Aurizon Operations Limited

Hexham Train Support Facility Turning Angle Stormwater Assessment

May 2019

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1. Introduction

1.1 Project background

Aurizon Operations Ltd (Aurizon) operate a Long Term Train Support Facility (LTTSF) at Hexham, NSW. The LTTSF was granted State Significant Infrastructure (SSI) Approval MP07_0171 (the SSI approval) in accordance with Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) by the NSW Minister for Planning and Infrastructure (under delegation) on 10th October 2013, subject to a number of conditions. The key components of the SSI approval are:

- Connections to the Great Northern Railway
- Seven train tracks parallel to the existing mainline and a shunt track at the northern part of the facility comprising 10.5 km of new railway track
- A provisioning building, a combined maintenance and administrative centre and service vehicle garage
- A bulk fuel storage area with capacity for up to 630,000 L of diesel fuel in seven above ground fuel storage tanks
- Vehicular intersection and new road from the Tarro Interchange and construction of sealed internal access roads
- Civil earthworks and importation of fill material
- Permanent stockpiling of up to 150,000 m^3 of Potential Acid Sulfate Soils
- Utility connections and the protection or diversion of existing utilities
- A wastewater treatment plant with on-site effluent irrigation

The LTTSF has been constructed and is currently operational under the SSI approval. It provides Aurizon with facilities to support operations in the Hunter Valley. This facility has entry and exit that connect to the mainline and provides provisioning and maintenance for Aurizon's fleet of locomotives and wagons.

Aurizon require the ability to better manage the movement of locomotives in and out of the LTTSF, specifically the capacity to marshal and re-orient locomotives to meet changing operational requirements.

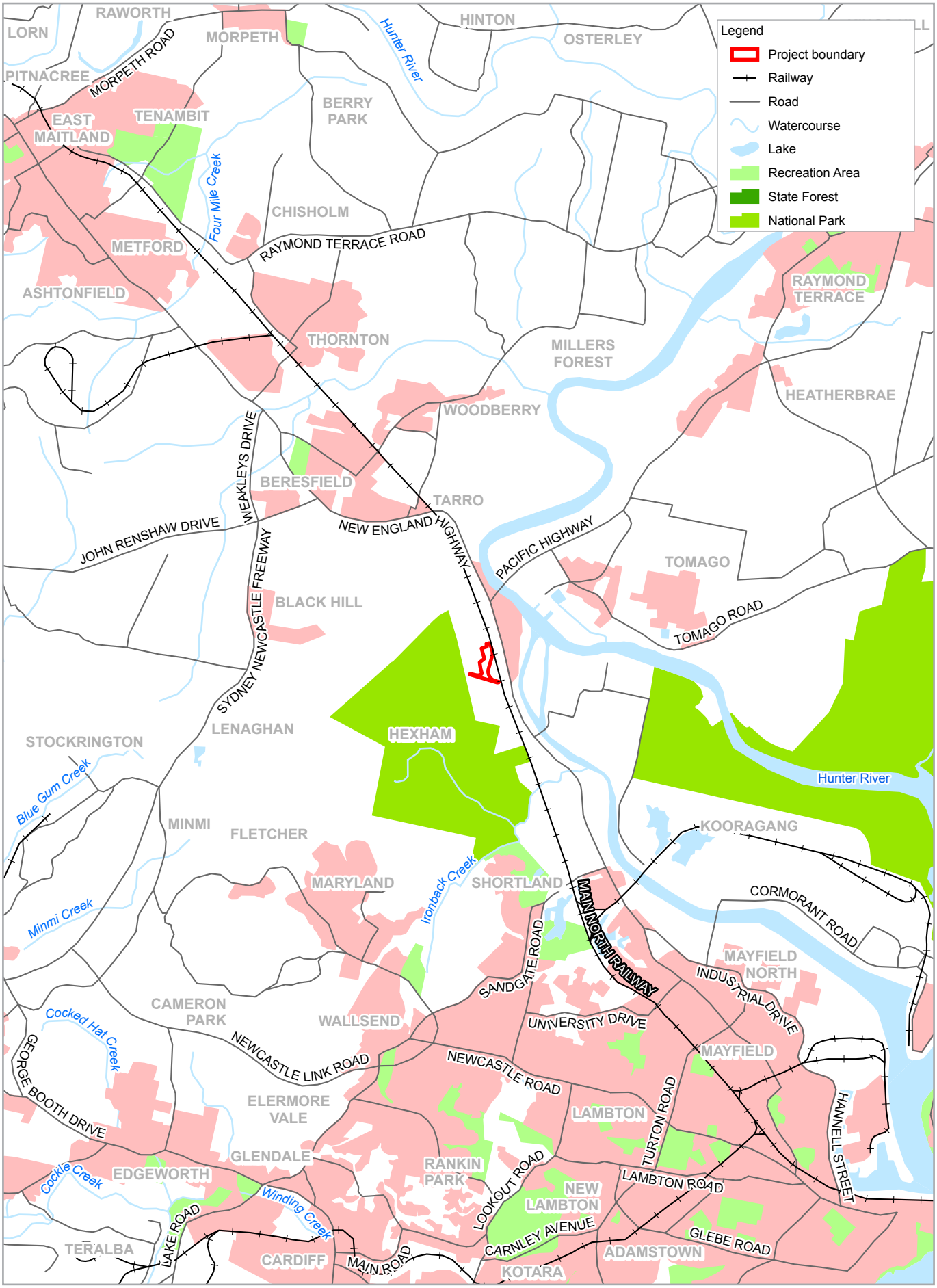
Aurizon is now proposing to alter the LTTSF by constructing a new turning angle in the southwestern portion of the site, which will require modification of the existing SSI approval (the proposal).

Aurizon engaged GHD Pty Ltd (GHD) to assess the potential impacts of the proposal on stormwater.

1.2 Purpose and scope of this report

The purpose of this report is to provide an assessment of potential impacts to stormwater as a result of the proposal. This assessment will inform the Environmental Impact Statement (EIS) for the modification to the existing SSI approval.

The Department of Planning and Environment (DPE) issued the Secretary's Environmental Assessment Requirements (SEARs) for the modification on 19 December 2018. This assessment has taken into account the SEARs related stormwater as identified in Section 1.6.



