Sustainable Management of Small Drinking-water Supplies

Resources for the Drinking-water Assistance Programme

2007
Sustainable Management of Small Drinking-water Supplies
Resources for the Drinking-water Assistance Programme
Contents

1 Introduction 1

2 What is Sustainable Management? 2
   2.1 Understanding the needs and wants of the community 2
   2.2 Having a clear system for managing the water supply 2
   2.3 Having a clear system for operating the water supply 2
   2.4 Efficient collection and use of funds 3
   2.5 Looking after and replacing infrastructure 3

3 Demand Management 4
   3.1 Tools for reducing water demand 4
   3.2 Leakage 4

4 Resource Consent Compliance 5

5 Calculating Operating and Maintenance Costs 6
   5.1 Benchmarking and budgeting 6
   5.2 Factors that can affect costs 6

6 Monitoring Treated Water Costs 8

7 How is the Water Paid for? 9
   7.1 User pays 9
   7.2 Flat fee 9
   7.3 Flat fee and usage charge 9
   7.4 Rateable value 9

8 Worked Example 10
   8.1 Background 10
   8.2 Budget 10
   8.3 Evaluation 10

List of Tables
Table 1: Normal life span of water supply equipment 3
Table 2: Activities categorised and costed in the annual budget 8
Table 3: Example of an annual budget for a small water supply 12

List of Figures
Figure 1: Method of treatment for sample small community 10
1 Introduction

Although water may fall from the sky at no charge, there are costs involved in producing safe water and delivering it to the tap. Managing a water supply is about balancing costs and income so that the supply is safe and sustainable in the long term. Furthermore, when water is taken from a source, there is an inevitable effect (sometimes small) on the environment it is taken from and on others who live nearby or downstream, to whom the water would otherwise be available. This booklet provides information about the supply of safe drinking-water to small water supplies serving fewer than 5000 people.

Water system owners need to know how to manage all aspects of their water system. They need to know about the system’s operation and the related regulatory requirements for the system to provide safe and reliable drinking-water. Acquiring this knowledge can take time and effort.

The Ministry of Health have produced this guide to help. For more information, contact your regional Technical Assistance Programme (TAP) facilitator at your Public Health Unit.
2 What is Sustainable Management?

Water supplies are normally planned for the long term. The pipes, tanks, pumps, buildings and treatment plants that make up a water supply are expected to last for a long time. Equipment can be expensive and must therefore be looked after and run efficiently.

Sustainable management is really about planning for costs that come up over the life of the water supply. The management of these costs incorporates the following elements.

2.1 Understanding the needs and wants of the community

In many communities, expectations of their water supply can be described through ‘levels of service’. It is wise to define these first so that the community knows what can be expected from their water supply. Below are some questions that can be asked in defining the needs and wants of the community.

- How much water does the community need?
- Are there community or public health concerns about the water supply?
- How much can they afford to spend?
- Will there be enough water in the future to match the community’s needs?
- How will people be encouraged to look after their water supply?
- How will the community be encouraged to avoid wasting water?
- What sort of reliability and continuity of supply do they expect?

2.2 Having a clear system for managing the water supply

A water supply could be managed by an individual, a committee, a marae trust or a rūnanga, a local council or some other body that has responsibility to ensure the water is safe on a day-to-day basis. The following are some questions that can be asked in clarifying the system of management.

- Is it clear who owns the water supply?
- Who makes the decisions when money has to be spent?
- How does the community know the plant is operated well?
- How does the community know the drinking-water is safe?

2.3 Having a clear system for operating the water supply

It is important to remember that, for sustainable management of a water supply, there needs to be more than one person that understands how it operates. To meet this need, there could be the usual operator and another person with an interest in the system who can step in when needed.
2.4 Efficient collection and use of funds

A water supply needs to bring in enough money to cover all costs. To balance the budget, the water supplier may need to increase income, reduce costs, or both. There needs to be a system for collecting the money and deciding how to spend it.

Decisions on how to spend money must be made for the benefit of existing and future generations.

2.5 Looking after and replacing infrastructure

Equipment needs to be repaired and replaced as it ages. Failure to replace system components or facilities as they get worn can threaten the quality and safety of the water supply and pose a risk to public health.

