

**WARMINGTON STREET PADDINGTON FIRE
4 SEPTEMBER 2016**

OPERATIONAL REVIEW

RELEASE DATE: 28 OCTOBER 2016

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Scope Limitations

This report does not constitute advice as it has been prepared for information purposes only. This report is current as at 27 October 2016. Queensland Urban Utilities reserves the right to alter or supplement this report should information that is relevant to the conclusions subsequently become available.

Queensland Urban Utilities is under no legal obligation to supply water for fire-fighting purposes, but does so as a community service, recognising that effective fire safety measures requires a whole of community approach.

While Queensland Urban Utilities believes that the statements made in this report are accurate, no warranty of completeness, accuracy, or reliability is given in relation to any statements, information or representations made or provided by any third party.

The preparation or making of any of the statements, representations, opinions or conclusions in this report, shall not be construed as:

- creating an obligation on Queensland Urban Utilities to supply water to a specific flow or pressure for fire-fighting purposes, or*
- an admission by Queensland Urban Utilities of any liability (in negligence or otherwise) in relation to the provision of water supply for fire-fighting purposes generally, or as regards to the specific events and circumstances referred to in this report, or*
- expressing any view on the operational expectations of any privately owned infrastructure as Queensland Urban Utilities has no responsibility for such infrastructure.*

1. EXECUTIVE SUMMARY

On Sunday, 4 September 2016, Queensland Fire and Emergency Services (QFES) was called to a significant and intense house fire at Warmington Street, Paddington (Paddington Fire). Queensland Urban Utilities (QUU) responded to a request for assistance by QFES, in the event that water network support was required for the fire-fighting efforts.

QUU assistance was not ultimately required, however, the QUU crew remained onsite until confirmation by QFES that the fire was under control. The outcome of this fire was that no lives were lost and property loss was contained to two properties.

QFES has advised that they accessed five street hydrants (described as H-2, H-7, H-8, H-5 and H-6) and one private shopping centre hydrant (at Paddington Central, described as H-1) to support the fire-fighting response. A further two street hydrants (described as H-3 and H-4) along Warmington Street towards Kennedy Terrace were available, but were not accessed during the Paddington Fire.

Following the containment of the fire by QFES, a burst occurred in the water main at Latrobe Terrace. While repairs were being undertaken, a water main network valve at the corner of Latrobe Terrace and Warmington Street was identified as being closed.

The provision of water for fire-fighting purposes is not a core service or function of QUU. However, in response to community concerns relating to water flow issues on the morning of the fire, QUU engaged independent consultants to undertake hydrant testing and hydraulic modelling of QUU's water network. This work was undertaken to determine if the water network met the relevant guidelines, to validate the operation of the network on the day and to consider the impact, if any, of the closed valve.

The independent fire hydrant testing verified that the fire flow capability from the water supply network met the Department of Energy and Water Supply *Planning Guidelines for Water Supply and Sewerage April 2010, Chapter 6 amended March 2014* (DEWS Guidelines). Independent hydraulic modelling based on this independent testing has concluded that:

1. *The DEWS Guidelines for flow and pressure were met at the time of the Paddington Fire Event.*

2. *The DEWS Guidelines for flow and pressure are met under the background conditions at the time of the Paddington Fire Event regardless of whether the valve in the Warmington Street main is open or closed.*
3. *A flow of significantly more than 15 L/s would have been available once the further QUU hydrants outside Warmington Street (H-7, H-8, H-5 and H-6) were accessed. Based on the modelling, it is estimated that a total flow of approximately 102 L/s was available from the six hydrants deployed at the time of the Paddington Fire Event. A flow of approximately 115 L/s would have been available from these hydrants if the valve in Warmington Street had been open, a difference of 13 L/s.*
4. *Consideration has also been given to the available water supply from only the QUU street hydrants (that is, excluding the Paddington Central Private Hydrant H-1). Using hydrants H 2, H-5, H-6, H-7 and H-8, it is estimated that a total flow of 98 L/s would have been available with the Warmington Street valve closed, and 98 L/s with the Warmington Street valve open – that is, no difference. If H-3 and H-4 are also included, the estimated total available flows were 112 L/s with the valve closed, and 120 L/s with the valve open, a difference of 8 L/s.*
5. *The results of the HTC hydrant flow tests are consistent with the GHD network modelling and are also consistent with the conclusion that fire flow availability from the network during the Paddington Fire Event met the DEWS Guidelines.*
6. *The Paddington Central Shopping Centre hydrant H-1 is a private hydrant and not owned or maintained by QUU. As such, the hydrant is not subject to the DEWS Guidelines but has been included in the modelling in this report for completeness as a hydrant accessed during the Paddington Fire Event¹.*

Unless stated otherwise, this report references and relies on the results of independent hydrant testing and the conclusions of the independent hydraulic modelling.

While it has been confirmed QUU's network met the DEWS Guidelines, QUU has committed, as part of its existing continuous improvement program, to undertake additional actions and initiatives aimed at further supporting water network operations for fire-fighting purposes.

¹GHD Report for Queensland Urban Utilities – Warmington Street fire – September 2016, Review of available fire flows, page 17.

2. BACKGROUND

2.1 Queensland Urban Utilities

Central SEQ Distributor-Retailer Authority, trading as Queensland Urban Utilities, is a statutory body established in 2010 under the *South East Queensland Water (Distribution and Retail Restructuring) Act 2009* (Qld) (Restructuring Act). QUU is a distributor-retailer under the Restructuring Act and a service provider under the *Water Supply (Safety and Reliability) Act 2008* (Qld) (Water Supply Act).

QUU's shareholders are the councils of Brisbane, Ipswich, Lockyer Valley, Scenic Rim and Somerset. Its service area covers the geographic areas of its shareholders.

2.2 Primary functions

QUU is responsible for delivering safe drinking water, recycled water and sewerage services to more than 1.4 million customers in South East Queensland.

To support these core services, QUU undertakes a number of functions, including, but not limited to:

- water quality management
- customer management
- asset planning and management
- water meter management
- development assessments and approvals
- wastewater management (including trade waste)
- community and stakeholder relations
- regulatory and legislative compliance
- scientific laboratory services.

QUU's establishing legislation, the Restructuring Act, does not list the provision of water for fire-fighting purposes as a core service or function of QUU.

2.3 Purpose of this report

This report provides an overview of QUU's water supply management and operational activities as they relate to the fire in Paddington. The report outlines:

- the regulatory framework within which QUU operates, as it relates to the provision of water for fire-fighting purposes
- QUU's water supply network in Paddington, Brisbane
- the results of independent hydrant testing and independent hydraulic modelling
- QUU's hydrant and network maintenance operations
- opportunities for improvement as part of QUU's continuous improvement program.

2.4 Report limitations

Access to water for fire-fighting purposes is only one aspect of a multi-faceted approach to fire safety in Queensland. Under the *Fire and Emergency Service Act 1990* (Qld) (FES Act), QFES is the primary provider of fire and emergency services in Queensland.

This function is supported by a range of legislation, standards, regulations and building and plumbing codes that collectively work together to assist the community in the prevention, mitigation, management and control of fire safety and fire-fighting measures.

Accordingly, this report does not address the cause of the fire, nor does it make an assessment of, or comment independently on, fire-fighting operations on the day of the fire. While consideration of these and other factors are necessary in order to gain a full understanding of the incident and response, they are outside QUU's core functions and responsibilities, and therefore the scope of this report.

3. SUMMARY OF EVENTS

On Sunday, 4 September 2016, QFES responded to a house fire in Warmington Street, Paddington. QFES has reported that on arrival, fire fighters found one house fully engulfed in fire, with sections of a close neighbouring property also on fire. Within eight minutes of the arrival of QFES, the neighbouring property was fully engulfed. The intensity of the fire triggered QFES to deploy multiple fire crews and appliances to the location and access five street hydrants and one private hydrant to support the fire-fighting response.

