Department of Climate Change,
Energy, the Environment and Water

Valuation methodologies

Extracted from the Water conservation cost-benefit analysis guidelines

September 2024

NSW GOVERNMENT

The *Water conservation cost-benefit analysis guidelines* have been developed to provide a framework to undertake cost-benefit analysis of urban water conservation options. These guidelines will assist utilities to consider the broad range of costs and benefits of water conservation initiatives. Their purpose is to encourage utilities to consider and evaluate water conservation initiatives on an equal basis with supply side measures that improve water security.

For ease of use, the full *Water conservation cost-benefit analysis guidelines* have been broken into the following sections to guide utilities through the analysis process:

- **About the *Water conservation cost-benefit analysis guidelines*** – Summary of the purpose, background and process for conducting a cost-benefit analysis.
- **Undertaking a cost-benefit analysis** – Describes the steps involved.
- **Valuation methodologies** – A successful analysis will assess economic, social, environmental and cultural costs and benefits.
- **Case study A** – Water conservation cost-benefit analysis in a metropolitan coastal community with a large population.
- **Case study B** – Water conservation cost-benefit analysis in an inland community with a small population.
- **Case study C** – Water conservation cost-benefit analysis in an inland community with a mid-size population.

Visit **water.dpie.nsw.gov.au** to download these documents or a copy of the full *Water conservation cost-benefit analysis guidelines*.

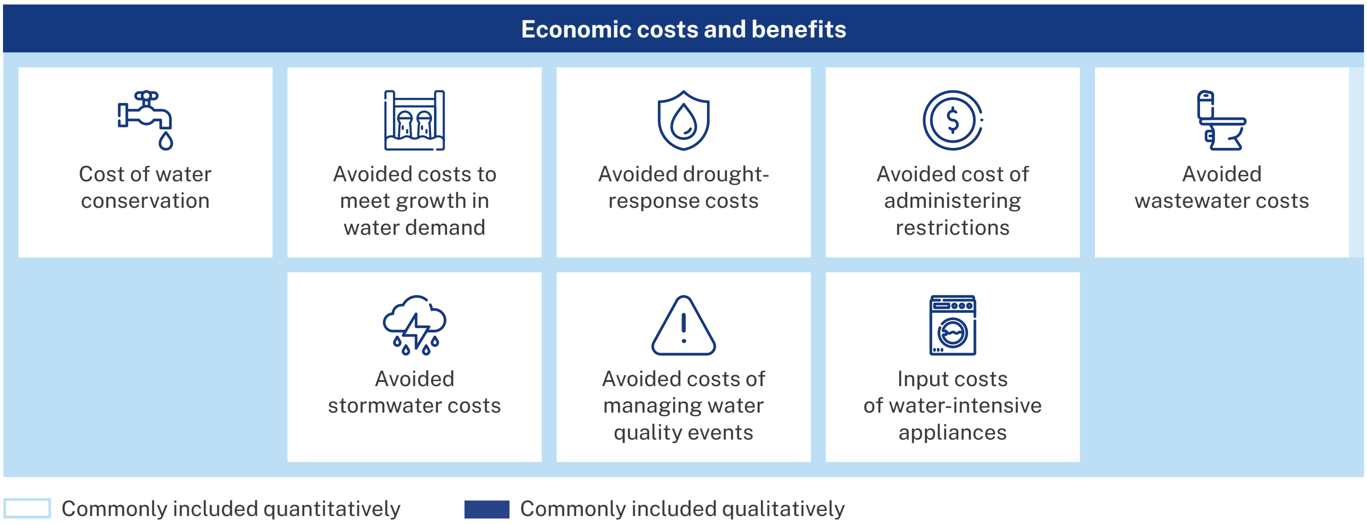
Contents

Appendix 2: Approaches to valuing key economic costs and benefits

This section provides further detail on valuing the key economic costs and benefits of water conservation measures. As shown in **Figure 31**, these include:

- the upfront and ongoing costs of the water conservation measure
- the value of avoided costs to meet growth in water demand
- the avoided costs of responding to drought, including under any local water utility's drought-response plan:
  - the value of avoided capital and operating costs related to construction and/or operation of a drought response
  - avoided cost of administering water restrictions
  - the social cost of water restrictions and the social cost of a shortfall (discussed in **Appendix 3**)
- the value of avoided capital and operating costs related to the wastewater network
- the value of avoided capital and operating costs related to stormwater management
- the avoided cost of managing degraded water quality/managing a water quality event
- the avoided input costs of water-intensive appliances.

Figure 31: Overview of key economic costs and benefits



We discuss the methodology to value each cost and benefit below.

Importantly, the "availability value" of water conservation isn't a category of costs and benefits in and of itself.[55] Rather, it is a form of water conservation you can evaluate using these methodologies and guidelines. The "availability value" of water conservation is its ability to further defer the costs of responding to drought.

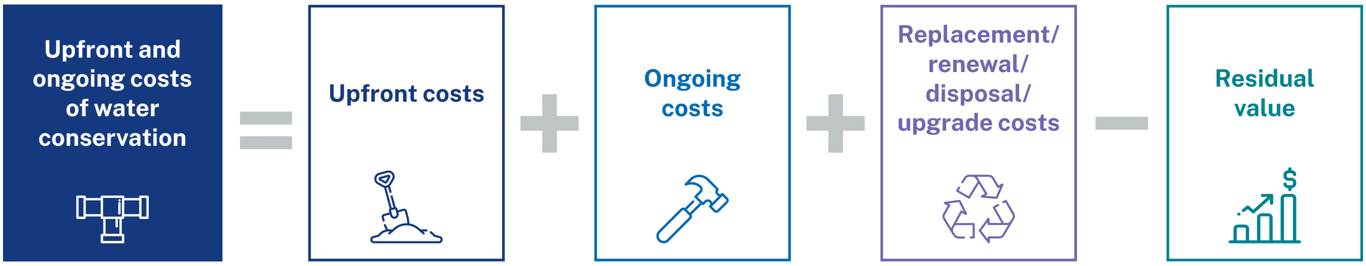
55 The availability value of water is the value of baseline investment in water conservation that maintains capabilities and enhances the ability to scale up water conservation during periods of drought.

A2.1 Approach to valuing costs of water conservation measures

Water conservation measures should consider all costs associated with the testing, planning, development, delivery, operation and, where relevant, disposal of assets over the modelling period. As shown in **Figure 32**, the costs of water conservation measures can include:

- **upfront costs** such as those associated with planning and non-recurring construction or purchase and installation
- **ongoing costs** such as operation and maintenance of services, implementing an education campaign, enforcement, and energy
- replacement, renewal, disposal, and/or upgrade
- **residual or salvage value**, where relevant, such as the value of the asset at the completion of the lifecycle or the period of analysis (see **Box 16**).

Figure 32: Valuing the costs of water conservation measures



Box 16: Calculating residual value

Estimate residual value whenever the project life is:

- shorter than the asset's useful life and the business intends to dispose of the asset
- greater than the appraisal period and the final year of the appraisal requires a residual/terminal value in recognition that the asset provides value beyond the modelling period.

The residual value of an asset can be based on its value in place or its resale or scrap value less the costs of disposal. This can include expenses such as disassembly and removal, recycling or safe disposal, and/or site remediation.

A2.2 Approach to valuing avoided costs to meet growth in water demand

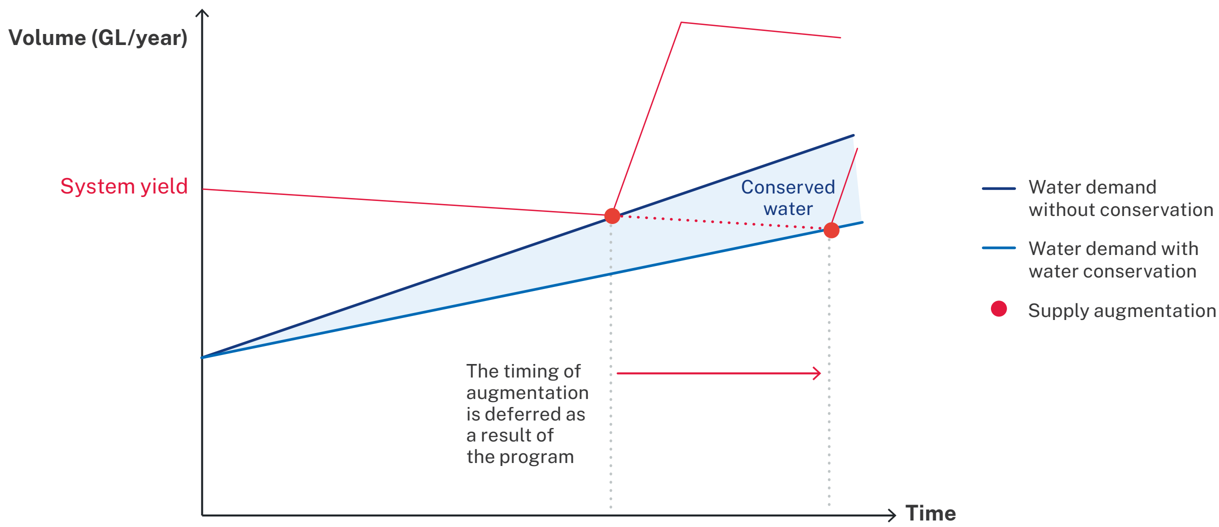
As shown in **Figure 33**, the use of water conservation can reduce the demand for water from the potable water system. In turn, this can defer or avoid the need to augment and/or operate key water supply assets that would otherwise be required to meet growth in water demand (see **Figure 34**).

The deferral of this expenditure represents an economic cost saving for the community (an "avoidable cost" benefit) relative to a base case.

Figure 33: The link between water conservation and avoided costs to meet growth in water demand

Impact on water demand	Impact on asset use/requirements	Impact on expenditure
Replacing appliances with more water-efficient appliances (such as washing machines) can reduce the demand for potable water, compared to the base case.	Reduced demand for potable water will **defer or avoid the need to use and/or augment the potable water system.**	**The deferral or avoidance of use and/or augmentation reduces expenditure in the water system** (resulting in an "avoided cost" compared to the base case).

Figure 34: The link between water conservation and costs to meet growth in water demand



Importantly, short-term water conservation measures and longer-term water conservation measures both deliver this benefit. Short-term water conservation measures lead to short-term reductions in demand. Longer-term water conservation measures deliver permanent reductions in demand.

As shown in **Figure 35**, at a high level, the present value of this avoided operating expenditure and capital expenditure can be calculated by multiplying together:

- LRMC of water supply (bulk and non-bulk water)[56] (**P**)
- **the change in water demand** (**ΔQ**) over the modelling period
- **the likelihood of incurring costs to meet growth in water demand** (**L**). This will be equal to 100 per cent because the likelihood of incurring costs to meet growth in water demand does not vary as a result of water conservation, nor do growth-related avoidable costs rely on a specific event occurring (such as drought).

56 This should include an estimate of the avoided energy costs of meeting growth in water demand, which is separate to the energy use associated with use of water-intensive appliances.

