BULKY GOODS STORE
LAKES WAY FORSTER

WOOLWORTHS LTD

GEOTTUNC01726AB-AB
15 January 2008

PRELIMINARY GEOTECHNICAL SITE ASSESSMENT

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
1/4 Douglas Avenue Tuncurry NSW 2428 Australia

15 January 2008

Woolworths Limited
PO Box 8000
Baulkham Hills NSW 2153

Attention: Nigel Smith

Dear Nigel,

RE: PROPOSED BULKY GOODS DEVELOPMENT, LAKES WAY FORSTER
PRELIMINARY GEOTECHNICAL SITE ASSESSMENT

Coffey Geotechnics Pty Ltd (Coffey) is pleased to provide our report for the above site.

We draw your attention to the enclosed sheet entitled *'Important Information about your Coffey Report'*, which should be read in conjunction with this report.

If you have any questions regarding this matter, please do not hesitate to contact the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd

Steve Morton

Principal

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CONTENTS

CONTENTS

1 INTRODUCTION

This report presents the results of an assessment carried out by Coffey Geotechnics Pty Ltd (Coffey) for an area of proposed filling associated with a proposed bulky goods development located on the Lakes Way at Forster. It is understood the bulky goods store development proposed for the site will require filling to raise the site to the required level. Part of the proposed development area has been stripped to allow for the filling. One corner of the site contains filling that encroaches onto the site from an adjacent filling operation, and elsewhere on the site there is a stockpile of soil that could potentially be used for the filling operations.

The work was commissioned by Woolworths Limited, with a view to potential future development of the site. The aims of the investigation were:

- To assess the stripped area for suitability for the subsequent placement of fill;
- To assess the stockpile for the potential re-use as fill in the proposed development;
- To assess the area of existing fill that extends onto the site with regards to its suitability for the proposed development.

2 SITE IDENTIFICATION

2.1 Location and Setting

The site is located on the southwest side of the intersection of The Lakes Way and Breese Parade, Forster (See Figure 1). The overall site has an area of 54,700m^2, and comprises two sites, Site A of 31,200m^2, and Site B of 23,500m^2. It is a battleaxe block located behind existing residences and a motel that front the Lakes Way. It is bounded by residential and motel development to the east, by an existing tavern to the north, and by a recently filled site to the northwest. To the south and southwest the site is bordered by undeveloped low-lying swamp-forest. Wallis Lake is located approximately 100m west of the site.

Topographically, the site is situated on a broad sand plain derived from Pleistocene aged wind-blown sands on the eastern shores of Wallis Lake. It is generally flat, with a gentle slope of 1 to 2 degrees towards the west. The northwestern corner of the site contains filling encroaching from an adjacent site. The surface of this part of the site is unvegetated and the exposed fill is mainly sandy, but with some visible concrete, timber, and minor plastic exposed.

South of this site there is an existing stockpile of soil, the approximate location and extent of which is delineated on Figure 1. The stockpile is heavily vegetated by grass and weeds. Surface exposures indicate the stockpiled material to be predominantly sandy, but there is some visible ripped rock gravel, and minor amounts of concrete and building rubble exposed.

The remainder of the site has been stripped to allow filling and consists of broad, low-lying stripped areas separated by mounds of the stripped topsoil. The surface exposes sand with sparse grass cover. The surrounding areas contain some well established large trees.

Site drainage is judged to primarily occur via infiltration into the predominantly sandy surface soils. Trafficability is restricted by the sandy nature of the surface soils.

2.2 Local Geology and Hydrogeology

Reference to the 1:100,000 Bulahdelah geology map indicates the site to be underlain by Quaternary Alluvium. The Forster 1:25,000 Acid Sulfate Soil Risk Map indicates the site to be located within an area of Estuarine sand plain with an elevation of approximately 1m and a high probability of acid sulfate soils (See Figure 2). Groundwater is likely to be within 1m of the natural ground surface and would have a very low gradient but with an overall flow towards Wallis Lake to the west of the site.

