4

Water supply description

A description of the drinking-water system is equally applicable to large utilities with piped distribution systems, piped and non-piped community supplies, including handpumps and individual domestic supplies. Assessment can be of existing infrastructure or of plans for new or upgrading of supplies (see Chapter 12). As drinking-water quality varies throughout the system, the assessment should aim to determine whether the final quality of water delivered to the consumer will routinely meet established health-based targets (see section 1.4.1).

Water safety plans should, by preference, be developed for individual water supplies, except for very small systems where this may not be realistic (see Chapter 13), in which case a 'model' water safety plan based upon the relevant technology may be most appropriate (see Appendix A).

4.1 DESCRIBE THE WATER SUPPLY

The first step in the system assessment process is to fully describe the water supply. This should cover the whole system from the source to the point of supply, covering the various types of source water, treatment processes and so on. Box 4.1 outlines examples of information to be considered in describing the water supply.

Catchments

- Geology and hydrology
- Meteorology and weather patterns
- General catchment and river health
- Wildlife
- Competing water uses
- Nature and intensity of development and land-use
- Other activities in the catchment which potentially release contaminants into source water
- Planned future activities

Surface water

- Description of water body type (e.g. river, reservoir, dam)
- Physical characteristics such as size, depth, thermal stratification, altitude
- Flow and reliability of source water
- Retention times
- Water constituents (physical, chemical, microbial):
- Protection (e.g. enclosures, access)
- Recreational and other human activity
- Bulk water transport

Groundwater systems

- Confined or unconfined aquifer
- Aquifer hydrogeology
- Flow rate and direction
- Dilution characteristics
- Recharge area
- Well-head protection
- Depth of casing
- Bulk water transport

Box 4.1: Examples of information useful to describe a water supply - continued

Treatment systems

- Treatment processes (including optional processes)
- Equipment design
- Monitoring equipment and automation
- Water treatment chemicals used
- Treatment efficiencies
- Disinfection removals of pathogens
- Disinfection resi dual / contact period time

Service reservoirs and distribution systems

- Reservoir design
- Retention times
- Seasonal variations
- Protection (e.g. covers, enclosures, access)
- Distribution system design
- Hydraulic conditions (e.g. water age, pressures, flows)
- Backflow protection
- Disinfectant residuals

Two brief supply description examples are shown in Box 4.2. These descriptions provide the water safety plan team with an overview of the supply and an initial understanding of existing controls.

Box 4.2: Example supply description (Godfrey *et al*. 2003)

Example 1
Water utility X's objective is to produce potable water.
The water is received from a bulk water supplier and delivered to customers to meet the water quality objectives set by the Health Authority according to public health targets.
The water quality objectives are captured in the Operating Licence, Customer Contract and the current and relevant drinking-water Guidelines.
Disinfection and fluoridation chemicals are supplied by ABC chemical manufacturer and form part of the delivered product. Quality agreements are in place in relation to treatment chemicals received from manufacturers and bulk water received.

Example 2
Water utility Y's objective is to produce, potable water for a town and a series of small communities.
Water is obtained from two surface water reservoirs, which are located 35 and 20 km from the town.
Both reservoirs have protected areas, but encroachment is a serious problem at one reservoir, which is also subject to pollution from small-scale industry.
The treatment works at each reservoir has a conventional configuration of coagulation-flocculation-settling, rapid sand filtration and terminal chlorination is used for disinfection.
The water from both reservoirs flows to a high-level and a low-level service reservoir. There are connections directly onto both transmission mains serving intermediate settlements.

4.2 CONSTRUCT FLOW DIAGRAM

Hazard identification (which will be considered more fully in Chapter 5) is facilitated through the conceptualisation of the specific water supply system, through the construction of a flow diagram. A generalised flow diagram for a drinking-water supply is shown in Figure 4.1.

