

Dover Investments Pty Ltd
GPO Box 5222
BRISBANE QLD 4000

Project 77861.01
23 May 2012
DSF:pc

Attention: Mr Barry Young

Email: barry_young@austcorp.com.au

Dear Sir

Geotechnical Assessment of Proposed Site Filling and Seawalls
Stage 11 – Lots A & C
Bayview, NT

1. Introduction

This letter report by Douglas Partners Pty Ltd (DP) provides a geotechnical assessment of proposed site filling and seawalls for Stage 11, Lots A and C at Bayview, Darwin, NT. It is understood that the assessment is required to provide additional information in respect to cross sections to ensure the land is suitably filled to a height to enable development of the lots for their intended purposes, thereby avoiding risk and damage as a result of any storm surge event. The letter report was requested by Mr Barry Young on behalf of Dover Investments Pty Ltd.

2. Site Descriptions

The location of the proposed Stage 11 Lots A and C relative to the currently developed areas of Bayview are shown on the attached Site Locality Plan, Drawing 1 and the individual Lots A and C together with adjacent lots are shown on Drawings 2 and 3 attached. Site photographs showing current surface conditions are attached.

Lot A comprises grassed and vegetated vacant land which is partially filled over intertidal mud flats. The lot is bounded by a filled area to the north, by residential allotments located on a filling platform to the south and west, and by a narrow corridor of cleared mangroves, then mangrove forest to the east. Lot A site surface currently slopes down to the east from about RL5.5 mAHD on the crest of the filling platform to about RL2 to 2.6 m along the eastern lease boundary.

Lot C comprises unvegetated vacant land located in a re-entrant corner of the Bayview rock armoured seawall, as well as low-lying intertidal mud flats. The lot is bounded by residential allotments located on a filling platform to the north, west and south and by a narrow corridor of cleared mangroves, then mangrove forest to the east. Lot C surface is currently level at about RL5.5 m along the western

boundary and slopes down across the rock wall to about RL1.8 to 2.4 m over intertidal mudflats along the eastern lease boundary.

3. Geology

Reference to the Darwin 1:100 000 Geological Map Series sheet indicates the site is underlain by recent marine sediments (mangrove mud) then Quaternary age sediments comprising ferruginous gravelly clayey sand and pisolitic mottled laterite, ferricrete (locally referred to as coffee rock) overlying bedrock comprising low to medium strength metasiltstone (phyllite) of the Burrell Creek Formation.

4. Previous Investigations and Reports

Previous field investigations and engineering analysis have been carried out in the areas of Lots A and C. The results of these investigations were presented in DP reports and letter reports listed as references Ref 1 to Ref 11 in Section 8 of this report. Previous work included mud depth probes, laboratory testing, engineering analysis, development of a construction strategy for filling over soft marine clays, and the results of settlement monitoring.

References 1 to 6 contain the field data and results of engineering analyses carried out to plan the earthworks in an area designated as Stage 10 of the Bayview subdivision. References 7, 8 and 9 contain the results of settlement monitoring for the Stage 10 area and Ref 10 is an earthworks certification report for the Stage 10b area. Reference 11 is the most recent report prepared for Dover Investments Pty Ltd in December 2011 for the rezoning application for Lots A and C.

5. Proposed Construction

It is understood that the proposed construction to develop each of the two lots will be as follows:

Lot A: Clear and reshape the sloping ground, then construct a building platform at a final level at about RL5.5m AHD by filling over the prepared site surface. Surcharge the lot for a period of up to 5 months with about 2 m of filling to reduce post construction settlements, then remove the surcharge and construct a seawall to RL6.5 m AHD.

Lot C: Remove and stockpile the rock armour from the current seawall, reshape the sloping fill batter, then construct a building platform at a final level at about RL RL5.5 m AHD by filling over the prepared site surface. Surcharge the lot for a period of up to 8 months with about 2 m of filling to reduce post construction settlements, then remove the surcharge and construct a seawall to RL6.5 m AHD.

6. Comments

6.1 Surface and Subsurface Conditions

The present surface conditions on Lots A and C are shown in the attached site photographs, Plates 1 and 2, taken in early May 2012. There are no mature mangroves within the lease boundary at either of the sites, and all vegetation on the earth and rockfill slopes is regrowth since the slopes were constructed.

The locations of mud depth probes from Ref 3 are shown on Drawing 4, and the depths of soft mud penetrated at each probe location are listed in Table 1. Based on these results, average mud depth along the lease boundary at Lot A is about 2 m and the average mud depth along the lease boundary at Lot C is about 2.5 m. The soft mud is underlain by a layer of stiff marine clay which averages about 1 m thick at Lot A and about 0.7 m thick at Lot C.

6.2 Geotechnical Issues for Design and Construction

Based on the previous earthworks carried out for construction of similar filling platforms suitable for residential construction in Stages 3 to 10 of the Bayview subdivision, there are four main geotechnical issues to be addressed. These include the following:

- a. stability of the filling and surcharge during placement over soft marine sediments;
- b. differential settlement between previously placed filling and new filling which may lead to the formation of tension cracks at the interface between the “old” and “new” filling;
- c. settlement of the filling platform; and
- d. stability of the seawall after surcharge is removed and rock armour is placed.

Each of these four issues will be specifically addressed by incorporating the following geotechnical design features and construction strategies into the site filling procedures, and by monitoring the settlement of fill platforms by precise survey.

