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Stream Hydrology and Chemistry at Anchorage, Alaska: Design Report

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MUNICIPALITY OF ANCHORAGE
WATERSHED MANAGEMENT PROGRAM

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WATERSHED MANAGEMENT

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Introduction

The Municipality of Anchorage (MOA) is undertaking a receiving water assessment to describe quantitatively the condition of waters with respect to stormwater impacts and management practices over time. This assessment will allow the MOA Stormwater Management Program to continually refocus on the worst pollutant sources and select the most efficient control practices. This information will be used along with other data gathered on watershed characteristics to identify the primary factors causing stream impairment with respect to water quality standards and designated uses. This information will also support modeling efforts that will examine possible options for future watershed management and protection strategies for improving water quality in MOA streams. The specific approach and steps for completing this receiving water assessment, which is required for the National Pollutant Discharge Elimination System (NPDES) stormwater first-term period (Appendix A Tasks 4.2.3.1 and 4.2.3.2 in the NPDES permit), is outlined in this document.

Historically, urbanization first occurred in coastal areas and today this trend continues with approximately 80 percent of the Nation's population living in coastal areas. While urbanization may enhance the use of property under a wide range of environmental conditions (U.S. Environmental Protection Agency [EPA], 1977), urbanization typically results in changes to the physical, chemical, and biological characteristics of a given watershed. During urbanization, pervious spaces, including vegetated and open forested areas, are converted to land uses that usually have increased areas of impervious surface. Without proper consideration, these land use modifications can have negative impacts on the hydrology and water quality of surface and groundwater within a watershed.

CHANGES IN HYDROLOGY

Hydrologic and hydraulic changes within a watershed occur in response to site clearing, grading, and the addition of impervious surfaces and maintained landscapes (Schueler, 1987). Most problematic are the greatly increased runoff volumes and the ensuing erosion and sediment loadings to surface waters that accompany these changes to the landscape. Uncontrolled construction site sediment loads nationwide have been reported to be on the order of 35 to 45 tons per acre per year (Novotny and Chesters, 1981; Yorke and Herb, 1978). In contrast, sediment loadings from undisturbed woodlands are typically less than 1 ton per year (Leopold, 1968). Hydrological changes to the watershed are magnified after construction is completed. Impervious surfaces, such as rooftops, roads, parking lots, and sidewalks, decrease the infiltrative capacity of the ground and result in greatly increased volumes of runoff. Elevated flows also necessitate the construction of runoff conveyance systems or the modification of existing drainage systems to avoid erosion of streambanks and steep slopes. Changes in stream hydrology resulting from urbanization include the following (Schueler, 1987):

- Increased peak discharges compared to predevelopment levels (Leopold, 1968)
- Increased volume of urban runoff produced by each storm in comparison to predevelopment conditions
- Decreased time needed for runoff to reach the stream (Leopold, 1968), particularly if extensive drainage improvements are made
- Increased frequency and severity of flooding
- Reduced streamflow during prolonged periods of dry weather resulting from reduced level of infiltration in the watershed
- Greater runoff velocity during storms because of the combined effects of higher peak discharges, rapid time of concentration, and the smoother hydraulic surfaces that occur as a result of development
- Increased stream icing potential due to decreased riparian zone storage and channelization and stream crossing effects

In addition, greater runoff velocities occur during spring snowmelts and rain-on-snow events in suburban watersheds than in less impervious rural areas (Buttle and Xu, 1988). Major snowmelt events can produce peak flows as large as 20 times initial flow runoff rates for urban areas (Pitt and McLean, 1992). Other physical characteristics of aquatic systems that are affected by urbanization include the total volume of watershed runoff baseflow, flooding frequency and severity, channel erosion and sediment generation, and temperature regime (Klein, 1985).

WATER QUALITY CHANGES

Urban development also causes an increase in pollutants. The pollutants that occur in urban areas vary widely, from common organic material to toxic metals. Some pollutants, such as insecticides, road salts, and fertilizers, are intentionally placed in the urban environment. Other pollutants, including metals from automobile exhaust and oil drippings from trucks and cars, are the indirect result of urban activities (EPA, 1977). Many researchers have linked urbanization to degradation of urban waterways (for example, Klein, 1985; Livingston and McCarron, 1992; Schueler, 1987). The major pollutants found in runoff from urban areas include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, pathogenic bacteria, and viruses.

Information Need Requiring New Data

Urban growth and development can adversely affect the water quality, biotic integrity, and designated uses of streams. Understanding the primary factors causing stream impairment is crucial to developing effective protection strategies for achieving water quality improvements and maintaining biotic integrity. The purpose of this assessment is assess the current status of MOA streams' hydrologic regime and water quality with respect to stormwater runoff.

The ultimate goal of the study is to give MOA a technically sound and defensible basis for making informed watershed management decisions that balance economic growth and the long-term health of streams in the MOA. The results of the monitoring will be especially useful in supporting NPDES permitting decisions, developing appropriate water quality parameters, and determining realistic combinations of flexible and economical protection scenarios for maintaining stream water quality into the future.

To meet these objectives and goals, additional data are required to confirm the general quality and quantity of water in Anchorage streams. Because new data are required, the following formal assessment design has been completed to guide data collection, analysis, and interpretation. These new data along with process analyses proposed in this assessment design document, will be used to address the following management question at an exploratory level:

What impact does urbanization within MOA watersheds have on the hydraulic behavior and water quality of Anchorage streams?

System Description

This assessment is focused on stormwater discharging to local receiving waters from urbanized areas within Anchorage. This following discussion briefly describes the principal elements of this system.

MUNICIPALITY OF ANCHORAGE WATERSHEDS

The corporate boundaries of the MOA encompass a triangular-shaped peninsula bounded to the northwest by Knik Arm and to the southwest by Turnagain Arm (both glacially carved estuaries of upper Cook Inlet), and to the east by the actively glaciated Chugach Mountains (Figure 1). The most densely populated urban areas are concentrated over a relatively flat, gravelly glacial outwash plain at the western tip of the peninsula. Rural