3 INVESTIGATIONS UNDERTAKEN

3.1 Issues to be addressed

Based on site conditions and the proposed development, the following issues were identified as requiring assessment:

- Suitability of the stripped area for the subsequent placement of fill. Issues to be addressed include the depth to groundwater, and the presence of soft, compressible, or peaty layers. The presence of acid sulfate soils in this area was not addressed as it is unlikely that there would be excavation required to that depth following the filling of the site;
- Potential re-use of the existing stockpile as fill in the proposed development. In particular the presence of contaminated materials, potential acid sulfate soils, or unsuitable materials such as oversized building rubble, organic matter, rubbish, or soft soils;
- Suitability of the area of existing fill that extends onto the site. Assessment included the nature, quality, and consistency of the material as well as the degree of compaction and the extent of stripping of the underlying natural foundation.

3.2 Fieldwork and sampling methodology

To address the above issues a series of excavator test pits were dug, logged, and sampled at the locations shown in Figure 3. Engineering logs of the test pits are attached in Appendix A together with explanation sheets defining the terms and symbols used in their preparation.

In addition, to assess the density of the subsurface profile in the previously stripped areas, a series of dynamic penetrometer tests was undertaken. The test results are included in Appendix A.

Environmental sampling activities were based on procedures and protocols outlined in Coffey's Environmental Field Manual (QP15/5-E, June 1995, revised September 1997) which is based on industry accepted standard practice. Sampling for contamination testing was undertaken using disposable samplers at each location and sampling into laboratory supplied glass jars which were then placed on ice during the field work and maintained on ice during transit to the laboratory under chain of custody conditions.

Samples for Acid Sulfate Soil analysis were wrapped tightly in plastic bags with excess air expelled. The samples were then placed on ice during field work and for transport to the laboratory.

3.3 Subsurface Conditions

3.3.1 Stripped area

Test pits TP3 to TP7 were excavated in the existing stripped area. Corresponding DCP test no's 3 to 7 were conducted adjacent to the test pits. The subsurface profile encountered consisted of a thin vegetation layer overlying medium dense alluvial/estuarine sand which extended to depths varying between 0.3m to 0.8m. This layer was underlain by a consistent layer of indurated sand, which was of sufficient strength to cause DCP refusal at all locations. The groundwater table was encountered above the indurated sand layer in all locations. Test pits did not extend below this layer due to collapsing of pit walls in sand below the water table.

3.3.2 Existing stockpile

Test Pits TP 8 to TP19 were excavated in the existing stockpile. The majority of the profile encountered within the stockpile consisted of silty and clayey Sand, grey to dark grey, with some minor cobbles and gravel and a trace of root fibres. Exceptions to this general condition were:

- TP9, with 0.8m of dark brown-red-orange silty sandy CLAY, stiff, underlain by clayey and gravelly sand;
- TP11, 0.0 – 0.9m encountered Clayey GRAVEL, fine to medium, subangular, cobbles up to 10cm diameter. Deeper in the same pit the material consisted of Sandy Gravelly CLAY, medium plasticity, grey with orange mottling;
- TP12, 0.0 – 0.8m; Silty Sandy CLAY some roots and timber up to 5cm diameter;
- TP13, 0.0 – 1.3m; Sandy GRAVEL, with approximately 10% consisting of bitumen pieces up to 50cm diameter;
- TP15, 1.6 – 2.2m; Clayey SAND, fine to medium grained, with timber up to 5cm diameterTP16, generally silty sand as per the general description, but with some glass and timber pieces
- TP19, 0 – 0.5m; SAND, with some fine roots and plastic fragments.

3.3.3 Existing filled area

Test pits TP1 and TP2 were excavated in the existing filled area in the northwest corner of the site and encountered 0.5m to 1.0 m of fill comprising SAND and Clayey SAND, fine to coarse, dark grey, with some bricks cement, plastic, and timber. DCP tests indicated the fill to be generally medium dense. Test pit TP2 encountered 0.2m of topsoil beneath the fill. Groundwater was encountered at or just below the fill/natural interface.