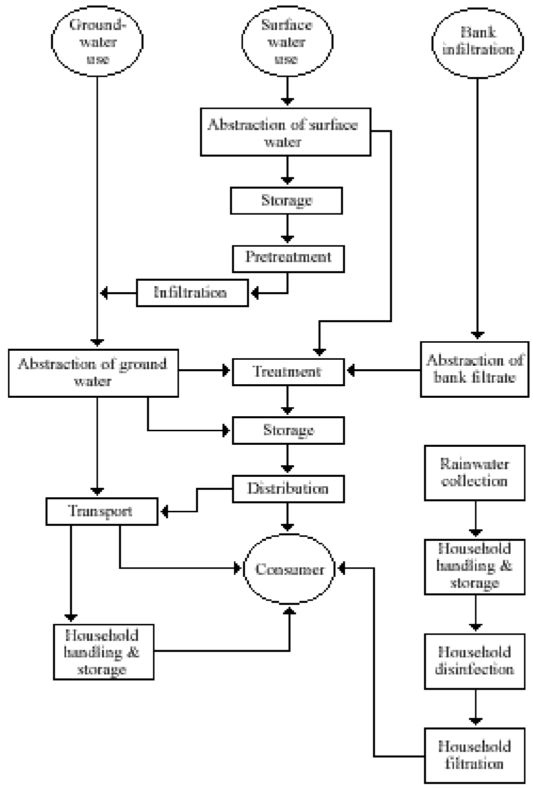

Figure 4.1 Generic system flow diagram (adapted from Havelaar 1994)

To enable hazards to be clearly identified, system-specific flow charts are required that elaborate on the processes involved at each step (Figure 4.2). Typically, this is done through the use of sub-ordinate flow charts and maps. For some water supplies the treatment step may only consist of chlorination, while for others there may be many steps including conventional treatment. Similarly, for some supplies there is little that can be done to influence catchments and source waters. For others, good access to catchment and source water information exists. This may be combined with the potential to influence catchment activities and/or undertake selective transfer and withdrawal of water. In such cases extensive catchment and source water information could be part of the flow chart or system map since catchment and source water control measures will be incorporated within the plan.

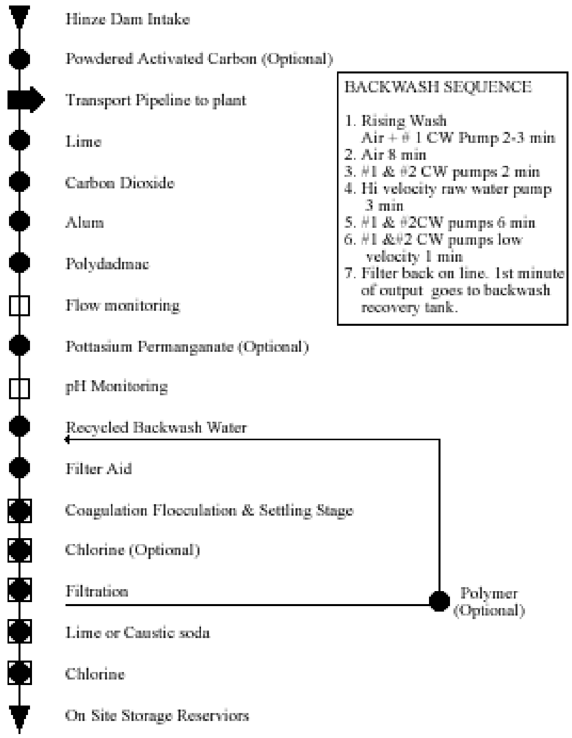

Figure 4.2: Flow chart for the Gold Coast Water (Australia) Molendinar water purification plant (clarifier model)

4.3 CONFIRMATION OF FLOW DIAGRAM

It is essential that the representation of the system is conceptually accurate, as the water safety plan team will use this as the basis for the hazard analysis. If the flow diagram is not correct, the team may miss significant hazards and not consider appropriate control measures.

To ensure accuracy, the water safety plan team validates the completeness and accuracy of the flow diagram. A common method of validating a flow diagram is to visit the system and check the set up of the system and processes.

Proof of flow chart validation should be recorded along with accountability. For example, a member of the water safety plan team may sign and date a validated flow chart as being accurate and complete.