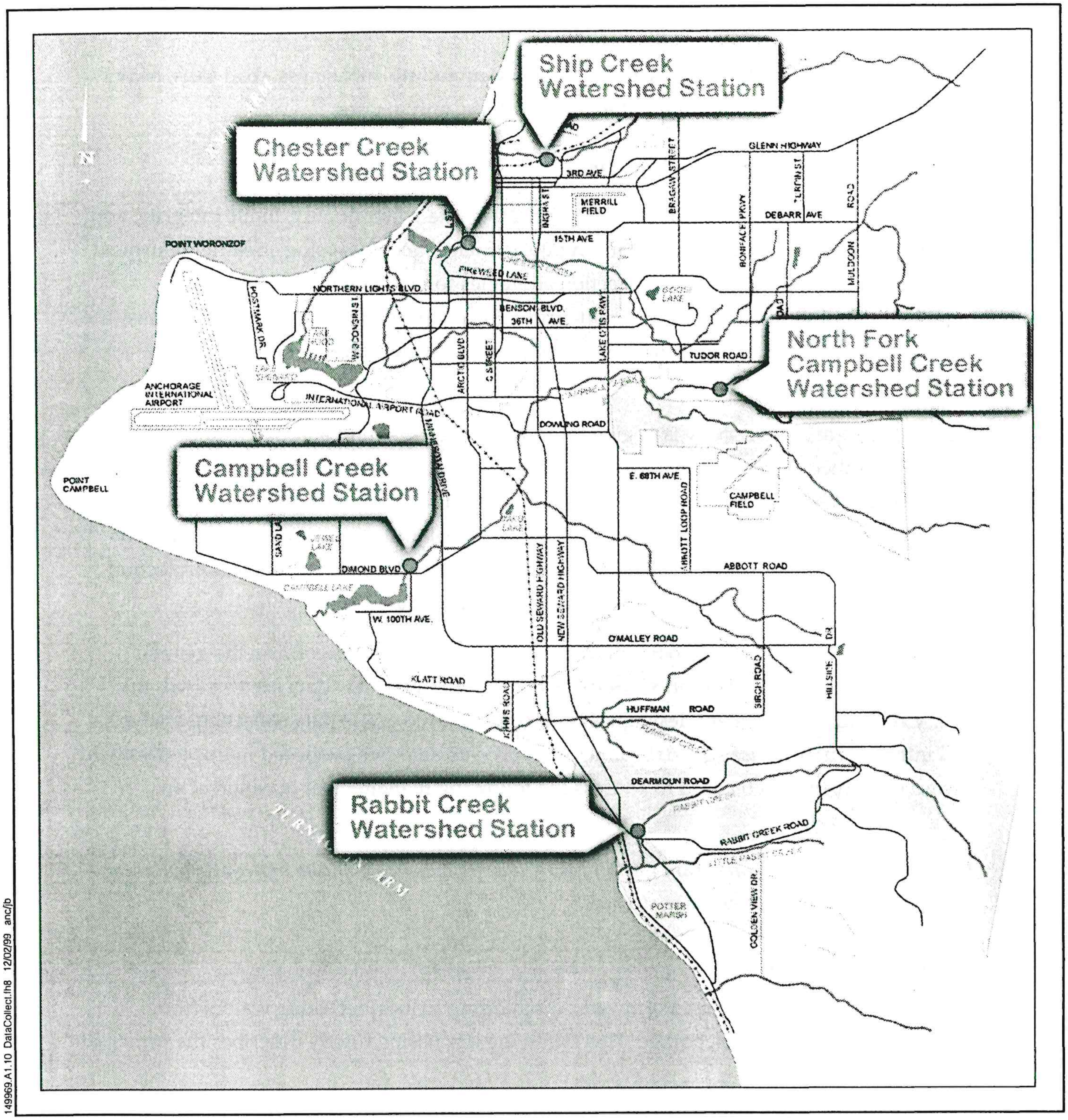

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Figure 1

Anchorage Bowl
Hydrology and Water Chemistry
Data Collection Stations

residential land uses surround the central urban area and predominate along the foothills of the Chugach Mountains and along the shores of Knik Arm and Turnagain Arm.

Stormwater from both the urban and rural areas runs off 26 major watersheds and sub-watersheds as identified by the MOA NPDES Stormwater Management Program. Of the streams that drain the 26 watersheds, all but Fish Creek have their headwaters in the Chugach Mountains. Eight of the 26 streams flow though the Anchorage urbanized area before discharging into Knik Arm and Turnagain Arm in Upper Cook Inlet. The remaining streams flow through low-density rural residential land and some scattered commercial land before entering Cook Inlet. Because of the location of the MOA on a young glacial terrain, numerous wetlands, small lakes, and tributary streams dot the landscape.

Eventually each of the streams that drain the 26 watersheds identified in the NPDES permit application will be assessed by using the watershed characterization process. However, in the first permit term, priority will be given to those streams that are currently most stressed by urban development, yet still provide the greatest opportunity to support a variety of uses.

STORMWATER RUNOFF

While the great majority of the state's waters are remote from population centers and are in pristine condition, Alaska nonetheless has typical water quality and other environmental problems associated with urban and suburban development. Urban and suburban development inevitably impacts local lakes, ponds, and streams. Pollution of waters often is a threat to public health and the environment, as well as a public nuisance and an aesthetic detriment. It is difficult and expensive to restore high water quality once it is degraded.

As a result of the development of impervious areas such as roofs, streets, and parking lots, the usual hydrologic effect of urbanization has been a reduction in the infiltrative capacity of urban watersheds and a corresponding increase in runoff rates and volumes. Increases in surface runoff often result in more frequent erosion of stream banks and flooding of near-channel areas. Stormwater runoff from developed areas has also been recognized as a source of contaminant loading to surface and groundwater resources. Heavy metals, oils and other hydrocarbons from automobiles and machinery; suspended solids from dirt and dust accumulation; and airborne pollutants washed out during precipitation events are all considered to be typical contaminants present in urban stormwater runoff.

Pollutants that originate from highway use, road maintenance activities, natural sources, and airborne deposition accumulate on highway surfaces, roadside areas, and rights-of-way during dry periods. Surface runoff that is generated during rainfall and spring snowmelt events picks up accumulated pollutants from the land surface and discharges them to waterbodies via natural and man-made storm drainage systems. The most serious environmental impacts occur when urban runoff drains into small streams where dilution is low. Water quality of streams is degraded during wet weather, and accumulation of benthic pollutants can affect the stream during dry periods. Sediments, nutrients, and toxic materials can all have adverse effects on the ecosystem of a stream.

Critical System Elements

WATERSHED/STREAM SELECTION CRITERIA

The following critical system elements were used to select the Anchorage streams that will be assessed during the first permit term:

- Availability of historical flow and water chemistry data from previous studies
- Ease of access to stream to facilitate monitoring activities (e.g., sampling and installation of stream gauging stations)
- Degree of stream impairment
- Representation of different land use categories (residential, commercial, industrial, and undeveloped)

STORMWATER RUNOFF WATER QUALITY PARAMETERS

The largest and most comprehensive investigation of urban storm runoff quality was the Nationwide Urban Runoff Program (NURP) undertaken by the EPA and the U.S. Geological Survey (USGS) in 1983. It included 2,300 storm events at 81 sites in 22 cities geographically distributed across the United States. The water quality parameters for stormwater runoff that are considered to be critical elements in this assessment are based on the results obtained from the NURP. The following discussion identifies the principal types of pollutants found in urban runoff and describes their potential adverse effects.

Sediment

Suspended sediments constitute the largest mass of pollutant loadings to surface waters. Sediment has both short- and long-term impacts on surface waters. Among the immediate adverse impacts of high concentrations of sediment are increased turbidity, reduced light penetration, decreases in submerged aquatic vegetation (Chesapeake Bay Local Government Advisory Committee, 1988), reduced prey capture for sight-feeding predators, impaired respiration of fish and aquatic invertebrates, reduced fecundity, and impairment of commercial and recreational fishing resources. Heavy sediment deposition in low-velocity surface waters may result in smothered benthic communities/reef systems, increased sedimentation of waterways, changes in the composition of bottom substrate, and degradation of aesthetic value. Additional chronic effects may occur where sediments rich in organic matter or clay are present. These enriched depositional sediments may present a continued risk to aquatic and benthic life, especially where the sediments are disturbed and resuspended.

Nutrients

The problems resulting from elevated levels of phosphorus and nitrogen are well known. Excessive nutrient loading to marine ecosystems can result in eutrophication and depressed dissolved oxygen (DO) levels because of to elevated phytoplankton populations. Eutrophication-induced hypoxia and anoxia have resulted in fish kills and widespread destruction of benthic habitats. Surface algal scum, water discoloration, and the release of toxins from sediment may also occur. Species composition and size structure for primary producers may be altered by increased nutrient levels. Occurrences of eutrophication have been frequent in several coastal embayments along the northeast coast, the Gulf Coast, and the West Coast (California and Washington) (National Oceanic and Atmospheric Administration [NOAA], 1991). High nitrate concentrations have also been implicated in blooms of nuisance algae in Newport Bay, California. Nutrient loadings in Louisiana coastal waters have decreased productivity, increased hypoxic events, and decreased fisheries yields (NOAA, 1991).

