

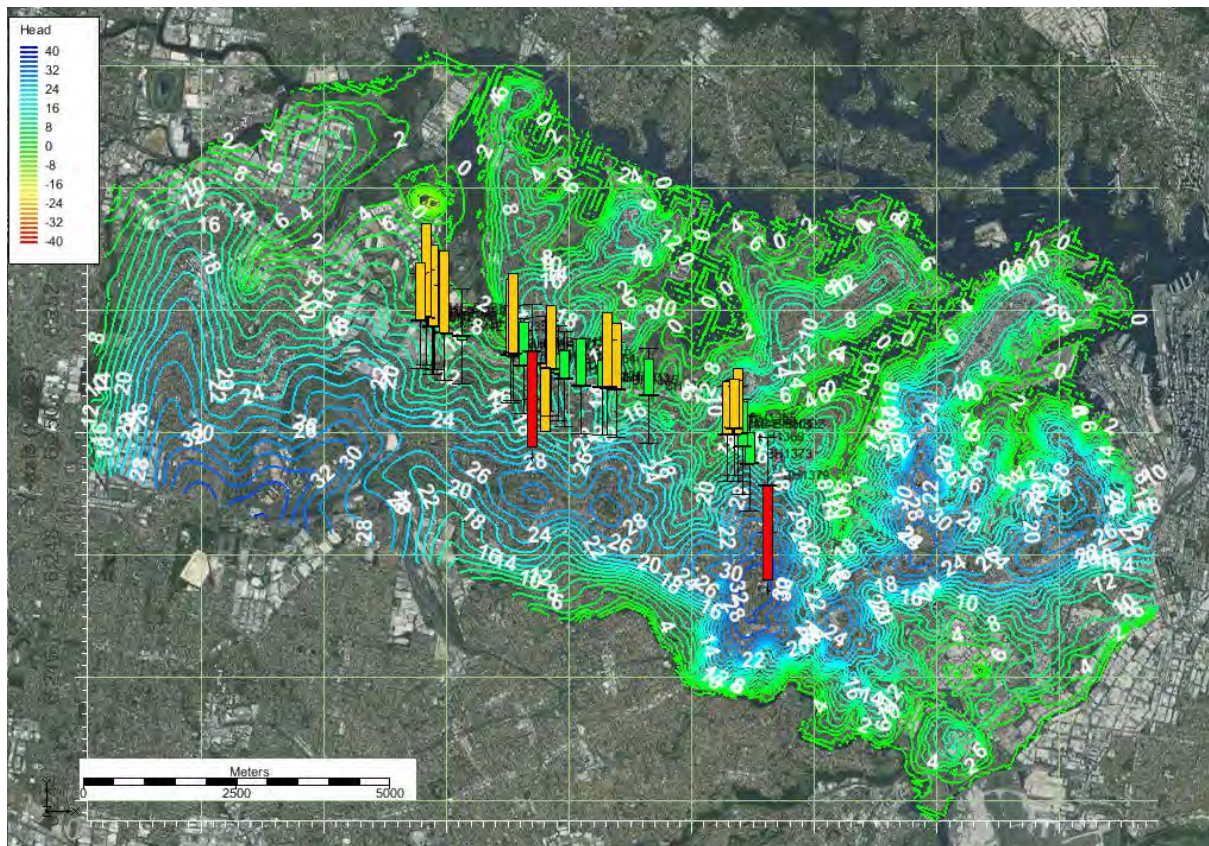


Figure 6.9 Run 106 layer 3 calibrated heads (metres AHD).

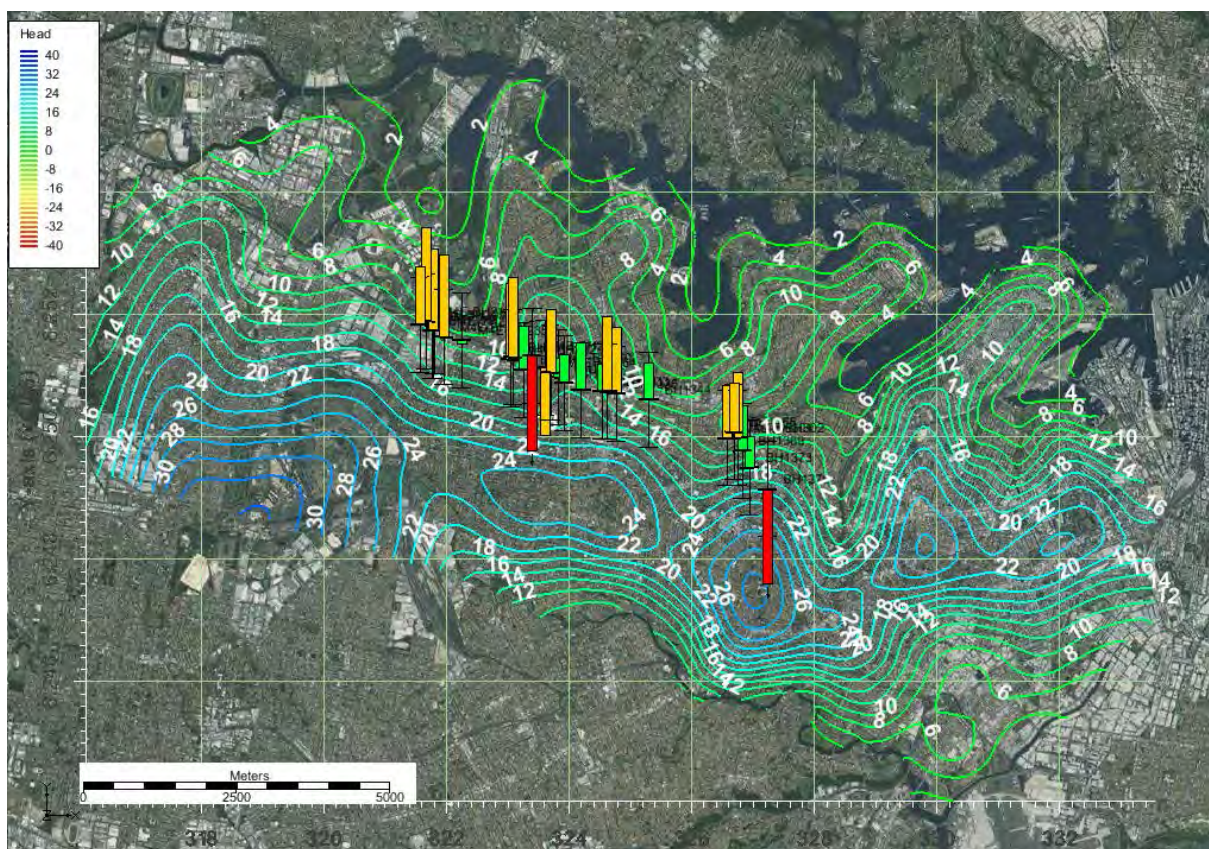


Figure 6.10 Run106 Layer 5 calibrated heads (metres AHD).

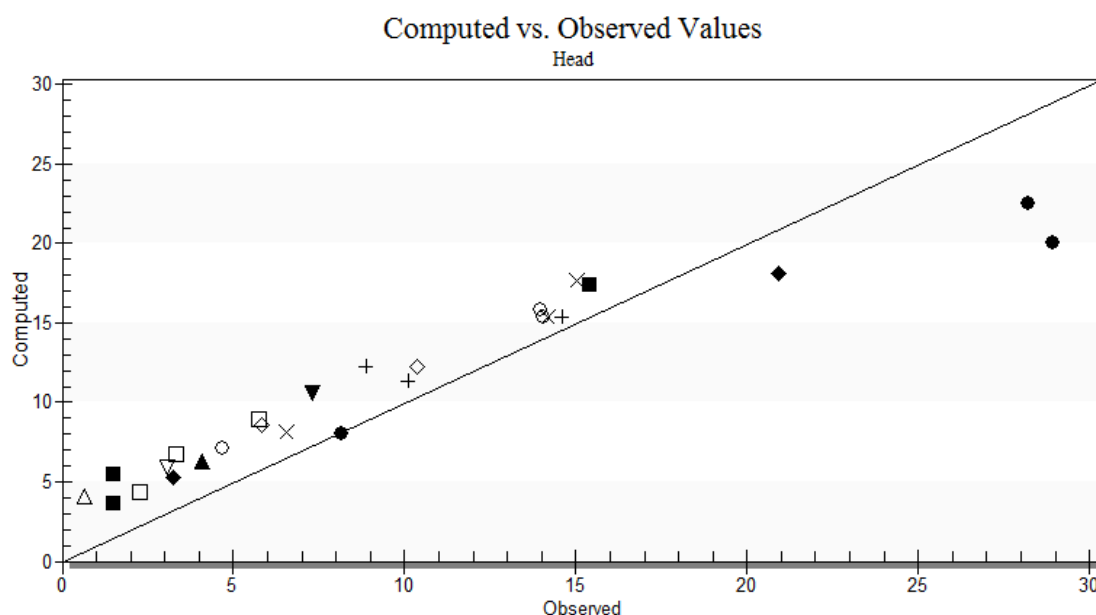


Figure 6.11 Run 106 calibration plot, computed versus observed head (metres AHD).

Table 6.3 Run 106 calibration statistics

Statistic	Value
Mean error (m)	-1.30
Mean absolute error (m)	2.65
Root mean squared error (m)	3.13
Scaled root mean squared error (%)	10

Run 108 steady-state Hawkesbury Sandstone only piezometric data

The baseline flow model was again automatically calibrated, this time using only available Hawkesbury Sandstone groundwater level data (run 108).

The calibrated model parameters are summarised in the table below.

Table 6.4 Calibrated hydraulic conductivity, run 108

Model layer	Material	Kh (m/day)
1	Alluvial clay	1.00E-01
2	Ashfield Shale shallow	4.00E-03
3	Hawkesbury Sandstone shallow	5.00E-02
4	Hawkesbury Sandstone intermediate	5.00E-02
5	Hawkesbury Sandstone intermediate	1.00E-02
6	Hawkesbury Sandstone deep	5.00E-03

The calibrated recharge for general sandstone and alluvial areas was 1.68E-04 metres per day and the recharge for shale or industrial areas was 1.71E-05 metres per day.

Table 6.5 **Run 108 calibration statistics**

Statistic	Value
Mean error (m)	-0.02
Mean absolute error (m)	0.35
Root mean squared error (m)	0.38
Scaled root mean squared error (%)	6

Based on the comparison between observed and modelled heads (**Figure 6.12**) the model appeared to be well calibrated, although groundwater levels away from the tunnel alignment appeared relatively high, indicating either recharge may have been too high or hydraulic conductivity too low. **Figure 6.13** shows the layer 3 (Mittagong Formation) head contours and calibration targets. The hydraulic conductivities are up to an order of magnitude higher than those for the full dataset calibration.

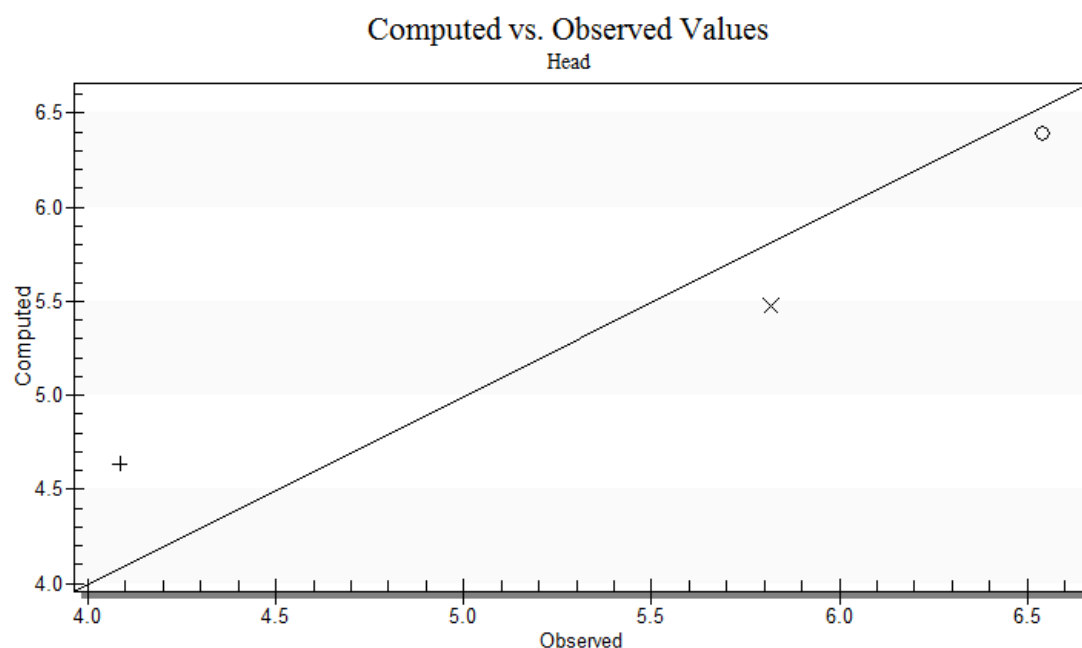


Figure 6.12 **Run 108 calibration plot of computed versus observed head (metres).**

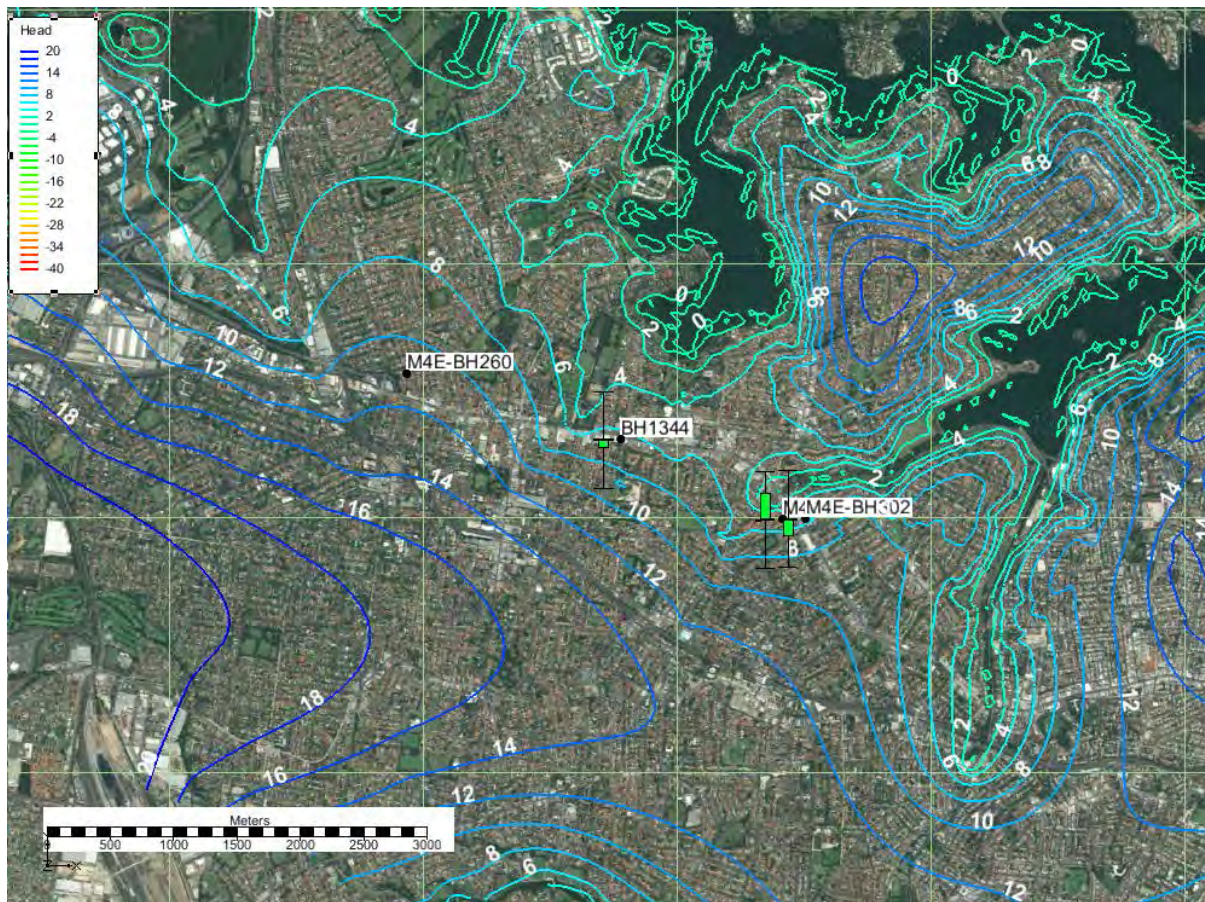


Figure 6.13 Run 108 layer 3 Hawkesbury Sandstone/Mittagong Formation calibrated groundwater contours.

6.2.2 Model predictions

Run 115 steady-state prediction based on full dataset calibration

Run 115 was based on calibration run 106, which used all available average water levels. The predicted steady-state tunnel inflow was 392 cubic metres per day, which is relatively low when compared to other similar tunnels (**Table 5.1**). Predicted water levels (heads) in layers 1 and 4 are shown in **Figure 6.14** and **Figure 6.16** and the drawdown in layers 1, 4 and 5 shown in **Figure 6.15**, **Figure 6.17** and **Figure 6.19**. The greatest lateral extent of drawdown is in layer 5.

As some of the DPI Water logs had missing or ambiguous lithological or construction data, it is assumed for this assessment that all production bores are screened within the most impacted layers of the Hawkesbury Sandstone. No licenced bores lie within the two metre drawdown limit in layer 4.

As the head levels drop below zero metres AHD near seawater-filled drainage channels close to the shore line, there is some potential for localised lateral inflow of saline water. Given the great thickness of the Hawkesbury Sandstone aquifer, there is also potential for saline groundwater to be present below the freshwater lens (**section 6.3.2**) Where water levels are drawn down to close to or below sea level, depending on the screened depth of the bore or tunnel depth, there is potential to draw up deeper saline groundwater, also referred to as 'upconing' of deep saline groundwater.

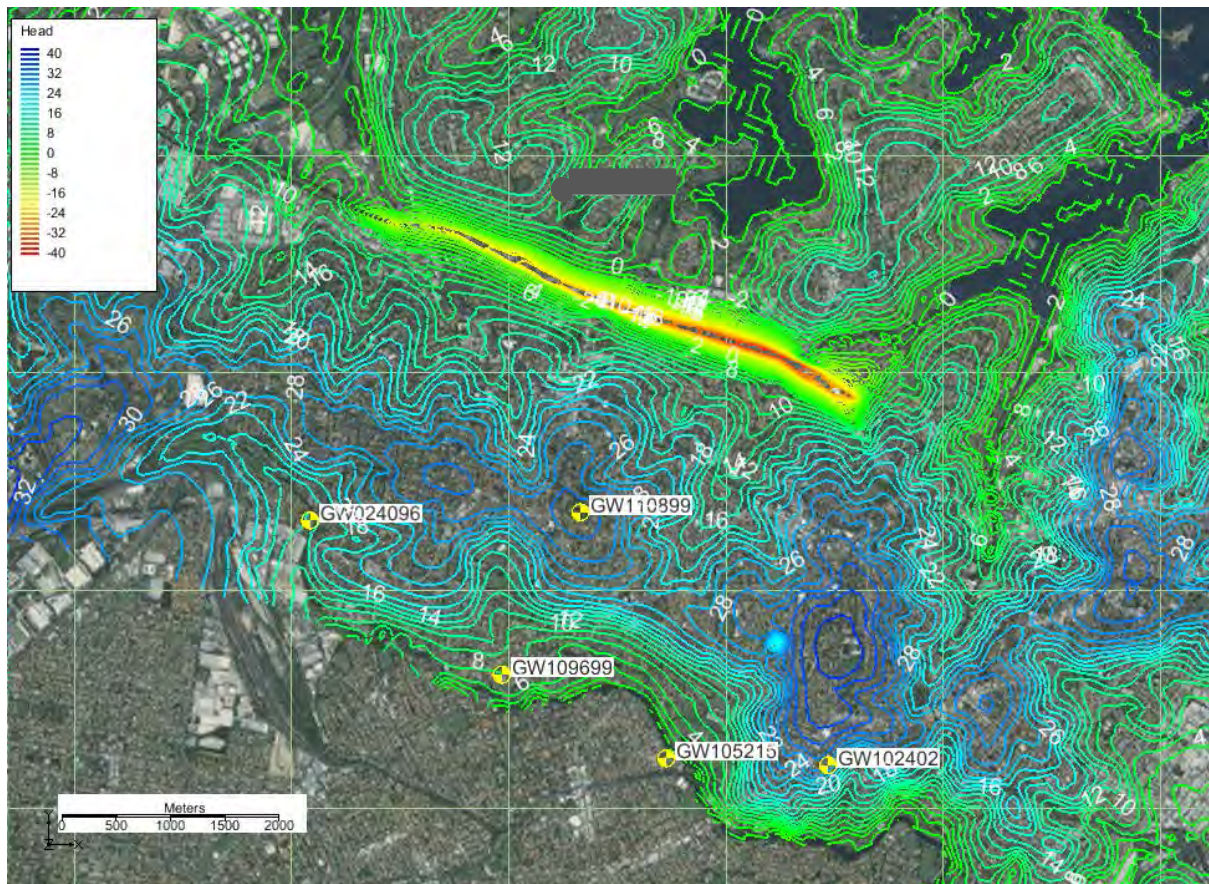


Figure 6.14 Run 115 layer 1 heads (metres AHD).

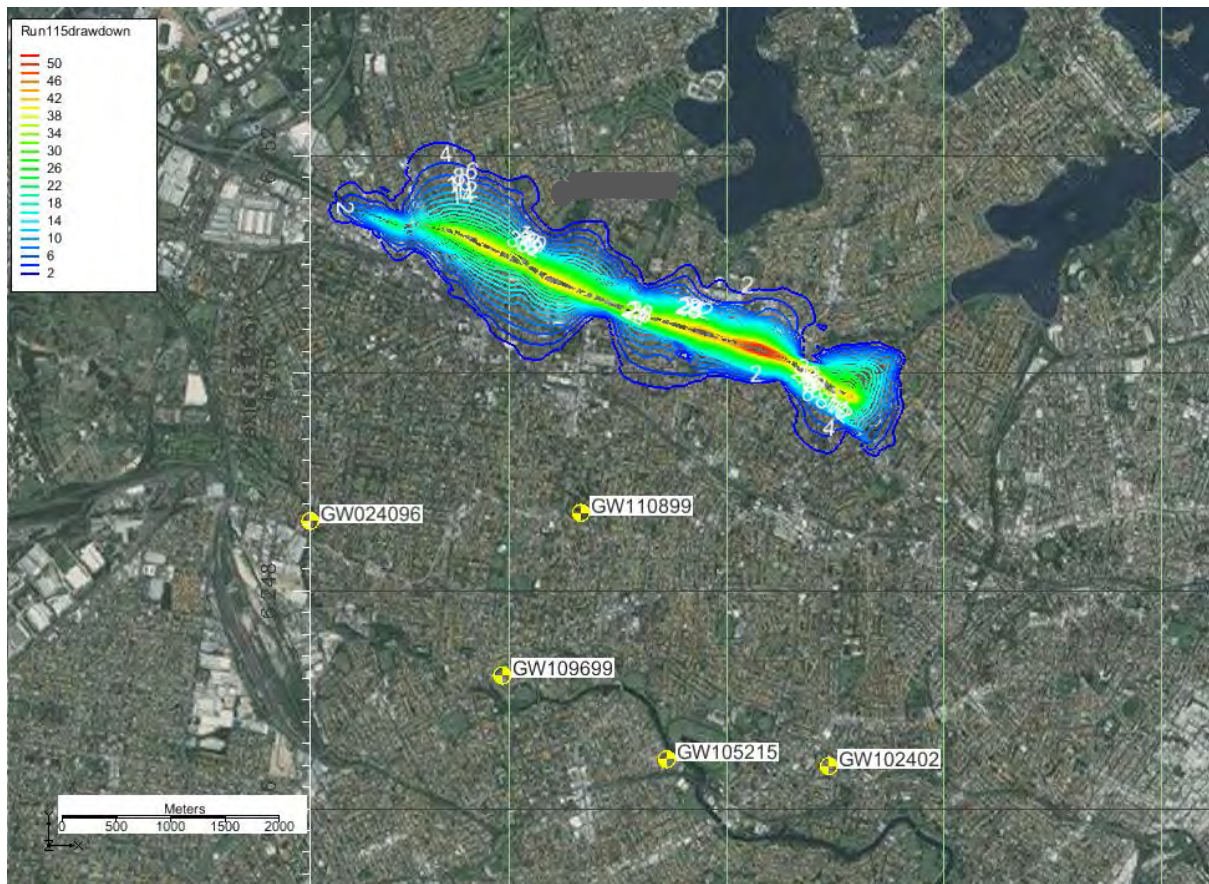


Figure 6.15 Run 115 layer 1 drawdown (metres).

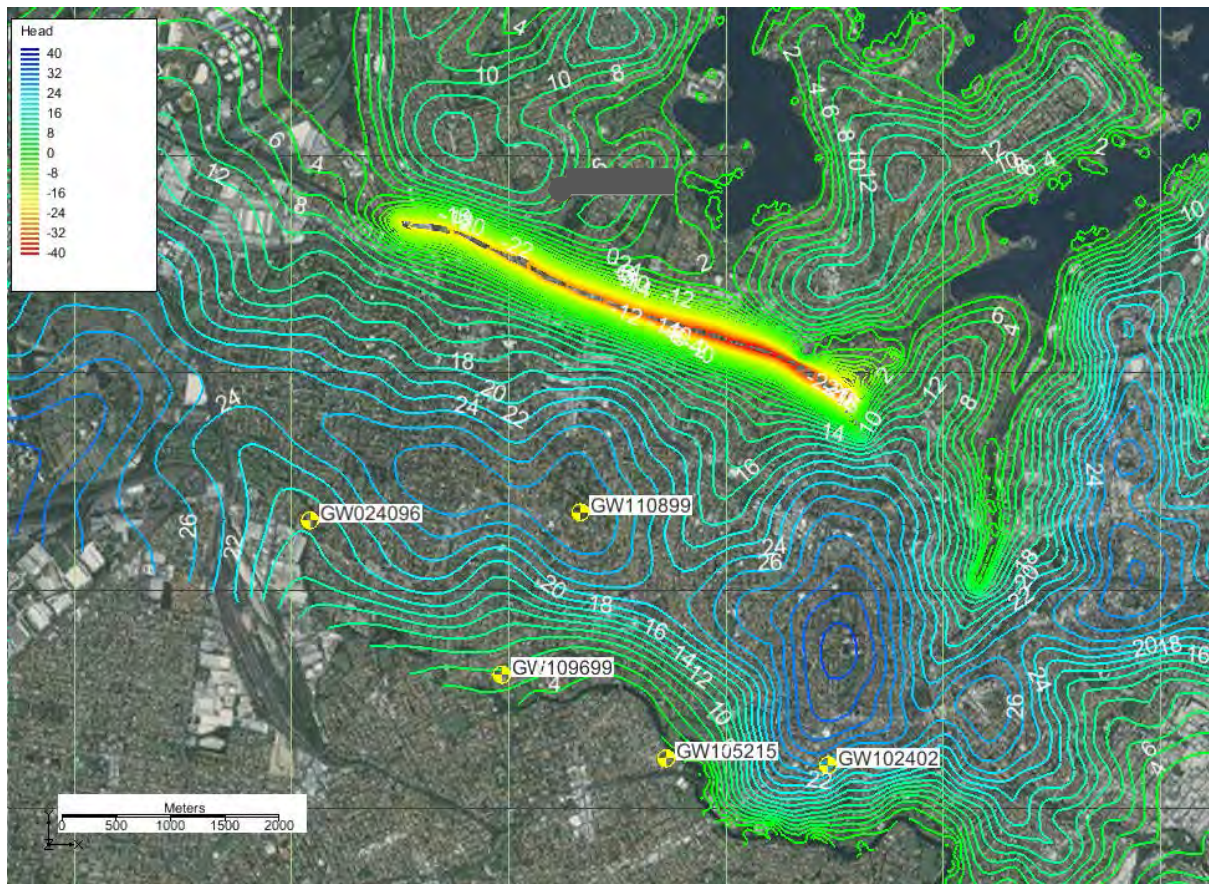


Figure 6.16 Run 115 layer 4 heads (metres AHD).

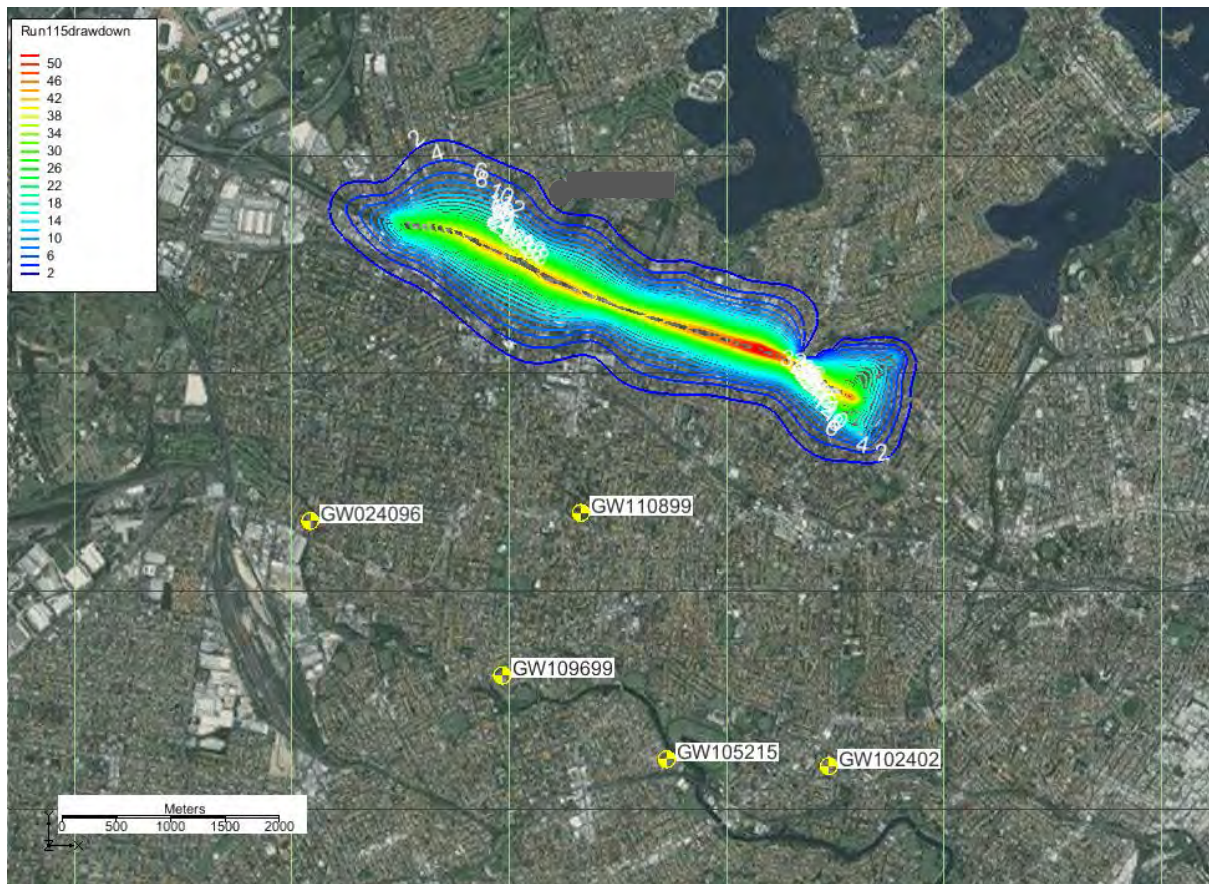


Figure 6.17 Run 115 layer 4 drawdown (metres).

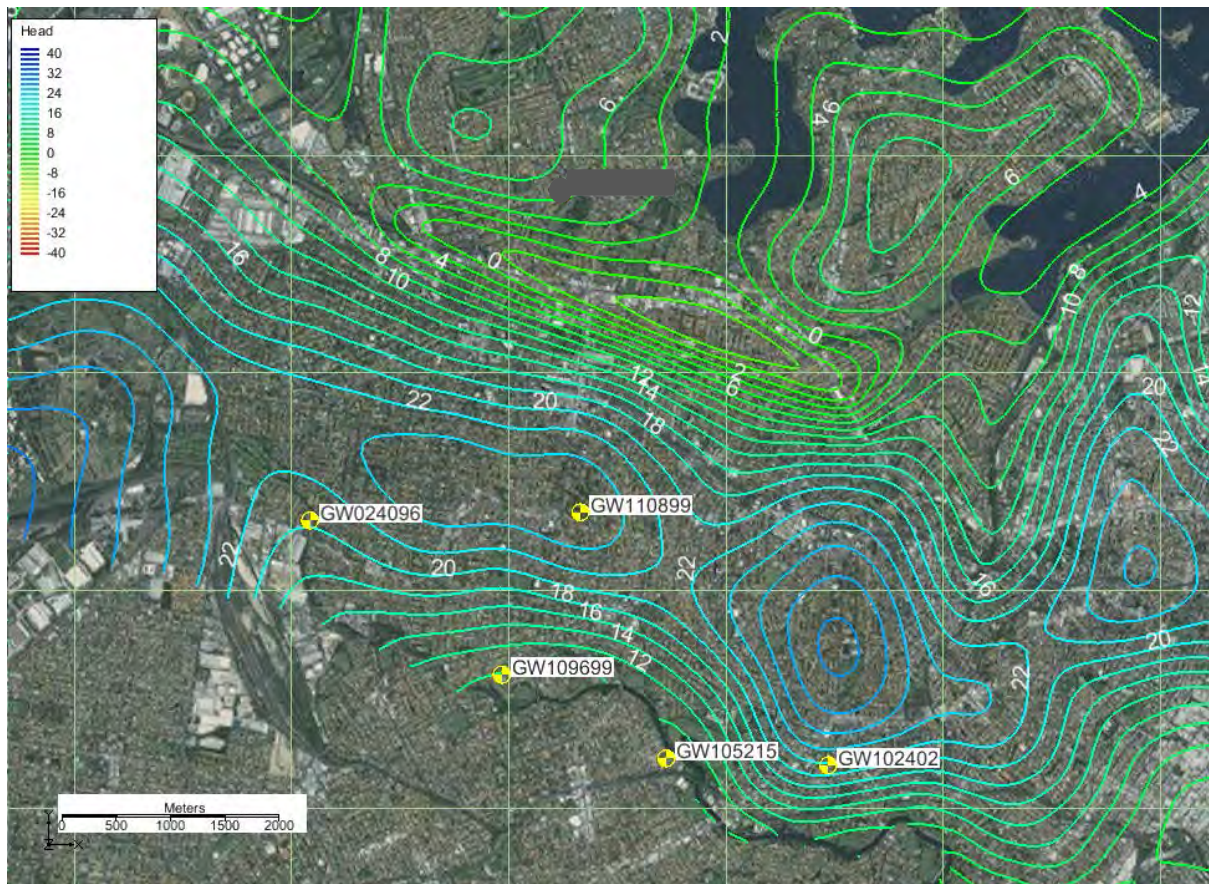


Figure 6.18 Run 115 layer 5 heads (metres AHD).

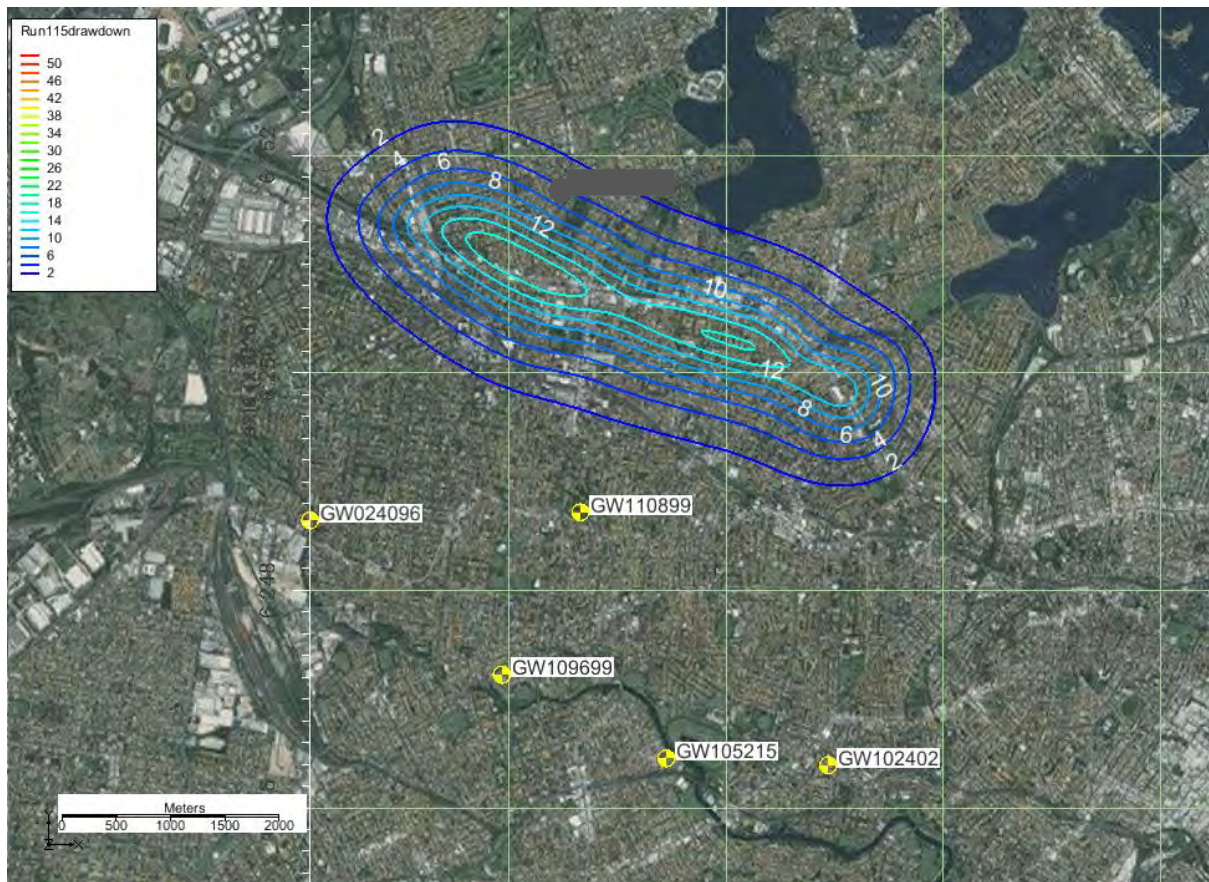


Figure 6.19 Run 115 layer 5 drawdown (metres).

Run 111 steady-state prediction based on sandstone dataset calibration

Run 111 was based on calibration run 108, which was calibrated against only steady-state water level data from monitoring bores intersecting sandstone. The predicted tunnel inflow was 1277 cubic metres per day, approximately three times that predicted by the full dataset calibration, which reflects the significantly higher hydraulic conductivities used in this model run.

