Illicit Discharge Detection and Elimination Program

Quality Assurance Project Plan

Seattle Public Utilities

NPDES Phase I Municipal Stormwater Permit

June 2014

City of Seattle

1.0 Definitions, Acronyms and Abbreviations

In this QAPP, the following definitions, acronyms and abbreviations are used as indicated below.

C	Centigrade or Celsius
CFU	Colony forming unit
City	City of Seattle
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
ERTS	Environmental Report Tracking System
F	Fahrenheit
GIS	Geographic Information System
GPS	Global Positioning System
IDDE	Illicit discharge detection and elimination
mg/L	Milligrams per liter = Parts per million
mS/cm	MilliSiemens per centimeter
MH	Maintenance hole
MS4	Municipal separate storm sewer system
MQO	Measurement Quality Objective
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
PCB	Polychlorinated biphenyl
Permit	Phase I Municipal Stormwater Permit
PSD	Piped storm drain
QAPP	Quality Assurance Project Plan
QC	Quality Control
SCPD	Source Control and Program Development
SM	Standard Methods
SPU	Seattle Public Utilities
SWMP	Stormwater Management Program
TMDL	Total Maximum Daily Load
µS/cm	MicroSiemens per centimeter

2.0 Contents

3.0 Introduction & Background

Seattle Public Utilities (SPU), a department of the City of Seattle (City), operates and maintains a municipal separate storm sewer system (MS4). The reissuance of the Phase I Municipal Stormwater Permit (Permit) by the Washington State Department of Ecology (Ecology) in 2007 requires the City to implement a Stormwater Management Program (Seattle, 2008a). The Permit requires the Stormwater Management Program to include a program to detect, remove, and prevent illicit connections and illicit discharges. SPU's Source Control and Program Development (SCPD) is responsible for developing and implementing the City's Illicit Discharge Detection and Elimination (IDDE) program.

3.1 IDDE Program context

The goal of the IDDE program is to detect, find, and remove non-permissible discharges to the MS4. The City currently implements IDDE through business inspections, water quality complaint response, and spill response in addition to sediment source tracing in the Lower Duwamish Waterway and East Waterway Superfund areas. The City also attempts to prevent illicit discharges through public education and outreach, and building code enforcement, as described in the City's Stormwater Management Program. In the summer of 2009, a a dry weather field screening element was added to the program.

The goal of the dry weather screening element of the IDDE program is to detect, find, and remove illicit discharges and connections from the MS4. The program element does this by:

- Performing dry weather field screening of the MS4
- Initiating source tracing investigations when the screening indicates the potential presence of illicit discharges or illicit connections
- Verifying illicit connections using additional tools such as dye-testing, smoke testing, or closed circuit TV (CCTV)
- Stopping/removing illicit discharges/illicit connections using the City's progressive enforcement process

3.2 Purpose of this QAPP

This Quality Assurance Project Plan (QAPP) describes the dry weather field screening element that will be used to detect illicit discharges. The enforcement process described in the Stormwater Management Program and the Seattle Municipal Code will be used to facilitate the removal of illicit discharges, once detected.

This QAPP is intended to describe the:

- Goals and objectives of the IDDE program
- Type and quality of data required to meet the objectives
- Sampling and analysis procedures required to acquire those data

- Quality assurance and quality control procedures to ensure that the data meets the objectives

This QAPP describes procedures to ensure that data of sufficient quality is generated and that a process is defined for the use of that data so that illicit connections and discharges are discovered and removed. The QAPP also serves the purpose of standardizing program procedures so that multiple field teams can pursue data screening in the same way.

3.3 Background

Illicit **discharges** are broadly defined as non-stormwater and non-natural waters entering the storm sewer system. Discharges may be continuous, intermittent, or transitory and include those discharges associated with illicit **connections**—those connections that by Code requirements should be made to the sanitary sewer rather than the drainage system. Examples of illicit **discharges** include the discharge of sewage, washwater, spills, improper disposal of materials, hyperchlorinated tap water, and sanitary or industrial wastewater. Section S5.C.8 of the Permit and Chapter 22.802 of the City Stormwater Code define illicit discharges and allowable exceptions.

Discharges to the MS4 travel to receiving water bodies without treatment. Receiving water bodies include streams, lakes, wetlands, and marine waters. Pollutants within illicit discharges may have adverse affects on aquatic ecosystems, wildlife, domestic animals, and humans that come in contact with the pollutants. Illicit discharges may also cause structural damage to drainage infrastructure.

3.4 Program Area

3.4.1 The MS4 outside of sediment remediation areas

The Permit requires that the City complete field screening of at least 12 percent of the stormwater conveyance system by January 2014. SPU will measure the percentage of MS4 screened as a measure of total drainage area (acreage). SPU will screen 12 percent of the MS4 in the separated and partially separated systems of the City. SPU conservatively estimates that the MS4 comprises 33,146 acres of drainage area. This estimate does include some drainage systems not owned by the City, such as the King County Airport. Systems not owned by the City will not be screened by the dry weather screening program.

The study area includes the separated and partially separated storm sewer systems within the City. The remainder of the city is on a combined system which conveys water to the West Point Treatment Plant. A description of the three types of drainage systems in the City is given below:

- Separated systems convey roof runoff and stormwater runoff to a storm drain system and wastewater to a sanitary sewer system in separate dedicated systems. The ditch and culvert drainage systems conveying stormwater north of 85th St are part of the separated system. These areas will be included in the field screening for this program. Approximately 30 percent of the City is served by separated drainage systems.
- Partially separated systems convey portions of the stormwater runoff to a storm drain system and wastewater with the remaining portions of the stormwater runoff to a sanitary sewer system. Partially separated systems are located in areas of the City where stormwater service was installed at a later time in an area that was previously served by combined

sewers. In these areas, portions of the stormwater runoff are usually reconnected into the newly installed stormwater service to decrease the amount of the stormwater runoff that discharges to the combined system. These areas will be included in the field screening for this program. Approximately 40 percent of the City is served by partially separated systems.

- Combined sewers carry both sanitary sewage and stormwater runoff and terminate at the West Point wastewater treatment plant. The combined sewer system is not covered by the 2007 Phase I Municipal Stormwater Permit and will not be field screened under this program. Approximately 30 percent of the City is served by combined sewer systems.

The City may need the cooperation of neighboring jurisdictions if problems are identified near City borders. Special Condition S5.C.3.b.ii of the Permit requires Permittees to establish a coordination mechanism clarifying roles and responsibilities for the control of pollutants between physically interconnected municipal storm sewer systems. The Special Condition goes on to state that failure to effectively coordinate is not a permit violation provided other entities, whose actions the Permittee has no or limited control over, refuse to cooperate. In February 2009, SPU sent notification letters to neighboring jurisdictions stating that the City will notify the jurisdiction and Ecology as soon as possible if an illicit discharge or connection is determined to be coming from a neighboring jurisdiction's drainage system. Jurisdictions notified include the City of Shoreline, King County, the Port of Seattle, Washington State Department of Transportation, the City of Tukwila, the University of Washington, and the Seattle School District.

3.4.2 Superfund Areas

The City's 2004 Comprehensive Drainage Plan (Seattle, 2005) recognized contaminated sediments as a threat to aquatic habitat and environmental health. The Lower Duwamish Work Group, a group of agencies and regulators pursuing early cleanup of contaminated sites, has identified basins where sediment remediation efforts are focused. Most of these basins are in industrial and commercial areas. Stormwater from these areas can carry pollutants that are not normally analyzed for in illicit discharge detection programs. However, the procedures used to detect on-going sources of pollutants from industrial and commercial runoff in the Duwamish area is similar to the techniques used to identify sources in the IDDE program. The City implemented a contaminated sediment source tracing program in 2002. The sediment source tracing project is described in two documents:

- Quality Assurance Project Plan: Duwamish River East Waterway Drainage Source Control (Seattle, 2008b)
- Sampling and Analysis Plan: Diagonal Avenue South Drainage Basin Pollutant Source Investigation (Seattle, 2003)

Sampling activities in these sediment remediation areas include grab samples at in-line maintenance holes, right-of-way catch basins, and catch basins on private property. In addition, monitoring is ongoing using sediment traps near outfalls and key maintenance holes throughout the targeted basins. These sediment samples have been analyzed for polychlorinated biphenyls (PCBs), semi-volatile organic compounds, metals (arsenic, copper, lead, mercury, and zinc), total petroleum hydrocarbons, total organic carbon, and grain size. These analyses have been selected to source trace contaminants of concern in the Lower Duwamish Waterway and East Waterway sediments. These analyses are also commonly associated with the upland industrial and commercial activities found in the drainage basins of the Lower Duwamish Waterway and East Waterway. Additional analyses are included on an as-needed basis.

The Lower Duwamish Waterway sediment remediation area is comprised of 14 drainage basins totaling 11,000 acres. Approximately 1000 sediment samples have been collected in these basins and ongoing sediment trap samples are being collected at 39 locations. The East Waterway sediment remediation area is comprised of 4 drainage basins totaling 820 acres. Approximately 100 sediment samples have been collected in these basins and ongoing sediment trap samples are being collected at 6 locations. Business inspections and sediment sampling have been ongoing in these sediment remediation areas since 2003. However, only samples collected since the Permit effective date (February 2007) will be reported for compliance purposes.

Dry weather field screening may be used to supplement source control efforts in Superfund areas; however, the Superfund areas are given a lower screening priority because of the extensive sediment sampling and business inspection efforts that has occurred, and is ongoing, in these drainage basins. SPU's basin prioritization plan is discussed in Section 4.1.

The remainder of this QAPP refers only to the dry-weather screenings activities. Sediment source-tracing activities in the superfund areas are governed by a separate QAPP (Seattle 2003).

4.0 Program Description

The dry weather field screening program takes a systematic approach to finding illicit discharges and illicit connections. Field screening is designed to identify and characterize continuous dry-weather flows and attempts to identify suspect intermittent and transitory flows. The dry weather field screening program attempts to find illicit discharges by:

1. Prioritizing basins based on existing data and basin characteristics
2. Identifying screening parameters to use as indicators of generic types of pollution characteristic of illicit sources
3. Setting trigger levels for the screening parameters to initiate source tracing
4. Performing field screening at key locations within selected basins, starting near outfalls and working up the drainage system. Field screening consists of comparing screening results to trigger levels
5. Source tracing where the comparison suggests problems exist

4.1 Prioritization of Drainage Basins

Drainage basins will be prioritized for field screening using existing data and basin characteristics to evaluate the potential for illicit discharges and illicit connections. The following screening factors were tabulated by drainage basin to generate a priority list for field screening:

1. Drainage basin acreage: *larger drainage basins will have a higher priority because of the increased potential for more illicit connections per basin*
2. Data analysis from the 2005 Outfall Inspection Project (Herrera, 2005) that included an inspection for environmental conditions at piped storm drain (PSD) outfalls: *outfalls that had indications of contamination will have a higher priority*
3. Drainage basin listings, such as total maximum daily loads (TMDLs), where data suggest impaired water quality in receiving water bodies: *basins subject to TMDLs will have a higher priority*
4. Areas of separation projects from combined drainage systems to separated systems: *partially separated drainage basins will have a higher priority because there is an increased potential for illicit connections from separation projects*
5. Public exposure: *drainage basins with outfalls where there is higher potential for public exposure, such as outfalls near swimming beaches, will have a higher priority*
6. Superfund areas: *drainage basins that are included in the Lower Duwamish Waterway and East Waterway Superfund areas will be <u>prioritized lower</u> for additional screening because these areas have had the greatest frequency of business inspections and sediment sampling, and have already been screened using sediment traps*.

During the 2010 field season, a significant number of illicit connections were found at a public housing development where the sewer and drainage connections were made well after the streets and other utilities were installed. This development pattern involves the use of stubb markers where future connections to the sanitary and storm sewer are anticipated. Other developments having this pattern (delay between the time the sewers and drains were marked and the time the connection is made) were identified City-wide to the extent possible. Basins with this development pattern coincided fairly well with the priorities for screening in 2011 as rated by the factors above, so no change in the overall basin priorities were made.

4.2 Screening parameters

The dry weather field screening element uses a limited number of parameters that are indicative of the presence of an illicit discharge or illicit connection. These parameters are not necessarily the most damaging constituent within a discharge, but act as surrogates to indicate that something is amiss and provide some indication of the source type.