4.4 MELBOURNE WATER CASE STUDY – ABBREVIATED SUPPLY DESCRIPTION

Melbourne Water harvests 90% of its water from more than 160,000 hectares of uninhabited, forested catchment with no public access, urban development or agriculture (catchments are shown in Figure 4.3).

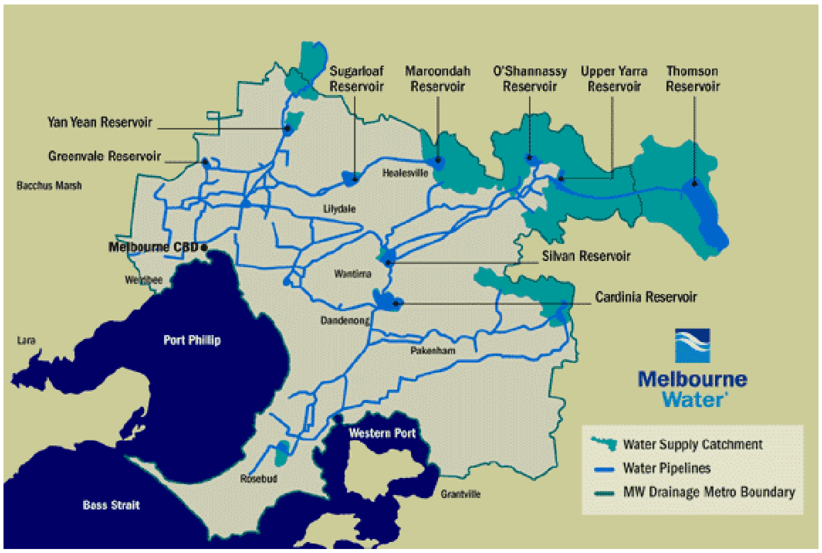

Figure 4.3: Water supply system (MW 2003)

Water is stored in a number of large reservoirs (40,000 ML to 1,000,000 ML) before treatment by disinfection only prior to distribution. The 10% of Melbourne Water's supply that is drawn from agricultural catchments is fully treated (convention filtration or membrane filtration) before distribution.

Melbourne Water is a State Government-owned utility and is the wholesale water supplier for the city of Melbourne (approximately 3.5 million people). Melbourne Water is responsible for harvesting and treatment of drinking-water. Drinking-water is distributed to consumers by three retail water companies, which operate under licences issued by the State Government. These licences specify standards of water supply for Melbourne consumers. Melbourne Water's water supply obligations to the retail companies are defined in a formal contract called the Bulk Water Supply Agreement (BWSA).

Melbourne Water manages the harvesting of water from catchments, the major transfer, storage and treatment of water and the transfer of water to numerous interface points with the retail companies. It operates, manages and plans Melbourne Water's water supply system which comprises:

- 156,756 hectares of catchments and headworks;
- 11 major storage reservoirs: 9 currently in use with 1,773GL capacity;

- 59 service reservoirs: 41 steel tanks, 5 concrete tanks and 13 earthen basins;
- 1,029 km of distribution mains;
- 225.5km of aqueducts, siphons and tunnels;
- 18 pump stations;
- 5 filtration plants;
- 46 disinfection plants: 42 chlorine and 4 ultra violet;
- 8 fluoridation plants;
- 13 pH correction plants;
- 2 hydro power stations;
- 19 valve complexes;
- 78 pressure reducing stations and flow control valves;
- 23 weirs;
- 78 billing flow meters;
- 46 hydrographic monitoring stations (streamflow and rainfall); and
- 14 aqueduct and reservoir cut-off (catch) drains.

A simplified process flow chart for the Silvan system is shown in Figure 4.4.