4 RE-USE OF EXISTING STOCKPILE

4.1 Geotechnical conditions

Test pit logs and observations indicate the stockpile consists predominantly of sandy soils with some interspersed gravel and clay patches. The bulk of the stockpiled material would be considered suitable for re-use from a geotechnical perspective. The test pitting encountered isolated oversized material as well as timber, organic matter and minor rubbish such as glass and plastic. The proportions of this material were such that it is anticipated the materials in the stockpile could be re-used with some minor sorting of unsuitable that could be undertaken during excavation and placement.

4.2 Contamination

4.2.1 Laboratory Testing

Laboratory testing included the following:

- Acid sulfate soil screening tests;
- Chromium Reducible Sulfur (CRS) analysis on selected samples based on response to acid sulfate screening tests;
- Testing for common contaminants including;
  - Heavy metals (Cu, Pb, Zn, Cd, Cr, As, Ni, Hg)
  - Petroleum hydrocarbons (TPH)
  - Polycyclic Aromatic Hydrocarbons (PAH)
  - BTEX Compounds
  - Organochlorine pesticides
  - Organophosphorus pesticides

Laboratory test results are presented in Appendix B.

4.2.2 Regulatory background and applicable guidelines

As per the ESA, the investigation criteria for soil were established based on the following references:

- NSW DEC (2006) Guidelines for the NSW Auditor Scheme; and
- NSW EPA (1994) Guidelines for Assessing Service Station Sites.

Other sources were used to supplement the above references where appropriate.

The NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme* present health based investigation levels for different land uses (e.g. industrial/commercial, residential, recreational etc.) as well as provisional phytotoxicity based investigation levels.

The future land use on the site is understood to be for commercial purposes. Therefore the investigation levels for commercial/industrial land use have been adopted as the primary investigation criteria.

The NSW EPA (1994) *Guidelines for Assessing Service Station Sites* provides acceptable threshold concentrations for petroleum hydrocarbons compounds at service station sites to be reused for sensitive land uses such as residential. The DEC has advised that these should also be used as investigation criteria for sites to be used for less sensitive land uses, including commercial/industrial.

The investigation results are compared to the adopted criteria in the attached Table 1.

4.2.3 Quality Control

Primary laboratory analysis was undertaken by ALS, which is a NATA registered laboratory for the analysis undertaken. Samples were received by ALS within the recommended holding times and they were chilled when received.

Samples were collected in appropriately preserved sampling containers and kept chilled in the field and during transit to the laboratory. The soil samples were dispatched under chain of custody conditions. Samples were received by the laboratory in good condition. Samples were extracted and analysed within the respective holding times for each analyte.

A review of the laboratory internal quality assurance/quality control reports indicate that the appropriate laboratory quality assurance/quality control procedures and rates were undertaken for contamination studies, and that surrogate recoveries were within the control limits for inorganics (approx. 70% to 130%).

On the basis of the field and laboratory quality control results discussed above, the field and laboratory methods are considered appropriate and the data obtained is considered to reasonably represent the concentrations at the sampling points at the time of sampling.

4.2.4 Results

The results of testing for contaminants within the existing stockpile materials are presented in Appendix B, and are compared to guideline criteria in Table 1. The results indicate that all analytes meet the criteria for re-use in a commercial development.

4.3 Acid sulfate soils

4.3.1 Background Information

Acid Sulfate Soils (ASS) are soils which contain significant concentrations of pyrite which, when exposed to oxygen, in the presence of sufficient moisture, oxidises, resulting in the generation of sulfuric acid. Unoxidised pyritic soils are referred to as <u>potential</u> ASS. When the soils are exposed, the oxidation of pyrite occurs and sulphuric acids are generated, the soils are said to be <u>actual</u> ASS.

