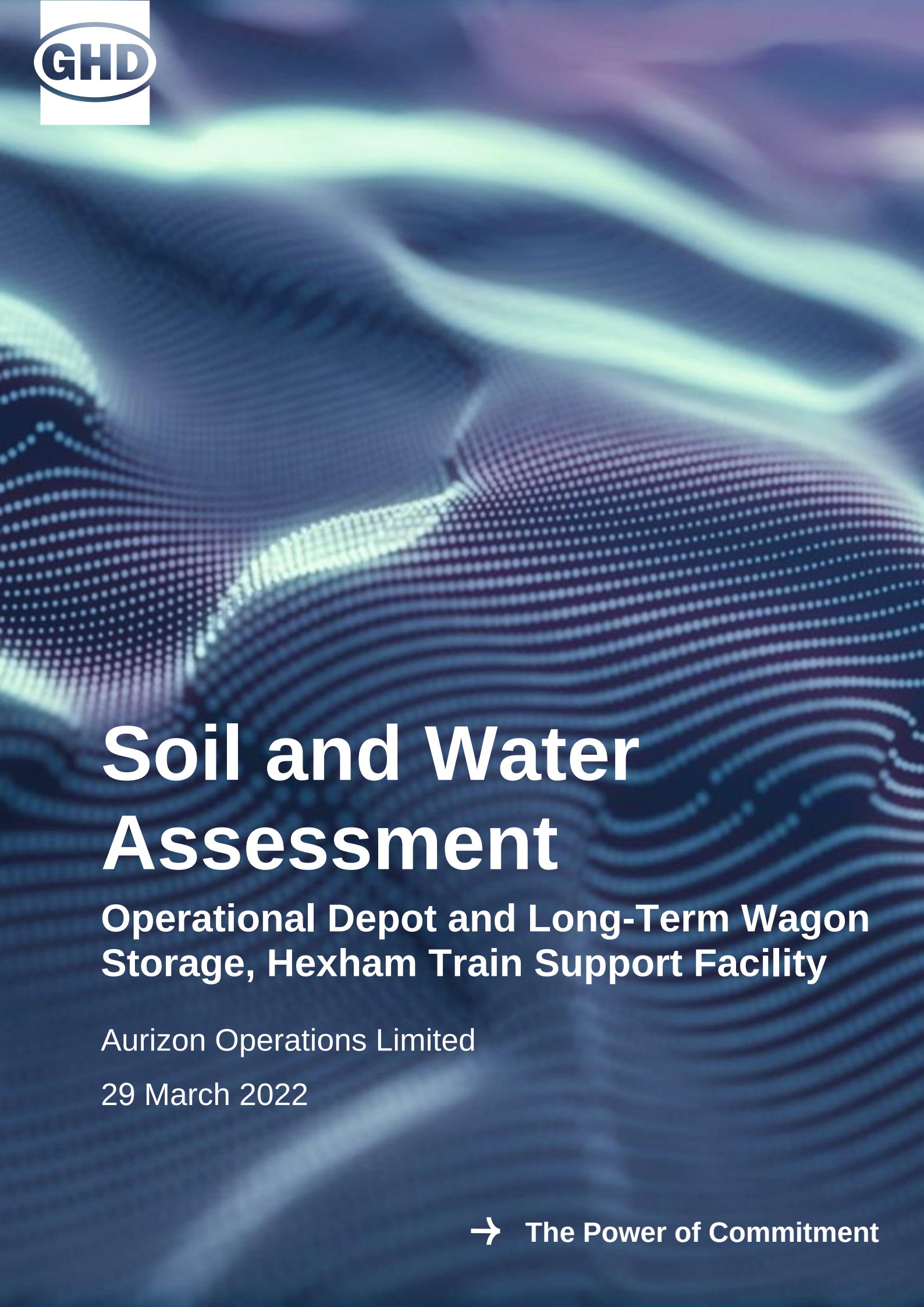

Soil and Water Assessment

Operational Depot and Long-Term Wagon Storage, Hexham Train Support Facility

Aurizon Operations Limited

29 March 2022

→ The Power of Commitment

GHD Pty Ltd | ABN 39 008 488 373
GHD Tower, Level 3, 24 Honeysuckle Drive
Newcastle, New South Wales 2300, Australia
T +61 2 4979 9999 | **F** +61 2 9475 0725 | **E** ntlmail@ghd.com | **ghd.com**

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S4	0	E. Griffin, B Foster, L Taylor	M. Kiejda, T. Tinkler		M. Kiejda		29/03/2022

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1. Introduction

This Soil and Water Assessment report has been prepared for the development of a depot, warehouse and wagon storage (the Modification Proposal) to support the ongoing operations of the Hexham Long Term Train Support Facility (Hexham LTTSF Project), Hexham (the Hexham LTTSF Site). The Modification Proposal is to be undertaken as a modification (under Part 5, Section 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act)) to the Hexham LTTSF Approval (MP07_0171).

This report has been prepared in accordance with the following, identified within the DPIE letter (dated 17/09/2021):

– The Secretary's Environmental Assessment Requirements (SEARs) issued for SSI-6090 Mod 1 (previously MP 07_0117 MOD 1)
– The relevant industry specific SEARs applicable to warehouse development

This report has been prepared by GHD Pty Ltd (GHD) on behalf of Aurizon.

1.1 Key terms

Table 1.1 identifies the key terms which are relevant to this report.

Table 1.1 Key terms

Term	Description
The Modification Proposal	The depot, warehouse, wagon storage and associated development for which apppoval is sought, as SSI-6090 – Mod 2.
Hexham LTTSF Project	The Hexham Long Term Train Stabling Facility (and associated development) approved under MP 07_0117, now SSI 6090 (inc. Mod 1).
The Hexham LTTSF Project Site	Area on which the Hexham LTTSF is located and the surrounds assessed under the MP 07_0117, now SSI 6090 (inc. Mod 1).
The Site	The area where the Modification Proposal works are to be undertaken. This area signifies the area to be directly impacted/disturbed by the Modification Proposal.

1.2 Purpose and scope of this report

This report has been prepared by GHD Pty Ltd (GHD) on behalf of Aurizon. The purpose of this report is to provide an assessment of potential impacts to soil and water as a result of the Modification Proposal. This assessment will inform the Modification Report for the modification to the existing SSI approval to be prepared by Ethos Urban Pty Ltd.

This assessment has taken into account the SEARs related to the key environmental issues of soil and water as identified in Section 2.4.

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 Scope 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 Aurizon Operations Limited as set out in Section 1.2 of 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.

GHD has not been involved in the preparation of the Environmental Impact Statement for the Modification Proposal and has had no contribution to, or review of the Environmental Impact Statement for the Modification Proposal other than in this Soil and Water Assessment. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the Environmental Impact Statement for the Modification Proposal.

Where the opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Any investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. LTTSF Modification Proposal

2.1 Site location and description

The LTTSF Site is located at Maitland Road, Hexham within the Newcastle Local Government Area approximately 16km north-west of Newcastle CBD. The Hexham LTTSF Site has a total area of 255ha with the LTTSF Project developed on a 38ha portion of the site parallel to (and to the west of) the Great Northern Railway (GNR). The LTTSF Site is located within an industrial setting with only a small number of dwellings within the local vicinity of the site. The site's locational context is shown at Figure 2.1.

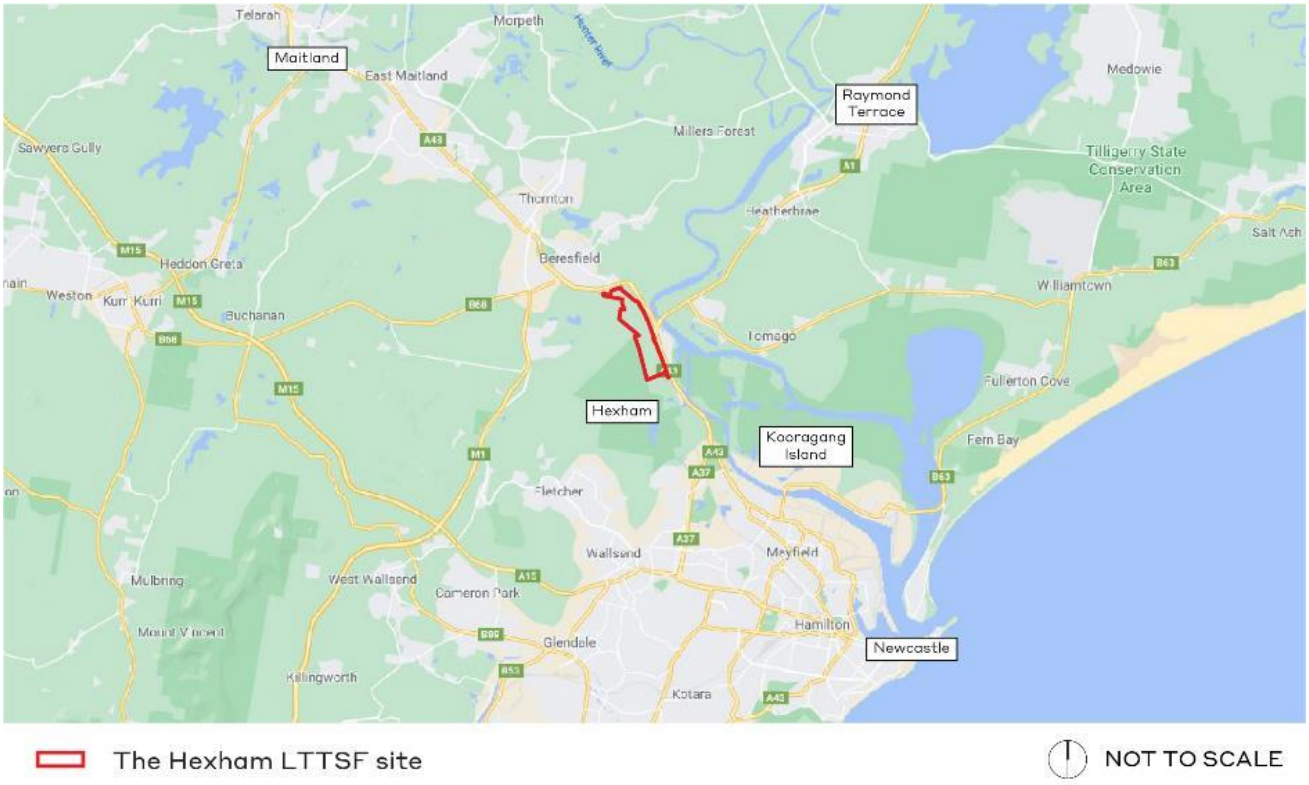


Figure 2.1 The Hexham LTTSF is located north-west of Newcastle

The LTTSF Site was formerly occupied by the Minmi-Hexham Railway and a Coal Preparation Plant with the majority of infrastructure associated with these uses now removed. The LTTSF Site has been heavily disturbed due to historical coal handling activities including a large coal washery reject stockpile located centrally to the LTTSF Site, which has been decommissioned and demolished and is currently heavily grassed, as well as land that contained a historical Coal & Allied rail turning loop and a tailings pond.

2.1.1 Site description

The Modification Proposal is fully contained within Lot 104 DP1189565 which is owned by Aurizon. The Hexham LTTSF Project Site covers multiple lots which are not affected by the Modification Proposal. The location of the Site in the context of the Hexham LTTSF Project Site is provided within Figure 2.2 and Figure 2.3.

