Appendix E

Draft Acid Sulfate Soil and Dewatering Management Plan

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Water Corporation

Keane Road Pressure Main, Balannup

Draft Acid Sulfate Soil and Dewatering Management Plan

April 2014

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Project Background

The Water Corporation (WC) is proposing an M&E upgrade of the Balannup Wastewater Sewerage Pump Station (WWPS) and to construct a new rising pressure main along Keane Road to the Waterworks Road WWPS in Haynes, 22km south of Perth in Western Australia. The site locality is depicted on Figure 1. The construction upgrade will be undertaken in a phased approach and Stage 1 (the remit of this ASSDMP) will comprise the following tasks:

1. **Section 1**: Construction of approximately 1km (Chainage (Ch) 0 to 1080) of pressure main at an assumed invert between 2m and 2.5m depth (Ch 0 to Ch 522) and 1m to 1.5m depth (Ch 522 to Ch 1080). The pressure main will commence at the existing DN375 pressure main located on Welcome Meander in Harrisdale to the start of Bush Forever area at the intersection of Skeet Road and Keane Road. The pressure main is anticipated to be installed utilising open excavation techniques.
2. **Section 2**: Installation of approximately 1.5km (Ch 1080 to 2600) DN450 PE pressure main at an invert level of 1.5m to 2m depth utilising trenchless methods (Eco-Ploughing) through the Bush Forever area to the Anstey Road and Keane Road intersection in Forrestdale.
3. **Section 3**: Construction of approximately 2km (Ch 2600 to Ch 4557) DN375 pressure main at an invert between 1m and 2m depth from the Anstey Road and Keane Road intersection to the Waterworks Road WWPS utilising open excavation techniques.
4. Three (3) road crossings have been identified during the installation; two (2) of these crossings will be undertaken utilising trenchless techniques, one (Anstey Road) will be open excavated. A DN450 PE100 pipe is anticipated to be installed for all road crossings outlined below at an invert between 3m and 3.5m depth.
    a. Armadale Road (trenchless);
    b. Tonkin Highway (trenchless); and
    c. Anstey Road/ Damper to Bunbury Natural Gas Pipeline (open excavation).

The general arrangement of the infrastructure outlined above is indicated in the GHD plan and longitudinal section drawings (i.e. Drawing No: HW91-085-01A1 to HW91-085-002-15A, Appendix B).

GHD was commissioned by Water Corporation to prepare an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP) based upon the recommendations of the geotechnical and acid sulfate soil (ASS) investigations performed as part of the geotechnical consulting services for the project.

The dewatering requirements have not yet been fully identified, and this document is therefore not considered to be the final ASS Dewatering Management Plan (ASSDMP). At the time of writing the detailed design has not been completed and the construction contractor procurement process has not yet commenced.

This document has been prepared using information available at the time of preparation (engineering design drawings). This document should be updated as additional information becomes available on construction elements requiring dewatering and dewatering designs are developed.

1.2 Purpose of this Document

This document and content has been prepared on a draft basis and requires to be finalised prior to the commencement of construction. The construction methodology and management strategies are based upon assumed construction methods and these methods are required to be finalised before the management strategies are valid and suitable for the works.

When finalised, the aim of this document is to summarise the results of the ASS and groundwater investigations and document the findings of those investigations (where relevant) to assist in the preparation of the ASSDMP. This document is considered to address the ASS management and dewatering requirements for the pressure main alignment.

This document addresses the key construction issues that may impact on groundwater, environmental receptors and groundwater users within the vicinity of the site and includes:

- A framework for the treatment and management of excavated/disturbed material defined as ASS during construction of the pressure main.
- A framework for management of dewatering effluent and groundwater, specifically with regards to managing the groundwater quality and levels, during development works.
- The likely depth to groundwater within the vicinity of the pressure main alignment and highlight areas, which may require dewatering; and
- An indication of further detailed groundwater investigation work required.

This document contains an ASSDMP that will be used to inform the Contractor constructing the proposed infrastructure and provide appropriate management and action criteria during the treatment and dewatering operations to minimise potential impacts to the local groundwater, surface water systems, ecology and other groundwater users.

This document should be read in conjunction with the following geotechnical, ASS and contaminated sites investigation report for the site. The document is referenced below:

- GHD, 2013. *Report on the Geotechnical, Acid Sulfate Soils and Contaminated Sites Investigation, Balannup A WWPS and Keane Road Pressure Main* (Document number 134551, Rev 0). November, 2013.

1.3 Scope and Limitations

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

GHD otherwise disclaims responsibility to any person other than Water Corporation 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 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 and any recommendations in this report are based on conditions encountered and the report was prepared.

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

GHD has prepared this report on the basis of information provided by Water Corporation 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.

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.

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. Background information

2.1 Acid Sulfate Soil

The classification of ASS includes both actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). AASS are soils that are generating acidity and may still have residual potential acidity, whereas PASS are soils that have the potential to generate acidity.

ASS are soils containing naturally-occurring, fine-grained metal sulfides typically pyrite (FeS_2), formed under saturated, anoxic/reducing conditions. They generally occur in Quaternary (1.8 Ma – Present) marine or estuarine sediments, predominantly confined to coastal lowlands (elevations generally below 5 m Australian Height Datum (AHD)). Within these sediments, the majority of soils that present an environmental risk are generally confined to Holocene aged material (<10 000 years). Where these materials have oxidised, they commonly have a mottled appearance (orange and yellow discolouration) due to the presence of oxidised iron minerals.

Although soils described above represent typical conditions where ASS occurs, the presence of ASS materials is not limited to these soil types. In Western Australia, ASS materials have been identified in other soil types such as leached sands and silts. Accordingly, for areas where no data is available, the extent of ASS materials should be established through field investigations.

2.2 Potential Risks of AASS and PASS

When PASS are disturbed, either by excavation or lowering of the water table below natural seasonal levels, sulfides present are exposed to air, allowing oxidisation and consequently, the formation of sulfuric acid (H_2SO_4). AASS are capable of generating acidity *in situ* in their natural state; disturbance is not required for acidic discharges to develop.

As a result of the presence of AASS, or the oxidation of PASS, surrounding land (soil) and nearby waterways may become acidic (pH<6.5). Under acidic conditions, metals such as aluminium (generally at pH<4.5) and iron, as well as trace heavy metals (including arsenic), become more mobile in the environment and can be taken up by infiltrating waters.

Disturbance of ASS impacted areas may release hydrogen sulfide gas which typically settles within confined spaces and excavations such as trenches and/or depressions. Hydrogen sulfide gas has the potential to reach toxic levels and appropriate occupational health and safety measures may require to be implemented within areas of depressions and/ or during excavation of confined spaces.

2.3 Potential Effects of Dewatering Groundwater

2.3.1 Water Quality

Dissolved metals including iron and aluminium may cause environmental issues, if the dewatering effluent is discharged prior to retention. Discharge without retention may cause iron hydroxides to precipitate out where effluent is discharged into water bodies (particularly surface water). These chemical reactions may release large quantities of acid and consume oxygen causing de-oxygenation of the water column in nearby ecosystems or the local groundwater system and decreasing local buffering capacity (alkalinity), where available. In cases where alkalinity can no longer buffer acidity, then acidification of the groundwater may occur.

Acidic conditions generated by ASS can also corrode concrete and steel (pipes, bridge abutments, underground services, and other infrastructure) and can result in the rapid deterioration of asphalt surfaces where they overlie AASS or PASS. Acidic groundwater plumes can impact on vegetation health of deep rooted vegetation, and affect the water quality of any

downstream groundwater receptors including surface water bodies and domestic and industrial water supply bores.

2.4 Management

2.4.1 Management of ASS

Avoiding or minimising disturbance of ASS is the primary methods of management. Where avoiding disturbance is not possible, management techniques available for ASS can include:

- Chemical neutralisation (use of pure fine agricultural lime (AgLime) or a similar neutralising agent).
- Anoxic storage or placement of PASS below the water table and beneath clean non-ASS fill; and
- Hydraulic separation of pyrite from the soil (high maintenance process suitable for coarse grained sediment).

The addition of agricultural lime is the most common amelioration technique applied to acidic soils, where mechanical mixing is completed by plough or excavator to provide adequate homogeneity of the soil/sediment-lime mix.

2.4.2 Management of Dewatering Effluent

The groundwater conditions at the site are indicative of an area which may be vulnerable to acidification and therefore the risk of the water quality impacts outlined within Section 2.3.1 occurring is high. Dewatering operations should be undertaken with appropriate management measures, monitoring trigger actions and contingency strategies to prevent the degradation of groundwater during construction.

The management strategies implemented within this document are in accordance with the appropriate legislative requirements and guidelines outlined within Section 2.5.

2.5 Legislative Requirements in Western Australia

The following legislative requirements may apply to works involving dewatering activities:

2.5.1 Western Australian Planning Commission Bulletin 64/2009

The recently amended *Planning Bulletin 64/2009 (PB 64/09)* aims to provide advice and guidance on matters that should be taken into account in the rezoning, subdivision and development of land containing acid sulfate soils. PB 64/09 requires the identification, assessment and management of soils where:

- The surface elevation is ≤ 5m AHD, and it is proposed to excavate ≥ 100m^3 of soil;
- Where the surface elevation is ≥ 5m AHD, and it is proposed to excavate ≥ 100m^3, and the excavation depth is ≥ 2m; or
- Where any dewatering works are to be undertaken.

2.5.2 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act 1986) provides for an Environmental Protection Authority, for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.

To prevent environmental harm, the EP Act 1986 established under Section 50A, states that:

A person who –

a. causes serious environmental harm; or

b. allows serious environmental harm to be caused - commits an offence.

Accordingly, all parties to a development must show that the environmental risk associated with the development has been assessed and minimised where possible.

2.5.3 Rights in Water and Irrigation Act (1914)

In accordance with the '*Water Corporation Acid Sulfate Soil and Dewatering Management Strategy'* (Water Corporation, July 2007) the Water Corporation is not required to obtain either a Section 5C or Section 26D license under the Rights in Water and Irrigation Act (1914) in regards to dewatering. The power given to the Water Corporation by Section 83(2)(b) of the Water Agencies (Powers) Act 1984 overrides the generic requirements of Sections 5C and 26D of the Rights in Water and irrigation Act and therefore the Water Corporation is exempt from the requirement to obtain a dewatering license.

3. Site Characterisation

The information presented below has been abstracted from the geotechnical and acid sulfate soil and contaminated sites investigation report (GHD, 2013) and has been utilised to assist with the preparation of this ASSDMP.

3.1 Site Description and Topography

3.1.1 Section 1: Ch 0 to C 1080

Section 1 extends from the north west corner of the project area in Harrisdale to Skeet Road. The pressure main will connect to an existing pressure main within a recently developed subdivision (Heron Park).

This portion of the alignment gently declines in elevation from the initial starting point at Turtledove Road to the Bush Forever Area located at the intersection of Skeet Road and Keane Road. Elevation typical ranges between 26.5m AHD to 25.6m AHD.

3.1.2 Section 2: Ch 1080 to Ch 2600

Section 2 extends the length of the Bush Forever designated land (Figure 1). Section 2 is characterised by a loose sandy track approximately following the Keane Road reserve alignment. The track is boarded on either side by scrub which becomes less dense towards the east. At the far east of the Bush Forever area the scrub gives way to grass/weeds along a Water Corporation easement.

The Bush Forever area typically gently slopes north west to south east with elevations ranging from 25m AHD to 22.2m AHD. The south eastern end of the road reserve track was characterised by standing water covering most of the track during the investigation undertaken in June and July 2013. Freestanding water to approximately 0.5 m was observed from approximately Ch. 2170 to Ch. 2600 during this period.

3.1.3 Section 3: Ch 2600 to Ch 4557

Section 3 between Ch. 2600 and Ch. 4557 extends along the south east continuation of Keane Road and into Hanlin Road beyond the Armadale Road intersection before crossing Tonkin Highway and terminating within the Water Corporation depot at the WWPS.

The proposed pressure main terminates inside the Water Corporation depot at the waterworks site. The Water Corporation grounds between Tonkin Highway and the waterworks generally consist of sandy tracks, defined by derelict wire fences and low lying grasses and shrubs. The waterworks and surrounding infrastructure are located within a paved area bordered by trees.

Elevation from the Bush Forever area typically inclines from Anstey Road to the Tonkin Highway with a few gently undulations. Elevation ranges from 22.2m AHD to 25.2m AHD, with the undulations to a minimum of 23.5m AHD. Elevation at the WWPS is typically 27.3 mAHD.

3.2 Climate

The Gosnells area (closest weather station with long-term recording information within the proximity to Armadale) has a Mediterranean climate of cool, wet winters and hot, dry summers. Climatic information collected from the Gosnells meteorological monitoring station is presented in Table 1.

Table 1 Climatic information

Station	Mean Annual Minimum Temperature Range (ºC)	Mean Annual Maximum Temperature Range (ºC)	Annual Rainfall (mm)
Gosnells City (09106)	17.3 (July) – 30.5 (Jan.)	20.1 (July) – 36.3 (Feb.)	640.0[1]

Source: Bureau of Meteorology Climatic Averages of Australian Sites, 2014.

3.3 Regional Geology

3.3.1 Published Information

The 1:50,000 Environmental Geology Series "*Armadale*" Part Sheets 2033 1 and 2133 IV indicate that the site is predominantly underlain by the Bassendean Sand unit (as indicated in Figure 2). Bassendean Sand is described as a *'white to pale grey at surface, yellow at depth, fine to medium grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin'*. A thin layer of friable variably cemented iron and/or organic rich sands colloquially known as 'coffee rock' is commonly encountered within the vicinity of the water table.

Coffee rock forms by the precipitation of humates and iron from groundwater, mainly in the zone of water table fluctuations, and may vary between bright orange, orange brown and dark brown to black. Coffee rock horizons contain stored potential acidity in a number of forms including inorganic sulfides such as di-sulfides (pyrites) and poorly crystalline and easily hydrolysable iron and manganese oxides.

The Bassendean Sand is underlain at variable depth by alluvial clayey, silty and sandy soils of the Guildford Formation. The Guildford Formation consists of clay, sand and gravel and is variably laterised and podsolised.

Small pockets of peaty clay associated with swamps (subject to seasonal flooding) are likely to be encountered at or near surface to the south east of Skeet Road. The peaty clay found in this region is formed from swamp deposits and is described as '*grey to black, fine to medium grained, moderately sorted quartz sand, slightly peaty of lacustrine origin'*.

3.3.2 Site Specific Ground Conditions

The soils intersected during execution of the geotechnical site investigation are generally consistent with the 1:50,000 Environmental Geology map for the region. The local ground conditions along the pressure main alignment where ASS and/or dewatering management is required is described in Table 2.

[1] Annual rainfall for 2012, rainfall data for 2013 not available.

Table 2 Summary of Site Specific Ground Conditions

Section	Chainage	Subsurface Conditions	Depth (m bgl)
Section 1	0 to 1080	Topsoil: black/brown medium grained sand.	0.1 – 0.2 m
		Fill: pale yellow/brown sand with fine to medium grained limestone gravel.	0.9 – 3.5 m
		Bassendean Sand: grey/brown poorly graded sand.	Max. 3.3 m
		Guildford Formation: black medium grained silty sand/sand with gravel and weakly iron cemented clasts.	>3.5 m
Section 2	1080 to 1400	Bassendean Sand: grey to brown, fine to medium grained, poorly graded sand with trace organics.	1.5 – 2.5 m
		Guildford Formation: dark brown/black, low plasticity silty sand/sandy silts.	1.5 – 3.0 m
	1400 to 2600	Bassendean Sand: grey to brown, medium grained, poorly graded sand with trace organics.	0.5 – 2.0 m
		Guildford Formation: grey/brown clayey sand, medium grained.	>2.0 m
Section 3	2600 to 4557	Fill: pale yellow/brown sand with fine to medium grained gravel.	0 - 0.5 m
		Bassendean Sand: grey/white fine to medium grained poorly graded sand, trace organics and silt.	0 – 3.4 m
		Guildford Formation: grey to brown with medium grained sand.	>0.7 m

3.4 Regional Groundwater

The Hydrogeological Atlas of Western Australia indicates two aquifers in the area, Perth Superficial Swan and Leederville Aquifer. The Bassendean Sand geological units make up the superficial aquifer within the study area. The Leederville Aquifer is deep relative to the proposed construction and is not relevant to this ASSDMP.

Review of the Department of Water's Perth Groundwater Atlas provides information in regards to the groundwater level (May, 2003) and the historical maximum groundwater levels for the pressure main alignment. Table 3 below summarises this information.

Table 3 Summary of Groundwater

Section	Chainage	May (2003) (m AHD)	Historical maximum (m AHD)
Section 1	0 to 1080	23.5 to 22.5	25.5 to 24.5
Section 2	1080 to 2600	23.0 to 21.0	25.0 to 23.0
Section 3	2600 to 4557	21.0 to 22.0	23.0 to 25.0

The Perth Groundwater Atlas historical maximum contours are presented on Figure 3, along with the groundwater monitoring data obtained during the monitoring program in August, 2013.

3.4.1 Site Specific Groundwater

Groundwater was encountered along the pressure main alignment during the June/July 2013 site investigation and the groundwater monitoring program in August 2013. Groundwater levels were estimated during the geotechnical investigation using groundwater depth data and estimates of surface elevations obtained from contour data are presented below.

The information below presented the maximum and minimum groundwater levels observed for each alignment section.

- Section 1 - 23.5 m AHD to 25.2 m AHD;
- Section 2 - 19.5 m AHD to 24 m AHD; and,
- Section 3 - 20 m AHD to 23.2 m AHD.

3.5 ASS Risk Mapping

Review of the Department of Environment Regulation (DER), formerly Department of Environment and Conservation (DEC) ASS risk mapping available through the Landgate Shared Land Information Portal (SLIP) indicates that the majority of the alignment overlies an area of *'Moderate to low risk of ASS occurring within 3 m of natural soil surface but high to moderate risk of ASS beyond 3 m of natural soil surface*'. Additionally there are three small areas of '*High to moderate risk of ASS occurring within 3 m of natural surface soil'*. These areas correspond to the following chainages:

- Section 2: Chainage 1640 – 1780;
- Section 2: Chainage 2445 – 2653; and
- Section 2: Chainage 2305 – 3612.

These areas are associated with peaty clay (Cps) sediments as depicted on the published geological information and were also targeted during the geotechnical site investigation.

The ASS risk and the environmental constraints for the pressure main alignment are presented on Figure 4.

4. Summary ASS Investigation

4.1 Background Investigation Information

In consideration of the moderate risk of ASS, a site walkover, visual assessment and site investigation was undertaken in conjunction with the geotechnical investigation. The site works were undertaken in accordance with the Water Corporation *Acid Sulfate Soil and Dewatering Management Strategy*, prepared by Parsons Brinkerhoff (Rev. C, July 2007).

The site investigation was undertaken in conjunction with the geotechnical and contamination investigation in June and July 2013 to establish the ASS risk within the footprint of the proposed works and the risk associated with potential dewatering operations associated with construction.

Additionally, a review of photographs obtained from the geotechnical investigation (where available) and logs were undertaken to identify any additional ASS indicators.

4.2 Summary of Results

The ASS investigation is reported within the geotechnical and ASS investigation report (GHD, 2013) and the below information provides a summary of the results obtained. The site investigation results are provided with Table 1, Appendix C for information purposes and to assist with the preparation of this ASSDMP. The investigation locations are provided on Figure 5.

ASS was identified in samples collected from fifteen (15) of the twenty eight (28) push probing locations drilled during the site investigation. PASS material is associated with the black silty sands, grey silty/clayey sands, black/brown sandy silt and coffee rock horizons, generally at or below the water table.

The maximum inferred RL of PASS encountered during the investigation was 23.5 m AHD within the brown silty sand horizon at BH15, located within the Bush Forever section.

Based on the proposed pipeline invert levels, it is likely that ASS material will be disturbed as part of the construction works. An Acid Sulfate Soil Management Plan (ASSMP) will be required prior to commencing earthworks to guide the treatment and management of ASS material during construction.

5. Summary of Groundwater Investigation

The groundwater investigation was undertaken as part of the geotechnical, ASS and contaminated sites investigation in August 2013 and is reported within the geotechnical and ASS investigation report (GHD, 2013), however to assist with the preparation of this ASSDMP, the groundwater investigation has been outlined below.

5.1 Groundwater Monitoring Locations

The groundwater monitoring well locations are presented in Figure 6 and summarised in Table 4.

Table 4 Borehole Summary Information

BH ID	Chainage	Co-ordinates		Elevation (m AHD)	Depth achieved (m)	Groundwater August 2013 (mAHD)
		Easting	Northing			
BH01	47	398909	6445341	26.80	3.45	25.20
BH03	570	399047	6444936	27.00	3.45	25.20
BH06 North	2,667	400565	6443495	22.00	6.00	21.20
BH06 South	2,674	400563	6443483	22.50	6.45	21.90
BH08	3,161	400922	6443153	24.25	2.80	22.60
BH10	3,665	401281	6442799	23.40	4.50	23.20
BH11	3,853	401414	6442667	23.50	4.50	22.10
BH12	4,199	401666	6442408	23.75	4.50	22.80
BH13	4,395	401821	6442405	24.75	4.50	22.50
BH16	1,396	399664	6444386	24.40	6.00	No access
BH19	1,685	399869	6444183	23.90	6.00	No access
BH22	2,000	400097	6443966	23.80	6.00	No access
BH25	2,293	400303	6443757	22.75	6.00	No access
BH28	3,553	401204	6442881	23.25	3.00	22.10

It should be noted that due to the ongoing dewatering being carried out to facilitate construction works at the Exchange Road end of the Harrisdale subdivisional site works the groundwater levels observed in BH04 may not give a true representation of natural groundwater levels.

5.2 Groundwater Laboratory Program

Laboratory testing of groundwater samples was carried out by Australian Laboratory Services (ALS), a National Association of Testing Authorities (NATA) accredited environmental laboratory based in Malaga, Perth.

Samples were submitted for the following analytes:

- Acidity, pH, electrical conductivity (EC), total dissolved solids (TDS), total suspended solids (TSS);
- Major anions (Cl, SO_4, alkalinity);
- Major cations (Ca, Mg, Na, K);
- Dissolved metals (Al, As, Cd, Cr, Fe, Mn, Ni, Se, Zn);
- Total metals (Al, Fe);
- Nutrients (nitrogen and phosphorus); and
- Sulfide.

5.3 Groundwater Assessment Criteria

The following assessment criteria have been adopted for a preliminary assessment of pre-existing contamination (if present) and ASS groundwater indicators at the Site and are referred to in the DER Assessment Levels for Soil Sediment and Water (DEC, 2010, Version 4.1).

- Fresh Water
- Short Term Irrigation (STI)
- DER ASS indicator criteria

5.3.1 Freshwater Guidelines

Guidelines for the protection of ecological receptors are provided in Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000), and adopted by DER in Assessment Levels for Soil, Sediment and Water (DEC, 2010, Version 4.1).

The site is located within the vicinity of natural wetland receptors and the freshwater guidelines are considered appropriate criteria to determine whether dewatered effluent may have a detrimental effect on the wetland water quality. The freshwater guidelines present various assessment criteria depending upon the surrounding environs. It is considered for this site that where more than one assessment criterion has been made available, the Wetland values will be selected.

5.3.2 Short Term Irrigation Water Guidelines

In consideration of the potential for infiltration to be used as a method for dewatering effluent disposal, groundwater quality was compared to the STI guidelines specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000).

5.3.3 DER ASS Indicator Criteria

The DER ASS Guideline Series (DEC, 2013) outline chemical indicators that may indicate the groundwater is being affected by, or has already been affected by, the oxidation of sulfides. These indicators are outlined below.

- An alkalinity: sulfate ratio of less than 5 (Swedish EPA, 2002);
- A pH of less than 5 and/or
- A soluble aluminium concentration greater than 1 mg/L.

It should be noted that the above criteria are indicators only and do not necessarily denote that the oxidation of ASS materials has occurred. Any exceedence of the criteria should be identified and compared to other analytes prior to drawing conclusions on ASS.

Additional groundwater assessment criteria (adopted by the DER from the Swedish EPA), relate alkalinity with pH and infer the potential buffering capacity of groundwater. The assessment guide for the buffering capacity of groundwater is provided in Table 5.

Table 5 Assessment Guide for Buffering Capacity of Groundwater

Class	Designation	Alkalinity (mg/L)	pH	Description
1	Very high alkalinity	>80	>6.5	Adequate to maintain acceptable pH level in the future.
2	High alkalinity	60-80	>6.0	Adequate to maintain acceptable pH level in the future.
3	Moderate alkalinity	30-60	5.5-7.5	Inadequate to maintain stable, acceptable pH level on areas vulnerable to acidification.
4	Low alkalinity	10-30	5.0-6.0	Inadequate to maintain stable, acceptable pH level.
5	Very low alkalinity	<10	<6.0	Unacceptable pH level under all circumstances.

Table 5 Adapted from Swedish EPA, 2002.

5.4 Groundwater Quality Results (August 2013)

5.4.1 Water Quality Field Parameters

Groundwater sampled from the monitoring well was generally brown, turbid and with a slight organic odour.

The following general water quality parameters were noted:

- pH values presented ranged from 5.69 to 7.68 and is indicative of acidic to near neutral conditions.
- EC values presented ranged from 0.169 mS/cm to 21.0mS/cm and are indicative of fresh water to brackish conditions.
- Temperature values presented ranged from 17.14º C to 21.72 ºC.
- Dissolved oxygen values presented ranged from 0.59mg/L to 6.12mg/L.

5.4.2 Laboratory Results

The laboratory results and the NATA endorsed final laboratory reports are available in the geotechnical and ASS investigation report (GHD, 2013). The groundwater results are provided in Table 2, Appendix C.

Laboratory results indicate that groundwater chemistry varies along the alignment:

- pH ranges from 5.83 (BH08, Ch 3161) to 7.84 (BH11, Ch 3853);
- EC ranges from 173 µS/cm (BH08, Ch 3161) to 20,800 µS/cm (BH28, Ch 3553);
- Acidity ranges from 20 mg/L $CaCO_3$ (BH11, Ch 3853) to 113 mg/L $CaCO_3$ (BH03, Ch 570);

- Alkalinity (present as bicarbonate) ranges from 11 mg/L $CaCO_3$ (BH08, Ch 3161) to 415 mg/L $CaCO_3$ (BH06 North, Ch 2667); and
- Sulfate concentrations range from 23 mg/L (BH08, Ch 3161) to 727 mg/L (BH28, Ch 3553).

DER ASS Indicator Criteria

The following groundwater indicators were noted:

- Seven of the samples recorded alkalinity:sulfate ratios < 5. These include: BH01, BH03, BH06 North, BH08, BH10, BH11, BH12, BH13 and BH28. The remaining samples collected from BH10 and BH11 contain alkalinity:sulfate ratios > 5.
- None of the groundwater samples present pH value < 5
- None of the groundwater samples present soluble aluminium concentrations > 1 mg/L.
- Acidity ranges from 20 mg/L CaCO3 (BH11, Ch 3853) to 113 mg/L CaCO3 (BH03, Ch 570);

It should be noted that the above criteria are indicators only and do not necessarily denote that the oxidation of ASS materials has occurred. Any exceedance of the criteria should be identified and compared to other analytes prior to drawing conclusions on ASS.

ANZECC and ARMCANZ (2000) Fresh Water Ecosystem Protection Guideline

The following heavy metal concentrations exceeding the adopted assessment criteria were noted:

- Total aluminium concentrations exceeded the criteria (0.027 mg/L) in all nine (9) wells with exceedances ranging from 0.51 mg/L (BH01) up to 540 mg/L (BH13);
- Dissolved aluminium concentrations exceeded the criteria (0.027 mg/L) in seven (7) wells - BH01 (0.08 mg/L), BH03 (0.35 mg/L), BH06 North (0.11 mg/L), BH08 (0.2 mg/L), BH10 (0.85 mg/L), BH12 (0.81 mg/L) and BH13 (0.04 mg/L);
- Dissolved chromium concentrations exceeded the criteria (0.00001 mg/L) in five (5) wells – BH06 North (0.005 mg/L), BH08 (0.002 mg/L), BH10 (0.001 mg/L), BH12 (0.004 mg/L) and BH28 (0.006 mg/L);
- Dissolved copper concentrations exceeded the criteria (0.001 mg/L) in seven (7) wells – BH01 (0.002 mg/L), BH08 (0.002 mg/L), BH10 (0.005 mg/L), BH11 (0.003 mg/L), BH12 (0.006 mg/L), BH13 (0.002 mg/L) and BH28 (0.006 mg/L);
- Dissolved lead concentrations exceeded the criteria (0.001 mg/L) in two (2) wells – BH01 (0.002 mg/L) and BH12 (0.004 mg/L);
- Dissolved manganese concentrations exceeded the criteria (1.2 mg/L) in one (1) well – BH28 (1.5 mg/L);
- Dissolved nickel concentrations exceeded the criteria (0.008 mg/L) in one (1) well – BH28 (0.021 mg/L); and
- Dissolved zinc concentrations exceeded the criteria (0.0024 mg/L) in five (5) wells – BH03 (0.007 mg/L), BH08 (0.025 mg/L), BH10 (0.008 mg/L), BH12 (0.008 mg/L) and BH28 (0.024 mg/L).

No exceedances were recorded for dissolved arsenic, cadmium, cobalt or selenium concentrations in the nine (9) groundwater wells monitored.

Short Term Irrigation Water Guidelines

The following total metal concentrations exceeding the adopted assessment criteria were noted:

- Total aluminium concentrations exceeded the STI criteria (20 mg/L) in four (4) wells – BH06 North (68.7 mg/L), BH10 (184 mg/L), BH12 (26.1 mg/L) and BH13 (540 mg/L); and
- Total iron concentrations exceeded the STI criteria (10 mg/L) in four (4) wells – BH06 North (32.1 mg/L), BH10 (52.6 mg/L), BH11 (18.5 mg/L) and BH12 (76 mg/L).

6. Acid Sulfate Soil Management Plan

The management strategies outlined below and within the Flow Chart 1 will be required to ensure that there are no adverse impacts to sensitive environmental receptors within the vicinity of the site. The management practices below will be implemented to ensure that soils identified as ASS are managed accordingly.

As the tender for earthworks has not yet been awarded, the following text includes generic terms for the parties that will be involved, as defined below.

- *Contractor:* Contractor to be appointed by the Water Corporation.
- *Principal's Environmental Consultant:* Environmental consultant appointed by the Water Corporation.
- *Superintendent:* Supervising engineer appointed by the Water Corporation.

The Contractor will be responsible for ensuring that all management measures outlined in this section (or as agreed otherwise) are adhered to for the duration of their contract.

6.1 ASS Management Areas

The following ASS management areas are based on the ASS laboratory results obtained by GHD (2013) and the ASS management strategies are in accordance with the DER ASS Guideline Series (DEC, 2011) and the *Water Corporation Acid Sulfate Soil and Dewatering Management Strategy'* (Water Corporation, July 2007).

6.1.1 Topsoil

No ASS treatment or management of topsoils (0 - 0.3 m bgl) is necessary during construction.

For the purpose of this project, topsoil is defined as material up to the first 300 mm of the soil profile generally containing organic and vegetative matter. It is routine practice to remove the topsoil before excavation and stockpile until it is needed for top-dressing.

6.1.2 Defined ASS Areas

Table 6 below defines the areas within the pressure main alignment which are deemed to be ASS. Any soil material excavated from the areas outlined Table 6 must be managed in accordance with this section.

The treatment method for ASS has yet to be defined and therefore ASS management may be undertaken via off-site or on-site treatment operations. However due to space constraints, it is assumed that off-site disposal is the preferred management option. The sections below outline the requirements for off-site management.

6.1.3 Estimated ASS Volumes Requiring Treatment

The total volume of material excavated from the pressure main alignment will be dependent on the finalised method of construction. Table 6 below identifies the anticipated volume and type of material to be excavated.

Table 6 Defined ASS Areas and Estimated Volumes Requiring Treatment

Section	Chainage	Location Description	ASS	Lithological Description	Estimated Volume of ASS Material[2]
Section 1	819 to 1080	Exchange Ave to Skeet Rd	All material below 24m AHD or approximately 1.0m to 1.5m bgl	Guildford Formation: Black medium grained sand with traces of silt and clay (including weakly cemented clasts)	650m^3 Assumes 0.5m of material requiring treatment within trench excavations[3]
Section 2	1080 to 2600	Bush Forever Area	All material regardless of depth	Bassendean Sand: Grey to brown, fine to medium grained, poorly graded sand with trace organics underlain by Guildford Formation	Material disturbed however not excavated.
Section 3	4060 to 4400	South of Armadale Road to east side of Tonkin Highway	All material below 21.75m AHD or approximately 2.0m to 3.0m bgl	Guilford Formation: Pale brown/grey, medium grained clayey sand grading to dark grey/red brown silty sand	1750m^3. Assuming 1.0m of material requiring treatment within trench and from launch/receival pit[4] excavations

[2] Bulk density assumed at 1.6 t/m^3
[3] Trench is assumed to be 3m wide and of varying depth, typically 1m to 1.5m bgl.
[4] Launch/receival pits are assumed to be 5m (length) x 3m (wide) and approximately 1m greater depth than the invert level of the pressure main.

6.2 Treatment Option 1: Off-site Management (Transport to Licensed Facility)

6.2.1 Excavation, storage and transport offsite

Excavated ASS intended for off-site treatment will be dispatched to a licensed ASS treatment facility after excavation at the end of each excavation day.

Excavated soils not able to be dispatched at the end of each day must be stored on a limestone pad constructed to the requirements of Section 6.2.5 and should comply with the temporary storage requirements outlined in Section 6.2.4.

As a minimum, the ASS treatment facility must be provided with details of the materials they are being requested to accept (i.e. volume of material, predominant texture, the maximum net acidity value for the ASS material) which is contained in Table 7. Different facilities have varying information requirements before accepting material, and it is critical to ensure that acceptance of the material is approved prior to commencing excavation.

Table 7 Off-site Disposal Information

ASS Information (Treatment Facility)	
Material Type	**Section 1**: Black medium grained sand with traces of silt and clay (including weakly cemented clasts) **Section 3**: Pale brown/grey, medium grained clayey sand grading to dark grey/red brown silty sand
Maximum Net Acidity	**Section 1:** 220 mol H+/t **Section 3:** 36 mol H+/t
Indicative Liming Rate	**Section 1:** 35kg/m^3 (including Section 6.2.3) **Section 3: 6**kg/m3 (including Section 6.2.3)

Daily records must be kept of excavation and transport volumes, as well as records of receipt at the licensed facility.

6.2.2 Offsite Treatment: Summary of Reporting Requirements

The Contractor will prepare and maintain a daily log of all ASS material disposed off-site to the nominated licensed facility. Table 8 provides a summary of the reporting requirements.

Table 8 Summary of Reporting Requirements

	Action Item	Report to	Timeframe
Contractor	Letter of approval from the operators of the treatment facility indicating that they are aware of the nature of the soil they are receiving (i.e. ASS).	Superintendent & WC Environmental Officer	Prior to commencement of construction
Contractor	Daily log of all ASS excavated and transported offsite. Log to contain information of the location	Superintendent & WC Environmental Officer	Fortnightly during construction

	Action Item	Report to	Timeframe
	and volume of ASS removed, as well as transport destination(s).		
WC Environmental Officer	Inclusion of the letter of approval and ASS delivery receipts in the Initial Closure Report.	WC Project Manager (& DER if elected by WC Project Manager)	To be prepared within 4-6 weeks of completion of all earthworks and dewatering operations.

6.2.3 Neutralisation Rate for Excavated ASS

The Contractor should provide the following information to the licensed facility operator(s) prior to excavation.

The following uncorrected liming rate calculation assumes the following variables and is adopted from the DER ASS Guideline Series (DEC, 2013):

- Maximum Net Acidity (See relevant section along alignment) ;
- Safety Factor of 2.0;
- Conservative bulk density[5] of 1.6 t/m^3; and
- Effective Neutralising Value (ENV) of neutralising material is assumed to be 100%

Table 9 provides a summary of the neutralisation rate for the site.

Table 9 Calculated Neutralisation Rates

ASS Unit	Maximum Net Acidity Result	Assumed Bulk Density (tonne/m^3)	Uncorrected Liming Rate (kg/m^3)[6]
Section 1: Ch 819 to Ch 1080	0.35%S (220 mol H+/tonne)	1.6	35
Section 3: Ch 4060 to Ch 4400	0.06%S (36 mol H+/tonne)	1.6	6

6.2.4 Temporary Storage Time Restriction

Temporary storage of ASS onsite pending treatment off-site disposal may be for a maximum of fourteen (14) days.

Excavated ASS soils may be temporarily stockpiled pending off-site disposal on the bunded treatment pad. Based on the texture of the identified ASS material (worse case consists of sands with less than 5% clay content), temporary storage of ASS pending treatment may be for a maximum of fourteen (14) days.

6.2.5 ASS Storage and Treatment Area (Limestone Pad)

Excavated soils deemed to be ASS must be stockpiled on a bunded limestone treatment pad after excavation if transport to an off-site facility cannot be achieved at the end of each excavation day.

[5] Bulk density derived from GHD (2013)
[6] Uncorrected liming rate assumes Aglime has 100% ENV, liming rate to be corrected prior to construction.

The treatment/ holding pad will consist of the following components:

- Constructed of compacted crushed limestone of not less than 300mm in thickness. The pad shall be graded to ensure good drainage towards the back of the pad to ensure runoff and any leachate is collected within a lined stormwater collection basin.
- Three (3) sides will be bunded with limestone or similar alkaline material to a minimum height of approximately 150mm above the surface of the pad to prevent lateral run-off. A leachate collection and treatment system will also be required to manage run-off during winter periods or rainfall events.
- The stormwater collection basin should be lined with a low permeability liner (clay or synthetic). The leachate collection basin should be of sufficient size to retain the first 10mm of runoff from the bunded area, and should overflow to a separate unlined infiltration area or basin after treatment (if monitoring indicates treatment is required).
- Stockpiles should not exceed 2.5m in height.

The Contractor is to provide a description of their proposed methodology including the location of the proposed storage area, if required prior to the commencement of works. The method and location is to be approved by the WC Environmental Officer prior to the commencement of excavation and may require adjustment during works.

6.3 Treatment Option 2: Ch 1080 to Ch 2600 (Bush Forever Area)

The area within the Bush Forever area has been defined as containing ASS material within varying depth throughout the proposed pressure main alignment however is predominately located from between 1m and 1.5m bgl. ASS was detected within the termination depth of sample locations to a maximum depth of 6.45m bgl.

The Water Corporation has indicated that Eco-Ploughing through this area is considered their preferred option after consultation with the Department of Parks and Wildlife (DPaW) and Department of Environmental Regulation (DER) to preserve the Bush Forever area.

The below management strategy can only be applied to an Eco-Ploughing method and should not be applied to any other area of the pressure main to be constructed. The following assumptions and construction limitations apply to this management strategy option:

Eco-Ploughing will consist of a two stage process:

- **Stage 1**: Soils will firstly be 'ripped' from the natural ground surface with a bull dozer tyne. This method is considered to loosen (by vibration) and displace soil and rocks (if present).
- **Stage 2:** The second pass will insert the pipe (DN450 PE) at the required depth typically between 1.5 and 2m depth.
- No material will be removed from the site during the installation of the pipe.
- No dewatering will be undertaken during the installation of the pipeline.

6.3.1 Stage 1: Initial Ripping of Natural Soil Surface

Prior to 'ripping' the ground surface, a layer of AgLime should be applied to the surface at a rate of 11kg per linear meter of ripped trench (uncorrected liming rate).

AgLime should be placed directly over the area to be ripped, to a maximum of 1m wide.

The rate of AgLime application is based upon the maximum net acidity encountered along this section of the pressure main alignment during the investigations undertaken in June/ July 2013. The liming rate is considered the equivalent of neutralising material required, if material was excavated and stockpiled for neutralisation.

Once AgLime has been applied to the area to be ripped, the bull dozer tyne should then rip the proposed alignment (through the neutralising material) and therefore blend the neutralising material whilst ripping the ground surface. The vibration from the tyne is also considered to assist the blending of the neutralising material to the deeper invert depths.

