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Date:	21/05/2018
To:	Laura Zimmerman
From:	Simon Hewitt
Subject:	Metronet - YRE Hydrology Assessment

1 Introduction

The Yanchep Rail Extension (YRE) project is a 14.5 kilometre (km) extension of the Joondalup railway line, which includes three new stations at Alkimos, Eglinton and Yanchep. The YRE project forms an integral component of Perth's long term public transport network and will provide essential transportation services to the rapidly expanding northern coastal suburbs. The delivery of the YRE project will foster the continued growth and development of activity centres in the northwest sub-region, stimulating new employment opportunities, vibrancy, higher density land use and better sustainability outcomes envisioned by the State Government's Perth and Peel @ 3.5 million plan (Department of Planning, Lands and Heritage and Western Australian Planning Commission 2018).

The YRE project is located within the City of Wanneroo, which is situated approximately 26 km north of Perth's Central Business District. The YRE project's 143.11 hectare (ha) development envelope, which encompasses the Part 1 and 2 development footprints (including railway extension and stations) and construction and access areas, generally lies between the suburbs of Butler and Yanchep and includes the suburbs of Alkimos and Eglinton.

Although it has previously been confirmed that dewatering will not be required due to sufficient separation of the earthworks from groundwater along the construction alignment, groundwater abstraction is required to service the construction phase of the YRE project. The Public Transport Authority (PTA) has provisionally proposed five locations within YRE development envelope for the installation of the production bores, of which four will be selected. It has been estimated that a total of 350,000 kL will be required over a 399 day construction period. However, following discussions with the Department of Water and Environmental Regulation (DWER), a safety factor of 1.5 has been added to the water requirements estimates. As such, this brings the estimated water requirement to a total of 525,000 kL over a 500 day construction period.

This memorandum details the outcomes of a hydrological assessment to assess the impacts of the proposed abstraction for the YRE project and will address the following:

- Potential drawdown expected during the project's proposed groundwater abstraction.
- Identify the direct, indirect and cumulative impacts of taking groundwater within the project area.
- Assess the potential impact to nearby waterbodies.
- Assess and provide recommended offset distances for the project's abstraction bores from Water Corporation abstraction bores, wellhead protection zones and other groundwater users.
- Provides comments on the potential risk of groundwater acidification.

2 Hydrogeological Setting

The following hydrological context has been adopted from the North West Coastal Superficial Aquifer Resource Assessment (Water Corporation 2014).

2.1 Regional Context

The North West Coastal strip (Quinns, Eglinton and Yanchep sub-areas) reside within the Swan Coastal Plain, part of a deep sedimentary basin bounded to the east by the Gingin and Darling scarps which represent the eastern extent of marine erosion that occurred during the Tertiary and Quaternary periods (Davidson 1995). The late Tertiary to Quaternary sediments underlying the Swan Coastal Plain are collectively termed superficial formations. These formations are up to 110 m thick and consist of sand, silt, clay and limestone. Generally, sediments are more clayey to the east, sandy in the central areas of the plain and predominantly comprise of limestone and sand in the west.

The superficial aquifer in the project area has a saturated thickness ranging from 20-40m. Groundwater flows from the crest of the Gnangara Mound in a south-westerly direction and discharges above a saltwater interface at the coast. Figure 1 presents the general groundwater contours presented on DWER's Perth Groundwater Atlas (DWER 2018); the contours show that groundwater flow is in line with the above description.

2.2 District Context

2.2.1 Geomorphology

The geomorphology of the study area is characterised by two dune systems that fringe the coastline to the west of the Bassendean Dune System. The most easterly of these is the Spearwood Dune System, which consists of slightly calcareous eolian sand remnant from leaching of limestone. The most westerly dune system, which flanks the ocean, is the Quindalup Dune System consisting of wind-blown lime and quartz beach sand forming dunes and ridges with a general orientation parallel to the present coast. Wetlands and lakes have formed in the interdunal swales of the Bassendean Dune System, and in the depressions between the Spearwood and Bassendean Dune Systems. Figure 2, sourced from the *North West Coastal Superficial Aquifer Resource Assessment* (Water Corporation 2014) presents a geological cross section through the Quinns sub-area, this section is typical of the project area.

2.2.2 Nearby Water Bodies

The YRE development envelope is located to the west of Yanchep National Park and north-west of the Neerabup National Park and their associated lakes. The PTA's proposed abstraction bores are located 1.91 km to the west of the nearest lake (Wilgarup Lake) associated with the Yanchep National Park.

2.2.3 Nearby Groundwater Users

The DWER's online Water Register identifies the superficial groundwater users within proximity to the YRE project development envelope. The nearby groundwater users located in close proximity to the PTA's proposed abstraction bores include the Water Corporation, LandCorp, local developers and the City of Wanneroo.

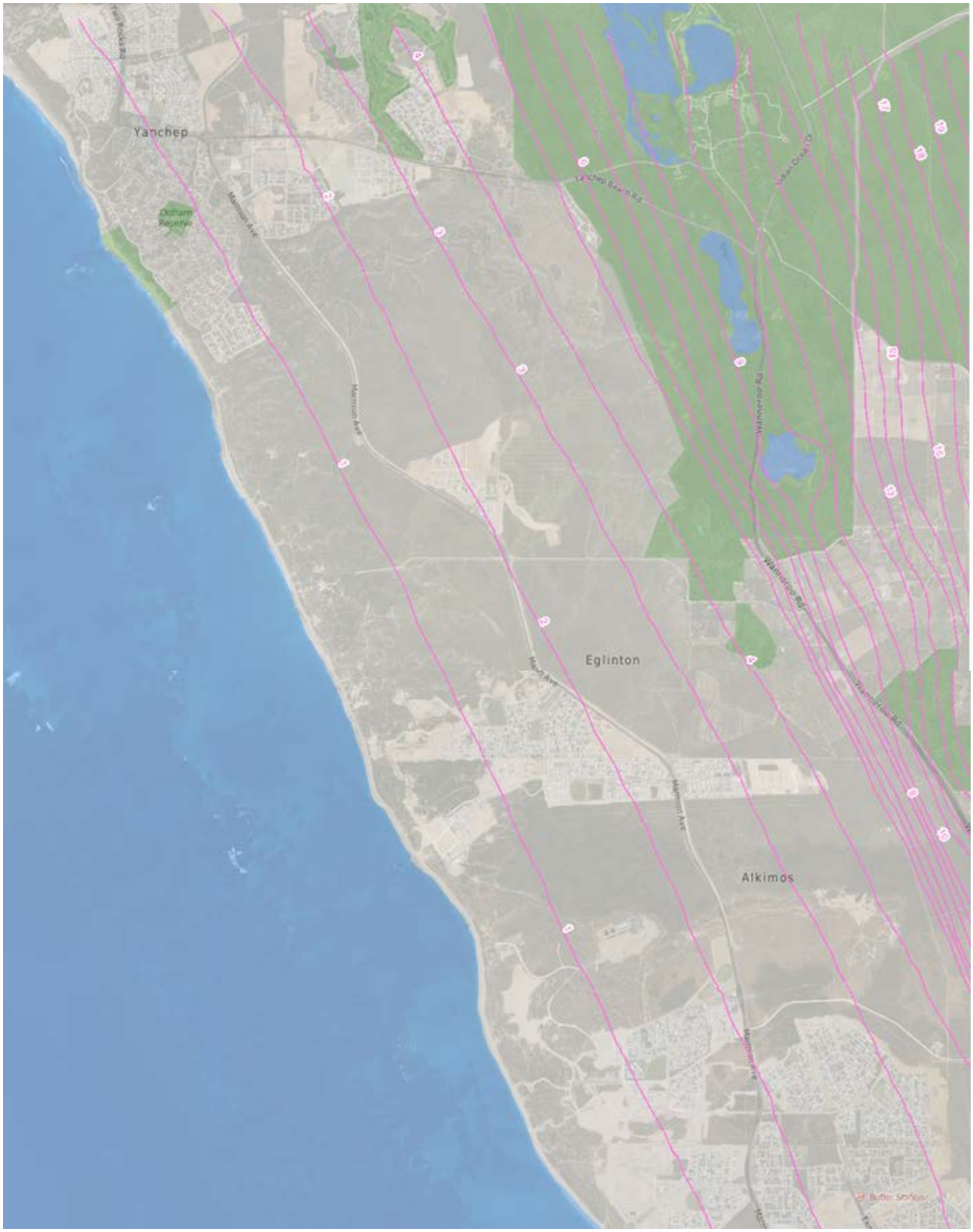


Figure 1 Maximum Groundwater Contours (mAHD) (Perth Groundwater Atlas, DWER 2018)