One bore GW110899 (eight metre drawdown) is within the two metre drawdown zone in layers 1–5 as indicated in **Figure 6.21**, **Figure 6.23** and **Figure 6.25**.

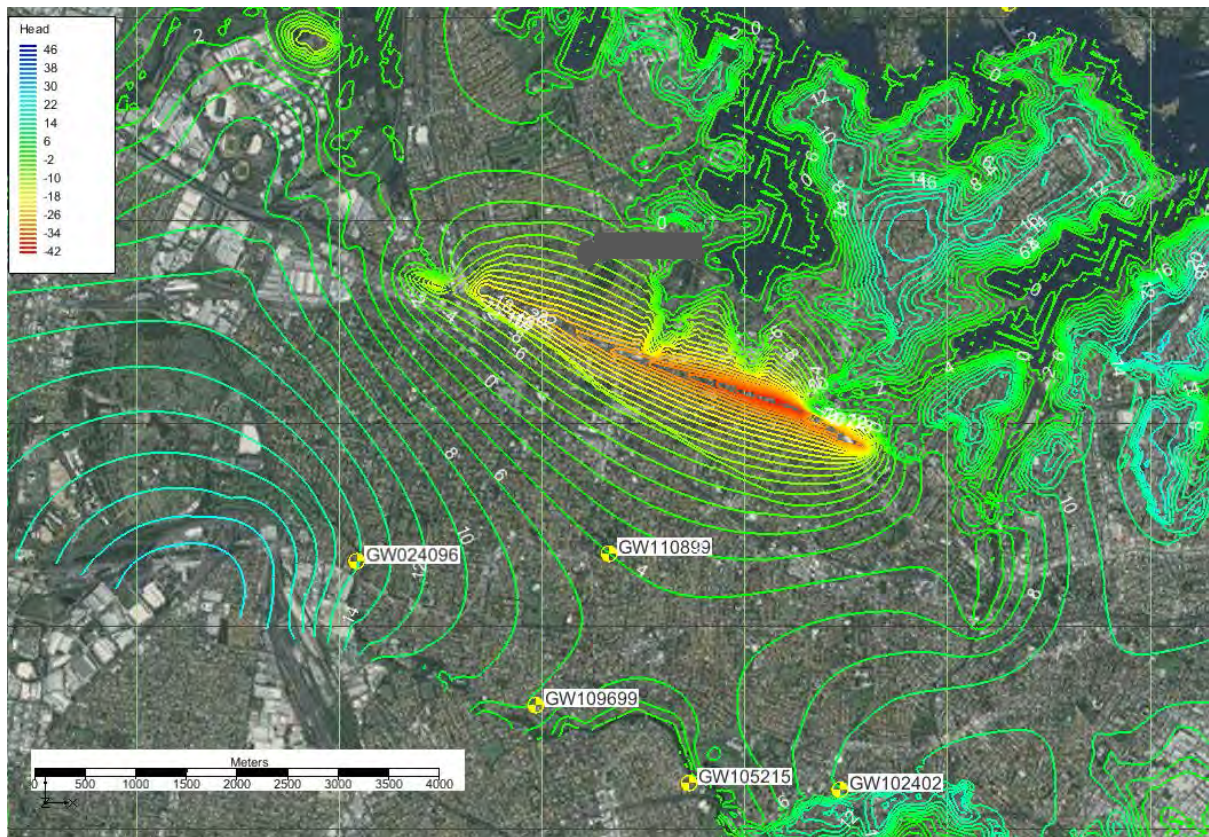


Figure 6.20 Run 111 layer 1 head (metres AHD).

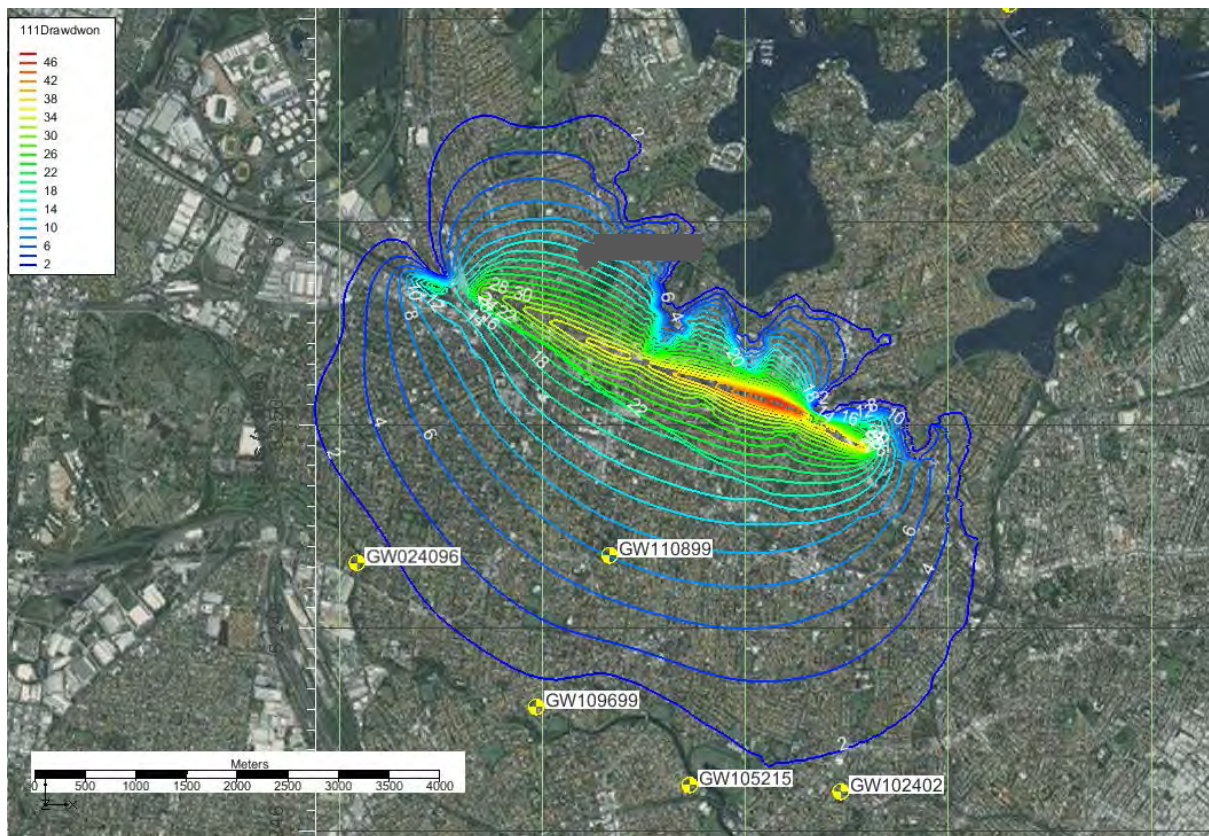


Figure 6.21 Run 111 layer 1 drawdown (metres).

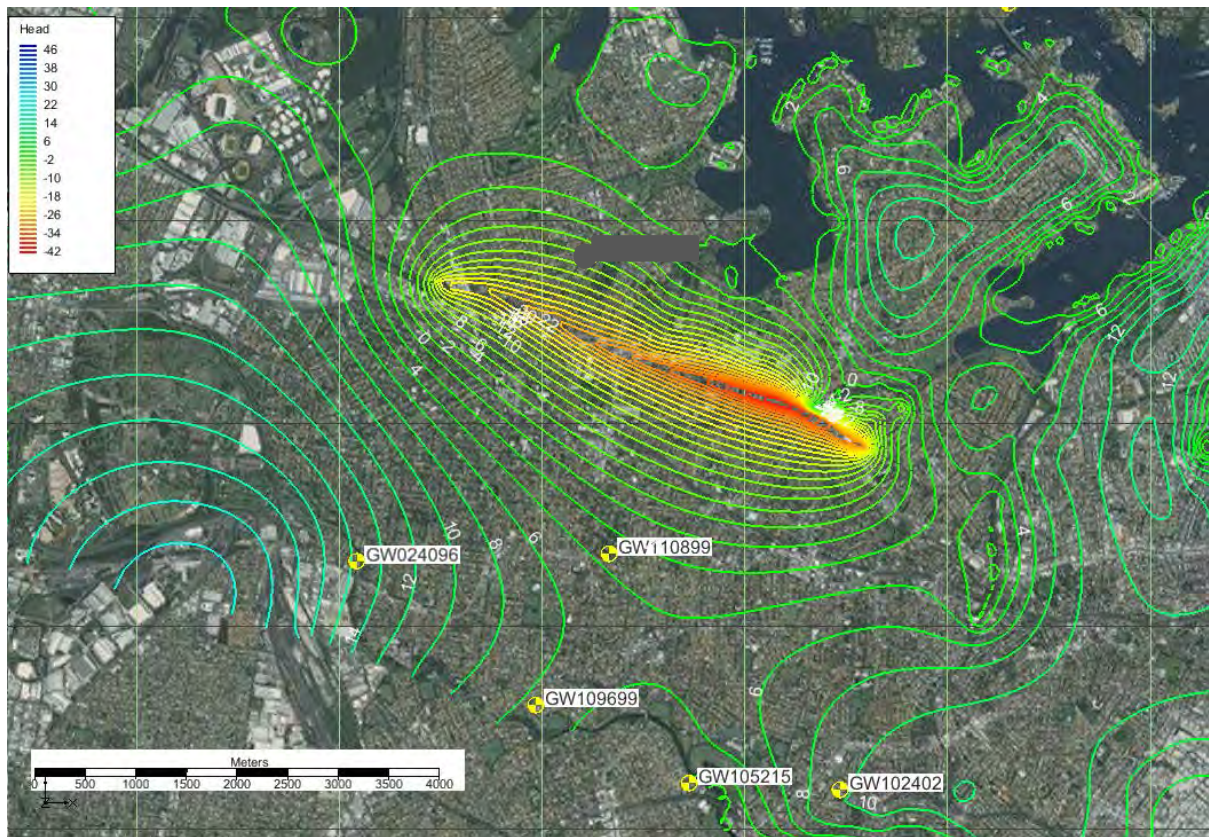


Figure 6.22 Run 111 layer 4 head (metres AHD).

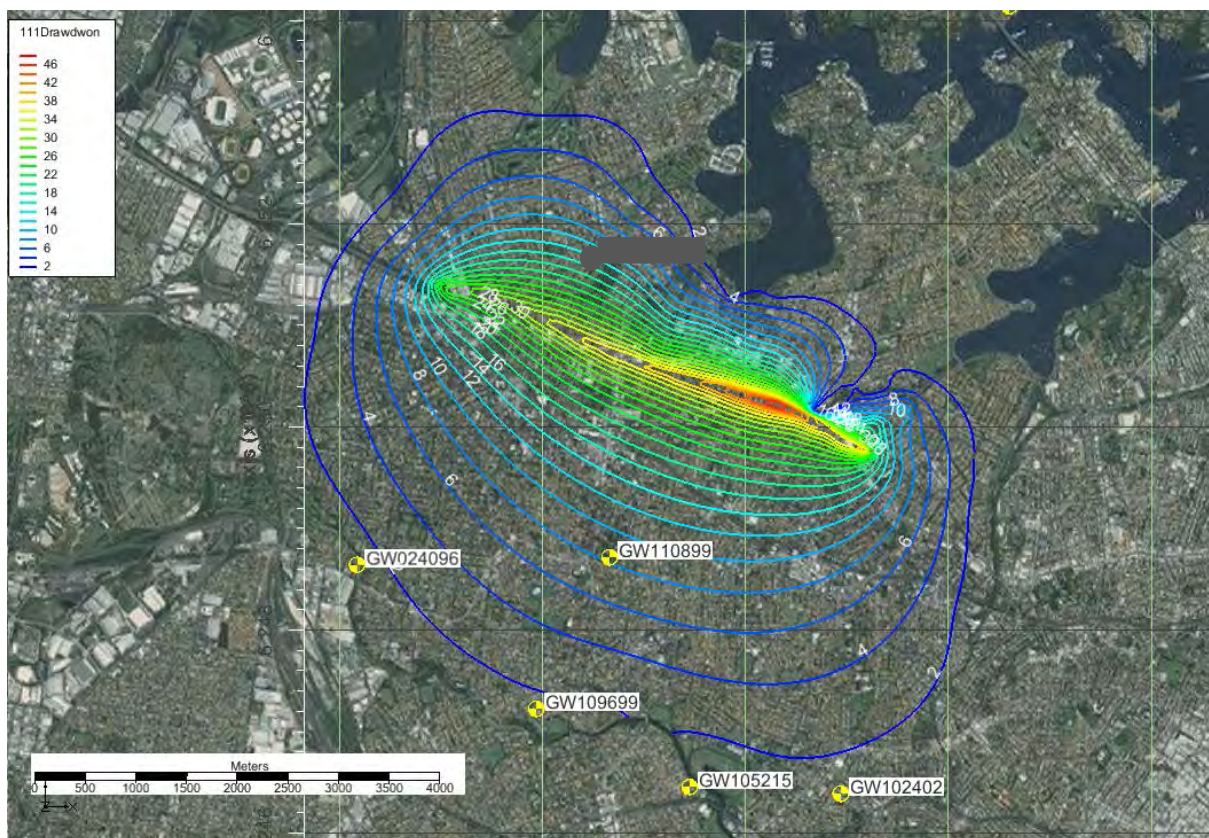


Figure 6.23 Run 111 layer 4 drawdown (metres).

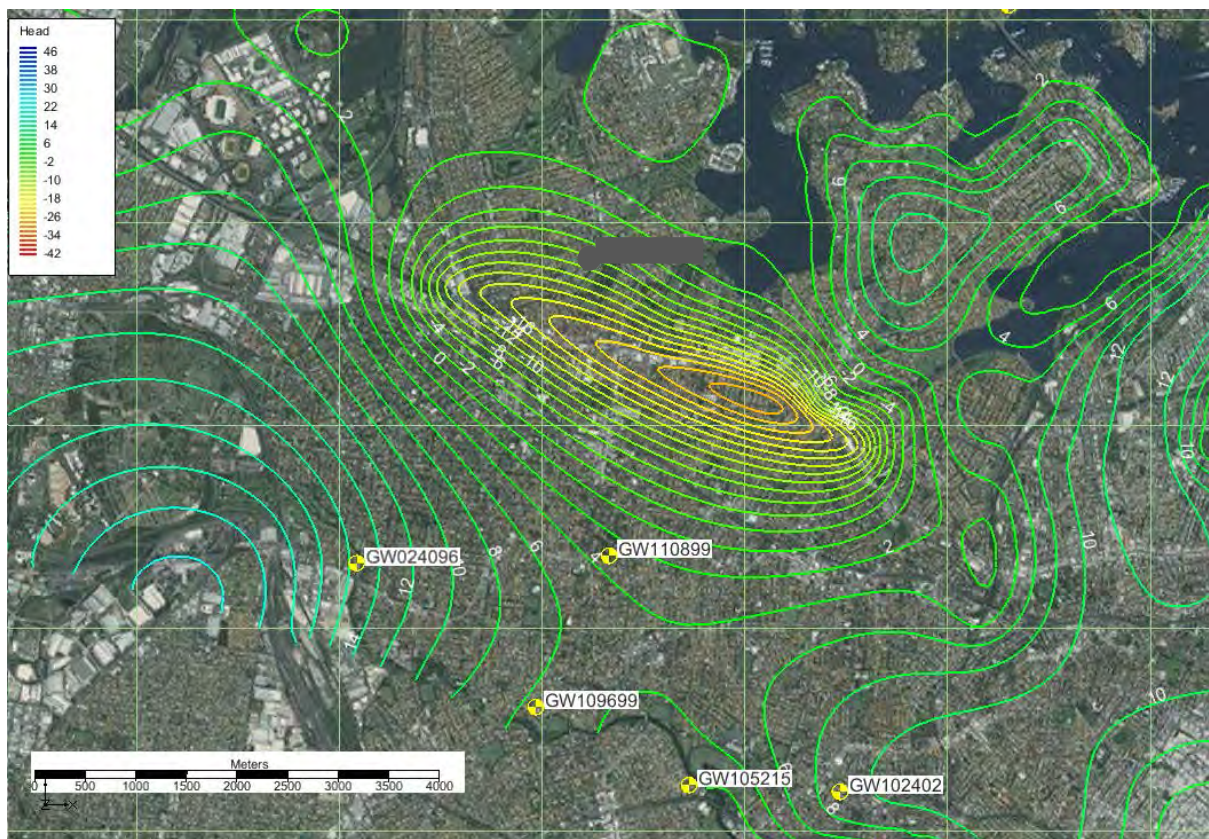


Figure 6.24 Run 111 layer 5 head (metres AHD).

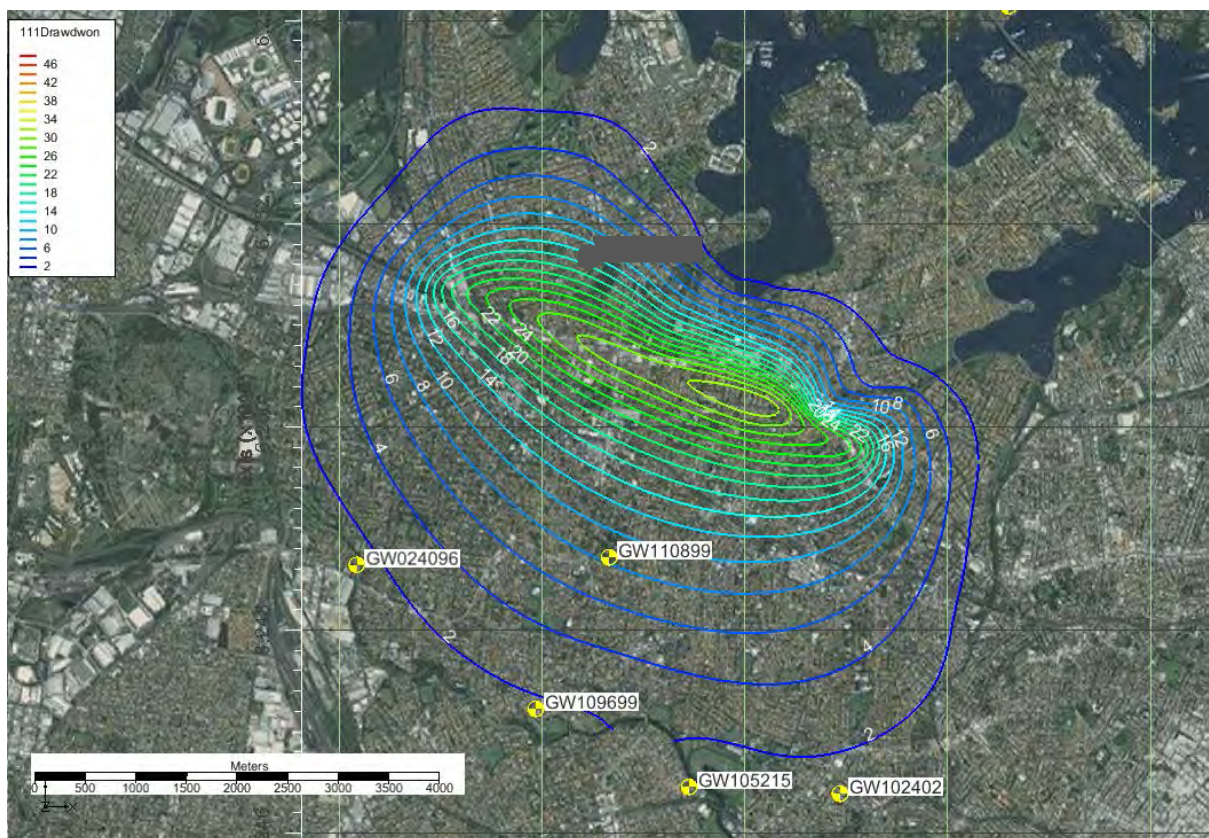


Figure 6.25 Run 111 layer 5 drawdown (metres).

Run 105 stochastic steady-state model runs

Given the lack of calibration data in the Hawkesbury Sandstone, along with the wide range of calibrated parameters in all formations depending on the observation data used, model uncertainty has been addressed using stochastic modelling of a wide range of likely recharge and hydraulic conductivity data.

Using this method, multiple random combinations of recharge and hydraulic conductivity, selected using a log-normal distribution for hydraulic conductivity and a normal distribution for recharge, based on the mean and standard deviation of the input parameters, are run and the model outputs used to provide a statistical assessment of the potential outcomes. A total of 50 models (runs 105001–105050) were run to enable statistical analysis of the output. Model input parameters are summarised in **Table 6.6** with the full matrix of inputs in **Appendix A**.

Table 6.6 Stochastic model parameter summary (in metres per day)

Statistic	Layer 1 Kh	Layer 2 Kh	Layer 3 Kh	Layer 4 Kh	Layer 5 Kh	Layer 6 Kh	Recharge zone 1	Recharge zone 2
Min	1.80E-03	3.17E-03	9.56E-03	7.99E-03	6.30E-03	3.91E-03	2.00E-05	3.40E-06
Mean	1.38E-01	3.98E-03	7.14E-02	6.48E-02	1.06E-02	5.01E-03	2.00E-05	3.40E-06
Max	9.82E-01	5.70E-03	3.42E-01	4.83E-01	1.64E-02	6.03E-03	2.00E-05	3.40E-06
Standard deviation	2.15E-01	4.55E-04	7.51E-02	7.53E-02	2.49E-03	5.15E-04	2.21E-09	6.60E-11

Simulated tunnel inflows range from 239 to 5530 cubic metres per day with a median inflow rate of 729 cubic metres per day. The 95% upper confidence level (UCL) was 1325 cubic metres per day. It is likely that high inflow zones would be grouted to reduce the inflow to the design rate of 1 litre per second per kilometre (approximately 1468 cubic metres per day over 17 kilometres of tunnelled area, including approximately two kilometres of uncovered entry and exit points and 15 kilometres of enclosed tunnel), but the impact assessment is based on the un-grouted case.

Table 6.7 Stochastic model simulated inflows

Statistic	Inflow (m ³ /day)
Min	239
Median	729
Geometric mean	749
Mean	948
95% Chebyshev (MVUE) UCL	1325
99% Chebyshev (MVUE) UCL	1842
Maximum	5530

Water levels for the area around the tunnels are shown in **Figure 6.26** to **Figure 6.32**. Water levels are shown for layer 4, the uppermost layer of Hawkesbury Sandstone being the layer intersected by most of the tunnel.

The zero metre AHD water level contours in the minimum, mean and maximum cases all intercept the lined drainage canals at the western and eastern ends of the tunnels, indicating that over the long term there may be some inflow of saline groundwater.

Drawdown contours for the mean, minimum and maximum water level cases are shown in **Figure 6.27**, **Figure 6.29** and **Figure 6.31**.

For the mean water level case, the zone of drawdown greater than two metres encompasses three registered bores – GW110899 (13 metres) GW024096 (eight metres) and GW109699 (six metres).

For the minimum water level case, the zone of drawdown greater than two metres encompasses three registered bores – GW110899 (16 metres) GW024096 (13 metres) and GW109699 (13 metres).

For the maximum water level case, the zone of drawdown greater than two metres encompasses only one registered bore – GW110899 (nine metres).

No GDEs are known within the two metre drawdown area. Two wetlands identified to the north of the project corridor near Homebush Bay are mapped by the BOM atlas as being potentially dependent on groundwater, however based on this assessment these two areas are likely to be tidally influenced and not expected to be dependent on groundwater that would be drawn into the tunnel (refer **section 5.10**). Total seepage face discharge for the model outside the tunnel footprint was in the order of 33,000 cubic metres per day for both the maximum (run 105007) and minimum (run 105040) tunnel seepage cases. The change in seepage face discharge for both cases was 33 and 78 cubic metres per day respectively, equivalent to between 0.01 and 0.02 per cent of total surface groundwater discharge, other than to saline waterbodies at sea level which were represented by general head boundaries. Consequently the tunnel drainage is unlikely to have a significant impact on local stream base flows.

The plan showing groundwater level standard deviation (**Figure 6.32**) shows that the variation was relatively low in the area around the tunnel, primarily because it is in the closest to the general head boundaries defining Sydney Harbour, which constrain the possible variation in groundwater levels. The highest variation is in the south-west near the no-flow boundary, which would tend to exaggerate differences due to variations in recharge or hydraulic conductivity. Given that the drawdown cones all intercept this no-flow boundary, it is possible that the drawdown in this area is exaggerated, but the boundary is far enough from the tunnel to not have a significant effect on near-tunnel impacts.

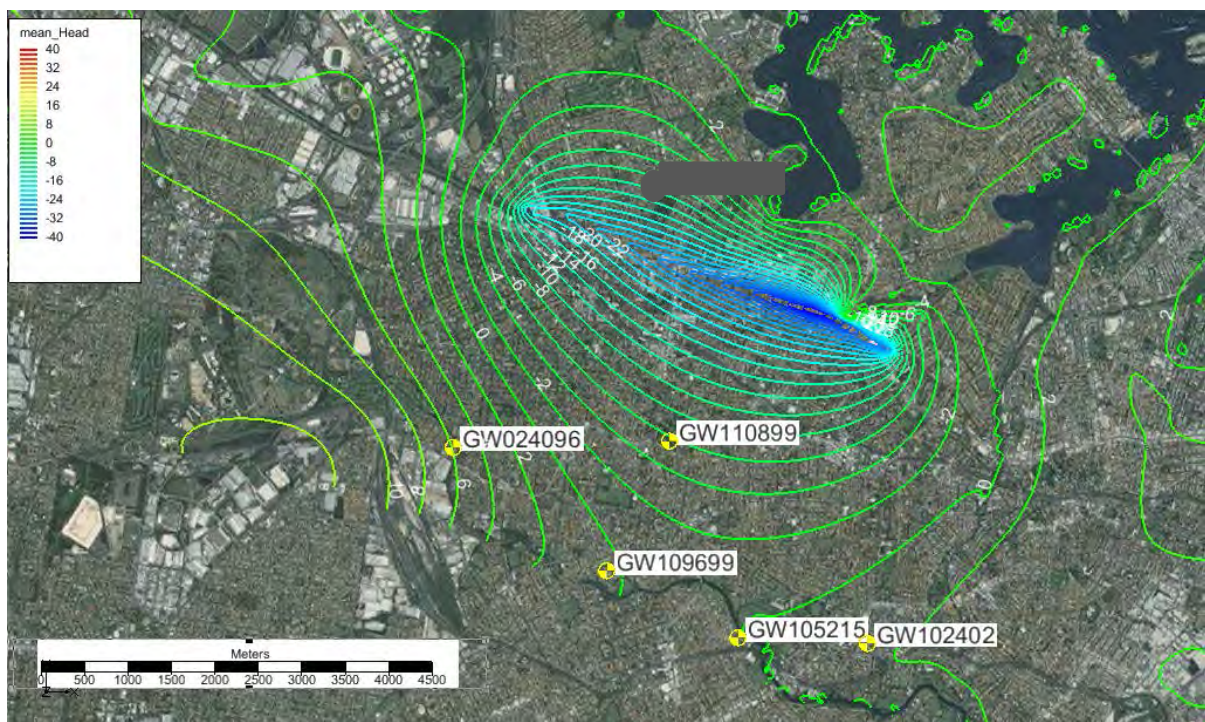


Figure 6.26 Run 105 layer 4 steady-state piezometric contours, mean level (metres AHD).

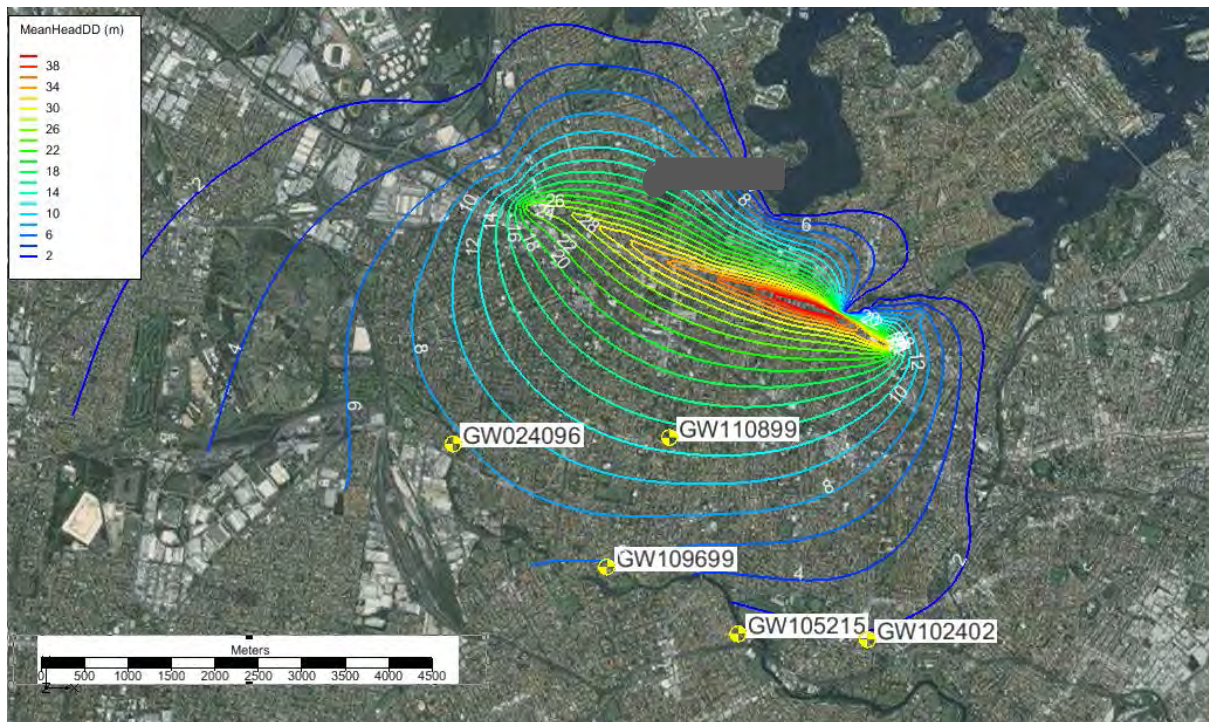


Figure 6.27 Run 105 layer 4 steady-state drawdown, mean level (metres).

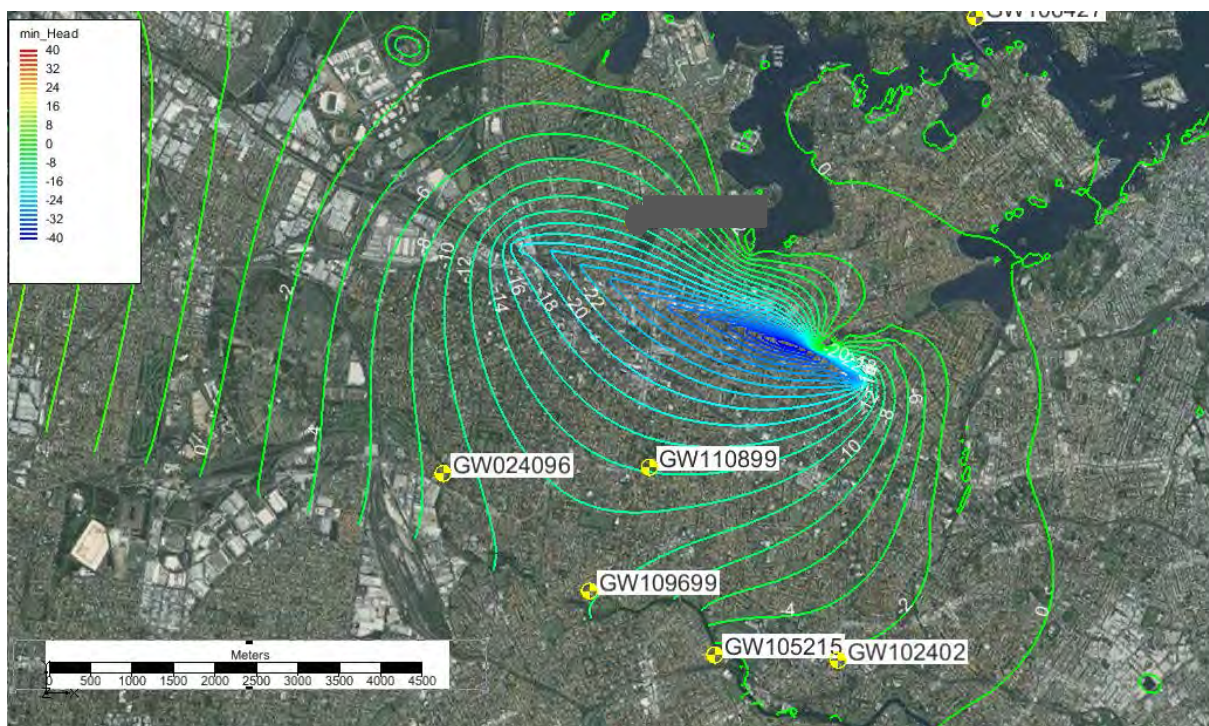


Figure 6.28 Run 105 layer 4 steady-state piezometric contours, minimum level (metres AHD).

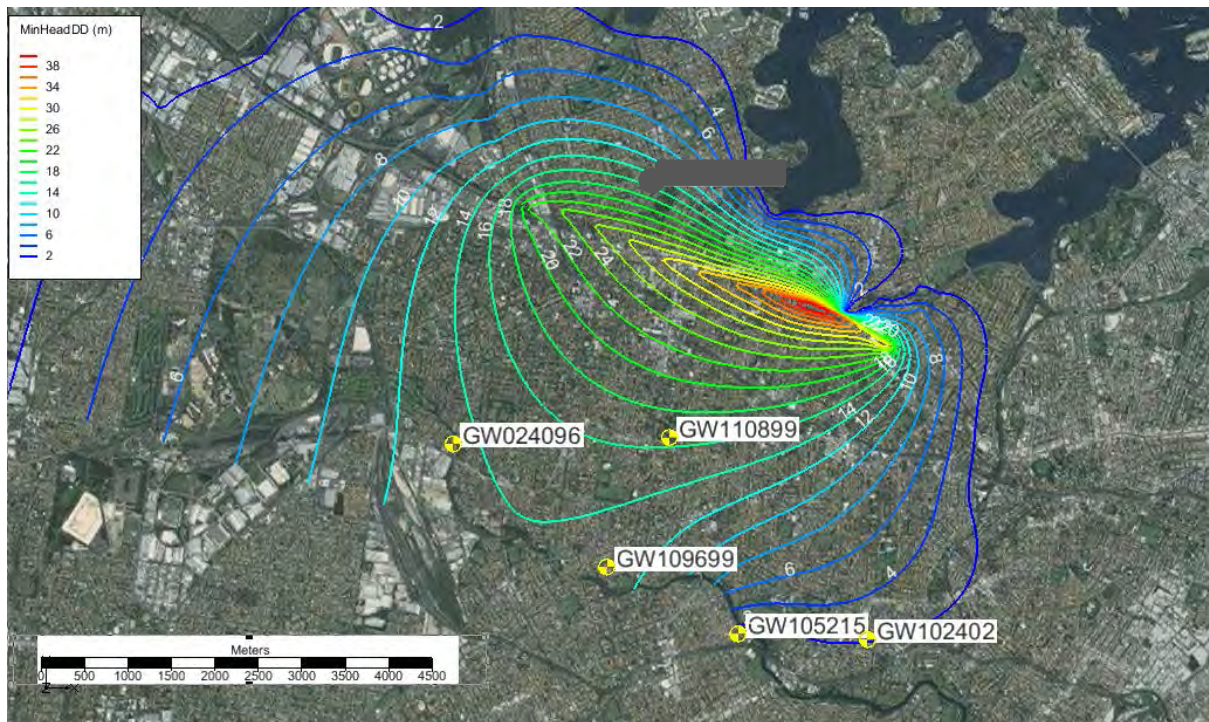


Figure 6.29 Run 105 layer 4 steady-state drawdown, minimum level (metres).

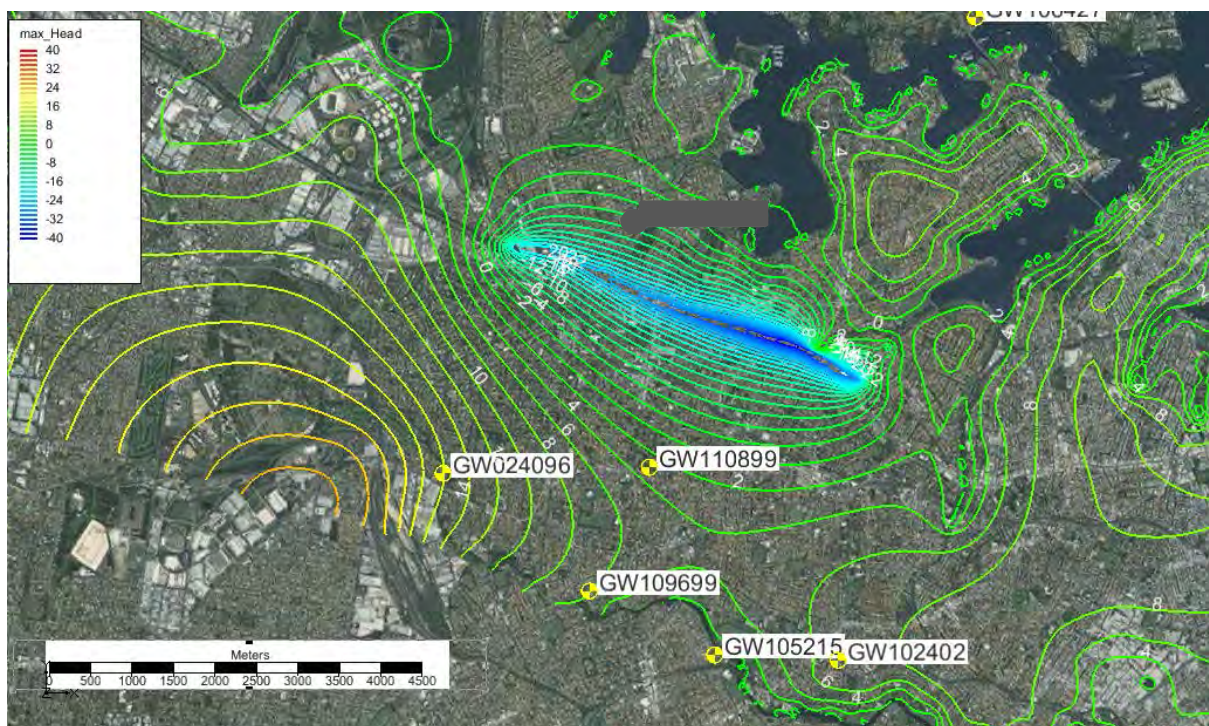


Figure 6.30 Run 105 layer 4 steady-state piezometric contours, maximum level (metres AHD).