The dry weather field screening element uses field observations, field analyses, and laboratory analyses of a select few chemical and biological parameters to characterize flowing discharges. When flow is not present, the field screening element relies on field observations, such as damage or staining, to suggest the presence of intermittent or transitory discharges.

As the program develops, each parameter is evaluated for usefulness in detecting illicit discharges. Other parameters may be evaluated andproposed for inclusion in future QAPP amendments, or used during source tracing investigations. Section 7 contains specific information on screening parameters used in the current IDDE program.

4.3 Trigger levels

Trigger values for the screening parameters are quantitative as well as qualitative. Trigger values are based on literature as well as the collective experience of SPU chemists, andfield scientists and are set to be at levels exceeding those of natural waters. The starting point for estimating the levels was Appendices E1 and E2 of the “Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments” (Brown, Caraco and Pitt, 2004a,b). Adjustments were made for some parameters based on values routinely observed in natural systems in the Seattle area, obtained from King County, Ecology, and Seattle websites. As data becomes available, the trigger and flow chart levels may be adjusted.

For instance, in 2011, the use of turbidity changed from use of a quantitative measurement to a qualitative visual observation made in the field. This change still provides adequate detection of problems in discharges while saving valuable field time.

4.4 Field screening

The general approach to field screening is to begin at an accessible location at or near the discharge point of a drainage basin, such as an outfall, key maintenance hole, ditch, or other structure. Field screening is performed at multiple key locations in most drainage basins instead of relying on elevated concentrations to be found only at the downstream discharge point. The size of the drainage basin is used to determine the number of locations screened. Key upstream maintenance holes representing major branches of the conveyance system are screened in larger basins in order to decrease the size of the area screened by an individual sample. The purpose of this approach is to help detect discharges that may be diluted and, therefore, masked by groundwater intrusion or blended flows.

SCM staff will be performing the field sampling and analyses for all parameters except fecal coliform, potassium, and fluoride, for which the SPU Water Quality Laboratory will perform the analysis. Samples collected will be grab samples of flowing water. Most field screening will occur during the summer months during dry weather conditions.

The principal components of the SPU's field screening element are:

- Field observations of the physical and environmental conditions at each site
- Field analyses by in-situ chemical screening
- Source tracing if illicit discharges or illicit connections are suspected based on the field observations or field analyses
- Laboratory analysis of the collected samples for the remaining chemical parameters
- Additional source tracing based on laboratory analyses

4.5 Source tracing values over trigger levels

Immediate source tracing in order to follow a suspected illicit discharge or connection upstream will be initiated whenever field observation or data show that any of the trigger levels have been reached.

Immediate source tracing may not require that a sample be collected at each location or that each sample be analyzed for all parameters due to the importance of tracking the discharge quickly and efficiently to locate the source, especially for intermittent and transitory flows. In these cases, SCM staff use field observations (color, odor, floatables, and turbidity) and field analyses (pH, conductivity, temperature, ammonia, surfactants, and turbidity) as necessary to track the suspected illicit discharge or connection.

Once the discharge source has been located or isolated to a smaller section of the drainage system, it may be necessary to use other source tracing methods such as additional water sampling, side sewer research, dye testing, smoke testing, business inspections, stream walks, or CCTV. These investigations may require the participation of other City inspectors, operations and maintenance staff, and other agencies and may not be able to be conducted immediately.

Once the suspected source is identified, a source sample may be collected and analyzed for all parameters to compare with the downstream screening sample. The purpose of the source sample is to match the discharge types. In addition, the next upstream location will be sampled to confirm that there are no other suspected upstream illicit discharges or connections that may have been masked by the suspected source location.

If field screening activities identify an illicit discharge that requires immediate cleanup the City Spill Response Coordinator will be notified immediately.

5.0 Program Organization and Timing

This section discusses IDDE program organization including special training, staff roles, and project phases during the next several years.

5.1 Special Training Needs/Certification

Environmental Compliance Inspectors working on the dry weather field screening program are usually trained and certified in the following disciplines due to the situations and hazards they may encounter:

- Hazardous Waste Operations and Emergency Response – 40 hour
- Emergency Spill Response – 24 hour
- Washington State Traffic Control Flagger
- Confined Space Entry

5.2 Roles and Responsibilities

Dry weather field screening is typically carried out by a team of two inspectors. When a potential source is found, subsequent source tracing investigations may require the assistance of other personnel within SPU and from other agencies. Table 1 describes the roles and responsibilities of key personnel and the program schedule.

Table 1: Team Contact Information

Role	Name	Office/Cell Phone	Responsibility
Source Control & Program Development Manager	Louise Kulzer	206-733-9162 206-255-9595	Manages source control program, including budget, schedule, and permit compliance
Source Control Supervisor	Ellen Stewart	206-615-0023 206-295-6561	Supervises inspectors, acts as liaison to other agencies and SPU units for source tracing investigations, oversees permit compliance
NPDES Permit Coordinator	Kate Rhoads	206-684-8298	Responsible for permit implementation and coordination and reports to regulatory agencies.
Bacteriological Laboratory Lead	Winsome Robinson Williams	206-615-1353	Oversees fecal coliform analyses and reporting.
Chemistry Laboratory Lead	Jim Dunn	206-684-7406	Oversees potassium and fluoride analyses and reporting.

Role	Name	Office/Cell Phone	Responsibility
Environmental Compliance Inspector (Water Quality Complaint and Spill Response Lead)	Eric Autry	206-684-7988 206-954-4379	Works with responsible parties to resolve illicit discharges.
Environmental Compliance Inspector (IDDE Program Lead)	Adam Bailey	206 684-7805 206-423-0409	Program development, oversee field screening and chemical analyses, trigger follow-up, data management and reporting, arrange for business inspections, oversee illicit discharge resolution.
Environmental Compliance Inspector	Matthew Garcia	206-615-0464 206-423-0682	Field screening and chemical analyses, data management and reporting
Environmental Compliance Inspector (Sediment Source Tracing, Business Inspections)	Brian Robinson	206-733-9160 206-786-0286	Performs business inspections and sediment sampling and works with responsible parties to resolve illicit discharges.
Environmental Compliance Inspector (Sediment Source Tracing, Business Inspections)	Megan Wisdom	206-733-9002 206-255-7751	Performs business inspections and sediment sampling and works with responsible parties to resolve illicit discharges.
Environmental Compliance Inspector (Sediment Source Tracing, Business Inspections)	Mike Jeffers	206-386-9085 206-423-3424	Performs business inspections and sediment sampling and works with responsible parties to resolve illicit discharges.
Environmental Compliance Inspector (Sediment Source Tracing, Business Inspections)	Nathan Hart	206-684-5037 206-465-6668	Performs business inspections and sediment sampling and works with responsible parties to resolve illicit discharges.
Environmental Compliance Inspector (Sediment Source Tracing, Business Inspections)	Bri Silbaugh	206-684-3693 206-255-9983	Performs business inspections and sediment sampling and works with responsible parties to resolve illicit discharges.

5.3 General IDDE Program Phases

Table 2 describes the programmatic steps in administering the City's IDDE program to proactively detect and eliminate illicit discharges into the MS4 and to comply with the City's Permit.

Table 2: IDDE Program Elements

Timeline	Action
2003 to Present	Sediment source tracing efforts in the Lower Duwamish Waterway and East Waterway drainage basins
May to September 2009	First season of dry weather field screening efforts, initiating source tracing efforts as necessary

Timeline	Action
October to December 2009	Data analysis, document illicit connections found, and prepare annual report
January to April 2010	Program analysis, review effectiveness of chosen parameters and prepare QAPP Addendum
May to September 2010	Second season of dry weather field screening efforts, initiating source tracing efforts as necessary
October 2010 to April 2011	Data analysis, document illicit connections found, prepare annual report. Review and amend QAPP.
May to September 2011	Third season of dry weather field screening. Complete the 60% screening requirement in the City's Phase I Stormwater Permit.
October 2011 to February 2012	Data analysis, document illicit connections found, and prepare annual report. Determine format for reporting Superfund sediment screening data for the NPDES annual report.
Program function after 2012 Season	Evaluate program and continue proactive screening to discover illicit discharges and connections in City drainage basins or other proactive pollution detection work as determined by the Drainage & Wastewater Program Managers.

6.0 Quality Objectives

6.1 Decision Quality Objectives

The goal of the dry weather screening program is to obtain screening level data of sufficient quality to find illicit connections and discharges-- not to obtain research-level data or background data for comparison with other projects. Dry-weather screening by definition does not test stormwater or receiving waters but only water from sources such as:

- Intermittent streams that were undergrounded before sensitive area codes were adopted
- Seeps & shallow groundwater
- Foundation drain water
- Construction dewatering
- Flows from illicit discharges
- Flows from illicit connections.

Therefore the IDDE program screening data are not considered valuable for establishing urban background information for comparing with other stormwater studies. For this reason, SPU has chosen not to include the IDDE screening data in their corporate database.

The level of quality control for screening level data needs to be sufficient only to be confident that a numeric value obtained is precise enough to tell whether a threshold trigger is exceeded.

6.2 Measurement Quality Objectives (MQO)

Measurement quality objectives (MQOs) specify how good the data must be in order to meet the objectives of the project. MQOs are the performance or acceptance thresholds based primarily on the data quality indicators of precision, bias, and sensitivity. The MQOs and corrective action required are listed in the Quality Control section 10.0.

7.0 Sampling Process Design

7.1 Screening Parameters

The dry weather field screening program uses field observations, field analyses, and laboratory analyses of a select few chemical and microbiological parameters to characterize flowing discharges. When flow is not present, the field screening program relies on field observations, such as damage or staining, to suggest the presence of intermittent or transitory discharges. The screening parameters given in Table 3 below have been selected to determine if an illicit discharge is likely.

Table 3: Screening Parameters (updated for 2011 field season)

Screening Parameter	Parameter Type	Trigger Parameter*
Color	Field observation	Yes
Odor	Field observation	Yes
Floatables	Field observation	Yes
Turbidity	Field observation	Yes
Estimated flow volume	Field observation	No
Conductivity	Field Analysis	Yes
pH	Field Analysis	Yes
Temperature	Field Analysis	Yes
Surfactants	Field Analysis	Yes
Ammonia	Field Analysis	Yes
Fluoride	SPU Water Quality Laboratory	Yes
Potassium	SPU Water Quality Laboratory	Yes
Fecal Coliform	SPU Water Quality Laboratory	Yes
E. Coli	Spu Water Qulatiy Laboratory	Yes

*Note: corresponding trigger levels, as applicable, are found in Table 4 below

These screening parameters have been found to be useful for identifying and characterizing residential, commercial, and industrial discharges (Brown, Caraco & Pitt, 2004) and from experience in prior field seasons. Most of the City's drainage basins consist of mixed land uses and are highly variable in their composition. Flows vary considerably as well. SPU will attempt to utilize all screening parameters at all sample locations to the extent possible. Additional parameters may be added in response to specific situations based on the experience and observations of the screening team. Conversley, parameters may be removed if it is determined that they are no longer helpful in detecting prohibited discharges.

7.2 SPU Trigger Levels

The dry weather field screening program uses a trigger method as the primary action level for source tracing. The trigger method uses field and laboratory screening parameters to prioritize investigations for source tracing. Trigger levels are estimates that are greater than what is encountered in natural systems.

As listed below in Table 4, SPU has established trigger levels for 12 screening parameters to initiate source tracing for suspected illicit discharges and illicit connections.

Table 4: SPU Trigger Values

Screening Parameter	SPU Trigger Values	Analysis Location
pH	<5.5 or >9	Field
Conductivity	>700 µS/cm***	Field
Turbidity	Severity Index 2	Field
Temperature	>80° F (26.67° C)	Field
Odor	Severity Index of 2	Field
Color	Severity Index of 2	Field
Floatables	Severity Index of 2	Field
Surfactants	> 1 mg/L	Field
Ammonia	> 5 mg/L	Field
Fecal coliform*	> 5000 CFU/100mL	SPU Water Quality Laboratory
E. Coli	>2419 Mpn	SPU Water Quality Laboratory
Fluoride	> 0.6 mg/L	SPU Water Quality Laboratory
Potassium	> 5 mg/L	SPU Water Quality Laboratory

Notes:
*Fecal coliform values are set fairly high due to the very frequent contamination of flows by pet waste and urban wildlife (squirrels, rats, etc.). Experience has shown that values above 5,000 CFU/100mL are above the chronic "urban background" level.
*** Conductivity was set at a higher level for the 2011 field season to roughly mirror the acceptable Total Dissolved Solids levels for drinking water.
Fluoride was increased to better account for the values often seen in urban groundwater. Note: Jim Dunn suggested that fluoride in drinking water is being decreased to 0.7 mg/L and we might want to adjust this level downward in 2012.