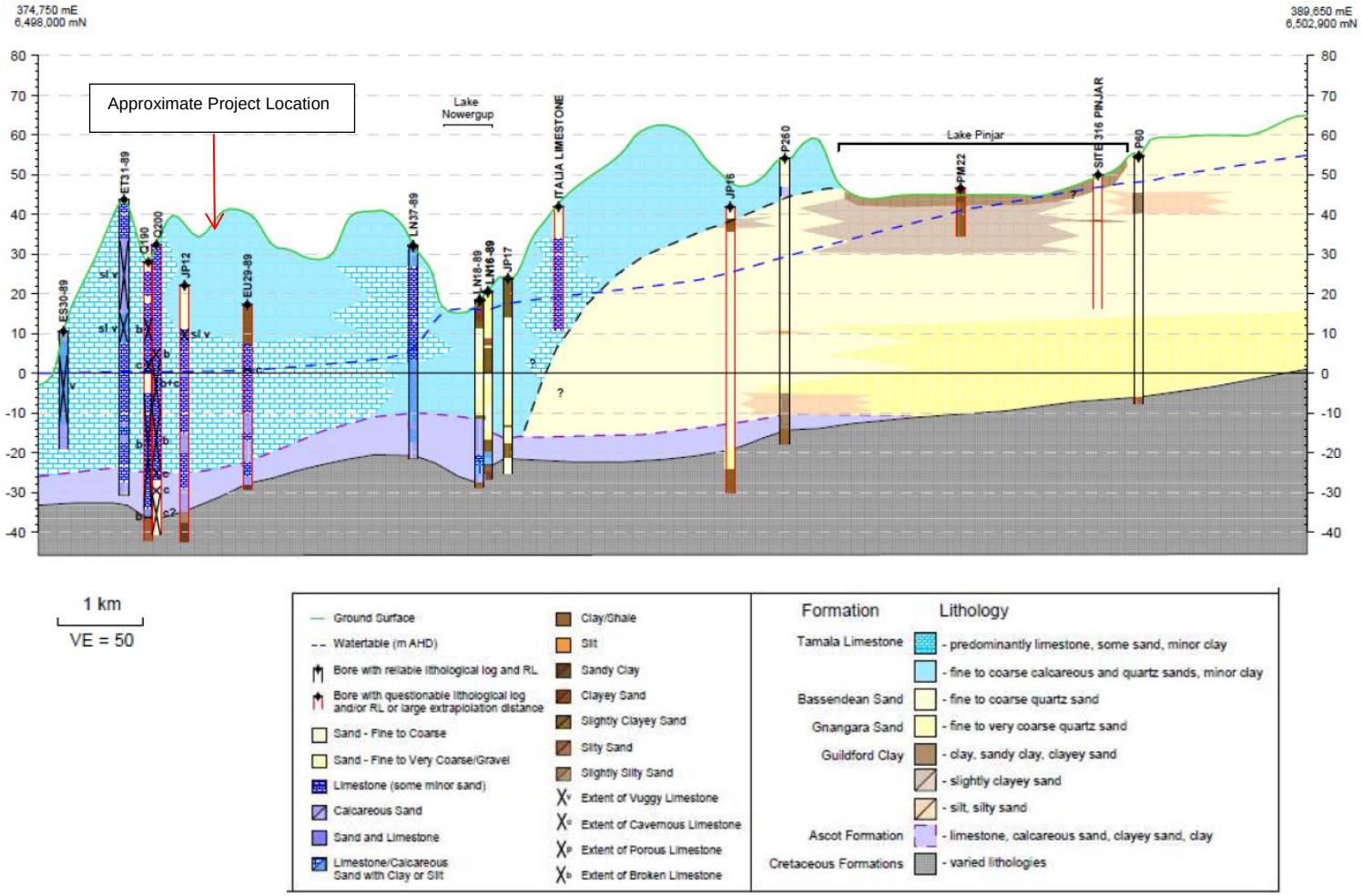


Figure 2 Project Area Typical Geological Cross-Section (Water Corporation 2014)

2.3 Local Context

2.3.1 Abstraction Locations

The PTA has outlined five provisional abstraction locations across Parts 1 and 2 of the YRE development envelope. Figure 3 presents the provisional abstraction bore locations. Table 1 and Table 2 show the distances to nearby environmentally sensitive areas and nearby groundwater bore users from each of the PTA's proposed abstraction bores respectively. Note that some of the environmentally sensitive areas may not be users of groundwater, which will depend on the depth to groundwater e.g. plant rooting depth.

Table 1 Distance from Proposed PTA Bores to Nearest Environmentally Sensitive Areas

PTA Abstraction Bore	Nearest Environmentally Sensitive Area	Distance to Sensitive Area
Bore #1	Carabooda Lake	2.3 km (to the east)
	Bush Forever #383 – Neerabup National Park	1.58 km (to the east)
Bore #2	Bush Forever #129 – Bermard Road Bushland	1.08 km (to the east)
Bore #3a	Bush Forever #288 - Yanchep National Park	1.3 km (to the east)
	Wilgarup Lake	2.24 km (to the east)
Bore #3b	Bush Forever #288 - Yanchep National Park	970 m (to the east)
	Wilgarup Lake	1.91 km (to the east)
Bore #4	Bush Forever #289 – Ningana Bushland	100 m (to the south)
	Bush Forever #288 - Yanchep National Park	1.85 km (to the east)
	Loch McNess	2.86 km (to the north-east)
	Yonderup Lake	3.47 km (to the east)

Table 2 Distance from Proposed PTA Bores to Nearest Groundwater User

PTA Abstraction Bore	Nearest Groundwater User	Distance to Abstraction Point
Bore #1	Western Australian Land Authority	300 m (to the north)
	Water Corporation	880 m (to the north-west)
Bore #2	Peet Alkimos Pty Ltd	300 m (to the north east)
	Western Australian Land Authority	600 m (to the south-west)
	Water Corporation	1.2 km (to the south-east)
Bore #3a	Eglinton Estates Pty Ltd	800 m (to the north-west)
	Water Corporation	1080m (to the west)
Bore #3b	Eglinton Estates Pty Ltd	850 m (to the south-west)
	Western Australian Land Authority	950 m (to the north-west)
	Water Corporation	680 m (to the north-west)
Bore #4	Water Corporation	500 m (to the south-west)
	Housing Authority	650 m (to the north-east)

2.3.2 Abstraction Regime

Groundwater abstraction will occur from the superficial aquifer; this aquifer extends to a depth of approximately -35 mAHD in the vicinity of the YRE development envelope. Groundwater will be abstracted from three of the production bores during Phase 1 (Butler to Eglinton) construction, with the fourth bore being utilised once Phase 2 (Eglinton to Yanchep) commences.

It has been estimated that the water requirement total of 525,000 kL will be abstracted over the 500 day construction period from all four of the finalised abstraction bores. This equates to an average abstraction rate of 262.5 kL/day/bore. This construction timeframe and total water requirement has been adopted to assess the potential impact to the superficial aquifer.