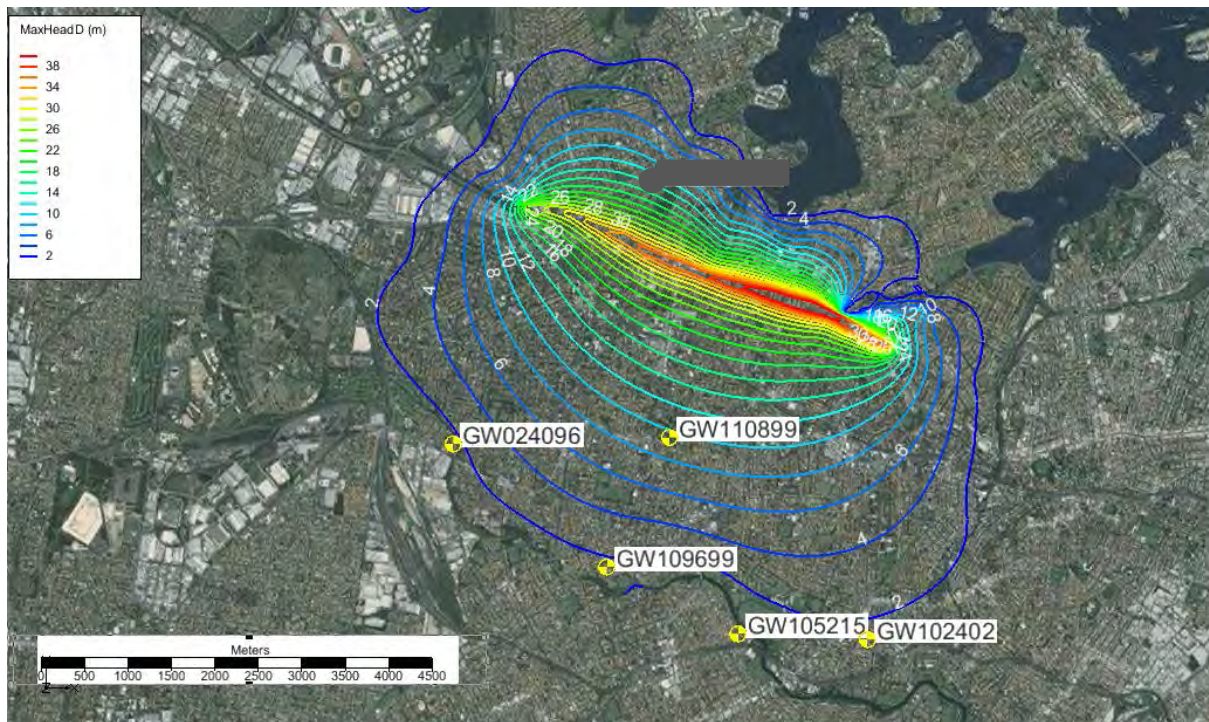


Figure 6.31 Run 105 layer 4 steady-state drawdown, maximum level (metres).



Figure 6.32 Run 107 layer 4 steady-state piezometric contours, standard deviation (metres) of all stochastic runs.

Run 209 transient flow modelling

In order to assess the changes in water levels and flow over time, a transient model was run (run 209). The model included modification by splitting the upper Hawkesbury Sandstone zone intercepted by tunnelling into multiple layers, giving the model a total of 14 layers. Tunnel development was split into quarterly intervals based on an indicative construction schedule. The calibrated hydraulic conductivity values used are summarised in **Table 6.8**. As the steady-state inflows vary greatly depending on the model parameters, run 209 was carried out to gain an understanding of the likely initial inflows relative to long-term or near steady-state conditions.

Table 6.8 Run 209 hydraulic conductivity

Layer and material	Horizontal hydraulic conductivity (m/day)
L1 – Alluvial clay	1.000E+00
L2 – Ashfield Shale shallow	6.620E-03
L3 – Ashfield Shale deep	1.910E-04
L4 – Mittagong Formation	5.00E-03
L5–L12 – Hawkesbury Sandstone shallow	9.880E-03
L13 – Hawkesbury Sandstone intermediate	1.000E-03
L14 – Hawkesbury Sandstone deep	5.000E-02

The model used 1211 monthly stress periods from 1 January 2000 to 1 December 2100, with two time steps per stress period. All other boundaries, including recharge, were constant throughout the stress periods. Recharge rates over industrial land use and Ashfield Shale areas was 4.82E-05 metres per day and recharge in remaining areas was 2.00E-05 metres per day.

After 50 years (**Figure 6.33**), the zone of drawdown in the Hawkesbury Sandstone (layer 10) of greater than two metres (**Figure 6.34**) encompasses two registered bores –GW110899 (three metres) and GW024096 (two metres).

The rate of drawdown in the two bores, assuming they are in the upper Hawkesbury Sandstone, is illustrated in **Figure 6.35**. The 50-year drawdowns in GW110899 and GW024096 are less than two metres and water levels remain well above sea level..

The total inflow to all tunnel workings is initially high, at around 1600 cubic metres per day during construction, but gradually decreases during operation to less than 500 cubic metres per day after 50 years, similar to the predicted steady-state inflow. On this basis, peak inflows are likely to be approximately three times the steady-state inflow, although as indicated in **section 6.2.2** this may vary depending on the tunnelling schedule and would vary significantly depending on the local overall aquifer hydraulic properties, local fracturing and grouting operations.

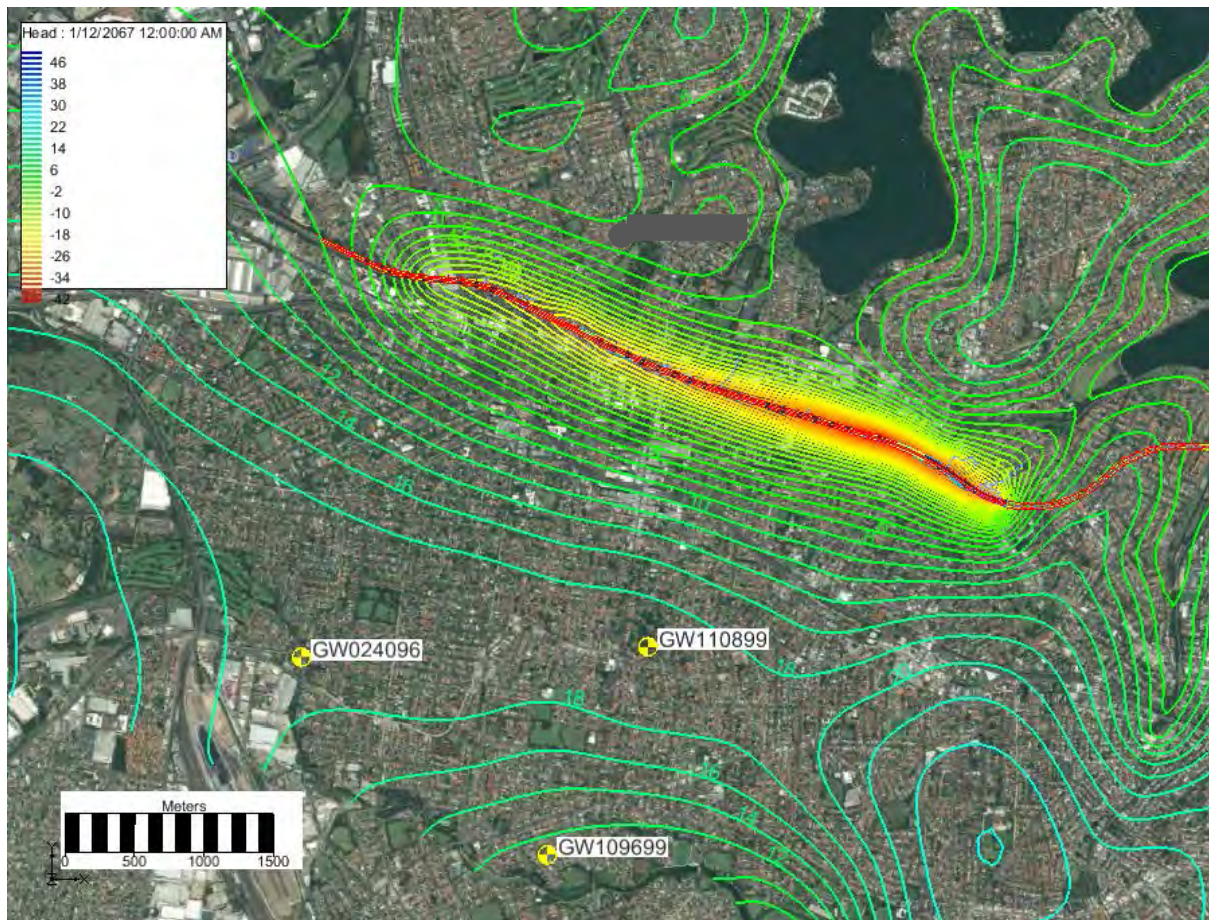


Figure 6.33 Run 209 layer 10 year 50 piezometric contours (metres AHD).

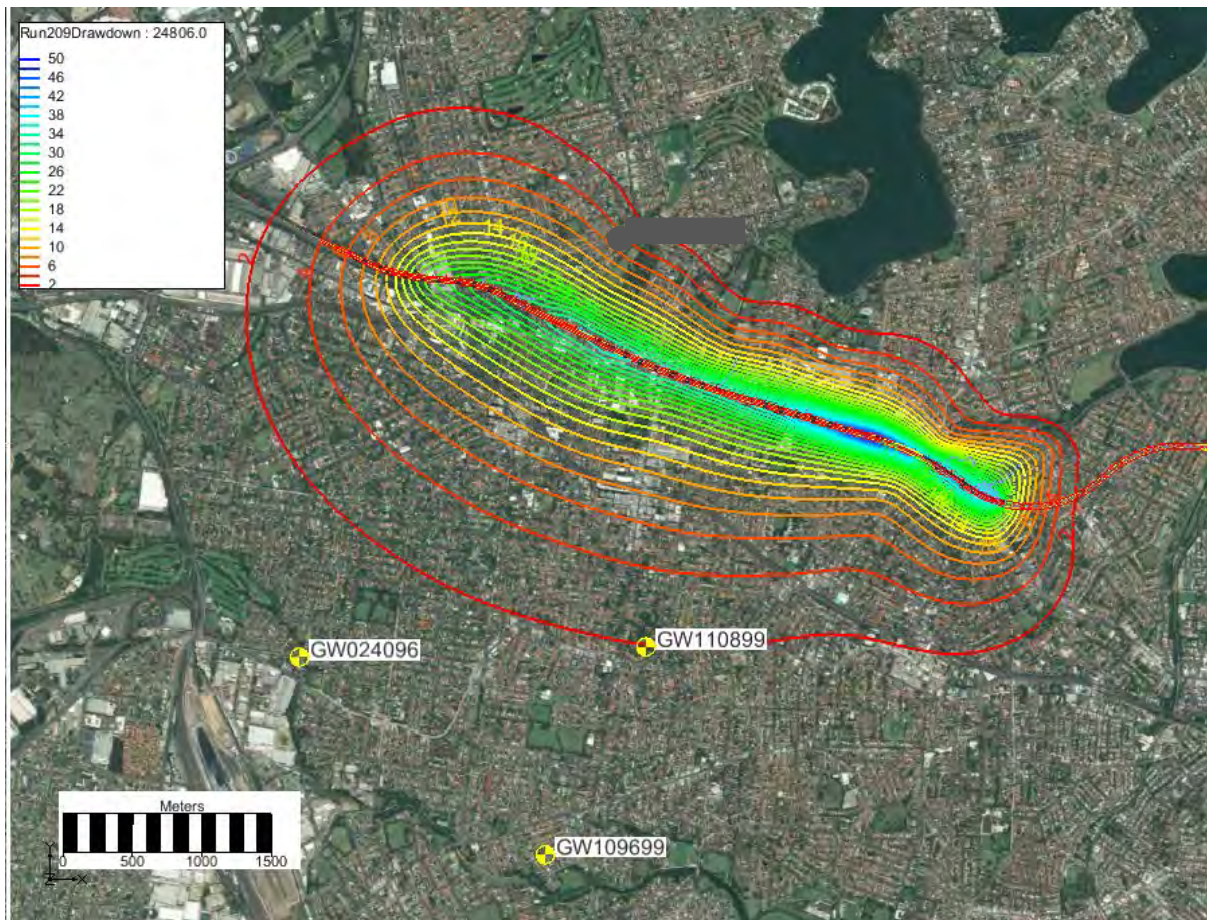


Figure 6.34 Run 209 Layer 10 year 50 drawdown contours (metres).

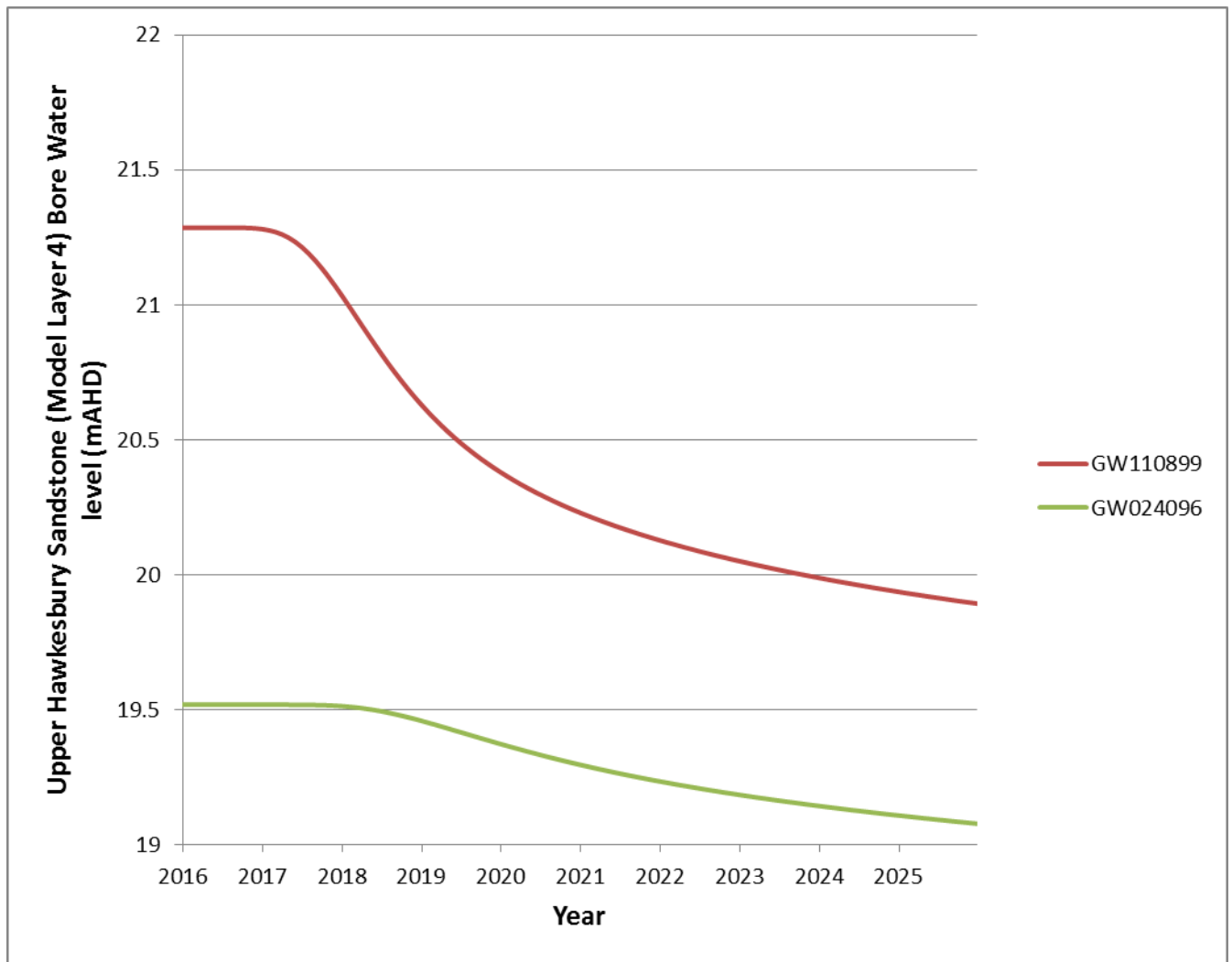


Figure 6.35 Run 209 layer 10 predicted water levels in impacted bores (metres AHD).

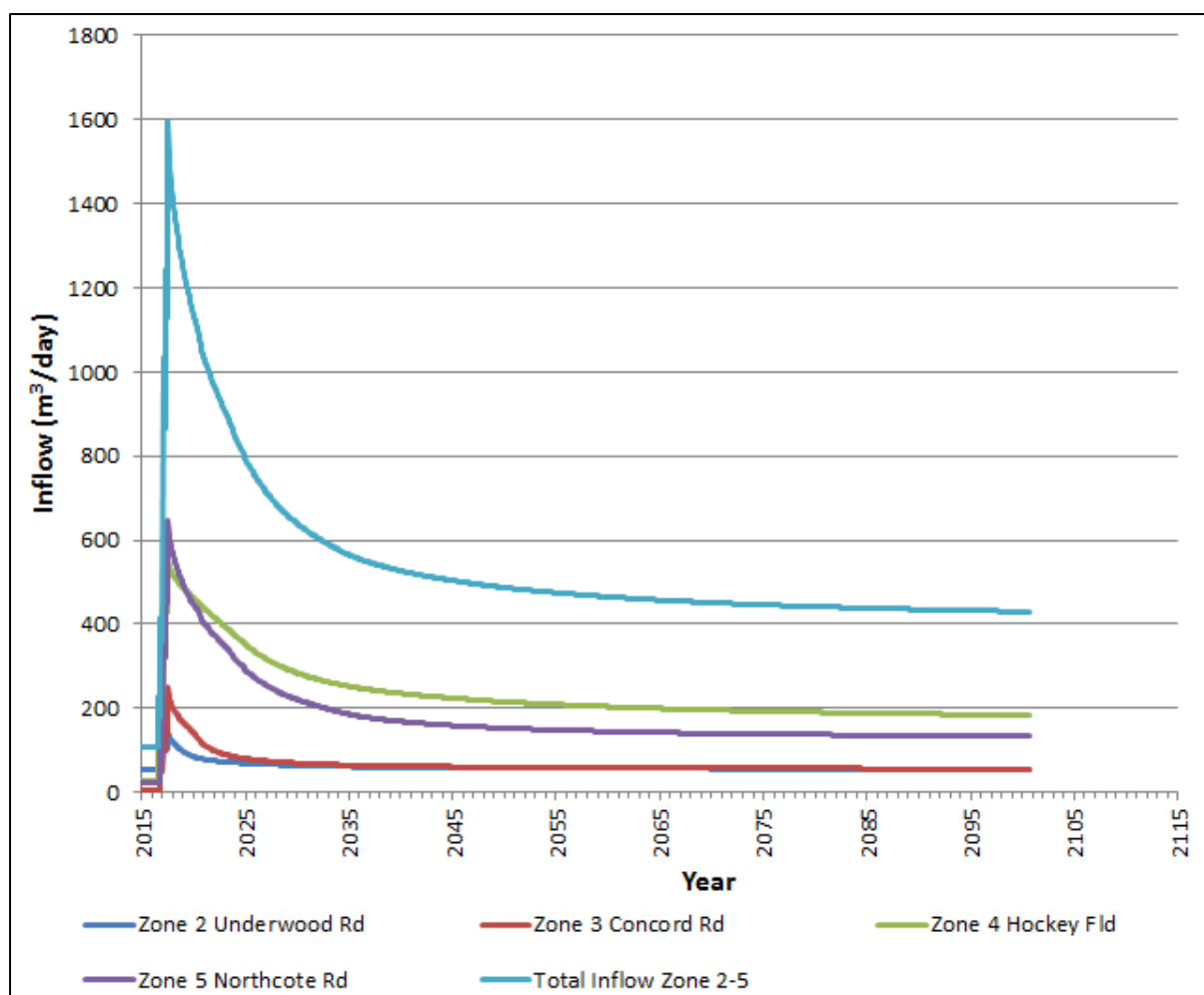


Figure 6.36 Transient tunnel inflow (cubic metres per day) – construction and operation.

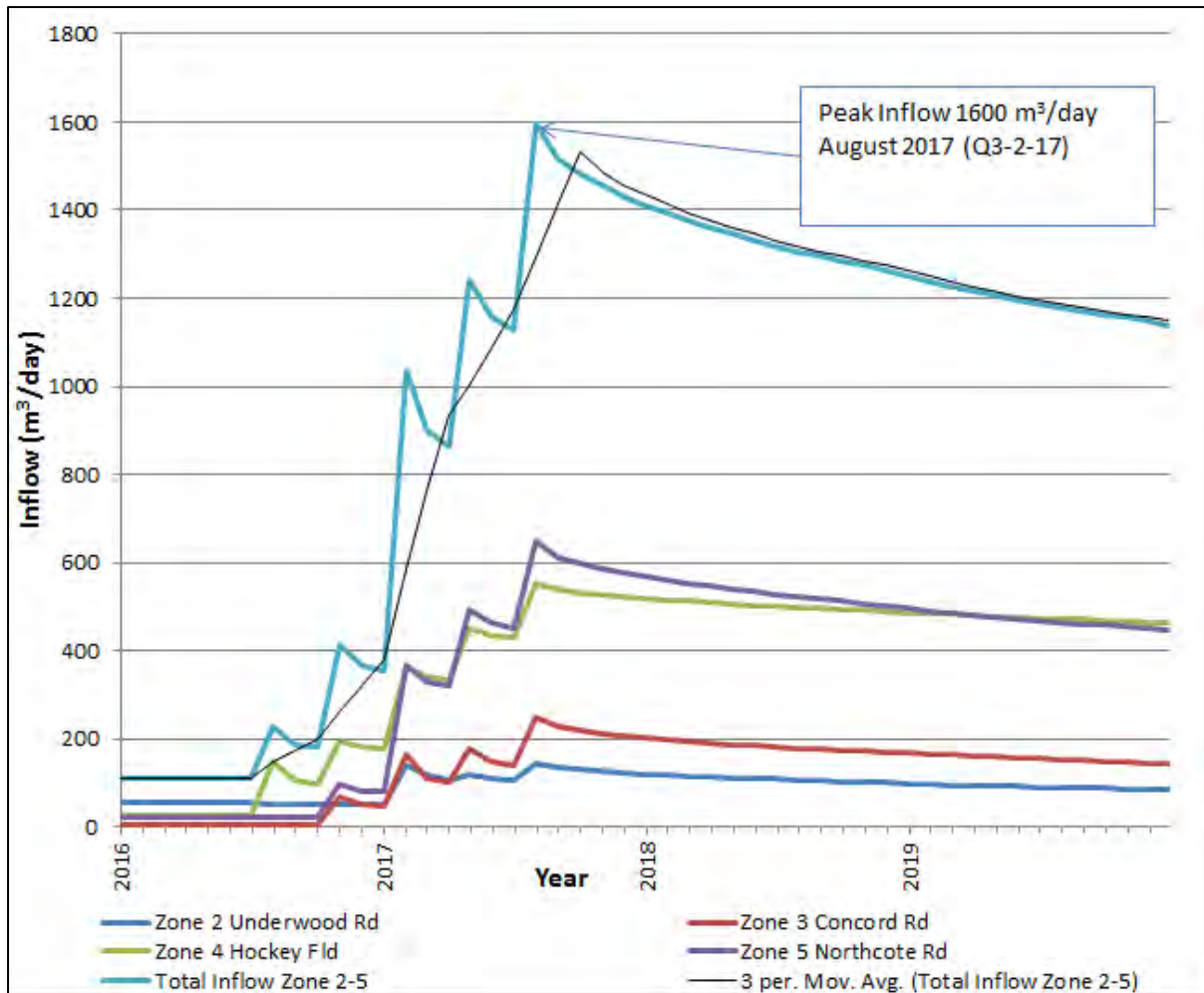


Figure 6.37 Transient tunnel inflow (cubic metres per day) – construction

Run 113 transient salt transport modelling

A basic transient salt transport model was run using MT3D on transient model run 113. The starting concentration was set at 30,000 milligrams per litre in all layers below tidal rivers and the Harbour and the corresponding general head boundaries set with source concentrations at 30,000 milligrams per litre. The remainder of the model's starting concentrations and recharge concentrations were set at 100 milligrams per litre, which is below the ambient groundwater salinity but allowed clear delineation of impacted and non-impacted areas. The model did not include density dependent flow or allow for a deep, underlying saline layer, but was adequate to illustrate areas likely to be impacted.

Figure 6.38 shows the predicted salt concentrations at year 50. It shows that groundwater beneath the eastern end of the tunnels and the embayment has become saline, with smaller areas of partial saline encroachment in the central embayment and beneath a tidal drain at the western end.

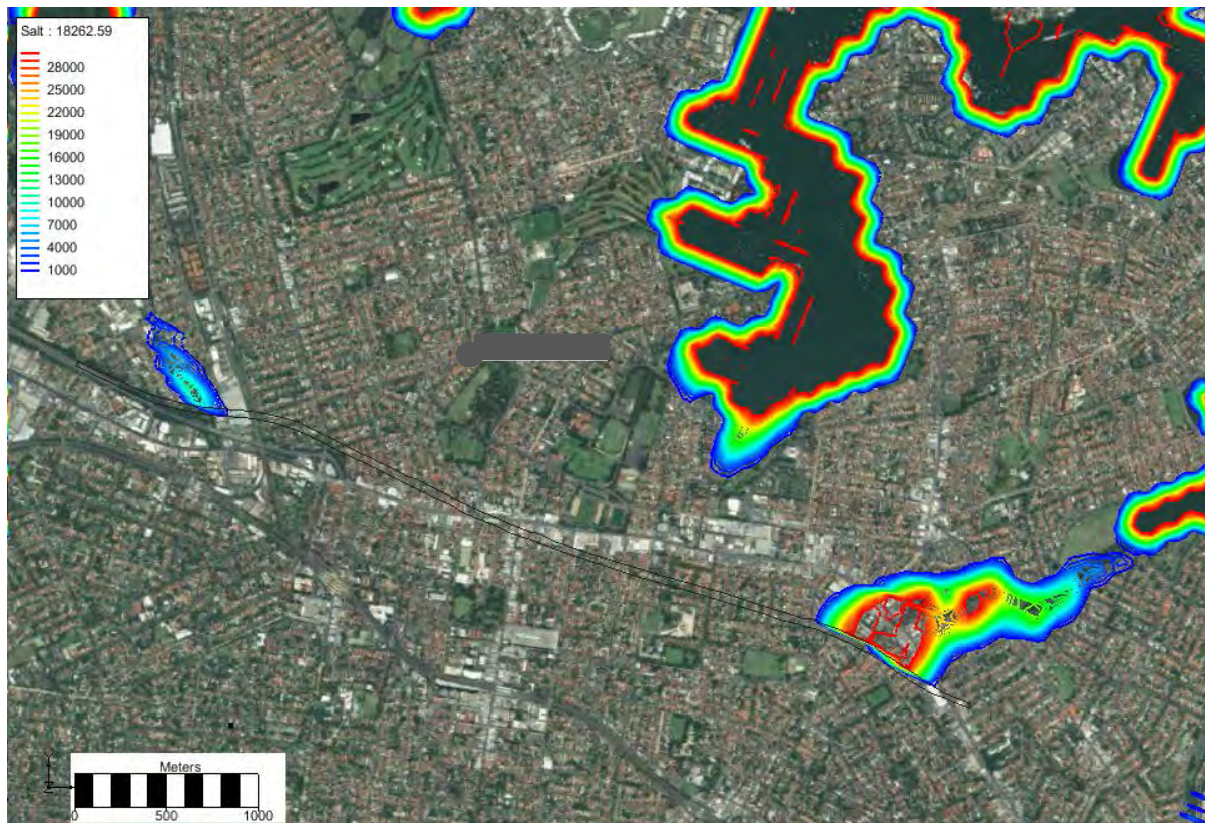


Figure 6.38 Run 113 Hawkesbury Sandstone year 50 salt concentrations (milligrams per litre)

6.3 Potential impacts

6.3.1 Groundwater recharge change

Given the likely tunnel construction methods, it is unlikely to significantly change groundwater recharge. Surface disturbance as a result of the project construction would largely be limited to the open trough structures and cut and cover sections and various approach roads. As none of the approach structures or main tunnels cut through areas of alluvium, there is no potential for the tunnel to block or otherwise interfere with significant shallow groundwater systems.

There could be a minor decrease in recharge due to the increased paved area from the above-ground roads, but given the already highly paved nature of the alignment the change is unlikely to have a significant impact on groundwater levels.

High rainfall events that coincide with the presence of open cut and cover areas or open troughs may temporarily flood workings and lead to a short period of localised increase in recharge to the aquifer system. In this instance the impacts would be considered minor, localised and of short duration.

As operational tunnel inflow would be discharged to lined tidal drains, the discharge would not modify groundwater recharge conditions.

6.3.2 Groundwater inflow rates and chemistry

As noted in **section 6.3.2**, final long-term tunnel inflows in the Hawkesbury Sandstone are typically in the order of one litre per second per kilometre. This is an average, long-term value and does not take in to account localised or short-term inflows and also reflects cases where localised high-inflow areas of a tunnel have been grouted.

Based on proposed total tunnelled length (of about 17 kilometres for the project, this crudely equates to a potential inflow in the order of 17 litres per second into the tunnel during operation. Modelling of a range of aquifer hydraulic properties and recharge rates (**section 6.1**) for this assessment has tested this assumption and indicates that operational inflows are likely to be in the order of five litres per second, but could be as high as around 15 litres per second without partial grouting of the sandstone or sealing of shallow approach structures.

The short-term inflow would depend on the rate of tunnelling progress, the tunnel construction method and the presence of localised zones with potential for high, short-term inflows and is estimated to be in the order of 19 litres per second during construction.

Based on the local groundwater chemistry and experience in other tunnels in the Hawkesbury Sandstone in the region, this inflow is likely to contain elevated concentrations of iron and calcium carbonate with potential to cause staining and possible blockage of drainage systems in the long term. The scaling potential of the ambient groundwater may be exacerbated by leaching of chemicals, such as sodium silicate, used in grouts as well as secondary ions derived from minerals dissolved in the highly alkaline grout leachate. The tunnel design team will need to investigate the detailed geochemistry to enable calculation of likely precipitation rates and include room for blockage and cleaning/flushing in the drainage design. Given the depth of the tunnel and predicted long-term water levels, there is potential for lateral inflow of saline water from the east, from unlined tidal drains at the western and eastern ends of the tunnel (**section 6.2.2**) as well as the potential for drawing up deeper saline groundwater (**section 6.3.4**). Such saline inflow may not develop immediately and may take several years to impact on inflow water quality, however it is likely to develop over the design life of the tunnel.

6.3.3 Groundwater level decline

Potential impact to groundwater dependent ecosystems

Under the various requirements discussed in section 4, drawdown must be within the allowable range of 10 per cent of baseline levels within 40 metres of a significant GDE, as defined by the *NSW Aquifer Interference Policy*.

It is likely that the level of groundwater dependency in the area is relatively low, with terrestrial vegetation, river base flow systems and aquifer systems potentially utilising groundwater in the saturated zone only during drought conditions where surface water flux is uncommon. No GDEs have been identified within the model domain hence none are within the area subject to two metres or more drawdown. It is noted, however, that there are two areas of wetlands present near Homebush Bay (Mason Park and the Homebush Bay wetlands) which are mapped on the BOM atlas as being potentially dependent on groundwater. However, the groundwater elevations in these area and which sustain these wetland areas are expected to be reliant on the Parramatta River and its associated tidal fluctuations, and as such are not likely to be adversely impacted by groundwater level decline associated with the project.

Based on the changes to water levels and surface water discharges noted in **section 6.2.2**, it is unlikely that long-term tunnel drainage would have a significant impact on surface water bodies or GDEs. Similarly, discharged tunnel inflow would be treated to meet the requirements of the receiving water environment at the water treatment plant at the Cintra Park site during operation. Treatment and discharge of tunnel inflow is discussed further in **section 7.2.2**.

Impacts on other groundwater users

Based on the water level declines or drawdowns indicated in **Table 6.9**, up to four licenced bores are likely to experience drawdowns of greater than two metres, with long-term drawdowns of as much as 16 metres predicted over the long term. Maximum predicted drawdowns are presented in **Table 6.9**. The four bores are the only registered water supply bores within the two metre drawdown contour for any impact model. Any other bores within the two metre drawdown zone are monitoring bores and are not subject to the impact provisions.

Depending on the usage, bore construction and pump type, the impacts from the drawdown may vary from a slight increase in pumping costs, a need to lower pumps or re-equip bores, or the possibility of the need to drill, construct and equip deeper replacement bores or provide alternative water supplies at a cost equivalent to the current groundwater supply cost.

To better define this possible impact, the potentially impacted bores need to be located to confirm they are still in use and inspected, and the condition, equipment, depth and yield reviewed prior to construction of the tunnel. Water chemistry and water levels should be regularly monitored, as indicated in **section 7.4.2**, prior to the start of tunnel construction and throughout the operational life of the tunnel. This would enable a better understanding of baseline conditions and the actual impacts of the project. If water levels and detailed drilling logs are available for the bores they would also provide valuable information for future monitoring and assessment.

Table 6.9 Maximum predicted bore drawdown

Bore ID	Maximum predicted drawdown
GW110899	16 m
GW024096	13 m
GW109699	13 m

6.3.4 Ground movement

The simulated drawdown in shallow sediments (layer one of the model) could result in settlement of soft sediments. Preliminary ground movement investigations have been undertaken by the contractor, the results of which are presented in this section.

Ground movement may occur as a result of:

- Tunnel induced movement caused by the relief of stress from tunnelling through intact rock
- Settlement induced from groundwater drawdown.

The risk to individual structures would be dependent on the geotechnical conditions, the depth of the tunnel, the number of storeys of the building, and the position, condition, and masonry of the structure itself.

Table 6.10 outlines the typical impacts of ground movement based on maximum building settlement, based on Burland et al. (1977), Boscardin and Cording (1989) and Rankin (1988).

Table 6.10 Typical impacts of ground movement

Maximum building settlement	Maximum tensile strain	Maximum ground slope	Degree of impact	Typical impact
Up to 10 millimetres	0.05% to 0.075%	Less than 1:500	Very slight	Fine cracks (0.1 to 1.0 millimetres wide) easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible on close inspection.
10 to 50 millimetres	0.075% to 0.015%	1: 500 to 1:200	Slight	Cracks (1 to 5 millimetres wide) easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible; some repainting may be required for weather-tightness. Doors and windows may stick slightly.
50 to 75 millimetres	0.15% to 0.3%	1:200 to 1:50	Moderate	Cracks (5 to 15 millimetres wide, or a number of cracks greater than 3 millimetres wide) may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Brick pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather-tightness often impaired.

Preliminary ground movement investigations indicate that there may be potential settlement of up to 50 millimetres at the mainline tunnels in the vicinity of Dobroyd Canal and the eastern ventilation facility, and the risk category has been assessed as slight to moderate. In the vicinity of the Concord Road interchange cut-and-cover tunnel structure, there may be potential settlement of up to 25 millimetres, and the risk category has been assessed as slight. Elsewhere, the risk category has been assessed as negligible to very slight.

This indicates that ground movement is generally likely to result in cosmetic damage only. For the majority of properties, the anticipated impacts are negligible, typically resulting in hairline cracking only. For a limited number of properties, ground movement may result in cracking of up to 15 millimetres. **Table 6.11** lists the potential impact on existing buildings resulting from settlement due to tunnel construction.

Table 6.11 Assessed impact on existing building structures

Location	Building type	Degree of impact	Number buildings potentially impacted
Between Powells Creek and George Street	Type 3	Slight	2
Between Concord Road and Concord Lane	Type 1	Slight	1
Near intersection of Coles Street and Ada Street	Type 1	Slight	2
Near intersection of Broughton Street and Parramatta Road	Type 1	Slight	5
	Type 2	Slight	3
		Very slight	2
	Type 3	Slight	3
Between Croydon Road and Earle Avenue	Type 1	Very slight	5
		Slight	49
	Type 2	Very slight	1
		Slight	9
	Type 3	Very slight	1
		Slight	7
Near intersection of Frederick Street and Parramatta Road	Type 3	Slight	1
Near intersection of Bland Street and Parramatta Road	Type 3	Very slight	1
	Type 1	Slight	3
Total			95

Note:

- Type 1 – single storey masonry building
- Type 2 – two storey masonry building
- Type 3 – masonry building greater than three storeys

These results are preliminary and do not take into account the specifics of individual or heritage buildings. Further assessments would be undertaken during detailed design to determine the level of potential impact on structures and to identify feasible and reasonable mitigation and management measures required to minimise potential ground movement impacts.

6.3.5 Impact on groundwater quality and contamination

Tunnel capture zone

The groundwater contours presented in **section 6.1** show that the tunnel has a relatively large capture zone, including coastal areas and canals which would act as a source of saline ground water inflow. However, as groundwater flow velocities are likely to be relatively low, the water from the entire capture zone is unlikely to travel to the tunnel over its design life.

Given the potential to draw in coastal or deep groundwater, the chemistry of inflow to the tunnel is likely to change over time. The most significant of these is the long-term potential to draw in seawater through the currently (relatively) fresh aquifer. This is discussed in more detail in **section 6.2.2**.

The impact of inducing contaminated groundwater to flow in to the tunnel or through adjacent previously uncontaminated sites may require management. Groundwater entering the tunnel would be treated prior to disposal. Consequently, construction of the tunnel would serve to intercept and treat contaminated groundwater that would otherwise discharge to surface water systems. Hence capturing of contaminated groundwater would have a positive impact on the aquifer and surface water systems.

The groundwater monitoring results from the soil and land contamination assessment (GHD 2015) discussed in **section 5.7** suggest that there is limited identified groundwater contamination in the project corridor. However, as the area contains numerous potential sources of contamination, such as service stations, light industrial and commercial facilities, it should be assumed that there is some potential for groundwater contamination over the life of the project. During construction, it is likely that ammonia and nitrate concentrations would be elevated due to blasting residues, however the likely levels and potential impact of these concentrations are expected to be negligible.

Consequently, regular monitoring for general groundwater chemistry and common contaminants should be carried out throughout the construction and operation periods, to provide early warning of contamination with potential to impact on water treatment requirements or environmental and human health. Refer to the soil and land contamination assessment report (GHD August 2015) for further details regarding contamination for the project.

Saltwater intrusion

The relationship between the depth of the fresh/salt water interface in a coastal aquifer is broadly defined by the Ghyben-Herzberg relationship.

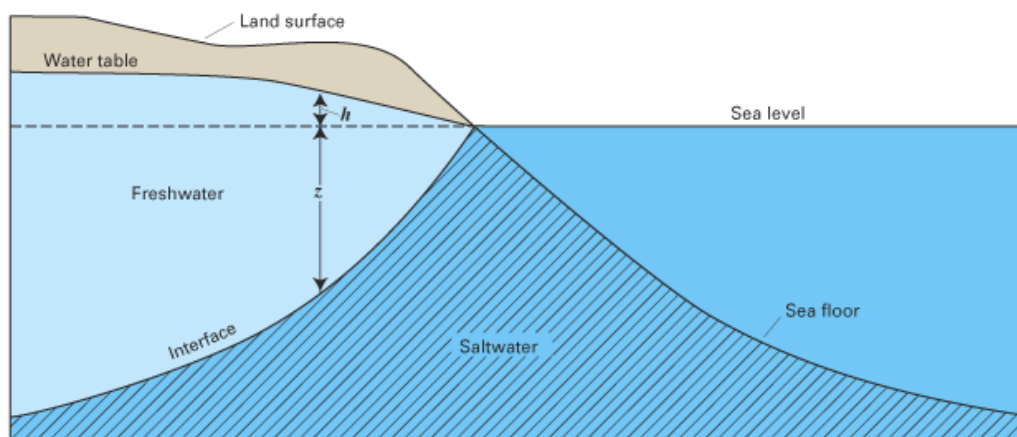


Figure 6.39 Ghyben-Herzberg relationship of the saltwater wedge.

