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**Forest Service Handbook 7409.11 – Sanitary Engineering and Public Health Handbook**

**Chapter 70 - Operation and Maintenance Of Drinking Water and Wastewater Systems**

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**Duration:** This amendment is effective until superseded or removed.

**Superseded Directive:** 70 thru 73.47; 7409.11\_40, Amendment 7409.11-2004-5

**Approved by:** Frederick L. Norbury, Associate Deputy Chief, NFS

**Date approved:** September 17, 2004

**Responsible Staff:**

**Explanation of changes:** Following is an explanation of the changes throughout the directive by section.

**Posting Instructions:** Amendments are numbered consecutively by Handbook number and calendar year. Post by document; remove the entire document and replace it with this amendment. Retain this transmittal as the first page(s) of this document. The last amendment to this Handbook was 7409.11-2004-5 to 7409.11\_40

**70:** This amendment changes the chapter title from “Operation and Maintenance of Water and Waste-Water Systems” to “Operation and Maintenance of Drinking Water and Wastewater Systems”; and updates the chapter in its entirety, incorporates technical changes, updates references, and makes grammatical and formatting changes throughout. Specific changes are as follows:

**70.1:** Adds authority for operation and maintenance of drinking water and wastewater systems.

**70.2:** Moves discussion on considerations to section 72.

**70.8:** Updates obsolete references.

**71.1:** Removes recommendation to obtain copy of obsolete references.

**71.2:** Removes requirement to have basic operations and maintenance (O&M) included in engineering report and requirement to complete the basic portions of the O&M manual during design phase. Clarifies requirements for procedural guides based on operating and monitoring experience. Removes direction on tabulation of parties responsible for development of an O&M guide.

**71.3:** Adds requirement for formal list of operating contacts and phone numbers in appendix. Adds requirement for copies of operator's certifications where applicable. Removes requirement for listing how operator fits into Forest Service Organization. Adds option to use Water Cost Estimator (WCE) to develop operating budget. Adds requirements for confined space and lockout/tagout procedures, and a requirement for a licensed electrician to perform electrical work. Adds requirement for safety references. Removes example format for system description. Adds requirement for specifying acceptable pumping rates and well characteristics. Adds requirement for discussing provisions included for expansion of system. Adds requirement for listing laboratory names and phone numbers at which lab tests can be completed. Removes requirement for using a card-based system and assigning number lots to the equipment. Adds requirement for operators to have working knowledge of cost to operate system. Removes former Figure 1. Adds requirement for Sanitary Survey records to be kept along with Condition Survey records. Adds requirement to include review of potential targets for terrorist activities. Adds requirement to include copies of reports and Notices of Violations (NOV) sent to and from State or Federal Agencies. Removes former Figure 2. In the Appendix section, updates to allow for reports, info, and so on, to be stored on CD-ROM so long as it remains accessible when needed.

**71.4:** Changes the caption from "Distribution" to "Distribution of Operation and Maintenance Manuals."

**73:** Redefines Sanitary Survey and requirements for completion.

**73.1:** Clarifies qualifications of engineer completing sanitary surveys.

**73.3:** Adds requirement that a copy of the sanitary survey report be sent to the appropriate State agency.

**73.43:** Adds characteristic of "aquifer confined or unconfined" to list.

**73.44:** Adds section on pumps.

**73.45:** Adds section on storage facilities.

**73.46:** Adds requirement to review Notices Violations for procedural evaluations.

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## **70.1 - Authority**

Title 40 of the Code of Federal Regulations, (CFR) Parts 9, 141, and 142 (42 CFR parts 9, 141, 142). Establishes primary drinking water regulations pursuant to the Safe Drinking Water Act (Pub. L. 93-523).

## **70.2 - Objectives**

The objective of this chapter is to provide operators and engineers the necessary tools, information, and references for operation and maintenance (O&M) of water and wastewater systems. The operation and maintenance manual (sec. 71) provides for optimum performance of these systems. Standards for system performance are a matter of law (sec. 70.1), which provides all administrative levels with expectations for proper system planning, design, construction, operation, and maintenance. Existing systems may need modifications or complex operation by highly skilled operators to meet these regulations.

## **70.8 - References**

1. Manual of Individual and Non-Public Water Supply Systems, EPA Number: 570991004, May 1991.
2. Small Water System Operation and Maintenance, 4<sup>th</sup> Edition, National Environmental Training Association, 2001.
3. State Programs to Ensure Demonstration of Technical, Managerial, and Financial Capacity of New Water Systems, EPA 816-R-01-018, July 2001.
4. Guidance Manual for Conducting Sanitary Surveys of Public Water Systems; Surface Water and Ground Water Under the Direct Influence (GWUDI), EPA 815-R-99-016, April 1999.
5. Onsite Wastewater Treatment Systems Manual, EPA/625/R-00/008, February 2002, Office of Water/Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.
6. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations (Second Edition), EPA Number: 832B01001, January 2001.
7. Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems, EPA Number: 832B03001, March 2003.
8. U.S. Environmental Protection Agency, Guide to Septage, Treatment and Disposal, EPA 625/R-94/002, 1994.
9. U.S. Environmental Protection Agency, Design Manual-Onsite Wastewater Treatment and Disposal Systems, EPA, 625/1-80/012, October 1980.