Issue a: The current site surfaces will be cleared and benched before an engineered filling platform comprising a woven geotextile layer, a rockfill working platform, engineered filling and surcharge is placed over the mud surface. The earthworks profile proposed for site filling and surcharge is shown on attached Drawing 5. A similar profile has been successfully used for construction of previous stages of Bayview including the adjacent Stage 10 earthworks.

Issue b: The new filling will be carefully placed in a controlled manner, and will be keyed into the current filling, to minimise the risk of longitudinal cracking and to ensure stability of the filling platform at all stages. Any tension cracks that form at the interface between “old” and “new” filling will be reinstated before surcharge is removed. Tension cracks that have formed due to differential settlement at Bayview and the nearby Tiger Brennan Drive embankments have been successfully reinstated with minimal detrimental effect to the filling platform using this approach.

Issue c: Surcharge will be placed over the engineered filling to heights predetermined by engineering calculations. Examples of surcharge profiles and estimated surcharge times for areas including part of Lot A and all of Lot C are shown on attached Drawings 6 and 7. Settlement of the filling platform under surcharge loads will be monitored by periodic survey and the surcharge will not be removed until approximately 90% of primary consolidation under filling load has been achieved. Settlement monitoring of previous stages of Bayview for periods of up to 5 years after removal of surcharge indicates that post construction settlements of monuments located on filled areas have generally been limited to 20 mm or less.

Issue d: The seawall section proposed for Lots A and C is shown on attached Drawing 8. This section differs from previous seawall sections at Bayview because shallower average mud depths along the lease boundary on this eastern side allow for a steeper, stable armour rock wall to be constructed on a rockfill base. The seawall construction comprises removing and displacing soft mangrove mud and replacing this soft soil with a rockfill base. The top of the rockfill base will be at or slightly below natural surface level and the rockfill base will be founded on the underlying stiff marine clay. This rockfill base will be placed before the working platform and site filling so that trenching required to remove mud does not cause any instability in the filling.

After the surcharge is removed to the design site level of about RL5.5 m AHD, the compacted outer fill batter will be trimmed to a slope of 5H:4V and a 1 m high precast concrete retaining wall will be constructed at the crest of the batter as shown on Drawing 8. A non-woven geotextile will be laid on the batter and secured under the wall, then armour rock (which was previously removed and stockpiled before filling Lots A and C) will be placed on the batter and over the base of the retaining wall.

7. Suitability for Residential Construction

The attached Drawing 4 shows the locations of the proposed Stage 11 - Lots A and C which confirms that the information on mud depths and surcharge calculations contained in previous DP geotechnical reports will adequately cover the proposed Stage 11 lot areas. In addition, the information on Drawings 6 and 7 indicate that previous calculations of surcharge heights and surcharge times could be revised to adequately address the proposed construction schedule of the Stage 11 lots.

The proposed composite wall profile with a rockfill base will be stable, will enable development of the lots for their intended purposes, and with a crest level of RL6.5 m AHD will mitigate risk and damage as a result of any storm surge event.

If the proposed seawall section shown on Drawing 5 is adopted for construction, some additional geo-environmental sampling, testing and reporting will be required to assess the potential for acid sulphate soils (PASS) and to address the issues of handling and disposal of PASS. The management of ASS has been addressed for previous stages of Bayview and the management plans would apply to this additional construction.

Providing construction is carried out in accordance with a strategy developed during the detailed design phase of the project, it is considered that the construction strategy and monitoring proposed above will produce filling platforms for Lots A and C that are suitable for residential construction of single (SU) or multiple (MU) residential buildings up to two storeys high. The geotechnical risk of damage as a result of a storm surge event is considered to be minimal.

8. References

- Ref 1 "Report on Geotechnical Assessment, Filling Surcharging and Mud Disposal, Proposed eastern Extension, Bayview Canal Estate, Darwin" prepared for Bayview Joint Venture, DP Project 23057, February 1999.
- Ref 2 Letter report "Review of Previous Work, Preparation of Sections and Preliminary Analysis of Stability, Settlement and Surcharge Requirements, Proposed Extension of Eastern Boundary – Bayview Project, Darwin, NT", DP Project 23057A, 22 Jan 2000.
- Ref 3 Letter Report "Stability, Settlement and Surcharge Analysis, Proposed Extension of the Eastern Boundary – Bayview Project", DP Project 23057A, 18 February 2002.
- Ref 4 Letter Report "Additional Geotechnical Assessment, Proposed Extension of Eastern Boundary – Bayview Project", DP Project 23057A, 19 March 2002.
- Ref 5 Letter Report "Embankment Design Stage 10 Bayview Canal Estate, Bayview, NT", DP Project 23057A, 16 July 2002.
- Ref 6 "Report on Geotechnical Investigation, Stage 10 Area, Bayview, NT", prepared for Bayview Joint Venture, DP Project 26718, March 2004.
- Ref 7 Letter Report "First Interim Report on Settlement Monitoring for Filling and Surcharge in the Stage 10 Area, Eastern Extension – Bayview", DP Project 23057B, 27 Mar 2003.
- Ref 8 Letter Report "Second Interim Report on Settlement Monitoring for Filling and Surcharge in the Stage 10 Area, Eastern Extension – Bayview", DP Project 23057B, 14 Jan 2004.
- Ref 9 Letter Report "Third Interim Report on Settlement Monitoring for Filling and Surcharge in the Stage 10 Area, Eastern Extension – Bayview", DP Project 23057B, 24 Sept 2004.
- Ref 10 "Report on Certification of Bulk Earthworks, Stages 10b Area, Bayview, Darwin, NT", prepared for Bayview Joint Venture, DP Project 26057C, February 2005.
- Ref 11 Letter report entitled "Bayview Stage 11 – Proposed Lots A, B & C, Bayview, Darwin, NT", prepared for Dover Investments Pty Ltd, DP Project 77861.00, December 2011.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at Stage 11 – Lots A and C, Bayview, NT, in accordance with DP's proposal dated 16 May 2012 and acceptance received from Mr Barry Young. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Dover Investments Pty Ltd and associated Consultants for this project only and for the purposes as described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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