Figure 6.39 shows the Ghyben-Herzberg relation. In the equation,

$$z = \frac{\rho_f}{(\rho_s - \rho_f)} h$$

The thickness of the freshwater zone above sea level is represented as h and that below sea level is represented as z . The two thicknesses h and z , are related by ρ_f and ρ_s where ρ_f is the density of freshwater and ρ_s is the density of saltwater. Freshwater has a density of about one gram per cubic centimetre at 20 degrees Celsius, whereas that of seawater is about 1.025 grams per cubic centimetre. The equation can be simplified to:

$$z = 40h.$$

Based on the Ghyben-Herzberg relationship, where the depth below sea level to the salt water interface is approximately 40 times the height of the water table above sea level, the saltwater wedge would encroach to a line where the head in the aquifer (in this case the Hawkesbury Sandstone) above sea level drops to less than 1/40th of the depth of the base of the aquifer below sea level. Given that the aquifer thickness is about 200 metres, it is likely that saline groundwater underlies fresh groundwater throughout the project area.

This then means that, for example, if the groundwater level is at four metres AHD salt water would be encountered at a depth of -160 metres AHD. As the groundwater level drops over time, either by pumping from the bore or from tunnel drainage, the thickness of the freshwater lens decreases as the water level approaches sea level. If the elevation of the groundwater head above sea level eventually drops to less than one fortieth of the pump intake or tunnel depth below sea level, they could eventually draw in saline groundwater..

As noted in **sections 6.2.2** and **6.3.2**, there are several areas where there is potential to laterally draw in seawater where the tunnel is or approach structures are close to coastal embayments or channels. There are no recorded groundwater users in these areas and there are unlikely to be any given the already relatively high salinity in the area and availability of alternative water supplies.

There is some potential for upconing of deep saline groundwater beneath existing bores where the groundwater level drops significantly. The risk would depend on the bore depth and groundwater usage. This should be addressed as part of the make good assessment discussed in **section 7.5**.

The greatest impact is likely to be an increase in tunnel inflow salinity over time, although the inflow over these areas is likely to be relatively small as a proportion of total tunnel inflow, therefore the changes in overall inflow chemistry from sea water intrusion are likely to be only moderate. As a precaution, any long-term inflow management system should be designed to handle salinities up to that of seawater.

6.3.6 Potential for acid sulfate soil drainage

The stochastic (run 105) model output indicates drawdown of greater than two metres, in the uppermost layer representing alluvial sediments, in two areas mapped as low risk of acid sulfate soils (ASS) in green in the maximum head case (**Figure 6.42**) plus a high risk area (red) in the minimum and mean head cases (**Figure 6.40** and **Figure 6.41**). However, drawdown within these areas would be limited, as local recharge from the nearby coastline and tidal canals would maintain saturated conditions. The high risk zone is an area of mangroves subject to regular tidal inundation which would prevent drying out and oxidising of potential ASS.

Given the low risk of direct disturbance of ASS by tunnel construction works, or drainage and oxidisation by dewatering, no further assessment of ASS risk is required.

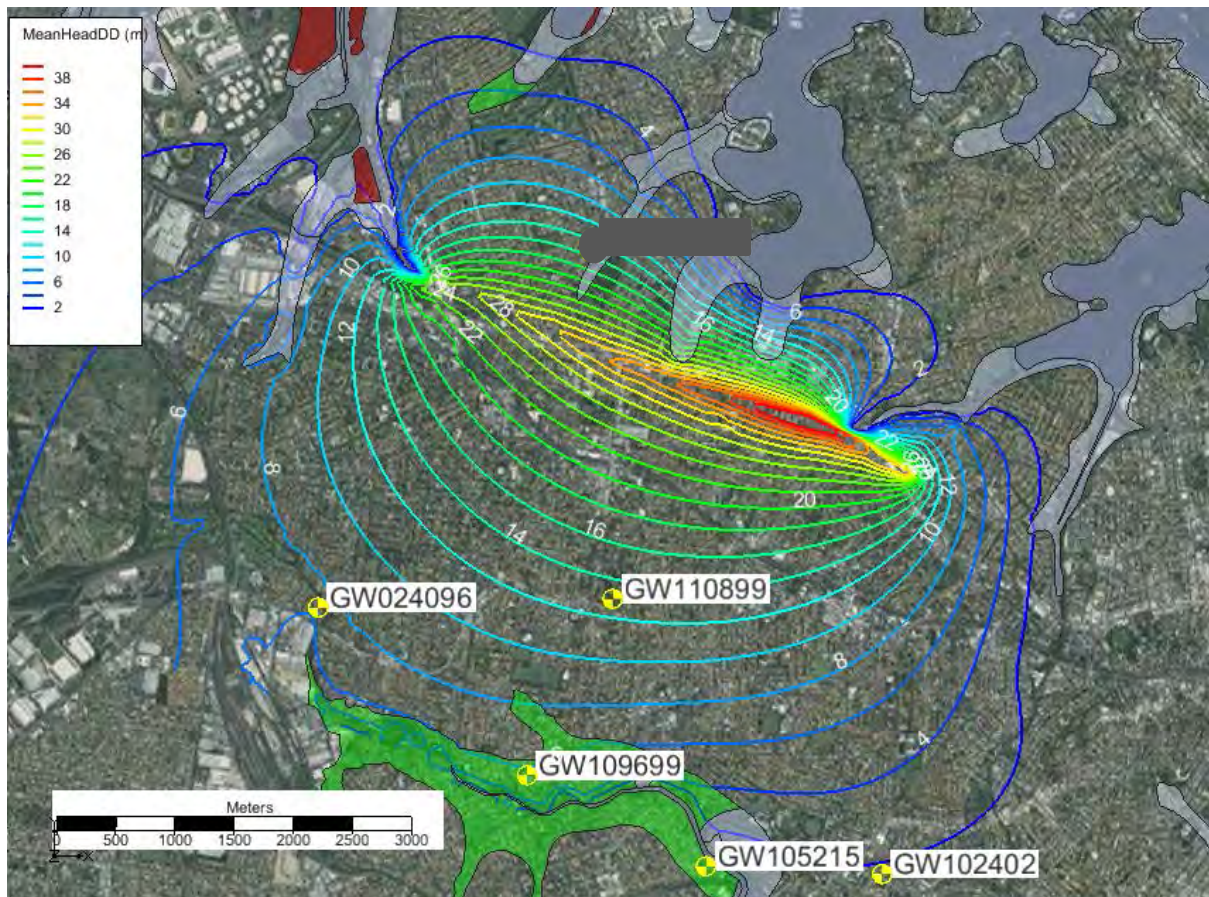


Figure 6.40 Run 105 layer 1 steady-state drawdown (metres) contours, mean predicted head case and ASS high risk (red) and low risk (green) areas.

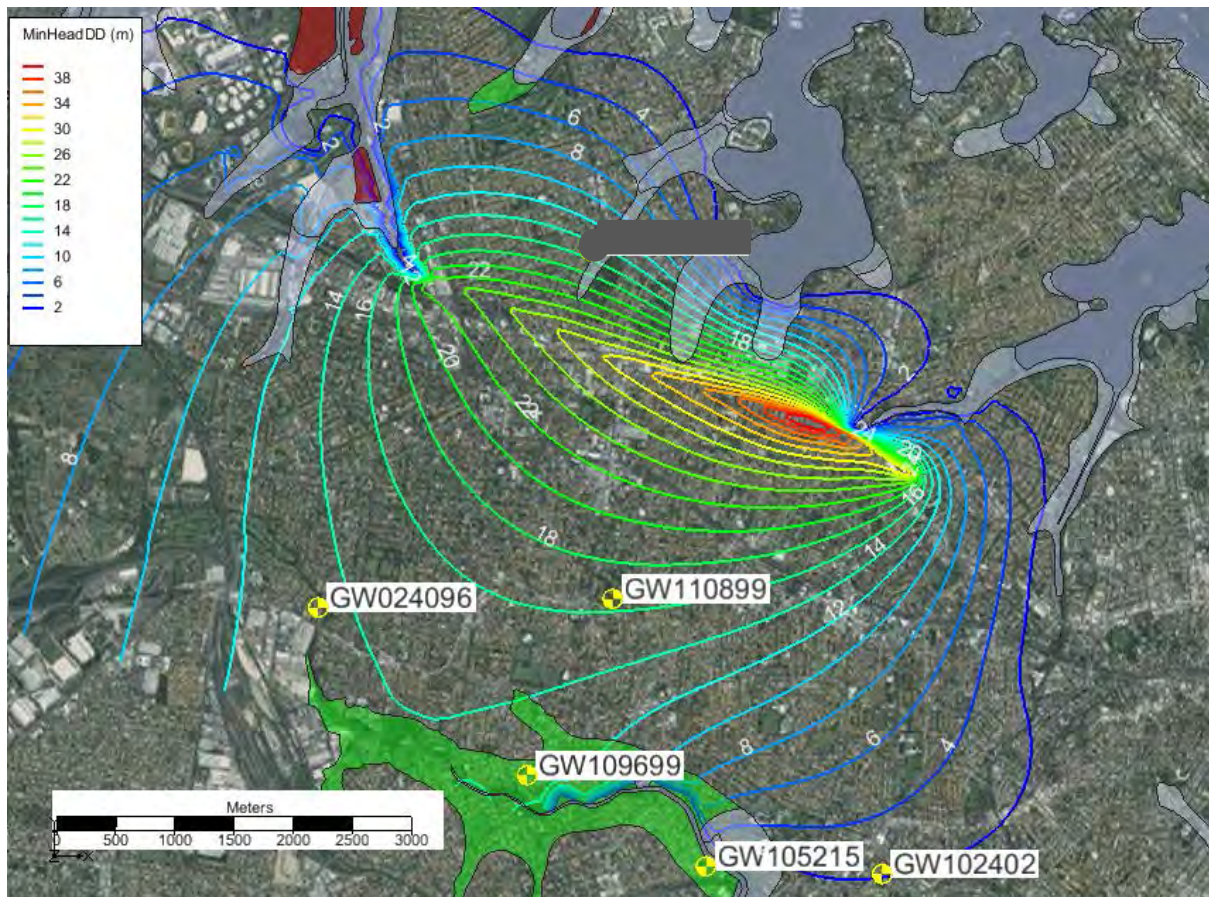


Figure 6.41 Run 105 layer 1 steady-state drawdown (metres) contours, minimum predicted head case and ASS risk areas.

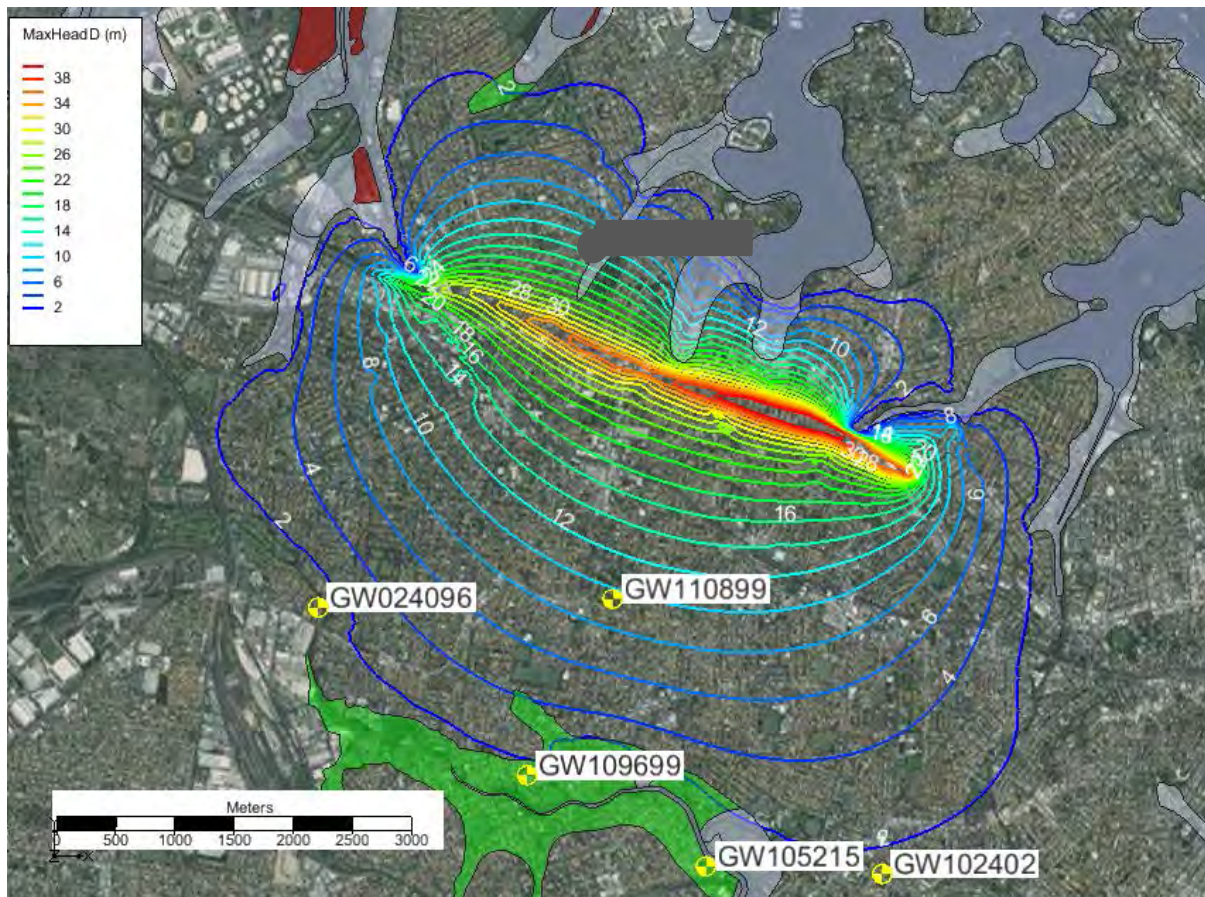


Figure 6.42 Run 105 layer 1 steady-state drawdown (metres) contours, maximum predicted head case and ASS risk areas.

6.4 Summary of impacts relative to the Aquifer Interference Policy

To provide a further understanding of the significance of identified impacts to groundwater (associated with the project) with regard to NSW legislation, the simulated impacts have been compared against the *NSW Aquifer Interference Policy* interference minimal impact criteria. Any exceedances of these criteria have been considered to be potentially adverse and mitigation and monitoring measures are proposed in Chapter 7.

Table 6.12 Summary of impacts relative to Aquifer Interference Policy minimal impact criteria

Type of impact	Minimal impact considerations (1) for aquifer interference activities	Summary of impacts
Water table impacts	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any: (a) high priority groundwater dependent ecosystem, or (b) high priority culturally significant site, listed in the schedule of the relevant water sharing plan. A maximum of a 2 m decline cumulatively at any water supply work.	There are no GDEs or culturally significant sites identified within the extent of the drawdown zone created by the project. The modelling suggests that drawdown curves would intersect with some wetland systems and potential ASS further to the north, which may be potentially groundwater dependent, however these wetland systems rely heavily on the Parramatta River for their water supply and are not likely to be reliant on groundwater from the project area. As such there is a low risk of these features being impacted by drawdown associated with the project. While the risk is low, monitoring and mitigation measures are proposed to reduce this risk further and are discussed in section 7. There are a number of groundwater bores registered for domestic use within the 2 m drawdown impact zone simulated by the modelling. These are considered to be potentially adversely impacted and mitigation and monitoring measures are proposed for these bores in section 7.
	2. If more than 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies (including the hydrogeology, ecological condition and cultural function) would need to demonstrate to the Minister’s satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or culturally significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	Based on the reasons provided for minimal impact item 1. above, these criteria are not expected to be exceeded.

Type of impact	Minimal impact considerations (1) for aquifer interference activities	Summary of impacts
Water pressure impacts	1. A cumulative pressure head decline of not more than a 2m decline, at any water supply work.	There is a number of groundwater bores registered for domestic use within the 2 m drawdown impact zone simulated by the modelling. These are considered to be potentially adversely impacted and mitigation and monitoring measures are proposed for these bores in section 7 .
	2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.	As above
Water quality impacts	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity.	The inherent groundwater quality characteristics and urban environment, suggest that the groundwater has limited beneficial use potential, particularly within the surficial and Ashfield Shale aquifers. It is noted however, that groundwater in the Hawkesbury Sandstone is used for domestic purposes. The modelling suggests that there may be saline water migration from Parramatta River to the M4 corridor, which may change the salinity of the groundwater between the corridor tunnels and Parramatta River. Given the innate groundwater chemistry (high metals), a low likelihood of future use (given that there is reticulated water supply) and that the surrounding urban environment represents ongoing potential for residual impacts, this is not expected to result in a lowering of the beneficial use category of the aquifer system.
	2. If condition 1 is not met then appropriate studies would need to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	Not applicable

7 Mitigation measures

7.1 Groundwater management objectives

The following groundwater management objectives will apply to the construction of the project:

1. Reduce the potential for drawdown of surrounding groundwater resources.
2. Prevent the pollution of groundwater through appropriate controls.
3. Reduce the potential impacts on wetlands which have the potential to be groundwater dependent.

All of the above impacts are broadly managed by minimising tunnel inflow, monitoring impacts and, where impacts cannot be avoided, making good any user's loss of groundwater supply due to water level drop or degradation of water quality.

As significant impact on areas potentially containing ASS is unlikely, due to regular tidal inundation or nearby surface water sources which prevent drainage, no further management or monitoring of ASS is proposed.

7.2 Groundwater inflow management

To limit the volume of inflow water requiring long-term treatment and to minimise the drawdown and changes to groundwater flow directions due to tunnel dewatering for the project, consideration should be given to options to reduce inflow including grouting areas of high inflow. Given the requirement to meet the one litre per second over any given kilometre performance requirement, it is likely that inflow in localised areas of high fracturing or faulting would need to be managed by grouting to seal localised inflow pathways. After grouting operations, inflow in grouted areas should be closely monitored and managed to prevent discharge of highly alkaline water impacted by grout accelerators such as sodium silicate, which can cause injury on contact with skin as well as lead to blockage of drainage infrastructure.

Given the likely elevated iron and salinity of inflowing ambient groundwater and the potential for contamination by grouting materials as well construction and operational contamination, the extracted groundwater would require treatment prior to discharge. This is likely to include as a minimum pH adjustment and aeration to reduce dissolved iron and manganese, settlement to remove precipitated iron as well as sediment and discharge to surface drains discharging to areas with compatible salinity. More detail on water treatment will be provided in the construction soil and water management plan. The management system should be designed to manage salinities up to that of seawater, to allow for long-term saline intrusion in some areas.

7.2.1 Inflow management

Construction-based tunnel inflows are expected to reach a maximum inflow rate of approximately 1600 cubic metres per day (or 584 megalitres per year). As suggested in **section 4.3**, there is currently 43,323 megalitres per year available within the groundwater source and therefore this allocation volume is unlikely to result in exceedance of the sustainable potential for the aquifer systems. It is noted that if a progressive grouting program is adopted both ahead and behind active excavation areas during construction, the overall inflows would be less than the predicted, non-grouted long-term operational flows.

Under operational conditions, the long-term operational tunnel inflows have been designed to achieve an inflow rate of one litre per second per kilometre (approximately 536 megalitres per year), however, simulated inflows prepared for this assessment indicate that operational inflows would be less than this (less than 200 megalitres per year) and would be significantly less than construction inflows. Despite this, areas of high inflow would be treated by targeted grouting and/or installation of localised liners.

7.2.2 Groundwater discharge management

With the volumes of groundwater inflow expected during construction and operation, the only discharge options would be disposal to the sewer via a trade waste licence, offsite disposal or discharge to downstream surface waters.

The best way to minimise the discharge requirements would be to minimise the overall seepage volumes being generated. During operation, this would be completed using targeted grouting to achieve required design inflow criteria of one litre per second over any given kilometre. During construction, this would include implementing the grouting program to reduce flows as tunnelling progresses. The modelling has been based on untreated tunnels (ie no grouting) so it can be expected that construction flows would be below long-term inflows if a progressive grouting programme was adopted.

Once the generation of flows has developed, the groundwater chemistry would require management prior to discharge to surface water. It is expected that groundwater seepage chemistry changes associated with grout (particularly with regard to pH) would be difficult to avoid during construction. To avoid further water quality impacts from construction activities, chemical storage, handling and emergency response procedures would need to be developed. These measures would be developed in accordance with Australian guidance and in consultation with relevant authorities (such as the NSW EPA and DPI Water) and documented in a construction environmental management plan. During operation, the operational design includes a drainage system which would keep groundwater seepage separate from surface water runoff and the surface water drainage system. This would minimise the potential for the operational activities to impact on groundwater seepage quality.

Despite these measures, there would be a low level residual risk of impact from site activities to groundwater seepage that may require treatment before discharge. These constituents would generally include petroleum related compounds such as TRH, BTEX and PAHs. The assessment of groundwater chemistry presented in **section 5.7** also suggests that there are other inherent risks associated with existing groundwater quality, particularly with regard to salinity, pH, metals, sulfates and nitrates. Of these, it is thought that salinity may be managed by strategic placement of discharge points in downstream areas that are more influenced by saline conditions. It is recommended that further surface water quality monitoring is undertaken at the proposed operational discharge location at St Lukes Canal to confirm the need for treatment for salinity prior to discharge.

There will also be design related issues associated with ochre development and groundwater aggressiveness that would need to be considered during detailed design.

As construction proceeds simultaneously across a number of workfronts, there would be a number of points that would generate groundwater seepage requiring management. As such, treatment would be undertaken at a number of tunnelling sites during construction, before discharge to surface waters or as trade waste via the sewer. Once in operation, a single treatment plant at Cintra Park would be able to manage treatment before offsite discharge.

The criteria for treatment plant discharge to surface waters would be based on existing water quality conditions at the point of discharge, with specific environmental criteria being set using the statistical methods outlined in the Australian guidelines for water quality monitoring and reporting (ANZECC & ARMICANZ, 2000). It is recommended that this approach is adopted in preference to the adopted default trigger values (ANZECC & ARMICANZ, 2000a) because the default trigger values are not suitably representative of the background surface water quality conditions and because the surface water systems are significantly disturbed by urban activities. Where no site data are available, the lower ANZECC 95th percentile default trigger value for fresh or marine water criteria would be adopted. In the absence of site-specific data the 95th percentile trigger value would be generally protective of moderately disturbed systems.

While considered unlikely, to suitably protect recreational users potentially coming into contact with treatment plant discharge into surface waters the treatment plant discharge water quality should also meet the Australian drinking water values (NHMRC, 2013) multiplied by a factor of 10, which is in line with the approach adopted by the WHO.

The volumetric and quality criteria required for discharge to trade waste would be established by Sydney Water in a trade waste license and would be expected to be in line with the industrial customer's trade waste acceptance standards listed on the Sydney Water website. In this instance the treatment plant would need to meet these standards before discharge to sewer.

7.3 Ground movement

Further assessments will be undertaken during detailed design to determine the level of potential impact on structures and to identify feasible and reasonable mitigation and management measures required to minimise potential ground movement impacts and make good identified impacts.

Prior to the commencement of tunnelling works, existing condition surveys will be undertaken on properties and structures within the project corridor (the zone on the surface equal to 50 metres from the outer edge of the tunnels) and within 50 metres of surface works. This will ensure a clear record of existing property condition before construction starts. Any damage resulting from the project will be repaired at no cost to the property owner.

7.4 Monitoring

7.4.1 Inflow monitoring

Throughout construction, tunnel water inflow rates and chemistry should be monitored. This should comprise, as a minimum, a general water balance of water pumped from the excavations minus any introduced water along with chemical testing of collected water discharged to treatment plants. Preferably, this monitoring should be broken down by tunnelling construction sections.

The observed inflow rates and chemistry should be compared against the predicted inflows to confirm they are within the range predicted.

Inflow rates and chemistry should continue to be monitored, for a reduced frequency and parameter list based on the results of the construction monitoring, for at least three years post construction.

7.4.2 Groundwater level monitoring

Several monitoring bores have been installed as part of previous investigations. Bores have been inspected to confirm they are still suitable for use and selected bores have been fitted with water level loggers. A groundwater monitoring plan for the project (**Appendix B**) has been developed and initial sampling commenced.

Additional bores should be installed and fitted with loggers in key areas identified as being sensitive to drawdown, including, areas subject to significant changes in water levels and groundwater flow directions.

General locations for these bores are indicated on **Figure 7.1**. The monitoring should be commenced prior to detailed design to allow for adequate assessment of seasonal groundwater level changes and to enable clear characterisation of baseline groundwater level conditions.

Given the lack of deep monitoring facilities in the Hawkesbury sandstone, additional bores should be constructed in this formation between the tunnel and potential sources of saltwater inflow, as well as locations to the south and west to provide background and baseline data.

The licenced bores identified as being at risk of drawdown of greater than two metres should be located to confirm they are still in use and inspected, and the condition, equipment, depth and yield reviewed prior to any tunnel development. Water chemistry and water levels should be regularly monitored prior to development and throughout the life of the project. This would enable a better understanding of the potential impacts as well as determine baseline conditions. If water levels and detailed drilling logs are available for the bores they would provide valuable information for future monitoring and assessment.

Table 7.1 Maximum predicted bore drawdown

Bore ID	Maximum predicted drawdown
GW110899	16 m
GW024096	13 m
GW109699	13 m

The modelling has identified groundwater elevation drawdown risks to the wetlands and potential ASS near Homebush Bay and Mason Park. These risks are expected to be low, as groundwater elevations in this area would be dominated by the Parramatta River and associated tidal fluctuations. To manage this low risk, however, it is recommended that groundwater elevation monitoring is undertaken on the southern fringe of these areas to assess potential impacts to groundwater elevations associated with the project. Automated monitoring using a groundwater elevation logger would properly resolve background conditions on which impacts can be established. There may already be bores in existence that can be used for this purpose. The identification of changes outside the acceptable range in background groundwater levels would instigate additional investigations into wetland health and the presence of ASS.

7.4.3 Groundwater chemistry monitoring

The results of the latest groundwater sampling (June 2015) should be assessed by the tunnel drainage design team to determine water treatment requirements and the potential for mineral precipitation, especially iron and manganese oxyhydroxides and carbonates to cause blockage of inflow collection, reticulation and treatment systems.

The monitoring includes physicochemical parameters, including oxidation-reduction potential, temperature and pH, and major ion and trace inorganic concentrations including dissolved, iron, silica and manganese which are critical for determining scaling rates. The tunnel design team should consider using equilibrium geochemistry models such as MINTEQ or PHREEQC to gain an understanding of likely precipitation rates, to inform drainage design and maintenance requirements.

7.5 Make good requirements

As noted above, there are several existing bores that may suffer drawdown greater than two metres as a result of the project. The need to make good groundwater levels or quality would depend on the individual bore details. Prior to commencement of tunnel excavation works and after the existing condition of the bores have been determined, appropriate make good trigger levels and make good requirements should be developed for each bore. The will include the following process:

- Review groundwater database to confirm locations and current data of licenced extraction bores within the predicted two metre drawdown zone
- Using the cadastral information in the database, identify and contact the bore owners to confirm the bore exists
- Arrange access and inspect the bore or otherwise confirm construction and equipment, obtain any additional construction details held by the owner not in the database, and if possible, measure the flow rate and collect a sample of the bore discharge for analysis
- Develop a suitable water level and chemistry monitoring program to suit the landowner and the bore construction, which defines appropriate water level or water quality trigger levels for potential make good options
- , If trigger levels met, apply appropriate make good options, for example modification of pump settings; compensation for additional power requirements; pump replacement; bore redrilling and/or equipping or provision of an alternative water supply of equivalent quality and cost.

7.6 Pollution management

Machinery used both in above-ground and underground works, and various chemicals such as grout additives, concrete fuels, lubricants and blasting materials have potential to contaminate groundwater during construction. Contamination from within the tunnel post-construction is not possible as groundwater flow would be inwards towards the tunnel and hence contamination cannot escape into the groundwater.

Where practicable, machinery or potentially contaminating equipment should be stored and operated on hardstand or bunded areas during construction. Chemical spill kits should be available on site in case of fuel or chemical spills. A construction and operation waste management plan should be developed to include these items.

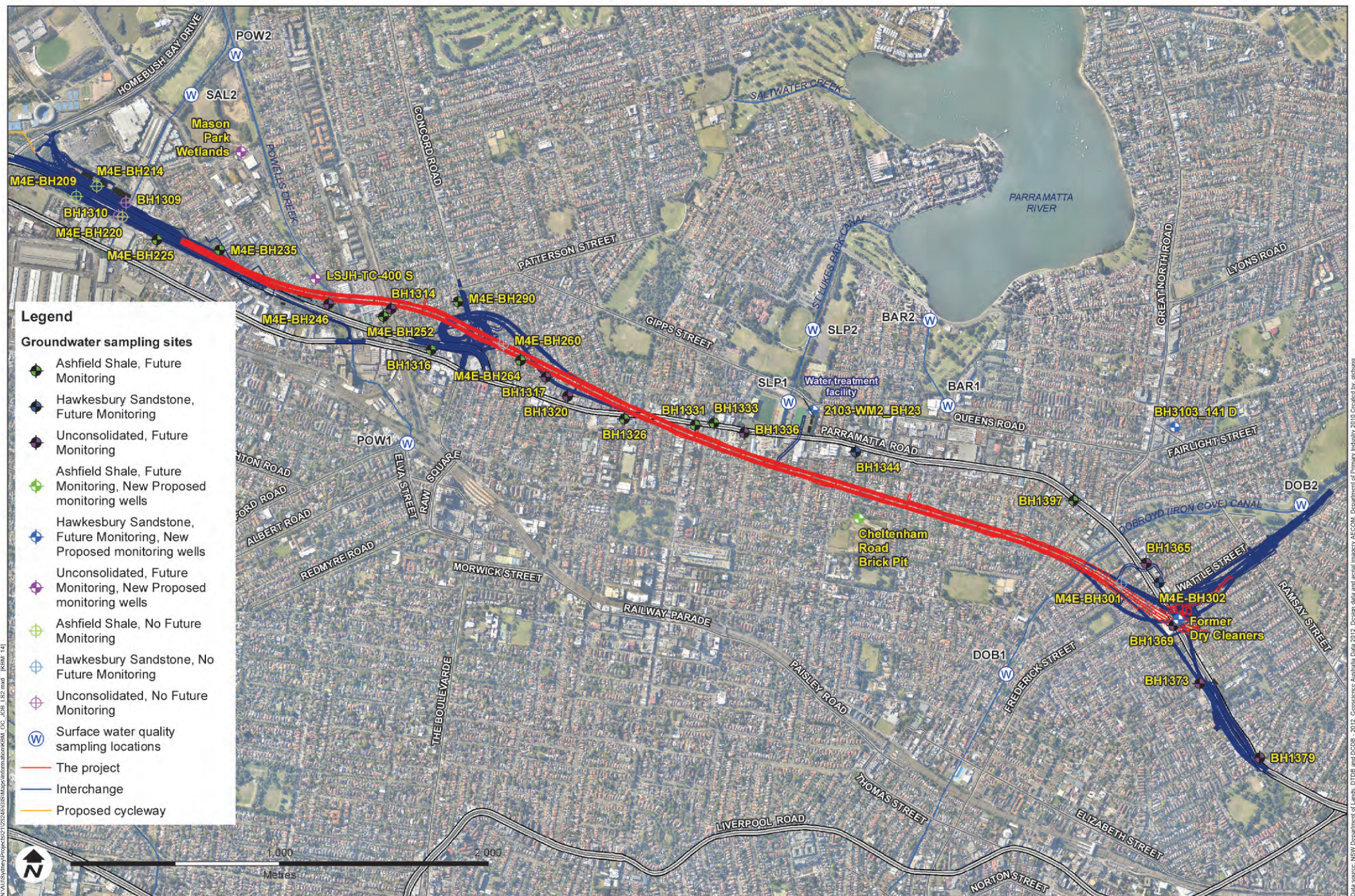


Figure 7.1 Groundwater monitoring locations

8 Scope and limitations

This report has been prepared by GHD for WestConnex and may only be used and relied on by WestConnex for the purpose agreed between GHD and WestConnex as set out below.

GHD otherwise disclaims responsibility to any person other than WestConnex 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 conditions encountered and 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. GHD disclaims liability arising from any of the assumptions being incorrect.

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The desktop study includes the collection of publically available data on the regional hydrogeology, along with the limited site-specific data collected as part of previously proposed projects. Based on this, the level of characterisation of the background conditions and potential impacts are limited to the data available. The assessment is further limited by the preliminary nature of the project design. The assessment, however, is adequate to assess general environmental impacts and recommendations for monitoring and mitigation, which would require refinement as the project passes through the detailed design stage, as well as validation through the construction and operational stages of the project.

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Appendix A Groundwater input data

Geochemistry data summary

Packer testing data summary

Groundwater level monitoring data

Run	Kh layer 1 (m/day)	Kh layer 2 (m/day)	Kh layer 3 (m/day)	Kh layer 4 (m/day)	Kh layer 5 (m/day)	Kh layer 6 (m/day)	Recharge urban (m/day)	Recharge industrial (m/day)	Inflow (m ³ /day)
StdDev	9.99E-01	3.96E-02	4.95E-01	4.95E-01	9.90E-02	4.95E-02	5.0000E-05	9.0000E-06	
Mean	1.00E-01	4.00E-03	5.00E-02	5.00E-02	1.00E-02	5.00E-03	2.0000E-05	3.4000E-06	
105001	1.80E-03	3.76E-03	1.51E-02	3.31E-02	1.35E-02	5.53E-03	2.0003E-05	3.4000E-06	6.01E+02
105002	8.63E-02	4.67E-03	3.09E-02	2.16E-02	1.21E-02	4.73E-03	2.0002E-05	3.3999E-06	4.48E+02
105003	2.41E-01	3.84E-03	7.44E-02	6.28E-02	1.08E-02	5.05E-03	1.9998E-05	3.4000E-06	9.51E+02
105004	8.82E-03	3.17E-03	1.91E-01	5.20E-02	8.20E-03	4.43E-03	2.0001E-05	3.3999E-06	8.04E+02
105005	1.41E-01	4.18E-03	1.37E-01	8.73E-02	8.22E-03	5.78E-03	2.0002E-05	3.3999E-06	1.23E+03
105006	2.28E-03	3.71E-03	3.33E-02	7.20E-02	1.07E-02	5.31E-03	2.0005E-05	3.4000E-06	1.05E+03
105007	3.20E-02	4.24E-03	1.91E-02	4.83E-01	1.54E-02	3.91E-03	1.9993E-05	3.3998E-06	5.53E+03
105008	5.63E-02	4.11E-03	1.84E-01	8.86E-02	1.08E-02	5.33E-03	1.9999E-05	3.3999E-06	1.26E+03
105009	5.79E-02	3.88E-03	2.39E-02	4.21E-02	8.81E-03	4.53E-03	1.9999E-05	3.4000E-06	6.87E+02
105010	7.53E-02	3.66E-03	6.45E-02	1.15E-01	1.05E-02	4.47E-03	2.0003E-05	3.4001E-06	1.55E+03
105011	6.64E-02	4.26E-03	1.74E-01	3.46E-02	7.08E-03	5.22E-03	2.0000E-05	3.4001E-06	5.89E+02
105012	8.17E-02	3.53E-03	9.56E-03	4.89E-02	9.48E-03	5.35E-03	2.0001E-05	3.4001E-06	7.73E+02
105013	7.01E-02	3.67E-03	2.84E-02	2.35E-02	1.01E-02	6.03E-03	2.0003E-05	3.3999E-06	4.60E+02
105014	1.21E-02	3.88E-03	3.41E-02	5.26E-02	1.14E-02	4.28E-03	2.0003E-05	3.4000E-06	8.28E+02
105015	2.71E-03	5.19E-03	1.12E-01	9.95E-03	1.12E-02	4.77E-03	1.9996E-05	3.4000E-06	2.85E+02
105016	2.17E-01	3.48E-03	1.75E-02	2.70E-02	1.33E-02	5.32E-03	1.9999E-05	3.4000E-06	5.23E+02
105017	1.04E-01	3.17E-03	1.01E-01	6.82E-02	7.75E-03	5.36E-03	2.0001E-05	3.3999E-06	9.93E+02
105018	1.17E-02	4.16E-03	5.20E-02	1.41E-01	1.04E-02	5.62E-03	2.0000E-05	3.3999E-06	1.84E+03
105019	5.29E-02	4.51E-03	1.99E-02	3.51E-02	1.14E-02	5.20E-03	1.9997E-05	3.4000E-06	6.17E+02

Run	Kh layer 1 (m/day)	Kh layer 2 (m/day)	Kh layer 3 (m/day)	Kh layer 4 (m/day)	Kh layer 5 (m/day)	Kh layer 6 (m/day)	Recharge urban (m/day)	Recharge industrial (m/day)	Inflow (m ³ /day)
105020	2.65E-03	4.01E-03	5.83E-02	9.86E-02	9.89E-03	5.13E-03	1.9997E-05	3.4000E-06	1.36E+03
105021	5.96E-02	4.02E-03	3.57E-02	7.83E-02	7.15E-03	4.66E-03	2.0001E-05	3.4000E-06	1.11E+03
105022	9.07E-01	4.22E-03	1.07E-02	4.74E-02	1.34E-02	4.54E-03	2.0002E-05	3.4000E-06	7.85E+02
105023	9.79E-02	4.21E-03	1.24E-01	9.38E-03	8.58E-03	4.80E-03	2.0002E-05	3.3999E-06	2.60E+02
105024	2.87E-02	4.19E-03	2.14E-02	3.25E-02	1.27E-02	4.51E-03	2.0001E-05	3.4000E-06	5.90E+02
105025	2.86E-02	4.21E-03	2.83E-02	3.10E-02	1.56E-02	5.13E-03	2.0000E-05	3.4000E-06	5.88E+02
105026	3.44E-03	4.19E-03	4.19E-02	1.73E-02	1.12E-02	4.60E-03	2.0000E-05	3.3999E-06	3.85E+02
105027	1.39E-01	4.13E-03	5.33E-02	1.65E-01	9.93E-03	4.47E-03	1.9999E-05	3.4001E-06	2.12E+03
105028	5.99E-02	3.90E-03	3.91E-02	5.07E-02	1.51E-02	4.76E-03	2.0001E-05	3.4001E-06	8.27E+02
105029	1.41E-01	3.48E-03	5.73E-02	2.91E-02	9.53E-03	5.80E-03	2.0000E-05	3.4000E-06	5.30E+02
105030	1.81E-03	4.06E-03	9.32E-02	9.06E-03	1.14E-02	5.03E-03	2.0001E-05	3.4002E-06	2.71E+02
105031	2.67E-01	3.74E-03	6.77E-02	3.32E-02	7.29E-03	4.49E-03	1.9998E-05	3.3999E-06	5.70E+02
105032	2.72E-01	3.70E-03	4.57E-02	1.11E-01	1.21E-02	4.75E-03	1.9998E-05	3.4000E-06	1.52E+03
105033	3.76E-03	3.68E-03	4.55E-02	1.57E-02	9.70E-03	4.40E-03	1.9999E-05	3.4000E-06	3.52E+02
105034	4.31E-02	3.75E-03	9.73E-02	1.85E-01	9.71E-03	6.01E-03	2.0003E-05	3.3999E-06	2.33E+03
105035	1.46E-02	3.38E-03	1.84E-01	2.78E-02	1.64E-02	5.59E-03	2.0000E-05	3.4000E-06	5.55E+02
105036	7.29E-03	4.09E-03	3.32E-01	3.03E-02	6.30E-03	4.47E-03	1.9999E-05	3.3999E-06	5.32E+02
105037	2.74E-01	4.33E-03	1.97E-01	9.52E-03	1.21E-02	4.90E-03	1.9996E-05	3.4000E-06	2.85E+02
105038	7.39E-02	3.41E-03	1.58E-02	4.12E-02	9.83E-03	5.16E-03	2.0000E-05	3.4000E-06	6.81E+02
105039	6.41E-01	4.12E-03	1.98E-02	5.35E-02	9.52E-03	5.22E-03	2.0002E-05	3.4001E-06	8.35E+02
105040	1.29E-02	4.10E-03	2.52E-02	7.99E-03	9.09E-03	4.95E-03	2.0003E-05	3.4000E-06	2.39E+02
105041	1.54E-02	3.63E-03	2.73E-02	1.35E-01	8.74E-03	4.93E-03	2.0001E-05	3.4000E-06	1.76E+03
105042	1.30E-02	3.50E-03	3.85E-02	1.91E-02	1.24E-02	4.08E-03	2.0002E-05	3.3999E-06	4.13E+02
105043	4.86E-01	4.51E-03	6.51E-02	6.26E-02	8.39E-03	5.34E-03	2.0001E-05	3.4000E-06	9.40E+02
105044	3.39E-01	4.09E-03	2.63E-02	1.00E-01	8.39E-03	5.69E-03	1.9998E-05	3.4000E-06	1.38E+03
105045	5.95E-02	5.70E-03	3.85E-02	4.94E-02	6.90E-03	5.21E-03	2.0002E-05	3.4000E-06	7.72E+02
105046	4.20E-01	3.70E-03	4.32E-02	1.89E-02	1.21E-02	5.78E-03	1.9999E-05	3.4000E-06	4.13E+02

Run	Kh layer 1 (m/day)	Kh layer 2 (m/day)	Kh layer 3 (m/day)	Kh layer 4 (m/day)	Kh layer 5 (m/day)	Kh layer 6 (m/day)	Recharge urban (m/day)	Recharge industrial (m/day)	Inflow (m ³ /day)
105047	1.58E-01	4.39E-03	2.82E-02	3.14E-02	1.45E-02	4.98E-03	1.9998E-05	3.4000E-06	5.89E+02
105048	9.82E-01	3.87E-03	3.04E-02	4.73E-02	1.42E-02	4.78E-03	2.0001E-05	3.4000E-06	7.89E+02
105049	3.16E-03	3.69E-03	1.73E-02	1.55E-02	8.23E-03	4.27E-03	2.0000E-05	3.4000E-06	3.40E+02
105050	2.42E-02	3.98E-03	3.42E-01	1.80E-01	7.60E-03	5.71E-03	2.0002E-05	3.4000E-06	2.27E+03

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Appendix B Groundwater monitoring plan

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WestConnex Delivery Authority

WestConnex M4 East

Pre-construction Groundwater Monitoring Program

September 2015

Prepared for

WestConnex Delivery Authority

Prepared by

GHD Pty Ltd

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Glossary of terms and abbreviations

Term	Meaning
ADWG	Australian drinking water guidelines
AHD	Australian height datum – A common national surface level datum approximately corresponding to mean sea level.
ANZECC	Australian and New Zealand Environment Conservation Council
Aquifer	A groundwater bearing formation sufficiently permeable to transmit and yield groundwater.
Aquitard	A formation that is of sufficiently low permeability to limit groundwater flow relative to more permeable groundwater bearing units.
ASS	Acid sulfate soils
BOM	Bureau of Meteorology
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.
btoc	Below top of casing – The top of the well casing where the depth to groundwater is measured from. The top of casing is usually at similar elevation to ground surface.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site.
DECC	Department of Environment and Climate Change
DGRs	Director General's Requirements
Drawdown	A reduction in piezometric head within an aquifer.
DTV	Default trigger value
DWE	NSW Department of Water and Energy
EC	Electrical conductivity
EIS	Environmental impact statement
EPA	Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
Fracture	Cracks within the strata that develop naturally or as a result of underground works.
GDE	Groundwater dependent ecosystem
GHD	GHD Pty Ltd
GMR	Greater metropolitan region
GMS	Groundwater modelling system
Groundwater	Subsurface water that occurs in soils and geological formations.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks.
Infiltration	The downward movement of water into soil and rock. It is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation) and the antecedent moisture content of the soil.
Kh	Horizontal hydraulic conductivity
Kv	Vertical hydraulic conductivity
L/s/km	Litres per second per kilometre of tunnel. A measure of tunnel groundwater inflow rates
LGA	Local government area
LTAAEL	Long term average annual extraction limit
NOW	NSW Office of Water – Recently renamed as the Department of Primary Industries – Water
NWQMS	National Water Quality Management Strategy
Outcrop	Where the bedrock is exposed at the ground surface.
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
Strata	Geological layers below the ground surface.