Photographs of the application of the neutralising material to verify the application volume and successful ripping process should be taken every 250m along the pressure main alignment.

Neutralisation Rate for Bush Forever

The Contractor should inform the WC Environmental Officer prior to commencement of construction and provide the Product Information Sheet (PIS) provided by the AgLime supplier to ensure the liming rate can be corrected prior to application.

The following uncorrected liming rate calculation assumes the following variables and is adopted from the DER ASS Guideline Series (DEC, 2013):

- Maximum Net Acidity - 0.35%S (equivalent 220 mol H+/tonne);
- Safety Factor of 2.0;
- Conservative bulk density[7] of 1.6 t/m^3; and
- Effective Neutralising Value (ENV) of AgLime of 100%

Table 10 provides a summary of the neutralisation rate for the Eco-Plough area.

Table 10 Calculated Neutralisation Rates

ASS Unit	Maximum Net Acidity Result	Assumed Bulk Density [8](tonne/m^3)	Uncorrected Liming Rate (kg/m^2)
Section 2: Ch 1080 to Ch 2600	0.35%S (220 mol H+/tonne)	1.6	11

Note: Uncorrected liming rate has been converted from m^3 into kg per linear meter. The rate will require to be corrected once the ENV value of the imported material is provided

6.3.2 Stage 2: Insertion of Pipe Alignment

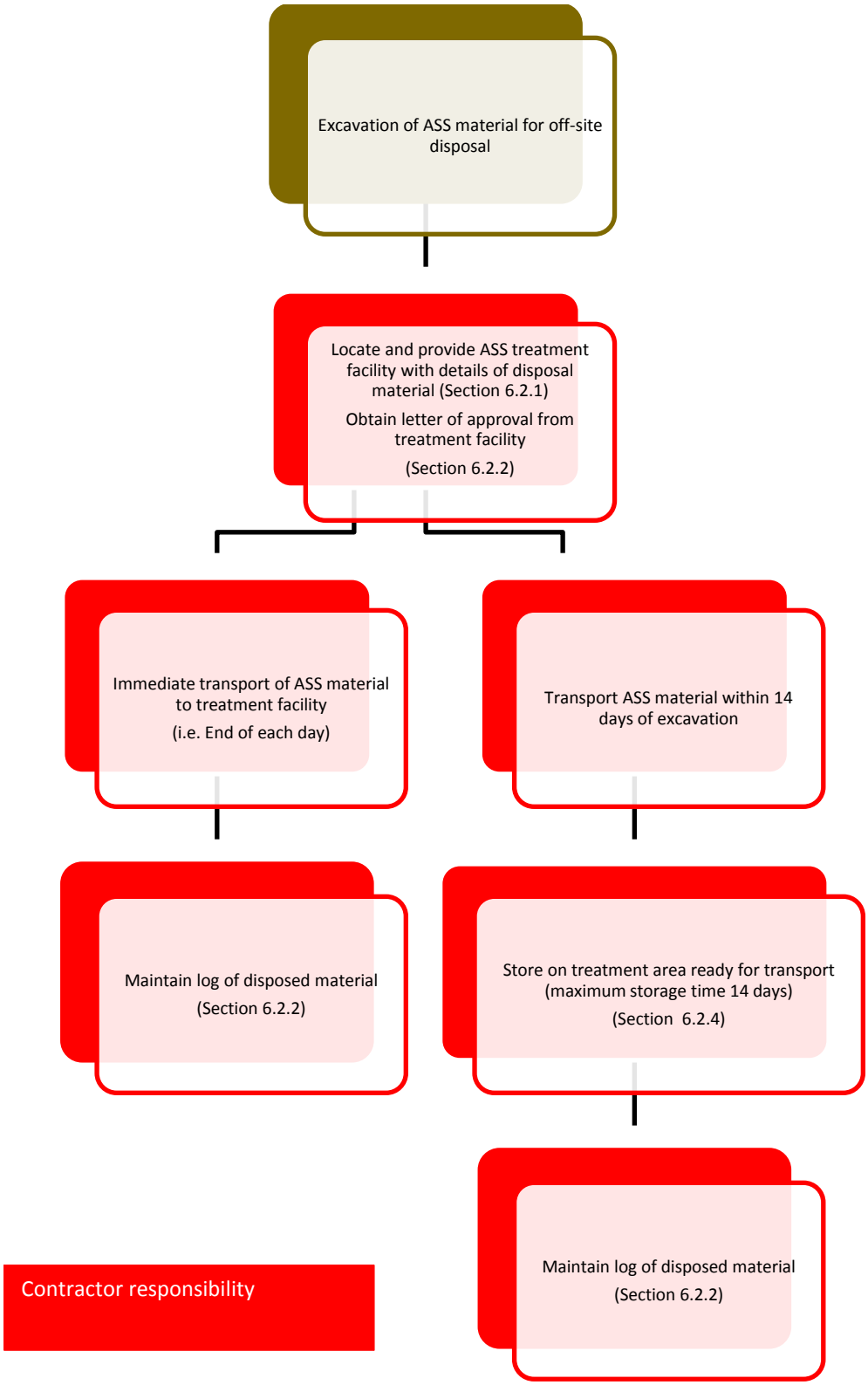
The insertion of the pipeline and backfill of natural material (including neutralising material) within one pass.

No material will be removed from the site during installation.

Photographs will be obtained of the finished alignment at 250m intervals.

[8] Bulk density derived from GHD (2013)

Flow Chart 1 Summary of ASS Off-Site Disposal Procedure



7. Dewatering Management Plan

Baseline groundwater investigations undertaken during August 2013 indicate that groundwater is classified as "Class 1: *Very high alkalinity - Adequate to maintain acceptable pH level in the future"* at most locations along the alignment (BH01, BH03, BH06 North, BH28, BH10, BH11 and BH12). Two (2) locations, BH08 and BH13 were designated as: "*Class 4: Low alkalinity - Inadequate to maintain stable, acceptable pH level"* as per the DER ASS Guideline Series (DEC, 2011).

However it should be noted that this assessment criteria does not take into account the acidity within the groundwater and the geochemistry changes that may take place during potential dewatering within identified PASS zones.

Dewatering operations should aim to maintain the current groundwater quality rather than allowing groundwater to degrade during abstraction operations. On this basis, trigger criteria and actions to manage the groundwater quality should be implemented and monitored on a daily basis during dewatering operations.

7.1 Infrastructure Requiring Dewatering

The geotechnical investigation outlined areas which have been identified as potentially requiring dewatering, determined from the maximum levels observed during the June to July investigations and August 2013 monitoring program. Dewatering is expected to be required where the observed groundwater level is either above the invert or less than 0.25 m below the invert level.

The following locations (Table 11) have been identified as potentially requiring dewatering, determined from the maximum levels observed during the June to July and August observations.

Table 11 Areas of Dewatering (August, 2013)

Section	Chainage	Comments
Section 1	Ch 0 to Ch 200 Ch 450 to 700 Ch 950 to Ch 1080	-
Section 2	-	Eco-Plough area, dewatering not required during installation. Eco-Ploughing to be undertaken when dewatering not required.
Section 3	Ch 2600 to Ch 3300 Ch 3500 to Ch 4316	High total metal concentrations exceeding short term irrigation criteria (filtration required).

Due to the seasonal fluctuation of groundwater, during construction additional areas may be identified where dewatering is required. Scheduling work for drier periods of the year will reduce the requirement for dewatering.

7.2 Dewatering Methods

The dewatering methodology would depend on the finalised construction method employed by the Contractor. However, it is likely that the following dewatering methods, or a combination thereof, could be utilised during construction.

- Dewatering spears - likely to be used for localised areas and/or trenches.
- Sump pumps - for localised dewatering inside pits and/or caissons.

7.3 Dewatering Modelling Calculations and Assumptions

GHD has estimated, using empirical modelling methods, the required abstraction rates and the potential extent of drawdown from dewatering of the excavated trenches for the pressure main. The following groundwater modelling has been based open-cut trench excavation methods with no hydraulic containment based upon the typically shallow depths of dewatering.

7.3.1 Methodology

Estimations of groundwater abstraction and the likely cones of depression have been calculated in accordance with the DER ASS Series Guideline (DEC, 2013).

The radius of influence can be estimated utilising Sichardt's equation:

$$R_o = 3000 \times s \times \sqrt{K}$$

Where:
R_o = radius of influence of an equivalent pumping bore (m)
s = maximum groundwater draw down (m)
K = hydraulic conductivity of aquifer matrix (units of m/s)

Groundwater elevation resulting from dewatering activities is related to the pumping rate, hydraulic conductivity of the aquifer matrix and the radius of influence of pumping by the following equation:

$$H^2 - h^2 = \frac{nq}{\pi k}\left(\ln R_o - \ln r_e\right)$$

Where:
H = saturated thickness of the aquifer undisturbed by pumping (m)
h = saturated thickness of the aquifer at maximum drawdown (m)
k = hydraulic conductivity of aquifer matrix (units of m/s)
R_o = radius of influence of an equivalent pumping bore (m)
r_e = effective radius of an equivalent pumping bore (m)
q = pumping rate of individual dewatering well points (m^3/s)
n = number of well points used to dewater the excavation

The pumping time required for the cone of depression to reach the full extent of water table drawdown is calculated utilising the Cooper-Jacob empirical relationship:

$$R_o = ((2.25\ k\ h\ t)/S)^{0.5}$$

Where:
t = pumping time (seconds)
S = specific yield of aquifer sediments
Other parameters as previously defined

As a minimum, a preliminary assessment of the radial extent of the cone of depression for dewatering operations in ASS areas should be estimated.

7.3.2 Assumptions and Limitations

The scale of dewatering is subject to many assumptions such as trench dimensions (i.e. length, width, depths of excavation) and local hydrogeological conditions (i.e. connectivity to surficial aquifer, proximity of surface water bodies, precipitation).

For the purposes of these estimates, open trenching scenario within a groundwater drawdown of 1m below the groundwater table (August, 2013).

7.3.3 Calculation Assumptions

- Trench width = 3 m

- Trench length = 25 m
- Saturated thickness of the aquifer (H): 31 m
- Saturated thicknesses at maximum drawdown (h): 30 m
- Maximum groundwater drawdown: 1.0 m
- Dewatering depth: +0.5 m below trench invert
- Default hydraulic conductivities of the aquifer matrix (k): 1.91x10-4 to 9.49x10-5 m/sec (16.5 to 8.2 m/day) (Davidson, 1995)
- Specific yield of superficial aquifer (S): 0.1 (Davidson, 1995)

The above modelling assumptions have been utilised to provide the results outlined in Table 12.

Table 12 Estimated Abstraction Rate and Radius of Drawdown Estimation

Predominant Lithology	Hydraulic conductivity (m/s)*	Drawdown (m)	Cone of Depression (R_0) (m)	Estimated Abstraction Rate (L/s)	Time taken to establish required drawdown (hours)
Medium grain SAND	1.91 x10-4	1.5	41	17	4
Fine to medium grain SAND	9.49 x10-^{5}	1.5	29	10	4

Initial abstraction rates may be high to cause mass groundwater drawdown and reduce the necessary pumping time to achieve the desired dewatering invert level however GHD expect maintenance abstraction rates to be in the vicinity of 12 L/s for the project.

These abstraction rate and volume estimates are approximations only and will vary according to (but are not limited) the following:

- groundwater levels (subject to seasonal variations from rainfall events, abstraction by local residents, mounding caused by onsite re-infiltration);
- changes in ground conditions which affect the hydraulic conductivity of the soil profile;
- any construction schedule changes; and
- any sewer invert level changes.

7.4 Groundwater Acidification Risk Matrix

GHD classified the potential groundwater acidification risk at the well locations using groundwater laboratory data. Parameters assessed include acidity, alkalinity, pH, ORP, sulfate, total aluminium and iron concentrations. The likelihood of dewatering being required within 50 m was also taken into consideration.

A summary of this matrix is presented in Table 13 to characterise the risk of groundwater acidification and determine the likelihood of the groundwater (dewatering effluent once abstracted) requiring lime dosing to adjust the pH of the effluent.

Table 13 Groundwater Acidification Risk Matrix

Well ID	Chainage	Groundwater Acidification Risk	Likelihood groundwater treatment
BH01	47	Low	Possible
BH03	570	High	Highly Likely
BH05 North	Unable to be sampled		
BH05 South	Unable to be sampled		
BH06 North	2,667	Moderate	Likely
BH06 South	2,674	Moderate	Likely
BH08	3,161	High	Highly Likely
BH10	3,665	Moderate	Likely
BH11	3,853	Low	Possible
BH12	4,199	Moderate	Likely
BH13	4,395	High	High Likely
BH16	Unable to be sampled		
BH19	Unable to be sampled		
BH22	Unable to be sampled		
BH25	Unable to be sampled		
BH28	3,553	Moderate	Likely

7.5 Management of Dewatering Effluent

Monitoring of the dewatering effluent and groundwater will be undertaken in accordance with Table 17 and the trigger levels provided within this table are based upon the DER ASS Guideline Series (DEC, 2011) and the baseline water quality parameters obtained during August 2013.

7.5.1 Dewatering Effluent Management

Dewatering effluent should be directed to a retention basin or holding tank immediately after abstraction. The retention basin will be constructed as per the following requirements to enable monitoring of the effluent and flocculation of metals prior to discharge.

- Dewatering effluent will be initially directed to an impermeable retention basin or holding tank (similar to a sea container), to allow sufficient time for the mixing (if applicable) and aeration process to flocculate and settle solids, subject to space constraints.

The retention area will be of sufficient size to contain the dewatering effluent and allow the filtration of metals and Total Suspended Solids (TSS) prior to discharge.

Table 14 outlines the recommended dimensions of the retention area and is based on an abstraction rate (and ultimately the construction method) proposed by the Contractor.

It is important to note that prior to the basin size being set by the Contractor the assumptions behind the dewatering volume calculated in this report will require validating (i.e. dewatering section dimensions, groundwater depth, dewatering rate, etc.).

The Contractor is responsible for the construction and modification (if required) of the retention area.

A schematic of the dewatering effluent management system considered suitable for the site is presented in Appendix D. Variations of the effluent management system must be discussed with the WC Environmental Officer prior to commencement.

Table 14 Recommended Retention Basin Sizes (based on depth of 0.5m)

Discharge Rate (L/S)*	Approx. Area (m^2)	Approx. Length (m)	Approx. Width (m)
1.60	12.25	4.95	2.48
3.00	24.51	7.00	3.50
6.00	49.01	9.90	4.95
12.00	98.03	14.00	7.00
18.00	147.04	17.15	8.57

Table 14, adapted from Table 3.1 of DoE, 2004)

* Assuming one hour of effluent storage capacity.

7.5.2 Dewatering Effluent Disposal Options

The dewatering disposal options will depend on the dewatering rate, infiltration rates and the abstracted groundwater quality.

The currently identified disposal options and in order of preference, are:

- Re-infiltration within close proximity to the dewatering operations (i.e completed service trenches) identified on Figure 6;
- Discharge into sewer network (permit required); and
- Discharge into stormwater system (permit required).

Re-infiltration

Re-infiltration is the preferred method of disposing of effluent subject to water quality and the trigger criteria outlined in Table 17.

Re-infiltration on-site may be a feasible dewatering discharge disposal option, if a suitable area is available during construction. Re-infiltration (post retention) may be viable over completed service trenches, however the re-infiltration rate would depend on the dewatering rates/volume and the infiltration capacity and depth to groundwater level at the time of construction.

Abstraction in some areas may exceed infiltration rate and the infiltration of effluent over completed services may not be a sole viable option. In this instance excess dewatering effluent can either be stored in holding tanks for infiltration over a period of time during the construction period or the construction of infiltration basin located to the east of Ch 0 to 1080 (subject to permission from the land owner). The construction of basins or disturbance of any Bush Forever area is not permitted.

Discharge to Sewer

Disposal to the sewer may be a feasible option, however, the following should be considered:

- Approval would be required from the Water Corporation by lodging a “one-off discharge of industrial waste”.
- The disposal volume is normally restricted by the sewer capacity, which would need to be discussed with the Water Corporation and would depend on the expected discharge rates and volumes.

This disposal option would require limited on-site treatment (pH adjustment and Total Suspended Solids (TSS) given the groundwater quality information obtained in August 2013.

Discharge to sewer may also be considered as a contingency measure as a backup to other selected disposal option(s) such as re-infiltration.

7.5.3 Treatment of Dewatering Effluent

Baseline groundwater data obtained during August 2013 provides an indication of the quality of the effluent likely to be abstracted during dewatering, however water quality can change during the dewatering process (as groundwater is drawn down in from within the cone of depression, subjected to increased aeration/oxygen).

Neutralisation via a Lime Dosing Unit (LDU) prior to discharge is likely to be required during construction and dewatering. As such a LDU should be sort and all effluent should pass through the LDU and neutralised on an 'as required' basis.'

7.5.4 Filtration of Dewatering Effluent

Baseline groundwater quality indicates the dewatering effluent is likely to have a dissolved metal concentration (particularly iron and aluminium) below the STI and DER ASS Criteria (10mg/L (STI) and 1mg/L DER ASS Criteria respectively) indicating that filtration of dewatered effluent is not required during the dewatering operations.

Groundwater quality information indicates exceedances when compared to Freshwater Guidelines, these are considered conservative criteria, however effluent should not be discharged directly to surface water bodies without retention and/or consultation with the WC Environmental Officer.

A schematic of the recommended dewatering effluent treatment system is presented as Appendix D.

7.6 Dewatering Effluent Monitoring

7.6.1 Dewatering Effluent Monitoring Locations

Dewatering effluent will be monitored at the following locations throughout the dewatering program and analysed for the parameters outline in Table 15.

- **Monitor Point 1**: Monitoring effluent prior to entering the retention basin (before LDU if this is required).
- **Monitor Point 2**: Monitoring effluent prior to entering the infiltration area.

7.6.2 Dewatering Effluent Monitoring Suite

Dewatering effluent should be tested for the parameters and analytes outlined in Table 15.

Table 15 Dewatering Effluent Monitoring Suite

Dewatering Effluent Monitoring (DEC 2013)	
Total acidity	Manganese (total)
Total alkalinity	Nickel (total)
pH	Zinc (total)
Sulfate	Selenium (total)
Chloride	Ammoniacal nitrogen
Aluminium (dissolved)	Hydrogen sulfide
Aluminium (total)	EC
Arsenic (total)	Total suspended solids (TSS)
Chromium (total)	TDS
Cadmium (total)	Total nitrogen
Iron (total)	Total phosphorus
Iron (dissolved)	Filterable reactive phosphorus (FRP)

7.6.3 Groundwater Monitoring during Dewatering Operations

Groundwater will be monitored every second day by the Contractor during dewatering from the monitoring bores outlined in Table 13 and identified on Figure 6 when the bores are located within 200m of the dewatering operations for the field parameters:

- pH, EC, total acidity and static water level.

Groundwater results to be provided on a weekly basis to the WC Environmental Officer or within 24 hours, if groundwater quality degrades to the trigger criteria outlined in Table 16.

Table 16 Groundwater Trigger Criteria

Analyte	Trigger Criteria	Determined From	Action
pH	- 10% from baseline pH value	Second day field results	Notify WC Environmental Officer within 24hrs
Total Acidity	>25% increase from the baseline value	Second day field results	
Static Groundwater Level	- 10cm from baseline values at maximum 100m radius of dewatering operations.	Second day field results	

Table 17 Dewatering Effluent Monitoring Matrix: Monitoring Frequency, Analytes, Trigger Levels and Actions

	Trigger	Action	Monitoring
1a.	**Total titratable acidity <40mg/L** pH >6	Continue daily field measurements of pH and total titratable acidity	**Daily** – field measurement: pH, electrical conductivity (EC) & Total Titratable Acidity (TTA). **Fortnightly** - laboratory analysis: total acidity, total alkalinity, pH
2a.	**Total titratable acidity <40mg/L** pH in range of 4 to 6.	Undertake neutralisation treatment (liming)	**Daily** – field measurement: pH, EC & TTA, total alkalinity **Fortnightly** - laboratory analysis: total acidity, total alkalinity, pH
3a.	**Total titratable acidity in range 40mg/L to 100mg/L** pH>6	Undertake neutralisation treatment (liming) Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals	**Daily** – field measurement: pH, EC & TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH **Fortnightly** - field measurement: dissolved oxygen (DO), redox potential (Eh)
4a.	**Total titratable acidity in range 40mg/L to 100 mg/L** pH in range of 4 to 6	Undertake neutralisation treatment (liming) Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals	**Daily** – field measurement: pH, EC, TTA, total alkalinity **Weekly -** laboratory analysis: total acidity, total alkalinity, pH **Fortnightly** - laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, EC, total suspended solids (TSS), total dissolved solids (TDS), total nitrogen (TN) and total phosphorus (TP) **Fortnightly** - field measurement: DO, Eh
5a.	**Total titratable acidity >100mg/L** or pH<4 or **Total alkalinity <30mg/L**	Increase neutralisation treatment (liming) rate Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals Advise Department of Environment Regulation (DER) Contaminated Sites Branch (CSB) immediately. CSB may advise appropriate action which may include ceasing dewatering	**Twice Daily –** field measurement: pH, EC, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, EC, TSS, TDS, TN and TP. **Fortnightly -** field measurement: DO, Eh May be required to undertake investigations to determine the size of the “acidic footprint” created and manage this impact appropriately

Additional notes:

[1] A slurry made from crushed limestone is the generally preferred neutralisation material. Other neutralising agents, such as hydrated lime or quick lime can be used, however they quickly increase the receiving waters' pH and can result in pH overshoot.

[2] Measurement of metal concentrations in dewatering effluent should be as total concentrations from an unfiltered water sample. These concentrations should then be used to determine appropriate treatment options for the effluent and to identify any emerging trends in groundwater quality. It is not the intention that these values for total metals be directly compared against environmental or health-based criteria for dissolved metals. However, when determining treatment options, it should be borne in mind that: **a)** any metals contained within suspended solids have the potential to be mobilised if pH and/or REDOX conditions change (which is obviously fairly common in ASS environments); and b) if dewatering effluent is to be discharged into a receiving environment then these suspended solids will be discharged along with the water.

Adapted from (DEC 2011).

Table 18 Roles and Responsibilities – Dewatering Effluent and Groundwater Monitoring

Responsibility	Task	Actions
Contractor	Continuously monitoring the dewatering discharge rate and volume. Daily monitoring and recording of the pH, EC, TTA and TAAlk of the dewatering effluent, subject to trigger criteria outlined in Table 17. When using retention areas, water sampled daily from the inlet and outlet point supplying the first tank. The trigger criteria specified in Table 17 will be used to determine the level of treatment required, or if more frequent field monitoring is required. Daily monitoring of dewatering effluent with respect to visual assessment, for example high sediment loading, iron precipitation, colour, odour etc. Daily assessment of the geofabric textiles (when installed) within the dewatering treatment system and cleaning/replacement, as required. Second day monitoring of the groundwater bores at the site for pH, EC, TTA during dewatering operations. Fortnightly groundwater monitoring of groundwater bores during dewatering operations as per Section 7.6.3.	Results of the water monitoring programs along with actions taken to achieve water quality targets including quality of the dewatering effluent to be provided to the WC Environmental Officer on a weekly basis. Results to be provided within 24 hours of water quality falling outside the parameters in Table 17.

7.7 Dewatering Management Roles and Responsibility

The water monitoring program including roles and responsibilities, outlined in Table 18, will be undertaken during dewatering operations.

A flow chart outlining the Actions and Responsibilities in relation to dewatering effluent and is included as Flow Chart 2. It is anticipated that this flow chart will be distributed amongst the Contractors at the start of the construction phase to compliment and disseminate the information contained within this management plan.

Example checklists for groundwater and dewatering effluent monitoring for the Contractor are included in Appendix E. The daily field sheet outlines all daily field measurements that are required to be recorded by the appointed Contractor and submitted to the Water Corporation on a weekly basis.

7.8 Decommissioning of Retention Basin

At the completion of the works, the WC Environmental Officer (or Principal's Environmental Consultant on formal delegation from the WC Environmental Officer) will be responsible for collection of samples of the accumulated sediments at the base of the retention basin (if utilised instead of the holding tank). The results will be used to determine the appropriate decommissioning requirements and disposal method for the accumulated sediments.

Accumulated sediments at the base of the holding tank should be disposed of by the Contractor to an appropriate facility. Sediments should not be disposed of on-site without prior consultation with the WC Environmental Officer.

Sample analyses will include, but not be limited to:

- SPOCAS; and
- Metals (Al, As, Cr, Cu, Fe, Mn, Pb, Ni, Se and Zn).

Once laboratory analysis is completed, sediments will be classified based upon the *Landfill Waste Classification and Waste Definitions* (DoE, 1996, as amended December 2009) and disposed offsite at an appropriate waste disposal facility.

7.9 Residential Bores Affected by Dewatering Operations

A search of the Department of Water (DoW) borehole database (WIN) was carried out to identify any registered bores within close proximity of the Site in March 2014.

Two (2) registered bores are located within a 500m radius of the site, both of these bores are located >100m from any dewatering operations and are operated by the City of Kwinana. The bores are licensed to abstract water from the superficial aquifer, the aquifer intended to be dewatered during construction.

Additionally some properties within and adjoining the works may have bores for producing water for their gardens. As the functionality of these bores and the quality of water may be affected by the dewatering works required for the construction of the infrastructure property owners/occupiers will have to be notified of the works prior to commencement.

The dewatering operations are not anticipated to extend beyond 100m of the dewatering site and therefore bores on the WIN database should remain unaffected.

7.9.1 Inspections of Bore and Reticulation Systems

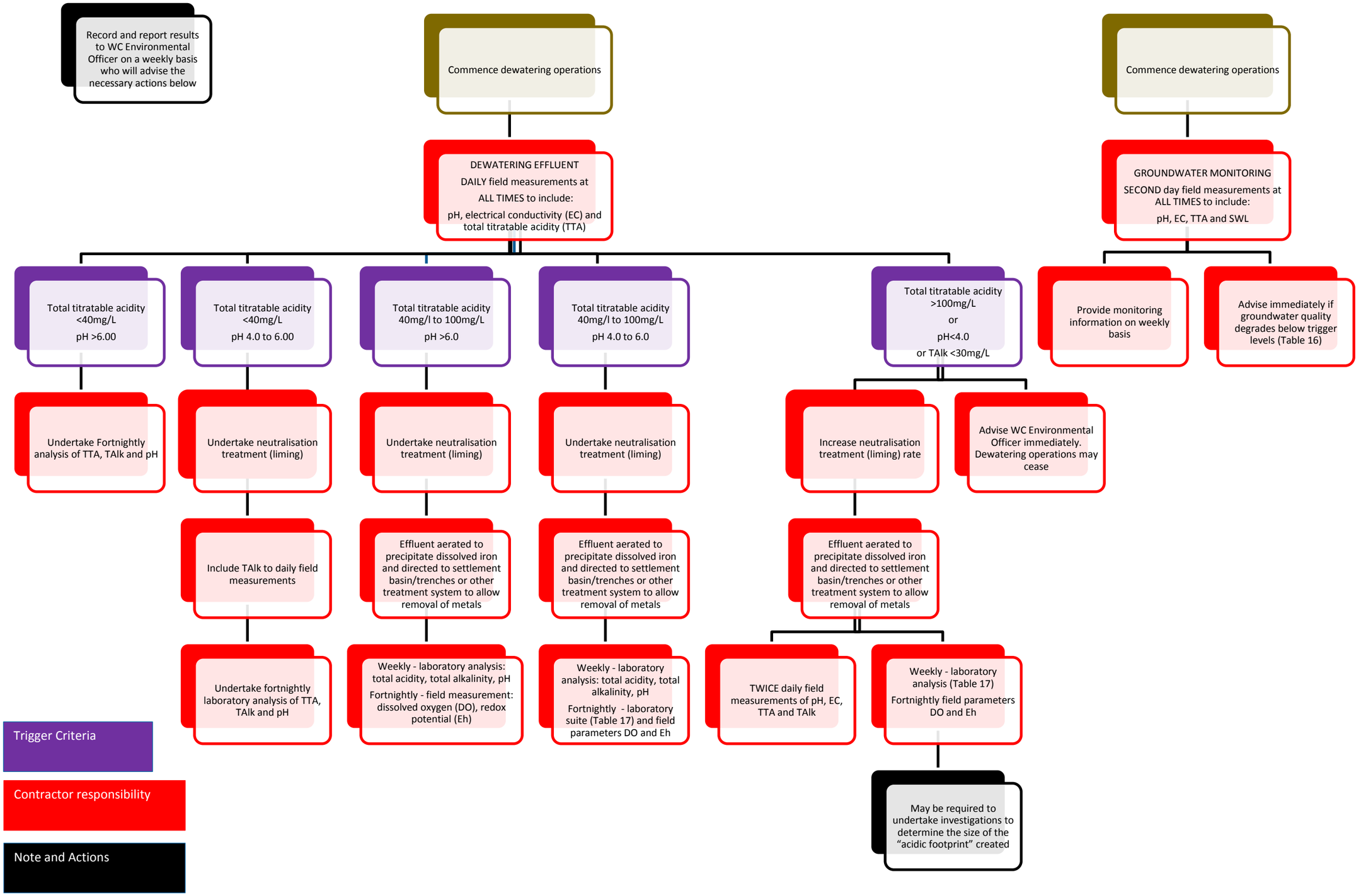
When dewatering is to commence at the pump station site, the Contractor shall:

- Request a list from the Superintendent identifying the owners and occupiers of known bores within 100m radius of the dewatering operations.
- Request an inspection of all properties within a 100m radius of the pump station to determine, if there is a bore on the property;
- Obtain the owner/occupiers permission and test the bore to confirm whether the bore is in operational or not;
- If the bore is operational then confirm which of the sprinkler or other outlets are in working order;
- Obtain the owner/occupiers signature on a 'pro forma' letter and plan of the sprinkler system to confirm they agree with results of the inspection;
- Leave the original signed letter and plan with owner/occupier, and retain a copy for the Contractor records;
- Leave a letter with the owner/occupier advising them of the start and finish date of dewatering work that will affect their property and advising them that they should not use the bore until advised by the Contractor;
- Reinspect each property with a working bore following completion of dewatering work and confirm that what equipment was working satisfactorily before, is still working satisfactorily;
- Obtain the owner/occupiers signature on the 'pro forma' letter and plan of the sprinkler system to confirm they are satisfied with results of the final inspection.

7.9.2 Records of Bore and Reticulation System Inspections

The Contractor shall maintain a file of copies of the 'bore and reticulation system' letters endorsed by the owner/occupier. A copy of the letters shall be provided to the Superintendent at the kick-off meeting.

Flow Chart 2 Summary of Monitoring and Management during Dewatering Operations



8. Groundwater Monitoring Program

8.1 General

Groundwater monitoring is an integral part of any project, where dewatering is undertaken as it allows for any changes in land and water quality to be monitored pre, during and post construction, giving an indication as to the success of the management strategies implemented.

A comprehensive monitoring program (including additional bores) will require to be finalised once the design and construction methods have been finalised. The extent of dewatering operations and type of construction method will dictate the number and location of bores required.

8.1.1 Additional Groundwater Wells

GHD recommend prior to construction commencing that wells at locations BH05 North and BH05 South be re-drilled to monitor groundwater levels and chemistry. This will provide a better network of groundwater wells to monitor pre, during and post-construction.

8.1.2 Replacement of Un-operational Groundwater Wells

It is considered that if any groundwater wells are rendered unusable as a result of construction, they will be required to be replaced as soon as possible after the well has been determined to be unusable. The WC Environmental Officer is to be informed immediately when a well has been damaged or rendered unusable.

8.2 Groundwater Monitoring Program

The groundwater monitoring program will utilise selected monitoring wells listed in Table 19 and shown in Figure 6 for the duration of the site works.

Table 19 Groundwater Monitoring Wells

BH ID	Chainage	Co-ordinates		Elevation (m AHD)	Depth (m)
		Easting	Northing		
BH01	47	398909	6445341	26.80	3.45
BH03	570	399047	6444936	27.00	3.45
BH06 North	2,667	400565	6443495	22.00	6.00
BH06 South	2,674	400563	6443483	22.50	6.45
BH08	3,161	400922	6443153	24.25	2.80
BH10	3,665	401281	6442799	23.40	4.50
BH11	3,853	401414	6442667	23.50	4.50
BH12	4,199	401666	6442408	23.75	4.50
BH13	4,395	401821	6442405	24.75	4.50
BH16	1,396	399664	6444386	24.40	6.00
BH19	1,685	399869	6444183	23.90	6.00
BH22	2,000	400097	6443966	23.80	6.00
BH25	2,293	400303	6443757	22.75	6.00
BH28	3,553	401204	6442881	23.25	3.00

Note: The proposed additional bores are likely to be required to monitor groundwater quality during dewatering operations. The location and extent of the monitoring program may be modified once the construction method is finalised.

8.2.1 Groundwater Monitoring Pre-Construction

The groundwater results presented in Section 5 are considered to be baseline groundwater geochemistry at the time of reporting. It should be noted that groundwater geochemistry within the well sampled is likely to change between the time this report is prepared and the commencement of construction.

Groundwater monitoring will be undertaken of the existing groundwater wells (Table 17) and any additional re-installed monitoring wells considered appropriate for the construction program within four (4) weeks prior to construction and this will be considered the most representative baseline groundwater quality against which results collected during and post-construction will be assessed.

8.2.2 Groundwater Monitoring During Construction

Groundwater monitoring will be undertaken on a fortnightly basis (during dewatering only) in order to assess groundwater quality trends within monitoring bores located within 200m radius of the dewatering operations. Table 20 outlines a summary of the overall monitoring program.

8.2.3 Groundwater Monitoring Post-Construction

Three (3) groundwater monitoring events undertaken bi-monthly over six months will be undertaken once construction has been finalised, if dewatering extends beyond 4 weeks and/or deterioration of groundwater quality is noted. All bores monitored during dewatering operations will be included in the post construction monitoring program.

Table 20 Overall Groundwater Monitoring Program

Parameter	Frequency	Responsibility
Pre-Construction		
Groundwater Suite as outlined in Section 5.2.	Prior to site works commencing	Principal's Environmental Consultant
During Construction (Dewatering Periods Only)		
Groundwater Suite as outlined in Section 5.2.	Fortnightly during dewatering (unless dewatering quality deteriorates – refer to Trigger criteria outlined in Table 17	Contractor
Post-Construction		
Groundwater Suite as outlined in Section 5.2.	Post-Construction once construction and dewatering have ceased	Principal's Environmental Consultant

8.3 Groundwater Action Criteria

GHD recommends the following groundwater trigger criteria (Table 21) are implemented during monitoring events and during dewatering to assess groundwater quality trends and ensure groundwater quality is not degraded.

Table 21 Groundwater Trigger Criteria

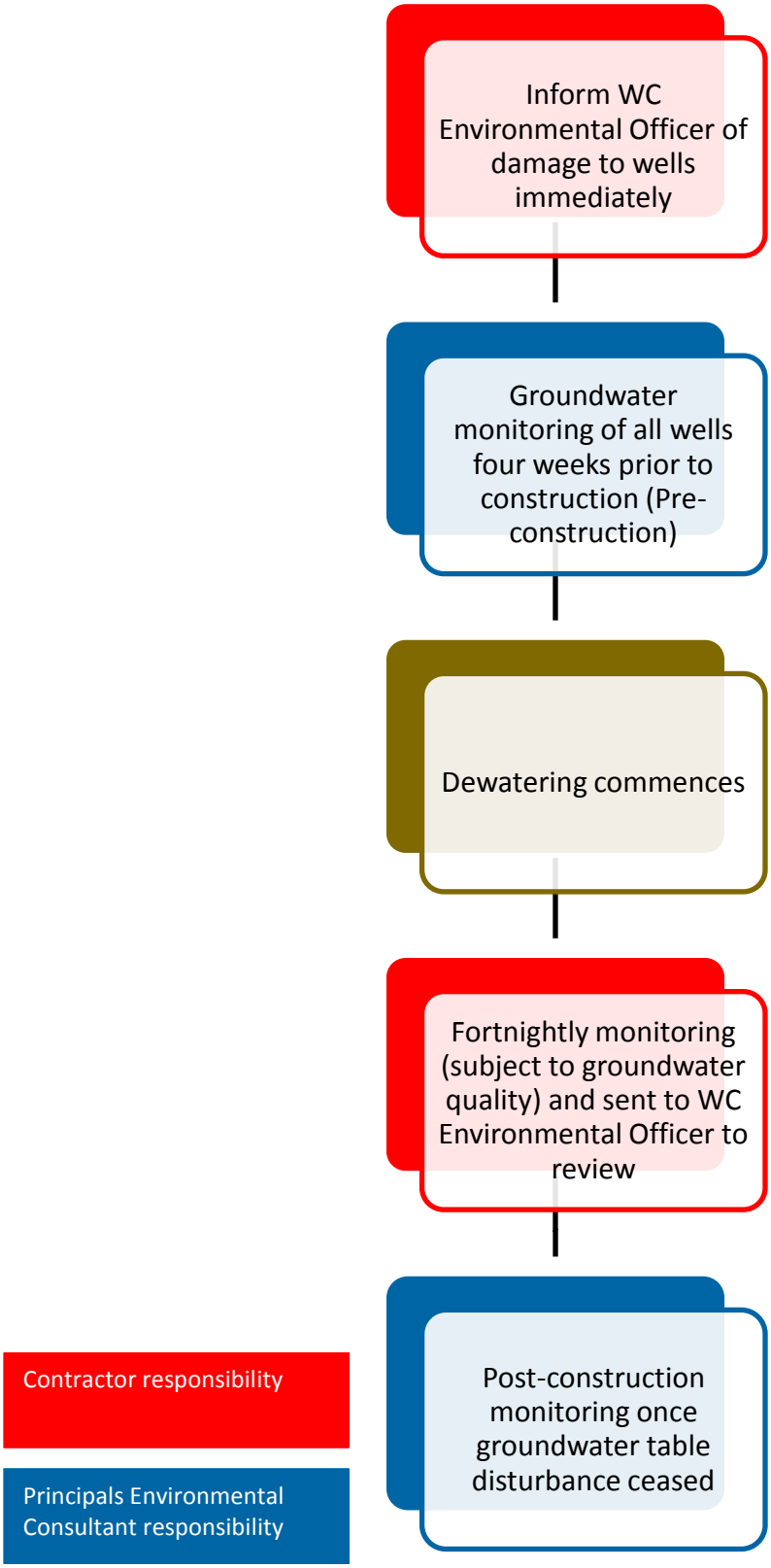
Analyte	Trigger Criteria	Responsibility	Determined From
pH	- 10% baseline value	WC Environmental Officer	Daily field results AND Fortnightly laboratory results
Total Acidity	>25% increase from the baseline value	WC Environmental Officer	Daily field results AND Fortnightly laboratory results
Soluble Aluminium	>1 mg/L (or >25% increase from the baseline value)	WC Environmental Officer	Fortnightly laboratory results
Soluble Iron	>1 mg/L (or >25% increase from the baseline value)	WC Environmental Officer	Fortnightly laboratory results

The pH and acidity will be compared to background results obtained from monitoring well baseline monitoring and the trigger values given in Table 21 (frequency of monitoring should be altered accordingly by the WC Environmental Officer).

The Flow Chart 3 provides a summary of the groundwater monitoring program and responsible parties for the monitoring.

Contingency measures outlined within Section 9 should be adhered to if the groundwater trigger criteria are exceeded.