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Locality plan

Figure 1-1

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Data source: Geosciences Australia: 250K Topographic Data Series 3, 2006; LPI: DTDB / DCDB, 2017; Aurizon: Project boundary, 2019. . Created by: fmackay

This assessment has been undertaken based on review of previous investigations at the site and publicly available information. No additional field investigation or sampling has been undertaken.

1.3 Assumptions and limitations

This report has been prepared by GHD for Aurizon Operations Limited and may only be used and relied on by Aurizon Operations Limited for the purpose agreed between GHD and the Aurizon Operations Limited as set out in this report.

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

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

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

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

GHD has prepared this report on the basis of information provided by Aurizon Operations Limited 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 Site location and description

The LTTSF site is located at Maitland Road, Hexham within the Newcastle Local Government Area (LGA). The LTTSF site has a total area of 255 ha and is located approximately 16 km north-west of Newcastle CBD. The LTTSF site is bounded by the Great Northern Railway (GNR) and the Pacific Highway to the east and the New England Highway to the north. To the south and west are rural properties and the Hexham Swamp Nature Reserve. The LTTSF has been developed in the easternmost 38 ha portion of the site, parallel to (and to the west of) the GNR.

The broader LTTSF site covers multiple lots which are not affected by the modification proposal. The proposed works are fully contained within Lot 104 DP1189565, with the project area shown on Figure 1-2.

1.5 Project description

The construction and operation of the proposal will consist of:

- Installation and operation of a new turning angle, including new rail tracks and level crossings comprising:
  - Excavation works for railway track foundation and ballast.
  - Approximately 1.5 km of rail track and associated signal and turnout infrastructure comprising a single track straight of approximately 400 m in length extending from the existing rail yard to the proposed turning angle.

  - A turning angle with two arcs approximately 250 m in length and a straight of approximately 275 m.
  - Two 85 m straight single tracks at either end of the turning angle.
  - Four tangential turnouts.
- Construction of vehicle access tracks and associated lighting.
- Installation of culverts within existing drainage channels, under the rail track and access tracks.
- Associated civil and stormwater works.

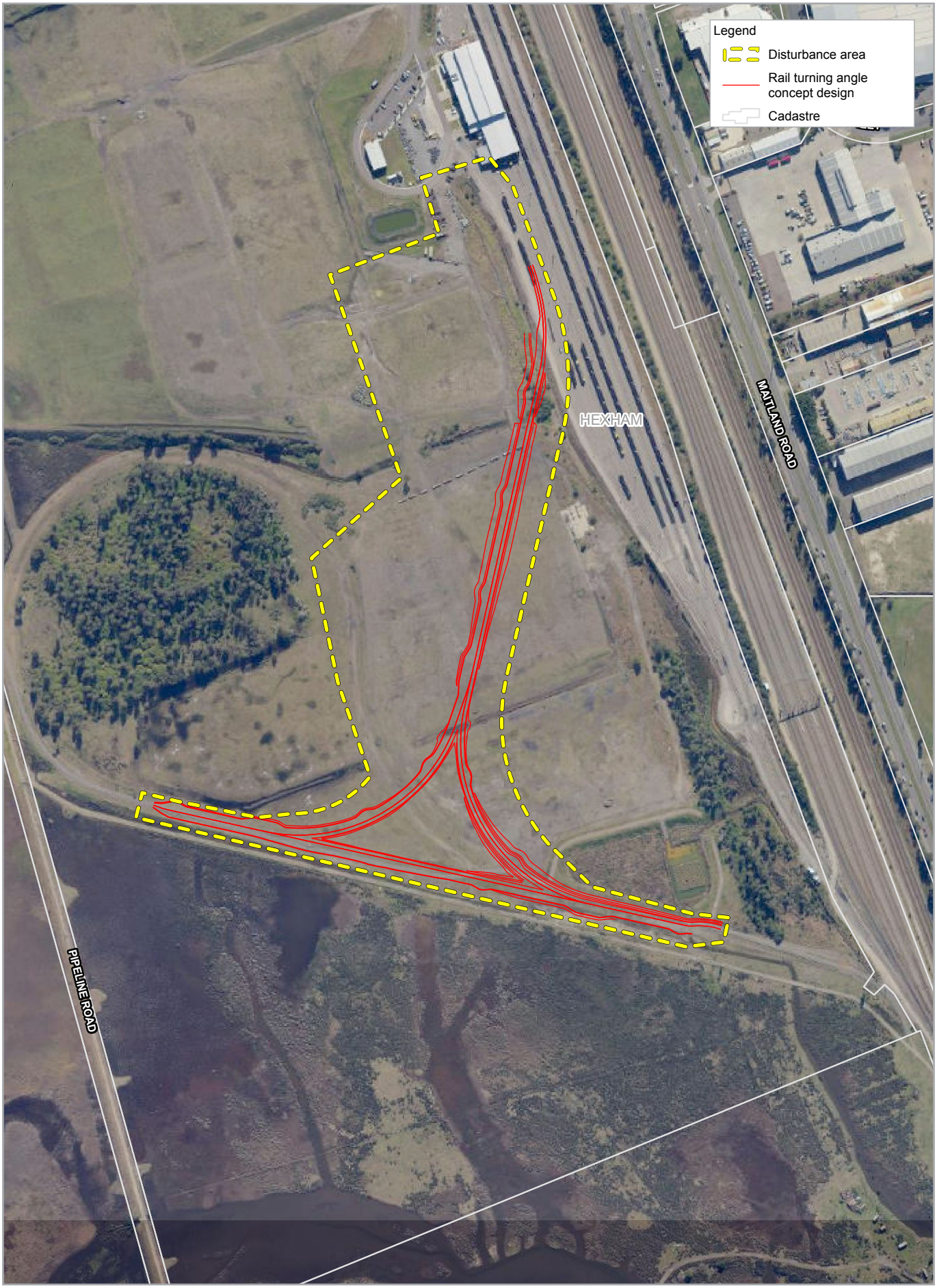
The proposal and relevant existing infrastructure are shown in Figure 1-2.

The proposed single track formation will lie between about 1.4 m below and about 1.0 m above the existing site surface. The majority of the formation, with the exception of the northernmost 350 m of the alignment, will lie between about 0.2 m below and 0.4 m above the existing surface.

Allowing for a formation (in both cut and fill areas) comprising 150 mm capping and 500 mm structural fill, excavations of up to about 2 m below the existing surface for the northernmost 350 m length of the alignment and up to 0.8 m below the existing surface for the remainder of the site are anticipated.

