Government of Western Australia
Department of Water and Environmental Regulation

Decision Report

Review of Existing Licence

Division 3, Part V *Environmental Protection Act 1986*

Licence Number	L6543/1991/11
Licence Holder	Water Corporation of Western Australia
File Number	2010/006732
Premises	Kwinana Wastewater Treatment Plant 119 and 143 McLaughlan Rd POSTANS WA 6167 Lot 2128 and Part of Lot 2129 on Plan 173137 within co-ordinates: 389182E, 6435349N 389721E, 6435355N 389586E, 6435032N 389073E, 6434825N 389503E, 6434735N
Date of Report	18 September 2020
Status of Report	Final

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1. Definitions of terms and acronyms

In this Decision Report, the terms in Table 1 have the meanings defined.

Table 1: Definitions

Term	Definition
AER	Annual Environment Report
Application	The licence amendment application for L6543/1991/11 submitted on 18 December 2015.
Category/ Categories/ Cat.	Categories of Prescribed Premises as set out in Schedule 1 of the EP Regulations
cfu	colony forming units
DBCA	Department of Biodiversity, Conservation and Attractions
Decision Report	refers to this document.
Delegated Officer	an officer under section 20 of the EP Act.
Department	means the department established under section 35 of the *Public Sector Management Act 1994* and designated as responsible for the administration of Part V, Division 3 of the EP Act.
DWER	Department of Water and Environmental Regulation As of 1 July 2017, the Department of Environment Regulation (DER), the Office of the Environmental Protection Authority (OEPA) and the Department of Water (DoW) amalgamated to form the Department of Water and Environmental Regulation (DWER). DWER was established under section 35 of the *Public Sector Management Act 1994* and is responsible for the administration of the *Environmental Protection Act 1986* along with other legislation.
EP Act	*Environmental Protection Act 1986* (WA)
EP Regulations	*Environmental Protection Regulations 1987* (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
Existing Licence	The Licence issued under Part V, Division 3 of the EP Act and in force prior to the commencement of, and during this Review
Licence Holder	Water Corporation
m^3	cubic metres
MS 665	'Use of the Cape Peron Outlet Pipeline to Dispose of Industrial Wastewater to the Sepia Depression, Kwinana' (Minister for the Environment Statement No. 000665, published 28 October 2004)

Term	Definition
Occupier	has the same meaning given to that term under the EP Act.
Peel-Harvey EPP	*Environmental Protection (Peel Inlet – Harvey Estuary) Policy 1992*
Prescribed Premises	has the same meaning given to that term under the EP Act.
Premises	refers to the premises to which this Decision Report applies, as specified at the front of this Decision Report
Review	the review of the Existing Licence which is undertaken through this Decision report
Revised Licence	the amended Licence issued under Part V, Division 3 of the EP Act following the finalisation of this Review.
Risk Event	As described in *Guidance Statement: Risk Assessment*
SDOOL	Sepia Depression Ocean Outlet Landline, as defined in Ministerial Statement 665

2. Purpose and scope of assessment

This review (***Review***) of Licence L6543/1991/11 (***Existing Licence***) was initiated following the submission of a licence amendment application (***Application***) lodged on 18 December 2015 by Water Corporation (***Licence Holder***) under the *Environmental Protection Act 1986* (***EP Act***). The Application requested an increase in the infiltration rate of treated sewage at the Kwinana Wastewater Treatment Plant (***Premises***) from the existing 4.7ML/day to 7.2ML/day. The Application was subsequently withdrawn by the Licence Holder on 19 December 2017 however, the Review has been completed by the Department.

In completing the Review the Department of Water and Environmental Regulation (***DWER***) has also sought to align the regulation of existing activities on the Premises with the risk-based approach described in DWER's *Guidance Statement: Risk Assessment* (February 2017).

This ***Decision Report*** presents an assessment of the foreseeable Risk Events to public health, amenity, water resources and the environment as a result of the Primary Activities being undertaken at the Premises and identified within the Review. As a result of this Review, the Existing Licence (set out in Attachment 3) is replaced by the revised licence (***Revised Licence***) set out in Attachment 1.

2.1 Application details

Table 2 lists the documents submitted as part of the Application. Despite the Application being withdrawn, this information was used to inform the Review.

Table 2: Documents and information submitted as part of the Application

Document/ information description	Date received
"Licence amendment application: Kwinana Wastewater Treatment Plant L6543/1991/11" Correspondence from Water Corporation to DWER dated 18 December 2015	18 December 2015
McFarlane, D.J. 2015. 'Recycled water for heavy industry and preventing sea water intrusion'. Australian Water Recycling Centre of Excellence, Brisbane Australia	Accessed online at: http://www.australianwaterrecycling.com.au/

3. Background

The Premises has a design capacity to treat up to 12 ML per day of sewage to a secondary standard via two screens, a grit tank, a bioselector, two oxidation ditches and two secondary clarifiers. The Existing Licence grants approval for treated sewage to be discharged at a rate of up to 4.7ML/day to two infiltration ponds on site. Additional treated sewage beyond the licenced 4.7 ML/day is discharged to ocean via the Sepia Depression Ocean Outlet Landline (***SDOOL***) under approval of Ministerial Statement 665 (***MS 665***).

The Premises is also approved to transfer treated sewage to other premises that are licensed for the treatment and/or storage of sewage. This approval was given via licence amendment in 2013, primarily in response to an application for the neighbouring Alcoa site to accept treated sewage for their lined cooling ponds; however, no reuse water has been supplied to Alcoa since the amendment was made.

The oxidation ditch plant is the result of an upgrade to the Premises which was completed in 2009 under works approval W4322/2009/1. Prior to the upgrade, sewage treatment was achieved via a conventional treatment process involving screening, primary sedimentation and activated sludge treatment. Nitrogen levels in treated sewage were significantly improved as a result of the upgrade, with median total nitrogen concentration decreasing from 41 mg/L to 4.5 mg/L.

The ***Prescribed Premises*** Category authorised by the Existing Licence is shown in Table 3 below. According to the 2018/2019 Annual Environmental Report (***AER***), the Licence Holder treated approximately 5,680.8 m^3/day at the Premises in 2018/2019.

Table 3: Prescribed Premises Categories

Classification of Premises	**Description**	***Approved premises production or design capacity or throughput***	***Schedule 1 Category Threshold***
Category 54	Sewage facility: premises — (a) on which sewage is treated (excluding septic tanks); or (b) from which treated sewage is discharged onto land or into waters.	12,000 m^3 per day	*100 m^3 per day*

4. Overview of Premises

4.1 Occupancy

The Premises to which the Application relates, being both Lot 2128 (Crown Reserve 29335) and part of Lot 2129 on Plan 173137 (Crown Reserve 29336), have Water Corporation listed as the proprietor and leaseholder.

Farfield Holdings Pty Ltd has a sublease under Water Corporation for part of Lot 2129 for other activities (works approval W5964/2016/1 and licence L8962/2016/1); and an Amendment Notice to L6543/1991/11 granted by DWER on 12 September 2016 excluded this portion of the property from the Premises Boundary.

The Premises is defined by GPS co-ordinates as follows:

389182E, 6435349N 389721E, 6435355N

389586E, 6435032N 389073E, 6434825N

389503E, 6434735N

As shown on the Premises Map attached to the Revised Licence.

Key Finding: The Delegated Officer considers that the Licence Holder is in legal occupation of the Premises.

4.2 Operational aspects

Current operations

The Licence Holder treats sewage from the reticulated sewage network from Perth's southern suburbs and discharges the treated effluent to land via infiltration basins on the Premises and separately via a pipeline to the SDOOL.

The Premises is designed to treat up to 12ML/day of sewage to a secondary standard using an oxidation ditch plant (see Table 4 for detailed infrastructure); however, inflow to the Premises currently averages 5.68 ML/day for the 2018/2019 annual period.

According to the 2018/2019 AER for the Premises, the average quality of treated sewage achieved by the secondary treatment process is as follows:

- Total nitrogen: 4.38 mg/L (*oxidation plant expected to achieve <5mg/L*)
- Total phosphorus: 4.72 mg/L;

- Biochemical oxygen demand: 2.5 mg/L (*oxidation plant expected to achieve design quality <5mg/L*);
- Total dissolved solids: 341 mg/L;
- Total suspended solids: 2.71 mg/L (*oxidation plant expected to achieve design quality <10mg/L*); and
- *E coli*: 1,7417 cfu/100mL (*with 6 of 12 result being ≥24,000 cfu/ 100 mL*).

	Total N	Total P	BOD	TDS	TSS	E coli
2016/2017 AER	6.34 mg/L	4.63 mg/L	2.5 mg/L	317 mg/L	3.12 mg/L	17,383 cfu/100mL (with 7 of 12 results being ≥24,000 cfu/ 100 mL)
2017/2018 AER	6.12 mg/L	4.09 mg/L	3.33 mg/L	330 mg/L	6.25 mg/L	20,183 cfu/100mL (with 6 of 12 results being ≥24,000 cfu/ 100 mL)
2018/2019 AER	4.38 mg/L	4.72 mg/L	2.5 mg/L	341 mg/L	2.71 mg/L	17,417 cfu/100mL (with 6 of 12 results being ≥24,000 cfu/ 100 mL)
Oxidation plant expected design quality	<5 mg/L	-	<5mg/L	-	<10 mg/L	-

4.3 Infrastructure

The existing facility infrastructure, as it relates to Category 54 activities, is detailed in Table 4.

Table 4: Category 54 infrastructure on the Premises

	Infrastructure
1	Inlet works: • 2 x band screens; • 2 x wash presses; • 1 x grit removal and washing system; • 2 x Spirotainers; and • 1 x Bioselector.
2	2 Oxiditches (one currently in use) each consisting of: • 1 x 6.0 ML/day oxidation ditch; • 2 x aerators each 184 KW (duty/standby); • 2 x Dissolved Oxygen probes (duty/standby); and • 2 x Submersible Banana Blade Propulsors 4.3 KW (duty/standby).

	Infrastructure
3	Return Activated Sludge (RAS) Pump Station: • 2 x RAS Pumps (22 KW each) (duty/standby); and • 2 x Flow meters to measure flow from clarifier 1 and clarifier 2 and associated valves, pipework and instrumentation.
4	Waste Activated Sludge (WAS) Pump Station: • 2 x WAS Pumps progressive cavity type (duty/standby); and • 1 x Magnetic flow meter to measure flow rate and provide feedback to the WAS pumps to maintain the set flow rate and associated valves, pipework and instrumentation.
5	2 Clarifiers: • 2 x 32m Clarifiers (duty-standby); and • Scraping mechanism, pipework and instrumentation.
6	Skimmings Pump Station: • 1 x Skimming Pump; • 1 x Level Transmitter; and • 1 x Solenoid Valve for Recycle water Wash Sprayer and wet well, pipework and instrumentation.
7	Dissolved Air Flotation Thickener (DAFT): • 1 x DAFT tank; • 2 x Recycle system pumps (22Kw); • 2 x Air compressors; • 1 x Saturation tank (air dissolving vessel); • 1 x DAFT sludge collection tank; and • 2 x DAFT sludge transfer pumps (1 duty / 1 standby).
8	Thickened Sludge Storage Tank: • 1 x Thickened sludge storage tank, 5 day storage capacity at maximum plant inflow; and • 3 x thickened sludge storage mixing pumps (duty/duty/duty).
9	Polymer Dosing System: • 1 x Liquid Polymer Bulk Storage Tank; • 2 x Polymer Transfer Pumps (Duty/Standby Mono Pumps Model); and • 2 x Polymer Dosing Pump.
10	Dewatering System: • 2 x Centrifuges (duty/duty); and • 2 x Centrifuge feed pumps.
11	Final Effluent Pumping System: • Effluent Pump Station (3 pumps: duty/assist/standby); and • Re-Use Effluent Water Pump Station (3 pumps: duty/assist/standby).
12	Four unlined infiltration ponds operated in pairs to allow for maintenance with a maximum infiltration area of approximately 4,800 m^2 for each pair of basins, located on the south-eastern portion of the Premises.

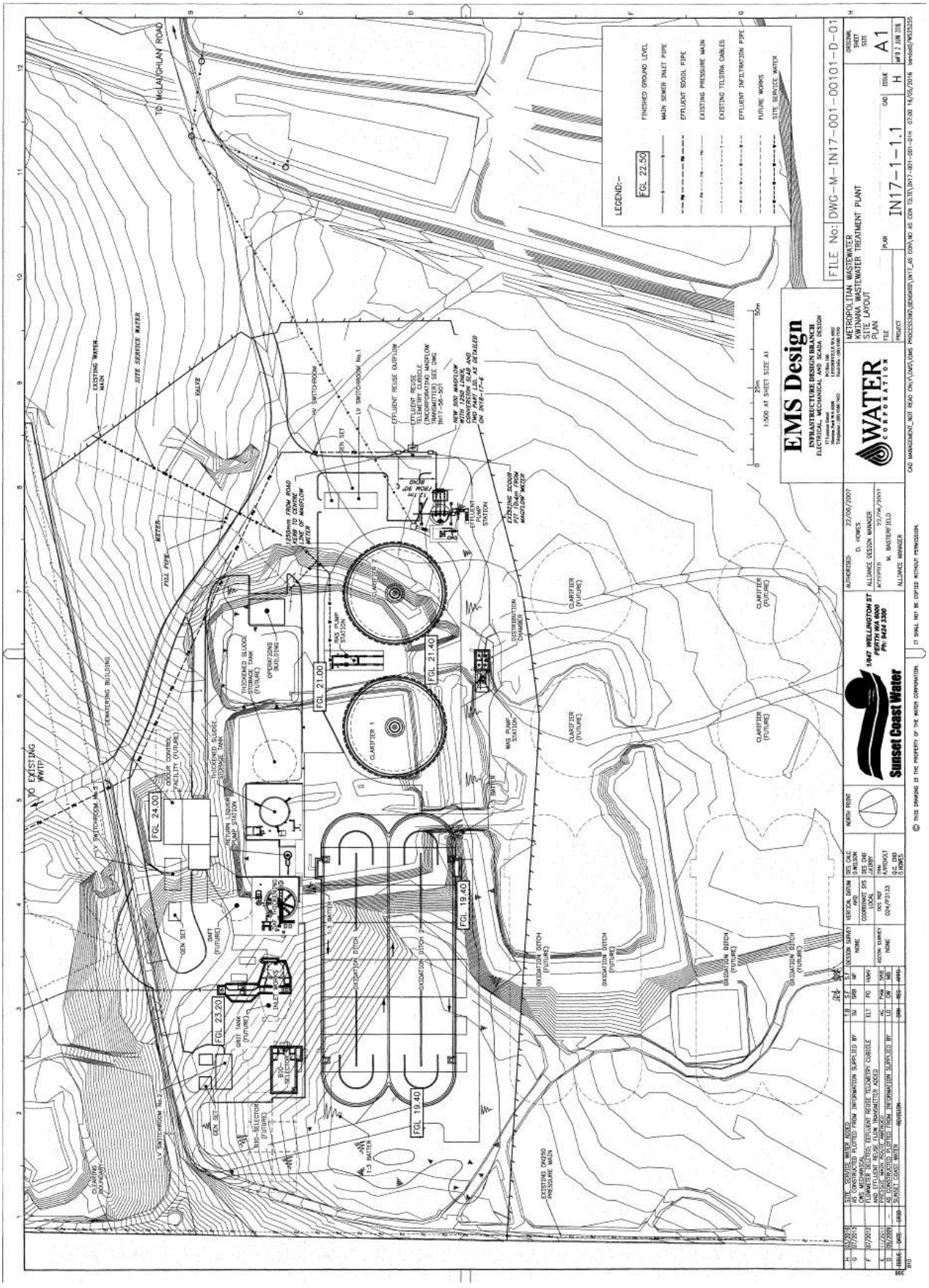


Figure 1: Premises infrastructure schematic

5. Legislative context

5.1 Applicable Standards and Guidelines

5.1.1 *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999*

Environmental Protection Policies (EPPs) are statutory policies developed under Part III of the EP Act.

The *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy Approval Order 1999* (Kwinana EPP) and the *Environmental Protection Kwinana) (Atmospheric Wastes) Regulations 1992* (Kwinana EPP Regulations) provide ambient air quality standards and ambient air quality limits for Sulphur dioxide and particulates.

The Kwinana EPP defines three areas (Areas A, B and C) where:

- Area A is the area of land on which heavy industry is located;
- Area B is outside Area A and is zoned for industrial purposes from time to time under a Metropolitan Region Scheme or a town planning scheme;
- Area C is beyond Areas A and B, predominantly rural and residential.

The Premises falls within Area B. Schedule 2 of the Kwinana EPP Regulations provide emissions standards and limits identified in Table 5.

Table 5: Ambient air quality standards and ambient air quality limits – total suspended particulates

Item	Area	Standard (µg/m^3)	Limit (µg/m^3)	Averaging period
1	Policy Area	-	1,000	15 minutes
2	Area B	150	260	24 hours

The Kwinana EPP defines 'standard' as the *"concentration of an atmospheric waste which it is not desirable to exceed"* and 'limit' as the *"concentration of an atmospheric waste which is not to be exceeded".*

This assessment has had regard to the Kwinana EPP and Kwinana EPP Regulations in assessing the risk of particulate emissions from the Premises.

5.1.2 *Environmental Protection (Peel Inlet - Harvey Estuary) Policy 1992*

The Premises is located within the *Environmental Protection (Peel Inlet – Harvey Estuary) Policy 1992* (Peel-Harvey EPP) area.

The EPP was developed as a result of nutrient enrichment of the Peel-Harvey estuary, especially from phosphorous, which resulted in excessive growth of algae causing degradation of the estuary and creating a serious public nuisance.

The EPP has three elements:

- Ascribes beneficial uses for the estuary;
- Sets targets for phosphorous loads entering the estuary, specifically requiring all landholders to contribute to reducing phosphorus loads into the estuary and achieve the overall target for phosphorus load of no more than 75 tonnes/yr; and
- Establishes a broad management framework for the catchment area.

This assessment has had regard to the Peel-Harvey EPP in assessing the risk of emissions from the Premises (refer to section 9.6 for specific details).

5.1.3 *State Environmental (Cockburn Sound) Policy 2015*

The health of Cockburn Sound is of state significance and is subject to the *State Environmental (Cockburn Sound) Policy 2015* and associated water quality objectives and management plan. Cockburn Sound is located 5km west of the Premises and is considered to be a potential receptor of emissions from the Premises. The policy was developed due to a history of significant nutrient pollution resulting in more than 75% of seagrass being lost from the early 1960s through to 2004. The overall objective of the policy is to establish the environmental values, objectives and criteria for Cockburn Sound, and ensure that these and the water quality of the Sound are maintained and/or improved resulting in no further net loss of seagrass area.

Since 2004, water quality has significantly improved; however, the density of seagrass beds is continuing to decline and it is understood that groundwater contamination from land practices is now the major source of contaminants, as opposed to the direct discharges of the past. The management plan for Cockburn Sound acknowledges that a better understanding of the relationship between nutrient inputs and water quality is required and takes the approach that the continued reduction of all sources of nitrogen inputs from human activities must continue in the interim.

5.2 Part IV of the EP Act

5.2.1 Ministerial Statement 665

Water Corporation holds Ministerial Statement No. 665 (MS 665), dated 28 October 2004, for the use of the SDOOL to dispose of up to 208 ML/day of treated sewage and industrial wastewaters combined. Water Corporation co-ordinates the disposal of wastewater from a number of sources via the SDOOL under MS 665, including Woodman Point and Cape Peron wastewater treatment plants, water from the Jervoise bay Groundwater Recovery Scheme, the Kwinana Wastewater Reclamation Plant, BP Refinery (Kwinana), CSBP Limited and Edison Mission Energy.

MS 665 has conditions pertaining to the following:

- Monitoring and management of the outlet;
- Ecological protection zones and toxicant criteria;
- New sources of discharge;
- Toxicant loads;
- Nitrogen/nutrient loads;
- Sediment quality; and
- Decommissioning plans.