10. Small Systems Guide to Safe Drinking Water Act Regulations, Office of Ground Water and Drinking Water, EPA 816-R-03-017, September 2003.

11. Water System Operations Guidebook, USDA Forest Service Engineering, October 1995.

12. "Sanitary Survey Inspection: Before you Begin...", Video, National Environmental Training Association, 2002.

13. "Considerations for Preparation of Operation and Maintenance Manuals," EPA-430/9-74-001, Environmental Protection Agency, Office of Water Program Operations, Washington, DC 20460.

## **71 - Development and Distribution of Operation and Maintenance Manuals**

The purpose of an operation and maintenance manual is to provide drinking water and wastewater system operators with the understanding, techniques, and references needed to efficiently operate and maintain their systems during routine and emergency periods.

### **71.1 - Preliminary Considerations**

A good operation and maintenance manual considers the complexity of the system and is tailored to the needs and competence of the person(s) who ultimately operates the system. It should be a flexible tool that can be modified and updated as necessary. Operation and maintenance manuals should consider entire systems, including offsite facilities or operations, such as collection of vault wastes that are to be treated by the system. It must be comprehensive and accurate, because it is the only available guide specifically prepared to ensure proper operation and maintenance for the life of that facility.

### **71.2 - Responsibility for Development**

The need for operation and maintenance instructions for a facility must be considered from the onset of planning through the end of its useful life. The Design Engineer should assume initial responsibility for development of the original operation and maintenance manual.

During construction, the Design Engineer should work with the Project Engineer to ensure that proper documentation is collected and incorporated into the manual. Such documentation includes: photos; as-built drawings; and submittals, such as wiring schematics, equipment literature and service manuals, and shop drawings; are collected and incorporated into the manual. Prior to startup of the system, a preliminary operation and maintenance manual should be presented to the operator for use during startup and initial operations. The Design and Project Engineers should continue to work with the operator during startup, and perhaps through an entire season's use for complex systems, to gather additional data for inclusion into what might be considered the basic operation and maintenance manual. From that point forward, it is the responsibility of the operator to initiate updates and amendments to the operation and maintenance manual as required. For optimum efficiency, the operator should add procedural

guides based on results of practical operating experience and monitoring. The operator should consult a qualified engineer if major problems are encountered.

### **71.3 - Format**

The format and content of a given operation and maintenance manual must be tailored to the specific system. The format set out in exhibit 01 is applicable to both drinking water and wastewater systems and provides a suggested list of those items considered most essential. This is a guide only, and additions and deletions are intended as appropriate. For smaller systems, several sections might even be combined. Manuals should be maintained in a hard-cover loose-leaf binder so that amending can be readily made.

## 71.3 - Exhibit 01

### **Sample Format for Operation and Maintenance Manuals**

#### TABLE OF CONTENTS

Section 1 - Introduction
Section 2 - Permits and Standards
Section 3 - Safety
Section 4 - System Description, Operation, and Control
Section 5 - Laboratory Controls
Section 6 - Startup and Shutdown
Section 7 - Maintenance
Section 8 - Condition Surveys
Section 9 - Utilities
Section 10 - Emergency Plans and Procedures
Section 11 - Records and Reports
Section 12 - Appendix

#### SECTION 1 - INTRODUCTION

This section of an operation and maintenance manual should, at a minimum, include the following:

1. Operator and Managerial Responsibility. To ensure efficient and effective operation of the system, the responsibility of the operator must be well-defined. In addition, this section of the manual should also clearly state who the operator should contact for assistance in the event of technical problems. A comprehensive list of contacts with telephone numbers should be included in the manual's appendix. Operations requiring close coordination between the operator and engineer overlap of responsibilities, or review procedures, such as National Pollution Discharge Elimination System (NPDES) permit data, should be clearly stated. A framework for periodic service trips by an Engineer, Electrical Technician, and so forth, to the more complex systems should be established. State requirements may require operator(s) to be certified operators. Copies of these certifications should be included in the manual's appendix.

2. Manpower and Training. Briefly describe the operator's role, expected performance, and job-related requirements. Discuss operational procedures, such as routine checking, and indicate the approximate hours per unit of time (day, week, and so forth) and frequency that the operator is expected to be on site. Outline job qualifications, certification, and appropriate training requirements and opportunities.

### **71.3 - Exhibit 01--Continued**

3. Scheduling. Scheduling for a Forest Service system is difficult since quite often there is only one operator with little or no backup available. Considering tour of duty, leave, holidays, and other duties, planning and scheduling of operation and maintenance are critical. Scheduling is dictated by personnel availability rather than system requirements. The schedules outlined in the manual should attempt to consider both aspects.

4. Planning and Budget. Describe the operator's responsibility for ensuring timely planning and budget requests for system operation and maintenance (O&M). Provide initial O&M estimates for new systems; the operator can update these as experience indicates. The Water Cost Estimator (WCE) tool can be used to develop these estimates. Describe any special accounting or budget requirements that the operator may be responsible for, such as cooperative agreement accounting.

