Water security level of service objectives

Guidelines for development

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Queensland Government

This publication has been compiled by Water Markets and Supply, Department Natural Resources, Mines and Energy.

Summary

Water is a vital resource, essential to the lives and livelihoods of every Queenslander. Fluctuations in water availability due to population growth, demand and climate variations highlight the need to plan for water supply security. A water service provider, with its knowledge of the local water supply system and understanding of water use and community expectations, is the most appropriate entity to undertake this planning.

Fundamental to planning for water supply security is a good understanding of the water supply characteristics, the water demand of the community as well as the expectations of the community. All of this information underpins an evaluation of the current level of water supply security. A water service provider can then assess what level of water supply security may be appropriate in the future and engage with the community on this. This will ultimately lead to a planned level of water supply security, defined by appropriate LOS objectives, for a community.

To determine appropriate water security level of service objectives a water service provider will need to:

1. Assess the available information, including the characteristics of the water supply and the community expectations.
2. Consider the trade-offs, for example identifying the costs of potential changes required to the water supply system to achieve a particular level of water supply security.
3. Determine a suitable target, by considering the ability to meet the level of service objective under varying circumstances.

This level of service approach can result in both the water service provider and the community having a greater awareness of the potential risks to the water supply and can lead to more efficient water management and appropriate investment in water infrastructure.

This guideline provides information about what water security level of service objectives are, why they are beneficial and how they can be developed for a community. They relate only to the availability of bulk water as there are regulatory requirements in place to ensure there are appropriate measures and plans in place to ensure the water is treated to the appropriate quality.

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1 Introduction

Queensland is a vast state with great variations in climate, from the tropical north to the temperate south and the arid west. Safe, secure, reliable and cost-effective water supplies underpin the livelihoods and lifestyles of all Queenslanders. Informed and effective planning is essential to support our industry, agriculture and population growth, in this variable and changing climate.

In Queensland the provision of reticulated water supplies to urban communities is the responsibility of local water service providers (WSPs), which are often the local council. This includes planning, demand management and infrastructure expenditure to maintain water supply over the short and long term. The state government actively works with WSPs to support effective water supply planning by understanding the ability of current water supply systems to meet future needs and through the establishment of innovative policy and regulatory frameworks.

Water security level of service (LOS) objectives can be viewed as a planning tool that sets targets for long-term water supply security for a community. The objectives relate to the bulk water supply system, or in other words, the 'bucket' of water available for treatment and distribution to a community. LOS objectives contribute to a community's understanding of their water security position and provide guidance to planners and decision-makers particularly regarding investment, to ensure there is adequate water supply available over the long-term.

Outside of South East Queensland, local councils and water service providers are encouraged to develop their own level of service objectives. This guideline has been prepared to support WSPs to develop local water security LOS objectives and targets.

2 Purpose

These guidelines have been produced to provide WSPs with information about the use of LOS objectives in water supply security planning and advice on how to develop them. It includes guidance on how to set appropriate measures and targets to underpin the long-term water supply security for their community. Towards this aim, these guidelines outline:

- what LOS objectives are (Section 3)
- why adopting LOS objectives is beneficial (Section 4)
- relationship with other legislative and regulatory requirements (section 5)
- the water security framework (Section 6)
- how a WSP could develop LOS objectives for a community (Sections 7 and 8).

3 What are level of service objectives?

Water security level of service (LOS) objectives are the targets set by the WSP, in consultation with the community, for providing long-term water supply security for the community. Tis is to ensure that there is sufficient reliable water to meet the needs of the community, businesses and industry. The LOS objectives provide specific targets for various water supply security indicators, such as expected water demand and the frequency, severity and duration of water restrictions.

3.1 Scope of these guidelines

While planning for quality, quantity and reliability of water supplies are each important, the focus of this guideline is on long-term planning for sufficient quantity of water for urban communities in Queensland.

Beyond the quantity of water supplies, LOS objectives can also describe quality standards and service reliability standards. Queensland has a well-established water quality management framework that requires the development of drinking water quality management plans with accompanying water quality monitoring and reporting. It is recommended that WSPs do not include water quality standards in their LOS objectives, other than a statement of compliance with the relevant existing legislative and regulatory frameworks.

LOS objectives can also describe reliability standards for the delivery of water services, such as pressure delivered, frequency of loss of supply and other such matters. In Queensland, WSPs are required to develop and publish customer service standards that set target levels of service for key performance indicators against activities such as billing, continuity of services and complaint management. By comparison, this guideline is focussed on long-term access to reliable water supplies.

3.2 An example of water security LOS objectives

LOS objectives are dependent on the community values as well the local supply characteristics and are therefore generally set for the urban water supply associated with a particular community or town. LOS objectives commonly include statements about:

- how much water the water supply system will typically be able to supply
- how often, how severe and for how long water restrictions might occur
- the possibility of needing an emergency water supply due to a prolonged drought.

Table 1 presents an example of LOS objectives developed for the Cairns community.

Table 1: Cairns level of service objectives

Type	**Target**		
	Trigger	**Severity**	**Frequency***
Restrictions	Level 1 (80% storage)	10% use reduction	1.5 years ARI*
	Level 2 (70% storage)	15% use reduction	5 years ARI*
	Level 3 (60% storage)	20% use reduction	10 years ARI*
	Level 4 (50% storage)	25% use reduction	25 years ARI*
Emergency measures	Emergency (40% storage)	Planned response	100 years ARI*
	Supply shortfall (dead storage)	Supply shortfall	>1000 years ARI (no simulated event)

Notes:
[a] Cairns Regional Council March 2015 Our water security: Cairns Regional Council water security strategy final report. Accessed August 2016 at: www.cairns.qld.gov.au.
* The frequency is given in terms of average recurrence interval (ARI) which is the expected average period of time between the specified event re-occurring (e.g. reaching a particular storage level).

3.3 Considerations

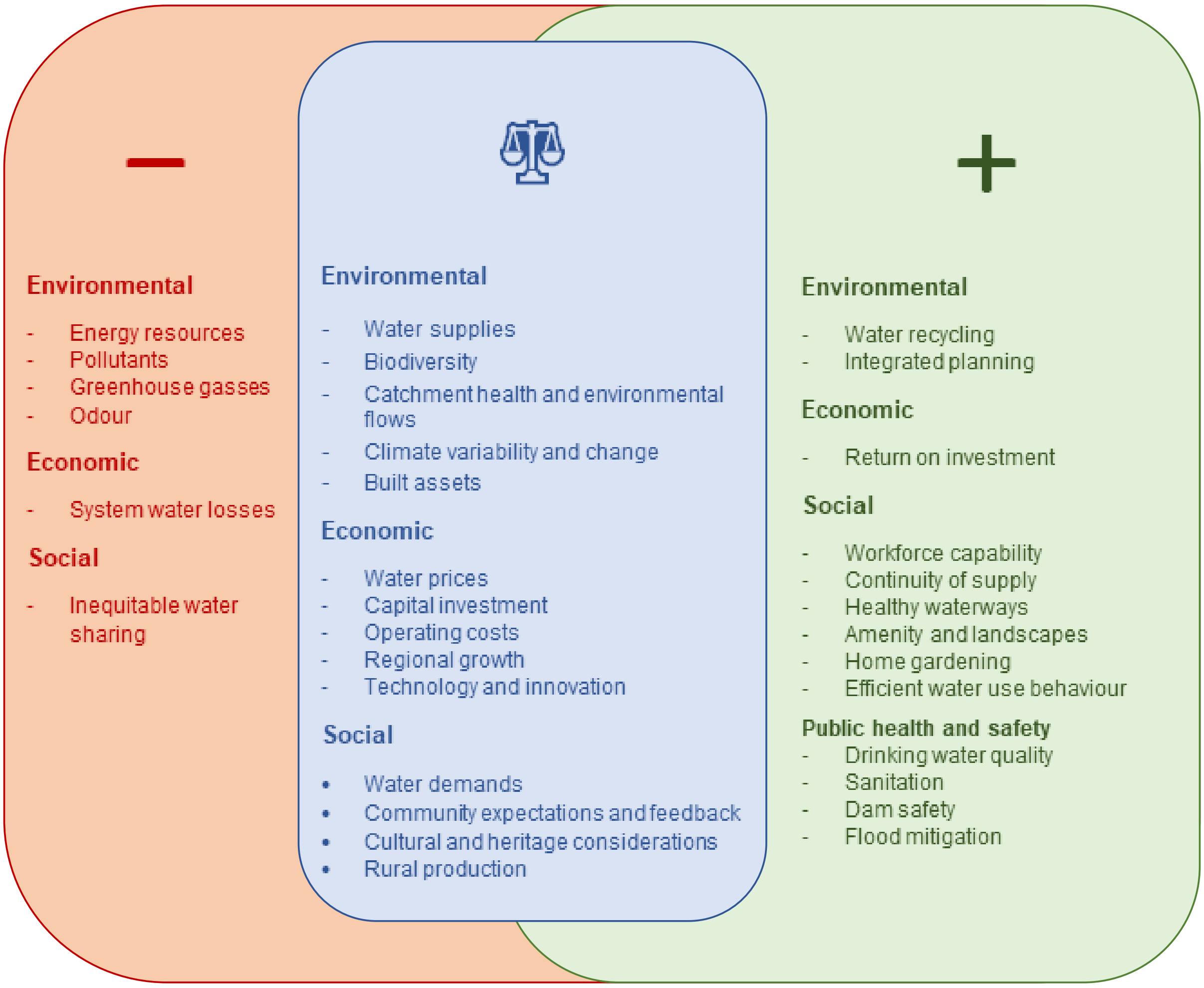
The selection of water security LOS objectives is affected by water demand, supply infrastructure and supply operations, including factors such as:

- historical water use, population projections and predicted future demand
- infrastructure capacity and hydrological nature of network
- cost (social, environmental and financial) of supply, changes to operations and of additional infrastructure
- supply characteristics, water restrictions and community resilience
- consequences and likelihood of emergency measures
- storage characteristics and climate variability.

These are all important considerations that are referred to regularly throughout these guidelines.

When deciding on LOS objectives, and undertaking water supply planning generally, there are a number of environmental, social and economic factors that should be considered and balanced appropriately. Figure 1 highlights these factors.

Figure 1: Factors that should be minimised, balanced and maximised when undertaking water supply security planning



The following considerations do not generally form part of the process for developing long-term LOS objectives, and have not been considered further in these guidelines:

- irregular short-term events or hazards that might affect the immediate quantity and quality of water supplies (e.g. floods, bushfires and acts of intentional vandalism)
- operational issues, such as:
  - temporary operational issues such as supply interruptions due to loss or power or maintenance (these are dealt with in customer service standards)
  - constraints within the water supply system that potentially limit the ability to meet demand, for example pumping capacity limiting the ability to transfer water within the system
  - water leaks, meter reading inaccuracies and unmetered take.

As previously noted, standards for water quality and short term service delivery are managed through existing frameworks and requirements established by the state and therefore do not form part of LOS objectives.

4 Why develop LOS objectives?

4.1 Benefits

LOS objectives establish the long-term aims for urban water supply for a community. This provides a basis for effective planning and decision-making. LOS objectives set a 'performance standard' for the bulk water supply system, against which the performance can be assessed. The achievement of the standards is transparent to everyone, as is the need to take action if necessary.

Benefits:

- Reflect community expectations
  - Consider the community expectations when developing the level of water security that is appropriate for the community.
- Appropriate investment
  - Through long-term planning, support appropriate investment in water supply infrastructure, and promote economic growth and wellbeing.
- Opportunity for community education and awareness
  - Educate about the limitations and trade-offs of the community's bulk water supply.
  - Facilitate a sense of ownership of and responsibility for the local bulk water supply to achieve effective demand management.
- Risk awareness
  - Identify the risk and potential consequence of running out of water.
- Efficient water management
  - Ensure that water resources are managed efficiently, planning for times of water scarcity and managing the likelihood of requiring emergency measures.
- Infrastructure planning
  - Identify infrastructure upgrades and augmentations that may be required for the water supply system.
- Planning for drought
  - Provide a robust basis on which to develop pre-planned, timely measures in response to drought and increased water demand.
- Meet community water needs
  - Ensure that the community's basic water needs can be met under all circumstances through emergency planning.
- Prepare for climate change
  - Reduce the water security risks associated with increased climate variability

4.2 Role of water service providers

The local WSP is best placed to develop LOS objectives for a community due to its operational knowledge of the local bulk water supply system, understanding the water use patterns and being in the best position to understand community expectations. It is important that WSPs work with the community, through education and engagement, to clearly outline the costs and benefits of the LOS objectives. This enables the community to make informed choices and enhances the potential for achieving the LOS objectives. Refer to the Section 7.5 on ‘Community engagement’ for further information.

5 Relationship with other legislative and regulatory requirements

The state has prescribed desired LOS objectives for water security for the South East Queensland (SEQ) region, in accordance with the *Water Act 2000*. The SEQ bulk water supply authority (Seqwater) has been given responsibility for developing a water security program to achieve the objectives. Outside of South East Queensland, there is no requirement for a WSP to establish LOS objectives for a community or to develop a water security program. However, the department encourages WSPs throughout the rest of Queensland to utilise these guidelines to establish water security LOS objectives as part of an effective water security framework (see Section 6.2 for more on the water security framework).

Delivering urban water supplies in accordance with agreed service levels, as outlined in the National Urban Planning Principles can be achieved by adopting LOS objectives for water security and customer service standards. The objectives are a planning tool to secure long-term water availability, whereas customer service standards provide details on ‘day to day’ service levels to be provided to customers and cover matters such as water quality, supply pressure and the response times for a supply issue. WSPs are required to have customer service standards under the *Water Supply (Safety and Reliability) Act 2008*.

Through the *Water Supply (Safety and Reliability) Act 2008* the state has introduced a mandatory performance reporting framework which requires WSPs to report annually on key performance indicators (KPIs). The purpose of performance reporting is to benchmark providers to encourage voluntary performance improvements and provide information to customers across Queensland to enable them to compare their provider performance to others around the state. Included in the KPIs are metrics to monitor and benchmark water supply security. Figure 2 illustrates the differences between LOS objectives, customer service standards and key performance indicators.