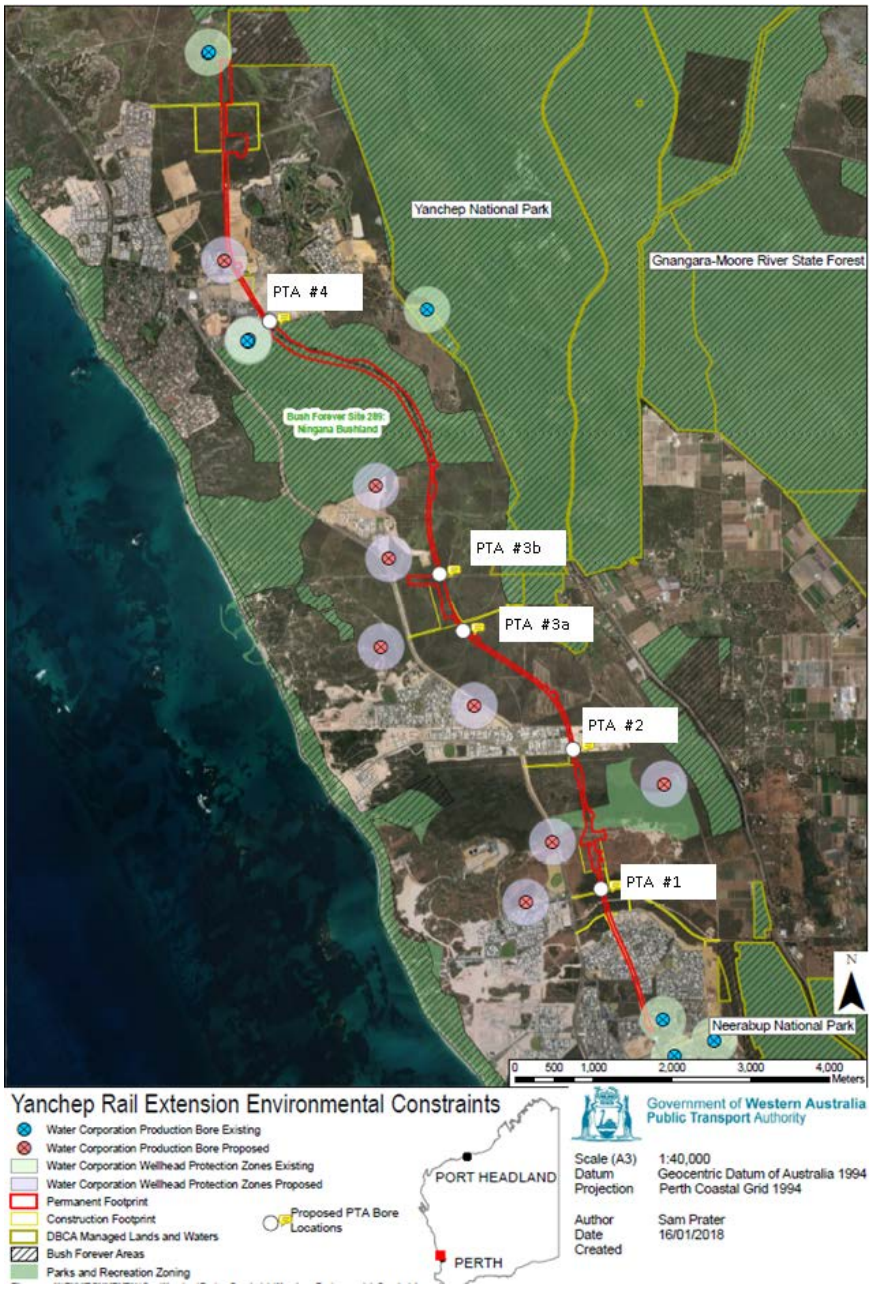


Figure 3 Proposed PTA Construction Groundwater Abstraction Bores

3 Drawdown Assessment

The Draft Yanchep YB80 H3 Hydrogeological Assessment (Water Corporation 2015) included groundwater modelling of the superficial aquifer within the Yanchep and Eglinton groundwater management sub-areas, and also covers the YRE development envelope. This document has been used to provide hydrogeological parameters for the superficial aquifer in the YRE development envelope for assessing the potential impact from the proposed groundwater abstraction.

3.1 Hydraulic Conductivity

Aquifer test results obtained through the analysis of the drawdown and recovery data conducted by Water Corporation (2015) provide an average hydraulic conductivity (K) value of 521 m/day. This is considered reasonable given the geology of the superficial aquifer in the region, i.e. Tamala Limestone, and is within the range of 100 to 1,000 m/d provided by Davidson (1995).

A K value of 500 m/day was initially utilised by Water Corporation (2015) to conduct initial model calibrations. PEST (Parameter Estimation) was utilised to optimise the K value across the Water Corporation's investigation area with a final calibrated K of 403 m/day. Figure 4 presents the calibrated K values across the model domain as estimated through Water Corporation modelling (2015).

As shown in Figure 4, the K ranges across the model domain, increasing towards the west and specifically in the north area of the investigation area. Based on the range of K values across the investigation area, two values have been adopted for this hydrology assessment of the YRE project:

- 100 m/day – a conservative estimate based on the lowest K anticipated to occur at the proposed PTA Bore #1 in the south
- 403 m/day – the estimated average K across the site.

3.2 Drawdown Estimation

Four scenarios where adopted to estimate the potential impact of the proposed abstraction. Table 3 details the scenario parameters:

Table 3 Drawdown Estimation Scenario Details

Scenario	Hydraulic Conductivity (m/day)	Abstraction Rate (kL/day)	Abstraction Rate Description
1	100	262.5	Abstraction from all four bores
2	403	262.5	Abstraction from all four bores
3	100	1050	Abstraction from a single bore
4	403	1050	Abstraction from a single bore

Graph 1 through to Graph 4 present the estimated drawdown based on the Theis (1935) analytical solution, utilising the following adopted parameters:

- saturated aquifer thickness – 33 m (this is the average saturated thickness across the proposed PTA locations based on DWER data-Perth Groundwater Atlas)
- specific yield – 0.1, conservative value for unconfined aquifer
- time – 500 days