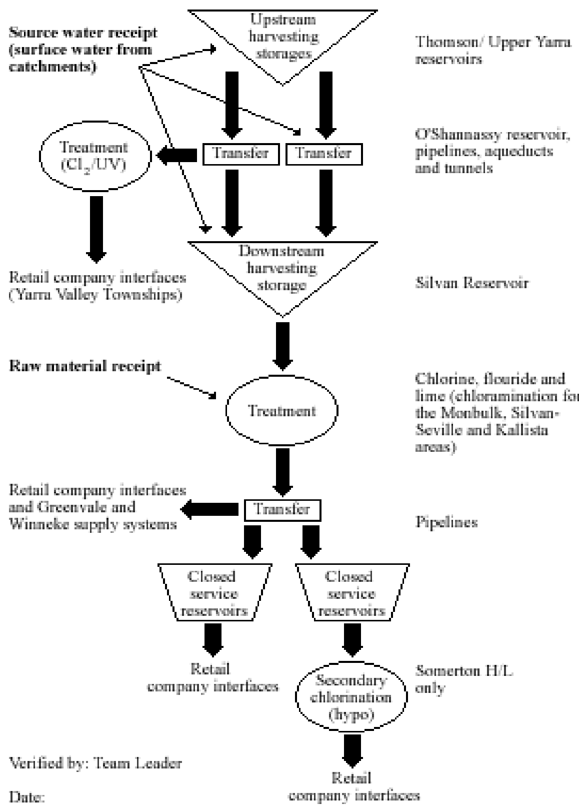

Figure 4.4: Simplified Process Flow Chart – Silvan System (adapted from MW 2003)

4.5 KAMPALA CASE STUDY – ABBREVIATED SUPPLY DESCRIPTION

The Kampala system takes its water from the mouth of the Inner Murchison Bay on Lake Victoria, the second largest inland water body in the world. The catchment of the Inner Murchison Bay includes Kampala and receives contaminated water from the urban drainage system which, because of low sanitation coverage, contains significant faecal material. The original extensive wetlands that fed into the Inner Murchison Bay and which provided some removal of contaminants are becoming rapidly degraded. The wastewater treatment works at Bugolobi discharges into the Inner Murchison Bay and there is growing industrial and commercial development with associated discharges. The catchment also includes agricultural land and local fishing.

The Kampala system has two treatment works at Gaba that utilise conventional treatment processes. The average combined capacity of the works is 95,000m^3/day, which is then distributed to 5 major service reservoirs. There are two distinct pressure zones (high and low) in the supply. The principal service reservoir for the low pressure transmission main is located in the city centre at Gun Hill. The high-pressure transmission mains supplies balancing tanks at Muyenga, South of the City. The Muyenga tanks serve some secondary transmission mains directly and also supplies three other service reservoirs located in the North (Naguru), East (Mutungo) and West (Rubaga) respectively. The entire network covers more than 871 kilometres of pipeline with over 40,000 household connections. Based on previous assessments of numbers of people served with household connections and of water source use by households without a household connection, it is estimated that the network serves 700,000 people.

Figure 4.5 below provides a schematic diagram for the Kampala system.

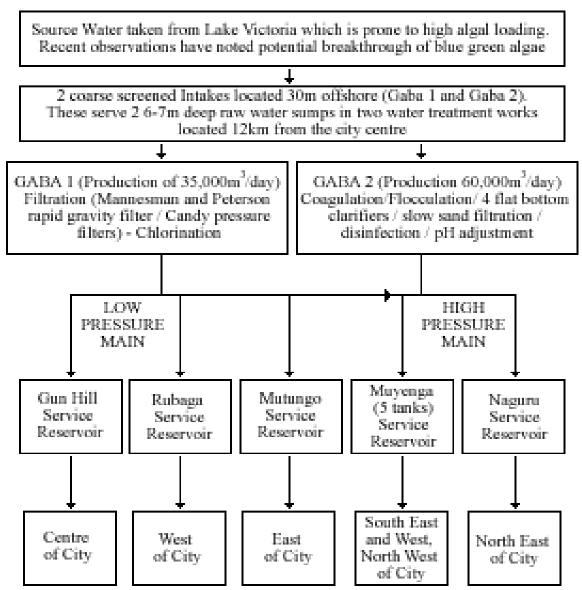

Figure 4.5: Flow diagram for the Kampala network (taken from Godfrey *et al*. 2003).