It is estimated that approximately 13 000 m^3 of soil will be required to be stockpiled during construction. All stockpiles, access roads and ancillary facilities will be located within the disturbance footprint shown in Figure 1-2.

The stormwater works have been designed to direct all stormwater from the operational parts of the turning angle to the existing stormwater management system, by means of the offset crowns, cess drains and culverts. All stormwater from the operational part of the proposed turning angle is expected to ultimately report to the existing Basin 03.



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Proposed turning angle

Figure 1-2

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1.6 Applicable standards and guidelines

This assessment has considered, where relevant, the following standards and guidelines.

Managing Urban Stormwater: Soils and Construction

Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom 2004) outlines the basic principles for the design, construction and implementation of sediment and erosion control measures to improve stormwater management and mitigate the impacts of land disturbance activities on soils and receiving waters. This document relates particularly to urban development sites; however, it is relevant to the proposal as it provides guidance on the configuration of erosion and sedimentation controls required during construction.

The potential impacts with respect to are considered the land disturbance during construction are considered in Section 4.1.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) provide guidance for assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values, such as aquatic ecosystems, primary industries, recreation and drinking water. A revised *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) was published in 2018 after a scientific review of the ANZECC (2000) guidelines. The Water Quality Management Framework (ANZG 2018) provides the key requirements for determining appropriate guideline values or performance criteria to evaluate the results of water quality monitoring programs.

NSW Water Quality and River Flow Objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) are the agreed environmental values and long-term goals for each catchment in NSW. The objectives are intended to be considered in assessing and managing the potential impacts of activities on waterways.

The proposal is located near waterways affected by urban development. DECCW (2006) identifies that waterways within urban areas that are often substantially modified and generally carry poor quality stormwater. The proposal has the potential to affect discharges to the Hexham Swamp.

The relevant water quality objectives are *protection of aquatic ecosystems* and *visual amenity* for the Hexham Swamp. The potential longer term objectives *secondary contact recreation* and *primary contact recreation* are not relevant to the Hexham Swamp and hence the proposal. The river flow objectives are to maintain wetland and floodplain inundation, mimic natural drying in temporary waterways (and wetlands), maintain natural flow variability, maintain natural rates of change in water levels and minimise effects of weirs and other structures.

Using the ANZECC Guidelines and Water Quality Objectives in NSW

Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006) provides guidance on applying appropriate trigger values from ANZG (2018) (formerly ANZECC 2000), including 'tailoring' trigger values to local conditions. This guideline was considered in this assessment, by considering the trigger values (in the form of discharge criteria) established for the site, as described in the approved management plan (Aurizon 2015b).

City of Newcastle Development Control Plan (2012)

The *City of Newcastle Development Control Plan (2012)* is the relevant local government standard that details requirements for development at the site and is required to be considered in the stormwater design by the SSI approval (C7). The development control plan includes water quality targets for the reduction of total suspended solids, total nitrogen, total phosphorous and gross pollutants that were considered in the EIS (WorleyParsons 2013).

Other guidelines

The following guidelines identified in the SEARs (refer to Section 1.7) are not considered relevant to this assessment for the following reasons:

- The *NSW Sustainable Design Guidelines Version 3.0* (TfNSW 2012) as the proposal is not being delivered by Transport for NSW.
- The *Biodiversity Assessment Method* (OEH 2017) as the proposal is located on a cleared, disturbed site and no new clearing is proposed.
- *NSW Aquifer Interference Policy* (DPI 2012) and *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (DPI 2012) as groundwater is not expected to be significantly impacted by the proposed earthworks, since all earthworks are planned above the groundwater table.
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DECC, 2008) as no sampling and analysis was undertaken for this assessment.

1.7 Secretary's Environmental Assessment Requirements

The Department of Planning and Environment (DPE) issued SEARs for the modification assessment on 19 December 2018. This report addresses SEARs for the key issue of stormwater. SEARs relevant to this assessment and where they are addressed in this report are presented in Table 1-1.

Table 1-1 Secretary's Environmental Assessment Requirements for the key issue of stormwater

Item No.	SEAR	How addressed
5.1	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	
5.1 (a)	Natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge.	The proposed works are located within the existing LTTSF and do not directly impact on natural processes in natural water features. The potential impacts on the proposal of stormwater discharges to the environment are assessed in Section 4.
5.1 (b)	Impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement.	Groundwater is not expected to be impacted by the proposed earthworks, as all earthworks are planned above the groundwater table.
5.1 (c)	Changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources.	No water is proposed to be removed or redirected from the receiving environment. Environmental water availability is therefore not expected to be impacted by the proposed works.
5.1 (d)	Direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	The proposed works are located within the existing LTTSF and do not directly impact on riparian vegetation or stability of watercourses. The potential impacts on the proposal of stormwater discharges to the environment are assessed in Section 4.
5.1 (e)	Minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems.	The potential impacts on the proposal of stormwater discharges to the environment and existing stormwater management system are assessed in Section 4. Mitigation measures are summarised in Section 5. No changes to wastewater are proposed.
5.1 (f)	Water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	No water is being diverted or extracted as part of the proposal.
5.2	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Monitoring of surface water and groundwater quality has been undertaken at the site since 2013. No additional baseline monitoring is recommended.

Item No.	SEAR	How addressed
6.1	The Proponent must:	
6.1 (a)	State the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values.	The NSW Water Quality Objectives for the site are identified in Section 1.6. Trigger values previously established for the site are used as the basis for assessment in Section 3.3.2.
6.1 (b)	Identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment.	Quantity and quality of all pollutants that may be introduced by the proposed works and the discussion of potential impacts associated with the works are described in Section 4.3.
6.1 (c)	Identify the rainfall event that the water quality protection measures will be designed to cope with.	The SSI approval requires that the existing stormwater system shall be capable of treating at least a 1% AEP stormwater event. This requirement is considered in Section 4.2.
6.1 (d)	Assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes.	The potential impact in terms of stormwater water quality are assessed in Section 4.3.
6.1 (e)	Demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: • Where the NSW WQOs for receiving waters are currently being met they will continue to be protected. • Where the NSW WQOs are not currently being met, activities will work toward their achievement over time.	The existing water quality is compared to the relevant trigger values in Section 2.6. Some concentrations of metals exceeded the trigger values, however this is likely attributable to historical land uses at the LTTSF site and unlikely to be impacted by the proposal. The potential for the proposal to impact on water quality objects that may be affected by the proposal is assessed in Section 4.3, and mitigation measures recommended to continue to achieve the water quality objectives are summarised in Section 5.
6.1 (f)	Justify, if required, why the WQOs cannot be maintained or achieved over time.	The exceedance of trigger values for some metals identified in Section 2.6 is likely attributable to historical land uses at the LTTSF site and unlikely to be impacted by the proposal. Refer to Section 3.3.
6.1 (g)	Demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented.	Mitigation measures have been incorporated into the detailed design and management and monitoring at the site has been reviewed. Refer to Section 5.