7.3 Field Screening

The general approach to field screening is to begin at an accessible location at or near the discharge point of a drainage basin, such as an outfall, key maintenance hole, ditch, or other structure. Field screening is performed at multiple key locations in most drainage basins instead of relying on elevated concentrations to be found only at the downstream discharge point. The size of the drainage basin is used to determine the number of locations screened. Key upstream maintenance holes representing major branches of the conveyance system are screened in larger basins in order to decrease the size of the area screened by an individual sample. The purpose of this approach is to help detect discharges that may be diluted and, therefore, masked by groundwater intrusion or blended flows.

SCPD staff will be performing the field sampling and analyses for all parameters except fecal coliform, E. Coli, potassium, and fluoride, which will be performed by the SPU Water Quality Laboratory. Most of the samples collected will be grab samples of flowing water. Most field screening will occur during the summer months during dry weather conditions.

Dry weather definition: For the purposes of the IDDE program, dry weather means a maximum of 0.04 inches of rainfall in the preceding six-hour period, with no more than 0.02 inches of rainfall in any one-hour period. If runoff can be observed entering the drainage system samples will not be collected, regardless of rainfall measured.

The City operates more than 17 rain measurement stations providing real-time data. Rainfall data will be obtained from the rain gauge station nearest the basin to be screened. The sampling schedule will also be adjusted to account for tidal intrusion in areas of the City influenced by tidal flows.

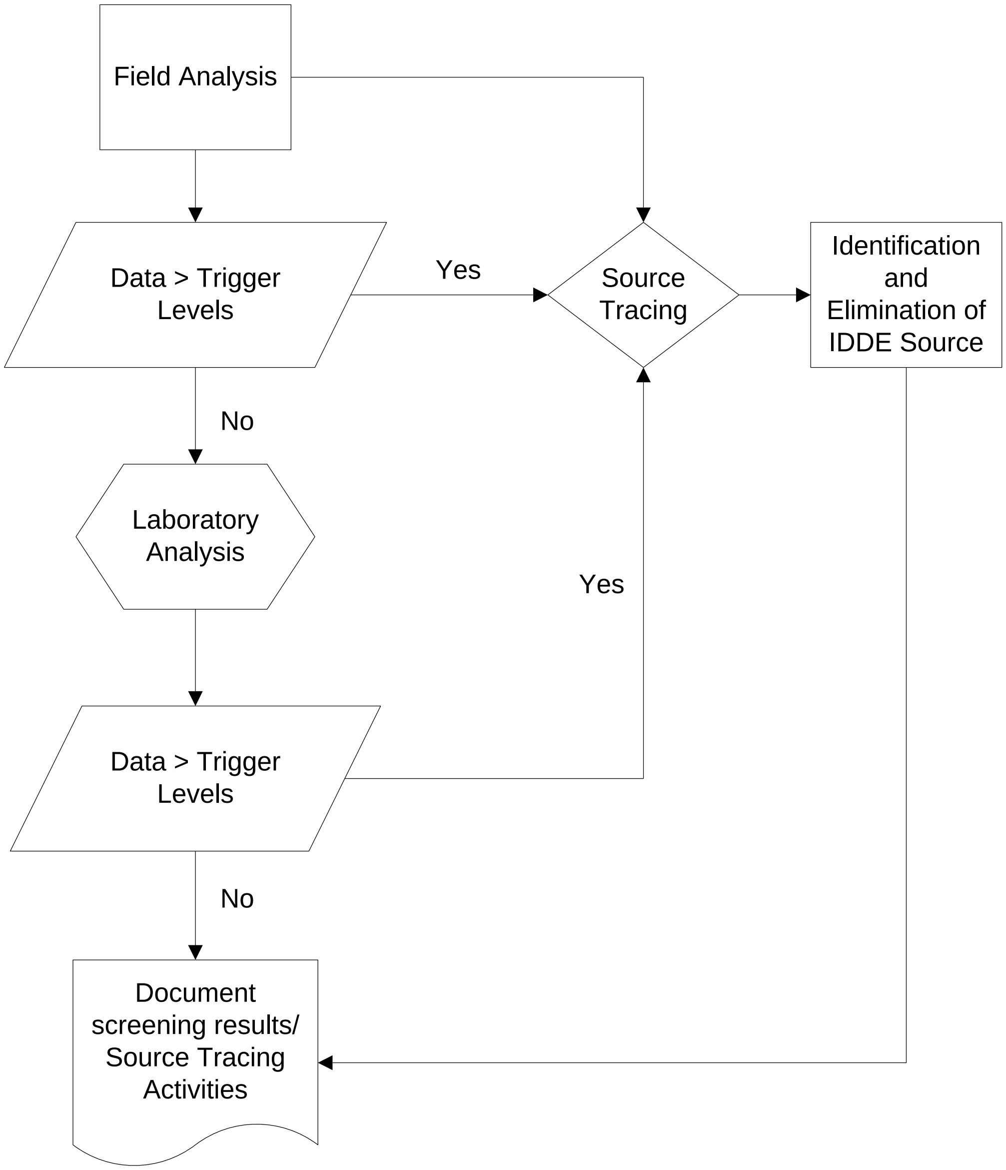
7.4 Source Tracing Process Using Screening Data

An iterative process to locate illicit connections based on screening data is shown in Figure 1. This process has two components: one triggered by field data and the other triggered by lab results, which are not available until well after the field data has been collected. The principal components of SPU's sample screening element are:

- Field observations of the physical and environmental conditions at each site
- Field analyses by in-situ chemical screening
- Source tracing if illicit discharges or illicit connections are suspected based on the field observations or field analyses
- Laboratory analysis of the collected samples for the remaining chemical parameters
- Additional source tracing based on laboratory analyses

Figure 1 illustrates how these components work together to result in identification and elimination of illicit discharge sources. Detailed procedures for field screening activities are included as an appendix to this QAPP.

Figure 1: Sample Screening Flow Chart



7.4.1 Immediate Source Tracing

Immediate source tracing will be initiated whenever field observation or data show that any of the trigger values listed in Table 4 above have been reached.

Immediate source tracing may not require that a sample be collected at each location or that each sample be analyzed for all parameters due to the importance of tracking the discharge quickly to locate the source, especially for intermittent and transitory flows. In these cases, SCPD staff may use field observations (color, odor, floatables, and turbidity) and selected field analyses (pH, conductivity, temperature, turbidity, etc.) to track the suspected illicit discharge or connection.

Once the source has been located or isolated to a smaller section of the drainage system, it may be necessary to use other source tracing methods such as additional water sampling, side sewer research, dye testing, smoke testing, business inspections, stream walks, or CCTV to identify and verify the illicit connection. These investigations may require the participation of other City inspectors, operations and maintenance staff, and other agencies and may not be able to be conducted immediately. The SPU SCPD Inspection Procedures Manual provides additional information on many of these investigative procedures.

Once the suspected source is identified, a source sample will be collected and analyzed for all screening parameters to compare with the downstream screening sample. The purpose of the source sample is to match the discharge types. In addition, the next upstream location will be sampled to confirm that there are no other suspected upstream illicit discharges or connections that may have been masked by the suspected source location.

In some instances, source tracing specific triggers will not lead to any obvious source of pollution. This is most likely to happen with conductivity, as groundwater contains minerals, organic matter, and nutrients which increase conductivity. Groundwater infiltration into the city storm system is a common occurrence. SCPD field staff will use their best judgment in determining whether or not a trigger, such as conductivity, should be investigated further. When source tracing does not lead to an obvious pollution source, the surrounding area will be investigated visually for any potential pollution source/s and field and lab data will be carefully looked over to ensure that there are no patterns suggesting a pollution source. Once field staff have exhausted these techniques, the trigger will be closed citing the “probable” source of the elevated trigger if one is suspected or will indicate “source unknown” if more appropriate.

Because many maintenance holes in the city have multiple inlets, it is possible for SCM staff to discover multiple triggers from several inlet flows at one site. In these cases SCM staff will prioritize public health and safety in deciding which trigger/s to source trace first. In general, parameters will be weighed in the following order:

- Field observations (staining, odor, floatables, etc.)
- Fecal Coliform/E. Coli
- Ammonia
- Surfactants
- pH
- Potassium
- Temperature
- Conductivity
- Fluoride
- Turbidity

7.4.2 Additional Source Tracing

Additional source tracing is required when field observations and field analysis results have not triggered immediate source tracing, but the results from the laboratory analyses are above the trigger values listed in Table 4. The SPU Water Quality Lab completes fecal coliform analysis daily while potassium and fluoride analysis is completed weekly. Results will be provided to SCPD staff within 2 weeks of sample collection and additional source tracing will be initiated within 21 days of receiving the data if results are above trigger values.

On occasion SCPD staff may receive multiple triggers in the bi-monthly lab reports. Source tracing prioritization will be based on public health and safety as listed above. In some instances, field observations and field analysis results will trigger source tracing and SPU staff will be able to locate the source immediately. Laboratory analysis results may also later confirm the suspected illicit discharge or connection with elevated trigger values, but additional source tracing will not be required in these instances as the source was already eliminated.

As the field season ends, field staff may have outstanding triggers, that is, may not have completed tracing values exceeding triggers to a source location. In this case, field staff will assess each individual trigger in relation to public health and safety. Triggers deemed likely to be the cause of a public health or safety issue will be investigated further into the wet season to the extent possible. Sampling will be performed during ‘dry weather’ conditions (a maximum of 0.04 inches of rainfall in the preceding six-hour period, with no more than 0.02 inches of rainfall in any one hour period) to the extent weather allows. However, data gathered from the use of dry weather screening during wet weather will be used carefully due to inputs to the MS4 such as groundwater, stormwater discharge from detention systems, etc. which can dilute or obsure source tracing efficiency. Other techniques, such as CCTV and basic investigation of the storm drainage network and drainage area (i.e. visual observations, odor etc.), will be used in an attempt to locate these sources late in the season. On occasion, smoke testing may be done if the problem is deemed to be a high priority and SPU management agrees.

7.5 Data Review and followup

Data review is performed on all collected data including field observations, field analyses, and laboratory analyses. The purpose of the data review is to:

- Confirm that source tracing has been initiated on all results from field screening that are over the trigger levels including field observations, field analyses, and laboratory analyses
- Use best professional judgment when the screening results are not over the trigger levels, but the data patterns suggest the potential for an illicit discharge or connection

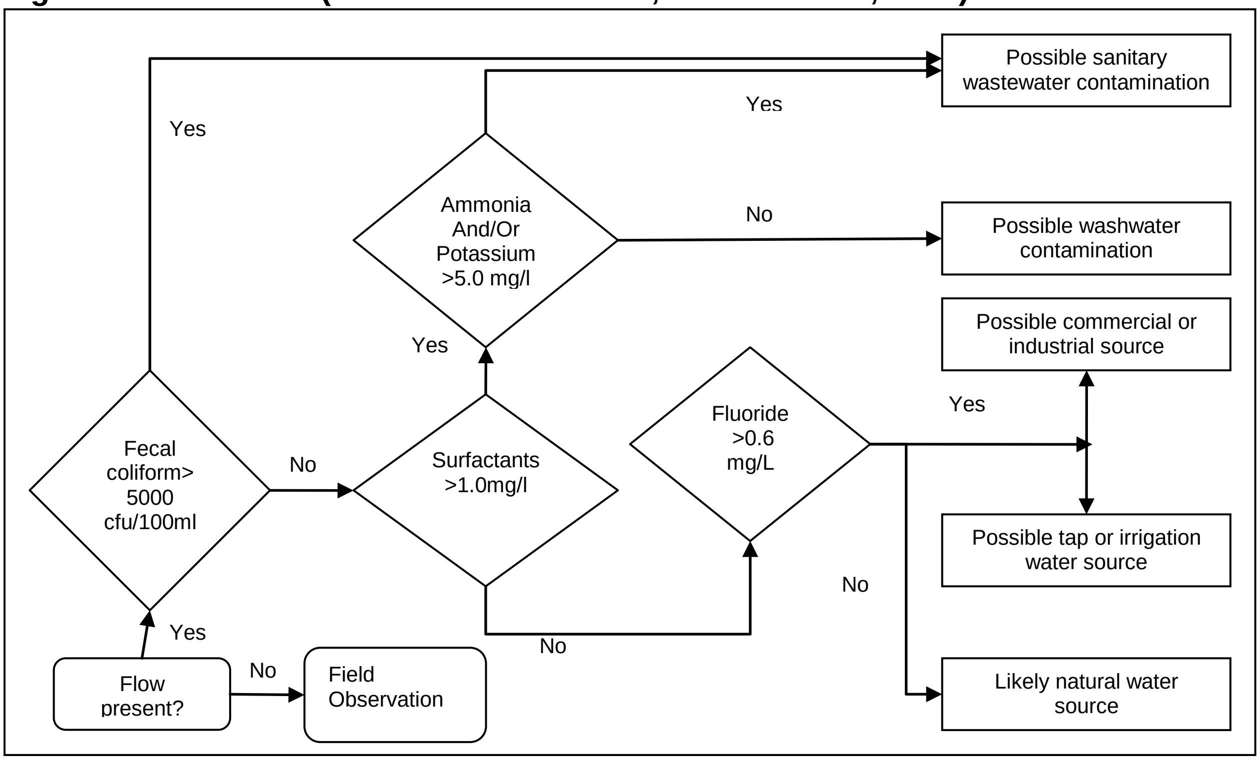
7.5.1 Comparing Data to Trigger Levels

The data review process involves comparing all screening parameters from field observations, field analyses, and laboratory analyses to the trigger levels to verify that source tracing has been initiated for all results over the trigger levels. In some instances, source tracing may be initiated after the data review process when the screening results are not over the trigger levels, but the data and best professional judgement suggest the potential for an illicit discharge or connection.

