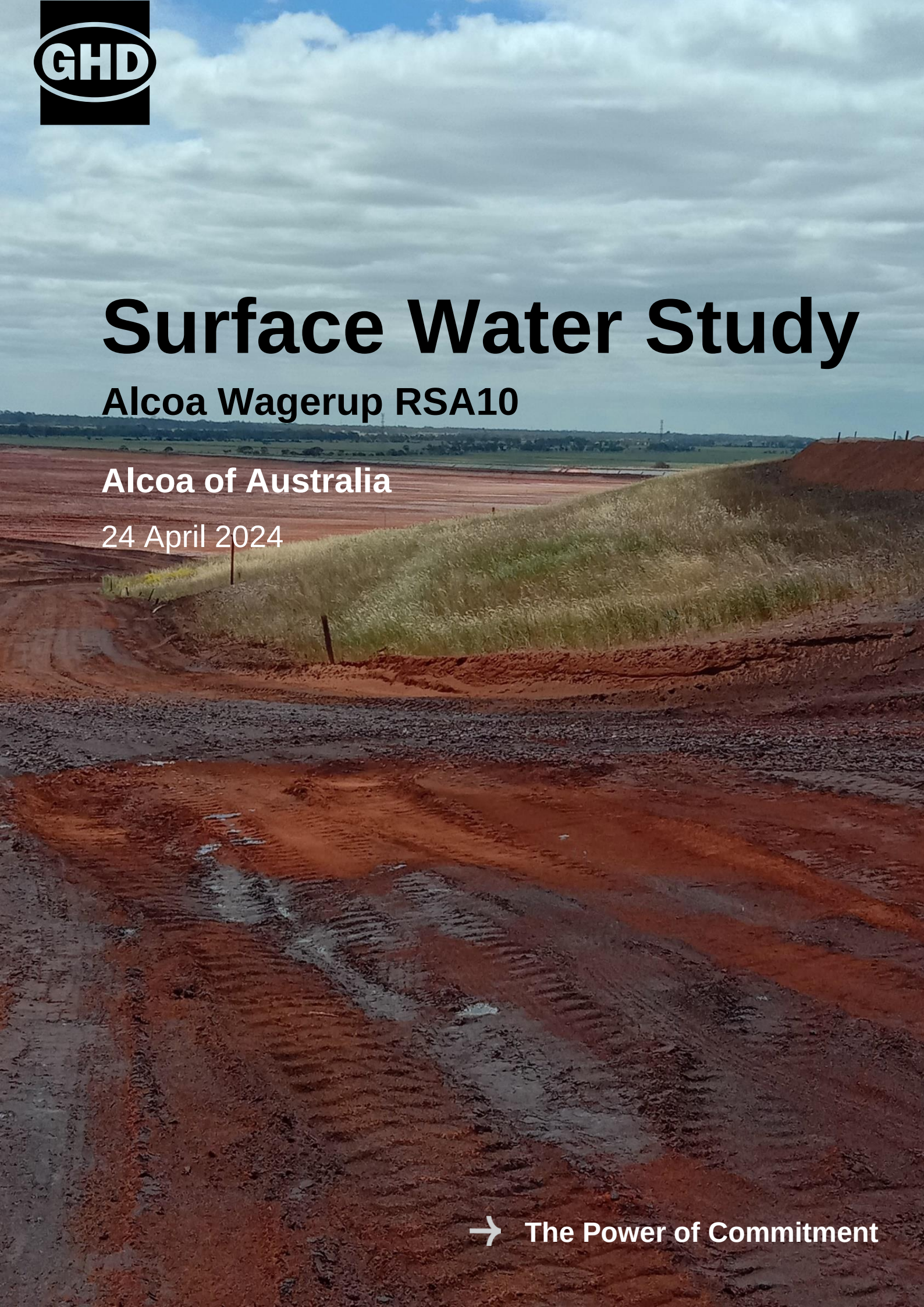

Surface Water Study

Alcoa Wagerup RSA10

Alcoa of Australia

24 April 2024

The Power of Commitment

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Executive summary

This report is subject to, and must be read in conjunction with, the limitations set out in sections 1.3 and 1.4 and the assumptions and qualifications contained throughout the Report.

Alcoa of Australia Limited (Alcoa) is proposing to construct an additional residue storage area (RSA). The original location of the RSA10 was to the south of the existing RSA's. However, in October 2023, Alcoa approached GHD to update the Surface Water Study report as the RSA10 location had been moved to the north of existing RSA areas at the Wagerup Alumina Refinery (Refinery). The proposed RSA10 facility will involve construction of a 53 ha RSA north of the existing RSA9/ROCP3 facilities, west of RSA7.

The proposed RSA10 will be constructed using clay mined from two potential borrow pits, one existing and one new, located to the north-west of Detention Pond 2.

This Surface Water Assessment (SWA) has been prepared to assess the impact of the construction and operation of the proposed RSA10 and borrow pit areas on surface waters in accordance with the inland water environmental factor.

A number of highly modified drains pass through the study area. These drains provide runoff to a range of water dependant ecosystems, supporting a range of flora and fauna. There are also defined environmental receptors, including the Harvey River and Haver Estuary.

Alcoa undertakes a surface water and groundwater monitoring program, measuring levels, flows, and water quality. Surface water quality is generally within the ANZECC and ARMCANZ (2000) range, with the exception of turbidity.

The surface water disturbance area of the proposed RSA10 and potential borrow pit locations are only a small proportion of the local contributing catchments, with similarly low impacts to the water balance. There is potential for construction and operation of the proposed RSA10 and borrow pits to increase surface water sediment and turbidity. A sediment management plan is required during the construction and rehabilitation of the infrastructure. Surface runoff from disturbed surfaces, and accumulated flows within borrow pits, should be captured, and managed using the existing Refinery runoff collection systems to mitigate any risk of environmental discharge. Ongoing maintenance of external facing batter walls will be required.

Hatch (2023) has confirmed that ASS exists in both the RSA10 and Northern Borrow pit areas. It has been assumed that any ASS materials used in RSA construction will be tested and neutralised prior to use, such that the risk of ASS runoff from outer embankments of the RSAs will be minimal. Groundwater impacts of RSA10 north construction and borrow from the existing and proposed borrow pits are yet to be formally assessed.

Exceedance of the 1 in 100-year event will result in RSA surface runoff collection and underdrainage being directed back into an existing operational water circuit via the Runoff Collection Pond. This water circuit has an emergency spillway designed in accordance with ANCOLD standards. A number of operational management processes are in place at the Refinery to maintain water levels and minimise spillway activation. Should the emergency spillway be activated in an event exceeding the 1 in 100-year event (Wet Winter), release of water is via controlled discharge onto Alcoa held farmland. Potential overflow from the spillway will allow for controlled release of alkaline process water, which will be diluted by large volume of flood water in the farmlands adjacent the existing residue storage area.

Characterisation of local ecological values was based on several surveys that have been completed across the study area, and it is recommended that a reconnaissance survey be completed to verify the values of areas that may be impacted by the proposed disturbances including the identified ecological corridors and linear riparian vegetation (Black Tom Brook). Monitoring of surface water systems should continue with additional flow monitoring recommended for Black Tom Brook.

It is recommended that a groundwater study be undertaken to assess the short term (during construction) and long term (post-construction) impacts of RSA10 and the Northern Borrow Pits to groundwater levels, groundwater and surface water flows and existing ASS in the area. The Groundwater Study should be informed by additional groundwater and ASS data from the Northern Borrow Pit areas and written to complement this Surface Water

Study. This Surface Water Study should be reviewed upon completion of the groundwater study to ensure that the assumptions, conclusions, and recommendations remain valid.

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Appendix G	Disturbance Areas

1. Introduction

1.1 Project description

1.1.1 Project background

Alcoa of Australia Limited (Alcoa) is proposing to construct an additional residue storage area (RSA) to the north of existing RSA areas at the Wagerup Alumina Refinery (Refinery). The proposed RSA10 facility will involve construction of a 53ha RSA north of the existing RSA9/ROCP3 facilities, west of the existing RSA7, the expansion of an existing borrow pit and the potential excavation of a new proposed borrow pit.

The study area, including the Refinery, proposed RSA10 and borrow pit disturbance areas and surrounding farmlands, is located 120 km south of the Perth metropolitan area, 2 km north of Yarloop and 7.5 km south of Waroona. The location of the proposed RSA10 and both the existing and proposed Northern Clay Borrow Pit disturbance areas are presented in Figure 1.

RSA10 will be constructed using clay mined from within the RSA 10 footprint as well as proposed borrow pit areas located to the north-east of the existing RSA areas. The proposed borrow pit areas are referred to as the Northern Clay Borrow Pit area. The area contains an existing borrow pit and a proposed borrow pit on its western side (Rockwater, 2023), refer Figure 1. It is most likely that all clay required for the RSA build will be derived from a combination of the existing borrow pit and from within the RSA10 footprint.

The requirement for a new proposed borrow pit to the west of the existing borrow pit (Figure 1) will depend on the final RSA10 design floor levels. The volume of additional borrow material required is sensitive to the RSA floor level design and hence the quantity of material able to be excavated from within the RSA10 footprint. Additional ground investigations and design optimisation is currently underway to determine the preferred sources of RSA10 construction materials (i.e., cut to fill within the RSA10 footprint, borrow from existing borrow pit and/or borrow from proposed new borrow pit). As such, detailed information about the proposed borrow pit excavation depths for existing and proposed borrow pits are not available at this time.

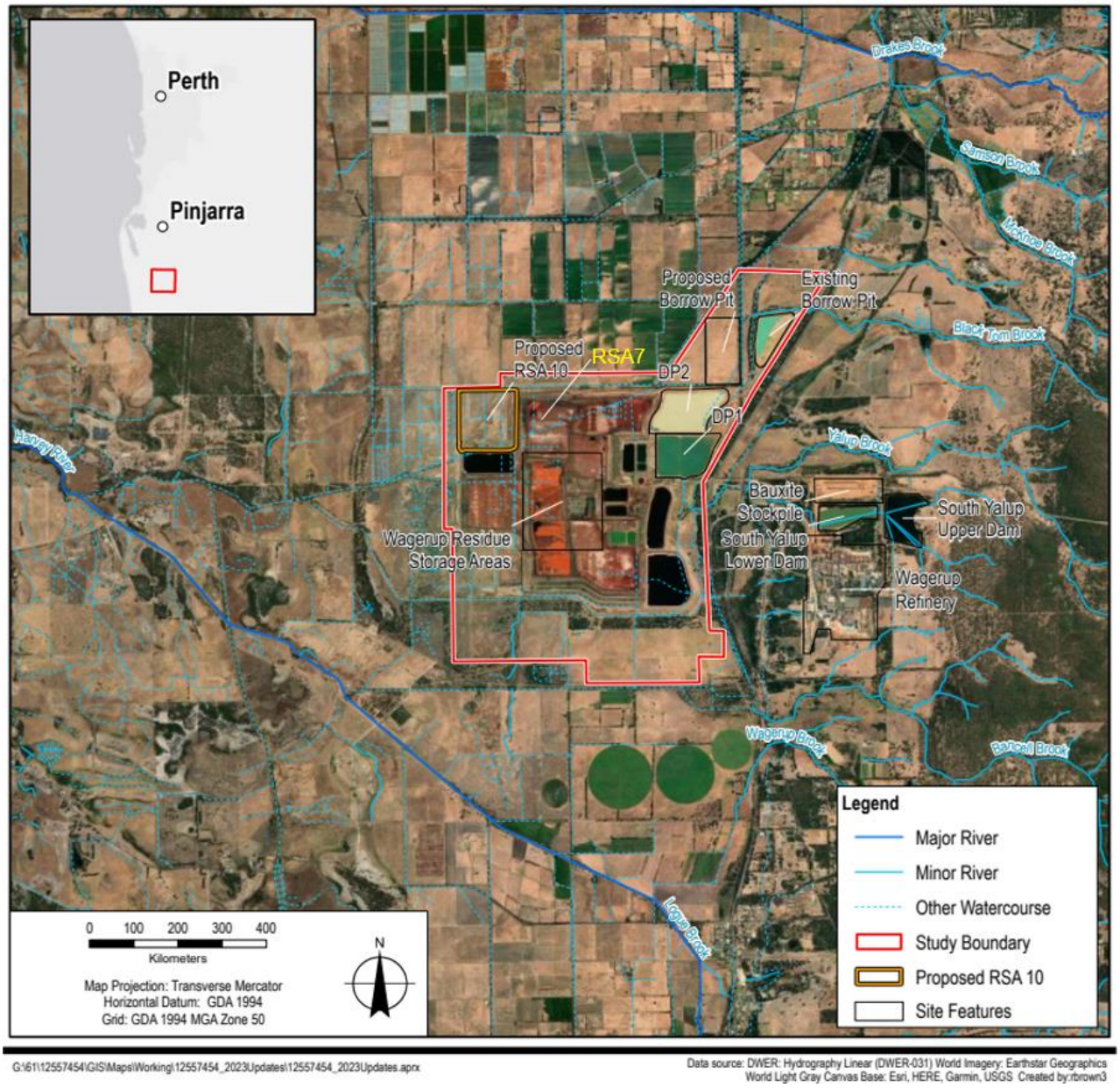

Figure 1 *Study area location including the proposed north RSA10, and potential borrow pit locations*

1.1.2 Construction and operation

The Northern Clay Borrow Pit area is in concept design phase. The current concept design of the proposed RSA10 is presented in Appendix B. Existing understanding of the concept design and construction requirements for potential disturbance areas is summarised in Table 1.

The concept designs for both RSA10 and Northern Clay Borrow Pit area are being refined with final designs to be used to inform a Licence Amendment under Part V of the EP Act. The design of RSA10 will be in accordance with the Australian National Committee on Large Dams (ANCOLD) Standards.

Table 1 *Understanding of potential disturbance areas*

Potential disturbance area	Existing understanding of concept design and construction requirements
RSA10 area	RSA10 proposed to be built to the north of the existing RSA9 and ROCP3, west of RSA 7 and south of the Samson South drain.
	Concept design drawings WG-RES-10-100020, WG-RES-10-10021, WG-RES-10-10030, and WG-RES – 10-10031 indicates the RSA10 will include the following key features:

Potential disturbance area	Existing understanding of concept design and construction requirements
	– New clay liner (minimum thickness of 500 mm on walls, create and floor) that ties into existing RSA7 and ROCP 3 clay liner. – The new clay liner will be overlain by a new 1.5mm HDPE liner that ties into the existing RSA9 HDPE liner and extends across the RSA10 floor to the top of the external batter wall. – 1m (floor) and 750 mm (walls and crest) residue sand layer overlying the HDPE liner. – Placement of topsoil on the external batter at 1:4 slope (north & west).
	Construction dewatering requirements and modelling are yet to be determined for the northern RSA10 location as floor levels are yet to be confirmed and groundwater levels within the footprint are still being investigated. However, based on preliminary water level data and concept designs, dewatering may not be required or at least be much less than those modelled for the former southern RSA10 location as modelled by Advisian (Advisian 2021). Given the presence of ASS in the area, dewatering volumes and impacts will be minimised as far as practicable. If dewatering occurs, dewater will not be discharged, but re-used within the refinery water circuit. It is assumed for the purposes of this study that estimates of any dewatering impacts to surface water will be assessed at a later date and will be managed via dewatering management plans. Excess water will be managed via existing Refinery water circuits. It is assumed that any ASS materials excavated from the RSA10 area and used in construction will be appropriately assessed, neutralised (if required) and validated prior to use in construction of RSA10.
Northern Clay Borrow Pit area	An existing clay borrow pit is located to the east-northeast of the proposed RSA10 area. An additional proposed borrow pit to the west may be required to obtain required volume of clay to construct RSA10 however it is most likely that all clay required for the RSA build will be derived from the existing borrow pit and from within the RSA10 footprint. An expanded existing borrow pit and new would remain separated from the Black Tom Brook and diversion channels and are not expected to have any significant direct impact on surface water flows, other than losses to the pit via seepage through the clayey Guildford formation. Alcoa have advised they currently extract surface and groundwater from this borrow pit as part of their license.
	Preliminary modelling of dewatering of the northern borrow pit and a potential expansion area was simulated over a 30-month period by Advisian (2021), primarily for the purpose of estimating likely maximum water abstraction volumes and flow rates. Key findings include: – Estimated dewatering volume ranging from 2.7 GL for the existing borrow pit to 3.1 GL for concurrent dewatering of the existing borrow pit and proposed expansion area for maximum rainfall scenario. – Additional 880 ML required to dewater standing water in borrow pit. – Preliminary modelling showed large seasonal variation in dewatering volumes indicating potential for seasonal groundwater inflows to the borrow pit. The Advisian (2021) assessment did not assess the drawdown impacts of the existing or proposed borrow pits, and the proposed borrow pit assessed was in a different location to the one currently preferred (north of the existing pit, as opposed to west of the existing pit). The assessment did not consider drawdown impacts from dewatering or potential ASS impacts. Alcoa has advised these issues will be assess in future studies, and as part of environmental management plans. It is assumed that any ASS materials excavated from the Northen Borrow Pit area and used in construction will be appropriately assessed, neutralised (if required) and validated prior to use in construction of RSA10.
	Alcoa's preferred option for expansion of the Northern Clay borrow pit area is initially for further extraction from the existing Northern Clay borrow pit to obtain the available clay resource. If required, the excavation of a separate proposed pit to the west of the existing Black Tom Brook channel would achieve the balance of the clay volume required.
Other disturbance areas	The plan view of the proposed disturbance areas is provided in Appendix G. The disturbance activities for other areas are mentioned below: – Area 2 is proposed for external embankments located adjacent to the west of RSA10. During Phase 1, this area will be draining to SUMP1 and surface water within SUMP1 will be pumped to DP2. During Phase 2, the surface water from Area2 will be directly discharging to ROCP3.

Potential disturbance area	Existing understanding of concept design and construction requirements
	– Area 4 is located to the south-west of RSA10 and proposed for contractor's car park/project office area with sealed roads. – Area 5 is located immediately north of RSA7 and RSA8. It includes existing Kubank Road, Farmlands and Adjacent Haul Roads. It will drain to SUMP3 (adjacent to the west), and its surface water will be pumped to DP2 during construction phase. The existing irrigation drain to the east will be realigned along the norther border of Area 5 and connected back to the existing drain to the west. – Area 6 and Area 8 are located to the north of RSA8 and DP2, respectively, and represent existing Haul Roads. Area 6 will be draining to SUMP4 to the west which will be pumped to DP2 during construction phase. Whereas Area 8 will directly be reporting to DP2. – Area 7 and Area 9 are proposed to be to the west of ROCP3. They are park-up areas separated by a triple lined intercept sump. They will be drained to SUMP2 and SUMP5, respectively, both sumps will be connected to ROCP3 via the triple lined intercept drain during the construction phase. Alcoa has advised that post construction, after regrowth and water quality is proven, Areas 2, 5, 6 and 9 will be allowed to flow through the farmlands as prior to construction. The anticipated impact on these areas is for the 3-year construction period only. The groundwater drawdown disturbance area associated with the existing and proposed Northern Borrow Pits is not known at this time.

1.2 Purpose and scope of this report

This Surface Water Assessment (SWA) has been prepared to assess the impact of the construction and operation of the proposed RSA10 (north) and borrow pit areas on surface waters in accordance with the inland water environmental factor.

The SWA included the following scope of work:

- Assess the impact of the project in accordance with Inland Waters environmental factor.
- Characterise the surface water systems in a local and regional context and describe discharge mechanisms, surface water/groundwater interaction and water chemistry. This should include identifying and mapping surface water dependent ecosystems.
- If required, undertake surveys to establish baseline water quality and the environmental values identified.
- Analyse, describe and assess surface water impacts, including direct and indirect impacts, from the scope of work. This should include, but not limited to:
    - Changes to surface water flows associated with the concept design construction footprints for RSA10 and Northern Clay borrow pit.
    - Changes to water quality
    - The nature, extent, and duration of impacts; and
    - Impacts on environmental values of surface water dependent ecosystems.
- Demonstrate how surveys are relevant, representative, and consistent with current EPA guidance. Where surveys have not been undertaken consistent with the EPA guidance, provide a justification for any variation.
- Identify the surface water impact of the 33 Ha Proposed Borrow pit directly to the west of the existing pit (Figure 1).
- Detail impacts associated with dewatering from the North Borrow Pit and impacts to nearby stream flows.
- Provide advice if a Bed and Banks permit is required.

