QUEENSLAND FLOODS
COMMISSION OF INQUIRY

STATEMENT No. 4 OF JOHN NEVILLE BRADLEY

I, **JOHN NEVILLE BRADLEY**, of c/- 400 George Street Brisbane in the State of Queensland, Director-General, Department of Environment and Resource Management, solemnly and sincerely affirm and declare:

1. I have previously provided sworn statements dated 4 April 2011, 18 April 2011 and 6 May 2011 to the Queensland Floods Commission of Inquiry.

2. Counsel assisting the Commission of Inquiry has questioned a number of witnesses in relation to requests from Minister Robertson to Seqwater and the QWC/SEQ Water Grid Manager in relation to the Full Supply Level of Wivenhoe Dam and/or any pre-emptive drawdown of the operating level of that dam.

3. In questioning of a number of witnesses Counsel Assisting the Commission appears to have focussed on the practical capacity of Seqwater and the QWC/SEQ Water Grid Manager to respond to Minister Robertson's requests for advice, given the nature of the objectives to be balanced and the functions of the entities from whom advice was sought.

4. Specifically, it appeared that questions were directed to:
   4.1 the extent to which it is within the remit or functions of Seqwater and the Queensland Water Commission to advise the Minister in relation to such matters; and
   4.2 the extent to which the Department of Environment and Resource Management is the only party which can contemplate the 'trade off' or optimisation between the two competing objectives and so advise the Minister.

5. I wish to bring to the attention of the Commission the following information and recent correspondence which I believe to be directly relevant to this issue.

6. There exists recent precedent for advice being provided by Seqwater and the Queensland Water Commission on matters relating to the trade-off between flood mitigation and water supply security and this is consistent with their institutional roles and statutory functions.

7. There are four (4) relevant factors, namely:
   7.1 Previous advice by Seqwater in relation to the Full Supply Level.
   7.2 Current requirements for an assessment of water supply and flood mitigation optimisation in the Brisbane River.
   7.3 Recent proposals for planning work to be undertaken in relation to any change to the Full Supply Level of Wivenhoe Dam.

7.4 Existing statutory functions in relation to water planning in South East Queensland

(1) Previous Advice by Seqwater in relation to the Full Supply Level

8. In its report dated March 2007, titled *"Provision of Contingency Storage in Wivenhoe and Somerset Dams"*, Seqwater recognised input from Sunwater and the then Department of Natural Resources and Water. A copy of the report is now attached and marked **JNB-66**. As the author of the report:

8.1 Seqwater explicitly makes recommendations relevant to a potential change in Full Supply Level, balancing apparent benefits and costs to water supply and flood mitigation objectives. In particular, the first recommendations at section 9, page 59, states that

> *"the provision of contingency storage in Wivenhoe Dam is investigated further. A 2m raising in the FSL could be achieved with minimal capital costs subject to addressing regulator and stakeholder issues."*

8.2 Seqwater's report at recommendations 2, 3 and 4 at section 9, page 59 clearly anticipates that the regulatory mechanism to give effect to any change in the Full Supply Level will be the Flood Mitigation Manual (underlining added):

> *<u>"A detailed assessment is carried out to develop and assess changes to the flood manual to allow the storage of the additional 2m in Wivenhoe.</u> The impact of the changes should be assessed for the full range of Annual Exceedance Probabilities and Storm durations. This assessment should also link with the Brisbane River Flood Damages Assessment currently being carried out by Brisbane City Council.*
>
> *A detailed review of the structural adequacy of the various components of the dam is carried out to confirm the assumptions of this report. This review will provide more design detail to refine the cost estimates and confirm the feasibility of the proposed increase in storage level.*
>
> *A program of consultation with the downstream stakeholders is carried out with the proposed changes to the flood manual once the assessment of flood events is completed.*

8.3 Seqwater clearly states in this report in 2007 at Appendix A "Wivenhoe Dam Description and Pertinent Data" under "Reservoir" at page 70 that the Full Supply Level of Wivenhoe Dam is EL 67.0, which means the Full Supply Level referred to here cannot have been 'set' in the *Moreton Resource Operation Plan 2009* as it was not then in existence. In this regard the statement of Peter Hugh Allen dated 4 April 2011 at paragraph 121 states that the Full Supply Level of all dams (including Wivenhoe Dam) were determined at the time of original construction and the General Arrangements Drawing for Wivenhoe Dam at

Attachment **PHA-04** which is dated 16 June 1978 shows in the drawing "FSL EL67.0".

(2) Current requirements for an assessment of water supply and flood mitigation optimisation in the Brisbane River

9. The Queensland Water Commission's 50 year water supply plan, the South East Queensland Water Strategy 2010, (Attachment-**JNB-67** and publicly available at http://www.qwc.qld.gov.au/planning/pdf/seqws-full.pdf) at page 143, SEQ Water Strategy Action No. 50, explicitly allocates responsibility to both the QWC and Seqwater to *"optimise the water supply yield and balance flood storage and water supply storage volume requirements."* This plan was endorsed by the Queensland Government and was subject to extensive consultation.

50	5.4.2	Review the operation of the Brisbane River system to optimise the water supply yield and balance flood storage and water supply storage volume requirements.	Medium-term	QWC and Seqwater

This set of responsibilities is further detailed at section 5.4.2 "Moreton Area" at page 98, which states:

The introduction of drought storage reserves has reduced the working volume of dams. This, in turn, has reduced the yield from the storage. In these cases, the reduction can be partially offset by increasing the working storage of the dam. The increase in working storage can be achieved by several methods, including raising the dam wall or modifying the operating rules that balance water storage capacity and flood mitigation capacity. Downstream flood impacts will be a key consideration in investigations into any of these options.

A detailed investigation will be conducted to determine the maximum level to which the working storage of Wivenhoe Dam could be raised without raising the dam wall. The investigation will be carried out in conjunction with Seqwater and the Brisbane and Ipswich City Councils. It will include detailed consideration of:

- the impact on frequency, severity and duration of flooding both upstream and downstream of the dam
- any effect on the structural integrity of the dam and its components or any required spillway upgrades
- environmental and social impacts, including adverse affects on any roads and crossings caused by flooding.

Hydrological investigations will be carried out to determine the increased security of supply or the additional volume of water that could be made available to the SEQ Water Grid while still remaining within the requirements of the water resource plan.

(3) Recent proposals for planning work to be undertaken in relation to any change to the Full Supply Level of Wivenhoe Dam

10. Further to the SEQ Water Strategy Action No. 50 referred to above, the Queensland Water Commission proposed earlier this year to augment its analysis of a potential raising of Wivenhoe Dam's Full Supply Level to also include potential requirements to optimise flood mitigation capacity following the floods. The Queensland Water Commission established a Project Reference Group for a project titled "Optimisation of the Brisbane River System". This is evidenced in an e-mail with attached agenda from Mr Ken Pearce, project officer, Queensland Water Commission dated 3 February 2011, a copy of which is Attachment **JNB-68** (and also see Attachment **JNB-11A** to my statement dated 4 April 2011).

11. On 23 May 2011, the Honourable Stephen Robertson MP, Minister for Energy and Water Utilities, wrote to the Chairperson of Seqwater about a Draft Study Proposal for a Wivenhoe Dam and Somerset Dam Optimisation Study. A copy of that letter is Attachment **JNB-69**. In that letter, the Minister states that Seqwater, as the owner and operator of the dams and, ordinarily, the proponent of any design or operational changes, should be the Steering Committee leader for the study. Further, the Minister states that Seqwater should work with the Queensland Water Commission and for the Queensland Water Commission to be the Water Supply Security Investigation Technical Committee leader.

12. Also on 23 May 2011, the Minister wrote to the Commissioner of the Queensland Water Commission to advise of the matters in, and provide a copy of, the letter to Seqwater. A copy of the letter to the Queensland Water Commission is Attachment **JNB-70**.

(4) Existing statutory functions in relation to water planning in South East Queensland.

13. Both Seqwater and QWC are currently required to consider both water supply and flood mitigation considerations under their existing regulatory frameworks.

14. Seqwater prepares a Flood Mitigation Manual in accordance with legislative requirements and supplies water supply services under Grid contracts approved by the Minister.

15. Under Chapter 2A of the *Water Act 2000,* the Queensland Water Commission's functions include at section 345(a)(i) "advise the Minister on matters relating to water supply and demand management for water" for the SEQ region and designated regions. However, the Queensland Water Commission is required by s. 346(3)(g) of the Act to apply "....for flood mitigation and dam safety—the principle that these issues should be considered in the preparation of assessments of regional water supply."

I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of the *Oaths Act 1867*.

Signed [redacted]

John Neville Bradley

Taken and declared before me, at Brisbane this 27th day of May 2011

COMMISSIONER FOR DECLARATIONS
Reg.No. 95162
DEPARTMENT OF JUSTICE

[redacted]

PAUL GREGORY WALSH

~~Solicitor~~ / ~~Barrister~~ / ~~Justice of the Peace~~ / Commissioner for Declarations

QUEENSLAND WATER COMMISSION

DEPARTMENT OF NATURAL RESOURCES AND WATER

PROVISION OF CONTINGENCY STORAGE IN WIVENHOE & SOMERSET DAMS

SEQWATER
Wivenhoe, Somerset & North Pine Dams
Quality of water. Quality of life.

March 2007

Report No WS/OPS 011106

1. Executive Summary

This report has been prepared in conjunction with the Queensland Department of Natural Resources and Water (NRW) to investigate options to provide contingency storage as part of the South East Queensland Regional Water Supply Strategy (SEQRWSS). As part of these investigations it is proposed to look at options for the provision of an additional 200 to 600 GL of contingency storage in the Brisbane River catchment. The two options for this report are:-

- Raising Wivenhoe Dam Full Supply Level (FSL)
- Raising Somerset Dam FSL

These two options are being compared with other storage options in South East Queensland.

1.1 Scope of Work

This scope of work for this report includes the following options for the provision of the contingency storage:-

- Option W1 - Raise Wivenhoe Dam FSL by 2m to EL69.0
- Option W2 - Raise Wivenhoe Dam FSL by 4m to EL71.0
- Option W3 - Raise Wivenhoe Dam FSL by 8m to EL75.0
- Option S1 - Raise Somerset Dam FSL by 2m to EL101.0
- Option S2 - Raise Somerset Dam FSL by 4m to EL103.0
- Option S3 - Raise Somerset Dam FSL by 6m to EL105.0

This report provides:-

- Background data for each dam including risk profiles.
- A broad description of the works required to raise each dam to the nominated FSL.
- Feasibility cost estimates for each option.
- A preliminary assessment of the environmental and social impacts of each option.
- Risks and opportunities associated with each option.

The six options for the provision of contingency storage in Wivenhoe and Somerset Dams are presented in Table 1-1.

Table 1-1 - Summary of Raising Options

Wivenhoe Raising Options				
Option	**Raising (m)**	**Raised FSL (m)**	**Increase in Storage Capacity (ML)**	**Estimated Cost ($m)**
W1	**2**	**69**	**228,000**	**63**
W1A (Operational change)	**2**	**69**	**228,000**	**5 to 10**
W2	**4**	**71**	**481,000**	**138**
W3	**8**	**75**	**1,066,000**	**248**
Somerset Raising Options				
S1	**2**	**101**	**92,000**	**55**
S2	**4**	**103**	**202,000**	**70**
S3	**6**	**105**	**332,000**	**85**

It can be seen from the table that the most attractive option for the provision of contingency storage would be a 2m raising of Wivenhoe Dam as an operational change eliminating the need for expensive capital works. Intuitively, Wivenhoe would be the most logical option for contingency storage given the size of the catchment and the corresponding probability of capturing the additional flows.

The provision of contingency storage in Somerset will be difficult due to the upstream flooding issues associated with Kilcoy and land owners.

1.2 Flood Security Costs

Neither Wivenhoe nor Somerset currently satisfies the ANCOLD Guidelines on Acceptable Flood Capacity (2003). SEQWater is committed to an agreed program of works to allow the dams to comply with both ANCOLD and the Spillway Adequacy Guidelines (NRW 2005) in the timeframe specified by NRW. Given the assumptions for this study that the dams will be required to pass the current estimate of the PMF, a substantial portion of the costs to raise the FSL is associated with the long term works to increase flood security. It is arguable whether these costs should be included for the provision of contingency storage as SEQWater is likely to incur these costs in the future even if the storage is not raised. An attempt has been made to separate out the costs associated with the provision of additional storage from the costs required to upgrade the current dams. These costs are presented in Table 1-2.

Table 1-2 – Flood Security Costs

Option	Increase in Storage Capacity (ML)	Direct Cost ($m_)		Total Estimated Cost ($m)*
		Raising FSL	Flood Security	
Wivenhoe Raising Options				
W1	228,000	13	40	63
W1A (Operational change)	228,000	NA	5 – 10	5 to 10
W2	481,000	64	40	138
W3	1,066,000	151	40	248
Somerset Raising Options				
S1	92,000	1.5	24	55
S2	202,000	1.5	24	70
S3	332,000	1.5	24	85

Note:

1. **The total costs include contingencies, design and construction supervision not included in the direct costs**
2. **The Wivenhoe flood security costs comprise the current estimated costs of the Stage 2 works. This work is required to be undertaken by SEQWater by 2035.**
3. **The works to raise the FSL at Somerset include gate seals, upgrading the crest, and upgrades to the controls. This work is constant for the three options as up to 6m additional storage could be held against the sector gates after upgrading.**
4. **The MFL for the Somerset Raising Options is similar for all three cases. Therefore, the post tensioning and downstream strengthening work are of a similar order of cost (at this level of assessment).**

For Wivenhoe it can be seen that the incremental cost associated with the small increase in the storage capacity is much less than the cost required to upgrade the dam to full PMF Capacity. For Somerset the cost of increasing the storage capacity is much less than the cost to upgrade to full PMF capacity in all cases.

1.3 Limitations

This report is intended to be a preliminary feasibility investigation for options to raise Wivenhoe or Somerset Dam. The investigations carried out for the report have focused on the engineering aspects of raising Wivenhoe and Somerset. There has been no attempt to quantify:-

- The potential impacts of the raising on the end of systems flows.
- The frequency and volumes of the storage to be held above FSL at either or both of the dams.

- The potential benefit of raising Wivenhoe or Somerset on the downstream flood impacts.

- Major environmental impacts.

- Impacts of the additional storage on the levels of service.

1.4 Flood Operational Procedures.

The proposed raising options investigated for Wivenhoe are capable of producing similar outflow hydrographs to the current configuration, thereby preserving the flood mitigation benefits downstream of the dam.

The proposed options for the raising of Somerset reduce the flood mitigation capacity of the storage for downstream stakeholders (impacts on the flood mitigation capacity of both Wivenhoe and Somerset) to limit the impacts of the raised storage levels on Kilcoy and upstream areas. These options would require a substantial revision of the flood operational procedures.

Option W1A has impacts on the flood capacity of the dam for events greater than the 1 in 1,000 AEP event. Given the rarity of this event it considered that this option has potential to be acceptable to the downstream stakeholders as a short term (10 to 15 years) option to capture additional storage in Wivenhoe.

It has been assumed that minor changes to the flood operational procedures and works to the downstream bridges may reduce the adverse impact of this operational change even further. It is proposed that this assumption be investigated further by SunWater, to provide a detailed assessment of the impacts of the raised storage on the downstream flood levels.

1.5 Wivenhoe Raisings.

The raising options W1, W2 and W3 considered involve:-

- Complex work in the spillway which could only proceed one bay at a time and probably only in the dry season months.

- The cost of such complex work with limited time windows is difficult to estimate with reasonable certainty.

Options W2 and W3 involve raising the embankments and a temporary relocation of the Brisbane Valley Highway causing major disruption to traffic. Less significant disruption would be caused to the Wivenhoe - Somerset Road. The indirect cost of these disruptions has not been estimated.

For Option W1A, the increase in downstream flooding is relatively minor but its acceptability would be dependent on consultation with stakeholders. A raising of Kholo Bridge and possibly of Burtons Bridge and Savages Crossing could be required to deal with possible concerns.

For Option W1A, the existing fuse plug will be triggered more frequently (existing 1:5,000 AEP flood). The frequency and consequences will need to be examined in further detail.

1.6 Somerset Raisings

Issues associated with the raising of Somerset include:-

- Flood Mitigation. Each of the options investigated for the raising of Somerset impact on the existing flood mitigation performance. This impact is greater as the proposed raising increases. This is due to constraints on the upstream flood levels imposed by Kilcoy and other upstream development.

- Equipment age. The gates and hoist equipment at Somerset Dam are of considerable age. There is some uncertainty whether it can be adapted as proposed.

- Dam condition. Cracking in a number of the dam monoliths and other stability concerns will be addressed concurrently with the raising proposals.

- Community opposition to the higher raising proposals is likely to be very strong.

- The indirect costs associated with the increased frequency of highway disruption have not been estimated.

1.7 Recommendations

It is recommended that:-

- Raising of the FSL level of Somerset Dam be rejected due to the impacts on the upstream population during flood events. Major flood events already result in inundation of the Kilcoy and surrounding private properties and infrastructure.

- The provision of contingency storage in Wivenhoe is investigated further. A 2m raising in the FSL could be achieved with minimal capital costs subject to addressing regulator and stakeholder issues.

- A detailed flood assessment is carried out to develop and asses changes to the flood manual to allow the storage of the additional 2m in Wivenhoe. The impact of the changes should be assessed for the full range of Annual Exceedance Probabilities and Storm Durations. This assessment should also link with the Brisbane River Flood Damages Assessment currently being carried out by Brisbane City Council.

- A detailed review of the structural adequacy of the various components of the dam is carried out to confirm the assumptions of this report. The review will provide design detail to refine the cost estimates and confirm the feasibility of the proposed increase in storage level.

- A program of consultation with the downstream stakeholders is carried out with the proposed changes to the flood manual once the assessment of flood events is completed.

- SEQWater be provided with the opportunity to instigate a public consultation process prior to the public release of options to raise the storage levels of Wivenhoe.

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2. Glossary

Australian Height Datum (AHD)	*Mean sea level at the thirty tide gauges located around Australia*
Annual Exceedance Probability (AEP)	*The probability of a specified magnitude of a natural event being exceeded in any year.*
Dam Crest Flood	*The flood event which, when routed through the reservoir, results in a still water reservoir level at the lowest crest level of the dam.*
Design Flood Level (DFL)	*The peak level in a dam storage derived from routing the critical design flood event through the dam.*
Elevation Level (EL)	*The elevation relative to a specific datum point. For this report all elevation data is quoted in m AHD.*
Full Supply Level (FSL)	*The maximum normal operating water surface level of a reservoir when not affected by floods.*
Probable Maximum Precipitation (PMP)	*The theoretical greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.*
Probable Maximum Flood (PMF)	*The probable maximum flood is the flood resulting from the PMOP and, where applicable, snow melt, coupled with the worst flood producing catchment conditions than can be realistically expected in the prevailing catchment metrological conditions.*
Maximum Flood Level (MFL)	*The peak water level in a dam storage derived from routing the critical design flood event through the dam. May be the same as the DFL or used to denote a different water level if the dam has a flood capacity deficiency.*
Outlet Works	*The combination of intake structure, conduits, tunnels, flow controls and dissipation device to allow release of water from a dam.*
Right Abutment	*The right hand side abutment of a dam looking in the downstream direction*
Left Abutment	*The left hand side abutment of a dam looking in the downstream direction*
Probability	*The likelihood of a specific event or outcome.*
Revise Generalised Tropical Storm Method (GTSM-R)	*A generalised method for the estimation of extreme rainfall events (PMP's) in the northern parts of Australia.*
Reservoir	*An artificial lake, pond or basin for storage, regulation, control of water, silt, debris or other liquid or liquid borne material.*

3. Introduction

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- Risks and opportunities associated with each option.

3.2 Assumptions

For the purposes of this study it has been assumed that the raised dam will be required to:

- Maintain the flood mitigation performance of the dam (for more frequent flood events up to the 1 in 500 Annual Exceedance Probability (AEP) flood event) provided by the current spillway facilities. Currently the flood manual for the operation of Wivenhoe and Somerset has four procedures. Procedure 4 marks the change from flood mitigation to ensuring the safety of the dam by passing the flood and occurs at approximately EL74. The intent of the manual is to be maintained for possible raising options. Any change to the manual intent will require extensive stakeholder consultation.

- Comply with the State's requirements on Acceptable Flood Capacity (AFC) for Dams. The Draft Guidelines on Acceptable Flood Capacity were issued by NRW (Dam Safety Regulator) in 2005 and are in the process of being finalised.

- Maintain the current release capability of the outlet works. The Dam is operated to release water supply discharges into the Brisbane River before being extracted by downstream customers. This requires an outlet capacity of approximately 1,500 ML/day.

4. Wivenhoe Dam General Information

4.1 Background

Wivenhoe Dam, as originally constructed, is a 56 m high, zoned earth and rock embankment with a concrete gravity spillway (crest level EL57), controlled by 5 radial gates, each 12.0m wide by 16.0 m high. Two saddle dam embankments are located on the left side of the reservoir. The Brisbane Valley Highway was relocated to pass over the dam.

The dam has four main functions by providing:

- A 1,165GL storage at full supply level (FSL EL67.0) providing water supply for Brisbane and surrounding areas;
- Flood mitigation in the Brisbane River with a dedicated flood storage volume of 1,450GL at a flood level of EL80.0;
- The lower pool for the Wivenhoe Pumped Storage Hydro-Electric power station which has a 500 MW generating capacity;
- A recreation area.

The dam was designed by the then Queensland Water Resources Commission. A design report was compiled by the then Department of Primary Industries for the South East Queensland Water Board (DPI, 1995). It was constructed by a series of contracts between 1977 and 1985, supervised by the Commission.

The dam has a HIGH hazard classification because of the significant development downstream in the Brisbane and Ipswich metropolitan areas, with the population at risk (PAR) numbering in the hundreds of thousands.

The first formal dam safety review was undertaken by Guthridge, Haskins & Davey Pty Ltd in 1997 (GHD, 1997). A concurrent review of the mechanical and electrical equipment was undertaken by HECEC Pty Ltd.

The original spillway capacity, with an Annual Exceedance Probability (AEP) of 1 in 22,000 for the Dam Crest Flood (DCF), was well below current standards for a high hazard dam. The Wivenhoe Alliance was formed by SEQWater to improve the flood security with a long-term goal of providing for the Maximum Probable Flood (PMF). Investigation studies concluded that a two-stage upgrade program outlined below would provide a cost-effective risk reduction program.

- **Stage 1 Upgrade Works**
  - Construction of a new secondary spillway on the right abutment that would enable the dam to handle an inflow flood with an AEP of 1 in 100,000 at a Maximum Flood Level (MFL) of EL80. This spillway is controlled by three fuse plug embankments;
  - Upgrading of the embankment crest to retain a MFL of EL80 with zero freeboard;
  - Upgrading of associated structures as appropriate, including protection of the main spillway gates and bridge and strengthening of the spillway gravity structure.
- **Stage 2 Upgrade Works**
  - Reconstruction of Saddle Dam 2 as a fuse plug spillway such that the dam can accommodate the PMF.

4.2 Flood Hydrology

The dam failure analysis report, WA (2005) summarises the storage and spillway discharge data, the PMF inflow data and downstream flood parameters for the following PMF scenarios:

- Original dam with dambreak
- The Stage 1 completed works with dambreak
- The proposed Stage 2 works without dambreak
- The proposed Stage 2 works with dambreak for comparison purposes.

The 36 hour PMP rainfall was found to produce the highest peak inflow and outflow at the dam. Details of the methodology used to derive the PMF hydrographs are described at WA (2004B).

The peak inflow for the PMF is 49,000 m3/s, which includes outflows from Somerset Dam. This was derived using the latest GTSM-R PMP rainfall depths and temporal patterns provided by BOM (2003). The PMF has a flood volume of 5,993,000 ML and the peak outflow discharge following Stage 2 construction is 37,400 m3/s.

4.3 Main Embankment

The Wivenhoe main embankment is located on the right hand side of the centrally placed spillway. The 1.2 km embankment is a 56 m high central clay core embankment with both upstream and downstream filters supported by outer shells of compacted sandstone with run of river gravel in the upper portion. The shoulder slopes are 2 horizontal to 1 vertical with a local steepening in the upper portion to 1.5 horizontal to 1 vertical. Riprap was provided on both upstream and downstream shoulders.

To the left of the spillway structure, the embankment has a sloping upstream core protected by both upstream and downstream filters and supported by a downstream shell of miscellaneous fill. Batter slopes are 3 horizontal to 1 vertical on the upstream face and 2 horizontal to 1 vertical on the downstream face. Riprap was provided on both upstream and downstream shoulders.

4.4 Saddle Dams

Two saddle dams close off low saddles on the left abutment of the dam. These are constructed from miscellaneous fill with some broad zoning of materials. They have a crest level at EL80 and have a maximum height of 10 m. The saddle dams only retain water during flood operation.

4.5 Foundation

A single line grout curtain, 15 m to 35m deep and an 8 m deep grout blanket was installed under the core of the main embankment and the sloping core of the left embankment. Water losses were generally low at depth but high water losses were noted as appearing to "coincide with poorly consolidated sandstone, which is a primary structural feature and is not the result of weathering" (DPI, 1995).

The foundation was cleaned off by removal of loose and shattered material and blasting with water - air jets. This was only done under the core and filter areas as the shoulders were founded on the alluvial materials. Foundation treatment generally comprised slush grout or mortar to seal fractures, fill irregularities and fill fissures. Dental concrete was used where the contact fill could not readily be compacted and to fill cavities and smooth abrupt vertical faces. Areas where the foundation was likely to weather rapidly were mortar treated immediately following clean up.

The contact clay (zone 1A) and filters (zone 2) were placed while the slush grout or mortar was still plastic. The contact clay was compacted with rubber tyred construction machinery.

4.6 Primary Spillway

The spillway is located in a low saddle between the two embankments and is controlled by 5 radial gates supported on a mass concrete ogee crest. The radial gates are 12m wide by 16m high and discharge via a flip bucket spillway to an unlined rock discharge channel.

The five 12m wide by 16m high radial gates in the Wivenhoe spillway structure are operated by hydraulic motor driven wire rope winches, one on each side of each gate. The power units (2) for the spillway gates and penstock gate are located in a winch room in the left abutment of the dam. Also located in the winch room is an auxiliary diesel operated hydraulic unit capable of operating the gates.

A left bank underground control complex in the dam comprises the winch room, water quality control room, main high voltage substation, main switchboard, fire control equipment, storeroom, diesel alternator set, and ventilation system.

A 79 tonne travelling gantry crane on the service bridge over the spillway structure serves to handle the bulkhead gate used for maintenance of the radial gates. A smaller gantry over the intake structure is used for handling the trash racks and water quality baulks.

4.7 Outlet Works

The following information on the Outlet Works is obtained from the DPI, 1995 report.

“The outlet works extend over 4 monoliths LH11 to LH14 with the entrances to the penstock and river outlet being in Monolith 11 and the regulating valves in Monolith 14. At the entrance to the outlet works in Monolith 11 a 3.6m diameter penstock with a large capacity intake was installed to provide for the future installation of a hydro power station. A 1.905m diameter river outlet was installed directly above the penstock so that one fixed wheel bulkhead gate could command either outlet (but not both outlets) to provide for emergency closure or dewatering” (DPI 1995).

In 2003, a 4.6MW mini hydro plant was constructed on the 3.6m diameter penstock. The GE turbine is utilised to generate electricity from the routine releases from the outlet works. The mini hydro is owned and operated by the Stanwell Corporation. The upper outlet, consisting of a 1.9m diameter pipe is controlled by a 1.5m diameter regulating valve. The regulating valve discharges into a stainless steel lined dispersion chamber. Additional off takes are provided for town water supplies.

“The inlet transition for both penstocks is steel lined because of the high 10m/s flow velocity in the pipes. The internal surfaces of the outlet pipes were coated with coal tar epoxy to a minimum thickness of 500 microns. This paint lining was refurbished in 2003.

A 4.1m wide by 5.25m high fixed wheel type emergency gate serves as a guard gate for the outlets through the dam (one 3.6m diameter penstock, and a 1.9m diameter outlet pipe).

Within the intake structure in the left abutment there is an arrangement of six baulks to allow selective withdrawal of water for quality control purposes” (DPI 1995).

4.8 Electrical Equipment

The electrical power system consists of the following major components:

- 11kV supply system and transformer
- Main switchboard
- Diesel generator
- Load bank
- Distribution boards
- UPS power supplies.

The diesel generator is a self contained skid mounted unit with a six cylinder Mitsubishi engine and a 330kVA Stamford generator providing a three phase 415 volt AC alternative power supply for the main dam distribution board. The rating of the engine is a nominal 250kW, with a continuous rating of 90% and a one hour rating of 110%.

The diesel is automatically started at a preset time delay after the mains power fails and the entire site load is automatically connected to the diesel a short time later. Upon the restoration of the mains power there is a short delay and the diesel is shut down and the load reverted to the mains supply. The instantaneous shutting down of the engine without any cooling down period is detrimental on the diesel and will shorten its service life.

To ensure that the diesel is not operated for prolonged periods of time on light load an automatic load bank has been provided. When the diesel load is below a preset level, the load is connected in one step and once the total loading has increased to another preset loading the load bank will be disconnected. Also the load bank is disabled when the 79 tonne gantry crane is operating form the diesel generator.

4.9 Supporting Services

There are several supporting services, which influence the safety of the asset and the operators and therefore indirectly compromise the gate operation. These services include:

- Fire detection
- Fire control and fighting
- Ventilation
- Security systems

- Communications
- Alarm systems
- Monitoring systems
- Access and material handling.

4.10 Stage 1 Upgrade Works

The Stage 1 upgrade works carried out by the Wivenhoe Alliance comprised:

- Construction of a secondary spillway in the right abutment. The excavation of the chute allowed for concrete works for a 3m high ogee crest, apron slabs, chute lining and divider walls to enable construction of three fuse plug embankments;
- Temporary diversion of the Brisbane Valley Highway and relocation of services to enable construction of a new road bridge across the new spillway;
- Upgrading of the existing crash barrier on the two main embankments to handle the new Maximum Flood Level (MFL) of EL80;
- Strengthening of the primary spillway with post-tensioned anchors to cater for the increased loading due to the raised flood level. Provision of a steel deflection baffle upstream of the radial gates to ensure the gates clear the flow profile for the raised MFL.
- Modifications to the saddle dams to prevent premature failure while ensuring they are overtopped prior to the main embankment.
- Associated works comprising spoil area, access roads, sediment and erosion controls, site facilities and landscaping.
- Refurbishment of the Visitors information Centre.

This Stage 1 upgrade changes the Dam Crest Flood (DCF) from a 1 in 22,000 AEP event to a 1 in 100,000 AEP flood event. The initial trigger level for the lowest of the fuse plug embankments is at EL76.2m (approximately the 1 in 6,000 AEP event).

4.11 Proposed Stage 2 Upgrade Works

Stage 2 works will involve the reconstruction of Saddle Dam 2 to incorporate a fully lined concrete chute spillway with a single fuse plug embankment. This 100 m wide spillway will provide full PMF protection with a conventional freeboard and will be triggered by the 1 in 50,000 AEP event. The concrete lining and flip bucket protects against erosion of the conglomerate foundation.

Under proposed State guidelines (NRW 2005) the Stage 2 spillway will be required to be in place by 2035 and will increase the flood capacity to cater for the PMF.

4.12 Geology

The following description of the site geology is taken from DPI, 1995 and GHD, 1997. Brief descriptions of the regional and rim geology are provided at GHD, 1995.

“The main dam is located wholly on the Helidon Sandstone (also known as the Wivenhoe Sandstone). The sandstone consists of quartz grains with minor dark chert fragments in a whitish kaolinitic matrix. Structurally, most of the rock foundation consisted of massive undulating layers of sandstone, sometimes cross bedded, which had dips between 2 and 10 degrees and strikes in the general ENE direction. Most of these units were separated by thin layers of shale, shale conglomerate or fine pebbly conglomerates containing minor amounts of fossilised plant material (coal).

An exception occurred on the right bank were up to 9 m of interbedded shales and fine sandstones were found. The sandstone unit above was fairly weathered and contained many thin layers of clay. A continuation of the shale / fine sandstone unit is thought to have been intersected on the left bank. This suggested that the unit was responsible for the incision of the river into the valley floor at the dam site and subsequent control of the alluvial deposition sequences upstream of the dam site.

Up to 20 m of alluvium / colluvium overburden was found to exist above the foundation rock.” (DPI 1995)

4.13 Seismology

SEQWater has six monitoring stations throughout the three dam catchments (North Pine, Somerset and Wivenhoe) with seismometers, which measure seismic activity in x, y & z directions in real time. This data is transmitted via radio telemetry to the Wivenhoe Office where the information is analysed. Six accelerometers are installed, two at each dam, one at the crest and one at the base of each dam, to measure the actual dam movement during earthquakes.

A review of earthquakes and earthquake hazard in the Somerset Dam area, northwest of Brisbane was undertaken by Gibson (RMIT, 1995) using earthquake information published to December 1994. The study covers the area bounded by the Somerset and North Pine Dams and includes the Wivenhoe site.

No major earthquakes have occurred in the area since European settlement. The available data suggests the earthquake hazard in the area is above average for Queensland but below the average for eastern Australia.

The Report provides the annual exceedance probability (AEP) for peak ground accelerations as shown in Table 4-1

Table 4-1 - Earthquake Peak Ground Accelerations for the Wivenhoe, Somerset, North Pine Area

AEP	Peak Ground Acceleration
1 in 1	0.006 g
1 in 3	0.010 g
1 in 10	0.017 g
1 in 30	0.030 g
1 in 100	0.052 g
1 in 300	0.088 g
1 in 1,000	0.152 g
1 in 3,000	0.24 g
1 in 10,000	0.392 g
1 in 20,000	0.505 g

5. Raising Options for Wivenhoe Dam

To provide input into the provision of contingency storage in Wivenhoe Dam three different raising levels were selected:-

- Raise FSL by 2 m to EL69.0. This option (W1) provides a significant increase in storage, 228,000ML, for a relatively small capital cost (i.e. compared to a greenfield site) and could be achieved relatively simply. There is an additional opportunity to raise Wivenhoe FSL by 1 to 2m (which could be temporary) without the need to carry out extensive capital works. This is discussed as option W1A in Section 5.3.

- Raise FSL by 4 m to EL71.0. This option (W2) provides a mid point for the cost curve and marks a significant change in the scope of work required to satisfy the flood mitigation, flood security and operational requirements. This raising would provide an additional storage capacity of 481,000ML.

- Raise FSL by 8 m to EL75.0. This option (W3) was selected to provide an upper limit to the raising options and provide an additional 1,066,000ML of storage (effectively doubling the storage volume of Wivenhoe). This option would utilise the limit of land owned by SEQWater for the FSL storage. There would need to be compulsory acquisitions by Government of additional land impacted by flood operations up to at least the 1 in 500 AEP event. There is major capital works required to allow the dam to satisfy the flood mitigation and flood security criteria.

5.1 Summary Table

Key data for the proposed options is summarised in Table 5 - 1. The options are described in Sections 5.2, 5.3, 5.4, and 5.5

5.2 Option W1 - Raise Wivenhoe FSL 2m (EL69.0)

This option involves raising the storage level by 2m to EL69.0. This would provide and additional 228,000ML of contingency storage. The proposed scope of work for this option would involve:-

- Raising the fixed concrete ogee crest of the gated spillway by 1.5m to EL58.5 to preserve the air space controlled by the radial gate above FSL for flood mitigation.

Table 5 - 1 - Wivenhoe: Elevation data for Raising Options

Raising Option	Dam Structure				Secondary Spillway				Tertiary Spillway
	FSL	Dam Crest	Service Spillway	Top of Radial Gates	Ogee Crest[1]	Fuse Plug initiation			Fuse Plug initiation
						Bay 1	Bay 2	Bay 3	Single Bay
Current configuration	67	80	57	73	67	75.7	76.2	76.7	78.3 (100m wide)[2]
Option W1 - 2m permanent	69	80	58.5	Approx 74.5	67	76.7	77.2	77.7	78.5 (140m wide)
Option W1A - 2m temporary	69	80	57	73	67	75.7	76.2	76.7	78.3 (100m wide for FSL EL67) 78.3 (120m wide for FSL EL69)
Option W2 - 4m permanent	71	84	60	76	69	77.7	78.2	78.7	Not Required
Option W3 - 8m permanent	75	87.5	70	76[3]	73	81.7	82.2	82.7	Not Required

[1] Ogee crest level the same for both the Secondary and the Tertiary Spillways.

[2] Spillway not required to be finished until 2035 by the NRW Draft Guidelines on AFC

[3] Existing radial gates replaced with fuse gates

- Raising of the three fuse plug embankments in the secondary spillway by 1m to preserve the initiation level for the first embankment at approximately the 1 in 5,000 AEP flood event as per the current design constructed in 2004. The initial trigger for the lowest of these fuse plugs would then be EL76.7.

- Construction of the tertiary spillway proposed currently for Stage 2 of the Wivenhoe Flood Security Upgrade at Saddle Dam 2 with a single 140m wide fuse plug initiating at a level of EL78.5.

- Maintaining the current Maximum Design Flood Level (MDL) of EL80m adopted for the Stage 1 upgrade work to avoid any work along the crest of the existing dam.

Drawings of the works required for this option are presented in Appendix D.

5.2.1 Spillway Capacity

Under the Governments proposed guidelines on spillway adequacy, the spillway capacity to allow the dam to safely pass the 2003 estimate of the Probable Maximum Flood (PMF) is required by no later than 1 October 2035. The spillway layout and capacity are discussed in the following sections.

Radial Gated Service Spillway

The flood mitigation benefits obtained for more frequent flood events from Wivenhoe Dam are due to the freeboard against the radial gates above the nominated FSL. To preserve the current flood mitigation performance if the FSL were raised, the air space between FSL and the top of the radial gates will need to be maintained.

The simplest method to achieve this would be keep the existing radial gate arrangement and raise the fixed crest level with reinforced concrete from EL57 to EL58.5. The existing trunnion corbel, bearing and winches would be maintained in their current location.

The bottom gate seal would need to be raised and incorporated in the new concrete. The lower 1.5m of the gate slots would be filled with concrete and a new connection with the bottom gate seal fabricated and installed. Extensive anchoring would be required along the existing crest to secure the new concrete to the underlying original concrete.

The works required to raise the crest will involve the placement of reinforced concrete with grouted anchors at a regular spacing to ensure connectivity to the underlying crest concrete over the length of the crest to a suitable profile (assumed to mirror the current profile with a 1.5m topping layer for the development of costs). The control systems for the gates would also need to be modified.

Replacement of the radial gates was considered but requires major capital expenditure to fabricate and install new gates as well as modify the existing piers, trunnion corbel and anchoring. Due to the current design of the piers and trunnion anchoring it may not even be a possibility to install new radial gates to achieve the levels specified for this option. Drawings of the works required for this option are presented in Appendix D.

Raising of the fixed crests for the existing radial gated primary spillway will reduce the ultimate discharge capacity from 13,400 m^3/s to approximately 12,000m^3/s. This lost capacity could be replaced by the provision of an additional 20m of spillway crest length in the Stage 2 works proposed for Wivenhoe.

Secondary Fuse Plug Spillway

The Stage 1 works constructed for the Flood Security Upgrade of Wivenhoe in 2004 consisted of a three bay, 164m wide fuse plug spillway located at the right abutment of the dam. The first fuse plug embankment trigger level was set at EL75.7 (nominally the 1 in 6,000 AEP flood event) to protect the flood mitigation benefits of the storage and minimise the cost of the upgrade.

To preserve the design intent it is possible to raise each of the three fuse plug bays by 1m preserving this initiation AEP for the raised storage level. The divider wall between bay 1 and Bay 3 of the fuse plug would need to be raised by 0.2m which would be achieved using anchor bars and conventional concrete at limited cost. The Left Hand Side of the chute is protected by a concrete gravity wall. This would need to be raised by 0.5m to protect the main dam embankment. As the Maximum Flood Level (MFL) would remain at EL80.0 there would be no need to modify the bridge over the spillway, the ogee crest or the wall lining.

The control crest would remain at EL67.0 resulting in an inability to store water at the new FSL of EL69.0 until the fuse plug embankment was reconstructed.

Tertiary Fuse Plug Spillway

Stage 2 works are proposed to allow Wivenhoe Dam to pass the 2003 estimate of the PMF. The current proposal is to construct a 100m wide tertiary spillway through Saddle Dam 2. The spillway would be controlled by a single fuse plug embankment initiating at a 1 in 50,000 AEP flood event (EL78.3).

To preserve the design intent and pass the PMF for the raised FSL of EL69.0 would require the tertiary spillway width to be increased to 140m from the current proposal of 100m. The initiation level of the fuse plug embankment would be increased from 78.3 to 78.5 (approx 1 in 50,000 AEP event).

5.2.2 Existing Embankments

The Stage 1 flood upgrade works have been designed for the new MFL of EL80.0. Therefore no works are required to raise the embankments, bridges or Saddle Dams for the new FSL.

5.2.3 Key Data for a 2 metre Raising

Item	Proposed EL / Storage	Current EL / Storage
FSL	69m	67m
MFL	80m	80m
Dam Crest Level	80m	80m
Top of Radial Gate	74.5m	73m
Service Spillway Fixed Crest Level	58.5m	57m
Storage Vol FSL to Top of Gates	760GL	761GL
Secondary Spillway - Fuse Plug 1 Initiation - Approx Initiation AEP - Storage Volume FSL to Initiation Level	 76.7m 1 in 5,000 1122GL	 75.7m 1 in 6,000 1182GL
Planned Tertiary Spillway Stage 2 - Crest Length - Fuse Plug Initiation - Approx Initiation AEP	 140m 78.5 1 in 50,000	 100m 78.3 1 in 50,000

5.2.4 Costs

Item	Cost	Comment
1. Raise the concrete ogee fixed crest of the existing service spillway by 1.5m in reinforced concrete	$8.7M for the five bays	This assumes anchoring, reinforcement, provision of access, steel work, mechanical system modifications, provision of access to the post tensioned anchors installed by the Alliance.
2. Construct the Stage 2 spillway to provide PMF capacity for the Dam	$27M	These works have been costed by the Wivenhoe Alliance.
3. Raise the secondary spillway fuse plug embankments, divider wall and the training wall	$2.5M	This assumes that the fuse plugs are all raised by 1m with works carried out on the downstream face of the embankments
4. Construction Supervision and Overheads (20%)	$7.6M	Contract Supervision and Constructors Overheads
5. Design and Approvals (15%)	$5.7M	Concept Design, Approvals and Detailed Design
7. Contingency (30%)	$11.5M	
Total	**$63.0M**	

A breakdown of the costs estimates is provided at Appendix C.

5.2.5 Inundation Area

The inundation area is presented in Appendix K. SEQWater owns land up to EL75m for operation of the dam during flood events. Currently, large parcels of this land are leased out to adjacent landholders to provide land management. Impacts from the raised storage levels would include:-

- Some reduction of land available to lease holders adjacent to the storage area. When the dam was constructed the landholders subject to resumption were granted favourable lease conditions. While the lease states that an increase in storage level is possible at the discretion of SEQWater there would need to be an early and comprehensive consultation program implemented.

- Loss of environmentally sensitive habitat (minor). There are areas around the storage listed as environmentally significant. The inundation of these areas may require the preparation of an EIS.

- Loss of access to private recreation areas at Billie's Bay and Hay's Landing currently leased from SEQWater. Substantial costs would be incurred to provide alternative access to these areas. This is not a considered a major issue as potentially the recreation areas could be closed after consultation.

- Slightly more frequent flooding of bridges on the Wivenhoe – Somerset Rd and significantly more frequent flooding of the A&PM Conroy Bridge.

5.3 Option W1A – Operational Change of Wivenhoe FSL

To satisfy the upgrading criteria (pass PMF and maintain flood mitigation capability as currently exists) it is necessary to incur significant capital expenditure. However, there is an opportunity to raise the FSL of Wivenhoe Dam without major capital works. Such a raising could provide temporary contingency storage until permanent works are undertaken. This would provide an additional storage of 228,000ML for the regional contingency storage for minimal cost.

5.3.1 Flood Mitigation Capacity

The possibility of increasing the FSL to EL71 was investigated by SEQWater previously in a draft report on the raising of Wivenhoe prepared for discussion with NRW. While this additional storage did not have a major impact on the flood discharges for extreme flood events (events greater than the 1 in 10,000 AEP event) it did have implications for the operation of Wivenhoe and Somerset for more frequent flood events (floods smaller than the 1 in 500 AEP event). This impact (increased discharges) is summarised in a report by SunWater presented in Appendix E. Key outcomes from the SunWater investigations was that the 4m raising of the storage compromised the ability of the Flood Operations Centre to manage small flood events without the initiation of a fuse plug.

As this previous work identified that flood mitigation would be compromised by a 4m raising of the storage without modifying the spillways, significant modification works are proposed for Options W2. The proposed scope of work is presented in Section 5.4.

The flood operation group of SunWater was subsequently engaged during this investigation of contingency storage options to assess the impact of increasing the Wivenhoe FSL to EL69.0 on the more frequent flood events. This report is presented in Appendix F. This assumes that there are no modifications to the existing primary and secondary spillways. The assessment looked at the impact of the raised storage level on the 1 in 100, 1 in 200 and 1 in 500 AEP events. A summary of the results of these investigations is presented in Table 5-2.

It can be seen from the table that the increase in the FSL of 2m has very limited effect on the 1 in 100, 1 in 200 and 1 in 500 AEP events in terms of the peak flow at the Moggill Gauge. These results suggest that 1 to 2m raising of the storage would not compromise the ability of the Senior Flood Operations Engineer to manage a large flood event up to and above the 1 in 500 AEP event. As a short term measure to provide contingency storage it would therefore appear feasible to allow the storage of Wivenhoe to be held at EL

69.0m (2m above the FSL of EL67.0) following a flood event without compromising the flood mitigation ability of the dam for follow up events up to and above the 1 in 500 AEP event.

Subject to a detailed review of the structural adequacy of all elements of the dam, this could be achieved with almost no capital expenditure and minimal impact on flood mitigation and the flood capacity of the dam. Alternatively, a 2 metre raising of Wivenhoe's FSL could become permanent if the Stage 2 spillway (which is required by 2035) were widened to 120 metres

5.3.2 Flood Risk

Holding the storage at EL69 after a flood event presents a small increase in risk due to:-

- Increasing discharges for a limited range of events (from the 1 in 1,000 AEP event to the 1 in 5,000 AEP event) to try and limit fuse plug initiation.

- Increasing the likelihood of initiating a fuse plug embankment from an AEP of 1 in 5,000 to an AEP of approximately 1 in 4,000.

- Increasing the AEP of the Dam Crest Flood from 1 in 100,000 to approximately 1 in 95,000 (peak inflow of approximately 41,000m^3/s instead of 42,600m^3/s). Note: Under the states Proposed Guidelines on Acceptable Flood Capacity, Wivenhoe Dam would be required to have full PMF capacity by 2035.

It should be noted that the additional storage volume of 228,000ML could be used within 10 months therefore limiting exposure to the increased risk. However, the impact of concurrent flood events and joint probability with storage levels would need to be assessed in more detail to quantify risk. It should be noted that historical precedence has shown follow up events occurring in the same season as major flood events.

Table 5-2 - Comparison of Wivenhoe Somerset Flood Operations Results

Design Flood Event Centered over Wivenhoe Dam

Peak Values

Flood Event	Wivenhoe FSL	Wivenhoe Dam			Somerset Dam			River Flows				Fuse Plug Init.
		Elevation (m AHD)	Inflow (m3/s)	Outflow (m3/s)	Elevation (m AHD)	Inflow (m3/s)	Outflow (m3/s)	O'Reillys (m3/s)	Lowood (m3/s)	Bremer (m3/s)	Moggill (m3/s)	
Feb 1999	67	72.836	6862	1552	105.021	3766	1265	132	1553	424	1629	*No*
	71	74.766	6862	3494	104.804	3766	1645	132	3621	424	3943	*No*
	Increase (m or %)	1.930	0	125	-0.217	0	30	0	133	0	142	
Jan 1974	67	74.123	5019	3930	105.871	3456	1716	3260	6074	4241	6312	*No*
	71	74.425	5019	6643	105.595	3463	1490	3260	9001	4241	9562	*No*
	Increase (m or %)	0.302	0	69	-0.276	0	-13	0	48	0	51	
Feb 1893	67	75.161	9085	9695	107.370	4602	4363	3089	11337	1845	11403	*No*
	71	75.555	9085	10385	107.075	4602	3494	3089	11992	1845	12105	*No*
	Increase (m or %)	0.394	0	7	-0.295	0	-20	0	6	0	6	
WD Q100	67	73.094	5397	2392	103.165	1964	541	1921	2853	1349	3608	*No*
	69	74.501	5397	2503	103.165	1964	541	1921	2958	1349	3645	*No*
48hr	71	na	na	na	na	na	Na	na	na	na	na	*na*
ARR(87)	Increase (m or %)	1.407	0	5	0.000	0	0	0	4	0	1	
WD Q200	67	73.377	8433	2863	103.535	2377	615	1334	2974	1069	3197	*No*
	69	74.825	8433	3013	103.555	2377	614	1334	3116	1069	3164	*No*
48hr	71	74.820	8433	6037	102.963	2377	946	1334	7332	1069	7684	*No*
GTSMR	Increase (m or %)	1.448	0	5	0.020	0	0	0	5	0	-1	
WD Q500	67	74.219	10543	4452	104.337	2930	968	1886	5922	1487	6193	*No*
	69	75.645	10543	4545	104.362	2930	980	1886	5862	1487	6123	*No*
48hr	71	75.664	10543	7649	104.462	2930	1188	1886	9311	1487	9694	*No*
GTSMR	Increase (m or %)	1.426	0	2	0.025	0	1	0	-1	0	-1	

5.3.3 Risk Reduction

There are opportunities to reduce exposure to this minor increase in flood risk such as:-

- Utilising early releases from the storage to take advantage of the flood warning system. Modification of the flood procedures could be made in conjunction with minor capital works to allow discharges to be ramped up earlier.

- Making the use of the additional stored water a priority within the region to draw down the storage quicker.

Early releases

A flood alert system was developed by NRW during the mid 1990's to provide accurate forecasting of the size of flood events and necessary gate operations to optimise the flood management from both Wivenhoe and Somerset Dams. This system was tested during a major flood event in 1999 and proved to be an accurate tool to predict flood levels and releases. The alert system is maintained by SEQWater and provides real time data to a flood operations centre in Brisbane.

This system will provide up to 18 hours advance warning during a flood event which allows the implementation of an early release strategy to lower the storage of Wivenhoe in the event of an imminent flood.

Currently the ability to release significant volumes of water from Wivenhoe Dam is limited by low level bridges across the Brisbane River at Kholo, Savages Crossing and Burton's Bridge. Savage's Crossing is cut by a flow of around 130m^3/s, Burtons Bridge at 430m^3/s and Kholo Bridge at 550m^3/s. If these bridge's were raised to allow a discharge of 1,200 to 1,500 m^3/s to be released without submerging them, then the opportunity for early releases becomes more attractive. The Brisbane River Flood Damages Study currently being carried out by Brisbane Water has also identified that these discharges would be non damaging.

A flow of 1,500m^3/s equates to a release of 97,000ML in the 18 hour warning time available to the Flood Operations Centre (approximately half of the additional storage held) thereby significantly reducing the flood risk.

The ability to provide early releases is conditional upon concurrent flows in Lockyer Creek and the Bremer River and should be investigated further. It is estimated that for a capital expenditure of $5M the three bridges could be raised to provide flood immunity up to a flow of 1,500m^3/s. Note: The proposed raising of Mt Crosby Weir would require a raising of Kholo Bridge.

Use Additional Storage

A simple method to further reduce the risk associated with this option is to use the additional storage as quickly as possible. With the proposed water grid for South East Queensland being constructed and the operational flexibility it will provide, there is an opportunity to use the additional storage across the region to increase the rate of draw down for Wivenhoe Dam. Additional work is required to assess the rate of draw down possible but it is conceivable that the 228,000ML of additional storage could be used within 9 months.

5.4 Option W2 - Raise Wivenhoe FSL 4m (EL71.0)

This option involves raising the storage level by 4m to EL71m. This would provide and additional 481,000ML of contingency storage. The proposed scope of work for this option would involve:-

- Increasing the Maximum Flood Level from EL80m to EL83.4m to maintain the flood mitigation benefits of the storage.

- Existing Spillway

    - Raising of the fixed crest spillway from EL57 to EL60m and raising the existing spillway radial gates so that the top of the spillway gates is at EL76m. Alternatively the radial gates could be abandoned and a new uncontrolled spillway crest constructed at an EL 71m. Undershot gates could be provided through the fixed crest to reinstate the flood mitigation capacity. This would allow the new crest to replicate the outflow hydrographs for the 1 in 100 and 1 in 200 and 1 in 500 AEP flood events.

    - Raising the service bridge deck and the Brisbane Valley Highway bridge across the existing spillway up to EL82m, above the flow surface.

    - Raising and strengthening the upstream training walls and rockfill bunds.

- Secondary Spillway

    - Reconstruct a new ogee crest upstream of the existing spillway crest to EL69m and raise the fuse plugs by 2m each to maintain the initiation levels. Other spillway configurations are possible to avoid the loss of storage but this option appeared to be considerable cheaper by avoiding the need for a tertiary spillway.

    - Raising the bridge over the secondary spillway by 2.5m to EL 82.8 to lift the underside of the bridge beams above the flow surface.

- Raise and post tension the divider walls and the entrance training walls for the spillway chute.

- Raise both Saddle Dams to EL84m

- Existing Dam Crest

  - Raising the crest of the dam by placing fill on the downstream face of the embankments to achieve a new crest level at EL84m

  - Reconstructing the Cormorant Bay entrance.

- Raising the bridges for the Brisbane Valley Highway away from the dam to EL82m and the bridges on the Wivenhoe - Somerset Road.

Drawings of the works required for this option are presented in Appendix D.

5.4.1 Spillway Capacity

The spillway capacity is required to allow the dam to safely pass the 2003 estimate of the Probable Maximum Flood (PMF) by October 2035. Spillway layout and capacity are discussed in the following sections.

Radial Gated Service Spillway

The flood mitigation benefits obtained for more frequent flood events from Wivenhoe Dam are due to the freeboard against the radial gates above the nominated FSL. To preserve the current flood mitigation performance if the FSL is raised, then an equivalent flood storage volume is required. This is not achievable with the current radial gates if the storage is raised to EL71m as the rate of opening for the gates during a flood event would be controlled by the rise in water level. This limitation is due to the need to avoid overtopping the radial gates as the storage rises. The current gates have 6m of storage rise available before overtopping providing the operational flexibility for flood mitigation. Raising the FSL to RL 71 without modifying the spillways does not provide the flood control centre adequate flexibility to manage the more frequent events.

To provide the required flexibility for flood mitigation it would be necessary to raise the current gates and the fixed crest level from EL57.0 to EL60.0. The proposed construction sequence would involve:-

- Drilling through the concrete pier to insert the necessary stress bars required for the gate loads. Installation and stressing of the bars.

- Construction of a new corbel and trunnion bearing support, winch ledge and modification to the hydraulic controls for the gate.

- Construction of a new upstream pier end to allow the upstream end of the pier to be post tensioned.
- Dewatering of one spillway bay at a time using the bulkhead gate.
- Disconnecting the radial gate from the trunnion bearing and raising the gate clear of the spillway crest to facilitate access to the crest.
- Placement of the concrete and anchoring on the existing spillway crest including new gate sill and cutting new gate slots for the side seals on the gate.
- Lifting the gate and connecting it to the new trunnion bearing support.
- Relocation and connection of the winch motors including modification to the hydraulic control lines. The hydraulic lines would need to be moved from the service bridge deck to another location to facilitate the raising of the service bridge.
- Raising of the service bridge deck and removal of the baffle plate from under the bridge. The baffle plate may be raised and re-used.
- Raising of the road bridge across the existing spillway to maintain the Brisbane Valley Highway across the dam.

The upstream training walls would need to be raised. This would be achieved through the use of anchor bars to join the raised concrete to the existing wall. The walls would then be post tensioned to cater for the increased load from the raised flood level.

Limited works would be required for the dissipator as the discharges from the spillway would be similar to the current design discharges.

The maximum design discharge from the spillway would remain at around 13,000m^3/s

Constraints

A major constraint for this work would be the need to maintain at least four gates fully operational for the duration of the works. It is unlikely that works could be carried out during the wet season so the construction works would need to be programmed for the 6 months during the dry season. It is anticipated that this work would require three dry seasons to complete resulting in significant cost penalties.

Secondary Fuse Plug Spillway

The Stage 1 works constructed for the Flood Security Upgrade of Wivenhoe in 2004 consisted of a three bay, 164m wide fuse plug spillway located at the right abutment of the dam. The first fuse plug embankment trigger level was set at EL75.7m (nominally the 1 in 5,000 AEP flood event) to protect the flood mitigation benefits of the storage and minimise the cost of the upgrade.

To preserve the flood mitigation benefits for more frequent events it will be necessary to raise the three fuse plug embankment initiation levels by 2.0m. This will preserve the initiation AEP at approximately 1 in 5,000.

Flood routing the PMF through the storage including the fuse plug embankments has identified the possibility of improving the flood security of the dam by changing the initiation levels to EL77.7, EL78.2 and EL78.7 and leaving the fixed crest level for the secondary spillway at EL69m. The loss of storage and the changed initiation levels would provide full PMF capacity with a maximum flood level of EL83.4m.

The incremental increases in downstream flood levels for the initiation of each fuse plug embankment need to be determined to asses the acceptability of this proposal. A major change in downstream flood levels (>1m) immediately following initiation of the fuse plug embankments would be unacceptable.

Tertiary Fuse Plug Spillway

The proposed Stage 2 works would not be required as the proposed modifications to the existing spillways would provide full PMF capacity.

5.4.2 Existing Embankments

The new adopted flood level of EL83.4 would require all of the embankments to be raised. Preliminary stability analysis has shown that raising the crest of the dam using a wave wall is not an option. Therefore it is proposed that the dam crest would be raised using placement of fill on the downstream face of the dam.

The proposed construction sequence would involve:-

- Diversion of the Brisbane Valley Highway off the existing crest.
- Stripping and stockpiling the downstream rip rap facing on the embankment.
- Extending the filter blanket on the downstream side of the core and providing an equivalent drainage system under the new downstream material.
- Placement of sandstone fill borrowed from adjacent land (potentially the spoil material from the Stage 1 works)
- Exposure of the clay core and downstream filters once the embankment has reached the height of the existing crest.

- Raising the height of the existing clay core and extending the upstream and downstream filters in the upper 5m of the raised embankment.

- Reinstating the road pavements and the upstream wave wall.

Constraints

There would be major disruption to the Brisbane Valley Highway traffic. An alternative route downstream of the dam would be required for the duration of the raising works for the embankment and the bridges. This would have significant social and environmental impacts on the downstream communities.

5.4.3 Key Data for a 4 metre Raising

Item	Propose EL / Storage	Current EL / Storage
FSL	71m	67m
MFL	83.4m	80m
Dam Crest Level	84m	80m
Top of Radial Gate	76m	73m
Service Spillway Fixed Crest Level	60m	57m
Storage Vol FSL to Top of Gates	748GL	761GL
Secondary Spillway (fixed crest at EL69) - Fuse Plug 1 Initiation - Approx Initiation AEP - Storage Volume FSL to Initiation Level	 77.7m 1 in 5,000 1044GL	 75.7m 1 in 6,000 1182GL
Tertiary Spillway Stage 2 - Crest Length - Fuse Plug Initiation - Approx Initiation AEP	 NA NA NA	 100m 78.3 1 in 50,000

5.4.4 Costs

Item	Cost	Comment
1. Raise the Embankment Crest	$24.3M	This includes filters, rip rap and bulk fill borrowed from the Stage 1 spoil.
2. Raise the existing Spillway Bridges	$4.7M	This assumes modification to the piers, abutments, concrete works, reinforcement, bearings, deck and roadway.
3 Raise radial gates and modify the concrete crest	$28.2M for the five bays	This assumes anchoring, reinforcement, provision of access, steel work, mechanical systems modifications, provision of access to the post tensioned anchors, post tensioning, gate modifications.
4. Raise the Saddle Dams	$2M	This assumes that the embankment dam remain as zones earthfill.
5. Raise the auxiliary spillway crest and the fuse plug embankments	$14.2M	This assumes that the training walls and raised, new ogee crest is constructed, fuse plug embankments are raised, divider walls are raised and post tensioned.
6. Raise the auxiliary spillway bridge	$2.5M	This includes strengthening the piers, additional anchoring, new headstocks, jacking the bridge beams and raising the abutments.
7. Somerset Dam Works	$2.5M	Modify power station and outlet works
8. Road and Bridge Works	$8.5M	Includes diversion of 14km of road and works to raise three small bridges.
9. Construction Supervision and Overheads (20%)	$15.7M	Contract Supervision and Constructors Overheads (does not include the road and bridge works away from the dam)
10. Design and Approvals (15%)	$11.8M	Concept Design, Approvals and Detailed Design (does not include the road and bridge works away from the dam)
11. Contingency (30%)	$23.5M	(does not include the road and bridge works away from the dam)
Total	**$138M**	

Note: Approximately $30M in savings is realised by the elimination of the Stage 2 works currently proposed

A breakdown of the costs estimates is provided at Appendix C.

5.4.5 Inundation Area

The inundation area for this option is presented in Appendix K. SEQWater owns land up to the EL75.0 contour due to the operation of the dam for flood mitigation. Currently large parcels of this land are leased out to adjacent landholders to provide land management. Impacts from the raised storage levels (not included in the cost estimate) would include:-

- Significant reduction of land available to lease holders.
- Loss of environmentally sensitive habitat (significant) including land at Mt Esk Pocket.
- Loss of recreation areas at Somerset Dam, O'Shea crossing, Captains Flat, Lumley Hill and Cormorant Bay.
- Loss of private recreation areas (Billie's Bay and Hay's Landing).
- Impacts on Somerset Dam outlet works and power station (costs incurred as the cone valves and power station would be inundated).
- Diversion of road required along the Wivenhoe Somerset Road (approximately 14km).
- Tarong Power Station off take would require modification.
- Minor reduction in the generating capacity at the Wivenhoe Pumped Storage Power Station.

5.5 Option W3 - Raise Wivenhoe FSL 8m (EL75.0)

This option involves raising the storage level by 8m to EL75.0. This would provide and additional 1,066,000ML of contingency storage, almost doubling the storage of Wivenhoe Dam. The proposed scope of work for this option would involve:-

- Increasing the Maximum Flood Level from EL80.0 to EL85.0 to maintain the flood mitigation benefits of the storage as well as supply the contingency storage.
- Existing Spillway
    - Removing the radial gates, raising the fixed crest to EL70 in reinforced and mass concrete and installing 6m high concrete fuse gates on the spillway crest.
    - Raising the service bridge and the bridge for the Brisbane Valley Highway across the existing spillway up to EL85.0.

  - Raising and strengthening the upstream training walls and rockfill bunds.

- Existing Dam Crest

  - Raising the crest of the dam by placing fill on the downstream face of the embankments to achieve a new crest level at EL87.5.

  - Reconstruct Cormorant Bay entrance.

- Raise both Saddle Dams to EL87.5

- Secondary Spillway

  - Reconstruct a new ogee crest upstream of the existing spillway crest to EL of 73.0 and raise the fuse plug embankments by 6m each to maintain the initiation levels.

  - Raising the bridge over the spillway by 5m.

  - Raise and post tension the divider walls.

- Raising the bridges for the Brisbane Valley Highway and the Wivenhoe – Somerset Road up to EL85.0.

Drawings of the works required for this option are presented in Appendix D.

5.5.1 *Spillway Capacity*

The spillway capacity is required to be adequate to allow the dam to safely pass the 2003 estimate of the Probable Maximum Flood (PMF). Spillway layout and capacity are discussed in the following sections.

Radial Gated Service Spillway

It is not feasible to alter the radial gates in the existing spillway to cater for such a large raising of the FSL. The most cost effective alternative would be to abandon the existing spillway radial gates and utilise concrete fuse gates on the raised crest to provide the required spillway capacity. This does not provide as much control over flood events but would still provide significant protection to the downstream areas for the full range of flood events investigated.

The upstream training walls would need to be raised. This would be achieved through the use of anchor bars to join the raised concrete to the existing wall. The walls would then be post tensioned to cater for the increased load from the raised flood level.

Limited works would be required for the dissipator as the discharges from the spillway would be similar to the current design discharges.

The maximum design discharge from the existing spillway would be reduced to around 7,700m^3/s.

Constraints

A major constraint for this option again would be the opportunity to work in only one bay at a time for the duration of the works.

The spillway works would need to be programmed after raising the embankment to avoid increasing the risk of failure during an extreme flood event.

Secondary Fuse Plug Spillway

The Stage 1 works constructed for the Flood Security Upgrade of Wivenhoe in 2004 consisted of a three bay, 164m wide fuse plug spillway located at the right abutment of the dam. The first fuse plug embankment trigger level was set at EL75.7 (nominally the 1 in 5,000 AEP flood event) to protect the flood mitigation benefits of the storage and minimise the cost of the upgrade.

To preserve the flood mitigation benefits of Wivenhoe Dam, it has been assumed that the secondary spillway would have the crest level raised to EL73.0 by building a much larger crest structure upstream of the existing spillway. The fuse plug embankment downstream of the new crest would need to be raised to EL81.7 for the first trigger level. This equates to approximately the 1 in 5,000 AEP event. The new MFL for this spillway configuration would be EL87.0.

Other works for the spillway would include:-

- raising of the spillway bridge by 6m.
- raising of the divider walls using post tensioning and reinforced concrete entrance walls.

Tertiary Fuse Plug Spillway

The proposed Stage 2 works would not be required as the existing spillways as modified would provide full PMF capacity.

5.5.2 Existing Embankments

The new adopted flood level of EL87.0 would require all of the embankments to be raised. Preliminary stability analysis has shown that raising the crest of the dam using downstream stabilising fill is the only viable option. Therefore it is proposed that the dam crest would be raised using placement of fill on the downstream face of the dam.

Main Embankments

The proposed construction sequence would involve:-

- Diversion of the Brisbane Valley Highway off the existing crest.
- Stripping and stockpiling the downstream rip rap facing on the embankment.
- Extending the filter blanket on the downstream side of the core and providing an equivalent drainage system under the new downstream material.
- Placement of sandstone fill borrowed from adjacent land (potentially the spoil material from the Stage 1 works)
- Exposure of the clay core and downstream filters once the embankment has reached the height of the existing crest.
- Raising the height of the clay core and the filters to the new embankment height as the final 8m of raised embankment is constructed.
- Reinstating the road pavements and the upstream wave wall.

Saddle Dams

Saddle Dam 1 and 2 are zoned earthfill embankments constructed in saddles on the left abutment area of the dam. Currently these embankments do not store water at the FSL of EL67.0. Raising the FSL to EL75 .0 would result in up to 6m of permanent storage against these embankments.

Given this permanent storage it is considered necessary to install filters within the embankment to minimise the risk of piping. Therefore the raising of the Saddle Dams to EL87.5 would include:-

- Stripping material from the downstream face and toe area.
- Placement of a two stage blanket filter across the embankment footprint downstream of the clay fill core.
- Raising the embankment in locally borrowed earthfill and extending the filter up to the new embankment crest.
- Extending the upstream rip rap and filter to the new crest level.

Coominya Saddle

There is a low saddle 8km along the Brisbane Valley Highway, near the turn off to Coominya, travelling toward Esk from Wivenhoe Dam which has a natural surface level at EL85.0. For the proposed MFL there would need to be a low level embankment constructed (maximum height of 3m to prevent flood flows from leaving the storage basin and discharging into the Lockyer Valley. This embankment would consist of a homogenous earthfill embankment with 1 (v) to 2 (h) slopes and a 5m crest width.

5.5.3 Key Data for an 8 metre Raising

Item	Propose EL / Storage	Current EL / Storage
FSL	75m	67m
MFL	87.0m	80m
Dam Crest Level	87.5m	80m
Top of Radial Gate	76m (6m high Fuse Gates)	73m
Service Spillway Fixed Crest Level	70m	57m
Storage Vol FSL to Top of Gates	164GL	761GL
Secondary Spillway (fixed crest at EL73) - Fuse Plug 1 Initiation - Approx Initiation AEP - Storage Volume FSL to Initiation Level	 81.7m 1 in 5,000 1218GL	 75.7m 1 in 6,000 1182GL
Tertiary Spillway Stage 2 - Crest Length - Fuse Plug Initiation - Approx Initiation AEP	 NA NA NA	 100m 78.3 1 in 50,000

5.5.4 Costs

Item	Cost	Comment
1. Raise the Embankment Crest	$32.7M	This includes filters, rip rap and bulk fill borrowed from the Stage 1 spoil.
2. Raise the existing Spillway Bridges	$5.2M	This assumes modification to the piers, abutments, concrete works, reinforcement, bearings, deck and roadway.
3. Raise the spillway crest, training walls, remove gates and install fuse gates	$46.7M	This assumes anchoring, reinforcement, provision of access, steel work, provision of access to the post tensioned anchors, post tensioning, fuse gates
4. Raise the Saddle Dams	$3.2M	This assumes that the embankment dam remain as zones earthfill.
5. New Saddle Dam at Coominya	$0.9M	Zoned earthfill embankment
6. Raise the auxiliary spillway crest and the fuse plug embankments	$26.5M	This assumes that the training walls and raised, new ogee crest is constructed, fuse plug embankments are raised, divider walls are raised and post tensioned.
7. Raise the auxiliary spillway bridge	$5M	This includes strengthening the piers, additional anchoring, new headstocks, jacking the bridge beams and raising the abutments.
8. Upgrade Somerset Dam outlet works and power station	$15M	Works are required to upgrade the outlets as the FDC Valves and the power station would be 5m below the water surface. The modifications would include new valves and valve chambers.
9. Road and Bridge Works	$25M	Includes diversion of 40km of road and works to six bridges.
10. Construction Supervision and Overheads (20%)	$27M	Contract Supervision and Constructors Overheads (does not include the road and bridge works away from the dam)
11. Design and Approvals (15%)	$20.2M	Concept Design, Approvals and Detailed Design (does not include the road and bridge works away from the dam)
12. Contingency (30%)	$40.5M	(does not include the road and bridge works away from the dam)
Total	**$248M**	

Note: Approximately $30M in savings is realised by the elimination of the Stage 2 works currently proposed

5.5.5 Inundation Area

The inundation area for this option is presented in Appendix K. SEQWater owns land up the EL75.0 due to the operation of the dam for flood mitigation. Currently large parcels of this land are leased out to adjacent landholders to provide land management. Impacts from the raised storage levels would include (not included in costs):-

- Inundation of private land during any flood event. May require the resumption of land by Government (SEQWater does not have any ability to compulsorily acquire land) and major potential for community opposition.
- Loss of environmentally sensitive habitat (high significance) including land at Mt Esk Pocket.
- Loss of recreations areas at Somerset Dam, O'Shea crossing, Captains Flat, Lumley Hill and Cormorant Bay.
- Loss of private recreation areas (Billie's Bay and Hay's Landing).
- Upgrading of the Somerset Dam outlet works and power as raised level would flood both. New outlet works would be required and major structural modifications required for the power station.
- Diversion of the Wivenhoe - Somerset Road (approximately 40km) including bridge replacement.
- The Tarong Power Station off take would need to be raised.
- Relocation of residential houses in the Wivenhoe Storage area (three houses are built close to EL 75m.
- Minor reduction in the generating capacity of the Wivenhoe Pumped Storage Power Station.

Flood Impacts

Relatively frequent flood events would impact on key infrastructure including:-

- Land holder residences (up to 50 houses would be impacted).
- The Wivenhoe Pumped Storage Power Station at Wivenhoe owned by Tarong. Additional work would be required to reduce flood risk (the floor level of the generator room is at EL 78m).
- The Brisbane Valley Highway would be cut at several locations for longer durations during flood events.

6. Somerset Dam General Information

6.1 Background

Somerset Dam is a 47m high concrete gravity dam on the Stanley River upstream of Wivenhoe Dam. It is a dual purpose dam providing water supply to Brisbane and adjacent Local Authorities and flood mitigation benefits for the Brisbane and Ipswich areas. A general arrangement of the dam is shown at Figure 2. A dam data sheet is provided at Appendix G.

Water is released as required from Somerset Dam to supplement Wivenhoe Dam which in turn supplements the natural flow of the Brisbane River and maintains an adequate supply of water to the Mt Crosby pumping station, 132 kilometres downstream from Somerset Dam.