As is standard practice, QUU was contacted by QFES and requested to attend the location, in the event that the QUU crews were needed to manually operate the water network to optimise it for fire-fighting activities. Upon arrival, the QUU crew was informed by the Fire Commander that QFES had adequate water flow, and no further action was required. The Fire Commander requested, as a precaution, that the QUU crew remain onsite until the fire was under control. Once the fire was under control, the QUU crew was stood down and left the site.

On that same morning, but after the fire was under control, QFES identified a burst water main in the vicinity (on Latrobe Terrace) and notified QUU. The QUU crew returned to the location and repaired the water main. While undertaking the necessary repair work, a water main valve at the intersection of Latrobe Terrace and Warmington Street was identified as being closed. The burst water main did not hamper fire-fighting efforts as it happened after the fire was under control, and water was available to Warmington Street at all times during the burst repairs.

After the Paddington Fire, and in response to community concerns about water flow issues reported at the fire, QUU carried out testing of available and accessed hydrants in the Warmington Street, Paddington vicinity. QUU also carried out hydraulic modelling of the water supply network. The results of these tests and modelling by QUU verified that the DEWS Guidelines for flow and pressure were met at the time of the Paddington Fire.

Subsequently, QUU engaged independent consultants to undertake hydrant testing and hydraulic modelling of the QUU assets, to assess flow and pressure against relevant guidelines, validate the operation of the network on the day and to consider the impact, if any, of the closed valve. Again, these investigations concluded that the DEWS Guidelines for flow and pressure were met under the background conditions at the time of the Paddington Fire, regardless of whether the valve in the Warmington Street main near Latrobe Terrace was open or closed.

On Thursday, 29 September 2016, QUU participated in a public meeting, called by The Hon. Dr Steven Miles, MP (Member for Mount Coot-tha) in response to residents' concerns. QFES representatives also attended this meeting. QUU representatives presented on the water supply network in Paddington, the operation of the water supply network on the day of the fire, the results of independent hydrant testing and the internal QUU hydraulic modelling. QUU also responded to questions from members of the community, in relation to the water supply network.

4. REGULATORY FRAMEWORK

4.1 Legislative framework

As prescribed under the Restructuring Act, QUU's core function is to provide water and wastewater (sewerage and trade waste) services to customers in its geographic area, being the local government areas of Brisbane, Ipswich, Lockyer Valley, Scenic Rim and Somerset.

There is no specific legislative requirement for QUU to provide a fire-fighting capability from its water network (i.e. to provide water for fire-fighting purposes at a specified flow rate or pressure). The FES Act enables QFES to shut off the supply of water from any main, pipe or other source to obtain a greater pressure or supply or take water from any source (which would include QUU's water service infrastructure), for the purpose of fighting fires.

Under the Water Supply Act, service providers must not charge for water taken from a fire-fighting system or hydrant for fire-fighting purposes. Further, the Water Supply Act makes it an offence to take water from a fire-fighting system or a hydrant without the service provider's permission, unless the taking occurs for fire-fighting purposes.

4.2 DEWS guidelines

According to the DEWS Guidelines, the primary purpose of the DEWS Guidelines is "to facilitate strategic thinking in the planning process". The DEWS Guidelines do not have statutory force, but provide guidelines for best practice.

Relevantly, Chapter 6 of the DEWS Guidelines outlines, among other things:

- the roles and responsibilities of each party with respect to fire provision and fire safety installations
- minimum fire flow performance that should be provided by the water service providers.

Chapter 6, Section 6.1 of the DEWS Guidelines reiterates that "water for fighting fires is a community service provided by water service providers through their water network. Provision of network capacity to fight fires in the community is an important part of the water supply network, however, there is no legal requirement for this service to be provided".

Chapter 6, Section 6.6 of the DEWS Guidelines provides advice on the minimum fire flow for water service provider networks. Relevantly, these include, for residential buildings:

- a. Minimum fire flow under general urban category – 15 L/s for two hour duration (from up to two hydrants)
- b. Residual pressure –
 - i. Minimum Residual Pressure in the main at the hydrant – 12 metres head (approximately 118 kilopascals (kPa)) at the minimum operating flow
 - ii. Minimum Pressure elsewhere in the supply zone during a fire event – 6 metres head (approximately 58.68 kPa) at the minimum operating flow
- c. Background demand in the network during a fire event – predominately residential areas:
 - i. 2/3 peak hour demand (PH)
 - ii. Not to be less than average day demand (AD)
 - iii. Check for positive pressure at PH.

It is worth noting that, in comparison to other jurisdictions, the DEWS Guidelines as it relates to fire flow for existing residential areas in urban areas (which QUU has adopted) are one of the highest in Australia.

5. WATER NETWORK IN PADDINGTON

5.1 Water supply infrastructure

The water supply network in Paddington is a pressurised system, consisting of 3km of trunk mains (larger-sized mains) and 37km of reticulation mains.

Based on QUU's asset records, the water main in Warmington Street, Paddington is a 100mm cast iron pipe, which was constructed between 1905 and 1911. The Warmington Street main was relined with cement in the 1960s to prevent internal corrosion of the pipe and mineral build-up. Accordingly, it is unlikely that mineral build-up or the age of the main was a contributing factor.

5.2 Water pressure

Paddington's water supply is gravity-fed by the large Green Hill reservoir, which is located in Russell Terrace at Chapel Hill.

QUU's customer service standard for water pressure is 210 kPa at the property boundary. Water pressure across Paddington ranges between 250 kPa (at the top of hills) to 800 kPa (at the bottom of hills). Relevantly, water pressure in Warmington Street ranges from 460 kPa to 630 kPa. These pressures are in excess of the minimum water pressure required under the QUU customer service standard and are a result of the elevation of the reservoir.

At the public meeting, community members enquired whether Paddington was impacted by any proactive 'pressure management' activities. While there are parts of Brisbane where QUU actively manages water pressure for operational reasons, Warmington Street, Paddington, as part of the Green Hill pressure zone, is not subject to pressure management.

5.3 Water network configuration during the Paddington Fire

When undertaking repairs as a result of a burst on the main at Latrobe Terrace following the fire, QUU identified that a valve at the intersection of Latrobe Terrace and Warmington Street was closed. There are just under 70,000 of these valves in QUU's water network. They are manually operated for a number of reasons, including when undertaking repair works, maintenance and water main upgrades.

QUU has not been able to determine when the valve was closed. QUU records indicate the valve was last accessed in 2015, for operational purposes and that it was noted as closed at this time.

While the typical position for the valve is open, records indicate it was subsequently left in the closed position. As there were no other factors alerting QUU to flow or pressure issues, and as flow testing results on relevant fire hydrants in the area for the period 2006-2015 consistently met the DEWS Guidelines, it is likely that further action was not prioritised. Given that the flow testing results during this period are consistent with the QUU testing and the independent hydrant testing completed after the Paddington Fire, it is likely that the valve may have been closed for a longer period.

To determine the impact of the closed valve on water flow and pressure, this configuration was included in the independent hydrant testing and the independent hydraulic modelling. The full results of the tests and modelling can be found at Appendix 1 and 2, respectively. A summary of these results can be found in Section 6.

5.4 Hydrants used in the Paddington Fire

QFES has advised they accessed five street hydrants and one private shopping centre hydrant (H-1), at Paddington Central, to support the fire-fighting response. The first hydrant accessed is located at 25 Warmington Street (H-2), on the road immediately outside the subject property. There are another two street hydrants along Warmington Street, approximately 90m and 180m from the subject site towards Kennedy Terrace, that were not accessed during the Paddington Fire (H-3 and H-4 respectively).

At the Paddington Central Shopping Centre, a private fire booster assembly located adjacent to the car park entry (Warmington Street) was accessed as the first alternative hydrant, after supply from the initial Warmington Street hydrant was deployed. The Paddington Central Shopping Centre hydrant is a private hydrant, not owned or maintained by QUU. As such, it is not subject to the DEWS Guidelines (refer Chapter 6, Section 6.6.1). The responsibility to design, maintain and ensure the performance of any private hydrant for fire-fighting resides with the property owner.

