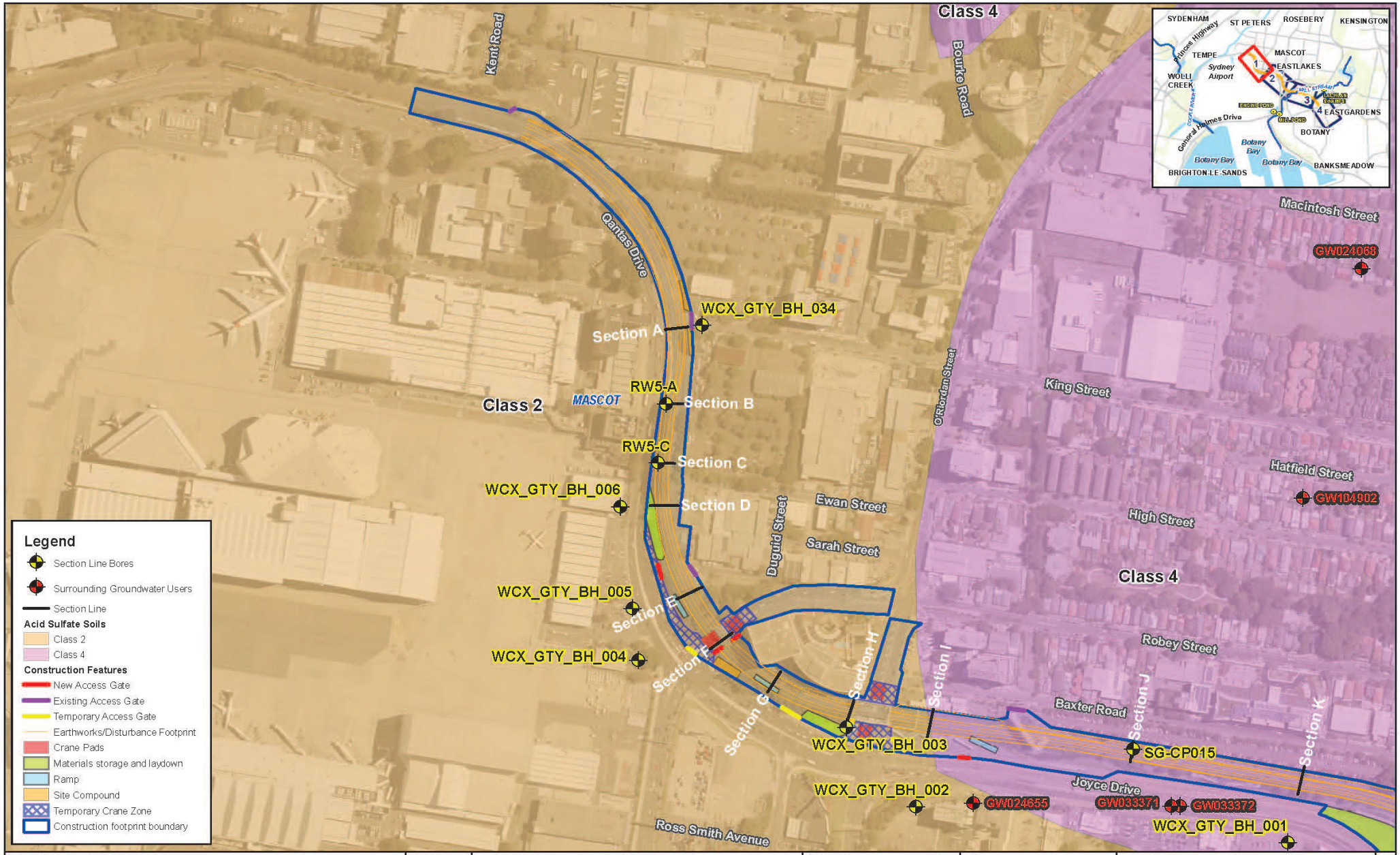
5. Assessment of impacts

Items of infrastructure that could potentially result in groundwater impacts relative to key receptors identified in Section 4 that could be impacted by the project are summarised in Figure 5.1 to Figure 5.4.

The aim of this section is to identify and discuss the key items of infrastructure associated with construction and operation that could potentially result in impacts and the magnitude of potential impacts. A more detailed discussion of the project infrastructure as a whole is provided in Chapter 6 and 7 of the main EIS document. As noted in Section 3, where data limitations prevent a detailed understanding of the actual impacts that may occur, a precautionary approach has been adopted for the identification of impacts and the associated magnitude of impact.



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CLIENT: ARTC

REV	DATE	AMENDMENT / REVISION DESCRIPTION
A1	29/05/2019	Surrounding Receptors East of Mill Stream
A2	03/06/2019	Surrounding Receptors East and South of Mill Stream
A3	06/06/2019	Surrounding Receptors East and South of Mill Stream

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MWR No. | APPROVAL

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CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: WSP, GHD

DRG No.

	NAME	DATE
DRAWN	D.NAIKEN	7/06/2019
DRG CHECK	P.QUIMORA	7/06/2019

PREPARED FOR

BOTANY RAIL DUPLICATION

A3

Groundwater Impact Assessment
Figure 5.1
Surrounding Receptors - Area 1

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ISSUE STATUS: FOR INFORMATION | EDMS No. | SHEET No.: 1 | ISSUE: A3

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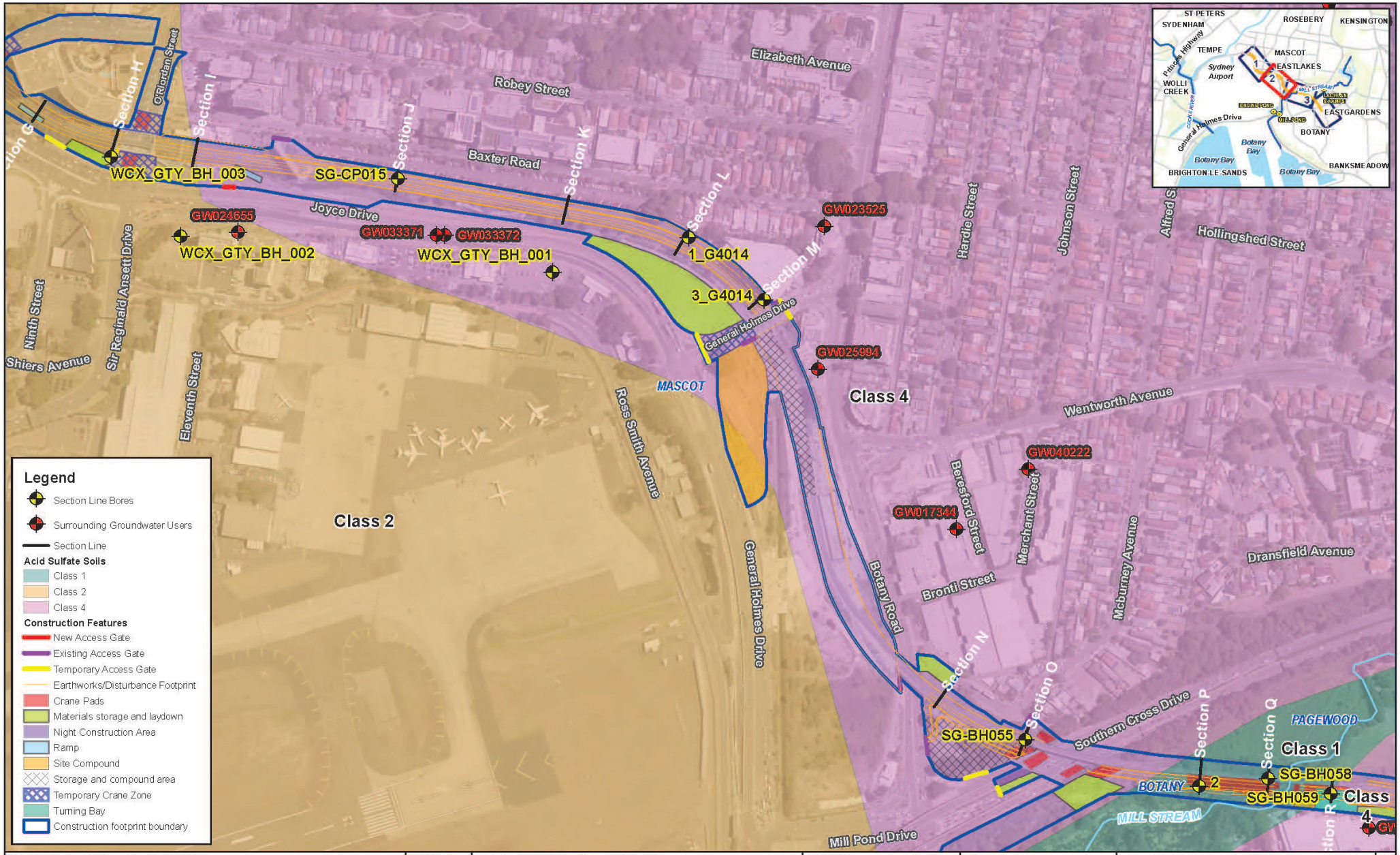