Development of water security LOS objectives may also provide critical input into some of the plans that are required to be developed by local councils under the *Local Government Act 2009*. Under this legislation, the corporate plan and annual performance plan are required to include the strategic vision for the future of the local government area, which could include the delivery of specified LOS objectives and the capital expenditure associated with achieving the objectives. The long-term asset management plan details the strategies for sustainable management of council assets, including water infrastructure and the estimated capital expenditure for the maintenance and renewal of these assets over at least a 10-year period.

The *Sustainable Planning Act 2009* requires council to develop infrastructure plans that identify the plans for trunk infrastructure, including trunk water infrastructure, that are necessary to service urban development at the desired standard of service in a coordinated, efficient and financially sustainable manner. Having developed LOS objectives provides council with an awareness of what additional infrastructure may be required in the future to meet growing water demand.

Figure 2: Comparison of LOS objectives, customer service standards and key performance

LOS objectives

- Relate to long-term adequacy of supply
- Supports water supply planning
- Deals with the volume of water available for treatment and urban distribution

Customer service standards

- Relate to how the water will be delivered
- Guides day-to-day operations
- Puts parameters around the reticulation network's design and operation (for example, water quality and pressure standards)

Key performance indicators (KPI)

- Relate to monitoring and benchmarking performance
- Reporting tool
- Shows how the customer service standards are being met, as well as other industry metrics

6 Towards water security

6.1 Success factors

The ability to achieve defined LOS objectives for water security is dependent on a range of factors including:

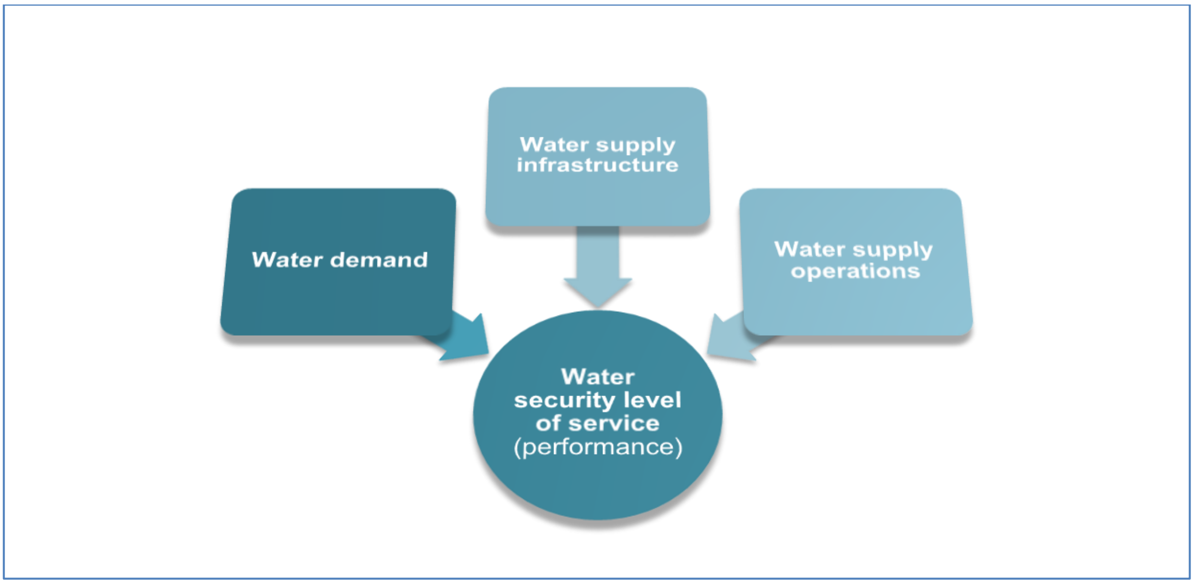
- the characteristics of the water supply, such as the hydrology and climate in the region and the effectiveness of infrastructure in capturing, storing and delivering water to a community
- how infrastructure is maintained and operated
- the demand for urban water, including the demand patterns associated with seasonal populations of workers and tourists.

Figure 3 shows the relationship between these factors and the actual water security level of service delivered. Also known as the performance of the system, the level of service delivered reflects the ability of the infrastructure to be effectively operated to meet demand.

A change in any one of the factors can affect the performance of the bulk water supply system and the corresponding level of water security achieved for a community. If the performance of the water supply system fails to meet the LOS objectives, a change is required to one or more of the factors (e.g. additional infrastructure or change to operations).

It is noted that while these factors are important considerations when establishing LOS objectives, they should not drive the determination of objective targets. Determining suitable LOS objectives for a community should be a considered analysis of the needs of the community along with consideration of the trade-offs that may be involved to facilitate the achievement of the objectives with consideration of economic, social and environmental impacts (e.g. fewer restrictions may require increased investment in water infrastructure but increase level of amenity for residents). This process of "trading-off" is discussed in more detail in later sections of these Guidelines.

Figure 3: Factors affecting achieving the water security level of service

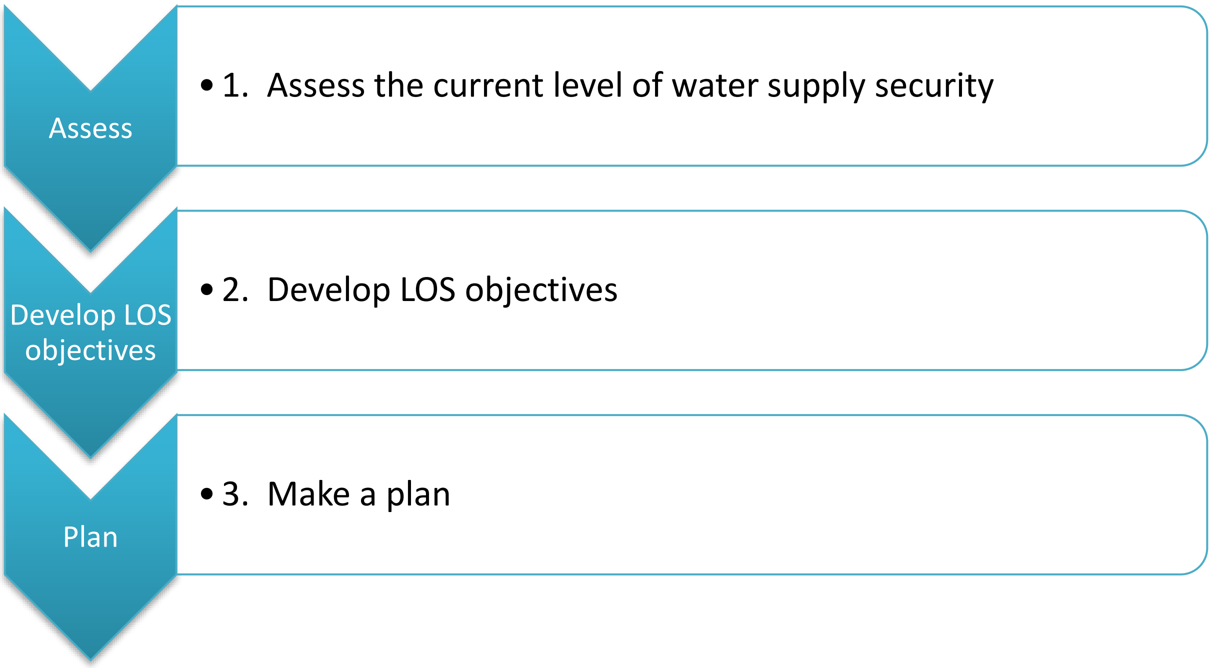


6.2 A water security framework

Developing LOS objectives is only part of the process for achieving long-term water supply security. An understanding of the water supply system and its current performance is essential to develop the LOS objectives suitable for a community. Once LOS objectives have been developed, a plan or strategy should be produced outlining how it is intended to achieve the targets.

Figure 4 presents this approach, with each step described in more detail below. The remainder of this guidelines is focussed on Step 2 – Develop water security LOS objectives, and the process for this is described in detail in Sections 7 and 8.

Figure 4: Key steps in a water security framework



Step 1. Assess the current level of the water supply security

As previously discussed, assessment of the current level of water supply security of a system considers existing infrastructure, operations and water demands. This provides an understanding of the current capability of the system and its capacity to support future growth. Information that may be required to undertake this assessment is outlined in the water security LOS development template provided in Appendix 1. This assessment can be useful independent of the development of LOS objectives as it provides an increased understanding and awareness of the water supply system and its potential limitations for supply.

For some communities this step may be achieved through the development of an RWSSA but other communities may use a process of self-assessment by considering the information suggested in this guideline.

> To support the development of LOS objectives, council and/or the local WSP may consider partnering with the department to develop a Regional Water Supply Security Assessment (RWSSA) for their community. The RWSSAs provide a shared understanding of the potential water supply security risks for a community. They do this by assessing the capability of existing water sources to meet current and future demand, under a range of climate and demand scenarios.

Step 2. Develop LOS objectives

The mix of LOS objectives that are adopted, including both the indicator type and the targets for each objective, need to be suitable for the community (Appendix 2 provides an overview on how objectives may be different between communities). Variation of objectives between communities is to be expected and will be due to a range of factors, including differing available water supply sources, community expectations and the willingness, or ability, to pay for changes to the infrastructure that may be required to meet the objectives.

This step, in essence, assesses the trade-off between the expectations of the community of the level of water supply security and what they are willing to pay to achieve that security. Effort should be made to consult with the community on the likely performance of the water supply system at this step to ensure that objectives are developed to meet the community's expectations and needs. Community engagement during the development may also contribute to the community gaining a sense of ownership, and foster an atmosphere of community responsibility, regarding the local water supply.

Step 3. Make a plan

The final step is to develop a water security plan to achieve the targets set in the LOS objectives.

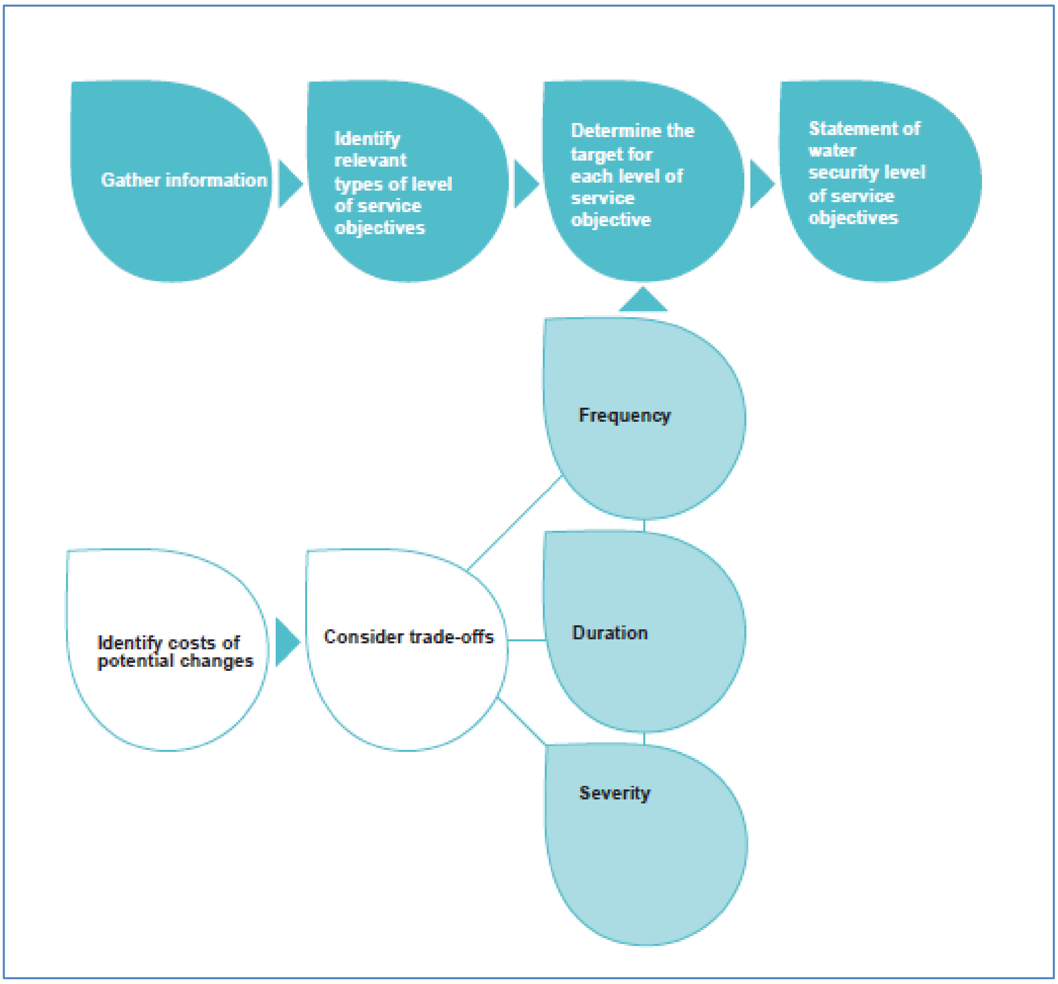
The plan will outline what changes to infrastructure, urban demand or operations may be needed to achieve the LOS objectives and when these changes may be required. Engineering, hydrological modelling studies, or information based on historical records, could be used to justify triggers for commencing particular actions, such as water restrictions or emergency measures. Focus should be given to planning for normal growth, drought scenarios and emergency events, describing how essential water needs would be ensured.

The plan should be adaptive and regularly reviewed to reflect the current understanding of the water supply system and any changes to demand, the infrastructure or operations.

7 Developing LOS objectives – process overview

An overview of the process for developing suitable LOS objectives for a community (Step 2 in the water security framework) is presented in Figure 5. Background information on the water security LOS approach can be found in 'WSAA, 2014. Occasional Paper No. 29 - Urban Water Planning Framework and Guidelines' prepared by the Water Services Association of Australia Incorporated.

Figure 5: Overview of process to develop LOS objectives



As outlined in Figure 5, at the beginning of the process it is essential to gather information on the current water supply security of the urban water supply system, how the bulk water supply system operates and what the community expects (Appendix 1). This information is used in working out what types of LOS objectives are relevant for a community and in setting a suitable target.

It is important to consider the costs of potential changes involved in meeting a specified target. Knowledge of these will help inform decisions on the trade-offs (i.e. risk, opportunities and consequences) for achieving the desired level of water supply security for the community and enable a suitable target to be determined. Once the target has been determined for each LOS objective the level of planned water supply security, that is the combined effect of meeting all of the proposed targets for the water security level of service objectives, should be considered to ensure there is no unforeseen cumulative impacts or trade-offs.