The plans of the dam are in imperial units. The level conversion that applies to these plans is:

$$\text{AHD (m)} = \text{EL(ft)} \times 0.3048 - 0.124\text{m}$$

6.2 Concrete Dam and Spillway

6.2.1 General

The 47m high concrete gravity dam has a central gated overflow spillway, controlled by 8 radial gates and 8 low level sluice gates. Full Supply Level (FSL) is at EL99.00, some 1.45 m below the spillway fixed crest and the gates are used only for flood control purposes. There are 4 low-level outlets through the abutment units and a pipeline leading to the power station downstream of the dam on the right hand side abutment. Water is released as required from Somerset Dam to supplement Wivenhoe Dam.

There are 7 mass concrete abutment units on each side of the central spillway structure supporting a road bridge at EL112.34. The abutment units are constructed with an open overflow section below the bridge at EL107.46. Flood flows passing through these openings flow down the back face of the dam and impact on an unprotected rock foundation, before flowing laterally towards the central spillway channel.

The concrete dam is a conventional mass concrete construction with upstream slopes of 0.05H:1V and downstream slopes of 0.7H:1V in the central overflow section and 0.75H:1V in the abutment units. There is an abrupt “change of slope” above FSL in the abutment units that provides a constant width of nominally 4.3 m in the top section. This “change of slope” discontinuity provides a critical section for dam stability due to the applied flood loads (indicated by the results of previous stability assessments).

6.2.2 Galleries

There are a number of galleries within the dam and there is some inconsistency in nomenclature in the surveillance data. The following terminology is used throughout this Report:

- The Foundation Gallery is located at EL60 and is normally half full of water;
- The Lower Gallery is located at EL66.0;
- The Upper Gallery is located at EL88.9;
- Gate Inspection Chambers for the sluice gates are located within the central portion of the dam near the level of the Upper Gallery.

Concrete cracking has occurred at the Upper Gallery providing the second critical section for dam stability. The cracking has the potential to induce full hydrostatic loads within the dam section impacting on stability. There is considerable horizontal cracking exposed in the gallery walls, presumably from temperature and shrinkage effects. The main cracks are located on the downstream side of the gallery wall, one about 0.4 m above floor level and the other 1.6 m to 1.8 m above floor level. The latter crack extends for most of the length of the gallery and appears to be at the same level as a construction joint in the downstream face of the dam. Cracks can also be seen extending to the downstream face in the two access adits at each end of the dam.

Horizontal hairline cracking can also be seen in the upstream gallery wall and in the stairways to the lower gallery. In one spillway monolith the crack emerges in the upstream face of the gate shaft and there has been long term leakage. There is no indication of leakage elsewhere in the Upper Gallery.

Investigation work by SMEC included horizontally drilled holes into the downstream gallery wall. There was some difficulty in following the cracks with horizontal holes as the cracks deviated around 50 mm along the drilled length. The surface of the cracks was irregular and rough. Drilling water returned along the crack for 0.5m either side of the borehole collar.

The drilling showed the cracks were open for at least 1 to 2 m from the downstream face of the gallery. At some distance from the gallery, they reduce to hairline cracks that appear to extend to the downstream face, as seen in the access adits.

A number of consultants have reviewed the stability of Somerset Dam. Both Commerce (2005) and GHD (2000) assumed that a crack exists across the full width and length of the monolith blocks and if the dam was subjected to unprecedented water levels, the upstream cracks could develop significant uplift pressures. SKM (2000) took the view that continuous cracking was a conservative assumption but accepted it for stability analyses.

It is not known whether cracking exists above or below the gallery. Cracks that emerge in the gallery walls will be drained by the gallery and are not necessarily a significant stability problem. If similar cracks exist above or below the gallery, these become a plane of weakness with uplift relieved only by the internal drains. Russo (1996) mentions cracking has been observed at EL95.3 and EL97.2.

Cracks have also been observed in the central pier area between the gate units L and M. Inspections and investigatory drilling, SMEC (2004), concluded that these cracks were due to thermal effects and were not significant in terms of adequacy of the dam.

6.3 Staged Construction

The construction of the township and dam began in 1935, but, work was suspended in 1942 due to the war. Work resumed on the construction of the dam in 1948. In 1953, the last structural concrete was placed and the hydro-electric power station on the right abutment of the dam was commissioned.

6.4 Foundation

Recent geological investigation studies (SMEC 2004) recorded the foundations to be generally slightly weathered and assessed visually to be of very high strength and high durability, showing no signs of significant degradation or weathering upon exposure. The dam was excavated into high strength, tight rock and while erosion of near surface materials below the dam could be expected under low to medium flows, the rock mass was tight at depth and was judged to have a high resistance to erosion.

6.5 Spillway Gates and Hoists

6.5.1 General

The dam has twenty-one controlled outlets, eight of which are radial gates (sector gates) installed on the top of the spillway. The remaining thirteen are conduits or sluice-ways through the bottom of the dam wall. One of the conduits supplies a small power station, four connect to fixed cone dispersion valves and the eight sluice-ways constitute the main outlet regulating capacity.

6.5.2 Radial (Sector) Gates

The eight radial gates are each 7m high by 8m long (23ft high by 26ft long), and are installed above full supply level and therefore can only be used to delay the passing of a flood peak that exceeds full supply level. While they do not normally come into operation during minor floods, they have been considered in this study because they could be employed in a major flood event. The gates are counterbalanced so that the hoist does not have to lift the full weight of the gate.

6.5.3 Sluice Gates

The eight main sluice gates are each 3.7m high by 2.4m wide (12ft by 8ft). The gates are not counterbalanced, and are hoisted by two ropes, each rope being reeved into a four-part system. The sluice tunnels are protected by similar roller gates which are 2.7m high and 2.7m wide (9ft by 9ft) with hoists essentially identical to the main sluice gate hoists, the differences relating to the rope drums.

6.5.4 Radial Gate Winches

Each winch unit comprises a six-pole electric motor close-coupled to a worm reduction gear set. The output of the worm reduction passes through three sets of spur gears, the last spur gear being bolted to the rope drum. The rope is attached directly to the centre of the gate without any intermediate pulleys, while the counterweight is attached to both ends of the gate. An electric thrustor brake operates on the motor-coupling drum. A parking brake is operated by a hand wheel applying a band brake to a drum mounted on the last spur gear drive shaft. To improve level of control and safety, the bank brakes of the drums could be spring applied with actuator and/or manual release when the hoist is operational. This is less significant for the sector gates than the sluice gates, but could be significant if a severe event failure involved loss of a counterweight. There is a connection point on the winch for attachment of a petrol engine to provide emergency power if the electrical system fails.

6.5.5 Sluice Gate Winches

Each winch unit comprises a six-pole electric motor close-coupled to a worm reduction gear set. The output of the worm reduction passes through two sets of spur gears, the last spur gear being bolted to the rope drum. The rope drum is a double drum with two ropes attached. Each rope is reeved through pulleys to create a four-fall rope system connected to an equalising beam on the top of the gate. An electric thrustor brake operates on the motor to worm pinion coupling. A band brake is hand wheel applied to a drum bolted to the rope drum for added security. If there was a component failure within the hoist during operation, the thrustor brake would be ineffective. Higher than desirable gate closure rate could result, depending on the failure point in the drive. To increase safety the band brakes of the drums could be spring applied with actuator and/or manual release when the hoist is operational. There is a connection point on the hoist unit for attachment of a petrol engine to provide emergency power if the electrical system fails.

6.5.6 Brakes

In both hoists the power operated brakes are mounted at the high-speed, low torque end of the drive train. This is often done to minimise the size of the brake. In the case of gate hoists it is not necessarily the best location. If a component in the drive train fails then the gate is liable to drop uncontrolled, unless an operator is immediately available to operate the emergency brake. Alternatively, if the brake tends to drag it can apply sufficient torque to prevent the hoist operating. Both situations are undesirable, with the latter bearing more on the risk of a gate not opening when required to assist in flood releases. Modern practice is to have the main brake as close to the final drive as is practicable, on or close to the rope drum. In the case of both the sector and sluice gate winches this is where the manual emergency brake is located.

6.6 Geology

6.6.1 General

The following assessment of geological conditions at Somerset Dam has been taken from SMEC (2004).

6.6.2 Topography

The dam is oriented northwest-southeast across the Stanley River in a valley section that flows south-west. Natural valley slopes average 25 degrees. The valley sides are wooded with frequent rock outcrops.

6.6.3 Geology

Available Information

The geology of the damsite, as indicated by the regional maps, a map of the immediate area by C.W. Ball and comments included in the SKM and SEQWater reports consists of volcanic and igneous rocks of Triassic Age. These rocks include fine-grained andesite lavas that were intruded by medium to coarse-grained diorite and granite with a later intrusion of fine-grained felsite dykes.

Ball's map indicates a complex distribution of these rock types - presumably exposed during the excavation of the dam foundation in the 1930s and now obscured by the dam structure.

Information on site investigations before construction is restricted to several cross sections with logs of test holes and shafts which identify the depth to "jointed rock" and "hard rock". No rock names are included.

The description of excavation conditions during construction are limited to comments included in the SKM and SEQWater reports that describe the removal of jointed rock and the control of excavation by the presence of joints.

Several joint sets were identified. There is no mention of the presence of low strength rock substance.

Investigations during 1999-2000 and reported in the SEQWater report included the drilling of several holes through the dam into the foundations for the installation of piezometers. The foundation core recovered from these holes was extremely high strength andesite.

Observations During Site Visit by SMEC 2004

"Rock is extensively exposed on the sides of the Stanley River and several outcrops were observed in the riverbed downstream of the dam. In the immediate area of the dam, near the downstream toe, the cliff line formed by the foundation excavation is distinct on the left bank and partly obscured by landscaping on the right bank. Both areas have large outcrops of rock. See photographs 3.1 to 3.3 show rock outcrops on the abutments in SMEC (2004).

The rock substances observed in the outcrops are fine-grained andesite and medium grained diorite. Both rock types are assessed to have a very high strength. The contacts between the two rock types are intrusive with no apparent loss of strength near the contact observed. No felsite dykes were observed during the site visit.

The dominant feature of the rock outcrops near the dam, which is also apparent in other outcrops on the valley sides and riverbed, is the presence of well developed jointing. These joints appear to be concentrated in three sets - one near vertical set striking approximately north-south, another near vertical set striking east-west and a third set dipping at about 10 degrees to the west-south-west into the right abutment.

Initial observation indicates that the vertical joints are smooth, often tight with a spacing that ranges from about 0.5m to about 3m. Observed joint continuity is less than 10m on the right bank but the cliff on the left bank appears to be controlled by a near vertical joint that is about 50m long. The low angle joints are irregular and rough with an apparent continuity on some surfaces of at least 20m" (SMEC 2004).

6.6.4 Engineering Geological Assessment

The data on site conditions before and during construction is limited but is supported by the observations made during the site visit. The dam is apparently underlain by a rock mass composed of several volcanic and igneous rock types. All contacts between these rock types are intrusive and therefore should not represent areas of rock mass weakness. The rock substance strength in all rock types is very high.

The feature that governs the engineering properties of the rock mass in the foundations is the rock mass defects and in particular the jointing. The control of excavation by jointing is mentioned in the construction reports and is obvious in outcrops near the downstream toe.

As is common, near the natural ground surface there is some opening of the joint surfaces due to stress relief and weathering. The foundation excavation during dam construction appears to have been taken below these open joints. This is indicated by the downstream exposures and the core recovered from the recent drilling.

The concerns raised about foundation conditions has speculated that the rock downstream of the dam toe in the non-overflow sections may be eroded to the extent that the stability of the dam structure may be affected.

Features that are relevant include:

- the very high substance strength of the rock;
- the presence of a topographic high of significant height downstream (about 10m high on the left bank);
- the characteristics of the joints in the area - location, orientation, spacing, continuity, surface shape, surface condition, opening, infilling; and
- the level of the existing excavation - apparently below the level of open joints.

It appears unlikely that the rock substance could be eroded by flood overflow water from the reservoir. High velocity water flow could attack the joints and remove detached blocks. The amount of material that could be displaced would depend on the duration of any overflow and the characteristics of the rock mass defects - the joints.

Based on the available information a preliminary assessment is that flood overtopping could remove some material from the rock outcrops near the downstream toe but the extent of this material removal is unlikely to extend into the dam foundation.

This assessment could be confirmed by a limited amount of additional site investigation.

6.7 Seismology

Refer to Section 4.13.

7. Raising Options for Somerset Dam

Currently the storage at Somerset Dam has a FSL at EL99 and a storage volume of approximately 380,000ML. To provide input into the provision of contingency storage in Somerset Dam three different raising levels were selected:-

- Raise FSL by 2 m to EL101.0. This option provides a significant increase in storage of 92,000ML above the current storage of 380,000ML for a relatively small capital cost (i.e. compared to a greenfield site development) and could be achieved relatively simply.

- Raise FSL by 4 m to EL103.0. This option provides a mid point for the cost curve. Upstream impacts start to become a key issue for this option. This raising would provide an additional storage capacity of 202,000ML.

- Raise FSL by 6 m to EL105.0. This option, selected to provide an upper limit to the raising options, provides an additional 332,000ML (effectively doubling the storage volume of Somerset). At this level, houses upstream of the dam are inundated and would require relocation and Kilcoy is isolated without extensive road works.

SMEC were engaged to investigate the works required to raise the FSL to the above levels. Their report is presented in Appendix J.

7.1 Scope of Works

The proposed scope of works required for all options would include:-

- Modifying the radial gates and hoist to allow them to be removed from the flow for the PMF. This work is required even without raising the storage.

- Provision of side seals, bottom seals, side guide rollers, roller paths for the radial gates to allow them to be used to retain water.

- Post tensioning of the dam for the flood load cases.

- Upgrading of the spillway dissipator.

There would be a nominal increase in MFL for the 2m raising. The 4m and 6m raisings would increase the MFL by 1.5m and 2.5m to EL113.5m and EL 114.5m respectively

The 4m and 6m raisings would also include:-

- Road diversion and bridge upgrades for the Daguilar Highway at Mary Smokes Creek

- Relocation of picnic facilities and public recreation areas.

- Relocation of the water supply intake and treatment plant for Kilcoy.

The 6m raising would require relocation of low lying houses in Kilcoy

7.1 Spillway Capacity

Increasing the FSL would negatively impact on the MFL and the flood discharge capacity of Somerset Dam. The spillway consists of 8 sluice gates, 4 regulators and eight overflow spillway bays with sector gates (not used to control flow). There is also the potential for the concrete abutments to be overtopped once the storage level exceeds EL107.46. Extensive works are required to strengthen the existing spillway to cater for the PMF. Refer to the SMEC report.

7.2 Key Data for the Raisings

Item	Current Storage	FSL Raised 2m	FSL Raised 4m	FSL Raised 6m
FSL (EL m)	99	101	103	105
MFL (EL m)	112	Approx 112	Approx 113.5	Approx 114.5
Dam Deck Level (EL m)	112.34	112.34	113.0	114.0
Top of Non Overflow Crest (abutments) (EL m)	107.46	107.46	107.46	107.46
Top of Sector Gates (EL m)	107.46	107.46	107.46	107.46
Service Spillway Fixed Crest Level (EL m)	100.46	100.46	100.46	100.46
Storage Vol FSL to Top of Gates	520GL	428GL	318GL	188GL

7.3 Estimated Costs

The estimated cost of physically raising the FSL of Somerset Dam for all options is $55M. Refer to the SMEC report for a break down of the costs.

For the 4m and 6m raisings additional costs of $15M and $30m respectively will be required for the highway diversion, relocation of recreation facilities and relocation of property at Kilcoy.

For the 6m raising additional costs will include the purchase and relocation of low lying houses at Kilcoy and surrounding areas. An allowance of $50M has been estimated but has not been included in the direct costs.

7.4 Inundation Area

The areas of inundation are presented in Appendix K. Impacts from all raisings of the storage level include:-

- Loss of environmentally sensitive habitat. While the loss is of generally minor significance it becomes major for the 6m increase in FSL.
- Some loss of picnic areas and recreational facilities at the Spit and Kirkleigh.

The 4m increase in FSL causes inundation of the Daguilar Highway at Mary Smokes Creek resulting in the need to relocate the Highway and the 6m increase extends the inundation into Kilcoy.

The 6m increase also inundates low lying houses in Kilcoy

7.5 Flood Impacts

- All options to raise the dam will cause more frequent inundation of private land during flood events with potential for community opposition.
- Kilcoy, which is impacted when water levels reach EL102.5m, will be flooded more frequently. For the 2m and 4m increases in FSL the AEP of flooding Kilcoy will be 1:20 and 1:5 respectively. If the dam is raised 8m Kilcoy will be impacted by any flood event.
- For all increases there is a loss of flood storage volume and an increase in the discharges to Wivenhoe Dam. For the 2m increase the impacts are minor. However, the loss of storage is significant for the 4m and 6m increases with a resulting moderate impact on the performance of the Wivenhoe /Somerset system.
- More frequent disruption to the major roads surrounding Kilcoy including the Daguilar Highway. The impacts are progressively more severe as the raising level is increased.

8. Discussion

Seven options for the provision of contingency storage in Wivenhoe and Somerset Dams have been investigated by SEQWater for the South East Queensland Water Supply Strategy. These options are presented in Table 8-1.

Table 8-1 - Summary of Raising Options

Option	Raising (m)	Raised FSL (m)	Increase in Storage Capacity (ML)	Estimated Cost ($m)
Wivenhoe Raising Options				
W1	2	69	228,000	63
W1A (Operational change)	2	69	228,000	5 to 10
W2	4	71	481,000	138
W3	8	75	1,066,000	248
Somerset Raising Options				
S1	2	101	92,000	55
S2	4	103	202,000	70
S3	6	105	332,000	85

It can be seen from the table that the most attractive option for the provision of contingency storage would be a 2m raising of Wivenhoe Dam as an operational change eliminating the need for expensive capital works. Intuitively, Wivenhoe would be the most logical option for contingency given the size of the catchment and the corresponding probability of capturing the additional contingency storage.

The provision of a significant volume of contingency storage in Somerset will be difficult due to the upstream flooding issues associated with Kilcoy and land owners.

8.1 Flood Security Costs

Neither Wivenhoe nor Somerset currently satisfies the State's Guidelines on Acceptable Flood Capacity (2005). Given the assumptions for this study that the dams will be required to pass the current estimate of the PMF, a substantial portion of the costs to raise the FSL is tied up in the works to increase flood security. It is arguable as to whether these costs should be included for the provision of contingency storage as SEQWater is likely to incur these costs even if the storage is not raised. An attempt has been made to separate out the additional costs associated with the provision of additional storage from the likely costs required to upgrade the current dams. These are presented in Table 8-2.

Table 8-2 – Flood Security Costs

Wivenhoe Raising Options				
Option	**Increase in Storage Capacity (ML)**	**Raising of FSL Direct Costs ($m)**	**Flood Security Direct Costs ($m)**	**Total Estimated Cost ($m)***
W1	228,000	13	40	63
W1A (Operational change)	228,000	NA	5 to 10	5 to 10
W2	481,000	64	40	138
W3	1,066,000	151	40	248
Somerset Raising Options				
S1	92,000	1.5	24	55
S2	202,000	1.5	24	70
S3	332,000	1.5	24	85

Note:

1. **The total costs include contingencies, design and construction supervision not included in the direct costs**
2. **The Wivenhoe flood security costs comprise the current estimated costs of the Stage 2 works. This work is required to be undertaken by SEQWater by 2035.**
3. **The works to raise the FSL at Somerset include gate seals, upgrading the crest, and upgrades to the controls. This work is constant for the three options as up to 6m additional storage could be held against the sector gates after upgrading.**
4. **The MFL for the Somerset Raising Options is similar for all three cases. Therefore, the post tensioning and downstream strengthening work are of a similar order of cost (at this level of assessment).**

It can be seen that the incremental costs associated with the small increase in the FSL are much less than the costs required to upgrade the dam to full PMF Capacity.

8.2 Potential benefits.

There has not been as yet, any attempt made to assess the likely benefits of any of the options by for example, assessing the frequency and volumes of storage likely to be held above the existing FSL's at either or both of the dams. Additional water in storage, available only at intervals, could provide an improvement in levels of service but this would need to be quantified before proceeding further with any of the high cost options.

8.3 Flood operational procedures.

The down stream flood impact results presented for the Wivenhoe W1B option are based on minor variations to the operational procedures defined in the existing approved Flood Operations Manual. Whether the impacts and these variations are acceptable will need to be agreed with the regulator and downstream stakeholders.

SunWater, consultants for this work, have reported that other variations to the operational procedures warrant consideration based on this recent work.

8.4 Wivenhoe Raisings.

- Options W1, W2 and W3 each involve complex work in the spillway which could only proceed one bay at a time and probably only in the dry season months.

- The cost of such complex work with very difficult access is difficult to estimate with reasonable certainty.

- Options W2 and W3 involve raising the embankments and therefore an at least temporary relocation of the Brisbane Valley Highway. Less significant disruption would be caused to the Wivenhoe Somerset Road. The cost of these disruptions has not been estimated.

- For Option W1A, the increase in downstream flooding appear to be relatively minor but its acceptability would be dependent on consultation with stakeholders. A raising of at least Kholo Bridge and possibly of Burtons Bridge and Savages Crossing could be required to deal with possible concerns.

- For Option W1A, the existing fuse plug will be triggered somewhat more frequently (existing 1:5,000 AEP flood). The frequency and consequences will need to be examined.

8.5 Somerset Raisings

- Each of the options assumes that the dams existing flood mitigation performance does not need to be maintained. Possible impacts have not been examined.

- The gates and hoist equipment at Somerset Dam are of considerable age. There is some uncertainty whether it can be adapted as proposed.

- Cracking in a number of the dam monoliths and other stability concerns could be addressed concurrently with the raising proposals.

- Community opposition to the higher raising proposals is likely to be very strong.

- Highway dislocation costs have not been estimated.

9. Recommendations

It is recommended that:-

- The provision of contingency storage in Wivenhoe Dam is investigated further. A 2m raising in the FSL could be achieved with minimal capital costs subject to addressing regulator and stakeholder issues.

- A detailed assessment is carried out to develop and asses changes to the flood manual to allow the storage of the additional 2m in Wivenhoe. The impact of the changes should be assessed for the full range of Annual Exceedance Probabilities and Storm durations. This assessment should also link with the Brisbane River Flood Damages Assessment currently being carried out by Brisbane City Council.

- A detailed review of the structural adequacy of the various components of the dam is carried out to confirm the assumptions of this report. This review will provide more design detail to refine the cost estimates and confirm the feasibility of the proposed increase in storage level.

- A program of consultation with the downstream stakeholders is carried out with the proposed changes to the flood manual once the assessment of flood events is completed.

- Raising of the FSL level of Somerset Dam be discounted due to the impacts on the upstream population during flood events. Major flood events will already result in inundation of the Kilcoy and surrounding private properties and infrastructure.

- SEQWater be provided with the opportunity to instigate a public consultation process prior to the public release of options to raise the storage levels of Wivenhoe.

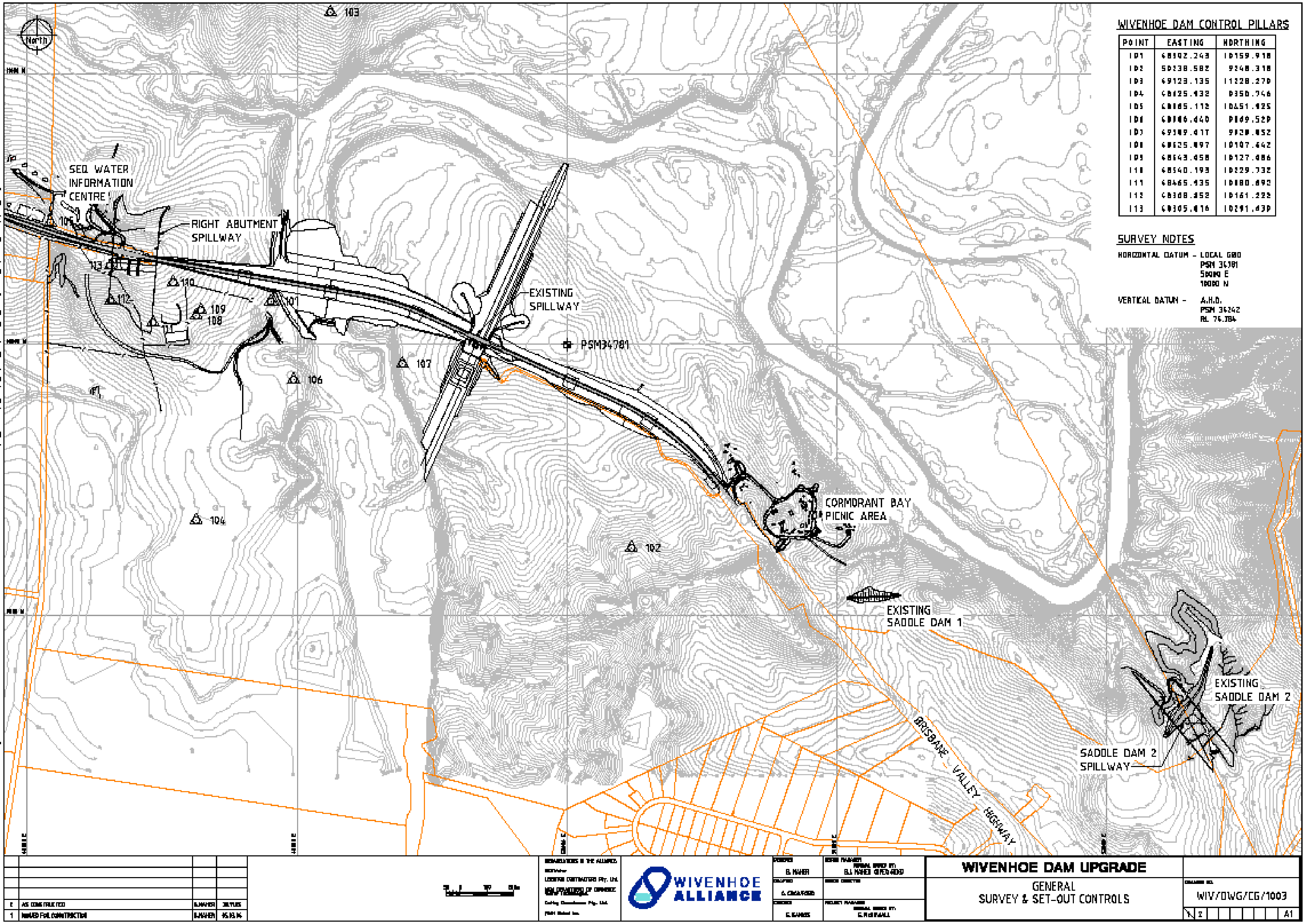
10. References

ANCOLD, 2000A	Guidelines on Selection of Acceptable Flood Capacity for Dams; prepared by the Australian National Committee on Large Dams, March 2000
ANCOLD, 2000B	Guidelines on the Assessment of the Consequences of Dam Failure; prepared by the Australian National Committee on Large Dams, May 2000
Commerce, 2003	Somerset Dam Annual Inspection Report, prepared by Department of Commerce, 9 December 2003
Commerce, 2004	Somerset & North Pine Dam, Dam Safety Review; prepared by Department of Commerce, December 2004
Commerce, 2005	Somerset Dam, Stability of Abutment Monoliths; prepared by Department of Commerce, May 2005
GHD, 1995	Safety Review of Somerset Dam, prepared by GHD Pty Ltd, September 1995.
GHD, 2000	Safety Review of Somerset Dam, prepared by GHD Pty Ltd, September 2000. This Report is based on GHD, 1995 but includes geotechnical work completed in following years upgrades the Report to take into account the comments made at Russo (1996).
GHD, 2002	Somerset Dam Annual Inspection Report, prepared by GHD for inspection on 4 September 2002
GHD, 2004	Somerset Dam Annual Inspection Report, prepared by GHD, 28 October 2004
NRW, 2005	Draft Guidelines on Acceptable Flood Capacity for Dams, October 2005
RMIT, 1995	Review of Seismicity, Somerset Dam and North Pine Dam; prepared by the Seismology Research centre at RMIT University, March 1995.
Russo, 1996	1996 GHD Somerset Dam Safety Review, Comments by R. Russo, prepared by R. Russo, August 1996
SEQWater, 2005	The Dam Safety Management Program for Wivenhoe, Somerset, North Pine Dams; prepared by SEQWater, March 2005

SKM, 2000	Preliminary Risk Assessment for Wivenhoe, Somerset and North Pine Dams; prepared by Sinclair Knight Merz in conjunction with Hydro Consulting, Hydro Electric Corporation, 2004
SMEC, 2004	Somerset Dam – Detailed Risk Assessment Stage 2; prepared by SMEC Australia Pty Ltd, March 2004
WA, 2004A	Somerset Dam – Maximum Flood Level Estimates for Various Gate Operation Scenarios; prepared by Wivenhoe Alliance, February 2004.
WA, 2004B	Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade; prepared by Wivenhoe Alliance 2004.
WA, 2004C	Wivenhoe Dam Spillway, Augmentation Works: Review and Updating of Risk Assessment, prepared by Wivenhoe Alliance 2004.
WA, 2005	Dam Failure Analysis of Wivenhoe Dam; prepared by Wivenhoe Alliance, Q1091, WIV-RP-HD-006, 2005

11. Figures

Figure 1 - Wivenhoe Dam General Arrangement



WIVENHOE DAM CONTROL PILLARS

POINT	EASTING	NORTHING
101	68592.243	10159.918
102	50238.582	9248.318
103	69123.135	11228.270
104	68125.432	8350.746
105	68185.112	10451.925
106	68186.440	9849.529
107	69189.417	9920.852
108	68625.897	10107.642
109	68643.458	10127.486
110	68540.193	10229.732
111	68465.435	10180.892
112	68308.852	10161.222
113	68305.816	10291.439

Figure 2 - Somerset Dam General Arrangement

Figure 3 - ANCOLD Total Societal Risk Assessment – from Wivenhoe Alliance, 2004

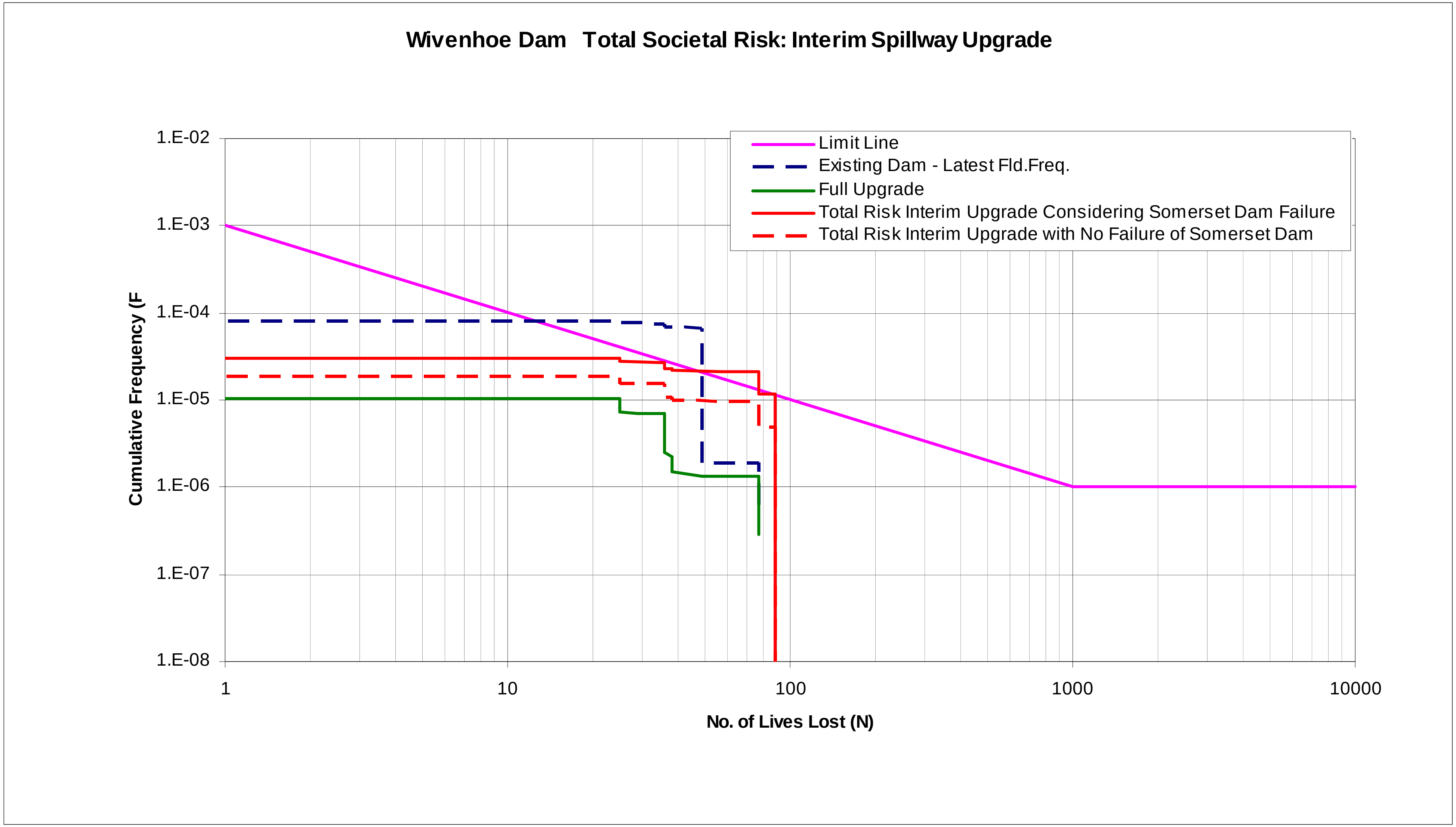
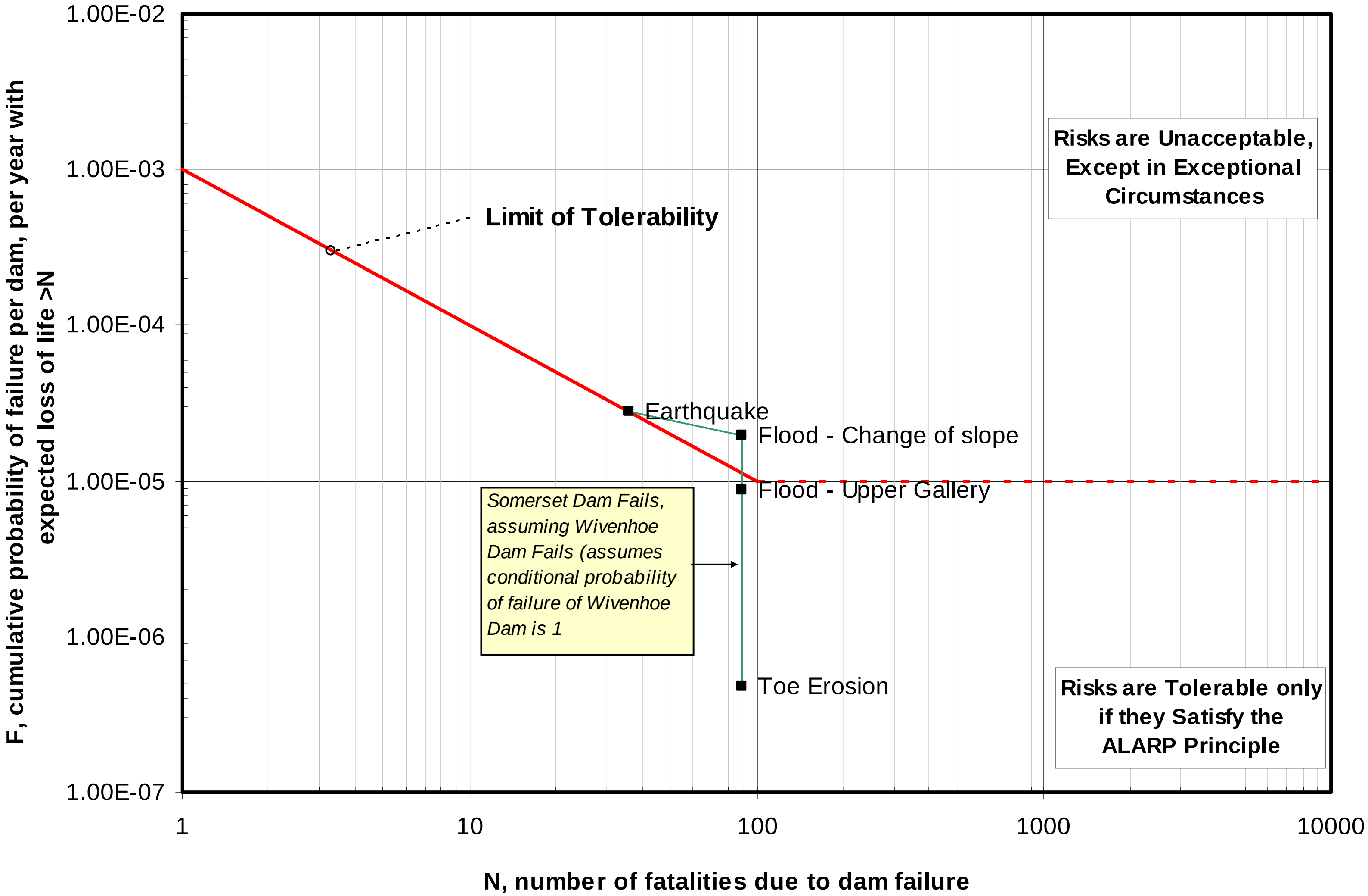


Figure 4 - ANCOLD Incremental Societal Risk Assessment – from Wivenhoe Alliance, 2004

Figure 5 - ANCOLD Societal Risk Assessment – from SMEC, 2004



Appendix 5.1 ANCOLD Societal Risk Guidelines: Existing Dams

Figure 6 - ANCOLD Total Societal Risk Assessment, – from Wivenhoe Alliance, 2004

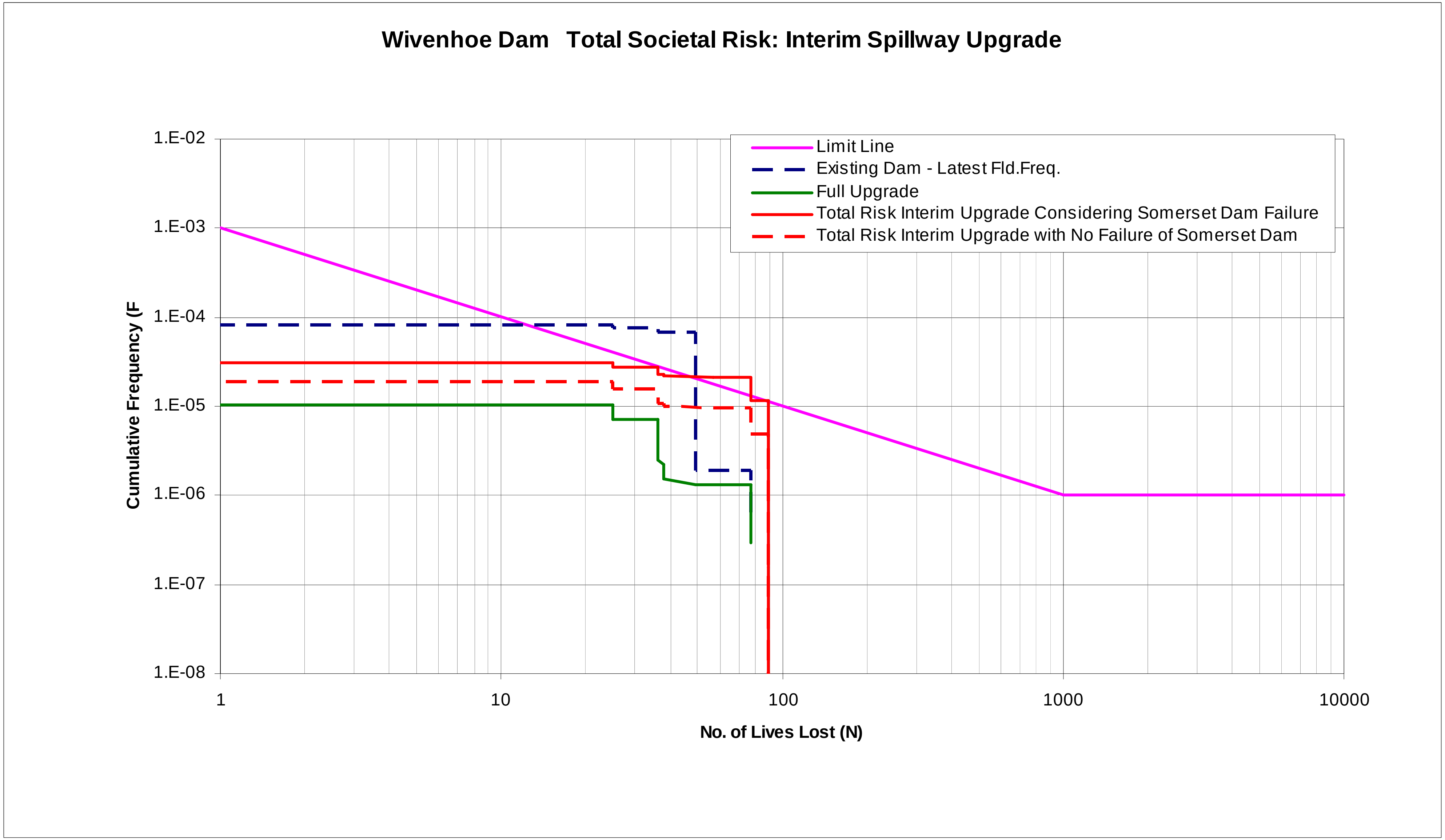
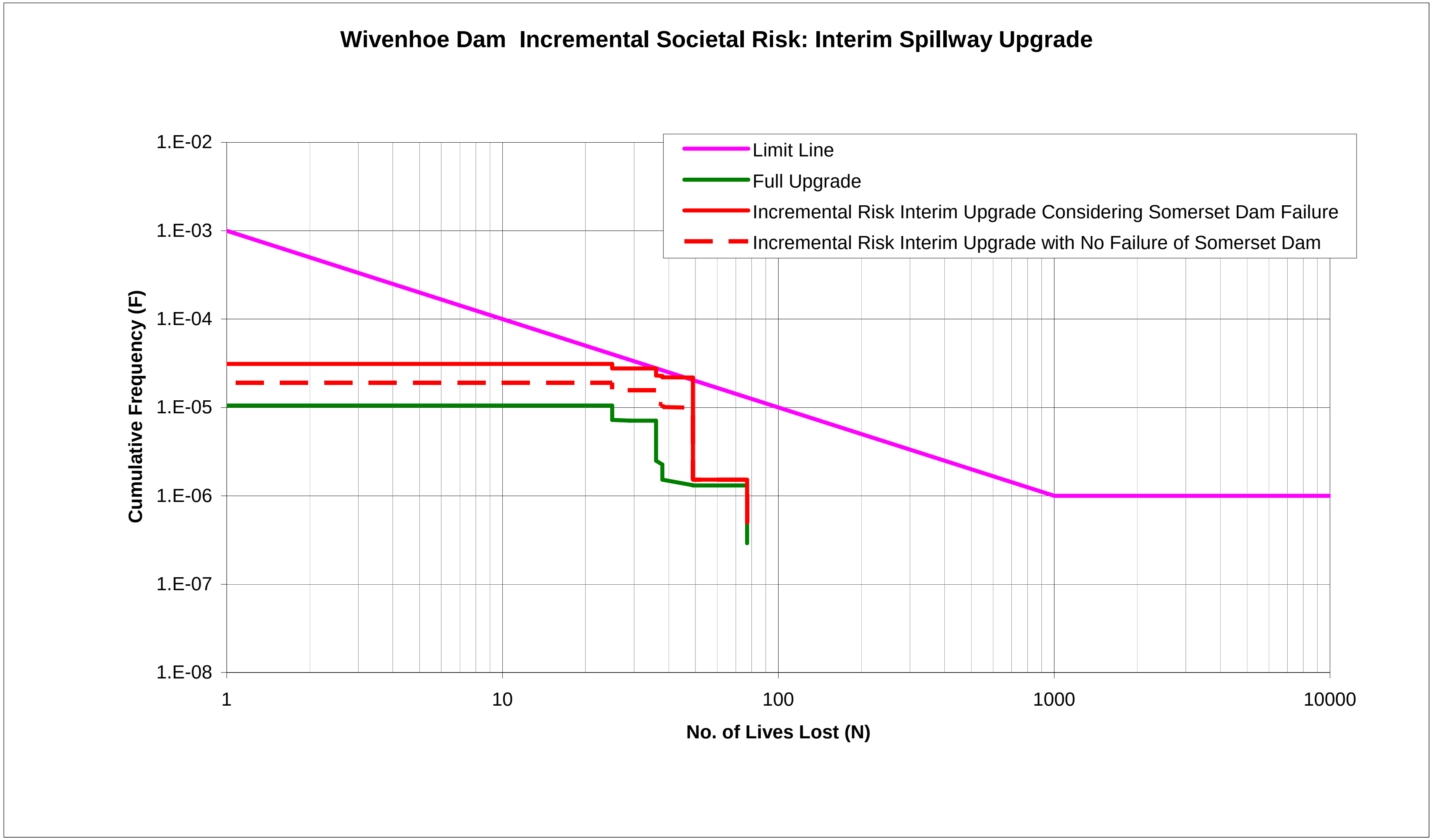


Figure 7 - ANCOLD Total Societal Risk Assessment, – from Wivenhoe Alliance, 2004



Appendix A. Wivenhoe Dam Description and Pertinent Data

Reservoir

Full Supply level (FSL)	EL67.0
Storage (at FSL)	1,150,000 ML
Reservoir Surface Area (at FSL)	10,820 ha

Dam

Type	Zoned earth and rockfill dam with a concrete gravity spillway section and two earthfill saddle dams.
Crest Level	EL79.15m excluding the wave wall

Main Dam

Type	Earth and rockfill dam
Crest Level	EL79.15
Wave Wall	EL79.7m (top of wall)
Dam length (including spillway section)	2260m
Dam height (maximum above downstream toe)	53m
Right embankment	Central core embankment
Left embankment	Sloping core embankment

Saddle Dam 1

Type	Earthfill embankment
Crest Level	EL80.0m
Crest width	4.0m
Upstream slope	3H:1V
Downstream slope	2.5H:1V
Embankment height (maximum)	11m
Embankment Length	160m

Saddle Dam 2

Type	Earthfill embankment.
Crest Level	EL80m
Crest width	4.0m
Upstream slope	3H:1V

Downstream slope	2.5H:1V
Embankment height (maximum)	6m
Embankment Length	225m

Outlet Works – Water Supply Intake

Variable level draw off facility	
Penstocks	2
Penstock diameters	1.9m & 3.6m

Outlet Works – Regulators

Number of regulators	2
Type and size of regulators	1.5 m diameter fixed cone dispersion valve 4.5MW power station owned by Stanwell Corporation
Level of centreline of regulators	EL31.5

Service Spillway

Type	Gated, concrete gravity section with flip bucket and flanking retaining walls.
Number of radial gates	5
Size of each gate	12.0m wide x 16.5m high
Top of gates when closed	EL73.0
Top of bridge deck	EL79.15
Spillway width (excluding piers)	60.0m
Unlined stilling basin invert	EL17.0
Peak water level as a result of PMF	Embankment overtopped
Imminent Failure Flood (IFF)	1 in 100,000 AEP event
Maximum flood level (IFF)	EL80.0
Peak discharge (IFF)	13,000m3/s

Secondary Spillway

Type	Ogee crest spillway with limited concrete lining controlled by fuse plug embankments
Number of Fuse Plug Embankments	3
Size of each Fuse Plug Embankment	Bay 1 (centre) 34m wide Bay 2 (LHS) 64m wide Bay 3 (RHS) 65m wide
Initiation Levels	Bay 1 (centre) EL75.7 Bay 2 (LHS) EL76.2 Bay 3 (RHS) EL76.7
Height of Ogee Crest	3m
Spillway width (excluding piers)	159m

Chute Floor Downstream	EL64.0
PMF Peak water level	Embankment overtopped
Imminent Failure Flood (IFF)	1 in 100,000 AEP event
Maximum flood level (IFF)	EL80
Peak discharge (IFF)	14,900m3/s

Appendix B. Wivenhoe Dam Risk Assessment, Failure Modes and Consequence Assessments

Risk Assessment Studies

A number of studies have been undertaken in recent years relating to various aspects of Wivenhoe and Somerset Dams. Somerset Dam is relevant in relation to the possibility of a cascade failure of the two dams. These include:

- A preliminary risk assessment of Wivenhoe, Somerset and North Pine Dams by SKM, reported at SKM (2000);
- A detailed risk assessment for Somerset Dam by SMEC;
- A review and updating of the Wivenhoe risk assessment report by the Wivenhoe Alliance, WA (2004C).
- Two short studies for Somerset Dam by Commerce, Commerce (2004 and 2005). These were based on a hydrology study by WRM Water and Environment, WRM (October 2004). It is understood that this Report has been revised and these revisions need to be incorporated in to the Commerce conclusions.

Failure Modes

Wivenhoe Dam, following the completion of the Stage 1 Upgrade works, is designed to handle a 1 in 100,000 flood event centred on the Wivenhoe catchment, assuming that Somerset Dam does not fail. A cascade failure would only result from a major flood event. Wivenhoe reservoir has sufficient capacity to store the normal Somerset storage without initiating the secondary spillway fuse plug.

The impact of a Somerset Dam failure on Wivenhoe Dam was detailed at Commerce (2004). The dominant risk associated with Somerset Dam is structural failure of the non-overflow units at the change in slope during a major flood event. Stability studies indicated, with some reservations over the cracking in the upper gallery, that the dam would satisfy normal stability criteria for the 1 in 100,000 AEP flood event centred on the Somerset catchment.

On this basis it is argued (Commerce, 2005), that any upgrade to Somerset Dam should attract the same degree of urgency as Stage 2 Wivenhoe works and should be examined at that time.

It is noted that there was a later revision of the hydrological studies, WRM (2005). The relevance of this update to the above comments is unclear.

Consequences of Failure for Wivenhoe Dam

Loss of Life Assessments

SKM (2000) provided loss of life estimates for both day and night failures of Wivenhoe Dam for a variety of load cases. SMEC (2004) has used the SKM data for total loss of life at night and adopted the following loss of life figures for the risk assessment:

- IFF Failure (Main Embankment) 89
- Earthquake 36
- Normal Operating Condition 77

Financial Loss Assessments

SKM (2000) has assessed the financial consequences associated with the failure of Wivenhoe Dam under three broad categories; third party damages, SEQWater direct damages and SEQWater loss of revenue. A major failure of Wivenhoe Dam was valued at $12B to $25B.

Environmental & Intangible Consequences

The SKM (2000) study included an assessment of environmental and intangible consequences. SKM assessed the incremental environmental consequences for Wivenhoe Dam as low while the incremental intangible consequences were assessed as high. It concluded that:

"These environmental and intangible consequences were far outweighed by the significant life loss and financial consequences for this portfolio. As such they did not play a significant role in the development of the risk reduction strategy."

Risk Analysis

The original risk analysis for Wivenhoe Dam was developed by SKM and is reported at SKM, 2000.

WA (2004C) reviews the risk to life presented by Wivenhoe Dam in both its existing state and after flood security upgrading works. It is an extension of the risk assessment undertaken by SKM (2000) and starts with a review of the earlier risk analysis of Wivenhoe Dam. It then considers the effect of the latest (2003) flood hydrology on the dam's risk profile.

The Wivenhoe Alliance further revised this work to incorporate the risks associated with a Somerset failure. The FN Charts for total loss of life are shown at Figure 3 and indicate that:

- The original Wivenhoe Dam plots well above the ANCOLD Limit Line;
- The Stage 1 Upgrade for Wivenhoe brings the risk below the ANCOLD Limit Line provided Somerset does not fail;
- If allowance is included for risks associated with a Somerset Dam Failure, the plot rises just above the Limit Line;
- The Stage 2 Upgrade brings the risk well below the Limit Line.

The total risk to Wivenhoe Dam as a stand-alone construction following the Stage 1 Upgrade works is assessed at $0.84*10^{-5}$. Introducing the risks associated with a Somerset failure increases these risks by a factor of 2,4 to $2.0*10^{-5}$.

The risk to life matrix (F-N Chart) using the incremental loss of life figures is reproduced at Figure 4. This shows the Wivenhoe risks plotting below the ANCOLD Limit Line.

The report recommended that due to its relatively simplistic nature and the way in which judgement was used (in conjunction with deterministic analysis) to estimate conditional probabilities, the risk analysis should not be used to determine the satisfaction of ANCOLD risk criteria in an absolute sense.

However, the risk analysis was useful in comparing the relative risk presented by various states of the dam (existing dam, fully and partially upgraded dam, various levels of radial gate upgrading). It further recommended that consideration be given to further, slightly more rigorous risk analysis. However, the decision for doing this analysis should not be made until the final option is determined and the dambreak studies completed and the consequences re-assessed.

Limitations of Risk Studies

The Wivenhoe Alliance study is a modification of the SKM study and as such is a Preliminary Risk Assessment. If the risk profile is a concern, a detailed risk analysis should be carried out, that includes a detailed assessment of the consequences, particularly loss of life. Previous consequence studies are dated and there has been considerable development in the Brisbane River study since the previous assessment.

Hazard Category

The Dam Safety Management Plan, SEQWater (2005) at Section 6.1 states "The Corporation's dams are classified under the ANCOLD classification guidelines as HIGH hazard because of the significant consequences of a dam failure".

The basis for this classification is outlined at GHD, 1997 and is based on:

- The significant development downstream in the Brisbane and Ipswich metropolitan areas, with the population at risk (PAR) numbering in the tens of thousands.

- The extensive residential and commercial development in the Brisbane along the river banks;

- The investment in infrastructure including key road and rail bridges.

The classification was based on an early version of ANCOLD, 2000B. The current Guideline has a more extensive classification system and it is recommended that the Hazard Classification be reviewed using the current Guideline.

It is anticipated that Wivenhoe Dam would be classified as Extreme Hazard.

Conclusions

The risk assessments for Wivenhoe Dam are Preliminary Assessments only. If the risk profile is a concern, a detailed risk analysis should be carried out, that includes a detailed assessment of the consequences, particular loss of life. Previous consequence studies are dated and there has been considerable development in the Brisbane River since the previous assessment.

Appendix C. Cost Estimates for Raising Wivenhoe Dam

Appendix D. Wivenhoe Dam Drawings

Appendix E. SunWater Assessment of Raised FSL (EL71) on Flood Operations

Appendix F. SunWater Assessment of Raised FSL (EL 69) on Flood Operations

Appendix G. Somerset Dam Pertinent Data

Reservoir

Full Supply level (FSL)	EL98.93
Storage (at FSL)	369,000 ML
Reservoir Surface Area (at FSL)	4,400 ha

Dam

Type	Concrete gravity dam
Crest Level	
bridge deck level	EL112.34m
non-overflow crest level	EL107.46m
spillway crest level	EL100.45m
Dam height (maximum)	58m
Embankment Length	308m

Outlet Works - Regulators

Number of regulators	4
Type and size of regulators	2.3 m diameter fixed cone dispersion valves
Level of centreline of regulators	EL69.97
Discharge capacity of each regulator with reservoir at FSL	79m3/s

Spillway

Type	Gated spillway with stilling basin and flanking retaining walls.
Number of radial gates	8
Size of each gate	7.9m wide x 7.0m high
Top of gates when closed	EL107.46

Sluice Gates

Type	Caterpillar type gates
Number of radial gates	8
Size of each gate	2.44m wide x 3.66m high
Invert level of sluice entrance	EL71.2

Stilling Basin

Concrete basin length	58.2m
Top of stilling basin training walls	EL73.02
Basin invert level	EL60.83

Baffle height	3.0m

Flood Flows

Peak water level as a result of PMF	
all gates open	EL110.4m
one gate out of service	EL110.7m
Maximum discharge as a result of PMF	
all gates open	8140 m3/s
one gate out of service	7950 m3/s

Power Station

Generating capacity	4MW

Appendix H.
Somerset Dam Risk Assessment, Failure Modes and Consequence Assessments

Risk Assessment Studies

A number of studies have been undertaken in recent years relating to various aspects of Somerset Dam. These include:

- A preliminary risk assessment of Wivenhoe, Somerset and North Pine Dams by SKM, reported at SKM, 2000;
- A dam safety review of Somerset Dam by GHD, reported at GHD, 2000;
- A detailed risk assessment for Somerset Dam by SMEC. This risk assessment was undertaken in two stages. The initial stage entailed a review of information and identification of deficiencies. Stage 2 provided a detailed assessment of the likelihood of failure of the identified deficiencies. This work is reported at SMEC, 2004.
- This study included an assessment of the reliability of the spillway gates.
- A short review of dam safety issues, based on the above Reports was carried out by Commerce in December 2004 and is reported at Commerce, 2004:
- Further stability assessments of abutment monoliths were carried out by Commerce and are reported at Commerce, 2005.
- The above Commerce Reports were based on a hydrology study by WRM Water and Environment, WRM (October 2004). This Report has been revised (WRM, September 2005) but these revisions have not been incorporated in to the Commerce, 2005 conclusions.

Failure Modes

The following is taken mainly for Commerce (2004) but includes information from all sources referenced above, particularly SMEC (2004).

The detailed risk analysis for Somerset Dam, SMEC (2004), identified three basic failure modes:

- Erosion of the downstream toe due to flood discharges passing through the open sections of the dam abutments and impacting on the foundation at the downstream toe of the dam;
- Structural failure of the dam under extreme water load. The dam was considered stable at the foundation interface for the PMF (albeit approaching the limit of its stability) but liable to failure at two higher locations for smaller flood events;
    - At the change of slope in the back face of the non-overflow sections;
    - At the Upper Gallery.
- Structural failure of the dam under earthquake.

The results obtained from the event tree analyses are summarised at **Table** 11-1. Structural failure of the non-overflow units at the change in slope of the back face was the dominant failure mechanism followed by failure at the Upper Gallery. Gate reliability was assessed and included in the event trees and had a significant effect on the results.

Table 11-1 - **Result of Event Tree Analyses**

Failure Mode	Probability of Failure (/year)
Failure at Change of Slope under Flood	110*10-7
Failure at Upper Gallery; under Flood	80*10-7
Failure under Earthquake	80*10-7
Failure due to Toe Erosion	5*10-7
Total for Somerset Dam	275*10-7

Reference SMEC (2004)

Failure due to toe erosion at the toe of the dam was not considered to be a major factor. The foundation was assessed as a hard strong andesite with jointing the major defect. While erosion of the surface rock is expected under low to medium flows, the rock mass was judged to be "tighter" at depth and have a high resistance to erosion that is unlikely to lead to dam failure.

Moderate earthquake events are likely to cause distress at the change of slope, but as this is above Full Supply Level, it had no impact on the risk analysis. Stability analyses, GHD (2000), indicate the dam is unstable at the Upper Gallery for the Maximum Design Earthquake.

Structural Investigation Studies

The critical flood levels adopted for the risk analysis were:

- EL109.7 for the Change of Slope failure;
- EL110.0 for the Upper Gallery failure.

These levels adopted by SMEC (2004) were based on separate stability analyses by GHD (2000) and SKM (2000). SMEC (2004) noted that "the results from the two analyses are at odds" and that "the reasons for the differences are not apparent". In addition, the Report in Appendix 3.6 extracts from DPI (1994) quotes a Ben Russo conclusion that differs from both of these studies.

"Russo also recommends that to ensure the survival of the two portions of two non-overflow monoliths above EL100.0 , the reservoir should not exceed EL111.7 . He adds that the structural integrity of the spillway gates(if used) would have to be checked for the loads such a reservoir level would impose."

The variations in these three stability assessments cover a range that could have a significant impact on the event trees developed by SMEC and on the overall risk assessment. The differences are presumably due to different assumptions for uplift and for the extent of cracking in the concrete at the Upper Gallery.

Commerce reviewed the stability assessments and concluded that stability criteria were satisfied for:

- Storage levels up to EL111.0 at the change of slope;
- Storage levels up to EL110.9 at the Upper Gallery;

However, if extensive cracking exists above or below the gallery. The dam just satisfies stability criteria for a storage at EL109.7.

Hydrological studies (WRM, 2004) assess the storage level for flood with an AEP if 1 in 100,000 at EL109.75. The above studies indicate that the dam would satisfy normal stability criteria at this level, although there would be little margin if cracked concrete exists above or below the Upper Gallery.

This conclusion needs to be reviewed following the revised hydrology study at WRM, 2005.

Impact of a Somerset Dam Failure on Wivenhoe Dam

The impact of a Somerset Dam failure on Wivenhoe Dam was detailed at Commerce (2004) and summarised below.

The consequences of failure of Somerset Dam are largely dependent on whether it can cause a cascade failure of Wivenhoe Dam. Wivenhoe Dam, with Stage 1 Upgrade works now completed, is designed to handle a 1 in 100,000 flood event centred on the Wivenhoe catchment, assuming that Somerset Dam does not fail.

Somerset Dam, on the basis of its known condition, satisfies stability criteria for a storage level of EL109.75 and will safely handle the 1 in 100,000 AEP flood event. This in turn ensures that the Stage 1 upgrade works for Wivenhoe Dam are not compromised by any Somerset Dam deficiencies.

On this basis upgrade work at Somerset Dam, if required at all, would reasonably attract the same degree of urgency as Stage 2 Wivenhoe works. It is recommended that any upgrading of Somerset Dam be considered at the time that Stage 2 Wivenhoe works are assessed.

Commerce, 2005 raises several issues in relation to the above:

- Cracking observed in the Upper Gallery walls may also exist above or below the Gallery. While such cracked concrete would just satisfy stability criteria for a storage level of EL109.75, stability reduces rapidly for higher storage levels and failure could occur at EL110.1. It was recommended that some exploratory drilling be carried out to determine whether such cracks do exist. A similar recommendation was made in GHD (2000);

- The WIVOPS flood operation program at one time required that the Somerset spillway gates be lowered if Wivenhoe Dam is in danger of being overtopped. This is a difficult procedure that would raise a number of operational and safety issues and require a review of the stability conclusions given above.

- Stability analyses assume that the gallery systems are not flooded by water overtopping the abutment monoliths. The dam layout should be reviewed to ensure this is the case and waterproof doors installed where necessary.

Consequences of Failure for Somerset Dam

Loss of Life Assessments

If Somerset Dam fails without causing a cascade failure of Wivenhoe Dam, the consequences are limited to the area between the two dams.

The SKM (2000) Report predicted no loss of life would occur from a Somerset failure for the following reasons.

- The small population at risk for flood failures;
- Adequate warning times for flood failure;
- The location of the population at risk above peak flood levels caused by normal operational failure.

If failure of Somerset causes a cascade failure of Wivenhoe Dam, then the loss of life figures are substantially increased. This could only occur during an extreme flood event as Wivenhoe reservoir has sufficient capacity to store the normal Somerset storage without initiating the secondary spillway fuse plug.

SKM (2000) provided loss of life estimates for both day and night failures of Wivenhoe Dam for a variety of load cases. SMEC (2004) has used the SKM data for total loss of life at night and adopted the following loss of life figures for the risk assessment:

- IFF Failure (Main Embankment) 89
- Earthquake 36
- Normal Operating Condition 77

Financial Loss Assessments

SKM (2000) has assessed the financial consequences associated with the failure of Somerset Dam under three broad categories; third party damages, SEQWater direct damages and SEQWater loss of revenue. A major failure of Somerset Dam, involving failure of the spillway gates and partial failure of the abutment units was valued at $20M, with $18M of this classed as SEQWater direct damages.

SMEC (2004) quote a far higher cost of $200M to repair Somerset, including environmental impacts.

These estimates depend heavily on the type of failure and extent of the damage. Failure of several abutment units at the change of slope would incur a relatively low repair cost, while major damage to the gated spillway would involve substantially higher repair costs. No detailed estimates are available but the SKM (2000) estimates appear low, particularly as they involve spillway gate failure.

Similarly, a major flood failure of Wivenhoe Dam is estimated at $12B to $25B by SKM (2000).

Environmental & Intangible Consequences

The SKM (2000) study included an assessment of environmental and intangible consequences. SKM assessed the incremental environmental consequences for both Somerset and Wivenhoe dams as low. The incremental intangible consequences were also assessed as low for Somerset although high for Wivenhoe. It concluded that:

> ***"These environmental and intangible consequences were far outweighed by the significant life loss and financial consequences for this portfolio. As such they did not play a significant role in the development of the risk reduction strategy."***

Risk Analysis

No Failure of Wivenhoe Dam

SMEC, 2004 notes that for zero loss of life, the ANCOLD life safety criteria do not apply.

The ANCOLD fallback criteria however, would require either PMF security for an "Extreme Category" or PMPDF security for a "High A Category." Somerset Dam does not satisfy PMF and is unlikely to satisfy PMPDF. This reflects the overall importance of the dam to SEQWater.

SMEC, 2004 also notes that the risk of failure could be reduced by around 3 orders of magnitude by:

- Installation of anchors to increase the structural adequacy at the upper gallery and change of slope;
- Construction of a concrete slab/cutoff at the toe of the dam to protect against erosion and undermining.

The above works have not been costed, SKM nominated costs between $1M and $2M (now dated) and SMEC "judged that costs are likely to be higher, but still in the millions of dollars range".

SMEC noted that the cost of anchors could be justified, even if consequential failure of Wivenhoe did not occur. The value of erosion protection was more difficult to justify and that ":it would need to be determined whether its cost is grossly disproportionate to the improvement gained".

Upgrading of Somerset Dam, as a stand alone structure is an ALARP issue under the ANCOLD Guidelines. As noted by SMEC, SEQWater needs to determine their acceptable level of risk in order to assess the need for risk reduction measures.

Cascade Failure of Wivenhoe Dam

The FN Chart produced by SMEC, 2004 is shown at Figure 5, and is based on the risk assessment of Somerset Dam with the assumption of a conditional probability of failure of Wivenhoe Dam of 1.0. This Report did not assess the likelihood of a failure of Somerset Dam resulting in a failure of Wivenhoe Dam. The FN Chart plots above the Limit of Tolerability and as such the risk would be deemed intolerable.

The original risk analysis for Wivenhoe Dam was developed by SKM. The Wivenhoe Alliance revised this work to incorporate the risks associated with a Somerset failure. The FN Charts for total loss of life is shown at Figure 6 and indicates that:

- The original Wivenhoe Dam plots well above the ANCOLD Limit Line;
- The Stage 1 Upgrade for Wivenhoe brings the risk below the ANCOLD Limit Line provided Somerset does not fail;
- If allowance is included for Somerset Dam failure case, the plot rises just above the Limit Line;
- The Stage 2 Upgrade brings the risk well below the Limit Line.

The total risk to Wivenhoe Dam as a stand-alone construction following the Stage 1 Upgrade works is assessed at $0.84*10^{-5}$. Introducing the risks associated with a Somerset failure increases these risks by a factor of 2.4 to $2.0*10^{-5}$.

The risk to life matrix (F-N Chart) using the incremental loss of life figures is reproduced at Figure 7. This shows the Wivenhoe risks plotting below the ANCOLD Limit Line.

Limitations of Risk Studies

The SMEC, 2004 study of Somerset Dam is considered a detail risk assessment, with the limitation that it does not consider the likelihood of a failure of Somerset Dam resulting in a failure of Wivenhoe Dam. The Report uses the SKM loss of life figures. The SKM Report was a preliminary assessment and as SMEC notes the consequence study is not developed to the same standard as the failure analysis.

The Wivenhoe Alliance study is a modification of the SKM study and as such is a Preliminary Risk Assessment. If the risk profile is a concern, a detailed risk analysis should be carried out, that includes a detailed assessment of the consequences, particular loss of life.

Hazard Category

The Dam Safety Management Plan, SEQWater (2005) at Section 6.1 states that "The Corporation's dams are classified under the ANCOLD classification guidelines as HIGH hazard because of the significant consequences of a dam failure". These are presumably the 1986 ANCOLD Guidelines.

The hazard classification was determined by GHD and the following statement included in GHD (2000).

"A hazard assessment was conducted in accordance with the DPI (DNR) Dam Safety Guidelines Procedure DS003 and the June 2000 ANCOLD Guidelines on Assessment of Consequences of Dam Failure. Both methods indicate that the dam should be classified as having a High Hazard Category."

No discussion of the hazard classification was provided at GHD (2000). It is assumed that the hazard classification allows for the possibility of a cascade failure of Wivenhoe Dam and, given the financial loss assessments noted at 0, that this would be a High A classification for flood under ANCOLD.

It is recommended that the Hazard Classification be given further consideration on the basis that:

- The PAR from a cascade failure would be in excess of 1,000, and the ANCOLD Guidelines would indicate a an Extreme Classification;
- The Hazard Classification for a sunny day failure would be lower, possibly High B or High C.

Conclusions

Somerset Dam as a stand alone structure satisfies the ANCOLD risk to life criteria. There is scope for substantially reducing the risk of failure, but the value of this work needs to be assessed in terms of the SEQWater risk management procedures.

A cascade failure of Somerset and Wivenhoe Dams is possible and stability is marginal for the 1 in 100,000 AEP event. Preliminary risk assessments indicate the cascade failure is close to the ANCOLD Limit of Tolerability.

SEQWater has completed Stage 1 of an upgrade program and Wivenhoe Dam now is now capable of handling a flood with an AEP of 1 in 100,000. Stage 2 would provide full PMF security. This would satisfy the ANCOLD Limit of Tolerability and the ALARP principle.

While Somerset Dam can also handle a 1 in 100,000 AEP flood event, upgrade work, if required at all, would reasonably attract the same degree of urgency as Stage 2 Wivenhoe works.

The various Reports however, raise a number of issues that require investigation:

- Cracking observed in the Upper Gallery walls may also exist above or below the Gallery. While such cracked concrete sections would just satisfy stability criteria for a storage level of EL109.75, stability reduces rapidly for higher storage levels and failure could occur at EL110.1. It was recommended that some exploratory drilling be carried out to determine whether such cracks do exist. A similar recommendation was made in GHD (2000);

- The WIVOPS flood operation program at one time required that the Somerset spillway gates be lowered if Wivenhoe Dam is in danger of being overtopped. This is a difficult procedure that would raise a number of operational and safety issues and require a review of the stability conclusions given above.

- Stability analyses assume that the gallery systems are not flooded by water overtopping the abutment monoliths. The dam layout should be reviewed to ensure this is the case and waterproof doors installed where necessary.

- SMEC, 2004 notes that should the spillway gates not operate as intended, the dam could become unstable and, “as part of its risk reduction strategy, SEQWater needs to consider this aspect”. Risk reduction methods considered included “removal of the sector (radial) gates, or anchoring the dam to the foundations”.