Figure 2.2 Site context (consideration of previous approvals)

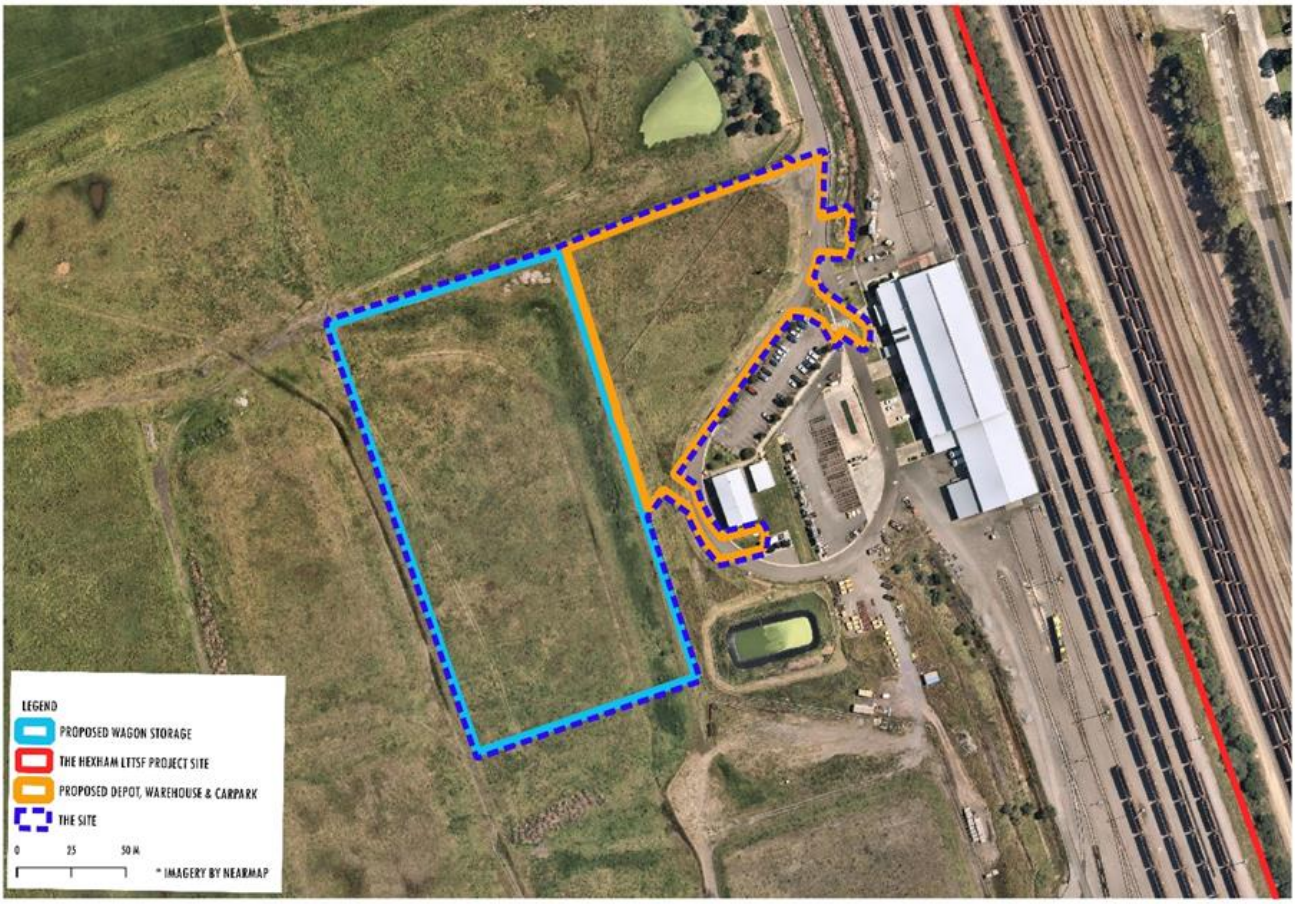


Figure 2.3 Site location

2.1.2 Topography

The LTTSF Site is located within the Hexham Swamp with 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 man-made features such as drainage channels, tracks and stockpiled excavated coal washery reject (CWR) and Potential Acid Sulfate Soils (PASS). The slopes of the LTTSF Site are generally less than 1% and the terrain of the low-lying areas do not form defined watersheds.

The Site reflects generally flat topography, with man-made access roads and drainage channels, extending over remediated stockpiled CWR and PASS as presented in Figure 2.4. Specific descriptions include:

– Area 1 is located west of the LTTSF access road, north of the LTTSF car parking area and to the east of Area 2. The site surface slopes gently (~7°) from RL 5.5 m AHD RL along the western edge to RL 4 m AHD along the eastern edge.
– Area 2 is located directly west Area 1 and the LTTSF. The majority of Area 2 is covered by a fill mound (approximately 5 m high), constructed as part of the LTTSF from 5.5 m AHD at the eastern boundary to between 10 m and 11.5 m AHD at the levelled area at the top of the mound. A higher fill mound is located to the west (outside of the Site) with a top surface level around 15 m AHD.

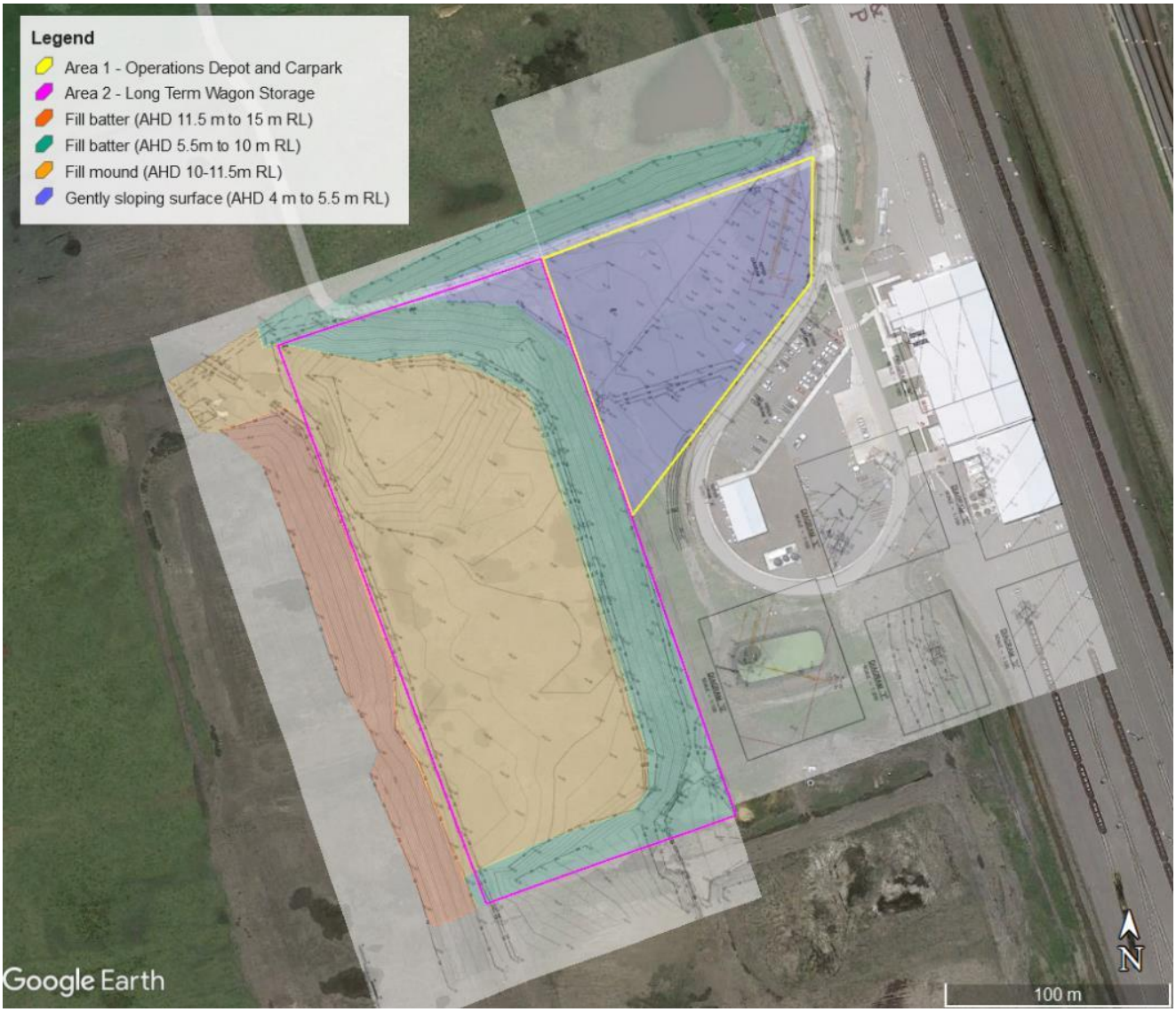


Figure 2.4 General site topography

2.1.3 Drainage

Natural conditions at the LTTSF Site have been significantly altered by historic activities including coal stockpiling, infilling of wetlands, construction of tailings ponds and drainage swales and irrigation of wastewater effluent. More recently, the remediation of portions of the site resulting in stockpiling of CWR and PASS. The resulting landform is considered highly disturbed.

The operational area of the LTTSF Site drains to the Hexham Swamp via the existing stormwater management system in three locations. Areas outside the operational area of the LTTSF Site drain to the Hexham Swamp via culverts around the boundary of the LTTSF Site.

Stormwater from the Site generally flows north via open channels, a retention basin, with eventual discharge to Hunter River. Section 4.1.1 provides the drainage details related to the Site.

2.1.4 Vegetation

A number of endangered ecological communities (EECs) have been identified near the LTTSF Site, including Swamp Oak Forest, Swamp Oak Floodplain Forest and Coastal Saltmarsh. Runoff from the LTTSF Site and Site discharges towards Estuarine Swamp Oak Forest to the north of the site. The low-lying areas and drainage channels within the LTTSF Site contain significant coverage of phragmites.

The Site is predominantly covered with sparse grasses, reflecting both historical and recent disturbance.

2.2 Modification Proposal description

The Modification Proposal is to be located within the LTTSF Site (identified within the LTTSF Project) at a location previously cleared and disturbed by historical coal handling activities and the LTTSF Project construction.

The Modification Proposal includes the development of a depot, warehouse, wagon storage and associated development to support the ongoing operations of the Hexham LTTSF Project.

An overview of the Modification Proposal is as follows:

- Site preparation and earthworks.
- Construction of the following elements:
  - A warehouse for the storage of rail maintenance equipment.
  - A depot for office staff and train crew.
  - Ancillary staff and visitor car park connected to the private roadway (existing main access road).
- Rail wagon storage area located on the western portion of the Site.
- Ancillary infrastructure (hardstand, water management, landscaping, lighting etc).
- Connection utilities.

The depot and warehouse would be operated 24 hours per day, 7 days a week.

It is understood that minimal changes are proposed to the existing site topography. We understand excavation is only proposed in Area 1 and will be limited to site levelling for the proposed carpark and excavation for construction of footings at the proposed operations depot buildings.

2.3 Applicable standards and guidelines

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

- Acid Sulfate Soils Assessment Guidelines (DoP 2008)
- Acid Sulfate Soils Manual (Acid Sulfate Soils Management Advisory Committee, 1998)
- Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land (DUAP & EPA, 1998)
- Guidelines for Consultants Reporting on Contaminated Land (NSW EPA 2020)
- Guidelines for the NSW Site Auditor Scheme 3rd Edition (EPA 2018)
- Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (EPA 2015)
- Site Investigations for Urban Salinity (DLWC 2002)
- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (DECC 2008):
  - 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 Modification 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 2.

– 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 Modification 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 Modification 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 Modification 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 Modification Proposal is not being delivered by Transport for NSW.
  - The Biodiversity Assessment Method (OEH 2017) as the Modification 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.

2.4 Secretary's Environmental Assessment Requirements (SEARs)

This report addresses SEARs issued for SSI-6090 Mod 1 (previously MP 07_0117 MOD 1) and industry specific SEARs (warehouses and distribution centres) for the Key Issues of Soil, Water – Hydrology, and Water – Quality. SEARs relevant to this assessment and where they are addressed in this report are presented in Table 2.1.

Table 2.1 SEARs for the key issues

Item No.	SEARs requirement	Relevant Section
MP 07_0117 MOD1 SEARs		
5.1	**Water – Hydrology** The Proponent must assess (and model if appropriate) the impact of the construction and operation of the modification and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	Section 1.1
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.	Section 4.3.1
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.	Section 4.1.3
5.1 (c)	Changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources.	Section 4.3.1
5.1 (d)	Direct or indirect increases in erosion, siltation.	Section 3.5.2
5.1 (e)	Water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Not applicable
5.2	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Section 4.1
6.1	**Water – Quality** 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 modification, including the indicators and associated trigger values or criteria for the identified environmental values.	Section 4.1.2
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.	Section 1.1
6.1 (c)	Identify the rainfall event that the water quality protection measures will be designed to cope with.	Section 4.4.3
6.1 (d)	Assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes.	Section 4.4.3
6.1 (e)	Demonstrate how construction and operation of the modification will, to the extent that the modification 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.	Section 1.1
6.1 (f)	Justify, if required, why the WQOs cannot be maintained or achieved over time.	Not applicable

Item No.	SEARs requirement	Relevant Section
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.	Section 1.1
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.	Section 1.1
6.2	Identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Section 5.1
8	**Soils**	
8.1	The Proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within, and in the area likely to be impacted by the modification.	Section 3.2
8.2	The Proponent must assess the impact of the modification on acid sulfate soils (including impacts of acidic runoff offsite) in accordance with the current guidelines.	Section 3.2
8.3	The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination to the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with the current guidelines.	Section 3.3
8.4	The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the modification.	Section 3.4
8.5	The Proponent must assess the impacts of the modification on soil salinity and how it will affect groundwater resources and hydrology.	Section 3.4
8.6	The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Section 3.5

3. Assessment of soil impacts

3.1 Geology and soils

3.1.1 Existing environment

Hexham Swamp forms part of a broad infilled paleo-valley associated with the Hunter River. Subsurface conditions at the Site consist of unconsolidated anthropogenic (man-placed fill) material on highly variable and soft estuarine and fluvial deposits, overlying Late Permian aged sedimentary bedrock, coal and tuff from the Four Mile Creek Formation of the Tomago Coal Measures.

Reference to the 1:25,000 scale Newcastle to Wollongong Gap (NTWG) mapping of NSW coastal Quaternary geology (Department of Industry, 2015) shows the Site surface geology as modern fill on quaternary deposits (Qmxf), lying adjacent to alluvial deposits of Hexham Swamp (Qhas). The near surface geology is shown to be fine grained estuarine deposits (Qhem) typically comprising gravel, sand, silt and clay.