Additional street hydrants were subsequently accessed outside 84 Latrobe Terrace (H-7) and also at 76 Alma Street (H-8). QUU's understanding is that shortly after, two hydrants at 28 and 42 Terrace Street (H-5 and H-6 respectively) were also accessed.

6. RESULTS OF HYDRANT TESTING AND HYDRAULIC MODELLING

6.1 QUU testing and modelling

After the Paddington Fire, QUU carried out testing of the available and accessed hydrants in the Warmington Street, Paddington vicinity. QUU also carried out hydraulic modelling of the water network. The results of these tests and modelling concluded that QUU's water supply network and street hydrants met the DEWS Guidelines.

To verify these results, QUU commissioned independent hydrant testing and hydraulic modelling.

At the community meeting, QUU shared data that was available at the time (i.e. QUU's internal hydraulic modelling). Now that independent hydraulic modelling is available, this report is based on the independent modelling.

6.2 Independent hydrant testing and hydraulic modelling

The independent hydrant testing was carried out by Hydraulic Testing and Certification Pty Ltd (HTC) on 22 September 2016. The results of this testing can be found at Appendix 1. The data from this independent hydrant testing was then used by GHD to undertake hydraulic modelling of the water network in its configuration on the day of the fire (i.e. with the valve closed) and with the valve open. The results of the independent hydraulic modelling can be found at Appendix 2.

6.3 Key findings of the independent hydrant testing and hydraulic modelling

Independent hydraulic modelling has been undertaken to assess the total capacity of QUU's network that was accessed during the Paddington Fire. This modelling does not take into account the way in which QFES operated fire appliances and controlled water flow from the hydrants and appliances during the fire-fighting response. While hydrants were tested in isolation, they were not used in isolation on the morning of the fire. It is important that the performance of the network be considered as a whole to establish overall fire flow availability.

The independent hydraulic modelling concluded:

1. *The DEWS Guidelines for flow and pressure were met at the time of the Paddington Fire Event.*
2. *The DEWS Guidelines for flow and pressure are met under the background conditions at the time of the*

Paddington Fire Event regardless of whether the valve in the Warmington Street main is open or closed.

3. *A flow of significantly more than 15 L/s would have been available once the further QUU hydrants outside Warmington Street (H-7, H-8, H-5 and H-6) were accessed. Based on the modelling, it is estimated that a total flow of approximately 102 L/s was available from the six hydrants deployed at the time of the Paddington Fire Event. A flow of approximately 115 L/s would have been available from these hydrants if the valve in Warmington Street had been open, a difference of 13 L/s.*
4. *Consideration has also been given to the available water supply from only the QUU street hydrants (that is, excluding the Paddington Central Private Hydrant H-1). Using hydrants H 2, H-5, H-6, H-7 and H-8, it is estimated that a total flow of 98 L/s would have been available with the Warmington Street valve closed, and 98 L/s with the Warmington Street valve open – that is, no difference. If H-3 and H-4 are also included, the estimated total available flows were 112 L/s with the valve closed, and 120 L/s with the valve open, a difference of 8 L/s.*
5. *The results of the HTC hydrant flow tests are consistent with the GHD network modelling and are also consistent with the conclusion that fire flow availability from the network during the Paddington Fire Event met the DEWS Guidelines.*
6. *The Paddington Central Shopping Centre hydrant H-1 is a private hydrant and not owned or maintained by QUU. As such, the hydrant is not subject to the DEWS Guidelines but has been included in the modelling in this report for completeness as a hydrant accessed during the Paddington Fire Event².*

As the conclusions indicate, in all scenarios, independent hydraulic modelling (based on the independent HTC testing) confirms that QUU met the DEWS Guidelines for flow and pressure, including with the closed valve.

While QUU's network performance met the DEWS Guidelines, the independent hydraulic modelling indicates that the impact of the closed valve was an 11% reduction in flow, or 13 L/s (115 L/s with the valve opened and 102 L/s with the valve closed).

²GHD Report for Queensland Urban Utilities – Warmington Street fire – September 2016, Review of available fire flows, page 17.

6. RESULTS OF HYDRANT TESTING AND HYDRAULIC MODELLING (CONTINUED)

At the public meeting on 29 September 2016, QFES indicated that they initially overran the capacity of the single hydrant at 25 Warmington Street (H-2) with multiple fire attack lines. QFES also mentioned that the system was again overran when they attempted to use a water monitor (that uses up to 60 L/s) after connecting to the private hydrant at Paddington Central Shopping Centre. This aligns with reports by some Paddington residents of a drop in flow during the initial stages of the fire-fighting effort.

A significant draw on the QUU network such as 60 L/s, is more than the capacity that a single hydrant is designed to ever supply under the DEWS Guidelines. As such, multiple hydrants were accessed during the Paddington Fire. While water was always available, as concluded in the GHD report, once water flow was established from multiple hydrants, fire-fighters were able to attack the fire with significant water flow.

While the exact times the water supply network was accessed were not recorded, QFES has reported that shortly after the private hydrant at Paddington Central Shopping Centre (H-1) was accessed, two hydrants at Latrobe Terrace and Alma Street (H-7 and H-8 respectively) were accessed, and shortly after that, two hydrants on Terrace Street (H-5 and H-6) were also accessed. These additional four hydrants were effectively upstream of the closed valve, and therefore water supply to these hydrants was not affected by the position of the valve.

7. HYDRANT AND NETWORK MAINTENANCE PROGRAMS

7.1 Hydrant testing and maintenance

As stated earlier the purpose of the DEWS Guidelines is “to facilitate strategic thinking in the planning process”. While there is no legal requirement to provide water for fire-fighting purposes at a specified flow or pressure, QUU uses these DEWS Guidelines to inform its ongoing maintenance programs.

QUU invests almost \$7 million each year in maintaining, testing and renewing fire hydrants. QUU periodically flow tests and maintains all street fire hydrants as part of this program. Hydrants are proactively replaced based on performance thresholds. QUU has set a maintenance threshold of at least 10 L/s, to ensure that the minimum water supply of 15 L/s across two hydrants is met, as set out in the DEWS Guidelines.

QUU’s fire hydrant flow testing program is cyclic and was last completed in Warmington Street, Latrobe Terrace, Alma Street and Terrace Street in June 2015. The results of these tests verified that all street hydrants met the DEWS Guidelines.

In addition to fire hydrant flow testing, QUU inspects the fire hydrants to ensure visibility, accessibility and operability. QUU’s hydrant inspection program is completed every two years, and was last completed in 2014. The outcomes from these inspections are prioritised and incorporated into QUU’s maintenance activities.

7.2 Water asset maintenance and investment

This financial year QUU will invest \$96 million in its maintenance and capital investment programs across its service territory, to ensure the reliability and sustainability of its water services.

8. OPPORTUNITIES FOR IMPROVEMENT

While independent hydraulic modelling has determined that QUU's water network and the hydrants accessed on the day met the relevant DEWS Guidelines, QUU operates within an established framework of innovation and continued improvement. Accordingly, QUU has identified and committed to undertaking the following activities to further support the provision of water for fire-fighting purposes:

- Identifying opportunities to work in greater collaboration with QFES. For example, QUU will review the current level of information sharing between QFES and QUU to improve operational decision-making.
- Allocating \$2.1 million to carry out additional works in close collaboration with QFES, including a review of QUU's hydrant replacement program to identify the strategic replacement and addition of new hydrants and to provide fire-fighters with improved access to QUU's water supply network in fire emergencies. These works will commence in 2017 and will be prioritised in 'tin and timber' suburbs, including Paddington, Red Hill and Kelvin Grove.
- Bringing forward \$1.02 million of network upgrade projects in 2016/17 across 'tin-and timber' suburbs.
- Allocating \$1.25 million to revise QUU's internal flow testing program to include valve configuration checking, prioritising older 'tin and timber' suburbs.
- Investigating an innovation program for the use of intelligent network technologies to enable real-time valve monitoring, and to support network optimisation for fire flow.
- Investigating ways to support QFES in promoting fire safety, thereby enabling the community to better manage fire risk at their properties.