1.3 Limitations

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

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

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

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

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in section 1.4 report. GHD disclaims liability arising from any of the assumptions being incorrect.

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

1.4 Assumptions

GHD made the following assumptions in the preparation of this report:

– Verbal and written information from Alcoa regarding the status of RSA10 investigations and designs is correct at the time of writing.
– Current Refinery environmental management practices and systems will be operational and available to manage any excess surface water and groundwater generated as a result of construction activities.
– The Department of Water and Environmental Regulation (DWER) hydrological catchments were used in the absence of updated topographic data,
– Contribution of disturbance areas to annual flows was assumed proportionate to the catchment area of the disturbance areas, and
– Construction footprints were derived from concept boundaries provided by Alcoa.

2. Local setting

2.1 Climate

The Wagerup Alumina Refinery is located in a Mediterranean climatic region characterised by hot dry summers and cool wet winters. The nearest Bureau of Meteorology (BoM) weather station with current rainfall and temperature data is Dwellingup (Station No. 9538) located approximately 30 km from Wagerup. The Dwellingup weather station records the highest mean maximum monthly temperature (29.7°C) in January (lowest in July, 15.1°C) and the lowest minimum mean monthly temperature (5.5°C) in July (highest in January, 14.3°C) (BoM 2020). Average annual rainfall for the period 1981-2020 is 1,152 mm.

Alcoa has a weather station installed to the east of the Wagerup Alumina Refinery, with data collected since 1981, (no data collected in 1985 and 1998, and incomplete records in 1984, 1986, 1987 and 1999). Figure 3 shows average monthly rainfall from 1981 to 2020. Average annual rainfall (excluding years with significant data gaps) is 841 mm with June and July recording the highest monthly average rainfall (159 and 156 mm respectively).

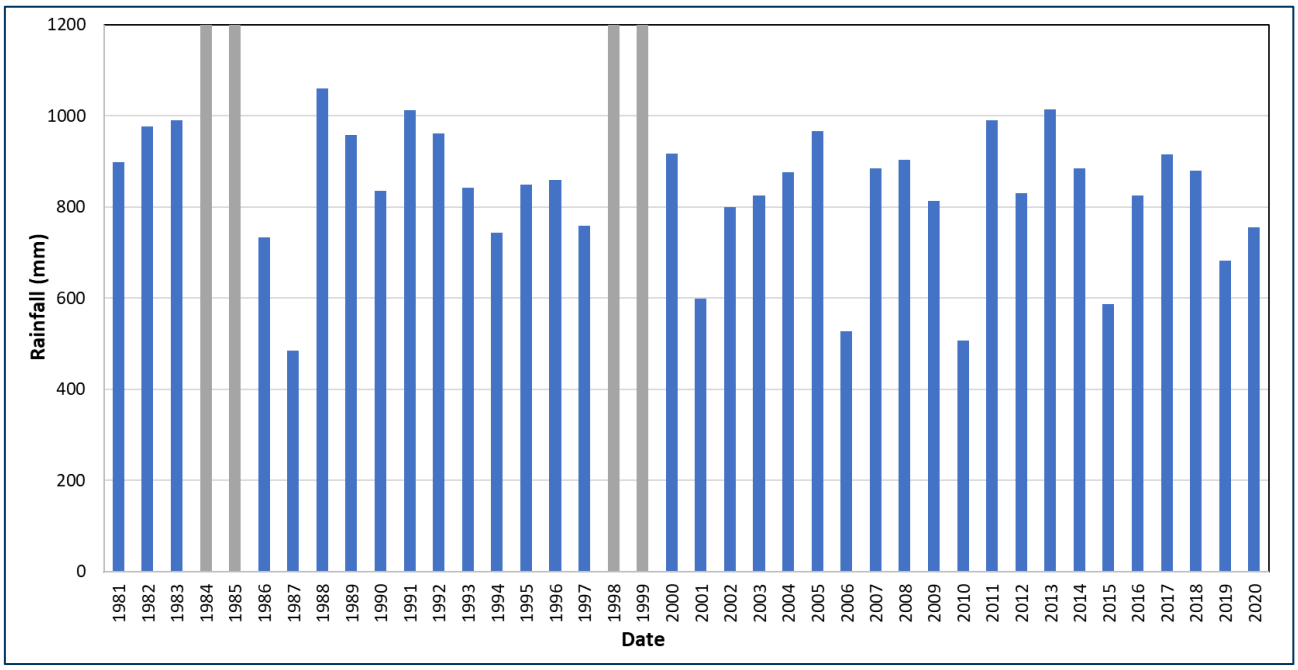

Figure 2 *Annual rainfall (1981-2020, greyed out years have significant data gaps)*

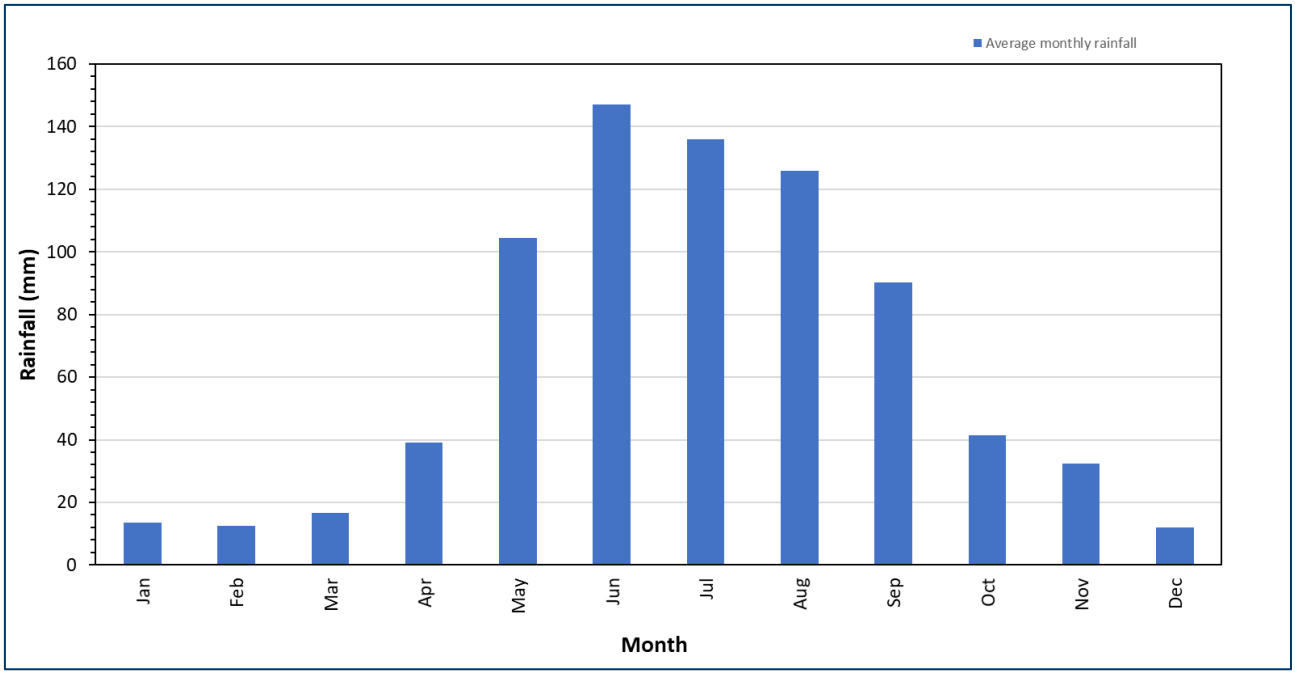

Figure 3 *Average monthly rainfall (1981-2020)*

The mean annual pan evaporation at the Refinery weather station is 1,841 mm with monthly pan evaporation rates ranging between 55 mm (July) and 273 mm (December and January) (Peter Clifton and Associates, 2015).

2.2 Topography and landforms

The study area is predominantly flat and low lying. The topography grades gently to the west from approximately 40-50 mAHD in proximity to the Wagerup Refinery to between 15 mAHD and 20 mAHD near the existing RSAs.

2.3 Geology and soils

Based on published 1:50,000 geology mapping (DMIRS 2021), the existing RSAs and those parts of the study area proposed for the RSA10 and two potential borrow pit areas are located on one geological unit:

– Ms2 – Sandy Silt: strong brown to mid-grey mottled blocky disseminated fine sand of alluvial origin.

The area immediately to the east of the existing residue storage areas and proposed RSA10 and borrow pits comprises the following geological unit:

– S12 – Sand: structureless yellow fine-grained subangular and medium to coarse-grained subrounded to rounded quartz feldspar and heavy minerals common to minor silt and clay.

Alcoa (2020) note that the existing residue storage areas are underlain by a sand underdrain and clay liners, with the Wagerup Refinery underlain by cut and fill.

The soils of the Yoganup Formation beneath the Refinery and Northern Borrow Pit area are sandy. Below the existing residue areas, the lower permeability clays and sandy soils of the Guildford Formation typically limit surface water infiltration to the superficial groundwater (Alcoa 2020). In this area the Guildford Formation is underlain by the sands and clayey sands of the Ascot and Yoganup formation. A conceptual stratigraphic cross-section of local geology is presented in Figure 4. Note that Figure 4 represents a cross section approximately 1600 m south of the centre of the proposed RSA10 site.

The study area is mapped as ‘moderate to low risk’ of Acid Sulphate Soils (ASS) occurring within 3m of natural soil surface but ‘high to moderate’ risk of ASS beyond 3m of natural soil surface (DWER-055) (see Figure 5). Generally, the site investigation completed by Hatch Engineering (Hatch) (Hatch, 2023) within areas proposed to be disturbed including the proposed RSA10 North (RSA10N) site and proposed/ existing borrow areas. Soils laboratory data exceeded the adopted ASS assessment criteria within shallow surface soils and at depth within the

RSA10N area and intermittently within the existing borrow pit at depth (maximum assessed depth 3 m below existing ground level). Alcoa have advised additional groundwater and ASS investigations are proposed for 2024 to inform approvals and management plans.

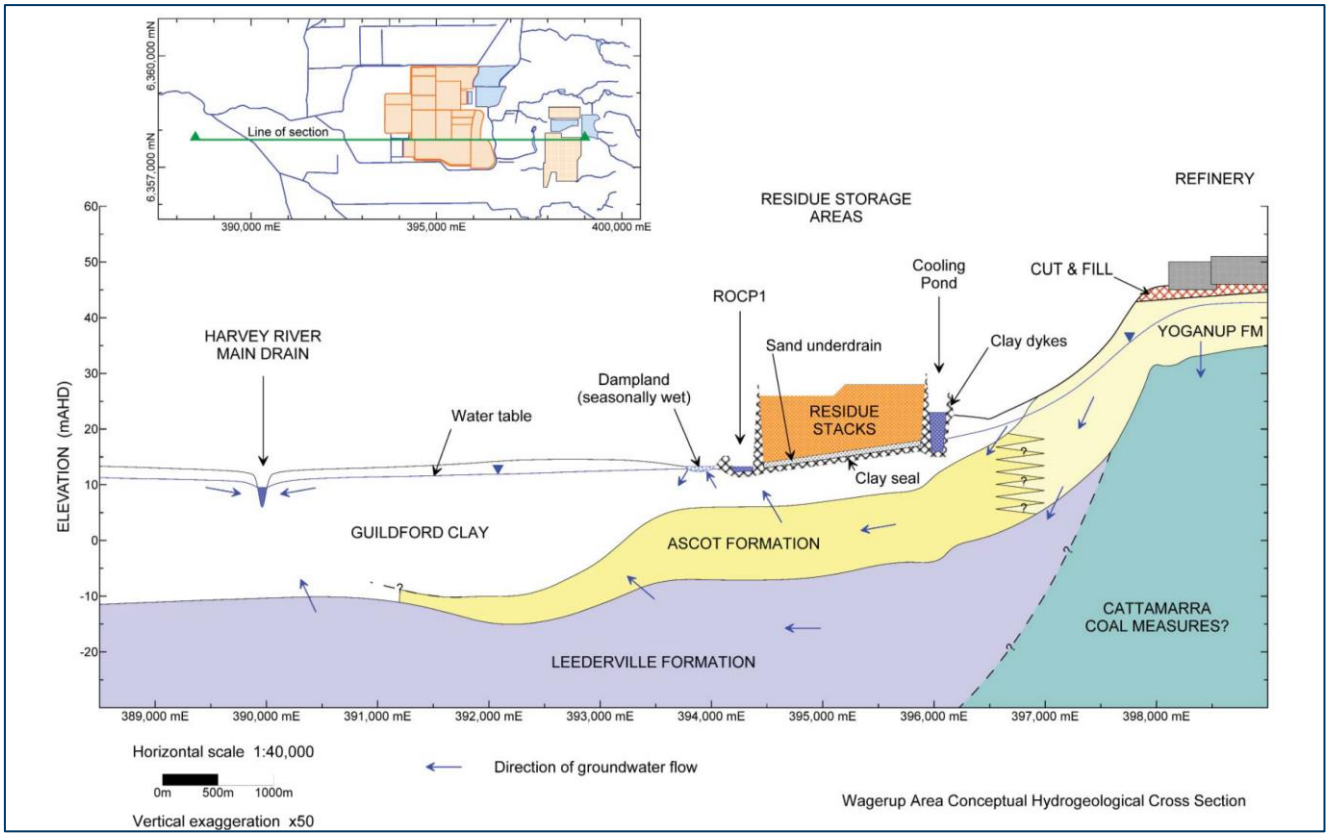

Figure 4 ***Conceptual stratigraphic cross-section (Alcoa 2020)***

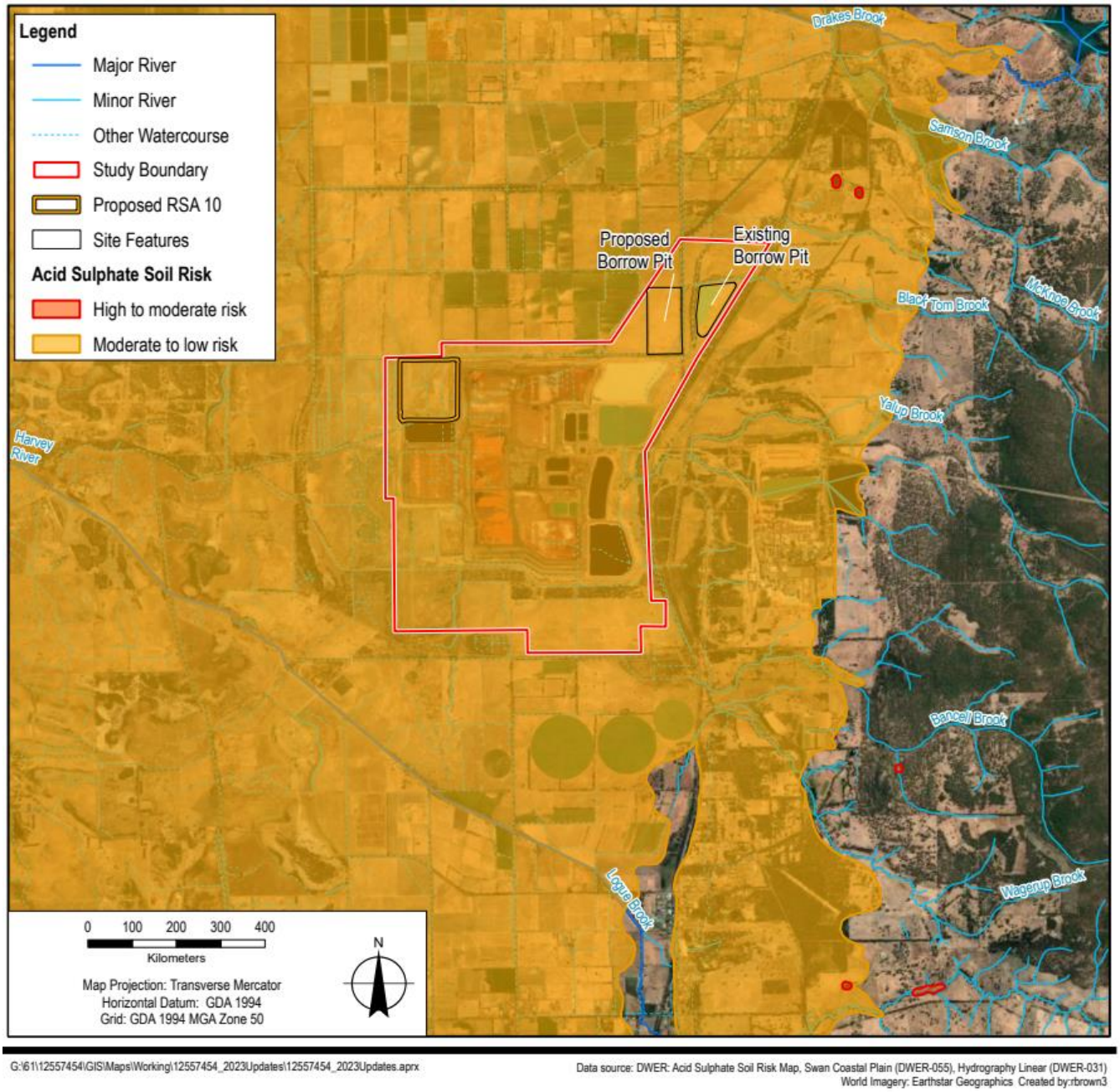

Figure 5 Acid sulphate soil risk within 3m of ground surface

2.4 Surface water drainage

2.4.1 Catchments and drainage

The study area is located in the lower Harvey River catchment (408 km^2), which is located within the larger Harvey River basin (1,921 km^2). The Harvey River Main Drain lies approximately 4 km to the west of the current RSAs and flows in a north-westerly direction discharging into the Harvey Estuary.

Existing drainage within the area has been significantly modified. Agricultural drains were constructed to drain low-lying farmlands of the coastal plain section that were winter water-logged, and modified sections of rivers and brooks have been renamed as drains. Surface water systems in the study area are also highly regulated, with some of the upland forested streams dammed for water supply, as well as diversion of flows from some catchments for district irrigation schemes.

Key tributary catchments of the Harvey River Main Drain that intersect the study area and that may be impacted by the construction, operation and management activities associated with the RSA10 and potential borrow pits include Samson Brook South Drain, Samson South Diversion Drain and Black Tom Brook catchments (see Figure 1).

The proposed RSA10 is located immediately west of the existing RSA7 area (see Figure 1). Under current conditions surface water drainage is directed around the existing residue storage area by the Samson Brook South Drain to the north and the Samson South Diversion Drain to the east and south. The existing Samson South Diversion Drain (SSDD) bypasses to the north of the proposed new RSA10, however it traverses to the south of the proposed RSA10 topsoil stockpile area which is located to the north of existing Haul Road and Kubank Rd. This is defined as Area 5 by the project. All construction site drainage from Area 5 will report to the new surface water collection Sump #3 and will be temporary pumped to DP 2. Flows from this area currently enter the farmlands irrigation channels north of Kubank Rd and no flows enter the South Samson Diversion Drain (SSDD) directly at this location.

The existing Northern Clay borrow pit is bounded to the north by the natural channel of the Black Tom Brook, and to the west by the South Samson Diversion Drain. The South Samson Diversion Drain flows into Detention Pond 1(PD1), which acts as a freshwater storage to meet the Wagerup Alumina Refinery process make-up water. Overflows from Detention Pond 1 are diverted around the southern side of the residue area and join the Samson Brook South Drain prior to entering the Harvey River Main Drain (see Figure 6).