Term	Meaning
Structure	The combination or spatial arrangement of primary soil particles (clay, silt, sand, gravel) into aggregates such as peds or clods, and their stability to deformation.
Subsidence	Movements and deformations at the ground surface where: • The vertical downward surface movements are greater than 20 mm • The potential impacts on major surface infrastructure, structures or natural features may be significant, notwithstanding that the vertical downward surface movements are less than 20 mm.
SEARs	Secretary's Environmental Assessment Requirements
Study area	Refers to area of assessment for the groundwater modelling, which is broadly from Cooks River in the south to Parramatta River in the north and from Homebush in the west to Leichhardt in the east.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Tanked tunnel	A tunnel with a fully complete impermeable liner that achieves seepage rates that are, for all intent and purpose, negligible.
TDS	Total dissolved solids
Un-tanked tunnel	A tunnel with a fully complete impermeable liner that achieves seepage rates that are, for all intent and purpose, negligible.
Vertical subsidence	Vertical downward movements of the ground surface.
WAL	Water access licence
WM Act	the Water Management Act 2000 (NSW)
WSP	Water sharing plan

Limitations

This report has been prepared by GHD for WestConnex and may only be used and relied on by WestConnex for the purpose agreed between GHD and WestConnex as set out below.

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The report includes the collection of publically available data on the regional hydrogeology, along with the limited site-specific data collected as part of previously proposed projects. Based on this, the level of characterisation of the background conditions and potential impacts are limited to the data available. The assessment is further limited by the preliminary nature of the project design. The report, however, is considered to be suitable for outlining a suitable groundwater monitoring network, but would require refinement as the project passes through the detailed design, construction and operational stages of the project.

1 Introduction

WestConnex is a major road transport scheme in Sydney, and one of the NSW Government's infrastructure priorities. It is a proposed 33 km toll motorway that will link the west of the city with Sydney Airport and Port Botany, and will feature some of the longest road tunnels in Australia. The scheme is being delivered in several stages. One of these stages - the M4 East project - will be a new tunnel that extends the M4 Motorway from Homebush Bay Drive to Parramatta Road and the City West Link.

GHD was engaged by AECOM Australia Pty Ltd (AECOM) to develop a groundwater quality management program for WestConnex Delivery Authority (WDA) for the project corridor including the M4 Motorway from Homebush Bay Drive at Homebush to Parramatta Road and City West Link (Wattle Street) at Haberfield, in inner western Sydney. These proposed works are described as the M4 East project (the project).

The project works would include two new three-lane tunnels (the mainline tunnels), one eastbound and one westbound, extending from west of Pomeroy Street at Homebush to near Alt Street at Haberfield, where they would terminate. Each mainline tunnel would be about 5.5 kilometres long would have a minimum internal clearance (height), to in-tunnel services, of 5.3 metres and will intersect the groundwater table. The mainline tunnels will have on and off ramps at the western end of the M4 East project near Pomeroy Street, Concord Road, at the City West link / Wattle Street, and to Parramatta Road at the eastern end of the project. The tunnel design would not be fully waterproof or tanked, and therefore groundwater ingress would occur. The seepage would be kept separate from the surface water and collected in a sump at the low point in the tunnel. The groundwater seepage would be discharged by a groundwater rising main to a water treatment plant for treatment and then discharged to St Lukes Park Canal.

An overview of the project is shown in Figure 1. A more detailed description of the project is available in the environmental impact statement (EIS) prepared for WDA by AECOM in September 2015.

The Secretary's Environmental Assessment Requirements (SEARs) for the EIS required that an assessment of groundwater impacts was completed and that, in addition to appropriate mitigation measures, groundwater monitoring be proposed to manage and monitor for the emergence of any potential impacts identified.

The groundwater assessment identified a number of potential issues/impacts that related to groundwater drawdown and groundwater quality impacts and has recommended monitoring as a measure to manage and respond to a number of these impacts.

1.1 Purpose of this report

This pre-construction groundwater monitoring plan builds on the recommendations made in the EIS groundwater assessment and soil and land contamination assessment and details a monitoring program that will allow WDA to identify any impacts pre-construction and characterise the baseline groundwater conditions. It would be modified as required to provide monitoring during construction and once the project is in operation. As the design of the project could change as part of the detailed design process, and groundwater and surface water conditions may change over the pre-construction period, this document should be considered a draft only, and would be modified as conditions change.

The overall objectives of the groundwater monitoring program are to:

- Address the groundwater monitoring requirements outlined in the groundwater and soil and contaminated land assessments
- Provide monitoring measures that will characterise the emergence of potential adverse impacts and safe guard the baseline environment
- Provide a monitoring plan that can be used as a basis for informing baseline, construction and operation monitoring requirements.

The monitoring plan has been designed to be considered in conjunction with a surface water monitoring plan which includes surface water quality sampling.

The groundwater monitoring plan described in this document does not address water ingress volumes and any water allocation license monitoring requirements. It is expected that this would be undertaken as part of the construction environmental management requirements and as part of licensing requirements (if required) or operational management plan requirements during operation.

The report does not specifically detail remedial measures if monitoring criteria are exceeded, however it does acknowledge that further investigation of remedial measures will be required if the selected criteria are exceeded.

At this stage the monitoring plan is designed to provide an understanding of the monitoring program that will be implemented along the corridor for baseline monitoring purposes. This plan will form the basis of a more detailed monitoring plan that will include further discussion on consultation, reporting requirements, implementation responsibilities and emergency response procedures that will be developed as part of management plans for construction and operation.

1.2 Monitoring plan structure

To describe the monitoring plan proposed for implementation the following document structure has been adopted:

- A summary of the key legal drivers outlined in the SEARs and relevant National and NSW policy and guidelines (Chapter 2)
- A summary of the key groundwater values, issues and impacts identified by the groundwater assessment and soil and contaminated land assessment completed for the EIS and recommended monitoring measures (Chapter 3). This provides the basis for the monitoring program
- Based on the key issues, environmental values and the legislative framework, key monitoring plan objectives and performance standards (assessment criteria) are developed (Chapter 4 and 5)
- The details of the monitoring program developed to monitor for impacts are presented in Chapters 6 to 10. This includes the rationale and methods for the sampling program and details the monitoring locations, the sampling parameters that will be measured and the quality assurance procedures that will be adopted for the monitoring
- Reporting requirements for the baseline monitoring are presented in Chapter 11.

2 Regulatory context

2.1 Introduction

The key legislative and policy based drivers for developing the monitoring plan are provided below.

2.2 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements (SEARs) for the environmental impact assessment required that an assessment of groundwater impacts was completed. The SEARs included the following requirements for groundwater monitoring:

"The assessment should include details of proposed surface and groundwater monitoring and be prepared having consideration to the requirements of the NSW Aquifer Interference Policy".

Further to relevant government agencies provided input for the SEARs. In this correspondence the NSW Office of water had the following recommendations:

- *"The environmental assessment be required to include.....Proposed surface and groundwater monitoring"*
- *"Where potential impact/s are identified the assessment will need to identify limits to the level of impact and contingency measures that would remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent groundwater environment or water users, including information on:*
 - *Any proposed monitoring programs, including water levels and quality data.*
 - *Reporting procedures for any monitoring program including mechanism for transfer of information.*
 - *An assessment of any groundwater source/aquifer that may be sterilised from future use as a water supply as a consequence of the proposal.*
 - *Identification of any nominal thresholds as to the level of impact beyond which remedial measures or contingency plans would be initiated (this may entail water level triggers or a beneficial use category).*
 - *Description of the remedial measures or contingency plans proposed.*
 - *Any funding assurances covering the anticipated post development maintenance cost, for example on-going groundwater monitoring for the nominated period."*

2.3 Aquifer interference policy (NOW, 2012)

The NSW Aquifer Interference Policy requires that potential impacts on groundwater sources, including their users and groundwater dependent ecosystems (GDEs), be assessed against minimal impact considerations, as outlined in Table 1 of the policy. If the predicted impacts are less than the Level 1 minimal impact considerations (outlined below), then these impacts would be considered as acceptable.

The policy indicates that the interference of an aquifer from a groundwater source not covered by a water sharing plan (WSP) requires a water licence under the Water Act 1912. Where the activity results in the loss of water from an overlying source that is covered by a WSP, an additional water access licence (WAL) is required under the Water Management Act 2000 (NSW) to account for this take of water.

The policy outlines the requirements for a detailed groundwater impact assessment and sets the requirement for acceptable impacts. The Hawkesbury Sandstone aquifer primarily intersected at the site, which is a highly productive aquifer in some areas even if not locally used as such, would be classed as type 3 porous rock water sources and the conditions from Table 1 – Minimal impact considerations (1) for aquifer interference activities that apply are presented in Table 2.1 below.

Table 2.1 - NSW Aquifer Interference Policy minimal impact criteria (NOW, 2012)

Type of impact	Minimal impact considerations (1) for aquifer interference activities
Water table impacts	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 metres from any (a) high priority groundwater dependent ecosystem, or (b) high priority culturally significant site, listed in the schedule of the relevant water sharing plan. A maximum of a 2 metre decline cumulatively at any water supply work.
	2. If more than 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies (including the hydrogeology, ecological condition and cultural function) would need to demonstrate to the Minister’s satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or culturally significant site. If more than 2 metre decline cumulatively at any water supply work then make good provisions should apply.
Water pressure impacts	1. A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.
	2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister’s satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.
Water quality impacts	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.
	2. If condition 1 is not met then appropriate studies would need to demonstrate to the Minister’s satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

Note: Water supply work is any infrastructure designed to extract water from water systems in NSW.

The criteria in **Table 2.1** will form the basis of setting performance criteria for the monitoring program. These will not apply to the baseline monitoring but will form the basis for assessing emergence of impacts and responding to those impacts during construction and operation.

2.4 Australian Groundwater Monitoring Guidelines

There are various state and federal guidelines and standards for monitoring groundwater in Australia. The guidelines and standards applicable to this project are:

- Australian Standard AS/NZS 5667.11:1998 Water quality – Sampling – Guidance on sampling of groundwaters (AS/ANZ, 1998).
- NSW Guidelines for the Assessment and Management of Groundwater Contamination (DEC, 2007).

- Geoscience Australia – Groundwater Sampling and Analysis – A Field Guide (Sundaram, et al., 2009).
- Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ, 2000)

These documents have been used as a basis for developing the monitoring program and monitoring protocols

2.5 Australian Drinking Water Guidelines

The Australian Drinking Water Guidelines (ADWG) (NHMRC, NRMMC, 2011) provide a framework for the appropriate management of drinking water supplies to achieve a safe and appropriate point of supply. The guidelines provide a base standard for aesthetic and health water quality levels. Groundwater is not used as a potable water supply and the urban area is on a reticulated water supply.

Groundwater may potentially be used for domestic purposes such as for gardens/watering and swimming pools and may include recreational contact. Comparison will therefore be made against ten times the ADWG (a value used as a measure of the risk from incidental ingestion of water from secondary contact, superseding the former recreational water quality guidelines) to assess the risk to the public from incidental exposure to untreated (in-tunnel workers) and treated groundwater (potentially discharged to surface water).

2.6 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the ANZECC guidelines) (ANZECC & ARMCANZ, 2000a), part of the National Water Quality Management Strategy (NWQMS) provides a national framework for improving water quality in Australia's waterways. The main policy objective of the NWQMS is to achieve sustainable use of the nation's water resources, protecting and enhancing their quality while maintaining economic and social development.

The NWQMS process involves community and government interaction, and implementation of a management plan for each catchment, aquifer, estuary, coastal water or other water body. This includes the use of national guidelines for local implementation.

For the project, the national guidelines on water quality benchmarks, the ANZECC guidelines, provide default trigger values (DTV) of various analytes for comparison with sampled values.

From the assessment of these DTVs, site-specific trigger values have been recommended for the project.

2.7 Roads and Maritime Services Water Policy

The above objectives also support the RMS water policy (Roads and Maritime Authority, 1999):-

'The Roads and Traffic Authority would use the most appropriate water management practices in the planning, design, construction, operation and maintenance of the roads and traffic system in order to:-

- *conserve water;*
- *protect the quality of water resources; and*
- *preserve ecosystems'.*

3 Summary of impact assessment

The existing environment desk-top assessment identified a number of key groundwater systems that could potentially interact with the project. These are outlined below.

High risk

- Hawkesbury Sandstone which was identified to be potentially useable for domestic and recreational purposes.

Low risk

- Shallow isolated groundwater systems within alluvium and fill around Powells Creek and Dobroyd (Iron Cove) Canal. These systems were considered to be impacted by urban activities have low environmental and beneficial use potential and have limited connection with the surface systems in these areas as the systems are concrete lined
- Ashfield Shale which was identified to have very low yield potential and high background salinity and therefore to have very limited beneficial use potential.

The assessment included the development of a numerical groundwater flow model to simulate the changes to the groundwater flow environment associated with the project. The modelling indicated the tunnelled areas would dominate the groundwater condition changes created by the project.

The long-term drawdown created by the project was identified to potentially affect a number of nearby bores that potentially use groundwater for domestic purposes. A bore survey was recommended to assess if these bores were being used, with subsequent monitoring and make good provision applying if the bores are adversely impacted (as indicated by the Aquifer interference policy criteria).

The model has simulated the potential migration of saline water into the Hawkesbury Sandstone aquifer from Parramatta River, which may result in beneficial use changes to the aquifer. This was considered to be low risk in that it is unlikely that the aquifer would be used significantly in future. Make good provisions would apply to the existing domestic users if impacts emerged.

The drawdown cone, or zone within which groundwater levels drop by more than two metres, was interpreted to extend beneath surface water features and intersect a zone of wetlands and potential acid sulfate soils near Homebush Bay. The potential for adverse impacts was expected to be low due to groundwater elevations in this area being maintained by inflow and tidal inundation from the Parramatta River, however it was recommended that groundwater elevation monitoring was undertaken in this area with changes outside background conditions being linked to further acid sulfate soils investigations and wetland health assessments.

The model also simulated inflow volumes to the tunnels and suggest that inflows are likely to be approximately 1600 cubic metres per day during construction and less than 450 cubic metres per day during operation. The water sharing plan for this area suggested that there is available water in the groundwater source to accommodate these volumes.

The project tunnels will be drained and therefore seepage will require collection and treatment before discharge. Discharge could either to be sewer or surface water during construction, but on a long term basis discharge to surface water will be required. A treatment plant would be commissioned and located at Cintra Park to manage the maximum expected long term flows (17 litres per second – 1469 cubic metres per day). The treatment plant would be designed to treat key contaminants of concern associated with construction and operational activities and associated with background groundwater concentrations above selected criteria. The treatment criteria recommended for the treatment plant to be protective of aquatic ecosystems would include existing water quality conditions at the point of discharge, with specific environmental criteria being set using the statistical methods outlined in the Australian guidelines for water quality monitoring and reporting (ANZECC & ARMCANZ, 2000). Where there are no site data available the lower value for the ANZECC 95th percentile default trigger value for fresh or marine water criteria would be adopted.

To suitably protect recreational users potentially coming into contact with treatment plant discharge in surface water, the treatment plant discharge water quality should also meet the Australian drinking water values (NHMRC, 2013) multiplied by a factor of 10, which is in line with the approach adopted by the World Health Organisation.

Further to this the groundwater assessment identified other issues that may limit the performance of the capture and treatment systems. These included:

- Groundwater aggressiveness and impact on concrete and steel structures
- Clogging of groundwater collection and drainage systems by precipitation of iron and manganese (Ochre formation).

The soil and contaminated land assessment also identified locations along the project corridor where impacted groundwater may have been present from existing or historical activities. These locations were considered most likely to result in adverse groundwater quality and hence dictate the treatment requirements of groundwater seepage into the tunnel before it could be discharge to surface water.

Groundwater bores were installed at these locations in 2014 to monitor for groundwater impacts and have been included in the monitoring program.

Further to these locations a number of additional sites were identified for monitoring consideration and included:

- A former brick pit located on Cheltenham Road that was understood to have been filled with non-putrescible waste
- A former service station on Parramatta Road near to Chandos Street
- A former dry cleaners located to the east of Bunnings Frederick Street over Parramatta Road.

4 Monitoring objectives

4.1 Performance objectives

When developing a monitoring program, performance objectives must be clearly stated to identify the goals of the monitoring program – i.e. what does the monitoring program aim to achieve. It is important the performance objectives are identified early and are agreed by stakeholders to ensure that the monitoring plan is focused on meeting these objectives.

The performance objectives for the project are based on the findings of the EIS assessment, take into account the key concerns of stakeholders, and reflect the intent of the SEARs.

The performance objectives are outlined in **Table 4.1**, which reflect the performance criteria adopted for other road infrastructure projects adopted in NSW.

Table 4.1 - Performance objectives for the monitoring program

Performance Objective
1. To monitor for the potential impact of the project on groundwater quality and quantity to protect the existing and ongoing human uses of that water.
2. To monitor for the potential impact of the project on water quality to protect existing and future status of aquatic ecology and ecosystem characteristics in all catchments intersected by, and downstream of, the project.

5 Performance standards

The performance objectives of this monitoring plan focus on the following key areas:

- Protection of groundwater quality
- Protection of groundwater hydrology, licensed bores and potential groundwater dependent ecosystems
- Protection surface water quality for aquatic systems and recreational use from discharge of groundwater seepage
- Protection of project infrastructure from clogging and degradation.

The proposed performance standards presented below provide a framework against which the protection of these aspects can be assessed.

5.1 Protection of groundwater quality

The SEARs for the project stipulated that the assessment would:

"have reference to relevant public health and environmental water quality criteria, including those specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMICANZ, 2000a) any applicable regional, local or site-specific guidelines and any licensing requirements"

As noted the key water risks to human health and the environment are expected to be from discharge of groundwater seepage to surface water which may be relied on for recreational purposes and by both freshwater and marine aquatic systems. It is noted that the surface water systems in this area are heavily modified and are concrete lined and as such are not expected to have significant environmental value.

The aquifer interference policy also stipulates that the beneficial use potential groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.

Criteria are also required for assessing groundwater aggressiveness. For the purposes of the pre-construction monitoring, the groundwater chemistry will be compared to the historical data for individual monitoring wells or grouped together for distinct aquifers.

5.1.1 Environmental criteria

As groundwater inflow to the tunnel will require discharge to the surrounding surface water environment it must be compared to guidelines applicable to the receiving water environment. The surrounding waterways are within an urban environment and are expected to be highly to moderately disturbed. *The criteria for treatment plant discharge to surface waters would be based on existing water quality conditions at the point of discharge, with specific environmental criteria being set using the statistical methods outlined in the Australian guidelines for water quality monitoring and reporting (ANZECC & ARMICANZ, 2000a) and discussed below. It is recommended that this approach is adopted in preference to the adopted of default trigger values (ANZECC & ARMICANZ, 2000a) because the default trigger values are not suitably representative of the background surface water quality conditions and because the surface water systems are significantly disturbed by urban activities. Where no site data are available, the lower of ANZECC & ARMICANZ 95th percentile default trigger value for fresh or marine water criteria would be adopted. However, baseline monitoring currently underway is aimed at collecting sufficient data to develop site-specific trigger values for all significant parameters.*

The Australian Guidelines for Water Quality Monitoring and Reporting (Water Quality Monitoring Guidelines) (ANZECC & ARMICANZ, 2000), provide guidance for the development of monitoring programs and assessment of water quality. They form Volume 7 of the National Water Quality Management Strategy (ANZECC, 2000a) of which the ANZECC guidelines are also part.

The Water Quality Monitoring guidelines provide the following discussion of control charts:-

Control charting techniques used for the last 70 years in industry have an important role to play in an environmental context. They are particularly relevant to water quality monitoring and assessment. Regulatory agencies are moving away from the 'command and control' mode of water quality monitoring, and recognising that, in monitoring, the data generated from environmental sampling are inherently 'noisy'. The data's occasional excursion beyond a notional guideline value may be a chance occurrence or may indicate a potential problem. This is precisely the situation that control charts target. They not only provide a visual display of an evolving process, but also offer 'early warning' of a shift in the process level (mean) or dispersion (variability).

The advantages of the use of control charts are identified as:-

- minimal processing of data is required;
- they are graphical: trends, periodicities and other features are easily detected; and
- they have early warning capability: the need for remedial action can be seen at an early stage.

This ability to recognise 'noise' in the water quality data and the early detection of changing trends makes the use of control charts a powerful tool for assessing the impact of the project within a water catchment where other land use factors may be contributing to a change in water quality and where background concentrations are above default trigger values (ANZECC & ARMCANZ, 2000a).

Control charts would be used for the assessment of the impact of treated groundwater discharge to surface water and would include comparing discharge water quality with water quality sampling up and down gradient of the treatment plant discharge point.

5.1.2 Human health criteria

The ADWG (*NHMRC, NRMCC, 2011*) would form the basis of the guidelines used to assess the potential health risks of incidental contact with groundwater. It is noted that the suburbs intersected by the project corridor are on reticulated water supplies and as such groundwater is not expected to be used for potable purposes. To assess the potential health risks associated with incidental exposure to chemical contamination in recreational waters, a simple screening approach concentration of 10 times that stipulated in the drinking water guidelines was adopted. This is the general approach adopted by the World Health Organisation (WHO) and assumes that 200 millilitres per day is consumed from recreational contact with water, which is one tenth of the drinking water intake (two litres). This approach is considered to be conservative because recreational water users are unlikely to come into contact with concentrations high enough to cause adverse effects following a single exposure and because, on a long-term basis, there is unlikely to be on-going continual exposure on which the drinking water criteria are based.

5.1.3 Other criteria

Changes to pH will be used to monitor for the emergence of acid sulfate soil exposure impacts to groundwater. A lower trend in pH over time compared with background conditions will be used as the primary indicator of the emergence of adverse impacts. (ANZECC & ARMCANZ, 2000a) default trigger values lowland rivers in south east Australia will also be used as a guide for recognising if the impact is critical.

Salinity changes will be compared against background conditions. A lower trend in pH over time compared with background conditions will be used as the primary indicator of the emergence of adverse impacts. (ANZECC & ARMCANZ, 2000a) default trigger values lowland rivers in south east Australia will also be used as a guide for recognising if the impact is critical.

5.1.4 Aggressiveness criteria

Sulfate and pH values from the latest groundwater monitoring event would be compared against aggressiveness criteria to better understand the potential impacts of existing groundwater water on subsurface infrastructure. The values adopted included the exposure classification criteria for concrete piles and steel piles presented in Australian Standard AS 2159-2009 Piling – Design and installation.

5.2 Ochre formation

Ferrous (soluble) iron concentrations in groundwater flowing into a drain have been found to be a reasonable indicator of the potential for ochre clogging. Ochre formation is a complex problem involving physical, chemical and biological processes that at times can be very difficult to predict and quantify. **Table 5.1** shows the estimated ochre potential based on ferrous iron concentrations in groundwater. These criteria would be used as a basis for highlighting the potential for ochre development.

Table 5.1 - Ochre potential based on ferrous iron concentrations (adapted from Stuyt et. al. 2005)

Ochre Potential	Ferrous (Fe ²⁺) Groundwater Concentration (mg/L)
Very high	>25
High	10-25
Moderate	5-10
Little	1-5
Negligible	<1

5.3 Protection of groundwater elevation and availability

In accordance with the aquifer interference policy impact criteria a nominal value of 2 metre drawdown relative to background conditions (including seasonal variations) would be used as the basis for determining the presence of an adverse impact at an existing groundwater supply bore. For any drawdown greater than this, more good provisions would apply.

5.4 Protection of groundwater dependent ecosystems

In accordance with the aquifer interference policy if more than 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 metres from the potential groundwater dependent ecosystem identified at Homebush Bay then further studies would be implemented to that the variation would not prevent the long-term viability of the dependent ecosystem.

6 Monitoring locations

6.1 Groundwater monitoring locations

The selection of groundwater monitoring sites for monitoring of impacts has been based on the outcomes of the assessment and modelling of impacts summarised in Section 3. These include:

- Assessing drawdown at potential acid sulfate soil areas surrounding Mason Park
- Assessing the water quality in the area of the proposed tunnel (particularly around historical and current potentially contaminating activities) for understanding water treatment requirements at treatment plants prior to discharge during construction and operation
- Characterising groundwater elevations within the impacted drawdown zone of the tunnel
- Monitoring for saltwater intrusion.

Further to this the monitoring locations have been designed to:

- Establish baseline water quality in a range of lithological units
- Establish baseline water quality along the entire project
- Allow ongoing monitoring during baseline, construction and operation and therefore allow consistency in the establishment of impacts during construction and operation.

To meet the above criteria, a selection of the 27 groundwater monitoring locations noted below are proposed for monitoring. The final number of locations may vary as the design changes or site conditions change. Some of the locations noted may be omitted due to sampling safety issues (bores on roads) or conflicting use (geotechnical monitoring). The well details and locations are presented in **Table 6.1** and **Figure 6.1**. The figure presents some locations which have recently been monitored but may need to be decommissioned as there is potential that they would be destroyed during construction. Some may be replaced with nearby bores or there may be adequate existing bores to take their place.

Photos of each location, where available, are presented in the Appendix C.

Table 6.1 - Wells Proposed for Baseline Monitoring

Bore ID	Existing / New Well	East (m)	North (m)	Well Depth (m)	Screen lithology
M4E-BH225	Existing	322208	6251637	17.95	Ashfield Shale
M4E-BH235	Existing	322508	6251588	15.2	Ashfield Shale
M4E-BH252	Existing	323294	6251270	28	Ashfield Shale
M4E-BH246	Existing	323031	6251330	6	Unconsolidated
BH1314	Existing	323330	6251307	7.5	Unconsolidated
BH1316	Existing	323522	6251111	7	Ashfield Shale
M4E-BH290	Existing	323651	6251341	20	Ashfield Shale
M4E-BH264	Existing	323950	6251060	18	Ashfield Shale
BH1317	Existing	324072	6250981	7	Unconsolidated
BH1320	Existing	324177	6250888	8.5	Unconsolidated
BH1326	Existing	324447	6250779	26	Ashfield Shale
BH1331	Existing	324785	6250750	7	Ashfield Shale
BH1333	Existing	324876	6250760	8	Ashfield Shale
BH1336	Existing	325021	6250714	8	Unconsolidated
BH1344	Existing	325555	6250622	25	Hawkesbury Sandstone
BH1397	Existing	326599	6250388	-	Ashfield Shale
BH1365	Existing	326948	6250090	16.8	Unconsolidated
M4E-BH302	Existing	327010	6249996	50	Hawkesbury Sandstone
BH1369	Existing	327079	6249791	8.5	Unconsolidated
BH1373	Existing	327204	6249512	8	Unconsolidated
BH1379	Existing	327491	6249158	9	Unconsolidated
Mason Park Wetlands	Existing	322610	6252060	10	Unconsolidated
LSJH-TC-400 S	New	322968	6251451	TBD	Unconsolidated
2103-WM2_BH23	Existing	325351	6250822	20	Hawkesbury sandstone
Cheltenham Road Brick Pit	Existing	325570	6250304	TBD	Ashfield Shale
BH3103_141 D	Existing	327085	6250741	TBD	Hawkesbury Sandstone
Former Dry Cleaners	New	327102	6249820	TBD	Hawkesbury Sandstone

Notes:

Blue highlighted locations represent approximate locations of new wells proposed for monitoring (six in total) which do not currently exist

TBD = to be determined

6.2 Surface water monitoring locations

Surface water monitoring locations will be required upstream and down-gradient of proposed treatment plant discharge points to surface water, as well as background locations outside the likely influence of tunnelling works, to facilitate and understanding of the proposed impact in stream water quality.

During construction there could be multiple discharge locations. These locations have not been established as yet. During operation it is expected that there will be a single treatment plant at Cintra Park (see **Figure 6.1****Error! Reference source not found.**) that will discharge to St Lukes Park Canal adjacent to the plant. The exact discharge point location could change depending on the salinity of the groundwater processed (a discharge location further down gradient and more influenced by seawater may facilitate less treatment for salinity).

There is currently a surface water monitoring program which includes twelve locations as indicated in Figure 1 and presented in **Table 6.2**. The surface water monitoring plan has been developed separately to groundwater, but is summarised herein to show the interrelationships between the two plans.

Table 6.2 - Surface water monitoring site details

Name	US/DS	Creek	Easting	Northing	Street address
POW1	US	Powells Creek	323407	6250662	4 Elva St, Strathfield
POW2	DS	Powells Creek	322585	6252522	Mason Park, Conway Ave Homebush
SAL1	US	Saleyards Creek	321495	6263956	Airey Park, Kessel Ave, Homebush
SAL2	DS	Saleyards Creek	322370	6252331	5 Underwood Road, Homebush
SLP1	US	St Lukes Park Canal	325232	6250861	Northern carpark Concord Oval, Gipps St entrance
SLP2	DS	St Lukes Park Canal	325347	6251207	Crane St car park, Concord
BAR1	US	Barnwell Park Canal	325995	6250844	104 William Street car park, Five Dock
BAR2	DS	Barnwell Park Canal	325909	6251252	2 Bellbird Close, Canada Bay
DOB1	US	Dobroyd Canal	326275	6249558	Gregory Ave
DOB2	DS	Dobroyd Canal	327689	6250369	Henley Marine Dr, Timbrell Park
USW	US	Finlaysons Creek	312451	6256914	68 Killeen Street, Wentworthville (Lytton St Park)
DSW	DS	Hawthorne Canal	328412	6248898	Hawthorne Pde

Notes: US = Upstream of project alignment DS = Downstream of project alignment

There are two surface water monitoring locations near to Cintra Park (SLP1 and SLP2 on Figure 1), that are currently being monitored and could form the baseline water quality data for comparison with treatment plant discharge water quality.

6.3 Groundwater seepage and treatment plant discharge monitoring

While not part of baseline monitoring, during construction and operation collected groundwater seepage and treatment plant discharge will be required to be monitored to understand treatment requirements, treatment efficiency and suitability for discharge to the receiving water environment. This will also provide early warning of any changes to groundwater inflow chemistry.

7 Sample parameters

7.1 Water Quality

The key drivers behind the water quality parameters selected are:

- Monitoring for groundwater impacts associated with general urban activities and the key potentially contaminating land uses along the project from the perspective of assessing treatment requirements. This primarily includes industrial and petroleum-related compounds such as heavy metals, benzene toluene, xylene, ethylbenzene, total recoverable hydrocarbons and polynuclear aromatic hydrocarbons. It may also include other organic constituents such as volatile organic compounds originating from dry cleaning practices, polychlorinated biphenyls from electrical substations and organo-chlorine pesticides. Ammonia and nitrate which are key constituents associated with landfills such as at that at Cheltenham Road could also be present in groundwater
- Characterising the potential for ochre development (iron and manganese) and aggressiveness (sulfate and pH) of the ambient groundwater environment to inform design and effective water management and hence treatment
- Understanding the background relationship between groundwater and surface water (receiving environment) to outline key natural difference that will require management for discharge, particularly with regard to metals, salinity (electrical conductivity and total dissolved solids), turbidity (and suspended solids), temperature and pH. Further to this instream ecological conditions are dependent on the relative abundance of nitrogen (in its various forms) and phosphorus.

The baseline sample parameters selected have been designed to address these key drivers. These parameters would be reviewed to inform the development of the construction and operational monitoring program.

Based on initial rounds of sampling that have been undertaken along the alignment and presented in the groundwater assessment, it is proposed that the metals analysis focuses on informing drainage suitability (such as ochre development) and characterising those metals that have been detected above adopted trigger values in previous sampling. This includes:

- Arsenic
- Beryllium
- Cadmium
- Cobalt
- Copper
- Chromium
- Iron (ferrous, ferric, total and dissolved)
- Lead
- Manganese
- Mercury
- Nickel
- Vanadium
- Zinc.

Initial rounds of field measurements presented in the groundwater assessment suggest that some organic based constituents are not present and as such only those contaminants previously detected have been selected for ongoing monitoring except where the existing or historical land uses suggest that additional targeted analytes should be considered (such as volatile organic compounds around dry cleaners).

Monitoring of field parameters including dissolved oxygen, temperature, pH, oxygen reduction potential, and electrical conductivity would be undertaken for quality assurance purposes, and these will also characterise ambient conditions and differences between surface water and groundwater.

The analytical schedule for the well proposed near the Homebush Bay wetlands focuses on assessing the generation of acid conditions (such as low pH or change in major ion ratios) and lowering of the groundwater table.

Additional sampling for sulfate for water aggressiveness purposes is not considered necessary as a reasonable picture is considered to have been obtained from existing monitoring.

Table 7.1 presents the analytical schedule proposed to be adopted for monitoring wells along the alignment.

Table 7.1 - Baseline Groundwater Monitoring Analytical Schedule

Bore ID	Screen lithology	Rationale for Selection	Proposed Water Quality Parameters
M4E-BH225	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
M4E-BH235	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus ferrous and ferric iron and manganese, total iron, speciated nitrogen, phosphorus, TDS.
M4E-BH252	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
M4E-BH246	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
BH1314	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
BH1316	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.

Bore ID	Screen lithology	Rationale for Selection	Proposed Water Quality Parameters
M4E-BH290	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
M4E-BH264	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
BH1317	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
BH1320	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
BH1326	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
BH1331	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
BH1333	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
BH1336	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
BH1344	Hawkesbury Sandstone	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
BH1397	Ashfield Shale	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.