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

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Yours faithfully

Douglas Partners Pty Ltd

Reviewed by



Dennis Ford
Senior Geotechnical Engineer

Michael J Thom
Principal

Attachments: Notes About this Report
Plates 1 and 2 - Site Photographs, Lots A and C
Table 1 – Mud Probe Results
Drawings 1 to 8

About this Report

Douglas Partners



Introduction

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

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

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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



Plate 1: View of existing embankment and site surface at Lot A



Plate 2: View of existing embankment and site surface at Lot C



Project No.
77861.01

Site Photographs

Date:
17 May 2012

Stage 11 - Lots A and C

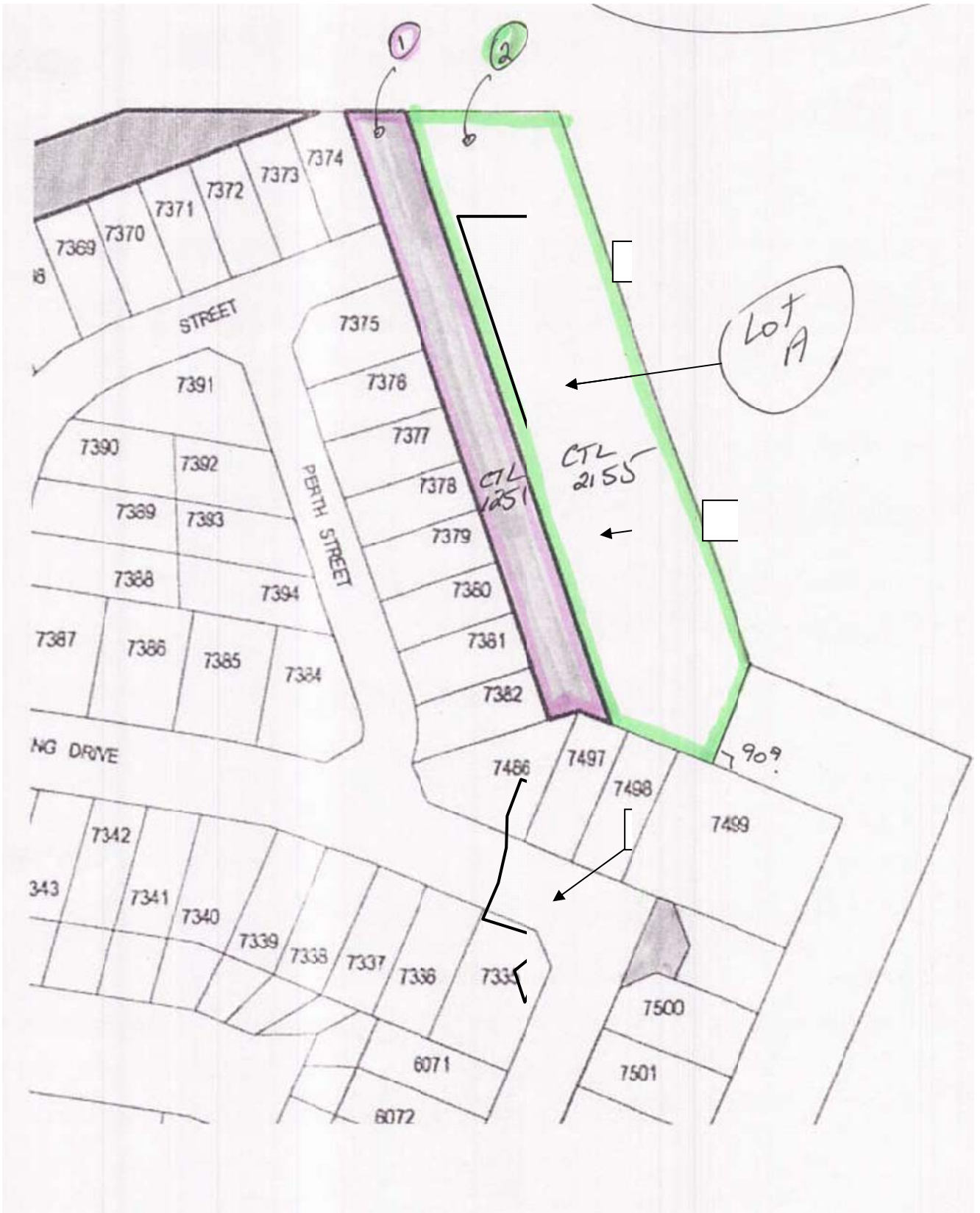