A summary of the key characteristics of these tributary catchments is provided in Table 2, and their location is shown in Figure 7. In the absence of updated LIDAR for the study area, DWER hydrographic sub-catchment boundaries (DWER-030) were considered acceptable for defining local catchments. However, the following sub-catchment boundaries were modified as follows:

– The existing RSA catchment (closed system) was modified to include RSA7, RSA8 and RSA9.
– Modification of the Samson Brook South Drain sub-catchment boundary north corresponding with its rerouting to accommodate the RSA expansion.
– Inclusion of Detention Pond 1 in the Samson South Sub Drain catchment.

Table 2 Catchment characteristics

Catchment name	Key characteristics
Samson Brook South Drain (SBSD)	– Flows from upper catchment controlled by the Harvey Water Cooperative at the Samson Brook gates – Samson Brook South Drain diverts flows along the northern boundary of the RSA area. – DWER hydrographic sub-catchment boundary (DWER-030) was modified to exclude the 'closed' RSA catchment area.
Samson South Diversion Drain (SSDD)	– Diversion Drain constructed by Alcoa to transfer flows from the intercepted Black Tom Brook catchment, as well as flows from the regulated Yalup Brook North and South, and purchased flows from the Harvey Water irrigation cooperative.
Black Tom Brook	– Majority of the catchment is within State Forest, with the natural stream channel forming the northern boundary of the existing Northern Clay borrow pit. – Black Tom Brook is intercepted at the confluence with the South Samson Diversion Drain. – Catchment area is considered to include the contributing areas downstream of the confluence of Black Tom Brook and the South Samson Diversion Drain into Detention Pond 1.

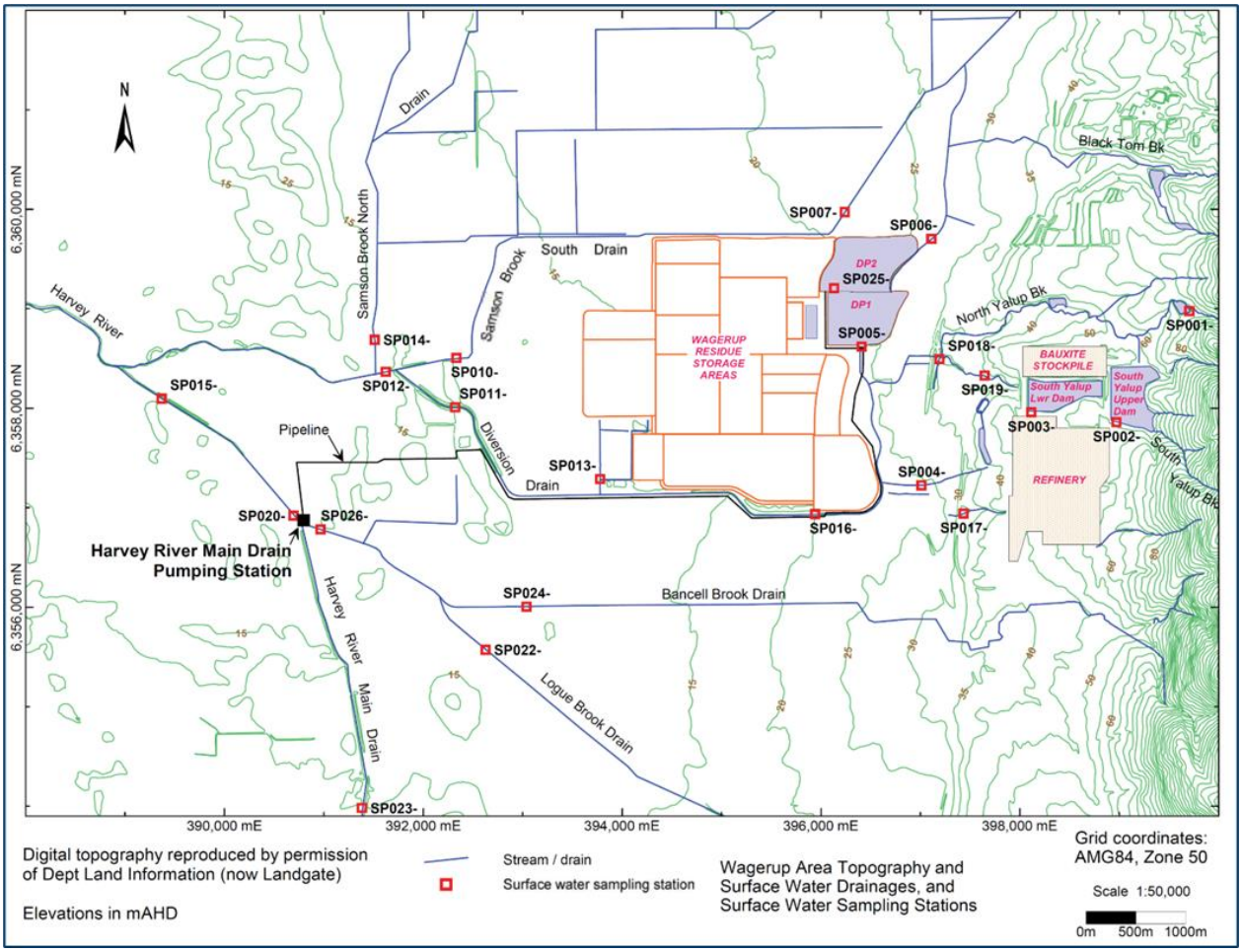

Figure 6 ***Map indicating Black Tom Brook, Samson Brook South Drain and Diversion Drain***

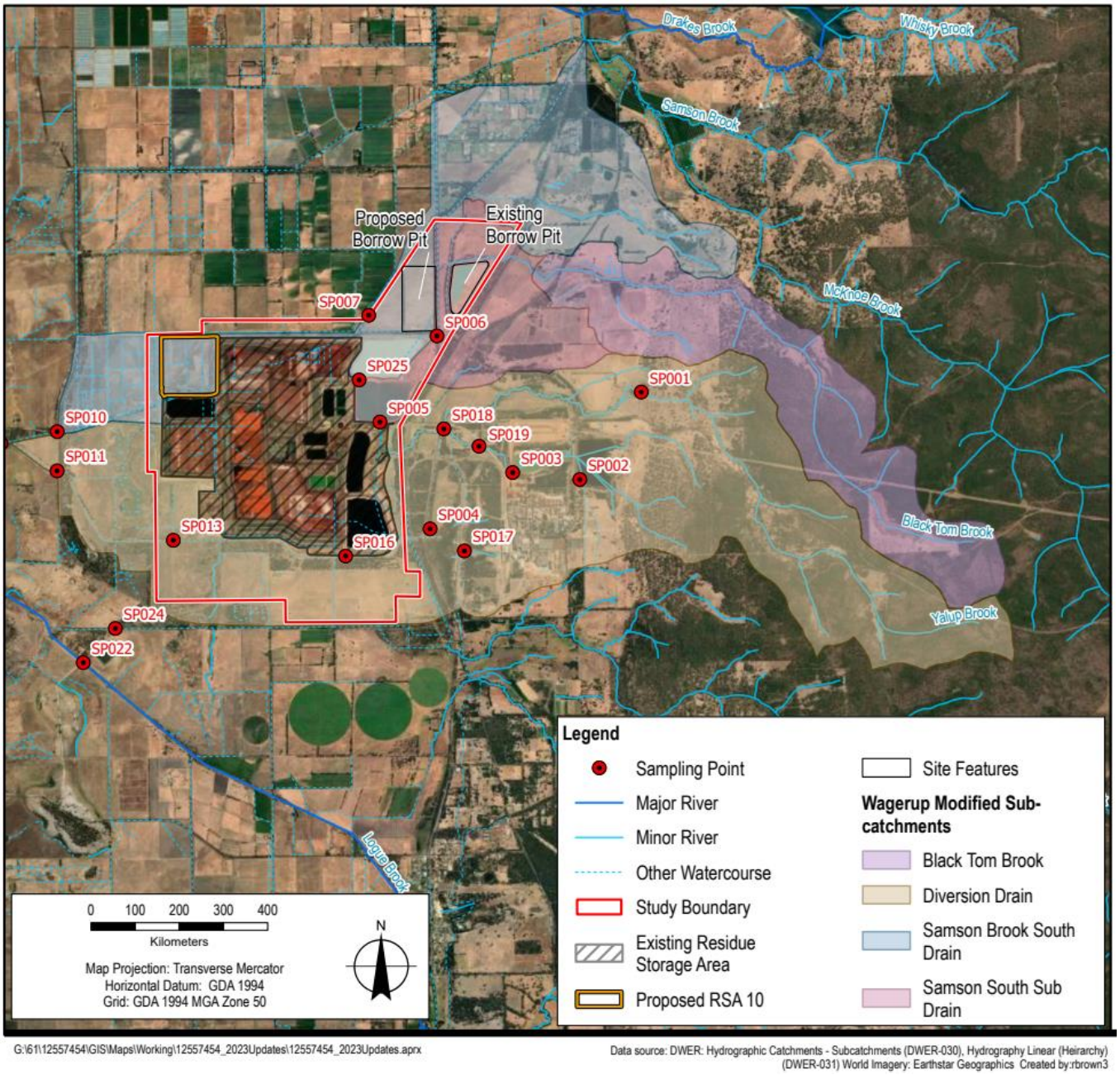

Figure 7 Key tributary catchments within the study area

Photo 1: Proposed RSA10 location, looking south towards existing ROCP3 and RSA9 (June 2023)

Photo 2: Proposed RSA10 location, taken in a south-west direction across the site, showing existing road, ROCP3 and RSA9 (June 2023)

Photo 3: Confluence of the natural channel of Black Tom Brook with the South Samson Diversion Drain (November 2021)

Photo 4: South Samson Diversion Drain looking south from confluence with Black Tom Brook (November 2021)

2.4.2 Surface water licences

The Alcoa Wagerup Alumina Refinery is dependent on surface water sources to provide process make-up water. Alcoa is licensed under the Rights in Water and Irrigation Act (1914) to divert water from the Harvey River Main Drain, North and South Yalup Brook and the South Samson Diversion Drain (including Black Tom Brook) for storage and use by the refinery. A summary of the current surface water licences for the Wagerup Alumina Refinery is provided in Table 3.

Table 3 Alcoa Wagerup Alumina Refinery licensed surface water volumes

Source	Licence Number	Licensed Amount (ML/a)
North and South Yalup Brooks	SWL 97472	1,600
South Samson Diversion Drain (includes Black Tom Brook)	SWL 99246	2,500
Harvey River Main Drain	SWL 151027	4,400

2.4.3 Surface water management areas

The study area is located within the Peel Inlet for the Harvey Estuary Environmental Protection Policy (1992) area, the purpose of which is to protect the Peel-Harvey estuarine system, maintain environmental quality objectives and to prevent environmental damage, primarily from nutrient pollution.

The Peel Inlet Management Area, a gazetted Waterways Conservation Act management area (DWER-072) occurs along the western boundary of Somers Road, approximately 1.3 km west of the existing RSA9 area and proposed RSA10 footprint (see Figure 9).

Flow in the Samson Brook South Drain is proclaimed under the Rights in Water and Irrigation Act 914 as part of the Waroona Irrigation District.

2.5 Groundwater

The study area is located in the Murray Groundwater Area (Figure 9), which is proclaimed groundwater area under the Rights in Water and Irrigation Act 1914.

Streamtec (2008) note that local groundwater discharge to surface water occurs in proximity to and immediately west of the existing residue storage area.

Advisian (2021) completed a preliminary groundwater assessment for the proposed construction of the RSA10, with key trends in groundwater across the study area including:

– The groundwater gradient flow is from east to west in the Superficial aquifer.
– Groundwater across the study area is strongly seasonal, rising in the winter months and falling during summer.
– Increased groundwater elevation in aquifers further west across the site which is attributed to increased thickness of confining clays.

GHD work in 2023 (GHD 2023a and GHD 2023b) confirmed that the surface drains in farmland surrounding the RSAs and the proposed Northern Borrow Pit area commonly receive seepage from superficial groundwater, particularly in winter and spring. Groundwater from the local area form part of the baseflow in these drains, and the drains in turn limit local recharge and the groundwater rise by conveying winter rainfall away from the area. GHD work also confirmed that water moves vertically between the aquifers, with upflow from the deeper and more permeable Ascot / Yoganup formations occurring, particularly where drains and excavations lower groundwater levels in the overlying Guildford formation. This upflow varies is seasonally based on the varying pressure differences between the upper and lower superficial aquifer units.

2.5.1 Survey of groundwater bores, water levels, geometry, and levels of nearby surface water drains

A GHD survey of groundwater bores, water levels as well as the geometry and levels of nearby surface water drains was done on the Wagerup site to study the surface water/groundwater interaction as part of the DSI works (2022/23). The IIuka bore downhole camera survey and groundwater level gauging event, undertaken by GHD in September 2023 was done in addition, because the screen depth of some wells were not known (refer GHD 2023a). Interpretation of the data confirmed the bulk of the area around RSA10 likely behaves in much the same way as the DSI study area around ROCP1 i.e., the surface water drains are likely losing streams in early winter and gaining streams in later winter/spring when the GWLs rise (refer to the Groundwater Modelling Report (GHD, 2023b)). The report concluded that the SW drains are there for two reasons:

1. to intercept high groundwater in the farming areas and keep the paddocks trafficable, and
2. to convey surface water and intercepted groundwater to the river.

The report also confirmed there are no groundwater well sufficiently proximal to the existing and proposed Northern Borrow Pit area to allow a meaningful assessment of groundwater impacts in the area.

2.5.2 Groundwater regime at the Northern Borrow Pit area

The Advisian (2021) groundwater assessment did not assess the drawdown impacts of the existing or proposed borrow pits, and the proposed borrow pit assessed was in a different location to the one currently preferred (north of the existing pit, as opposed to west of the existing pit). This was likely due to a lack of data in the area and the high-level nature of the assessment.

GHD's assessment of the groundwater environment at the northern borrow pit, based on the limited available information, is described below.

The existing borrow pit (and potentially the proposed borrow pit) represents a groundwater sink. Historical aerial photography and Alcoa observations confirm that the pit contains water all year around, with water levels around

20mAHD despite annual net evaporation (pan evaporation minus direct rainfall) being over 800mm per year and Alcoa pumping from the pit. GHD's estimated natural groundwater levels in the existing borrow pit are 25 to 28 mAHD (based on Alcoa groundwater monitoring reported in Rockwater, 2021), indicating the existing borrow pit has locally lowered groundwater levels 5 to 8 m. The lateral extent of the drawdown is unknown as there are no sufficiently proximal groundwater monitoring wells. The estimated drawdown in illustrated in Figure 8.

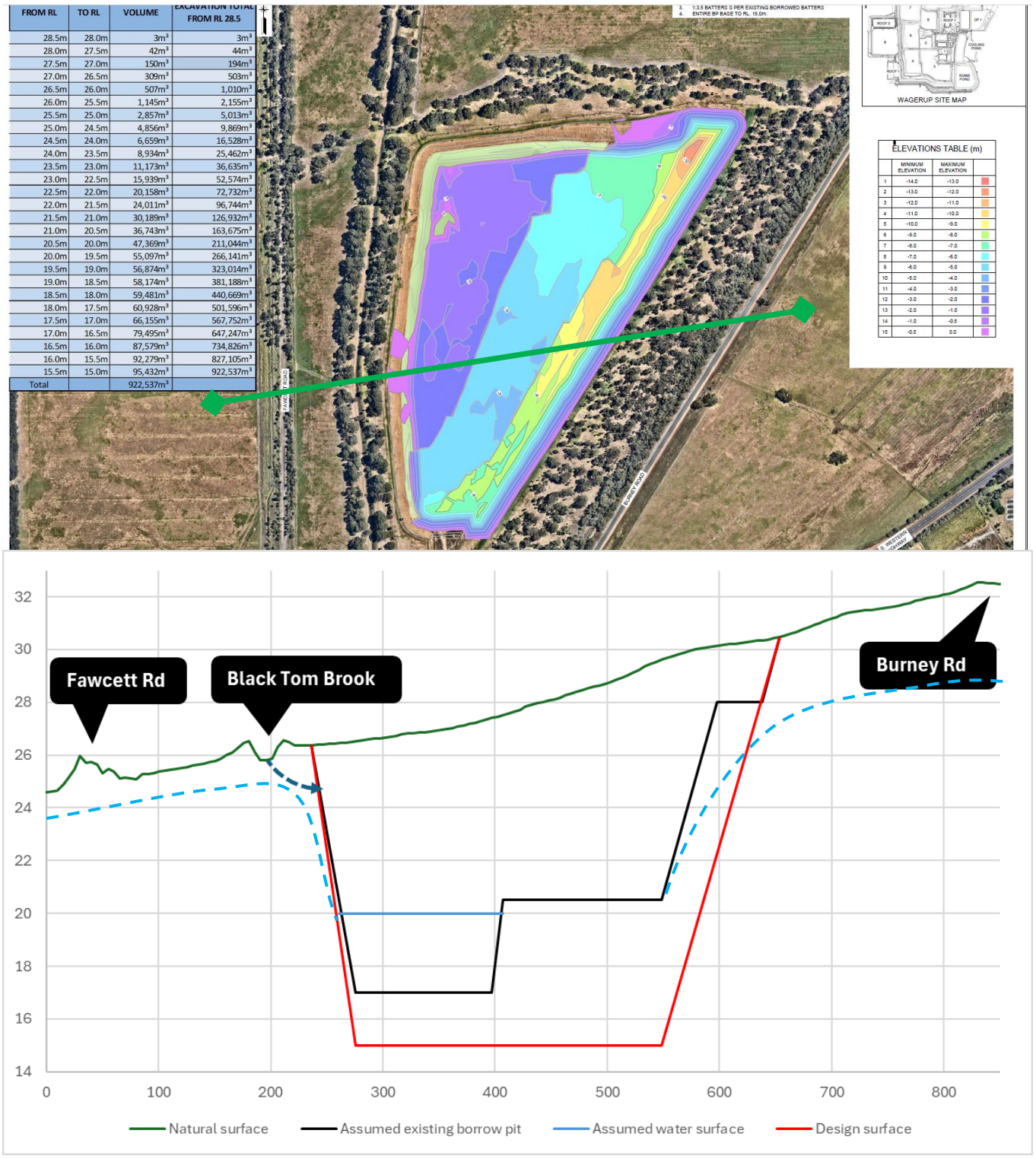

Figure 8 ***Existing Northern Borrow pit base elevations (top) and GHD estimated cross section and groundwater drawdown (bottom)***

In this instance, the existing borrow pit and proposed borrow pit are both located within an area characterised as containing reduced inorganic sulfur (i.e., potential acid sulfate soils or PASS) within soils potentially to be exposed to air on a long-term basis, and hence has the potential be creating actual acid sulfate soil (AASS) based on the Hatch (2023) investigation.

The above issue regarding the local lowering of the water table was discussed at a Wagerup contamination workshop (GHD, 2022 - refer page 23 – Data Gap 10). It is also covered by Water Quality Protection Note (WQPN) #15 (DWER, 2021) 'Basic raw materials extraction'. WQPN documents the potential water quality contamination risks associated with borrow pits and mining pits as including:

– Dramatic changes in hydrological regimes such as groundwater levels, flooding, and waterway channel migration – sometimes well beyond the extraction site or many years later
– Exposure of the groundwater table, leading to evaporation and providing a pathway for contamination to enter the aquifer
– Possible exposure of acid sulfate soils

The long-term impacts of the existing borrow pit (and any new borrow pit) are currently unknown. Future extensions of the existing borrow pit and/ or the proposed new borrow pit may lead to further exposure of PASS material. The volume of acid generation currently generated based on the current borrow pit excavation and the potential acid generation due to further excavation(s) has not currently been calculated and/ or assessed sufficiently to date. Furthermore, there is a risk that re-saturated soils (either by flooding and/ or infilling activities) may initiate the mobilisation of leachate/ gravitational water impacted by but not limited to acidity, metals and nutrients which has the potential to reach surface water receptors and underlying aquifer system.

