.2 Coding Guidelines:

.1 Good programming practices are to be followed. The following guidelines apply to all languages and SCADA scripts:

.1 Each application shall be divided into logical segments (programs, subroutines, etc.) with a brief description describing the purpose of each segment within the code.
.2 Code shall be well structured including comments for each block of programming that describe the function of each block.
.3 Field and variable names shall be meaningful.
.4 Where possible, subroutines and/or defined functions will be used to reduce amount of code.

.2 The integrator shall provide sample code to the Engineer demonstrating the proposed documentation level for approval and use as a benchmark for all programming on the project. Suitable level of documentation shall be determined at the Engineer's sole discretion. These samples shall provide a benchmark to determine if adequate documentation has been provided.

.3 SCADA Scripts:

.1 Scripts shall be kept as short as possible by using functions and wizards provided by the SCADA Software Manufacturer wherever possible.

.2 When designing the application, every effort will be made to ensure the operator interface remains responsive to the operator at all times. The multi-threading nature of the operating system is to be taken advantage of to ensure that complex scripts do not interfere with the operator interface.

.3 All comment fields for scripts, tags, etc., shall be filled to clearly describe the function of the associated element.

.4 All system initialization/installation requirements and settings (for example, changes or additions to INI files, SYS files, operating system settings, application settings, driver settings) not set forth in the SCADA standards, and installed as part of the standard installation of the SCADA software, or included as part of the application in the application directory, shall be described as a comment in the application startup script AND in a README.DOC file in the application directory. The README.DOC file shall also clearly describe in

a step-by-step fashion exactly how to regenerate and install the control software and associated application.

.5 Primary SCADA control screens will not display device status for equipment that has no active I/O signal or is not actually monitored by a PLC. If the operators require a "peg board" to record operational changes to equipment not directly monitored, a separate screen will be provided for this purpose.

.3 PLC Programming:

.1 All PLC programs will be designed to be maintained by the Engineer's personnel. The following guidelines are provided to fulfil this goal.

.1 All PLCs are to be programmed using exclusively ladder logic.
.2 Program structure will be designed to enhance ease of maintenance. Some tools to accomplish this include: subroutines, grouping of control logic for a subsystem into blocks, control I/O from one rung only, minimizing the use of latched outputs.
.3 The operation of the system must be subdivided into a series of simple steps. The conditions for the transition from one step to another must be clearly defined. The active steps at any time must be readily identifiable.
.4 Temporary coils and indirect referencing shall not be used.
.5 The program shall not make repeated use of the same register for more than one function.
.6 Each device output must be programmed only once in the program.
.7 Each device having more than one input and/or output point must have an alarm status bit that will detect any inconsistent combination of inputs and/or outputs. If the alarm status bit remains on in excess of the alarm-preset time, a device alarm will be triggered. Each device will have its own timer.

.8 All runtimes and totalizers are to be programmed into the PLC such that shutting down the SCADA software does not result in any data loss.
.9 All discrete control actions shall be performed by direct binary setting of bits. For example, setting M001 starts the device while setting M002 stops the device. The PLC resets the coil as soon as the action is performed. M001 is not used to both start and stop the device.

.10 All setpoint control limits from the SCADA to the PLC will use separate registers for writing and reading to confirm that the values have been received and acted upon by the PLC.

.2 Ladder Logic:

.1 Program documentation will include rung comments and address comments.

.2 Output rungs are to be organized with enabling conditions grouped at the beginning of the rung followed by any interlock conditions that inhibit the output.

.3 Where an output rung is dependent on inputs and/or outputs from another rack, the rung must include interlocks for "Rack Running" for each of the remote racks.

.4 Independent valve (or similar control device) status open and close inputs will be examined to determine if: Open, Closed or In Transition.

.5 Independent Hand, Off, and Auto inputs will be examined for all selector switches to determine status.

.6 Jump and master control relay instructions shall be used sparingly.

.7 All mathematical functions shall be programmed using floating point math and fully scaled values.

.4 Naming Convention:

.1 The SCADA & PLC tagnames are structured as an assembly of character fragments in such a fashion as to ensure the tags are as readable (i.e., understandable by an operator) as possible. The tagnames are 28 characters long.

.2 The detail breakdown and components of the tagname will be provided to the Contractor during construction by the Engineer.

.3 The System Integrator will update the "Points List" for each PLC in Section 13200 with respective tagnames.

