WorleyParsons Consulting

EcoNomics

ESSO AUSTRALIA PTY LTD

Longford Liquids Pipeline Replacement Project

Acid Sulfate Soil Characterisation Report

WP-RPT-355-EN008

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Geotechnical
Level 12, 333 Collins Street
Melbourne
VIC 3000
Australia
Telephone: +61 3 8676 3500
Facsimile: +61 3 8676 3505
www.worleyparsons.com
ABN 61 001 279 812

SYNOPSIS

This report presents the results of the preliminary Acid Sulfate Soils characterisation study undertaken for the Esso Pipeline Replacement Project. The purpose of the investigation was to identify whether Acid Sulfate Soils or Potentially Acid Sulfate Soils are present within the project survey envelope.

The results of the investigation identified that within the survey envelope soils are present with acidity which exceed the EPA screening criteria for Acid Sulfate Soils. The soils however have low concentrations of sulfur and, as a result, it can be inferred that there is not widespread Acid Sulfate Soil present within the survey envelope, but widespread acidic soils. It is noted that the nature and formation of Acid Sulfate Soils is such that they can be encountered in localised areas. Therefore Acid Sulfate Soils or Potential Acid Sulfate Soils may still be encountered in localised areas within the construction right of way.

The management of acidic soils will be addressed in the construction environmental management plan (CEMP) in accordance with the Pipelines Act (2005). Consultation with the relevant government agencies will occur in the course of developing the CEMP.

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PROJECT - LONGFORD LIQUIDS PIPELINE REPLACEMENT PROJECT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CUSTOMER APPROVAL	DATE
A	DRAFT issued for internal review	LBM	LPG		18-01-14	N/A	
B	DRAFT issued squad check	LBM	LPG	AE	20-01-14		
0	Issued for use	LBM	LPG	AE	10-02-14		

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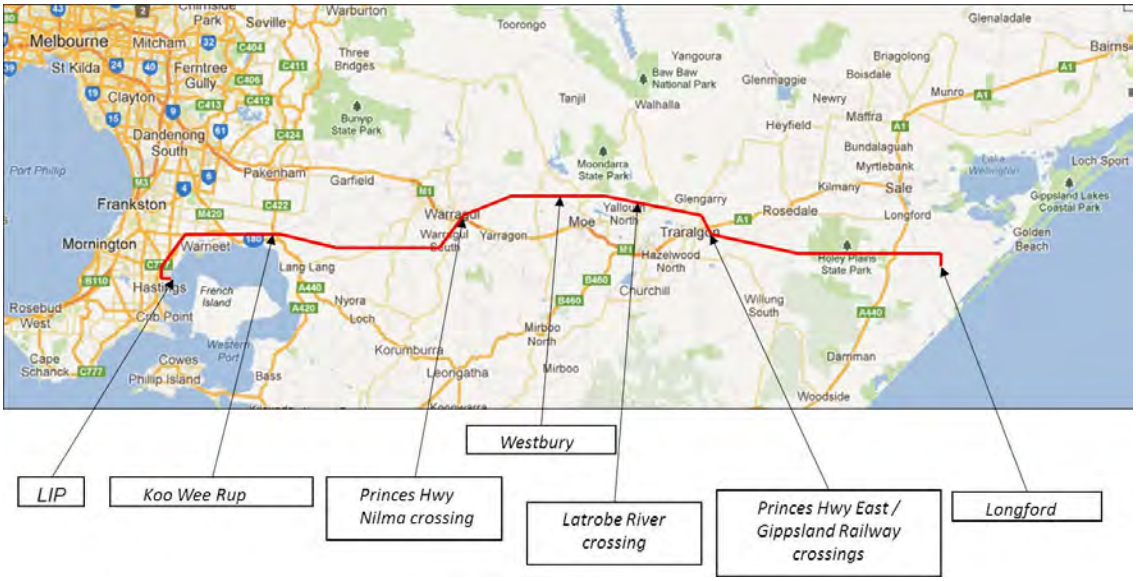
Appendices

1. INTRODUCTION

Esso Australia Pty Ltd (EAPL) currently transports liquids in a pipeline between the Longford Crude Stabilisation Plant in Longford and the Long Island Point Tank Farm in Hastings (Inset 1). The pipeline (LFD700, approximately 187 km long) was constructed in 1969 and the 86 km section between Longford and Westbury was replaced in 1980. The existing pipeline is proposed for replacement, due to pipeline integrity and projected future flows. It is proposed to replace the pipeline with a new generation, smaller capacity pipeline within the existing easement. The starting point of the replacement pipeline is the pig-trap at the Longford Crude Stabilisation Plant Kilometre Point 0 (KP0) with the end point being the pig-trap at the Long Island Point (LIP) Tank Farm (KP186.62).

Inset 1: Pipeline Alignment



A desktop investigation into the expected ground conditions within the survey envelope[1] identified the potential for Acid Sulfate Soils to be present in some areas. Given the potential environmental impact that may result from disturbance of Acid Sulfate Soil (ASS) and Potential Acid Sulfate Soil (PASS), a study was commissioned during the Front End Engineering Design (FEED) phase of the project to characterise the soils within the survey envelope with respect to ASS and PASS, and to identify whether widespread ASS and PASS were present. The presence of ASS and PASS may significantly impact the construction methodology required. This report presents the findings of the PASS and ASS characterisation study.

2. ABOUT ACID SULFATE SOILS AND ROCK

Acid sulfate soils and rocks have high sulfide content and when exposed to the air, oxidise, producing sulfuric acid, which can leach off into the environment. Sulfide is present in many soils and rock but if present at low concentrations in these soils and rocks, the risk of environmental impact is minimal.

Metal sulfides are present in some older geological formations including ore deposits rich in metals and coal deposits. However the materials of more concern on this project were the ASS that is often found in soils which have been deposited in low lying coastal areas, estuaries, lakes and swamps. These materials often appear as soft black, dark grey or greenish, often with visibly high organic content or pyrite ('fool's gold'). These deposits are often present below or just above high tide level, between 5 m to 20 m above Australian Height Datum (AHD).

The process of oxidisation relies on the presence of sulfur, oxygen and water. When high sulfide soils are saturated and buried in the ground, there is little oxygen present, however when these materials are disturbed, oxidation of the sulfides, and subsequent acid generation, can take place. The greater the disturbance, the greater the rate of acid generation and greater the potential environmental impact.

ASS are soils that have already been exposed to oxygen and water and so are already acidic, but can often oxidise further when exposed to the air. PASS are soils that are unoxidised as they have remained below the water table or other low oxygen environments but are prone to oxidation when exposed to the air. Thereafter in this report 'Acid Sulfate Soil' will refer to both ASS and PASS.

Activities associated with the pipeline construction that could expose buried soils to oxygen include trenching and tunneling, as well as lowering the water table that may occur with these activities.

Environmental impact, due to the sulfuric acid produced by the oxidation of ASS and PASS, can include the following:

- ***Damage to vegetation and soil quality, affecting rural productivity and requiring additional soil management, such as the addition of lime and other fertilisers;***
- ***Damage to surface water quality, affecting users of surface water such as farmers and aquatic ecosystems;***
- ***Damage to groundwater quality, affecting sensitive users of groundwater;***
- ***Damage to buried and surface structures made from concrete and steel;***
- ***Visual impact; and***

- ***Human health risks such as skin and eye irritation and risk of drinking contaminated surface and groundwater.***

3. STUDY BACKGROUND

A desktop study[1] undertaken as part of the feasibility study for the Esso Pipeline Replacement Project was based on a review of Coastal Acid Sulfate maps published by the Victorian Department of Primary Industries (DPI)[2] and identified that "the potential for localised interaction with ASS increased" between points KP150 and KP186 (Koo Wee Rup Marsh and Westernport Bay area). The study also identified that PASS and ASS may be present near rivers and creeks along the survey envelope.

In addition to the above plans published by the DPI, the Australian Government Department of Agriculture, Fisheries and Forestry and the Australian Collaborative Land Evaluation Program and the CSIRO, have developed the Australian Soil Resource Information System (ASRI)[3], an interactive map which also identifies areas potentially containing ASS or PASS. Review of the data presented within ASRI in reference to the survey envelope identified that PASS or ASS are potentially present between KP55 and KP 71 (sub-parallel to LaTrobe River, north of Traralgon), and between KP129 and KP170 (Koo Wee Rup Marsh and Westernport Bay area, from Modella to northwest of Cannons Creek).

4. STUDY OBJECTIVE

The objective of the study was to identify PASS and ASS which could pose a significant risk to the environment and significantly change construction requirements within the survey envelope. It should be noted that ASS and PASS can be present in very localised areas (even a highly organic material within a soil layer) and so its presence cannot entirely be ruled out by a single study. In the event of the identification of ASS or PASS along the route, potential mitigation measures are presented in section 9.3.

The objective was achieved by undertaking a site investigation at locations identified as higher risk by the desk study along the survey envelope. Soil samples were collected and PASS and ASS characterisation testing undertaken in a National Australian Testing Accredited (NATA) laboratory.