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	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL	SCALES ON A1 SIZE DRAWING	DRAWINGS / DESIGN PREPARED BY	TITLE	NAME	DATE	Groundwater Impact Assessment
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	A2	03/06/2019	Surrounding Receptors East and South of Mill Stream					DRG CHECK	P.QUIMORA	7/06/2019	Surrounding Receptors - Area 1
	A3	06/06/2019	Surrounding Receptors East and South of Mill Stream								
						CO-ORDINATE SYSTEM MGA ZONE 56	HEIGHT DATUM AHD				
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											ISSUE STATUS FOR INFORMATION EDMS No. SHEET No. 2 ISSUE A3

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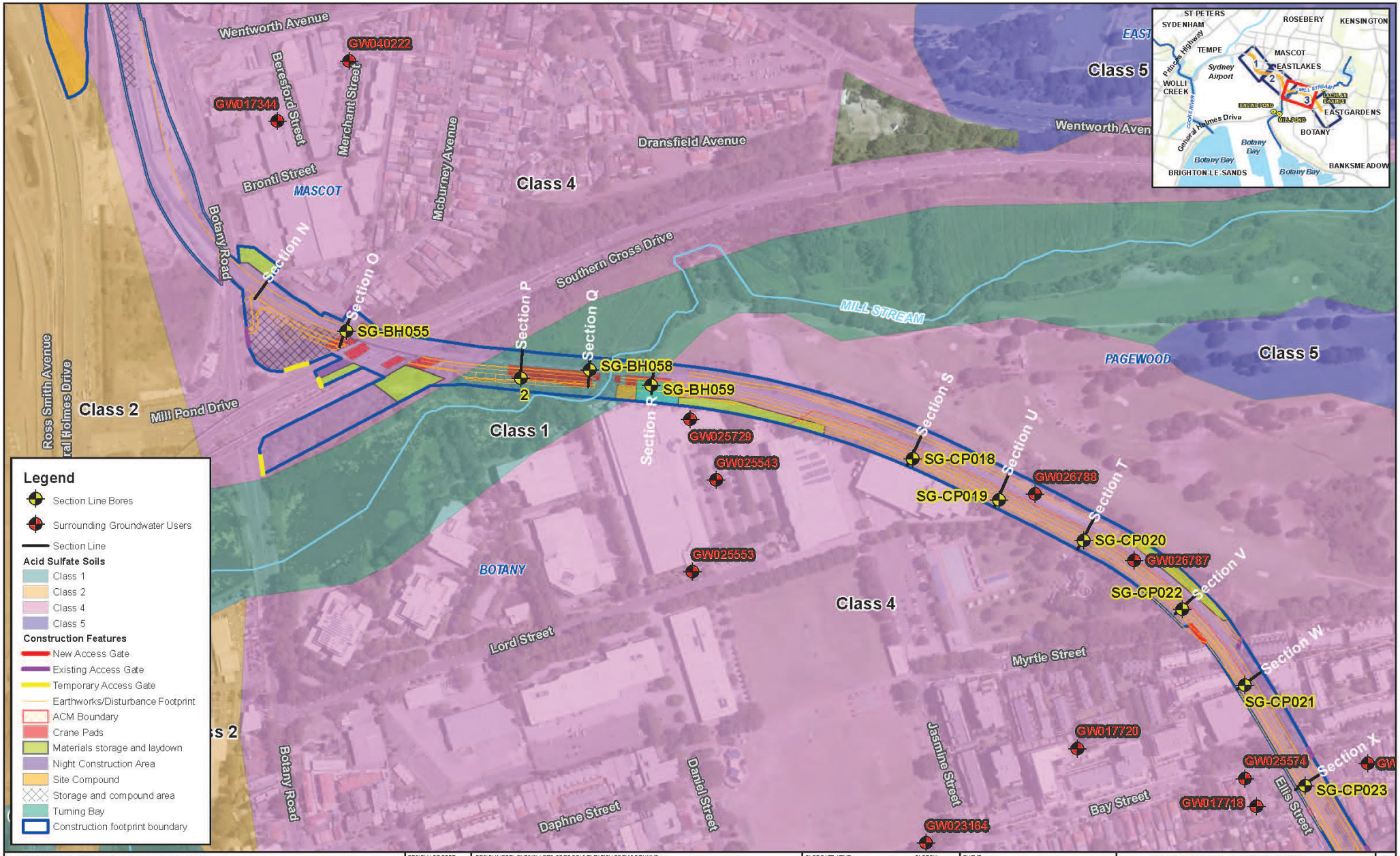

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REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
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A3	06/06/2019	Surrounding Receptors East and South of Mill Stream		

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HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: WSP, GHD

DRG No.

	TITLE	NAME	DATE
DRAWN	D.NAIKEN		7/06/2019
DRG CHECK	P.QUIMORA		7/06/2019

PREPARED FOR

BOTANY RAIL DUPLICATION

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Groundwater Impact Assessment
Figure 5.3
Surrounding Receptors - Area 2

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PART

ISSUE STATUS: FOR INFORMATION

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SHEET No.: 3

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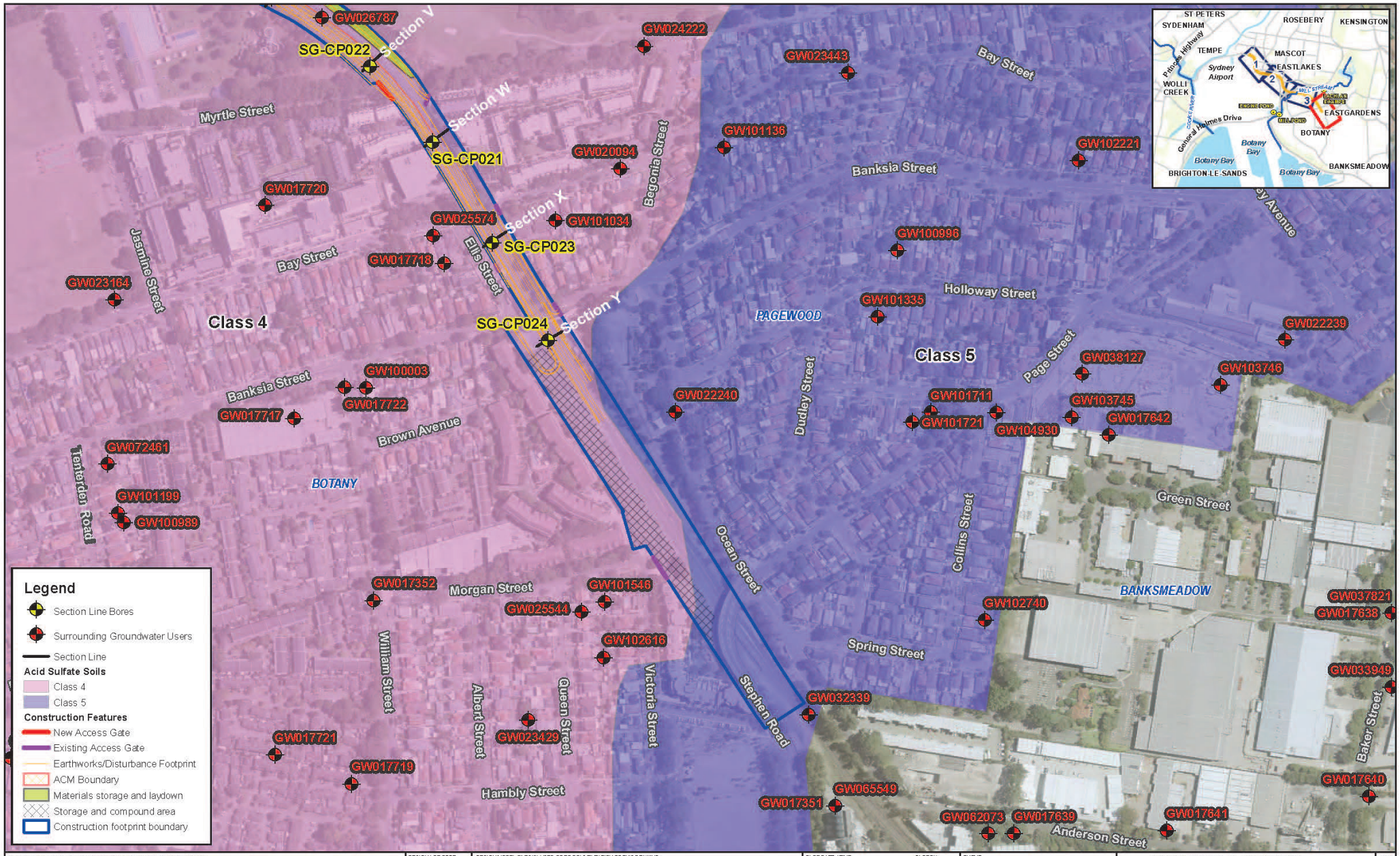

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REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
A1	29/05/2019	Surrounding Receptors East of Mill Stream		
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A3	06/06/2019	Surrounding Receptors East and South of Mill Stream		

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CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: wsp GHD

DRG No.