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. Typical environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL.5m AHD. They can also form as bottom sediments in coastal rivers and creeks.

Pyritic soils of concern on low lying NSW and coastal lands have mostly formed in the Holocene period, (ie, 10,000 years ago to present to day) predominantly in the 7,000 years since the last rise in sea level.

It is generally considered that pyritic soils which formed prior to the Holocene period (ie. >10,000 years ago) would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen.

4.3.2 Significance of ASS

Disturbance or poorly managed development and use of acid sulfate soils can generate significant amounts of sulfuric acid, which can lower soil and water pH to extreme levels (generally <4) and produce acid salts, resulting in high salinity.

The low pH, high salinity soils can reduce or altogether preclude vegetation growth and can produce aggressive soil conditions which may be detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

Generation of the acid conditions often releases aluminium, iron and other naturally occurring elements from the otherwise stable soil matrices. High concentrations of some such elements, coupled with low pH and alterations to salinity can be detrimental to aquatic life. In severe cases, affected waters flowing off-site into aquatic ecosystems can have detrimental effect on aquatic ecosystems.

4.3.3 Acid Sulfate Soil Risk Maps

Reference to the Forster 1:25,000 Acid Sulfate Soil Risk Map indicates the site to be located within an area of Estuarine sand plain with an elevation of approximately 1m and a high probability of acid sulfate soils (See Figure 2).

4.3.4 Test Results

Screening for Actual and Potential ASS was undertaken using the laboratory test methods 21Af and 21Bf presented in the ASSMAC Acid Sulfate Soil Manual. The results are presented in Appendix B and revealed the following:

- pH in distilled water ranged from 5.20 to 6.41. A pH of less than 4 in this test can be an indicator of Actual ASS;
- pH in hydrogen peroxide ranged from 3.46 to 5.30. A pH of less than 3 in this test can be an indicator of Potential ASS.

On the basis of these test results the soils sampled and analysed do not appear to be Actual or Potential ASS. To confirm the above, four samples were selected for more detailed analysis by Chromium Reducible Sulfur methodology. Results are attached in Appendix B and summarised in Table 2.

The results shown in Table 2 indicate that there is some residual acidity in the soils that exceeds Action Criteria for use of more than 1,000 tonnes of soil. Based on these results it is recommended that where these soils are used, lime should be mixed through the soil at a rate of 5kg lime per tonne of soil to neutralise the acidity within the soil.

This liming should be incorporated into an earthworks management plan for the site.

Table 2. Results of Laboratory Chromium Reducible Sulfur Analysis

Location	Depth (m)	Reduced Inorganic Sulfur ($\%_{SCR}$)	Reduced Inorganic Sulfur (mol/tonne)	Net Acidity (mol/tonne)	Lime Requirement (kg_{lime} / m^3_{soil})
TP9	0.9 – 1.0	0.013	8	43	5
TP12	0.9 – 1.0	0.005	3	35	4
TP15	1.7 – 1.8	0.006	4	37	4
TP6	1.5 – 1.6	<0.005	0	33	3
Action Criteria		0.03	18	18	

4.4 Conclusions regarding re-use of existing stockpile

On the basis of this assessment the stockpiled materials would be considered suitable for re-use within the proposed development provided some care is taken during their extraction and placement to remove minor quantities of oversize, organic, and otherwise unsuitable material, and lime is added at a rate of 5kg lime per tonne of soil during placement.

5 SUITABILITY OF EXISTING STRIPPED AREA

Test pits and DCP tests undertaken in the existing stripped area encountered a thin vegetation layer overlying medium dense alluvial/estuarine sand which extended to depths varying between 0.3m to 0.8m. This layer was underlain by a consistent layer of indurated sand, which was of sufficient strength to cause DCP refusal at all locations. The groundwater table was encountered above the indurated sand layer.