5. GEOLOGICAL SETTING

5.1 Regional Geological Setting

Reference to the geological maps of the area (Geological Survey of Victoria's 1:63,360 scale Western Port Sheet, 1:63,360 scale Cranbourne sheet and the 1:250,000 scale Warragul sheet) indicates that there are soils (clay, silts, sands and gravels) along the majority of the route. However in some areas near Yallourn North, the geological map indicates that there are areas with outcropping mudstone, siltstone, sandstone and coal. In areas near Warragul the geological map indicates that there are areas with outcropping mudstone, siltstone and sandstone as well as areas of basalt. The rock formations are typically weathered to a clay, silt or sand soil near the surface. Table 1 presents a summary of the geological conditions along the pipeline route.

Table 1: Overview of Geology Along Pipeline Alignment

Location and approximate chainage	Geology
Longford to Nilma (east side of Warragul) (KP 0 to KP 106) except	*Tertiary age Haunted Hill Gravels which typically comprise clays, silts and sands. Also includes gravel beds as well as ferruginous (cemented) sand beds.*
• *Near Creeks/Rivers*	*Quaternary age fluvial (colluvium and alluvium) deposits comprising sand, silts and clays.*
• *Yallourn North*	
- *KP 73 to KP 74*	*Devonian age Walhalla Group sandstone, siltstone and minor conglomerate and residual soils.*
- *KP 70 to KP 72*	*Some outcropping Cretaceous Strzelecki Group Wonthaggi formation sandstone, siltstone and conglomerate.*
Nilma to Drouin South (east side of Warragul) (KP 106 to KP 126)	*Devonian age mudstone, siltstone and sandstones and Tertiary age Older Volcanics basalt.*
Drouin South to French Island (KP 126 to KP 171)	*Quaternary age alluvium 'Koo Wee Rup Swamp deposits' comprising sand, silts and clays. Sections of colluvium, also comprising sand, silts, clays and also some areas of sand dunes.*
French Island to Hastings (KP 171 to KP 186)	*Tertiary age Baxter Sandstone comprising clays, silts, sands and ferruginous (cemented) sand beds with Sections of colluvium, also comprising sand, silts, clays.*

5.2 Ground Conditions

Table 2 presents a summary of the expected near-surface ground conditions, as identified by the desktop study[1] undertaken as part of the feasibility study for the project.

Table 2: Expected Near-surface Ground Conditions

Location and approximate chainage	Near-surface Ground conditions
KP0 to KP106 (east of Nilma)	*Zone A: Silty/sandy 'topsoil' overlying clays or sands. Gravels may be encountered in localised areas particularly near creeks or on ridges, and cemented sands may also be encountered. Potential sandstone layer between KP19 and KP25.*
KP106 to KP126 (Between Drouin South and Darnum)	*Zone B: Silts and clays primarily derived from the weathering of basalt and sedimentary mudstone, siltstone and sandstone rock. Potentially weathered rock underlying the surface soils. Some basalt cobbles and boulders ('floaters') may be present within the clays, derived from the weathering of the basalt*
KP126 to KP186 (west of Drouin South)	*Zone A: Silty/sandy 'topsoil' overlying clays or sands. Gravels may be encountered in localised areas particularly near creeks or on ridges, and cemented sands may also be encountered.*

6. SITE INVESTIGATION METHODOLOGY

Boreholes were drilled at nominated locations, with samples obtained for testing for acid sulfate potential at a NATA accredited laboratory. The sampling and testing were undertaken in accordance with methods outlined in Victorian EPA publication 655.1[4].

Locations for the investigation were based on the findings of the desktop study[1] and following review of the information presented in ASRI[3], and comprised 25 x 1.5 m deep boreholes spaced within and outside the potential PASS/ASS zones identified in Section 3. Table 3 outlines the typical spread of investigation locations applicable to the site investigation.

Table 3: Site Investigation Indicative Locations

Location	Borehole Locations
KP55 to KP71	*1 x borehole at each of the inferred entry and exit points of the given KP range. Nominally 2 km spacing^ within given KP range.*
KP129 to KP170	*1 x borehole at each the inferred entry and exit point of the given KP range. Nominally 3 km spacing^ within given KP range.*
Notes: ^ provided hole spacing is nominal only as actual locations were altered in the field due to factors including site inaccessibility, land use at the time of the investigation etc.	

The site investigation was undertaken predominantly during the period 21-22 October 2013, during which 22 of the 25 boreholes were drilled and sampled. Due to restrictions with gaining access to test sites, two of the remaining boreholes were drilled on 20 November 2013. At the time of issue of this draft report, the remaining borehole had not been drilled due to access restrictions.

The majority of the boreholes were drilled using a four wheel drive mounted auger rig, however due to site accessibility restrictions, particularly due to the wet weather, a selection of holes were drilled with a hand auger. To reduce the potential for cross-contamination of the samples, the drilling and sampling equipment was cleaned between each hole. Samples were typically obtained from 0.2 m, 0.5 m and 1 m depth and two out of the three samples were tested for acid sulfate producing potential.

The weather at the time of the 21-22 October 2013 component of the investigation was typically wet with light to heavy rain. During the drilling on the 20 November 2013, the weather was fine.

7. SITE INVESTIGATION FINDINGS

Borehole logs for each of the holes are presented in Appendix 1. In summary, the ground conditions intersected were consistent with the expected ground conditions (presented as the Zone A 'profile' in Table 2).

Most boreholes were located in ground conditions consistent with fluvial deposits and the 'Koo Wee Rup Swamp' alluvial deposits or in the Baxter Formation or the Haunted Hill Gravels clays, silts and gravels. As a result, a relatively consistent ground profile was encountered along the majority of the route investigated, as summarised in Table 4.

Table 4: Summary of Ground Conditions

Depth to top of layer (m)	Typical Layer thickness (m)	Typical ground profile
Surface	*0.04*	*Rootmat*
0.04	*0.4*	*SILTY CLAY or CLAYEY SILT ('TOPSOIL/LEACHED HORIZON') firm, stiff, very stiff or hard, low plasticity, grey-brown, damp or moist*
0.4	*Not penetrated*	*SILTY CLAY: Stiff, very stiff or hard, high plasticity, mottled yellow-brown and grey, trace sand, trace sand lenses and sandy bed, moist*

Exceptions to this profile were encountered in boreholes located in Colluvial Areas, namely BH12 and BH65 where dark-brown clays and BH62 where dark grey clays were encountered. A different profile was also encountered in boreholes BH67 and BH69 where sands 'sand dunes' were encountered and borehole BH27 where low plasticity clays and soils consistent with residual soils derived from the weathering of the Strzelecki Group.

No groundwater was encountered in the majority of the boreholes, with the exception of borehole BH27, where groundwater seeps were encountered at 0.7 m depth. It is noted however, that the boreholes were not left open long enough to ensure that equilibrium groundwater levels were established. Groundwater in these areas, particularly west of Drouin South, is known to be within a few metres of the surface and thus groundwater may actually be present within the depth of the borehole in some areas even though it was not identified at the times of the investigation.

8. LABORATORY TESTING

Over the course of the fieldwork, a total of 48 samples were sent to independent, NATA accredited laboratory ALS Global for preliminary (pH field and pH fox) testing. Of this suite of samples, and based on the preliminary screening, all but two were identified as being exceeding the screening limits for characterising ASS/PASS soils. As a result, further analysis (SPOCAS) testing was undertaken on all samples that had been subject to the preliminary testing. Table 5 presents a summary of the laboratory testing undertaken on the samples.

The results of the laboratory testing are attached in Appendix 3 and a summary by geological unit and interpretation of the results are provided in Section 10. Quality assurance testing and analysis carried out.

Table 5: Laboratory Testing Programme

Test	Number	Comments
pH (field) / pH (fox)	*48*	*Two samples per borehole*
SPOCAS	*48*	*All samples*

9. ACID SULFATE SOIL GUIDELINES

9.1 Overview

EPA Publication 655.1 titled 'ACID SULFATE SOIL AND ROCK' dated July 2009[4] ('EPA Publication 655.1') is the primary Victorian guideline relevant to the management of acid sulfate soil.

EPA Publication 655.1 both defines the criteria for material to be classified 'Acid Sulfate Soil' in Victoria and also outlines the requirements for management of materials classified as 'Acid Sulfate Soil'. It also provides some general guidance on how to meet these requirements and recommends additional information sources.

In summary, EPA Publication 655.1 requires that materials exceeding the listed criteria for 'Acid Sulfate Soils' must be managed as a waste, in accordance with the requirements of the Industrial Waste Management Policy (Waste Acid Sulfate Soils), 1999 (the 'Policy'). The Policy also cross references EPA Publication 655.1. As such, if materials are classified as 'Acid Sulfate Soil' then they can only be disposed of or reused on sites that have an Environmental Management Plan (EMP) approved by the EPA, or at a landfill with the appropriate license under the *Environment Protection Act 1970.* ***Both EPA Publication 655.1 and the Policy state that*** *'onsite management of waste acid sulfate soil may take place where best practice environmental management guidelines, which have been approved by the Authority, are used.'*

9.2 Criteria for Acid Sulfate Soil

The EPA Publication 655.1 permits a risk based approach beginning with a desk top and initial field assessment to identify if acid sulfate may be present, consistent with the process of desk study and initial field assessment undertaken as part of this and the previous study.

EPA Publication 655.1 permits initial screening of soils samples retrieved from site for pH testing in the field and following oxidation. If the pH of the soils in the field is less than 5 or experience significant oxidation, then additional detailed SPOCAS of 'chromium reducible sulfur' testing is required. The results of this testing are then compared to applicable criteria outlined in EPA Publication 655.1, (Table 6). If any criteria are exceeded, the material is classified as an acid sulfate soil.