Alcoa has acknowledged there are currently data gaps with respect to the current groundwater conditions and potential groundwater and ASS impacts and associated with proposed RSA10 construction activities in the Northern Borrow Pit area. Alcoa have indicated that these gaps will be addressed as part of investigation planned during 2024, and that impacts will addressed part of preparation of environmental management plans for the area.

GHD recommends potential future impacts, such as ASS impacts from rebounding groundwater water levels should the borrow pits be back filled or used as future water storage, should also be assessed at this time.

However, as the immediate impacts of any groundwater changes to the surface water drains and streams within to the Northen Borrow Pit area from RSA10 construction activities are likely to be low, the identified data gaps are not critical to this surface water study.

2.6 Conservation areas

2.6.1 Wetlands and waterbodies

2.6.1.1 Wetlands

Geomorphic Wetlands of the Swan Coastal Plain (DBCA-019) mapping (Figure 10 identifies the study area and its surrounds as a multiple use wetland, comprising a palusplain (seasonally waterlogged flat) that extends north south along the Swan Coastal Plain.

The lower extent of Samson South Drain is mapped as conservation wetland (floodplain flat), with two linear resource enhancement sumpland basins occurring over 2 km west.

The Peel Yalgorup System occurs along the coastline to the south of Mandurah. The Department of Biodiversity Conservation and Attractions (DBCA) mapping (DBCA-045) identifies the wetlands of the Peel Yalgorup System in the Directory of Important Wetlands in Australia.

2.6.1.2 Ramsar wetlands

The Peel Yalgorup System including the Peel Inlet and adjacent Harvey Estuary (also termed the Peel-Harvey Estuary) and the Yalgorup Lakes (comprising Lake Clifton and Lake Preston) are listed as Ramsar wetlands of international significance (Figure 10).

The Harvey River discharges directly to the southern extent of the Harvey Estuary, approximately 22 km downstream of the study area (from lower extent of Samson South Drain).

The Yalgorup Lakes occur 14.5 km west of the study area. Review of linear hydrography mapping (DWER-031) identifies there is no direct surface water discharge from the study area catchments into the Yalgorup Lakes.

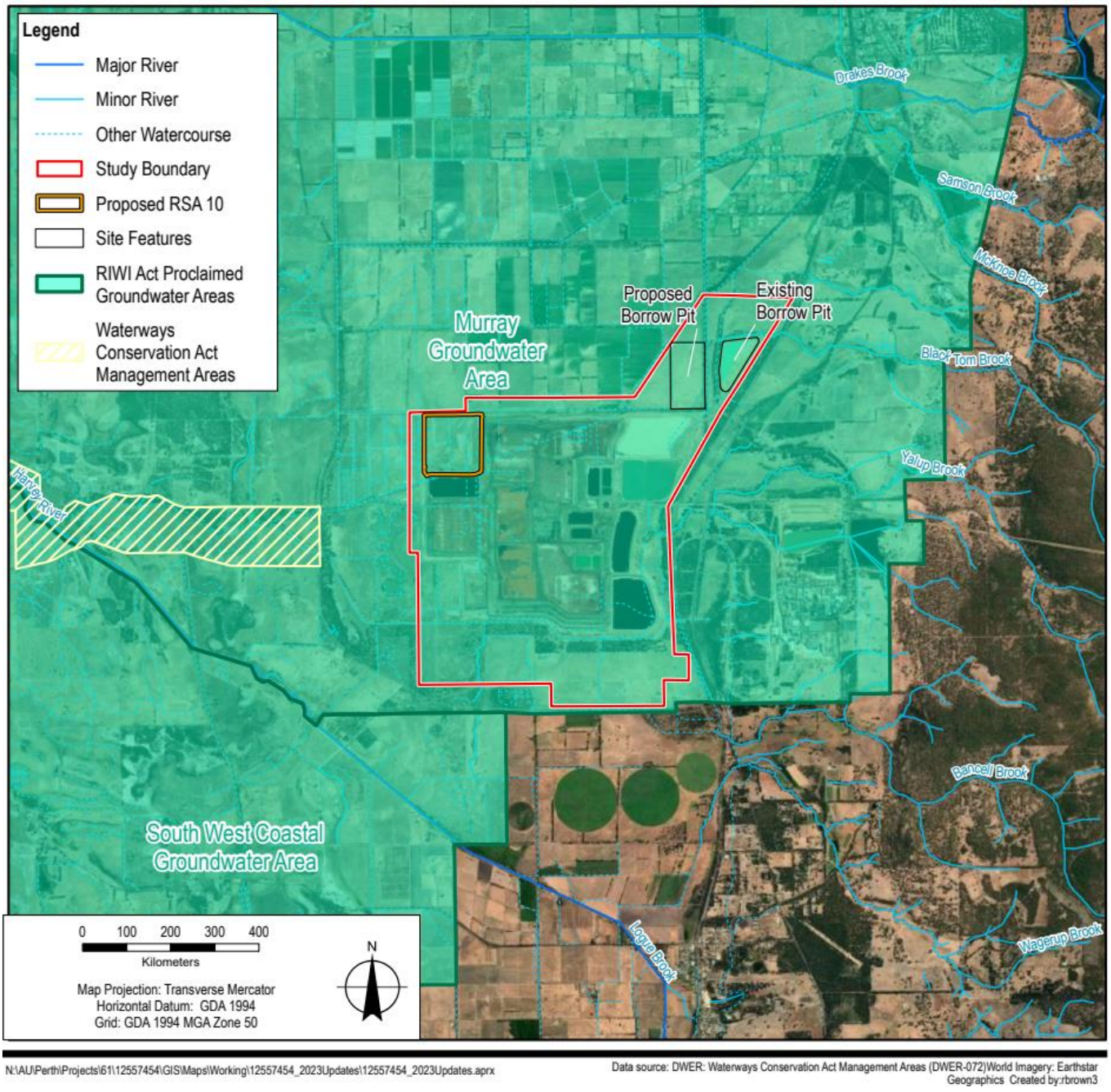

Figure 9 ***Peel Inlet Management Area and Murray Groundwater Area***

2.6.2 Reserves

The Buller Nature reserve occurs to the north-west of the study area (Figure 11). The reserve is located along the sub-catchment boundary of the Samson Brook North Drain and would not be impacted by the potential construction and operation of the RSA10 and borrow pits.

2.6.3 Flora and vegetation

Remnant vegetation occurs across parts of the study area and is typically confined to linear corridors along road reserves and drainage lines.

Previous flora and vegetation survey of the study area was completed by Mattiske Consulting during proposed development of the RSA9 site and associated infrastructure (Mattiske Consulting, 2011). The survey area included some of the potential disturbance areas within the study area, including the proposed RSA10 site as well as the Northern Clay Borrow Pit and potential expansion area, and section of Black Tom Brook that separates the borrow pit expansion area. The vegetation communities and vegetation condition across parts of the study area are summarised in Table 4 with the Mattiske Consulting mapping reproduced in Appendix C.

ENV (2008) completed an assessment of both remnant vegetation and revegetation areas across the Wagerup Farmlands between May and July 2008. The assessment identified that the vegetation lacks connectivity and comprises linear remnants. The assessment identified the Diversion Drain as an ecological corridor through the area, with several individual sites along the drain also containing wetland habitat. The assessment identified the importance of the drainage lines in provision of fauna habitat and ecological linkages, and recommended they be improved.

Table 4 Vegetation community and vegetation condition for parts of the study area

Potential disturbance area	Vegetation community	Vegetation community description	Vegetation community condition
RSA10 area	P1	Closed grassland of *Cynodon dactylon species with emergent Juncus pallidus with mixed weed and pasture species on flat sandy-loam soil	Completely degraded
Northern Clay Borrow Pit and the proposed borrow pit extension area	P1	Closed grassland of **Cynodon dactylon* species with emergent *Juncus pallidus* with mixed weed and pasture species on flat sandy-loam soil	Completely degraded
Black Tom Brook between existing Northern Clay Borrow Pit and expansion area	E1	Woodland of *Eucalyptus rudis Corymbia calophylla* with occasional *Melaleuca rhaphiophylla* over *Taxandria linearfolia* with mixed weed species on loamy soils in localised drainage lines	Good

2.6.4 Threatened and priority ecological communities

Mattiske Consulting (2003; 2012) identified the presence of three vegetation communities that were identified as equivalent to threatened ecological communities in remnant bushland pockets, in the vicinity of the Wagerup Refinery. These remnant bushland pockets are located upstream of the proposed construction and dewatering activities and will not be impacted.

A Priority Ecological Community (*Banksia*-dominated Woodlands of the Swan Coastal Plain IBRA Region (P3)) is located west of the RSA within the Buller Nature Reserve (Appendix D).

2.7 Environmental receptors

2.7.1 Surface water

Key environmental receptors in proximity to the study area and potential disturbance areas include the surface water systems including the Samson Brook South Drain and the South Samson Diversion Drain, which converge downstream of the existing RSA area and discharge to the Harvey River. The Samson North Drain is located north of Samson Brook South Drain and is not considered a direct receptor.

The Harvey Estuary (Section 2.6.1.2) comprise a further receptor approximately 22 km downstream.

2.7.2 Groundwater

The connection and interactions between groundwater and surface water at the site, particularly at the existing borrow pit and potential borrow pit area has yet to be established and fully understood.

2.8 Water dependent ecological values

Water dependent ecological values have been identified from the ecological water requirements studies completed for some surface waters systems, as well as other vegetation and fauna surveys completed for the study area and surrounding areas. A summary of these values is provided in the following sections with the ecological water requirements summarised in Section 3.4.

2.8.1 Ecosystem processes

Environmental water requirements studies for the various surface water systems identified the following key ecosystem processes and associated flow requirements:

- Fish migration: flows to enable fish to migrate upstream
- Pool scouring: flows to remove aggraded material
- Channel maintenance flows
- Energy flows: permanent flows and a linkage between forested reaches and downstream
- Riparian flows: floodplain flows to stimulate seed-set and recruitment.

2.8.2 Groundwater dependent vegetation

Potential groundwater dependent ecosystems across the study area may include:

- Riparian vegetation along streamlines and drainage lines that have a groundwater contribution to baseflow or where groundwater is within 10 m of the natural ground.
- Isolated remnant vegetation stands throughout the Alcoa Wagerup Farmlands which include vegetation species that prefer and occur on seasonally moister and wetter soils and are considered groundwater dependent vegetation indicator species.

2.8.3 Aquatic fauna

Understanding of the aquatic fauna population of the surface water systems in the vicinity of the study area and surrounds has been collated from a suite of targeted aquatic fauna surveys and general fauna surveys completed across the Alcoa Wagerup Farmlands and surrounding surface water systems. Key findings from the various surveys in relation to aquatic fauna species are summarised in Table 5.

Table 5 Aquatic fauna recorded in the vicinity of the study area

Species	Description
Carters Mussell	– Carters Mussels (CFM) (Westralunio carteri) are listed as Vulnerable under the EPBC Act 1999. – Carters Mussels were identified during aquatic fauna surveys in proximity to the study area, including of several sites of the upstream Logue Brook Drain (DWER 2021). – Alcoa commissioned a Carters Mussell survey of surface water bodies in the vicinity of the Wagerup Refinery and Wagerup Farmlands, including Yalup Brook Drain and Harvey River downstream of Logue Brook Drain. The survey did not identify the presence of Carters Mussell (Alcoa 2021). – The Alcoa Wagerup RSA 10 Aquatic Fauna Survey (Spring 2022), reports that the finding of greatest significance to the RSA 10 project was a population of listed Carter's freshwater mussels at surface water sampling site SP012, located on Samson Brook, immediately downstream of where Yalup Brook enters Samson Brook (WRM-SLR 2023). – Following the 2022 survey, Alcoa commissioned a survey by SLR Consulting to assess the extent and density of freshwater mussel populations in Samson Brook near the proposed RSA 10 site and new borrow pit options. The survey, conducted in July 2023, found no CFM along the Samson Brook South (SBS) drain from SBS4 to SBS10, including the area north of RSA 10. A low-density population was observed at SBS11, upstream of a higher-density population at SP012. Small populations were also

Species	Description
	found at SBS sites 1 to 3, near Borrow Pit option 2, with no CFM recorded along Samson Brook East (SBE) (SLR 2023).
Fish	– Four fish species recorded during April 2000 surveys of the Yalup Brook and South Samson Drain (Streamtec 2000). Fish species included western minnow (*Galaxias occidentalis*), pygmy perch (*Edelia 21ittate*), nightfish (*Bostockia porosa*) and introduced mosquitofish (*Gambusia holbrooki*).
Turtles	– An Alcoa commissioned fauna survey of the South Samson Drain/Black Tom Drain identified that the drain was well vegetated and likely to provide suitable habitat for a variety of waterfowl, with the southern section with open pools suitable for freshwater turtles. One Oblong Turtle (*Chelodina oblonga*) was observed (Bamford Consulting 2013)
Frogs	– ENV (2008) recorded frogs present across multiple remnant vegetation and revegetation sites of the Wagerup Farmlands, with presence noted by their frog call. 15 potentially occurring amphibian species were noted. – Environmental Management and Research Consultants (2005; 2008) recorded nine frog species during a fauna survey of the farmland and wetlands surrounding the Wagerup Refinery.

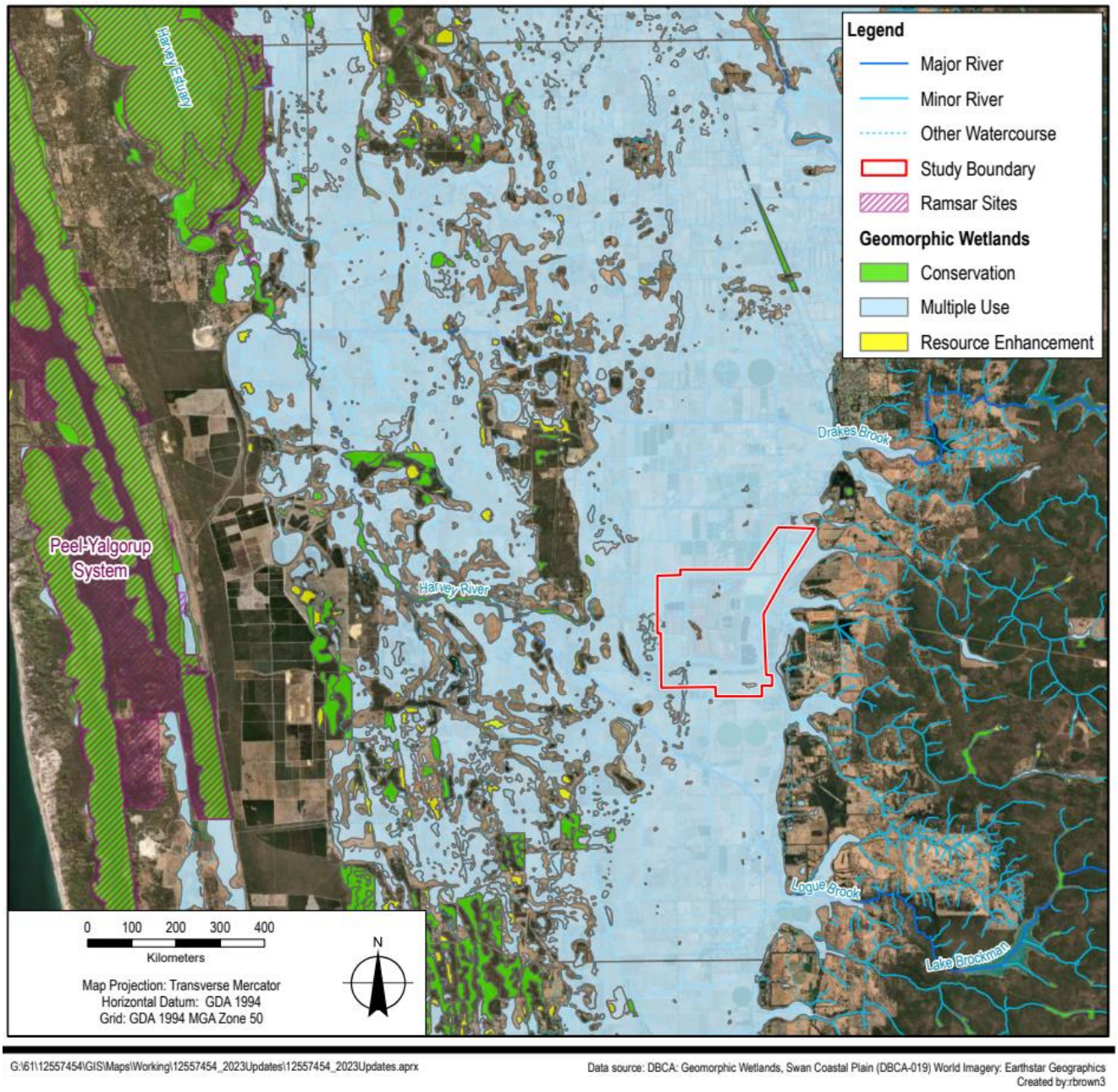

Figure 10 Wetlands

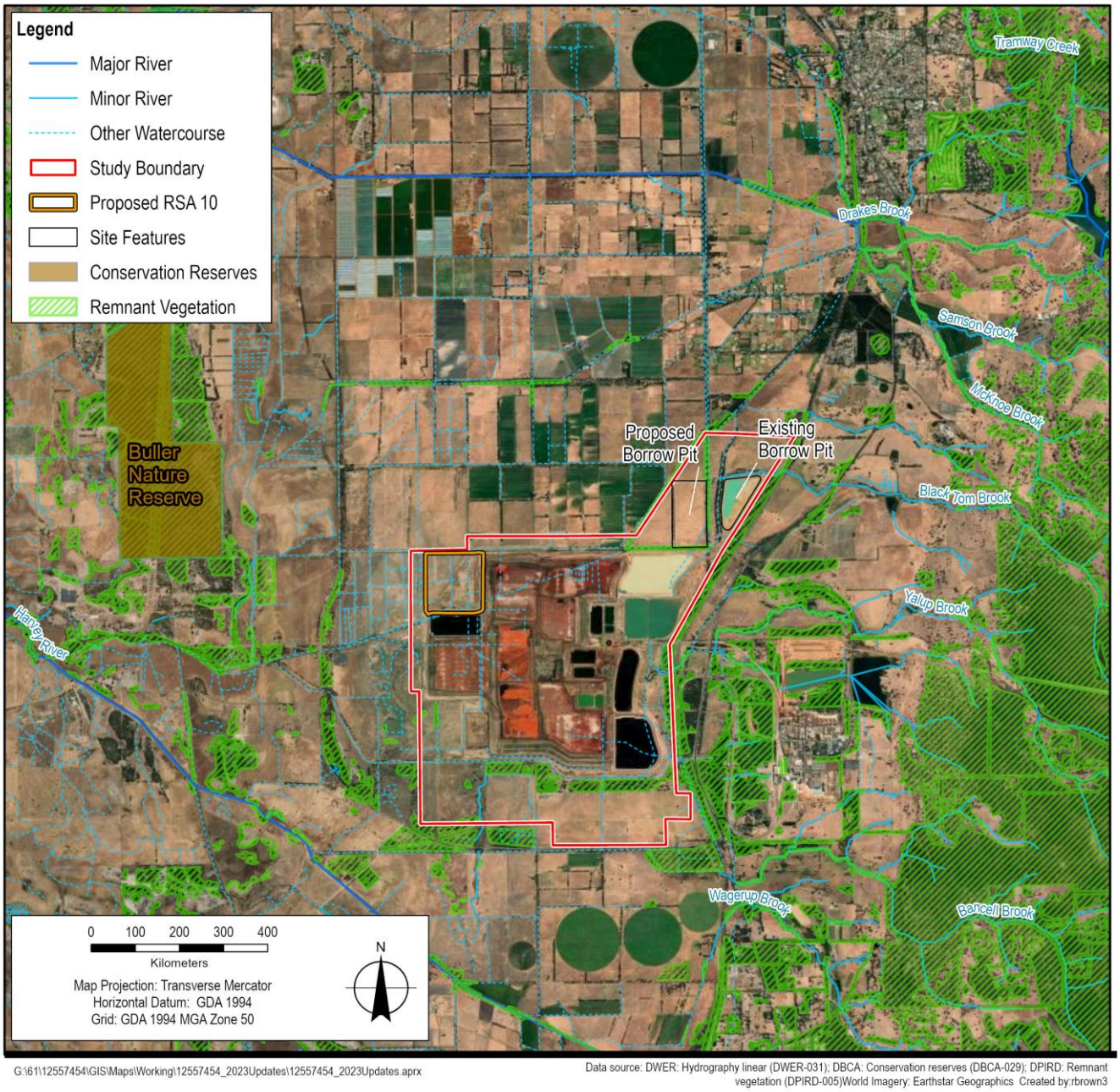

Figure 11 Reserves and remnant vegetation

3. Hydrology and water quality

3.1 Monitoring locations

Alcoa maintains an extensive network of surface water monitoring points upstream and downstream of the study area in accordance with the Alcoa World Alumina – Australia; Wagerup Refinery Surface Water Licences Operating Strategy (Alcoa, 2017). A summary of the monitoring locations is provided in Table 6 with locations presented in Figure 12.