Item No.	SEAR	How addressed
6.1 (h)	Identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments.	The existing environment is described in Section 2. Mitigation measures are summarised in Section 5.
6.2	Identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Surface water monitoring began in 2015 (refer to Section 2.6). No additional monitoring is recommended (refer to Section 5).

2. Existing environment

2.1 Historical and current land use

Formerly, the site of the existing LTTSF contained a coal tailings stockpile and washery facility and a section of the former Richmond Vale Railway, which operated between 1856 and the late 1980s. In the 1950s the southern portion of the site was reclaimed and utilised as a Coal and Allied coal preparation, stockpiling and despatch terminal. These operations ceased in 1987, at which time the washery and the majority of the rail facilities were removed.

As a result of this previous land-use, there are significant stockpiles of coal washery reject in the central and southern portions of the site. There is also potential for a wide range of soil contamination to be present. At the time of the construction of the LTTSF, the site was used for cattle grazing and irrigated pastures.

The site of the proposal includes an existing access road on the formation of rail balloon loop associated with the historical washery. The site is cleared, and crossed by a number of access tracks and drainage channels.

2.2 Topography

The existing LTTSF site is within the Hexham Swamp and generally flat topography with natural ground surface ranging between 0 m AHD and 2 m AHD. There are some areas above or below this elevation due to manmade features such as drainage channels, tracks and the historical coal preparation plant and coal reject stockpile located north of the site with the highest point at 16 m AHD.

The slopes of the site are generally less than 1% and the terrain of the low lying areas do not form defined watersheds.

The site of proposal reflects this generally flat topography, with manmade access roads and drainage channels. The site of the proposal does not extend over the coal reject stockpiles.

2.3 Groundwater

Geotechnical investigation undertaken by GHD (2018b) revealed subsurface conditions consistent with Soil Landscape mapping. Fill, predominantly comprising coal washery reject material (including sandy gravel, gravelly sand and/or clayey gravel), was encountered at all locations to depths ranging from 1.7 m to greater than 3.5 m below the existing surface. At four locations, the fill was penetrated to encounter the underlying alluvial clay soils.

Groundwater was encountered at depths of generally 1.5 m (but up to 3.5 m in the northern area) below ground level within the proposal area. As described in Section 1.5, excavations of up to about 2 m below the existing surface for the northernmost 350 m length of the alignment and up to 0.8 m below the existing surface for the remainder of the site are anticipated. Therefore no groundwater is expected to be intercepted by excavations associated with the proposal.

2.4 Drainage

Prior to European settlement of the Hexham area, the site formed part of the Hexham Swamp Estuarine wetlands. However, over the past 150 years, manmade alterations on both a local and regional scale have been significantly altered by coal stockpiling, infilling of wetlands, construction of tailings ponds and drainage swales and irrigation of waste water effluent. The resulting landform is considered highly disturbed.

Surface water runoff from the LTTSF operational area reports to the onsite Basin 01, Basin 02 and Basin 03 via the constructed drainage line on the western boundary of the LTTSF infrastructure area. Water within the basins is retained allowing settlement of suspended particulates and bioremediation through floating wetlands. Under certain rainfall conditions the basins overflow to the Hexham Swamp. In the event of major regional flooding of the Hunter River, Basin 03 would be inundated along with the surrounding floodplain.

Areas outside the operational area drain to the Hexham Swamp via culverts around the boundary of the site. The site of the proposal is currently outside the operational areas and drains via two man-made drains towards the west. The site of proposal is adjacent to the Basin 03. Stormwater flows to Basin 03 along a stormwater drain from the north and discharges via two 450 mm diameter culverts at the south east corner of the LTTSF site.

The proposal will redirect the catchment area that is currently outside the operational area of the LTTSF site to the existing water management system that reports to Basin 03.

2.5 Vegetation

Hexham Swamp Nature Reserve is located to the west of the LTTSF site and is approximately 1950 ha in area. In conjunction with the Kooragang Nature Reserve to the east, it is the largest estuarine reserve in NSW with a total combined area of around 3000 ha. Hexham Swamp is recognised as a regionally important system and receives inflows from catchments extending from Mt Sugarloaf (14.5 km south-west of Hexham) Bluegum Hills, Minmi, Maryland, Ironbark Creek and Canoe Channel. These catchments are experiencing urbanisation. In addition to the ecological aspects, Hexham Swamp is also important as a storage during major flooding events. Although under the operation of flood gates since the 1970s, the swamp is inundated by flows from the Hunter River during floods generally around the 10 year ARI.

The EIS identified a number of endangered ecological communities (EECs) near the LTTSF site: Swamp Oak Forest, Swamp Oak Floodplain Forest and Coastal Saltmarsh. Basin 03 discharges towards the Coastal Saltmarsh community to the south east of the site and may potentially be impacted by the proposal. There are no potential impacts expected to the other EECs, since no change to the catchments reporting to them is proposed.

The site of the proposal is predominantly covered with grasses with scattered trees, reflecting the historical disturbance.

2.6 Water quality

An operational surface and groundwater quality monitoring program has been undertaken at the LTTSF site since late 2015 (Aurizon 2015b). The surface water quality monitoring program includes the location SW5 near the outlet of Basin 03 into a drainage channel that reports to Hexham Swamp (refer to Figure 1-2. SW5 is monitored when flow is present and has been sampled for laboratory analysis approximately 20 times over about a three year period.

Trigger values, in the form of discharge criteria, have been established for this site for a range of parameters (Aurizon 2015b). Category B values for the Hexham Nature Reserve are applied at SW5.

A recent review of surface monitoring results (GHD 2018a) identified that turbidity (2 samples), iron (all 5 samples), nickel (all 5 samples) and zinc (1 sample) exceeded the relevant trigger value for SW5 during 2018. These elevated metal concentrations are likely attributable to the historical land use of the site (refer to Section 2.1).