Review of the Newcastle 1:100 000 Soil Landscape Map and Report (Matthei 1995) reveals that the Site is located within the Disturbed Terrain Soil Landscape. The Millers Forest Soil Landscape is located adjacent to the Site to the north and east, while the Hexham Swamp Soil Landscape is located adjacent to the Site to the south and west.

The Disturbed Terrain Soil Landscape is defined as being extensively disturbed by human activity, including the complete disturbance, removal or burial of soil. Relief and slopes are highly variable, with original vegetation completely cleared and replaced with turf or grassland. Limitations of the Disturbed Terrain Soil Landscape are highly variable depending on the area. The Disturbed Terrain Soil Landscape within the Site is associated with the following:

– Disturbance within Area 1 during LTTSF construction – Area 1 was used as a site office and carpark. Fill placed for the compound is likely to still exist.
– Disturbance within Area 2 during LTTSF construction – Area 2 was used for fill stockpiles, drying and lime mixing of excavated material for reuse.

It is likely that prior to disturbance of the natural soils, the Site would have been located within the Millers Forest Soil Landscape and the Hexham Swamp Soil Landscape. The Millers Forest Soil Landscape consists of deep (>150 m), imperfectly to poorly drained Prairie Soils. Soils typically comprise 10 - 55 cm of well-structured brownish black silty clay loam over >120 cm of well-structured brown silty clay over saturated grey plastic clay.

The Millers Forest Landscape comprises extensive alluvial plain on recent sediments. Elevations range from 3 to 6 m AHD, with local relief of <1 m and slope gradients of <1%. Vegetation consists of cleared tall open forest with river mangrove occurring on riverbanks and phragmites often growing in shallow waters. Limitations of the Millers Forest Soil Landscape include:

– Flood hazard
– Permanently high-water tables
– Seasonal waterlogging
– Foundation hazard
– Low wet bearing strength soils
– Moderate soil erodibility
– Potential acid sulfate soils
– Sodic/dispersive soils
– Localised deep salinity

The Hexham Swamp Soil Landscape consists of deep (>200 m) waterlogged humic gleys. Soils typically comprise 15-60 cm of black pedal silty clay loam overlying >200 cm of saturated grey sticky plastic clay. This landscape comprises broad, swampy, estuarine backplains on the Hunter delta. Elevations range up to 2 m AHD, with local relief of <2 m and slopes of <1%. Vegetation consists of sedgeland with open woodland on swamp margins. Limitations of the Hexham Swamp Soil Landscape include:

– Flood hazard
– Permanently high-water tables
– Seasonal waterlogging
– Foundation hazard
– Low to moderate soil erodibility
– Localised tidal inundation
– Highly plastic potential
– Acid and potential acid sulfate soils
– Shrink-swell potential
– Highly sodic/dispersive soils
– Localised very high salinity

3.1.2 Review of previous investigations

The following reports were reviewed as part of the desk top study and assessment of soil impacts at the Site:

– GHD 2021a – Geotechnical Investigation Plan - Operational Depot and Long-Term wagon Storage, Hexham Train Support Facility, July 2021.
– GHD 2021b - Geotechnical Investigation – Operational Depot and Long-Term wagon Storage, Hexham Train Support Facility, October 2021.

The scope of works for both reports consisted of:

– GHD 2021a consisted of a desktop review including review the site setting (topography, soils, geology, hydrology and hydrogeology) and a review of historical aerial photographs and previous investigations.
– GHD 2021b consisted of the geotechnical investigation including:
    - Excavation of eight test pits in Area 1 and six test pits in Area 2.
    - Dynamic cone penetrometer (DCP) testing adjacent to seven selected test pits.
    - Collection of disturbed and bulk samples for geotechnical and environmental laboratory analysis

Test locations are shown in the Test Location Plan below (Figure 3.1).

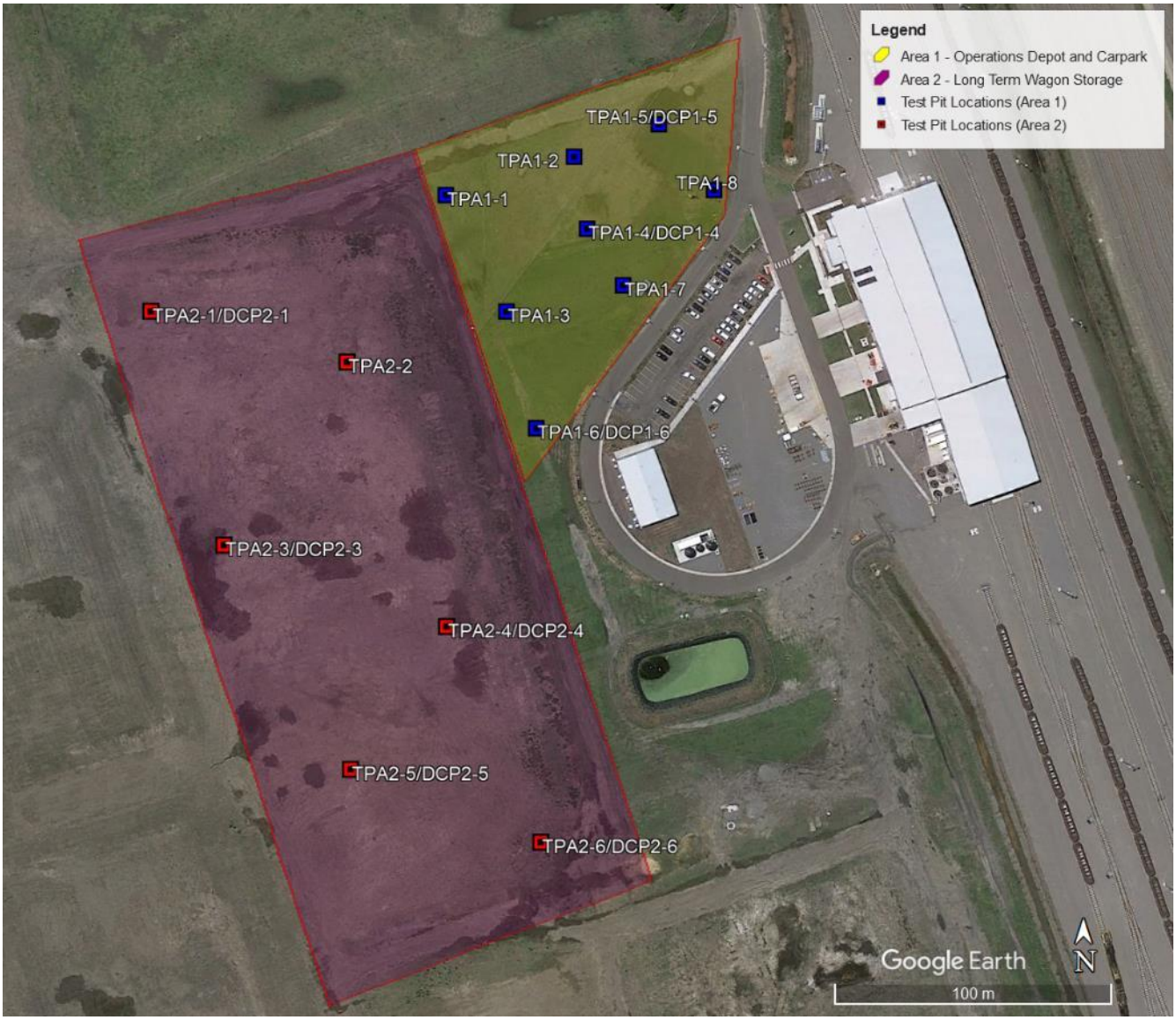


Figure 3.1 Test location plan

Area 1 – Operations depot and carpark (TPA1-1 to TPA1-8)

Subsurface conditions in Area 1 comprised a thin layer of recent (LTTSF construction) fill acting as topsoil overlying older variable fill associated with the previous coal handling facility to the limit of investigations as follows:

– LTTSF Construction Fill: Clay / Sandy clay or Clayey sand to between 0.1 m and 0.2 m depth with some / trace gravel and rootlets, low to medium plasticity and judged to be poorly compacted; overlying.
– Variable Fill: Sandy clay to Clay with sand, gravel and coal, low to high plasticity and encountered as:
  - Moderately well to well compacted and moist to between 1.7 m and 2.2 m depth.
  - Poorly compacted/moisture softened and wet materials to the limit of excavation between 2.35 m and 3 m depth.

Groundwater was encountered in all test pits in Area 1 between 1.2 m and 3.3 m depth.

Area 2 – Long term wagon storage (TPA2-1 to TPA2-6)

Subsurface conditions in Area 2 comprised recent fill associated with LTTSF construction to the limit of investigation described as follows:

– LTTSF Construction Fill: Sandy Clay / Clay with low to high plasticity and encountered as:
  - Moderately well to well compacted, moist materials with construction waste comprising geogrid, fibrous geotextiles and irrigation pipes to between 0.85 m and 1.05 m depth.
  - Moderately well to well compacted, moist materials with coal fragments and shells to between 2.4 m and 3 m depth.
  - Poorly compacted/moisture softened and wet materials with coal fragments to the limit of excavation (between 2.7 m and 2.9 m).

Groundwater was encountered in TPA2-5 and TPA2-6 at 2.55 m and 2.5 m depth respectively and assumed to be a perched water table within the fill mound.

3.2 Acid sulfate soils

3.2.1 Existing environment

Prior to the construction of the LTTSF, an acid sulfate soils (ASS) assessment was conducted as part of preliminary geotechnical investigations undertaken by Douglas Partners (2012a). These investigations confirmed that potential acid sulfate soils (PASS) were present within the LTTSF Site. As such, the disturbance of natural soils, either by dewatering or excavation, during the construction of LTTSF were treated as PASS and managed under an Acid Sulfate Soils Management Plan (ASSMP), also prepared by Douglas Partners (2013).

As part of the LTTSF construction works, ASS and PASS were stored in stockpiles within the Site. These soils were progressively neutralised with Grade 1 agricultural lime in accordance with the rates detailed in the ASSMP. These areas have been remediated as required in accordance with the ASSMP, and validation reports prepared and issued to the Site Auditor.

The Beresfield 1:25,000 scale Acid Sulfate Soil Risk Map shows that the Site has a high probability of occurrence of actual or potential ASS within 1 m of the ground surface, within alluvial and estuarine plain environments. The Newcastle ASS Acid Sulfate Soils Map – Sheet ASS_001 shows that the Site is Class 2, indicating that ASS is likely to be encountered at any depth and that development consent is required for works below the natural ground surface or by which the water table is likely to be lowered.

3.2.2 Review of previous investigations

As per section 3.1.2, GHD 2021a and GHD 2021b were reviewed as part of the desk top study and assessment of soil impacts at the Site.

The desk top study indicated a high probability that potential or actual acid sulfate soils (PASS/ASS) will be present up to 1 m to 3 m into natural soils. Previous assessments completed by GHD confirm sulfate is present in the natural soils at the sites and that acidic conditions can be generated by oxidisation of pyrites in the coal waste. Although PASS/ASS were remediated, there is a potential for pockets of PASS / ASS to remain within the neutralisation/treatment pad. GHD 2021b consisted of the excavation of eight test pits in Area 1 and six test pits in Area 2 (see Figure 2.1 above) with collection and analysis of soil samples for PASS as follows:

– Acid sulfate soil (ASS) field indicator (pH Field, pHFOX) – five from Area 1 and five from Area 2.
– Chromium reducible sulphur (CRS) – four from Area 1 and two from Area 2.

ASS testing found no actual ASS (pHF results below 4), with four potential ASS samples (pHFOX below 3 and/or change in pH more than 3). Strong and extreme reaction rates are indicative of ASS. However, this could be accounted for by the presence of organic matter (rootlets, degraded organics, coal and carbonaceous material).

It is expected that significant impacts on underlying PASS materials in Site 1 are unlikely to occur associated with the minor excavation works required as part of construction including levelling of car park and excavation of footings and services for the depot building. While five of the tested samples could be considered PASS on the basis of the significant depression in the soil pH upon oxidisation (reduction of more than 3 pH units), these are greater than 2 m below the surface level and it is considered unlikely they will be disturbed during construction. No excavations are proposed on Area 2 – Wagon Storage.

The results of the CRS testing indicate that the tested samples within Unit 1 have values exceeding the action criteria. Proposed construction of the depot buildings area carpark in Area 1 may include excavation of the existing Unit 1 material. Given this potential, an ASSMP will be required prior to construction, incorporating monitoring and treatment strategies to ensure that surrounding soils and surface waters are not adversely impacted by acid generation.

3.2.3 Impact assessment

Construction

Acid generation from the CWR materials proved to be a significant challenge during construction of the LTTSF. Based on the results of GHD 2021b, there is a potential for areas of PASS/ASS to remain within the Site.

Site works in Area 1 will include excavation of the existing site materials for site levelling, footings and services. Although proposed excavations are expected to be shallower than encountered groundwater levels, there is a potential for groundwater levels to fluctuate with meteorological and hydrological conditions and interception of groundwater during construction cannot be ruled out. Therefore, there is a potential for PASS/ASS to be exposed to oxygen. Given this potential, an ASSMP will be required prior to construction, incorporating monitoring and treatment strategies to ensure that the surrounding environment is not impacted by acid generation.