	TITLE	NAME	DATE
DRAWN		D.NAIKEN	7/06/2019
DRG CHECK		P.QUIMORA	7/06/2019

PREPARED FOR

BOTANY RAIL DUPLICATION

A3

Groundwater Impact Assessment
Figure 5.4
Surrounding Receptors - Area 2

RMS REGISTRATION No.: | PART

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5.1 Construction impacts

5.1.1 Changed groundwater recharge conditions

The key aspects of the rail duplication project that may limit or increase recharge are listed below:

- New rail track and movement (slewing) of the existing rail line to provide space for the rail duplication. This infrastructure is primarily surficial and any subsurface foundations will generally be closer than 1.0 metre from the existing ground surface. Re-alignment of the access track will result in the movement of the access track mound between sections W and X (south of the proposed Mill Stream bridge to Bay St – see Figure 5.1 to Figure 5.4), which will lower the existing ground surface by up to two metres, however the track in this section is elevated relative to the surrounding topography and will not result in intersection with the groundwater table. The removal of the surface is expected to expose more permeable sediments which will promote groundwater recharge events.
- Access tracks and the main line rail areas are proposed to be capped with lower permeability material than the underlying aquifer during construction. This represents a significant portion of the proposed operational project site. During construction existing infrastructure will be removed potentially exposing underlying materials. This will also increase the potential for groundwater recharge during rainfall events.

As noted in Section 1.1 the overall change in recharge areas is small relative to the overall recharge area for the Botany Sands aquifer (less than 0.3 per cent). Given this, any increases in recharge are not expected to have a measurable effect on groundwater elevations, especially given the relatively small climatic fluctuation in this area (Section 4.7.1), and the aquifer water balance. As such impacts to groundwater elevations are expected to be negligible relative to the AIP minimal impact criteria for water table changes and water pressure changes. Further to this, increases in recharge are also expected to represent positive impacts in regards to resource availability.

Based on the above, there will be negligible groundwater drawdown impacts on the following receptors:

- contaminated sites
- acid sulfate soils
- settlement of surrounding infrastructure
- surrounding groundwater supplies
- groundwater dependent ecosystems such aquatic ecology present in Mill Stream, Botany Bay and the Cooks River.

An increase in rainfall recharge will increase the potential for construction water quality impacts hence a potential for a change in the beneficial use potential of the aquifers in this area. If this occurred it would be considered to be more than a negligible impact as defined in the AIP and is discussed further in (Section 7).

Areas of expected higher risk of water quality impacts associated with general construction activities will include:

- storage and compound areas located near Section Y on Figure 5.4, between Section N and O on Figure 5.3, and near Section M on Figure 5.2
- material storage and laydown areas near Sections D and H on Figure 5.1, Sections L, N, O and P on Figure 5.2 and Sections R and V on Figure 5.3. Particularly those areas near to Mill Stream
- earthworks areas located along the entire project as presented in Figure 5.1 to Figure 5.4. Particularly those areas located near to Mill Stream. In this instance historical impact within subsurface soils may be exposed and released via rainfall infiltration
- areas where tracks are being slewed may liberate old impacts associated with a long history of active rail use such as historic lubricants
- areas of potential groundwater intersection where there will be a direct connection between potential construction activities and exposed groundwater.

The above activities may temporarily increase the potential for a change in beneficial use potential at the following down-gradient receptors:

- Industrial/irrigation users down-gradient of the project site including wells:
  - GW024036, which is a shallow well located on Sydney Airport that is registered as being used for irrigation purposes. It is noted that this well is already in the vicinity of the contamination remediation area at the Taxi car park. The groundwater in-take zone of the well (i.e. the bore screen) is expected to be positioned in the shallow unconsolidated aquifer that is either reworked/reclaimed Botany Sands or natural Botany Sands. Given the proximity to a remediation area, it is expected that this well is unlikely to be adversely impacted (by a change in beneficial use potential) by project construction activities.
  - GW024655 is registered as an abandoned irrigation well and is therefore no longer considered to be in use or potentially impacted by the project.
  - GW033371 and GW033372 are registered as commercial and industrial wells that may still be in use and could be impacted by the project. Given the depth of these wells they are expected to be screened in the Botany Sands aquifer. Given the proximity of these wells to the project, it is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW025994 is located in very close proximity to the project site although up-gradient and is registered as an irrigation well that may still be in use and therefore could be impacted. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. Given the proximity of this well to the project, it is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW100754 is located on the airport and is registered as a commercial and industrial well that could be in use. It has a depth of 148 metres and is screened within the underlying Hawkesbury Sandstone and is unlikely to be impacted by the project. As such this well is not considered further in this assessment.
  - GW025729 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. Given the proximity of this well to the project, it is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW025553 is registered as a commercial and industrial well that may still be in use and could be impacted the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. Given the proximity of this well to the project, it is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW026787 and GW026788 are registered as commercial and industrial wells that may still be in use and could be impacted by the project. Given the depth of these wells they are expected to be screened in the Botany Sands aquifer. Given the proximity of these wells to the project, it is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW017720 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. Given the proximity of these wells to the project, it is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW023164 is registered as an irrigation well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. It is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).

  - GW017722 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. It is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW017717 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. It is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
  - GW017718 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer. Given the proximity of these wells to the project, it is expected that this well would have a reasonable likelihood of being impacted by construction activities (by a change in beneficial use potential).
- Ecological and recreational users in Mill Stream, Botany Wetlands (including Lachlan Swamps), Cooks River and Botany Bay. The change in beneficial use would occur by the migration of impact groundwater down gradient with subsequent discharge to these surface water features. In areas near to Mill Stream the potential for impacts will be greater than in others where advection and dispersion of impacted groundwater would reduce the potential for a change in the beneficial use impacts. It is expected that impacts would be localised to the near shore ecology where groundwater has not been diluted.

At present, while it is acknowledged that the aquifer system in this area has water quality that is reflective of an industrial and urban setting, and is therefore unlikely to be subject to a change in beneficial use from construction it cannot be ruled out. Water quality impacts to down-gradient wells are therefore considered to be potentially significant and as such, environmental management measures will be required to minimise the potential for a change in beneficial use potential.

5.1.2 Groundwater drawdown impacts

A description of the potential for project infrastructure for reference design that intersect or avoid groundwater is provided below:

- New rail track and movement (slewing) of the existing rail line to provide space for the rail duplication. This infrastructure is primarily surficial and any subsurface foundations will generally be closer than one metre from the existing ground surface. Re-alignment of the access track will result in the movement of the access track mound between sections W and X (south of the proposed Mill Stream bridge to Bay Street) on Figure 5.4, which will lower the existing ground surface by up to two metres, however the track in this section is elevated relative to the surrounding topography and will not result in intersection with the groundwater table.
- New combined services routes for rail infrastructure (CSR). These are primarily located in between section V and the eastern end of the project site, in between sections O and S (east of Southern Cross Drive to Lord Street), in between sections N to O, and in between sections H and M. All of these will primarily be above ground structures with isolated locations below ground along Joyce Drive, in between sections I and J.
- Shallow concrete lined channels for capturing and managing rainfall run-off. These will be present in most areas of the project site and will generally be less than 0.5 metres deep and would not intersect groundwater.
- Retaining wall works on Mill Stream to Southern Cross Drive. These will be elevated relative to the surrounding topography and will be anchored horizontally removing the requirement for deep footings and any interaction with groundwater. In some instances foundations for the retaining walls may require piling works, however, similar techniques to that adopted for bridge pilings works would be adopted, which do not require groundwater dewatering (see bulleted points below).

