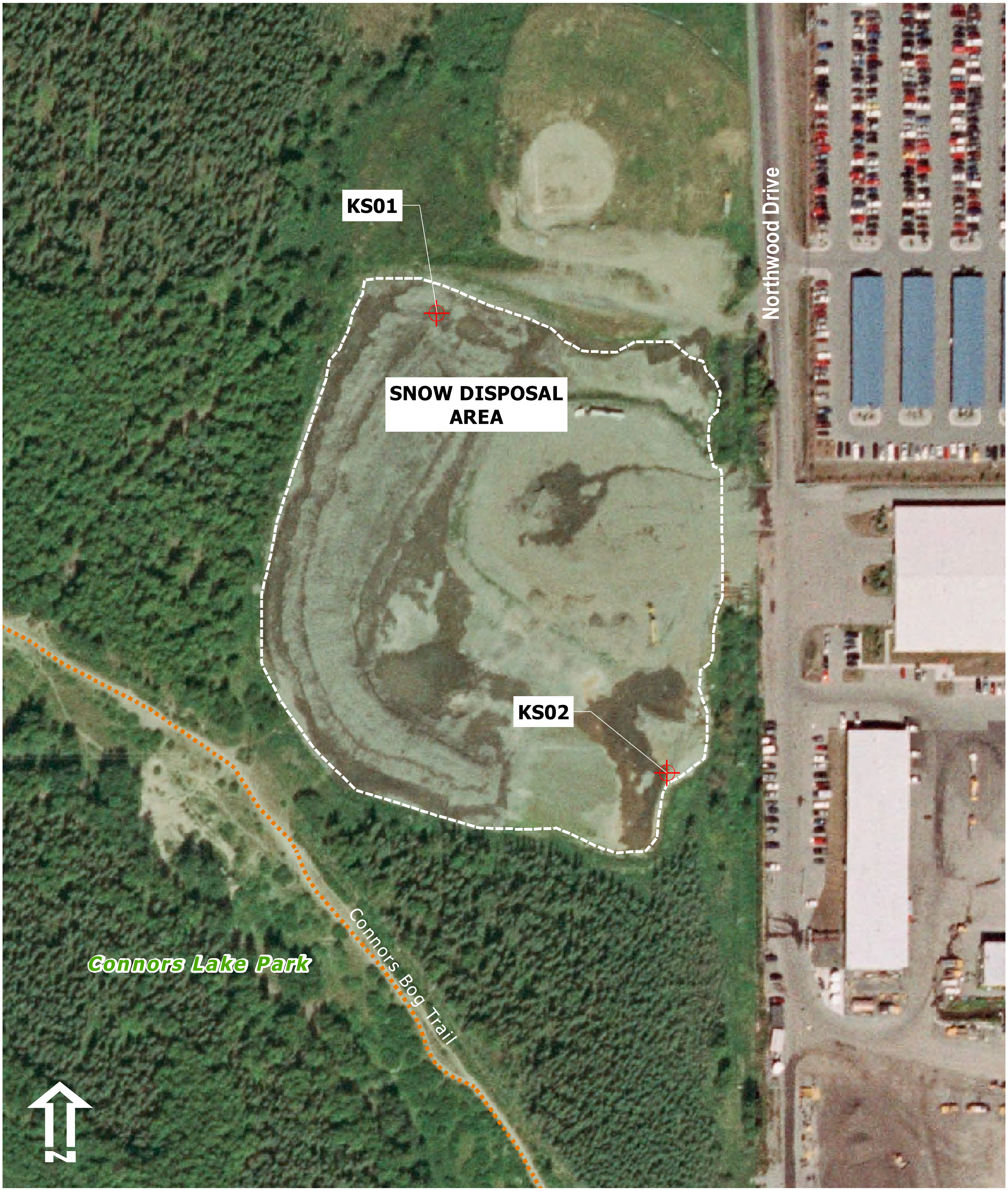
During all sampling events, MOA will monitor flow (staff gage height) and specific conductance continuously using data loggers at select stations and instantaneously at the remainder of the stations using the volumetric method to measure flow and the YSI 556 to measure specific conductance. MOA will obtain daily grab samples for turbidity at all locations and chloride at the locations described in Section 3.

To determine the effectiveness of the V-pad BMP at retaining particulates, MOA will monitor turbidity at the three V-pad outlets at each of the snow storage sites. For the Tudor site, turbidity measurements will be compared to the data obtained in 2000 and 2001 at that site (MOA, 2000b and 2001). For the Kloep Station site, turbidity data obtained at the three V-pad outlets will be compared with the data gathered from snow storage sites that were previously monitored. Turbidity will also be monitored as it discharges from the detention ponds. MOA will monitor turbidity by obtaining daily grab samples.

To determine the effectiveness of the detention ponds at ameliorating chloride concentrations, the three V-pad outlets and the discharge from each pond will be monitored for specific conductance (a surrogate for chloride) and flow depth over a weir. The V-pad outlets will be monitored for specific conductance and flow either continuously (KS01 and TU01 in Figures D-2 and D-3, respectively) or daily (KS02, KS03, TU02, and TU08) to establish chloride concentrations and flow entering the detention ponds.

MOA will also obtain 10 grab samples for laboratory analysis of chloride at each site. Chloride grab samples and specific conductance readings will be obtained simultaneously. The chloride samples will be used to derive a correlation equation between specific conductance and chloride and employed to estimate chloride concentrations at the monitoring points and chloride loading discharges from each site.

Flow depth will be monitored continuously at an existing or installed weir crest at TU01 and TU04 at the Tudor site and at KS01 and KS04 at the Kloep site. At the other sample locations weir stage levels will be obtained at the time of grab sampling. Existing weirs will be used where available and in good condition. Where needed, temporary weirs will be installed at the sampling locations. Where necessary, sand bags will be used to direct flow over the weirs. The appropriate equations for the chosen weir configuration will be applied to obtain either continuous or instantaneous flow records.



0 100 200
Feet

Sample Location
Park
Trail

Date: December 3, 2010
Source data: HDR, MOA.
Projection: AK State Plane Zone 4, NAD 83 ft.
File: Fig D2_Kloep.mxd
Author: HDR Alaska, Inc.

Municipality of Anchorage
Watershed Management Services

Snow Storage Site Retrofits

FIGURE D-2
KLOEP SNOW DISPOSAL SITE

Date: September 10 2010
Source data: HDR, MOA.
Projection: AK State Plane
Zone 4, NAD 83 ft.
File: Fig D3_Tudor.mxd
Author: HDR Alaska, Inc.

Municipality of Anchorage
Watershed Management Services

Snow Storage Site Retrofits

FIGURE D-3
TUDOR SNOW DISPOSAL SITE

MOA will identify the locations of origin of the snow stored at each location and obtain data from the Department of Maintenance and Operations, Street Maintenance about the quantities of de-icing and anti-icing compounds applied in the contributing areas.

2.2 Schedule of Sampling

The MOA will install specific conductance and flow monitoring equipment (data loggers) at the locations described in Section 3.0, Monitoring Locations. The equipment will be installed during the last week in March or the first week of April of the years in which sampling is to occur. The instruments will record data until flow diminishes to 0.001 cfs at the outfalls (between mid-May and the end of June). The end date will vary depending on the onset and intensity of spring thaw.

MOA will obtain daily grab samples for field and laboratory analysis between 2:00 and 3:30 pm.

3.0 Monitoring Locations

Runoff from both snow storage sites flows to the north through three outlets depicted on Figure D-2 as KS01through KS03 at the Kloep Station site and on Figure D-3 as TU01, TU02, and TU08 for the Tudor Road site. The discharge from the detention ponds will be monitored at KS04 and TU04

For each of the monitoring locations, Table D-2 summarizes the purpose of monitoring and criteria for selection of the specific sites.

Table D-2. Sampling Site Representativeness

Site ID	Monitoring Purpose	Criteria for Site Selection
TU01	Characterize snowmelt quality after V-swales but before pond	Downstream of V-swales, and upstream of pond
TU02	Characterize snowmelt quality after V-swales but before pond	Downstream of V-swales, and upstream of pond
TU08	Characterize snowmelt quality after V-swales but before pond	Downstream of V-swales, and upstream of pond
TU04	Characterize snowmelt quality after pond treatment	Downstream of pond
KS01	Characterize snowmelt quality after V-swales but before pond	Downstream of V-swales, and upstream of pond
KS02	Characterize snowmelt quality after V-swales but before pond	Downstream of V-swales, and upstream of pond
KS03	Characterize snowmelt quality after V-swales but before pond	Downstream of V-swales, and upstream of pond
KS04	Characterize snowmelt quality after pond treatment	Downstream of pond

4.0 Parameters to be Measured and Methods

Table D-3 summarizes the samples that will be taken at each location, and Table D-4 lists the parameters that will be monitored at each sample location, the sample types, frequencies, and times at which samples will be obtained and the total number of measurements that will be compiled from the sampling efforts.

Table D-3. Sampling Summary

	Flow		Specific Conductance		Turbidity	Chloride
Site ID	Continuous	Instantaneous	Continuous	Grab	Grab	Grab
TU01	X		X	X	X	X
TU02		X		X	X	
TU08		X		X	X	
TU04	X		X	X	X	X
KS01	X		X	X	X	X
KS02		X		X	X	
KS03		X		X	X	
KS04	X		X	X	X	X

Table D-4. Site Sampling Schedule

Site ID	Monitored Parameters	Type of Sample	Frequency	Sample Time	Total No. of Measurements
TU01	Specific conductance, flow stage	C	Continuously	Continuous (4 per hour)	~6,000
	Specific conductance, Chloride	G	1 - 2 times/week	Between 2 and 3:30 pm	5
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45
TU02	Specific conductance, flow stage (staff gage)	G, I	Daily	Between 2 and 3:30 pm	~45
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45
TU08	Specific conductance, flow stage (staff gage)	G, I	Daily	Between 2 and 3:30 pm	~45
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45
TU04	Specific conductance, flow stage	C	Continuously	Continuous (4 per hour)	~6,000
	Specific conductance, Chloride	G	1 - 2 times/week	Between 2 and 3:30 pm	5
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45
KS01	Specific conductance, flow stage	C	Continuously	Continuous (4 per hour)	~6,000
	Specific conductance, Chloride	G	1 - 2 times/week	Between 2 and 3:30 pm	5
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45
KS02	Specific conductance, flow stage (staff gage)	G, I	Daily	Between 2 and 3:30 pm	~45
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45
KS03	Specific conductance, flow stage (staff gage)	G, I	Daily	Between 2 and 3:30 pm	~45
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45
KS04	Specific conductance, flow stage	C	Continuously	Continuous (4 per hour)	~6,000
	Specific conductance, Chloride	G	1 - 2 times/week	Between 2 and 3:30 pm	5
	Turbidity	G	Daily	Between 2 and 3:30 pm	~45

C = Continuous monitoring: I = In-situ measurement (staff gage); G = Grab sample

MOA will use a YSI 6920-V2 water quality monitor or an equivalent data logger for monitoring specific conductance. The instrument will meet the ranges of parameters provided in Table D-5. A weir, coupled with a pressure transducer and data logger, will be installed at the outlet of the detention pond in order to determine flow discharging from the snow storage site. Based on previous data (MOA, 2000 and 2001) flows are anticipated to range from 0 to approximately 0.8 cfs. The flow will be calculated based on water depth over the specific weir as measured by a HOBO water level data logger (model U20-001-04) or equivalent.
Table D-5 lists the parameters and methods that MOA will measure and the methods that will be used for analysis.