Operation

The main operation requirements of the depot and wagon stowage area are not expected to involve disturbance of PASS.

3.2.4 Mitigation measures

As previously discussed in Section 3.1.1, an ASSMP was previously prepared pursuant to Condition E63(d) of the SSI approval to ensure that any excavated ASS was appropriately disposed off-site or reused on-site in accordance with appropriate procedures for the treatment, temporary storage and monitoring.

The ASSMP previously used during construction of the LTTSF will apply during the Area 1 and Area 2 works.

The ASSMP outlines management strategies to be implemented to address PASS / ASS, which include:

– Soil Treatment – Neutralisation of ASS should be undertaken in accordance with the ASSMAC (1998) guidelines.
– Neutralising Leachate - Leachate water collected from the bunded area (in a multistage sedimentation tank, if required) will be neutralised as necessary before release.
– Dewatering – A specific dewatering procedure is recommended in order to minimise potential adverse impacts resulting from excavation and dewatering of ASS or PAF during construction.

A more comprehensive outline of the management strategies is contained within the ASSMP.

The key elements of the management measures were presented as mitigation measures as detailed in LTTSF EIS (ADW 2012).

Based upon the potential impacts of the Modification Proposal and the previously established mitigation measures (most recent within the Mod 1), no additional mitigation measures are considered necessary. The relevant mitigation measures established as part of the Hexham LTTSF Project (MP 07_0117 – now SSI 6090 Mod 1) would be implemented as relevant for the Modification Proposal with the exception that liming rates will be updated with reference to GHD 2021b.

The Site Management Plan (Aurizon, 2021) includes a Sub -Surface Disturbance Protocol, which includes any areas of ASS or PASS identified during the works. The Protocol will be followed, and the area remediated in accordance with the ASSMP.

3.3 Contamination

3.3.1 Existing environment

Previous desktop reviews (GHD 2021a) have identified the larger LTTSF Site as having a long history of industrial development including the Minmi-Hexham Railway and a Coal Preparation Plant previously located to the south of the Site. The majority of infrastructure associated with these uses has now been removed. Areas 1 and 2 were previously used for the storage of coal and coal reject with no major infrastructure present. Past and present use of the Site and surrounding land includes:

– Historic railways, embankments and train yards.
– Buildings, former coal preparation plant (CPP) and associated coal stockpile and tailings areas.
– Drainage channels.
– More recently, Aurizon's train support facility constructed in 2014.

Significant physical changes to the Site have been identified from examination of historic aerial photographs as part of GHD 2021a including:

– Construction of a main line prior to 1850 and expansions of the railway lines circa 1911.
– Construction of coal preparation plant, rail loop and associated coal and CWR stockpiles between 1953 and 1972.
– Coal preparation plant facilities and coal stockpile areas between 1958 and 1988.
– Removal of CHPP sometime before 1993.
– Construction of a surface water retention pond immediately northwest of Area 2 between 2001 and 2005.
– Construction of the LTTSF in 2014 and 2015 which included:
    - Construction of the Leighton Works site and then removal of the same site on Area 1.
    - PASS/ASS soil treatment (lime mixing) and filling of Area 2.
– Filling of the surface water retention pond immediately north-west of Area 2.

In addition to the heavy industry impacts, construction of the LTTSF has locally impacted the soil profile resulting in settlement, changes to the surface water drainage system, excavation and filling.

A historical aerial photograph review was undertaken as part of Douglas Partners (DP 2012) and GHD 2021a and details relating to the Site are summarised in Table 3.1.

Table 3.1 Historical aerial photograph summary

Photograph	Site observations
1958 - Type: B & W 	Approximate outline of Area 1 and 2 (yellow): – Both Areas 1 and 2 are undeveloped – Great Northern Rail line to the east, constructed prior to the 1850s and with up to four lines by circa 1911 – Minmi-Hexham Railway and associated crushing and sizing plant to the south operational between 1936 and 1955
1965 - Type: B & W 	Approximate location of Area 1 and 2 (yellow): – Both Areas 1 and 2 remain undeveloped – Development of CHPP to the south
1971 - Type: B & W 	Approximate location of Area 1 and 2 (yellow): – Area 1 and 2 utilised for storage of coal and coal reject material piles – CHPP and rail loop developed to the south of Areas 1 and 2

Photograph	Site observations
1976 - Type: Colour 	Approximate outline of Area 1 and 2 (yellow): – Area 1 - Coal and coal reject material piles – Area 2 – Coal and coal reject piles. Cleared area (presumably for additional handling) with onsite dam / water detention basin
1993 - Type: Colour 	Approximate outline of Area 1 and 2 (yellow): – Area 1 – Evidence of historic coal preparation areas. Now vegetated with grass – Area 2 – Evidence of historic coal preparation areas. Now vegetated with grass with dam / water detention basin filled in
2013 – Type Colour 	Approximate outline of Area 1 (yellow) and Area 2 (pink): – Area 1 – Site grassed with evidence of historic coal handling and preparation areas – Area 2 - Site grassed with evidence of historic coal handling and preparation areas – Pond to the north-west was constructed sometime after 2001

Photograph	Site observations
March 2014. Type – Colour 	Approximate outline of Area 1 (yellow) and Area 2 (pink): – Area 1 – Leighton construction compound comprising parking, temporary buildings and facilities – Area 2 - Access tracks for earthmoving machinery and stacking of excavated material – Pond to the north-west remains
September 2014. Type – Colour 	Approximate outline of Area 1 (yellow) and Area 2 (pink): – Area 1 - Leighton construction compound located in Area 1 comprised parking, temporary buildings and facilities – Area 2 – Stacking, spreading, drying and ASS treatment (lime mixing) of excavated material – Pond to the north-west is being used for onsite water management
November 2015. Type Colour 	Approximate outline of Area 1 (yellow) and Area 2 (pink): – Area 1 - Leighton compound temporary buildings and hardstand removed – Area 2 – Area appears regraded. Assumed to be mounded – Pond to the north-west has been filled

3.3.2 Review of previous investigations

A review of historical investigations has been undertaken to characterise the soils within the Site. The following reports have been reviewed in this section:

– DP (2012) – Preliminary Contamination Assessment, Proposed Train Support Facility, Maitland Road and Woodlands Close, Hexham. Douglas Partners, September 2012.
– GHD 2021a – Geotechnical Investigation Plan - Operational Depot and Long-Term wagon Storage, Hexham Train Support Facility, July 2021.
– GHD 2021b - Geotechnical Investigation – Operational Depot and Long-Term wagon Storage, Hexham Train Support Facility, October 2021.

DP 2012 presented the results of a number of investigations that have been undertaken across the larger LTTSF Site since 2010 however, only a select few sample locations were located within or adjacent to the Site including:

– DP 2008 - Test pit location – TP112. All results indicated concentrations of contaminants below the adopted site assessment criteria.
– ERM 2012 - Borehole locations BH07 and BH08 and test pit locations TP04, TP07 and TP17. All results indicated concentrations of contaminants below the adopted site assessment criteria.

The information from DP 2012 has since been outdated with construction of the LTTSF and significant disturbance of Area 1 (Leightons Compound) and Area 2 (PASS/ASS treatment works and stockpiling).

Previous investigations GHD 2021a and GHD 2021b consist of investigations targeted to the Site and are summarised in further detail below.

3.3.2.1 GHD 2021a

GHD 2021a consisted of a contamination desktop study including review of historical aerial photographs and previous contamination investigations relevant to the Site.

Previous investigations identified historical activities across the larger LTTSF Site that have resulted in soil contamination as follows:

– Hazardous waste and building materials including asbestos containing materials (ACM)
– Total Petroleum Hydrocarbons (TPH) C_{10}-C_{36}
– Polyaromatic Hydrocarbons (PAH)
– Coal Washery Reject (CWR) (aesthetic impacts)

Remediation and validation of portions of the wider LTTSF Site have been undertaken and the LTTSF is subject to a long-term Site Management Plan (SMP) (Aurizon 2021) to manage potentially remining contamination.

In relation to Areas 1 and 2 and in the context of the overall site contamination assessments completed, the underlying soils in these areas were considered to be highly disturbed however there was limited contamination information available. As such, it was noted that the contamination status of the Site was unknown and further investigations were required to assess these data gaps.

3.3.2.2 GHD 2021b

GHD 2021b consisted of a contamination investigation undertaken in conjunction with geotechnical investigations.

Scope of work

The scope of works consisted of excavation of eight test pits in Area 1 and six test pits in Area 2 (see Figure 2-2 above) with collection of disturbed soil samples for analysis of contaminants of potential concern (COPC). Twenty-seven (27) soil samples were analysed for heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn), total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN), polychlorinated aromatic hydrocarbons (PAH) and for asbestos in soil (absence/presence).

Assessment criteria

The following guidelines were referenced for the assessment of contamination at the Site:

– NEPC (2013) National Environment Protection (Assessment of Site Contamination) (NEPC 2013).
– CRC CARE (2011) Health Screening Levels for petroleum hydrocarbons in soil and groundwater. Technical report series No. 10. Friebel, E. and Nadebaum, P., 2011.

The assessment criteria were selected to allow decisions to be made for the following identified current and future receptors:

– Commercial workers on-site (current and future use – Aurizon)
– Intrusive maintenance workers on-site (during construction and future maintenance)
– On-site ecological receptors (limited - flora and fauna)

Results

– No staining, odours or other indicators of contamination were noted during the test pitting or in the test pit logs. No PACM were noted during excavation of the test pits.
– Health criteria - Concentrations of COPC were all below the laboratory limit of reporting (LOR) or the selected health criteria for commercial / industrial land use. No asbestos was detected in the samples selected for analysis.
– Ecological criteria - Concentrations of COPC were below the LOR or the selected ecological criteria with the exception of zinc concentrations in TPA1-4_0.0-0.1 which were marginally above the conservative EIL for commercial/industrial land use.

Discussion and recommendations

As above, concentrations of zinc at TPA1-4 (0.0-0.1 mbgl) were detected marginally above the ecological criteria (commercial/industrial). TPA1-4 was located in the unsealed central portion of Area 1. A deeper sample from TPA1-4 (TPA1-4_0.3-0.4) revealed zinc concentrations below the assessment criteria indicating concentrations were reducing with depth. The elevated zinc result is likely due to the presence of fill (Unit 1 - LTTSF Construction fill) in this area of the Site.

Soil concentrations above EILs may indicate a potential for unacceptable risk to ecological receptors in the area affected, however, this result is conservative for commercial/industrial land use. Given the low concentration, isolated nature of the impact, and that there is limited ecological amenity in Area 1, this result is considered unlikely to pose a significant impact to the surrounding environment (including groundwater, surface water and flora and fauna).

Based on the current and historical land use of the Site and surrounding area and the findings of the investigation, the shallow soils at the Site are considered suitable for the proposed development (construction and operation of a depot and wagon storage). The overall risk of contamination being encountered that would require remediation during works that disturb the ground surface or by future site users is considered low.

To manage any potential impacts to sensitive environments or groundwater during construction, works that disturb the ground surface should be managed in accordance with Aurizon's Site Management Plan (Aurizon, 2021). This plan includes measures for the management, of soils, sediments, groundwater and surface waters in the event that impacts are identified during construction and includes unexpected finds protocols and any monitoring requirements.

3.3.3 Impact assessment

Construction

We understand excavation is only proposed in Area 1 and will be limited to site levelling for the proposed carpark and excavation for construction of footings at the proposed operations depot buildings. No excavations or significant disturbance to surface soils is proposed for Area 2 (wagon storage).

Based on the findings of GHD 2021b, the overall risk of contamination being encountered that would require remediation during construction of the depot, amenities and car park and placement of the wagons is considered to be low. Further, there is a low potential for ACM to be present in Area 1 as it has not been generally associated with former site infrastructure. Further assessment/remediation would only be required if significant contamination (from unexpected finds) is identified during construction.

Operation

Future use of Area 1 as a depot with amenities and Area 2 for wagon storage is not anticipated to involve activities that that disturb the ground surface by site workers or visitors during the operation phase.

3.3.4 Mitigation measures

Based upon the potential impacts of the Modification Proposal and the previously established mitigation measures (most recent within the Mod 1), no additional mitigation measures are considered necessary. The relevant mitigation measures established as part of the Hexham LTTSF Project (MP 07_0117 – now SSI 6090 Mod 1) would be implemented as relevant for the Modification Proposal with the exception of the following:

– Potential impacts to sensitive environments, surface or groundwater during construction, would be managed in accordance with the Site Management Plan (SMP) (Aurizon 2021).

The SMP includes measures for the management, including unexpected finds protocols, and monitoring requirements for soils, sediments, groundwater and surface waters in the event that impacts are identified during construction. The SMP is specific to the LTTSF Site and includes the following:

– Appropriate management controls to minimise the potential for impacts as the result of disturbance of soils during construction and to a lesser extent, operation.
– Description of appropriate excavation, validation, management and/or disposal requirements for potentially contaminated materials (if encountered during the construction).
– Sampling and analysis requirements for assessment and validation of soils for re-use or for waste classification prior to offsite disposal, including acceptance criteria, particularly for materials remaining on-site and any proposed imported materials.
– Materials tracking procedures to be followed during construction.
– Unexpected finds protocols for the management and assessment of potentially contaminated soils (if encountered) including anthropogenic wastes and PACM. The plan will include requirements for assessment, monitoring of soils, sediment, groundwater and surface waters (if impacts occur) including reporting requirements.

