Chapter 11

OPERATION AND MAINTENANCE

General Considerations

The nature and scope of the operation and maintenance required will vary with the design and elements of water-supply systems. Depending upon the particular situation, the field work may include:

1. well, spring, or drainage basin inspection and maintenance;
2. dam and reservoir maintenance;
3. pump and engine operation and maintenance;
4. treatment operation;
5. distribution system maintenance;
6. service connexions to system;
7. meter repairs and maintenance;
8. operation in emergencies;
9. detection and elimination of cross-connexions.

Some information has already been given under the relevant sections regarding the principal features of operation and maintenance of various elements of water systems. This will not be repeated here; but some additional points of interest to waterworks field personnel are described in Annex 9 (see page 313).

There are two principal factors which contribute to most failures in water systems: (a) equipment and materials used under conditions for which they were not designed; and (b) operators who, because of either ignorance or disinterest, do not recognize the signs which precede or portend breakdowns and failures. By careful review of plans, design, and specifications, the water-supply-control administration can succeed in preventing or eliminating most difficulties of a mechanical character. The reduction of troubles caused by the human element is perhaps harder to achieve; but much can be done, as previously indicated, through training of field personnel, assistance from outside qualified staff (a form of in-service training) and close supervision.

Equipment

For small water systems, the following suggestions may be made:

1. Manufacturers' recommendations as to operation and maintenance procedures should be scrupulously observed. They should be drafted into
a form which can be easily understood by the operators. This is especially important with regard to pumping machinery.

(2) Maintenance should be organized according to rigid schedules. This applies to operations such as greasing, oiling, inspections, adjustments, and minor repairs.

(3) A system of supervision should be established to ensure that procedures and schedules are followed.

(4) Lubrication recommendations by the manufacturer of a particular piece of equipment must be followed.

(5) Ample space must be provided for equipment operators or maintenance men to work and to keep tools, spare parts, oil, grease and other supplies.

(6) Provision must be made for the establishment of suitably equipped workshops.

The following major field equipment will be found useful in most instances (depending upon the scope of the water system):

(1) dump truck(s), for the transportation of pipes smaller than 25 cm (10 in.) in size;

(2) an air compressor, pavement breakers, and air hammers;

(3) ditch pumps (at least two of them) equipped with 3.6-m (12-ft) hoses, for keeping trenches dry during work;

(4) electric generators, with two floodlights and extension cords, for emergency work at night;

(5) a small crane, handling up to about 2.5 metric tons (3 tons), equipped with pneumatic tires and a ball-bearing swivel safety hook and capable of 180° turning capacity. A crane is not needed for handling pipes of less than 15 cm (6 in.) in diameter, but is useful for handling, turning, and lowering pipes of larger diameter. Handling large pipes with hand labour and ropes usually results in an undue amount of breakage of pipe joints.

**Distribution System**

First and foremost, the operation and maintenance of a distribution system require the establishment of system maps and records. The system map should be drawn on large scale, preferably not less than 1:10,000, and should show all streets and their names, mains and their sizes and locations, valves and hydrants, reservoirs and elevated tanks, supply sources, and any other useful information. Besides the making of at least one full map, the same map may be divided into sections and bound for easy handling in the field.

In addition to the system map, valve records are necessary (except in very small water-supplies) to show their exact location, their numbering, and any particular reference regarding their operation. These records
can take the form of separate large-scale drawings, each for one valve, entered in a loose-leaf binder for handy reference. A system should be devised to ensure that these records and the maps are kept up to date. This is facilitated if pertinent information is reported and recorded after each repair or maintenance job is performed. These records are especially useful when valve boxes and cones are hidden or "lost", having been covered in the course of street repairs or construction.

The following specific suggestions may apply:

(1) **Valves**: Their function and installation are described in a previous section (see page 205). Valves and hydrants (if any) should be inspected every two months. This should be a primary duty of field operators and should be carried out on a regular inspection schedule using a simple check list to ensure that no valve is missed. The effort spent will repay itself many times in cases of emergency and fire when valves must be located and operated quickly. Packing and leakage can also be checked at inspection time.

(2) **Piping**: The maintenance of distribution pipes consists in checking for leaks, corrosion, and scale. Each time a line is opened, the interior of the piping can be observed. The life of more than one system has been greatly extended by workmen who have reported pipe damage when making a house connexion.