.5 Database:

.1 Stored procedures shall be developed to compile daily and monthly summary information in standard database tables. The tables shall include equipment runtimes, chemical usage summary, water summary and flow summary. Daily summary information is to be compiled at 12.01 a.m. each day. Monthly summary information is to be compiled at 12:01 a.m. the first day of each month.

.6 Data Historian:

.1 The SCADA software vendor's data-logger software shall be used to log the data to the database.

.2 Individuals with Manager/Supervisor or Developer/Systems Integrator security clearance shall be able to disable the logging of data on a point by point by changing a single data point in the SCADA software logic. A graphic screen shall indicate which trends are currently being logged and which have been disabled.

.3 In addition to logging of historical trend data, the system shall also log status information event trends for generation of reports as specified by the Engineer (include runtimes, No. of starts and stops, specified alarm occurrences, laboratory results, and any other information required).

.4 The database shall recognize and accommodate gaps in the database caused by the entire system, or portions thereof, being down due to power failure or system maintenance, by indicating the data is not available. However, the missing data shall in no way restrict access to data preceding the gap and following the gap.

.5 In addition to the previously described data, operators shall be able to enter log entries onto the system. The system shall allow operators to enter comments of up to five lines of 80 characters each (total of 400 characters per entry) and shall automatically time stamp the entry with the operator name, time and date of the entry.

.6 The operators shall be able to scroll through all log entries stored on the system from within the SCADA package and have the database perform a search for the occurrence of an operator specified string of characters in the historical log entries.

.7 Full security measures shall be implemented in order to ensure data integrity. Only individuals with Manager/Supervisor or Developer/Systems Integrator security clearance shall be able to modify the data in the historical database. Irrespective of who performs the modification, a detailed secured audit trail shall be maintained.

.8 The database historian shall provide for the storage of a minimum of 5 years' worth of data online at all times.

.7 Reports:

.1 The data, once stored by the database server, shall be accessible by the report generators that will be used as the report generation front end.

.2 The system shall be configured to allow supervisory staff to perform ad-hoc enquiries of the historical data simply by entering the necessary parameters into a predefined template.

.3 Templates shall be developed by the System Integrator that allows operators to enter laboratory test data into the database in such a manner that it is immediately accessible by all other nodes on the network. These templates shall allow for the entry of all laboratory results specified by the Engineer in consultation with the Systems Integrator.

.4 Templates shall be provided to automate the generation of the following reports:

.1 daily summary
.2 monthly summary
.3 annual summary
.4 monthly equipment runtime
.5 annual equipment runtime
.6 monthly chemical usage
.7 annual chemical usage
.8 monthly operational
.9 annual operations
.10 analytical summary
.11 MOE compliance reports.

PART 3 - EXECUTION

3.1 General Instructions

.1 The Programming Integrator must own a licensed version of the MMI and SCADA development software.

.2 PLC software development is to be done using the Siemens Simatic Industrial software.

.3 The Contractor will provide the System Integrator with all required software packages detailed in Section 13200.

.4 The Programming Integrator will load all PLC, operator interface panel and computer software onto their respective platforms at site.

3.2 Programming

.1 The System Integrator shall program the PLCs and the SCADA system as outlined in the previous section and the Process Logic Description (PLD) at the end of this section.

.2 The System Integrator shall flow chart the PLC logic and interaction of the SCADA System as per the PLD.

.3 The System Integrator will be responsible for keeping the "Points List" and the PLD up to date with all changes during the project construction. The final version will be part of the final documentation.

3.3 Testing

.1 Factory Acceptance Testing (FAT):

.1 This is the final stage of testing and is used by the Engineer to verify that all project requirements have been addressed and that the system is ready for installation.

.2 The Factory Acceptance Test (FAT) will be conducted at the Systems Integrator's site. This test will cover all functionality and performance requirements as defined in the functional specifications.

.3 At least two weeks prior to the Factory Acceptance Test, the Systems Integrator will submit a FAT document for the Engineer's approval that outlines a testing methodology and provides a complete check list of all functionality to be tested.

.4 As insufficient real data will be available at time of the FAT to evaluate database performance using real data, a simulated database of approximately the same size as is ultimately anticipated shall be generated.

.5 The FAT tests shall include, but not necessarily be limited to:

.1 Processing discrete and analog field inputs (triggering of alarms, status update and event logging).

.2 Field setpoint change requests at an Operator Interface Node, Programmable Logic Controller confirmation and Operator Interface Node display update.

.3 Failure and recovery of the SCADA operator interface.

.4 Failure and recovery of each PLC.

.5 Generation and examination of the historical database.