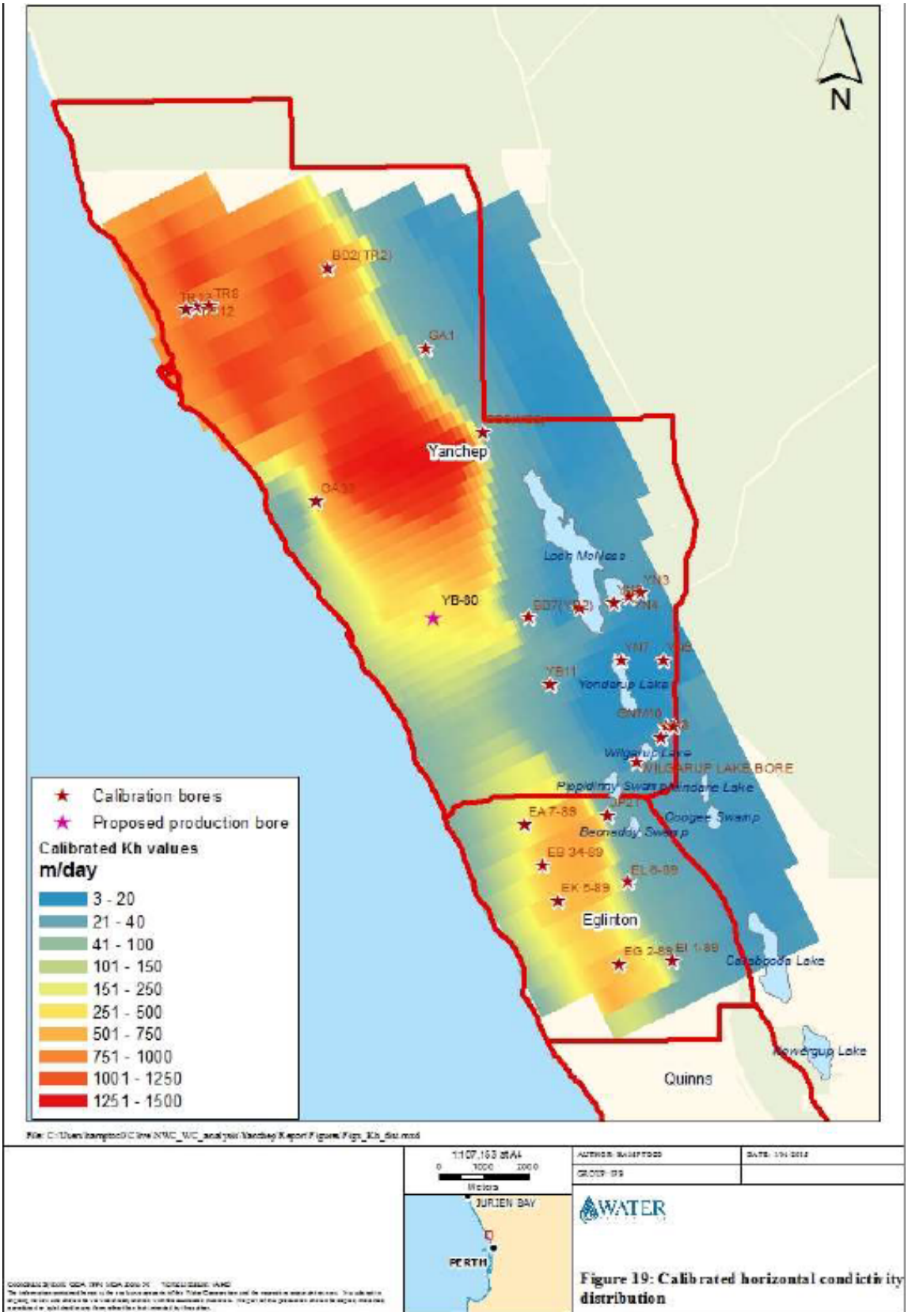
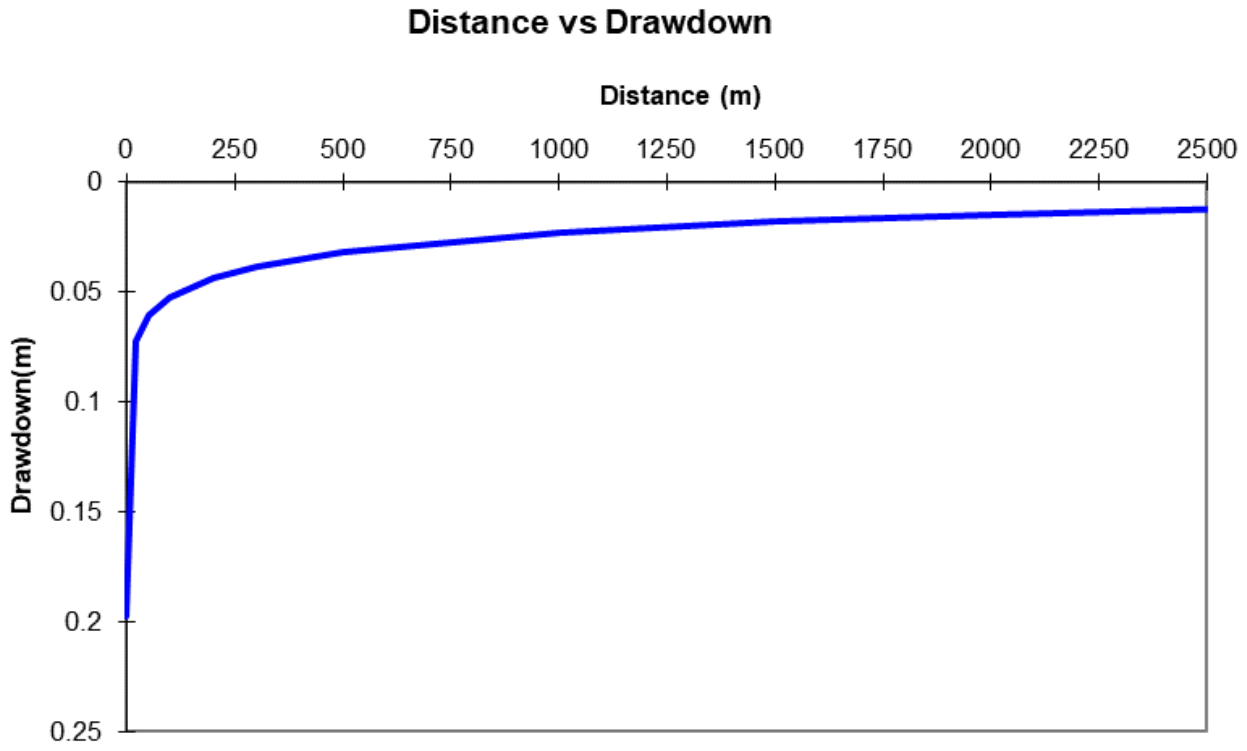
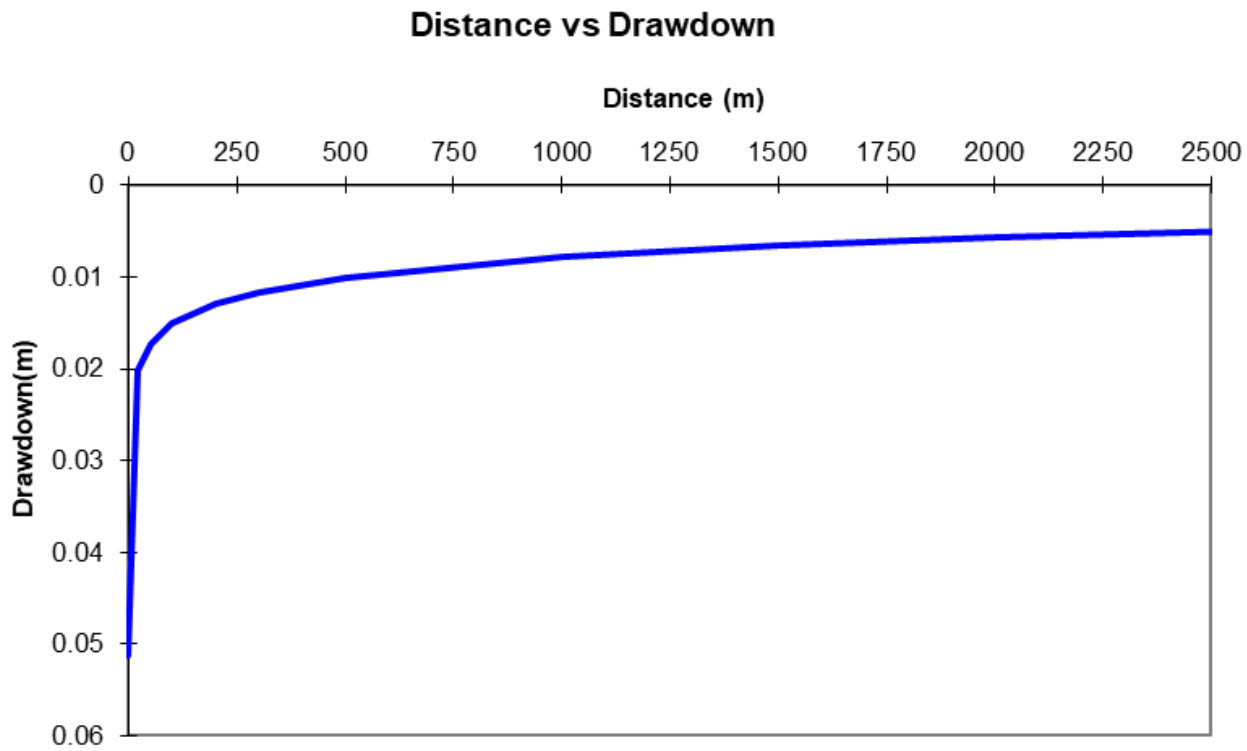