Table D-5. Parameters to be Measured in Snow Storage Site Discharges

Parameters	Method	Range
Continuous flow (staff gage) (TU01, TU04, KS01, KS04)	Staff gage and data logger	0 to stage height*
Instantaneous flow (TU02,TU08, KS02, KS03)	Staff gage or volumetric	0 to stage height
Turbidity	EPA 1801.M Hach 2100P Turbidimeter	0.1-1,000 NTU
Specific conductance	EPA 120.1 YSI 6820 or equivalent with data logger	0 - 100 µS/cm
Specific conductance	EPA 120.1 YSI 556 hand-held probe	0 - 100 µS/cm
Chloride	EPA 300.0 Rev 2.1	NA

*For example, stage over a 90° V-weir, 4 inches equals 0.169 cfs; 12 inches equals 2.5 cfs
M = Modified for field use per manufacture's recommendations

Method detection limits, practical quantitation limits, and precision, accuracy, and completeness criteria are provided in the Quality Assurance Project Plan (QAPP).

5.0 Sampling Methods

5.1 Site-Specific Sample Methods, Handling, and Field QC

As noted above, one V-pad outlet and the detention pond discharge at each of the snow storage sites will be continuously monitored for flow stage and specific conductance. Continuous records will be generated since all instrumentation will be programmed to collect water stage and specific conductance at 15-minute intervals.

Grab samples for turbidity, specific conductance, and chloride will be collected each day in the late afternoon (between approximately 2:00 p.m. and 3:30 p.m.) when diurnal flow is the greatest. The continuous reading specific conductance meter (YSI 6820 or equivalent) will be checked against the YSI 556 calibrated hand-held probe daily, and the continuous meter may need to be adjusted or re-calibrated. The field crews will also record flow (either by weir stage or the volumetric method) at each of the non-continuous monitoring locations.

After ensuring that the flow monitoring and specific conductance meters are functioning, the water samples will be collected using a grab sampler from the water flowing over the weir to represent the discharge. This is accomplished by holding the grab sampler below the flowing water. If no water is flowing over the weir, a sample will be taken just behind the weir by submerging the bottle beneath the water surface and pulling upward through the water column. Sample crews should take care not to disturb any sediment accumulated behind the weir when collecting a water sample. Field equipment will be used to measure turbidity and specific conductance. When chloride samples are taken, the sample crew will measure specific conductance from a field instrument at the same time. They will also record the exact time the chloride sample was taken for comparison with continuous monitor for specific conductance. They will fill the laboratory bottle for chloride first. Water will be reserved in the grab samples for the field crew to use in measuring turbidity. Field measurements will be recorded in the field log book.

5.2 Site-specific, Non-Direct Measurements

Records of operational BMPs will be maintained throughout the season. These include: locations of origin of the snow; quantities of deicing chemicals applied in the source areas of snow destined for these sites; placement of snow including sequencing of site fill, setbacks from berms, and height of the snow mass. Field crews will identify the dominant watershed land uses from MOA land use maps and the dominant land uses that contribute to the two snow storage sites.

5.3 Sample Preservation and Packing

The turbidity and specific conductance measurements will be recorded in the field, eliminating the need for preservation and packing.

The 10 chloride samples from each site will be collected, preserved, and packed for shipment to the laboratory as described in the QAPP.

5.3.1 Chain of Custody

Use and completion of the chain of custody forms is provided in Appendix G of the QAPP.

5.4 Field Instrument Calibration

Instrument calibration is addressed in Appendix H of the QAPP. Each field instrument will be calibrated according to the manufacturer's directions and records of calibrations will be maintained in the project-specific field log book. Stage height will be recorded using commercially available staff gages calibrated to the hundredth of a foot.

6.0 Training

Each field crew member must complete the following training prior to conducting field work:

- Field safety

- Installation and programming the data loggers
- Operation and calibration of the data loggers
- Sampling protocols
- Calibration and operation of turbidimeter and specific conductance meter
- Proper recording of data in field log book
- Field quality control samples
- Sample preservation and packaging
- Chain of custody completion
- Familiarity with laboratory location.

Before field crew members are allowed to conduct reportable work, they must demonstrate competence in conducting field analyses. A tenured field crew will ensure that new field crews are competent in all field procedures and test protocols.

7.0 Report

MOA will prepare a brief report following each of the sampling seasons at each snow storage site that will be appended to the annual APDES report. The report will include a description of the data logger specific conductance and flow depth data, sampling events, field and laboratory results, a discussion of the results, quality control/quality assurance reporting, and any recommended changes to the protocols for future sampling events. In discussing the results, MOA will:

- Develop a correlation equation between the laboratory chloride data and the specific conductance for each site and use the equation to estimate chloride concentrations obtained at the monitoring points.
- Provide the weir equation(s) that relate stage height with flow rate.
- Compare the peak chloride concentrations and turbidity and curves of chloride concentrations and turbidity before and following BMP installation. For the Tudor site, the comparisons will be made with those reported in the data reports from 2000 and 2001 (MOA, 2000b and 2001). For the Kloep site, post-BMP installation data will be compared to data from the Tudor, South Anchorage, or Sitka Street pre-BMP installation monitoring efforts. The reports will also discuss similarities and postulate reasons for possible differences.
- Estimate chloride loading from each site.
- Compare the average reductions in turbidity from full-scale implementation of a V-pad BMP in this study with those reported for the pilot study (samples with and without the BMPs in place i.e., TU01 results in Table 5 of MOA, 2001).
- Compare differences in chloride loadings from the two sites and identify possible reasons for differences (such as locations of snow origin, volumes of snow stored, etc).

8.0 References

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Appendix E
Low Impact Development Pilot Project Monitoring Plan

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E. Low Impact Development Pilot Project Monitoring Plan

1.0 Introduction

1.1 Background

The U.S. Environmental Protection Agency (EPA) issued the Municipality of Anchorage (MOA) and the Alaska Department of Transportation and Public Facilities (ADOT&PF) a Municipal Separate Storm Sewer System (MS4) permit under the National Pollutant Discharge Elimination System (NPDES) in 1999. EPA re-issued the permit in October 2009 with a requirement to install five pilot projects that use low impact development (LID) techniques for on-site stormwater management. The permit directs the MOA to evaluate the performance of each pilot project and include an evaluation report with the fourth year Annual Report. The permit is now administered under the Alaska Pollutant Discharge Elimination System (APDES).

1.2 Problem Definition

Uncontrolled runoff from new development and redevelopment can adversely affect receiving water bodies if the tools used to manage stormwater focus solely on hard infrastructure and end-of-pipe controls (EPA, 2009). The National Research Council's 2008 report entitled *Urban Stormwater Management in the Untied States* recognized that stormwater control measures that harvest, infiltrate, and evapotranspire stormwater are critical to reducing the volume and pollutant loading from small storms. "Green infrastructure," also called low impact development (LID), uses soil, trees, vegetation, wetlands, and open space to capture stormwater and enhance its treatment. LID techniques are more cost-effective, sustainable, and environmentally friendly that the more traditional infrastructure solutions aimed at rapid removal. EPA indicates that a comprehensive green infrastructure approach to stormwater management seeks to:

- Preserve the natural vegetation such as undisturbed forests, meadows, and wetlands
- Reduce total watershed impervious surface
- Direct new development to areas of previously developed and degraded areas
- Reuse stormwater on-site through infiltration, evapotranspiration, and other reuse techniques.

To assist MOA in its development of a comprehensive stormwater program, the EPA-issued permit requires the MOA to implement and evaluate five LID pilot projects. The five projects are subject to the following permit conditions:

- All of the pilot projects must manage the runoff from a 0.52-inch rain event (the 90^{th} percentile event) from at least 10,000 square feet of impervious surface
- At least two of the projects must address drainage areas greater than five acres
- One pilot project must be located in the Chester, Campbell, Fish, or Little Campbell Creek watersheds
- One of the pilot project rain gardens must be located in a neighborhood and one in a public-private community partnership

- Two of the pilot projects must retrofit two public parking lots with infiltration, evapotranspiration, or reuse techniques.

This monitoring plan is designed to predict and monitor the quantity of stormwater discharged from each of the five LID pilot projects pursuant to the APDES permit obligations.

1.3 Goals and Objectives

One goal of the MOA's comprehensive stormwater program and the LID pilot projects is to reduce stormwater volume discharged to receiving water bodies by reducing total stormwater runoff volumes from newly developed and redeveloped areas that have been retrofit. The LID pilot project monitoring efforts will compare model-generated peak flow, volume, and duration estimates for runoff from the pilot projects to measured values. As directed by the permit:

- For retrofit projects, the MOA will calculate changes in runoff quantities as a percentage of 100% pervious surface, before and after implementation of the LID projects
- For new construction projects, the MOA will calculate changes in runoff quantities for development scenarios both with and without LID practices.

For both retrofit and new construction projects, MOA will measure runoff flow rates with a 20% or less margin of error and will prepare runoff hydrographs to characterize peak runoff rates and volumes, discharge rates and volumes, and duration of discharge volumes. The outcome of this monitoring effort will be used to evaluate the overall effectiveness of the LID features installed, to develop recommendations for future LID practices, and to update the final LID criteria in the Storm Water Design Criteria Manual.

2.0 Description of Program and Rationale

Monitoring the hydrologic effectiveness of LID is challenging because LID principally seeks to minimize or prevent the formation of concentrated stormwater runoff. The use of hydrologic/hydraulic modeling makes it possible to estimate diffuse flows into or out of LID facilities that could not be accurately measured based on the contributing area characteristics, local rainfall patterns, and LID facility configuration. This program will pair modeling and monitoring data to 1) select appropriate monitoring equipment, 2) characterize the full water balance, and 3) evaluate the post-construction performance of each LID feature.

Although the five LID features to be evaluated have not yet been designed or constructed, this monitoring plan assumes that they will consist of bioretention facilities (i.e., rain gardens and/or bioretention swales) with varying configurations of inflow, overflow, and possibly underdrain pipes. The designs for those features will need to explicitly account for monitoring in the construction plans. Furthermore, the final monitoring plans to be developed by MOA will vary based on the specific design and installation at each site.

2.1 Sampling Design

The first step in developing a sampling design for each site will be to review the design report to determine the design flows that were used. The design flows will inform the selection of monitoring equipment, where specialized equipment may be needed for particularly low flows.

For each LID feature, a pressure transducer will be installed in each bioretention area, or cell, to record continuous surface ponding levels. The pressure transducers will be installed in a sump to be located in the lowest portion of the cell (if not flat). The sump will be lined with an impermeable liner to maintain water over the pressure transducer during times when there is no ponded water in the cell. The sump will have a minimum depth of 12 inches, or will follow the manufacturer's recommendations.

If overflow pipes are present and have sufficient slope and diameter to allow for accurate flow monitoring, overflows may also be continuously monitored. The equipment used for monitoring will depend on the overflow construction. For instance, a pressure transducer or ultrasonic level sensor may be installed in the overflow pipe itself with an in-pipe weir or flume to meter the flows. Alternatively, a pressure transducer may be installed in a stilling structure, such as a manhole or catch basin immediately downstream of the overflow, where such structures exist and have no other flow contributions. The pressure transducer continuously records water levels, and corresponding weir, orifice equations or other stage-discharge relationships, as appropriate, are used to convert the water level records into continuous flow records.

If overflow pipes are not present or cannot be accurately monitored, MOA will develop a stage-volume-discharge relationship based on detailed topographic survey of the facilities' surface storage capacity (conducted by MOA) and the use of mathematical equations (i.e., weir, orifice, and/or Manning's equation, etc.). Appropriate equations and relationships will be selected and parameterized based on a field evaluation of each site.

Similarly, if inflow and/or underdrain pipes are present and have sufficient slope and diameter to allow for accurate flow monitoring, those flows will also be directly monitored. Otherwise, hydrologic/hydraulic modeling will be performed to simulate those flows. See Section 2.2 for more detail.

General considerations for the final sampling plans to be developed by MOA for each site include:

- Provisions for monitoring in the final construction plans for each site in order to make monitoring relatively easy and effective.
- Monitoring design measures that protect against vandalism (i.e., fences, manhole covers with locking lids, etc.)
- Location of rain gage as close to the LID feature as possible, while not disrupting use of the site and with as little interference as possible from buildings, overhangs, landscaping and trees, wind, or other factors that may affect accurate readings. The rain gage must be protected from vandalism.
- Location of pressure transducers in sumps or stilling structures, such as manholes, catch basins, and/or stilling wells with corresponding mathematical relationship to calculate flow from recorded depths.