Flow Chart 3 Summary of Groundwater Monitoring



9. Contingency Strategy

GHD recommends the following dewatering effluent and groundwater trigger criteria (Table 22) are implemented during monitoring of effluent:

Table 22 Dewatering Effluent Trigger Criteria

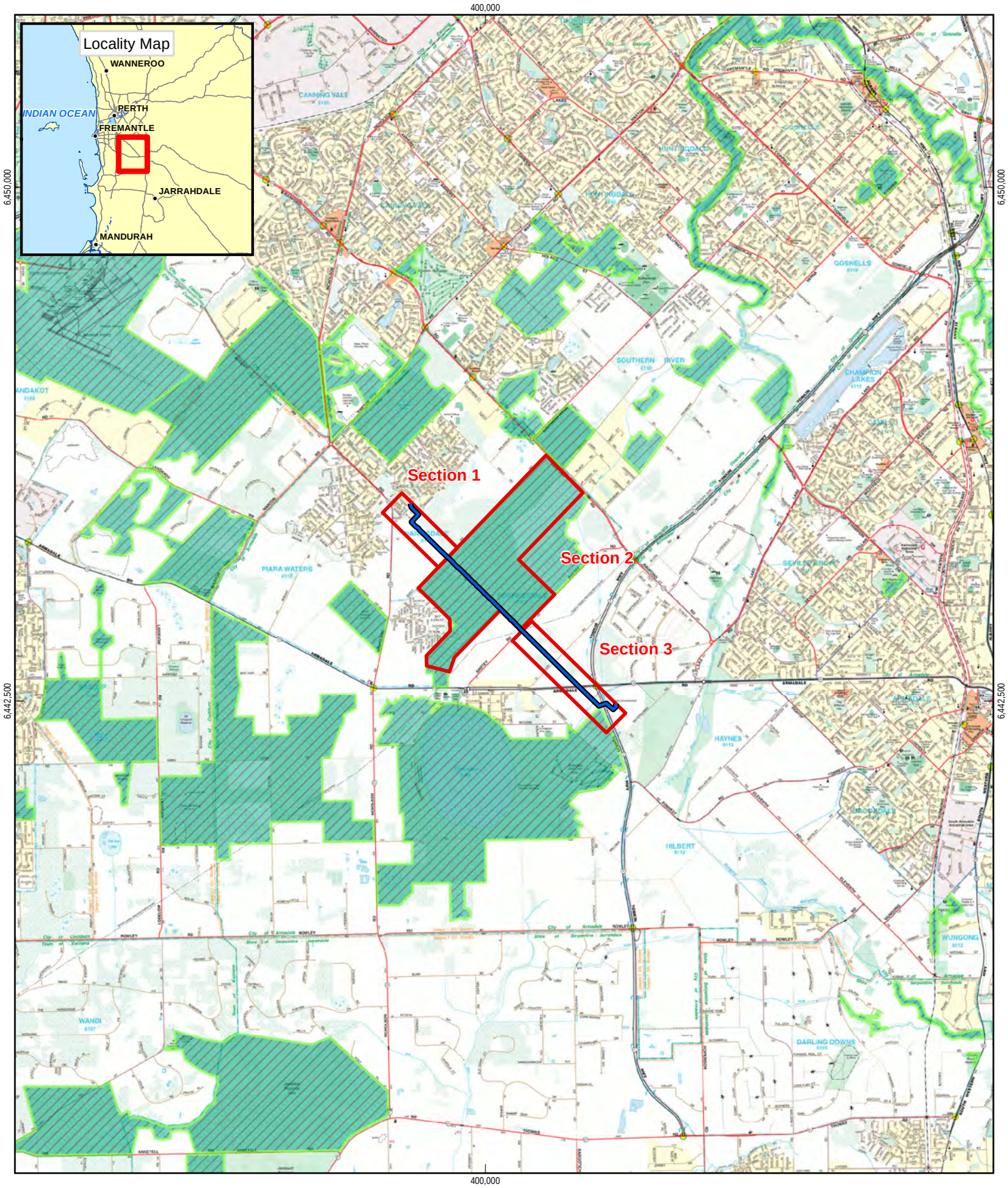
Analyte	Trigger Criteria	Responsibility	Determined From
pH	- 10% baseline value	Contractor	Daily field results AND Fortnightly laboratory results
Total Acidity	>25% increase from the baseline value	Contractor	Daily field results AND Fortnightly laboratory results
Soluble Aluminium	>1 mg/L (or >25% increase from the baseline value)	WC Environmental Officer	Fortnightly laboratory results
Soluble Iron	>1 mg/L (or >25% increase from the baseline value)	WC Environmental Officer	Fortnightly laboratory results

If any of the triggers in are exceeded, it is recommended that the dewatering operations are ceased (where practically possible) to avoid unnecessary environmental damage. If there is a significant delay between a trigger level being reached and the mitigation measures being implemented, this could result in unacceptable damage to groundwater quality and other sensitive receptors. The WC Environmental Officer may advise on the following contingency measures to take place:

- Commence/increase liming rates via the automated lime dosing unit;
- Employ the use of aeration/settlement tanks with geotextile fabric to remove total iron, aluminium and other metal floc;
- Implementation of longer settlement times (which may involve more settlement tanks to cater for areas requiring significant discharges);
- Implementation of increased aeration (for example, use of sprayer head);
- Modification of dewater effluent reinjection to limit drawdown in area of concern;
- Modification of the construction method (i.e. implementation of cut off walls to localise impact of dewatering and reduce the cone of depression).
- The WC Environmental Officer should be consulted if pH and total acidity trigger criteria in Table 16 are exceeded during dewatering.

Appendices

Appendix A - Figures



Legend

- Pressure Main
- Section
- Bush Forever

1: 75,000 (at A4)

0 375 750 1,500 2,250 3,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

Water Corporation
Keane Road Pressure Main
Draft Acid Sulfate Soil and Dewatering Management Plan

Job Number 61-29471
Revision 0
Date 17 Apr 2014

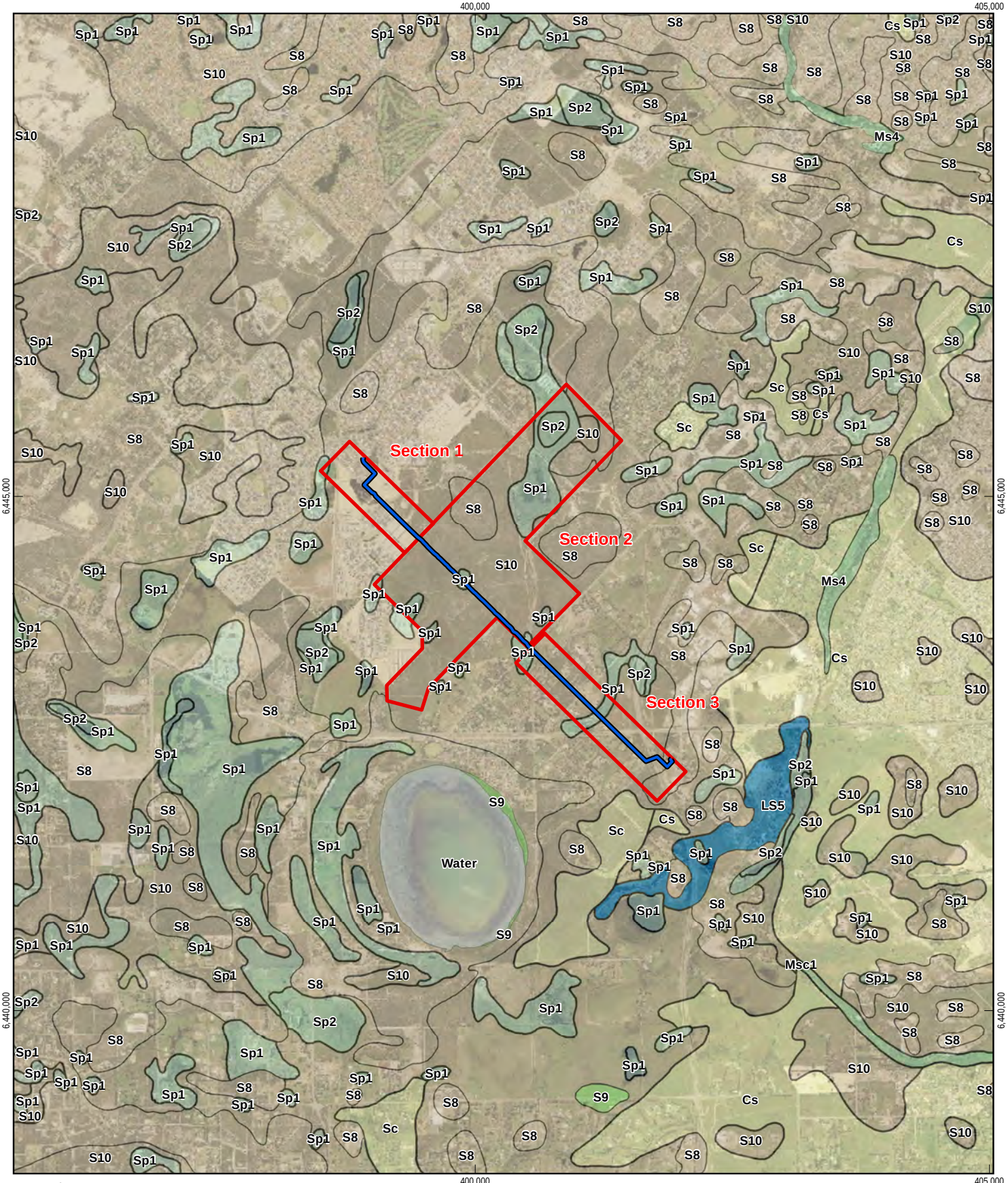
Locality Plan and Site Location

Figure 1

239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

G:\61\29471\GIS\Maps\MXD\6129471_G001_Rev0.mxd

Data source: GHD: Pressure Main - 20140415, Section - 20140415; DoP: Bush Forever - 20120301; GA: Topo 250k Series 3 - 2006; WC: Streetsmart Directory - 2011. Created by: mczekaj



Legend

Pressure Main

Section

Geology 50k

Sp1 - PEATY SAND - grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty, of lacustrine origin

Sp2 - PEAT-RICH SAND - fine to medium-grained quartz sand with much brown to black organic material, grades to peat, of lacustrine origin

Ms4 - SANDY SILY - cream to pale brown alluvium, clayey in part, fine to medium-grained sand, of alluvial origin

Msc1 - CLAYEY SANDY SILT - pale brown, angular to rounded sand, low cohesion, of alluvial origin

S9 -

LS5 - LIMESTONE - white to cream, fine-grained, algal lamination common

S8 - SAND - white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangul0ar to subrounded, minor heavy minerals, of eolian origin

S10 - SAND - as S8 over sandy clay to clayey sand of the Guildford Formation, of eolian origin

Sc -

Cs -

Water -

1: 50,000 (at A4)

0 250 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Water Corporation
Keane Road Pressure Main
Draft Acid Sulfate Soil and Dewatering Management Plan

Published Geological Information

Figure 2

Job Number	61-29471
Revision	0
Date	17 Apr 2014

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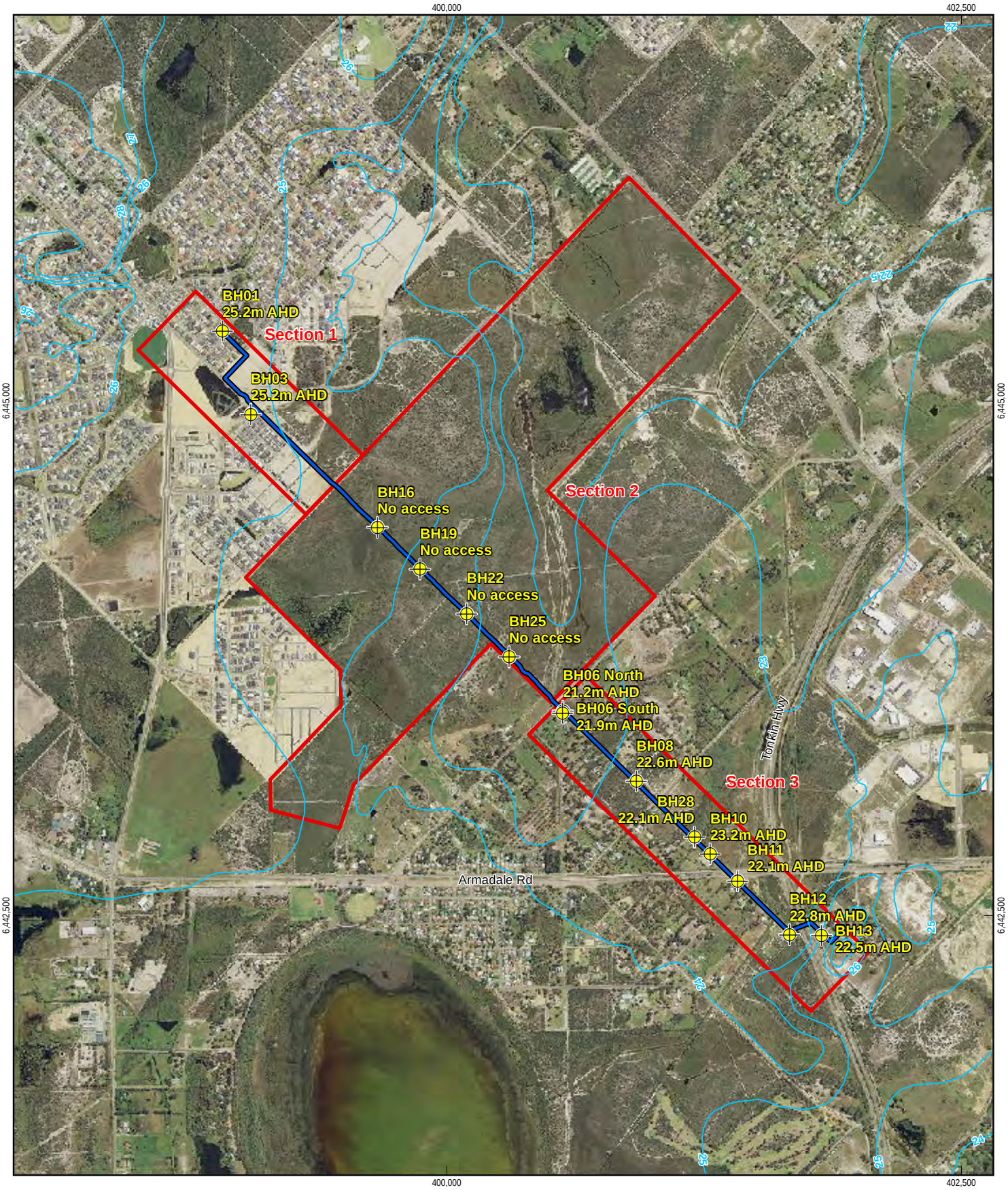
G:\61\29471\GIS\Maps\MXD\6129471_G002_Rev0.mxd

Data source: GHD: Pressure Main - 20140415, Section - 20140415; Landgate: Virtual Mosaic - 20140416; DMP: Geology 50k - 20120612. Created by: mczekaj



Legend

- Groundwater Well
- Groundwater Contours Maximum
- Pressure Main
- Section

1: 25,000 (at A4)

0 125 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Water Corporation
Keane Road Pressure Main
Draft Acid Sulfate Soil and Dewatering Management Plan
Maximum Groundwater Contours (Perth Groundwater Atlas) and August 2013 Groundwater Levels

Job Number	61-29471
Revision	0
Date	17 Apr 2014

Figure 3

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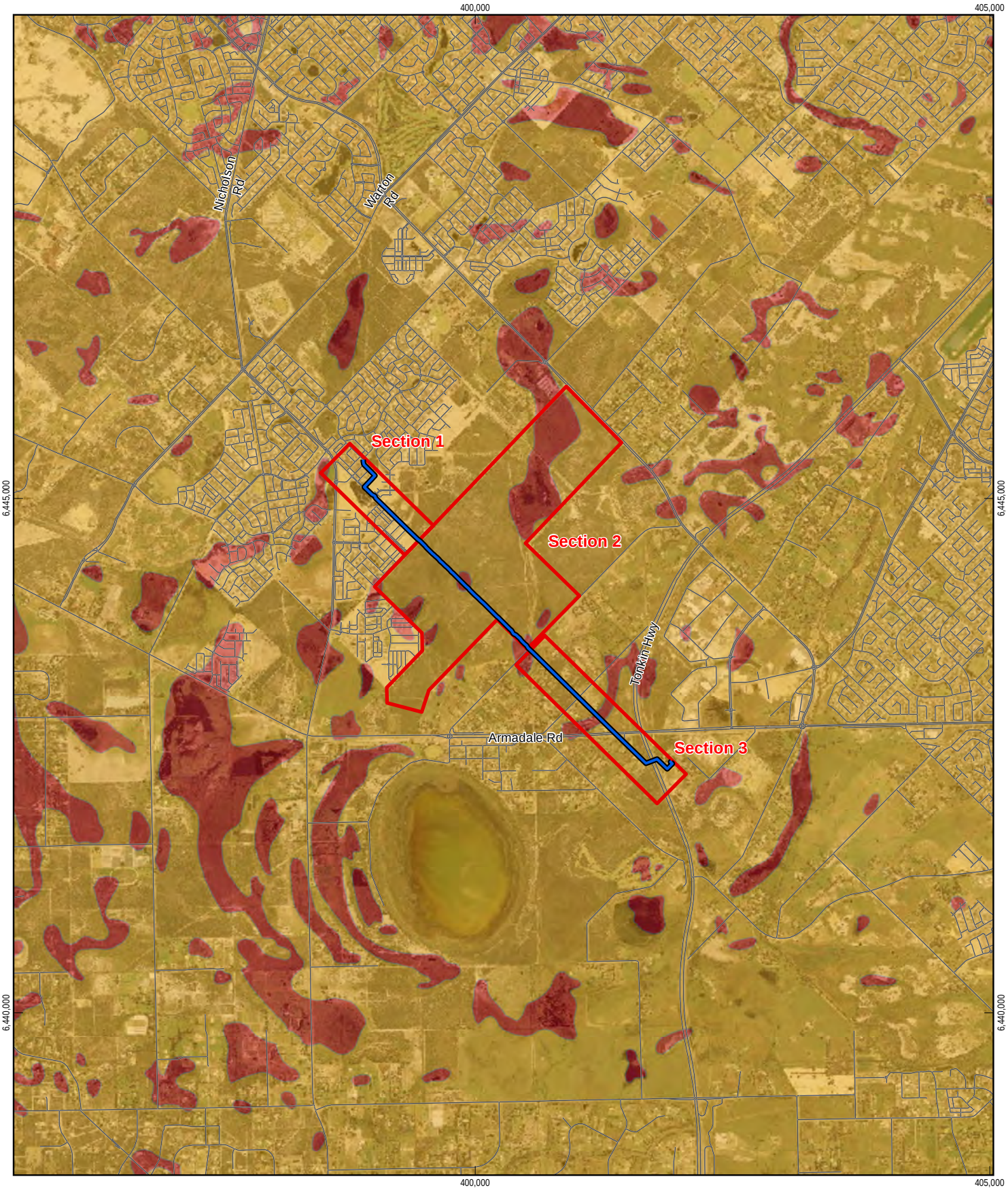
G:\61\29471\GIS\Maps\MXD\6129471_G003_Rev0.mxd

Data source: GHD: Pressure Main - 20140415, Section - 20140415, Groundwater Well - 20140416; DoW: Groundwater Contours Maximum - 20050725; Landgate: Virtual Mosaic - 20140416, Road Names - 20140416. Created by: mczekaj



Legend

- Pressure Main
- Section
- Road

Acid Sulfate Soil Risk

- Class 1 - High to moderate risk of ASS occurring within 3m of natural soil surface
- Class 2 - Moderate to low risk of ASS occuring within 3m of natural soil surface but high to moderate risk of ASS beyond 3m of natural soil surface

1: 50,000 (at A4)

0 250 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Water Corporation
Keane Road Pressure Main
Draft Acid Sulfate Soil and Dewatering Management Plan

Job Number 61-29471
Revision 0
Date 17 Apr 2014

Acid Sulfate Soil Risk Mapping

Figure 4

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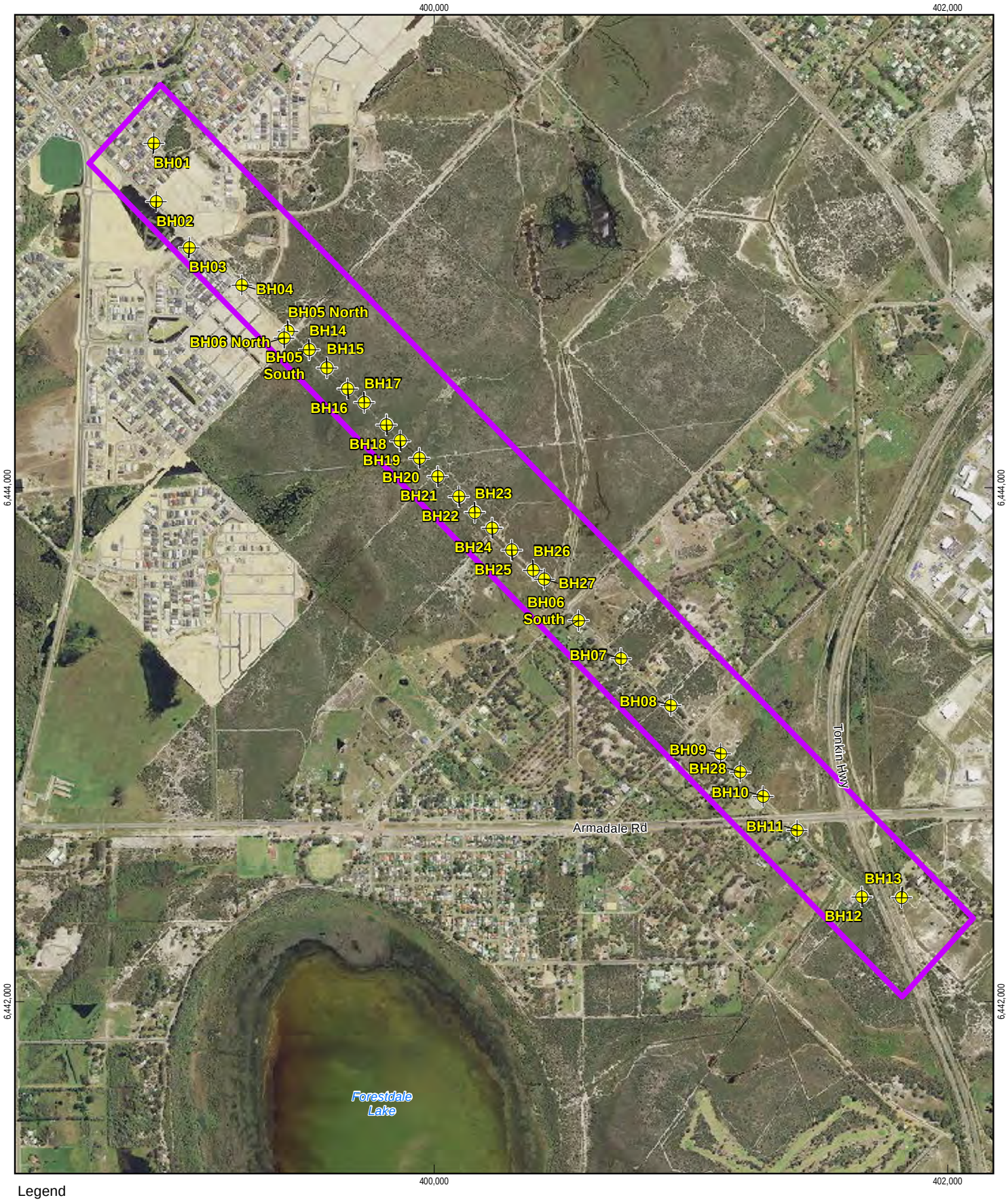
G:\61\29471\GIS\Maps\MXD\6129471_G004_Rev0.mxd

Data source: GHD: Pressure Main - 20140415, Section - 20140415; DEC: Acid Sulfate Soil Risk - 20120229; Landgate: Virtual Mosaic - 20140416, Road - 20140416. Created by: mczekaj



Legend

- Groundwater Well
- Balannup A WWPS and Keane Road Pressure Main Works Site

1: 20,000 (at A4)

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Water Corporation
Keane Road Pressure Main
Draft Acid Sulfate Soil and Dewatering Management Plan

Job Number 61-29471
Revision 0
Date 17 Apr 2014

Geotechnical and ASS Investigation Locations Figure 5

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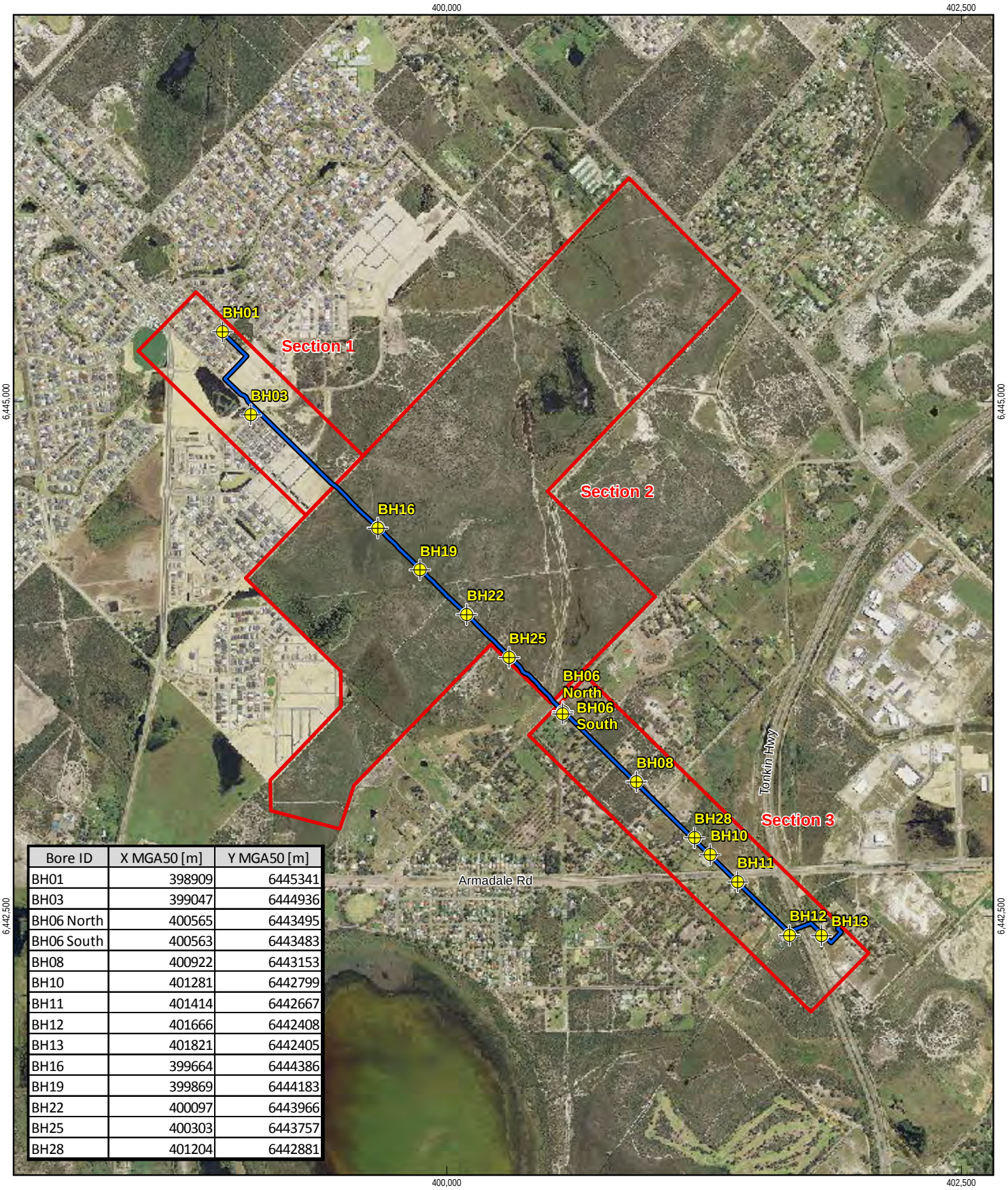
G:\61\29471\GIS\Maps\MXD\6129471_G005_Rev0.mxd

Data source: GHD: Balannup A WWPS and Keane Road Pressure Main Works Site - 20140415, Groundwater Well - 20140417; Landgate: Road Names - 20140416, Virtual Mosaic - 20140416. Created by: mczekaj



Bore ID	X MGA50 [m]	Y MGA50 [m]
BH01	398909	6445341
BH03	399047	6444936
BH06 North	400565	6443495
BH06 South	400563	6443483
BH08	400922	6443153
BH10	401281	6442799
BH11	401414	6442667
BH12	401666	6442408
BH13	401821	6442405
BH16	399664	6444386
BH19	399869	6444183
BH22	400097	6443966
BH25	400303	6443757
BH28	401204	6442881

Legend

Selected Groundwater Well

Section

Pressure Main

1: 25,000 (at A4)

0 125 250 500 750 1,000

Metres

Map Projection: Transverse Mercator

Horizontal Datum: Geocentric Datum of Australia

Grid: Map Grid of Australia 1994, Zone 50

N

Water Corporation

Keane Road Pressure Main

Draft Acid Sulfate Soil and Dewatering Management Plan

Groundwater Well Locations

Job Number 61-29471

Revision 0

Date 17 Apr 2014

Figure 6

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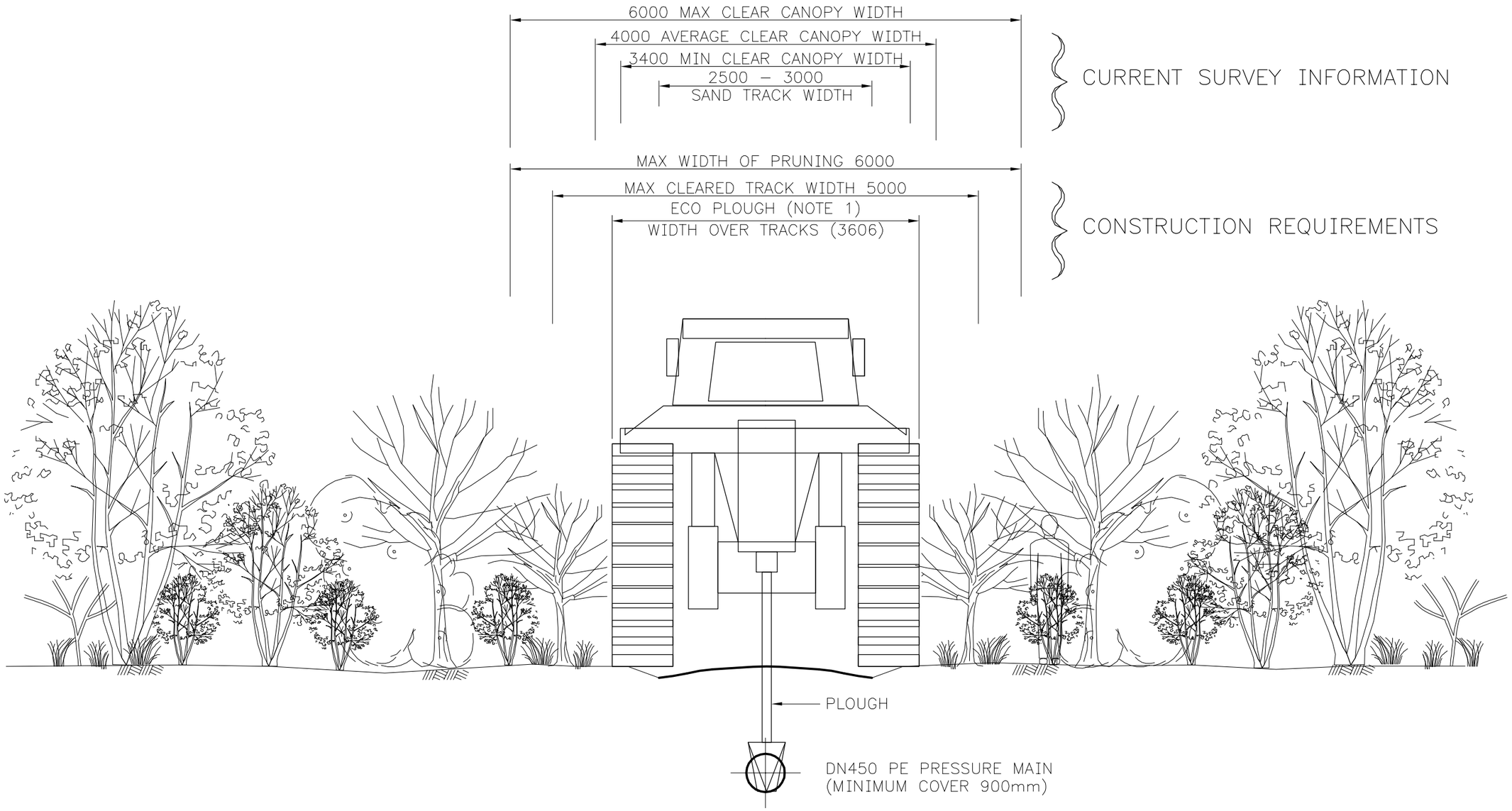
G:\61\29471\GIS\Maps\MXD\6129471_G006_Rev0.mxd

Data source: GHD: Pressure Main - 20140415, Section - 20140415, Selected Groundwater Well - 20140416; Landgate: Virtual Mosaic - 20140416, Road Names - 20140416. Created by: mczekaj

Appendix B – Preliminary Design Drawings



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FOR GENERAL NOTES REFER DRG HW91–2–13–1

NOTE
1. DIMENSIONS BASED ON CATERPILLAR D11

1000 500 0 1000 2000 3000 mm (1:50)

DES CALC E. BISHOP DES CHD G. DUNLOP	RECOMMENDED 06/02/2014 P.G. SPENCER (SIGNED) for CONSULTANT JOB MANAGER	METROPOLITAN WASTEWATER WAPC 127155 BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM DN450 PE PRESSURE MAIN – BUSH FOREVER AREA TYPICAL SECTION OF ECO PLOUGH THROUGH BUSH FOREVER AREA
DRN K.BOSMAN Q.C. CHD R. SPILLANE	APPROVED 06/02/2014 P.G. SPENCER (SIGNED) CONSULTANT PROJECT DIRECTOR	FILE JT1 201202141 VO1 · PLAN CAD HW91–2–13–2 · ISSUE A · PROJECT C–S01249

ORIGINAL SHEET SIZE A3

MF

283
394

61\29471\CADD\HW91\HW91–002–013–02A 06/02/2014

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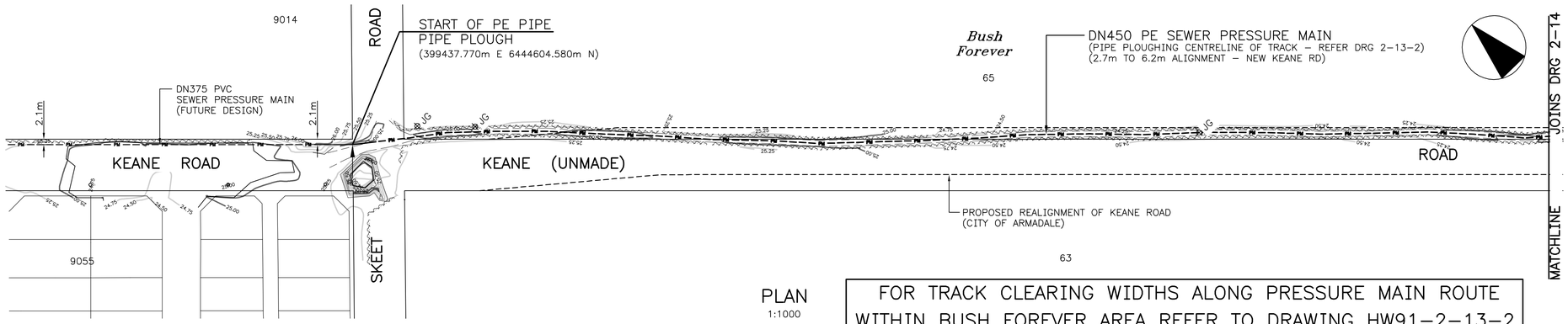
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	
EXISTING BUSHLINE	
JACKSONIA GRACILLIMA LOCATION	JG

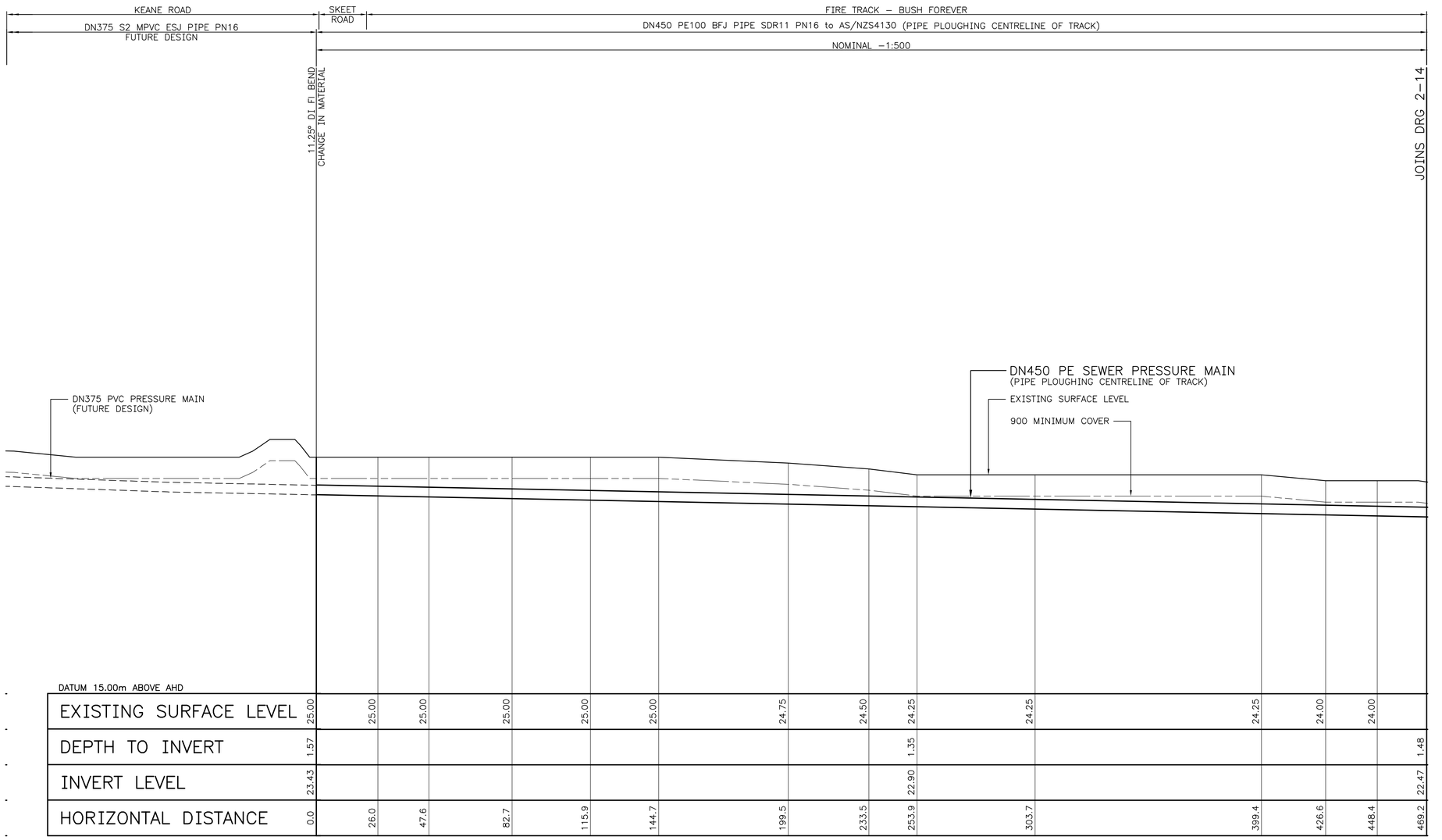
GENERAL NOTES

1. PRESSURE MAIN SHALL BE SET OUT AS SHOWN ON THE DRAWINGS WITH REAL TIME RECORDING OF ALIGNMENT GPS CO-ORDINATES, INCLUDING DEPTH, USING IN-VEHICLE ELECTRONIC EQUIPMENT.
2. NO DEVIATION FROM THE ALIGNMENT SHOWN IS ACCEPTABLE UNLESS APPROVED IN WRITING BY THE SUPERINTENDENT.
3. PRESSURE MAIN SHALL HAVE A MINIMUM DEPTH OF COVER OF 900mm.
4. PRESSURE MAIN SHALL BE LAID TO UNIFORM GRADE BETWEEN INVERT LEVELS SHOWN.
5. PRIOR TO CONSTRUCTION OF THE PRESSURE MAIN THE EXISTING DRAIN AS SHOWN ON DRAWING HW91-2-15 SHALL BE REMOVED TO 3 METRES EITHER SIDE OF THE TRACK CENTRELINE. THE DRAIN SHALL BE REINSTALLED AT ITS ORIGINAL LEVELS ON COMPLETION OF INSTALLATION OF THE PRESSURE MAIN.
6. PE PRESSURE MAIN TO BE AS/NZS4130, SERIES 1. PRESSURE MAIN PIPES TO BE COLOURED BLACK.
7. DEFLECTION AT BENDS SHALL BE ACHIEVED BY BENDING THE PIPE IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
8. PE PIPES SHALL BE BUTT FUSION WELDED.
9. NO CONSTRUCTION OR LAYDOWN AREAS TO BE CREATED WITHIN THE 'BUSH FOREVER' AREA OTHER THAN WITHIN THE APPROVED CLEARED TRACK ALIGNMENT.
10. NO CLEARING OR DAMAGE TO BUSHLAND SHALL OCCUR OUTSIDE THE APPROVED CLEARED TRACK ALIGNMENT WITHIN THE 'BUSH FOREVER' AREA.
11. JACKSON GRACILLIMA, AS LOCATED ON THE PLANS, ARE NOT TO BE REMOVED OR DAMAGED DURING CONSTRUCTION.
12. ANY CONSTRAINTS TO CONSTRUCTION OR DAMAGE TO EXISTING FLORA TO BE REPORTED IMMEDIATELY TO THE SUPERINTENDENT.
13. NO DEWATERING OR OPEN TRENCHING (OTHER THAN DRAIN CROSSING INDICATED ON DRG 2-15) TO BE CARRIED OUT WITHIN THE BUSH FOREVER AREA.



