Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Assessment of Potential Groundwater Level Impacts

Proposed Train Support Facility
Woodlands Close, Hexham

Prepared for
QR National

Project 39798.09
November 2012

Douglas Partners
Geotechnics | Environment | Groundwater

Document History

Document details

Project No.	39798.09	Document No.	1
Document title	Assessment of Potential Groundwater Level Impacts		
Site address	Proposed Train Support Facility Woodlands Close, Hexham		
Report prepared for	QR National		
File name	P:\39798.09\Docs\39798.09 - [Rev 3] - FINAL - 121112.doc		

Document status and review

Revision	Prepared by	Reviewed by	Date issued
0 (Draft)	Will Wright	Chris Bozinovski	12 September 2012
1 (Final)	Will Wright	Chris Bozinovski	27 September 2012
2 (Final)	Will Wright	Chris Bozinovski	11 October 2012
3 (Final)	Will Wright	Chris Bozinovski	12 November 2012

Distribution of copies

Revision	Electronic	Paper	Issued to
0 (Draft)	1	0	Mr Chris Puslednik, Engenicom Pty Ltd
1 (Final)	1	0	Mr Chris Puslednik, Engenicom Pty Ltd
2 (Final)	1	0	Mr Chris Puslednik, Engenicom Pty Ltd
3 (Final)	1	0	Mr Chris Puslednik, Engenicom Pty Ltd

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		12 November 2012
Reviewer		12 November 2012

NCS INTERNATIONAL CERTIFIED QUALITY MANAGEMENT SYSTEM

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region MC NSW 2310
Phone (02) 4960 9600
Fax (02) 4960 9601

Table of Contents

Report on Assessment of Potential Groundwater Level Impacts
Proposed Train Support Facility
Woodlands Close, Hexham

1. Introduction

This report presents the results of an assessment of potential groundwater level impacts for a proposed Train Support Facility (TSF) off Woodlands Close, Hexham. The report was prepared at the request of QR National.

It is understood that the proposed development includes the construction of a rolling stock provisioning facility, located adjacent to the Great Northern Railway Line, west of the Pacific Highway at Hexham.

The proposed development will include the following aspects:

- A railway siding, approximately 3 km in length and up to 100 m in width;
- An associated sealed access road about 3 km in length;
- Cut and fill to construct the facility.
- Construction of several buildings, including wash down bays, administrative office and fuelling facility;
- Construction of a multi-celled stormwater culvert.

The purpose of the assessment was to assess the potential impact on groundwater recharge associated with the change in surface water hydrological regime associated with the proposed TSF development.

The scope of work comprised the following:

- Review available hydrogeological information regarding the site and surrounds;
- Review of potential receptors which could be affected by changes to the hydrogeological regime;
- Site inspection by senior groundwater engineer;
- Review of proposed development, in particular proposed changes to the surface hydrology;
- Development of a conceptual groundwater flow model for the site;
- Use of the conceptual model as a basis to provide a qualitative assessment of likely impacts to groundwater levels, based on the proposed development.

For the purpose of the assessment the following information was supplied by the client:

- Mapping of groundwater dependant ecosystems within the site, undertaken by Ecological Australia;
- Drawings by WorleyParsons (Ref 14):
  - Existing Hydrology;

- Proposed Arrangement of Train Support Facility;
- Proposed Hydrology;
- Preliminary Construction Stormwater Plan.

- Drawings by GHD:
  - Areas of Disturbance Cut;
  - Areas of Disturbance of Fill.

2. Site Description

The site description is based on a site inspection which was undertaken by a senior groundwater engineer in August 2012 and includes descriptions of the existing hydrological features of the site, as detailed on the attached sheets "Existing Hydrology Train Support Facility" – Sheets 1 and 2 by WorleyParsons.

The site contains various Groundwater Dependant Ecosystems (GDEs) as presented on Ecological Australia's drawing "Vegetation Communities and Threatened Flora" in Appendix A, some of which are Endangered Ecological Communities (ELAs). The location of these GDEs and ELAs are described in the sections below.

The site is located at the southern end of Woodlands Close, Hexham and is bounded to the east by the Great Northern Railway which runs north-south parallel to the New England Highway and the Hunter River which is situated further to the east. The site has overall dimensions of about 3.5 km by 700 m.

The proposed TSF development area is generally limited to a corridor about 150 m wide adjacent to the Great Northern Railway, due to the linear nature of the development. The ARTC Hexham Relief Roads Project which comprised five new train line (tracks) is located between the proposed TSF and the Great Northern Railway. The development generally only occupies a relatively narrow strip along the eastern side of the overall site, as shown on the WorleyParsons general arrangement figures in Appendix A.

The site can be divided into two distinctly different sections. The southern section has been heavily disturbed, with the site raised by filling. The northern part of the site is mostly low lying grazing land with only very localised areas of filling having been placed, associated with narrow access roads.

Each section of the site is described below.

Southern Site (Ch 174.170 km to Ch 175.800 km)

The southern parts of the site have mostly been filled in the past and comprise remains of a former Coal Preparation Plant and associated facilities, former tailing ponds (stockpiles) and part of the Minmi-Hexham Railway and Colliery Sidings.

The south western corner of the site is low lying with only minor filling and contains Endangered Ecological Communities including Freshwater Wetlands and Saltmarsh.

To the south and west of the site is a low-lying swamp with the area to the west comprising Hexham Swamp Nature Reserve. Hexham Swamp is understood to contain Groundwater Dependant Ecosystems (GDEs).

Site levels have been modified by the placement of filling (Figure 1), generally associated with the former Coal Preparation Plant facilities, including rail sidings. Site levels on the eastern parts of this area associated with abandoned rail lines and access roads are typically in the range RL 2 to RL 4 m (AHD).

A former tailings pond in the north-western portion of the area has been filled with coal fines and coal reject forming an elevated platform (stockpile) approximately 6 m (RL 8 AHD) above the surrounding site. It is understood that the stockpile is spray irrigated with treated effluent.

Relevant existing drainage features on this part of the site include the following:

- Open drain around the western and northern sides of the tailings stockpile. This drain seems to collect run-off and seepage from the tailings stockpile. The drain discharges to the Hexham Swamp to the west via two existing culverts which run below a perimeter access road. At times of high rainfalls, the drain can be expected to overflow to lower ground to the northern parts of the site, as well as Hexham Swamp to the west. This drain is understood to contain Swamp Oak;
- Run-off and seepage from the north western part of the tailings stockpile is expected to be collected in a former tailings pond at the to the north west, which is understood to discharge to the above described perimeter drain. This pond is understood to contain Freshwater Wetlands which is an Endangered Ecological Community (ELA);
- Run-off from the south eastern part of the tailing stockpile drains to the north to a low lying area, where surface water was observed to be ponding on 15 August 2012. This ponded area would be expected to overflow to the above described the tailings dam located to the north;
- In the south east part of the overall site there is an open drain running parallel to the existing rail lines, which drains to a former tailings pond in the very south eastern corner of the site. The tailings dam is understood to overflow to the swamp to the south. The drain and ponds are understood to contain Swamp Oak and Coastal Floodplain Sedgelands, which are an ELA;
- Slightly further to the west and parallel with the above described drain there is another low lying section of the site, which is understood to the be former tailings dam. This low lying section is heavily vegetated and water was observed to be ponding in the overall area on 15 August 2012. This area is understood to contain Swamp Oak and Coastal Floodplain Sedgelands which are an ELA;
- There is a former rail loop on the western side do the site to the south of the tailing disposal area. Vegetation within the rail loop includes Swamp Oak. There are low lying areas around the northern perimeter of the former rail loop which contain Freshwater Wetlands (ELA). These areas would be expected to accept run-off from the rail loop area and would overflow towards Hexham Swamp to the west.

Existing site hydrology is shown on the WorleyParsons Existing Hydrology Sheets 1 and 2 in Appendix A.

Figure 1: Filling stockpiles in the eastern portion of the site

Northern Side (Ch 175.800 km to Ch 177.200 km)

The northern part of the site is identified as the eastern part of Lot 113 DP 755232 and Lot 104 DP 1084709. An access road is also proposed to extend through Lot 2 DP735456, Lot 10 DP 735235 and Lot 21 DP 842856.

The northern site is generally low lying with dense grass cover and scattered trees. The site levels typically range from RL 0.5 AHD to RL 1.5 AHD.

The site is accessed via a gravel access road which forms an extension to Woodlands Drive.

Surface water was ponding at many locations at the time of field investigations in July to September 2007 as well as during a site inspection in August 2012, as shown in Figure 2 below, located on the alignment of the proposed access road.