2.2 Hydrologic/Hydraulic Modeling

Where monitoring of inflows is infeasible due to lack of pipes (or other concentrated conveyance), or due to pipes that are installed in a manner unsuitable for monitoring for reasons described above, the Stormwater Management Model Version 5.0.021 (SWMM5 LID) will be used to simulate those inflows.

Hydrologic modeling will be performed using a 5-minute time step, and hydraulic modeling will be performed using a maximum 1-minute time step. These small time steps will allow for accurately estimating peak flow intensities into the LID facilities. The simulation time period will match the monitoring period, as described Section 2.3.

2.2.1 Modeling of LID Facilities

Inflows to the LID facilities will be modeled based on the characteristics of the contributing drainage areas (i.e., soils, vegetation, slopes, and land use), stormwater conveyance pipe network, and local rainfall data, and evaporative losses. The Green-Ampt approach for estimating overland infiltration will be used. Green-Ampt considers the effects of a sharp wetting front moving through the soil column on the capacity of the soil to infiltrate stormwater runoff. Overland infiltration is defined as the infiltration that occurs across the subbasin, before stormwater runoff would enter a LID facility, as opposed to the infiltration that may occur within the LID facility itself through the bottom and/or side slopes. Section 5.1.2 describes the rainfall data to be input to the models.

As described previously, outflows will be monitored if possible. Outflows may include overflow and underdrains, if installed for a given LID facility. Where monitoring outflows is unfeasible, the outflows will be estimated through the use of appropriate physical equations using hydrologic modeling software, as described in more detail above, or an analogous spreadsheet tool.

2.2.2 Modeling of Baseline Conditions

The permit defines the baseline conditions that must be compared with the monitoring data for retrofit and new construction sites (See Section 1.3). For retrofit projects, this baseline condition is defined as 100% pervious surfaces, which is interpreted to mean pre-developed conditions herein. For new construction projects, the permit defines the baseline condition to be the developed project site without mitigation from LID facilities. The SWMM5 LID model will be used to simulate those baseline conditions for each site for purposes of comparing mitigated and unmitigated runoff conditions in accordance with the permit.

In addition to meeting the permit requirements, the model will be used to simulate the following additional baseline conditions for further evaluation of LID facility performance:

- For smaller sites (i.e., in the range of 10,000 square feet), the model will be used to simulate runoff from 100 percent impervious coverage.
- For larger sites (i.e., 5 acres or greater), the model will be used to simulate runoff from the actual land use breakdown that exists at the site, but with no LID facilities.

These additional baseline conditions are similar to the permit requirements, but are based on the size of the contributing area, rather than whether the project is a retrofit or new construction. Comparing the LID facility performance with unmitigated runoff from 100 percent impervious surfaces, in addition to the pre-developed baseline condition for smaller sites, will provide additional useful information on system performance going beyond the permit requirements.

2.2.3 Modeling Results

The results of the modeling will be coupled with the monitoring records and will be graphed in the inflow, stage, and outflow hydrographs, as described previously. Statistical analysis of the modeling results will also be performed to calculate the peak flow, volume, and flow duration reductions achieved by each LID facility. Alternatively, scatter plots or histograms may be developed to graphically illustrate the frequency of rainfall and discharge events (Geosyntec, 2009). This allows visualization of threshold discharge as a function of rainfall depth or inflow.

2.3 Schedule of Flow Monitoring

For a single wet season (approximately May through October) following installation of each pilot project, the MOA will monitor inflows and outflows for the LID facilities. Prior to the sampling season chosen for each pilot project, the monitoring locations will be identified and a map of the monitoring locations will be prepared as an addendum to this monitoring plan.

3.0 Monitoring Locations

The specific LID features and their locations have not been determined at this time.

4.0 Parameters to be Measured and Methods

For each LID feature, the depth of surface ponding will be used to calculate overflow from the LID feature. Section 2.1 outlines other monitoring points.

The MOA will also install tipping-bucket rain gages at each site and will measure continuous rainfall at 0.01 inch intervals throughout the wet season. These rain gages will be co-located at the LID feature.

4.1 Site-Specific, Non-Direct Measurements

No non-direct measurements are associated with this monitoring plan.

5.0 Sampling Methods

5.1 Site-Specific Sample Methods, Handling, and Field QC

MOA will install the pressure transducers, data loggers, and rain gages at each of the sites as early in the spring as feasible, considering spring thaw. MOA will download data and ensure that the equipment is functioning properly on a bi-weekly basis. The monitoring equipment will be removed in October to prevent freezing.

5.1.1 Precipitation Records

Precipitation will be recorded using a tipping bucket rain gage and data logger recording in 0.01 inch increments. The rain gages will be co-located with the LID feature. During precipitation events the collection cup in the gage collects precipitation until it reaches the equivalent of 0.01 inches of precipitation where upon the bucket tips, triggering a reed switch and recording an event with a time stamp. These events are stored in the data logger and downloaded into a computer program where they can be summarized over different time intervals or graphed over time to produce a hyetograph. Data from tipping-bucket rain gages will be downloaded every two weeks.

For each 24-hour storm event, the following data will be gathered: total 24-hour precipitation, beginning and ending time, and date of each storm event flow. A hyetograph will be generated from the collected data.

5.1.3 Water Quality Sampling

No water quality samples will be obtained for the LID pilot project monitoring.

5.2 Sample Preservation and Packing

No water quality samples will be obtained for the LID pilot project monitoring.

5.2.1 Chain of Custody

No water quality samples will be obtained for the LID pilot project monitoring, and no chain of custody forms will be needed.

5.3 Field Instrument Calibration

Instrument calibration will be conducted in accordance with the specific manufacture's manuals for the equipment installed.

Tipping bucket rain gages are calibrated by the manufacturer prior to field deployment and require no additional calibration. Weirs and installed staff gages will be calibrated at installation. The field crew will check calibration against visual stage height prior to a predicted storm event.

6.0 Training

Each field crew member must complete the following training prior to conducting field work:

- Field safety
- Proper installation of pressure transducers, data loggers, and rain gages
- Proper downloading of field recording data.

Before field crew members are allowed to do reportable work, they must demonstrate competence in conducting field analyses. A tenured field crew will ensure that new field crews are competent in all field procedures and test protocols.

7.0 Report

MOA will prepare a report that will include a brief introduction; a description of each of the LID features that were monitored; monitored and modeled inflows and outflows and monitored stage time series for each LID facility; a discussion of the results; and recommendations for changes to the LID design requirements in the Storm Water Design Criteria Manual based on findings from the performance evaluations. The results section of the report will include the following for each LID facility:

- For smaller sites (i.e., approximately 10,000 square feet), comparison of LID facility outflows (overflow plus underdrain discharge, if applicable) with modeled runoff for a hypothetical 100% impervious, unmitigated site.
- For larger sites (i.e., 5 acres or greater), comparison of LID facility outflows (overflows plus underdrain discharge, if applicable) with runoff for a hypothetical unmitigated condition for the same-size site with the actual land use distribution for that site.
- Runoff and stage hydrographs to characterize peak flow, volume, and flow duration reductions, as well as ponding levels and drawdown times, as compared with observed rainfall intensities.

Inflow, stage, and outflow hydrographs will be developed for each LID facility for the full monitoring period. Rainfall will be plotted on the secondary x-axis for each hydrograph for direct comparison of rainfall intensity and volume with LID facility performance. Summary statistics, including maximum surface ponding drawdown times and reduction in peak flow rates, volume, and duration of flows will be included in a note on the hydrographs.

8.0 References

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Appendix F
Dry Weather Screening Monitoring Plan

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F. Dry Weather Screening Monitoring Plan

1.0 Introduction

1.1 Background

The U.S. Environmental Protection Agency (EPA) issued the Municipality of Anchorage (MOA) and the Alaska Department of Transportation and Public Facilities (ADOT&PF) a Municipal Separate Storm Sewer System (MS4) permit under the National Pollutant Discharge Elimination System (NPDES) in 1999. The permit is now administered under the Alaska Pollutant Discharge Elimination System (APDES). To meet the requirements of the permit, MOA initiated dry weather screening in 1999 to identify the potential illicit discharges to the MS4 system. MOA conducted the program during the dry season each year through 2009. EPA re-issued the permit in October 2009 with a continued requirement of dry weather screening and subsequent follow-up to eliminate illicit discharges and associated pollutants from the MS4.

1.2 Problem Definition

Dry weather screening is conducted to identify illicit discharges to the MS4 within the MOA. Illicit discharges to the MS4 can introduce pollutants from industrial process wastewater, domestic wastewater, or car wash wastewater inadvertently connected to the system. The first step to eliminating these discharges is to identify them. Flow from storm drains during dry weather in most municipalities is an indicator of improper discharges to the storm system. In Anchorage, flow is more frequently an indicator of groundwater infiltrating into the storm pipe rather than illicit discharges. To identify potential illicit discharges, screening techniques are used to ascertain gross differences in pollutant concentrations from those that would not normally be associated with clean stormwater. Guidance on illicit discharge screening identifies a list of 15 indicator parameters that can be used to confirm the presence of illicit discharges, noting that generally only 3 to 5 of these parameters need to be used to characterize the discharge for subsequent identification and elimination of the discharge (CWP and Pitt, 2004). This monitoring plan is designed to identify potentially illicit discharges.

The APDES permit requires MOA to sample flow from at least 15 stormwater outfalls and to have an additional 30 outfalls prioritized each year for sampling as alternate sites, should an outfall be dry. The permit also requires that outfalls be geographically dispersed and represent all major land uses. The permit specifies screening for seven parameters including: pH, total chlorine, detergents, total copper, total phenol, fecal coliform, and turbidity that may be contributed to the MS4. Benchmark or threshold exceedances are used to trigger further action and provide information that will support that action. Thresholds are not necessarily based on exceedances of water quality standards.

1.3 Goals and Objectives

The ultimate goal of the MOA's illicit discharge elimination program is to ensure that stormwater outfalls do not include illicit discharge of pollutants of concern by methodically testing outfalls and, for those that are found to have elevated levels of pollutants, to follow-up and remove those discharges from the system.

The objective of this dry weather screening program is to measure indicators of pollutants in stormwater outfalls during dry weather flows and to compare the results against threshold (screening) levels so that outfalls with potentially on-going illicit discharges (above the threshold levels) can be targeted for follow-up action.

2.0 Description of Program and Rationale

2.1 Sampling Design

Each year, beginning in the summer of 2011, outfalls from three selected watersheds will be identified based on the watershed and outfall selection methodology described below. Fifteen flowing outfalls will be sampled for seven pollutants that serve as indicators of illicit discharges. Each year, sampling will focus on three of the 12 watersheds that have outfalls from the MS4 to streams. Up to five outfalls within each of the three watersheds that have received complaints during the previous year will be prioritized for sampling. If a total of five outfalls have not been identified through complains, additional outfalls will be sampled beginning both at the downstream end of the receiving water body and at approximately half way upstream and working upstream from both points until 5 outfalls with flow within a watershed have been sampled. Sampling from three different watersheds each year will ensure that the sample sites are geographically dispersed. Sampling from the mouth moving upstream and from the mid-point of the stream length moving upstream will ensure that a variety of land uses are sampled over the course of the permit cycle.

2.2 Watershed and Outfall Selection Methodology and Rationale

Dry weather screening will be performed in a semi-systematic way. Watersheds with outfalls that discharge to an impaired water body, with evidence of contamination in the past three years, or watersheds with a high percentage of impervious cover, and/or have a large proportion of high commercial/industrial (including schools and parks) land uses will receive higher priority for screening. Over the duration of the permit, at least some qualifying outfalls representing a variety of land uses in all identified watersheds[1] will be sampled. Outfalls whose screening results exceed the threshold criteria will be investigated and any illicit discharges will be addressed within 45 days (as per the permit).