PLAN
1:1000

FOR TRACK CLEARING WIDTHS ALONG PRESSURE MAIN ROUTE WITHIN BUSH FOREVER AREA REFER TO DRAWING HW91-2-13-2



DATUM 15.00m ABOVE AHD

EXISTING SURFACE LEVEL	25.00	25.00	25.00	25.00	25.00	25.00	24.75	24.50	24.25	24.25	24.25	24.00	24.00	
DEPTH TO INVERT	1.57								1.35					1.48
INVERT LEVEL	23.43								22.90					22.47
HORIZONTAL DISTANCE	0.0	26.0	47.6	82.7	115.9	144.7	199.5	233.5	253.9	303.7	399.4	426.6	448.4	469.2

LONGITUDINAL SECTION

HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)

10.5 0 1 2 3 4 5 6 7 m (1:100)

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC E. BISHOP	NORTH POINT
	COORDINATE SYS MGA94-50	DES CHD G. DUNLOP	
ASCON SURVEY NONE	DES REF GHD 61-29471	DRN K.BOSMAN	
		Q.C. CHD R.SPILLANE	

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RECOMMENDED	06/02/2014
P.G. SPENCER (SIGNED)	
for CONSULTANT JOB MANAGER	
APPROVED	06/02/2014
P.G. SPENCER (SIGNED)	
CONSULTANT PROJECT DIRECTOR	

WATER CORPORATION

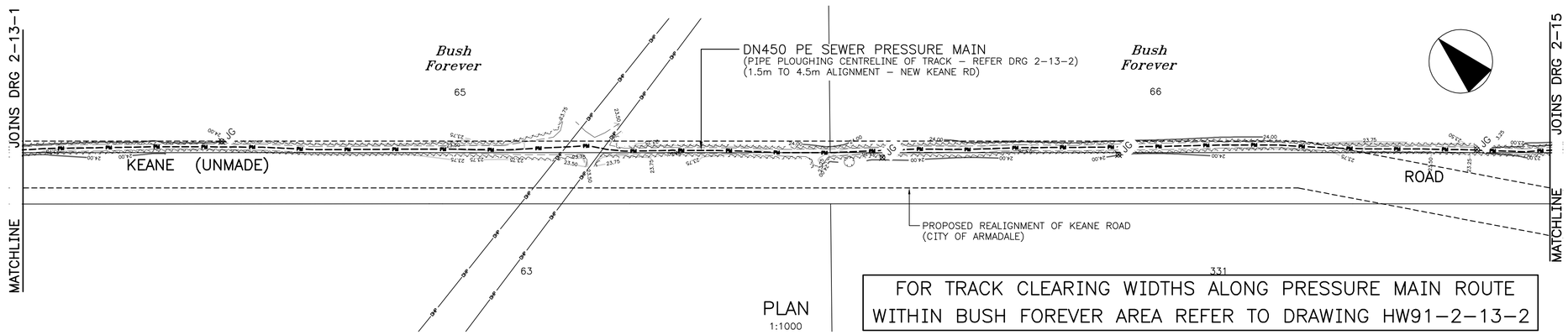
METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
DN450 PE PRESSURE MAIN - BUSH FOREVER AREA
PLAN AND LONGITUDINAL SECTION - SHEET 1 OF 3

FILE JT1 201202141 V01	PLAN HW91-2-13-1	CAD	ISSUE A
PROJECT C-S01249			MF

ORIGINAL SHEET SIZE A1

566
810

61\29471\CADD\HW91\HW91-002-013-01A 06/02/2014



PLAN
1:1000

FOR TRACK CLEARING WIDTHS ALONG PRESSURE MAIN ROUTE WITHIN BUSH FOREVER AREA REFER TO DRAWING HW91-2-13-2

DIAL BEFORE YOU DIG www.1100.com.au

NOTE:
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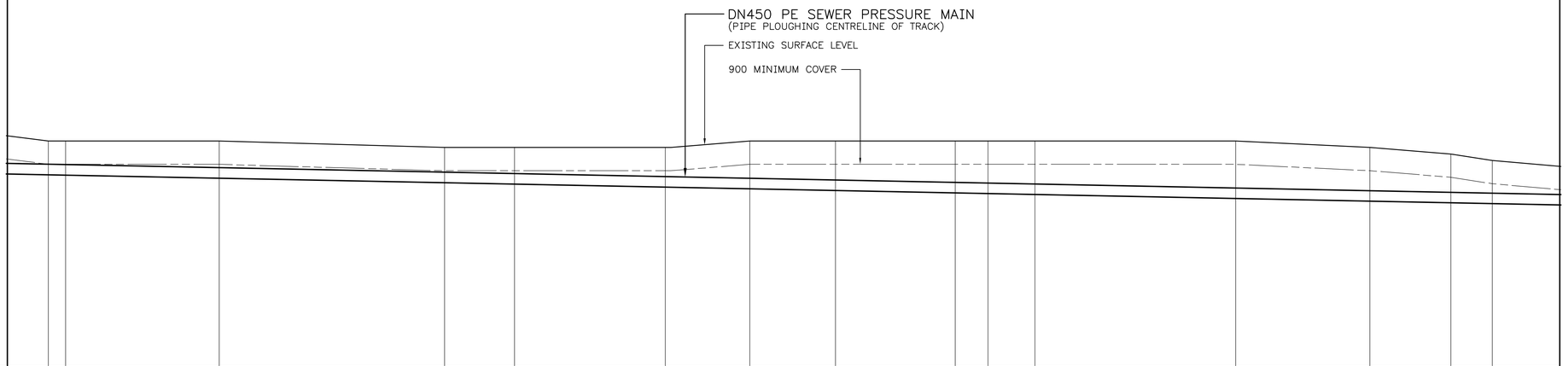
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	
EXISTING BUSHLINE	
JACKSONIA GRACILLIMA LOCATION	JG

FOR GENERAL NOTES REFER DRG HW91-2-13-1

FIRE TRACK – BUSH FOREVER
DN450 PE100 BFJ PIPE SDR11 PN16 to AS/NZS4130 (PIPE PLOUGHING CENTRELINE OF TRACK)
NOMINAL –1:500



DATUM 15.00m ABOVE AHD

EXISTING SURFACE LEVEL		23.75	23.75	23.75	23.50	23.50	23.50	23.75	23.75	23.75	23.75	23.75	23.75	23.50	23.25	23.00	22.77			
DEPTH TO INVERT	1.48	1.31															1.50			
INVERT LEVEL	22.47	22.44															21.27			
HORIZONTAL DISTANCE	469.2	485.0	491.6	551.0	638.9	665.2	723.5	756.1	789.3	835.5	848.3	866.3	944.0	995.8	1027.1	1043.2	1069.2			

LONGITUDINAL SECTION
HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)
10.5 0 1 2 3 4 5 6 7 m (1:100)

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY: GHD 2661551 V01
ASCON SURVEY: NONE
VERTICAL DATUM: AHD
COORDINATE SYS: MGA94-50
DES REF: GHD 61-29471
DES CALC: E. BISHOP
DES CHD: G. DUNLOP
DRN: K.BOSMAN
Q.C. CHD: R.SPILLANE
NORTH POINT

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E permail@ghd.com.au W www.ghd.com.au

RECOMMENDED 06/02/2014
P.G. SPENCER (SIGNED)
for CONSULTANT JOB MANAGER
APPROVED 06/02/2014
P.G. SPENCER (SIGNED)
CONSULTANT PROJECT DIRECTOR

WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 – COLLARED ST & PM
DN450 PE PRESSURE MAIN – BUSH FOREVER AREA
PLAN AND LONGITUDINAL SECTION – SHEET 2 OF 3

FILE JT1 201202141 V01
PROJECT C-S01249
PLAN HW91-2-14
CAD
ISSUE A
ORIGINAL SHEET SIZE A1
MF

566
810

61\29471\CADD\HW91\HW91-002-014-01A 06/02/2014

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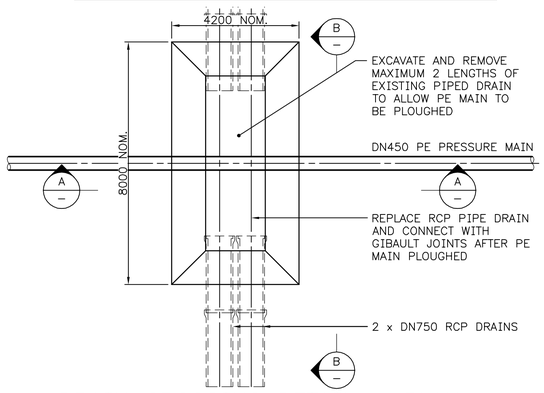
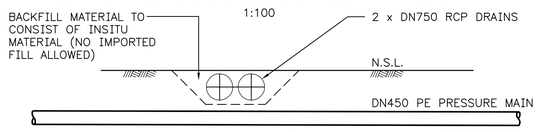
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	
EXISTING BUSHLINE	
JACKSONIA GRACILLIMA LOCATION	JG

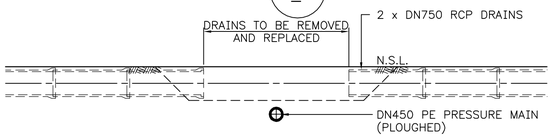
FOR GENERAL NOTES REFER DRG HW91–2–13–1



DRAIN CROSSING DETAIL – PLAN
1:100



SECTION A



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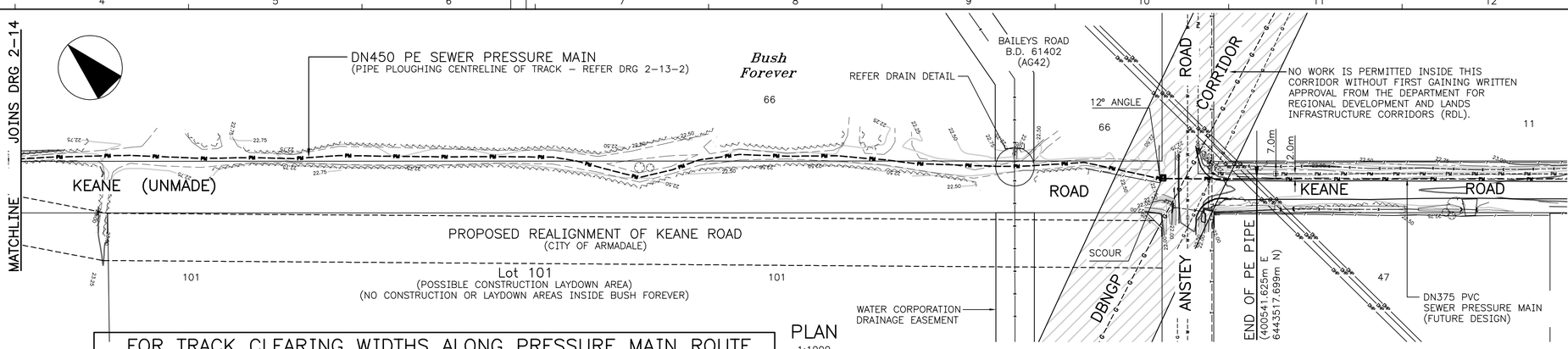
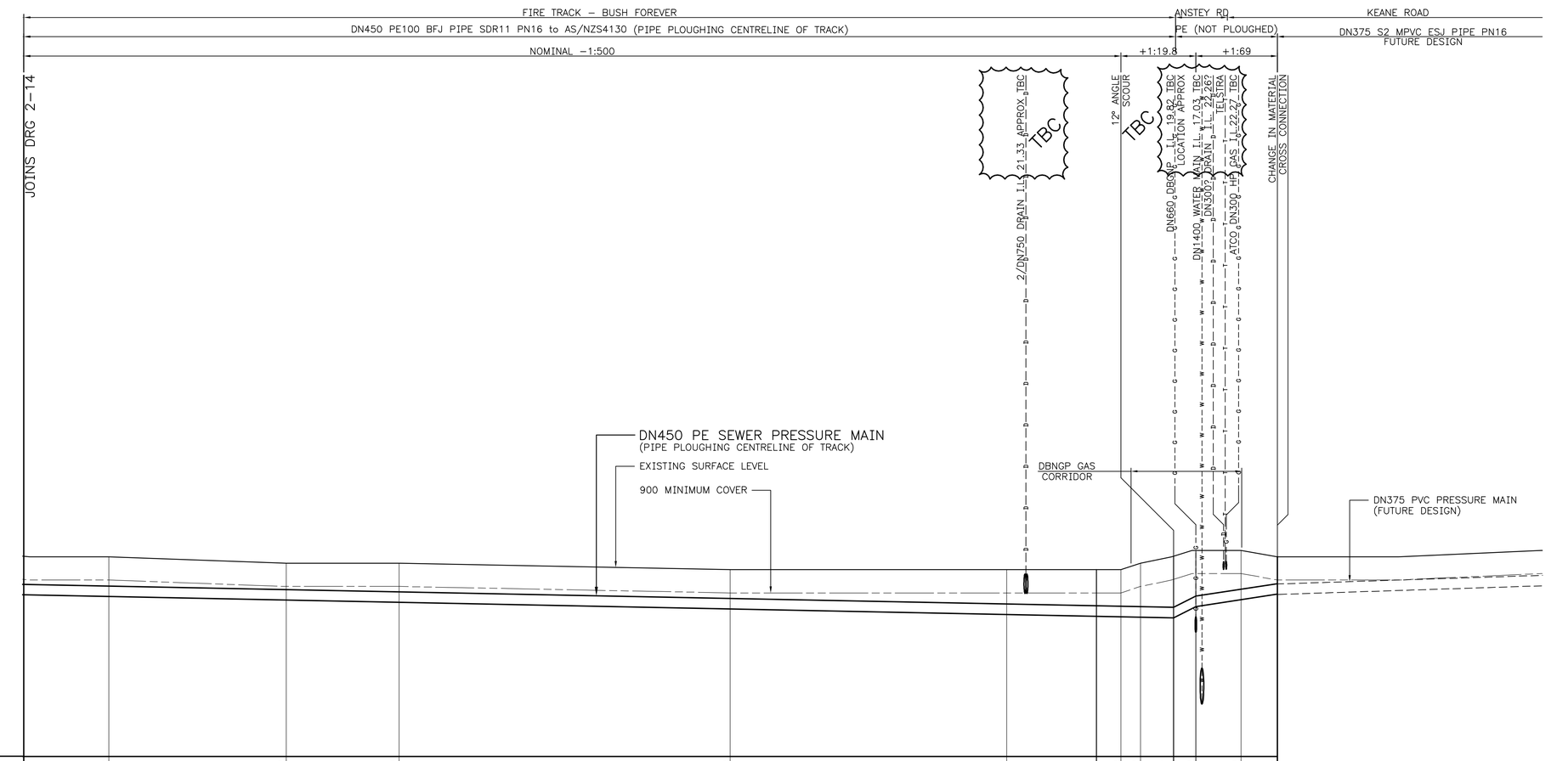


PLAN
1:1000

FOR TRACK CLEARING WIDTHS ALONG PRESSURE MAIN ROUTE WITHIN BUSH FOREVER AREA REFER TO DRAWING HW91–2–13–2



DATUM 15.00m ABOVE AHD

EXISTING SURFACE LEVEL	22.77	22.75	22.50	22.50	22.25	22.25		22.25	22.50	22.77	23.00	23.00	22.75
DEPTH TO INVERT	1.50		1.43							2.39	2.18		1.45
INVERT LEVEL	21.27		21.07							20.38	20.82		21.30
HORIZONTAL DISTANCE	1069.2	1102.2	1171.1	1214.9	1343.5	1450.8	1485.7	1495.2	1502.8	1515.7	1522.8	1541.9	1556.0

LONGITUDINAL SECTION
HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)
10.5 0 1 2 3 4 5 6 7 m (1:100)

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01
ASCON SURVEY NONE
VERTICAL DATUM AHD
COORDINATE SYS MGA94–50
DES REF GHD 61–29471
DES CALC E. BISHOP
DES CHD G. DUNLOP
DRN K.BOSMAN
Q.C. CHD R.SPILLANE
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WATER CORPORATION

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BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM
DN450 PE PRESSURE MAIN – BUSH FOREVER AREA
PLAN AND LONGITUDINAL SECTION – SHEET 3 OF 3

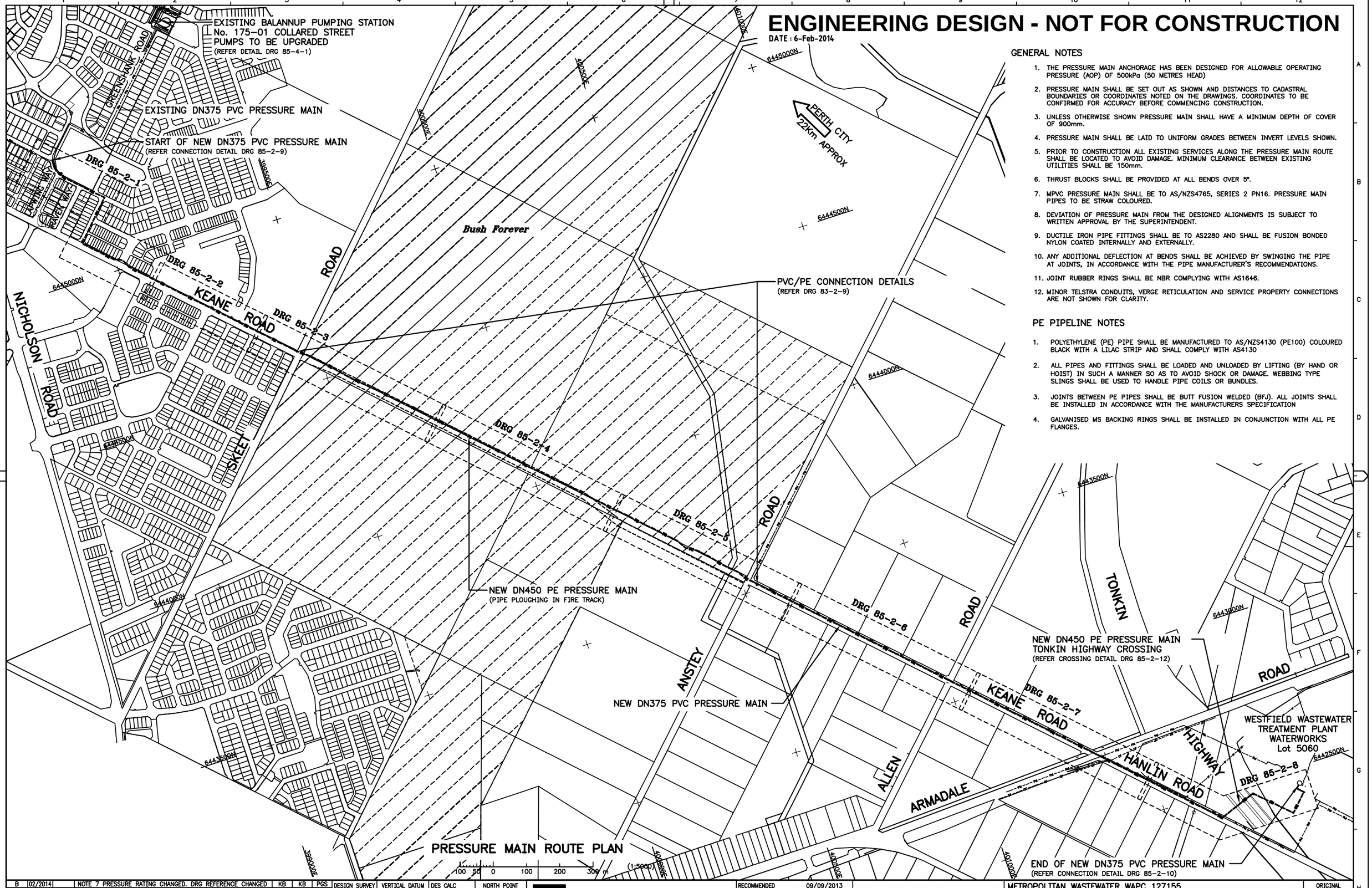
FILE JT1 201202141 V01
PROJECT C–S01249
PLAN HW91–2–15
CAD
ISSUE A
ORIGINAL SHEET SIZE A1
MF

566
810

61\29471\CADD\HW91\HW91–002–015–01A 06/02/2014

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

DATE : 6-Feb-2014



GENERAL NOTES

1. THE PRESSURE MAIN ANCHORAGE HAS BEEN DESIGNED FOR ALLOWABLE OPERATING PRESSURE (AOP) OF 500kPa (50 METRES HEAD)
2. PRESSURE MAIN SHALL BE SET OUT AS SHOWN AND DISTANCES TO CADASTRAL BOUNDARIES OR COORDINATES NOTED ON THE DRAWINGS. COORDINATES TO BE CONFIRMED FOR ACCURACY BEFORE COMMENCING CONSTRUCTION.
3. UNLESS OTHERWISE SHOWN PRESSURE MAIN SHALL HAVE A MINIMUM DEPTH OF COVER OF 900mm.
4. PRESSURE MAIN SHALL BE LAID TO UNIFORM GRADES BETWEEN INVERT LEVELS SHOWN.
5. PRIOR TO CONSTRUCTION ALL EXISTING SERVICES ALONG THE PRESSURE MAIN ROUTE SHALL BE LOCATED TO AVOID DAMAGE. MINIMUM CLEARANCE BETWEEN EXISTING UTILITIES SHALL BE 150mm.
6. THRUST BLOCKS SHALL BE PROVIDED AT ALL BENDS OVER 5°.
7. MPVC PRESSURE MAIN SHALL BE TO AS/NZS4765, SERIES 2 PN16. PRESSURE MAIN PIPES TO BE STRAW COLOURED.
8. DEVIATION OF PRESSURE MAIN FROM THE DESIGNED ALIGNMENTS IS SUBJECT TO WRITTEN APPROVAL BY THE SUPERINTENDENT.
9. DUCTILE IRON PIPE FITTINGS SHALL BE TO AS2280 AND SHALL BE FUSION BONDED NYLON COATED INTERNALLY AND EXTERNALLY.
10. ANY ADDITIONAL DEFLECTION AT BENDS SHALL BE ACHIEVED BY SWINGING THE PIPE AT JOINTS, IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS.
11. JOINT RUBBER RINGS SHALL BE NBR COMPLYING WITH AS1646.
12. MINOR TELSTRA CONDUITS, VERGE RETICULATION AND SERVICE PROPERTY CONNECTIONS ARE NOT SHOWN FOR CLARITY.

PE PIPELINE NOTES

1. POLYETHYLENE (PE) PIPE SHALL BE MANUFACTURED TO AS/NZS4130 (PE100) COLOURED BLACK WITH A LILAC STRIP AND SHALL COMPLY WITH AS4130
2. ALL PIPES AND FITTINGS SHALL BE LOADED AND UNLOADED BY LIFTING (BY HAND OR HOIST) IN SUCH A MANNER SO AS TO AVOID SHOCK OR DAMAGE. WEBBING TYPE SLINGS SHALL BE USED TO HANDLE PIPE COILS OR BUNDLES.
3. JOINTS BETWEEN PE PIPES SHALL BE BUTT FUSION WELDED (BFJ). ALL JOINTS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATION
4. GALVANISED MS BACKING RINGS SHALL BE INSTALLED IN CONJUNCTION WITH ALL PE FLANGES.

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD
B	02/2014		NOTE 7 PRESSURE RATING CHANGED. DRG REFERENCE CHANGED	KB	KB	PGS

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM NONE	DES CALC K.BOSMAN
	COORDINATE SYS MGA94-50	DES CHD P.SPENCER
ASCON SURVEY NONE	DES REF GHD 61-29471	DRN K.BOSMAN
		Q.C. CHD R.SPILLANE

NORTH POINT

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G. DUNLOP (SIGNED)	
CONSULTANT JOB MANAGER	
APPROVED	09/09/2013
P.G. SPENCER (SIGNED)	
CONSULTANT PROJECT DIRECTOR	

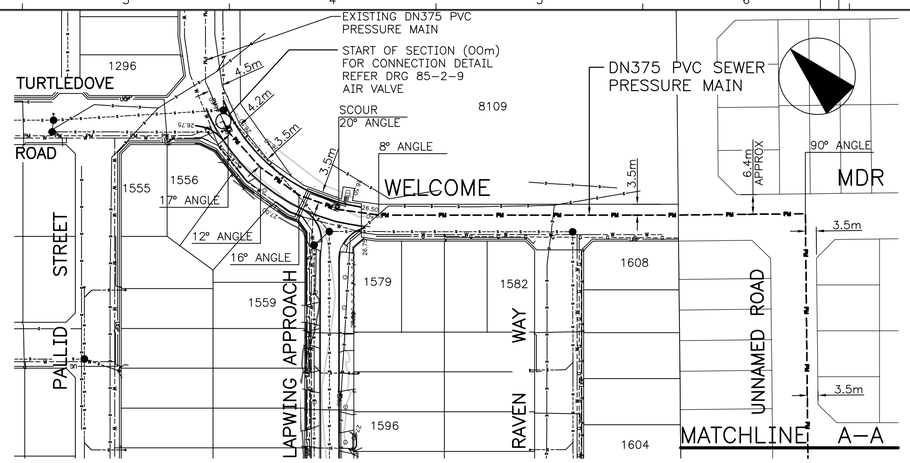
WATER CORPORATION

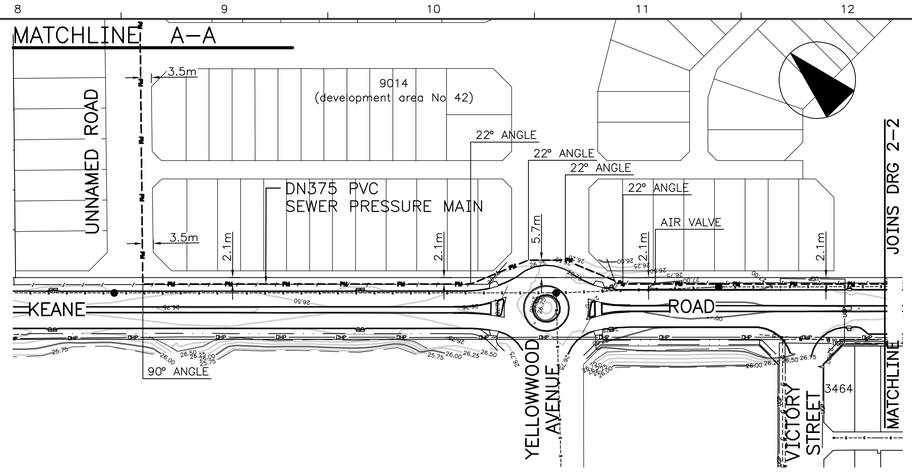
METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
ROUTE PLAN AND GENERAL NOTES

FILE	PLAN	CAD	ISSUE	ORIGINAL SHEET SIZE
PROJECT C-S01249	HW91-85-1-1		B	A1
				MF

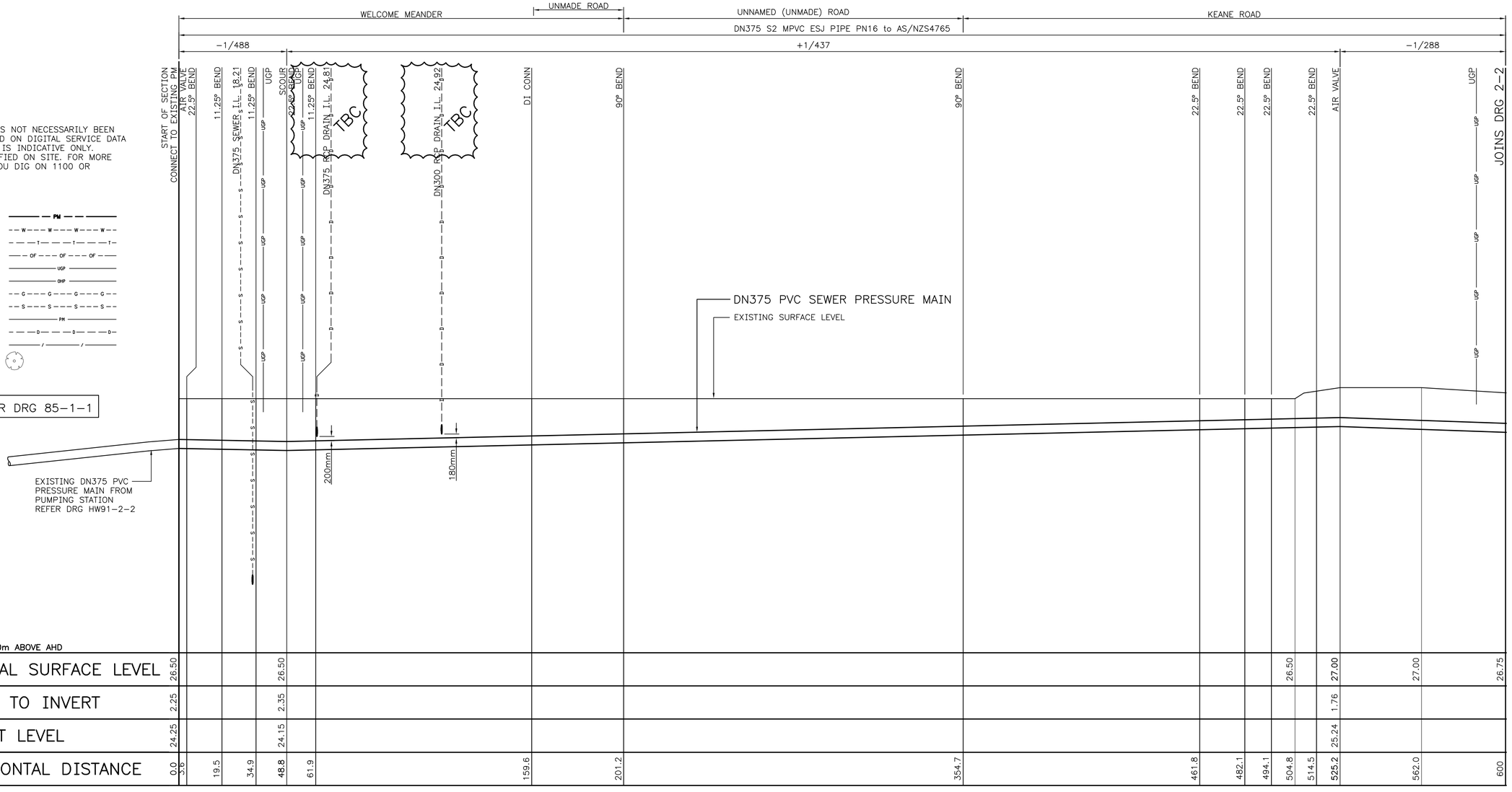
566
810

61\29471\CADD\HW91\HW91-085-001-01B 06/02/2014





PLAN
1:1000



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LEGEND

- PROPOSED SEWER PRESSURE MAIN — PM —
- EXISTING WATER MAINS — W —
- EXISTING TELECOMMUNICATION CABLES — T —
- EXISTING OPTIC FIBRE — OF —
- EXISTING UNDERGROUND POWER — UGP —
- EXISTING OVERHEAD POWER — OHP —
- EXISTING GAS MAINS — G —
- EXISTING SEWER MAINS — S —
- EXISTING SEWER PRESSURE MAINS — PM —
- EXISTING DRAINAGE — D —
- EXISTING FENCE — / —
- EXISTING TREE

FOR GENERAL NOTES REFER DRG 85-1-1

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION

HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)

10 5 0 1 2 3 4 5 6 7 m (1:100)

DATE : 10-Sep-2013

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC K.BOSMAN
	COORDINATE SYS MGA94-50	DES CHD P.SPENCER
ASCON SURVEY NONE	DES REF GHD 61-29471	DRN K.BOSMAN
		Q.C. CHD R.SPILLANE

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WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION - SHEET 1 OF 8

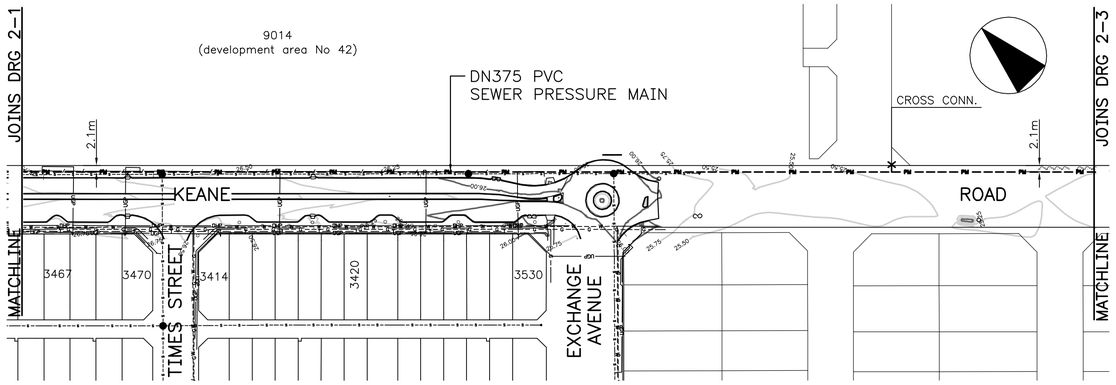
FILE	PLAN	CAD	ISSUE
PROJECT C-S01249	HW91-85-2-1		A

ORIGINAL SHEET SIZE A1

MF

566
810

61\29471\CADD\HW91\HW91-085-002-01A 10/09/2013



PLAN
1:1000

DIAL BEFORE YOU DIG
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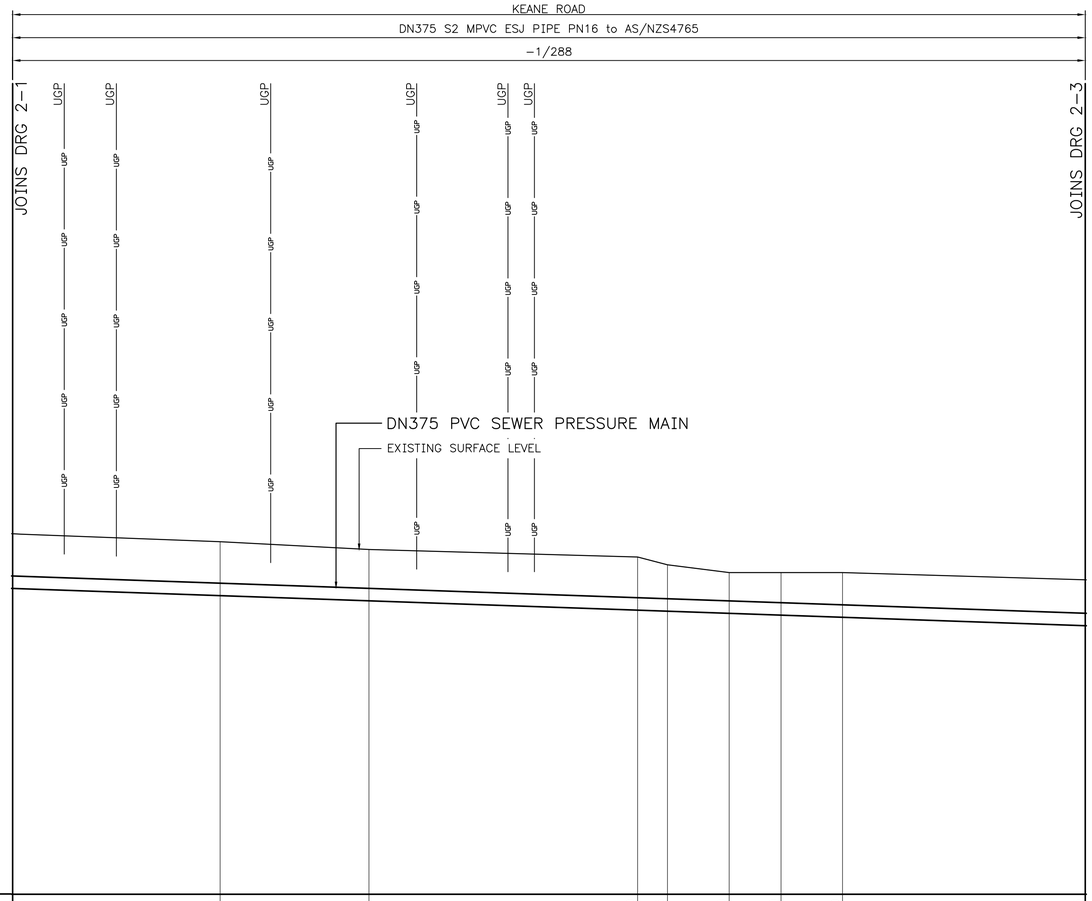
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	

FOR GENERAL NOTES REFER DRG 85-1-1



DATUM 15.00m ABOVE AHD

NATURAL SURFACE LEVEL	26.75	26.50	26.25	26.00	25.75	25.50	25.50	25.50	25.25
DEPTH TO INVERT									
INVERT LEVEL									
HORIZONTAL DISTANCE	600	667.7	716.3	804.0	813.7	833.8	850.8	870.8	950

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION
HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)
10 5 0 1 2 3 4 5 6 7 m (1:100)

DATE : 10-Sep-2013

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC K.BOSMAN
	COORDINATE SYS MGA94-50	DES CHD P.SPENCER
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WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION - SHEET 2 OF 8

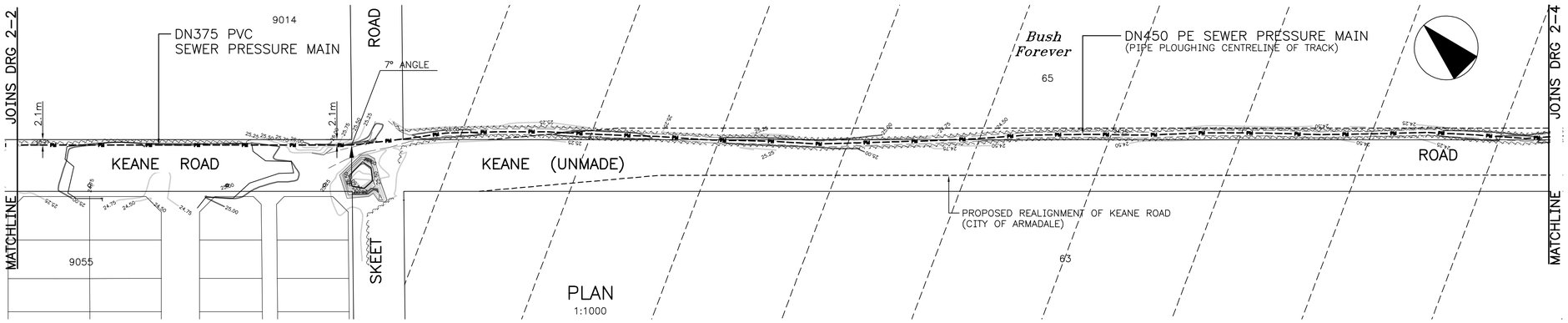
FILE	PLAN	CAD	ISSUE
PROJECT C-S01249	HW91-85-2-2		A