Figure 2: General site figure showing low lying areas

There are effluent treatment dams located at the southern end of this part of the site, immediately to the north of the elevated tailings stockpile described in the previous section. It is understood that effluent is treated to a secondary level and then spray irrigated on areas to the north of the treatment dams.

The site is relatively flat and low lying with limited existing drainage features, and flow is primarily overland and towards the north. Drainage feature which are present include the following:

- An existing excavated channel which cuts across the northern part of the site. The channel originates in Hexham Swamp to the west and drains to the towards the Hunter River to the east, via a culvert below the rail line (Figure 3) and Pacific Highway;
- To the immediate south of the channel there is a small network of channels and ponds, which drain into the channel.

The low lying areas immediately to the south of the drainage channel include extensive areas of Swamp Oak and Coastal Floodplain Sedgelands both of which have been designated Endangered Ecological Communities. There are also some smaller areas of Swamp Oak, adjacent to and beneath the proposed development, at the southern end of this part of the site.

Figure 3: Culvert beneath existing track at Ch 177.060 km

3. Data Review

3.1 General

The data review had two main components: published information and in-house information from Douglas Partners files on previous investigations. The published information includes geological maps, soil landscape maps, acid sulphate risk maps and historical aerial photographs. These are described on Section 3.2 below.

The in-house information comprises data from several previous investigations both within the subject site and on adjacent or nearby sites, dating from 1959 to 2011.

3.2 Published Data

3.2.1 Geological Map

The 1:100,000 scale Newcastle Coalfield Regional Geology map (Sheet 9321), published by the Department of Mineral Resources, indicates that the site is underlain by Quaternary Alluvium. The alluvium typically comprises unconsolidated sediments deposited in a fluvial or estuarine environment, and includes gravel, sand, silt and clay.

3.2.2 Landscape Map

The soil landscape map for Newcastle (Sheet 9232), published by the Soil Conservation Service, shows that the majority of the southern part of the site is categorised as “disturbed terrain”, being extensively disturbed by human activity. The soils and hence the potential limitations are highly variable, and may include foundation hazard, unconsolidated low wet bearing strength materials, potential acid sulphate soils, impermeable soils, poor drainage, erosion hazard, very low fertility.

The northern part of the site is shown to be part of the Millers Forest landscape, described as comprising extensive alluvial flood plain / delta on recent sediments with elevation below 3 m to 6 m AHD. Limitations, as listed, include flood hazard, permanently high water table, seasonal water-logging, foundation hazard. This landscape would also be expected to underlie the disturbed terrain of the remainder of the site.

3.2.3 Acid Sulphate Soil Risk Map

The Acid Sulphate Soil Risk Map for Beresfield (Sheet 9232 N3), published by the Department of Land and Water Conservation, indicates that the entire site has a high probability of acid sulphate soils within one metre of the (natural) ground surface. There would be an environmental risk if acid sulphate materials were disturbed without appropriate management procedures in place.

3.3 Registered Groundwater Bores

An online records search of registered groundwater with the Department of Water and Energy (DWE-currently NSW Office of Water) indicated that there are nine registered groundwater wells located around the perimeter of the site and are used for monitoring purposes. The monitoring bores were registered in October 2011 and were installed as part of the current investigations associated with the proposed TSF development.

3.4 Data Review

The archive search revealed a number of relevant previous investigations by DP (and its predecessors). Some of these were carried out within the subject site, and the others were on adjacent or nearby sites. These assist in building a geotechnical model of the site. The reports are listed in Table 2 in chronological order.

Table 2: Previous Investigations Undertaken on the Site and Surrounding Area by DP

Reference Prefix**	Project Number	Date	Report Title	Field Tests
A	00083	February 1959	Subsoil Investigation, Hexham	3 Bores (location uncertain)
B	02961	March 1971	Foundation Investigation, Ironbark Colliery, Hexham	13 Bores
C	03389	March 1972	Foundation Conditions, Proposed Coal Preparation Plant Hexham	4 Bores
D	06109	June 1978	Foundation Conditions Proposed Road and Rail Interchange Station, Hexham	5 Bores, 2 CPTs
E	16781	August 1993	Geotechnical Investigation, Proposed Depot Redevelopment, Australian Co-Operative Foods Ltd, New England Highway Hexham	4 Bores, 3 CPTs
F	17163, 17163A	August 1995	Geotechnical Investigation and Building Preload, Proposed Service Station Redevelopment, Pacific Highway Hexham	8 Wells*
G	18419, 18419A, 18419B	November 1995	Geotechnical and Acid Sulphate Soil Investigation, Proposed Effluent Ponds, ACF, New England Highway Hexham	6 Test Pits
H	18419C	November 1995	Geotechnical And Acid Sulphate Soil Investigation, Proposed Effluent Ponds, ACF, New England Highway Hexham	2 Bores
I	18457	February 1996	Geotechnical Investigation, Proposed Industrial Development, Lots 1 and 2 Old Maitland Road Hexham	3 CPTs
J	18603	November 1996	Geotechnical Investigation, Proposed Extensions to Club and Car park, Hexham Bowling Club, Hexham	6 Bores, 2 CPTs
K	18891	September 1998	Geotechnical Investigation, Proposed Access Road Hexham	12 Test Pits
L	18891A	January 1999	Geotechnical Investigation, Power Poles, Access Road and Smithy's Crossing, Hexham	5 Bores
M	18944, 18944A, 18944B	February 1999 to November 2000	Groundwater Monitoring, Dairy Farmers, 189 Maitland Road Hexham	10 Wells*
N	31773	July 2003	Geotechnical Investigation, Augmentation Of Hexham Bowling Club Wastewater Facilities, Hexham Bowling Club Hexham	2 Bores
O	39033	September 2004	Geotechnical Investigation, Proposed Weighbridge, Sparke Street Hexham	3 Test Pits, 1 CPT
P	39052	September 2004	Preliminary Site Assessment, Maitland Road, Hexham	Desktop review of geotechnical and geo-environmental data
Q	39159	June 2005	Report on Water Balance Assessment for Disposal of Treated Waste Water	NA
R	39798	October 2007	Preliminary Geotechnical Investigation, Proposed Maintenance Facility, Woodlands Close, Hexham	15 CPTs, 12 Bores, 11 hand augers
S	39798.01	March 2008	Geotechnical Assessment Proposed Rail Siding, Hexham	Desktop review of geotechnical data
T	39798.05	February 2012	Groundwater Assessment, Proposed Hexham Redevelopment, Maitland Road and Woodlands Close, Hexham	12 Wells*

Notes to Table 2:

* Wells – Groundwater monitoring wells

** - Refer Drawing 4 for reference Prefix location

CPT – Cone Penetration Test

NA – Not Applicable

It should be noted that the locations of the tests are approximate in most cases, particularly for the older investigations where site plans are unclear or open to interpretation.

3.5 Subsurface Conditions

The following is a summary of the subsurface conditions from previous investigations undertaken on and in the vicinity of the site:-

Table 3: Summary of Subsurface Profile

Stratum	Description
FILL	Predominantly comprising coarse coal reject (chitter), and intermixed with sand and clays where spread elsewhere particularly on the southern half of the site in the area of a former Coal Handling Preparation Plant. Over the southern half of the site the fill depth is typically 0.5 m to 1.5 m depth, but up to about 2 m.
CLAY (alluvial)	Soft to firm silty clays / clays and clayey silts are present beneath the fill at all CPT test locations. The clay layer is typically 15 m to 17 m thick but up to 25m thick at the southern end of the site. It is this layer which presents issues of poor bearing capacity for footings and pavements, as well as potential long term settlements under load due to its compressibility. The clay profile is inter-bedded by silty sand / clayey sand, particularly in the upper profile of the unit.
SAND	Sand, clayey sand or silty sand, with occasional gravel, usually loose to medium dense, becoming dense with depth. The thickness and distribution of this layer is quite variable and it is not present at all locations.
CLAY (residual)	The deeper clays are generally stiff to very stiff sandy clay, grading to hard clays and weathered rock although weathered rock was not encountered during the current investigation.
BEDROCK	Sandstone, siltstone, shale and coal were encountered in previous bores that were taken to rock. The depth to rock varies considerably, from about 25 m (below natural surface) in the south-eastern area (former colliery facilities) to 33 m near the former rail loop, west of the southern end of the site. More generally, it appears that the depth to rock is round 30 m to 35 m over most of the site, probably increasing to the west towards Hexham Swamp.

Previous test locations with the site are shown in the Test Location Plan in Appendix A.