3.4 Soil salinity

3.4.1 Existing environment

Geotechnical investigation undertaken by GHD (2021b) revealed subsurface conditions consistent with Soil Landscape mapping (refer to Section 3.1). The Site is located within the Disturbed Terrain Soil Landscape and is adjacent to The Millers Forest Soil Landscape to the north and east, and the Hexham Swamp Soil Landscape to the south and west. Limitations of the Disturbed Terrain Soil Landscape are highly variable depending on the site. It is likely that prior to disturbance of the natural soils, the Site would have been located within the Millers Forest Soil Landscape and the Hexham Swamp Soil Landscape, which include the limitations of localised deep salinity and localised very high salinity respectively.

Geotechnical investigation undertaken by Douglas Partners in 2008 (summarised in Douglas Partners (2012)) for a rail siding to the east of the Site encountered fill material largely consistent with that encountered for Area 1 by GHD (2021b). Whilst the fill material at Area 1 and Area 2 was not tested for salinity (GHD 2021b), the fill material (as reported in Douglas Partners (2008)) was tested for electrical conductivity, chloride and sulphate with results indicating soils typically ranging from non-saline to moderately saline.

Based on review of the available information, it is considered that soil salinity within the Site is likely to be variable. Localised areas of saline soils may occur within the Site.

Groundwater

GHD (2021b) encountered groundwater during test pitting at Area 1 between 1.2 m and 3.3 m below ground level and for Area 2 at 2.5 m depth which was assumed to be a perched water table within the fill mound.

Aurizon undertakes a groundwater monitoring program for the existing LTTSF Project Site in accordance with the conditions of the existing SSI approval. Performance criteria were developed by Douglas Partners (2014) (summarised in Aurizon 2021) based on analysis of historic and baseline data. The adopted performance criteria developed for conductivity in groundwater is 20,500 µS/cm. Annual groundwater monitoring results from locations within the LTTSF Project Site returned conductivity results ranging from 881 to 22,285 µS/cm (GHD 2021c), indicating that groundwater across the LTTSF Project Site is brackish to saline. Salinity of the groundwater would be variable depending on tidal effects and rainfall.

Hydrology

Surface runoff from the Site ultimately flows to the Hunter River and Hexham Swamp. Aurizon undertakes a surface water monitoring program for the existing LTTSF Project Site in accordance with the conditions of the SSI approval. Performance criteria were developed by Douglas Partners 2014 (summarised in Aurizon 2021) based on analysis of historic and baseline data. The adopted performance criteria developed for conductivity in Hexham Swamp and the Hunter River is 6,000 µS/cm and 40,000 µS/cm respectively. These adopted criteria indicate that the background salinity of the hydrological environment is brackish in the case of Hexham Swamp and saline in the case of the Hunter River.

Annual surface water monitoring results from locations nearby to (west and south) of the Site returned conductivity results ranging from 458 to 3,656 µS/cm (GHD 2021c), indicating that surface water in the vicinity is generally brackish.

3.4.2 Impact assessment

Construction

Removal of vegetation and topsoil through cut and fill operations can result in the exposure of saline sub-soils, leading to salinity related impacts to buildings, infrastructure and vegetation. Small, shallow amounts of subsoils would be exposed during earthworks for construction at Area 1 of the site for a short period, however, any exposed potentially saline soils would be covered by the footprint of the depot and warehouse once construction is completed. Therefore, impacts associated with exposed saline sub-soils are not anticipated as a result of the Modification Proposal. For Area 2, there is considered no impact given that the Modification Proposal involves above ground wagon storage.

The removal of deep-rooted trees can result in a rise in groundwater levels, increasing salinity at or near the ground surface, however as there are no deep-rooted trees within the Site, there is no considered impact.

Artificially increasing infiltration to the water table can result in raised groundwater levels, increasing salinity near the ground surface. The Modification Proposal does not involve increased inputs to groundwater through irrigation or similar activities.

Increased salinity of surface soils can result in salinisation of otherwise fresh surface water and groundwater resources. As the Modification Proposal is not anticipated to result in impacts to existing soil salinity, and runoff and groundwater infiltration is not expected to be significantly altered, impacts to groundwater and hydrology as a result of soil salinity are not anticipated. Additionally, existing groundwater and surface water salinity at and nearby to the Site is brackish to saline. As such, no otherwise fresh groundwater and surface water resources would be impacted as a result of the Modification Proposal. Additionally, there is limited use of groundwater in the vicinity of the Site. It is understood that there are no wells registered for beneficial use within 3 km of the Site. The water quality is generally poor and the highest possible beneficial use for the water would be commercial/industrial uses.

Impeding groundwater flows through the placement of impervious material, such as footings within the groundwater table can result in sub-soil salinity being expressed on the surface at these points. The Modification Proposal is not anticipated to intercept the groundwater table. Groundwater levels can fluctuate over time due to variations in rainfall and seasonal/climatic effects, however, the footings to be placed for construction of Area 1 of the Modification Proposal are not anticipated to significantly impede groundwater flow.

Operation

As the main operational requirements of the Modification Proposal is for wagon storage, warehousing and depot usage, it is not expected that operation of the Modification Proposal would result in impacts to soil salinity through excavation or alteration of the groundwater table.

3.4.3 Mitigation measures

Based upon the potential impacts of the Modification Proposal and the previously established mitigation measures (most recent within the Mod 1), no additional mitigation measures are considered necessary. The relevant mitigation measures established as part of the Hexham LTTSF Project (MP 07_0117 – now SSI 6090 Mod 1) would be implemented as relevant for the Modification Proposal.

3.5 Soil and land resources

3.5.1 Existing environment

Soil landscape

Review of the Newcastle 1:100 000 Soil Landscape Map and Report (Matthei 1995) reveals that the Site is located within the Disturbed Terrain Soil Landscape. It is likely that prior to disturbance of the natural soils, the Site would have been located within the Millers Forest Soil Landscape or the Hexham Swamp Soil Landscape. Soil landscape limitations are described in Table 3.2.

Table 3.2 Soil landscapes within the Project extent

Soil landscape	Limitations
Disturbed Terrain	Highly variable depending on site. Mass movements hazard, steep slopes, foundation hazard, unconsolidated low wet bearing strength material, potential acid sulphate soils, impermeable soils, poor drainage, erosion hazard.

Slope/ gradient

The topography of the Site is varied. As described in Section 2.1.2, Area 1 is gently sloping from 5.5 m AHD and 4 m AHD on a slope gradient of approximately 12.3%. Area 2 contains two fill batters and a fill mound area, which for the purposes of assessment have been assessed separately. The fill mound surface was levelled, with local relief being <1%. The eastern batter (shown in green in Figure 2.4) had a slope gradient of 26.8%. The western batter (shown in red in Figure 2.4) has a slope gradient of 21.2%.

Rainfall

The nearest climate station with a long-term rainfall record to the Site is Williamtown RAAF (Station 061078) located approximately 15 km away. Monthly rainfall statistics (from 1991 to 2021) were sourced from the BOM (2021) and are summarised in Table 3.3.

Table 3.3 Rainfall statistics for Williamtown

Month	Mean rainfall (mm)	Mean number of rain days (days ≥ 1 mm)
January	99.5	7.1
February	118.3	7.4
March	125.2	8.3
April	109.3	7.5
May	108.4	7.6
June	124.3	8.4
July	72.2	6.4
August	72.4	6.0

Month	Mean rainfall (mm)	Mean number of rain days (days ≥ 1 mm)
September	60.5	5.7
October	75.9	7.3
November	81.6	7.3
December	78.6	7.1
Annual	1121.5	86

Table 3.3 shows that rainfall depths and rain days are higher during late summer to early winter within the Site.

3.5.2 Impact assessment

Construction

During construction, disturbance to the existing surface, particularly associated with earthworks has the potential to result in soil loss due to erosion. The potential impact has been assessed according to current guidelines, particular the 'Blue Book' (Landcom 2004).

Erosion hazard was assessed for the two areas of the Site. The R-factor for the Site was determined to be 2500 based on Map 9 of Appendix B in the 'Blue Book' (Landcom 2004). Findings of the assessment are presented in Table 3.4.

Table 3.4 Potential for erosion hazard

Area	Slope	Potential for erosion hazard
Area 1	12.3%	High
Area 2 – Fill mound surface	1%	Low

Based on the information summarised in Table 3.4, Area 1 would present a high erosion hazard as the slope is greater than approximately 10%.

Operation

During operations, hardstand or vegetated surfaces will have been established and therefore no potential impact on soil and land resources is expected. Stormwater within Area 1 would be fed into existing stormwater systems through a new system established during construction. The topography of Area 2 is not proposed to be changed, and water would flow along the existing pathways as described in Section 4.1.

3.5.3 Mitigation measures

Based upon the potential impacts of the Modification Proposal and the previously established mitigation measures (most recent within the Mod 1) the following additional mitigation measures are considered necessary:

– Minimising the lengths of slopes by limiting the extent of excavations and/or using diversion drains to reduce water velocity over disturbed areas.
– Minimising the lengths of slopes by limiting the extent of excavations and/or using diversion drains to reduce water velocity over disturbed areas.
– Progressive rehabilitation or sealing of works areas.

The relevant mitigation measures (and those above) established as part of the Hexham LTTSF Project (MP 07_0117 – now SSI 6090 Mod 1) would be implemented as relevant for the Modification Proposal.

4. Assessment of water impacts

4.1 Existing environment

4.1.1 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 wastewater effluent. The resulting landform is considered highly disturbed.

Surface water runoff from the LTTSF Project Site reports to the onsite water quality controls basins; Basin 01, Basin 02 and Basin 03, via the constructed drainage line on the western boundary of the LTTSF Project Site. 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 02 would be inundated along with the surrounding floodplain.

4.1.2 Water quality

An operational surface and groundwater quality monitoring program has been undertaken at the LTTSF Site since late 2015. The surface water quality monitoring program includes the project relevant water quality monitoring locations presented in Table 4.1 and shown in Figure 4.1.

Table 4.1 Relevant surface water monitoring locations

Monitoring location	Coordinates, MGA Zone 56		Monitoring frequency	Description
	Easting	Northing		
Basin 2	376481	6367284	Monthly	Monitor discharge water quality from Basin 02
SW3	375884	6367384	Quarterly	Monitor surface water in a swale from the surrounding sub-catchment and discharge water from Basin 02
SW2	375612	6368068	Quarterly	Monitor surface water in Middle Creek which intercepts water from the swale
SW1	376210	6368225	Quarterly	Monitor surface water in Middle Creek capturing LTTSF northern discharge waters

Trigger values, in the form of discharge criteria, have been established for this Site for a range of parameters (Aurizon 2015b). The criteria are based on the *Australian and New Zealand Guidelines for Fresh Water Quality* 95% species protection levels *(*ANZECC 2000). The NSW Water Quality Objectives (WQO) 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 informing the site-specific trigger values (in the form of discharge criteria) established for the Site, as described in the approved Operational Surface and Groundwater Management Plan (OSGMP). Therefore, the adopted criteria are consistent with the NSW WQOs.