.6 Interactive ad-hoc report generation using reporting tools

.7 Complete system shutdown and startup

.8 Simulated power failure

.9 System backup to the tape backup device and system recovery from tape.

.10 Security support, including automatic node time-out and operator log-in.

.11 Creation and utilization of virtual discrete and analog points in the database.

.12 Creation and linking of a new device on a display screen.

.13 Database response times for accessing historical data.

.6 During the Factory Acceptance Test, all deficiencies will be noted and classified as critical or non-critical by the Engineer. All critical deficiencies must be resolved before the Engineer will approve installation.

.2 Site Performance Test:

.1 This test will be conducted on site after completion of installation of all PLC equipment.

.2 At least two weeks prior to the test, the Systems Integrator will submit a test procedure document to the Engineer for approval that outlines a testing methodology and provides a complete checklist of functionality to be tested.

.3 The tests shall include, but not necessarily be limited to:

.1 Verification of communication between the SCADA computer and all devices on the PLC DH+LAN.

.2 Verification of successful reads and writes of all PLC digital inputs and outputs by the SCADA computer by simulating I/O at the PLCs.

.3 Verification of operation of all computers and printers, including remote communication via the laptop computer.

.4 The Contractor is to coordinate testing and ensure the Instrumentation and Programming trades are on site at the same time to execute the testing procedures. Requirements are detailed in Section 13200, Clause 3.4, Pre-Commissioning, Testing and Inspection.

.4 During the Site Performance Test, all deficiencies will be noted and must be resolved before the Engineer will approve installation of the system application software.

3.4 Commissioning

.1 The Systems Integrator shall draft a commissioning plan that will

include a proposed schedule and detailed description of each proposed test procedure.

.1 Each description shall depict the purpose of the procedure, a step by step outline, the proposed method for evaluating the results, and check lists for sign off.

.2 A simulated database, of approximately the same size as is ultimately anticipated, shall be generated to evaluate database performance since insufficient real data will be available at time of commissioning.

.3 The commissioning tests shall include, but not necessarily be limited to:

.1 Processing discrete and analog field inputs (triggering of alarms, status update and event logging).

.2 Field setpoint change requests at an Operator Interface Node, Programmable Logic Controller confirmation and Operator Interface Node display update.

.3 Failure and recovery of the SCADA operator interface.

.4 Failure and recovery of each PLC.

.5 Generation and examination of the historical database.

.6 Interactive ad-hoc report generation using templates developed by the integrator.

.7 Interactive ad-hoc report generation using reporting tools.

.8 Compete system shutdown and start-up.

.9 Simulated power failure.

.10 System back-up to the tape back-up device and system recovery from tape.

.11 Local Real-time configuration modifications.

.12 Real-time configuration modification via dial-in phone connection.

.13 Security support including automatic node time-out and operator log-in.

.14 Creation and utilization of virtual discrete and analog points in the database.

.15 Creation and linking of a new device using a wizard developed by the integrator for the project on a display screen.

.16 Database response times for accessing historical data.

.4 All tests shall be performed with the system under full load, with all functionality described in the design documents fully implemented and operational.

.5 The commissioning shall include 100% verification of all logic in the controller, remote telemetry, data transfer between the operator interface and the controller, all logic within the operator interface configuration, all information displayed on the graphic screens, all trends, all historical data, all database interfaces and all alarms.

.6 All testing shall be witnessed and each test and verification procedure shall be individually signed off by the Engineer.

3.5 Training

.1 General Requirements:

.1 Course outline shall be provided to the Engineer not less than four weeks prior to the date of each course. All reasonable modifications to the course outlines requested by the Engineer shall be incorporated.

.2 Following completion of the preliminary testing and after correction of deficiencies, the equipment will be made available for training. All simulation software, hardware and techniques used by the Systems Integrator to develop the system will be provided to the Operating Staff for training purposes during installation.

.3 After training, the Operating Staff will be cable of operating the system effectively and safely and will be able to maintain all equipment and other components. The training shall be complete and thorough so that the trained nucleus can pass the knowledge and technology to other personnel.

.2 Systems Administrator Training:

.1 This course will assume that students are computer literate with a firm understanding of PC based hardware, software and operating systems.

.2 The course at a minimum will address the following issues relating to the system:

.1 Initialization and configuration
.2 System management
.3 System modifications
.4 Problem identification and resolution
.5 System troubleshooting
.6 Modification and generation of custom reports.