3.6 Soil Permeability

There is limited direct information on soil permeability on the site, however based on the limited testing as well as experience with similar estuarine soils associated with the Hunter River the following comments are made:

- Due to the variable nature of the filling on site the permeability of the filling can be expected to be variable. The coarse coal reject fill which can be expected to have a medium to high permeability. The coal fines filling can be expected to have a low to medium permeability;
- The underling soft marine clays can be expected to have a low permeability. Limited testing suggests hydraulic conductivity in the order of about 2 $x10^{-9}$ mls (3.5 $x10^{-4}$ m/day) to less than 1 $x10^{-10}$ m/s (1.7 $x10^{-5}$ m/day);
- The underlying sand would be expected to have a moderate to high permeability, with typical hydraulic conductivity for estuarine sands in the range $1x10^{-4}$ to $4x10^{-4}$ m/s (1 to 40 m/day);
- The underlying residual clay and weathered rock would be expected to be of low permeability.

3.7 Groundwater Quality

The results of the desktop assessment identified the following with respect to groundwater at the Hexham redevelopment site:

- The site has previously been used for a number of agricultural and commercial/industrial landuses including grazing, wastewater treatment plant and associated effluent disposal, coal preparation plant and associated railway lines and sidings;
- A number of potential contamination sources are associated with the current/former landuses at the site, including above ground fuel storage tanks and bowsers, railway lines, coal reject filling, fill material of unknown origin, former cropping, WWTP and associated irrigation, potentially buried wastes, potential acid generation from exposure of ASS during construction of the HWC pipeline;
- Laboratory testing of groundwater and surface water samples has found elevated concentrations of heavy metals, nutrients and faecal coliforms in the majority of samples. Elevated hydrocarbons were also detected in some locations. The groundwater contamination was considered likely to be associated with effluent irrigation on-site, leaching of contaminants from fill materials or localised contaminant sources (ie fuel storage).

It is noted that groundwater impact is widespread and this portion of the Hexham Wetland is in a degraded stage. It is understood that groundwater impacts at the site will be managed through the implementation of a Water Quality Management Plan.

3.8 Groundwater Levels

Thirty-five (35) groundwater monitoring wells were gauged and sampled in October 2011 using existing groundwater wells. Groundwater piezometric levels were measured in each of the wells prior to purging and are summarised in Table 4 below.

Table 4: Summary of Groundwater Level Observations – 17 October 2011

Bore	Coordinates		RL Ground Surface[1] (AHD)	RL Top Of Casing (AHD)	17 October 2011	
	Easting	Northing			Depth to Ground Water [1]	RL Ground Water
1	376427.48	6367261.72	0.97	1.37	0.415	0.96
2	376503.71	6367189.18	1.06	1.40	0.545	0.86
3	376283.31	6367405.31	1.08	1.47	0.710	0.76
4	375776.02	6367407.54	0.9	1.36	0.970	0.39
5	376411.2	6367889.2	1.51	1.85	0.880	0.97
7	376069.98	6367887.72	0.36	0.58	0.230	0.35
101	377124.418	6365964.809	2.6	3.12	1.695	1.43
102	376979.477	6366102.279	2.55	3.11	1.193	1.92
103	376597.602	6366198.096	3.07	3.56	1.448	2.11
106	376661.164	6366956.879	1.96	2.48	1.068	1.41
107	376777.668	6366997.239	1.84	2.58	1.305	1.28
108	376089.421	6366959.47	3.29	4.02	1.044	2.98
109	376272.699	6368094.83	1.48	2.14	1.952	0.19
MW01	377073.15	6365746.08	2.45	2.95	1.131	1.82
MW02	376711	6365816.51	2.7	3.25	1.612	1.64
MW03	376374.67	6366182.73	3.81	4.34	2.683	1.66
MW04	377057.4	6366155.42	2.06	2.48	0.901	1.58
MW05	377015.97	6366140.16	2.1	2.62	1.035	1.59
MW06	376865.66	6366709.26	2.03	2.56	0.986	1.57
MW07	376367.59	6367065.9	1.78	2.25	1.139	1.11
MW08	376419.59	6366506.77	12.17	12.66	3.631	9.03
MW09	376574.57	6366696.72	9.01	9.50	1.068	8.43
MW10	376257.92	6366690.37	9.04	9.50	4.637	4.86
301	376610.95	6367416.45	1.28	2.26	1.321	0.94
302U	376941.25	6366534.90	2.64	3.60	2.121	1.48
302AL	376941.50	6366538.45	2.18	2.61	1.221*	1.39
303U	377107.20	6366122.85	1.75	2.84	1.306	1.53
303AL	377107.80	6366120.65	1.81	2.80	1.564*	1.24
304	377272.65	6365661.65	2.03	3.09	2.140	0.95
305	375647.40	6368029.05	0.50	1.53	1.408	0.12
306U	376164.15	6366699.00	1.32	2.27	1.371	0.90
306AL	376162.85	6366701.75	1.31	2.07	2.663*	-0.59
307	376271.45	6366360.90	1.30	2.32	1.408	0.91
308U	376393.60	6365942.85	2.36	3.03	2.328	0.70
308AL	376393.25	6365944.10	2.39	3.30	2.091*	1.21

Notes to Table 4:

1 - Depth below Top of PVC Casing

* - Depth to ground water recorded 17 November 2011

N/A - Not available

U - well screened in upper filling

L - Well screened in low natural soils (i.e. clays)

RL - Relative Level

Contours of groundwater head for the 17 October 2011 gauging event are presented in Drawing 2 in Appendix A.

The groundwater contours indicate the following:

- Substantial mounding of groundwater in the coal tailings stockpile area (up to RL 8.0), with groundwater flow radiating from the near the centre of this area to the south of the proposed development area;
- To the north of the coal tailings stockpile area, the hydraulic gradient drops substantially with a slight gradient towards the channel crossing the northern part of the site. Groundwater levels on the northern site typically range from about RL 1.0 to RL 0.5 with groundwater at or near the surface;
- To the east of the coal tailings stockpile area, where the site contains filling to depths typically in the range 0.5 m to 2.5 m the groundwater flow is to the north, towards the existing rail lines and Pacific Highway. Groundwater levels are typically in the range RL 2.5 to RL 1.5 at depths ranging from near surface level (at localised low points) to 1.0 m depth;
- On the southern part of the site there is a hydraulic divide running approximately north-south through the centre of the area. Groundwater levels are in the range RL 2.0 to RL 1.0 and flow is primarily to the east on the eastern parts of the site and west on the western parts of the site, with some flow to the south.

3.9 Acid Sulphate Soils

The result of the testing indicate that the natural clay soils are Potential Acid Sulphate soils and an Acid Sulphate Soil Management Plan (ASSMP) will be required for any activities which are likely to disturb PASS (i.e. excavation or dewatering of the natural clay / sand).

4. Proposed Development

It is understood that the proposed development includes the construction of a rolling stock maintenance facility, located adjacent to the Great Northern Railway Line. The proposed development will include the following aspects as shown on the attached plan by GHD:

Stage 1:

- Construction of a connection to the Tarro Interchange and main vehicle access road to the site;
- Construction of earthworks, drainage, circulating roadwork and the construction of one provisioning track, a train examination road, two cut out roads and two wagon maintenance roads;
- Filling and grading of the TSF area (approximately 380,000 m^3 of suitable fill to be imported) so that site levels can match the adjoining rail network;
- Associated signalling and connections to the down coal road on the Great Northern Line;
- Construction of a Provisioning Facility;

- 2 x Provisioning roads and UTM road;
- 2 x Wagon Maintenance roads;
- Wagon storage road;
- Construction of a Wagon Maintenance Building;
- 1 x Wagon storage road;
- Fuel storage area to initially accommodate 2 x 100,000 litre tanks and to be constructed in such a manner as to allow for future expansion of up to 4 x 100,000 litre tanks of diesel fuel.

Stage 2:

- Locomotive Maintenance Building;
- Locomotive Wash Building;
- Locomotive Turntable;
- Locomotive Maintenance roads.

The proposed TSF development is shown in WorleyParsons Proposed Arrangement Figure 2 in Appendix A.

Filling

The majority of filling is proposed to be along the rail formation with the depth of filling in the range 0.2 m to 0.4 m on the southern parts of the site where the site is already filled and from 1.4 m to 1.8 m on the northern parts of the site, where the site is at low lying natural grades.

Localised areas of filling are also proposed as follows:

- 0.3 m high access road on northern parts of site;
- 0.3 m perimeter road around overall southern site, mostly on existing filled areas;
- 0.5 m high temporary construction compound on northern low lying part of site.