APPENDIX 1

HTC: Flow and Pressure Test Report for Warmington St, Paddington



HYDRAULIC TESTING & CERTIFICATION

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Testing the Water

HTC Reference: Q2580

Attn: Robert Mahony

Report Issued: 22nd of September, 2016

Queensland Urban Utilities

Robert.Mahony@urbanutilities.com.au

Flow and Pressure Test Report for Warmington St, Paddington





Hydraulic Testing and Certification were commissioned by Queensland Urban Utilities (QUU) to conduct a suite of tests. HTC performed the tests independently at the hydrants identified by QUU. Traffic control and access permits were supplied by QUU.

The tests below have been ordered so the hydrants are flowed from sequentially. The tests were conducted in a different order in the field. The time each test was conducted has been included below in the results table.

Tests for H1, H2, H3 and H4 were carried out under two scenarios:

1. Valve connecting Warmington St and the Latrobe Terrace mains closed (Network configuration as on day of fire).
2. Valve connecting Warmington St and the Latrobe Terrace mains open.

Hydrants performance for H5, H6, H7 and H8 were not sensitive to the valve status and test was carried out with the valve open only.

Summary of Results with network configuration as on day of fire (Valve connecting Warmington St and the Latrobe Terrace mains closed)

Hydrant No.	Hydrant Location	Time Tested (on 22 nd September, 2016)	Flow Achieved (L/s)	Water Mains Pressure (kPa) ¹
H1	2 Warmington St (Woolworth Private Hydrant)	10:40am	14.9	185 at H2
H2	25A Warmington St	09:50am	15.9	385 at H3
H3	38 Warmington St	10:15am	19.8	215 at H2
H4	53 Warmington St	09:35am	21.1	460 at H3
H5	28 Terrace St	- ²	-	-
H6	42 Terrace St	-	-	-
H7	84 Latrobe St	-	-	-
H8	76 Alma St	-	-	-

Summary of Results with valve connecting Warmington St and the Latrobe Terrace mains open

Hydrant No.	Hydrant Location	Time Tested (on 22 nd September, 2016)	Flow Achieved (L/s)	Water Mains Pressure (kPa)
H1	2 Warmington St (Woolworth Private Hydrant)	08:20am	30.6	370 at H2
H2	25A Warmington St	09:10am	23.2	520 at H3

¹ Water mains pressure is measured at an adjacent hydrant.

² Not in scope.



HYDRAULIC TESTING & CERTIFICATION

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Testing the Water

Hydrant No.	Hydrant Location	Time Tested (on 22 nd September, 2016)	Flow Achieved (L/s)	Water Mains Pressure (kPa)
H3	38 Warmington St	08:50am	25.2	435 at H2
H4	53 Warmington St	09:20am	23.4	550 at H3
H5	28 Terrace St	11:15am	21.0	540 at H6
H6	42 Terrace St	11:40am	30.8	460 at H5
H7	84 Latrobe St	12:00pm	18.2	-
H8	76 Alma St	12:20pm	20.7	-

Hydrant Condition: All of the hydrants (H2, H3, H4, H5, H6 H7 and H8) were of cast iron construction.

Notes:

1. The test results are correct at the time of the tests
2. It is the responsibility of the recipient to determine the effect of changes in domestic/industrial usage, modifications to the main, differences in RL and extra hydraulic losses between the hydrant and tie in locations
3. Flow meters and pressure gauges are calibrated annually
4. Flows are accurate to ± 0.2 L/s. Pressures are accurate to ± 10 kPa.

Thank you for engaging HTC. Please do not hesitate to call me on 0429 000 302 should you have any queries.

Regards,



Daniel Barwick

MIEAust CPEng, RPEQ
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APPENDIX 2

GHD: Warmington fire – September 2016 – Review of available fire flows



Queensland Urban Utilities
Warmington Street fire - September 2016
Review of available fire flows

October 2016

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Executive summary

Background

At approximately 5.30am on Sunday 4 September 2016, a fire in a residential house at 25 Warmington Street, Paddington, Brisbane, was reported in a call to the Queensland Fire and Emergency Services (QFES). Two houses, 25 and 25A Warmington Street, were destroyed in the fire (Paddington Fire Event). The fire was contained by approximately 8.00am.

Based on information supplied to GHD, hydrants were accessed at the following locations during the Paddington Fire Event in sequence listed:

- 25 Warmington Street (H-2);
- Paddington Central (private hydrant H-1);
- 84 Latrobe Tce (H-7);
- 76 Alma St (H-8);
- 28 Terrace St (H-5);
- 42 Terrace St (H-6).

A further two hydrants were available along Warmington Street but not accessed during the Paddington Fire Event:

- 38 Warmington Street (H-3);
- 53 Warmington Street (H-4).

Queensland Urban Utilities (QUU) has undertaken a review internally of water supply available from the hydrants in the area of the fire. GHD Pty Ltd (GHD) has been engaged to undertake an independent hydraulic assessment of supply availability during the Paddington Fire Event.

Purpose of this report

The purpose of this report is to document GHD's investigation of fire flow availability at hydrants in the vicinity of the subject fire, based on a water supply network modelling approach.

The principal objectives of the investigation are to:

- Assess whether QUU's network was in accordance with Section 6.6 of Chapter 6 of the DEWS Guidelines¹ for the Paddington Fire Event;
- Validate the hydraulic performance of the hydrants and network through the Paddington Fire Event;
- Consider the impact, if any, of the closed valve (discovered subsequent to the Paddington Fire Event) at Warmington Street; and
- Consider the hydraulic performance of alternative hydrant sources not accessed during the Paddington Fire Event.

¹ Department of Energy & Water Supply (Queensland) (2010, amended 2014), Planning Guidelines for Water Supply and Sewerage (the DEWS Guidelines)

Conclusions

The key conclusions drawn from the investigation are that:

1. The DEWS Guidelines for flow and pressure were met at the time of the Paddington Fire Event.
2. The DEWS Guidelines for flow and pressure are met under the background conditions at the time of the Paddington Fire Event regardless of whether the valve in the Warmington Street main is open or closed.
3. A flow of significantly more than 15 L/s would have been available once the further QUU hydrants outside Warmington Street (H-7, H-8, H-5 and H-6) were accessed. Based on the modelling, it is estimated that a total flow of approximately 102 L/s was available from the six hydrants deployed at the time of the Paddington Fire Event. A flow of approximately 115 L/s would have been available from these hydrants if the valve in Warmington Street had been open, a difference of 13 L/s.
4. Consideration has also been given to the available water supply from only the QUU street hydrants (that is, excluding the Paddington Central Private Hydrant H-1). Using hydrants H-2, H-5, H-6, H-7 and H-8, it is estimated that a total flow of 98 L/s would have been available with the Warmington Street valve closed, and 98 L/s with the Warmington Street valve open – that is, no difference. If H-3 and H-4 are also included, the estimated total available flows were 112 L/s with the valve closed, and 120 L/s with the valve open, a difference of 8 L/s.
5. The results of the HTC hydrant flow tests are consistent with the GHD network modelling and are also consistent with the conclusion that fire flow availability from the network during the Paddington Fire Event met the DEWS Guidelines.
6. The Paddington Central Shopping Centre hydrant H-1 is a private hydrant and not owned or maintained by QUU. As such, the hydrant is not subject to the DEWS Guidelines but has been included in the modelling in this report for completeness as a hydrant accessed during the Paddington Fire Event.

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1. Introduction

1.1 Background

At approximately 5.30am on Sunday 4 September 2016, a fire in a residential house at 25 Warmington Street, Paddington, Brisbane, was reported in a call to the Queensland Fire and Emergency Services (QFES). Two houses, 25 and 25A Warmington Street, were destroyed in the fire (Paddington Fire Event). The fire was contained by approximately 8.00am.

Based on information supplied to GHD, hydrants were accessed at the following locations during the Paddington Fire Event in sequence listed:

- 25 Warmington Street (H-2);
- Paddington Central (private hydrant H-1);
- 84 Latrobe Tce (H-7);
- 76 Alma St (H-8);
- 28 Terrace St (H-5);
- 42 Terrace St (H-6).