Table 6 Samson South Dam, Yarloop Drain and Black Tom Brook monitoring locations

Alcoa Site ID	Site description	Monitoring parameters	
		Water quality	Water quantity
SP005	DP1 overflow into the Diversion Drain.	X	X
SP006	Black Tom Brook downstream of the Northern Borrow pit	X	X
SP007	Samson Brook South Drain south of the Northern Borrow pit	X	
SP010	Samson Brook South Drain prior to the Samson Brook South Drain-Diversion Drain confluence	X	X
SP011	Diversion Drain prior to the Samson Brook South Drain-Diversion Drain confluence	X	
SP012	Samson Brook downstream of Diversion Drain and Samson Brook South Drain confluence	X	X
SP013	Minor drains from Alcoa farmlands in proximity to proposed RSA10 footprint	X	
SP016	Southern edge of the RSA area in the Diversion Drain.	X	X

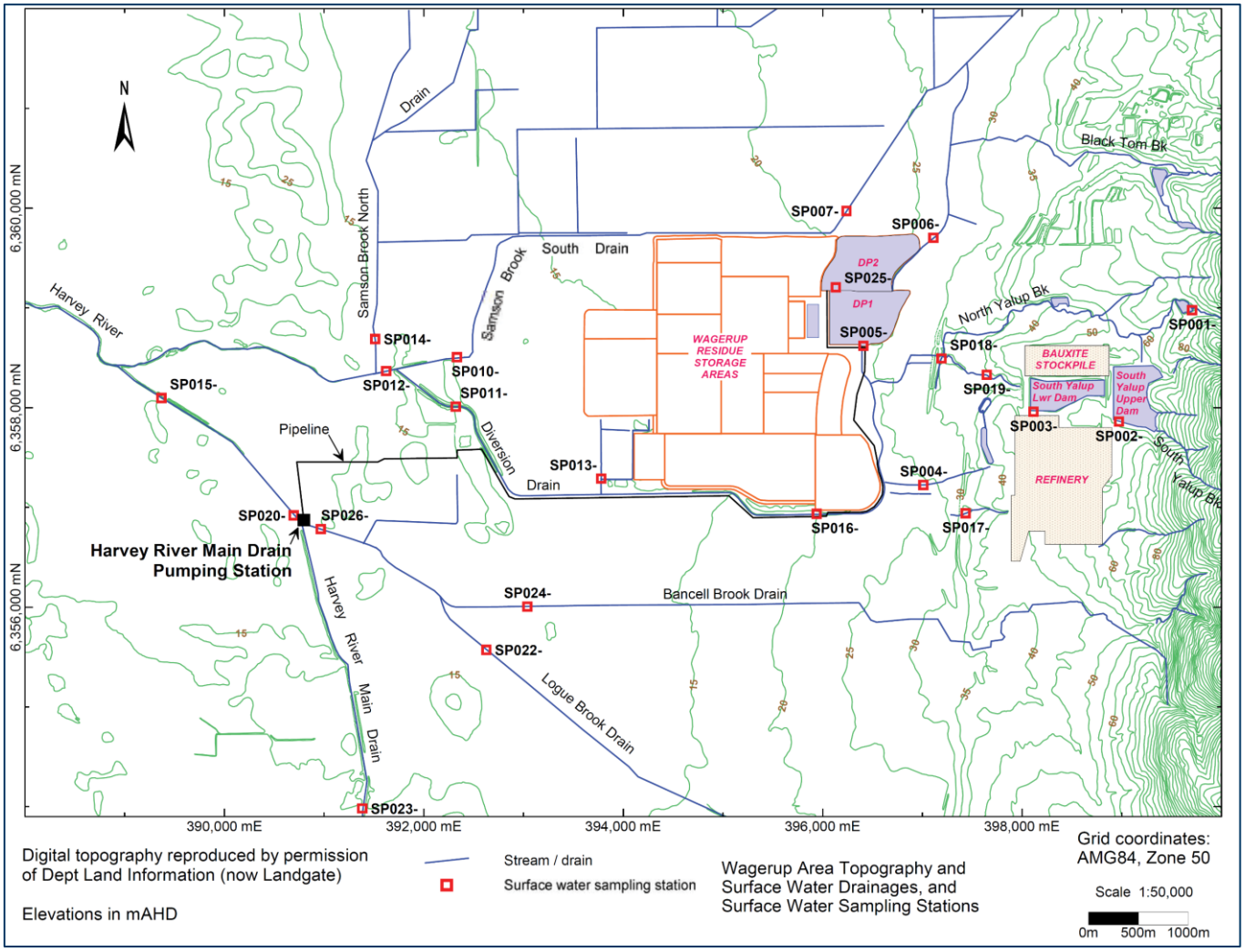

Figure 12 Alcoa Wagerup surface water monitoring locations (Alcoa 2020)

3.2 Surface water flow

3.2.1 Samson Brook South Drain

The following general surface water flow conditions are observed based on available flow data and published information for Samson Brook South Drain:

– The natural flow regime is characterised by seasonal flows, with significant flows occurring in winter months.

– Streamtec (2000) reports shallow groundwater can discharge to the surface in the Samson Brook catchment, forming temporary water bodies and streams that are conveyed by small drains directly to the South Samson Drain.

– Review of flow data for monitoring location SP012 for the period 2003-2020 (Appendix B) indicates:

  - Peak total daily flow rates occur in the winter months, ranging between 200 ML to 1,110 ML. This trend was not present in 2015 and 2016, where flows were significantly lower.
  - Median monthly flows indicate highest flows are present during the winter months, before declining in September and October to reach the lowest flows during the summer months through to April. The highest monthly median flow on record is 765 ML and occurs in August.

3.2.2 South Samson Diversion Drain (including Yalup Brook North and South)

Based on available flow data and available reports the South Samson Diversion Drain has the following general flow conditions:

– The South Samson Diversion Drain was constructed by Alcoa to divert drainage waters around the residue areas.
– The regime is characterised by seasonal flows, with significant flows occurring in the winter months. The diversion drain is also used by the Harvey Water irrigation cooperative to transfer water during summer months.
– Flow in the Diversion Drain is directed into Detention Pond 1, with overflow from the pond into the Diversion Drain.
– Headwaters for Yalup Brook North and South are in the northern jarrah forest, with flows of both brooks regulated by a dam, with overflows from the dams joining the Diversion Drain downstream of Detention Pond 1.
– Review of flow data for monitoring location SP016 for the period 2003-2020 (Appendix B) indicates:
    - While flow is typically seasonal there was a period of consistent flows during 2007-2009, with no drying of the drain.
    - Peak total daily flow rates occur annually in the winter months, ranging between 10 ML to 1,400 ML.
    - Median monthly flows indicate highest flows are present during the late winter and early spring (August and September), before declining in October and over summer. Maximum median flow of 149 ML occurs in August.

3.2.3 Black Tom Brook

There is currently no flow monitoring data available for Black Tom Brook. As noted in Section 2.4.1 the natural channel of Black Tom Brook flows into the South Samson Diversion Drain. Alcoa monitoring location SP06 is the closest flow monitoring station to Black Tom Brook and includes the combined flow from Black Tom Brook and the South Samson Diversion Drain, which includes surface water purchased from the Harvey Irrigation Scheme.

Based on available flow data and available reports flow at SP06 has the following general flow conditions:

– As with the other drains in the area, the natural flow regime is characterised by seasonal flows, with significant flows occurring in the winter months.
– Overflow from Detention Pond 1 is directed around the RSA area by the South Samson Diversion Drain.
– Review of flow data for monitoring location SP06 for the period 2003-2020 (Appendix B) indicates:
    - Total daily flow rates indicate short periods of no to little flow during summer months before extended periods of significant flows during the winter and shoulder months. Peak daily flow rates typically range from 40 ML to 120 ML.
    - Median monthly flows indicate highest flows are present during winter months. Maximum monthly median flow is 492 ML and occurs in August.

3.3 Water quality

Water quality monitoring of key receptors in proximity to the Study Area (Samson Brook South Drain, Diversion Drain and Black Tom Brook) has been completed by Alcoa.

Alcoa monitors surface water quality at locations indicated in Figure 12. Alcoa water quality monitoring includes monthly monitoring when the brooks are flowing of a suite of water quality parameters including pH, salinity (as electrical conductivity or total dissolved solids), alkalinity, turbidity, and six-monthly monitoring of metals at site SP012.

Table 7 summarises the range and average Alcoa water quality data for the period 1989-2021. Average baseline water quality indicators reviewed are within the recommended range based on the water quality guidelines

(ANZECC and ARMCANZ, 2000), except for turbidity and total suspended solids. The turbidity and TSS values are higher than trigger values upstream of the refinery site and increase downstream, which indicates that there is an elevated turbidity source from the local catchment, either the refinery or adjacent farmland. According to ANZECC and ARMCANZ (2000), the guidelines do not signify threshold levels of pollution, instead, provide certainty that there will be no significant impact on water resource values if the guidelines are achieved. Therefore, the baseline values may not indicate poor quality, but provide an opportunity to redefine the appropriate threshold levels which are site-specific and suitable for the intended use.

Table 7 ***Summary water quality data within study area for the period 1989-2021 (data is range of values with average in brackets)***

Parameter	ANZECC and ARMCANZ (2000) range	SP005	SP006	SP007	SP010	SP011	SP012	SP013	SP016
Electrical conductivity (EC) (µS/cm)	1600-4500	250-1720 (462)	231-1450 (610)	185-668 (321)	155-1510 (363)	191-5600 (825)	192-1832 (443)	151-4430 (1169)	171-2530 (562)
Dissolved Oxygen (mg/L	6.8-10.2	10.15	ND	ND	8.83	5.43	7.74	9.56	10.09
Alkalinity (ppm as CaCO3 at pH 8.3)	20-100	13-55 (30)	3-181 (40.9)	6-157 (24)	6-120 (29)	0-285 (58.1)	5-120 (34)	20-210 (58.4)	2-387 (52.3)
pH	6-9	6.2-9.4 (7.6)	5.4-8.8 (7.1)	6.1-8.4 (7.0)	6.0-8.1 (7.1)	3.8-8.6 (6.9)	5.5-9.1 (7.0)	5.7-7.9 (6.8)	4.9-10.3 (7.3)
Total Dissolved Solids (mg/L)	0-5000	110-290 (218.2)	97-1365 (432.6)	63-471 (215.1)	97-720 (246.3)	120-920 (421.9)	0-790 (279.6)	170-1900 (869.3)	120-1069 (318.8)
Total Nitrogen (mg/L)	25-125	0.38-1.3 (0.76)	0.34-1.5 (0.72)	0.26-3.3 (1.25)	0.25-1.7 (0.7)	1.2-4.1 (1.91)	0.23-2.3 (1.03)	1.1-3.4 (2.01)	0.6-2.1 (1.17)
Total Phosphorus (mg/L)	0.8-12	0.005-0.77 (0.05)	0.005-0.41 (0.044)	0.005-0.16 (0.046)	0.005-0.19 (0.051)	0.01-1 (0.281)	0.005-0.83 (0.107)	0.03-0.67 (0.154)	0.005-0.21 (0.051)
Total Suspended Solids (mg/L)	<40	ND	ND	1-93 (32)	16-140 (75.1)	ND	36-158 (82.4)	ND	ND
Turbidity (NTU)	2-15	14-35 (26.3)	0.6-118 (16.8)	1-68 (10.7)	10.7-165 (74.7)	14	6-508 (43.7)	ND	38.2
	ND – no data								

3.4 Ecological water requirements

Several ecological water requirement (EWR) studies have been commissioned by Alcoa for the surface water systems that occur in the vicinity of the Wagerup Alumina Refinery operations. Recognising the highly modified state of the surface water systems in the area the EWR studies were completed to assess flow volumes required to maintain existing ecological values of the surface water systems, and to ensure sustainable management of abstraction from the surface water systems.

Previous EWR studies of relevance to the study area include:

– *Yalup & Samson Brook: Environmental Water Requirements* (Streamtec, 2000)
– *Yalup Brooks & South Samson Drain: Adequacy of Environmental Water Provisions: Results from Biomonitoring* (Streamtec, 2002)
– *Sustainable yield: flows in the lower Harvey River Main Drain and South Samson Drain* (Streamtec, 2008)

The ecological water requirements for the reaches of the North Yalup Brook and the South Yalup Brook are not considered further in this assessment as these sites are located upstream of the proposed RSA10 and potential borrow pit disturbance areas.

The EWRs for the Samson Brook South Drain were determined for the section of the drain below the confluence with the Diversion Drain, with flow measurements corresponding with monitoring location SP012 (Figure 12). Initial estimates of EWRs for Samson Brook South Drain at SP012 were completed by Streamtec (2000) and were revised. Follow up surveys were completed to assess the sustainable yield under average and dry flow conditions (Streamtec, 2008, Appendix E).

The follow up assessment by Streamtec in 2008 assessed the sustainable yield under average and dry flow conditions (Streamtec, 2008) with the sustainable yield at SP012 identified as:

– Average flow conditions sustainable yield–- 5,700 ML (May to October)
– Drought flow conditions sustainable yield–- 4,600 ML (May to October)

Review of annual flow data for monitoring location SP012 identifies that the annual EWR has been met in 8 years of the 17 years with a complete flow monitoring record (Appendix E). Additional allocation to Samson Brook by the Harvey Water Cooperative may be required to meet future EWR.

Annual reporting by Alcoa of surface water abstraction against licensed volumes (Table 3) identifies that the full water allocation has not been abstracted in recent years (2016-2020).

4. Impacts

4.1 Overview

Construction, operation, and management activities may result in impacts to the water quality and water quantity within the Samson Brook South Drain, Diversion Drain and Black Tom Brook catchments, however the implementation of adequate measures would seek to prevent impacts.

The following sections provide a summary of potential impacts from the Proposal.

4.2 Potential impacts

4.2.1 Surface water quantity

The construction footprint for the proposed RSA10 and borrow pit footprint are shown in Table 8, along with their respective contributing area as a percentage of their contributing catchment area. The construction footprints were derived from concept boundaries provided by Alcoa, with the catchment areas derived from the catchment boundaries shown in Figure 7.

Table 8 Impacted catchment area

Potential disturbance	Concept design area (km^2)	Catchment name	Catchment area (km^2)	Proportion disturbed	Lower Harvey River catchment disturbed	Harvey River catchment proportion disturbed
RSA10	0.53	Samson Brook south drain	26.6	2.16%	0.14%	0.03%
Northern borrow pit (existing and proposed are the same footprint area)	0.19	South Samson Sub Drain (including Black Tom Brook)	10.9	1.75%	0.05%	0.01%

The percentages calculated identify that the concept design surface water disturbance area of the proposed RSA10 and potential borrow pit locations are only a small proportion of the local contributing catchments (Table 8). On an annual flow basis, the reduction in flow contribution to local catchments would broadly be equivalent to these percentages.

The potential impacts to the Lower Harvey River catchment are expected to be negligible as the combined disturbance areas (proposed RSA10 and the Northern borrow pit area) comprise less than 0.25% of the catchment. Seasonal flow patterns and event-based flows at the local catchment and Lower Harvey River catchment will remain.

GHD has identified that due to anticipated high groundwater levels within the proposed borrow pit location it is anticipated a dewatering system will need to be installed during excavation of the locally sourced clay for the construction of RSA10, and that the remaining borrow pit will act as an ongoing groundwater sink due to evaporation of the exposed groundwater table. The short term and long-term dewatering drawdown are likely to impact on baseflow contribution to local drainage lines (including Black Tom Brook and South Samson Diversion Drain), however the potential change to the baseflow contribution due to dewatering has not been quantified as part of this assessment. Potential impact to other water users, including Harvey Water, has not yet been assessed in this study, but should be included in any groundwater study undertaken for the area.

4.2.2 Surface water quality

Potential surface water quality impacts that may occur during the construction and operation of the RSA10 and borrow pits, including rehabilitation of the borrow pits, include:

– Increase in sediment and turbidity in surface water runoff during construction and operation of the RSA10 and borrow pits.
– Potential for increase in sediment in surface water runoff due to surface disturbance during rehabilitation of disturbance areas.
– Potential for mobilisation of contaminants during construction and operation.

4.2.2.1 Sediment and turbidity

Construction of the proposed infrastructure is likely to occur over a period of three years (Advisian, 2021) and therefore a sediment management plan will be required to minimise potential impact to the receiving watercourses in proximity to the disturbance area.

Any direct surface water runoff from the external facing batters/walls of the proposed disturbance areas would be expected to be sediment laden, and sediment controls will be required to ensure there is no increase in suspended sediment concentrations and turbidity downstream. Options to address sediment loads may include:

– Measures to stabilise the construction footprint should be considered so that excess sediment runoff does not occur.
– Outlets from construction areas should include a sediment basin to reduce flow velocity and allow sediment particles to settle out of the water column.
– Where borrow pits are designed to drain accumulated water a vegetated exit channel swale should be designed to promote infiltration and final treatment of sediments. Vegetation should consist of native plant species that provide adequate ground cover and are relatively fast growing.
– Maintenance of batter slopes to prevent formation of rivulets.

Sediment controls will also be required around the footprint of the RSA10, to address ongoing sediment control of external embankment batters and interface with the adjacent farmland, details of which will be provided in the sediment management plan.

4.2.2.2 Potential leaks from RSA10

Due to high alkalinity of stormwater runoff from the RSA and Wagerup Refinery areas the water is not suitable for direct discharge to the environment. Runoff from these areas is contained internally and is collected and stored in lined ponds from where it is recycled via the refinery process as make-up water (Alcoa, 2020).

The design of the RSA10 will be in accordance with ANCOLD Standards. The RSA10 will be designed to accommodate a 1 in 100-year (1% Annual Exceedance Probability) rainfall event with freeboard designed to safely allow underflow back into an existing operational circuit in a rainfall event greater than 1 in 100-year. This circuit is actively managed as part of the Refinery operations with an emergency spillway that may be activated under the Refinery Emergency Response Plan.

The Wagerup Alumina Refinery RSA is operated with a 100% containment policy (Alcoa, 2020). The concept design for the proposed RSA10 identifies multiple barrier design, with multiple liners including a 500 mm clay liner as well as a 1.5 mm thick HDPE liner that will traverse the whole of the RSA10 footprint.

The potential for leakage from the proposed RSA10 is considered to be low.

4.2.2.3 Acidification of soils

Acidification of soils is only anticipated to be a risk in areas affected by groundwater drawdown. As such, these should be assessed as part of a groundwater study of the area and informed by local baseline groundwater monitoring data from wells within the Northern Borrow Pit area.