Oxygen-Demanding Substances

Proper levels of DO are critical to maintaining water quality and aquatic life. Decomposition of organic matter by microorganisms may deplete DO levels and result in the impairment of the waterbody. Data have shown that urban runoff with high concentrations of decaying organic matter can severely depress DO levels after storm events (EPA, 1983a). The NURP study found that oxygen-demanding substances can be present in urban runoff at concentrations similar to secondary treatment discharges.

Pathogens

Urban runoff typically contains elevated levels of pathogenic organisms. The presence of pathogens in runoff may result in waterbody impairments such as closed beaches, contaminated drinking water sources, and shellfish bed closings. Pathogen contamination from failing septic systems has been implicated in a number of shellfish bed closings. This problem may be especially prevalent in areas with porous or sandy soils.

Road Salts

In northern climates, road salts can be a major pollutant in urban areas. Klein (1985) reported on several studies by various authors of road salt contamination in lakes and streams and cases where well contamination had been attributed to road salts in New England. Snow runoff can produce high salt/chloride concentrations at the bottom of ponds, lakes, and bays. Not only can this condition prove toxic to benthic organisms, but it can also prevent crucial vertical spring mixing (Bubeck et al., 1971).

Hydrocarbons

Petroleum hydrocarbons are derived from oil products, and the source of most such pollutants found in urban runoff are auto and truck engines that drip oil. Concentrations of petroleum-based hydrocarbons are often high enough to cause mortalities in aquatic organisms. Oils and greases contain a wide variety of hydrocarbon compounds. Some polynuclear aromatic hydrocarbons (PAHs) are known to be toxic to aquatic life at very low concentrations. Hydrocarbons have a high affinity for sediment, and they collect in bottom sediments where they may persist for long periods of time and result in adverse impacts on benthic communities. Lakes and estuaries are especially prone to this phenomenon.

Heavy Metals

Heavy metals are typically found in urban runoff. For example, Klein (1985) reported on a study in the Chesapeake Bay that designated urban runoff as the source for 6 percent of the cadmium, 1 percent of the chromium, 1 percent of the copper, 19 percent of the lead, and 2 percent of the zinc. Heavy metals are of concern because of toxic effects on aquatic life and the potential for ground-water contamination. Copper, lead, and zinc are the most prevalent nonpoint source pollutants found in urban runoff. High metal concentrations may bioaccumulate in fish and shellfish and impact beneficial uses of the affected waterbody.

Standard Pollutants Contained in Urban Runoff

On the basis of these findings, EPA adopted the following constituents as standard pollutants that characterize urban runoff:

- TSS Total suspended solids
- BOD Biochemical oxygen demand
- COD Chemical oxygen demand
- TP Total phosphorous (as P)
- SP Soluble phosphorous (as P)
- TKN Total Kjeldahl nitrogen (as N)
- NO_{2+3}-N Nitrate and nitrite (as N)

- Cu Total copper
- Pb Total lead
- Zn Total zinc

These standard pollutants can be considered as representatives of others. These pollutants have been examined both in point and nonpoint source studies and include representatives of solids, oxygen-consuming constituents, nutrients, and heavy metals.

Most of the urban runoff data presented by the EPA consists of flow-weighted average concentrations–that is, the event mean concentration (EMC) of each pollutant for each runoff event. The median and coefficient of variation of the EMC of several constituents found in urban runoff have been quantified and listed by the EPA. Driscoll (1986)showed that for most sites and pollutants, the EMCs are lognormally distributed and are weakly correlated with runoff volumes. The mean annual load can be estimated for urban runoff constituents by choosing the appropriate rainfall and runoff coefficient values and selecting the appropriate EMC values published by the EPA. The EPA also publishes estimates of annual pollutant loads for different types of urban developments.

Rainfall events produce bursts of runoff from highly impervious urban areas. These slugs of runoff are conveyed by the drainage system to the receiving waters. Therefore, rivers and streams that receive urban runoff are exposed to pulses of contaminated urban runoff. The EPA (1983) has made the probabilistic analysis of the concentration characteristics of the instream storm pulses. These concentrations are compared to stream target concentrations associated with different degrees of adverse impact (significant mortality, threshold effect, and EPA maximum) on more sensitive biological species. This type of presentation is useful to show how the frequency of concentrations may be interpreted to infer the presence or degree of severity of a pollution problem.

OTHER IMPACTS

Other impacts not related to a specific pollutant can also occur as a result of urbanization. Temperature changes, for example, result from increased flows, removal of vegetative cover, and increases in impervious surfaces. Impervious surfaces act as heat collectors that increase the temperature of urban runoff as it passes over the impervious surface. Recent data indicate that intensive urbanization can increase stream temperature as much as 5 to 10 degrees Celsius during storm events (Galli and Dubose, 1990). Thermal loading disrupts aquatic organisms that have finely tuned temperature limits.

Salinity can also be affected by urbanization. Freshwater inflows from increased runoff can impact estuaries by disrupting the natural salinity of the water. Increased impervious surface area and the presence of stormwater conveyance systems commonly result in elevated peak flows in streams during and after storm events. These rapid pulses or influxes of fresh water into the watershed may be 2 to 10 times greater than normal. This may lead to a decrease in the number of aquatic organisms living in the receiving waters (McLusky, 1989).

The alteration of natural hydrology by urbanization and the accompanying runoff diversion, channelization, and destruction of natural drainage systems has resulted in riparian and tidal wetland degradation or destruction. Deltaic wetlands have also been impacted by changes in historic sediment deposition rates and patterns. Hydromodification projects designed to prevent flooding may reduce sedimentation rates and decrease marsh aggradation, which would normally offset erosion and apparent changes in sea level within the delta (Cahoon et al., 1983).

Problem Representation

Representation of the Critical Elements

For this assessment, critical system elements have been selected based on the requirements outlined in the MOA NPDES permit application. The drainage basins and water quality parameters presented below were specified by the EPA for inclusion in the watershed assessment program. Each of these critical system elements is described below.

DRAINAGE BASINS

Of the 26 streams identified in the NPDES permit application, priority will be given to streams which are currently stressed by urban development yet provide the greatest opportunity to support a variety of uses. The following drainage basins meet the critical element criteria described in the Critical System Elements section of this report and are required for inclusion in the first permit term as per Part II.A.6.f of the NPDES permit application:

- Chester Creek
- Campbell Creek
- Ship Creek
- Rabbit Creek

A brief description of each of these drainage basins is provided below.

Chester Creek Drainage

Chester Creek drains approximately 6,000 acres of undeveloped land from the Chugach foothills to just upstream of Muldoon Road. The majority of the watershed basin downstream of Muldoon Road is urbanized and covers an area of approximately 10,100 acres. Within the urbanized portion of the watershed, land use is divided approximately as follows: residential (40 percent), commercial (40 percent), undeveloped acreage (15 percent), and industrial (5 percent). Thirty-four parks in the watershed represent approximately 13 percent of the urbanized acreage in the basin.

Chester Creek does not currently serve as a drinking water, culinary, or food processing source for humans. Known uses of Chester Creek include secondary recreation activities and limited-contact recreation. Chester Creek also provides an area for growth and propagation of fish, other aquatic life, and wildlife, a designated use as defined in the Alaska water quality standards.

Campbell Creek Drainage

The Campbell Creek watershed consists of three waterbodies: Campbell Creek, Little Campbell Creek, and Campbell Lake. Together they drain an area of approximately 74 square miles. The headwaters of Campbell Creek originate in undeveloped areas. Campbell Creek consists of two main forks, the North and South forks, which merge to form the main stem approximately 8 miles upstream of Campbell Lake. Little Campbell Creek also consists of two forks and flows into Campbell Creek approximately 4 miles upstream of Campbell Lake.