7.5.2 Comparing Data to the Flow Chart

The flow chart in Figure 2 is a tool that uses five of the SPU screening parameters to differentiate between potential sources in order to form a better idea about the nature of the suspected illicit source. Details are available in the document "Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments" (Brown, Caraco and Pitt, 2004a,b). Three flow charts are discussed in the guidance manual. The City is using a modified version of the guidance manual Figure H.1 (Figure 2 is adapted from this source).

Figure 2: Flow Chart (Modified from Brown, Caraco & Pitt, 2004)



The purpose of the flow chart is to help identify the likely source of flow using five screening parameters: fecal coliform, surfactants, ammonia, potassium, and fluoride. SPU trigger levels correspond to the flow chart concentrations for identifying flow types. The flow chart is to differentiate between the following flow types and assist with source tracing efforts:

- Sanitary wastewater contamination
- Washwater contamination
- Commercial or industrial sources
- Tap or irrigation water source
- Natural water source

7.6 Removing Illicit Discharges and Illicit Connections

When screening parameters are triggered and an illicit connection is suspected, an investigation must be initiated within 21 days according to the City's NPDES Permit to determine the source and responsible party. The following should also be followed:

1. Contact Ecology upon discovering an illicit connection that presents a severe threat to human health or the environment.
2. Assign an Environmental Response Tracking System (ERTS) number, document on a Water Quality Complaint Investigation Field Form and track the trigger in the Water Quality Complaint database.
3. Continue source tracing to locate the source of the high trigger values.

When a specific illicit connection is identified, the following should occur:

1. Response to eliminate the illicit connection is a top priority and initial action should occur within 24 hours.
2. Use enforcement authority in a documented effort to eliminate the illicit connection within 6 months of confirming that an illicit connection exists.
3. If the connection is verified to be a private source, inspectors initiate contact to the property owner(s) responsible for the illicit connection. Follow the procedures in the Inspector's procedures manual and fill out the "follow-up illicit form"as a basis to determine if a by-pass should be installed(..\..\..\Codes, Policy,Procedures and Opinions\Procedures\Procedures Manual\Inspector Manual\Inspection Procedures\Procedures_Manual_-2010_Update _ FINAL.docx, page 7-1).
4. A "Notice of Violation" is sent to the property owner, per the enforcement section of the SPU Source Control procedures manual, specifying a compliance deadline based on the specific activity and severity of human, environmental, and public safety impact. The deadline to correct an illicit connection is given within the SPU Source Control Procedures Manual, and may vary based on the nature of the connection. The NOV deadline may be extended for valid reason at the discretion of the inspector. In no case should the correction date be extended beyond 6 months without involving the Source Control & Program Develpment Supervisor and the NPDES Permit Manager.
5. Fill out the "Illicit Connection Found" form and the "Follow-up Information on Illicit Connection" form ..\..\..\..\..\..\Inspection Programs\All Programs - Forms, BMP Fact Sheets, Outreach Info\Insp Form - Illicit Connection Notification forms.docx. Submit to the Health Dept. See Inspection Procedures Manual, p.7-1, Section 7.3 Residential Illicit connections.
6. Notify the Department of Planning and Development via sidesewerinfo@seattle.gov that SPU has sent a recent corrective action requiring a permit with the specific address noted.
7. If the illicit connection is verified to be City owned, SPU Drainage and Wastewater Asset Management Division (Frank McDonald and Jeff Williams) are notified to initiate a repair.
8. If the suspected or known pollutant discharges from a municipal outfall into a receiving water body **that is on the 303(d) list or is known to violate WQ standards**, contact the SCPD Supervisor and City of Seattle Permit coordinator. It may be necessary to file an SF4 letter concerning this situation.
9. After the source has been removed or eliminated, perform follow up inspection and/or monitoring to confirm that the source of pollution has been successfully removed.

Existing City enforcement authority and protocols will be used for correcting illicit connections to the storm water system. The procedures are described in:

1. The City of Seattle Stormwater Code, Chapter 22.800
2. The City of Seattle Source Control Requirements and Technical Guidance Manual, 2000
3. Seattle Public Utilities Source Control and Monitoring Team Inspection Procedures Manual, 2008

8.0 Sampling Procedures

Fecal coliform, e. coli, fluoride, and potassium samples will be collected in the field by SCPD staff and transported on ice to the SPU Water Quality Laboratory for analysis by laboratory staff. The transfer of samples between SCPD and laboratory staff will be documented using Chain of Custody forms.

8.1 Safety

Refer to the Source Control & Monitoring Team Inspection Procedures Manual for safety guidance.

8.2 Sample Collection

If flow is present, samples are collected for analysis of pH, conductivity, temperature, surfactants, ammonia, fluoride, potassium, fecal coliform, and e. coli. The field analysis results are recorded in a Field Log notebook and then entered into the geodatabase via ArcMap from a laptop. Table 5 lists container types & sizes for collecting and submitting field and laboratory parameters. Detailed methods for conducting field analysis are included in Appendix A to this QAPP. Table 6 lists the holding times and preservatives for samples not immediately analyzed in the field.

Table 5: Sample Container Requirements

Parameter	Sample Collection		Sample Analysis		Field Container Preparation
	Type	Volume	Type	Volume	
Temperature	Plastic	1000 mL	Plastic	1000 mL	Rinsed
pH					
Conductivity					
Dissolved Oxygen					
Ammonia & Surfactants	Plastic	1000 mL	Plastic	60 mL	
Fluoride	Plastic	1000 mL	Plastic	125 mL	
Potassium					
Fecal coliform	Plastic	290 mL	Plastic	290 mL	Sterile

Note: This table is repeated in Appendix A3 for ease of reference. Any changes to this Table must also be made to the Appendix.

Table 6: Sample Additives, Preservation, and Holding Times

Parameter***	Preservation	Holding Time
Fluoride	Cool to 4°C	28 days
Potassium	*Nitric acid (HNO_3) to pH 2*, Cool to 4°C	6 months
Fecal coliform	Sodium thiosulfate powder, Cool to 4°C	24 hours**

* Samples will be analyzed for fluoride prior to being acidified for potassium analysis and preservation will not be completed in the field.

** The Standard Methods for the Examination of Water and Wastewater specifies a 6 hour transport and 2 hour holding time for fecal coliform samples. Ecology typically allows a 24 hour holding time before results must be flagged with qualifiers if the samples are not NPDES compliance samples.

*** All other parameters will be analyzed upon collection.

9.0 Measurement Procedures

The method of analysis for each parameter has been selected based on a literature review,consultation with similar programs, and SPU chemists at the Water Quality Laboratory.

The intent of the dry weather field screening program is to find sources of contaminated water, not to provide research-level analysis of environmental samples of long-term interest. The methods chosen allow a relatively quick turn-around time for sample results at the expense of accuracy and sensitivity.

Contaminated waters may have concentrations levles several orders of magnitude higher than the selected methods can determine without diluting samples. When this occurs, results will be reported as greater than the maximum range instead of performing dilutions to determine an absolute value. Dilutions will not typically be employed to determine how much a concentration is above the SPU trigger levels.

9.1 Analytical Methods and Procedures

Table 7 below lists the methods for parameters used in dry-weather screening along with the detection method, range, resolution, and reporting limit for the parameter.

Table 7: Measurement Methods for Water Matrix

Parameter	Method	Range	Resolution	Reporting Limit
Field				
Discharge/Flow	Multiple methods	Variable	Variable	NA
Conductivity	SM 2510	0 to 3000 mS/cm	±1 µS/cm	10 µS/cm
pH	SM 4500H+	1.00 to 14.00	0.01 SU	0.01 S.U.
Ammonia	Salicylate method adapted from Clinica Chimica Acta, 14 403 (1966), Hach 8155	0.01 to 0.5 mg/L	0.1 mg/L	0.01 mg/L
Surfactants	SM 5540C, Chemetrics Colorimetric Comparator	0 to 3.00 mg/L		0.25 mg/L
Laboratory				
Fluoride	ASTM D1179-93B	0.1 to 1.50 mg/L		0.1 mg/L
Potassium	SM 3111-B	0.5 to 20.0 mg/L		0.5 mg/L
Fecal coliform	SM 9222D-	10 to 60,000 CFU/100mL		10 CFU/100mL

9.2 Field Observations

SCPD staff note physical and environmental field conditions of each field screening location. These observations are recorded using a geodatabase in ArcMap on a laptop. As presented previously in Table 4, SPU has set trigger levels for four primary field observations: color, odor, turbidity, and floatables. Field observations are rated by a relative severity index that uses a scale from 0 to 2 (see Table 8 below). The SPU trigger level for each field observation is set at Severity Index 2, which indicates obvious signs of illicit discharges and connections.

Table 8: Field Observation Severity Indices

Field Parameter	Severity index		
	0	1	2
Color	No color or staining	Noticeable color or staining	Pronounced color or staining
Odor	Little noticeable odor	Noticeable odor	Pronounced odor
Turbidity	Slight discoloration	Moderate discoloration	Pronounced discoloration
Floatables	Floatables cover minor amount of surface area sampled	Floatables cover about 25% of surface	Floatables cover over half of surface

9.3 Field Measurement Procedure

Instrument calibration against pH buffer and standard concentration solutions is performed regularly to confirm that instruments are attaining stated accuracy and resolution specifications. Multiparameter meter calibration procedures are given in Appendix A2.

9.4 Laboratory Analysis of Collected Samples

Samples collected for fluoride, potassium, fecal coliform, and e. coli are transported on ice to the SPU Water Quality Laboratory for analysis. These samples are submitted to the SPU Water Quality Lab the same day that samples are collected and are analyzed within the holding time for each parameter. Samples will be analyzed and results will typically be received within two weeks of sample collection. Laboratory standard operating procedures (SOPs) are available from the lead chemist and bacteriologist, but a summary description follows.

Potassium

The SPU Water Quality Lab is no longer accredited by Ecology (2009) to test non-potable waters by the Standard Methods 3111-B, Flame Atomic Emission (FAE) procedure. However, this method will be used as a screening tool to determine if high concentrations of potassium occurs in the drainage system. Samples will be acidified to 0.5% with HNO3 and analyzed using a Thermo Jarrell Ash SH4000 Spectrophotometer.

The detection limit is 0.5 mg/L and the precision for this method is 0.06 mg/L. Calibration standards are 5.00, 10.0, and 20.0 mg/L.

In this method, the sample is aspirated into an acetylene torch. The potassium atoms are thermally excited and emit a specific wavelength of light. The intensity of this wavelength is directly proportional to the concentration of potassium in the sample. Intensities are then compared to the standards that are analyzed and a resulting concentration is recorded by the instrument. Hold time for acidified samples is 6 months.

Fluoride

The SPU Water Quality Lab is accredited by Ecology to test non-potable waters by the American Society for Testing and Materials, No: D 1179-93B, Ion Selective Electrode (ISE) procedure. Sample volume is modified to use only 10.0 mL sample volume thus reducing reagent use for this method. Analysis is completed using a Thermo Electron pH/ISE meter.