Approximate areas of proposed filling are shown on the GHD Areas of Disturbance – Fill plan in Appendix A.

Excavations

Excavations on site are proposed to comprise the following:

- Proposed Basins 1 to 3, with cut ranging from 0.1 m for Basins 1 and 2 on the northern part of the site which are expected to be through natural clay soils to 2.6 m for the Basin 3 at the southern part of the site, which is expected to be mostly through existing filling;
- Proposed cess drains leading to the various basins with depths of cut ranging from 1.6 m though existing filling on the southern site to 1.0 m or less on the northern site;
- Site preparation for proposed access roads and associated culverts with depths of cut typically 0.3 m or less and in places up to 1.5 m;
- Temporary trench excavations for buried services, to depths of up to about 0.8 m.

Approximate areas of proposed cut (excavations) are shown on the GHD Area of Disturbance – Cut plan in Appendix A.

Ground Improvement

- The site is underlain by substantial thickness of soft clay, which when subject to loads from the proposed development will lead to ground settlements. In order to reduce/manage the ground settlement, various geotechnical ground improvement strategies may be employed for the rail track and buildings. These methods may include one or the more of the following:
  - Piles (more likely for buildings);
  - Preloading (with wick drains);
  - Deep soil mixing;
  - Vacuum consolidation;
  - Stone columns.

Irrigation and Drainage

- Effluent is proposed to be spray irrigated on filled ground on the southern part of the site, to the west of the rail lines;
- The existing surface hydrology is to remain essentially unchanged on the majority of the site. On the developed parts of the site, three formal detention basins will be created (Basins 1 to 3) to collect run-off from the development, as follows:
  - Diversion of flow from the approximate southern third of the rail alignment towards Basin 3 which is located in the south west corner of the site in the location of an existing tailings dam. This would then discharge to the wetlands to the south. In essence this is formalising the existing hydraulic regime on this part of the site;
  - Diversion of flow from the very northern part of the development into Basin 1, located immediately to the south of the existing channel. Basin 1 will overflow into the existing channel;

  - For the remaining sections of the site, the flow will be diverted to Basin No 2 which is located on the northern part of the site to the south of Basin 1. Basin 1 will overflow to the a surface drain located on low lying relatively flat ground to the west.
- A new multi cell culvert at the northern end of the project to connect into the existing culvert which runs beneath the Great Northern Railway.

Proposed site hydrology is shown in WorleyParsons Proposed Hydrogeology Sheets 1 and 2 in Appendix A. Details of the proposed stormwater management strategy is provided in the WorleyParsons Stormwater Management Plan (Ref 13).

5. Conceptual Groundwater Model

A conceptual groundwater model has been developed based on the available background information as follows:

- The majority of groundwater flow is expected to occur in the filling and will be driven by infiltration of rainfall and irrigated waters on the more elevated parts of the site, in particular the coal tailings stockpiles which are located to the west of the proposed TSF development area;
- Groundwater flow radiates out from near the centre of the coal tailings area, however much of the groundwater flow from this area towards the north, west and east would be expected to be intercepted by the perimeter drainage, rather than flowing to the groundwater beyond. The intercepted water is diverted towards the Hexham Swamp to the west. Therefore a large proportion of groundwater flow from the site is directed to the west, away from the TSF development area;
- Infiltration of rainfall will also occur on the lower lying filled land to the east of the tailings stockpiles (i.e. within the TSF development area). Groundwater flow in this area is expected to occur towards the east towards the Hunter River. Some groundwater flow will be intersected by the existing open drain running parallel to the rail line with the remainder continuing towards the river. Some fluctuations in groundwater levels within the filling could be expected in close proximity to the Hunter River. Based on an average water level in the Hunter River of about RL 0.0 or slightly higher and a distance of between about 600 m and 900 m to the river, the available hydraulic gradient towards the Hunter River will be limited, with associated limited groundwater flow rates;
- Groundwater flow in the south western corner of the site is expected to be towards the Hexham swamp to the west;
- On the northern parts of the site, which have not been filled, groundwater flow will be very limited. This is because the soils are of low permeability and due to the flat grades, there is very little hydraulic gradient to drive groundwater flow. Groundwater is typically at or near the ground surface, with the ground surface drainage system providing a control on the upper groundwater levels which are possible on this part of the site. Groundwater flow which does occur is expected to be in a northerly direction towards the open channel;

- There is a sand layer found at depth below about 15 m to 25 m of very low permeability clay soils. It could be expected that there would be very limited connectivity between the upper fill layers and this deeper sand layer, due to the low permeability of the clay. Groundwater flow directions in the sand are expected to be in a general south easterly direction, possibly flowing toward the Hunter River. Based on surrounding low lying surface levels and the presence of the overlying clay layer, driving heads and therefore flows in the sand would be expected to be very low;
- Groundwater flow the in the underlying residual clay and rock is also expected to be very limited.

6. Potential Groundwater Impacts

6.1 General

Potential groundwater level impacts from the development are expected to include:

- The environment, in particular groundwater dependant ecosystems (GDEs);
- To existing groundwater user;
- Cumulative impact including proposed ARTC Hexham Relief Roads project to the immediate east.

In terms of existing users, as outlined in Section 3.3, registered groundwater users are limited to the monitoring bores currently present at the perimeter of the site. The water quality is poor and the highest possible beneficial use for the water would be commercial/industrial uses.

In terms of the environment, there are several GDEs identified within the site as well as the Hexham Swamp to the west of the site. The Hunter River is also a receptor of limited groundwater flows from the site. It is noted that the proposed development passes directly over a number of GDEs on the site and these will be lost below the development footprint. The remaining parts of these GDEs will be therefore located in close proximity to the edge of the TSF development.

Potential site activities with potential to affect groundwater levels include the following:

- Excavation and dewatering during construction;
- Site Filling;
- Ground improvement;
- Site Capping;
- Formation of permanent drainage channels and detention ponds;
- Irrigation of Effluent.

6.2 Excavation and Dewatering During Construction

Excavations on site are expected to include:

- Proposed Basins 1 to 3;
- Proposed cess drains;
- Site preparation for proposed access roads and associated culverts;
- Temporary trench excavations for buried services.

Based on the shallow groundwater levels at site it is anticipated that most excavations will intersect groundwater. Temporary dewatering may be required to allow construction activities, especially for the access road, culvert and buried service excavations. For the proposed cess drains and detention ponds it may be possible to excavate these without dewatering.

Excavations on the southern parts of the site will be predominantly through existing filling which is typically granular and can be expected to be relatively permeable. Dewatering is likely to be achieved by a combination of sump and pump methods for localised excavations with the possibility of spear point dewatering in some areas.

On the northern parts of the site excavations will be through the natural clay soils, which are generally of low permeability with the exception of local sandy or silty layers. Sump and pump dewatering is expected to be used and due to the low permeability of these soils flow rates are expected to be relatively low if they are not under surface water.

Drawdowns for such construction dewatering are expected to be limited and localised and are not expected to have significant impacts on water levels outside of the development footprint, especially for sump and pump dewatering. There is a higher risk if more extensive spear point dewatering is undertaken, however this can be managed by limiting the extent of dewatering undertaken at any one time, monitoring of groundwater levels and recharging groundwater, if required.

6.3 Site Filling

Filling of the site is required to raise site levels. The southern parts of the site are already filled, however additional placement of filling is anticipated. The northern parts of the road and rail alignments will need to be constructed on filled embankments.

Groundwater levels on site are currently constrained by low surface levels and the water table is often present at the ground surface, especially on the northern parts of the site. The placement of filling on the site provides the opportunity for groundwater to occupy the filling and this may lead to localised increased groundwater levels within the filling.

The occurrence of mounding of groundwater levels within the filling will be dependent on the permeability of the filling and the presence of capping material on the filling. For coarse rock fill, which may be used, especially on the northern parts of the site, minimal mounding of groundwater can be expected. For less permeable soils such as sand or clay, localised mounding may occur within the fill, particularly prior to placement of any capping on the site. In either case, impacts on the groundwater levels outside the footprint of filling would be limited, as the groundwater levels here are generally controlled by existing surface levels and drainage controls.

Placement of filling on the site will lead to consolidation settlement of the underlying clay soils. This settlement occurs, in part, by expulsion of pore water from the existing clay soils. This expulsion of water has the potential to lead to elevated groundwater levels during the consolidation phase, following construction. Due to the low permeability of the soil the expulsion of water will occur very slowly, with some of the water draining to the underlying sand layer and some water draining to the overlying filling, or ground surface. The increase in flow rates will be temporary and would be expected to be masked by flow rates due to typical variations in climatic conditions.