- New deep drainage lines that will direct run-off to surface existing positive drainage systems– primarily between section S (invert 5.25 metre AHD) and Q (invert 4.4 metres AHD) and near section P, section L (invert 4.75 metres AHD), in between sections N and O, near sections F C, and B.
- Six new rail underbridges are to be built at four locations to replace or be adjacent existing underbridge structures. The exact construction of these underbridges has not been finalised. However, construction techniques will be adopted that prevent groundwater drawdown of the foundation excavations. For example, piling works are expected to adopt cast in situ techniques such as continuous flight auger. The cast insitu process would involve positive displacement of groundwater with concrete, while this is a form of dewatering it will not result in groundwater drawdown and the groundwater volumes displaced would be incidental and small.

Other existing utilities may be intersected or need to be relocated by the construction works and include:

- existing combined services routes that are to be removed or replaced. These are expected to include utilities owned by Sydney Water, Telstra and Ausgrid
- gas pipelines including:
  - Jemena high pressure gas pipelines (primary and secondary). This will not be relocated
  - a high pressure ethylene pipeline (referred to as the Qenos pipeline). This pipeline has been purged and contains inert Nitrogen. It is proposed that this pipeline would be relocated along section M (invert 4.5 metres AHD) to K (invert 3.0 metres AHD), in between sections I and J (invert 4.4 metres AHD) to F (invert 5.0 metres AHD). It is assumed that the old pipeline would be abandoned insitu and replaced by a new pipeline at the revised location
- Moomba to Sydney ethane pipeline (referred to as MSE). This pipeline may require protection at a number of locations along the project
- Ausgrid high voltage power
- drainage assets (Council).

Table 5.1 summarises the subsurface infrastructure by location, starting in Botany near Banksia Street, and whether the type of construction is occurring within that area. The sections are location on Figure 5.1 to Figure 5.4.

Table 5.1 Infrastructure with the potential to intersect groundwater along the alignment of the project site

Section	CSR – relocation and new	Retaining Wall	Bridge foundations	Earthworks	New Drainage	Qenos Pipeline relocation
Y to eastern end of the project site	X			X		
V to Y	X	X		X	X	
T to V	X					
R to T	X				X	
P to R	X	X	X		X	
N to P	X	X	X		X	
Botany Rd near Wentworth Avenue to P	X	X			X	
M to Botany Rd near Wentworth Avenue			X		X	
K to M	X	X	X	X	X	X

Section	CSR – relocation and new	Retaining Wall	Bridge foundations	Earthworks	New Drainage	Qenos Pipeline relocation
North of the IBIS budget hotel to K	X			X		
G to North of the IBIS budget hotel	X	X	X	X	X	X
D to G		X	X		X	X
King St to D		X		X	X	
Lancastrian Drive to Qantas Drive near King St				X		

Table 5.2 summarises the design inverts, observed groundwater elevations and reasonable worst case groundwater elevations at locations with groundwater data along the rail corridor. These locations are presented in Figure 5.1 to Figure 5.4. The reasonable worst case groundwater elevations are based on the observed groundwater elevations in 1999, which were associated with a period of expected higher groundwater elevations as reflected in the CRD curve on Figure 4.7 and/or a potential increase of 0.9 metres from existing groundwater elevations based on the variation in long term groundwater elevations at NSW DoI monitoring wells GW075022 and GW075023 located to the west and east of Mill Stream and near to the project.

Table 5.2 Summary of groundwater elevations and infrastructure invert elevations

Section	Invert level of lowest infrastructure (m AHD)	Infrastructure at lowest invert	Observed groundwater elevations (m AHD)	Reasonable worst case groundwater elevation (m AHD)	Depth from infrastructure to observed groundwater level (m)	Depth from infrastructure to RWC groundwater level (m)
A	5.339	Invert of track foundation	2.09	2.99	3.25	2.35
B	6.031	Invert of track foundation	1.98	2.88	4.05	3.15
C	6.544	Invert of track foundation	2.43	3.33	4.12	3.22
D	6.836	Invert of track foundation	1.51	2.41	5.33	4.43
E	7.389	Invert of track foundation	1.50	2.40	5.89	4.99
F	5	Qenos Pipeline	1.59	2.49	3.41	2.51
G	3.9	Qenos Pipeline	5.23	6.13	-1.33	-2.23
H	5.3	Qenos Pipeline	3.11	4.01	2.19	1.29
I	6.9	Qenos Pipeline	3.03	3.93	3.87	2.97
J	7.193	Invert of track foundation	3.78	4.68	3.41	2.51
K	5.185	Invert of track foundation	3.22	4.12	1.97	1.07
L	4.758	Invert of track foundation	3.07	3.97	1.69	0.79

Section	Invert level of lowest infrastructure (m AHD)	Infrastructure at lowest invert	Observed groundwater elevations (m AHD)	Reasonable worst case groundwater elevation (m AHD)	Depth from infrastructure to observed groundwater level (m)	Depth from infrastructure to RWC groundwater level (m)
M	5.88	Invert of track foundation	3.12	4.02	2.76	1.86
N	10.086	Invert of track foundation	8.30	9.20	1.79	0.89
O	10.715	Invert of track foundation	2.99	3.89	7.73	6.83
P	9.935	Invert of track foundation	3.80	4.70	6.14	5.24
Q	9.248	Invert of track foundation	2.81	3.71	6.44	5.54
R	4.7	Subsurface stormwater pipe	3.24	4.14	1.46	0.56
S	7.172	Invert of track foundation	5.73	6.63	1.44	0.54
T	7.364	Invert of track foundation	6.48	7.38	0.88	-0.02
U	7.449	Invert of track foundation	6.58	7.48	0.87	-0.03
V	7.543	Invert of track foundation	6.37	7.27	1.17	0.27
W	7.746	Invert of track foundation	7.40	8.30	0.35	-0.55
X	7.2	CSR	7.27	8.17	-0.07	-0.97
Y	8.519	Invert of track foundation	7.37	8.27	1.15	0.25

Notes:

Table excludes bridge piling works – which will be installed using cast insitu techniques that will not require dewatering but will intersect groundwater.

RWC = Reasonable worst case.

Table 5.2 indicates that the project infrastructure is intersected by groundwater at a small number of locations along the project site as summarised below:

- in the vicinity of Section G in Figure 5.1 to Figure 5.4 for relocation of the Qenos pipeline under worst case wet conditions and current groundwater conditions. It is noted however, that the groundwater elevations in this area are based on groundwater strike information at SG-CP013 (Table 4.9), which appear to be anomalously high
- in the vicinity of Sections T to W (excluding Section V) by the track foundations under reasonable worst case wet groundwater elevation conditions. There is no intersection under currently observed conditions
- in the vicinity of Section X on Figure 5.1 to Figure 5.4 by the new combined service route under worst case wet conditions (albeit slight) and current groundwater conditions.

The above summary indicates that there is a reasonable likelihood of intersection with groundwater at isolated locations along the alignment of the project site, particularly under wet conditions. In these areas if groundwater is intersected construction activities will be designed to prevent groundwater dewatering (and hence groundwater drawdown).

Bridge footings will intersect groundwater but as noted earlier cast insitu techniques will be adopted that do not require dewatering.

As such, impacts to groundwater elevations are expected to be negligible relative to the AIP minimal impact criteria for water table changes and water pressure changes. Further to this, increases in recharge (Section 5.1.1) are also expected to represent positive impacts in regards to resource availability.

With regard to receptors, the outcome of this approach will be that there will be no more than negligible drawdown impacts to:

- contaminated sites
- acid sulfate soils
- settlement of surrounding infrastructure
- surrounding groundwater supplies used for industrial purposes
- groundwater dependent ecosystems.

5.1.3 Groundwater quality

As outlined above, construction activities will involve moving the existing track and re-profiling of the existing surface to facilitate implementation of the proposed design. This will temporarily increase the potential for rainfall recharge and raise the potential for water quality impacts associated with construction activities.

Further to this, intensified construction activities relative to existing site use raise the potential for isolated spills and diffuse impacts. Chemicals of primary concern include hydrocarbons.

Impact is likely to occur through the infiltration of spilled pollutants onto the ground surface and/or liberated pollutants from disturbed fill/soils (see Section 5.1.1 for sources) and migration to underlying groundwater. Further detail on the contaminants present in soil that could be liberated by construction works is presented in the *Botany Rail Duplication EIS, Technical Report 5 – Contamination Assessment*.

Impacted groundwater from the above sources may then migrate to surface water features or other receptors (such as groundwater supply wells) where the beneficial use potential (environmental value) may be lowered.

The adoption of non-dewatering construction techniques, in line with normal construction practice, could result in direct contamination of exposed groundwater in excavations by construction activities, which would also migrate to down gradient receptors. These activities would include:

- increased potential for spills (fuels and hydraulics) from the construction machinery directly to exposed groundwater
- increased potential liberation of substances from tracks being removed and replaced such as historical rail lubricants and migration into open excavations with groundwater located in them
- disturbance of underlying contaminated materials and liberation of chemicals, via rainfall run-off into open excavations
- improper storage and handling of chemicals in and around the exposed groundwater in excavations.