Client: Dover Investments Pty Ltd

TABLE 1**MUD PROBE RESULTS**

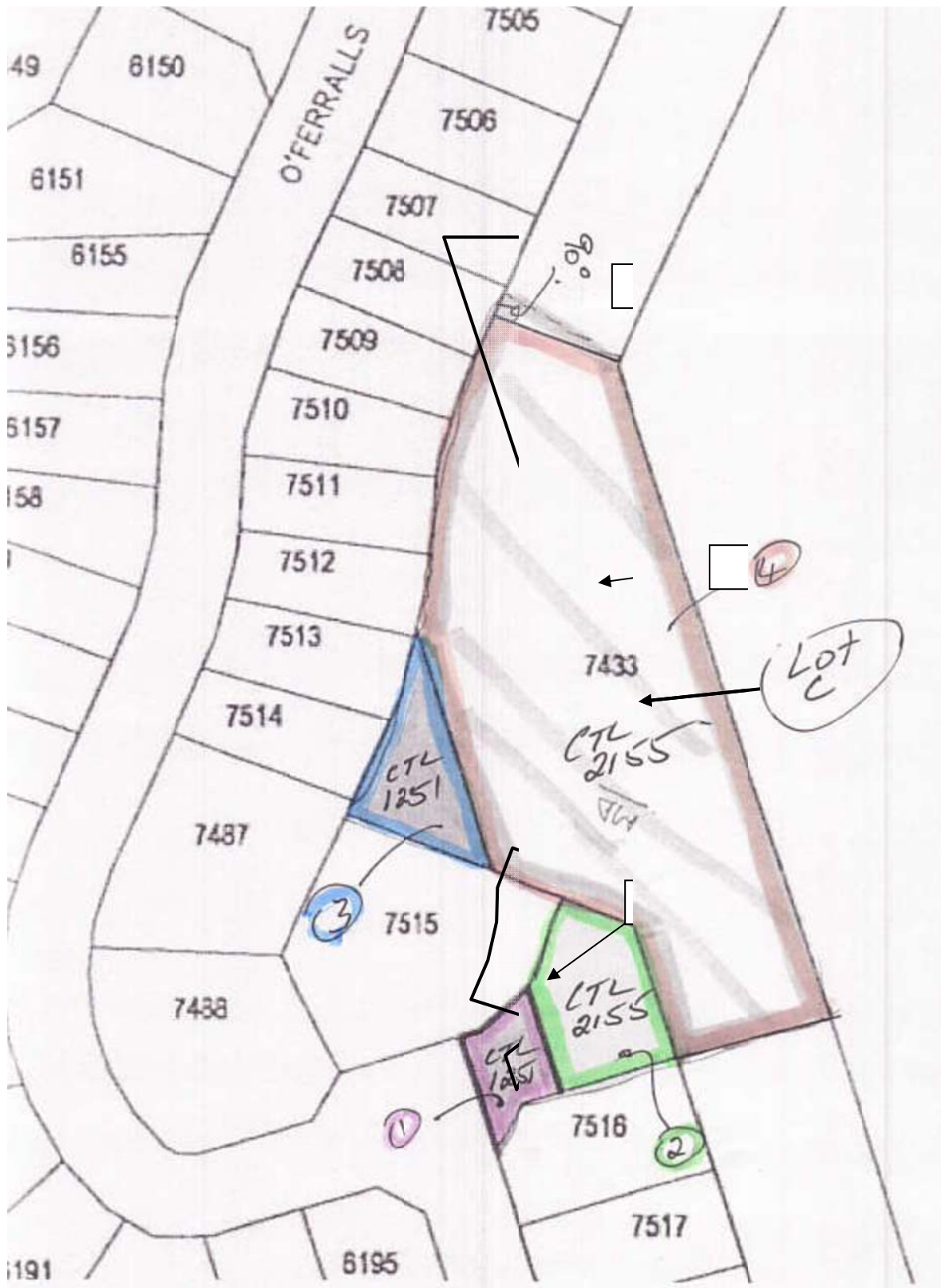
PROBE No	SECTION No	OFFSET (m)*	SURF RL (m)	MUD DEPTH (m)	BASE OF MUD RL (m)
24	5	0	2.8	2.0	0.8
25	5	30	2.6	3.2	-0.6
26	5	60	2.4	3.0	-0.6
33	6	0	3.0	2.0	1.0
34	6	30	2.5	2.4	0.1
47	10	0	2.5	2.6	-0.1
48	10	30	2.5	2.8	-0.3
49	10	60	2.0	2.2	-0.2
51	11	0	2.5	2.4	0.1
52	11	30	2.5	1.2	1.3
53	11	60	1.5	1.8	-0.3
54	12	30	2.3	1.8	0.5
55	12	60	2.0	2.0	0.0
56	12	90	2.2	1.6	0.6
58	13	0	2.7	0.0	2.7
59	13	30	2.5	1.8	0.7
60	13	60	2.3	2.2	0.1



TITLE: Site Locality Plan Stage 11 - Lots A and C Bayview, NT.	PROJECT: 77861.01
	DWG No: 1
	REV: A
	CLIENT: Dover Investments Pty Ltd
	DATE: 16 May 2012



TITLE: Site Plan Proposed Stage 11 - Lot A Bayview, NT.	PROJECT: 77861.01
	DWG No: 2
	REV: A
	CLIENT: Dover Investments Pty Ltd
DATE: 16 May 2012	



TITLE: Site Plan
Proposed Stage 11 - Lot C
Bayview, NT.