7.1 Gather information

Information on the bulk water supply system underpins the development and selection of LOS objectives. One of the main purposes of gathering information is to be able to assess the current level of water supply security of the urban water supply system. This baseline information provides a platform for scoping potential changes and the trade-offs that could be involved in providing the same, or different, level of water supply security in the long-term. The information that is available may also influence the level of risk that a WSP is willing to adopt for its targets. Types of information that should be considered at this stage include:

Water supply characteristics

- Current water supply infrastructure and its ability, in the long-term, to meet the future water demand. Augmentation of the water supply system may be required to continue to meet growing demand over time.
- Estimates of the associated cost for upgrading and/or building infrastructure to meet future water demand.

  If significant costs are associated with upgrading water supply infrastructure to provide the same level of water security in the long-term, the option of a lower LOS objective should be considered.

Community values and expectations

- Community understanding of the bulk water supply system and its capacity
- Willingness and ability of the community to pay for increased urban water supply security
- Community acceptance of a lower level of water security (e.g. community willingness to change behaviour and permanently reduce water usage or implement a restriction regime more frequently)
- Water use and the amenity value it provides
- Community value on volume of water available and frequency of water restrictions
- Community attitudes towards potential supply and demand options, such as desalination, re-use of treated wastewater, permanent water saving measures

  For the LOS objectives to be successful, the community needs to be supportive and willing to adopt the plan (e.g. water restrictions, using recycled water).

Water users

- Water consumption behaviour of the different water users within the community. This information can help to determine trends in usage and/or explore ways to best minimise water use
- The potential for different restriction regimes for different users
- Potential effectiveness of demand management, including community education campaigns and, for large business/industry users, Water Efficiency Management Plans (WEMPS)

  It may be appropriate to set specific LOS objectives for different water user groups within the same community.

Uncertainty

- Potential data inaccuracies, including unmetered water use
- Changing community profile and water use behaviour, which can alter long-term urban water demands
- Natural events, including climate variability, bushfires, revegetation and changes in water quality can affect water availability

  Greater uncertainty could lead to a lower level of risk being adopted for water security planning purposes, and therefore a higher water security LOS.

7.2 Identify LOS objective indicator types

LOS objectives to measure the level of water supply security are composed of an indicator type and a target. There are generally three types of indicators used to measure urban water supply security:

- water demand
- restrictions
- emergency measures.

The selection of indicator types is determined following consideration of a range of matters, which are discussed in more detail in Section 8.

7.3 Determining LOS objective targets

Determining an appropriate target for each LOS objective indicator type can be summarised as a three step process:

1. Assess information (including costs of potential changes to the water supply)
2. Consider trade-offs
3. Set target.

Section 8 describes how to apply each of these steps to the different indicator types. A general summary of each step is provided below.

7.3.1 Assess information

To determine the target for each LOS objective indicator type, the information that has been gathered should be assessed to estimate the costs of potential changes that would be involved in achieving the same, or different, target over the long-term. This detail will provide information about the trade-offs involved, i.e. the risks, costs and benefits of achieving a specified target.

7.3.2 Consider trade-offs

Consideration of the trade-off will inform whether the target is suitable for that community.

Figure 6 presents an overview of the implications of setting the target for an LOS objective too ‘low’ or too ‘high’.

‘Lower’ target

- ‘Lower level’ of water supply security.
- Likely to be lower costs (environmental and financial) of providing the urban water supply service but the trade-off may result in more frequent water restrictions or greater risk of requiring emergency measures for the community.
- Can result in socio-economic costs to the community (e.g. water restrictions can lead to loss of income due to insufficient water, loss of assets, reduced aesthetics and inconvenience).

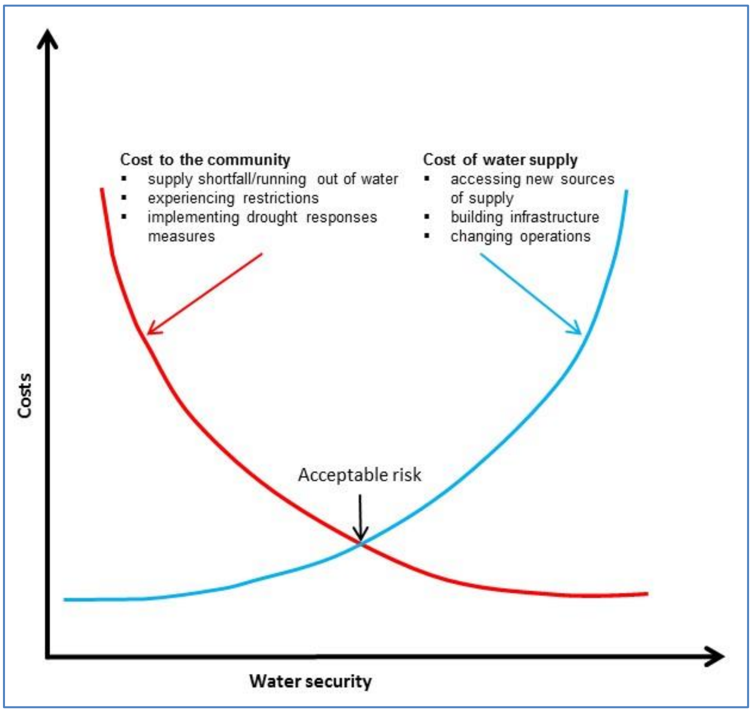
‘Higher’ target

- ‘Higher level’ of water supply security.
- Likely to lead to higher costs (social and economic) of providing the water supply service (e.g. capital and operational, due to potentially needing to access new sources of supply), which are generally passed on directly to the community.

- Can result in fewer disruptions to water supply due to less frequent, shorter and/or less severe water restrictions. A community may perceive that the cost to achieve a 'higher level' of water supply security is more than the costs/impacts associated with those restrictions.

Figure 6: Trade-off of costs versus water security

(Figure adapted from Erlanger and Neal, 2005, WSAA - Occasional Paper No. 14 - Framework for Urban Water Resource Planning,' Water Services Association of Australia Incorporated.)



To enable a comparative assessment between different targets for a LOS objective, the consequences, or trade-offs, over a set time period (e.g. 30 years) should be considered. This period should be determined based on having reasonable confidence in the population and the urban water demand projections over the time period.

7.3.3 Set target

Each LOS objective should be tested against different weather scenarios, population projections, changes to water use behaviour (e.g. improved water efficiencies measures of new businesses and houses), climate variability (which might lead to a prolonged very dry or very wet spell) and uncertainty estimates (e.g. data inaccuracies). The ability, and cost associated, to meet the LOS objective under varying circumstances should be considered before setting the target for the LOS objective.

7.4 Statement of level of service objectives

Before deciding on the statement, the impact of the group of LOS objectives should be assessed. The impact of the objectives acting together may be different to that of each individually. The combined impact of the LOS objectives could lead to unexpected need to change operations or require additional infrastructure. It is therefore important that the impact of the combined effect of the statement of LOS objectives is considered before finalising it.

Once suitable targets are set, how they are expressed should be considered. The statement should be written to make it easy to understand. For example, referring to residential demand rather than total urban demand can provides a more identifiable target for the community, promoting responsibility at times when demand management action is needed.

7.5 Community engagement

The community should be engaged in all stages of the development of the LOS objectives to achieve a sense of ownership and foster community responsibility regarding the local water supply. In order for LOS objectives to be achievable, the community needs to embrace and contribute to its successful implementation. Effort should be made to consult with the community on the expected level of water supply security of the water supply system so that it meets their expectations and needs.

It is expected that a WSP will already have established methods for communicating with its customers. In engaging the community on water security, key areas of focus may include:

- the current level of water supply security, including details about the supply capability and demand.
- any upgrades or augmentations that are planned or are under consideration
- the use of demand management measures, particularly water restrictions, and the community's willingness to have demand management measures imposed
- details of the potential changes to water supply security that may be beneficial for the community (e.g. higher level of water restrictions to delay additional infrastructure)
- potential impacts on the community to maintain the current level of water supply security and the potential impacts if a different level of water security was sought.

Appropriate and well communicated LOS objectives can provide greater awareness of the current level of water security of a community as well as of potential measures that may be required under drought conditions. In particular, community involvement can generate support for potential demand management measures which can enhance their effectiveness.

7.6 Implementation and evaluation

Once a set of LOS objectives has been established for a community, water security planning can be undertaken (e.g. using hydrological modelling and cost-benefits analyses) to identify options to address the potential 'weak links' in the system and, if needed, augment the system to cater for expected water demands. Chapter 3 of the Queensland Government's 'Planning Guidelines for Water Supply and Sewerage – April 2010' provides additional guidance on water supply planning. The Planning Guidelines recognise that such planning should be an iterative process that includes assessment of non-asset solutions, such as operational changes and demand management. Consideration of all possible solutions, the associated full lifecycle costs and potential risks should enable the most cost-effective and appropriate planning solution to be identified.

Ideally, the LOS objectives should be reviewed at least every 5 years to ensure that they still reflect the community expectations and to consider significantly changed circumstances. The review should also incorporate consideration of any updated data. The achievement of the LOS objectives themselves can typically be only assessed over a long time period. This is because the objectives typically target an average frequency over medium to long term durations.

8 LOS objectives – indicator types and targets

As outlined above, there can be various ‘types’ of LOS objectives that may be used to describe the level of the planned urban water supply security. Generally, there are three types of LOS objectives that are used, which are described in Table 2 and in the following sections.

Table 2: Summary of the main types of LOS objectives

LOS objective type	**Description**
Water demand	Ensure that the water supply system will be able to supply the expected average volume of water that will be used by the community into the future
Water restrictions	The acceptable maximum frequency, severity and duration of restrictions for a community
Emergency measures	The acceptable likelihood for a community to require emergency measures when demands cannot be met by the local supply sources due to climatic conditions (i.e. when a supply shortfall occurs due to drought)

8.1 Water demand

The LOS objective for water demand sets a target for water supply based on the expected average urban water demand. A realistic estimate of the expected average urban water demand helps ensure additional water supplies are sourced at an appropriate time. Some urban water planning, such as water treatment capacity, is based upon peak demands to ensure there is sufficient capacity within the supply system. Using average demands for long-term planning of water supplies maintains the level of supply security and results in appropriate investment in bulk water infrastructure. Calculating urban demand should also not be constrained by existing assets or infrastructure because if demand is expected to exceed supply then upgrades to infrastructure would be undertaken.

Using an average urban water demand provides an indication of the expected water demand for a community in the long-term. Water security planning based on the average demand, rather than maximum, peak or dry time demand, reduces the risk of excessive investment in water supply infrastructure that may have only a very low likelihood of being needed. However long term water security planning should incorporate consideration of low likelihood events, such as drought, and increased demand to mitigate possible risks. Operational factors, such as managing peak demands and ensuring adequate infrastructure to deliver the water to each household, that can affect the overall performance of a water supply system are not included as LOS objectives. Appropriate plans should be put in place to manage such operational factors.

This LOS objective is generally expressed in terms of volume of water that is planned to be made available under normal or non-drought situations. However, it is up to the WSP to decide how to best state this LOS objective for the community. It could be set, for example, as the raw water demand, the total treated water demand, or as only the treated water required to meet residential demand. However, water security planning should be based on the total raw water demand, which takes into account the total expected urban demand, and the treatment process. Figure 7 shows the ‘different’ demands that form the ‘total urban demand’. That is, total urban demand includes residential and non-residential water demand as well as losses, for example, in the treatment process, delivery losses (leakage) and unmetered water use (such as for fire-fighting) and unauthorised losses (such as theft).

By considering all aspects of water demand, planning will ensure that the 'bucket of water' available for treatment and distribution will be big enough to meet future water demands of the community.

Figure 7: The considerations used in water security planning to assess total urban demand.

Urban water demand can differ a lot across communities. Table 3 shows examples of how much the total urban water demand can vary across Queensland and therefore the need to assess towns on an individual basis.

Table 3: Average daily total urban water demand across Queensland communities

Community	**Total urban demand (L/c/d)[1]**
Bundaberg	306
Cairns	434
Townsville	742
Mt Isa	549
Dirranbandi	884
Longreach	1 440
Winton	2 429
Kowanyama	864

Source: Statewide Water Information Management (SWIM) for 2014-15 water year based on reported connected population.

[1] L/c/d is litres per capita per day, calculated by dividing the total water supplied by the population connected to the reticulation network.

8.1.1 Benefits of defining the objective

The benefits of developing an LOS objective for water demand include:

- Provides a basis for planning
  Ensure that a water supply system can deliver enough water for a community at the present and into the future.

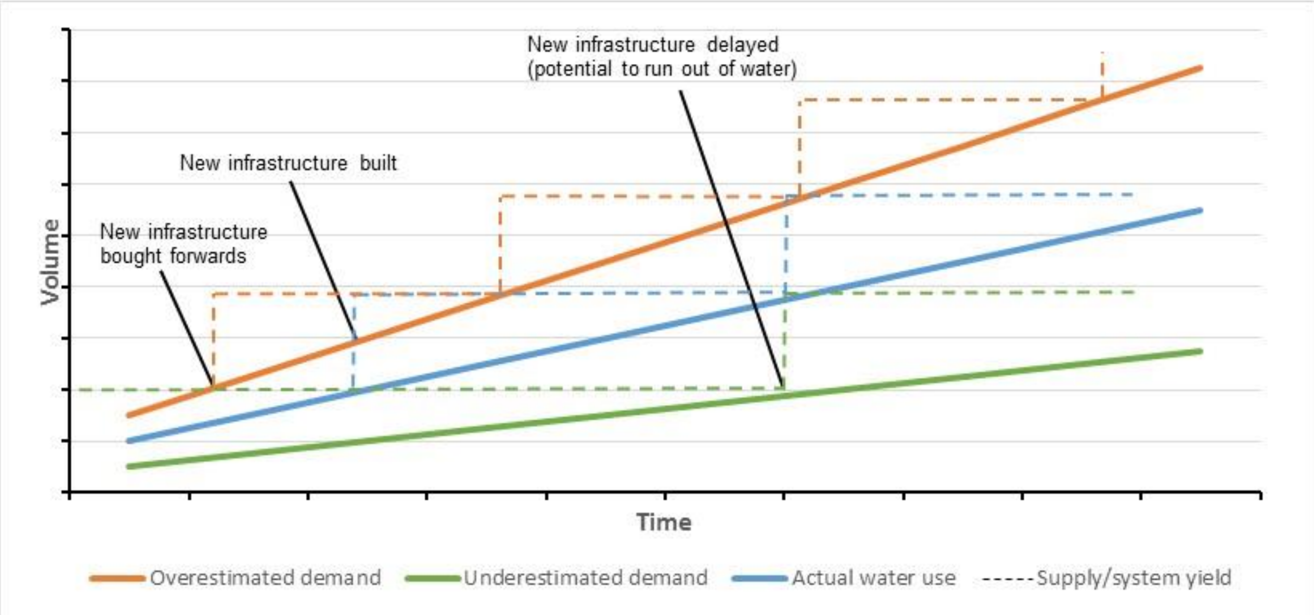
- Promote appropriate investment
  Facilitate appropriate investment in water supply infrastructure.