4.2.2.4 Acidification of waterways

The RSA10 construction has the potential locally raise groundwater levels (by reducing evapotranspiration losses from the RSA10 footprint), which theoretically could result in some acid mobilisation and discharge to the surface water drains. However, the general low level actual and potential soil acidity identified in shallow ASS investigations (Hatch 2023), the inherently modest nature of any groundwater rise (maximum groundwater levels are already managed by existing surface drains) and the naturally acidic nature of existing groundwater discharges to the surface water drains mean the potential impacts of any RSA10 induced acidification on water ways is likely to be minor.

The Northern Borrow Pit area is likely to act as a groundwater and by extension, surface water sink. The pits are unlikely to overflow (providing drains remain directed around the pits and not through them), therefore the risk of contributing to acidification of waterways is low. The existing pit would likely drain to DP1 and hence be captured in the Refinery water circuit, mitigating any potential impacts. There is a low risk of short-term surface water impact should the Proposed borrow pit become flooded and drainage ran through the pit instead of around. The water quality within the pit would be a mixture of surface water and groundwater and its quality would be difficult to predict. However, the impact would likely to short term as reinstating flow around the pit should be a relatively simple task.

4.2.3 Impact to receptors

The assessment of potential receptors and water dependent ecological values within the study area has relied upon information from existing documents as well as publicly available information. The assessment has used data from several vegetation and flora and fauna survey reports, as well as ecological water requirement reports, that were completed within and adjacent to the study area. It is noted that a number of these reports were completed more than 10 years ago. While the findings of these surveys have been included in the characterisation of the study area, potential receptors, and water dependent ecological values it is recommended that additional surveys be completed to assess the status of identified values (Section 4.3).

4.3 Recommendations

Alcoa currently monitors several locations in proximity to the study area (Figure 12) in accordance with its Surface Water Operating Strategy. Surface water monitoring is recommended to inform the assessment of borrow pit options, as well as during construction, operation, and rehabilitation.

Water quality data during the construction, operation and rehabilitation period should be compared to baseline data. Where exceedance of baseline water quality occurs, it is recommended that the following contingency measures be considered:

– Localised site investigation during monthly monitoring to identify potential cause of exceedance.
– Undertake follow up monitoring if required.
– Review site activities and procedures (e.g., construction management, erosion, and water management during operation) and implement remediation measures if required.

The current water quantity monitoring at site SP012 should continue to monitor flows downstream of the Wagerup Alumina Refinery, and the adequacy of EWRs.

It is understood that Alcoa has commissioned a review of the EWR studies for surface water systems in the vicinity of the Wagerup Alumina Refinery however this study was not completed at the time of the SWA. Aquatic fauna surveys have identified potential turtle habitat, and fish and macroinvertebrate species have been identified in the adjacent North and South Yalup Brooks. In addition, Carters Mussels were identified during aquatic fauna surveys in proximity to the study area, including of several sites of the upstream Logue Brook Drain and the upper end of Black Tom Brook, and downstream of the residue storage area footprint. The river reach also provides an important connection for flow of detritus from the less disturbed forested upper reaches of the catchment to the coastal plain.

It is further recommended that reconnaissance surveys are completed for areas with potential to impact ecological corridors or remnant native vegetation.

The study area and proposed disturbance areas are located within the Murray Groundwater Area which is a proclaimed groundwater area under the *Rights in Water and Irrigation Act (1914).* The proposed borrow pits had been licensed for dewatering under GWL102669 which has an annual allocation of 550,000 kL (Rockwater, 2023). The licence expired in May 2023; however, a renewal application has been submitted to DWER.

Our internal assessment has further concluded that a bed and banks permit will likely be required, due to Wagerup falling within the Harvey Irrigation District (Surface Water Proclamation Areas, DWER, retrieved from https://www.wa.gov.au/government/publications/proclaimed-surface-water-areas-map). The proposed RSA10 (north) will be constructed on the south bank of the Samson South drain, and its construction may also alter the flow of Samson Brook and Black Tom Brook. As these may be considered watercourses, this will affirm the checklist conditions set for the permit (excavating the watercourse bed or banks, stockpiling material and operating earth moving machinery on the watercourse bed or banks). At this stage, the only way the get a more definite answer, will be to consult DWER and act on their advice.

It is recommended that a groundwater study be undertaken to assess the short term (during construction) and long term (post-construction) impacts of RSA10 and the northern Borow Pits to complement this Surface Water Study. Surface water is connected to the groundwater at both the Northern Borrow Pit area and RSA10 area with drains receiving groundwater baseflow in late winter and spring, while flows potentially recharge aquifers after rainfall in summer, autumn, and early winter. There is very limited groundwater information in the Northern Borrow Pit area, and the existing and proposed borrow pits are likely having a significant, but localised impact on the local groundwater regime. The confirmed presence of ASS in the soils of the Guildford formation in both the RSA10 and Northern Borrow pit locations mean that changes to groundwater levels have the potential to impact on groundwater and surface water quality, the extent of which is not able to be assessed at this time.

5. Conclusion

The SWA of the proposed development of an additional residue storage area (RSA10) and associated clay borrow pits was undertaken to assess the potential impacts of the proposed disturbances on surface water resources and identified ecological values.

The SWA was completed based on desktop review of available information including preliminary concept designs of the proposed RSA and associated borrow pits, information relating to water dependent ecological values, EWRs, gauged surface water flow data, and water quality monitoring data.

Based on the small proportions of the proposed disturbance areas within their respective contributing catchments the direct impact on water quantity (and flow regime) is negligible. The percentages calculated show that the disturbed areas are only a small proportion of their respective catchments, and on an annual flow basis, the reduction in flow would broadly be equivalent to these percentages.

Dewatering associated with construction of the proposed RSA10, and the potential borrow pits may temporarily impact on baseflow contribution to the local surface water systems downstream of the disturbance areas, including Samson Brook South Drain and the Samson South Sub Drain (and local Black Tom Brook area). Longer term impacts are also likely due to reduced evapotranspiration from the RSA10 area (localised groundwater rise) and increased evaporation from the borrow pit (localised depression). These groundwater related impacts, along with any related ASS impacts are yet to be formally assessed.

Primary surface water quality impacts during construction and operation of the proposed RSA10 and borrow pits primarily relate to management of sediment and turbidity. A sediment management plan is required during the construction and rehabilitation of the infrastructure. Surface runoff from disturbed surfaces, and accumulated flows within borrow pits, should be treated using recommended controls prior to discharge to the environment via vegetated overland pathways. Ongoing maintenance of external facing batter walls will be required. It has been assumed that any ASS materials used in RSA construction will be tested and neutralised prior to use, such that the risk of acidified runoff from outer embankments of the RSAs will be minimal.

Exceedance of the 1 in 100-year event will result in RSA surface runoff collection and underdrainage being directed back into an existing operational water circuit via the Runoff Collection Pond. This water circuit has an emergency spillway designed in accordance with ANCOLD standards. Operational management processes are in place at the Refinery to maintain pond water levels and minimise the chance of spillway activation. Should the emergency spillway be activated in an event exceeding the 1 in 100-year event (Wet Winter), release of water is via controlled discharge onto Alcoa held farmland. Potential overflow from the spillway will allow for controlled release of alkaline process water, which will be diluted by large volume of flood water in the farmlands adjacent the existing residue storage area.

Characterisation of local ecological values was based on a number of surveys that have been completed across the study area, and it is recommended that a reconnaissance survey be completed to verify the values of areas that may be impacted by the proposed disturbances including the identified ecological corridors and linear riparian vegetation (Black Tom Brook). Monitoring of surface water systems should continue with additional flow monitoring recommended for Black Tom Brook.

It is recommended that an ASS study be undertaken to assess the risk of ASS in the RSA10 and clay pit locations, and to inform the development of an ASS management plan if required. If a new Northern Borrow Pit is required to the west of the existing borrow pit, it is recommended that a separate Groundwater Study be undertaken to assess the short term (during construction) and long term (post-construction) impacts of the Northern Borrow Pits to groundwater levels, groundwater and surface water flows. This Surface Water Study should be reviewed upon completion of the Groundwater Study to ensure that the assumptions, conclusions, and recommendations remain valid.

6. References

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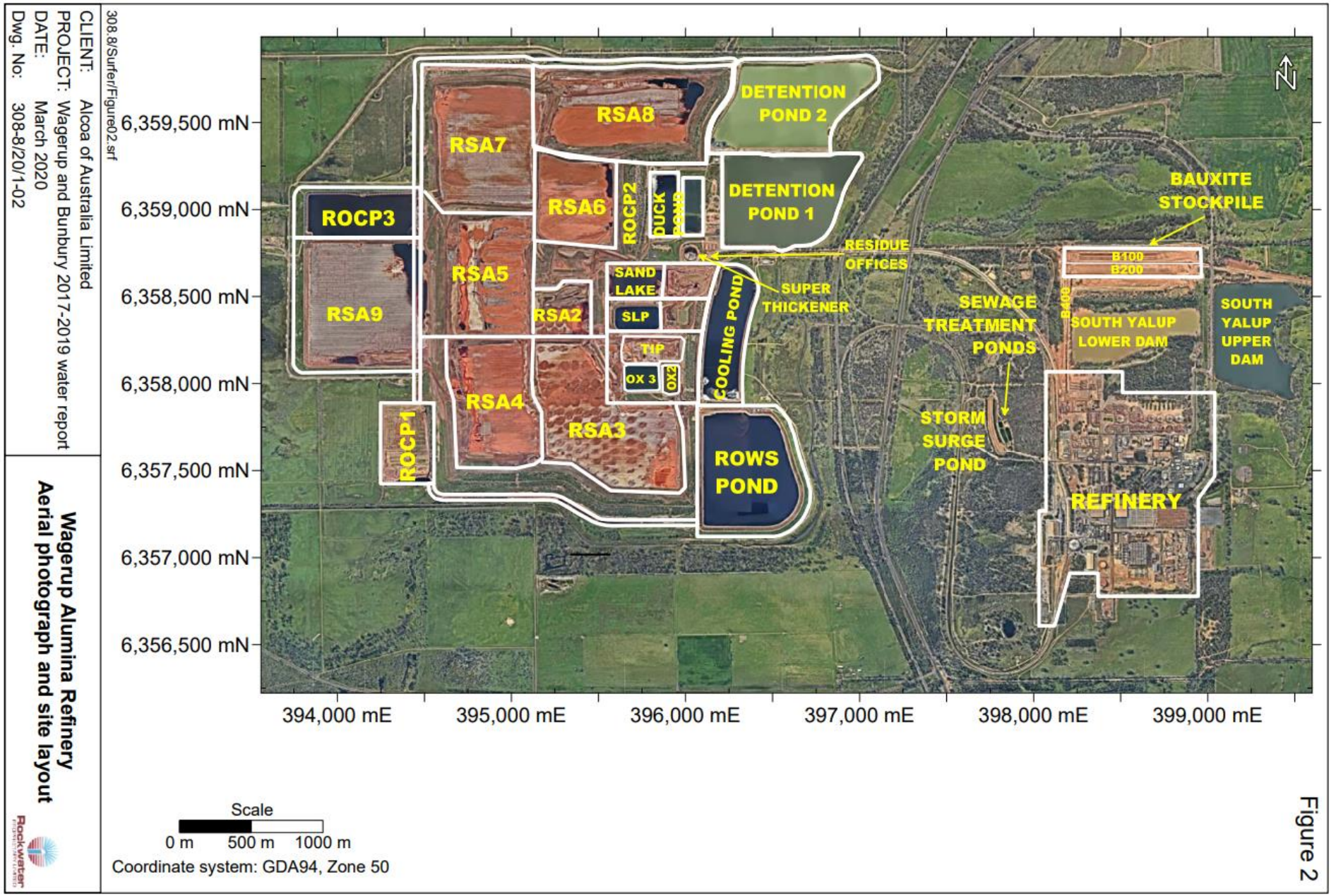
Appendix A

Existing RSA layout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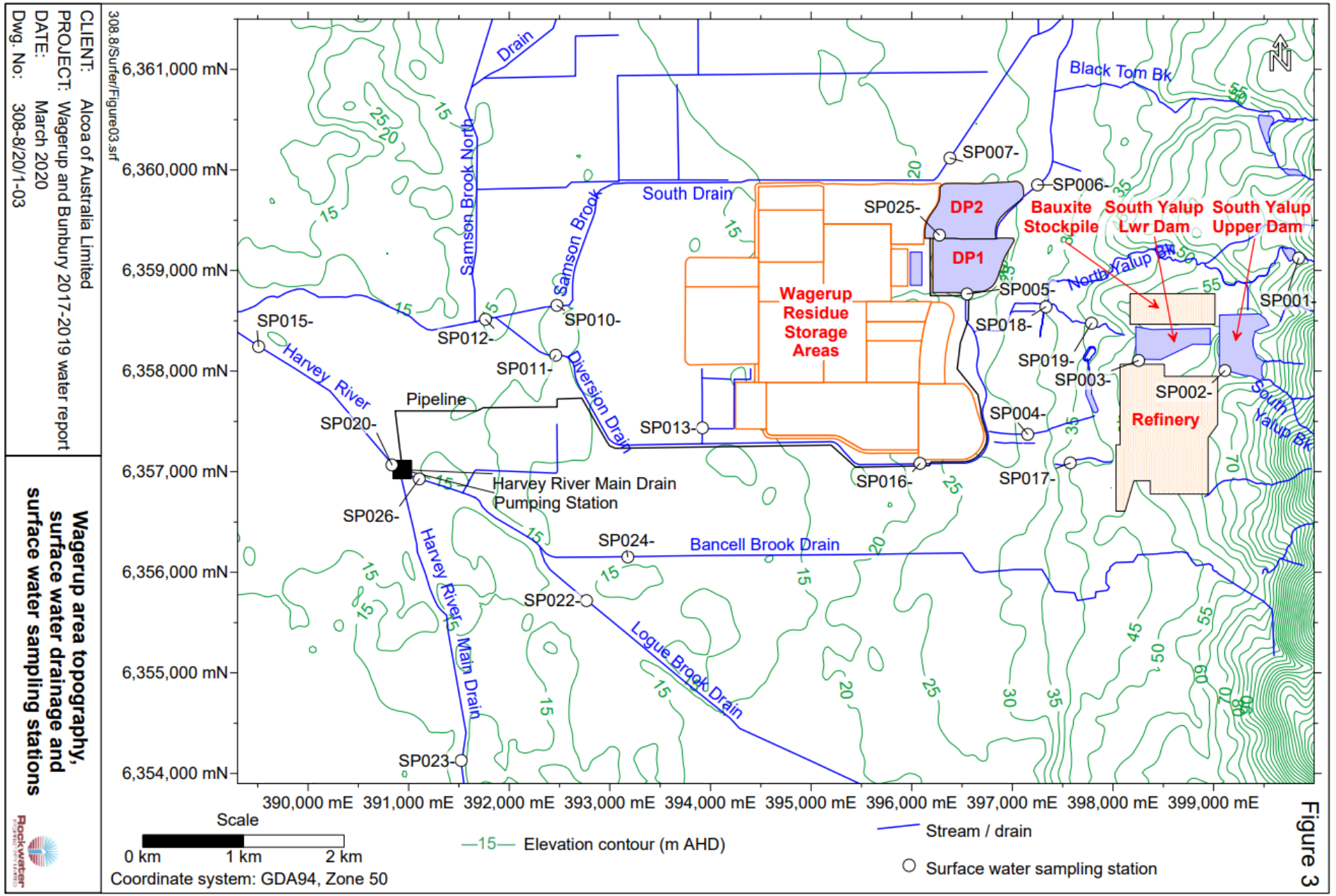
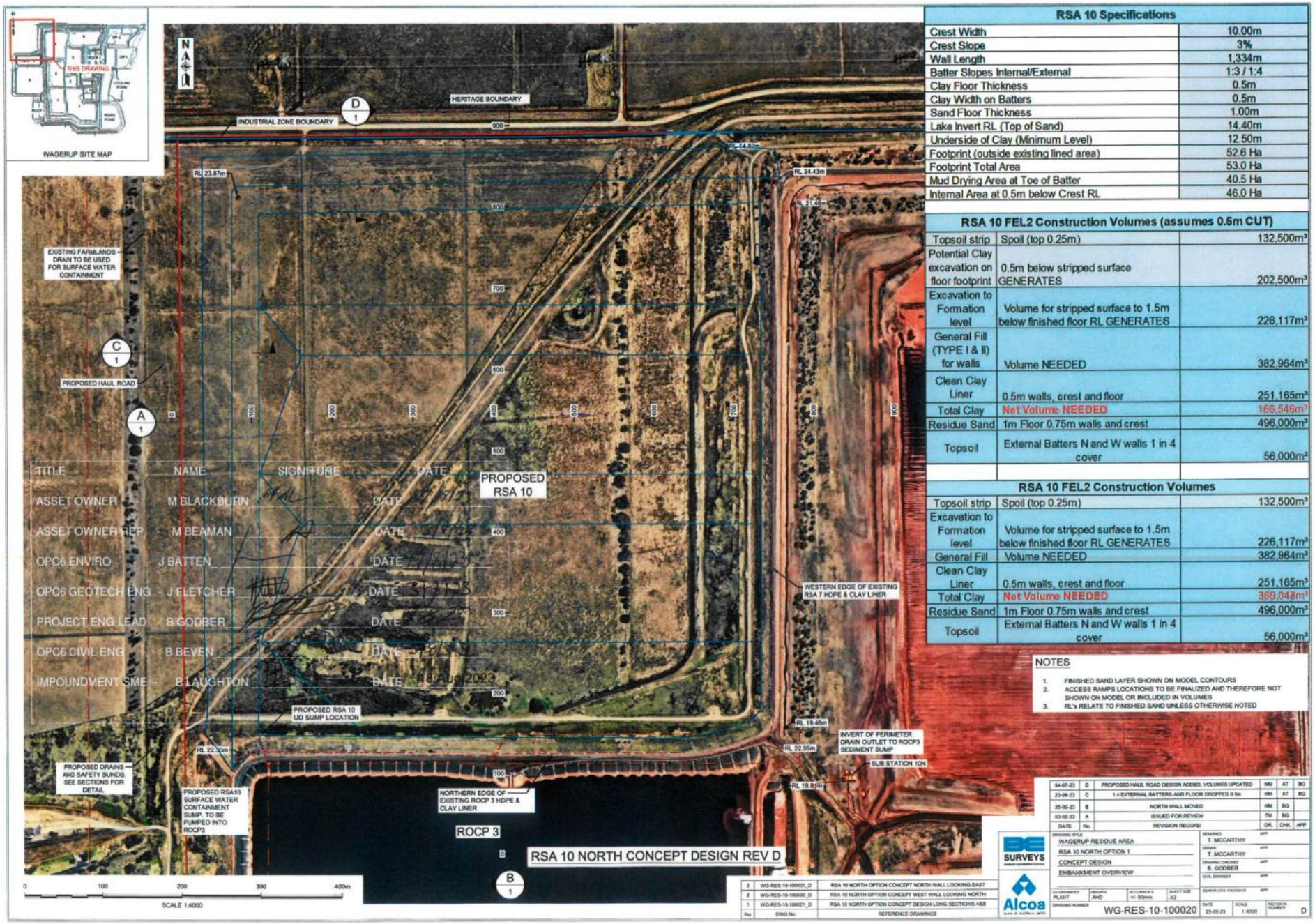
PROJECT: Wagerup and Bunbury 2017-2019 water report
DATE: March 2020
Dwg. No: 308-8/20/1-02
308.8/Surfer/Figure02.srf
Wagerup Alumina Refinery
Aerial photograph and site layout
Rockwater
6,359,500 mN
6,359,000 mN
6,358,500 mN
6,358,000 mN
6,357,500 mN
6,357,000 mN
6,356,500 mN
394,000 mE
395,000 mE
396,000 mE
397,000 mE
398,000 mE
399,000 mE
RSA8
DETENTION POND 2
RSA7
DETENTION POND 1
ROCP3
RSA6
ROCP2
DUCK POND
BAUXITE STOCKPILE
RESIDUE OFFICES
B100
B200
RSA5
SAND LAKE
SUPER THICKENER
COOLING POND
SEWAGE TREATMENT PONDS
B04
SOUTH YALUP LOWER DAM
SOUTH YALUP UPPER DAM
RSA9
RSA2
SLP
TIP
OX 3
OX2
RSA4
RSA3
ROCP1
ROWS POND
STORM SURGE POND
REFINERY
N
Scale
0 m 500 m 1000 m
Coordinate system: GDA94, Zone 50
Figure 2