To avoid regulatory duplication, the Existing Licence does not regulate the volume, quality or impacts of the discharge of treated sewage from the Premises to the SDOOL.

5.3 Contaminated sites

The Premises is currently classified as “Possibly contaminated – investigation required” under the *Contaminated Sites Act 2003*. It was originally classified in 2014 as a result of the potentially contaminating activities having been conducted over the history of the Premises, and also due to a spill of approximately 3,000L of raw sewage (and a further 5,000L directed to an unlined area) which occurred in 2011. Limited information has been provided to DWER to date to demonstrate the site was remediated adequately, or to otherwise enable detailed classification of the sites’ contamination status.

5.4 Other relevant approvals

5.4.1 Planning approvals

The Premises is zoned as “Public purposes - Water Authority of WA” under the Metropolitan Region Scheme. As such, development of the land for ‘permitted development’ purposes (i.e. Water Services Works) is exempt from the requirement to obtain development approval from the local authority or the Western Australian Planning Commission.

Key Finding: The Delegated Officer determined that the Premises operations are consistent with the Premises zoning and are not subject to a requirement to obtain separate planning approval with the City of Kwinana.

5.5 Part V of the EP Act

5.5.1 Applicable regulations, standards and guidelines

The overarching legislative framework of this assessment is the EP Act and EP Regulations.

The guidance statements which inform this assessment are:

- *Guidance Statement: Regulatory Principles (July 2015)*
- *Guidance Statement: Setting Conditions (October 2015)*
- *Guidance Statement: Licence Duration (August 2016)*
- *Guidance Statement: Decision Making* (*June 2019*)
- *Guidance Statement: Risk Assessments* (*February 2017*)
- *Guidance Statement: Environmental Siting (November 2016)*

5.5.2 Key and recent works approvals

Works approval W4322/1991/1 was granted on 9 August 2007. This works approval authorised significant upgrades to the treatment plant, including the conversion of the plant to an oxidation ditch and clarifier. The upgrade was completed in 2009 and resulted in a reduction (9 times lower) in nitrogen concentrations in treated sewage and a lesser reduction in phosphorus, electrical conductivity and total suspended solids.

5.5.3 Key and recent licence amendments

Licence amendments since 2013 include:

- Licence amendment granted 18 July 2013 to allow the transfer of treated sewage to other premises licensed for the treatment or storage of sewage waste (primarily to enable Alcoa to utilise some of the treated sewage);
- Licence reissued 22 September 2014, including update of licence format;
- Licence amendment granted on 5 March 2015 for minor administrative changes requested by Water Corporation (clarification of averaging period for monitoring);
- Licence amendment notice granted 29 April 2016 to extend the expiry date of the licence to 23 September 2022; and
- Licence amendment notice granted 12 September 2016 to update the Premises boundary and remove a third-party lease area.

The Delegated Officer has noted that on 20 May 2011 the Licence Holder submitted a request

for a licence amendment to increase the infiltration rate above the allowable 4.7 ML/day. The Application was declined due to the previous infiltration modelling provided by the Licence Holder lacking the necessary detail to demonstrate increased infiltration would not have an adverse environmental impact on the Spectacles. This was explained in correspondence to the Licence Holder on 13 September 2012, as follows:

*"**Non-Compliance***

1. *Condition W1(b): The licensee confirmed exceedance of 4.7ML/day as calculated over any consecutive 3 day period. This target has been exceeded several times this year.*

REQUIRED ACTION FOR COMPLIANCE

In response to regular exceedances, the licensee made an application for amendment of this licence condition on 20 May 2011. Amending a licence to remove the risk of non-compliance is not an appropriate corrective action. When Water Corporation completed the upgrade of the Kwinana Wastewater Treatment Plan (KWWTP) in 2008, DEC amended the conditions of licence based on Water Corporation's intention to discharge treated wastewater to the Sepia Depression Ocean Outlet Landline (SDOOL). The Water Corporation infiltration modelling was found to lack the necessary detail to allow a less conservative target to be used as the potential environmental implications and risk from modelled infiltration rates were not adequately detailed. DEC therefore used Water Corporation's modelling outcomes and the precautionary principle pursuant to section 4A(1) of the Environmental Protection act 1986 to aid its decision making. To date, no supplementary evidence has been provided to scientifically demonstrate that increased infiltration rates or increased infiltration rates over a longer time span will not have adverse environmental impact on the Spectacles Wetland and surrounding area. In the absence of additional information, DEC does not intend to consider amendment to condition W1(b)".

5.5.4 Compliance inspections and compliance history

Compliance inspections conducted on 9 February 2017 and 17 February 2015 did not identify any material issues.

A compliance inspection on 14 February 2013 identified the following compliance issues:

- Omission of data within the AER and Annual Audit Compliance Report;
- Failure to keep the discharge of treated sewage to not more than 4.7 ML/day, with the level being exceeded several times in March and April 2012;
- Failure to notify the Director of target exceedances.

All items were closed out, following the provision of a response from the Licence Holder on 11 July 2013 which included a revised AER and confirmation that exceedances had been reported to DWER, which was deemed to be sufficient.

5.5.5 Annual Audit Compliance Reports and Annual Environmental Reports

Annual Audit Compliance Reports submitted since 2013 have identified non-compliances as follows:

- Failure to maintain a meter for the monitoring of outflows (use of inflow data), reported for the period 1 July 2012 – 30 June 2013. No action was taken by DWER.
- Failure to include groundwater bore data for pH or electrical conductivity in 2014/2015 AER. No action was taken by DWER.
- Non-compliance with Existing Licence Condition 2.5.2 when the 3 consecutive day average target of 4.7ML/day discharged to infiltration ponds was breached due to a failure of the PLC and SDOOL pump system following a power failure on-site. An

average of 5.14ML/day was discharged for the period of 28 – 30 August 2018. The following day, the 3-day average (29 – 31 August 2018) target was breached again, with an average of 5.42 ML/day. Non-compliance with Existing Licence Condition 5.3.1 due to a failure of the main PLC on 27 February 2019, supernatant effluent from the dissolved air floatation process flowed via gravity to the Return Liquor Pump Station, however pumps did not activate due to the PLC failure. Liquid overflowed the pump station and surrounding bunding, discharging into stormwater drains and soakwells on-site and into the environment beneath the plant. The Licence Holder advised there was no discharge beyond the plant boundary. The failure was identified by site operators the following morning.

Monitoring of treated sewage submitted via AERs since 2013 indicate:

- A declining trend in ammonium nitrogen in treated sewage (from ~4mg/L in 2013 to <1mg/L in 2018/2019);
- A slight declining trend in E coli in treated sewage (from ~50,000 cfu/100mL in 2013 to ~25,000 cfu/100mL in 2018/2019);
- An increasing trend in nitrites plus nitrates in treated sewage (from <1mg/L in 2013 to ~3mg/L in 2018/2019); and
- A slight decreasing trend in total nitrogen (from ~5mg/L in 2013 to ~4mg/L in 2016).

5.5.6 Compliance history check

DWER's incidents and complaints management system (ICMS) notes the following compliance matters recorded since 2013:

- 8 reports of compliance issues from the February 2013 inspection, which were closed out as detailed in section 5.5.4;
- 1 notification from the Licence Holder of interruption to the sewage treatment process due to a power outage (DWER did not establish any non-compliance on reviewing this report);
- Eight reports of exceedances of the 4.7ML/day infiltration rate;
- Notification of an accidental spillage of raw sewage (matter closed due to low risk of environmental impact); and
- Notification of asset failure resulting in overflow of approximately 260kL of treated wastewater onto the treatment plant grounds, the treated wastewater was of similar quality to that usually discharged to the infiltration basin.

DWER's licence files indicate a further two exceedances of the infiltration target of 4.7ML/day which were not reflected on ICMS.

6. Modelling and monitoring data

Some modelling has been undertaken over the licensed history of the Premises to investigate the potential impacts of infiltration of treated sewage. Additionally, some groundwater monitoring is undertaken at the Premises, as required by the Existing Licence.

- In June 2006, site-specific modelling was carried out by Nield Consulting (Nield Consulting 2006) to simulate the hydraulic impacts (specifically the susceptibility of surrounding areas to inundation by rising water tables) of increasing the infiltration of treated sewage at the Premises. The modelling indicated that infiltration rates greater than 5ML/day could cause inundation of a low-lying area 500m south-southwest of the infiltration lagoons. This supported the existing target on the licence at that time of no

more than 4.7ML/day of infiltration.

- The CSIRO Report provided with the Application incorporated regional-scale groundwater modelling of the effects of managed aquifer recharge (i.e. infiltration) at various sites, including the Premises. The modelling concluded that while groundwater gradients indicate some treated sewage might flow towards the Spectacles from the infiltration ponds, advective transport indicates that the majority travels deeper within the aquifer and is carried on this path towards Cockburn Sound. Notwithstanding this, it was acknowledged in the report that the regional-scale model did not calibrate well at the local level and the study recommended further investigations to assess local impacts.
- Groundwater monitoring from 8 groundwater monitoring bores undertaken in 2016/2017 indicates nitrogen levels between 0.5mg/L and 7.8mg/L and phosphorus of 0.45 mg/L and 7 mg/L. All monitoring bores referred to on the Existing Licence are within the Premises and therefore all within 500m of the infiltration and treatment infrastructure; however, it is known that there are additional bores outside the Premises and extending into the Spectacles which are not reflected on the Existing Licence.
- A simulation of the mounding of the water table beneath the infiltrations ponds was undertaken by DWER's Expert Hydrogeologist (see Attachment 2). The purpose of this simulation was to determine what fate an increase in infiltration from the current rate of 4.7ML/day to a proposed 7.2ML/day (as per the Application) might have in the environment. The simulation indicated that the infiltration increase could potentially result in:
    - an increase from approximately 240 m^3/day of potentially contaminated groundwater currently being discharged to the Spectacles to approximately 390 m^3/day;
    - an increase of average groundwater flow rate between the infiltration basins and the Spectacles from 290 m/year to 475 m/year;
    - an increase in the rate of discharge of phosphorus from 273 kg/year to 427 kg/year; and
    - an increase in the mass flux of mercury from groundwater to the Spectacles from 13 g/year to 21 g/year.

The full content of the Technical Expert Report has been provided in Attachment 2 of this Decision Report to provide transparency to the Licence Holder and to put the consultation comments received in relation to the Premises into context.

7. Consultation

The Application was referred to the former Department of Water[1] (DoW) on 29 February 2016, with a formal response received on 23 March 2016 (summarised in Appendix 2). While the Application has been withdrawn, DWER has in completing the Review, considered the comments received and therefore they are provided below.

A summary of the advice received from the former DoW is as follows:

- The regional-scale model used in the CSIRO Report calibrated poorly at a local scale;
- The proposed increase in phosphorus loads is contrary to the *Environmental Protection*

[1] Prior to the DER, OEPA and DoW merger to form DWER on 1 July 2017.

(Peel Inlet-Harvey Estuary) Policy 1992;

- Observed groundwater data indicates that phosphorus concentrations in bores between the infiltration area and the Spectacles wetlands are already one to two orders of magnitude higher than the ANZECC guidelines for wetlands;
- Treated sewage may also contain other harmful contaminants which may not be monitored in groundwater or in the Spectacles wetlands;
- Recommendations made on the information that would be required to support the increased infiltration:
    - Recommendation 1: five additional groundwater bores are installed (including four nested bores in one location) and monitored for a period of 12 months to better delineate the plume and predict changes under infiltration scenarios;
    - Recommendation 2: Hydrological and nutrient mass-balance modelling to determine potential impacts on the Spectacles wetlands; and
    - Recommendation 3: local scale groundwater solute modelling.

A copy of the Technical Expert Report (Attachment 2) was also forwarded to the former DoW for comment on 21 April 2017. A response was received on 9 June 2017 which highlighted that the Application was not recognised by them as a managed aquifer recharge scheme and that further work would be required for this to occur (see Appendix 2 for more detail).

The Department of Biodiversity, Conservation and Attractions (***DBCA***) were provided with a copy of the Technical Expert Report on 4 October 2017. DBCA responded on 3 November 2017 recommending significantly more monitoring to characterise the baseline conditions in the Spectacles and therefore measure any potential impacts to the Spectacles. A summary of this consultation is also included in Appendix 2.

Appendix 3 provides a summary of the consultation process and how DWER has taken any items raised into consideration.

8. Location and siting

8.1 Siting context

The Premises is located on the Swan Coastal Plain, in the City of Kwinana approximately 30 km south of the Perth City centre and 5 km inland from Cockburn Sound, as shown in Figure 2. The Premises is owned by the Water Corporation, approximately 40 ha in size and is a local scheme reserve for water supply sewerage and drainage.

Surrounding land uses comprise of:

- Public purpose, including regional park directly east and south;
- The Alcoa tailings and evaporation dams to the west and north west;
- Residential properties to the south; and
- A strip of general industry between the Premises and Cockburn Sound.

The Premises Map is shown in Figure 3 below and can also be found as an attachment to the Revised Licence.

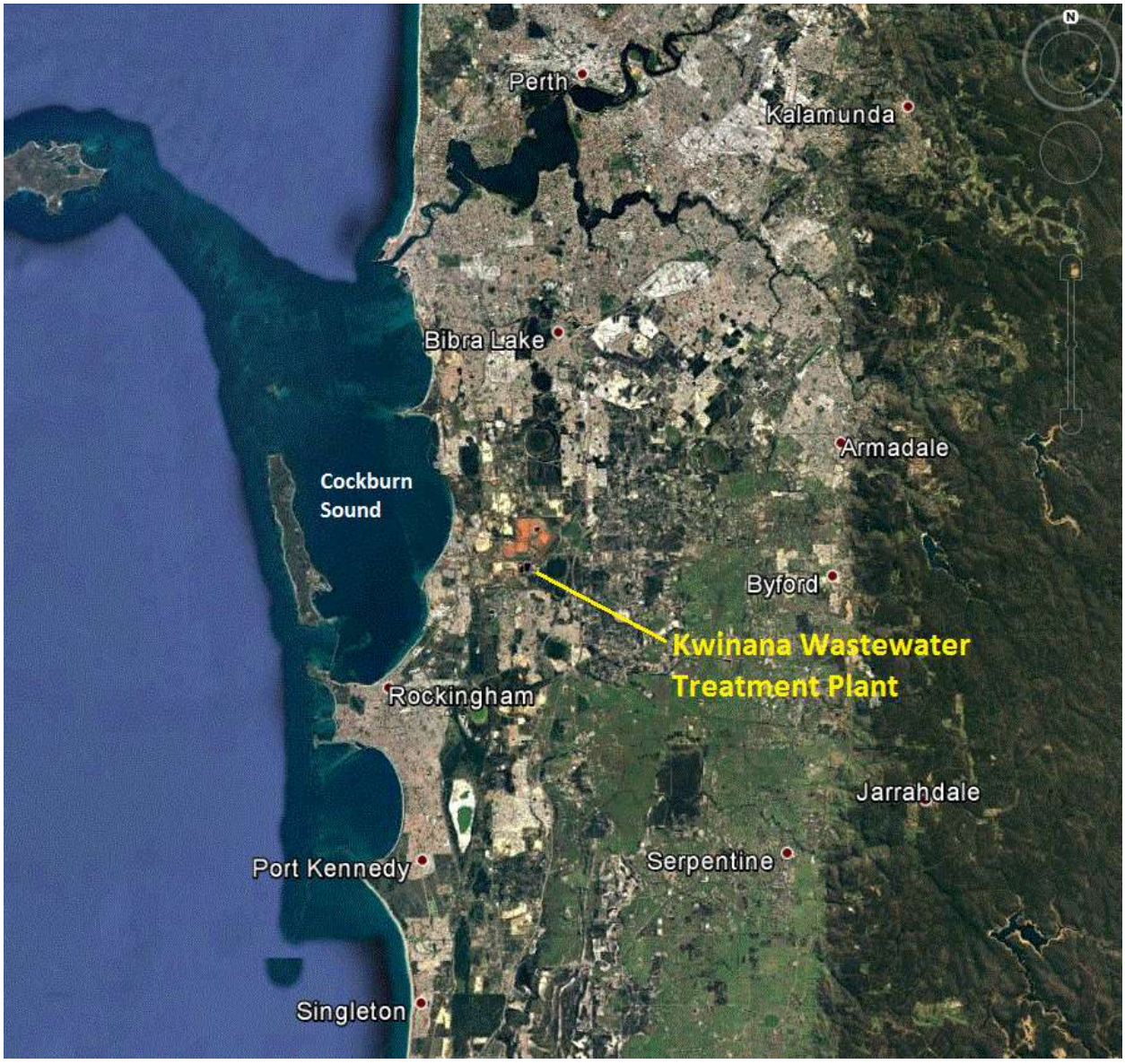


Figure 2: Location of Premises within regional context

Figure 3: Premises map

8.2 Residential and sensitive Premises

The Premises is immediately adjacent to industrial land uses, including Alcoa's mudlakes and tailings stockpiles 550m to the north, and Alcoa's cooling ponds 100m to the west.

The distances to residential and sensitive receptors are in Table 6 as follows:

Table 6: Receptors and distance from prescribed activity

Residential and Sensitive Premises	Distance from Prescribed Activity
Orelia – high density residential area	1.2 km directly to the south
Thomas Road	1.2 km directly to the south
Mandogalup townsite - rural residential area	900m to the northeast
Department of Agriculture and Food	580m to the southwest (vacant bushland immediately south is also owned by Department of Agriculture and Food)
Farfield Holdings Pty Ltd	Leased area within Lot 2129, immediately south of plant and infiltration ponds
Alcoa	Immediately adjacent to the north and west boundary of the Premises

8.3 Specified ecosystems

There are no declared rare or priority flora species as listed/defined by DBCA within 1.5km of the Premises. The site does contain mainly Banksia low Woodland species; however, none of these vegetation communities are threatened as defined by the *Environmental Protection Biodiversity Conservation Act (1999)* (***EPBC Act***) or DBCA. Some priority P3 and P4 reptiles and mammals have been caught or trapped nearby with the closest record (a reptile caught/trapped in 2007) being approximately 300m from the north-eastern boundary of the Premises, and approximately 750m from the infiltration ponds.

No natural wetlands exist within the Premises; however, the Premises is located approximately 500m west from the northern two lakes that comprise the "Spectacles", a conservation category wetland network listed on the Directory of Important Wetlands in Australia which covers approximately 3.7km^2 and consists primarily of two lakes connected by a drain. The Spectacles are also located within the Beeliar Regional Park managed by DBCA.

The major specified ecosystems within 2.5km of the Premises are listed in Table 7 below.

Table 7: Specified ecosystems

Specified ecosystems	Distance from Prescribed Premises
The Spectacles northern lakes, connected to the Peel Main Drain line (Conservation category geomorphic wetland)	500m to the east of the Premises.
Threatened ecological community (TEC)	680m to the west of the Premises (to outer edge of 500m TEC buffer).
State Environmental (Cockburn Sound) Policy 2015	Policy area includes the Premises. Cockburn Sound is ~5km west of the Premises.
Environmental Protection (Peel Inlet – Harvey Estuary) Policy 1992 area	Policy area includes the Premises.

Bush Forever nature reserve site (# 269) and Beeliar Regional Park	Immediately adjacent (east, encompassing the Spectacles).
Mandogalup swamp (Multiple use geomorphic wetland)	2km to the northeast of the Premises.
Long Swamp (Multiple use geomorphic wetland)	2.5m to the northwest of the Premises.
Physical component	**Distance from Prescribed Premises**
Other minor swamps and areas subject to inundation	2.3km to the east of the Premises.

8.4 Groundwater and water sources

The distances to groundwater and water sources are shown in Table 8.