With good maintenance, equipment life spans can be expected to be in the ranges indicated in Table 1.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Normal lifespan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings, concrete or steel structures, buried pipes</td>
<td>50–100 years</td>
</tr>
<tr>
<td>Pumps, valves, switchboards and similar equipment</td>
<td>15–20 years</td>
</tr>
<tr>
<td>Instruments and controls</td>
<td>10–15 years</td>
</tr>
</tbody>
</table>

Unfortunately, equipment sometimes becomes obsolete just because replacement parts are not available. A decision on purchasing equipment should be based on an assessment of its expected life, purchase cost and estimated length of use until needs change or replacement is inevitable. This decision is often not as simple as it may seem. For example, an item that is cheap to buy may be more expensive in the long term because it needs to be replaced more often, or because it is expensive to run.
3 Demand Management

In many communities, water demand needs to be managed in order to control treatment costs or to ensure that the available water will be sufficient for the community’s needs. In summer the water demand generally increases at the same time as source water flow decreases. Many small supplies also serve rural customers that use the water for stock watering, irrigation, wash down, or cooling.

3.1 Tools for reducing water demand

Identifying large users

It is important to identify the larger users so that their consumption can be measured and possibly charged for. The measurements can also be used to help the user to consider ways to economise on water use.

When consumers are aware of their level of water usage they are more likely to make repairs or changes. This could include repairing leaking pipes or installing dual flush toilet cisterns and conserving water. One method is a charge per unit volume. Another example is a stepped tariff structure where the rate increases when consumption exceeds the average for that category of user.

Restricting use

The most common way to manage water demand is to implement water restrictions. These work in varying ways. Examples are: hose bans; watering on alternating days of the week, with the specific days depending on whether the user’s house number is odd or even; watering only in certain hours, such between 9 pm and 8 am (both to take advantage of cool conditions and to redistribute water demand).

Many rural schemes operate as Restricted Flow Supplies (NZS9201, 1994, Model General Bylaws, Chapter 7). These are networks where a small continuous flow is supplied through a flow control device, and storage is provided by the customers to cater for their flow fluctuations. The system is designed to spread the load of water demand. This system also restricts the total amount of water that can be taken by individual customers but may increase risks related to water storage.

3.2 Leakage

Inevitably, leakage will occur in a distribution network and in the homes of consumers. The severity of the leakage problem can be calculated by measuring the water demand when it should be at a minimum, such as in the early hours of the morning, and comparing it with actual use. Various techniques can then be used to locate the individual leaks.

If left unchecked, leakage can greatly increase the amount of water that needs to be collected and treated. It can lead to localised problems around the leak site. Most importantly, it means that there is a point where contaminants can potentially enter the system if water pressure is lost.
4 Resource Consent Compliance

Regional councils may grant consents for any activity that directly affects the natural environment. Examples are water abstraction and water discharge. Consents are generally given for a fixed term. Monitoring and reporting are also required for compliance with most consents. This is likely to require regular laboratory tests and/or measurements of flow.

A water supply is often subject to resource consents for taking water from a natural water source, including both surface water and groundwater, and for the disposal of wastes. There may also be consents required for one-off activities such as disposal of water from mains flushing programmes. The particular requirements vary from region to region and from catchment to catchment.

If a community has on-site wastewater systems the effect of reticulating the community’s drinking-water supply on the wastewater systems, needs to be taken into account and would be considered when a resource consent application was assessed.
5 Calculating Operating and Maintenance Costs

Water treatment operating and maintenance costs include the cost of materials, chemicals, energy, wages, and contracted labour. To keep control of these costs, the supplier needs to record the costs of operation and maintenance, have planned maintenance programmes and monitor equipment condition.

The decision to install new treatment processes must take account of an assessment of the effect on operating costs. Ongoing costs can be factored into a purchase decision.

5.1 Benchmarking and budgeting

It can be helpful to compare your costs at a plant with those of other comparable plants to see if the figures that you have calculated are in a normal range.

It is also useful to compare costs over months and years to look for patterns at each plant that may point to important changes. Costs should be divided into categories, such as the individual treatment processes, to further improve comparisons.

To be able to categorise your costs, it is necessary to record the costs of running the water supply separately from the other costs in the community. Without this separation, unfair comparisons could be made.

Operating costs per unit of water or time for each process could be estimated for:

- employment costs
- power
- chemicals
- materials/consumables
- hired/contracted services.

With this information, you will soon understand normal expenditure patterns and be able to determine whether there are unusual circumstances that warrant further scrutiny.

5.2 Factors that can affect costs

It is important to remember that the costs applying to one water supply do not necessarily translate easily to another. The following are some of the factors that need to be considered.

**Water demand:** Both the average demand and the peak demand for water need to be considered when reaching an understanding of the cost of treating water. Sometimes peak demand is due to an influx of visitors during the tourist season. It can be difficult to recover the costs of treatment from these non-resident consumers.

**Water source quality:** In general, the more dirty the source water is, the more it costs to clean it. The costs increase due to the greater input required, such as paying to dispose of more waste, cleaning equipment more often, replacing components (such as cartridge filters) and using more chemicals. This kind of impact on cost can be
important if the cost is estimated based on a period of particularly good, or poor, water quality.