For each soil type there are one set of criteria for works requiring less than 1000 tonne of soil to be moved and a second, lower set of criteria, for work requiring more than 1000 tonne of soil to be moved. The split in the criteria by volume is due to the greater potential for environmental impact as the volume of soil to be moved increases.

Due to the staged construction approach to be adopted for the project, the less than 1000 tonne criteria are considered applicable to the project.

Table 6: Texture based action criteria for classification of acid sulfate soil

Soil or sediment texture	Approximate clay content (%)	Net acidity criteria (1-1000 tonnes)		Net acidity criteria (>1000 tonnes)	
		(%S) (oven-dry basis)	mol H+/tonne (oven-dry basis)	(%S) (oven-dry basis)	mol H+/tonne (oven-dry basis)
Sands to loamy sands	*< 5*	*0.03*	*18*	*0.03*	*18*
Sandy loams to light clays	*5-40*	*0.06*	*36*	*0.03*	*18*
Medium to heavy clays and silty clays	*> 40*	*0.1*	*62*	*0.03*	*18*

9.3 Management of acid sulfate soils

The majority of the materials excavated during pipeline construction are likely to remain on site. Given that dewatering activities are likely to be required in some areas, any materials that exceed the criteria in Table 6 will be managed as outlined in the approved CEMP (which will be developed in consultation with the relevant government agencies as required by the Pipelines Act (2005)). The management of ASS in the CEMP will be in accordance with best practice to avoid and control adverse environmental impacts.

EPA Publication 655.1 suggests Acid Sulfate Soils be managed in accordance with the following hierarchy of measures:

1. Avoid disturbance or drainage of acid sulfate soil

Select areas onsite or alternative sites which do not contain acid sulfate soils.

2. Minimise disturbance or drainage of acid sulfate soil

Project works can be designed to minimise the need for excavation or disturbance of acid sulfate soils.

3. Prevent oxidation

This may include placing PASS into an anaerobic environment, usually below the water table. However, PASS must not be disposed of below the water table without prior neutralisation or implemented control measures.

Minimise oxidation rate

This may include covering (capping) exposed material with low permeability soil (such as clay) to reduce oxygen availability and to prevent infiltration of water, reducing the potential for leaching. Additional methods may include securing high-density polyethylene (HDPE) sheeting over acid sulfate soils for short periods, or controlling bacteria and other limiting factors (e.g. alkalinity) by either physical or chemical means to reduce oxidation rate.

Separate higher risk acid sulfate material from lower risk materials

Strategic excavation of soil to keep high risk and lower risk materials separate can minimise the volume of acid sulfate material requiring management. This may also include sluicing or hydrocycloning techniques (often used during dredging), to separate acid sulfate fines from non-acid sulfate material, followed by treatment and/or disposal of acid sulfate fines.

Provide an agent to neutralise acid as it is produced

Typically, this would involve mixing the acid sulfate soil with lime or another neutralising agent, at predetermined rates. The rate of lime application must be managed carefully to avoid mobilisation of other compounds in soil such as ammonia. Verification testing should be carried out following treatment to confirm an acceptable rate of neutralisation.

Contain and treat acid drainage to minimise risk of significant offsite impacts

Typically, this would involve installing a leachate or run-off collection, storage and treatment system, ensuring that leachate or run-off does not infiltrate into local sewers, soil, groundwater or surface water receptors.

Manage stockpiled materials

Stockpiled acid sulfate soil material needs to be managed to ensure no adverse environmental impacts occur. This may include placement of stockpiles on low permeable bases, application of lime beneath stockpiles, bunding around the storage area, minimising the quantity and duration of material requiring storage, covering with HDPE sheeting to minimise infiltration and limit oxygen exposure, diverting up-gradient storm water run-off, controlling erosion and collection/treatment of run-off and leachate.

4. Treat to reduce or neutralise acidity

Actual acid sulfate material may be reused onsite if it has been treated and has undergone testing to verify the effectiveness of that treatment. In this instance, the resultant geotechnical properties need to be determined to ensure compliance with the intended

material use. If reburial is planned, the pit walls and base should be limed, at a predetermined rate, prior to backfill.

5. Offsite reuse or disposal

Acid sulfate material may be removed offsite and reused or disposed of in accordance with the Policy.

10. INTERPRETATION OF THE LABORATORY TEST RESULTS

Laboratory tests results are presented in Appendix 3. As discussed in Section 9.2, the criteria associated with less than 1000 tonnes are considered appropriate for this project. Of the 48 samples tested, 4 samples exceeded the action criteria for projects with less than 1000 tonnes of soil (refer to Table 6 for criteria). Table 7 presents summary of the reported acid sulfate analytical results for the various geological units compared with the ASS action criteria. As evident from the table, all geological units exceed the action criteria for ASS.

Despite exceeding the criteria, it is expected that these soils would not be ASS because, as outlined in Section 2, ASS are soils which have high sulfide content. The majority of the samples had sulfide content below the laboratory detection limits and all had sulfide content a fraction of what would be expected in ASS. In the absence of sulfur, soils can be oxidised due to the presence of metals such as iron and aluminium. Limonite/iron oxide 'rust' was noted in a number of the boreholes. It is therefore considered that the soils encountered during this assessment are acidic soils, not ASS.

Although the laboratory test results indicate that the soils are more acidic than initially anticipated the results are not unrealistic. The Brighton Group, which is a very similar geological formation to the Baxter Sandstone and relatively similar to the Haunted Hill Gravels, have been found around Melbourne to be acidic and occasionally also ASS. The Baxter Sandstone and the Haunted Hill Gravel formations are widespread along and surrounding the route and, by nature, the Fluvial deposits and Alluvium are materials which are derived from the weathering of the older surrounding formations. As such it is not surprising that the Fluvial deposits and Alluvium have similar soil chemistry to the older geological formations in the area.

Table 7 Acid Sulfate Soil action criteria and summary test results for geological units

EPA Publication 655.1 - Soil or sediment texture	*Reference Criteria*					
	pH KCl	*pH OX*	*Potential Acidity Peroxide oxidisable sulfur %*	*Actual Acidity Sulfidic-Tritratiable Actual Acidity %pyrite S*	*Net Acidity (sulfur Units) %S*	*Net Acidity (acidity units) mol H^+/tonne*
Sands to loamy sands						
(1-1000 tonnes)	***-***	***-***	***-***	***-***	***0.1***	***62***
(>1000 tonnes)	***-***	***-***	***-***	***-***	***0.03***	***18***
Sandy loams to light clays						
(1-1000 tonnes)	***-***	***-***	***-***	***-***	***0.06***	***36***
(>1000 tonnes	***-***	***-***	***-***	***-***	***0.03***	***18***
Medium to heavy clays and silty clays						
(1-1000 tonnes)	***-***	***-***	***-***	***-***	***0.03***	***18***
(>1000 tonnes	***-***	***-***	***-***	***-***	***0.03***	***18***
Baxter Formation/Haunted Hill Gravels	4.5 to 5.9	3.7 to 6.3	<0.02 to 0.03	<0.02 to 0.06	<0.02 to 0.08	<10 to 51
Fluvial Deposits/Alluvium (including Koo Wee Rup Swamp)	4.2 to 5.0	***3.3 to 4.9***	***<0.02 to 0.5***	<0.02 to 0.10	<0.02 to 0.14	<10 to 87
Strzelecki Formation	4.6 to 4.9	***2.9 to 3.9***	***<0.02 to 0.03***	0.03 to 0.04	0.03 to 0.07	17 to 44
Dune Sands	4.5 to 5.8	***2.7 to 5.6***	***<0.02***	<0.02 to 0.05	<0.02 to 0.05	<10 to 29
Colluvium	4.5 to 5.5	***3.7 to 5.4***	***<0.02 to 0.04***	<0.02 to 0.14	<0.02 to 0.18	<10 to 112

11. DISCUSSION

The test results in the majority of samples found the net acidity to be greater than the Victorian EPA's action criteria for ASS. The soils are however considered to be acidic soils, not acid sulfate producing soils given that ASS, by their nature, have high sulfide content. Many of the sulfur levels reported in the laboratory testing were below the laboratory detection limits and all samples reported sulfide levels of a fraction of what is normally present in ASS. These test results can be explained by the fact that oxidation is known to occur in non-Acid Sulfate Soil in the presence of metals such as iron and aluminium. Limonite (iron oxide or 'rust') was noted in several of the boreholes and thus the presence of iron (and potentially other metals) is considered to be the explanation for the widespread acidic soils.

Although the soils are not considered to be ASS, the laboratory testing indicates that the soils are subject to oxidation. It is therefore recommended that oxidation management techniques are incorporated into the Construction Environmental Management Plan (CEMP) to minimize the oxidation of the soils and minimize changes to the soil geochemistry, which may impact on the beneficial uses of the environment (established in State environment protection policies (SEPPs)). As required by the Pipelines Act (2005), consultation with the relevant government agencies will occur in the course of developing the CEMP.

