Analytical Quality Control Program

Sweetwater Authority

Robert A. Perdue Water Treatment Plant

PREPARED BY

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Analytical Quality Control Program

I. Introduction

A concern for the conformance of potable water quality with promulgated state regulations, as well as the need for consolidation and examination of information between different water quality laboratories, makes it essential that laboratory programs be adopted which will produce reliable and uniform analytical results on a state wide basis

The purpose of this document is to provide guidelines for laboratory personnel in establishing and maintaining a laboratory quality assurance program. Consideration is given to each step in the process, including the handling of samples, materials used in analytical examinations, and factors effecting the precision and accuracy of the analytical results.

II. IMPORTANCE OF QUALITY CONTROL

In order to ensure that the quality of a potable water supply complies with current regulations, the water purveyor must rely on laboratory data generated by a testing program, which adheres to an acceptable set of standard analytical practices. Determining the kinds and amounts of contaminants in the water supply with a high degree of accuracy and reliability is one of the most important of these analytical practices. An accurate description of the character and concentration of waterborne constituents is needed to accurately assess the quality of the laboratory's product and to inform those responsible for water quality control that a change in quality or other problem is occurring. Good decisions are based upon accurate and precise data. It is the role of the laboratory to provide this information.

An adequate program of quality assurance, which controls the factors affecting the reliability of results, is necessary in order to ensure the validity and reproducibility of all laboratory data. Ideally, all the factors, which can affect the final answer, should be considered in such a program.

The four main factors affecting the reliability of the analytical data are:

- The quality and dependability of the laboratory's instrumentation.
- The quality and condition of standards, reagents, media and other analytical tools.
- The accuracy and precision of the methods and techniques used in analysis of the water.
- The training and ability of the analyst to use the above correctly and professionally.

Without exception, the final responsibility for the reliability of the resulting analytical data rests with the Laboratory Director and his staff. They will be charged with the operation of a good quality assurance program, which, in turn, will produce valid, reliable analytical results.

III. PERSONNEL

A. REQUIREMENTS

The Principal Analyst(s) for microbiology and chemistry shall have a bachelor's degree in microbiology, biology, chemistry or a related field, plus one year of experience under the supervision of a qualified microbiologist and/or two years of experience under the supervision of a qualified analytical chemist. In addition, the analyst for microbiology will receive 30 days of on-the-job training prior to being allowed to work in the laboratory without supervision. The inorganic chemistry analyst shall receive 6 months of on-the-job training prior to being allowed to perform more analyses without supervision. The Water Quality Laboratory Director will be responsible for conductance of the on-the-job training of analyst(s), which will include review of this Quality Assurance document.

Analysts for microbiology shall have a bachelor's degree in microbiology, biology, chemistry or a related field. Analysts for chemistry shall have a bachelor's degree in chemistry, microbiology or biology with significant course work in chemistry.

The Water Quality Laboratory Director shall have a bachelor's degree in chemistry, biology, or microbiology, with course work in analytical and physical chemistry, plus five years of experience in laboratory operations, one year of which includes major supervisory experience.

The Water Quality Laboratory Director and the chemist are responsible for conducting the analyses, generating the resultant data and preparing all analytical reports which are the main functions of the laboratory operation. Questionable and/or unsatisfactory results will be brought to the attention of the Water Quality Laboratory Director as soon as possible. The Water Quality Laboratory Director will determine what further action is necessitated. The appropriate chemist and the Water Quality Laboratory Director will sign the reports. The Water Quality Laboratory Director will be responsible for the dissemination of the reports to the proper agencies or interested parties.

The Water Quality Technician will collect water samples and after being trained, perform routine water quality analyses.

In addition to the requirements above, the capabilities of laboratory personnel will be periodically checked. These checks will be performed by using standard curves, unknown samples, and blanks prepared internally, or by using commercially prepared quality control and proficiency testing standards.

B. STAFF

Mark Hatcher, Water Quality Laboratory Director
Bachelor of Science Degree in Chemistry
10/89 – 9/96: Maxwell/S-CUBED GC/MS Lab Supervisor
9/96 – 12/99: Sweetwater Authority Associate Chemist/Chemist
1/00 – 2/06: Sweetwater Authority Principal Chemist
3/06 – Present: Sweetwater Authority Laboratory Director

Justin Brazil, Water Quality Chemist
Bachelor of Science Degree in Chemistry
02/03 – 09/04: Sweetwater Authority Laboratory Intern
09/04 – 10/05: Biosite Inc. Production Chemist I
10/05 – 5/06: Environmental Engineering Laboratory Laboratory Analyst
5/06 – Present: Sweetwater Authority Chemist

Aaron Huff, Water Quality Technician
2/05 – 8/05: Water Quality Technician I
8/05 – 12/05: Water Quality Apprentice I
12/05 – 2/07: Water Quality Apprentice II
2/07 – Present: Operator I

David Kutnock, Water Quality Technician
9/02 – 11/05: Laboratory Technician I
11/05 – 11/06: Operator Trainee
11/06 – Present: Operator I

Rick Anderson, Water Quality Technician
9/02 – 11/05: Laboratory Technician I
11/05 – 11/06: Operator Trainee
11/06 – Present: Operator I

IV. LABORATORY FACILITIES AND SERVICES

Appendix Reference - A

A. Facilities:

The laboratory contains 560 square feet of floor space and 185 square feet of counter top space. There are three exhaust hoods with a total of 30 square feet of counter space.

There are four full sized sinks with a supply of hot and cold water available. Demineralized water is provided at two of the sinks. There are two cup sinks; each located in a fume hood with cold-water faucets only.

B. Water:

An important part of laboratory quality assurance is the evaluation of the many services that affect the production of reliable data. Chief among these is the absolute necessity for an abundant supply of distilled or deionized water, which is free from contaminants. Laboratory water should be free of toxic or nutritive substances that could influence survival or growth of bacteria, and free from contaminants, which affect the reliability of reagents and standards used in other analytical tests.