Bore ID	Screen lithology	Rationale for Selection	Proposed Water Quality Parameters
BH1365	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
M4E-BH302	Hawkesbury Sandstone	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
BH1369	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters, TRH, BTEX, PAH, Dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
BH1373	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
BH1379	Unconsolidated	Near potentially contaminating activities, that may impact groundwater seepage treatment requirements.	Insitu field parameters. Intermittent TRH, BTEX and PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium and manganese. Speciated nitrogen, phosphorus, TDS.
Mason Park Wetlands	Unconsolidated	New well to monitor for low risk potential drawdown and ASS impacts at Mason Park and Homebush Bay Wetlands	Field parameters, TDS, Dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese, major ions
LSJH-TC-400 S	Unconsolidated	To monitor of impacts to Powells Creek - To be installed as part of geotech programme (may not be available if used for geotechnical monitoring).	Insitu field parameters, TRH, BTEX, PAH. Dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
2103-WM2_BH 23	Hawkesbury sandstone	Existing well checked to be suitable for monitoring saltwater intrusion into Hawkesbury Sandstone	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
Cheltenham Road Brick Pit	Ashfield Shale	Characterise groundwater elevations to south in shales and assess impact from former landfill.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.
BH3103_141 D	Hawkesbury Sandstone	To monitor Hawkesbury Sandstone for purpose of increasing number of monitoring wells in this system.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS.

Bore ID	Screen lithology	Rationale for Selection	Proposed Water Quality Parameters
Former Dry Cleaners	Hawkesbury Sandstone	Monitoring Sandstone quality and for detecting impacts from the former Dry Cleaners - Needs to be shallow and above tunnel depth.	Insitu field parameters, TRH, BTEX, PAH, dissolved metals 8 plus vanadium, cobalt, beryllium, and manganese. Total, ferrous and ferric iron, speciated nitrogen, phosphorus, TDS. Intermittent VOCs

Notes:

Blue highlighted locations represent new wells proposed for monitoring (six in total) which do not currently exist

TBD = to be determined

TDS = total dissolved solids

BTEX = benzene, toluene, ethylbenzene and xylene

PAH = polynuclear aromatic hydrocarbons

VOC = volatile organic compounds

For the purposes of highlighting consistency with the surface water monitoring program being implemented, the analytical schedule adopted for the surface water sampling sites presented in **Figure 6.1** are summarised in **Table 7.2**.

Table 7.2 Surface water monitoring analytical schedule

Analyte	Surface Water Sampling
Temperature (field)	✓
pH (field)	✓
Dissolved oxygen (field)	✓
Oxygen reduction potential (field)	✓
Electrical conductivity (field)	✓
Suspended Solids	✓
Dissolved Metals (8 metals)	✓ (minus mercury)
Total Kjeldahl Nitrogen	✓
Nitrogen (Total Oxidised)	✓
Nitrogen (Total)	✓
Phosphate total (P)	✓
Total Recoverable Hydrocarbons	✓
Benzene, toluene, ethylbenzene, xylene (BTEX) and mono aromatic hydrocarbons	✓
Polycyclic aromatic hydrocarbons (PAH)	✓ (Naphthalene only)

All of these compounds have been proposed for the groundwater analytical suite except for suspended solids, which is not considered to be a key issue for groundwater. Suspended solids would be added to the treatment plant monitoring requirements during construction and operation.

Groundwater seepage and treatment plant discharge monitoring would be required during construction and operation to inform treatment requirements and efficiency of treatment. The same analytical schedule would be adopted for groundwater seepage and treatment plant discharge to that outlined above. It is recommended that major ions are also scheduled during construction and operation to inform the potential for scale generation and further assessment of speciation (and hence saline influence).

7.1.1 Sampling frequency

Groundwater sampling will be initially undertaken on a monthly basis to characterise the baseline conditions and to highlight seasonal changes in baseline quality.

Reduced sampling (every second month) is proposed for a number of analytes where previous monitoring has indicated no detectable concentrations. These are highlighted as being monitored intermittently in **Table 7.1**.

It is expected that quarterly groundwater monitoring during construction and operation would be suitable to characterise changes in groundwater quality conditions as groundwater migration is slow and quality changes would subsequently emerge slowly. This would be subject to consultation with DPI – Water.

It is expected that operation monitoring will continue for a maximum period of 3 years or until there is confidence that there are no impacts emerging.

Groundwater seepage and treatment plant monitoring would be required during construction and operation. The sampling frequency will be based on the confidence in the treatment plant achieving the appropriate water quality for discharge to surface water or sewer. Where confidence is lower the sampling regime will be increased accordingly to provide confidence that discharge water quality is meeting the discharge criteria. Given this initial sampling rates may be daily, but as data provides greater confidence in the treatment plant discharge water quality the sampling rate may be dropped to a monthly or quarterly basis that is in-line with surface water quality sampling frequencies.

7.2 Groundwater elevation monitoring

Groundwater elevation monitoring will be completed at all monitoring well locations during water quality monitoring. Based on this, sampling frequency will be on a monthly basis for the baseline monitoring. This may change for construction and operational purposes.

To provide a more detailed understanding of the groundwater behaviour in different lithological units and in key areas, such as near to the Homebush Bay wetland systems water level loggers would be installed in the wells listed in **Table 7.3**. The sampling frequency would be at a maximum of daily intervals during baseline, construction and operation stages.

Table 7.3 - Groundwater level logger locations

Bore ID	Lithology
BH1326	Ashfield shales (to be moved to Homebush Bay Wetlands when location is confirmed)
BH1344	Hawkesbury sandstone
BH1365	Unconsolidated aquifer
BH246	Unconsolidated aquifer
BH260	Ashfield Shale

7.3 Groundwater seepage monitoring

To inform treatment plant volume requirements the inflow rates and chemistry would be monitored during construction and operation. During construction, flow monitoring could be required at multiple locations in order to determine specific treatment volumes for batch treatment plants located at each active tunnelling location.

Seepage monitoring would also help to identify whether the seepage rates are within the specified seepage requirements for design and or are meeting licensing requirements for operation (if required). This could mean that during operation seepage flows are monitored at kilometre intervals along the groundwater seepage collection system.

8 Monitoring method

All fieldwork would be conducted in general accordance with GHD's Standard Field Operating Procedures which are aimed at ensuring that all environmental samples are collected by a set of uniform and systematic methods, as required by GHD's Quality Assurance system.

8.1 Groundwater levels and purging

The static groundwater level within each groundwater monitoring well will be measured prior to purging or sampling of monitoring wells. The water level will be measured using a groundwater level dip meter from the Top of Casing (TOC). The measurement will be taken to the nearest millimetre. Similarly, the Bottom of Casing (BOC) will be measured as well by lowering the meter to the base of the well until it touches the bottom of the casing. These levels will be recorded on groundwater standard sampling record sheets (Appendix A).

Following the initial measurements of water level, the groundwater monitoring well will be purged prior to sampling. Purging ensures that stagnant water within the well casing is removed and a representative sample is able to be taken. The purging of the well will be undertaken with either a bladder pump or peristaltic pump using a low flow method. The pump will be attached to a water quality meter with a flow through cell, which allows the observation of water quality parameters (temperature, dissolved oxygen, pH, oxidation and reduction potential and electrical conductivity) during purging. The flow rate of the pump will be regulated (where possible) to match the recharge rate of the groundwater well if possible.

The groundwater monitoring well will be considered to be purged when one of the following criteria is achieved (whichever occurs first):

- Three well volumes of water have been purged
- The well is purged until no more water can be removed (considered dry)
- The water quality parameters are stabilised within 10% over three consecutive recorded measurements.

While not anticipated, in the event that low-flow sampling methods are not feasible, a disposable plastic bailer or dedicated inertial sampler will be used for purging and sampling.

During purging, abstracted water will also be observed for colour, odour, the presence of sheens (that may be representative of the presence of petroleum related constituents) and sediment content.

All equipment will be calibrated prior to commencing purging and sampling and re-calibrated for each subsequent day of sampling (if required). Copies of laboratory calibration certificates and field calibration events will be kept with the groundwater sampling record sheets.

8.2 Collection of sample for laboratory analysis

At the completion of purging, groundwater samples will be collected directly into dedicated laboratory supplied sampling bottles with sufficient volume to satisfy the requirements for all analytes. The samples will be placed into a chilled ice-chest for transport to the nominated laboratory(s). The constituents and parameters to be analysed are listed in **Table 7.1** (Section 7). Where required for some laboratory containers (metal analysis), the water sample will also be field filtered using a dedicated 0.45 µm water filter to remove fine suspended particles.

To prevent cross-contamination, dedicated tubing for the low-flow pump will be used at each sampling location. Non-dedicated equipment will be decontaminated with phosphate-free detergent and clean water between sampling locations. A new pair of disposal nitrile gloves will also be used between sampling locations.

8.3 Quality assurance and control

8.3.1 Quality control samples

The collection of quality assurance and control samples during sampling will be undertaken to ensure the integrity of the dataset. Field quality control procedures for use during the project shall comprise the collection and analysis presented in **Table 8.1**.

Table 8.1 - QAQC samples and procedures

Type	Purpose and Description	Frequency
Rinsate Blank (Equipment blank)	A sample of analyte free water poured over decontaminated field sampling equipment prior to the collection of samples. The rinsate sample is used to assess the adequacy of the decontamination process	One scheduled per day of sampling, where sampling methods use the same equipment between locations.
Blind Duplicate (Intra-lab Replicate)	Comprises a single sample that is divided into two separate sampling containers. Both samples are sent anonymously to the project laboratory. Blind duplicates provide an indication of the analytical precision of the laboratory as well as sampling procedures, but are inherently influenced by other factors such as sampling techniques and sample media heterogeneity.	Collected and analysed at a rate of not less than 20%.
Split Duplicate (Inter-laboratory replicate)	Comprises a single sample that is divided into two separate sampling containers. Each sample will be sent to a different project laboratory. Split duplicates provide an indication of the analytical proficiency of the laboratories as well as sampling procedures.	Collected and analysed at a rate of not less than 20%.
Trip Spike	A sample is prepared by the testing laboratory, containing known quantities of volatile contaminants. The trip spike accompanies the samples between the site and laboratory. The trip spike is analysed for benzene, toluene, ethyl benzene and xylene (BTEX) and Total recoverable hydrocarbons (TRH) C6-C9 compounds and results are used to assess the loss of volatile contaminants during transport of the samples.	Not considered necessary for this program. Reasons for this are presented in the following report text.
Trip Blank	A sample of laboratory supplied deionised water is bottled and accompanies the other samples over the course of the fieldworks and submitted to the laboratory for analyses. Trip blanks provide an indication of contamination introduced during sample transport and handling, and also ensure that the testing laboratory is not reporting "false positives". Trip blanks should not indicate concentrations of the chemicals of potential concern (CoPC) above the laboratory detection limit.	Not considered necessary for this program. Reasons for this are presented in the following report text.

Field (trip) blanks have not been collected and/or are not recommended as part of the sampling program. While these can be useful components of a QA/QC program, their omission is not considered to affect the outcome of the sampling program. The rationale for this omission is summarised below.

The role of trip blanks is to detect potential contamination during sample transport and nominally comprise deionised water. Given that the samples are sealed immediately following collection, it would not be expected that cross contamination of samples would have occurred. In order for contamination to occur during transit the bottles would have to be compromised (i.e. break or be open), which is recorded by the laboratory upon receipt and subsequently reported on laboratory results and would act as a suitable indicator of the sample bottles being compromised.

Samples reporting concentrations of metals and TRH below the laboratory detection limit may also be considered representative of surrogate trip blanks, demonstrating no introduction of contaminants during the sample handling procedure. Initial sampling results suggest that a number of these results exist.

Field (trip) spikes have not been collected and/or are not recommended as part of the sampling program. While these can be useful components of a QA/QC program, their omission is not considered to affect the outcome of the sampling program. The rationale for this omission is summarised below.

Trip spikes are samples of deionised water that are spiked with known concentrations of BTEX compounds. While the NSW OEH states that these samples can be collected, there is no guidance regarding how results from the analysis of these samples are to be evaluated. Further, given that volatile loss could occur immediately after the trip spike is prepared and may in fact continue to occur whilst the sample is in transit from the laboratory to the field (before reaching site), it is not considered that trip spike results would reliably assist in evaluating the potential loss of volatiles from samples collected in the field.

Rinsate blanks can provide an indication of the thoroughness of decontamination of sampling equipment and may be taken to evaluate whether cross contamination between sampling points has occurred. The absence of rinsate blanks will result in false positives if cross contamination occurs during the sampling program, which means that not taking rinsate blanks is inherently conservative.

8.3.2 Quality assurance documentation

Sample identification and records

At each sampling location, a sampling record sheet is completed to accurately note information associated with the collection of the samples. Examples for the field record sheets are supplied in Appendices A and B. As a minimum the sample record sheets will include the following information:

- Location of groundwater well;
- Details of sampling location (location ID);
- Date and time of sampling;
- Method of sampling;
- Name of sampler;
- Any duplicate samples taken at the sampling location (if applicable);
- Preservation procedure; and
- Any other information which may assist with results interpretation and analysis.

The sample containers used for sampling are supplied by the nominated analytical laboratory and have the appropriate preservation within the bottles prior to filling. To prevent misidentification of samples, each sample is labelled with a unique identification (sampling location), and as a minimum the following will be written on the label:

- Unique sample ID;
- Date and time of sampling;
- Samplers name or initials; and
- Unique job / project number

Chain of custody

Following the completion of sampling, a chain of custody (CoC) record will be completed to document the sample history and to schedule the relevant analyses. The CoC accompanies the samples to the laboratory at all times. An example of the laboratory CoC is supplied in Appendix B. As a minimum the CoC must have the following information:

- Laboratory reference number;
- Site identification;
- Contact details of sampler and project manager;
- Sample type;
- Sample collection time and date;
- Analyses to be performed by the laboratory;
- Sample preservation (if applicable);
- Dispatch information and signature; and
- Any comments or details about the samples which may assist in analysis.

8.3.3 Sampling personnel

All fieldworks will be undertaken by nominated staff with appropriate qualifications and experience in similar investigations. Where nominated staff vary from that proposed, they will be appropriately trained by staff familiar with the project. The name of staff undertaking the sampling will be recorded on the sampling record sheets for each sampling location and event.

9 Data analysis and interpretation

9.1 Water quality

During baseline monitoring the focus would be on building up an understanding of the background water quality against which construction and operation quality results could be compared. This would include comparing water quality criteria against the selected water quality criteria (see Section 5) and developing statistics that represent background water quality characteristics including the development of data ranges and the average, median and 80th percentile values for the baseline data set.

During construction and operational phases, the monitoring program would focus on assessing whether any changes in groundwater quality are attributable to the project. This would include comparing results with baseline dataset statistics for increasing trends in those statistics. It would also include plotting the concentrations of key contaminants (with detections and potentially unacceptable trends) over time to visualise the significance of trends. It would also include comparison against trigger values adopted for the presence of exceedances.

If exceedances/unacceptable trends were identified a management response would be instigated. The management response for observed impacts is outlined in Section 10.

For treatment plant discharge the data analysis and interpretation would include comparing treatment plant discharge water quality with background surface water quality conditions (up-stream and down-stream of the discharge point). The data analysis would include development of a control chart which compares the 80th percentile values from the up-stream site to the median values for a down-stream site. Comparison would also be undertaken between treatment plant discharge water quality and the quality of the up-stream monitoring location and for exceedances of default trigger values.

If exceedances/unacceptable trends were identified a management response would be instigated. The management response to any observed impacts are outlined in Section 10.

9.2 Groundwater elevations

Where groundwater drawdown exceeds more than two metres (in accordance with the AIP) compared with baseline conditions in monitoring wells screened in the same lithology to the nearest groundwater use bore a potential adverse impact at the water use bore will be considered to exist and further management actions would be implemented. Further management will include the following process:

- Review groundwater database to confirm locations and current data of licenced extraction bores within the predicted two metre drawdown zone
- Using the cadastral information in the database, identify and contact the bore owners to confirm the bore exists
- Arrange access and inspect the bore or otherwise confirm construction and equipment, obtain any additional construction details held by the owner not in the database, and if possible measure the flow rate and collect a sample of the bore discharge for analysis
- Develop suitable water level and chemistry monitoring program to suit the landowner and the bore construction
- Define appropriate water level or water quality trigger levels for potential make good options such as modification of pump settings, compensation for additional power requirements, pump replacement, bore redrilling and equipping or provision of an alternative water supply of equivalent quality and cost.

The Homebush Bay Wetlands (Mason Park) are recognised as a potential groundwater dependent ecosystem. In accordance with the AIP, a variation of 10% or more outside the baseline conditions would trigger further management actions. The analysis and interpretation would include comparing key statistics for the baseline groundwater elevation dataset with construction and operation datasets. It would also include plotting groundwater elevations over time to visually identify any changes associated with construction and operation.

10 Management outcomes

For a monitoring program to be effective, the performance objectives, performance standards and measurement criteria trigger must be linked to management actions. The management outcomes outlined in this section relate specifically to where the monitoring program identifies potential impacts. Management actions and responses for all other environmental impacts would be covered under the Construction Environmental Management Plans (CEMPs) and operational environmental management systems.

In the event that management actions are triggered any short term solutions will be implemented where possible to prevent ongoing impacts while detailed investigations are being undertaken to isolate the source of impact.

Subsequent to the identification of the source of the issues, long term solutions would be developed to mitigate the impact or appropriately manage the ongoing impact.

For groundwater quality issues this may include:

- Enhanced treatment before discharge to surface water
- Developing engineered solutions to prevent seepage from contaminated areas
- Review and changing site practices to prevent ongoing impacts (i.e. cut off walls)
- Segregation of inflow streams to enable beneficial re-use or minimise treatment requirements.

For groundwater elevations related issues this may include:

- Make good provisions
- Enhancing recharge to minimise drawdown impacts
- Engineered solutions to decrease hydraulic connection with drawdown at the receptor.

11 Baseline monitoring reporting requirements

A monthly baseline report would be developed that would be designed to facilitate consistency in monitoring completed for the project. The monthly baseline monitoring report would include the following key topics:

- An overview of the project monitoring and drivers
- The monitoring configuration including what is being monitored
- The monitoring approach including a discussion of:
 - The monitoring parameters and measurement methods/protocols
 - The quality assurance and control procedures
- Water Quality and Groundwater Elevation Assessment Criteria
- Results including tabulated presentation of the results relevant to select criteria and graphs of key analytical constituents to show and time series plots of groundwater elevations and water quality for the parameters of key concern
- Summary statistics for each parameters at each monitoring location
- Recommendations for changes to the monitoring plan based on the results.

The report will be provided to WestConnex Delivery Authority after completion of each monitoring report.

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Appendix A Groundwater sampling field sheet

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PROJECT DETAILS	Borehole ID
Project Number:	
Project Name:	Sample ID:
Client:	Date:
Site:	Sampler:
Well Condition (i.e road box, locked etc):	Purge Method:
Depth to Water Table Pre-purge (from TOC):	Sample Method:
Depth of PSH (from TOC):	Casing Type:
Depth to Bottom of Casing (BOC) from TOC:	Well Diameter:
Casing Stickup:	Calculated Bore Volume(L):
Depth to Water Table Post - purge (from TOC):	QA Collected:

[illegible]

Post Sample Parameters							

Number of Bottles:	Comments:
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Well Volume Calculation (50mm diameter) $3.8 \times H$ (H=height of water column)

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Appendix B Chain of custody document

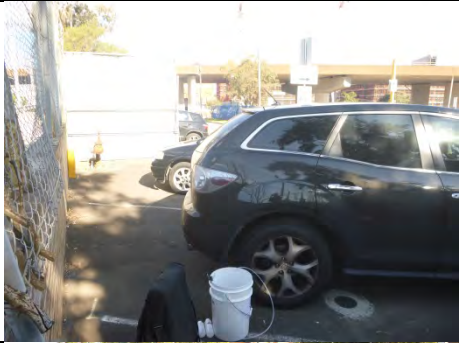
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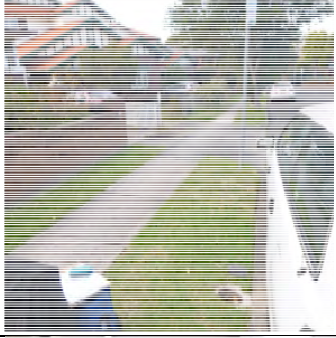
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Appendix C Photographs of groundwater monitoring wells

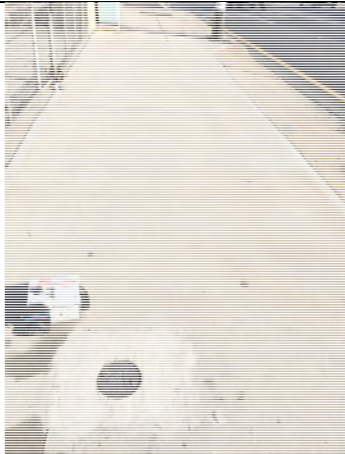
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Monitoring Well	Location Description	Location Photo
2103-WM2_BH23	Installed in the grass to the east Cintra Hockey Complex, Concord.	
M4E-BH209	Installed in the reserve on the southern side of the M4, north of Flemington Road, Homebush.	
M4E-BH214	Installed in the grass reserve on the northern side of the M4 and the southern side of DFO Homebush.	
M4E-BH220	Installed in the grass on the north eastern end of Park Road, Homebush and adjacent to a stormwater canal.	

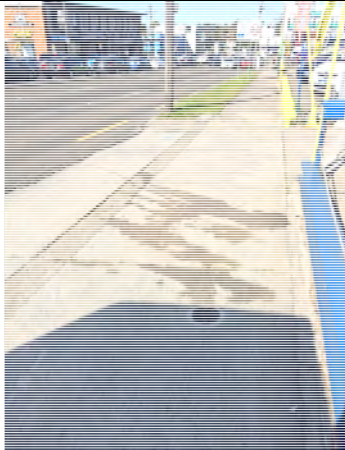
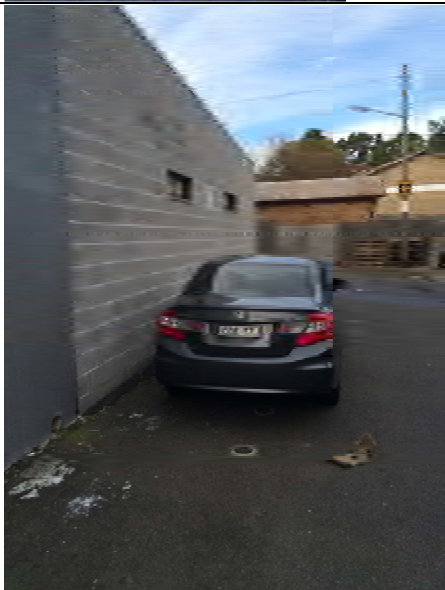
Monitoring Well	Location Description	Location Photo
M4E-BH225	Installed in the reserve on the southern side of the M4, north of Flemington Road, Homebush.	
M4E-BH235	Installed in a grass reserve south of Pomeroy Street, Homebush.	
M4E-BH246	Installed in a reserve south of Allen Street, Homebush.	
M4E-BH252	Installed in a car park adjacent Railway Lane, North Strathfield.	
M4E-BH260	Installed in the grass adjacent Alexandria Street, Concord.	

Monitoring Well	Location Description	Location Photo
M4E-BH264	Installed in the nature strip adjacent Daly Avenue, Concord.	
M4E-BH290	Installed in the grass north of Welfare Street, Homebush.	
M4E-BH301	Installed in the grass adjacent Page Avenue, Ashfield.	
M4E-BH302	Installed in the side of Northcote Street, Haberfield.	
BH1309	Installed in the grass reserve on the northern side of the M4 and the south eastern corner of DFO Homebush.	

Monitoring Well	Location Description	Location Photo
BH1310	Installed in the grass on the north eastern end of park road adjacent a stormwater canal.	
BH1314	Installed in the nature strip on the side of the road.	
BH1316	Installed in the grass behind the property.	
BH1317	Installed in the centre of Ada Street.	

Monitoring Well	Location Description	Location Photo
BH1320	Installed in the side of Coles Street, Concord.	
BH1326	Installed in the footpath adjacent Park Road, Burwood.	
BH1331	Installed in the footpath on the southern side of Parramatta Road.	
BH1333	Installed in the footpath on the side of Parramatta Road.	

Monitoring Well	Location Description	Location Photo
BH1336	Installed in the footpath on the southern side of Parramatta Road, Burwood.	
BH1344	Installed in the side of Cheltenham Road, Croydon.	
BH1373	Installed in the footpath on the northern side of the road.	
BH1379	Installed in the middle of the footpath on the corner of Rodgers Avenue and Parramatta Road.	

Monitoring Well	Location Description	Location Photo
BH1397	Installed in the footpath on side of Parramatta Road.	
BH3103_141	Installed in the centre of Cashman Lane, Five Dock.	

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Appendix C Groundwater geochemical data

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Appendix C
Table 1
November 2014 Sampling Event - Groundwater Analytical Results

Westconnex Delivery Authority
WestConnex
Targeted Phase II Contamination ASS Assessment

											Area			Section 1. Homebush Bay Drive to Short Street East			Section 3. Powells Creek to Concord Road			Section 4. Concord Road to Grantham Street		
											Location ID			BH1309		BH1310	BH1314	BH1316		BH1317	BH1320	
											Sample Date			6/11/2014		4/11/2014	6/11/2014	4/11/2014		6/11/2014	4/11/2014	
											Field ID			BH1309		QA3	BH1310	BH1314	BH1316	QA1	BH1317	BH1320
											Sample Type			Normal		Interlab D	Normal	Normal	Normal	Field D	Normal	Normal



Appendix C
Table 1
November 2014 Sampling Event - Groundwater Analytical Results

Westconnex Delivery Authority
WestConnex
Targeted Phase II Contamination ASS Assessment

										Area			Section 1. Homebush Bay Drive to Short Street East			Section 3. Powells Creek to Concord Road			Section 4. Concord Road to Grantham Street				
										Location ID		BH1309		BH1310		BH1314		BH1316		BH1317		BH1320	
										Sample Date		6/11/2014		4/11/2014		6/11/2014		4/11/2014		6/11/2014		4/11/2014	
										Field ID		BH1309		QA3		BH1310		BH1314		BH1316		QA1	
										Sample Type		Normal		Interlab D		Normal		Normal		Normal		Field D	
										Normal		Interlab D		Normal		Normal		Field D		Normal		Normal	
																				</			



Appendix C
Table 1
November 2014 Sampling Event - Groundwater Analytical Results

Westconnex Delivery Authority
WestConnex
Targeted Phase II Contamination ASS Assessment

										Area		Section 1. Homebush Bay Drive to Short Street East			Section 3. Powells Creek to Concord Road			Section 4. Concord Road to Grantham Street										
										Location ID		BH1309		BH1310		BH1314		BH1316		BH1317		BH1320						
										Sample Date		6/11/2014		4/11/2014		6/11/2014		4/11/2014		6/11/2014		4/11/2014						
										Field ID		BH1309		QA3		BH1310		BH1314		BH1316		QA1		BH1317		BH1320		
										Sample Type		Normal		Interlab D		Normal		Normal		Field D		Normal		Normal				
										ANZECC 2000 FW 95%		ANZECC 2000 MW 95%		ANZECC 2000 FW Med-Low Reliability		NEPM 2013 Table 1A(4) Rec HSL D GW for Vapour Intrusion, Sand			NEPM 2013 Table 1C GILs, Fresh Waters		NEPM 2013 Table 1C GILs, Marine Waters		NEPM 2013 Table 1C GILs, Drinking Water					



Appendix C
Table 1
November 2014 Sampling Event - Groundwater Analytical Results

Westconnex Delivery Authority
WestConnex
Targeted Phase II Contamination ASS Assessment

											Area		Section 5. Grantham Street to Wattle Street						Section 6. Wattle Street to Ormond Street			
											Location ID	BH1326	BH1331	BH1333	BH1336	BH1344	BH1365	BH1369	BH1373	BH1379		
											Sample Date	4/11/2014	4/11/2014	4/11/2014	4/11/2014	6/11/2014	5/11/2014	5/11/2014	5/11/2014			
											Field ID	BH1326	BH1331	BH1333	BH1336	BH1344	BH1365	BH1369	BH1373	BH1379		
											Sample Type	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal		
											ANZECC 2000 FW 95%	ANZECC 2000 MW 95%	ANZECC 2000 FW Med-Low Reliability	NEPM 2013 Table 1A(4) Rec HSL D GW for Vapour Intrusion, Sand			NEPM 2013 Table 1C GILs, Fresh Waters	NEPM 2013 Table 1C GILs, Marine Waters	NEPM 2013 Table 1C GILs, Drinking Water			
Analyte	Units	EQL				2-4m	4-8m	>8m														
Surfactants																						
MBAS	µg/L	100										-	-	<100	-	-	-	-	-			
Inorganics																						
pH (Lab)	pH Units	0.1										7	6.6	6.1	6.3	6.8	6.3	5.4	6	4.8		
Metals																						
Arsenic (Filtered)	mg/L	0.001										0.003	0.003	<0.001	<0.001	0.002	<0.001	0.002	0.001	<0.001		
Cadmium (Filtered)	mg/L	0.0001	0.0002	0.0055	0.0002							0.0002	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001		
Chromium (III+VI) (Filtered)	mg/L	0.001	0.001	0.0044								<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
Copper (Filtered)	mg/L	0.001	0.0014	0.0013	0.0014							0.0014	0.0013	0.001	0.002	<0.001	0.001	0.002	0.002	0.004		
Lead (Filtered)	mg/L	0.001	0.0034	0.0044	0.0034							0.0034	0.0044	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
Mercury (Filtered)	mg/L	0.00005	0.0006	0.0004								0.00006	0.0001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005		
Nickel (Filtered)	mg/L	0.001	0.011	0.07	0.011							0.042	0.006	0.012	0.002	0.006	0.057	0.017	0.032	0.003		
Zinc (Filtered)	mg/L	0.001	0.008	0.015	0.008							0.25	0.014	0.059	0.011	0.013	0.11	0.054	0.097	0.022		
TRH - NEPM 2013																						
C6-C10 minus BTEX (F1)	µg/L	10				6000	6000	7000				<10	<10	<10	<10	29	<10	<10	<10	<10		
C6 - C10 Fraction	µg/L	10										<10	<10	<10	<10	34	<10	<10	<10	<10		
>C10-C16 minus Naphthalene (F2)	µg/L	50				NL	NL	NL				110	<50	<50	<50	220	50	<50	<50	<50		
>C10 - C16 Fraction	µg/L	50										110	<50	<50	<50	230	50	<50	<50	<50		
>C16 - C34 Fraction (F3)	µg/L	100										180	<100	<100	<100	310	140	<100	<100	<100		
>C34 - C40 Fraction (F4)	µg/L	100										200	<100	<100	<100	<100	<100	<100	<100	<100		
TRH - NEPM 1999																						
C6 - C 9 Fraction	µg/L	10										<10	<10	<10	<10	23	<10	<10	<10	<10		
C10 - C14 Fraction	µg/L	50										<50	<50	<50	<50	130	<50	<50	<50	<50		
C15 - C28 Fraction	µg/L	100										170	<100	<100	<100	370	130	<100	<100	<100		
C29 - C36 Fraction	µg/L	100										<100	<100	<100	<100	<100	<100	<100	<100	<100		
C10 - C36 (Sum of Total)	µg/L	100										-	-	-	-	-	-	-	-	-		
BTEX & MAH																						
Benzene	µg/L	1	950	700	950	5000	5000	5000	950	500	1	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Toluene	µg/L	1			180	NL	NL	NL			800	<1	<1	<1	<1	1	<1	<1	<1	<1		
Ethylbenzene	µg/L	1			80	NL	NL	NL			300	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Xylene (o)	µg/L	1	350		350				350			<1	<1	<1	<1	1	<1	<1	<1	<1		
Xylene (m & p)	µg/L	2										<2	<2	<2	<2	3	<2	<2	<2	<2		
Xylene Total	µg/L	3				NL	NL	NL			600	-	-	-	-	-	-	-	-	-		
1,2,4-trimethylbenzene	µg/L	1										<1	<1	<1	<1	2	<1	<1	<1	<1		
Isopropylbenzene	µg/L	1			30						30	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Styrene	µg/L	1									30	<1	<1	<1	<1	<1	<1	<1	<1	<1		
PAH																						
Pyrene	µg/L	1										<1	<1	<1	<1	<1	<1	<1	<1	<1		
Acenaphthene	µg/L	1									530	<1	<1	<1	<1	1	<1	<1	<1	<1		
Acenaphthylene	µg/L	1	16							50		<1	<1	<1	<1	2	<1	<1	<1	<1		
Anthracene	µg/L	1			0.01							<1	<1	<1	<1	<1	<1	<1	<1	<1		
Benz(a)anthracene	µg/L	1										<1	<1	<1	<1	<1	<1	<1	<1	<1		
Benzo(a)pyrene	µg/L	1			0.1						0.01	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Benzo(b+j)fluoranthene	µg/L	1										-	-	-	-	-	-	-	-	-		
Benzo(k)fluoranthene	µg/L	1										-	-	-	-	-	-	-	-	-		
Benzo(b)&(k)fluoranthene	µg/L	2										<2	<2	<2	<2	<2	<2	<2	<2	<2		
Benzo(g,h,i)perylene	µg/L	1										<1	<1	<1	<1	<1	<1	<1	<1	<1		
Chrysene	µg/L	1										<1	<1	<1	<1	<1	<1	<1	<1	<1		
Dibenz(a,h)anthracene	µg/L	1										<1	<1	<1	<1	<1	<1	<1	<1	<1		
Fluoranthene	µg/L	1			1							<1	<1	<1	<1	<1	<1	<1	<1	<1		
Fluorene	µg/L	1									290	<1	<1	<1	<1	3	<1	<1	<1	<1		
Indeno(1,2,3-c,d)pyrene	µg/L	1										<1	<1	<1	<1	<1	<1	<1	<1	<1		
Naphthalene	µg/L	1	16	70	16	NL	NL	NL	16	50		<1	<1	<1	<1	5 - 6	<1	<1	<1	<1		
Phenanthrene	µg/L	1			0.6							<1	<1	<1	<1	5	<1	<1	<1	<1		
PAHs (Sum of total) - Lab calc	µg/L	1										0	0	0	0	-	0	0	0	0		
Benzo(a)pyrene TEQ (LOR) - Lab Calc	µg/L	5										<5	<5	<5	<5	-	<5	<5	<5	<5		

[Filter]



Appendix C
Table 1
November 2014 Sampling Event - Groundwater Analytical Results

Westconnex Delivery Authority
WestConnex
Targeted Phase II Contamination ASS Assessment

			Area							Section 5. Grantham Street to Wattle Street						Section 6. Wattle Street to Ormond Street		
			Location ID	BH1326	BH1331	BH1333	BH1336	BH1344	BH1365	BH1369	BH1373	BH1379						
			Sample Date	4/11/2014	4/11/2014	4/11/2014	4/11/2014	6/11/2014	5/11/2014	5/11/2014	5/11/2014	5/11/2014						
			Field ID	BH1326	BH1331	BH1333	BH1336	BH1344	BH1365	BH1369	BH1373	BH1379						
			Sample Type	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal						
			ANZECC 2000 FW 95%	ANZECC 2000 MW 95%	ANZECC 2000 FW Med-Low Reliability	NEPM 2013 Table 1A(4) Rec HSL D GW for Vapour Intrusion, Sand		NEPM 2013 Table 1C GILs, Fresh Waters	NEPM 2013 Table 1C GILs, Marine Waters	NEPM 2013 Table 1C GILs, Drinking Water								
Analyte	Units	EQL				2-4m	4-8m	>8m										
VOCs																		
1,1,1,2-tetrachloroethane	µg/L	1									<1	<1	<1	<1	<1			
1,1,1-trichloroethane	µg/L	1			270						<1	<1	<1	<1	<1			
1,1,2,2-tetrachloroethane	µg/L	1			400						<1	<1	<1	<1	<1			
1,1,2-trichloroethane	µg/L	1	6500	1900	6500			6500	1900		<1	<1	<1	<1	<1			
1,1-dichloroethane	µg/L	1			90						<1	<1	<1	<1	<1			
1,1-dichloroethene	µg/L	1			700					30	<1	<1	<1	<1	<1			
1,2,3-trichlorobenzene	µg/L	1	10		3			3		30	<1	<1	<1	<1	<1			
1,2,3-trichloropropane	µg/L	1									<1	<1	<1	<1	<1			
1,2,4-trichlorobenzene	µg/L	1	170	80	85			85	20	30	<1	<1	<1	<1	<1			
1,2-dibromoethane	µg/L	1									<1	<1	<1	<1	<1			
1,2-dichlorobenzene	µg/L	1	160		160			160		1500	<1	<1	<1	<1	<1			
1,2-dichloroethane	µg/L	1			1900					3	<1	<1	<1	<1	<1			
1,3,5-trimethylbenzene	µg/L	1									<1	<1	<1	<1	<1			
1,3-dichlorobenzene	µg/L	1	260		260			260			<1	<1	<1	<1	<1			
1,4-dichlorobenzene	µg/L	1	60		60			60		40	<1	<1	<1	<1	<1			
2-butanone (MEK)	µg/L	1									-	-	-	-	-			
4-methyl-2-pentanone (MIBK)	µg/L	1									-	-	-	-	-			
Bromodichloromethane	µg/L	1									<1	<1	<1	<1	<1			
Bromoform	µg/L	1									<1	<1	<1	<1	<1			
Carbon disulfide	µg/L	1			20						-	-	-	-	-			
Carbon tetrachloride	µg/L	1			240					3	<1	<1	<1	<1	<1			
Chlorobenzene	µg/L	1			55					300	<1	<1	<1	<1	<1			
Chlorodibromomethane	µg/L	1									<1	<1	<1	<1	<1			
Chloroethane	µg/L	10									<10	<10	<10	<10	<10			
Chloroform	µg/L	1			370						<1	<1	<1	<1	<1			
cis-1,2-dichloroethene	µg/L	1									<1	<1	<1	<1	<1			
cis-1,3-dichloropropene	µg/L	1									<1	<1	<1	<1	<1			
Cyclohexane	µg/L	1								13,000	<1	<1	<1	<1	<1			
Dibromomethane	µg/L	1									<1	<1	<1	<1	<1			
Dichloromethane	µg/L	1			4000					4	-	-	-	-	-			
Hexachlorobutadiene	µg/L	1			0.04					0.7	<1	<1	<1	<1	<1			
Iodomethane	µg/L	1									-	-	-	-	-			
n-butylbenzene	µg/L	1									<1	<1	<1	<1	<1			
n-propylbenzene	µg/L	1									<1	<1	<1	<1	<1			
p-isopropyltoluene	µg/L	1									<1	<1	<1	<1	<1			
sec-butylbenzene	µg/L	1									<1	<1	<1	<1	<1			
TCE	µg/L	1			330						<1	<1	<1	<1	<1			
tert-butylbenzene	µg/L	1									<1	<1	<1	<1	<1			
Tetrachloroethene	µg/L	1			70					50	<1	<1	<1	<1	<1			
trans-1,2-dichloroethene	µg/L	1									<1	<1	<1	<1	<1			
trans-1,3-dichloropropene	µg/L	1									<1	<1	<1	<1	<1			
Trichlorofluoromethane	µg/L	10									<10	<10	<10	<10	<10			
Vinyl chloride	µg/L	10			100					0.3	<10	<10	<10	<10	<10			
OC Pesticides																		
4,4-DDE	µg/L	0.2			0.03						<0.2	<0.2	<0.2	<0.2	<0.2			
a-BHC	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
Aldrin	µg/L	0.2			0.001						<0.2	<0.2	<0.2	<0.2	<0.2			
b-BHC	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
chlordan	µg/L	1	0.08		0.03			0.03		2	-	-	-	-	-			
Chlordane (cis)	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
Chlordane (trans)	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
d-BHC	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
4,4 DDD	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
4,4 DDT	µg/L	0.2	0.01		0.006			0.006		9	<0.2	<0.2	<0.2	<0.2	<0.2			
Dieldrin	µg/L	0.2			0.01						<0.2	<0.2	<0.2	<0.2	<0.2			
Endosulfan I	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
Endosulfan II	µg/L	0.2			0.007						<0.2	<0.2	<0.2	<0.2	<0.2			
Endosulfan sulphate	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
Endrin	µg/L	0.2	0.02	0.008	0.01			0.01	0.004		<0.2	<0.2	<0.2	<0.2	<0.2			
Endrin aldehyde	µg/L	0.2									<0.2	<0.2	<0.2	<0.2	<0.2			
Endrin ketone	µg/L	0.1									-	-	-	-	-			
g-BHC (Lindane)	µg/L	0.2	0.2		0.2			0.2		10	<0.2	<0.2	<0.2	<0.2	<0.2			
Heptachlor	µg/L	0.2	0.09		0.01			0.01			<0.2	<0.2	<0.2	<0.2	<0.2			
Heptachlor epoxide	µg/L	0.2								0.3	<0.2	<0.2	<0.2	<0.2	<0.2			