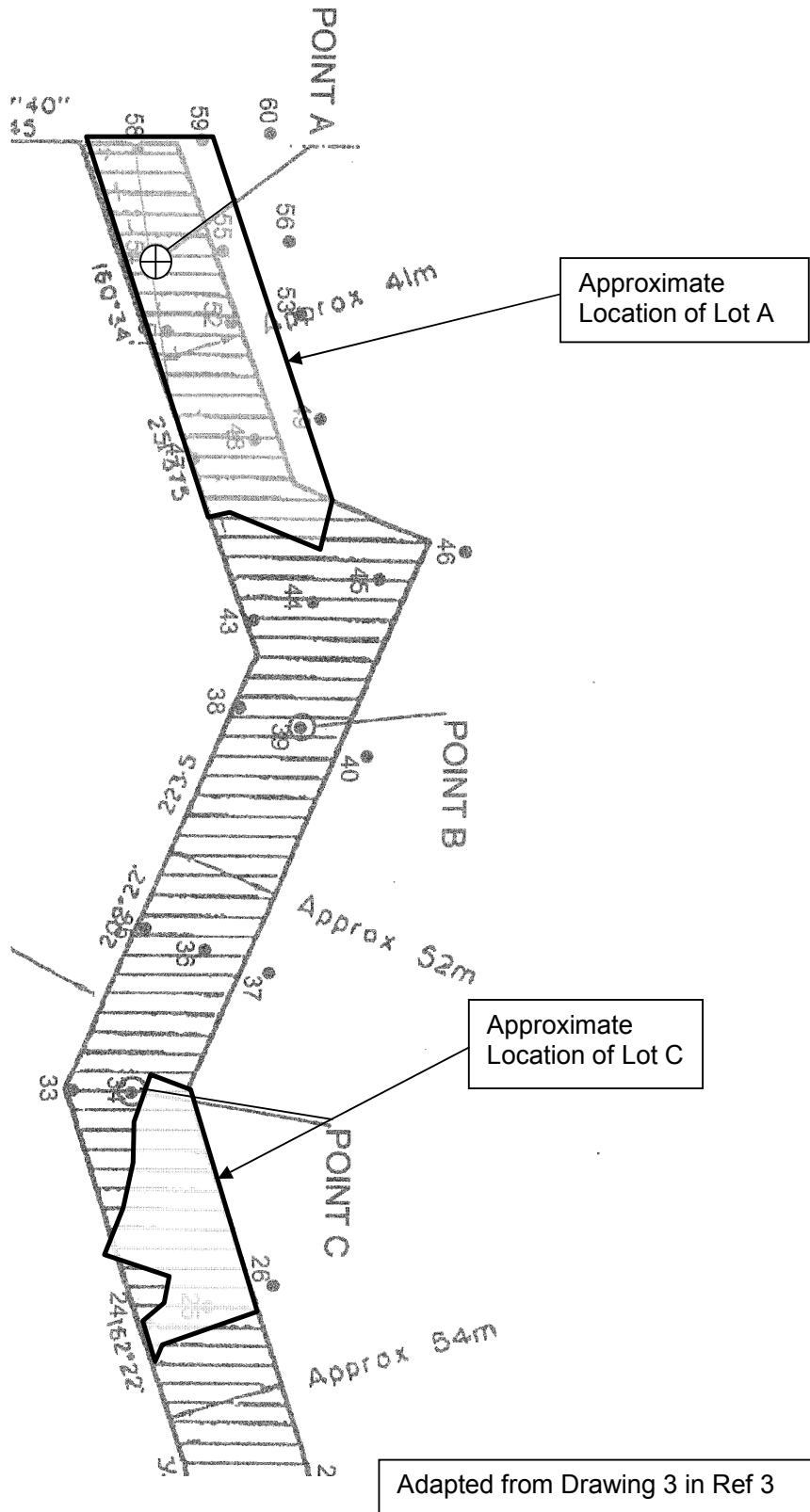
PROJECT: 77861.01

DWG No: 3

REV: A

CLIENT: Dover Investments Pty Ltd

DATE: 16 May 2012



TITLE: Mud Probe Locations and
Surcharge Calculation Points
Stage 11 - Lots A and C
Bayview, NT.