Table 8: Groundwater and water sources

Groundwater and water sources	Distance from Premises	Environmental Value
Unconfined groundwater aquifer Abstraction within the area is subject to the *Rights in Water Irrigation Act 1914* due to being within the proclaimed Cockburn Groundwater Area.	The water table is approximately 4 - 13 mAHD according to 8 monitoring bores which are required to be monitored six-monthly under the Existing Licence. Ground level on the Premises ranges from 15 – 30 mAHD. It is noted that since the mid 1980's, over 25 bores have been monitored by Water Corporation for the purposes of detecting impacts to the Spectacles (exact location and scope of monitoring unknown).	Being inland, infiltrated sewage from the Premises mixes with ambient groundwater and travels up to 6 km to the coast, being abstracted by a range of down-gradient water users (industrial, residential and rural) within 3 km for industrial process water, irrigation, livestock and domestic/household use. The CSIRO Report attached to the Application was in support of managed aquifer recharge for the benefit of groundwater users in the region.

8.5 Soil type

DWER's soil and geology mapping indicates that predominant soil types in the area are brown sands with associated siliceous sands and leached sands. Surface geology at the site is described as Tamala limestone consisting of eolian calcarenite, variably lithified, leached quartz sand. Tamala limestone is highly transmissive and is assumed in the CSIRO Report to have a hydraulic conductivity of between 100 and 1000 m/day.

8.6 Other site characteristics

8.6.1 Topography

DWER's elevation mapping indicates that the Premises slopes from 40 mAHD at the northwest to 15 mAHD at the south-eastern corner of the Premises, with ground levels tending to fall towards a low-lying area to the south and the Spectacles to the east.

9. Risk assessment

9.1 Determination of emission, pathway and receptor

In undertaking its risk assessment, DWER will identify all potential emissions pathways and potential receptors to establish whether there is a Risk Event which requires detailed risk assessment.

To establish a Risk Event there must be an emission, a receptor which may be exposed to that emission through an identified actual or likely pathway, and a potential adverse effect to the receptor from exposure to that emission. Where there is no actual or likely pathway and/or no receptor, the emission will be screened out and will not be considered as a Risk Event. In addition, where an emission has an actual or likely pathway and a receptor which may be adversely impacted, but that emission is regulated through other mechanisms such as Part IV of the EP Act, that emission will not be risk assessed further and will be screened out through Table 9.

The identification of the sources, pathways and receptors to determine Risk Events are set out in Table 9 below.

Table 9. Identification of emissions, pathway and receptors during operation

Risk Events						**Continue to detailed risk assessment**	**Reasoning**
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
Receipt and Treatment of sewage	Preliminary treatment (inlet works) and secondary treatment (oxidation ditches, activated sludge return, clarifiers)	Odour	Orelia – high density residential area 1.2km S	Air / wind dispersion (winds predominantly southerly to south-westerly)	Amenity impacts causing nuisance, potential psychological or physical health effects	Yes	Refer to section 9.4
			Thomas Road 1.2km S				
			Mandogalup townsite - rural residential area 900m NE				
			Department of Agriculture and Food 580m SE				
			Farfield Holdings Pty Ltd lease within Lot 2129, S of plant				
			Alcoa immediately N and W of Premises				
		Noise from pumps, screens, grit	Orelia – high density residential area 1.2km S	Air / wind dispersion	Amenity impacts causing nuisance	No	The Delegated Officer considers that noise from these sources is not likely to exceed

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
Receipt and Treatment of sewage **Cont.**	Preliminary treatment (inlet works) and secondary treatment (oxidation ditches, activated sludge return, clarifiers) Cont.	removal, aerators and propulsors (in oxiditches), sludge dewatering infrastructure and vehicle movements.	Thomas Road 1.2km S	(winds predominantly southerly to south-westerly)			assigned levels at the closest receptor. Noise can be adequately regulated under the *Environmental Protection (Noise) Regulations 1997* There are no noise complaints on DWER's Incidents and Complaints Management System for the Premises
			Mandogalup townsite - rural residential area 900m NE				
			Department of Agriculture and Food 580m SE				
		Accidental spillage / overland flow of sewage, or unintended leakage/infiltration of sewage through storage or pipeline failures	Local soil and vegetation in the Premises	Overland flow and seepage through soil (highly permeable sand and Tamala Limestone)	Alteration to soil and/or vegetation condition	Yes	Refer to section 9.5
			Downstream groundwater users (abstracted by a range of industrial, residential and rural parties within 3km for process water, irrigation, livestock and domestic/household use).	Overland flow and seepage through soil and groundwater (water table is approximately 4 - 13 mAHD; ground level 15 – 30mAHD)	Health impacts (human and animal)		
		Accidental spillage of solid wastes, or unintended leakage/infiltration of leachates from solid wastes (e.g. screenings) due to	Local soil and vegetation in the Premises	Overland flow and seepage through soil (highly permeable sand and Tamala Limestone)	Alteration to soil and/or vegetation condition	Yes	Refer to section 9.5

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
		infrastructure failures	Downstream groundwater users (abstracted by a range of industrial, residential and rural parties within 3km for process water, irrigation, livestock and domestic/household use).	Overland flow and seepage through soil and groundwater (water table is approximately 4 - 13 mAHD; ground level 15 – 30mAHD)	Health impacts (human and animal)		
Sludge thickening and dewatering	Dissolved air flotation, thickened sludge storage, polymer dosing and dewatering system	Odour	Orelia – high density residential area 1.2km S	Air / wind dispersion (winds predominantly southerly to south-westerly)	Amenity impacts causing nuisance, potential psychological or physical health effects	Yes	Refer to section 9.4
			Thomas Road 1.2km S				
			Mandogalup townsite - rural residential area 900m NE				
			Department of Agriculture and Food 580m SW				
			Farfield Holdings Pty Ltd lease within Lot 2129, S of plant				
			Alcoa immediately N and W of Premises				
		Noise	Orelia – high density residential area 1.2km S	Air / wind dispersion (winds predominantly southerly to south-westerly)	Amenity impacts causing nuisance	No	The Delegated Officer considers that noise from these sources is not likely to exceed assigned levels at the closest receptor. Noise can be adequately regulated under the *Environmental Protection (Noise) Regulations 1997* There are no noise complaints on DWER's Incidents and Complaints Management System for the Premises.
			Thomas Road 1.2km S				
			Mandogalup townsite - rural residential area 900m NE				
			Department of Agriculture and Food 580m SW				
			Farfield Holdings Pty Ltd lease within Lot 2129, S of plant				
			Alcoa immediately N and W of Premises				

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
Sludge thickening and dewatering Cont.	Dissolved air flotation, thickened sludge storage, polymer dosing and dewatering system Cont.	Spillage/overland flow or leakage and/or infiltration of dewater, sludge or sludge leachate due to storage/ pipeline failures	Local soil and vegetation in the Premises	Overland flow and seepage through soil (highly permeable sand and Tamala Limestone)	Alteration to soil and/or vegetation condition	Yes	Refer to section 9.4
			Downstream groundwater users (abstracted by a range of industrial, residential and rural parties within 3km for process water, irrigation, livestock and domestic/household use).	Overland flow and seepage through soil and groundwater (water table is approximately 4 - 13 mAHD; ground level 15 – 30mAHD)	Health impacts (human and animal)		
Discharge of treated sewage (current operations)	Final effluent pumping system transferring treated sewage to the SDOOL and infiltration ponds	Discharge of treated sewage to SDOOL	Sepia Depression (Cockburn Sound)	Direct discharge	Marine ecosystem impacts on Cockburn Sound	No	The discharge is regulated under MS 665 administered by the EPA Services branch of DWER.
		Discharge of treated sewage to infiltration ponds at 4.7ML/day	The Spectacles northern lakes (500m E)	Groundwater flows towards the Spectacles	Nutrient impacts potential algal blooms, anoxic events and alterations to trophic status	Yes	Refer to section 9.6
			Peel-Harvey EPP surface water catchment.	Surface water (Peel Main Drain line from Spectacles)	Nutrient impacts potential algal blooms, anoxic events and alterations to trophic status		
			Cockburn Sound (5km W)	Groundwater	Marine ecosystem impacts on Cockburn Sound		

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
Discharge of treated sewage (current operations) Cont.	Final effluent pumping system transferring treated sewage to the SDOOL and infiltration ponds Cont.	Discharge of treated sewage to infiltration ponds at 4.7ML/day Cont.	Mandogalup swamp (2km NE)	Groundwater	Nutrient impacts potential algal blooms, anoxic events and alterations to trophic status	No	The distance from the area of groundwater mounding indicates this would not be a receptor of shallow groundwater.
			Other minor swamps and areas subject to inundation (2.3km E)	Groundwater	Nutrient impacts potential algal blooms, anoxic events and alterations to trophic status	No	The distance from the area of groundwater mounding indicates these would not be receptors of shallow groundwater.
			Long Swamp (2.5m NW)	Groundwater	Nutrient impacts potential algal blooms, anoxic events and alterations to trophic status	No	The distance from the area of groundwater mounding indicates this would not be a receptor of shallow groundwater.
		Odour (infiltration ponds)	Orelia – high density residential area 1.2km S	Air / wind dispersion (winds predominantly southerly to south-westerly)	Amenity impacts causing nuisance, potential psychological or physical health effects	No	Sewage is treated to a secondary standard, incorporating several stages of sediment/sludge removal. Point-source discharge is unlikely to be detected at the receptors. There are less than 5 historic odour complaints on DWER's Incidents and Complaints Management System which may be related to the Premises; however none could be distinguished from neighbouring sites.
			Thomas Road 1.2km S				
			Mandogalup townsite - rural residential area 900m NE				
			Department of Agriculture and Food 580m SW				
			Farfield Holdings Pty Ltd lease within Lot 2129, S of plant				
			Alcoa immediately N and W of Premises				
		Noise (pumping station)	Orelia – high density residential area 1.2km S	Air / wind dispersion (winds predominantly	Amenity impacts causing nuisance	No	The Delegated Officer considers that noise from these sources is not likely to exceed assigned levels at the closest receptor. Noise can be adequately regulated under
			Thomas Road 1.2km S				

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
Discharge of treated sewage (current operations) Cont.	Final effluent pumping system transferring treated sewage to the SDOOL and infiltration ponds Cont.		Mandogalup townsite - rural residential area 900m NE	southerly to south-westerly)			the *Environmental Protection (Noise) Regulations 1997* There are no noise complaints on DWER's Incidents and Complaints Management System for the Premises
			Department of Agriculture and Food 580m SW				
			Farfield Holdings Pty Ltd lease within Lot 2129, S of plant				
			Alcoa immediately N and W of Premises				

9.2 Consequence and likelihood of risk events

A risk rating will be determined for risk events in accordance with the risk rating matrix set out in Table 10 below.

Table 10: Risk rating matrix

Likelihood	Consequence				
	Slight	Minor	Moderate	Major	Severe
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

DWER will undertake an assessment of the consequence and likelihood of the Risk Event in accordance with Table 11 below.

Table 11: Risk criteria table

Likelihood		**Consequence**		
The following criteria has been used to determine the likelihood of the Risk Event occurring.		**The following criteria has been used to determine the consequences of a Risk Event occurring:**		
			Environment	**Public health* and amenity (such as air and water quality, noise, and odour)**
Almost Certain	The risk event is expected to occur in most circumstances	Severe	• **onsite impacts**: catastrophic • **offsite impacts local scale**: high level or above • **offsite impacts wider scale:** mid-level or above • Mid to long-term or permanent impact to an area of high conservation value or special significance^ • Specific Consequence Criteria (for environment) are significantly exceeded	• Loss of life • **Adverse health effects:** high level or ongoing medical treatment • Specific Consequence Criteria (for public health) are significantly exceeded • **Local scale impacts:** permanent loss of amenity
Likely	The risk event will probably occur in most circumstances	Major	• **onsite impacts**: high level • **offsite impacts local scale**: mid-level • **offsite impacts wider scale**: low level • Short-term impact to an area of high conservation value or special significance^ • Specific Consequence Criteria (for environment) are exceeded	• **Adverse health effects:** mid-level or frequent medical treatment • Specific Consequence Criteria (for public health) are exceeded • **Local scale impacts**: high level impact to amenity
Possible	The risk event could occur at some time	Moderate	• **onsite impacts**: mid-level • **offsite impacts local scale**: low level • **offsite impacts wider scale**: minimal • Specific Consequence Criteria (for environment) are at risk of not being met	• **Adverse health effects:** low level or occasional medical treatment • Specific Consequence Criteria (for public health) are at risk of not being met • **Local scale impacts:** mid-level impact to amenity
Unlikely	The risk event will probably not occur in most circumstances	Minor	• **onsite impacts**: low level • **offsite impacts local scale**: minimal • **offsite impacts wider scale**: not detectable • Specific Consequence Criteria (for environment) likely to be met	• Specific Consequence Criteria (for public health) are likely to be met • **Local scale impacts:** low level impact to amenity
Rare	The risk event may only occur in exceptional circumstances	Slight	• **onsite impact**: minimal • Specific Consequence Criteria (for environment) met	• **Local scale**: minimal to amenity • Specific Consequence Criteria (for public health) met

^ Determination of areas of high conservation value or special significance should be informed by the *Guidance Statement: Environmental Siting.*

* In applying public health criteria, DWER may have regard to the Department of Health's *Health Risk Assessment (Scoping) Guidelines.*

"onsite**"** means within the Prescribed Premises boundary.

9.3 Acceptability and treatment of Risk Event

DWER will determine the acceptability and treatment of Risk Events in accordance with Table 12 Risk treatment below:

Table 12: Risk treatment table

Rating of Risk Event	Acceptability	Treatment
Extreme	Unacceptable.	Risk Event will not be tolerated. DWER may refuse application.
High	May be acceptable. Subject to multiple regulatory controls.	Risk Event may be tolerated and may be subject to multiple regulatory controls. This may include both outcome-based and management conditions.
Medium	Acceptable, generally subject to regulatory controls.	Risk Event is tolerable and is likely to be subject to some regulatory controls. A preference for outcome-based conditions where practical and appropriate will be applied.
Low	Acceptable, generally not controlled.	Risk Event is acceptable and will generally not be subject to regulatory controls.

9.4 Risk Assessment – Odour

9.4.1 General hazard characterisation and impact

Odour may be generated from operations at the Premises including;

- fugitive emissions from the receipt, treatment (primary and secondary) and storage of sewage; and
- Sludge thickening and dewatering infrastructure and activities.

Odour from the operation of the Premises may vary depending on influent quality and quantity received. The most significant odour emissions in the context of the Premises are expected from the selectors, oxidation ditches and sludge processing activities, with emissions from other key stages as preliminary treatment and infiltration being modelled several magnitudes lower[2].

Odour can cause amenity impacts through nuisance to people living in areas that are receiving the emissions, and potential psychological and/or physical health impacts in the case of severe and persistent odour emissions.

The nearest odour sensitive receptors include a high density residential area (Orelia) 1.2km south of the Premises, and a rural residential area (Mandogalup townsite) 900m northeast of the Premises.

Other/non-residential receptors include Farfield Holdings Pty Ltd who hold a lease over the southern portion of Lot 2129, people travelling on Thomas Road (1.2km south), the Department of Agriculture and Food research station (580m southwest), and Alcoa of

[2] Based on the 'Report on Odour Modelling for Revised Kwinana Wastewater Treatment Plant' (Water Corporation, March 2007), prepared for works approval W4322/1991/1.

Australia Ltd (immediately adjacent to the northern and western Premises boundary). To the west of the Premises is the Kwinana Industrial area.

There is one odour complaint on record (from 2007) which was substantiated to be attributable to the temporary storage of biosolids on the Premises. There are no other substantiated odour complaints on record relating to activities on the Premises.

9.4.2 Criteria for assessment

The Delegated Officer considers that due to the time that the Premises has been in operation, the key criteria for assessment is the number and nature of substantiated complaints which have been received by the DWER.

9.4.3 Proponent controls

There is no direct odour control infrastructure on the Premises. Works approval W4322/1991/1 granted in 2007 included approval for installation of an odour control system for the inlet works, screens, grit removal, bioselector, DAFT, WAS tank and sludge dewatering; however, odour control equipment was never installed.

Odour emissions are managed by the ongoing maintenance and desludging of the ponds. Oxidation ditches at the plant reduce BOD and ammonia.

The Premises has some inherent infrastructure features which function as odour controls, as set out in Table 13 below.

Table 13: Proponent infrastructure controls for odour emissions

Infrastructure	Description of control
Siting	The Premises maintains a 1.2km separation distance to the nearest residential area and 900m to the nearest rural residential development.
Inlet works	Enclosed screenings handling system, covered and ventilated.
Oxidation ditches	Concrete covers over mixers.
Sludge storage tank	Aerated to prevent anaerobic decomposition of the sludge.

9.4.4 Key findings

The Delegated Officer has reviewed the information regarding the odour impacts from the Premises and has found:

1. *There are no substantiated odour complaints on record which can be directly attributed to the current activities on the Premises.*
2. *There have been no odour complaints logged within the last three years which could be linked to the Premises (substantiated or not).*

9.4.5 Consequence

Based upon the fact that the odour control system was never installed under works approval W4322/1991/1, and the 1.2km proximity to high-density residential receptors, the Delegated Officer has determined that amenity impacts causing nuisance off-site could be low-level. Therefore, the Delegated Officer considers the consequence to be **Moderate.**

9.4.6 Likelihood of consequence

Based upon the fact that there are no substantiated odour complaints on record attributable to

the current activities, no recent complaints linked to the Premises, and a distance of 1.2km to residences the Delegated Officer has determined that the moderate consequence will probably not occur in most circumstances. Therefore, the Delegated Officer considers the likelihood of the consequence to be **Unlikely**.

9.4.7 Overall rating

The Delegated Officer has compared the consequence and likelihood ratings described above for the Risk Criteria and determined that the overall rating for the risk of amenity impacts causing nuisance on sensitive receptors during operation is **Medium.**

9.5 Risk Assessment – Unintended spillage, leakage or overflow from infrastructure that stores and treats wastes

9.5.1 General hazard characterisation and impact

Unintended spillage, leakage and overflow of sewage or solid wastes/sludge from infrastructure failures at the Premises may result in the leaching of contaminants (such as nutrients, heavy metals and pathogens) into the environment via the soil, potentially affecting the health of local soils and nearby vegetation, and posing health risks to some downstream groundwater users (i.e. domestic/household bore abstraction, rural abstraction for livestock, garden irrigation, all occurring within 3km of the Premises according to DWER's groundwater bore database).

The key contaminants of concern in sludge, sewage and treated sewage from the Premises include nitrogen, phosphorus, E. coli and some heavy metals (mercury). There is also potential for endocrine-disrupting compounds and perfluoroalkyl substances to be present in sewage and persist in groundwater, which could have potential impacts on fauna in groundwater discharge areas (or downstream bore users abstracting the water for stock) if released in large enough quantities that infiltration to groundwater occurs.

Excess nutrients in soil may result in the proliferation of non-native vegetation in the area, and if significant levels of nutrients reach natural surface water bodies they could cause algal blooms and anoxic events. The introduction of E coli and other bacteria in high levels could cause public health risks to humans and animals if ingested (e.g. through domestic bore and livestock water usage). Heavy metals such as lead, cadmium, mercury and arsenic are known to pose a wide range of different health human health impacts and can accumulate in soil and vegetation in the environment where they may pose secondary health risks to animals and humans who ingest, inhale or otherwise come into contact with them. Mercury exposure specifically can result in damage to the nervous system, respiratory system, digestive system, immune system, skin and kidneys (Risher et al. 2002). Endocrine-disrupting compounds and perfluoroalkyl substances may alter reproductive function in animals and humans, and may increase the risk of some cancers and tumours.

Spillage, leakage or overflow of sewage or solid waste/sludge could occur as a result of infrastructure or process failures during the receipt and treatment of sewage and sludge thickening and dewatering activities. The Premises includes a range of infrastructure for the storage and treatment of sewage, as specified in Table 4.