As noted above groundwater intersection has potential to occur in the vicinity of Sections G and T- X (including Section V) which raises the potential for direct contamination of the aquifer system by construction activities.

With regard to receptors, the outcome of this will be a temporary increase in the potential for change in the beneficial use potential to down gradient receptors. While it is noted that the beneficial use potential of the existing aquifers in this area are low and there is an embargo on groundwater use for domestic purposes, the following receptors may still be impacted:

- Industrial/irrigation users down-gradient of the project site are presented below, all other wells located in this region are water supply wells subject to the Botany Sands aquifer water use embargo:
  - GW024036, which is a shallow well located on Sydney Airport that is registered as being used for irrigation purposes. It is noted that this well is already in the vicinity of the contamination remediation area at the Taxi car park. The well is expected to be screened in the shallow unconsolidated aquifer that is either reworked/reclaimed Botany Sands or natural Botany Sands.
  - GW033371 and GW033372 are registered as commercial and industrial wells that may still be in use and could be impacted by the project. Given the depth of these wells they are expected to be screened in the Botany Sands aquifer.
  - GW025994 is located in very close proximity to the project site although up-gradient and is registered as an irrigation well that may still be in use and therefore could be impacted. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
  - GW100754 is located on the airport and is registered as a commercial and industrial well that could be in use. It has a depth of 148 metres and is screened within the underlying Hawkesbury Sandstone and is unlikely to be impacted by the project. As such this well is not considered further in this assessment.
  - GW025729 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
  - GW025553 is registered as a commercial and industrial well that may still be in use and could be impacted the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
  - GW026787 and GW026788 are registered as commercial and industrial wells that may still be in use and could be impacted by the project. Given the depth of these wells they are expected to be screened in the Botany Sands aquifer.
  - GW017720 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
  - GW023164 is registered as an irrigation well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
  - GW017722 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
  - GW017717 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
  - GW017718 is registered as a commercial and industrial well that may still be in use and could be impacted by the project. Given the depth of this well it is expected to be screened in the Botany Sands aquifer.
- Ecological and recreational users in Mill Stream, Lachlan Swamps, Cooks River and Botany Bay.

Management measures will be required to limit the potential for a change in beneficial use potential.

5.1.4 Construction water balance

All water will be sourced from reticulated water supply, there will be no dewatering of the groundwater system by construction and there will be a temporary but negligible increase in groundwater recharge.

As such there will be a negligible change to the groundwater balance presented in Section 1.1.

5.1.5 Construction licensing

Due to the adoption of construction techniques that do not require dewatering, no licensing is expected to be required for the abstraction, management or discharge of groundwater from the site.

5.1.6 Summary of key findings

The following key points are made in regard to the impacts of construction activities on groundwater:

- Construction excavation activities may intersect groundwater at isolated locations during wet weather, but it is unlikely intersection will occur during dry conditions (other than at Section X). Bridge piling works will adopt cast insitu techniques that do not require groundwater dewatering and other non-dewatering techniques, in line with normal construction practice, will be adopted for other infrastructure such as the track foundations, the CSR and the Qenos pipeline if intersection occurs.
- There is a potential for a small increase in groundwater recharge during construction due to re-profiling works exposing more permeable materials.
- Based on the above, there will be no more than a negligible groundwater table impact relative to AIP groundwater table criteria.
- There will be an increased risk of water quality impacts associated with construction, which could change the beneficial use potential at a number of potentially sensitive groundwater receptors down gradient especially industrial water supply wells and Mill Stream. A change in water quality could represent a change in the beneficial use potential of the groundwater and surrounding receptors that is above the AIP minimal impact criteria for water quality. As such, management measures will be required.

5.2 Operational impacts

There would be additional tracks and increased train numbers during operation. However it is expected that there would be no more potential for impacts outside those that currently exist. In addition upgrades to the surface water drainage system would lower the potential for infiltration of any impacts to groundwater.

Other than increase train movements operational activities are expected to include:

- track lubrication using inert lubricants
- maintenance works, such as reconditions of the track, topping up of ballast, bridge and culvert inspections, rail grinding and track tamping
- any other major works would be completed in accordance with ARTC's environmental management system (EMS) which includes a procedure for completed a review of environmental factors when required.

Specific operational changes with regard to groundwater and their potential impacts are discussed further below.

5.2.1 Groundwater recharge

The main aspects of operation that will potentially impact on groundwater are expected to be:

- the new rail track and associated foundations will be constructed of material which has low permeability. As such it will reduce recharge to groundwater
- increased surface runoff associated with the new drainage structures and therefore better capture of rainfall will reduce rainfall infiltration to groundwater.

It is expected that the above applies to a small portion of the project site, and as such for the purposes of this assessment, if groundwater recharge was prevented in its entirety the overall impact on rainfall recharge to the Botany Sands aquifer would be less than 0.3 per cent (less than 104 m^3/day) of the overall groundwater balance.

Given this, any decreases in recharge are not expected to have a measurable effect on groundwater elevations, especially given the relatively small climatic fluctuation in this area associated with rainfall events (Section 4.7.1).

As such, operational groundwater recharge impacts are interpreted to be negligible and below the AIP minimal impact criteria for groundwater drawdown.

With regard to receptors, the outcome of these elements of construction will be no more than negligible recharge reduction (and hence drawdown) impacts to:

- contaminated sites
- acid sulfate soils
- settlement of surrounding infrastructure
- surrounding groundwater supplies
- groundwater dependent ecosystems such as aquatic ecology present in Mill Stream (Botany Wetlands), Botany Bay and the Cooks River.

5.2.2 Groundwater drawdown

Due to the nature of the works, and the existing known contamination within the Botany Sands aquifer, with management zones and embargos on groundwater take, all water required for operation would be sourced from non-groundwater sources. This will include reticulated water supplies.

Operational design will not require ongoing dewatering of groundwater, as such there will be no groundwater drawdown impacts during operation.

There may be permanent intersection of groundwater by new infrastructure as indicated in Table 5.2, however this will be negligible relative to overall aquifer thickness and as such there will be no change to groundwater elevations from subsurface barriers.

As such, operational groundwater drawdown impacts are interpreted to be negligible and below the AIP minimal impact criteria for drawdown.

With regard to receptors, there will be no more than negligible drawdown impacts to:

- contaminated sites
- acid sulfate soils
- settlement of surrounding infrastructure
- surrounding groundwater supplies used for industrial purposes.
- groundwater dependent ecosystems.

5.2.3 Groundwater quality

During operation groundwater impacts could result from infiltration of contaminants released by site activities or spilt or leaked chemicals during operation activities (such as via hydraulic leaks). The occurrence of this is expected to be low and no more than existing conditions.

The upgraded drainage system across the site further minimise the potential for infiltration of contaminants to groundwater and spills from accidents.

The revised capping material across the operational area will also reduce overall groundwater recharge and hence reduce the potential for negative groundwater quality impacts.

Groundwater quality in the Botany Sands aquifer is broadly impacted in this area by a range of ongoing industrial and commercial activities as well as the existing rail corridor (see Section 1.1).

Given the above, changes in water quality should not lower the beneficial use category of the groundwater source beyond 40 metres of the activity.

5.2.4 Operation water balance

Any water required for operational activities such as maintenance works will be sourced from reticulated water supply, there will be no dewatering of the groundwater system by operational activities and there will be minimal reduction in groundwater recharge.

As such there will be a negligible change to the groundwater balance presented in Section 1.1 and hence groundwater elevations.

5.2.5 Operation licensing

No groundwater licensing is expected to be required for the management of groundwater as no groundwater is expected to be abstracted or discharged from the site.

Any works outside of normal maintenance activities and requiring dewatering would be managed under the existing environmental management system and the requirement for licences would be determined at this time.

5.3 Summary of key findings

The key findings regarding impacts of operational activities on groundwater are:

- Operational activities are not expected to intersect groundwater or require ongoing dewatering.
- Groundwater recharge will slightly reduce in all areas of earthworks where new capping and foundation material has been emplaced but will result in a minimal reduction in the Botany Sands aquifer water balance. It will also result in a slightly reduced potential for groundwater quality impacts relative to existing conditions.
- Groundwater drawdown impacts relative to the AIP drawdown criteria will be no more than negligible.
- While there will be a slightly reduced potential for adverse impacts to groundwater quality and while existing water quality data indicates the Botany Sands aquifer is of limited value, there will be on going potential for impacts that could change the beneficial use potential and result in impacts greater than the AIP minimal impact criteria for water quality. The key potential impacts are spills and leaks from operational activities, however, these are expected to be no more than present day conditions. As such the potential for change in the beneficial use potential of down gradient groundwater is expected to be unlikely. Environmental management measures will be implemented to manage this.