.3 Operational Training:

.1 Operator training will use the process simulation model to allow staff to be trained on the actual control system. Training will be scheduled just prior to implementation and repeated immediately

following installation to maximize knowledge retention. An operator quick reference guide on the operation of all component software, including explanations of all programmed features pertaining to the operators, shall be provided.

.2 This training will be provided to Operation Staff that includes line supervisors, operational trainers and employees responsible for the day-to-day operation of the system. The training must include, but not be limited to:

.1 Basic operation and control of the system.
.2 Changes to safety and emergency procedures.
.3 Operation of Console Operator terminals.
.4 Operation of other terminals.
.5 New functions and capabilities
.6 Fault handling and problem diagnostics
.7 Productivity analysis
.8 Report generation.

.3 A refresher course shall be conducted about 3 months after commissioning to refresh earlier training and to address questions and concerns.

3.6 Post-Commissioning Review

.1 Six months following commissioning, the Systems Integrator shall return to the site for a minimum period of ten (10) days on a 24-hour basis at the Contractor's expense, to address any outstanding issues and co-ordinate any revisions into the system identified by the Engineer.

1.0 GENERAL

1.1 Work Included

.1 Supply, unloading, installation, and commissioning of the package water treatment plant.

1.2 Related Work

.1	Process Description:	Section 13010
.2	Process Piping:	Section 13100
.3	Chemical Feed System:	Section 13680
.4	Identification:	Section 13910

1.3 Submissions

.1 Shop Drawings: Submit in accordance with Section 01300.

.2 Operating and Maintenance manuals: Provide as specified in Section 01730. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

1.4 Storage

.1 Identify special storage requirements.

1.5 Coordination

.1 Coordinate with other divisions to ensure there are no conflicts in the work.

1.6 Standard of Acceptance

.1 US Filter GAC Package Plant and ancillaries as specified in this section.

2.0 PRODUCTS

2.1 Description

.1 The water treatment plant shall consist of a packaged multimedia plant suitable for treating the raw water. The unit shall be capable of producing up to 300 l/min, with a normal operating rate of 200 l/m. The package plant will have a duel train, each capable of the above rates of treated water, meeting all quality requirements listed in the Health Canada document *Guidelines for Canadian Drinking water Quality* (Sixth edition, 1996).

.2 The plant shall be capable of producing treated water of the specified flow and quality when operating with raw water having a temperature of between 0.1 degrees C and 20 degrees C.

.3 The equipment shall be at least the equivalent of the GAC, Dual train each having 2.62 square meters of bed area, system as US Filter Corporation. The following items shall be incorporated:

.1 GAC including tankage stainless steel pipework, valves and actuators, raw water flow control, filtrate flowmeter, pressure transmitter, and steel frame. Electrical components to comply with CSA, NEC, and NEMA 4 specifications.

.2 Filter media to be as described on the data sheet

.3 Backwash supply system, including duplex air compressor, air receiver and coalescer/filter.

.4 All electrical controls required for fully automatic operations, including control panel. Allen-Bradley PLC, Panel view operator interface and modem for remote operation, monitoring and programming of the PLC.

.5 All custom tools required for operation and maintenance of the equipment.

.6 Six copies of the operation and maintenance manuals

.4 Plant functions shall be automated with the exception of the setting of plant flow rate. Manual override shall be provided to all automatic controls.

2.2 Raw Water

.1 Raw water will be provided to the plant inlet at a maximum head of 5 m.

2.3 Plant Construction

.1 The plant shall be supplied as a packaged unit, factory assembled and requiring the minimum on on-site assembly to achieve fully functional operation.

.2 The plant shall be generally of the size and shape shown on the drawings.

3.0 EXECUTION

3.1 Installation

.1 The plant shall be installed in accordance with the manufacturer's written recommendations.

.2 All work shall be carried out in accordance with applicable federal, territorial and AWWA standards and regulations.

.3 Welding, pipefitting and electrical assembly shall be performed by qualified, certified tradesmen.

3.2 Manufacturer's Representative

.1 The treatment plant manufacturer's representafive shall provide for an initial trip of at least five day's duration on site for start-up and operator training at no extra cost to the Owner.

.2 The representative shall inspect the plant and certify in writing that it has been installed in accordance with the manufacturer's recommendations.

.3 A second trip of at least three days' duration on site shall be made two months after commissioning, at no extra cost to the Owner, to review plant operation and remedy and deficient operating practices.

END OF SECTION

1.0 GENERAL

1.1 Work Included

.1 Complete chemical feed systems for the dosing of sodium hypochlorite. The systems shall include all miscellaneous items required for complete and functional operation.