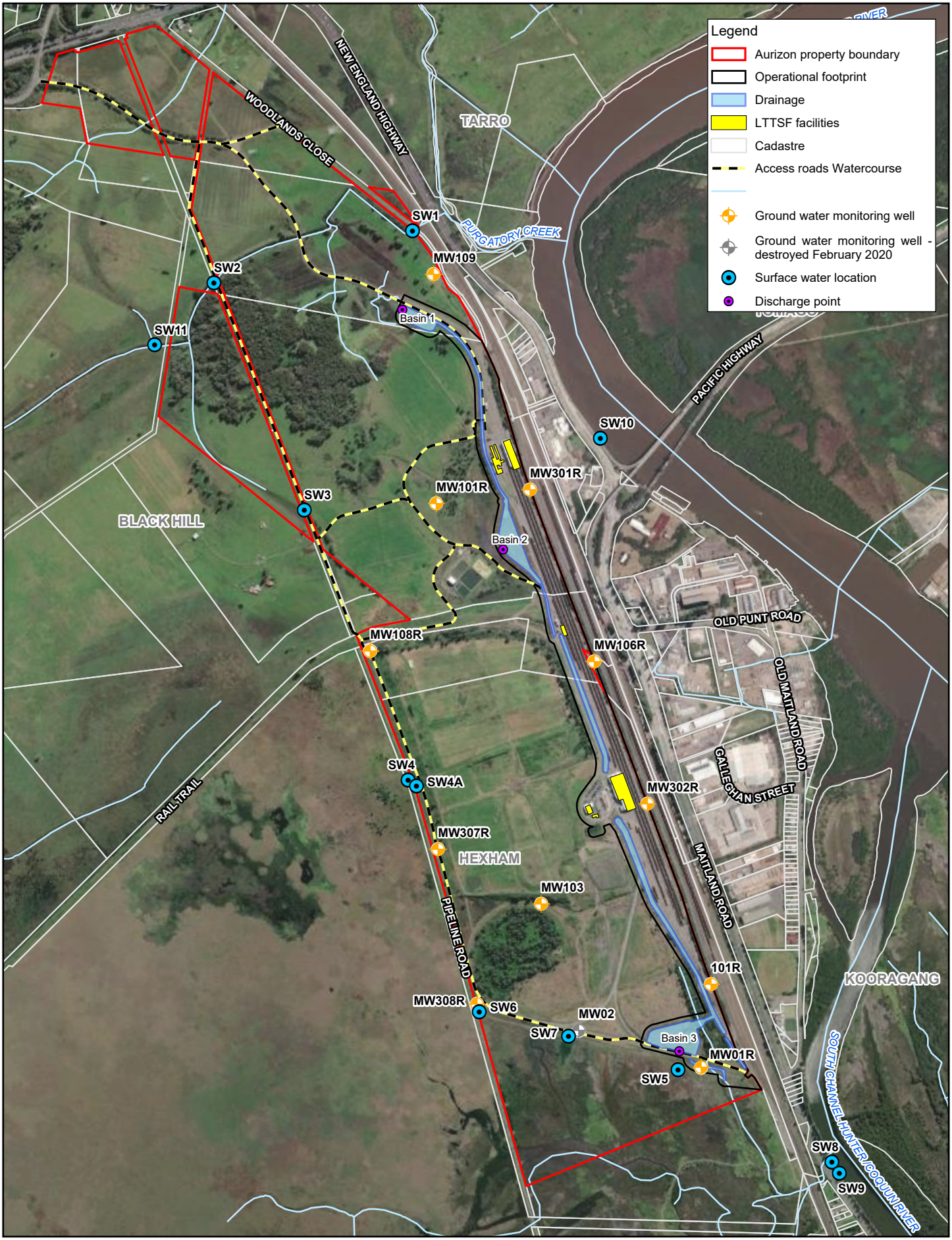
The ANZECC 95% investigation levels apply to typical slightly to moderately disturbed fresh waters systems. Discharge criteria were issued to Department of Planning and Environment (DP&E; now Department of Planning, Industry and Environment) and approved as a component of the OSGMP.

Category A values for the Hunter River are applied at SW1, SW2, and SW3. A recent review of surface monitoring results (GHD 2021c) identified the following category A exceedances for 2020 surface water quality monitoring results (Table 4.2).

Table 4.2 2020 surface water quality category A exceedances

Location	Number of Category A exceedances									
	Turbidity	TSS	Faecal coliforms	Aluminium	Arsenic	Chromium	Copper	Lead	Nickel	Zinc
SW1	2	1	1	2	2	1	2	3	1	1
SW2	0	0	0	0	0	0	1	1	1	0
SW3	1	2	3	1	0	1	1	1	1	1

Elevated metal concentrations are likely attributable to the historical land use of the Site (refer to Section 3.3). Turbidity, TSS and faecal coliforms exceedances are likely attributable to the presence of livestock proximal to sampling points and the influence of rainfall mobilising sediment from surrounding land use.



Paper Size ISO A4

0 110 220 330 440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Aurizon Operations Limited
Hexham Depot and Rail Wagon Storage
Soil and Water Assessment

Surface and Groundwater Monitoring Locations

Project No. **12564230**
Revision No. **B**
Date **11/03/2022**

FIGURE 4-1

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Print date: 16 Dec 2021 - 10:22

Data source: Aurizon: Site Data, 2017; LPI: DTDB / DCDB, 2017World Imagery: Maxar. Created by: fmackay

4.1.3 Groundwater

Geotechnical investigation undertaken by GHD (2021b) revealed subsurface conditions consistent with Soil Landscape mapping. Construction and variable fill comprising of coal washery reject material (including sandy gravel, gravelly sand and/or clayey gravel), was encountered at all locations to a depth up to 3.3 m below the existing surface. No natural soils were encountered in the investigation.

Groundwater was encountered in all test pits Area 1 at depths between 1.2 m and 3.3 m below ground level. Groundwater in Area 2 was encountered in test pits in the southern extent around 2.5 m below ground level and is assumed to be a perched water table within the fill mound.

Excavations of up to about 0.4 m below the existing surface for the northern carpark area and up to 0.3 m below the existing surface for the remainder of the Site are anticipated. Therefore, no groundwater is expected to be intercepted or impacted by excavations associated with the Modification Proposal.

4.1.4 Water use

Existing water usage for the LTTSF is via Hunter Water Corporation (HWC) potable mains supply. Any additional water supply for required for construction and operation of the depot facilities will be met by HWC potable mains.

4.2 Modification Proposal

The Modification Proposal includes a proposed stormwater system that will drain to the stormwater drain, north of the existing combined maintenance facility, via a proposed stormwater outlet. Stormwater flows north in an open drain (swale), and through a culvert approximately 400 m north of the outlet, and into Basin 02. Basin 02 discharges via a culvert into a low-lying paddock and eventually flows into swales that flow into Middle Creek, a tributary of the Hunter River. A diversion bund is proposed to be constructed west of the depot to divert upgradient flow north, away from the warehouse.

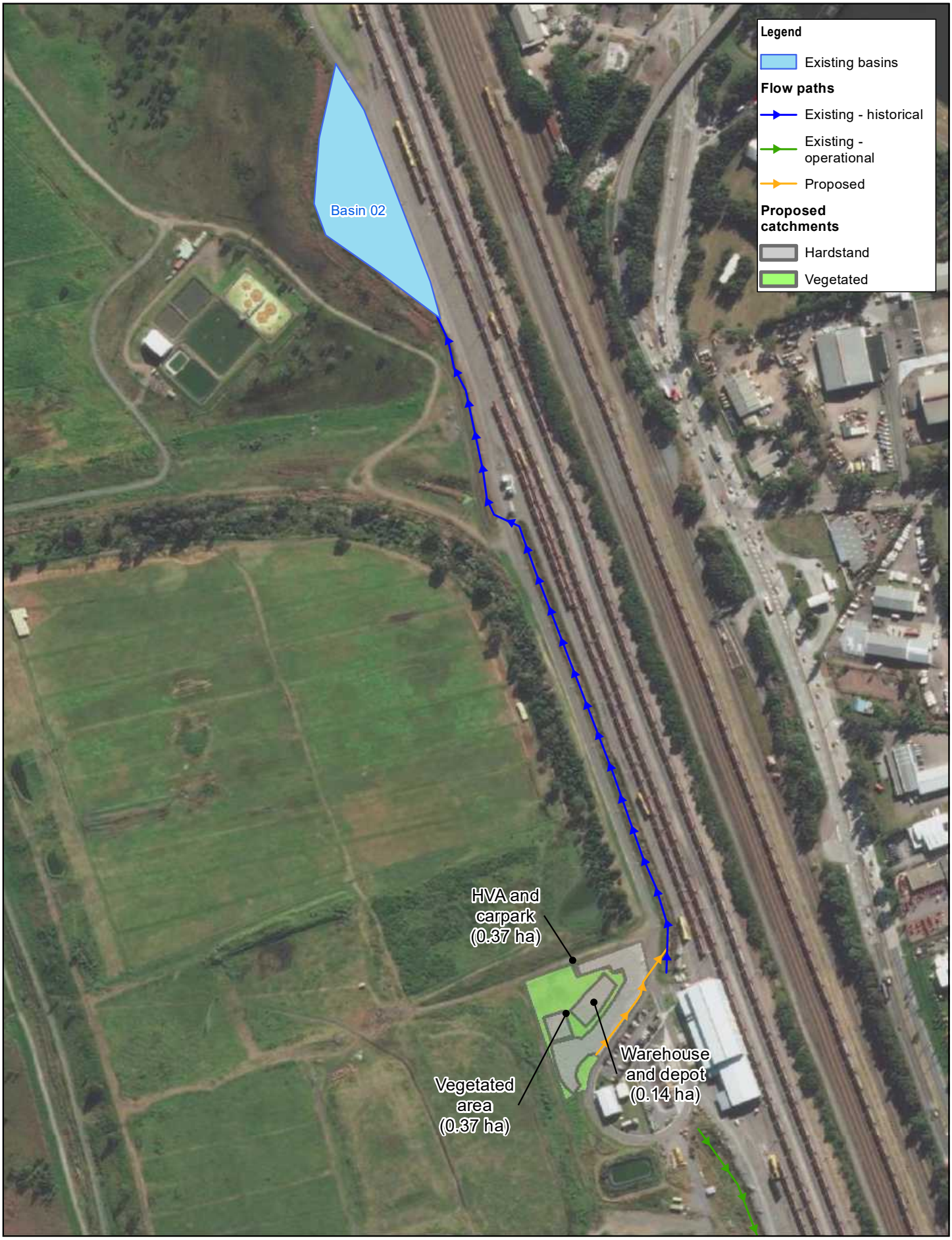
The long-term wagon storage (Area 2) area's topography is proposed to be left unchanged. The majority of water from the long-term wagon storage area drains to the east, down the eastern batter and in a northerly direction toward the open drain to where the operations depot stormwater drains.

The objective of this assessment is to identify and assess the significance of the potential impacts of the Modification 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 Modification Proposal, as shown in Figure 4.2. Stormwater from the Modification Proposal area will be directed to the northern swale that drains to the Hunter River via Basin 02.

Where the Modification Proposal area crosses the existing drainage lines that flow to the north, new culverts are proposed as part of the detailed design, with runoff from the areas to be conveyed by existing drains towards Basin 02.

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



Paper Size ISO A4

0 0.03 0.06 0.09 0.12

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Aurizon Operations Limited
Hexham Depot and Rail Wagon Storage
Soil and Water Assessment

Project No.	**12564230**
Revision No.	**0**
Date	**28/03/2022**

Proposed catchment to Basin 02

FIGURE 4-2

\\ghdnet\ghd\AU\Newcastle\Projects\22\12564230\GIS - do not use - see 2219997\Maps\Deliverables\12564230_SWA001_Proposed_catchment_Basin02_0.mxd
Print date: 28 Mar 2022 - 15:17

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: mfredle

4.3 Methodology

4.3.1 Water quantity

4.3.1.1 Hydrologic modelling

The hydrological assessment for this investigation was performed using XP-RAFTS (2018.1), 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 2019 (ARR2019: Ball et al. (eds.) 2019), and the proposed change in catchment due to the Modification 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 36 hours were considered. The peak discharge from Basin 02 had a critical duration of 1 to 2 hours for frequent stormwater events and 45 minutes for rarer stormwater events.

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. Since the stormwater assessment for the turning angle (GHD 2019), new advice for initial and continuing losses for use specifically based in NSW has been provided by the ARR data hub, which were adopted for this assessment. Therefore, the results from this assessment are not directly comparable to the assessment for the turning angle undertaken in GHD (2019). No previous loss calibrations for Hexham were identified and therefore the flood frequency analysis reconciled, for pervious areas, continuing loss of 1.1 mm/hour and probability neutral burst initial loss obtained from ARR data hub (Ball 2019) were adopted. For the impervious areas, 1 mm initial loss and 0 mm/hr continuing loss were used.

The catchment roughness parameter of the catchment reflects the efficiency of the stormwater moving through the catchment. For pervious areas, a parameter value of 0.05 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):2(H) and longitudinal grade of 0.1%. Basins were modelled in the XP-RAFTS model, based on the design stage storage and outlet sizes.

4.3.1.2 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

4.3.2 Water quality

The proposed areas are not expected to be used 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 potentially impacted by the Modification Proposal. As discussed in Section 3.3, the elevated metal concentrations likely reflect the historical land use at the LTTSF Project Site and are unlikely to be impacted by the Modification 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.

4.3.2.1 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 Project Site and updated for MOD1 assessment. This model was further updated to reflect the proposed changes in catchments due to the Modification Proposal.

Rainfall and evaporation

The rainfall and evaporation data were 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 4.3 shows the long-term monthly averages for rainfall and evaporation used for MUSIC modelling.

Table 4.3 Monthly rainfall and evaporation adopted for MUSIC modelling

Month	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 Water by Design (2010).
– Soil storage and field capacity are the default MUSIC rainfall-runoff parameters as summarised in Table 4.4.

Table 4.4 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

Rainfall-Runoff Parameter	Input
Groundwater Daily Recharge Rate	25%
Groundwater Daily Base Flow Rate	5%
Groundwater Daily Deep Seepage Rate	0%

Basin 02

As part of the LTTSF Project Site, the existing Basin 02 was constructed with a floating wetland designed to provide enhanced nutrient and sediment removal from stormwater discharged from the Site. Wetlands are intended to be 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 4.5 and are based on the volumes and areas extracted from the design.

Table 4.5 Sediment Pond MUSIC parameters

Basin	Pond Surface Area (m^2)	Pond Permanent Water Volume (m^3)	Extended Detention Depth (m)
Basin 02	5,200	390	0.20

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 4.6.

Table 4.6 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 4.7 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 4.7.

