SECTION XIII QUALITYASSURANCE AND QUALITY CONTROL

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A. Introduction

Control of the quality of an onsite wastewater renovation system (OWRS) project begins with the investigations to determine project requirements and site, soil, and ground water conditions. It is not completed until the work of the contractor(s) is completed, all tests are satisfactorily completed, all of the construction work has been finally approved by the engineer(s) responsible for design and construction services and accepted by the Owner, and any contractor and manufacturer guarantee periods have expired. Previous sections of this document have dealt with investigations for determining requirements for and design of various components of an OWRS. This section addresses some of the general considerations that must be given to the overall design of the OWRS facilities and to assuring that the OWRS facilities are constructed in accordance with construction documents (drawings and technical specifications) approved by the Department and will operate as intended.

The quality of construction will depend to a great extent upon the qualifications and experience of the contractor(s) selected to construct the OWRS facilities; equally important, however, is the quality of the construction documents. If these documents are not clear, complete, concise and correct, the contractor(s) will not have the guidance they require to arrive at the quality desired for the completed project. The contractor(s) should not have to guess at the intent of the project designers; it should be clearly and unambiguously set forth in the construction documents. Almost inevitably however, while perfection is sought it is rarely attained and conflicts and omissions will occur despite all the skill, experience, and good faith effort of those that have prepared and reviewed these documents. When such conflicts and omissions arise, they should be rectified promptly and in a decisive manner, so as to leave no doubt as to what is required.

Construction drawings and technical specifications are supportive of each other; carefully prepared drawings will not eliminate the problems that will most certainly arise where equal care has not been paid to the preparation of the written specifications. Good communication with the contractor(s) regarding the project requirements depends upon having complete and fully coordinated construction documents.

B. General Design Considerations.

Design considerations for basic and enhanced pretreatment facilities and subsurface wastewater absorption systems have been presented in previous sections of this document. There are additional considerations that must be given with respect to providing the quality of facilities required for satisfactory long-term service. Some of these considerations are discussed below; however, the designer should consider all aspects of the operation, maintenance, monitoring and security of such facilities.

Aboveground facilities should be designed to present a neat appearance that will engender confidence in the ability of such facilities to carry out their functions. A sloppy appearance will tend to convey to observers a sense of careless operation and maintenance, regardless of how well the O&M is performed. It may also cause a lackadaisical approach to O & M by the operator.

Attractive and functional enclosures for equipment and controls, where not a part of another structure meeting building code requirements, can be obtained as small prefabricated, transportable enclosures, or prefabricated, field-erected enclosures. They can also be constructed on-site using basic building materials. The external surfaces of such enclosures should be clad with long-lasting materials requiring minimum maintenance.

These enclosures should be provided with adequate provisions for heating, ventilation and lighting. The enclosures should be made as vandal-proof as possible. In addition to secure access-ways, any windows should be small enough and high enough above surrounding finished grades to prevent unauthorized entrance and should face in the direction of occupied buildings. The enclosures should conform to the various codes applicable (e.g.: National Electric Code, State and local building and plumbing codes, NFPA recommendations). The enclosures housing equipment and controls should be insulated. All insulation should be covered by rigid, durable wall and ceiling materials that are suitable for washdown or other cleaning methods. The interior walls and ceilings should be coated with materials that will permit ease of cleaning and will protect their surfaces from dampness resulting from cleaning processes or other causes.

A neat and logical placement of equipment and associated piping and electrical conduit within enclosures housing such facilities should also be provided. The facilities and equipment within such enclosures should be laid out in such a manner as to provide for easy access for servicing equipment, delivery of chemicals, pumping of tanks, etc. Adequate space should be provided around electrical control panels as required by the National Electrical Code and protective rubber mats provided wherever a person may stand while operating or maintaining such panels. Spill prevention facilities should be provided in all areas dedicated to storage and feeding of chemicals.