1.2 Related Work

.1	Processing Piping:	Section 13100
.2	Process Valves:	Section 13110
.3	Process Piping:	Section 13100
.4	Electrical:	Division 16

2.0 MATERIALS

2.1 Chemical Metering Pumps

.1 Pumps shall be suitable for metering the relevant chemical solution. Pumps shall be of the solenoid-driven diaphragm type with manually adjustable stroke length and manually adjustable stroke frequency.

.2 Pump motors shall be TEFC. 120 V 1 ph 60 Hz, suitable for continuous operation. A 2 m long power shall be provided with each metering pump.

.3 Each pump shall be provided complete with backpressure valve, pressure relief valve and suction strainer/foot valve.

.4 CMP-1 and CMP-2: Rated capacity 5.3 L/h at 8090 Pa. Pumps to be supplied mounted on a single FRP support stand, pre-plumbed and valved to allow common or dual suction and discharge line configuration. Suction piping: flexible PVC to allow feeding directly from hypochlorite drum. Discharge piping: 12 mm PVC. Standard of acceptance: Prominent Gamma 4b 0806NP2000D20000 metering pump with 810164.4 mounting bracket and 0806 NP2 spare parts kit.

3.0 EXECUTION

3.1 Installation

.1 Install the equipment in accordance with the manufacturer's specifications and recommendations, and generally as shown on the drawings.

3.2 Piping

.1 Make necessary piping connections to the point of dosing as directed on the drawings.

3.3 Testing

.1 Ensure the equipment, including all component parts, operates as designed.

END OF SECTION

1.0 GENERAL

1.1 Work Included

.1 Supply of laboratory equipment.

2.0 MATERIALS

.1 Laboratory equipment as listed in the following table.

Item	Qty	Description	Hach Catalog No.
1	1	Hach DR890 portable colorimeter	48470-00
2	1	Hach DR890 hard-sided case	49425-00
3	1	Spare cells for DR890 (6-pack)	24019-06
4	1	Hach 2100P portable turbidmeter	46500-00
5	1	Beakers, polypropylene, 100ml (12-pack)	1080-72
6	1	Beakers, polypropylene, 250ml (6-pack)	1080-76
7	1	Beakers, polypropylene, 1000ml (3-pack)	1080-83
8	2	Graduated cylinder, 100ml	1081-42
9	2	Graduated cylinder 500ml	1081-49
10	2	Graduated cylinder, 1000ml	1081-53
11	2	Wash bottle, polypropylene, 500ml	620-11
12	2	Thermometer with nylon case, -5 to 45?C	26763-00
13	20	Dynalon HDPE sample bottles	D00022
14	1	Hach Ferro Ver iron reagents (100)	21067-69
15	1	Hach LR manganese reagents (1000)	22433-00
16	5	Hach total chlorine reagents (100)	21055-69
17	5	Hach Free chlorine reagents (100)	21056-69

3.0 EXECUTION

3.1 Storage and delivery

.1 Store the equipment in a dry, clean, heated environment until delivered to the Owner.

END OF SECTION

1.0 GENERAL

1.1 Work Included

.1 Identification of equipment, motors, vessels, valves, ferrous, non-ferrous and insulated piping.

1.2 Related Work

.1 Field Applied Protective and Maintenance Coatings Section 13900

2.0 PRODUCTS

2.1 Equipment Manufacturer's Nameplates

.1 Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Provide Underwriters' Laboratories and/or CSA registration plates, as required by respective agency.

.3 Manufacturer's nameplates to indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

2.2 Equipment - Project Identification

.1 Supply and install black lamacoid identification plates for all equipment installed under this contract. The identification shall consist of the unit name and equipment number in 12 mm high lettering and electrical characteristics, if applicable, in 6 mm high lettering.

.2 Example:

Raw Water Pump	- 12 mm lettering
RWP-11	- 12 mm lettering
115V/1 ph/60 Hz	- 6 mm lettering
Circuits MCC#, #, #	- 6 mm lettering

.3 Submit list of plates for review prior to engraving.

2.3 Valves

.1 Provide all valves with a 32 mm diameter brass tag with 12 mm black engraved numbers complete with non-ferrous chains.

.2 Consecutively number valves in distinct systems in accordance with the process schematic drawings.

.3 Furnish a directory consisting of a typewritten valve list showing the tag number, the location of the valve and its use. The directory may be made up in sections to suit the respective plant area or system.

.4 Mount one copy of these lists in glazed frames as directed by the Engineer. Provide lists in the operating and maintenance manual.