Management measures for consideration in developing the CEMP may include:

- ***avoid disturbing additional soils;***
- ***minimize disturbance of soils excavated;***
- ***minimize oxidation by stockpiling;***
- ***progressive construction so that soils are not exposed for longer periods than necessary; and***
- ***covering and/or managing runoff in soil that need to be stockpiled for longer.***

These techniques are consistent with management practices for ASS as outlined in EPA Publication 655.1. The techniques are also consistent with standard measures adopted to maintain a safe and tidy site, prevent excessive drying of clays and prevent sediment washing into creeks. Therefore they are not expected to impact significantly on typical construction practices.

As neither the desk top study nor this preliminary field assessment found evidence of widespread ASS, it is proposed that further acid sulfate testing is not required. However, as ASS can be present in localised areas, as described in Section 2, the construction of a pipeline that covers such a large geographic distance may encounter ASS in localized swampy areas. As such, it is proposed that key contractor personnel or others likely to be

accessing large areas of the route ahead of the construction be trained in the identification of ASS. This would be in accordance with EPA practice, in which the EPA permits preliminary ASS identification by personnel of limited training or experience. If any soils are suspected to be ASS, WorleyParsons or another suitably qualified consultant should be contacted for a more detailed field assessment in the identified areas.

12. REFERENCES

1. ***WorleyParsons Services Pty Ltd,*** *Longford Liquids Pipeline Replacement Project, Inferred Ground Conditions,* ***18 March 2013, document reference 401010-01002-SS-REP-001 Rev C.***

2. ***Department of Primary Industries Victoria, Coastal Acid Sulfate Soils, website: http://vro.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil_acid_sulfate_soils***

3. ***Australian Soil Resource Information System: http://www.asris.csiro.au/index.html***

4. ***Victorian EPA Publication 655.1 July 2009***

Appendix 1 - Figures

Appendix 2 - Borehole Logs

BOREHOLE LOG

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BOREHOLE NO.: ***BH07***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***22.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***22.10.2013***
LOCATION:	***approx. KP56.3***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	459060	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5775283	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Root mat**	D	Hd							PP = Pocket Penetrometer Reading	
							CI	**SILTY CLAY:** friable, dark brown, trace of crushed rock, M<Wp, reworked/disturbed soil				E						
												D						
				0.5			CI-CH	**SILTY CLAY:** mottled yellow-brown and grey-brown, minor black nodules, M>Wp	M	VSt		E						
												D					PP @ 0.7m = 320-380 kPa	
				1.0								E						None Observed
				1.5								D					PP @ 1.3m = 300-350 kPa	
								Target depth reached End of BH07 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH11***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***22.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***22.10.2013***
LOCATION:	***approx. KP57.1***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	458359	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5775533	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CI	**SILTY CLAY:** friable, dark brown, M<Wp	M	VSt		E					PP @ 0.3m = 300 kPa	
												D						
							CH	**SILTY CLAY:** mottled yellow-brown and grey-brown, minor black nodules, M>Wp				E						
				0.5								D					PP @ 0.7m = 350-400 kPa	
												E						None Observed
				1.0								D					PP @ 1.3m = 350-380 kPa	
				1.5				Target depth reached End of BH11 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH12***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***22.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***22.10.2013***
LOCATION:	***approx. KP58.9***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	456913	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5776061	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CI	**SILTY CLAY:** friable, dark brown, M<Wp	D	Hd		E					PP @ 0.25m = 370 kPa	
												D						
							CI-CH	**SILTY CLAY:** mottled yellow-brown and grey-brown, minor black nodules, M>Wp	M	VSt		D						
				0.5								E					PP @ 0.5m = 350-380 kPa	
								...Increase in moisture content		St		E					PP @ 1.0m = 150-180 kPa	None Obeserved
				1.0														
				1.5								D					PP @ 1.4 = 160-170kPa	
								Target depth reached End of BH12 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH14***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***22.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***22.10.2013***
LOCATION:	***approx. KP60.8***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor: Horizon Drilling **Bore Size:** 80mm **Hole Angle:** 90° **Easting:** **Surface R.L.:** Not measured

Drill Model: Custom 4x4 auger **Drill Fluid:** - **Bearing:** **Northing:** **Datum:**

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**										
							CI	**SILTY CLAY:** friable, dark brown	M	VSt								
												E						
								...Becoming firm and moisture increasing.	M/W			D					PP = Pocket Penetrometer Reading PP @ 0.2m = 200kPa	
							CI-CH	**SILTY CLAY:** mottled yellow-brown and grey-brown, minor black mottling, M>Wp	M	VSt								
				0.5								E					PP @ 0.4m = 80kPa	
												D					PP @ 0.7m = 330-370kPa	
							CH	...Silt content decreased										▼ None Obeserved
				1.0								E						
										St-VSt								
				1.5								D					PP @ 1.3m = 220-230kPa	
								Target depth reached End of BH14 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH16***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***22.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***22.10.2013***
LOCATION:	***approx. KP62.6***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	453355	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5777457	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**	M	VSt							PP = Pocket Penetrometer Reading	
							CI-CH	**SILTY CLAY:** friable, dark brown, M=Wp				E					PP @ 0.2m = 200 kPa	
												D					PP @ 0.25m = 180 kPa	
							CI-CH	**SILTY CLAY:** mottled yellow-brown and grey, minor black nodules	M	St								
				0.5								E						
												D					PP @ 0.7m =170-180 kPa	
							CH	...Becoming high plasticity, silt fraction decreased										None Observed
				1.0								E						
				1.5								D					PP @ 1.4m =160-190 kPa	
								Target depth reached End of BH16 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH23***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***22.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***22.10.2013***
LOCATION:	***approx. KP23.6***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	451464	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5777951	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							ML	**CLAYEY SILT:** friable, mottled yellow-brown and grey	M	VSt		E						
												D					PP @ 0.25m = 400 kPa	
							CH	**SILTY CLAY:** mottled yellow-brown and grey brown, M>Wp										
				0.5								E						
												D					PP @ 0.7m = 350 kPa	▼ None Observed
				1.0								E						
				1.5								D					PP @ 1.3m = 300-400 kPa	
								Target depth reached End of BH23 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH24***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***23.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***23.10.2013***
LOCATION:	***approx. KP66.6***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	449467	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5778274	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							ML	**CLAYEY SILT:** damp, grey-brown, M<Wp	D	Hd		E						
												D						
							ML	**SILT:** friable, mottled grey brown with some clay, trace of sand, M<Wp										
				0.5								E						
												D						
							CH	**SILTY CLAY:** mottled yellow-brown, grey and red-brown, M close to Wp	M									▼ None Observed
				1.0								E						
				1.5								D					PP @ 1.3m = 450-600+ kPa	
								Target depth reached End of BH24 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH25***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***23.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***23.10.2013***
LOCATION:	***approx. KP68.4***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	447538	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5778579	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							MI	**CLAYEY SILT:** friable, mottled yellow-brown and grey	M	St		E						
												D						
									M-W									
				0.5			CL	**SILTY CLAY:** mottled yellow-brown and grey, minor black nodules, M>Wp	M			E						
												D						
							CL	...Silt content decreased, trace of fine sand.	M-W	F		E					PP @ 0.9m = 80-120 kPa	None Obeserved
				1.5								D					PP @ 1.3m = 100 kPa	
								Target depth reached End of BH25 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH26***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***23.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***23.10.2013***
LOCATION:	***approx. KP70.0***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	446130	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5778858	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CI/SM	**FILL / SILTY CLAY AND SILTY SAND:** brown, with some crushed rock, appears lossely compacted, appears as if material has been progressively placed over time	M	L		E						
												D					Fill appears to be placed locally to improve traffickability in gully	
				0.5								E						
												D						
							ML	**CLAYEY SILT:** brown, with some sand	W	F							Water seeps 0.8m-0.9m (perched water)	▼
				1.0			CH	**SILTY CLAY:** grey, minor orange-brown and black mottling, M>Wp	M	VSt		E					PP @ 1.0m = 220 kPa	
												D					PP @ 1.3m = 200-220 kPa	
				1.5				Target depth reached End of BH26 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH27***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***23.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***23.10.2013***
LOCATION:	***approx. KP71.0***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	444668	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5779203	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CI	**SILTY CLAY:** friable, dark brown, M close to Wp	M	VSt		E						
												D						
							CL	**SILTY CLAY:** mottled grey-brown and yellow-brown										
				0.5								E						
									M-W			D					Minor water seeps between 0.7m-0.8m	▼
							CH	**SILTY CLAY:** mottled grey-brown and yellow-brown, trace of sand lenses, fissured clay, M>Wp	M								
				1.0								E					PP @ 1.0m = 200 kPa	
				1.5								D					PP @ 1.4m = 200-220 kPa	
								Target depth reached End of BH27 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH44***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***24.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***24.10.2013***
LOCATION:	***approx. KP128.0***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	389977	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5772485	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CL	**SILTY CLAY:** mottled yellow-brown and grey-brown	M-W	F		D						
												E					Hand auger due to water ponding on ground	
							ML	with trace of iron oxide gravel										
							ML	**becoming SILTY:** mottled yellow-brown and grey-brown, some coarse sand, some clay, M>Wp	W	F								
				0.5								E						
												D						
							CI	**SILTY CLAY:** mottled yellow-brown and grey-brown, minor black nodules, M>Wp	M	VSt								▼ None Observed
				1.0								E						
				1.5								D					PP @ 1.0m = 220-240 kPa	
								Target depth reached End of BH44 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH45***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***24.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***24.10.2013***
LOCATION:	***approx. KP129.0***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	389060	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5772428	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0.0				Rootmat									PP = Pocket Penetrometer Reading	
							ML	**CLAYEY SILT:** mottled grey-brown and yellow brown, clay fraction increasing with depth, M>Wp	M	St		D						
												E					Hand auger due to water ponding at surface	
				0.5								E						
							CH	**SILTY CLAY:** mottled yellow-brown and grey-brown, minor black mottling		VSt		D					PP @ 0.7m = 220 kPa	▼ None Observed
				1.0								E						
				1.5								D					PP @ 1.3m = 280-320 kPa	
								Target depth reached End of BH45 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH46***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***24.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***24.10.2013***
LOCATION:	***approx. KP132.4***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	385676	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5772392	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CH	**SILTY CLAY:** mottled grey and orange-brown, M>Wp	M	VSt		D						
												E					Hand auger due to wet paddock	
				0.5								E						
												D					PP @ 0.7m = 230 kPa	
								..Minor black mottling										None Observed
				1.0								E						
				1.5								D					PP @ 1.3m = 220-240 kPa	
								Target depth reached End of BH46 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH47***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***24.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***24.10.2013***
LOCATION:	***approx. KP135.8***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	382324	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5772086	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None							**Rootmat**									PP = Pocket Penetrometer Reading	
							CH	**SILTY CLAY:** friable, mottled brown and orange-brown, M<Wp	M	VSt		D					PP @ 0.1m = 200-220 kPa	
												E						
																	Hand auger due to surface water	
				0.5			CH	**SILTY CLAY:** mottled yellow-brown and grey, minor black, M>Wp				E					PP @ 0.5m = 220-240 kPa	
												D						
				1.0								E						None Observed ▼
																	PP @ 1.1m = 200-320 kPa	
				1.5								D						
								Target depth reached End of BH47 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH48***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***24.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***24.10.2013***
LOCATION:	***approx. KP139.2***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	378900	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	577182	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CH	**SILTY CLAY:** mottled grey-brown and orange-brown, M>Wp	M	VSt		E						
												D					Hand auger due to boggy paddock	
				0.5								E						
												D					PP @ 0.7m = 200-220 kPa	▼
				1.0								E						None Observed
												D					PP @ 1.4m = 220-230 kPa	
				1.5				Target depth reached End of BH48 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH49***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***24.10.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***24.10.2013***
LOCATION:	***approx. KP142.6***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor: Horizon Drilling **Bore Size:** 50mm **Hole Angle:** 90° **Easting:** **Surface R.L.:** Not measured