The Premises does not have a significant history of incidents on DWER's record relating to the failure of infrastructure or processes relating to the storage of sewage or sludge, apart from the following three incidents:

- ICMS 21214 (2011) - Burst sewer pipe resulting loss of 3kL sewage.
- ICMS 41237 (2016) - 16kL discharge to gravel hardstand due to sample tap being left on overnight.

- ICMS 53272 (2019) – Asset failure caused on-site containment to be overwhelmed which resulted in overflow of approximately 260kL of treated wastewater onto the treatment plant grounds.

9.5.2 Criteria for assessment

The Delegated Officer considers that due to the time that the Premises has been in operation, a key criteria for assessment is the number and nature of incidents relating to discharges of sewage or sludge from the Premises. Details of incidents informs the likely quantity of waste that could be accidentally discharged and is therefore relevant to the consequence.

The Delegated Officer does not consider the adoption of water quality or sludge quality criteria appropriate as assessment criteria for the risk of an unplanned or accidental discharge.

9.5.3 Proponent controls

The Licence Holder controls to manage unintended spillage, leakage or overflow from infrastructure are set out in Table 14:

Table 14: Licence Holders controls for unintended spillage, leakage or overflow from infrastructure

Control	Description
Engineering	With the exception of the unlined infiltration ponds, all other infrastructure for the handling of untreated and treated sewage is impervious
	Sewage and sludge levels are maintained in daily operation by review of the WAS flow rate and DAFT operating hours which have operating targets in place. The SCADA system maintains process control points with alarms throughout the plant, which require operators to investigate and/or any necessary shutdowns occur automatically to prevent overflows.
	The inlet screens, bioselector and dissolved air flotation tank are surrounded by bitumised hardstands.
	The sludge storage tank is located on a concrete hardstand area.
Management	Minimum freeboard height maintained between highest water level and the top of the embankment

9.5.4 Key findings

The Delegated Officer has reviewed the information regarding the risk of spillage, leakage or overflow impacts from the Premises and has found:

1. *Spillages and leakages are not considered to be a normal part of operation. Incidents of contaminants accessing the environment in this manner may vary in severity but are expected to be infrequent.*
2. *The Premises does not have a significant history of incidents on record which related to the spillage/leakage or overflow of sewage. This either indicates limited reporting of events or limited frequency of events.*
3. *For the purpose of DWER's assessment, the receptor considered most likely affected by spillage/leakage is the local environment (i.e. soil and groundwater), giving consideration to the distance to foreseeable human receptors and the expected infrequent nature of these events.*

9.5.5 Consequence

Based upon the low occurrence of incidents relating to the accidental spillage/leakage or overflow of sewage, the Delegated Officer has determined that the impact of alteration to soil and/or vegetation condition and groundwater contamination will be minimal at a local scale over time. Therefore, the Delegated Officer considers the consequence to be **Minor**.

9.5.6 Likelihood of consequence

Based upon the fact that incidents relating to the spillage/leakage or overflow of sewage have occurred, the Delegated Officer has determined that minimal consequences to soil and groundwater quality at a local scale could occur at some time. Therefore, the Delegated Officer considers the consequence to be **Possible**.

9.5.7 Overall rating

The Delegated Officer has compared the consequence and likelihood ratings described above for the Risk Criteria and determined that the overall rating for the risk of Unintended spillage, leakage or overflow from infrastructure storing and treating wastes on sensitive receptors during operation is **Medium**.

9.6 Risk Assessment – Discharge of treated sewage via infiltration at current rate of 4.7ML/day

9.6.1 General hazard characterisation and impact

Up to 4.7ML/day of treated sewage is currently discharged to infiltration ponds on the Premises as a key disposal method. Sewage contains a range of contaminants which are potentially harmful when accessing surface water ecosystems. These include phosphorus, nitrogen compounds, heavy metals and metalloids, endocrine-disrupting compounds and perfluoroalkyl substances.

According to the 2018/2019 AER for the Premises, the average quality of sewage being achieved by the secondary treatment process is as follows:

- Total nitrogen: 4.38 mg/L;
- Total phosphorus: 4.72 mg/L;
- Biochemical oxygen demand: 2.5 mg/L;
- Total dissolved solids: 341 mg/L;
- Total suspended solids: 2.71 mg/L;
- *E coli*: >17,416 cfu/100mL;
- Zinc: 0.0.03 mg/L; and
- Arsenic, cadmium, chromium, copper, lead, mercury and nickel either below limits of detection, or otherwise less than 0.005mg/L (5µg/L).

Endocrine-disrupting compounds and perfluoroalkyl substances are not monitored in treated sewage. N-nitrosodimethylamine (NDMA) is also not monitored; however there is no chlorination at the Premises that could contribute NDMA into the treated wastewater stream.

There are three key potential receptors identified for the infiltration of treated sewage explored in more detail below:

a) The Spectacles

The infiltration of treated sewage has resulted in a consistent local water table mound

positioned under the infiltration site and the western side of the Spectacles. Under the current conditions, it is likely that some treated sewage is flowing eastward through the unconfined aquifer into the Spectacles, particularly in summer periods (as indicated in the CSIRO Report and the advice from DWER's expert Hydrogeologist in Attachment 2).

The discharge of treated sewage to infiltration ponds at the Premises has the potential to cause environmental impacts on the Spectacles wetland. This is due both to the proximity (500m) of the wetland to the infiltration ponds and the mounding of the water table as a result of infiltration which has resulted in some groundwater flow toward the wetland.

According to advice from DWER's expert Hydrogeologist (Attachment 2):

- it is estimated that about 240 m^3/day of groundwater that is potentially contaminated with chemical constituents from the infiltration is currently being discharged to the Spectacles wetland;
- the mass-flux of phosphorus discharged from groundwater to the Spectacles wetland across the 100 m wide discharge zone under the current treated sewage infiltration regime is approximately 273kg/year; and
- It is likely that the phosphorus is transported in the aquifer at a rate of 10% the rate of groundwater flow. This means that it could take 17 years for the phosphorus plume to travel from the Premises to the Spectacles wetland under the current recharge regime.
- If concentrations of 0.15 µg/L of mercury were to reach the Spectacles wetland (as seen in detailed investigations at Cape Cod), the mass-flux of mercury from groundwater to the wetland could be 13 g/year under the current treated sewage infiltration regime.

Phosphorus impacts:

Groundwater bore data presented in the CSIRO Report indicates that phosphorus sorption capacity has been exceeded in the ground near the infiltration ponds and is increasing over time in bores close to the wetland. When phosphorus sorption capacity is exceeded along the entire treated sewage pathway/plume to the Spectacles, there is potential for a phosphorus 'breakthrough' event, in which phosphorus levels arriving in the Spectacles will experience a significant increase over a relatively short period of time. This is considered to be an inevitable event assuming infiltration continues.

A significant increase in phosphorus inputs into the Spectacles as a result of a phosphorus breakthrough is likely to increase any eutrophication effects and therefore may result in prolific algal growth (and other biomass) and potential secondary effects related to the decay of this material and possible anoxic conditions affecting fauna living in and/or using the wetland. These impacts are largely expected over the summer periods, when contaminated groundwater from the infiltration mound is drawn into the Spectacles.

Other impacts:

A secondary effect of increased phosphorus inputs is the potential for naturally occurring arsenic to be mobilised in the wetland as it is desorbed from coatings on grain surfaces by phosphorus. Arsenic can accumulate in living tissue and is toxic to humans and animals.

Mercury may be associated with elevated nutrient concentrations and any discharge of mercury may pose some risk to the ecology of the Spectacles in that it would be methylated by microbiological activity in wetland sediments and that methylmercury

would be biomagnified in local food-webs. It is noted that mercury was below the limits of detection in the 2018/2019 AER reporting period except in October 2018 where total mercury was measured at 0.002 mg/L. Mercury levels returned to below the limits of detection in the following months.

Groundwater in sandy aquifers can become contaminated with a range of pharmaceutical compounds (i.e. endocrine-disrupting compounds and perfluoroalkyl substances) as a result of treated sewage discharge to infiltration ponds. Based on concentrations of these in the Cape Cod area (Massachusetts, similar scenario and plume), concentrations of these would be of environmental concern if discharged by groundwater to the Spectacles.

Groundwater can become contaminated with NDMA from municipal wastewater treatment plants, which is known to be a human carcinogen and toxic to a number of organs and tissues in the human body (Bradley et al. 2005). However, as the Premises does not employ chlorination in its treatment process, NDMA is not expected to be present in the treated wastewater.

b) The Peel-Harvey EPP

The Premises is geographically located within the Peel-Harvey EPP area, which requires all landholders to contribute to reducing phosphorus loads into the estuary and achieve the overall target for phosphorus load of no more than 75 tonnes/yr.

Treated sewage infiltrated at the Premises could represent a nutrient loading into the EPP due to the Peel Main Drain flowing through the Spectacles and into the Serpentine River; however, available information indicates that connectivity between the Premises and the EPP is likely to be limited due to seasonal variations.

A 1997 study estimated that approximately 48% of water flowing into the Spectacles is from the Peel Main Drain, with the remainder from groundwater. A groundwater study tracking K:Cl ratios from the CSIRO Report gives evidence of treated sewage flowing eastward via groundwater from the Premises infiltration ponds and ending up in the western edge of the Spectacles Lake where it comprises 20-23% of the shallow groundwater. However due to the timing of these studies (April 2014) this is representative of dry season conditions, and it is known that the Peel Main Drain dries out completely in summer months therefore disconnecting the link with the EPP. Conversely, in winter months when the Peel Main Drain is more likely to be flowing, inputs of treated sewage (via groundwater) into the Spectacles are less likely, due to the already high levels of surface water within the wetland.

c) Cockburn Sound

Available information suggests that treated sewage which does not migrate eastward via groundwater towards the Spectacles travels westward via groundwater towards Cockburn Sound. The modelling presented in the recent CSIRO report supported the theory that the majority of treated sewage which is infiltrated migrates downward deeper into the aquifer.

While the CSIRO Report acknowledges the Cockburn Sound policy, it highlights the need for the expected economic and environment benefits of managed aquifer recharge to be balanced with the risk of increased nitrogen and phosphorus loads entering Cockburn Sound, and also notes the need for further site-specific investigations to assess the potential environmental impacts.

According to DWER's Expert Hydrogeologist (Attachment 2), it is expected that the rate of discharge of nitrogen from infiltration activities on the arrival of the plume at the coast would initially be of the order of 1 tonne of N per year into Cockburn Sound. However, depending on the rate at which nitrogen is removed from groundwater by

denitrification and on the amount of groundwater abstraction from the plume, this could progressively increase over time to a maximum of about 15 tonnes of N per year (but it would take up to 50 years for the treated sewage plume to reach the coast). It should be noted that this rate of discharge of nitrogen would be relatively low compared to the current discharge rate by groundwater to Cockburn Sound of an estimated 350 tonnes/year.

Based on the information above, it is considered that the receptor most likely to be impacted by the infiltration of treated sewage is the Spectacles.

9.6.2 Criteria for assessment

The Delegated Officer referred to advice (Attachment 2) from DWER's expert Hydrogeologist to assess the potential impacts of infiltration on a site-specific basis.

The internal technical advice drew upon a range of literature sources, in addition to the expertise of the author, to assess the potential risk of impact to the Spectacles wetland, including (but not limited to) the following:

- Scientific literature on an intensively studied example of a groundwater plume from a sewage treatment plant in Cape Cod, Massachusetts where discharge to ground over a 60 year period created a plume over 1 km wide and more than 6 km in length;
- Toxics information for metals from the U.S. Geological Survey website; and
- CSIRO literature on endocrine-disrupting compounds.

Refer to Attachment 2 for more detail on the sources used for the assessment.

9.6.3 Proponent controls

Controls to reduce and manage the risks associated with the infiltration of up to 4.7ML/day are included in Table 15 as follows:

Table 15: Proponent controls for the discharge of treated sewage via infiltration at current rate of 4.7ML/day

Control	Description
Sewage treatment process	Upgrade to oxidation ditch technology in 2009 (previously a conventional treatment plant consisting of primary and secondary treatment with sludge activation) resulted in an almost tenfold reduction in total nitrogen and a slight reduction in phosphorus. See section 9.6.1 for details on the average treated sewage quality from the Premises.
Infiltration target	Infiltration to ponds is targeted to a maximum 4.7ML/day with the remainder sent to the SDOOL. This practice is controlled with the use of pumps on variable speed drives and a buried magnetic flowmeter. Pump rates are adjusted to balance out treated wastewater that exceeds the infiltration limit. The SCADA system also alerts operators if daily flow exceeds the high (4.7ML/day) limit, at which point it is diverted to SDOOL.

In addition to the controls above, the Licence Holder conducts monitoring for potential impacts, including:

- continuous monitoring of the volumes of treated sewage infiltrated on the Premises and analyses of pH, biochemical oxygen demand, total dissolved solids, total suspended solids, nutrients and E coli of the discharge; and
- six-monthly groundwater monitoring for standing water level, nutrients, pH and electrical conductivity from eight monitoring bores within the Premises.

  The groundwater monitoring bores include two bores west, four bores south and one

bore north of the treatment plant infrastructure, and one bore immediately northeast of the infiltration ponds. The bores provide some (limited) information to assist in detecting the extent of the groundwater mound under the infiltration ponds, and level of nutrients expressing in the groundwater as a result of infiltration. It is noted that there are no groundwater monitoring bores required to be monitored on the Existing Licence located between the infiltration ponds and the Spectacles wetland, despite the existence of bores in this area.

9.6.4 Key findings

The Delegated Officer has reviewed the information regarding the impacts from the discharge of treated sewage via infiltration at the current rate of 4.7ML/day and has found:

1. *Treatment processes at the Premises result in a reasonable sewage quality compared with conventional plants, since the 2009 oxidation-ditch upgrade;*
2. *Current infiltration rates have formed a groundwater mound under the infiltration ponds, from which contaminated water is drawn into the Spectacles in Summer months;*
3. *The Spectacles is the receptor most likely to be affected by infiltration. Continued infiltration is likely to result in a phosphorus breakthrough into the Spectacles in future. The ongoing phosphorus inputs and a breakthrough could result in algal proliferation and anoxic events in summer periods and may alter the trophic status of the wetland over time.*
4. *Impacts to the Spectacles from other contaminants at unknown concentrations (endocrine-disrupting compounds and perfluoroalkyl substances) are also possible but cannot be clearly defined or assessed based on the available information.*
5. *Contamination of the groundwater with NDMA is not expected to occur from the Premises due to chlorination not occurring.*
6. *The Peel-Harvey EPP is not considered a receptor of significance. The Spectacles has limited-no connectivity with the Peel Main Drain at the time of year that it is likely to have drawn any contaminated groundwater from the groundwater infiltration mound;*
7. *Cockburn Sound is not a receptor of significance. Potential nitrogen loading is minor compared with nitrogen inputs from other sources, and it is estimated to take ~50 years for nitrogen from the infiltration site to arrive at the coast;*
8. *Groundwater monitoring required by the Existing Licence is limited in its capacity to show contamination or inform the transfer of contaminated groundwater from the infiltration site to the Spectacles. The number and location of groundwater bores and contaminants, metals in particular, should be reviewed.*
9. *There is no documented evidence of algal blooms or anoxic events to date available to DWER; however, it is still considered that these events are reasonably foreseeable at current infiltration rates.*

9.6.5 Consequence

Based upon internal technical advice (Attachment 2), the Delegated Officer has determined that the impact of algal blooms and anoxic events would be a short-term impact to an area of high conservation value (the Spectacles). Therefore, the Delegated Officer considers the consequence to be **Major**.

A reduction in the consequence to the environmental receptor from mid to long term down to

short term impacts is considered appropriate based on the historical impacts to the receptor and the broader range of factors continuing to influence the health of the receptor.

9.6.6 Likelihood of consequence

Based upon the limited tangible evidence that current infiltration rates have already resulted in impacts, the Delegated Officer has determined that algal blooms and anoxic events in summer periods *could* occur at some time. Therefore, the Delegated Officer considers the consequence to be **Possible**.

9.6.7 Overall rating

The Delegated Officer has compared the consequence and likelihood ratings described above for the Risk Criteria and determined that the overall rating for the risk of discharge of treated sewage via infiltration at current rate of 4.7ML/day on sensitive receptors during operation is **High**.

The Delegated Officer notes that the above risk assessment has been undertaken without monitoring data from groundwater monitoring bores located between the infiltration ponds and the Spectacles. Should additional monitoring data become available, this risk assessment may be reviewed.

9.7 Summary of acceptability and treatment of Risk Events

A summary of the risk assessment and the acceptability or unacceptability of the risk events set out above, with the appropriate treatment and control, are set out in Table 16 below. Controls are described further in section 10.

Table 16: Risk assessment summary

	Description of Risk Event			Licence Holder controls	Risk rating	Acceptability with controls (conditions on instrument)
	Emission	**Source**	**Pathway/ Receptor (Impact)**			
1	Odour	Preliminary treatment (inlet works) and secondary treatment (oxidation ditches, activated sludge return, clarifiers) Dissolved air flotation, thickened sludge storage, polymer dosing and dewatering system	Air/Wind dispersion (winds predominantly southerly to south-westerly) Rural/residential receptors (Amenity impacts causing nuisance, potential psychological or physical health effects)	Siting 1.2km from receptor Enclosed inlet works Oxidation ditches with concrete covers on mixers Aerated sludge storage tank	Moderate consequence Unlikely **Medium risk**	Acceptable subject to regulatory controls
2	Unintended spillage, leakage or overflow from infrastructure that stores and treats wastes	Preliminary treatment (inlet works) and secondary treatment (oxidation ditches, activated sludge return, clarifiers) Dissolved air flotation, thickened sludge storage, polymer dosing and dewatering system	Overland flow and seepage through soil and groundwater (water table is approximately 4 - 13 mAHD; ground level 15 – 30mAHD) (Contamination of local soil/ groundwater, alteration to soil and/or vegetation condition. Health impacts (human and animal) with downstream groundwater users)	Impervious equipment Hardstands underlying key infrastructure Maintenance of minimum freeboards SCADA system with process control points with alarms throughout the plant to prevent overflows Groundwater monitoring	Minor consequence Possible **Medium risk**	Acceptable subject to regulatory controls

	Description of Risk Event			Licence Holder controls	Risk rating	Acceptability with controls (conditions on instrument)
	Emission	**Source**	**Pathway/ Receptor** **(Impact)**			
3	Discharge of treated sewage via infiltration at current rate of 4.7ML/day	Final effluent pumping system transferring treated sewage to the SDOOL and infiltration ponds	Groundwater flows towards The Spectacles northern lakes (500m E) (Nutrient impacts potential algal blooms, anoxic events and alterations to trophic status)	Sewage treatment process Adherence to daily infiltration target Groundwater monitoring	Major consequence Possible **High risk**	May be acceptable. Subject to multiple regulatory controls.

10. Regulatory controls

A summary of regulatory controls determined to be appropriate for the Risk Event is set out in Table 17. The risks are set out in the assessment in section 9 and the controls are detailed in this section. DWER will determine controls having regard to the adequacy of controls proposed by the Licence Holder. The conditions of the Licence will be set to give effect to the determined regulatory controls.

Table 17: Summary of regulatory controls to be applied

		Controls (references are to sections below, setting out details of controls)						
		10.1.1 Input restrictions	10.1.2 Infrastructure and equipment	10.1.3 Sewage treatment processes	10.1.4 Monitoring of operations	10.1.5 Emission requirements	10.1.6 Monitoring of receiving environment	10.1.7 Information and reporting
Risk Items (see risk analysis in section 9)	**1A. Odour** Receipt and treatment of sewage	•		•	•			
	1B. Odour Sludge thickening and dewatering	•		•				
	2A. Spillage/seepage Receipt and treatment of sewage		•	•			•	•
	2B. Spillage/seepage Sludge thickening and dewatering		•	•			•	•
	3A. Infiltration At current 4.7ML/day	•		•	•	•	•	•

10.1 Licence controls

10.1.1 Input restrictions

(Condition 1) The Revised Licence will subject the Licence Holder to a restriction on the type of waste being received to sewage only. This is a requirement on the Existing Licence. The Licence Holder will be approved on the Revised Licence for a maximum treatment capacity of 12ML/day, in accordance with the design capacity of the infrastructure. This is also the approved capacity on the Existing Licence. The Licence Holder will also be required to report on the volumes of sewage accepted on the Premises (see Monitoring of operations section 10.1.4 below).