A further two hydrants were available along Warmington Street but not accessed during the Paddington Fire Event:

- 38 Warmington Street (H-3);
- 53 Warmington Street (H-4).

Queensland Urban Utilities (QUU) has undertaken a review internally of water supply available from the hydrants in the area of the fire. GHD Pty Ltd (GHD) has been engaged to undertake an independent hydraulic assessment of supply availability during the Paddington Fire Event.

1.2 Purpose of this report

The purpose of this report is to document GHD's investigation of fire flow availability at hydrants in the vicinity of the subject fire, based on a water supply network modelling approach.

The principal objectives of the investigation are to:

- Assess whether QUU's network was in accordance with Section 6.6 of Chapter 6 of the DEWS Guidelines² for the Paddington Fire Event;
- Validate the hydraulic performance of the hydrants and network through the Paddington Fire Event;
- Consider the impact, if any, of the closed valve (discovered subsequent to the Paddington Fire Event) at Warmington Street; and
- Consider the hydraulic performance of alternative hydrant sources not accessed during the Paddington Fire Event.

² Department of Energy & Water Supply (Queensland) (2010, amended 2014), Planning Guidelines for Water Supply and Sewerage (the DEWS Guidelines)

1.3 Assumptions

The following key assumptions have been made:

- The water network model for the Green Hill zone as supplied by QUU is an accurate representation of the network, and has been sufficiently calibrated except as otherwise noted in this report.
- Information provided in relation to the fire response is accurate.
- Boundary conditions for the Green Hill zone at the time of the fire as advised by QUU are correct.

1.4 Scope and limitations

This report has been prepared by GHD for QUU and may only be used and relied on by QUU for the purpose agreed between GHD and the QUU as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than QUU arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report and as specifically indicated in Section 1.3. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided to GHD by QUU and others (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Site information

2.1 Site description

The locality of the subject site is shown in Figure 1 with additional detail in Figure 2. Warmington Street is mostly residential with a shopping centre ("Paddington Central") located at the junction of Warmington Street and Latrobe Terrace. From the subject property at 25 Warmington Street, the street rises gradually to Latrobe Terrace to the south, and falls gradually to the north to a low point before rising to Kennedy Terrace. The elevation of the street outside the subject property is approximately 32m above the Australian Height Datum (AHD). The subject property rises slightly from the street. The houses at 25 and 25A Warmington Street were two-storey timber dwellings.

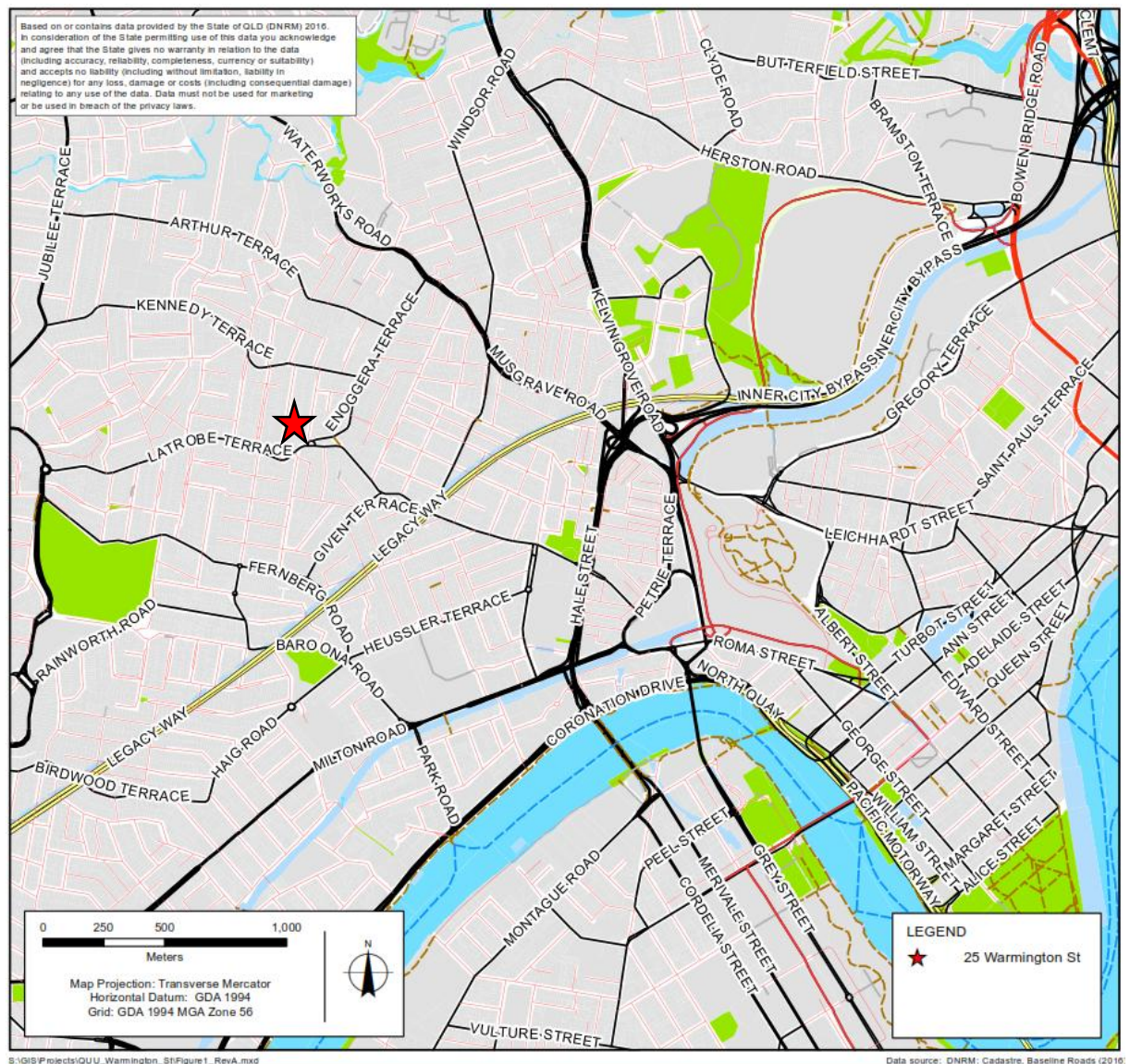


Figure 1 Locality plan



Figure 2 Site plan

2.2 Water supply network

The subject property is located in the “Green Hill” zone of Brisbane’s water supply network. This area is supplied by gravity water pressure from the Green Hill Reservoir located at Russell Terrace in Chapel Hill. The network comprises a large number of pipes of varying diameter designed to provide an adequate water supply to QUU’s customers in the zone.

Based on QUU information, local water services in Warmington Street are provided from a 100mm nominal diameter pipeline that runs under the road pavement. This connects between 150mm nominal diameter pipelines in Latrobe Terrace at the southern end of the street and Kennedy Terrace at the northern end of the street.

A similar configuration exists in Terrace Street, which runs parallel to Warmington Street to the east, between Enoggera Terrace and Kennedy Terrace, although there is an additional cross connection between Terrace Street and Enoggera Terrace along Glamorgan Street.

2.3 Fire hydrants

The local network and fire hydrant locations are shown in Figure 3. There is a QUU spring hydrant (H-2) located on the road immediately outside the subject property (refer Figure 4)³. Based on QUU data and site observations, there are another two spring hydrants along Warmington Street towards Kennedy Terrace approximately 90 m (H-3) and 180 m (H-4) from the subject site that were not accessed during the Paddington Fire Event.

At the Paddington Central Shopping Centre, there is a fire booster assembly (Private Hydrant H-1) located adjacent to the car park entry (refer Figure 5). According to the records provided, H-1 was the first alternative hydrant accessed after supply from H-2 was deployed. H-1 is not owned or maintained by QUU and, as such, it is not subject to the DEWS Guidelines (refer Chapter 6, Section 6.6.1).