3. Methodology

3.1 Potential impacts

The objective of this assessment is to identify and assess the significance of the potential impacts of the proposal on the receiving surface water environment. This enables the development of measures to avoid or mitigate impacts.

In terms of stormwater, the potential impacts are related to the changes to catchments due to the proposal, as shown in Figure 3-1. The area of the proposed turning angle will be redirected from outside the operational area of the LTTSF (that currently drains west to Hexham Swamp) to Basin 03. Where the proposal cross the existing historical drainage lines that flow to the west, new culverts are proposed as part of the detailed design, however runoff from the operational part of the proposal turning angle will be conveyed by the proposed drains away from the existing historical drainage lines and towards Basin 03.

The proposal will also result in an increase in impervious catchment. Therefore, the proposal has the potential to impact on the quantity and quality of stormwater discharge to the environment.

3.2 Stormwater quantity

3.2.1 Hydrologic modelling

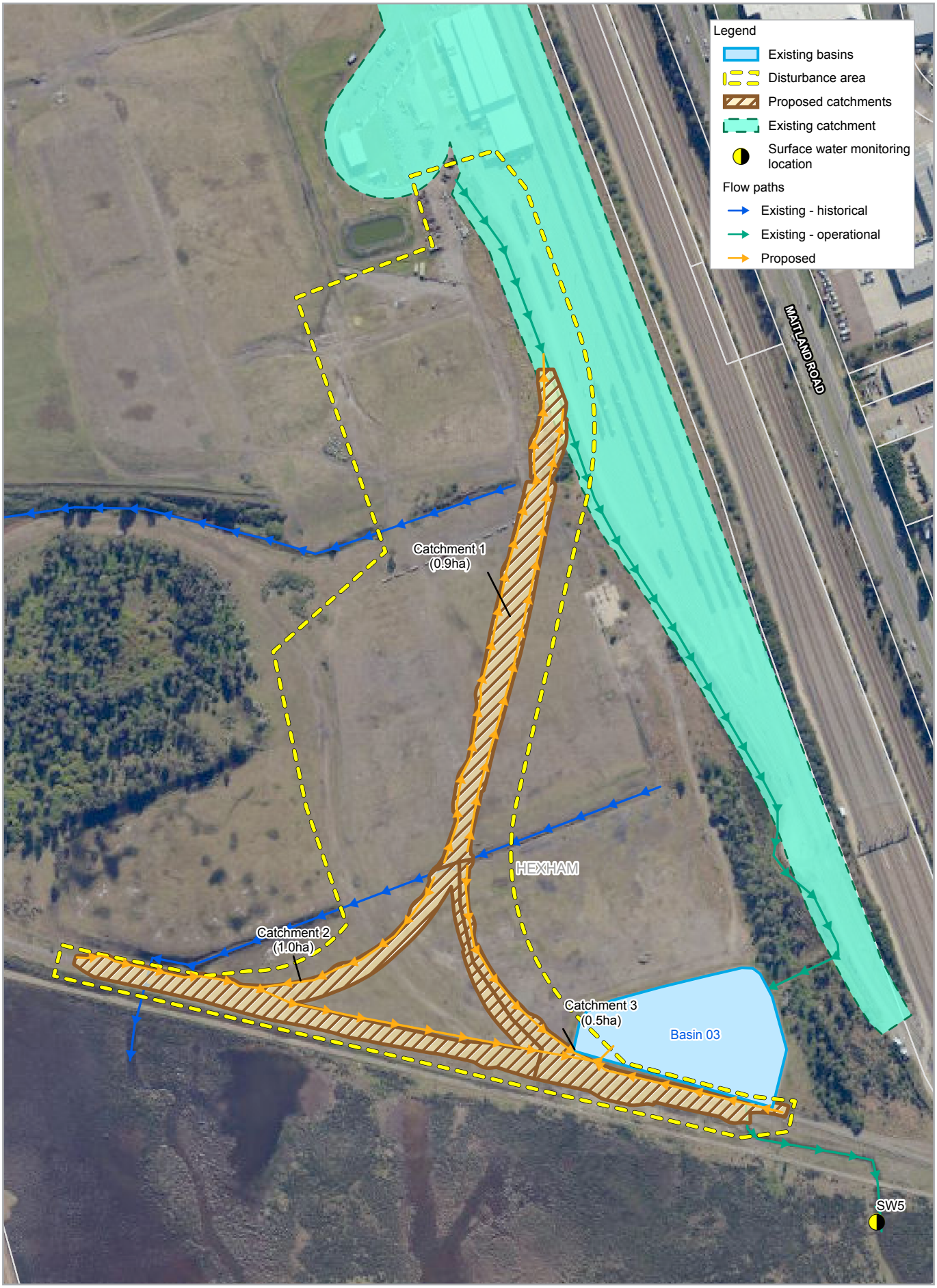
The hydrological assessment for this investigation was performed using XP-RAFTS (2013), a rainfall-runoff model designed for Australian catchments. An XP-RAFTS model was previously developed for the detailed design of the LTTSF. This model was updated to reflect the current industry guidelines, Australian Rainfall and Runoff 2016 (ARR2016: Ball et al. (eds.) 2016), and the proposed change in catchment due to the proposal.

Design rainfall and design losses for the site was obtained from the BOM (2019) and the ARR data hub (Ball 2019) respectively for the nearest grid cell (32.8375 S, 151.6875 E). Standard design frequencies from each year (12EY) and 1% AEP and standard durations from 30 minutes to 12 hours were considered. The peak discharge from Basin 03 was generally had a critical duration of 6 hours.

Rainfall losses represent the rainfall depths which are lost from the system and will not contribute to runoff from the site. These losses aim to simulate general losses through interception, infiltration and surface depressions. For this assessment, the losses adopted for pervious areas were 17 mm initial loss and 2.7 mm/hr continuing loss and for the impervious areas were 1 mm initial loss and 0 mm/hr continuing loss.

The catchment roughness parameter of the catchment reflects the efficiency of the stormwater moving through the catchment. For pervious areas, a parameter value of 0.035 was adopted. For impervious areas, a value of 0.025 was adopted, reflecting more efficient hydraulic conditions representative of paved or compacted surfaces. The catchment slopes for both the developed and existing conditions modelled are generally less than 1%. For the existing and developed conditions 0.5% was adopted as the typical catchment slope.