Exposed piping and conduit should run parallel or perpendicular to walls wherever possible. Flexible connectors should be provided between rigid electrical conduit and electrically operated equipment. Air breaks and reduced pressure backflow prevention devices should be provided between potable and non-potable water lines in conformance with the requirements of the Connecticut Department of Public Health. Hose bibs for wash down of structures and equipment should be provided, fed from sources downstream of backflow prevention devices. All exposed piping, conduit, and equipment should be coated with suitable materials that will provide long-lasting corrosion resistance.

The ability to monitor the operations of the various facilities of an OWRS at a remote location during periods when the operator is not present on-site is vital to successful operation of such facilities. Provisions for monitoring and control of pretreatment processes are discussed in subsection N of Section XI of this document and provisions for monitoring pump chambers are discussed in subsection H of Section XII. Facilities for transmitting alarm signals to remote locations for remote monitoring of alarm conditions should be provided. This can be accomplished using a telephone dialing alarm monitor or by more sophisticated radio transmitting alarm equipment. The dialing alarm monitor system has proven to be reliable and robust and is a cost-effect method for monitoring alarms.

Radio alarm transmission equipment is useful, and may be required in certain instances, for sending alarms to central monitoring agencies. Radio alarm transmission equipment has the advantage of not being affected by telephone line outage conditions, and provides essentially the same alarm functions as a telephone dialing alarm monitor.

The purpose of a dialing alarm monitor is to monitor the status of alarms and report any alarm to persons assigned to respond to system malfunctions. When the alarm system for the OWRS facilities detects a fault, a signal is sent to the dialing alarm monitor. The monitor will then begin to place a series of telephone calls, dialing in succession a number of pre-programmed telephone numbers until a number is answered and the alarm message is delivered. Once acknowledged by the receiving party, the system enters a programmable inter-call delay to allow the alarm condition to be corrected before dialing the next telephone number. Communications are transmitted via a standard telephone line dedicated to the dialing alarm monitor.

The dialing alarm monitor should include provisions for voice message recording and an internal speakerphone that will allow authorized personnel to call from a remote location to determine any alarm conditions. A self-contained rechargeable battery power backup supply should be incorporated in the monitor. The memory containing the voice messages and telephone numbers should be sustained regardless of power, battery backup condition or transient conditions that may be experienced by the dialing alarm monitor.

Security fencing should be provided around all aboveground structures and equipment. Where security fencing is not provided, provisions should be made for locking all access hatches and securing manhole covers. Ground water monitoring well access covers should be of a type that can be secured against vandalism.

C. Construction Drawings

The construction drawings depict the dimensions, assembly and relationships of materials and equipment that comprise the OWRS facilities and provide some basic notes and instructions that are best shown on a graphic presentation of the proposed facilities. The drawings should be prepared to appropriate scales that will provide a clear representation of the work involved. In addition to the numerical scales shown, it is good practice to provide a graphic scale on each drawing to provide for situations where the drawings may be printed in reduced size for convenience in the field. All dimensions and elevations should be positioned in conspicuous locations where they will not be obscured by the line work of the drawings. All notes should be concise; where extensive written instructions are required, they should be contained in the technical specifications and the location of these instructions referenced on the drawings.

All drawings should show the date of preparation and the dates of any revisions made to the original drawings. Any revisions should be clearly flagged so as to draw attention to the revisions. A set of construction drawings for OWRS systems should include:

- A Location Plan, clearly showing where the construction project is located. This plan is often included on a title sheet drawing, if included, or on the Site Plan.

- A Site Plan, showing existing and proposed aboveground and underground facilities (including storm drainage, potable water supply, electrical and communication conduits and public utility facilities), existing and proposed contours, and the locations where subsurface investigations were made.
- A Site Layout Plan, showing the horizontal relationship between all proposed structures, piping, electrical, communication and other public utility facilities.
- A detailed Layout Plan of the subsurface wastewater absorption system (SWAS) if the layout cannot clearly be shown on the Site Plan.
- A Process Flow Schematic and Hydraulic Profile.
- Detail Sheets for all proposed structural, mechanical, electrical, communication and piping facilities.
- Elevation Views and Cross-Sections of SWAS
- Detail Sheets for SWAS facilities.
- A Floor Plan of enclosures housing proposed aboveground facilities, showing the relationship between all facilities housed in such structures or rooms.
- Elevation views and sections through enclosures housing proposed aboveground facilities.