Figure 35: Valuing avoided costs to meet growth in water demand

Valuing avoidable costs to meet growth in water demand	=	LRMC of relevant water system	×	Change in water demand	×	Probability of triggering investment to meet growth
$P \times \Delta Q \times \Delta L$		P		ΔQ		ΔL

In cases where an estimate of the LRMC of water supply is not available, adopt the usage price as a proxy until developing LRMC estimates. If you adopt the usage price in place of the LRMC, the results of the analysis should be subject to a “sense check” against the relevant planning documents, where:

- a low usage price implies there is sufficient capacity in the system, and therefore, it is likely the planning documents will indicate that no augmentation is required in the shorter term
- a high usage price implies there may be capacity constrains in the system, and therefore, it is likely the planning documents will indicate that augmentation is required in the shorter term.

A2.3 Approach to valuing avoided costs of a drought response

In the event of drought, it may be necessary to bring additional measures online as part of a management plan to ensure the local water utility can continue to meet its level of service. The cost of this measure will depend on a local water utility’s specific drought-response plan. It could include the cost of construction a drought-response desalination, new infrastructure to access existing sources (ground water), and/or the cost of carting water for smaller communities. CBA should account for the additional operating and capital expenditure associated with these measures.

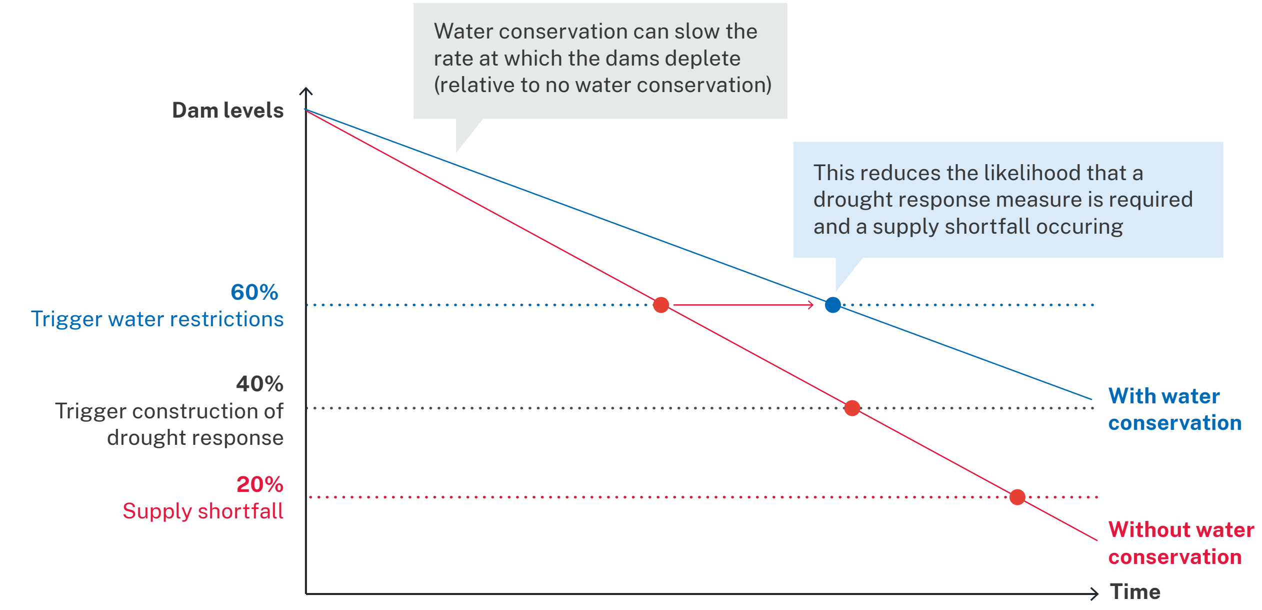
In any given year there is some likelihood of drought conditions occurring, thus requiring drought-response measures. Water security planning is designed to ensure utilities can meet key level of service system criteria[57] such as frequency and duration of water restrictions. Different options, for example with and without water conservation, can have higher or lower likelihood of triggering a drought response, driven by differences in the depletion rate of the storages. In other words, as shown in **Figure 36** and **Figure 37**, reducing the rate at which storages deplete enables water conservation to avoid the costs of a drought response.

Figure 36: The link between water conservation and avoided costs of a drought response

Probability of triggering drought costs each year	Impact on storage depletion rates	Impact on the likelihood of triggering a drought response	Impact on society
At any point in time there is a likelihood that construction of a drought response is triggered due to reaching a water storage trigger level.	Use of water conservation can reduce draw on the potable water system. This in turn can reduce the rate at which storage levels deplete.	Slower depletion of storage levels reduces the likelihood of triggering construction of a drought response.	Reducing the likelihood of triggering a drought response will reduce the likelihood of incurring the costs of constructing and operating the drought response. This represents a cost saving to the community.

57 See website here for the then Department of Planning and Environment’s guidance on water supply yield analysis for town water supply schemes: www.industry.nsw.gov.au/__data/assets/pdf_file/0007/547297/guidance-understanding-water-security.pdf

Figure 37: The link between water conservation and avoided drought-related costs



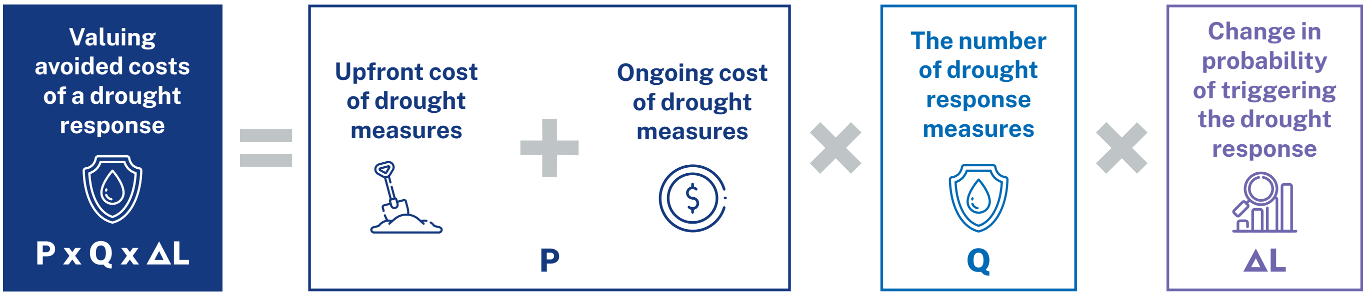
The reduced likelihood of a cost being incurred represents an avoided cost or benefit to the community

Importantly, **the rate of storage depletion can be impacted whether the water conservation measure is delivered in times of water surplus or in times of water scarcity. But the impact or size of the change will differ.**

As shown in **Figure 38**, at a high level, the value of avoided costs of a drought response can be estimated by multiplying together:

- **the cost of the drought response measure, including the construction costs and operating costs** (**P**). The cost of this measure will depend on a local water utility's specific drought-response plan.
- **the number of drought response measures required** (**Q**). This will typically be equal to one because water conservation generally changes the likelihood of triggering a drought-response measure, not the measure itself.
- **the likelihood of triggering a drought response** (**ΔL**).

Figure 38: Valuing avoided costs of a drought response



A2.4 Approach to valuing avoided costs of administering water restrictions

In the event of drought, it may be necessary to implement water restrictions as part of a management plan to ensure the local water utility can continue to meet its level of service. While the cost of this measure will depend on a local water utility's specific drought-response plan, implementing water restrictions can require additional administration costs to the local water utility. This can include the costs of implementation, engagement, enforcement, and advertising.

Similar to above, reducing the rate at which storages deplete, as shown in **Figure 39**, enables water conservation to lower the likelihood of triggering water restrictions and therefore avoid the costs of administering them. **Appendix 3** discusses the link between water conservation and avoided social cost of restrictions.

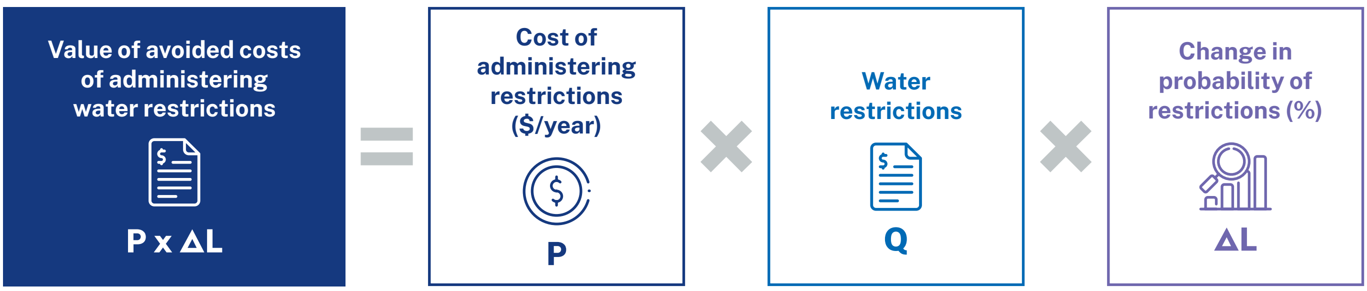
Figure 39: The link between water conservation and avoided administration costs of water restrictions

Probability of triggering drought costs each year	Impact on storage depletion rates	Impact on the likelihood of triggering restrictions	Impact on society
At any point in time there is a likelihood that water restrictions are due to water storage levels.	Use of water conservation can reduce draw on the potable water system and the rate at which storage levels deplete.	Slower depletion of storage levels reduces the risk of triggering water restrictions and/or reduces the duration and severity of restrictions.	Reduced risk of water restrictions will reduce the cost associated with administering water restrictions.

The exact approach to valuing the change in avoided cost of administering water restrictions will depend on the manner in which these administration costs are expressed (for example, $/year). See the example in **Figure 40**. It shows that at a high level, the value of avoided costs of administering water restrictions can be estimated by multiplying together:

- an estimate of the cost of administering water restrictions (**P**)
- **the number of water restrictions implemented** (**ΔQ**). In this example this is equal to one as the administration cost of water restrictions are on an annual basis.
- the change in probability of triggering the drought response under each option (**ΔL**).

Figure 40: Valuing avoided costs of administering water restrictions



Appendix 3 discusses estimating the avoided social cost of restrictions from water conservation.

A2.5 Approach to valuing avoided wastewater costs

Some water conservation measures can reduce the volume of wastewater managed downstream. These include:

- water-efficient programs such as water-saving showerheads and water-efficient washing machines that reduce the volume of water and in turn reduce the volume of wastewater to be managed
- reuse of wastewater as a result of small-scale initiatives.

In many cases, wastewater volumes drive the need for, and timing of, augmentations in the wastewater system. But they may not necessarily be the only factor driving investment. In cases where growth in volumes drives expenditure, a reduction in wastewater volumes as a result of conservation can defer or avoid expenditure. These are also known as avoidable costs. For example, as shown in **Figure 41**, water conservation measures that reduce the quantity of wastewater volumes discharged through the wastewater system can avoid or defer a wastewater system augmentation. The deferral of this expenditure represents an economic cost saving for the community in the form of avoided capital and operating expenditure (an "avoidable cost" benefit), relative to a base case of no conservation.