Deionized (DI) water is provided through a series of ion-exchange resin tanks and activated carbon filters provided by U.S. Filter Water Company. The purity of the deionized water is checked with an on-line conductivity bridge, which indicates when the conductance exceeds 1 µmohs. In addition to the on-line bridge, measurements of the conductivity, pH, and chlorine residual are taken monthly on the bench instruments to confirm the purity of the deionizing system. Also, a Heterotrophic Plate count is performed on the DI water on a monthly basis. The suitability of the water for bacteriological examination shall be checked annually, according to Standard Methods (19th Ed. Standard Methods, 9020 B.). Records of these quality assurance results will be entered and kept in the proper Quality Assurance Notebook (Appendix D).

A Barnstead E-Pure water purification system is also available for polishing of the deionized water. The polished deionized water will also be checked monthly for conductivity, pH, chlorine resid-

ual, and Heterotrophic Bacteria. Water Suitability tests will also be performed annually on the distilled water, as is the case with the demineralized water. Records of these quality assurance results will be entered and kept in the bacteriological Quality Assurance Notebook (Appendix D).

The deionized water will be used to prepare reagents and to rinse all glassware, which has been washed and previously rinsed in warm tap water. The polished water will be used to prepare all bacteriological media and most analytical reagents and standards Wherever high quality water is needed for preparation of analytical solutions, polished water will be used.

C. Electricity:

The laboratory is provided with 34 110V outlets and four 220V outlets. The laboratory is adequately lit with 48 feet of fluorescent ceiling lights. Lights are also provided in the exhaust hoods and at the titration table

D. Compressed Air, Propane and Vacuum:

Compressed air is supplied by either of two; two-stage air compressors capable of supplying 15 static cubic feet per minute each, with a total auxiliary storage capacity of 23 cubic feet at 120 p.s.i. The compressed air is filtered for oil and particulate removal. The laboratory has eleven compressed air outlets. Air for the atomic absorption spectrophotometer is kept dry and oil free by use of special in-line filters

Propane gas is stored in a tank of 40 cubic feet capacity and is supplied to 11 laboratory outlets at a pressure of 0 4 pounds per square inch.

Eleven Laboratory vacuum outlets are provided at 29 inches of mercury

E. Compressed Gases:

All gases used in any gas chromatographic analyses are prepurified to a "high" purified grade (99.998%). Acetylene will have at least a minimum purity specification of 99.8%. A new cylinder will be installed when the acetylene pressure falls below 75 p.s.i. Nitrogen and Helium will be kept dry and free from oxygen using the appro-

priate filters. Laboratory air pressure will be maintained between 40 to 80 p.s.i. and will be free of oil and water as stated in Section 4.4. All compressed gas cylinders will be secured to the wall in the tank storage room and handled in a safe manner. Empty cylinders will be marked and the valve bonnet screwed in place. At no time will cylinders be moved without the valve bonnet in place.

F. Laboratory Safety Equipment:

Safety equipment includes two eyewash and shower stations, two fire extinguishers, a fire blanket, and a first aid kit. In addition, the analyst shall be provided with adequate safety apparel, including face shield, rubber gloves and a laboratory apron. At all times the regulations and guidelines established by the Occupational Safety and Health Administrations shall be followed.

V. LABORATORY INSTRUMENTATION AND EQUIPMENT

Appendix Reference - B

The measurement of trace constituents in water requires instrumentation which is capable of maximum sensitivity in order to detect small quantities of an element or a compound in water, and which, at the same time, can retain a high degree of precision and accuracy in order to provide statistically significant reproducibility's and standard deviations. No matter how great the care and skill of the analyst, the results will only be as precise and as accurate as the instrument is capable of producing.

In order to assure that the instruments are in correct working order and are properly calibrated, records establishing the type of instrument and the frequency of servicing operations will be kept on each instrument. This information, compiled in an Instrument Maintenance Log Book (Appendix D), will include the type of instrument, the manufacturer, the model and/or model number and the serial number. In addition, a record of all servicing operations performed by laboratory personnel or by authorized service technicians shall be kept on each piece of equipment. This record will include the type of service performed, the date of servicing, and the name of the servicing personnel (Appendix D)

Manufacturer's instructions for the proper operation and maintenance of the instrument shall be followed in all cases, and service contracts will be obtained, where possible, on the more sophisticated instrumentation such as the spectrophotometers and the chromatographs.

A. Amperometric Titrator:

Manufacturer	Model	Serial Number
Wallace and Tiernan	320-G	BL13482

The potassium iodide solution will be discarded at the first appearance of discoloration. The normality of the phenylarsine oxide solution will be checked quarterly against a chlorine solution standardized via the DPD ferrous titrimetric method (Standard Methods, 17 ed.; Method 408D). Results of these standardization re-

cords will be kept on the Instrument Servicing Record forms. Examination of the cell will be done quarterly. Examination of the platinum electrode and cell terminals for signs of discoloration will be done with each use of the titrator. Clean up will be done as needed, including the washing off of any accumulated crystals and replenishment of the salt tablets.

B. Analytical Balance:

Manufacturer	Model	Serial Number
Mettler	AT200	J81923

QA/QC:
Balance level and sensitivity shall be checked weekly using 0 1000 gram and 1.000 gram Class S weights. These results will be entered in the balance calibration log (Appendix D). Manufacturer's servicing will also be obtained on a yearly basis; these records will be kept in QAR Instrumentation folder.

C. Analytical Pan Balance

Manufacturer	Model	Serial Number
Mettler	PB602-S/FACT	1127403919

QA/QC:
Balance level and sensitivity shall be checked weekly. Sensitivity will be checked using 1 gram, 10, and 50 gram Class S weights. These results will be entered in the balance calibration log (Appendix D). Manufacturer's servicing will also be obtained on a yearly basis; these records will be kept in QAR Instrumentation folder.

D. Atomic Absorption Lamps:

The laboratory has 1 multi-element hollow cathode lamp manufactured by Perkin-Elmer. The following precautions will be taken with all AA lamps:

- Do not exceed the lamp's operating current or wattage specifications
- Do not touch the optical surfaces of the lamp; wipe the optical surfaces with a soft, lint-free tissue paper

- Discharge backgrounds and sensitivities will be monitored and the lamps will be discarded when deterioration of signal strength is noted.

E. Atomic Absorption Spectrophotometer:

Manufacturer	Model	Serial Number
Perkin-Elmer	380	117656

For operating procedures refer to the Flame A.A. SOP.