Checking of the drawings should be done by persons who are not tasked with their preparation. Any corrections proposed by the checker should be back-checked by the person who prepared the original drawing. Care should be taken to only show dimensions and elevations once, to avoid conflicts that may occur due to changes in dimensions or elevations during the final design process. Such conflicts arise when the corrections are made on one drawing but are not carried over to other drawings that may also contain the same dimensions or elevations.

D. Technical Specifications

Technical specifications should spell out in a clear and concise manner:

- Quality assurance (QA) and quality control (QC) requirements for the work.
- Guarantees required of manufacturers and the contractors.
- Materials and products to be incorporated in the work.
- Requirements for execution of the work, including testing of the completed work.

Construction industry standards for preparation of written technical specifications are available and should be followed whenever possible. One source of such standards is the Construction Specification Institute MasterFormat™ (CSI -1995) developed jointly by CSI and Construction Specifications Canada (CSC) and used throughout North America.

Based on the results of conferences attended by representatives from all sectors of the construction industry in the early 1960s, CSI/CSC developed a 16-division format for technical specifications that has received widespread acceptance as a standard in the construction industry. The 16-division format established broad categories of construction information so that specification sections of a similar nature could be grouped together.

In the 16-division format, specifications in each division are subdivided into a number of sections, each covering one portion of the total work or requirements. CSI/CSC have published a master list of titles and numbers for construction industry technical specifications, with the latest revision being published in 1995. CSI/CSC have also published a number of "master" standard specifications, available in hard copy or electronic format, arranged for ease of editing to adapt them to the specific needs of a particular project.

In 2001, CSI/CSC undertook a complete review of their standard format and it is anticipated that a completely new MasterFormat™ was scheduled to be published in late 2004 that addresses past concerns of the construction industry as well as new technologies. The new MasterFormat will have a much larger number of divisions, with some of the new divisions addressing specific needs of civil and environmental engineers. Only those divisions and sections applicable to a project need to be included in the project specifications. Each division may include a number of individual technical specification sections.

In the CSI format for technical specifications, each specification is comprised of the following three parts:

Part I. General:	Defines the specific administrative and procedural requirements unique to each section.
Part II. Products:	Describes, in detail, the quality of items that are required for incorporation into the project under each section.
Part III. Execution:	Describes, in concise detail, preparatory actions and how the products are to be incorporated into the project.

E. Quality Assurance and Quality Control

General requirements for the contractor's quality assurance (QA) and quality control (QC) procedures for products and workmanship are covered in Division 1, to be re-designated as Division 01 in the proposed new format. QA and QC requirements in Division 1 can be given in a single "broad scope" specification or in several "narrow scope" sections. These quality control requirements may include:

- Testing Laboratory Services
- Inspection Services
- Field Samples
- Mock-ups (usually for architectural components only)
- Contractor's Quality Control Procedures
- Manufacturer's Field Services

QA and QC are also addressed in the individual specification sections. An article on QA is usually provided in Part I of each specification section. Specific QC requirements for the contractor(s) are given in the various articles in Part III of each specification section, which may also include a special article on Field Quality Control.

In Part I of each technical specification section, quality assurance requirements may include such items as:

- Prerequisites, standards, limitations and criteria that establish an overall level of quality for products and workmanship.

  These should include qualifications for manufacturers, fabricators, welders, installers and applicators of products and completed works.

- Regulatory Requirements

  These should include obligations for compliance with specific code requirements and requirements of public authorities having jurisdiction.

- Certifications

  These should include requirements for submitting statements to certify compliance with certain requirements.

- Submission of Samples
- Pre-Installation Conference

  This conference should coordinate materials and techniques and sequence related work for sensitive and complex items.