Over succeeding permit cycles, MOA will continue monitoring where they stopped the preceding cycle within a watershed and sample every outfall moving upstream. The total of 15 outfalls that will be sampled each year will result in 5 outfalls per watershed that will be sampled each year. This approach is based on the following assumptions:

[1] Identified watersheds include Mirror Creek; Peters Creek; Eagle River and its tributaries South Fork Eagle River and Meadow Creek; Ship Creek; Chester Creek and its tributaries and run-of-river impoundments; Fish Creek; Campbell Creek including Little Campbell Creek, Craig Creek, and other tributaries; Furrow Creek; Hood Creek; Rabbit Creek and its tributaries including Little Rabbit Creek and Little Survival Creek; Potter Creek; and Glacier Creek.

- Screening within all 12 watersheds that have discharges from the MS4 to streams will be completed within the term of the permit
- Stormwater outfalls include direct, unsubmerged outfalls to the stream and are those that are part of the MS4, as defined in 40 CFR122.26 (b)(9)[2]
- Any threshold exceedances in the 2011 year and beyond will be investigated as outlined in "follow-up protocols" provided in Attachment F-1
- Greater concentrations of pollutants of concern (POCs) are generated from more urbanized areas (measured as greater impervious area) than undeveloped areas within the Anchorage bowl, Eagle River, and Girdwood
- Greater concentrations of most POCs are generated from industrial/commercial land uses than residential land uses within the Anchorage bowl, Eagle River, and Girdwood
- Past exceedances of thresholds are indicative of potential illicit discharges within a watershed.

The rationale for this method is that by addressing unresolved complaints and systematically moving up the watershed from downstream to upstream at two starting points (the mouth and the approximate midpoint), illicit discharges can be tracked down and eliminated. By 2014 (the end of the current permit cycle), all watersheds will have received some testing. Continuing this approach across permit cycles, MOA will identify and eliminate illicit discharges throughout each watershed. The prioritization scheme is described below:

To prioritize watersheds for screening for the permit cycle, MOA will answer questions and use the point system described below:

1. Does any of the watershed drain to a Category 4 or 5 waterbody for one of the POCs.
   a. If not, assign 1 point to the watershed.
   b. If yes, assign 5 points to the watershed.
2. Calculate the number of outfalls with threshold exceedances over the 2007 to 2009 period divided by the number of outfalls sampled in that watershed over the three year period and compare to table below for point assignments. They count as multiple exceedances if the same outfall had exceedances for 2 or more POCs on the same date.

[2] At the point where a municipal separate storm sewer discharges to waters of the United States and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the United States and are used to convey waters of the United States.

% of outfalls sampled with threshold exceedances	Points
>90	20
80-89	18
70-99	16
60-69	14
50-59	12
40-49	10
30-39	8
20-29	6
10-19	4
1-9	2
0	0

3. Assign points to the watersheds based on the relative impervious area based on the 2003 GIS layers within the Anchorage bowl, Eagle River, and Girdwood, as in the table below:

% Impervious Area	Points
>90	5
70-89	4
50-69	3
<50	1

4. Assign points to the watershed based on the percent of commercial and industrial land uses based on GIS zoning layers within the Anchorage bowl, Eagle River, and Girdwood areas as listed in the table below:

C/I%	Points
>80	6
60-79	5
40-59	4
20-39	3
<20	2

5. Add the points for each watershed.
6. Rank the watersheds from highest to lowest.

Each year, MOA will identify three highest priority watersheds that have not been sampled during the permit cycle.

To identify the five outfalls within each of the three watersheds, MOA will use the following procedures:

1. The Dry Weather Screening program will only evaluate samples from outfalls that both 1) fit the definition of outfall provided at 40 CFR 122.25(b)(9) and 2) are owned by the

Municipality of Anchorage or ADOT & PF. Outfalls fitting these criteria will be preliminarily identified from the MOA and ADOT's storm sewer inventory and mapping before field mobilization. Samples from pipes or ditches that are privately owned or from pipes that convey streamflow will not be considered part of the Dry Weather Screening program.

2. In April of each year, MOA will consult the list of complaints received by MOA that involve discharges from the MS4. Within each watershed to be sampled in a given year, MOA will identify any outfalls directly associated with these complaints that have been received but not resolved within the permit cycle. The complaint outfalls will be identified on a map.

3. Each of the three watersheds will be divided in approximately half (an upper watershed and a lower watershed). The locations of outfalls with unresolved complaints will be located in either the upper or the lower watershed. If there are not five "complaint" outfalls within the watershed, outfalls will be added beginning at the mouth of the lower half of the watershed and beginning at the line identifying the upper half of the watershed until five sample sites have been identified in the watershed. These are the primary sampling sites within that watershed. Care will be taken to distribute the intended sampling sites approximately equally between the upper and lower portions of each watershed. Ten alternate outfall sites will be identified (five in the lower and five in the upper watershed).

4. An alternate site will be selected when the site is dry or access to the site is through private property for which permission cannot be obtained to cross or if site access is unsafe. Other reasons for an alternate site selection also include outfalls that area completely submerged or the outfalls cannot be located.

5. At field mobilization, MOA will preferentially sample the unresolved complaint sites first, then begin at the mouth and half way marker and sample each flowing outfall identified for the dry weather sampling.

2.3 Selection of Screening Thresholds and Rationale

The Illicit Discharge Detection and Elimination Guidance (CWP and Pitt, 2004) suggests that ideal indicator parameters should:

- Exhibit significantly different concentrations from clean stormwater
- Exhibit chemical characteristics of the potential discharge type
- Be easily and inexpensively measured (e.g., screening technique using field test kits)
- Provide rapid results, preferably results that are obtained in the field
- Be chemically and biologically conservative.

Table F-1 below provides the screening parameters required by the permit and thresholds that will be used to compare outfall sample results. The MOA Dry Weather Sampling Plan (MOA, 1999) established rationale for screening parameter thresholds. Thresholds are established at concentrations sufficiently different from clean stormwater to detect potential illicit discharges. CWP and Pitt (2004) recommend benchmarks (thresholds) orders of magnitude higher than ambient stormwater quality to reduce the incidences of false positives. Thresholds in Table F-1 were established based on available environmental data and field test kit specifications. Values below the threshold are considered to be within an acceptable range for background concentrations. Values at or above the threshold concentration for a parameter indicate that the parameter may be above background concentrations. Outfalls with results higher in concentration (or outside the pH range) for one or more of the pollutant indicators will be targets for follow-up action. Each of the screening parameters is described in greater detail below and follow-up action for threshold exceedances is described in Section 5.1.2.

Table F-1. Parameters Tested in Dry Weather Screening and Associated Thresholds

Parameter	Threshold
pH	≤ 4 or ≥9 STD
Total Chlorine	≥ 1.0 mg/L
Detergents	≥ 1.0 mg/L
Total Copper	≥ 1.0 mg/L
Total Phenols	≥ 0.5 mg/L
Turbidity	≥ 250 NTU
Fecal Coliform	≥ 400 cfu/100 mL

2.3.1 Total Chlorine

Chlorine is a useful parameter for the indication of large quantities of potable water discharge to the storm sewer (Pitt et al., 1993). The Safe Drinking Water maximum contaminant level for chlorine is 4 mg/L. Thus a 1 mg/L threshold appears to be a conservative indicator. The threshold for total chlorine was maintained from the previous dry weather sampling (MOA, 1999).

2.3.2 Detergents

The presence of detergents in stormwater indicates that wastewater may be entering the storm sewer system. Typically, natural surface waters contain surfactant concentrations below 0.1 mg/L, whereas the surfactant concentrations in raw sanitary wastewater commonly range from 1 to 20 mg/L. The LaMOTTE® Detergent test kit measures surfactants in the range of 1.0 to 5.0 mg/L. Therefore, a threshold of 1 mg/L has been set based on these factors. The threshold for detergents was maintained from previous dry weather sampling (MOA, 1999).

2.3.3 Total Copper

Copper can be an indicator of industrial process wastewater to the sewer. The LaMOTTE® kit that was used in the past testing has a range of 0.0 to 4.0 mg/L. Therefore the threshold was set at 1 mg/L. While the threshold concentration will be maintained at 1 mg/L from the previous dry weather screening (MOA 1999), the total copper analysis was conducted in the laboratory using a method that achieved a method detection limit of 0.3 µg/L. Copper concentrations in stormwater are generally measured in much lower concentrations than 1 mg/L. By using the laboratory analysis, MOA gathered quantitative data that helped determine whether the MOA should revise the threshold in the next permit cycle. During 2012 sampling, total copper will once again be analyzed using the LaMOTTE® kit previously used. The threshold is currently 1 mg/L and laboratory testing in 2011 showed concentrations were well below the threshold, which can be indicated with the field sample kits. Prior to field sampling, a spiked sample of copper will be obtained from the contract laboratory and used to test the copper kit to ensure that it is accurately.

2.3.4 Total Phenols

Phenols are a component of many commercial compounds that should not be found in stormwater. The LaMOTTE® kit measures total phenols in the range of 0.1 to 1.0 mg/L. Discharges from riparian habitats and wetlands to the MS4, allowable under the MS4 permit, contain dissolved organic carbon that can potentially produce a false positive in the test result. A threshold set at 0.5 mg/L, as established in previous dry weather screening (MOA, 1999) will reduce the probability of false positive results. To ensure field kits are reading correctly, prior to field work, spiked samples will be obtained from a contract laboratory and used as a sample to check the field kit for accuracy.

2.3.5 Turbidity

The most stringent water quality standard for turbidity applies to waters designated for recreation. The water quality standard for turbidity is a change of 5 NTU above background levels of the receiving water. While this standard protects the beneficial uses of the receiving water, the screening threshold should provide assurance that false positives are not identified. A 250 NTU threshold will provide stronger evidence of a potential illicit discharge than the water quality standard. The threshold is set by comparing water upstream of the outfall to the water in the outfall discharge to determine whether or not the difference exceeds 250 NTUs.

2.3.6 Fecal Coliform

Elevated fecal coliform concentrations can be an indicator of illicit wastewater discharges to an MS4. The most stringent water quality standard for fecal coliform in non-treated waters required that the geometric mean of samples taken in a 30-day period cannot exceed 200 colony forming units (cfu)/100 mL. However, because each outfall will be sampled only once, the water quality standard based on a geometric mean is not relevant. This level would also not be sufficiently different from background to prevent false positives. Another portion of the water quality standard for fecal coliform stipulates that no more than 10% of the samples may exceed 400 cfu/100 mL. The threshold of 400 cfu/100 mL in a single grab sampling will provide an indicator of illicit discharges of waste from humans, pets, and/or warm-blooded wildlife.

2.4 Schedule of Sampling

MOA will conduct dry weather screening following spring break up (snowmelt) and before the beginning of summer rainstorms. This will occur between June 1 and August 30 each year in accordance with the permit. Dry weather screening will be conducted no sooner than 48 hours following a storm event. Since dry weather screening activities are weather dependant, the exact dates of sampling events may vary from year to year. Precipitation data for the Anchorage bowl and Girdwood will be consulted to determine antecedent conditions.

3.0 Monitoring Locations

Specific sites in each watershed will be selected based on criteria described in Section 2.2 and will be determined annually.

4.0 Parameters to be Measured and Methods

4.1 Methods, MDLs, Precision, Accuracy, and Completeness

Table F-2 lists the indicator parameters and the field or laboratory method that will be used for analysis for each.