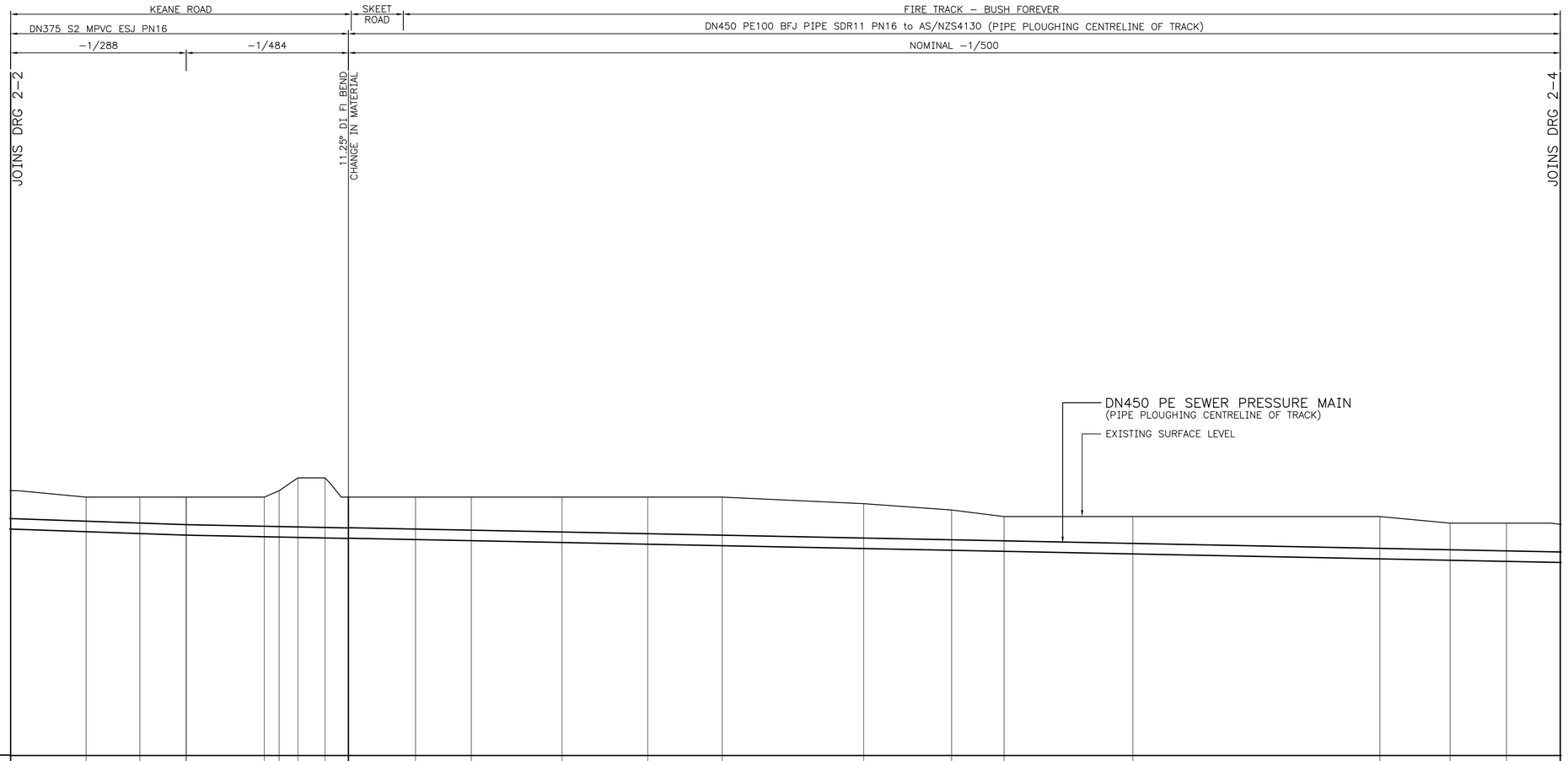
ORIGINAL SHEET SIZE A1

MF

566
810

61\29471\CADD\HW91\HW91-085-002-02A 10/09/2013





DIAL BEFORE YOU DIG www.1100.com.au

NOTE:
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LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	

FOR GENERAL NOTES REFER DRG 85-1-1

DATUM 15.00m ABOVE AHD

NATURAL SURFACE LEVEL	25.25	25.00	25.00	25.00	25.00	25.25	25.75	25.75	25.00	25.00	25.00	25.00	25.00	25.00	24.75	24.50	24.25	24.25	24.25	24.00	24.00												
DEPTH TO INVERT				1.47					1.60	1.57																							
INVERT LEVEL				23.53					23.40	23.43																							
HORIZONTAL DISTANCE	950	979.2	1000.0	1017.9	1048.2	1053.9	1061.2	1071.7	1080.8		1106.8	1128.4	1156.9	1163.5	1196.7	1225.5	1280.3	1314.3	1334.7	1384.5	1480.2	1507.4	1529.2	1550										

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION

HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)

10 5 0 1 2 3 4 5 6 7 m (1:100)

DATE : 10-Sep-2013

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC G.DUNLOP	NORTH POINT
	COORDINATE SYS MGA94-50	DES CHD P.SPENCER	
ASCON SURVEY NONE	DES REF GHD 61-29471	DRN K.BOSMAN	
		Q.C. CHD R.SPILLANE	

GHD House, 239 Adelaide Terrace, Perth WA 6004 Australia
T 61 8 6222 8222 F 61 8 6222 8555
E permail@ghd.com.au W www.ghd.com.au

RECOMMENDED 09/09/2013	G. DUNLOP (SIGNED)
CONSULTANT JOB MANAGER	
APPROVED 09/09/2013	P.G. SPENCER (SIGNED)
CONSULTANT PROJECT DIRECTOR	

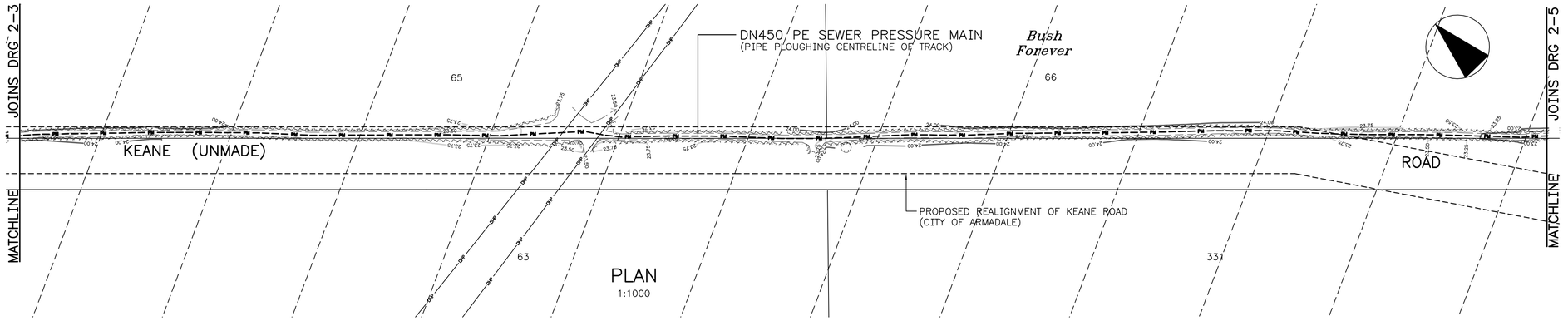
WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION – SHEET 3 OF 8

FILE	PLAN	CAD	ISSUE	ORIGINAL SHEET SIZE
PROJECT C-S01249	HW91-85-2-3		A	A1
				MF

566
810

61\29471\CADD\HW91\HW91-085-002-03A 10/09/2013



DIAL BEFORE YOU DIG www.1100.com.au

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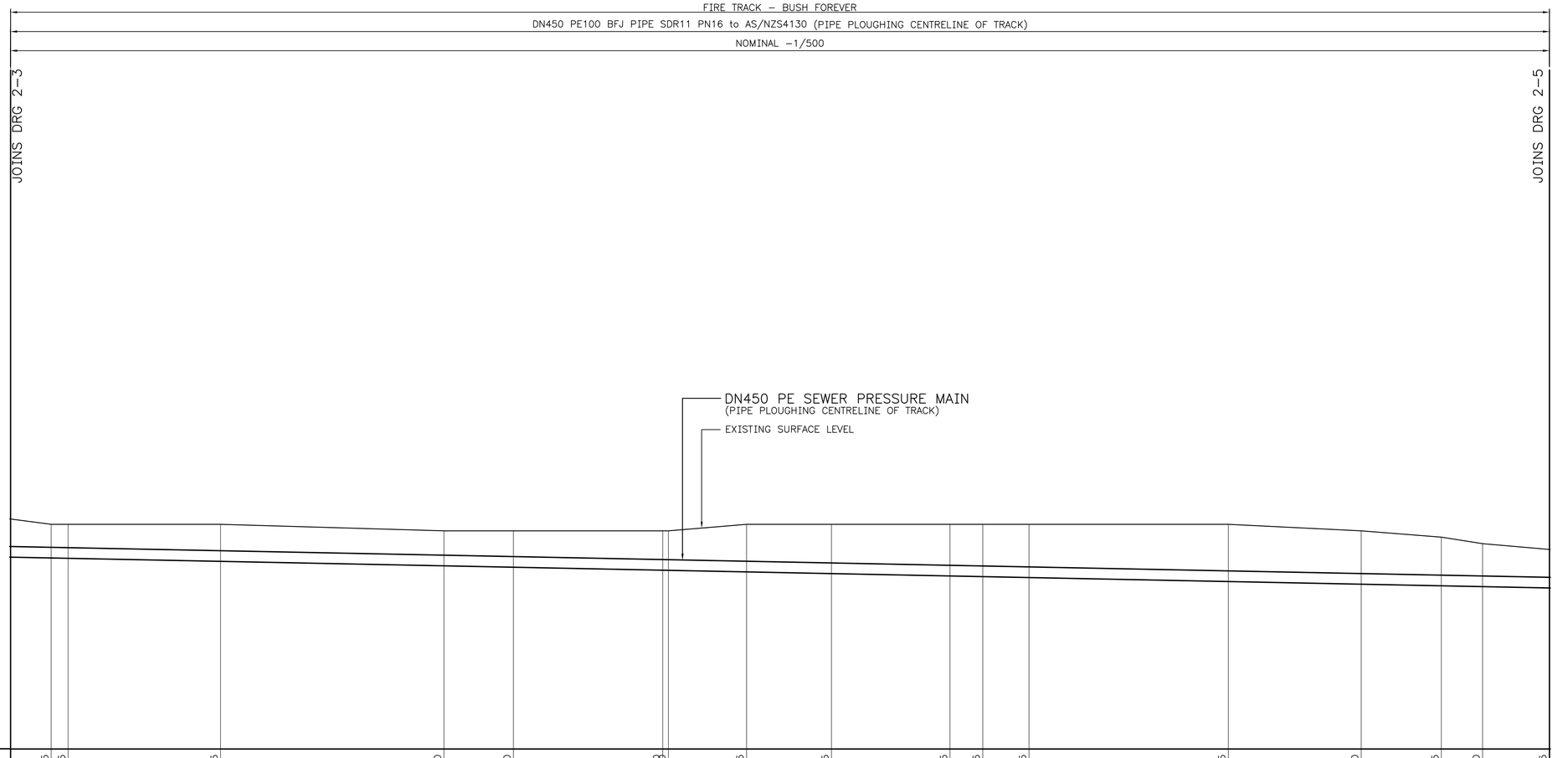
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	

FOR GENERAL NOTES REFER DRG 85–1–1



DATUM 15.00m ABOVE AHD

NATURAL SURFACE LEVEL	23.75	23.75	23.75	23.50	23.50	23.50	23.50	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.50	23.25	23.00	22.75
DEPTH TO INVERT																		
INVERT LEVEL																		
HORIZONTAL DISTANCE	1550	1565.8	1572.4	1631.8	1719.7	1746.0	1804.3	1806.5	1836.9	1870.1	1916.3	1929.1	1947.1	2024.8	2076.6	2107.9	2124.0	2150

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION

HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)

10 5 0 1 2 3 4 5 6 7 m (1:100)

DATE : 10-Sep-2013

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC G.DUNLOP	NORTH POINT
	COORDINATE SYS MGA94–50	DES CHD P.SPENCER	
ASCON SURVEY NONE	DES REF GHD 61–29471	DRN K.BOSMAN	
		Q.C. CHD R.SPILLANE	

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P.G. SPENCER (SIGNED)	
CONSULTANT PROJECT DIRECTOR	

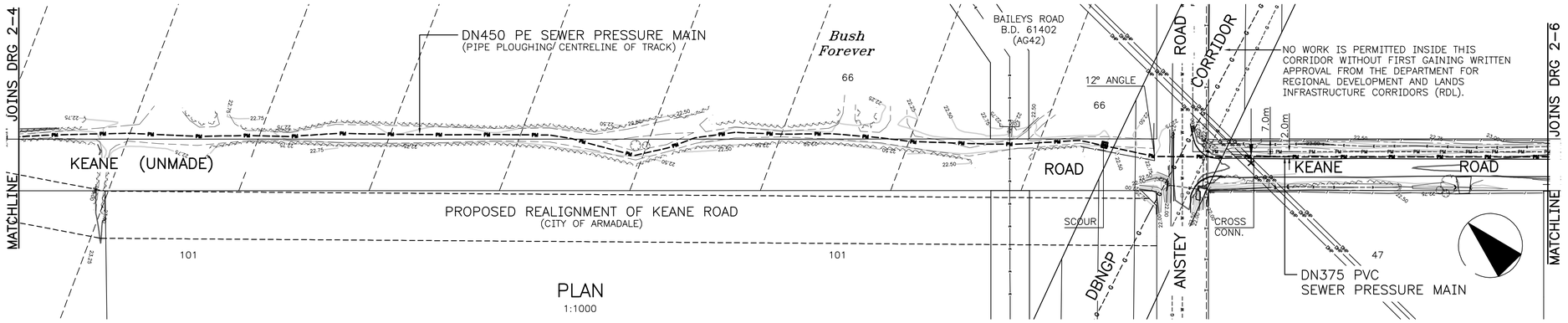
WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION – SHEET 4 OF 8

FILE	PLAN	CAD	ISSUE	ORIGINAL SHEET SIZE
PROJECT C–S01249	HW91–85–2–4		A	A1
			MF	

566
810

61\29471\CADD\HW91\HW91–085–002–04A 10/09/2013



PLAN
1:1000

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www.1100.com.au

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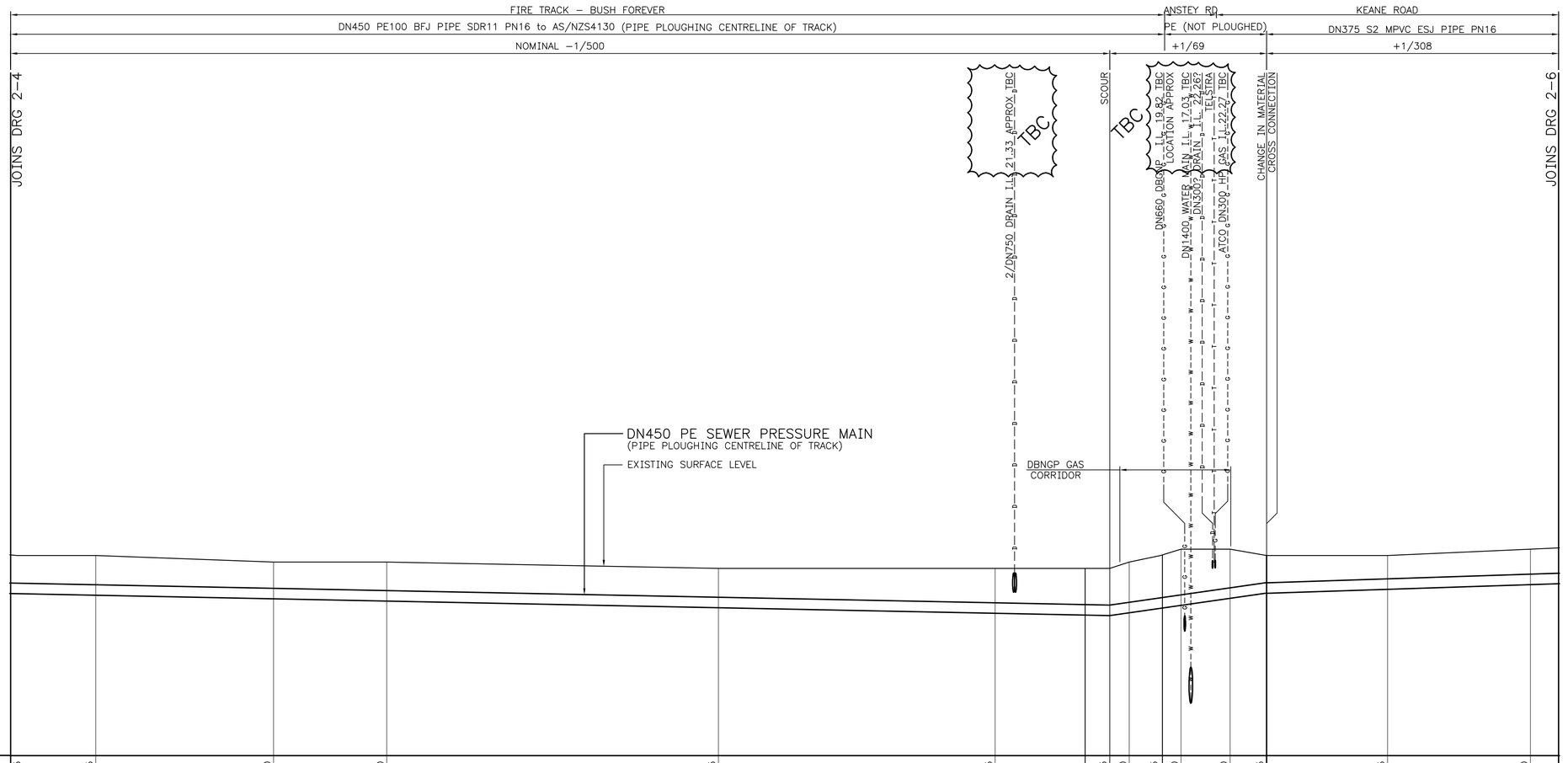
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	

FOR GENERAL NOTES REFER DRG 85-1-1



DATUM 15.00m ABOVE AHD

NATURAL SURFACE LEVEL	22.75	22.75		22.50	22.50			22.25			22.25		22.25	22.50	22.75	23.00	23.00	22.75		22.75		23.00				
DEPTH TO INVERT													1.82					1.45	1.46							
INVERT LEVEL													20.42					21.30	21.29							
HORIZONTAL DISTANCE	2150	2183.0		2251.9	2295.7			2424.3			2531.6	2542.1	2566.5	2576.0	2583.6	2596.5	2603.6	2622.7	2636.8	2683.8		2739.1	2750				

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION

HORIZONTAL 1:1000, VERTICAL 1:100

(1:1000) (1:100)

DATE : 10-Sep-2013

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC K.BOSMAN
	COORDINATE SYS MGA94–50	DES CHD P.SPENCER
ASCON SURVEY NONE	DES REF GHD 61–29471	DRN K.BOSMAN
		Q.C. CHD R.SPILLANE

NORTH POINT

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CONSULTANT JOB MANAGER

APPROVED 09/09/2013
P.G. SPENCER (SIGNED)
CONSULTANT PROJECT DIRECTOR

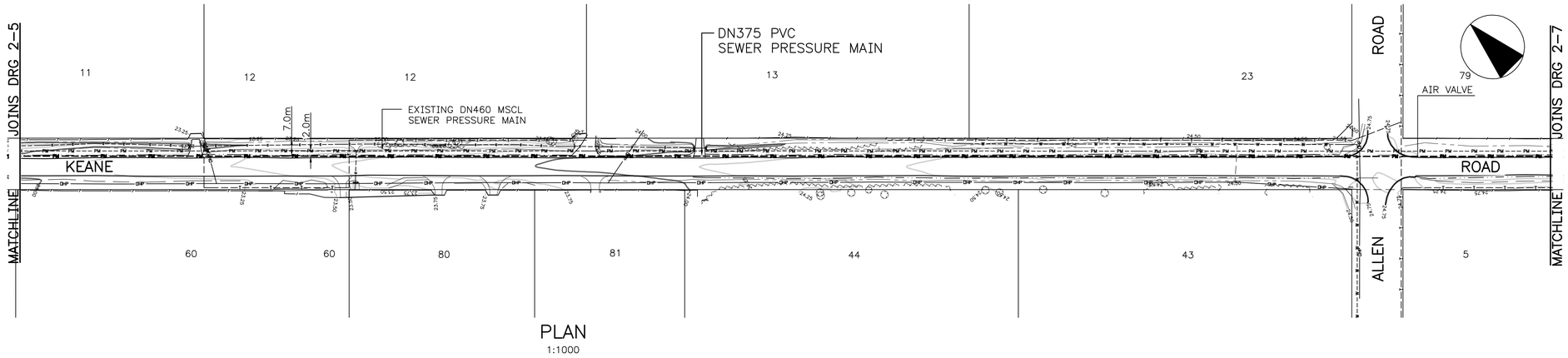
WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION – SHEET 5 OF 8

FILE PROJECT C–S01249
PLAN CAD HW91–85–2–5
ISSUE A
ORIGINAL SHEET SIZE A1
MF

566
810

61\29471\CADD\HW91\HW91–085–002–05A 10/09/2013



PLAN
1:1000

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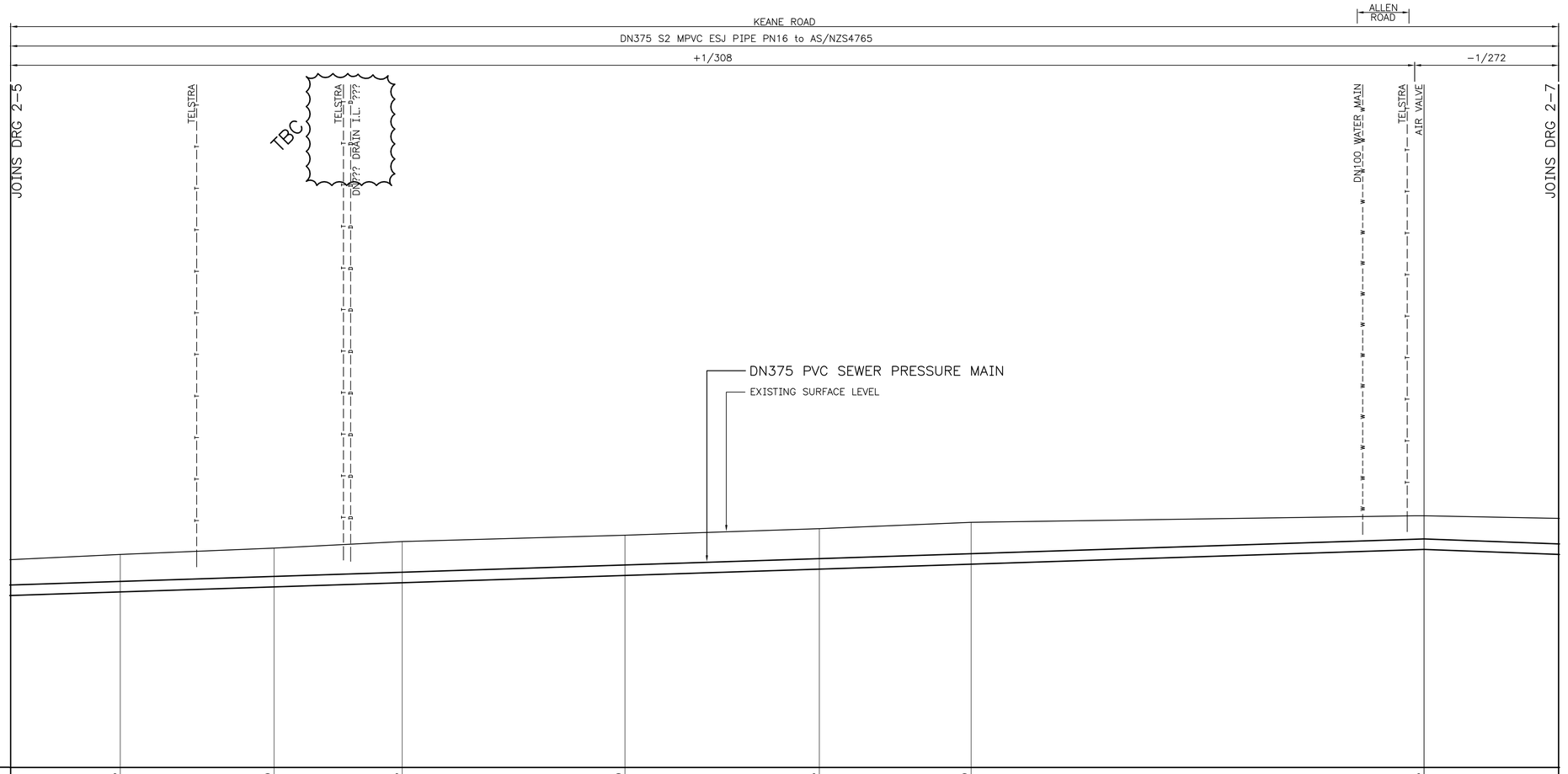
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	

FOR GENERAL NOTES REFER DRG 85-1-1



DATUM 15.00m ABOVE AHD

NATURAL SURFACE LEVEL	23.25	23.50	23.75	24.00	24.25	24.50	24.75		
DEPTH TO INVERT							1.31		
INVERT LEVEL							23.44		
HORIZONTAL DISTANCE	2750	2792.5	2852.1	2901.8	2988.1	3063.5	3122.3	3297.9	3350

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION
HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)
10 5 0 1 2 3 4 5 6 7 m (1:100)

DATE : 10-Sep-2013

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC K.BOSMAN	NORTH POINT
	COORDINATE SYS MGA94-50	DES CHD P.SPENCER	
ASCON SURVEY NONE	DES REF GHD 61-29471	DRN K.BOSMAN	
		Q.C. CHD R.SPILLANE	

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APPROVED 09/09/2013	P.G. SPENCER (SIGNED)
CONSULTANT PROJECT DIRECTOR	

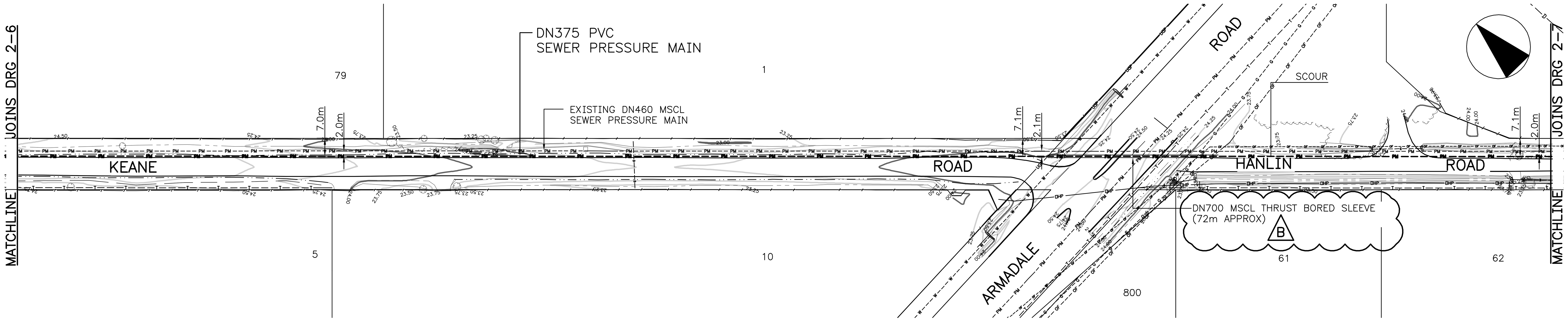
WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION - SHEET 6 OF 8

FILE	PLAN	CAD	ISSUE	ORIGINAL SHEET SIZE
PROJECT C-S01249	HW91-85-2-6		A	A1
			MF	

566
810

61\29471\CADD\HW91\HW91-085-002-06A 10/09/2013



PLAN
1:1000

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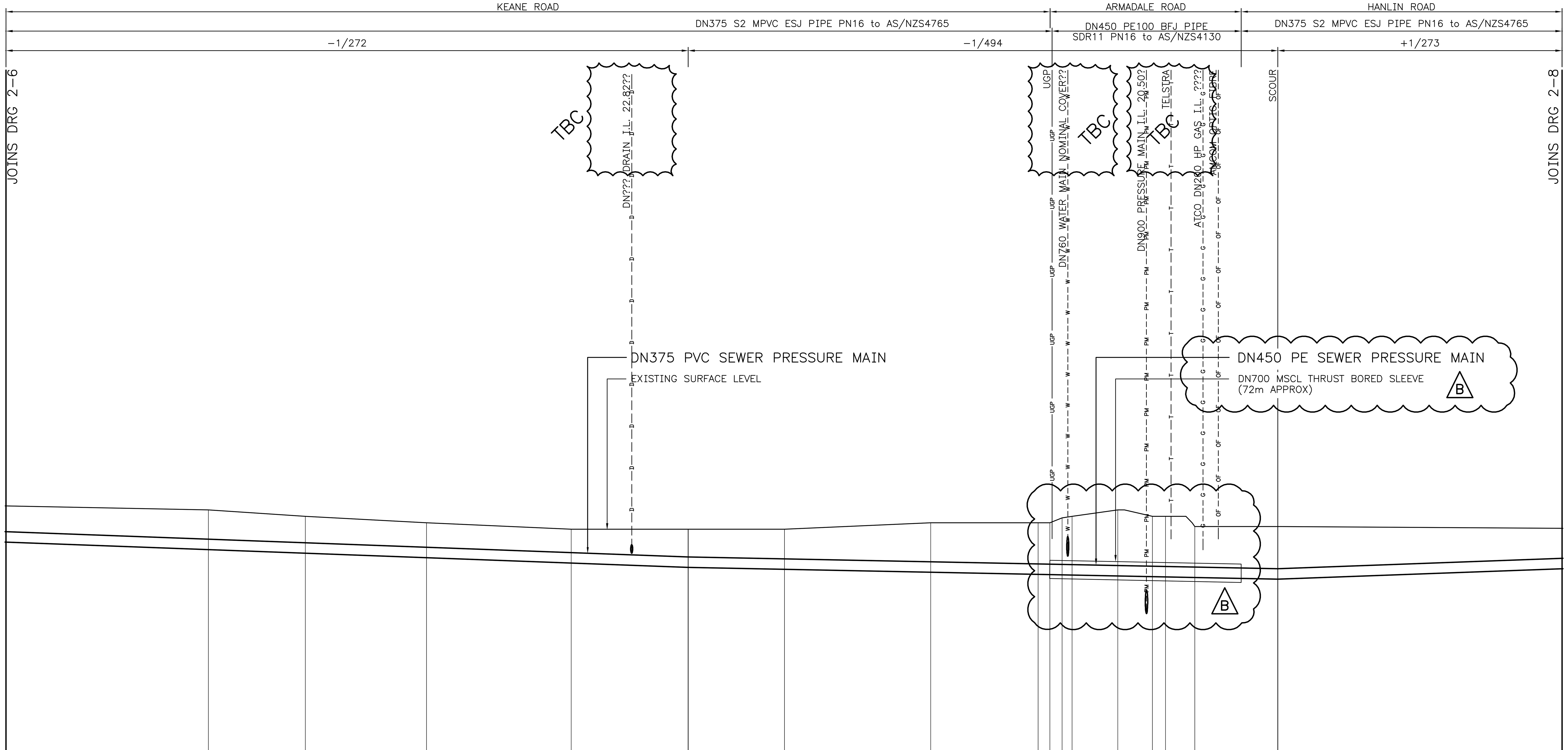
LEGEND

- PROPOSED SEWER PRESSURE MAIN
- EXISTING WATER MAINS
- EXISTING TELECOMMUNICATION CABLES
- EXISTING OPTIC FIBRE
- EXISTING UNDERGROUND POWER
- EXISTING OVERHEAD POWER
- EXISTING GAS MAINS
- EXISTING SEWER MAINS
- EXISTING SEWER PRESSURE MAINS
- EXISTING DRAINAGE
- EXISTING FENCE
- EXISTING TREE

FOR GENERAL NOTES REFER DRG 85–1–1



DATUM 15.00m ABOVE AHD

HORIZONTAL DISTANCE	NATURAL SURFACE LEVEL	DEPTH TO INVERT	INVERT LEVEL
3350			
3428.0	24.50		
3465.4	24.25		
3512.2	24.00		
3567.9	23.75		
3613.1		1.47	22.28
3650.2	23.75		
3706.5	24.00		
3748.0	24.00		
3752.5	24.00		
3757.2	24.19		
3761.1	24.25		
3778.7	24.50		
3792.0	24.25		
3797.1	24.25		
3808.4	23.85		
3840.4	23.85	2.03	21.82
3950			

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION
HORIZONTAL 1:1000, VERTICAL 1:100

DATE : 6-Feb-2014

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD
B	02/2014		TRENCHLESS INSTALLATION SHOWN UNDER ARMADALE RD	KB	KB	PGS

DESIGN SURVEY: GHD 2661551 V01
ASCON SURVEY: NONE
VERTICAL DATUM: AHD
COORDINATE SYS: MGA94–50
DES REF: GHD 61–29471
DES CALC: K.BOSMAN
DES CHD: P.SPENCER
DRN: K.BOSMAN
Q.C. CHD: R.SPILLANE
NORTH POINT

GHD House, 239 Adelaide Terrace, Perth WA 6004 Australia
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P.G. SPENCER (SIGNED)
CONSULTANT PROJECT DIRECTOR

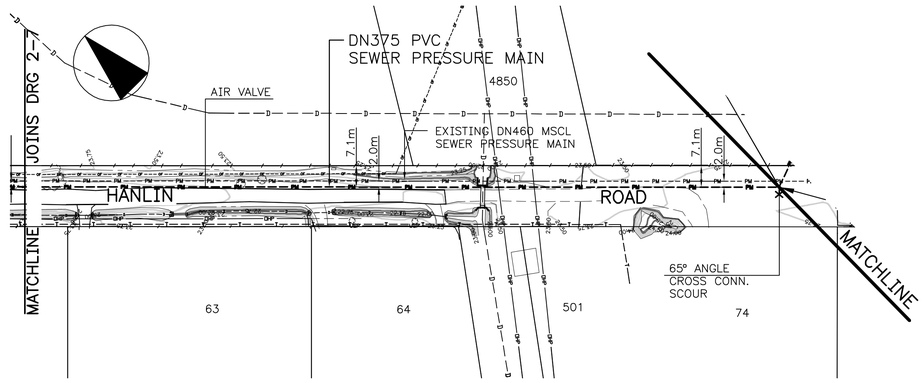
WATER CORPORATION

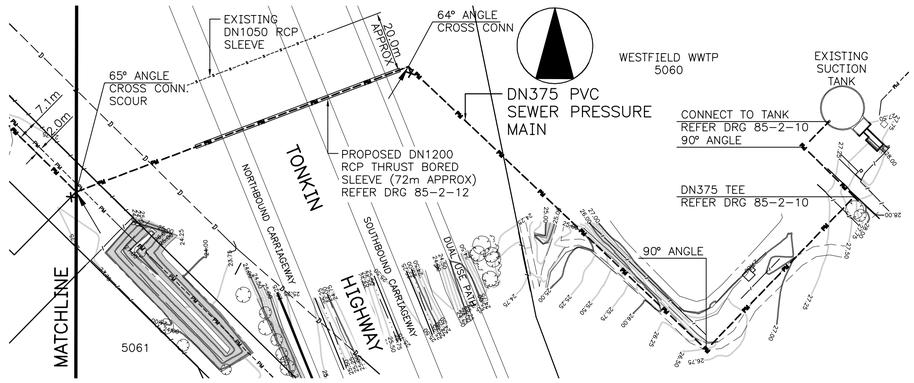
METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION – SHEET 7 OF 8

FILE
PROJECT C–S01249
PLAN HW91–85–2–7
CAD ISSUE B
ORIGINAL SHEET SIZE A1

566
810

61\29471\CADD\HW91\HW91–085–002–07B 06/02/2014





PLAN
1:1000

DIAL BEFORE YOU DIG
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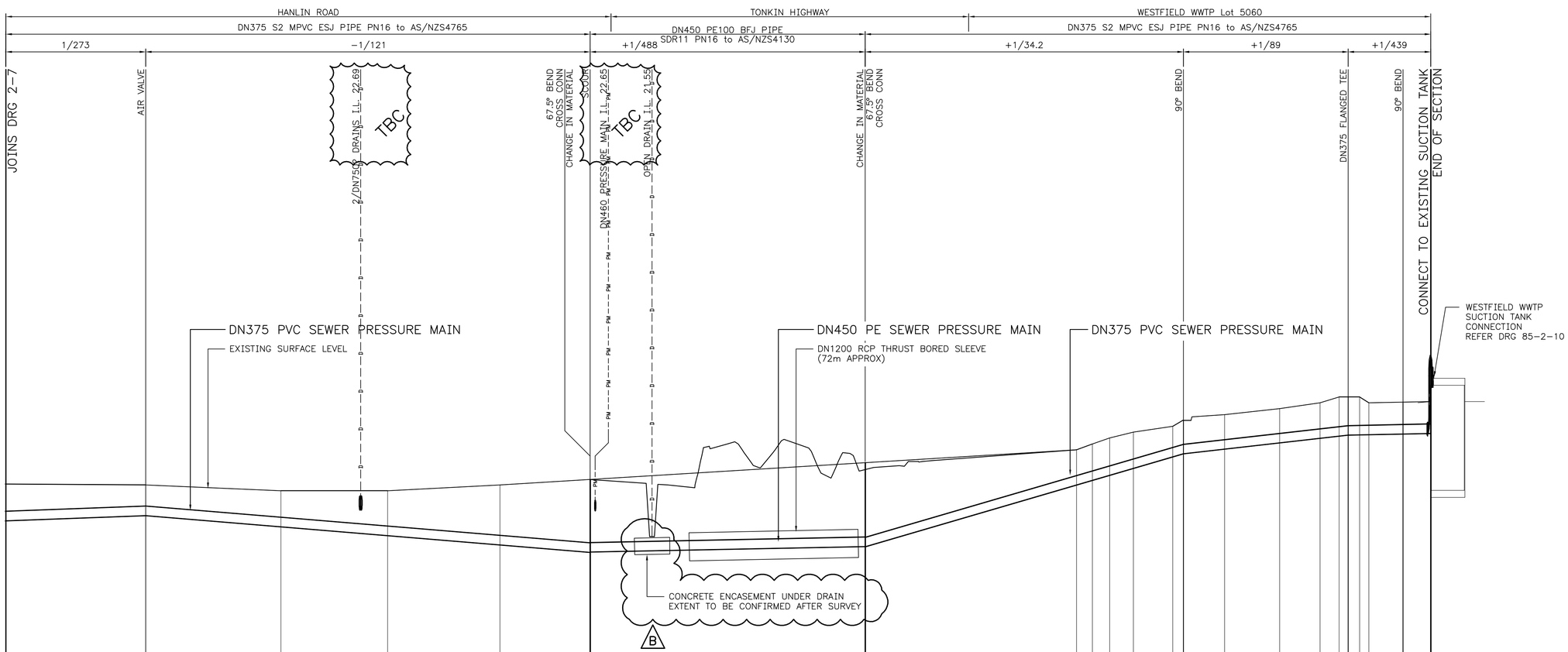
LEGEND