Quality depends upon the design of a product, the materials used in a product, and the quality of workmanship employed in manufacturing and installing the product. Wherever possible, the specifications should refer to applicable codes and standards, and workmanship recommendations of trade associations, all of which should be clearly identified as to origin and subject matter. It is common practice to list the codes, standards, etc. under “References” in Part I of each specification section. A listing of sources of construction codes, standards and similar information is given in the CSI publication “A Directory of Construction Industry Associations, Societies, and Institutes”.

For proof of quality, materials and products should be tested according to applicable standards and the manufacturer should provide certification of such tests to the contractor(s) who should forward them to the Owner’s duly authorized representative for approval. Certified records of physical, chemical and other pertinent tests, and/or certified statements from the manufacturer that the materials have been manufactured and tested in conformity with the specifications can be accepted for pipe, cement, steel reinforcement, paint and similar materials that are normally tested in the shop by the manufacturer.

Where such a small quantity of material is required as to make physical tests or chemical analyses impractical, a certificate from the manufacturer stating the results of such tests or analyses on similar materials concurrently produced may be considered as the basis for the acceptance of such materials. Each manufacturer’s or supplier’s certificate should be endorsed or accompanied by the Contractor’s certificate that the material certified by the manufacturer or supplier will be the material incorporated in the work.

Quality of workmanship includes both fabrication of the products and application or installation of the products. Examples of requirements addressing fabrication of a product are:

- The design and fabrication of the product should conform to industry standard practices for the type of product involved.
- All materials and equipment incorporated into the product should be new and of a quality conforming to industry standards for industrial material and equipment.
- The product is to be fabricated by reputable firms that are experienced in the design, production and operation of such products, and only skilled craftsmen should be employed in the fabrication processes.
- The product should be of heavy duty, industrial grade, designed for a long life of trouble free operation in the environment in which it will operate.
- All parts should be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially adapted for the services they will provide.

Information on the materials and design of each product should be provided in shop drawings and technical specifications submitted to the contractor by the manufacturer of each material and product. The contractor in turn should be required to check the manufacturer's shop drawings and technical specifications to determine if they conform to the requirements of the construction contract documents before submitting them to the Applicant's Engineer for review and comment. The Engineer's comments on the manufacturer's shop drawings and technical specifications should normally be confined to determining if they are in compliance with the information given in the construction contract documents. They should not address items that are the responsibility of the contractor (e.g.: dimensions, weights, coordination of trades, or similar items).

An example of a general requirement addressing installation of manufactured items is:

- Manufactured products, materials and equipment should be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer and in compliance with the construction documents.

An example of addressing the quality of workmanship with respect to installation of a specific product (in this case, pumps) is:

- The contractor must provide at least one person who should be present at all times during the installation of the pumps and who is thoroughly familiar with the pumps being installed and the manufacturer's recommended methods of installation and who should direct all of the installation work.
- The pumps should be installed, connected and tested as directed by the manufacturer and in compliance with the construction documents by experienced workers skilled in the trades required for such installation.
- All piping that is to be connected to the pumps must be thoroughly cleaned before connection.

- After satisfactory tests, pumps should be operated for a period of time sufficient to satisfy the Engineer that each complete unit has been properly installed and aligned and that it runs free from heating, rubbing or vibration.
- Correct direction of impeller rotation has been verified by visual observation.
- Starting and running amps are within the manufacturer's specifications.
- Pumps and piping are free and clear of debris and obstruction.
- The specified discharge is pumped against the specified head.
- The performance of each pump unit is entirely acceptable and meets the requirements of the specifications.

QC procedures for underground construction are particularly important. In general, QC procedures in the technical specification sections for such construction should include materials, workmanship and testing. The QC procedures should cover such items as excavation; dewatering; protection of excavations from inflow of surface water and frost; preparation of acceptable earth foundations for proposed structures, piping and conduit; bedding materials and methods of installation; and procedures for backfilling around and over the structures piping and conduit.