The detection limit is 0.1 mg/L and the precision for this method is 0.02 mg/L. Calibration standards are 0.50, 1.00, and 1.50 mg/L.

In this method, 1.5 mL of TISAB is added to 10 mL of sample and the resulting solution is measured by a fluoride sensing electrode with a reference electrode comparison. The milli-volt potential is compared to the potential of the standards with the resulting concentration displayed by the meter.

Fecal Coliform

The SPU Water Quality Lab (WQL) is accredited by Ecology to test non-potable waters by the Standard Methods for the Examination of Water and Wastewater, No: 9222 D, 24-hour Membrane Filter (MF) procedure. This method will be used by this program with the following exceptions:

- Holding temperature is to be between zero and 4°C (SM allows up 10°C)
- Holding time is not to exceed 24 hours (Standard Methods recommends no more than 8 hours but allows up to 24 hours)

Densities are reported as colony forming units (CFU)/100 mL. The WQL will as standard practice for the IDDE program perform a 0.1 mL, and 1.0 mL dilution on each sample. The method detection limit for these two dilutions is between 100 CFU/100 mL and 60,000 CFU/100 mL. If a lower detection level is needed, for instance to check contamination of blanks, a dilution of 10 mL should also be added. This will lower the detection limit to 10 CFU/100 mL. Similarly, a 100 mL dilution will result in a 1 CFU/100mL detection limit. These lower detection limits may be desired when sampling receiving waters to determine the impact of illicit connections. The table below shows the relationship between the volume analyzed and the quantitation level.

Analyzed Volume (mL)	Range of Results (CFU/100mL) (Low to High)	
100	1	60
50	2	120
10	10	600
5	20	1,200
1	100	6,000
0.5	200	12,000
0.1	1,000	60,000

0.05	2,000	120,000
0.01	10,000	600,000
0.005	20,000	1,200,000
0.001	100,000	6,000,000

In this method, samples are filtered using varying volumes to establish fecal coliform density in the range of 20 and 60 fecal coliform colonies. The filtered samples are incubated for 24 ± 2 hours at 44.5 ± 0.2°C. The colonies produced by fecal coliform bacteria are various shades of blue. The colonies are counted with a low power microscope or other optical device.

10.0 Quality Control (QC)

The SPU Water Quality Lab has a routine set of quality control activities they undertake. Among those are sterility checks, analysis of blanks and for the fecal coliform analysis, media control samples (e. coli?). In addition, the laboratory analyzes proficiency test samples once per year to maintain accreditation. Lab instruments are calibrated according to the manufacturer's specifications or as specified by the listed method.

Table 9 below describes the types of blanks, duplicates, and replicates that are typically used in projects and defines how they will be used during dry-weather screening.

Table 9: Blanks, Duplicates and Replicates Used in the IDDE Program

QC type	Definition/Reason
Check Standards	Standards purchased from an analytical supply house that are of a known value. Used to check if instrument drift is occurring after a number of samples have been analyzed. In the IDDE program, check standards will be used for the multimeter parameters of pH & conductivity.
Field duplicates	A field duplicate is a sample collected in a separate bottle at the same time and location as the primary sample. It is used to determine the variability of the sample matrix, environment or collection practices.
Analytical Duplicates/Replicates	A second analysis from the same bottle as the primary sample. Used to test the precision of the laboratory or field measurement.
Matrix Spike	A QC sample prepared by adding a known amount of the target analyte to an aliquot of a sample to check for bias due to interference or matrix effects.
Blanks	Blanks evaluate the effectiveness of cleaning and rinsing the sampling apparatus and sample containers. They consist of deionized water processed as actual samples, with appropriate reagents added. Blank results are expected to be below the method reporting limit. High results may indicate contaminatin of equipment, conainter, or the deionized water supply.

Tables 10 & 11 below describe the frequency with which the QC measure will be carried out, the measurement quality objective for the QC and the action that will be taken if the MQO is not met. In the case of fecal coliform, testing of duplicates during the 2010 field season revealed that variability in the sample matrix was often very high. Rather than use duplicates to determine whether fecal coliform values near the trigger are reliable enough to initiate source tracing, the following procedure will be used. For fecal coliform values over 3,250 CFU/100 mL, SPU will look at the other parameters for threshold exceedances. Based on the suite of values, field staff will determine whether further investigation of the fecal coliform trigger should be pursued.

Table 10: QC Frequency to be used in the IDDE Program

Screening Parameter	Check Standard (LCS)	Blanks		Duplicates		Matrix Spikes
		Method	Field	Analytical	Field	
Field Analysis						
Conductivity	1/day				1/month	
pH	1/day				1/month	
Temperature					1/month	
Surfactants			1/month		1/month	
Ammonia			1/month			
Laboratory Analysis						
Fluoride	1/week		1/month	1/batch	1/month	1/week
Potassium	1/batch	1/batch	1/month	1/batch	1/month	1/batch
Fecal Coliform		2/batch	1/month			

= Not Applicable

Table 11: MQOs and Corrective action to be used in the IDDE Program

QC type	Criteria	Corrective Action
Check Standards and Laboratory Control Samples	15% of true value	Stop analysis. Re-calibrate and re-analyze the last sample. If sample result is > ± 20% of the original value, reanalyze all samples that are close to a trigger level after the last acceptable check standard.
Method Blanks	≤ RL	Stop analysis and investigate for the cause of contamination. Make adjustments to the analytical protocol as necessary to improve performance. Re-analyze all samples with results >RL and < 10X RL. Samples, with those results, that cannot be re-analyzed will be qualified with a "J" for estimated.
Field Blanks	< RL	Re-assess bottle washing procedures to ensure no cross contamination is taking place.
Analytical Duplicates/ Replicates	RPD ≤ 25% for results > 5x RL	Resample locations if variance is effecting trigger identification. Make adjustments to the analytical protocol as necessary to improve performance.
Field duplicates	RPD ≤ 35% for results > 5x RL	Resample field duplicate location if the results exceed criteria. Determine if variance is effecting trigger identification. Make adjustments to the sampling protocol as necessary.
Matrix Spike Recovery	70 - 130%	If other recoveries are acceptable (e.g., blank spike, certified reference material, etc.), the data user should be informed that the result in the unfortified sample is suspect due to heterogeneity or an uncorrected interference. Criteria is not required if the concentration of the analyte added is < 30% of parent sample. Determine if variance is effecting trigger level.

* Since the IDDE threshold for initiating source tracing is greater than 5,000 CFU/100mL, some glassware contamination can be tolerated as it will very rarely affect the initiation of source tracing.

RL = reporting limit.

RPD = relative percent difference.

Field meter calibration

The IDDE Team uses a VWR Symphony Multiparameter Research Meter SP90M5 which measures pH, dissolved oxygen, conductivity and temperature. The meter is calibrated before use every day to confirm that the instrument is attaining stated accuracy and resolution specifications and values are recorded into a Calibration Field Logbook noting the date, conductivity cell constant, pH slope, and any applicable notes. pH is calibrated using a 3-point calibration with a 4, 7 and 10 buffer and conductivity is calibrated using a 2-point calibration with 100 and 1413 us/cm standard solution. If necessary, dissolved oxygen is calibrated by creating 100% saturated air.

Afternoon field checks are conducted for pH and conductivity by measuring both against known values and making sure the instrument is reading within 15% of the know values. pH is checked against the buffer closest to the previous sample and conductivity is checked against the standard closest to the previous sample. If either of these values are outside the allowable 15%, the instruments are re-calibrated and the last sample is re-analyzed for both parameters. If the instrument reads >20% of the last value, all prior data exceeding triggers levels for pH and conductivy will be re-analyzed once the instrument has been repaired. All data taken prior to the instrument malfunction will be flagged with a J qualifier which means the data was qualified as it does not conform to the measured quality objectives.

Nitrogen, Ammonia is meausured using a Hach DR/890 Portable Colorimeter. The DR/890 is a microprocessor-controlled, LED-sourced filter photometer and is precalibrated for common colorimetric measurements including Nitrogen, Ammonia. The instrument is checked against a known value during the afternoon field check and if the instrument is out of the specified range of 15% the previous data is qualified and the instrument is sent in for repair.

More detailed multiparameter meter calibration procedures are given in Appendix 2.

11.0 Data Management Procedures

Table 12 below describes the types of records that will be generated during screening, source tracing, and enforcement activities.

Table 12: Records Management

Document	Media	Comment
Field Log	Paper (notebook)	Used as backup for parameter data in case the geodatabase crashes and data is lost. Also used to document sample QC data (duplicate samples).
Locational information & field screening results	Electronic, transferred to database	A laptop equipped with ARC Map 10 (with a geodatabase) will be used to record location and all field screening data. Laboratory data will be entered as received. See Appendix A1, Field Operations, for more information.
Photographs	Electronic	Used to document sample locations in some instances and retained in SCM IDDE network folders. See Appendix A1, Field Operations, for more information.
Lab results	Electronic, transferred to database	Provided by SPU Water Quality Lab for potassium, fluoride, and fecal coliform.
Calibration Log	Paper (notebook)	Used to note all calibrations, maintenance, troubleshooting, and repair for multi-parameter meter and turbidimeter.
Ecology Environmental Report Tracking System (ERTS)	Electronic	Used to report source tracing investigations and filed in the SCM ERTS network folder.
Water Quality Complaint Investigation Field Form	Paper & Database	Used to record details of source tracing investigations and filed in the SCM complaints database.
Business Inspection Form	Paper & Database	Used to record details of business inspections resulting from source tracing investigations and filed in the SCM business inspection database.
Enforcement Letters	Paper/Electronic	Copies of originals retained with complaint files and electronic copies maintained in SCM Complaints network folder.

All field screening records will ultimately be recorded using the geodatabase, Excel database, and SCM complaint and business inspection databases. Log notebooks will be retained for backup and reference. Complaint Investigation and Business Inspection forms will be filed according to SCPD standard procedure. All record sources will be linked using the GIS “feakey” or other unique identifier for each station location.

12.0 Audits and Reports

12.1 Audits

The field screening team assigned to this program is responsible for both sample collection and analysis. They will periodically review the field, laboratory, and quality control results as well as document any process deficiencies and actions taken to correct deficiencies.

The IDDE Program Lead will review the program for adherence to this QAPP and report findings to the SCPD Manager at the end of each dry weather screening season. Any deviations from the QAPP that are intended to be permanent must be changed in the QAPP prior the commencement of the next dry-weather screening season. The report shall note deficiencies related to sampling or discrepancies in procedures that do not follow this QAPP. The IDDE Audit form will be completed noting functional areas of the program, as well as noting areas that need modification. Areas to be addressed include:

- Deficiencies related to sampling methods include but are not limited to :
  sample container, volume, and preservation variations; improper storage temperature; holding-time exceedances; and sample site adjustments;
- Deficiencies related to chain-of-custody include but are not limited to delays in transfer, resulting in holding time violations; incomplete documentation; possible tampering of samples; broken or spilled samples, etc.
- Deficiencies related to field and laboratory measurement systems include but are not limited to instrument malfunctions, blank contamination, quality control sample failures, etc.
- Deficiencies should be documented in logbooks, field data sheets, etc., by field or laboratory staff and reported to the IDDE Program lead, who will inform the Source Control Supervisor if the deficiency is persistent and may initiate procedural or program changes.

Due to the nature of field screening, changes to sampling procedures will occur frequently, and must be properly documented.

12.2 Reports

Six types of reports may be generated during the course of the dry weather field screening program:

1. Water Quality Complaint Investigations - field personnel will use the existing water quality complaint investigation forms to document investigation of found or suspected illicit discharges. IDDE Blue Form Instructions

2. Business Inspections - field personnel will use the existing business inspection forms to document business inspections that are conducted as a result of source tracing investigations, in addition to using the water quality complaint investigation forms.

3. Ecology ERTS Reports - field personnel will file ERTS reports using an electronic form (http://www.ecy.wa.gov/programs/spills/forms/nerts_online/NWRO_nerts_online.html)

upon discovery of parameters over the trigger values that present a potential threat to human health or the environment. ERTS reports will be updated by email (TSAC461@ECY.WA.GOV) to reflect final disposition of source tracing activities.