6. Cumulative impacts

6.1 Introduction

Major developments currently under construction in the vicinity of the project include:

- M4–M5 Link and New M5. The interpreted zone of groundwater impact associated with this project is not interpreted to intersect the BRD project.
- Sydney Metro Southwest. The interpreted zone of groundwater impact associated with this project is not interpreted to intersect the BRD project.
- Airport North upgrades – O'Riordan Street. This project is expected to be largely completed in 2020 at which time BRD project is expected to have commenced as such cumulative construction based impacts may occur. However, it is noted that the construction works will be staged such that the progression of each project will not be hindered.
- Airport East upgrades – General Holmes Drive, Botany Road, Joyce Drive. This project will be completed prior to the commencement of the BRD project as such cumulative construction based impacts are not expected.

Other developments in the vicinity of the project that are proposed but not yet approved include the Sydney Gateway road project and F6 Stages 1 and 2. The F6, which will extend off from the new M5 is expected to have an interpreted zone of groundwater impact that does not intersect with the BRD project.

Further detail on the potential groundwater impacts of the Sydney Gateway road project projects are provided below.

6.2 Groundwater recharge

Recharge is expected to increase marginally during construction resulting in an increase in rainfall infiltration with no material impact to the groundwater balance and resource availability in this area. As such there is not expected to be any contribution to cumulative drawdown and water balance impacts potentially associated with other projects in this region.

There may a slight increase in the potential for infiltration of impacted groundwater that will overlap with construction works on the Sydney Gateway road project and the Airport North upgrades.

During operation, there will be marginally reduced recharge that is not expected to result in material change to groundwater elevations or the groundwater balance that currently exists. The Sydney Gateway Road project and the WestConnex enabling works airport north precincts are in close proximity to the BRD project close proximity to one another and any impacts would overlap. These projects are also expected to have negligible operational impacts on groundwater recharge compared to existing conditions as they will primarily be replacing existing sealed areas in the vicinity of the Botany Rail Duplication project.

6.3 Groundwater drawdown

Based on the information presented in Sections 1.1 and 5.2, there will not be construction or operational groundwater drawdown associated with the Botany Rail Duplication project and therefore the project will not contribute to ongoing cumulative groundwater drawdown impacts associated with other projects in the area. Any impacts associated with those projects will be assessed as part of the approvals process for those projects.

6.4 Groundwater quality

While the beneficial use potential of the groundwater system in this area is already impacted by existing industrial uses, there will be increased potential for infiltration of construction impacted rainfall to groundwater. The potential for this impact will also be associated with the Sydney Gateway road project and the WestConnex enabling works north precinct construction (in areas at and west of O'Riordan Street only), which will be occurring at a similar time. This will result in the potential for cumulative impacts, however, it is noted that the construction works will be staged such that the progression of each project will not be hindered. Construction works for the WestConnex enabling works east precinct is expected to be completed in 2019 and will not overlap with the construction works for the Botany Rail Duplication works.

During operation the existing land uses would remain the same albeit to support increased traffic volumes. The upgraded drainage and other operational infrastructure for all projects would also further reduce the potential for infiltration of contaminants to groundwater from leaks, spills, accidents and general operational activities.

The revised capping material across the operational area will also reduce overall groundwater recharge and hence the potential for adverse groundwater quality impacts by contaminant infiltration. This will reduce any contribution to cumulative water quality impacts from the BRD project.

Further to this, existing environmental management systems are in place to manage and maintain equipment and storage facilities that could be sources of hazardous chemicals and to respond appropriately to spills associated with accidents and leaks.

Based on this, cumulative impacts that could result in a change in the beneficial use potential criteria outlined in the AIP are not expected to occur however, this would need to be verified with monitoring.

7. Management of impacts

7.1 Approach

7.1.1 Overview

As a general guiding principle for major civil design and construction works, water quality mitigation and management measures will be implemented in accordance with the relevant requirements of NSW legislative framework for groundwater quality and availability, paying particular attention to the NSW aquifer interference policy, relevant water sharing plans (Botany Sands aquifer management plan), the NSW groundwater dependent ecosystems policy, and NSW and Australian groundwater quality guidance.

Mitigation measures would be managed through the following:

- ARTC's Site environmental management plans (EMPs) for enabling works
- project specific construction and environmental management plan (CEMP) for main construction works
- community and stakeholder engagement plan
- ARTC's environmental management system for operation of the project.

A Soil and Water Management Plan (SWMP) would be developed to manage soil and water risks during the main construction works. The SWMP would comply with the proposal conditions of approval and be in accordance with best on site practice, reflected in the Blue Book (Landcom, 2004).

7.1.2 Groundwater recharge

Groundwater recharge impacts relative to the AIP minimal impact criteria for groundwater elevation changes are considered to be negligible during construction and operation and therefore no mitigation measures are proposed.

7.1.3 Groundwater drawdown

There will be no construction or operational activities that will result in groundwater drawdown. As such no impacts are expected to occur.

The proposed construction approach of no dewatering would result in no greater than negligible impacts and as such no specific mitigation is proposed.

7.1.4 Groundwater quality

Construction

Construction activities are expected to have potential to increase the occurrence of contaminants infiltrating to groundwater and hence changing the beneficial use potential of underlying groundwater.

Given the existing groundwater conditions, which reflect historical urban and industrial activities, it is expected the likelihood of a change in the beneficial use potential of the underlying aquifer will be small, although this is uncertain.

Potential water quality impacts associated with the enabling works would be managed through the site environmental management plan. Potential water quality impacts associated with the main construction works would be managed by implementing environmental management measures within the a SWMP. This would include appropriate handling and management procedures for incidental groundwater ejected at the ground surface by bridge pile installation works.

As presented in the *Botany Rail Duplication EIS Technical Report 5 – Contamination Assessment*, the SWMP would include additional management plans to manage potential water quality impacts. These are:

- water quality objectives for the project
- an erosion and sediment control plan that allows for site-specific erosion and sediment controls at all work sites in accordance with the Blue Book
- an asbestos management plan (AMP) that would be prepared in accordance with NEPM 2013 and the *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia* (WA Department of Health, 2009)
- an acid sulfate soil management plan (ASSMP) that would be developed in accordance with the *Acid Sulfate Soils Manual* (ASSMAC, 1998).

Operation

The project would include capping and surface water capture systems that manage surface water and limit migration to the underlying groundwater system. Operation of the project would therefore, result in reduced potential for impacts to the beneficial use potential of the underlying groundwater system relative to existing conditions.

There would however, be an ongoing potential for groundwater quality impacts from isolated spills and leaks associated with operational and maintenance activities that could adversely impact groundwater quality. These would be no more than existing conditions and as such there is unlikely to be a change in the beneficial use potential of the underlying groundwater system.

The existing environmental management system would be continued to prevent ongoing groundwater quality impacts. This system includes a range of environmental procedures/protocols such as:

- a contaminated land database to inform intrusive maintenance works that could disturb and liberate contamination in subsurface soils
- material handling procedure
- spill prevent and response procedure
- emergency response procedures
- pesticide application and use
- project risk management protocols, which include consideration of risks to the environment.

7.2 List of mitigation measures

The mitigation measures that would be implemented to address potential groundwater impacts are listed in Table 7.1 and will be incorporated into the relevant management plans.

Table 7.1 Mitigation measures

Stage	Impact	Measure
Construction	Spills and leaks contaminating groundwater	Procedures to store, handle and use materials and equipment appropriately to prevent spills will be prepared and included in the Soil and Water Management Plan.
	Change in beneficial use potential of groundwater quality	Leakage of fuels, oils, chemicals and other hazardous liquids will be immediately cleaned up in accordance with the Safety Data Sheet and relevant emergency response procedure.
Operation	Spills and leaks contaminating groundwater	A groundwater construction monitoring program will be developed to verify the effectiveness of construction activities at preventing changes in the beneficial use potential of the aquifer system. This is detailed in Section 8.
	General maintenance activities	Potential spills and/or leaks will be managed in accordance with ARTC's pollution incident response procedure (under the Environment Management System) or in accordance with an Operator's Operational Management Environmental Management Plan (OEMP) prepared in accordance with ARTC's access agreement requirements (depending on the extent and natural of the spill).

8. Monitoring

Proposed monitoring to verify the effectiveness of construction and operation activities at limiting potential impacts to groundwater quality are presented below.

A groundwater monitoring program would be prepared and implemented to characterise baseline groundwater conditions and construction and operational impacts. A summary of the proposed monitoring program is provided below.