6.4 Ground Improvement

The ground improvement measures to be used, if any, are yet to be established from detailed geotechnical design, however could include the following:

Piles

Piles are only likely to be used for support of buildings and would likely comprise either CFA or driven piles, neither of which required dewatering during construction. The piles would form isolated columns through the soil stratum, however would not provide any significant barrier to groundwater flows. Therefore impacts to groundwater from piling are expected to be minimal.

Preloading

Preloading could be used to induce settlement of the soil profile prior to construction to reduce residual post construction settlements. In order for this to be practical, wick drains would be required to speed up the settlement times. These wick drains comprise permeable strips, typically only about 0.1 m in width, installed to depth by pushing into the ground using a long probe (mandrel).

The depth of the drains would be subject to detailed design, however they would be expected to only partially penetrate into soft clay and would not provide a hydraulic connection between the filling and underlying sand layers. Pore water could be expected to be expelled from the clay into the surface filling during the preloading phase and this may lead to a slight temporary mounding of groundwater levels within the filling, or flow to surface drainage immediately where the preloading is occurring. Impacts on groundwater levels outside the immediate development area are considered to be minor.

Stone Columns

Stone columns comprise coarse gravel material being pushed into the soil to form stiffer columns. A grid of stone columns would typically be used immediately beneath the area of development and the depth would be subject to detailed design, however they would only be expected to partially penetrate the soft clay layer. Some short term disturbance of groundwater levels could occur in close vicinity to the columns during construction if water is used to jet the gravel in place.

Vacuum Consolidation

Vacuum consolidation is the process of stiffening the soil by essentially extracting the pore water out of the soft clay layer through suction and will lead to settlement of the clay soil occurring prior to development. The process is similar to preloading with wick drains, however the pore water is removed in a more controlled manner to the surface, reducing impacts on groundwater levels.

Deep Soil Mixing

Deep soil mixing involves a grid of columns of the soft clay mixed with lime or cement, thereby providing a stiffer area of soil with improved founding conditions. The columns of mixed soil generally have only a slightly higher permeability than the surrounding soils and therefore are not expected to significantly alter the groundwater flow regime. Settlement are reduced and therefore any short term increases in flow due to loading are avoided.

Ground Improvement Summary

Overall, some limited impact on groundwater levels in the immediate vicinity of the development area could occur from ground improvement during construction, however impacts would not be significant outside the area of immediate development. As none of the ground improvement methods are expected to fully penetrate the soft clay, long term impacts are expected to be negligible.

6.5 Site Capping

Capping of the development area has the potential to reduce rainfall recharge to the developed site. Site capping could occur in the following areas:

- Possibly below rail formations;
- Sealed road pavements, mostly access roads;
- Buildings and associated hardstand/paving.

With regard to rail formations, it is standard practice to include a capping layer below the railway ballast layer to prevent water entering and softening the rail subgrade. On this site, particularly if coarse rock fill is used to raise the site level, a capping layer is unlikely to be utilised as the subgrade is already saturated by high groundwater levels.

For both the access road and rail alignment (if utilising a capping layer) the capped formation would be in the form of a long, relatively narrow strip across the site and therefore the overall loss of groundwater recharge would be minor. Areas which have potential for more extensive capping is in the vicinity of buildings, especially where car parking and hardstand is proposed.

Capping will prevent groundwater recharge from occurring through the capping, however will also prevent evaporation, which would be a significant component of the water balance on this site because of the shallow groundwater table. Therefore the overall change to net recharge will be limited.

Any lost recharge would become surface water runoff and would be transferred to the stormwater drainage system where it will be available to recharge to groundwater.

Overall it is unlikely that a significant drop in groundwater levels would occur below the developed site, with a slight increase in water levels possible due to rising of the site. Groundwater levels around the perimeter of the developed areas are currently controlled by ground levels and surface water controls, which should continue to apply, limiting impacts from the development.

6.6 Irrigation of Effluent

Irrigation of effluent currently occurs on the central raised parts of the site. It is proposed to undertake irrigation of effluent generated by the TSF on the central southern area of the site. The effluent irrigation area will be designed to accommodate the expected irrigation rates through evapotranspiration. The design should incorporate appropriate management of run-on and run-off and site drainage, together with provisions for wet weather storage. The effluent disposal system and irrigation area will be maintained to meet the design requirements. In the event that irrigation may lead to increased groundwater seepage, the majority of this seepage would be to the east and is likely to be intercepted by the proposed drains and routed towards Basin 3. On this basis, the potential for elevated groundwater levels in the vicinity of effluent irrigation is considered to be low.

6.7 Formation of Drainage Channels and Detention Ponds

Review of the drawings by WorleyParsons showing the existing and proposed site hydrology indicate that the proposed stormwater controls are sympathetic to the existing site hydrology (refer to Appendix A Hydrology drawings by WorleyParsons).

Run-off from the site is directed to three detention basins as described in more detail in Section 4. Each pond is located in or near to areas where surface water currently collects, including one location at an existing tailings pond on the southern filled part of the site. The basins receive water from similar catchment areas and have outlets, which discharge to locations where surface runoff from the undeveloped site could be expected to have occurred. For the central Basin 2, there will be some concentration of the flows compared to the pre-developed case, however these flows are expected to disperse readily across the relatively flat ground surface.

The drains discharge into detention basins, and provided that the outlet points for these basins matches relatively closely the level of existing surface water controls, then the drains will not lead to reductions in groundwater levels to below those which currently occur.

The northern access road will be constructed on a raised embankment, however the alignment of the road is sub-parallel to the surface flow direction which will limit impacts to the flow regime and is proposed to incorporate regular culverts to allow flow across the alignment, as necessary.

The majority of groundwater and surface water interaction with Hexham Swamp and other GDEs on the western parts of the site, occurs well away from the proposed TSF development area. There are no proposed changes to the hydrology on this side of the site and therefore impacts to groundwater levels on the western parts of the site are expected to be insignificant.

6.8 Potential Impacts to GDEs

The proposed development will be constructed partly over several areas of groundwater dependant ecosystems, some of which are classified as Endangered Ecological Community (ELA), and as a consequence the remnant ELA will be left in immediate proximity on one or both sides of the development. Remnant areas on the eastern side of the proposed TSF area (i.e. between TSF and the Great Northern Railway) are likely to be directly affected by the proposed ARTC development.

As discussed in the sections above, impacts to water levels due to the development are generally expected to be localised and in the case of construction activities only temporary and recoverable.

During construction there is some risk of lowering of the water table due to localised dewatering estimates, however such drawdowns are not expected to have significant impacts on water levels outside of the development footprint.

Groundwater levels on the majority of the site are at or near the surface and typically controlled by surface water drainage features. The majority of site changes have potential for slightly changed groundwater levels within filled areas (probably slightly higher), increased run-off, and in places increased seepage, to the ground surfaces adjacent to the development. The increased run-off will have little effect on groundwater levels during wet times as the water levels are controlled by surface water controls. In times of dryer weather the increased run-off is likely lead to certain areas staying wetter for longer than they may have prior to development. There would be some risk of localised pockets receiving less run-off than previously, however the risk of this is limited as the ground is generally low lying with limited fall, encouraging spreading of the run-off.

Impacts to groundwater levels from the development are expected to be limited to close proximity to the TSF development footprint. Impacts on water levels on the western parts of the site in Hexham Swamp to the West and the Hunter River to the east, are expected to be negligible.

6.9 Existing Groundwater Users

There is limited beneficial use of groundwater in the vicinity of the site. Registered wells in the vicinity of the site are limited to nine monitoring bores installed in 2011 at the perimeter of the site for the purpose of monitoring groundwater quality and levels. The wells were installed as part of site investigations for the proposed TSF development. It is understood that there are no wells registered for beneficial use within 3 km of the site. Therefore, no impacts to groundwater levels from the TSF development are expected to occur at such a proximity to the site.

6.10 Cumulative Impacts with respect to ARTC development

6.10.1 ARTC Development

The proposed ARTC development comprises the construction of five new rain lines immediately to the east of the QR National Maintenance Facility (adjacent to the Great Northern Railway) and will include similar components such as:

- Localised excavations;
- Filling;
- Ground improvement.

A groundwater assessment has been undertaken for the ARTC project by Parsons Brinkerhoff (Ref 13). The assessment indicated that some minor changes in groundwater level may be experienced with in the GDEs if dewatering activity occurs nearby, however this would be of a short term, recoverable nature.