## **SECTION 2 - PERMITS AND STANDARDS**

The operator must be familiar with permits and/or standards which apply to the system. A copy of such permits and/or standards should be included in this section or in the manual's appendix and properly referenced in this section. In addition to inclusion in the manual, a summary should be prepared outlining information such as:

1. Coordination and reporting requirements.
2. Manner, nature, volume, and frequency of discharges.
3. Monitoring requirements - including parameters and frequency.
4. Spill or bypass reporting procedures.
5. Regional and/or Forest policies or requirements.

## **SECTION 3 - SAFETY**

Some of the following should be considered for inclusion in the manual. Emphasis should be placed on the specific hazards within the system under consideration. This is necessary because safety requirements, as outlined in FSH 6709.11, are generally not specific enough to cover such specialized hazards and equipment as lift stations, manholes, high-pressure equipment, power tools, gas masks, showers, and eye spray.



### 71.3 - Exhibit 01--Continued

1. Emergency telephone numbers. List these on a separate sheet to allow for additions and deletions.
2. Health hazards. Discuss the following actions where applicable to prevent health hazards:
  - a. Required inoculations.
  - b. Good personal hygiene.
  - c. Care of cuts and injuries.
  - d. First aid.
3. Confined space and lock out/tag out programs and procedures. Address Federal, State, local, and Agency requirements.
4. Electrical hazards. Require a certified and/or licensed electrician to perform electrical repairs.
5. Mechanical equipment hazards. Require the use of equipment guards to reduce mechanical equipment hazards.
6. Chlorine and chemical hazards. Follow Federal, local, and Agency requirements including FSH 6709.11, chapter 30.
  - a. Chlorine handling, testing, protective equipment, ventilation.
  - b. Laboratory hazardous materials, handling, protective equipment.
7. Explosion and fire hazards. Provide the following information:
  - a. Location of fire extinguishers.
  - b. Possible sources of fire or explosion and preventive measures.
8. Oxygen deficiency and noxious gases (see confined space procedures FSH 6709.11, ch. 30). Lift station and manhole hazards, protective devices and equipment, ventilation, safety procedures.
9. Duties requiring two or more persons.

### 71.3 - Exhibit 01--Continued

10. Safety equipment requirements. Require use of Personal Protective Equipment as listed in FSH 6709.11, chapter 20.

- a. First-aid kits.
- b. Fire extinguishers.
- c. Protective clothing.
- d. Gas masks.
- e. Other.

11. Accident reporting. Reference requirements listed in FSH 6709.12, chapter 30.

12. References. List pertinent safety references, such as Forest Service Confined Space and Lock-Out Tag-Out Programs (FSH 6709.11).

For ease of location in an emergency situation, and as a constant reminder to the operator of the importance of day-to-day safety, the safety section of the O&M Manual should be written on different colored paper than the remainder of the manual. Selected portions of this section could be reproduced and posted in various work areas for quick reference.

#### SECTION 4 - SYSTEM DESCRIPTION, OPERATION, AND CONTROL

This is a fundamental section of the O&M manual. It provides the operator with an understanding of the purpose and function of the system, and the control necessary to make the system perform as designed. A key element of an operation and maintenance manual is the system description, operation, and control section. It is through this section that the operator gains an understanding of the purpose and function of the system, and the control necessary to make it perform as designed. This section should provide an overview of the entire drinking water or wastewater system outlining types of treatment, expected usage and flow conditions, treatment requirements and expected efficiencies, peak loads, and so forth. A simplified flow diagram can serve as a useful aid for this purpose. Include a design criteria summary in this section or reference its location in the section or reference its location in the appendix. In addition, discuss each process or unit of the system in a logical sequence.

### 71.3 - Exhibit 01--Continued

Following are some of the items that should be considered when discussing each of the system's processes or units:

1. Description. Describe the specific function of the process or unit and trace the flow through it. Where applicable, present information on maximum and minimum design flows, strengths, and so forth, and expected efficiency for each. Specify acceptable pumping rates, well characteristics, reserves to be maintained for fire storage, and so forth.
2. Relationships to Adjacent Units. Discuss interrelationships of the various processes and units.
3. Operation and Control. Include adequate information to fully and effectively utilize the flexibility in process control or function provided for in the system design. Discuss methods of controlling the unit or process for optimum efficiency and relate this to normal, uncommon, and emergency flow conditions. Schematic diagrams are useful tools for displaying this information.
4. Common Operating Problems. Use the operation and maintenance manual as a reference book to help solve operating problems as they arise. Each of the major units and processes in the system should be analyzed, potential problems defined and possible solutions recommended. Charts and troubleshooter's guides should be developed for this purpose. General problems that are adequately described in project submittals or manufacturer literature can be referenced and included in the manual appendix.
5. Expansion Provisions. Describe any future expansion opportunities that have been designed into the system. Include any adjustments to the system controls that will be required or affect the overall performance of the system.
6. Startup and Shutdown. Complete instructions, including checklists where applicable, for placing each unit or process in service or taking out of service, should be fully described. System startup and shutdown is covered in section 6.

## SECTION 5 - MONITORING CONTROLS

Recognizing experience and training limitations of operators for most Forest Service operated systems, it is important that this section be detailed and all inclusive. It cannot, for instance, be automatically assumed that operators are completely familiar with sampling techniques.