Residential housing predominates in the Little Campbell Creek drainage area. A small amount of commercial (16.6 percent) and industrial (1.8 percent) development also is present. In contrast, the majority of the acreage drained by both the North and South forks of Campbell Creek, a total of approximately 38.6 square miles, or more than half of the entire Campbell watershed, remains in its natural state, with a very small percentage used by low-density residential development. The land use in the subbasin draining into the main stem of Campbell Creek is mostly residential, but does include approximately 28.6 percent commercial development and 5.5 percent industrial development.

Ship Creek Drainage

Ship Creek is a major water supply source for the MOA, Fort Richardson, and Elmendorf Air Force Base. The 114-square-mile drainage is principally composed of undeveloped highlands of the Chugach State Park. Industrial development has taken place on military lands and Alaska Railroad Reserve near the mouth of the creek. The creek serves two fish hatcheries and a power plant in addition to the public water supply.

The drainage area of Ship Creek below the municipal corporate boundary comprises a drainage area of 2,088 acres. This watershed is divided into the following use categories: 16.8 percent residential, 41.1 percent commercial, 15.6 percent industrial, and 26.5 percent undeveloped.

Rabbit Creek Drainage

The 15-square-mile drainage area for Rabbit Creek begins in a glacial cirque in Chugach State Park and flows through a rural residential development and a bedrock canyon to Potter Marsh. The immediate drainage area for the monitoring point on Rabbit Creek comprises 4,992 acres. This watershed is divided into the following use categories: 29.4 percent residential, 10.2 percent commercial, 0.2 percent industrial, and 60.4 percent undeveloped.

The gradient of the stream, except for the reach between the Old and New Seward highways, is steep, falling more than 3,000 feet over the length of the stream. Except for a reach of the stream below the Old Seward Highway, the channel of Rabbit Creek is well defined.

WATER QUALITY PARAMETERS

As outlined in Part II.A.6.f of the NPDES permit application, the following water quality parameters have been considered critical elements in the characterization of the aforementioned watersheds:

- Copper (dissolved fraction)
- Lead (dissolved fraction)
- Zinc (dissolved fraction)
- Fecal coliform
- Hardness
- Total suspended solids
- Turbidity
- Temperature
- Conductivity
- pH
- Pesticides
- Chloride

The water quality parameters shown above include parameters used by the EPA to characterize urban runoff and parameters of specific interest to the MOA. Parameters based on previous EPA studies include metals and total suspended solids. The EPA has typically used the total recoverable concentrations of copper, lead, zinc to characterize the presence of metals in stormwater runoff. In this study, however, the dissolved fraction of each of these metals will be used because the dissolved fraction better represents the bioavailable fraction of metals in the water.

In revising the metals criteria to establish the EPA Metals Policy (1995), EPA held that the criteria based on dissolved metals are protective of aquatic life and better approximate the biologically available fraction of water borne metals compared to previous criteria based on total recoverable metals concentrations. EPA considers the use of total recoverable fraction to be more stringent than necessary to protect designated uses for aquatic life. It is the aim of both the CWA EPA policy that the States incorporate new science into the water quality program by their own standards and implementation policies.

Water quality parameters of specific interest to the MOA include fecal coliform, chloride, and pesticides. The presence of fecal coliform in urban runoff is of interest because many of Anchorage's lakes and streams have been classified on the 303(d) list as "impaired water bodies" because of fecal coliform concentrations that exceed water quality standards. Chloride is of interest to the MOA because of the widespread use of chloride-based deicers (such as magnesium chloride) that are applied to Anchorage roads during the winter months. Pesticide concentrations in stormwater will also be examined to assess the sources and impacts of pesticide use within Anchorage drainage basins.

Conventional water quality parameters including hardness, turbidity, temperature, conductivity, and pH will also be analyzed in urban runoff. These parameters were selected because they can be readily compared to existing Anchorage watershed data and because all of these parameters (with the exception of hardness) can be analyzed in the field using a single hand-held instrument.

Problem Resolution

The MOA is interested in tracking local and areawide changes in the pollutant generation potential and the functional characteristics of street maintenance activities, stormwater transport systems, and stormwater treatment facilities relative to their potential to affect local receiving waters. The MOA is interested in obtaining this information to help in understanding the cause and effect relationship between Anchorage's street systems and the health of receiving waters so that appropriate and practicable watershed management goals and practices can be identified and implemented. Ultimately, information will be used to set priorities for receiving water uses, measure costs and successes in maintaining or enhancing the quality of receiving waters for various uses, assess and refine the effectiveness of stormwater controls, and make management decisions in application of stormwater controls. These uses are at the core of the MOA's watershed characterization program, of which the Receiving Water Quality Project (Task 4.2.3 of the NPDES permit) is one element.

The Receiving Water Quality Project will initially provide information about the quality of the water in streams that receive urban stormwater flow. Collection of information will be designed so that stream water quality characteristics can, at some selected scale, be attributed to specific stormwater runoff source (watershed) areas. Collection of water quality information will also be designed so that data can be used to reasonably represent the general range of the seasonal character of storm and base flows in sampled streams. The project design will result in information that will allow general estimates of the expected variability in the water quality at a point in a stream for selected properties or constituents under selected seasonal flow conditions. Specific project goals include the following:

- Preparation of design documentation and data collection and reporting supporting the needs for information about the hydrology and water chemistry of receiving waters of the Watershed Management Program as required under the municipal NPDES permit to discharge stormwater
- Preparation of descriptions of the selected characteristics of the contributing watershed and local riparian zone of each sampling station
- Collection of continuous flow information for selected streams (near their mouths or at other locations representative of specified watershed conditions) for use in estimating seasonal variations in stream discharge and representative water quality character of stream flows for specified parameters during seasonal baseflow and storm flow events
- Collection of representative data and preparation of estimates of event mean concentrations of copper, lead, zinc, fecal coliform, hardness, TSS, turbidity, temperature, conductivity, and pH. These parameters will be collected during representative seasonal baseflow and storm stream flow conditions and in compliance with the MOA NPDES permit to discharge stormwater.
- Preparation of annual data reports and digital data compilations summarizing and representing receiving water data collection efforts, quality control information, valid measured results, estimated EMCs, selected climatography, and descriptive statistics.

Project Approach

The scope of work for the Hydrology and Receiving Water Chemistry Assessment Tasks (Tasks 4.2.3.1 and 4.2.3.2, respectively, of the NPDES permit) includes the following major elements:

- Existing data review
- Monitoring station selection
- Establishing and calibrating monitoring stations
- Equipment installation and monitoring
- Collecting continuous flow data
- Water quality monitoring for 12 baseflow and stormflow events
- Developing event mean concentrations for selected parameters

The following sections describe the detailed technical approach for completing each of these tasks.

Existing Data Collection

Existing data on the MOA watershed characteristics will be gathered from various local, state, and federal sources. The information will be used to assist in the selection of water quality and flow monitoring stations, characterize existing stream conditions in the watersheds, identify primary causes of water quality impairment, and support definition and input of parameters for use in the watershed modeling effort, including pollutant loading sources and magnitudes.