4. SF.4 Reports - field personnel will send reports of fecal coliform samples to the S4F fact discovery coordinator within five days of sample validation if the sample satisfies all of the following:

   a) the sample/s were collected in a 303d listed water body that is a category 4 or 5

   b) sample results are greater than 14 CFU/100mL and less than the trigger value of 5,000 CFU/100mL, (results greater than 5000 cfu/100mL will still be sent through ERTS notifications. The fact discovery person will be able to review the results greater than 5000 cfu/100mL through reviewing the ERTS.)

   c) sample is representative sample furthest downstream screening value in a MS4 discharging to a water body. A representative sample for purposed of S4F notification is defined as a MS4 location that receives no additional inputs prior to discharging to the receiving water body

   That fact discovery person will then compile facts and present it to the Source Control Supervisor. Review for S4F shall occur within 7 days of the date of data validation. Information to be reported may include details of the discharge uncovered, steps taken to address this discharge, and the plan moving forward. The NPDES Permit Coordinator will use this information to prepare the S4F Report within 30 days of the incident.

5. Monthly Reports (or as needed) - the IDDE Program Lead will prepare written or oral reports for the Source Control & Monitoring Program Manager that may include the following information:

   - Percentage of MS4 screened (completed basins)
   - Number-of outfalls screened and basin percentage completion estimate (in-progress basins)
   - Number of source tracing investigations initiated
   - Number of illicit discharges and connections identified

6. Annual Dry Weather Field Screening Report - the IDDE Program Lead will provide the following information to the Source Control Supervisor, to be included in the Annual Report required by the Permit:

   - Number of source tracing investigations and verification that all investigations were initiated within 21 days of receiving knowledge of the trigger. If the investigation occurred later than the 21-day window a description of the circumstances that prevented the attainment of this goal will be included.
   - Number of enforcement actions
   - Number of illicit connections eliminated and verification that elimination occurred within 6 months of discovery
   - Number of referrals to Ecology (ERTS reports)

12.3 Evaluation of Dry-Season Activities

After the completion of the IDDE field season, the IDDE Program lead will prepare an evaluation of the utility of the screening parameters and their usefulness in detecting illicit connections. The evaluation shall include ideas on what other types of screening or other information might make the program more useful. This evaluation will be provided to the Source Control & Program Development Manager as well as the NPDES Permit Coordinator via the end of year audit form. This evaluation may also be in the form of a meeting with other inspectors and/or interested parties provided meeting minutes are taken and made available to the Manger and Permit coordinator.

13.0 Data Verification

Data verification is a completeness check that is performed before the data review process continues in order to determine whether the required information is available for further review. Although this step is not designed for use in qualitative review, it is essential for ensuring the availability of sufficient information for subsequent steps of the data review process.

Data verification involves examining the data for transcription errors or omissions as well as examining the results for compliance with quality control (QC) frequency criteria.

Once the measurement results are recorded, they are verified to ensure that:

- Data are consistent and complete, with no transcription errors or omissions
- Results for QC samples are recorded in the Field Log
- Instrument calibrations are recorded in the Calibration Log
- Established criteria for QC and calibration frequency are met
- Methods and protocols specified in the QAPP are followed

This program aims to verify data through the following process:

Basis	Data	Check
Per Station	Field Log and Geo-database	Reviewed to ensure all information is recorded correctly.
Weekly	SPU Water Quality Lab Results	Reviewed for omissions and errors.
Weekly	Field Results	Reviewed for omissions and errors.

14.0 Data Validation (Usability) Assessment

Data validation is an analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the analytical quality of a specific data set. It involves a detailed examination of the data package using professional judgment to determine whether the MQOs for precision, bias, and sensitivity have been met. Validation is the responsibility of the project manager (Ecology, 2004).

Validation is a process that includes evaluating data against criteria based on the quality objectives. The purpose of validation is to assess the performance of the sampling and analysis process to determine the quality of specified data.

The data verification, validation, and usability assessment are typically exercises to prepare data for potential enforcement, compliance, and litigation requirements. As the data objects for the IDDE program are specific to source tracing purposes, data validation considerations, while still important, are simplified to match data objectives. IDDE screening data is seldom used to build an enforcement case. Dye testing, CCTV and/or smoke testing are used to confirm illicit connections for corrective action enforcement.

Three classes of data quality are used when assessing the usability of data collected during field screening activities:

- **Accepted** - Data conform to all requirements, all quality control criteria are met, methods were followed, and documentation is complete
- **Qualified** - Data conform to most, but not all, requirements, critical QC criteria are met, methods were followed or had only minor deviations, and critical documentation is complete
- **Rejected** - Data do not conform to some or all requirements, critical QC criteria are not met, methods were not followed or had significant deviations, or critical documentation is missing or incomplete

14.1 Validation procedure

All sample results will be checked against the MQOs (Table 11) and sampling procedures (Tables 7 and 8). Samples exceeding criteria will be qualified as "J". The project manager will determine if the exceedance(s) are sufficient to hinder the evaluation of trigger levels. Data that is sufficiently suspect using the project manager's best professional judgment will be rejected and qualified as "R."

Field Data- If data are qualified as estimated, a "J" will be entered onto the field sheet and also into the master IDDE data spreadsheet. If data are rejected in the field, they will not be entered into the IDDE database.

Lab data –All qualified lab data will be entered into the master IDDE data spreadsheet.

14.2 Usability

Ecology gives the following guidance about data usability:

After the data have been verified and validated, Data Quality Assessment (DQA) or Usability Assessment is done. If the MQOs have been met, the quality of the data should be useable for meeting project objectives. If the MQOs have not been met for data (i.e., data have been qualified), you need to determine if they are still useable. You also need to determine if the quantity of data is sufficient to meet project objectives. This includes an assessment of whether the requirements for representativeness and comparability have been met. If you set an MQO for completeness, compare the number of valid measurements completed with those established by the MQO. And you need to evaluate whether the implementation of the sampling design gave the information expected for meeting project objectives.

DQA is built on a fundamental premise: data quality is meaningful only when it relates to the intended use of the data. DQA determines whether the study questions can be answered and the necessary decisions made with the desired confidence. (Ecology, 2004)

The dry weather field screening program is using a limited number of parameters and is performing fairly simple computations to make decisions. Therefore, the data usability assessment is fairly straightforward.

After the data quality validation procedure is performed, all Accepted and J-qualified data is considered to be usable for the source tracing flow chart and trigger levels. Rejected data will not be used.

15.0 References

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Appendices

Procedures

A1 Daily Checklist
A2 Multiparameter Meter Calibration
A3 Field Operations
A4 Surfactant Analysis
A5 Ammonia Analysis
A6 Laborartory Procedures
A7 Glassware and Bottle Cleaning

Material Safety Data Sheets

Manuals

VWR sympHony Multiparameter Meter
VWR sympHony Ammonia ISE Probe
VWR sympHony DO Probe
VWR sympHony pH Probe
VWR sympHony Conductivity Probe
Hach Portable Turbidimeter

Appendix A: Procedures

A1 Daily Checklist

Prior to leaving for the first station:

- Check rainfall data and download tide data if the Basin to be screened is in the tidally influenced areas of Seattle (mainly in the upper Duwamish valley). A map of these areas can be found on the GIS layers.
- Inspect the multi-parameter meter and probes for deposits, damage, and battery warnings, and make sure all probes are connected securely to the meter.
- Immerse the pH and conductivity probes in tap water. The pH probe should be given a few minutes to "warm up" before calibration, particularly if there have been recent calibration problems.
- **On the first day of the week or whenever batteries are changed**, verify all meter and probe settings in setup mode.
- Calibrate the multiparameter meter for pH and conductivity, according to the calibration procedures.
- Leave the meter on.
- Verify all equipment and supplies are in the vehicle.

Table A1: Field Equipment

		General	
○ DI water carboys ○ Squirt bottles ○ Spare batteries ○ Hand towels ○ Permanent markers ○ White board	○ Dry erase markers ○ Sample bottles ○ pH indicator paper ○ Hand sanitizer ○ Ice chest ○ Field bottles	○ Stopwatch ○ Clip boards ○ Masking and duct tape ○ Waste bottles for ammonia & surfactant tests	○ Spare sample cells ○ Calculator
		Instruments	
○ Laptop ○ Camera	○ Turbidimeter ○ Multiparameter meter	○ Ampoule breaker ○ Colorimeter	○ 0.1 to 1 mL pipettor ○ Pipettor tips
		Tools	
○ Sampling poles ○ Flashlights ○ Tape measure	○ Inspection mirror ○ Ropes ○ Sledge hammer	○ Sampling devices ○ Shovel	○ Machete and pruner ○ MH puller
		Chemicals	
○ Silicone oil ○ Oiling cloth	○ Gelex standards ○ Surfactants kits	○ pH buffers ○ pH probe storage solution	○ Conductivity standards ○ DO probe electrolyte

Documents			
○ QAPP and Appendices ○ Tide charts ○ Notebook ○ Confined Space permits	○ IDDE Manual ○ Bottle labels ○ Chain of custody forms	○ Field Log ○ Traffic Flagger Certs ○ Complaint forms ○ MSDS sheets	○ Calibration Log ○ Business Inspection forms
Safety Gear			
○ Safety vests ○ Leather gloves ○ Traffic cones and signs ○ Confined space entry gear	○ Hardhats ○ First aid kit ○ Sunscreen ○ Fire extinguisher	○ Safety glasses ○ Chest waders ○ Tyvek suits	○ Nitrile gloves ○ Steel toe boots ○ Sharps container

At the end of the day:

- Complete Chain of Custody forms and submit the fecal coliform, fluoride and potassium samples to the SPU Water Quality Laboratory for analysis.
- Store the pH probe in a capful of storage solution and the dissolved oxygen probe in its sleeve with a moist sponge. The conductivity probe should be stored dry.
    - All probes may be left connected to the meter unless there is a reason to disconnect them. Do not store the probes in distilled or deionized water.
- Place the used 125 mL acid-rinsed sample collection bottles in the tub labeled “for acid-washing.”
- Pour liquid waste from the surfactant reaction tubes into the labeled hazardous waste accumulation container and place the empty tubes in the tub labeled for acid-washing. Small CHEMets are considered hazardous waste as well. After proper labeling, both methylene blue and CHEMets may be stored in the HAZ WASTE cupboard in the Organic Chemistry lab room.
- Use pH test strips to determine the pH of the ammonia waste. Use soda ash as necessary to adjust the pH of the waste to between 6 and 9. Dispose of pH-adjusted waste in the laboratory sink with copious amounts of running cold water.

A2 Multiparameter Meter Calibration

Conductivity and pH vary with temperature. The temperature probe is integrated within the conductivity probe. Investigators should use buffers, standards and deionized water that have been stored together so they are near the same temperature. Ideally, buffer and standard temperatures should be near 25°C.

Replace buffers and standards once each week, or more often as necessary if readings become unstable.

On a weekly basis and after battery changes verify that the meter is still programmed to the correct settings.

Table A2: Meter Preferred Setup Table

Category	Description	Selection
General	Manual Temperature Setting	25.0
	Auto Shutoff	On
Time and Date	Six submenus - self explanatory	
Read	Continuous, Timed or Auto-Read	Continuous preferred, Auto-read acceptable
Due	Calibration Alarms	Set all to 0000 (off)
Datalog	Roll-over or delete data upon downloading	YES preferred, either acceptable
Log View	View and send data	Purpose dependent – consult manual
RS232	Baud rate selection	9600
Printout	Data format	Comp
pH Setup	pH resolution	0.01
	pH buffer set	USA
DO Setup	% saturation resolution	0.1
	Concentration resolution	0.01
	Barometric pressure compensation	Auto
	Salinity correction	Auto
	Calibration type	Air
Conductivity Setup	Temperature compensation	NLF (non-linear)
	Linear compensation coefficient	2.1
	TDS Factor	0.49
	Autocalibration default cell constant	0.475
	Temperature reference	25
	Cell type	Standard

Morning Calibration

The following is a summary of the calibration steps to be performed at the start of each field day. Refer to the instrument and probe manuals for detailed calibration instructions:

1. Conductivity
   a. Rinse the probe with deionized water. Gently shake the probe to remove water drops. Place the probe in the **100 µS/cm** solution.
   b. Select the conductivity measurement line. When the conductivity concentration icon stops flashing press the **Calibrate** button.

c. Wait until the concentration icon stops flashing. The meter will display the temperature corrected value if it recognizes the reference standard. If the displayed value is acceptable, press the **Calibrate** button (the AutoCal method). If the value is not acceptable, use the scroll and digit jump buttons to adjust the conductivity value (the DirectCal method). When it is acceptable, press the **Calibrate** button.
d. Rinse the probe with deionized water and place it in the **1413 µS/cm** standard.
e. Repeat steps b and c until ready to accept the value for the 1413 µS/cm standard. Press the **Measure** button instead of the calibration button.
f. For the next few seconds the screen will display CELL and a value. Record the value on the Calibration Log under cell constant.