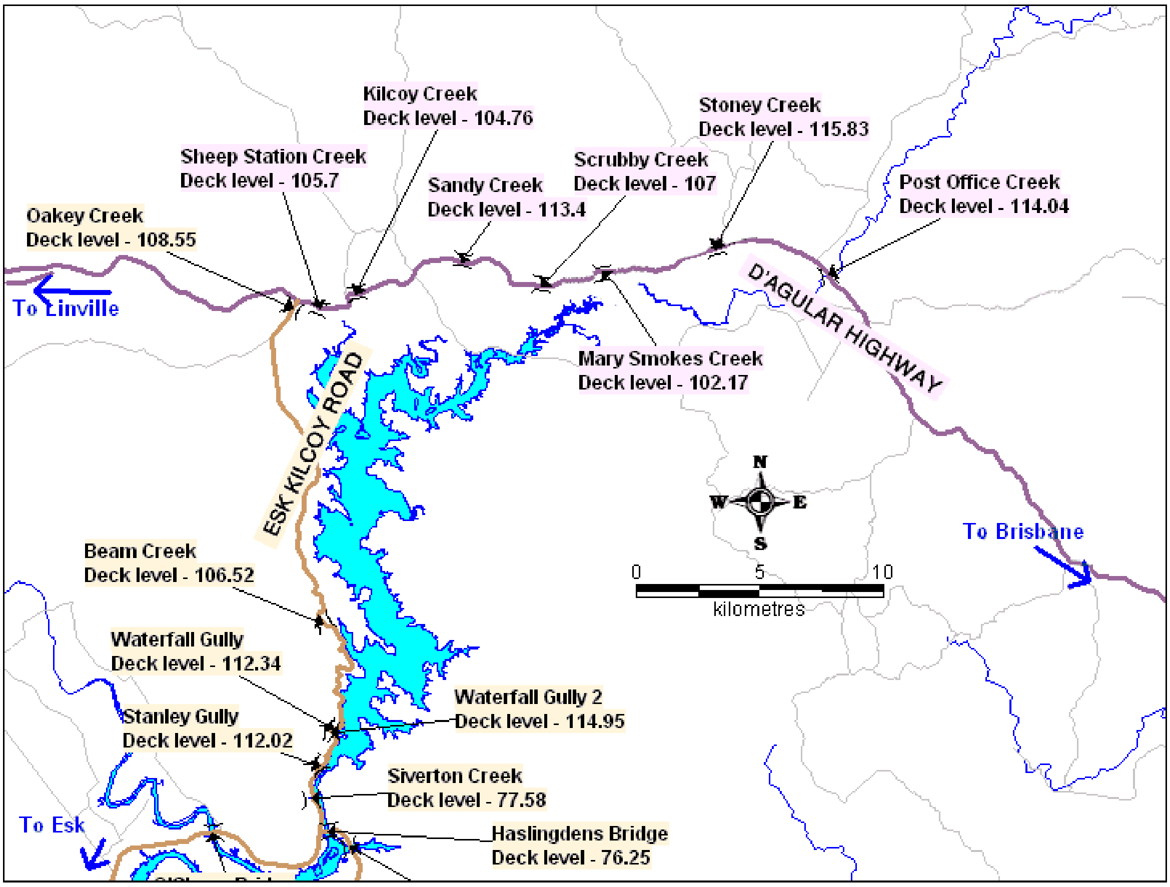
Appendix I. Cost Estimates for Raising Somerset Dam

Appendix J. Raising Somerset Dam Feasibility Investigations by SMEC

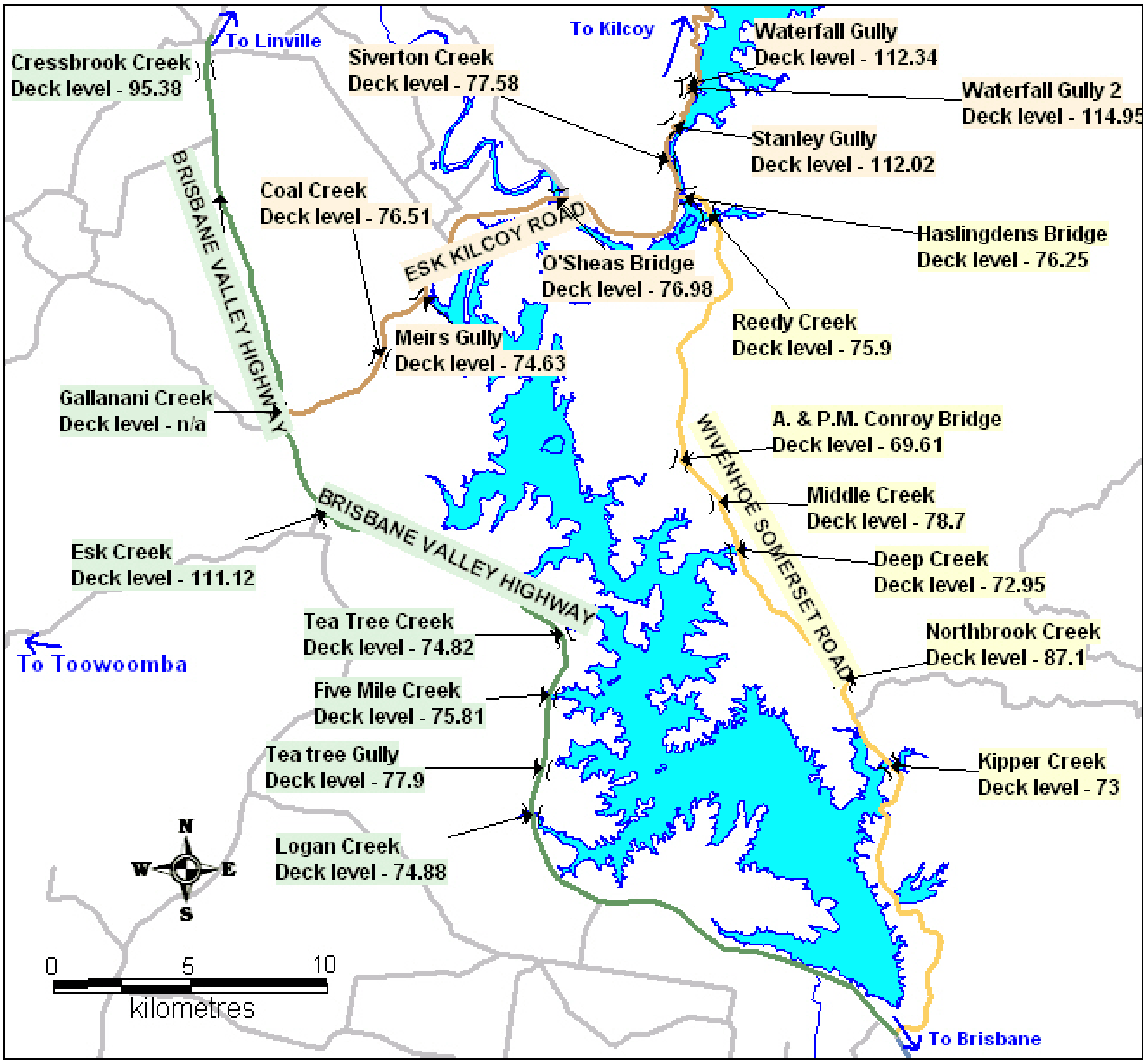
Appendix K. Inundation Maps for Wivenhoe and Somerset Dams

Appendix L. BRIDGE Levels Upstream and Downstream of the Dams

Roads North of Somerset Dam

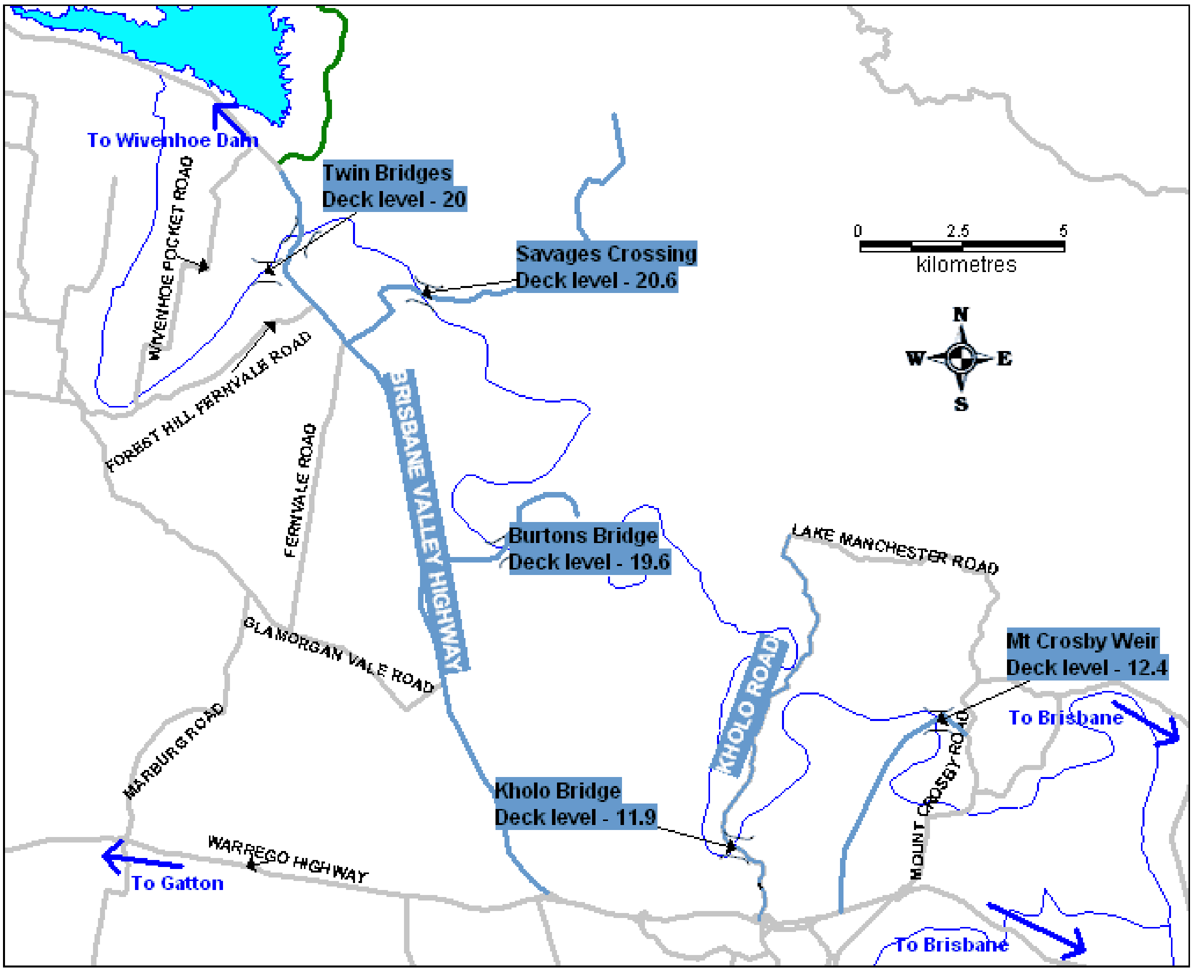


Roads Surrounding Wivenhoe Dam



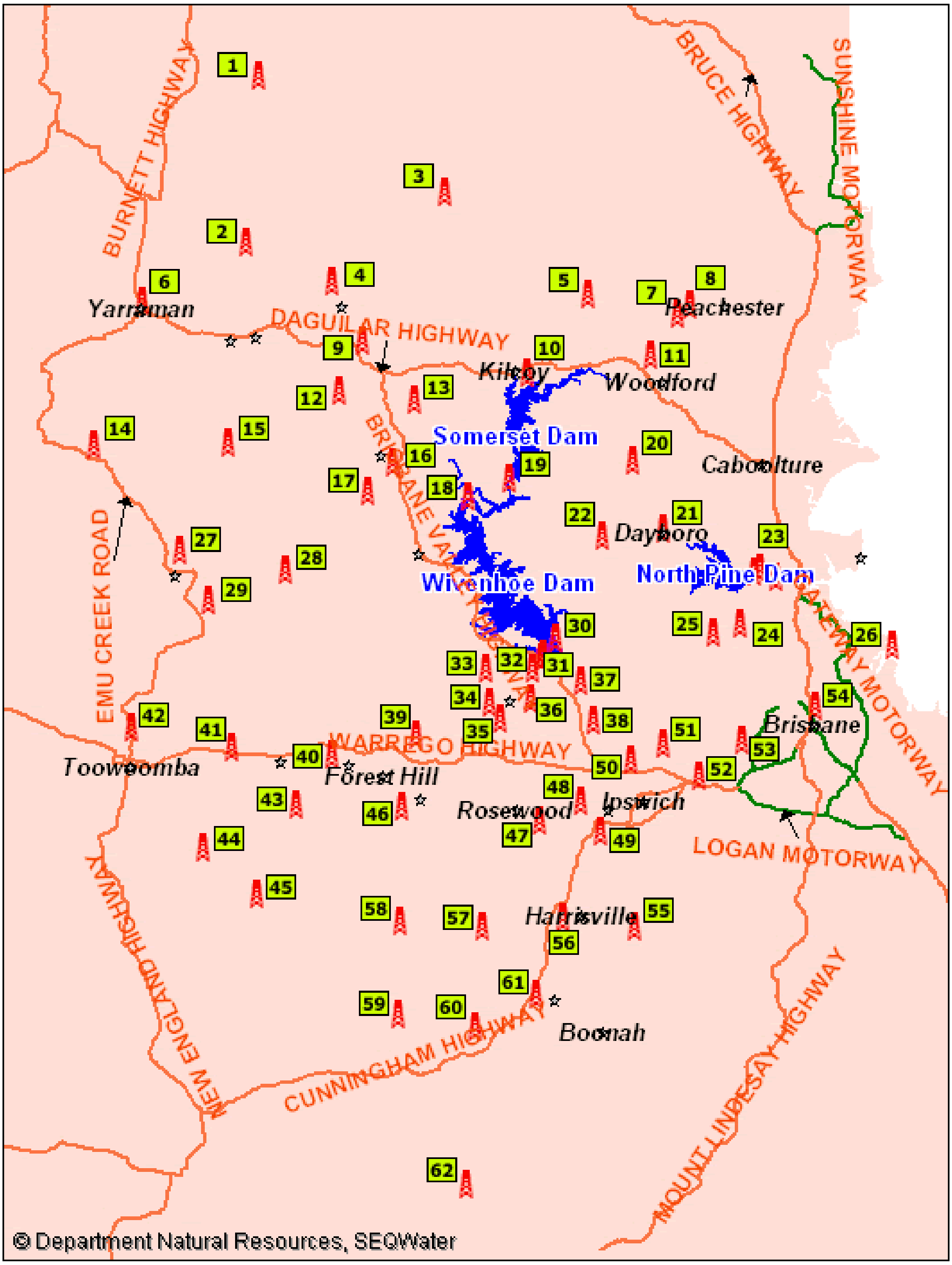
SEQWATER
Wivenhoe, Somerset & North Pine Dams

Bridges Downstream of Wivenhoe Dam



SEQWATER
Wivenhoe, Somerset & North Pine Dams

Figure 8 - Alert Station Locations



Appendix M. Somerset Drawings

South East Queensland Water Strategy

2010

Queensland water Commission

Securing our water, together.

South East Queensland
Water Strategy

Queensland water Commission

Securing our water, together.

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Table of Contents

Executive summary

The *South East Queensland Water Strategy* (the Strategy) is the adaptable blueprint for maintaining water security in South East Queensland (SEQ) into the future.

The Strategy enhances the transparency of planning for, and operation of, the SEQ Water Grid. It delivers a Water Supply Guarantee, which ensures sufficient water is available to support a comfortable, sustainable and prosperous lifestyle while meeting the needs of urban, industrial and rural growth and the environment.

This Guarantee will be delivered through a demand management framework, appropriate infrastructure investment and efficiencies gained through operation of the region-wide SEQ Water Grid.

Context

The Millennium Drought is now behind us. Our water supply is now secure, due to SEQ dams currently at or near full capacity and due to the range of measures that were adopted as part of the drought response. These measures include improved water use efficiency, new supplies and streamlined institutional arrangements. All of SEQ is now under the same consistent out-of-drought water management framework, with average regional residential consumption remaining consistently below 200 litres per person per day.

Now is the time to plan for the region's future needs, ensuring that security of supply is maintained in the face of population growth and climate variability and change. The opportunity now exists to use water and operate existing infrastructure more efficiently, deferring the next bulk water supply source for as long as possible. A more staged and inclusive approach to planning for these new supplies can also be adopted.

The Strategy builds on the range of institutional changes that are currently underway to ensure the efficient and effective operation of the SEQ Water Grid, and on the enhanced security provided by the diverse range of supply sources that have now been constructed.

Within this context, the key features of the Strategy are encapsulated in the general themes of:

- use less
- be supply-ready
- manage efficiently.

Use less

Efficient water use: Planning has been based on the conservative assumption that the community will reduce per-person water consumption by over 24 per cent compared to trends prior to the Millennium Drought.

Target 200: The Strategy challenges residents to do even better than planning assumptions, maintaining average consumption at or below 200 litres per person per day. If this can be achieved, the need for new supplies will be deferred.

Local water supplies: Off-Grid supplies, such as rainwater tanks, must now be installed for all new houses and most new industrial and commercial buildings. This water will be used for appropriate internal purposes, as well as for outdoor watering. The Strategy supports the adoption of stormwater harvesting and recycling where efficient and effective.

Be supply-ready

Drought planning: The Strategy plans to minimise the impact of future droughts through planned investment, prudent management and a pre-determined drought response plan. It sets an objective that the community experience water restrictions no more than once every 25 years, on average.

New water supplies: The Strategy will be reviewed before another major supply source is required. In the meantime, a range of potential supplies will be investigated in detail. Based on current information and technology, desalination facilities will underpin future water security for SEQ.

Manage efficiently

Purified recycled water: The Western Corridor Recycled Water Scheme provides security of supply as a standby facility. This means that existing sources can be more effectively utilised because in times when dam levels are low, purified recycled water will be available to supplement our dams—ensuring that security of region's water supply can be maintained.

Rural production: A range of measures to enhance the availability of water for rural production will be investigated, including making water that is not required for urban use available on an interruptible basis. Up to 32 000 megalitres per year of recycled water has been made available for supply to the Lockyer Valley and other areas, subject to commercial arrangements that are fair and do not disadvantage other SEQ water users.

Our vision

The Strategy's vision is expressed as desired Level of Service (LOS) objectives, which relate to the expected frequency, duration and severity of restrictions during future droughts. A conservative approach has been taken when determining the required LOS system yield for SEQ, which considers population growth, climate change and variability and the extent of the potential rebound in consumption demand following the drought.

The LOS objectives mean that future investments in the water supply system will be made so that sufficient water from the SEQ Water Grid will be available to meet average regional urban demand of up to 375 litres per person per day, including an allowance of up to 230 litres per person per day for residential uses. Infrastructure will be planned so that the frequency of restrictions will be no more than once every 25 years, on average. These restrictions would be much less severe than those that applied during the recent drought, which prohibited almost all outdoor water use.

Use less

The Strategy outlines measures for residents, business and industry to maintain efficient and responsible water consumption by residents, business and industry.

The Strategy challenges SEQ residents to do even better than the planning assumption of an average residential consumption of 230 litres per person per day, maintaining average residential consumption at or below 200 litres per person per day (Target 200). If this target is achieved, future water supplies can be deferred and the amount of water that is treated and distributed through the SEQ Water Grid can be reduced—saving money and electricity and reducing the carbon footprint.

The Strategy's aim is to achieve this target without significantly changing the lifestyle that SEQ residents enjoy, including the ability to sustain healthy, water-wise gardens. The challenge is maintaining, in the long term, the behavioural change brought about by the drought, as actual residential consumption will vary between households and across SEQ, and between seasons and years.

Building on Permanent Water Conservation Measures, which were introduced across SEQ on 1 December 2009, where time restrictions have generally been relaxed but efficiency measures remain in place, a range of other existing measures will continue and a number of new measures will be investigated in order to encourage efficient water use. These measures include:

- ensuring that all new buildings are water-efficient
- ensuring that existing buildings become more water-efficient, such as by requiring water-efficient showerheads to be installed as part of major renovations
- moving business and industry towards best practice water efficiency, through the preparation and implementation of water efficiency management plans
- minimising system losses
- undertaking targeted information and education programs, such as for schools and selected industries.

The QWC will review the key components of the demand management program on an ongoing basis and will seek to ensure that the program encourages water efficiency at the lowest overall economic, social and environmental cost.

Local supplies

Since 1 January 2007, all applications lodged for the construction of new homes in SEQ have had to demonstrate how they achieve the mandatory water savings targets. Detached houses must target savings of 70 000 litres per year, while terrace houses and townhouses must aim to achieve savings of 42 000 litres per year.

The water savings targets are forecast to apply to about 500 000 new houses by 2026 and about 800 000 houses by 2056, depending on population growth and household type.

These off-Grid supply sources are forecast to reduce demand on the SEQ Water Grid by about 35 000 megalitres per year in 2026 and about 60 000 megalitres per year in 2056— almost one and a half times the capacity of the existing desalination facility at Tugun. Savings from existing rainwater tanks and new tanks on commercial and industrial buildings are in addition to this.

Internally plumbed rainwater tanks are one option to achieve the water savings target. Alternatives include communal rainwater tanks, stormwater harvesting and dual-reticulation recycled water systems. Each of these options can have beneficial outcomes for other elements of the water cycle—such as capturing stormwater run-off and reducing the discharge of nutrients into waterways—but must be balanced against cost considerations.

The most appropriate solution will vary depending on local circumstances. To ensure that these decisions are well informed, a range of research is underway and some demonstration stormwater harvesting schemes are proposed.

Be supply-ready

Saving water will postpone, but not preclude, the need for additional supplies in the future, to meet growth and ensure security in times of drought.

Scenario analysis indicates that the construction of the next supply source will probably be triggered by demand growth. While this could be required in 2021, it is more likely to occur around mid-2020s (refer to Figure A). The 2021 timeframe could be delayed if there is:

- high series population growth and a regional average residential consumption of 200 litres per person per day
  or
- medium series population growth and a regional average residential consumption of 230 litres per person per day.

Residential consumption can have a major impact on the timing of the next major supply. By achieving the voluntary target of maintaining average residential consumption at or below 200 litres per person per day, additional supplies could be deferred by at least five years. For example, the earliest time at which a new supply will be required could be deferred from 2021 to around 2027.

Several scenarios have been prepared to assess the possible implications of the uncertainties of the key variables of population growth, demand and climate change. Table A illustrates possible augmentation timeframes. The Strategy has been developed to ensure that the region's water supplies will be secure in all of these scenarios.

Climate change and our dams

Climate change may have a significant impact on the supply from our dams. The majority of climate modelling done to date indicates that SEQ is likely to become hotter and drier, with reduced inflows to dams and increased demand for water.

The CSIRO is undertaking local-scale modelling for SEQ. The preliminary results indicate that, while climate change may reduce yield by about 10 per cent, the impact is likely to occur over decades, rather than immediately.

The impact of climate change is being researched through the Queensland Climate Change Centre of Excellence and the Urban Water Security Research Alliance. The Strategy will be revised as our understanding of the likely impacts of climate change on SEQ water supplies improves.

Table A Impact of reduced consumption on the timing of the next augmentation

Scenario	Regional average residential consumption	
	230 litres/person/day	200 litres/person/day
Earliest date with: • high population growth • provision for climate impact	2017	2022
Likely date with: • high population growth	2021	2027
Likely date with: • medium population growth • provision for climate impact	2020	2027
Latest date with: • medium population growth	2026	2032

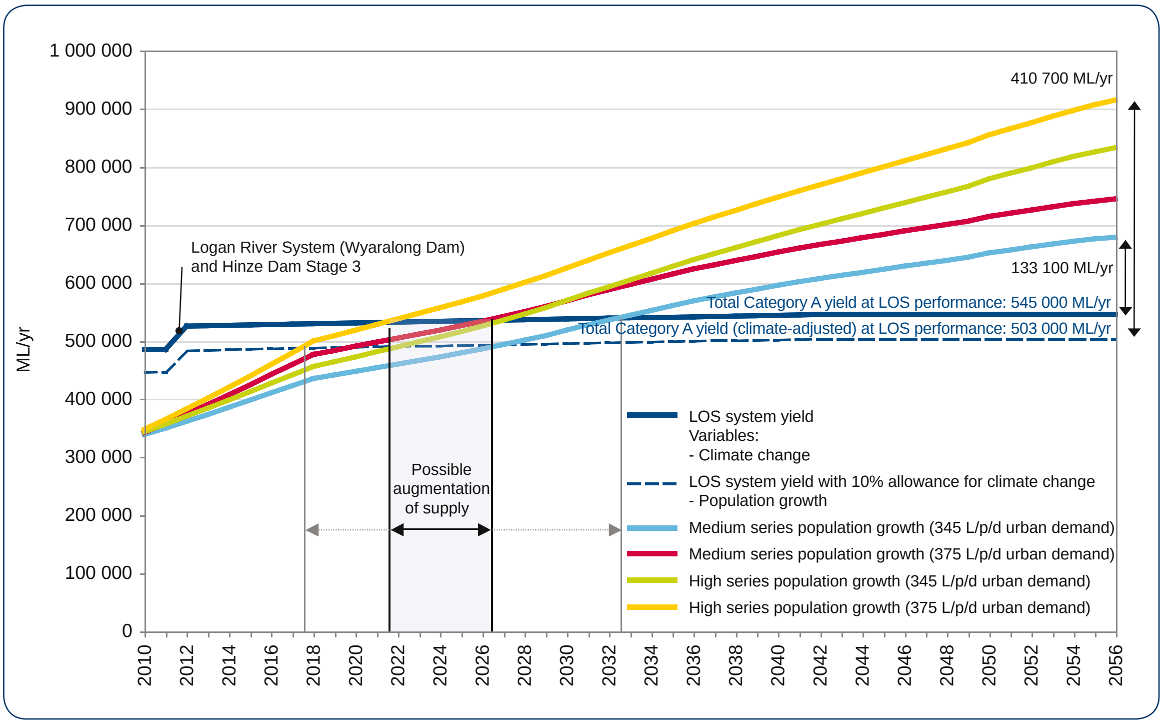


Figure A Water balance in normal operating mode

The purpose of the Strategy is to augment supplies at appropriate times to prevent a gap from developing. The QWC will update the Strategy regularly and as key assumptions change. The timing of future infrastructure will become clearer as projected population growth estimates are revised, average residential consumption patterns are confirmed and there is more certainty about the long-term impacts of climate change on water supply sources. Changes to these forecasts will have a direct impact on the planning program for potential water supplies.

The construction of major new supplies may also be triggered as part of a drought response. A drought response plan is an integral part of the Strategy as it establishes an upfront plan to ensure continuity of supply regardless of climatic conditions. The QWC will complete the drought response plan in 2011.

Our potential future sources of supply

Prudent planning for future supplies is needed, to ensure that the best options can be selected when required. With new supplies unlikely to be required until after 2021, the QWC will take advantage of that time to investigate the options thoroughly, including appropriate research and stakeholder engagement.

It is expected that desalination facilities will underpin our future water security, based on existing information and technology. The Queensland Government has announced priority and reserve desalination sites, as listed in Table B.

Table B Priority and reserve desalination sites

Category	Site	Property description	Owner
Priority	Lytton	Lot 49 SP193294	State of Queensland
	Marcoola	Lot 753 CG3375	Sunshine Coast Regional Council
Reserve	Tugun (duplication of existing facility)	Lot 30 SP197355	Gold Coast City Council/State of Queensland
	Bribie Island	Lot 67 SP214143	State of Queensland

There are also a number of small potential dams and weirs that will be investigated, as well as options to upgrade existing supplies. Options will be investigated in the Mary River catchment, including raising Borumba Dam and water harvesting. Making use of the remaining strategic reserve of unallocated water in SEQ warrants further investigation, given the limited number of alternatives.

Purified recycled water is currently available to augment Wivenhoe Dam as part of a drought response, increasing the amount that can be taken from dams and weirs in normal conditions. Over time, community confidence in purified recycled water schemes may permit the development of additional schemes and the further utilisation of the Western Corridor Recycled Water Scheme. The QWC considers it prudent to proceed with investigations of these potential schemes, with a view to preserving land for treatment facilities and pipeline corridors if viable. The QWC will continue to provide information to the community regarding purified recycled water.

The water supply options that will be investigated in detail are listed in Table C.

Table C Potential supplies to be investigated in detail

Type of source	Potential source
Desalination sites	• Marcoola (priority site) • Lytton, near the Brisbane River mouth (priority site) • Duplication of the facility at Tugun on the Gold Coast (reserve site) • Bribie Island (reserve site)
Dams and weirs	• Borumba Dam Stage 3, water harvesting from the Mary River or a combination of both • Raised operating levels in Wivenhoe Dam • Raising of the Mt Crosby Weir • Additional minor supplies in the Logan and Albert catchment, potentially including a pipeline between the Bromelton Off-stream Storage and Wyaralong Dam • Stormwater augmentation of dams
Purified recycled water schemes	• Augmentation of Hinze Dam • Augmentation of North Pine Dam

Scenario analysis indicates that if climate change impacts occur relatively soon additional water supplies might need to be available from 2017, with construction commencing by 2014. While unlikely, it is prudent to be ready to respond if necessary. The QWC will now commence detailed planning and obtain preliminary approvals to ensure that new supplies can be delivered efficiently when required. The QWC will engage with local councils and neighbouring communities in all stages of the planning process.

The detailed planning will inform a final decision regarding the next major supply when regionally significant supplies are needed. The Strategy sets out the process by which the QWC will assess alternatives and the basis for its advice to Queensland Government, including a Statement of Needs process similar to that used in the electricity sector.

Manage efficiently

Water supply for SEQ is secure for the short to medium-term, due to the construction of the SEQ Water Grid and key storages being full or near full. Given this situation, and assuming continued water efficiency, there is about 1 per cent probability of key storages falling to 40 per cent of capacity over the next 10 years, triggering the re-introduction of Medium Level Restrictions.

This Strategy seeks to ensure that the benefits of the short to medium-term security are maximised, deferring the time when major new supplies will be required. It establishes a framework for the efficient operation of the SEQ Water Grid, which complements the measures in place for efficient water use in homes and businesses.

The SEQ Water Grid allows water supplies to be managed efficiently in a way not previously possible, providing the ability to shift our water to where it is needed most.

Linking our water sources across the region has produced a 14 per cent increase in the LOS system yield of sources of supply existing in 2006. The increase is being achieved through the coordinated management of dams, and by managing risk at a regional level.

The SEQ Water Grid also benefits from the availability of the desalination facility at Tugun and the Western Corridor Recycled Water Scheme. These supplies provide a secure supply in severe drought, enabling more water to be taken from dams when levels are high. Importantly, they deliver this benefit without being operated at capacity at all times.

In the case of the Western Corridor Recycled Water Scheme, this means that the policy of using the Scheme to augment Wivenhoe Dam only when key Water Grid storage levels fall to 40 per cent of capacity reflects an optimal operating strategy at this time.

The Western Corridor Recycled Water Scheme is expected to directly supply up to about 36 000 megalitres per year for urban purposes, depending upon the level of demand from the power stations. However, its overall contribution towards the yield of the SEQ Water Grid is much greater. In conjunction with desalinated water, the Scheme increases the capacity of the Water Grid by up to 100 000 megalitres per year.

At the same time, increasing the trigger would have minimal impact on overall system yield, deferring the next source of supply by up to one and a half years,. Increasing the trigger point at which purified recycled water is added to Wivenhoe Dam—currently 40 per cent—would increase operating costs and the likelihood of the dam spilling. The costs and benefits of changing the trigger will be assessed as demand approaches supply.

Water for rural towns

About 20 000 SEQ residents live in communities that have drinking water supplies not directly connected to the SEQ Water Grid. These communities differ in terms of size and forecast population growth, and they are serviced by a diverse range of water supply sources with varying levels of security.

A number of communities are indirectly supplied from SEQ Water Grid assets and are benefiting from improved security of supply following the completion of new supplies. These communities include:

- Beaudesert, Kooralbyn and Rathdowney, which are supplied from the Logan River system
- Aratula, Boonah, Kalbar and Mount Alford, which are supplied from the Warrill Valley system.

Over time, the Strategy seeks to achieve the same LOS objectives for all communities with reticulated water supplies as for those connected to the SEQ Water Grid. Options to improve security to a number of towns are currently being investigated, with the highest priorities being Beaudesert and Canungra given the size and recent history of water supply issues in these communities.

Water for rural production

Rural producers in SEQ used about 150 000 megalitres per year of water in 2005.

The Queensland Government has announced that up to 32 000 megalitres per year of additional water supplies will be made available for rural production from the Western Corridor Recycled Water Scheme, outside times of severe drought.

The QWC will lead the investigation of a range of other options to potentially improve the availability of water for rural production. These options may increase the total amount of water available, or improve the reliability of its supply.

The SEQ Water Grid provides opportunities for aligning the management of urban and rural water supplies in some catchments. A range of options are to be investigated, including ways to provide higher levels of reliability for existing allocations and provide certainty about allocations earlier in the water year. Any such supply must occur within a transparent framework, which ensures that the costs are appropriately shared.

For example, 8250 megalitres per year of high priority water previously used by the Swanbank power station and Ipswich City Council has been reserved under the SEQ System Operating Plan to increase supply reliability for urban growth in Boonah and surrounding towns. Through this reserved water, the reliability of supply to irrigators in the Warrill Valley has also been improved.

The Strategy builds on existing Queensland Government initiatives in the Rural Futures Strategy, to ensure appropriate pricing, fair water trading and improved water use efficiency.

Energy for water

By using water more efficiently, the amount of water that is treated and distributed through the SEQ Water Grid will be reduced and region’s carbon footprint lowered.. The Strategy estimates that, by maintaining average total consumption at 24 per cent below pre-drought trends, a 38 per cent saving in energy consumption can be achieved for bulk water requirements in 2048. These savings are equivalent to the total energy consumption of around 86 000 homes in 2020. Additional savings will be achieved if residents of SEQ achieve the voluntary Target 200.

Despite these savings, SEQ’s water supply system will become increasingly energy-intensive over time, especially with an increased reliance on climate independent desalination. When dam levels are high, the SEQ Water Grid encourages lower energy use as it:

- allows less energy-intensive sources to be used first
- reduces water transfers.

With existing infrastructure, the energy intensity of bulk water delivered to a home in SEQ is still less than 3 per cent of typical household energy consumption.

Institutional arrangements

Reforms needed for water management in SEQ were implemented in order to fully realise the benefits of the SEQ Water Grid and ensure the efficient and effective operation of the diverse range of supply sources.

The first phase of reform implementation was completed on 1 July 2008, with the establishment of the four new entities that own and operate the SEQ Water Grid.

With the establishment of the three new distributor-retailers owned by local councils on 1 July 2010, the next stage of institutional reform was completed. These entities own and operate the water reticulation and wastewater infrastructure in the region.

Beyond the physical operation of the SEQ Water Grid, the reformed institutional arrangements also have the potential to deliver significant benefits to the community through:

- simplified business structures to deliver water services in a coordinated manner
- creation of economies of scale and scope due to the reduced number of entities
- efficiency in service provision by specialist entities, with the amalgamation of technical skill sets
- higher technical skill levels across the industry through coordinated training and education
- clarification of the respective roles of state and local governments
- improved transparency and accountability for bulk transport and distribution networks with a strong asset management regime
- enhanced economic regulation.

Implementation and review

The Strategy outlines the key elements of the first Statement of Needs, which are the projects that must proceed over the next 10 years in order to ensure that the LOS objectives can be achieved. The key elements are as follows:

- Committed projects should be completed.
- Beyond these projects, additional bulk water supplies could be required in 2021.
- Operational improvements and capital upgrades should continue, in order to comply with water quality requirements under the *Water Supply (Safety and Reliability) Act 2008*.
- A drought response plan will be prepared.

The QWC will review and update the Strategy at least every five years, aligned with the review of the *South East Queensland Regional Plan 2009-2031*, or as major developments or changes in key assumptions occur. The QWC will report annually on the implementation of the Strategy, considering the currency of key assumptions.

Chapter 1

Setting the scene

This chapter explains the purpose of the *South East Queensland Water Strategy* (the Strategy), the guiding principles and the Water Supply Guarantee, which is the Queensland Water Commission's (QWC) vision for the future and the basis for water supply planning.

Key messages

- The Strategy will deliver the Water Supply Guarantee, a vision of sufficient water to support a comfortable, sustainable and prosperous lifestyle while meeting the needs of urban, industrial and rural growth and the environment.
- This vision includes a well-informed, water-wise community that is engaged in the planning process as decisions are made. Key elements of this vision are:
  - balancing community expectations of water security, quality and cost
  - embedding water efficiency throughout the water supply and demand chain
  - managing water security through diversified and integrated water supplies, and drought preparedness
  - improving environmental outcomes, including healthier waterways, through integrated strategic planning and catchment management.
- The Strategy provides a comprehensive planning and implementation framework to secure water supplies for South East Queensland (SEQ) for the long-term.

1.1 Purpose of the Strategy

As described in the *South East Queensland Regional Plan 2009–2031* (the Regional Plan), the purpose of the Strategy is to ensure that water in SEQ is managed on a sustainable and integrated basis to provide secure and reliable supplies of acceptable quality for all uses for the long term.

For the purposes of water planning, the local government areas that make up SEQ are:

- Brisbane City Council
- Gold Coast City Council
- Ipswich City Council
- Lockyer Valley Regional Council
- Logan City Council
- Moreton Bay Regional Council
- Redland City Council
- Scenic Rim Regional Council
- Somerset Regional Council
- Sunshine Coast Regional Council.

Planning for SEQ must be integrated with planning for adjoining areas. Water is already supplied to and from SEQ from adjoining areas. The Strategy takes these supplies into account. It also identifies other potential opportunities.

The largest existing supply from SEQ is to Toowoomba. Toowoomba Regional Council is responsible for water planning and management in Toowoomba. The Strategy takes into account the amount of water that might be supplied from the SEQ Water Grid through the recently completed pipeline.

Figure 1.1 shows the extent of the area covered by the Strategy.

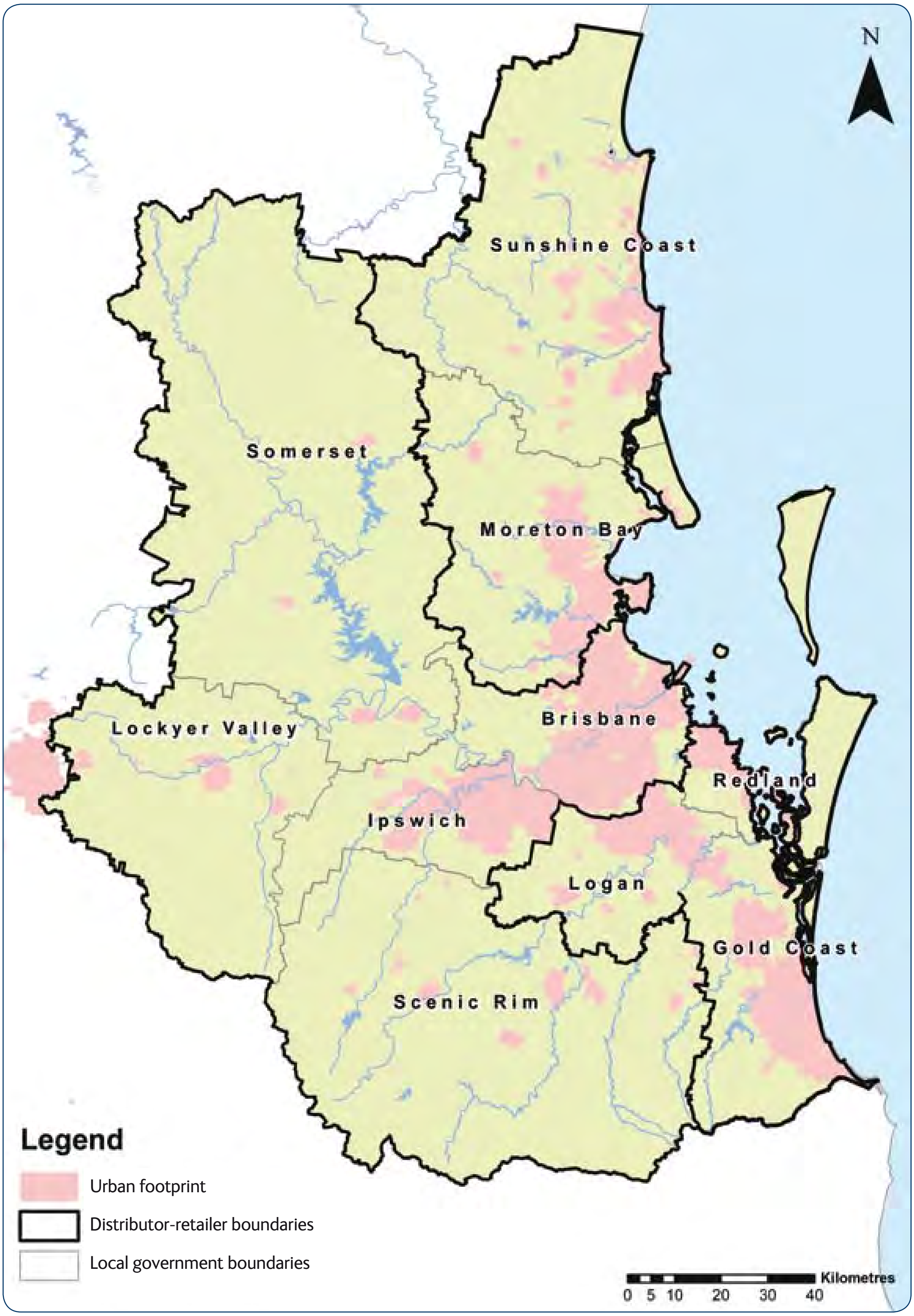


Figure 1.1 Area covered by the *South East Queensland Water Strategy*

1.2 Guiding principles

The QWC is responsible for advising the Queensland Government on achieving water security in SEQ. The *Water Act 2000* sets out the role of the QWC. The principles underpinning the Strategy derive from section 346 of the *Water Act 2000*.

Guiding principles

- Water is a scarce resource that is to be shared across the region.
- Water quality should be managed from its source to its end-users in a way that:
  - ensures the health of catchments, aquifers and their ecosystems
  - delivers water of a quality desired by the end-users at the lowest overall cost.
- Water supply arrangements should maximise efficient and cost-effective service delivery and the efficient use of water, such as appropriate connectivity between supply sources, in accordance with the Level of Service (LOS) objectives.
- The cost of water sources should be shared among users who benefit from them. Pricing should recognise Queensland Government commitments under inter-governmental agreements.
- Regional water supply assessments should consider environmental, social and economic factors, and include 'least cost planning' to ensure proper economic comparison of all supply and demand options.
- QWC water restrictions should help to achieve the region's objectives for long-term demand management for water and enable the appropriate management of any significant threat to the sustainability and security of the region's water supply.
- Flood mitigation and dam safety should be considered in assessments of regional water supply.

1.3 The Water Supply Guarantee

Economic development and a highly liveable environment have resulted in significant migration to SEQ in recent years, with the population doubling since 1981. This growth has increased demand for water.

In addition to this increased demand, SEQ recently experienced a severe drought and the worst recorded inflows to major storages in its history. In response to the drought, the community has demonstrated an outstanding commitment to reducing water consumption by embracing water restrictions and other voluntary water-saving behaviours.

The Strategy aims to reflect the community's attitude towards water through the vision of the Water Supply Guarantee for SEQ.

To deliver this regional vision, the Strategy was developed using the LOS approach to regional water planning. It includes ongoing consideration of climate change, climate variability, population growth and other regional factors affecting supply and demand.

The vision for water security in SEQ is explained in more detail below.

The Water Supply Guarantee

It is our vision that there will be sufficient water to support a comfortable, sustainable and prosperous lifestyle while meeting the needs of urban, industrial and rural growth and the environment.

Known as the Water Supply Guarantee, this water security vision will be achieved by:

- balancing community expectations of water security, quality and cost
- embedding water efficiency throughout the water supply and demand chain
- managing water security through diversified and integrated water supplies and drought preparedness
- improving environmental outcomes, including healthier waterways, through integrated strategic planning and catchment management.

1.3.1 Balancing community expectations

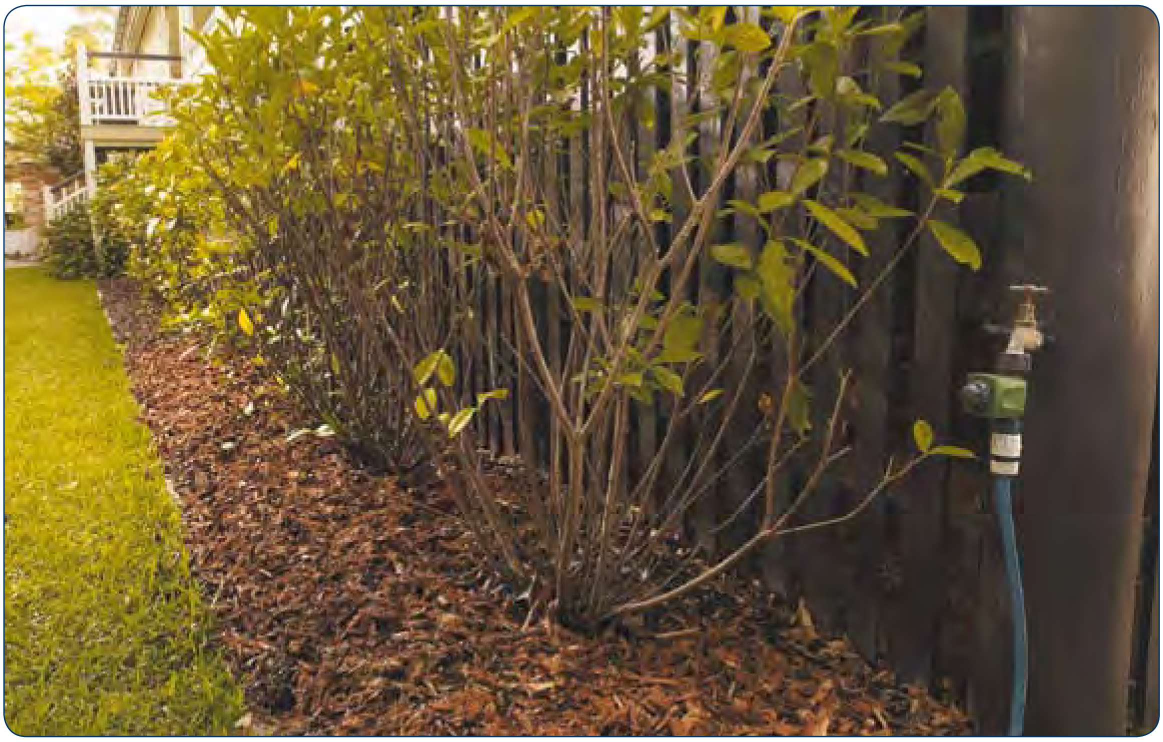
Water resources in SEQ will be managed sustainably, on a total water cycle basis.

Planning will be regularly reviewed, taking into account technological advances and changing demand patterns and attitudes.

Investments in the water supply system will be made with the objective that Medium Level Restrictions will not occur more than once every 25 years on average. The effect of these Medium Level Restrictions will be less onerous than the Extreme and High Level Restrictions applied during the recent drought.

Public health and safety will not be compromised.

These outcomes will be achieved at least cost to the community.



1.3.2 Embedding water efficiency

The Queensland Government will promote ways for residents of SEQ to value water and to use water efficiently without compromising quality of life.

There will be enough water to maintain our gardens, wash cars, top up swimming pools and fill paddle pools. As a water-wise community, we will water our gardens in the cool of the day, use efficient watering devices, such as drip irrigation, and minimise pool losses by using pool covers. Our houses will be fitted with water-efficient appliances, such as dual-flush toilets, so we can save water without thinking about it. Water conservation will be an important design aspect when building and renovating houses, and commercial and industrial buildings.

Our major commercial, industrial and government water users will have water efficiency embedded in their business. Once water efficiency is embedded, additional savings during drought will mostly come from residents reducing their outdoor use.

Our rural water users will be able to trade water and they will have efficient irrigation equipment and on-farm water use practices.

The SEQ Water Grid will be operated as efficiently as possible while achieving the LOS objectives, minimising operating costs and energy consumption.

1.3.3 Water security through diversified and integrated water supplies

SEQ will have a water supply system that is increasingly diversified and interconnected, including dams and weirs, desalination and water recycling.

This combination will allow us to make the most of the rain we receive and, in combination with a pre-determined drought response plan, meet our water needs during future periods of prolonged drought.

Local supplies, such as rainwater tanks and stormwater harvesting, will be an integral part of all new developments, reducing the demand for water from the SEQ Water Grid and contributing to improved environmental outcomes.

Corridors and potential infrastructure sites will be identified and preserved, at appropriate triggers, so we are ready to build the water supply infrastructure required in the future.

1.3.4 Improving environmental outcomes

Water supply sources will be managed in a way that enhances the health of our waterway systems. Nutrient discharges into Moreton Bay will be reduced because more of SEQ's water will be recycled. Enough water will be released into rivers and streams from our dams to maintain flora, fauna and river health.

1.4 Working in partnership

The Strategy was developed in partnership with key stakeholders, initially with the Queensland Government, the Council of Mayors (SEQ) and the bulk water authorities. Input was sought from industrial and rural water user groups, specialist working groups, the SEQ Healthy Waterways Partnership and the community.

1.5 Results of consultation

Two versions of the Strategy have been released for public consultation.

The first version was released for public consultation from 26 March 2008 to 31 July 2008.

During the consultation period, the QWC ran a campaign to raise awareness of the draft Strategy and its key content. The QWC sent a direct-mail brochure to 1.1 million SEQ households outlining the key features of the draft Strategy and information was conveyed in press advertising in a range of newspapers in SEQ. More than 2600 copies were distributed to other members of the community and almost 1500 people attended Strategy presentations. Community members were also engaged through events such as World Environment Day and the Royal Queensland Show (the 'Ekka').

The QWC received 175 responses on this version, of which 117 came from residents. Feedback was also received from 10 local government agencies, state and federal members of parliament, 20 business groups and organisations, 13 community and environmental groups and four rural water user groups.

Feedback on demand issues generally related to the proposed planning target of an average regional residential usage of 230 litres per person per day, total water cycle management, and business water efficiency measures. Feedback on water supply issues generally related to the proposed Traveston Crossing and Wyaralong dams, purified recycled water and other types of recycling, desalination and alternative additional water sources.

Feedback was also received on a range of other issues, including LOS objectives, population management, water pricing, the SEQ Water Grid, rural water and environmental issues.

The revised draft Strategy was released for public consultation from 20 November 2009 to 12 February 2010. The revised draft Strategy incorporated feedback on the initial draft and policy decisions by the Commonwealth and state governments, notably the cancellation of Traveston Crossing Dam. In releasing the revised draft Strategy, the Minister and Commissioner specifically sought feedback on whether the regional average residential consumption target should be 200 or 230 litres per person per day.

The QWC received 3410 submissions on the revised draft Strategy, of which 3192 primarily related to identifying potential desalination sites on the Sunshine Coast.

The final Strategy responds to many of the issues raised during consultation. Key changes include:

- a voluntary regional residential consumption target of 200 litres per person per day (Target 200)
- more detail explaining the process by which the QWC will prepare advice on the next bulk water supply (Section 3.5)
- information about the framework for implementing total water cycle management in SEQ (Section 2.3)
- more detail in Section 4.6 to explain the role of local supply sources generally, and rainwater and stormwater specifically—including case studies for projects that are currently underway
- more explanation of how the LOS objectives will be achieved in communities with stand-alone water supplies (Section 6.5.1)
- more detail about the investigations into opportunities to increase the amount or reliability of water for rural production (Section 6.5)
- extensive revision of the section on the Strategy's energy implications, plus a new section on greenhouse gas impacts—including forecast greenhouse gas emissions for the operation of the SEQ Water Grid at full capacity and when supply equals demand (Section 6.8.4).

A consultation report has been released with the Strategy.

Chapter 2

Our planning context and challenges

This chapter describes the framework of plans, policies, strategies and programs that help to develop and manage growth and resources in SEQ. The chapter also describes the major challenges that affect how we plan for water for the future.

Key messages

- The Strategy will be reviewed on a five-yearly basis, aligned with the review of the Regional Plan, or in response to emerging issues that might be identified through the annual reporting process.
- The Strategy has been developed with consideration of the relevant laws, regulations, guidelines and agreements related to planning in SEQ.
- Key challenges facing SEQ include population growth and climate variability and change.
- Water supply planning must reflect a total water cycle management approach, contributing to improved outcomes for waterways and catchments.
- Water supplies for rural communities and rural irrigation should be enhanced.
- Potential sites for future water supply projects need to be identified, investigated and preserved.

2.1 Our legislative and policy frameworks

This section describes the legislative and policy framework for the Strategy.

Figure 2.1 shows some of the key state and regional plans that have influenced the development of the Strategy. Other policies and initiatives such as the National Water Initiative and the National Water Quality Management Strategy have also influenced its development.

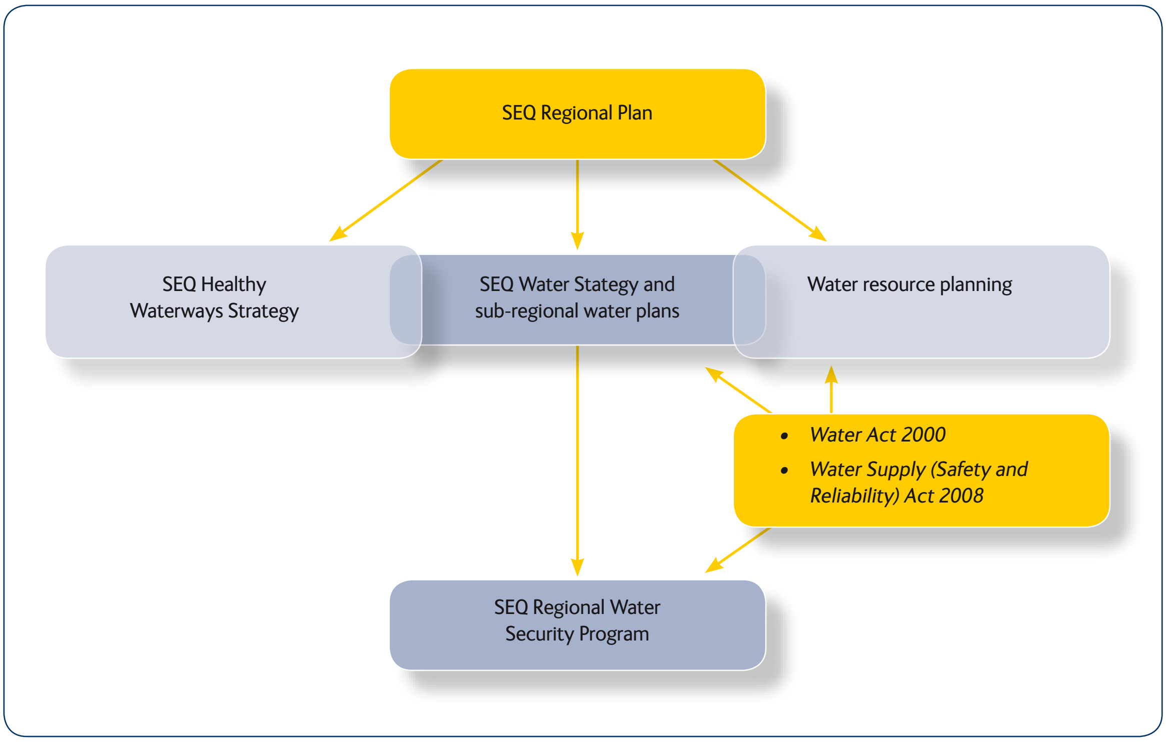


Figure 2.1 Relationship between the Strategy and other key planning processes

2.1.1 The SEQ Regional Water Security Program

The legislative and policy framework for water management in SEQ specifies a number of required (and enforceable) programs and plans. The Regional Water Security Program is one of these. The Regional Water Security Program is made by the Minister for Natural Resources, Mines and Energy and the Minister for Trade. It specifies, at a high level, how regional water security is to be achieved.

The Regional Water Security Program was adopted on 13 November 2006, providing for the construction of significant infrastructure. This program was revised on 5 March 2010 following the completion of most of these projects and the significant increase in storage levels across the SEQ region.

The Strategy and its associated analysis will provide the basis for future advice that the QWC provides to the Minister for Natural Resources, Mines and Energy and Minister for Trade on regional water security options.

2.1.2 The South East Queensland Regional Plan

The *South East Queensland Regional Plan 2009–2031* (Regional Plan) provides a framework for sustainable growth to the year 2031. It describes management strategies, regional land use patterns and policies to address growth management issues.

The Regional Plan states that water is a valuable and finite regional resource that requires management on a total water cycle basis.

The Regional Plan requires that there are secure supplies of water to meet reasonable growth and development in the region, including meeting rural water needs. This must be done while minimising overall system costs and protecting and enhancing the ecological health of our groundwater and surface water systems. It supports targeted reductions in water consumption by efficient use of water and management of consumer behaviour. Under the Regional Plan, the Strategy is to examine alternative water sources and demand management options, and develop a strategic direction for water supply in the region through to 2056.

2.1.3 Water resource planning

Water resource planning provides a framework for the sustainable allocation of water resources. Together, water resource plans and resource operations plans specify:

- the proportion of water flows that are provided for the environment
- the volumes of water that have already been allocated as entitlements which may be used for urban, industrial or rural purposes
- what water, if any, might be available for future allocation and use.

Water resource plans provide a framework for the allocation and management of water in a specified area. They do this by:

- defining the availability of water in an area
- providing a framework for sustainably managing and taking water in an area
- identifying priorities and mechanisms for dealing with future water requirements
- providing a framework for reversing, where practicable, degradation that has occurred in natural ecosystems.

Water availability is mainly reflected as entitlements, which are specified following rigorous environmental, hydrologic, social and economic assessment processes.

Resource operations plans implement water resource plans by management rules and arrangements necessary to satisfy the water resource plans' objectives and outcomes. They establish rules for monitoring, water sharing and water trading, and processes for dealing with unallocated water, within a single catchment. In addition, they establish tradeable water allocations.

In SEQ, the water resource plans for the Mary, Moreton, Logan and Gold Coast catchments have been finalised (refer to Figure 2.2). Resource operations plans for the Logan, Gold Coast and Moreton have been completed, while the resource operations plan for the Mary catchment is currently in development. Figure 2.3 illustrates the relationship between water resource plans, resource operations plans and the System Operating Plan, which is described in Chapter 3. Separate plans address other aspects of water planning, such as demand management.

Figure 2.2 Water resource plan areas

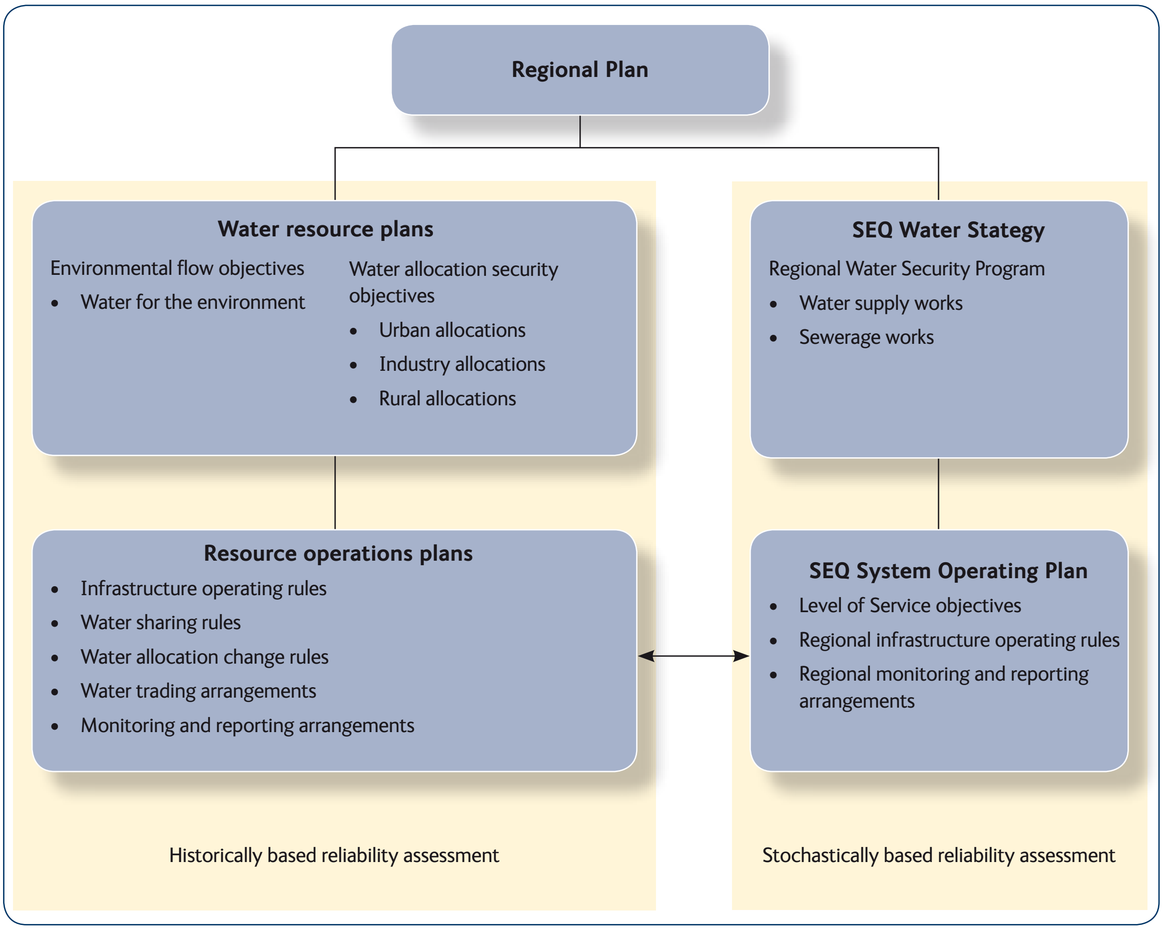


Figure 2.3 Relationship between water resource planning and the SEQ System Operating Plan

The water resource plans for the Mary Basin and Moreton are the only plans for SEQ that apply to groundwater. Declared sub-artesian areas, defined in the Water Regulation 2002, exist over Moreton Island and North Stradbroke Island.

The Strategy complies with the water resource plans. Section 3.1.3 discusses the importance of resource operations plans in achieving the desired supply reliability stated in the Strategy planning framework.

Water for the environment

Water resource plans specify a range of general and ecological outcomes. For example, some of the water resource plans for SEQ contain ecological outcomes that seek to minimise changes to the delivery of fresh water sediment, nutrients and organic matter to Moreton Bay. Monitoring and reporting programs will be established under the resource operations plans to assess whether or not water resource plans are achieving these outcomes.

In large part, the ecological outcomes are achieved by ensuring that actual flows meet or exceed specified environmental flow objectives. The environmental flow objectives are specified for high, medium and low flow regimes, and take into account seasonality. Wherever possible, environmental flow objectives attempt to mimic the natural flow regime of a catchment system.

In SEQ, environmental flows will exceed the minimum specified in water resource plans, because:

- each water resource plan identifies unallocated water that is available for urban or rural use. Until this water is fully granted, it would appear as surplus system flow (refer to Section 5.4.2)
- the SEQ Water Grid Manager will use less than the full urban water allocation to achieve the LOS objectives described in Chapter 3. This will increase the operating level of urban water supply dams, therefore increasing the potential frequency and volume of dam overflows to the environment.

The environmental flow objectives and water allocation security objectives included in the water resource plans are based on the historical record. The impacts of climate variability and change will be taken into account as part of future reviews of the plans.

Water for urban and rural use

Water resource plans also provide a level of security to water allocation holders, by establishing water allocation security objectives. These objectives define minimum performance levels that should be achieved through the implementation of operational and management rules specified in the relevant resource operations plans. The water allocation security objectives take into account any unallocated water that may be released for urban or rural use in the future.

There are a range of high priority and medium priority water entitlements from supplemented water supply schemes and some unsupplemented water entitlements. A supplemented water supply is one that is made more reliable by releases of stored water, such as from dams. Supplemented water supplies are managed by water supply scheme operators, such as Seqwater. An unsupplemented supply is one that is not sourced by releases of stored water. Unsupplemented supplies are managed by the Department of Environment and Resource Management.

In SEQ, most water resource plans specify that supply reliability[1] for high priority water allocations must be at least 95 per cent. Medium priority water allocations will generally have a lower reliability of supply. These performance levels reflect the nature of the use, with high priority allocations being suitable for urban and industrial uses and medium priority allocations being appropriate for rural uses.

For supplemented systems, announced allocation rules will generally be used to share water between allocation holders. Water trading rules will be specific to each plan and will generally apply to only supplemented water allocations in the initial resource operations plans. Water trading is intended to encourage water use efficiency and business development by enabling water allocation holders to sell, lease or seasonally assign spare water.

Groundwater

The *Water Act 2000* is the primary tool for management of groundwater extraction in Queensland.

Regulated groundwater areas have recently been identified in the water resource plans for the Mary and Moreton catchments. These mainly affect existing irrigation supplies. Bores for domestic use in SEQ are regulated on an as-needs basis.

Water bores may require a development permit under the *Sustainable Planning Act 2009* before they can be constructed. This ensures that these works are constructed properly and do not pose a risk to public safety or to the groundwater resource. Generally, the permit is required for all purposes except for stock water and domestic use.

2.1.4 Waterway health

Environmental values for water are set under the *Environmental Protection (Water) Policy 2009*. Objectives are set for key water quality parameters to protect these values, such as the percentage of sea grass coverage in parts of Moreton Bay or levels of nitrogen or phosphorus. These values provide a common set of goals to help integrate planning and management decisions.

The SEQ Healthy Waterways Partnership is a whole-of-government, whole-of-community collaboration. It focuses on leadership, commitment and voluntary cooperation to understand, plan and manage the use of SEQ's waterways and catchments. The program aims to complement other strategies and plans, including the Regional Plan, the Strategy and natural resource management plans.

The SEQ Healthy Waterways Partnership released the final version of the *SEQ Healthy Waterways Strategy 2007–2012* in 2008. The Healthy Waterways Strategy includes separate issue-based action plans regarding point source pollution, non-urban diffuse pollution, water-sensitive urban design, coastal algal blooms and protection of high conservation areas.

The Queensland Government released the draft State Planning Policy for Healthy Waterways for consultation in November 2009. The policy is intended to ensure that urban development is planned, designed and managed in ways that protect the environment.

1 This means the percentage of months of being able to take the full water allocation over the historical simulation period. Not being able to take the full water allocation in any month does not mean that no water is available in that month, but rather that the full water allocation could not be taken for that month.

2.1.5 Drinking and recycled water quality

Drinking water quality in Queensland is regulated by the *Water Supply (Safety and Reliability) Act 2008*, the *Public Health Act 2005* and their accompanying regulations and guidelines. These Acts provide a framework for managing and ensuring the safety of drinking water supplies.

These regulations are based on the *Australian Drinking Water Guidelines*. The *Australian Drinking Water Guidelines* are designed to provide an authoritative reference on what defines safe, good quality water, how it can be achieved and how it can be assured. They address health and aesthetic issues and include guideline values for water quality parameters.

The *Water Supply (Safety and Reliability) Act 2008* and the *Public Health Act 2005* also establish a regulatory framework to ensure that recycled water schemes produce water of a quality that is suitable for its intended use. The Acts apply to all new and existing schemes across Queensland, including the Western Corridor Recycled Water Scheme.

These regulations are based on the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks*.

Brisbane Water, Runcorn Water Treatment Plant

Photo courtesy of Brisbane City Council

2.1.6 National Water Initiative

The National Water Initiative (NWI) is an inter-governmental agreement between the Commonwealth of Australia and all states and territories. The overall objective of the NWI is to achieve a nationally compatible system of managing surface and groundwater resources for rural and urban use—a system that optimises economic, social and environmental outcomes and is based on markets, regulations and planning. In particular, the National Water Initiative seeks to:

- progressively remove barriers to water trading and to broaden and deepen the water market with the creation of an open trading market
- improve confidence for those investing in the water industry due to more secure water access entitlements; better and more compatible registry arrangements; better monitoring, reporting and accounting of water use; and improved public access to information
- return all currently over-allocated or overused systems to environmentally sustainable levels of extraction

- make water planning more sophisticated, transparent and comprehensive to deal with key issues such as the interaction between surface and groundwater systems, and the provision of water to meet specific environmental outcomes
- more efficiently manage water in urban environments—for example, through the increased use of recycled water and stormwater.

2.2 Institutional arrangements

The Queensland Government is implementing wide-ranging institutional reforms in the water industry in SEQ.

The reforms were required in order to realise the benefits of the SEQ Water Grid, ensuring the efficient and effective operation of the diverse range of supply sources. The previous arrangements were fragmented, with bulk source, transport and treatment assets being owned by 25 different entities. Customer service standards and water pricing were variable, there was no means of equitably sharing the cost of new infrastructure across the beneficiaries, and there was minimal transparency in the structure and level of water pricing.

The first phase of reform implementation was completed on 1 July 2008 with the establishment of the four new entities that own and operate the SEQ Water Grid (refer to Figure 2.4). These entities are:

- Seqwater, which owns all dams, groundwater infrastructure and water treatment plants in SEQ
- WaterSecure, which owns the desalination plant at the Gold Coast and the Western Corridor Recycled Water Scheme
- Linkwater, which owns all major pipelines in SEQ
- the SEQ Water Grid Manager.

These entities are all Queensland Government–owned statutory authorities.

Figure 2.4 Institutional arrangements

The second stage of the reforms was completed on 1 July 2010, when three new council-owned distribution and retail entities commence operation. These entities own the water and sewerage distribution infrastructure and sell water and sewage disposal services to customers. The new entities are owned by the following councils and provide services within their areas (see Figure 2.5):

- Unitywater, servicing the Sunshine Coast and Moreton Bay areas
- Queensland Urban Utilities, servicing the Brisbane, Scenic Rim, Ipswich, Somerset and Lockyer Valley areas
- Allconnex Water, servicing the Gold Coast, Logan and Redland areas.

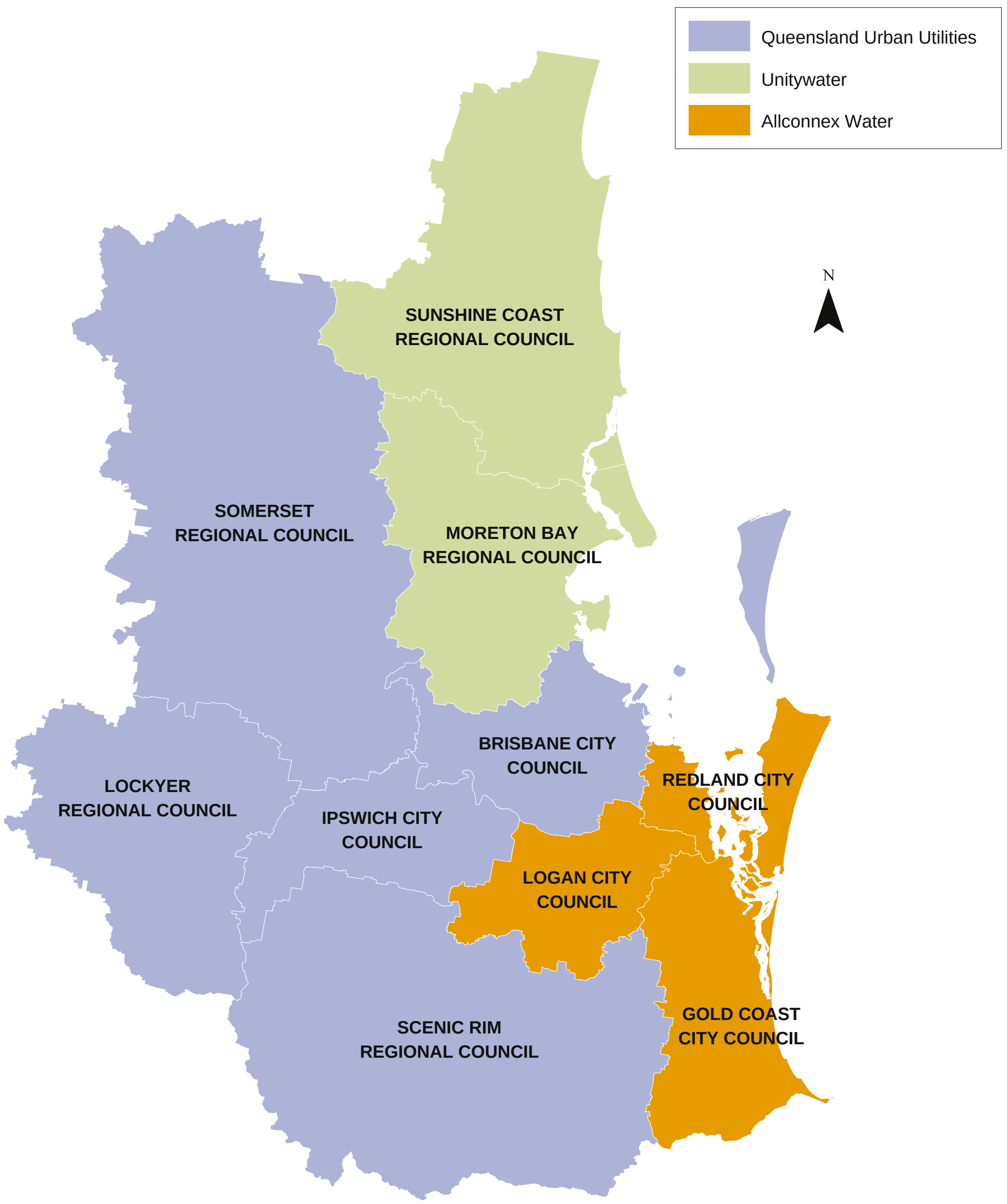


Figure 2.5 Boundaries of the three council-owned distributor-retailers

The SEQ Water Grid Manager is responsible for directing the physical operation of the SEQ Water Grid. The SEQ Water Grid Manager optimises the scheduling of supply from each source, taking into account a range of factors, including system reserves, dam inflows, operating costs, water quality and risk management.