Links were used in XP-RAFTS to model channels, to reflect the attenuation and storage provided throughout the site by the existing and proposed drainage channels. The channels linking the sub catchments were modelled as trapezoidal channels, with a typical base width of 2 m, side slopes of 1(V):3(H) and longitudinal grade of 0.1%. Basins were modelled in the XP-RAFTS model, based on the design stage storage and outlet sizes. For the purpose of the modelling, the “triangle” formed by the proposed turning angle was considered as a basin.



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Proposed catchments and drainage

Figure 3-1

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Print date: 20 Mar 2019 - 09:34

Data source: LPI: DTDB / DCDB, 2017; Aurizon: Disturbance boundary, 2019. public_NSW_Imagery: public_NSW_Imagery: . Created by: fmackay

3.2.2 Assessment criteria

The assessment criteria for stormwater quantity were based on the SSI approval, consistent with previously prepared Stormwater Management Plan (WorleyParsons 2013), namely:

- Runoff volumes are maintained, as far as practicable, to pre-construction levels
- Site stormwater is directed to stormwater detention basins for treatment
- The stormwater system shall be capable of treating at least a 1% AEP stormwater event

3.3 Stormwater quality

The proposed turning angle is not expected to be used routinely for maintenance activities and therefore there is a low probability of oils, hydrocarbons and contaminated materials entering the stormwater management system. Therefore, assessment of potential impacts to water quality are limited to total suspended solids, total nitrogen and total phosphorous as these are water quality parameters that are potential impacted by the proposal. As discussed in Section 2.6, the elevated metal concentrations likely reflect the historical land use at the LTTSF site and are unlikely to be impacted by the proposal. However, as identified in WorleyParsons (2013), removal of nutrients would also generally also be associated with some removal of any potential heavy metals, oil and grease in the stormwater.

3.3.1 MUSIC modelling

MUSIC is a continuous conceptual water quality assessment model developed by the Cooperative Research Centre for Catchment Hydrology. MUSIC can be used to estimate the long-term annual average stormwater volume generated by a catchment as well as the expected pollutant loads. MUSIC is able to conceptually simulate the performance of a group of stormwater treatment measures (treatment train) to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

A MUSIC model was previously prepared for the detailed design of the LTTSF. This model was updated to reflect the proposed changes in catchments due to the proposal.

Rainfall and evaporation

The rainfall and evaporation data was sourced from BOM for the Williamtown (Station 061078) located about 15 kilometres to the east. This site had a long period of consistent data and was an adequate representation of the long-term averages of rainfall and evaporation near the site. The average annual rainfall for the 18 year period available was 1106 mm.

Table 3-1 Monthly rainfall and evaporation adopted for MUSIC modelling

	Rainfall (mm)	Evaporation (mm)
January	95	188
February	121	148
March	120	148
April	107	96
May	115	66
June	122	53
July	73	56
August	76	72
September	59	100
October	72	138
November	81	162
December	79	180

Catchment

For the purposes of the water quality modelling, the following catchment parameters were adopted:

- Impervious fraction of 90%. Although the majority of the site is earth and allows infiltration, the high impervious fraction has been adopted to account for the capture of the of stormwater runoff into the subsoil system which would require treatment.
- Urban pollutant loads stochastically generated using parameters detailed in ater by Design (2010).
- Soil storage and field capacity are the default MUSIC rainfall-runoff parameters as summarised in Table 3-2.

Table 3-2 MUSIC modelling catchment parameters

Rainfall-Runoff Parameter	Input
Field Capacity	80 mm
Impervious Area Rainfall Threshold	1 mm/day
Pervious Area Soil Storage Capacity	30 mm
Pervious Area Soil Initial Storage	30% (of capacity)
Groundwater Initial Depth	10 mm
Groundwater Daily Recharge Rate	25%
Groundwater Daily Base flow Rate	5%
Groundwater Daily Deep Seepage Rate	0%

Basin 03

As part of the LTTSF, the existing Basin 03 was constructed with a floating wetland designed to provide enhanced nutrient and sediment removal from stormwater discharged from the site. Wetlands have long been acknowledged as effective means to provide stormwater treatment however floating wetlands were selected for the LTTSF due to improved treatment efficiency.

The inlet bays were modelled as the sediment ponds on the inlets to each basin as detailed below. The parameters for the ponds are detailed in Table 3-3 and are based on the volumes and areas extracted from the design.

Table 3-3 Sediment pond MUSIC parameters

Basin	Pond Surface Area (m^2)	Pond Permanent Water Volume (m^3)	Extended Detention Depth (m)
Basin 03	6400	240	0.30

The generic treatment node parameters are based on information provided by the manufacturer (SPEL) with the low and high flow parameters altered to match the 90th percentile flow for the site. The parameters for the treatment effectiveness for the floating wetland are summarised in Table 3-4.

Table 3-4 Floating wetland transfer functions

Parameter	<90th Percentile		>90th Percentile	
	Input	Output	Input	Output
TSS (mg/L)	1000	100	1000	400
TP (mg/L)	5	1.55	5	2.25
TN (mg/L)	50	5	50	55.5

The transfer function shown in Table 3-5 depend on the incoming flow rate. For both of the catchments, the 90th percentile flow rate is approximately the three month flow from the catchment as summarised in Table 3-5.

Table 3-5 Floating wetland flow thresholds

Basin	<90th Percentile		>90th Percentile	
	Low Flow By Pass	High Flow By Pass	Low Flow By Pass	High Flow By Pass
Basin 03	0.00	0.075	0.075	3.50

3.3.2 Assessment criteria

The City of Newcastle (CN) Development Control Plan 2012 (CN 2012) outlines criteria for water quality. These criteria were used to assess the LTTSF in WorleyParsons (2013). The criteria are summarised in Table 3-6.

Table 3-6 Pollution reduction criteria

Parameter	Units	Reduction target
Total Suspended Solids (TSS)	kg/year	85%
Total Phosphorus (TP)	kg/year	65%
Total Nitrogen (TN)	kg/year	45%
Gross pollutants	kg/year	90%

Following the construction of the LTTSF facility, a program of regular sampling of surface water and groundwater monitoring has been active in accordance with the requirements of the site Operational Environment Management Plan (OEMP). In preparation of the OEMP, Discharge criteria were developed for Aurizon by Douglas Partners (February 2014) based on the Australian and New Zealand Guidelines for Fresh Water Quality 95% species protection levels (ANZECC, 2000).The discharge criteria were issued to the Department of Planning and Environment (DP&E) and approved as a component of the operating strategy General Management Plan (OSGMP).