Drill Model: Hand Auger **Drill Fluid:** - **Bearing:** **Northing:** **Datum:**

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0.0				**Rootmat**	M	Vst							PP = Pocket Penetrometer Reading	
							CH	**SILTY CLAY:** dark brown, trace of nodules potentially from introduced fertiliser				D						
												E						
							CH	**SILTY CLAY:** mottled orange-brown and grey-brown, M>Wp									Hand auger due to water in paddock	
				0.5								E						
																	PP @ 0.6m = 220 kPa	
												D						
							CH	**SILTY CLAY:** mottled yellow-brown and grey, trace of sand, M>Wp		H								▼ None Observed
				1.0								E					PP @ 1.0m = 400 kPa	
				1.5								D						
								Target depth reached End of BH49 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH50***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***25.10.2010***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***25.10.2013***
LOCATION:	***approx. KP146.0***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	371996	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5771491	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CH	**SILTY CLAY:** mottled grey-brown and orange-brown, M>Wp	D-M	Hd		E					Hand auger due to water in paddock	
								...Becoming very stiff, increased moisture	M	VSt								
				0.5								E D					PP @ 0.5m = 220 kPa	
												D					PP @ 0.7m = 200-220 kPa	
								...Becoming mottled grey and yellow-brown										None Observed
				1.0								E						
				1.5								D					PP @ 1.3m = 230-300 kPa	
								Target depth reached End of BH50 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH53***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***25.10.2010***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***25.10.2013***
LOCATION:	***approx. KP149.38***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	369125	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5770509	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CH	**SILTY CLAY:** dark grey-brown, M>Wp	M	VSt		D						
												E						
							CH	**SILTY CLAY:** dark grey-brown with minor yellow-brown mottling, trace of coarse sand										
				0.5								E					PP @ 0.5m = 200-240 kPa	
												D					PP @ 0.7m = 220 kPa	
				1.0								E						None Observed
				1.5								E					PP @ 1.3m = 220-240 kPa	
								Target depth reached End of BH53 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH62***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***20.11.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***20.11.2013***
LOCATION:	***approx. KP156.1***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**		**Hole Angle:**	90°	**Easting:**	363116	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	577167	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger				0.5			CH	**SILTY CLAY:** dark grey, M>Wp	D	St - VSt		E D					PP = Pocket Penetrometer Reading Water seepage	▼
				1.0								E D					PP @ 0.8m = 130-160 kPa	
				1.5				Target depth reached End of BH62 at 1.5m				E D					PP @ 1.3m = 150 kPa	
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH64***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***25.10.2010***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***25.10.2013***
LOCATION:	***approx. KP159.6***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	359984	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5771898	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**										
							CL	**SANDY SILTY CLAY:** brown, trace of fine grained quartz sand, M>Wp	M	VSt		D					PP = Pocket Penetrometer Reading PP @ 0.15m = 200-220 kPa	
												E						
							CH	**SILTY CLAY:** dark brown and minor yellow-brown mottling, M>Wp										
				0.5								E					PP @ 0.5m = 200-220 kPa	
												D					PP @ 0.7m = 200 kPa	
							SM	**SILTY SAND:** fine to medium grained quartz sand, grey-brown		MD		E						None Observed
				1.0														
							CH	**SILTY CLAY:** mottled yellow-brown and grey, trace of silty sand lenses, M>Wp		St - VSt		D					PP @ 1.3m = 180-210 kPa	
				1.5														
								Target depth reached End of BH64 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH65***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***25.10.2010***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***25.10.2013***
LOCATION:	***approx. KP163.0***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	50mm	**Hole Angle:**	90°	**Easting:**	356775	**Surface R.L.:**	Not measured
Drill Model:	Hand Auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5771780	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
HA	None			0.0				**Rootmat**									PP = Pocket Penetrometer Reading	
							CH	**SILTY CLAY:** dark brown-black	M	St		D						
												E					PP @ 0.2m = 180-200 kPa	
				0.5				...Becoming mottled dark grey-brown and minor orange-brown mottling				E					PP @ 0.5m = 160-200 kPa	
												D						
				1.0								E					Drilled by hand auger due to locked gate	None Observed
				1.5								D					PP @ 1.3m = 140-180 kPa	
								Target depth reached End of BH65 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH66***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***25.10.2010***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***25.10.2013***
LOCATION:	***approx. KP166.5***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	353666	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5771422	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**	M	VSt							PP = Pocket Penetrometer Reading (qu)	
							CH	**SILTY CLAY:** brown, minor yellow brown mottling				D						
												E						
								...Becoming mottled yellow-brown and grey-brown, M>Wp										
				0.5								E					PP @ 0.5m = 300-360 kPa	
												D					PP @ 0.7m = 320-340 kPa	
							CH	**SILTY CLAY:** becoming mottled yellow-brown and grey, minor black mottling, trace of coarse sand and fine sandstone gravel										None Observed
				1.0								E					PP @ 1.1m = 280-320 kPa	
												D					PP @ 1.4m = 200-260 kPa	
				1.5				Target depth reached End of BH66 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH67***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***20.11.2013***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***20.11.2013***
LOCATION:	***approx. KP170.0***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**		**Hole Angle:**	90°	**Easting:**	350163	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5770356	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger				0.0			SM	**Rootmat** **SILTY SAND:** dark brown and orange-brown, fine quartz sand	M	L-MD		E					PP = Pocket Penetrometer Reading Dune sand	
				0.5			SP	**SAND:** grey brown, fine quartz sand	W			D					Gradual water seepage	▼
												E						
				1.0								D						
							SC	**CLAYEY SAND:** mottled yellow-brown and grey-brown, fine quartz sand	M	MD		E						
				1.5				becoming sandy clay				D					PP @ 1.4m = 200 kPa	
								Target depth reached End of BH67 at 1.5m										
				2.0														
				2.5														
				3.0														

BOREHOLE LOG

WorleyParsons
resources & energy

BOREHOLE NO.: ***BH69***
SHEET: 1 OF 1

CLIENT:	***ESSO Australia Pty Ltd***	DATE COMMENCED:	***25.10.2010***
PROJECT:	***LOLIPIP***	DATE COMPLETED:	***25.10.2013***
LOCATION:	***approx. KP170.98***	LOGGED BY:	***LM***
JOB NUMBER:	***401010-01002***	CHECKED BY:	***LPG***

Drill Contractor:	Horizon Drilling	**Bore Size:**	80mm	**Hole Angle:**	90°	**Easting:**	349259	**Surface R.L.:**	Not measured
Drill Model:	Custom 4x4 auger	**Drill Fluid:**	-	**Bearing:**		**Northing:**	5769956	**Datum:**	