### 71.3 - Exhibit 01--Continued

Operating personnel must understand the relationship between laboratory test results and the proper operation of treatment units and process. Testing is used for both monitoring and control. Parameters to be tested, efficiencies expected, analyses and interpretation of results, sampling points, and so forth are typical of the type of information that should be covered in this section. In addition, the following items should be considered for inclusion in this section of the manual:

1. Purpose of each test.
  - a. For process control.
  - b. Record of operation.
  - c. Aid to analysis.
2. Sampling.
  - a. Definition of sampling techniques.
  - b. Complete instructions for sampling.
  - c. Sampling equipment.
3. Testing, interpretation, and control.
  - a. Tests to be completed.
  - b. Frequency.
  - c. Interpretation and control.
  - d. Instructions for testing, including worksheets.
  - e. Equipment, supplies, chemicals.
4. Commercial laboratories. List names and addresses of commercial and/or State laboratories where tests can be made.
5. Records and Reports (sec. 11).
6. Reference material.

### **71.3 - Exhibit 01--Continued**

#### **SECTION 6 - STARTUP AND SHUTDOWN**

Due to the seasonal nature of many Forest Service systems, it is important that complete instructions for startup and shutdown be included in the manual. In addition to the major processes in the system, attention should also be given to such items as draining of lines to prevent freezing. Procedures should be described in a step-by-step format and accompanied by diagrams and schematics, and photos as applicable. Special attention should be given to facilities that need to be winterized, dismantled, or secured to minimize vandalism. In addition, consideration should be given to the following items:

1. Condition and sanitary surveys.
2. Preventive maintenance and repair.
3. Startup sequence, including flushing and disinfection.
4. Shutdown sequence, including draining.
5. Dismantle or lock and secure.

#### **SECTION 7 - MAINTENANCE**

A good maintenance management system is an essential component of the operation and maintenance manual. A breakdown in the maintenance system can be costly in terms of additional repairs, higher operating costs, poor plant efficiency, poor quality treatment, and reduced overall system performance. Development of a maintenance management system, tailored to meet the requirements of a specific system and its equipment and components, is an integral part of preparation of an O&M manual. For Forest Service systems, it is prudent to consider ancillary components of the system (pipelines, valves, travel trailer stations, and so forth) as well as pumps, motors, and other common maintenance items for inclusion in the maintenance management system. This system should provide a permanent record of all maintenance work together with the advanced scheduling of preventive maintenance for an entire year. The system should provide a permanent record of all maintenance work performed, and the advanced scheduling of preventive maintenance for an entire year.

1. Generally a maintenance management system consists of the following:
  - a. Equipment record system.
  - b. Planning and scheduling.
  - c. Equipment and parts inventory.

### 71.3 - Exhibit 01--Continued

- d. Maintenance personnel.
  - e. Cost and budgets for operation and maintenance.
2. Format and points to consider for developing this section of a manual are as follows:
- a. General information.
    - (1) Purpose.
    - (2) Description.
    - (3) Basic features.
  - b. Equipment Records System. The equipment records system should be a complete, logical record of all equipment. A manual should establish the framework for setting up the proposed system and should:
    - (1) Describe the equipment numbering system. Each structure and major piece of equipment should be assigned a file number. The assigned numbers will serve to identify each item of equipment in all of the plant records and should also be used to catalog spare parts.
    - (2) Summarize equipment catalogs, manufacturer's literature, parts, manuals, etc; reference them to the equipment numbering system; and include them, or make reference to their location in the appendix of an operation and maintenance manual. Information relating to maintenance, operation, and servicing of each item of equipment must be included.
    - (3) Develop mechanical troubleshooting checklists and charts, and reference these to appropriate equipment records.
    - (4) Provide instruction for use of the equipment record system, type of information to be recorded, filing and retrieval, etc.
  - c. Planning and Scheduling. Maintenance costs and preventive-maintenance scheduling should be consistent with value, life expectancy, and replacement.

### 71.3 - Exhibit 01--Continued

Unnecessary or too frequent preventative maintenance can be wasteful. Equipment should be rated as to its critical position in the system operation when considering maintenance priorities. In most cases, manufacturer's recommended maintenance schedules should be used. These schedules usually take the form of preventive maintenance being accomplished at regular intervals, such as daily, weekly, monthly, and yearly. The record keeping system will establish the framework for this scheduling.

d. Equipment and Parts Inventory. Recommend spare parts and equipment to be maintained.

e. Maintenance Personnel.

(1) Recognizing limitations of operators, list specific and general maintenance items which should be repaired by others.

(2) List names and addresses of specialists to be contacted for appropriate repairs.

f. Cost and Budget. Discuss estimated equipment maintenance budget details including such items as equipment amortization, spare parts inventory, and so forth. It is critical that operators have a working knowledge of the cost to operate the systems.

In addition to the basic maintenance management features outlined, the maintenance section of a manual should also consider such things as housekeeping, grounds keeping, special tools and equipment, lubrication requirements, warranty provisions, and equipment performance testing.

In order to maintain an effective maintenance program, the maintenance record system should be kept up to date faithfully and consistently. Service requirements should be modified as equipment ages and flow rates increase. All modifications to major plant equipment should be recorded in the maintenance record system. In addition, changes to plant piping, equipment, electrical circuitry, and so on, should be made to as-built drawings as they occur.