[Filter]

Appendix C
Table 1
November 2014 Sampling Event - Groundwater Analytical Results

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Appendix C

Table 2

Westconnex M4 East Evaluation Phase

June 2015 Groundwater Monitoring Event - Field Parameters and well details

NM Not monitored

- no result

Bore ID	Date monitored	Water quality parameter						Well details				
		Volume purged L	Depth to water m TOC	Dissolved Oxygen ppm	Electrical Conductivity uS/cm	pH	Reduction oxidation potential mV	Temperature deg C	Depth to water pre purge m TOC	depth to BOC m TOC	Depth to water post purge mTOC	Casing stick up m
M4E-BH209	23/06/2015	7	6.72	0.42	20034	6.39	-47.4	20.6	5.9	18.56	6.79	0.6
M4E-BH214	24/06/2015	4.25	5.85	0.07	1645	7.76	-183.6	18.6	4.55	9.99	6.33	0.78
BH1309	24/06/2015	5.75	2.23	1.85	3450	6.89	-167.6	18.6	2.09	4.75	2.23	0
BH1310	23/06/2015	3	2.43	1.6	2428	6.42	-1030	18.9	2.08	4.22	2.47	0
M4E-BH220	23/06/2015	6.5		0.29	20443	6.23	-57.4	19.3	2.69	26.29	2.9	0.62
M4E-BH223	NM	-	-	-	-	-	-	-	-	-	-	-
M4E-BH225	23/06/2015	11	9.95	2.7	8972	5.47	-21.1	20.1	6.58	17.88	10.59	0
M4E-BH230	NM	-	-	-	-	-	-	-	-	-	-	-
M4E-BH235	23/06/2015	7	10.37	0.53	7554	5.78	-38.6	18.7	5.96	13.24	10.56	0
M4E-BH246	NM	-	-	-	-	-	-	-	-	-	-	-
M4E-BH252	24/06/2015	5	3.52	1.55	6659	5.56	-69.5	21.4	3.18	28.15	3.86	0
BH1314	23/06/2015	2.5	5.65	6.84	20.7	5.9	-47.7	18.9	5.29	6.11	6.11	0
BH1316	23/06/2015	4.5	4.49	2.97	2078	5.94	-133.7	19.9	3.95	5.97	4.96	0
M4E-BH290	25/06/2015	9	7.49	1	3214	6.19	-12.8	20.3	3.98	18.88	8.22	0
M4E-BH260	24/06/2015	12	3.6	1.22	1143	6.27	-53	18.5	2.28	30.92	3.77	0
M4E-BH264	24/06/2015	10	5.84	0.25	3058	6.03	-63.1	20	3.85	16.84	6.31	0
BH1317	24/06/2015	5	0.59	5.9	7233	4.74	-12	20.9	0.55	3.99	0.59	0
BH1320	24/06/2015	7	1.01	4.47	7335	5.22	-78.3	22.7	0.85	7.95	0.99	0
BH1326	24/06/2015	10.5	8.09	0.19	7372	6.72	-148.3	20.7	7.37	22.93	8.11	0
BH1331	24/06/2015	3.5	4.41	3.12	6080	6.46	-101.1	21.8	3.33	7.34	4.9	0
BH1333	25/06/2015	3.75	4.93	5.12	7211	6.1	-128.3	20.7	4.25	7.66	5.2	0
BH1336	24/06/2015	6.5	2.94	3.67	12617	6.17	-99.6	21.3	2.92	5.61	2.93	0
BH1344	24/06/2015	7	6.85	0.54	1812	6.32	-82.5	22.4	5.47	25.26	7.8	0
BH1397	25/06/2015	3	3.43	0.79	5050	6.42	-152.6	20.9	2.79	8.05	3.59	0
BH1365	25/06/2015	7	5.81	0.59	3000	5.42	-93.4	20.9	5.03	15.13	6.79	0
M4E-BH301	25/06/2015	7	3.98	1.7	878	5.34	-66.9	20.1	2.82	16.41	5.79	0
M4E-BH302	25/06/2015	7	7.3	0.3	1203	11.65	-110.9	21.3	4.72	>31.9	8.45	0
BH1369	25/06/2015	3.75	2.96	5.07	4527	5.73	-150	20.9	2.2	8.39	3.27	0
BH1373	25/06/2015	4	2.18	3.95	8706	6.02	-137.8	20.9	1.62	7.78	2.37	0
BH1379	25/06/2015	4.5	2.6	5.44	1054	4.24	24.9	21.7	1.67	9.02	2.9	0



Appendix C
Table 3
June 2015 Sampling Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Inorganics										Metals									
	Hardness (Filtered)	Phosphate (as P)	Bicarbonate as CaCO3	Carbonate as CaCO3	Electrical conductivity (lab)	Ferrous Iron	pH (Lab)	Total Dissolved Solids	Hydroxide	Antimony (Filtered)	Arsenic (Filtered)	Beryllium (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Ferric Iron	Iron (Filtered)	Lead (Filtered)
	mg/L	mg/L	mg/L	mg/L	µS/cm	mg/L	pH Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL	3	0.005	5	5	1	0.5	0.1	5	5	0.005	0.001	0.001	0.01	0.0001	0.001	0.001	0.001	0.5	0.05	0.001
ANZECC 2000 FW 95%											0.013 ^{#1}		0.37	0.0002	0.001 ^{#2}		0.0014			0.0034
ANZECC 2000 MW 95%														0.0055	0.0044	0.001	0.0013			0.0044
ANZECC 2000 FW Med-Low Reliability										0.009	0.013 ^{#1}	0.00013	0.37	0.0002		0.0014	0.0014		0.3	0.0034

SampleCode	Field_ID	Location_Code	Sampled_Date	-	-	-	-	3300	4.1	7	2300	-	<0.005	0.004	<0.001	0.15	<0.0001	<0.001	0.006	<0.001	0.8	4.9	<0.001	
S15-Jn21295	M4E-BH1309		BH1309	24-Jun-15	-	-	-	3300	4.1	7	2300	-	<0.005	0.004	<0.001	0.15	<0.0001	<0.001	0.006	<0.001	0.8	4.9	<0.001	
S15-Jn21572	BH1310		BH1310	23-Jun-15	-	-	-	2400	13	6.5	1100	-	<0.005	0.003	<0.001	0.23	<0.0001	<0.001	0.007	<0.001	2	15	<0.001	
S15-Jn21577	QA01		BH1310	23-Jun-15	-	-	-	2400	14	6.5	1300	-	<0.005	0.003	<0.001	0.22	<0.0001	<0.001	0.007	<0.001	<0.5	14	<0.001	
S15-Jn21571	BH1314		BH1314	23-Jun-15	-	-	-	3600	<0.5	6.4	2000	-	<0.005	<0.001	<0.001	0.13	0.0003	<0.001	0.024	0.002	<0.5	<0.05	<0.001	
S15-Jn21570	BH1315		BH1315	23-Jun-15	-	-	-	2600	4.9	6.2	1200	-	<0.005	0.002	<0.001	0.05	<0.0001	<0.001	0.063	<0.001	<0.5	4.9	<0.001	
S15-Jn21296	M4E-BH1317		BH1317	24-Jun-15	-	-	-	7300	4.1	4.9	4100	-	<0.005	<0.001	0.006	0.03	0.0008	<0.001	0.19	0.017	<0.5	4.3	<0.001	
S15-Jn21297	M4E-BH1320		BH1320	24-Jun-15	-	-	-	7400	18 ^{#1}	5.5	4200	-	<0.005	0.002	0.003	0.03	0.0004	<0.001	0.15	0.008	<0.5	17	<0.001	
S15-Jn21298	M4E-BH1326		BH1326	24-Jun-15	-	-	-	7400	<0.5	7.1	3600	-	<0.005	<0.001	<0.001	0.05	<0.0001	<0.001	0.038	<0.001	<0.5	0.35	<0.001	
S15-Jn21299	M4E-BH1331		BH1331	24-Jun-15	-	-	-	3200	4.7 ^{#1}	6.4	1900	-	<0.005	0.002	<0.001	0.21	0.0001	<0.001	0.05	<0.001	<0.5	4.6	<0.001	
S15-Jn24885	BH1333		BH1333	25-Jun-15	-	-	-	7000	4.8 ^{#1}	6.2	4300	-	<0.005	<0.001	0.001	0.09	<0.0001	<0.001	0.023	<0.001	<0.5	4	<0.001	
S15-Jn24886	QA03		BH1333	25-Jun-15	-	-	-	6800	4.8 ^{#1}	6.2	4100	-	<0.005	<0.001	<0.001	0.09	<0.0001	<0.001	0.021	<0.001	<0.5	4	<0.001	
S15-Jn21300	M4E-BH1336		BH1336	24-Jun-15	-	-	-	13,000	6.4	6.4	7800	-	<0.005	<0.001	0.001	0.06	<0.0001	<0.001	0.004	<0.001	<0.5	6.7	<0.001	
S15-Jn21302	QA02		BH1336	24-Jun-15	-	-	-	13,000	6.4 ^{#1}	6.5	6500	-	<0.005	<0.001	<0.001	0.05	<0.0001	<0.001	0.005	<0.001	<0.5	1.4	<0.001	
S15-Jn21301	M4E-BH1344		BH1344	24-Jun-15	-	-	-	1700	5.4	6.6	1100	-	<0.005	0.003	<0.001	0.07	<0.0001	<0.001	0.004	<0.001	0.9	6.3	<0.001	
130206-2	QA05		BH1365	25-Jun-15	260	<0.005	74	<5	2500	27	5.7	1500	<5	<0.001	<0.001	0.002	0.047	<0.0001	<0.001	0.013	<0.001	<0.05	22	<0.001
S15-Jn24878	BH1365		BH1365	25-Jun-15	-	-	-	2800	26 ^{#1}	5.7	1700	-	<0.005	<0.001	0.001	0.04	<0.0001	<0.001	0.013	<0.001	<0.5	24	<0.001	
S15-Jn24884	BH1369		BH1369	25-Jun-15	-	-	-	4000	23 ^{#1}	5.5	2400	-	<0.005	0.002	<0.001	0.02	<0.0001	<0.001	0.013	<0.001	<0.5	20	<0.001	
S15-Jn24881	BH1373		BH1373	25-Jun-15	-	-	-	8900	5.2 ^{#1}	6.1	4800	-	<0.005	<0.001	<0.001	0.03	0.0004	<0.001	0.069	<0.001	<0.5	4.7	<0.001	
S15-Jn24883	BH1379		BH1379	25-Jun-15	-	-	-	990	0.5 ^{#1}	4.3	780	-	<0.005	<0.001	<0.001	0.24	<0.0001	<0.001	0.002	0.004	<0.5	0.41	<0.001	
S15-Jn24882	BH1397		BH1397	25-Jun-15	-	-	-	4900	8.1 ^{#1}	6.1	2800	-	<0.005	<0.001	<0.001	0.04	<0.0001	<0.001	0.056	<0.001	<0.5	6.8	<0.001	
S15-Jn21575	BH209		BH209	23-Jun-15	-	-	-	20,000	2.2	6.7	12,000	-	<0.005	<0.001	<0.001	0.05	<0.0001	<0.001	<0.001	<0.001	<0.5	2.3	<0.001	
S15-Jn21291	M4E-BH214		BH214	24-Jun-15	-	-	-	1600	0.73 ^{#1}	7.6	1000	-	<0.005	0.007	<0.001	0.05	<0.0001	<0.001	0.002	<0.001	<0.5	0.7	<0.001	
S15-Jn21574	BH220		BH220	23-Jun-15	-	-	-	20,000	0.5	6.6	1300	-	<0.005	<0.001	<0.001	0.1	<0.0001	<0.001	<0.001	<0.001	<0.5	0.61	<0.001	
S15-Jn21576	BH225		BH225	23-Jun-15	-	-	-	11,000	5.5 ^{#1}	5.7	6400	-	<0.005	<0.001	<0.001	0.02	0.0003	<0.001	0.053	0.003	<0.5	5.3	<0.001	
S15-Jn21573	BH235		BH235	23-Jun-15	-	-	-	8300	17 ^{#1}	6	4800	-	<0.005	0.001	<0.001	0.03	<0.0001	0.002	0.13	0.006	<0.5	16	<0.001	
S15-Jn21292	M4E-BH252		BH252	24-Jun-15	-	-	-	6700	<0.5	6	3400	-	<0.005	0.002	<0.001	0.07	<0.0001	<0.001	0.004	0.004	<0.5	0.09	<0.001	
S15-Jn21293	M4E-BH260		BH260	24-Jun-15	-	-	-	760	<0.5	6.8	490	-	<0.005	0.002	<0.001	0.09	<0.0001	0.001	0.004	0.016	<0.5	<0.05	<0.001	
S15-Jn21294	M4E-BH264		BH264	24-Jun-15	-	-	-	3200	8.4 ^{#1}	6.3	1800	-	<0.005	0.002	<0.001	0.04	<0.0001	<0.001	0.004	<0.001	<0.5	8.3	<0.001	
130206-1	QA04		BH290	25-Jun-15	290	0.2	530	<5	3500	0.27	6.4	2300	<5	<0.001	<0.001	<0.0005	0.031	<0.0001	0.042	<0.001	<0.001	<0.05	0.087	<0.001
S15-Jn24877	BH290		BH290	25-Jun-15	-	-	-	4000	<0.5	6.7	2300	-	<0.005	<0.001	<0.001	0.02	<0.0001	0.056	0.001	<0.001	<0.5	<0.05	<0.001	
S15-Jn24879	BH301		BH301	25-Jun-15	-	-	-	890	<0.5	5.6	640	-	<0.005	0.002	<0.001	0.03	0.0001	0.035	<0.001	0.015	<0.5	0.06	0.002	
S15-Jn24880	BH302		BH302	25-Jun-15	-	-	-	1100	<0.5	11	360	-	<0.005	<0.001	<0.001	<0.01	<0.0001	0.008	<0.001	<0.001	<0.5	<0.05	<0.001	

[Filter]



Appendix C
Table 3
June 2015 Sampling Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Inorganics										Metals									
	Hardness (Filtered)	Phosphate (as P)	Bicarbonate as CaCO3	Carbonate as CaCO3	Electrical conductivity (lab)	Ferrous Iron	pH (Lab)	Total Dissolved Solids	Hydroxide	Antimony (Filtered)	Arsenic (Filtered)	Beryllium (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (II+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Ferric Iron	Iron (Filtered)	Lead (Filtered)
	mg/L	mg/L	mg/L	mg/L	µS/cm	mg/L	pH Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL	3	0.005	5	5	1	0.5	0.1	5	5	0.005	0.001	0.001	0.01	0.0001	0.001	0.001	0.001	0.5	0.05	0.001
ANZECC 2000 FW 95%											0.013 ^{#1}		0.37	0.0002	0.001 ^{#2}		0.0014			0.0034
ANZECC 2000 MW 95%														0.0055	0.0044	0.001	0.0013			0.0044
ANZECC 2000 FW Med-Low Reliability										0.009	0.013 ^{#1}	0.00013	0.37	0.0002		0.0014	0.0014		0.3	0.0034

SampleCode Field_ID Location_Code Sampled_Date

Statistical Summary

Number of Results	2	2	2	2	32	32	32	32	2	32	32	32	32	32	32	32	32	32	32	32
Number of Detects	2	1	2	0	32	25	32	32	0	0	14	6	31	7	6	26	9	3	28	1
Minimum Concentration	260	<0.005	74	<5	760	0.27	4.3	360	<5	<0.001	<0.001	<0.0005	<0.01	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.05	<0.001
Minimum Detect	260	0.2	74	ND	760	0.27	4.3	360	ND	ND	0.001	0.001	0.02	0.0001	0.001	0.001	0.002	0.8	0.06	0.002
Maximum Concentration	290	0.2	530	<5	20000	27	11	12000	<5	<0.005	0.007	0.006	0.24	0.0008	0.056	0.19	0.017	2	24	0.002
Maximum Detect	290	0.2	530	ND	20000	27	11	12000	ND	ND	0.007	0.006	0.24	0.0008	0.056	0.19	0.017	2	24	0.002
Average Concentration					5820	6.8	6.4	3008		0.0024	0.0014	0.00084	0.075	0.00011	0.0049	0.03	0.0027	0.33	6.2	0.00055
Median Concentration	275	0.10125	302	2.5	3800	4.8	6.35	2300	2.5	0.0025	0.0005	0.0005	0.05	0.00005	0.0005	0.007	0.0005	0.25	4.45	0.0005
Standard Deviation					5016	7.8	1.1	2501		0.00049	0.0014	0.0011	0.066	0.00016	0.013	0.047	0.0047	0.35	7.1	0.00027
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	32	0	5	25	9	0	25	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	6	0	5	5	25	9	0	25	0

Env Stds Comments

#1:As (V) used as conservative value
#2:Cr(VI) guideline has been adopted
#3:Ammonia (as N) value multiplied by 1.216
#4:Nitrate (as NO3) value divided by 4.427

Data Comments

#1 Ferrous Iron results are present at higher levels than total/soluble Iron results. This is due to experimental uncertainties associated with the different analytical techniques used in analysing Iron (total/soluble) and Ferrous Iron.
#2 Theoretically the TKN result should be greater or equal to ammonia concentration. However the difference reported is within the uncertainty of the individual tests
#3 The LORs have been raised due to matrix interference

[Filter]



Appendix C
Table 3
June 2015 Sampling Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

										Alkalinity			Major Ions											
	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Tin (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Alkalinity (total)	Alkalinity (total as CaCO3)	Hardness as CaCO3	Fluoride	Calcium	Calcium (Filtered)	Chloride	Magnesium	Magnesium (Filtered)	Potassium	Potassium (Filtered)	Sodium			
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			
EQL	0.001	0.0001	0.001	0.001	0.005	0.0001	0.005	0.005	0.005	5	5	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5			
ANZECC 2000 FW 95%	1.9	0.0006		0.011	0.011	0.00005			0.008															
ANZECC 2000 MW 95%		0.0004		0.07		0.0014		0.1	0.015															
ANZECC 2000 FW Med-Low Reliability	1.7		0.034	0.011	0.005	0.011	0.00005	0.003	0.006	0.008														
SampleCode	Field_ID	Location_Code	Sampled_Date																					
S15-Jn21295	M4E-BH1309	BH1309	24-Jun-15	1.1	<0.0001	<0.001	0.017	<0.005	<0.0001	<0.005	<0.005	0.016	-	310	830	<0.5	150	-	400	110	-	20	-	420
S15-Jn21572	BH1310	BH1310	23-Jun-15	0.67	<0.0001	<0.001	0.003	<0.005	<0.0001	<0.005	<0.005	0.014	-	250	280	<0.5	38	-	590	46	-	10	-	300
S15-Jn21577	QA01	BH1310	23-Jun-15	0.64	<0.0001	<0.001	0.003	<0.005	<0.0001	<0.005	<0.005	0.008	-	240	290	<0.5	41	-	580	47	-	11	-	330
S15-Jn21571	BH1314	BH1314	23-Jun-15	1.9	<0.0001	<0.001	0.024	<0.005	<0.0001	<0.005	<0.005	0.051	-	160	370	<0.5	57	-	740	55	-	25	-	560
S15-Jn21570	BH1315	BH1315	23-Jun-15	10	<0.0001	<0.001	0.043	<0.005	<0.0001	<0.005	<0.005	0.02	-	200	170	1.3	12	-	470	33	-	11	-	440
S15-Jn21296	M4E-BH1317	BH1317	24-Jun-15	9.9	<0.0001	<0.001	0.11	<0.005	<0.0001	<0.005	<0.005	0.43	-	55	530	0.9	17	-	2200	120	-	16	-	1200
S15-Jn21297	M4E-BH1320	BH1320	24-Jun-15	10	<0.0001	<0.001	0.12	<0.005	<0.0001	<0.005	<0.005	0.38	-	60	610	0.5	31	-	2400	130	-	12	-	1100
S15-Jn21298	M4E-BH1326	BH1326	24-Jun-15	3.2	<0.0001	0.003	0.1	<0.005	<0.0001	<0.005	<0.005	0.006	-	270	580	1.1	63	-	2100	100	-	31	-	1100
S15-Jn21299	M4E-BH1331	BH1331	24-Jun-15	4.7	<0.0001	<0.001	0.023	<0.005	<0.0001	<0.005	<0.005	0.059	-	270	220	<0.5	26	-	530	38	-	9.3	-	480
S15-Jn24885	BH1333	BH1333	25-Jun-15	4.2	<0.0001	<0.001	0.011	<0.005	<0.0001	<0.005	<0.005	0.041	-	250	490	1.3	36	-	1900	97	-	19	-	1100
S15-Jn24886	QA03	BH1333	25-Jun-15	4	<0.0001	<0.001	0.01	<0.005	<0.0001	<0.005	<0.005	0.037	-	260	490	1.3	36	-	1900	97	-	19	-	1000
S15-Jn21300	M4E-BH1336	BH1336	24-Jun-15	1.3	<0.0001	<0.001	0.002	<0.005	<0.0001	<0.005	<0.005	<0.005	-	350	1300	1.2	110	-	4100	240	-	42	-	1600
S15-Jn21302	QA02	BH1336	24-Jun-15	1.3	<0.0001	<0.001	0.002	<0.005	<0.0001	<0.005	<0.005	<0.005	-	350	1300	1.1	110	-	4200	240	-	40	-	1600
S15-Jn21301	M4E-BH1344	BH1344	24-Jun-15	0.69	<0.0001	<0.001	0.031	<0.005	<0.0001	<0.005	<0.005	0.046	-	250	190	<0.5	34	-	290	25	-	3.5	-	240
130206-2	QA05	BH1365	25-Jun-15	1.3	<0.00005	<0.001	0.063	<0.001	<0.001	<0.001	<0.001	0.02	74	-	-	0.1	-	22	660	-	50	-	4.9	-
S15-Jn24878	BH1365	BH1365	25-Jun-15	1.4	<0.0001	<0.001	0.06	<0.005	<0.0001	<0.005	<0.005	0.019	-	70	250	<0.5	14	-	150	52	-	5.3	-	350
S15-Jn24884	BH1369	BH1369	25-Jun-15	1.2	<0.0001	<0.001	0.013	<0.005	<0.0001	<0.005	<0.005	0.031	-	70	220	<0.5	2.6	-	840	52	-	12	-	760
S15-Jn24881	BH1373	BH1373	25-Jun-15	16	<0.0001	<0.001	0.035	<0.005	<0.0001	<0.005	<0.005	0.097	-	170	1000	0.5	72	-	2800	200	-	12	-	1200
S15-Jn24883	BH1379	BH1379	25-Jun-15	0.24	<0.0001	<0.001	0.004	<0.005	<0.0001	<0.005	<0.005	0.023	-	<5	31	<0.5	1	-	150	7	-	3.3	-	170
S15-Jn24882	BH1397	BH1397	25-Jun-15	4.5	<0.0001	<0.001	0.04	<0.005	<0.0001	<0.005	<0.005	0.059	-	180	350	<0.5	35	-	1000	64	-	11	-	790
S15-Jn21575	BH209	BH209	23-Jun-15	0.066	<0.0001	<0.001	0.015	<0.005	<0.0001	<0.005	<0.005	0.034	-	870	2700	<0.5	400	-	6800	420	-	77	-	3500
S15-Jn21291	M4E-BH214	BH214	24-Jun-15	0.049	<0.0001	0.002	0.003	<0.005	<0.0001	<0.005	0.007	0.68	-	220	66	<0.5	12	-	290	8.6	-	6.8	-	300
S15-Jn21574	BH220	BH220	23-Jun-15	0.53	<0.0001	0.001	0.028	<0.005	<0.0001	<0.005	<0.005	0.04	-	420	2400	<0.5	350	-	7300	370	-	67	-	2700
S15-Jn21576	BH225	BH225	23-Jun-15	7.8	<0.0001	<0.001	0.1	<0.005	<0.0001	<0.005	<0.005	0.1	-	160	930	0.5	45	-	3600	200	-	34	-	2100
S15-Jn21573	BH235	BH235	23-Jun-15	21	<0.0001	<0.001	0.086	<0.005	<0.0001	<0.005	<0.005	0.072	-	440	780	<0.5	46	-	2700	160	-	32	-	1200
S15-Jn21292	M4E-BH252	BH252	24-Jun-15	0.46	<0.0001	0.005	0.077	<0.005	<0.0001	<0.005	0.009	0.044	-	530	710	<0.5	72	-	1800	130	-	30	-	1200
S15-Jn21293	M4E-BH260	BH260	24-Jun-15	0.54	0.0001	0.001	0.017	<0.005	<0.0001	<0.005	<0.005	0.066	-	150	95	<0.5	18	-	99	12	-	3.3	-	120
S15-Jn21294	M4E-BH264	BH264	24-Jun-15	2.8	<0.0001	0.002	0.012	<0.005	<0.0001	<0.005	<0.005	0.035	-	150	210	<0.5	14	-	750	42	-	8.1	-	520
130206-1	QA04	BH290	25-Jun-15	0.35	<0.00005	0.008	0.2	<0.001	<0.001	<0.001	0.005	0.035	530	-	-	<0.1	-	43	770	-	44	-	260	-
S15-Jn24877	BH290	BH290	25-Jun-15	0.16	<0.0001	0.002	0.14	<0.005	<0.0001	<0.005	0.007	0.12	-	580	190	<0.5	28	-	830	30	-	290	-	550
S15-Jn24879	BH301	BH301	25-Jun-15	0.046	<0.0001	0.002	0.05	<0.005	<0.0001	<0.005	0.016	0.12	-	220	90	<0.5	28	-	71	4.7	-	43	-	130
S15-Jn24880	BH302	BH302	25-Jun-15	<0.001	<0.0001	<0.001	<0.001	<0.005	<0.0001	<0.005	<0.005	<0.005	-	280	270	<0.5	110	-	15	1.3	-	11	-	37

[Filter]



Appendix C
Table 3
June 2015 Sampling Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

										Alkalinity			Major Ions								
	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Tin (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Alkalinity (total)	Alkalinity (total as CaCO ₃)	Hardness as CaCO ₃	Fluoride	Calcium	Calcium (Filtered)	Chloride	Magnesium	Magnesium (Filtered)	Potassium	Potassium (Filtered)	Sodium
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL	0.001	0.0001	0.001	0.001	0.005	0.0001	0.005	0.005	0.005	5	5	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5
ANZECC 2000 FW 95%	1.9	0.0006		0.011	0.011	0.00005			0.008												
ANZECC 2000 MW 95%		0.0004		0.07		0.0014		0.1	0.015												
ANZECC 2000 FW Med-Low Reliability	1.7		0.034	0.011	0.005	0.011	0.00005	0.003	0.006	0.008											

SampleCode	Field ID	Location Code	Sampled Date																			
Statistical Summary																						
Number of Results	32	32	32	32	32	32	32	32	32	2	30	30	32	30	2	32	30	2	30	2	30	30
Number of Detects	31	1	9	31	0	0	0	5	29	2	29	30	11	30	2	32	30	2	30	2	30	30
Minimum Concentration	<0.001	<0.00005	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.005	74	<5	31	<0.1	1	22	15	1.3	44	3.3	4.9	37	37
Minimum Detect	0.046	0.0001	0.001	0.002	ND	ND	ND	0.005	0.006	74	55	31	0.1	1	22	15	1.3	44	3.3	4.9	37	37
Maximum Concentration	21	0.0001	0.008	0.2	<0.005	<0.001	<0.005	0.016	0.68	530	870	2700	1.3	400	43	7300	420	50	290	260	3500	3500
Maximum Detect	21	0.0001	0.008	0.2	ND	ND	ND	0.016	0.68	530	870	2700	1.3	400	43	7300	420	50	290	260	3500	3500
Average Concentration	3.5	0.00005	0.0012	0.045	0.0024	0.000078	0.0024	0.0034	0.085		260	598	0.46	67		1657	104		30		903	903
Median Concentration	1.3	0.00005	0.0005	0.026	0.0025	0.00005	0.0025	0.0025	0.0385	302	245	360	0.25	36	32.5	800	59.5	47	14	132.45	660	660
Standard Deviation	5	0.000011	0.0016	0.049	0.00049	0.00011	0.00049	0.0028	0.14		177	634	0.4	91		1847	105		52		792	792
Number of Guideline Exceedances	13	0	0	23	0	32	30	4	27	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	13	0	0	23	0	0	0	4	27	0	0	0	0	0	0	0	0	0	0	0	0	0

Env Stds Comments

#1:As (V) used as conservative value
#2:Cr(VI) guideline has been adopted
#3:Ammonia (as N) value multiplied by 1.216
#4:Nitrate (as NO₃) value divided by 4.427

Data Comments

#1 Ferrous Iron results are present at higher levels than total/soluble Iron result
#2 Theoretically the TKN result should be greater or equal to ammonia concen
#3 The LORs have been raised due to matrix interference

[Filter]



Appendix C
Table 3
June 2015 Sampling Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

										Nutrients									
			Sodium (Filtered)	Sulphate	Ionic Balance				Ammonia	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate (as N)	Nitrite (as N)	Nitrogen (Organic)	Nitrogen (Total)	Phosphate total (P)	Phosphorus	Reactive Phosphorus as P	TKN (as N)
			mg/L	mg/L	%				mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.5	2					0.005	0.01	0.2	0.01	0.01	200	0.1	0.05	0.05	0.05	0.1
ANZECC 2000 FW 95%									1.094 ^{#3}	0.9		0.158 ^{#4}							
ANZECC 2000 MW 95%									1.107	0.91									
ANZECC 2000 FW Med-Low Reliability									0.9			0.7							
SampleCode	Field_ID	Location_Code	Sampled_Date																
S15-Jn21295	M4E-BH1309	BH1309	24-Jun-15	-	480	-	-	-	5.3	6.8	<0.01	<0.01	1500	6.8	0.06	-	<0.05	-	
S15-Jn21572	BH1310	BH1310	23-Jun-15	-	77	-	-	-	0.27	1.5	0.01	<0.01	1230	1.51	<0.05	-	<0.05	-	
S15-Jn21577	QA01	BH1310	23-Jun-15	-	77	-	-	-	0.28	1.7	0.02	<0.01	1420	1.72	<0.05	-	<0.05	-	
S15-Jn21571	BH1314	BH1314	23-Jun-15	-	620	-	-	-	0.06	3.2	1.8	0.03	3140	5.03	9.5	-	<0.05	-	
S15-Jn21570	BH1315	BH1315	23-Jun-15	-	400	-	-	-	<0.05	0.7	<0.01	<0.01	700	0.7	0.23	-	<0.05	-	
S15-Jn21296	M4E-BH1317	BH1317	24-Jun-15	-	550	-	-	-	0.15	0.7	<0.01	<0.01	550	0.7	0.18	-	<0.05	-	
S15-Jn21297	M4E-BH1320	BH1320	24-Jun-15	-	260	-	-	-	0.15	0.3	<0.1	<0.1	150	0.3	<0.05	-	<0.05	-	
S15-Jn21298	M4E-BH1326	BH1326	24-Jun-15	-	360	-	-	-	0.47	0.8	<0.01	<0.01	330	0.8	<0.05	-	<0.05	-	
S15-Jn21299	M4E-BH1331	BH1331	24-Jun-15	-	570	-	-	-	0.1	0.7	0.03	<0.01	600	0.73	0.39	-	<0.05	-	
S15-Jn24885	BH1333	BH1333	25-Jun-15	-	520	-	-	-	0.18	0.8	0.03	<0.01	620	0.83	0.33	-	<0.05	-	
S15-Jn24886	QA03	BH1333	25-Jun-15	-	530	-	-	-	0.17	0.9	0.04	<0.01	730	0.94	0.32	-	<0.05	-	
S15-Jn21300	M4E-BH1336	BH1336	24-Jun-15	-	390	-	-	-	0.16	0.6	<0.1	<0.1	440	0.6	<0.05	-	<0.05	-	
S15-Jn21302	QA02	BH1336	24-Jun-15	-	400	-	-	-	0.17	0.7	<0.1	<0.1	530	0.7	<0.05	-	<0.05	-	
S15-Jn21301	M4E-BH1344	BH1344	24-Jun-15	-	190	-	-	-	<0.05	0.4	<0.01	<0.01	400	0.4	<0.05	-	<0.05	-	
130206-2	QA05	BH1365	25-Jun-15	490	110	8.4	0.026	-	-	-	<0.005	<0.005	500	0.5	-	<0.05	-	-	0.5
S15-Jn24878	BH1365	BH1365	25-Jun-15	-	27	-	-	-	0.02	0.5	<0.1 ^{#3}	<0.1 ^{#3}	480	0.5	<0.05	-	<0.05	-	
S15-Jn24884	BH1369	BH1369	25-Jun-15	-	800	-	-	-	0.15	0.5	<0.1 ^{#3}	<0.1 ^{#3}	350	0.5	<0.05	-	<0.05	-	
S15-Jn24881	BH1373	BH1373	25-Jun-15	-	200	-	-	-	0.16	0.4	<0.01	<0.01	240	0.4	<0.05	-	<0.05	-	
S15-Jn24883	BH1379	BH1379	25-Jun-15	-	260	-	-	-	0.06	0.5	0.09	<0.01	440	0.59	<0.05	-	<0.05	-	
S15-Jn24882	BH1397	BH1397	25-Jun-15	-	860	-	-	-	0.18	0.4	<0.1 ^{#3}	<0.1 ^{#3}	220	0.4	<0.05	-	<0.05	-	
S15-Jn21575	BH209	BH209	23-Jun-15	-	630	-	-	-	4.9 ^{#2}	4.2 ^{#2}	<0.01	<0.01	<50	4.2	<0.05	-	<0.05	-	
S15-Jn21291	M4E-BH214	BH214	24-Jun-15	-	67	-	-	-	0.1	1.1	<0.01	<0.01	1000	1.1	0.07	-	<0.05	-	
S15-Jn21574	BH220	BH220	23-Jun-15	-	500	-	-	-	1.4	1.6	<0.01	0.06	200	1.66	<0.05	-	<0.05	-	
S15-Jn21576	BH225	BH225	23-Jun-15	-	370	-	-	-	0.09	0.7	<0.01	<0.01	610	0.7	0.25	-	<0.05	-	
S15-Jn21573	BH235	BH235	23-Jun-15	-	220	-	-	-	0.1	1	<0.01	<0.01	900	1	<0.05	-	<0.05	-	
S15-Jn21292	M4E-BH252	BH252	24-Jun-15	-	290	-	-	-	0.12	0.7	0.17	<0.01	580	0.87	<0.05	-	<0.05	-	
S15-Jn21293	M4E-BH260	BH260	24-Jun-15	-	75	-	-	-	<0.05	1	0.41	<0.01	1000	1.41	0.06	-	<0.05	-	
S15-Jn21294	M4E-BH264	BH264	24-Jun-15	-	300	-	-	-	0.09	0.7	<0.1	<0.1	610	0.7	0.19	-	<0.05	-	
130206-1	QA04	BH290	25-Jun-15	840	110	17	0.74	-	-	-	0.17	0.009	600	1.5	-	0.3	-	-	1.3
S15-Jn24877	BH290	BH290	25-Jun-15	-	110	-	-	-	0.72	1.6	0.04	<0.01	880	1.64	0.24	-	0.14	-	
S15-Jn24879	BH301	BH301	25-Jun-15	-	120	-	-	-	<0.01	1.2	0.41	<0.01	1200	1.61	0.14	-	<0.05	-	
S15-Jn24880	BH302	BH302	25-Jun-15	-	2.9	-	-	-	0.02	0.7	0.15	0.53	680	1.38	0.05	-	<0.05	-	

[Filter]



Appendix C
Table 3
June 2015 Sampling Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Sodium (Filtered)	Sulphate	Ionic Balance	Nutrients										
				Ammonia	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate (as N)	Nitrite (as N)	Nitrogen (Organic)	Nitrogen (Total)	Phosphate total (P)	Phosphorus	Reactive Phosphorus as P	TKN (as N)
	mg/L	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL	0.5	2		0.005	0.01	0.2	0.01	0.01	200	0.1	0.05	0.05	0.05	0.1
ANZECC 2000 FW 95%				1.094 ^{#3}	0.9		0.158 ^{#4}							
ANZECC 2000 MW 95%				1.107	0.91									
ANZECC 2000 FW Med-Low Reliability				0.9			0.7							

SampleCode	Field_ID	Location_Code	Sampled_Date											
Statistical Summary														
Number of Results	2	32	2	2	30	30	32	32	32	32	30	2	30	2
Number of Detects	2	32	2	2	26	30	13	4	31	32	14	1	1	2
Minimum Concentration	490	2.9	8.4	0.026	<0.01	0.3	<0.005	<0.005	<50	0.3	<0.05	<0.05	<0.05	0.5
Minimum Detect	490	2.9	8.4	0.026	0.02	0.3	0.01	0.009	150	0.3	0.05	0.3	0.14	0.5
Maximum Concentration	840	860	17	0.74	5.3	6.8	1.8	0.53	3140	6.8	9.5	0.3	0.14	1.3
Maximum Detect	840	860	17	0.74	5.3	6.8	1.8	0.53	3140	6.8	9.5	0.3	0.14	1.3
Average Concentration		327			0.52	1.2	0.12	0.034	714	1.3	0.41		0.029	
Median Concentration	665	295	12.7	0.383	0.15	0.7	0.035	0.005	600	0.815	0.025	0.1625	0.025	0.9
Standard Deviation		230			1.3	1.3	0.32	0.093	569	1.4	1.7		0.021	
Number of Guideline Exceedances	0	0	0	0	3	0	5	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	3	0	5	0	0	0	0	0	0	0