**Suitability and quality of equipment:** Equipment purchased cheaply is not always designed for constant operation and can fail frequently if it is heavily used. Sometimes the wrong type or size of equipment is installed for the application. It is important to record the history of equipment and to have evidence to base your replacement decisions on. It is not enough to rely on memory when spending money provided by the community or from government.

**The relative costs of the different treatment options:** Some plants are selected for low construction cost but they sometimes have a high ongoing cost after that. Certainly the operating costs of one type of plant should not be used to estimate the costs of another.
6 Monitoring Treated Water Costs

Once an annual budget is created, it should be allocated on a monthly basis. In practice, the monthly costs will depend on water usage and the timing of expenditure throughout the year. Expenditure in some months may be much greater than others. A sensible estimate will have to be made.

Costs for operation and maintenance can then be compared monthly against the budget figures. Where there is a difference between actual costs and the budget, there is a need for careful attention to the reasons for the difference. Sometimes expenditure can be over or under budget each month without having an impact on the overall annual expenditure. However, where there is overexpenditure that will have an impact on revenue requirements, it is important to be aware of these circumstances as soon as possible. The actions that are required will depend on the funding arrangements for the water supply and the financial systems that are used.

An annual budget could be prepared under the headings indicated in Table 2 below. It may be that more detail is helpful in some areas. You may also allocate the costs to processes or parts of your water supply.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries and wages for paid operations, maintenance and administration functions, including labour costs for treatment, maintenance, monitoring and testing (for example, for a school caretaker it might be the time that is spent working on the supply, ordering equipment, following up on monitoring results, etc)</td>
<td></td>
</tr>
<tr>
<td>Utilities, including electricity and telephone charges</td>
<td></td>
</tr>
<tr>
<td>Chemicals and other consumables used (eg, filter cartridges)</td>
<td></td>
</tr>
<tr>
<td>Removal or disposal of wastes</td>
<td></td>
</tr>
<tr>
<td>Water quality monitoring (sampling and laboratory)</td>
<td></td>
</tr>
<tr>
<td>Components for the repair of equipment</td>
<td></td>
</tr>
<tr>
<td>Insurance (on facilities and vehicles), tax, ACC levies</td>
<td></td>
</tr>
<tr>
<td>Accounting, legal, engineering and other professional services</td>
<td></td>
</tr>
<tr>
<td>Rent, mortgages, rates</td>
<td></td>
</tr>
<tr>
<td>Office supplies, computer software</td>
<td></td>
</tr>
<tr>
<td>Transport and plant hire</td>
<td></td>
</tr>
<tr>
<td>Staff training</td>
<td></td>
</tr>
<tr>
<td>Allowance for equipment replacement (pumps, valves, etc)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>
7 How is the Water Paid for?

The operation of a water supply should be treated as a business. In any business the generation of costs must be met by the generation of revenue. Provision should be made for one-off replacement of plant and equipment according to a programmed schedule, as well as for ongoing operations and maintenance expenditure. Unforeseen expenditure can be difficult to fund and can create negative consumer reaction.

The following are four possible ways of funding the operation of a water supply.

7.1 User pays

A user pays system relies on readings taken from water meters that are installed on the connections to each consumer. The charge that is payable is calculated from the meter reading. The frequency of the meter reading may vary – from monthly to annual. Many different tariff structures can be designed for a water supply. Often the tariff may be designed to discourage water wastage. Designing a tariff using meter reading is an activity for which special expertise is recommended.

7.2 Flat fee

Where meters are not installed, flat fees are often adopted. This fee is set for individual connections and will not depend on the number of occupants beyond the boundary. Sometimes the fee depends on the connection type or connection size – to reflect in some way the particular demands placed on the supply by different types of consumers. Sometimes special fees will be levied for installation of new connections, testing of backflow prevention devices or other special services.

7.3 Flat fee and usage charge

A third charging mechanism relies on readings taken from water meters but recognises that many services for a water supply are at fixed costs that do not depend on water usage. This method is a mix of user pays and a flat rate. Here, the water user pays a flat rate to be on the water supply but also pays a charge for the water they use. Specialist advice is also likely to be needed for the task of designing of this type of tariff.

7.4 Rateable value

In many communities, consumers are charged for their water according to the rateable value of their property. Usually the council will adopt a charging policy to allow this to happen and will then determine the rate charge year by year.
8 Worked Example

The following worked example illustrates how budgets can be prepared to provide for the cost of treating water.

8.1 Background

Community: This small community uses approximately 20,000 litres per day in winter and 30,000 litres per day in summer.