The SEQ Water Grid Manager also provides a mechanism to share the costs of the SEQ Water Grid, by acting as the single buyer of bulk water services and the single seller of bulk water for urban purposes. It sells a wholesale 'pool' product, reflecting the portfolio cost of supplying retailers with a defined security and quality of supply at a defined bulk supply node.

Case study: Regional approach to maintaining a quality water service

On 29 December 2008, the SEQ Water Grid Manager was notified that residents in the south and west of Brisbane and some parts of Ipswich were experiencing changes to the taste, colour and odour of their tap water.

This was due to high summer temperatures, intense summer storms and seven years of extreme drought conditions. In combination, these factors increased the amount of soluble and insoluble inorganic and organic compounds flowing into water supplies at Mt Crosby. This elevated the levels of naturally occurring organic compounds, such as manganese and geosmin in the water. These organic compounds altered the colour and taste of the drinking water from the Mt Crosby Water Treatment Plant; however, the tap water continued to meet the strict health requirements of the *Australian Drinking Water Guidelines*.

The SEQ Water Grid Manager worked with four Grid participants to manage the water quality incident. Actions included:

- increasing the production of water from North Pine Water Treatment Plant
- flushing the Mt Crosby Weir with fresh water
- transferring 50 million litres of water a day from the Gold Coast to blend with Mt Crosby water
- transferring 20 million litres of water a day from the Gold Coast to Logan.

These measures resulted in reduced manganese and geosmin levels, improving the taste and odour of the tap water for Brisbane and Ipswich residents.

By 14 January 2009, test results confirmed that the concentration of organic compounds and minerals in the water at the Mt Crosby Water Treatment Plant was back to normal levels and below the *Australian Drinking Water Guidelines* aesthetic threshold.

Beyond the physical operation of the SEQ Water Grid, the reformed institutional arrangements have the potential to deliver significant benefits to the community by:

- improving and simplifying business structures to deliver water services in a coordinated manner
- creating economies of scale and scope due to the reduced number of entities
- improving service delivery by specialist entities, with the amalgamation of technical skill sets
- clarifying the respective roles of state and local governments
- improving the transparency and accountability for bulk transport and distribution networks with a strong asset management regime
- enhancing economic regulation and pricing.

The ability to introduce competition was a consideration in developing the new arrangements. Scope for practical competition will be actively assessed as part of the significant policy and regulatory reform agenda being undertaken by the QWC. While the SEQ Water Grid Manager is a monopoly service provider in the short term, some scope for the sale of bulk water directly to SEQ Water Grid customers by suppliers will be established at an early stage. This bypass mechanism is likely to see the development of new supply sources, particularly for localised solutions such as dual-reticulation recycled water schemes.

The SEQ Water Grid Manager can also enter into urban and rural water contracts. The Queensland Government has previously announced that recycled water will be made available from the Western Corridor Recycled Water Scheme to Lockyer Valley irrigators when not required to meet urban supply requirements (refer to Section 6.6.3). Additional supplies could also be made available from the SEQ Water Grid for rural production when not required to meet urban needs, such as through temporary or seasonal supply. Temporary allocations would be made available through a competitively neutral and transparent process. Any sales would be required to recover the cost of supply and not disadvantage other system users.

2.3 Total water cycle planning

The regional framework for total water cycle planning is set out in Section 11 of the Regional Plan. This section provides further detail on implementing this framework in SEQ.

The Strategy seeks to optimise total water cycle outcomes by:

- using and managing all water resources sustainably and within water resource plan limits
- introducing a demand management program to ensure that we continue to conserve our precious water resources
- considering all potential water sources, including possible future purified recycled water schemes and local recycling and stormwater schemes
- establishing new design standards for development, including for water efficiency and provisions of alternative supply sources
- recognising the importance of catchment management in protecting public and ecosystem health.

The following text box explains the framework for total water cycle management.

Framework for total water cycle management in SEQ

Total water cycle management (TWCM) involves the integration of land use and infrastructure planning across SEQ as a whole and for major development areas, local areas and specific sites. Key features of total water cycle management planning include:

- water efficiency and recycling
- integrated management of urban and rural water
- water-sensitive urban design in development
- stormwater management to improve water quality and water supply and to minimise the alteration to natural flow regimes
- a focus on catchment management to protect drinking water supplies and waterways from pollution.

Total water cycle management needs to be considered at a number of scales, with the planning process and the focus of investigations differing for each. For instance, regional planning focuses on regionally significant outcomes and infrastructure, such as the LOS objectives for water supply. At the other extreme, on-site development involves delivering built outcomes such as rainwater tanks, stormwater reuse or water-efficient devices.

Figure 2.6 illustrates the scales of planning and the key planning focus for each. At each scale, the planning requirement sets the context for planning at the scale below. At the more strategic levels, planning should not be unnecessarily prescriptive. Rather, target outcomes should be specified only where they are regionally significant.

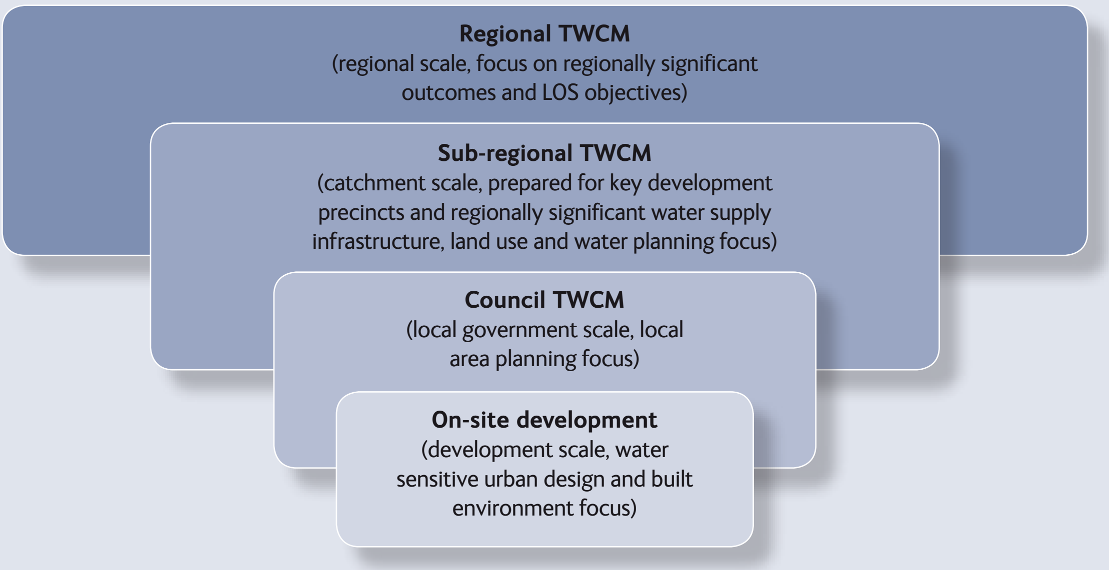


Figure 2.6 Framework for total water cycle management

Regional scale

The Queensland Government is responsible for overarching water management in SEQ. This responsibility involves a range of regional policies and initiatives, including the *South East Queensland Regional Plan*, the Strategy and the *South East Queensland Healthy Waterways Strategy 2007-2012*. These policies and initiatives are reviewed on a regular basis.

Sub-regional scale

Sub-regional total water cycle plans will be prepared for key development precincts, and where regionally significant water supply infrastructure is located. The purpose of these plans is to integrate land use planning with planning for waterway health and urban and rural supply purposes.

Sub-regional total water cycle plans will be led by the QWC, in conjunction with the local distributor-retailer entity and local governments.

The plans will build on and integrate existing processes undertaken by a range of entities. The key processes are:

- water resource planning, led by the Department of Environment and Resource Management
- specification of environmental values and water quality objectives, led by the Department of Environment and Resource Management
- water supply planning, led by the QWC
- drinking water catchment protection, led by councils and Seqwater
- recycled and wastewater infrastructure planning, led by councils and the distributor-retailers
- overland flow and flood management, led by the Department of Environment and Resource Management and local governments
- land use planning and development assessment, led by the Department of Infrastructure and Planning and local governments
- rural community planning, led by the Department of Infrastructure and Planning and the Department of Employment, Economic Development and Innovation.

The plans will include key decisions about the scope of possible future purified recycled water schemes, local recycling for non-potable uses, development controls to protect water quality, and stormwater capture and use. The plans could lead to the imposition of requirements on the way in which development is delivered and on any local supply solutions, in order to achieve optimal overall outcomes.

The outcomes from sub-regional total water cycle planning will be recommended for inclusion into the Regional Water Security Program. The Program will list key infrastructure and outcomes that should be incorporated into planning schemes and supporting documents.

Local governments will continue to have a controlling influence over local water cycle management through the preparation of planning instruments such as priority infrastructure plans.

The QWC is finalising a sub-regional water cycle plan for key development areas located within the boundaries of the Logan City Council and Scenic Rim Regional Council. This plan is being undertaken in partnership with the two councils, the SEQ Healthy Waterways Partnership and relevant Queensland Government agencies. Water-related issues affecting the area, include:

- providing water supplies for existing and new land uses, including for rural production
- managing sewage and stormwater discharges from existing and new developments
- protecting water supply catchments.

The plan will assess local supply solutions, as addressed in Section 4.6 of the Strategy. It will also consider opportunities to minimise the cost of, and energy used by, water cycle infrastructure. These issues are not council area specific and involve a number of entities. Some need to be resolved quickly to enable urban development to proceed, while others are associated with the operation and health of the Logan River system and require a long-term commitment to improving the management of resource and catchment issues within that system.

Future plans will be prepared in the short term for the key development and identified growth areas within the Moreton Bay region, Caloundra South and Palmview within the Sunshine Coast region and Ripley Valley within the Ipswich region. Other sub-regional plans will be prepared for key development and growth areas within the Regional Plan on a progressive basis.

Council scale

Under the *Environmental Protection (Water) Policy 2009*, local governments are required to develop total water cycle management plans that will guide their operating principles and decision making at the local level. Council total water cycle management plans must be developed in accordance with the guidelines being prepared by the Department of Environment and Resource Management. They will generally include provisions for integrating urban water services, including water supply, sewerage, trade waste and stormwater management. Among other things, they will address harvesting of rainwater and stormwater, wastewater recycling and water-sensitive urban design.

Council total water cycle management plans generally cover a larger spatial area than sub-regional total water cycle plans and will provide a higher level of detail to guide decision making for future planning.

On-site scale

At the on-site scale, development should comply with the planning framework outlined above and other requirements, such as the Queensland Development Code and state planning policies.

In recent years, some local governments in SEQ have incorporated water-sensitive urban design into these requirements, often in partnership with developers.

Water-sensitive urban design is a planning and design approach that integrates water cycle planning management into the built form of houses, allotments, streets, suburbs and master-planned communities. Among other things, water-sensitive urban design seeks to avoid or minimise the impacts of development by:

- protecting and enhancing the intrinsic values of the natural water cycle by minimising disturbance to natural landforms, wetlands, watercourses and riparian zones
- protecting surface and groundwater quality
- reducing downstream flooding and drainage impacts on aquatic ecosystems by managing stormwater run-off and peak flows
- promoting more efficient use of water by providing access to alternative local supplies of water, such as recycled water or stormwater
- minimising wastewater generation and ensuring treatment of wastewater to a standard suitable for wastewater reuse or release to receiving waters
- controlling soil erosion during construction and operational phases
- providing localised water supply solutions.

These initiatives complement Regional Plan requirements. The *Regional Plan Implementation Guideline Number 7* specifies design objectives for best practice urban stormwater management and describes how they should be adopted. The design objectives address three components of urban stormwater that affect water quality and waterway health:

- frequency of urban stormwater flows
- magnitude and duration of urban stormwater flows
- loads of sediment, nutrients and litter in urban stormwater.

The *Water Sensitive Urban Design Technical Design Guidelines for South East Queensland* describe appropriate methods for the detailed design of some common structural stormwater management measures.

2.4 The challenges we face

The Strategy seeks to ensure that SEQ has a safe and secure water supply. The social and economic consequences of an unreliable water supply or a failure of supply are unacceptable.

In providing this security, a balance needs to be struck between the outcomes sought by various stakeholders, which are not always well aligned. Some examples include:

- providing sufficient regional water security while minimising social, environmental and economic impacts
- providing sufficient water without over-capitalising on excess supply capacity
- improving water use efficiency while maintaining adequate supplies to support the SEQ community's lifestyle expectations

- providing improved access to water supplies for rural production while maintaining user-pays principles
- ensuring that the recommended infrastructure programs are sufficiently flexible to respond to uncertainty and, in particular, climatic risk.

Figure 2.7 illustrates the key considerations that have been taken into account in preparing the Strategy and the broad outcomes sought. The Strategy must specifically address the following key challenges.

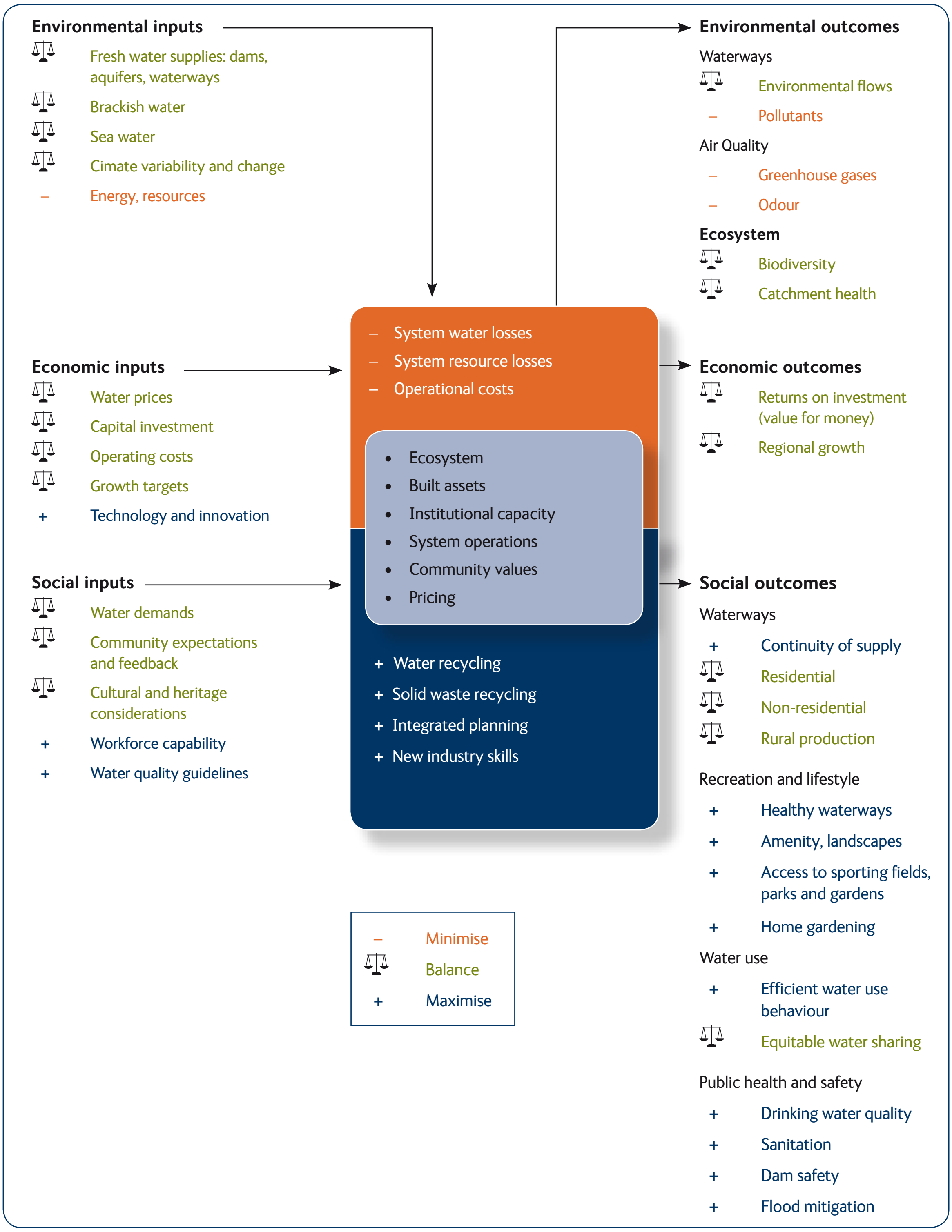


Figure 2.7 Key considerations and outcomes sought in preparing the Strategy

2.4.1 Population growth and demand trends

SEQ is forecast to continue to grow (refer to Table 2.1). Given the past trends, the Strategy has been prepared on the basis that future population growth in SEQ will trend between the medium and high series projections. Based on a high series projection, the population of SEQ could surpass six million people by 2051.

If SEQ residents were to return to pre-drought water usage of nearly 300 litres per person per day, regional water demand would double within the next 30 years, based on high series population forecasts. However, the community's response to the current drought has demonstrated that implementing simple behavioural changes, supported by basic water efficiency devices, can result in substantial water savings—reducing and deferring the need for additional infrastructure.

Table 2.1 Medium and high population projection series

Year	Population	
	Baseline	
2008[1]	3 043 100	
	Medium series	**High series**
2011	3 214 700	3 290 300
2016	3 567 100	3 737 200
2021	3 898 100	4 179 900
2026	4 204 700	4 609 300
2031	4 495 700	5 024 200
2051[2]	5 492 200	6 636 200
2056[3]	5 696 300	7 014 700

1 Includes Toowoomba and Cooloola

2 Sourced from the Planning Information and Forecasting Unit (PIFU), Department of Infrastructure and Planning. SEQ forecasts from 2006 to 2051; Queensland's future population 2008 edition (2008)

3 SEQ forecasts 2051 to 2056: PIFU consultancy (2008) for all local governments but Toowoomba and extrapolation for Toowoomba; and Cooloola: Queensland's future population 2006 edition (2006)

2.4.2 Climate variability and change

The more we learn about the climate system, the more we are aware of its unpredictability.

Australian Bureau of Meteorology studies indicate that Queensland's climate is changing, becoming drier and hotter since 1910. Australian Bureau of Meteorology and CSIRO studies also suggest that the region is heading into a period of increased climate variability, potentially with drought occurring more often and for longer periods.

Research on the impact of climate change on inflows has been undertaken for the catchment areas in the western parts of SEQ, including Wivenhoe and Somerset dams. Case studies involving a number of global climate models and higher resolution regional climate models indicate a range of possible climate change outcomes by 2030. Mean temperatures in the western parts of SEQ could increase by between 0.8˚C and 1.2˚C, evaporation could increase by 2 per cent to 8 per cent, and annual rainfall could reduce by 5 per cent or increase by 20 per cent. The annual stream flow for the Brisbane River downstream of Mt Crosby Weir could be reduced by up to 28 per cent in a dry scenario or increased by up to 14 per cent in a wet scenario.

Even small changes in climate could have significant impacts for water security. Figure 2.8 shows the historical record for rainfall and combined inflows for two key storages in the SEQ region. It illustrates that, from the start of the Federation Drought through to the early 1950s, average rainfall was only slightly lower than during the second half of the century. However, inflows were, on average, substantially lower in the first half of the twentieth century than the second. This demonstrates the significant impacts of slight changes in rainfall on catchment wetting and drying and the effect of patterns of rainfall within a year, particularly the intensity of rainfall leading to run-off.

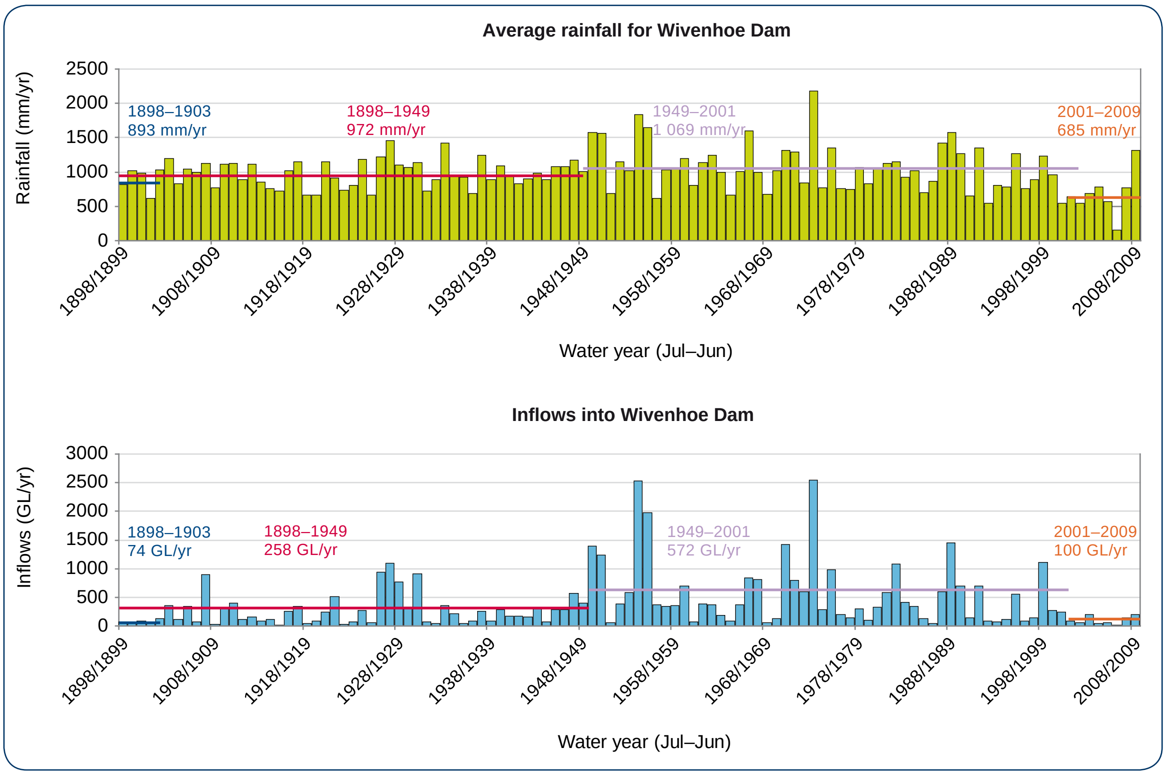


Figure 2.8 Rainfall and inflows into Wivenhoe Dam

Note: Average rainfall is the mean rainfall from the Wivenhoe and Somerset rain gauges.

Considerably more analysis is necessary to improve our understanding of climate change impacts, with the impacts expected to be highly variable across the region. Such work is being done by the Queensland Government Climate Change Centre of Excellence and the SEQ Urban Water Security Research Alliance.

The challenge is to ensure that water security planning accommodates drought impacts and maintains sufficient flexibility to adapt as climate change science improves. This is particularly important in SEQ, given our current high reliance on surface water supplies. The challenge for the SEQ community is to recognise that our regional water supply planning will continue to evolve as our understanding of climate change science improves.

The Federation and Millennium droughts

From 2001 to 2009, SEQ experienced the worst drought in the region's recorded history in terms of both length and reduced run-off: the Millennium Drought. On 20 May 2009, Wivenhoe, Somerset and North Pine Dams reached 60 per cent of their combined capacity, signalling an end to the water security crisis for SEQ.

Until the Millennium Drought, the Federation Drought was the worst drought in Australia's recorded history. Figure 2.9 illustrates the difference between the accumulated rainfall deficits across the catchment area to the west of Brisbane during the Millennium and Federation droughts. Accumulated rainfall deficit is the difference between rainfall over the drought period and average rainfall.

SEQ suffered the Federation Drought for five years from 1898 to 1903. At its worst, the accumulated rainfall deficit reached 1278 mm.

In comparison, the SEQ Millennium Drought ran for nearly eight years from 2001 to 2009. The maximum accumulated deficit during the period was 1530 mm.

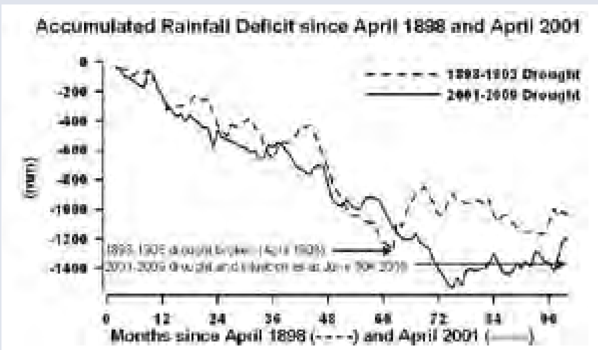


Figure 2.9 Accumulated rainfall deficit for the Federation and Millennium droughts

Source: Prepared by the Queensland Climate Change Centre for Excellence, July 2009

The El Niño-Southern Oscillation

The El Niño-Southern Oscillation (ENSO) phenomenon was a major contributor to the Millennium Drought, with El Niño events in 2002–03, 2004–05 and 2006–07.

ENSO is a global phenomenon that has a strong impact on Australian rainfall, particularly summer rainfall in Queensland. ENSO involves interplay between the ocean and atmosphere, which sets up a see-saw-like fluctuation in air pressure and sea surface temperature across the eastern and western Pacific. One extreme of this fluctuation is known as El Niño and the other extreme as La Niña. The fluctuation tends to lock into one mode (either El Niño or La Niña, or a more neutral mode) for several months—typically from spring through to the end of summer.

El Niño events tend to lead to dry summers in Queensland due to a reduced onshore flow, fewer tropical cyclones (particularly in southern Queensland) and a less active and less extensive monsoon system. Opposite conditions tend to occur during La Niña events.

ENSO has not been the only factor contributing to the dry conditions experienced in SEQ. Rainfall in SEQ is also influenced by both tropical systems from the north and fluctuations in the high-pressure ridge to the south. Interaction of these phenomena throws significant uncertainty around rainfall projections and long-term climate behaviour of the SEQ climate system. As a result, the impact of El Niño or La Niña differs somewhat from one event to the next. Another factor influencing the duration and intensity of drought, and the impact of ENSO, is variability in climate over long cycles. The SEQ Urban Water Security Research Alliance is undertaking research in this area, including a project on the Inter-decadal Pacific Oscillation.

Modified from: The South East Queensland Drought to 2007, Queensland Climate Change Centre of Excellence, 2007.

2.4.3 Efficient operation

The SEQ Water Grid provides the capacity to manage water supply on a regional basis. The challenge is to operate the SEQ Water Grid in a cost-effective and efficient manner for the SEQ community, while still achieving regional water security objectives.

Prior to the establishment of the SEQ Water Grid, the region was supplied as eight largely discrete water supply zones, with differing levels of reliability and, until recently, different owners and operators. Due to the lack of connectivity, restrictions were frequently applied in parts of the region while dams in other parts might have been full or overflowing. For instance, a severe drought was experienced on the Gold Coast in 2002, resulting in the application of severe restrictions and planning for the construction of a pipeline from Brisbane. A few years later, Brisbane was experiencing the most severe drought on record while dams on the Gold Coast were overflowing.

The SEQ Water Grid allows risk to be managed on a regional level, rather than on an individual storage or system basis. It allows optimal location of drought storage reserves and allows water to be moved from areas of surplus to areas that face a shortfall.

Conversely, when dam levels are high, the SEQ Water Grid Manager can reduce operating costs and energy consumption by:

- reducing production from expensive and energy-intensive sources, which are generally the climate resilient water sources
- 'mothballing' or reducing production from small supplies, such as aquifer projects
- altering the rate of transfer through major interconnections
- selling water to irrigators or adjoining areas on an interruptible basis.

2.4.4 Rural water supplies

The Regional Plan identifies around 80 per cent of the region as Regional Landscape and Rural Production Area. A portion of this area comprises protected national and conservation parks, water storages and state forests. However, the majority is privately owned farmland.

For the rural production sector in SEQ, access to water and the cost of that water has proven to be a major challenge. This challenge has been compounded because:

- there are thirteen sub-catchments in SEQ, which fragment potential water delivery schemes and make movement of water from one area to another difficult and expensive
- rural producers are required to provide increasing levels of certainty to major purchasers, which is difficult to provide without secure water.

These characteristics create a unique set of challenges to be overcome when developing a rural water supply strategy that aims to meet the objectives of the Regional Plan.

With SEQ now out of drought, the QWC can investigate options to increase the availability of water for rural irrigation. These investigations will be a key focus for 2010 and 2011, and are described in Section 6.6.

2.4.5 Potential water supplies

Planning for future bulk water supplies presents several challenges.

Additional bulk water supplies to meet growth might be required in 2021, and most likely not until mid-2020s. However, as the population continues to grow, competition for land is rapidly increasing. Planning for future water infrastructure requires site investigation and preservation well ahead of future need. Sufficient land must be preserved for potential future water supply options, including interconnections, with the least possible impact on adjacent communities. Pre-planning can also reduce the time required to construct any new water infrastructure.

All remaining potential bulk water supplies must be investigated in detail, including climate resilient options such as desalination and purified recycled water. There are few sound opportunities for further development of major surface water storages in the region. This is due to the shortage of suitable sites in areas identified by the water resource plans as having reliable water inflows. Groundwater is also almost fully developed, apart from smaller opportunistic extractions.

Rainwater tanks and alternative local supplies must also be investigated in detail. Some of these alternatives have the potential to exceed the minimum savings required under the Queensland Development Code, or to deliver the minimum savings more efficiently. However, they must be compared to other options on a triple bottom line basis. More research is needed to quantify the benefits and costs of these alternatives, and to ensure that they are capable of consistently supplying fit-for-purpose water quality.

Finally, there is a need for a robust and transparent process by which the QWC will prepare advice for the Queensland Government regarding the nature, location and timing of the next augmentation.

2.4.6 Our environment

SEQ contains some of the most valuable waterways and estuaries in Queensland. These waterways and estuaries are affected by a range of factors associated with human settlement, such as:

- altered environmental flows from water resource development and changes in land uses
- polluted run-off and degradation of riparian zones from urban or rural development
- point source pollution from wastewater treatment plants and industry
- in-stream sand extraction and erosion of river banks
- fishing.

The SEQ Healthy Waterways Partnership publishes an annual Report Card on waterway health. The Report Card demonstrates that these factors have caused degradation to a number of rivers and estuaries, despite some major achievements over the past decade, An increasing population, together with substantial industrial growth, will put more pressure on ecosystem health.

To restore our waterways, new development must be designed to protect water quality and flows, existing uses must be better managed, and degraded areas must be rehabilitated. These challenges highlight the importance of total water cycle management, as explained in Section 2.3. Section 4.6.3 describes some of the direct environmental benefits that can be achieved to reduce nutrients in waterways, through the use of well-planned water recycling.

Chapter 3

Striking the balance —Methodology

This chapter provides an overview of the planning framework that underpins the Strategy. It explains the approach to water security planning in SEQ, and the Level of Service (LOS) objectives that have been adopted. It also provides an explanation of how the SEQ Water Grid will be operated to achieve the LOS objectives. Finally, the chapter provides an overview of the methodology for demand forecasting and comparing alternative demand and supply options.

Key messages

- LOS objectives provide a basis for planning and managing SEQ's water resources.
- LOS objectives include the duration, severity and frequency of water restrictions.
- The Strategy aims to achieve the LOS objectives for all communities with reticulated water supplies in SEQ. See Section 3.1.1 for the full list of LOS objectives.
- The potential impact of climate change has been analysed assuming an immediate 10 per cent decrease in the yield from dams and weirs.
- A drought response plan will be developed. The plan will require the introduction of Medium Level Restrictions and the construction of new climate resilient or climate independent water supplies, such as desalination plants, as necessary.

3.1 Urban water supply planning underpinning the Strategy

The SEQ Water Grid is an interconnected system of dams and weirs, groundwater, desalination and purified recycled water. Through optimal operations, the SEQ Water Grid provides a secure water supply. While the region will continue to have a high reliance on its surface water storages, the ability to introduce climate independent water into the system and draw on a variety of sources significantly improves the security of supply.

The Strategy adopts an analytical technique based on the LOS objectives approach, originally published by the Water Services Association of Australia in June 2005. This approach is reflected in the *Water Act 2000*, which requires the QWC to provide advice based on desired LOS objectives.

The LOS approach is intended to ensure that the community has a safe and reliable water supply, and that this is communicated to consumers. Water supply planning achieves this purpose in three ways:

1. The system has the capacity to maintain an adequate level of water supply over most periods in the long term.
2. When droughts occur, a drought response plan protects against water shortages through the planned implementation of Medium Level Restrictions and the construction of new climate resilient or climate independent supplies, such as desalination, as necessary.
3. In cases of extreme drought or critical water shortage, a contingency or emergency plan ensures that basic water needs for a community can be met for the duration of that situation.

The LOS approach involves:

- stochastically[1] generating longer time sequences of hydrologic data that have similar statistical characteristics to that of the historical record—this provides better information about climate variability and the potential for droughts worse than have occurred on record
- analysing climate models to assess potential reductions in surface water availability due to climate change
- reducing demand through cost-effective measures
- planning for future droughts as a core element of the planning process
- defining a yield for the SEQ Water Grid as a whole, such that water can be supplied at the specified LOS objectives.

[1] A stochastic model is a tool for estimating probability distributions of potential outcomes by allowing for random variation in one or more inputs over time. The random variation is usually based on fluctuations observed in historical data for a selected period using standard time-series techniques. For our model, the historical record was used to generate 1000 replicates of data with each replicate representing more than 100 years of inflow data.

3.1.1 Level of Service objectives

LOS objectives provide a basis for establishing a secure water supply. The objectives define:

- the desirable maximum frequency, duration and severity of water restrictions
- the average amount of water per capita that must be supplied in normal times.

The objectives are used to determine the volume of water that can be supplied from the SEQ Water Grid, on average, every year—this is the LOS system yield. The LOS system yield is used, together with the projected demands, to ensure that supply and demand initiatives are put in place to meet future water needs.

When the LOS system yield exceeds demand, there is a lower likelihood of triggering restrictions than is specified in the LOS objectives. When demand exceeds the LOS system yield, there is a higher likelihood that restrictions will be triggered.

LOS objectives should reflect community expectations about water restrictions and the community's willingness to pay for improved security of supply. The LOS approach acknowledges that future severe droughts will occur, and that water restrictions are an effective and efficient way of managing the impact of these droughts—but restrictions can have a significant impact on the community. The LOS objectives make clear the assumptions made by water supply planners, and will inform investment decisions by the community.

The LOS objectives for SEQ have been developed on the basis that, in order to maintain a comfortable lifestyle, the community would prefer to use Permanent Water Conservation Measures coupled with Medium Level Restrictions in times of drought. In normal times, this means that water will be used wisely. In periods of drought, Medium Level Restrictions will be introduced early enough and at such a level that they avoid negative impacts on community amenity and the regional economy. For instance, in future droughts, it is expected that restrictions would not require a ban on handheld hosing and water-efficient sprinklers.

The LOS objectives are listed below. The objectives will be targeted across all SEQ communities with reticulated drinking water supplies.

Level of Service objectives

- During normal operating mode, sufficient water will be available from the SEQ Water Grid to meet an average regional urban demand of 375 litres per person per day (including residential, non-residential and system losses).
- Sufficient investment in the water supply system will occur so that:
  - Medium Level Restrictions will not occur more than once every 25 years, on average
  - Medium Level Restrictions will only reduce consumption by 15 per cent below the total consumption volume in normal operating mode
  - drought response infrastructure will be not be required to be built more than once every 100 years, on average
  - combined regional storage reserves do not decline to 10 per cent of capacity more than once every 1000 years, on average
  - regional water storages do not reach 5 per cent of combined storage capacity
  - Wivenhoe, Hinze and Baroon Pocket dams do not reach minimum operating levels.
- It is expected that Medium Level Restrictions will last longer than six months, no more than once every 50 years on average.

On the basis of the LOS objectives, the community can expect to experience water restrictions no more than once every 25 years, on average. Such restrictions would reduce regional urban demand by an average of 15 per cent, across the entire community. In setting future Medium Level Restrictions, the QWC will consider the likely impact of the measures, community preference and the existing level of efficiency for residential and non-residential customers. Once business and industry have implemented best practice water efficiency, it is likely that additional savings will be made by the residential sector curtailing outdoor use. The QWC expects that residential consumption may be curtailed to a regional average of about 185 litres per person per day.

The QWC considers that these objectives represent appropriate planning assumptions, given the current variation in consumption across SEQ and the high level of uncertainty regarding population growth, impacts of climate change and a range of other factors. In particular, the QWC recognises the risk that consumption may rebound over a relatively short period of time, compared to the time required to plan and construct new sources of supply.

The LOS objectives will be reviewed as part of future reviews of the Strategy, taking into account a range of factors including the level of residential water use and community acceptance of continued water efficiency measures. For example, the QWC would consider reducing the overall demand planning assumption if average regional urban consumption remains significantly below 375 litres per person per day and community acceptance of continued water efficiency measures remains strong. An annual performance review of the Strategy provides the opportunity to review the overall demand planning assumption.

The planning assumptions are discussed in more detail in Section 4.3.

Establishing the LOS objectives has involved trade-offs between financial costs, environmental impacts and the willingness of the community to accept restrictions on a periodic basis. Information gained from managing the Millennium Drought has been used in the formulation of the LOS objectives. The experience of managing regional water security during the Millennium Drought has provided useful evidence about practical issues and community expectations. Feedback on the draft Strategy indicated that residents of SEQ generally support ongoing water efficiency measures and planning to ensure that water supplies are secure during extreme droughts.

3.1.2 Drought response planning

A drought response plan is required to achieve the LOS objectives. The purpose of the drought response plan is to ensure continuity of supply regardless of climatic conditions or failures of the water supply system.

The drought response plan will contain the pre-determined response to droughts, including trigger levels for implementing and exiting water restrictions, water efficiency measures and construction of new climate resilient water supplies. The drought response plan will also include the introduction of purified recycled water to Wivenhoe Dam to supplement drinking water supplies. If Medium Level Restrictions and purified recycled water are introduced and the combined regional storage levels continue to decline, then the construction of projects identified in the drought response plan will be triggered. The trigger points for various aspects of the drought response plan are discussed in the following sections, together with the size and placement of the drought storage reserves.

Preparation for the construction of infrastructure in response to a drought will commence no later than when restrictions commence. However, it may be prudent to commence preparation for construction in advance of the commencement of restrictions, depending on the time of year, the rate of decline of regional storages and the level of preparedness of alternative options under the drought response plan.

The construction of drought response infrastructure is expected to occur not more than once every 100 years on average. Once constructed, this infrastructure will become part of the permanent water supply arrangements and would delay the need for future planned augmentations of the system.

While the drought response plan projects will be completed within a nominal period of 30 months, the water restrictions will only be lifted if:

- the drought conditions ease—that is, following one or more major rainfall events resulting in significant inflows,
  or
- the commencement of construction of additional pre-planned infrastructure that increases the volume of climate resilient or climate independent water supplies is brought forward.

The drought response plan will also contain contingency or emergency measures to manage extreme risk events, such as if one of the drought response projects is delayed or an extremely poor inflow sequence occurs. The measures will reflect the circumstances of the event, and may only be determined when Medium Level Restrictions have been introduced. One option is the introduction of a second tier of water restrictions—emergency restictions. Such restrictions would involve reducing average regional residential consumption to 140 litres per person per day. This is equivalent to approximately 25 per cent reduction from the planning assumption of a regional urban consumption of 375 litres per person per day under normal operating mode. For comparison, during the most critical water supply period of the Millennium Drought, residents in the restricted area of SEQ used an average of 129 litres per person per day. The likelihood that emergency measures such as these would need to be implemented is sufficiently low that it is not considered appropriate to warrant their inclusion as an LOS objective, but rather to embed them in the drought response plan as emergency restrictions.

3.1.3 SEQ Water Grid operations

The Strategy partitions the water storage compartment in SEQ dams both individually and as a combined total SEQ system into:

- working volume
- drought storage reserve
- minimum security volume
- minimum operating volume (dead storage).

Figure 3.1 illustrates the partitioning of the water storage compartment of the region's dams. These partitions apply both to individual dams and across the SEQ Water Grid as a whole. Many individual dams are also constructed with a flood storage compartment that sits above the water storage compartment.

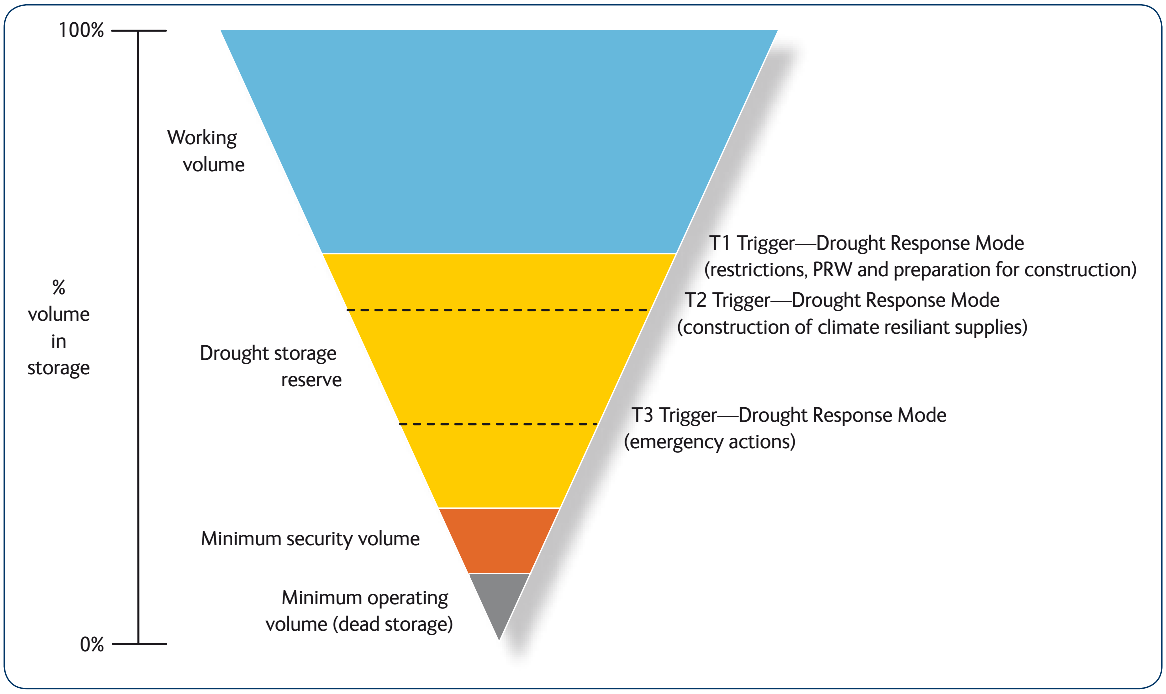


Figure 3.1 Partitioning of key SEQ Water Grid storages

The normal operating mode applies when the SEQ Water Grid is within the working volume. This mode will apply over most periods in the long term, consistent with the LOS objectives.

Below the working volume is the drought storage reserve. The combined SEQ Water Grid drought storage reserve underpins the drought response plan. The drought storage reserve is sized to provide, in conjunction with climate resilient sources, a minimum of 36 months' supply of water at a restricted demand. The actual volume of the drought storage reserve will vary over time according to the mix of supplies and the demand for water.

Calculation of the drought storage reserve requires consideration of:

- the restricted demand
- climate resilient dam inflows
- system losses, including evaporation and transport losses
- access to climate resilient and climate independent supplies, such as purified recycled water and desalination.

The drought storage reserve will only be held in the dams included in the definition of the key Water Grid storages.

Section 5 lists the region's surface water supplies. The following supplies are included in the definition of key SEQ Water Grid storages used to calculate the critical triggers—Baroon Pocket Dam, Ewen Maddock Dam, Cooloolabin Dam, Wappa Dam, Lake McDonald, Somerset Dam, Wivenhoe Dam, North Pine Dam, Lake Kurwongbah, Leslie Harrison Dam, Hinze Dam and Little Nerang Dam. This list includes all storages in SEQ owned by Seqwater, but excludes:

- weirs and off-stream storages that are too small to contain significant drought storage reserves
- storages that predominantly supply rural users, since these will not be required to be operated in accordance with the urban storage rules
- storages that supply a community that has no existing or committed SEQ Water Grid connection.

It is noted that drought storage reserves may still be specified for some of the predominately rural dams. For example, Moogerah Dam will include a volume to ensure security of supply for Boonah and connected towns. However, these reserves will be based on local considerations, rather than on the methodology outlined below.

At this time, the partitioning of individual dams defined as key Water Grid storages will be the same as the partitioning of the overall SEQ Water Grid. That is, the working volume of each dam will be between 40 per cent and 100 per cent of storage capacity. This partitioning may be reviewed over time, once the operation of the SEQ Water Grid has been refined.

The SEQ System Operating Plan describes the rules for operation of the SEQ Water Grid. These rules will influence the take from, and level of, specific dams. The rules establish acceptable levels of short to medium-term risk associated with triggering water restrictions and constructing new climate resilient water supplies. The LOS objectives also provide for the average expected performance of water supply over the long term. The rules balance short-term operational cost and efficiency benefits with maintenance of the long-term security objectives. This is achieved by understanding the real operational risks over shorter timeframes. Importantly, short-term financial gains should not be realised at the expense of long-term water security.

Within the combined SEQ Water Grid drought storage reserve there are three trigger levels:

- T1 is the trigger to enter the drought response mode (preparation phase). It applies when regional storage volumes drop down into the drought storage reserve. Pre-planned Medium Level Restrictions will be introduced and purified recycled water will be added to Wivenhoe Dam at this time. This phase provides time to prepare for construction, in the event of continued drought conditions.
- T2 is the trigger to enter the drought response mode (construction phase). It applies when construction of new climate resilient or climate independent water supplies, such as desalination plants, is required to commence to ensure that the restricted water demands for the community can be met for the duration of a long, severe drought.
- T3 is the trigger to enact emergency measures.

The trigger levels are stated in the SEQ System Operating Plan and will be reflected in the drought response plan.

For the SEQ Water Grid, the risk of drawing down to operationally significant storage levels, such as T1 or T2, will depend on the current storage volume within the system. Larger storage volumes, coupled with the increased opportunity for conjunctive system operation (transfers, desalination, or use of purified recycled water), result in a reasonably long period over which supply can be maintained with below-average inflows without drawing down to these trigger levels. However, operational decisions made when storage volumes are relatively high can still have a significant effect on regional water security (and potential infrastructure expenditure) if extended periods of low inflows are experienced.

Essentially, rules in the SEQ System Operating Plan enable timely modification of system operation to ensure that these risks are maintained within acceptable levels to the extent that is possible.

T1 has been set at 40 per cent of the combined capacity of the key Water Grid storages in SEQ. This aligns with advice to the Queensland Government from the QWC regarding the appropriate trigger to commence the introduction of purified recycled water in Wivenhoe Dam as an emergency source of supply.

T2 has been set at 30 per cent of the combined capacity of the key Water Grid storages in SEQ. This is determined by the need to allow a nominal 30 months for the construction of infrastructure in response to a drought, and by the LOS objective that the frequency of triggering drought response infrastructure will be not more than once every 100 years, on average. If the drought response plan identifies a critical project that requires more than 30 months to implement, then the time and associated trigger point for T2 will need to be reassessed. It is essential that both the T1 and T2 triggers are appropriate for the type and scale of response planned.

T3 will be set in the drought response plan. It is likely to vary depending on factors such as the period of time until drought response infrastructure is completed. It is expected to be set at 20 per cent or less of SEQ Water Grid storage capacity.

All the trigger levels may change over time, as new sources of supply are constructed and demand increases.

The minimum security volume is set at 5 per cent by the LOS objective that regional water storages must not be permitted to reach 5 per cent of combined storage capacity.

The minimum operating volume for any storage is included in the appropriate resource operations plan and may be referred to as the dead storage level. Water below the minimum operating level cannot be accessed with existing infrastructure.

3.1.4 Drought response exit

To exit the drought response mode, the combined SEQ Water Grid storage levels will need to increase beyond the T1 trigger level. The exit level will need to be set sufficiently above the drought storage reserve to minimise the risk of re-triggering water restrictions within an appropriate period. The actual exit level would be determined following consideration of:

- climate forecasts
- the existing mix of climate dependent and climate resilient supplies
- the status of any infrastructure projects in construction
- current policy on the use of purified recycled water
- short-term limitations on system capacity due to water quality
- managing the risk of use rebounding above consumption targets once the drought response mode is exited.

Ultimately, the capacity above T1 that is selected will need to strike a balance between the cost of staying in drought response mode unnecessarily, and the economic and social cost of moving out too early, and being forced to re-enter shortly after, if dam levels decline back to T1.

3.1.5 Determining the yield of the SEQ Water Grid

The LOS objectives are performance objectives for the delivery of bulk water supplies from the SEQ Water Grid.

The LOS system yield is the volume of water that can be supplied from the SEQ Water Grid every year and still achieve the LOS objectives. Until recently, estimating the system yield of a suite of integrated sources of supply has been based on an aggregation of yields of individual sources of supply, treated as unconnected. The modelling undertaken for this Strategy incorporates assessments of the LOS yield of specific dam systems and of the SEQ Water Grid as a whole. Future water availability has been estimated following consideration of:

- the LOS objectives
- environmental flow objectives and associated releases needed to maintain riverine, estuarine and marine ecosystem health
- water allocation security objectives
- resource operations plans
- total water storage capacity in the SEQ Water Grid
- inflows to the SEQ Water Grid storages over the period of the historical record
- estimated variability in inflows based on synthetically generated datasets that have the same statistical inflow characteristics as the historical record
- the possible impacts of climate change on inflows
- supply from climate resilient sources
- the volume of the regional drought storage reserve, and its distribution across individual dams.

Under the Strategy, less water is proposed to be used than is permitted under water resource plans and resource operations plans. This is because, in order to achieve the LOS objectives, water must be 'banked' in the wetter periods so that it is available during droughts that may be worse or more frequent than has occurred in the last 100 years. Fully using the available allocation could place the urban community at risk of supply failure during extended drought, especially from droughts worse than those that have been experienced since records were kept.

However, while the LOS system yield of the SEQ Water Grid is less than the sum of the allocations held by the SEQ Water Grid Manager for urban use, it is larger than the sum of the LOS yields of the individual systems.

Using less urban water than permitted under water allocations issued in compliance with water resource plans generally results in dam levels being higher than would otherwise be the case, because additional reserves are held in storage. In turn, this results in an increased likelihood of overflows from dams with associated environmental benefits and higher announced allocations for rural irrigation. The benefits for rural users of this arrangement are described further in Section 6.6.

For the purposes of water supply planning, modelling focused on the quantity of water. In practice, considerations such as water quality and other physical operational constraints will affect the performance of the SEQ Water Grid. However, these influences, though important in the short-term management of our water supplies, do not significantly impact on the overall LOS system yield of the SEQ Water Grid.

The regional water balance model has informed the development of broad operating rules for the SEQ Water Grid. These rules seek to balance the short-term operational costs and efficiency benefits of SEQ Water Grid operation with long-term water security objectives.

Operating rules for optimal use of the region's urban water supplies will be addressed in the SEQ System Operating Plan (refer to Chapters 5 and 7). Optimising the use of any surplus water supplies might include supplying rural production or transferring water to areas outside of the SEQ region or those areas not covered by the SEQ System Operating Plan. This could include supplying surplus water to the Tweed Shire in northern New South Wales, if appropriate.

3.1.6 Determining the climate resilient yield of the SEQ Water Grid

Some inflows will be received into the region's dams and weirs even in the most severe droughts. These inflows are referred to as climate resilient, as distinct from climate independent water supplies such as desalination. For example, during the most severe period of the Millennium Drought in 2006–2007 35 000 megalitres of inflows was recorded into the Wivenhoe–Somerset system, compared to an average of 615 000 megalitres per year in the preceding twenty years.

Assumptions about the level of climate resilient inflows influence the size of the drought storage reserve as well as the capacity of the climate resilient infrastructure that is constructed as part of the drought response plan. Assumptions must be based on a clear understanding of the risk of future drought inflow sequences occurring.

The 30-month construction period represents a critical component of the drought response plan. The trigger level for commencing construction depends on the assumed level of inflows over this 30-month period. If lower inflows occur during this period than were assumed in calculating the trigger level, then the volume of water in storage will be drawn down to critical levels before contingency infrastructure is completed. This could compromise regional water security. Planning for new infrastructure that might be required can shorten the construction time and is therefore an important part of drought response planning.

Stochastic modelling has been undertaken to determine the severity of potential droughts in SEQ. The modelling shows that SEQ should be prepared for droughts that are significantly worse than what was experienced during the Millennium Drought. However, the likelihood of these extreme events occurring is less than one in 10 000 years, on average.

The sequence used to calculate the climate resilient inflows was 30 months of inflows equivalent to a drought with a severity of between a one in 1000 and one in 10 000 year occurrence. The emergency plan provides a way of responding in the unlikely event that a drought is more severe than this.

3.1.7 Achieving the Level of Service objectives

The LOS objectives are performance objectives for the delivery of bulk water supplies from the SEQ Water Grid.

The statutory instrument for achieving the LOS objectives in SEQ is the SEQ System Operating Plan. The SEQ System Operating Plan specifies rules for how the SEQ Water Grid is operated to achieve the LOS objectives, within the bounds of the resource operations plans. The SEQ System Operating Plan directs how water can be supplied to meet the water needs of urban consumers and any other contracted customers in SEQ. This includes the supply of manufactured water sources, such as purified recycled water.

LOS objectives form part of the product definition for bulk water supplied in accordance with the SEQ System Operating Plan by the SEQ Water Grid Manager to any bulk transport node, ready for local distribution. Figure 3.2 illustrates where the LOS objectives apply under the SEQ institutional arrangements.

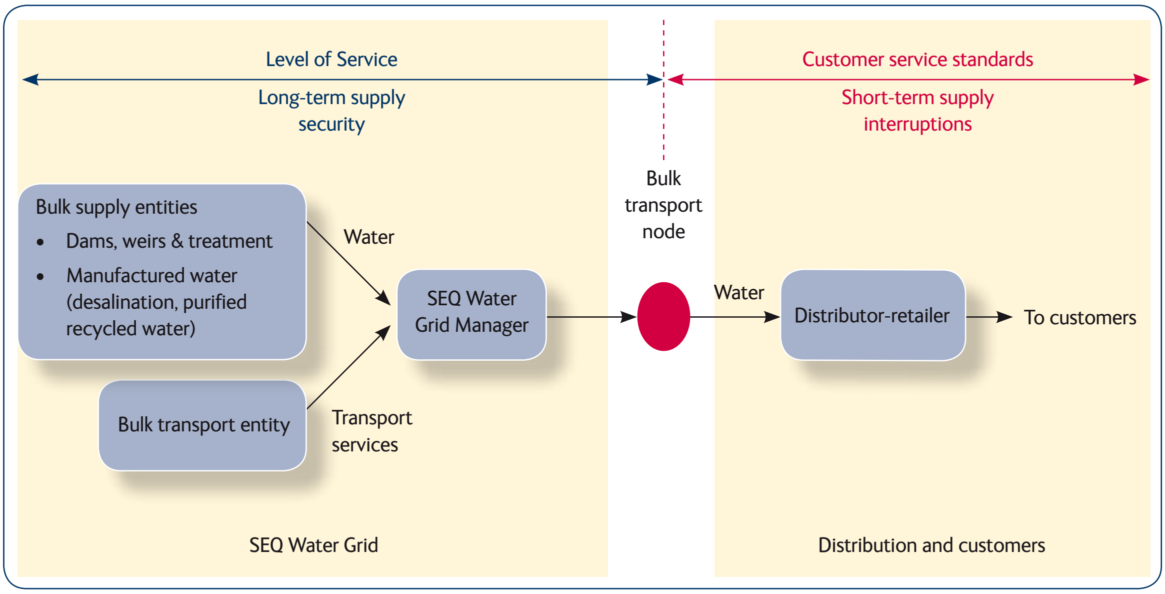


Figure 3.2 Application of LOS objectives and customer service standards

LOS objectives should not be confused with customer service standards. Customer service standards describe the level of service that a customer can reasonably expect from their distributor-retailer—for example, the response time to a breakdown or an interruption to supply. Each distributor-retailer will have the primary interface with customers, particularly through reading meters and issuing water and wastewater bills. Over the next three years, customers will move from local government area customer service standards under the *Water Supply (Safety and Reliability) Act 2008* to a Customer Water and Wastewater Code and regionally consistent service standards, and finally to guaranteed service standards. Customers will have input into the type of guaranteed service standards they want. A distributor-retailer will be required to compensate a customer if a guaranteed service standard is not met.

3.2 Planning for climate change

Climate models are used to forecast possible short- and longer-term climate change and likely impacts. They simulate oceanic and atmospheric processes and the important connections between land, oceans and the atmosphere. A factor affecting the usefulness of the climate models is the resolution, with most global climate models typically using a grid of between 150 and 300 kilometres.

There is considerable uncertainty about the accuracy of climate change projections and this uncertainty increases with the length of the projections made.

Regional climate models have been developed that increase the resolution of global climate models. This process is called ‘downscaling’ and requires enormous computing power. These models have reduced the uncertainty associated with the low resolution of global climate models. Work is underway to improve climate change estimates in terms of impact on stream flows. As already indicated in Section 2.4.2, case studies indicate that by 2031 the annual stream flow for the Brisbane River downstream of Mt Crosby Weir could be reduced in a dry scenario by up to 28 per cent or increased by up to 14 per cent in a wet scenario. Such impacts are expected to be highly variable across the whole of SEQ. Climate research indicates that, as a conservative estimate, a 10 per cent reduction in surface water availability is likely to occur by 2030.

The majority of climate modelling results for SEQ catchments indicate that the region is likely to become drier, with increases in average temperature and evaporation rates. This suggests that climate change may dramatically impact on regional water supplies. Consequently, less surface water is likely to be available for water catchments and dams. These changes are expected to occur over the medium to long term. This contrasts with Perth, where there is evidence that a change in inflows has already occurred.

More analysis is necessary to improve our understanding of climate change impacts. Such work is being progressed by the Queensland Government Climate Change Centre of Excellence and the CSIRO, through the SEQ Urban Water Security Research Alliance. Over time, this work will downscale the CSIRO global model simulations, and simulations from six other international modelling groups, to a 14 to 20 kilometre resolution for SEQ. It will result in a better integration between the climate change models and hydrologic modelling.

In Chapter 6, a scenario analysis has been undertaken assuming a 10 per cent reduction in the LOS yield of surface storages due to climate change. If there was an immediate climate change impact, the earliest date for supply augmentation could move forward from 2022 to 2017 (refer to Section 6.4.2). However, this impact is likely to occur over decades and the true impacts of climate change are currently difficult to quantify.

The scenarios adopted in the Strategy will be reviewed annually and revised as our understanding of the likely impacts of climate change in SEQ water supplies becomes better informed.

3.3 Planning for rural production

The Strategy includes significant initiatives to improve supply to the rural sector, as discussed in Chapter 6.

Rural water entitlements are defined through the water resource planning processes. In supplemented schemes, rural water allocations are generally specified as medium priority water, with a reliability of supply less than high priority (urban or industrial) water. This approach enables larger volumes of water to be made available during periods when dam levels are high. A significant portion of rural water entitlement exists from unsupplemented supplies—that is, water not supplemented by releases from dams or weirs.

In SEQ, water supply schemes exist in the Mary, Logan, mid-Brisbane, Lockyer and Warrill valleys. These supplemented schemes have historically operated with varying degrees of performance success and irrigators have sought ways to further enhance water security. Irrigators currently do not pay for the full cost of running these schemes. Chapter 6 discusses options to improve the reliability of supply within these schemes.

Additional water for rural use has also been made available due to the construction of the SEQ Water Grid, especially the Western Corridor Recycled Water Scheme. This additional water will be supplied to Category B (refer to Section 5.3.1) customers as an interruptible source. It will be available when the SEQ Water Grid is in normal operating mode, and is intended to cease when a drought response plan is implemented. Chapter 6 contains further information about these opportunities.

3.4 Profiling future demand

The Strategy is based on a comprehensive assessment of current and forecast water demands across SEQ. The methodologies and modelling will continue to be refined to actively monitor demand assumptions.

For this version of the Strategy, forecasting of urban water demands in SEQ has been based on:

- medium series population growth projections derived from the Queensland Government population projections—high series population forecasts have been used for sensitivity testing
- assessment of historical patterns of water use
- assessment of the historical effectiveness of existing and potential water-saving programs, including analysis of the costs and benefits of different water conservation and source substitution options at the end-user level
- aggregation of the forecast demands in each local government area to produce demand trend forecasts based on the continuation of existing policy in 2006—that is, assuming that water use continues into the future without savings from any additional demand management initiatives other than those that were already in place
- aggregation of the forecast demands in each local government area based on high, medium and low savings scenarios. The savings scenarios differ in terms of number and scope of demand management measures.

Population forecasts were revised in 2008, following the release of the first draft Strategy. The population forecasts contained in this Strategy have been adjusted based on these forecasts.

The potential reduction in demand from savings measures was estimated based on a range of complex considerations and assumptions. These included:

- structural water-saving measures implemented during the Millennium Drought
- the effectiveness of potential demand management measures, including participation rates and the number of water-efficient devices installed
- changing demographic patterns—in particular, the trend towards smaller households
- ongoing compliance with rules and regulations.

Demand forecasts are outlined in Chapter 4. Growth in demand for water for rural production is addressed in Chapter 6. To ensure that demand assumptions underpinning the Strategy remain current, ongoing demand monitoring and management will be undertaken using a water accounting framework, known as the Waterhub.

Increasing supply or reducing demand?

Some components of the supply and demand balance could be considered as either increasing supplies or reducing demand. The Strategy defines any new water source that contributes to the SEQ Water Grid as an increase in supply. For example, purified recycled water is considered to increase potable supply as it is added to the SEQ Water Grid. Water from rainwater tanks and other types of recycled water reduces demand on drinking water supplies from the SEQ Water Grid.

3.5 Process to select future supplies

The QWC proposes the use of an objective and transparent process to develop its advice to the Minister about the need for regionally significant augmentations of the SEQ Water Grid. This process is intended to:

- ensure the timely delivery of capital expenditure
- promote total water cycle planning
- provide an opportunity for parties other than the QWC to nominate innovative solutions for consideration
- ensure that options are compared on an objective, transparent and like basis, regardless of scale or type
- ensure that market participants receive information in a structured and equitable manner.

The process will consider demand and supply options, and options at a number of different scales. It will build on the detailed investigations outlined in Chapter 7, while also providing opportunities for the community and stakeholders to have input. The process may also provide opportunities for third parties to propose alternative solutions for assessment.

The key elements of the process will be:

- review of the Strategy
- a Statement of Needs
- a project selection process
- advice to the Minister on regional water security options.

The proposed process is illustrated in Figure 3.3.

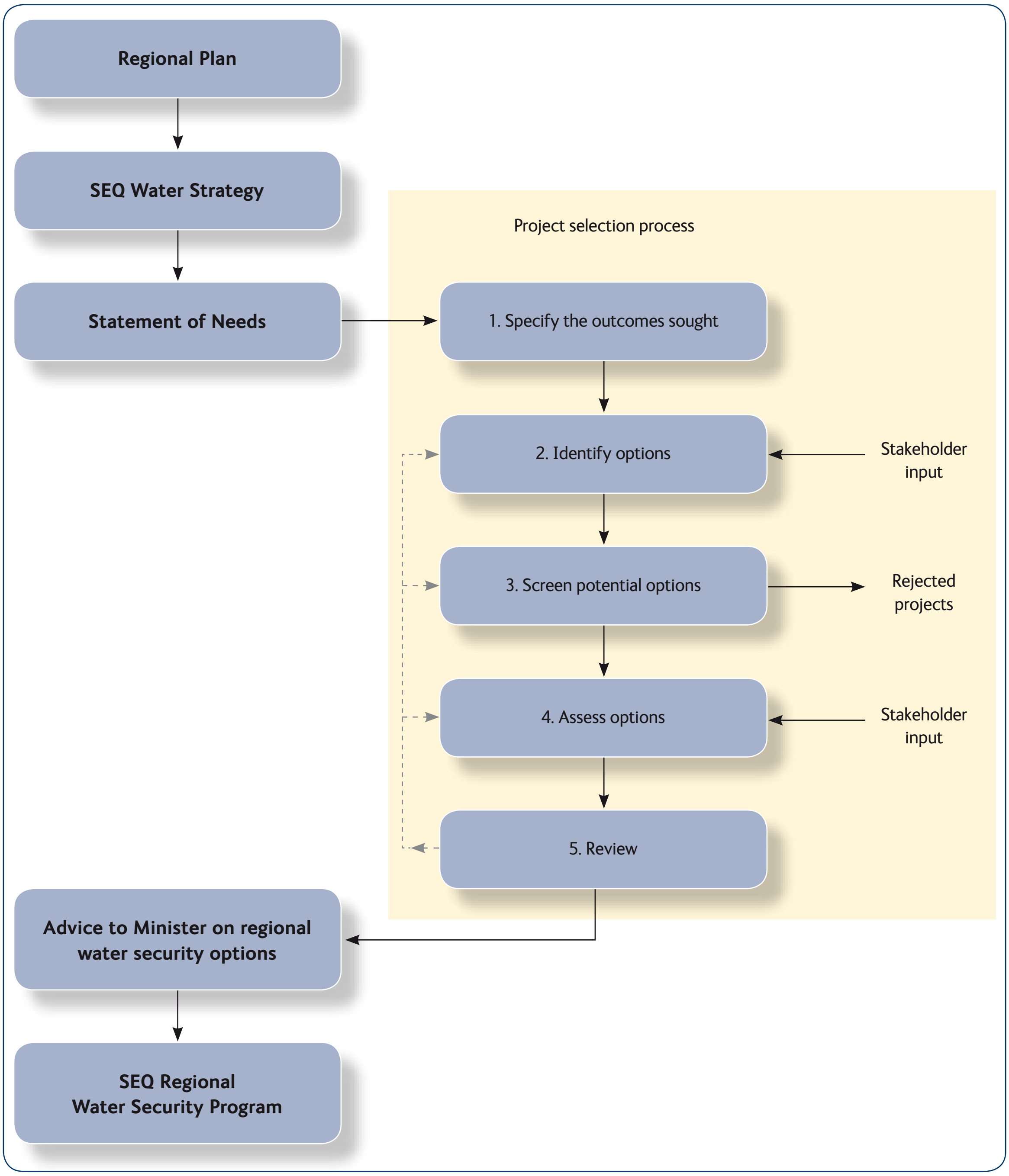


Figure 3.3 Statement of Needs and proposed project selection process

This process applies to development of new regionally significant projects only. Regionally significant projects generally involve expansion of the capability of the SEQ Water Grid to ensure that the LOS objectives can be achieved throughout the region, while operating in accordance with all relevant legislation.

Water service providers will undertake a range of other projects that are planned and regulated through separate processes. This includes projects such as renewal of existing infrastructure, the construction of new infrastructure for local needs, or improvements to the efficiency of service delivery. In some locations, planning for this infrastructure may be informed by a total water cycle plan, as explained in Section 2.3.

3.5.1 Review of the Strategy

The QWC will coordinate the review of the Strategy at appropriate times. The Strategy will be reviewed on a five-year cycle aligned with the review of the Regional Plan. Demand will be monitored as part of the assessment of the water balance, which will be reported on annually (refer to Section 7.1.2), and could result in a review of the Strategy being undertaken earlier.

3.5.2 Statement of Needs

Following the Strategy review, the QWC will prepare and publish a Statement of Needs that will clearly describe strategic requirements over the short to medium term. The Statement of Needs may identify the following types of regionally significant needs:

- an improvement to water quality within the region, such as feed water or treated water quality
- an augmentation of the water supply system, including broad identification of the scale and location of the augmentation
  or
- an improvement to system performance, such as the coverage of the SEQ Water Grid or the degree of interconnectedness.

The Statement of Needs may also include reference to institutional arrangements required to facilitate regional water security.

The Statement of Needs will be developed on the basis of the Strategy, including the water balance models that underpin it, and input from the SEQ Water Grid Manager and the water entities.

The QWC will seek endorsement of the Statement of Needs by the Queensland Government, to ensure it is aligned with current policies and strategies for SEQ.

3.5.3 Project selection process

In undertaking the project selection process (shown in Figure 3.3), the QWC will seek input to the process from professionals with appropriate expertise, as well as from a stakeholder reference group. This group will be established from key community and government stakeholders in SEQ who are likely to have an interest in the outcomes sought.

The assessment of projects will be based on the incremental benefits they could provide for the SEQ Water Grid as a whole. For example, an assessment could consider the benefits of increasing the operating level of Wivenhoe Dam in terms of the yield of the SEQ Water Grid as a whole, rather than the yield of the dam operating on a stand-alone basis.

3.5.4 Advice on regional water security options

The QWC is required to provide advice to the Minister on regional water security options. The advice must address the following issues:

- the desired LOS objectives
- demand management for the region
- water supply or sewerage works for achieving the desired Level of Service objectives
- an assessment of the likely costs and pricing implications of the works
- the preferred ways of sharing the cost of the works.

After completing the options selection process, the QWC will provide advice to the Minister on the outcomes sought, options considered and the recommended projects to be adopted in the Regional Water Security Program.

3.6 Potential portfolio

For this Strategy, a long-term water balance was constructed for the entire SEQ region and for the northern, central and southern sub-regions. This water balance was prepared on the basis of:

- projected regional demands
- the LOS objectives described earlier in Section 3.1.1
- purified recycled water being used to supplement supplies in Wivenhoe Dam when SEQ Water Grid storage levels fall to 40 per cent of capacity.

The water balance was used to identify approximately when and where supply gaps would occur in the future on a whole-of-grid basis. This preliminary assessment was conducted for the case of medium series growth, with ongoing demand management embedded. Further work will be required considering sub-regional and local needs when the Statement of Needs is produced.

Current and potential water supply sources are described in Chapter 5. As noted above, these projects will provide the base case supply solutions against which any alternatives can be assessed following the Statement of Needs process.

Chapter 6 includes a number of potential portfolios based on these projects. These portfolios demonstrate that the potential sources are sufficient to ensure a secure water supply for SEQ to 2056 and to indicate the potential portfolio of future supplies based on currently identified sources and technologies. The portfolios do not pre-empt or pre-judge the outcomes of the selection process outlined above.

A potential base case portfolio was identified to be the medium series base case portfolio for the region. Building on this, a second portfolio was identified that could be used to fill the supply gap if high series demands emerge. A range of sensitivity analyses were conducted to understand the impact of key assumptions on the possible timing and scale of infrastructure that might constitute the future portfolio of projects.

The base case portfolio will be used to assist in the development of the region's drought response plan and as a standard for comparing future water supply options on either a bulk or local scale within the region. The base case portfolio will be reviewed and updated over time, utilising the assessment methodology as required.

Chapter 4

SEQ's future water demand

This chapter discusses water consumption trends as well as initiatives and projects being implemented to reduce water demand and increase efficiency of use. It also describes demand management strategies to support the LOS objectives for water supplies during normal times.

Key messages

- All sectors of the community should use water efficiently.
- A wide range of demand management programs have been implemented.
- The Strategy is based on maintaining demand for SEQ Water Grid water at least 24 per cent below pre-drought trends. By 2056, this will save about 241 000 megalitres per year based on medium series population growth.
- A conservative planning assumption of a maximum average regional urban consumption of 375 litres per person per day of SEQ Water Grid water underpins the Strategy. In 2004–05, average consumption was about 450 litres per person per day.
- Planning assumptions will be reviewed on a regular basis.
- Large non-residential water users, including business and industry, will be required to continue to keep moving towards best practice water efficiency.
- Businesses with reasonable access to the Western Corridor Recycled Water Scheme will be encouraged to use recycled water.
- Power stations will be required to use recycled water rather than other supplies when using water from the SEQ Water Grid.
- All building development applications lodged for the construction of new homes in SEQ must meet mandatory water savings targets. Internally plumbed rainwater tanks are one option to achieve the water savings target.
- Rainwater tanks and stormwater harvesting in new developments are forecast to reduce demand on bulk water supplies by about 7 per cent by 2056.

The demand management program that will support the achievement of the LOS objectives for water supply in normal operating mode is described in Section 6.1.

Water demand information

Water accounting data for the Strategy has been collected at a billing level from the 10 local government authorities listed in Section 1.1. Demand analyses were conducted on a local and regional basis, historically and out to 2056. Demand has been forecast for the residential, commercial and industrial sectors, and system losses. Forecasts have been prepared with and without demand initiatives and climate change impacts being applied.

4.1 Pre-drought water consumption

Prior to the Millennium Drought, there were very few drivers for urban and industrial users to reduce consumption. During periods of poor inflows, Wivenhoe Dam had previously contained sufficient storage reserves to maintain unrestricted supplies across most of the region. There have always been limitations on supply for rural water users, which have resulted in some inherent self-regulation of use.

Unrestricted consumption provides a starting point for water planning. In SEQ, the most recent unrestricted consumption occurred prior to May 2005. Table 4.1 summarises water use patterns in 2005.