Available existing data will be obtained from MOA, the Alaska Department of Environmental Conservation (ADEC), the EPA, the USGS, the Department of Natural Resources (DNR), and other sources. The following types of information will be gathered:

- Water quality data
- Other point source discharge locations and characteristics, including permitted point sources, and records of Anchorage Water and Wastewater Utility enforcement actions
- Hydrologic and meteorological data
- Existing water quality attainment status for streams, and data upon which status was determined for 305(b)-active waters (not supporting or partially supporting)
- Existing land use cover types and acreage
- Existing impervious surface acreage

- Future land use scenarios and population growth projections (in accordance with the MOA Comprehensive Plan and in coordination with the MOA Department of Planning and Development)
- Soil maps
- Topographic maps, including information on areas where steep slopes, presence of wetlands, and other factors limit development
- Existing and proposed sewer service areas; areas with failing septic tanks, if available
- Existing zoning and other restrictions on land use and development
- Existing use of best management practices and associated stormwater data, if available
- Existing ordinances and regulations for specific watershed protection initiatives
- Existing ordinances on sediment and erosion control and floodplain management

Monitoring Station Selection

Scheduled activities shall include establishing gauging stations during permit Year 1, data collection, field maintenance and reporting on an annual basis during Years 1 through 5, with equipment replacement and repairs scheduled for Year 5.

A total of five monitoring sites will be selected in the Anchorage area. These sites will be in the vicinity of Rabbit Creek near the Old Seward Highway, Chester Creek at Arctic Boulevard, Campbell Creek near Dimond Boulevard and Northwood Street, North Fork of Campbell Creek near the Municipal Building, and Ship Creek near Ingra Street and Warehouse Avenue as required in the permit. Specific site locations will be selected based on channel geometries and stream reaches that will allow accurate measurements of stream velocities and stage.

When possible, flow and water quality data from existing USGS gauging stations will be used to supplement the information gathered from the monitoring sites described above. Most USGS stations use either natural or artificial flow control structures that allow accurate determination of flow as a function of stage. Although there are several USGS stations located within the Anchorage Bowl, the only active station located within the boundaries of this study is situated just downstream of the proposed Chester Creek monitoring site. Unfortunately, this station cannot serve as monitoring site for this study because real-time flow data, which is necessary for evaluating water quality data, is not available. Nonetheless, data collected from this USGS station will be compared to data collected from the monitoring site located upstream to ensure that flow measurements and water quality results are consistent. Historical data from a USGS gauging station previously located on Rabbit Creek will be evaluated to determine if hydraulic and/or water quality trends are present.

After a site has been selected, a permanent benchmark will be established and used to survey the cross-sectional configuration of the channel with standard land-survey techniques. The channel slope, configuration, and other pertinent features of each site will also be recorded. Stream velocity measurements will then be made along each cross section following standard USGS methodology. Each cross section will be broken into 20 to 30 partial sections for measurements of current velocity. Current measurements will use the two-point method (measurements taken at 0.2 and 0.8 of the depth) for depths greater than 2.5 feet and the one-point method (measurements taken at 0.6 of the depth) for shallower depths. Current velocity measurements taken by the USGS mid-section method will be used to determine the flow in each partial section from the average velocity and cross-sectional area. The stage at each site will also be measured and recorded at the time of discharge survey and will be tied into the vertical benchmark datum.

STREAM CROSS-SECTION SURVEYS

In addition to the initial survey, cross-section surveys will be performed for each of the four sites. Survey methods will be the same as described above. Survey times will be selected based on stream flow so that each stream will be characterized for a range of discharge conditions. Stream discharge versus stage rating curves will then be produced for each of the five sites based on the five surveys and any USGS data that may be available for the site. If possible, sites will have been selected for which it is expected that simple rating curves can be established. Complex or multiple curves are often necessary in instances where the channel geometry changes drastically at a particular stage (for example, a channel with steep banks that opens into a flat floodplain). For these circumstances, it must be determined at what stage height the discrepancy occurs, and two or more rating curves must be developed for the different stage ranges.

Equipment Installation and Monitoring

A permanent monitoring station will be established at each site that will enable continuous recording of stream stage. The following components will be used at each station:

- A steel security enclosure mounted on a cement pad of sufficient size and strength so as to deter theft and vandalism and large enough to enclose optional water sampling equipment (such as ISCO 3700) that may be added in the future

- A data logger and control module for recording data and programming the operation of the sampling station
- A high-precision pressure sensor to measure the depth of the water (stage) used to calculate flow
- Power source (either 120-volt AC or 12-volt DC with a solar panel for charging batteries).

This system has been used extensively on numerous other stormwater monitoring programs. It is very versatile and can be adapted to almost any stormwater monitoring application. The system uses off-the-shelf components that have been integrated and for which custom software has been developed for a wide range of sampling requirements. If desired, the proposed configuration could be expanded to include the following components:

- A telephone modem (cellular or land line) that would allow access to stored data and programming capability from a remote location
- A rain gauge to measure precipitation and/or trigger a sampling event
- Water sampling equipment such as an ISCO 3700 that would allow flow-composite sampling based on stream discharge/stage ratings
- Continuous recording of actual current velocities based on an installed current meter
- Monitoring of a variety of other water quality parameters such as pH, conductivity, and temperature

Water Quality Monitoring

MONITORING PLAN DEVELOPMENT

The goal of monitoring the receiving water chemistry is to characterize the overall effects of urban development on the quality of Anchorage streams in context with aquatic life (for example, existing fish productivity) and other stream uses such as recreation.

The monitoring program shall provide the following:

- Measurement of EMCs of selected water quality parameters for baseflows and a range of storm flows and seasonal conditions
- Correlation between magnitude of storm event and pollutant concentration stratified by season

Water chemistry and discharge characteristics representative of total stream flow at downstream points for late winter, spring breakup, early summer (low flow), late summer/fall (high flow), and early winter periods during both baseflow and stormflow conditions will be addressed.

MONITORING LOCATIONS

The physical locations of each water quality monitoring station are described in the Monitoring Station Selection section and shown in Figure 1.

WATER QUALITY SAMPLING PARAMETERS

Water quality samples will be flow-weighted 24-hour composite samples that are collected during 12 baseflow and stormflow events (unless conditions prohibit data collection) at the four stream station locations. Event mean concentrations will be determined for copper, lead, zinc, fecal coliform, hardness, TSS, turbidity, temperature, conductivity, pH, pesticides, and chloride.

A minimum of 12 events will be sampled over a 12-month period in the second and fourth year of the permit. All samples will be taken at a mid-stream location and analyses will be conducted for the water quality parameters described on page 12.

An automated sampler will be used to collect analytical samples over the rising and falling limbs of storm flows. Grab samples will be collected during all baseflow events by project staff with appropriate training and certification in sample collection techniques.

Containers will be provided by the laboratory performing the analyses. The project name, station location, station identifier, date of sample, and name of person taking the sample will be clearly marked on sample container labels. Samples will be stored on ice in coolers for overnight shipment or hand delivery to the laboratory. Each shipping container will include a chain-of-custody form that indicates the analyses to be performed by the laboratory. Bacteria samples (fecal coliform) will be delivered immediately to the laboratory to meet the 6-hour holding time limit.

Analytical methods and testing procedures will be in accordance with EPA-approved protocol and guidelines. Priority pollutants will be analyzed to the appropriate detection limits as specified by the EPA. The laboratories performing the analyses will be certified by the EPA and will have approved quality assurance/quality control (QA/QC) programs.

Proper sampling techniques will be utilized during the collection of samples for dissolved metals analyses to minimize inadvertent contamination of the samples and to permit analysis to low detection levels (for comparison with state water quality criteria). The field sampling teams will use the following protocols during the collection of water samples for metals analysis:

- Metals-free sample bottles
- Non-talc gloves
- Certified metals-free acid preservation

Project Responsibilities

The Watershed Management Section (WMS) of the Department of Public Works (DPW) will provide final design and data report documentation and will schedule and lead all investigation activities. WMS or its consultants will install and maintain the stream gauging stations and perform water quality sampling, laboratory analysis, and data reporting.