2.4 Piping

.1 All piping installed under this Contract shall be identified with pipe markers designating the pipe service and the direction of flow.

.2 Pipe markers may be self-adhesive, plastic coated cloth labels provided that each marker is secured, in addition to its adhesive, with a full tape band at each end of the label.

.3 Direction arrows are to be 150 mm long by 50 mm wide for piping with an outer diameter 75 mm or larger, including insulation. Use 100mm long by 20 mm wide for smaller diameters. Provide double headed arrows where appropriate.

.4 Block capital letters are to be used for names, 50 mm high for piping with an outer diameter 75 mm or larger, including insulation. Use 20 mm high for smaller diameters. Pipe fluid codes shall be sued as detailed on the drawings.

.5 Use plastic marker tags for pipes and tubing with an outer diameter 20 mm and smaller.

2.5 Colour Coding

.1 Colour coded system identification shall be carried out on the following items:

.1 All piping and valves.

.2 All pumps - pumps shall be coated the colour identifying the material being pumped.

.3 All motors - all motors shall be painted grey.

.2 Identification shall consist of the following:

.1 Full coating of pipes and valves to the colour of the medium being conveyed.

.2 Non-submerged process equipment shall be coated to match the colour requirement of the material being processed.

.3 Valve handles, chain wheels, and similar appurtenances shall be black.

.3 Identification colours shall be in accordance with the following schedule. The code numbers are as defined in CGSB 1-GP-12C

1.0 GENERAL

1.1 Work Included

.1 Disinfection of water retaining structures and piping.

1.2 Related Work

.1 General Process Provisions: Section 13001

1.3 Related Codes

.1 AWWA C651-99 Disinfecting Water Mains

.2 AWWA C652-02 Disinfection of Water Storage Facilities

.3 AWWA C653-97 Disinfection of Water Treatment Plants

1.4 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

1.5 Schedule of Items to be Disinfected

.1 The Contractor shall disinfect all items which will be used for the conveyance or storage of potable water; these include but are not limited to the following structures and piping:

.1 All pipework conveying potable water, including but not necessarily limited to:

.1 Transfer piping to and from treated water reservoir

.2 Treated water reservoir

.3 Suction piping to all pumps

.4 Discharge pipework from truck fill pumps

.5 Plant service water lines

1.6 Entry Into Existing Structures

.1 Where work is undertaken within existing structures or piping used for the storage or conveyance of potable water, they shall be disinfected prior to being put back into service.

2.0 MATERIALS

2.1 Water

.1 Water for disinfection shall be provided by the Contractor. The water shall be free from all suspended and deleterious material.

2.2 Hypochlorite

.1 Hypochlorite shall comply with AWWA B-300.

3.0 EXECUTION

3.1 Applicable Standards

.1 Except as otherwise specified, the work shall be undertaken in accordance with the following codes:

.1 AWWA C651-99 Disinfecting Water Mains

.2 AWWA C652-02 Disinfection of Water Storage Facilities

.3 AWWA C653-97 Disinfection of Water Treatment Plants

3.2 Cleaning

.1 All tanks and pipework to be disinfected shall be thoroughly cleaned prior to disinfection.

.2 All construction material not part of the permanent structure shall be removed.

.3 The surfaces of walls, floor and roof of structures shall be cleaned using a high pressure jet, sweeping, scrubbing or equally effective means.

.4 Pipes shall be flushed to remove all dirt prior to disinfection. If necessary, the pipe shall be cleaned by swabbing or other mechanical means as directed by the Engineer.

3.3 Disinfection of Piping

.1 Pipework shall be disinfected by adding a chlorine compound to the filling water during the pipe pressure test to produce an initial even concentration of at least 25 mg/L of free clorine. The pipes shall be left full of chlorinous water for 24 hours and the free chlorine residual after 24 hours shall not be less than 10 mg/L.

.2 If the chlorine residual is less than 10 mg/L after 24 hours, the main shall be flushed and the procedure repeated.

3.4 Disinfection of Structures

.1 Structures and tanks shall be disinfected by either of the following two methods:

.1 The structure or tank shall be filled to the overflow level with water, with an initial even concentration of at least 25 mg/L of free chlorine. After 24 hours the free residual shall be at least 10 mg/L; if not, the procedure shall be repeated.

.2 A solution of 200 mg/L available chlorine shall be applied directly to the surfaces of all parts of the tank or structure including the underside of the roof. The solution shall be applied by suitable brushes or spray equipment, and shall