Figure 41: The link between demand management and downstream wastewater-related costs

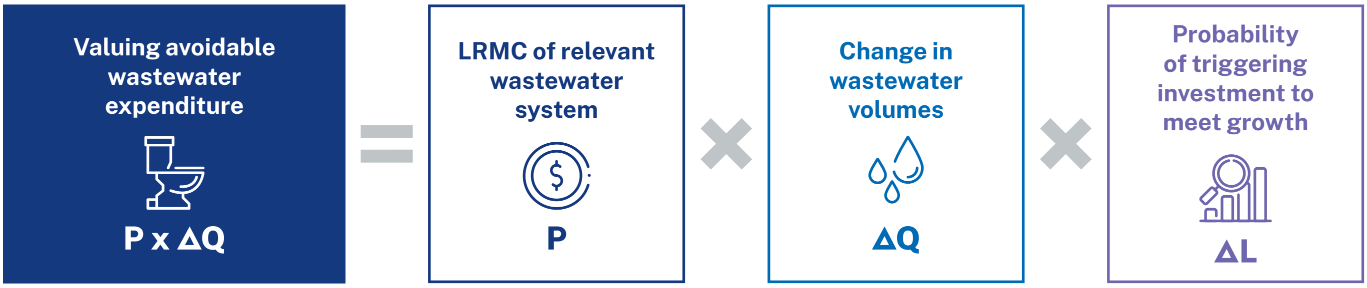
Impact on wastewater flow and volumes	Impact on augmentation requirements	Impact on augmentation requirements	Impact on expenditure
The use of demand management (water conservation education programs) can facilitate a behavioral change to reduce demand for potable water and thereby wastewater flows.	Assuming a portion of the avoided water demand would have otherwise been discharged through the wastewater system, this reduced potable water demand should reduce pressure on the wastewater system.	Reduced wastewater volumes can avoid or defer a system augmentation.	The deferral or avoidance of augmentation also defers or avoids operating and capital expenditure in the wastewater system (resulting in an "avoided cost" compared to the base case).

In most instances, for example, water conservation associated with indoor use outside extreme drought times will provide an avoided wastewater cost benefit. In these instances, wastewater volumes may be less than required for wastewater recycling. However, in determining the size of this impact, including whether water conservation leads to reduced or increased wastewater management costs, decision-makers should consider the site-specific nature of their investment.

As shown in **Figure 42**, to calculate the present value of this downstream wastewater capital and operating avoidable costs (cost savings), multiply:

- **LRMC of wastewater management** (**P**) – this should include an estimate of the avoided energy costs of wastewater treatment and transportation
- **the change in wastewater system volumes** (**ΔQ**) over the modelling period – there may not be a 1:1 relationship between the volume of water conservation and the change in wastewater volumes, because for example, not all water is discharged down the wastewater network
- **the likelihood of incurring costs to meet growth in wastewater volumes** (**L**) – this will be equal to 100 per cent as the likelihood of incurring costs to meet growth in wastewater volumes does not vary as a result of water conservation, nor do wastewater avoidable costs rely on a specific event occurring, such as drought.

Figure 42: Valuing avoidable wastewater costs



In cases where an estimate of the LRMC of wastewater management is not available, use the short-run marginal cost (SRMC) of wastewater as a proxy until developing LRMC estimates. The SRMC typically captures the treatment and energy costs of wastewater management and can be thought of as a lower bound estimate of the potential value of avoidable wastewater costs.

As above, you can use planning documents to "sense check" the results, where:

- there are no planned upgrades of the wastewater network, the LRMC may be closer to SRMC, and the avoidable wastewater costs are likely to be lower
- there are planned upgrades of the wastewater network, the LRMC is likely to be higher than the SRMC, and the avoidable wastewater costs are likely to be higher.

A2.6 Approach to valuing avoided stormwater management costs

In many cases, stormwater volumes drive the need for, and timing of, investments in stormwater management. But they may not be the only factor driving investment.

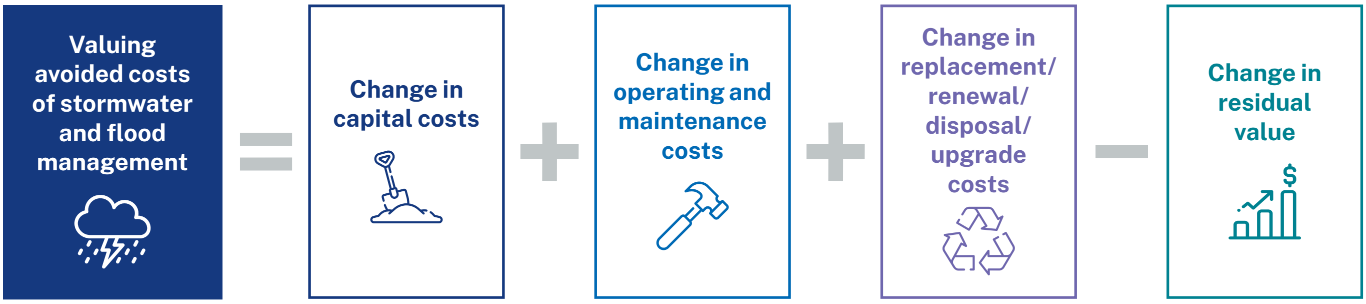
In cases where growth in volumes drives expenditure, a reduction in stormwater volumes resulting from water conservation can defer or avoid expenditure. These are known as avoidable costs. For example, as shown in **Figure 43**, water conservation measures such as rainwater tanks or stormwater harvesting can reduce the volume of stormwater managed downstream. This in turn can reduce or defer the need for investment in stormwater management. This represents a cost saving for the community.

Figure 43: Link between water conservation and avoided stormwater management costs

Impact on stormwater management volumes to be managed	Impact on stormwater management requirements
Some water conservation measures (such as rainwater tanks and small-scale reuse) involve the reuse of stormwater and rainwater. This reuse can reduce the volume of stormwater to be managed downstream of a dwelling.	If volumes of stormwater is the trigger for investment, reduced volume of stormwater to be managed can reduce, avoid, or defer investment in stormwater management. This change in expenditure represents a cost saving to the community.

As there is no LRMC of stormwater management, as shown in **Figure 44**, estimating the value of avoided stormwater management costs requires comparing the cost of stormwater management with and without water conservation. Estimating these costs often involves drawing on other planning documents, for example, development servicing plans.

Figure 44: Approach to valuing avoided stormwater management costs



A2.7 Approach to valuing the avoided cost of managing a water quality event

A water quality event refers to a set of events that temporarily compromise potable water quality due to the contamination of a water source. Water quality events can occur for several reasons including:

- decaying organic matter in water sources, also known as a blackwater event
- sewerage and/or wet weather overflows
- flooding
- Escherichia coli bacteria and/or blooms of cyanobacteria.

In the event of a water quality emergency, water suppliers and utilities in consultation with local public health units and the NSW Health response protocols may issue a boil-water alert or other warnings to protect the wellbeing and health of customers[58]. Alternatively, water suppliers and utilities may increase the operation of treatment facilities, such as a desalination plant, to cope with a water quality event.

As shown in **Figure 45**, some water conservation measures can reduce the cost of responding to water quality events by reducing potable water demand, which in turn, can reduce the volume of water to be supplied during a water quality event. This reduced demand may avoid the need to trigger a water quality event response or reduce the severity or duration of these measures.

Figure 45: The link between water conservation and avoided costs of managing a water quality event

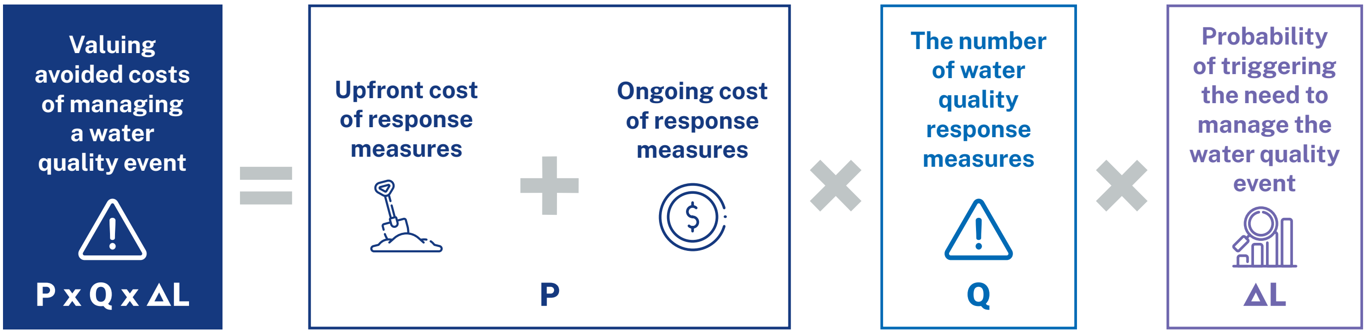
Impact on water demand	Impact on augmentation requirements	Impact on expenditure
Water conservation measures (such as replacing appliances with more water-efficient versions) can reduce the demand for potable water, compared to the base case.	Reduced potable water demand can reduce the volume of water that needs to be supplied, including during a water quality event.	Reduced volume of water to be supplied during a water quality can reduce the severity of, or avoid the need for, measures to respond to a water quality event.

58 NSW Health (2023). Drinking water quality and incidents. Drinking water quality information.

As shown in **Figure 46**, estimate the value of avoided costs of managing a water quality event by multiplying the following:

- **The cost of responding to the water quality event** (**P**). As with the approach to estimating the value of avoided cost of a drought response, the value of the avoided cost of managing a water quality event depends on the local water utility's response. These response costs could include increased operation of a desalination plant, issuing a boiled-water alert, or trucking water.
- **The number of water quality response measures required** (**Q**). This is typically equal to one because water conservation does not generally impact the water quality response measures implemented. Rather, it reduces the likelihood of needing to trigger the response measure.
- **The change in probability of triggering the response to the water quality event under each option** (**ΔL**)

Figure 46: Valuing avoided costs of managing a water quality event



A2.8 Approach to valuing avoided input costs to water-intensive appliances

Some water conservation measures can reduce the need for other input products for water-intensive appliances such as energy, detergent, or chemicals and the associated greenhouse emissions.

This is in addition to the energy cost and other cost savings from avoided water supply or wastewater management.

In terms of energy, the use of water-efficient appliances, such as a washing machine or showerhead, can reduce household energy consumption, and reduce the costs of generating and transporting energy. This can include operating costs and costs of augmenting energy infrastructure. This reduction represents an avoided cost compared to the base case.