Table 4.1 SEQ water consumption in 2005

Sector	Water consumption (megalitres per year)	Proportion urban demand (per cent)	Total demand (per cent)
Urban	277 459	65	
Residential	91 426	21	
Non-residential	59 808	14	
Total urban	**428 693**	**100**	**69**
Power generation	38 000[1]		6
Rural communities	5 703[1]		1
Rural production	150 000		24
Total	**622 396[2]**		**100**

1 Historical information that includes estimated consumption for Rosalie, Jondaryan, Crow's Nest and Cooloola.

2 Excludes recycled water supplied to industry, golf courses and parks.

About 75 per cent of water consumed in SEQ in 2005 was used for urban purposes and power generation. The remainder was used for rural purposes. This pattern differs from the overall Australian consumption pattern. In 2000, Australia used 83 per cent of its water for rural applications and only 17 per cent for urban and industrial applications.

System losses accounted for about 14 per cent of the water used for urban purposes, including fire services, metering errors, leakage and theft (refer to Section 4.3).

Average total urban consumption in SEQ varied between local government areas, from 300 to 500 litres per person per day with an average of 450 litres per person per day. On average, residents of SEQ with reticulated drinking water supplies consumed approximately 300 litres per person per day. As shown in Table 4.2, this rate of consumption was comparable with that in other capital cities in Australia.

Table 4.2 Average residential water consumption in Australian cities (2004–05 to 2008–09)

City	2004–05 (litres per person per day)	2008–09 (litres per person per day)
SEQ[1]	282[1]	143[1]
Sydney	215	202[2]
Canberra	255	195[2]
Melbourne	195	157[2]
Adelaide	265	228[2]

1 Average residential consumption in all local government areas in SEQ.

2 Estimates calculated from National Water Commission and Water Services of Australia (2010) *National Performance Report 2008–2009*, and Australian Bureau of Statistics information. Consumption in some cities was affected by water restrictions.

4.2 How the Millennium Drought changed our thinking

From 2005, as the extent and impacts of the Millennium Drought became evident, the Queensland Government introduced a range of demand management measures. Many of these measures have been made permanent.

Following implementation of these measures, there was a significant improvement in water efficiency coupled with a substantial reduction in demand. In the central SEQ and Gold Coast region, average urban consumption dropped from 450 litres per person per day in 2005 to approximately 230 litres per person per day from mid-2007 to mid-2009 (refer Figure 4.1). It has remained below 260 litres per person per day since mid-2009, despite the easing of restrictions.

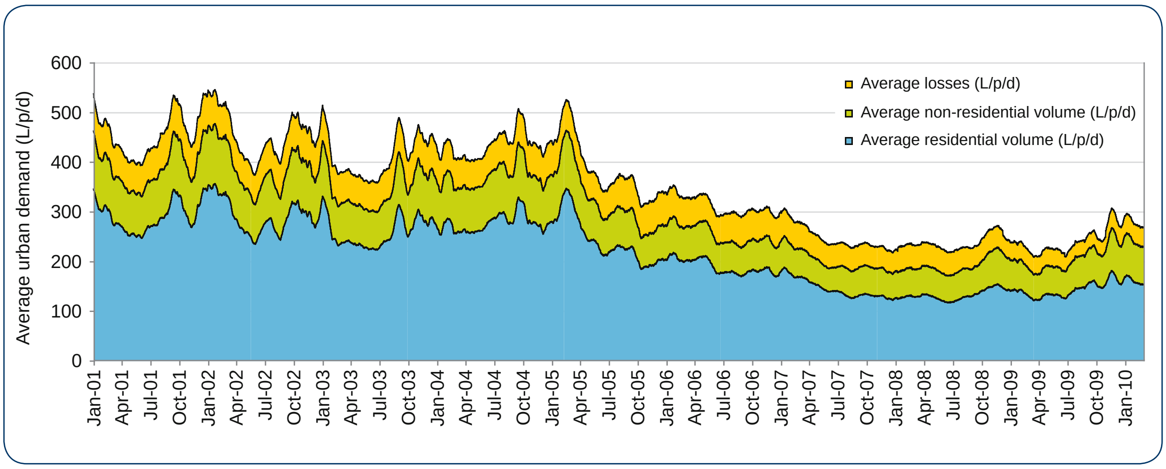


Figure 4.1 Average total per person consumption since 2001 in central SEQ and Gold Coast

Residents achieved most of the savings. Average residential use in those regions of SEQ that were under QWC restrictions was 131 litres per person per day from mid-2007 to mid-2009 (refer to Figure 4.2). In mid-2010, with Permanent Water Conservation Measures and Target 200 in place, residential consumption in the same region continues to be low, averaging around 165 litres per person per day. This indicates that the water-efficient habits developed by residents during the height of the drought are being maintained.

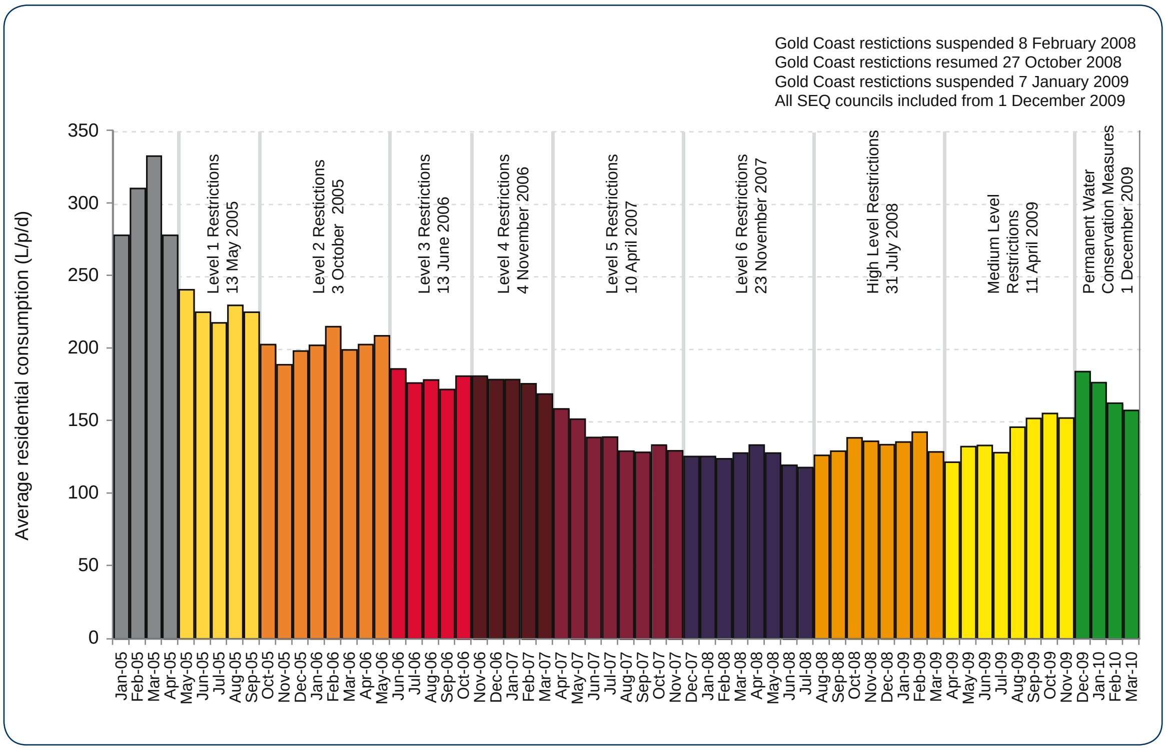


Figure 4.2 Average residential consumption for SEQ regions under QWC restrictions since 2005

Residents in other parts of SEQ have also reduced consumption, but not to the same level as central SEQ. For instance, residents on the Sunshine Coast reduced average consumption from about 317 litres per person per day in 2004–05 to about 224 litres per person per day over the six months to the end of May 2010. Gold Coast residents used an average of 206 litres per person per day over the same period. While these residents were not subject to QWC water restrictions until 1 December 2009, these areas had access to the same rebate and retrofit schemes as central SEQ.

Non-residential water use has also decreased. In 2009, 32 per cent less water was used by the non-residential sector than in 2004–05, saving 76.6 megalitres per day. These savings have been achieved despite the total number of businesses increasing by 16.9 per cent. Figure 4.3 illustrates the savings achieved by sector for moderate and major water users. Aside from irrigation, which was curtailed through temporary banning of outdoor watering, the most dramatic reductions were achieved by the public sector, followed by the commercial and other industrial sectors.

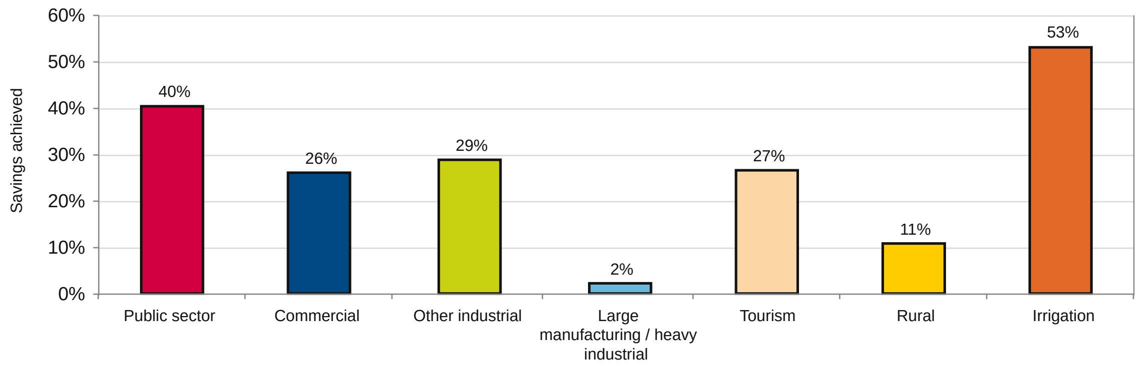


Figure 4.3 Savings achieved by non-residential sectors (2004–05 to the end of 2009)

4.3 Planning assumptions

The LOS objectives for normal operating mode include that sufficient SEQ Water Grid water be available to meet a regional average urban demand of 375 litres per person per day (including residential, non-residential and system losses).

The LOS objectives are the planning assumptions that are the basis for regional water supply planning, including detailed design of pipeline networks and water treatment plants. The assumptions are conservative, ensuring that new infrastructure can be constructed in sufficient time.

More detailed planning assumptions for residents, business and industry and system losses are specified in the remainder of this section. Chapter 6 outlines the demand management program that will contribute to the achievement of these assumptions, including the voluntary residential consumption target.

Residential planning assumption

Residential consumption is the largest sector of urban water use in SEQ (refer to Section 4.1). The community response to the Millennium Drought demonstrates the significant influence that this sector has on water security in SEQ.

The planning assumption of regional urban consumption of an average of 375 litres per person per day includes an allowance of up to 230 litres per person per day for residential use. This level of water use is considered to be comfortably sufficient to maintain the outdoor amenity and lifestyle that characterises SEQ.

This is a conservative assumption, and a prudent approach for water supply planning, taking into account the timeframes for delivering bulk water supply infrastructure and the level of uncertainty regarding:

- the extent of permanent behavioural changes by the community
- population growth
- climate variability
- the potential impacts of climate change.

However, the Strategy challenges residents to use less, voluntarily maintaining a regional average residential consumption below 200 litres per person per day. By maintaining consumption below this level, the need for new supplies could be deferred by at least five years. This challenge is described in Section 6.2.

Non-residential planning assumption

The planning assumption for non-residential water use is a regional average of 145 litres of water per person per day from the SEQ Water Grid.

Business, industry, government and other large users of water need to conserve water by being more efficient water users. The QWC has implemented Permanent Water Conservation Measures, which require these users to use water efficiently while minimising the risks to economic production and employment. The measures focus on businesses using more than 1 megalitre per year, and particularly those using more than 10 megalitres per year. The businesses in these categories comprise almost 90 per cent of existing non-residential water consumption in SEQ.

Through these permanent measures, business and industry will continue to move towards best practice water efficiency. Given this embedded best practice approach, it is expected that if there is another drought that requires the introduction of water restrictions, there will be minimal impact on water use associated with business activities.

Power generation planning assumption

Power stations are required to use recycled water when available, if accessing water from the SEQ Water Grid.

Consistent with this assumption, the SEQ System Operating Plan directs that purified recycled water from the Western Corridor Recycled Water Scheme must be the primary source of supply for any water being taken from the SEQ Water Grid to the Swanbank, Tarong and Tarong North power stations. The SEQ System Operating Plan is discussed in Section 7.2.1.

System losses planning assumption

System losses include losses from authorised uses such as fire fighting and maintenance, as well as unauthorised uses such as theft and leakage. System losses comprised 14 per cent of urban demand in 2005.

Bulk transport and network distribution system loss targets have been set at no more than 8 per cent of total urban water use. This target will be achieved through universal metering, better understanding and management of the operation of the system as a consequence of the pressure and leakage reduction project, and the design and management of new distribution infrastructure.

4.3.1 Basis for the residential planning assumption

The planning assumption of an urban consumption of a regional average of 375 litres per person per day includes a conservative allowance of 230 litres per person per day for residential consumption. The basis for this allowance is explained below. These considerations have also informed the level of the voluntary regional residential consumption target (refer to Section 6.2).

The residential planning assumption will be reviewed as part of the review of the Strategy, which will be at least every five years in line with the Regional Plan. It will also be reviewed at any point in the intervening period if it becomes clear that demand remains low, or is significantly increasing. This review of the planning assumption might be undertaken as part of preparing the annual report on the implementation of the Strategy (refer to Section 7.1.2).

Scenario assessment

The Strategy has been informed by a detailed assessment of future water demand (refer to Section 3.4). The assessment forecast the impact of individual measures upon 2004–05 trends, taking into account a range of factors including interactions between measures. For instance, shorter average shower times reduce projected savings from water-efficient showerheads.

A high savings scenario was derived, based on:

- education programs
- pricing and tariff design
- retrofit and rebate programs
- building audit programs
- irrigation management and controls
- sub-metering programs
- building code amendments
- pressure and leakage management
- dual-reticulation recycled water schemes in major new residential and industrial developments.

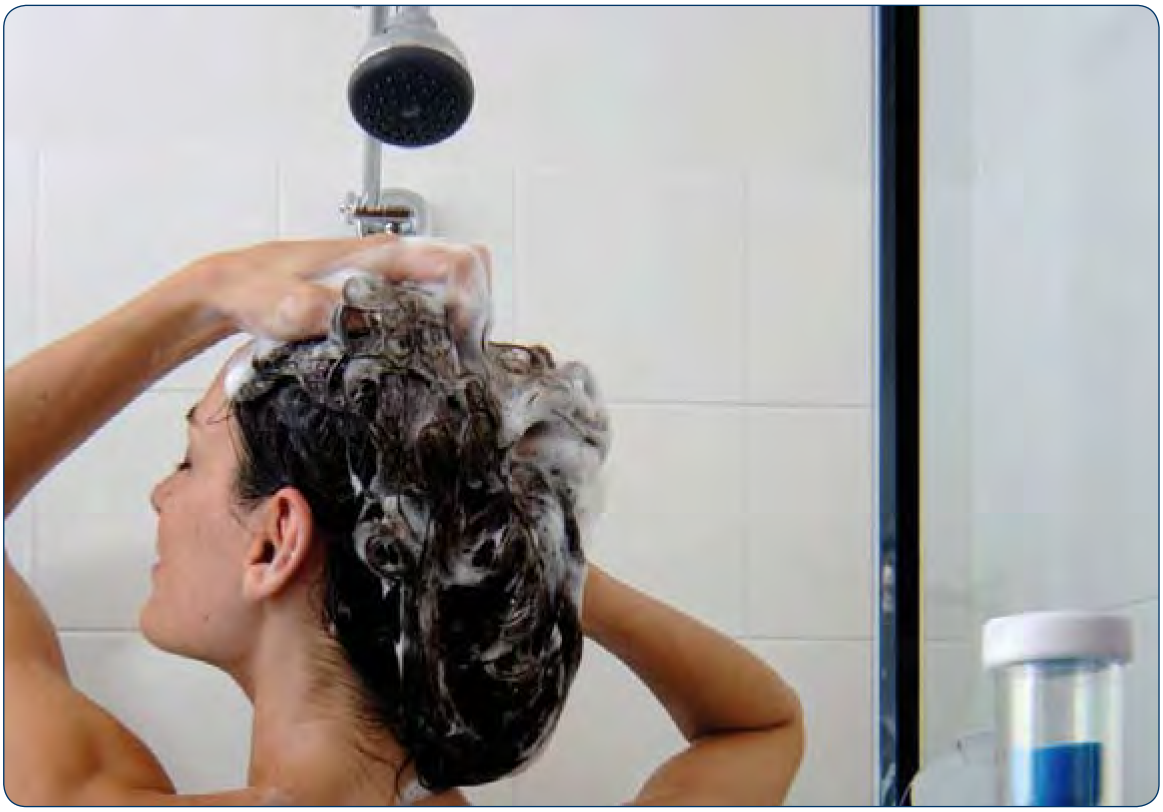
The high savings scenario forecast that average regional residential consumption would reduce by about 25 per cent, from 300 litres per person per day to slightly below 230 litres per person per day. The structural measures that have been implemented as part of the drought response were forecast to result in an immediate saving of 13 per cent, increasing to a saving of more than 20 per cent over time. The remainder of the savings was due to assumptions made about sustained behavioural changes. Greater savings may be able to be achieved with more sustained long-term behavioural changes (refer to Section 6.2).

Drought rebound assessment

There are limited precedents against which to assess how much of the behavioural changes made during the Millennium Drought will be sustained in the future. Until the late 1990s, water supply authorities in Australia did not generally seek to maintain savings that had been achieved during drought.

The information available for recent droughts in Australia and overseas indicates that the rebound back to this level of consumption can be expected to occur gradually over a minimum of two years with maximum savings of 10 to 15 per cent. The period of time over which the rebound occurs depends on a range of factors, including the amount of rainfall in following years and the extent of communications to the public to maintain water efficiency.

The extent and duration of demand reduction in SEQ exceeds that experienced in other major cities during severe drought. On this basis, the demand forecasts contained in Section 4.5 and Chapter 6 are based on consumption increasing gradually from actual levels at the end of 2009 to equal the planning assumptions by 2018.



Rebound from the Gold Coast drought

The Gold Coast experienced a severe drought during the period between June 2002 and January 2004. Water restrictions included total outdoor watering bans, with a high level of public awareness of these bans. Average regional urban consumption reduced from 440 litres per person per day to 360 litres per person per day at the height of the restrictions. In the 18 months after restrictions were lifted, regional urban demand increased to 400 litres per person per day and continued to rise. Restrictions were then imposed and demand reduced again. The effect of the 18 months of severe drought and restrictions was equivalent to an ongoing saving of less than 10 per cent.

This rebound occurred despite Gold Coast Water introducing an active demand management program that continued after restrictions were eased. Household retrofits, pressure and leakage management and volumetric pricing were all implemented after the restrictions eased.

The same drought affected northern New South Wales, where restrictions were in place in for more than 12 months and reached Level 7. During the drought, average total consumption reduced from 440 litres per person per day to as low as 300 litres per person per day. Average total demand remained at about 370 litres per person per day after the drought, a reduction of 16 per cent over the long-term average. Changes to water prices may also have contributed towards the saving.

Building block assessment

A building block approach was used to test the average lifestyle impacts of the proposed combination of measures across SEQ.

The Millennium Drought has shown that SEQ residents can reduce average residential consumption to below 140 litres per person per day compared to about 300 litres per person per day in 2005. However, for some members of the community, this may be unacceptable or unachievable over the longer term.

The allowance in the planning assumption of an average regional residential use of 230 litres per person per day represents an increase of 90 litres per person per day over the drought consumption levels. This represents around two hours of outdoor water use per household per week, if indoor use remained at approximately the same level as achieved under Target 140. In practice, some rebound in internal water use is likely to occur and some water will be used for other external uses, including topping up pools and washing cars.

By comparison, prior to the Millennium Drought, residents of SEQ used on average more than 120 litres per person per day for outdoor irrigation.

The reductions in outdoor water use are being achieved through a combination of structural and operational measures, as well as by sustained behavioural change (refer to Section 6.1).

High water users

A small proportion of households using a large volume of water have a major impact on average consumption. Since 2005, in the central SEQ and Gold Coast region, there has been a major reduction in the number of households using more than 800 litres per day and a significant increase in the number of households using between 300 and 600 litres per day. Prior to 2005, about 4.6 per cent of households in central SEQ used more than 2000 litres per day and about 36 per cent used more than 800 litres per day. In comparison, over the last three months of 2009, only 0.6 per cent of households used more than 2000 litres per day and 10.5 per cent used more than 800 litres per day (refer to Figure 4.4).

These savings have underpinned the significant reduction in average residential consumption in these areas. However, a significant rebound in the number of high water using households would have a major impact on average residential consumption across SEQ.

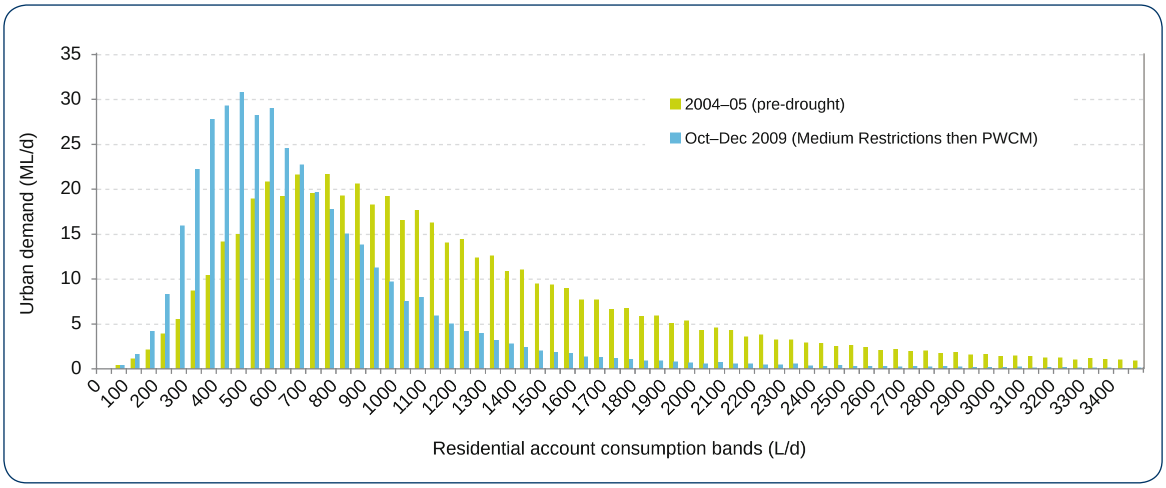


Figure 4.4 Residential consumption by consumption band for the central SEQ and Gold Coast region

Regional and household variation

The residential planning assumption and Target 200 are regional averages. Actual consumption varies considerably between households and across SEQ due to the type and age of a home, the number of occupants, the location of the home (in terms of climate and soil type conditions), and many other factors. In particular, it is forecast that:

- residents of new dwellings will use less water than residents of existing dwellings, due to water-efficient devices, rainwater tanks or other water supply alternatives. On average, residents of new dwellings are expected to use about 150 litres per person per day

- residents of units will generally use less water than residents of detached dwellings with gardens. The size and type of a garden, as well as access to tank water will influence the additional water requirements for such detached houses
- households with more people will continue to use less water per person than smaller households. For example, on average, a two-person household may use 200 litres per person per day (a total of 400 litres per day) while a six-person household may use 140 litres per person per day (a total of 840 litres per day)
- differences in rainfall will result in daily variations in external water use between locations, seasons and years, as illustrated in Figure 4.5.

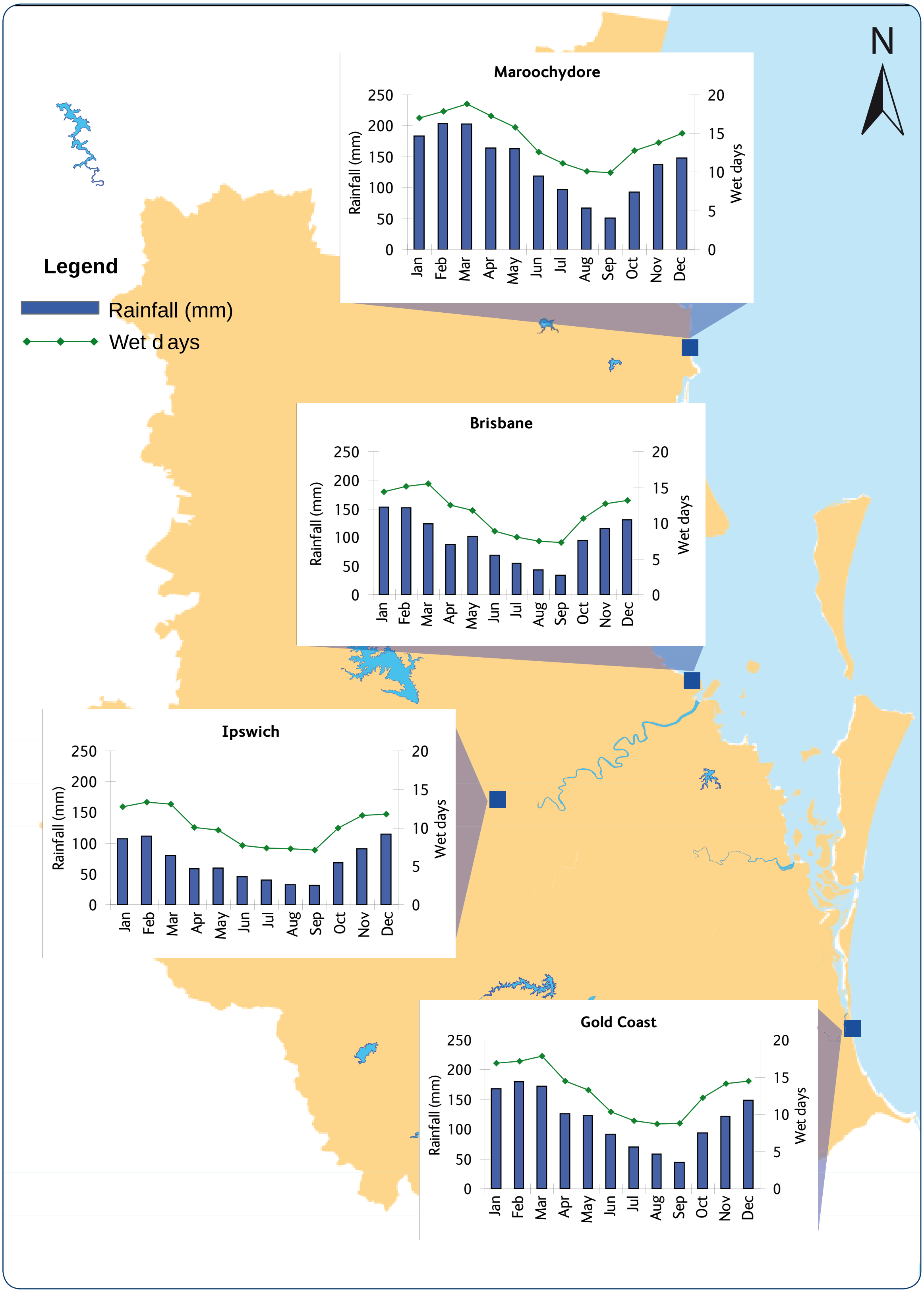


Figure 4.5 Regional variation in rainfall and rainfall days (data from 1957 to 2008)

External water use

Water is used outside the home for watering gardens, filling pools, washing cars and general cleaning activities.

Actual external water use will vary significantly depending on regional differences, such as rainfall and soil type. The greatest variation will relate to watering of gardens. Figure 4.6 shows the predicted water needed, on average, each month for a number of locations within SEQ, based on climate information, soil type and a range of other factors. Figure 4.7 predicts the number of times a garden needs to be watered for the same locations, on average. Both figures are based on an assumption that residents use efficient irrigation, watering only when necessary.

Together, these figures illustrate that:

- residents in coastal locations should use less water on their gardens, on average, than similar residents located in inland regions, due primarily to rainfall patterns
- soil conditions should significantly affect the frequency of watering, as distinct from the volume of water used.

For instance, Ipswich has generally loamy soils. In an average September, it is predicted that a gardener in this location would need to water their garden twice in a month, delivering the equivalent of 160 litres per person per day. By comparison, Maroochydore has very sandy soils and more rainfall, meaning that the same gardener would need to water their garden four times in the month but only use the equivalent of about 140 litres per person per day.

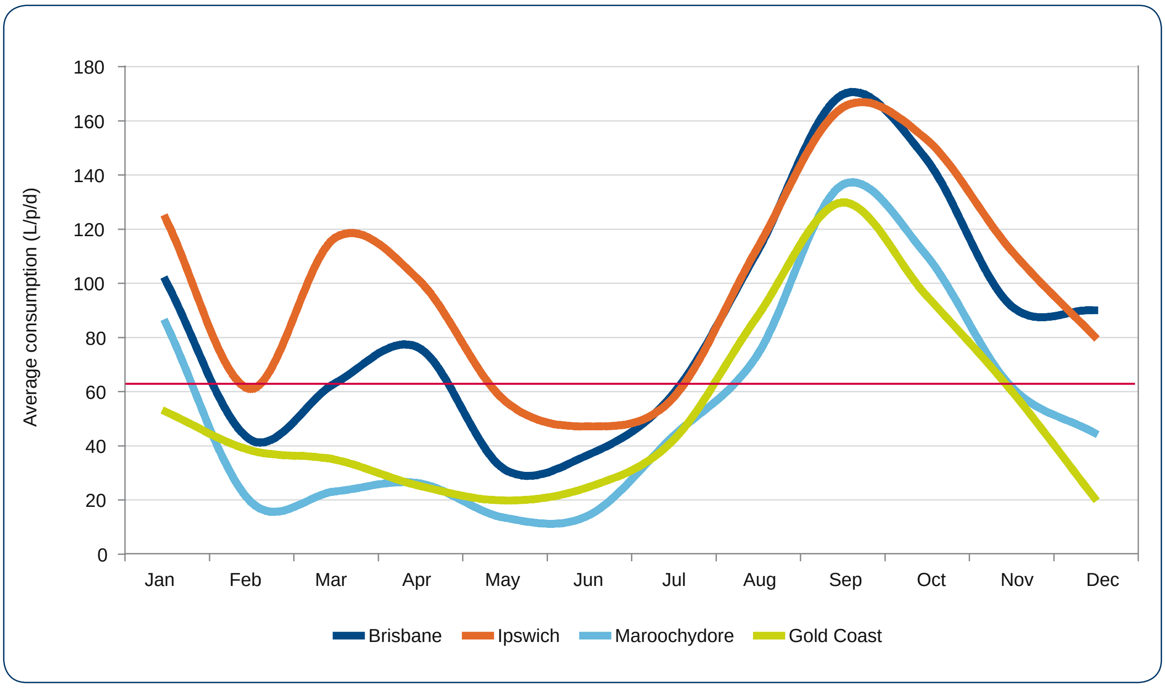


Figure 4.6 Forecast average external water use by location and month

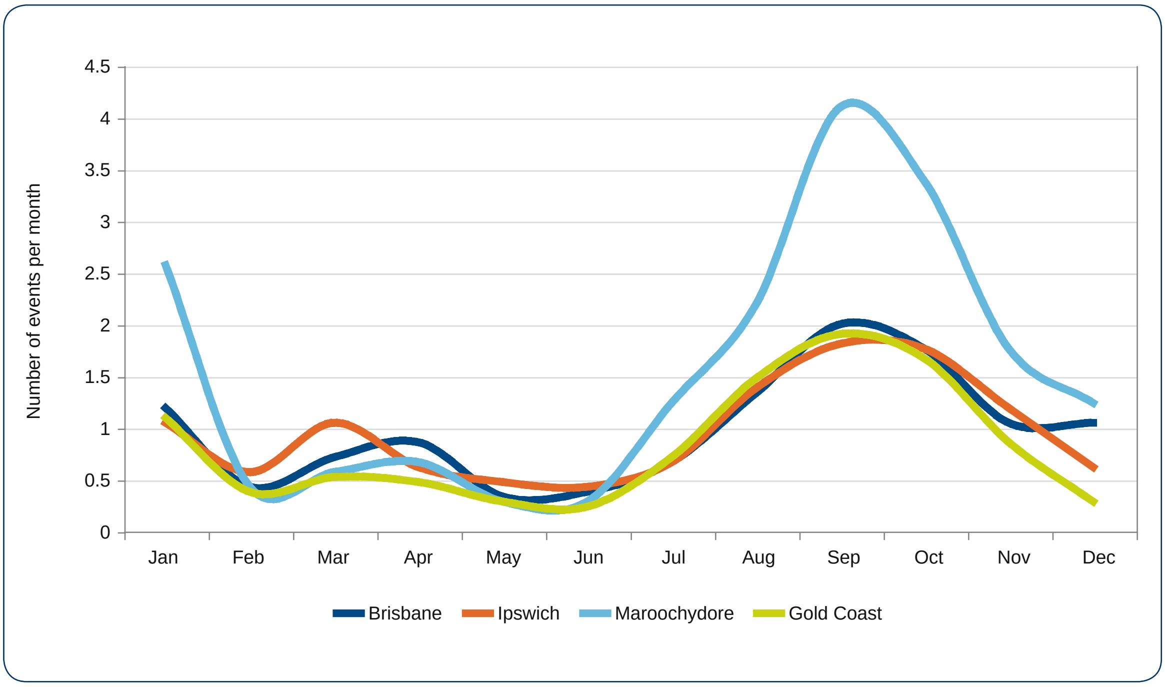


Figure 4.7 Forecast average number of watering events by location and month

4.4 Measures currently being implemented

Responses to the Millennium Drought included a number of demand management measures.

There are three categories of water efficiency measures:

- structural—making sure that our homes and businesses have water-efficient devices, appliances and equipment installed
- operational—making sure that water-efficient equipment is used correctly to achieve efficient outcomes
- behavioural—encouraging good use water behaviours and ensuring that the community understands the benefits of conserving water.

Table 4.3 gives information about the measures that have been implemented and factored into demand forecasts. These measures are long-term, as explained in Chapter 6.

Section 6.3.2 contains further demand management measures for investigation, to support achievement of the LOS objectives. Ongoing monitoring and review of water usage will be needed to determine the effectiveness of the program, including the potential to further reduce regional water consumption without significantly affecting our lifestyle, environment, or business and industry.

Drought response measures were identified during the early phases of Strategy development. A detailed and comprehensive assessment was conducted of some 100 potential measures across all customer sectors and involved a range of implementation mechanisms. Potential demand management measures were screened based on the following criteria:

- significance of water savings from a regional perspective
- sustainability of water savings from a regional perspective
- reductions in energy use
- improved public awareness
- likely public acceptance
- equity across customer base
- regulatory obstacles
- life cycle cost to customers
- life cycle cost to water service providers.

The annualised cost of potential measures was compared to the cost of potential sources of supply. Annualised cost is the cost of the measure divided by the amount of water that it will save each year. On this assessment, the measures proposed in the Strategy were generally cost-effective relative to potential sources of supply. Figure 4.8 illustrates the annualised cost of some of the potential demand management measures, based on the initial planning assumptions. More detailed economic analysis was undertaken for significant measures, including levelised[1] cost assessments and portfolio analysis, which is explained in Section 6.3.2.

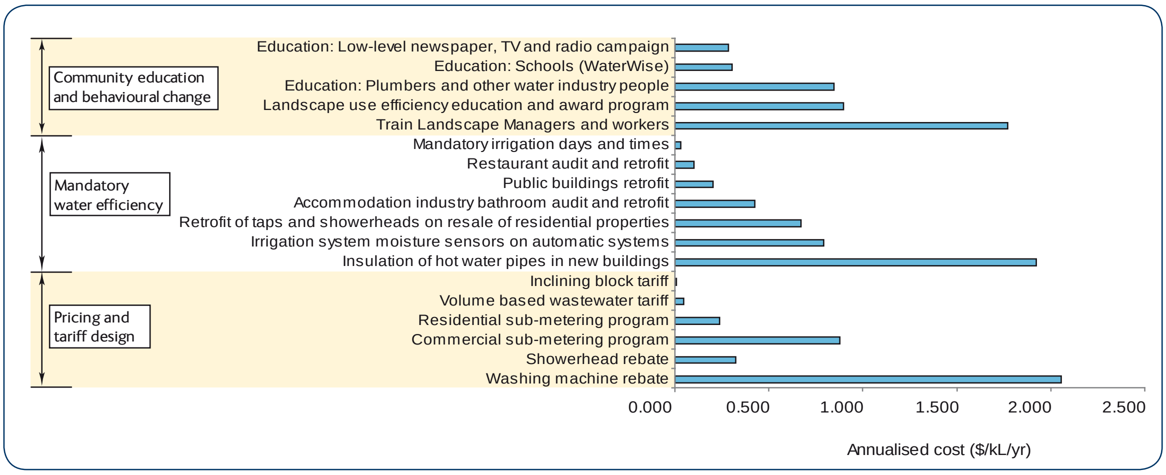


Figure 4.8 Annualised cost of potential demand management measures

[1] Levelised cost is calculated as the ratio of the present value of projected capital and operating cost of an option to the present value of the projected annual demand supplied or saved by the option.

Table 4.3 Permanent efficiency measures

Structural water efficiency measures
Water efficiency management plans
Water efficiency management plans (WEMPs) are required to be prepared for large water-using businesses and other non-residential activities. Under a WEMP, businesses must assess their current water use and identify and implement water savings. The plans demonstrate if a water user is already at best practice in water efficiency, or how a user is planning to become water-efficient in the near future. All businesses using 10 megalitres per year or more must prepare, submit and comply with a WEMP. WEMPs are also required for public swimming pools, nurseries, turf farms and market gardens, and premises with cooling towers. WEMPs are a long-term measure. Businesses that are subject to a WEMP are required to review and update their WEMP at least every five years, with the aim of achieving business best practice water efficiency. All businesses must ensure that their urinals and cooling towers are efficient, and businesses using 1 megalitre per year or more must ensure that all internal water fittings on the premises are water-efficient.
Queensland Development Code Part 4.1—sustainable buildings
Since 1 March 2006, new houses in Queensland are required to use water and energy more efficiently. Detached houses, terrace houses and townhouses must contain water-efficient showerheads and toilets, and water pressure limiting devices. Units must have water-efficient showerheads and toilets. Homes undergoing bathroom renovations must include water-efficient showerheads and taps.
Queensland Development Code Part 4.2—water savings targets
Since 1 January 2007, all building development applications lodged for the construction of new homes in SEQ must meet mandatory water savings targets. Detached houses must target savings of 70 000 litres per year, while terrace houses and townhouses must aim to achieve savings of 42 000 litres per year. Internally plumbed rainwater tanks are one option to achieve the water savings target. Alternative solutions to achieve the water savings target include communal rainwater tanks, stormwater harvesting, dual-reticulation recycled water schemes, and the treatment and reuse of greywater.
Queensland Development Code Part 4.3—alternative water sources, commercial buildings
From 1 January 2008, most new commercial and industrial buildings are required to have alternative water sources. Options include internally plumbed rainwater tanks and treated greywater.
Topping up swimming pools
Water from the reticulated supply system may be used for topping up swimming pools only if a rainwater tank or downpipe rainwater diverter is installed. The pool must also be an accredited ecopool or the premises must comply with three of four water efficiency measures, namely the use of: • a swimming pool cover • water-efficient taps and showerheads • water-efficient toilets • water-efficient washing machines.
Pressure and leakage reduction program
The Queensland Government has collaborated with local governments to reduce supply pressure and distribution system leakage losses by 60 megalitres per day by 2012. As at March 2010, a reduction of 52 megalitres per day had been achieved.
Expanded use of greywater
Allowable uses for greywater have been expanded where appropriate, through setting treatment standards and amending the types of buildings eligible to install greywater use facilities. Commercial and industrial building owners are allowed to reuse greywater captured within their buildings. These provisions commenced on 1 January 2008 and allow treated greywater to be used for toilet flushing, laundry use, vehicle washing, washdown of paths or walls, and spray irrigation of lawns and gardens.
Installation of water meters
Accurate water usage data is a critical factor for effective water use management. Individual water meters must be installed in all new residential and commercial multi-unit developments. In addition, businesses must install sub-meters: • on the supply line of any process or equipment that uses a significant portion of the total water use on the site • on the supply line of an irrigation system that irrigates an area greater than 500 square metres.

Operational water efficiency measures

Guidelines for business

Working with industry, the QWC has developed water efficiency guidelines that identify water-efficient equipment and practices to assist businesses and commercial operators. The guidelines cover a range of business and sporting operations, from fixed commercial vehicle washing to playing surface management. Generally, operators must:

- use water-efficient equipment, appliances, accessories and products that enhance water efficiency
- undertake activities in a water-efficient manner in accordance with manufacturers' instructions and equipment and training requirements
- check for leaks and, when a leak is found, undertake immediate repairs
- improve processes and upgrade to water-efficient equipment when it becomes economically feasible
- ensure that performance targets are met and equipment is maintained in good condition.

Active Playing Surfaces Guidelines

The Active Playing Surfaces Guidelines set out rules for irrigating grassed active playing surfaces to ensure that water is used efficiently while surfaces are maintained in a safe and playable condition. Over 620 registered active playing surfaces in SEQ use water in accordance with these guidelines.

Efficient Urban Irrigation Program

Irrigating outdoor areas can consume large amounts of water. The QWC has introduced the Efficient Urban Irrigation Program to improve the efficiency of outdoor water use for establishing and maintaining gardens and lawns around homes and businesses.

Irrigation systems must operate with a timer and a soil or rainwater moisture sensor. Irrigation must also be supported by efficient gardening practices. For business and commercial applications, a sub-meter must also be installed.

Residents and businesses operators are encouraged to choose landscaping elements that are appropriate to the climate and require minimal water to flourish.

The Efficient Urban Irrigation Program is based on the *Efficient Irrigation for Water Conservation Guideline*. The guideline has been granted the Smart Approved WaterMark and links to the use of efficient products which can be identified by the Smart Approved WaterMark.

Mobile commercial operator training and registration programs

Water is the primary input to the businesses of many mobile commercial operators, such as mobile car washing businesses, external cleaners and pet washers, making it important that these businesses operate in a water-efficient manner. The QWC developed Water Efficiency Guidelines to ensure operators are trained in efficient water use practices. By the end of 2009, 1130 operators were registered, trained in efficient water use, and operating according to the QWC guidelines.

Behavioural water efficiency measures

Rebate schemes

The Queensland Government and a number of local governments have provided rebates for installing rainwater tanks and water-efficient devices, including dual-flush toilets, showerheads, washing machines and swimming pool covers. In some instances, increased rebates were offered for rainwater tanks that had been plumbed to internal fixtures.

More than 580 000 rebates were paid under the Queensland Government's WaterWise Rebate Scheme, with a total estimated value of almost $330 million. Rebates were paid to retrofit rainwater tanks to 236 000 houses and to provide water-efficient showerheads and other fittings.

Water-efficient showerheads continue to be available through the Queensland Government's ClimateSmart Home Service.

ecoBiz is a Queensland Government program that provides rebates to help businesses save money through reduced energy and water consumption, and reduced waste.

Public education and communication

The QWC implemented successful public education and communication campaigns, including Target 140, Target 170 and Target 200, to encourage residents of SEQ to reduce their water use and to use water efficiently. A separate campaign, Water at Work, promoted water efficiency in the workplace. Further community and business education campaigns will be undertaken as required and to support the voluntary Target 200.

WaterWise

The WaterWise program targets particular sectors of the community and seeks to establish efficient lifetime water consumption habits. *Water: Learn it for life!* has been developed for preparatory and primary school children. The program is administered by the Department of Environment and Resource Management.

Council water savings and efficiency education programs

Many local governments provide educational information and water savings tips and toolkits for households and businesses. Some local governments also offer water efficiency rebates.

Behavioural water efficiency measures (continued)

Water use information to residential tenants

This measure requires water service providers to give water use information to occupiers of residential rental properties. The advice states the volume of water supplied to the premises during each meter-read period so residents can monitor their water use.

Water efficiency calculator

The QWC has developed a water efficiency calculator to help residents and business operators become more water-wise. The calculator determines water usage volumes in and around the household or premises, using information provided by the user. The calculator suggests water savings tips and enables residents to compare estimated water usage with metered water usage.

Water-efficient technologies display

A water-efficient technologies display has been established at the Home Ideas Centre in Brisbane. The display features a range of water-efficient devices, appliances and fixtures and promotes water-efficient technology to people building or renovating a home.

4.4.1 Role of rebate schemes

The demand management program focuses on structural measures that will continue to provide cost-effective savings well beyond the time when additional sources of supply are required. The main focus is for new houses and commercial and industrial buildings to be water-efficient—for example, by using water from rainwater tanks to flush toilets or for other purposes. Unless many of these measures are undertaken now, the opportunity could be lost and the future cost of retrofitting would be prohibitive.

With these requirements in place, substantial water savings will be achieved through natural replacement of the building stock, either when constructed or as part of renovation.

Most of the rebate schemes have now been discontinued. They were effective in bringing forward demand savings as part of a drought response. However, they are less cost-effective when LOS system yield exceeds demand, and when similar demand savings will be embedded over time through regulation and the natural replacement of fittings and fixtures.

Refer to behavioural water efficiency measures in Table 4.3 for more information on rebate schemes.

Examples of measures implemented by non-residential users

Industrial water recycling—BP and Caltex refineries

Since 2000, the BP Amoco Refinery at Bulwer Island in Brisbane has been using an average of 3650 megalitres per year of recycled water. Since May 2008, the Caltex refinery at Lytton has been receiving 1600 megalitres per year of high-quality recycled water from the nearby Wynnum Wastewater Treatment Plant. Both of these projects use the recycled water for boilers and cooling towers, and are examples of recycled water substitution that will directly reduce the demand on drinking water supplies.

Industrial water management—Dairy Farmers, Ipswich

Dairy Farmers is one of the largest dairy manufacturers in Australia. Recent improvements at the Booval Dairy Farmers plant have led to greater recovery and reuse of water, allowing the plant to reduce water consumption by 25 per cent. An additional benefit is that wastewater discharge from the plant has been reduced.

Commercial water management—Conrad Jupiters Casino

Conrad Jupiters Casino on the Gold Coast has reduced its potable water consumption by 37 per cent. Key initiatives include installing water-efficient fittings on showers, taps and urinals; a recycled water treatment facility for garden irrigation; dual-flush toilets; and rainwater tanks for topping up swimming pools.

Government buildings—Water SMART Buildings

This program reduced water consumption in Queensland Government–owned commercial buildings, facilities and parks. High water use facilities were targeted with a program of works to improve their water efficiency. Projects included replacing single-flush toilets and installing water-efficient tapware, showerheads and flow restrictors. A reduction in potable water consumption of approximately 55 per cent was achieved in 37 government buildings in SEQ when comparing 2004–05 and 2008-2009 annual water usage data.

Rural water use efficiency—SEQ Irrigation Futures

The SEQ Irrigation Futures project was established to improve the efficiency and off-farm impacts of irrigation. Participating industries include horticulture, dairy and fodder, turf, flora, and nursery and garden sectors. A key objective is to provide research and development, which has underpinned a 12 per cent improvement in water use efficiency as at the end of 2009—equivalent to an estimated 21 000 megalitres per year. Technologies and management practices for improved irrigation practice have been developed, trialled and evaluated through water balance models, spatial variability assessments, zonal irrigation management and 'tool kit' support for industry consultants.

4.5 Forecast demand

Based on 2004–05 trends, demand for water for urban uses and power generation would have increased from around 467 000 megalitres per year in 2005 to approximately 985 000 megalitres per year in 2056. With high series population growth, demand would have increased to around 1 196 000 megalitres per year.

Overall, a reduction in demand of 24 per cent compared to 2004–05 patterns is forecast by 2056. Table 4.4 contains the current demand forecasts, based on the planning assumptions outlined above. It also takes into account projects and initiatives currently being implemented and the demand management program described in Section 6.3.

Table 4.4 Forecast SEQ urban and power generation demand (excluding rural allocations)

	2005 estimated water consumption (megalitres per year)	2026 forecast demand (megalitres per year)	2056 forecast demand (megalitres per year)
Medium series population projections			
Pre-drought trends	466 693	690 000	985 000
Strategy forecast demand management program	–	533 000	744 000
Per cent saving	–	23 per cent	24 per cent
High series population projections			
Pre-drought trends	466 693	749 000	1 196 000
Strategy forecast demand management program	–	577 000	914 000
Per cent saving	–	23 per cent	24 per cent

Figure 4.9 illustrates forecast demand over time, in total and for key sectors. A demand range has been prepared to ensure that the Strategy is flexible enough to respond to changes in population growth or consumption trends. Cases where water savings initiatives within the high series forecast are slower to come into effect, or do not fully materialise, are expected to be within the range.

The Toowoomba and Cooloola local government areas are not part of SEQ. However, the pipeline connecting Wivenhoe Dam to Cressbrook Creek Dam provides the capacity to supply up to 10 000 megalitres per year of untreated water to Toowoomba Regional Council. This potential supply has been included in the modelling of future demand.

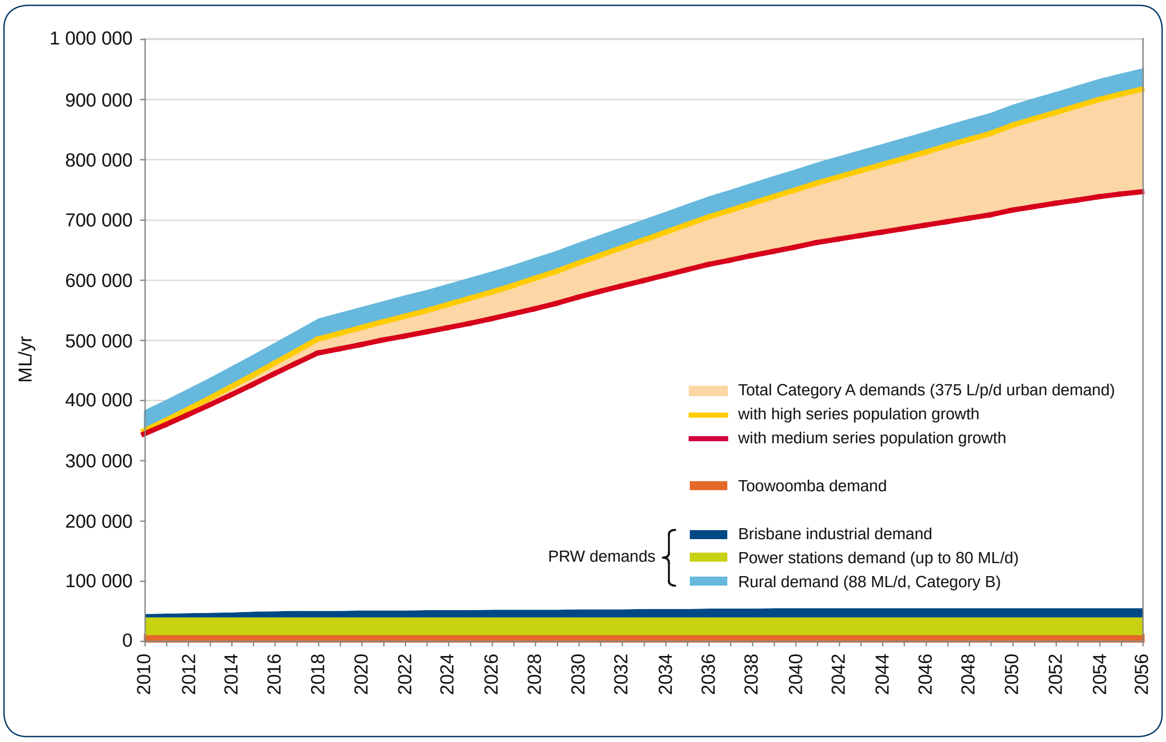


Figure 4.9 Forecast demand

4.5.1 Forecast urban demand

Before 2005, residential use accounted for around 65 per cent of urban demand. The relative proportion of residential water use is projected to decline slightly to about 58 per cent of urban water use by 2056.

Non-residential water use (excluding system losses and power generation) represented approximately 21 per cent of total urban water use in 2005. Non-residential demand is forecast to increase from about 91 000 megalitres per year in 2005 to about 117 000 megalitres per year in 2026 and about 172 000 megalitres per year in 2056, based on medium series population growth. At these rates, non-residential water use is forecast to comprise about 24 per cent of urban demand in 2056.

4.5.2 Forecast power generation demand

In 2005, about 38 000 megalitres was used for power generation in SEQ, equivalent to 6 per cent of total consumption. Most of the water was used in coal-fired power stations.

Since 2005, SEQ power stations have implemented a range of water-saving measures that have permanently reduced demand on the SEQ Water Grid. At the Swanbank B and E power stations, these measures include stormwater collection to supplement cooling water. At the Tarong and Tarong North power stations, the measures include installation of a reverse osmosis plant to recycle stormwater, boiler blowdown water and ash dam water.

Demand will also be reduced by the progressive closure of the Swanbank B power station over the period to mid-2012. Potentially offsetting this, CS Energy has long-term plans to build another gas-fired power station at the site. Power stations may also be built elsewhere in the region at some stage.

Taking these factors into account, the Strategy allows for supply to power generation of up to 29 500 megalitres per year. This is a conservative assumption, based on existing contracts. Actual consumption in any year may be lower, due to lower demand for electricity or to the Tarong power station taking water from Boondooma Dam rather than from the SEQ Water Grid.

When accessing water from the SEQ Grid Water, the Swanbank, Tarong and Tarong North power stations will use purified recycled water from the Western Corridor Recycled Water Scheme. For the Swanbank and Tarong North power stations, purified recycled water is the primary source of supply. For the Tarong power station, the primary source of supply will continue to be Boondooma Dam, with purified recycled water being used when supply is unavailable from the dam.

4.5.3 Forecast rural community demand

In the future, demand for water in rural communities with stand-alone supplies is expected to remain at approximately 1 per cent of total SEQ demand.

These demand forecasts were derived from the October 2006 population growth forecasts from the former Department of Local Government, Planning, Sport and Recreation. An assumption has been made regarding the proportion of future connected and unconnected properties in each local government area.

Section 6.5 provides more information on securing water supplies for all rural communities, both with and without reticulated supplies.

4.5.4 Forecast rural production demand

The growth in rural activities in SEQ is limited by the availability of water, with some restrictions on land use. With the current allocations of water available under the water resource plans, there are only limited opportunities for growth in the rural sector in terms of hectares under irrigation. Within this area, there may be changes to the types of crops and rural activities driven by the national water reforms and other initiatives.

Section 6.6 explains commitments made regarding additional water for rural production. If this water is not taken into account, rural water consumption is likely to remain at around 150 000 megalitres per year, which is the amount used in 2005.

4.5.5 Supply to areas outside SEQ

A pipeline between Wivenhoe Dam and Cressbrook Creek Dam was completed in early 2010. Through this pipeline, the SEQ Water Grid can initially supply up to 10 000 megalitres per year to Toowoomba Regional Council. The conditions of supply have been specified in a contract with Toowoomba Regional Council. This supply is allowed for in water balance models.

Supply to other areas outside SEQ may be considered subject to appropriate terms and conditions, including that the security of supply to SEQ is not reduced below the LOS objectives (refer to Section 6.1).

4.6 Local water supplies

Local water supplies are an integral part of the Strategy. These local supplies will complement supply from the SEQ Water Grid, helping to reduce the amount that needs to be supplied from bulk water supplies and the distance over which it is transported.

Development of local water supplies is required under the Queensland Development Code's water savings targets for new residential, commercial and industrial buildings. As noted in Table 4.3, since 1 January 2007 all building applications in SEQ for detached houses must target savings of 70 000 litres per year, while terrace houses and townhouses must aim to achieve savings of 42 000 litres per year. These local supplies must be internally plumbed to provide water for, at a minimum, toilet flushing and washing machine cold water taps, as well as for outdoor use.

The water savings target is forecast to apply to about 500 000 new houses by 2026 and about 800 000 new houses by 2056. At this rate, local supplies in new houses are forecast to reduce demand for the SEQ Water Grid water by about 35 000 megalitres per year by 2026 and 60 000 megalitres per year by 2056. The actual number of new houses depends on a range of factors including population growth and household size. The forecast takes into account variations in the yield of rainwater tanks across the region. These forecasts are based on the minimum requirements.

Internally plumbed rainwater tanks are one option to achieve the water savings target. Other options to achieve the water savings target include communal rainwater tanks, stormwater harvesting, greywater, and dual-reticulation recycled water systems. These options can benefit other elements of the water cycle, as described in Section 2.3.

The most appropriate solution to the water savings target will vary depending on local circumstances, and should be determined as part of the planning processes described in Section 2.3. In key development areas, the optimal solution may be specified as part of sub-regional total water cycle planning. In other locations, it may be considered on a site-specific basis by developers or as part of local government total water cycle planning.

In some circumstances, local water supplies may be able to deliver savings above the minimum required under the Queensland Development Code. These opportunities should be investigated and pursued when the incremental benefits are cost-effective compared to alternative sources of supply. Potential economic benefits of these options include:

- reducing and deferring the need for major supply augmentation
- reducing or avoiding the need for upgrades to the water distribution system
- reducing whole-of-system operating costs
- reducing the overall demand for water.

These opportunities should be assessed on a total water cycle basis, taking into account environmental and social considerations (refer to Section 3.5). Local water supplies can have significant benefits for the local environment. For example, local recycled water schemes can significantly reduce nutrient discharges from wastewater treatment plants, improving the health of receiving waterways and estuaries. These benefits vary between schemes, depending on a range of factors including the treatment process and the other flows in the receiving waterway. Other issues, such as energy intensity, must also be taken into account—local supplies can be more or less energy-intensive than bulk water supplies (refer to Section 6.8.3).

Demand for SEQ Water Grid water will be further reduced by existing tanks including those retrofitted to existing houses during the drought response and tanks on new industrial and commercial buildings.

With few exceptions, local supplies will be insufficient to achieve the LOS objectives described in Chapter 3. As a result, the water balance takes into account the amount of water that will be required to augment supplies from rainwater tanks during severe droughts.

4.6.1 Rainwater tanks

Rainwater tanks were installed in 236 000 homes in SEQ as part of the Queensland Government's WaterWise Rebate Scheme. This represents a penetration rate of almost one in four detached and semi-detached dwellings. These tanks enabled residents to reduce the impact of the drought on gardens while maintaining average consumption below 140 litres per person per day for over a year.

A large proportion of development in SEQ is located in coastal areas that receive higher rainfall than existing major dam catchments. Rainwater tanks and stormwater harvesting provide a way to capture some of this rainfall. Rainwater tanks are able to collect inflows from light rainfall, whereas dams may require 50 millimetres or more of rainfall in the catchment area before run-off commences.

The minimum requirements specified in the Queensland Development Code ensure that rainwater tanks are cost-effective compared to desalination and purified recycled water. This cost effectiveness is due to:

- cost being minimised by installing the tank and internal plumbing connections during construction
- yield being maximised by regulating the minimum size of the tank, connected roof area and plumbing into toilets and washing machines.

The savings that could be achieved for similar costs in existing homes are estimated to be considerably lower. Retrofitted rainwater tanks are generally less cost-effective due to smaller tanks, smaller connected roof area and fewer, if any, internal connections such as to toilets or washing machines. Further work is planned to improve the yield, energy efficiency and cost-effectiveness of rainwater tank systems installed in new dwellings.

4.6.2 Stormwater harvesting

Stormwater harvesting involves collecting and storing stormwater, then treating and using it at a later time. The appropriate use depends on the quality of treatment. Undertaken as part of water-sensitive urban design, stormwater harvesting has the potential to reduce the impacts from urban development on local waterways, rivers and Moreton Bay. These benefits relate to:

- reducing the quantity of pollutants entering waterways, by trapping and filtering pollutants before discharge and use
- reducing the volume, intensity and frequency of stormwater run-off and stream flow, which helps to maintain in-stream habitats and bank stabilisation.

Stormwater harvesting can vary from on-site scale, such as a shopping centre or industrial development, to regional scale. At the on-site scale, stormwater harvesting may involve capturing and reusing water for use in toilets and for outdoor irrigation. Storage could be provided in underground tanks under car parks or internal roads.

At the local scale, run-off from a new development area might be collected in a wetland for treatment and used for outdoor irrigation or through a dual-reticulation system. At the sub-regional or regional scale, stormwater harvesting might involve collecting run-off from a large catchment area that includes urban and rural areas. The water may be treated to a high standard and used to supplement drinking water supplies.

In a number of greenfield development scenarios, stormwater harvesting could deliver water supply to meet or exceed the water savings targets at a cost comparable to or lower than rainwater tanks.

It is most likely to be cost-effective in developments where:

- the density of development is high, increasing the demand for water and decreasing the unit cost
- the development is large, providing the opportunity for economies of scale
- land is available for surface water storage that does not reduce lot yield, such as low-lying land that would be drainage reserve or passive parkland
- moderate to steep catchments allow for drainage and storage to limited areas.

Similar to rainwater tanks, it is generally more cost-effective to install stormwater supply systems as part of new developments.

Stormwater harvesting could more efficiently achieve both the water savings targets and water-sensitive urban design requirements than if these requirements were addressed separately.

The QWC will also consider opportunities to use managed stormwater harvesting to augment:

- bulk water storages, such as occurs in Orange in New South Wales
- recycled water flows as part of the detailed investigations of potential purified recycled water schemes. Such schemes could have significant benefits for waterways, due to capturing the first-flush stormwater.

The Queensland Government is undertaking more detailed research to assess opportunities for stormwater harvesting in SEQ, as explained in Section 7.4. This includes investigating where large stormwater harvesting schemes could be developed. Much of the research also relates to the health risks that must be managed due to the variation in the quality of stormwater between locations and over time. At present, the cost of meeting regulatory requirements for stormwater use will be a significant factor in determining the viability of such schemes.

The Queensland Government is investigating a number of potential demonstration projects, as summarised in the following text box.

Stormwater harvesting at South Bank

The South Bank Stormwater Harvesting and Recycling Centre (SHARC) will harvest water from a highly urbanised catchment, providing a basis for research. Construction is scheduled to be completed by late 2010.

The scheme involves harvesting stormwater run-off from a 30 hectare urban catchment extending from South Bank into West End. Water will be extracted from a diversion pit in front of the Suncorp Piazza. The water will be treated before being pumped into an underground storage tank and again before distribution. The plant room will include opportunities for community viewing and education.

The SHARC project is expected to supply approximately 77 megalitres per year of treated stormwater. Initially, the water will be used for irrigation, water features and toilet flushing. Once potential water quality issues have been investigated, the water could be used to top up the South Bank pools.

The Queensland Government is contributing $3.3 million to the project. The Australian Government is contributing $4.6 million.

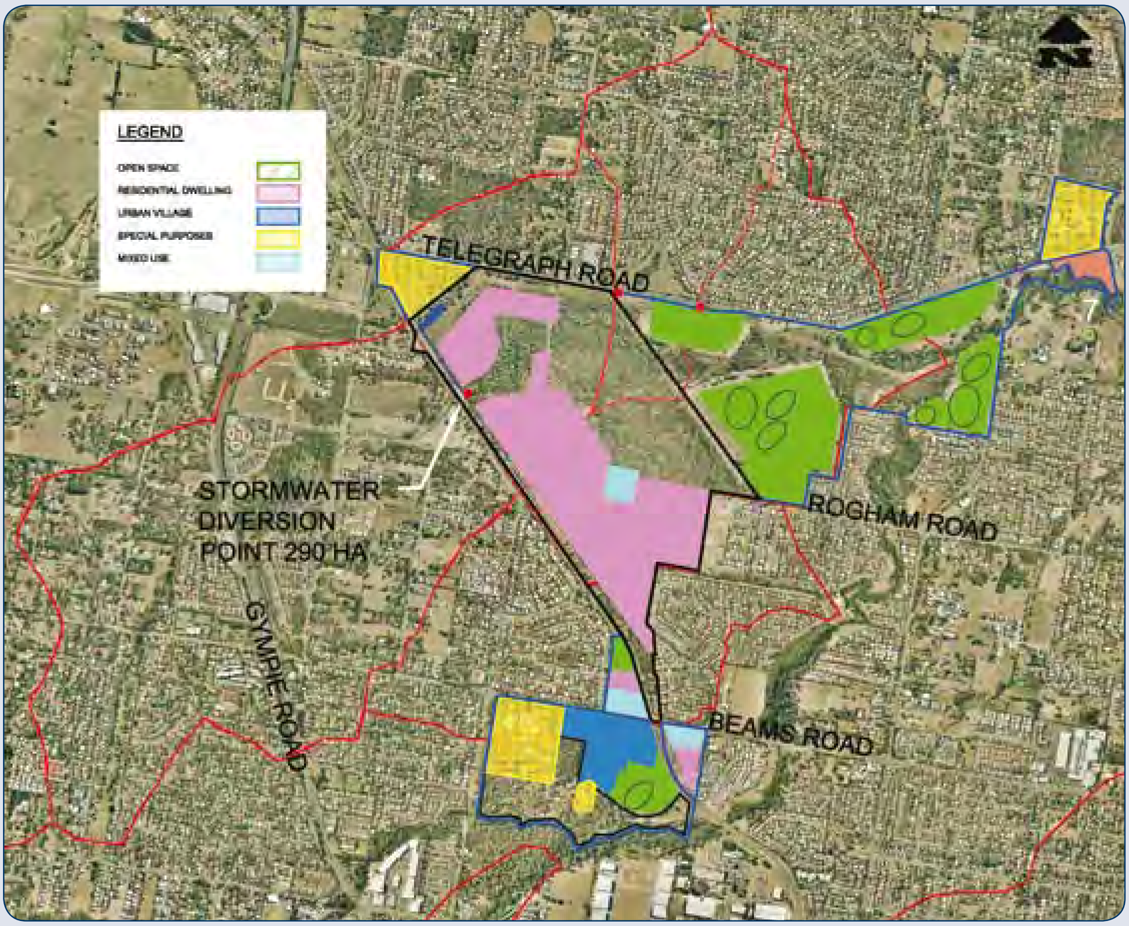
Catchment feeding the South Bank stormwater harvesting scheme

Fitzgibbon Chase

The Fitzgibbon Chase development is an innovative housing affordability initiative, combining recreational, cultural, education, business and medium-density residential development. The Urban Land Development Authority, in partnership with the QWC, is investigating whether a stormwater harvesting scheme could be constructed within the development.

The proposed Fitzgibbon Stormwater Harvesting (FiSH) scheme would divert urban stormwater run-off from an adjacent 290 hectare urban catchment, storing the water in a 5 megalitre urban lake. Stormwater would be treated and distributed to houses and units through a dual-reticulation system. Treated stormwater would be used for toilet flushing, cold laundry taps, garden irrigation and outdoor use.

The FiSH scheme would supply about 89 megalitres per year—about 84 per cent of the development's non-potable demand.



Fitzgibbon Chase stormwater harvesting catchment

4.6.3 Local recycling

Local recycling is an option to achieve the Queensland Development Code's water savings requirement for new dwellings. As with stormwater harvesting, local recycling is more appropriate for offsetting demand from larger scale greenfield industrial or residential developments rather than single properties or brownfield sites.

Apart from purified recycled water, other types of water recycling may provide additional water supplies for the region. Such recycling opportunities may involve:

- wastewater from a wastewater treatment plant that is not part of a purified recycled water scheme
- excess wastewater from a wastewater treatment plant that is surplus to the requirements for any local purified recycled water scheme
- water that is extracted from the sewerage system and treated locally
- greywater.

A feature of recycled water is that the treatment process and water quality can be tailored to suit the use, optimising the capital and operating costs. Where treated wastewater is not fully upgraded to purified recycled water, it might still be of a suitable quality to be used for:

- agricultural applications such as irrigation
- parkland irrigation
- industry activities
- toilet flushing and outdoor irrigation in residential developments, through a dual-reticulation system.

The optimal type of recycling in a particular location, if any, will be considered as part of the total water cycle planning process outlined in Section 2.3. Sub-regional total water cycle plans will incorporate a receiving water load-based analysis, taking into account the costs and benefits of recycling and reuse across the study area. Local recycling will be a key consideration in the first sub-regional total water cycle plan for key growth areas in Logan City Council and Scenic Rim Regional Council areas.

Dual-reticulation recycled water schemes

Dual-reticulation recycled water schemes involve constructing separate distribution systems for drinking water and recycled water. In residential areas, the recycled water is plumbed to homes for flushing toilets and outdoor irrigation. Dual-reticulation recycled water schemes can result in a high percentage of recycled water reuse and potentially reduce the impact of any future water restrictions.

A permanent reduction in average outdoor water use could have a negative effect on the economic viability of dual reticulation recycled water schemes. The amount of water supplied would reduce without equivalent savings in terms of the cost of constructing and operating the scheme. As with stormwater, the viability of dual-reticulation systems need to be assessed based on the characteristics of a specific site.

Pimpama Coomera WaterFutures Master Plan

The suburbs of Pimpama and Coomera at the northern end of the Gold Coast are expected to grow from approximately 15 000 people to around 120 000 people by 2056[2]. The Pimpama Coomera WaterFutures Master Plan has been developed by the Gold Coast City Council and is the largest integrated water cycle management program in Australia.

The Master Plan aims to reduce the use of potable water in new homes by up to 84 per cent. Under the Master Plan, all new homes will be supplied with recycled water for toilet flushing and outdoor use. Rainwater tanks will be installed to supply washing machines.

Greywater systems and wastewater mining

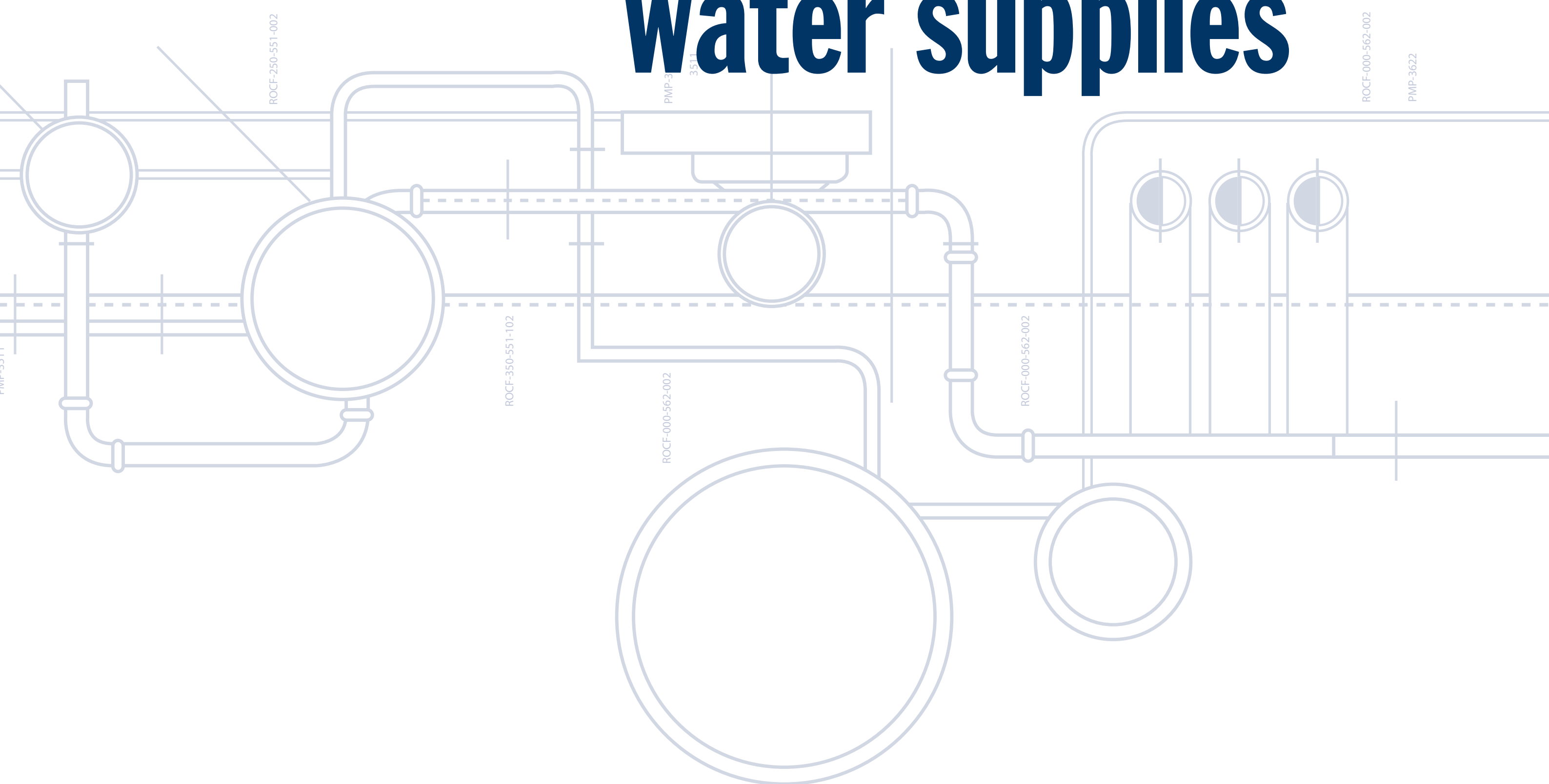
Greywater systems can help to reduce demand for potable supplies. These must be carefully managed, due to potential health risks. The Queensland Government introduced new laws in March 2006 to broaden the use of greywater. Under this legislation, anybody is allowed to manually bucket greywater from the laundry and bathroom, or to connect a flexible hose to divert it from the washing machine to the garden. An application to the local government is required for more sophisticated systems, such as a diverter unit or treatment plant. Such systems must be installed by a plumber licensed in Queensland and must meet Australian standards.