(3) **Tanks**: Concrete tanks require very little attention, while steel tanks must be painted often to prevent damage from corrosion. Instructions of manufacturers regarding type of paints and methods for painting must be closely followed.

(4) **Meters**: Meters usually require much attention. An organized maintenance system must be set up, or else the whole metering process will soon fail. A small repair shop is required for the cleaning and testing of meters and for the replacement of worn-out parts. It can be a room about 4 x 5 m (13 x 17 ft), equipped with benches, small tools, water connections, gauges, etc. It need not be complex and may be run by from one to four trained persons. A well-equipped repair shop manned by four experienced workmen can handle up to 5000 ordinary service meters a year.

**Cross-Connexions**

In small community water-systems, many opportunities exist for direct cross-connexions between public water-supplies and private cisterns and wells. Also, there is the always-present danger of back-siphonage of contaminated water from lavatory washbasins, water-closets, etc., into public distribution pipes when the domestic plumbing systems are not properly built. Furthermore, it does happen sometimes that the positive pressure existing in a main pipe drops suddenly to nil, or even becomes negative,
because of an accident, fire demand, leaking valves, or some human error of operation. Sanitary engineers are very familiar with the different types of cross-connexion and with the public health hazards associated with them. Many water-borne epidemics caused by accidental cross-connexions are reported in the literature. The field personnel of small water-systems should be alert to the danger and, although they are usually not responsible for inspection of house plumbing, the field service should be prepared to advise and assist customers in eliminating such plumbing defects.

Cross-connexions should be expressly forbidden. However, special requests from industries or neighbouring public water systems, for example, for connexions of their water pipes with the town’s distribution system should be closely examined by competent public health or water engineers on behalf of, or attached to, the controlling health administration. Wherever possibilities exist for back-siphonage, a free-fall discharge of the town’s water should be observed. It is generally agreed that a free fall equal to at least two pipe diameters above the highest flood level of the receiving unit is safe. In the case of lavatory washbasins, the maximum flood level would be the top of the basin, even though an overflow pipe is provided. Vacuum breakers are also used to prevent back-siphonage. They are usually installed at least 10-15 cm (4-6 in.) above the maximum flood level of the receiving unit, according to manufacturers’ instructions. Special devices, such as the back-flow preventer, must be approved by the public health administration before they can be installed in a system linking private and public water-supplies.

Operation in Emergencies

Every public water-system, whether large or small, should be as prepared as possible for emergency operating procedures which may be necessitated by such catastrophes as earthquake, flood, war damage, or evacuation of populations due to war or sudden cataclysms. It must be remembered that, in such circumstances, water is probably the most urgent need of individuals, who will use any available source, polluted or not, with the consequent hazards of epidemics, if provision is not made quickly for a supply of safe water. In fact, the amount of water available may govern the number of evacuees who may be received and handled in a particular village or town. For this reason, it is recommended that, soon after the start of operation of a new water-system, or even before, a realistic inventory be made covering all available sources of water supplies, public or private, together with their capacities, location, accessibility and potability. This inventory should also include personnel resources and available, emergency-type, water-supply equipment, hand and motor pumps, water-tank trucks, pipe accessories (especially coupling and jointing materials), mobile or
portable filter units, tools, spare parts, and chemicals (especially those for water disinfection purposes).

At times of emergencies, a minimum of 1 litre (1 qt) of water should be provided daily for drinking only and another 3 litres (3 qt) for other purposes, in such places as temporary shelters. In camps with tents, a minimum of 20 litres (5 US gal.) should be provided, and this amount should be doubled for the supply of temporary hospitals and first-aid stations. It goes without saying that every step should be taken to conserve water, and that every possible sanitary safeguard should be employed to protect existing supplies—especially surface supplies such as lakes, ponds, open reservoirs, and springs—from contamination. While ground-water supplies from properly constructed wells, infiltration galleries, and spring structures may sometimes be considered safe, all surface water should be considered of doubtful quality and should be disinfected by boiling, chlorination, or disinfection by iodine compounds. The notes previously given under “Household purification of water” (see page 185) also apply here, except that heavier chlorination is recommended. The free chlorine residual in reasonably clear water at times of emergencies should be not less than 5 p.p.m. after 30 minutes of contact when the water has not had the benefit of prior filtration. The raw water should be taken from an approved source; and, if it has strong taste, odour, or colour, it should be avoided as far as possible.