## SECTION 8 - CONDITION AND SANITARY SURVEYS

Condition surveys (including seasonal, changed conditions, and maintenance needs collection) should be an ongoing responsibility of the operator for every system. This role should be clearly defined in an operation and maintenance manual. Condition and sanitary survey records should be retained from survey to survey for reference. They are the primary documents for planning, programming, and implementing necessary replacement, repair, and corrective action. For seasonal systems, it is desirable to schedule condition surveys for the shutdown of the system.

### 71.3 - Exhibit 01--Continued

This allows time for equipment and materials to be purchased and installed prior to startup the following season. Again, the checklist must be tailored to the specific system.

#### SECTION 9 - UTILITIES

The relationship between drinking water and wastewater systems and other utilities plays a significant role in proper performance of the system. In many cases, operation of the system is totally dependent on a utility and a break in service may be critical, if not catastrophic. For this reason, it is imperative that an operation and maintenance manual outline and describe the interrelationship of the various utilities and more importantly, what to do should failure occur. Every operation and maintenance manual should contain a complete utilities site plan, showing locations of all lines on the site. Coverage should include the entire administrative or recreation site and not just the project site, such as the wastewater treatment area. Details should include pipe sizes, manholes, valves, transformers, voltage, and alarm systems. Names, addresses, and telephone numbers of persons to contact in the event of an emergency are particularly important for inclusion in this section of a manual. In addition, consideration should be given to the following items:

1. General information.
  - a. Give overview of all utility systems, their interrelationship, and specific function within the system.
  - b. List names, addresses, and telephone numbers to contact for all utilities.
2. Electrical.
  - a. Reliability.
  - b. Voltages and equipment.
  - c. Standby sources.
  - d. Emergency procedures.
3. Telephone.
  - a. Alarm systems that rely on telephone.
4. Natural gas.



### 71.3 - Exhibit 01--Continued

5. Water.
  - a. Backflow preventers.
  - b. Normal operating pressures.
6. Water-water collection and treatment.
7. Fuel oil, liquefied petroleum gas.
  - a. Tank capacities.
  - b. Suppliers.
  - c. Spill prevention, control, and countermeasures (SPCC) plan reference.
  - d. Alarm system info.

## SECTION 10 - EMERGENCY PLANS AND PROCEDURES

This section of an operation and maintenance manual should summarize possible situations of an emergency nature, safeguards and alarms built into the system, action to be taken in the event of an emergency, and coordination or contacts to be made. Examples of the type of information to be included:

1. Summary of Vulnerability Analysis.
  - a. Present a brief history of prior spills, bypasses, and other emergencies.
  - b. List potential for natural disasters, such as forest fire or flood.
  - c. List possible weak links in the system, and possible accident areas, potential targets for terrorist activity.
  - d. Recommend possible preventive measures and emergency responses.
2. Summary of Built-In Safeguards, Fail-Safe Features, and Alarms. Describe each feature, alarm, and safeguard; its function, location, operation, and required response. These might include lift-station overflow dumps; water-supply shutoff solenoid valves; and various horn-, buzzer-, and light-alarm systems.

### 71.3 - Exhibit 01--Continued

3. Contact and Coordination. List contacts to be made in various emergency situations (both FS and non-FS), along with the information that is or may be required by these contacts.

4. Emergency Standby Equipment. Describe function, location, service dates, and operation of all emergency standby equipment.

#### SECTION 11- RECORDS AND REPORTS

Records and reports are a guide for system operation and control and also serve as a historical record of the performance of a system. They also serve as a memory aid to accomplishment of routine maintenance operations, testing procedures, and so on. Reports and forms can be standardized, but must be adapted to each individual system and operation. Summarizing recorded data in graphical form for visual display facilitates analysis and system operation.

Following are some of the types of records and reports, which might be considered for each system:

1. Reports to/from State or Federal Agencies. This should be thoroughly covered under section 2.

2. Forms. Appropriate forms should be supplied along with reporting requirements. Include in this section copies of any notices of violations (NOV) and other correspondence received from the state or Environmental Protection Agency (EPA) regarding the system.

3. Process Control and Daily Operating Log. This is a day-by-day log of the operation of the system. A form should be prepared to facilitate this activity. It is important that operating logs be developed to suit the particular needs and operational requirements of each specific system, and are not just records being kept. Operating logs should be kept in a bound notebook.

4. Laboratory Records and Reports. Laboratory worksheets should be maintained, summarizing all laboratory testing each day. This activity should be thoroughly covered under section 5. Prepare standard forms and worksheets as applicable. This may be included on the daily operating log.

5. Maintenance. Maintenance records and reports are covered in section 7. Applicable forms and schedules should be prepared as indicated.

### 71.3 - Exhibit 01--Continued

6. Operating Costs and Records. Operators should maintain adequate operation and maintenance cost records for budgeting and historical purposes. Standard forms can be prepared, including the following items:

- a. Labor
- b. Utilities
- c. Chemicals
- d. Supplies
- e. Maintenance items
- f. Equipment replacement

## SECTION 12 - APPENDIX

This section of an operation and maintenance manual is used for the inclusion of additional or supplemental materials not suitable for inclusion in the main text. Some of these items will be bulky and cumbersome. They can be bound separately, folded as foldout pages, kept on CD-ROMs, or placed in pouches. The preparer should make use of schematics, tabulations, summaries, color coding, diagrams, sketches, sample forms, worksheets, overlays, and various other techniques to ensure that material presented is as descriptive and yet concise as possible.