Table F-2. Parameters Measured for Dry Weather Screening

Parameter	Method [a]	Reporting Range
pH	YSI 556 hand-held probe	0 - 14 STD
Total Chlorine	LaMotte Total Chlorine Octa-Slide Bar kit (3314) (EPA 330.5)	0.1 - 6.0 mg/L
Detergents	Hach model DE-1 Toluidine blue colorimetric (Analytical Chemistry Method #38-791)	0.05 - 1 mg/L
Total Copper	LaMotte model EC-70 Cuprizone Color Chart	0.05- 1mg/L
Total Phenols	LaMotte 4 Amino Anti-Pyrene (4 AAP) colorimetric (SM 5530C)	0.1 - 1 mg/L
Turbidity (outfall and upstream)	Hach 2100P Turbidimeter	0.1 - 1,000 NTU
Fecal Coliform	Standard Methods 9222D	1 col/100 mL – too numerous to count

[a] Field screening parameters are recommended by CWP and Pitt (2004) for illicit discharge detection

4.2 Site-specific, Non-Direct Measurements

Prior to entering the field, the field crew will identify the dominant watershed land uses from MOA land use maps and the dominant land uses that contribute to the outfalls that will be sampled.

The field crew will evaluate precipitation data to determine whether 48 hours has elapsed since the previous precipitation event that resulted in surface water runoff (approximately 0.1 inch or more). Precipitation data can be obtained from the following websites and will be appended to the field form:

For Anchorage: http://www.srh.noaa.gov/data/obhistory/PANC.html
For Girdwood:
http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=MGDWA2&day=31&year=2010&month=8

The following observations will be made at each outfall location and will be documented for the record on the field data form (Attachment F-2):

- Time since the last rain event
- Quantity of precipitation during the last rain event
- Type of conveyance
- Structural condition of the outfall
- Vegetation surrounding the outfall
- Biology (e.g., presence of fish or algae in stormwater)
- Outfall water conditions
  - Odors
  - Color
  - Clarity
  - Floatables
  - Deposits or stains
  - Sheen
  - Surface scum
  - Debris
- Other unusual conditions.

5.0 Sampling Methods

5.1 Site-Specific Sample Methods, Handling, and Field QC

One two-person team will conduct the field sampling when weather permits. The standing protocol is that sampling can occur 48 hours after a storm event that creates runoff in the MS4. The team will have an outfall list; site maps with outfall areas; field equipment and LaMOTTE® and Hach water analysis kits; water analysis sampling protocols; a digital camera; measuring tape; and field data sheets with guidelines.

Upon arriving at the site, the field crew will record field observations in the field log book. Visual observations include those items identified on the field form. The team will also will complete the General Information on the back of the field form (Attachment F-2).

5.1.1 Flow Analyses

From a position of safety, the field crew will measure flow by one of the following methods:

Primary method: Measure the length of time required to fill a calibrated 1- or 5-gallon bucket using a stop watch. Calculate gallons per unit of time.

Secondary method (if the team member is unable to measure the flow): visually estimate the flow as one of the following:

- Low - flow of water is not intense and moving very slowly
- Medium - flow of water is moving at a moderate pace
- High - flow of water is intense and moving very quickly.

5.1.2 Water Quality Sampling

After measuring flow, a grab sample will be collected as described in Appendix G. All dry weather screening water samples must be collected from the water flowing out of the end-of-pipe. Samples collected from other areas are not representative of stormwater.

Once the water sample has been collected, the field crew will record visual observations and measurements concerning the clarity of the water and its color.

The field crew will measure pH, total chlorine, total phenols, total copper, turbidity, and surfactants with field kits (or pH paper) as described on the back of the field data form (instructions are included in Attachment F-2). Field measurements will be recorded and compared against the thresholds described in this plan. Finally, the crew will fill bottles with sample water for the laboratory analyses of fecal coliform.

The field team will conduct equipment blank analysis at the beginning of each day of dry weather sampling. Equipment blank procedures are described in the main body of this Quality Assurance Project Plan (QAPP). The field crew will conduct replicate sample analyses at a rate of 15 percent per day or once per day per parameter, whichever is greater. Replicate sampling procedures are also described in the QAPP. The field crew will also collect replicate samples for the laboratory parameters at a rate of 15 percent per day or once per day per parameter, whichever is greater.

Before sampling begins for the dry weather season, spiked samples will be provided by the contract laboratories to test the total copper and phenols field kits. The spiked sample will be used to ensure that the sample kits are reading accurately and that none of the reagents have been contaminated.

When a dry weather screening parameter exceeds a threshold, field crews will immediately notify the MOA Project Manager of the location and parameter of exceedance so that follow-up actions can be initiated. For fecal coliform and total copper results that exceed the thresholds, the laboratory Project Manager will be requested to notify the Contract QA Officer immediately after the analysis is complete (within approximately 24 hours). The Contract QA Officer will immediately notify the MOA Project Manager for follow-up action. Follow-up actions are described in the flow chart in Attachment F-1.

5.2 Sample Preservation and Packing

Fecal coliform and total copper samples will be collected, preserved, and packed for shipment to the laboratory as described in Appendix G of this QAPP.

5.2.1 Chain of Custody

Instructions for the use and completion of the chain of custody forms are provided in the QAPP.

5.3 Field Instrument Calibration

Instrument calibration is addressed in Appendix H of this QAPP. Each field kit will be calibrated according to the manufacturer's directions provided with the kit.

6.0 Training

Each field crew member must complete the following training prior to conducting field work:

- Field safety
- Proper recording of data on field data sheets
- Calibration and operation of all field water analysis kits
- Sampling protocols
- Visual monitoring requirements
- Field quality control samples
- Sample preservation and packaging
- Chain of custody completion
- Familiarity with laboratory location.

Before field crew members are allowed to do reportable work, they must demonstrate competence in conducting field analyses. A tenured field crew will ensure that new field crews are competent in all field procedures and test protocols.

7.0 Report

MOA will prepare an annual report of the results of dry weather screening. The report will include a brief introduction, a description of the dry weather screening outfalls selected; field and laboratory results; quality control/quality assurance; a discussion of the results; and a description of any follow-up actions taken as a result of threshold exceedances, and recommended changes to the protocols for the upcoming year.

8.0 References

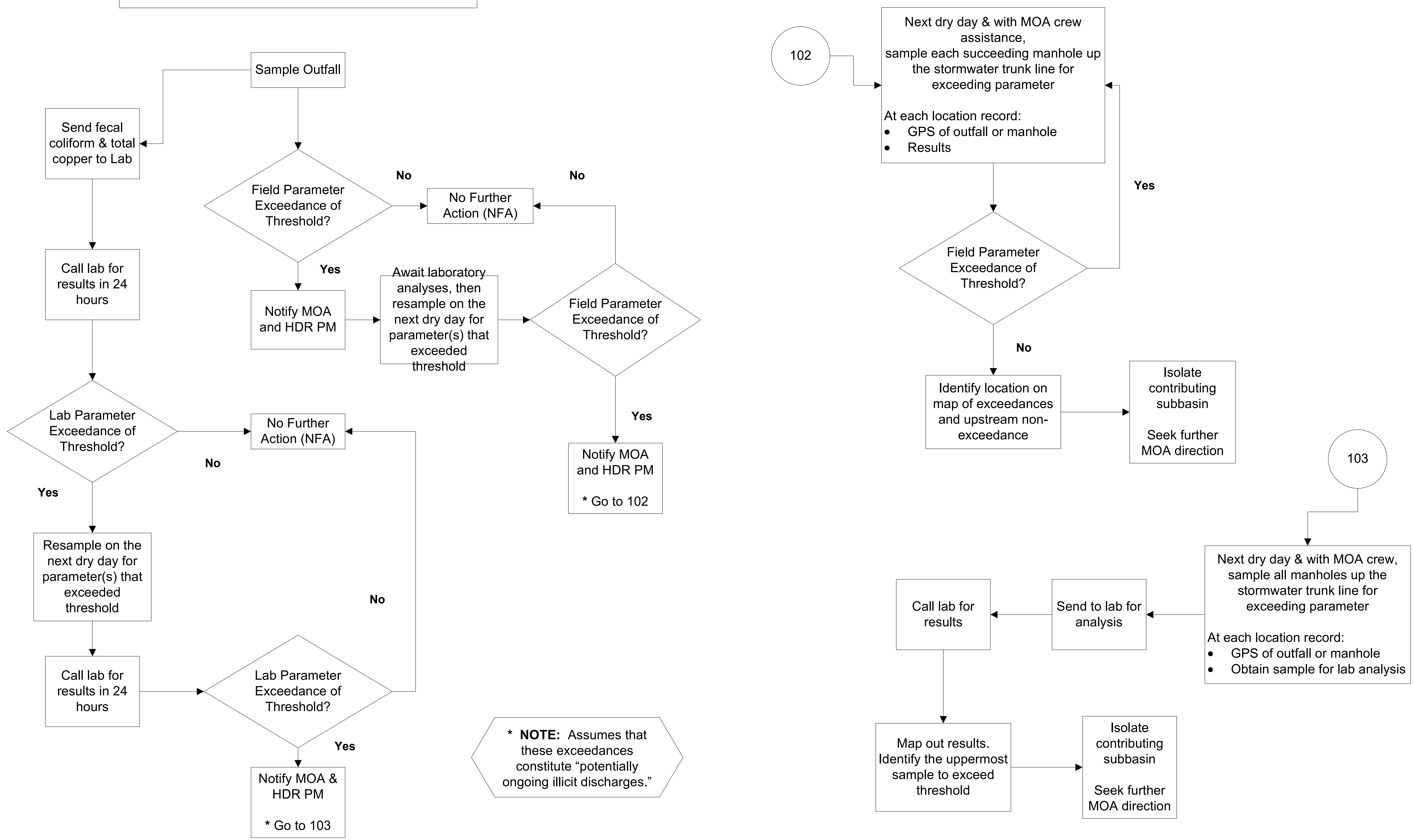
MOA. 1999. Illicit Discharge Program, Dry Weather Screening Plan. Document No. WMP CPp99001. Municipality of Anchorage, Watershed Management Program.

CWP and Pitt, R. 2004. Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessments. Prepared by the Center for Watershed Protection and Robert Pitt, University of Alabama. October 2004

Pitt, R., M. Lalo, R. Field, D. Adrain, and D. Barbe. 1993. Investigation of Inappropriate Pollutant Entries into storm Drainage Systems. Publication No. EPA/600/R-92/239 January 1993.

Attachment F-1
Dry Weather Screening Follow-Up Activities

DRY WEATER SCREENING FOLLOW-UP
(AKA Illicit Discharge Elimination)



Attachment F-2
Field Data Form

DRY WEATHER SCREENING FIELD DATA FORM

Municipality of Anchorage — Department of Public Works — Watershed Management

Outfall Number: ______________________

Part 1. General Information

1. Date ______________________ Time ____________
2. Field Crew ______________________________________ Water quality analyses conducted by: ____________________
3. How long since last rainfall? ☐ raining now ☐ less than 3 days ☐ 3 or more days ☐ unknown
4. Size of last rain event.__________ inches (Attach data from Anchorage International Airport or Girdwood. Websites provided on back of form.)
5. End-of-pipe diameter: ___________feet ___________ inches
6. Depth of water in end-of-pipe: __________feet _______inches

Part 2. Visual Observations

7. Photograph Log: Camera # and frame number (s) ____
8. Water flowing from end-of-pipe? ☐ No ☐ Yes

   If NO, take and log photograph of outfall, record any pertinent information in comments, and go to next outfall. *If YES, continue.*
9. Odors: ☐ No ☐ Yes *If yes, describe in comment section.*
10. Floatables in water flowing from end-of-pipe: ☐ None ☐ Moving oily sheen ☐ Surface scum ☐ Soapy suds ☐ Debris ☐ Other
11. Vegetation: ___________________________ 12. Structural Condition: ______________________________________
13. Biology ____

Part 3. Field Analyses

14. Flow: _______ gal/min; OR

☐ Low: Not intense, water moving very slowly ☐ Medium: Water moving at a moderate rate ☐ High; Intense water moving very quickly

15. Appearance of water flowing from end-of-pipe: ☐ Clear ☐ Cloudy/Muddy
16. Color of water flowing from end-of-pipe: ☐ Clear ☐ Colored ______________________________
17. Water Quality Analyses:

Quality Control Samples		
Parameter	**Equipment Blank** [1 each before sampling event]	**Duplicate Sample** [1 each sampling event]
pH	N/A	pH units
Total chlorine	ppm	ppm
Detergents	ppm	ppm
Total copper	ppm	ppm
Total phenols	ppm	ppm
Turbidity (outfall)		
Turbidity (upstream)		
Fecal Coliform		

Water Quality Samples	
Parameter	**Primary Sample**
pH	pH units
Total chlorine	ppm
Detergents	ppm
Total copper	ppm
Total phenols	ppm
Turbidity (outfall)	
Turbidity (upstream)	
Fecal Coliform	

Part 4. Comments:

GUIDELINE FOR DRY WEATHER SCREENING FIELD DATA FORM
A SEPARATE DATA FORM MUST BE FILLED OUT FOR EACH OUTFALL

***"End-of-Pipe"** is the open end of a pipe discharging stormwater from the stormwater sewer system into the environment.*

Outfall Number: Write the outfall identification number on the field data form. The outfall identification number can be found on the location map. Verify the map guiding you to the outfall location is accurate. Make location corrections to the map and/or in the comment section. If the outfall cannot be found based on map information, make a note and return the uncompleted form and map to WMS representative.