Method	Casing	Drill Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Rock Strength / Soil Consistency	Rock Weathering / Soil Cementation	Sample / In - situ Test	Lab Tests: UCS (MPa)	Lab Tests: Liquid Limit (%)	Lab Tests: Plastic Index	Lab Tests: Su-uu (kPa)	Field Records / Comments	Water
Solid Flight Auger	None			0.0				**Rootmat**										
							SM	**SILTY SAND:** fine grained quartz, brown	M	MD		D						
												E						
								...Becoming grey-brown										
				0.5								E						
												D						
								...Becoming mottled red-brown, yellow-brown and grey, minor black, trace of clay		D								
				1.0								E						
												D						
				1.5				Target depth reached End of BH69 at 1.5m										
				2.0														
				2.5														
				3.0														

None Obeserved

Appendix 3 - Laboratory Test Results

CERTIFICATE OF ANALYSIS

Work Order	: **EB1330241**	Page	: 1 of 17
Client	: **WORLEY PARSONS - INFRASTRUCTURE MWE**	Laboratory	: Environmental Division Brisbane
Contact	: LUCIE MISSEN	Contact	: Steven McGrath
Address	: LEVEL 12, 333 COLLINS STREET MELBOURNE VIC, AUSTRALIA 3000	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: lucie.missen@worleyparsons.com	E-mail	: steven.mcgrath@alsenviro.com
Telephone	: +61 03 8676 3500	Telephone	: +61-3-8549 9600
Facsimile	: +61 03 86763770	Facsimile	: +61-3-8549 9601
Project	: 401010-01002 LOLIPIP	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 401010-01002 WBS 3G2003A		
C-O-C number	: ----	Date Samples Received	: 04-DEC-2013
Sampler	: ----	Issue Date	: 16-DEC-2013
Site	: ----		
		No. of samples received	: 48
Quote number	: ME/507/13	No. of samples analysed	: 48