PROPOSED SEWER PRESSURE MAIN	PM
EXISTING WATER MAINS	W
EXISTING TELECOMMUNICATION CABLES	T
EXISTING OPTIC FIBRE	OF
EXISTING UNDERGROUND POWER	UGP
EXISTING OVERHEAD POWER	OHP
EXISTING GAS MAINS	G
EXISTING SEWER MAINS	S
EXISTING SEWER PRESSURE MAINS	PM
EXISTING DRAINAGE	D
EXISTING FENCE	/
EXISTING TREE	

FOR GENERAL NOTES REFER DRG 85-1-1



DATUM 15.00m ABOVE AHD

NATURAL SURFACE LEVEL		23.75		23.50		23.50		23.75									25.25	25.50	25.75	26.00	26.25	26.50	26.75		27.00		27.25	27.50	27.50	27.25		27.30
DEPTH TO INVERT		1.31							3.10	3.09			3.28	3.29								1.42						1.63				1.36
INVERT LEVEL		22.44							20.88	20.89			21.12	21.11								25.08						25.87				25.94
HORIZONTAL DISTANCE	3950	4009.5		4067.1		4112.6		4160.4		4198.8			4316.0				4406.0	4412.8	4420.1	4430.2	4447.0	4451.5	4469.1		4492.5		4509.7	4517.8	4521.7	4526.5	4530.5	4545.0	4556.8

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

LONGITUDINAL SECTION
HORIZONTAL 1:1000, VERTICAL 1:100

10 5 0 10 20 30 40 50 60 70 m (1:1000)
10 5 0 1 2 3 4 5 6 7 m (1:100)

DATE : 6-Feb-2014

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD
B	02/2014		CONCRETE ENCASEMENT ADDED TO DRAIN CROSSING	KB	KB	PGS

DESIGN SURVEY: GHD 2661551 V01
ASCON SURVEY: NONE
VERTICAL DATUM: AHD
COORDINATE SYS: MGA94-50
DES REF: GHD 61-29471
DES CALC: K.BOSMAN
DES CHD: P.SPENCER
DRN: K.BOSMAN
Q.C. CHD: R.SPILLANE
NORTH POINT

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CONSULTANT PROJECT DIRECTOR

WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
PLAN AND LONGITUDINAL SECTION - SHEET 8 OF 8

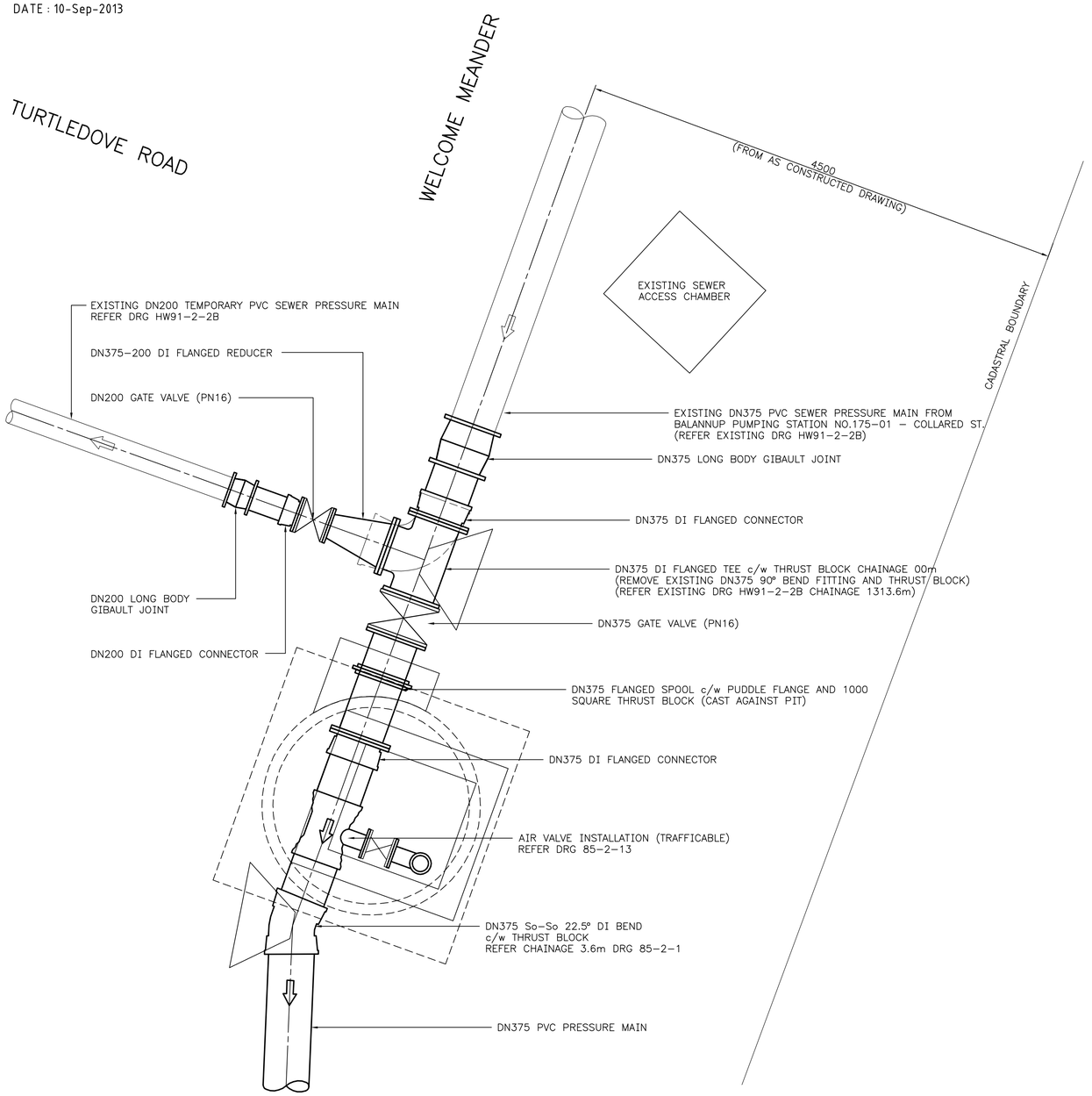
FILE: PROJECT C-S01249
PLAN: HW91-85-2-8
CAD
ISSUE: B
ORIGINAL SHEET SIZE: A1
MF

566
810

61\29471\CADD\HW91\HW91-085-002-08B 06/02/2014

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

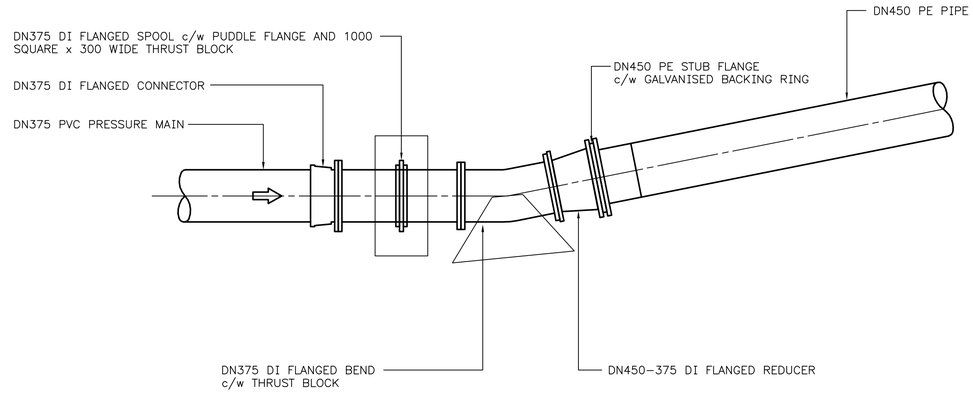
DATE : 10-Sep-2013



CONNECTION TO EXISTING PRESSURE MAIN

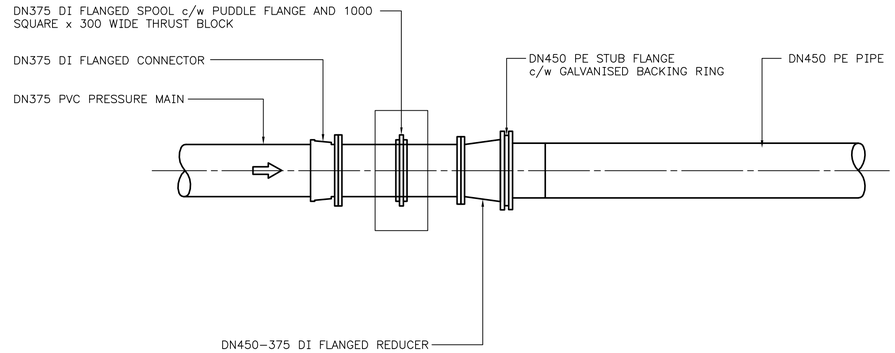
REFER DRG 85-2-1

1:25



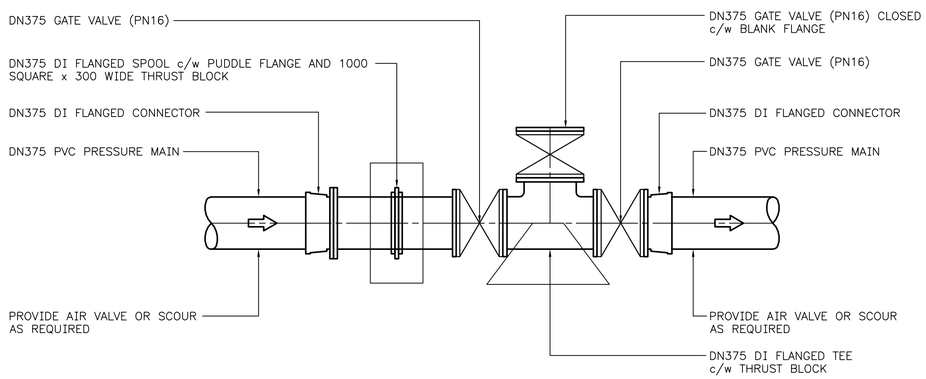
DN375 PVC TO DN450 PE CONNECTION AT A BEND

1:25



DN375 PVC TO DN450 PE STRAIGHT CONNECTION

1:25



TYPICAL CROSS CONNECTION FOR FUTURE PRESSURE MAIN

(4 REQUIRED)

1:25

500 0 500 1000 1500 mm (1:25)

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY: GHD 2661551 V01 | VERTICAL DATUM: NONE | COORDINATE SYS: NONE | ASCON SURVEY: NONE | DES REF: GHD 61-29471 | DES CALC: K.BOSMAN | DES CHD: P.SPENCER | DRN: K.BOSMAN | Q.C. CHD: R.SPILLANE

NORTH POINT

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RECOMMENDED 09/09/2013
G. DUNLOP (SIGNED)
CONSULTANT JOB MANAGER

APPROVED 09/09/2013
P.G. SPENCER (SIGNED)
CONSULTANT PROJECT DIRECTOR

WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
CONNECTION DETAILS - SHEET 1

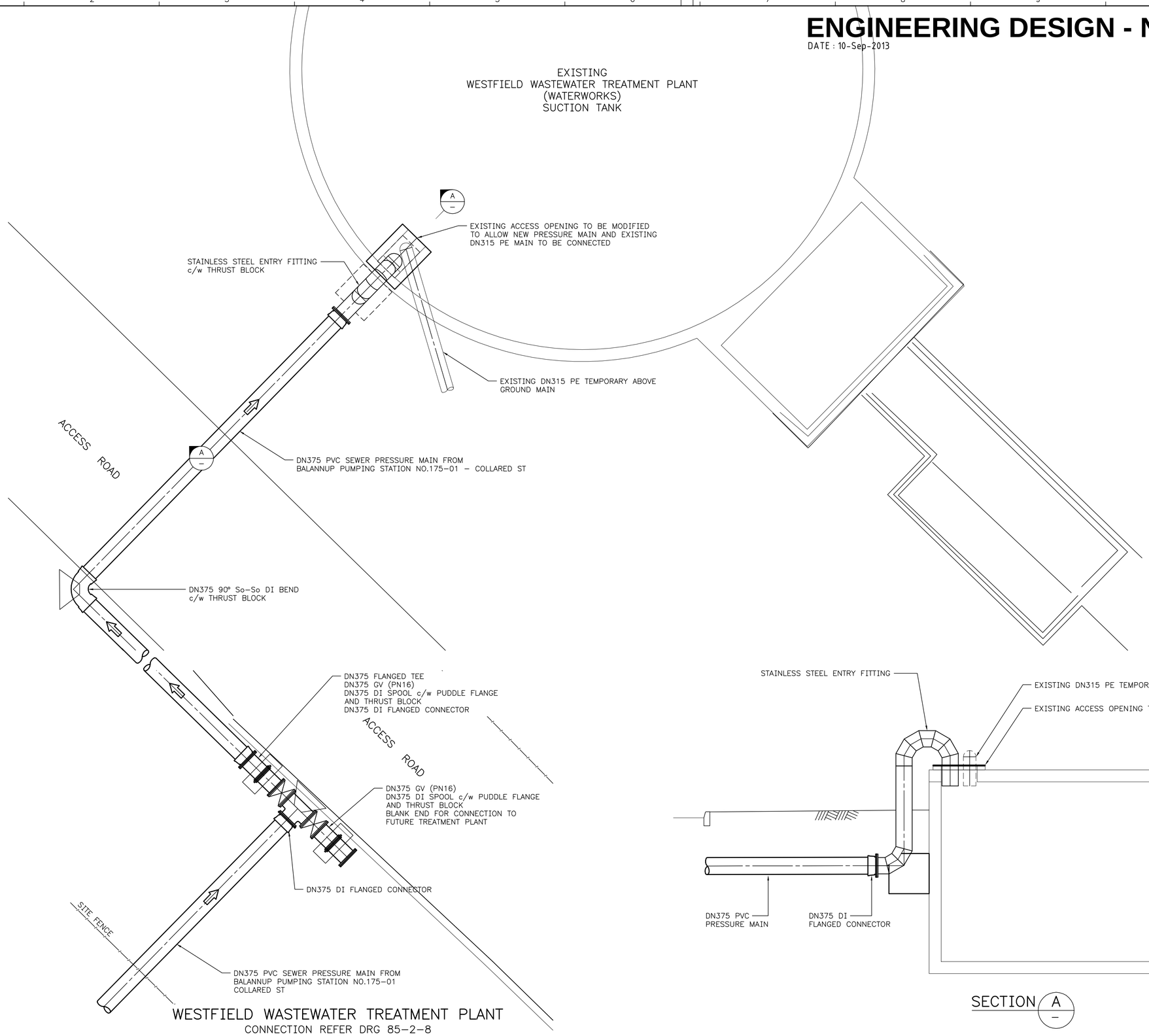
FILE: PROJECT C-S01249 | PLAN: HW91-85-2-9 | CAD | ISSUE: A | ORIGINAL SHEET SIZE: A1 | MF

566
810

61\29471\CADD\HW91\HW91-085-002-09A 10/09/2013

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

DATE : 10-Sep-2013



ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM NONE	DES CALC K.BOSMAN
	COORDINATE SYS NONE	DES CHD P.SPENCER
ASCON SURVEY NONE	DES REF GHD 61–29471	DRN K.BOSMAN
		Q.C. CHD R.SPILLANE

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P.G. SPENCER (SIGNED)	
CONSULTANT PROJECT DIRECTOR	

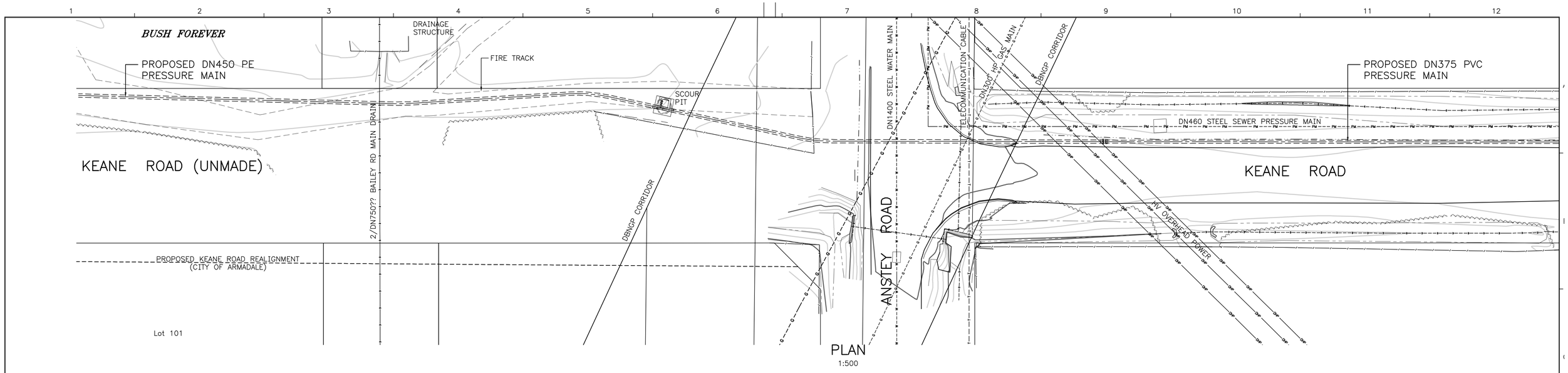
WATER CORPORATION

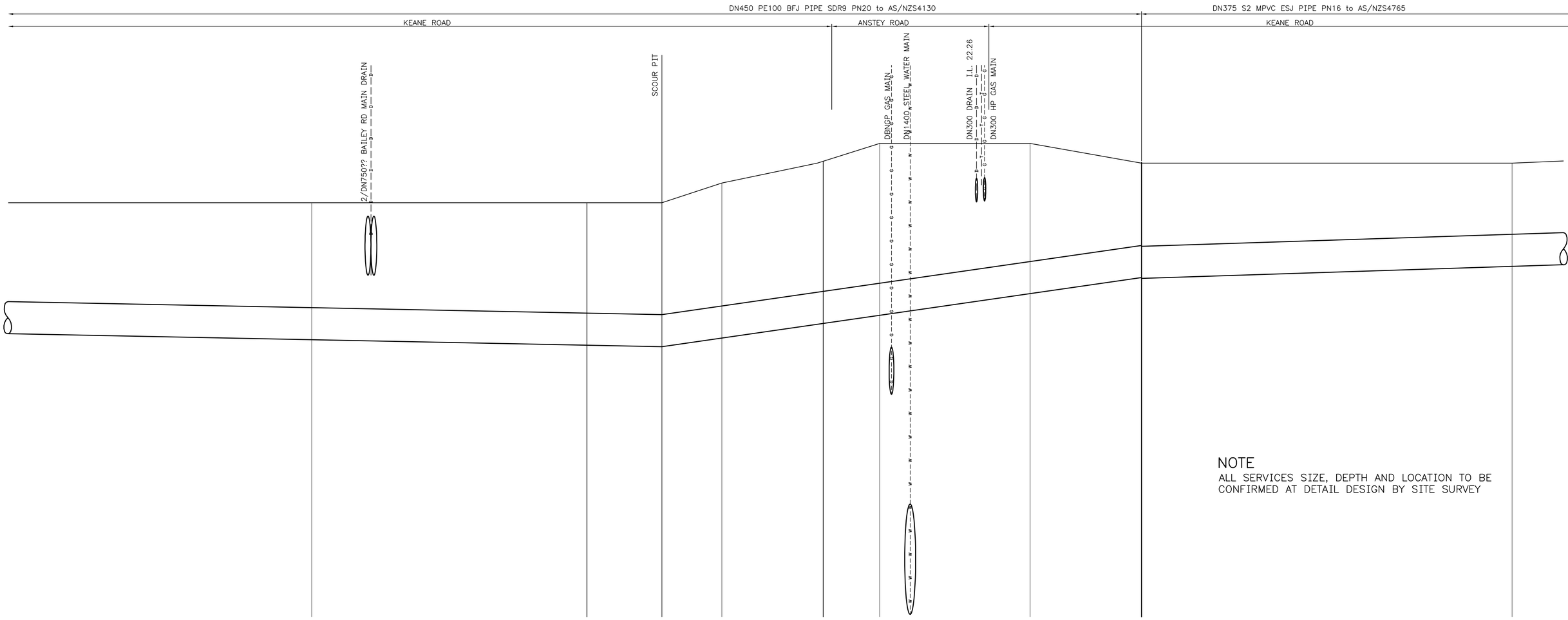
METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
CONNECTION DETAILS – SHEET 2

FILE	PLAN	CAD	ISSUE	ORIGINAL SHEET SIZE
PROJECT C–S01249	HW91–85–2–10		A	A1
			MF	

566
810

61\29471\CADD\HW91\HW91–085–002–10A 10/09/2013





NOTE
ALL SERVICES SIZE, DEPTH AND LOCATION TO BE CONFIRMED AT DETAIL DESIGN BY SITE SURVEY

SECTION
HORIZONTAL 1:250
VERTICAL 1:25

VERTICAL SCALE 500 0 500 1000 1500 mm (1:25)
HORIZONTAL SCALE 5 4 3 2 1 0 5 10 15 m (1:250)

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

DATE : 10-Sep-2013

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY GHD 2661551 V01	VERTICAL DATUM AHD	DES CALC K.BOSMAN
	COORDINATE SYS MGA94-50	DES CHD P.SPENCER
ASCON SURVEY NONE	DES REF GHD 61-29471	DRN K.BOSMAN
		Q.C. CHD R.SPILLANE

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CONSULTANT PROJECT DIRECTOR	

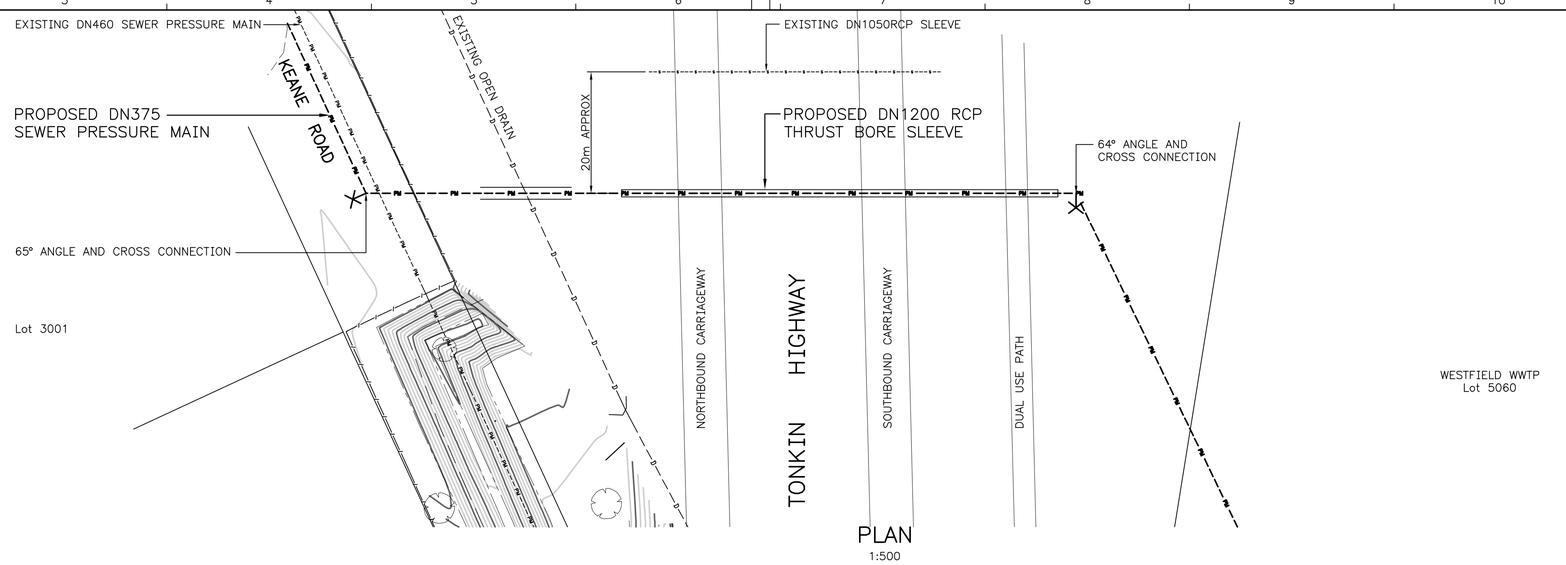
WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
DBNGP CROSSING

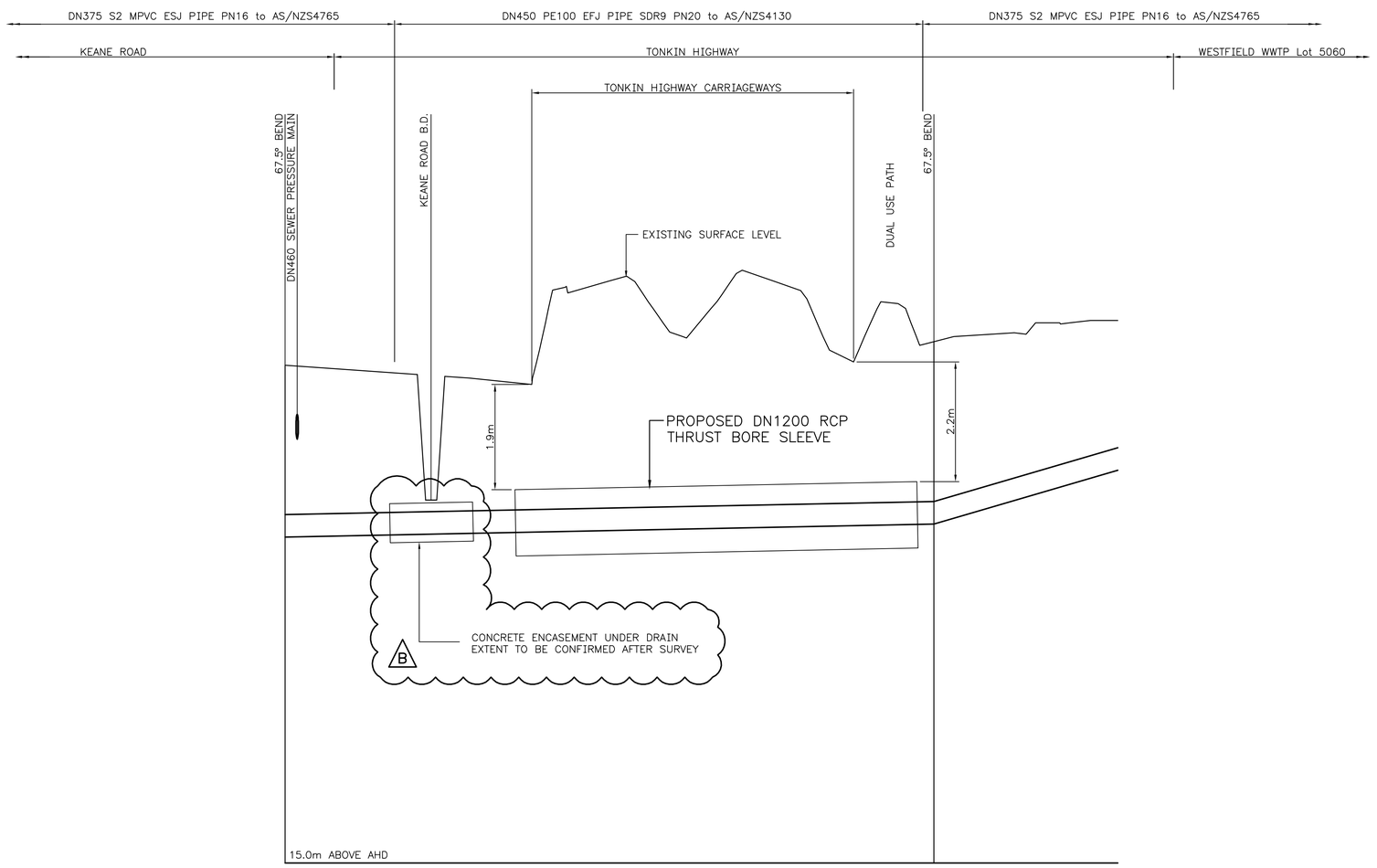
FILE	PLAN	CAD	ISSUE	ORIGINAL SHEET SIZE
PROJECT C-S01249	HW91-85-2-11		A	A1
				MF

566
810

61\29471\CADD\HW91\HW91-085-002-11A 10/09/2013



PLAN
1:500



SECTION
HORIZONTAL 1:500
VERTICAL 1:50

VERTICAL SCALE 1000 500 0 1000 2000 3000 mm (1:50)
HORIZONTAL SCALE 5 0 5 10 15 20 25 30 35 m (1:500)

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

DATE : 6-Feb-2014

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD
B	02/2014		CONCRETE ENCASEMENT ADDED TO DRAIN CROSSING	KB	KB	PGS

DESIGN SURVEY: GHD 2661551 V01
ASCON SURVEY: NONE
VERTICAL DATUM: NONE
COORDINATE SYS: NONE
DES REF: GHD 61-29471
DES CALC: K.BOSMAN
DES CHD: P.SPENCER
DRN: K.BOSMAN
Q.C. CHD: R.SPILLANE

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CONSULTANT PROJECT DIRECTOR

WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 - COLLARED ST & PM
ENGINEERING DESIGN - DN375 PRESSURE MAIN
TONKIN HIGHWAY CROSSING

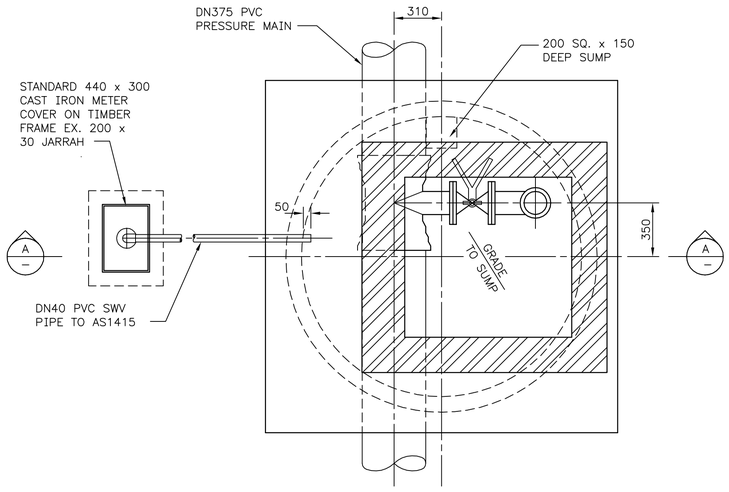
FILE: PROJECT C-S01249
PLAN: HW91-85-2-12
CAD
ISSUE: B
ORIGINAL SHEET SIZE: A1
MF

566
810

61\29471\CADD\HW91\HW91-085-002-12B 06/02/2014

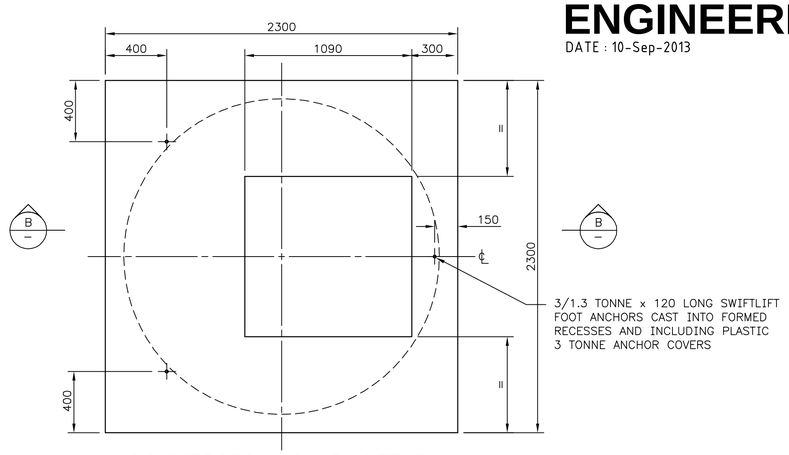
ENGINEERING DESIGN - NOT FOR CONSTRUCTION

DATE : 10-Sep-2013



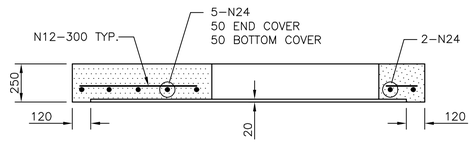
PLAN

SCALE (1)



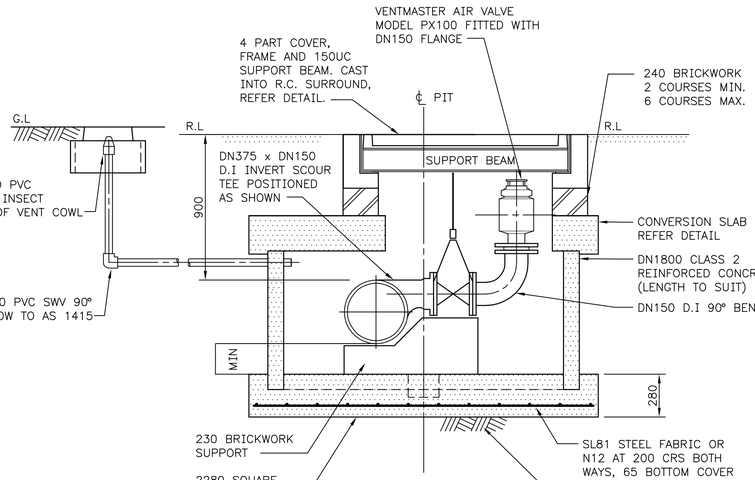
CONVERSION SLAB DETAIL

SCALE (1)



SECTION B

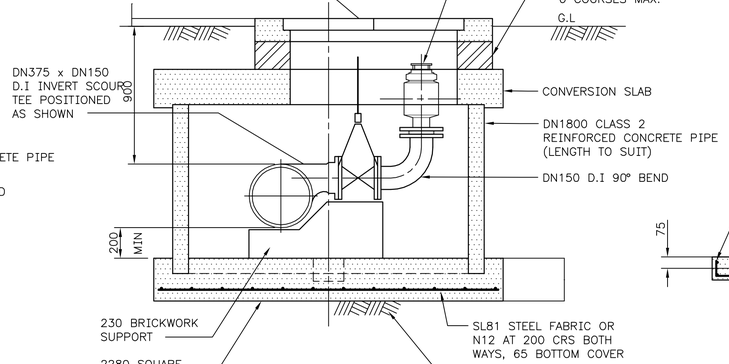
SCALE (1)



SECTION A

SCALE (1)

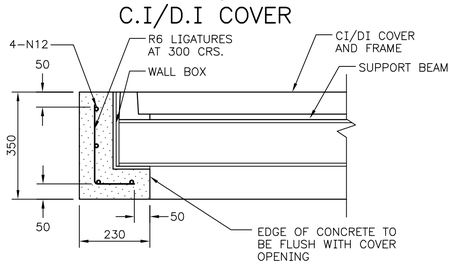
C.I/D.I COVER



SECTION A

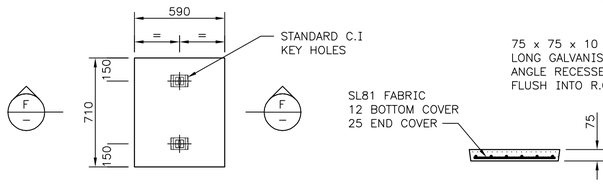
SCALE (1)

CONCRETE COVER



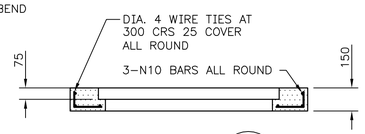
C.I/D.I COVER SURROUND DETAIL

SCALE (2)



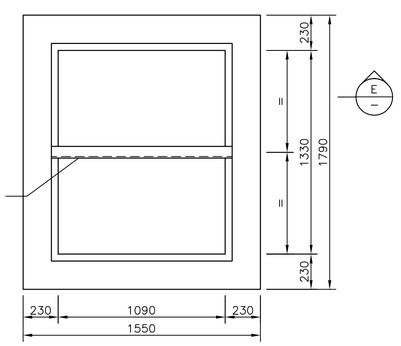
CONCRETE COVER DETAIL

SECTION F



SECTION E

SCALE (1)



FRAME DETAIL

GENERAL NOTES

1. ALL DIMENSION IN MILLIMETRES UNLESS SHOWN OTHERWISE.
2. ALL STEELWORK SHALL COMPLY WITH AS4100 AND SHALL BE HOT DIP GALVANISED AFTER FABRICATION TO AS/NZS4680. STEELWORK TO BE FABRICATED TO SUIT HOT–DIP GALVANISING REQUIREMENTS. INCLUDING REMOVAL OF SHARP EDGES, WELDING SLAG AND SURFACE IRREGULARITIES.
3. DAMAGE TO THE HOT DIP GALVANISING SHALL BE REPAIRED IN ACCORDANCE WITH APPENDIX E OF AS/NZS4680 USING 'DIMET ZEDEN' OR ACCEPTABLE EQUIVALENT PRODUCT.
4. ALL WELDS TO BE 6mm CONTINUOUS FILLET WELDS TO AS1554 PT. 1.
5. CONCRETE SHALL BE GRADE N32 TO AS1379 PLACED IN ACCORDANCE WITH AS3600.
6. REINFORCING STEEL TO BE NORMAL DUCTILE GRADE 500N TO AS/NZS4671.
7. GATE VALVES SHALL BE TO SPS 272 AND RESILIENT SEATED. ALL FLANGES AND FLANGE DRILLING SHALL COMPLY WITH AS4087 PN16.
8. DUCTILE IRON PIPE FITTINGS SHALL BE TO AS2280 AND SHALL BE FUSION BONDED NYLON COATED INTERNALLY AND EXTERNALLY. SOCKETED (RRJ) D.I. PRESSURE MAIN FITTINGS SHALL MATCH THE AS/NZS1477 SERIES 2 PVC PIPE DIAMETER, EXCEPT WHERE OTHERWISE SHOWN.
9. ALL FASTENERS SHALL BE 12ø SS. SS TO BE TO ASTM A276 GRADE 316.
10. IF SOIL AT VALVE PIT FOUNDATION LEVEL IS NOT SAND IT SHALL BE EXCAVATED TO A MIN. DEPTH OF 300mm BELOW PIT AND THIS EXCAVATION REFILLED WITH SAND. FOUNDATION OR SAND REFILL MATERIAL SHALL BE COMPACTED AS PIPE UNDERLAY
11. AIR VALVE AVAILABLE FROM GFR INDUSTRIES, 8 ARTELLO BAY RD, MIDVALE WA 6056 PHONE (08) 9250 2944. TO SPS 201.
12. UNLESS OTHERWISE SHOWN. ALL FLANGE BOLTS, NUTS AND WASHERS TO BE HOT DIP GALVANISED STEEL. ALL DAMAGE TO HOT DIP GALVANISING SHALL BE REPAIRED IN ACCORDANCE WITH APPENDIX E OF AS/NZS4680 USING 'DIMET ZEDEN' OR APPROVED SIMILAR PRODUCT.
13. UNLESS SHOWN OTHERWISE METALLIC FLANGED JOINTWORK INCLUDING NUTS AND BOLTS SHALL BE FIELD–WRAPPED BY A PROTECTION SYSTEM COMPRISING 'DENSO 600' TAPE AND 'DENSO 901' OVERWRAP TAPE OR APPROVED EQUIVALENT.