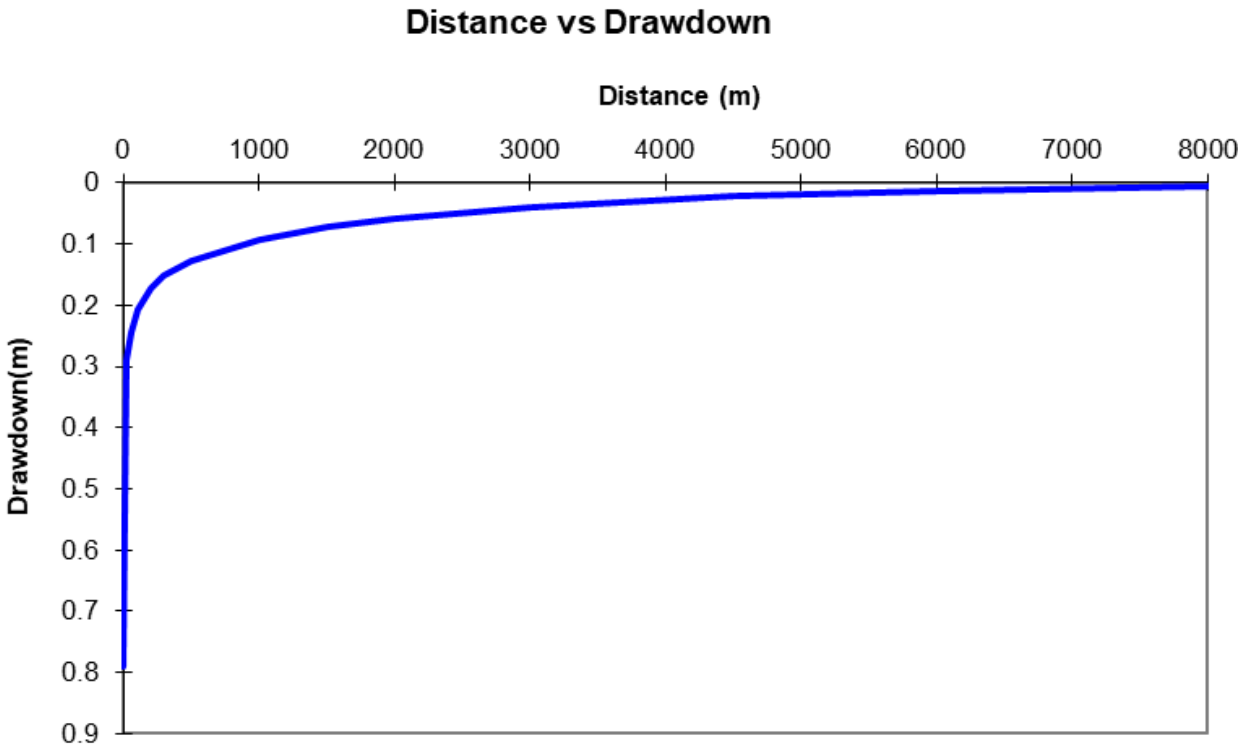
Figure 4 Calibrated Hydraulic Conductivity (Water Corporation 2015)



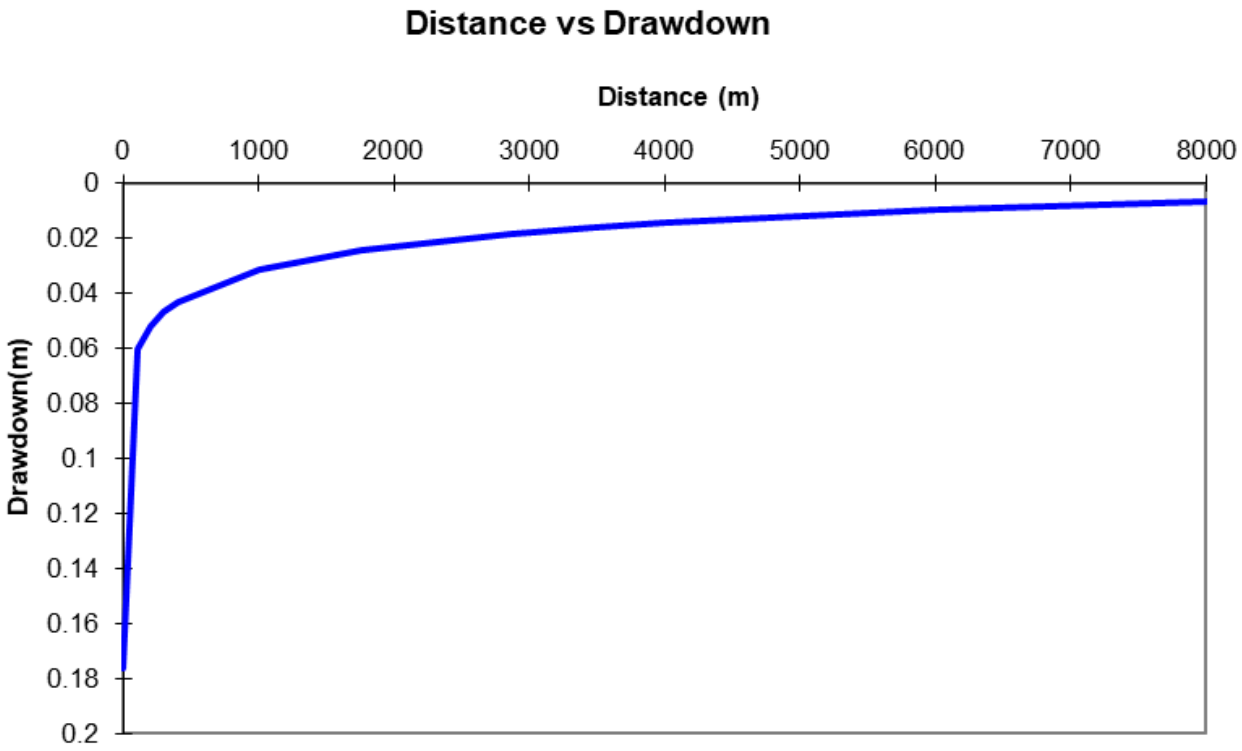
Graph 1 Scenario 1 Calculated Drawdown



Graph 2 Scenario 2 Calculated Drawdown



Graph 3 Scenario 3 Calculated Drawdown



Graph 4 Scenario 4 Calculated Drawdown

Table 4 and Table 5 present the estimated drawdown at the closest environmentally sensitive areas and groundwater bore users respectively after 500 days of abstraction.

Table 4 Estimated Drawdown at Nearest Environmentally Sensitive Area after 500 Days

PTA Abstraction Bore	Nearest Environmentally Sensitive Area	Distance to Environmentally Sensitive Area	Estimated Drawdown (m) (262.5 kL/day)		Estimated Drawdown (m) (1050 kL/day)	
			K of 100 m/day	K of 403 m/day	K of 100 m/day	K of 403 m/day
Bore #1	Carabooda Lake	2.3 km (to the east)	0.012	0.005	0.05	0.021
	Bush Forever #383 – Neerabup National Park	1.58 km (to the east)	0.017	0.006	0.07	0.025
Bore #2	Bush Forever #129 – Bermard Road Bushland	1.08 km (to the east)	0.022	0.007	0.088	0.030
Bore #3a	Bush Forever #288 - Yanchep National Park	1.3 km (to the east)	0.019	0.007	0.078	0.028
	Wilgarup Lake	2.24 km (to the east)	0.013	0.005	0.052	0.021
Bore #3b	Bush Forever #288 - Yanchep National Park	970 m (to the east)	0.023	0.007	0.093	0.031
	Wilgarup Lake	1.91 km (to the east	0.015	0.005	0.06	0.023
Bore #4	Bush Forever #289 – Ningana Bushland	100 m (to the south)	0.052	0.015	0.21	0.060
	Bush Forever #288 - Yanchep National Park	1.85 km (to the east)	0.015	0.005	0.061	0.023
	Loch McNess	2.86 km (to the north-east)	0.01	0.004	0.041	0.018
	Yonderup Lake	3.47 km (to the east)	<0.01	0.004	0.032	0.016

Table 5 Estimated Drawdown at Nearest Groundwater Draw Point after 500 Days of Abstraction

PTA Abstraction Bore	Nearest Groundwater User	Distance to Abstraction Point	Estimated Drawdown (m) (262.5 kL/day)		Estimated Drawdown (m) (1050 kL/day)	
			K of 100 m/day	K of 403 m/day	K of 100 m/day	K of 403 m/day
Bore #1	LandCorp	300 m (to the north)	0.038	0.011	0.152	0.046
	Water Corporation	880 m (to the north-west)	0.024	0.008	0.098	0.033
Bore #2	Peet Alkimos Pty Ltd	300 m (to the north east)	0.038	0.011	0.152	0.046
	LandCorp	600 m (to the south-west	0.029	0.009	0.117	0.037
	Water Corporation	1.2 km (to the south-east)	0.020	0.007	0.082	0.029
Bore #3a	Eglinton Estates Pty Ltd	800 m (to the north-west	0.025	0.008	0.103	0.034
	Water Corporation	1080m (to the west)	0.022	0.007	0.088	0.030
Bore #3b	Eglinton Estates Pty Ltd	850 m (to the south-west)	0.024	0.008	0.099	0.033
	LandCorp	950 m (to the north-west)	0.023	0.008	0.094	0.032
	Water Corporation	680 m (to the north-west)	0.027	0.009	0.111	0.036
Bore #4	Water Corporation	500 m (to the south-west)	0.031	0.010	0.126	0.040
	Housing Authority	650 m (to the north-east)	0.028	0.009	0.113	0.036

3.3 Assessment of Drawdown Impacts

The impacts discussed in the following sections are considered conservative as they are largely based on the abstraction of 100% of the water requirement from a single bore and utilising the lowest reasonable K value for the YRE development envelope (unless otherwise described). Abstraction from multiple bores and higher K values will result in a reduction in drawdown impacts to the superficial aquifer; which is the likely scenario. Also, the drawdown estimations do not incorporate recharge (via rainfall) during the abstraction period, which would reduce drawdown on the superficial aquifer.