- Provides a basis for the establishment of voluntary water conservation behaviours
  Supports the delivery of education and awareness campaigns that promote voluntary water conservation and thereby influence water demand.

If the estimated future total urban water demand is significantly higher than actually occurs, unnecessary investment in water supply infrastructure could occur due to planning for these unrealistic high demand projections.

If the estimated future total water demand is significantly lower than actually occurs, the security of the water supply would be less than desired, potentially reaching critical levels more often and earlier than expected, possibly resulting in more severe water restrictions sooner and/or more costly infrastructure as emergency measures are triggered. Figure 8 illustrates the importance of having a realistic estimate of the expected future water demand.

Figure 8: Relationship between estimated future water demand and investment in new water supply infrastructure



8.1.2 Planning considerations

Urban water demand is driven by a range of factors, including weather cycles (dry/wet spells), community values, industry changes, population growth and commercial trends. Also, the demographic of water users can vary in different regions and at different times of year (e.g. regions with significant seasonal tourism). The Queensland Government's 'Planning Guidelines for Water Supply and Sewerage' outlines some of the data that may be useful in determining urban water demand projections.

Planning considerations:

- Historical water use
  - All types of water users on the reticulation network should be considered as well as water losses.
  - Potential changes and trends in water use behaviour should be assessed. This includes the impact of water prices and the water use behaviour of each type of water user including possible seasonal variations and changes in industry, environmental, recreational and other commercial water use.
- Estimates of future population
  - Estimates should be based upon appropriate projections of population and number of connections to the water supply.
- Community characteristics
  - The water use and desires of the community, e.g. volume of outdoor water use required to meet aspirations of the community, patterns of water use.
  - The water needs of local industry and businesses.
- Projected water demand
  - Use population estimates to underpin realistic estimates of the total volume of water supply that may be required into the future.
- The current supply capacity and hydrological nature of the water supply system
  - Augmentations that may be required in the future to maintain supplying the current average urban water demand should be identified. In doing this, current entitlements and infrastructure need to be considered

8.1.3 Development

Typically, the LOS objective for water demand is developed starting from the current urban water use. Consideration should then be given to potential changes in water use behaviour (such as that realised from education and awareness campaigns) and community water requirements, compared to the costs of future system augmentations that may be needed to meet urban water demand. This process is outlined below, in Figure 9, and further information on background information gathering is provided in Appendix 1.

1. **Assess information**

   The assessment of the available information will result in an estimate for future water demand and a comparison of this with the current capacity of the water supply system.

   Projected future total water demand

   The total water demand should be estimated based on the average volume of water that is expected to be used by the community on an annual basis over the planning timeframe and the expected population growth of the community. This should take into account the planning considerations listed above, particularly historical water use trends with consideration of any influences of the weather conditions on the demand and supply.

   In estimating future total water demand, different rates of population growth and how that may impact the future water demand should be considered. The expected non-residential water demand (e.g. demands associated with industry and commercial uses that are supplied by the urban reticulation network) should be estimated with consideration given to whether it will increase proportionally with residential population or at a different rate of increase.

Current capacity of water supply system

The current capacity of the water supply system should be estimated to determine if changes to the water supply system (such as additional infrastructure, demand management measures or operational changes) may be needed within the planning timeframe in order to provide the desired level of water security.

2. Consider trade-offs

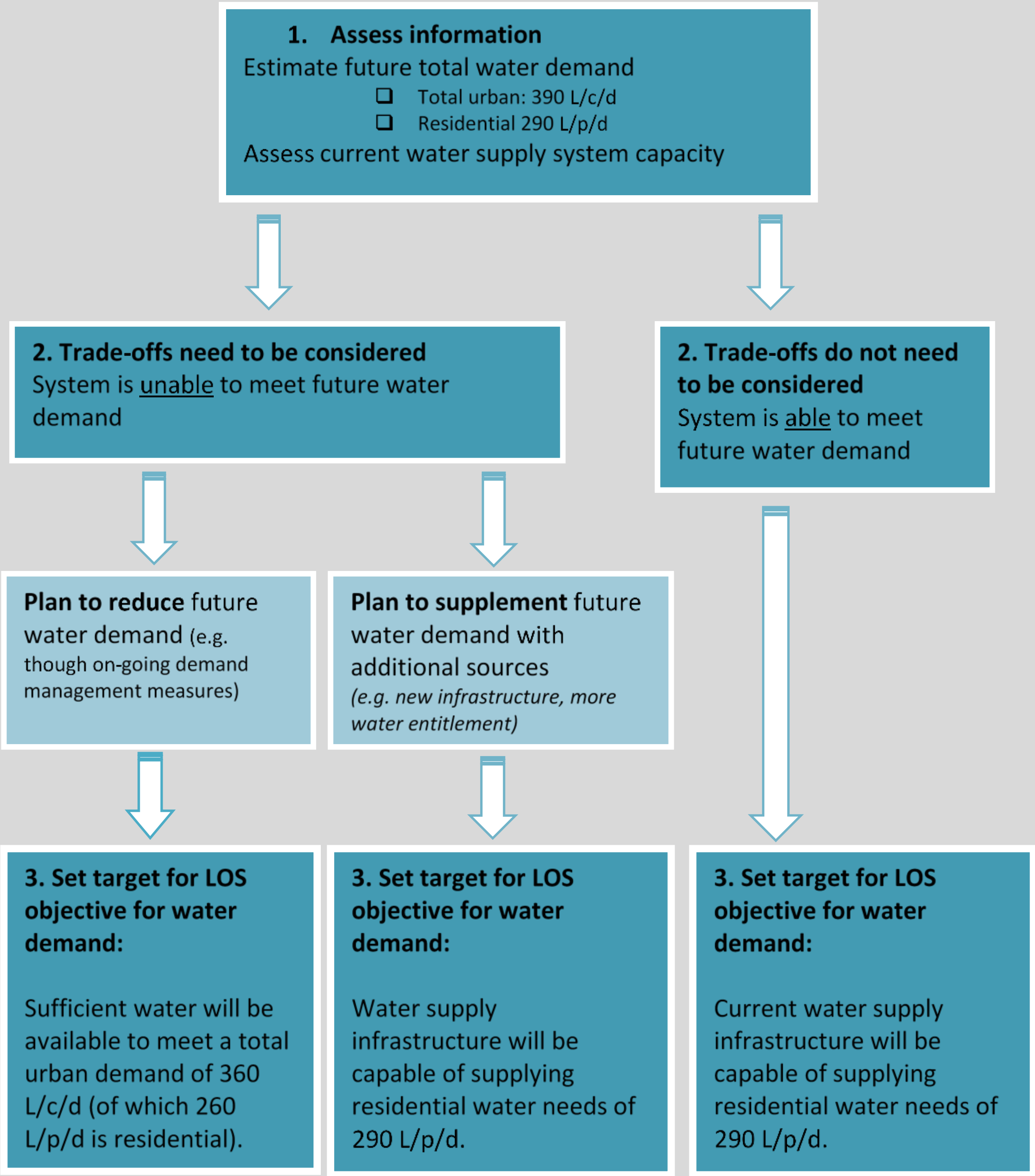
If the future total water demand exceeds the current capacity, the trade-offs involved in providing additional infrastructure or operational changes should be assessed. The trade-offs in providing for a lower water demand, for example through on-going demand management measures, should also be considered.

An indicative assessment of the trade-offs should be done to give an idea of the consequences, e.g. the types and magnitude of the changes (a detailed plan or cost benefit analysis of options for meeting the requirement is not needed for this step).

3. Set target

Based on the above steps, set the target for what the water supply system will be able to supply to satisfy the community’s future water demand.

Figure 9: Overview of process to develop LOS objective for water demand



8.2 Water restrictions

The LOS objectives for water restrictions describe the reduction in normal urban water use that is aimed to be achieved during drought.

This LOS objective is generally expressed in terms of frequency (i.e. how often restrictions are expected to occur), severity (i.e. expected magnitude of the restrictions, the reduced level of water use sought) and duration (i.e. how long the restrictions are expected to last). For clarity for community expectations and urban water supply planning, severity should be defined as a maximum usage target on a per person per day basis. This rate of supply can be determined based on an acceptable percentage reduction of urban water use from the expected unrestricted demand.

In practice, the introduction of water restrictions should reduce urban water demand. This means less water is required to be provided to the community so the water supply can last longer and the implementation of additional drought response measures, such as new infrastructure, can be deferred. The effectiveness of introducing water restrictions can be influenced by the characteristics of the water supply system (e.g. the behaviour during low inflows and losses) and the community itself.

Water restrictions have been widely and effectively used across Australia in the past to manage reduced water supplies due to drought. They can provide a clear measure that is readily understood by the community compared to descriptions, such as the reliability or annual performance of a system, that have been used historically. Water restrictions will have an impact on the community which needs to be considered when determining the role of restrictions in a community’s long-term urban water supply plan and in setting targets for this LOS objective.

8.2.1 Benefits of defining the objective

In summary, the benefits of developing a LOS objective for water restrictions include:

- Simple tool to extend supply
  - Restrictions are a simple, potentially cost-effective way to prolong the time until the water in a water supply system is diminished during drought.
- Potentially defer costly measures
  - The associated reduced urban water use can defer (or potentially negate) the need for contingency or emergency measures. Such measures (often infrastructure) can be much more expensive and may have a more significant impact on the community than planned measures.
  - Facilitates a pre-planned, less reactive, and therefore potentially less costly, drought response plan.
- Clear progressive approach
  - Restrictions can provide clear expectations to the community in regards to what actions may be required during drought.
  - Restrictions provide a measured and well-communicated reduction in urban water use as drought conditions continue and supply status worsens, which can reduce the shock to community when they are limited to essential minimum supply.
- Improve community awareness of water use
  - A pre-agreed restrictions regime provides transparency to the community and therefore more likely to be achieved.
  - Restrictions provide an easily understood measure of the level of water supply security and encourages community awareness of the limitations of a water supply system.

8.2.2 *Planning considerations*

The extent, nature and application of water restrictions is driven by several factors such as water availability, community resilience and the socio-economic impacts of restrictions. All aspects should be considered when developing LOS objectives for water restrictions.

Planning considerations:

- Hydrological nature of the local water supply
  - The size and variability of the local water supply infrastructure will affect the ability to determine when it is appropriate to implement restrictions.
  - The water supply behaviour during low inflow affects whether there is sufficient lead time to initiate a drought response and there may be accessibility issues at low storage levels.
- Previous restrictions
  - Frequency and duration of restrictions, who is affected and what was achieved.
- Impact of restrictions
  - The potential economic impact of restrictions on the profitability of businesses, the effect on tourism, and on residents (e.g. for replacing gardens).
  - The social impact of restrictions and the effect on the community's lifestyle. For example, the 'cost' (aesthetically and emotionally) of losing gardens or not being able to use sports grounds etc.
  - The resilience of the community to drought and restrictions. This can be indicated by previous response to drought, the acceptance of past water restrictions and influence of community education on water use behaviours.

Table 4 illustrates how the planning considerations discussed above may affect the target for a LOS objective for water restrictions.

*Table 4: Example LOS objective for water restrictions in two communities**

Considerations	Community A	Community B
Characteristics of community	Large storage with the capacity to supply several years of water demand	Small storage which relies on seasonal inflows (e.g. weather dependent storages)
	Generally consistent inflows with potential drought conditions preceded by a long period of low inflows	Short lead time between 'normal' supply conditions and 'drought' conditions
	Potentially significant economic impact on local industry under drought conditions	Large industries that rely on water supply, so possible economic impact under drought conditions
	Restrictions only occurred once in the last 20 years, therefore the community is not used to restrictions	Residential restrictions regularly implemented before beginning of dry season as preventative measure, therefore the community is used to restrictions
Potential characteristics of restrictions	Restrictions could be infrequent, but potentially with high level of severity, depending on the potential economic impact of the restrictions and the willingness of the community to reduce their water use in drought	Restrictions could be implemented on residential water use as a frequent, seasonal basis as a pre-emptive measure
Potential LOS objectives	Restrictions will be less than once every 25 years and will not be more severe than 350 L/c/d (220 L/p/d for residential water use) on average	Low level residential water restrictions (maximum of 250 L/p/d) will occur for an average of 6 weeks every year

Notes: * This table provides an example of the considerations that are made and how they could affect the resultant LOS objective for water restrictions. This table should not be used to provide an indication of the target that should be adopted for the LOS objective for water restrictions.

8.2.3 Development

Typically, the LOS objective for water restrictions is developed based on the performance of the current bulk water supply system and assessing the trade-offs of different levels of water restrictions. This process is outlined below and further information is provided in the template (Appendix 1.2).