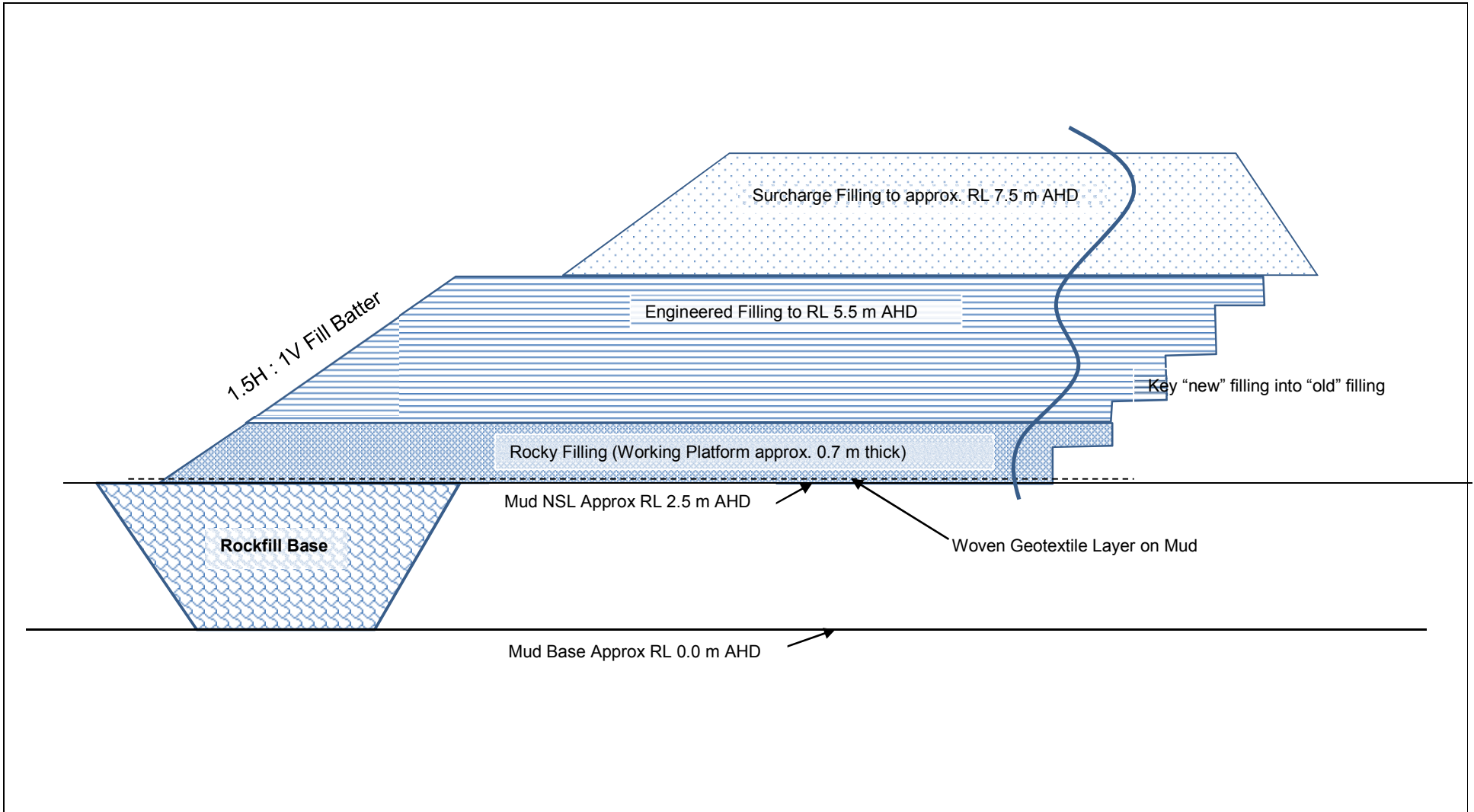
CLIENT: Dover Investments Pty Ltd


PROJECT: 77861.01

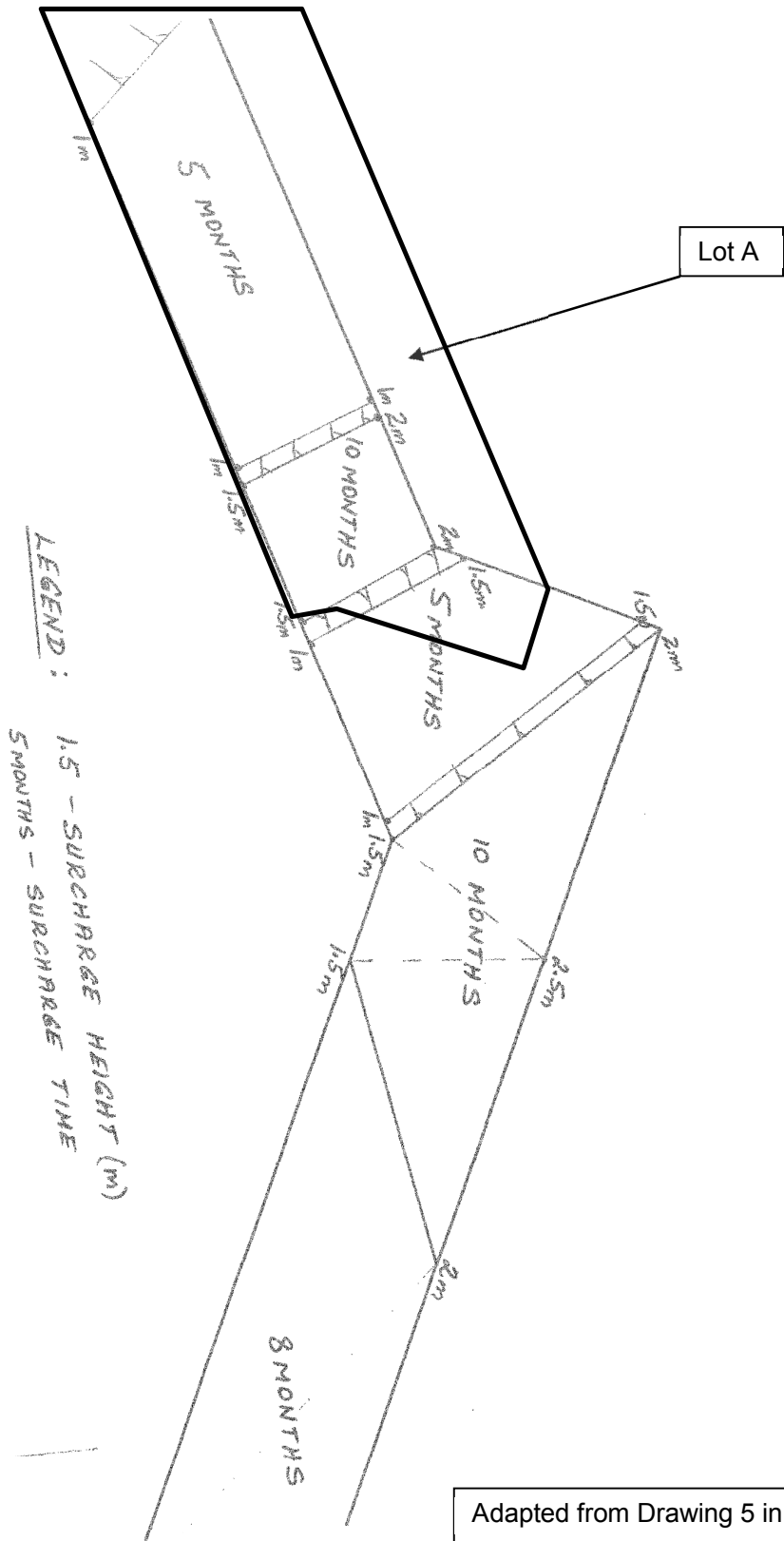
DWG No: 4

REV: A

DATE: 16 May 12



	TITLE:	Typical Section through Filling and Surcharge	PROJECT:	77861.01