REFERENCE DRAWINGS

PLAN AND LONGITUDINAL SECTIONS	85–2–1 TO 85–2–8

1 500 0 500 1000 mm (SCALE 1:20 – A1 DRAWING)

2 100 50 0 100 200 300 400 500 600 700 mm (SCALE 1:10 – A1 DRAWING)

THIS DRAWING IS DERIVED FROM CA01–52–3A

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

566
810

DESIGN SURVEY	VERTICAL DATUM NONE	DES CALC WC STD	NORTH POINT
	COORDINATE SYS NONE	DES CHD WC STD	
ASCON SURVEY NONE	DES REF GHD 61–29471	DRN K.BOSMAN	
		Q.C. CHD R.SPILLANE	

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P.G. SPENCER (SIGNED)	
CONSULTANT PROJECT DIRECTOR	

WATER CORPORATION

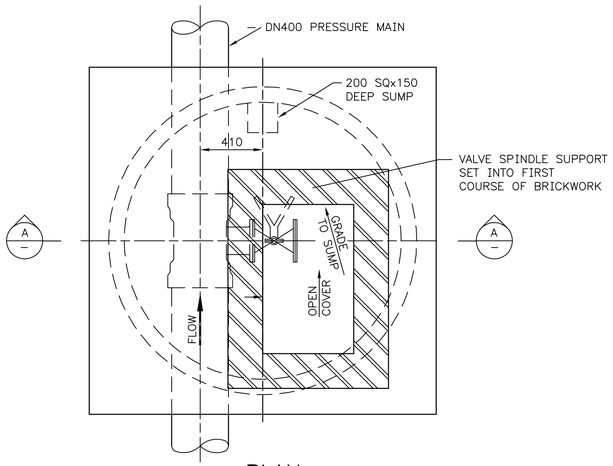
METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
AIR VALVE ARRANGEMENT AND DETAILS

FILE	PLAN	CAD	ISSUE	ORIGINAL SHEET SIZE
PROJECT C–S01249	HW91–85–2–13		A	A1
			MF	

61\29471\CADD\HW91\HW91–085–002–13A 10/09/2013

ENGINEERING DESIGN - NOT FOR CONSTRUCTION

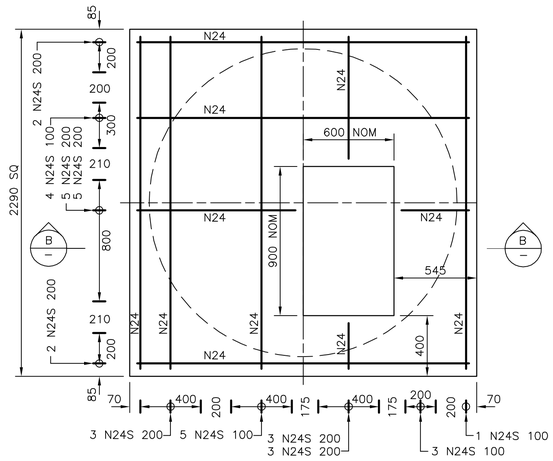
DATE : 6-Feb-2014



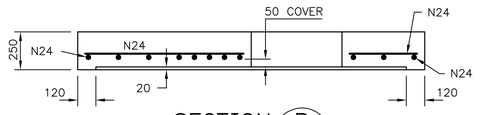
PLAN

SCALE (1)

C.I./D.I. CLASS D COVERS SHALL BE USED IN ROAD PAVEMENTS.
C.I./D.I. CLASS C COVERS SHALL BE USED IN ROW'S AND CARPARKS.
REINFORCED CONCRETE COVERS SHALL BE USED ELSEWHERE.

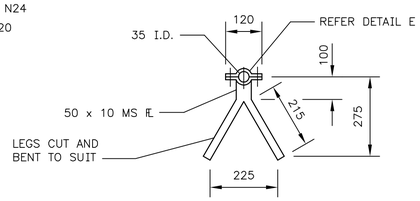


CONVERSION SLAB



SECTION (B)

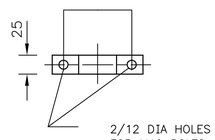
SCALE (1)



VALVE SPINDLE SUPPORT BRACKET

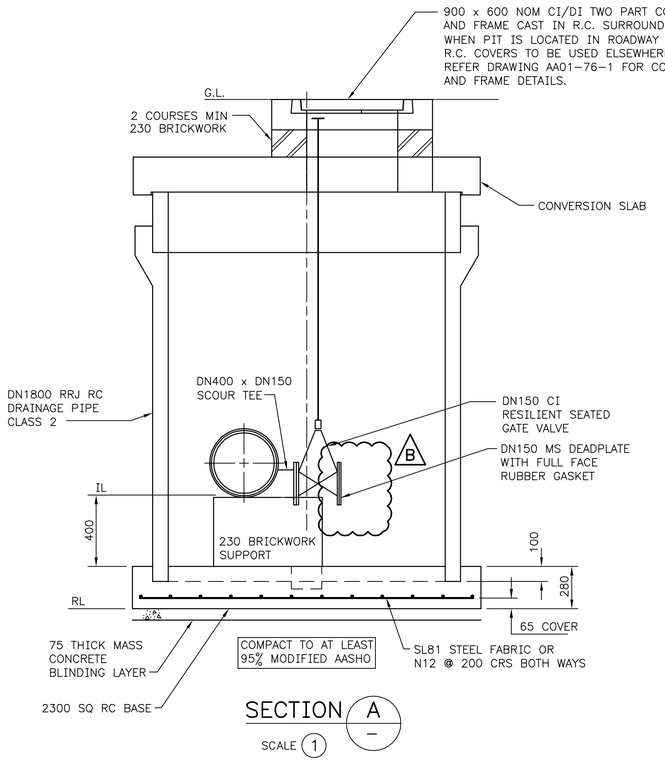
HOT DIP GALVANISED

SCALE : DIAGRAMMATIC



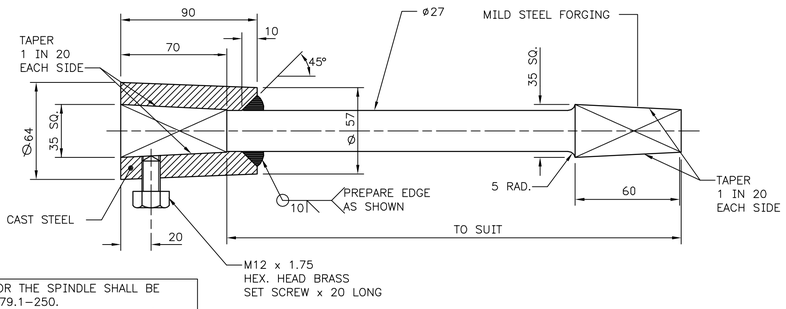
DETAIL (E)

SCALE (2)



SECTION (A)

SCALE (1)



- MILD STEEL FOR THE SPINDLE SHALL BE TO AS/NZS 3679.1-250.
- CAST STEEL SHALL BE GRADE AS 2074/C3. CASTINGS TO BE SOUND AND FREE OF BURRS AND SHARP EDGES.
- THE SPINDLE INCLUDING TAPERED KEY END SHALL COMPLY WITH AS 2638.2
- ALL WELDING WORK SHALL CONFORM TO AS/NZS 1554.1

VALVE SPINDLE EXTENSION

SCALE : DIAGRAMMATIC

GENERAL NOTES

1. ALL DIMENSIONS ARE SHOWN IN MILLIMETRES UNLESS SHOWN OTHERWISE.
2. ALL STRUCTURAL STEELWORK WELDING SHALL COMPLY WITH AS 1554 – PART 1. STEELWORK FABRICATION SHALL COMPLY WITH AS 4100.
3. MILD STEEL (MS) LADDER COMPONENTS SHALL BE HOT-DIP GALVANISED AFTER FABRICATION TO AS/NZS 4680. STEELWORK SHALL BE FABRICATED TO SUIT HOT-DIP GALVANIZING REQUIREMENTS, INCLUDING REMOVAL OF SHARP EDGES, WELDING SLAG AND SURFACE IRREGULARITIES.
4. ALL DAMAGE TO THE HOT DIP GALVANISING SHALL BE REPAIRED IN ACCORDANCE WITH APPENDIX E OF AS/NZS 4680 USING 'DIMET ZEDEN' OR APPROVED EQUIVALENT PRODUCT.
5. CONCRETE SHALL BE GRADE N32 TO AS 1379 PLACED IN ACCORDANCE WITH AS 3600.
6. REINFORCING STEEL TO BE NORMAL DUCTILE IRON GRADE 500N TO AS/NZS 4671.
7. SLUICE VALVES SHALL BE RESILIENT SEATED AND TO SPS 272.
8. ALL FASTENERS SHALL BE STAINLESS STEEL TO ASTM A276 GRADE 316L.
9. IF SOIL AT VALVE PIT FOUNDATION LEVEL IS NOT SAND IT SHALL BE EXCAVATED TO A MIN. DEPTH OF 300mm BELOW PIT BLINDING LAYER AND THIS EXCAVATION REFILLED WITH SAND. FOUNDATION OR SAND REFILL MATERIAL SHALL BE COMPACTED AS PIPE UNDERLAY
10. EXTENSION SPINDLES TO CONFORM TO WATER CORPORATION STANDARD DRG AQ71-3-1 (LENGTH TO SUIT) AND FIXED WITH M12 SET SCREW TO VALVE SPINDLE. SPINDLES GREATER THAN 2m IN LENGTH SHALL REQUIRE AN ADDITIONAL MID-HEIGHT SUPPORT ATTACHED TO THE MANHOLE LINER.
11. MILD STEEL FOR THE SPINDLE SHALL BE TO AS/NZS 3679.1-250
12. CAST STEEL SHALL BE GRADE AS 2074/C3. CASTINGS TO BE SOUND AND FREE OF BURRS AND SHARP EDGES.
13. THE SPINDLE INCLUDING TAPERED KEY END SHALL BE HOT FORGED.
14. CAST STEEL SOCKET END AND TAPERED KEY END SHALL COMPLY WITH AS 2638.2
15. ALL WELDING WORK SHALL CONFORM TO AS/NZS 1554.1
16. DEPTH TO TOP OF VALVE SPINDLE SHALL BE MEASURED OR CALCULATED FROM THE FINISHED SURFACE LEVEL

REFERENCE DRAWINGS

PLAN AND LONGITUDINAL SECTIONS 85-2-1 TO 85-2-8

(1) 500 0 500 1000 mm (SCALE 1:20 – A1 SHEET)

(2) 100 50 0 100 200 300 mm (SCALE 1:5 – A1 SHEET)

THIS DRAWING IS DERIVED FROM CA01-54-5A

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD
B	11/2013	2G	ARROW RELOCATED TO POINT AT DEADPLATE	KB	GD	PGS

DESIGN SURVEY NONE | VERTICAL DATUM NONE | COORDINATE SYS NONE | DES CALC WC STD | DES CHD WC STD | ASCON SURVEY NONE | DES REF GHD 61-29471 | DRN K.BOSMAN | Q.C. CHD R.SPILLANE | NORTH POINT

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APPROVED 09/09/2013 P.G. SPENCER (SIGNED) CONSULTANT PROJECT DIRECTOR

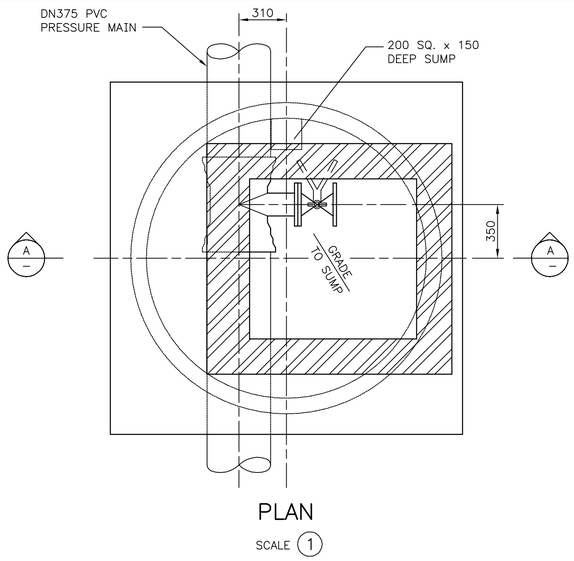
WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175-01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
GREATER THAN 2.2m TO INVERT – SCOUR ARRANGEMENT AND DETAILS

FILE JT1 201202141 VO1 | PROJECT C-S01249 | PLAN HW91-85-2-14 | CAD | ISSUE B | ORIGINAL SHEET SIZE A1 | MF

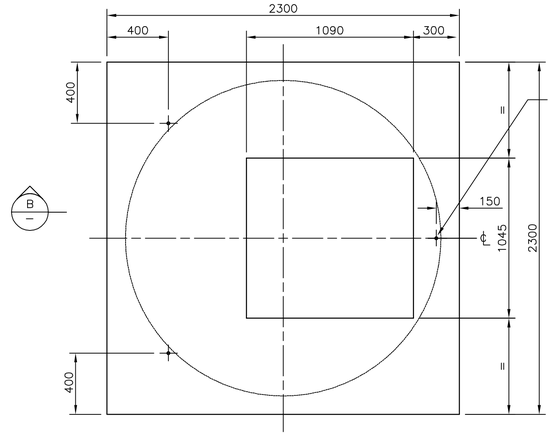
566
810

61\29471\CADD\HW91\HW91-085-002-14B 06/02/2014



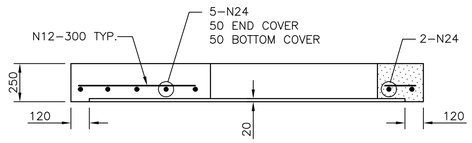
PLAN

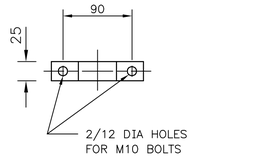
SCALE (1)



CONVERSION SLAB DETAIL

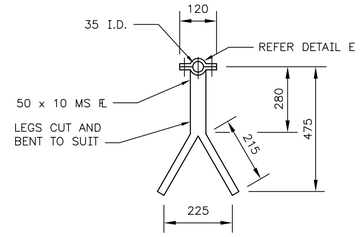
SCALE (1)





DETAIL (E)

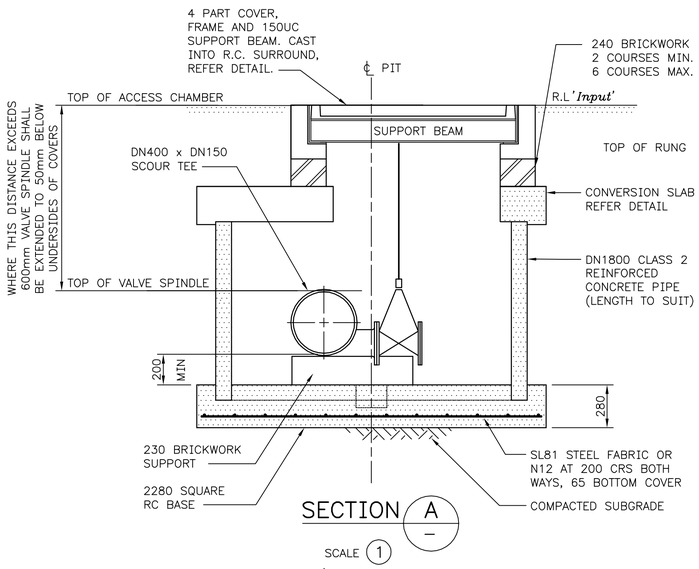
SCALE (3)



VALVE SPINDLE
SUPPORT BRACKET

HOT DIP GALVANISED

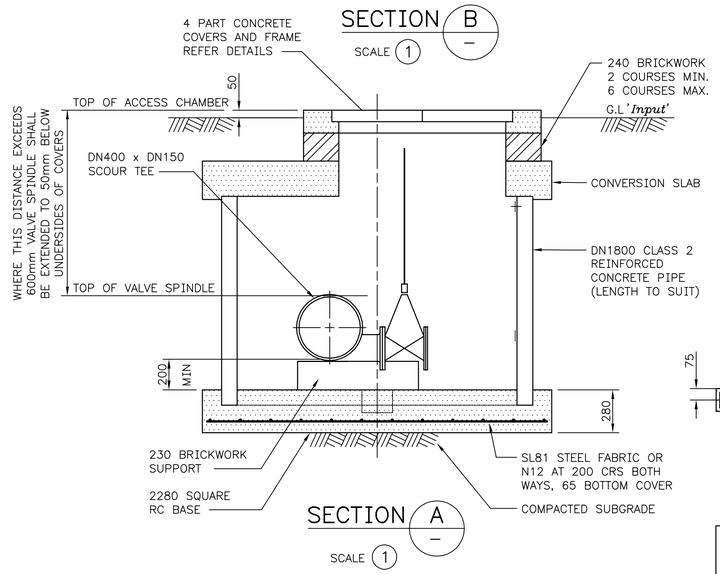
SCALE : DIAGRAMMATIC



SECTION (A)

SCALE (1)

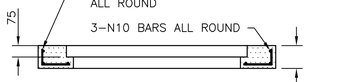
C.I/D.I COVER



SECTION (A)

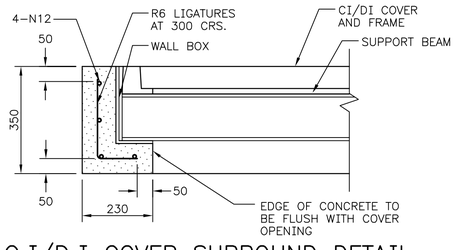
SCALE (1)

CONCRETE COVER



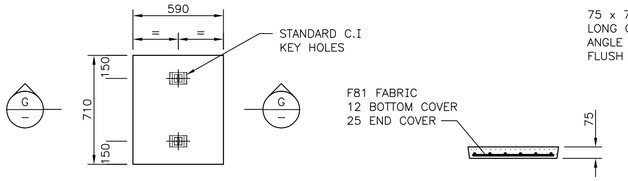
SECTION (F)

SCALE (1)



C.I/D.I COVER SURROUND DETAIL

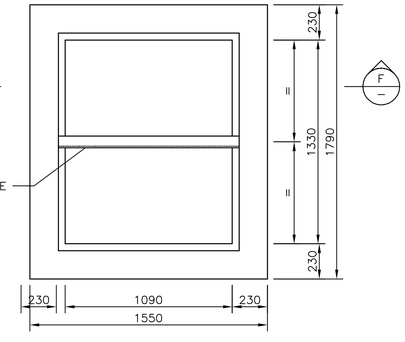
SCALE (2)



CONCRETE COVER DETAIL

SECTION (G)

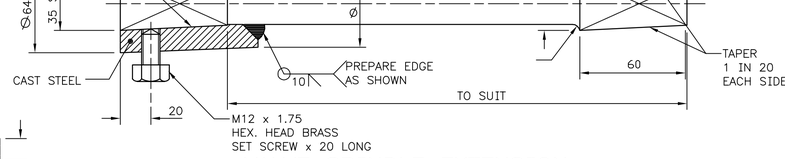
(1) 500 0 500 1000 mm (SCALE 1:20 – A1 SHEET)



FRAME DETAIL

(2) 100 50 0 100 200 300 400 500 600 700 mm (SCALE 1:10 – A1 SHEET)

- MILD STEEL FOR THE SPINDLE SHALL BE TO AS/NZS 3679.1–250.
- CAST STEEL SHALL BE GRADE AS 2074/C3. CASTINGS TO BE SOUND AND FREE OF BURRS AND SHARP EDGES.
- THE SPINDLE INCLUDING TAPERED KEY END SHALL COMPLY WITH AS 2638.2
- ALL WELDING WORK SHALL CONFORM TO AS/NZS 1554.1



VALVE SPINDLE EXTENSION

SCALE : DIAGRAMMATIC

GENERAL NOTES

1. ALL DIMENSIONS ARE SHOWN IN MILLIMETRES UNLESS SHOWN OTHERWISE.
2. ALL STRUCTURAL STEELWORK WELDING SHALL COMPLY WITH AS 1554 – PART 1. STEELWORK FABRICATION SHALL COMPLY WITH AS 4100.
3. MILD STEEL (MS) LADDER COMPONENTS SHALL BE HOT–DIP GALVANISED AFTER FABRICATION TO AS/NZS 4680. STEELWORK SHALL BE FABRICATED TO SUIT HOT–DIP GALVANISING REQUIREMENTS, INCLUDING REMOVAL OF SHARP EDGES, WELDING SLAG AND SURFACE IRREGULARITIES.
4. ALL DAMAGE TO THE HOT DIP GALVANISING SHALL BE REPAIRED IN ACCORDANCE WITH APPENDIX E OF AS/NZS 4680 USING 'DIMET ZEDEN' OR APPROVED EQUIVALENT PRODUCT.
5. CONCRETE SHALL BE GRADE N32 TO AS 1379 PLACED IN ACCORDANCE WITH AS 3600.
6. REINFORCING STEEL TO BE NORMAL DUCTILE GRADE 500N TO AS/NZS 4671.
7. SLUICE VALVES SHALL BE RESILIENT SEATED AND TO SPS 272.
8. ALL FASTENERS SHALL BE STAINLESS STEEL TO ASTM A276 GRADE 316L.
9. IF SOIL AT VALVE PIT FOUNDATION LEVEL IS NOT SAND IT SHALL BE EXCAVATED TO A MIN. DEPTH OF 300mm BELOW PIT BLINDING LAYER AND THIS EXCAVATION REFILLED WITH SAND. FOUNDATION OR SAND REFILL MATERIAL SHALL BE COMPACTED AS PIPE UNDERLAY
10. EXTENSION SPINDLES TO CONFORM TO WATER CORPORATION STANDARD DRG AQ71–3–1 (LENGTH TO SUIT) AND FIXED WITH M12 SET SCREW TO VALVE SPINDLE. SPINDLES GREATER THAN 2m IN LENGTH SHALL REQUIRE AN ADDITIONAL MID–HEIGHT SUPPORT ATTACHED TO THE MANHOLE LINER.
11. MILD STEEL FOR THE SPINDLE SHALL BE TO AS/NZS 3679.1–250
12. CAST STEEL SHALL BE GRADE AS 2074/C3. CASTINGS TO BE SOUND AND FREE OF BURRS AND SHARP EDGES.
13. THE SPINDLE INCLUDING TAPERED KEY END SHALL BE HOT FORGED.
14. CAST STEEL SOCKET END AND TAPERED KEY END SHALL COMPLY WITH AS 2638.2
15. ALL WELDING WORK SHALL CONFORM TO AS/NZS 1554.1
16. DEPTH TO TOP OF VALVE SPINDLE SHALL BE MEASURED OR CALCULATED FROM THE FINISHED SURFACE LEVEL

REFERENCE DRAWINGS

PLAN AND LONGITUDINAL SECTIONS 85–2–1 TO 85–2–8

THIS DRAWING IS DERIVED FROM CA01–54–4A

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY | VERTICAL DATUM NONE | DES CALC WC STD | NORTH POINT

ASCON SURVEY NONE | COORDINATE SYS NONE | DES CHD WC STD

DES REF GHD 61–29471 | DRN K.BOSMAN | Q.C. CHD R.SPILLANE

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E permail@ghd.com.au W www.ghd.com.au

RECOMMENDED 09/09/2013
G. DUNLOP (SIGNED)
CONSULTANT JOB MANAGER

APPROVED 09/09/2013
P.G. SPENCER (SIGNED)
CONSULTANT PROJECT DIRECTOR

WATER CORPORATION

METROPOLITAN WASTEWATER WAPC 127155
BALANNUP PUMPING STATION NO.175–01 – COLLARED ST & PM
ENGINEERING DESIGN – DN375 PRESSURE MAIN
LESS THAN 2.2m TO INVERT – SCOUR ARRANGEMENT AND DETAILS

ORIGINAL SHEET SIZE A1

FILE PROJECT C–SO1249 | PLAN HW91–85–2–15 | CAD | ISSUE A | MF

566
810

61\29471\CADD\HW91\HW91–085–002–15A 10/09/2013

Appendix C – Site Investigation Results

Table 1, Appendix C
Acid Sulfate Soil Investigation Results
Keane Road Pressure Main, Balannup
Acid Sulfate Soil and Dewatering Management Plan

				ASS - Field				ASS - pH			ASS - Acidity Trail						ASS - Sulfur Trail				ASS - Calcium Values					ASS - Magnesium Values					ASS - Potential Acidity		ASS - Net Acidity excl A		ASS - Excess ANC			ASS - Acid Base Accounting					
				pHF	pHFox	pH Difference (Field) - Calc	Reaction Rate	pH KCL	pHOX	pH Difference - Calc	s-TAA	s-TPA	s-TSA	Titratable Actual Acidity	TPA	TSA	a-SPOS	SKCl	SP	SPOS	a-CaA	CaA	CaKCL	CaP	sCaA	a-MgA	MgA	MgKCL	MgP	s-MgA	SCr (Sulfur Units)	SCr (Acidity Units)	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	a-ANCE	ANCE	s-ANCE	ANCFF	a-NetAcidity	Liming Rate	Liming Rate excluding ANC	s-NetAcidity
				pH Units	pH Units	pH Units	-	pH Units	pH Units	pH Units	% pyrite S	% pyrite S	% pyrite S	mole H+/t	mole H+/t	mole H+/t	mole H+/t	% S	% S	% S	mole H+/t	% Ca	% Ca	% Ca	% Ca	mole H+/t	% Mg	% Mg	% Mg	% S	% S	mole H+/t	mole H+/t	% CaCO3	% S	-	mole H+/t	kg CaCO3/t	kg CaCO3/t	% S
EQL				0.1	0.1		1	0.1	0.1		0.005	0.005	0.005	2	2	2	5	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	0.005	5	10	0.02	10	0.02	0.02	0.5	10	1	1	0.02
DEC 2013 ASS Criteria				**<4**	**<4**	**2**			**<4**	**2**	**0.03**	**0.03**	**0.03**	**18.7**	**18.7**	**18.7**	**18.7**			**0.03**											**0.03**	**18.7**	**18.7**	**0.03**								
LocCode	**Sample Depth**	**Sampled Date**	**Sample Elevation**																																						
BH01	0	25/06/2013	26.8	8.8	6.1	**2.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH01	0.5	25/06/2013	26.3	8.6	6.2	**2.4**	2	9.6	**7.5**	**2.1**	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	68	0.14	0.14	0.28	0.11	<5	<0.005	<0.005	0.008	0.006	-	-	<10	<0.02	178	0.89	0.28	1.5	<10	<1	<1	<0.02
BH01	1.5	25/06/2013	25.3	8.4	6.1	**2.3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH01	2	25/06/2013	24.8	8.6	6	**2.6**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH01	2.5	25/06/2013	24.3	8.1	5.9	**2.2**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH01	3	25/06/2013	23.8	8.4	6	**2.4**	1	9.1	**7**	**2.1**	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.07	0.06	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	44	0.22	0.07	1.5	<10	<1	<1	<0.02
BH02	0	25/06/2013	26.5	8.3	6.4	1.9	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02	0.5	25/06/2013	26	9.7	6.7	**3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02	1	25/06/2013	25.5	8	5.1	**2.9**	2	7.4	**3.4**	**4**	<0.005	**0.41**	**0.41**	<2	**256**	**256**	10	<0.005	0.02	0.02	<5	<0.005	0.37	0.29	<0.005	<5	<0.005	0.02	0.02	<0.005	-	-	10	0.02	-	-	-	1.5	174	13	1	0.28
BH02	1.5	25/06/2013	25	7.8	6.1	1.7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02	2	25/06/2013	24.5	7.9	6.2	1.7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02	2.5	25/06/2013	24	7.4	6.2	1.2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH02	3	25/06/2013	23.5	8.2	6.1	**2.1**	2	8	**6.3**	1.7	<0.005	<0.005	<0.005	<2	<2	<2	12	0.006	0.02	0.02	<5	<0.005	0.29	0.15	<0.005	<5	<0.005	0.008	0.006	<0.005	-	-	12	0.02	-	-	-	1.5	<10	<1	1	<0.02
BH03	0	25/06/2013	26.9	9.4	6.6	**2.8**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03	0.5	25/06/2013	26.4	9.6	6.6	**3**	1	9.7	**8**	1.7	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	2670	5.36	0.22	5.58	4.28	38	0.05	0.006	0.05	0.06	-	-	<10	<0.02	3560	17.8	5.71	1.5	<10	<1	<1	<0.02
BH03	1	25/06/2013	25.9	9.1	6.6	**2.5**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03	1.5	25/06/2013	25.4	9.4	6.7	**2.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03	2	25/06/2013	24.9	9	6	**3**	2	8.7	**6.8**	1.9	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.09	0.08	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	22	0.11	0.04	1.5	<10	<1	<1	<0.02
BH03	2.5	25/06/2013	24.4	6.7	5.7	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH03	3	25/06/2013	23.9	7.2	5.6	1.6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH04	0	25/06/2013	25.5	8.7	6.5	**2.2**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH04	0.5	25/06/2013	25	8.4	6.2	**2.2**	2	8.2	**9.3**	-1.1	<0.005	<0.005	<0.005	<2	<2	<2	**48**	0.009	0.08	**0.08**	242	0.48	0.43	0.91	0.39	8	0.009	0.01	0.02	0.01	-	-	**48**	**0.08**	379	1.9	0.61	1.5	<10	<1	4	<0.02
BH04	1.5	25/06/2013	24	8.4	6.2	**2.2**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH04	2	25/06/2013	23.5	8.3	6.2	**2.1**	2	9.2	**7.5**	1.7	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	0.01	<0.005	332	0.66	0.27	0.93	0.53	6	0.007	0.006	0.01	0.01	-	-	<10	<0.02	498	2.49	0.8	1.5	<10	<1	<1	<0.02
BH04	2.5	25/06/2013	23	8.2	5.9	**2.3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH04	3	25/06/2013	22.5	8.3	5.9	**2.4**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05N	0	27/06/2013	25.5	8.9	6.3	**2.6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05N	0.5	27/06/2013	25	7.8	5.9	1.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05N	1	27/06/2013	24.5	7.4	5.9	1.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05N	1.5	27/06/2013	24	7.2	5.9	1.3	1	7	**5.5**	1.5	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.02	0.01	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	-	-	-	1.5	<10	<1	<1	<0.02
BH05N	2	27/06/2013	23.5	7.3	5.6	1.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05N	2.5	27/06/2013	23	5	**3.5**	1.5	1	5.1	**2.6**	**2.5**	**0.1**	**0.78**	**0.68**	**63**	**485**	**422**	**62**	<0.005	**0.1**	**0.1**	<5	<0.005	0.08	0.08	<0.005	<5	<0.005	0.02	0.01	<0.005	<0.005	<5	**126**	**0.2**	-	-	-	1.5	126	9	9	0.2
BH05N	2.9	27/06/2013	22.6	5.2	**3.9**	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05S	0	25/06/2013	25.4	9.1	6.5	**2.6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05S	0.5	25/06/2013	24.9	8.7	5.8	**2.9**	1	8.5	**6.6**	1.9	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.06	0.04	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	20	0.1	0.03	1.5	<10	<1	<1	<0.02
BH05S	1.5	25/06/2013	23.9	6.6	4.9	1.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05S	2	27/06/2013	23.4	4.4	5.5	-1.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH05S	2.5	27/06/2013	22.9	5.3	4	1.3	1	4.8	**2.8**	2	**0.22**	**1.11**	**0.89**	**137**	**695**	**558**	**83**	<0.005	0.14	**0.13**	<5	<0.005	0.01	0.007	<0.005	<5	<0.005	0.008	0.007	<0.005	0.006	<5	**220**	**0.35**	-	-	-	1.5	220	17	17	0.35
BH06N	0.5	17/07/2013	22	8.9	7.4	1.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	1	17/07/2013	21.5	7.7	6.4	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	1.5	17/07/2013	21	8.2	6.9	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	2	17/07/2013	20.5	8.6	7.2	1.4	1	6.7	**7**	-0.3	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.02	0.01	<0.005	<5	<0.005	0.07	0.08	<0.005	-	-	<10	<0.02	28	0.14	0.04	1.5	<10	<1	<1	<0.02
BH06N	2.5	17/07/2013	20	9.6	8.7	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	3	17/07/2013	19.5	9.4	7.9	1.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	3.5	17/07/2013	19	8.7	7.9	0.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	4	17/07/2013	18.5	9.3	8	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	4.5	17/07/2013	18	8.7	8	0.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	5	17/07/2013	17.5	9.2	7.5	1.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06N	5.5	17/07/2013	17	8.4	5.7	**2.7**	1	6.4	**4.4**	2	<0.005	**0.04**	**0.04**	<2	**23**	**23**	**57**	0.005	0.1	**0.09**	8	0.02	0.01	0.03	0.01	7	0.008	0.03	0.04	0.01	**0.038**	**24**	**57**	**0.09**	-	-	-	1.5	57	4	4	0.09
BH06N	6	17/07/2013	16.5	8.2	5.6	**2.6**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	0	27/06/2013	22.5	8.6	6.2	**2.4**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	0.5	27/06/2013	22	8.8	5.8	**3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	1	27/06/2013	21.5	9.3	6.2	**3.1**	1	5.9	**4.8**	1.1	0.02	<0.005	<0.005	10	<2	<2	<5	0.006	0.01	0.008	<5	<0.005	0.02	0.01	<0.005	<5	<0.005	0.06	0.05	<0.005	<0.005	<5	15	0.02	-	-	-	1.5	15	1	1	0.02
BH06S	1.5	27/06/2013	21	8.2	5.4	**2.8**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	2	27/06/2013	20.5	8.6	6	**2.6**	1	6.8	**6.8**	0	<0.005	<0.005	<0.005	<2	<2	<2	**20**	0.01	0.05	0.03	16	0.03	0.03	0.06	0.02	<5	<0.005	0.05	0.05	0.005	-	-	**21**	0.03	24	0.12	0.04	1.5	<10	<1	2	<0.02
BH06S	2.5	27/06/2013	20	9.8	6.2	**3.6**	1	7.2	**6.7**	0.5	<0.005	<0.005	<0.005	<2	<2	<2	**38**	0.008	0.07	**0.06**	25	0.05	0.02	0.08	0.04	10	0.01	0.05	0.06	0.02	0.009	6	**38**	**0.06**	23	0.12	0.04	1.5	<10	<1	3	<0.02
BH06S	3	27/06/2013	19.5	9.1	6.3	**2.8**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	3.5	27/06/2013	19	8.6	4.3	**4.3**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	4	27/06/2013	18.5	9	**2.4**	**6.6**	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	4.5	27/06/2013	18	8.8	**2.2**	**6.6**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	5	27/06/2013	17.5	8.7	**2.1**	**6.6**	2	6.7	**4.6**	**2.1**	<0.005	0.02	0.02	<2	16	16	**36**	0.01	0.07	**0.06**	<5	<0.005	0.02	0.02	<0.005	<5	<0.005	0.05	0.05	<0.005	**0.031**	**19**	**36**	**0.06**	-	-	-	1.5	23	2	3	0.04
BH06S	5.5	27/06/2013	17	8.9	**2.9**	**6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH06S	6	27/06/2013	16.5	9	**3.3**	**5.7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH07	0.5	17/07/2013	23.25	6.9	6.3	0.6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH07	1	17/07/2013	22.75	5.2	4.7	0.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH07	1.5	17/07/2013	22.25	5.4	4.8	0.6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH07	2	17/07/2013	21.75	5.4	5	0.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH07	2.5	17/07/2013	21.25	5.3	4.6	0.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH07	3	17/07/2013	20.75	5.4	4.6	0.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH08	0.5	17/07/2013	23.75	8.1	7.2	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH08	1	17/07/2013	23.25	7.5	6.7	0.8	1	6.9	**5.6**	1.3	<0.005	<0.005	<0.005	<2	<2	<2	**25**	<0.005	0.04	**0.04**	17	0.03	0.02	0.06	0.03	11	0.01	0.02	0.03	0.02	-	-	**25**	**0.04**	-	-	-	1.5	<10	1	2	<0.02
BH08	1.5	17/07/2013	22.75	6.9	6.7	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH08	2	17/07/2013	22.25	5.8	5.6	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH08	2.5	17/07/2013	21.75	5.6	5.3	0.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH08	2.8	17/07/2013	21.45	5.4	4.4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1, Appendix C
Acid Sulfate Soil Investigation Results
Keane Road Pressure Main, Balannup
Acid Sulfate Soil and Dewatering Management Plan