3.3.1 Maximum Anticipated Drawdown

Based on the drawdown estimations the maximum drawdowns anticipated are as follows:

- maximum drawdown at nearest environmentally sensitive area if abstraction occurs across four bores at 262.5 kL/day
  - 0.015 m at Lake Wilgarup due to abstraction from PTA Bore #3b
  - 0.05 m at Bush Forever Site 289 – Ningana Bushland due to abstraction from PTA Bore #4
- maximum drawdown at nearest Water Corporation Asset if abstraction occurs across four bores at 262.5 kL/day
  - 0.03 m at Corporation Production Bore YB90 due to abstraction from PTA Bore #4
- maximum drawdown at nearest environmentally sensitive area if abstraction occurs at a single location at 1050 kL/day
  - 0.04 m at Loch McNess due to abstraction from PTA Bore #4
  - 0.09 m at Yanchep National Park dur to abstraction from PTA Bore #3b
  - 0.21 m at Bush Forever Site 289 – Ningana Bushland due to abstraction from PTA Bore #4
- maximum drawdown at nearest Water Corporation Asset if abstraction occurs at a single location at 1050 kL/day
  - 0.13 m at Corporation Production Bore YB90 due to abstraction from PTA Bore #4.

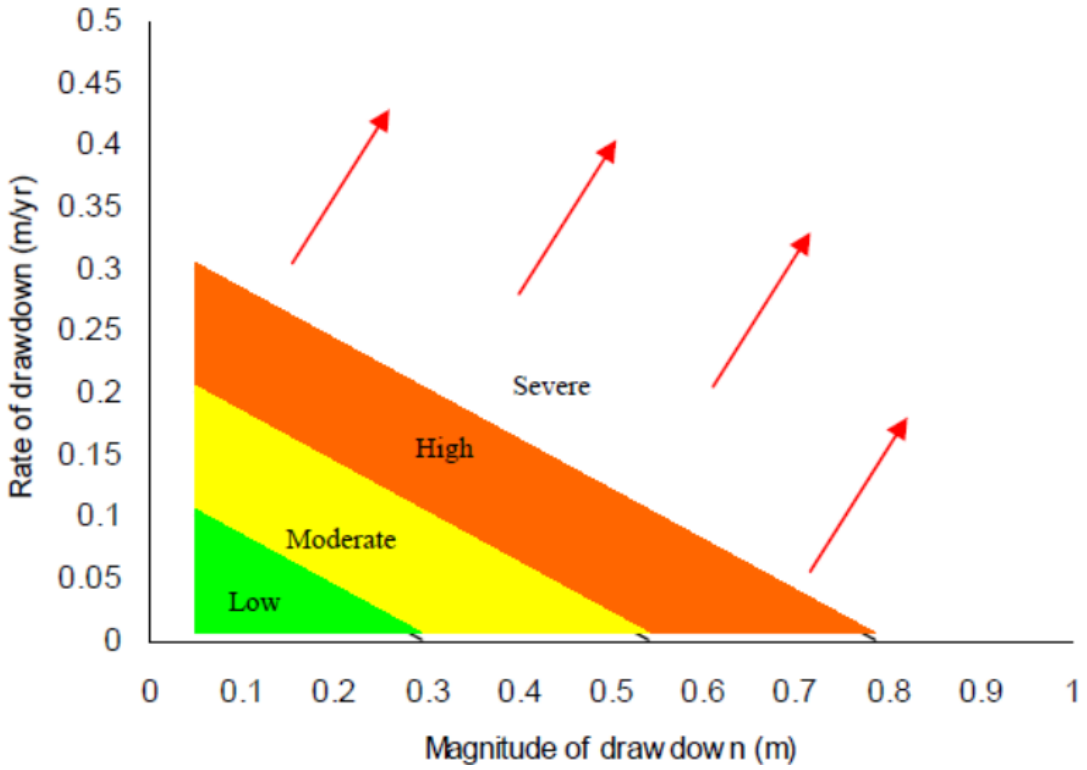
3.3.2 Groundwater Acidification

In close proximity to the proposed bores, due to the source aquifer being comprised predominantly of limestone, the groundwater is anticipated to contain a significant concentration of dissolved calcium carbonate. As such it is anticipated that the groundwater will have a high degree of buffering capacity against acidification; due to the above and the significant clearance to groundwater from the topographical surface, groundwater acidification is not anticipated.

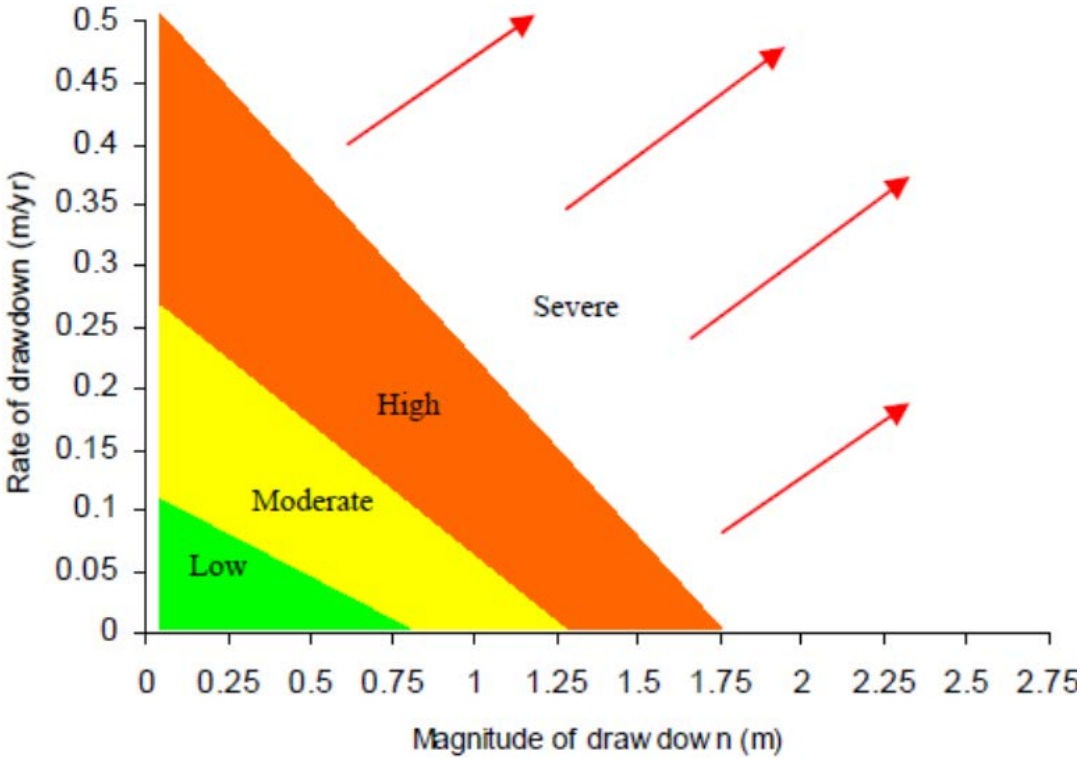
The DWER Perth Groundwater Map (DWER 2018) provides Acid Sulphate Soil Risk Mapping for the project area. The entire project area (including the estimated areas of groundwater drawdown) is mapped as “No known ASS disturbance Risk (<3m from surface). However the chain of lakes of the National Parks located to the east are mapped as having a “high to moderate ASS disturbance risk (<3m from surface). However as presented in Table 4, based on the most likely scenario (abstraction from four production bores) the estimated drawdown at the nearest lakes is between 1 – 1.5 cm. This is considered negligible in terms of seasonal variation and would not result in any further groundwater acidification that would not already be experienced at the site during typical seasonal variations (i.e. winter and summer).