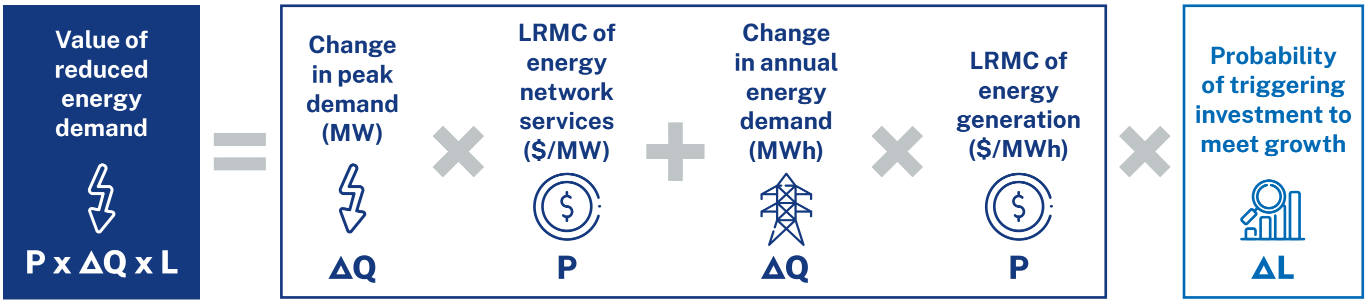
Figure 47: The link between water conservation, energy demand, and energy costs

Impact on demand	Impact on energy consumption	Impact on energy costs
Water conservation measures (water-efficient appliances) can reduce household demand for water through increasing water efficiency.	A reduction in household demand for water can reduce energy consumption associated with the heating of water.	A reduction in household energy consumption can reduce costs to generate and transport energy and potentially defer and/or avoid network augmentation.

As shown in **Figure 48**, estimate the value of reduced energy demand by multiplying together:

- LRMC of energy generation ($/MWh) (**P**) by the change in household energy demand (MWh) (**ΔQ**)
- LRMC of energy network services ($/MW) (**P**) by the change in peak demand (MW) (**ΔQ**)
- **the likelihood of incurring costs to meet growth in energy demand** (**L**). This will be equal to 100 per cent because the likelihood of incurring costs to meet growth in energy demand does not vary as a result of water conservation, nor do energy infrastructure costs generally depend on a specific event occurring, such as a drought.

Figure 48: Valuing reduced energy demand



Importantly, the change in energy demand associated with transporting and treating water and wastewater is assumed to be captured as part of changes to water-related and wastewater-related costs above (for example, as part of reduced operating expenditure).

In addition to avoided energy use, some water conservation measures can reduce need for other input products for water-intensive appliances such as detergent or chemicals and associated greenhouse emissions.

For example, as shown in **Figure 49**, front-loader washing machines can typically require less laundry detergent per wash than traditional top loaders. Avoided other costs to society could be economic costs (costs of producing and transporting these goods) as well as environmental costs associated with disposal and discharge.

Figure 49: The link between water conservation, reduced laundry detergent consumption, and community outcomes

Impact on laundry detergent consumption	Impact on community outcomes
The use of water conservation measures, such as water efficient washing machines, can reduce household consumption of laundry detergent as front loaders typically require less detergent than traditional top loaders.	A reduction in the consumption of laundry detergent reduces the economic costs to society (costs of producing and transporting these goods) as well as environmental costs (associated with disposal and discharge) to society.

Where appropriate, utilities may undertake additional primary research to determine the value of avoided detergent costs as a result of water-efficient washing machines. This involves identifying:

- average household spend in their customer base – reflecting specific demographics – on laundry detergent (use and market price)
- changes to this spend as a result of water conservation measures
- marginal change in this cost to calculate the avoided cost.

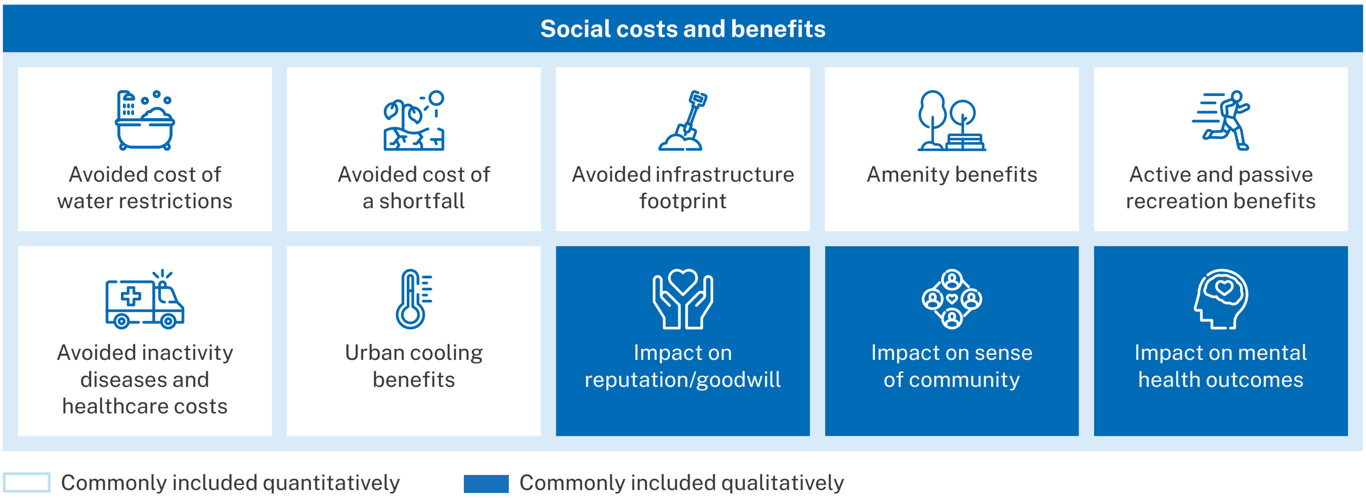
Alternatively, you could include this benefit qualitatively.

Appendix 3: Approaches to valuing key social costs and benefits

This section provides further detail on the approach to valuing key social costs and benefits of water conservation. As shown in **Figure 50**, these include:

- the avoided cost of water restrictions on the community
- the avoided cost of a shortfall (insufficient water supply) on the community
- the avoided infrastructure footprint
- amenity and recreation benefits arising from greater availability of irrigated open space
- health benefits resulting from reduced inactivity in the form of reduced mortality and morbidity
- urban heat-related benefits from providing irrigation
- urban cooling-related benefits
- impact on utility reputation and goodwill (qualitative)
- impact on sense of community (qualitative)
- impact on mental health outcomes (qualitative).

Figure 50: Overview of key social costs and benefits



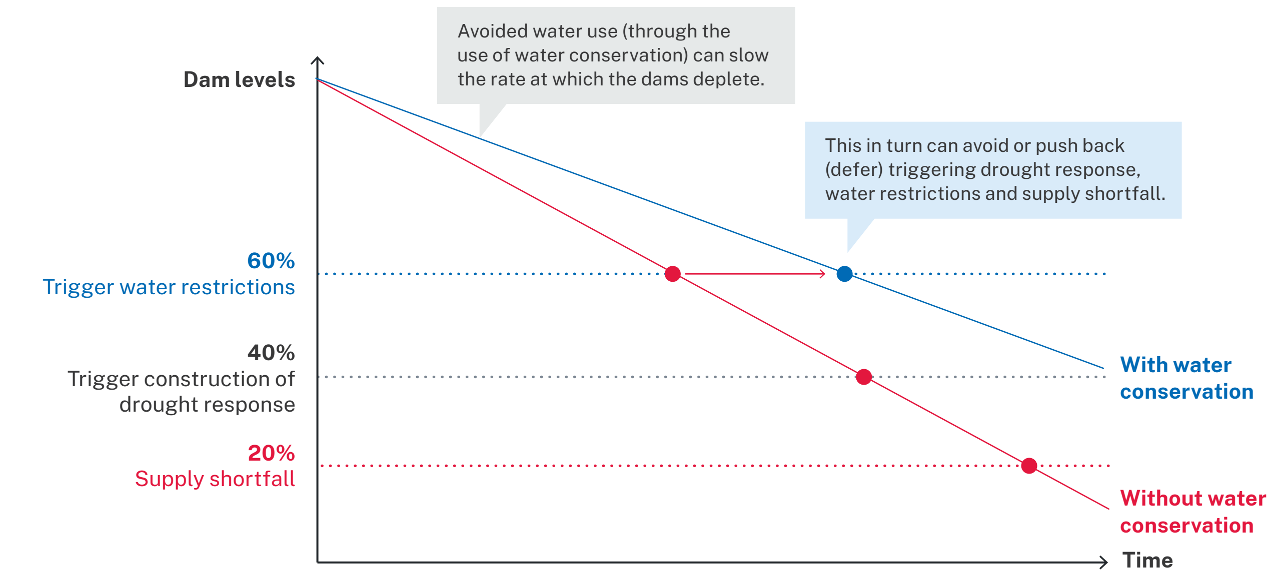
We discuss the methodologies to value key costs and benefits below.

Given a lack of publicly available information, it can be extremely difficult to identify and quantitatively assess the causal link between water conservation measures and changes in utility reputation and goodwill, sense of community, mental health outcomes, and urban cooling outcomes. However, these social outcomes may still derive some additional benefit from water conservation measures to different material extents, and thus should be assessed qualitatively.

A3.1 Approach to valuing avoided cost of water restrictions

Water security planning ensures all options meet the level of service system reliability criteria, such as frequency and duration of water restrictions and likelihood of a shortfall. However, different options, for example, with and without water conservation, can have a higher or lower likelihood of triggering water restrictions, driven by differences in the depletion rate of the storages. In other words, as shown in **Figure 51** and **Figure 52**, reducing the rate at which storages deplete enables water conservation to avoid the costs of water restrictions on the community.

Figure 51: The link between water conservation and avoided drought-related costs



For example, as shown in **Figure 52**, reducing the draw on the potable water system enables leakage management to slow the rate at which storage levels deplete. This in turn can reduce the likelihood and/or severity/duration of water restrictions. In turn, this reduces the extent to which customers experience restricted demand compared to the base case.

Figure 52: The link between water conservation and avoided social cost of water restrictions

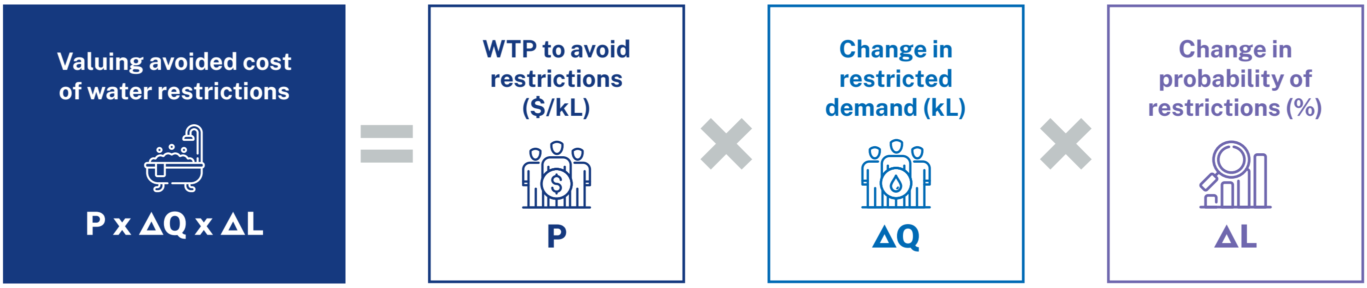
Probability of triggering drought costs each year	Impact on storage depletion rates	Impact on the likelihood of triggering a drought cost	Impact on society
At any point in time there is a likelihood that a drought cost (water restrictions, drought response, shortfall) are incurred due to reaching a water storage trigger level.	Use of water conservation can reduce draw on the potable water system. This in turn can reduce the rate at which storage levels deplete.	Slower depletion of storage levels reduces the likelihood of triggering, and/or the duration of, water restrictions.	Restrictions on water use impose a cost on the community, particularly high-level restrictions. Reduced likelihood of restrictions reduces the impact on residential and commercial customers.