Installation of structures, piping and conduit or placement of fill or backfill on frozen ground should be expressly prohibited. Unless the Engineer gives written permission, work liable to be affected by frost should be suspended during freezing weather. When permission is given to work under such conditions, the Contractor should provide approved facilities for heating the materials and protecting the finished work.

Testing procedures (e.g.: pressure testing, vacuum testing) should be specified with respect to leakage of piping and structures. Procedures to be used for correction of any leakage, and for re-testing, should also be specified.

QC procedures for on-site construction of subsurface and aboveground structures should also be included in the technical specifications. Wherever possible, they should refer to industry standards.

QC procedures also extend to the delivery, unloading, and storage of materials and equipment to insure the preservation of their quality and fitness. Stored materials and equipment that will be incorporated in the OWRS facilities should be located so as to facilitate their prompt inspection. Mechanical and electrical equipment that requires servicing during long-term storage should have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on the exterior of each package. Materials such as PVC pipe and conduit should be protected against the damaging ultraviolet rays of the sun when stored for long periods of time. Equipment and materials that may be damaged by temperature extremes should be stored where they will not be subjected to such conditions.

F. Field Quality Control by Applicant

The Department may require that the applicant for a OWRS Discharge Permit retain a licensed professional engineer to provide construction services to verify that construction of the OWRS is done in conformance with the construction contract documents approved by the Department. The Department may also require submission of Record Drawings and supporting information upon completion of construction.

The construction services that should be provided by the Engineer include:

- Review of shop drawings and samples for conformance with the design concept and the requirements of the construction contract documents.

  The Engineer and his office staff normally provide these services.

- On-site observations of the work in progress to determine if the work is in general proceeding in accordance with the construction drawings and specifications.

  These services are normally provided by the Engineer's authorized field representative(s). It is particularly important that construction of all under-ground facilities, and facilities that will be hidden beneath floors, behind walls and above ceilings of aboveground structures, be observed as construction proceeds. This generally involves the full-time presence of the Engineer's field representative during such construction activities. Construction of facilities that remain visible can be observed on a periodic basis and thus may not require the full-time presence of the field representative.

The following tasks are usually assigned to the Engineer's field representative as part of his observations of the work in progress

- Report to the Engineer whenever the representative believes that any work is unsatisfactory, faulty or defective or does not conform to the construction drawings and specifications, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise the Engineer of work that the representative believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.
- Consult with Engineer for further instructions should conditions of work or specified requirements conflict with manufacturer's instructions.
- Verify that tests, equipment and systems startups, and operating and maintenance training are conducted in the presence of appropriate personnel, and that Contractor has maintained adequate records thereof; and observing, recording and reporting to the Engineer appropriate details relative to the test procedures and startups.
- Accompany visiting inspectors representing public or other agencies having jurisdiction over the project, record the results of these inspections and report the results to the Engineer.
- Ensure that Contractor maintains accurate project record documents.
- Ensure that O&M instructions are provided to the designated OWRS facility operator by the manufacturers' authorized representative(s).

- Maintain copies of approved shop drawings, field sketches, manufacturers' instructions, etc.
- Assist the Engineer in conducting a semi-final review of the constructed project and preparing a list of items requiring completion or correction by the Contractor.
- Assist the Engineer in conducting a final review of the constructed project.

The Engineer's field representative should not authorize any deviation from the construction documents or substitution of materials or equipment, unless authorized by the Engineer. The field representative should not engage in, or assist, any construction work or other duties that are the responsibility of the Contractor, and should direct any comments, both written and verbal, regarding the quality of the work to the Contractor's on-site supervisor, rather than directly to the construction workers.

Finally, it should be understood that the Engineer has the responsibility to protect the interests of several entities. He has contractual obligations to the Applicant or Owner of the OWRS facilities and must look out for their interests. He also is responsible to the Department for seeing that the completed project conforms to the construction documents approved by the Department. Further, by virtue of his licensing as a Professional Engineer, he has a responsibility to protect the public interest.

G. References

CSI 1995 MasterFormat™. The Construction Specifications Institute. Alexandria, VA.