On the basis of these results it is considered that the stripped area would be appropriate for the proposed filling without further stripping. It should be noted that the groundwater table was encountered in close proximity to the existing ground surface and as such trafficability and compaction of fill may be difficult on the sandy soils. Therefore prior to placement and compaction of fill in this area it may be advisable for a working platform of 300mm of granular material such as quarry overburden or similar, to be placed over the area to be filled.

6 AREA OF EXISTING FILL

Test pitting and DCP testing in this area indicated the fill to contain some unsuitable material, and the underlying natural surface was found not to have been stripped to a satisfactory foundation material prior to the placement of fill. The fill did not appear to have been placed and compacted in layers in a manner that would comply with the requirements of Controlled Fill suitable for the use of high level footings.

It is therefore recommended that structures placed on this area should be supported by deepened footings or piles founded in dense natural sands or better, beneath all existing fill and topsoil. Alternatively, the fill could be removed and replaced with Controlled fill placed and compacted in accordance with the recommendations of this report.

7 RECOMMENDATIONS ON PLACEMENT AND COMPACTION OF FILL

Site preparation and earthworks suitable for pavement and structure support should consist of:

- Prior to placement of any fill, the proposed areas should be stripped to remove all vegetation, topsoil, root affected or other potentially deleterious material;
- Following stripping, the exposed subgrade materials should be proof rolled to identify any wet or excessively deflecting material. Any such areas should be over excavated and backfilled with an approved select material;
- In the lower lying areas of the site a working platform consisting of 300mm of select quality fill should be placed to improve trafficability and provide a firm base for the compaction of subsequent layers;
- Approved fill should be placed in layers not exceeding 300mm loose thickness and compacted to a minimum density ratio of 95% Standard Compaction in accordance with AS1289.5.1.1 or equivalent (or 70% Density Index for Sands).
- The top 300mm of natural subgrade below pavements or the final 300mm of road subgrade replaced should be compacted to minimum density ratio of 100% Standard Compaction or equivalent (80% density Index) within the above stated moisture range;
- All fill should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected against erosion.

Earthworks should be carried out in accordance with the recommendations outlined in AS3798-1996 “Guidelines for Earthworks for Commercial and Residential Developments”.

8 LIMITATIONS

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points. Should any site conditions be encountered during construction that vary significantly from those discussed in this report, Coffey should be advised and appropriate action taken.