Importantly, the approach to valuing the change the social cost of water restrictions will depend on the way in which the willingness to pay study expresses the cost of water restrictions (for example, $/year or $/kL of restricted demand).

Figure 53 provides an example of valuing the avoided cost of water restrictions. In this example, the present value of changes in the likelihood and duration of water restrictions can be estimated by **multiplying the following**:

- **Community willingness to pay to avoid water restrictions** (**P**). The evidence suggests the social cost of water restrictions for residential customers differs from the social cost for commercial/business customers and will vary by level of water restriction.
- **Change in restricted demand under different levels of water restrictions** (**ΔQ**) – for residential and non-residential demand. The reduction in demand is calculated based on the forecast annual demand for each scenario and will vary by level of water restriction.
- **The change in probability of restrictions**, across the different levels of water restrictions (**ΔL**), based on hydrological modelling.

Figure 53: Valuing the avoided cost of water restrictions on the community



A3.2 Avoided cost of a shortfall on society

Under extreme drought conditions, there is a risk that water supply will be insufficient to meet demand, resulting in a shortfall. Being in shortfall imposes a direct social cost on the community associated with running out of water. This is measured by the community's willingness to pay to avoid shortfall. This is separate to the impact of water restrictions discussed above.

Similar to valuing the cost of water restrictions on society, water conservation measures that slow the rate at which storage levels deplete can reduce the likelihood of a shortfall on society. For example, as shown in **Figure 54**, the use of waterwise rules and education programs can reduce demand for potable water by inducing a behavioural change in customers. A reduction in demand will slow the rate at which storage levels deplete and reduce the likelihood of, and time spent with, insufficient water supply (a shortfall).

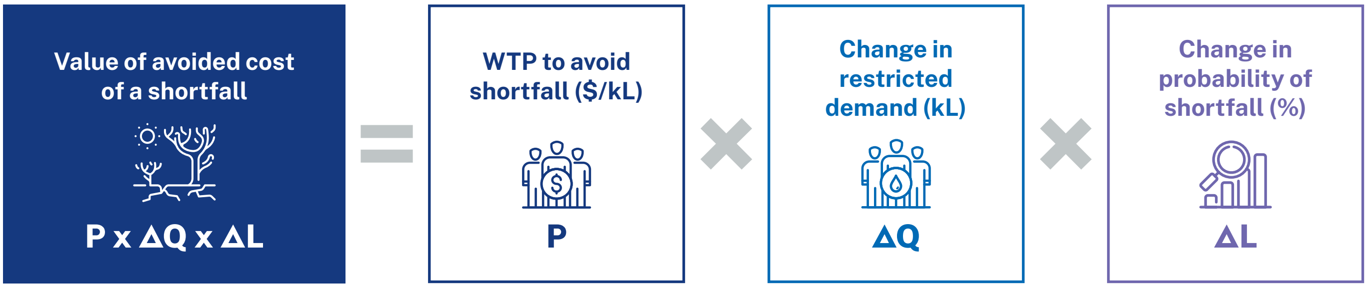
Figure 54: The link between water conservation and avoided cost of a shortfall

Impact on demand	Impact on the likelihood of a shortfall	Impact on society
Use of waterwise rules and water conservation education programs can reduce demand for potable water. This in turn can reduce the rate at which storage levels deplete.	Slower depletion of storage levels reduces the likelihood of, and time spent with insufficient water supply (a shortfall).	Insufficient water supply during a drought (a shortfall) imposes a cost on the community by restricting water use. Reduced risk of insufficient water supply during a drought reduces the risk that households and commercial customers will experience restricted demand.

As shown in **Figure 55**, estimate the cost of shortfall by multiplying the following:

- **Willingness to pay to avoid a shortfall** (P) – it is likely that the cost imposed on residential customers will differ from the cost imposed on commercial/business customers. This is different to the willingness to pay to avoid water restrictions, discussed above.
- **The change in probability of shortfall** (ΔL) – based on hydrological modelling.
- **Change in restricted water consumption under shortfall conditions** (ΔQ).

Figure 55: Valuing the cost of a shortfall (insufficient water supply during a drought)



A shortfall on society represents a high-cost, low-probability event. The material impact on society is highly significant but the likelihood of the event occurring remains comparatively low. Quantifying the full scope of costs posed to society as a result of a shortfall can be difficult as there may not be a monetised cost for all related impacts. An example is the cost associated with outward migration or reduced sense of community and social cohesion. Where impacts cannot be quantified monetarily, users should include these impacts qualitatively. See **Section 7.4** for further information on considering qualitative costs and benefits.

A3.3 Approach to valuing avoided infrastructure footprint

As shown in **Figure 56**, the use of water conservation measures can defer or avoid the need for supply augmentation. Different supply and demand options require different footprints of land. Avoiding or deferring the need to invest in supply side augmentation can avoid the need to use land for construction of the supply side measures, increasing the availability of land for other uses.

Figure 56: The link between water conservation and avoided infrastructure footprint

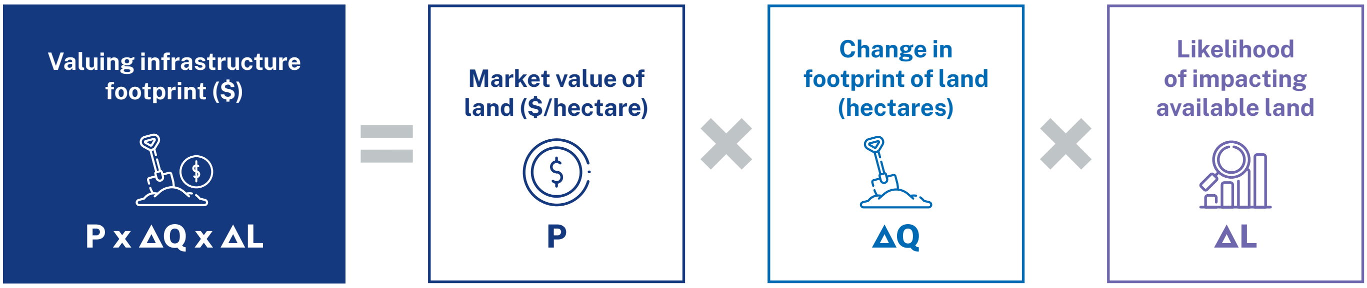
Impact on land required	Impact on availability of land for other uses
Water conservation generally requires a smaller footprint of land than supply side augmentations. As a result, deferring or avoiding the need to augment the water system using water conservation can reduce the footprint of land required.	To the extent that this land can be used for an alternative use (development, recreation, industry, biodiversity), water conservation can increase the availability of land for other uses.

As shown in **Figure 57**, calculate the present value of the avoided infrastructure footprint by multiplying the following:

- **The appropriate price per hectare of land** (**P**) – generally taken from the NSW Valuer General's database[59]. As discussed below, in some cases such as valuing lost industrial use, where there is unlikely to be a market failure, the cost of land acquisition represents an appropriate proxy for the opportunity cost of land.
- **The change in available land in hectares** (**ΔQ**).
- **The likelihood of impacting the amount of available land** (**L**). This is typically equal to 100 per cent because water conservation does not generally impact this likelihood, nor does the infrastructure footprint generally depend on a specific event occurring, such as a drought.

59 NSA Government (N/A). Valuer General: Land values online. www.valuergeneral.nsw.gov.au/land_values/where_can_you_learn_more_about_your_land_value/land_values_online

Figure 57: Valuing changes in infrastructure footprint



Repeat the calculation above for each location of land because different areas will have different values.

Box 17: When is it appropriate to value the opportunity cost of land using the cost of land acquisition?

As discussed above, cost-benefit analysis is concerned with the change in real resource outcomes, rather than financial transfers between parties – that is, the "size of the pie", rather than how it's shared between parties.[60]

As such, including land acquisition as a cost to the local water utility or government agency as part of an economic appraisal is not appropriate. It is not an economic cost, that is, a change in real resource outcomes. Rather, it is a transfer between 2 parties. For example, for land acquisition of $18m:

- the utility acquiring the land incurs a cost of $18m
- the landholder receives a benefit of $18m
- this leaves society, as a whole, unchanged.

However, if the use of that land changes under different options, there is a change in real resource outcomes to the community, and thus the need to include a relevant impact as part of an economic appraisal. This is irrespective of whether the utility needs to acquire the land or not. For example, construction of wetlands may require acquiring land (a transfer) but also reduces the amount of land available for other uses, such as development or industrial use (a change in real resource outcomes). This change in resource outcomes (or opportunity cost) is *"the value foregone by society from using a resource in its next best alternative use [and] reflects market prices where there is an absence of market failure".*[61]

The most appropriate proxy for the opportunity cost of land will vary depending on the specific project circumstances and alternative land-use. In some cases (the absence of market failure), the market value – the cost of land acquisition excluding taxes – may be an appropriate proxy for the opportunity cost of industrial or farming land. The cost of land acquisition may accurately represent the change in real resource outcomes. However, in other cases, such as valuing lost biodiversity, using the land acquisition is an unlikely appropriate proxy as it does not capture the community's willingness to pay to protect biodiversity. In cases such as these, a robust WTP survey is likely to better represent the change in real resource outcomes. We note that land acquisition and WTP values should only be added together where there is a clear gap in the land acquisition value and a good proxy WTP to minimise the risk of double counting.

Importantly even in cases where land acquisition is an appropriate proxy, the economic appraisal is valuing changes in land use, rather than changes to the utility's cashflow.

60 Transfers between parties are relevant for distributional analysis and financial appraisal.
61 NSW Government Transport for NSW, Transport for NSW Cost-Benefit Analysis Guide, p. 38.

A3.4 Approach to valuing amenity benefits from proximity to open space and healthy waterways

Different water conservation measures can lead to amenity benefits for those living and working in the area. Examples follow:

- As shown in **Figure 58**, the use of small-scale reuse, such as wastewater management, can enable irrigation of open space during periods of water restrictions. This increased irrigation of open space can improve its quality. Assuming the open space is within proximity to dwellings, its improved quality can then improve amenity for those who live in the area.
- Small-scale stormwater reuse can reduce the volume of stormwater discharged to nearby waterways, which in turn, can improve the health of receiving waterways. Assuming the waterways are in proximity to dwellings, this improved health of waterways can improve amenity for those who live in the area.

Figure 58: The link between water conservation and amenity from improved open space

Impact on irrigation of open space	Impact on quality of open space	Impact on amenity benefits
Water conservation measures that involve the use of small-scale reuse or supply provide the opportunity to irrigate during periods of water restrictions.	Irrigation of open space during periods of water restrictions, can improve the quality of open space.	Assuming the open space is within proximity to dwellings, improved quality of open space can increase amenity of these dwellings. House prices can be used as a proxy for this improved amenity benefit.