The proposed ARTC development comprises a narrow strip to the immediate east of the QR National Maintenance Facility and in essence can be considered as an incremental widening of the development. When both developments are taken into account the majority of remnant GDEs will be located to the west of the Maintenance Facility and therefore associated incremental impacts on groundwater levels are expected to be minor.

6.11 Mitigations

Potential mitigations to reduce the risk of impacts to groundwater levels would include:

- Detailed design of any dewatering to limit impacts on groundwater levels. This may include limiting the depth of excavation as well as the extent of dewatering occurring at any one time, in particular for dewatering in close proximity to GDEs;
- Matching the level of outlet structures from the drainage system to closely match level of existing surface flow controls;
- Groundwater monitoring during and following construction.

7. Conclusion

The assessment of potential groundwater level impacts from the development of the proposed TSF at Hexham considered possible impacts associated with the following:

- Excavation dewatering;
- Site filling;
- Ground improvement;
- Site capping;
- Site drainage;
- Irrigation of Effluent.

A conceptual groundwater model was developed for the site on the basis of available background information including site hydrogeology, the proposed TSF development and existing and proposed site hydrology.

In summary, the proposed development and stormwater controls are generally sympathetic to the existing site hydrology.

Potential impacts to groundwater levels are likely to be limited to the immediate vicinity of the proposed TSF development, or short term and recoverable.

It is noted that the TSF development area is limited to a corridor of approximately 150 m adjacent to the Great Northern Railway (excluding the five ARTC train lines) located over the western strip of the greater site area.

Potential risks associated with impacts to groundwater levels will be managed / investigated through detailed design, construction and monitoring for the proposed TSF development.

8. References

1. Douglas Partners Pty Ltd, "Report on Preliminary Geotechnical Investigation, Proposed Maintenance Facility, Woodlands Close, Hexham", Project 39798 (Rev A), August 2008.
2. AS 2159-2009, "Piling Design and Installation", Standards Australia.
3. ASSMAC Acid Sulfate Soil Manual", New South Wales Acid Sulfate Soil Management Advisory Committee, August 1998.
4. NSW EPA Contaminated Sites. "Guidelines for Consultants Reporting on Contaminated Sites", September 2000.
5. NSW EPA Contaminated Sites. "Guidelines for NSW Site Auditor Scheme", (2nd Edition) April 2006.
6. NSW EPA Contaminated Sites, "Guidelines for Assessing Service Station Sites", December 1994.
7. NSW DECCW, "Waste Classification Guidelines, Part 1: Classifying Waste", December 2009.
8. NSW EPA Contaminated Sites, "Sampling Design Guidelines", 1995.
9. Coleman, R.A (1986) "Hexham embankment, Case study, Wick drains, Predictions".
10. Australian Standard AS 2870-2011 "Residential Slabs and Footings", Standards Australia.
11. APRG Report No 21 "A guide to the design of new pavements for light traffic", January 1998.
12. Douglas Partners Pty Ltd, "Preliminary Contamination Assessment, Proposed Hexham Redevelopment, Maitland Road and Woodlands Close, Hexham", Project 39798.04, August 2011.
13. Parsons Brinkerhoff, "Upper Hunter Valley Alliance, Hexham Relief Roads, Groundwater Assessment", June 2012.
14. WorleyParsons Services Pty Ltd, "Hexham Train Support Facility, Stormwater Management Plan", Ref 301020-03465-CI-REP-0002-05.doc, August 2012.

9. Limitations

DP has prepared this report for a project at Woodlands Close, Hexham with reference to DP's Proposal NCL120293 dated 29 June 2012 and acceptance received by QR National. The report is provided for the exclusive use of QR National for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

It is noted that this report assessment does not represent a preliminary contamination assessment in accordance with NSW EPA guidelines (Ref 4).

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

Douglas Partners Pty Ltd

Appendix A

About This Report
Test Location Plan – Drawing 39798.06-2a-2
Proposed Arrangement –Sheets 1 and 2 (WorleyParsons)
Groundwater Contour Plan – Drawing 39798.05-2
Vegetation Communities and Threatened Flora (Ecological Australia)
Existing Hydrology – Sheets 1 and 2 (WorleyParsons)
Proposed Hydrology – Sheets 1 and 2 (WorleyParsons)
Areas of Disturbance Cut - Drawing 2216395-16-FIG-C0002 (GHD) – Rev 4 – 10 October 2012
Areas of Disturbance of Fill – Drawing 2216395-16-FIG-C0003 (GHD) – Rev 2 – 26 September 2012
Location of Previous Investigation Data – Drawing 4

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

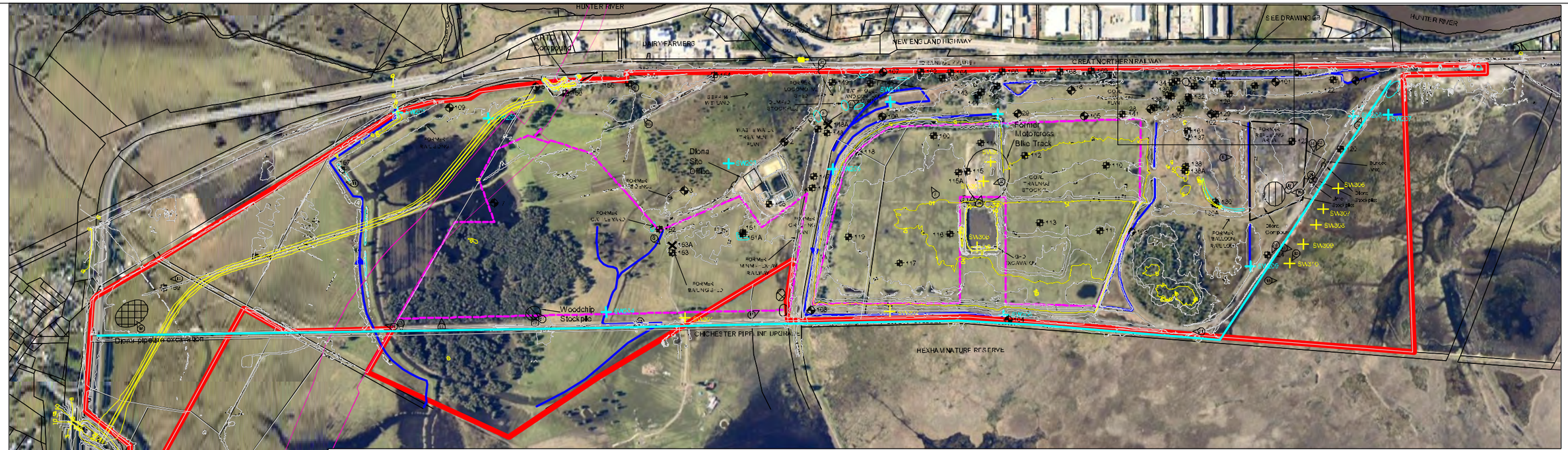
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



LEGEND

- Site Boundary
- Approximate Borehole Location (397795 - Oct2007)
- Approximate Borehole Location (397952)
- Approximate Test Pit Location (397952)
- Approximate Surface Water Sample Location(397952)
- Groundwater Monitoring Well
- Approximate Surface Water Sample Location(397604)
- Approximate Creek/Drainage Channels and Direction/Flow
- Approximate Surface Sample Location (397952)
- Approximate Location of Saddles
- Approximate Area of Trees to Be Removed/Mulched
- Approximate Photo Location & Orientation
- Contours - 1m Intervals(A-D)
- Approximate Location of Bore Saddle
- Approximate Location of Excavation Mound
- HWC Trunkmain Pipeline_approx