All material contained in the appendix should be logically arranged and appropriately referenced to other sections of a manual. Following are examples of the type of material that might be included in the appendix, if it is found to be too bulky or not particularly appropriate for inclusion in the body of a manual:

1. Permits and/or standards
2. Detailed design criteria in summary form
3. Schematics
  - a. Flow diagrams
  - b. Hydraulic profiles
  - c. Pipe arrangements

### 71.3 - Exhibit 01--Continued

4. Valve summaries
  - a. Function
  - b. Type
  - c. Size
  - d. Location
  - e. Identification
5. Sample forms and worksheet
  - a. Daily operating log
  - b. Equipment data cards
  - c. Laboratory records and worksheets
  - d. Other
6. Manufacturer's literature and worksheets
7. Construction progress photographs
8. Pipe and electrical color codes
9. Equipment supplier summaries
10. Warranties
11. Reference material listings
12. As-built drawings and specifications; Half-sized drawings with changes noted in red are acceptable for inclusion in the manual. An additional set of full-sized as-built prints should be available to the operator.
13. Shop drawings
14. Cooperative agreements
15. Blanket purchase orders

## **71.4 - Distribution of Operation and Maintenance Manuals**

A complete operation and maintenance manual should be physically located at the system site where it is readily accessible to the operator and at the Supervisor's Office. For very small systems having no onsite housing, manuals are frequently kept at a Ranger Station or work center, but the operator should carry a copy from site to site. For large systems, duplicate manuals should also be placed at the Regional Office. These duplicate manuals are used for:

1. Backup manuals in the event the original is misplaced.
2. A communications link between operator and engineer at different locations.
3. An effective trouble shooting tool for specialists, such as Mechanical or Electrical Engineers.
4. A design aid for future projects.
5. A review document prior to a service trip to the site by engineering personnel.
6. Part of the project file.

Additional copies of the manual may have to be duplicated for distribution to Environmental Protection Agency or State offices to satisfy local requirements.

## **72 - Implementation of Operation and Maintenance Programs**

The first consideration for good operation and maintenance (O&M) is to establish the proper framework at each organizational level to ensure responsibility and accountability for the operation and maintenance of each system. There must also be assurance of the availability of continuous funding, consulting services, technical skills, audit and inspection procedures, and follow up actions as required. These are essentially management actions that relate to implementation of O&M programs. The second consideration is to provide for the proper force-account operation and maintenance of each system. This relates to organization and personnel, but is perhaps more dependent on use of an O&M manual, which is an integral part of every system. A third consideration, which applies only to water systems, is the sanitary survey. It is a survey to collect sufficient information to ensure the continuing capability of a system to meet current drinking water standards.

Initiating an operation and maintenance program to function effectively requires broad and long range consideration. Very small systems operated as a side duty, on a "whenever time allows" basis, should be avoided in the interest of safety to the public and water quality standards. An operation and maintenance organization should include centralized response and dispatch personnel who can provide supervision, backup, relief, procurement and technical assistance to meet all situations. For complex and costly systems, it is essential to utilize certified operators as required by State and National law. Thought must be given to immediate needs for maintenance equipment and future needs for replacement of system components due to wear and obsolescence.

Following is a guide for considerations and alternatives, which management must weigh prior to implementing an operation and maintenance program for a system or group of systems:

1. Organization.

a. Management responsibility.

- (1) Programming and budgeting.
- (2) Interagency and inter-level coordination.
- (3) Operator training.
- (4) Operator staffing.
- (5) Centralized contact and backup personnel.
- (6) Technical consultation services.
- (7) Audit and inspection.

b. Operator responsibility.

- (1) Force-account operation and maintenance.
- (2) Manual updates.
- (3) Budget preparation.

2. Personnel.

a. Available skills.

- (1) In-Service.
- (2) Out-Service.
- (3) Contract.

b. System complexity.

c. Proximity of systems.

d. Manpower utilization.

e. Alternate operators.

f. Operator training.

- (1) In-Service.
- (2) Out-Service.
- (3) On-job training.
- g. Operator certification.
- 3. Program Structure.
  - a. Single-operator systems.
  - b. Multiple-operator systems.
  - c. Multiple-system operators.
- 4. Sampling and Testing.
  - a. Central laboratories.
  - b. Onsite laboratories.
  - c. Contract testing.
  - d. Forest-wide sampling programs.
  - e. Single-system sampling.

## **73 - Sanitary Surveys for Water Systems**

A sanitary survey is an on-site review of the water source, facilities, equipment, operation and maintenance procedures, and management practices of a water system. The objective of the sanitary survey is to collect sufficient information to determine conclusively the capability of a water supply to continuously provide water that meets current regulatory agency and public-health standards (40 CFR parts 140-143). A periodic sanitary survey is required for all Forest Service water systems. Initial sanitary surveys are performed to evaluate the source of water and its ability to meet existing and future needs. Condition surveys are limited sanitary surveys conducted on an as-needed basis to meet a specific need, that is, for startup of seasonal systems, investigation of contamination, maintenance needs collection, and so forth.