1. **Assess information**

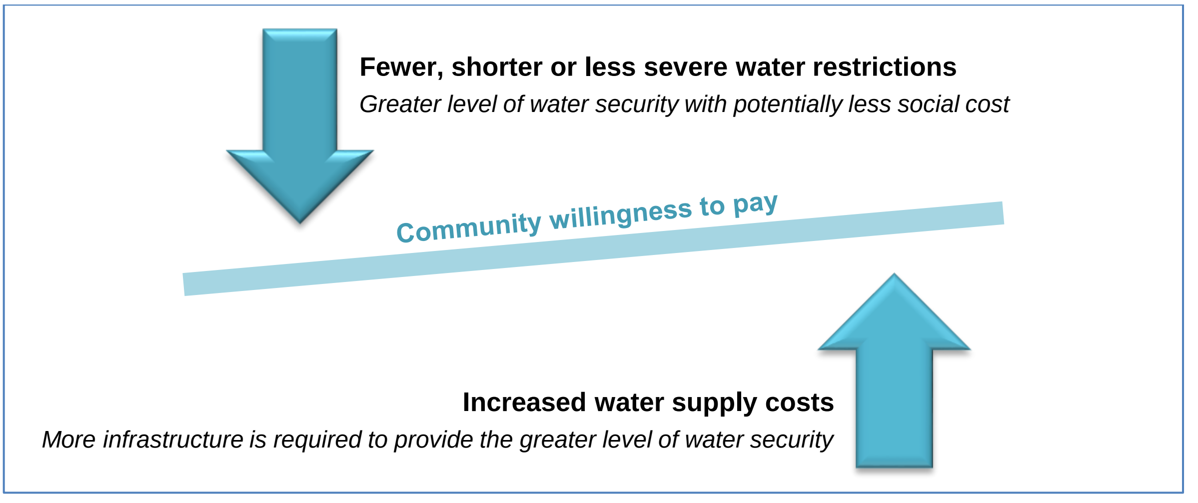
   This will involve understanding the current water supply system performance, e.g. how often water storages reach low levels, based on existing infrastructure. This can be achieved by using the WSP own assessment methods such as looking at historical records or, if applicable, can be obtained from an RWSSA.

   Information that may be useful for developing the water restrictions LOS objective includes details of previous droughts, rainfall, water use, the community population and types of water users. The water restrictions that have previously been imposed can be used to develop an idea of how frequently drought impacts on the water supply, how the water supply 'behaves' during drought and how often water restrictions may be required based on expected future demands.

2. **Consider trade-offs**

The trade-offs involved in providing various levels of water supply security in relation to different water restriction scenarios should be assessed to find a balance between restrictions and cost (Figure 10), considering the costs associated with both low restrictions (e.g. possible new infrastructure) and high restrictions (e.g. social and economic impacts). Assessment methods may include hydrological modelling, desktop investigations and cost-benefit analysis. The costs associated with additional infrastructure, as well as social, economic and environmental costs, for each water restriction scenario should be considered.

Figure 10: Balance between water restrictions and costs



3. **Set target**

Set the target based on consideration of the trade-offs as well as the potential community acceptance.

Consideration should be given to which parts of the community restrictions will apply, e.g. just residents and/or particular industry sectors. How the restrictions might be applied should also be part of the considerations when determining an appropriate target. For example, before setting a target for restrictions to apply to industry, how will water savings be achieved and measured will need to be considered.

The potential community acceptance of a water restriction scenario can be gauged by:

- data on water restrictions previously implemented
- consultation to determine the community's view of what is suitable in terms of water security and water restrictions, within the constraints of cost effectiveness and willingness to pay.

The achievement of the LOS objective for water restrictions is highly dependent on community understanding and acceptance. If the community do not cooperate and adhere to the nominated water restrictions, the urban water use may not be reduced to the planned LOS objective target. This means that there is a greater risk of a water supply shortfall and that new water supply infrastructure may need to be built sooner, and possibly of larger capacity. Community awareness campaigns and education can enhance the acceptance of water restrictions.

To help ensure that the target for the LOS for water restrictions can be met, the WSP should develop a pre-agreed restriction regime that is communicated to all stakeholders. Triggers for water restrictions should be pre-determined to ensure that the water restriction level does not exceed that specified in the LOS objective.

Hydrological modelling can be undertaken to determine the impacts of adopting different 'triggers' for when water restrictions will be imposed. For example, imposing water restrictions at an earlier trigger may significantly reduce the risk of a supply shortfall while still meeting the LOS objective for water restrictions. Table 5 provides an example of how water restriction regimes can vary across Queensland.

Table 5: Water restriction regimes for Hervey Bay and Cairns [1]

Restriction Level	Trigger levels (% of full storage capacity)	Per capita water consumption target (L/c/d)	Target urban water demand reduction (%)
Hervey Bay[2]			
Level 1	Lenthalls Dam - 100%	326**	0
Level 2	Lenthalls Dam - 60%	310	5
Level 3	Lenthalls Dam - 40%	261	20
Level 4	Lenthalls Dam - 30%	196	40
Cairns [3]			
No restrictions	Copperlode Falls Dam - ≥80%	418***	0
Level 1	Copperlode Falls Dam - <80%	389	10
Level 2	Copperlode Falls Dam - <70%	374	15
Level 3	Copperlode Falls Dam - <60%	359	20
Level 4	Copperlode Falls Dam - <50%	345	25

Notes:
[1] Water restriction regimes were taken from the relevant Regional Water Supply Security Assessment (available on the departmental website). The restriction regimes may have changed since the time of publishing the assessments. Water restriction regimes may apply to residential water use only or residential and commercial/industrial/municipal water use.
[2] Regional Water Supply Security Assessment – Hervey Bay (April 2015) *** based on the per capita urban water use in 2012-13
[3] Regional Water Supply Security Assessment – Cairns (October 2014)*** based on the per capita urban water use in 2012-13

8.3 Emergency measures

The LOS objective for emergency measures is about the acceptable likelihood, or frequency of occurrence, of needing to impose emergency measures to meet essential water demands due to drought. In other words, it is the frequency at which the volume of water provided to the community meets only essential water needs. This objective is not necessarily about what the emergency measures are.

This LOS objective promotes appropriate emergency planning by quantifying the potential likelihood that local supplies will not be able to meet the urban water demand in extreme, but possible, climatic conditions, and identifying the potential impacts.

There is always some level of risk that a community will run out of water due to the uncertainties involved in planning and the possibility of a drought more extreme than has occurred in the past or that was considered possible. In the event of a supply shortfall approaching, emergency measures should be applied to ensure the essential water needs can continue to be provided indefinitely, in order to minimise health and safety risks.

Setting an appropriate target for this LOS objective can manage or mitigate the risk that a community will run out of water. Through the association pre-planning, defining this objective can help reduce the impacts and cost of implementing the emergency measure.

Whether or not a WSP decides to have this LOS objective, an emergency plan should be in place that outlines how an imminent threat to water supply would be determined and how it would be ensured that there would be adequate water to meet essential water needs (through emergency measures).

8.3.1 Benefits of developing this objectives

The benefits of developing a LOS objective for emergency measures include:

- Promote emergency planning
  - Identify the likelihood and impacts of a supply shortfall
  - Minimise the impact of a potential supply shortfall
  - Help ensure essential water needs can be met under all circumstances
- Develop community awareness
  - Improve understanding of water security levels
  - Appreciation of emergency measures that might be required

8.3.2 Planning considerations

The primary planning consideration when establishing objectives to manage emergencies should be assessing the consequences of the community only having essential water needs met or running out of water. The consequences may vary greatly for communities and will be influenced by factors such as the size of the community, the level of industry and the emergency supply options available.

Planning considerations:

- Community characteristics
  - Community values, including resilience to drought conditions and whether the community is prepared to have less water security at the cost of potentially requiring emergency measures.
    For example, if the community responds well to drought conditions, is able to significantly reduce water use and is able to pay for potentially costly emergency measures, then a comparatively high likelihood of relying on emergency supply could be adopted.
  - Community size
    For example, in large communities there may be fewer options for emergency measures available to provide the essential water needs of a community and these options may be more expensive. For instance, carting water may not be a viable option. Therefore, a low likelihood of having to implement emergency measures is generally adopted for large communities.
  - Consequences to the community, including the level of development, infrastructure and industry
    For example, in communities where businesses have a high water demand, supply shortfalls would have a significant economic impact. In communities with a high proportion of industry, a supply shortfall could have potentially more wide spread impacts, affecting neighbouring towns. Under these circumstances, where supply shortfalls are likely to have a significant and/or wide-spread economic impact, a low likelihood of requiring emergency measures is generally adopted.
- Geographic location
  - Distance to potential emergency water sources (e.g. carting water, pipeline to alternative source)
    For example, some towns may not have access to a viable emergency source. Adopting an LOS objective that has a low likelihood of requiring emergency measures would be appropriate for such communities.
- Economic and engineering capacity
  - Resources
    For example, some communities might lack the resources to implement emergency measures in a short time during a drought situation. Therefore, the LOS objective should reflect a low likelihood of requiring emergency measures.
  - Augmentation options
    For example, available emergency supply options that could provide the essential water needs of the community.

- Potential emergency measures
  - Risks to water availability
    For example, there may be other water users or entitlement holders that need to be taken into consideration.
  - Time needed to implement emergency measures, should there be a supply shortfall
    For example, if there are sufficient resources and planning in place to ensure that emergency measures can be implemented on time, a high likelihood of requiring emergency measures could be adopted in this water security LOS objective.
  - Costs to access and maintain the emergency source
- Hydrological nature of the local water supply system
  - Storage capacity
    For example, large storages, that have the capacity to supply several years of water demand, may provide more time to respond i.e. introducing emergency measures. Therefore, a lower likelihood of requiring emergency measures may be appropriate.
  - The nature of the water supply
  - The behaviour or nature of the water supply can affect the potential likelihood of supply shortfall
    For example, supplies that are highly weather dependent or variable, such as stream fed weirs, may allow a short time to respond (i.e. to introduce emergency measures) compared to a more weather independent supply, such as a groundwater bore. In this case, a higher likelihood of requiring emergency measures could be appropriate.
- Climate
  - The climate of the area will influence the behaviour of a water supply system.
    For example, communities with frequent and high rainfall are less susceptible to regular supply shortfalls. However, if the community has a water supply system with relatively small storage capacity due to these generally regular and reliable inflows, it may be less resilient if they do encounter an extended drought period, so they may require a low risk of relying on emergency measures.
    In comparison, a community that relies on a very seasonal water supply may be accustomed to regularly reducing water demand with minimal impact on the community's lifestyle. Therefore, a high likelihood of requiring emergency measures could be appropriate.

Table 6 presents an example of how the considerations discussed above may affect the choice of a target for setting LOS objective for emergency measures in two different communities; examples of detailed LOS objectives for these communities can be found in Appendix 2.

*Table 6: Example LOS objective for emergency measures in two communities**

Considerations	Community A	Community B
Characteristics of community	Medium sized community that would need an additional climate resilient source to provide for essential water needs	Small size community used to regularly carting water
	Providing only essential water needs likely to have a significant socio-economic impact on the community	Providing only essential water needs likely to have minimal socio-economic impact on the community
Potential LOS objective	Sufficient planning and investment undertaken so risk for requiring emergency measures is less than 1 in 100 years	Carting may be required once every 5 years on average

Notes:
* This table is to provide an example of the considerations that are made and how they could affect the resultant LOS objective for emergency measures. This table should not be used to provide an indication of the target that should be adopted for the LOS objective for emergency measures.

8.3.3 Development

The process for setting a suitable target and developing the LOS objective for emergency measures is outlined below and further information is provided in the template presented in the template (Appendix 1.3).

1. **Assess information**

   Consideration will need to be given to the consequences and likelihood of running out of water and the community having only sufficient water to meet essential water needs.

   The consequences consider the planning considerations mentioned above, particularly:

   - community characteristics
   - geographic location - access and availability of emergency water sources
   - economic and engineering capacity.

   The likelihood of needing to implement emergency measures should be based on:

   - hydrological modelling (if available)
   - local water supply system characteristics
   - climate.

   Information about the potential emergency measure that is likely to be implemented in such a circumstance may also be useful, particularly when undertaking the consideration of trade-offs.

2. **Consider trade-offs**

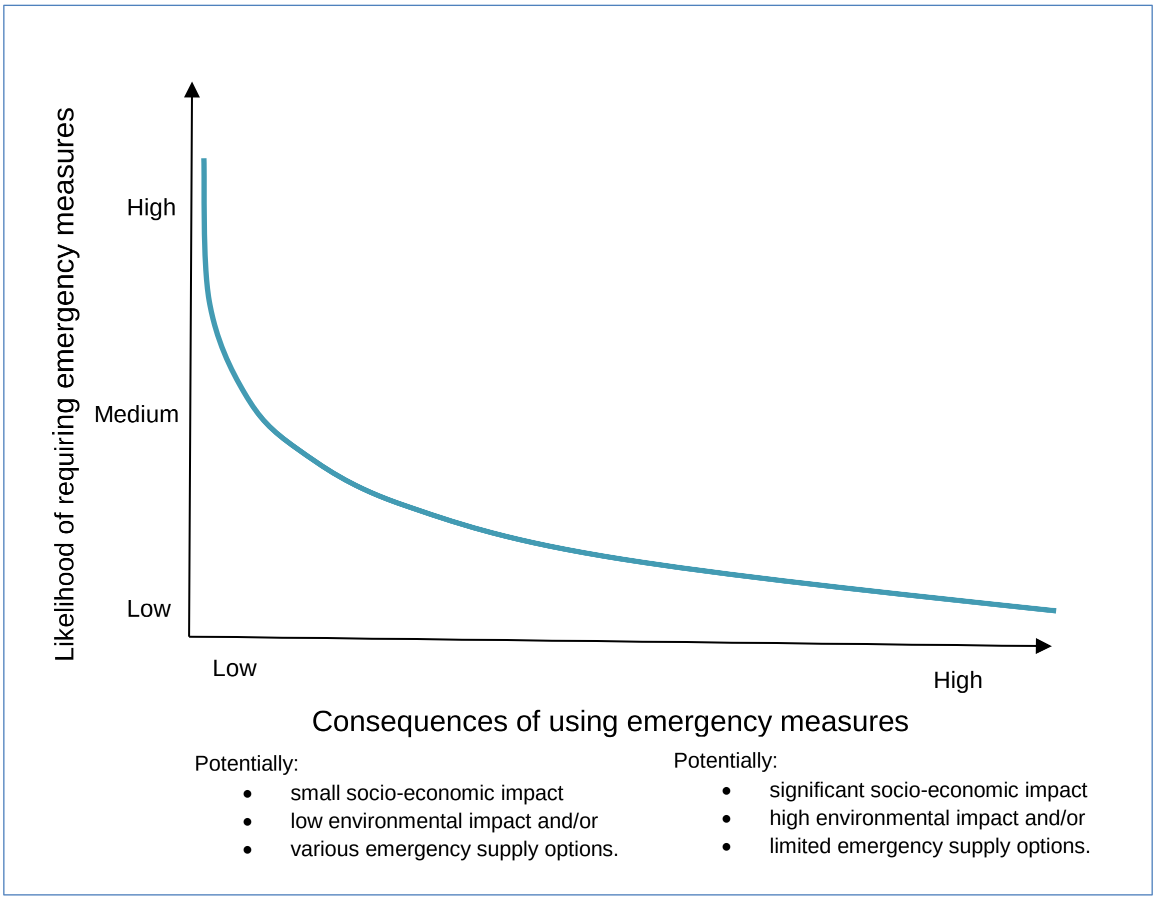
   The cost-benefit trade-off between proactive spending to reduce the risk of a potential supply shortfall and the reactive spending required for emergency measures should be considered.