Table 4.7 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 02	0.000	0.014	0.014	0.40

4.3.2.2 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 4.8.

Table 4.8 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 A applies to discharge locations SW01, SW02 and SW03 of the OSGMP. These locations discharge from the LTTSF Site to the Hunter River along the northern border of the Site. The Category A Criteria are for the parameters relevant to the assessment are summarised in Table 4.9.

Table 4.9 Discharge criteria

Parameter	Units	Discharge criteria (Category A, Hunter River)
Total Nitrogen (TN)	mg/L	10
Total Phosphorus (TP)	mg/L	2.75
Total Suspended Solids (TSS)	mg/L	50

4.4 Assessment of water impacts

4.4.1 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 small disturbance area and expected short duration of the construction phase, the potential impacts to stormwater other than erosion are considered minor and will be managed.

Refer to Section 3.5 for assessment of erosion and soil loss.

4.4.2 Operational water quantity

The area of the proposed hardstand pavement and access road will drain towards Basin 02 (refer to Figure 4.2). The Modification Proposal will also result in an increase in impervious catchment. The impact of these changes on the peak flows from the Basin 02 outlet for various design frequencies are summarised in Table 4.10. As discussed in Section 4.3.1, since the updated recommendations on storm losses were applied for is assessment, the results are not directly comparable to the results presented in GHD (2019). Given the minor nature of the Modification Proposal, the relative increase was used to assess the potential impacts.

Table 4.10 Impact on peak flows from Basin 02 outlet

Design frequency	Peak flow from Basin 02 outlet (m^3/s)		
	Baseline	Proposed	Relative increase
12EY	0.3	0.31	3.3%
6EY	0.38	0.4	5.3%
4EY	0.52	0.55	5.8%
3EY	0.62	0.71	14.5%
2EY	0.9	0.96	6.7%
1EY	1.3	1.37	5.4%
50% AEP	1.53	1.61	5.2%
20% AEP	2.23	2.32	4.0%
10% AEP	2.57	2.68	4.3%
5% AEP	2.99	3.1	3.7%
2% AEP	3.42	3.49	2.0%
1% AEP	3.55	3.59	1.1%

Table 4.10 shows that the Modification Proposal is expected to result in slightly higher peak flows from the outlet of Basin 02 in Hexham Swamp compared to the baseline conditions, due to the increased impervious catchment proposed to report to Basin 02. The Modification Proposal caused an increase in peak flows up to 14.5% for the very frequent 3EY design frequency and 1.1% for the 1% AEP design frequency compared to the baseline.

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 02, and therefore the existing stormwater management system is expected to provide a similar level of treatment under proposed and existing conditions for the 1% AEP stormwater event.

Overall, the impacts of the Modification Proposal on stormwater quantity are comparable to the impacts of the baseline condition and are considered minor.

4.4.3 Operational water quality

The MUSIC model was used to assess the impact of the Modification Proposal on stormwater quality. Modelling results for the existing development and the proposed development are summarised in Table 4.11.

Table 4.11 Treatment train effectiveness

Parameter	Load without treatment	Load with treatment	Reduction	Criteria
Flow (ML/yr)	274	256	6.5%	NA
Total Suspended Solids (kg/yr)	56400	10600	81.2%	80%
Total Phosphorus (kg/yr)	113	30.1	73.5%	65%
Total Nitrogen (kg/yr)	784	251	67.9%	45%
Gross Pollutants (kg/yr)	7200	37.5	99.5%	90%

Table 4.11 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 02 are compared to the site-specific triggers (as discharge criteria) in Table 4.12.

Table 4.12 Median nutrient concentrations at Basin 02 outlet

Parameter	Units	Category A Discharge Criteria	Baseline	Proposed
Total Suspended Solids (TSS)	mg/L	50	1.46	1.46
Total Phosphorus (TP)	mg/L	2.75	0.030	0.030
Total Nitrogen (TN)	mg/L	10	0.168	0.168

Table 4.12 shows that the modelling results indicate that the Modification Proposal is expected result in negligible change in concentrations of nutrients at the outlet of Basin 02 and remain well below the discharge criteria.

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

5. Summary of management 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 soil and water which could arise as a result of the Modification Proposal. Mitigation measures to be implemented are summarised in Table 5.1.

Table 5.1 Summary of mitigation measures

Environmental aspect	Mitigation measure	Timing	Responsibility
Acid Sulfate Soils	As previously discussed in Section 3.1.1, an ASSMP was previously prepared pursuant to Condition E63(d) of the SSI approval to ensure that any excavated ASS was appropriately disposed off-site or reused on-site in accordance with appropriate procedures for the treatment, temporary storage and monitoring. The ASSMP previously used during construction of the LTTSF will apply during the works. The ASSMP will be adopted directly into the CEMP for the Site applying to excavation and dewatering activities. The Site Management Plan includes a Sub Surface Disturbance Protocol, which includes any areas of ASS or PASS identified during the works. The Protocol will be followed, and the area remediated in accordance with the ASSMP.	Construction	Contractor
Contamination	Based upon the potential impacts of the Modification Proposal, the relevant mitigation measures established as part of the Hexham LTTSF Project (MP 07_0117 – now SSI 6090 Mod 1) would be implemented. To manage any potential impacts to sensitive environments, surface or groundwater during construction, it is recommended that soils are managed in accordance with the Site Management Plan (SMP) (Aurizon 2021) which includes measures for the management, including unexpected finds protocols, and monitoring requirements for soils, sediments, groundwater and surface waters in the event that impacts are identified during construction. The SMP is specific to the LTTSF Site.	Construction	Contractor
Soil Salinity	Based upon the potential impacts of the Modification Proposal, the relevant mitigation measures established as part of the Hexham LTTSF Project (MP 07_0117 – now SSI 6090 Mod 1) would be implemented.	Construction	Contractor
	As above, site drainage is to be designed to maintain existing levels of runoff and infiltration where possible.	Design	Aurizon
Soil and land resources	Based upon the potential impacts of the Modification Proposal and the previously established mitigation measures (most recent within the Mod 1) the following additional mitigation measures are considered necessary: – Minimising the lengths of slopes by limiting the extent of excavations and/or using diversion drains to reduce water velocity over disturbed areas. – Minimising the lengths of slopes by limiting the extent of excavations and/or using diversion drains to reduce water velocity over disturbed areas. – Progressive rehabilitation or sealing of works areas The relevant mitigation measures (and those above) established as part of the Hexham LTTSF Project (MP 07_0117 – now SSI 6090 Mod 1) would be implemented as relevant for the Modification Proposal.	Construction and operation	Aurizon

Environmental aspect	Mitigation measure	Timing	Responsibility
Water	Construct stormwater drainage of the Modification Proposal as per the design.	Construction	Aurizon
	Continue groundwater and surface water monitoring and reporting as per the OSGMP.	Construction and Operation	Aurizon
	Maintain the existing stormwater management system as per the existing Operational Stormwater Management Sub-Plan.	Operation	Aurizon
	Update the Operational Stormwater Management Sub-Plan for consistency once construction of the Modification 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 relating to impacts to soils will continue to apply throughout the operation of the Modification Proposal.

6. Conclusion

This Soil and Water assessment report has been prepared for the development of a depot, warehouse and wagon storage (the Modification Proposal) to support the ongoing operations of the Hexham Long Term Train Support Facility (Hexham LTTSF Project), Hexham (the Hexham LTTSF Site). The Modification Proposal is to be undertaken as a modification (under Part 5, Section 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act)) to the Hexham LTTSF Approval (MP07_0171).

This report has been prepared in accordance with the following, identified within the DPIE letter (dated 17/09/2021):

– The Secretary's Environmental Assessment Requirements (SEARs) issued for SSI-6090 Mod 1 (previously MP 07_0117 MOD 1).
– The relevant industry specific SEARs applicable to warehouse development.

This report has been prepared to provide an assessment of potential impacts to soil and water as a result of the Modification Proposal. This assessment will inform the Modification Report for the modification to the existing SSI approval.

The soil and water assessment has been undertaken based on previous investigations at the Site and publicly available information. No additional field investigation has been undertaken.

Acid sulfate soils

Previous acid sulfate soils (ASS) testing conducted at the LTTSF Project Site indicates the presence of both potential ASS and actual ASS. As the Site works in Area 1 would include excavation of the surface and subsurface materials for site levelling, footings and services and/or possible interaction with the groundwater table, there is a potential for PASS / ASS to be exposed to oxygen. Given this potential, an ASSMP will be required. The ASSMP previously used during construction of the LTTSF Project Site will apply during the works.

Contamination

A review of historical investigations identified the LTTSF Project Site as having a long history of industrial development, including former coal handling and rail operations. Contamination in fill material had previously been identified following use of coal wash reject associated with the former coal handling preparation plant.

Targeted contamination investigations in Areas 1 and Area 2 (undertaken in conjunction with a geotechnical investigation) did not identify significant contamination of soils and shallow soils at the Site were considered suitable for the proposed development (construction and operation of a depot and wagon storage area). The overall risk of contamination being encountered that would require remediation during works that disturb the ground surface or by future site users was considered low.

To manage any potential impacts to sensitive environments or groundwater during construction, works that disturb the ground surface should be managed in accordance with Aurizon's Site Management Plan (Ref: Hexham Train Support Facility: Site Management Plan, Rev 3 dated 12 January 2021). This plan includes measures for the management, of soils, sediments, groundwater and surface waters in the event that impacts are identified during construction and includes unexpected finds protocols and any monitoring requirements.

Soil salinity

Based on review of soil landscape mapping, it is considered that soil salinity within the Site is likely to be variable. Localised areas of saline soils may occur. Impacts to infrastructure and vegetation relating to soil salinity can occur due to the exposure of saline soils at the surface and through rising groundwater levels transporting salts to the surface.

Subsoils would be exposed during earthworks for construction of the Modification Proposal in Area 1 for a short period, however, any exposed potentially saline soils will be covered by once construction is completed. Erosion of any saline soils during construction would be managed through appropriate erosion and sedimentation controls, minimising mobilisation of any saline soils.

The Modification Proposal does not involve the removal of deep-rooted vegetation (none present) or increased inputs to groundwater. Additionally, existing runoff and catchment volumes will not change significantly from the existing conditions, as such groundwater levels are not expected to be significantly impacted by the Modification Proposal.

Soil and land resources

During construction, disturbance to the existing surface, particularly associated with earthworks has the potential to result in soil loss due to erosion.

Erosion hazard was assessed for the two areas of the Site with Area 1 being identified as a high potential for erosion hazard and Area 2 fill mound surface being identified as a low potential for erosion hazard.

During operations, hardstand or vegetated surfaces will have been established and therefore no potential impact on soil and land resources is expected. Stormwater within Area 1 would be fed into existing stormwater systems through a new system established during constriction.

Erosion and sedimentation control measures would be implemented during construction to minimise any potential impacts to soil and land resources.

Water

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 small disturbance area and expected short duration of the construction phase, the potential impacts to stormwater other than erosion are considered minor and will be managed.

During operation, the impacts of the Modification Proposal on stormwater quantity are comparable to the impacts of the baseline condition and are considered minor. Impacts to stormwater quality as a result of the Modification Proposal are expected to be minor.

Overall

Based on our impact assessment, no additional significant mitigation measures (above those previously identified within the approval (and Mod 1)) are considered necessary for the Modification Proposal.