		Proposed Stage 11 - Lots A and C	DWG No:	5
		Bayview, NT.	REV:	A
	CLIENT:	Dover Investments Pty Ltd	DATE:	18 May 2012

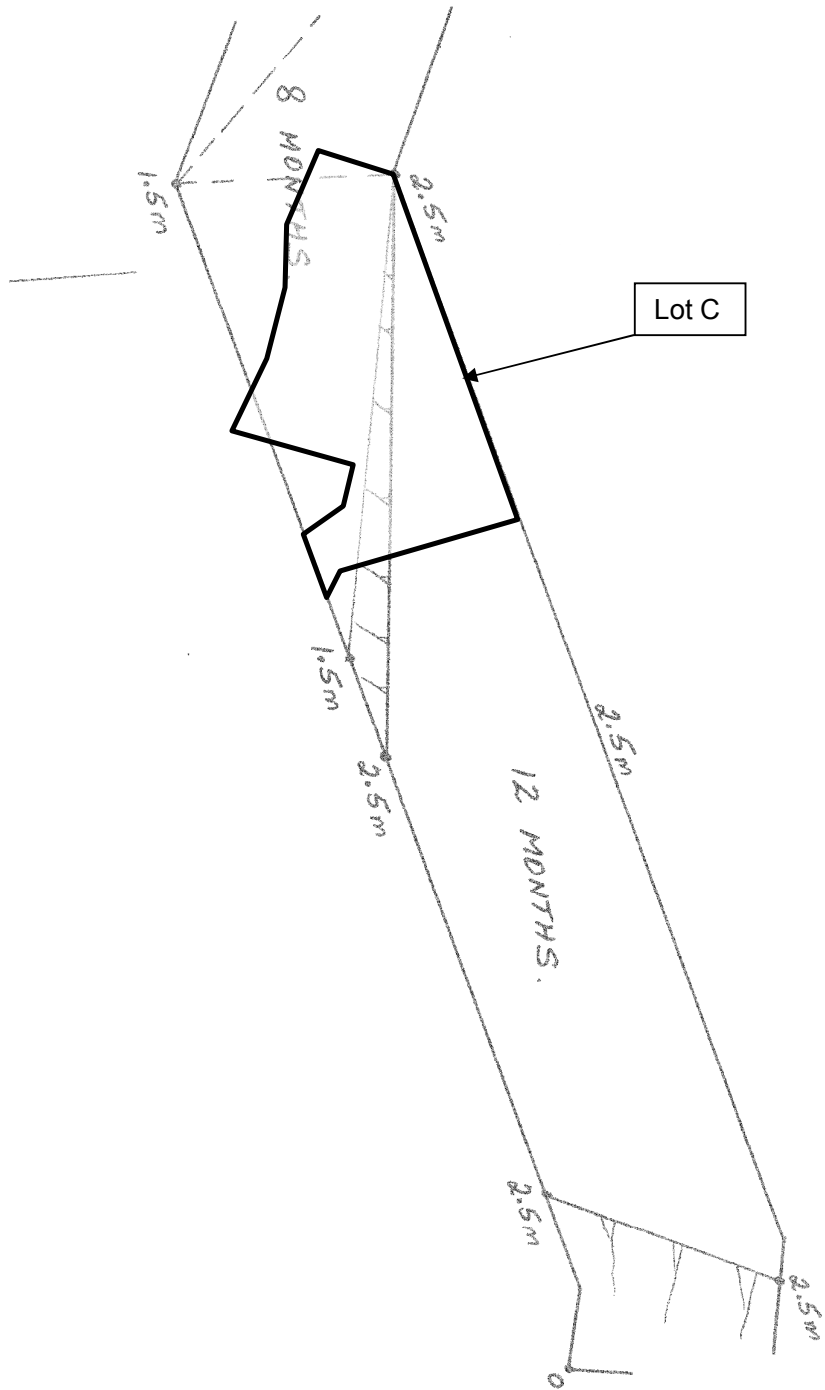


TITLE: Typical Surcharge Heights and Surcharge Times
 Proposed Lot A
 Stage 11, Bayview, NT.