Part 1 GENERAL INFORMATION

1. Date and Time: Record the date and time the outfall assessment begins.
2. Field Crew: Write in the names of the field crew and the name of the person conducting the water quality analyses.
3. How Long Since Last Rainfall? Check the box that best represents when the last rainfall occurred. "Rainfall" is defined as a rainstorm big enough to cause runoff from the streets to enter the local storm drains (approximately 0.1 inch or more).
4. Size of Last Rain Event: The amount of rain occurred and the duration of the storm. Attach printout of rain event from Anchorage International Airport http://www.srh.noaa.gov/data/obhistory/PANC.html or from Girdwood: http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=MGDWA2&day=31&year=2010&month=8
5. End-of-pipe diameter. Measure and record the diameter of the outfall using a measuring tape or stick.
6. Depth of water in end-of-pipe. Measure and record the depth of the water flowing from the end-of-pipe using a measuring tape or stick. If this cannot be safely done, make a note to that effect in the comment section.

PART 2 VISUAL OBSERVATIONS

7. Take a photograph(s) of the outfall. Write in the digital or disposable camera number and frame number(s).
8. Water Flowing from end-of-pipe? Check the NO box if there is no water flowing out of the end-of-pipe. Note: If you see standing water in the end-of-pipe or the end-of-pipe is partially submerged in water and you cannot determine if the water is actually flowing out of the pipe, also check the NO box. Check the YES box only if water is flowing out of the end-of-pipe.

If NO water is flowing from the end of the pipe, make sure a photograph(s) has been taken, write any pertinent information in the comment section, and go to the next outfall. If the pipe is submerged, make a note (#14).Do not sample this site.
If YES, water is flowing from the end-of-pipe continue with the assessment.

9. Odors: NEVER place your head inside of an outfall pipe or culvert. Note any odors detected in the general vicinity of the mouth of the outfall in the comment section.
10. Floatables in water flowing from the end-of-pipe:

Moving oily sheen: Imagine pouring new or used motor oil onto water. Do you see this effect in the water flowing from the end-of-pipe? Only check this box if you see floating globs or a moving sheen of oil in the water flowing from the end-of-pipe ..
Surface scum: Scum can be a layer of organic material or impurities floating on the surface of the water.
Soapy suds: Imagine what a bubble bath looks like.
Debris: Debris includes any trash, garbage, vegetative material, etc. If YES, or other briefly describe in the comment section.

11. Vegetation: Describe the presence and the condition of the vegetation around the outfall.
12. Structural Condition: Describe the condition of the outfall.
13. Biology: Describe the biology that is observed in and around the site including wildlife, fish, algae, macroinvertabrates, etc.

PART 3 FIELD ANALYSES

14. Flow. Flow refers to the volume of the water flowing out of the end-of-pipe per unit time.

Primary Method: Hold a calibrated 1- or a 5-gallon bucket under the flow from the end-of-pipe. Using a stop watch, time how long it takes to fill with the bucket. If the bucket fills in less than one-minute, record the number of seconds. Calculate the flow in gal/minute and record.
Secondary Method. *If you are unable to use the primary method, use the secondary method and visually estimate the flow by checking one of the boxes that best describes the observed flow.*

Use the grab sampler to collect a water sample. Note sample collection location in the comment section. Conduct the following two visual observations and water quality analyses using the water collected in the grab sampler.

15. Appearance of water flowing from end-of-pipe:

Clear: Imagine a glass of drinking water or tea, you can see through the liquid regardless of color.
Cloudy/Muddy: You cannot see through the water (it has a cloudy or muddy appearance).

16. Color of water flowing from end-of-pipe:

Clear: Imagine a glass of drinking water, you can see through the water and the water is not colored.
Colored: Imagine a glass of tea, you can see through the water, but the water is colored. Color can range from light to dark. If the water is colored, check the "Colored" box and write a description of the color of the water on the line next to "Colored." If the water seems very lightly colored and you are in doubt, mark the "Clear" box.

17. Water Quality Analysis. Refer to the Water Quality Sampling Analysis Protocol sheet for instructions.

PART 4 COMMENTS

As needed, explain answers. Record unusual observations of the outfall site not covered by the questions on the form.

PARAMETER THRESHOLDS

Field: pH: < 4.0 or > 9.0; Total Chlorine and Detergents: ≥1 ppm; Total Phenol: ≥0.5 ppm; Turbidity ≥ 5 NTU

Laboratory: Fecal coliform ≥ 400 cfu/100 mL; Total copper ≥ 1 mg/L

Appendix G
Standard Operating Procedures

Table of Contents

G. Standard Operating Procedures

1.0 Field Data Collection SOPs

The stormwater outfall monitoring and dry weather screening programs include collection of water samples from storm drain outfalls; the pesticide screening program involves collection of water samples from lakes; and the structural controls and snow storage site retrofit monitoring programs require collection of water samples from flowing water at designated stormwater control sites, all within the Municipality of Anchorage (MOA).

1.1 Collecting Water Quality Samples

Upon arriving at a sample location, record visual observations in the field log book. Next conduct the field analyses and replicates using probes and test kits, if applicable and record measurements in the field log books. Obtain grab samples and replicates as described below for the laboratory analyses.

1.1.1 Equipment Decontamination

A composite grab sampling method will be used for collecting some samples for analysis. Before handling the bottles, the sampler will decontaminate the sample container using the following procedure:

1. Put on nitrile gloves
2. Using a non-metallic brush scrub the large inert composite sample container with a dilute Alconox solution
3. Rinse the container a minimum of three times with distilled de-ionized water
4. Between each sample location, repeat the procedure.

1.1.2 Grab Sampling

Procedures for collecting grab samples are outlined below:

1. Label sample bottles as directed in Section B.3 of the QAPP with the project name, date, time, preservative (if added), site identification, analysis, task lead's name, and the appropriate consulting firm.
2. Put on nitrile gloves.
3. Remove any trip blanks from the cooler for a minimum of 5 minutes during sampling activities. Do not open the zipper-seal bags in which the blank is enclosed and ensure that the blank gets returned to the cooler before the leaving site.
4. Collecting samples for laboratory analysis and field parameters will be accomplished by collecting sample water into a single inert, decontaminated sample collection container or directly into the laboratory sample bottle, when possible. Sample collection containers must be made of inert materials such as glass, Teflon, or stainless steel. Samples will be transferred from the sampling bottle to a laboratory analysis bottle. Fill all non-preserved sample bottles first, followed by preserved sample bottles to prevent cross-contamination from sample

preservatives. Do not dunk the laboratory sample bottles into the sample collection container. For samples collected directly from the flow, place the laboratory sample bottle, being careful not to over fill bottles that contain preservatives.

For standing water behind a weir, submerge the sampling device about 2 to 3 inches below the water surface immediately behind the weir, being careful not to entrain sediments.

5. Sample bottles for TAH must not contain any air bubbles. This is accomplished by pouring the sample from a clean collection bottle into the 40 mL bottle until there is a slight convex meniscus at the top of the bottle, placing and tightening the cap, and inverting the bottle to ensure no air bubbles are trapped. TAH bottles contain preservative, thus they cannot be poured out and re-filled.
6. Fill out the appropriate field forms documenting sampling location, time, and other pertinent information before leaving the sampling station.

1.1.3 Sample Packing and Shipping

Samples collected in the field for laboratory analysis will be labeled, packed, and shipped as follows:

1. Ensure sample bottle is labeled as described in the QAPP.
2. Place each sample bottle in a zip-locked bag.
3. Pack sample bottles into insulated ice chests with either gel ice (freezable gel packs) or crushed ice that is double-bagged in zip-locked plastic bag.
4. Maintain temperatures in the cooler as listed in Table 8 of the QAPP (plus or minus 2oC) until delivered to the laboratory. Temperature in transit will be monitored with a temperature blank provided by the laboratory.
5. Complete a chain of custody form for each packed ice chest; place the form in a plastic zip-locked bag in the ice chest. All samples will be in control of the field crew until they are delivered to the laboratory, at which time the chain of custody form will be signed by the laboratory personnel indicating that they have assumed custodial responsibility. In the event that full sample coolers are removed from the direct control of the sampling team without being transferred to the laboratory, custody seals will be placed on the cooler from lid to base and taped in place with clear packing tape.

1.2 Measurement of Field Parameters

A YSI 556 multi-probe meter will be used at each site to measure the following field parameters: specific conductance, temperature, pH, and dissolved oxygen (DO). A Hach 2100P meter will be used in the field to measure turbidity. The procedures for using these instruments are described below.

Turbidity, pH, and conductivity calibration solutions will accompany the meter to the field each day in case a reading or meter function warrants either a calibration check or recalibration. Calibration data will be recorded in the field log books for the specific monitoring project.

1.2.1 YSI 556 Meter

1. Turn the YSI 556 on.
2. Place the probe in flowing storm water to be sampled and allow it to equilibrate. If the flow is insufficient to submerge the probe, use a clean sample collection container to collect the flowing water and submerge the probe in water once it is overflowing the container. Allow it to equilibrate. The meter should equilibrate within five minutes.
3. Record the YSI meter number.
4. Once the readings have stabilized or 5 minutes have passed (whichever comes first), record all parameters at the same time.

1.2.2 Hach 2100P Meter

1. Turn on the instrument, and place it on a flat, sturdy surface.
2. Check the calibration of the turbidimeter (see steps 3, 5 and 6 below) and record the results for each:
   a. Run a cycle with an empty chamber (no vial).
   b. Run a clean vial (see step 3) filled with deionized (DI) water.
   c. Run each secondary standard using the appropriate pre-assigned reading for the meter in use.
   d. The empty meter reading should be < 0.1 NTU.
   e. The meter should read within ± 5% of the assigned value for the standards.
   f. In the event the meter is out of calibration, a back-up meter will be used.
3. Clean the sample cell using a KimWipe® tissue and several rinses with DI water. Be careful to handle the cell by the top to avoid smudging or scratching the glass. Do not use paper towels on cells.
4. Invert (do not shake) the sample-collection vial once to re-suspend any material and fill the cell with sample water. Apply a thin film of silicone oil to the outside of the cell. Wipe with a KimWipe® tissue to create an even film on the surface of the cell. Avoid excess oil.
5. Place the sample cell in the instrument compartment making sure that the orientation mark on the cell aligns with the raised mark on the meter. Close the lid.
6. Press **Read**. The final measurement will display after approximately 13 seconds. If the reading is very unstable, press **Signal Average** to average 10 measurements. This action takes approximately 20 seconds.
7. Record the meter number and the meter reading on the field sheet.
8. Use the same sample cell for all samples collected during the sampling event. Rinse the sample cell with DI water between each sample.