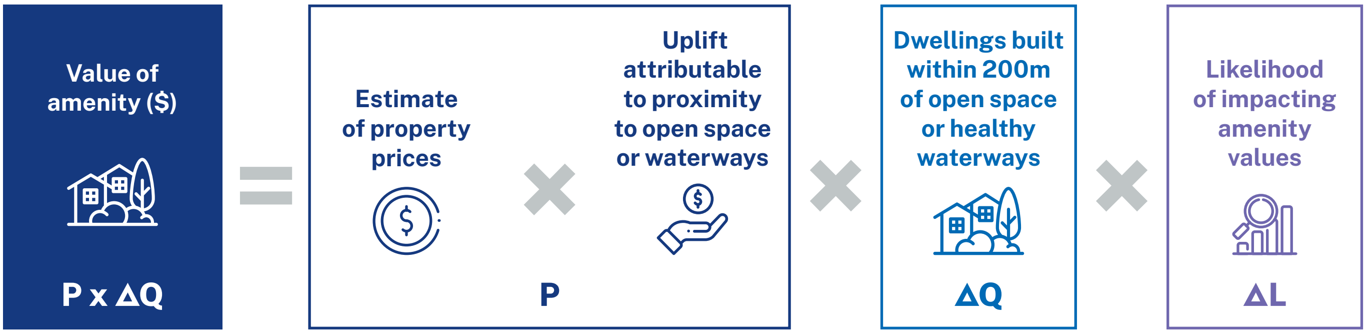
Various studies have investigated the relationship between property uplift and proximity to improvements in local environments such as accessible open space or healthy waterways.

This form of "hedonic pricing" uses statistical techniques to isolate the contribution to the value of the property as a result of specific environmental characteristics. In turn, this can be used to estimate the value of the amenity impact. The uplift in the prices of properties within proximity to accessible open space or healthy waterways, relative to those that are not, reflects an estimate of the amenity value the community places on this space.

As illustrated in **Figure 59**, estimate the value of improved amenity by multiplying the following:

- **An estimate of property prices in the area** – this will vary depending on dwelling type (**P**). We recommend separately calculating the uplift for low, medium, and high-density dwellings.
- **The uplift in property prices attributable to open space or healthy waterways** (**P**). This uplift will vary depending on the characteristics of the water conservation measure, for example, its relation to irrigation of existing open space or improvements in the health of waterways.
- **The number of dwellings** located within 200 metres of open space or healthy waterways (**ΔQ**).
- **The likelihood of impacting amenity values.** This is typically equal to 100 per cent because water conservation does not generally impact this likelihood, nor does delivering amenity values generally depend on a specific event occurring, such as a drought.

Figure 59: Valuing amenity benefits from proximity to open space or waterways



A3.5 Approach to valuing active and passive recreation benefits

As discussed above, some water conservation measures can enable increased irrigation of open space. This increased irrigation of open space can improve access to, or the quality of, active and passive recreation opportunities (see **Figure 60**).

Figure 60: The link between water conservation and recreation benefits

Impact on open space

Some water conservation (irrigation) can increase the quality of open space, because the open space can be irrigated throughout the year and is not subject to water restrictions.

Impact on active and passive recreation

Increased availability or quality of open space can increase the opportunities for active and passive recreation (for example, through providing recreation opportunities during periods of water restrictions).

As shown below, the total value of these recreational opportunities is a function of how many people use the space, and how much they may be willing to pay (WTP) for different types of recreation opportunities. Depending on the option considered, water conservation measures may deliver a range of recreation opportunities including walking, running, and passive recreation such as picnicking.

As shown in **Figure 61**, estimate the total value of these active and passive recreation opportunities by multiplying the following:

- **An estimate of how much they may be willing to pay** (WTP) for different types of recreation opportunities (**P**). There is rich literature relating to the community's willingness to pay for active and passive recreation opportunities, primarily reflecting use values. This includes estimates derived from surveys[62] as well as real-world situations[63] including prices or charges the community pays for these opportunities in competitive environments. Examples include fees for bike hire or car parking at recreation facilities.
- An estimate of the change in the number of people engaging in the recreation activity, either active or passive (**ΔQ**).
- **The likelihood of impacting recreation opportunities** (**L**). This is typically equal to 100 per cent because water conservation does not generally impact this likelihood. The exception would be if some recreation opportunities depend on a certain event occurring. For example, periods of water restrictions can lead to cancellation of team sports and reduce active recreation opportunities.

62 Commonly known as stated preference methods.
63 Commonly known as revealed preference methods. Revealed preference methods analyse observed behaviour to impute the dollar value that people place on non-market outcomes such as recreation or amenity.

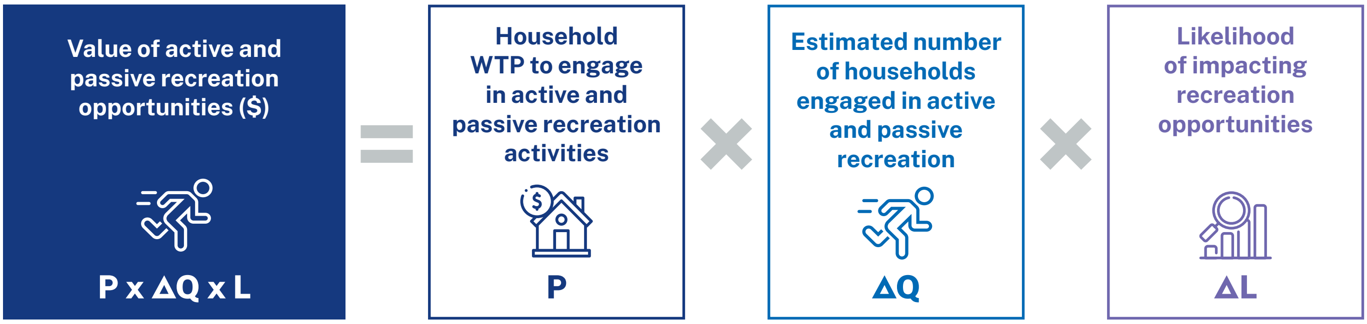


Figure 61: Valuing active and passive recreation opportunities

Take care to avoid double counting the estimate of the following:

- **Amenity-related benefits**. For those who live within proximity (200m) to accessible open space, the uplift in prices paid for property may reflect a willingness to pay for improved recreation opportunities in public open space (a direct use value) in addition to amenity value (an indirect use value).
- **Health-related benefits**. Willingness to pay for recreation opportunities may reflect some people's consideration of related health benefits. An example is reducing the risk of morbidity or mortality as a result of recreation. However, behavioural research suggests participants' willingness to pay for recreation may not fully account for these risks and resulting health impacts. This is particularly the case with impacts that are external to the individual. The health benefits associated with reduced inactivity may not be captured in participants' willingness to pay for recreation.

A3.6 Approach to valuing health benefits of reduced inactivity (mortality and morbidity)

In general, improved health risk factors in the form of reduced inactivity have flow-on effects through reduced morbidity and mortality. While inactivity is rarely listed as the cause of death, various studies[64] have found that increased inactivity leads to increased risk of death or illness across a range of diseases. These include:

- breast cancer
- bowel cancer
- uterine cancer
- coronary heart disease
- stroke
- diabetes
- dementia.

64 See for example, Australian Institute of Health and Welfare (2017), *Impact of physical inactivity as a risk factor for chronic conditions: Australian Burden of Disease Study*, Australian Burden of Disease Study series no, 15.

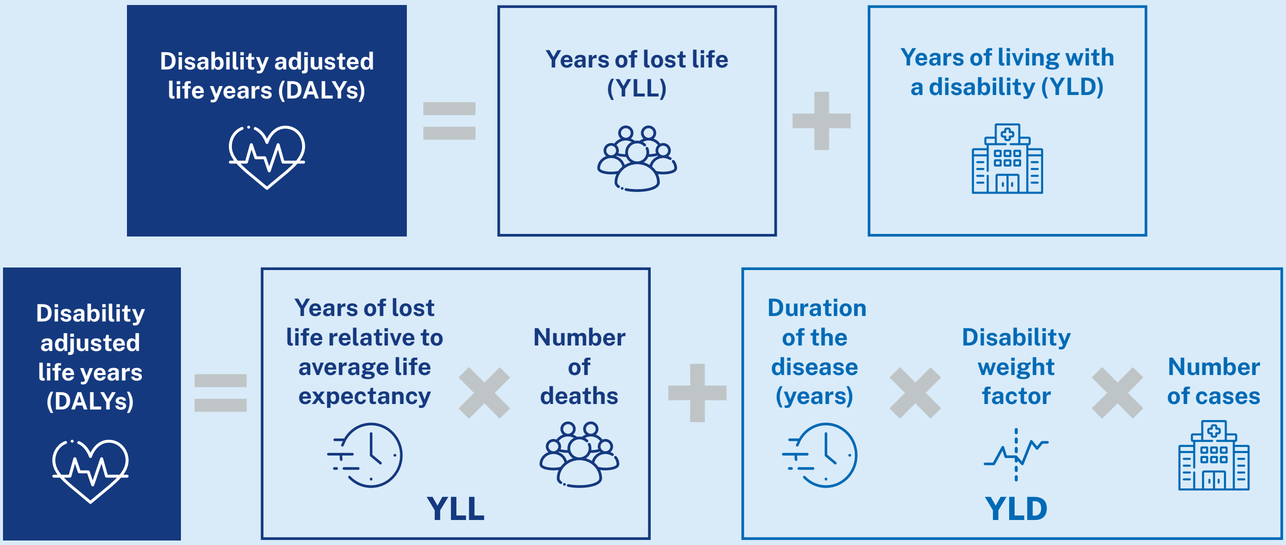
Options that increase the opportunity for active recreation (as discussed above) are likely to reduce the risk of inactivity-related diseases and the inactivity-related disease burden. Disability-adjusted life years (DALYs) measure this (see **Box 18**). Valuing recreation-related health outcomes requires estimating the change in disease burden (as measured by DALYs) based on a population attributable fraction – a measurement of the percentage reduction in burden that would occur if exposure to the risk factor were avoided or reduced to its theoretical minimum.

Box 18: Using disability-adjusted life years to estimate the benefit of reduced activity

DALYs are a widely accepted measurement for comparing health outcomes across different diseases. One DALY can be thought of as a measurement of the gap between current health status, and an ideal situation where everyone lives into old age, free of disease and disability. That is, one DALY is equivalent to the loss of one year of full health. When applied to a population, the number of DALYs can be regarded as a measure of the attributable burden of disease, or total disability, incurred due to a specific disease.

As shown below, a DALY is the sum of years of life lost (YLL) and years lived with disability (YLD), where:

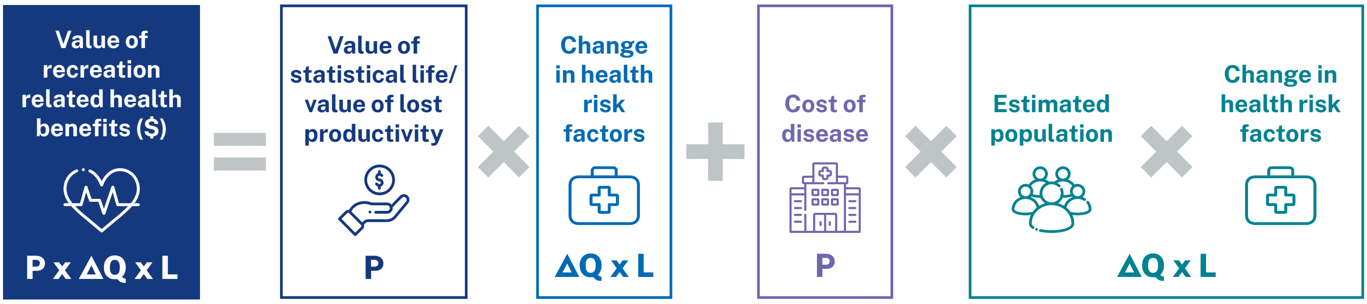
- YLL measures the number of years of life lost due to premature mortality (also referred to as "fatal burden")
- YLD measures the impact of living with ill-health, that is, the non-fatal component of the burden of disease. The disability weights are within a scale of 0 to 1, where 1 corresponds to death and 0 corresponds to perfect health.