The discharge criteria for the site have been categorised as A, B or C, based on the receiving environment. The Category B applies to discharge locations 4, 5 and 6 of the OSGMP. These locations discharge from the LTTSF site to Hexham Swamp along the western and southern border of the site. The Category B Criteria are for the parameters relevant to the assessment are summarised in Table 3-7.

Table 3-7 Discharge criteria

Parameter	Units	Discharge criteria (Category B, Hexham Nature Reserve)
Total Nitrogen (TN)	mg/L	4
Total Phosphorus (TP)	mg/L	7.9
Total Suspended Solids (TSS)	mg/L	40

4. Assessment of stormwater impacts

4.1 Construction phase

During the construction phase, earthworks and other construction activities have the potential to disrupt flow paths and increase the concentration of suspended sediments in stormwater due to erosion. Given the short duration of the construction phase, the potential impacts to stormwater other than erosion are considered minor, and therefore the potential stormwater impacts are considered as part of the soil assessment (GHD 2019).

4.2 Operational stormwater quantity

The area of the proposed turning angle will be redirected from western outlet to Hexham Swamp towards Basin 03 (refer to Figure 3-1). The proposal will also result in an increase in impervious catchment. However, the impact will be mitigated by the hydraulic attenuation of Basin 03 and the "triangle" of the turning angle. The impact of these changes on the peak flows from the Basin 03 outlet for various design frequencies are summarised in Table 4-1.

Table 4-1 Impact on peak flows from Basin 03 outlet

Design frequency	Peak flow from Basin 03 outlet (m^3/s)			
	Pre-development	Existing	Proposed - without mitigation	Proposed
12EY	0.30	0.14	0.21	0.15
6EY	0.32	0.15	0.21	0.17
4EY	0.34	0.16	0.24	0.19
3EY	0.36	0.18	0.25	0.21
2EY	0.38	0.20	0.28	0.23
1EY	0.44	0.24	0.34	0.28
50% AEP	0.48	0.26	0.38	0.33
20% AEP	0.65	0.41	0.59	0.54
10% AEP	0.75	0.52	0.76	0.71
5% AEP	0.90	0.58	0.88	0.82
2% AEP	1.05	0.83	1.18	1.03
1% AEP	1.21	0.95	1.36	1.18

Table 4-1 shows that the proposal is expected to result in higher peak flows from the outlet of Basin 03 in Hexham Swamp compared to the existing conditions, due to the increased impervious catchment proposed to report to Basin 03. However, Table 4-1 shows that this increase is mitigated, especially for rarer stormwater events, by the proposed mitigation measure of routing runoff from the proposed turning angle, where practical, through the "triangle" formed by the proposed turning angle that acts as an attenuation basin. Table 4-1 also shows that the proposed peak flows are similar to or below the pre-development flows, as estimated in GHD (2013).

The results of the modelling indicate that the peak flow for the 1% AEP design flood remains within the hydraulic capacity of the existing Basin 03, and therefore the existing stormwater management system is expected to provide a similar levels of treatment under proposed and existing conditions for the 1% AEP stormwater event.

Overall, the impacts of the proposal on stormwater quantity are comparable to the impacts of the existing LTTSF and considered minor.

4.3 Operational stormwater quality

The MUSIC model was used to assess the impact of the proposal on stormwater quality. Modelling results for the existing development and the proposed development are summarised in Table 4-2.

Table 4-2 Treatment train effectiveness

Parameter	Annual load	Reduction	Criteria
Flow (ML/yr)	258	6.9%	NA
Total Suspended Solids (kg/yr)	52 900	82.1%	80%
Total Phosphorus (kg/yr)	107	74.2%	74%
Total Nitrogen (kg/yr)	743	68.6%	69%
Gross Pollutants (kg/yr)	6 770	99.6%	99.5%

Table 4-2 shows that the existing stormwater water management system is expected to continue to achieve the relevant water quality reduction criteria under proposed conditions.

The modelled nutrient concentrations at the outlet of the existing Basin 03 are compared to the site specific triggers (as discharge criteria) in Table 4-3.

Table 4-3 Median nutrient concentrations at Basin 03 outlet

Parameter	Units	Category B Discharge Criteria	Existing	Proposed
Total Suspended Solids (TSS)	mg/L	40	1.21	1.48
Total Phosphorus (TP)	mg/L	1.9	0.028	0.031
Total Nitrogen (TN)	mg/L	4	0.108	0.170

Table 4-3 shows that the modelling results indicate that the proposal is expected to result in an increase in concentrations, however, the concentrations remain well below the discharge criteria.

Overall, the impacts to stormwater quality as a result of the proposal are expected to be minor.

5. Summary of mitigation measures

5.1 Mitigation measures

A number of safeguards and management measures have been identified in order to minimise potential adverse environmental impacts relating to stormwater due to the proposal.

The design of the proposed turning angle includes measures to direct all stormwater from the operational parts of the turning angle to the existing water management system, and provides additional flow attenuation in the “triangle” of the proposed turning angle. The design of the existing and proposed water quality protection measures was found to adequately convey the 1% AEP design flood event.

As part of this assessment, the Operational Surface and Groundwater Management Sub-Plan (Aurizon 2015b) and the Operational Stormwater Management Sub-Plan (Aurizon 2015c), as part of the Operational Environmental Management Plan (Aurizon 2015a) have been reviewed. The plans include details on actions for routine inspections, maintenance, water quality monitoring and reporting. The actions are expected to be adequate to mitigate the residual potential impacts of the proposal, however, it is recommended that the plans are updated for consistency once construction of the proposal is complete.

The recommended mitigation measures are summarised in Table 5-1.

Table 5-1 Summary of mitigation measures

Environmental aspect	Mitigation measure	Timing	Responsibility
Stormwater quantity and quality	Mitigation measures as detailed in soil assessment (GHD 2019).	Construction	Aurizon
Stormwater quantity and quality	Construct stormwater drainage of the proposal as per the design.	Construction	Aurizon
Stormwater quantity and quality	Maintain the existing stormwater management system as per the existing Operational Stormwater Management Sub-Plan.	Operation	Aurizon
Stormwater quantity and quality	Update the Operational Stormwater Management Sub-Plan for consistency once construction of the proposal is complete.	Operation	Aurizon

5.2 Conditions of approval

The SSI approval for the LTTSF establishes a number of conditions that must be adhered to prevent, minimise, and/or offset adverse environmental impacts as a result of the development. These conditions set standards and performance measures for acceptable environmental performance, establish requirements for regular monitoring and reporting and provide for the ongoing environmental management of the development. Conditions from the SSI approval relevant to stormwater and how they are addressed in this report are summarised in Table 5-2.