Env Stds Comments

#1:As (V) used as conservative value
#2:Cr(VI) guideline has been adopted
#3:Ammonia (as N) value multiplied by 1.216
#4:Nitrate (as NO3) value divided by 4.427

Data Comments

#1 Ferrous Iron results are present at higher levels than total/soluble Iron result
#2 Theoretically the TKN result should be greater or equal to ammonia concent
#3 The LORs have been raised due to matrix interference

[Filter]



Appendix C
Table 4
June 2015 Monitoring Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Inorganics								Metals											
	Hardness (Filtered)	Phosphate (as P)	Bicarbonate as CaCO3	Carbonate as CaCO3	Electrical conductivity (lab)	Ferrous Iron	pH (Lab)	Total Dissolved Solids	Hydroxide	Antimony (Filtered)	Arsenic (Filtered)	Beryllium (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Ferric Iron	Iron (Filtered)	Lead (Filtered)
	mg/L	mg/L	mg/L	mg/L	µS/cm	mg/L	pH Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL	3	0.005	5	5	1	0.5	0.1	5	5	0.005	0.001	0.001	0.01	0.0001	0.001	0.001	0.001	0.5	0.05	0.001
ADWG 2015 Aesthetic							6.5-8.5	600									1		0.3	
ADWG 2015 Health										0.003	0.01	0.06	4	0.002			2			0.01

SampleCode	Field ID	Location Code	Sampled Date																				
S15-Jn21295	M4E-BH1309	BH1309	24-Jun-15	-	-	-	-	3300	4.1	7	2300	-	<0.005	0.004	<0.001	0.15	<0.0001	<0.001	0.006	<0.001	0.8	4.9	<0.001
S15-Jn21572	BH1310	BH1310	23-Jun-15	-	-	-	-	2400	13	6.5	1100	-	<0.005	0.003	<0.001	0.23	<0.0001	<0.001	0.007	<0.001	2	15	<0.001
S15-Jn21577	QA01	BH1310	23-Jun-15	-	-	-	-	2400	14	6.5	1300	-	<0.005	0.003	<0.001	0.22	<0.0001	<0.001	0.007	<0.001	<0.5	14	<0.001
S15-Jn21571	BH1314	BH1314	23-Jun-15	-	-	-	-	3600	<0.5	6.4	2000	-	<0.005	<0.001	<0.001	0.13	0.0003	<0.001	0.024	0.002	<0.5	<0.05	<0.001
S15-Jn21570	BH1315	BH1315	23-Jun-15	-	-	-	-	2600	4.9	6.2	1200	-	<0.005	0.002	<0.001	0.05	<0.0001	<0.001	0.063	<0.001	<0.5	4.9	<0.001
S15-Jn21296	M4E-BH1317	BH1317	24-Jun-15	-	-	-	-	7300	4.1	4.9	4100	-	<0.005	<0.001	0.006	0.03	0.0008	<0.001	0.19	0.017	<0.5	4.3	<0.001
S15-Jn21297	M4E-BH1320	BH1320	24-Jun-15	-	-	-	-	7400	18 ^{#1}	5.5	4200	-	<0.005	0.002	0.003	0.03	0.0004	<0.001	0.15	0.008	<0.5	17	<0.001
S15-Jn21298	M4E-BH1326	BH1326	24-Jun-15	-	-	-	-	7400	<0.5	7.1	3600	-	<0.005	<0.001	<0.001	0.05	<0.0001	<0.001	0.038	<0.001	<0.5	0.35	<0.001
S15-Jn21299	M4E-BH1331	BH1331	24-Jun-15	-	-	-	-	3200	4.7 ^{#1}	6.4	1900	-	<0.005	0.002	<0.001	0.21	0.0001	<0.001	0.05	<0.001	<0.5	4.6	<0.001
S15-Jn24885	BH1333	BH1333	25-Jun-15	-	-	-	-	7000	4.8 ^{#1}	6.2	4300	-	<0.005	<0.001	0.001	0.09	<0.0001	<0.001	0.023	<0.001	<0.5	4	<0.001
S15-Jn24886	QA03	BH1333	25-Jun-15	-	-	-	-	6800	4.8 ^{#1}	6.2	4100	-	<0.005	<0.001	<0.001	0.09	<0.0001	<0.001	0.021	<0.001	<0.5	4	<0.001
S15-Jn21300	M4E-BH1336	BH1336	24-Jun-15	-	-	-	-	13,000	6.4	6.4	7800	-	<0.005	<0.001	0.001	0.06	<0.0001	<0.001	0.004	<0.001	<0.5	6.7	<0.001
S15-Jn21302	QA02	BH1336	24-Jun-15	-	-	-	-	13,000	6.4 ^{#1}	6.5	6500	-	<0.005	<0.001	<0.001	0.05	<0.0001	<0.001	0.005	<0.001	<0.5	1.4	<0.001
S15-Jn21301	M4E-BH1344	BH1344	24-Jun-15	-	-	-	-	1700	5.4	6.6	1100	-	<0.005	0.003	<0.001	0.07	<0.0001	<0.001	0.004	<0.001	0.9	6.3	<0.001
130206-2	QA05	BH1365	25-Jun-15	260	<0.005	74	<5	2500	27	5.7	1500	<5	<0.001	<0.001	0.002	0.047	<0.0001	<0.001	0.013	<0.001	<0.05	22	<0.001
S15-Jn24878	BH1365	BH1365	25-Jun-15	-	-	-	-	2800	26 ^{#1}	5.7	1700	-	<0.005	<0.001	0.001	0.04	<0.0001	<0.001	0.013	<0.001	<0.5	24	<0.001
S15-Jn24884	BH1369	BH1369	25-Jun-15	-	-	-	-	4000	23 ^{#1}	5.5	2400	-	<0.005	0.002	<0.001	0.02	<0.0001	<0.001	0.013	<0.001	<0.5	20	<0.001
S15-Jn24881	BH1373	BH1373	25-Jun-15	-	-	-	-	8900	5.2 ^{#1}	6.1	4800	-	<0.005	<0.001	<0.001	0.03	0.0004	<0.001	0.069	<0.001	<0.5	4.7	<0.001
S15-Jn24883	BH1379	BH1379	25-Jun-15	-	-	-	-	990	0.5 ^{#1}	4.3	780	-	<0.005	<0.001	<0.001	0.24	<0.0001	<0.001	0.002	0.004	<0.5	0.41	<0.001
S15-Jn24882	BH1397	BH1397	25-Jun-15	-	-	-	-	4900	8.1 ^{#1}	6.1	2800	-	<0.005	<0.001	<0.001	0.04	<0.0001	<0.001	0.056	<0.001	<0.5	6.8	<0.001
S15-Jn21575	BH209	BH209	23-Jun-15	-	-	-	-	20,000	2.2	6.7	12,000	-	<0.005	<0.001	<0.001	0.05	<0.0001	<0.001	<0.001	<0.001	<0.5	2.3	<0.001
S15-Jn21291	M4E-BH214	BH214	24-Jun-15	-	-	-	-	1600	0.73 ^{#1}	7.6	1000	-	<0.005	0.007	<0.001	0.05	<0.0001	<0.001	0.002	<0.001	<0.5	0.7	<0.001
S15-Jn21574	BH220	BH220	23-Jun-15	-	-	-	-	20,000	0.5	6.6	1300	-	<0.005	<0.001	<0.001	0.1	<0.0001	<0.001	<0.001	<0.001	<0.5	0.61	<0.001
S15-Jn21576	BH225	BH225	23-Jun-15	-	-	-	-	11,000	5.5 ^{#1}	5.7	6400	-	<0.005	<0.001	<0.001	0.02	0.0003	<0.001	0.053	0.003	<0.5	5.3	<0.001
S15-Jn21573	BH235	BH235	23-Jun-15	-	-	-	-	8300	17 ^{#1}	6	4800	-	<0.005	0.001	<0.001	0.03	<0.0001	0.002	0.13	0.006	<0.5	16	<0.001
S15-Jn21292	M4E-BH252	BH252	24-Jun-15	-	-	-	-	6700	<0.5	6	3400	-	<0.005	0.002	<0.001	0.07	<0.0001	<0.001	<0.001	0.004	<0.5	0.09	<0.001
S15-Jn21293	M4E-BH260	BH260	24-Jun-15	-	-	-	-	760	<0.5	6.8	490	-	<0.005	0.002	<0.001	0.09	<0.0001	0.001	0.004	0.016	<0.5	<0.05	<0.001
S15-Jn21294	M4E-BH264	BH264	24-Jun-15	-	-	-	-	3200	8.4 ^{#1}	6.3	1800	-	<0.005	0.002	<0.001	0.04	<0.0001	<0.001	0.004	<0.001	<0.5	8.3	<0.001
130206-1	QA04	BH290	25-Jun-15	290	0.2	530	<5	3500	0.27	6.4	2300	<5	<0.001	<0.001	<0.0005	0.031	<0.0001	0.042	<0.001	<0.001	<0.05	0.087	<0.001
S15-Jn24877	BH290	BH290	25-Jun-15	-	-	-	-	4000	<0.5	6.7	2300	-	<0.005	<0.001	<0.001	0.02	<0.0001	0.056	0.001	<0.001	<0.5	<0.05	<0.001
S15-Jn24879	BH301	BH301	25-Jun-15	-	-	-	-	890	<0.5	5.6	640	-	<0.005	0.002	<0.001	0.03	0.0001	0.035	<0.001	0.015	<0.5	0.06	0.002
S15-Jn24880	BH302	BH302	25-Jun-15	-	-	-	-	1100	<0.5	11	360	-	<0.005	<0.001	<0.001	<0.01	<0.0001	0.008	<0.001	<0.001	<0.5	<0.05	<0.001

[Filter]



Appendix C
Table 4
June 2015 Monitoring Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Inorganics									Metals										
	Hardness (Filtered)	Phosphate (as P)	Bicarbonate as CaCO3	Carbonate as CaCO3	Electrical conductivity (lab)	Ferrous Iron	pH (Lab)	Total Dissolved Solids	Hydroxide	Antimony (Filtered)	Arsenic (Filtered)	Beryllium (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Ferric Iron	Iron (Filtered)	Lead (Filtered)
	mg/L	mg/L	mg/L	mg/L	µS/cm	mg/L	pH Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL	3	0.005	5	5	1	0.5	0.1	5	5	0.005	0.001	0.001	0.01	0.0001	0.001	0.001	0.001	0.5	0.05	0.001
ADWG 2015 Aesthetic							6.5-8.5	600									1		0.3	
ADWG 2015 Health										0.003	0.01	0.06	4	0.002			2			0.01

SampleCode	Field_ID	Location Code	Sampled Date																	
Statistical Summary																				
Number of Results	2	2	2	2	32	32	32	32	2	32	32	32	32	32	32	32	32	32	32	32
Number of Detects	2	1	2	0	32	25	32	32	0	0	14	6	31	7	6	26	9	3	28	1
Minimum Concentration	260	<0.005	74	<5	760	0.27	4.3	360	<5	<0.001	<0.001	<0.0005	<0.01	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.05	<0.001
Minimum Detect	260	0.2	74	ND	760	0.27	4.3	360	ND	ND	0.001	0.001	0.02	0.0001	0.001	0.001	0.002	0.8	0.06	0.002
Maximum Concentration	290	0.2	530	<5	20000	27	11	12000	<5	<0.005	0.007	0.006	0.24	0.0008	0.056	0.19	0.017	2	24	0.002
Maximum Detect	290	0.2	530	ND	20000	27	11	12000	ND	ND	0.007	0.006	0.24	0.0008	0.056	0.19	0.017	2	24	0.002
Average Concentration					5820	6.8	6.4	3008		0.0024	0.0014	0.00084	0.075	0.00011	0.0049	0.03	0.0027	0.33	6.2	0.00055
Median Concentration	275	0.10125	302	2.5	3800	4.8	6.35	2300	2.5	0.0025	0.0005	0.0005	0.05	0.00005	0.0005	0.007	0.0005	0.25	4.45	0.0005
Standard Deviation					5016	7.8	1.1	2501		0.00049	0.0014	0.0011	0.066	0.00016	0.013	0.047	0.0047	0.35	7.1	0.00027
Number of Guideline Exceedances	0	0	0	0	0	0	21	30	0	30	0	0	0	0	0	0	0	0	25	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	21	30	0	0	0	0	0	0	0	0	0	0	25	0

Env Stds Comments

Data Comments

- #1 Ferrous Iron results are present at higher levels than total/soluble Iron results. This is due to experimental uncertainties associated with the different analytical techniques used in analysing Iron (total/soluble) and Ferrous Iron.
#2 Theoretically the TKN result should be greater or equal to ammonia concentration. However the difference reported is within the uncertainty of the individual tests
#3 The LORs have been raised due to matrix interference

[Filter]



Appendix C
Table 4
June 2015 Monitoring Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Tin (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Alkalinity			Major Ions									
										Alkalinity (total)	Alkalinity (total as CaCO ₃)	Hardness as CaCO ₃	Fluoride	Calcium	Calcium (Filtered)	Chloride	Magnesium	Magnesium (Filtered)	Potassium	Potassium (Filtered)	Sodium	Sodium (Filtered)
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQI	0.001	0.0001	0.001	0.001	0.005	0.0001	0.005	0.005	0.005	5	5	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5
ADWG 2015 Aesthetic	0.1								3			200				250					180	180
ADWG 2015 Health	0.5	0.001	0.05	0.02	0.01	0.1							1.5									

SampleCode	Field ID	Location Code	Sampled Date																							
S15-Jn21295	M4E-BH1309	BH1309	24-Jun-15	1.1	<0.0001	<0.001	0.017	<0.005	<0.0001	<0.005	<0.005	0.016	-	310	830	<0.5	150	-	400	110	-	20	-	420	-	
S15-Jn21572	BH1310	BH1310	23-Jun-15	0.67	<0.0001	<0.001	0.003	<0.005	<0.0001	<0.005	<0.005	0.014	-	250	280	<0.5	38	-	590	46	-	10	-	300	-	
S15-Jn21577	QA01	BH1310	23-Jun-15	0.64	<0.0001	<0.001	0.003	<0.005	<0.0001	<0.005	<0.005	0.008	-	240	290	<0.5	41	-	580	47	-	11	-	330	-	
S15-Jn21571	BH1314	BH1314	23-Jun-15	1.9	<0.0001	<0.001	0.024	<0.005	<0.0001	<0.005	<0.005	0.051	-	160	370	<0.5	57	-	740	55	-	25	-	560	-	
S15-Jn21570	BH1315	BH1315	23-Jun-15	10	<0.0001	<0.001	0.043	<0.005	<0.0001	<0.005	<0.005	0.02	-	200	170	1.3	12	-	470	33	-	11	-	440	-	
S15-Jn21296	M4E-BH1317	BH1317	24-Jun-15	9.9	<0.0001	<0.001	0.11	<0.005	<0.0001	<0.005	<0.005	0.43	-	55	530	0.9	17	-	2200	120	-	16	-	1200	-	
S15-Jn21297	M4E-BH1320	BH1320	24-Jun-15	10	<0.0001	<0.001	0.12	<0.005	<0.0001	<0.005	<0.005	0.38	-	60	610	0.5	31	-	2400	130	-	12	-	1100	-	
S15-Jn21298	M4E-BH1326	BH1326	24-Jun-15	3.2	<0.0001	0.003	0.1	<0.005	<0.0001	<0.005	<0.005	0.006	-	270	580	1.1	63	-	2100	100	-	31	-	1100	-	
S15-Jn21299	M4E-BH1331	BH1331	24-Jun-15	4.7	<0.0001	<0.001	0.023	<0.005	<0.0001	<0.005	<0.005	0.059	-	270	220	<0.5	26	-	530	38	-	9.3	-	480	-	
S15-Jn24885	BH1333	BH1333	25-Jun-15	4.2	<0.0001	<0.001	0.011	<0.005	<0.0001	<0.005	<0.005	0.041	-	250	490	1.3	36	-	1900	97	-	19	-	1100	-	
S15-Jn24886	QA03	BH1333	25-Jun-15	4	<0.0001	<0.001	0.01	<0.005	<0.0001	<0.005	<0.005	0.037	-	260	490	1.3	36	-	1900	97	-	19	-	1000	-	
S15-Jn21300	M4E-BH1336	BH1336	24-Jun-15	1.3	<0.0001	<0.001	0.002	<0.005	<0.0001	<0.005	<0.005	<0.005	-	350	1300	1.2	110	-	4100	240	-	42	-	1600	-	
S15-Jn21302	QA02	BH1336	24-Jun-15	1.3	<0.0001	<0.001	0.002	<0.005	<0.0001	<0.005	<0.005	<0.005	-	350	1300	1.1	110	-	4200	240	-	40	-	1600	-	
S15-Jn21301	M4E-BH1344	BH1344	24-Jun-15	0.69	<0.0001	<0.001	0.031	<0.005	<0.0001	<0.005	<0.005	0.046	-	250	190	<0.5	34	-	290	25	-	3.5	-	240	-	
130206-2	QA05	BH1365	25-Jun-15	1.3	<0.00005	<0.001	0.063	<0.001	<0.001	<0.001	<0.001	0.02	74	-	-	0.1	-	22	660	-	50	-	4.9	-	490	-
S15-Jn24878	BH1365	BH1365	25-Jun-15	1.4	<0.0001	<0.001	0.06	<0.005	<0.0001	<0.005	<0.005	0.019	-	70	250	<0.5	14	-	150	52	-	5.3	-	350	-	
S15-Jn24884	BH1369	BH1369	25-Jun-15	1.2	<0.0001	<0.001	0.013	<0.005	<0.0001	<0.005	<0.005	0.031	-	70	220	<0.5	2.6	-	840	52	-	12	-	760	-	
S15-Jn24881	BH1373	BH1373	25-Jun-15	16	<0.0001	<0.001	0.035	<0.005	<0.0001	<0.005	<0.005	0.097	-	170	1000	0.5	72	-	2800	200	-	12	-	1200	-	
S15-Jn24883	BH1379	BH1379	25-Jun-15	0.24	<0.0001	<0.001	0.004	<0.005	<0.0001	<0.005	<0.005	0.023	-	<5	31	<0.5	1	-	150	7	-	3.3	-	170	-	
S15-Jn24882	BH1397	BH1397	25-Jun-15	4.5	<0.0001	<0.001	0.04	<0.005	<0.0001	<0.005	<0.005	0.059	-	180	350	<0.5	35	-	1000	64	-	11	-	790	-	
S15-Jn21575	BH209	BH209	23-Jun-15	0.066	<0.0001	<0.001	0.015	<0.005	<0.0001	<0.005	<0.005	0.034	-	870	2700	<0.5	400	-	6800	420	-	77	-	3500	-	
S15-Jn21291	M4E-BH214	BH214	24-Jun-15	0.049	<0.0001	0.002	0.003	<0.005	<0.0001	<0.005	0.007	0.68	-	220	66	<0.5	12	-	290	8.6	-	6.8	-	300	-	
S15-Jn21574	BH220	BH220	23-Jun-15	0.53	<0.0001	0.001	0.028	<0.005	<0.0001	<0.005	<0.005	0.04	-	420	2400	<0.5	350	-	7300	370	-	67	-	2700	-	
S15-Jn21576	BH225	BH225	23-Jun-15	7.8	<0.0001	<0.001	0.1	<0.005	<0.0001	<0.005	<0.005	0.1	-	160	930	0.5	45	-	3600	200	-	34	-	2100	-	
S15-Jn21573	BH235	BH235	23-Jun-15	21	<0.0001	<0.001	0.086	<0.005	<0.0001	<0.005	<0.005	0.072	-	440	780	<0.5	46	-	2700	160	-	32	-	1200	-	
S15-Jn21292	M4E-BH252	BH252	24-Jun-15	0.46	<0.0001	0.005	0.077	<0.005	<0.0001	<0.005	0.009	0.044	-	530	710	<0.5	72	-	1800	130	-	30	-	1200	-	
S15-Jn21293	M4E-BH260	BH260	24-Jun-15	0.54	0.0001	0.001	0.017	<0.005	<0.0001	<0.005	<0.005	0.066	-	150	95	<0.5	18	-	99	12	-	3.3	-	120	-	
S15-Jn21294	M4E-BH264	BH264	24-Jun-15	2.8	<0.0001	0.002	0.012	<0.005	<0.0001	<0.005	<0.005	0.035	-	150	210	<0.5	14	-	750	42	-	8.1	-	520	-	
130206-1	QA04	BH290	25-Jun-15	0.35	<0.00005	0.008	0.2	<0.001	<0.001	<0.001	0.005	0.035	530	-	-	<0.1	-	43	770	-	44	-	260	-	840	-
S15-Jn24877	BH290	BH290	25-Jun-15	0.16	<0.0001	0.002	0.14	<0.005	<0.0001	<0.005	0.007	0.12	-	580	190	<0.5	28	-	830	30	-	290	-	550	-	
S15-Jn24879	BH301	BH301	25-Jun-15	0.046	<0.0001	0.002	0.05	<0.005	<0.0001	<0.005	0.016	0.12	-	220	90	<0.5	28	-	71	4.7	-	43	-	130	-	
S15-Jn24880	BH302	BH302	25-Jun-15	<0.001	<0.0001	<0.001	<0.001	<0.005	<0.0001	<0.005	<0.005	<0.005	-	280	270	<0.5	110	-	15	1.3	-	11	-	37	-	

[Filter]



Appendix C
Table 4
June 2015 Monitoring Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Manganese (Filtered)	Mercury (Filtered)	Molybdenum (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Silver (Filtered)	Tin (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Alkalinity			Major Ions									
										Alkalinity (total)	Alkalinity (total as CaCO3)	Hardness as CaCO3	Fluoride	Calcium	Calcium (Filtered)	Chloride	Magnesium	Magnesium (Filtered)	Potassium	Potassium (Filtered)	Sodium	Sodium (Filtered)
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL	0.001	0.0001	0.001	0.001	0.005	0.0001	0.005	0.005	0.005	5	5	1	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5
ADWG 2015 Aesthetic	0.1								3			200				250					180	180
ADWG 2015 Health	0.5	0.001	0.05	0.02	0.01	0.1							1.5									

SampleCode	Field ID	Location Code	Sampled Date																			
Statistical Summary																						
Number of Results				32	32	32	32	32	32	32	32	2	30	30	32	30	2	30	2	30	2	2
Number of Detects				31	1	9	31	0	0	5	29	2	29	30	11	30	2	30	2	30	2	2
Minimum Concentration				<0.001	<0.00005	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	74	<5	31	<0.1	1	22	15	1.3	44	3.3	4.9
Minimum Detect				0.046	0.0001	0.001	0.002	ND	ND	0.005	0.006	74	55	31	0.1	1	22	15	1.3	44	3.3	4.9
Maximum Concentration				21	0.0001	0.008	0.2	<0.005	<0.001	<0.005	0.016	530	870	2700	1.3	400	43	7300	420	50	290	260
Maximum Detect				21	0.0001	0.008	0.2	ND	ND	0.016	0.68	530	870	2700	1.3	400	43	7300	420	50	290	260
Average Concentration				3.5	0.00005	0.0012	0.045	0.0024	0.000078	0.0024	0.0034	260	598	4.46	67	1657	104	30			903	
Median Concentration				1.3	0.00005	0.0005	0.026	0.0025	0.00005	0.0025	0.0025	302	245	360	0.25	36	32.5	800	59.5	47	14	132.45
Standard Deviation				5	0.000011	0.0016	0.049	0.00049	0.00011	0.00049	0.0028	177	634	0.4	91	1847	105	52			792	
Number of Guideline Exceedances				28	0	0	18	0	0	0	0	0	0	23	0	0	0	27	0	0	0	26
Number of Guideline Exceedances(Detects Only)				28	0	0	18	0	0	0	0	0	0	23	0	0	0	27	0	0	0	26

Env Stds Comments

Data Comments

- #1 Ferrous Iron results are present at higher levels than total/soluble Iron result
#2 Theoretically the TKN result should be greater or equal to ammonia concen
#3 The LORs have been raised due to matrix interference

[Filter]



Appendix C
Table 4
June 2015 Monitoring Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

			Nutrients										
	Sulphate	Ionic Balance	Ammonia	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate (as N)	Nitrite (as N)	Nitrogen (Organic)	Nitrogen (Total)	Phosphate total (P)	Phosphorus	Reactive Phosphorus as P	TKN (as N)
	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EOL	2		0.005	0.01	0.2	0.01	0.01	200	0.1	0.05	0.05	0.05	0.1
ADWG 2015 Aesthetic	250		0.5										
ADWG 2015 Health	500												

SampleCode	Field ID	Location Code	Sampled Date												
S15-Jn21295	M4E-BH1309	BH1309	24-Jun-15	480	-	-	5.3	6.8	<0.01	<0.01	1500	6.8	0.06	-	<0.05
S15-Jn21572	BH1310	BH1310	23-Jun-15	77	-	-	0.27	1.5	0.01	<0.01	1230	1.51	<0.05	-	<0.05
S15-Jn21577	QA01	BH1310	23-Jun-15	77	-	-	0.28	1.7	0.02	<0.01	1420	1.72	<0.05	-	<0.05
S15-Jn21571	BH1314	BH1314	23-Jun-15	620	-	-	0.06	3.2	1.8	0.03	3140	5.03	9.5	-	<0.05
S15-Jn21570	BH1315	BH1315	23-Jun-15	400	-	-	<0.05	0.7	<0.01	<0.01	700	0.7	0.23	-	<0.05
S15-Jn21296	M4E-BH1317	BH1317	24-Jun-15	550	-	-	0.15	0.7	<0.01	<0.01	550	0.7	0.18	-	<0.05
S15-Jn21297	M4E-BH1320	BH1320	24-Jun-15	260	-	-	0.15	0.3	<0.1	<0.1	150	0.3	<0.05	-	<0.05
S15-Jn21298	M4E-BH1326	BH1326	24-Jun-15	360	-	-	0.47	0.8	<0.01	<0.01	330	0.8	<0.05	-	<0.05
S15-Jn21299	M4E-BH1331	BH1331	24-Jun-15	570	-	-	0.1	0.7	0.03	<0.01	600	0.73	0.39	-	<0.05
S15-Jn24885	BH1333	BH1333	25-Jun-15	520	-	-	0.18	0.8	0.03	<0.01	620	0.83	0.33	-	<0.05
S15-Jn24886	QA03	BH1333	25-Jun-15	530	-	-	0.17	0.9	0.04	<0.01	730	0.94	0.32	-	<0.05
S15-Jn21300	M4E-BH1336	BH1336	24-Jun-15	390	-	-	0.16	0.6	<0.1	<0.1	440	0.6	<0.05	-	<0.05
S15-Jn21302	QA02	BH1336	24-Jun-15	400	-	-	0.17	0.7	<0.1	<0.1	530	0.7	<0.05	-	<0.05
S15-Jn21301	M4E-BH1344	BH1344	24-Jun-15	190	-	-	<0.05	0.4	<0.01	<0.01	400	0.4	<0.05	-	<0.05
130206-2	QA05	BH1365	25-Jun-15	110	8.4	0.026	-	-	<0.005	<0.005	500	0.5	-	<0.05	0.5
S15-Jn24878	BH1365	BH1365	25-Jun-15	27	-	-	0.02	0.5	<0.1 ^{#3}	<0.1 ^{#3}	480	0.5	<0.05	-	<0.05
S15-Jn24884	BH1369	BH1369	25-Jun-15	800	-	-	0.15	0.5	<0.1 ^{#3}	<0.1 ^{#3}	350	0.5	<0.05	-	<0.05
S15-Jn24881	BH1373	BH1373	25-Jun-15	200	-	-	0.16	0.4	<0.01	<0.01	240	0.4	<0.05	-	<0.05
S15-Jn24883	BH1379	BH1379	25-Jun-15	260	-	-	0.06	0.5	0.09	<0.01	440	0.59	<0.05	-	<0.05
S15-Jn24882	BH1397	BH1397	25-Jun-15	860	-	-	0.18	0.4	<0.1 ^{#3}	<0.1 ^{#3}	220	0.4	<0.05	-	<0.05
S15-Jn21575	BH209	BH209	23-Jun-15	630	-	-	4.9 ^{#2}	4.2 ^{#2}	<0.01	<0.01	<50	4.2	<0.05	-	<0.05
S15-Jn21291	M4E-BH214	BH214	24-Jun-15	67	-	-	0.1	1.1	<0.01	<0.01	1000	1.1	0.07	-	<0.05
S15-Jn21574	BH220	BH220	23-Jun-15	500	-	-	1.4	1.6	<0.01	0.06	200	1.66	<0.05	-	<0.05
S15-Jn21576	BH225	BH225	23-Jun-15	370	-	-	0.09	0.7	<0.01	<0.01	610	0.7	0.25	-	<0.05
S15-Jn21573	BH235	BH235	23-Jun-15	220	-	-	0.1	1	<0.01	<0.01	900	1	<0.05	-	<0.05
S15-Jn21292	M4E-BH252	BH252	24-Jun-15	290	-	-	0.12	0.7	0.17	<0.01	580	0.87	<0.05	-	<0.05
S15-Jn21293	M4E-BH260	BH260	24-Jun-15	75	-	-	<0.05	1	0.41	<0.01	1000	1.41	0.06	-	<0.05
S15-Jn21294	M4E-BH264	BH264	24-Jun-15	300	-	-	0.09	0.7	<0.1	<0.1	610	0.7	0.19	-	<0.05
130206-1	QA04	BH290	25-Jun-15	110	17	0.74	-	-	0.17	0.009	600	1.5	-	0.3	1.3
S15-Jn24877	BH290	BH290	25-Jun-15	110	-	-	0.72	1.6	0.04	<0.01	880	1.64	0.24	-	0.14
S15-Jn24879	BH301	BH301	25-Jun-15	120	-	-	<0.01	1.2	0.41	<0.01	1200	1.61	0.14	-	<0.05
S15-Jn24880	BH302	BH302	25-Jun-15	2.9	-	-	0.02	0.7	0.15	0.53	680	1.38	0.05	-	<0.05

[Filter]



Appendix C
Table 4
June 2015 Monitoring Event
Groundwater Quality Results

WestConnex Delivery Authority
WestConnex
Baseline Groundwater Monitoring

	Nutrients													
	Sulphate	Ionic Balance	Ammonia	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate (as N)	Nitrite (as N)	Nitrogen (Organic)	Nitrogen (Total)	Phosphate total (P)	Phosphorus	Reactive Phosphorus as P	TKN (as N)	
	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
EQL	2		0.005	0.01	0.2	0.01	0.01	200	0.1	0.05	0.05	0.05	0.1	
ADWG 2015 Aesthetic	250		0.5											
ADWG 2015 Health	500													

SampleCode	Field_ID	Location	Code	Sampled	Date											
Statistical Summary																
Number of Results				32	2	2	30	30	32	32	32	30	2	30	2	
Number of Detects				32	2	2	26	30	13	4	31	32	14	1	2	
Minimum Concentration				2.9	8.4	0.026	<0.01	0.3	<0.005	<0.005	<50	0.3	<0.05	<0.05	<0.05	0.5
Minimum Detect				2.9	8.4	0.026	0.02	0.3	0.01	0.009	150	0.3	0.05	0.3	0.14	0.5
Maximum Concentration				860	17	0.74	5.3	6.8	1.8	0.53	3140	6.8	9.5	0.3	0.14	1.3
Maximum Detect				860	17	0.74	5.3	6.8	1.8	0.53	3140	6.8	9.5	0.3	0.14	1.3
Average Concentration				327			0.52	1.2	0.12	0.034	714	1.3	0.41		0.029	
Median Concentration				295	12.7	0.383	0.15	0.7	0.035	0.005	600	0.815	0.025	0.1625	0.025	0.9
Standard Deviation				230			1.3	1.3	0.32	0.093	569	1.4	1.7		0.021	
Number of Guideline Exceedances				19	0	1	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)				19	0	1	0	0	0	0	0	0	0	0	0	0

Env Stds Comments

Data Comments

- #1 Ferrous Iron results are present at higher levels than total/soluble Iron result
- #2 Theoretically the TKN result should be greater or equal to ammonia concn
- #3 The LORs have been raised due to matrix interference

[Filter]

Appendix C

Table 5

Westconnex M4 East Evaluation Phase

June 2015 Surface Water Monitoring Event - Field Parameters

Analyte	POW1	POW2	SAL1	SAL2	SLP1	SLP2	BAR1	BAR2	DOB1	DOB2	USW	DSW
pH (in situ)	8.4	7.87	8.48	7.87	8.31	8.37	7.9	7.46	8.61	7.58	8.21	7.97
Conductivity (µS/cm)	995	23959	2067	19473	808	1640	2749	40944	697	25564	2183	20008
DO (mg/L)	12.81	15.51	15.39	14.32	11.92	13.52	10.79	11.09	13.1	11.66	16.3	13.83
DO (%sat)	130.2	167.7	151.2	150.8	120.7	142	109.6	138.6	131.9	131.9	155.7	161.9
Turbidity (NTU)	12.3	16.2	5.85	5.47	3.01	5.42	21.8	11.2	45.9	16.2	6.43	35.7



Appendix C
Table 6
June 2015 Monitoring Event
Surface Water Quality Results

West Connex Delivery Authority
M4 East Corridor
Baseline Surface Water Monitoring

	Inorganics	Metals							TRH - NEPM 2013							TRH - NEPM 1999				
	Total Suspended Solids	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Nickel (Filtered)	Zinc (Filtered)	C6-C10 minus BTEX (F1)	C6 - C10 Fraction	>C10-C16 minus Naphthalene (F2)	>C10 - C16 Fraction	>C16 - C34 Fraction (F3)	>C34 - C40 Fraction (F4)	>C10 - C40 (Sum of Total)	C6 - C9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 (Sum of Total)
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	5	0.001	0.0001	0.001	0.001	0.001	0.001	0.005	20	20	100	100	100	100	100	20	50	100	50	50
ANZECC 2000 FW 95%		0.013 ^{#1}	0.0002	0.001 ^{#2}	0.0014	0.0034	0.011	0.008												
ANZECC 2000 MW 95%			0.0055	0.0044	0.0013	0.0044	0.07	0.015												
ANZECC 2000 FW Med-Low Reliability		0.013 ^{#1}	0.0002		0.0014	0.0034	0.011	0.008												

SampleCode	Field_ID	Location_Code	Sampled_Date																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</
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Statistical Summary																					
Number of Results	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
Number of Detects	6	1	0	0	8	1	5	6	0	0	0	0	1	1	1	0	0	1	1	1	
Minimum Concentration	<5	<0.001	<0.0001	<0.001	0.002	<0.001	<0.001	<0.005	<20	<20	<100	<100	<100	<100	<20	<50	<100	<50	<50		
Minimum Detect	6	0.001	ND	ND	0.002	0.003	0.001	0.006	ND	ND	ND	ND	330	150	480	ND	ND	170	260	430	
Maximum Concentration	40	<0.01	<0.001	<0.01	0.022	<0.01	<0.01	0.2	<20	<20	<100	<100	330	150	480	<20	<50	170	260	430	
Maximum Detect	40	0.001	ND	ND	0.022	0.003	0.004	0.2	ND	ND	ND	ND	330	150	480	ND	ND	170	260	430	
Average Concentration	13	0.002	0.0002	0.002	0.006	0.0022	0.0027	0.032	10	10	50	50	73	58	86	10	25	60	45	59	
Median Concentration	4.25	0.0005	0.00005	0.0005	0.005	0.0005	0.002	0.0215	10	10	50	50	50	50	50	10	25	50	25	25	
Standard Deviation	14	0.0022	0.00022	0.0022	0.0052	0.0022	0.0019	0.054	0	0	0	0	81	29	124	0	0	35	68	117	
Number of Guideline Exceedances	0	0	4	4	12	4	0	9	0	0	0	0	0	0	0	0	0	0	0	0	
Number of Guideline Exceedances(Detects Only)	0	0	0	0	8	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	

Env Stds Comments
#1:As (V) used as conservative value
#2:Cr(VI) guideline has been adopted

[Filter]



Appendix C
Table 6
June 2015 Monitoring Event
Surface Water Quality Results

West Connex Delivery Authority
M4 East Corridor
Baseline Surface Water Monitoring

	BTEX & MAH							PAH	Nutrients			
	Benzene	Toluene	Ethylbenzene	Xylene (o)	Xylene (m & p)	Xylene Total	BTEX (Sum of Total) - Lab Calc	Naphthalene	Total Kjeldahl Nitrogen	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L
EQL	1	2	2	2	2	2	1	5	0.1	0.01	0.1	0.01
ANZECC 2000 FW 95%	950			350				16				
ANZECC 2000 MW 95%	700							70				
ANZECC 2000 FW Med-Low Reliability	950	180	80	350				16				

SampleCode	Field_ID	Location_Code	Sampled_Date												
ES1525010001	POW1	POW1	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	0.9	1.62	2.5	0.11
ES1525010002	POW2	POW2	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	0.5	0.34	0.8	0.16
ES1525010003	SAL1	SAL1	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	0.5	0.48	1	0.05
ES1525010004	SAL2	SAL2	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	0.7	0.14	0.8	0.03
ES1525010005	SLP1	SLP1	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	0.6	0.63	1.2	0.02
ES1525010006	SLP2	SLP2	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	0.8	0.7	1.5	0.03
ES1525010007	BAR1	BAR1	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	7.6	0.63	8.2	1.62
ES1525010008	BAR2	BAR2	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	0.9	0.18	1.1	0.05
ES1525010009	DOB1	DOB1	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	3.3	1.82	5.1	0.31
ES1525010010	DOB2	DOB2	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	2.9	0.75	3.6	0.23
ES1525010011	USW	USW	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	3.5	0.47	4	0.45
ES1525010012	DSW	DSW	29-Jun-15	<1	<2	<2	<2	<2	<2	<1	<5	1	1.63	2.6	0.08

Statistical Summary															
Number of Results	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Number of Detects	0	0	0	0	0	0	0	0	0	12	12	12	12	12	12
Minimum Concentration	<1	<2	<2	<2	<2	<2	<2	<1	<5	0.5	0.14	0.8	0.02	0.02	0.02
Minimum Detect	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	0.14	0.8	0.02	0.02	0.02
Maximum Concentration	<1	<2	<2	<2	<2	<2	<2	<1	<5	7.6	1.82	8.2	1.62	1.62	1.62
Maximum Detect	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.6	1.82	8.2	1.62	1.62	1.62
Average Concentration	0.5	1	1	1	1	1	0.5	2.5	1.9	0.78	2.7	0.26	0.26	0.26	0.26
Median Concentration	0.5	1	1	1	1	1	0.5	2.5	0.9	0.63	2	0.095	0.095	0.095	0.095
Standard Deviation	0	0	0	0	0	0	0	0	2.1	0.58	2.2	0.45	0.45	0.45	0.45
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Env Stds Comments
#1:As (V) used as conservative value
#2:Cr(VI) guideline has been adopted

[Filter]