As shown in **Figure 62**, we can estimate the present value of these recreation-related health benefits:

- To calculate the value of reduced disease burden arising from reduced inactivity, multiply together:
  - **the change in health risk factors (as measured by the change in DALYs)** under the options, compared to the **base case** (**ΔQ x L**)
  - **the appropriate value of life** (**P**) (adopting either the value of statistical life approach or the value of lost productivity approach).
- To calculate the change in the cost of healthcare service use arising from reduced inactivity, multiply together:
  - **the change in health risk factors (as measured by the change in DALYs)** under the **options**, compared to the **base case** (**ΔQ x L**)
  - **the population** of the surrounding areas (**ΔQ**)
  - **an estimate of the cost of treatment**, per instance of disease (**P**).

Figure 62: Valuing changes in inactivity-related health outcomes



A3.7 Approach to valuing urban cooling benefits (qualitative)

As discussed above, water conservation can enable increased irrigation of open space and tree canopy through:

- reducing the rate at which storages deplete, and therefore, reducing the likelihood or duration of water restrictions
- using alternative supply sources, such as small-scale supply or reuse, which may not be subject to water restrictions.

Increased irrigation of open space and urban canopy can contribute to urban cooling benefits and avoided urban heat-related impacts. These include:

- reduced energy infrastructure requirements arising from reduction in cooling-related energy demand
- improved health outcomes in the form of reduced urban heat-related mortality and morbidity, and reduced pressure on the healthcare sector.

Importantly, the materiality of this benefit will depend on the scale of the intervention. That is, influencing urban heat can require large-scale irrigation. As a result, in many cases, this impact can be relatively minor. Users should consider the likely materiality of this benefit, and in cases where the impact is likely to be minor, the urban cooling benefits can be included qualitatively.

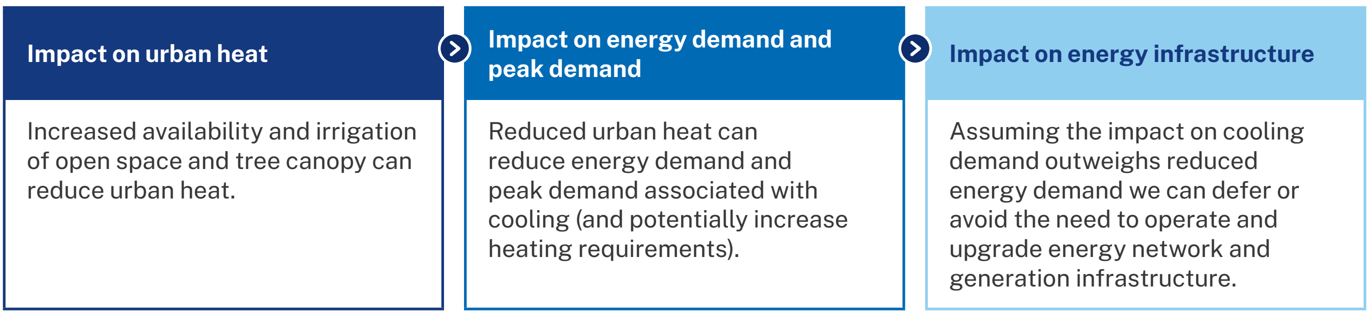
Each benefit of reduced urban heat is discussed briefly below.

A3.8 Approach to valuing avoided energy distribution and generation infrastructure costs (from urban cooling)

As shown in **Figure 63**, water conservation measures that enable increased irrigation of open space and tree canopy can lead to reductions in urban heat. In turn, this can reduce the cooling-related energy needs of those living and working in the area.

One of the key benefits of this urban cooling are the reductions in the future cost of providing energy generation and network infrastructure that are required to meet these energy needs. This reduction in energy consumption and peak energy demand defers the operation and augmentation of energy generation and network infrastructure.

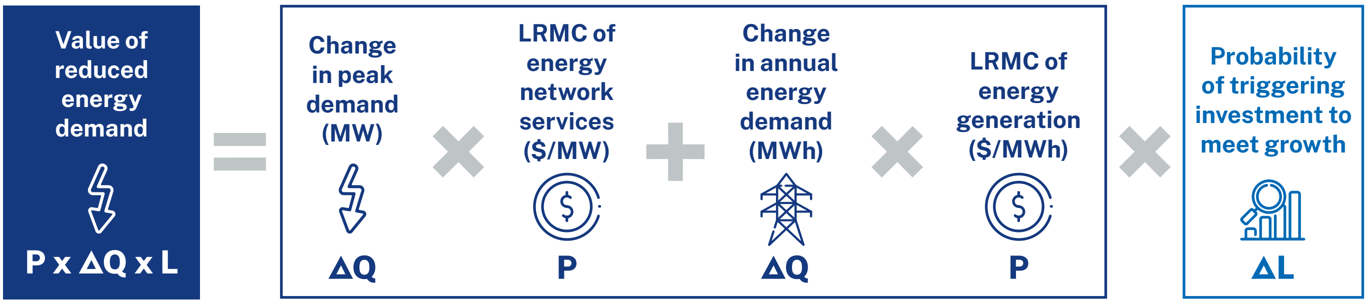
Figure 63: The link between reduced urban heat and energy infrastructure requirements



As shown in **Figure 64**, estimate the value of reduced energy demand from reduced urban heat by multiplying the following:

- **LRMC of energy network services** (**P**) by the estimated level of peak energy demand (**ΔQ**) in each year over the period of analysis
- **LRMC of energy generation** (**P**) by the estimated level of energy consumption (**ΔQ**) in each year over the period of analysis
- **the likelihood of incurring costs to meet growth in energy demand** (**L**). This will be equal to 100 per cent because the likelihood of incurring costs to meet growth in energy demand does not vary as a result of water conservation, nor do energy infrastructure costs generally depend on a specific event occurring, such as a drought.

Figure 64: Approach to valuing cooling-related energy demand



A3.9 Approach to valuing avoided urban heat-related diseases and healthcare costs (from urban cooling)

As shown in **Figure 65**, water conservation measures that enable increased irrigation of open space and tree canopy can lead to reductions in urban heat. In turn, this can provide benefits in the form of reductions in heat-related mortality and illness.

While urban heat is rarely listed as the cause of death, various studies have found that increased heat levels lead to increased risk of death or disease, especially among the most vulnerable in the community – the very young and elderly. A reduction in urban heat reduces the risk of heat-related diseases, reducing the number of heat-related deaths and the use of health services. This leads to a benefit for the broader community beyond those who live and work in the area.

Figure 65: The link between reduced urban heat and urban heat-related disease burden

Impact on urban heat	Impact on health of residents	Impact on public health outcomes
Increased availability and irrigation of open space and tree canopy can reduce urban heat.	Reduced heat-related diseases is likely to reduce mortality and morbidity associated with those diseases, however, the exact impact will depend on the vulnerability of the population to heat stress (age and access to cooling).	Reduced mortality and morbidity from heat-related diseases reduces the strain on the public health sector (as there is likely to be a reduction in associated admissions and treatment).

As shown in **Figure 66**, you can estimate the value of avoided urban heat-related diseases and healthcare costs.

To calculate the value of reduced disease burden arising from reduced urban heat, multiply:

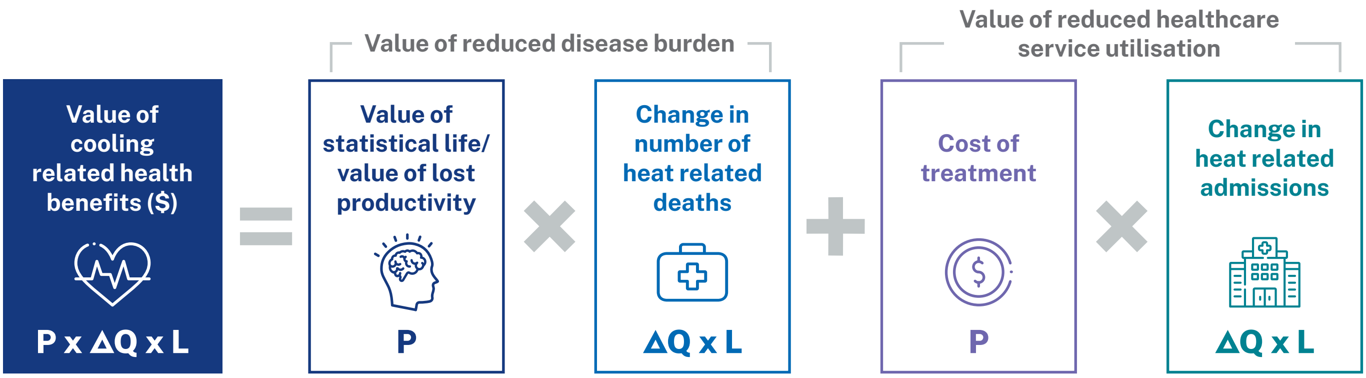
- **the number of heat-related deaths** under the *base case* and the alternative options (**ΔQ x L**)
- **the appropriate value of life** (**P**) (adopting either the value of statistical life approach or the value of lost productivity approach).

To calculate the change in the cost of healthcare service use arising from reduced urban heat, multiply:

- **the multiple of the number of heat-related admissions** under the *base case* and the alternative options (**ΔQ x L**)
- **an estimate of the cost of treatment**, per admission (**P**).

We then compare the present value of this expenditure under each of the options to identify the extent to which there are incremental costs or benefits, that is, compared to the base case.

Figure 66: Approach to valuing cooling-related health benefits



A3.10 Approach to valuing impact on utility reputation and goodwill (qualitative)

Water conservation measures can slow the rate at which storage levels deplete. This reduces the likelihood of triggering a drought response (for example, water restrictions) and the risk of a shortfall on society. As discussed above, restrictions and a shortfall can impose significant social costs on the community, and therefore, if these events occur, the community may have highly negative views of utilities. For example, they might question why the utility didn't take further action to avoid this outcome.

By reducing the likelihood of water restrictions or a shortfall, water conservation can reduce the risk of these events. This can improve utility reputation and goodwill.

Water conservation measures can aid in building trust with the local community but monetising this benefit can be extremely difficult. There is a lack of quantitative information on how a utility's reputation and goodwill changes from specific investments in water conservation. As a result, decision makers should consider impacts on utility reputation and goodwill qualitatively in a CBA of water conservation measures.