Grounds: The treatment plant is designed for the treatment of sewage and the addition of other liquid wastes into the system could upset the balance in the system and result in increased odour emissions and poorer quality treated sewage being discharged.

The acceptance of more sewage than the plant is designed for could reduce the effectiveness of the treatment process and result in poorer quality treated sewage. This may result in an increase in odour emissions from receipt and treatment of sewage and sludge management, and increases in contaminant loading via the discharge, beyond the levels assessed in this Decision Report.

10.1.2 Infrastructure and equipment

(Condition 2) The Licence Holder will be subject to conditions for the storage and treatment of wastes in the key infrastructure that was considered in the assessment of risk within this Decision Report. The conditions specify where infrastructure is to be enclosed, impervious or include leachate drainage, and specify that the infrastructure is to be maintained free of defects or leaks which could result in the discharge of waste to the environment. The infiltration ponds will be listed as infrastructure; however the only requirement will be that they are unlined to facilitate the planned discharge.

Grounds: The requirement for infrastructure to be impervious/enclosed and free of leaks/defects minimises the risk of spillage or seepage of sewage with high contaminant loads from the plant before fully treated and transferred to the infiltration ponds for controlled discharge. The maintenance of infrastructure in its current state also ensures the relevance of the risk assessment in this Decision Report.

10.1.3 Sewage treatment processes

(Conditions 3 and 4) The Licence Holder will be subject to minimum requirements for the treatment of sewage and sludge dewatering and management on the Premises. Conditions will require that sewage undergoes preliminary treatment (screening and grit removal) and secondary treatment (physical and biological) through the key infrastructure already identified on the Premises, with the maintenance of freeboards where applicable to ensure the overtopping of waste does not occur. Similarly, sludge will be required to be treated and dewatered through the existing infrastructure without overtopping.

Grounds: The continued effective treatment of sewage and sludge ensures that the quality of the treated sewage is maintained as considered in the risk assessment in this Decision Report. Failure to treat the sewage properly could result in higher contaminant loads to the infiltration ponds and have further negative impacts on the Spectacles. Failure to treat effectively could also result in higher odour emissions beyond that considered by the Delegated Officer in this Decision Report.

The requirement for the maintenance of freeboards where relevant within infrastructure will be added as a management control to minimise the risk of unintended spillages of waste where it may access the environment. Where freeboards are relevant, they will be set at a minimum of 300mm which is consistent with the Existing Licence and considered by the Delegated Officer to be a sufficient level of control for the Premises.

10.1.4 Monitoring of operations

(Conditions 5 - 6) The Licence Holder will be subject to standards relating to the maintenance of an accurate monitoring program as follows:

- the maintenance of flow metering devices for the monitoring of volumes of sewage entering the Premises, being discharged to the infiltration ponds, being discharged to the SDOOL, or being transferred for third party reuse;
- flow meters to be measured in accordance with relevant Australian Standards, as

listed in the document “Guidelines for Water Meter Installation” (Department of Water, 2009); and

- the collection and preservation of water samples to be in accordance with AS/NZS 5667.1, and submission of the samples to laboratory with relevant NATA accreditation/s.

The requirements for sampling in accordance with Australian Standards and NATA accreditation are on the Existing Licence.

Grounds: These conditions will be included to support the accuracy and value of the monitoring required in the Monitoring of Operations and Monitoring of ambient environment sections of the Revised Licence. The accuracy of the monitoring of volumes of the discharge is particularly integral to demonstrating compliance with the infiltration limit of 4.7ML/day.

(Condition 5) The Licence Holder will be subject to a condition for the monitoring of daily and monthly cumulative volumes of sewage received via the inlet works of the Premises. The Licence Holder will also be subject to requirements for the monitoring of the quality of treated sewage prior to discharge (at the effluent pump station) from the Premises. The parameters required to be monitored will include pH, nutrients, total suspended solids, total dissolved solids, biochemical oxygen demand, oil and grease, heavy metals and *Escherichia coli*. Monitoring of the quantity (flow rate) of treated sewage will also be required to be measured for discharge to infiltration ponds, discharge to the SDOOL and transfer for third party reuse.

Grounds: The flow rates of sewage entering the Premises for treatment enable direct comparison with the maximum approved treatment capacity (which is related to odour and infiltration risk) and are required to be reported annually in the Compliance Report. They will also be considered in the calculation of annual licence fees.

The monitoring of the quality of effluent discharged will enable observations to be made on the effectiveness of the treatment system at and may highlight if there are problems with the treatment process/es. The Delegated Officer considers the parameters specified are relevant for the waste stream, and according to the 2015/2016 AER, the parameters are already analysed in treated sewage at the Premises.

The monitoring of the quantities of effluent leaving the Premises will also allow contaminant loads to the environment to be calculated for the assessment of potential impacts of infiltration (which will be required under the Information section of the Revised Licence) and for the calculation of the discharge component for annual licence fees. Quantities of treated sewage discharged to infiltration will also allow comparison with the infiltration limit in the Waste disposal requirements section of the Revised Licence.

Volumes of treated sewage to the SDOOL and third party reuse allow the balance of disposal to be observed and significant discrepancies between inflows and outflows may assist in the detection of infrastructure failure or seepage.

10.1.5 Emission requirements

(Condition 7) The Licence Holder will be subject to conditions to authorise the disposal of treated sewage to infiltration ponds, the SDOOL, and transfer for third party reuse.

Grounds: The discharge of treated sewage to the infiltration ponds and the SDOOL will be specified emissions under Condition 7 of the Revised Licence. The disposal options are also on the Existing Licence.

This Decision Report has not assessed the risk of the discharge to the SDOOL due to it being addressed by MS 665. Similarly, the risk of transfer for third party reuse has not been assessed. The lawful acceptance of treated wastewater by other premises will be the responsibility of the occupier of those premises, including the responsibility to obtain any necessary approvals.

(Condition 8) The Licence Holder will be subject to a condition restricting the discharge of treated sewage to infiltration ponds to a maximum of 4.7ML/day based on any consecutive period of three days. This is the level authorised on the Existing Licence.

Monitoring is required under the Monitoring of operations section of the Revised Licence (see section 10.1.4). Where the limit is exceeded over an average of any three consecutive results, the Licence Holder is required to investigate the exceedance in accordance with Condition 17 and notify DWER within 14 days of the event occurring (see Condition 18).

There will be no restrictions on discharge to the SDOOL or transfer for third party reuse; however, volumes will be required to be monitored under the Monitoring of operations section of the Revised Licence (see section 10.1.4).

Grounds: In accordance with the risk assessment within this Decision Report, the volume limit imposed through Condition 8 ensure the contaminant loads to the environment are adequately controlled and reflect the emissions assessed in this document. The Delegated Officer may review this position on receipt of a more detailed investigation from the Licence Holder into the risk to the Spectacles and other receptors posed by this infiltration rate.

(Condition 9) The Licence holder is required to monitor a series of water quality investigation triggers (based on the design performance standard for the current plant). Where trigger values are exceeded over an average of any three consecutive results (or a three consecutive day period for daily discharge flow), the Licence Holder is required to investigate and report to DWER on a twelve monthly basis (as part of the Annual Environmental Report – required by Condition 17)

Grounds: This condition ensures that the Licence Holder uses the expected design performance of the plant as a benchmark and actively investigates when performance is consistently low. The conditions helps to ensure the risk posed by the infiltration is controlled and allows early identification of problems and ability to implement remedial action if risk increases due to reduced treatment performance. Note that investigation triggers specified in this condition are not limits; failure of treated wastewater to comply with them is not a non-compliance but only a prompt for investigation and reporting.

(Condition 17) Corresponding reporting requirement for condition 9; the Licence Holder will be required to report on any trigger value exceedances for the levels specified in condition 9 (Table 6) on a twelve monthly basis (as part of the Annual Environmental Report).

Grounds: The Delegated Officer considers that the high risk associated with the current rate of infiltration warrants trigger values to be set with corresponding investigation and management actions.

The exceedance of the investigation triggers for treated wastewater quality may indicate that the plant is not performing in accordance with its design and requires investigation. Although the investigation triggers are not limits, the Delegated Officer considers that consistent exceedance (over the average of any three consecutive results) of design performance criteria warrants active investigation and reporting to the CEO.

10.1.6 Monitoring of receiving environment

(Condition 10) The Licence Holder will be subject to requirements for the monitoring of groundwater quality and standing water levels on and around the Premises. This includes the sampling of all groundwater monitoring bores on the Existing Licence and also additional bores located between the infiltration ponds and the Spectacles. The additional monitoring bores were drilled in 2009 and are sampled but were not previously required to be sampled under the Existing Licence. The parameters required to be analysed include pH, nutrients, total dissolved solids, biochemical oxygen demand, oil and grease, heavy metals and *Escherichia coli*.

Grounds: The monitoring of monitoring bores is integral in detecting any unplanned seepage or infrastructure failure, as well as verifying the risk assessment and any impacts from infiltration activities.

Upon review of the existing monitoring bores on the Premises, the Delegated Officer noted a lack of impact bores which would provide relevant information about the interaction between the infiltration ponds and the Spectacles. The lack of impact monitoring on the Existing Licence means that the full extent of impacts from the current level of infiltration on the Spectacles remains unclear. This was supported by the internal technical advice from DWER's expert Hydrogeologist (Attachment 2).

As such, the Delegated Officer has determined that the additional monitoring bores cited in the Application will be included on the Revised Licence for the detection of impacts from the existing rate of infiltration, and all groundwater monitoring will be required to be undertaken quarterly (groundwater monitoring was six-monthly on the Existing Licence) to ensure a robust data set is developed.

10.1.7 Information and Reporting

(Conditions 13 - 15) The Licence Holder will be subject to conditions requiring the maintenance of legible, up to date records related to the conditions of the licence (including the maintenance of infrastructure, monitoring, reportable events, complaints and any material change to operations). The Licence Holder will be subject to a condition requiring the recording and reporting of complaints received.

Grounds: These conditions contain necessary administrative and reporting requirements to ensure compliance with the Licence can be demonstrated, as required. The reporting of complaints is considered by the Delegated Officer to be a necessary administrative and reporting requirement given the medium risk of odour emissions from wastewater treatment and sludge management activities at the Premises. There are five historic odour complaints on DWER record which were linked with the Premises, but never confirmed to be a direct result of the Premises operations due to other industry in the area.

(Condition 16) The Licence Holder will be subject to a condition requiring the submission of an Annual Audit Compliance Report on an annual basis which indicates the extent to which the Licence Holder has complied with the conditions of the Licence. This condition is on the Existing Licence with some minor wording changes and the incorporation of a new format available on DWER's website. The new format Annual Audit Compliance Report will require the reporting of the annual throughput (sewage inflows), which was not previously required.

Grounds: In accordance with DWER's Guideline on Annual Audit Compliance Reports, the requirement for licence holders to audit and report on their environmental compliance is an integral part of the DWER's wider compliance management framework and therefore a necessary administrative reporting condition.

The inclusion of the reporting of annual throughput in the new format Annual Audit Compliance Report will enable the Delegated Officer to verify that the Licence Holder is operating in accordance with the licenced capacity and facilitate the calculation of annual licence fees.

(Condition 17) The Licence Holder will be subject to a condition requiring the submission of an AER containing all relevant information from the monitoring of treated sewage and groundwater quality, a summary of trigger value exceedances and corrective actions and a summary of any complaints received. The Existing Licence requires the submission of an AER.

Grounds: The Delegated Officer considers the annual reporting of monitoring data and trigger value exceedances is necessary for the risk of impacts to groundwater and/or the Spectacles wetland from the infiltration of treated wastewater or to be reviewed by DWER on a regular

basis. The regular provision of monitoring data may also enable the detection of any integrity issues (leakage or failure) with infrastructure holding raw sewage on the Premises.

(Condition 18) The Licence Holder will be required to notify the CEO of any exccedance of the daily discharge flow limit (4.7 ML/Day) as specified in Condition 8.

Grounds: The 4.7ML/day maximum for infiltration is a critical limit and relates to the key emission authorised by the licence. The extent of the environmental impacts of exceeding this limit is unclear, but likely to be high or extreme based in the worst-case scenario detailed in the internal technical advice (Attachment 2). The Delegated Officer considers that the high risk associated with the current rate of infiltration warrants notification to the CEO whenever the limit is exceeded.

11. Determination of Licence conditions

The conditions in the Revised Licence in Attachment 1 have been determined in accordance with DWER's *Guidance Statement on Setting Conditions*.

The Existing Licence is due to expire in 2022 and the expiry date has not been changed in the Revised Licence. This is in accordance with DWER's *Guidance Statement on Licence Duration*.

Condition Ref	Grounds
Input restrictions 1	These conditions are valid, risk-based and contain appropriate controls (see section 10).
Infrastructure and equipment 2	
Sewage treatment processes 3 and 4	
Monitoring of operations 5 and 6	These conditions are valid, risk-based and will assist in validating assessment predictions and provide assurance over the effectiveness of outcome, process and management conditions
Emission requirements 7, 8, 9	These conditions are valid, risk-based and contain appropriate controls (see section 10).
Monitoring of receiving environment 10, 11 and 12	These conditions are valid, risk-based and will assist in validating assessment predictions and provide assurance over the effectiveness of outcome, process and management conditions
Records and reporting 13, 14, 15, 16 and 17, and 18	These conditions are valid and are necessary administration and reporting requirements to ensure compliance.

DWER notes that it may review the appropriateness and adequacy of controls at any time and that, following a review, DWER may initiate amendments to the licence under the EP Act.

12. Licence Holder's comments

The Licence Holder was provided with the draft decision report and draft Revised Licence on 27 March 2018. In response, the Licence Holder provided specific comments on the draft licence and Decision Report and expressed some concerns about the setting of treated wastewater quality limits which may not be achievable all year round. The Licence Holder requested that the licence amendment be put on hold until January 2019 to allow the completion of a detailed hydrogeological investigation which would help inform the risk of impacts to the Spectacles.

Details of a hydrogeological investigation have not been provided to date, and as such, in consultation with Water Corporation, DWER has determined to proceed with finalising the Licence Review.

To facilitate the finalisation of the licence review, on 8 May 2020 DWER afforded Water Corporation the opportunity to provide final comment on the proposed revised licence and associated Decision Report. Water Corporation respond to DWER on the 10 August 2020.

Details of the Licence Holder's comments and how the Delegated Officer has considered them are provided in Appendix 3.

13. Conclusion

This assessment of the risks of activities on the Premises has been undertaken with due consideration of a number of factors, including the documents and policies specified in this decision report (summarised in Appendix 1).

Based on this assessment, it has been determined that the Revised Licence will be granted subject to conditions commensurate with the determined controls and necessary for administration and reporting requirements.

Ruth Dowd
SENIOR MANAGER WASTE INDUSTRIES
REGULATORY SERVICES
Delegated Officer
under section 20 of the *Environmental Protection Act 1986*

Appendix 1: Key Documents

	Document Title	In text ref	Availability
1.	"Licence amendment application: Kwinana Wastewater Treatment Plant L6543/1991/11" Correspondence from Water Corporation to DWER dated 18 December 2015	Application	DWER records (A1025160)
2.	Works approval W4322/1991/1 granted 9 August 2007 (12ML/day wastewater treatment plant upgrade)	W4322	DWER records (A1366611)
3.	*State Environmental (Cockburn Sound) Policy 2015*	-	accessed at http://www.dwer.wa.gov.au
4.	*Environmental Protection (Peel Inlet – Harvey Estuary) Policy 1992*	Peel-Harvey EPP	accessed at http://www.dwer.wa.gov.au
5.	McFarlane, D.J. 2015. 'Recycled water for heavy industry and preventing sea water intrusion'. A report to the Australian Water Recycling Centre of Excellence Government and industry partners from the CSIRO Land and Water Flagship	CSIRO Report	Available online at: https://publications.csiro.au/rpr/download?pid=csiro:EP155284&dsid=DS2
6.	'Use of the Cape Peron Outlet Pipeline to Dispose of Industrial Wastewater to the Sepia Depression, Kwinana' (Minister for the Environment Statement No. 000665, published 28 October 2004)	MS 665	accessed at http://www.dwer.wa.gov.au
7.	'Report on Odour Modelling for Revised Kwinana Wastewater Treatment Plant' (Water Corporation, March 2007), prepared for works approval W4322	-	DWER records (A1367429)
8.	Correspondence from Simon Nield of Nield Consulting Pty Ltd to Margaret Dunlop of ENV Australia on 7 June 2006 titled '*Kwinana Sewage Treatment Plant: Modelling the Hydraulic Impacts of Lagoon Infiltration*'	Nield Consulting 2006	DWER records (A1367429)
9.	Risher, J.F., Murray, H. E. and Prince, G. R., 2002. *Organic mercury compounds: human exposure and its relevance to public health*. Toxicology and Industrial Health 2002; 18: 109-160	Risher et al. 2002	Available online at: https://pdfs.semanticscholar.org/fca1/0665979562808b62b648f75f6dc899288d85.pdf
10.	Bradley, P.M., Carr, S.A., Baird, R.B., and Chapelle, F.H., 2005. *Biodegradation of N-*	Bradley et al. 2005	Available online at https://toxics.usgs.gov/highli

	nitrosodimethylamine in soil from a water reclamation facility. Bioremediation Journal, 9(2) 115-120		ghts/ndma_biodegradation.html
11.	DWER *Guidance Statement on Regulatory principles* (July 2015)	-	accessed at http://www.dwer.wa.gov.au
12.	DWER *Guidance Statement on Setting conditions* (October 2015)	-	
13.	DWER *Guidance Statement on Licence duration,* (November 2014)	-	
14.	DWER *Guidance statement: Decision Making* (February 2017)	-	
15.	DWER *Guidance Statement: Environmental Siting* (November 2016)	-	
16.	DWER *Guidance Statement: Risk Assessments* (February 2017	-	

Appendix 2: Summary of comments from former DoW and DBCA

Stakeholder	Aspect	Summary of comment	DWER response
Former Department of Water (now Regulatory Services, Kwinana-Peel region of DWER) 23 March 2016	CSIRO Report	The CSIRO modelling used a regional scale model that calibrated poorly to observed groundwater bores that surround the Kwinana WWTP. Also the model did not account for local lithology or include the effects of water density. The model is not suitable for making local scale predictions of groundwater movement. It is also important to note that CSIRO model estimated that infiltrated wastewater reached the horizontal boundary of the Spectacles Wetland within 5 years.	Noted and considered in DWER's risk assessment.
	Groundwater mounding	Infiltrated treated wastewater is mounding beneath the infiltration zone, resulting in groundwater levels that are continually higher than the Spectacles Wetlands. Therefore some of the treated wastewater could migrate to the Spectacles Wetland.	Consistent with advice received in Technical Expert Report and considered in DWER's risk assessment.
	Peel Harvey EPP	The Kwinana WWTP currently infiltrates approximately 8 tonnes per year of phosphorous within 500m of the Spectacles and the Peel Main Drain. Increasing treated wastewater infiltration to 7.2ML/day would result in approximately 12 tonnes per year of phosphorous being infiltrated on site. This may increase the phosphorous load within the Spectacles and in the Peel Main drain which is contrary to the Peel Harvey EPP.	Increased loads of phosphorous to the Spectacles has been identified in the Technical Expert Report and considered in DWER's risk assessment.