3.3.3 Impacts to Environmentally Sensitive Areas

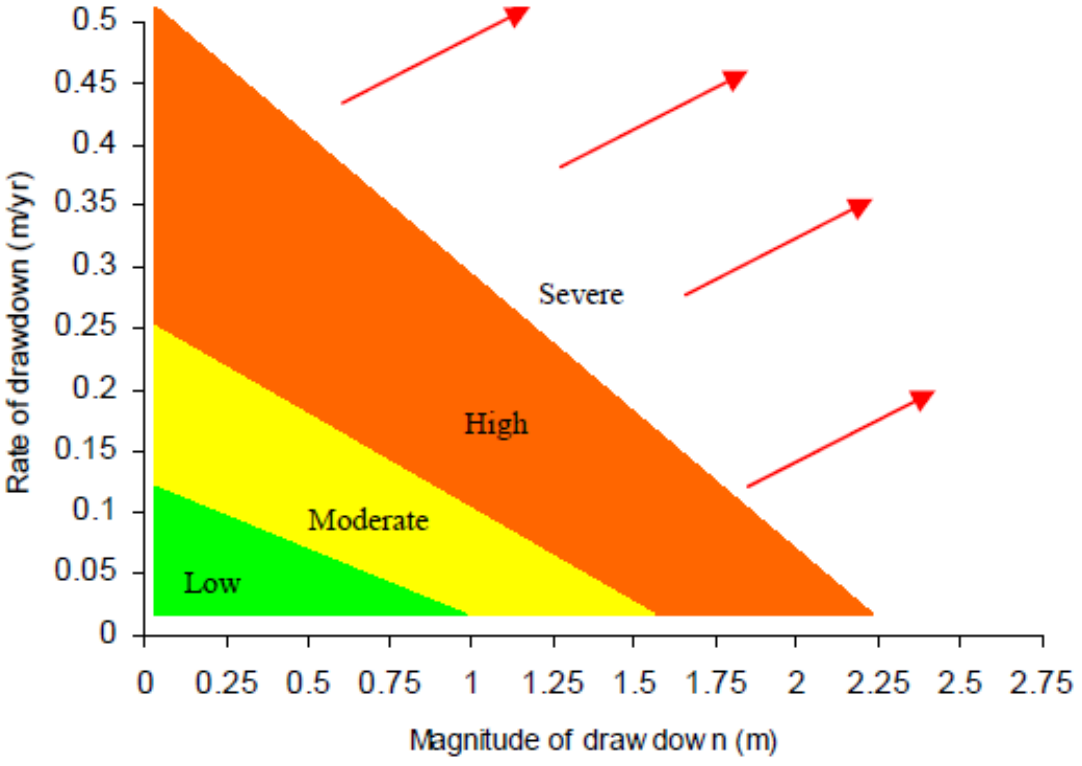
The DWER has established Ecological Water Requirements (EWRs) for Groundwater Dependent Ecosystems (GDEs) in the south west groundwater areas. These generic EWRs relate to maximum drawdown limits and rate of change limits for wetlands and phreatophytic vegetation, as shown in Graph 5 to Graph 8.



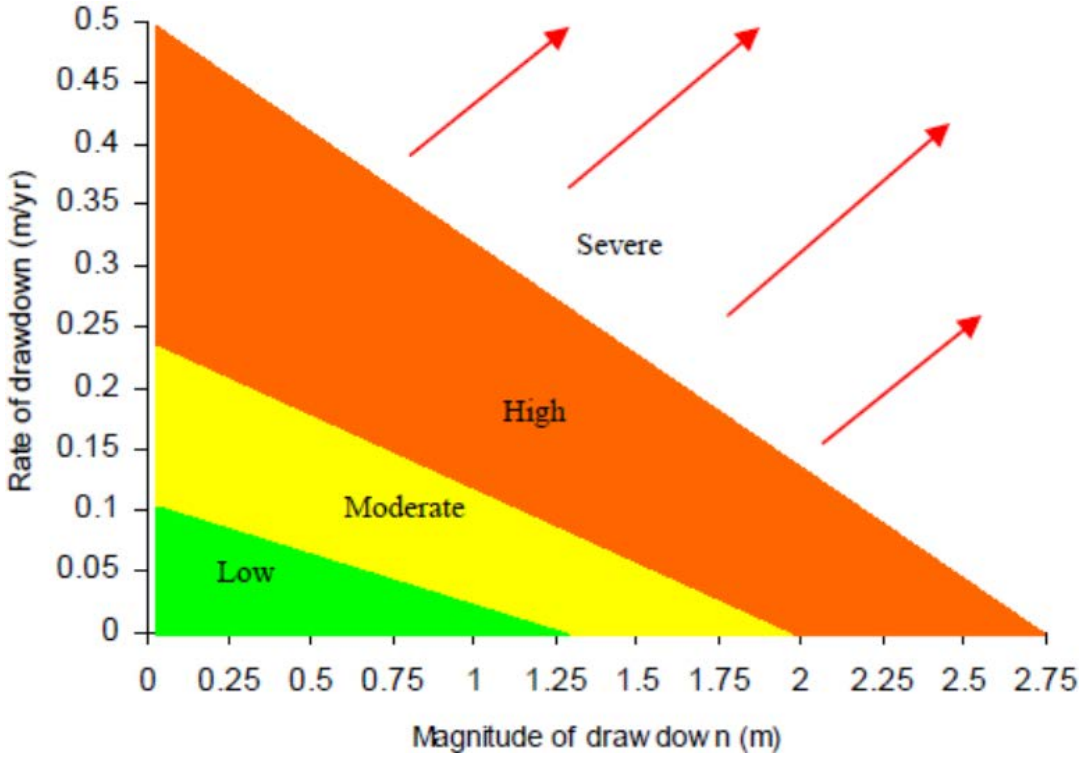
Graph 5 Risk of Impact for Wetland Vegetation Based on Magnitude of Groundwater Level Change (from Froend and Loomes 2004)



Graph 6 **Risk of Impact for Phreatophytic Vegetation – Depth to Groundwater 0–3 m (From Froend and Loomes 2004)**



Graph 7 **Risk of Impact for Phreatophytic Vegetation – Depth to Groundwater 3–6 m (From Froend and Loomes 2004)**



Graph 8 Risk of Impact for Phreatophytic Vegetation – Depth to Groundwater 6–10 m (From Froend and Loomes 2004)

The graphs show “risk of impact” categories for wetlands and phreatophytic vegetation that were developed based on the results of research into the response of vegetation to groundwater decline (Froend and Loomes 2004). The cumulative rate and magnitude of groundwater drawdown is defined and the possible ecological responses to the varying degrees of drawdown are described broadly as either low, moderate, high or severe in terms of probability of noticeable impact to groundwater change. As the graphs show, the risk of impact due to water level decline decreases with increasing depth to groundwater, which can be expected due to the increased potential for the vegetation to utilise unsaturated zone moisture.

Based on the worst case scenario i.e. all abstraction is from a single bore with a hydraulic conductivity of 100 m/day the estimated maximum drawdown of the superficial aquifer in the entire project area is 0.21 m below the Bush Forever Site 289 - *Ningana Bushland, Yanchep/Eglinton* after 500 days of abstraction; based on the risk categories provided above, the risk to the vegetation within the bush forever site is considered low, due to the following:

- Depth to groundwater is approx. 35 mbgl.
- The rate of drawdown is 0.15 m/year.
- The magnitude of drawdown is 0.21 m.