QA/QC:

- Calibration curves will be prepared and analyzed the day of analysis.
- A Quality Control Sample (QCS) will be analyzed with every FAA sample batch.
- A laboratory-fortified blank will be analyzed with every ten samples.
- A matrix sample replicate will be analyzed a minimum of once every 10 samples.
- Laboratory Fortified Matrix (LFM) sample will be analyzed a minimum of once every 10 samples.
- Method Detection Limits (MDL) will be determined annually.

F. Autoclave:

Manufacturer	Model	Serial Number
Market Forge	STM-E	115719

QA/QC:

For QC procedures refer to the Autoclave SOP

- Weekly temperature checks with a min./max thermometer.
- Monthly sterilization check using *Bacillus stearothermophilus* spores.
- Quarterly sterilization time cycle check using a second timing device.
- Constant documentation of all maintenance performed on the autoclave.

G. Conductivity Bridge:

Manufacturer	Model	Serial Number
YSI	3100	96M0230AA

QA/QC:
Calibration will be checked monthly against a 0.01 M Potassium Chloride standard. These results will be entered in the conductivity bridge instrument servicing record (Appendix D). The cell will be frequently examined for overall cleanliness, chipping or flaking of the platinum coats, or any other disturbances or damage

H. Dissolved Oxygen Meter:

Manufacturer	Model	Serial Number
YSI	650 MDS	01L0083 AB

QA/QC:
The instrument will be calibrated with each use. Calibration will be against saturated tap water at room temperature, with the elevation set at 250 feet above sea level. This is the elevation of the Sweetwater Filter Plant and the Sweetwater Dam area.

I. Dissolved Oxygen Probe:

Manufacturer	Model	Serial Number
YSI	600 QS	01 L0478

QA/QC:
The laboratory will use only probes compatible with the above mentioned dissolved oxygen meter. The membrane will be replaced with each use, if required, or as often as necessary depending on the frequency of use and the quality of the response time. The pH will be calibrated with each use.

J. Dry Air Incubators:

Manufacturer	Model	Serial Number
Precision	6LM	600011104

QA/QC:
Incubator will be maintained at an internal temperature of 35.0EC ∀ 0 5EC. The temperature will be recorded twice daily from the thermometer inside the incubator. These values will be recorded in the Thermometer Readings Quality Assurance Notebook (Appendix D). The thermometer temperature accuracy will be checked semi-annually with an ASTM certified thermometer. If needed, adjustments will be made to correct the daily thermometer readings. Results from the checks will be recorded in the Thermometer Readings Quality Assurance Notebook (Appendix D).

Manufacturer	Model	Serial Number
Precision	Thelco	699121117

QA/QC:
Incubator will be maintained at an internal temperature of 41.0EC ∀ 0 2EC. The temperature will be recorded twice daily from the thermometer inside the incubator. These values will be recorded in the Thermometer Readings Quality Assurance Notebook (Appendix D). The thermometer temperature accuracy will be checked semi-annually with an ASTM certified thermometer. If needed, adjustments will be made to correct the daily thermometer readings. Results from the checks will be recorded in the Thermometer Readings Quality Assurance Notebook (Appendix D)

Manufacturer	Model	Serial Number
Millipore	Single Chamber Incubator	5434

QA/QC:
Incubator will be maintained at an internal temperature of 44.5EC ∀ 0.2EC. The temperature will be recorded twice daily from the thermometer inside the incubator. These values will be recorded in the Thermometer Readings Quality Assurance Notebook (Appendix D). The thermometer temperature accuracy will be checked semi-annually with an ASTM certified thermometer. If needed, adjustments will be made to correct the daily temperature readings. Results from the checks will be recorded in the Thermometer Readings Quality Assurance Notebook (Appendix D).

K. Dry Air Oven:

Manufacturer	Model	Serial Number
Blue M	OV-18A	18A-1234

QA/QC:
The oven is capable of maintaining temperatures between 38°C and 288°C. Time and temperature measurements shall be recorded with each use for sterilizing of microbiological equipment or for drying purposes in other analytical-type applications. These results will be recorded in the proper Quality Assurance Notebook (Appendix D).

L. E.C. Water Bath:

Manufacturer	Model	Serial Number
CMS	Equatherm	12AU-1

QA/QC:
The temperature will be maintained at 44 5°C ∀ 0 2EC. The temperature will be recorded twice daily from an ASTM thermometer These values will be recorded in the Thermometer Readings Quality Assurance Notebook (Appendix D).

M. Gas Chromatograph:

Manufacturer	Model	Serial Number
Varian	Star 3400 CX	21722

For operating procedures, refer to the THM SOP.

QA/QC:

- Calibration curves will be prepared and analyzed the day of analysis.
- Solvent and lab blanks will be analyzed with every THM sample batch.
- A Quality Control Sample (QCS) will be analyzed with every THM sample batch.
- A laboratory-fortified blank will be analyzed with every ten samples.
- A matrix sample replicate will be analyzed a minimum of once every 10 samples.
- Laboratory Fortified Matrix (LFM) sample will be analyzed a minimum of once every 10 samples.
- Method Detection Limits (MDL) will be determined annually.

N. Gas Chromatograph Autosampler

Manufacturer	Model	Serial Number
Varian	8200 CX	8509

O. Glassware:

Glassware for specific analyses will be cleaned as according to the procedures SOP.

All general glassware will be washed in phosphate free detergent, which has been tested yearly and has been proven non-toxic via the inhibitory residue test. These records will be kept in the Quality Assurance Notebook (Appendix D).

The proper glassware will be used for all analyses performed as per the testing requirements of Section 7. Class A volumetric glassware will be used where required for preparation of standards, reagents and aliquots of 100 mls or less. Volumes greater than 100 mls may be measured in Class A graduated cylinders.

Separate glassware shall be maintained for use in microbiological, toxic inorganic, and organic analyses.

P. Hot Plates, Magnetic Stirrers, Desiccators:

The laboratory has three hot plates (two of which contains a variable speed magnetic stirrer) capable of surface temperatures up to 370° C. In addition to the stirring hot plate, the laboratory has two other variable speed magnetic stirrers. There are also three desiccators; each utilizing anhydrous Calcium Sulfate and an indicating gel as desiccants.