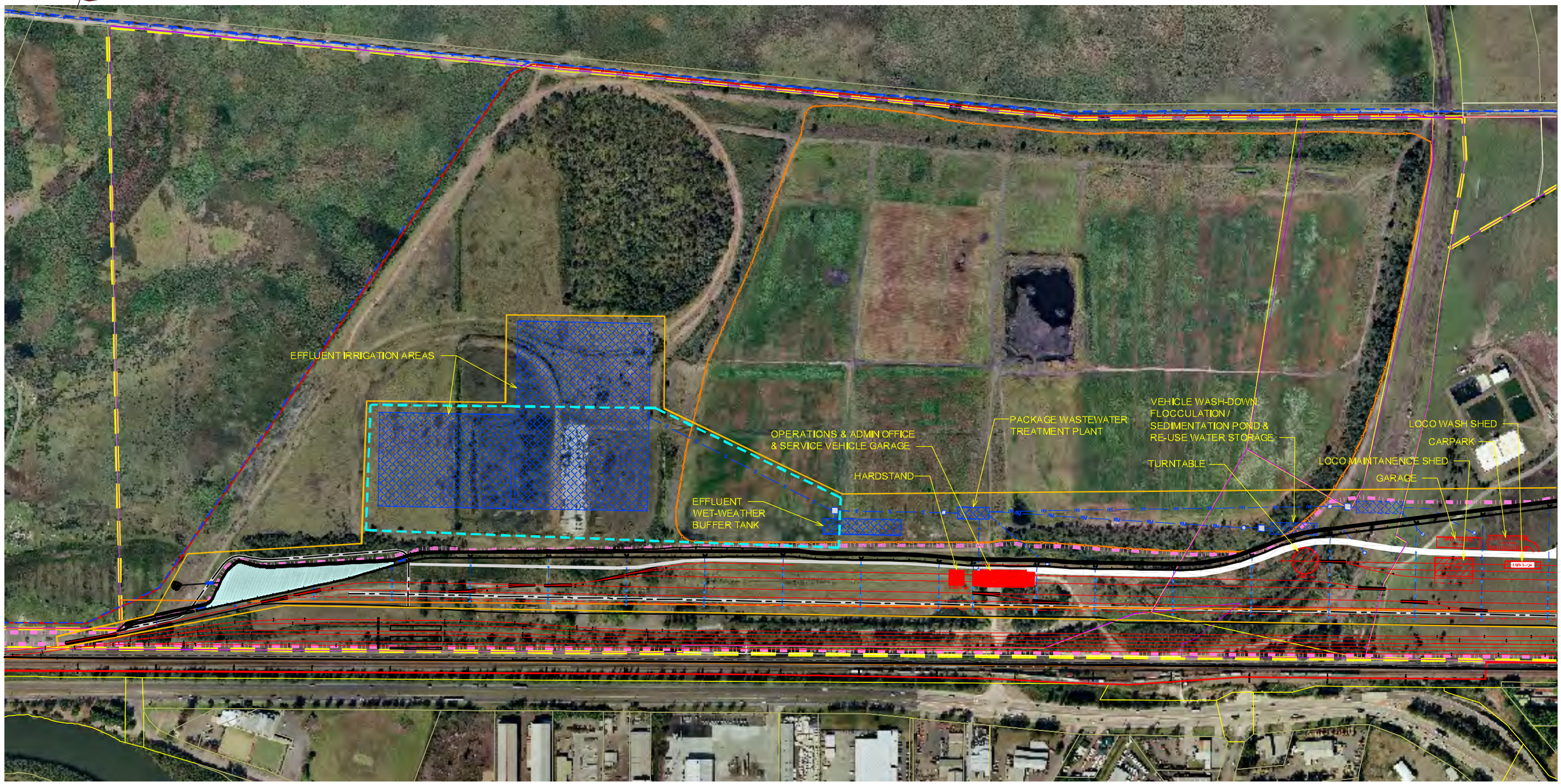
Drawing created from plan supplied by client, File Ref:d:\Master_Services_A.dwg and Contour Plan by Worley Parsons_Interference.dwg 0508, and Nearmap image dated 26 June 2011

0 50 100 150 200 300 400 500m
1:5000 @ A1

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: QR National		TITLE: Test Location Plan	PROJECT No: 39793.06
OFFICE: Newcastle	DRAWN BY: PJH	Proposed Train Support Facility	DRAWING No: 2a
SCALE: 1:5000@A1	DATE: 17.04.2012	Maitland Road & Woodlands Close, Hexham	REVISION: 1

FIGURE 2



LEGEND

- TRAIN SUPPORT FACILITY BOUNDARY
- PROPERTY BOUNDARY
- WATER RECYCLING & WASTEWATER TREATMENT SYSTEM
- HWC PROPOSED WATER MAIN
- EXISTING WATER MAIN
- PROPOSED ARTC RELIEF ROADS (TRACKS)
- TSF ROADS (TRACKS)
- STORMWATER DRAINAGE NETWORK
- COAL TAILINGS STOCKPILE EXTENTS
- PROPOSED CESS DRAIN
- PROPOSED WASTEWATER DRAINAGE LINE
- PROPOSED RISING MAIN

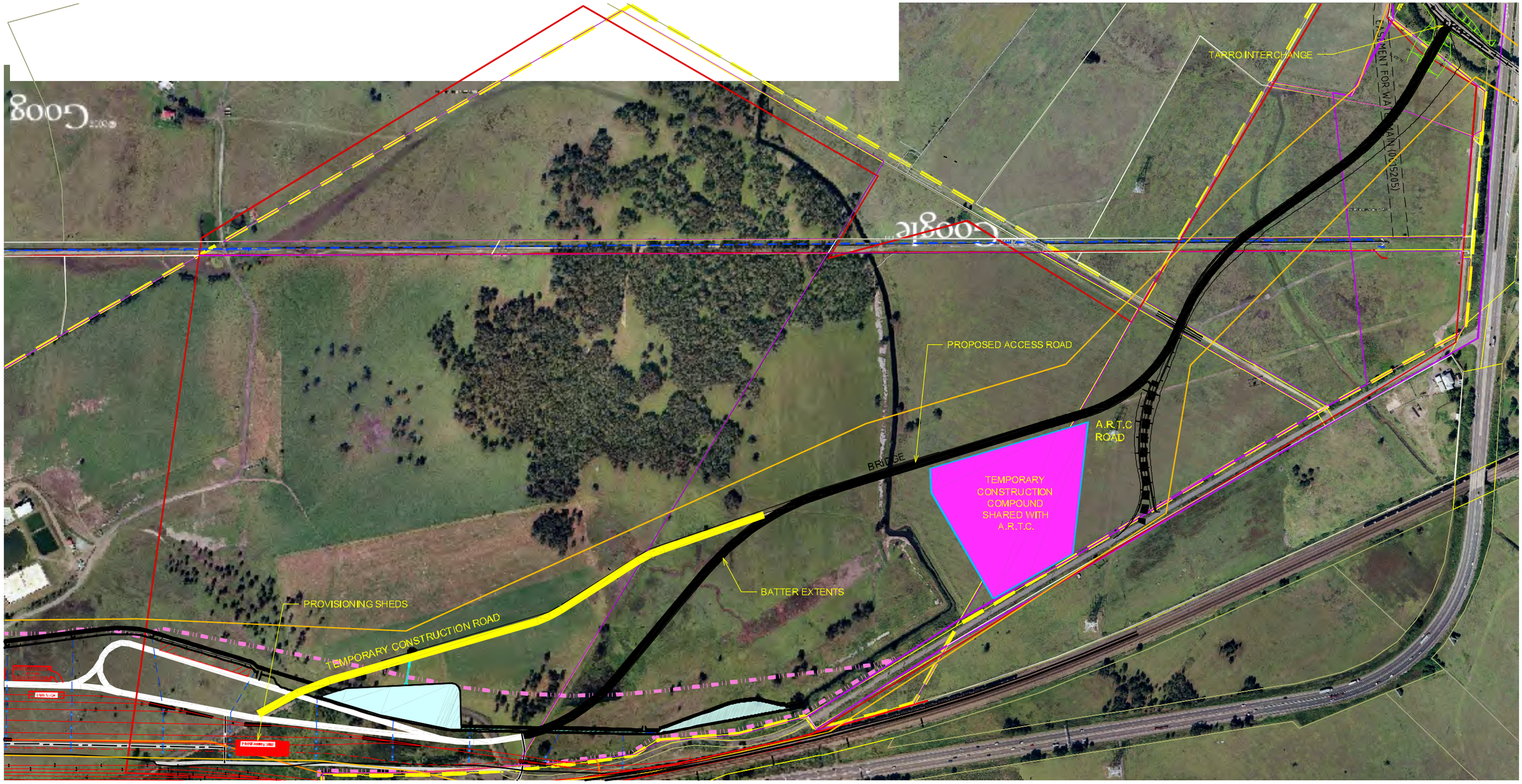
WorleyParsons
resources & energy

0 200m
1:5000

PROPOSED ARRANGEMENT TRAIN SUPPORT FACILITY SHEET 1 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 2-1_2-2_PROPOSED ARRANGEMENT.dwg 23/08/2012

FIGURE 2



LEGEND

- TRAIN SUPPORT FACILITY BOUNDARY
- PROPOSED CESS DRAIN
- PROPERTY BOUNDARY
- WATER RECYCLING & WASTEWATER TREATMENT SYSTEM
- TRUCK SHAKEDOWN AND WASHDOWN BAY (IF REQUIRED)