Water source: The water comes from a small stream in a native forest.

Treatment: A pressure filter acts as a roughing filter for cartridge filters and a UV unit disinfects the water. Water is then pumped into the distribution network at pressure (see Figure 1).

8.2 Budget

Based on the previous year of operation, a budget of $6,150 is allowed for the upcoming year. The main costs for this supply are electricity and new cartridges for the filters. Most costs occur evenly throughout the year so the water supplier budgets to spend around $500 a month.

8.3 Evaluation

Several events happen over the year that affect the cost of running the water supply.

First, in April a UV lamp fails and has to be replaced. UV lamps are expected to last around 10,000 hours and this lamp has run for 8000 hours. Because this item is provided for in the contingency allowance for expenses like equipment replacement, the money needed to replace the unit is taken from that fund. The cost of the lamp and replacement sleeve is $300.

In addition, the community’s water demand in summer is higher than in winter. Consequently, more cartridges are normally used in summer due to the higher flows. However, over the late winter period (July to August) the cartridges block repeatedly because of a large slip in the water catchment, which makes the water very turbid for several weeks. As a result, the costs for cartridges are much higher than normal in the winter period.
In November there is a breakdown on the treated water supply pump, requiring a technician to repair it. This cost, while high in that month, is catered for – like the UV lamp costs – by the contingency allowance for the year.

Table 3 that follows illustrates the way that costs fall in the year and how they can be represented in a table. The way this table is laid out may, or may not, suit the particular situation for your supply. The same principles, however, may be adapted and applied to any situation.

As the example sheet shows, this year has been more expensive than the costs that were budgeted for, and the money that the water supply has in savings has eroded over the year. More money, including an allowance for unforeseen events, will need to be collected next year.
**Table 3:** Example of an annual budget for a small water supply

<table>
<thead>
<tr>
<th>Month</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Budget income</strong></td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$7200</td>
</tr>
<tr>
<td><strong>Budget costs</strong></td>
<td>$620</td>
<td>$620</td>
<td>$620</td>
<td>$580</td>
<td>$580</td>
<td>$580</td>
<td>$580</td>
<td>$580</td>
<td>$580</td>
<td>$620</td>
<td>$620</td>
<td>$620</td>
<td>$7200</td>
</tr>
<tr>
<td><strong>Actual income</strong></td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$7200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Actual costs</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries and wages</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Utilities</td>
<td>112</td>
<td>110</td>
<td>100</td>
<td>95</td>
<td>95</td>
<td>90</td>
<td>85</td>
<td>95</td>
<td>90</td>
<td>110</td>
<td>110</td>
<td>1187</td>
<td>1840</td>
</tr>
<tr>
<td>Chemicals and other consumables used</td>
<td>90</td>
<td>90</td>
<td>80</td>
<td>350</td>
<td>50</td>
<td>50</td>
<td>400</td>
<td>500</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>1840</td>
</tr>
<tr>
<td>Removal or disposal of wastes</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>Water quality monitoring costs</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>960</td>
</tr>
<tr>
<td>Components for the repair of equipment</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Insurance, tax, ACC payments</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>600</td>
</tr>
<tr>
<td>Professional services</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1200</td>
<td>0</td>
<td>1200</td>
</tr>
<tr>
<td>Rent, mortgages, rates payments</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>960</td>
</tr>
<tr>
<td>Office supplies</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Transport and plant hire</td>
<td>60</td>
<td>66</td>
<td>72</td>
<td>57</td>
<td>63</td>
<td>60</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>57</td>
<td>63</td>
<td>60</td>
<td>765</td>
</tr>
<tr>
<td>Staff training</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Monthly payment to cover contingencies</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>1200</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td>$587</td>
<td>$581</td>
<td>$567</td>
<td>$817</td>
<td>$523</td>
<td>$520</td>
<td>$925</td>
<td>$981</td>
<td>$532</td>
<td>$512</td>
<td>$2088</td>
<td>$565</td>
<td>$9198</td>
</tr>
</tbody>
</table>

| Account balance | Starting balance | $2000 | $2013 | $2032 | $2065 | $1848 | $1925 | $2005 | $1680 | $1299 | $1367 | $1455 | -$33 |
|                 | $13 | $19 | $33 | -217 | $77 | $80 | -325 | -381 | $68 | $88 | -1488 | $35 |
|                 | Finishing balance | $2013 | $2032 | $2065 | $1848 | $1925 | $2005 | $1680 | $1299 | $1367 | $1455 | -$33 | $2 |
Sustainable Management of Small Drinking-water Supplies
Resources for the Drinking-water Assistance Programme

2007