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Appendix A

Previous sampling results (GHD 2021b)

	Inorganics	Asbestos	Metals								BTEXN						TRH - NEPM 2013							TRH - NEPM 1999				
	Moisture Content (%)	Asbestos in Soil	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	F1 (C6-C10 minus BTEX)	C6-C10 Fraction	F2 (>C10-C16 minus Naphthalene)	>C10-C16 Fraction	F3 (>C16-C34 Fraction)	F4 (>C34-C40 Fraction)	>C10-C40 (Sum of Total)	C6-C9 Fraction	C10-C14 Fraction	C15-C28 Fraction	C29-C36 Fraction	C10-C36 (Sum of Total)
	%	Yes/No	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	1	-	2	0.4	5	5	5	0.1	5	5	0.1	0.1	0.1	0.1	0.2	0.3	20	20	50	50	100	100	100	20	20	50	50	50
NEPM 2013 EIL-Commercial/Industrial			**160**		**310[#1]**	**85[#1]**	**1,800**		**55[#1]**	**110[#1]**																		
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil											**75**	**135**	**165**			**180**	**215[#2]**			**170[#3]**	**1,700**	**3,300**						
NEPM 2013 Table 1A(1) HIL D Comm/Ind		Yes	3,000[#4]	900	3,600[#5]	240,000	1,500[#6]	730[#7]	6,000	400,000																		
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, Sand 0-1m											3	NL[#10]	NL[#10]			230	260[#2]		NL[#10]									
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, Sand 1-2m											3	NL[#10]	NL[#10]			NL[#10]	370[#2]		NL[#10]									
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, Sand 2-4m											3	NL[#10]	NL[#10]			NL[#10]	630[#2]		NL[#10]									
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																		700[#11]		1,000[#11]	3,500	10,000						
CRC CARE 2011 Soil Direct Contact HSL-D Commercial / Industria											430	99,000	27,000			81,000	26,000		20,000		27,000	38,000						
CRC CARE 2011 Soil Direct Contact Intrusive Works											1,100	120,000	85,000			130,000	82,000		62,000		85,000	120,000						
CRC CARE 2011 Soil HSL Vap.Int Intrusive Works,0 to <2m,Sand											77	NL[#10]	NL[#10]			NL[#10]	NL[#10]		NL[#10]									
CRC CARE 2011 Soil HSL Vap.Int Intrusive Works,2 to <4m,Sand											160	NL[#10]	NL[#10]			NL[#10]	NL[#10]		NL[#10]									
Location	**Date**	**Field ID**	**Depth**																									
Area 1																												
TP1	17/08/2021	TPA1-1_0.4-0.5	0.4-0.5	11	No	5	< 0.4	< 5	18	27	0.4	< 5	51	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	53	53	310	< 100	363	< 20	29	250	120	399
	17/08/2021	TPA1-1_0.9-1.0	0.9-1.0	13	No	4	< 0.4	< 5	8	15	0.1	< 5	31	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	57	57	420	< 100	477	< 20	28	330	120	478
TP2	17/08/2021	TPA1-2_0.0-0.1	0.0-0.1	11	No	9	< 0.4	7	15	14	0.2	9	46	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	56	56	400	< 100	456	< 20	32	300	170	502
TP3	17/08/2021	TPA1-3_0.4-0.5	0.4-0.5	19	No	28	< 0.4	< 5	16	22	0.3	5	34	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	160	160	1000	160	1320	< 20	91	820	330	1241
	17/08/2021	TPA1-3_1.8-1.9	1.8-1.9	14	No	6	< 0.4	6	18	10	0.3	19	39	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	68	68	500	110	678	< 20	35	380	210	625
TP4	17/08/2021	TPA1-4_0.0-0.1	0.0-0.1	19	No	22	< 0.4	28	36	50	0.1	24	**120**	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	290	< 100	290	< 20	< 20	210	110	320
	17/08/2021	TPA1-4_0.3-0.4	0.3-0.4	16	No	8	< 0.4	< 5	16	29	0.2	< 5	52	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	120	120	710	120	950	< 20	70	580	250	900
TP5	17/08/2021	TPA1-5_0.0-0.1	0.0-0.1	10	No	3	< 0.4	< 5	< 5	7	< 0.1	< 5	22	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	190	< 100	190	< 20	< 20	140	65	205
	17/08/2021	TPA1-5_0.9-1.0	0.9-1.0	11	No	11	< 0.4	< 5	22	23	0.3	< 5	61	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	97	97	560	100	757	< 20	58	460	210	728
TP6	17/08/2021	TPA1-6_0.0-0.1	0.0-0.1	15	No	6	< 0.4	< 5	9	12	0.2	< 5	33	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	110	110	780	140	1030	< 20	63	600	270	933
	17/08/2021	TPA1-6_0.4-0.5	0.4-0.5	11	No	17	< 0.4	< 5	13	15	0.3	< 5	43	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	65	65	380	< 100	445	< 20	38	310	140	488
TP7	17/08/2021	TPA1-7_0.4-0.5	0.4-0.5	15	No	10	< 0.4	< 5	17	21	0.3	< 5	41	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	100	100	550	< 100	650	< 20	63	450	200	713
	17/08/2021	TPA1-7_0.9-1.0	0.9-1.0	13	No	11	< 0.4	< 5	15	18	0.5	< 5	65	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	83	83	420	< 100	503	< 20	52	340	130	522
TP8	17/08/2021	TPA1-8_0.4-0.5	0.4-0.5	6.4	No	3	< 0.4	8	8	8	< 0.1	< 5	30	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	130	< 100	130	< 20	< 20	91	< 50	91
	17/08/2021	TPA1-8_1.9-2.0	1.9-2.0	17	No	4	< 0.4	< 5	10	13	0.2	< 5	29	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	78	78	560	110	748	< 20	44	430	230	704
Area 2																												
TP1	17/08/2021	TPA2-1_0.4-0.5	0.4-0.5	6.5	No	7	< 0.4	7	14	10	< 0.1	12	47	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	330	< 100	330	< 20	< 20	240	120	360
	17/08/2021	TPA2-1_1.4-1.5	1.4-1.5	8.9	No	6	< 0.4	7	11	7	< 0.1	11	52	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	< 100	< 100	< 100	< 20	< 20	< 50	< 50	< 50
TP2	17/08/2021	TPA2-2_0.4-0.5	0.4-0.5	12	No	4	< 0.4	26	20	9	< 0.1	37	58	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	< 100	< 100	< 100	< 20	< 20	< 50	< 50	< 50
	17/08/2021	TPA2-2_1.9-2.0	1.9-2.0	15	No	5	< 0.4	19	14	8	< 0.1	19	40	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	< 100	< 100	< 100	< 20	< 20	< 50	< 50	< 50
TP3	17/08/2021	TPA2-3_0.0-0.1	0.0-0.1	13	No	5	< 0.4	13	19	13	< 0.1	14	45	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	370	< 100	370	< 20	24	270	130	424
	17/08/2021	TPA2-3_0.4-0.5	0.4-0.5	9.6	No	6	< 0.4	24	18	12	< 0.1	21	54	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	< 100	< 100	< 100	< 20	< 20	< 50	< 50	< 50
TP4	17/08/2021	TPA2-4_0.0-0.1	0.0-0.1	4.7	No	8	< 0.4	9	16	10	< 0.1	14	52	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	< 100	< 100	< 100	< 20	< 20	54	< 50	54
	17/08/2021	TPA2-4_1.0-1.1	1.0-1.1	9.5	No	5	< 0.4	9	15	11	< 0.1	13	56	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	100	< 100	100	< 20	< 20	75	< 50	75
TP5	17/08/2021	TPA2-5_0.4-0.5	0.4-0.5	8.3	No	6	< 0.4	18	19	10	< 0.1	19	56	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	< 100	< 100	< 100	< 20	< 20	< 50	< 50	< 50
	17/08/2021	TPA2-5_0.9-1.0	0.9-1.0	28	No	6	< 0.4	53	38	49	< 0.1	35	78	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	< 100	< 100	< 100	< 20	< 20	< 50	< 50	< 50
TP6	17/08/2021	TPA2-6_0.4-0.5	0.4-0.5	15	No	6	< 0.4	17	19	18	< 0.1	17	56	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	230	< 100	230	< 20	< 20	160	110	270
	17/08/2021	TPA2-6_1.3-1.4	1.3-1.4	12	No	4	< 0.4	10	14	10	< 0.1	10	37	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 20	< 20	< 50	< 50	210	< 100	210	< 20	< 20	160	72	232

Comments

#1 Develop site specific based on CEC, pH, clay conter
#2 To obtain F1 subtract the sum of BTEX concentrations from the C6 - C10 fractio
#3 Errata 30 April 2014 - Naphthalene should not be subtracted from >C10-C16 (as there is no separate ESL for naphthale
#4 Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability maybe important and should be considered where appropriate (refer Schedule
#5 In the absence of a guideline value for total chromium, chromium VI value adopt
#6 Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered. Site-specific bioavailability should be considered where appro
#7 Elemental mercury: HIL does not address elemental mercury. a site specific assessment should be considered if elemental mercury is present, or suspected to be pre
#8 Total PAHs: Based on sum of 16 most common reported (WHO 98). HIL application should consider presence of carcinogenic PAHs (should meet BaP TEQ HIL) & naphthalene (should meet relevant h
#9 Carcinogenic PAHs: HIL based on 8 carc. PAHs & their TEFs (rel to BaP ref Schedule 7) BaP TEQ calc by multiplying the conc of each carc. PAH in sample by its BaP TEF (ref Table 1A(1)) & summ
#10 Not limiting: Derived soil HSL exceeds soil saturation concentrati
#11 Separate management limits for BTEX & naphthalene are not available hence should not be subtracted from the relevant fractions to obtain F1

				PAHs - standard 16																				
				Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b+j)fluoranthene	Benzo(k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Naphthalene-PAH	Phenanthrene	Pyrene	PAHs (Sum of total) - Lab calc	Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	Total 8 PAHs (as BaP TEQ) (half LOR) - Lab Calc	Total 8 PAHs (as BaP TEQ)(full LOR) - Lab Calc
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
NEPM 2013 EIL-Commercial/Industrial																	**370**	**370**						
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil								**1.4**																
NEPM 2013 Table 1A(1) HIL D Comm/Ind																					4,000[#5]	40[#9]	40[#9]	40[#9]
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, S																	NL[#10]	NL[#10]						
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, S																	NL[#10]	NL[#10]						
NEPM 2013 Table 1A(3) HSL D Comm/Ind Soil for Vapour Intrusion, S																	NL[#10]	NL[#10]						
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soi																								
CRC CARE 2011 Soil Direct Contact HSL-D Commercial / Industria																	11,000	11,000						
CRC CARE 2011 Soil Direct Contact Intrusive Works																	29,000	29,000						
CRC CARE 2011 Soil HSL Vap.Int Intrusive Works,0 to <2m,Sand																	NL[#10]	NL[#10]						
CRC CARE 2011 Soil HSL Vap.Int Intrusive Works,2 to <4m,Sand																	NL[#10]	NL[#10]						
Location	**Date**	**Field ID**	**Depth**																					
Area 1																								
TP1	17/08/2021	TPA1-1_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5	< 2.5	< 1	< 2.5	< 1	< 1	1.3
	17/08/2021	TPA1-1_0.9-1.0	0.9-1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.7	< 0.5	0.7	< 0.5	0.6	1.2
TP2	17/08/2021	TPA1-2_0.0-0.1	0.0-0.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	< 0.5	1	< 0.5	0.6	1.2
TP3	17/08/2021	TPA1-3_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.1	< 0.5	1.1	< 0.5	0.6	1.2
	17/08/2021	TPA1-3_1.8-1.9	1.8-1.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	0.9	< 0.5	0.6	1.2
TP4	17/08/2021	TPA1-4_0.0-0.1	0.0-0.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA1-4_0.3-0.4	0.3-0.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.5	< 0.5	1.5	< 0.5	0.6	1.2
TP5	17/08/2021	TPA1-5_0.0-0.1	0.0-0.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5	0.5	< 0.5	0.6	1.2
	17/08/2021	TPA1-5_0.9-1.0	0.9-1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.3	< 0.5	1.3	< 0.5	0.6	1.2
TP6	17/08/2021	TPA1-6_0.0-0.1	0.0-0.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.6	< 0.5	2.1	< 0.5	0.6	1.2
	17/08/2021	TPA1-6_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.8	< 0.5	0.8	< 0.5	0.6	1.2
TP7	17/08/2021	TPA1-7_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	< 0.5	< 0.5	< 0.5	< 0.5	2.3	0.6	3.5	< 0.5	0.6	1.2
	17/08/2021	TPA1-7_0.9-1.0	0.9-1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.9	< 0.5	1.9	< 0.5	0.6	1.2
TP8	17/08/2021	TPA1-8_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA1-8_1.9-2.0	1.9-2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	< 0.5	< 0.5	< 0.5	< 0.5	1.4	0.7	2.7	< 0.5	0.6	1.2
Area 2																								
TP1	17/08/2021	TPA2-1_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA2-1_1.4-1.5	1.4-1.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
TP2	17/08/2021	TPA2-2_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA2-2_1.9-2.0	1.9-2.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
TP3	17/08/2021	TPA2-3_0.0-0.1	0.0-0.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA2-3_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
TP4	17/08/2021	TPA2-4_0.0-0.1	0.0-0.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA2-4_1.0-1.1	1.0-1.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
TP5	17/08/2021	TPA2-5_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA2-5_0.9-1.0	0.9-1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
TP6	17/08/2021	TPA2-6_0.4-0.5	0.4-0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2
	17/08/2021	TPA2-6_1.3-1.4	1.3-1.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2

Comments

#1 Develop site specific based on CEC, pH, clay conter
#2 To obtain F1 subtract the sum of BTEX concentrations from the C6 - C10 fractio
#3 Errata 30 April 2014 - Naphthalene should not be subtracted from >C10-C16 (as there is no separate ESL for naphthale
#4 Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability maybe important and should be considered where appropriate (refer Schedule
#5 In the absence of a guideline value for total chromium, chromium VI value adopt
#6 Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered. Site-specific bioavailability should be considered where appro
#7 Elemental mercury: HIL does not address elemental mercury. a site specific assessment should be considered if elemental mercury is present, or suspected to be pre
#8 Total PAHs: Based on sum of 16 most common reported (WHO 98). HIL application should consider presence of carcinogenic PAHs (should meet BaP TEQ HIL) & naphthalene (should meet relevant H
#9 Carcinogenic PAHs: HIL based on 8 carc. PAHs & their TEFs (rel to BaP ref Schedule 7) BaP TEQ calc by multiplying the conc of each carc. PAH in sample by its BaP TEF (ref Table 1A(1)) & summ
#10 Not limiting: Derived soil HSL exceeds soil saturation concentrati
#11 Separate management limits for BTEX & naphthalene are not available hence should not be subtracted from the relevant fractions to obtain F1

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