Q. Inoculating Equipment:

Loops and/or needles are of 22 to 24 gauge nichrome wire. Blackened and brittle loops will be discarded.

R. Ion Chromatograph:

Manufacturer	Model	Serial Number
Dionex	ICS-2000 w/ AS-40 Autosampler	07090509; 98060173

For operating procedures, refer to the appropriate IC analysis SOP (i.e. chlorite and chlorate by EPA 300.1 or bromide, nitrite, nitrate, sulfate by 300.0).

QA/QC:

- Calibration curves will be prepared and analyzed the day of analysis.
- A Quality Control Sample (QCS) will be analyzed with every sample batch
- A laboratory-fortified blank will be analyzed with every ten samples.
- A sample replicate will be analyzed a minimum of once every 10 samples.
- Laboratory Fortified Matrix (LFM) sample will be analyzed a minimum of once every 10 samples.
- Method Detection Limits (MDL) will be determined annually.

S. Ion Selective Analyzer:

Manufacturer	Model	Serial Number
Orion	720	46772

For operating procedures refer to the specific Ion analysis SOP required (i.e. fluoride or ammonia).

T. Membrane Filtration Equipment:

The glass filtration units will be kept clean and leak-free. MF filters will be of cellulose-ester construction, 47 mm in diameter and have a 0.45-micron pore size. Pads are 47 mm in diameter, as are the plastic petri dishes that house them.

U. UV Sterilizer

Manufacturer	Model	Serial Number
Millipore	UV sterilizer	XX6370000

Each month the UV Sterilizer is disconnected and the lamps are cleaned by wiping with a soft cloth moistened with ethanol. The UV Sterilizer is tested quarterly by the agar spread plate method.

V. Muffle Furnace:

Manufacturer	Model	Serial Number
Thermolyne	F-B1415M	186942

The muffle furnace contains a single three-section element embedded in refractory cement and will be capable of temperatures not to exceed 1037° C. Care will be taken not to leave the furnace unattended at operating inputs of greater than 40 % (400° C).

W. Optical and Counting Equipment:

A 10x to 20x power stereo microscope (Swift; serial number 8216438) is available for counting membrane filter colonies. A Reichert Quebec Darkfield Colony Counter (Model 3325; serial number 005850904) is used to determine Heterotrophic plate count colonies. A compound microscope (Leitz Laborlux; serial number

512859/103389), with a 1000x-power oil immersion lens for gram stain evaluation, is available for magnification work from 100x to 2000x power.

X. pH Meter:

Manufacturer	Model	Serial Number
Orion	420	050357

QA/QC:
The pH meter will be calibrated with each use, the date and type of calibration will be logged in the pH calibration Logbook.

Y. Standards Refrigerator:

Manufacturer	Model	Serial Number
CMS	E1226	50454-0009

QA/QC:
The laboratory standards refrigerator will be maintained at a temperature of 4EC ∀ 2EC. The temperature will be read twice daily and logged into the Thermometer Readings Quality Assurance Notebook (Appendix D)

Z. Sample Refrigerators

Manufacturer	Model	Serial Number
General Electric	TAX4DNCABL	HA 314597
Kirkland	ST21PKXHW00	EJ2514211

QA/QC:
The laboratory samples refrigerators will be maintained at a temperature of 4EC ∀ 2EC. The temperature will be read twice daily and logged into the Thermometer Readings Quality Assurance Notebook (Appendix D).

AA. Specific Ion Probes:

The laboratory has probes for fluoride and ammonia, plus a single junction and a double junction reference electrode.

BB. UV-VIS Spectrophotometer:

Manufacturer	Model	Serial Number
Hach	DR/4000U	9804U001097

For operating procedures refer to the specific UV/VIS analysis SOP required.

QA/QC:

- A Quality Control Sample (QCS) will be analyzed with every sample batch.
- Method Detection Limits (MDL) will be determined annually.
- A wavelength check (using Holium Oxide filters or equivalent) will be performed yearly; the results will be entered in the UV/VIS maintenance Logbook.

CC. Steam Bath:

Manufacturer	Model	Serial Number
Blue M	MW-1120A-1	M5-8600

A portable steam bath capable of temperatures from 25°C to 100°C is available. The water level will be maintained above the heating element and the bath will be maintained in good working order.

DD. Thermometer:

Incubator, refrigerator, water bath and oven thermometers will be calibrated against an NIST Certified Thermometer semi-annually and such calibrations will be documented on the thermometer and in the Thermometer Reading Log book.

EE. TOC Analyzer and Autosampler

Manufacturer	Model	Serial Number
Shimadzu	TOC-VCSH	H51104535235CS
Shimadzu	ASI-V	H52104401952

For operating procedures refer to the TOC SOP.

QA/QC:

- Calibration curves will be prepared and analyzed the day of analysis
- All samples and QA/QC checks will be analyzed in duplicate.
- A Quality Control Sample (QCS) will be analyzed with every sample batch.
- A laboratory-fortified blank will be analyzed with every ten samples.
- A matrix sample replicate will be analyzed a minimum of once every 10 samples.
- Laboratory Fortified Matrix (LFM) sample will be analyzed a minimum of once every 10 samples.
- Method Detection Limits (MDL) will be determined annually

FF. Turbidimeter:

Manufacturer	Model	Serial Number
Hach	2100N	950800001748

QA/QC:

The turbidimeter will be calibrated monthly, using EPA certified AMCO AEPA-1 standards. Documentation of the calibration will be entered in the Turbidity Calibration Log book. A gel turbidity standard, which is in the same NTU range as the samples, will be used to check the calibration of the turbidimeter scale before each use

GG. Water Polish:

Manufacturer	Model	Serial Number
Barnstead	E-Pure D4641	109006090235

A Barnstead E-pure water purification system is available to provide the laboratory with 18 megohm ASTM Type I water. It will be maintained in proper working condition in the laboratory. Purity of the polished water will be checked monthly for conductivity, Heterotrophic plate counts and pH. These quality assurance tests will be recorded in the appropriate Quality Assurance Notebook.