Wastewater mining (where wastewater is pumped directly from the sewer, treated and used on-site) is a minor element of the Strategy, due to cost. With advances in technology, wastewater mining may become more economically viable and schemes may be developed where treated wastewater is available.

2 Source: http://www.goldcoastwater.com.au/t_gcw.aspx?PID=7994

Chapter 5

South East Queensland's water supplies



This chapter describes existing and committed water supply sources for SEQ. It explains the yield of these sources using the Level of Service (LOS) approach outlined in Chapter 3, including the benefits of the SEQ Water Grid and the potential impact of climate change. It also describes the opportunities identified for future water supplies, including potential desalination and purified recycled water schemes, as well as surface water and groundwater opportunities.

Key messages

- The SEQ Water Grid is operational, including the desalination facility at Tugun, the Western Corridor Recycled Water Scheme and major interconnecting pipelines.
- A number of other projects are currently underway, including the Hinze Dam upgrade and the construction of Wyaralong Dam.
- Operating the SEQ Water Grid as a single system increases the system yield by about 14 per cent compared to a disconnected system.
- The desalination facility and Western Corridor Recycled Water Scheme provide security of supply as standby facilities. They do not need to be operated at capacity at all times.
- The projects currently underway, including the Western Corridor Recycled Water Scheme, will increase the LOS system yield to 525 000 megalitres per year of high reliability (Category A) water around 2011, rising over time to its maximum capacity of 545 000 megalitres per year .
- An additional 32 000 megalitres per year of recycled water is available for rural irrigation when not required for urban supply.
- The climate change scenario adopted for planning analysis would reduce the yield of surface water storages and groundwater supplies by 10 per cent.
- The Strategy will be revised at least every five years as information on climate change impacts, population growth and water demands improves.
- Based on existing technology and identified alternative water source options, desalination is currently the only practical supply to fill a regionally significant supply gap.
- Priority desalination sites have been confirmed at Lytton and Marcoola. Reserve sites are at Tugun and Bribie Island.
- There are limited opportunities to substantially increase supply by developing new dams in SEQ, beyond those already committed.
- Groundwater in the SEQ region is considered to be almost fully utilised.

5.1 Existing water sources

In August 2006, the Minister for Infrastructure and Planning introduced a range of measures in response to the Millennium Drought in SEQ, including the construction of major new water assets. The measures are set out in the Water Regulation 2002 (Part 8) (Emergency Regulation). This program includes about 20 infrastructure projects, ranging from the first purified recycled water scheme in Australia to a number of local groundwater schemes and SEQ's first desalination plant.

Construction of the projects set out in the Emergency Regulation is almost complete. This section describes the existing bulk water supplies and major interconnections in SEQ as at mid-2010.

Figure 5.1 shows the current bulk water supplies in the SEQ Water Grid. The major surface water sources are:

- the Brisbane River system, comprising the Wivenhoe and Somerset dams, Lake Manchester and the Mt Crosby Weir
- North Pine Dam
- Hinze and Little Nerang dams
- Baroon Pocket Dam.

Borumba, Moogerah and Maroon Dams supply significant quantities of irrigation water. Lake Dyer, Lake Clarendon and Atkinson Dam are small dams that have been constructed specifically to deliver irrigation supplies.

The Cedar Grove Weir and Bromelton Off-stream Storage were operational from July 2008 and are being used to enhance the performance of the Logan River Water Supply Scheme for current entitlement holders. From 2012, these supplies will be operated in conjunction with Wyaralong Dam (refer to Section 5.2).

Figure 5.1 Existing bulk water supplies

Groundwater aquifers generally provide relatively high-quality water that, under the right circumstances, requires little treatment before use. In SEQ, water from groundwater aquifers currently supplies:

- significant quantities of drinking water to Bribie Island, Redlands, Toowoomba and some southern suburbs of Brisbane
- drinking water to small communities, such as those on North Stradbroke Island
- irrigation water to the Lockyer and Warrill valleys.

Private bores provide small quantities of water, mainly for garden irrigation. On Tamborine Mountain, some residents use private bores for drinking water supplies.

Two major new climate resilient water supplies have been constructed as part of the response to the Millennium Drought, namely the Western Corridor Recycled Water Scheme and the SEQ (Gold Coast) Desalination Facility, located at Tugun.

The Western Corridor Recycled Water Scheme is now the primary source of supply for water being taken from the SEQ Water Grid to the Swanbank, Tarong and Tarong North power stations. If insufficient purified recycled water is available for the power stations, backup supplies can be sourced from Moogerah Dam and the Brisbane River system. The Tarong Power Station also obtains supplies from Boondooma Dam, which is outside the SEQ Water Grid.

Cressbrook Creek, Perseverance and Cooby Creek dams supply water to Toowoomba and are owned by Toowoomba Regional Council. These dams, and the council-owned groundwater schemes, are not part of the SEQ Water Grid.

Bulk water interconnections

Bulk water interconnections are a key feature of the SEQ Water Grid and are at the core of future water security for the region.

Prior to the Millennium Drought, SEQ was supplied from eight largely discrete water supply zones, with differing levels of security and reliability and, until 2008, different owners and operators. Due to the lack of connection, restrictions were applied in some parts of the region while dams in other parts were full or overflowing. For instance, the Gold Coast experienced a severe drought in 2002, resulting in severe restrictions as well as plans to construct a pipeline from Brisbane. A few years later, while dams on the Gold Coast were overflowing, Brisbane was experiencing the most severe drought on record with the lowest recorded inflow into water storages.

Following the completion of most of the Emergency Regulation projects, there are now bulk water interconnections between most of the region's major water treatment plants. Figure 5.2 shows the new grid of interconnecting pipelines, featuring:

- the Southern Regional Water Pipeline, two-way between Brisbane and the Gold Coast
- the Eastern Pipeline Inter-connector, two-way between Redlands and Logan
- the Northern Pipeline Inter-connector Stage 1, between the Sunshine Coast at Caloundra and Brisbane.

These interconnections enable the coordinated management of treated water supplies across SEQ, allowing:

- water to be moved from areas of surplus to areas that face a shortfall
- risk to be managed on a regional level, rather than on an individual storage or system basis
- supply costs to be optimised, taking into account a range of factors including demand, storage levels and the variable costs of treating and transporting water.

In addition, a 38-kilometre pipeline connecting Wivenhoe Dam to Cressbrook Creek Dam has been completed. The pipeline became operational in January 2010, initially providing the capacity to supply up to 10 000 megalitres per year of untreated water to Toowoomba.

5.2 Projects currently underway

A range of catchment management works will soon be undertaken throughout the Logan River Basin. These works will be integrated with a total water cycle management plan for the Logan and Beaudesert areas, which seeks to optimise the overall outcomes for water supply, waterway health and wastewater management. The total water cycle management plans will incorporate the other projects currently underway, which are detailed below.

Wyaralong Dam is scheduled for completion by the end of 2011. Detailed planning of the Wyaralong water treatment plant is being led by a joint Seqwater—Department of Infrastructure and Planning project team. This planning will provide an accurate assessment of the construction timeframes and costs for the water treatment plant. In the latter half of 2010, the QWC will make a recommendation to the Queensland Government on overall timeframe for the water treatment plant based on the regional water balance and the construction timeframes and costs. The goal is to ensure that the water treatment plant is available to meet growth in demand in the most cost-efficient way.

Planning and preliminary design works have commenced for two interconnecting pipes to bring water from the Logan River system (Cedar Grove Weir, Bromelton Off-stream Storage and Wyaralong Dam) into the SEQ Water Grid. These are:

- the Cedar Grove Connector, from the proposed Wyaralong water treatment plant to the Southern Regional Water Pipeline
- the Karawatha Inter-connector, from the Southern Regional Water Pipeline to Kuraby in Brisbane.

The pipelines will enhance the operating flexibility of the SEQ Water Grid by allowing water to be transferred from the Logan River system into the Brisbane area, Beaudesert and parts of the Logan City Council area.

The Cedar Grove Connector is expected to be built at the same time as Stage 1 of the Wyaralong water treatment plant, to connect to the SEQ Water Grid. The Karawatha Inter-connector will be built, if required, to improve the operational efficiency of the SEQ Water Grid.

Work is progressing on Hinze Dam Stage 3, which is scheduled to be completed by December 2010. This involves raising the dam wall by 15 metres, which will increase water supply from Hinze Dam by at least 6000 megalitres per year and provide additional flood mitigation for downstream communities.

The Northern Pipeline Inter-connector Stage 2 will provide a two-way connection within the Sunshine Coast. As part of the project, reverse flow capacity will also be installed onto the Stage 1 Inter-connector. The project is scheduled to be completed by the end of 2011.

The Northern Pipeline Inter-connector Stages 1 and 2 will ensure that the same level of security can be provided to the Sunshine Coast as to the rest of SEQ. Without connection to the remainder of the SEQ Water Grid, dams on the Sunshine Coast would remain vulnerable to severe drought. Although usually reliable, these dams are relatively small, with a storage-to-yield ratio of less than half that of the Brisbane River system. As a result, drought response plans for the Sunshine Coast region, as a stand-alone system, would need the ability to be implemented within a relatively short period of time—less than 18 months. By comparison, a desalination facility requires at least three years to construct; although this time might be shortened by pre-planning for a preferred site, it would be unlikely to be shortened by more than about six months.

The Northern Pipeline Inter-connector Stages 1 and 2 will also ensure that adequate supplies are maintained in normal conditions, regardless of the location and timing of the next supply on the Sunshine Coast. Without the pipeline, an additional supply capacity of between 10 000 and 40 000 megalitres per year would have been required for this area by 2026, depending on population growth and the extent to which average consumption remained below pre-drought trends.

Figure 5.2 SEQ Water Grid interconnections

Major projects

Western Corridor Recycled Water Scheme

The Western Corridor Recycled Water Scheme is one of the largest purified recycled water schemes in the world. It has the capacity to supply up to 84 680 megalitres per year of high-quality water to power stations and industry, and to replenish Wivenhoe Dam. Water is also available for supply to irrigators in the Lockyer Valley and below Wivenhoe Dam when not required for urban purposes.

The Western Corridor Recycled Water Scheme comprises three advanced water treatment plants at Luggage Point, Gibson Island and Bundamba that treat wastewater from six wastewater treatment plants. The project was completed in 2008.

South East Queensland (Gold Coast) Desalination Facility

Construction of the SEQ (Gold Coast) Desalination Facility at Tugun was completed in early 2009. The plant has the capacity to supply 46 000 megalitres per year of water into the SEQ Water Grid.

Logan River system

The Cedar Grove Weir and Bromelton Off-stream Storage were completed in December 2007 and July 2008 respectively. The storages are currently releasing water for treatment at South Maclean Weir and supply to areas between Cedar Grove and Logan City.

The Wyaralong Dam is scheduled for completion before the end of 2011. This dam will be operated in conjunction with the Bromelton Off-stream Storage and the Cedar Grove Weir. The three storages are all located in the Logan River catchment. When operated together, the projects will be able to supply more than 30 000 megalitres per year to SEQ.

Interconnections

The SEQ Water Grid is made up of a group of water supply sources connected by a series of large water pipelines.

The key interconnecting pipelines are the:

- the Northern Pipeline Inter-connector between the Sunshine Coast and Brisbane
- the Southern Regional Water Pipeline between the desalination plant at Tugun and Mt Crosby
- the Eastern Pipeline Inter-connector between the Heinemann Road reservoir in Redlands and the Kimberley Park Reservoir in Logan.

The Northern Pipeline Inter-connector Stage 1, Southern Regional Water Pipeline and Eastern Pipeline Inter-connector are all complete and operational. The Northern Pipeline Inter-connector Stage 2 is due for completion in 2011.

The Toowoomba pipeline, between Wivenhoe and Cressbrook Creek dams, became operational in January 2010.

5.3 System yield

The maximum amount of water permitted to be extracted from existing surface and groundwater supplies in SEQ has been established through water resource plans. These plans are implemented through resource operations plans, which have been completed for all SEQ catchments except the Mary River. The resource operations plans specify the operating rules for all dams and weirs. These processes are explained in Chapter 2.

The water resource plans allocate about 530 000 megalitres per year of water from existing major sources of supply for urban use in SEQ. Some 525 000 megalitres per year has been allocated for communities physically attached to the SEQ Water Grid, with the remaining approximately 5000 megalitres per year supplying communities with stand-alone sources of supply. These allocations have differing levels of reliability, and were commonly determined using the Historical No Failure Yield approach without a contingency for drought worse than anything on record.

The Strategy seeks to improve the security of supply in SEQ. One of the means of achieving this has been to apply the LOS approach to assessment of system yield, as described in Chapter 3. By applying the LOS objectives selected for SEQ, less water will be used for urban purposes than is permitted under water resource planning.

The QWC will continue its storage yield investigations, researching the effects of infrastructure operations on evaporative losses, as well as evaluating physical evaporative options.

Operating the SEQ Water Grid

The SEQ Water Grid Manager directs the operation of the SEQ Water Grid, in accordance with the rules described in the SEQ System Operating Plan.

The SEQ System Operating Plan is designed to help achieve the LOS objectives for the region. It guides the SEQ Water Grid Manager in the operation of the SEQ Water Grid. The SEQ System Operating Plan balances the need to maximise water supply security with the need for least-cost operation. It will allow for the take of water from specific sources to vary over time depending on a range of factors, including inflows to dams, operating costs and risk management. The SEQ System Operating Plan is available on the QWC website.

5.3.1 Yield of existing sources and projects currently underway

The LOS system yield will increase from about 485 000 megalitres per year in 2009 to about 525 000 megalitres per year of high priority (Category A) water in 2011, following completion of committed projects. This yield will further increase over time to 545 000 megalitres per year as the Western Corridor Recycled Water Scheme reaches full capacity. Industrial use of purified recycled water will also increase over time.

An additional 32 000 megalitres per year of recycled water is available from the Western Corridor Recycled Water Scheme for rural irrigation (Category B). These Category B supplies will be diverted to Wivenhoe Dam in the event that SEQ Water Grid storage levels decline to 40 per cent of storage capacity. Category B supplies depend on commercial negotiation and could increase over time to about 37 000 megalitres per year, depending on urban demands and increases in wastewater supply to feed the Western Corridor Recycled Water Scheme.

Purified recycled water supplied from the Western Corridor Recycled Water Scheme to the power stations and other industrial users is considered as high priority (Category A) use and is included in the LOS system yield of 545 000 megalitres per year, as these uses would otherwise need to be supplied from other high reliability supplies.

The total combined system yield at 2011 is 553 000 megalitres per year (Categories A and B), increasing to 584 000 megalitres per year over time as the Western Corridor Recycled Water Scheme reaches full capacity.

Depending on the drawdown of sources in the interconnected SEQ Water Grid, there are many alternative scenarios that can achieve the LOS system yield of 545 000 megalitres per year of Category A supplies. Table 5.1 presents an average supply scenario using the existing and committed water sources. It includes the benefit of operating the SEQ Water Grid as a system. The actual amount extracted from any specific source will vary from year to year depending on climate patterns and other influences.

Table 5.1 Supply from existing and committed sources to obtain SEQ LOS system yield

System	Urban allocation (Megalitres per year)[1]	Average contribution to LOS yield (Megalitres per year)	Storage volume (Megalitres)	Minimum operating volumes (Megalitres)
Dams and weirs				
Mary Basin Water Resource Plan area				
Baroon Pocket Dam	36 495	21 900	61 000	4 500
South Maroochy system (Cooloolabin, Wappa, Poona dams)	16 500	7 800	19 470	570
Ewen Maddock Dam	4 315[2]	2 300	16 700	450
Lake Macdonald	3 500	3 300	8 000	800
Borumba Dam	10 144	5 300	46 000	510
Moreton Water Resource Plan area				
Brisbane River system (Wivenhoe, Somerset and Gold Creek dams, Lake Manchester, and Mt Crosby Weir)	285 545	256 300	1 574 650	13 840
Enoggera Dam	1 700	900	4 500	10
North Pine Dam	59 000	33 700	215 000	2 100
Lake Kurwongbah	7 000	3 200	14 370	~ 500
Caboolture Weir	3 600	3 600	1 300	130
Moogerah Dam	890	800	83 700	1200
Toowoomba Pipeline		10 000		
Logan Basin Water Resource Plan area				
Leslie Harrison Dam	7 640[3]	4 300	24 800	2340
Logan River system (Maroon Dam, Cedar Grove Weir, Wyaralong Dam, Bromelton off-stream storage)	19 856 (+ ~ 25 000[4])	36 900	157 140	19 500
Gold Coast Water Resource Plan area				
Hinze Dam	76 300 (+ ~ 7 700[5])	56 300	161 070	2180
Little Nerang Dam			8 400	200
Total dams and weirs	**532 485 (+ ~ 32 700)**	**446 600**	**2 396 100**	**~ 48 830**
Groundwater[6]				
Bribie Island		8 400		
Brisbane aquifers (Algester, Chandler, Forest Lake, Sunnybank, Runcorn)		–[7]		
North Stradbroke Island		9 000		
Total groundwater		**17 400**		
Manufactured water				
SEQ (Gold Coast) Desalination Facility	46 000	46 000[8]		
Western Corridor Recycled Water Scheme	84 680	35 000[9]		
Total manufactured water	**130 680**	**81 000**		
LOS system yield		545 000		

1 Sourced from existing resource operations plans, interim resource operations licences and preparatory information associated with current operating plan development.

2 When the Mary Basin Resource Operations Plan, is released, it is expected to include a licence for taking water from Addlington Creek for 2900 megalitres per year and a licence to take water from the Mooloolah River for 1415 megalitres per year.

3 Expected volume to be included in the final Logan Basin Resource Operations Plan, based on calculations by SunWater.

4 Bracketed values indicate anticipated allocations to be associated with Wyaralong Dam.

5 Bracketed values indicate anticipated allocations to be associated with the Hinze Dam upgrade.

6 Groundwater entitlements are estimated average water take.

7 The sustainable take of these aquifers is currently being determined. A conservative approach has been taken and the yield has been excluded from the calculation of LOS system yield.

8 The desalination facility also increases the LOS system yield by providing the security to take more water from dams. These increases have been included in the take from dams.

9 Supply for high priority (Category A) uses only, including supply to power stations and industry. In normal operating mode, the Western Corridor Recycled Water Scheme also increases the LOS system yield by providing the security to take more water from dams. These increases have been included in the take from dams.

Table 5.1 also highlights some of the differences between SEQ's dams. Without being connected to the SEQ Water Grid, dynamic smaller coastal storages, such as Baroon Pocket Dam, would be vulnerable to severe drought—particularly as the demand approaches the LOS system yield. These dams have high yield-to-storage volume ratios, meaning that the time available to respond to a water crisis would be short.

Figure 5.3 illustrates LOS system yield over time as the projects currently underway are completed and commissioned. It also illustrates the Category B and combined yield.

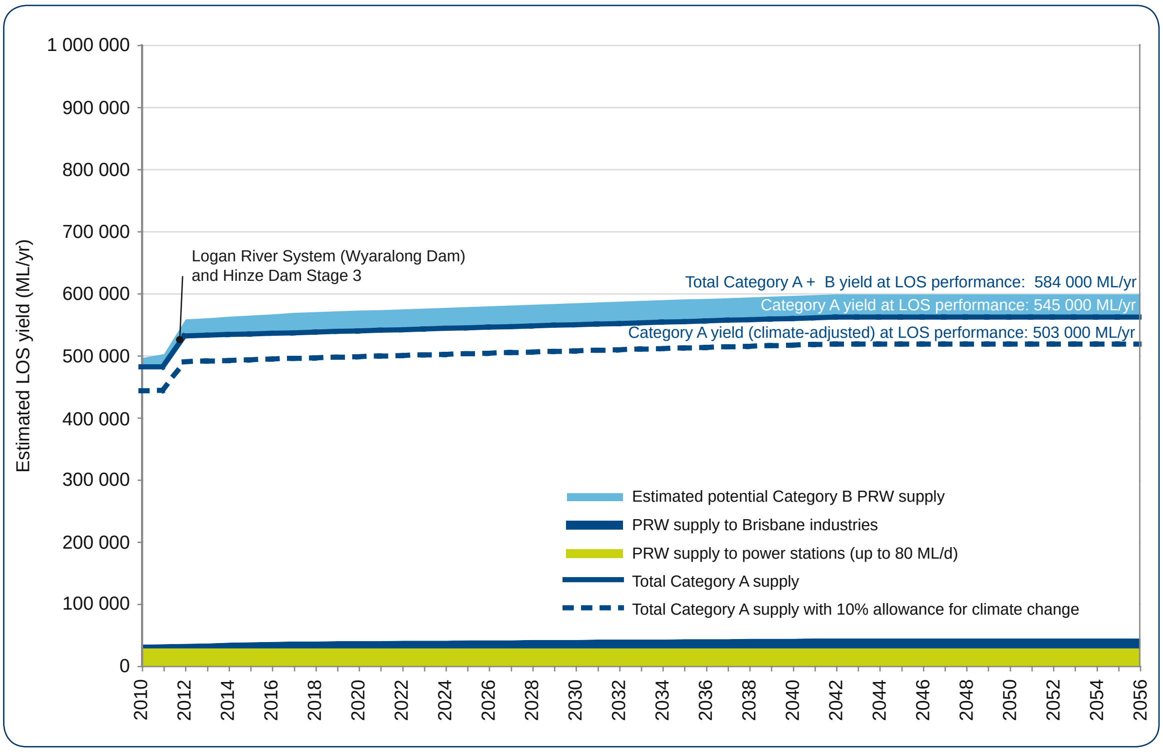


Figure 5.3 System yield of existing and committed infrastructure

Figure 5.4 shows the composition of supplies from the SEQ Water Grid following completion of the committed projects when fully utilised. By comparison, prior to the construction of the SEQ Water Grid, 95 per cent of the region's water supplies were sourced from dams and weirs. The Western Corridor Recycled Water Scheme is included at capacity.

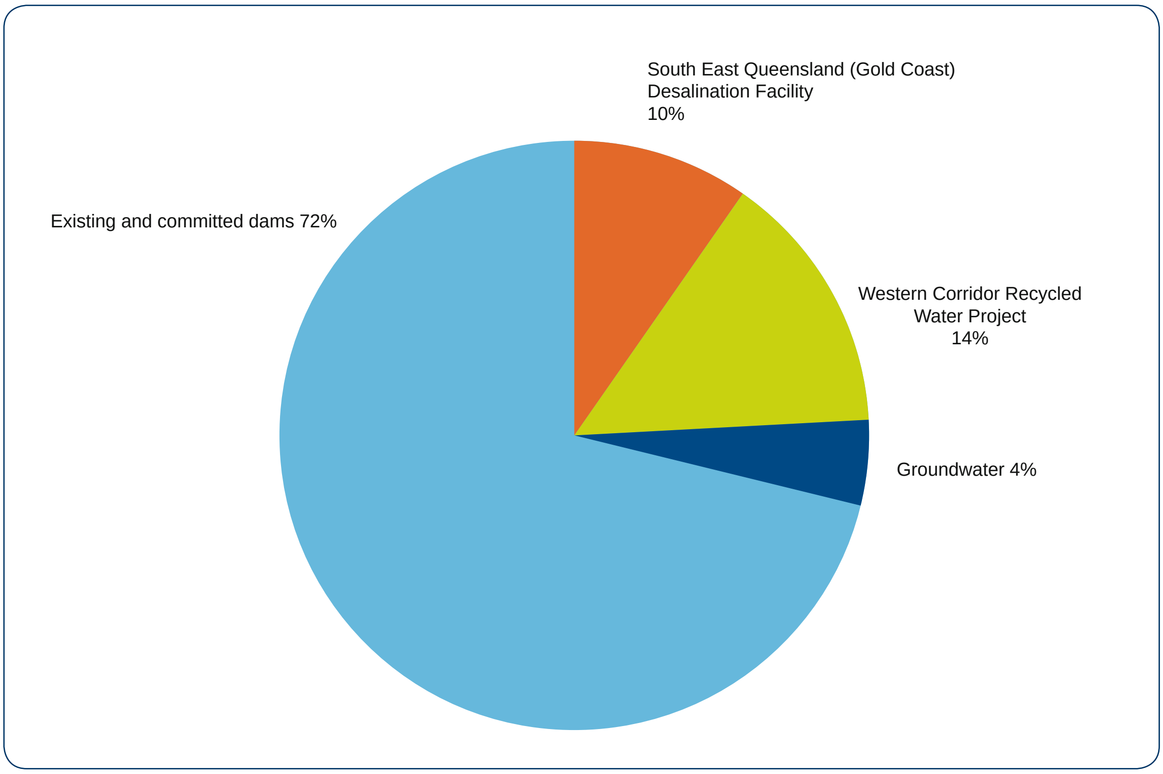


Figure 5.4 Supply distribution from existing and committed infrastructure in 2012

Figure 5.5 illustrates the impact of the LOS system yield on the level of key Water Grid storages using recorded inflows. The analysis is for existing infrastructure and committed projects,where demand equals the LOS system yield and the SEQ Water Grid is operated at capacity. In this scenario, over the past 100 years, restrictions would only have been triggered twice and preparations for constructing new drought-response infrastructure commenced once, as a response to the Millennium Drought. As described in Section 6.1, demand is forecast to equal supply between 2021 and 2033.

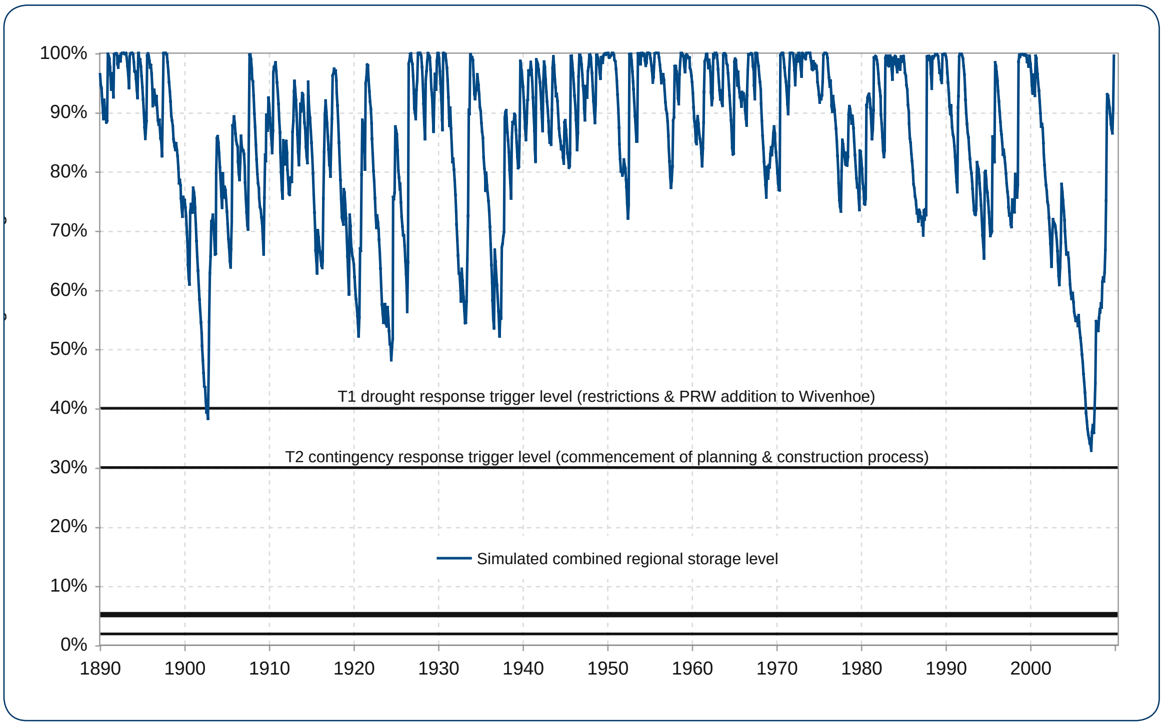


Figure 5.5 Simulated SEQ Water Grid levels based on historic inflows and operation at LOS system yield

Interconnection and diversification benefits of the SEQ Water Grid

An interconnected and diversified SEQ Water Grid increases the LOS system yield above the combined LOS yields of the discrete water supply systems.

Benefits of interconnection

The benefits of interconnection come about because local demands do not need to be met exclusively by local supplies. Likewise, any excess water in a local system can be diverted to supply other areas, rather than be lost as overflow or spill from a dam.

Further benefits can be realised through the cooperative operation of infrastructure that harvests and stores water, and thereby maximises system yield.

Modelling of the regional water balance in two different modes—connected and disconnected—has determined that if the sources of supply existing in 2006 were operated as a connected SEQ Water Grid, there would have been an estimated increase in the system yield of about 14 per cent.

Benefits of diversification

A dam operated in conjunction with a desalination facility or purified recycled water scheme has the potential to yield a greater supply than the same dam operated in isolation.

Desalination facilities and purified recycled water schemes can deliver these benefits as standby facilities—increasing the amount that can be taken from dams when storage levels are high. This mode of operation reduces operating costs and energy consumption.

Purified recycled water will be available to augment Wivenhoe Dam in severe drought, extending the period before drought response infrastructure is needed. The Western Corridor Recycled Water Scheme does not need to be used to augment Wivenhoe Dam at all times, which means that the water can be made available to irrigators on an interruptible basis without affecting the security of supply for urban users.

Without the benefit of the Western Corridor Recycled Water Scheme (WCRWS) introducing purified recycled water into Wivenhoe Dam when the combined key storages fall to 40 per cent of total capacity, the system yield would reduce from 545 000 megalitres per year to about 445 000 megalitres per year (refer to Figure 5.6a).

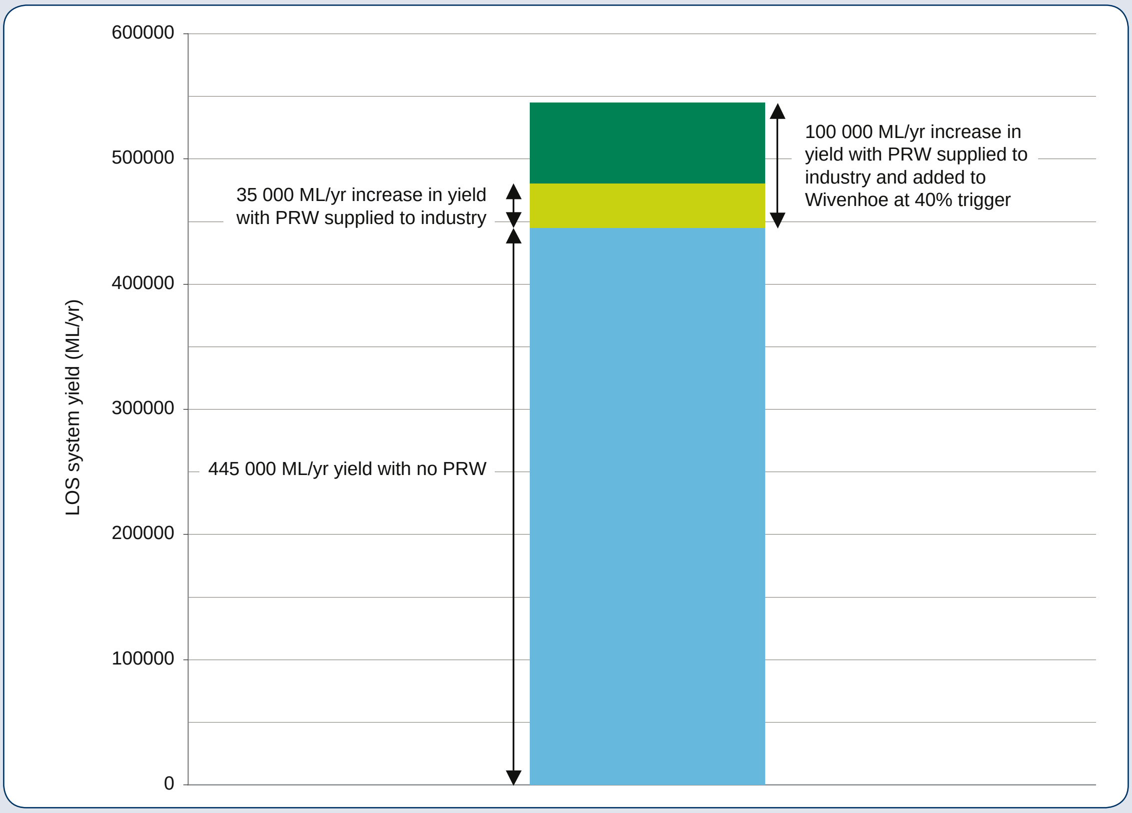


Figure 5.6a Standby value of PRW into Wivenhoe Dam

Using purified recycled water to augment Wivenhoe Dam only when key Water Grid storages fall to 40 per cent of capacity reflects an optimal operating strategy at this time. Using purified recycled water to augment the dam more frequently would have a relatively small impact on the system yield, while significantly increasing our operating costs. It would defer the need for the next major source of supply by up to about 18 months. Figure 5.6 illustrates the impact of varying the trigger level on LOS system yield.

However, when dam levels drop below the 40 per cent trigger point, it is vital that purified recycled water is introduced to Wivenhoe Dam to ensure that LOS is maintained. Figure 5.6b shows that reducing the trigger point would have a relatively significant impact on the LOS system yield.

The impact of varying the trigger depends on the volume of purified recycled water that is supplied directly to power stations, industry and new residential developments, as illustrated in Figure 5.6. The Strategy is based on purified recycled water directly supplying about 35 000 megalitres per year for urban uses including power stations. Higher levels of substitution would increase the LOS system yield and defer augmentation of bulk water supplies.

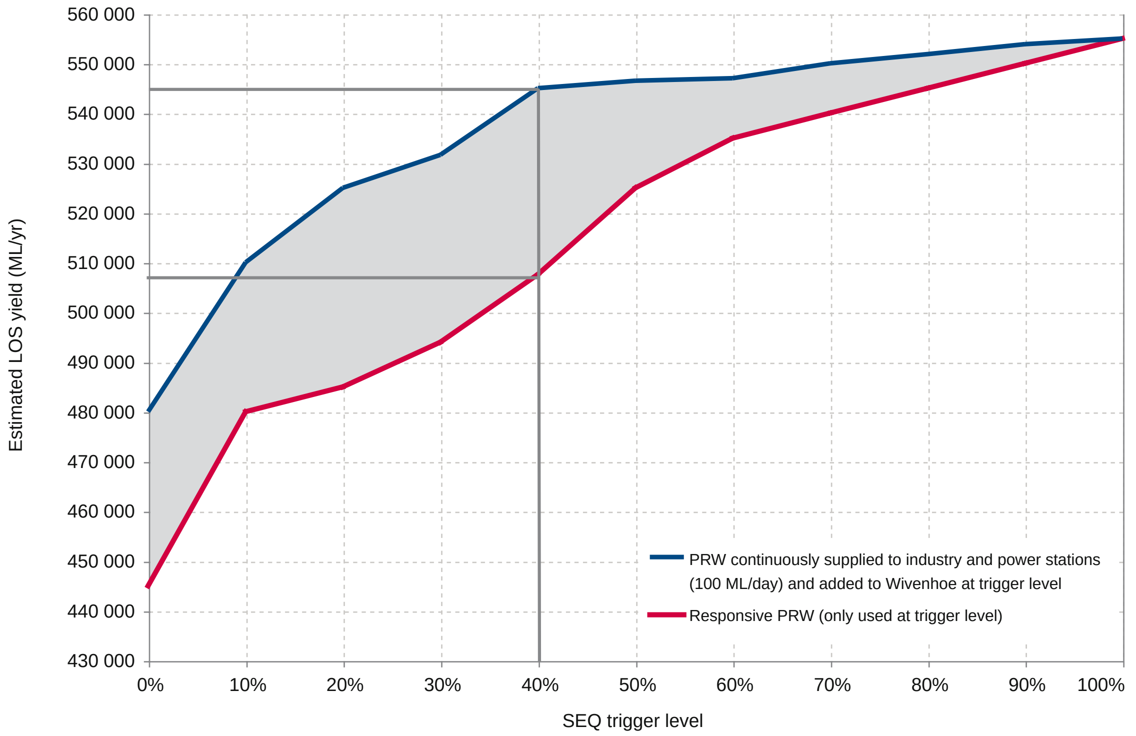


Figure 5.6b Impact of varying the trigger for augmenting Wivenhoe Dam

5.3.2 Potential impacts of climate change

A scenario analysis has been undertaken assuming a 10 per cent reduction in the LOS system yield of surface storages across SEQ due to climate change.

When this climate change scenario is applied, the LOS system yield, including committed infrastructure and the benefits of establishing and operating the SEQ Water Grid, is estimated to reduce from 545 000 megalitres per year to 503 000 megalitres per year. This is shown in Figure 5.3. The system yield in times of drought is discussed in Section 5.3.3.

Case studies have been undertaken for the catchment areas in the western parts of SEQ, as explained in Section 5.3.3. These case studies indicated that changes to annual rainfall could result in annual stream flow for the Brisbane River downstream of Mt Crosby Weir reducing by up to 28 per cent in a dry scenario or increasing by up to 14 per cent in a wet scenario. A preliminary analysis indicates that the upper limit of predicted reduced annual inflows of 28 per cent would result in approximately a 17 per cent reduction in the yield of the system, operating in isolation.

Ongoing work is being undertaken to refine climate impact assessments across the whole of SEQ (refer to Section 3.2). As climate change is unlikely to have a significant impact on supplies in the near future, until this work is completed portfolios for new infrastructure will not include climate change impacts (refer to Section 6.4). However, construction of new infrastructure will be brought forward if evidence of a reduction in yield emerges or if a severe drought triggers the need to construct additional climate resilient or climate independent supplies as part of a drought response plan.

5.3.3 Climate independent and climate resilient supplies

Climate independent and climate resilient water supplies include:

- desalinated water
- recycled water
- the component of inflows to dams that can be relied on under extended and severe drought conditions
- extractions from groundwater aquifers that can be relied on under extended and severe drought conditions.

Producing drinking water from a desalination plant does not depend on the weather. By comparison, producing purified recycled water could be affected by the weather if water restrictions were introduced and access to wastewater was limited. However, at the targeted reduction in demand of 15 per cent in future droughts, Medium Level Restrictions would be highly unlikely to significantly reduce the yield of the Western Corridor Recycled Water Scheme.

Calculating the climate resilient supplies available from dams and aquifers depends on the selection of an appropriate inflow sequence to represent an extended or severe drought. This is discussed in detail in Section 3.1.6. The climate resilient water supplies in the region have been calculated based on the adopted drought inflow sequence. The yields are presented in Table 5.2.

Table 5.2 Climate independent and climate resilient supplies from existing and committed sources

Water supply source	Climate independent and climate resilient yield (Megalitres per year) in severe drought	Indicative contribution to LOS yield (Megalitres per year) in normal times
SEQ surface and groundwater		
• Northern SEQ		89 500
• Central SEQ		268 000
• Southern SEQ		106 500
Subtotal	*220 000*	*464 000*
SEQ (Gold Coast) Desalination Facility	46 000	46 000[1]
Western Corridor Recycled Water Scheme	84 680[2]	35 000[1]
Total	**350 680**	**545 000**

1 Supply to high priority (Category A) uses. The desalination facility and Western Corridor Recycled Water Scheme also increase the LOS system yield by providing the security to take more water from dams. This benefit has been included in the yield from surface water.

2 Assumes that sufficient treated effluent will be available to operate at capacity. Treated effluent flows will increase over time due to population growth. Alternatively, flows could be increased by transferring treated effluent from Loganholme to Gibson Island.

Following the completion of the committed projects, climate resilient and climate independent supplies are forecast to increase to about 331 700 megalitres per year in 2012. These supplies will comprise about 63 per cent of LOS system yield at that time. Climate resilient supplies will increase to 350 700 when the Western Corridor Recycled Water Scheme reaches capacity. The volume of available climate resilient yields in the region is critical to the calculation of the drought storage reserve and the T1 and T2 triggers (as described in Section 3.1.6).

The QWC is investigating options to enable the Western Corridor Recycled Water Scheme to operate at capacity should a drought occur in the short to medium term. Options under investigation include:

- diverting additional wastewater into the catchment of the Gibson Island wastewater treatment plant
- transferring treated effluent from the Loganholme wastewater treatment plant to the Gibson Island advanced water treatment plant.

These options would reduce treated effluent discharges to the Logan River, contributing to improved waterway health.

5.4 Potential future water sources

It is important that the best supply options and pipeline routes are preserved now to prevent inappropriate development on or near the sites and to enable a timely and well-informed response to demand growth and future droughts.

The following categories of potential water supply sources have been considered in developing the Strategy:

- desalination
- dams and weirs
- stormwater harvesting to dams
- purified recycled water
- groundwater
- water trading
- supplies outside SEQ.

Rainwater, stormwater and other types of recycling are addressed in Section 4.6, as opportunities to reduce demand for SEQ Water Grid water.

5.4.1 Desalination

Water supply by desalination became part of the SEQ Water Grid in early 2009, when the SEQ (Gold Coast) Desalination Facility commenced operation.

New desalination plants present an option for additional climate independent supplies. Preserving sites where future supply sources might be required is good planning to ensure that we are ready to respond to future droughts that might occur.

How does desalination work?

There are two widely applied and commercially proven desalination technologies—thermal (evaporative) and membrane-based (reverse osmosis). Thermal desalination involves boiling water and condensing the vapour, leaving the impurities behind. Membrane-based desalination involves forcing water at very high pressure through a semi-permeable membrane. Impurities are too large to fit through the pores of the membrane.

Historically, thermal methods have dominated the desalination market. Thermal desalination requires more energy than membrane-based methods, but tends to be more robust. Thermal methods can accept variable feed quality, while reverse osmosis usually requires extensive pre-treatment.

Desalination by reverse osmosis is now the most common process, following recent advances in membrane technology. Reverse osmosis is being used in all major desalination plants in Australia, including at Tugun.

The Queensland Government has announced priority sites for potential future desalination sites in SEQ at Lytton and Marcoola. Table 5.3 lists the site details.

Reserve sites have been identified at Bribie Island and at Tugun. At Tugun, duplication of the facility could be over land currently occupied by a wastewater pumping facility and landfill waste site. Triplication into the sporting fields to the north of the site has been excluded from further investigation. Table 5.3 lists the site details.

Table 5.3 Priority and reserve desalination sites

Category	Site	Property description	Owner
Priority	Lytton	Lot 49 SP193294	State of Queensland
	Marcoola	Lot 753 CG3375	Sunshine Coast Regional Council
Reserve	Tugun (duplication of existing facility)	Lot 30 SP197355	Gold Coast City Council / State of Queensland
	Bribie Island	Lot 67 SP214143	State of Queensland

Alternative sites were investigated at Brisbane Airport and Fisherman Islands. These sites were found to be viable, but are currently not available for development and are therefore not considered to warrant preservation. The current preferred site at the mouth of the Brisbane River would be reviewed, if either of the Brisbane Airport or Fisherman Islands sites becomes available for development prior to significant investment in early works and early construction on the Lytton site.

Technological advances could improve the viability of some sites in the future. Reviews will also take into account population growth and augmentations of the SEQ Water Grid, which might affect where future supplies are required.

Due to environmental considerations the Kawana and North and South Stradbroke Island sites, which were identified in the draft Strategy, have been excluded from any further consideration.

Phase 1 and Phase 2 detailed investigations

Detailed site investigations were undertaken in two phases between 2006 and 2009.

The first phase involved several rounds of investigations by consultants, and identified six potential sites. The QWC considered potential sites along the coastal strip from the New South Wales border to Noosa, including the islands of Moreton Bay and the tidal parts of major rivers, particularly the Brisbane River. Information from previous Gold Coast and Sunshine Coast desalination siting studies was incorporated into the review. The investigations highlighted that opportunities for locating additional desalination facilities in SEQ are limited. The key constraints were the shallow protected areas of Moreton Bay and the extent of urban development and conservation areas along the Sunshine Coast and Gold Coast.

Through consultation on the draft Strategy, additional sites were identified by landholders at:

- Brisbane Airport, on Commonwealth land leased by the Brisbane Airport Corporation
- Fisherman Islands, on Port of Brisbane Corporation land.

The option of expanding the SEQ (Gold Coast) Desalination Facility at Tugun was also considered.

The second phase of investigations was conducted during 2008 and 2009 for the nine potential sites identified in initial investigations and during subsequent consultation. The second phase involved:

- identification of potential environmental and social issues
- engineering pre-feasibility studies to determine the full extent of works required
- preliminary economic assessment of capital and operating costs
- further brine dispersion modelling and mapping of ecologically significant areas in Moreton Bay
- a pre-feasibility study for the expansion of the SEQ (Gold Coast) Desalination Facility
- investigation into potential airport operation issues at the Sunshine Coast Airport.

The priority and reserve sites were selected based on regional water balance considerations and detailed site investigations. In relation to the regional water balance, the sites were selected to:

- potentially accommodate desalination facilities with a combined capacity in excess of 1000 megalitres per day, being the potential supply gap at 2056
- maintain diversity in the location of sites within SEQ.

Phase 1 and 2 reports are available on the QWC website.

Desalination site assessments

The priority and reserve sites are the best available desalination sites in SEQ. A number of issues need to be addressed in further detailed planning for each site.

Northern sub-region

Marcoola is the priority site in northern SEQ. Bribie Island is a reserve site.

The Marcoola site was selected as the priority site in northern SEQ due to lesser environmental impacts, lower costs and fewer construction and operational issues.

Marcoola

The Marcoola site is former cane land, devoid of significant vegetation or permanent structures.

The site is adjacent to the proposed second runway for the Sunshine Coast Airport. Advice indicates that operational issues due to the proximity of the two sites are manageable.

Connecting infrastructure must traverse a strip of Mt Coolum National Park to the east of the site. The impact of construction is likely to be minimised by less invasive construction techniques and thorough site rehabilitation once construction is complete. This matter will be addressed as part of Phase 3 detailed planning.

Bribie Island

Bribie Island is a reserve site. While it is one of the best sites in SEQ, a range of issues would need to be addressed as part of detailed planning.

Bribie Island National Park surrounds most of the land parcel containing the proposed site. To access the sea, pipelines would need to traverse a section of the national park that is also part of the Moreton Bay Marine Park, which is a listed Ramsar Wetland.

The pipelines to transport product water from the desalination facility to the SEQ Water Grid would traverse Pumicestone Passage. The passage is recognised on the directory of important wetlands and is zoned Conservation Park under the Moreton Bay Marine Park. Tunnelling could be required in order to avoid unacceptable impacts, increasing the cost of the project.

Power supply to the Bribie Island site would be more expensive than for Marcoola and traffic would need to be managed during construction, particularly around the bridge.

Central sub-region

In the central sub-region, Lytton is a priority site. This designation might be reviewed if and when the alternatives become available for development. If not already developed, the Lytton site could be immediately released for industrial development. Brine dispersion is a key consideration for all sites at the mouth of the Brisbane River.

Lytton

The Lytton site is currently industrial land. No significant constraints exist on the site that would inhibit the construction of a desalination plant.

Brisbane Airport

The site nominated at the Brisbane Airport could be considered as an alternative to the Lytton site. The site is relatively free from environmental constraints. Subject to airport master planning, it could become available after completion of the parallel runway, which is currently scheduled for 2018.

Fisherman Islands

The Fisherman Islands site lies within an operational rail loop at the port. The site is not currently available. In order to develop the site, a planned expansion of the rail loop would need to be completed. Significant ground preparation works would also be required. The Brisbane Airport site is a superior option.

Southern sub-region

No priority sites have been designated in southern SEQ. The reserve site in this sub-region is for a duplication of the existing desalination facility at Tugun.

Duplication of the Tugun desalination facility would involve use of adjoining land occupied by a wastewater pump station, a decommissioned wastewater treatment plant, sporting fields and an active landfill.

Tugun is not a priority site, due to the security of supply in this sub-region with the existing desalination facility and upgrade to Hinze Dam. However, over the long term, demands on the Gold Coast are forecast to exceed existing supplies. Additional capacity at the Tugun site could be used to meet increased local demand, minimising bulk transport costs compared to alternative supplies in other regions.

Future investigations

Detailed investigations of priority sites for desalination have commenced so that they can be delivered whenever required, including as a drought response.

This preparatory phase will culminate in a business case that will recommend the preferred location, size, cost and project delivery mechanism for the facility. The business case is expected to be completed by the end of 2011, for consideration by the Queensland Government.

The business case will recommend a detailed work program for delivering the project when required. Having completed this phase, it could be possible to put the project on hold until about four years prior to when the next facility is required, as guided by the supply and demand balance. Alternative bulk water supplies will also be investigated and, if feasible, might defer the need for additional desalination facilities.

The subsequent phases and key activities are summarised in Table 5.4. This approach will minimise the time and uncertainty involved in construction while providing scope for design innovation at the time that the plant is delivered. In particular, it provides an opportunity for the most recent technologies to be used as part of the detailed design.

Table 5.4 Planning and delivery of the next desalination facility

Phase	Activities	Outcome
Preparatory	• Community consultation • Preservation of sites, land use planning • Identification and preservation of connecting corridors • Detailed engineering options analysis, including for water quality and electricity supply • Detailed review of environmental and cultural factors • Confirmation of environmental approvals processes, including through a referral to the Australian Government Department of the Environment, Water, Heritage and the Arts • Identification of potential project delivery mechanism • Refined cost estimates • Business case for delivering the next desalination facility • Detailed work program, including the approvals process	Recommendation regarding preferred location, size, cost and project delivery mechanism for the next desalination facility
Holding	• Ongoing stakeholder consultation and community information • Baseline environmental monitoring • Feedwater characterisation • Ongoing technology scan • Ongoing review of key assumptions	Detailed and up-to-date basis for project procurement and delivery
Procurement	• Community consultation • Securing of funding • Confirmation of project delivery mechanism • Preparation of project scope and specifications • Acquisition of remaining corridors, if required • Tender, assessment and letting	Engagement of a company to deliver the facility
Design and approvals	• Community consultation • Preliminary design • Piloting of plants • Gaining of environmental and other project approvals • Early works	Approval to construct the facility
Construction	• Community information • Detailed design • Construction • Commissioning • Practical completion and project handover • Monitoring of environmental compliance	An operational desalination facility

The preparatory phase will include consideration of whether it is more cost-effective to construct a larger plant at one site, rather than two smaller plants at different locations. In addition, while the structure and connecting pipelines will all be built as one activity, there could be scope for the treatment trains to be installed in stages.

This phase will also include a review of environmental factors for each site, incorporating terrestrial and marine environmental studies. Input from the key stakeholders will be incorporated and cultural heritage issues addressed, as part of this review. Informed by the review, the approvals process required under the *Environmental Protection and Biodiversity Conservation Act 1999* will be confirmed. The approvals process will inform design and approval stages and the terms of reference for an environmental impact assessment.

A project is already underway to investigate the marine communities that exist in the receiving waters, through the SEQ Healthy Waterways Partnership. This project will determine the range of fauna and flora that live on and in the seabed in the vicinity of a brine discharge point. It will also investigate the resilience of these ecosystems to potential elevations in salinity. Detailed field investigations will be carried out.

The SEQ Healthy Waterways Partnership has also started a project with the CSIRO to develop an enhanced receiving water quality model. The enhanced model will be used to assess the impacts of brine discharges in more detail. A range of other issues identified by the Partnership will also be considered as part of detailed planning.

A full assessment of the cultural heritage value of sites will be carried out for both the plant sites and other land that could be required for pipeline construction. Consultation with relevant Indigenous groups will be carried out where required.

Preparatory works will be undertaken for the Marcoola and Lytton sites only. For the Tugun site, the master plan for the local area is being updated to ensure that the potential use of the site for an expanded desalination facility is taken into account. This planning will be undertaken in partnership with the Gold Coast City Council. No further investigations of the Bribie Island site will be undertaken until the need for the site is defined.

Protecting the health of Moreton Bay

Desalination involves removing salt and other impurities from sea water. The salt is then concentrated into a separate stream of high-salinity water, commonly called brine. The most common way of managing the brine is to mix it back into the ocean where it came from. Sometimes this can present environmental risks for the receiving waters, such as Moreton Bay, which has poor flushing characteristics.

The QWC engaged the SEQ Healthy Waterways Partnership to model brine dispersion for different capacity plants and different discharge locations in Moreton Bay, and to provide advice on how species and communities could be affected by the elevated salt concentrations.

Modelling conducted by the SEQ Healthy Waterways Partnership showed that brine dispersion from a 100-megalitre-per-day capacity desalination plant located at the mouth of the Brisbane River would have 'negligible to low risks' on Moreton Bay marine life, with the impacts being further reduced by placing the discharge further out into the bay.

The SEQ Healthy Waterways Partnership recommended that a discharge site located outside the river mouth towards Mud Island could disperse brine from a plant of 73 000 megalitres per year capacity with 'negligible to low risks'.

Figure 5.7 Example output from hydrodynamic modelling—median salinity contours

5.4.2 Dams and weirs

Additional surface water supplies could be developed through:

- constructing new dams and weirs
- augmenting existing dams and weirs

  or
- water harvesting during high flow events into off-stream storages.

A comprehensive review has highlighted that there are no sound opportunities for developing major new dams in SEQ, beyond committed projects. This is due to the limited availability of additional water for urban use under the water resource plans and the shortage of suitable sites.

Water resource plans specify environmental flow and water allocation security objectives, as described in Section 2.1.3. Through environmental flow objectives, water resource plans for SEQ have already protected a significant portion of surface water flows for the environment.

Water resource plans contain environmental flow objectives at various locations. Table 5.5 specifies the end-of-system flow that must not be jeopardised by future water resource planning decisions in SEQ. This flow is expressed as a percentage of mean annual flow for the area in an undeveloped state. These objectives are a minimum, with actual environmental flows being higher where strategic reserves are not fully allocated for urban or rural use.

Table 5.5 Mean annual flow objectives at river mouth

Water resource plan	Gold Coast	Logan Basin	Mary Basin	Moreton
Location	Mouth of the Nerang River	Mouth of the Logan River	Mouth of the Mary River	Mouth of the Brisbane River
Mean annual flow objective as a proportion of pre-development flows	66 per cent	76 per cent	85 per cent	66 per cent

Mary Basin area

The *Water Resource (Mary Basin) Plan 2006* nominates a strategic reserve of 150 000 megalitres per year as available in the Mary Basin.

The decision of the Commonwealth Minister for the Environment, Heritage and the Arts not to allow the Traveston Crossing Dam project to proceed indicates that it might be challenging to achieve environmental approvals for other water storage projects drawing on this reserve. However, given the limited surface water supply options available to the region, a number of smaller development options will be investigated.

Investigations will be undertaken in partnership with the Department of Environment and Resource Management and in collaboration with Seqwater and the Sunshine Coast and Gympie regional councils. Stakeholder input will be sought in accordance with the proposed project selection process that is outlined in Section 3.5. Options to increase the security and volume of supply to downstream urban and rural users will be considered, including for Gympie.

The options to be investigated include:

- an upgrade to Borumba Dam (Stage 3)
- a weir or pumping pool on the Mary River in the vicinity of Coles Crossing
- one or more off-stream storages
- water harvesting from the Mary River.

Combinations of options will also be considered.

Borumba Dam was raised in 1997 (Stage 2), increasing its storage capacity to 46 000 megalitres. Without water harvesting to the dam, a further (Stage 3) raising to around 350 000 megalitres capacity is considered the upper limit of practical development, taking into account the environmental flow requirements and the probability of filling the dam.

In conjunction with a new weir on the Mary River at Coles Crossing, this raising could provide an additional 20 000 to 30 000 megalitres of water per year. The weir would make available significantly more water than the dam alone, while also providing a pumping pool for extracting water from the Mary River to supply local areas and the SEQ Water Grid.

An off-stream storage could enhance the efficiency of pumping to the dam. Water harvested from the Mary River to the storage could be pumped to the dam over a longer period, reducing the capacity and cost of connecting pumps and pipes. The construction of one or more off-stream storages without pumping to the dam will also be investigated as an option to reduce cost and energy requirements. The off-stream storages could be excavated to below river level and be gravity-fed from the river, or be constructed at a higher level with pumping from the river to the storage.

In addition, the QWC will also investigate options to operate the SEQ Water Grid to provide local benefits. For example, when supply for SEQ exceeds demand, Noosa could be supplied from the Northern Pipeline Interconnector Stage 2 rather than from Borumba Dam. This would enable the SEQ Water Grid Manager to make additional water available from Borumba Dam for local purchase and use, subject to appropriate conditions. This could defer the need for additional supplies in the Mary Basin.

Similarly, should one of the smaller options be viable, the QWC will investigate options to integrate water treatment for the SEQ Water Grid with water treatment for Gympie and other local areas.

The QWC will not investigate further options to raise Borumba Dam to make available 70 000 megalitres per year at a similar level of reliability to Traveston Crossing Dam. A 2007 consultancy report, undertaken as part of the Strategy investigations, estimated that the capital cost of such a scheme was in the order of $3 billion. The scheme would also have high ongoing pumping costs.

Other potential dam options have also been excluded from further consideration, including the construction of dams on:

- Amamoor Creek
- Obi Obi Creek at Kidaman
- Mary River near Cambroon.

The options of future storages on the Mary River (Cambroon) and Obi Obi Creek (Kidaman) were excluded by the Queensland Government from further consideration in a 1994 study due to the high cost and significant environmental and social impacts. The dam on Amamoor Creek would also have significant environmental impacts.

Logan Basin area

In the Logan Basin area, there is still potential for up to around 14 000 megalitres per year of high priority water allocation beyond the allocations for committed projects.

A number of options to make additional water available will be investigated, including:

- raising Cedar Grove Weir
- constructing a raw water pipeline to transfer water from the Bromelton Off-stream Storage to Wyaralong Dam
- constructing a weir on the Albert River, immediately downstream of the proposed Wolffdene Dam site
- constructing an off-stream storage adjacent to the Albert river in the vicinity of the existing Luscombe Weir
- constructing a small on-stream or off-stream storage, in the vicinity of the proposed Glendower Dam site on the Albert River.

Moreton area

In the Moreton Water Resource Plan area, an estimated 25 000 megalitres per year of strategic reserve is available.

The introduction of drought storage reserves has reduced the working volume of dams. This, in turn, has reduced the yield from the storage. In these cases, the reduction can be partially offset by increasing the working storage of the dam. The increase in working storage can be achieved by several methods, including raising the dam wall or modifying the operating rules that balance water storage capacity and flood mitigation capacity. Downstream flood impacts will be a key consideration in investigations into any of these options.

A detailed investigation will be conducted to determine the maximum level to which the working storage of Wivenhoe Dam could be raised without raising the dam wall. The investigation will be carried out in conjunction with Seqwater and the Brisbane and Ipswich City Councils. It will include detailed consideration of:

- the impact on frequency, severity and duration of flooding both upstream and downstream of the dam
- any effect on the structural integrity of the dam and its components or any required spillway upgrades
- environmental and social impacts, including adverse affects on any roads and crossings caused by flooding.

Hydrological investigations will be carried out to determine the increased security of supply or the additional volume of water that could be made available to the SEQ Water Grid while still remaining within the requirements of the water resource plan.

Some of the reserve could be accessed by raising the Mt Crosby Weir. Another possibility is as an additional extraction from Wivenhoe Dam. Some of the reserve might also be accessed in other smaller river systems.

Gold Coast area

In the Gold Coast Water Resource Plan area, an estimated 30 000 megalitres per year of additional high priority water allocation may be made available through the construction of additional infrastructure.

Around 7700 megalitres per year of this will become available through the raising of the wall of Hinze Dam. There is some potential to water harvest from Gold Coast creeks and the Coomera River into Hinze Dam.

5.4.3 Stormwater harvesting to dams

The QWC will investigate opportunities to use stormwater to augment inflows to dams, to improve system yield and benefit the local environment.

Sunshine Coast Water has undertaken preliminary investigations into a scheme for collecting stormwater from the Caloundra South development area to augment Ewen Maddock Dam. The scheme could double the catchment area of the dam, increasing the volume and reliability of supply. It would also reduce stormwater discharges from the development area.

The proposed scheme is likely to be the most feasible in SEQ, because:

- the dam is located only 7 kilometres from the potential development area, meaning that the transfer pipeline would be relatively short

- the dam is at a relatively low height above the potential development area, meaning that the energy required to pump stormwater up to the dam is relatively small
- the dam supplies an advanced water treatment plant with surplus capacity, meaning that upgrades are unlikely to be required
- it is a new development area, meaning that it can be designed around the proposed stormwater harvesting scheme.

A range of issues will need to be investigated before the scheme proceeds, including water quality risks, environmental flow benefits, impacts on the ecology of the dam, and economic viability. The benefits of water-sensitive urban design in removing contaminants of concern will also be considered. The QWC will further investigate the proposal, as part of the proposed sub-regional total water cycle management plan for the area. Investigations will be undertaken in partnership with Seqwater, Unitywater and the Sunshine Coast Regional Council.

Local rainwater and stormwater harvesting are addressed in Section 4.6, as opportunities to reduce demand for SEQ Water Grid water. This includes proposed research projects at Coolum and Fitzgibbon to harvest roofwater for treatment and introduction to water distribution systems.

5.4.4 Purified recycled water

Purified recycled water is wastewater that has been treated to drinking water quality using the best available technology. This high-quality water can be delivered directly to end-users, such as power stations or industries, or used to augment a dam or aquifer. If purified recycled water is added to a dam, natural processes provide an additional environmental and time buffer before treatment of the blended water at the existing water treatment plant and distribution to consumers. More information about the treatment process, including an explanatory video, is available on the QWC website.

The water is subject to water quality monitoring and testing at all stages of this process. In Queensland, purified recycled water must meet health and safety requirements contained in the *Water Supply (Safety and Reliability) Act 2008* and the Public Health Regulation 2005.

Purified recycled water has many benefits:

- Purified recycled water is highly climate resilient. Weather is unlikely to significantly affect the availability of purified recycled water. At the targeted reduction in demand of 15 per cent in future droughts, Medium Level Restrictions would be highly unlikely to significantly reduce the volume of wastewater produced and therefore would not significantly reduce the yield of purified recycled water schemes.
- The treatment process removes about 50 per cent of phosphorus that otherwise would have been released into waterways, rivers and Moreton Bay. Phosphorus from existing wastewater treatment plants is one of the key causes of algal blooms in the Brisbane River and Moreton Bay.
- Energy requirements for purified recycled water are less than for seawater desalination. The pressure required to operate reverse osmosis units is approximately proportional to the salinity of the water being treated. Seawater commonly has a salinity of over 30 times that of treated wastewater, resulting in substantially higher energy requirements. Energy consumption is further discussed in Section 6.8.

Interim Water Quality Report

In February 2009, an *Interim Water Quality Report* on purified recycled water from the Bundamba advanced water treatment plant was published. The report contains the results of more than 8000 tests undertaken during the validation testing program for the plant.

The QWC also published a review from the Expert Advisory Panel, which states that the commissioning of the Western Corridor Recycled Water Scheme is proceeding well, demonstrating that it is capable of consistently producing purified recycled water that is safe to be used to augment Wivenhoe Dam.

Western Corridor Recycled Water Scheme

The Western Corridor Recycled Water Scheme is one of the largest purified recycled water schemes in the world. It has the capacity to supply up to 84 680 megalitres per year of recycled water to industry and power stations and for replenishing Wivenhoe Dam.

Up to 32 000 megalitres per year of recycled water will be available for rural production in the Lockyer Valley and along the middle reaches of the Brisbane River when not required to supplement Wivenhoe Dam. Subject to urban demands, the amount available for supply to irrigators mgiht increase to 37 000 megalitres per year over time as feed water flows to the project increase.

The Western Corridor Recycled Water Scheme will maintain a high level of water quality in preparedness for augmenting water supply as necessary.

An expert advisory panel of world leaders in toxicology, environmental science, microbiology and advanced water treatment provide independent advice on the regulatory framework for purified recycled water and the Western Corridor Recycled Water Scheme. There are nine members on the Panel, which is chaired by Professor Paul Greenfield, AO (Vice-Chancellor, The University of Queensland). More information about the panel is available on the QWC website.

Industrial use of purified recycled water

A number of industrial customers have expressed interest in receiving purified recycled water. The process to receive this water involves negotiations between the industrial customer and the retailer, who negotiates with the SEQ Water Grid Manager for supply and delivery of the purified recycled water to the customer.

The uptake of purified recycled water by current industrial customers is limited by a number of factors:

- Many large industrial users are already using recycled water, including the BP and Caltex refineries.
- The supply of purified recycled water requires dedicated infrastructure, including pipelines to individual customers, pumps, valves and meters, which adds to its cost.
- Many high-volume industrial water users are not situated within a reasonable vicinity of the pipeline that delivers purified recycled water from the Western Corridor Recycled Water Scheme.
- As businesses have established water efficiency management plans (WEMPs), they have already reduced their water consumption.

Over time, there is potential for the supply of purified recycled water via dual reticulation to a number of proposed industrial parks located within reasonable proximity of the Western Corridor Recycled Water Scheme. Planning for supply to industrial areas will focus on locations where one or more large foundation customers can be established to provide an anchor for new recycled water schemes.

Other potential schemes

Increased community confidence in purified recycled water schemes could permit the development of additional schemes and the greater utilisation of the Western Corridor Recycled Water Scheme. The QWC considers that it is prudent to proceed with investigations of these potential schemes, with a view to preserving land for treatment facilities and pipeline corridors if viable.

Two potential purified recycled water schemes have been identified as possible future sources of supply, or as part of the response to a severe drought:

- augmentation of supply to North Pine Dam using purified recycled water produced from the Sandgate wastewater treatment plant and wastewater treatment plants in the Moreton Bay Regional Council area
- augmentation of supply to Hinze Dam using purified recycled water produced from one or more of the Coombabah, Elanora and Merrimac wastewater treatment plants at the Gold Coast.

These additional schemes have the potential to increase the available supply, in total, by about 60 000 megalitres per year by 2056.

The assessment of potential schemes took into account wastewater availability, future water demands, capital and operating costs, options for concentrate disposal, and the potential level of dilution and detention in dams.

Local governments and distributor-retailers should consider alternative uses for any treated wastewater effluent, except that required to feed the Western Corridor Recycled Water Scheme, especially where improvements to the health of receiving waterways can be achieved.

5.4.5 Groundwater

Groundwater resources in SEQ are almost fully developed. The annual volume of groundwater used for urban purposes over the next 50 years is expected to remain largely static. The use of groundwater for rural production is also considered fully developed and, in some cases, over-developed.

Groundwater sources have been developed at Bribie Island and at several aquifers in greater Brisbane. These projects were initiated in 2006 as part of the drought response and are now supplying water to the SEQ Water Grid. The sustainable yield of the Brisbane aquifers is currently being determined.

At this stage, development of any additional groundwater supplies will not be pursued. The identified opportunities within and adjacent to SEQ are generally small and not considered to be economically viable as a regional resource. These opportunities include:

- the offshore sand dune islands, including North and South Stradbroke, Moreton, Bribie and Fraser islands
- localised, onshore sand dune deposits near to the coastline and extending intermittently from Rainbow Beach in the north to the Gold Coast in the south
- an extensive system of mostly fractured volcanic rocks associated with what is known geologically as the Gympie Province, extending from just north of Nambour to Gympie
- sedimentary deposits, mostly sandstones associated with the southern part of the Maryborough Basin and known locally as the Myrtle Creek Sandstone
- limited outcrops of relatively young tertiary basalts in the Maleny, Buderim, Sunnybank, Redland Bay and Tamborine Mountain areas
- reasonably extensive tertiary sedimentary deposits outcropping in the Brisbane metropolitan area to the north and south of the city.

Several of these aquifers were investigated as part of the Millennium Drought. Drilling in the extensive sedimentary deposits associated with the Nambour Basin—extending from north of Maroochydore inland to Maleny and southwards to Caboolture—revealed that the available groundwater supplies are small and do not warrant development as an urban supply.

Of the remaining opportunities, the most significant are the Moreton Island and the Cooloola–Teewah sand masses. These aquifers have not been considered as normal supply options because of their location within national parks and the relatively small quantities that could be extracted without unacceptable environmental impacts.

Increased extraction from the aquifer on North Stradbroke Island was considered as part of the response to the Millennium Drought. The project was not progressed due to the risk of long-term impacts on the sensitive environment of the island. A detailed investigation was undertaken, with potential impacts on Blue Lake and other groundwater dependent ecosystems considered.

Separately, the *Water Resource (Moreton Basin) Plan 2007* has established groundwater management areas in Cressbrook Creek, the Lockyer Valley and the Warrill–Bremer Valley. These management areas are expected to reduce the rate of groundwater extractions to more sustainable levels with the aim of protecting water quality and ecosystem health.

The use of aquifers as storage for recycled water is under consideration as part of the Urban Water Security Research Alliance project, building on earlier work by the CSIRO. Preliminary indications are that a limited number of sites around Brisbane could be developed for stormwater harvesting and aquifer storage. A specific application of aquifer storage and recovery is under investigation on the Gold Coast to store recycled water for irrigation purposes.

5.4.6 Water trading between rural and urban allocations

Water resource plans provide a framework for water trading between water users, as explained in Section 2.1.3. In some cases, this framework can provide for the conversion of medium priority to high priority water allocations, and potentially vice-versa.

For SEQ, converting medium priority water for rural production to high priority water for urban supply is not considered to be a viable alternative for augmenting urban water supplies. In general, rural water allocations are small compared to existing urban demand. With conversion from medium priority to high priority, the volumes would be significantly smaller. Measures to increase the availability of water for rural production are explained in Chapter 6. In the right environment, there could be some small trading opportunities with willing sellers and purchasers of water allocations.

5.4.7 Supplies from outside SEQ

There are opportunities to import water into SEQ from outside the region.

Investigations were completed in October 2007 into a direct pipeline connection between the Burdekin Basin and SEQ. The capital cost estimates for the project were found to be prohibitive at that time. Operating such a scheme would also exceed the total energy cost of a desalination plant. The completed report is available on the Department of Environment and Resource Management website.

Consideration has also been given to supplies from north-eastern NSW, such as the Tweed, Brunswick, Clarence, Richmond and Wilson river catchments. Bulk water supply opportunities were investigated, but were found to be costly compared to committed SEQ projects and to have numerous social and environmental issues.

5.4.8 Supplies from coal seam gas developments

Water extracted as a by-product of coal seam gas developments in the Surat Basin could be a future water supply source for SEQ. Before coal seam gas water is considered for SEQ the highest and best local uses should first be investigated. The supply of coal seam gas water to SEQ for potable use must meet strict water quality regulations. In addition, the supply would be at no cost to the SEQ Water Grid, at least until further water supplies are required.

Chapter 6

The Strategy

This chapter outlines a comprehensive strategy to ensure that SEQ never runs out of water. It describes the water supply and demand management initiatives required to meet the needs of regional growth and provide security of supply during drought.