8.1 Baseline monitoring

A baseline monitoring program would be implemented to characterise baseline groundwater conditions.

The locations for groundwater monitoring should focus on the early detection of impacts and the potential for impacts at groundwater receptors. As such, the monitoring would include locations:

- up and down-gradient of the project site and at depths equivalent to the depth of construction and operational infrastructure (e.g. the shallow groundwater system of the Botany Sands aquifer)
- along the entire alignment of the project site, to understand the breadth of water quality characteristics on which impacts can be assessed
- near groundwater receptors including industrial groundwater supply wells and in between the project site and receiving surface water features (Botany Bay and Cooks River and Mill Stream).

An existing ongoing monitoring program has been implemented, from which baseline groundwater data could be used. The locations of existing groundwater monitoring locations are presented in Appendix A.

It is expected that the analytical suite used for water quality monitoring would focus on key contaminants associated with construction activities and the existing surrounding land use (to highlight pre-existing impacts associated with other industry in the area). As a minimum the analytical suite should include:

- total dissolved solids
- pH
- dissolved heavy metals, particularly cadmium, iron, lead, nickel, manganese and zinc
- chloride, sodium and sulfate
- nitrate, ammonia and phosphorus
- total recoverable hydrocarbons, benzene, toluene, ethylbenzene and xylene (BTEX) and polycyclic aromatic hydrocarbons (PAHs)
- PFAS.

The water quality results should be compared against criteria that facilitate the establishment of the current beneficial use potential of the groundwater system and receiving water bodies, on which any project related impacts can be assessed. This is expected to include:

- Criteria for the protection of aquatic species such as:
  - ANZG (2018) marine and freshwater criteria for the protection of 95 percent of aquatic species unless otherwise justified
  - the NEMP (2018) PFAS guidelines for marine and freshwater.
- Recreation criteria such as the NHMRC (2008) recreational guideline values. This would also be used as conservative criteria for assessing the suitability of the water for industrial purposes as well, assuming that industrial water supplies are not suitable for potable purposes without treatment (in accordance the Botany Sands embargo on domestic users).

A registered groundwater supply bore survey should be conducted to verify the use of the wells and or subsequently understand water quality criteria needed for the wells to maintain their viability. Any operational bores, could then be incorporated into the monitoring program or 'fit for purpose' water quality monitoring undertaken by the user in accordance with the Botany Sands groundwater source water restriction order 2018 could be used.

8.2 Construction monitoring

As there is an increased risk of a groundwater quality impacts (a change in beneficial use potential) relative to existing conditions, a construction base groundwater monitoring program is proposed.

The baseline groundwater monitoring program would be continued through construction for the purpose of identifying and responding to any groundwater quality impacts outside of those predicted. Quarterly monitoring is expected to be suitable to highlight the emergence of groundwater quality impacts relative to the baseline groundwater data. The construction monitoring period at each monitoring well would be completed once construction in the vicinity of each well was completed.

The emergence of groundwater impacts is expected to be relatively quick as groundwater flow velocities are estimated to be in the order of 255 m/year (Section 1.1) in the Botany Sands aquifer. As such quarterly monitoring is expected to be suitable to resolve the emergence of any construction based quality impacts. It is recommended that post-construction monitoring is continued for 1 year after the completion of each stage of the project to characterise the emergence of any construction impacts after completion.

Assessment of water quality impacts should focus on background (baseline) groundwater and surface water quality conditions where data is available to establish site specific criteria in accordance with ANZECC 2000 guidelines and ANZG (2018) while being cognisant of the NSW Water quality objectives and the Botany Bay and Catchment water quality improvement plan. Other criteria such as ANZG (2018) values, NEMP (2018) values and NHMRC (2008) values would be adopted where site specific data cannot be established.

Exceedance of these criteria would instigate further investigations and/or remedial response measures. These measures would be specified in the CEMP groundwater management plan.

8.3 Operation monitoring

As operational impacts are expected to be no more than existing conditions and that operational activities will be subject to the existing environmental management system to identify and manage environmental incidents, no ongoing groundwater quality monitoring is proposed.

9. Conclusion

A groundwater impact assessment has been completed to assess the impacts of the proposed project on the existing groundwater resources and down-gradient receptors.

The assessment has been desktop based, with the assessment of impacts and mitigation measures. The data available for this assessment is limited to information from previous investigations and public databases. As such, a conservative approach identifying potential impacts is necessary due to gaps in hydrogeological understanding based on the limited data to accommodate any uncertainty.

The characterisation of impacts has focused on comparing the impacts from the project against the AIP criteria for groundwater table changes and changes in beneficial use potential of the groundwater quality.

All potential groundwater impacts have been assessed to be manageable. The potential impacts and recommended mitigation measures are outlined below.

9.1 Groundwater drawdown impacts

The assessment has included establishing reasonable worst case groundwater elevations along the alignment of the project site and comparing those to the project design, particularly subsurface infrastructure. Further to this, consideration has been given to impacts of changed recharge conditions during construction and operation on groundwater drawdown and resource availability/water balance.

- The assessment of groundwater impacts during construction has relied on the adoption of non-dewatering techniques, in line with normal construction practice, where groundwater is encountered. Incidental and very localised displacement of groundwater for bridge and retaining piling works will occur but this will not result in groundwater drawdown.

Groundwater drawdown impacts during both construction and operation is considered negligible.

As such no mitigation measures are proposed.

9.2 Groundwater quality impacts

9.2.1 Construction impacts

The groundwater system is already typical for a historical urban and industrial use. The construction activities are however a change in use, albeit temporary, above an aquifer that supports industrial groundwater use and that discharges to wetland ecosystems of significance. There is uncertainty with regard to whether construction impacts will change the beneficial use potential (which would represent an adverse impacts under the AIP criteria), but given the presence of surface water systems of significance and potential down gradient industrial groundwater users, a precautionary approach has been adopted. This approach includes the adoption of the following mitigation measures:

- Potential water quality impacts would be managed by implementing environmental management measures within a relevant management plan. It also includes a number of target measures to manage contaminated soil and groundwater, including the development of a ASSMP.
- A baseline and construction monitoring program would be implemented to verify the effectiveness of the measures outlined in the SWMP to prevent groundwater quality impacts.

There may be an increased potential for cumulative groundwater quality impacts from increased rainfall infiltration during the combined construction of the Sydney Gateway Road Project and the Botany Rail Duplication project. This potential impact will be managed by implementing appropriate measures for each project separately.

9.2.2 Operation impacts

Impacts during operation are expected to be no more than existing conditions and with the ongoing implementation of the environmental management systems the potential for impacts is expected to be negligible.

10. References

- AECOM, (2016). WestConnex New M5 – Groundwater Monitoring Report.
- AECOM, 2015. M4-M5 Link Environmental Impact Assessment.
- AECOM, 2017. WestConnex New M5- Environmental Impact Assessment.
- AECOM. Sydney Gateway Project – Monthly Baseline Surface Water Monitoring. Multiple reports.
- Ahern CR, Stone Y, and Blunden N (1998). Acid Sulfate Soil Assessment Guidelines. Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.
- ANZG (2018) Australian and New Zealand Environment Guidelines for Fresh and Marine Water Quality (Australian and New Zealand and Australian State and Territory Governments.
- ANZECC and ARMCANZ (2000), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
- Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (2000b). The Australian Guidelines for Water Quality Monitoring and Reporting (Water Quality Monitoring Guidelines), Australian Water Association, Artarmon, NSW.
- Barnett, B., Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A. (2012), Australian Groundwater Modelling Guidelines, Waterlines Report Series No. 82, National Water Commission.
- Cooper, H. H., & Jacob, C. E. (1946). A generalized graphical method for evaluating formation constants and summarizing well-field history. Eos, Transactions American Geophysical Union, 27(4), 526-534.
- CDM Smith (2015) AECOM WestConnex Stage 2 New M5 Groundwater Modelling Report.
- Department of Environment, Climate Change and Water. (2006). *NSW Water Quality and River Flow Objectives*.
- Department of Environment and Conservation (DEC) (2004), Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales. March 2004.
- Department of the Environment and Energy (DoE&E) (2016). Commonwealth environmental management guidance on perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). Draft report dated October 2016.
- Department of Health (DoH) (2017), Health Based Guidance Values for PFAS – for use in site investigations in Australia. Fact sheet.
- Department of Land and Water Conservation (DLWC) (1997a). The NSW State Groundwater Policy Framework Document.
- Department of Land and Water Conservation (1997b). Acid Sulfate Soil Risk Map - Botany Bay (Ed. 2). Department of Land and Water Conservation, Sydney, NSW Department of Mineral Resources and Energy (1991). 1:100,000 Geological Series Sheet 9130, Sydney. NSW Department of Mineral Resources and Energy, Sydney, NSW.
- Department of Primary Industries (DPI), Office of Water (2012). *NSW Aquifer Interference Policy*. NSW Government policy for the licensing and assessment of aquifer interference activities.
- Doherty, J. E., (2010). PEST: Model Independent Parameter Estimation. Watermark Numerical Computing, Brisbane, Australia.