   Figure 11 depicts the relationship between the likelihood (i.e. the potential frequency) of requiring emergency measures and the consequences for communities of such action. In general, if consequences are significant, a low likelihood/ frequency of occurrence would be desirable for a community (e.g. 1 in 10 000 or 1 in 1000 years). However, some communities might be comfortable regularly implementing emergency measures, have the capacity to readily implement such measures and deal well with the consequences.

Example:

Cairns Regional Council has adopted a LOS objective of not reaching the trigger for a planned emergency response more than once every 100 years on average. The emergency measure is to ensure that Council has the ability to supply the agreed minimum water requirements prior to reaching the dead storage level in the main water supply. In determining the target for the objective, Council considered the timeframe to implement the emergency measure and the acceptable level of risk of reaching dead storage.

Figure 11: Trade-off between the likelihood of requiring emergency measures and the consequence of those measures



To assess the costs, possible emergency measures should be identified along with an indication of possible cost, time required to implement, availability and accessibility.

3. Set target

The differences in potential costs between alternate risk scenarios (for requiring emergency measures) should be assessed to determine a suitable target. Risk is a function of likelihood and consequence. The consequence of loss of supply is based on the community. Therefore the LOS objective defines the appropriate level of risk by setting an appropriate target for the likelihood to trigger emergency measures to maintain essential water demands for a community.

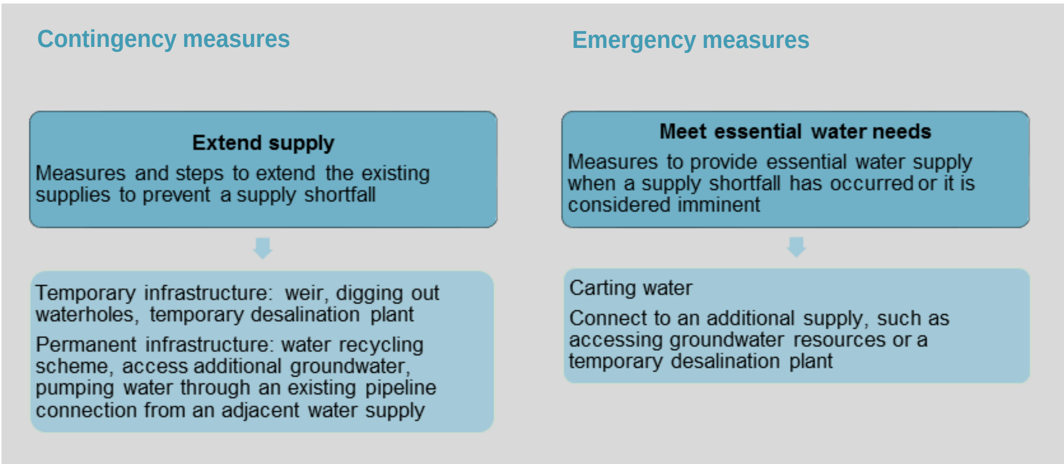
8.4 Other objective indicator types

A WSP may decide that, in addition to the three common LOS objective indicator types, it is relevant for the community to have other LOS objectives. These may provide additional criteria for the community's water supply security and/or relate to costly water supply measures. Such objectives typically relate to the expected frequency of reaching a particular trigger that requires a change in how the water supply system is operated or how water is sourced.

8.4.1 Triggers and contingency supply measures

It is common practice for water supply managers to establish trigger points (in terms of water supply volumes) that force the implementation of pre-agreed actions to extend the capability of the existing bulk water supplies. Such actions are aimed at reducing the likelihood of a water supply shortfall. Supply contingency measures typically involve accessing water from alternative local sources not generally utilised (for example due to reduced raw water quality, high operating costs or limited sustainability). In contrast, emergency measures are those measures implemented in order to meet only essential water needs when a local supply shortfall has occurred or it is considered imminent. The main differences between contingency and emergency measures is shown in Figure 12.

Figure 12: Contingency measures vs emergency measures



A WSP may want to develop an objective for the risk, or the potential frequency, of requiring a contingency supply measure due to the following benefits:

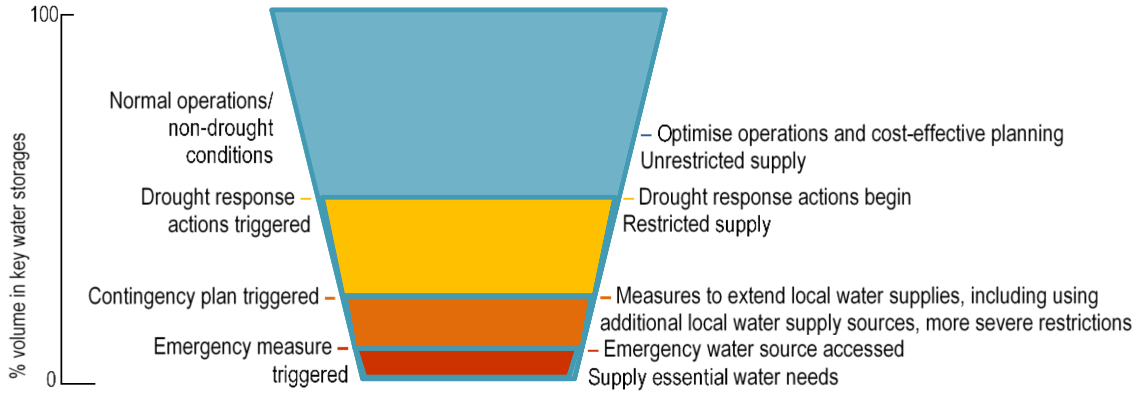
- Cost-effective
  - More cost-effective and timely planned augmentation of water infrastructure.
- Reduce costs
  - Reduce costs of expensive reactive measures (e.g. constructing emergency infrastructure).
- Avoid or delay likelihood of requiring emergency measures
  - By planning for long-term water security.

To develop LOS objective for supply contingency measures, the considerations are similar to those for determining the LOS objective for emergency measures. Primarily, the feasibility and economics of contingency measures should be considered when determining how often could be appropriate to construct contingency infrastructure.

Whether or not a WSP develops an LOS objective for contingency measures, having a contingency plan may be appropriate if a community possess the resources and the minimum response time of local storages (i.e. the average amount of time that the water storage takes to go from full to empty) is long enough to allow the implementation of contingency measures. For example, triggers could be identified for when action is required, including a trigger to prepare for the implementation of the contingency measure (e.g. obtain the necessary approvals), and a subsequent trigger to implement the contingency measures (e.g. commence construction of the infrastructure).

Figure 13 provides a schematic of how a water storage levels may influence the operating modes of a water supply system.

Figure 13: Example of operating modes of a water supply system based on water security level

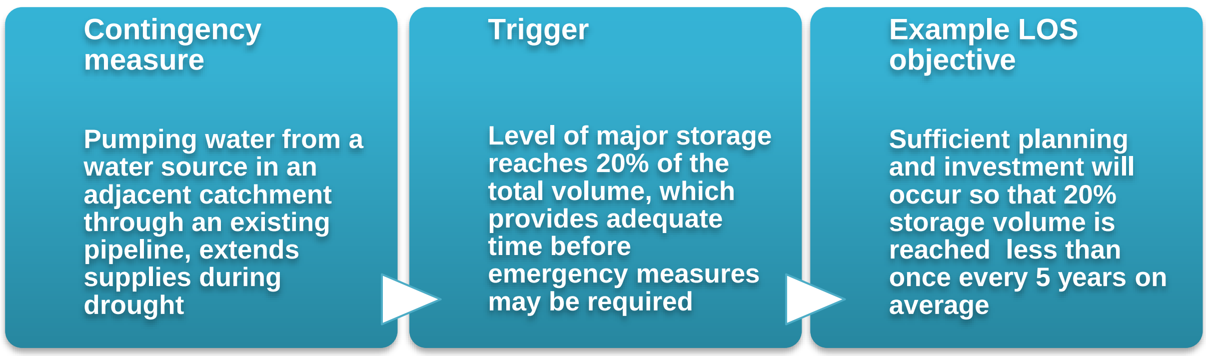


A community will have to rely on the emergency measures to ensure the continuity of the urban water supply if it does not have the resources and/or the response time of the local storages is too short (e.g. small and variable storage where time it might take until the storage is drawn down is too short to provide adequate time to implement an appropriate contingency supply).

8.4.2 Specific operational parameters

Specific operational parameters are conditions within a water supply scheme that identify a potential water scarcity risk (Figure 14). An example of an operational parameter is falling below a particular level in a storage that may indicate an impending local water supply shortfall. The trigger at which the contingency measures are implemented is an operational parameter. Specific operational parameters are unique to each community.

Figure 14: Development of water security LOS objectives for operational parameters



A WSP may decide to develop a LOS objective relating to the potential frequency of specific operational parameters being reached or triggered. This could help further describe the level of water supply security to a community. During development the WSP should undertake similar considerations to the LOS objective for emergency measures. Further details on developing LOS objective for operational parameters can be found in Appendix 1.4.

9 Conclusion

Establishing LOS objectives contributes to ensuring that the community has a reliable and secure water supply into the future. It is about communicating to the community the expected level of water supply security of a water supply system, and seeking their input on the acceptability of the risks. Clearly articulated LOS objectives can generate greater awareness of the current characteristics and level of security of a community's water supply system as well as making clear actions required under various drought conditions.

LOS objectives provide a fundamental basis upon which water supply planning can be progressed, enabling more efficient and effective water supply solutions.

10 Glossary and acronyms

10.1 Glossary

Community: includes residential and non-residential water users. For the purpose of these guidelines and the water supply LOS framework, it is all water users that access water from the reticulated water supply system.

Contingency measure: a supply measure or source that is in addition to normal supply, usually implemented under exceptional circumstances (e.g. drought) to ensure the continuity of supply to meet demands when the capacity of the existing water supply system is reduced. Contingency measures generally obtain water from local sources e.g. digging out waterholes, accessing additional groundwater resources, building a desalination plant and implementing a recycling water scheme.

Drought circumstances: a period of abnormally dry weather, expressed by the Bureau of Meteorology as a serious or severe rainfall deficiency for a continuous period of three months or more.

Emergency measure: a supply measure that is implemented to provide the essential water needs of a community under extreme, or emergency, circumstances (e.g. via building a pipeline to an adjacent catchment, carting water in or constructing a manufactured water source, such as a desalination plant). These emergency supplies would typically need to be provided by a climate resilient source to ensure supply is always available and is often sourced externally from the water supply system/region. Such measures would typically be implemented at the time of, or just prior to, a local supply shortfall occurring.

Essential water needs: the volume of water necessary to provide for drinking and basic hygiene and for essential services such as power generation, health and safety needs. This volume of water would typically need to be provided by a climate resilient source to ensure supply is always available and is often sourced externally from the water supply system/region.

Future water demand: an estimate of how much water the community is likely to use over a given period in the future.

Level of service objectives: are specific targets for various water supply security indicators, such as expected water demand and the frequency, severity and duration of water restrictions.

Minimum operating level: also referred to as dead storage level. It is the minimum operating level of the dam stated in the resource operations plan relating to the dam. It is water level below which the infrastructure owner must not release or supply water from that storage, unless authorised under exceptional circumstances.

Non-residential water use: is urban water use that is not residential use (e.g. water use in industry, power station or for business purposes).

Residential water use: is water use at a residence or for other domestic purposes (e.g. watering a garden at a residence).

Restrictions: are the limitations of the community water use to specified amounts, or for certain types of uses, for limited periods, during drought. Frequency (i.e. how often restrictions are expected to occur), severity (i.e. expected magnitude of the restrictions) and duration (i.e. how long the restrictions are expected to last) of restrictions can be used to indicate the level of water supply security that can be provided to the community.

Restriction regime: is an array of water restrictions that are set in stages that become more severe as the drought continues. Moving from one stage to the next is often triggered by the amount of water remaining in major water storages.

Supply shortfall: occurs when water supplies, including any contingency measures that may have been undertaken to avoid and or delay such shortfall, cannot meet the demands of a community and local storages reach minimum operating level. Adopting a restricted demand can avoid or delay a supply shortfall.

10.2 Acronyms

L/c/d: Litres per capita per day. Can be used as a unit measure of water use or demand. Volume of water used in a day divided by the relevant population, usually population serviced by the reticulation network.

L/p/d: Litres per person per day. Can be used as a unit measure of water use or demand. Volume of water used in a day divided by the population serviced by the reticulation network.

Water security LOS: Level of service. The level of water security provided by the water supply, defined by relevant objectives.

RWSSA: Regional water supply security assessment. A report collaboratively developed between the Queensland Government, through the Department of Natural Resources, Mines and Energy, and local Council to provide an understanding of the current and potential future water supply security and risks of the existing water supply system.

SEQ: South East Queensland region.

WSP: Water service provider.

Appendix 1: Water security LOS objective development template

This appendix provides a template for recording much of the information that will assist with understanding the current water supply system and will underpin information that is required for developing the LOS objectives. This template contains guidance on the information required to develop water demand, water restrictions, emergency measures and operational LOS objectives. An assessment of the information recorded, along with feedback from the community, should ensure reasonable and appropriate targets are developed for each objective.