Sampling and Data Collection

The purpose of this section is to establish the sampling and analytical procedures that will direct the collection of data so that the regulatory requirements of the permit are satisfied.

SAMPLING LOCATIONS

The following hydraulic factors will be considered during selection of the sampling sites:

- Sites that have an existing stage-discharge rating or sites with a suitable control where a reliable rating curve can be established
- Uniform and stable channel conditions for a distance equal to at least six channel widths upstream of the station
- Lack of tidal influence or backwater effects caused by downstream conditions
- No evidence of surcharging or submergence over the normal range of precipitation
- Adequate distance from major tributaries to allow for complete mixing

SAMPLING METHODS

For stormwater characterization, both grab samples and composite samples will be collected. A grab sample is a discrete sample of water collected at a specific time. A composite sample is formed by combining portions of each discrete sample (called an aliquot) so that the concentration of pollutants in the final sample represents the average concentration for the entire storm. The average concentration is defined as the total mass of pollutants divided by the total storm runoff volume. Composite samples will be prepared in the field after the last aliquot has been collected.

Automatic samplers will be used during storm events to avoid the difficulties associated with manual sample collection (such as mobilizing a sampling crew so it will be ready to proceed at the start of the storm). It can take 30 minutes to 1 hour for the sampling team to get ready and in position, and storms can occur any time of day or on weekends.

Grab Sampling

Grab samples will be collected to establish the baseline conditions at a given stream. For this project, grab samples will be collected by hand by using a bucket submerged in the stream. The field crew will be trained in the use of appropriate sampling techniques so that the potential for contamination during sample collection is minimized.

Automatic Composite Sampling

Automatic samplers will be programmed to collect flow-weighted composite samples. Initiation of sampling will be set based on the type of storm flow event to be sampled.

SAMPLE CONTAINERS

Sampling equipment shall consist pre-cleaned plastic buckets, 2.5-liter glass bottles for compositing, 8-liter glass and 7.5-liter plastic aspirator bottles for preparing composites, appropriately sized bottles and vials with preservatives added for shipping samples to the laboratory, coolers, reagent-grade distilled water, ice, labels and forms, mobile telephone, and protective equipment appropriate for the sampling site. Additional back-up bottles will be available in case of accidental breakage or contamination.

The parameters sampled, required containers, sample volumes, method of preservation, and bottle types to be used are shown in Table 1. Parameters with compatible bottle types and preservatives will be shipped to the laboratories as combined to minimize the number of individual containers that must be filled and labeled in the field. Table 2 shows the bottles, preservatives, and minimum holding times for the various analytical parameters.

SAMPLE HANDLING PROCEDURES

All water samples will be stored in a cooler immediately after they are collected. Ice will be stored and sealed in plastic bags to avoid potential contamination of the samples as the ice melts. Samples will be delivered to the laboratory in a timely fashion to allow analysis of all parameters within the holding times specified in Tables 1 and 2.

Sample handling will follow established chain-of-custody procedures. A chain-of-custody form will accompany each cooler used to store samples. The primary objective of establishing sample custody documentation is to create an accurate written record that can

Table 1
LABORATORY PARAMETERS, CONTAINER TYPES, AND VOLUMES REQUIRED BY LABORATORIES, SAMPLE PRESERVATIVES, AND SHIPPING BOTTLES FOR COMBINED SAMPLES

Parameter	Container	Sample Volume	Preservation
Total Suspended Solids	P,G	500 ml	Cool, 4°C
Chloride	P,G	500 ml	Cool, 4°C
Hardness	P,G	100 ml	HNO_3
Turbidity	P,G	100 ml	4°C
Temperature	–	1 L	None
Fecal Coliform	P,G	125 ml	4°C, $Na_2S_2O_3$
pH	P,G	25 ml	None
Metals (Appendix D, Table III, 40 CFR 122)	P,G	1 liter	4°C, HNO_3, pH less than 2.0
Conductivity	P,G	100 ml	Cool, 4°C

P = plastic, G = glass, ml = milliliter, L = Liter

Table 2
PART II (WET-WEATHER) SAMPLING PARAMETERS

Parameter	Sample Type	EPA Method[a]	Holding Time
Total suspended solids	G,C	160.2	7 days
Chloride	G,C	325.1	7 days
Fecal coliform	G	909C[b]	6 hours
Copper, Dissolved	G,C	220.2	6 months
Lead, Dissolved	G,C	239.2	6 months
Turbidity	G,C	180.1	48 hours
Total Hardness	G,C	200.7	6 months
pH	G,C	150.1	Immediate–24 hours
Zinc, Dissolved	G,C	289.1	6 months
Conductivity	G	SM2510B	24 hours

G = Grab sample, C = Composite sample.
[a]U.S. EPA. *Methods for Chemical Analysis of Water and Wastes.* EPA-600/4-79-020. 1979.
[b]American Public Health Association. *Standard Methods for the Examination of Water and Wastewater,* 16th edition. Washington, D.C. 1985.

be used to trace the possession of a sample from the moment of collection through laboratory analysis. The sampler will retain a copy of the completed chain-of-custody form and the original form will be sealed in a resealable plastic bag that is affixed to the inside lid of the cooler. The individuals relinquishing and accepting possession of the samples will sign, date, and note the time on the chain-of-custody form to document transfer from sampling crews to the laboratory.

Weather conditions during sampling and any unusual events will be noted by the sampling team in a field log. Field logs will be archived for attachment to the project reports.

SAMPLE ANALYSIS

Samples will be analyzed in accordance with Title 40, Part 136, of the *Code of Federal Regulations* (CFR). Table 2 lists the parameters to be analyzed and the EPA methods to be used. Two parameters, temperature and pH, will be measured in the field at the time of collection. Temperature will be measured with a stem thermometer and pH will be measured with a precalibrated pH meter.

CALIBRATION PROCEDURES

Equipment used in the field during sample collection will be calibrated according to the manufacturer's instructions. The equipment manager will be responsible for equipment calibration, maintenance, and repair during the monitoring program.

The Marsh-McBirney meters and depth sensors will be cleaned and the depth calibration will be checked weekly. Flow data will be downloaded onto a portable computer at that time to verify recorder operation. Base flow at the Ship Creek and Chester Creek sampling points will be compared to data collected from nearby USGS monitoring stations to give an indication of sensor and data logger performance. After a storm event, the probes will again be cleaned, the depth will be calibrated, and the data will be downloaded for final analysis.

The USGS stream gauging station was not used for this project because access to real-time flow data was not available. Data from the USGS station would be adequate if flow monitoring were the only activity, but real-time flow data will be necessary during chemical sampling.

Individual records of calibration will be maintained for each piece of equipment and will include the name, dates, times, records of calibration/deviation, and unique features or problems of each piece.

Project Networks

Sampling Locations

Water quality and flow monitoring will be conducted at four stream locations (referred to as study stations) selected in the MOA watershed to represent the variety of land uses, nonpoint pollutant loading sources, point source discharges, and other watershed factors directly affecting water quality and aquatic biota in Anchorage streams. Similar monitoring also will be conducted at one additional reference station at the north fork of Campbell Creek to provide comparative sampling information for nearby streams representing least-disturbed watershed conditions. The locations of the monitoring stations are described in the Monitoring Locations Selection section of this report.

Sampling Schedule

The schedule for completing the Receiving Water Characterization task is shown in Figure 2. The installation of the stream gauging stations will be completed by October 1999. Flow data for all watersheds will be continuously recorded for the first permit year to establish baseline and storm event flows.