Although a site specific vegetation assessment has not been undertaken as part of this assessment, it is considered unlikely that the vegetation within Bush Forever Site 289 - *Ningana Bushland, Yanchep/Eglinton* will be utilising groundwater at this depth, and hence the risk of impact would be negligible.

The risk for impact to all other sites identified in this study is considered low as the maximum magnitude of drawdown and rate of drawdown is <0.1m/yr.

3.3.4 Impacts to Nearby Groundwater Users

As shown in Table 5, the estimated maximum drawdown at the closest groundwater draw point is 0.15 m for LandCorp (drawdown caused from PTA Bore #1 abstraction) and Peet Alkimos Pty Ltd (drawdown from PTA Bore #2 abstraction).The closest Water Corporation asset is YB43/YB4/YB90 located approximately 500 m to the southwest of PTA Bore #4. The maximum drawdown at the nearest Water Corporation asset is estimated at 0.13 m. These values are minimal in terms of the drawdown typically observed within a pumping bore. Also, the bores within the superficial aquifer are likely to be screened at the base of the aquifer, which means there is a sufficient height of groundwater above the abstraction point which would preclude it from drying.

These drawdowns are considered conservative as they are based on the entire abstraction volume being sourced from a single location. It is understood that abstraction would occur from multiple abstraction bores within the development corridor, this would reduce drawdown within the superficial aquifer.

3.3.5 Regional Impacts

The PTA's proposed groundwater abstraction will cause a minor and localised drawdown of the superficial aquifer within the YRE Development envelope. It is estimated that the maximum drawdown will occur just outside the production bore. If abstraction occurs from a single abstraction bore (1050 kL/day) the drawdown at the production bore would be approximately 0.8 m. If the abstraction occurred across four production bores (262.5 kL/day) the drawdown at each bore would be approximately 0.2 m. This will likely cause localised variations in the groundwater flow direction around each of the abstraction bores.

The regional groundwater flow in the superficial aquifer would not be impacted nor would the hydrology of the greater Swan Coastal Plain.

Table 6 details the identified potential local, district and regional impacts associated with the proposed groundwater abstraction.

Table 6 Potential Construction Impacts to Hydrological Processes

Scale	Direct Impact	Indirect Impact	Cumulative Impact
Construction			

Local	• Localised groundwater drawdown in the immediate vicinity of the abstraction bores.
	  • Impact considered low due to minimal drawdown within the abstraction bores; estimated 20 cm of drawdown within production bores (based on abstraction from four bores).
		• Impact on groundwater availability for nearby native vegetation.
		  • Impact considered low as the rate and magnitude of drawdown is small and considered low risk of impacting on the ecological water requirements of the native vegetation.
		• Impact on availability of groundwater for nearby abstractors.
		  • Considered low due to the low magnitude of drawdown anticipated in the superficial aquifer and the highly transmissive nature of the aquifer.
			• Localised minor variation of groundwater contours / flow directions in vicinity of abstraction bores.
			  • Considered low to negligible as drawdown within the aquifer is minimal and groundwater flow will only be impacted within close proximity to the abstraction bore.

District	• Reduction of groundwater levels within the area of influence.
	  • Considered low as drawdown is anticipated to be approximately 2 cm at a radius of 1.2 km from the abstraction bores when abstraction occurs across all proposed abstraction bores.
		• Impact on groundwater availability for native vegetation within bush forever sites located in close proximity to and within the YRE development envelope.
		  • Impact considered low as the depth to groundwater is significant i.e. approx. 30 m. The rate and magnitude of drawdown is small and considered low risk of impacting on the ecological water requirements of the vegetation.
		• Impact on water levels within nearby wetlands associated with Yanchep National Park.
		  • Risk is considered low as the drawdown estimates at the nearest wetland (Lake Wilgarup) ranges from 1 – 2 cm after the 500 day construction period. Drawdown estimates do not include recharge via rainfall which will reduce drawdown impacts.
		• Impact on availability of groundwater for nearby abstractors
		  • Considered low due to the low magnitude of drawdown anticipated in the superficial aquifer and the highly transmissive nature of the aquifer. Drawdown at the nearest Water Corporation drawpoint YB90 is anticipated to be approximately 13 cm (if 100% of the abstraction requirements are sourced from PTA Bore #4). The estimate has not included rainfall recharge of the superficial aquifer which will reduce drawdown impacts.
			• Localised minor variation of groundwater contours / flow directions in vicinity of abstraction bores.
			  • Considered low to negligible as drawdown within the aquifer is minimal and groundwater flow will only be impacted within close proximity to the abstraction bore.
			• Potential impact of saline water ingress inland from the coast.
			  • Considered very low as the groundwater drawdown will not cause a significant enough drawdown to reverse groundwater flow directions from the coast nor cause saline upconing.

Scale	Direct Impact	Indirect Impact	Cumulative Impact

Regional	• Reduction of groundwater levels within the area of influence.
	  • Considered low as drawdown is anticipated to be approximately 2 cm at a radius of 1.2 km from the abstraction bores when abstraction occurs across all proposed abstraction bores and drawdown is considered negligible beyond 2.8 km from the abstraction bores; estimated drawdown in <1cm.
		• Impact on groundwater availability for native vegetation within bush forever sites located in close proximity to and within the YRE development envelope.
		  • Impact considered low as the depth to groundwater is significant i.e. approx. 30 m. The rate and magnitude of drawdown is small and considered low risk of impacting on the ecological water requirements of the vegetation.
		• Impact on water levels within nearby wetlands associated with the Yanchep National Park.
		  • Risk is considered low as the drawdown estimates at the nearest wetland (Lake Wilgarup) range from 1 – 2 cm after the 500 day construction period. Drawdown estimates do not include recharge via rainfall which will reduce drawdown impacts.
		• Impact on availability of groundwater for nearby abstractors
		  • Considered low due to the low magnitude of drawdown anticipated in the superficial aquifer and the highly transmissive nature of the aquifer. Drawdown at the nearest Water Corporation draw point YB90 is anticipated to be approximately 13 cm (if 100% of the abstraction requirements are sourced from PTA Bore #4). The estimate has not included rainfall recharge of the superficial aquifer which will reduce drawdown impacts.
			• Localised minor variation of groundwater contours / flow directions in vicinity of abstraction bores.
			  • Considered low to negligible as drawdown within the aquifer is minimal and groundwater flow will only be impacted within close proximity to the abstraction bore.
			  • Regional groundwater flow will not be impacted.
			• Potential Impact of saline water ingress inland from the coast.
			  • Considered very low as the groundwater drawdown will not cause a significant enough drawdown to reverse groundwater flow directions from the coast nor cause saline upconing.

RPS

4 Summary

The anticipated impacts from the abstraction of groundwater from the PTA's proposed abstraction bores are considered low for the following reasons:

- The hydraulic parameters of the superficial aquifer lend itself to being highly transmissive and capable of providing sufficient volumes of groundwater with minimal impact on the groundwater levels.
- The anticipated drawdowns are considered to be minimal and have been estimated using conservative assumptions that will overestimate the impacts to the aquifer.
- Rainfall recharge is not included in the drawdown calculations, which provides a conservative assessment of drawdown impacts. Rainfall recharge will reduce the estimated impacts of abstraction.
- The significant groundwater clearance, coupled with the rate and magnitude of drawdown indicates that the impact to the ecological water requirements of wetland and phreatophytic vegetation is considered minimal.
- The highly transmissive nature of the aquifer coupled with the minimal estimated drawdowns at groundwater bore users and Water Corporation draw points indicates that impacts to these groundwater abstractors will be negligible. Maximum drawdown at the Water Corporation bore YB90 caused by abstraction from PTA Bore #4 is anticipated to be < 13 cm.
- The drawdown estimates show that the aquifer is able to provide sufficient groundwater volumes for the construction requirements from a single abstraction bore without significant impacts to the local environment and nearby groundwater users. An abstraction rate of 1,050 kL/day would be required to meet the estimated water requirement from a single bore.
- The drawdown estimates show that when the required groundwater volumes are abstracted over a network of four production bores, the drawdown impact is lower. An abstraction rate of 262.5 kL/day would be required to meet the estimated water requirement from a network of four production bores.

5 References

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