- Douglas Partners (2014), Report on Preliminary Site Investigation of Contamination. Sydney Airport T2/T3 Ground Access Solutions and Hotel Major Development Plan. December 2014.
- Environmental Earth Sciences (ESS). (2018). Dewatering Feasibility Study Westconnex Enabling Works Botany Road Rail Underpass.
- GHD (2015). Groundwater Impact Assessment as part of the WestConnex Delivery Authority (NSW). M4 East Environmental Impact Statement. September 2015.
- Golder (2016). Design Package Report, Groundwater Baseline Report (Project-wide) FD, M5 East – Design and Construct. December 2016.
- Golder (2017). Design Package Report, Hydrogeological Design Report, FD, The New M5 Design and Construct. April 2017.
- Golder (2018). M5 East-Groundwater Baseline Report.
- Hatley R.K. (2004) Hydrogeology of the Botany Basin. Australian Geomechanics Vol 39 No 3 September 2004.
- Hewitt, P., (2005); Groundwater Inflow for Sydney Rock Tunnels; Parsons Brinckerhoff.
- Hydrogeologic, (1996). MODHMS Software (Version 2.0) Documentation. Volume I: Groundwater Flow Modules.
- Jolly I, Gow L, Davies P, O'Grady A, Leaney F, Crosbie R, Wilford J and Kilgour P. (2011). Recharge and discharge estimation in data poor areas: User guide for the recharge and discharge estimation spreadsheets and MapConnect. CSIRO: Water for a Healthy Country National Research Flagship.
- Lerner D.N, (2002). *Identifying and quantifying urban recharge*. Hydrogeology Journal 10:143-152.
- Jacobs (2016). Chatswood to Sydenham Environmental Impact Statement. May 2016.
- JBS&G (2017). Stage 3, Northern lands Precinct Investigation, Sydney Airport, Mascot, NSW. 23 May 2017.
- McNally, G. H. (2004). Shale, salinity and groundwater in western Sydney. *Australian Geomechanics, 39*(3), 109-123.
- National Environment Protection Council (NEPC) (2013). *National Environment Protection (Assessment of Site Contamination) Amendment Measure*, Adelaide, SA.
- National Health and Medical Research Council (NHMRC) of Australia, 2008; *Guidelines for Managing Risks in Recreational Waters*; Australian Government.
- NHMRC (2013), *Australian Drinking Water Guidelines*, National Health and Medical Research Council (version 3.5 updated August 2018).
- NOW (2011), *Water Sharing Plan for the Greater Metropolitan Region Groundwater Resources – Background Document*. State of NSW Department of Primary Industries.
- NOW (2012), *Risk Assessment Guidelines for Groundwater Dependent Ecosystems*, Department of Primary Industries, NSW Office of Water.
- NSW Department of Environment and Conservation (DEC) (2004), *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales,* NSW Department of Environment and Conservation.
- NSW Department of Land and Water Conservation (DLWC) (1997), *The NSW State Groundwater Policy Framework Document*.
- NSW Department of Land and Water Conservation (DLWC) (1998); The NSW Groundwater Quality Protection Policy.
- NSW Department of Land and Water Conservation (DLWC) (2002); The NSW State Groundwater Dependent Ecosystems Policy.

- NSW Department for Mines (2002). Geological Series 1:250,000 Surface Geology Units (Statewide_250K_Geology_GCS94.shp). Geological Survey of New South Wales.
- NSW Department of Water and Energy (DWE) (2007); NSW Water Extraction Monitoring Policy.
- NSW Government (2000), Environmental Planning and Assessment Regulation.
- New South Wales Government (2017). Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011.
- Och, D.J., Offler R., Zwingmann, H., Braybrooke, J. and Grahman, I.T. (2009). Timing of brittle faulting and thermal events, Sydney region: association with the early stages of extension of East Gondwana. Australian Journal of Earth Science, 56:7, 873-887.
- RMS, (2011). Environmental Management of Construction Site Dewatering. April 2011.
- RMS (2018) Sydney Gateway, State Significant Infrastructure Scoping Report.
- Silo Climate Data, The State of Queensland Department of Environment and Science for climate data at Sydney Airport.
- Stewart J.R. and Alder J.D. (1995). New South Wales Petroleum Potential, New South Wales Department of Mineral Resources Sydney, Eds 1995.
- Sydney Airport Corporation Limited (SACL) Sydney Airport Master Plan 2033.
- Sydney Metropolitan Catchment Management Authority (SMCMA). (2011). *Botany Bay & Catchment Water Quality Improvement Plan*. Sydney: Botany Bay Water Quality Improvement Program.
- Tammetta, P. and Hewitt P. (2004). Hydrogeological Properties of Hawkesbury Sandstone in the Sydney Region. Australian Geomechanics. Vol. 39, No. 3. September 2004.
- Tenix Projects. (2006). Tempe Lands, Site Environmental Management Plan for Area 4 to 11. Prepared for Marrickville Council.
- Uminex. (2015). Tempe Landfill Leachate Management Scheme Improvement, Collection, Treatment and Disposal System Technical Review. March 2015.
- Uminex. (2018a). Groundwater Monitoring at the Former Tempe Lands. Letter dated February 16 2018.
- Uminex (2018b) Leachate Management review at the Former Tempe Land. Letter dated 22 February 2018.
- WaterNSW online database, accessed July 2018.
- Weight, W.D. and Sonderegger, J.L. (2001), Manual of Applied Field Hydrogeology, McGraw Hill Professional, New York.
- WSP (2018), PSH Recovery Program (2017), Taxi Parking Area, Sydney Domestic Airport, NSW. Letter dated 22 March 2018.

Appendix A
Proposed monitoring wells

Table A1 - Proposed wells for monitoring

Location ID	Easting	Northing	Existing Ground RL (m AHD)	Depth of well (m bgl)	Lithology	Ongoing baseline monitoring (as at April 2019)
GW14s	332104.69	6244353.19	4.10	6	Quaternary Sediments	Yes
GW15s	332081.84	6244179.48	3.25	6.02	Quaternary Sediments	Yes
WCX_GTY_BH_002	332395.54	6243838.78	5.63	3.96	Quaternary Sediments	Yes
WCX_GTY_BH_004	332115.79	6243985.37	3.30	3.97	Quaternary Sediments	Yes
MW04	332499.46	6243947.98	8.71	TBC	TBC	TBC
GW100s	331988.66	6244625.921	3.44	6.1	Fill / Quaternary Sediments	Yes
GW101	331863.565	6244877.462	2.19	6.1	Fill / Quaternary Sediments	Yes
GW102	332774.612	6244535.026	9.17	7.3	Fill / Quaternary Sediments	Yes
GW103	333004.73	6244155.16	8.14	5.98	Fill / Quaternary Sediments	Yes
GW104	331896.331	6244379.956	2.56	5.88	Fill / Quaternary Sediments	Yes
GW200-SG_BH059	333557.319	6243276.522	7.37	17.51	Fill / Quaternary Sediments	Yes
GW201	333899.745	6243165.058	9.30	6.51	Fill / Quaternary Sediments	Yes
GW203	334326.81	6242790.84	10.58	7.09	Fill / Quaternary Sediments	Yes
GW204	334297.052	6242711.503	9.89	5.2	Fill / Quaternary Sediments	Yes
GW205	333247.51	6243348.59	8.29	6.48	Fill / Quaternary Sediments	Yes
MW2	332876.5007	6243727.832	4.04	5.8	Fill / Quaternary Sediments	'
MW3	332959.6991	6243349.178	6.06	9	Fill / Quaternary Sediments	'
MW4	333047.8954	6243656.976	5.97	6	Fill / Quaternary Sediments	'
MW5	333101.1085	6243460.89	8.71	6	Fill / Quaternary Sediments	'

LEGEND

RL	Reduced level
mAHD	metres Australian Height Datum
mbgl	metres below ground level
TBC	To be confirmed
(10)	Brackets indicate approximation only.
DA	Data available (from previous investigation)
SWL	Standing water level
N/A	Not applicable
4.04	Historical survey or estimated data
'	Expected ongoing monitoring as part of Airport east project

Author: David Naiken
Date: 24/07/2019
Map no: PS113386_GIS_073_A1

Appendix A

Proposed Wells for Monitoring

ARTC

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