Stakeholder	Aspect	Summary of comment	DWER response
	Groundwater quality	Phosphorous concentrations in groundwater likely to be reaching the Spectacles is one to two orders of magnitude greater than the ANZEEC guidelines for wetlands. Increased wastewater infiltration may increase loads of heavy metals, pesticides as well as estrogenic and androgenic compounds in the Spectacles. DoW is not aware of any monitoring for these substances.	Additional monitoring requirements – including heavy metals – have been included in Revised Licence to ensure greater data set to review risk assessment for existing infiltration rates in future.
	Recommendations	• Recommendation 1: five additional groundwater bores are installed (including four nested bores in one location) to better delineate the plume and predict changes under infiltration scenarios; • Recommendation 2: Hydrological and nutrient mass-balance modelling to determine potential impacts on the Spectacles wetlands; and • Recommendation 3: local scale groundwater solute modelling.	Additional monitoring requirements included in Revised Licence to ensure greater data set to review risk assessment for existing infiltration rates in future.
Former Department of Water (now Regulatory Services, Kwinana-Peel region of	Managed Aquifer Recharge	The proposed scheme is not a managed aquifer recharge scheme recognised under *Operational policy 1.01 Managed aquifer recharge in Western Australia* (DoW 2011). To have the scheme recognised as a MAR scheme requires a risk assessment in accordance with the *Australian guidelines for water recycling: Managing health and environmental risks (Phase 2) – managed aquifer recharge* (National Water Quality Management Strategy, July 2009).	Noted.

Stakeholder	Aspect	Summary of comment	DWER response
DWER) 9 June 2017		There is an ongoing CSIRO project for managed aquifer recharge on two sites in the Western Trade Coast, due for completion in April 2018. These projects should be considered in the assessment of the KWWTP Application.	The risk assessment for the Application has been considered in isolation of other projects within the wider region, due to the highly localised potential impacts identified to the Spectacles.
Department of Biodiversity and Attractions (DBCA) 3 November 2017	DWER Technical Expert report	DBCA suggest that the conclusions presented are not at this stage supported by groundwater monitoring data and further investigative work is required to verify the threats prior to endorsement of the management measures proposed.	Noted. Additional monitoring requirements have been included in Revised Licence to ensure greater data set to review risk assessment for existing infiltration rates in future.
	Monitoring recommendations	DBCA agrees with CSIRO's recommendation for a detailed investigation of the water budget of the Spectacles is undertaken, and suggests this should include a review of monitoring infrastructure, data and monitoring program. Current licensed operation should include continuous monitoring of groundwater levels and quality, and surface water monitoring as follows: • Minimum and maximum depths and duration of inundation; • Water chemistry parameters including nutrients, metals, endocrine disrupting compounds and perfluoroalkyl substances; • Wetland vegetation health surveys; • Establish baseline conditions so that limits can be determined for parameters.	Additional monitoring requirements – including heavy metals and additional monitoring bores – have been included in Revised Licence to ensure greater data set to review risk assessment for existing infiltration rates in future. The Delegated Officer may consider the addition of monitoring surface waters and riparian health of the Spectacles in future, pending the review of results from the additional groundwater monitoring.

Appendix 3: Summary of Licence Holder's comments on risk assessment and draft conditions

Reference	Summary of Licence Holder comment	DWER response
Licence Holder comments received 18 May 2018		
General	Request that amendment be delayed until January 2019, to coincide with the consolidation of detailed hydrogeological investigations currently being undertaken to understand the impacts of the infiltration on receptors (including the Spectacles). The additional monitoring specified in the draft licence amendment has already been incorporated into the monitoring being undertaken as part of the hydrogeological investigation.	Finalisation of the Licence Review was put on hold awaiting additional information from the Licence Holder. Additional information from the Licence Holder has not been received to date and as such, the Delegated Officer has determined to finalise the Revised Licence in the absence of this information. The Licence Holder may request an amendment to the Licence at a later date should additional information become available. The most material changes to the licence requirements as a result of the Review were that of the increased monitoring frequency and scope, and the addition of treated wastewater quality limits. The Licence Holder has advised that monitoring at the increased frequency and rate is already occurring, thus the formalisation of this via the Revised Licence should not be onerous. The inclusion of treated wastewater quality limits has been reviewed in response to the submission as detailed further below.
Cover pages, premises maps	Accurate co-ordinates provided for the premises boundary.	Co-ordinates updated in documents where applicable. Premises map updated.
Condition 3 / Table 4	Suggested wording changes to improve accuracy of description of the DAFT process.	Amended as suggested.

Reference	Summary of Licence Holder comment	DWER response
Condition 4 / Table '5' (6)	a) Noted error in the naming of two tables as 'Table 5'. b) Noted that the table is very detailed and may restrict future equipment placement. Requested removal of specific details and model numbers of equipment.	a) Corrected and table numbers reviewed. b) One model number was identified and removed from Table. The Delegated Officer does not consider the remaining information in the Table to be specifically detailed. The function of the table is (in part) to set the infrastructure in accordance with what has been assessed and inhibit significant changes to infrastructure which would otherwise require an amendment or works approval.
Condition 6 / Table 5	Treated wastewater limits on the draft licence are stringent and are likely to be exceeded multiple times per year based on recent data. The inclusion of limits which cannot be met in the licence is considered to be unreasonable. Loading limits area suggested as a more relevant mechanism for managing the potential impact to the receiving environment.	The inclusion of treated wastewater quality limits was for the purposes of ensuring the loads to the environment are adequately controlled and reflect the emissions assessed via the licence review and were derived from the design specification of the treatment process. The Delegated Officer has reviewed the use of these concentration limits and has determined that while it is still appropriate for the design specification of the treatment infrastructure to be maintained, the concentrations can be set in the form of investigation triggers rather than limits. Investigation triggers for any given parameter will apply when a stated level is exceeded three times consecutively, so that outliers or extraordinary results are not captured. The finalisation of the hydrogeological investigation and provision of advice to DWER may prompt the Delegated Officer to review this position and set limits for the protection of the environment, if this is appropriate for the level of risk.
Condition 8	Details for flow monitoring devices provided for condition.	Relevant conditions have been revised to specify that flow monitoring devices are magnetic.
Condition 11 / Table 7	a) Increased frequency of monitoring from 6-monthly to monthly is suitable for the current investigation but	a) The proposed increase in frequency has been retained. The key disposal method at the premises is the infiltration of a high

Reference	Summary of Licence Holder comment	DWER response
	should be reviewed from the perspective of ongoing operations. b) Details for flow monitoring devices provided for table.	volume of wastewater to the ground and limited historic data set. The Delegated Officer considers monthly treated wastewater sampling to be appropriate for the Premises. Over time, if sample results demonstrate that a lower frequency of sampling will produce representative results, the Licence Holder can apply for a licence amendment for the Delegated Officer's consideration. b) Details provided have been added to the Table.
Condition 12 / Table 8	Increased frequency of monitoring from 6-monthly to quarterly and additional parameters is suitable for the current investigation phase but further discussion with DWER is required for ongoing operations.	The proposed increase in frequency has been retained. The key disposal method at the Premises is the infiltration of a high volume of wastewater to the ground and limited historic data set. The Delegated Officer considers quarterly groundwater sampling to be appropriate for the currently determined level of risk posed by disposal at the Premises. Over time and subject to the results of the hydrogeological investigation, if sample results demonstrate that a lower frequency of sampling will produce representative results, the Licence Holder may apply for a licence amendment for the Delegated Officer's consideration.
Conditions 15 and 16	Request timing of AER and AACR due date be aligned to achieve due date of 1 September doe consistency with other licences.	Due date in both conditions revised to 1 September as requested.
Schedule 2 / Table '10' (11)	The information in Table '10' (11) is similar to Table 3. Table '10' (11) could be replaced with a reference to Table 3 instead.	The Licence has been revised to the latest format which removes this duplication.

Reference	Summary of Licence Holder comment	DWER response
Schedule 2 / Table '11'	The information in Table 11 is very detailed and duplicates what is already contained in Table '5' (6). Table 11 could be replaced with a reference to Table '5' (6) instead, and specific details of process equipment or their components should be removed to allow change during repair or maintenance.	The tables have been reviewed and key information relevant to the licence conditions has been consolidated in Table 2. The table in schedule 2 has been removed. One model number was identified in Table 2 and removed.
Decision Document - miscellaneous	Additional clarifying detail provided for Decision Document where requested, including: • Reuse by Alcoa not occurring since 2013; • Clarification on leaseholders; • Management of sewage sludge; • Management of infiltration within allowable limit; • Management of unintended spillage/leakage/overflow	Additional detail added to the Decision Report where relevant.
Decision Document Sections 5.1.2 and 9.6.1	Incorrect statement about Peel-Harvey EPP requiring landholders to contribute to a target for overall phosphorus loads of no more than 12 tonnes/year.	This typographical error has been corrected to 75 tonnes/annum.
Licence Holder comments received 10 August 2020		
Condition 4 / Table '3'	Sewage sludge – please correct the "…return thickening pumping station…" to	Proposed wording change implemented.

Reference	Summary of Licence Holder comment	DWER response
	"…return liquor pumping station…"	
Condition 6 / Table '4'	Effluent Pump Station monitoring now includes metals. The units for reporting these are listed as µg/L whereas the previous licence, and other licences, list metals in mg/L and this is how Water Corp data systems are set up. Please can these units be changed back to mg/L	Units updated to reflect 'mg/L'. Unit conversion factors can be used to determine concentrations in µg/L if required.
	Reference to Biochemical oxygen demand (BOD) should be BOD (filtered).	Biochemical oxygen demand (BOD) analysis should be carried-out on un-filtered samples. These requirements are consistent with other similar plants that may discharge to land or via ocean outlets and provide an accurate representation of the discharge stream (BOD analysis is also required for discharge fee calculations). Water Corporation may wish to carry out additional analysis (to that specified in the revised licence) for filtered samples as part of routine process monitoring.
Condition 9 / Table '6'	The trigger values shown in the draft licence for TN, TSS and BOD equate to median design treatment characteristics of the Kwinana plant (refer Works Approval W4322 EAR Table 3). The values are expected to be exceeded around half the time as they form the central part of the operational range. They are not derived scientifically using investigations, to produce a specified environmental outcome. As Water Corporation already monitors and reports against TN , TSS and BOD (amongst the wider suite of current and	DWER has retained the requirement to monitor and report on exceedances of specific trigger values as originally proposed, however DWER has elected that this information can be reported annually as part of annual reporting requirements, as opposed to 6 monthly. DWER acknowledges that the specified levels may equate to median design treatment specifications for the plant but consider the continual review of treatment performance as a useful verification measure for regulatory and operational purposes. As previously outlined, the investigation triggers are not limits and failure of the treated wastewater to comply with them is not a non-compliance but only a prompt for investigation, potential corrective actions and reporting.

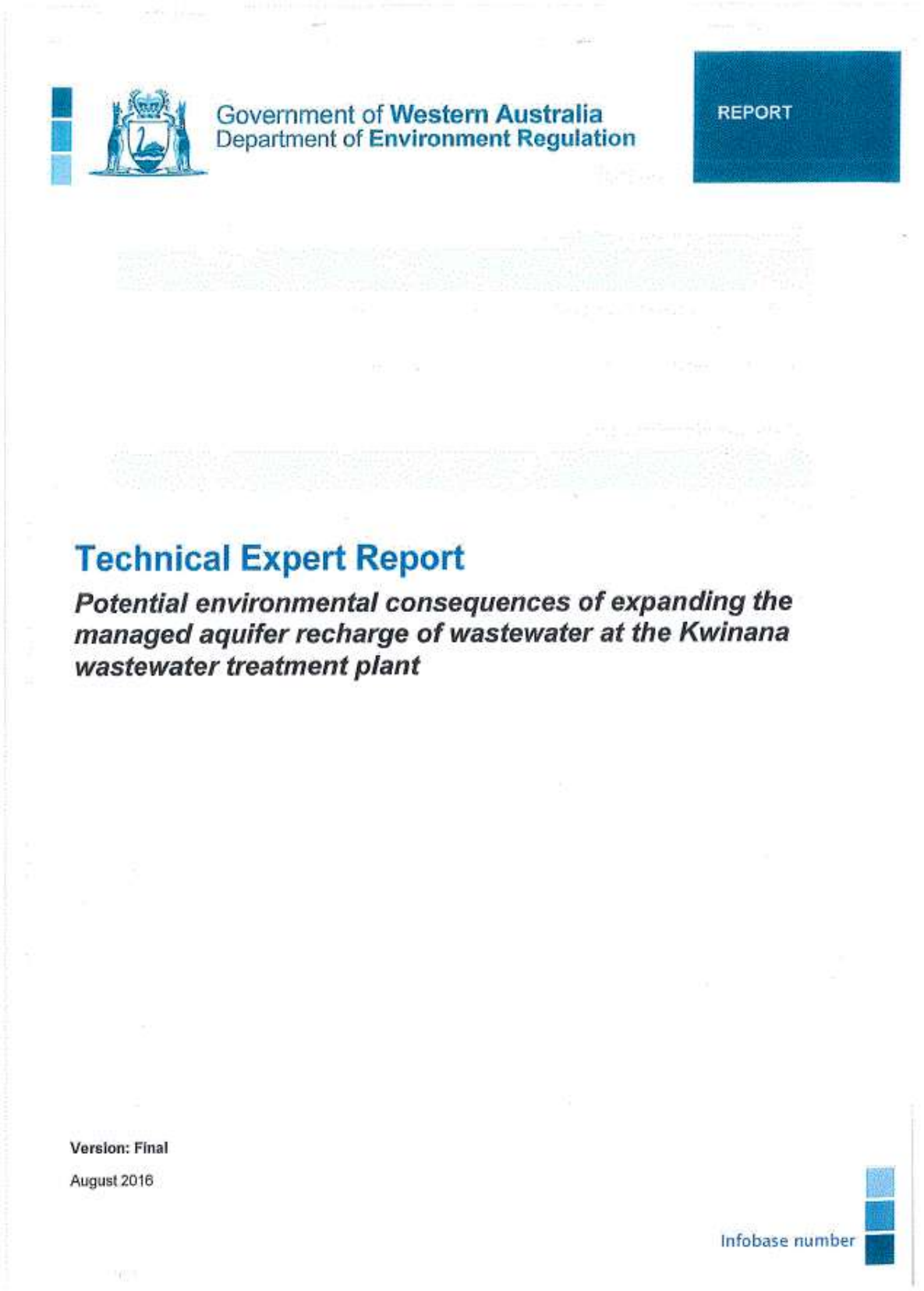
Reference	Summary of Licence Holder comment	DWER response
	proposed parameters) we request that the proposed exceedance reporting against trigger values be removed. Instead, Water Corporation will continue to provide the same data and analysis in standard reporting against these parameters as part of the annual reporting process (as per current licence conditions 5.2.1 and 5.2.2, or the proposed Condition 18). Hydrogeological investigations and an environmental risk assessment are continuing and anticipated to be finalised during 2021. Finalisation of this will inform potential imposition of further risk-based controls for environmental protection through the future renewal/amendment of the licence. In the interim, the present level of nutrient loading to land is largely limited by the flow restriction of 4.7 MLD (note the WWTP was not designed specifically for TP removal and thus, although significant TP removal can occur, the TP removal is incidental and operators have limited ability to tune it).	
	If proposed triggers are removed but DWER require more visibility of monitoring besides the annual reports (mentioned above), Water Corporation can provide the data sets more frequently, such as on a 6- or 3-monthly basis (potentially coinciding with	Trigger values and exceedance reporting requirements retained – see above comment.

Reference	Summary of Licence Holder comment	DWER response
	proposed quarterly bore monitoring events).	
Condition 10	Request therefore that condition 10 (or similar) be retained solely for reporting against the infiltration value of 4.7 ML/day which is an accepted upper value for the present.	Condition 10 has been deleted and reporting requirements relocated to Condition 17 (Annual Environmental Report). See above comment also in relation to trigger values and exceedance reporting requirements being retained in licence conditions. Condition 18 has also been included to require notification for any exceedance of the limit specified in Condition 8; daily discharge volume of 4.7ML/day over an average of any three consecutive day period.
Condition 10(d)	Time series graphical plots for the day on which the exceedance occurred is only possible for flow monitoring, where continuous monitoring is undertaken. That is, treated wastewater quality monitoring is undertaken monthly, so daily time series plotting is not possible.	Condition 10 has been deleted and reporting requirements relocated to Condition 17 (Annual Environmental Report). Former provision 10(d) has been removed from the reporting requirements. Data in tabulated form is sufficient.
Condition 13 / Table '7' (revised condition number – 12)	These are listed in µg/L whereas the previous licence, and other licences, list metals in mg/L and this is how Water Corp data systems are set up. Please can these units be changed back to mg/L.	Units updated to reflect 'mg/L'. Unit conversion factors can be used to determine concentrations in µg/L if required.
	Reference to Biochemical oxygen demand (BOD) should be BOD (filtered).	Biochemical oxygen demand (BOD) analysis should be carried-out on un-filtered samples. These requirements are consistent with other similar plants that may discharge to land or via ocean outlets and provide an accurate representation of the discharge stream (BOD analysis is also required for discharge fee calculations).

Reference	Summary of Licence Holder comment	DWER response
		Water Corporation may wish to carry out additional analysis (to that specified in the revised licence) for filtered samples as part of routine process monitoring.

Attachment 1: Revised Licence L6543/1991/11

Attachment 2: Internal technical advice



Government of Western Australia
Department of Environment Regulation

REPORT

Technical Expert Report

Potential environmental consequences of expanding the managed aquifer recharge of wastewater at the Kwinana wastewater treatment plant

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August 2016

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Date	Expert name / position	Version	Role
31/1/16	Dr Steve Appleyard	Final	Author
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Accessibility This document is available in alternative formats and languages upon request.

Expert's details

Personal details: Author

Name	Dr Steve Appleyard
Employer	Department of Environment Regulation
Position title	Principal Hydrogeologist
Classification level	SC5
Recognised field of expertise	The author is recognised by the Department of Environment Regulation as an expert in hydrogeology and geochemistry

Qualifications and experience

The qualifications and experience and technical capability relevant to the provision of this advice are as follows:

Qualification

Qualification	Year obtained	Additional comments
Ph.D. in Hydrogeochemistry	1987	

Professional experience

Employer	Position	Tenure
Various since 1982		

Other – Publications/memberships/associations etc.

Author of more than 40 peer-reviewed papers Adjunct Professor in the School of Earth and Environment, University of WA Associate Editor of the international science journal "Earth and Environmental Sciences"

Purpose of this report, limitations and disclaimer

This is technical expert advice prepared by experts employed within the Department of Environment Regulation for the purposes set out in the "Advice summary details" and should not be used for any other purpose.

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In preparing this report the technical experts have considered the request made, the information and materials provided in support of the request, literature relevant to the field, and other evidence the expert is aware of and can access through their expert capacity.

The report is based on the information provided to the experts, which is summarised in the "Advice summary details". Relevant materials that were not provided could materially change the advice. The requesting organisation needs to use appropriate judgment about the information that is relevant to the request, and the possible implications of any information that was not provided.

Where requests made require input from more than one area of technical expertise, the advice will be provided separately. Each advice will consider technical issues relevant to the specific field of expertise. No effort is made to integrate the issues raised by different technical fields. It is the responsibility of the regulatory organisation requesting the advice to determine how to weight the various matters they need to consider, and the relevance of the advice on any particular matter to making their decisions.

The interpretation of this technical expert report, and decisions about how the advice it contains should be considered in undertaking regulatory functions are matters for the recipient organisation to determine. The Department of Environment Regulation accepts no responsibility for the use or misuse of the advice, or the consequences of decisions made in reference to it.

The advice provided is limited to technical expert advice, and author(s) **have not** considered any aspect of regulatory matters that could come within the scope of legislation administered by the Department of Environment Regulation, either currently or at some time in the future. As such, the report does not purport to represent the Department of Environment Regulation's views on how such matters may be considered by the Department of Environment Regulation in its regulatory capacity. If advice is required on the Department of Environment Regulation's position on how it would consider matters relevant to its regulatory functions, a separate request for advice must be made.