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA029 (SPOCAS): Excess ANC not required because pH OX less than 6.5.**
- **ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	BH62 0.2-0.3	BH62 0.7-0.8	BH67 0.05-0.3	BH67 0.6-0.9	----
			Client sampling date / time	20-NOV-2013 16:00	20-NOV-2013 16:00	20-NOV-2013 16:00	20-NOV-2013 16:00	----
Compound	CAS Number	LOR	Unit	EB1330241-045	EB1330241-046	EB1330241-047	EB1330241-048	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**4.5**	**4.7**	**4.5**	**5.1**	----
pH OX (23B)	----	0.1	pH Unit	**3.8**	**3.7**	**2.7**	**3.5**	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**85**	**27**	**29**	**3**	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**252**	<2	**202**	**4**	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**167**	<2	**173**	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.14**	**0.04**	**0.05**	<0.02	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	**0.40**	<0.02	**0.32**	<0.02	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	**0.27**	<0.02	**0.28**	<0.02	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	**0.04**	**0.02**	<0.02	<0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	**0.04**	**0.02**	<0.02	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	**27**	**14**	<10	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	**0.20**	**0.11**	**0.04**	<0.02	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	**0.20**	**0.12**	**0.03**	<0.02	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	**0.19**	**0.11**	<0.02	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	**0.19**	**0.11**	<0.02	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S	**0.18**	**0.06**	**0.05**	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	**112**	**40**	**29**	<10	----
Liming Rate	----	1	kg CaCO3/t	**8**	**3**	**2**	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH48 0.1-0.2	BH48 0.4-0.6	BH49 0.1-0.2	BH49 0.4-0.6	BH45 0.1-0.2
			Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EB1330241-001	EB1330241-002	EB1330241-003	EB1330241-004	EB1330241-005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	4.3	4.3	5.0	4.7	4.7
pH OX (23B)	----	0.1	pH Unit	4.1	4.1	3.3	4.5	3.8
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	34	37	20	18	13
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	54	56	<2	21	42
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	20	19	<2	3	28
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.05	0.06	0.03	0.03	0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	0.08	0.09	<0.02	0.03	0.07
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	0.03	0.03	<0.02	<0.02	0.04
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	0.05	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.05	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	31	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.09	0.08	0.19	0.13	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	0.08	0.08	0.18	0.13	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	0.06	0.06	0.06	0.14	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	0.06	0.06	0.06	0.14	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-G: Retained Acidity								
HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	<0.02	----	----	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	<0.02	----	----	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	<10	----	----	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	<0.02	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH48 0.1-0.2	BH48 0.4-0.6	BH49 0.1-0.2	BH49 0.4-0.6	BH45 0.1-0.2
			Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EB1330241-001	EB1330241-002	EB1330241-003	EB1330241-004	EB1330241-005
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.05**	**0.06**	**0.08**	**0.03**	**0.02**
Net Acidity (acidity units)	----	10	mole H+ / t	**34**	**37**	**51**	**18**	**13**
Liming Rate	----	1	kg CaCO3/t	**2**	**3**	**4**	**1**	**1**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH49 0.8-1.2	BH44 0.1-0.2	BH44 0.8-1.2	BH46 0.1-0.2	BH46 0.8-1.2
				Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00
Compound	CAS Number	LOR	Unit		EB1330241-006	EB1330241-007	EB1330241-008	EB1330241-009	EB1330241-010
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit		4.3	4.8	4.4	4.3	4.3
pH OX (23B)	----	0.1	pH Unit		4.5	4.1	3.9	4.1	4.0
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		29	9	38	47	39
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		49	33	86	104	79
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		20	24	48	58	40
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S		0.05	<0.02	0.06	0.07	0.06
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S		0.08	0.05	0.14	0.17	0.13
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S		0.03	0.04	0.08	0.09	0.06
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S		<0.02	<0.02	0.02	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S		<0.02	<0.02	0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t		<10	<10	15	<10	<10
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.02	% Ca		<0.02	<0.02	<0.02	0.09	0.05
Peroxide Calcium (23Wh)	----	0.02	% Ca		<0.02	<0.02	<0.02	0.10	0.05
Acid Reacted Calcium (23X)	----	0.02	% Ca		<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg		0.07	<0.02	0.06	0.08	0.08
Peroxide Magnesium (23Tm)	----	0.02	% Mg		0.06	<0.02	0.06	0.08	0.08
Acid Reacted Magnesium (23U)	----	0.02	% Mg		<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-G: Retained Acidity									
HCl Extractable Sulfur (20Be)	----	0.02	% S		<0.02	----	0.02	<0.02	<0.02
Net Acid Soluble Sulfur (20Je)	----	0.02	% S		<0.02	----	0.02	<0.02	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t		<10	----	10	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S		<0.02	----	<0.02	<0.02	<0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH49 0.8-1.2	BH44 0.1-0.2	BH44 0.8-1.2	BH46 0.1-0.2	BH46 0.8-1.2
			Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EB1330241-006	EB1330241-007	EB1330241-008	EB1330241-009	EB1330241-010
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.05**	<0.02	**0.10**	**0.07**	**0.06**
Net Acidity (acidity units)	----	10	mole H+ / t	**29**	<10	**63**	**47**	**39**
Liming Rate	----	1	kg CaCO3/t	**2**	<1	**5**	**4**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH47 0.1-0.2	BH47 0.4-0.6	BH50 0.1-0.2	BH50 0.4-0.6	BH53 0.1-0.2
				Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00
Compound	CAS Number	LOR	Unit		EB1330241-011	EB1330241-012	EB1330241-013	EB1330241-014	EB1330241-015
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit		4.2	4.2	4.5	4.4	4.3
pH OX (23B)	----	0.1	pH Unit		4.2	4.2	3.7	4.0	4.0
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		64	32	37	34	56
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		132	52	<2	56	92
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		68	20	<2	22	36
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S		0.10	0.05	0.06	0.05	0.09
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S		0.21	0.08	<0.02	0.09	0.15
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S		0.11	0.03	<0.02	0.03	0.06
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S		0.04	<0.02	0.03	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S		0.04	<0.02	0.03	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t		23	<10	17	<10	<10
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.02	% Ca		0.12	0.06	0.14	0.10	0.13
Peroxide Calcium (23Wh)	----	0.02	% Ca		0.13	0.06	0.14	0.10	0.13
Acid Reacted Calcium (23X)	----	0.02	% Ca		<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg		0.04	0.04	0.06	0.10	0.08
Peroxide Magnesium (23Tm)	----	0.02	% Mg		0.04	0.04	0.06	0.10	0.08
Acid Reacted Magnesium (23U)	----	0.02	% Mg		<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-G: Retained Acidity									
HCl Extractable Sulfur (20Be)	----	0.02	% S		<0.02	<0.02	----	<0.02	<0.02
Net Acid Soluble Sulfur (20Je)	----	0.02	% S		<0.02	<0.02	----	<0.02	<0.02
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t		<10	<10	----	<10	<10
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S		<0.02	<0.02	----	<0.02	<0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH47 0.1-0.2	BH47 0.4-0.6	BH50 0.1-0.2	BH50 0.4-0.6	BH53 0.1-0.2
			Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EB1330241-011	EB1330241-012	EB1330241-013	EB1330241-014	EB1330241-015
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.14**	**0.05**	**0.09**	**0.05**	**0.09**
Net Acidity (acidity units)	----	10	mole H+ / t	**87**	**32**	**54**	**34**	**56**
Liming Rate	----	1	kg CaCO3/t	**6**	**2**	**4**	**2**	**4**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH53 0.4-0.6	BH66 0.1-0.2	BH66 0.8-1.2	BH69 0.1-0.2	BH69 0.8-1.2
				Client sampling date / time	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00
Compound	CAS Number	LOR	Unit		EB1330241-016	EB1330241-017	EB1330241-018	EB1330241-019	EB1330241-020
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit		4.3	4.7	4.9	4.7	5.8
pH OX (23B)	----	0.1	pH Unit		4.0	4.7	4.5	4.2	5.6
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		57	23	12	13	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		110	<2	15	<2	6
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		53	<2	2	<2	6
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S		0.09	0.04	<0.02	0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S		0.18	<0.02	0.02	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S		0.08	<0.02	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S		<0.02	0.02	<0.02	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S		<0.02	0.02	<0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t		<10	14	<10	<10	<10
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.02	% Ca		0.12	0.15	0.09	<0.02	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca		0.11	0.16	0.09	<0.02	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca		<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg		0.09	0.06	0.10	<0.02	0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg		0.09	0.06	0.11	<0.02	0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg		<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-G: Retained Acidity									
HCl Extractable Sulfur (20Be)	----	0.02	% S		<0.02	----	----	----	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S		<0.02	----	----	----	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t		<10	----	----	----	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S		<0.02	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH53 0.4-0.6	BH66 0.1-0.2	BH66 0.8-1.2	BH69 0.1-0.2	BH69 0.8-1.2
			Client sampling date / time	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EB1330241-016	EB1330241-017	EB1330241-018	EB1330241-019	EB1330241-020
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.09**	**0.06**	<0.02	**0.02**	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**57**	**37**	**12**	**13**	<10
Liming Rate	----	1	kg CaCO3/t	**4**	**3**	<1	**1**	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH64 0.1-0.2	BH64 0.4-0.6	BH65 0.1-0.2	BH65 0.4-0.6	BH12 0.1-0.2
				Client sampling date / time	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	23-OCT-2013 15:00
Compound	CAS Number	LOR	Unit		EB1330241-021	EB1330241-022	EB1330241-023	EB1330241-024	EB1330241-025
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit		4.8	4.5	5.3	5.5	5.2
pH OX (23B)	----	0.1	pH Unit		4.9	4.2	4.0	4.4	4.7
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		19	20	16	9	12
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		<2	38	<2	<2	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		<2	17	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S		0.03	0.03	0.02	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S		<0.02	0.06	<0.02	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S		<0.02	0.03	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S		<0.02	<0.02	0.03	0.03	0.03
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S		<0.02	<0.02	0.03	0.03	0.03
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t		<10	<10	20	21	18
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.02	% Ca		0.06	0.05	0.27	0.26	0.13
Peroxide Calcium (23Wh)	----	0.02	% Ca		0.06	0.04	0.29	0.28	0.12
Acid Reacted Calcium (23X)	----	0.02	% Ca		<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg		0.04	0.08	0.24	0.26	0.04
Peroxide Magnesium (23Tm)	----	0.02	% Mg		0.04	0.07	0.23	0.26	0.04
Acid Reacted Magnesium (23U)	----	0.02	% Mg		<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S		0.03	0.03	0.06	0.05	0.05
Net Acidity (acidity units)	----	10	mole H+ / t		19	20	36	30	31
Liming Rate	----	1	kg CaCO3/t		1	2	3	2	2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH12 0.4-0.6	BH14 0.1-0.2	BH14 0.8-1.2	BH11 0.1-0.2	BH11 0.4-0.6
			Client sampling date / time	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EB1330241-026	EB1330241-027	EB1330241-028	EB1330241-029	EB1330241-030
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.1	4.7	5.9	4.8	4.5
pH OX (23B)	----	0.1	pH Unit	5.4	4.2	6.3	4.9	4.4
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	8	18	<2	18	24
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	6	<2	6
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	6	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	0.03	<0.02	0.03	0.04
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	<0.02	0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	<0.02	0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	<10	13	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.08	0.05	0.05	0.10	0.07
Peroxide Calcium (23Wh)	----	0.02	% Ca	0.08	0.06	0.05	0.10	0.07
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	0.05	0.02	0.12	0.04	0.04
Peroxide Magnesium (23Tm)	----	0.02	% Mg	0.04	0.02	0.14	0.03	0.04
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	0.03	<0.02	0.05	0.04
Net Acidity (acidity units)	----	10	mole H+ / t	<10	18	<10	32	24
Liming Rate	----	1	kg CaCO3/t	<1	1	<1	2	2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH7 0.1-0.2	BH7 0.4-0.6	BH16 0.1-0.2	BH16 0.4-0.6	BH23 0.1-0.2
				Client sampling date / time	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00
Compound	CAS Number	LOR	Unit		EB1330241-031	EB1330241-032	EB1330241-033	EB1330241-034	EB1330241-035
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit		4.8	4.6	4.9	4.6	5.7
pH OX (23B)	----	0.1	pH Unit		4.9	4.4	3.8	4.3	5.1
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		21	21	14	14	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		<2	4	<2	4	3
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		<2	<2	<2	<2	3
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S		0.03	0.03	0.02	0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S		<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S		0.03	<0.02	<0.02	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S		0.03	<0.02	<0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t		17	<10	<10	<10	<10
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.02	% Ca		0.13	0.10	0.11	0.08	0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca		0.13	0.10	0.11	0.08	0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca		<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg		0.08	0.07	0.05	0.08	0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg		0.07	0.06	0.05	0.08	0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg		<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S		0.06	0.03	0.02	0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t		38	21	14	14	<10
Liming Rate	----	1	kg CaCO3/t		3	2	1	1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH23 0.4-0.6	BH24 0.1-0.2	BH24 0.4-0.6	BH25 0.1-0.2	BH25 0.4-0.6
				Client sampling date / time	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00
Compound	CAS Number	LOR	Unit		EB1330241-036	EB1330241-037	EB1330241-038	EB1330241-039	EB1330241-040
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit		5.3	4.3	4.5	4.7	4.5
pH OX (23B)	----	0.1	pH Unit		5.4	3.7	3.7	3.7	3.8
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		3	51	24	17	23
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		6	106	54	<2	63
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		3	56	29	<2	40
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S		<0.02	0.08	0.04	0.03	0.04
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S		<0.02	0.17	0.08	<0.02	0.10
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S		<0.02	0.09	0.05	<0.02	0.06
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t		<10	<10	<10	<10	<10
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.02	% Ca		0.02	<0.02	<0.02	0.04	0.03
Peroxide Calcium (23Wh)	----	0.02	% Ca		0.02	<0.02	<0.02	0.05	0.04
Acid Reacted Calcium (23X)	----	0.02	% Ca		<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg		0.05	<0.02	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg		0.05	<0.02	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg		<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t		<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
EA029-G: Retained Acidity									
HCl Extractable Sulfur (20Be)	----	0.02	% S		----	<0.02	----	----	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S		----	<0.02	----	----	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t		----	<10	----	----	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S		----	<0.02	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH23 0.4-0.6	BH24 0.1-0.2	BH24 0.4-0.6	BH25 0.1-0.2	BH25 0.4-0.6
			Client sampling date / time	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EB1330241-036	EB1330241-037	EB1330241-038	EB1330241-039	EB1330241-040
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.08**	**0.04**	**0.03**	**0.04**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**51**	**24**	**17**	**23**
Liming Rate	----	1	kg CaCO3/t	<1	**4**	**2**	**1**	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH26 0.4-0.6	BH26 0.8-1.2	BH27 0.1-0.2	BH27 0.4-0.6	----
			Client sampling date / time	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	----
Compound	CAS Number	LOR	Unit	EB1330241-041	EB1330241-042	EB1330241-043	EB1330241-044	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	4.7	4.5	4.9	4.6	----
pH OX (23B)	----	0.1	pH Unit	4.2	3.9	2.9	3.9	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	26	37	24	17	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	96	103	15	53	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	69	66	<2	36	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.04	0.06	0.04	0.03	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	0.15	0.16	0.02	0.08	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	0.11	0.10	<0.02	0.06	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	0.03	<0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.03	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	20	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.04	0.04	0.15	0.02	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	0.04	0.04	0.14	0.02	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	0.04	0.06	0.07	0.03	----
Net Acidity (acidity units)	----	10	mole H+ / t	26	37	44	17	----
Liming Rate	----	1	kg CaCO3/t	2	3	3	1	----