PROJECT: 77861.01
 DWG No: 6
 REV: A

CLIENT: Dover Investments Pty Ltd

DATE: 17 May 2012



LEGEND:
 2.5m - SURCHARGE HT. (m)
 8 MONTHS - SURCHARGE TIME.

Adapted from Drawing 6 in Ref 3

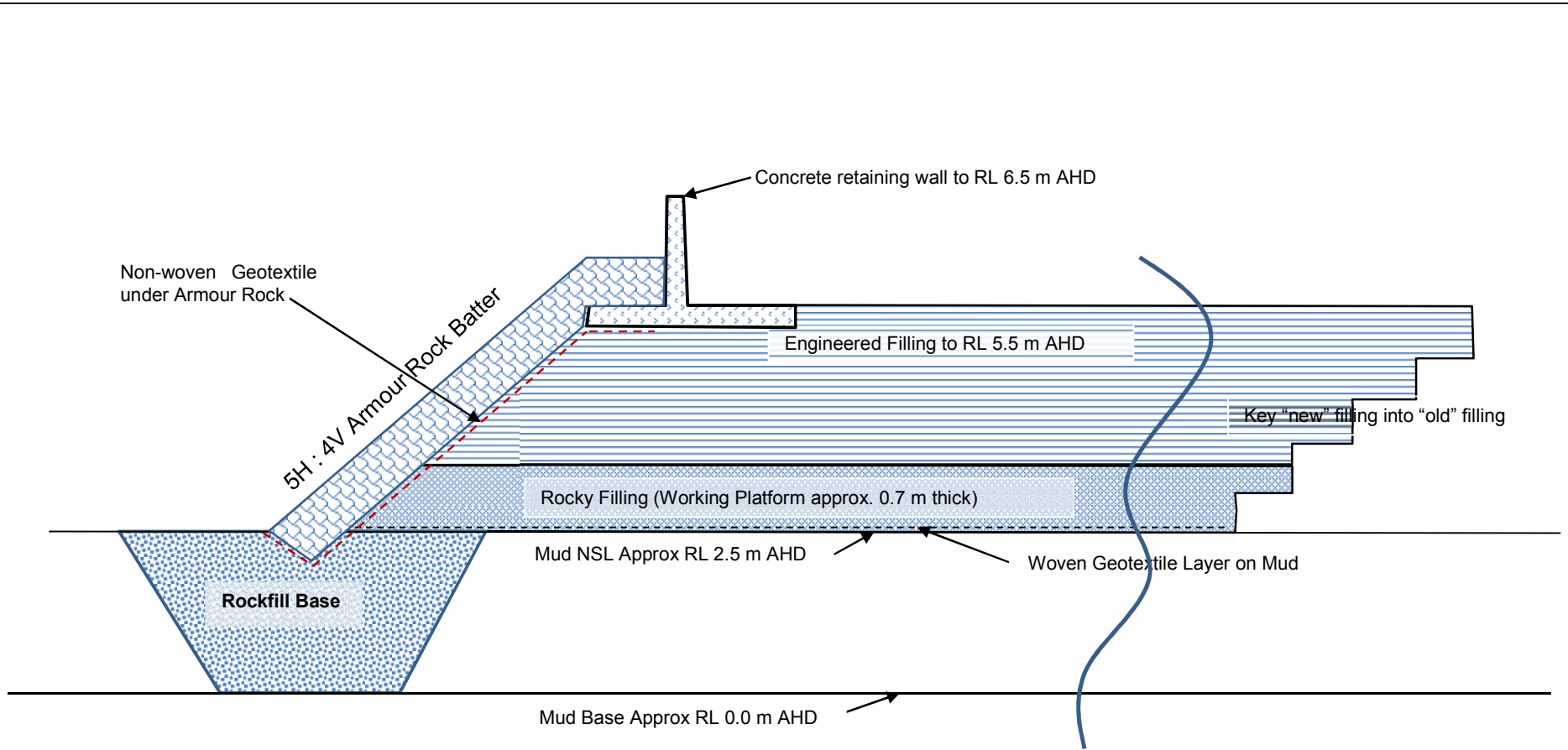


TITLE: Typical Surcharge Heights and
 Surcharge Times
 Proposed Lot C
 Stage 11, Bayview, NT.

PROJECT: 77861.01
 DWG No: 7
 REV: A

CLIENT: Dover Investments Pty Ltd

DATE: 17 May 2012



TITLE: Typical Section through Final Seawall
 Proposed Stage 11 - Lots A and C
 Bayview, NT.

CLIENT: Dover Investments Pty Ltd

PROJECT:	77861.01
DWG No:	8
REV:	A
DATE:	18 May 2012