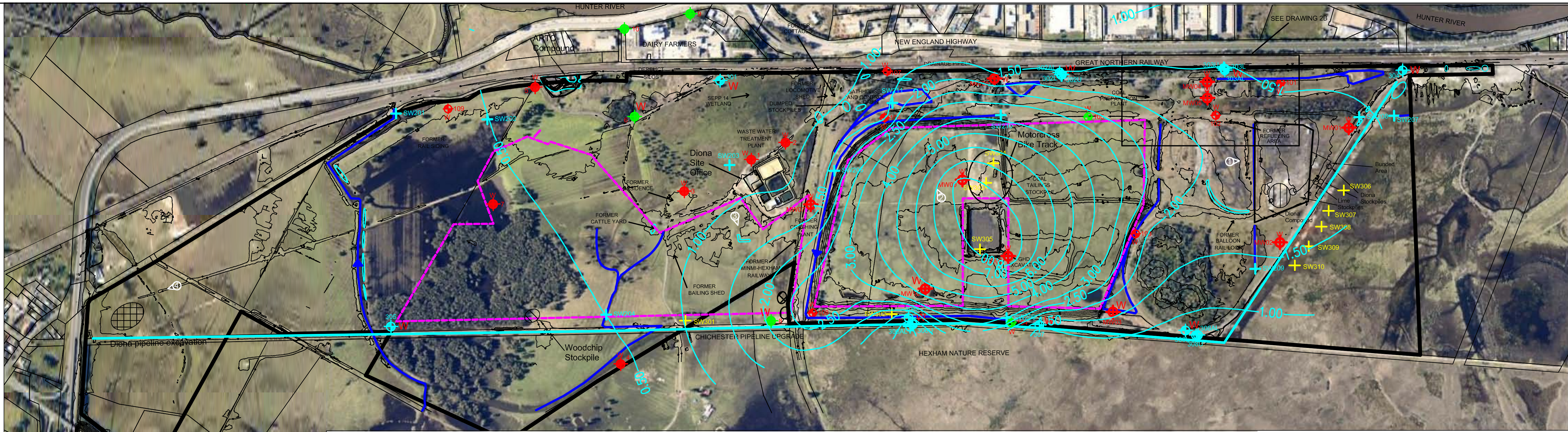
0 200m

1:5000

WorleyParsons
resources & energy

PROPOSED ARRANGEMENT
TRAIN SUPPORT FACILITY
SHEET 2 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 2-1_2-2_PROPOSED ARRANGEMENT.dwg 23/08/2012



LEGEND

- Site Boundary
- Approximate Borehole Location (39798.02)
- Approximate Surface Water Sample Location (39798.02)
- Groundwater Monitoring Well
- Approximate Surface Water Sample Location (39798.04)
- Approximate Borehole Location (18944-1999)
- Approximate Borehole Location (ERM-2010)
- Approximate Borehole Location (Current Investigation)
- Wells not sampled as part of the current investigation (ie damaged/outside site)
- U Well screened in upper fill
- L Well screened in natural soils (ie clay) underlying fill
- Approximate Creek/Drainage Channels and Direction of Flow
- Approximate Location of Stockpiles
- Approximate Area of Treated Effluent Irrigation (39798.02)
- Approximate Photo Location and Orientation
- Contours - 1m Intervals (AHD)
- Approximate Location of Sand Stockpile
- Approximate Location of Excavated Material
- HWC Trunkmain Pipeline Upgrade
- Interpolated Groundwater Contours m AHD
- Approximate Groundwater Flow Direction

Drawing adapted from Concept Plan by Queensland Rail, Ref Sur1884 dated 23.4.08 and Contour Plan by Worley Parsons, Unreferenced, dated 05.08, and NearMap Image dated 25 June 2011

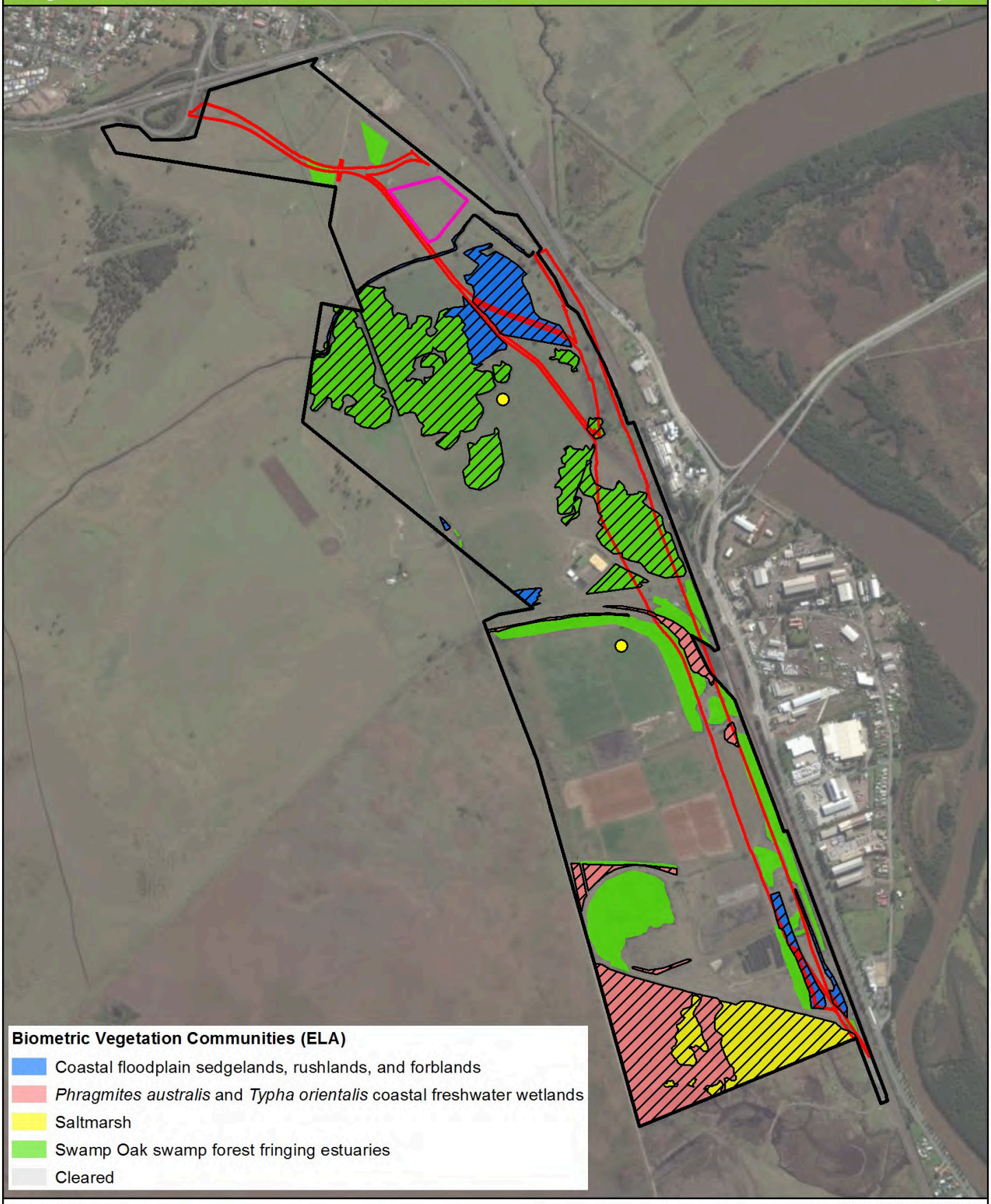
Note: Conours are based on discrete data points and numerical interpretation. The actual surface may vary from contoured surface shown.

0 50 100 150 200 300 400 500m
1:5000 @ A1

Douglas Partners — Geotechnics | Environment | Groundwater	CLIENT: QR National		TITLE: Groundwater Contour Plan - 17 October 2011	PROJECT No: 39798.05
	OFFICE: Newcastle	DRAWN BY: PLH	Groundwater Assessment	DRAWING No: 2
	SCALE: 1:5000@A1	DATE: 24.02.2012	Maitland Road & Woodlands Close, Hexham	REVISION: 0

Vegetation Communities and Threatened Flora

QR National Project



Legend

- Subject Site (QR National Footprint)
- Proposed Temporary Site Compound
- Property Boundary
- Grey-headed Flying-fox
- Endangered Ecological Communities (ELA)

Image: Microsoft Virtual Earth

0 125 250 500

Meters

Projection: GDA 1994 MGA Zone 56

N

eco logical AUSTRALIA

www.ecoaus.com.au