A3.11 Approach to valuing impact on sense of community (qualitative)

Community exposure to drought-related economic stressors such as loss of income and increased debt from prolonged water shortage, drought, and water restrictions can have significant impact on the local population's sense of community. Due to the interconnectedness of rural communities, the impact of drought-related economic stressors can quickly filter through the community to inform a larger "net" of social impacts. This includes heightened unemployment, outward migration, and heightened rates of poverty.

As shown in **Figure 67**, water conservation measures slowing the rate at which storage levels deplete can reduce community exposure to economic stressors associated with water shortages, drought, and water restrictions.

Figure 67: The link between water conservation and impact on sense of community

Impact on storage levels	Impact on water shortage event	Impact on drought related stressors	Impact on sense of community
Water conversation measures can reduce draw on the potable water system and slow storage depletion.	Slowing the rate at which storage levels deplete reduces the likelihood of a water shortage event.	Reducing the likelihood of a water shortage event reduces community exposure to drought-related economic stressors.	Reducing community exposure to drought-related economic stressors can enhance the sense of community.

While the material benefit could be significant, as discussed above, quantifying the value of drought-related impacts on a local population's sense of community can be extremely challenging. That's aside from ways in which these outcomes will change as a result of increased investment in water conservation. In most cases, it is appropriate to include impacts on sense of community qualitatively.

A3.12 Approach to valuing impact on mental health outcomes (qualitative)

Similar to impact on sense of community, drought-related economic stressors can have significant, negative impacts on the mental health outcomes for those affected. Several studies have noted feelings of fear and helplessness among those living through drought in NSW. In extreme cases, studies warn of increased risk of psychiatric morbidity, including depression and anxiety, and suicide as a result of prolonged exposure to water shortage events and related economic stressors[49].

As shown in **Figure 68**, water conservation measures slowing the rate at which storage levels deplete can reduce community exposure to economic stressors associated with water shortages, drought, and water restrictions and subsequent declines in mental health outcomes in those affected.

Figure 68: The link between water conservation and mental health outcomes

Impact on storage levels	Impact on water shortage event	Impact on drought related stressors	Impact on mental health outcomes
Water conversation measures can reduce draw on the potable water system and slow storage depletion.	Slowing the rate at which storage levels deplete reduces the likelihood of a water shortage event.	Reducing the likelihood of a water shortage event reduces community exposure to drought-related economic stressors.	Reducing community exposure to stressors can reduce the likelihood of deteriorations in mental health outcomes.

Within close-knit communities, the cost of declining mental health among the local population could be significant. Water conservation can reduce the likelihood of drought and/or a shortfall on society and the associated impacts on affected people's mental health. However, understanding the exact change in mental health outcomes as a result of water conservation measures can be challenging due to a lack of publicly available information. Current literature focuses on the impact of drought-related economic stressors on mental outcomes qualitatively. In most cases, it is appropriate to include mental health impacts qualitatively.

Appendix 4: Approaches to valuing key environmental and cultural costs and benefits

This section provides further detail on the approach to valuing key environmental and cultural costs and benefits of water conservation measures. As shown in **Figure 69**, these include:

- impact on river and ocean health
- avoided cost of wet weather overflows or meeting other environmental regulation
- reduced greenhouse gas emissions.

We discuss the methodologies to value key costs and benefits below.

Figure 69: Overview of key economic costs and benefits

Environmental costs and benefits		
Impact on river and ocean health	Impact on cost of managing wet weather overflows	Impact on greenhouse gas emissions

Commonly included quantitatively — Commonly included qualitatively

A4.1 Approach to valuing impacts on ocean and river health from wastewater (including wet weather overflows) and/or stormwater discharge

Water conservation can reduce the volume of wastewater (water-efficient showerheads) or stormwater (stormwater tanks). In turn, this reduces the likelihood of wet weather overflows from wastewater networks and/or stormwater run-off into local waterways. This could reduce the expenditure required to manage these impacts (see **Figure 70**) and/or the health of the environment in NSW (see **Figure 71**).

Figure 70: The link between water conservation and river and ocean health

Impact on stormwater management volumes to be managed	Impact on stormwater flows	Impact on river and ocean health
Some water conservation measures can reduce dry weather or wet weather volumes (such as rainwater tanks and small-scale reuse).	This reduction in the volume of stormwater and wastewater to be managed can reduce the volume of stormwater or wastewater discharged into surrounding waterways (in dry and wet weather).	Reducing the volume of stormwater discharged into the surrounding environment can lead to improvements in waterway health and biodiversity outcomes.

In determining the size of this impact, including whether water conservation leads to an improvement in waterway health (benefit to the community) or a deterioration in waterway health (cost to the community), decision-makers should consider the site-specific nature of their investment. This includes the volume of water the environment requires.

Figure 71: The link between water conservation and expenditure related to environmental regulation

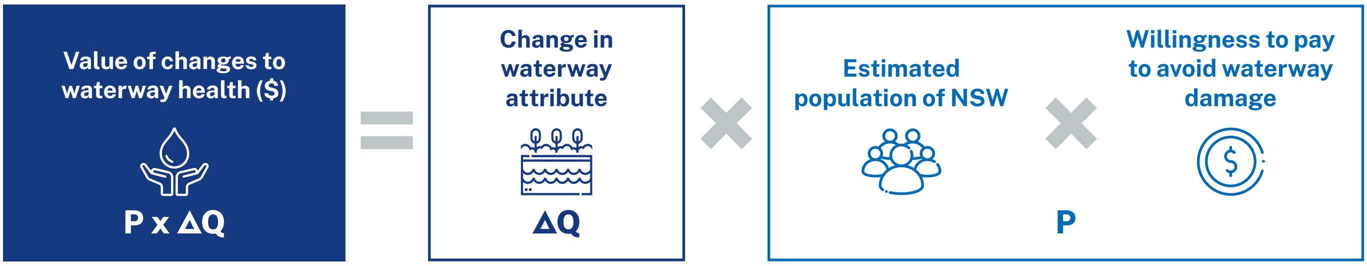
Impact on stormwater management volumes to be managed	Impact on stormwater flows	Impact on expenditure
Some water conservation measures can reduce dry weather or wet weather volumes (such as rainwater tanks and small-scale reuse).	This reduction in the volume of stormwater and wastewater to be managed can reduce the volume of stormwater or wastewater discharged into surrounding waterways (in dry and wet weather).	This in turn, can reduce or avoid the costs of meeting environmental regulation, for example, around wet weather overflows and/or avoid environmental damage associated with wet weather overflow events.

As shown in **Figure 72**, calculate the present value of changes to environmental outcomes such as biodiversity or waterway or ocean health by multiplying:

- **the estimated change in environmental outcomes** (**ΔQ**)
- **an estimate of the relevant population** – which will vary depending on the characteristics of the study
- **the willingness of the community to pay for changes in these environmental outcomes** (**P**) – which will vary depending on the change in outcomes (see below).

We then compare the present value of this expenditure under each of the options to identify the extent to which there are incremental costs or benefits (that is, compared to the ***base case***).

Figure 72: Valuing changes in waterway health



As shown in **Figure 73**, calculate changes in the cost of meeting environmental regulation by comparing:

- **the present value of the cost of meeting environmental regulation under the base case** (**P**) – for example, cost of managing wet weather overflows
- **the present value of meeting environmental regulation under alternative options** (**P**).

In practice, the environmental cost of wet weather overflow events can be relatively minor because wastewater systems are designed to meet environmental standards around the likelihood of wet weather overflows.

Figure 73: Valuing the avoided cost of managing around wet weather overflows

You can apply this broad valuation methodology to a range of environmental outcomes, including river health, ocean health and biodiversity-related metrics. However, depending on the outcome of interest – biodiversity protected or ocean health – the appropriate **P** and **ΔQ** will vary. It is possible to calculate a change in environmental outcomes the community values in multiple ways.

For example, to value changes in waterway health, users may have access to information about:

- the length of waterway impacted (for example, change in the length of waterway in good health)
- the volume of nutrients discharged into the river
- activities related to the waterway and how this may change (swimming days, fishing days, or quality of fishing).

While each of these metrics seek to estimate the change in the environmental outcomes related to waterway health, they use very different information on changes in biophysical outcomes. There will be overlap between these metrics and there is a risk of double counting if seeking to value the environmental impact using more than one measure.

A4.2 Approach to valuing reduced greenhouse gas emissions

Depending on the measure, water conservation can reduce energy demand by:

- reducing the volume of water to be supplied through the potable water system (that is, avoiding treating and transporting water)
- reducing the energy demand and greenhouse emissions associated with:
  - utility supply of water (see **Figure 74**)
  - customer use of water-intensive appliances (see **Figure 75**).

Figure 74: The link between water conservation, utility energy demand, and avoided greenhouse emissions

Impact on utility water supply	Impact on utility energy demand	Impact on greenhouse gas emissions
The use of water conservation can defer the need for use or augmentation of the supply system.	Avoided water supply reduces the demand for energy needed to treat and transport water.	A reduction in energy demand will reduce greenhouse gas emissions.

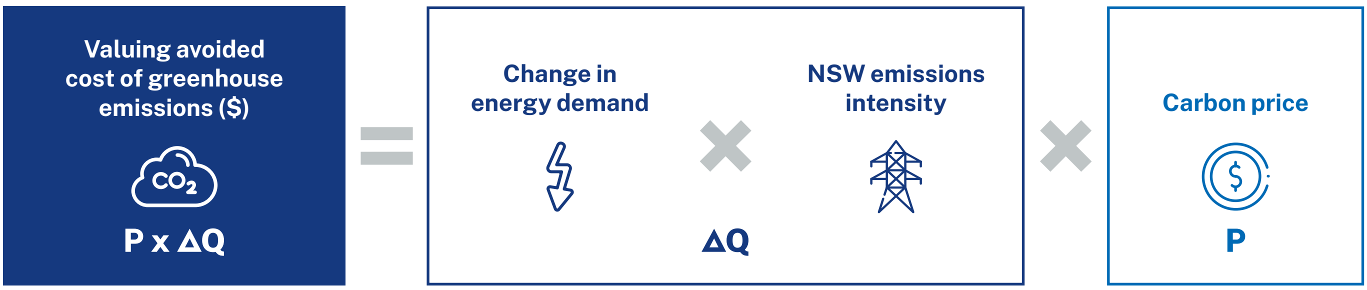
Figure 75: The link between water conservation, customer energy demand, and reduced greenhouse gas emissions

Impact on customer water use	Impact on customer energy demand	Impact on greenhouse gas emissions
Water conservation (water-efficient shower heads) can reduce customer use of water for water intensive appliances.	Reduced use of water-intensive appliances can reduce customer energy demand.	A reduction in energy demand will reduce greenhouse gas emissions.

As shown in **Figure 76**, estimate the cost of greenhouse emissions by multiplying:

- **the change in greenhouse emissions** (**ΔQ**) – this is equal to annual energy demand (that is, not from renewable sources) multiplied by the emissions intensity of energy consumption (accounting for any energy losses)
- **the carbon price** (**P**) – NSW Treasury biannually publishes an update to its recommended carbon price estimates for inclusion in CBA[65]. These estimates reflect global social damage cost that Treasury requires to be used in NSW CBAs with NSW standing.

Figure 76: Valuing the avoided cost of greenhouse emissions



65 NSW Treasury, Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08: Carbon value in cost-benefit analysis, February 2023.