CLIENT: Alcoa of Australia Limited
PROJECT: Wagerup and Bunbury 2017-2019 water report
DATE: March 2020
Dwg. No: 308-8/20/1-03
308.8/Surfer/Figure03.srf
Wagerup area topography, surface water drainage and surface water sampling stations
6,361,000 mN
6,360,000 mN
6,359,000 mN
6,358,000 mN
6,357,000 mN
6,356,000 mN
6,355,000 mN
6,354,000 mN
390,000 mE
391,000 mE
392,000 mE
393,000 mE
394,000 mE
395,000 mE
396,000 mE
397,000 mE
398,000 mE
399,000 mE
Drain
Samson Brook North
Samson Brook
South Drain
Black Tom Bk
SP007-
SP006-
SP025-
DP2
DP1
Bauxite Stockpile
South Yalup Lwr Dam
South Yalup Upper Dam
North Yalup Bk
SP005-
SP001-
SP018-
SP019-
SP003-
SP002-
Refinery
South Yalup Bk
SP004-
SP017-
SP016-
Wagerup Residue Storage Areas
SP015-
SP012-
SP010-
SP011-
Diversion Drain
Harvey River
Pipeline
SP020-
SP013-
Harvey River Main Drain Pumping Station
SP026-
SP024-
Bancell Brook Drain
SP022-
Logue Brook Drain
Harvey River Main Drain
SP023-
Scale
0 km
1 km
2 km
Coordinate system: GDA94, Zone 50
15 Elevation contour (m AHD)
Stream / drain
Surface water sampling station
Figure 3

Appendix B

RSA10 Concept design



RSA 10 Specifications	
Crest Width	10.00m
Crest Slope	3%
Wall Length	1,334m
Batter Slopes Internal/External	1:3 / 1:4
Clay Floor Thickness	0.5m
Clay Width on Batters	0.5m
Sand Floor Thickness	1.00m
Lake Invert RL (Top of Sand)	14.40m
Underside of Clay (Minimum Level)	12.50m
Footprint (outside existing lined area)	52.6 Ha
Footprint Total Area	53.0 Ha
Mud Drying Area at Toe of Batter	40.5 Ha
Internal Area at 0.5m below Crest RL	46.0 Ha

RSA 10 FEL2 Construction Volumes (assumes 0.5m CUT)		
Topsoil strip	Spoil (top 0.25m)	132,500m³
Potential Clay excavation on floor footprint	0.5m below stripped surface GENERATES	202,500m³
Excavation to Formation level	Volume for stripped surface to 1.5m below finished floor RL GENERATES	226,117m³
General Fill (TYPE I & II) for walls	Volume NEEDED	382,964m³
Clean Clay Liner	0.5m walls, crest and floor	251,165m³
Total Clay	Net Volume NEEDED	166,548m³
Residue Sand	1m Floor 0.75m walls and crest	496,000m³
Topsoil	External Batters N and W walls 1 in 4 cover	56,000m³

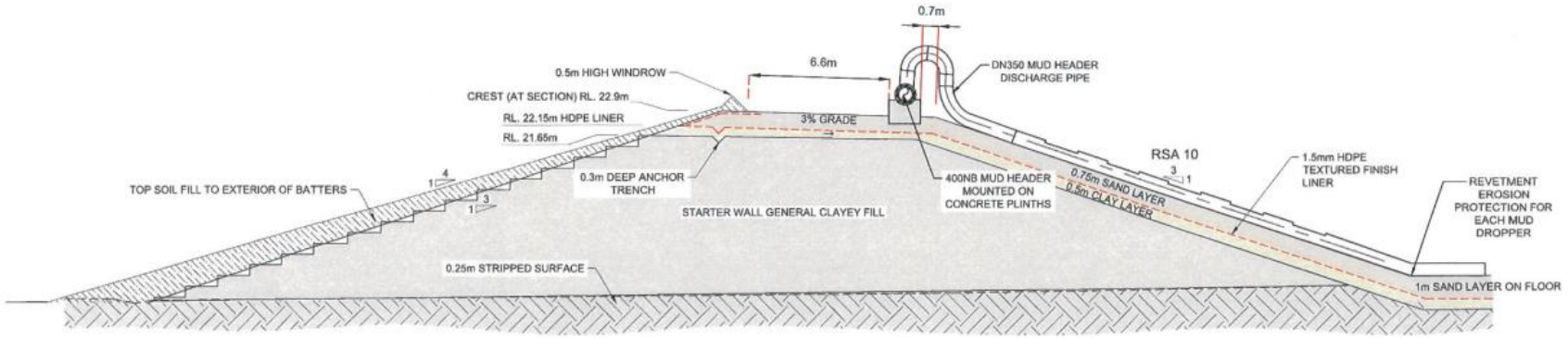
RSA 10 FEL2 Construction Volumes		
Topsoil strip	Spoil (top 0.25m)	132,500m³
Excavation to Formation level	Volume for stripped surface to 1.5m below finished floor RL GENERATES	226,117m³
General Fill	Volume NEEDED	382,964m³
Clean Clay Liner	0.5m walls, crest and floor	251,165m³
Total Clay	Net Volume NEEDED	369,048m³
Residue Sand	1m Floor 0.75m walls and crest	496,000m³
Topsoil	External Batters N and W walls 1 in 4 cover	56,000m³

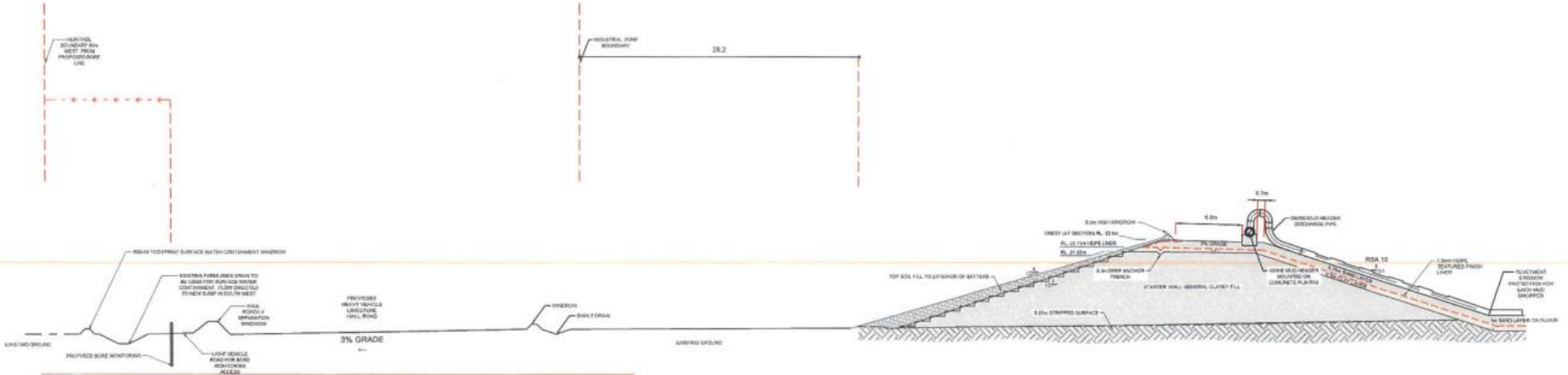
NOTES
1. FINISHED SAND LAYER SHOWN ON MODEL CONTOURS
2. ACCESS RAMPS LOCATIONS TO BE FINALIZED AND THEREFORE NOT SHOWN ON MODEL OR INCLUDED IN VOLUMES
3. RL's RELATE TO FINISHED SAND UNLESS OTHERWISE NOTED

3	WG-RES-10-100031_D	RSA 10 NORTH OPTION CONCEPT NORTH WALL LOOKING EAST			
2	WG-RES-10-100030_D	RSA 10 NORTH OPTION CONCEPT WEST WALL LOOKING NORTH			
1	WG-RES-10-100021_D	RSA 10 NORTH OPTION CONCEPT DESIGN LONG SECTIONS A&B			
No.	DWG No.	REFERENCE DRAWINGS			

04-07-23	D	PROPOSED HAUL ROAD DESIGN ADDED, VOLUMES UPDATED	NM	AT	BG
23-06-23	C	1:4 EXTERNAL BATTERS AND FLOOR DROPPED 0.5m	NM	AT	BG
25-05-23	B	NORTH WALL MOVED	NM	BG	
03-02-23	A	ISSUED FOR REVIEW	TM	BG	
DATE	No.	REVISION RECORD	DR.	CHK.	APP

DRAWING TITLE: WAGERUP RESIDUE AREA / RSA 10 NORTH OPTION 1 / CONCEPT DESIGN / EMBANKMENT OVERVIEW
DESIGNED: T. MCCARTHY
DRAWN: T. MCCARTHY
DRAWING CHECKED: B. GODBER
CIVIL ENGINEER:
SENIOR CIVIL ENGINEER:
CO-ORDINATES: PLANT
HEIGHTS: AHD
ACCURACIES: +/- 50mm
SHEET SIZE: A3
DRAWING NUMBER: WG-RES-10-100020
DATE: 25-05-23
SCALE: 1:4000
REVISION NUMBER: D





TITLE	NAME	SIGNATURE	DATE
ASSET OWNER	M BLACKBURN		17/8/23
ASSET OWNER REP	M BEAMAN		3/8/23
OPC6 ENVIRO	J BATTEN		17/8/23
OPC6 GEOTECH ENG	J FLETCHER		31/8/23
PROJECT ENG LEAD	B GODBER		3/8/23
OPC6 CIVIL ENG	B BEVEN		3/8/23
IMPOUNDMENT SME	B LAUGHTON		18/Aug/2023

RSA 10 -SECTION C
WEST WALL LOOKING NORTH

PRELIMINARY ONLY

30-08-23	D	PROPOSED HAUL ROAD DESIGN ADDED	NM	AT	BG
23-06-23	C	1:4 EXTERNAL BATTERS AND FLOOR DROPPED 0.5m	NM	AT	BG
23-05-23	B	NORTH WALL MOVED	NM	BG	
03-02-23	A	ISSUED FOR REVIEW	TM	BG	
DATE	No.	REVISION RECORD	DR.	CHK.	APP.

SURVEYS

Alcoa

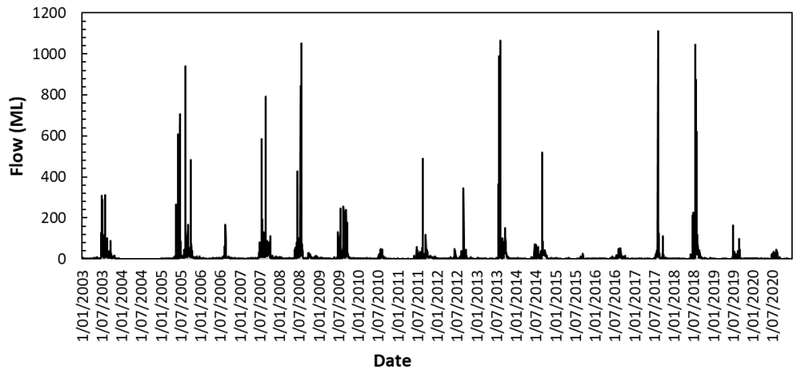
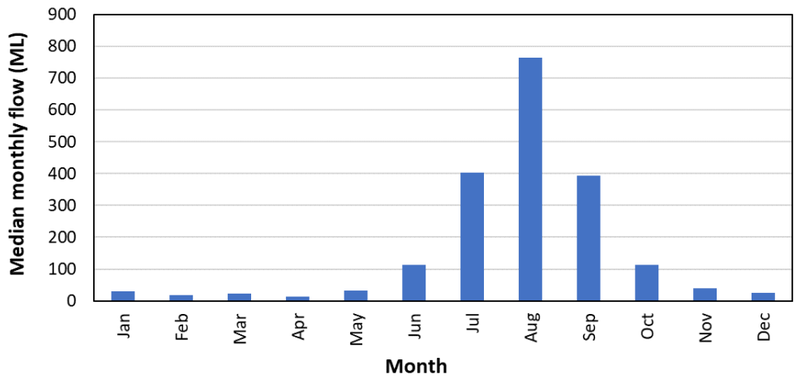
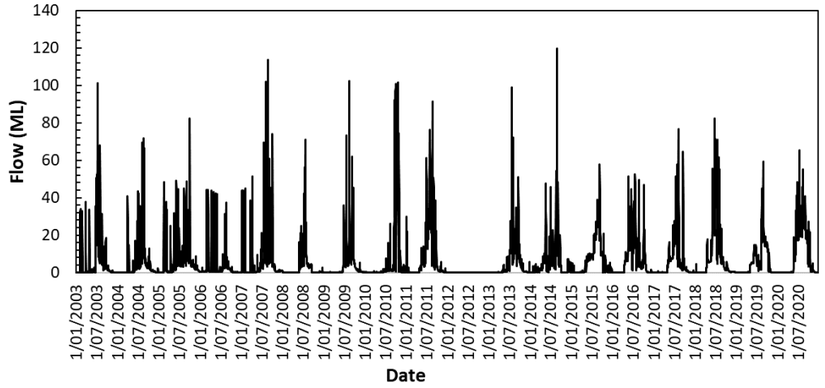
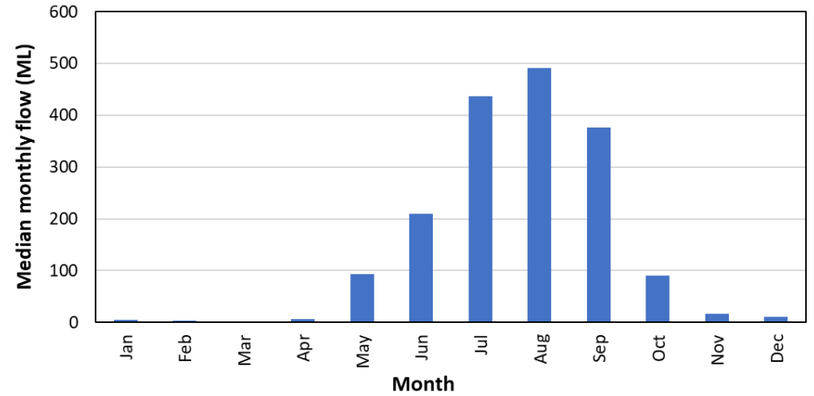
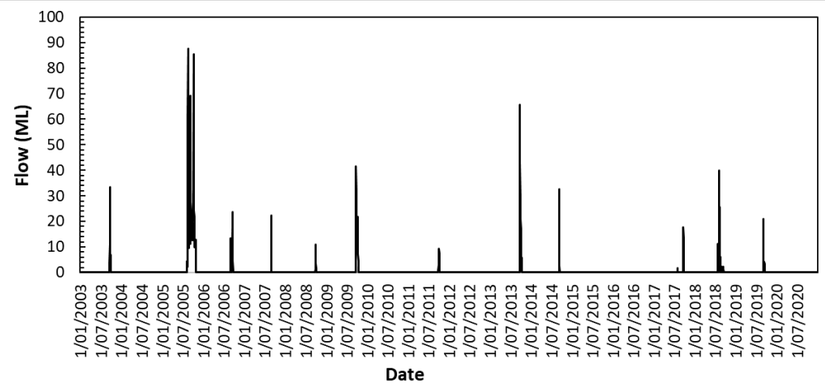
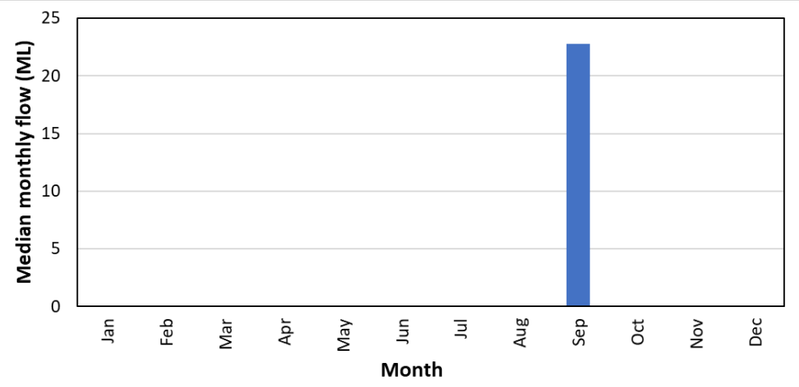
DRAWING TITLE	WAGERUP RESIDUE AREA RSA 10 NORTH OPTION 1 CONCEPT DESIGN SECTION C WEST WALL LOOKING NORTH
DESIGNED	T. MCCARTHY
DRAWN	T. MCCARTHY
DRAWING CHECKED	B. GODBER
CIVIL ENGINEER	
SENIOR CIVIL ENGINEER	
DRAWING NUMBER	WG-RES-10-100030
DATE	23-05-23
SCALE	1:1000
REVISION NUMBER	D

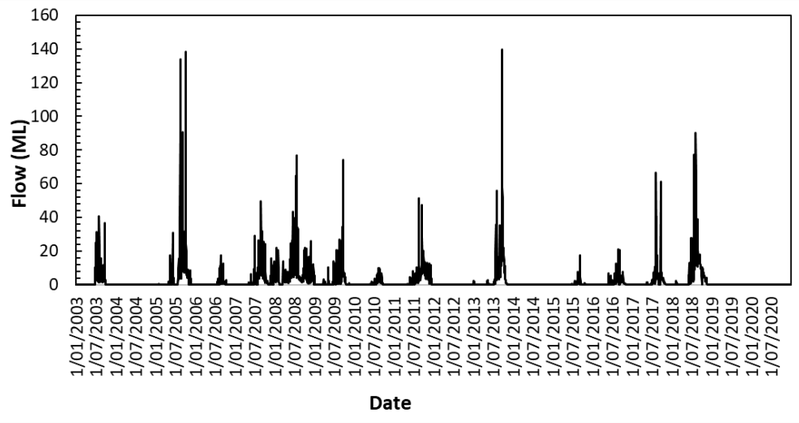
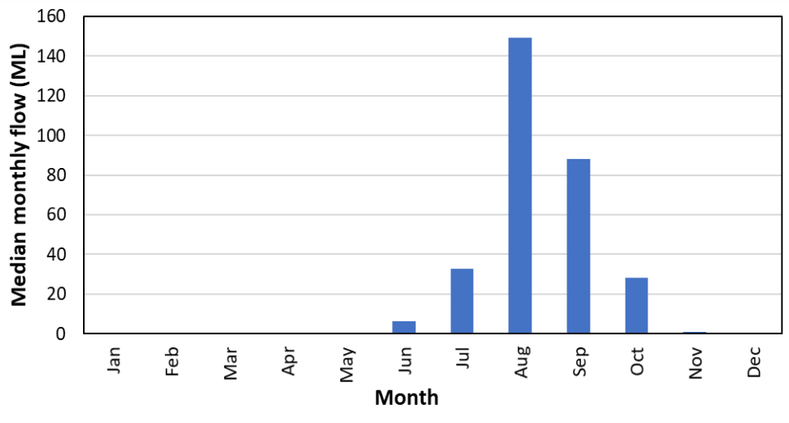
1	WG-RES-10-100020	WAGERUP NORTH OPTION RSA 10 CONCEPT DESIGN
Rev.	DWG No.	REFERENCE DRAWINGS

Appendix C

Alcoa water quantity plots

Table B.1 Surface water quantity for key monitoring locations

Surface water system	Monitoring location	Period	Daily flows (ML)	Median monthly flows
Samson Brook South Drain	SP012	2003 - 2020		
South Samson Diversion Drain	SP06	2003 - 2020		
	SP05	2003 - 2020		

Surface water system	Monitoring location	Period	Daily flows (ML)	Median monthly flows
	SP016	2003 - 2020		

Daily flows in Table B.1 contain periods of missing data, as summarised in Table B.2.