				ASS - Field				ASS - pH			ASS - Acidity Trail						ASS - Sulfur Trail				ASS - Calcium Values					ASS - Magnesium Values					ASS - Potential Acidity		ASS - Net Acidity excl ANC		ASS - Excess ANC			ASS - Acid Base Accounting					
				pHF	pHFox	pH Difference (Field) - Calc	Reaction Rate	pH KCL	pHOX	pH Difference - Calc	s-TAA	s-TPA	s-TSA	Titratable Actual Acidity	TPA	TSA	a-SPOS	SKCl	SP	SPOS	a-CaA	CaA	CaKCL	CaP	sCaA	a-MgA	MgA	MgKCL	MgP	s-MgA	SCr (Sulfur Units)	SCr (Acidity Units)	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	a-ANCE	ANCE	s-ANCE	ANCFF	a-NetAcidity	Liming Rate	Liming Rate excluding ANC	s-NetAcidity
				pH Units	pH Units	pH Units	-	pH Units	pH Units	pH Units	% pyrite S	% pyrite S	% pyrite S	mole H+/t	mole H+/t	mole H+/t	mole H+/t	% S	% S	% S	mole H+/t	% Ca	% Ca	% Ca	% S	mole H+/t	% Mg	% Mg	% Mg	% S	% S	mole H+/t	mole H+/t	% CaCO3	% S	-	mole H+/t	kg CaCO3/t	kg CaCO3/t	% S
EQL				0.1	0.1		1	0.1	0.1		0.005	0.005	0.005	2	2	2	5	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	0.005	5	10	0.02	10	0.02	0.02	0.5	10	1	1	0.02
DEC 2013 ASS Criteria				**<4**	**<4**	**2**			**<4**	**2**	**0.03**	**0.03**	**0.03**	**18.7**	**18.7**	**18.7**	**18.7**			**0.03**											**0.03**	**18.7**	**18.7**	**0.03**								
LocCode	**Sample Depth**	**Sampled Date**	**Sample Elevation**																																							
BH09	0.5	17/07/2013	23.8	6.4	6.2	0.2	2	7	**4.4**	**2.6**	<0.005	<0.005	<0.005	<2	<2	<2	**31**	0.008	0.06	**0.05**	10	0.02	0.06	0.08	0.02	10	0.01	0.04	0.05	0.02	-	-	**31**	**0.05**	-	-	-	1.5	10	1	2	0.02
BH09	1	17/07/2013	23.3	6.3	6	0.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH09	1.5	17/07/2013	22.8	6.6	6.9	-0.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH09	2	17/07/2013	22.3	5.5	5.2	0.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH09	2.5	17/07/2013	21.8	6	5	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH09	3	17/07/2013	21.3	6	5.8	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH10	0.3	18/07/2013	23.1	7.2	7.1	0.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH10	1.5	18/07/2013	21.9	9.2	7.7	1.5	1	6.9	**7.1**	-0.2	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.07	0.06	<0.005	<5	<0.005	0.12	0.11	<0.005	-	-	<10	<0.02	37	0.18	0.06	1.5	<10	<1	<1	<0.02
BH10	2	18/07/2013	21.4	8.8	7.4	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH10	2.5	18/07/2013	20.9	8.6	7.3	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH10	3	18/07/2013	20.4	8	6.2	1.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	0.5	18/07/2013	23	9.5	7.9	1.6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	1	18/07/2013	22.5	8.3	7.6	0.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	1.5	18/07/2013	22	9.6	8.2	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	2	18/07/2013	21.5	8.9	6.8	**2.1**	1	6.2	**7.7**	-1.5	<0.005	<0.005	<0.005	2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.19	0.15	<0.005	<5	<0.005	0.29	0.26	<0.005	-	-	<10	<0.02	61	0.31	0.1	1.5	<10	<1	<1	<0.02
BH11	2.5	18/07/2013	21	9.6	6.6	**3**	1	6.7	**6.7**	0	<0.005	<0.005	<0.005	<2	<2	<2	18	<0.005	0.03	0.03	9	0.02	0.04	0.06	0.01	<5	<0.005	0.06	0.06	<0.005	-	-	18	0.03	18	0.09	0.03	1.5	<10	<1	1	<0.02
BH11	3	18/07/2013	20.5	9.1	7.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	3.5	18/07/2013	20	9.5	6.8	**2.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	4	18/07/2013	19.5	9.3	6	**3.3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH11	4.5	18/07/2013	19	9.2	**3.1**	**6.1**	1	6.4	**5.3**	1.1	<0.005	0.006	0.006	<2	4	4	16	<0.005	0.03	0.03	<5	<0.005	0.03	0.02	<0.005	<5	<0.005	0.04	0.03	<0.005	-	-	17	0.03	-	-	-	1.5	17	1	1	0.03
BH12	0.5	18/07/2013	23.25	8.8	6.9	1.9	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	1	18/07/2013	22.75	8.8	6.3	**2.5**	2	7.1	**6.2**	0.9	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.02	0.01	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	-	-	-	1.5	<10	<1	<1	<0.02
BH12	1.5	18/07/2013	22.25	7.3	5.9	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	2	18/07/2013	21.75	6.8	5.6	1.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	2.5	18/07/2013	21.25	4.5	**2**	**2.5**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	3	18/07/2013	20.75	5.8	**2.5**	**3.3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	3.5	18/07/2013	20.25	6.2	**2.7**	**3.5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH12	4	18/07/2013	19.75	5.6	**1.6**	**4**	2	5.8	**3.4**	**2.4**	<0.005	**0.04**	**0.04**	2	**26**	**24**	**33**	0.006	0.06	**0.05**	<5	<0.005	0.01	0.01	<0.005	<5	<0.005	0.02	0.02	<0.005	-	-	**36**	**0.06**	-	-	-	1.5	36	3	3	0.06
BH12	4.5	18/07/2013	19.25	5.6	**1.5**	**4.1**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	0.5	19/07/2013	24.25	6.1	**3.7**	**2.4**	2	6.2	**3.5**	**2.7**	<0.005	<0.005	<0.005	<2	<2	<2	8	<0.005	0.01	0.01	<5	<0.005	0.06	0.04	<0.005	<5	<0.005	0.02	0.01	<0.005	-	-	<10	0.02	-	-	-	1.5	<10	1	1	0.02
BH13	1	19/07/2013	23.75	6.2	4.4	1.8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	1.5	19/07/2013	23.25	6.3	5	1.3	1	6.3	**5.2**	1.1	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	-	-	-	1.5	<10	<1	<1	<0.02
BH13	2	19/07/2013	22.75	6.3	4.9	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	2.5	19/07/2013	22.25	5.7	4.8	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	2.8	19/07/2013	21.95	5.9	5	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	3.5	19/07/2013	21.25	5.7	4.8	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH13	3.5	25/07/2013	21.25	-	-	-	-	5.7	**5.1**	0.6	0.01	**0.04**	0.03	8	**27**	**19**	<5	<0.005	0.008	0.005	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	12	0.02	-	-	-	1.5	12	1	1	0.02
BH14	0.5	22/07/2013	24.4	**3.7**	4	-0.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	1.5	22/07/2013	23.4	**3.9**	**3.2**	0.7	1	6.7	**4.5**	**2.2**	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<0.005	<5	<10	<0.02	-	-	-	1.5	<10	<1	<1	<0.02
BH14	2	22/07/2013	22.9	4.4	**3.3**	1.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	2.5	22/07/2013	22.4	4.2	4	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	3	22/07/2013	21.9	4.3	**3.8**	0.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	3.3	22/07/2013	21.6	4.7	**3.8**	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	4.5	22/07/2013	20.4	4.6	**3.9**	0.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	5.5	22/07/2013	19.4	4.9	**3.8**	1.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH14	5.95	22/07/2013	18.95	5.2	4.4	0.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	0.5	23/07/2013	24.5	4.8	4.8	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	1	23/07/2013	24	4	4.6	-0.6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	1.5	23/07/2013	23.5	**3.9**	**3.6**	0.3	1	4.7	**2.4**	**2.3**	**0.2**	**0.84**	**0.64**	**123**	**521**	**398**	**51**	<0.005	0.08	**0.08**	<5	<0.005	0.005	0.005	<0.005	<5	<0.005	0.03	0.02	<0.005	-	-	**174**	**0.28**	-	-	-	1.5	174	13	13	0.28
BH15	2	23/07/2013	23	**3.6**	**3.2**	0.4	1	5.3	**4.2**	1.1	**0.09**	**0.2**	**0.11**	**55**	**125**	**70**	11	0.04	0.06	0.02	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	**66**	**0.11**	-	-	-	1.5	66	5	5	0.11
BH15	3.45	23/07/2013	21.55	4.8	4.4	0.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	4.5	23/07/2013	20.5	5.2	4.2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	4.95	23/07/2013	20.05	5.6	4.7	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	5.5	23/07/2013	19.5	5.6	4.2	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH15	5.95	23/07/2013	19.05	5.6	4.2	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH16	0.5	23/07/2013	23.9	5.2	5	0.2	1	6.8	**3.3**	**3.5**	<0.005	0.01	0.01	<2	8	8	<5	<0.005	<0.005	<0.005	<5	<0.005	0.006	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	-	-	-	1.5	<10	<1	<1	<0.02
BH16	1	23/07/2013	23.4	4.4	4.8	-0.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH16	1.5	23/07/2013	22.9	4.6	4.5	0.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH16	2	23/07/2013	22.4	**3.8**	**3.5**	0.3	1	5.2	**3.9**	1.3	**0.08**	**0.32**	**0.23**	**52**	**197**	**145**	**25**	<0.005	0.04	**0.04**	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	0.014	9	**77**	**0.12**	-	-	-	1.5	77	6	6	0.12
BH16	3	23/07/2013	21.4	4.7	4.4	0.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH16	4	23/07/2013	20.4	5.6	4.8	0.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH16	4.4	23/07/2013	20	5.5	4.5	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH16	4.5	23/07/2013	19.9	5.3	5.5	-0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH16	4.95	23/07/2013	19.45	5.4	4	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	3	25/07/2013	21.5	6.4	5.3	1.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	3.5	25/07/2013	21	7	4.7	**2.3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	4	25/07/2013	20.5	7.6	4.9	**2.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	4.5	25/07/2013	20	7.8	4.8	**3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	5	25/07/2013	19.5	7.3	4.4	**2.9**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	5.5	25/07/2013	19	6.9	**2.1**	**4.8**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	6	25/07/2013	18.5	7.1	**3.3**	**3.8**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1, Appendix C
Acid Sulfate Soil Investigation Results
Keane Road Pressure Main, Balannup
Acid Sulfate Soil and Dewatering Management Plan

				ASS - Field				ASS - pH			ASS - Acidity Trail						ASS - Sulfur Trail				ASS - Calcium Values					ASS - Magnesium Values					ASS - Potential Acidity		ASS - Net Acidity excl ANC		ASS - Excess ANC			ASS - Acid Base Accounting					
				pHF	pHFox	pH Difference (Field) - Calc	Reaction Rate	pH KCL	pHOX	pH Difference - Calc	s-TAA	s-TPA	s-TSA	Titratable Actual Acidity	TPA	TSA	a-SPOS	SKCl	SP	SPOS	a-CaA	CaA	CaKCL	CaP	sCaA	a-MgA	MgA	MgKCL	MgP	s-MgA	SCr (Sulfur Units)	SCr (Acidity Units)	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	a-ANCE	ANCE	s-ANCE	ANCFF	a-NetAcidity	Liming Rate	Liming Rate excluding ANC	s-NetAcidity
				pH Units	pH Units	pH Units	-	pH Units	pH Units	pH Units	% pyrite S	% pyrite S	% pyrite S	mole H+/t	mole H+/t	mole H+/t	mole H+/t	% S	% S	% S	mole H+/t	% Ca	% Ca	% Ca	% S	mole H+/t	% Mg	% Mg	% Mg	% S	% S	mole H+/t	mole H+/t	% S	mole H+/t	% CaCO3	% S	-	mole H+/t	kg CaCO3/t	kg CaCO3/t	% S
EQL				0.1	0.1		1	0.1	0.1		0.005	0.005	0.005	2	2	2	5	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	0.005	5	10	0.02	10	0.02	0.02	0.5	10	1	1	0.02
DEC 2013 ASS Criteria				**<4**	**<4**	**2**			**<4**	**2**	**0.03**	**0.03**	**0.03**	**18.7**	**18.7**	**18.7**	**18.7**			**0.03**											**0.03**	**18.7**	**18.7**	**0.03**								
LocCode	**Sample Depth**	**Sampled Date**	**Sample Elevation**																																							
BH18	0.5	25/07/2013	23.5	4.5	5.7	-1.2	1	6	**4.1**	1.9	<0.005	**0.05**	**0.05**	<2	**30**	**29**	<5	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	-	-	-	1.5	<10	<1	<1	<0.02
BH18	1	25/07/2013	23	4.9	5.7	-0.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	1.5	25/07/2013	22.5	5.5	**3**	**2.5**	2	6.7	**3.3**	**3.4**	<0.005	0.03	0.03	<2	17	17	<5	<0.005	0.006	0.006	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<0.005	<5	<10	<0.02	-	-	-	1.5	12	1	<1	0.02
BH18	2	25/07/2013	22	5.4	5.3	0.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	2.5	25/07/2013	21.5	5.4	**2.1**	**3.3**	2	5.7	**3.3**	**2.4**	0.02	**0.08**	**0.07**	11	**53**	**42**	**30**	0.006	0.05	**0.05**	<5	<0.005	0.01	<0.005	<0.005	<5	<0.005	0.04	0.03	<0.005	0.018	11	**41**	**0.07**	-	-	-	1.5	41	3	3	0.07
BH18	3	25/07/2013	21	6.3	**2.3**	**4**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	3.5	25/07/2013	20.5	6.1	**2.4**	**3.7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	4	25/07/2013	20	5.8	**3.1**	**2.7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	4.5	25/07/2013	19.5	5.8	4.5	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	5	25/07/2013	19	7	**2.4**	**4.6**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	5.5	25/07/2013	18.5	6.7	**2**	**4.7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH18	6	25/07/2013	18	6.8	**2.5**	**4.3**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	0.5	25/07/2013	23.4	5.7	5.9	-0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	1	25/07/2013	22.9	9	6.2	**2.8**	1	6.3	**6.8**	-0.5	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	0.02	0.02	<0.005	<5	<0.005	0.11	0.08	<0.005	<0.005	<5	<10	<0.02	16	0.08	0.02	1.5	<10	<1	<1	<0.02
BH19	1.5	25/07/2013	22.4	9.1	6.2	**2.9**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	2	25/07/2013	21.9	10.3	6	**4.3**	1	6.6	**6.4**	0.2	<0.005	<0.005	<0.005	<2	<2	<2	15	<0.005	0.02	0.02	<5	<0.005	0.02	0.01	<0.005	<5	<0.005	0.07	0.07	<0.005	0.008	<5	15	0.02	-	-	-	1.5	<10	<1	1	<0.02
BH19	3	25/07/2013	20.9	10.1	6.4	**3.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	3.5	25/07/2013	20.4	10.2	6.2	**4**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	4	25/07/2013	19.9	10.2	6.3	**3.9**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	4.5	25/07/2013	19.4	9.4	**3**	**6.4**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	5	25/07/2013	18.9	9.4	**2.4**	**7**	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	5.5	25/07/2013	18.4	9.4	**2.8**	**6.6**	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH19	6	25/07/2013	17.9	10	6.3	**3.7**	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	0.5	25/07/2013	23.1	6.5	5.8	0.7	1	6.9	**4.4**	**2.5**	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	-	-	<10	<0.02	-	-	-	1.5	<10	<1	<1	<0.02
BH20	1	25/07/2013	22.6	6.2	5.8	0.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	1.5	25/07/2013	22.1	6.8	5.9	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	2	25/07/2013	21.6	6.1	5.9	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	2.5	25/07/2013	21.1	8.1	6	**2.1**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	3	25/07/2013	20.6	9.4	6.4	**3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	3.5	25/07/2013	20.1	9.6	6.4	**3.2**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	4	25/07/2013	19.6	9.5	6.5	**3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	4.5	25/07/2013	19.1	8.9	6.4	**2.5**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	5	25/07/2013	18.6	9.1	6.1	**3**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	5.5	25/07/2013	18.1	8.7	**2.2**	**6.5**	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH20	6	25/07/2013	17.6	8.7	6	**2.7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	0.5	25/07/2013	23.25	6.1	5.9	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	1	25/07/2013	22.75	6.3	5.4	0.9	1	5.7	**3.1**	**2.6**	0.03	**0.39**	**0.36**	**20**	**242**	**223**	**68**	<0.005	0.11	**0.11**	<5	0.005	0.02	0.02	<0.005	<5	<0.005	0.06	0.05	<0.005	-	-	**87**	**0.14**	-	-	-	1.5	87	7	7	0.14
BH21	1.5	25/07/2013	22.25	6.5	4.8	1.7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	2	25/07/2013	21.75	7.2	4.3	**2.9**	3	5.7	**2.8**	**2.9**	0.02	**0.26**	**0.25**	11	**164**	**153**	**78**	<0.005	0.13	**0.12**	<5	0.008	0.02	0.03	0.006	<5	<0.005	0.06	0.06	<0.005	<0.005	<5	**89**	**0.14**	-	-	-	1.5	89	7	7	0.14
BH21	2.5	25/07/2013	21.25	4.3	**2.1**	**2.2**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	3	25/07/2013	20.75	6.8	**2.9**	**3.9**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	3.5	25/07/2013	20.25	7.6	**3.2**	**4.4**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	4	25/07/2013	19.75	7.8	5.8	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	4.5	25/07/2013	19.25	7.6	5	**2.6**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	5	25/07/2013	18.75	7.4	**3.8**	**3.6**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	5.5	25/07/2013	18.25	7.5	**1.6**	**5.9**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH21	6	25/07/2013	17.75	7.3	**1.8**	**5.5**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	0.5	26/07/2013	23.3	5.6	5.8	-0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	1	26/07/2013	22.8	5.1	5.7	-0.6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	1.5	26/07/2013	22.3	6.6	5.7	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	2	26/07/2013	21.8	4.5	**3.8**	0.7	1	5.2	**2.5**	**2.7**	**0.08**	**0.47**	**0.39**	**48**	**293**	**245**	**46**	<0.005	0.08	**0.07**	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	0.01	0.01	<0.005	0.006	<5	**94**	**0.15**	-	-	-	1.5	94	7	7	0.15
BH22	2.5	26/07/2013	21.3	5.7	4.4	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	3	26/07/2013	20.8	5.5	4.6	0.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	3.5	26/07/2013	20.3	6.6	4.6	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	4	26/07/2013	19.8	6.8	4.4	**2.4**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	4.5	26/07/2013	19.3	6.6	**1.7**	**4.9**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	5	26/07/2013	18.8	6.6	**3.9**	**2.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	5.5	26/07/2013	18.3	6.4	**2.6**	**3.8**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH22	6	26/07/2013	17.8	6.7	**1.7**	**5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	0.5	26/07/2013	22.9	5.6	5.6	0	1	6.6	**3.5**	**3.1**	<0.005	0.02	0.02	<2	14	14	11	<0.005	0.02	0.02	<5	<0.005	<0.005	0.008	<0.005	<5	<0.005	0.006	0.008	<0.005	-	-	11	0.02	-	-	-	1.5	13	1	1	0.02
BH23	1	26/07/2013	22.4	6	6.5	-0.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	1.5	26/07/2013	21.9	5.3	**3.8**	1.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	2	26/07/2013	21.4	5.4	5.2	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	2.5	26/07/2013	20.9	5.3	5.1	0.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	3	26/07/2013	20.4	5.8	**2.3**	**3.5**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	3.5	26/07/2013	19.9	6	**2.3**	**3.7**	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	4	26/07/2013	19.4	7.5	4.3	**3.2**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	4.5	26/07/2013	18.9	6.8	**2.5**	**4.3**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	5	26/07/2013	18.4	6.6	**2.2**	**4.4**	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	5.5	26/07/2013	17.9	7.2	**2.6**	**4.6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH23	6	26/07/2013	17.4	7.1	**2.9**	**4.2**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1, Appendix C
Acid Sulfate Soil Investigation Results
Keane Road Pressure Main, Balannup
Acid Sulfate Soil and Dewatering Management Plan

				ASS - Field				ASS - pH			ASS - Acidity Trail						ASS - Sulfur Trail				ASS - Calcium Values					ASS - Magnesium Values					ASS - Potential Acidity		ASS - Net Acidity excl A		ASS - Excess ANC			ASS - Acid Base Accounting					
				pHF	pHFox	pH Difference (Field) - Calc	Reaction Rate	pH KCL	pHOX	pH Difference - Calc	s-TAA	s-TPA	s-TSA	Titratable Actual Acidity	TPA	TSA	a-SPOS	SKCl	SP	SPOS	a-CaA	CaA	CaKCL	CaP	sCaA	a-MgA	MgA	MgKCL	MgP	s-MgA	SCr (Sulfur Units)	SCr (Acidity Units)	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	a-ANCE	ANCE	s-ANCE	ANCFF	a-NetAcidity	Liming Rate	Liming Rate excluding ANC	s-NetAcidity
				pH Units	pH Units	pH Units	-	pH Units	pH Units	pH Units	% pyrite S	% pyrite S	% pyrite S	mole H+/t	mole H+/t	mole H+/t	mole H+/t	% S	% S	% S	mole H+/t	% Ca	% Ca	% Ca	% S	mole H+/t	% Mg	% Mg	% Mg	% S	% S	mole H+/t	mole H+/t	% S	mole H+/t	% CaCO3	% S	-	mole H+/t	kg CaCO3/t	kg CaCO3/t	% S
EQL				0.1	0.1		1	0.1	0.1		0.005	0.005	0.005	2	2	2	5	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	5	0.005	0.005	0.005	0.005	0.005	5	10	0.02	10	0.02	0.02	0.5	10	1	1	0.02
DEC 2013 ASS Criteria				**<4**	**<4**	**2**			**<4**	**2**	**0.03**	**0.03**	**0.03**	**18.7**	**18.7**	**18.7**	**18.7**			**0.03**											**0.03**	**18.7**	**18.7**	**0.03**								
LocCode	**Sample Depth**	**Sampled Date**	**Sample Elevation**																																							
BH24	0.5	26/07/2013	22.4	8.8	6.3	**2.5**	2	6.2	**6.1**	0.1	<0.005	<0.005	<0.005	<2	<2	<2	7	0.006	0.02	0.01	<5	<0.005	0.03	0.03	<0.005	<5	<0.005	0.14	0.15	<0.005	-	-	<10	<0.02	-	-	-	1.5	<10	1	1	<0.02
BH24	1.5	26/07/2013	21.4	8.1	5.8	**2.3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	2	26/07/2013	20.9	8.8	**2.8**	**6**	4	6.2	**4.7**	1.5	<0.005	<0.005	<0.005	<2	<2	<2	**21**	<0.005	0.04	0.03	<5	<0.005	0.02	0.01	<0.005	<5	<0.005	0.07	0.06	<0.005	0.017	11	**22**	**0.04**	-	-	-	1.5	22	2	2	0.04
BH24	2.5	26/07/2013	20.4	7.9	4.6	**3.3**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	3	26/07/2013	19.9	7.8	4.3	**3.5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	3.5	26/07/2013	19.4	8	4.5	**3.5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	4	26/07/2013	18.9	8.3	**3.6**	**4.7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	4.5	26/07/2013	18.4	7.6	**2.2**	**5.4**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	5	26/07/2013	17.9	8.2	**2.4**	**5.8**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	5.5	26/07/2013	17.4	8.2	**2.4**	**5.8**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH24	6	26/07/2013	16.9	7.3	**3.7**	**3.6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	0.5	26/07/2013	22.25	8.8	6.9	1.9	3	6.7	**7.4**	-0.7	<0.005	<0.005	<0.005	<2	<2	<2	<5	0.005	<0.005	<0.005	<5	<0.005	0.03	<0.005	<0.005	<5	<0.005	0.14	<0.005	<0.005	-	-	<10	<0.02	47	0.24	0.08	1.5	<10	<1	<1	<0.02
BH25	1	26/07/2013	21.75	8.4	6.1	**2.3**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	1.5	26/07/2013	21.25	7.9	6.1	1.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	2	26/07/2013	20.75	9.3	6.8	**2.5**	1	7	**7**	0	<0.005	<0.005	<0.005	<2	<2	<2	<5	0.007	0.007	<0.005	<5	<0.005	0.03	0.03	<0.005	41	0.05	0.11	0.16	0.07	-	-	<10	<0.02	48	0.24	0.08	1.5	<10	<1	<1	<0.02
BH25	2.5	26/07/2013	20.25	9.4	6.8	**2.6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	3	26/07/2013	19.75	9.2	6.3	**2.9**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	3.5	26/07/2013	19.25	9.2	**2.9**	**6.3**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	4	26/07/2013	18.75	8.8	**3.2**	**5.6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	4.5	26/07/2013	18.25	8.6	4.4	**4.2**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	5	26/07/2013	17.75	8.9	**3.9**	**5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	5.5	26/07/2013	17.25	8.1	4	**4.1**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH25	6	26/07/2013	16.75	8.6	**2.6**	**6**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	0.5	26/07/2013	21.8	9.7	6.9	**2.8**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	1	26/07/2013	21.3	9.3	6.4	**2.9**	2	9.3	**7.8**	1.5	<0.005	<0.005	<0.005	<2	<2	<2	<5	0.02	0.02	<0.005	159	0.32	0.16	0.48	0.25	36	0.04	0.06	0.1	0.06	-	-	<10	<0.02	274	1.37	0.44	1.5	<10	<1	<1	<0.02
BH26	1.5	26/07/2013	20.8	8.5	6.1	**2.4**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	2	26/07/2013	20.3	8.1	6	**2.1**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	2.5	26/07/2013	19.8	7.4	5.9	1.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	3	26/07/2013	19.3	8.1	**1.6**	**6.5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	3.5	26/07/2013	18.8	8.2	**1.7**	**6.5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	4	26/07/2013	18.3	9.3	5.8	**3.5**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	4.5	26/07/2013	17.8	9	6.1	**2.9**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	5	26/07/2013	17.3	7.8	5.9	1.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	5.5	26/07/2013	16.8	9	5.9	**3.1**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH26	6	26/07/2013	16.3	8	6.3	1.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	0.5	27/07/2013	21.8	8.7	6.3	**2.4**	1	7.7	**7.1**	0.6	<0.005	<0.005	<0.005	<2	<2	<2	<5	0.006	0.007	<0.005	<5	<0.005	0.03	0.02	<0.005	31	0.04	0.1	0.14	0.05	-	-	<10	<0.02	64	0.32	0.1	1.5	<10	<1	<1	<0.02
BH27	1	27/07/2013	21.3	8.4	6.2	**2.2**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	1.5	27/07/2013	20.8	8.3	6.1	**2.2**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	2	27/07/2013	20.3	7.4	6	1.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	2.5	27/07/2013	19.8	9	6.3	**2.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	3	27/07/2013	19.3	8.2	5.7	**2.5**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	3.5	27/07/2013	18.8	8.8	**2**	**6.8**	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	4	27/07/2013	18.3	9.3	**2.3**	**7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	4.5	27/07/2013	17.8	9	5.3	**3.7**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	5	27/07/2013	17.3	9.1	5.7	**3.4**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH27	5.5	27/07/2013	16.8	8.8	6.1	**2.7**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH28	0.5	18/07/2013	22.8	8.8	7.6	1.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH28	1	18/07/2013	22.3	9.5	8.1	1.4	1	8.4	**7.5**	0.9	<0.005	<0.005	<0.005	<2	<2	<2	**30**	0.01	0.06	**0.05**	21	0.04	0.07	0.12	0.03	48	0.06	0.1	0.16	0.08	-	-	**30**	**0.05**	105	0.53	0.17	1.5	<10	<1	2	<0.02
BH28	1.5	18/07/2013	21.8	9	8.3	0.7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH28	2	18/07/2013	21.3	8.4	**3.4**	**5**	1	7.9	**5.5**	**2.4**	<0.005	<0.005	<0.005	<2	2	2	**78**	0.03	0.16	**0.12**	16	0.03	0.08	0.11	0.03	13	0.02	0.11	0.12	0.02	**0.067**	**42**	**78**	**0.12**	-	-	-	1.5	28	2	6	0.04
BH28	2.5	18/07/2013	20.8	9.2	7.9	1.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH28	3	18/07/2013	20.3	8.4	7.6	0.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Statistical Summary

Number of Results	268	268	268	268	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	16	16	52	52	19	19	19	52	52	52	52	52	52
Number of Detects	268	268	268	268	52	52	52	11	19	19	13	20	20	28	19	35	31	13	15	42	40	14	12	12	37	37	14	10	7	28	29	19	19	19	52	21	24	30	22
Minimum Concentration	3.6	1.5	-1.2	1	4.7	2.4	-1.5	<0.005	<0.005	<0.005	<2	<2	<2	<5	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<5	<0.005	<0.005	<0.005	<0.005	<0.005	<5	<10	<0.02	16	0.08	0.02	1.5	<10	<1	<1	<0.02
Minimum Detect	3.6	1.5	ND	1	4.7	2.4	ND	0.01	0.006	0.006	2	2	2	7	0.005	0.006	0.005	8	0.005	0.005	0.005	0.006	6	0.007	0.006	0.006	0.005	0.006	6	10	0.02	16	0.08	0.02	1.5	10	1	1	0.02
Maximum Concentration	10.3	8.7	7	4	9.7	9.3	4	0.22	1.11	0.89	137	695	558	83	0.04	0.16	0.13	2670	5.36	0.43	5.58	4.28	48	0.06	0.29	0.26	0.08	0.067	42	220	0.35	3560	17.8	5.71	1.5	220	17	17	0.35
Maximum Detect	10.3	8.7	7	4	9.7	9.3	4	0.22	1.11	0.89	137	695	558	83	0.04	0.16	0.13	2670	5.36	0.43	5.58	4.28	48	0.06	0.29	0.26	0.08	0.067	42	220	0.35	3560	17.8	5.71	1.5	220	17	17	0.35
Average Concentration	7.4	5.1	2.3	1.4	6.8	5.4	1.5	0.019	0.1	0.084	11	62	52	20	0.0055	0.036	0.031	71	0.14	0.062	0.19	0.11	6.9	0.008	0.043	0.044	0.01	0.014	9	31	0.051	287	1.4	0.46	1.5	30	2.4	2.5	0.049
Median Concentration	7.8	5.6	2.2	1	6.7	5.4	1.7	0.0025	0.0025	0.0025	1	1	1	9	0.0025	0.02	0.015	2.5	0.0025	0.02	0.02	0.0025	2.5	0.0025	0.02	0.02	0.0025	0.007	2.5	11.5	0.02	47	0.24	0.08	1.5	5	0.5	1	0.01
Standard Deviation	1.6	1.7	1.8	0.71	1.2	1.8	1.2	0.045	0.23	0.19	28	146	120	23	0.0068	0.041	0.037	372	0.75	0.095	0.78	0.6	11	0.014	0.053	0.054	0.019	0.018	11	45	0.07	804	4	1.3	0	49	3.7	3.3	0.078
Number of Guideline Exceedances	0	0	143	0	0	0	19	6	14	13	7	14	14	19	0	0	17	0	0	0	0	0	0	0	0	0	0	3	3	20	19	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	143	0	0	0	19	6	14	13	7	14	14	19	0	0	17	0	0	0	0	0	0	0	0	0	0	3	3	20	19	0	0	0	0	0	0	0	0

Reaction Rate

1	Slight
2	Moderate
3	Strong
4	Extreme

Table 2, Appendix C
Acid Sulfate Soil Investigation Results
Keane Road Pressure Main, Balannup
Acid Sulfate Soil and Dewatering Management Plan

			Inorganics				Nutrients						Major Ions						Acidity	Alkalinity				Metals															
			Electrical conductivity *(lab)	pH (Lab)	Sulphide	Total Dissolved Solids	Ammonia as N	Kjeldahl Nitrogen Total	Nitrogen (Total Oxidised)	Nitrogen (Total)	Phosphorus	Reactive Phosphorus as P	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate (Filtered)	Acidity as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Carbonate Alkalinity as CaCO3	Aluminium	Aluminium (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Zinc (Filtered)
			uS/cm	pH Units	mg/L	mg/L	µg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			1	0.01	0.1	10	10	0.1	0.01	100	0.01	0.01	1	1	1	1	1	1	1	1	1	1	1	0.01	0.01	0.001	0.0001	0.001	0.001	0.001	0.05	0.05	0.001	0.001	0.001	0.01	0.005
ANZECC 2000 Freshwater							**2632**																	**0.027**	**0.027**		**0.00006**	**0.00001**		**0.001**			**0.001**	**1.2**	**0.008**	**0.005**	**0.0024**
ANZECC 2000 Short-term Irrigation										***25000***														***20***	***20***	***2***	***0.05***	***1***	***0.1***	***5***	***10***	***10***	***10***	***10***	***2***	***0.05***	***5***
Field ID	**Date**	**Lab Report Number**																																				
BH01	12/08/2013	EP1306149	531	7.43	0.2	398	50	1.2	6.52	7700	<0.05	0.01	84	30	11	6	29	55	22	199	<1	199	<1	**0.51**	**0.08**	<0.001	<0.0001	<0.001	<0.001	**0.002**	0.6	0.08	**0.002**	0.015	<0.001	<0.01	<0.005
BH03	12/08/2013	EP1306149	652	6.09	<0.1	570	880	4.8	12.2	17,000	0.33	0.25	58	80	14	18	51	104	113	100	<1	100	<1	**1.42**	**0.35**	0.001	<0.0001	<0.001	0.001	<0.001	1.01	0.6	<0.001	0.086	0.001	<0.01	**0.007**
BH06/N	12/08/2013	EP1306149	10,800	6.84	2.4	9880	140	5	<0.05	5000	0.4	<0.01	47	3470	149	12	1940	146	101	415	<1	415	<1	***68.7***	**0.11**	0.002	<0.0001	**0.005**	0.003	0.001	***32.1***	1.32	0.001	0.591	0.004	<0.01	<0.005
BH08	12/08/2013	EP1306149	173	5.83	<0.1	212	60	1.4	0.28	1700	0.04	<0.01	10	23	3	1	25	57	30	11	<1	11	<1	**0.68**	**0.2**	<0.001	<0.0001	**0.002**	<0.001	**0.002**	2.66	1.74	<0.001	0.024	0.003	<0.01	**0.025**
BH10	13/08/2013	EP1306178	852	7.31	<0.1	1520	60	10.1	0.1	10,200	0.83	<0.01	11	101	15	2	165	52	40	274	<1	274	<1	***184***	**0.85**	0.002	<0.0001	**0.001**	<0.001	**0.005**	***52.6***	0.42	0.001	0.025	0.002	<0.01	**0.008**
BH11	13/08/2013	EP1306178	1580	7.84	<0.1	2180	20	0.9	0.02	900	0.16	<0.01	16	64	22	2	353	84	20	702	<1	702	<1	**16.7**	0.01	0.003	<0.0001	<0.001	0.001	**0.003**	***18.5***	<0.05	<0.001	0.151	0.004	<0.01	<0.005
BH12	13/08/2013	EP1306178	628	7.15	<0.1	600	50	4.2	4.31	8500	0.31	<0.01	67	38	20	2	43	97	36	167	<1	167	<1	***26.1***	**0.81**	0.004	<0.0001	**0.004**	0.002	**0.006**	***76***	1.07	**0.004**	0.091	0.006	<0.01	**0.008**
BH13	13/08/2013	EP1306178	375	6.3	<0.1	760	20	9	0.13	9100	8.17	<0.01	13	65	6	6	54	54	98	18	<1	18	<1	***540***	**0.04**	<0.001	<0.0001	<0.001	0.005	**0.002**	9.52	0.23	<0.001	0.097	<0.001	<0.01	<0.005
BH28	13/08/2013	EP1306178	20,800	7.12	<0.1	14,300	200	2.7	<0.01	2700	0.1	<0.01	97	7940	478	17	4640	727	65	368	<1	368	<1	**3.21**	0.02	0.002	<0.0001	**0.006**	0.014	**0.006**	9.78	3.79	<0.001	**1.5**	**0.021**	<0.01	**0.024**
Statistical Summary																																						
Number of Results			9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Number of Detects			9	9	2	9	9	9	7	9	8	2	9	9	9	9	9	9	9	9	0	9	0	9	9	6	0	5	6	8	9	8	4	9	7	0	5
Minimum Concentration			173	5.83	<0.1	212	20	0.9	<0.01	900	0.04	<0.01	10	23	3	1	25	52	20	11	<1	11	<1	0.51	0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	0.6	<0.05	<0.001	0.015	<0.001	<0.01	<0.005
Minimum Detect			173	5.83	0.2	212	20	0.9	0.02	900	0.04	0.01	10	23	3	1	25	52	20	11	ND	11	ND	0.51	0.01	0.001	ND	0.001	0.001	0.001	0.6	0.08	0.001	0.015	0.001	ND	0.007
Maximum Concentration			20,800	7.84	2.4	14,300	880	10.1	12.2	17,000	8.17	0.25	97	7940	478	18	4640	727	113	702	<1	702	<1	540	0.85	0.004	<0.0001	0.006	0.014	0.006	76	3.79	0.004	1.5	0.021	<0.01	0.025
Maximum Detect			20,800	7.84	2.4	14,300	880	10.1	12.2	17,000	8.17	0.25	97	7940	478	18	4640	727	113	702	ND	702	ND	540	0.85	0.004	ND	0.006	0.014	0.006	76	3.79	0.004	1.5	0.021	ND	0.025
Average Concentration			4043	6.9	0.33	3380	164	4.4	2.6	6978	1.2	0.033	45	1312	80	7.3	811	153	58	250	0.5	250	0.5	93	0.27	0.0017	0.00005	0.0022	0.0031	0.0031	23	1	0.0012	0.29	0.0047	0.005	0.0091
Median Concentration			652	7.12	0.05	760	60	4.2	0.13	7700	0.31	0.005	47	65	15	6	54	84	40	199	0.5	199	0.5	16.7	0.11	0.002	0.00005	0.001	0.001	0.002	9.78	0.6	0.0005	0.091	0.003	0.005	0.007
Standard Deviation			7129	0.67	0.78	5097	275	3.3	4.3	5064	2.6	0.081	34	2730	156	6.7	1563	218	37	221	0	221	0	178	0.33	0.0012	0	0.0022	0.0044	0.0021	26	1.2	0.0012	0.49	0.0064	0	0.0091
Number of Guideline Exceedances			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	7	0	9	9	0	7	4	0	2	1	1	9	9
Number of Guideline Exceedances(Detects Only)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	7	0	0	5	0	7	4	0	2	1	1	0	5

Appendix D – Dewatering Schematic

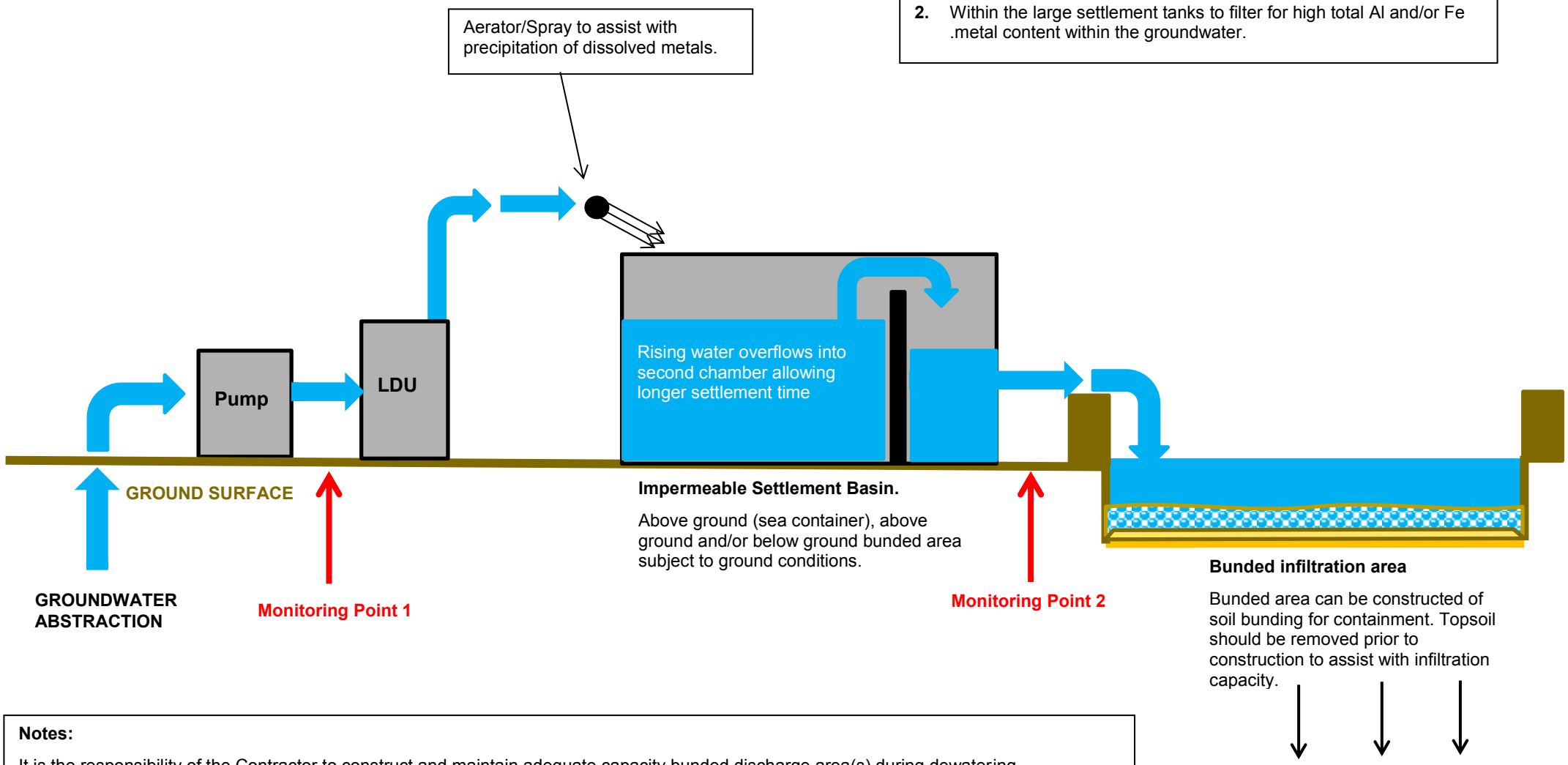
Example of Dewatering Treatment System

Geotextile Installation Notes

Geotextile only installed if effluent exceeds STI guideline post-retention (Principal's Environmental Consultant to advise when/if required.

Geotextile (pore size <0.3 mm) must be installed where either at:

1. At the base of the bunded discharge point OR
2. Within the large settlement tanks to filter for high total Al and/or Fe .metal content within the groundwater.



Notes:

It is the responsibility of the Contractor to construct and maintain adequate capacity bunded discharge area(s) during dewatering.

Lime Dosing Unit (LDU) is required if the pH is less than 6.00.

Schematic is not to scale and is a guide for treatment systems only.

Appendix E – Contractor Daily Record Sheets

DEWATERING FIELD RECORD SHEET

Date	Time	Flow rate (L/s)	Daily Total Volume of Dewatering Effluent (kL)	Water Quality Meter Calibrated?	Monitoring Point 1 (Before Treatment)				Monitorign point 2 (After Treatment)				kg of Lime used	Aeration/Settlement Tank in use? Inc geotextile fabric?	Discharge Location	Comments (filtered for acidity/alkalinity) / observations (colour, sediment load, odour)
					pH	EC (µS/cm)	TTA (mg/L)	TTAlk (mg/L)	pH	EC (µS/cm)	TTA (mg/L)	TTAlk (mg/L)				
Dewatering effluent pH is to remain >pH 6.75 and acidity is to be below 40 mg/L. If water quality falls 'outside' the aforementioned criteria, the Superintentendent's Representative (Water Corporation) and the nominated Environmental Consultant should be notified immediately.																

GROUNDWATER WELL FIELD MONITORING RECORD

Date	Time	Sampler	Well ID	Total Depth of Well (m TOC)	Depth to Water Level (m TOC)	Water Column (m)	Litres to purge *	pH	EC (µS/cm)	TTA (mg/L)	TAAlk (mg/L)	Comments: Condition of headworks, requirement for filtering and observations noted (colour, sediment load, odour)

Notes:
* Litres to purge = Water column (m) x 6
m TOC denotes measurements to be taken from top of the PVC casing

Contractor:	Acid Sulfate Soil Stockpile Report

	Comments	Onsite Person Responsible
Stockpile #		
Stockpile Location		
Where has the material come from?		
When was it first excavated?		
What is the volume of the stockpile?		
How much ag-lime is needed?		
What date was it treated / mixed?		
What date was it tested?		
Where has it been used for backfill?		

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