Additional QUU hydrants were subsequently accessed. According to the records provided, the access sequence was H-2, Private Hydrant H-1, H-7, H-8, H-5, H-6 as shown on Figure 3. H-3 and H-4 were not used during the Paddington Fire Event.

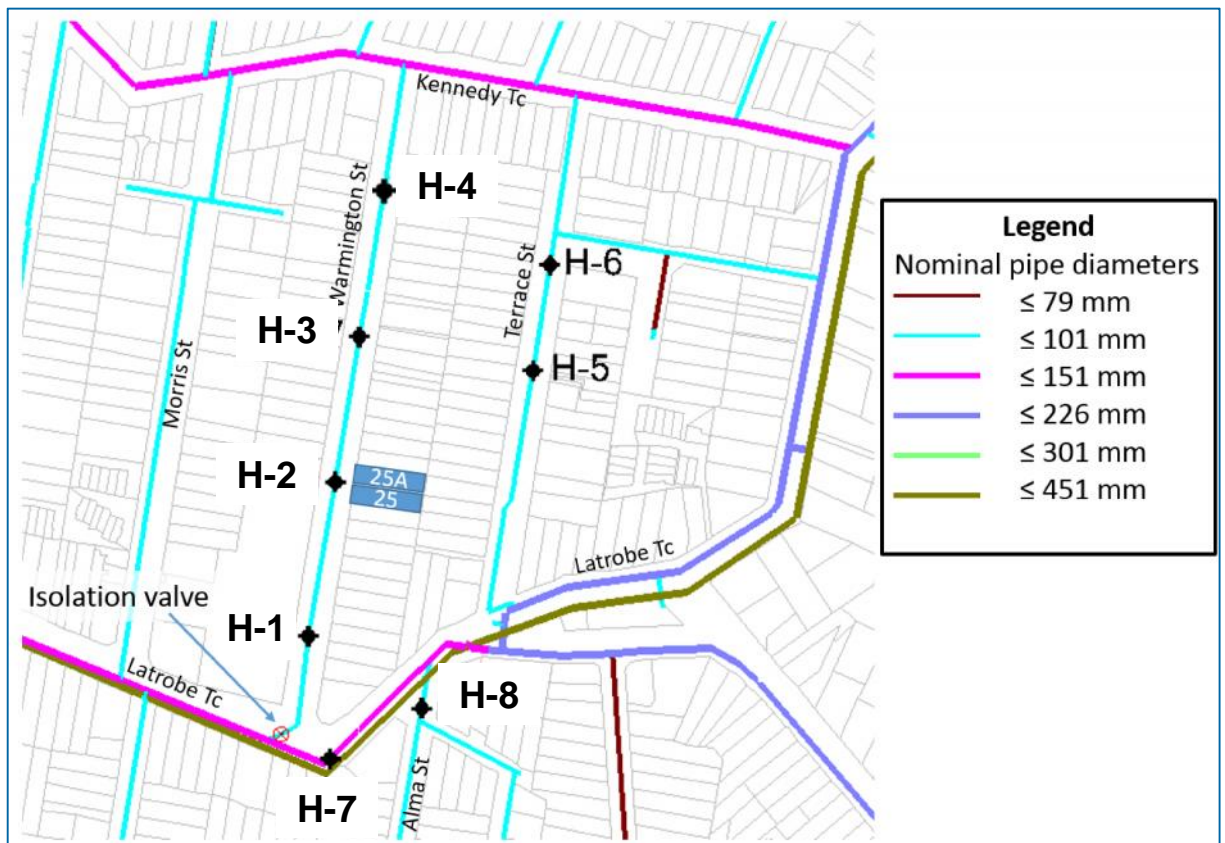


Figure 3 Water network and hydrant locations (from WaterCAD model)

³ The address of this hydrant is referenced in this report as 25 Warmington Street. The HTC report refers to 25A Warmington Street.



Figure 4 Spring hydrant adjacent to 25 Warmington St (H-2) (under test)



Figure 5 Fire booster assembly (H-1) at Paddington Central Shopping Centre

3. Fire flow objectives

3.1 Relevant publications

The following publications have been reviewed to confirm fire flow objectives:

- Water Supply (Safety and Reliability) Act (2008) (Qld) (WSSR Act)
- QUU (2014), Customer Charter
- QUU (2012), Customer Service Standards
- Department of Energy & Water Supply (Queensland) (2010, amended 2014), Planning Guidelines for Water Supply and Sewerage (the DEWS Guidelines)
- Water Services Association of Australia (2011), WSA-03 Water Supply Code of Australia, Part 1: Planning and Design, Third Edition, Version 3.1 (the WSAA Code)
- SEQ Water Supply and Sewerage Design & Construction Code, Amendment to Water Supply Code of Australia (WSA03 – 2011 V3.1) (the SEQ Water Supply Code)

3.2 Water Supply (Safety and Reliability) Act 2008

Under the WSSR Act, entities that supply water or sewerage services are required to register as a “service provider”. QUU is a service provider. While there are no provisions under the WSSR Act or associated regulations in relation to fire fighting capability from water networks, there are some provisions (Sections 144 and 145) which deal with the use of water for fire fighting at no fee or charge to the user/customer. Although the WSSR Act requires a service provider to document Customer Service Standards, as set out in chapter 2, part 4, division 3, for QUU this obligation is superseded by the obligation to create a service standard as required by the South-East Queensland (Distribution and Retail Restructuring) Act 2009, chapter 4, part 4 (DR Act). There are no provisions under the DR Act or associated regulation mandating fire fighting capability from water networks.

3.3 QUU Customer Charter

QUU’s Customer Charter states that QUU will “assist the Queensland Fire and Rescue Service [*now Queensland Fire and Emergency Service*] in the role of community safety by installing and maintaining a fire fighting capability in our network”. There are no other specific statements regarding fire services in the Customer Charter.

3.4 QUU Customer Service Standards

QUU’s adopted service standards are described in general terms. There are no standards described in the Customer Service Standards in relation to the supply of water for fire fighting purposes.

3.5 Department of Energy & Water Supply (DEWS) Guidelines

Section 6.3 of Chapter 6 of the DEWS Guidelines states that there is “no legislative requirement for a water service provider to provide a water supply for fire fighting purposes”.

Section 6.6 of Chapter 6 of the DEWS Guidelines indicates minimum fire flow provisions, which “*should be considered as the minimum provisions that should be provided by the water service provider*”. The “general urban category” is most appropriate for this case, and the design fire flow conditions are defined by:

- For design purposes, an additional modelling assessment is required to check that the system has a positive residual pressure throughout with fire demand applied in conjunction with peak hour demand. This assessment does not directly relate to the Paddington Fire Event and has not been considered further in this review.

The WSA Code (Section 3.1.5) does not specify or require any particular fire flow provisions in the design of water supply systems, and states that:

In Queensland, a *Water Agency* is considered to be a “service provider” under the WSSR Act.

The SEQ Water Supply Code, which is a series of amendments to the WSAA Code applicable to service providers in South East Queensland (SEQ), amends Section 3.1.5 of the WSAA Code to add:

There is a part of the SEQ Water Supply Code which deals with design criteria for future additions to the water distributions networks in SEQ (that is, ie newly constructed infrastructure). However, Section 1.4 of the Design Criteria states that *“in all instances, the criteria provided relate to future additions to the water/sewer distribution networks within SEQ and are not to be confused with existing customer standards of service.”* As such, the design criteria relating to providing water for fire fighting purposes are not applicable to the supply of water for the Paddington Fire Event because the network in that locality does not include “future additions” in the context of the Design Criteria.

In summary, it is concluded that the relevant fire flow condition to be used to evaluate the water supply from QUU's network during the Paddington Fire Event is included in the DEWS Guidelines as:

- 8 | **GHD** | Report for Queensland Urban Utilities - Warmington Street fire - September 2016, 41/30293/

4. Network modelling parameters

4.1 Model configuration

The existing QUU WaterCAD model of the Green Hill zone has been adopted for this review. WaterCAD was developed by Bentley Systems and is used by water utilities across the world. As a recognised international professional water technical advisor and consultant, GHD has used WaterCAD (including prior versions) on many projects for more than a decade and is of the view that it is a sound and robust modelling tool for application in this case.