Contactors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

For and on behalf of Coffey Geotechnics Pty Ltd

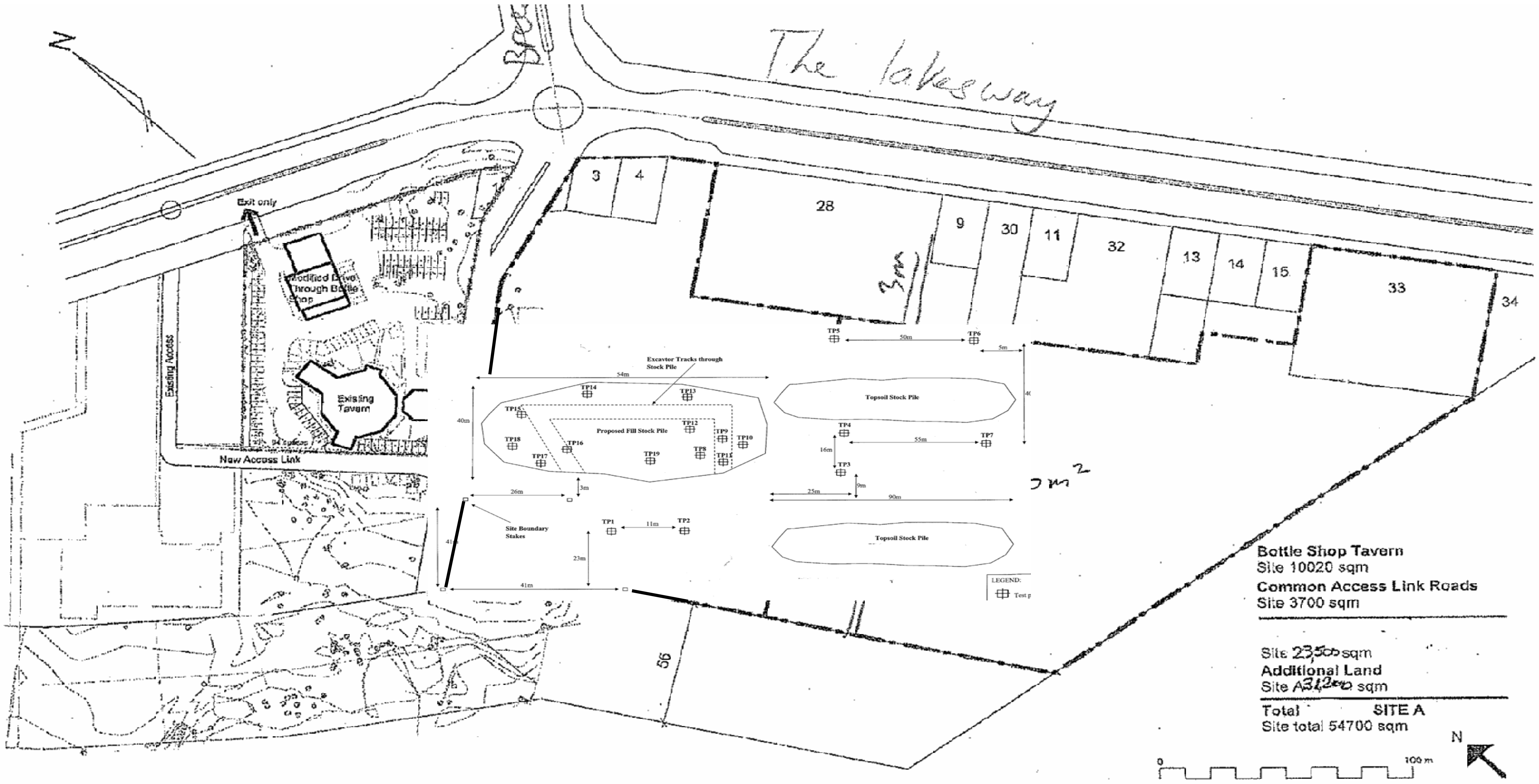
Steven Morton

Principal

Figures

Appendix A

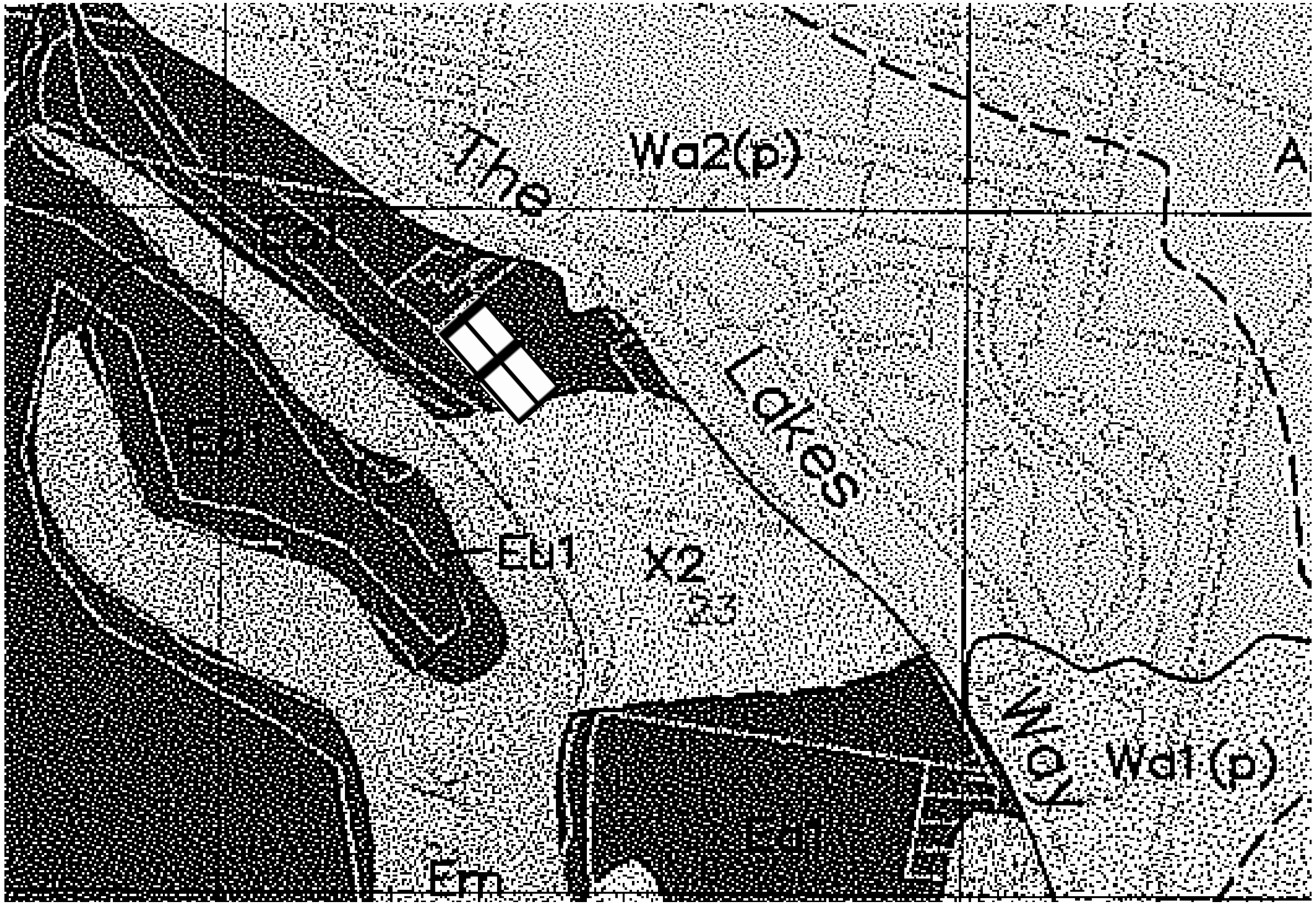
Field Investigation Logs



drawn	JP	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	WOOLWORTHS LIMITED
approved			project:	Bulky Goods Store Development, The Lakes Way Forster
date	18/12/2007			
scale	NTS		title:	Site Location Plan
original size			project no: GEOTTUNC01726AB-AB	figure no: FIGURE 1

Appendix B

Laboratory Testing



0 1 2 3 4 5 6

LEGEND:

Development Site

Ea1 *Estuarine Sandplain Elevation 1m. High Probabilty of ASS within 1m of Ground Surface.*

X2 *Disturbed Terrian Elevation 2-4m. No known occurrence of acid sulfate materials.*

drawn	**JC**
approved	
date	**18/12/2007**
scale	**NTS**
original size	original size

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client:	**WOOLWORTHS LIMITED**
project:	**Bulky Goods Store Development, The Lakes Way Forster**
title:	**Acid Sulfate Risk Map**

	original size	original size	THE EARTH	project no:	**GEOTTUNC01726AB-AB**	figure no:	**FIGURE 2**