Information considered should include:

- Water use
  - Historical and projected water demand
  - Previous water restrictions
  - Demand management measures
  - Future population growth
- Water supply system
  - Infrastructure details
  - Areas of constrained operations (minimum water treatment rates) and areas of operational flexibility (e.g. multiple supply points for single demand)
  - Storage losses
  - Hydrological nature of the system
  - Possible future augmentations
- Operations of the water supply
  - Schematic of the water supply system
  - Water entitlement details (volume and access conditions)
  - Operational rules
  - Climatic data (e.g. rainfall, evaporation and stream flow data)
  - Available alternative supplies (e.g. potential yields, timeframe for development and cost to access and maintain)

Note: The template includes possible sources of information including data that is reported under various frameworks, such as the Queensland Government Key Performance Indicators (e.g. QG #.#), Statewide Water Information Management (SWIM WA#.#) or the Bureau of Meteorology's National Performance Reporting framework (NPR W#).

Water demand objective

<table>
<tr><th colspan="2">Information required</th><th>Details [example answer]</th><th>Possible sources of information</th></tr>
<tr><td rowspan="5">Historical water use</td><td>Residential</td><td>• Water taken from the reticulation network for residential use by residential connections [megalitres per year (ML/a) / litres per person per day (L/p/d), calculated by dividing the water taken from the reticulation network for residential use by people that live in the community and are connected to the reticulation network]
• Water use trend [stable / increasing / decreasing]
• Any uncertainties in historical water use [new residential development that has high level of water efficient devices with unknown]</td><td rowspan="4">• Water volume supplied
- QG 1.17: Volume of water supplied – residential (NPR W8, SWIM WA8)
- QG 1.18: Volume of water supplied – commercial, municipal and industrial (NPR W9, SWIM WA9)
• Monthly sewage treatment plant inflow volumes
• Water billing data, if possible split into account type groups (residential, commercial, industrial, other)
• Estimates of other water users for irrigation of public spaces (e.g. parks, sports grounds)
• Estimates of non-revenue water losses (e.g. network distribution losses, fire-fighting)</td></tr>
<tr><td>Commercial</td><td>• Water taken from the reticulation network through commercial connections [megalitres per year (ML/a)]
• Water use trend [stable / increasing / decreasing]
Any uncertainties in historical water use [new business area with increasing demand network]</td></tr>
<tr><td>Industrial</td><td>• Water taken from the reticulation network through industrial connections [megalitres per year (ML/a)]
• Water use trend [stable / increasing / decreasing]
• Any uncertainties in historical water use [relatively new industry with potentially increasing demand network]</td></tr>
<tr><td>Other water users</td><td>• Water taken from the reticulation network by significant water users and other connections (standpipes, parks, green spaces, water features) [megalitres per year (ML/a)]</td></tr>
<tr><td>Non-revenue water</td><td>• Difference between total volume of raw water taken and total volume of water supplied. Indication of losses in the reticulation network, treatment losses and other unaccounted water [megalitres per year (ML/a)]</td><td>• Derived from historical water volume supplied compared to water produced and raw water sourced (to indicate water losses during treatment and distribution)
- QG 1.19: Volume of non-revenue water (NPR W10.1, SWIM WA36)
- QG 1.8: Volume of water sourced from surface water (NPR W1, SWIM WA1)
- QG 1.9: Volume of water sourced from groundwater (NPR W2, SWIM WA2)
- QG 1.10: Volume of water sourced from desalination of marine water (NPR W3.1, SWIM WA61)</td></tr>
</table>

			- QG 1.11: Total recycled water supplied (NPR W26, SWIM WA26) - QG 1.12: Total water sourced (NPR W7, SWIM WA7) - QG 1.6: Total volume of potable water produced (NPR W11.3, SWIM WA74) - QG 1.17: Volume of water supplied – residential (NPR W8, SWIM WA8) - QG 1.18: Volume of water supplied – commercial, municipal and industrial (NPR W9, SWIM WA9)
	Total historical water use	• Total water demand on the reticulation network [litres per capita per day (L/c/d), i.e. total volume of raw water taken for a year divided by the total connected population within the area for the corresponding year]	• Derived from historical water use data - QG 1.8: Volume of water sourced from surface water (NPR W1, SWIM WA1) - QG 1.9: Volume of water sourced from groundwater (NPR W2, SWIM WA2) - QG 1.10: Volume of water sourced from desalination of marine water (NPR W3.1, SWIM WA61) - QG 1.11: Total recycled water supplied (NPR W26, SWIM WA26) - QG 1.12: Total water sourced (NPR W7, SWIM WA7)
Estimates of future population growth		• 20 to 30 year growth forecasts • Identify if particular sectors are growing that may affect water use [manufacturing industry water needs will remain constant / increase in multi-family dwellings may lead to reduced average] • Identify any uncertainties in population estimates [expected that greater proportion of population will become transient]	• Council planning documents • Queensland Government Statistician's Office (QGSO) • Australian Bureau of Statistics • The relevant regional plan
Projected demand	Residential	• Estimated projected demand [megalitres per year (ML/a) / litres per person per day (L/p/d)] • Water use trend [stable / increasing / decreasing]	• Based on historical water use and estimate of future population growth - QG 2.5: Total anticipated annual water demand in five years' time • Proposed water efficiency measures (e.g. demand management measures and associated savings) • Land use plans and priority infrastructure plans • Seasonal demand patterns • Temperature and rainfall data • Internal water use (by type) • Tariff (including historical changes)
	Commercial Industrial Other water users Non-revenue water	• Estimated projected demand [megalitres per year (ML/a) / litres per capita per day (L/c/d)] • Water use trend [stable / increasing, rate of increase, water demand increase proportional with population growth / decreasing]	

			• Water demand forecasting model
	Total projected urban demand	The total estimated projected urban water demand, i.e. volume of raw water required to meet residential and non-residential water needs (20 to 30 years)	• Derived from projected demand from particular sectors within the community

Current infrastructure capacity		• Estimation of the current maximum capacity of existing infrastructure to supply water to the reticulation network [megalitres per year (ML/a) – limited by water treatment plant capacity and by the potential yield from the system]	• Potential yields
			• Storage losses [annual evaporation and seepage (metres/a)]
			• Water storage capacity
			  - QG 1.7: Total treated / drinking water storage
			• Water entitlement details (volume and access conditions)
			• Operational constraints (e.g. maximum water treatment production)
			  - QG 1.4: Capacity of water treatment plants

Hydrological nature of water supply system		• How the system behaves [seasonal inflows / long drawdown / qualitative rate of evaporation]	• Historical records • Hydrological studies

Current capacity vs project demand		• Whether there is adequate capacity within the system to supply the projected demand [Potential supply shortfall in 20 years - megalitres per year (ML/a) / litres per capita per day (L/c/d)]
		• Possible augmentations that may be required to meet the supply shortfall [significant supply shortfall that would require significant new water supply infrastructure / unlikely to be significant supply shortfall in next 20 years / supply shortfall could be met with small augmentation or upgrade to existing infrastructure]
			• Based on projected demand and current infrastructure capacity
			  - QG 2.6: Anticipated capacity to meet demand in 5 years' time
			  - QG 2.7 - Planned supply system response

Water restrictions objective

<table>
<tr><th colspan="2">Information required</th><th>Details [example answer]</th><th>Possible sources of information</th></tr>
<tr><td rowspan="2">Hydrological nature of local water supply</td><td>Characteristics</td><td>Volume of storage [megalitres]
Minimum operating volume [megalitres]
Storage curve
Supply commitments (other entitlements to water from the water source) [significant agricultural demand on the storage, which is stopped when the dam reaches 10%]
Type of inflows [constant / reliable / seasonal]
Seepage and evaporation losses [metres/year]
Average length of supply [full storage has nearly 5 years of supply, assuming full demand, average evaporation and no inflows]</td><td>Water supply design diagram
Resource operations plan
Records from the Water Monitoring Information Portal (https://www.dnrm.qld.gov.au)</td></tr>
<tr><td>Behaviour during low inflow</td><td>General characteristics [e.g. annual filling cycles, permanent/seasonal inflows, drawdown behaviour]
Estimates of ‘dry spell’ inflows [reliable / highly variable and volume]
Flow probability curves from gauging stations
Historical levels [has not reached critical levels in the past / has reached]
Length of lead time between ‘normal’ supply conditions and ‘drought’ conditions [quickly empty over a few months / supply slowly depletes over several years]
Identify any uncertainties with regards to possible drought [data based on historical record so potential risk that a worse event could occur / drought planning undertaken based on stochastic modelling of a 1:1000 year event / assessment based on last 10 years of data only]</td><td>Historical data on periods of no or minimal flows
- QG 2.1: Months of supply remaining at end of reporting period (30 June)
Records from the Water Monitoring Information Portal (https://www.dnrm.qld.gov.au)
Climate data (https://www.longpaddock.qld.gov.au)
Hydrological model</td></tr>
<tr><td>Previous restrictions</td><td>Water restriction information</td><td>Details of previous water restrictions (triggers, targeted water savings)
Achievement of water restrictions (savings achieved vs savings targeted) [Takes an average of 6 months to achieve targeted water savings]
Application to customers (residential only or all customers)</td><td>Historical information (e.g. frequency of restrictions being enacted in previous years and number of times and length of enforcement)
- QG 2.8: Water restrictions (duration)
- QG 2.9: Water restrictions (severity)</td></tr>
<tr><td></td><td>Economic impact</td><td>Identify business and industry that may have reduced output/suffer loss from reduced water supply and the associated potential</td><td>Community profile
Industrial/commercial outputs</td></tr>
</table>

Potential impact of restrictions		economic impact [significant / moderate / minor impact on business] • Possible economic impact on the community, e.g. loss of gardens [significant / moderate / minor economic impact]	
	Social impact	• Impact on the community [e.g. loss of sport grounds or play areas] • Possible aesthetic impacts [e.g. significant portion of community green space will be affected] • Identify different water user needs and if different water restriction regime is appropriate [restrictions will be limited for business and industry as it would have significant impact on commercial viability of town]	• Community feedback • Historical information • Anticipated volumetric savings or percentage savings for each water user type
	Community resilience to drought	• Community resilience indicated by previous response to drought [quick adoption of drought response measure / low acceptance of drought measures leading to long lag time] • Community awareness of the trade-offs with restrictions, i.e. potential costs associated with avoiding restrictions and impact of restrictions [community has high level of understanding shown by automatic reduction of water use during low rainfall / community has limited awareness as shown by low acceptance of drought measures]	• Demand management program • Historical information on demand management and water use • Community feedback

Emergency measures objective

<table>
<tr><th colspan="2">Information required</th><th>Details [example answer]</th><th>Possible sources of information</th></tr>
<tr><td rowspan="3">Consequences of emergency measures on community</td><td>Community characteristics</td><td>Community values [prepared to have less water security as willing to have emergency measures / unwilling to run out of water]
Community size [serviced population]
Community profile and risks [high level of commercial activity that is dependent upon water / high level of tourism that could be affected by low water supply / low water supply would affect ability to supplement water supply of surrounding rural residents]</td><td>Community feedback
Regional plans
Regional profiles http://statistics.oesr.qld.gov.au</td></tr>
<tr><td>Geographic location</td><td>Distance to potential emergency water sources [distance and time to emergency source]</td><td>Drinking water quality management plan
Water supply design diagram</td></tr>
<tr><td>Economic and engineering capacity</td><td>Feasibility of potential emergency measure including availability of resources to enable the construction of necessary infrastructure and accessibility to funding and technical expertise to operate the emergency measure [potential limitation in resource availability and therefore additional lead time required]
Possible emergency measures that could be accessed [carting water / desalination plant]
Potential yields</td><td>Community feedback
Regional plan
Council technical reports
Contingency supply information
QG 2.3: Available contingency supplies
QG 2.2: Anticipated capacity to meet demand for next reporting year
Drinking water quality management plan
Risk management/Emergency plan
Water supply design diagram</td></tr>
<tr><td>Potential emergency measure</td><td>Availability</td><td>Any risks to emergency water source availability, including other users of the source [new source so no risks / groundwater has four other entitlement holders]
Time required to implement necessary arrangements and gain access to the emergency source [time required for approvals and estimated time for construction]
Costs to access and maintain the emergency source [estimated capital and operating expenditure]</td><td>Regional plan
Council technical reports
Contingency supply information
QG 2.3: Available contingency supplies
Risk management/Emergency plan
Drinking water quality management plan</td></tr>
</table>

Likelihood of requiring emergency measures	Hydrological modelling (if applicable)	• Demonstrate the hydrology of the system including the likelihood, frequency and duration of water supply shortfalls	• Hydrological model in RWSSA (if applicable)
	Hydrological nature of local water supply system	• Storage capacity [volume (ML)] • Storage reliability [weather dependent / relies upon seasonal inflows / high losses] • Climate resilience [weather dependent storage and little lead time / climate resilient groundwater source / large storage and long lag time to empty storage / manufactured water source available]	• Regional plan • Council reports • Contingency supply information - QG 2.3: Available contingency supplies - QG 2.1: Months of supply remaining at end of reporting period (30 June) - QG 2.2: Anticipated capacity to meet demand for next reporting year • Planned supply system response • Drinking water quality management plan
	Essential minimum supply volume	• Estimated volume of water required to meet basic water needs for health and safety (i.e. for drinking and basic hygiene and for essential services) • Capacity to meet essential minimum supply volume [volume of climate independent sources]	• 'WSAA, 2014. Occasional Paper No. 29 - Urban Water Planning Framework and Guidelines' • Risk management plan • Drinking water quality management plant • Local drought management plan
	Climate	• Rainfall and inflow patterns [reliable, seasonal inflows / constant, reliable inflows / storage relies on storm inflows] • Drought history [regular drought conditions / infrequent but prolonged conditions] • Evaporation	• Historical record • Water supply design diagram • Climate data (https://www.longpaddock.qld.gov.au) Records from the Water Monitoring Information Portal (https://www.dnrm.qld.gov.au

Operational parameters objective

As outlined in the Guidelines, it may be appropriate to have a water security LOS objective for operational parameters that are associated with a potentially significant impact (i.e. economic, social or environmental). Such parameters may be associated with a significantly increased risk of water supply shortfall and it is appropriate to manage the supply source so that this trigger is reached infrequently.