Advice summary details

TO:	Ruth Dowd, Senior Manager, Industry Regulation (Waste Industries)
PREPARED BY:	Dr Steve Appleyard
REVIEWED BY:	Andrew Miller
SUBJECT	**Potential environmental consequences of increased wastewater recharge at the Kwinana WWTP site**

* The details of these experts is summarised below (see Expert's details).

Scope of advice
This advice relates to the assessment of the potential environmental consequences of increasing the rate of discharge of wastewater to ground at the Kwinana wastewater treatment plant site.

In support of this request, DER Industry Regulation has made the following materials and documents available. These materials form the basis of this technical expert advice.

Material / document name	Type of resource / description	Date supplied (if different from original request)
Recycled Water for Heavy Industry and Preventing Seawater Intrusion (Kwinana Managed Aquifer Recharge)	CSIRO Technical Report	

In preparing this advice I have considered the information provided with the request. I have also:

- Undertaken a literature review of other relevant information;

My advice is as follows:

Key points:

- The proposed expansion of the MAR scheme at the Kwinana treatment plant could cause phosphorus to be discharged by groundwater to the Spectacles wetland at rates in excess of 400 kg/year. This phosphorus discharge rate could cause frequent algal blooms and periods of anoxia in the wetland;
- The proposed expansion of the MAR scheme could also lead to mercury, pharmaceutical compounds and the perfluoroalkyl compound PFOS being discharged by groundwater to the Spectacles wetland at environmentally significant concentrations;
- Potential environmental impacts of the MAR scheme on the Spectacles wetland could be mitigated by the construction of a reactive barrier to remove phosphorus and metals from groundwater or by relocating the wastewater infiltration basins;
- It is considered that the MAR scheme will have a negligible environmental impact on Cockburn Sound.

1. Introduction

Managed aquifer recharge (MAR) is the purposeful recharge of water to aquifers, often for subsequent recovery and reuse (Dillon *et al.*, 2009a). Depending on the source of the recharge water and its chemical composition, MAR may also provide environmental benefits in supporting wetlands and other groundwater-dependent ecosystems in regions where low rainfall and widespread groundwater abstraction has caused a large-scale decline in the elevation of the regional water table.

However, under some circumstances chemical constituents in treated sewage or other wastewater sources that may be used for MAR have the potential to cause adverse impacts on stygofauna, on riparian vegetation and on wetland ecosystems (Dillon *et al.*, 2009b), as do metals and metalloids of natural origin which may be released into groundwater from aquifer sediments through chemical reactions between the sediments and wastewater constituents. These potential impacts should generally be considered when new MAR schemes are proposed or when existing schemes are expanded.

This is potentially the case for a MAR scheme at the Kwinana wastewater treatment plant where currently up to 4.7 ML/day of wastewater treated to tertiary standard is discharged to ground through infiltration basins. The Water Corporation would like to increase the target infiltration rate at the site to 7.2 ML/day of wastewater and are seeking a licence amendment from DER to do this. Additionally, a report prepared by CSIRO (McFarlane, 2015) indicates that there are a number of alternative options for the use of wastewater for MAR in the Kwinana area which have yet to be assessed by DER and which have the potential to affect environmental receptors.

This report provides information on the potential environmental impacts of wastewater recharge on environmental receptors in the Kwinana area under conditions where there are

limited monitoring data to inform an appropriate regulatory response to MAR schemes in the area.

2. Characteristics of wastewater plumes from MAR schemes

The discharge of treated wastewater to ground for a prolonged period of time can create extensive groundwater plumes that may be several kilometres in length and can contain elevated concentrations of a range of chemical constituents including nutrients and boron.

The best and most intensively studied example of this is a groundwater plume from a wastewater treatment plant in Cape Cod, Massachusetts where discharge to ground over a 60 year period has created a plume over 1 km wide and more than 6 km in length (Fig. 1) that is discharging nutrients into a groundwater-throughflow wetland and to the nearshore marine environment at the coast (Walter *et al.*, 1996; McCobb *et al.*, 2003; Barbaro *et al.*, 2013). Phosphorus concentrations within the anoxic core of the plume commonly exceed 1 mg/L (Walter *et al.*, 1996) indicating that the adsorption capacity of aquifer sediments has been greatly exceeded within the plume.

2.1 Impacts of phosphorus discharge on freshwater wetland ecosystems and management interventions

Groundwater investigations at the Cape Cod site have indicated that phosphorus concentrations in excess of 3 mg/L are being discharged by groundwater into Ashumet Pond Fig. 2), a groundwater flow-through wetland located about 500 metres from the sewage infiltration basins (McCobb et al., 2003), and this has caused frequent algal blooms, fish-kills and periods of anoxia in this wetland. Reactive transport modelling of the movement of phosphorus in the shallow aquifer at the site (Parkhurst *et al.*, 2003) has indicated that the peak mass-flux of phosphorus by groundwater to Ashumet Pond exceeded 1000 kg/year and that discharge of phosphorus from the plume would continue to cause environmental impacts in the wetland for many decades without active management.

As a result of this work, a 100 m long permeable reactive barrier (PRB) containing zero-valent reactive iron was constructed in 2004 along part of the shoreline of the wetland to intercept the groundwater plume (CH2MHill, 2005). Monitoring has indicated that this PRB has reduced the discharge of phosphorus from the groundwater plume by about 95% (McCobb *et al.*, 2009) and have indicated that the PRB has sufficient capacity to remove phosphorus from groundwater for about a 25 year period. However, it likely that the barrier would have to be replaced several times before phosphorus levels in groundwater plume discharging to Ashumet Pond have naturally declined to levels that would be environmentally benign.

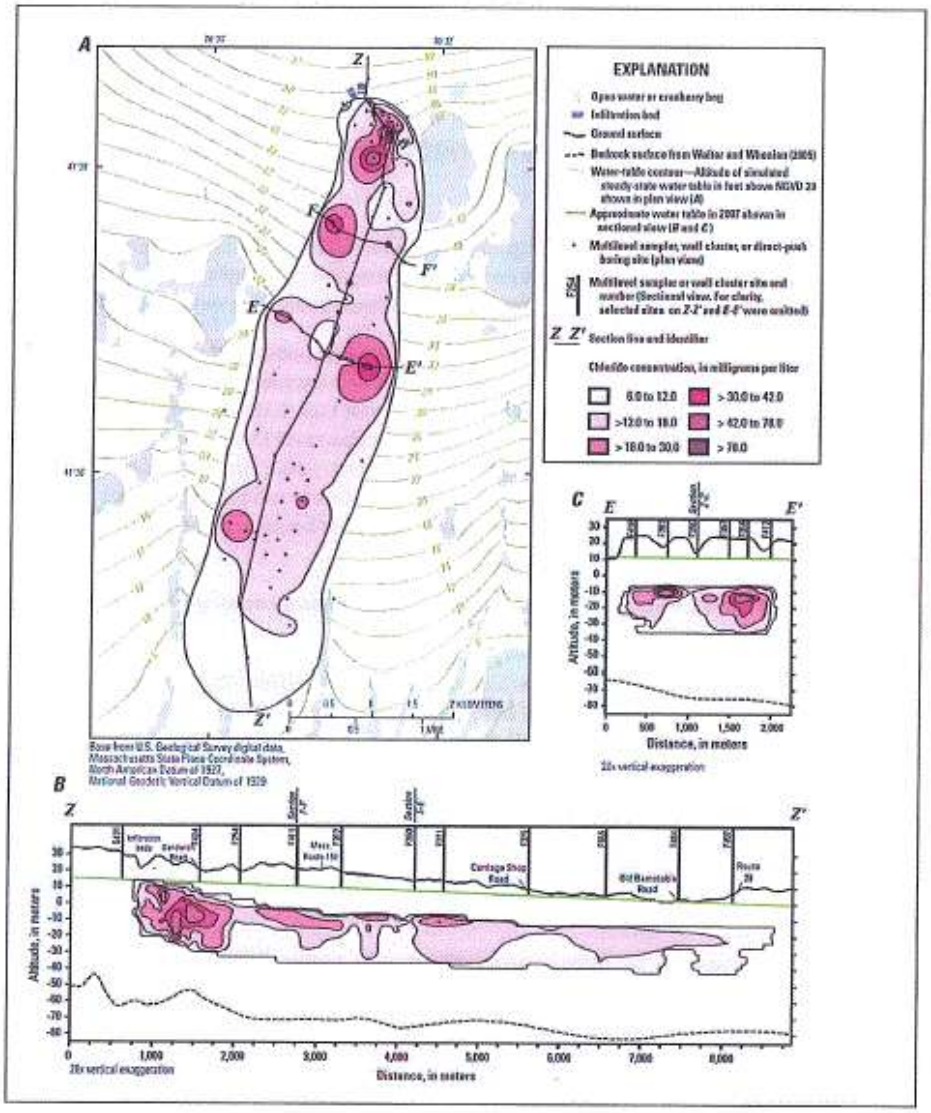

Figure 1. Example of a groundwater plume from a wastewater treatment plant (defined by elevated chloride concentrations) in an unconfined aquifer at Cape Cod, Massachusetts, USA (from Barbaro et al., 2013). The plume is shown in plan-view, as a longitudinal section along the plume axis, and as a cross-section across the plume.

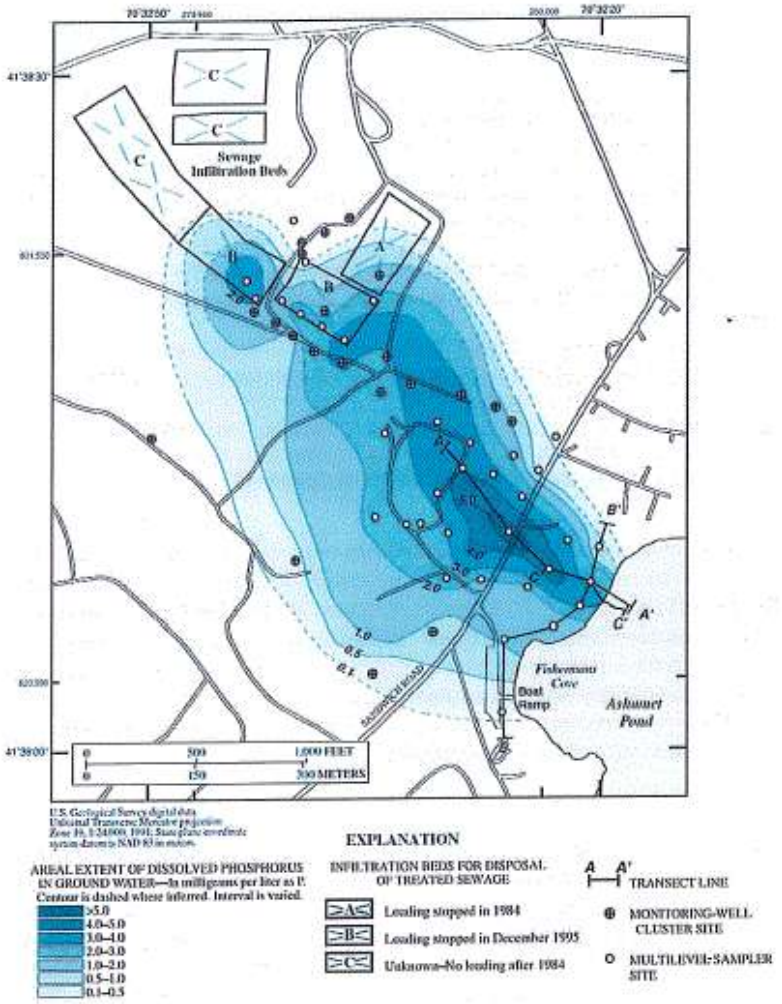

Figure 2. Groundwater discharge of phosphorus to a fresh groundwater-throughflow wetland from an MAR scheme at Cape Cod Massachusetts (from McCobb et al., 2003)

2.2 Metals and metalloids of environmental concern

Metals and metalloids can be input to groundwater from wastewater recharge by two processes:

- From the wastewater itself, particularly if commercial or industrial premises are present in the WWTP catchment; and/or
- From the reductive dissolution of iron oxide coatings present on minerals in soil and aquifer sediments and the release of naturally-occurring adsorbed metals and metalloids into groundwater due to changes in aquifer geochemistry caused by the high organic loading in wastewater.

Research undertaken by the US Geological Survey suggests that the metals and metalloids of most concern in in a groundwater plume from an MAR scheme are:

- Mercury (refer to the following web site for more information: http://toxics.usgs.gov/highlights/2014-12-24-mercury_in_gw.html);
- Zinc (refer to the following web site for more information: http://toxics.usgs.gov/highlights/pHexperiment/index.html); and
- Arsenic (refer to the following web site for more information: http://toxics.usgs.gov/highlights/arsenic_desorption.html)

Mercury is of particular concern for freshwater wetlands because of the potential for this element to be biomagnified in local food webs and to affect bird populations when methylated Burger and Gochfield, 1997; Burgess and Meyer, 2008). Detailed investigations on the Cape Cod wastewater plume have indicated that mercury occurred in groundwater near the MAR infiltration basins at concentrations up to 0.15 µg/L or about 700 times natural background levels in groundwater in the area (Lamborg *et al.*, 2013). Mercury concentrations of this magnitude have the potential to cause environmental impacts if discharged at significant rate in groundwater to a wetland environment.

2.3 Nitrogen compounds

Elevated nitrogen concentrations in groundwater discharge to the coast can cause algal blooms and the loss of seagrass meadows in sheltered nearshore marine environments as these environments are particularly sensitive to nitrogen inputs. This is the case for Cockburn Sound where groundwater discharge is the largest source of nitrogen to this water body, discharging about 350 tonnes of nitrogen on an annual basis from mainly industrial sources of contamination on the Kwinana strip (Appleyard, 1994; Smith and Johnston, 2003). Although many industries in the area have implemented measures to reduce inputs of this contaminant to Cockburn Sound from groundwater, it is likely that high rates of groundwater discharge of nitrogen to this marine embayment will continue for many years.

Investigations undertaken by Barbaro *et al.* (2013) in Cape Cod have indicated that elevated nitrogen concentrations in a groundwater plume may persist at distances of more than 6 km downgradient of an MAR scheme. This means that high nitrogen concentrations in the wastewater plume from the Kwinana treatment plant could eventually discharge to Cockburn Sound which is located about 5 km downgradient of the site. However, at the current rate of groundwater flow of about 50-100 m/year, this will take many decades to occur. If the plume from the Kwinana wastewater treatment plant behaves in a similar manner to the plume at the

Cape Cod site, it is expected that the rate of discharge of nitrogen on arrival of the plume at the coast would initially be of the order of 1 tonne of N per year into Cockburn Sound. However, depending on the rate at which nitrogen is removed from groundwater by denitrification and on the amount of groundwater abstraction from the plume, this could progressively increase over time to a maximum of about 15 tonnes of N per year (approximately the proposed rate of N input in recharge to the aquifer at the treatment plant).

2.4 Endocrine disrupting compounds (EDCs)

Treated wastewater typically concerns significant levels of pharmaceutical compounds, constituents of personal care products and surfactants that have the potential to cause adverse impacts on fauna in groundwater discharge areas. Research undertaken by CSIRO (Ying et al., 2008) suggests that many of these so-called endocrine disrupting compounds (EDCs) could persist for long periods of time under anoxic conditions in groundwater and therefore could be discharged at environmentally significant concentrations in groundwater flow to wetlands. However, as many of these compounds are readily adsorbed by aquifer sediments, the rate at which they move in an aquifer is generally much slower than the rate of groundwater flow.

2.5 Perfluoroalkyl substances (PFAS)

Treated wastewater often contains perfluoroalkyl compounds at levels of environmental concern, particularly the compounds perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). These compounds are highly soluble in water, are extremely persistent in aquifers and can cause environmental harm at low concentrations when discharged into surface water environments. Insufficient information has been provided in the CSIRO report to indicate whether one or more of these compounds are present at levels in treated wastewater from the Kwinana WWTP that could cause adverse environmental effects on discharge to wetlands or other aquatic environments.

3. Assessment of "worst case" environmental impacts

A "worst case" scenario has been examined for the potential environmental impacts of wastewater recharge at the Kwinana site on discharge to both the Spectacles wetland and to Cockburn Sound. Worst case scenarios have been examined for both the current recharge rate of 4.7 ML/day for wastewater, and for the proposed recharge rate of 7.2 ML/day. The development and assessment of these scenarios is discussed in the following sections:

3.1 Hydrogeological setting of the Spectacles wetland

The discharge of wastewater to ground at the Kwinana wastewater treatment plant has the potential to cause significant environmental impacts on the Spectacles wetland. This is due to the proximity of this feature to the MAR site (within 500 metres) and due to the fact that mounding of the water table cause by the recharge scheme has caused some groundwater flow to take place towards the wetland.

The assessment of the potential impact of chemical constituents in wastewater on the Spectacles wetland must consider the details of a hydrogeological setting where a MAR scheme is located hydraulically downgradient of a groundwater throughflow wetland.

Such a wetland will have an extensive "capture zone" defined by flow-divides on its upgradient side (Fig. 3) where groundwater from either part of or the whole of the saturated thickness of the aquifer will flow into the wetland. The thickness of the capture zone will depend on the size and shape of the wetland as well as on the hydraulic characteristics of the aquifer (Nield *et al.*, 1994). Throughflow wetlands also have a release zone on their downgradient side where water is discharged back into the aquifer. This water is more saline than natural groundwater due to the effects of evaporation in the wetland and therefore the discharge forms a plume that sinks back into the aquifer. Groundwater investigations undertaken near the Kwinana wastewater treatment plant indicate that the upper surface of the brackish groundwater plume discharging from the Spectacles wetland occurs at a depth of about 10 metres below the water table on the western edge of the lake.

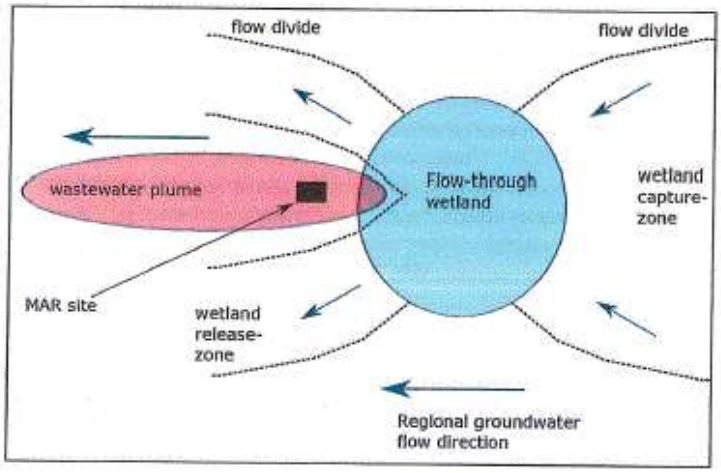

Figure 3. Conceptual model of an MAR scheme that is located downgradient of a groundwater throughflow wetland

The installation of a MAR scheme on the downgradient side of a throughflow wetland would lead to the development of an additional groundwater flow regime within the release zone of the wetland which will be bounded by a parabolic-shaped flow divide with a flow stagnation-point that will lie on the wetland side of the MAR scheme (Fig. 3). Depending on the magnitude of the mounding that takes place beneath a wastewater infiltration basin, the flow stagnation point may extend back into the wetland, and groundwater contaminated with chemical constituents from the MAR scheme has the potential to be discharged into the wetland (Fig. 3). As groundwater contaminated with chemical constituents from wastewater is likely to have a lower density than brackish groundwater in the wetland release zone, the

contaminated groundwater is likely to ride over a brackish water interface and be discharged to a seepage face near the edge of the wetland.