Key messages

- The Strategy aims to deliver sufficient water to support a comfortable, sustainable and prosperous lifestyle while meeting the needs of urban, industrial and rural growth and the environment.
- Water supply for SEQ is now secure. There is a less than 1 per cent probability of key SEQ Water Grid storages falling to 40 per cent of combined capacity over the next five years, triggering the reintroduction of Medium Level Restrictions.
- The Strategy is sufficiently robust to accommodate uncertainty regarding population growth, lifestyle expectations and climate.
- Demand for water will be managed by continuing to improve structural and operational water efficiency and continuing to encourage efficient water use.
- The Strategy challenges residents to maintain average consumption at or below 200 litres per person per day (Target 200).
- If this target is achieved, new supplies will not be required until around 2027. New supplies could be required from 2021, should the target not be achieved.
- Over time, climate change could reduce the yield of our dams, potentially bringing forward the time at which new supplies are required. The QWC will continue to research the impacts of climate change, in partnership with the CSIRO and local universities.
- Demand management is forecast to almost halve energy consumption for the SEQ Water Grid at 2050, compared to pre-drought trends.
- Local supplies are forecast to reduce demand on the SEQ Water Grid by about 35 000 megalitres per year in 2026 and about 60 000 megalitres per year in 2056.
- The QWC will review the Strategy before providing advice about the next major water supply. Potential supplies will be assessed through a robust and transparent process.
- Additional desalination facilities will underpin future water security. Detailed planning for facilities at Marcoola and Lytton has commenced.
- A range of other options is being investigated that could reduce and defer the need for additional desalination facilities.
- Drought response plans will be prepared for rural towns and for the SEQ Water Grid as a whole.
- 32 000 megalitres per year of recycled water has been made available for rural production.

The main purpose of the Strategy is to achieve the LOS objectives. Critical to achieving this outcome is to ensure that water is used efficiently and available supplies always exceed demand.

Many elements of the Strategy are already being implemented. Critical planning elements must be finalised in order to ensure that we are ready to respond to the effects of population growth, consumption trends and climate change.

This chapter applies the planning methodology outlined in Chapter 3 to:

- quantify the potential future supply gap in normal operating mode (refer to Section 6.1)
- identify additional demand management measures (refer to Section 6.3)
- identify a preferred infrastructure program, pending the outcomes of detailed investigations of potential sources of supply (refer to Section 6.4)
- establish drought response plan requirements (refer to Section 6.9).

In addition, the chapter specifically addresses water supplies for rural communities and rural production, water quality, research and development, and energy and greenhouse gas emission implications of the Strategy.

6.1 Water balance

Water supply for SEQ is secure for the short to medium term, due to the SEQ Water Grid being constructed and key Water Grid storages being full or nearly full.

The next major supply will be triggered by demand increasing to the point that it exceeds the LOS system yield or by drought causing dam levels to fall to 30 per cent of capacity.

The next supply is likely to be triggered by demand growth, due to key Water Grid storages being full or almost full. A major new supply might be required in 2021, beyond the completion of projects currently underway. This forecast is based on:

- average total consumption of 375 litres per person per day
- high series population growth.

However, it is more likely that a major new supply will not be required until mid-2020s. For example, a new supply would not be required until around 2026 with:

- average total consumption of 375 litres per person per day
- medium series population growth.

Figure 6.1 presents a scenario for the water balance for Category A supplies to 2056, based on existing infrastructure and projects currently underway, and with demand forecasts based on medium and high series population forecasts.

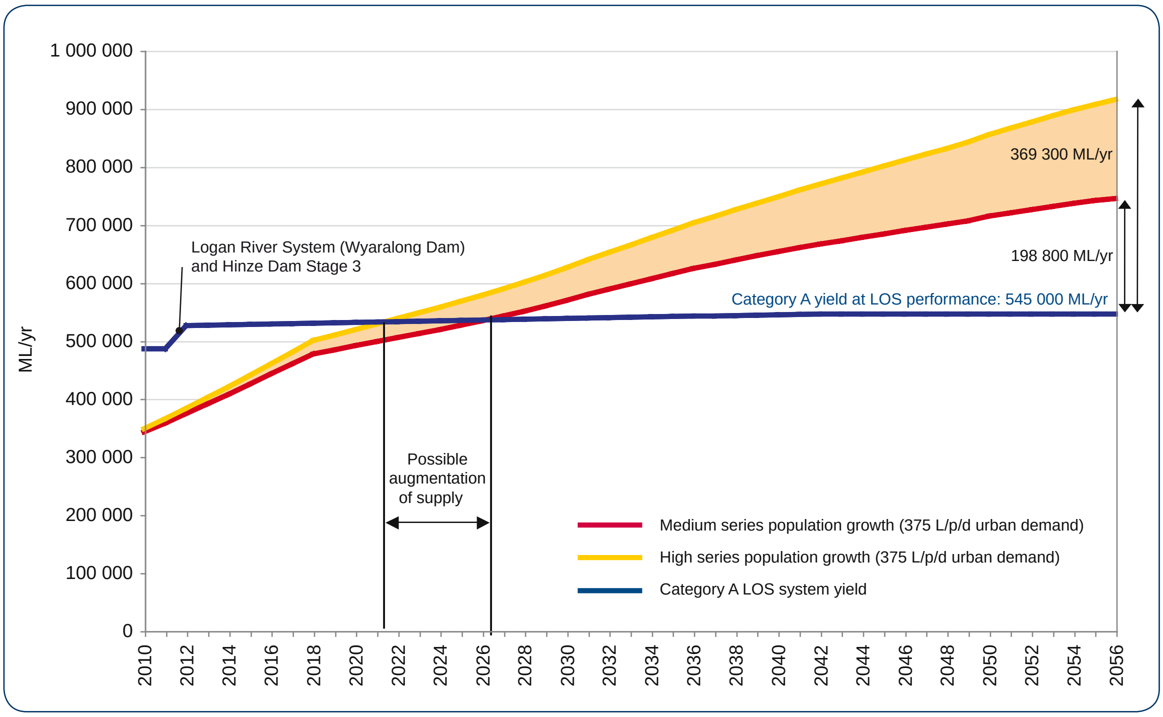


Figure 6.1 Category A water balance in normal operating mode

Figure 6.1 illustrates approximately when supply gaps could occur in the future. A supply gap occurs when demand is greater than the LOS system yield. The potential supply gap depends on the assumptions made regarding the demand for water and the effects of climate change.

As explained in Section 3.2, detailed analysis of the potential impacts of climate change on SEQ water supplies is being undertaken by the Queensland Government Climate Change Centre of Excellence and the CSIRO, through the SEQ Urban Water Security Research Alliance. Until this work is completed, a mid-range climate change scenario of 10 per cent reduction in surface water availability by 2030 has been adopted. In contrast to Perth, these changes are expected to occur over the medium to long term. However, should there be an immediate 10 per cent reduction, the earliest date for supply augmentation would move forward from about 2022 to about 2017. While this scenario is considered unlikely, it is prudent that we continue to plan to be prepared to respond as required.

Having a supply gap does not mean that water supplies will be completely depleted. A supply gap results in an increased likelihood that LOS objectives cannot be met and a greater chance of water restrictions being imposed.

Where supply equals demand, indicated where the demand and system yield lines intersect, the likelihood of entering restrictions is one in 25 years on average. When the system is in surplus, there is a reduced likelihood of entering restrictions, depending on how the SEQ Water Grid is operated.

In accordance with the LOS objectives, the Strategy plans to make sufficient Water Grid water available to meet an average regional urban demand of 375 litres per person per day. As explained in Chapter 4, this is a conservative assumption, and a prudent approach for water supply planning. It takes into account the timeframes for delivering bulk water supply infrastructure, and the level of uncertainty regarding the extent of permanent behavioural changes by the community, population growth, climate variability and the potential impacts of climate change.

6.2 Target 200

The Strategy seeks to build a long-term water savings culture in the SEQ community. It sets a voluntary regional residential consumption target of 200 litres per person per day (Target 200). This challenge is separate from restrictions and will be actively encouraged but not enforced.

The QWC considers that this target can be achieved without significantly changing the lifestyle we enjoy, including the ability to sustain healthy, water-wise gardens. By doing so, the need for additional supplies and the amount of water that is treated and distributed through the SEQ Water Grid can be reduced and deferred, saving money and electricity.

Figure 6.2 shows that reducing average regional consumption by 30 litres per person per day to 345 litres per person per day would defer the need for additional supply beyond projects currently underway from 2026 to around 2033 with medium series population growth and no allowance for climate change.

It would also reduce the supply gap at 2056 by at least 65 700 megalitres per year—equivalent to the Grid water used by about 300 000 houses.

Usage of 345 litres per person per day is equal to the saving that will be achieved if residents of SEQ maintain average regional residential consumption at or below 200 litres per person per day (Target 200). However, changes in the demand profiles can occur for many other reasons.

The sensitivity assessment assumes no adjustments to the LOS objectives relating to the frequency, severity and duration of restrictions and to the frequency of triggering a drought response plan. If the planning assumption for average regional consumption were to be reduced, it would be necessary to consider the impact on effectiveness of future restrictions.

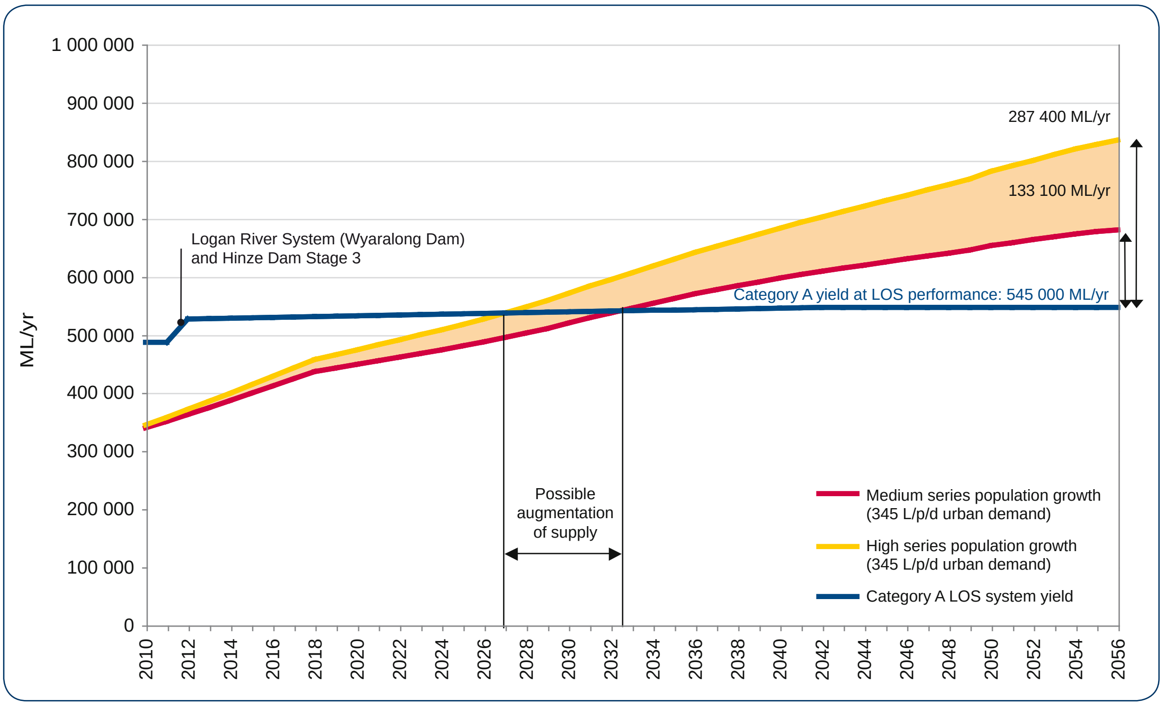


Figure 6.2 Impact of reducing average total consumption by 30 litres per person per day

At the same time, for the reasons outlined in Section 4.3, the QWC recognises that there could be a rebound in water use that might make the consumption target challenging to achieve.

In setting the target, the QWC recognises that actual residential consumption will vary considerably between households and across SEQ due to the type and age of homes, number of occupants, location in terms of climate, soil type conditions and the size and type of gardens. Small households in dry locations might use more, but households in new houses should aim to use less. Actual residential consumption will also vary between seasons and years.

The consumption target will be a key element of an ongoing low level education and communications program. This program will provide timely, well-targeted information and will seek to reinforce some of the basic behavioural changes that enabled residents of SEQ to reduce average demand to below 140 litres per person per day during the Millennium Drought, and to support structural and operational water efficiency measures. The program will include ongoing reporting on achievement of Target 200, with a focus on the long-term benefits of maintaining average regional consumption below 200 litres per person per day.

The collective benefits of these types of behavioural changes can be dramatic, as demonstrated by the success of the Target 140 residential campaign. Once the Target 140 campaign commenced, average residential consumption in central SEQ dropped to below 140 litres per person per day within six weeks and remained below 140 litres per person per day for the year from July 2007 to July 2008. This was a significant drop from the 300 litres per person per day used in 2004–05.

Support for Target 200

Across SEQ, average residential consumption was 165 litres per person per day over six months from 1 December 2009, when Permanent Water Conservation Measures commenced. In central SEQ, average consumption has remained at 148 litres per person per day. Consumption has also:

- remained low on the Gold Coast, where residents were exempted from restrictions from 8 January 2009 until the commencement of Permanent Water Conservation Measures, with average residential consumption of 206 litres per person per day
- reduced on the Sunshine Coast, which has not previously been subject to QWC water restrictions, with average residential consumption of 224 litres per person per day.

These trends reflect the results of a 1000 respondent online survey undertaken from 3 to 8 March 2010, during which combined dam levels rose from 82.3 to 95.8 per cent of capacity. In particular:

- 74 per cent of respondents were either very comfortable or comfortable with 200 litres per person per day as a permanent usage target
- 42 per cent of respondents indicated that we should preserve water and hold people to usage levels similar to those we have now (200 litres per person per day). Nearly a third (29 per cent) of respondents indicated that the target should not go far above 200 litres per person per day.

6.3 Demand management program

The Strategy aims to build on the successful demand management programs that commenced during the Millennium Drought. Existing measures that will be continued are described in Section 4.4 and summarised below. New structural, operational and behavioural elements of this program are described below. Consistent with Section 4.4, demand management measures have been categorised as:

- structural—making sure our homes and businesses have water-efficient devices, appliances and equipment installed
- operational—making sure that water-efficient equipment is used correctly to achieve efficient outcomes
- behavioural—encouraging good water use behaviours and ensuring that the community understands the benefits of conserving water.

The continuing and proposed water savings measures are generally cost-effective compared to new sources of supply and can be achieved without significant changes to lifestyle. Chapter 4 explains the basis for the savings and the impacts for residents.

Continuing water use efficiency measures

A range of water use efficiency measures that were implemented during the drought will continue long term. These measures include:

- public education and communication programs
- requirements for alternative local water sources, such as internally connected rainwater tanks, to be installed in most new buildings
- requirements for water-efficient fittings and fixtures to be installed in new and renovated commercial, industrial and residential buildings
- requirements for businesses using more than 10 megalitres per year to prepare a water efficiency management plan that demonstrates how they will move towards best practice water use efficiency
- requirements for all businesses to ensure that their urinals and cooling towers are efficient
- requirements for businesses using 1 megalitre per year or more to ensure that all internal water fittings on the premises are water-efficient
- requirements for sub-meters to be installed in new residential and commercial multi-unit developments
- provision of water use information to residential tenants, in accordance with guidelines issued by the QWC
- ability for landlords to pass on water consumption charges to tenants of individually metered and water-efficient premises.

6.3.1 Water restrictions

Water restrictions will continue to be part of the demand management program.

Permanent Water Conservation Measures were introduced across SEQ on 1 December 2009. Under these measures, time restrictions have generally been relaxed, but efficiency measures remain in place.

The QWC will continue to review the role of water restrictions as part of the overall demand management program. In doing so, the QWC will seek to ensure that it achieves an appropriate balance between water restrictions and other demand management measures, with the objective of encouraging water efficiency at the lowest possible economic, social and environmental costs.

The QWC will also develop future Medium Level Restrictions as part of the drought response plan. These restrictions will be designed to achieve the LOS objective of reducing average regional consumption of 375 litres per person per day by 15 per cent.

Permanent Water Conservation Measures

Permanent Water Conservation Measures are low-level water restrictions that were introduced across SEQ on 1 December 2009—the first time that common restrictions had applied across the region. These measures reflect feedback on the Strategy that the community supports the ongoing use of low-level restrictions, provided that the focus is on water efficiency rather than water use volume.

Permanent Water Conservation Measures have been designed specifically to capture long-term demand savings, such as through integration with other demand management and water efficiency programs.

Time restrictions on outdoor water use are generally removed, except for a requirement to water gardens and lawns outside the heat of the day. There is also a requirement to use water-efficient devices, such as trigger nozzles on hoses, high-pressure cleaners and efficient irrigation.

Heavy residential water users will continue to be identified and, where high water use cannot be justified, the user will enter a program to assist their household to reduce water use. Section 4.3 highlights the importance of this program.

Permanent Water Conservation Measures also give effect to a small number of structural and operational measures that are not currently implemented through other means, such as the Queensland Development Code.

Outdoor water use requirements for non-residential water users are generally the same as for residents, except where a business wishes to irrigate an area greater than 500 square metres. Where this is the case, the business is required to develop an irrigation water efficiency management plan.

The QWC will review the Permanent Water Conservation Measures during 2010 and 2011. Working with key stakeholders, the QWC will review and refine each measure individually to ensure that it is necessary, effective and efficient. The QWC will specifically investigate whether some requirements should be integrated into end-user contracts, moved to other regulations, or discontinued. The review will focus on non-residential restrictions. Key residential restrictions, such as the restriction on the use of water for irrigation in the middle of the day, are not expected to change.

Target 200 is not part of Permanent Water Conservation Measures. It is a voluntary measure that will be actively encouraged but not enforced.

6.3.2 Demand management measures for investigation

A range of new structural, operational and behavioural water efficiency measures are currently being investigated, as are improvements to existing programs. In combination with the existing measures, these new measures will assist the SEQ community to meet our water savings targets. These new measures are listed below.

Demand management measures under investigation Structural water use efficiency measures
Promote water use efficiency star ratings for non-residential property
Water consumption in office buildings will be monitored and rated on a scale of one to five stars (best practice is five stars).
Ban the sale of inefficient water devices
With the exception of toilets, plumbing and white goods, producers currently do not have to meet minimum water use performance standards. This measure involves working with the Australian Government and industry to develop and implement minimum standards. Consideration could also be given to expanding the range of products covered by the existing WELS scheme.
School water use efficiency
This measure involves a trial to assess the benefits of installing web-based smart monitoring and alarm systems on water meters in a number of schools. The web-based monitoring system is designed to trigger an alarm if water consumption rises above a pre-set level. Sydney Water has successfully trialled this type of monitoring. An audit of 13 Sydney schools showed that 44 per cent of water used within the grounds was lost through leaks.
Operational water use efficiency measures
Targeted education programs for selected industries
This measure involves developing a training program for professions and trades involved in the sale and installation of water-using appliances and fixtures, and garden and landscaping products.
Behavioural water efficiency measures
Regionally consistent billing approach
This measure involves phasing in a standardised approach to billing information. Distributor-retailers are required to produce water bills in accordance with guidelines that specify a minimum content and format, with regular billing cycles. This will allow consumers to become more informed about their water consumption.

6.3.3 Updating the demand management program

A comprehensive review of the demand management program will be undertaken regularly and as part of future reviews of the Strategy. Additional demand management measures will be identified as part of continuous improvement. These measures will be informed by changes in population growth, climatic conditions, consumption trends and community expectations, as well as technological developments and the timeframe for constructing additional sources of supply.

The LOS objective for the volume of water to be supplied in normal times (375 litres per person per day for all uses) might be amended at the next review of the Strategy if average water use across the region remains significantly below the planning assumption.

In assessing any changes to the LOS objectives for supply in normal operating mode, consideration will be given to the impact on the scope for future restrictions if the T1 trigger is hit. Once residents, business and industry achieve best practice water use efficiency, consumption cannot be further reduced without significant economic or lifestyle impacts. These matters could affect the LOS objectives relating to the severity of restrictions.

Consistent with the approach adopted in the Strategy, additional demand management measures should be undertaken where they are cost-effective compared to the cost of building new supplies.

6.4 Meeting the supply gap

This section summarises potential supply options and infrastructure programs. Some of the minor dam and weirs projects could also be developed to improve availability of water for rural users, subject to their capacity to pay.

As explained above, major new supplies are unlikely to be required for at least 10 years. The Strategy seeks to further defer when these supplies are required through:

- the efficient operation of existing infrastructure (refer to Sections 3.1 and 7.2.2)
- ongoing water efficiency (refer to Sections 4.4, 6.2 and 6.3)
- the integration of local supplies into new development (refer to Section 4.6).

Section 5.4 outlines a range of investigations into potential supplies that will inform future revisions of the Strategy. The investigations will also establish a benchmark against which water efficiency and local supply options can be assessed. For example, as noted in Section 4.6, some local supplies might be able to exceed the minimum requirements in the Queensland Development Code. Options that improve water savings locally should be implemented if they meet all regulatory requirements and if the incremental cost above the minimum requirements is equal to or less than the cost of major new supplies, compared on a triple bottom line basis. The QWC is investigating methods for objectively undertaking such assessments.

6.4.1 Potential supply options

Future supply options were identified in Chapter 5 and are listed in Table 6.1.

Table 6.1 Potential sources of supply for detailed investigation

Type of source	Potential source
Desalination sites	• Marcoola (priority site) • Lytton, near the Brisbane River mouth (priority site) • Expansion of the facility at Tugun on the Gold Coast (reserve site) • Bribie Island (reserve site)
Dams and weirs	• Borumba Dam Stage 3, water harvesting from the Mary River or a combination of both • Raised operating levels in Wivenhoe Dam • Raising of the Mt Crosby Weir • Additional minor supplies in the Logan and Albert catchment, including potentially a pipeline between the Bromelton Off-stream Storage and Wyaralong Dam
Purified recycled water schemes	• Augmentation of Hinze Dam • Augmentation of North Pine Dam
Decentralised systems	• Investigations into proposed sites, including North Brisbane and the Sunshine Coast for stormwater, rainwater systems and local recycling

Based on existing technology and identified alternative water source options, desalination is currently the only practical supply to fill a regionally significant supply gap. Desalination facilities at the priority and reserve sites will underpin water security for SEQ. Current information indicates that these sites could accommodate desalination facilities with a combined capacity of over 300 000 megalitres per year. With improvements in technology, the same sites could accommodate facilities with more capacity.

There are limited bulk supply options beyond these sites. As explained in Section 5.4.2, dam and weir options could supply an additional 50 000 to 100 000 megalitres per year in normal operating mode. In addition, two purified recycled water schemes that could supply up to 100 000 megalitres per year have been identified for detailed investigation. However, the development of these schemes depends on improved community confidence in purified recycled water.

The supply gap could be reduced if local supplies achieve savings larger than required for new houses under the water savings targets. Detached houses must target savings of 70 000 litres per year, while terrace houses and townhouses must aim to achieve savings of 42 000 litres per year. These savings could be met by internally plumbed rainwater tanks, stormwater harvesting, dual-reticulation recycled water schemes, or the treatment and reuse of greywater. For new houses, the water savings target is forecast to reduce demand by about 60 000 megalitres per year by 2056. However, higher savings might be cost-effective in particular locations and sites—for example by adopting a water-sensitive urban design approach that seeks to integrate stormwater harvesting with stormwater management.

Due to the limited opportunities available, there are currently no plans for substantial increases in the volume of water extracted from groundwater.

6.4.2 Potential supply portfolios

This section presents the preferred portfolio of projects to fill the supply gap, based on current forecasts and pending detailed investigations of potential supplies, as described in Section 3.5

The final selection of each future water supply project will be made based on detailed feasibility studies coupled with the latest information on regional growth patterns and climate change impacts. Section 3.5 describes the process by which the QWC will assess options and make a recommendation to the Minister.

In the meantime, a number of potential infrastructure programs have been developed based on information currently available.

The projects in these programs have been timed to ensure that LOS system yield exceeds forecast demand at all times. This approach does not put water security at risk, but defers both capital expenditure and minimum operating costs. In turn, this defers the impact of price increases. Deferring the next supply also provides time for technology to improve, with a range of potential benefits in terms of cost and efficiency.

The portfolios were based on sub-regional demand and supply analysis. The distribution costs and the capacity of interconnections in the SEQ Water Grid were key considerations for the sequence, timing and location of supply projects. For example, it is expected that the desalination facility at Tugun will only be duplicated from around 2030, following the emergence of significant further population growth on the Gold Coast.

The analysis assumed average total regional consumption across SEQ of 375 litres per person per day, with some differences between locations. Lower consumption could significantly defer the need for augmentation and the sequencing of new supplies across SEQ, including as a result of achieving Target 200.

The portfolios will be reviewed and updated in the future reviews of the Strategy. In particular, detailed investigations could find that some potential projects are not viable or could highlight advantages and disadvantages that were not taken into account at an earlier time. The framework developed for these assessments can also be adapted and applied to any portfolio being considered, including local water supplies or demand management initiatives that exceed the minimum standards.

Medium series population growth

Figure 6.3 illustrates one potential infrastructure program, based on average total consumption of 375 litres per person per day, medium series population growth and no allowance for climate change. This scenario identifies:

- the development of a desalination facility at either Marcoola or Lytton as the next major augmentation of the SEQ Water Grid, with connecting pipelines constructed to enable a duplication of the facility when required
- the expansion of this desalination facility, around 2030
- the third major augmentation being the development of the other priority desalination site
- the final augmentation being the expansion of the existing desalination facility at Tugun, which is identified as occurring beyond 2030 in order to supply new development on the Gold Coast.

In total, this scenario involves development on three of the four desalination sites. While the desalination facilities only provide an additional 155 500 megalitres per year of capacity to the system, the LOS system yield increases by approximately 185 000 megalitres per year due to an improvement in the performance of the dams. Pending detailed investigations other options, such as dams and weirs, could reduce the need for desalination.

In addition, this program includes raising the operating level of Wivenhoe Dam and raising Borumba Dam (with allowances for the impact of climate change). Both of these options require detailed investigations, with a range of technical and environmental issues to be addressed. However, they would be less energy-intensive than desalination and, at least in the case of Wivenhoe Dam, cheaper.

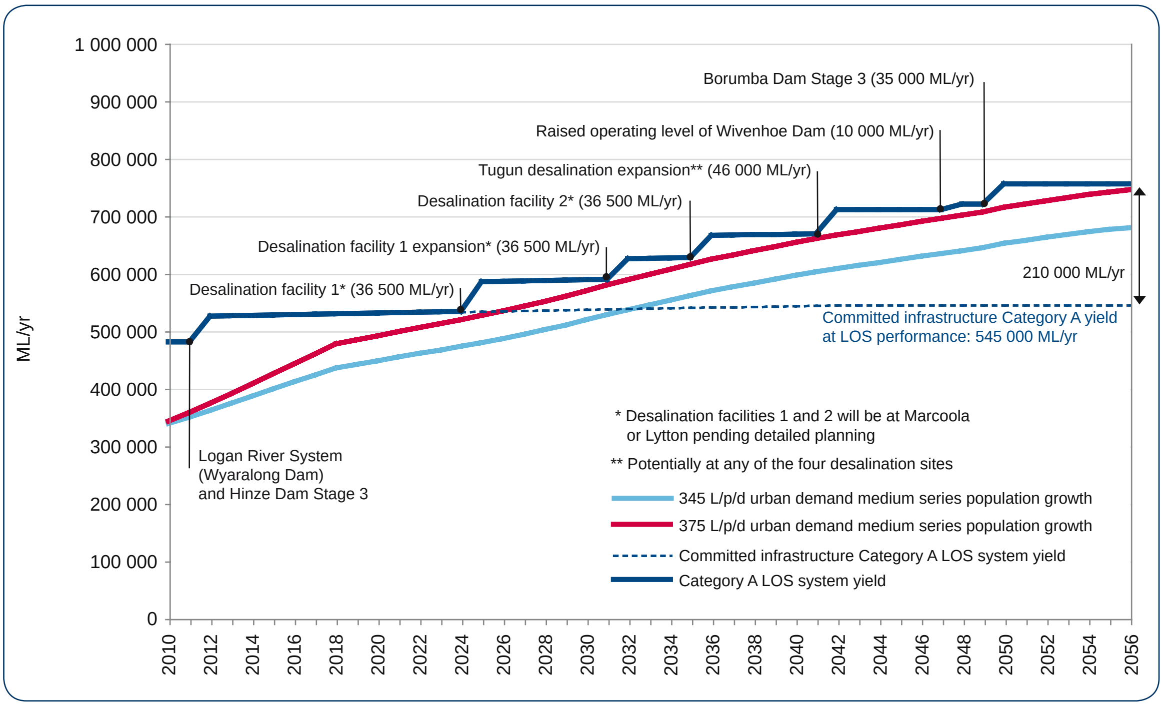


Figure 6.3 Potential portfolio with medium series population growth (subject to detailed planning and assessment)

High series population growth

A sensitivity assessment has been undertaken, indicating the impact of high series population growth and no allowance for climate change. In this scenario, up to 369 300 megalitres per year of additional supply capacity would need to be constructed by 2056.

A possible portfolio of supply options to meet this increased demand is presented in Figure 6.4.

The first augmentations are the same as for the medium series population forecast scenario.

Beyond the upgrades of Wivenhoe and Borumba dams, additional desalination facilities and the expansion of some of these facilities would be required. These facilities could be located at Marcoola, Bribie Island or Lytton. Pipeline costs and environmental considerations would determine the preferred location and sequence of these facilities.

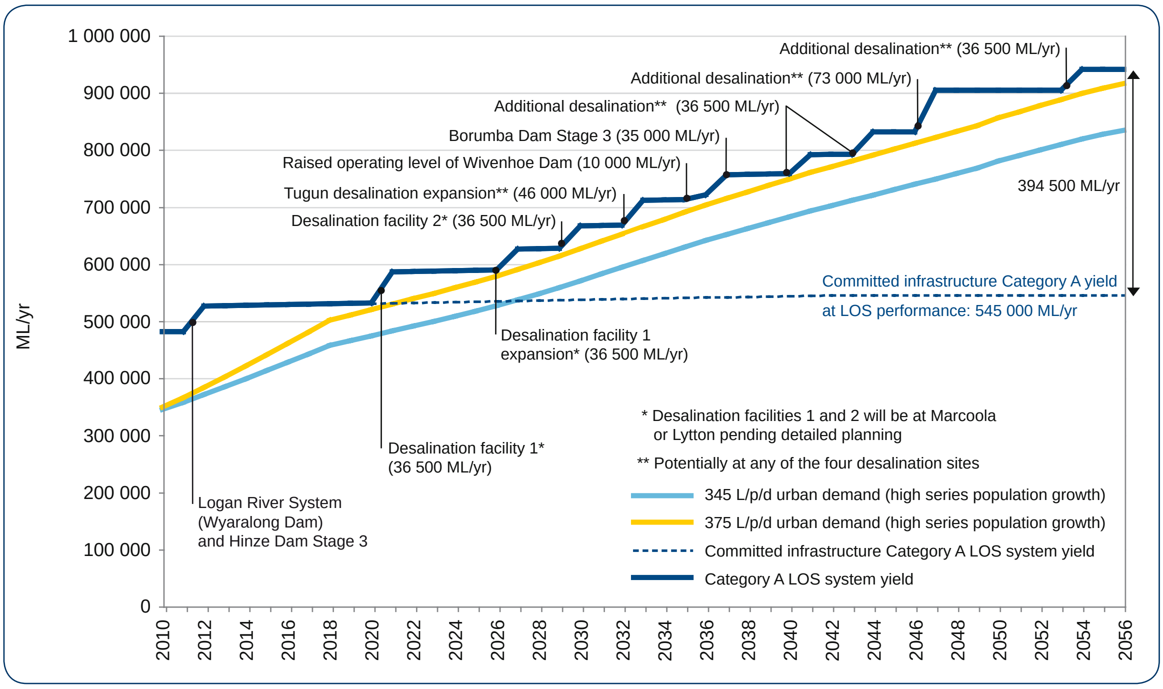


Figure 6.4 Potential portfolio with high series population growth and no allowance for climate change (subject to detailed planning and assessment)

Impact of reduced consumption

Reducing average consumption will defer and reduce the need for additional desalination facilities. Figure 6.3 shows that with medium series population growth and average total regional consumption of 345 litres per person per day, it is possible that only two additional desalination facilities would be required before 2050. The need for the first of these facilities would be deferred to 2033, as explained in Section 6.2.

The portfolio with high series population growth and average total consumption of 345 litres per person per day would be similar to that identified in Figure 6.4. This reduction in consumption, which could be achieved by average residential consumption remaining at or below 200 litres per person per day, could result in fewer desalination facilities being required to meet demand.

Potential impacts of climate change

The extent and timing of any climate change impacts is another key variable for determining when the next bulk water supply might be required. As explained in Section 3.2, the CSIRO is currently undertaking downscaling modelling (reducing the size of modelling grids used for global scale models to smaller scales that are more useful for localised assessments) for SEQ through the Urban Water Security Research Alliance. The preliminary results indicate that, while climate change might reduce yield by about 10 per cent, the impact is likely to occur over decades, rather than immediately. A scenario has been prepared to assess such a possible climate change impact and is shown in Figure 6.5. Such a scenario may bring forward the next possible augmentation date to as early as 2017. However, as discussed above, this climate change impact is unlikely to occur in the immediate future.

The supply gap will reduce if population growth or the average regional consumption is below the planning assumptions outlined above. Conversely, it will increase if climate change impacts are greater than the assumed scenario or if average regional urban water consumption increases to greater than a regional average of 375 litres per person per day, or growth exceeds high series projections.

The volume required will also vary. Without additional water supplies, by 2056 the gap between supply and demand could be between 133 100 and 410 700 megalitres per year, depending on population growth, the demand for water and the impacts of climate change.

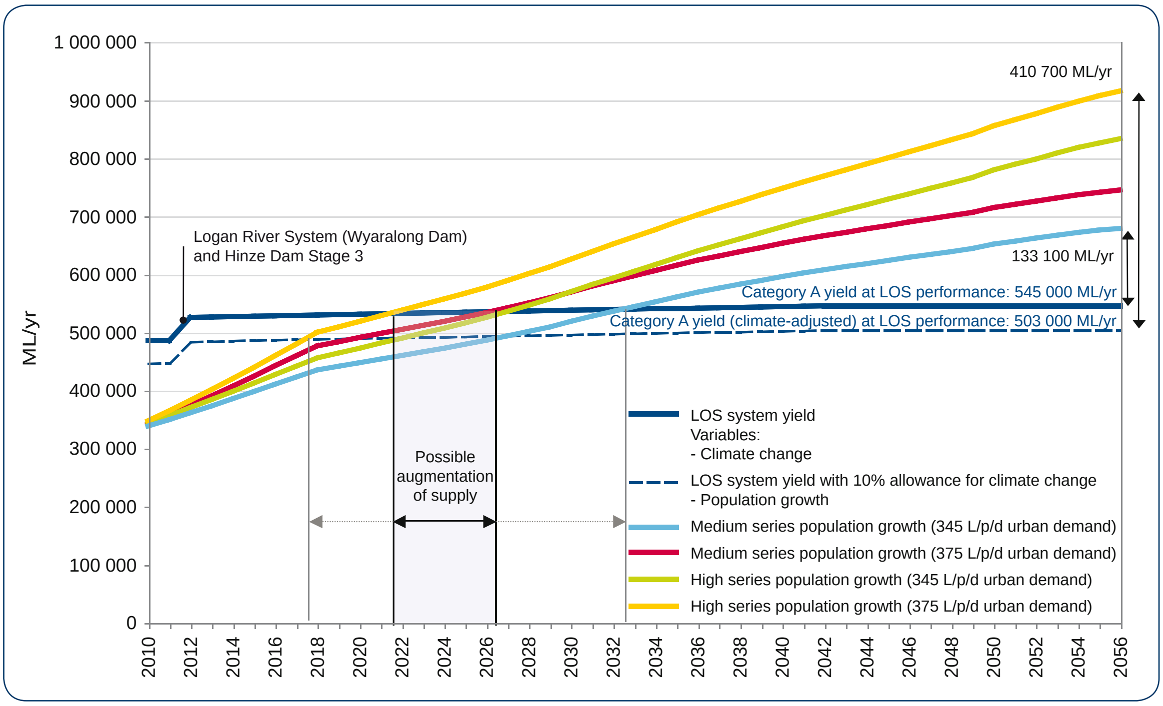


Figure 6.5 Category A water balance in normal operating mode and an allowance for climate change

The purpose of the Strategy is to bring on supplies at appropriate times to prevent this gap from developing. The QWC will monitor demand and supply forecasts on an ongoing basis. Changes to these forecasts will have a direct impact on the potential supply gap, which will be reflected in future revisions of the Strategy and the planning program for potential water supplies.

The construction of major new supplies could also be triggered as part of a drought response. However, with key SEQ Water Grid storages full or almost full, it is likely to be at least 10 years before storages fall to 30 per cent of capacity (refer to Section 6.9.1). The probability of this occurring prior to 2020 is estimated at about 1 per cent.

6.5 Rural towns and villages

The Strategy plans to provide increased security of supply to more than 200 000 residents of SEQ who live in towns that are not connected to the SEQ Water Grid. These residents rely on local surface water or groundwater supplies or on water from rainwater tanks.

6.5.1 Communities with reticulated drinking water

About 20 000 residents of SEQ live in communities that have reticulated drinking water supplies not directly connected to the SEQ Water Grid. These communities have a diverse range of water supply sources and varying levels of security. They also differ in terms of size and forecast population growth.

The Strategy seeks to achieve the same security of supply for these communities in the future as for those connected to the SEQ Water Grid.

A number of these communities are already benefitting from improved security of supply, following the completion of SEQ Water Grid projects.

In the Logan River system, the construction of the Bromelton Off-stream Storage and Cedar Grove Weir has allowed the SEQ Water Grid Manager to reduce the demand on Maroon Dam, increasing supply reliability to the communities of Beaudesert, Kooralbyn and, to a lesser extent, Rathdowney. These communities rely on high priority water allocations from the Logan River Water Supply Scheme and have previously experienced restrictions once every 10 years, on average. With the new supplies, hydrologic modelling indicates that it should be possible to reduce the frequency of restrictions to less than once every 15 years, on average. In the short to medium term, it could even be possible to achieve the LOS objectives.

In the Warrill Valley system, more than 8000 megalitres per year of high priority water allocation has been made available. Previously, 7000 megalitres of this allocation was held by the Swanbank Power Station, which is now supplied from the Western Corridor Recycled Water Scheme. Through the SEQ System Operating Plan, the QWC has reserved this allocation to enhance the short-term security for urban users in Aratula, Boonah, Kalbar and Mount Alford.

The QWC is reviewing the future needs of all rural towns and villages with reticulated supplies. The review will inform decisions regarding supply augmentations and drought response planning. Options to improve security of supply include:

- directly connecting to the SEQ Water Grid through the construction of new pipelines
- augmenting existing sources of supply with additional surface and groundwater supplies
- carting water.

The Sunshine Coast Regional Council began constructing a water supply pipeline to Maleny from the Landers Shute water treatment plant in mid-January 2010. The pipeline is expected to be completed about mid-2010.

A range of options are being investigated for other communities. Table 6.2 lists the key priorities. The QWC will provide advice to the Queensland Government about the preferred means of securing supply to Beaudesert and Canungra in late 2010.

Table 6.2 Options to improve security of supply to rural towns

Town	Current investigations
Beaudesert	Options under investigation are a pipeline to the planned Wyaralong water treatment plant or an upgrade to the existing water treatment plant.
Canungra	Options under investigation include a pipeline to Beaudesert or the construction of an off-stream storage and an upgrade to the existing water treatment plant.
Dayboro	A pipeline from Petrie is being investigated. Moreton Bay Regional Council has completed a planning study concluding that the construction of a pipeline would be the most cost-effective option.
Boonah	A pipeline to either Ipswich or the planned Wyaralong water treatment plant is being investigated as a possible drought response measure.

For some communities, the LOS objectives will be targeted but might not be deliverable in the short term. The priority of connection will be determined based on the likelihood of restrictions and size of the community, including business and industry.

The Lockyer Valley Regional Council communities of Preston, Upper Flagstone and Upper Lockyer (bordering on Highfields) currently have water services supplied by Toowoomba Regional Council. This operating arrangement will continue.

Amity Point, Dunwich and Point Lookout on North Stradbroke Island already have very secure supplies and are unlikely to require augmentation.

For communities that are not physically connected to the SEQ Water Grid, security of supply will generally be maintained by water carting in severe drought.

6.5.2 Communities without reticulated drinking water

About 180 000 residents dispersed across SEQ in small villages and rural residential developments rely on drinking water from rainwater tanks and private bores.

These residents will be able to supplement local supplies from the SEQ Water Grid as necessary, through existing carting services. Water carters will continue to have regulated access to stand pipes, and residents will continue to be responsible for organising and paying for carting. Such arrangements will also continue to apply to communities such as Mt Tamborine. Demand forecasts for the SEQ Water Grid include water to supplement rainwater tanks during periods of low rainfall.

Local government planning schemes specify the minimum size of rainwater tanks required for new houses in areas where reticulated drinking water is not available. These requirements currently vary across SEQ. The QWC will review the minimum requirements for the size of rainwater tanks and connected roof area across SEQ, taking into account the costs of new rainwater tanks and carting. Local governments could choose to mandate larger tanks than the minimum size.

Over time, reticulated drinking water could be supplied to some rural villages that are currently supplied from rainwater tanks and private bores. Factors that will be taken into account when considering supplying these villages with reticulated water include:

- demand from residents and industry
- population growth
- cost and cost recovery
- community views.

Local governments and the new distributor-retailers will decide whether a reticulated drinking water system will be provided to rural villages and determine pricing to provide service delivery to customers.

The QWC will develop a new policy framework to guide decisions regarding the supply of reticulated drinking water to communities that currently rely on drinking water from rainwater tanks and private bores.

6.6 Rural production

Water resource plans have assured access to water for rural production. However access to additional water for rural production and the cost of that water has proven to be a major challenge in parts of SEQ.

While some of the projects that have been constructed as part of the drought response are already delivering benefits for rural users in parts of SEQ, there is potential to do more.

The QWC and the Department of Environment and Resource Management will lead the investigation of a range of options to improve the availability of water for rural production. These options could increase the total amount of water available, or improve the reliability of its supply. They would build on existing entitlements, under which about 150 000 megalitres was used for rural production in SEQ in 2005, excluding recycled water and rural water consumption in the Mary Basin.

Any water supply initiatives in SEQ must directly address the needs of existing and potential producers. In most catchments the volume of unallocated water available under water resource planning is limited, meaning that there are no opportunities for major new rural supply dams. Recycled water could provide further opportunities, but can be expensive to transport over long distances.

Rural water advisory group

A rural water advisory group has been established to assist planning for rural water supply initiatives in SEQ. The group was established by the Queensland Farmers Federation, in partnership with the QWC and the Department of Environment and Resource Management. It will comprise representatives of rural water users, who will provide input to the investigations outlined in this section, ensuring that options address local needs.

6.6.1 Introduce tradeable allocations

Water allocated for rural uses in SEQ includes a range of high priority and medium priority entitlements from supplemented schemes and some unsupplemented water entitlements. A supplemented water supply is one that is made more reliable by releases of stored water from dams.

While available, some of these existing allocations are not being used or only partly used (i.e. 'dozers' and 'sleepers').

There are a range of reasons why allocations are not being used—for example, some farms that were previously irrigated are now used for less water-intensive activities. The reasons for these types of changes range from water not being available during the drought, to the land having been purchased as a hobby farm.

The QWC has received feedback from some irrigators that these entitlements do not match their business needs. For example, some irrigators have explained that major purchasers are increasingly requiring certainty of supply over a number of years. The irrigators have expressed concern that they cannot match these demands under their existing allocations. Some other irrigators have expressed concern that they often do not receive most of their announced allocations until after the planting season.

As water resource plans are progressively implemented in SEQ, water trading is likely to provide opportunities for expanding production through the movement of under-utilised existing water entitlements. The QWC, with the Department of Environment and Resource Management, will investigate options to facilitate trading in key areas as identified through the rural water advisory group.

6.6.2 Investigate options to increase reliability

The SEQ Water Grid provides a range of opportunities to conjunctively manage rural and urban supplies, potentially increasing both the volume and reliability of supply for rural use. Options that could directly benefit rural users include:

- providing access to surplus urban allocations on a temporary basis, in addition to existing rural allocations
- temporarily increasing the reliability of existing rural allocations or the announced allocations earlier in the water year, through under-utilised urban allocations.

Rural users can indirectly benefit if less than the full allocation is used for urban purposes. This occurs when water is held back in the dam, so as to be available during a severe drought, or is simply not needed at that time. Where the water is held back in the dam, announced allocations for rural users will be higher than would otherwise be the case.

Some of these indirect benefits are already being realised. In the Warrill Valley, as a temporary measure, the QWC has reserved 8250 megalitres of interim water allocation to enhance supply reliability for Boonah and connected towns, as explained in Section 6.5.1. As a result, Moogerah Dam will be maintained at a higher level than would otherwise be the case. In turn, announced allocations for rural users will generally be higher.

In the Logan River, the reliability of supplemented supplies to communities and rural irrigators has improved due to the construction of Cedar Grove Weir and the Bromelton Off-stream Storage and applying LOS objectives to the delivery of urban water supplies (refer to Section 6.5.1). Hydrological modelling indicates that application of LOS principles to the operation of the urban supplies will increase supplemented irrigator monthly supply reliability required under the water resource plan by up to 10 per cent. Options to further improve availability or reliability, for the period until Wyaralong Dam and the water treatment plant are constructed and while LOS system yield continues to significantly exceed demand, are being assessed.

Any such supply must occur within a transparent framework, which ensures that the costs are appropriately shared. The QWC will develop this framework in 2010 and 2011. The framework will address a range of issues, including the conditions of supply and the price to rural users. For example, the framework will specify when supply to rural users will be interrupted.

As background to the framework, the QWC will seek input from existing rural producers in partnership with the rural water advisory group and the local governments to establish whether existing entitlements meet local needs. Where they do not, the QWC, in collaboration with the Department of Environment and Resource Management, will assess possible options that address these needs within the water resource planning framework.

Options for conjunctive management of urban and rural water supply apply in specific catchments, generally where an urban water supply source is located upstream of rural irrigation areas. These circumstances apply to:

- Borumba Dam on the Mary River
- Wivenhoe Dam on the Brisbane River
- Maroon Dam and the Bromelton Off-Stream Storage on the Logan River
- Moogerah Dam in the Warrill Valley.

The QWC will also investigate these options in 2010 and 2011.

6.6.3 Increase the use of recycled water

About 245 000 megalitres of treated wastewater was discharged from wastewater treatment plants in SEQ in 2006. About 17 000 megalitres of this was recycled, including about 400 megalitres for rural production. By 2056, it is forecast that the amount of treated wastewater available for recycling will exceed 400 000 megalitres per year.

The QWC is investigating a range of opportunities to increase the use of recycled water for irrigation, as a means of increasing rural production and improving the health of waterways and Moreton Bay. Some of these investigations are discussed below.

Western Corridor Recycled Water Scheme

The Lockyer Valley is generally regarded as one of Australia's most productive horticultural regions. It contains over 40 000 hectares of the most productive horticultural soil in Queensland. However, water availability and reliability has become increasingly critical to growing operations. Declining volume and quality of both surface water and groundwater in the valley has led to a reduction of up to 75 per cent in the productivity of this key horticultural production area. Recent surveys indicate that current production operates at only 20 to 30 per cent of total potential due to the poor reliability of the water supply.

The supply of recycled water from the Western Corridor Recycled Water Scheme has the potential to significantly improve water availability, and especially water reliability. This reliability is fundamental to restoring profitability and productivity to the irrigators, and vibrancy to the area. For example, it could restore farm practices of planting three crops per season and thereby allow local irrigators to secure a stable and sustainable share of the Brisbane and Sydney markets.

It could also help to transform farm practice and crop selection to higher value products. At present, Lockyer Valley irrigators mainly grow cereal, fodder and forage crops that do not have the same value as fruit, flora and vegetable crops. Water reliability would enable more of these farms to grow higher value crops, ensuring their long-term economic sustainability and a more sustainable supply located close to the Brisbane market.

The Queensland Government first announced that 32 000 megalitres per year would be available from the Western Corridor Recycled Water Scheme for supply to irrigators in mid-2006. Supply is contingent on a number of conditions, which were made clear in the business case and have been reflected in draft term sheets and negotiations. These conditions include that:

- supply ceases when key SEQ Water Grid storage levels fall to 40 per cent of combined capacity
- pricing is at short-run marginal cost
- a sustainable management regime is implemented over the Lockyer Valley aquifers.

As outlined in Section 5.4.4, the optimal operating strategy for purified recycled water is currently to use it to augment Wivenhoe Dam only when key Water Grid storage levels fall to 40 per cent of capacity. This mode of operation means that recycled water will be available for supply to Lockyer Valley irrigators at all other times.

In addition, the amount of recycled water available for rural production from the Western Corridor Recycled Water Scheme in normal operating mode could increase over time from 32 000 to 37 000 megalitres per year. The time at which the additional Category B recycled water became available would depend on the rate of increase in feed water flows to the Western Corridor Recycled Water Scheme and demands for urban use.

The Lockyer Water Users Forum has proposed a number of recycled water schemes prior to and following this announcement. Each of these schemes has involved distribution from the Western Corridor Recycled Water Scheme direct to irrigators, and each has relied on further funding commitments by the Queensland and Australian governments to be economically viable.

The SEQ Water Grid Manager and the QWC are now investigating a number of options to enable the supply of recycled water to the Lockyer Valley at less overall cost. These options include using the existing Western Corridor Recycled Water Scheme pipeline and existing irrigation dams as balancing storages. If these investigations prove to be unsuccessful, supply of a smaller volume of recycled water to irrigators near the existing pipeline will be considered. The SEQ Water Grid Manager and the QWC will continue to consult with irrigators.

Other investigations

The QWC is investigating options for regionally significant recycled water schemes across SEQ, as part of sub-regional total water cycle planning (refer to Section 2.4.5).

The first sub-regional total water cycle management plan has involved detailed assessment of the potential for reusing treated wastewater from the Beaudesert and Flagstone areas for irrigation purposes along the Logan River. The advantages of this option include an increase in water for rural irrigation and a significant reduction in the discharge of nutrients into the Logan River.

The QWC will also investigate other local reuse opportunities, in areas such as Redland Bay and Somerset. Some of these opportunities are being investigated as an alternative to, or to supplement, a planned upgrade to a wastewater treatment plant in the area. Studies are required to determine the viability of using the treated wastewater, potential uptake, and costs of any new or upgraded infrastructure.

At the local scale, schemes could be identified as part of local government planning processes or by a distributor-retailer. Any recycled water scheme would be subject to physical supply constraints, pricing that reflects at least the short-run marginal cost of supply and compliance with relevant water resource plan and water quality requirements.

6.6.4 Investigate potential surface storages

Under water resource planning, there are few remaining opportunities in SEQ for surface storages for urban or rural purposes.

The QWC will undertake detailed investigations of remaining options in the Logan and Mary basins, as explained in Section 5.4.2. These investigations could identify small storages that might be used for rural purposes, subject to cost and within the requirements of water resource plans.

Rural water availability in the Warrill Valley area could be further increased if and when a pipeline is constructed to Boonah from the SEQ Water Grid.

6.6.5 Increase efficiency

Improved rural water use efficiency will continue to be driven by:

- programs to improve farm efficiency, such as the SEQ Irrigation Futures program
- water markets and trading
- appropriate pricing to better reflect National Water Initiative pricing principles
- more efficient rural water supply schemes.

Queensland Government initiatives for rural water supply

Rural Futures Strategy

The Rural Futures Strategy has been released as part of the Regional Plan. The Rural Futures Strategy supports the sustainable economic and social development of rural areas in SEQ. It builds on existing strategies, policies and programs, providing a whole-of-government approach to address planning and economic issues in rural SEQ.

SEQ Irrigation Futures

SEQ Irrigation Futures is a partnership program between the Queensland Government, five major irrigation industry groups and SEQ Catchments to help irrigators use water more efficiently. An efficiency gain of 12 per cent was achieved across all irrigation sectors in the region by the end of 2009, equivalent to approximately 21 000 megalitres per year. The program addresses irrigation management and impacts from irrigation. It includes system efficiency assessments, field trials and workshops and, where appropriate, financial incentives to assist irrigators to cut consumption.

Rural Water Use Efficiency Initiative

The Rural Water Use Efficiency Initiative is a partnership between the Queensland Government and seven industry groups. It helps irrigators to improve on-farm management of natural resources and reduce off-farm impacts, particularly through efficient irrigation and management of nutrients. The initiative includes extension activities, on-farm trials, demonstrations and system assessments, and financial incentives to upgrade irrigation and effluent management systems. The Queensland Government has committed $6.5 million over four years.

Knowledge Management System for Irrigation

An internet-based system that assists irrigators to manage a range of water issues on their properties was launched in August 2008. Known as the Knowledge Management System for Irrigation, it is an initiative of SEQ Irrigation Futures and it gives irrigators and industry personnel access to decision making tools, water use calculators and natural resource information. This enables irrigators to improve aspects of their water management, such as irrigation scheduling and pump efficiency.

Water metering project

In 2005, the Queensland Government initiated a statewide policy to establish a consistent approach for metering unsupplemented water taken for irrigation and other commercial purposes. Metering is a cornerstone of the National Water Initiative. It ensures the fair use of resources, enhances entitlement security and reliability, and improves water planning and management outcomes.

6.7 Supplies to outside SEQ

In the same way that SEQ's water supplies could be affected by the ability to source water from outside SEQ, consideration has also been given to supplying water from SEQ to neighbouring communities.

With the completion of key SEQ Water Grid assets, a level of water security has been reached that enables consideration of further opportunities to supply water outside SEQ.

A substantial amount of work is required to prepare a policy framework that would govern supplies from the SEQ Water Grid to urban areas outside the SEQ region, including economic and operational principles, standard contractual provisions and even possible inter-governmental agreements.

Any new supply should be on a full commercial basis. The price will vary depending on whether the supply is interruptible and whether it brings forward the timing of the next major supply.

Any supply of water to irrigators and to urban areas outside of SEQ will not be permitted to impact on the achievement of the LOS objectives for urban customers within SEQ.

6.7.1 Toowoomba

The Queensland Government has made a commitment to supply up to 10 000 megalitres per year from Wivenhoe Dam to the Toowoomba Regional Council area. This supply has been factored into demand forecasts and the water balance.

Supply could increase to 18 000 megalitres per year over time, depending on demand from the Toowoomba Regional Council area.

6.7.2 Cooloola region

The QWC will investigate options to operate the SEQ Water Grid to improve the volume and reliability of supply to towns in the Mary Basin (refer to Section 5.4.2).

In the short to medium term, when supply for SEQ exceeds demand, Noosa could be supplied from the Northern Pipeline Inter-connector Stage 2 rather than from Borumba Dam. This would enable the SEQ Water Grid Manager to make additional water available from Borumba Dam for local purchase and use, potentially deferring the need for additional supplies in the Mary Basin.

In the longer term, new supplies could be developed in the Mary Basin for local use and to supply the SEQ Water Grid.

6.7.3 Tweed

With the current high level of security of supply from the SEQ Water Grid, the Queensland Government will consider supply to the Tweed Shire Council area and other adjoining areas, where supply has no impact on the achievement of the LOS objectives for SEQ and on a full commercial basis, without subsidy or a price path.

6.8 Energy

The SEQ Water Grid will become increasingly energy-intensive over time, due to the operation of manufactured water sources and interconnecting pipelines. This section outlines the energy savings that will be achieved through demand management and the efficient operation of the SEQ Water Grid.

6.8.1 Total water cycle energy use

Energy use for water supply and wastewater collection and treatment represented about 0.1 per cent of energy use in the total urban system in SEQ in 2006–07.

Actual energy consumption for water supply varies across the region. About 2430 megajoules of energy was consumed for every megalitre of water supplied in Brisbane in 2006–07. By comparison, the energy intensity of supplying water to the Gold Coast from Hinze Dam is relatively low (about 750 megajoules per megalitre of water supplied), due to the lower treatment requirements and the height of the dam.

Tertiary treatment of wastewater before discharge to Moreton Bay is a significant user of energy in the SEQ water cycle. In Brisbane, wastewater treatment plants use another 2070 gigajoules for every megalitre of water supplied. On the Gold Coast, wastewater treatment plants use 3600 gigajoules per megalitre of water supplied.

The end uses of water are responsible for substantially more energy consumption and greenhouse gas emissions than its supply. Most of this energy is used to heat water. Across Australia, water heating is responsible for about 25 per cent of residential energy demand and 27 per cent of greenhouse gas emissions in households, excluding transport.

In Brisbane, residential hot water systems are estimated to use about 0.5 per cent of energy use in the total urban system in 2006–07. On the Gold Coast, it is 1.3 per cent—more than nine times the energy used for water supply and wastewater collection and treatment.

This section focuses on the energy used in the operation of the SEQ Water Grid. However, it is acknowledged that water efficiency can also contribute to major reductions in energy consumption for residential and non-residential end uses and for collecting, treating and discharging wastewater.

6.8.2 Avoided energy use due to demand management

A demand management program across all customer groups is an integral part of the Strategy, as outlined in Section 6.2.

Maintaining average regional urban consumption at or below 375 litres per person per day will result in a total energy saving of around 315 000 megawatt hours per year in 2020 compared to pre-drought trends, increasing to around 720 000 megawatt hours per year by 2048 (refer to Table 6.3). Additional savings will be achieved if actual consumption is less than the planning assumption of 375 litres per person per day. These estimates highlight the importance of the demand management program in reducing the need for additional energy-intensive water supplies. The estimates are based on the updated portfolio, including the greater use of desalination and increased energy intensity.

These estimates are also based on most of the additional demand being supplied from desalination and using the energy intensities described in Figure 6.6. It represents a saving of about 40 per cent in energy consumption for the supply of bulk water and is equivalent to the total energy consumption of about 86 000 homes.

These estimated energy savings reflect current technology and do not take into account the effects of state and federal government policies such as the Mandatory Renewable Energy Target, Renewable Energy Target and any future emissions trading scheme.

The savings listed in Table 6.3 relate to SEQ Water Grid assets. Energy consumption for distributing treated water and collecting and distributing wastewater is also likely to be reduced. The analysis also does not include energy savings to residents and businesses inside the home or business associated with the demand management program. Conversely, the estimate does not include additional energy requirements associated with local supply solutions such as rainwater tanks and greywater systems.

Table 6.3 Forecast energy savings from demand management (medium series population growth, no allowance for climate change and including rural communities within the SEQ Water Grid)

	2020		2048	
	Forecast demand for Grid water (Megalitres per year)	Forecast Grid energy consumption (Megawatt hours per year)[1]	Forecast demand for Grid water (Megalitres per year)	Forecast Grid energy consumption (Megawatt hours per year)[1]
Pre-drought trends	608 000	769 000	867 000	1 896 000
With the demand management program	491 000	454 000	701 000	1 176 000
Savings due to water efficiency	**117 000 (19 per cent)**	**315 000 (41 per cent)**	**166 000 (19 per cent)**	**720 000 (38 per cent)**

Note: Data has been rounded, including the savings estimates.

1 Assumes that the SEQ Water Grid is operated to maximise energy efficiency.

6.8.3 Energy to deliver water

Until recently, SEQ's water has been supplied through dams and other low energy intensity infrastructure. Diversifying the sources of supply to achieve the LOS objectives comes with an increased energy cost. Managing this increase is a key consideration for water supply planning.

As illustrated in Figure 6.6, water from desalination is expected to be significantly more energy-intensive to produce than treated dam water. The energy requirements are based on the infrastructure operating at capacity. While the energy requirement for transporting water is similar for all new sources, the increased movement of water around the SEQ Water Grid will increase the overall energy intensity of the region's water supply.

Water supplied from rainwater tanks can vary enormously in its energy intensity. Water that is delivered by gravity, with no additional treatment, does not require any other energy inputs. However, water that is treated to drinking water quality and delivered by pump can exceed the energy intensity of water produced from local dams or even the Western Corridor Recycled Water Scheme.

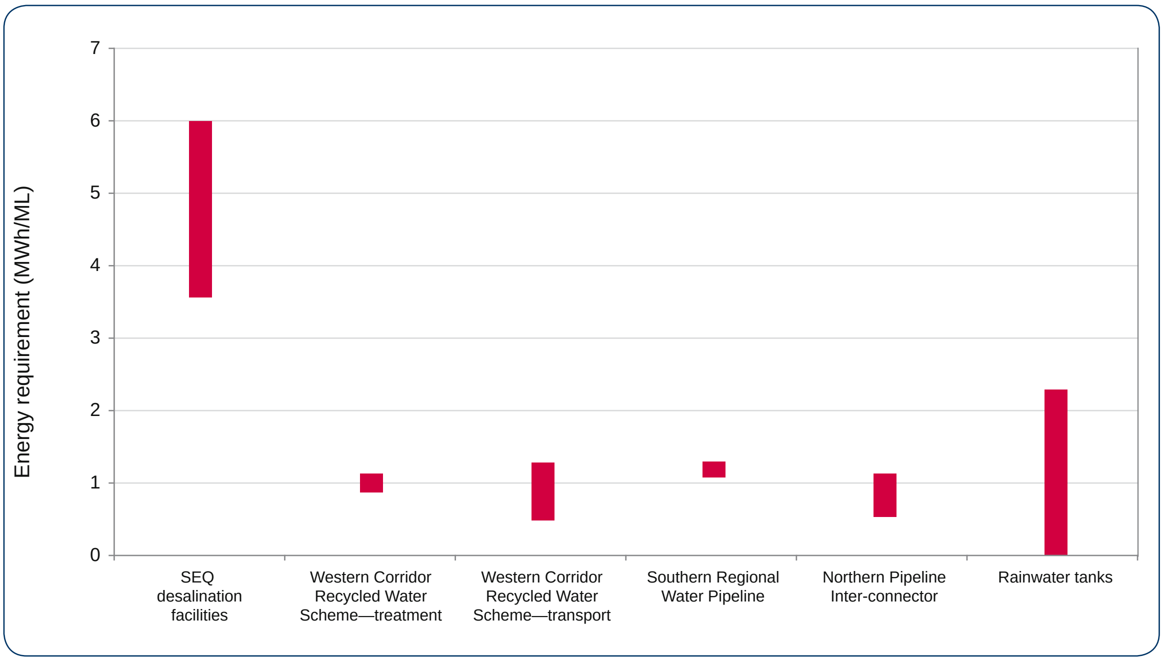


Figure 6.6 Estimated energy intensity of selected components of the SEQ Water Grid

Figure 6.7 shows the forecast energy required to produce water if the SEQ Water Grid were operating at capacity in 2020.

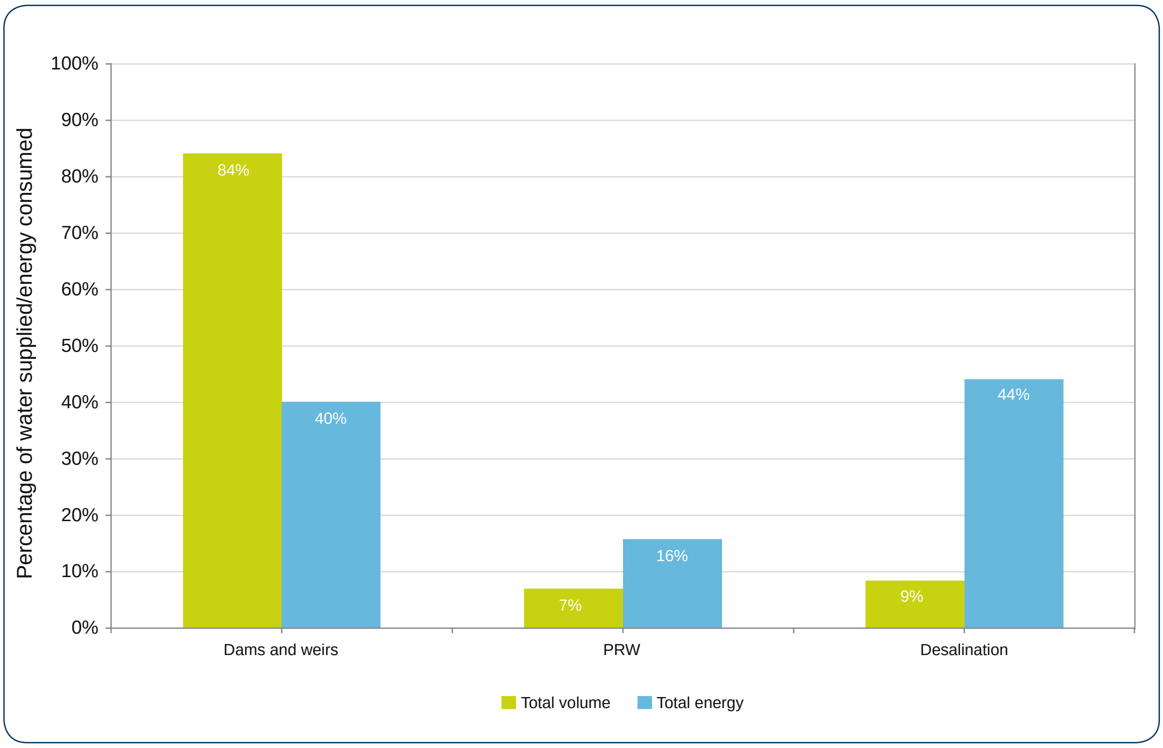


Figure 6.7 Projected water production capacity and associated energy consumed in 2020

In practice, desalination and purified recycled water schemes will not be required to operate at maximum capacity at all times. Figure 6.8a illustrates the estimated energy required to operate the SEQ Water Grid if population grows in line with the medium series projections. Figure 6.8b shows the energy usage if population growth tracks on the high series projections. At any time, actual energy used will be within the ranges presented. Without the demand management program, significantly more water would be required, and the overall energy requirement would increase accordingly.

The average energy intensity of water supplied from the SEQ Water Grid is estimated to be about 0.5 megawatt hours per megalitre per year in 2010. As the proportion of desalination supplies increases over time, the average energy intensity of water will increase to about 0.9 megawatt hours per megalitre per year in 2020 and 1.6 megawatt hours per megalitre per year in 2050.

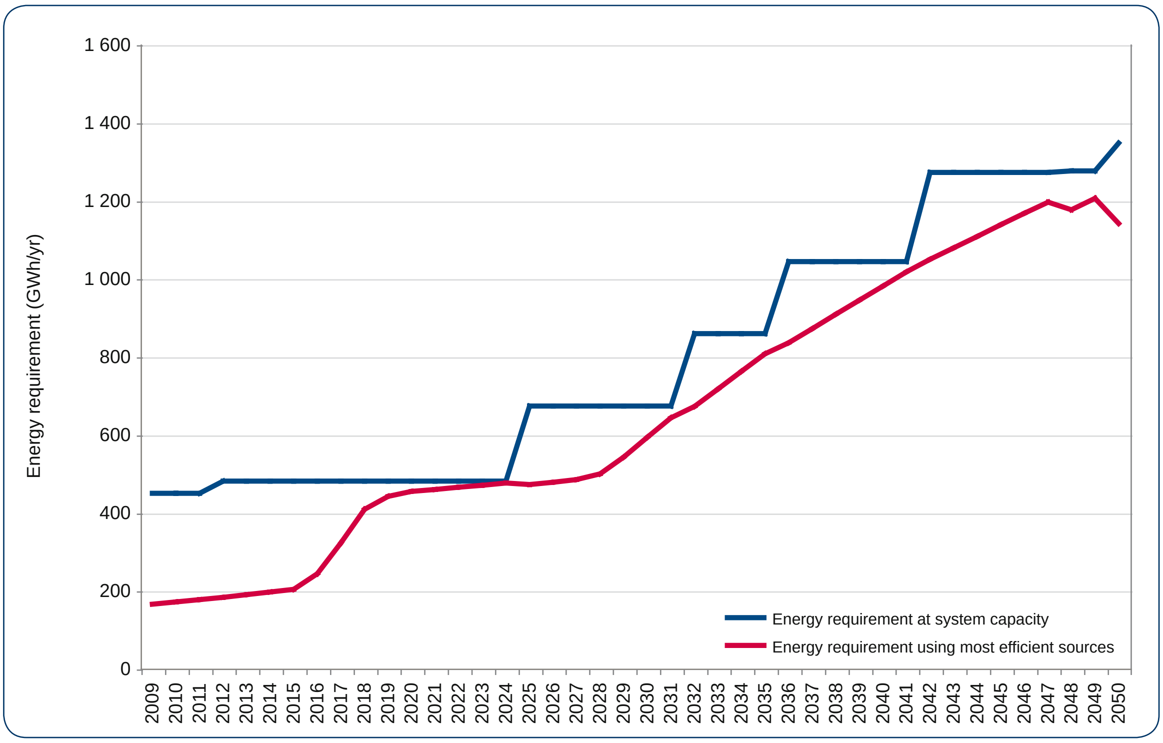


Figure 6.8a Estimated energy consumption for bulk water supply (proposed portfolio, medium series population growth, no allowance for climate change)

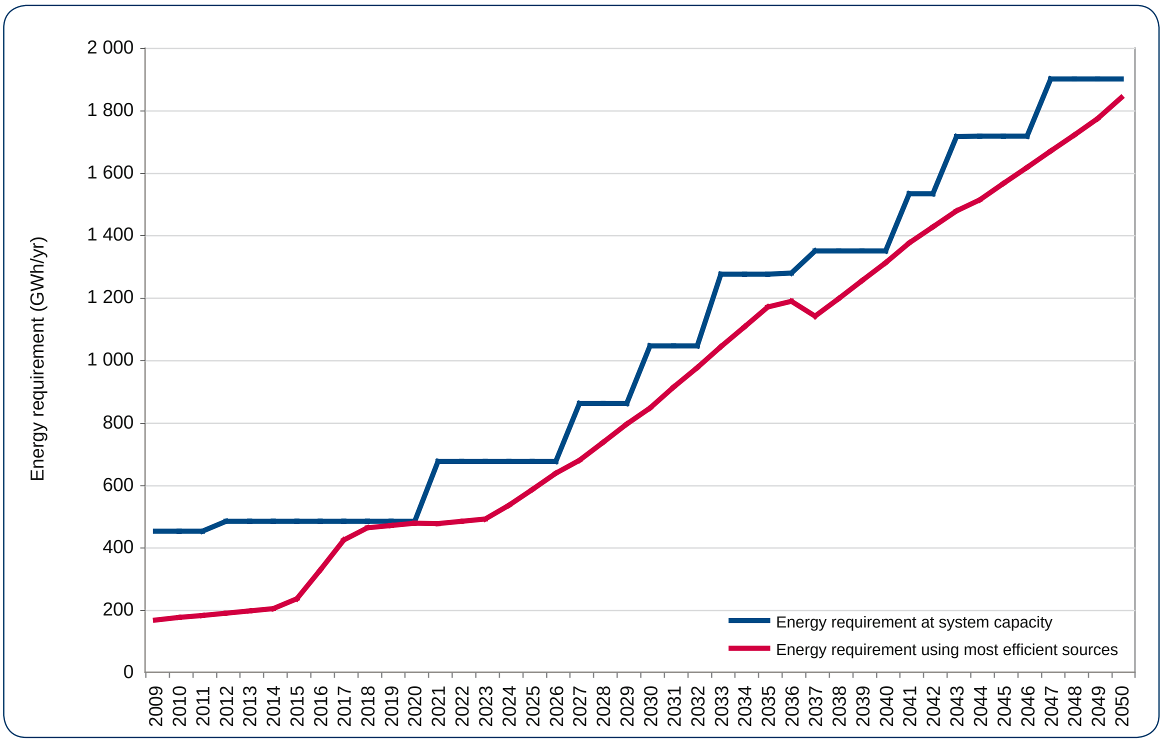


Figure 6.8b Estimated energy consumption for bulk water supply (proposed portfolio, high series population growth, no allowance for climate change)

If average total consumption is maintained at 345 litres per person per day, the projected average energy intensity and greenhouse gas emissions from the grid would reduce.

The QWC will assess all aspects of energy consumption associated with projected new water sources and factor these into water supply planning.

6.8.4 Greenhouse gas emissions of water supplies

Greenhouse gas emissions are calculated from energy use by applying greenhouse gas emissions factors, calculated by considering all the emissions associated with energy production and transmission. Emissions are standardised to carbon dioxide equivalents published by the Australian Government Department of Climate Change and Energy Efficiency. The emissions generated for each kilowatt hour of electricity supplied in Queensland are equivalent to approximately 0.89 kilograms of carbon dioxide.

WaterSecure is purchasing renewable energy certificates to offset the operational energy requirements of the SEQ (Gold Coast) Desalination Facility.

Conversely, fugitive emission such as nitrous oxide and methane from wastewater treatment processes or methane emissions from water storages could be significant in some systems.

6.8.5 Water and energy reporting

Industries across the country are increasingly required to become more energy- and water-efficient. The co-dependence of energy and water in many industries presents opportunities to improve water and energy efficiency simultaneously, with users receiving a net benefit of lower electricity and water bills.