Table B.2 Missing data for each gauge

Date	Gauge station				
	SP12	SP05	SP06	SP16	SP10
1/02/2003	Yes				
30/09/2003				Yes	
15/12/2003					
16/12/2003	Yes	Yes	Yes	Yes	Yes
30/03/2004					
31/03/2004	Yes	Yes		Yes	Yes
31/12/2004					
1/01/2005					Yes
2/01/2005			Yes		
24/01/2005					
10/03/2005					
30/03/2005				Yes	
3/04/2005					
22/06/2005				Yes	
26/07/2005					
24/04/2006					Yes
24/07/2006					
1/01/2007				Yes	
3/01/2007					
27/02/2007				Yes	
27/03/2007					
1/05/2007				Yes	
29/06/2007					Yes
19/07/2007				Yes	
1/08/2007					
7/01/2008			Yes		
28/05/2008					
23/09/2008			Yes		
25/11/2008					
1/01/2009	Yes	Yes	Yes	Yes	
6/01/2009				Yes	
25/03/2009					
28/08/2009		Yes			
24/09/2009					
13/11/2009		Yes			
2/12/2009		Yes			
8/01/2014	Yes	Yes	Yes	Yes	

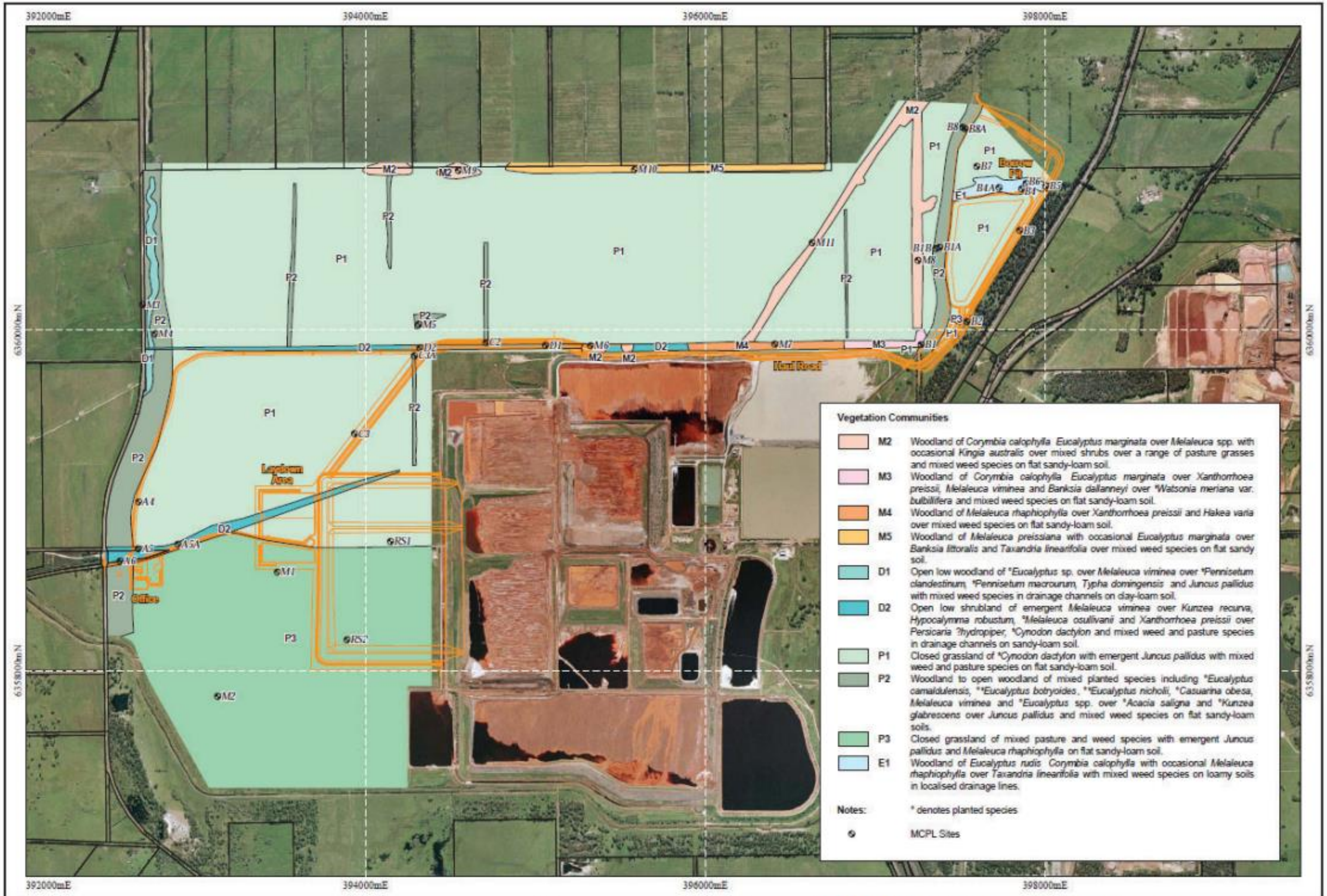
Date	Gauge station				
	SP12	SP05	SP06	SP16	SP10
5/10/2014			Yes		
3/12/2014					
4/12/2014					
6/01/2015	Yes		Yes		Yes
7/01/2015		Yes			
25/07/2015					Yes
5/11/2015					
3/01/2016			Yes		
6/04/2016					
2/12/2016					Yes
3/01/2018				Yes	
1/02/2018					
17/02/2018		Yes			
12/04/2018					
4/06/2019				Yes	
2/07/2019		Yes			
3/09/2019					
31/12/2020					

Note: Dates are inclusive and blank cells indicate available data.

Appendix D

Flora and vegetation mapping

Mattiske Consulting (2011)



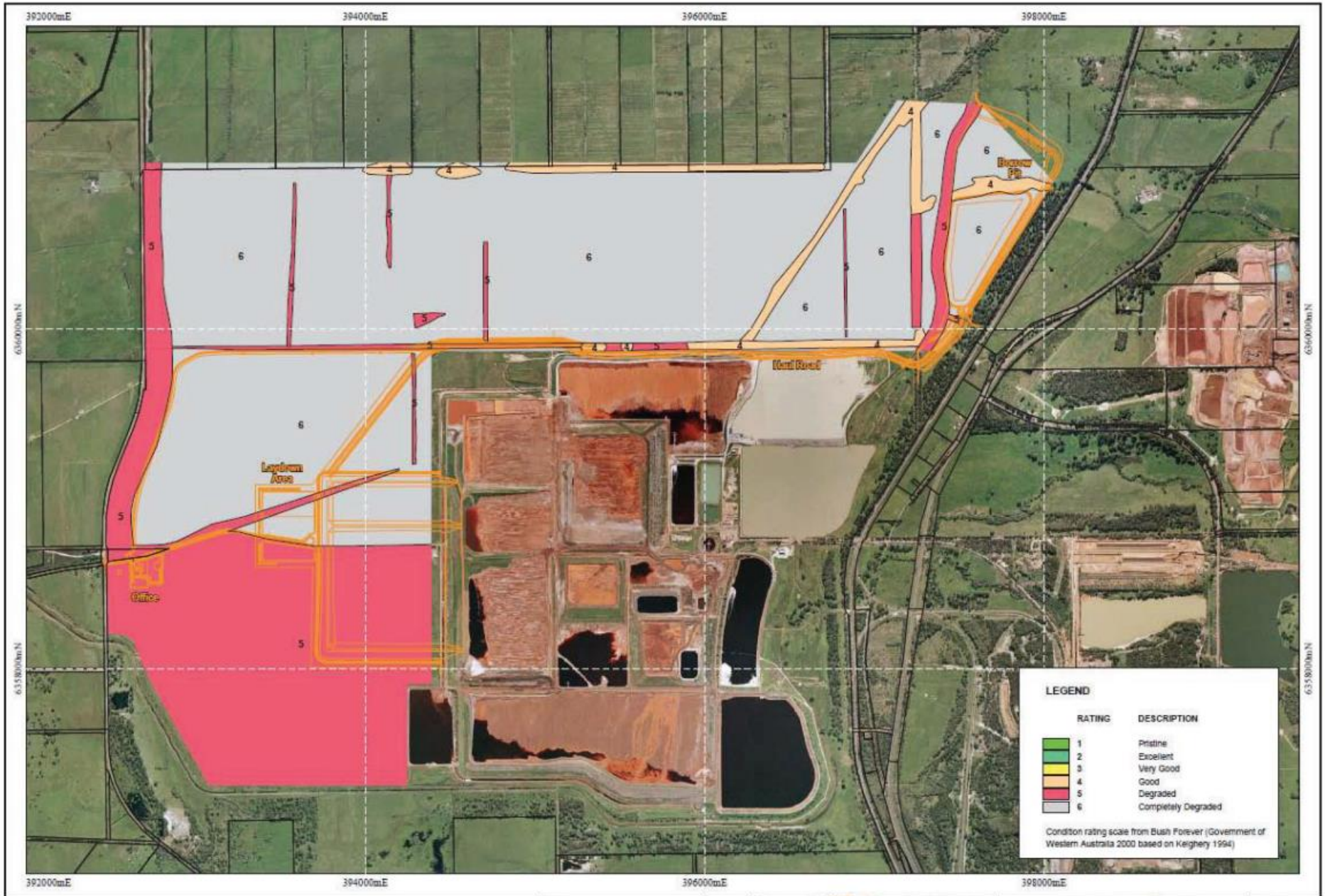
Client: ALCOA

MATTISKE CONSULTING PTY LTD

WAGERUP REFINERY

VEGETATION

Figure: 3



Client: ALCOA

MATTISKE CONSULTING PTY LTD
29 Central Road, Kalamunda WA 6076
Tel: 9257 9225 – Fax: 9257 5540

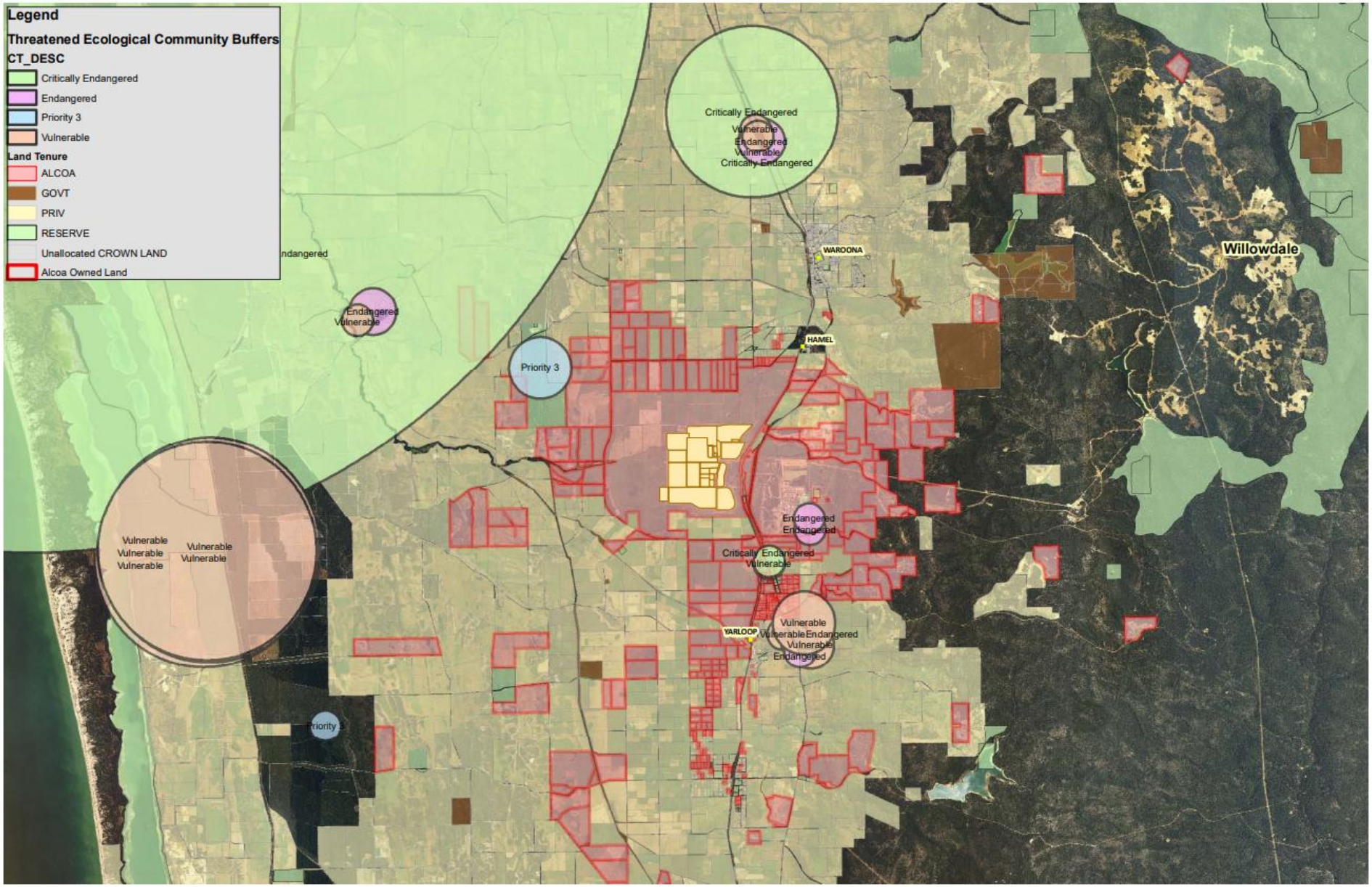
WAGERUP REFINERY

VEGETATION CONDITION

Figure: 4

Appendix E

TEC mapping


Legend
Threatened Ecological Community Buffers
CT_DESC
Critically Endangered
Endangered
Priority 3
Vulnerable
Land Tenure
ALCOA
GOVT
PRIV
RESERVE
Unallocated CROWN LAND
Alcoa Owned Land
Critically Endangered
Vulnerable
Endangered
Vulnerable
Critically Endangered
WAROONA
Willowdale
HAMEL
Priority 3
Endangered
Vulnerable
Vulnerable
Vulnerable
Vulnerable
Vulnerable
Endangered
Endangered
Critically Endangered
Vulnerable
YARLOOP
Vulnerable
Vulnerable
Endangered
Vulnerable
Endangered

Appendix F

Samson Brook South Drain EWR

Ecological water requirement at SP012 (Streamtec, 2008)

Table D.1 Recommended monthly flow regime to maintain ecological values for Samson Brook South Drain at flow data for monitoring location SP012 , based on EWRs (Streamtec 2008)

Month	Flow (ML) to maintain ecological value					
	Channel form	River pools	Macro-invertebrates	Fish passage	Seasonal adjustment	EWRs
January		78.7	15.0			78.7
February		75.6	13.5			75.6
March		88.2	11.2			88.2
April		97.8	14.5			97.8
May		101.1	15.0			101.1
June		10.8	14.5			280.3
July		11.2	15.0		156.8	842.5
August	1,296	11.2	15.0	1,268		1,268.5
September		10.8	14.5	1,310		765.4
October		283.2	15.0		161.3	283.2
November		101.4	14.5			101.4
December		98.3	15.0			98.3
Winter period (May to October) estimated EWR – 3,541 ML						

Table D.2 Annual flow data for monitoring location SP012 (2003-2020) in ML

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2003	40	12	22	38	78	433	1787	1076	509	284	54	11	4345
2004	No data												
2005	28	18	32	26	478	3218	452	2124	1174	1266	127	66	9009
2006	32	18	9	24	62	62	136	749	192	87	45	33	1451
2007	25	10	27	43	58	145	1635	1953	1058	459	81	142	5636
2008	97	32	29	49	286	1452	4092	346	215	318	138	159	7214
2009	118	69	61	38	65	387	1272	1164	1539	169	51	37	4968
2010	49	32	34	34	26	17	351	370	62	17	6	6	1003
2011	10	8	6	10	6	200	349	978	680	415	213	166	3042
2012	40	26	32	42	83	341	50	199	679	37	51	2	1582
2013	56	14	38	8	37	11	2030	2196	1721	323	39	29	6503
2014	34	17	10	1	44	277	719	780	1029	272	29	21	3232
2015	27	8	4	13	19	5	19	76	104	17	14	15	322
2016	19	43	32	11	19	51	101	626	205	94	15	10	1224
2017	14	25	7	10	12	2	342	3368	522	131	19	27	4479
2018	20	14	13	13	8	420	3651	1816	184	70	12	24	6244
2019	12	6	9	16	10	35	489	411	278	20	40	30	1358
2020	32	28	25	8	7	83	151	216	37	6	15	11	619

Appendix G

Disturbance Areas

WAGERUP ANNUAL RAINFALL			
ARI (year)	DEPTH (mm)	LOWER (mm)	UPPER (mm)
2	901.7	875.1	931.2
5	1043.6	1015	1073.2
10	1118.6	1087.7	1151.4
25	1196.1	1155.2	1242.3
50	1243.2	1188.2	1301.4
100	1282.9	1213	1356.8
200	1316.3	1231.9	1408.1
500	1352.7	1255.8	1468.4
1000	1375.4	1266.8	1515.9
10000	1428.8	1289.4	1627.4

WAGERUP MONTHLY PRECIPITATION													
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANN
AVG	18.8	13.6	20.9	45.8	129.6	178.5	183	135.5	88.6	52.7	25.8	13.7	906.6
MAX	116.7	75	76.8	157.6	267.4	404.1	370	288.7	202.5	137.2	72.3	62.6	1322.1
MIN	0	0	0.2	0.2	31.8	44.4	47.5	26.5	9.8	2.9	0.8	0	501.7

HATCHED AREA	AREA DESCRIPTION	CATCHMENT AREA m2	DURING CONSTRUCTION - CATCHMENT REPORTING TO	POST CONSTRUCTION - CATCHMENT REPORTING TO
1	CREST AREA OF RSA10 INCLUDING INTERNAL WALLS AND FLOOR	448131	PHASE 1 SUMP1 --> DP2 (NO RESIDUE SAND) PHASE 2 DIRECT TO ROCP3 (RESIDUE SAND CONTAMINATION)	RSA10N UD
2	EXTERNAL RSA10 EMBANKMENTS AND SURROUNDING AREA	125502	SUMP1 --> DP2	SUMP 1 --> FARMLANDS IRRIGATION/PADDOCK
3	EXISTING BORROW PIT AND HAUL ROADS	238571	BORROW PIT --> DP1	BORROW PIT --> DP1
4	EXISTING SEALED PROJECT AREAS	61000	SEALED AREAS --> FARMLANDS IRRIGATION/PADDOCK	SEALED AREAS --> FARMLANDS IRRIGATION/PADDOCK
5	EXISTING KUBANK ROAD/ FARMLANDS AND ADJACENT HAUL ROADS	219565	SUMP 5 --> DP2	SUMP 5 --> FARMLANDS IRRIGATION/PADDOCK
6	EXISTING HAUL ROAD	28320	SUMP 4 --> DP2	SUMP 4 --> SOUTH SAMSON DRAIN
7	PREVIOUS HV PARK-UP AREA	26000	SUMP 2 --> TRIPLE INTERCEPTOR --> ROCP3	SUMP 2 --> FARMLANDS IRRIGATION/PADDOCK
8	EXISTING HAUL ROAD	18271	DP2	DP2
9	EXISTING MATERIALS LAY DOWN AND PROPOSED HV PARK-UP	54400	SUMP 9 --> TRIPLE INTERCEPTOR --> ROCP3	SUMP 9 --> FARMLANDS IRRIGATION/PADDOCK

AREA 1
AREA 2
AREA 3
AREA 4
AREA 5
AREA6
AREA 7
AREA8
AREA9

0 300 600 900 1200m
SCALE 1:15000

PRELIMINARY ONLY

SERVICE AND SURFACE WATER MANAGEMENT PLAN

WAGERUP RESIDUE AREA
SITE
RSA10N OPTION 1
SERVICE AND SURFACE WATER MANAGEMENT PLAN

WG-RES-10-100041

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