<table>
<tr><th colspan="2">Information required</th><th>Details [example answer]</th><th>Possible sources of information</th></tr>
<tr><td colspan="2">Operational matter that has potentially significant impact</td><td>• Detail any operational matter that has a potentially significant impact or indicates a significant increase in risk in requiring emergency measures [when storage reaches 25% capacity contingency measures are implemented that have associated high cost / when groundwater yield drops below a specified rate, indicates that there is a significantly high risk of local supply shortfall]</td><td>• Historical records
• Hydrological model</td></tr>
<tr><td colspan="2">Likelihood of operational matter</td><td>• Storage reliability [weather dependent / relies upon seasonal inflows]
• Likely lead time between ‘normal’ supply conditions and operational matter being triggered [‘flashy’ storage so little lead time / long lag as consistent inflows]</td><td>• Historical records
• Hydrological model</td></tr>
<tr><td rowspan="2">Trigger of the operational matter</td><td>Operational measure</td><td>• Actions associated with operational matter [water supplied from adjacent town via pipeline / at lower groundwater yields higher level water restrictions implemented]
• Trigger and current frequency of triggering</td><td></td></tr>
<tr><td>Availability and accessibility</td><td>• Any issues to implementing operational measure [limitations on access due to other users / community acceptance of high level restrictions]
• Time required for implementation [requires time to put arrangements in place to access measure]
• Resources required to implement [cost in implementing measure / require additional staff to implement measure]</td><td></td></tr>
<tr><td colspan="2">Consequence of operational measure being triggered</td><td>• Impact of operational matter being triggered on water security [when contingency plan implemented indicates significant risk of local supply shortfall]
• Economic impacts of operational matter [different water quality from pipeline impacts manufacturing processes and has associated cost implications / higher level water restrictions affects output from major industry in the community]
• Social impacts [higher level water restrictions affects community lifestyle and can only be successfully imposed infrequently and for short periods]</td><td>• Historical records</td></tr>
</table>

Appendix 2: Example for community A and B

This appendix contains examples of two different communities to demonstrate how the template can be used to develop LOS objectives.

2.1. Community A

Water demand objective

Information		Details
Historical water use	Residential	• Average daily 280 L/p/d, 1461 ML/a • Connected population 14 300 • Water use fluctuates with temperature and rainfall
	Commercial	• Average 88 ML/a • Use is relatively stable • Waterpark: Average 51 ML/a • Use is relatively stable • Total commercial water use: 139ML/a
	Industrial	• Average 275 ML/a • Use is fairly stable • Abattoir: Average 38 ML/a • Use is fairly stable • Total industrial water use: 313 ML/a
	Other water users	• Municipal / public: average 39 ML/a • Water use fluctuates with temperature and rainfall: public use dominated by a school and a hospital
	Non-revenue water	• Average 272 ML/a
	Total historical water use	• 426 L/c/d (approximately 2224 ML/a in 2014)
Estimates of future population growth		• Estimated 1.2% per year population growth • 14 300 in 2014 to approximately 18 153 by 2034
Projected demand	Residential	• Reducing to 270 L/p/d year 2034 forecast use 1789 ML/a • Demand management program in place: assumed increase uptake in water efficient devices

	Commercial	• Expected to increase proportional with population growth • 2034 forecast use 176 ML/a
	Industrial	• Expected to increase proportional with population growth • 2034 forecast use 397 ML/a
	Other water use	• Expected to increase proportional with population growth • 2034 forecast total raw water demand 50 ML/a
	Non-revenue water	• Losses expected to reduce to approximately 12%
	Total projected demand	• 2034 projected demand 2412 ML/a excluding non-revenue water • 2034 projected demand 2757 ML/a including non-revenue water (416 L/c/d) • Slight reduction (~2%) in total daily water use over a 20 year timeframe due to greater efficiency in water use • Urban demand increase about 19% in 20 years • If residential and loss reduction not achieved year 2034 total raw water demand would be 2864 ML/a being 432 L/c/d
Current infrastructure capacity		• Maximum treatment capacity of 3000 ML/a
Hydrological nature of water supply system		• Seasonal inflows into storages • Typically constant rate of drawdown with minimal evaporation
Current capacity vs project demand		• Sufficient capacity to meet projected 2034 demand, may need water treatment plant upgrade to meet peak demands • No identified potential supply shortfalls in the next 20-30 years • No studies undertaken to date to find additional water supply • Consideration of measures for reducing non-revenue water in the future as well as potential for water efficiency measures
LOS objective		Sufficient water will be available to meet a total urban demand of 420 L/c/d

Water restrictions objective

Information		Details

Hydrological nature of local water supply	Characteristics	• Dam A: 106 000ML supplying industry, agriculture and urban demand
		• Dam B: 2 600ML
		• Dam A is a deep storage with small surface area minimising the impact of evaporation
		• Water users and operating rules
		  o Dam A storage commitments
		    - supply up to 4000 ML/annum industry
		    - supply up to 15000 ML/annum agricultural
		    - supply up to 5000 ML/annum urban
		  o Dam A operating rule prevents agricultural take when storage level below 25%
		  o Critical storage characteristics: Full storage providing a full demand with assumed losses of 8000 ML/annum has nearly 4 years of supply when considering no inflow

	Behaviour during low inflow	• Annual filling cycles • Constant drawdown behaviour • Longest duration of recorded no flow (1 ML/d or less) was 13 months • Seasonal – summer month high flows resulting in storage filling cycles • 95% of the time there are recorded daily flows above 5 ML/d • Historically 82% of the time, the major watercourse/s entering the Dam A have a recorded total daily flow above 70 ML/d • Supply slowly depletes over 4 years, if no significant inflows occur during that time • Historically Dam A has not been below 45% full (~47 000 ML available) • Based on historical data it has reached low levels of around 45% full for period of 3 months in 60 years • Stochastic hydrological modelling indicates approximately 1:1000 chance of reaching dead storage level
Previous restrictions	Water restriction information	• No history of previous restrictions being implemented
Potential impact of restrictions	Economic impact	• The abattoir water demand is ~15 % of total demand. Restriction of supply may have reduced output and may result in reduction to local workforce associated with reduced water supply • Large and well developed industries in the area so high economic impact
	Social impact	• Significant social impact on the community, community value and ability to maintain green space • Community access and support the development and maintenance of park, event and social green space areas
	Community resilience to drought	• Water restrictions have not been enacted previously • Education programme undertaken. Community understand the consequences of the water supply system not supplying water and the need for accessing alternative sources of supply • Unknown community response to drought and implementation of restrictions

LOS objective	Restrictions will not occur more than 1 in 20 years, will not be more severe than reducing residential water use to an average of 245 litres per person per day (15% reduction) and will not last longer than 18 months

Emergency measures objective

<table>
<tr><th colspan="2">Information</th><th>Details</th></tr>
<tr><td rowspan="3">Consequences of emergency measures on community</td><td>Community characteristics</td><td>Community is not used to running out of water but understand that the possibility of resorting to emergency measures exists
Residential population of approximately 14 300 people
Community has significant industry and tourism
Potentially significant social and economic impact of reduced water availability</td></tr>
<tr><td>Geographic location</td><td>Coastal location, potential to access temporary desalination</td></tr>
<tr><td>Economic and engineering capacity</td><td>Possible mobile desalination plant (3 ML/day)
Alternatives sources being investigated</td></tr>
<tr><td>Potential emergency measure</td><td>Availability</td><td>Hire a mobile desalination plant, which can produce up to 3.5ML/d
Time required for pre-planning for the mobile desalination plant and approval within Council; approximately 3-4 months
Commencing arrangements for delivery of the portable desalination plant when storage falls below 25% (estimated 12 months to supply failure with no further inflow)
Delivery and installation initiate when storage falls below 10% (estimated 6 months to supply failure with no further inflow)
Approximately 2 days required to install the portable plant plus transportation</td></tr>
<tr><td rowspan="4">Likelihood of requiring emergency measures</td><td>Hydrological modelling (if applicable)</td><td>Stochastic hydrological modelling indicates approximately 1:1000 chance of reaching dead storage level</td></tr>
<tr><td>Hydrological nature of local water supply system</td><td>Storage generally has reliable seasonal inflows</td></tr>
<tr><td>Essential minimum supply volume</td><td>140 L/c/d</td></tr>
<tr><td>Climate</td><td>Rainfall produces constant reliable inflow to the storage
While prolonged drought circumstances have occurred (including millennium drought) storages have not fallen below 45%</td></tr>
<tr><td colspan="2">LOS objective</td><td>Emergency drought response infrastructure will not be constructed more than 1 in 1000 years</td></tr>
</table>

Operational parameters objective

Information		Details
Operational matter that has potentially significant impact		• When storage falls below 40%, it is anticipated that water will be pumped from adjacent town, Whoville, through existing Kanga pipeline (very reliable supply) • High associated costs
Likelihood of operational matter		• Highly stable storage, which has annual filling cycles • Low rate of evaporation • Stochastic hydrological modelling indicates approximately a 1:50 chance of reaching 40%, based on 2020 population
Trigger of the operational matter	Operational measure	• Water supplied for adjacent town, Whoville • Accessed once in past 60 years
	Availability and accessibility	• Water can be pumped from Whoville, using existing Kanga pipeline, within 48 hours • Can use on-call staff to facilitate rapid response, however an additional 0.5 staff member would be required for pump/pipe operation and maintenance • Have on-going contract to enable access to 100 ML of water from Whoville when required
Consequence of operational measure being triggered		• Using water from existing Kanga pipeline is reliable but costly • Water quality is good • Restriction to some users (e.g. residential and non-residential) to be applied to reduce demand
LOS objective		Water will not be sourced from the adjacent town, Whoville, via the Kanga pipeline more than 1 in 50 years

2.2. Community 'B'

Water demand objective

Information		Details
Historical water use	Residential	• Average 325 L/p/d, 95 ML/a • Use is relatively stable
	Commercial	• Average 20 ML/a • Use is relatively stable
	Industrial	• Average 55 ML/a • Use is stable
	Other water use	• Tourism: Average 19 ML/a • Use is relatively stable • Public: 13 ML/a • Monthly fluctuations, as a school and a hospital largely dominate consumption in the public sector
	Non-revenue water	• Non-revenue water 24 ML/a
	Total historical water use	• 774 L/c/d (approximately 226 ML/a in 2014) • Includes non-revenue water (11% of total raw water demand)
Estimates of future population growth		• Minimal population growth projected • 800 people in 2014 to 850 by 2034 (approximately 6% growth, which is approximately 0.3% growth per year) • No major changes in water demand in any of the sectors
Projected demand	Residential	• Reducing to 315 L/p/d by year 2034 forecast use 98 ML/a
	Commercial	• Expected to be proportional increase with population growth, year 2034 forecast use 21 ML/a
	Industrial	• Expected to be proportional increase with population growth, year 2034 forecast use 58 ML/a (main user is an abattoir just outside town)
	Other water use	• Tourism: expected to be proportional increase with population growth, year 2034 forecast use 20 ML/a • Public: expected to be proportional increase with population growth, year 2034 forecast use 14 ML/a
	Non-revenue water	• Non-revenue water expected to reduce to 10%
	Total water demand projection	• Total forecast water use in year 2034 211 ML/a (excluding non-revenue water) • Forecast total raw water demand in year 2034 232 ML/a, 748 L/c/d includes non-revenue water • Approximately 6% total increase over a 20 year timeframe due to population increase
Current infrastructure capacity		• Maximum treatment capacity is 300 ML/a
Hydrological nature of water supply system		• Highly variable inflows, which rely on seasonal rainfall

	• High rate of evaporation
Current capacity vs projected demand	• Adopted annual demand for planning purposes 232 ML/a • No identified potential supply shortfalls in the next 20 years • No studies undertaken to date to find cost effective plan for augmentation of storage • Consideration of measures for reducing non-revenue water in the future as well as potential for water efficiency measures
LOS objective	Sufficient water will be available to meet a total urban demand of 750 litres per capita per day

Water restrictions objective

Information		Details
Hydrological nature of local water supply	Characteristics	• Weir: 160 ML • Storages susceptible to high rate of evaporation • Groundwater: 3 bores used as contingency measure when the water quality of weir is poor or water is unavailable
	Behaviour during low inflow	• Weir quickly empties over a few months, generally during dry season and replenishes quickly with seasonal inflows. • Extended drought might dry up storage
Previous restrictions	Water restriction information	• Restrictions are usually implemented during the dry season
Potential impact of restrictions	Economic impact	• The abattoir may have reduced output/suffer loss from reduced water supply with a moderate associated potential economic impact • Minimal economic impact on rest of the community
	Social impact	• Minimum social impact on the community as the community is resilient to seasonal drought and restrictions to water use • Hospital relies on groundwater supply during drought
	Community resilience to drought	• Good community resilience indicated by previous response to drought • The community is used to seasonal restrictions and understands trade-offs shown by automatic reduction of water use during low rainfall
LOS objective		Seasonal restrictions to be adopted each year at the beginning of each dry season and ceased at the beginning of the wet season

Emergency measures objective

Information		Details
Consequences of emergency measures on community	Community characteristics	• Community are drought resilient (accepting of seasonal water restrictions) but unwilling to run out of water. • Community are aware of the possibility of resorting to emergency measures • Community size: 800 • Hospital and abattoir dependent upon full access to water • Low water supply would affect water supply of surrounding rural residents (tankers use town water supply to supplement these rural residents, some groundwater available as an alternative source)
	Geographic location	• 50 km to potential emergency water carting locations, approximately 1 hour (one way)
	Economic and engineering capacity	• Potential measures include using bore water or carting water
Potential emergency measure	Availability	• Carting water: drawn from nearby town water supply network with very reliable supply • Bore water – 3 bores close to town. Set up costs included in an existing budget. Unknown long-term viability • Community has relied on groundwater 10 times in 20 years (approximately once very second year) and carting of water only once in 20 years • Time required: 1-2 days for arranging carting and 24 hours for temporary bore water pumps to be set up
Likelihood of requiring emergency measures	Hydrological modelling (if applicable)	• None undertaken
	Hydrological nature of local water supply system	• Highly variable storage, which relies on seasonal inflows • High rate of evaporation • Supply empty quickly over a few months ('flashy' storage so little lead time) but fills up quickly with seasonal inflows • When inflow falls below 7ML/day, 3 months are estimated to supply failure with no further rainfall
	Essential minimum supply volume	• Estimated 120 L/c/d
	Climate	• Average annual rainfall is about 1200mm (based on data recorded from 1961 to 2015). Most of rainfall is during summer months • Regular drought conditions during winter
LOS objective		Carting of water will not occur more than 1 in 20 years