VI. LABORATORY PRACTICES:

Appendix References – Summaries C & D 6.1

A. Sampling:

All samplers shall be given training and instructions outlining proper sampling techniques. Care will be exercised in selecting sampling points which are representative of the entire potable water distribution system and in ensuring that the sample does not become contaminated at the time of collection, during transportation to the laboratories, or before examination. The samples will be properly identified and labeled and delivered to the laboratory within 24 hours after sampling for chemical or physical testing and within 12 hours for microbiological sampling.

Sample identification will include assignment of a sample number, sample location, time and date of sample collection, and the sampler's name. In addition, pertinent field test data (chlorine residual, temperature, pH) will be recorded on a water sample inventory sheet which will be signed and dated by the sampler.

Laboratory personnel will be responsible for the custody, care, and processing of the sample upon arrival at the laboratory. A logbook will be maintained showing time of receipt of the samples from the sample collector; along with any comments noted on the field water sample inventory sheet. All field worksheets recording the name of the sampler, chlorine residuals, results of field tests, and other pertinent information will become the responsibility of the laboratory analyst as to their safekeeping.

Samples sent to contract laboratories will be accompanied by a completed Chain of Custody form. Sample shipment will be in coolers containing "Blue Ice" to keep the temperature of the samples at 4.0 °C.

1. Chemical Samples:

Monthly Partial Mineral Analysis and Semi-Annual General Mineral Analysis samples will be collected in plastic, labeled bottles and will be delivered to the laboratory as soon as possible, which in most instances will be within a maximum of 8 hours from the sampling time. Heavy Metal Analysis samples will be collected in

labeled 1 liter plastic bottles with 1 ml of concentrated HNO_3 added as outlined per Appendix C. Care will be taken with acidified samples to insure that the bottle is not filled to overflowing, which could result in a loss of acid. These samples will be refrigerated when not being analyzed and they will be analyzed within the limits for holding time specified in Appendix C.

2. Bacteriological Samples:

Samples will be collected in sterile, 125 ml plastic bottles containing approximately 0.1 ml of a 10% solution of Sodium Thiosulfate. The sample tap will be run for 2 to 3 minutes before sampling occurs and will be free of aerators, hoses, strainers, etc. A minimum of 100 mls. will be sampled. Laboratory personnel will reject any sample where sampling-induced contamination is suspected. All samples less than 100 mls. in volume will be noted. Bacterial samples will be separated in a rack and stored during transportation in a cooler containing "Blue Ice" or other ice substitute, and will be analyzed within 12 hours of receipt. Any coliform test sample not analyzed on the day of receipt will be refrigerated during the interim period, not to exceed 30 hours holding time from collection to analysis. Do not exceed the 8 hour holding time for the Heterotrophic plate count test samples.

3. Physical Samples:

Weekly Physical Analysis samples will be collected in labeled, 250 ml polypropylene bottles. These samples will be delivered to the laboratory within 8 hours and analyzed within 24 hours of receipt. Care will be taken to insure that the sampling tap is adequately flushed and that the sample delivered to the laboratory is representative of water in the distribution system. Physical tests will be performed not later than 48 hours after they are received, or such samples will be discarded and resampled.

4. Organic Samples:

Samples will be collected in amber glass bottles that have been scrupulously cleaned as per the Laboratory Glassware Cleaning Procedures SOP. Samples that are taken to be analyzed for purgeable organics, such as THM's or volatile chlorinated solvents, will be collected in 40 ml vials that have been cleaned as above plus baked at 180° C for two hours. Screw caps for all sample bottles or

vials will be filled with a teflon faced silicon septum. Both the screw caps and the septa will be baked at 105°C for two hours before use.

Sampling personnel will note any unusual conditions or possible sources of contamination that exist at the time of sampling. Care will be taken to prevent contamination from the sample tap. The laboratory staff will discard any questionable sample. The organic samples will be analyzed as soon as possible after collection, but typically no later than 2 days after sampling for purgeable organics. Organic samples will be refrigerated when not being analyzed.

Organic samples collected for contract laboratories will be packed in a cooler with "Blue Ice" and shipped to the contracting laboratory within 24 hours of collection.

B. Microbiology:

1. Sterilization Procedures:

Lauryl Tryptose Broth, 2% Brilliant Green Bile, and E.C. media will be autoclaved at 120° C at 15 p.s.i. for 15 minutes. The media shall not be allowed to remain in the autoclave for longer than 45 minutes, measured from the time the autoclave door is closed until it is opened at the end of sterilization. M-Endo broth will be prepared with sterile water and will be heated only to the boiling point as per the Difco preparation instructions. Broth, which is suspected of having been overheated, will be discarded. Heterotrophic Plate Count Agar will be prepared with DI water and will be heated in a double boiler, only to the boiling point. The Agar will be sterilized in 10 mls. portions at 120° C and 15 p.s.i. for 15 minutes. At no time will media be allowed to stay in the autoclave for longer than 45 minutes, measured from the moment the autoclave door is closed. Buffered rinse water of quantities in excess of 500 mls. will be autoclaved for 30 minutes at 120° C and 15 p.s.i.

The time the media was placed in the autoclave, and the time the media was removed from the autoclave, will be recorded in the proper section of the Bacteriological Quality Assurance notebook. The pressure and temperature readings will also be noted at one-half the total time and recorded in the notebook.

2. Media Preparation:

Commercially prepared media will be used for all bacteriological examinations. Media will be ordered in one-quarter pound containers and upon receipt will be labeled as to date received, date opened, and pull date (usually 6 months). In addition, the lot number and the pH after autoclaving will be recorded in the Bacteriological Quality Assurance notebook (Appendix D) with each new batch of media prepared. Aged media (greater than 2 weeks) will be discarded rather than used. Plate Count Agar will be refrigerated until melted for use.

No air bubbles should be produced in the media insert tube; however, if bubbles are observed, the media will be discarded and prepared anew. The sterilization temperature and time will be recorded in the appropriate Laboratory Quality Assurance notebook (Appendix D). The sterilization time shall be counted from the time the autoclave door is shut till the door is opened and shall not exceed 45 minutes

C. Chemistry:

1. Field Kits:

Field kits will be used for the measurement of "DPD" chlorine residuals. pH will be measured with an Orion Model 201 pH field test kit, which has been standardized in the laboratory prior to being taken on the sample route. The Chlorine field tester is a Hach pocket colorimeter, which utilizes DPD reagent and the appropriate sample cell. In addition, the routine filter plant chlorine residual monitoring will utilize a Hach DR/700 Colorimeter. All colorimeters are properly zeroed before sample readings are taken. Water temperatures will be taken with a thermometer traceable to an ASTM standard, which has been crosschecked with the lab's NIST certified thermometer.