### **73.1 - Survey Engineer**

A Sanitary or Civil Engineer plays a key role in conducting the sanitary survey. The engineer should have training and experience in water quality, microbiology, and treatment processes. The engineer should also have broad knowledge and experience in water supply and should be trained in recognition of sanitary features and conducting sanitary surveys. Required sanitary surveys for public water systems must be conducted by agents appointed or approved by the

State or primacy agency. System operators should be included in the sanitary survey team; in many cases they are responsible for correcting any deficiencies found in the system.

### **73.2 - Frequency**

Drinking water supplies should be surveyed at intervals frequent enough to ensure a continuous supply of potable water meeting applicable standards. The condition portion of the sanitary survey should be completed in the fall for seasonal systems. This allows time for ordering material and correcting deficiencies prior to the next season's startup. See FSM 7421.23 for sanitary survey frequency schedules and other requirements.

### **73.3 - Reporting**

A sanitary survey report should be maintained for each system. This is a required document while conducting a survey on the same system at a later date. The State agency responsible for water systems requires a copy of the report for all public systems. Forests and Ranger Districts should retain these reports as a historical record of deficiencies and modifications to the system. Forms can be used to make sanitary surveys; however, they should not be as explicit or rigid as to preclude good engineering judgment or restrict consideration to a recipe format.

### **73.4 - Conducting Sanitary Survey**

Although no precise outline can be prepared to cover all aspects of every water system to be surveyed, the following basic data in sections 73.41 through 73.49 should be considered as applicable. Evaluations and other data can be summarized under broad headings in paragraph format. Detailed survey considerations can be found throughout this Handbook, particularly in chapter 40.

#### **73.41 - Description**

1. Site identification. Use site name and number from Form 7400-2, Potable Water Supply Inventory.

- a. System name and number from water systems inventory.
- b. State public water system identification number, where applicable.
- c. Forest.
- d. Ranger District.
- e. Facilities served.
- f. People At One Time ( PAOT) and use.
- g. Use period.
- h. Water demand.



2. Survey data.
  - a. Date of survey.
  - b. Survey participants.
  - c. Purpose of survey (whether routine or due to tests that did not meet standards, give reason).
  - d. Date and summary of last survey.
3. System description.
  - a. Source.
  - b. Present average daily production.
  - c. Treatment.
  - d. Storage.
  - e. Distribution.
  - f. Special features (Travel trailer stations, and so on).
4. History.
  - a. When built.
  - b. Major modifications.
  - c. Major extensions.
  - d. Major repairs.
5. Schematics, well logs, construction details, and so on.

#### **73.42 - Source Water Assessment**

1. Ground water supplies.
  - a. Geology and topography.
  - b. Nature of soil and strata.
  - c. Water table, drainage area, slope, and so on.
  - d. Sources of contamination; proximity.

- e. Physical, chemical, bacteriological analyses.
- f. Protection from accidental spillage.
- 2. Surface water supplies.
  - a. Geology.
  - b. Nature and topography of watershed.
  - c. Character of vegetation, etc.
  - d. Upstream uses and ownership.
  - e. Pollution potential of watershed.
  - f. Susceptibility of watershed to change, such as variable runoff, seasonal use, and animal use.
  - g. Physical, chemical, bacteriological, radiological, and pesticidal analyses.
  - h. Reservoir characteristics.
    - (1) Wind direction and velocity.
    - (2) Drift of debris and pollution.
    - (3) Algae.
    - (4) Protection from pollution sources, such as fishing, swimming, and animals.
    - (5) Protection from accidental spillage.
    - (6) Security systems (barriers, and so forth) in place.
    - (7) Other.

### **73.43 - Source Water Protection**

- 1. Wells.
  - a. Evaluation of well characteristics.
    - (1) Well log of depth, formations, and so on.
    - (2) Casing, screen, perforations, seals, and so on.
    - (3) Pumping rates, drawdown, and so on.
    - (4) Aquifer confined or unconfined.

- b. Protection from floods.
  - c. Protection from surface runoff.
  - d. Protection of wellhead.
    - (1) Sanitary seal.
    - (2) Casing extended at least 12 inches above ground.
    - (3) Protected vent.
    - (4) Protection from erosion, animals, and so on.
  - e. Potential for cross-connection with nonpotable sources.
  - f. Proper casing, curbing, and grouting.
  - g. Watertight installation of pump and accessories.
  - h. Sound condition of all construction.
2. Springs.
- a. Determine if spring is in fact a spring source or intermittent surface source.
  - b. Evaluate spring encasement for proper watertight installation.
  - c. Protection from surface runoff.
  - d. Suitable watertight cover or lid.
  - e. Suitable and well-protected overflows, drains, vents.
  - f. Evaluation of potential sources of pollution.
  - g. Suitably fenced to protect area from entry by livestock or other animals.
  - h. Protection from trespass.
3. Surface source intakes.
- a. Protection from runoff or entry of other undesirable water.
  - b. Protection from animals, birds, floating material, and so on.
  - c. Protection from bottom muds, sands, plugging, and so on.
  - d. Proper screening and location of intake pipes.