Table 5-2 Conditions of approval

Condition		How addressed
Stormwater		
C7	The SSI shall be designed, and employ surface water management techniques, such that runoff volumes, rates and pollutant loads are maintained as far as practicable to pre-construction levels and there are no adverse effects to adjoining lands as a result of runoff. The stormwater design shall be undertaken in consultation with the OEH and City of Newcastle, and shall have consideration of the Newcastle Development Control Plan 2012.	Stormwater quantity and quality at Basin 03 are assessed in Section 4, with consideration of the Newcastle Development Control Plan 2012.
C8	The SSI shall be designed and constructed to incorporate operational stormwater management measures, including (but not limited to):	
C8 (a)	Areas of high sediment, areas of storage and use of oil and grease and areas containing nutrient loads (including the wash bays, provisioning sheds and servicing sheds) shall be separated from the general site stormwater system through the use of separate drainage systems, bunds and hardstands and subject to separate discharge to trade waste or re-use in the wash down bays.	No potential impact. No changes to these areas are proposed.
C8 (b)	Where connection to the reticulated sewer system is identified to not be feasible, subject to justification based on further investigations, wastewater from the administration buildings, toilets, showers, lunch rooms, etc. shall be managed through a water treatment plant and be disposed via irrigation into existing agricultural pasture land.	No potential impact. No additional wastewater is proposed.
C8 (c)	site stormwater shall be directed into a drain on the western boundary of the SSI site and directed into one of three stormwater detention basins for treatment of suspended sediments and nutrients through floating wetlands, prior to its offsite discharge. This stormwater system shall be capable of treating at least a 1% AEP stormwater event.	The design directs all stormwater from the operational parts of the turning angle to the existing water management system, considering the 1% AEP stormwater event. Refer to Section 1.5 and Section 5.
C8 (d)	Access roads shall be provided with road side swales to provide treatment through flow attenuation and entrainment of suspended sediments.	No potential impact as no additional access roads proposed.
C9	Prior to the commencement of construction, the Proponent shall, in consultation with NoW and OEH, prepare a Stormwater Management Plan and submit the plan for the approval for the Director-General at least one month prior to the commencement of construction of the SSI. The Plan shall include but not necessarily be limited to:	The Stormwater Management Plan was prepared previously by WorleyParsons (2013)
C9 (a)	Final details of operational stormwater management measures to be implemented for the SSI based on detailed design, including identification of offsite discharge locations.	No changes to discharge locations are proposed.
C9 (b)	If required, identification of the water quality standards to which wastewater from the wastewater treatment plant would be treated to prior to its irrigation. The plan shall demonstrate that the water quality criteria to which the waste water would be treated to is suitable for irrigation purposes based on the land capability of the irrigation site (including nutrient loads, pH and salinity), considering existing baseline conditions and cumulative inputs from other irrigation sources to the site.	No changes to wastewater are proposed.

Condition		How addressed
C9 (c)	Identification of the water quality standards to which stormwater from the three stormwater detention basins would be treated to prior to offsite discharge with consideration of the receiving environment and relevant water quality standards such as Managing Urban Stormwater: Environmental Targets (DECC & CMA, October 2007).	No changes to water quality standards are proposed.
C9 (d)	Monitoring, review and maintenance procedures to assess and maintain the operational stormwater integrity and performance of the SSI consistent with the requirements of condition C19. Nothing in this condition precludes the Proponent from updating the Stormwater Management Plan presented in Appendix E (Stormwater Management Plan) or the document referred to in condition C19 to meet the requirements of this condition.	No changes to monitoring, review and maintenance procedures are considered necessary. Refer to Section 5.
Groundwater		
C10	Excavation activities near the Hexham Swamp Nature Reserve shall be undertaken in a manner which prevents the drawdown of groundwater within the Nature Reserve to a level which results in desaturation of acid sulfate soils within the Nature Reserve.	No potential impact. Groundwater is not expected to be significantly impacted by the proposed earthworks, as all earthworks are planned above the groundwater table.
C11	All drainage structures, including but not limited to pits, pipes, cess drains, sediment basins and detention basins, shall be designed and constructed so as to minimise long term connection with groundwater. The stormwater system components, including but not limited to detention basins and floating wetlands, shall be designed and constructed to ensure that there is no permanent interception of, and/or connection with groundwater.	

6. Conclusion

Aurizon engaged GHD to assess the potential stormwater impacts due to the proposed turning angle at Aurizon's LTTSF at Hexham. The proposal is expected to increase the area of impervious catchment reporting to the existing Basin 03, part of the existing stormwater management system at the LTTSF.

This change has the potential to increase the peak flows and reduce the water quality of discharges from the LTTSF to the environment. The potential impacts were assessed based on the detailed design of the proposed turning angle, using hydrology and water quality modelling consistent with the detailed design of the LTTSF.

Hydrology modelling results indicated that the proposal is expected to result in an increase in peak flows at the outlet of the existing Basin 03 into Hexham Swamp, however the existing and proposed mitigation measures mean that peak flows will remain similar to or below the pre-development flows.

Water quality modelling indicated that the proposal is expected to result in a slight increase in nutrient concentrations compared to existing conditions. However, the reduction targets and site specific discharge criteria are still expected to be met under proposed conditions.

The detailed design of the proposed turning angle includes measures to direct all stormwater from the operational part of the proposal to the existing stormwater management system. Monitoring and management actions were identified in Aurizon's Operational Environment Management Plan (and sub-plans) and are expected to be adequate to address the residual potential impacts of the proposal.

Overall, the potential stormwater impacts of the proposal are expected to be mitigated by the design of the turning angle and existing measures at the LTTSF site. Therefore, the stormwater impacts are a result of the proposal are considered minor.

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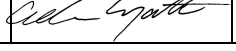
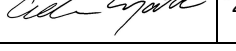
1	T Tinkler	A Wyatt		A Wyatt		24/05/2019

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