Industries are currently targeted under mandatory federal and state initiatives to identify and report on energy efficiency opportunities. At the same time, large water using industries in SEQ are required to implement water efficiency management plans.

The overlap between mandatory reporting for energy and water could result in potential for synergies, conflicts and duplication between an individual business's water and energy management plans. The QWC proposes to work in collaboration with water service providers and the Queensland and Australian governments to improve the efficiency of reporting for industry and move towards streamlined water and energy reporting.

6.9 Drought response planning

The purpose of drought response planning is to ensure continuity of supply consistent with the LOS objectives and regardless of climatic conditions, as explained in Section 3.1.2. The proposed process for developing and implementing the regional drought response plan is described in Chapter 7.

Under the LOS objectives, a regional drought response plan is expected to be triggered no more than once every 25 years, on average. Three out of four of these droughts will ease within the preparatory phase, before the construction of new supply sources commences.

Drought response plans will also be maintained for communities that have reticulated drinking water supplies not directly connected to the SEQ Water Grid.

6.9.1 Probability of triggering implementation of a drought response plan

SEQ now has a much more secure water supply than it did prior to the Millennium Drought, due to the efficient use of water and the completion of climate resilient supplies and interconnections. Due to this improved level of security, it is likely that the next augmentation will be triggered by population growth, rather than another severe drought.

The QWC models short-term security based on the combined levels of the twelve key SEQ Water Grid storages, including dams in the Sunshine and Gold Coasts. The combined level of these storages provides the trigger to initiate water strategy measures, such as implementing water restrictions.

Figure 6.9 shows probable dam levels of the next five years, based on different drawdown curves that have defined probabilities that the dams will be drawn down at a greater rate. For example, the 99 per cent curve shows dam levels that have a 99 per cent probability of exceedence at any point along the curve (that is, there is only a 1 per cent chance that these low levels will occur). The drawdown curves use data for inflows, rainfall and weather patterns extending back for 117 years as inputs to stochastic modelling.

The model illustrates that there is a less than 1 per cent probability of dams falling to 40 per cent of combined capacity over the next five years, which would trigger the implementation of the regional drought response plan.

The model also illustrates that there is an even lower probability of key SEQ Water Grid storages falling to 30 per cent of capacity before the end of 2014, triggering the construction of new climate resilient supplies.

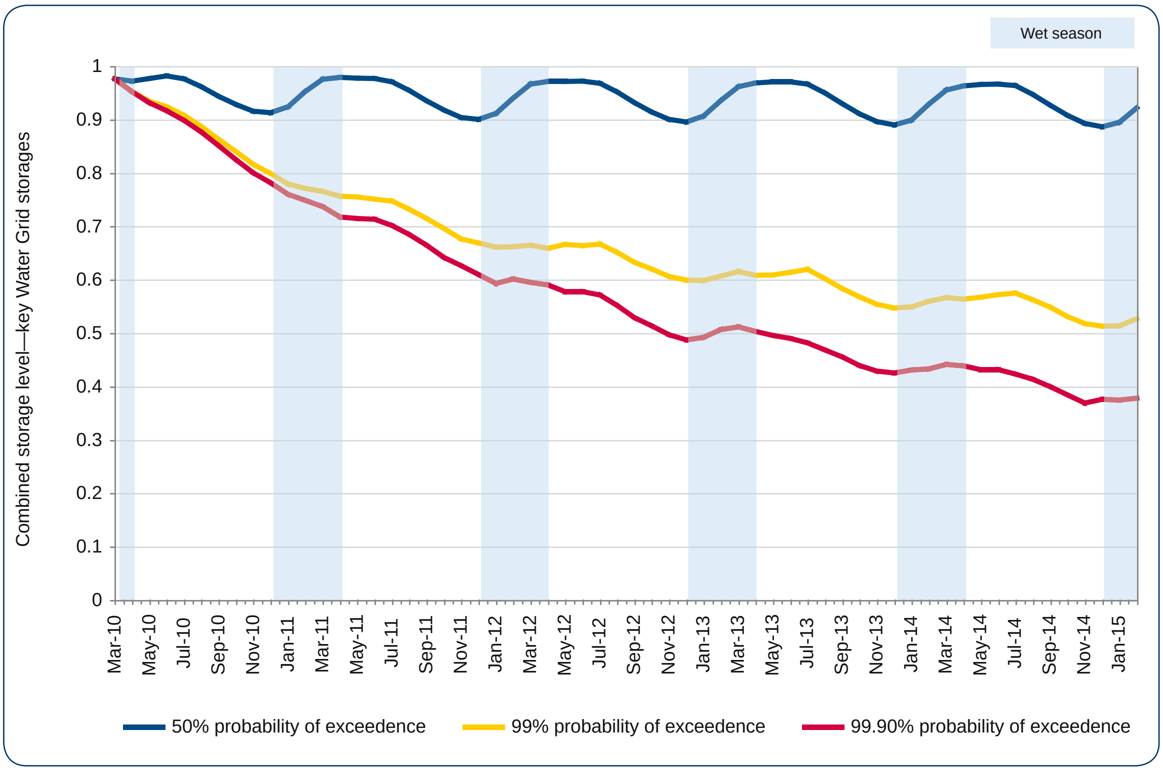


Figure 6.9 Forecast SEQ Water Grid storage levels

The modelling is based on average regional urban consumption across SEQ of 375 litres per person per day, and includes an allowance for medium series population growth. Lower levels of consumption will result in higher dam levels than are reflected in the model. The model is based on operation of the SEQ Water Grid in accordance with the existing SEQ System Operating Plan (for instance, one of the requirements of the existing SEQ System Operating Plan is to reduce production from the SEQ (Gold Coast) Desalination Facility to one-third of capacity when dam levels are high). It also takes into account supply from Wivenhoe Dam to Toowoomba and new sources, including Wyaralong Dam from 2012.

6.9.2 Drought supply requirement

The drought response plan will include a combination of applying Medium Level Restrictions, introducing purified recycled water to Wivenhoe Dam and constructing climate resilient supplies. The drought response plan should consider the ability to construct sufficient new climate resilient infrastructure within a nominal 30 months. This timing would be reviewed based on the preparatory planning outlined above.

The drought supply requirement is the gap between restricted demand and the climate resilient supply capability of existing supplies at any time over the planning horizon. This is the amount that would need to be supplied by the drought infrastructure, which must be able to be commissioned within the 30-month period to achieve the LOS objectives. This timeframe will be refined based on the amount of preparatory work undertaken and the level of preparedness.

As explained in Section 5.3.3, climate resilient and independent supplies are forecast to increase to about 331 700 megalitres per year following the completion of the committed projects. At this time, climate resilient supplies will comprise about 63 per cent of the LOS system yield, compared with 40 per cent in 2006.

As a result, much less infrastructure would need to be constructed in response to another severe drought than was required in response to the Millennium Drought. The drought response plan of the time would need to address these requirements

There might be a practical limit to the amount of infrastructure that can be constructed as part of a drought response. For example, if the drought supply requirement were to become greater than 180 000 megalitres per year at any point in time, it might not be possible, if a drought occurred, to procure and commission sufficient drought infrastructure in time to avoid extreme level restrictions—meaning that the LOS objectives would be at risk of not being achieved. These risks can be reduced through construction of additional climate resilient supplies as part of infrastructure development to maintain supplies during normal conditions. These factors should be considered in future long-term planning decisions as the Strategy is reviewed.

The drought response plan will also set specific triggers to start building infrastructure, based on detailed technical investigations. These triggers are likely to include preparatory work in advance of the 40 per cent trigger to commence drought response activities to enable completion of the projects within the assumed timeframe.

6.9.3 Local drought response planning

Drought response plans will be maintained for communities that are not physically connected to the SEQ Water Grid, including Kenilworth, Kilcoy, Linville, Jimna, Coominya and Canungra. These plans usually involve a combination of water efficiency measures and carting of water, as were implemented in Maleny and Canungra in late 2009.

The costs of implementing local drought response plans will be shared across all customers of the SEQ Water Grid.

Over time, the Strategy seeks to achieve the same security of supply for these communities as for those connected to the SEQ Water Grid, as explained in Section 6.5.

6.10 Strategy outcomes

An outcome of the Strategy is a list of actions that, if implemented, would deliver the Water Supply Guarantee. Table 6.4 provides an overview of the key elements of the Strategy and the likely outcomes.

Table 6.4 Key elements of the Strategy

Strategy	Outcomes
Implement LOS objectives	• Infrastructure is planned and operated to meet a regional urban water demand of 375 litres per person per day so that: – Medium Level Restrictions are expected to be required no more than once every 25 years, on average – Medium Level Restrictions are not expected to exceed six months' duration more than once every 50 years, on average – Medium Level Restrictions will require a reduction in demand of 15 per cent. • The system yield is increased by about 14 per cent, due to optimised use of all water sources and taking advantage of variable conditions across the region.
Efficient water use	• Water is used at least 24 per cent more efficiently compared to pre-drought trends, while the active, outdoor lifestyle that residents of SEQ enjoy is maintained. • Planning is based on a conservative assumption of average urban water consumption of 375 litres per person per day. • The community is encouraged to maintain average residential consumption at or below 200 litres per person per day (Target 200). • Business and industry is regulated to move towards best practice water use efficiency. • Urban water system losses are reduced from 14 per cent in 2005 to a target of 8 per cent. • Permanent Water Conservation Measures are introduced. • Power stations in the SEQ region use purified recycled water when taking water from the SEQ Water Grid. • The demand management program encourages efficient water use through an appropriate balance of structural, operational and behavioural measures.

Local supplies	• All new homes in SEQ meet mandatory water savings targets. Rainwater tanks and stormwater harvesting are options to meet the target. • Most new industrial and commercial buildings install alternative water supplies, potentially including a rainwater tank. • Higher savings are pursued where cost-effective, provided that community health and safety are maintained. • Water to top up pools is primarily sourced from a rainwater tank or downpipe rainwater diverter. • Increased recycling and increased capture of rainwater and stormwater contribute to the improved water quality of waterways and Moreton Bay.
Water balance	• Additional supplies could be required in 2021, depending on average consumption, population growth and the impact of climate change on the supply from dams and weirs. • Maintaining average residential consumption at 200 litres per person per day could defer the need for additional supplies by at least five years, to between 2027 and 2033. • The QWC will now undertake detailed planning to ensure that additional supplies can be delivered efficiently and when required. The planning investigations will inform a final decision regarding the preferred location, capacity and timing of future water supplies. • Further investigations will also be undertaken for a range of other potential sources of supply. • Priority desalination sites have been confirmed at Lytton and Marcoola. Reserve sites are at Tugun and Bribie Island. • Investigations to enable a decision on the preferred desalination sites, including a project plan for delivery as a drought response if required are continuing. It is anticipated that the preferred site will be identified in the 2011–12 financial year.
Drought response planning	• A drought response plan is prepared for future droughts. • Drought response plans are prepared for communities with stand-alone sources of supply.
Operating the SEQ Water Grid	• The SEQ System Operating Plan will direct water security, considering cost and a range of other factors including energy use. • Measures will be introduced to ensure that the SEQ Water Grid is managed in accordance with the *Australian Drinking Water Guidelines* and the *Australian Guidelines for Water Recycling*.
Groundwater	• Water from groundwater aquifers will continue to make a small contribution in the delivery of urban supplies. The sustainable take from these aquifers is expected to remain relatively static. • Over time, the overall take from regulated groundwater aquifers in the Warrill Creek and Lockyer Creek catchments is planned to be reduced to sustainable levels.
Rural communities	• Consistent LOS objectives are targeted across communities with reticulated drinking water. • Drought response plans will be prepared for communities that are not directly connected to the SEQ Water Grid. • About 180 000 residents of SEQ rely solely on water from rainwater tanks and groundwater aquifers. These residents will be able to access water from the SEQ Water Grid when required. • A policy position will be developed for providing reticulated drinking water to communities that rely on water from individual rainwater tanks and groundwater aquifers.
Rural production	• Additional supplies could potentially be made available from the SEQ Water Grid for rural production when not required to meet urban needs. • Up to 32 000 megalitres per year of purified recycled water has been made available to irrigators when not needed for urban supplies, subject to conditions. • Options to make supply of recycled water to the Lockyer Valley economically viable will continue to be investigated in detail. • Other recycled water schemes will be investigated, to increase production and reduce wastewater discharges to waterways and Moreton Bay. • Rural water use efficiency will continue to improve, driven by water markets and trading and other factors. • A rural water advisory group has been established to investigate actions for improving the security of water supply for rural production through SEQ Water Grid operation.

Integration with the Regional Plan	• Sub-regional total water cycle plans will be prepared for key development areas and where regionally significant water supply infrastructure is located. The purpose of these plans is to integrate land use planning with planning for waterway health and for water supply for urban and rural purposes. • A water-sensitive urban design approach will be adopted, whereby planning for water supply and sewerage is integrated with planning for stormwater management.
Environmental outcomes	• Environmental flows are maintained under water resource plans. • Using water efficiently will reduce the amount of energy used by the SEQ Water Grid. The savings are equivalent to the total energy consumption of around 67 000 homes in 2048, compared to pre-drought consumption trends. • Further energy will be saved in the distribution and wastewater system, and within buildings.
Flood mitigation	• New or raised dams will provide additional flood mitigation benefits.
Research and development	• Research and development programs will influence and support future water decision making by exploring new technologies and opportunities.
Implementation and review	• The QWC will monitor and report on the implementation of the Regional Water Security Program. • The Strategy will be reviewed at least every five years, in parallel with the Regional Plan, or as changes to key assumptions require. • The QWC will provide an annual report on key issues, progress on actions and a review of assumptions.

Chapter 7

Implementation and review

This chapter summarises the actions that will be undertaken in the short to medium term to implement the Strategy. It also explains the proposed timeframe for future reviews.

Key messages

- The Regional Water Security Program sets out the future planning actions to ensure ongoing water security for SEQ.
- The Strategy will form the basis of advice to the Minister for Natural Resources, Mines and Energy and Minister for Trade about the Regional Water Security Program.
- The QWC is responsible for monitoring, reviewing and reporting on the implementation of the Regional Water Security Program.
- A number of different agencies are responsible for implementing elements of the SEQ water planning framework.
- The Strategy will be reviewed at least once every five years, aligned with the SEQ Regional Plan.
- The QWC will report on implementation annually. The annual report will include an assessment on whether an earlier review may be appropriate.

7.1 Water planning framework

The Strategy is part of a suite of regional water policies that contribute to achieving the outcomes of the SEQ Regional Plan, as described in Figure 2.1. The Strategy will be implemented in conjunction with those policies and strategies.

To deliver the Water Supply Guarantee, a range of detailed plans must also be prepared, as described in Table 7.1. The scope of these plans varies from regional policies to detailed operational plans.

Before building future water infrastructure, detailed feasibility assessments are required to prove project viability and sustainability. All state and Commonwealth government statutory approvals must also be obtained.

The QWC will continue to refine the hydrologic modelling on which the Strategy is based, in partnership with the Department of Environment and Resource Management (DERM) and the Urban Water Security Research Alliance. In particular, the QWC will review and update the modelling as climate change science improves.

Table 7.1 SEQ water planning framework

	Elements	Responsibility
Regional scale	• Strategy	• QWC
	• Regional Water Security Program	• Minister to make program • QWC to provide advice and coordinate implementation
	• SEQ System Operating Plan	• QWC
	• Drought response plan	• QWC
	• SEQ Water Grid Quality Management Plan	• SEQ Water Grid Manager
	• Healthy Waterways Strategy	• Healthy Waterways Partnership
Sub-regional scale	• Water resource planning	• DERM
	• Sub-regional total water cycle planning	• QWC in partnership with key stakeholders
	• Detailed investigation of potential upgrades to the SEQ Water Grid, including potential sources of supply	• QWC in partnership with key stakeholders
	• Waterways and catchment planning	• DERM, Healthy Waterways Partnership, Seqwater and local governments
	• Distribution and wastewater planning	• Local governments and distributor-retailers

	Elements	Responsibility
Local government scale	• Planning schemes, including master plans	• Local government
	• Local total water cycle planning	• Local government
	• Distribution network planning	• Local governments and distributor-retailers
	• Wastewater network planning	• Local governments and distributor-retailers
	• Drinking water quality management plans and recycled water management plans	• SEQ Water Grid Manager and water service providers
On-site development scale	• Development assessment	• Local governments , with the involvement of other stakeholders, as appropriate
	• Water efficiency management plans	• Businesses

7.1.1 Regional Water Security Program

On 5 March 2010, a revised Regional Water Security Program was made. The Program was informed by the revised draft Strategy. It specifies LOS objectives and key projects to achieve water security for the region.

The QWC is responsible for ensuring that the key actions and responsibilities of Queensland Government departments and water service providers are carried out or complied with in delivering the Program.

Based on the final Strategy, the Minister may request that the QWC provide updated advice about revised regional water security options. Within four months of receiving the QWC advice, the Minister will make and publish a revised Program.

The QWC will monitor progress against the Program to ensure that water security continues to be achieved for the region.

7.1.2 Review and updating of the Strategy

In general, it is expected that the Strategy will be reviewed on a five-year cycle, aligned with the review of the Regional Plan. The next review of the Strategy may be undertaken earlier, depending on the rate and extent of rebound in demand following the introduction of Permanent Water Conservation Measures across SEQ.

Implementation and monitoring of the Strategy will be reported and published yearly through a report to the Minister, which is required under the SEQ Water Market Rules. Performance will be measured and reported against the activities, works and initiatives (listed in Table 7.3) that must be undertaken to achieve the goals of the Strategy and the underlying assumptions for determining the required LOS yield.

To ensure successful implementation of the Strategy, the monitoring program will include:

- implementing infrastructure against milestones and performance criteria
- continually analysing and assessing the water balance assumptions against population growth, economic development, climate impacts and regional water efficiency
- regularly reviewing and evaluating the SEQ Water Grid performance, seeking improved efficiencies and service delivery
- integrating outcomes from detailed investigations of demand management measures and potential sources of supply
- incorporating findings from the research and development program
- reviewing outcomes delivered through Strategy implementation.

Based on this assessment, the annual report may recommend that the next review of the Strategy be brought forward. This approach will guide further Strategy development and assist in ensuring that the Water Supply Guarantee can be achieved.

7.1.3 Stakeholder and community engagement

The QWC is committed to open, accountable and inclusive community engagement processes. The QWC will provide stakeholder organisations, individuals and interest groups with opportunities to influence water planning and management. Stakeholders and community groups will be consulted as part of detailed investigations of potential demand management measures and potential sources of supply.

A separate stakeholder group will be formed to provide input and advice on the implementation of the Strategy and its review.

Figure 7.1 identifies the principle stakeholder organisations and interest groups.

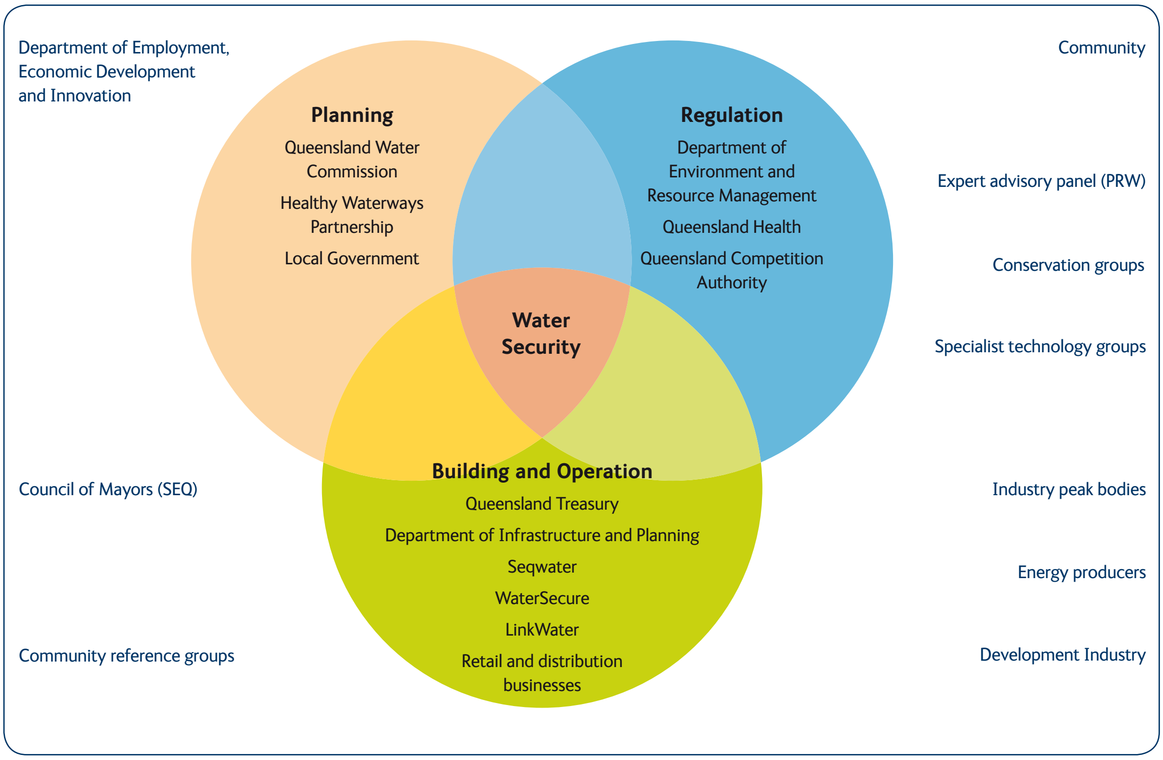


Figure 7.1 Strategy consultative framework

7.2 Efficient operation of the SEQ Water Grid

Water security is the first and foremost purpose of the SEQ Water Grid. A new framework has been established to ensure that this security is delivered as efficiently as possible, taking into account quality and reliability of service. Key features of the framework are:

- the SEQ System Operating Plan
- a detailed operating strategy
- an integrated water quality management framework.

7.2.1 SEQ System Operating Plan

The SEQ System Operating Plan outlines the rules for operating the SEQ Water Grid to help achieve the LOS objectives for the region, as specified in the Regional Water Security Program.

The SEQ System Operating Plan:

- facilitates water sharing across the region by specifying the share of available water that SEQ Water Grid customers may access
- establishes risk criteria for the short- and medium-term management of available water
- provides rules to promote the efficient and cost-effective operation of the SEQ Water Grid
- details minimum requirements, including for the production and supply of manufactured water
- ensures that operating costs are reduced, where possible, without compromising regional water security.

The risk criteria are a key feature of the SEQ System Operating Plan (refer to Table 7.2). The LOS objectives specify the basis for operating the SEQ Water Grid over the long term. The criteria provide the basis for balancing water security and operating costs over the short to medium term.

The risk criteria establish the acceptable levels of risk of triggering restrictions and construction of drought response infrastructure. Through these criteria, the SEQ System Operating Plan effectively mandates that the SEQ Water Grid be operated at capacity as key SEQ Water Grid storages approach 40 per cent of capacity. Under the current rules, it is it is estimated that full operation will be required below about 60 per cent of combined capacity, depending on the time of year and level of demand.

The risk criteria do not guarantee that the defined trigger levels will not be reached. However, they do ensure that potential operational changes to avoid them are taken as and when required.

Table 7.2 SEQ System Operating Plan risk criteria at March 2010

Volume of water stored by all key Water Grid storages	Probability of reaching stored volume		
	within 1 year	within 3 years	within 5 years
40 per cent	Less than 0.2 per cent	Not specified	Less than 5 per cent
30 per cent	Not specified	Less than 0.5 per cent	Less than 1 per cent

When the probability of reaching the trigger levels is less than the risk criteria, the SEQ Water Grid should be operated so as to minimise costs. Options include:

- reducing production from climate resilient supplies, such as desalination
- placing high-cost water treatment plants in standby mode
- reducing transfers through major interconnections
- selling water to irrigators on an interruptible basis (refer to Section 6.6).

The current risk criteria are conservative. They may be revised as new information becomes available on the efficient operation of the SEQ Water Grid and factors such as climate change.

7.2.2 Operating strategy

The SEQ System Operating Plan requires the SEQ Water Grid Manager to prepare an operating strategy outlining how the SEQ Water Grid will be operated.

The operating strategy must demonstrate how the LOS objectives and risk criteria are planned to be achieved as efficiently and effectively as possible. For example, it must address the amount of water that is expected to be taken from key supplies and the amount that is expected to be transferred through major interconnecting pipelines.

The SEQ Water Grid Manager will issue monthly Grid instructions based on the approved operating strategy. The operating strategy will focus on operation over a 12-month period. It will be submitted to the QWC for approval at 6-month intervals.

The operating strategy is based on overarching principles for various water supply assets. These principles include:

- ensuring compliance with resource operations plans and system operating rules
- maximising the use of more efficient supply options
- minimising the use of small, inefficient treatment plants, where an alternative exists
- maintaining minimum production levels at the desalination facility, ensuring that it is available when required
- maintaining minimum water flows through major inter-connectors, minimising the cost of operation and ensuring that they are available at short notice
- maintaining water quality from the Western Corridor Recycled Water Scheme in preparedness to augment Wivenhoe Dam as required.

The operation of the SEQ Water Grid is based on a robust risk management framework. This framework protects water security, quality and reliability by integrating operations across water supply entities. The SEQ Water Grid Manager has given specific consideration to:

- emergency management, ensuring business and service delivery continuity in the event of natural disasters or system failures
- security management, due to water supply being an essential community service
- risk management practices consistent across the seven entities in the supply chain.

7.2.3 Drinking water quality management

The SEQ Water Grid creates the opportunity to improve water quality management across the region by managing multiple treatment plants and potentially the blending of treated water. This is a significant change from the traditional approach where there is a dependency on individual water treatment plants.

Consistent with this approach, the quality of water delivered from the SEQ Water Grid will be assured through an integrated set of management plans for individual assets and across the Grid as a whole.

The SEQ Water Grid Manager manages the overarching water quality strategy through the Water Grid quality management plan. The aim of the quality management plan is to mitigate water quality risks and achieve water quality standards across the SEQ Water Grid as a whole.

Within this framework, each water service provider is required to prepare a drinking water quality management plan in accordance with the requirements in the *Water Supply (Safety and Reliability) Act 2008*. The regulations are being introduced in two stages. Providers are required to:

- carry out an initial mandatory monitoring and reporting program from 2 January 2009, until they have an approved drinking water quality management plan in place
- develop and implement the approved drinking water quality management plan.

In a drinking water quality management plan, the provider is required to:

- assess the risks in the system
- document the process for managing these risks
- outline operational requirements for managing the system, including how mandatory criteria will be monitored, how operational and verification monitoring will be conducted, and what reporting arrangements are in place to ensure safe water.

A recycled water management plan and drinking water quality management plan must be approved before purified recycled water is released into Wivenhoe Dam.

Rainwater tanks

Queensland Health does not recommend the use of water from rainwater tanks for drinking and food preparation if a potable reticulated water supply is available.

Many people in Queensland rely on water from rainwater tanks for their drinking water. Although the risk of contracting illness from these supplies is low when roof catchments and tanks are well maintained, the quality of water from rainwater tanks is not as consistently high as that provided by well-managed reticulated supplies that obtain their water from a high-quality source. The risks from using rainwater for potable purposes, including drinking and food preparation, can be managed through a risk management framework such as the one described in the 2004 enHealth Council document, *Guidance on use of rainwater tanks*.

Improvement program

Improvement programs will also be coordinated across the SEQ Water Grid. Upgrades may be undertaken as part of the renewal of existing infrastructure, or in response to increasing water quality standards or community expectations.

The QWC will coordinate regionally significant water quality improvements, through the Statement of Needs process described in Sections 3.5.2 and 7.3.

In partnership with the SEQ Water Grid Manager, the QWC will also coordinate periodic reviews of water quality standards and infrastructure. In 2010 and 2011, the QWC will review the costs and benefits of moving to a common residual disinfection standard across SEQ. The review will focus on disinfection by-products, residual maintenance, costs and operability and will inform planning for future water treatment plants and major upgrades to existing treatment plants.

Catchment management

Catchment management is a core element of drinking water quality management. Existing uses need to be managed, and new development planned and assessed, to ensure that risks to water quality are controlled to an acceptable level. These controls need to be applied for all land from which water flows to drinking water supplies.

Local government planning schemes and related policies must identify these catchment areas and include appropriate development controls. Planning studies in these areas must consider how to avoid future types or scales of development that would pose an unacceptable risk to water quality. Where development is permitted, strict controls may be required. Infrastructure should also be located and designed taking into account water quality risks.

Administrative arrangements are being established to refer relevant development applications in dam catchments to Seqwater for consideration. Seqwater has prepared guidelines on how to address development in dam catchments.

In the longer term, Seqwater must have appropriate involvement in land use planning in dam catchment areas. Drinking water quality management plans will involve both planning and development assessment.

The QWC is reviewing current policy for managing the effect of land use and development in water storage catchments on drinking water quality. The purpose of the review is to ensure that arrangements can manage risks to drinking water quality. As an initial step, Seqwater has an assessment role for selected developments surrounding drinking water storages. The review will address the areas and activities that may need improved assessment and management arrangements to protect drinking water quality. Local governments are currently required, under the SEQ Regional Plan, to control the water quality impacts of all development in drinking water catchments.

7.3 Statement of Needs

The Statement of Needs will be based on the Strategy, and will summarise key activities that must proceed over the next ten years to ensure that the LOS objectives can be achieved (refer to Section 3.5.2). Based on the Strategy, the key elements of the first Statement of Needs will be as follows:

- Remaining committed projects in the Regional Water Security Program should be delivered. Timing and staging options should be considered, where applicable.
- Beyond these projects, additional bulk water supplies may be required as early as 2017. However, if SEQ is able to maintain regional average total water use at or below 345 litres per person per day, then new bulk water supplies may not be required until at least 2022.
- Operational improvements and capital upgrades to comply with water quality requirements under the *Water Supply (Safety and Reliability) Act 2008* should continue.
- A drought response plan should be prepared for the region and for towns with stand-alone sources of supply.
- Capital upgrades should be made over time to achieve the same level of service for stand-alone communities as for the remainder of the SEQ Water Grid.

7.4 Research and development

Applied research and development will improve the sustainable and integrated management of water in SEQ. This research will make significant contributions to reducing costs and environmental impacts, as well as improving planning and investment decisions.

7.4.1 Urban Water Security Research Alliance

The Urban Water Security Research Alliance (UWSRA) is the largest urban water research program in Australia. It was formed in 2007 as a partnership between the Queensland Government, the CSIRO, The University of Queensland and Griffith University. The partners have committed $50 million over five years.

The objective of the program is to collaboratively develop the knowledge and tools to inform and support the implementation of the Strategy. The program will address areas such as climate change, changes in technology and the introduction of purified recycled water. Research is being undertaken on three themes, with each theme involving a number of specific projects.

The themes are described in Table 7.3. Further information is available from the UWSRA website at <www.urbanwateralliance.org.au>.

Table 7.3 Projects comprising the Urban Water Security Research Alliance

Reducing demand	
Stormwater harvesting and reuse	Researching the innovative capture and storage of stormwater for additional water supply in SEQ. The impact of harvesting stormwater on creek and ecosystem health is also being investigated.
Decentralised systems	Researching the performance and reliability of rainwater tanks and decentralised water supply systems in residential and commercial developments, including energy use and water quality standards.
Demand management and communication research	Researching community attitudes and behaviour in relation to demand management.
Residential water end-use	A detailed survey into household water end-uses that will quantify the impact of urban water demand management strategies.

Water quality	
Hospital wastewater	Researching the contribution of pharmaceutical and other compounds to domestic wastewater from hospitals.
Pathogens and trace contaminants in dams	Researching sources of target pathogens and organic chemicals and the treatment capacities of dams to remove them under different climatic and seasonal conditions in SEQ.
Bio-assays and risk communication	Development of scientific, technical and communication bases for the implementation of bio-analytical tools in water quality monitoring programs.
Health risk assessment of local source waters	Researching the survival, and removal, of pathogens in rainwater tanks and stormwater.
Enhanced treatment	Evaluating alternative treatment processes that may be able to achieve similar water qualities and risk profiles as the micro-filtration and reverse osmosis process used for purified recycled water.
Disinfection by-product formation in alternative source waters	Researching disinfection by-product formation from blending treated drinking water of different qualities from different sources within the SEQ Water Grid.
Electrochemical treatment of reverse osmosis concentrate	Supporting research into the efficiency of electrochemical treatment of reverse osmosis concentrate to remove total organic carbon, chemical oxygen demand and dissolved organic nitrogen.
Managing efficiently	
Climate and water	Through the use of modelling, this project is examining how the climate has changed, what the key drivers are, and the regional implications for water resources.
Total water cycle analysis	Evaluating the impact of rainwater tanks, recycling, stormwater harvesting and sub-regional scale water cycle plans on the water balance at the regional scale.
Water quality monitoring technology and information collection	Developing systems for online, real-time monitoring of water quality in sewage systems. A proof-of-concept system has been developed to monitor inflows to wastewater treatment plants, providing the capacity to detect sudden changes.
Evaporation losses from water storages	Assessing the reduction in evaporation that can be achieved through the use of mono-layers and the potential impacts of these mono-layers on water quality and ecology.
Purified recycled water in the Lockyer Valley	Evaluating the impacts on soil quality of delivering recycled water to the Lockyer Valley for irrigation.

7.4.2 Water Cycle Sciences Project

The multidisciplinary Water Cycle Sciences Project is another key element of water research in SEQ. Managed by DERM, the project has a focus on identifying the barriers and solutions to achieving a sustainable long-term water cycle.

7.4.3 Queensland Climate Change Centre of Excellence

In March 2007, the Queensland Government established the Queensland Climate Change Centre of Excellence as a specialist unit within DERM. The Centre provides policy advice and scientific information on climate change and its impact on the community, economy and environment. The Centre has formed links with national and international researchers to ensure that Queensland benefits from global research on climate change, as well as having strong links with national policy initiatives. At the same time, that knowledge will be applied at a regional level so that the local climate change impacts can be assessed and managed.

7.5 Key actions

Table 7.4 summarises the activities, works and initiatives that the QWC considers should be undertaken over the next 10 years to achieve the goals of the Strategy.

The activities are additional to:

- existing measures, such as the demand management program
- committed projects, such as those listed in the Emergency Regulation
- legislative and regulatory requirements, such as the preparation of drinking water quality management plans
- requirements under the SEQ System Operating Plan and market rules, including the development of a SEQ Water Grid operating strategy.

Table 7.4 Recommended planning activities and initiatives

Number	Section reference	Activity, work or initiative	Timeframe	Responsible agency
Total water cycle planning				
1	2.3	Finalise the Mt Lindesay and Beaudesert sub-regional total water cycle management plan.	Short-term	QWC in partnership with key stakeholders
2	2.3	Prepare sub-regional total water cycle management plans for key development areas, including in the Moreton Bay and Sunshine Coast Regional Council areas.	Medium-term	QWC in partnership with key stakeholders
3	2.3	Prepare and publish a guideline for sub-regional and local total water cycle planning.	Medium-term	QWC in partnership with DERM and local governments
Strategy review and implementation				
4	3.5 and 7.1.1	Provide updated regional water security options to the Minister based on the key elements of the Strategy.	By the end of 2010	QWC
5	3.5 and 7.1.1	Report on the status of the implementation of the Regional Water Security Program.	Annually	QWC
6	3.5 and 7.1.2	Publicly report on the implementation of the Strategy and currency of key assumptions.	Annually	QWC
7	3.5	Develop a triple bottom line assessment framework for potential demand management measures and potential water supplies.	Short-term	QWC
8	7.1.3	Establish an expert stakeholder forum to discuss issues associated with the implementation of the Strategy—as a priority.	Short-term	QWC
9	3.5	Review the Strategy as required, and prior to a decision regarding the next major supply.	At least once every five years, aligned with the Regional Plan	QWC
Drought response planning				
10	6.5.1	Finalise drought response plans for towns with stand-alone sources of supply.	Short-term	QWC
11	6.9	Prepare a drought response plan for the SEQ Water Grid in accordance with legislative requirements.	Medium-term	QWC
Demand and supply modelling				
12	3.2 and 5.3.2	Undertake further hydrologic modelling to better address the potential impact of climate change on inflows of major dams.	Medium-term	UWSRA, QWC and DERM
13	7.1.2	Publish an annual water report, summarising key consumption and demand trends in SEQ.	Annually	QWC
14	7.1.2	Monitor and analyse consumption and demand trends, and review and refine future demand forecasts as appropriate.	Ongoing basis	QWC

Number	Section reference	Activity, work or initiative	Timeframe	Responsible agency
Demand management program				
15	6.2	Deliver information and education campaigns related to efficient water use and Target 200, including through the development and delivery of targeted education programs for schools and selected industries.	Ongoing	QWC, DERM and Seqwater
16	6.3.1	Review the efficiency and effectiveness of the existing Permanent Water Conservation Measures. Investigate whether individual measures can be integrated into end-user contracts, moved to other regulations, or discontinued.	2010 and 2011	QWC, distributor-retailers and other stakeholders
17	6.3.3	Review the overall demand management program to ensure that it continues to achieve an appropriate balance between water restrictions and other demand management measures, with the objective of encouraging water efficiency at the lowest possible economic, social and environmental costs.	Ongoing	QWC
18	4.4 and 6.3	Develop an online reporting facility and templates for businesses with water efficiency management plans.	Short-term	QWC
19	6.3.2	Work with the Commonwealth and other jurisdictions to develop a national approach to water efficiency for large water users, potentially including a star-rating system.	Long-term	QWC and DERM
20	6.3.2	Work with the Commonwealth Government to promote the Water Efficiency Labelling Scheme and ban the sale of appliances that do not meet these requirements.	Ongoing	QWC and DERM
21	6.3.2	Assess viability and trial the use of web-based water monitoring systems to detect leaks within schools.	Long-term	QWC and Department of Education and Training
22	6.3.2	Implement standardised water billing requirements across SEQ.	Commencing July 2010	Distributor-retailers
23	6.3.3	Undertake a comprehensive review of the potential demand management measures.	As part of future reviews of the Strategy	QWC
24	4.5	Review medium- to long-term non-residential demand forecasts based on updated development and water use trends.	Medium-term	QWC and distributor-retailers
25	4.3	Undertake a detailed review of system leakage targets for bulk and distribution infrastructure using the Infrastructure Leakage Index approach.	Long-term	QWC, LinkWater and distributor-retailers
26	4.3	Review peaking factors recommended in the Planning Guidelines for Water Supply and Sewerage based on the planning assumption for average total consumption, with allowance for local demand and supplies.	Medium-term	QWC and DERM

Number	Section reference	Activity, work or initiative	Timeframe	Responsible agency
Local supplies				
27	4.6	Research options to enhance the efficiency of the water saving target acceptable solutions, including by increasing the average yield, cost-effectiveness or energy efficiency.	Ongoing basis	QWC, Department of Infrastructure and Planning and the UWSRA
28	4.6	Quantify and assess the performance and reliability of rainwater tanks in residential and commercial developments, including the costs and benefits of larger tanks.	Medium-term	QWC and UWSRA
29	4.6	Research the survival and removal of pathogens in rainwater tanks and stormwater.	Long-term	QWC, UWSRA and Queensland Health
30	4.6 and 5.4.3	Investigate opportunities to use stormwater to safely and efficiently provide alternative water supplies. Potential impacts on environmental flows and the benefits of water-sensitive urban design in removing contaminants of concern will also be investigated.	Medium-term	QWC and the UWSRA
31	4.6	Facilitate the development of major stormwater harvesting demonstration projects that achieve the water saving target through supply to toilet cisterns and washing machines.	Medium-term	QWC with local governments and developers
32	4.6	Deliver an education program for local governments and developers regarding options to achieve the water saving target.	Medium-term	QWC
33	4.4	Research into community attitudes and behaviour in relation to demand management.	Medium-term	UWSRA and QWC
Committed projects				
34	5.1	Complete remaining Emergency Regulation projects.	As specified in the Emergency Regulation	Responsible entities
35	5.2	Construct the first stage of the Wyaralong water treatment plant and Cedar Grove Connector.	Medium- to long-term (to be based on QWC's recommendation)	Department of Infrastructure and Planning
36	5.2	Construction the second stage of the Wyaralong water treatment plant and Karawatha Inter-connector.	Medium- to long-term (based on QWC's recommendation)	Department of Infrastructure and Planning
Potential desalination facilities				
37	5.4.1	Preserve priority sites at Marcoola and Lytton and reserve sites at Bribie Island and at Tugun.	Short-term	QWC
38	5.4.1	Establish community reference groups and consultation programs for investigations of priority sites. Conduct community consultation on the Phase 3 investigation work at and surrounding the priority sites.	Short-term	QWC
39	5.4.1	Prepare a land use master plan for land surrounding the existing SEQ (Gold Coast) Desalination Facility as a priority to enable coordination of planning activities for a range of different uses in the area.	Short-term	Gold Coast City Council and the QWC
40	5.4.1	Identify and preserve pipeline corridors required to connect priority sites to the SEQ Water Grid and to augment the Water Grid as required.	Medium-term	LinkWater

Number	Section reference	Activity, work or initiative	Timeframe	Responsible agency
41	5.4.1	Undertake detailed engineering investigations at priority sites to investigate such issues as ground conditions and flooding risk to provide input into the design and approvals processes.	Medium-term	QWC
42	5.4.1	Undertake detailed investigations into the composition and condition of flora and fauna communities in Moreton Bay in order to establish a baseline condition of potentially affected marine ecosystems.	Medium-term	QWC and SEQ Healthy Waterways Partnership
43	5.4.1	Commence appropriate water quality monitoring for priority sites to establish baseline seawater conditions.	Medium-term	QWC and SEQ Healthy Waterways Partnership
44	5.4.1	Through the SEQ Healthy Waterways Partnership, develop an advanced three-dimensional receiving water quality model to investigate potential effects of brine dispersion.	Medium-term	QWC and SEQ Healthy Waterways Partnership
45	5.4.1	Commence ecological investigations at priority sites and adjoining areas to confirm the presence of any native habitats and any significant environmental values not yet identified.	Medium-term	QWC
46	5.4.1	Compile a review of environmental factors, which could constitute a project referral document for referral of a proposed new desalination plant to the Commonwealth environmental regulator.	Medium-term	QWC, LinkWater and Watersecure
47	5.4.1	Based on the investigations outlined above, develop a business case for the development of additional desalination capacity as a future bulk water supply source.	Medium-term	QWC
Potential dams and weirs				
48	5.4.2	Undertake a detailed investigation of the option to further raise Borumba Dam and the potential of water harvesting from the Upper Mary River to the dam.	Short-term	QWC, DERM and local government
49	5.4.2	Undertake a detailed investigation of options to increase supply from the Logan Basin, including by development of a small storage on the Glendower Dam site or by a pipeline to transfer water from the Bromelton Off-stream Storage to Wyaralong Dam.	Medium-term	QWC
50	5.4.2	Review the operation of the Brisbane River system to optimise the water supply yield and balance flood storage and water supply storage volume requirements.	Medium-term	QWC and Seqwater
51	5.4.2	Review the potential to water harvest from Gold Coast creeks and the Coomera River into Hinze Dam.	Long-term	QWC
Stormwater harvesting to dams				
52	5.4.3	Investigate opportunities to use stormwater to augment dams, including a scheme to augment Ewen Maddock Dam.	Medium-term	QWC, local government, Unitywater and Seqwater

Number	Section reference	Activity, work or initiative	Timeframe	Responsible agency
Purified recycled water				
53	5.4.4	Enhance community access to information regarding purified recycled water, including in relation to water quality, environmental benefits and the role of the Western Corridor Recycled Water Scheme as a standby facility with the capacity to supplement Wivenhoe Dam at appropriate times.	Ongoing	WaterSecure
54	5.4.4	Publish water quality reports for the Western Corridor Recycled Water Scheme.	At least annually	WaterSecure
55	5.4.4	Develop a strategy to maximise cost-effective supply of purified recycled water to existing and future industrial users.	Short-term	SEQ Water Grid Manager and QWC
56	5.4.4	Investigate options to increase treated effluent flows to the Gibson Island advanced water treatment plant, as a drought response measure or normal operating practice.	Medium-term	QWC with distributor-retailers
57	5.4.4	Investigate projected wastewater volumes available for supply, and potential viable sources of demand, as well as ecosystem consequences of wastewater discharge and recycling options.	Medium-term	QWC with distributor-retailers
58	5.4.4	Investigate potential purified recycled water schemes to augment Hinze Dam and North Pine Dam.	Long-term	QWC
59	5.4.4	Commence baseline hydrodynamic and water quality monitoring on Hinze and North Pine dams, informed by detailed investigations.	Long-term	Seqwater
Rural towns				
60	6.5.1	Recommend options to improve water security for Beaudesert and Canungra.	Short-term	QWC
61	6.5.1	Investigate water security options for other towns with a stand-alone source of supply, including Dayboro and Boonah.	Medium-term	QWC
62	6.5.2	Review minimum requirements regarding rainwater tank capacity and connected roof area where reticulated drinking water supplies are not available.	Medium-term	QWC
63	6.5.2	Investigate the volumes of water required to augment supply from rainwater tanks during drought, where reticulated drinking water supplies are not available.	Medium-term	QWC and distributor-retailers
64	6.5.2	Develop a policy position regarding the provision of reticulated water supplies to communities that currently rely on drinking water from rainwater tanks and groundwater bores.	Long-term	QWC, distributor-retailers and local governments
Rural production				
65	6.6	Establish a rural water advisory group to oversee planning for rural water supply initiatives in SEQ.	Short-term	QWC
66	6.6.2 and 6.6.3	Develop a framework, including pricing policies, to make additional water available for rural production, when not required for urban supply.	Short-term	QWC, DERM, SEQ Water Grid Manager and Seqwater

Number	Section reference	Activity, work or initiative	Timeframe	Responsible agency
67	6.6.2	Undertake a survey of existing rural producers in partnership with the rural water advisory group and local governments to establish whether existing entitlements meet local needs.	2010	QWC, DERM and local governments
68	6.6.2	In the Warrill Valley, investigate an option to enhance the reliability of supply to rural irrigators through an amendment to the interim resource operations licence.	Short-term	QWC and Seqwater
69	6.6.2	Investigate opportunities to make additional SEQ Water Grid water available for rural production, when not required for urban supply.	Medium-term	QWC and SEQ Water Grid Manager
70	6.6.3	Investigate alternative schemes to make the supply of recycled water from the Western Corridor Recycled Water Scheme to the Lockyer Valley economically viable, including options involving use of existing infrastructure and, if necessary, a reduction in the irrigation area.	Short-term	SEQ Water Grid Manager, QWC and DERM
71	6.6.3	Investigate opportunities to supply recycled water for rural irrigation, including as part of sub-regional total water cycle planning.	Medium-term	QWC, distributor-retailers and local governments
Supply to outside SEQ				
72	6.7	Develop a framework for the supply of water to areas outside SEQ, on a full commercial basis and without impacting on the ability to deliver LOS reliability to SEQ. The framework should include economic and operational principles, standard contractual provisions and possible inter-governmental agreements.	Short-term	QWC
System operation				
73	7.2.1	Review the SEQ System Operating Plan as required.	As required	QWC
74	7.1.2	Report annually to the Minister on the operation of the SEQ Water Grid, as part of the annual market rules review.	No later than 30 November each year or by such other time as the Minister may determine	QWC
75	7.2.3	Review the costs and benefits of moving to a common residual disinfection standard across SEQ.	Short-term	QWC with water service providers
76	7.2.3	Implement appropriate development controls in the catchment area of Cedar Grove Weir, while preserving appropriate development rights.	Medium-term	QWC and Scenic Rim Regional Council
77	7.2.3	Develop a policy approach on catchment management controls for management of water quality risks in dam catchments.	Medium-term	QWC, DERM and Seqwater
78	7.2.3	Participate in future planning scheme reviews and in the development assessment process as a concurrence agency.	Ongoing	Seqwater

Number	Section reference	Activity, work or initiative	Timeframe	Responsible agency
Other research				
79	7.4	Quantify residential water end-uses and develop options for target interventions to improve water use efficiency.	Medium-term	UWSRA and QWC
80	7.4	Research opportunities to further improve the quality of purified recycled water through source control, wastewater treatment technologies and management within natural water bodies.	Medium-term	UWSRA and WaterSecure
81	7.4	Research sources of target pathogens and organic chemicals and the treatment capacities of dams to remove them under different climatic and seasonal conditions in SEQ.	Medium-term	UWSRA and Seqwater
82	7.4	Evaluate alternative treatment processes that may be able to achieve similar water qualities and risk profiles as the micro-filtration and reverse osmosis process used for purified recycled water.	Medium-term	UWSRA
83	7.4	Research disinfection by-product formation from blending treated drinking water of different qualities from different sources within the SEQ Water Grid.	Medium-term	UWSRA, QWC and Seqwater
84	7.4	Research and evaluate options to reduce evaporation from dams.	Medium-term	UWSRA and DERM

Key terms

Term	Definition
Allocation	A right to take water that is an asset separate from land title and can be traded. Water allocations are generally granted via processes contained within resource operations plans.
Brisbane River system	Wivenhoe and Somerset dams, Lake Manchester, Gold Creek Dam and the Mt Crosby Weir.
Bulk water price path	Ten-year price path projected for bulk water prices based on assumed interest rates and consumption patterns.
Category A water	Category A water is supplied from the SEQ Water Grid at the reliability specified in the LOS objectives. Category A water is used for high priority uses including for urban and some industrial purposes. It includes purified recycled water that is supplied to power stations and those industrial customers that require LOS reliability.
Category B water	Category B water is supplied from the SEQ Water Grid at a lower reliability than that specified in the LOS objectives. Category B water includes purified recycled water that is available from the Western Corridor Recycled Water Scheme for rural irrigation. These supplies will be used to augment Wivenhoe Dam if SEQ Water Grid storage levels decline to 40 per cent of capacity.
Climate independent supply	Climate independent water supplies are not affected by rainfall or inflow patterns. Water from desalination and artesian water are examples of climate independent supplies.
Climate resilient supply	Climate resilient supplies are not likely to be significantly affected by climate variability. Such supplies include: - climate independent supplies, such as desalination - purified recycled water - adopted net inflows to dams and extractions from groundwater aquifers under extended and severe drought conditions. For the Strategy, the climate resilient supply from dams and weirs across SEQ is based on 30 months of inflows equivalent to a drought with a severity of between one in 1000 and one in 10 000 year occurrence, adjusted for evaporation and river transport losses.
Demand management	Any program that reduces water consumption and the demand for water from the region's bulk water sources. Demand management programs may include water use efficiency measures, reductions in water losses, water trading to make better use of existing supplies, and substitution of existing supplies with alternative supplies such as rainwater tanks, recycled water and stormwater.
DERM	Department of Environment and Resource Management.
Destination price point	Under the water price path, councils will reach the final price point at different times, reflecting the fact that councils have different bulk water costs at present. Once the final price point is reached, bulk water increases should only be based on inflation. The years in which the relevant councils reach the final destination price point are: - Lockyer: 2011-12 - Somerset: 2014-15 - Scenic Rim: 2015-16 - Logan: 2015-16 - Gold Coast: 2016-17 - Brisbane, Ipswich, Moreton Bay, Sunshine Coast and Redlands: 2017-18.
DIP	Department of Infrastructure and Planning.
Drought response mode	The mode of operation when the combined regional storage levels drop below the T1 trigger and enter the regional Drought Storage Reserve. This mode has two phases – the preparation phase and the construction phase.
Drought response plan	A pre-determined suite of restrictions, demand management programs and new sources of supply that will be implemented once combined dam levels reach a specified trigger.
Drought storage reserve	Volume of water located below the working storage. The SEQ Water Grid drought storage reserve is sized to provide, in conjunction with climate resilient sources, a minimum of 36 months supply of water at a restricted demand.
Effective evaporation	Losses due to surface evaporation and seepage minus infiltration.
Emergency Regulation	*Water Regulation 2002* (Part 8)

Term	Definition
Entitlement	A term used to describe some water authorities granted under the *Water Act 2000*. A water entitlement is a water allocation, interim water allocation or a water licence.
Environmental flows	Flow requirements specified in Water Resource Plans necessary to maintain and support aquatic biota and ecosystem processes.
Federation Drought	The drought experienced in SEQ from 1898 to 1903. Prior to the Millennium Drought, it was the most severe drought in recorded history in SEQ.
Greywater	Wastewater from the bath, spa bath, shower, wash basins and laundry, which can be diverted for use on lawns and gardens. It does not include water from the kitchen, swimming pool or toilet, as this water would pose health and environmental risks.
Grid Water	Any water supplied into or extracted from the SEQ Water Grid.
Groundwater	Groundwater, as defined in the Water Regulation 2002, is water from an underground source.
Key Water Grid storages	Baroon Pocket, Ewen Maddock, Cooloolabin, Wappa, Somerset, Wivenhoe, North Pine, Leslie Harrison, Hinze and Little Nerang dams and Lakes McDonald and Kurwongbah. Key Water Grid storages are used to calculate current dam levels and critical drought response triggers.
Levelised cost	The cost of a measure expressed in terms of dollars per megalitre. Levelised cost is generally calculated by dividing the net present value of the cost of the measure by the net present value of the water saved or supplied.
Level of Service (LOS) objectives	LOS objectives provide a basis for establishing a secure water supply. The objectives define inter alia the desirable maximum frequency, duration and severity of water restrictions, and the average amount of water per capita that must be supplied in normal times. For the purposes of the Strategy, LOS objectives are the same as 'desired Level of Service objectives' as defined in the *Water Act 2000*.
L/p/d	Litres per person per day.
LOS system yield	The LOS system yield is the volume of water that can be supplied from the SEQ Water Grid, on average every year and still achieve the LOS objectives.
Logan River system	Wyaralong Dam, Cedar Grove Weir, Bromelton Off-stream Storage and Maroon Dam.
ML	A megalitre or 1 000 000 litres.
ML/yr	Megalitres per year.
Measures	Used to describe initiatives or projects which are expected to achieve a defined outcome.
Millennium Drought	The drought that occurred in SEQ (and other parts of Australia) from 2001 until 2009. The Millennium Drought was declared over in SEQ on 20 May 2009 when Wivenhoe, Somerset and North Pine dams reached 60 per cent of their combined capacities.
Minimum operating level	The minimum operating volume for any storage is included in the appropriate resource operations plan and might be referred to as the dead storage level. Water below the minimum operating level cannot be accessed with existing infrastructure.
Minimum security volume	The minimum security volume is set at 5 per cent by the LOS objective that regional water storages must not be permitted to reach 5 per cent of combined storage capacity.
Normal operating mode	This is the mode of operation when the combined regional water storage level is within the working storage. Most commonly, the region will operate in this mode.
Priority	Groups of water allocations and interim water allocations are assigned a priority, largely based on the performance of the groups and the rules in place to provide for the sharing of available water between the priority groups. High priority A group of water allocations and interim water allocations that perform more reliably than lesser priority groups. High priority water allocations are mainly used for urban purposes and for power generation, although they are also sometimes utilised for irrigation. Medium priority A group of water allocations or interim water allocations that have less security than high priority. Once the available water in a scheme has been set aside for the high priority group, the remainder is divided amongst those in the medium priority group. Access to medium priority water is often prohibited before access to higher priority water begins to reduce. Medium priority allocations are generally used in the rural production sector.
Purified recycled water (PRW)	Purified recycled water is wastewater that has been treated to a very high standard using world's best technology through an advanced water treatment process. The Public Health Regulation 2005 and the *Water quality guidelines for recycled water schemes* specify the water quality standards that must be met for recycled water and drinking water.

Term	Definition
Queensland Water Commission (QWC)	A statutory authority established to advise the Queensland Government on matters relating to water supply and demand management, and to facilitate and implement the regional water security program.
Regional water security options	Advice from the QWC regarding options to achieve water security in SEQ. Among other things, the options must address: • LOS objectives • demand management for water • the extent to which implementation of the desired LOS objectives would involve modifying existing water supply works or building new water supply works • the likely costs and pricing implications and the preferred ways of sharing the cost.
Regional water security program	A program to achieve water security for the region made and published by the Minister for Natural Resources, Mines and Energy and Minister for Trade within four months of receiving regional water security options from the QWC. A revised regional water security program was made in March 2010.
Reliability of supply	An indication of the proportion of time that a supply system is able to meet the full assumed demand. Reliability may be expressed as the proportion of time over a historical period that the full demand is met or conversely not met.
Resource operating plan (ROP)	A plan that details the water sharing rules, infrastructure operating rules and other water management rules that will be applied in the day-to-day management of water supplies within a catchment or water supply scheme.
Restricted demand	The volume of water required to meet the region's needs if the combined regional storage drops below the T1 trigger. The LOS objective for Medium Level Restrictions is to reduce demand by 15 per cent below the demand when Permanent Water Conservation Measures are in force. See also Water Restrictions.
Regional Plan	*South East Queensland Regional Plan 2009-2031*.
SEQ	South East Queensland, as defined in the SEQ Regional Plan.
SEQ Water Grid	The connected group of bulk supply and transport assets in South East Queensland that when operated conjunctively can deliver the LOS objectives.
SEQ Water Grid Manager	A Government owned, not for profit, entity established to purchase bulk supply, treatment and transport services, sell water and water services to Water Grid customers, and oversee the physical operation of the SEQ Water Grid.
Sewer mining	The extraction of raw sewage effluent from the wastewater collection system for treatment and use as recycled water. Waste from the treatment plant is generally returned to the sewer. The final quality of the water produced can be fit to purpose.
South Maroochy system	Cooloolabin, Poona and Wappa dams.
Standards of service	The characteristics of product delivered by water retailers to their customers. The *Water Act 2000* describes the requirements for establishing standards of service. Examples of standards of service relate to water quality, delivery pressure and continuity of supply.
Stochastic modelling	A stochastic model is a tool for estimating probability distribution of potential outcomes by allowing for random variation in one or more inputs over time. The random variation is usually based on fluctuations observed in historical data for a selected period using standard time-series techniques.
System losses	The difference between the amount of water extracted from water supplies and that delivered to water users. The difference may be due to approved activities such as fire fighting or unapproved such as theft or due to leakage losses.
SEQ System Operating Plan	A plan made under section 360V of the *Water Act 2000* to give effect to the regional water security program. The SEQ System Operating Plan describes rules for operating water supply infrastructure in order to achieve the LOS objectives, as specified in the regional water security program.
Urban activity	A residential, industrial, retail, commercial, sporting, recreation, tourism or community activity within the urban footprint.
Urban footprint	One of the regional land use categories in the Regional Plan. The urban footprint identifies land to provide for the region's urban development needs to 2031.
Waterhub	The SEQ water accounting framework managed by the Queensland Water Commission.
Water harvesting	The taking of unsupplemented water during high flow events. Water harvesting generally involves extraction of water when set flow thresholds are exceeded and pumping and storing the water off-stream for later use.

Term	Definition
Water resource plan (WRP)	Subordinate legislation under the *Water Act 2000* that provides the framework for defining the balance between water for consumptive use and environmental requirements. These plans also provide the basis for establishing tradable water allocations including the specification of: • water allocation security objectives (WASOs) • environmental flow objectives (EFOs).
Water restrictions	Permanent Water Conservation Measures Permanent low level restrictions that will be introduced across SEQ. Medium Level Water Restrictions Initiatives that form part of the drought response plan to reduce demand for SEQ Grid Water by 15 per cent.
Western Corridor Recycled Water Scheme (WCRWS)	Waste water treatment and recycling project that manufactures drought resilient water supplies for emergency use (when the combined volume of SEQ storages falls below 40 per cent of capacity. The project includes: • more than 200 kilometres of large-diameter underground pipeline, reaching from Luggage Point on Brisbane's east to Caboonbah north-west of Ipswich • three advanced water treatment plants at Bundamba, Luggage Point and Gibson Island • the capacity to supply up to 232 million litres of purified recycled water per day When not required for emergency water supply, the WCRWS supplies purified recycled water to power stations
Water year	An annual cycle associated with the natural progression of the hydrologic seasons. It is intended to commence with the start of the season of soil moisture recharge, includes the season of maximum run-off, stream flows and groundwater recharge and concludes with the season of maximum evapo-transpiration. In SEQ, it is generally described as the period 1 June to 31 May but does vary from catchment to catchment.
Working storage	The portion of a dam or weir above the drought storage reserve that is drawn upon in normal operating mode.
Yield	The average annual volume that can be drawn from a supply source or a supply option to meet a specified demand at a specified probability of occurrence. Historical no failure yield (HNFY) The maximum amount that, if it had been extracted in each year for which flow data exists, the storage would not have reached minimum operating level. That is, extraction of the HNFY every year would not cause the dam to be drawn down below the dead storage level during the worst drought on record. This approach does not accommodate a drought worse than the worst drought on record. LOS yield The yield of a dam, weir or other water storage to achieve the LOS objectives. LOS system yield The yield that can be supplied from a system, such as the SEQ Water Grid, on average every year and still achieve the LOS objectives.

Reference List

The following documents have informed the development of the Strategy. The Strategy also drew on a range of technical reports that have been published on the QWC website.

Title	Website
Regional planning framework	
South East Queensland Regional Plan 2009-2031	http://www.dip.qld.gov.au/regional-planning/regional-plan-2009-2031.html
South East Queensland: Infrastructure Plan and Program 2007-2026	http://www.dip.qld.gov.au/regional-planning/south-east-queensland-infrastructure-plan-and-program.html
Our Water – Urban Water Supply Arrangements in South East Queensland May 2007	http://www.qwc.qld.gov.au/Urban+Water+Supply+Arrangements+Report
Planning, Information and Forecasting Unit (PIFU), Population and Housing Fact Sheet for SEQ Region	http://www.oesr.qld.gov.au/queensland-by-theme/demography/population-characteristics/profiles/pop-housing-fact-sheets-reg-planning/pop-housing-fact-sheets-south-east-qld-200908.pdf
Queensland Government Population Projections to 2051: Queensland and Statistical Divisions 2008 Edition	http://www.oesr.qld.gov.au/queensland-by-theme/demography/population/tables/pop-proj/proj-pop-sd-qld/index.shtml
Improving water use efficiency in Queensland urban communities Nov 2000	http://www.derm.qld.gov.au/publications/water_management.html
Related legislation	
Water Act 2000	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WaterA00.pdf
Water Supply (Safety and Reliability) Act 2008	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/S/SouthEQWA07.pdf
Water Regulation 2002	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WaterR02.pdf
South East Queensland Water (Restructuring) Act 2007	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/S/SouthEQWA07.pdf
Sustainable Planning Act 2009	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/S/SustPlanA09.pdf
Queensland Development Code 2003	http://www.dip.qld.gov.au/building/queensland-development-code.html
Water resource plans	
Gold Coast	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WatResGCP06.pdf
Logan Basin	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WatResLBP07.pdf
Mary Basin	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WaterReMaryP06.pdf
Moreton	http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WatResMorP07.pdf
Resource operations licences and interim resource operations licences	
Logan River water supply scheme (rol)	http://www.derm.qld.gov.au/water/management/rols.html
Lower Mary River water supply scheme	http://www.derm.qld.gov.au/water/management/irols.html
Upper Mary River water supply scheme	http://www.derm.qld.gov.au/water/management/irols.html
Nerang water supply scheme	http://www.derm.qld.gov.au/water/management/rols.html
Warrill Valley water supply scheme	http://www.derm.qld.gov.au/water/management/irols.html
Climate	
South East Queensland Drought to 2007	http://www.longpaddock.qld.gov.au/AboutUs/Publications/HiddenArea/seq_drought_2007.pdf
Intergovernmental Panel on Climate Change Fourth Assessment Report Climate Change 2007: Synthesis Report	http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

Title	Website
Energy demand and water supply	
Energy use in the provision and consumption of urban water in Australia and New Zealand	http://www.clw.csiro.au/publications/waterforahealthycountry/2008/wfhc-urban-water-energy.pdf
Drinking water quality guidelines	
Australian Drinking Water Guidelines	http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm
Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)	http://www.ephc.gov.au/taxonomy/term/39
Guidance on use of rainwater tanks 2004	http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-document-metadata-env_rainwater.htm
National Performance Report -: Urban water utilities	https://www.wsaa.asn.au/Publications/Pages/PerformanceReports.aspx

From: Pearce Ken
Sent: Thursday, 3 February 2011 5:15 PM
To: Tucker, Greg [redacted]; [redacted] Hogan Bernadette; [redacted] 'Colin Apelt'; Sommer Peter; Tony Jacobs
Cc: Sommer Peter; Patullo Emma
Subject: Optimising the Brisbane River System

Dear PRG Members,

The Brisbane River System Project is being set up to address Key Action #50 in the SEQ Water Strategy. Seqwater and the Commission are obligated by the Strategy to :

"Review the operation of the Brisbane River system to optimise the water supply yield and balance flood storage and water supply storage volume requirements."

Initially the scope of the Project was limited to consideration of the "maximum level to which the working storage of Wivenhoe Dam could be raised without raising the dam walls."

Owing to recent flooding in the Brisbane River Valley, it is seen as prudent to develop the scope, with input from the Project Reference Group, for consideration of the Commission's Executive. The scope as currently proposed is as follows.

Optimise water supply and flood mitigation in the Brisbane River system using existing water supply infrastructure (Wivenhoe Dam), new infrastructure and operational arrangements. This would require the consideration of:

* a FSL for existing water supply infrastructure (Wivenhoe Dam) that balances supply and flood mitigation;
* new infrastructure that can optimise the yield of the system and or flood mitigation; including management infrastructure;
* new and existing infrastructure working in unison to optimise supply and flood mitigation;
* improving or upgrading downstream infrastructure that would increase operational flexibility at upstream structures, such as raising road crossings downstream of Wivenhoe Dam; and
* operational improvements.

Consideration of the FSL of existing infrastructure could lead to a dynamic FSL approach for water supply infrastructure in the Brisbane River system. This dynamic approach could take into consideration the likelihood and degree of inflows in the water cycle year along with the supply/demand balance of the Water Grid.

Optimisation of the Brisbane River System

Agenda

TYPE OF MEETING	**Inaugural meeting of the Project Reference Group (PRG)**
TIME & DATE	9:30 am – 4:00 pm, Friday 25 February 2011
LOCATION	Wivenhoe Dam Operations Complex

Item	Time	Subject	Lead	Outcome required
1	9:30 - 9:50 am	**Tea/Coffee**	Seqwater	
2	9:50 – 10:00 am	**Welcome by Chairman**	Peter Sommer (QWC)	
3	!0:00 – 11:00 am	**Brisbane River System Operations** o **Recent drought and flood events** o **Constraints on operation** o **Issues**	Rob Drury (Seqwater)	
4	11:00 – 1:00 pm	**Tour of Wivenhoe Dam and downstream constraints**	Rob Drury (Seqwater)	
5	1:00 – 1:45 pm	**Lunch**	Seqwater	
6	1:45 – 2:00 pm	**Project Scope**	Peter Sommer	
7	2:00 – 2:30 pm	**Terms of Reference for the PRG** o **Membership of the PRG**	Peter Sommer	Agreement on TOR
8	2:30 – 3:00 pm	**Commission of Inquiry into QLD's unprecedented flood disaster**	Peter Sommer	
9	3:00 – 3:30 pm	**Project Strategy**	Ken Pearce (QWC)	Agreement on strategy
10	3:30 – 3:45 pm	**Close**	Peter Sommer	
11	3:45 – 4:15 pm	**Afternoon Tea**	Seqwater	

Hon Stephen Robertson MP
Member for Stretton

Queensland Government

Minister for Energy and Water Utilities

Ref CTS 08836/11

2 3 MAY 2011

Mr Phil Hennessy
Chairman of the Board
Seqwater
PO Box 16146
CITY EAST QLD 4002

Dear Mr Hennessy

I refer to Mr Peter Borrows' letter of 9 May 2011 to Mr John Bradley, Director-General, Department of Environment and Resource Management, outlining a Draft Study Proposal for a Wivenhoe Dam and Somerset Dam Optimisation Study.

I understand that the draft study proposes to optimise the water supply security and flood mitigation outcomes associated with the potential future operation and possible upgrade of the dams. Results of the study would inform any future review of the Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam, the South East Queensland Water Strategy and flood plain management by local government.

The South East Queensland Water Strategy, approved and released by the government in mid 2010, previously identified that Seqwater and the Queensland Water Commission should jointly lead a review into the operation of the Brisbane River system to optimise the water supply yield and balance flood storage and water supply storage volume requirements. This action built on the work undertaken in the March 2007 SEQWater report titled "Provision of Contingency Storage in Wivenhoe and Somerset Dams" and was intended to consider the maximum level to which the working storage of Wivenhoe Dam could be raised without raising the dam walls.

In keeping with the South East Queensland Water Strategy recommendations, I request that Seqwater works with the Queensland Water Commission to undertake such work, but with an expanded scope to appropriately incorporate information relevant to recent flooding in the Brisbane River system.

However, I consider that alternative arrangements to those outlined in the Draft Study Proposal sent to Mr Bradley need to be put in place. As the owner and operator of the dams and, ordinarily, the proponent for any design or operational changes, Seqwater should be the Steering Committee leader for the study, continuing and expanding the work commenced in the above 2007 report.

Level 17
61 Mary Street Brisbane Qld 4000
PO Box 15216 City East
Queensland 4002 Australia
Telephone +61 7 3225 1861
Facsimile +61 7 3225 1828
Email energy@ministerial.qld.gov.au

In addition, I consider that it is more appropriate that the Water Supply Security Investigation Technical Committee leader be the Queensland Water Commission and that the Expert Review Committee leader be provided by either the Queensland Water Commission (which already runs an Expert Panel for Purified Recycled Water) or Seqwater (as the study leader).

The optimisation study should provide an informed view of how to manage and, if necessary, upgrade Brisbane River water and other infrastructure to optimise flood mitigation and water supply security outcomes for South East Queensland, both in the short and longer terms. I am particularly interested in timely advice in respect of operation of the Brisbane River system for the forthcoming wet season and any amendments required to the Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam and the Moreton Resource Operations Plan.

The Queensland Floods Commission of Inquiry is also seeking comment on a suggested list of work to be done to review the Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam. The Queensland Floods Commission of Inquiry proposes that the work be completed at three different phases: an interim review of the Manual before the 2011-2012 wet season, a longer term review of the Manual and future reviews of the Manual. The work undertaken as part of the optimisation study should consider matters raised by the Queensland Floods Commission of Inquiry.

Clearly, there will need to be appropriate consultation with stakeholders to both scope and undertake the work required for the optimisation study with clearly assigned responsibilities.

The reports prepared as part of the proposed optimisation study would need to be submitted to the Queensland Government, which would consider the financial implications and regulatory matters. Following consideration by the government, the Department of Environment and Resource Management would need to approve any future changes to the Manual of Operational Procedures for Flood Mitigation and any changes needed to the Resource Operations Plan. Likewise, the Queensland Water Commission would need to approve any changes to the System Operating Plan for the South East Queensland Water Grid.

I have asked that the Department of Environment and Resource Management meet with Seqwater and the Queensland Water Commission as a matter of priority to agree a study proposal so that it can be sent to other stakeholders for comment.

I look forward to being regularly updated on the progress of the work required.

Yours sincerely

STEPHEN ROBERTSON MP

Hon Stephen Robertson MP
Member for Stretton

Queensland Government

Minister for Energy and Water Utilities

Ref CTS 08836/11

2 3 MAY 2011

Ms Mary Boydell
Commissioner
Queensland Water Commission
PO Box 15087
CITY EAST QLD 4002

Dear Ms Boydell

Seqwater recently wrote to Mr John Bradley, Director-General, Department of Environment and Resource Management, suggesting a Draft Study Proposal with respect to a Wivenhoe Dam and Somerset Dam Optimisation Study.

I have requested that Seqwater works with the Queensland Water Commission to develop an informed view of how to manage and, if necessary, upgrade Brisbane River water and other infrastructure to optimise flood mitigation and water supply security outcomes for South East Queensland both in the short and longer terms. I am particularly interested in timely advice in respect of operation of the Brisbane River system for the forthcoming wet season and any interim amendments required to the Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam, the Moreton Resource Operations Plan and the South East Queensland System Operating Plan.

Please find attached a copy of the letter I have sent to the Chairman of the Board for Seqwater.

Should you have any further enquiries, please do not hesitate to contact Ms Jenny Downie, Assistant Policy Advisor on telephone [redacted]

Yours sincerely

STEPHEN ROBERTSON MP

Att

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Hon Stephen Robertson MP
Member for Stretton

Queensland Government

Minister for Energy and Water Utilities

Ref CTS 08836/11

23 MAY 2011

Mr Phil Hennessy
Chairman of the Board
Seqwater
PO Box 16146
CITY EAST QLD 4002

COPY

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STEPHEN ROBERTSON MP