1.3 Measurement Using Field Test Kits

*WARNING: Reagents marked with a * are considered to be potential health hazards. See MSDS for hazard and handling information.

1.3.1 LaMotte Free, Total & Combined Chlorine Test Kit Instructions

The LaMotte Model SL-16 Octa-Slide Viewer contains eight permanent color standards. A test sample is inserted into the openings in the top of the comparator. The sample can then be compared to four color standards at once, and the value read off the comparator. The Octa-Slid viewer should be held so non-direct light enters through the back of the compartor. With sample tube inserted at the top, slide the Octa-Slide bar through the view and match with the color standard.

Check Standard Preparation

1. Dilute 891 mg of potassium permanganate in 1,000 mL of distilled water in a volumetric flask (1,000 ppm equivalent solution).
2. Dilute 1 mL of this solution to 1,000 ml with distilled water in a volumetric flask. This solution is equivalent to 1 ppm Free Available Chlorine.

Procedure - Free Available Chlorine

1. Rinse a test tube (0106) with sample water. Fill test tube to the 5 mL line with sample water.
2. Add one *Chlorine #1R Tablet (6999A). Cap and shake until tablet disintegrates. A pink to red color indicates the presence of chlorine.
3. Immediately insert test tube into the top of the Octa-Slide Viewer (1100). Slide the 0.1 to 1.0 ppm chlorine Octa-Slide Bar (3405) into the Octa-Slide Viewer. Match sample color to a color standard. Record as ppm free available chlorine.
4. If the sample is darker than the 1.0 standard, remove the 0.1 to 1.0 ppm Octa-Slide bar, replace it with the 1.0 to 6.0 Octa-Slide Bar (3404). Match sample color to a color standard. Record as ppm free available chlorine.

NOTE: Save sample if total residual and combined chlorine are to be determined.

Procedure - Total Residual Chlorine and Combined Chlorine

1. Add one *Chlorine #3R Tablet (6905A) to the sample from Step 4. Cap and shake until tablet disintegrates.
2. Insert test tube into the Octa-Slide Viewer (1100). Match sample color to a color standard. Record as ppm total residual chlorine.
3. Calculate combined chlorine:

Combined Chlorine (ppm) = Total Residual Chlorine - Free Available Chlorine

NOTE: Thoroughly clean and rinse test tubes after each test.

1.3.2 LaMotte Total Phenols in Water Test Kit Instructions

Procedure

1. Fill three test tubes to the line with the sample water. Two tubes will be used as blanks for the Axial Reader. The third tube is the test sample.
2. Add 0.1 g spoon of Aminoantipyrine reagent to the test sample. Cap and mix.
3. Using the unmarked pipet add 4 drops of *Ammonium Hydroxide solution to the test sample. Cap and mix.
4. Using the 1 mL pipet add 2 mL (2 droppers full) of the *Potassium Ferricyanide solution to the test sample. Cap and mix. If phenols are present, the sample will develop a reddish color.
5. Wait 2 minutes.
6. Insert test tube into the Phenol Comparator with the Axial Reader. Record as ppm Phenols.

1.3.3 Hach Detergents Test Kit Instructions

Procedure

1. Fill one of the test tubes to the upper mark (20 mL) with the water to be tested.
2. Add 12 drops of detergent test solution and shake to mix.
3. Add chloroform to the lowest mark (5 mL) on the test tube. (Chloroform is heavier than water and will sink.) Stopper, shake vigorously for 30 seconds, and allow to stand for one minute to allow the chloroform to separate.
4. Using the draw-off pipet, remove the water from the tube and discard.
5. Refill the test tube to the upper mark with the wash water buffer and, using the draw-off pipet, remove the wash water buffer and discard. This step washes away the remaining water sample.
6. Refill the test tube to the upper mark with the wash water buffer, stopper and shake vigorously for 30 seconds. Allow to stand for one minute to allow the chloroform to separate.
7. Insert the test tube containing the prepared sample in the right opening of the color comparator.
8. Fill the other test tube with demineralized water and place it in the left opening of the comparator.
9. Hold the comparator up to a light, such as the sky, a window or a lamp, and view through the two openings in the front. Rotate the detergents color disc until a color match is obtained. Read the ppm detergents (LAS and/or ABS) from the scale window.
10. If the color is darker than the highest reading on the color disc, the original sample may be diluted 20-to-1 by adding 1 mL of sample to the test tube (using the plastic dropper filled to the top or 1-mL mark) and filling the test tube to the upper mark (20 mL) with demineralized water. Repeat Steps 2 through 9 and multiply the results by 20.

Notes:

If the water sample is turbid, the chloroform layer must be filtered after Step 6, using the procedure given below.

a. Place a small ball (about the size of a large pea) of glass wool in the filter thimble.

b. Using the draw-off pipet to remove the chloroform, filter the chloroform through the glass wool and into the extra test tube.
c. Proceed with Step 7.
d. Enough wash water buffer is included for 32 tests.

Enough detergent test solution and chloroform are included for approximately 90 tests.

WARNING: *The chemicals in this kit may be hazardous to the health and safety of the user if inappropriately handled. Read all warnings carefully before performing the test and use appropriate safety equipment.*

1.3.4 Lamotte Copper Test Kit Instructions

Procedure

1. Fill tube (0106) to the 10mL line with sample water.
2. Add 5 drops of Copper A (P-6367) to tube.
3. Cap and invert tube to mix.
4. Remove cap and add 5 drops of *Copper B (P-6368) to tube.
5. Cape and invert tube to mix
6. Insert tube into holder. Wait 3 minutes for full color development.
7. Remove cap and hold tube so bottom is ½ inch above the white area of the color chart. Match color by looking down into the tube.

   NOTE: Always empty and rinse tubes promptly after testing to avoid staining.

2.0 Flow Monitoring SOPs

2.1 Weir Evaluation

When assessing weirs for usability or installing temporary weirs, the weir must meet the following criteria:

1. Weir crest should be a sharp edge so that the nappe of the weir springs free from the crest at overfall.
2. The nappe should not be partially submerged in the tail water below the weir.
3. The pool behind the weir should be calm without significant velocity as it approaches the weir.
4. The minimum head should be 0.2 feet to prevent the nappe from clinging to the crest of the weir.
5. The head measurement should be made a minimum of four times the height of the water over the weir upstream from the crest of the weir.

2.2 Staff Gage Measurements

When obtaining staff gage measurements in the field, the observer should ensure that:

1. The staff gage is placed adjacent to the weir, where it will not interfere with flow over the weir.
2. Sediments have not accumulated behind the weir.
3. The observer's eye must be level to the water level when reading the staff gage.
4. Record the staff gage measurement to the nearest 0.01 inch.

2.3 Data Logger QC Measurements

To ensure data loggers are accurately calibrated, use the following procedures prior to a storm event and during a storm event:

1. Observe the staff gage as described in Section 2.2.
2. Record the exact time of manual measurement.
3. Compare that measurement with the data logger measurement from the same time. If a difference exists:
   a. Adjust the data logger to eliminate the difference, if the quality control is conducted prior to a storm event.
   b. Adjust the flow data by a correction factor, if the difference is detected during a storm event.

Attachment G-1

Chain of Custody Form

CHAIN OF CUSTODY

Laboratory Name		Date:	Page: of
Laboratory Address	Phone:	Project Manager:	
Anchorage, AK	FAX:	Project Name:	
		Location:	City:
Client:		Collector:	Date of Collection:
Address:			
Phone:			
Client Project #:			

Sample Number	Time	Sample Type	Container Type	Chloride (300.0)	Total Copper (200.8)	BOD5 (SM 5210B)	Fecal coliform (SM 9222D)	TSS SM (2540D)	TAH (624)	TAqH(625)	2,4-D (8151A)	Carbaryl (8270C)	Other	Field Notes
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														

Relinquished by:	Date/Time	Received by:	Date/Time	**Sample Receipt:**			**Remarks:**
				Good Condition?			
Relinquished by:	Date/Time	Received by:	Date/Time	Cold?			
				Seals intact?			
Relinquished by:	Date/Time	Received by:	Date/Time	Total # Containers			

Distribution: White - Lab; Yellow - File; Pink - Originator

Sample Label Example

XXX Laboratory

Field Information:

Sample Number: ______________________

Sample Location: ______________________

Sample: ______________ of ____________

Date:______________ Time:______________

Preservation Method: ___________________

Printed Name & Sgnature of Sample Collector:

____

____

Phone: _______________________

Comments: ____________________________

Attachment G-2

Data Logger Download Field Form

Station ID:	Date:	Start Time:	End Time:	GPS - Lat:
Team:		Site Observer:		GPS - Long:
Photos:	Camera:	Air (C):	Wind:	Precip:

HYDROLOGY	SAMPLER:	Type of flow Laminar Turbulent Other:
Flow (Wade) (Ice)	IQ Measurement description and constraints:	
Method: (Boat) (Salt)	Control: (Channel) / (Section / (Both)	

DATA LOGGER		**Comments pertinent to data loggers:**
Depth of water at data logger (ft):		
Device used to download:		
Time data loggers removed from rope wire:		
Water Level data logger SN:		
Barotroll data logger SN:		
Water Level log filename downloaded:		
Time Water Level log file stopped:		
Time Water Level log file downloaded:		
Barotroll log filename downloaded:		
Time Barotroll log filename downloaded:		
Time Barotroll log filename downloaded:		
NEW Water Level log file started:		
Time Water Level log file started:		
NEW Barotroll log file started:		
Time Barotroll log file started:		

Sketch, Notes and Remarks

Hydrology level 1 review	Name:		Date:	

Appendix H
Maintenance and Calibration of Equipment

Table of Contents

H. Maintenance and Calibration of Equipment

1.0 Maintenance and Calibration of Field Meters

A YSI 556 field meter will be used to measure the following parameters: specific conductance, temperature, pH, and dissolved oxygen. A Hach 2100P will be used to measure turbidity. The procedure for collecting field measurements is described in Appendix G. Maintenance, decontamination, and calibration of the meters are described below.

1.1 Equipment Maintenance

Maintenance for the rented field meters will be performed in Anchorage (typically by TTT Environmental (TTT), the rental company) before travel to the field or by the MOA if MOA owns the equipment. Maintenance for the Hach 2100P includes cleaning, battery replacement, and lamp replacement, when necessary. Maintenance for the YSI 556 and YSI 600 OMS V2 sonde includes cleaning of sensors and replacement of the DO membrane (YSI 556) and other sensors when necessary. Complete descriptions of these procedures can be found in the instrument manuals, which are kept with the instruments. If the maintenance and troubleshooting procedures in the instrument manuals are insufficient, the instruments will be sent to their respective manufacturers for repair.

1.1.1 YSI 600 OMS V2 Meter

The YSI 600 OMS V2 sonde is a battery-powered device that can be set to collect data and then disconnected from the read-out device or computer for deployment in the field. Battery installation instructions are included in the sonde manual.

A field connector cable and adapter is necessary to set-up, calibrate, see real time readings and upload files to a computer or a hand-held 650 MDS display. The field connector cable also includes a strain relief cable that should be connected to the bail wire attached to the sonde to ease pressure on the electronic connection. A separate laboratory calibration cable can also be used to connect the sonde to a computer. The initial set-up and launching of the sonde requires that EcoWatch for Windows software is installed on the operating computer.

While connected to a computer for set-up, many features can be adjusted. While connected you can activate or deactivate sensors, calibrate the sensors (must be activated), select the read-out language, set the date and time, select which parameters will appear on output reports, view real-time read-outs (sensor must be activated), and select display units (i.e., ^{0}F, ^{0}C or K). Exact set-up instructions are included in the sonde manual.