- e. Protection from undesirable uses through the use of signs, fences, and so on., as applicable.
- f. Evaluate ability of intake to withstand physical damage by ice, wind, accident, and so on.
- g. Capability of intake to furnish adequate quantity of water.
- h. Protection from trespass, terrorist activity.

#### **73.44 - Pumps**

- 1. Number, location and type of pumps.
- 2. Rated capacity of pumps.
- 3. Condition of pumps.
- 4. Provision of backup pumps/motors.
- 5. Underground compartments and suction wells waterproofed and vented.
- 6. Condition of electrical control systems.
- 7. Provision of emergency/backup systems.
- 8. Availability of spare parts.
- 9. Adequate records of operational data.
- 10. Preventive maintenance program.
- 11. Condition of pump house building.

#### **73.45 - Storage Facilities**

- 1. Gravity Storage.
  - a. Type of water stored: raw or treated
  - b. Amount of storage: volume, number of days supply
  - c. Control systems reliable and properly protected.
  - d. Site protected against flooding.
  - e. Surface runoff and underground flow directed away from tank.
  - f. Ability to isolate tank from system.

- g. Overflow lines, air vents, drainage lines or clean out pipes turned downward or covered, screened and terminated a minimum of 3 diameters above the ground or storage tank surface.
  - h. Surface coatings in contact with water ANSI/NSF approved.
  - i. Tank protected against icing and corrosion.
  - j. Treated water storage covered.
  - k. General inspection and cleaning frequency for tanks.
  - l. Inspection for structural integrity.
  - m. Disinfection protocol after routine maintenance and repairs.
  - n. Access hatch sealed properly and locked.
  - o. Condition of interior/exterior ladders.
  - p. Condition of interior walls and buildup on tank bottom.
2. Hydropneumatic Storage Tanks.
- a. Operable pressure gauge.
  - b. Low pressure level provides adequate distribution system pressure.
  - c. Cut-in and Cut-out pressures.
  - d. Whether tank water logs.
  - e. Ability to by-pass tanks for repair.
  - f. Exterior surface of tank in good physical condition.
  - g. Pump cycle rate (captive air).
  - h. Pressure tanks: water level sight gauge; bottom drain valve; pressure relief valve; adequate air charge system.

### **73.46 - Treatment Evaluation**

1. Review applicable water-quality standards and regulations.
2. Compare treated water quality test results with applicable standards.
3. Compare design flows with actual use records.

4. Ensure that treatment system is being used as designed or modified for most efficient and effective treatment.

5. Ensure that treatment system has flexibility to meet standards during stress periods, such as heavy runoff, high demand, and drought.

6. Review trends in quality which may indicate a deteriorating system.

7. Review disinfection equipment, installation, detention time, and residuals.

8. Review emergency plans and standby equipment.

#### **73.47 - Distribution System Evaluation**

##### **1. Storage Protection.**

- a. Protection against floodwaters.
- b. Protection against surface runoff.
- c. Suitable watertight roofs, covers, and lids.
- d. Properly screened and positioned vents, drains, overflows, and so on.
- e. Adequately supported pipes, fittings, and so on.
- f. Proximity to sources of pollution.
- g. Adequate frost protection.
- h. Protection from trespass, terrorist activity.

##### **2. Distribution System Protection.**

- a. Adequate pressure maintained throughout system.
- b. No leakage.
- c. Adequate circulation without deadends.
- d. Acceptable pipe materials, joints, and fittings.
- e. Proximity to sources of pollution.
- f. Crossings and proximity to sewerlines.
- g. Proper drains.

- h. Properly constructed and maintained blowoff, vacuum, air-release and air-relief valves.
  - i. Properly constructed and maintained stream and river crossings.
  - j. Adequate-sized pipe for all uses.
  - k. Adequate frost protection.
  - l. Adequate maintenance program.
3. Cross-Connections.
- a. Proper selection, installation, testing and maintenance of backflow devices.
  - b. No physical connection between potable and non-potable waters.
  - c. Adequate system pressure.
  - d. Evaluation of potential for negative pressures.
  - e. Proper air gaps throughout system.
  - f. Nonpotable water piping identified.

#### **73.48 - Procedural Evaluation**

- 1. Review management and operation methods.
- 2. Review operator skill and qualifications, including training and experience.
- 3. Review operation and maintenance manual for update material and use.
- 4. Review test results, including disinfection.
  - a. Proper frequency.
  - b. Proper sampling techniques and handling.
  - c. Proper laboratory equipment.
  - d. Proper laboratory procedures.
  - e. Proper recording.
  - f. Proper evaluation.
  - g. Proper follow up and corrective action.

5. Review and evaluate violation notices and trends in non-compliance.
6. Evaluate force-account operation and maintenance.
  - a. Is plant operation efficient?
  - b. Is plant operation effective?
  - c. Are recommended operational and control procedures being used?
  - d. Is recommended maintenance being performed at required frequencies?
7. Is plant operation being checked daily or at other required intervals?
8. Are all parts of system properly cleaned, disinfected, flushed and tested at seasonal startup or periodic intervals?
9. Review all records and reports for adequacy and accuracy.

#### **73.49 - Deficiency Summary and Corrective Action Schedule**

A complete summary of all items requiring corrective action should be compiled, along with a schedule for completing each item. In some cases, immediate action may be required or the system closed until compliance can be obtained.