All colorimeters will be calibrated on a yearly basis with the standards, which are applicable to the analysis methods specified in Appendix E.

2. Chemicals and Reagents:

All reagents will be prepared from Analytical Reagent Grade chemicals and solvents which are as free as possible from contami-

nating substances, especially those constituents that would adversely affect the analytical outcome of specific test results. Reagents will be prepared in volumetric glassware analytical techniques. Stock and working solutions will be checked regularly for signs of deterioration, e.g. discoloration, formation of precipitates and concentration losses. Also, they will be freshly prepared as often as required by their stability and as stipulated in the methods in Appendix E. All solutions will be properly labeled as to compound, supplier, lot number, concentration, solvent, date prepared and prepared by. Also, projected discard dates will be indicated.

All organic solvents will be of pesticide quality or better. Care will be taken to prevent the contamination of opened bottles, either from atmospheric movements or from extraction instruments, which could enter the container. Unnecessary or possible contaminating substances will be stored at locations outside of the laboratory working areas, and climate control and air filtration will be practiced where possible to protect the purity of organic solvents and working organic standard solutions. Also, organic stock and working solutions will be prepared daily, or as needed if contamination is suspected and will be discarded after the completion of the analysis.

D. Records and Reports:

All final reports will be maintained for a minimum of 20 years. Final reports will be specific as to the tests performed, test results, sampling point(s), date and time of sampling, the analyst's name and the date the analyses were completed. All supportive laboratory notebooks and worksheets will be kept a minimum of 10 years. Worksheets will be specific as to the tests performed, the test results, the method(s) used, the sampling point(s), the date of sampling, the date(s) of analysis, and the analyst's name and field or laboratory comments. Records regarding any resampling due to questionable or non-conforming results will be kept for 20 years. All quality assurance records will be kept a minimum of 20 years.

VII. ANALYTICAL METHODOLOGY

Appendix Reference - E

To facilitate the consolidation and examination of information between different water quality laboratories, it is necessary to standardize the analytical methods used in State certified laboratories so that this is not a variable in comparison of, or joint use of, the resultant data.

Without standardization of methodology, doubts are raised as to the validity of the data generated at different laboratories. Methods will be selected on the basis of precision and accuracy. The procedure should utilize the equipment and skills normally available to any laboratory and should be sufficiently rapid to permit routine use for the examination of large numbers of samples.

Procedures for all analyses will be taken from any of the following four references:

- Standard Methods for the Examination of Water and Wastewater. Current edition.
- EPA-Methods for the Chemical Analysis of Water and Wastes.
- EPA-Methods for the determination of Organic Compounds in Finished Drinking Water and Raw Water Sources.
- Part 23 of ASTM

Regardless of the procedure used, the specific methodology will be carefully documented in a written manual. This manual will be provided for, and maintained by, laboratory personnel and will outline the methods for all chemical and bacteriological examinations being routinely performed as a part of the water quality monitoring and testing program. Due consideration will be given to the interferences actually found or might be found when performing the analysis and to the sensitivities which should be obtained with the analysis for a particular chemical constituent by the specified analytical methodology.

For each test, the method used will be referenced in the notebook, along with the date the sample was taken, the date the test was run,

the measurement made or obtained for standards and samples, and the name of the analyst who performed the test. Quality assurance samples, such as replicates or chemical additions, will also be clearly cataloged in the notebook.

A. Bacteriological Methods:

The Membrane Filter (MF) method is preferred at the Sweetwater Filter Plant Laboratory over the Multiple Tube Fermentation (MTF) method for Safe Drinking Water Act compliance. The MF method will be restricted to routine samples analyzed on a weekly basis as required by State regulations. The Colilert® test method will be used for all special samples acquired during the week and for watershed monitoring. Membrane Filter colonies will be verified by transferring a representative number of typical or atypical colonies to Lauryl Tryptose Broth and subsequently to 2% Brilliant Green Bile and E.C. Media. Source water fecal coliform enumeration will be performed using mFc media incubated at 44.5° C. Heterotrophic Plate Counts will be conducted weekly on routine samples, counts will be made using the Quebec Dark Field Colony Counter.

B. Chemical Methods:

The methods of analysis for mineral, metal and organic constituents will be those listed in the Appendix - E. These are based on either titration, flame photometry, spectrophotometry, ion electrode measurements, atomic absorbance measurements, gas chromatography, ion chromatography or gravimetric determinations. Whenever possible, tests will be performed by this laboratory. However, if outside laboratory testing is necessary, samples will be sent only to an approved commercial laboratory which is State certified and will follow the methods specified in Appendix E.

C. Physical Methods:

Chlorine residual and temperature will be measured in the field at the time of sampling. Turbidity units, color units and Odor Threshold Numbers will be measured at the laboratory by recommended EPA methods or methods approved by the State Department of Health Services, which are currently based upon nephelometry, color comparison and odor dilution methodologies respectively as outlined in the cited references, Appendix E.

VIII. QUALITY ASSURANCE PROGRAM

Appendix Reference - F

To assure the reliability of the analytical results obtained from this laboratory, the Laboratory Quality Assurance Program will include documentation of the control measures practiced by all personnel who perform analyses intended to meet the requirements of the Safe Drinking Water Act. The written program will be set up in such a way as to offer controls over both the quality of laboratory equipment and materials, and the reliability of the analytical methods, procedures and techniques used for analysis.

The Water Quality Laboratory Director will supervise the Analyst(s) and the Chemist in fulfilling those duties, and the final responsibility for personnel performance in this area of the quality assurance program will be his.

A. Microbiology:

1. Laboratory Quality Control:

Written records on media, materials and equipment will be kept. Records will include the daily operating temperatures of the dry air incubator, the operating temperatures of the circulating water bath, the operating temperature and pressure of the autoclave during each sterilization run, and the operating temperatures of the dry air oven. All thermometers will be calibrated against an NIST certified thermometer, and any correction factors will be noted on the instrument.