Water quality sampling will be initiated in the second permit year during 12 flow events (late winter, spring breakup, early summer, late summer/fall, and early winter periods during both baseflow and stormflow conditions).

The field schedules for water quality monitoring will be dependent on rain and flow conditions. Water quality monitoring will be conducted as 12 events, under wet and dry weather conditions, as described in the NPDES permit. Water quality monitoring will be conducted from March through December 2000 (Figure 2). The monitoring period will capture seasonal variations in the types and magnitudes of storm events and in the degree of vegetation development in the watersheds.

Quality Control

DATA QUALITY OBJECTIVES

Data collected during baseline and stormwater sampling events will be used to supplement existing MOA stormwater flow and water quality data. The general data quality objective is consistency with, and comparability to, existing data. The data generated from this assessment will be used to estimate mass loadings of pollutants from the individual basins during each storm. Because possible inherent variability and error in measuring flow, sampling, and laboratory analysis could be multiplicative, the overall data quality objective is to obtain data that permit order-of-magnitude estimates of mass loadings.

DATA QUALITY ASSESSMENT

Flow Measurements

Flow, temperature, and pH measurements will be collected in the field. The chemical parameters will be collected by an autosampler and sent to a certified laboratory for analysis.

Under "good" conditions, open-channel flow can generally be measured with an accuracy of +/-5 percent and comparable precision. The physical conditions at the sampling points of the five gauging stations may not be conductive to establishing good conditions for measuring flow without structural modifications. The data quality goal for the flow measurement for this project is an accuracy level of +/-20 percent. This goal is still ambitious and will require some temporary structural modifications of the sampling points to be achievable. Flows measured during summer months will likely have a higher degree of accuracy due to a stable stream cross section. Conversely, flows measured during the winter months will have a lower degree of accuracy due to a fluctuating stream cross sectional area (due to variations in snow and ice buildup). Where possible, flow measurements will be compared to measurements collected from established USGS stream gauging stations.

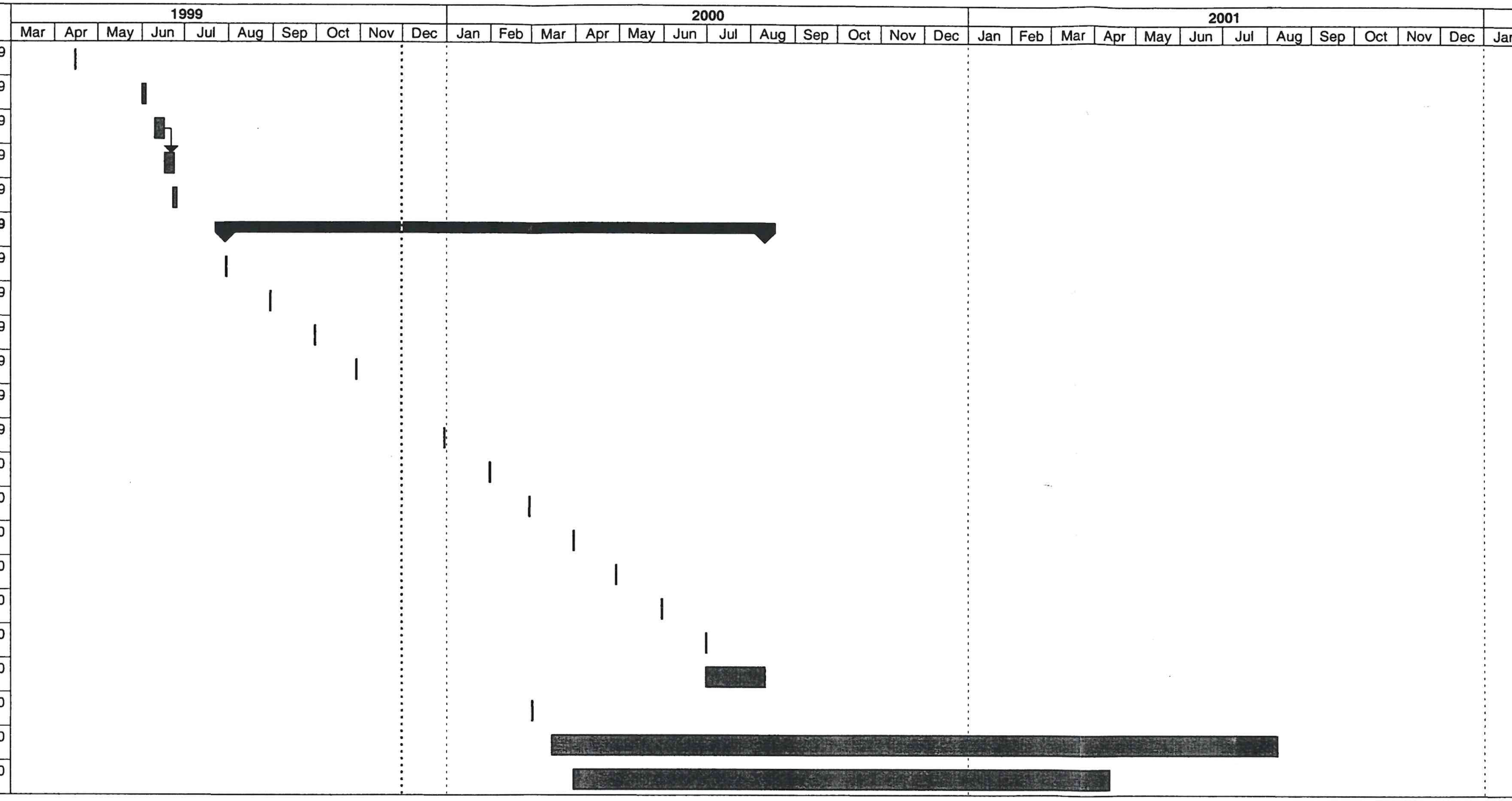
The accuracy and precision of the pressure transducers for flow measurements are determined largely by appropriate placement of the transducers, accurate rating curves, and proper maintenance. To the extent possible within the physical constraints of the basins and sampling sites, the pressure transducers will be installed and maintained according to the manufacturer's specifications.

Chemical Analyses

Specific data quality objectives for analytical results are established based on the criteria of precision, accuracy, completeness, representativeness, and comparability. The application of these criteria to sample collection and analysis is discussed below and is summarized in Table 3 for the constituents to which these QA objectives apply. The analytical methods and sensitivities (method detection limit) are outlined in the Project Approach section and in Table 3, respectively. Quality control measures and the frequencies of their use for sample collection and analysis are further discussed below. Microbiological tests could be based on most probable number measurements, so precision and accuracy objectives are not appropriate for these parameters.