The sonde can be set to collect discrete samples or unattended samples. Unattended sampling will be used for long-term deployment of the sonde. While connected to the operating computer the following items can be viewed or adjusted: sample collection interval, start date, start time, duration of sample collection, file name, site description, battery life (in days), and free memory (in days). Battery life and memory is dependant upon the sample collection frequency. The sonde manual provides detailed launching instructions. Downloading data files follows the similar steps as set-up and launching the sonde. Battery life should be checked before the sonde is launched each time the sonde is downloaded.

1.2 Equipment Calibration

1.2.1 YSI 556 Meter

Rental instruments will be calibrated as described in the QAPP by the rental agency and records provided to the Contractor. MOA or Contractor-owned instruments will be checked daily prior to entering the field using confidence solution and will be calibrated as needed. All results from the calibrations and daily calibration checks will be logged in the field log book specific to the monitoring project.

Electrolyte solution must be added to the DO membrane cap before initial use. Install the membrane cap as follows:

1. Unscrew and remove probe sensor guard.
2. Discard old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water (not deionized water).
4. Prepare electrolyte solution.
5. Fill membrane cap half full with electrolyte solution.
6. Reattach membrane cap onto sensor, moderately tightly. A small amount of solution should overflow.
7. DO NOT touch the membrane surface.
8. Screw probe sensor guard on moderately tightly.

All of the sensors, except the one for temperature, require calibration if air-pressure changes occur. Calibration tips are as follows:

- Ensure that all sensors are completely immersed in calibration solutions.
- The top vent hole of the conductivity sensor must also be immersed during some of the calibrations.
- Loosen the transport/calibration cup during DO calibration to allow pressure equilibration.
- For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe module. It may be desirable to save the old calibration standards for this purpose.
- Rinse the probe module between calibration solutions with ambient-temperature water.
- Use paper towels or clean cotton cloths to dry the probe between rinses. Making sure the probe is dry reduces carry-over contamination of calibration solutions and increases the accuracy of the calibration.
- Install port plugs in all the ports where the sensors are not installed. It is extremely important to keep these electrical connectors dry.

The YSI 556 meters will be calibrated for three parameters: DO, pH, and specific conductance. Calibration procedures are provided below.

- Before calibrating the instruments, clean the sensors with an Alconox solution and rinse several times with distilled water.
- Shake off excess water before immersing the probe in the calibration cup with solution. Make sure that the sensors are covered when running the calibration. Used calibration solution can be used to rinse the sensors before calibration to provide an extra level of accuracy.

The steps for entering the calibration mode are as follows:

1. Press the **On/Off** key to display the Run screen.
2. Press **Escape** to display the main menu.
3. Use the arrow keys to highlight the Calibration selection.
4. Press **Enter**. The Calibration screen is displayed.

Conductivity Calibration

1. Record the calibration solution lot number.
2. On the Calibration screen, select Conductivity and press **Enter**.
3. Select Specific Conductance and press **Enter**. (Calibrating for specific conductance will also calibrate for conductivity and salinity.)
4. Place 55 milliliters (mL) of the conductivity solution in the clean, dry calibration cup, and immerse the sensors in the solution.
5. Rotate or move the probe module up and down to remove any bubbles from the conductivity cell. Make sure that the conductivity sensor is completely immersed past the vent hole.
6. Tighten the calibration cup onto the probe module.
7. Allow at least 1 minute for the temperature to stabilize. Note the temperature of the calibration solution for the pH calibrations.
8. When the specific conductivity reading is stable for 30 seconds, press **Enter**.
9. Enter the calibration value as reported on the used calibration-solution bottle. (The value for specific conductivity is always in microSiemens per centimeter at 25°C.) Press **Enter** again to accept the calibration.
10. Record the pre-calibration and final, or post-calibration specific conductivity reading. Press **Escape** to return to the calibrate screen.
11. Rinse the sensors and calibration cup, and save the solution for a pre-rinse prior to the next calibration.

Dissolved Oxygen Calibration

Before calibrating for DO, empty the calibration cup. Then place the probe into the unsecured cup. Place the cup in water which is at a temperature similar to field temperatures (it may be necessary to add ice to the water, especially in winter).

1. On the Calibration screen, select Dissolved Oxygen and press **Enter**.
2. Select DO% and press **Enter**. (Calibrating for DO% will also calibrate DO in milligrams per liter).

3. Make sure that the DO and temperature sensors are NOT immersed in the water.
4. Secure the cup to the module by only one or two threads to ensure that the DO sensor is vented to the atmosphere.
5. Use the keypad to accept the internal barometric pressure reading.
6. Allow 10 minutes for the air temperature in the calibration cup to equilibrate. When the DO% reading shows no significant change for 30 seconds, press **Enter**. Press **Enter** again to accept the calibration.
7. Record pre-calibration reading and post-calibration reading.
8. Press **Escape** to return to the Calibration menu.

pH Calibration

1. Record the calibration solution lot number.
2. On the Calibration screen, select pH and press **Enter**.
3. Select 3 point and press **Enter**. A 3-point calibration is used to calibrate for surface water measurements that are both basic and acidic.
4. Place 30 mL of the first pH buffer in the clean, dry calibration cup, and immerse the sensors in the solution.
5. Rotate or move the probe module up and down to remove any bubbles from the pH sensor. Make sure that the sensor is completely immersed.
6. Tighten the calibration cup onto the probe module.
7. Enter the value of the pH buffer at the current temperature. The temperature of the stored calibration solutions should have been recorded during the conductivity calibration.
8. Press enter and allow at least 1 minute for the temperature to stabilize.
9. When the pH reading is stable for 30 seconds, press **Enter**. Press **Enter** again to accept the calibration.
10. Record the pre-calibration and post-calibration readings.
11. Press **Enter** to return to the specified pH calibration screen.
12. Rinse the probe module, calibration cup, and sensors in DI water and dry.
13. Repeat steps 3 through 10 for the second and third buffer solutions.
14. Press **Escape** to return to the Calibration screen.
15. Rinse the sensors and calibration cup, and save the solution for a pre-rinse before the next calibration.

Return to Factory Settings

1. Press the **On/Off** key to display the Run screen.
2. Press the **Escape** key to display the Main Menu.
3. Use arrow keys to highlight the Calibration selection.
4. Press **Enter**. The Calibration screen is displayed.
5. Use the arrow keys to highlight the Conductivity selection. Note: The conductivity sensor is being used as an example; however, this process will work for any sensor.

6. Press **Enter**.
7. Use the arrow keys to highlight the Specific Conductance selection.
8. Press **Enter**.
9. Press and hold down the **Enter** key and press the **Escape** key.
10. Use the arrow keys to highlight the YES selection. This returns a sensor to the factory settings.
11. Press **Enter**.
12. Press **Escape**.

1.2.2 YSI 600 OMS V2 Sonde

The probes used in the YSI 600 OMS V2 sondes are the same as those in the YSI 556 with the exception of the optical turbidity sensors. The method for preparing the sonde for calibration is also the same as the YSI 556. However, to calibrate the probes on the sonde, it must first be attached to a PC with the appropriate software installed or the 650 display.

1. With the proper cable, connect the sonde to a PC or 650 display, access EcoWatch for Windows (PC only) and proceed to the Main menu. From the sonde Main menu, select **2-Calibrate**.
2. To select any of the parameters from the Calibrate menu, input the number that is next to the parameter. Once you have chosen a parameter, some of the parameters will have a number that appears in parentheses. These are the default values and will be used during calibration if you press **Enter** without inputting another value. Be sure not to accept default values unless you have assured that they are correct. If no default value appears, you must type a numerical value and press **Enter**.
3. After you input the calibration value, or accept the default, press **Enter**. A real-time display will appear on the screen. Carefully observe the stabilization of the readings of the parameter that is being calibrated. When the readings have been stable for approximately 30 seconds, press **Enter** to accept the calibration.
4. Press **Enter** to return to the Calibrate menu, and proceed to the next calibration.

Turbidity 3-Point Calibration

The 6136 turbidity sensor can be calibrated using either the standard length calibration cup or with an extended length calibration cup. If you choose to calibrate with the standard calibration cup, you also MUST first make certain that the vessel is equipped with a BLACK bottom. In addition, you should engage only ONE THREAD when screwing the calibration cup onto the sonde in order to keep the turbidity probe face as far as possible from the calibration cup bottom to avoid interference. Even with these techniques, there will still be a small interference from the bottom of the calibration cup that will cause your field turbidity readings to be approximately 0.5 nephelometric turbidity units (NTU) lower than the actual reading. This small error is usually only evident when the sonde is deployed in very clear water where the readings might appear as slightly negative values, e.g., a turbidity of 0.1 NTU would appear as –0.4 NTU.

1. Place enough 0 NTU standard (clear deionized or distilled water) to completely submerse the turbidity sensor into the calibration cup.

2. Immerse the sonde in the water. Input the value 0 NTU at the prompt, and press **Enter**. The screen will display real-time readings that will allow you to determine when the readings have stabilized.
3. Activate the wiper 1-2 times by pressing **3-Clean Optics** as shown on the screen, to remove any bubbles.
4. After stabilization is complete, press **Enter** to "confirm" the first calibration and then, as instructed, press **Enter** to continue.
5. Dry the sonde carefully and then place the sonde in the second turbidity standard (100 or 126 NTU) using the same container as for the 0 NTU standard.
6. Input the correct turbidity value in NTU, press **Enter**, and view the stabilization of the values on the screen in real-time.
7. Activate the wiper with the "3" key or manually rotate the sonde to remove bubbles.
8. After the readings have stabilized, press **Enter** to confirm the calibration and then press **Enter** to return to the Calibrate menu.

1.2.3 Hach 2100P Turbidimeter

Routine calibration checks will be performed on the 2100P turbidimeter by using Gelex secondary turbidity standards. The Gelex standards must have values assigned to them by TTT immediately after calibration has been performed with formazin. These standards will be used as a calibration check before running samples each day. If the readings are outside 5 percent accuracy, the instrument will be recalibrated using StablCal stabilized formazin standards before being used for recorded measurements. A recalibration will be performed a minimum of once every three months by TTT. Methods for checking the calibration are outlined below.

Calibration

1. If the StablCal standards have been sitting for longer than one month, shake them to break the condensed suspension into its original particle size. If the standards are used weekly, start at Step 2, below. Standards of less than 0.1 NTU should not be shaken.
   a. Shake the standard vigorously for 2 to 3 minutes to resuspend any particles.
   b. Allow the standard to stand undisturbed for 5 minutes.
2. Gently invert the bottle 5 to 7 times.
3. Prepare the standard vial.
   a. Clean the cell with a lint-free tissue (outside) and a DI water rinse. Do not use paper towels on cell.
   b. Allow the cell to air dry. Handle the cell by the top to avoid scratching or contaminating the glass surface.
   c. Apply a small bead of silicone oil to the surface of the cell, and rub with a lint-free cloth. The cloth will absorb oil, and after a few applications, it will be sufficient to rub the cloth over the cell. Avoid using too much oil; the cell should appear dry with little or no visible oil.
4. Turn on the instrument by pressing **I/O**.

5. Press **CAL**. The CAL and SO icons will display, indicating that it is calibrating the first standard at 0 NTU.
6. Rinse the sample cell one time with the standard and discard the rinse.
7. Fill the cell with the first standard. Cap the cell and let it stand for 1 minute.
8. Insert the cell in the compartment by aligning the orientation mark on the cell with the mark on the front of the compartment.
9. Close the lid.
10. Press the → arrow key to get a numerical display.
11. Press **Read**. The instrument will count from 60 to 0 and then switch to the next standard.
12. Repeat Steps 6 through 11 for the three remaining standards.
13. When the last standard is done, the display will increment back to S0. Press **CAL** to accept the calibration, and the instrument will return to measurement mode.
14. If E1, E2, or CAL? is flashing after the CAL button is pressed, check the standards and repeat the calibration. Refer to the instrument manual for troubleshooting guidelines.

Checking Calibration

1. Check the instrument calibration using the Gelex standards.
2. If the readings are not within 5 percent of the previously established values, recalibrate using the StablCal stabilized formazin standard.