The pH and lot number of all bacteriological media will be recorded with each new batch prepared. New batches will be prepared when pH values on existing media solutions are not consistent with the stipulated pH ranges for the bacteriological media after sterilization.

Tests for water suitability and inhibitory tests will be conducted annually and will be recorded in the proper Laboratory notebook. Conductivity, pH, Chlorine residual and Heterotrophic Plate Counts of the demineralized water and nanopure water used in media preparation will be recorded monthly

2. Analytical Quality Control:

A stock culture of *E. coli* will be used as a positive control, *E. aerogenes* will be used as a total coliform positive/fecal coliform negative control, and *P. aeruginosa* will be used as a negative control for each Membrane Filter test. A dilution water blank will be used as a control and will be run at the beginning and end of each sample run in order to check for contamination. A representative number of coliform MF colonies from each positive sample will be confirmed in Lauryl Tryptose Broth, 2% BGB and EC media.

B. Chemistry:

1. Laboratory Quality Control:

Written records on all instruments will be kept showing maintenance, calibration and servicing operations. Service contracts will be maintained where previously stated in other sections of this manual.

Solvents, chemicals and reagents will be properly labeled as to date received, date opened or made and shelf life. At the first sign of deterioration, the chemical or reagent will be discarded. Analytical results falling outside of the usual quality assurance parameters will be so indicated and investigated.

2. Analytical Quality Control:

At least 10% of the samples analyzed will be duplicated for a precision check between identical samples and at least 10% of the samples will be spiked by standard additions methodology for an accuracy check between standards and samples. Annual method detection limits will be determined for each analyte and is defined as 3 times the standard deviation of at least seven low-level replicate analyzes.

Quality Control Charts for precision and accuracy will be established on each of the parameters for which enough samples have been analyzed. Once the initial data has been generated, at least 10% of the samples will be duplicated for a precision check and at least 10% of the samples will be spiked for an accuracy check. When control charts are exceeded, all samples will be redone and the test results will be considered suspect.

Standard Calibration curves using at least 3 calibration points will be set up and verified for each analytical test. The linearity of the curve shall be at least 95% as determined by regression coefficient analysis. One standard will be run for every 10 samples as a Quality Control check.

Standard titrants will be checked against known standards upon makeup then verified monthly.

The laboratory will analyze at least one unknown standard sample semi-annually for each parameter or constituent, which is routinely analyzed for as part of the laboratory's testing program.

Appendix A

Laboratory Facilities

Work Space	Quantity Available
Floor Space	730 sq. ft.
Bench Space	185 sq. ft.
Exhaust Hoods	30 sq. ft
Sinks	
wash	4
sample	1
cup	3

Services	Quantity Available
Lighting	
Fluorescent	48
Titration Table	1
Hood lights	3
Electrical Outlets	
110V outlets	35
220V outlets	4
Compressed Air Outlets	11 at 120 PSI
Propane Gas Outlets	11 at 0.4PSI
Demineralized Water	2 at 4 l/min
Type I (18 megohm) Water	1 at 3 l/min
Compressed Gases	
Acetylene	1 at 400 cu. ft
Nitrogen	2 at 304 cu. ft
Helium	1 at 291 cu. ft
Zero Grade air	1 at 330 cu ft

Safety Equipment	Quantity Available
Fire Extinguisher	1
Fire Blanket	1
Safety Shower	2
Eyewash	2
Spill Cleanup Kits	3

Appendix B

Instrumentation and Equipment

Analytical Balance

Mettler AT200

Precise to ± 0.05 mg

Amperometric Titrator

Wallace & Tiernan 320-G

0 - 100 milliamps

± ppm Cl_2, ClO_2^-, ClO_2

Atomic Absorption Spectrophotometer

Perkin Elmer Model 380

Double Beam with deuterium arc background corrector Volts; 0-50mA; 0000 to 9999 display readout in emission, absorption, peak area (A-seconds), and concentration units

Lamp (multi-element)

Fe-Mn-Cu-Zn

Autoclave

Marketforge Sterilmatic

120°C at 15 PSI with 60 minute timer

Auto-titrator

Hach AutoCAT 9000

Chemical Water Bath

Blue M 1120A-1

0 to 100°C ± 0.2°C

Conductivity Meter

YSI 3100 Conductivity Meter

0 to 5000 µmhos ± 1 µmhos

0 to 5000 millimhos± 1 millimhos

Dissolved Oxygen Meter

YSI 650 MDS

0 to 15 ppm O_2 ± 0.2 ppm

Probe YSI model 600QS

Dry Air Incubator

Precision 6LM

35°C ± 0.5°C

Precision Thelco

41.0°C ± 0.2°C

Millipore Single Chamber

44.5°C ± 0.2°C

Appendix B

Instrumentation and Equipment

Dry Air Oven
- Blue M #OV-18A
  - +38°C to 288°C

Gas Chromatograph
- Varian Star3400 CX w/8200-CX Autosampler
  - Electron Capture Detectors
    - Nickel-63 source sealed detector
    - gC/second detectability
  - Programmable oven range
  - from ambient to 499°C±0.25°C

Glassware
- Pyrex, Kimax
- Graduated Cylinders
  - TD at 20°C
- Volumetric Flasks
  - Class A, ± 1%
- Volumetric Pipets
  - Class A, ± 1%

Hot Plates
- Thermolyne #1000
- Thermolyne #2200
  - 40°C to 370°C

Selective Ion Analyzer
- Orion Model 720A+
  - mV range of -999.9 mV to +999.9 mV
  - concentration readability of .001 to .999 units

pH Meter
- Orion Model 420A+
  - pH range of 0.000-13.999 pH units
  - pH value precision of 7.00 ± 0.02 pH units

Ion Chromatograph
- Dionex Model ICS-2000 w/AS-40 Autosampler
  - Electrical Conductivity Detector
  - 0.1 to 10,000 mSimens
  - Anion Columns with eluent suppression