3.2 Determining the potential rate of groundwater discharge to the Spectacles wetland

The extent of mounding of the water table beneath the infiltration basins at the Kwinana treatment plant site under the current recharge regime was simulated using a spreadsheet-based solution to the Hantush analytical equation for the development of groundwater mounds (Hantush, 1967). This was done to determine the hydraulic conductivity of aquifer sediments in the vicinity of the treatment plant, and to enable the degree of mounding of the water table to be determined if the recharge rate were to be increased to 7.2 ML/day.

The initial simulation indicated that the current mounding of the water table indicated in McFarlane (2015) could be matched if the average hydraulic conductivity of sediments in the Superficial Aquifer in the area was assumed to be 30 m/day. Under the current recharge regime, the average hydraulic gradient towards the Spectacles wetland is about 0.008, but modelling suggests that this gradient would be increased to about 0.013 if the wastewater recharge rate were to be increased to 7.2 ML/day.

If it is assumed that that the discharge of wastewater contaminants in groundwater flow at the Spectacles wetland takes place in a similar manner to Ashumet Pond at Cape Cod, the width of the zone discharging contaminants from the treatment plant will be about 100 m. If it is also assumed that the thickness of aquifer that is contributing to groundwater discharge of wastewater contaminants to the wetland is 10 m, the rate of discharge can be determined by Darcy's Law:

$$Q = KiA$$

Where
Q = rate of groundwater discharge (m^3/day)
K = Hydraulic conductivity of aquifer sediments (m/day)
i = Hydraulic gradient (m/m)
A= Cross-sectional area of aquifer (m^2)

Using this equation and the assumptions made above, it is estimated that about 240 m^3/day of groundwater that is potentially contaminated with chemical constituents from the MAR scheme is currently being discharged to the Spectacles wetland. This would be increased to about 390 m^3/day if the wastewater recharge rate at the treatment plant were to be lifted to 7.2 ML/day.

The average rate of groundwater flow between the treatment plant and the Spectacles wetland can be estimated using the following equation:

$$V = Ki/\theta$$

Where
V = groundwater flow rate (m/day)
θ = porosity of the aquifer sediments

Assuming that the porosity of aquifer sediments near the treatment plant is about 0.30, under the current recharge regime the average groundwater flow rate between the wastewater

infiltration basins and the Spectacles wetland is estimated to be about 0.8 m/day, or about 290 m/year. This could increase to a flow rate of about 475 m/year if the recharge rate at the treatment plant were to be lifted to 7.2 ML/day.

3.3 Potential discharge rate of phosphorus from groundwater to the Spectacles wetland

If it is assumed that sediments in the Superficial Aquifer near the Kwinana treatment plant are similar to sediments in the aquifer near the Cape Cod site, it is likely that the phosphorus would be transported in the aquifer at a rate of 10% the rate of groundwater flow (Walter *et al.*, 1996; Parkhurst *et al.*, 2003). This means that it could take up to 17 years for the phosphorus plume to travel from the treatment plant to the Spectacles wetland under the current recharge regime, but this travel time could be shortened to about 11 years if the wastewater recharge rate were to be increased to 7.2 ML/d.

The concentration of phosphorus in groundwater in the Cape Cod plume on arrival at the Ashumet Pond wetland was about 3 mg/L (see Fig. 2 and McCobb et al., 2003). If the plume from the Kwinana treatment plant were to behave in a similar fashion, the mass-flux of phosphorus discharged from groundwater to the Spectacles wetland across a 100 m wide discharge zone under the current wastewater infiltration regime would be about:

(3 x 240) = 747 g/day = 273 kg/year

The rate of discharge of phosphorus could increase to about 427 kg/year if the wastewater infiltration rate at the Kwinana treatment plant were to be raised to 7.2 ML/day.

Phosphorus discharge rates to the Spectacles wetland of this magnitude would be likely to adversely impact on the trophic status of the wetland and could lead to frequent algal blooms and periods of intense anoxia in this water body.

3.4 Potential discharge rate of mercury from groundwater to the Spectacles wetland

Detailed investigations on the Cade Cod wastewater plume have indicated that mercury occurred in groundwater near the MAR infiltration basins at concentrations up to 0.15 µg/L or about 700 times natural background levels in groundwater in the area (Lamborg *et al.*, 2013). If concentrations of this magnitude were to reach the Spectacles wetland, the mass-flux of this element from groundwater to the wetland could be 13 g/year under the current wastewater recharge regime, or as high as 21 g/year if the recharge rate were to be lifted to 7.2 ML/year.

Given that this mercury discharge will also be associated with elevated nutrient concentrations, there is a significant risk that much of the mercury would be methylated by microbiological activity in wetland sediments, and that methylmercury would be biomagnified in local food-webs. This could be assessed by biomonitoring with caged fish in the wetland (refer to the following web site for more information: http://www.werc.usgs.gov/Project.aspx?ProjectID=189) and by periodic monitoring of mercury levels in bird feathers and eggs.

3.5 Potential discharge of EDCs and PFOS to the Spectacles wetland

Recent sampling of domestic bores in the Cape Cod area (Schaider *et al.*, 2016) has indicated that groundwater in sandy aquifers can become contaminated with a range of pharmaceutical compounds as a result of wastewater discharge to ground. The most commonly detected compounds were the antibiotic sulfamethoxazole which was detected in 45% of the bores that were sampled at concentrations of up 60 ng/L, and the drug carbamazepine which was detected in 25% of the groundwater samples at concentrations of up to 62 ng/L. The perfluoroalkyl compound PFOS was also detected in 55% of the sampled bores at concentrations of up to 7 ng/L.

Concentrations of these compounds of this magnitude would be of environmental concern if they were to be discharged by groundwater to the Spectacles wetland and would require further assessment.

3.6 Potential discharge of contaminants from the MAR scheme to Cockburn Sound

The large distance between the Kwinana treatment plant and the coast (more than 5 km) means that it will take many wastewater constituents many decades to centuries to be discharged to Cockburn Sound. As indicated in Section 2.3, up to 15 tonnes/year of nitrogen could be discharged by groundwater to Cockburn Sound, but it would take up to 50 years for the wastewater plume to reach the coast. Additionally, this rate of discharge of nitrogen would be relatively low compared to the current discharge rate by groundwater to Cockburn Sound of about 350 tonnes/year.

Other chemical constituents of environmental concern in the wastewater plume are not expected to reach Cockburn Sound at significant levels due to the effects of adsorption and biodegradation within the Superficial Aquifer.

4. Possible management measures to mitigate environmental impacts on the Spectacles wetland

The above discussion has indicated that the current MAR scheme at the Kwinana treatment plant has the potential to cause significant impacts on the aquatic ecosystem in the Spectacles wetland predominantly through the discharge of phosphorus by groundwater, and that the risk of environmental impacts due to eutrophication in this wetland would be increased by raining the wastewater recharge rate to 7.2 M/L. This wetland could also be affected by the discharge of mercury, EDCs and PFOS by groundwater, but there is currently no information about the presence of these chemical constituents in groundwater in the area.

Management measures that could be considered to deal with these environmental risks for the Spectacles wetland include:

4.1 Installation of a reactive barrier to remove phosphorus from groundwater

This management measure would maintain the benefit of increased water levels caused by groundwater mounding associated with the Kwinana treatment plant MAR scheme but would ensure that harmful levels of phosphorus and dissolved metals were not discharged by groundwater into the wetland. This could be constructed in a similar manner to the barrier at the Cape Cod site (CH2MHill, 2005) where a 15 metre wide and 1 metre thick layer of sediment was removed over a 100 metre long section of a wetland and replaced with sand containing metallic iron (Fig. 4) to remove phosphorus from groundwater discharge. Research by the US Geological Survey has indicated a 95% phosphorus removal rate through the formation of the insoluble iron phosphate mineral vivianite.

Such a barrier would need to be managed and maintained over at least the duration of the MAR scheme to protect the Spectacles wetland from phosphorus inputs.

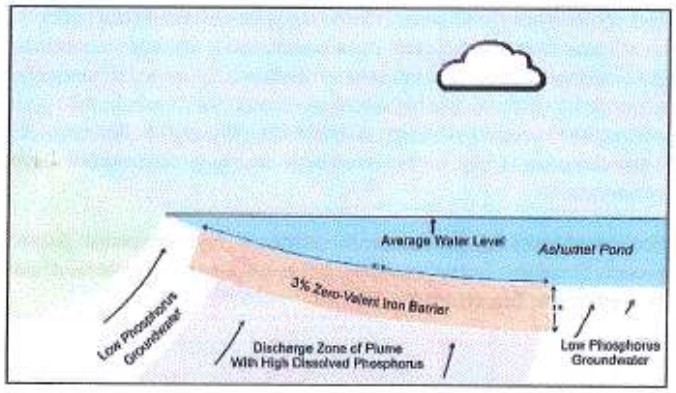

Figure 4. Removal of phosphorus from groundwater discharge to a wetland with a reactive barrier containing metallic (zero-valent) iron

4.2 Relocation of the wastewater infiltration basins

The risks of environmental impacts taking place in the Spectacles wetland could be mitigated if the location of the wastewater infiltration ponds was moved from its current location. The report by McFarlane (2015) suggested there are a number of potential infiltration sites in the region where wastewater recharge could take place without affecting sensitive water bodies. However, this would probably increase the cost of the MAR scheme as treated wastewater from the Kwinana wastewater treatment plant would have to be piped some distance to these potential infiltration sites.

4.3 Information gaps

The assessment of the potential impacts of wastewater disposal on the Spectacles wetland has been hampered by the limited amount of groundwater monitoring data that are available near the Kwinana wastewater treatment plant. There is currently insufficient information available to allow the full spatial extent of groundwater contamination associated with the MAR scheme to be determined or to allow the vertical distribution of chemical constituents in the Superficial Aquifer to be assessed. The absence of a comprehensive groundwater monitoring network such as the one that exists near Ashumet Pond in Cape Cod (refer to Fig. 2 and McCobb *et al.*, 2003) and the limited suite of chemical parameters that are monitored at the Kwinana wastewater treatment plant site also means that it is not possible to track the movement of chemical constituents in the Superficial Aquifer over time to assess their potential impacts on the Spectacle wetland.

5. Specific Issues

1. ***Investigation undertaken by the licensee or DER in relation to the classification of the premises***

   No additional reports relevant to the contamination status of the site have been received by DER since the site was classified on 11 September 2014. On 22 March 2016, a letter was sent to the Water Corporation requesting that they provide the following information by 14 April 2016:

   a) any additional reports and findings of relevant works undertaken at the site in Water Corporation's possession, or available to Water Corporation, in addition to the reports mentioned above;

   b) details of all works that are currently being undertaken on the site and off-site to investigate, assess or monitor the contamination status of the site, including the dates for the completion of current works and the expected date of submission of associated reports to DER; and

   c) a strategy or plan for the commissioning of further works on the site and off-site relevant to the investigation, assessment or monitoring of the contamination status of the site, including the proposed dates for the start and completion of further works and the submission of associated reports to DER.

   No response has been received at this time.

2. ***Classification of the premises***

   The current classification of *possibly contaminated – investigation required* is appropriate given the limited information available to DER at present. When further information is received, it will be reviewed and any implications for classification of the site will be considered.

3. ***Possible impacts on the Peel-Harvey EPP given the premises' location within the geographical boundary of the Peel-Harvey EPP.***

   As noted, the site is located within the geographical boundary of the Peel-Harvey Environmental Protection Policy (EPP). The Peel-Harvey EPP boundary is derived from an assessment of the catchment boundary for all surface drainage feeding to the Serpentine, Murray and Harvey Rivers. However, the available information about surface drainage in

the vicinity of the KWWTP indicates that its connection to the Peel-Harvey catchment varies seasonally.

The Peel Main Drain runs through The Spectacles wetland to the east of this site, and drains to the Serpentine River[1]. Although The Spectacles is a groundwater flow-through wetland, a 1997 study[2] has estimated that approximately forty-eight percent (48%) of water flowing into The Spectacles wetlands is from the Peel Main Drain, while the remainder is from groundwater. The Peel Main Drain dries out completely during the summer months, but conveys flows of up to 350 ML/day during winter events[3]. So during the winter months, any groundwater inputs to The Spectacles that originate from wastewater infiltrated at the KWWTP could be considered as inputs to the Serpentine River catchment via the Peel Main Drain.

The groundwater studies outlined in the CSIRO report indicate that a portion of the wastewater infiltrated at the KWWTP flows eastward from the infiltration ponds and reaches the western edge of The Spectacles northern lake. The most compelling evidence for this is the tracking of K:Cl ratios in groundwater bores between the KWWTP and the wetland (Figure 6.21 of the CSIRO report), and this data was used to estimate that infiltrated waste water comprises 20 -23% of the shallow groundwater near the western edge of the wetland. The groundwater data used in this assessment were obtained in April 2014, so they represent dry season conditions, when the wetland is disconnected from any surface flows to the Serpentine River catchment. Waste water inputs to the wetland are likely to be lower during the winter months due to the higher water levels in the wetland.

Overall the model of wastewater flow and hydraulic inputs/outputs for The Spectacles wetland indicates that it is unlikely that current infiltration of wastewater contributes a direct loading of nutrients into the Peel-Harvey estuary.

The CSIRO report does provide evidence for an alternative pathway for infiltrated wastewater that reaches the wetland. This pathway is operative during the summer months when evaporation causes an increase in the salinity of water within the lake. Salinity and oxygen isotope data presented in Figure 6.19 of the CSIRO report suggest that groundwater flowing out of the lake during the dryer months of the year will flow deeper into the aquifer due to an evaporation-driven increase in its density.

Is this scenario likely to change if infiltration rates increase from 4.7 to 7.2 ML/day? Yes - an increase in infiltration volumes is likely to cause an increase in water levels in The Spectacles northern lake, and therefore a greater risk that nutrients may periodically be flushed from the lake through the Peel Main Drain during winter events. The increase in the total nutrient load entering the lake from the KWWTP may also pose an increased risk to the wetland itself through the processes described below in the answer to question 4.

4. ***CSIRO study***

The focus of the research project described in the CSIRO report was to examine the benefits of managed aquifer recharge (MAR) to heavy industry in the Kwinana area, and therefore its purported benefits are predominantly economic rather than environmental. However, the report does give consideration to potential risks to the environment, and also identifies some potential environmental benefits of MAR. Contaminated Sites considers that the CSIRO report makes appropriate, qualified comment about these potential environmental benefits, but it also acknowledges the need for a considerable body of additional study in order to confirm that MAR can be appropriately managed to realise the purported benefits to the environment.

The CSIRO report acknowledges that its groundwater model, while appropriate to characterise regional scale flow and transport, did not calibrate well on a local scale. The limitations of this groundwater model mean that the CSIRO report can provide only a general approximation of the fate and transport of nutrients from the infiltrated wastewater,

and is unlikely to be able to provide a reliable estimate of total nutrient inputs to The Spectacles from the infiltrated wastewater.

In regard to the potential long term impacts of nutrient loading associated with waste water recharge at KWWTP, the information provided in the CSIRO report suggests that, under current conditions infiltration from the KWWTP contributes only a small portion of groundwater inputs to The Spectacles northern lake. However, the measurements of total phosphorus in groundwater bores between the waste water infiltration ponds and the wetland indicate that the phosphorus sorption capacity of the aquifer close to the basins has been exceeded.

It is a concern that phosphorus levels in the shallow groundwater close to the western edge of The Spectacles shows an increasing trend over time. This indicates that there is a risk that phosphorus 'breakthrough' may occur at some time in the future and phosphorus inputs to the wetland will, under that scenario, increase significantly over a very short period of time. The proposed increase in the rate of infiltration increases the risk by potentially accelerating the processes that will lead to phosphorous breakthrough and subsequently placing a greater total phosphorus load on the wetland.

A further risk associated with increased phosphorus inputs to the aquifer is the potential for naturally occurring metals and metalloids including arsenic, zinc and mercury in soil to be mobilised as it is desorbed from coatings on grain surfaces by phosphorus in the aquifer. This process has been well documented in studies of a subsurface plume of wastewater from a sewage treatment plant on Cape Cod, Massachusetts[4].

It is also noted that the CSIRO report cites environmental benefits to The Spectacles wetland by virtue of the fact that groundwater mounding beneath the KWWTP is maintaining elevated water levels in the wetland throughout the year while other wetlands in the region have experienced significant drying out. However, the study does not provide any comment on the potential for other contaminants in treated wastewater, including some known to pose a particular risk to freshwater ecosystems (e.g. endocrine disrupting compounds, pharmaceuticals and perfluorinated compounds) to impact the wetland. These potential contaminants are relevant given the significance of the Spectacles as a conservation category wetland.

5. *Additional Investigations*

Additional, more detailed, groundwater investigations are required on a local scale, with a focus on the zone between the KWWTP infiltration ponds and The Spectacles wetland. The installation and sampling of additional nested bores in this area should be undertaken to enable the development of detailed local-scale model of groundwater flow conditions, their seasonal variations, and the fate and transport of nutrients. These investigations should aim to clearly identify the extent of the zone within the aquifer in which phosphorus sorption capacity has been exceeded, and to identify the risk of phosphorous breakthrough to the wetland under various scenarios, including business as usual, and under increased infiltration rates.

A wide range of potential contaminants of concern for secondary waste water treatment effluent have not been investigated to date, and as the KWWTP is infiltrating water in close proximity to a wetland, groundwater around the KWWTP should be investigated for a broad suite of analytes in order to assess the potential risks to ecological function in The Spectacles. Relevant analytes should include a full suite of metals, endocrine disrupting compounds (EDCs), pharmaceuticals and perfluorinated alkyl substances (PFAS).

Tracer studies have the potential to clarify the question of whether treated wastewater provides a significant input to surface water in The Spectacles northern lake. The artificial sweetener sucralose has been effectively used as a means of tracking the fate of wastewater in urban environments[5], and Water Corporation has been involved in recent

collaborative studies with CSIRO on the use of sucralose as a tracer for tracking the fate of infiltrated wastewater at its Gordon Road treatment plant near Mandurah.

6. *Other Recommendations*

Any process improvements or changes to the infiltration regime that could reduce nitrogen and phosphorus inputs to the shallow aquifer should be explored and promoted through appropriate regulatory controls where possible. Appropriate concentration limits should be applied for total nitrogen and total phosphorous in treated wastewater entering the infiltration ponds. However, a more detailed understanding of the total input of infiltrated wastewater to The Spectacles wetland may be required to support the selection of concentration limits.

It is noted that existing groundwater monitoring requirements are limited to bores located within the premises boundary. A condition requiring periodic monitoring of additional groundwater 'sentinel' bores located off-site near the western edge of the Spectacles wetland would greatly improve the proponent's ability to characterise the risk of phosphorus breakthrough to the wetland, and would ensure that any adverse impacts to the wetland could be identified rapidly

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In addition to the information in the "Purpose of this report, limitations and disclaimer" section, important limitations relevant to this specific advice are detailed under "Specific limitations of this advice" below.

Specific limitations of this advice

This advice was produced assuming that the information provided in the reviewed reports is correct.

Expert's details

Personal details: Reviewer

Name	Andrew Miller
Employer	Department of Environment Regulation
Position title	Senior Manager Contaminated Sites
Classification level	SC5
Recognised field of expertise	The reviewer is recognised as an expert in Contaminated Sites by the Department of Environment Regulation

Qualifications and experience

The qualifications and experience and technical capability relevant to the provision of this advice are as follows:

Qualification

Qualification	Year obtained	Additional comments
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Professional experience

Employer	Position	Tenure
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Golder Associates	Environmental Consultant	2002 – 2005
Parsons Brinkerhoff	Environmental Consultant	1992 – 2002

Other – Publications/memberships/associations etc.

Member Australian Land and Groundwater Association

Contaminated Environments Network

Member of the technical working group for CRC Technical Report No 34: A practitioners guide for the analysis, management and remediation of LNAPL

Signatures

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Attachment 3: Existing Licence L6543/1991/11