Network models are used by water service providers to facilitate better understanding of network capacity and function. The Green Hill zone model has been built by QUU over a number of years and is used for modelling network performance and augmentation requirements. The model provided by QUU has been adopted for the purposes of this analysis, except as noted in the following sections.

4.2 Boundary conditions

The key boundary conditions for the model are:

-) The water level in the Green Hill reservoir; and
-) Outflows from the Green Hill zone at various locations.

QUU has advised that, at the time of the fire:

-) the water level in Green Hill reservoir was 91.5 m AHD;
-) there were no significant outflows from the zone.

These conclusions are supported by available pressure and level data from QUU's SCADA system that have been supplied to GHD.

4.3 Background demand

The background demand used in the model is an important factor that influences the pressure conditions across the network at the time of the fire. Background demand has been adopted as modelled in the QUU model at the time of the fire (6.00am). Fire fighting activities occurred between 5.30am and 8.00am on Sunday morning, which in GHD's experience is a period of low demand. This means that pressure losses across the network are small at this time, and suggests that the background hydraulic grade surface levels would be close to the level in the Green Hill Reservoir. Hydraulic grade levels calculated using the model are consistent with this.

4.4 Local conditions

Specific local pipe network details in the vicinity of the hydrants used during the fire are an important consideration in locations such as Warmington Street. Given the network configuration and the nature of the conditions experienced during the fire, particular focus has been placed on the 100 mm nominal diameter pipes in Warmington Street and Terrace Street.

GHD has been advised by QUU that both pipes are made from cast iron and have been in-situ cement mortar lined. That is, the pipes have been lined with a layer of cement mortar after they were laid. The addition of a cement mortar lining is intended to limit biological growth inside the mains and to prolong the life of the pipes. The in-situ lining means that there is some variability in the internal diameter of the pipes which is an important consideration in estimating network conditions.

GHD has also been advised by QUU that it was determined subsequent to the fire that a valve on the Warmington street water main was in the closed position, meaning that water from the Latrobe Terrace main could not flow directly into the Warmington Street main although supply was still available from Kennedy Terrace. The impact, if any, of the closed valve has been considered as part of this report.

Subsequent to the fire, hydrant flow testing was undertaken at spring hydrants in both streets to confirm the availability of fire flows. The private hydrant at Paddington Central was also tested by HTC and the results have been used to assist in model calibration. The results of the testing have been used to calibrate the model for local conditions by determining effective pipe internal diameters and friction loss coefficients. GHD has undertaken an analysis of the results of hydrant testing and the resulting adopted pipe details used in the hydraulic modelling are provided in Table 1.

Table 1 Adopted local pipe details

Location	Effective pipe internal diameter (mm)	Adopted roughness Hazen-Williams "C" value
Warmington Street	84	100
Terrace Street	88	100

5. Network analysis

5.1 Analysis strategy

Two strategies have been applied to analyse the performance of the network under fire flow conditions:

- **Design fire flow test.** In this test, fire flows are applied to the model in sequence at the first two hydrant locations used in fighting the fire, being H-2 and then Private Hydrant H-1, if required. A total fire flow of 15 L/s has been applied, as per the DEWS Guidelines. The full flow is initially applied at the first hydrant, and the second hydrant is only used if the resulting pressure head at the first hydrant does not meet the guideline.
- **Available flow assessment.** For this case, each hydrant is modelled with a pressure-dependent flow (an “emitter” in the WaterCAD model) to assess the available flows as additional hydrants are added. This provides a more realistic assessment of the likely flow available from QUU’s mains during the Paddington Fire Event because it simulates the hydraulics of the hydrants.

The above analysis strategies have been applied with the valve at Warmington Street closed and open.

While both analysis strategies described above are valid for testing what fire flows may be available from the network, the available flow assessment strategy above is not required to test whether the flows in the DEWS Guidelines can be achieved and has been undertaken to better inform this review.

5.2 Design fire flow test

The design fire flow test establishes whether the criteria in the DEWS Guidelines are met.

Model results are shown in Table 2 for a closed and open valve at Warmington Street. The model shows that the DEWS Guidelines flow of 15 L/s can be accommodated from H-2 alone with a residual pressure head of more than 12 m in the main both with the valve closed and valve open. It is not necessary to take additional flow from H-1 (private hydrant at Paddington Central) to achieve the DEWS Guidelines flow.

Table 2 Design fire flow test

Hydrant	Location	Elevation (m AHD)	Valve Closed		Valve Open	
			Flow (L/s)	Residual head (m)	Flow (L/s)	Residual head (m)
H-2	25 Warmington St	32.5	15	20	15	43

5.3 Available flow assessment

While the available flow assessment has not been undertaken to ascertain whether the DEWS Guidelines were met, the network has been further analysed to assess the flows likely to be available at each hydrant, based on measured hydrant flow characteristics.

The results of independent hydrant flow testing undertaken by HTC have been used to derive estimates of the specific hydrant discharge coefficients for each of the hydrants H-1, H-2, H-5, H-6, H-7 and H-8. These coefficients are a characteristic of the specific hydrant, and can vary

according to hydrant type, size, design and age. Coefficients are based on discharge from the hydrant riser, where the hoses would be connected.

The flows calculated using this strategy are provided in Table 3 and Table 4 for the Warmington Street valve closed and open, respectively, for six cases as hydrants H-2, H-1, H-7, H-8, H-5 and H-6 are progressively deployed. The cumulative flow available from the hydrants is illustrated in Figure 6.

The assessment identified that the system achieved flows higher than the minimum flow in the DEWS Guidelines. The estimated total flow available from all six hydrants with the Warmington Street valve closed is 102 L/s (see Table 3), while it is estimated that 115 L/s (see Table 4) would have been available with the valve open.

For the case of the valve closed, the residual pressure at H-2 drops when Private Hydrant H-1 at Paddington Central is deployed. This is to be expected. Increased combined flows from H-2 and H-1 lead to higher velocities and higher friction losses along the Warmington Street main, resulting in lower pressures. This is a physical process where increased combined flow from H-2 and H-1 will intrinsically lead to lower pressures.

This outcome indicates that as soon as water was taken from Private Hydrant H-1 at Paddington Central, the pressure at H-2 would have dropped, although the combined total flow would have increased slightly. This is consistent with reported field observations on the day.

Table 3 Available flow assessment (valve closed)

Note: The DEWS Guidelines are not relevant to the calculation modelling results shown in Table 3.

Hydrant (listed in sequence deployed)	Location	Case 1 Flow (L/s) Head (m)	Case 2 Flow (L/s) Head (m)	Case 3 Flow (L/s) Head (m)	Case 4 Flow (L/s) Head (m)	Case 5 Flow (L/s) Head (m)	Case 6 Flow (L/s) Head (m)
H-2	25 Warmington St	15 21	10 9	10 9	10 8	10 8	9 8
H-1	Paddington Central (private hydrant)		8 2	8 2	8 2	8 2	8 2
H-7	84 Latrobe Tce			17 50	17 49	17 48	17 48
H-8	76 Alma St				20 46	20 46	20 45
H-5	28 Terrace St					21 50	19 38
H-6	42 Terrace St						29 42
	Total flow	15	18	35	55	76	102

Table 4 Available flow assessment (valve open)

	Location	Case 1 Flow (L/s) Head (m)	Case 2 Flow (L/s) Head (m)	Case 3 Flow (L/s) Head (m)	Case 4 Flow (L/s) Head (m)	Case 5 Flow (L/s) Head (m)	Case 6 Flow (L/s) Head (m)
H-2	25 Warrington St	20 37	15 21	15 20	15 20	15 20	15 19
H-1	Paddington Central (private hydrant)		24 19	23 18	23 18	23 17	23 17
H-7	84 Latrobe Tce			15 41	15 39	15 39	15 38
H-8	76 Alma St				18 39	18 39	18 38
H-5	28 Terrace St					20 44	17 33
H-6	42 Terrace St						27 37
	Total flow	20	39	53	71	91	115