CERTIFICATE OF ANALYSIS

Work Order	: **EM1311266**	Page	: 1 of 5
Client	: **WORLEY PARSONS - INFRASTRUCTURE MWE**	Laboratory	: Environmental Division Melbourne
Contact	: LUCIE MISSEN	Contact	: Steven McGrath
Address	: LEVEL 12, 333 COLLINS STREET MELBOURNE VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: lucie.missen@worleyparsons.com	E-mail	: steven.mcgrath@alsenviro.com
Telephone	: +61 03 86763700	Telephone	: +61-3-8549 9600
Facsimile	: +61 03 86763770	Facsimile	: +61-3-8549 9601
Project	: 401010-01002 LOLIPIP	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 401010-01002 WBS 3G2003A		
C-O-C number	: ----	Date Samples Received	: 24-OCT-2013
Sampler	: LM	Issue Date	: 04-NOV-2013
Site	: ----		
		No. of samples received	: 18
Quote number	: ME/507/13	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme**
- **pH field/fox (EA003) conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH48 0.1-0.2	BH48 0.4-0.6	BH49 0.1-0.2	BH49 0.4-0.6	BH45 0.1-0.2
			Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311266-001	EM1311266-002	EM1311266-004	EM1311266-005	EM1311266-007
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.6**	**5.6**	**6.2**	**6.9**	**5.2**
pH (Fox)	----	0.1	pH Unit	**2.5**	**2.7**	**3.2**	**4.5**	**3.1**
Reaction Rate	----	1	Reaction Uni	**3**	**2**	**3**	**2**	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH45 0.8-1.2	BH44 0.1-0.2	BH44 0.8-1.2	BH46 0.1-0.2	BH46 0.8-1.2
			Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00	24-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311266-009	EM1311266-010	EM1311266-012	EM1311266-013	EM1311266-015
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.4**	**6.0**	**5.4**	**5.6**	**5.4**
pH (Fox)	----	0.1	pH Unit	**4.0**	**3.3**	**3.5**	**2.4**	**2.8**
Reaction Rate	----	1	Reaction Uni	**2**	**2**	**2**	**3**	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH47 0.1-0.2	BH47 0.4-0.6	----	----	----
			Client sampling date / time	24-OCT-2013 15:00	24-OCT-2013 15:00	----	----	----
Compound	CAS Number	LOR	Unit	EM1311266-016	EM1311266-017	----	----	----
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.3**	**5.6**	----	----	----
pH (Fox)	----	0.1	pH Unit	**2.4**	**2.9**	----	----	----
Reaction Rate	----	1	Reaction Uni	**3**	**3**	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **EM1311275**	Page	: 1 of 6
Client	: **WORLEY PARSONS - INFRASTRUCTURE MWE**	Laboratory	: Environmental Division Melbourne
Contact	: LUCIE MISSEN	Contact	: Steven McGrath
Address	: LEVEL 12, 333 COLLINS STREET MELBOURNE VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: lucie.missen@worleyparsons.com	E-mail	: steven.mcgrath@alsenviro.com
Telephone	: +61 03 86763700	Telephone	: +61-3-8549 9600
Facsimile	: +61 03 86763770	Facsimile	: +61-3-8549 9601
Project	: 401010-01002 LOLIPIP	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 401010-01002 WBS 3G2003A		
C-O-C number	: ----	Date Samples Received	: 25-OCT-2013
Sampler	: LM	Issue Date	: 04-NOV-2013
Site	: ----		
		No. of samples received	: 30
Quote number	: ME/507/13	No. of samples analysed	: 20

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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Signatories

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Signatories	*Position*	*Accreditation Category*
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme**
- **pH field/fox (EA003) conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH12 0.1-0.2	BH12 0.4-0.6	BH14 0.1-0.2	BH14 0.8-1.2	BH11 0.1-0.2
			Client sampling date / time	22-OCT-2013 15:00	22-OCT-2013 15:00	22-OCT-2013 15:00	22-OCT-2013 15:00	22-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311275-001	EM1311275-002	EM1311275-004	EM1311275-006	EM1311275-007
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**6.4**	**6.9**	**6.1**	**8.6**	**6.5**
pH (Fox)	----	0.1	pH Unit	**2.7**	**3.4**	**2.2**	**6.3**	**3.0**
Reaction Rate	----	1	Reaction Uni	**3**	**2**	**3**	**2**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH11 0.4-0.6	BH7 0.1-0.2	BH7 0.4-0.6	BH16 0.1-0.2	BH16 0.4-0.6
			Client sampling date / time	22-OCT-2013 15:00	22-OCT-2013 15:00	22-OCT-2013 15:00	22-OCT-2013 15:00	22-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311275-008	EM1311275-010	EM1311275-011	EM1311275-013	EM1311275-014
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**6.3**	**5.7**	**6.0**	**6.4**	**6.3**
pH (Fox)	----	0.1	pH Unit	**3.4**	**3.0**	**3.2**	**2.6**	**2.7**
Reaction Rate	----	1	Reaction Uni	**3**	**4**	**2**	**3**	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH23 0.1-0.2	BH23 0.4-0.6	BH24 0.1-0.2	BH24 0.4-0.6	BH25 0.1-0.2
			Client sampling date / time	22-OCT-2013 15:00	22-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311275-016	EM1311275-017	EM1311275-019	EM1311275-020	EM1311275-022
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**7.3**	**7.5**	**4.9**	**4.6**	**6.0**
pH (Fox)	----	0.1	pH Unit	**3.7**	**5.2**	**2.0**	**2.6**	**2.2**
Reaction Rate	----	1	Reaction Uni	**2**	**1**	**2**	**1**	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH25 0.4-0.6	BH26 0.4-0.6	BH26 0.8-1.2	BH27 0.1-0.2	BH27 0.4-0.6
			Client sampling date / time	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00	23-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311275-023	EM1311275-026	EM1311275-027	EM1311275-028	EM1311275-029
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.8**	**5.4**	**5.6**	**5.8**	**5.7**
pH (Fox)	----	0.1	pH Unit	**2.0**	**2.4**	**2.5**	**2.0**	**2.7**
Reaction Rate	----	1	Reaction Uni	**2**	**2**	**2**	**2**	**2**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1311321**	Page	: 1 of 5
Client	: **WORLEY PARSONS - INFRASTRUCTURE MWE**	Laboratory	: Environmental Division Melbourne
Contact	: LUCIE MISSEN	Contact	: Steven McGrath
Address	: LEVEL 12, 333 COLLINS STREET MELBOURNE VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: lucie.missen@worleyparsons.com	E-mail	: steven.mcgrath@alsenviro.com
Telephone	: +61 03 86763700	Telephone	: +61-3-8549 9600
Facsimile	: +61 03 86763770	Facsimile	: +61-3-8549 9601
Project	: 401010-01002 LOLIPIP	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 401010-01002 WBS 3G2003A		
C-O-C number	: ----	Date Samples Received	: 25-OCT-2013
Sampler	: LM	Issue Date	: 04-NOV-2013
Site	: ----		
		No. of samples received	: 18
Quote number	: ME/507/13	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme**
- **pH field/fox (EA003) conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH50 0.1-0.2	BH50 0.4-0.6	BH53 0.1-0.2	BH53 0.4-0.6	BH66 0.1-0.2
			Client sampling date / time	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311321-001	EM1311321-002	EM1311321-004	EM1311321-005	EM1311321-007
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.8**	**6.2**	**5.5**	**5.5**	**5.8**
pH (Fox)	----	0.1	pH Unit	**2.8**	**2.8**	**2.6**	**2.8**	**2.6**
Reaction Rate	----	1	Reaction Uni	**3**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH66 0.8-1.2	BH69 0.1-0.2	BH69 0.8-1.2	BH64 0.1-0.2	BH64 0.4-0.6
			Client sampling date / time	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00	25-OCT-2013 15:00
Compound	CAS Number	LOR	Unit	EM1311321-009	EM1311321-010	EM1311321-012	EM1311321-013	EM1311321-014
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**6.1**	**5.7**	**7.3**	**6.5**	**6.0**
pH (Fox)	----	0.1	pH Unit	**4.4**	**2.4**	**5.2**	**2.6**	**3.4**
Reaction Rate	----	1	Reaction Uni	**2**	**3**	**3**	**3**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH65 0.1-0.2	BH65 0.4-0.6	----	----	----
			Client sampling date / time	25-OCT-2013 15:00	25-OCT-2013 15:00	----	----	----
Compound	CAS Number	LOR	Unit	EM1311321-016	EM1311321-017	----	----	----
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**7.0**	**7.1**	----	----	----
pH (Fox)	----	0.1	pH Unit	**3.6**	**4.4**	----	----	----
Reaction Rate	----	1	Reaction Uni	**3**	**2**	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1312266**	Page	: 1 of 3
Client	: **WORLEY PARSONS - INFRASTRUCTURE MWE**	Laboratory	: Environmental Division Melbourne
Contact	: LUCIE MISSEN	Contact	: Steven McGrath
Address	: LEVEL 12, 333 COLLINS STREET MELBOURNE VIC, AUSTRALIA 3000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: lucie.missen@worleyparsons.com	E-mail	: steven.mcgrath@alsenviro.com
Telephone	: +61 03 86763700	Telephone	: +61-3-8549 9600
Facsimile	: +61 03 86763770	Facsimile	: +61-3-8549 9601
Project	: 401010-01002 LOLIPIP	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 401010-01002 WBS 3G2003A		
C-O-C number	: ----	Date Samples Received	: 20-NOV-2013
Sampler	: ----	Issue Date	: 28-NOV-2013
Site	: GIPPSLAND		
		No. of samples received	: 6
Quote number	: ME/507/13	No. of samples analysed	: 4

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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- **ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme**
- **pH field/fox (EA003) conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH62 0.2-0.3	BH62 0.7-0.8	BH67 0.05--0.3	BH67 0.6-0.9	----
			Client sampling date / time	20-NOV-2013 16:00	20-NOV-2013 16:00	20-NOV-2013 16:00	20-NOV-2013 16:00	----
Compound	CAS Number	LOR	Unit	EM1312266-001	EM1312266-002	EM1312266-004	EM1312266-005	----
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.1**	**6.0**	**4.3**	**4.4**	----
pH (Fox)	----	0.1	pH Unit	**2.3**	**2.5**	**2.5**	**3.2**	----
Reaction Rate	----	1	Reaction Uni	**3**	**2**	**1**	**1**	----

Appendix 4 - Laboratory COC and QA/QC