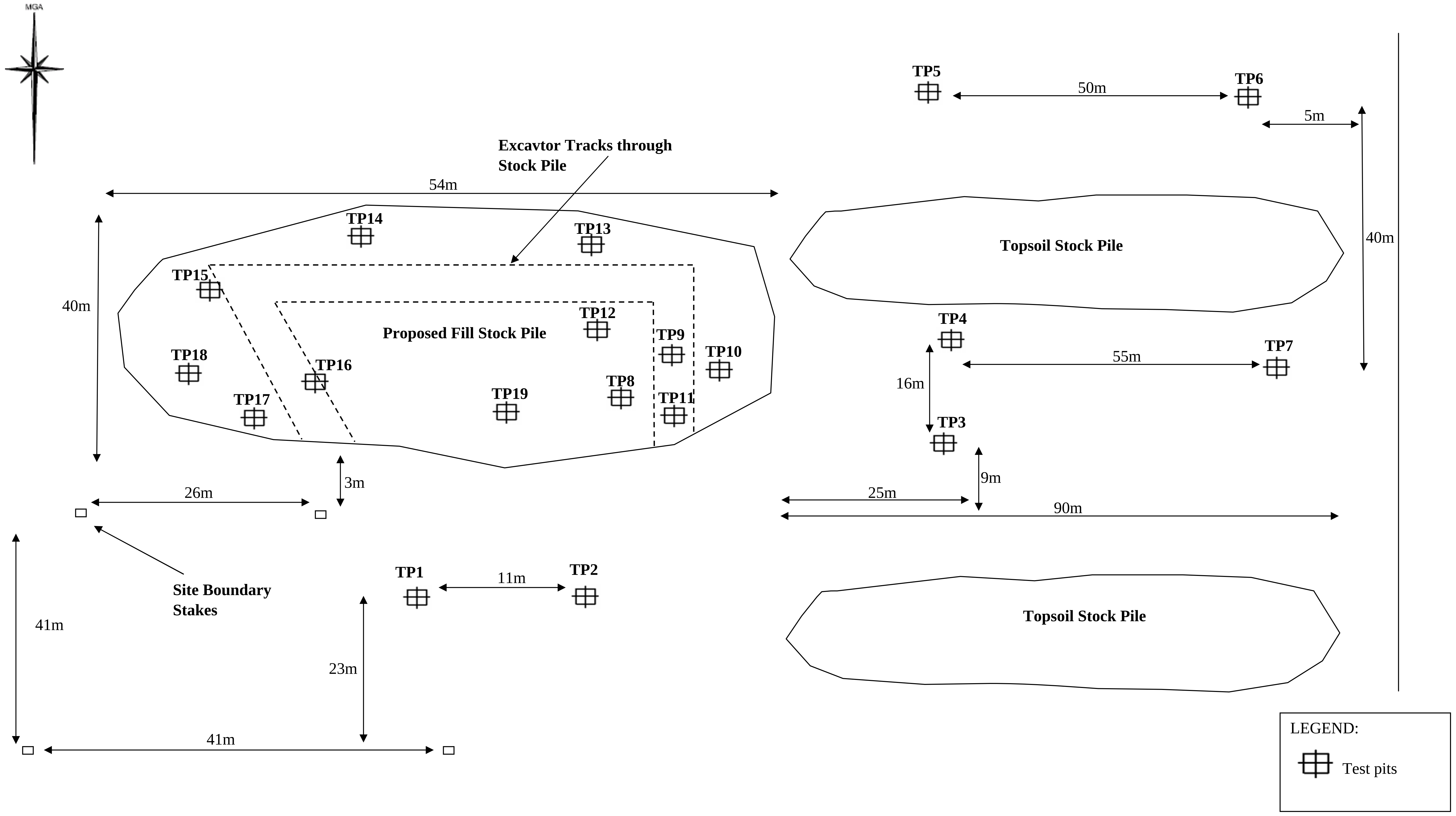
Borehole

Test pit

DCP

Appendix C

Title History Search



revision	description	drawn	approved	date		drawn	JP		client:	WOOLWORTHS LIMITED
						approved		coffey geotechnics SPECIALISTS MANAGING THE EARTH	project:	Bulky Goods Store Development, The Lakes Way Forster
						date	18/12/2007			
						scale	NTS		title:	Field Investigation Sketch Plan
						original size			project no: GEOTTUNC01726AB-AB	figure no: FIGURE 2