Membrane Filtration
- Millipore
  - 300 ml capacity

Appendix B

Instrumentation and Equipment

Microscope
- Leitz Laborlux S
  - 100X to 1000X
- Swift Stero 80
  - 10X and 30X

Quebec Dark Field Colony Counter
- Reichert
  - 1.5X

Muffle Furnace
- Thermolyne F-B1415M
  - Ambient to 1037°C

Pan Balance
- Mettler PB602–S/FACT
  - 0 – 610 gms

Plasticware
- Nalgene

Refrigerator
- CMS Equatherm
  - 1°C to 8°C
- General Electric Company
  - 1°C to 8°C
- Kirkland
  - 1°C to 8°C

Spectrophotometer
- Hach DR/4000U
  - UV/Visible
  - 200 nm to 1000 nm

Steam Bath
- Precision Scientific
  - 20°C to 100°C

Thermometers
- ASTM and NBS Certified

Total Organic Carbon Analyzer
- Shimadzu TOC-VCSH w/ASI-V Autosampler

Turbidimeter
- Hach 2100N
  - ± 2% full scale
  - 0 - 4000 NTU

Water Bath
- CMS #B6885-12
  - 44.5°C ± 0.2°C

Appendix C

Sampling and Preservation

Mineral	Preservative	Bottle Type	Holding Time
Alkalinity	4°C	P or G	24 hours
Ammonia	4°C	P or G	24 hours
Boron	4°C	P or G	24 hours
Chloride	none	P or G	7 days
Fluoride	none	P or G	1 month
Hardness	4°C	P or G	7 days
MBAS	4°C	P or G	24 hours
Nitrate	4°C	P or G	48 hours
Phosphate	4°C	P or G	48 hours
Potassium	none	P or G	7 days
Silica	4°C	Plastic	7 days
Sodium	none	P or G	7 days
Sulfate	4°C	P or G	28 days
Physical Tests	none	Glass	2 days
Heavy Metals			
Aluminum	HNO_3	P or G	6 months
Antimony	HNO_3	P or G	6 months
Arsenic	HNO_3	P or G	6 months
Barium	HNO_3	P or G	6 months
Cadmium	HNO_3	P or G	6 months
Chromium	HNO_3	P or G	6 months
Copper	HNO_3	P or G	6 months
Iron	HNO_3	P or G	6 months
Lead	HNO_3	P or G	6 months
Manganese	HNO_3	P or G	6 months
Mercury	HNO_3	P or G	14 days
Selenium	HNO_3	P or G	6 months
Silver	HNO_3	P or G	6 months
Zinc	HNO_3	P or G	6 months
Organic Compounds			
VOC's Trihalomethanes	NaS_2O_3	Glass with Teflon lined septum	14 days
SOC's	4°C	Glass with Teflon lined septum	14 days

Appendix D

Laboratory Records

1) **Bacteriological Records:**
   - Bacteriological Worksheet
   - Completed Membrane Filter Worksheet
   - Filter Plant Coliform Worksheet
   - Membrane Filter Report
   - Heterotrophic Plate Count Report
   - Coliform Monitoring Summary Report

2) **Chemical Analysis Records:**
   - Laboratory Chemical Analysis Notebook
   - Chloramine Analysis Worksheet
   - Chloramine Analysis Report
   - Partial Mineral Analysis Worksheet
   - Partial Mineral Analysis Report
   - Complete Chemical analysis Report
   - Trihalomethane Worksheet
   - Trihalomethane Report
   - Trihalomethane Quarterly Report
   - Heavy Metal Analysis Report

3) **Physical Analysis Records:**
   - Physical Analysis Worksheet
   - Filter Plant Physical Analysis Worksheet
   - Water Quality Report
   - Filter Plant Physical Analysis Report
   - Daily Turbidity Report

4) **Quality Assurance Notebooks:**
   - Media Preparation
     - Media Preparation Records
     - Autoclave
   - Calibration Notebook
     - pH Meter
     - DI Water Check
     - Turbidimeter
     - Conductivity Check
   - Autoclave QA/QC
     - Bacti Bottle Sterilization Check
     - Min/Max Thermometer Check
     - Spore Sterilization Check
     - Quarterly Autoclave Timer Check
   - Thermometer Readings
     - Incubator Readings
     - Refrigerator Readings
     - Thermometer Calibration
   - Instrument Maintenance Logs
     - Atomic Absorption Spectrophotometer
     - Autoclave
     - Gas Chromatograph
     - Ion Chromatograph
     - Spectrophotometer
     - TOC Analyzer

- Titrant and Standard Preparation
  - Standard Preparation
  - Titrant Preparation
  - Analytical Balance Calibration
  - Turbidimeter Calibration

5) Sampling Inventory

- Sample Inventory

QUALITY ASSURANCE PROGRAM
SWEETWATER AUTHORITY
ROBERT A. PERDUE WATER TREATMENT PLANT

Appendix E

Chemical Methodolgy

Parameter	Reference page Standard Methods	EPA	Method Description
Minerals			
Alkalinity	2320 B		Bromocresol green
Ammonia	4500-NH3 F		Ion Selection
Bromide		300.0	Ion Chromatography
Calcium	3500-Ca-D		EDTA Titration
Chlorine Dioxide	4500-ClO2 D		DPD Method
Chlorine Dioxide	4500-ClO2 E		Amperometric Method
Chloride	4500-Cl-D	300.0	Argentometric/IC
Chlorate		300.1	Ion Chromatography
Chlorite	4500-ClO2 E		Amperometric Method
Chlorite		300.1	Ion Chromatography
Conductivity	2510B		Conductivity Cell
Fluoride	4500-F-C		Ion Selection
Magnesium	3500-MG E		Calculation
Nitrate		300.0	Ion Chromatography
Nitrite		300.0	Ion Chromatography
Phosphate	4500-P E	300.0	Abscorbic acid/IC
Sulfate		300.0	Ion Chromatography
Total Dissolved Solids	2540C		TDS at 180 deg C
Total Hardness	2340C		EDTA Titration
Total Organic Carbon	5310B		High-Temp Combustion
UV254	5910B		Ultraviolet Absorption
Heavy Metals			
Iron	3111-B		Flame AAS
Manganese	3111-B		Flame AAS
Organics			
Trihalomethanes		551.1	Liquid Extraction