2. pH
    a. Calibrate with fresh buffers each day. Don't risk contaminating the large bottles of pH buffers. Transfer pH buffers from the vendor bottle to one of the smaller calibration bottles.
    b. Rinse the conductivity probe with deionized water, gently shake it, and place it into the conductivity standard, which should be close to the same temperature as the pH buffers.
    c. Rinse the pH electrode with deionized water. Gently shake the water off and place it in the **pH 7.00 buffer**.
    d. Select the pH measurement line and then press the **Calibrate** button. Gently stir the buffer with the probe for a few seconds.
    e. Either the Auto-Buffer Recognition or Manual Calibration methods can be used. If the Automatic method has been selected, a temperature-corrected value will appear after the pH values stop flashing. If the Manual Calibration method is being used, the investigator will need to change the value after it stops flashing. Interpolate using values printed on the buffer bottle or box.
    f. Press the **Calibrate** button to accept the value. Remove the probe and rinse it with deionized water. Shake gently, and then place it in the **pH 4.01 buffer.** Gently stir the buffer with the probe. Repeat step e.
    g. Press the **Calibrate** button to accept the value. Remove the probe and rinse it with deionized water. Shake gently then place it in the **pH 10.01 buffer.** Gently stir the buffer with the probe. Repeat step e.
    h. To accept the calibration, press the **Measure** button. The slope will be displayed for about 2 seconds. Record this value on the Calibration Log. If the slope is not between 92% and 102%, consult the troubleshooting section.

3. Dissolved oxygen
    a. Remove the cap from the calibration sleeve and remove the sponge from the cap.
    b. Saturate the sponge with distilled/deionized water and squeeze excess water from the sponge.
    c. Reassemble the calibration sleeve and insert the DO probe into the sleeve (do not let the probe touch the sponge).
    d. Make sure the probe is connected to the meter.
    e. Select measurement mode.
    f. Select the DO measurement line.
    g. Press the **Calibrate** key.
    h. When the reading stabilizes the meter will display 102.3% saturation, proceed to measurement mode.

Afternoon Field Check

The following is a summary of the field check steps to be performed after analyzing the last sample before lunch during each field day. Refer to the instrument and probe manuals for detailed calibration instructions:

1. Rinse the conductivity probe with deionized water, gently shake it, and place it into one of the conductivity standards, which should be close to the same temperature as the pH buffers and ammonia standards.

2. Remove the pH probe from the storage solution. Rinse with deionized water and shake gently to remove water drops. Place it in the buffer nearest to the same pH as the sample just measured.

3. After readings stabilize, compare the result to the temperature-corrected interpolated value for the buffer in use. Be aware that the pH 4 buffer is the least temperature dependent, and the pH 10 buffer is the most temperature dependent.

4. If the pH measured value differs from the interpolated expected value:
    a. By less than 0.15, the measurement is still within accepted limits
    b. By greater than 0.15, recalibrate

5. If the conductivity reading is not within 15% of the standard, proceed to troubleshooting. The following ranges are acceptable:
    a. 95 to 105 µS/cm if using the 100 µS/cm standard
    b. 1350 to 1480 µS/cm if using the 1413 µS/cm standard

6. Prepare the Nitrogen-Ammonia Standard Solutions as NH3-N, 1 mg/L, 500 mL by pipetting 1 milliliter prepared standard into the ammonia vial. Add 9 milliliters of waterto the same vial and insert the prepared vial into the SR/890. Prepare a blank ammonia vial by pouring 10 mL of deionized water into a second ammonia vial. Prepare the vials according to Hach Method 8155. The prepared sample should be within 15% of .1 mg/L of NH3-N. If the result is not within 15% send the instrument to the manufacturer for troubleshooting.

7. Record all results in the Calibration Log.

Troubleshooting

The following is a summary of troubleshooting techniques to be used if calibration fails to establish stable readings. Refer to the instrument and probe manuals for detailed troubleshooting instructions:

1. Conductivity
    a. Verify that the reference temperature is correctly programmed into the meter to match the reference temperature of the standard.
    b. Verify that non-linear temperature compensation is selected.
    c. Use fresh standards to recalibrate.
    d. If readings become erratic or unstable, verify that the probe is securely attached and that the electrical contacts are clean and not corroded. If the problem persists or if the probe has been in very contaminated samples then cleaning may be required. Perform the following cleanings:
        i. Water soluble contaminants – thorough rinse with deionized water

    ii. Lubricants or oil contamination – soak in warm water and liquid detergent (if severe contamination, soak in ethanol or acetone for up to 5 minutes)
    iii. Lime or hydroxide coating – soak in 10% acetic or hydrochloric acid
  e. If the probe works correctly in standards but not in the sample, then there may be interfering substances or substances causing physical damage to the probe within the sample. These may be indicative of an illicit discharge. If possible, collect additional sample in order to have laboratory analyses performed.

2. pH
   a. If the slope is not between 92 and 102%:
      i. Make sure the NIST [USA] buffer set is selected in setup mode
      ii. Recalibrate with buffers from different bottles
      iii. Clean calibration bottles by wiping with a wet cloth and rinsing with water. Refill with fresh buffer.
   b. If recalibration fails, inaccurate measurement is suspected, the meter drifts, or takes more than 90 seconds to stabilize, perform one or more of the following:
      i. Change the pH buffer and probe filling solutions and recalibrate
      ii. Soak the probe in hot water for 15 minutes and recalibrate
      iii. Remove all pH filling solutions, fill probe with hot water and let soak for 5 minutes, rinse with filling solution then refill with filling solution, and recalibrate
   c. If problems persist:
      i. Soak the probe in 0.1 M HCl or HNO_3 for 5 to 15 minutes (if the problem is slow response or drifting)
      ii. Use the pepsin, EDTA, or mild detergent treatments described in the probe instruction manual
      iii. Alternate soaking in household ammonia and pH 4 solution several times for 5-minute intervals
      iv. Perform a meter self-test, as described in the meter instruction manual
      v. Perform the millivolt test as described in the probe instruction manual
      vi. Try a different probe.
   d. If the electrode and meter operate properly in the buffers but not in a sample, then the problem may be due to interferences, incompatibilities, or temperature effects within the sample. These may be indicative of an illicit discharge and initiating source tracing may be warranted.

3. Dissolved oxygen
   a. If calibration is difficult or not possible, it is likely due to:
      i. The probe membrane not touching the sponge
      ii. Drops of water present on the membrane
      iii. Air bubbles under the membrane
      iv. Damage to the membrane
      v. Old membrane or electrolyte
   b. If readings are unrealistic or do not stabilize, it is likely due to:
      i. Probe placement in area with too much flow
      ii. Air bubbles under the membrane
      iii. Old membrane or electrolyte

c. If readings are very low (<1 mg/L), then anoxic conditions may exist. The meter and probe are not accurate below 1 mg/L unless additional calibrations are performed. Low dissolved oxygen may be due to natural conditions or to wastes with high oxygen demand, in which case an illicit discharge may be present.
d. If readings are 0 mg/L, the probe may not be attached to the meter or the electrical connections may not be clean, or corrosion may be present.

DR/890 Colorimeter

a. The DR/890 Colorimeter is precalibrated for common colorimetric measurements including Nitrogen, Ammonia. If the instrument is not within the acceptable measured quality objective range send the instrument to the manufacture for troubleshooting and/or repair.

Multimeter Tech Support: Thermo Orion: 800 225-1480

A3 Field Operations

General recommendations while collecting and processing samples:

- Collect samples by pointing the open end of the bottle into the flow and when possible, the bottle should be dipped below the surface without hitting bottom
- Wear nitrile gloves while collecting samples and safety glasses when conducting analysis
- Don't touch the inside or threads of the bottle and cap
- Be careful to not dislodge debris from the structure, as it could contaminate the sample
- Wear safety vests and steel toed boots while working in and around traffic at all times
- Set up traffic control in situations where it is needed
- If accessing a maintenance hole, use confined space entry equipment and trained personnel. Also, fill out a confined space entry permit for the individual site if confined space entry is required. The permit shall be filed in the office and be accessible on demand.
- Using vehicles flashing amber lights when working in and around traffic

At outfalls and ditches it may be possible to hand-dip the bottles or it may be necessary to use a pole. At maintenance holes use a pole or a sampling device attached to a rope. It may be necessary to perform confined space entry in order to construct caulk dams or otherwise collect samples in low flow situations where pole or other sampling from the ground surface is not possible.

Three grab samples will be collected at each sample location in order to fill a 125 mL plastic bottle a1000 mL plastic bottle and a 290 mL plastic bottle. Sample bottles collected will be divided amongst analysis containers as necessary for both transport to the SPU Water Quality Lab and completion of field screening activities, as described below.

Table A3: Sample Container Requirements

Parameter	Sample Collection		Sample Analysis		Field Container Preparation
	Type	Volume	Type	Volume	
Temperature pH Conductivity Dissolved Oxygen	Plastic	1000 mL	Plastic	1000 mL	Rinsed
Ammonia & Surfactants	Plastic	1000 mL	Plastic	60 mL	Rinsed
Fluoride Potassium	Plastic	1000 mL	Plastic	125 mL	Rinsed
Fecal coliform	Plastic	290 mL	Plastic	290 mL	Sterile

Adhere to the following good laboratory practices:

- Safety glasses and appropriate gloves will be worn while performing all analyses
- Keep material on hand to prevent and clean up spills
- Keep incompatible chemicals segregated (i.e., do not store acids and bases together)
- Keep a fire extinguisher of the correct rating near where chemicals are stored
- Keep containers closed when not in use to reduce vapors and spills
- Return chemicals to their proper storage place
- Properly label containers with their contents and primary hazards

Sample Collection

1. Don proper personal protective equipment, including safety glasses or face shield and nitrile gloves, before sampling.
2. Collect 1000 mL, 290 mL and 125 mL of sample in each respective bottle. If you are not able to fill the 290 mL bottle directly from the discharge use a pre-washed 1 liter bottle to collect the sample and fill the 290 mL bottle from this bottle.
3. Fill the 125 mL bottle from the 1000 mL bottle for potassium and fluoride analysis. Fill the 60 mL plastic bottle with sample from the 1000 mL bottle for ammonia analysis.
4. Label the 290 mL, 125 mL (potassium and fluoride sample bottle) and 60 mL bottles with the following information
    a. Sample collection date and time
    b. Sample identifier with the date and "feakey" in the following format: mmddyy_feakey
        i. Add directional indicators at the end of the sample name when there are multiple inputs to a single feakey location: mmddyy_feakey_N
        ii. Indicate duplicate samples as follows: mmddyy_feakey_dup
    c. Sample location description (i.e., NW 101st Ave and 98th St NW)
5. Place the 290 mL, 125mL (potassium and fluoride bottle) and 60 mL sample bottles in the ice chest for transport to the SPU Water Quality Laboratory.
6. Transfer 10 mL of sample from the 60 mL bottle to the ammonia test vial bottle. Rinse the ammonia test vial with the sample and discard. Again, transfer 10 mL of sample to the ammonia test vial and reserve the remaining sample for dilutions if needed. Perform analysis in accordance to the Ammonia test procedures (Hach Method 8155) and record in the field log book.
7. Rinse the pH, conductivity and dissolved oxygen probes with deionized water and shake gently to remove any excess water.
8. Place the pH and conductivity probes in the 1000 mL sample bottle. Deploy the dissolved oxygen probe in situ if possible; otherwise, place in the sample bottle with the other probes.
9. Press measure and record the displayed values in the field log book. Repeat the measurement two or three times to ensure the readings are stable. Recalibrate the meter for any parameters that do not appear stable.
10. Perform surfactant analysis in accordance with the method card included with the test kit (and QAPP Appendix) and record the results in the field log book.
    a. Place the broken ampoule tips into a labeled sharps container.
    b. Dispose of flexible CHEMet assembly tubing in the garbage.
    c. Return spent ampoule and CHEMet assembly to paper rack included with the test kit.
11. Dispose of the ammonia and surfactant samples in labeled waste bottles. Other remaining sample water can be disposed of at source or on ground.
12. Rinse the 1000 mL sample collection bottle with deionized water to be used at the next sampling site. Place the surfactant reaction tube in a labeled container for acid-washing at the lab.
13. Rinse the pH, conductivity and dissolved oxygen probes with deionized water. Leave the dissolved oxygen and conductivity probes in deionized water and the pH probe in electrode storage solution between stations.
14. Proceed with data entry into the geodatabase using ArcMap on the laptop. Instructions found here.