Figure 2. 1999-2000 Receiving Water Characterization Task Schedule

ID	Task Name	Duration	Start
1	Complete Planning Task Report	1d	4/15/99
2	Initial Site Selection	3d	6/1/99
3	Initial Stream Surveys	5d	6/10/99
4	Cross-Section Surveys	5d	6/17/99
5	Equipment Installation	3d	6/23/99
6	**Monthly Monitoring**	**270d**	**7/30/99**
7	July	1d	7/30/99
8	August	1d	8/30/99
9	September	1d	9/30/99
10	October	1d	10/29/99
11	November	1d	11/30/99
12	December	1d	12/30/99
13	January	1d	1/31/00
14	February	1d	2/28/00
15	March	1d	3/30/00
16	April	1d	4/28/00
17	May	1d	5/30/00
18	June	1d	6/30/00
19	Summary Report of Data	30d	6/30/00
20	Install Water Quality Monitoring Equipment	1d	3/1/00
21	Water Quality Sampling	365d	3/15/00
22	Monthly Monitoring	270d	3/30/00



Project:
Date: 11/30/99

Task | Milestone | Rolled Up Task | Rolled Up Progress
Progress | Summary | Rolled Up Milestone

Table 3
QUALITY ASSURANCE OBJECTIVES

Parameter	Method Detection Limit (ppb)[a]	Precision[b]	Accuracy[c]
Fecal coliform bacteria, MF	2 (colonies per 100 ml)	NA	NA
Dissolved copper	1	30	88-105
Dissolved lead	2	29	73-123
Dissolved zinc	10	14	85-106
Hardness, total	NA	NA	NA
Total suspended solids	1,000	10	NA
Chloride	NA	NA	NA
Turbidity	NA	NA	NA
pH	0.5	10	NA
Temperature	NA	NA	NA

[a] Except where otherwise indicated
[b] Precision defined as relative percent difference.
[c] Accuracy defined as percent recovery of known spike sample.

The QA objectives for precision, accuracy, and completeness are presented in Table 3. These objectives, expressed as percentages, are reasonable goals based on protocols, experience, and the data needs of the project. These are target values; the actual values will depend on sample matrix and field conditions, as well as on adherence to specific procedures.

Precision

Precision is a measure of the reproducibility of the results in a given group of analyses under a given set of conditions. It assesses the scatter of data when more than one measurement of the same sample is taken.

The overall sampling and analytical precision will be determined by obtaining and analyzing field duplicate (split) samples that are unknown to the laboratory. The analytical precision will be determined by analyzing laboratory duplicated (split) samples using ordinary duplicates or matrix spike/matrix spike duplicates (MS/MSDs), as appropriate to the analytical method.

Sampling precision will be determined on one or two analyte groups for each storm event at a rate on one in 20 until all analytes have been sampled for precision. The precision values are expressed as relative percent difference (RPD), except where noted as specific units or not applicable (NA) because of characteristics of the specified analytical method.

The precision RPD criterion has one modification that will account for the sensitivity of the analytical method. Where appropriate, a range of plus or minus the method detection limit (MDL) will be acceptable for reported values less than three times the MDL.

Accuracy

Accuracy is a measure of bias within a measurement system. It assesses the margin of error between the reported results and the true sampling concentration. Unlike precision, accuracy is difficult to measure for the true sample concentration. Sources of error pertaining to accuracy include the sampling method, field contamination, preservation, handling, sample matrix, calibration, and analysis.

The elimination of false positive and false negative analytical data from the measurement system is one of the primary objectives of the accuracy criterion. The potential for false positive values will be assessed through the analysis of field blanks and laboratory blanks, which must be less than the MDL or instrument detection limit. The potential for false negative values will be assessed through the analyses of matrix spikes, and where appropriate, surrogate compound spikes. The analysis of spikes provides information on percent recovery of an analyte, and thus the amount of bias. Because of the difficulties inherent in field spiking, this method will not be used to assess sampling and analytical accuracy.

Field control samples (FCS) will be submitted as "blind" samples for analysis by the laboratory. Laboratory control samples (LCS) will be analyzed by the laboratory with each analytical batch, as appropriate. The accuracy criteria, expressed as percent of "true value," will be +/-20 percent for FCS and +/-10 percent for LCS.

Completeness

Completeness is a measure of the amount of valid data obtained from an analytical measurement system. Completeness can be affected by access to sampling locations, sampling problems, analytical problems, and data validation problems, all of which can result in missing data. Completeness is defined as the total number of samples collected for which acceptable analytical data are generated, divided by the total number of samples collected, and multiplied by 100, yielding a percentage value. The data quality objective for this monitoring program is to obtain valid analytical results for at least 90 percent of the samples collected during this project. The completeness criterion will be 100 percent for field blanks and FCS.

Representativeness

Representativeness is a qualitative measure of how closely the measured analytical data reflect the actual distribution of parameter concentrations in the environment. Representativeness depends primarily on design of the sampling program. The number and locations of sampling sites, sampling techniques, sample preservation, and sample handling procedures all affect the representativeness of the sampling data that are generated. Representativeness can best be ensured by establishing and following specific criteria for sampling site selection and standard operating procedures for sample collection and handling. The sampling site selection criteria for this program are described in the Project Approach section.

Representativeness can also be assessed by comparing analytical results from repeated sampling events. In this program, stormwater and baseline sampling will be done throughout each of the 2 years of sampling.

Comparability

Comparability is another quantitative measure of the confidence with which one data set can be compared with another. The use of EPA-approved sampling and analytical standard operating procedures and reporting of analytical data in appropriate, common units will help ensure that this data quality objective is satisfied.

DATA REDUCTION

The laboratory will be responsible for data reduction associated with sample analyses. Data reduction techniques will be consistent with EPA guidance and will result in the reporting of concentration data in common units. Specific data reduction procedures are described in the laboratory's internal QA/QC plan and have been reviewed by the quality assurance officer during the laboratory evaluation process.

DATA VALIDATION

As part of each laboratory's internal QC program, analytical data produced by the laboratory will be validated before they are released. Performance goals and QC evaluation procedures should be documented individually for each analytical procedure in the QA/QC plan of the participating laboratory.

In general, all laboratory data will be reviewed internally in light of analytical instrumentation, calibration and performance information, analytical results for laboratory blanks, analytical results for split samples, and recoveries achieved for matrix and surrogate spikes. The analytical results will be reviewed for their reasonableness, as well as for calculation and recording errors. When data validation is finished, the sample analyst and the laboratory supervisor will approve the final analytical report.

Field blanks and duplicate samples will be prepared by the sampling teams for laboratory analysis. These field-initiated QC samples will provide part of the information needed to review the overall monitoring program (sampling and analysis) performance. The precision of the laboratory split samples will be assessed by comparing the analytical results with the data quality objectives for precision. Also at this time, field blank analytical results, as well as laboratory-generated QA/QC information (for example, detection limits achieved, recoveries for spiked samples), will be evaluated relative to the data quality objectives.

Data Reporting

Data reporting will begin in the field and will be tightly interwoven with the chain-of-custody procedures. Upon collection of each sample, the sampling team will record in a field notebook the sample number, sampling location, date, military time, weather and field conditions, and visual characteristics of the sample. Some of this information will also be recorded, as necessary, on the sample bottle label and on the chain-of-custody record.

The field team leader will maintain a log book of pertinent information for each sample (including QC samples), including sample number, sample preparation, and laboratory destination. As in the field, much of the log book information will be recorded on the new sample bottle labels and chain-of-custody records. The sample logbook, however, also contains information on field blanks, duplicate samples, and performance evaluation samples.

In the laboratory, incoming samples will be stored in a designated location, for which a log book will be maintained by the laboratory sample custodian. The log book will be used to record sample storage location, sample storage conditions, and the transfer of samples to the analytical areas for analysis. The analyst receiving samples also will maintain a log book in which the sample number, sample characteristics, and the results of sample analysis and data reduction will be recorded.

The final data sheets, as well as bottle labels, sample custodian log books, and field notebooks, will be retained by the project manager upon their completion for use in the report as appropriate.

The output of the data validation effort will be a data usability evaluation in the report that will attest to the suitability of the data for its intended use. The report recommendations will qualify specific data points, if necessary, so that the data are not used incorrectly during later data evaluations. These recommendations could qualify a reported parameter concentration as an estimated rather than measured value; reject reported parameter concentrations because of contamination of blanks; or render judgement as to the overall accuracy, precision, and representativeness of the data. All data will be provided in digital format and forwarded to WMS along with the original records for archiving.

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