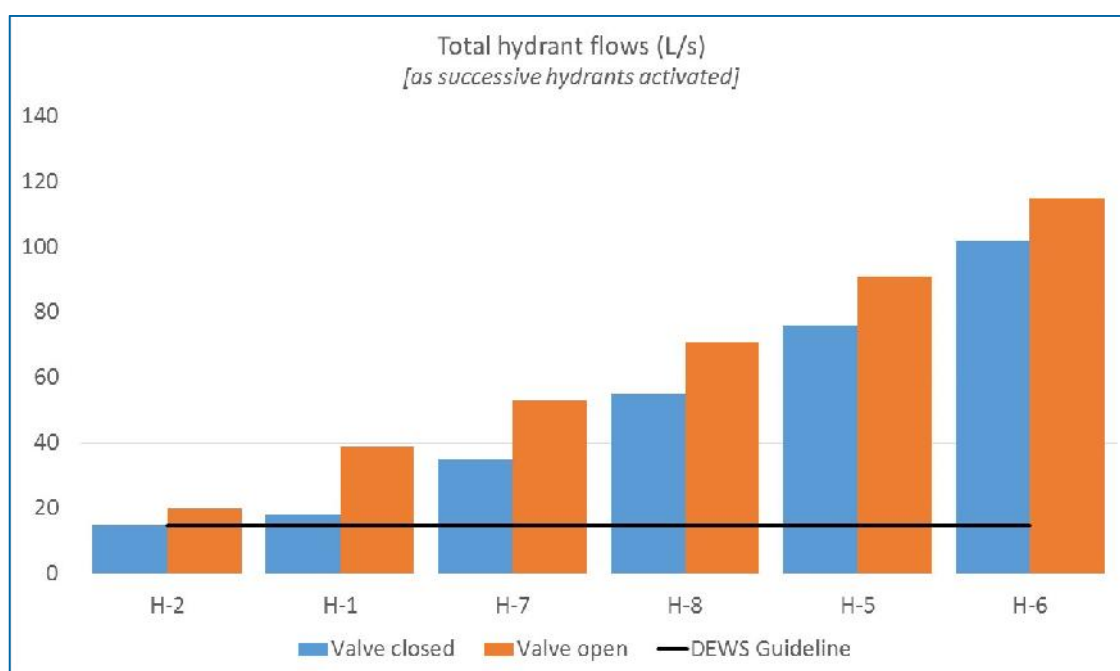


Figure 6 Cumulative available flow

Consideration of available flows from alternative hydrant combinations in the Warmington Street area

Two additional hydrant combinations have been considered to estimate the flows that would have been available from only QUU hydrants.

The first combination comprised the same hydrants used in the Paddington Fire Event but excluding Private Hydrant H-1. That is, deploying H-2, H-5, H-6, H-7 and H-8. Using a similar methodology to that described above, it is estimated that a total flow of 98 L/s would have been available from these hydrants with the Warmington Street valve closed, and 98 L/s with the valve open. That is, no difference was indicated. The reduced flow from H-2 is offset by slight increases in flows from the other hydrants.

Consideration has also been given to what flows would have been available if the other two QUU hydrants at 38 and 53 Warmington Street (H-3 and H-4) were accessed instead of Private Hydrant H-1. That is, deploying H-2, H-3, H-4, H-5, H-6, H-7 and H-8. Using a similar methodology to that described above, it is estimated that a total flow of 112 L/s would have been available from these hydrants with the Warmington Street valve closed, and 120 L/s with the Warmington Street valve open, being a difference of 8 L/s or 7%.

6. Hydrant field testing

Subsequent to the Paddington Fire Event, QUU has performed hydrant flow tests and also engaged an independent company, HTC, to test the hydrants that were used during the fire. GHD has been provided with QUU's test results and a report prepared by HTC dated 22 September 2016. QUU's testing was conducted on 6 September 2016 and HTC's testing was conducted on 22 September. The results may be expected to vary slightly because different test equipment has been used and because background demands and network conditions may have been different.

Hydrant flow tests provide a practical approximate comparison with the DEWS Guidelines. It is difficult to directly measure the pressure in the main at the test hydrant when conducting flow tests, but hydrant flow tests are nonetheless a useful surrogate.

Among other things, hydrant flow tests indicate the total flow available from a hydrant or multiple hydrants operated simultaneously, based on the discharge from the hydrant riser (refer Figure 4 for an example of a test in progress). For the purposes of this review, maximum flows available from the individual hydrants are listed in Table 5.

The results of the hydrant flow tests are consistent with the network modelling and are also consistent with the conclusion that fire flow availability from the network during the Paddington Fire Event met the DEWS Guidelines.

Table 5 Summary of hydrant flow tests

Hydrant(s)	Location	Maximum flow during QUU testing (L/s)	Maximum flow during HTC testing* (L/s)
Warmington Street main valve closed			
H-1	Paddington Central (private hydrant)	15	14.9
H-2	25 Warmington Street	15	15.9
H-3	38 Warmington Street	19 [†]	19.8 [†]
H-4	53 Warmington Street	Not tested [†]	21.1 [†]
H-5, H-6, H-7, H-8		Not tested**	Not tested**
Warmington Street main valve open			
H-1	Paddington Central (private hydrant)	33	30.6
H-2	25 Warmington Street	21	23.2
H-3	38 Warmington Street	25 [†]	25.2 [†]
H-4	53 Warmington Street	Not tested [†]	23.4 [†]
H-5	28 Terrace St	20	21.0
H-6	42 Terrace St	28	30.8
H-7	84 Latrobe Tce	18	18.2
H-8	76 Alma St	20	20.7

* HTC results have a stated accuracy of ± 0.2 L/s.

** H-5, H-6, H-7 and H-8 were not tested for the valve closed case as the valve is effectively downstream of these hydrants.

[†] H-3 and H-4 were not accessed during the Paddington Fire Event.

7. Conclusions

The key conclusions drawn from the investigation are that:

1. The DEWS Guidelines for flow and pressure were met at the time of the Paddington Fire Event.
2. The DEWS Guidelines for flow and pressure are met under the background conditions at the time of the Paddington Fire Event regardless of whether the valve in the Warmington Street main is open or closed.
3. A flow of significantly more than 15 L/s would have been available once the further QUU hydrants outside Warmington Street (H-7, H-8, H-5 and H-6) were accessed. Based on the modelling, it is estimated that a total flow of approximately 102 L/s was available from the six hydrants deployed at the time of the Paddington Fire Event. A flow of approximately 115 L/s would have been available from these hydrants if the valve in Warmington Street had been open, a difference of 13 L/s.
4. Consideration has also been given to the available water supply from only the QUU street hydrants (that is, excluding the Paddington Central Private Hydrant H-1). Using hydrants H-2, H-5, H-6, H-7 and H-8, it is estimated that a total flow of 98 L/s would have been available with the Warmington Street valve closed, and 98 L/s with the Warmington Street valve open – that is, no difference. If H-3 and H-4 are also included, the estimated total available flows were 112 L/s with the valve closed, and 120 L/s with the valve open, a difference of 8 L/s.
5. The results of the HTC hydrant flow tests are consistent with the GHD network modelling and are also consistent with the conclusion that fire flow availability from the network during the Paddington Fire Event met the DEWS Guidelines.
6. The Paddington Central Shopping Centre hydrant H-1 is a private hydrant and not owned or maintained by QUU. As such, the hydrant is not subject to the DEWS Guidelines but has been included in the modelling in this report for completeness as a hydrant accessed during the Paddington Fire Event.

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GHD

Level 9

145 Ann Street

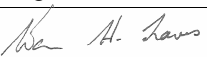
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<https://projects.ghd.com/oc/sqoc/reviewofwarmingtonst/Delivery/Documents/QUU Warmington Street Fire Flows Report.docx>

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