Photo Log

1. Label the white board with the following information:
   Date and Time
   Field Staff Initials
   Feakey Number the structure type the sample was taken from (eg Maintenance Hole: MH, SandBox: SB). If the structure has no Feakey number write the cross streets and the direction the structure is from them.
   Sample Number. If no sample was taken write “No Sample”
   If source tracing: Source Tracing and Source Feakey
2. Place the white board next to the maintenance hole, sandbox, catch basin, etc and take a picture of the white board and structure.
3. Remove the lid from the structure and take a second picture of the inside of the structure.
4. Take a third photo of the general area; Street signs, addresses ect.

A4 Surfactant Analysis

*The following is a summary of the Detergents CHEMets procedure for surfactant analysis. See the instruction card included with the test kit for further guidance.

Procedure:

1. Rinse the reaction tube with sample then fill it to the 5 mL mark with sample.
2. Hold the double-tipped ampoule in a vertical position then snap the upper tip using the tip breaking tool.
3. Place broken tip into a labeled sharps container.
4. Invert the ampoule and position the open end over the reaction tube.
5. Snap the upper tip and allow the contents to drain into the reaction tube.
6. Place broken tip into a labeled sharps container.
7. Cap the reaction tube and shake it vigorously for 30 seconds.
8. Allow the tube to stand undisturbed for approximately 1 minute.
9. Make sure that the flexible tubing is firmly attached to the CHEMet ampoule tip.
10. Insert the CHEMet assembly (tubing first) into the reaction tube making sure that the end of the flexible tubing is at the bottom of the tube.
11. Break the tip of the CHEMet ampoule by gently pressing it against the side of the reaction tube. The ampoule should draw in fluid only from the organic phase (bottom layer).
12. When filling is complete (1-2 seconds), remove the CHEMet assembly from the reaction tube.
13. Remove the flexible tubing from the CHEMet ampoule and wipe all liquid from the exterior of the ampoule.
14. Place an ampoule cap firmly on to the tip of the CHEMet ampoule.
15. Invert the ampoule several times, allowing the bubble to travel from end to end each time.
16. Place the CHEMet ampoule, flat end downward, into the center tube of the comparator.
17. Direct the top of the comparator up toward a source of bright light while viewing from the bottom.
18. Rotate the comparator until the color standard below the CHEMet ampoule shows the closest match. If the color of the CHEMet ampoule is between two color standards, a concentration estimate can be made.

Note: Occasionally the CHEMet break improperly drawing up the “methylene blue” portion of the test vessel. This could give false positives if not caught.

A5 Ammonia Analysis

Ammonia Analysis: Method 8155

A6 Laboratory Procedures

Fecal coliform, fluoride, and potassium samples will be collected in the field by SCPD staff and transported to the SPU Water Quality Laboratory for analysis by laboratory staff. Transfer of samples between SCPD and laboratory staff will be documented using Chain of Custody forms.

Sample Preservation and Holding Times

The Standard Methods for the Examination of Water and Wastewater specifies a 6 hour transport and 2 hour holding time for fecal coliform and e. coli samples. Fecal coliform samples for NPDES monitoring are subject to a 6 hour holding time. The dry weather field screening samples are not subject to NPDES or SM requirements. Ecology typically allows a 24 hour holding time before results must be flagged with qualifiers if the samples are not NPDES compliance samples.

Table 1 below describes the preservation requirements and holding times for each parameter that will be transported to the SPU Water Quality Laboratory for analysis.

Table 1: Sample Additives, Preservation, and Holding Times

Parameter	Preservation	Holding Time
Fluoride	Cool to 4°C	7 days
Potassium	Nitric acid (HNO_3) to pH 2*, Cool to 4°C	6 months
Fecal coliform/e. coli	Sodium thiosulfate powder, Cool to 4°C	24 hours (8 hrs*)

*Note: Sample will be analyzed for fluoride prior to being acidified for potassium analysis and preservation will not be completed in the field.

Methods

The intent of the dry weather field screening program is to find sources of contaminated water, not to provide model-grade or research-grade analysis of the water in the conveyance system. The methods chosen allow fast turn-around of sample results at some expense of accuracy and sensitivity. Contaminated waters may have concentrations several orders of magnitude higher than what the selected methods can determine without diluting samples. When this occurs, results will be reported as greater than the maximum range instead of performing dilutions to determine an absolute value. Dilutions will not be necessary to determine whether a concentration is above the SPU trigger levels.

Potassium (See Appendix 6 "Potassium SOP" for a Detailed Method)

The SPU Water Quality Lab is no longer accredited by Ecology (2009) to test non-potable waters by the Standard Methods 3111-B, Flame Atomic Emission (FAE) procedure, but will use the method as a screening tool only. Samples will be acidified to 0.5% with HNO3 and analyzed using a Thermo Jarrell Ash SH4000 Spectrophotometer.

The detection limit is 0.5 mg/L and the precision for this method is 0.06 mg/L. Calibration standards are 5.00, 10.0, and 20.0 mg/L.

In this method, the sample is aspirated into an acetylene torch. The potassium atoms are thermally excited and emit a specific wavelength of light. The intensity of this wavelength is directly proportional to the concentration of potassium in the sample. Intensities are then compared to the standards that are analyzed and a resulting concentration is recorded by the instrument. Hold time for acidified samples is 6 months.

Fluoride (See Appendix 6 "Fluoride Low Level SOP" for a Detailed Method)

The SPU Water Quality Lab is accredited by Ecology to test non-potable waters by the American Society for Testing and Materials, No: D 1179-93B, Ion Selective Electrode (ISE) procedure. Sample volume is modified to use only 10.0 ml sample volume thus reducing reagent use for this method. Analysis is completed using a Thermo Electron pH/ISE meter.

The detection limit is 0.1 mg/L and the precision for this method is 0.02 mg/L. Calibration standards are 0.50, 1.00, and 1.50 mg/L.

In this method, 1.5 ml of TISAB is added to 10 ml of sample and the resulting solution is measured by a fluoride sensing electrode with a reference electrode comparison. The milli-volt potential is compared to the potential of the standards with the resulting concentration displayed by the meter.

Fecal Coliform (See Appendix 6 "SM-9222D-FC-01-06" for a Detailed Method)

The SPU Water Quality Lab is accredited by Ecology to test non-potable waters by the Standard Methods for the Examination of Water and Wastewater, No: 9222 D, 24 hour Membrane Filter (MF) procedure. This method will be used by this program with the following exceptions:

- Holding temperature is to be between zero and four degrees Celsius (SM allows up to ten degrees Celsius)
- Holding time is not to exceed 24 hours (Standard Methods recommends no more than eight hours but allows up to 24 hours)

The detection limit and the precision for this method are both 1 colony per 100 mL. Densities are reported as colony forming units per 100 mL.

In this method, samples are filtered using varying volumes to establish fecal coliform density in the range of 20 and 60 fecal coliform colonies. The filtered samples are incubated for 24 ± 2 hours at 44.5 ± 0.2°C. The colonies produced by fecal coliform bacteria are various shades of blue. The colonies are counted with a low power microscope or other optical device.

Quality Assurance and Quality Control

The SPU Water Quality Lab performs sterility checks and analyzes blanks and media control samples for quality control purposes for the fecal coliform analysis. Once per year the laboratory analyzes proficiency test samples to maintain accreditation. Lab duplicates are performed once per week for fluoride and potassium analysis and no lab duplicates are performed for fecal coliform analysis Instruments are calibrated according to the manufacturer's specifications or as specified by the listed method.

A7 Glassware and Bottle Cleaning

Use proper personal protective equipment and engineering controls when preparing glassware and bottles. Face shields or chemical goggles, aprons and gloves shall be worn when working with acids. Use fume hoods with fan on high when possible and provide adequate ventilation otherwise.

- NEVER ADD WATER TO ACID! Always add acid to water. Mixing acid and water generates heat and causes the acid to splatter. Water is able to absorb the heat when acid is added.
- KEEP ACIDS AND BASES SEPARATE!
- KEEP INCOMPATIBLE CHEMICALS SEPARATE!
  - Hydrochloric acid is incompatible with bleach, strong bases, metals, metal oxides, hydroxides, amines, carbonates, cyanides, sulfides, sulfites and formaldehyde
  - Nitric acid is incompatible with acetic acid, acetone, alcohol, aniline, chromic acid, flammable gases and liquids, hydrocyanic acid, hydrogen sulfide and nitratable substances
  - Sulfuric Acid is incompatible with chlorates, perchlorates, permanganates, compounds with light metals such as sodium, lithium and potassium.

Prior to performing cleaning duties, ensure that appropriate gloves are selected for the type of chemicals that will be utilized.

Table A5-1: North and Ansell Gloves Chemical Resistance*

North Gloves	**Silver Shield**	**Viton**	**Butyl**	**Nitrile**	**Natural Rubber**
Hydrochloric acid	>8 hours, Excellent	I/D	I/D	>6 hours, Excellent	>6 hours, Excellent
Sulfuric acid	>8 hours, Excellent	>8 hours, Excellent	>8 hours, Excellent	1.9 hours, Fair	5.1 hours, Good
Ansell Gloves	**Laminate Film Barrier**	**Neoprene 29-865**	**Neoprene/Natural Rubber Blend Chemi-Pro**	**Nitrile Sol-vex**	**Natural Rubber**
Hydrochloric acid	>8 hours, Not rated	>8 hours, Excellent	>6 hours, Excellent	>6 hours, Excellent	4.8 hours, Excellent
Sulfuric Acid	>8 hours, Excellent	1.75 hours, Fair	Not recommended	Not recommended	Not recommended

Sources: North Chemical Resistance Guide at www.northsafety.com , Ansell Chemical Resistance Guide at www.ansellpro.com

*Time rating is Breakthrough Time. Qualitative rating is Degradation. Excellent and Good can be used for total immersion. Fair is for accidental splash protection and intermittent contact.

Perform glassware and bottle cleaning according to the procedures outlined in Table A6-2 below.

Table A5-2: Glassware and Bottle Cleaning Guidelines

<table>
<tr><th>Parameter</th><th>Laboratory Glassware Cleaning</th><th>Sample Bottle Preparation</th><th>Field Bottle Preparation</th></tr>
<tr><td>Fluoride</td><td>Per SPU Water Quality Laboratory Standard Operating Procedure</td><td rowspan="2">Clean with laboratory detergent.
Rinse thoroughly with deionized water.
Air dry.</td><td rowspan="3">Rinse with deionized water between stations.

Clean with laboratory detergent if deposits observed or otherwise deemed necessary. Rinse thoroughly with deionized water.</td></tr>
<tr><td>Potassium</td><td>Per SPU Water Quality Laboratory Standard Operating Procedure</td></tr>
<tr><td>Ammonia</td><td>Clean with laboratory detergent and tap water.
Rinse thoroughly (at least 4 times) with deionized water.
Air dry.</td><td>Clean with laboratory detergent and tap water.
Rinse thoroughly (at least 4 times) with deionized water.
Air dry.</td></tr>
<tr><td>Surfactants</td><td>Ampoules are already clean.</td><td>Clean with tap water. Rinse with deionized water.
Rinse with dilute sulfuric acid (0.7% v/v).
Rinse thoroughly (at least 4 times) with deionized water.
Air dry.</td><td>New bottle cleaned according to sample bottle preparation used for each sample location. No field cleaning necessary.</td></tr>
<tr><td>Fecal Coliform</td><td>Per SPU Water Quality Laboratory Standard Operating Procedure</td><td>Sterile</td><td>Use sterile sample bottle</td></tr>
</table>

Appendix B: Material Safety Data Sheets

Chemetrics Surfactants:

Conductivity Standard 100.pdf

Conductivity Standard 1413 us/cm:

Hach Method 8155: Nitrogen, Ammonia:

pH Buffers:

pH Electrode Storage Solution:

Sulfuric Acid:

Appendix C: Manuals

Hach DR/890 Colorimeter:

VWR Symphony Multiparameter Research Meter SP90M5: